Photo courtesy of Chelan PUD

April 2019
Rocky Reach Hydroelectric Project FERC License No. 2145

Annual Report Calendar Year 2018 Activities Under the Anadromous Fish Agreement and Habitat Conservation Plan

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Prepared for
Federal Energy Regulatory Commission
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ABBREVIATIONS

BiOp	Biological Opinion
BY	brood year
CCD	Cascadia Conservation District
CCFEG	Cascade Columbia Fisheries Enhancement Group
CCNRD	Chelan County Natural Resources Department
CCT	Colville Confederated Tribes
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
EA	Environmental Assessment
ELISA	Enzyme-Linked Immunosorbent Assay
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
GSHP	General Salmon Habitat Program
GSI	gonadosomatic index
HCP	Habitat Conservation Plan
HGMP	Hatchery and Genetic Management Plan
M&E	monitoring and evaluation
MSRF	Methow Salmon Recovery Foundation
NMFS	National Marine Fisheries Service
NNI	No Net Impact
NOAA	National Oceanic and Atmospheric Administration
OD	optical density
OLAFT	off-ladder adult fish trap
ONA	Okanagan Nation Alliance
pHOS	proportion of Hatchery-Origin Spawners
PIT	passive integrated transponder
Plan Species	species addressed in the HCP
PNI	Proportionate Natural Influence
PRCC	Priest Rapids Coordinating Committee
RI	Rock Island Plan Species Account
RM	river mile
RR	Rocky Reach Plan Species Account
RRJFBS	Rocky Reach Juvenile Fish Bypass System
RRS	relative reproductive success
SOA	statement of agreement
SRFB	Salmon Recovery Funding Board

TU	Trout Unlimited
UCR	upper Columbia River
UCSRB	Upper Columbia Salmon Recovery Board
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
W	Wells Plan Species Account
WDFW	Washington Department of Fish and Wildlife
YN	Yakama Nation

1 Introduction

On June 21, 2004, the Federal Energy Regulatory Commission (FERC) approved an Anadromous Fish Agreement and Habitat Conservation Plan (HCP) for the Rocky Reach Hydroelectric Project (Rocky Reach – FERC License No. 2145) on the Columbia River in Washington State, operated by Public Utility District No. 1 of Chelan County (Chelan PUD). The HCP provides a comprehensive and long-term adaptive management plan for meeting a No Net Impact (NNI) goal for species addressed in the plan (Plan Species) and their habitat. This document fulfills Article 10 of Appendix B and Section 9.8 of Appendix E of the FERC License issued on February 19, 2009[1], and Section 4.8 of the HCP, which requires annual reporting of progress toward achieving the NNI goal. Responsibilities toward achieving the NNI goal are described in Section 3 of the HCP, and in a 10-year Comprehensive Report assessing overall status of NNI (HCP Coordinating Committees 2013),[2] as well as successive 10-year intervals, in common understandings based upon completed studies, including those conducted as research and development for NNI progress or those not considered valid due to extenuating circumstances (Section 5.2.3 of the HCP).

The signatories of the Mid-Columbia HCPs (HCPs for the Wells, Rocky Reach, and Rock Island hydroelectric projects) meet as combined Coordinating Committees, Hatchery Committees, and Tributary Committees to expedite the process of overseeing and guiding HCP implementation. Minutes from the 2018 monthly meetings are compiled in Appendix A (HCP Coordinating Committees), Appendix B (HCP Hatchery Committees), and Appendix C (HCP Tributary Committees). The HCP Policy Committees provide a forum for resolution of disputes that are either elevated to or arise in the HCP Coordinating Committees and remain unresolved. The HCP Policy Committees did not meet in 2018, because no issues were discussed requiring dispute resolution. Therefore, there are no HCP Policy Committees meeting minutes to append to this annual report. Appendix D lists members of the Rocky Reach HCP Committees. The Rocky Reach HCP Coordinating Committee oversaw the preparation of this 15th Annual Report, which covers the period from January 1 to December 31, 2018. (The 1st through 14th Annual Reports covered the periods January 1 to December 31, 2004, through 2017, respectively.)

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[1] 126 FERC, paragraph 61,138 (2009)

[2] Public Utility District No. 1 of Chelan County – Natural Resources Department, 2013 Rock Island and Rocky Reach Anadromous Fish Agreements and Habitat Conservation Plans 2013 Comprehensive Progress Report. February 2013.

2 Progress Toward Meeting No Net Impact

The Rocky Reach HCP requires preparation of an Annual Report that describes progress toward achieving the performance standard of NNI for each Plan Species. The NNI standard consists of two components: 1) 91% combined adult and juvenile project survival, as achieved by project improvement measures implemented within the geographic area of the project; and 2) up to 9% compensation for unavoidable project mortality provided through hatchery and tributary programs, with up to 7% compensation provided through hatchery programs and 2% through tributary programs (Section 3.1 of the HCP).

In 2018, Chelan PUD has met or exceeded all requirements for NNI under the Rocky Reach HCP for spring migrant HCP Plan Species (spring Chinook salmon [*Oncorhynchus tshawytscha*], steelhead [*O. mykiss*], sockeye salmon [*O. nerka*], and coho salmon [*O. kisutch*]). Project survival standards have been exceeded for steelhead, yearling Chinook salmon, sockeye salmon, and coho salmon; all of which are currently designated Phase III (Standards Achieved). For subyearling summer/fall Chinook salmon (a summer migrant and non-Endangered Species Act [ESA]-listed Plan Species), considerable life-history variability and limited technology constrain the ability to meaningfully estimate project survival (see Section 2.1.1). As a result, subyearling summer Chinook salmon are designated as Phase III (Additional Juvenile Studies[3]) and will continue to be compensated through the Tributary Conservation and Hatchery Compensation Plans at levels consistent with the guidance provided in the HCP. As established in Section 3.1 of the HCP, the inability to estimate survival due to limitations of technology shall not be construed as a success or a failure to achieve NNI.

Recalculated NNI production levels for all Plan Species were agreed on in 2011 within the HCP Hatchery Committees, and implementation began with the 2014 release year and will continue for the next 10 years (release years 2014 through 2023). In 2017, coho salmon were classified as Phase III (Standards Achieved) under the Rocky Reach HCP (see Section 2.1.1). Discussions then began about hatchery compensation needed to meet Chelan PUD's NNI mitigation requirement for coho salmon, which were finalized in January 2018 (see Section 2.2.2.11). Chelan PUD funded the Tributary Conservation Plan at the level established in the HCP ($229,800 in 1998 dollars; see Section 2.3; Table 1).

[3] The current phase designation will be re-evaluated in 2019.

Table 1
Rocky Reach Habitat Conservation Plan No Net Impact Progress for Plan Species (2018)

HCP Plan Species (ESA Status)	Survival Standard Met	Hatchery Compensation Provided	Tributary Conservation Plan Funded	NNI
Spring Chinook Salmon Yearlings (ESA-listed)	Yes – Combined Adult and Juvenile	Yes	Yes	Yes
Steelhead (ESA-listed)	Yes – Combined Adult and Juvenile	Yes	Yes	Yes
Sockeye (Not Listed)	Yes – Combined Adult and Juvenile	Yes	Yes	Yes
Summer/Fall Chinook Salmon (Not Listed)	Phase III (Additional Studies)	Yes	Yes	Yes – NNI compensation provided, but additional studies required
Coho Salmon (Not Listed)	Phase III (Standards Achieved)	Yes	Yes	Yes

Throughout 2018, the HCP Coordinating, Hatchery, and Tributary Committees reached agreement on numerous issues during meetings in support of achieving the NNI goals, all of which were documented in the meeting minutes or were described in stand-alone statements of agreement (SOAs). These agreements, along with approvals for funding of habitat projects by the Rocky Reach HCP Tributary Committee, are summarized in Table 2 and discussed in the remainder of this report.

Table 2
Summary of 2018 Decisions for Rocky Reach Habitat Conservation Plan

Date	Agreement	HCP Committee	Reference
January 17, 2018	Approved Chelan PUD's SOA "Regarding District's Coho Obligation"	Hatchery	Appendix B and Appendix E
January 17, 2018	Approved the hatchery portion of the 2018 Rock Island and Rocky Reach HCP Action Plan	Hatchery	Appendix B
January 17, 2018	Approved Chelan PUD's request to collect four female and four male surplus steelhead broodstock from the Wells Fish Hatchery volunteer channel to support their egg-to-emergence evaluation in 2018	Hatchery	Appendix B
January 17, 2018	Approved Chelan PUD's request to move approximately 25,000 hatchery by hatchery steelhead, destined for final acclimation at Blackbird Island Pond, from the ELISA Pond to Raceway No. 2 at the Chiwawa Acclimation Facility and forego final acclimation at Blackbird Pond in 2018	Hatchery	Appendix B

Date	Agreement	HCP Committee	Reference
January 17, 2018	Agreed to cull part of the BY 2017 Chelan Falls summer Chinook salmon program to manage disease concerns, which include the progeny of hatchery females with ELISA values over 0.12 (approximately 35,000 eyed-eggs)	Hatchery	Appendix B
January 23, 2018	Agreed to add Betsy Bamberger, the new Douglas PUD Fish Health and Evaluation Specialist, to select HCP Hatchery Committees email distribution lists and provide Bamberger with visitor access to the HCP Hatchery Committees extranet site	Coordinating	Appendix A
January 31, 2018	Approved the tributary portion of the 2018 Rock Island and Rocky Reach HCP Action Plan, after no disapprovals were received prior to the review deadline on January 31, 2018	Tributary	Appendix C
February 21, 2018	Approved the lethal removal of all known hatchery-origin *Oncorhynchus mykiss* between 12 and 18 inches at Chelan PUD and Douglas PUD hydroelectric projects during fish rescues associated with fishway maintenance outages	Hatchery	Appendix B
February 27, 2018	Approved the 2018 Rock Island and Rocky Reach HCP Action Plan	Coordinating	Appendix A and Appendix F
February 27, 2018	Approved the 2017 Rocky Reach Juvenile Fish Bypass System Report	Coordinating	Appendix A and Appendix G
February 27, 2018	Approved Chelan PUD's proposed operating plan for the RRJFBS Surface Collector and Turbine Unit C2, during the Turbine Unit C1 outage in spring 2018	Coordinating	Appendix A
February 27, 2018	Approved the 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan	Coordinating	Appendix A and Appendix H
March 12, 2018	Approved the Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)	Hatchery	Appendix B and Appendix I
March 15, 2018	Approved the 2017 Rock Island and Rocky Reach HCP Annual Reports after no disapprovals were received following the 30-day review period	Coordinating	Appendix A
March 27, 2018	Approved the 2018 Rock Island and Rocky Reach Fish Spill Plan, as revised	Coordinating	Appendix A and Appendix J
April 18, 2018	Agreed to implement lethal, post-release, early maturation sampling for steelhead as described in the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program*	Hatchery	Appendix B
April 18, 2018	Approved the 2018 Broodstock Collection Protocols	Hatchery	Appendix K
May 23, 2018	Approved a time extension request from CCFEG on the Burns-Garrity Restoration Design Project, to extend the completion date from May 1, 2018 to December 1, 2018	Tributary	Appendix C

Date	Agreement	HCP Committee	Reference
July 12, 2018	Approved a request for funding from CCNRD on the Cottonwood Flats Floodplain Restoration Entiat River Project, contributing $90,090 from HCP Plan Species Account Funds to the project	Tributary	Appendix C
July 12, 2018	Approved a request for funding from CCFEG on the Entiat Basin Fish Passage and Screening Assessment Project, contributing $25,500 from HCP Plan Species Account Funds to the project	Tributary	Appendix C
August 24, 2018	Approved Chelan PUD's 2019 Hatchery M&E Implementation Plan	Hatchery	Appendix L
October 23, 2018	Approved the 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report, as revised (USFWS approved via email on November 20, 2018)	Coordinating	Appendix A and Appendix M
October 23, 2018	Agreed to add Bill Towey, Chelan PUD Senior Fisheries Scientist, to select HCP Hatchery and Coordinating Committees email distribution lists and provide Towey with visitor access to the HCP Hatchery and Coordinating Committees extranet sites	Coordinating	Appendix A
December 4, 2018	Agreed to add Mary Mayo, Douglas PUD Support Staff, to select HCP Tributary Committees email distribution lists and provide Mayo with administrator access to the HCP Tributary Committees extranet site	Coordinating	Appendix A
December 13, 2018	Approved a time extension request from CCFEG on the Burns-Garrity Restoration Design Project, to extend the completion date from December 1, 2018 to December 1, 2019	Tributary	Appendix C
December 13, 2018	Approved a Small Projects proposal from CCNRD titled: *Peshastin Creek RM 8.8 Channel Reconnection: Environmental Site Assessment*	Tributary	Appendix C

The following sections summarize the achievements, actions, and activities taken in 2018 specific to project survival and dam operations, hatchery compensation, and funding of tributary habitat protection and restoration projects.

2.1 Project Survival and Dam Operations

2.1.1 Status of Phase Designations for Current Plan Species

A major feature of the Rocky Reach HCP is what is termed a "phased implementation plan" to achieve the survival standards. This approach includes three phases (Phase I, II, and III), and consists of conducting survival studies over multiple years and evaluating the achievement of survival standards, which is needed to proceed to the next phase. Progress through each phase has been described at length in previous HCP Annual Reports submitted to FERC.

Current phase designations for all Rocky Reach HCP Plan Species are summarized in Table 3.

Table 3
Current Phase Designations for Rocky Reach Habitat Conservation Plan

Plan Species	Project Survival (%)	Phase Designation	SOA Date
UCR Steelhead	94.77[1]	Phase III (Standards Achieved)	January 25, 2013
Okanogan River Sockeye Salmon	92.58[1]	Phase III (Standards Achieved)	January 25, 2013
UCR Yearling Chinook Salmon	92.28[1]	Phase III (Standards Achieved)	August 30, 2011
UCR Subyearling Summer/Fall Chinook Salmon	To Be Determined	Phase III (Additional Juvenile Studies)	September 29, 2016
Coho Salmon	92.94[2]	Phase III (Standards Achieved)	March 30, 2017

Notes:
1. Combined adult and juvenile survival achieved (HCP standard is 91%)
2. Juvenile project survival achieved (see below)

In 2013, information was reviewed on the status of tag technology and life-history attributes of subyearling summer Chinook salmon in the Mid-Columbia. Based on this information and review, the Rocky Reach HCP Coordinating Committee agreed that empirical estimates of juvenile project survival were not feasible. As a result, on June 25, 2013, the Rocky Reach HCP Coordinating Committee approved an SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for 3 years (through June 2016). In June 2016, the Rocky Reach HCP Coordinating Committee re-evaluated the ability to conduct survival studies on subyearling Chinook salmon. Once again, available data indicated conducting survival studies on subyearling Chinook salmon was not feasible at the time. On September 29, 2016, the Rocky Reach HCP Coordinating Committee approved an SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for another 3 years (through September 2019) and stipulating that it will continue to evaluate or monitor study design, tag technology, and life-history information to better understand future survival study feasibility by 2019.

In 2016, coho salmon were classified as Phase III (Standards Achieved – Interim Value) and were due to be re-evaluated in 2017. In September 2016, Chelan PUD began discussing estimates of juvenile coho salmon survival through the Rock Island and Rocky Reach projects with the Rocky Reach HCP Coordinating Committee. In January 2017, Chelan PUD presented results from an analysis conducted by Drs. John Skalski and Richard Townsend (Columbia Basin Research), based on passive integrated transponder (PIT)-tag data from 2010 to 2016, which indicated that projected coho salmon survival through the Rock Island Project is 93.98% with a standard error of 0.0233, and through the

Rocky Reach Project is 92.94% with a standard error of 0.0081. Chelan PUD drafted an SOA indicating these data demonstrate that yearling Chinook salmon are a good surrogate for juvenile coho salmon, with 93% survival at both Rock Island and Rocky Reach projects. The draft SOA designated juvenile coho salmon as being in Phase III (Standard Achieved) at both the Rock Island and Rocky Reach projects. Concern was expressed about combining survival through the Rock Island and Rocky Reach projects and setting a precedent for accepting lower standards than is stated in the HCPs[4] (the projected survival for coho salmon through the Rocky Reach Project was slightly less than 93%). The Rock Island and Rocky Reach HCP Coordinating Committees discussed how Drs. Skalski's and Townsend's initial analysis used only 2 years of acoustic and PIT-tag data (2010 and 2011) for the Rocky Reach Project that resulted in an average survival of 95.15% for the 2-year period, which meant that a survival level of only 88.71% would be needed during the third year of study to achieve Phase III [Standards Achieved]). Chelan PUD chose not to accept these data in the interest of using all data available for a more robust dataset. Governing documents were reviewed, including past SOAs containing variability in the data and based on less years of data, where the HCP Coordinating Committees were satisfied with making a decision based on the available data. After 3 months of discussion, the Rock Island and Rocky Reach HCP Coordinating Committees agreed there is a high level of confidence that the projected coho salmon survival through the Rocky Reach Project is sufficient to meet or exceed the standard. On March 30, 2017, the Rock Island and Rocky Reach HCP Coordinating Committees approved the Rock Island and Rocky Reach Coho Phase Designation SOA, as revised, designating juvenile coho salmon in Phase III (Standard Achieved) at both Rock Island and Rocky Reach projects. The Rock Island and Rocky Reach HCP Coordinating Committees notified their respective HCP Hatchery Committees of approval of this SOA, to initiate moving forward with hatchery compensation planning (see Section 2.2.2.11).

2.1.2 Assessment of Project Survival

The Rocky Reach HCP requires that Chelan PUD shall work toward a 91% combined adult and juvenile project survival at Rocky Reach Dam, which is achieved by project-improvement measures implemented within the geographic area of the project. Progress toward this objective is described in the sections below.

2.1.2.1 Adult Passage Monitoring

When the Rocky Reach HCP was signed in 2002, it was acknowledged there was no scientifically rigorous method for the Rocky Reach HCP Coordinating Committee to assess adult project passage survival for Plan Species. Existing methods did not differentiate between mortality caused by the project and other sources of mortality (e.g., delayed mortality from injuries resulting from passage at downstream projects, injuries sustained by marine mammals, or harvest activities). Section 5.2 of the

[4] Section 5.2.2 of the Rocky Reach HCP states, "If Juvenile Project Survival for each Plan Species is measured to be greater than or equal to 93%, then the District will proceed to Phase III (Standard Achieved)."

Rocky Reach HCP states that given the inability to differentiate between the sources of adult mortality, initial compliance with the combined adult and juvenile survival standard would be based on the measurement of 93% juvenile project survival or 95% juvenile dam passage survival, and an adult survival estimate of 98 to 100%.

Beginning in December 2012, Chelan PUD was able to evaluate adult passage survival through the Rocky Reach Project (dam and reservoir) for steelhead and sockeye salmon, even though unknown harvest mortality remained in the survival estimates. PIT-tag detections from the PIT Tag Information System database were used to evaluate adult fish migrating upstream in 2010, 2011, and 2012 to estimate project conversion rates. For steelhead, adult fish destined for the Methow and Okanogan river systems were used for the survival evaluation. For sockeye salmon, adults returning to the Okanogan River Basin were evaluated. The 3-year arithmetic mean survival rates at Rocky Reach Project for adult steelhead and sockeye salmon were 98.93% and 98.92%, respectively (Table 4). A year prior, in 2011, Chelan PUD estimated the 3-year mean survival rates for adult spring Chinook salmon migrating through the Rocky Reach Project. This survival estimate was 99.90% for migration years 2009 through 2011. Chelan PUD will re-evaluate adult passage survival at Rocky Reach in 10-year intervals, as required per the HCP.

Juvenile, adult, and combined (juvenile and adult) survival rates at the Rock Island and Rocky Reach projects are presented in Table 4. Adult conversion rates were calculated from adult passage data for the years 2010 through 2012.[5]

Table 4
Habitat Conservation Plan Juvenile, Adult, and Combined Survival Rates at Rock Island and Rocky Reach

Project	Species	Juvenile Survival	Adult Survival	Combined[5]
Rock Island	Steelhead	96.75%	99.31%[2]	96.08%
	Spring Chinook Salmon	93.75%[1]	99.89%[3]	93.65%
	Sockeye Salmon	93.27%	98.37%[2]	91.75%
Rocky Reach	Steelhead	95.79%	98.93%[2]	94.77%
	Spring Chinook Salmon	92.37%[1]	99.90%[3]	92.28%
	Sockeye Salmon	93.59%	98.92%[4]	92.58%

Notes:
1. Includes spring-migrating yearling Chinook salmon.
2. Estimate does not account for fish losses due to recreational harvest in any years.
3. No recreational harvest occurred.
4. Estimate adjusted for fish losses from recreational harvest in 2010 and 2011, but not for harvest losses in 2012.
5. Combined survival is the product of juvenile and adult survival estimates (e.g., 98% × 93% = 91%).

[5] Buchanan, R. A., and J. R. Skalski, 2012. Estimation of the Adult Salmon and Steelhead Conversion Rates through Rock Island and Rocky Reach Projects, 2010-2012. Prepared for Public Utility District No. 1 of Chelan County. December 2012.

The HCP combined adult and juvenile project survival standard is 91%. The HCP combined adult and juvenile project survival estimates apply to fish actively migrating through the Rock Island and Rocky Reach projects in the mainstem Columbia River and do not include mortality occurring in other locations (i.e., they do not include ocean or tributary mortality).

2.1.2.2 Valid Study Flow Duration Curve Update

Section 13.24 of the Rocky Reach HCP requires that as part of the 2013 comprehensive review, and every 10 years thereafter, the Rocky Reach HCP Coordinating Committee shall update the spring and summer period Flow Duration Curves used to define valid survival studies. The updated Flow Duration Curves must reflect "Representative Flow Conditions," meaning river flows between the 10th and 90th percentiles on the Flow Duration Curve, as calculated from the Grand Coulee Dam daily average outflow. In 2013, efforts began to update the Flow Duration Curve. The HCP Coordinating Committees agreed to develop the updated Flow Duration Curve with the historical 1929 to 1978 and 1983 to 2001 datasets used previously, to which the new 2002 to 2012 dataset was added. For comparison, Flow Duration Curves were also constructed using only the 1983 to 2012 dataset. The HCP Coordinating Committees also agreed to revise the definition of the summer period to comprise June 1 through August 15, compared to the former July 1 through August 15 period. Updated Flow Duration Curves were expected to become final in early 2014; however, in February 2014, a fracture discovered in Wanapum Dam postponed a number of efforts, including updating the curves, until time allows. The final updated Flow Duration Curves are projected to be completed in 2019.

2.1.2.3 2018 Survival Studies

No yearling or subyearling Chinook salmon or steelhead survival studies were conducted in 2018 at the Rocky Reach Project. In 2019, the Rocky Reach HCP Coordinating Committee will continue to evaluate the feasibility of studying subyearling summer Chinook salmon survival, as stipulated in the SOA maintaining subyearling summer Chinook salmon in Phase III (Additional Juvenile Studies) for another 3 years (through September 2019), approved September 29, 2016 (see Section 2.1.1).

There are no planned Rocky Reach juvenile salmonid project survival studies for 2019. However, in 2018, the Rocky Reach HCP Coordinating Committee continued discussing the upcoming HCP 10-year check-in survival study for Rocky Reach Dam in 2021, in terms of completing ongoing improvements and maintenance (see Section 2.1.3.2).

2.1.3 Project Operations and Improvements

This section summarizes project operations and progress toward maintaining the juvenile project survival standard at Rocky Reach Dam in 2018. Actions in 2018 were guided by the 2018 Rocky Reach and Rock Island HCP Action Plan (Appendix F), as approved by the Rocky Reach and Rock Island HCP Coordinating Committees on February 27, 2018 (Appendix A).

2.1.3.1 Operations

2.1.3.1.1 Juvenile Bypass System and Fish Spill Operations[6]

At Rocky Reach Dam, juvenile fish spill operations are guided by two documents. The Rocky Reach and Rock Island HCP Coordinating Committees approved the *2018 Rocky Reach Juvenile Fish Bypass System Operations Plan* (Appendix H) and the *2018 Rocky Reach and Rock Island Fish Spill Plan* (Appendix J) on February 27 and March 27, 2018, respectively. The Rocky Reach Juvenile Fish Bypass System (RRJFBS) operated continuously from April 1 through August 31, 2018, which covered the normal bypass operating period for the outmigration of juvenile salmon and steelhead at Rocky Reach Dam.

The 2017 Rocky Reach Juvenile Fish Bypass System Report (Appendix G), which summarizes activities at the RRJFBS in 2017, was approved by the Rocky Reach HCP Coordinating Committee on February 27, 2018.

Spill for summer-migrating subyearling Chinook salmon at Rocky Reach Dam began on May 25, 2018, at 0001 hours, and continued uninterrupted for 74 days through 2400 hours on August 6, 2018. The target spill level for the duration of the summer spill period in 2018, was 9% of the estimated daily average river flow, as specified and approved in the Rocky Reach Fish Spill Plan (Appendix J). Spill volume for the 74-day summer period averaged 22.29% of the total river flow and comprised 9.14% fish spill and an additional 13.15% unavoidable hydraulic spill. The Columbia River flow rate past Rocky Reach Dam during the spill period averaged 154,663 cubic feet per second (cfs), and the daily average spill rate was 34,471 cfs. Following completion of the bypass operations on August 31, 2018, it was estimated that spill was provided for 94.1% of the subyearling Chinook salmon outmigration passing Rocky Reach Dam. Although the "declared" spill provided coverage for only 94.1% of the subyearling Chinook salmon outmigration passing Rocky Reach Dam, "all" spill (including forced hydraulic spill from May 18 to 24, 2018) provided coverage for 96.5% of the subyearling Chinook salmon outmigration passing Rocky Reach Dam. "Declared" versus "all" spill with regard to the subyearling Chinook salmon outmigration passing Rocky Reach Dam in 2018 was discussed at length during the HCP Coordinating Committees meeting on September 25, 2018 (Appendix A). The Rocky Reach HCP Coordinating Committee agreed there was prior biological benefit in the form of hydraulic spill and the Rocky Reach HCP Coordinating Committee was supportive of capturing this biological benefit in the final spill report while preserving the dates when summer spill was turned on and off.

Complete Rocky Reach Dam 2018 fish spill operations results, including a distinction between "declared" and "all" spill, are summarized in the 2018 Rocky Reach and Rock Island Fish Spill Report

[6] 129 FERC ¶ 62,183 (issued December 8, 2009). Order Modifying and Approving Operations Plan Pursuant to License Article 402.

(Appendix M), which was approved by the Rocky Reach and Rock Island HCP Coordinating Committees on October 23, 2018 (U.S. Fish and Wildlife Service [USFWS] approved via email on November 20, 2018).

2.1.3.1.2 Rocky Reach Dam Large Unit Repair

In 2013, Rocky Reach Dam Turbine Units C8, C9, C10, and C11, were modified from their normal Kaplan configuration to a temporary, fixed blade configuration as an interim measure while permanent repairs are fabricated and installed on these four large units (see Section 2.1.3.2.1). An interim operating angle of 31 degrees was selected because it is the most hydraulically efficient angle at full turbine discharge of 23,000 cfs. The 31-degree angle is the safest angle for fish passage (due to it being hydraulically efficient), and it represents the safest position of the blades because at this angle cavitation is minimized and the risk of a turbine runaway is lowest. Maintenance is underway on these units with a target completion date of first quarter 2021.

2.1.3.1.3 Rocky Reach Dam Turbine Unit C1 Outage

On January 14, 2018, the Washington Department of Ecology was dispatched to the Rock Island reservoir to investigate a report of oil observed in the Columbia River. The only recent change in operation was returning Rocky Reach Dam Turbine Unit C1 to service the week prior; therefore, on January 16, 2018, Unit C1 was taken offline and mechanics discovered a loss of oil from the unit hub via the trunnion seals. Unit C1 remained offline for the remainder of 2018 while Rocky Reach Dam mechanics worked on repairing the unit (see Section 2.1.3.2.3). The current return-to-service date is estimated to be August 2019.

2.1.3.1.4 Rocky Reach Dam Surface Collector and Turbine Unit C2 Altered Operations

On February 27, 2018, in preparation for operating without Rocky Reach Dam Turbine Unit C1 online at the start of the juvenile bypass system operations on April 1, 2018 (see Section 2.1.3.1.1), the Rocky Reach HCP Coordinating Committee approved an Operating Plan for the Rocky Reach Dam Surface Collector and Turbine Unit C2 during the Turbine Unit C1 outage (Appendix A). The key changes from normal operations include: 1) using three additional RRJFBS Surface Collector pumps to increase attraction flow from 6,000 to 6,660 cfs into the RRJFBS Surface Collector entrances (3,330 cfs for each entrance); and 2) increasing Unit C2 flow from its normal soft-limit set-point of 12.2 kcfs to a soft-limit flow of 15.2 kcfs. The Rocky Reach HCP Coordinating Committee-approved altered operations that were appended to the *2018 Rocky Reach Juvenile Fish Bypass System Operations Plan* (Appendix H). These altered operations are the same as those implemented in June 2014 through the end of the 2014 fish bypass season, when Unit C1 was taken offline to repair a crack in the rotor.

2.1.3.1.5 Tumwater Dam Fishway Outage

On February 28, 2018, the fishway at Tumwater Dam was shutdown briefly to allow staff and contractors to perform a visual inspection and verification of the as-built drawings of the existing count board structure that is scheduled to be replaced in 2019. The fishway was dewatered to an elevation equal with the tailrace elevation, and a fish rescue was performed. After 3 hours, the fishway was returned to service. No impacts to Plan Species, bull trout (*Salvelinus confluentus*), or Pacific lamprey (*Entosphenus tridentatus*) were observed.

2.1.3.1.6 Juvenile Fish Bypass System Pre-Season Marked Fish Releases

The RRJFBS is used for monitoring the physical condition of fish and species composition. Chelan PUD also uses the facility to evaluate seasonal run timing for target species. Each year, Chelan PUD conducts pre-season marked fish releases at the RRJFBS to test the system for possible descaling injury or mortalities prior to the start of the bypass season, which begins on April 1 at 0000. Test fish are fin-clipped to differentiate between release locations, released into the system, recovered at the sampling facility, are visually inspected, and the results are tallied.

On March 22, 2018, Chelan PUD conducted 2018 pre-season marked fish releases in the RRJFBS and intake screen system deployed in Rocky Reach Dam Turbine Unit C2. The releases were conducted under the altered operations that were approved by the Rocky Reach HCP Coordinating Committee on February 27, 2018 (see Section 2.1.3.1.4). A total of 100 and 130 fish were released in the north and south entrances, respectively; and 96 and 129 fish were recovered, respectively. A second Unit C2 release was conducted at a higher velocity and 100 of 100 fish were recovered. No signs of descaling or injury were observed during any of the releases. A complete report summarizing 2018 activities at the RRJFBS is expected in 2019.

2.1.3.1.7 Pikeminnow Predator Control

Chelan PUD has implemented a northern pikeminnow (*Ptychocheilus oregonensis*) predator-control program in the Rocky Reach Project since 1994. Since 1996, the Chelan PUD has contracted annually with the United States Department of Agriculture (USDA) to carry out this program. Chelan PUD also provides funding for the annual Pikeminnow Derby sponsored by the East Wenatchee Rotary Club.

Complete results from the 2017 removal effort were summarized in the 2017 Rocky Reach HCP Annual Report and are described in the 2017 Rock Island and Rocky Reach Pikeminnow Control Program Summary Report, which is available for review by the Rocky Reach HCP Coordinating Committee and is expected to be finalized in early 2019.

In 2018, Chelan PUD continued implementing the northern pikeminnow removal program with Columbia Research long-line angling during the pre-migration period to target large pikeminnow that stage in deep reservoir areas and are difficult to capture with other gear types. The 2018 USDA hook-and-line angling program commenced during the peak of the juvenile salmonid migration. The total combined harvest of pikeminnow in 2018 from Rocky Reach and Rock Island reservoirs was 84,218 fish. Harvest numbers from the various control efforts in 2018 were as follows: USDA hook-and-line angling, 54,410 fish; Columbia Research long-line angling, 25,412 fish; East Wenatchee

Rotary Club Pikeminnow Derby, 3,209 fish; and removal by Chelan PUD Fish and Wildlife personnel, 1,187 fish. A report summarizing results of the 2018 removal effort is expected sometime in early 2019.

2.1.3.1.8 Entiat Marina Application Consultation

In 2018, Chelan PUD provided a Rocky Reach Project Land-Use Permit Application for the City of Entiat for Rocky Reach HCP Coordinating Committee review. The application was to construct a 64-slip dock on the Columbia River in the City of Entiat. As requested, the Rocky Reach HCP Coordinating Committee submitted edits and comments, or an indication of no comments, by the application by the review deadline.

2.1.3.2 Improvements and Maintenance

Facility improvements and maintenance at the Rocky Reach Project in 2018 that had the potential to affect Plan Species are described in this section.

2.1.3.2.1 Rocky Reach Dam Large Unit Repair

In 2013, while repairing internal hydraulic issues in Rocky Reach Dam Turbine Unit C10, mechanic crews discovered a deep hairline crack in a stainless-steel rod that delivers oil to the servo motor. Rocky Reach Dam Turbine Units C8, C9, and C11 all have the same stainless steel rod design as part of the servo motors. During the 2013/2014 winter maintenance outage, interim fixes were installed on Units C8, C9, C10, and C11 (see Section 2.1.3.1.2). In 2015, permanent fixes were underway. Repairs were anticipated to require 6 months per unit and were projected to be completed by 2019, pending any additional unforeseen delays. In 2016, head-cover issues were identified in Unit C8, and cracks were identified in the wheels of the bridge crane required to hoist the turbines for repair. These unexpected issues postponed the projected completion date to first quarter 2021. This new return-to-service date is the same year Chelan PUD will conduct the HCP 10-year check-in survival study for Rocky Reach Dam (see Section 2.1.2.3). In preparation for the study, Chelan PUD has prioritized which units are most important to be back online in time for the survival study, with the order of priority, from highest to lowest, being Unit C8, Unit C9, Unit C10, and finally Unit C11.

2.1.3.2.2 2017/2018 Rocky Reach Adult Fish Ladder Winter Maintenance

The adult fish ladder at Rocky Reach Dam was taken offline for annual winter maintenance on December 11, 2017, and returned to service on February 27, 2018. Key activities included maintenance on the: 1) butterfly valve actuator; 2) middle spillway entrance gate; 3) middle spillway entrance fish fence; 4) attraction water pump C; 5) traveling water screen; 6) picket barrier screens; 7) attraction water pump intake; and 8) 30-inch raw water valve.

The Rocky Reach HCP Coordinating Committee discussed the high number of rainbow/*O. mykiss* rescued during the fish rescue performed in the adult fish ladder prior to maintenance activities at Rocky Reach Dam. Washington Department of Fish and Wildlife (WDFW) expressed interest in the lethal removal of all known hatchery-origin *O. mykiss* between 12 and 18 inches in length to try and identify the source of these fish. On February 21, 2018, the HCP Hatchery Committees approved this request for Chelan PUD and Douglas PUD hydroelectric projects during fish rescues associated with fishway maintenance outages (see Section 2.2.2.12).

2.1.3.2.3 Rocky Reach Dam Turbine Unit C1 Repair

On January 16, 2018, Rocky Reach Dam Turbine Unit C1 was taken offline to investigate an oil leak (see Section 2.1.3.1.3). Mechanics discovered a loss of oil from the unit hub via the trunnion seals. In April 2018, new replacement stock trunnion seals were received, installed, and tested in Unit C1; however, the new stock seals failed to stop oil from leaking from the unit hub. Chelan PUD investigated hydraulically locking the blades into place; however, engineers were not confident that operating in a hydraulically locked configuration would not result in an oil leak with a failed trunnion seal. In May 2018, Chelan PUD Board of Commissioners approved entering into a sole-source contract to design and manufacture engineered trunnion seals for Turbine Unit C1 at Rocky Reach Dam. In September 2018, the engineered trunnion seals were received from the contractor and were installed and tested. Initial testing occurred from September 29 to 30, 2018. On October 1, 2018, the unit was dewatered, after being watered up but not operated over a weekend, to inspect for loss of oil and no oil leak was found and the unit was placed back into service. Almost 24 hours later, oil loss from the unit was observed and the unit was immediately taken offline. Rocky Reach Dam mechanics believe the issue may be leaky trunnion seals due to trunnion bushing wear, which will be further investigated in 2019.

2.1.3.2.4 Tumwater Dam Fishway Maintenance

In September 2018, a snorkeling survey at the Tumwater Dam fishway identified erosion at the end of the fishway. On December 26, 2018, a private contractor began drilling core samples within the footprint of the fishway to inform a scope for additional work that will involve installation of pin piles in February 2019. This work does not require an interruption in the adult fishway operation, and the work in its entirety will be completed by mid-March 2019.

2.1.3.2.5 2018/2019 Rocky Reach Adult Fish Ladder Winter Maintenance

The adult fish ladder at Rocky Reach Dam will be taken offline for annual winter maintenance in early January 2019. Key maintenance activities will include: 1) diffuser replacement and inspection; 2) attraction water pump inspection C; and 5) traveling water screen inspection.

A fish rescue will again be performed in the adult fish ladder prior to maintenance activities. WDFW expressed interest in collecting any unique species encountered during the fish rescue to determine the source. Chelan PUD and WDFW plan to coordinate, as needed, prior to conducting the fish rescue in early January 2019.

2.2 Hatchery Compensation

Section 8.1 of the Rocky Reach HCP describes a Hatchery Compensation Plan with two primary objectives: 1) to provide compensation for Plan Species; and 2) to implement specific elements of the hatchery program consistent with the overall objectives of rebuilding natural populations and achieving NNI. In 2018, Chelan PUD continued to provide funding and capacity for hatchery production consistent with meeting NNI. Recalculated hatchery production values required to meet NNI through release year 2023 were approved by the Rocky Reach HCP Hatchery Committee on December 14, 2011 and represented in *Chelan PUD's No Net Impact and Inundation Obligations for Release Years 2014-2023*. Hatchery compensation for the Rocky Reach Project in 2018 included the release of 1,504,363 juvenile salmonids (combined Rocky Reach and Rock Island hatchery compensation; Table 5).

To improve coordination, a representative from Grant PUD is invited to the monthly HCP Hatchery Committees meetings. The Grant PUD representative and the Priest Rapids Coordinating Committee (PRCC) Hatchery Sub-Committee facilitator also receive meeting announcements, final agendas, and meeting minutes. Furthermore, in June 2015, the HCP Hatchery Committees agreed to convene joint sessions of the HCP Hatchery Committees and PRCC Hatchery Sub-Committee when discussing agenda items applicable to and requiring participation from both committees. This practice benefits the HCP Hatchery Committees through increased coordination and sharing of expertise. The Grant PUD representative has no voting authority under the HCPs; however, because these joint discussions influence similar and sometimes overlapping hatchery programs, those discussions are documented and included here, accordingly. The HCP Hatchery Committees and PRCC Hatchery Sub-Committee continued holding joint sections of meetings in 2018 when agenda items pertained to both sets of committees. This coordination and joint process is planned to continue in 2019.

2.2.1 Hatchery Production Summary

Table 5 summarizes and compares HCP hatchery production objectives and actual 2017 smolt releases.

Table 5
2018 Production Level Objectives and Smolt Releases for Rocky Reach Habitat Conservation Plan Hatchery Programs

Species[a]	Program	Final Rearing Site	Rocky Reach Production Level Objectives (2014 to 2023)[b]	Total Releases for Rocky Reach in 2018 (Number of Fish)
Spring Chinook Salmon	Methow	Methow Hatchery	60,516	65,112 smolts
Summer Chinook Salmon	Chelan Falls	Chelan Falls	576,000	500,940 smolts
Steelhead	Wenatchee	Chiwawa Hatchery	247,300[c]	253,619 smolts
Sockeye Salmon	Okanogan	kł cp̓əlk̓ stim̓ Hatchery	591,050[e] (34% of kł cp̓əlk̓ stim̓ Hatchery production)	414,800 fry
Spring Chinook Salmon	Okanogan	Chief Joseph Hatchery	115,000 (12.81% of Chief Joseph Hatchery production)	96,903 smolts
Summer Chinook Salmon	Okanogan	Chief Joseph Hatchery /Omak Pond	94,570 (13.51% of Chief Joseph Hatchery production	24,651 subyearlings
Summer Chinook Salmon	Okanogan	Similkameen	166,569 (12.81% of Chief Joseph Hatchery production)	146,375 yearlings

Notes:

a. Coho salmon mitigation met by the funding agreement with the YN.
b. As specified in the Rocky Reach and Rock Island HCP Hatchery Committees SOA Chelan PUD Hatchery Compensation, Release Years 2014 to 2023, approved December 14, 2011.
c. Steelhead production at Chiwawa Acclimation Facility includes Rock Island and Rocky Reach obligations.
d. Combined with the Rock Island HCP, the Okanogan sockeye salmon production requirement totals 591,050 smolts (production is allocated between the two HCPs); the table includes the number of fry released. By agreement of the HCP Hatchery Committees, this production requirement is satisfied for Okanogan sockeye salmon by funding of the Okanagan Skaha Lake sockeye salmon reintroduction program until otherwise determined by the HCP Hatchery Committees.

2.2.2 Hatchery Planning and Implementation

This section details the actions taken in 2018 that are relevant to planning for hatchery operations that support the HCP.

2.2.2.1 2018 Broodstock Collection Protocols

In March 2018, the HCP Hatchery Committees began their review of the draft 2018 Broodstock Collection Protocols for Chinook salmon and steelhead. The revised draft protocols were approved via email, as follows: WDFW, Chelan PUD, Douglas PUD, National Marine Fisheries Service (NMFS), USFWS, the Colville Confederated Tribes (CCT), and the Yakama Nation (YN) approved on April 18, 2018. The final 2018 Broodstock Collection Protocols (Appendix K) were distributed to the HCP Hatchery Committees on April 24, 2018, and implemented at program hatcheries throughout 2018. In-season revisions were made as needed in coordination with the HCP Hatchery Committees. As in previous years, the 2018 Broodstock Collection Protocols were intended to guide the collection of salmon and steelhead broodstock in the Methow River, Wenatchee River, Chelan River, and

Columbia River basins. The protocols are consistent with previously defined program objectives such as program operational intent (i.e., conservation and/or harvest augmentation) and mitigation production levels (i.e., HCPs), and they comply with ESA permit provisions.

2.2.2.1.1 Methow Spring Chinook Salmon Broodstock Collection

In response to broodstock collection issues in 2016 due in part to trapping constraints at Wells Dam, the 2017 Broodstock Collection Protocols included additional trapping days (5 days total per week, not to exceed 3 days in a row) to increase the probability of meeting the broodstock collection targets for the Methow spring Chinook salmon program, and a decrease in the total trapping hours per day to 12 hours. This schedule provides more availability and flexibility in broodstock collection without a significant increase in trapping hours. A similar trapping schedule was included in the 2018 Broodstock Collection Protocols (Appendix K), with further flexibility for up to 7 days a week of trapping at the Wells Dam East and West ladders.

2.2.2.1.2 Wenatchee Steelhead Release Plan 2018-2020

In February 2018, Chelan PUD presented to the HCP Hatchery Committees a Draft 2018-2020 Steelhead Release Plan (Appendix B). The permit for the Wenatchee steelhead programs includes a special condition to minimize residualism and maximize downstream survival, so Chelan PUD and WDFW drafted a three-year release plan with the objectives: evaluate survival based on size at release to optimize hatchery practices, evaluate rearing vessels, minimize confounding variables, and use data to assess monitoring and evaluation (M&E) objectives. The HCP Hatchery Committees discussed previous release plans, concerns about stray rates, and survival metrics. Analysis for the program included a PIT-tag study and size evaluation. Because NMFS does not provide direction on how to measure residualism and survival to determine baseline conditions for the Wenatchee programs, the HCP Hatchery Committees are responsible for agreeing on a methodology for meeting this permit condition. The HCP Hatchery Committees provided feedback to Chelan PUD and WDFW on release location, tag burden, and study design. In March 2018 the HCP Hatchery Committees approved the *Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)* as follows: Chelan PUD, WDFW, USFWS, NMFS, YN, and CCT approved on March 12, 2018 (Appendix I). The plan is a three-year study beginning with the 2018 release year (BY 2017).

As part of the 3-year release plan, Chelan PUD was in the planning stages for a PIT-tag study evaluating residualism in early 2018 (described below). In order to reduce the number of co-variates and PIT tag enough steelhead to evaluate residualism, Chelan PUD requested approval to not transfer a proportion of the steelhead overwintered at Chiwawa Acclimation Facility to Blackbird Pond for final acclimation in January 2018, before the final plan was developed. The HCP Hatchery Committees discussed the draft plan and the proposed transfer and approved Chelan PUD's request to move approximately 25,000 hatchery-by-hatchery (HxH) steelhead, destined for final acclimation at Blackbird Pond, from the enzyme-linked immunosorbent assay (ELISA) pond to Raceway 2 at the Chiwawa Acclimation Facility and forego final acclimation at Blackbird Pond in 2018.

2.2.2.1.2.1 Establishing Baseline Conditions in the Wenatchee Steelhead Program

The Wenatchee steelhead permit also requires Chelan PUD and WDFW to minimize residualism and maximize downstream migration of steelhead. Because NMFS does not direct the permit holders how to determine baseline conditions for residualism or downstream migration, Chelan PUD developed the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program* (Appendix B) that the HCP Hatchery Committees reviewed in March 2018. Options to measure residualism included a PIT-tag evaluation, post-release sampling, and an electrofishing and angling study. The HCP Hatchery Committees discussed the options and methods for estimating rates of residualism, as well as sampling ideas and statistical approaches. The Hatchery Evaluation Technical Team met to discuss the draft plan in addition to the Hatchery Committees. Based on feedback from the HCP Hatchery Committees and the Hatchery Evaluation Technical Team, Chelan PUD indicated they intend to complete a PIT-tag evaluation and use gonadosomatic index (GSI) sampling to assess maturation. Only the lethal, post-release, GSI sampling required approval from the HCP Hatchery Committees, which was provided as follows: Chelan PUD, YN, CCT, WDFW, USFWS, and the National Oceanic and Atmospheric Administration (NOAA) approved on April 18, 2018. The PIT-tag study and GSI sampling will occur in 2019 as described in the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Programs* plan (Appendix B).

2.2.2.1.3 Wenatchee Steelhead Surplus and Precocial Maturation Study

In November 2018, WDFW and Chelan PUD notified the HCP Hatchery Committees that there was an overage in the Wenatchee steelhead program of about 21,000 excess HxH BY 2018 steelhead, which were destined for isolated ponds along Rock Island Reservoir. Chelan PUD developed a plan to study the effects of temperature regime on early maturation using 1,500 of the excess fish. Discussions with steelhead experts at NOAA yielded a recommendation to apply different temperature regimes to overwintering fish to evaluate whether transferring fish to the Chiwawa Acclimation Facility and rearing steelhead on colder water in November may be contributing to early maturation. Chelan PUD decided to rear 500 steelhead in each of three different locations (Eastbank Hatchery, Chiwawa Acclimation Facility, and Chelan Hatchery) with different temperature regimes at similar densities through early March, then transfer all 1,500 fish to the Chiwawa Acclimation Facility where final rearing occurs. The fish will be lethally sampled in June 2019 to evaluate the effects of temperature regimes on precocial maturation using GSI sampling. The HCP Hatchery Committees discussed the overage and provided feedback on the study plan, particularly regarding what other data will be collected in addition to GSI sampling.

2.2.2.2 Hatchery Monitoring and Evaluation Plan Implementation

2.2.2.2.1 Hatchery Monitoring and Evaluation Plan – 2017 Update

Since 2013, Chelan PUD hatchery M&E programs have been operated in accordance with the *Monitoring and Evaluation Plan for PUD Programs 2013 Update*. The plan and its appendices were updated in 2017, titled *Monitoring and Evaluation Plan for PUD Hatchery Programs – 2017 Update*, as described in the 2017 Rocky Reach HCP Annual Report.

2.2.2.2.2 Independent Scientific Advisory Board Recommendations

In 2017 and 2018, the Independent Scientific Advisory Board reviewed habitat assessment, research and monitoring, and prioritization and coordination of recovery actions for spring Chinook salmon in the Wenatchee, Entiat, and Methow basins. Their final report, *Review of Spring Chinook Salmon in the Upper Columbia River*,[7] includes several recommendations pertaining to the Hatchery M&E Plan and its appendices. In February 2018, the HCP Hatchery Committees discussed the report and requested that Hillman begin updating the M&E Plan and its appendices and analyses as needed. Hillman worked on this task throughout 2018, reporting back to the HCP Hatchery Committees regularly with updates. To date, his review has focused on the statistical analyses in Appendix H of the M&E Plan. Updates to the plan and its appendices will continue in 2019.

2.2.2.2.3 Hatchery Monitoring and Evaluation Implementation Plan

The *Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan* is prepared annually to describe the M&E activities for the next calendar year. In August 2018, the HCP Hatchery Committees discussed changes between the 2017 and 2018 plans, including the discontinuation of Chiwawa spring Chinook salmon parr estimates and observer efficiency data collection. The Rock Island and Rocky Reach HCP Hatchery Committees approved the Chelan PUD 2019 Hatchery M&E Implementation Plan (Appendix L) on August 24, 2018, following a 30-day HCP Hatchery Committees review period.

2.2.2.2.4 Genetic Analyses for Habitat Conservation Plan Program Species

The M&E Plan specifies genetic analyses, which should occur at 10-year intervals in order to examine the potential for changes in genetic diversity of natural populations as a result of hatchery programs. In 2016, the HCP Hatchery Committees recognized the need to reconsider the genetic sampling intervals and scheduling for HCP program species.

WDFW worked on this task throughout 2016 and 2017. They conducted a literature review and made a list of relevant reports. They developed a draft timeline for sample collection, analyses, and reporting

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7 Independent Scientific Advisory Board, 2018. Review of Spring Chinook Salmon in the Upper Columbia River. ISAB 2018-1. February 9, 2018. Available at: https://www.nwcouncil.org/sites/default/files/ISAB%202018-1UpColSpringChinookReview10AprilUPDATE.pdf.

to meet all monitoring objectives, and they investigated potential analyses with geneticists to inform updated sampling intervals. This material was shared with the HCP Hatchery Committees in January 2017, then revised and shared again in April 2017. The timeline includes analysis needs, the projected year of the analysis, and the requirements for M&E reporting. The HCP Hatchery Committees discussed whether analysis intervals should be based on listing status or other factors, and whether to synchronize analysis years for the same species across basins, or by each basin. A power analysis was proposed as a way to determine how large of a genetic change could be detected in a population and how rapid it may occur (which would inform the analysis interval). The HCP Hatchery Committees also recognized the need to identify a baseline genetic period for each program, because hatchery programs change over time, especially broodstock. It was determined that the WDFW genetics laboratory should perform a power analysis to inform recommended analysis frequency, and the HCP Hatchery Committees should identify baseline periods for each program.

The HCP Hatchery Committees continued to work on developing timelines for HCP Plan Species (Section 2.2.2.2.5) in 2018. The WDFW Molecular Genetics Laboratory did not complete a power analysis citing the need to be funded to complete this task.

In February 2018, the HCP Hatchery Committees discussed how the timeline and intervals for genetic sampling depend largely on sample sizes and analysis intervals. It was determined that input from geneticists from multiple agencies would help determine a strategy for genetics M&E for the upper Columbia River (UCR) PUD hatchery programs. In June through August 2018, the HCP Hatchery Committees reviewed draft questions for geneticists regarding M&E and nominated geneticists to participate on a panel. The goal of asking questions of the panel was to ensure that genetic analyses and reporting completed as part of hatchery M&E answer appropriate genetic questions for each program. In September 2018, the HCP Hatchery Committees met with the panel of geneticists: Drs. Morgan Robinson (NOAA), Christian Smith (USFWS), Ilana Koch and Shawn Narum (Columbia River Inter-Tribal Fish Commission), and Todd Seamons (WDFW). Discussions focused on the HCP Hatchery Committees' questions about genetics M&E for PUD programs and populations and processes of concern. Further coordination, questions, and data-sharing followed. In December 2018, the panel responded with consensus answers to the HCP Hatchery Committees' questions about genetics M&E in the memorandum, *Response to questions posed by the HCP Hatchery Committees regarding the PUD M&E Plan* (Appendix B). The HCP Hatchery Committees discussed the recommendations and conclusions of the panel in December 2018 and will continue these discussions in 2019.

2.2.2.2.5 Timelines for Habitat Conservation Plan Programs

To complete analyses specified in Section 8 of the M&E Plan, Chelan PUD and the HCP Hatchery Committees recognized the need to identify major program changes in fish culture or M&E for each program and began drafting program timelines in October 2017. The timelines will be used to determine breaks for statistical analysis for use in completing the 5-year statistical and 10-year comprehensive reports.

Hillman drafted the timelines for spring Chinook salmon (Wenatchee, Methow, Entiat, and Okanogan), summer steelhead (Wenatchee, Entiat, and Methow), summer Chinook salmon (Wenatchee, Entiat, and Methow), and sockeye (Wenatchee, Entiat, Methow, and Okanogan) in 2017 and 2018. The HCP Hatchery Committees reviewed and added to the timelines in 2018. The HCP Hatchery Committees discussed how program changes often occurred over many years, so the precise year a statistical break should occur is difficult to assign. The timelines will be discussed further in 2019 as analyses for the 10-year Program Review are initiated.

2.2.2.2.6 Expanded Sampling at the Off-Ladder Adult Fish Trap

In February 2017, WDFW introduced the idea of expanding sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam as an approach for monitoring spring Chinook salmon. The HCP Hatchery Committees discussed how sampling could inform unbiased estimates for prespawn mortality and provide data for managing the proportion of Hatchery-Origin Spawners and Proportionate Natural Influence objectives. Sampling at Wells and Tumwater dams for spring Chinook salmon could potentially be decreased if a sampling scheme for the OLAFT is developed. WDFW indicated they would develop an overview of the expanded sampling strategy. In March 2018, WDFW summarized methodologies to estimate run escapement and spawning escapement for the UCR Distinct Population Segment of steelhead. The HCP Hatchery Committees discussed spawning distribution and redd surveys in different areas of the UCR. They discussed assignment of fish to spawning locations, model selection, and the accuracy of the model. The current methodologies for steelhead helped inform later discussions about expanded sampling at the OLAFT.

In May 2018, WDFW presented how PIT tagging via expanded sampling at the OLAFT could be used to estimate spawning escapement at various spatial scales. WDFW summarized that expanded sampling at the OLAFT would benefit other HCP Plan Species and provide real-time escapement monitoring for broodstock collection and gene flow management purposes. The HCP Hatchery Committees discussed current sampling strategies, population models pertaining to monitoring in the UCR, carcass recovery bias, and potential funding sources for the expanded sampling. The schemes for how sampling could be expanded at the OLAFT were summarized in a document, *Priest Rapids Dam Expansion Project*, and reviewed by the HCP Hatchery Committees in July 2018 (Appendix B). In August 2018, the HCP Hatchery Committees discussed whether Douglas, Chelan, and Grant PUDs would support the expanded sampling with funding, and the appropriate avenues for requesting funding and changes to M&E contracts. Neither Douglas, Chelan, nor Grant PUD indicated support for the expanded sampling because the M&E objectives were being met with the current methodology. WDFW also provided an update on how potential reductions in funding sources from Bonneville Power Administration of steelhead monitoring programs in the UCR could affect current monitoring for steelhead related to the PUD M&E programs. WDFW communicated that potential funding reductions may target PIT-tag infrastructure in the UCR. Instead of proposing expanded OLAFT sampling to spring Chinook salmon, WDFW proposed instead a cost-sharing arrangement between WDFW and the PUDs to continue the existing monitoring program at Priest Rapids Dam for steelhead (BY 2020 and beyond).

Conversations among the HCP Hatchery Committees continued in 2018 about the level of steelhead monitoring that is needed for BY 2020 and beyond. Douglas, Chelan, and Grant PUDs also considered the cost-share proposal outside the purview of the Hatchery Committees.

2.2.2.2.7 Hatchery Monitoring and Evaluation Plan Reporting

In September 2018, the Chelan PUD 2017 Hatchery M&E Plan Report, titled *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs 2017 Annual Report,* which documented M&E activities in 2017 (Appendix N) was finalized following a 30-day HCP Hatchery Committees review period. In addition, Chelan PUD began working with the HCP Hatchery Committees in 2016 to develop a long-term scheduling plan to logically orchestrate HCP requirements and M&E reporting, including annual and 5-year statistical reports, and the 10-year Program Review (Rocky Reach HCP: Section 8.7). The *Final M&E Reporting Schedule for the PUD Hatchery Programs,* finalized in March 2017, describes the content and function of each report and development and due dates through 2052.

2.2.2.3 Review of the Five-Year Hatchery Monitoring and Evaluation Report

In March 2015, while working toward approving an Interlocal Agreement between Chelan PUD and Douglas PUD to rear Chelan PUD's Methow spring Chinook salmon production at the Methow Fish Hatchery, the HCP Hatchery Committees unanimously agreed on the need to revisit the results of M&E in the Methow Basin to date and develop an adaptive management plan to improve the performance of the Methow Hatchery Programs. The HCP Hatchery Committees also approved an SOA titled, *Regarding Timeline for Review of 'Evaluation of Hatchery Programs Funded by Douglas County PUD 5-Year Report 2006-2010,'* which outlined specific actions to accomplish within 1 year of approval of the SOA. In April 2015, the HCP Hatchery Committees agreed to review the Five-Year Hatchery M&E Report by species and basin, starting with spring Chinook salmon in the Methow Basin, and moving forward program-by-program (e.g., Methow, Twisp, and Chewuch). The review of Methow spring Chinook salmon was completed in 2017 and is summarized in 2017 Rocky Reach HCP Annual Report. Other species and basins were not addressed in 2018.

2.2.2.3.1 Improving Homing in the Methow Basin: Adult Outplanting Plan

As described in previous annual reports, the HCP Hatchery Committees began designing a pilot management plan to address Objective 5 of the Hatchery M&E Plan in 2016. The HCP Hatchery Committees approved the Final Outplanting Adults Plan in April 2017 and intended to implement the study in 2017. However, the translocation study did not occur in 2017 or in 2018 because the spring Chinook salmon run was small and no surplus hatchery-origin adults were available for translocation. The study is planned to begin in 2019 depending on sufficient fish numbers in 2019. Pending the results of the outplanting study, the HCP Hatchery Committees may consider other methods of meeting spawning escapement goals for certain rivers or reaches.

2.2.2.4 Okanogan Sockeye Salmon Mitigation

In 2018, Chelan PUD provided a thirteenth year of funding for a portion of the Okanagan Nation Alliance (ONA)'s 12-year Skaha Lake Sockeye Salmon Reintroduction Program (the current hatchery production obligation for Okanogan sockeye salmon mitigation is a combined 591,050 smolts for Rocky Reach and Rock Island HCPs). Chelan PUD funding contributed to the construction of the new kł cp̓əlk̓ stim̓ Sockeye Salmon Hatchery in Penticton, British Columbia, which was completed in September 2014; currently Chelan PUD funding contributes to operation and maintenance of the hatchery and to the M&E program. In June 2015, the hatchery held its first official fish release of roughly 1.7 million fry, mostly in Shingle Creek, and some in Okanagan Lake as part of a ceremonial ONA release. The hatchery was designed to support up to an 8-million-egg program; however, the plumbing system initially installed supported a production capacity of 5 million eggs. The egg-take goal of 5 million eggs was achieved for the first time in 2016. In spring 2018, the hatchery released roughly 1,220,000 fry (Chelan PUD's proportion was 414,800) into Skaha Lake.

2.2.2.5 Hatchery and Genetic Management Plans

Efforts continue to complete the consultation process, including coordination in prior years among Chelan PUD, NMFS, USFWS, the YN, WDFW, the CCT, and Grant and Douglas PUDs.

2.2.2.5.1 Wenatchee Steelhead

On June 30, 2014, after more than 4 years of consultation, the initial draft Wenatchee Steelhead Biological Opinion (BiOp) was completed by NMFS. The BiOp was revised several times in 2014 and 2015, and a final BiOp was issued on July 20, 2016. Section 7(a)(2) consultation with USFWS was completed in 2017 and the Section 10 (a)(1)(A) permit (NMFS No. 18583) was issued on December 31, 2017.

2.2.2.5.2 Biological Opinion for Chiwawa Spring Chinook Salmon, Wenatchee Steelhead, and Wenatchee Summer Chinook Salmon Programs

On November 28, 2012, NMFS requested formal consultation with USFWS under Section 7(a)(2) of the ESA on the proposed permitting of the following five hatchery programs that operate in the Wenatchee subbasin: Chiwawa River spring Chinook salmon, Nason Creek spring Chinook salmon, White River spring Chinook salmon, Wenatchee River summer steelhead, and Wenatchee River summer Chinook salmon. A partial draft BiOp was distributed by USFWS on December 23, 2014.

Another draft was submitted for review on September 8, 2016. A completed BiOp was issued by USFWS on November 27, 2017.

2.2.2.5.3 Methow Spring Chinook Salmon

In June 2013, NMFS requested that Chelan PUD prepare a full Methow Spring Chinook Hatchery and Genetic Management Plan (HGMP), despite formerly indicating that the HCP Hatchery Committees-approved addendum would be acceptable for the program. After multiple revisions to the draft HGMP, in March 2014, the Rocky Reach HCP Hatchery Committee approved the Chelan PUD Methow Spring Chinook Salmon HGMP, as revised. In October 2014, NMFS decided that the Chelan PUD Methow spring Chinook salmon consultation would be combined with the Methow Fish Hatchery and Winthrop National Fish Hatchery consultations with a target completion date of March 31, 2015.

Throughout 2015 to 2017, Chelan PUD and Douglas PUD coordinated with USFWS and NMFS to develop: 1) a PNI approach for applying a PNI standard to reduce the contribution of the Winthrop Program to pHOS, for incorporation into the permit; and 2) language outlining shared research, monitoring, and evaluation responsibilities. The HCP Hatchery Committees also agreed to adopt the three-population gene flow model for calculating PNI. The Gene Flow Management Standards approved in March 2016 included using a sliding scale for PUD targets and a reduced pHOS target for Winthrop National Fish Hatchery as natural runs increase. NMFS indicated the standards are aggressive and may be challenging to meet; therefore, permits will recognize the challenges of adult management in the Methow Basin and will be written to allow flexibility in meeting targets during the first few years of implementation.

The final permits, including Permit 20533 for Chelan PUD, were issued in February 2017, and will expire in December 2027. Permits issued for the Methow spring Chinook salmon programs allow lethal removal of hatchery-origin adults for the purposes of gene flow management. Adult management actions will be used to support achieving hatchery production levels and escapement/ sliding-scale PNI targets identified in the Methow Spring Chinook Salmon BiOp and permits.

2.2.2.5.4 Chelan Falls Summer Chinook Salmon

In May 2013, NMFS requested that Chelan PUD and other Permit No. 1347 permit holders submit letter applications for extension of permit 1347. NMFS indicated that an extension of the existing Permit No. 1347 was feasible. Chelan PUD submitted an extension request letter on August 27, 2013. Subsequently, on September 20, 2013, Chelan PUD received a letter from NMFS indicating that the existing ESA permits would be extended until new consultations are completed, and new permits issued. In 2014, NMFS indicated that, due to higher priority permitting of programs rearing ESA-listed species, permitting of summer and fall Chinook salmon programs would not be addressed until spring 2015. In 2015, permitting of summer and fall Chinook salmon programs was postponed again because parties agreed that these programs are the lowest priority for completing consultation.

In May 2017, NMFS indicated they were drafting the proposed action for the batch of unlisted Chinook salmon programs in the UCR (Wenatchee summer Chinook, Chelan Falls summer Chinook, Wells summer Chinook, Priest Rapids fall Chinook, Methow summer Chinook, and Ringold upriver bright fall Chinook), and would be coordinating with parties to gain needed information. In June 2017, the HCP Hatchery Committees discussed possible consultation pathways for the unlisted programs. In September 2017, NMFS indicated that the BiOp for the Columbia River unlisted summer Chinook salmon programs is being drafted. The applicants officially initiated consultation with request letters in November 2017, and NMFS responded with letters of sufficiency to the applicants on November 25, 2017. The draft BiOp was available for the applicants and HCP Hatchery Committees to review and was finalized on December 25, 2017.

In February 2018 NMFS indicated that the National Environmental Policy Act process, including an Environmental Assessment (EA) encompassing the Methow steelhead and unlisted programs (summer/fall Chinook salmon for Wenatchee, Wells, Methow, Chelan Falls, Dryden, and Priest Rapids hatcheries), is underway. In September 2018, NMFS indicated the EA is under internal review. The next step is for the EA and HGMPs to be available for public comment. The final EA and ESA permit for the Chelan falls summer Chinook salmon program are expected in 2019, but at the time of this report, no date has been provided by NMFS for issuance of permits.

2.2.2.6 Wenatchee Steelhead Relative Reproductive Success Study

The Rocky Reach HCP, Section 8.5.3, requires that Chelan PUD fund and implement a steelhead relative reproductive success (RRS) study. The Wenatchee Steelhead RRS Study began in 2008 and incorporated data from each subsequent BY to 2011. The study objective was to measure the RRS of hatchery-origin steelhead in the natural environment and determine the degree to which any differences in reproductive success between hatchery- and natural-origin steelhead can be explained by measurable biological characteristics.

In September 2015, WDFW and NMFS presented to the HCP Hatchery Committees the results of the Wenatchee Steelhead RRS Study. In summary, many differences in life-history traits were detected between hatchery and natural fish; however, there were no apparent differences in spawn timing. Additionally, spawning distribution was similar. Hatchery-by-hatchery broodstock male and female fish had the lowest RRS. Hatchery-by-wild broodstock male and female fish had an RRS between those of hatchery-by-hatchery broodstock and wild-by-wild broodstock. Wild-by-wild male and female fish had almost indistinguishable RRS from wild fish, though the RRS had greater variance between years. Size and season also contributed to variation in RRS among individuals. A final report documenting the study results will be distributed in 2019.

2.2.2.7 Summer Chinook Salmon Size Target Study

In 2015, Chelan PUD conducted the second and final year of the Wenatchee and Chelan Falls Summer Chinook Salmon Size Targets Study with NOAA's Northwest Fisheries Science Center to help inform the feasibility of converting the Dryden Acclimation Facility to an overwinter facility in conjunction with determining how best to meet total maximum daily load requirements. During the first year of this study (BY 2012), there were challenges reaching the specific size targets. During the second year of this study (BY 2013), size targets were generally met, and preliminary results showed differences as a result of rearing vessel and/or release size in juvenile performance for Wenatchee summer Chinook salmon and no difference in juvenile performance between the four size-at-release targets. In 2015, the HCP Hatchery Committees agreed for Chelan PUD to conduct a third year of the study (BY 2014) to attempt to replicate success from the BY 2013 study. Results from the BY 2014 study will be available in 2019.

2.2.2.8 Multi-Species/Expanded Acclimation

In the interest of developing a long-term, multi-species/acclimation plan for UCR salmon mitigation programs, in January 2013, the Joint Fisheries Parties developed a plan outlining multi-species acclimation options for UCR salmon and steelhead mitigation programs. Throughout 2013 and 2014, the YN further discussed with the HCP Hatchery Committees potentially expanding acclimation areas in the Upper Methow Basin and agreed to develop a document summarizing the details of these plans. In October 2014, after review by the HCP Hatchery Committees of the YN's initial proposal to acclimate 50,000 spring Chinook salmon at one of two acclimation sites in the Upper Methow Basin, the YN proposed acclimating 25,000 Methow spring Chinook salmon at the Goat Wall Acclimation Site, located significantly upstream of the site used in the past (the Mid-Valley Pond site). The HCP Hatchery Committees requested that the YN prepare a proposal for expanded acclimation in the Methow Basin, including an explanation of pond operations, tagging, M&E, project objectives, and adult management, to be further discussed in 2015.

In January 2015, the YN, in coordination with the HCP Hatchery Committees, developed a Draft YN Upper Methow Spring Chinook Salmon Acclimation Proposal, as requested. The proposal was to acclimate 25,000 Methow spring Chinook salmon at the Goat Wall Acclimation Site as part of the YN's Upper Columbia Spring Chinook Salmon and Steelhead Acclimation Project (Bonneville Power Administration Project No. 2009-00-001), beginning with the 2016 release (BY 2014), and with releases continuing through 2020. The YN also distributed a Draft Goat Wall Acclimation SOA for HCP Hatchery Committees review. In February 2015, the HCP Hatchery Committees further discussed the draft proposal and SOA (which were also vetted with the Joint Fisheries Parties), and the Wells and Rocky Reach HCP Hatchery Committees approved the YN *Upper Methow Spring Chinook Acclimation Proposal* and Goat Wall Acclimation SOA, with NMFS abstaining, as follows: the YN approved on March 3, 2015; NMFS abstained on March 3, 2015; Chelan PUD, Douglas PUD, WDFW, and the CCT approved on March 4, 2015; and USFWS approved on March 5, 2015.

Chelan PUD and Douglas PUD requested that the YN have its own ESA permit coverage for the planned releases. NMFS indicated, however, that it was unlikely to have permits in place before March 2016 when the fish would need to be transferred. The YN, NMFS, and HCP Hatchery Committees explored options for how to move fish to the site and determined it cannot be done without the proper permits in place. Therefore, due to permitting delays, a 2016 release did not happen, despite HCP Hatchery Committees approval of the proposal and SOA.

NMFS issued a permit to YN for these activities in February 2017, and the YN released 25,923 spring Chinook salmon from the Goat Wall Acclimation Site in 2017 and 28,253 in 2018. The YN intends to conduct 5 years of spring Chinook salmon releases from the Goat Wall Acclimation Site now that permits are in place. An update from YN on the results of this acclimation project is expected in 2019.

2.2.2.9 Releasing Passive Integrated Transponder-Tagged Pacific Lamprey in the Tumwater Dam Fishway

In April 2016, YN presented a scope of work to the HCP Hatchery Committees titled *Scope of Work for Releasing Adult Pacific Lamprey within Tumwater Dam Fish Ladder*. The YN agreed to monitor Pacific lamprey passage through the ladder throughout Plan Species broodstock collection, and report back to the HCP Hatchery Committees should any effects be identified. PIT-tagged Pacific lamprey were released in the Tumwater fishway in 2016, 2017, and 2018.

Pacific lamprey were released into several locations in the Wenatchee River again in 2017. In 2017, 14 Pacific lamprey were counted at the Tumwater Dam observation window during non-trapping periods indicating complete ascension of the Tumwater fishway. Additionally, one Pacific lamprey was observed ascending the denil to the trap hopper while trapping was actively occurring.

In August 2018, YN released 200 adult Pacific lamprey into the Wenatchee River. 120 Pacific lamprey were released upstream of Tumwater Dam: 60 in Jolanda Lake, and 60 near the town of Plain. Downstream of Tumwater Dam, 80 Pacific lamprey were released: 40 near the mouth of the Wenatchee River just downstream of the first PIT array, and 40 just downstream of Tumwater Dam. In 2018, 12 Pacific lamprey were counted at the Tumwater Dam observation window during non-trapping periods indicating complete ascension of the Tumwater fishway. Additionally, two Pacific lamprey were observed ascending the Denil to the trap hopper while trapping was actively occurring.

2.2.2.10 Egg to Emergence Evaluation in the Chelan River

As in 2017, in 2018 Chelan PUD requested surplus steelhead from Douglas PUD to conduct an egg-to-emergence evaluation in the habitat channel of the Chelan River to evaluate the effectiveness of Chelan PUD's Chelan River Biological Evaluation and Implementation Plan. In 2017, researchers used green eggs from Wells Fish Hatchery. In 2018, the study involves using 2,800 eyed eggs from four pairs of broodstock. The Rocky Reach and Rock Island HCP Hatchery Committees approved Chelan PUD's request to collect four female and four male surplus steelhead broodstock from the Wells Fish Hatchery Volunteer Channel to support the egg-to-emergence evaluation in 2018. Chelan PUD spawned the surplus broodstock in March 2018 and planted the eyed-eggs in mid-April 2018. Results will be available from the Chelan River Fishery Forum in 2019.

2.2.2.11 Coho Salmon Recalculation Agreements

In March 2017, the Rocky Reach and Rock Island HCP Coordinating Committees approved the Designation of Juvenile Coho Salmon in Phase III (Standard Achieved) at the Rock Island and Rocky Reach Projects SOA, as described in Section 2.1.1. Approval of this SOA initiated the hatchery compensation planning process, because survival estimates inform mitigation calculations. Chelan PUD and YN worked together to calculate mitigation numbers based on methods used during the 2013 NNI Recalculation for other species.

In 2017, Chelan PUD reviewed the 2013 NNI Recalculation approach for determining mitigation. Chelan PUD presented a draft SOA, regarding District's Coho Obligation that included a 7% compensation rate at both Rocky Reach and Rock Island as agreed to by the Rocky Reach and Rock Island HCP Coordinating Committees for BYs 2017 to 2021. The SOA is an agreement about the methodology used to calculate hatchery compensation levels and is an agreement that Chelan PUD will meet its obligation through funding and/or facility use to support a coho salmon reintroduction project. The details of the funding arrangement were separated into a second SOA in January 2018. The Rocky Reach and Rock Island HCP Hatchery Committees approved both the SOAs Regarding District's Coho Obligation on November 15, 2017, and January 17, 2018, respectively (Appendix E).

2.2.2.12 Hatchery-Origin Steelhead Adult Management

Fish salvage activities are conducted during ladder dewatering for maintenance at Douglas PUD and Chelan PUD hydroelectric projects. In January 2018, Chelan PUD presented the results of fish salvage activities to the HCP Coordinating Committees. There was a substantial number of adipose-fin-clipped *O. mykiss* (steelhead/rainbow) collected, varying in size. In February 2018, WDFW indicated to the HCP Hatchery Committees that they were concerned about hatchery steelhead remaining in the river as resident trout (because it is unlikely that the *O. mykiss* collected by Chelan PUD are hatchery-reared rainbow trout). WDFW proposed lethally removing any 12- to 18-inch *O. mykiss* collected during fish salvage activities and examining tags to determine the source of the fish. WDFW's Section 10 permits allows for lethal removal of hatchery-origin steelhead at dams, traps, and weirs, so this activity would be a permitted component of adult management. In February 2018, the HCP Hatchery Committees approved the lethal removal of all known-hatchery-origin *O. mykiss* between 12 and 18 inches at Chelan PUD and Douglas PUD hydroelectric projects during fish rescues associated with fishway maintenance outages.

2.2.2.13 Brood Year 2017 Chelan Falls Summer Chinook Salmon Culling

In January 2018, WDFW notified the HCP Hatchery Committees that part of the Chelan Falls summer Chinook salmon program may need to be culled to address disease concerns. The program was short on brood due to prespawn mortality, poor eye-up rates, and lower than anticipated fecundities. Higher than usual ELISA levels in females meant that culling fish may be necessary to manage for bacterial kidney disease. The 2017 Broodstock Collection Protocols allowed for a cull allowance of 2% or less, and the number of high-ELISA females (greater than 0.12 optical density [OD]) was approximately 6% for the program. WDFW proposed culling all eggs from hatchery-origin females with ELISA vales of 0.12 OD or higher, approximately 35,000 eyed eggs, because that is the standard applied to spring Chinook salmon. The Rocky Reach HCP Hatchery Committee discussed the total egg-take goals and release goals, as well as the risks of maintaining these eggs on station. On January 17, 2018, the Rocky Reach HCP Hatchery Committee agreed to cull part of the BY 2017 Chelan Falls summer Chinook salmon program (approximately 35,000 eyed eggs that are the progeny of hatchery females with ELISA values over 0.12 OD) to manage disease concerns.

2.2.2.14 WDFW's Adult Prophylactic Disease Management Plan

In July 2018, WDFW distributed an Adult Prophylactic Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Salmon Programs in 2018-2020 to the HCP Hatchery Committees (Appendix B). WDFW reviewed the plan, which includes a trend away from using antibiotics in prophylactic treatments. The HCP Hatchery Committees discussed which aspects of fish health are the purview of the HCP Hatchery Committees and the importance of communication between fish health staff at different hatcheries and agencies. WDFW proposed adding an appendix to the annual Broodstock Collection Protocols. This appendix will likely be discussed further in 2019.

2.2.3 Maintenance and Improvements

2.2.3.1 Chelan Fish Hatchery Rehabilitation Design

In 2015, a rehabilitation feasibility study began for the Chelan Fish Hatchery Building, which is more than 60 years old. Rehabilitation is planned for the existing hatchery building, including the offices, incubation, early rearing, and ancillary functions. No program changes are proposed at this time. The feasibility study continued in 2016 and will be finalized in 2019.

2.2.3.2 Chelan Falls Canal Trap Engineering Feasibility

In January 2018, Chelan PUD indicated to the HCP Hatchery Committees that a more permanent structure for the Chelan Falls canal trap is being considered. Chelan PUD awarded a contract to study the feasibility of designing permanent facilities for summer Chinook salmon broodstock collection at Chelan Falls and design work is expected to continue into 2019.

2.2.3.3 Eastbank Fish Hatchery Generator

In September 2018, Chelan PUD installed a generator as a second backup power source at the Eastbank Fish Hatchery. Programming to automate generator power will be finalized in 2019.

2.3 Habitat Conservation Plan Tributary Committees and Plan Species Accounts

As outlined in the Rocky Reach HCP, the signatory parties each designated one member to serve on the HCP Tributary Committee. The Rock Island, Rocky Reach, and Wells HCP Tributary Committees meet on a regularly scheduled basis as a collective group to enhance coordination and minimize meeting dates and schedules. Subject items requiring decisions are voted on in accordance with the terms outlined in the specific HCPs. During 2018, the Rocky Reach HCP Tributary Committee met on seven occasions.

An initial task of the HCP Tributary Committees in 2018 was to review and update their operating procedures that provide a mechanism for decision making. These were initially developed in 2005 and were included in that year's annual report (Anchor 2005).[8] The HCP Tributary Committees also developed Policies and Procedures for soliciting, reviewing, and approving project proposals (Anchor 2005). The Policies and Procedures provide formal guidance to project sponsors on submission of proposals for projects to protect and restore habitat of Plan Species within the geographic scope of the HCP. The HCP Tributary Committees established two complementary funding programs, the General Salmon Habitat Program (GSHP) and the Small Projects Program.

In 2018, the HCP Tributary Committees reviewed their Policy and Procedures document and made edits to clarify language in Sections 3.2 (General Salmon Habitat Program), 3.6 (Permits), 4.2 (Eligible Projects and Elements), 6.5 (Site Inspections), 6.7 (Project Reimbursements). In addition, the HCP Tributary Committees rearranged some sections of the Policy and Procedures document to reflect a more logical order.

The HCP Tributary Committees also reviewed and updated their Operating Procedures. Chelan PUD designated Catherine Willard as their voting member and Scott Hopkins as the alternate on the Rocky Reach HCP Tributary Committee. The YN designated Brandon Rogers as the alternate on the Rocky Reach HCP Tributary Committee.

In 2018, the HCP Tributary Committees began the process of identifying high-priority, targeted, habitat projects within each of the Wenatchee, Entiat, Methow, and Okanogan subbasins. Based on the HCP Tributary Committees' extensive knowledge of the subbasins, limiting habitat factors, threats,

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[8] Anchor Environmental, L.L.C. 2005. Annual Report, Calendar Year 2005, of Activities under the Anadromous Fish Agreement and Habitat Conservation Plan. Rocky Reach Hydroelectric Project, FERC License No. 2145. Prepared for FERC by Anchor Environmental L.L.C. and Public Utility District No. 1 of Chelan County.

and limiting life stages, they will identify enhancement or protection actions within each subbasin and call for proposals. They will work closely with the Upper Columbia Regional Technical Team on identifying high priority habitat actions. This is similar to the Bonneville Power Administration Targeted Solicitation Process. Although the HCP Tributary Committees will continue to accept project applications from sponsors anytime during the year, they plan to take a more active role in identifying and funding targeted projects within each subbasin. The goal is to call for targeted proposals in 2019.

2.3.1 Regional Coordination

Similar to the HCP Hatchery Committees and to improve coordination, a representative from Grant PUD and the facilitator of the PRCC Habitat Sub-Committee were invited to the HCP Tributary Committees monthly meetings. In addition, these representatives received meeting announcements, draft agendas, and meeting minutes. This benefits the HCP Tributary Committees through increased coordination and the sharing of expertise. The Grant PUD representative and PRCC Habitat Sub-Committee facilitator have no voting authority within the HCP Tributary Committees.

The HCP Tributary Committees also coordinate with the Upper Columbia Salmon Recovery Board (UCSRB). Coordination is typically between the chairperson of the HCP Tributary Committees and the Executive Director or the Natural Resource Program Manager of the UCSRB. In addition, some members of the HCP Tributary Committees typically attend UCSRB meetings to foster coordination in developing and selecting projects for funding. Some members of the HCP Tributary Committees are also members of the UCSRB's Regional Technical Team, which increases coordination in selecting projects for funding. Many of the Policies and Procedures of the Salmon Recovery Funding Board (SRFB) and HCP Tributary Committees are complementary, and annual funding rounds by these funding entities have been coordinated during the last several years.

In addition to coordinating with the SRFB process and the PRCC Habitat Sub-Committee, the Rocky Reach HCP Tributary Committee coordinates funding of GSHP proposals with Bonneville Power Administration and the U.S. Bureau of Reclamation. The purpose of this coordination, according to Section 2 of the Tributary Fund Policies and Procedures for Funding Projects, is to collaborate with regional, local, state, tribal, and national organizations that fund salmon habitat projects. The efforts resulted in identification of possible cost-shares for suitable habitat restoration projects.

2.3.2 Fiscal Management of Plan Species Accounts

The HCP Tributary Committees set up methods for the long-term management of the Plan Species accounts for each HCP. The Rocky Reach HCP Tributary Committee appointed the accounting firm Clifton Larson Allen to perform the necessary tasks for fiscal management of the Rocky Reach Plan Species Account. These tasks include the following: 1) develop a long-term approach to maintain the funds and to carry out tax calculations and reporting; 2) conduct the daily management of activities (such as processing of invoices); and 3) provide technical expertise on financial matters to the committees. The beginning balance of the Rocky Reach Plan Species Account on January 1, 2018 was $2,657,368.15. Chelan PUD's annual contribution was $359,935.00. Interest received during 2018 was $27,776.84. Funds disbursed for projects in 2018 totaled $153,785.19. In addition, $3,084.19 was paid to Clifton Larson Allen and Chelan PUD for account administration, and $86.00 was paid in bank fees. The ending balance on December 31, 2018, was $2,888,124.61. The 2018 Annual Financial Report for this Plan Species Account is provided in Appendix O.

The Rocky Reach HCP Tributary Committee delegated signatory authority to the Chairperson for processing of payments for invoices approved by the HCP Tributary Committee, with the HCP Coordinating Committee Chairperson serving as the alternate. Chelan PUD recognizes the uniqueness of the Rocky Reach HCP Tributary Committee decision-making process and delegation of signatory authority to the Chairperson, and the Chelan PUD subsequently has provided funding necessary to assign reasonable liability insurance to the Tributary Chairperson.

2.3.3 General Salmon Habitat Program

The HCP Tributary Committees established the GSHP as the principle mechanism for funding projects. The goal of the program is to fund projects for the protection and restoration of Plan Species habitat. An important aspect of this program is to assist project sponsors in developing practical and effective applications for relatively large projects. Many habitat projects are increasingly complex in nature and infeasible without extensive design, permitting, and public participation. Often, a reach-level project involves many authorities and addresses more than one habitat factor. Because of this trend, the GSHP was designed to fund relatively long-term projects. There is no maximum financial request in the GSHP; the minimum request is $100,000, although the HCP Tributary Committees may approve lesser amounts during a phased project.

In 2014, the HCP Tributary Committees announced that they would accept GSHP applications at any time during the year. They also announced that they would continue to accept SRFB applications for projects where Plan Species Account Funds are included as cost-shares in SRFB Proposals.

In an effort to coordinate with ongoing funding and implementation programs within the region, the HCP Tributary Committees used the previously established technical framework and review process for this geographic area and worked with the other funding programs to identify cost-sharing procedures (see Section 2.3.1).

2.3.3.1 2018 General Salmon Habitat Projects

The SRFB announced its 2018 funding cycle in March, with draft proposals due on April 13, 2018, and final proposals due on June 29, 2018. The HCP Tributary Committees received and reviewed 19 draft proposals. The HCP Tributary Committees identified eight projects that they believed warranted full proposals and dismissed 11 projects because they were inconsistent with the intent of the Tributary Fund, did not have strong technical merit, or were not cost effective.

In July, the HCP Tributary Committees received 11 full SRFB proposals to the GSHP. All were cost-shares with the SRFB or other funding entities. The HCP Tributary Committees approved funding for five projects. In addition, the HCP Tributary Committees received seven full proposals to the GSHP that were outside the SRFB process. Table 6 identifies the projects, sponsors, total cost of each project, amount requested from Tributary Funds, and, if funded, which Plan Species Account supported the project.

Table 6
General Salmon Habitat Program Projects Reviewed by the Habitat Conservation Plan Tributary Committees in 2018

Project Name	Sponsor	Total Cost	Request from Tributary Committee	Plan Species Account
Salmon Recovery Funding Board Applications				
Burns-Garrity Perennial Side-Channel	CCFEG	$735,000	$316,000	W: $316,000
Cottonwood Flats Floodplain Restoration Entiat River	CCNRD	$600,598	$90,090	RR: $90,090
Entiat Basin Fish Passage and Screening Assessment	CCFEG	$76,142	$25,500	RR: $25,500
Goodwin Side Channel	CCFEG	$120,500	$45,000	Not funded
Lower Entiat Tributaries Aquatic Habitat Assessment	CCD	$211,010	$45,000	Not funded
Merritt Oxbow	CCFEG	$110,500	$30,000	Not funded
Methow Beaver Project – Beavers and Anadromy	MSRF	$499,576	$180,574	Not funded
Methow Watershed Riparian Stewardship II	MSRF	$116,721	$19,373	Not funded
Monitor Side Channel Design and Construction	CCNRD	$294,000	$44,100	RI: $44,100
Twisp River Floodplain Spring-fed Alcove	MSRF	$42,348	$17,779	W: $17,779
Wenatchee EDT Model Development	CCNRD	$273,000	$92,500	Not funded
General Salmon Habitat Program Applications				
Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screens	WDFW	$2,468,000	$476,000	Tabled
Chiwawa Nutrient Enhancement	CCFEG	$267,650	$267,650	RI: $267,650
Twisp Confluence Habitat Complexity	YN	$299,300	$269,600	Not funded
Icicle Creek Fish Passage – Wild Fish to Wilderness II	TU	$2,275,000	$375,000	Funded conditionally[1]
Upper Kahler Stream and Floodplain Enhancement	YN	$482,500	$231,500	Not funded
Stormy Project Area "A" Stream and Floodplain	YN	$1,652,218	$1,140,968	Not funded
Scaffold Camp Acquisition #2	YN	$104,950	$94,500	Not funded

Note:
1. The Committees have yet to assign the funding account—either Rocky Reach or Rock Island.

In 2018, the Rocky Reach HCP Tributary Committee agreed to fund the following GSHP projects:

- **Cottonwood Flats Floodplain Restoration Entiat River (RM 17.65) Project –** for the amount of $90,090 (with cost share the total cost of the project was $600,598). This project will complete final designs and permitting and will reconnect six acres of floodplain habitat and side channels near river mile (RM) 17.7 on the Entiat River. This project will increase seasonal, high-flow rearing and refugia habitat for juvenile Chinook and steelhead and increase alcove habitat during low flows.
- **Entiat Basin Fish Passage Screening Assessment Project –** for the amount of $25,500 (with cost share the total cost of the project was $76,142). This project will conduct a comprehensive fish passage and screening assessment throughout the Entiat Subbasin.

2.3.3.2 Modifications to General Salmon Habitat Program Contracts

In 2018, the Rocky Reach HCP Tributary Committee received the following requests from sponsors asking for modifications to GSHP projects funded by the Committee:

- In May, Cascade Columbia Fisheries Enhancement Group (CCFEG) asked the Rocky Reach HCP Tributary Committee for a time extension on the *Burns-Garrity Restoration Design Project* from May 1, 2018 to December 1, 2018. Extra time is needed because there was a change in landownership, which delayed the project five months. The Rocky Reach HCP Tributary Committee approved the time extension.
- In September, CCFEG asked the Rocky Reach HCP Tributary Committee for a time extension on the *Burns-Garrity Restoration Design Project* from December 1, 2018 to December 1, 2019. Extra time is needed to evaluate and discuss alternative designs because of an avulsion in the mainstem Chewuch River near the entrance to the proposed side channel. The Rocky Reach HCP Tributary Committee approved the time extension.

2.3.4 Small Projects Program

The Small Projects Program has an application and review process that increases the likelihood of participation by private stakeholders that typically do not have the resources or expertise to go through an extensive application process. The HCP Tributary Committees encourage small-scale projects by community groups, in cooperation with landowners, to support Plan Species recovery on private property. Project sponsors may apply for funding at any time, and in most cases, will receive a funding decision within three months. The maximum contract allowed under the Small Projects Program is $100,000.

2.3.4.1 2018 Small Projects

In 2018, the HCP Tributary Committees received two requests for funding under the Small Projects Program. Table 7 identifies the projects, sponsors, total cost for each project, amount requested from Tributary Funds, and which Plan Species Account supported the projects.

Table 7
Projects Reviewed by the Habitat Conservation Plan Tributary Committees under the Small Projects Program in 2018

Project Name	Sponsor	Total Cost	Request from Tributary Committee	Plan Species Account
Larsen Creek Tributary Enhancement	CCNRD	$59,100	$44,200	Not funded
Peshastin Creek RM 8.8 Channel Reconnection: Environmental Site Assessment	CCNRD	$17,700	$17,700	RR: $11,100[1]

Note:

1. The proposal included costs for an appraisal. Because the Committees hire their own appraiser, the budget approved by the Rocky Reach HCP Tributary Committee was reduced accordingly.

In 2018, the Rocky Reach HCP Tributary Committee agreed to fund the following Small Project:

- **Peshastin Creek RM 8.8 Channel Reconnection: Environmental Site Assessment –** for the amount of $11,100 (there was no cost share). This project will conduct a Phase I and, if necessary, a Phase II Environmental Site Assessment within a potential channel reconnection project near RM 8.8 on Peshastin Creek, a tributary to the Wenatchee River. The site appears to have been contaminated with petroleum products. Therefore, an assessment is needed to evaluate the levels of contaminates throughout the project area. This work is needed before funds are spent on reconnecting the channel.

2.3.4.2 Modifications to Small Project Contracts

In 2018, the Rocky Reach HCP Tributary Committee received no requests from sponsors asking for modifications to Small Projects funded by the Committee.

2.3.5 Tributary Assessment Program

The Rocky Reach HCP established the Tributary Assessment Program (separate from the Rocky Reach Plan Species Account) to fund M&E of the relative performance of projects funded by the initial contribution to the Plan Species Account. The Tributary Assessment program comprised a fixed (one time) contribution of $200,000, not subject to inflation adjustment. The Rocky Reach HCP Tributary Committee began funding monitoring projects from the Tributary Assessment Program in 2014, with the funding of the ONA proposal to monitor the effects of spawning platforms as adaptive management for designing and construction of more platforms. This work focuses on quantifying spawners (redd surveys), egg retention (carcass surveys), egg-to-fry success, and habitat conditions (e.g., gravel stability, thalweg slope, fine sediment deposition, and gravel composition) within treated and untreated areas. Monitoring will occur throughout a 5-year period (2014 through 2018).

The Rocky Reach HCP Tributary Committee did not receive any monitoring or assessment applications in 2016 or 2017. In 2018, the HCP Tributary Committees received a monitoring application from Chelan-Douglas Land Trust titled, "Proposal to Provide Supplemental Effectiveness Monitoring in the Gray and Stormy Reaches of the Entiat River." This project was not funded because Assessment Funds can only be used to evaluate enhancement actions funded by Plan Species Accounts. Currently, the HCP Tributary Committees have not funded any of the proposed actions to be implemented in the Gray and Stormy Reaches in the Entiat River.

To date, Chelan PUD has spent $53,738.14 of the original $200,000.00 total for the Rocky Reach HCP Tributary Assessment Program. Of the remaining balance in the Rocky Reach HCP Tributary Assessment Program ($146,261.86), $11,210.84 are allocated to the Penticton Channel Monitoring Spawning Platforms project and $135,051.02 are unallocated.

3 Habitat Conservation Plan Administration

This section lists events of note that occurred in 2018 related to the administration of the HCPs and provides a list of reports published in 2018 that relate to the HCPs.

3.1 Mid-Columbia Habitat Conservation Plan Forums

In 2005 and 2006, Mid-Columbia Forums were held as a means of communicating and coordinating with the non-signatories and other interested parties regarding the implementation of the HCPs. Non-signatory parties at the time of the 2006 meeting included the Confederated Tribes of the Umatilla Indian Reservation and American Rivers. As in 2006 through 2017, these parties were invited by letter in 2018 to participate in a meeting with members of the HCP Coordinating, Hatchery, and Tributary Committees, in conformity with the 2005 FERC Order on Rehearing 109 FERC 61208 and in accordance with the offer to non-signatory parties of non-voting membership in HCP Hatchery and Tributary Committees processes. The non-signatory parties again indicated no interest in attending a meeting with the HCP Committees in 2018.

3.2 Upper Columbia Salmon Recovery Board Integrated Recovery

In 2018, Chelan PUD participated on the UCSRB Hydropower Integrated Recovery Technical Advisory Group, along with Grant and Douglas PUDs, the YN, the CCT, and other state and federal agencies. The Hydropower Integrated Recovery Technical Advisory Group helped review and develop the UCSRB Hydropower Background Summary as part of the UCSRB Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan's recovery strategies across all four Hs (habitat, harvest, hydropower, and hatcheries). The UCSRB Hydropower Background Summary compiles information on this management area and addresses progress in accomplishing established objectives and goals. The UCSRB presented a status update and the draft summary report during the HCP Coordinating Committees meeting on October 23, 2018. The final UCSRB Hydropower Background Summary is expected to be released in early 2019.

3.3 Habitat Conservation Plan Related Reports and Miscellaneous Documents Published in Calendar Year 2018

The following is a list of reports released in 2018 that are related to the implementation of the Rocky Reach HCP:

- Anchor QEA and Chelan PUD (Public Utility District No. 1 of Chelan County), 2018. Annual Report Calendar Year 2016 of Activities Under the Anadromous Fish Agreement and Habitat Conservation Plan Rocky Reach Hydroelectric Project FERC License No. 2145 Prepared for FERC. April 2018.

- Chelan PUD, 2017. Monitoring and Evaluation Reporting Schedule for the Douglas PUD, Grant PUD and Chelan PUD Hatchery Programs. Prepared for Rocky Reach and Rock Island HCP Hatchery Committees. March 13, 2017.
- Chelan PUD, 2018. Chelan PUD Rocky Reach and Rock Island HCPs Final 2018 Fish Spill Report. September 2018.
- Chelan PUD, 2018. 2018 Rocky Reach and Rock Island HCP Action Plan – Final. April 2018.
- Hillman, T., T. Kahler, G. Mackey, Andrew Murdoch, K. Murdoch, T. Pearsons, M. Tonseth, and C. Willard, 2017. Monitoring and evaluation plan for PUD hatchery programs: 2017 update. Report to the HCP and PRCC Hatchery Committees. November 16, 2017.
- Hillman, T., M. Miller, M. Johnson, M. Hughes, C. Moran, J. Williams, M. Tonseth, C. Willard, S. Hopkins, B. Ishida, C. Kamphaus, T. Pearsons, and P. Graf, 2018. *Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs: 2017 Annual Report*. Report to the HCP and PRCC Hatchery Committees. September 15, 2018.
- Keller, L., and S, Hopkins, 2017. 2017 *Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System Final Report*. Prepared for Public Utility District No. 1 of Chelan County. December 2017.
- Keller, L., and S, Hopkins, 2018. *2018 Rocky Reach Juvenile Fish Bypass System Operations Plan*. Prepared for Public Utility District No. 1 of Chelan County. January 2018.
- Mosey, T., 2018. *2018 Fish Spill Plan Rock Island and Rocky Reach Dams*. Prepared for Public Utility District No. 1 of Chelan County. February 27, 2018.
- Public Utility District No. 2 of Grant County, 2018. Final Wenatchee Summer Chinook HGMP Addendum and Preamble. December 13, 2018.
- Tonseth, M., 2018. Draft Upper Columbia River 2018 BY Salmon and 2019 BY Steelhead Hatchery Program Management Plan and Associated Protocols for Broodstock Collection, Rearing/Release, and Management of Adult Returns. Prepared with the Washington Department of Fish and Wildlife. Prepared for NMFS, HCP HC and PRCC Hatchery Sub Committee. April 24, 2018.
- Willard, C., 2018. *Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2019 – Final*. August 2018.
- Willard, C., S. Hopkins, and C. Moran, 2018. *Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)*. March 12, 2018.

Appendix A
Habitat Conservation Plan Coordinating Committees 2018 Meeting Minutes and Conference Call Minutes

FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: February 28, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the January 23, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, January 23, 2018, from 9:00 to 11:45 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Kristi Geris will coordinate with Tracy Hillman (HCP Hatchery Committees Chairman) and will notify the HCP Coordinating Committees of the date the HCP Hatchery Committees plan to tour the new Wells Fish Hatchery (tentatively scheduled for spring 2018; Item I-C).
- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Chelan PUD will request approval of the 2018 Rock Island and Rocky Reach HCP Action Plan during the HCP Coordinating Committees meeting on February 27, 2018 (Item III-A).
- Lance Keller will provide fish rescue numbers for Rock Island and Rocky Reach dams, to Kristi Geris for inclusion in the meeting minutes and distribution to the HCP Coordinating Committees (Item III-B). *(Note: Keller provided these numbers following the meeting on January 23, 2018, which Geris distributed to the HCP Coordinating Committees on January 24, 2018.)*
- Scott Carlon will verify who is currently the National Marine Fisheries Service (NMFS) point of contact for issuing Section 10 incidental take permits for steelhead (Item III-B).
- John Ferguson will notify Tracy Hillman about HCP Coordinating Committees discussions regarding potential modifications to Section 10 incidental take permits to allow 12- to 18-inch steelhead collected in fish ladders during fish rescues associated with fishway winter maintenance outages to be sampled for coded wire tags (CWTs) and identified as to their source (Item III-B). *(Note: Ferguson discussed this with Hillman via email on January 26, 2018.)*
- Douglas PUD will request approval of the 2018 Wells HCP Action Plan during the HCP Coordinating Committees meeting on February 27, 2018 (Item IV-A).
- The Wells HCP Coordinating Committee will submit a vote via email on the Draft 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan to Tom Kahler (and copy Kristi Geris) no

later than February 12, 2018 (Item IV-D). *(Note: the Wells HCP Coordinating Committee approved the plan prior to the deadline, as described under the Decision Summary.)*

- Douglas PUD and the Wells HCP Coordinating Committee will complete the following action items associated with the Douglas PUD 2020 Verification Survival Study (Item IV-E):
  - Keely Murdoch will provide smolt-to-adult return (SAR) data, based on CWTs, for coho salmon released and recaptured at Wells Dam.
  - Tom Kahler will ask John Skalski (Columbia Basin Research) to calculate sample size ranges needed, based on SARs, to achieve precision standards for Wells summer Chinook salmon, Winthrop spring Chinook salmon, and Methow coho salmon; and Kahler will determine if these ranges result in capacity issues at Wells Fish Hatchery.
  - Kirk Truscott will determine the feasibility of using Winthrop spring Chinook salmon from Chief Joseph Hatchery for the study, including transferring the fish to Wells Fish Hatchery for rearing.
  - Tom Kahler will determine whether there are permitting issues for rearing study fish at Wells Fish Hatchery.
  - The Wells HCP Coordinating Committee will continue discussing what potential biological risks exist associated with management of verification survival study fish when they return to spawn.
- Kristi Geris will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) and Julene McGregor (Douglas PUD Information Systems Staff) to add Betsy Bamberger (Douglas PUD Fish Health and Evaluation Specialist) to select HCP Hatchery Committees email distribution lists and provide Bamberger with visitor access to the HCP Hatchery Committees extranet site, as approved by the HCP Coordinating Committees (Item IV-F). *(Note: Geris contacted Montgomery and McGregor, as discussed, on January 24, 2018.)*
- The HCP Coordinating Committees meeting on February 27, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item V-B).

Decision Summary

- The Wells HCP Coordinating Committee representatives approved via email the 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan, as follows: U.S. Fish and Wildlife Service (USFWS) approved on January 25, 2018; Douglas PUD, NMFS, Washington Department of Fish and Wildlife (WDFW), and the Colville Confederated Tribes (CCT) approved on January 26, 2018; and the Yakama Nation (YN) approved on February 2, 2018 (Item IV-D).

Agreements

- HCP Coordinating Committees representatives present agreed to add Betsy Bamberger, the new Douglas PUD Fish Health and Evaluation Specialist, to select HCP Hatchery Committees email distribution lists and provide Bamberger with visitor access to the HCP Hatchery Committees extranet site (Item IV-F).

Review Items

- The Draft 2017 Wells Post-Season Bypass Report (including the appended Draft 2017 Wells Dam Passage Dates Analysis) was distributed to the Wells HCP Coordinating Committee by Kristi Geris on December 29, 2017. The draft report is available for a 60-day review period, with edits and comments due to Tom Kahler by February 27, 2018 (Item IV-C).
- The Draft 2018 Wells HCP Action Plan was distributed to the Wells HCP Coordinating Committee by Kristi Geris on January 22, 2018. The draft plan is available for a 30-day review period, with edits and comments due to Tom Kahler by February 21, 2018 (Item IV-A).
- The Draft 2017 Rocky Reach Juvenile Fish Bypass System Report, Draft 2017 Rock Island Smolt and Gas Bubble Trauma Evaluation Report, Draft 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan, Draft 2018 Rock Island Bypass Monitoring Plan, and Draft 2018 Rock Island and Rocky Reach HCP Action Plan were distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on January 22, 2018. The draft documents are available for a 30-day review period, with edits and comments due to Lance Keller by February 21, 2018 (Items III-A and III-C).
- The Draft 2018 Rock Island and Rocky Reach Fish Spill Plan was distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on February 1, 2018. The draft document is available for a 30-day review period, with edits and comments due to Lance Keller by March 2, 2018 (Item III-C).
- The Draft 2017 Wells HCP Annual Report was distributed to the Wells HCP Coordinating Committee by Kristi Geris on February 7, 2018. The draft report is available for a 30-day review period, with edits and comments due to Kristi Geris by March 7, 2018 (Item VI-A).
- The Draft 2017 Rock Island and Rocky Reach HCP Annual Reports were distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on February 14, 2018. The draft reports are available for a 30-day review period, with edits and comments due to Kristi Geris by March 15, 2018 (Item VI-A).

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Tom Kahler added: 1) Wells Dam fishway maintenance update; and 2) HCP Hatchery Committees email distribution list and extranet access – Betsy Bamberger.
- Scott Carlon added Columbia River sockeye salmon stocks and whirling disease.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft December 12, 2017 meeting minutes. Kristi Geris said she added under the review items the several documents that were recently distributed for review. She said all other comments and revisions received from members of the Committees were incorporated into the revised minutes. Tom Kahler requested one more addition under the Douglas PUD 2020 Survival Verification Study agenda item, explaining that historically, Douglas PUD has not needed to use acoustic tags because there has been no need to determine route-specific survival at Wells Dam. This was discussed during the meeting on December 12, 2017, but was inadvertently not included in the minutes. This addition was made, as requested.
HCP Coordinating Committees members present approved the December 12, 2017 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees conference call on December 12, 2017, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on December 12, 2017):*

- *Kristi Geris will coordinate with Tracy Hillman and will notify the HCP Coordinating Committees of the date the HCP Hatchery Committees plan to tour the new Wells Fish Hatchery (tentatively scheduled for spring 2018; Item II-C).*
  This action item will be carried forward.
- *Chelan PUD will provide the Final 2017 Rock Island and Rocky Reach Fish Spill Program Report to Kristi Geris for distribution to the HCP Coordinating Committees (Item II-C).*
  Lance Keller provided the final report to Geris following the HCP Coordinating Committees meeting on December 12, 2017, which Geris distributed to the HCP Coordinating Committees on December 13, 2017.
- *The Rock Island HCP Coordinating Committee will submit edits, comments, or indication of no comments on the Application for Non-Capacity Amendment for Coyote Dunes, to Jeff Osborn*

(Chelan PUD) and Lance Keller (and copy Kristi Geris) no later than December 15, 2017 (Item III-B).
All Rock Island HCP Coordinating Committee representatives responded to Chelan PUD by December 14, 2017.

- *Kristi Geris will resend the email detailing the Application for Non-Capacity Amendment for Coyote Dunes for review, to the Rock Island HCP Coordinating Committee (Item III-B).*
  This email was re-distributed to the HCP Coordinating Committees by Geris on December 13, 2017.
- *Lance Keller will verify internally that Chelan PUD has addressed cultural resource impacts, if any, associated with the Application for Non-Capacity Amendment for Coyote Dunes (Item III-B).*
  Keller verified that Chelan PUD has initiated the appropriate actions regarding addressing potential cultural resource impacts associated with this amendment, as explained in an email distributed to the HCP Coordinating Committees by Keller following the meeting on December 12, 2017, and by Kristi Geris on December 13, 2017.
- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item IV-B).*
  This action item will be carried forward.
- *The Wells HCP Coordinating Committee will submit edits and comments on the Draft 2017 Wells Dam Passage Dates Analysis to Tom Kahler no later than January 5, 2018 (Item IV-B).*
  This will be discussed during today's meeting.
- *Douglas PUD will provide a matrix outlining the pros and cons for potential study species to use in the Douglas PUD 2020 Survival Verification Study (including such details as species selection, release location, and tag type), for further discussion and decision in January 2018 (Item IV-C).*
  Tom Kahler provided this matrix to Kristi Geris on January 17, 2018, which Geris distributed to the HCP Coordinating Committees that same day. This will be further discussed during today's meeting.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on January 11, 2018:

- *Policies and Procedures for Funding Projects*: The HCP Tributary Committees reviewed and edited sections of the Policies and Procedures document for clarity and to reflect a more logical order.

- *Operating Procedures*: Chelan PUD designated Catherine Willard as the voting member and Scott Hopkins as the alternate on the Rock Island and Rocky Reach HCP Tributary Committees. The YN designated Brandon Rogers as the alternate on all three HCP Tributary Committees (Wells, Rocky Reach, and Rock Island).
- *Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screens Project*: The HCP Tributary Committees received a General Salmon Habitat Program proposal from WDFW titled, "Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screen Project." WDFW and Trout Unlimited provided a presentation describing the project. The purpose of the project is to bring both the Icicle-Peshastin Irrigation District (IPID) and City of Leavenworth screens into compliance to protect all fish species and life stages from injury, entrainment, and mortality. The diversions are located at river mile 5.8 on Icicle Creek. The proposed work will complement the Icicle Creek – Boulder Field – Wild Fish to Wilderness Project. The total cost of the screening project is about $2.4 million. The sponsor requested $476,000 from HCP Plan Species Account Funds. Although the HCP Tributary Committees support fish passage, the application was found to be incomplete and additional information was requested, including: 1) IPID and the City of Leavenworth need to demonstrate the ability to fund the project, including incorporating respective contributions as line items in the budget; and 2) there can be no strings attached to the funding and implementation of the project. The latter is regarding a letter IPID provided stating, "This agreement would have to have an incidental take permit and hold harmless agreement to cover our continued diversion with our current screens until our new screens are constructed at no cost to the Districts." The HCP Tributary Committees found this to be unacceptable and requested a letter from IPID stating that installation of the screens is not contingent on any other agreements. Once the requested additional information is received, the HCP Tributary Committees will reevaluate the proposal.
- *Upper Columbia Science Conference*: The conference will be held January 24 and 25, 2018, in Wenatchee, Washington, and is hosted by the Upper Columbia Salmon Recovery Board.
- *HCP Tributary Committees Meeting Dates*: The HCP Tributary Committees will continue to meet on the second Thursday of each month in 2018.
- *Next meeting*: There will be no meeting in February 2018. The next meeting of the HCP Tributary Committees will be on March 8, 2018.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on January 17, 2018:

- *Coho Salmon Statement of Agreement*: The Rock Island and Rocky Reach HCP Hatchery Committees approved the draft Statement of Agreement (SOA) regarding Chelan PUD's coho salmon obligation. This SOA included the funding arrangement with the YN. The SOA describing the methodology for meeting Chelan PUD's coho salmon obligation was approved last November 2017.

- *Request for Steelhead Gametes for 2018 Egg-to-Emergence Evaluation*: Chelan PUD requested steelhead gametes to conduct a steelhead egg-to-emergence survival study in the habitat channel of the Chelan River. This study is a requirement of their Federal Energy Regulatory Commission (FERC) license. The HCP Hatchery Committees agreed that Douglas PUD will provide Chelan PUD with four female and four male surplus hatchery-by-hatchery (HxH) steelhead collected from the volunteer channel at Wells Fish Hatchery in spring 2018. Chelan PUD will spawn the fish at Eastbank Fish Hatchery, incubate the fish to the eyed-egg stage, and use the fish in the survival study. John Ferguson asked about the genesis for this requirement. Hillman explained that this study is part of the FERC license requirement for operating Chelan Falls Dam. He said a habitat channel was built near the tailrace in the Chelan River, and Chelan PUD needs to conduct egg-to-fry studies to verify the habitat is serving its proposed purpose. Hillman said he believes these studies are required for both steelhead and summer/fall Chinook salmon. He said the study has been completed for summer/fall Chinook salmon, and now Chelan PUD is completing the study for steelhead.
- *Draft 2018 Rock Island and Rocky Reach HCP Action Plan*: The Rock Island and Rocky Reach HCP Hatchery Committees approved the hatchery portion of the plan.
- *Steelhead Acclimation*: As required by their permit, Chelan PUD is proposing to evaluate residualism using 25,000 HxH steelhead that were destined for Blackbird Pond. These fish would be moved from the "Enzyme-Linked Immunosorbent Assay (ELISA)" pond, which is supplied with Chiwawa River water, to Raceway No. 2, which is supplied with Wenatchee River water. Raceway No. 2 currently supports HxH and wild-by-wild steelhead, which are differentially marked. The 25,000 HxH fish will be split into three size groups (small, medium, and large), with each group marked differently. Chelan PUD and WDFW will prepare a release plan for review. The HCP Hatchery Committees approved the transfer of HxH steelhead from the "ELISA" pond to Raceway No. 2.
- *Brood Year 2017 Chelan Falls Summer Chinook Salmon Culling*: Due to high ELISA levels in female summer Chinook salmon broodstock for the Chelan Falls Summer Chinook Salmon Program, WDFW asked permission from the Rock Island and Rocky Reach HCP Hatchery Committees to cull eyed-eggs from females with ELISA values greater than 0.12. This equates to culling about 35,000 eyed-eggs. As a result of higher than expected ELISA values, relatively high pre-spawn mortality, and less than expected fecundities, the program will likely fall short of its release goal of 576,000 smolts. The Rock Island and Rocky Reach HCP Hatchery Committees approved the culling.
- *Draft 2018 Wells HCP Action Plan*: The Wells HCP Hatchery Committee is reviewing the hatchery portion of the action plan and will likely approve the plan in February 2018.

- *Wells and Methow Fish Hatcheries Transition*: Douglas PUD has fully staffed both the Wells and Methow fish hatcheries and hired Betsy Bamberger as their fish health expert. The Wells Fish Hatchery modernization is mostly complete and National Pollutant Discharge Elimination System permits are in place. The HCP Hatchery Committees will likely hold a meeting at the new facility in April or May 2018.
- *Twisp River Steelhead*: Last year, the Wells HCP Hatchery Committee convened a subgroup charged with developing management strategies for steelhead conservation programs in the Methow River Basin that would increase effective population size and allow local adaptation of Twisp steelhead. The subgroup submitted a memo to the Wells HCP Hatchery Committee outlining four alternatives, and the Committee agreed to implement Alternative 3 (the preferred alternative) as a pilot study in 2018. This preferred alternative balances effective population size with factors enhancing local adaptation.
- *National Marine Fisheries Service Consultation Update*: The Wenatchee steelhead permit was issued and the Biological Opinion (BiOp) for the unlisted programs in the upper Columbia River was signed on December 26, 2017. NMFS is still waiting on approval of the Section 10 permit.
- *U.S. Fish and Wildlife Service Bull Trout Consultation Update*: All Section 7 consultations are complete.
- *Timeline of Changes in Hatchery Programs*: The HCP Hatchery Committees are still working on timelines of major hatchery program changes for spring Chinook salmon, summer Chinook salmon, steelhead, and sockeye salmon. The timelines will inform statistical analyses for the 5-year statistical and 10-year comprehensive reports.
- *Chief Joseph Hatchery Update*: The summer/fall Chinook salmon broodstock experienced significant mortalities because of columnaris disease. Natural-origin fish suffered higher mortalities than hatchery-origin fish. As a result, the program will not release subyearlings; rather, all fish will be released as yearlings. Columnaris is a recurring issue at Chief Joseph Hatchery and is likely related to the warm temperatures of their well water (61°F or 16°C). Hatchery staff are working to reduce stressors. Ferguson suggested drilling deeper wells. Kirk Truscott said the wells are deep already. He said temperature probes are installed in the wells, and some are colder than others. He said October is when columnaris is an issue, which is a time of year when all available water is needed, and water from each well all goes to the same head box where it is mixed. He said the CCT are considering operational modifications to reduce stress, including potentially dividing the adult holding ponds to minimize handling effects. He said the CCT may also pursue securing funding from the Bonneville Power Administration (BPA). He recalled when piping was installed to convey colder water to the head box, the CCT made it clear to BPA they were deferring, not eliminating, facilities in the design to better manage water temperatures; therefore, accessing additional water may be an

option. Mike Tonseth (WDFW) asked if this additional water is considered pathogen free? Truscott said it is.

- *Next meeting*: The next meeting of the HCP Hatchery Committees will be on February 21, 2018.

III. Chelan PUD

A. Draft 2018 Rock Island and Rocky Reach HCP Action Plan (Lance Keller)

Lance Keller said the Draft 2018 Rock Island and Rocky Reach HCP Action Plan was distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on January 22, 2018. The draft plan is available for a 30-day review period, with edits and comments due to Keller by February 21, 2018. Keller said the plan is similar to past years, with only two differences (additions) from the 2017 plan: 1) update the HCP Coordinating Committees on Rocky Reach Dam large unit repairs; and 2) update the HCP Coordinating Committees on Rock Island Dam Powerhouse 1 Turbine Units B1 to B4 repairs.

Chelan PUD will request approval of the 2018 Rock Island and Rocky Reach HCP Action Plan during the HCP Coordinating Committees meeting on February 27, 2018.

B. Rocky Reach and Rock Island Adult Fishway Maintenance Updates (Lance Keller)

Lance Keller reviewed maintenance updates at Rocky Reach Dam and Rock Island Dam, as follows:

<u>Rocky Reach Dam</u>

Keller recalled, during the HCP Coordinating Committees meeting on December 12, 2017, discussing that the upper adult fish ladder at Rocky Reach Dam was taken offline for annual winter maintenance on December 11, 2017, and a fish rescue was conducted in the upper ladder that same day. He said on December 19, 2017, the lower ladder was dewatered for maintenance and a fish rescue was performed that same day. Keller reviewed the species that were recovered from the lower ladder, as follows:

Species	Stage/Length	Clip	Count
Pacific lamprey	adult	NA	48
Rainbow/steelhead	NR	ad-present	14
	NR	ad-clipped	16
	14 inches	ad-clipped	5
	16 inches	ad-clipped	2
	18 inches	ad-clipped	1
Whitefish	NR	NA	150
Sucker	NR	NA	75
Pikeminnow	NR	NA	8
Shiner	NR	NA	2

Species	Stage/Length	Clip	Count
Chiselmouth	NR	NA	6
Sculpin	NR	NA	3
Chinook salmon	juvenile	ad-present	1

Notes:
ad: adipose
NA: not applicable
NR: not reported

Keller said he will provide fish rescue numbers for Rocky Reach and Rock Island dams to Kristi Geris for inclusion in the meeting minutes and distribution to the HCP Coordinating Committees. *(Note: Keller provided these numbers following the meeting on January 23, 2018, which Geris distributed to the HCP Coordinating Committees on January 24, 2018.)*

Keller recalled, during the HCP Coordinating Committees meeting on December 12, 2017, discussing the high number of rainbow/O. mykiss (*Oncorhynchus mykiss*) rescued from the upper ladder at Rocky Reach Dam. Keller said he reviewed the numbers and typically O. mykiss dominates. He said he believes hatchery fish have been more common opposed to wild fish, and although he cannot speak to life stage with certainty, the fish are in the 12- to 18-inch range.

Mike Tonseth asked if Chelan PUD has considered lethal removal of O. mykiss? He said he believes there may be value in removing CWTs to try identifying source. Keller said this is an interesting question he has never considered. He said unless the fish is a pikeminnow, Chelan PUD returns rescued fish to the river. Tom Kahler noted that the new Section 10 incidental take permits for steelhead have not yet been issued and suggested incorporating a provision in the new permits. Tonseth said he sees no issues with this, noting that this may fall under adult management. Keller added that it seems obvious these fish are not anadromous. Kahler asked who currently is the NMFS point of contact for issuing Section 10 incidental take permits for steelhead? Scott Carlon said he can find out.

John Ferguson said he will also notify Tracy Hillman about HCP Coordinating Committees discussions regarding potential modifications to Section 10 incidental take permits to allow 12- to 18-inch steelhead collected in fish ladders during fish rescues associated with fishway winter maintenance outages to be sampled for CWTs and identified as to their source. *(Note: Ferguson discussed this with Hillman via email on January 26, 2018.)*

Keller said currently, the lower ladder at Rocky Reach Dam is still dewatered. He said maintenance is underway. He said the contractor repairing the 30-inch raw water valve is onsite and everything is progressing as planned. He said the lower ladder should be back to service by the end of February 2018.

Rock Island Dam

Keller recalled that the right ladder at Rock Island Dam was taken offline for annual winter maintenance on December 4, 2017. He said the ladder was back in service on December 15, 2017. He said during this short outage, engineers completed an inspection of the ladder, including inspecting the new sluice gate, RO4, installed during the 2015/2016 winter maintenance. He said everything tested well with the new gate.

Keller said the left ladder at Rock Island Dam was taken offline for annual winter maintenance on December 18, 2017, and was back in service on January 15, 2018. Keller reviewed the species that were recovered from the left ladder, as follows:

Species	Stage/Length	Clip	Count
Pacific lamprey	ammocoete	NA	1
Rainbow/steelhead	NR	ad-present	13
Red sided shiner	NR	NA	2
Chinook salmon	adult	ad-present	1
		ad-clipped	1
Carp	adult	NA	1

Notes:
ad: adipose
NA: not applicable
NR: not reported

Keller said the center ladder at Rock Island Dam was taken offline for annual winter maintenance on January 8, 2018, and a fish rescue was conducted in the center ladder that same day. Keller reviewed the species that were recovered from the center ladder, as follows:

Species	Stage/length	Clip	Count
Rainbow/steelhead	NR	ad-present	13
		ad-clipped	1
Sucker	NR	NA	1
Sculpin	NR	NA	1

Notes:
ad: adipose
NA: not applicable
NR: not reported

Keller said the center ladder will be returned to service next week. He said the mechanic crew is currently verifying the integrity of the recently rehabilitated lower ladder attraction water valves. He added that all maintenance at Rocky Reach and Rock Island dams could be complete by the first week in February 2018.

C. Draft Rock Island and Rocky Reach 2017 Reports and 2018 Study Plans (Lance Keller)

Lance Keller said the Draft 2017 Rocky Reach Juvenile Fish Bypass System Report, Draft 2017 Rock Island Smolt and Gas Bubble Trauma Evaluation Report, Draft 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan, and Draft 2018 Rock Island Bypass Monitoring Plan were distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on January 22, 2018. The draft documents are available for a 30-day review period, with edits and comments due to Keller by February 21, 2018.

Keller said additional upcoming documents for review include the Draft 2017 Pikeminnow Removal Program Report, and the Draft 2018 Rock Island and Rocky Reach Fish Spill Plan. He said the latter is included in a FERC-required Rocky Reach Dam Operations Plan and therefore has time sensitivity associated with it. *(Note: the Draft 2018 Rock Island and Rocky Reach Fish Spill Plan was distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Geris on February 1, 2018. The draft document is available for a 30-day review period, with edits and comments due to Keller by March 2, 2018.)*

IV. Douglas PUD

A. Draft 2018 Wells HCP Action Plan (Tom Kahler)

Tom Kahler said the Draft 2018 Wells HCP Action Plan was distributed to the Wells HCP Coordinating Committee by Kristi Geris on January 22, 2018. The draft plan is available for a 30-day review period, with edits and comments due to Kahler by February 21, 2018.

Kahler said the Wells HCP Hatchery Committee reviewed the hatchery portion of the action plan last week; however, that portion has since changed. He said the HCP Coordinating Committees portion is located on the first page of the action plan. John Ferguson asked if anything has changed from last year. Kahler said the only new item is the survival verification study. Kahler asked the Wells HCP Coordinating Committee to review the action plan, let him know if there is anything to add, and Douglas PUD will request approval of the 2018 Wells HCP Action Plan during the HCP Coordinating Committees meeting on February 27, 2018.

Kirk Truscott asked if there will be any additional passive integrated transponder (PIT)-tag antennas installed in 2018. Kahler said additional PIT-tag antennas might be installed at the outlets of all four dirt ponds. He said currently, Pond 4 is monitored as fish are pumped into trucks. He said fish in Ponds 2 and 3 are conveyed into a raceway and released from the raceway to Columbia River via the

Wells Fish Hatchery volunteer channel, and Pond 1 is a direct release into the Columbia River via the volunteer channel. He said currently, there is no way to monitor these direct releases into the river, but there is a desire to. He said there is a convenient location behind the screen, but this location might be noisy. He said another possible location is in the pipe where it dumps into the volunteer channel; however, this location is not ideal because it empties to the volunteer channel just upstream of one of the weirs. He said there has been some consideration in extending the pipe to the corner; however, sometimes this area gets inundated by 10 to 15 feet of water (tailwater). Ferguson asked what is driving the need for PIT detections? Kahler said various permits held by Douglas PUD require the District to evaluate, by any means possible, whether fish are residualizing. He said tag detection at release is important to understand because fish are placed in ponds in the fall; however, it is unknown how many tagged fish actually leave each pond.

Kahler said, with regard to the PIT detection system installed in Spill Bay 2, Douglas PUD wants to leave this system as is and collect a few years of data before changing anything. He said Douglas PUD will never wire up the entire spillway. He said if anything, additional antennas might be installed at the far other end, at Spill Bay 10 (the other top-spill bay). Ferguson asked if this is where the thalweg is located, and Kahler said yes. Kahler said he is interested to see how the detection system in Spill Bay 2 performs this year, because last year there was a lot of involuntary spill and subyearlings were likely passing Wells Dam via that route. He said additionally last year, maintenance was being performed on Turbine Units 1, 2, and 4, and Spill Bay 2 is located over Turbine Unit 2, so there was a problem with attraction flow in that area. Andrew Gingerich (Douglas PUD Aquatic Settlement Work Group Technical Representative) asked when the PIT detection system in Spill Bay 2 was in service last year. Kahler said it was in service at the start of the bypass season, but at that time last year, the project was already spilling.

B. Wells Dam Fishway Maintenance Update (Tom Kahler)

Tom Kahler said currently, the west fishway at Wells Dam is offline for winter maintenance and will be back in service on January 24, 2018. He said the east fishway will be taken out of service next week and is the shorter of the two maintenance outages. He recalled longer and shorter maintenance outages for each fishway rotate every year. He said this year, the shorter routine maintenance is planned for the east fishway. He said a little more than 2 weeks are noted for this maintenance in the Draft 2018 Wells HCP Action Plan.

C. Wells Dam 2017 Post-Season Bypass Report (Tom Kahler)

Tom Kahler said the Draft 2017 Wells Post-Season Bypass Report (including the appended Draft 2017 Wells Dam Passage Dates Analysis) was distributed to the Wells HCP Coordinating Committee by Kristi Geris on December 29, 2017. The draft report is available for a 60-day review period, with edits and comments due to Kahler by February 27, 2018. Kahler said similar to past years' reports, the first page is a summary of bypass operations and the rest of the document is the passage dates analysis. John Ferguson recalled discussing this document over the last few meetings, notably with regard to separating out wild versus hatchery fish. Ferguson said Douglas PUD has an action item to further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees. Kahler said he is still working on this action item.

D. 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan (Tom Kahler and Andrew Gingerich)

Kristi Geris recalled the Draft 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan was distributed to the Wells HCP Coordinating Committee by Geris on January 16, 2018. The draft plan is available for review with an email vote due to Tom Kahler (and copy Geris) by February 12, 2018.

Kahler said when Douglas PUD obtained the new FERC license in 2012, the license stipulated that a gas abatement plan and bypass operating plan are due to FERC each year by February 28. He said the requirement is to submit a combined document, but approval from the Wells HCP Coordinating Committee is only needed on the bypass operating plan. He said the license requires only "consultation" with the Wells HCP Coordinating Committee on the gas abatement plan.

John Ferguson asked if anything has changed in these plans from last year. Kahler said no, the plans are identical to last year. Andrew Gingerich said these same plans have been produced and implemented since 2013. He recalled that last year, Jim Craig submitted comments to make the document stronger, but the document is largely the same iteration each year with small changes based on comments received.

The Wells HCP Coordinating Committee will submit a vote via email on the Draft 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan to Kahler (and copy Geris) no later than February 12, 2018.

(Note: the Wells HCP Coordinating Committee representatives approved via email the 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan, as follows: USFWS approved on January 25, 2018; Douglas PUD, NMFS, WDFW, and the CCT approved on January 26, 2018; and the YN approved on February 2, 2018.)

E. Wells Project 2020 Survival Verification Study - Study Species (Tom Kahler)

Tom Kahler said the task at hand is to select a study plan species to represent all yearling spring-migrating HCP Plan species. He said discussions to date have included identifying various pros and cons of each species, and the HCP Coordinating Committees suggested that Douglas PUD provide a matrix outlining the pros and cons for potential study species to use in the Douglas PUD 2020

Survival Verification Study (including such details as species selection, release location, and tag type), for further discussion. Kahler said he provided a Comparison Matrix of Potential Study Subjects for the Wells Project 2020 Survival Verification Study (Attachment B) to Kristi Geris on January 17, 2018, which Geris distributed to the HCP Coordinating Committees that same day. Kahler said in reviewing Attachment B, it seems obvious why Douglas PUD is proposing to use yearling summer Chinook salmon for the study. He said this species is the simplest, has a lot of advantages, and very few disadvantages.

Mike Tonseth asked how many study fish are needed, and what is the proposed detection methodology. Kahler said the sample size for the 2010 survival study was approximately 80,000 fish. He said this sample size easily met the precision targets for juvenile survival and met (although it was close) the precision targets for the delayed mortality requirement. He said Douglas PUD may propose a larger sample size for the 2020 study, suggesting perhaps 85,000 fish. He said sample size will ultimately be based on the results of a power analysis, SARs, and which stocks are used for the study. He said PIT tags will be used, which are required in order to evaluate delayed mortality.

Kahler said on January 19, 2018, he requested that mid-Columbia River coho and summer Chinook salmon SARs be added to the SAR estimator tool on the Columbia River Data Access in Real Time database (DART) site (http://www.cbr.washington.edu/dart/query/pit_sar_esu). He said as of yesterday, January 22, 2018, these data have been added and are available for review. He noted, however, there is no way to exclude mini jacks from the SAR estimates. He explained that SARs drive sample size when evaluating delayed mortality, and based on the new data available in DART, PIT-tag-based spring Chinook salmon SARs are approximately half those of yearling summer Chinook salmon SARs, not the approximately 1/10th reported in the matrix, which value was based on SARs derived from CWTs (see under spring Chinook salmon cons in Attachment B). He asked if the YN use CWTs for coho salmon. Keely Murdoch said CWTs have been used in past years; however, the YN are transitioning to parentage-based tagging. Murdoch said she believes only CWTs have been used to date, but she would need to verify this. She added that a draft 2016 report, which contains SARs data for coho salmon will be available for review soon.

Kahler reviewed SAR data off of DART using the SAR category "Rocky Reach (All) to Bonneville Adult" (i.e., adult returns to Bonneville Dam of juveniles detected at the Rocky Reach Juvenile Fish Bypass System [RRJFBS]), based on PIT-tags, and compared those with CWT-based SARs reported in the 2016 annual monitoring and evaluation report for hatchery programs funded by Douglas PUD. He said, however, because the study will employ PIT-tags, and PIT-tag returns will be used to estimate delayed mortality, the PIT-tag data provides the relevant information for determining sample size and comparing candidate study subjects. He said data based on CWTs are not identical to PIT-tag data.

Tonseth said he anticipates the sample size required for spring Chinook salmon (springers) would be higher than for summer/fall Chinook or coho salmon. He asked about the number of PIT detections at RRJFBS for springers. Kahler said detections range from 4,028 to 11,055 for spring Chinook salmon and from 4,900 to 42,000 for summer Chinook salmon.

John Ferguson asked what SAR was used in the power analysis for the 2010 study. Kahler said he cannot recall and would need to review the report.

Kahler said he does not believe there were many PIT-tagged summer Chinook salmon (summers) above Wells Dam at the time of the 2010 study. Tonseth said there would have been from the Carlton and Similkameen programs.

Kahler continued reviewing Attachment B. Murdoch noted that coho salmon usually always come back as 3-year-olds.

Tonseth asked if the Wells HCP Coordinating Committee has considered tagging additional springers from the segregated harvest program at Chief Joseph Hatchery. He said using these fish would have the same benefits as using summers; however, instead of producing additional summers for the study, the verification study would use however many additional springers are already being produced upstream at Chief Joseph Hatchery. He said these fish could be released at the mouth of the Okanogan River, mouth of the Methow River, and downstream of Wells Dam, without the Endangered Species Act (ESA)-related issues associated with using fish from the Methow Safety-Net and Okanagan River Section 10(j) programs.

Kirk Truscott said the CCT would have to think about this with regard to risk and logistics. He added that there is no history of SARs for these fish. Kahler said without SARs, understanding sample size will be tricky. He said Douglas PUD conducts this study every 10 years and suggested if springers from Chief Joseph Hatchery are not used in 2020, this idea can be further discussed and evaluated for use in the 2030 study. Truscott said whatever species is chosen, there should be equal release strategies, and the releases should also be volitional. Kahler said Douglas PUD randomly assigns fish to a release container so there is no bias with rearing vessels. Truscott said the CCT holds all fish in one large pond, which at full program is about 700,000 fish. Kahler asked if Chief Joseph Hatchery is setup to segregate out a proportion of those fish, and Truscott said probably not.

Ferguson asked where the summers will come from, and Kahler said from Wells Fish Hatchery. Tonseth said another concern with summers is the BiOp recently issued for upper Columbia River summer Chinook salmon did not include fish for the verification study. Kahler said summers for this study will come out of Douglas PUD’s yearling production, so the fish will already be permitted.

Ferguson recalled discussing in past meetings that a decision is needed no later than February 2018. Truscott asked why the urgency? Kahler clarified that at least 85,000 fish will be used from the 320,000-fish program. Truscott said if the study fish are part of the 320,000-fish program, making a decision by February 2018 is not an issue for the annual Broodstock Collection Protocols.

Truscott questioned the release location at the mouth of the Okanogan River, noting that Wells Project effects reach farther (up to 14 miles) upstream than just at the mouth. He said this may not be a true accounting of Project-level mortality out of the Okanogan Basin. Kahler said the Wells HCP stipulates releasing at the mouth. Ferguson added, for comparability, the release locations should be the same places as in the 2010 study. Kahler also clarified that Project effects extending 14 miles into the Okanogan River are only under extreme conditions, and conditions in the reach are typically really turbid anyway. Andrew Gingerich added that the challenges the Okanogan River faces is not just because of Project influence, but rather a host of other environmental changes which have occurred over the last several decades.

Truscott questioned using Wells Fish Hatchery stock for release at the mouth of the Okanogan River with regard to straying into the Okanogan River. He suggested possibly reviewing past CWT recovery data to determine how many fish from the 2010 study may have strayed into the Okanogan River. Tonseth said WDFW may have the same concern with releases at the mouth of the Methow River. He said Chinook salmon do not seem to have as strong of a sense for homing compared to steelhead when truck-planted. Truscott added that Wells Fish Hatchery stock are a more domesticated stock. He said the issue associated with reviewing the spawning contribution data from 2010 is that the 2010 study fish were only PIT-tagged, not CWT-tagged. Tonseth suggested reviewing adipose-clipped, not CWT-tagged fish, and assume those were Wells Fish Hatchery stock. Truscott said if he finds something interesting he will bring it back to the HCP Coordinating Committees.

Kahler said if the Wells HCP Coordinating Committee proposes using spring Chinook salmon from Chief Joseph Hatchery, this will need to be reviewed and approved by Douglas PUD policy staff. Kahler asked about transferring the study fish to Wells Fish Hatchery when the fish are ready to pond out to the acclimation sites. Truscott said the CCT will likely be opposed to this because the fish will then likely home to Wells Dam. Tonseth said this also increases the risk of straying to the Methow River. Kahler said there is so much riding on a survival study, he has a strong reluctance for someone else raising study fish for a Douglas PUD study. Jim Craig asked if Douglas PUD could use both springers from Chief Joseph Hatchery and summers from Wells Fish Hatchery. Craig said if something happens to one stock, use the other. Tonseth noted this is still predicated on the CCT being able to do this. Truscott said even if these fish could be separated, this still means releasing a non-listed fish at the confluence of a river where the goal is to increase endemic species. He said he is not sure the CCT want to do this.

Kahler said the results of this survival study have the potential to affect compensation; however, survival is evaluated as a multi-year average, so results would need to be extreme to affect compensation. Ferguson asked if Douglas PUD has calculated what level of survival in the 2020 study would result in the Project no longer being in compliance. Kahler said the verification study estimate can be no less than 93% survival, and if the survival is 93% in 2020, the resulting 5-year estimate would be 95.6%. He said if Douglas PUD fails to achieve 93%, the study can be repeated two more times, and then can result in operational changes if the standard is not achieved. Lance Keller said this can also result in phase designation changes.

Murdoch said in Attachment B, under coho salmon, the bullet indicating "Coho have a tendency to rear in reservoirs upstream of McNary Dam rather than exhibit obligatory migratory behavior" is not consistent with the YN data. She said it does occur; however, it is about 0.1%. She asked if this is just a belief of some managers, or does Douglas PUD have data she has not seen. Kahler said this statement is based on the Turtle Rock Program. Murdoch said she does not believe this is true anymore. She recalled the Turtle Rock Program had many issues, which is why it was discontinued. Kahler said this statement does not necessarily represent coho salmon programs today; however, it has happened in the past. Murdoch said the YN have release data from Wells Dam and she recalls those fish did really well. She said she will provide these data, even though they are based on CWTs.

Craig asked if Douglas PUD chooses to study springers and the study fails, is the retest done with springers again? He cautioned making sure there is sufficient broodstock, if needed. Tonseth said if the same species is consistently used to reflect survival for any other yearling-sized species, this makes a broad assumption without other data. He said when evaluating long-term, mitigation responsibilities, as some point, managers need to step outside of the box and use other HCP Plan species to be sure assumptions are true. Kahler said to date, Douglas PUD has conducted 2 years of steelhead and 2 years of summer Chinook salmon survival studies. Murdoch said the YN need to further discuss this internally and prefers not to vote today. She said she likes the idea of studying untested species like springers and coho salmon; however, she also understands these come with more risks. She said she likes coho salmon because no regional PUD has studied coho salmon. She said she does not feel any of these species choices will cause huge issues, and she is curious what other Wells HCP Coordinating Committee representatives are thinking.

Ferguson recalled from the HCP Coordinating Committees meeting on October 24, 2017, the discussion that there are no coho salmon in the Okanogan River, and if this species is chosen there will only be a Methow River release. Kahler clarified the Wells HCP indicates that Project survival will be studied using yearling Chinook salmon and steelhead originating from the Okanogan Basin. He said the HCP does not prevent releases of coho salmon at the mouth of the Okanogan River, but it also does not say coho salmon should be released at the mouth of the Okanogan River.

Tonseth said he still likes the idea of using spring Chinook salmon and suggested using springers from the Methow Safety-Net Program, even though these fish are ESA-listed. He said this program includes 600,000 juveniles—200,000 Section 10(j) Okanagan River and 400,000 Methow River fish. He suggested planning ahead to produce and PIT-tag 30,000 Section 10(j) Okanogan River fish, so releasing fish at the mouth of the Okanogan River will now be a non-issue. He said using 30,000 fish from Winthrop National Fish Hatchery will represent the Methow River releases. He said this plan gets over the hurdles discussed regarding use of Chief Joseph program springers. Ferguson asked about permit issues. Tonseth said there are only permit issues for releases within the tailrace. Kahler said considering SARs, this plan to use spring Chinook salmon may double the required sample size, which may result in capacity issues at Wells Fish Hatchery.

Ferguson asked what next steps are needed to use a new species for the 2020 study. Tonseth said it seems Douglas PUD needs to figure out what the sample sizes will be. Kahler said he can coordinate with John Skalski on this. Ferguson said this may not be one number; rather, a range depending on recent ocean conditions.

Truscott said summer Chinook salmon seem to be the easiest choice and are consistent with past studies. Kahler said coho salmon seem to be the next easiest. Murdoch said spring Chinook salmon seem to be the most difficult choice and have possible permitting issues. Tonseth said from a permitting standpoint, the biggest issue is raising spring Chinook salmon at Wells Fish Hatchery, which is inconsistent with the intent of the current permit.

Douglas PUD and the Wells HCP Coordinating Committee will complete the following action items associated with the Douglas PUD 2020 Verification Survival Study:

- Murdoch will provide SAR data, based on CWTs, for coho salmon released and recaptured at Wells Dam.
- Kahler will ask John Skalski to calculate sample size ranges needed, based on SARs, to achieve precision standards for Wells summer Chinook salmon, Winthrop spring Chinook salmon, and Methow coho salmon; and Kahler will determine if these ranges result in capacity issues at Wells Fish Hatchery.
- Truscott will determine the feasibility of using Winthrop spring Chinook salmon from Chief Joseph Hatchery for the study, including transferring the fish to Wells Fish Hatchery for rearing.
- Kahler will determine whether there are permitting issues for rearing study fish at Wells Fish Hatchery.
- The Wells HCP Coordinating Committee will continue discussing what potential biological risks exist associated with management of verification survival study fish when they return to spawn

Craig said he will also discuss this topic with USFWS hatchery staff.

Tonseth said perhaps the most efficient path forward is to use summers for this check-in in 2020, and if data are consistent with the 2010 study, make a commitment to select an alternate species for the next check-in in 2030. He said this gives the HCP Coordinating Committees time to work out the details and is also a plan to make sure assumptions are consistent across all species.

Chad Jackson said he is also supportive of using summer Chinook salmon for the 2020 check-in, but agrees with Tonseth about the need to memorialize the commitment to evaluate other species at the next check-in. Tonseth noted that another consultation will be underway by then, and it would be good to have these components included in the new permits, instead of back-tracking. Ferguson suggested the Wells HCP Coordinating Committee discuss developing an SOA at a future meeting to memorialize the discussions, decision, basis for the decision, and any future commitments.

F. HCP Hatchery Committees Email Distribution List and Extranet Access – Betsy Bamberger (Tom Kahler)

Tom Kahler said Greg Mackey (Douglas PUD HCP Hatchery Committees Representative) requested to add Betsy Bamberger, the new fish health specialist at Wells Fish Hatchery, to select HCP Hatchery Committees email distribution lists and provide Bamberger with access to the HCP Hatchery Committees extranet site. HCP Coordinating Committees representatives present agreed to add Bamberger to select HCP Hatchery Committees email distribution lists and provide Bamberger with visitor access to the HCP Hatchery Committees extranet site.

Kristi Geris will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) and Julene McGregor (Douglas PUD Information Systems Staff) to add Bamberger to select HCP Hatchery Committees email distribution lists and provide Bamberger with visitor access to the HCP Hatchery Committees extranet site, as approved by the HCP Coordinating Committees. *(Note: Geris contacted Montgomery and McGregor, as discussed, on January 24, 2018, and Bamberger was added to the distribution list and extranet site.)*

V. NMFS

A. Columbia River Sockeye Salmon Stocks and Whirling Disease (Scott Carlon)

Scott Carlon asked if there are known cases of whirling disease in Columbia River sockeye salmon stocks. Mike Tonseth explained that whirling disease is caused by the parasite, *Myxobolus cerebralis*, which attacks the cartilage of the head and spine of mainly trout and salmon. Tonseth recalled some research being conducted on this in the Columbia River Basin; however, the results were inconclusive. He said he believes the research was prompted by potential cases in the lower Columbia River.
Kirk Truscott said he believes whirling disease has been detected in resident fish. Carlon said he

asked because Oregon Department of Fish and Wildlife (ODFW) is considering obtaining adult sockeye salmon from Priest Rapids Dam for release in the Deschutes River. Tonseth asked where these discussions are taking place. Carlon said nothing is official yet; rather, ODFW is only thinking about pursuing this.

VI. HCP Administration

A. Draft 2017 HCP Annual Reports (John Ferguson)

John Ferguson said the Draft 2017 Wells HCP Annual Report will be distributed to the HCP Coordinating Committees by Kristi Geris for a 30-day review on Wednesday, February 7, 2018. Ferguson said the Draft 2017 Rock Island and Rocky Reach HCP Annual Reports will be distributed for a 30-day review on Thursday, February 15, 2018. *(Note: please coordinate review of the reports with respective HCP Tributary and Hatchery Committees representatives, as needed.)*

The Draft 2017 Wells HCP Annual Report was distributed to the Wells HCP Coordinating Committee by Kristi Geris on February 7, 2018. The draft report is available for a 30-day review period, with edits and comments due to Kristi Geris by March 7, 2018.

The Draft 2017 Rock Island and Rocky Reach HCP Annual Reports were distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on February 14, 2018. The draft reports are available for a 30-day review period, with edits and comments due to Geris by March 15, 2018.

B. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on February 27, 2017, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The March 27 and April 24, 2018 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	Comparison Matrix of Potential Study Subjects for the Wells Project 2020 Survival Verification Study

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*	Washington Department of Fish and Wildlife
Mike Tonseth	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* * Denotes HCP Coordinating Committees member or alternate
* † Joined by phone
* †† Joined by phone for the HCP Tributary and Hatchery Committees Update

Comparison Matrix of Potential Study Subjects for the Wells Project 2020 Survival Verification Study

Douglas PUD will conduct a survival study in 2020, as specified in Section 4.2.5.1 of the Wells HCP. The study will re-evaluate whether yearling spring-migrating Plan Species currently designated as in Phase III (Standard Achieved) continue to survive passage through the Wells Project at greater than or equal to 93 percent. The Wells HCP specifies that for each survival-verification study (SVS), the Coordinating Committee (CC) shall select one study species to represent all the spring-migrating Plan Species currently designated as in Phase III (Standard Achieved), and those species currently include yearling Chinook, steelhead, and coho.

At the December 2017 CC meeting, the Wells CC requested that Douglas PUD prepare a matrix comparing the pros and cons associated with the use of each species (and ESU, in the case of Chinook) as a representative subject for the Wells Project 2020 SVS. This memo presents that comparison matrix (Table 1). Study method forms an important context for the comparisons within the matrix, with the Wells HCP dictating that survival studies "consider direct, indirect and delayed mortality wherever it may occur and can be measured…." Therefore, all comparisons assume that the 2020 study will rely on PIT tags.

Table 1. Comparison of study-fish candidates for the 2020 SVS for the Wells Project, to inform the Wells Coordinating Committee's selection process.

Study Fish	Pros	Cons
Spring Chinook	• Not previously studied • Okanogan and Methow releases provide a pooled estimate of Wells Project survival representing emigrants from both rivers	• ESA Endangered • Existing production numbers inadequate for a study • Additional brood stock collection and juvenile production that would greatly exceed collection and release numbers in ESA Permit No. 18925 • May not be able to collect sufficient brood to produce study fish • Increased production for a study would jeopardize achievement of rearing-density criteria at Methow Hatchery • Additional adult returns from study fish released at the mouth of the Methow River could stray and jeopardize achievement of pHOS targets in ESA Permit No. 18925 • Relatively low SAR (1/10th of yearling summer Chinook SAR) dramatically (10X) increasing sample size requirements to achieve precision target for delayed mortality
Steelhead	• Existing production numbers adequate for a study • Provides consistency with previous studies • Okanogan and Methow releases provide a pooled estimate of Wells Project survival representing emigrants from both rivers	• ESA Threatened • Propensity to home to release locations could reduce homing to Wells Hatchery, and complicate adult management • Adult returns to the Methow and Okanogan would jeopardize achievement of pHOS targets in both basins • Previous study results suggest model assumptions can be violated with this species (equal post-treatment mixing, survival, migration and capture probability). The propensity of this species to residualize could jeopardize achievement of precision standard; and, if differentially expressed between treatment and control releases, would violate basic survival model assumptions of equal post-treatment probability of capture, detection and survival • Possible ecological interactions of residuals with listed taxa • Measures necessary to exclude non-migrants from the study complicate study implementation and increase sample size
Coho	• Not previously studied • Not ESA listed • Not concerned with returns interfering with pHOS goals	• Provides Wells Project survival estimate for only Methow releases • Existing production numbers inadequate for a study. Additional hatchery production necessary above current mitigation goals • May not be able to collect sufficient brood to produce study fish • Coho have a tendency to rear in reservoirs upstream of McNary Dam rather than exhibit obligatory migratory behavior. • Untested concern regarding residualization, which, if it occurred, could jeopardize achievement of precision standard; and, if differentially expressed between treatment and control releases, would violate assumptions of equal probability of detection
Summer Chinook	• Not ESA listed • Existing production numbers adequate for a study and easily scalable if additional fish are requested to perform the study. • Could easily collect brood and rear additional fish with available hatchery infrastructure. • Provides consistency with previous studies • Okanogan and Methow releases provide a pooled estimate of Wells Project survival representing emigrants from both rivers • Adult returns won't jeopardize achievement of pHOS targets for ESA stocks • Relatively high SAR (10x spring Chinook SAR) reduces the sample size necessary to achieve precision target for delayed mortality estimates • Previous study results indicate that model assumptions can be met with this species (equal post-treatment mixing, survival, migration and capture probability)	• Summer Chinook exhibit the slowest migration speeds of any species being indexed by the study.

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: March 29, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the February 27, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, February 27, 2018, from 10:00 a.m. to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Kristi Geris will coordinate with Tracy Hillman (HCP Hatchery Committees Chairman) and will notify the HCP Coordinating Committees of the date the HCP Hatchery Committees plan to tour the new Wells Fish Hatchery (tentatively scheduled for spring 2018; Item I-C).
- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Douglas PUD and the Wells HCP Coordinating Committee will complete the following action items associated with the Douglas PUD 2020 Verification Survival Study (Items I-C and III-C):
  - Keely Murdoch will provide smolt-to-adult return (SAR) data, based on coded wire tags (CWTs), for coho salmon released and recaptured at Wells Dam. *(Note: Murdoch provided these data during the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.)*
  - Tom Kahler will ask John Skalski (Columbia Basin Research) to calculate sample size ranges needed, based on SARs, to achieve precision standards for Wells summer Chinook salmon, Winthrop spring Chinook salmon, and Methow coho salmon; and Kahler will determine if these ranges result in capacity issues at Wells Fish Hatchery.
  - Tom Kahler will determine whether there are permitting issues for rearing study fish at Wells Fish Hatchery.
  - Tom Kahler will ask John Skalski about the feasibility of implementing a study design using both passive integrated transponder (PIT)-tagged summer Chinook salmon and acoustic-tagged spring Chinook salmon.
- Lance Keller will provide an email detailing the Tumwater Dam fishway outage scheduled for February 28, 2018, and the HCP Coordinating Committees will contact Keller with comments, if any, no later than end of day February 27, 2018 (Item IV-A). *(Note: Keller provided this email*

following the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.)

- Lance Keller will incorporate language into the Draft 2018 Rock Island and Rocky Reach Fish Spill Plan, documenting the conversion of notched spill gates 18 and 26 back to full gate operation during spring 2018 (Item IV-I). *(Note: Keller provided an updated spill plan following the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.)*
- The HCP Coordinating Committees meeting on March 27, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item V-A).

Decision Summary

- The Wells HCP Coordinating Committee representatives present approved the 2018 Wells HCP Action Plan (Item III-A).
- The Wells HCP Coordinating Committee representatives present approved the 2017 Wells Dam Post-Season Bypass Report (Item III-B).
- The Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the 2018 Rock Island and Rocky Reach HCP Action Plan (Item IV-B).
- The Rocky Reach HCP Coordinating Committee representatives present approved the 2017 Rocky Reach Juvenile Fish Bypass System Report (Item IV-C).
- The Rock Island HCP Coordinating Committee representatives present approved the 2017 Rock Island Smolt and Gas Bubble Trauma Evaluation Report (Item IV-D).
- The Rock Island HCP Coordinating Committee representatives present approved the 2018 Rock Island Bypass Monitoring Plan (Item IV-E).
- The Rocky Reach HCP Coordinating Committee representatives present approved Chelan PUD's proposed operating plan for the Rocky Reach Juvenile Fish Bypass System Surface Collector (RRJFBS SC) and Turbine Unit C2, during the Turbine Unit C1 outage in spring 2018 (Item IV-F).
- The Rocky Reach HCP Coordinating Committee representatives present approved the 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan (Item IV-G).
- The 2017 Wells HCP Annual Report was approved by the Wells HCP Coordinating Committee after no disapprovals were received following the 30-day review period, which ended on March 7, 2018.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- An updated Draft 2018 Rock Island and Rocky Reach Fish Spill Plan was distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on February 27, 2018 (originally distributed on February 1, 2018). The draft document is available for a 30-day review period, with edits and comments due to Lance Keller by March 2, 2018 (Item IV-I).
- The Draft 2017 Wells HCP Annual Report was distributed to the Wells HCP Coordinating Committee by Kristi Geris on February 7, 2018. The draft report is available for a 30-day review period, with edits and comments due to Geris by March 7, 2018.
- The Draft 2017 Rock Island and Rocky Reach HCP Annual Reports were distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on February 14, 2018. The draft reports are available for a 30-day review period, with edits and comments due to Geris by March 15, 2018.
- The Draft 2018 Broodstock Collection Protocols were distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on March 12, 2018.

Finalized Documents

- The Final 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan, which was approved by the Wells HCP Coordinating Committee via email on February 2, 2018, was distributed to the HCP Coordinating Committees by Kristi Geris on March 7, 2018.
- The Final 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on March 13, 2018 (Item III-A).
- The Final 2017 Wells Dam Post-Season Bypass Report was distributed to the HCP Coordinating Committees by Kristi Geris on March 13, 2018 (Item III-B).
- The Final 2017 Wells HCP Annual Report was distributed to the HCP Coordinating Committees by Kristi Geris on March 23, 2018.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Lance Keller added a Rocky Reach Dam Turbine Unit C1 Outage.
- Mike Tonseth added a Tumwater Dam Fishway Outage.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft January 23, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the Committees were incorporated into the revised minutes. Keely Murdoch requested an edit under the HCP Tributary Committees Update, Operating Procedures bullet, clarifying that the Yakama Nation (YN) designated Brandon Rogers as the alternate on all three HCP Tributary Committees (Wells, Rocky Reach, and Rock Island), opposed to all three HCP Committees (Coordinating, Hatchery, and Tributary). Geris incorporated this edit as requested. HCP Coordinating Committees members present approved the January 23, 2018 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees conference call on January 23, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on January 23, 2018):*

- *Kristi Geris will coordinate with Tracy Hillman (HCP Hatchery Committees Chairman) and will notify the HCP Coordinating Committees of the date the HCP Hatchery Committees plan to tour the new Wells Fish Hatchery (tentatively scheduled for spring 2018; Item I-C).*
  This action item will be carried forward.
- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Chelan PUD will request approval of the 2018 Rock Island and Rocky Reach HCP Action Plan during the HCP Coordinating Committees meeting on February 27, 2018 (Item III-A).*
  This will be discussed during today's meeting.
- *Lance Keller will provide fish rescue numbers for Rock Island and Rocky Reach dams, to Kristi Geris for inclusion in the meeting minutes and distribution to the HCP Coordinating Committees (Item III-B).*
  Keller provided these numbers following the meeting on January 23, 2018, which Geris distributed to the HCP Coordinating Committees on January 24, 2018.
- *Scott Carlon will verify who is currently the National Marine Fisheries Service (NMFS) point of contact for issuing Section 10 incidental take permits for steelhead (Item III-B).*
  Carlon said the current point of contact is Brett Farman (NMFS HCP Hatchery Committees Representative). Carlon also indicated that Farman is located in Portland, Oregon.
- *John Ferguson will notify Tracy Hillman about HCP Coordinating Committees discussions regarding potential modifications to Section 10 incidental take permits to allow 12- to 18-inch steelhead collected in fish ladders during fish rescues associated with fishway winter*

maintenance outages to be sampled for coded wire tags (CWTs) and identified as to their source (Item III-B).
Ferguson discussed this with Hillman via email on January 26, 2018.

- *Douglas PUD will request approval of the 2018 Wells HCP Action Plan during the HCP Coordinating Committees meeting on February 27, 2018 (Item IV-A).*
  This will be discussed during today's meeting.
- *The Wells HCP Coordinating Committee will submit a vote via email on the Draft 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan to Tom Kahler (and copy Kristi Geris) no later than February 12, 2018 (Item IV-D).*
  The Wells HCP Coordinating Committee approved the plan prior to the deadline, as described under the Decision Summary.
- *Douglas PUD and the Wells HCP Coordinating Committee will complete the following action items associated with the Douglas PUD 2020 Verification Survival Study (Item IV-E):*
  - *Keely Murdoch will provide smolt-to-adult return (SAR) data, based on CWTs, for coho salmon released and recaptured at Wells Dam.*
    Murdoch said she has these data and will provide them to Kristi Geris. (Note: Murdoch provided these data [Attachment B] during the meeting on February 27, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)
  - *Tom Kahler will ask John Skalski (Columbia Basin Research) to calculate sample size ranges needed, based on SARs, to achieve precision standards for Wells summer Chinook salmon, Winthrop spring Chinook salmon, and Methow coho salmon; and Kahler will determine if these ranges result in capacity issues at Wells Fish Hatchery.*
    Kahler said he has this request into Skalski and has a call scheduled for today (February 27, 2018) to further discuss the request. This action item will be carried forward.
  - *Kirk Truscott will determine the feasibility of using Winthrop spring Chinook salmon from Chief Joseph Hatchery for the study, including transferring the fish to Wells Fish Hatchery for rearing.*
    Truscott said this is not feasible from a permitting standpoint and it is counter to these fish achieving a high homing fidelity to the Okanogan River, which is the goal of the Chief Joseph Dam program.
  - *Tom Kahler will determine whether there are permitting issues for rearing study fish at Wells Fish Hatchery.*
    Kahler said he has not yet discussed this with NMFS. This action item will be carried forward.

  - *The Wells HCP Coordinating Committee will continue discussing what potential biological risks exist associated with management of verification survival study fish when they return to spawn.*
    John Ferguson said the Wells HCP Coordinating Committee will keep this in mind; however, the action item will be closed.
- *Kristi Geris will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) and Julene McGregor (Douglas PUD Information Systems Staff) to add Betsy Bamberger (Douglas PUD Fish Health and Evaluation Specialist) to select HCP Hatchery Committees email distribution lists and provide Bamberger with visitor access to the HCP Hatchery Committees extranet site, as approved by the HCP Coordinating Committees (Item IV-F).*
  Geris contacted Montgomery and McGregor, as discussed, on January 24, 2018.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman reported that the HCP Tributary Committees did not meet in January 2018 and will next meet on March 6, 2018.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on February 21, 2018:

- *DECISION: 2018 Wells HCP Action Plan*: The Wells HCP Hatchery Committee reviewed and approved the hatchery section of the action plan. John Ferguson asked if the tributary portion has been approved. Hillman said the Wells HCP Tributary Committee approved the tributary section of the action plan after no disapprovals were received by the review deadline on January 31, 2018.
- *Methow Steelhead Broodstock Collection Update*: Douglas PUD indicated broodstock collection for the Methow River Basin combined steelhead programs is going well. To date, angling efforts have collected about half of the program needs (63 steelhead).
- *Steelhead Broodstock Collection at Wells Hatchery Volunteer Channel*: Due to an unexpected outbreak of Columnaris in Wells Fish Hatchery brood year 2018 steelhead, additional broodstock may be trapped to serve as backup brood for programs that may fall short of program targets. Washington Department of Fish and Wildlife (WDFW) and Douglas PUD plan to collect steelhead at the Wells Fish Hatchery volunteer channel and hold the fish in ponds until the fish are needed as broodstock or treat them as required under normal adult management protocols. WDFW and the HCP Hatchery Committees will decide the fate of fish that are held but are not used for broodstock.

- *Draft 2018-2020 Steelhead Release Plan*: Chelan PUD shared a draft 2018-2020 Steelhead Release Plan with the HCP Hatchery Committees. The purpose of the plan is to evaluate steelhead survival to McNary Dam based on size-at-release and rearing vessel (raceway versus reuse circulars). The goal is to inform best hatchery management practices to optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions. The plan identifies a two-factor ANOVA design with three replicates (years). The HCP Hatchery Committees are reviewing the release plan, will provide Chelan PUD with comments by March 7, 2018, and will discuss release locations and hopefully approve the plan during the HCP Hatchery Committees meeting on March 12, 2018.
- *Lethal Removal of Steelhead from Fishways*: WDFW proposed to remove 12- to 18-inch hatchery *Oncorhynchus mykiss* that are collected during fishway outage salvage operations. All hatchery *O. mykiss* collected in the fishways would be examined for tags to determine their origin. Permits allow for the lethal removal of hatchery-origin steelhead at dams, traps, and weirs; and because of the hatchery origin, lethal removal falls under adult management. The HCP Hatchery Committees approved the lethal removal of all known hatchery-origin *O. mykiss* between 12 and 18 inches at Chelan PUD and Douglas PUD hydroelectric projects during fish rescues associated with fishway maintenance outages. Grant PUD also indicated concurrence but stated they would need to follow up with facility staff about the feasibility of implementing such actions. Ferguson asked if the HCP Coordinating Committees have any follow-up questions about this discussion. None were raised.
- *Broodstock Collection Protocols*: WDFW will distribute the draft Broodstock Collection Protocols for review later this week. The final protocols are due to NMFS on April 15, 2018.
- *National Marine Fisheries Service Consultation Update*: NMFS provided an update on the National Environmental Policy Act process and indicated Chuck Peven (Peven Consulting, Inc.) has been retained to write the Environmental Assessment for Methow River Basin steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids dams). NMFS will review the draft first, then the applicants, and then the draft will be available for public review and comment.
- *Timeline of Changes in Hatchery Programs*: The HCP Hatchery Committees are continuing to work on timelines of major hatchery program changes for spring and summer Chinook salmon, steelhead, and sockeye salmon. The timelines will inform statistical analyses for the 5-year statistical and 10-year comprehensive reports.
- *Independent Scientific Advisory Board Report*: The HCP Hatchery Committees briefly reviewed the recommendations within the Independent Scientific Advisory Board (ISAB) Upper Columbia Spring Chinook Salmon Report. The ISAB made several recommendations related to genetic diversity, coordination and oversight, and research, monitoring, and evaluation. The

HCP Hatchery Committees will study the ISAB recommendations and discuss them during future meetings.

- *Next meeting*: The next meeting of the HCP Hatchery Committees will be on March 12, 2018.

III. Douglas PUD

A. DECISION: 2018 Wells HCP Action Plan (Tom Kahler)

Tom Kahler said the Draft 2018 Wells HCP Action Plan was distributed to the Wells HCP Coordinating Committee by Kristi Geris on January 22, 2018. The draft plan was available for a 30-day review period, with edits and comments due to Kahler by February 21, 2018. Kahler said the Wells HCP Tributary and Hatchery Committees have approved their portions of the plan and asked if the Wells HCP Coordinating Committee has any questions or edits. None were expressed.

The Wells HCP Coordinating Committee representatives present approved the 2018 Wells HCP Action Plan. *(Note: the Final 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Geris on March 13, 2018.)*

B. DECISION: 2017 Wells Dam Post-Season Bypass Report (Tom Kahler)

Tom Kahler said the Draft 2017 Wells Post-Season Bypass Report (including the appended Draft 2017 Wells Dam Passage Dates Analysis) was distributed to the Wells HCP Coordinating Committee by Kristi Geris on December 29, 2017. The draft report is available for a 60-day review period, with edits and comments due to Kahler by today, February 27, 2018. Kahler noted that the appendix has been reviewed and edited several times, but he said no comments have been received since the full document was distributed for review. John Ferguson said, considering the review period is not technically closed until close-of-business today, he asked if any Wells HCP Coordinating Committee representatives were not ready to vote at this time.

The Wells HCP Coordinating Committee representatives present approved the 2017 Wells Dam Post-Season Bypass Report. *(Note: the Final 2017 Wells Dam Post-Season Bypass Report was distributed to the HCP Coordinating Committees by Geris on March 13, 2018.)*

C. Wells Project 2020 Survival Verification Study – Study Species (Tom Kahler)

Tom Kahler said he anticipates having answers to the sample size questions for discussion during the HCP Coordinating Committees meeting on March 27, 2018.

Kahler requested clarification regarding the use of Winthrop spring Chinook salmon. He asked if the Colville Confederated Tribes (CCT) do not support using specifically Section 10(j) fish, or spring Chinook salmon in general? Kirk Truscott said taking spring Chinook salmon (springers) from the Methow Safety-Net Program and rearing the fish at Wells Fish Hatchery may result in fish homing back to Wells Dam and not to the Methow River, where they may be needed as safety-net fish. Keely Murdoch recalled releasing fish at Wells Dam early in the YN's coho salmon program when those fish were a back-up source of brood at the time. She said fish that returned to Wells Dam could be trapped at the dam and fish hatchery, if necessary. Truscott said his concern is if all the fish end up in the volunteer channel, and also whether procedures are in place for moving those fish to the Methow River Basin to meet spawning escapement targets.

John Ferguson recalled discussing during the last HCP Coordinating Committees meeting on January 23, 2018, potentially using summer Chinook salmon (summers) in 2020 and while continuing to investigate using alternative species for study in 2030. Murdoch said ultimately, the Wells HCP Coordinating Committee did not make a final decision; rather, the Committee was tasked with homework to help inform a final decision. She said Douglas PUD made their preference clear for summers; however, the general consensus was for Douglas PUD to also consider other species.

Murdoch said, for clarification, Douglas PUD has not conducted survival studies using spring Chinook salmon. Kahler said that is correct, and clarified "yearling" Chinook salmon. Murdoch also noted that Douglas PUD does not want to use acoustic tags because the Wells HCP requires studying delayed mortality. She asked if Douglas PUD would consider conducting a side-by-side yearling Chinook salmon study using PIT and acoustic tags. She said within the PIT-tagged summers there would also be a small group of acoustic-tagged summers and acoustic-tagged spring Chinook salmon (springers). She said this would provide confidence that what is observed in summers is the same as springers. Kahler said Douglas PUD would rather just use PIT-tagged springers to get at this question. He requested clarification on the scope of the comparison study since conducting any side-by-side comparison using a "small group" of acoustic tags would mean taking an already fairly small sample size and making it smaller, which would compromise achieving precision targets. Murdoch said she is not suggesting a smaller sample size; rather, she is suggesting conducting a study similar to what Chelan PUD conducted using acoustic and PIT tags at the same time. Lance Keller recalled in 2004, Chelan PUD conducted a side-by-side comparison specifically for the sake of changing tag methodology. Murdoch said it seems studying springers is really complicated and might not be possible but indicated she is not comfortable accepting that springers may never be studied.

Ferguson asked about the locations of downstream PIT detections. Kahler said study fish are tracked from Rocky Reach Dam all the way down to the "trawl" (PIT tag trawl system in the lower Columbia River Estuary below Bonneville Dam, near river kilometer 75), and back upstream as adults. Truscott noted, if acoustic tags are used there is no need to measure all the way down to the trawl. He suggested conducting a PIT evaluation on summers, including 3,000 acoustic-tagged fish in this group; and acoustic-tagging 3,000 springers to evaluate instream survival to a specified location to show these species are statistically surviving through reaches similarly. Kahler said survival to Bonneville Dam cannot be evaluated based on acoustic tags, which is what the Wells HCP requires. Murdoch said the PIT-tags will evaluate this, but there will also be the comparison to acoustic-tagged fish. Kahler said then, the studies will need to be comparable, meaning that the study would need to compare PIT-tagged summers to acoustic-tagged summers, and PIT-tagged springers to acoustic-tagged springers; if the within-stock comparisons show no difference, then among-stock tag comparison would be valid. Therefore, to conduct the requested comparison is really three full studies in one. He said, furthermore, PIT-tag studies use all downstream detections in the survival model, whereas acoustic-tag studies use only survival to arrays a short distance downstream, and thus the "survival" measured is not comparable other than for the reaches in common. Therefore, Douglas PUD would not be "verifying" previous studies. Kahler said he needs to discuss this with John Skalski to determine what sample sizes are needed to study springers. Kahler said if studying springers is feasible and is selected by the Wells HCP Coordinating Committee, Douglas PUD would study them directly with PIT tags rather than relying solely on acoustic tags or on a tag comparison study. He said if studying springers is not feasible, the Wells HCP Coordinating Committee needs to figure out how to address the lack of direct studies on springers. He said for discussion purposes, Grant and Chelan PUDs also have not studied springers. Keller said Chelan PUD uses run-of-the-river fish, regardless of origin, and also has experienced difficulties achieving adequate sample sizes.

Ferguson summarized there is a sample size question and study design question. He said if the desire is to study acoustic- and PIT-tagged summers and springers, releases need to be at the same time or the results are not comparable. Kahler said he will ask Skalski about the feasibility of implementing a study design using both PIT-tagged summer Chinook salmon and acoustic-tagged spring Chinook salmon.

Jim Craig asked about fish source. Kahler said either Winthrop National Fish Hatchery or Methow Safety-Net. He said this will be a question for NMFS. He asked, how many springers can be released upstream and downstream of Wells Dam, and what is the probability of springers returning to Wells Dam? He said it is difficult to speak to potential straying. He said trapping at Wells Dam will be ongoing during the time of year the study will be implemented, so there is a chance of pulling in the study fish. He said study fish will be clipped and PIT-tagged. Mike Tonseth said trap operators can selectively remove individuals and place them in the correct programs or surplus them. Keller said Douglas PUD could also do something similar to what Chelan PUD implemented using a database and sort-by-code operation without automation.

Tonseth recalled last month, WDFW's position in the long-term was to validate that results of studying yearling summer Chinook salmon truly represent and reflect yearling spring Chinook salmon survival. He acknowledged this may not be feasible in 2020; however, there is a long-term desire to make sure these assumptions can be validated.

Kahler asked about coho salmon. Murdoch said SAR data, based on CWTs, for coho salmon released and recaptured at Wells Dam (Attachment B) were provided to Kristi Geris during today's meeting (February 27, 2018). *(Note: Geris distributed these data to the HCP Coordinating Committees following the meeting that same day.)*

Murdoch explained that Attachment B was calculated by considering all coho salmon collected at Wells Dam as a random sample and expanding those ratios to include the entire basin. She said returns to the hatchery were not included because these fish were biased to the hatchery. She reviewed Attachment B, noting that SARs for Wells Dam releases were slightly higher than returns to the basin. She said SARs may be higher depending on how many fish turned into the collection channel. She also said these data could suggest fish are residualizing; however, the data do not prove this. *(Note: the impetus for reviewing these data was to fact-check the statement, "Coho have a tendency to rear in reservoirs upstream of McNary Dam rather than exhibit obligatory migratory behavior," included in the Comparison Matrix of Potential Study Subjects for the Wells Project 2020 Survival Verification Study [Attachment B of the HCP Coordinating Committees January 23, 2018 meeting minutes].)*

Murdoch said she spoke with Cory Kamphaus (YN) and determined if the Wells HCP Coordinating Committee would like to study coho salmon, the YN can accommodate this request. Murdoch said further, the YN would make the collection of coho salmon for the study a priority even if this means falling short of program broodstock targets. She said collection of these fish would be covered under the YN's permits. She said if this path is chosen, the YN would collect and spawn the fish, and transfer eyed-eggs to Wells Fish Hatchery.

Kahler asked how these CWT data (Attachment B) compare to PIT-tag data. Murdoch said the CWT data are quite a bit lower because the CWT are returns to Wells Dam and the PIT-tag data are returns to Bonneville Dam (approximately 0.4%). She caveated that this is based on only 3 years of data. Craig also noted that coho salmon tend to migrate up other tributaries, so the estimate to Wells Dam will be a minimum. He said coho salmon survive very well. Murdoch agreed and said coho salmon also tend to move into Chelan Falls and stray into the Entiat River. Kahler said coho salmon are also detected at the Eastbank Fish Hatchery outfall. Keller said coho salmon have also been observed near Kirby Billingsley Hydro Park migrating up a small irrigation canal.

Ferguson said it seems coho salmon are more feasible than 1 month ago. Murdoch agreed and stated that coho salmon seem more feasible than springers; however, coho salmon are also less desirable because they are not listed. Kahler asked about an Okanogan River release if coho salmon are used for the study. Murdoch said only on rare occasions are coho salmon observed migrating up the Okanogan River. Ferguson asked if releasing coho salmon at the mouth of the Okanogan River would be problematic. Truscott said he does not believe so. Murdoch said currently, there is no reintroduction program for coho salmon in the Okanogan River.

Tonseth suggested incorporating a stray evaluation into the methodology to help inform stray potential in future studies. Ferguson agreed this is a good idea.

Ferguson asked about timing issues with regard to selecting a species. Kahler said issues will only arise if additional broodstock need to be collected for the study (which only applies to springers). Ferguson summarized the discussion by saying the next step is for Douglas PUD to discuss sample sizes and study designs with Skalski.

IV. Chelan PUD

A. Tumwater Dam Fishway Outage (Mike Tonseth and Lance Keller)

Mike Tonseth said he spoke with Ian Adams (Chelan PUD Hatchery Maintenance and Operations Coordinator), who indicated the fishway at Tumwater Dam will be briefly shutdown tomorrow, February 28, 2018, to obtain measurements, and then will be watered back up the same day. Kirk Truscott asked if the fishway is gravity fed, and Lance Keller said it is. Truscott asked if there might be any fish present in the ladder, and Keely Murdoch asked particularly about bull trout. Jim Craig said this time of year is just ahead of the bull trout migration. Truscott asked about how much water will remain in the ladder in case steelhead, Pacific Lamprey, or other species are present in the ladder. Keller said he is unsure but guessed the fishway would be dewatered to an elevation equal with the tailrace elevation. John Ferguson noted that Pacific Lamprey can survive out of water for a short while, and Tonseth said the issue would be these fish being able to survive the freezing temperatures if out of water.

Keller said he will confirm details with Adams and will provide an email detailing the Tumwater Dam fishway outage scheduled for February 28, 2018. The HCP Coordinating Committees will contact Keller with comments, if any, no later than end of day February 27, 2018. *(Note: Keller provided this email following the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.)*

B. DECISION: 2018 Rock Island and Rocky Reach HCP Action Plan (Lance Keller)

The Draft 2018 Rock Island and Rocky Reach HCP Action Plan was distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on January 22, 2018. The draft action plan was available for a 30-day review period, with edits and comments due to Lance Keller by February 21, 2018. Keller said no comments were received on the action plan. The Rock Island and

Rocky Reach HCP Coordinating Committees representatives present approved the 2018 Rock Island and Rocky Reach HCP Action Plan.

C. DECISION: 2017 Rocky Reach Juvenile Fish Bypass System Report (Lance Keller)

The Draft 2017 Rocky Reach Juvenile Fish Bypass System Report was distributed to the Rocky Reach HCP Coordinating Committee by Kristi Geris on January 22, 2018. The draft report was available for a 30-day review period, with edits and comments due to Lance Keller by February 21, 2018. Keller said no edits were received on the draft report. The Rocky Reach HCP Coordinating Committee representatives present approved the 2017 Rocky Reach Juvenile Fish Bypass System Report.

D. DECISION: 2017 Rock Island Smolt and Gas Bubble Trauma Evaluation Report (Lance Keller)

The Draft 2017 Rock Island Smolt and Gas Bubble Trauma Evaluation Report was distributed to the Rock Island HCP Coordinating Committee by Kristi Geris on January 22, 2018. The draft report was available for a 30-day review period, with edits and comments due to Lance Keller by February 21, 2018. Keller said comments were received from Jim Craig regarding percent descaling reported for juvenile fish examined. Keller said he provided a response to Craig, and Keller asked Craig if the question was adequately addressed. Craig said it was. He added that his question was not to imply descaling is an issue at Rock Island Dam and Keller's explanation of holding times and impacts of debris in the trap makes sense. The Rock Island HCP Coordinating Committee representatives present approved the 2017 Rock Island Smolt and Gas Bubble Trauma Evaluation Report.

E. DECISION: 2018 Rock Island Bypass Monitoring Plan (Lance Keller)

The Draft 2018 Rock Island Bypass Monitoring Plan was distributed to the Rock Island HCP Coordinating Committee by Kristi Geris on January 22, 2018. The draft plan was available for a 30-day review period, with edits and comments due to Lance Keller by February 21, 2018. Keller said comments were received from Jim Craig requesting to add language explaining the purpose of PIT-tagging juvenile fish. Keller said this language was added, as requested. The Rock Island HCP Coordinating Committee representatives present approved the 2018 Rock Island Bypass Monitoring Plan.

F. Rocky Reach Dam Turbine Unit C1 Outage (Lance Keller)

Lance Keller said Turbine Units C1 and C2 at Rocky Reach Dam are important to promote fish guidance into the juvenile fish bypass system and, because of this, are also the first units on and last off while loading the powerhouse. Keller said on January 14, 2018, the Washington State Department of Ecology was dispatched to the Rock Island reservoir to investigate a report of oil observed in the Columbia River. Keller said Rocky Reach Dam staff were notified on January 15, 2018, and began investigating the source of the oil. He said the only recent change in operation was returning Turbine

Unit C1 to service the week prior. He said the unit showed no loss of oil during maintenance and was returned to service on January 12, 2018. He said mechanics took Turbine Unit C1 offline on January 16, 2018, and discovered a loss of oil from the unit hub via the trunnion seals. Keller said Rocky Reach Dam mechanics are currently searching for a safe, reliable fix to bring the unit back into service as soon as possible. He said, however, it currently appears that Turbine Unit C1 will be offline when the juvenile bypass system begins operation on April 1, 2018, and could remain offline for a portion of the 2018 juvenile passage season. He said Rocky Reach Dam operators have been in a similar situation before (in 2014, from June through end-of-season), when Turbine Unit C1 was taken offline to repair a crack in the rotor.

Keller distributed hard copies of a proposed Operating Plan for the Rocky Reach Dam Surface Collector and Turbine Unit C2 during the Turbine Unit C1 Outage in Spring 2018 (Attachment C), which was distributed electronically to the HCP Coordinating Committees by Kristi Geris following the meeting on February 27, 2018. Keller said Chelan PUD is proposing to implement the same operations in spring 2018 as implemented in 2014 when Turbine Unit C1 was offline. He said key changes from current operations include: 1) using three additional RRJFBS SC pumps to increase attraction flow from 6,000 to 6,660 cubic feet per second (cfs) into the RRJFBS SC entrances (3,330 cfs on each side); and 2) increasing Turbine Unit C2 flow from its normal soft-limit set-point of 12,200 cfs (12.2 kcfs) to a soft-limit flow of 15.2 kcfs (see Nos. 1 and 4 in Attachment C).

Keller said Chelan PUD would like to append these modified operations for the RRJFBS SC and Turbine Unit C2 to the 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan, with the stipulation that Chelan PUD will keep the Rocky Reach HCP Coordinating Committee apprised of plans for the Turbine Unit C1 repairs. Keller acknowledged that this is a last-minute request and said additional time can be provided for discussion and consideration prior to voting on the 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan.

Jim Craig asked if there is any concern about the trunnion seals in other turbine units at Rocky Reach Dam. Keller said Turbine Unit C1 is a unique situation, one identified by the mechanics through a "blade droop" analysis.

Scott Carlon asked if fry have been observed at the RRJFBS. Keller said yes, and no impingement locations have been observed or were identified under the proposed altered operations in 2014. He said staff will continue collecting these data, which should be a good indicator if something is wrong with the altered operations.

Truscott asked if in 2014, were these same operations were implemented, notably Turbine Unit C2 flow increased to a soft-limit flow of 15.2 kcfs, and there were no issues with fish condition? Keller said this is correct. He added that Rocky Reach Dam operators consulted with the hydro superintendent to confirm a soft-limit flow of 15.2 kcfs would not impact the differential or structural integrity of the intake screen deployed in Turbine Unit C2. John Ferguson also added that in 2014, these same operations were implemented from June through the end of the season, which means there were months of data. Truscott asked if there will be any changes to the blade angle when increasing unit flow from 12.2 kcfs to 15.2 kcfs? Keller said to his knowledge no, that the difference in blade angle under the different operations is minimal and unit efficiency is maintained.

The Rocky Reach HCP Coordinating Committee representatives present approved Chelan PUD's proposed operating plan for the RRJFBS SC and Turbine Unit C2, during the Turbine Unit C1 outage in spring 2018.

G. DECISION: 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan (Lance Keller)

The Draft 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan was distributed to the Rocky Reach HCP Coordinating Committee by Kristi Geris on January 22, 2018. The draft plan was available for a 30-day review period, with edits and comments due to Lance Keller by February 21, 2018. Keller said no comments were received on the draft plan. The Rocky Reach HCP Coordinating Committee representatives present approved the 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan.

H. Rock Island and Rocky Reach Adult Fishway Maintenance Updates (Lance Keller)

Lance Keller reviewed maintenance updates at Rocky Reach Dam and Rock Island Dam, as follows:

Rock Island Dam

Keller said as of the last HCP Coordinating Committees meeting on January 23, 2018, the only remaining outage at Rock Island Dam was the middle fishway, which was returned to service on February 7, 2018. He said adult fish passage facilities at Rock Island Dam are now fully operational.

Rocky Reach Dam

Keller said as of today, February 27, 2018, Rocky Reach Dam adult passage facilities are fully watered up and operational. He said Chelan PUD appreciates the Rocky Reach HCP Coordinating Committee's approval of allowing additional time for contractors to complete needed work. Keller said all inspections went very well this year.

I. Rock Island Dam Spill Gate Change (Lance Keller)

Lance Keller recalled last May 2017, two notch gates were converted back to full gate operation at Rock Island Dam due to three automated spill gates being out of service. Keller said engineering staff are continuing to repair the three spill gates and an analysis has indicated the gates are also under-powered. He said last year, Rock Island Dam engineers requested to convert notched spill gates 18 and 26 back to full gate operation while the three automated spill gates were out of service, to address concerns about overall spillway capacity and dam safety. Keller said 1 week ago, he received the same request from Rock Island Dam engineers to be implemented prior to the initiation of the 2018 spill season. Keller explained that if a large spill event suddenly occurs, the functioning automated gates will open, but the manual gates will need to be removed and stored on either side of the dam. He said having any automated spill gates out-of-service means a loss of important timely automated responsiveness. He said spill gates 18 and 26 will be in full gate operation only through the spring runoff period, and then will be returned back to notch gate operation. He said Rock Island Dam engineers estimated repairs to the three out-of-service automated spill gates should be completed by September or October 2018.

Kirk Truscott asked if spill gates 18 and 26 are the same notch gates that were converted back to full gate operation in 2017. Keller said this is correct and recalled these gates were selected in the best interest of fish passage and impacts to total dissolved gas. He said for reference, spill gates 18 and 26 are located between the middle fishway at Rock Island Dam and Powerhouse 2 (river left). He said route-specific data at Rock Island Dam indicate the preference for fish passage is via river right.

Truscott asked if converting spill gates 18 and 26 is the solution while the other spill gates are being repaired. Keller said this is correct and added that discovering the spill gates are also under-powered has made it more difficult to identify the best solution.

Truscott asked if Chelan PUD completes a facility evaluation report for Chelan PUD projects. He asked how many of these recent equipment failures were preventable? He said Chelan PUD already knew the automated spill gates were not in proper working order, the HCP Coordinating Committees conduct survival studies under normal operating conditions but the operations keep changing, and he said it is concerning that these failures are repetitive. He asked when Chelan PUD requests modifications to operations, what can the HCP Coordinating Committees do but approve them? He said from his standpoint, this is not what the HCP Coordinating Committees signed up for. Jim Craig asked how the HCP Coordinating Committees can get this message to the general managers. Keller said Chelan PUD fully understands Truscott's concerns. Keller assured the HCP Coordinating Committees that these concerns have been communicated internally. Keller said as a Fisheries Biologist, he has no input on where repairs fall on the priority list; however, it is the job of the Chelan PUD Fish and Wildlife Department to figure out how to best mitigate these situations to minimize and prevent impacts to natural resources. He said these are interim situations and operations will return to the normal operating configuration as soon as possible. Truscott acknowledged budgetary constraints, but still suggested actions could have been completed to avoid some of these issues. He also acknowledged the aging infrastructure and asked when Rock Island Dam was built. Keller said

Rock Island Dam was built in the 1920s and was in-service by 1933. He said Rock Island Dam was the first hydropower project to span the entire Columbia River.

Truscott asked if more spill routed through spill gates 18 and 26 means less spill through other gates. Keller said there will be no modifications to spill gates that affect fish passage. He said he will incorporate language into the Draft 2018 Rock Island and Rocky Reach Fish Spill Plan, documenting the conversion of notched spill gates 18 and 26 back to full gate operation during spring 2018. John Ferguson said the review timeline for this document will remain the same. *(Note: Keller provided an updated spill plan following the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.)*

J. ISAB Upper Columbia Spring Chinook Salmon Review (Lance Keller)

Lance Keller said an email with a link to the ISAB Review of Spring Chinook Salmon in the Upper Columbia River was distributed to the HCP Coordinating Committees by Kristi Geris on February 12, 2018. Keller said an article was subsequently published in the *Columbia Basin Bulletin* on February 16, 2018, which included data points that were interpreted improperly. He said what this article suggests is not correct. He said Chelan PUD has since spoke with Mike Tonseth, Andrew Murdoch (WDFW), and ISAB staff to discuss and attempt to correct this misinterpretation of data.

Keller explained that Murdoch provided a presentation to the ISAB with a slide showing migration timing based on PIT-tag data from the lower Wenatchee River Smolt Trap to the lower PIT-tag array in the Wenatchee River to demonstrate migration timing from the lower smolt trap to the Wenatchee and Columbia rivers confluence vicinity. Tonseth said the data where intended to describe entrance timing into the Columbia River and were not intended to describe potential impacts from spill or lack thereof at Rock Island Dam. Keller said spill data and Rock Island Dam references were also included on this presentation slide, which unfortunately led to the inadvertent misinterpretation of a travel time from the Wenatchee River to Rock Island Dam. He said, while the misinterpretation was not included in the ISAB report, the slide containing this information was included in the presentation package. He said Murdoch has since corrected this slide to be clearer; unfortunately, the *Columbia Basin Bulletin* already published the following:

> *"Added to all this is that spring fish live longer in their natal streams and so are constrained by those streams' limitations. Also, most spring juveniles migrate out of the tributaries and down the mainstem Columbia prior to the beginning of spill at mainstem dams. 'The fish don't have many options but to go through the powerhouse at PUD dams,' [Dr. Stan] Gregory [Oregon State University ecologist and an ISAB member] added."*

Keller said according to acoustic tag survival results for juvenile yearling Chinook salmon, only 13.6% of downstream migrants at Rock Island Dam use the spillway as a passage route, and the remaining pass via Powerhouse 1 or 2. He said Dr. Gregory's statement is implying that if fish passage is poor then passage through the powerhouse is poor, which is incorrect.

Keller said Murdoch changed the presentation to remove the chance of misinterpretation. Tonseth said the ISAB presentation package was also updated to reflect these changes. Keller said Chelan PUD wanted to notify the HCP Coordinating Committees of this misinterpretation of data in case it comes up in other venues.

Tonseth said dam passage survival and Columbia River entrance timing are two different questions. He asked, once spring migrants enter the Columbia River, what are these fish doing? He asked, what influences are in play that may be contributing to lower adult returns (essentially, recovery of spring Chinook salmon)? He said this is unknown. Keller said he believes these questions are what spurred the misinterpretation.

Tom Kahler said he discussed with Dr. Gregory and Dr. Steve Schroder (ISAB member) that the original bypass dates were based on fyke-net data, which are real data on the actual timing of fish passage, but 15 to 30 years old. Kahler asked, has climate change shifted migration timing since the collection of these data? He said the ISAB report suggests spring and summer emigrant migration timing that does not match the publicly available data.

V. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on March 27, 2017, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The April 24 and May 22, 2018 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	SARs for Coho Salmon Released and Recaptured from Wells Fish Hatchery (based on CWTs)
Attachment C	Operating Plan for the Rocky Reach Juvenile Fish Bypass System Surface Collector and Turbine Unit C2 during the Turbine Unit C1 Outage in Spring 2018

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*†	Washington Department of Fish and Wildlife
Mike Tonseth	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

Smolt To Adult Survival Rates for Coho Salmon released from Wells FH

Brood Year	Wells SAR	Mean SAR for program
2011	0.38%	0.32%
2010	0.061%	0.058%
2009	0.20%	0.15%

Operating Plan for Rocky Reach Surface Collector and Unit C2 Turbine Unit during the C1 Turbine unit outage in Spring 2018

1) RR JFB Surface Collector (SC) will utilize three additional installed SC pumps to increase attraction flow from 6,000 to 6,660 cfs into the SC entrances (3,330 cfs each side) while Unit C1 is out of service during spring bypass operations in 2018.

2) The dewatering screen cleaning system will function normally under the increased entrance flow and the cleaning process should not be affected. The automated screen cleaning routine will be more frequent if increased debris load is encountered.

3) Normal water velocity (Vn) through the dewatering screens in the SC channels will increase proportionally to the SC flow-rate increase, which is approx 11%. Calculations show screen velocity will increase from 0.4 fps to about 0.444 fps (an 11% increase) under the 6,660 SC flow. Water velocity will increase uniformly (no hot spots) across the entire SC dewatering screen surface area as regulated by the tuned screen baffling.

4) RR will increase turbine Unit C2 flow, from its normal *soft-limit* set-point of 12.2 kcfs to a *soft-limit* flow of 15.2 kcfs during the outage.

5) The bypass system will return to normal operations as soon as Unit C1 is operational.

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: April 16, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Revised Minutes of the March 27, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, March 27, 2018, from 10:00 a.m. to 12:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Kristi Geris will distribute a notification to the HCP Coordinating Committees to contact Tracy Hillman (HCP Hatchery Committees Chairman) or Sarah Montgomery (HCP Hatchery Committees support staff) if members are interested in attending a tour of the new Wells Fish Hatchery facility on April 18, 2018 (Item I-C). *(Note: Geris distributed this notification on March 29, 2018.)*
- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Andrew Gingerich (Douglas PUD) will distribute the report by Drs. John Skalski and Richard Townsend (Columbia Basin Research), which calculates sample size ranges needed to achieve precision standards for various study species and designs, as discussed by the HCP Coordinating Committees for the upcoming Wells Project 2020 Survival Verification Study (Item III-A). *(Note: Tom Kahler provided this report to Kristi Geris on April 13, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Douglas PUD will provide results from the most recent spring and summer Chinook salmon smolt-to-smolt comparative studies conducted by Douglas PUD to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-A).
- Scott Carlon will discuss internally with the National Marine Fisheries Service (NMFS), with regard to the Wells Project 2020 Survival Verification Study: 1) permitting requirements for using spring Chinook salmon, including modifications to Douglas PUD's HCP Incidental Take permit to allow for handling and tagging over 100,000 spring Chinook salmon smolts; 2) modifications to hatchery permits to allow for the collection of additional broodstock and for straying and percentage of hatchery origin spawners (pHOS) issues associated with releasing spring Chinook salmon raised at the Wells Fish Hatchery at the mouth of the Methow and

Okanogan rivers; and 3) concerns with releasing coho salmon at the mouth of the Okanogan River given that the Yakama Nation (YN) program currently does not have coverage for releasing fish at that site (Item III-A).

- Kristi Geris will redistribute the Draft 2018 Broodstock Collection Protocols (originally distributed March 12, 2018) along with a voting deadline for the Wells HCP Coordinating Committee, to be submitted via email to Mike Tonseth (Washington Department of Fish and Wildlife [WDFW]) and Geris by close-of-business (COB) on Friday, April 6, 2018 (Item V-A). *(Note: Geris redistributed the protocols, as discussed, following the meeting on March 27, 2018.)*
- John Ferguson, in coordination with Tracy Hillman and Chelan and Douglas PUDs, will draft a letter to Grant PUD expressing thanks for the use of the Grant PUD office in Wenatchee, Washington, for convening monthly HCP Committees meetings (Item VI-B). *(Note: this letter was sent to Grant PUD on March 29, 2018, and was distributed by Kristi Geris to the HCP Coordinating Committees, Hillman, and Denny Rohr on April 2, 2018.)*
- The HCP Coordinating Committees meeting on April 24, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item VI-C). *(Note: the meeting on April 24, 2018, was changed to a conference call to accommodate the Lake Roosevelt Forum meeting.)*

Decision Summary

- The Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the 2018 Rock Island and Rocky Reach Fish Spill Plan, as revised (Item IV-A).
- The 2017 Rock Island and Rocky Reach HCP Annual Reports were approved by the Rock Island and Rocky Reach HCP Coordinating Committees after no disapprovals were received following the 30-day review period, which ended on March 15, 2018.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- The Draft 2018 Broodstock Collection Protocols were distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on March 12, 2018. Wells HCP Coordinating Committee vote via email is due to Mike Tonseth and Geris by COB Friday, April 6, 2018 (Item V-A).

Finalized Documents

- The 2017 Rock Island and Rocky Reach HCP Annual Reports were distributed to the HCP Coordinating Committees by Kristi Geris on April 2, 2018.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. No changes were requested by HCP Coordinating Committees representatives; however, Ferguson added under the administrative updates: 1) an upcoming pinniped presentation by Michelle Rub (National Oceanic and Atmospheric Administration [NOAA]); and 2) a thank you letter to Grant PUD.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft February 27, 2018 meeting minutes. Kristi Geris said John Ferguson identified a typo under Douglas PUD's Wells Project 2020 Survival Verification Study agenda item regarding the location of the passive integrated transponder (PIT) tag trawl system, which is located in the lower (not upper) Columbia River Estuary below Bonneville Dam, near river kilometer 75. Geris said all other comments and revisions received from members of the Committees were incorporated into the revised minutes and there are no outstanding items remaining to be discussed. HCP Coordinating Committees members present approved the February 27, 2018 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees conference call on February 27, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on February 27, 2018):*

- *Kristi Geris will coordinate with Tracy Hillman and will notify the HCP Coordinating Committees of the date the HCP Hatchery Committees plan to tour the new Wells Fish Hatchery (tentatively scheduled for spring 2018; Item I-C).*
  Hillman said the HCP Hatchery Committees meeting on April 18, 2018, will be held in-person at Wells Dam and will include a tour of the new Wells Fish Hatchery facility. Geris will distribute a notification to the HCP Coordinating Committees to contact Hillman or Sarah Montgomery if members are interested in attending the tour (note: Geris distributed this notification on March 29, 2018).

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Douglas PUD and the Wells HCP Coordinating Committee will complete the following action items associated with the Douglas PUD 2020 Verification Survival Study (Items I-C and III-C):*
  - *Keely Murdoch will provide smolt-to-adult return (SAR) data, based on coded wire tags (CWTs), for coho salmon released and recaptured at Wells Dam.*
    Murdoch provided these data during the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.
  - *Tom Kahler will ask John Skalski (Columbia Basin Research) to calculate sample size ranges needed, based on SARs, to achieve precision standards for Wells summer Chinook salmon, Winthrop spring Chinook salmon, and Methow coho salmon; and Kahler will determine if these ranges result in capacity issues at Wells Fish Hatchery.*
    This will be discussed during today's meeting.
  - *Tom Kahler will determine whether there are permitting issues for rearing study fish at Wells Fish Hatchery.*
    This will be discussed during today's meeting.
  - *Tom Kahler will ask John Skalski about the feasibility of implementing a study design using both passive integrated transponder (PIT)-tagged summer Chinook salmon and acoustic-tagged spring Chinook salmon.*
    This will be discussed during today's meeting.
- *Lance Keller will provide an email detailing the Tumwater Dam fishway outage scheduled for February 28, 2018, and the HCP Coordinating Committees will contact Keller with comments, if any, no later than end of day February 27, 2018 (Item IV-A).*
  Keller provided this email following the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.
- *Lance Keller will incorporate language into the Draft 2018 Rock Island and Rocky Reach Fish Spill Plan, documenting the conversion of notched spill gates 18 and 26 back to full gate operation during spring 2018 (Item IV-I).*
  Keller provided an updated spill plan following the meeting on February 27, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on March 6, 2018:

- *Larsen Creek Enhancement Project*: The HCP Tributary Committees received this Small Project proposal from Chelan County Natural Resource Department. The purpose of this project is to increase channel length in lower Larsen Creek, which is an intermittent tributary to Peshastin Creek. This will be accomplished by constructing a 450-foot new channel across the floodplain thereby improving fish passage, off-channel habitat, and habitat complexity for juvenile steelhead. The total cost of the project is $59,100. The sponsor requested $44,200 from HCP Plan Species Account Funds. The HCP Tributary Committees declined the opportunity to fund the project, due to concern about spreading a channel with intermittent flow across an alluvial fan causing even more limited stream flow and possibly resulting in higher occurrences of fish stranding and entrapment.
- *Provide Supplemental Effectiveness Monitoring in the Grey and Stormy Reaches of the Entiat River*: The HCP Tributary Committees received this Monitoring proposal from Chelan-Douglas Land Trust (CDLT). The U.S. Bureau of Reclamation and their partners will fund the implementation of a variety of treatments aimed at increasing habitat complexity, quality, and availability in the Grey and Stormy Reaches between river miles 16.1 and 21.1 on the Entiat River. Improvements include installation of large wood, excavation of new side channels and/or improving access to existing side channels, levee removal, and riparian vegetation plantings. CDLT would like to monitor the effects of these actions on wood dynamics, floodplain connectivity, and channel bed change. The total cost of the project over the 11-year monitoring period is $386,523. The sponsor requested the entire amount from the Assessment Funds. The HCP Tributary Committees declined the opportunity to fund the project, because Assessment Funds can only be used to evaluate enhancement actions funded by the HCP Tributary Committees. Additionally, the HCP Tributary Committees are more interested in understanding fish responses (opposed to geomorphic and riparian responses). The HCP Tributary Committees have also been informed that the Integrated Status and Effectiveness Monitoring Program and Columbia Habitat Monitoring Program (ISEMP/CHaMP) in the Entiat River Basin may not proceed because the Bonneville Power Administration cut funding for the Intensively Monitored Watershed (IMW) component. Therefore, it is unlikely the monitoring work will have a cost share. John Ferguson asked about the IMW report on the Entiat River Basin. Hillman said he understands the final report may not be finished.

- *M2 Mid-Sugar Appraisal*: Chris Johnson (Methow Salmon Recovery Foundation) asked the Wells HCP Tributary Committee to review the M2 Mid-Sugar Appraisal conducted by Larry Rees (Cascade Chelan Appraisal Company). After reviewing the appraisal, the Wells HCP Tributary Committee identified several questions to discuss with Rees. Rees attended the HCP Tributary Committees meeting on March 6, 2018, to answer these questions. Following these discussions, the Wells HCP Tributary Committee approved the appraisal.
- *Plan Species Account Deposits*: At the end of January 2018: 1) Chelan PUD had deposited $759,967 into the Rock Island Account and $359,935 into the Rocky Reach Account; and 2) Douglas PUD had deposited $275,968 into the Wells Account. As of March 2018, the unallocated balances within each account were $6,501,189 in the Rock Island Account, $2,854,244 in the Rocky Reach Account, and $1,765,256 in the Wells Account. Among the three accounts, there is about $11,120,689 available for funding projects. Ferguson asked if these funds expire, and Hillman said no, the funds are good for the entire life of the HCP.
- *Salmon Recovery Funding Board/HCP Tributary Committees Proposed Schedule*: Each year the HCP Tributary Committees coordinate with the Salmon Recovery Funding Board process. This year, draft proposals are due on Friday, April 13, 2018. Project tours will be on May 9 (Wenatchee), May 10 (Entiat), May 15 (Methow), and May 16, 2018 (Okanogan). The HCP Tributary Committees will evaluate the draft proposals on Friday, May 11, 2018 (note: this date was later changed to May 23, 2018), and decide which projects should be submitted as final proposals. Sponsors will give presentations on Wednesday, June 13, 2018. Final proposals are due on Friday, June 29, 2018. The HCP Tributary Committees will evaluate final proposals and make funding decisions on Thursday, July 12, 2018.
- *Next meeting*: The next meeting of the HCP Tributary Committees will be on April 12, 2018. Hillman said currently there are not a lot of agenda items and this meeting may be canceled.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on March 12, 2018:

- *Draft 2018-2020 Steelhead Release Plan*: The HCP Hatchery Committees reviewed Chelan PUD's draft 2018-2020 Steelhead Release Plan. The purpose of the plan is to evaluate steelhead survival to McNary Dam based on size at release and rearing vessel (raceway versus reuse circulars). The goal is to inform best hatchery management practices that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions. The plan is to use a two-factor ANOVA design with three replicates (years). The Rock Island and Rocky Reach HCP Hatchery Committees approved the release plan, which will be implemented this year.
- *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program*: The new steelhead permit calls for maximizing the number of steelhead that migrate downstream

and reducing the number that residualize. Chelan PUD proposed possible methods for evaluating steelhead residualism in the Wenatchee Basin. Possible methods include PIT-tag evaluations, post-release sampling, and electrofishing/angling surveys. The HCP Hatchery Committees discussed possible sampling designs and sampling methods. Chelan PUD will convene the Hatchery Evaluation Technical Team to help identify appropriate methods for estimating residualism rates. Hillman said he believes the HCP Hatchery Committees will be discussing this item for a while. He said NMFS is deferring to the HCP Hatchery Committees to develop a method, which is a large effort.

- *Fish Health and Production at Wells and Methow Hatcheries*: Dr. Betsy Bamberger (Douglas PUD Fish Heath Specialist) shared a presentation titled, "Columnaris Disease at Wells Hatchery – A Case Review." Bamberger described Columnaris disease, its significance, and its presence at Wells Fish Hatchery and elsewhere. She outlined treatment and management strategies including the use of Diquat to treat the disease, which she found to be very effective in treating summer steelhead. Ferguson asked if Columnaris is a fungal infection, and Hillman said it is a bacterial infection.
- *Sinkhole at Wells Fish Hatchery*: Douglas PUD described what appears to be a leak in the pond liner for dirt pond 3 at Wells Fish Hatchery. At one point, the pond was losing about 1,000 gallons per minute. It is apparent from detailed inspections that the old liner simply failed due to age. Heavy equipment contractor KRCI sealed the pond with an engineered fill including sand, gravel and bentonite clay, which appears to have sealed the leak for the time being. The pond is currently rearing the Columbia River safety-net steelhead program. It does not appear any steelhead have disappeared into the sinkhole. After the fish are released in mid-April, Douglas PUD will develop a plan to reline the dirt ponds at Wells Fish Hatchery.
- *Advancements in Estimating Steelhead Escapement Methodology*: Andrew Murdoch (WDFW) shared a presentation titled, "Estimating Steelhead Escapement in the Upper Columbia DPS" *(note: DPS means "distinct population segment")*. Andrew Murdoch described a Bayesian hierarchical patch occupancy model, which uses PIT tag detections to estimate run escapements into the Okanogan, Methow, Entiat, and Wenatchee river subbasins. Adult steelhead are PIT tagged at Priest Rapids Dam and subsequently redetected at arrays scattered throughout the subbasins. Estimated run escapements were generally precise (with coefficients of variation less than 15%) for both hatchery and wild fish. Andrew Murdoch then described a method for estimating spawning escapements using both PIT-tag detections (in tributaries) and redd counts (in subbasin mainstems). Redd counts were converted to spawning escapements using a Gaussian Area Under the Curve method and observer error models. This approach provided generally precise spawning escapement estimates. Hillman said the more fish marked and redetected the more precise the model. Ferguson asked what these models were compared to, and Hillman said the models were compared to redd counts.

Ferguson asked about the purpose of discontinuing using redd counts to obtain these data. Hillman clarified that redd counts still have to be used in the mainstem. He also noted that this patch occupancy method was originally developed in the Snake River and was adapted to the Columbia River.

- *2018 Broodstock Collection Protocols*: The HCP Hatchery Committees are currently reviewing the Draft 2018 Broodstock Collection Protocols. Comments are due to WDFW by the end of March 2018. The final protocols are due to NMFS by April 15, 2018.
- *National Marine Fisheries Service Consultation Update*: NMFS indicated that the National Environmental Policy Act process is moving forward with Chuck Peven (Peven Consulting) writing the Environmental Assessment for Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids).
- *Next meeting*: The next meeting of the HCP Hatchery Committees will be on April 18, 2018, at Wells Dam.

III. Douglas PUD

A. Wells Project 2020 Survival Verification Study – Study Species (Andrew Gingerich)

John Ferguson said the HCP Coordinating Committees have been discussing this topic for the last 3 months. He recalled last month, there was a focused discussion regarding using either coho or summer Chinook salmon and not using steelhead. He said Keely Murdoch indicated the YN would support making coho salmon available from their production groups if the Wells HCP Coordinating Committee chose to study this species. Ferguson said spring Chinook salmon as a study species is pending the results of John Skalski's and Richard Townsend's analyses on sample sizes, which will be further discussed during today's meeting. Ferguson said the other species under discussion is summer Chinook salmon. He said the goal of today is to continue discussing regarding using either spring Chinook or coho salmon for the study and reach a point where Douglas PUD can draft a Statement of Agreement.

Andrew Gingerich said presentation slides titled, "Wells Dam Survival Verification 2020 – Species and Methodology Considerations," were distributed to the HCP Coordinating Committees by Kristi Geris on March 26, 2018. Gingerich recalled that Tom Kahler left the last meeting with a few action items under this agenda item, which these slides intend to address. *(Note: Gingerich provided final slides, which included corrected data [Attachment B], to Geris on March 28, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

Slide 2 of Attachment B

Gingerich said this slide explains why PIT tags are currently the only tool available to achieve the study goals contained within the Wells HCP. He said PIT tags provide easy comparisons to past studies, and PIT tags also provide accurate measurements of direct, indirect, and any potential delayed mortality (as required by the Wells HCP). He said the issue of tag burden also needs to be considered, and he noted studies conducted by Battelle in 2009 (Brown et al.), and 2012 (Carlson et al.), which evaluated tag burden using simulated turbine passage; showing that fish with the current generation of acoustic tags had higher mortality than PIT-tagged fish. This was particularly evident when Chinook salmon with higher tag burden exposed to pressure changes had increased mortal injury compared to lower tag burdened Chinook salmon.

Slide 3 of Attachment B

Gingerich said this slide contains a direct quote from Richard Brown's 2009 paper and summarized if acoustic tagged fish pass a dam via the turbine route, the fish are more susceptible to mortal injury compared to PIT or untagged conspecifics. He said this is one measure to evaluate fish mortality, and he noted that the figures on this slide show examples of the pressure profile to which fish are exposed when passing through a turbine.

Slide 4 of Attachment B

Gingerich said the punchline of this Carlson et al. 2012 study is that tag burden from relatively larger acoustic tags and the ratio of pressure change were the two biggest factors in predicting mortal injury to tagged fish when passing through turbines. Gingerich said the table on this slide shows tag burdens that were tested in the study and therefore support this conclusion. He said different types of tags (e.g., double- and single-battery acoustic tags, and PIT tags) were included in this study.

Slide 5 of Attachment B

Gingerich said Skalski's team built a series of logistic regressions for fish with various types of tags, including no tag, that were exposed to different ratios of pressure change, which show a dramatic change in the probability of mortality associated with tag type. He said for these treatment fish the only difference was the tag burden. He said in his opinion, this is fairly important in terms of the survival challenges associated with using acoustic tags for survival studies. Ferguson recalled working for NOAA and evaluating tag effects using the juvenile salmon acoustic telemetry (JSAT) system. Ferguson said it seemed the survival of JSAT- and PIT-tagged fish was comparable for a distance of one dam and reservoir, around at a distance of two dams and two reservoirs the results started diverging dramatically; and at three dams and three reservoirs there was a definite question about using JSATs for survival studies. He said at that time, tag burden was not only about turbine passage; it also included accumulative effects. Gingerich said, further, acoustic arrays are not located everywhere; therefore, the infrastructure component gets larger. Tag burden, active tag battery failure issues, post-release detections of dead fish, infections at suture sites 20 days after release, and surgical effects (anesthetic and large incisions) were all discussed in relation to why PIT-tags are a more accurate tool for estimating hydro survival.

Slides 6 and 7 of Attachment B

Gingerich said regarding the YN's inquiry about conducting a smaller-scale side-by-side study, Skalski's team developed a hypothetical situation that demonstrates the release of acoustic-tagged fish would also require the release of a control group below Wells Dam. Gingerich said the data would not be adequate to only have an acoustic group next to a PIT group; therefore, to conduct a smaller-scale, side-by-side study, there would really need to be two separate studies.

Slide 8 of Attachment B

Gingerich said Skalski and Townsend estimated that 90,000 study fish (45,000 treatment and 45,000 control), regardless of species, will be needed for the Wells Project 2020 Survival Verification Study. Gingerich said this number assumes that detection probability at the Rocky Reach Juvenile Fish Bypass System (RRJFBS) is in the 0.2 to 0.4 range, similar to most years; and given a standard error requirement of ≤0.025. Gingerich said he will distribute the report by Skalski and Townsend, which calculates the sample size ranges needed to achieve precision standards for various study species and designs. *(Note: Tom Kahler provided this report to Geris on April 13, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

Slide 9 of Attachment B

Gingerich said the series of lines on this slide are logistic regressions. He said the P_{RR} is the likely detection probability at the RRJFBS. He said for coho salmon, to achieve a standard error ≤0.025 (y-axis) would require approximately 45,000 treatment and 45,000 control fish (x-axis).

Slide 10 of Attachment B

Gingerich said these are the exact same plots as show on slide 9 of Attachment B, only the data evaluate spring Chinook salmon (springers) on top and summer Chinook salmon (summers) on bottom. He said again, a release size of about 90,000 fish meets precision targets for both species.

Slide 11 of Attachment B

Gingerich said less fish (32,000) per release site are needed to meet HCP precision and accuracy standards for either of the three species when McNary detection probability is 0.10 to 0.25 (the typical range).

Slide 12 of Attachment B

Gingerich said estimating delayed mortality can be difficult. He said the Wells HCP does not specify what the standard error should be around delayed mortality estimates. He said Skalski developed a similar plot to the previous slides, which evaluates adult returns using SARs. Gingerich said, to achieve a standard error of 0.025 with reasonable SARs, release size can increase quickly. He said more fish in the release group results in tighter survival estimates. Shane Bickford (Douglas PUD HCP

Policy Staff) added that this exercise is estimating something that is very small or not significant (i.e., delayed mortality), which means a lot of fish are required to achieve a meaningful level of precision around the estimate.

<u>Slide 13 of Attachment B</u>

Gingerich said in conclusion: 1) using PIT tags will provide a clean comparison to results of previous verification studies and conforms to the survival requirements of the Wells HCP; 2) Douglas PUD will need about 90,000 fish for the study, which is a little more than what was used in the 2010 verification study; 3) higher SARs will help in terms of tightening up the precision around the estimates; and 4) challenges with using springers include Endangered Species Act concerns and permitting. Gingerich said Kahler called Brett Farman (NMFS) two times and was unable to reach him. Gingerich said Douglas PUD is unsure about what is realistic in terms of meeting permitting requirements in time to collect springers this year. He noted that using yearling summer Chinook salmon released in the spring, to serve as a surrogate for springers in the 2010 study, was approved by the Wells HCP Coordinating Committee at that time. Jim Craig asked which species have been studied in past years, and Bickford clarified that yearling Chinook salmon were studied in 1998 and yearling steelhead were studied 1999 and 2000. The 2010 survival verification study used yearling summer Chinook salmon raised at the Wells Fish Hatchery.

Bickford noted that because of the leaking liner in dirt pond 3, Douglas PUD's hatchery capacity is currently degraded and if Douglas needs to raise an additional 100,000 fish for this study (spring Chinook or coho salmon) the study would need to be postponed one year (or until 2021). Conversely, if the study used summer Chinook salmon, already required for mitigation at Wells Fish Hatchery, then no new fish would need to be raised and the study could take place in 2020, as originally scheduled.

<u>Discussion</u>

Murdoch asked if Chelan PUD observed tag burden issues when conducting survival studies using acoustic tags. Lance Keller said Chelan PUD was aware of Battelle's tag burden investigation, but without turbine specific measurements conducted with sensor-fish, site-specific tag burden effects cannot be factored into survival results. He said Chelan PUD had been using acoustic tags for a while when the Battelle data about tag burden were published. Keller said Chelan PUD visited Battelle and observed tag burden and decompression studies, but no results were incorporated into Chelan PUD studies. He said with this in mind, Chelan PUD had confidence that the survival estimates were conservative. He said for the next survival study, Chelan PUD was considering double-tagging; however, based on the most recent data this may be reconsidered. He said it is understood there is an effect; however, it is still unclear what is affected and to what extent dam specific, turbine-specific modeling. Ferguson noted that Rock Island Dam also has lower head and bulk turbines, which are more fish friendly in terms of pressure.

Bickford said Douglas PUD tags study fish 4 to 5 months prior to the study to give the fish time to heal and allow them to behave normally when released. He noted that handling and anesthetizing fish during tagging puts a tremendous amount of stress on the fish, impacting normal behavior and physiological processes as documented in Douglas PUD's prior four years of survival-related physiological studies. He said in 1998 and 1999, study fish were tagged directly before release. He said it takes 15 days for fish to overcome just the stress of tagging much less transportation and release.

Kirk Truscott said that some Wells HCP Coordinating Committee members have expressed interest in studying springers. He said one goal of these survival studies is to verify surrogacy through a comparison of ratios. He noted that if the control and study groups are both double-tagged, both will have equal tag burden. He said part of the reasoning behind using springers and acoustic tags is attempting to avoid needing 90,000 study fish.

Bickford said if there is a desire to evaluate whether or not spring and summer Chinook salmon have similar survival, then there is a simple way to do this. He noted that in prior evaluations that spring and summer Chinook salmon yearlings have displayed similar smolt-to-smolt survival. However, it should be noted that there are differences between steelhead and Chinook salmon, but very small differences between coho and Chinook salmon and coho salmon and steelhead. He said steelhead have lower survival in the Columbia and Snake rivers. He said sockeye salmon have high survival, and coho salmon have intermediate survival which is why the Wells HCP Coordinating Committee was comfortable with having summer Chinook salmon yearlings to serve as a surrogate species in the past. He said with Chinook salmon, there is really no inter-dam survival differences. He said Douglas PUD would not be opposed to using springers as a study species; however, there is a lot more preparation and permitting to achieve what Douglas PUD considers to be a valid verification study.

Truscott asked about the transport component. Bickford cautioned that at some point, fish performance can be affected by transport. He recalled a study conducted by NOAA in 1998, when there was inadequate oxygen provided during transport from Eastbank Fish Hatchery to the Wells Dam tailrace when compared to fish transported to the Rocky Reach Dam tailrace for release. He said the difference in transport was only 10 minutes longer in the study, but this difference manifested in a 2% difference in survival of fish migrating through Rocky Reach Dam according to NOAA. Bickford said little differences during these studies can manifest into significant impacts to the precision and accuracy of the survival studies.

Bickford said regarding surrogacy, it would be beneficial to review the smolt-to-smolt comparison data for summers and springers to determine if these species behave similarly throughout the hydrosystem. If there are no statistically significant differences between the two Chinook salmon stocks, then it would make sense to use the one that can be done without another ESA consultation and that can be done on schedule (2020).

Ferguson said a decision on species is needed with regard to broodstock and facility capacity. Truscott asked if there is also a capacity issue if coho salmon are used, and Bickford said yes. Bickford added that Douglas PUD is not averse to using coho salmon. The study would simply need to be moved to 2021. Murdoch recalled that the YN's permit allows for a 10% overage. She said even if the YN's full broodstock is met, the study fish for Douglas PUD would still be within the 10% allowance.

Ferguson recalled discussing that there is no coho salmon program in the Okanogan River and a possible issue with straying. Murdoch said the YN's permit does not have the Okanogan River as a release site. She said she does not believe this is an issue; however, approval from NOAA should be obtained just in case.

Truscott noted that summers are beneficial in the event there is a bad ocean year, compared to springers. Murdoch said coho salmon SARs can vary significantly (either really good or really bad) depending on the ocean year. Truscott suggested using whichever species has the best chance at achieving survival standards considering all scenarios.

Murdoch agreed it will be beneficial to review the results from the most recent spring and summer Chinook salmon smolt-to-smolt comparative studies conducted by Douglas PUD. Bickford said Douglas PUD can provide these data to Geris for distribution to the HCP Coordinating Committees. Bickford noted that using springers would also require Douglas PUD to modify the HCP incidental take statement. Scott Carlon said he will discuss internally with NMFS, with regard to the Wells Project 2020 Survival Verification Study: 1) permitting requirements for using spring Chinook salmon, including modifications to Douglas PUD's HCP Incidental Take permit; 2) concerns with collecting additional broodstock and straying and pHOS issues associated with releasing spring Chinook salmon raised at the Wells Fish Hatchery at the mouth of the Okanogan and Methow rivers and below Wells Dam; and 3) concerns with releasing coho salmon at the mouth of the Okanogan River given that release site is not currently covered under the YN's coho permit.

Truscott asked about broodstock needed. Gingerich said for 90,000 fish, Tom Kahler was estimating needing 60 males and 60 females in excess of other programs. Truscott noted that springers have low SARs and more brood may be needed if this species is used for the study.

IV. Chelan PUD

A. DECISION: Draft 2018 Rock Island and Rocky Reach Fish Spill Plan (Lance Keller)

An updated Draft 2018 Rock Island and Rocky Reach Fish Spill Plan was distributed to the Rock Island and Rocky Reach HCP Coordinating Committees by Kristi Geris on February 27, 2018 (originally distributed on February 1, 2018). The draft document was available for a 30-day review period, with edits and comments due to Lance Keller by March 2, 2018. Keller recalled last month discussing converting notch gates 18 and 26 to full capacity. He said once river flows decrease, these gates will be converted back to a notch gate configuration. He said these changes were incorporated into the fish spill plan and no comments were received from Rock Island and Rocky Reach HCP Coordinating Committees members. Keller reminded the HCP Coordinating Committees that these changes to the spill gates were in response to losing the use of a few automated spill gates. He said the changes increase dam safety through additional full gate capacity.

The Rock Island and Rocky Reach HCP Coordinating Committees representatives present approved the 2018 Rock Island and Rocky Reach Fish Spill Plan, as revised.

B. Rocky Reach Dam Turbine Unit C1 Maintenance Update (Lance Keller)

Lance Keller recalled last month, discussing with the HCP Coordinating Committees the condition of Turbine Unit C1 and the possibility that the unit may not be available in time for the start of the spill season on April 1, 2018. Keller said it has been confirmed this is the case. He said Chelan PUD is currently moving forward on two parallel paths to return this unit back into service. He said Chelan PUD is working with a company that specializes in trunnion seals to fix the leak. He said the replacement seals will be on site at Rocky Reach Dam next week for installation, and the target operational date is currently in early May 2018. Keller said secondly, Chelan PUD is considering hydraulically locking the turbine blades in a fixed position. He said this is different than what was implemented on the large units during servo rod repairs. He said to hydraulically lock the blades, the blades are set at the desired angle, and then the oil is removed from the hub. This does not allow the servo motor to adjust the blades (i.e., the blades are locked in position). He said, however, there is concern when trunnion seals are leaking that water will get into the hub and cause issues. He said Chelan PUD is leaning towards the seal fix but is also continuing to research the hydraulically locking fix. He said the hydraulically locking option may result in the unit coming back into service 2 weeks behind the seal fix; however, regardless of the fix, the unit is expected back online by early-to mid-May 2018 at this current time.

Keller said a marked fish release was recently conducted in the RRJFBS and intake screen system deployed in Turbine Unit C2. He said the release was conducted under the altered operations, as discussed by the Rocky Reach HCP Coordinating Committee last month. Keller recalled these operations included using three additional RRJFBS surface collector pumps to increase attraction flow to 3,330 cubic feet per second on each side of the RRJFBS surface collector entrances. He said 100 and 130 fish were released in the north and south entrances, respectively; and 96 and 129 fish were recovered, respectively. He said a second Turbine Unit C2 release was conducted at a higher velocity and 100 of 100 fish were recovered. He said no signs of descaling or injury were observed during each test.

Keely Murdoch asked regarding the first test, if Chelan PUD expected to recover all test fish? She also asked if the five unrecovered fish were mortalities. Keller said the fish were not mortalities; rather, the fish were just unaccounted for. He said it is common during these tests for a few fish to swim upstream and out of the RRJFBS. He further explained that the test was conducted as high (upstream) in the system as possible, which increases the chance that a fish may swim out. He said the test fish were destined for Dryden, so there was a large range of fish sizes. He said the test could be conducted by releasing fish lower in the system, but then a portion of the system would not be captured in the evaluation. He said additionally, the test is ideally conducted at the same location each year.

V. WDFW

A. Draft 2018 Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth said the Draft 2018 Broodstock Collection Protocols were distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on March 12, 2018. Tonseth recalled there is a Wells HCP requirement for Wells HCP Coordinating Committee approval of the annual Broodstock Collection Protocols. Tonseth said the most notable difference from last year is a broadening trapping window for spring Chinook salmon at Wells Dam from 5 to 7 days per week (which is allowed under the Wells Biological Opinion), up to 16 hours per day. Tonseth said this protocol still allows for nighttime passage, but also allows operators to meet weekly and programmatic targets. He recalled in 2017, although there were sufficient numbers of fish, there were issues reaching targets because of trapping hour constraints. He said the adult return forecast for 2018 is similar to 2017.

Tonseth said the HCP Hatchery Committees have a comment deadline of COB Friday, March 30, 2018, and the Federal Energy Regulatory Commission (FERC) submission deadline is April 15, 2018. Tonseth asked that the Wells HCP Coordinating Committees submit a vote via email before the FERC deadline. Geris will redistribute the Draft 2018 Broodstock Collection Protocols (originally distributed March 12, 2018) along with a voting deadline for the Wells HCP Coordinating Committee, to be submitted via email to Tonseth and Geris by COB Friday, April 6, 2018. *(Note: Geris redistributed the protocols, as discussed, following the meeting on March 27, 2018.)*

VI. HCP Administration

A. Pinniped Presentation by Michelle Rub (John Ferguson)

John Ferguson said he contacted Michelle Rub (NMFS) about possibly presenting an update on her pinniped research to the HCP Coordinating Committees *(note: Rub last presented her research to the HCP Coordinating Committees on June 23, 2015)*. Ferguson said Rub indicated she may be available to present at the HCP Coordinating Committees meeting on June 26, 2018. Ferguson noted that Rub has most recently been conducting genetics-based work.

B. Thank You Letter to Grant PUD (John Ferguson)

John Ferguson suggested drafting a letter to Grant PUD from the HCP Committees thanking Grant PUD for the use of the Grant PUD office in Wenatchee, Washington. The HCP Coordinating Committees agreed this is a good idea. Ferguson, in coordination with Tracy Hillman and Chelan and Douglas PUDs, will draft a letter to Grant PUD expressing thanks for the use of the Grant PUD office in Wenatchee, Washington, for convening monthly HCP Committees meetings. *(Note: this letter was sent to Grant PUD on March 29, 2018, and was distributed by Kristi Geris to the HCP Coordinating Committees, Hillman, and Denny Rohr on April 2, 2018.)*

C. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on April 24, 2017, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington. *(Note: the meeting on April 24, 2018, was changed to a conference call to accommodate the Lake Roosevelt Forum meeting.)*

The May 22 and June 26, 2018 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A List of Attendees
Attachment B Wells Dam Survival Verification 2020 – Species and Methodology Considerations

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood†	Chelan PUD
Shane Bickford*	Douglas PUD
Andrew Gingerich	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*	Washington Department of Fish and Wildlife
Mike Tonseth	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone

Wells Dam Survival Verification

2020

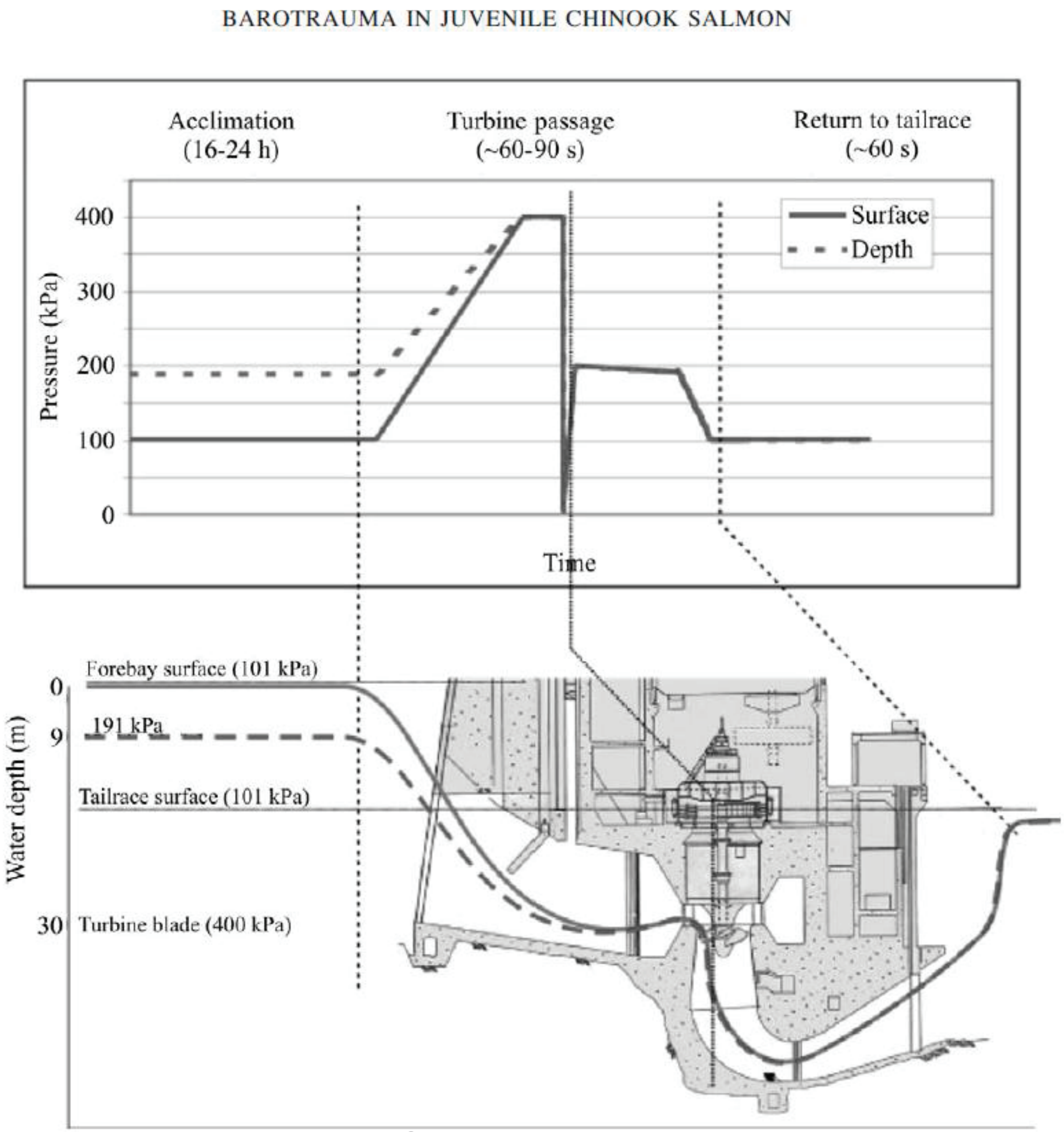
Species and Methodology Considerations

HCP CC: March 27, 2018

Why PIT?

- Best method for "Verification" is to use the same methods as prior studies.
- Direct, indirect, and delayed mortality are included. PIT-tags are the only technology that can provide an estimate of delayed mortality.
- Assume tagged fish are representative of untagged Project "influenced" fish? Acoustic tagged fish are not representative of the run at large (Brown et al. 2009; Carlson et al. 2012).

- **Brown et al. (2009)** *"Juvenile Chinook Salmon implanted with active tags were more likely than those without to die or sustain injuries during simulated turbine passage."*
- Mechanism is, more negatively buoyant requires more dissolved gasses in tissues and therefore more susceptible to decompression. Worse "bends" for tagged fish.



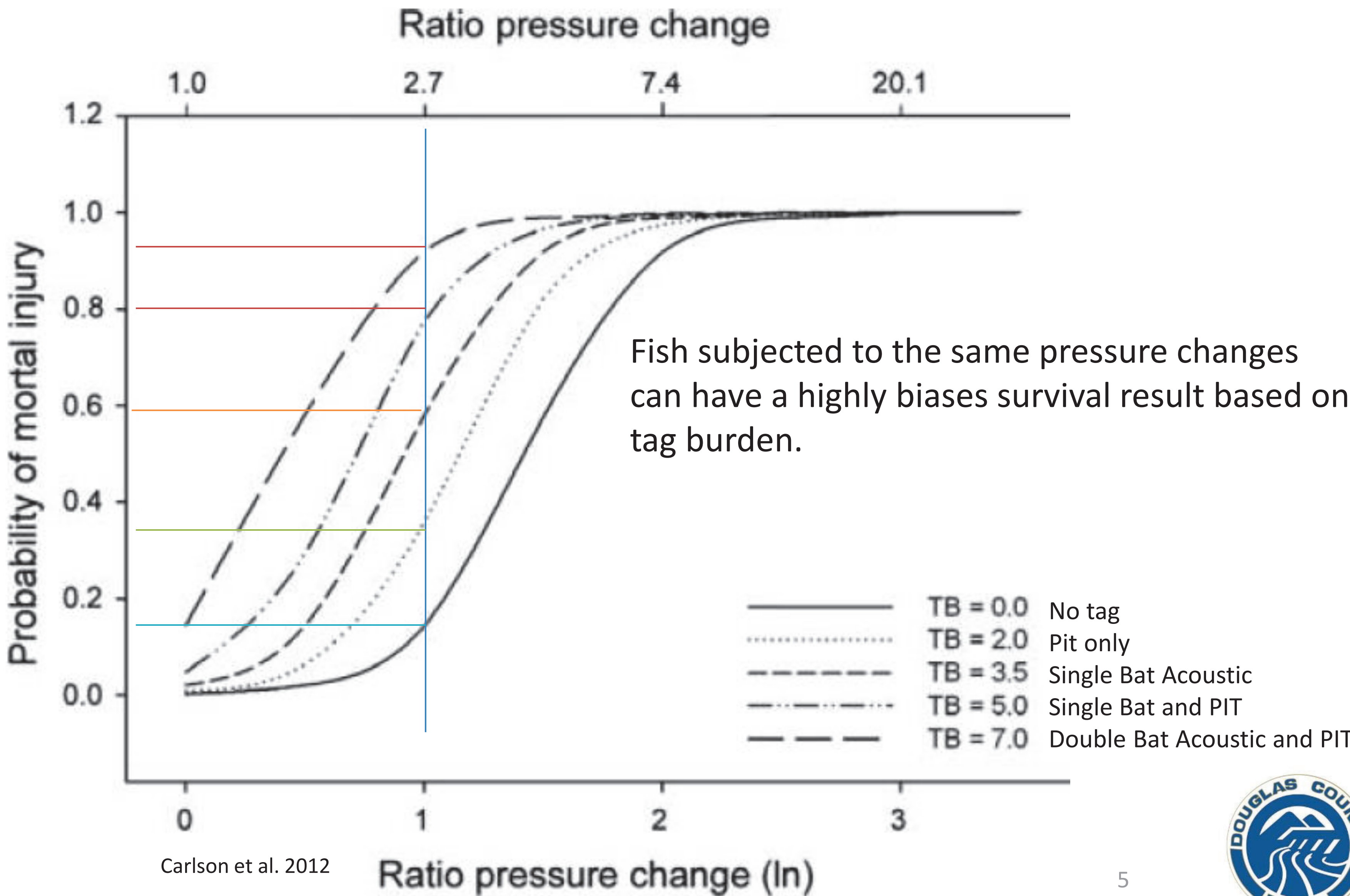
Carlson et al. 2012

- *"Several factors were examined as predictors of mortal injury for fish undergoing rapid decompression; of these factors, the log $_e$ transformed ratio of acclimation pressure: exposure pressure (LRP) and the* ***tag burden (tag mass expressed as a percentage of fish mass)*** *were the most predictive. As the LRP and tag burden increased****, the likelihood of mortal injury also increased****. **Our results suggest that previous estimates of survival for juvenile Chinook salmon passing through hydroturbines were negatively biased due to the presence of telemetry tags…"***

TABLE 2. Combined mass of tags (in air and water), tag volume, and median tag burden (tag weight expressed as a percentage of fish body weight in air; range in parentheses) associated with each transmitter treatment group (defined in Table 1) of juvenile Chinook salmon exposed to simulated turbine passage.

Transmitter treatment	Tag mass in air (g)	Tag mass in water (g)	Tag volume (mL)	Tag burden (%)
Double battery + PIT	0.53	0.36	0.18	2.05 (0.37–6.62)
Single battery + PIT	0.41	0.25	0.15	1.35 (0.34–5.06)
Single battery only	0.31	0.19	0.11	1.49 (0.27–4.69)
PIT only	0.10	0.06	0.04	0.51 (0.08–1.66)

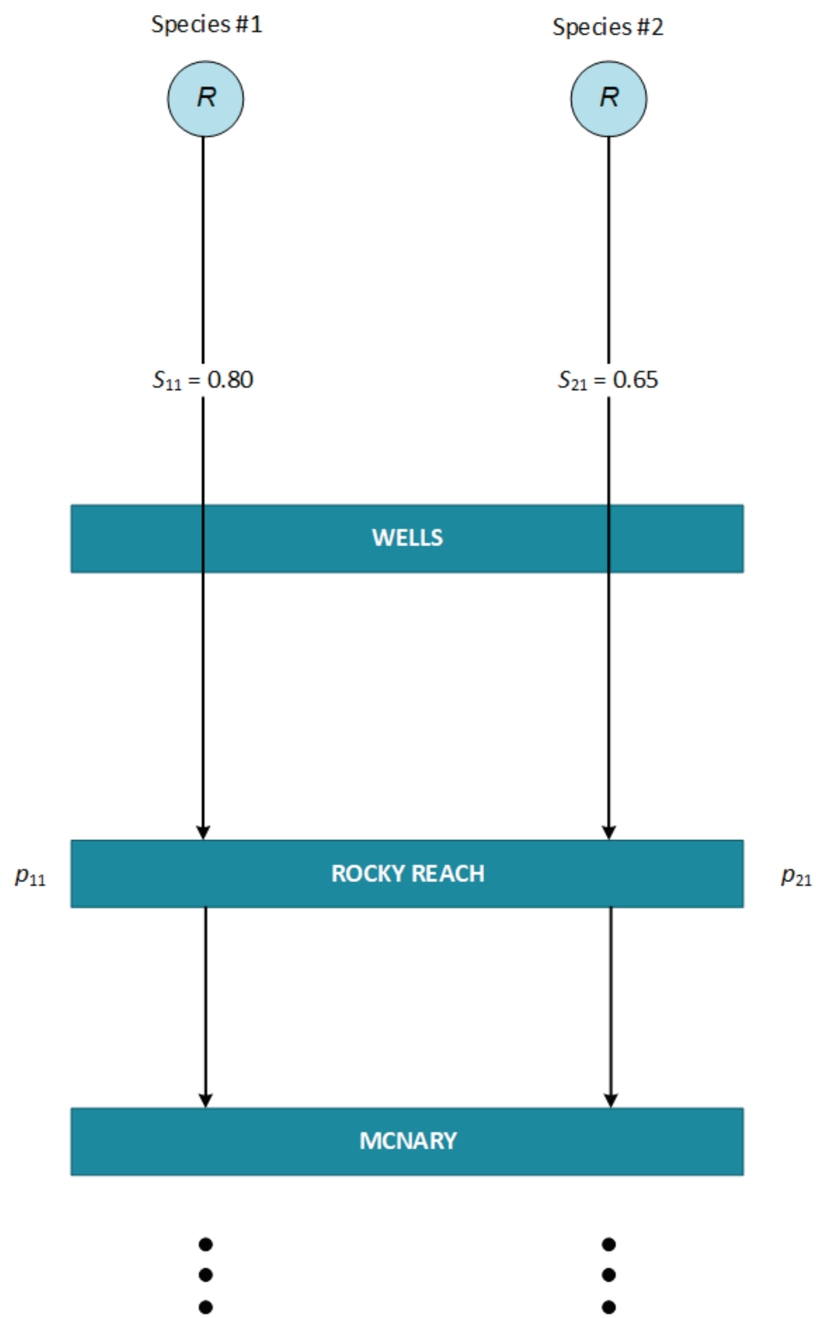
Do tagged fish represent the untagged population?



Fish subjected to the same pressure changes can have a highly biases survival result based on tag burden.

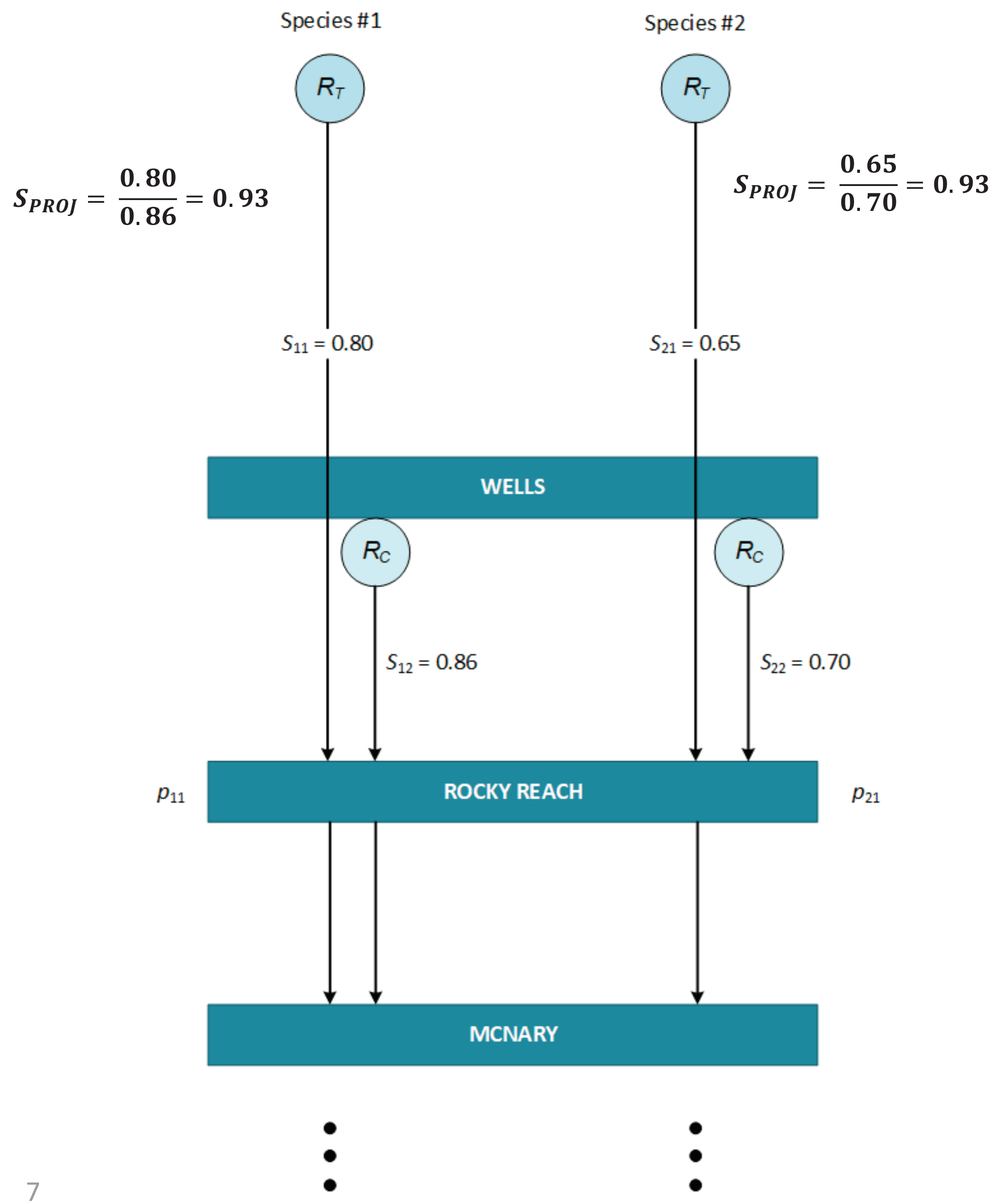
Carlson et al. 2012

Why Paired Release and Controls are Needed



Why Pair Release and Controls Needed

Emphasizes the lack of utility pairing acoustic tags next to RT group

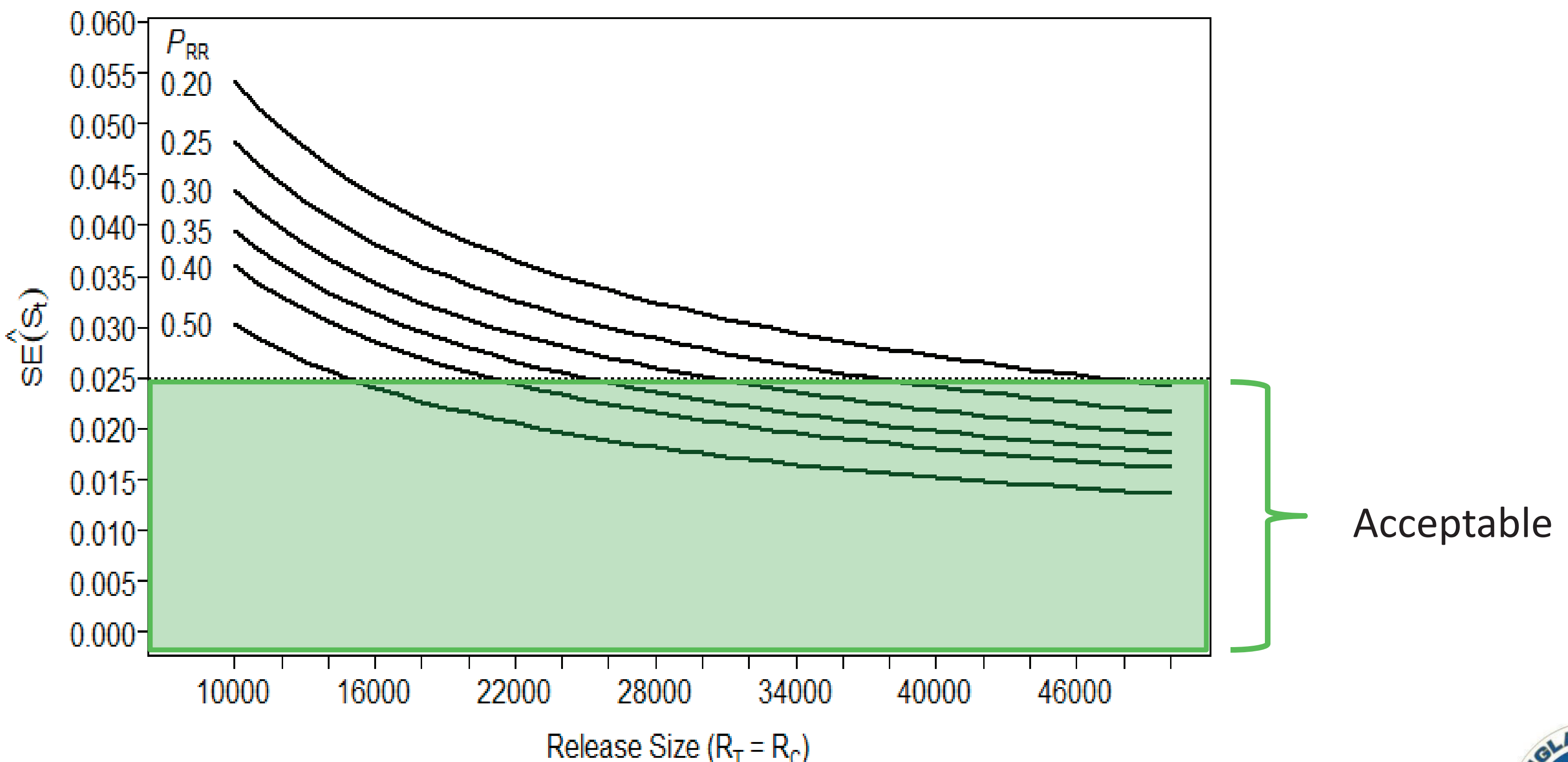


Sample Size: Juvenile Project Survival

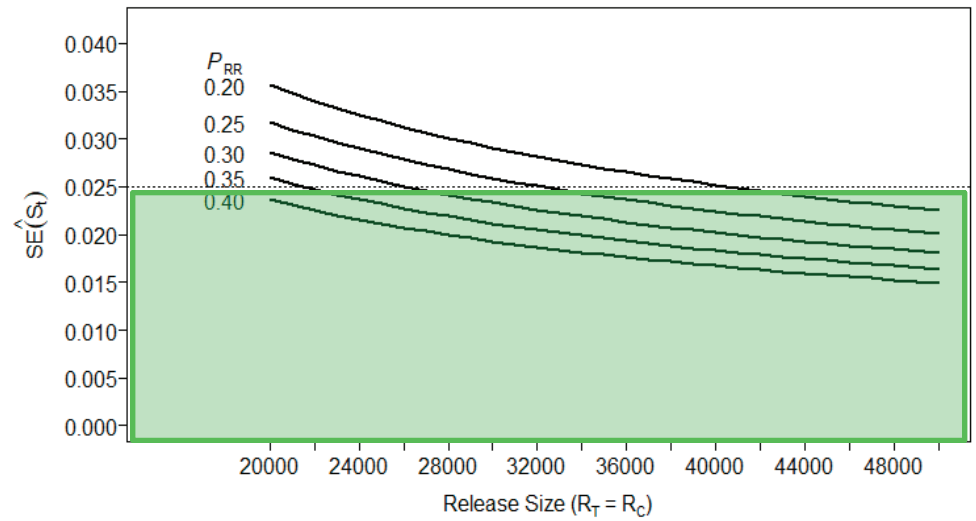
- Skalski and Townsend: Need 90K fish under most conservative circumstances (RRJB detection of 0.2-0.4). That is 45 K Treatment and 45 K control or tailrace releases.
  - *“Consequently, regardless of fish species, release sizes of $R_T = R_C = 45{,}000$ should in most circumstances be adequate to produce a $\widehat{SE} \leq 0.025$.”*
  - Note. Coho more variability around detection probability

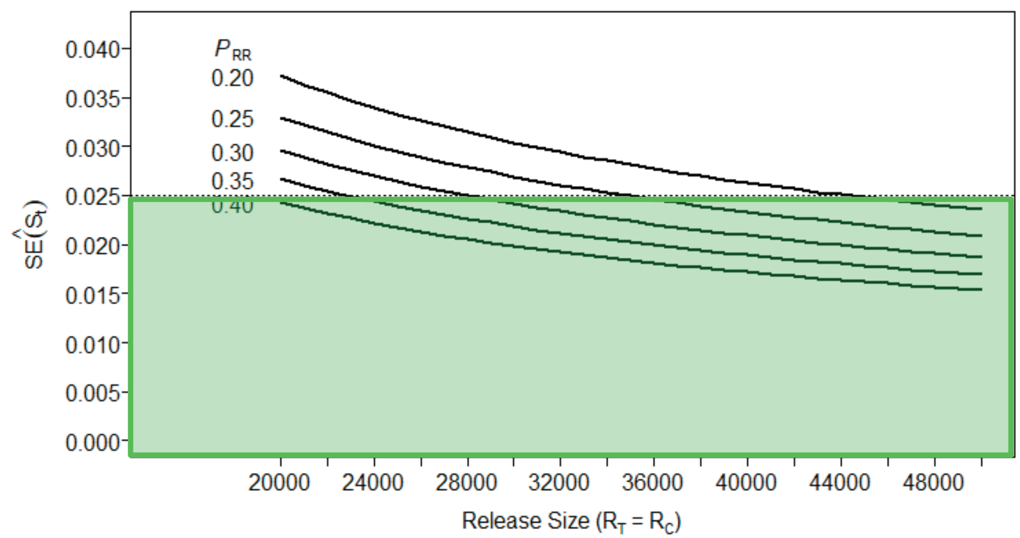
Sample Size: How many fish to get SE of 0.025?

- E.g. Coho



Sample Size: Springers (top) and Summers (bottom)





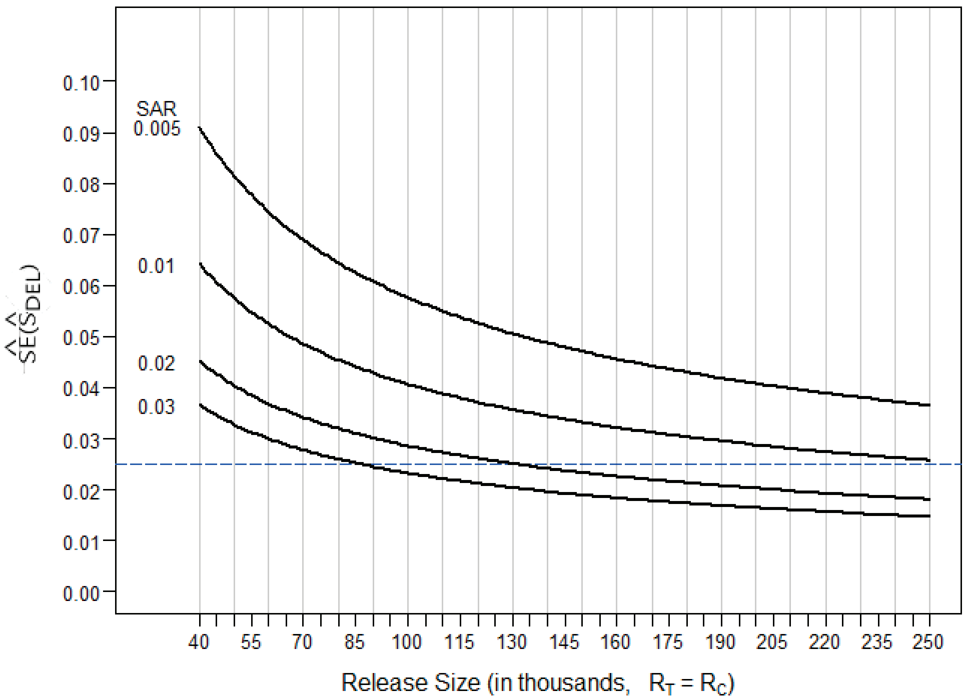
Also Need McNary Range

- 32K PIT tagged treatments and 32K PIT tagged controls are needed to achieve the HCP precision and accuracy standards for either of the three species when McNary DP is 0.10-0.25 (typical range).
- 45K PIT tagged fish are needed to meet RRJBS detection probability ranges and SE standard of 0.025

Adult Returns or SAR Sample Sizes

- 45K PIT tagged fish needed, at average SARs, to get a reasonable estimate of delayed mortality

- Using fish with higher SARs like coho and summer Chinook provide a much more precise estimate or delayed mortality, if it exists and can be measured.



Conclusions

- PIT tags released using the paired release-recapture model are the only methodology currently available that allows precise and accurate juvenile project survival estimates to be collected at Wells Dam that conform to the requirements in the Wells HCP.
- PIT-tags are also consistent with prior studies and the intent of the required 2020 survival verification study.
- 90K needed to meet the HCP's precision and accuracy requirements.
- Fish with historically higher SARs provide more robust and accurate estimates of delayed mortality.
  - Suggest summer Chinook yearlings to avoid ESA concerns with Spring Chinook
  - Summer Chinook don't require any additional rearing space at Wells since they are already part of program.
    - Wells Capacity limited with the sinkhole in dirt pond #3 and ongoing hatchery modernization construction activities.

References

- Brown R. et al. Assessment of barotrauma from rapid decompression of depth-acclimated juvenile Chinook salmon bearing radiotelemetry transmitters. Transactions of the American Fisheries Society 138: 1285–1301.
- Carlson T. et al. 2012. The Influence of Tag Presence on the Mortality of Juvenile Chinook Salmon Exposed to Simulated Hydroturbine Passage: Implications for Survival Estimates and Management of Hydroelectric Facilities. North American Journal of Fisheries Management 32(2):249-261

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: May 22, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the April 24, 2018 HCP Coordinating Committees Conference Call

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met by conference call on Tuesday, April 24, 2018, from 10:00 to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Douglas PUD will provide results from the most recent spring and summer Chinook salmon smolt-to-smolt comparative studies conducted by Douglas PUD to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C). *(Note: Tom Kahler provided these results to Geris on May 21, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Kristi Geris will forward to the HCP Coordinating Committees the Washington Department of Fish and Wildlife (WDFW) document outlining ongoing discussions on the Broodstock Collection Protocols, which was distributed to the HCP Hatchery Committees by Sarah Montgomery on April 19, 2018 (Item II-A). *(Note: Geris forwarded this document to the HCP Coordinating Committees following the conference call on April 24, 2018.)*
- Douglas PUD will inquire with Jeff Fryer (Columbia River Inter-Tribal Fish Commission [CRITFC]) about the feasibility of using the anesthetic, Aqui-S, during CRITFC's proposed annual sockeye salmon tagging effort at Wells Dam in 2018 (Item V-A).
- Keely Murdoch will inquire internally within the Yakama Nation (YN) about the feasibility of using the anesthetic, Aqui-S, during CRITFC's proposed annual sockeye salmon tagging effort at Wells Dam in 2018 (Item V-A). *(Note: Murdoch determined that the YN have no issues with using Aqui-S for this tagging effort, as distributed to the HCP Coordinating Committees by Kristi Geris on April 25, 2018.)*
- Scott Carlon will inquire internally within the National Marine Fisheries Service (NMFS) about the required permitting process for using coho salmon as a study species in the Douglas PUD 2020 Survival Verification Study (Item V-B).

- Kristi Geris will notify Jim Craig and Chad Jackson that the Wells HCP Coordinating Committee representatives present approved the Wells Project Land-Use Permit Application for Landscaping in Tract 333; and will request U.S. Fish and Wildlife Service (USFWS) and WDFW approval via email, as discussed (Item V-C). *(Note: Geris provided this notification to Craig and Jackson following the HCP Coordinating Committees conference call on April 24, 2018.)*
- The HCP Coordinating Committees meeting on May 22, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item VI-B).

Decision Summary

- The Wells HCP Coordinating Committee representatives present approved the 2018 Broodstock Collection Protocols, as revised. Jim Craig provided USFWS approval via email on April 19, 2018; Chad Jackson provided WDFW approval via email on April 23, 2018 (Item III-A).
- The Wells HCP Coordinating Committee representatives present approved the Wells Project Land-Use Permit Application for Landscaping in Tract 333. Jim Craig and Chad Jackson provided USFWS and WDFW approval, respectively, via email on April 25, 2018 (Item V-C).

Agreements

- There were no HCP Agreements discussed during today's conference call.

Review Items

- CRITFC's annual request to tag sockeye salmon at Wells Dam in 2018 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on April 13, 2018. Douglas PUD will seek approval of the request during the HCP Coordinating Committees meeting on May 22, 2018 (Item V-A).
- A Wells Project Land-Use Permit Application for Landscaping in Tract 333 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on April 24, 2018. This application was approved on April 25, 2018 (see Decision Summary; Item V-C).
- A Rocky Reach Project Land-Use Permit Application for the City of Entiat was distributed to the Rocky Reach HCP Coordinating Committee by Kristi Geris on May 10, 2018. This application is available for a 30-day review with comments or indication of no comments due to Lance Keller, Jeff Osborn (Chelan PUD), and Geris no later than Monday, June 11, 2018.

Finalized Documents

- The Final 2018 Broodstock Collection Protocols were distributed to the HCP Coordinating Committees by Kristi Geris on April 24, 2018 (Item III-A).

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Ferguson said Chad Jackson added a decision item on the 2018 Broodstock Collection Protocols via email on April 23, 2018. Ferguson said Mike Tonseth (WDFW) will lead this agenda item in Jackson's absence.
- Tom Kahler added: 1) Wells Project Land-Use Permit Application for Landscaping in Tract 333; and 2) Wells Dam Bypass Update.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft March 27, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the HCP Coordinating Committees were incorporated into the revised minutes and there are no outstanding items remaining to be discussed. HCP Coordinating Committees members present approved the March 27, 2018 meeting minutes, as revised. Jim Craig provided USFWS approval via email on April 17, 2018; Chad Jackson provided WDFW approval via email on April 18, 2018.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on March 27, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the meeting on March 27, 2018):*

- *Kristi Geris will distribute a notification to the HCP Coordinating Committees to contact Tracy Hillman (HCP Hatchery Committees Chairman) or Sarah Montgomery (HCP Hatchery Committees support staff) if members are interested in attending a tour of the new Wells Fish Hatchery facility on April 18, 2018 (Item I-C).*
  Geris distributed this notification on March 29, 2018.
- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Andrew Gingerich (Douglas PUD) will distribute the report by Drs. John Skalski and Richard Townsend (Columbia Basin Research), which calculates sample size ranges needed to achieve precision standards for various study species and designs, as discussed by the*

HCP Coordinating Committees for the upcoming Wells Project 2020 Survival Verification Study (Item III-A).
Tom Kahler provided this report to Kristi Geris on April 13, 2018, which Geris distributed to the HCP Coordinating Committees that same day.

- *Douglas PUD will provide results from the most recent spring and summer Chinook salmon smolt-to-smolt comparative studies conducted by Douglas PUD to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-A).*
  This action item will be carried forward.
- *Scott Carlon will discuss internally with the NMFS, with regard to the Wells Project 2020 Survival Verification Study: 1) permitting requirements for using spring Chinook salmon, including modifications to Douglas PUD's HCP Incidental Take permit to allow for handling and tagging over 100,000 spring Chinook salmon smolts; 2) modifications to hatchery permits to allow for the collection of additional broodstock and for straying and percentage of hatchery origin spawners (pHOS) issues associated with releasing spring Chinook salmon raised at the Wells Fish Hatchery at the mouth of the Methow and Okanogan rivers; and 3) concerns with releasing coho salmon at the mouth of the Okanogan River given that the Yakama Nation (YN) program currently does not have coverage for releasing fish at that site (Item III-A).*
  This will be discussed during today's conference call.
- *Kristi Geris will redistribute the Draft 2018 Broodstock Collection Protocols (originally distributed March 12, 2018) along with a voting deadline for the Wells HCP Coordinating Committee, to be submitted via email to Mike Tonseth (WDFW) and Geris by close-of-business (COB) on Friday, April 6, 2018 (Item V-A).*
  Geris redistributed the protocols, as discussed, following the meeting on March 27, 2018.
- *John Ferguson, in coordination with Tracy Hillman and Chelan and Douglas PUDs, will draft a letter to Grant PUD expressing thanks for the use of the Grant PUD office in Wenatchee, Washington, for convening monthly HCP Committees meetings (Item VI-B).*
  This letter was sent to Grant PUD on March 29, 2018, and was distributed by Kristi Geris to the HCP Coordinating Committees, Hillman, and Denny Rohr (Priest Rapids Coordinating Committee [PRCC Facilitator]) on April 2, 2018.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman reported that the HCP Tributary Committees did not meet in April 2018 and will next meet on May 23, 2018 (the day after the HCP Coordinating Committee meeting on May 22, 2018). Hillman said the HCP Tributary Committees received 20 draft proposals to review, which are all cost-shares with the Salmon Recovery Funding Board. He said the HCP Tributary Committees will also be attending the upcoming project tours in the Wenatchee, Entiat, Methow, and Okanogan river basins during May 2018.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on April 18, 2018:

- *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program*: The new Wenatchee steelhead permit calls for maximizing the number of steelhead that migrate downstream and reducing the number that residualize. Chelan PUD proposed three methods for evaluating steelhead residualism in the Wenatchee Basin. The first method evaluates the number and proportion of passive integrated transponder (PIT)-tagged hatchery steelhead detected within the Wenatchee Basin after the smolt outmigration period. This is a requirement of the permit. The second method involves holding 300 hatchery-by-hatchery and 300 wild-by-wild steelhead for at least 2 months after juvenile steelhead are released to assess maturation of precocial parr. The Rocky Reach and Rock Island HCP Hatchery Committees approved this method. The final method being developed by the Hatchery Evaluation Technical Team is to sample for residual steelhead within the Wenatchee Basin. This method may include a combination of snorkel and PIT-tag surveys and is still under discussion.
- *National Marine Fisheries Service Consultation Update*: The National Environmental Policy Act process is moving forward. NMFS is working on the Environmental Assessment (EA) for Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids). The EA is currently missing the cumulative impacts section. Once it is complete, the EA will go through internal review, applicant review, and then a 30-day public review. The Wells and Winthrop steelhead permits should be available for review by mid-May 2018.
- *Broodstock Collection Protocols*: The HCP Hatchery Committees reviewed and approved the last revised version of the 2018 Broodstock Collection Protocols. There are six issues to be discussed further (five related to the HCP Hatchery Committees and one related to the PRCC Hatchery Subcommittee [PRCC-HSC]). Resolution on these issues will be included in the 2019 Broodstock Collection Protocols. The approved Final 2018 Broodstock Collection Protocols will be submitted to NMFS on April 27, 2018. John Ferguson asked what the five HCP-related issues are about. Hillman recalled the outstanding issues, as follows: 1) collection of summer Chinook salmon eggs at Wells Fish Hatchery for a YN reintroduction program in the Yakima River—the YN will provide a presentation on the YN Summer Chinook Salmon Program; 2) inclusion of age-3 males (or H3 jacks) in broodstock with regard to life history diversity; 3) bacterial kidney disease (BKD) risk assessment criteria and management regarding whether the Washington Animal Disease Diagnostic Laboratory (WADDL) at Washington State

University will be consistent with WDFW's Olympia Washington lab for analyzing numerical optical density values—Betsy Bamberger (Douglas PUD Fish Health Specialist) will present on BKD, and WADDL will be discussed further; 4) how to differentiate between natural-origin recruit (NOR) Okanogan spring Chinook salmon collected at Wells Dam for the Section 10(j) program from Methow NORs collected at Methow Fish Hatchery; and 5) re-evaluating the size of the Spring Chinook Salmon Conservation Programs with regard to how many fish should be produced under conservation versus safety-net programs. Hillman said he believes Keely Murdoch and Mike Tonseth will take the lead on the fifth item and will produce recommendations on how to move forward on determining these proportions by September or October 2018. Hillman said the sixth issue is regarding fall Chinook salmon at Priest Rapids Dam and will be addressed by the PRCC-HSC. Tonseth said he produced a document outlining these ongoing discussions on the Broodstock Collection Protocols, which are based on comments received on the protocols. He said the document was distributed to the HCP Hatchery Committees and suggested forwarding this document to the HCP Coordinating Committees for their reference. Kristi Geris said she will forward this document, as requested. *(Note: Geris forwarded this document to the HCP Coordinating Committees following the conference call on April 24, 2018.)*

- *HCP Hatchery Committees Support Staff:* Ferguson said Anchor QEA supports the HCP Hatchery Committees through Sarah Montgomery. Ferguson said Montgomery will be attending graduate school at the University of Washington in fall 2018, and Anchor QEA is working diligently on finding a replacement.
- *Next meeting*: The next meeting of the HCP Hatchery Committees will be on May 16, 2018.

III. WDFW

A. DECISION: Revised Draft 2018 Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth said a fifth revised draft 2018 Broodstock Collection Protocols was distributed to the HCP Coordinating Committees by Kristi Geris on April 19, 2018. Tonseth said version 5 is not substantially different from version 4 (distributed April 17, 2018). He said as discussed during the HCP Coordinating Committees meeting on March 27, 2018, the revision of most significance to the HCP Coordinating Committees is an increase in the trapping window for spring Chinook salmon at Wells Dam from 5 to 7 days per week, which is allowed under the Wells Biological Opinion.

The Wells HCP Coordinating Committee representatives present approved the 2018 Broodstock Collection Protocols, as revised. Jim Craig provided USFWS approval via email on April 19, 2018; Chad Jackson provided WDFW approval via email on April 23, 2018.

The Final 2018 Broodstock Collection Protocols were distributed to the HCP Coordinating Committees by Geris on April 24, 2018.

IV. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 Maintenance Update (Lance Keller)

Lance Keller recalled last month, discussing issues with Turbine Unit C1 and notifying the HCP Coordinating Committees the unit would be out of operation during the start of the juvenile bypass season but will hopefully return to service by mid-May 2018.

Keller said Chelan PUD received new replacement stock trunnion seals for Turbine Unit C1 the week of April 9, 2018. He said the new seals were installed on April 16, 2018, and tested on April 20, 2018. He said on April 23, 2018, the hub was filled with oil and pressurized to 50 pounds per square inch, which is a typical step in commissioning a unit. He said mechanics evaluated the turbine area for leaks at the trunnion seals and determined one seal is continuing to leak. He said the leak is minor (drips); however, this means Turbine Unit C1 will not be returned to service as soon as anticipated.

Keller said Chelan PUD plans to move forward with the parallel path, as discussed with the HCP Coordinating Committees last month. He said this path involves investigating the possibility of hydraulically locking the turbine blades in the most efficient fixed operating position at its normal soft-limit set-point of 12,200 cubic feet per second (cfs; 12.2 kcfs). He recalled Chelan PUD's concern with this approach regarding the leaking seals allowing water into the hub when oil is removed, and he said mechanics are still working on this fix. Keller said Chelan PUD anticipates hydraulically locking the turbine blades to be complete over the coming weeks (not months), if possible. He said additionally, a sole-source contractor is working on a custom engineered seal; however, completion of this is still months out. He said he will keep the HCP Coordinating Committees apprised of progress.

John Ferguson asked if there have been any issues with the alternate operations[1]? Keller said Chelan PUD is conducting daily fish indexing and nothing abnormal has been detected to date. He added that the intake screen system is running as it should on Turbine Unit C2, as well as the surface collector channels.

Keller said he tried locating past documentation showing when the last rehabilitation was conducted, which would indicate when the trunnion seals were last replaced; however, he has not yet located it. Ferguson suggested sharing this information during a future meeting.

[1] As discussed during the HCP Coordinating Committees meeting on February 27, 2018, alternate operations include: 1) using three additional Rocky Reach Juvenile Fish Bypass System Surface Collector (RRJFBS SC) pumps to increase attraction flow from 6,000 to 6,660 cfs into the RRJFBS SC entrances (3,330 cfs on each side); and 2) increasing Turbine Unit C2 flow from its normal soft-limit set-point of 12.2 kcfs to a soft-limit flow of 15.2 kcfs.

V. Douglas PUD

A. DECISION: CRITFC Annual Request for Sockeye Tagging at Wells (Tom Kahler)

Tom Kahler said CRITFC submitted their annual request to tag sockeye salmon at Wells Dam in 2018, which was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on April 13, 2018. Kahler said generally, the request is the same as usual; however, there will be no acoustic tagging in 2018, as was also the case in 2017. He said the proposed trapping would start in late June 2018. He recalled CRITFC's preference for trapping at the east fish ladder to avoid interference with other trapping efforts or running fish through the adult handling facility.

Kirk Truscott asked what CRITFC was proposing to use for an anesthetic. Kahler said this was not specified in the request; however, he believes tricaine methanesulfonate (MS-222) is typically used. Truscott said, considering the projected low sockeye salmon return and the resulting small fishery for the Colville Confederated Tribes (CCT), if the Wells HCP Coordinating Committee approves CRITFC's request, the CCT are requesting that fish be anesthetized with something that will not require withdrawals. Kahler said he believes a similar request has been accommodated in the past. Keely Murdoch said she believes MS-222 is what is generally used, and the fish are floy-tagged to avoid consumption. Truscott said his concern is that it is written in the CCT regulations to release floy-tagged fish (avoid collecting fish that have been subject to MS-222 for the fishery), and with the already low returns he would like to avoid releasing any fish at all. Kahler suggested CRITFC use Aqui-S, and Truscott said this would be the CCT's preference. Truscott also noted that in some years the CCT had a subcontract with CRITFC to participate in this annual tagging effort and he is unsure whether this is the case for 2018. Murdoch explained that the CCT helped with acoustic tagging in the past, which is likely why a subcontract is not in place for 2018 since the fish are not being acoustically tagged this year. Truscott asked why CRITFC does not just tag more fish at Bonneville Dam. Kahler said one reason is due to temperature issues at Bonneville Dam. He said additionally, CRITFC has attempted to collect more fish at the Priest Rapids Dam off ladder adult fish trap, but ultimately efforts have focused at Wells Dam to attempt to boost numbers of known Okanogan River fish.

Douglas PUD will inquire with Jeff Fryer about the feasibility of using the anesthetic, Aqui-S, during CRITFC's proposed annual sockeye salmon tagging effort at Wells Dam in 2018. John Ferguson asked if the Wells HCP Coordinating Committee wants to vote on this now, where approval is contingent on CRITFC using Aqui-S. Murdoch said she prefers to wait to vote because the YN conduct the anesthetizing for this tagging effort, and she wants to verify internally whether Aqui-S is on site and if there is budget to purchase it, if needed. Murdoch will inquire internally within the YN about the feasibility of using the anesthetic, Aqui-S, during CRITFC's proposed annual sockeye salmon tagging effort at Wells Dam in 2018. *(Note: Murdoch determined that the YN have no issues with using Aqui-S for this tagging effort, as distributed to the HCP Coordinating Committees by Geris on April 25, 2018.)*

B. Wells Project 2020 Survival Verification Study – Study Species (Tom Kahler)

John Ferguson briefly recapped discussions to date. He said per a requirement in the Wells HCP, PIT-tags are the only feasible option for this study. He said there was a good discussion on acoustic tags, as well. He said Douglas PUD has been coordinating with Drs. John Skalski and Richard Townsend on sample sizes and return rates. Ferguson said last month, the discussions ended with action items to research aspects of permitting requirements for using spring Chinook salmon as a study species. He said there may also be ponding (capacity) issues, including a leaking liner in dirt pond 3 at Wells Fish Hatchery, and if spring Chinook or coho salmon are used, the study will need to be postponed until 2021.

Tom Kahler recalled Douglas PUD's action item to provide results of an analysis comparing the smolt-to-smolt survival estimates of the last eight years of releases of spring and summer Chinook salmon above Wells Dam. He said Skalski and Townsend have started these analyses; however, a draft is not yet ready for review.

Kahler said regarding the permitting issue, during his conversation with Brett Farman (NMFS), he realized something that has not yet been discussed which may affect selecting a study species. He explained that ideally, a 1-year study is conducted and is successful. He said, however, there are various reasons the study may not succeed, including: 1) not achieving the 93% standard; 2) not meeting precision requirements; or 3) experiencing an extreme year that falls outside the 90th percentile of river conditions (failing to meet representative conditions and operations) where the Wells HCP Coordinating Committee has discretion on whether to accept the results. Kahler said if the study does not succeed for whatever reason, then Douglas PUD needs to be in the position to conduct a second year of study. He said, therefore, Douglas PUD would need to collect brood in 2018 for a 2020 study, collect brood in 2019 for a potential 2021 study, and collect brood in 2020 for a potential 2022 study. This is because collection of brood for a 2021 study would precede the releases for a 2020 study, and results from a 2020 study will not be available until fall of that year following spawning of the brood for the 2022 releases. He recalled the potential issues with ponding and the leaking liner and said, considering all of this, Douglas PUD may not have the rearing capacity to use spring Chinook or coho salmon. He said additionally, if Douglas PUD collects 2 years of spring Chinook salmon (springer) broodstock and the first year of study is successful, there will be 90,000-plus parr on-station to figure out what to do with. He said this would require engaging the HCP Hatchery Committees, as well. Kahler apologized for not discussing this earlier and said he had not remembered this until his discussion with Farman.

Scott Carlon said additionally for springers, one risk might be not having enough brood for a second year. Kahler said this is correct and added there is risk of not have enough brood for the first year when dealing with springers.

Ferguson asked Keely Murdoch if the YN might still be able to provide coho salmon, given this new information. Murdoch recalled that the YN committed to prioritizing brood for a Douglas PUD verification study, if coho salmon are chosen to be the study species. She said if the run is small, this means the YN reintroduction program will fall short. She said the difference now, is this will be a 2-year commitment and not 1 year. Kahler said this is correct. Murdoch said she is assuming the YN will maintain their commitment; however, this will need to be verified internally. Kahler apologized again for not remembering this earlier.

Ferguson asked about permitting. Carlon said he spoke with Farman who indicated permitting spring Chinook salmon for the study is doable; however, Farman needs to investigate what paperwork will be needed. Kahler said he also spoke with Farman, and he said the same thing. Kahler added that Farman was not as familiar with coho salmon. Kahler said he and Farman also discussed scenarios to contain springers upon return. Kahler said based on smolt-to-adult return ratios from past survival studies, adult returns can be expected anywhere from 200 adults up to 1,500 to 2,000 adults. He said Douglas PUD might be slightly concerned with the returns in the lower range, and very concerned with returns in the upper range with regard to adult management. He said regardless, Farman believes he can permit springers in time for a 2021 study, so permitting does not appear to be a deal-breaker. Kahler said he is still unsure about coho salmon with regard to release locations not specified in the current permits.

Ferguson asked if Farman plans to continue looking into permitting springers, or if the Wells HCP Coordinating Committee needs to make a formal request. Kahler said Farman is planning to look more into permitting spring Chinook salmon, and more should be known by the HCP Coordinating Committees meeting on May 22, 2018. Kahler said since Farman is not as familiar with coho salmon, he anticipated that Farman would discuss permitting for this species with Charlene Hurst (NMFS), who knows more about the consultation history for coho salmon.

Carlon asked what the permitting questions are for coho salmon. Murdoch said what was discussed is that an Okanogan River release site is not included in the YN permit. She said Craig Busack (NMFS) wrote the original permit and either Amilee Wilson (NMFS) or Hurst wrote the revision.

Ferguson summarized that 2 years (versus 1 year) of broodstock collection will be needed in case additional years of study are required. He said more information is coming next month from Farman on spring Chinook salmon permitting. Ferguson said if coho or spring Chinook salmon are chosen as a study species, the study will be postponed until 2021. He said permitting for coho salmon is still unknown. Kahler said he can contact Hurst about coho salmon unless Carlon wants to take this on.

Carlon asked when a final decision on a study species is needed. Kahler said the current available capacity at Wells Fish Hatchery relaxes the need for a decision if spring Chinook or coho salmon are chosen. He said if summer Chinook salmon (summers) are chosen, Douglas PUD will need to know by mid-summer and no later than August 2018 (before spawning summers for Douglas PUD's usual summer Chinook salmon program is complete). He said sooner rather than later would be helpful.

Ferguson said currently, the Wells HCP Coordinating Committee is in a position where a decision is needed; however, Committee representatives also need time to review all available information and thoroughly think this through. Kahler said Douglas PUD will provide to the Wells HCP Coordinating Committee the analysis about springers versus summers performance before the HCP Coordinating Committees meeting on May 22, 2018. Kahler said he thinks this will help and anticipates that the Wells HCP Coordinating Committee will be able to reach a decision by May or June 2018. Ferguson agreed and said also by May 2018, Farman will know more on permitting springers and Murdoch will know more on the YN's commitment about coho salmon.

Kahler said Douglas PUD prefers not to derail the study schedule; therefore, Douglas PUD's preference is for summers and study in 2020. He added, however, Douglas PUD understands the Wells HCP Coordinating Committee's desire to study springers and coho salmon.

Carlon said finding out more on permitting coho salmon should be done, and he said he will inquire internally within NMFS about the required permitting process for using coho salmon as a study species in the Douglas PUD 2020 Survival Verification Study. Murdoch asked Carlon to let her know if he needs help on this or needs a copy of the YN's permit.

Kahler said considering there are a few HCP Hatchery Committees members on today's conference call, he asked that those members begin thinking about what Douglas PUD can do with 90,000-plus springer parr that are not used for study (fish on-station for second year brood). He said it may also be useful to have representatives inquire within their respective agencies and tribes on what to do. Murdoch asked if there would be harm in collecting only 1 year of springers and if a second year is needed, skip 1 year of study and collect additional springers only if needed. She said it seems it would be best to not over-collect, if possible. Kahler reviewed the Wells HCP and said it does not indicate the second year of study needs to be immediate. He said this is a good idea and could be applicable to coho salmon, as well, so the YN would not need to sacrifice fish destined to the Methow River Basin. Murdoch agreed and said the Wells HCP Coordinating Committee would need to approve skipping a year of study. Kahler agreed.

C. DECISION: Wells Project Land-Use Permit Application for Landscaping in Tract 333 (Tom Kahler)

Tom Kahler said a Wells Project Land-Use Permit Application for Landscaping in Tract 333 (Attachment B) was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris prior to the conference call on April 24, 2018. Kahler recalled that Douglas PUD owns nearly all of the property along the shoreline of the Wells Reservoir up to what is referred to as the "G-line," which is the line where the Wells Reservoir is expected to extend into the upland under extreme conditions. He said Douglas PUD is required to either lease or own this land and Douglas PUD chose to own it. He said Douglas PUD enforces restrictions on private development in this area and has completed a lot of planting and enhancement of the shoreline. He said for land-use purposes, if a property owner owns upland property, but desires to modify the strip of land owned by Douglas PUD to access the water, the property owner must submit a land-use permit. He said the Wells HCP stipulates that the Parties to the Wells HCP review any land-use permitting activities, and that Douglas PUD provide this review opportunity via the Wells HCP Coordinating Committee. He said Attachment B is one of these opportunities.

Kahler explained that the previous property owner removed the landscape junipers planted in this area and dumped rubble in its place. He said the new property owner has been removing the rubble and would like to level the area, fill the holes, and place sod; however, he needs a permit to do this. He said the permit application is out for Wells HCP Coordinating Committee review, which is typically a 60-day review period. He said, however, the property owner has requested an expedited review in order to lay the sod during spring-like weather opposed to during the middle of summer. He said this request is not a critical urgency; rather, just a practicality.

Scott Carlon said this request does not seem unreasonable, and asked if the work is all out-of-water? Kahler said it is. Keely Murdoch asked if this property is located in the lower Methow River, and Kahler said it is. Kahler further explained that the property is located across from the fruit stand before turning onto Highway 53. Murdoch said her first thought is why are property owners allowed to plant grass in areas where there should be native vegetation? She said the adjacent properties do not have grass in this area, and asked why not keep this area the same as adjacent properties? Kahler explained, the condition of the shoreline with the previous owner was of grass along the shore and landscaping junipers at the top of the bank, which provided no habitat benefit. He said the native bunch grass Douglas PUD originally requested the current landowner to plant, in place of the junipers removed by the previous owner, did not provide the erosion control desired. Kahler said the way Douglas PUD manages land-use is by restricting development with a preference of keeping the land as natural as possible. He said the one concession Douglas PUD makes is within the city limits of Brewster, Pateros, and Bridgeport, where landowners are not necessarily required to landscape or replace low-value landscaping with only native species. He said, nevertheless, Douglas PUD

Commissioners restrict development in a manner that is very fish and wildlife-friendly. He said Douglas PUD provides this concession to these communities but asks property owners to avoid anything draconian.

Kahler said with regard to fish rearing, juvenile Chinook salmon are not typically observed rearing along this shoreline unless a lot of complex debris is present in the water (e.g., tops of trees or brush in the water). He said regarding shoreline habitat in this part of the reservoir, fry leave it quickly as they grow. He said this is true even if cottonwoods and willows were present, as these do not provide adequate shade or in-water habitat structure; they would just be more natural-looking.

Ferguson asked if the Wells HCP Coordinating Committee is amenable to an expedited review, and perhaps even a vote during today's conference call? Kahler said with regard to voting now, Jim Craig and Chad Jackson have not yet had an opportunity to review the permit application. Kahler suggested allowing the entire Wells HCP Coordinating Committee to review the application before voting. Carlon suggested voting now and having Craig and Jackson submit votes via email. Carlon said NMFS approves. Murdoch said the YN approves. Kirk Truscott said the CCT approves.

Geris will notify Craig and Jackson that the Wells HCP Coordinating Committee representatives present approved the Wells Project Land-Use Permit Application for Landscaping in Tract 333; and will request USFWS and WDFW approval via email, as discussed. *(Note: Geris provided this notification to Craig and Jackson following the HCP Coordinating Committees conference call on April 24, 2018.)*

The Wells HCP Coordinating Committee representatives present approved the Wells Project Land-Use Permit Application for Landscaping in Tract 333. Craig and Jackson provided USFWS and WDFW approval, respectively, via email on April 25, 2018.

D. Wells Dam Bypass Update (Tom Kahler)

Tom Kahler said on April 23, 2018, bypass barriers were removed from Bypass Bay 6 due to high river flow. He said the current river forecast out of Chief Joseph Dam is 160 kcfs. He said 15 kcfs and 4 to 5 kcfs are projected out of the Okanogan and Methow rivers, respectively. He said he does not foresee reinstalling the barriers in Bypass Bay 6 anytime soon. John Ferguson noted that the Grand Coulee Reservoir was also being drawn down. Kahler said the goal was to reach 1,222 feet above mean sea level, which was achieved on April 21, 2018.

VI. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on May 22, 2018, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington. John Ferguson noted that he will be unavailable to meet in-person due to a conference in Washington, D.C.; however, he will call into the meeting from the east coast.

The June 26 and July 24, 2018 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A List of Attendees

Attachment B Wells Project Land-Use Permit Application for Landscaping in Tract 333

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman†	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Mike Tonseth	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined for the HCP Tributary and Hatchery Committees Update and 2018 Broodstock Collection Protocols

Wells Project
Tract 333 Land Use Permit

This map is for display purposes only, all locations are approximate.
Data may have changed since the publication of this map.

Lambert conformal Conic, Washington State Plane North NAD 83 - Feet

Wells Base Map
G Line Current

From:	Kristi Geris
To:	Jackson, Chad S (DFW); Jim Craig (jim_l_craig@fws.gov); John Ferguson; Keely Murdoch (murk@yakamafish-nsn.gov); Keller, Lance; kirk.truscott@colvilletribes.com; Kristi Geris; Scott Carlon; "Tom Kahler (tkahler@dcpud.org)"
Cc:	Aaron Beavers; Alene.Underwood@chelanpud.org; Bill Tweit; Bob Rose; Casey Baldwin; Catherine Willard; Dale Bambrick; Gallaher, Becky; jeff.smith@chelanpud.org; Justin Yeager; "Mary Mayo"; Mike Tonseth; Ritchie Graves; Shane Bickford (sbickford@dcpud.org); Steve Hemstrom (steven.hemstrom@chelanpud.org); Steve Parker; Verhey, Patrick M (DFW); "william_gale@fws.gov"
Subject:	FW: New Land Use Permit application Tract 333-02
Date:	Tuesday, April 24, 2018 9:58:06 AM
Attachments:	2018_04_24 Douglas - Tract 333 Land Use permit.jpg

Hi HCP-CC: please see the emails below from Tom and Beau and the attached application for a landscaping action on DPUD shoreline property on the Methow River, which will be discussed during today's CC 4/24 call.

The attached application is also available for download from the HCP Coordinating Committees Extranet Site, under: Final Documents > All by Mtg Date > 4/24/2018 (instructions below). Thanks! – kristi

Instructions:

To gain access to the HCP Coordinating Committees Extranet Homepage, please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcpcc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

You should now be at the HCP CC homepage.

If you encounter problems, or need a login username and password to access the site: Please feel free to contact me or Julene McGregor [jmcgregor@dcpud.org; (509) 881-2236] and we will gladly assist you with questions or issues.

Kristi Geris

ANCHOR QEA, LLC

kgeris@anchorqea.com

C 360.220.3988

From: Tom Kahler <tomk@dcpud.org>
Sent: Tuesday, April 24, 2018 8:52 AM
To: Kristi Geris <kgeris@anchorqea.com>
Cc: John Ferguson <jferguson@anchorqea.com>
Subject: FW: New Land Use Permit application Tract 333-02

Hi Kristi,

Please distribute this message from Beau to the CC for consideration and comment on an application for a landscaping action on DPUD shoreline property on the Methow River, per Section 5.1 of the Wells HCP. Recognizing that we typically operate with a 60-day comment period, the applicant requests a quick approval to allow the work to proceed during cooler spring weather. We'll talk about this during the meeting today.

Thanks,

Tom

From: Beau Patterson
Sent: Monday, April 23, 2018 4:24 PM
To: Tom Kahler
Cc: John Brown; Shane Bickford; Scott Kreiter
Subject: FW: New Land Use Permit application Tract 333-02

Tom,

We have received a new land use permit application for landscaping in Tract 333 at 513 Riverside Drive within Pateros City Limits. Landscaping use was previously permitted under Commission Resolution 97-145. Prior unauthorized activity by the current and previous owners resulted in debris being placed on Project land and has caused land-based sheet and rill erosion on Project land which will rill onto the adjacent private property if not corrected. The applicant proposes to remove concrete and other debris, fill cuts and holes with topsoil, and plant grass to arrest current erosion and preclude future rill erosion.

The attached aerial image shows the application area, however the green vegetation shown in this 2012 image is common juniper that was pulled out without permission or permit by the previous owner of this adjacent property. We required him to replant with a native grass mix however the bunch grasses are not sufficient to preclude erosion on the steep slope. The current owner wishes to lay sod on the upland part of the Project land after filling the voids on the bank with top soil. This measure would effectively halt the erosion and I consider it mutually beneficial to the District and adjacent property owner.

Please provide this information to the HCP Coordinating Committee Representatives for review. Although they are entitled to a 60 days review period, I would be appreciative if they are willing to provide responses sooner, as the erosion is active and sod will establish best if laid while the weather is still cool. The area to be planted is outlined in blue in the photos below. The fence on the property line will remain to deter geese from his lawn, while the grass on the Project side will be available for geese and other wildlife.

Thank you,

Beau


04/12/2018 15:25


04/12/2018 15:26

FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: June 26, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the May 22, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, May 22, 2018, from 10:00 a.m. to 12:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Tom Kahler will inquire internally about expediting contracting to re-line dirt pond No. 3 at Wells Fish Hatchery to avoid overstocking steelhead during winter 2018-2019 (Item II-A).
- Douglas PUD will provide a hyperlink to access reports from the Columbia River Inter-Tribal Fish Commission's (CRITFC's) annual sockeye salmon tagging efforts at Wells Dam (Item III-A). (*Note: Tom Kahler provided this hyperlink to Kristi Geris following the meeting on May 22, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Douglas PUD will provide a representation designation letter to John Ferguson (and copy Kristi Geris), replacing Shane Bickford with Andrew Gingerich (Douglas PUD) as the Douglas PUD HCP Coordinating Committees Alternate Representative (Item III-B).
- Kristi Geris will add Andrew Gingerich to the HCP Coordinating Committees email distribution list and will coordinate with Julene McGregor (Douglas PUD Information Systems) to provide Gingerich with member access to the HCP Coordinating Committees extranet site (Item III-B). *(Note: Geris added Gingerich to the email list and requested extranet access from McGregor following the meeting on May 22, 2018.)*
- Scott Carlon will inquire internally within the National Marine Fisheries Service (NMFS) about the required permitting process for using coho and spring Chinook salmon as study species in the Douglas PUD 2020 Survival Verification Study (Item III-D).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item IV-A).
- Kirk Truscott will provide Lance Keller with questions from the Colville Confederated Tribes (CCT) regarding the State Historic Preservation Office (SHPO) consultation on the Rocky Reach

Project Land-Use Permit Application for the City of Entiat, including: 1) did this application undergo SHPO consultation; and 2) if not, what is Chelan PUD's policy regarding approval for an application that has not undergone SHPO consultation (Item IV-B)? *(Note: Truscott's questions were addressed and the CCT have no further comments on this application, as distributed to the HCP Coordinating Committees by Kristi Geris on June 5, 2018.)*

- Lance Keller will inquire internally within Chelan PUD about the CCT's questions regarding SHPO consultation on the Rocky Reach Project Land-Use Permit Application for the City of Entiat, as well as what authority the Federal Energy Regulatory Commission (FERC) has over this application; and will report back to the HCP Coordinating Committees prior to Monday, June 11, 2018 (Item IV-B).
- The CCT and the Yakama Nation (YN) will submit comments or indication of no comments on the Rocky Reach Project Land-Use Permit Application for the City of Entiat to Lance Keller, Jeff Osborn (Chelan PUD), and Kristi Geris no later than Monday, June 11, 2018 (Item IV-B). *(Note: the CCT and the YN submitted indication of no comments on June 4 and 5, 2018, respectively, as distributed to the HCP Coordinating Committees by Geris on June 5, 2018.)*
- John Ferguson will coordinate with Michelle Rub (NMFS) regarding availability and timing of a presentation by Rub on pinniped predation during the HCP Coordinating Committees meeting on June 26, 2018 (Item V-A). *(Note: Ferguson coordinated with Rub, who will present during the next HCP Coordinating Committees meeting on June 26, 2018.)*
- The HCP Coordinating Committees meeting on June 26, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item VI-B).

Decision Summary

- The Wells HCP Coordinating Committee representatives present approved CRITFC's annual request to tag sockeye salmon at Wells Dam in 2018 (Item III-A).

Agreements

- HCP Coordinating Committees representatives present agreed to add Andrew Gingerich to the HCP Coordinating Committees email distribution list and provide Gingerich with access to the HCP Coordinating Committees extranet site (Item III-B).

Review Items

- A Rocky Reach Project Land-Use Permit Application for the City of Entiat was distributed to the Rocky Reach HCP Coordinating Committee by Kristi Geris on May 10, 2018. This application is available for a 30-day review with comments or indication of no comments due to Lance Keller, Jeff Osborn (Chelan PUD), and Geris no later than Monday, June 11, 2018

(Item IV-B). *(Note: the Rocky Reach HCP Coordinating Committee provided indication of no comments on June 5, 2018.)*

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. Tom Kahler removed Douglas PUD's Land-Use Permit Application agenda item.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft April 24, 2018 conference call minutes. Kristi Geris said all comments and revisions received from members of the HCP Coordinating Committees were incorporated into the revised minutes and there are no outstanding items remaining to be discussed. Tom Kahler reviewed two clarifications under the Wells Project 2020 Survival Verification Study – Study Species agenda item as follows:

- Douglas PUD's action item was to provide results of an analysis comparing the smolt-to-smolt survival estimates (not results of smolt-to-smolt comparative studies) of the last 8 years of releases of spring and summer Chinook salmon above Wells Dam.
- Douglas PUD would need to collect brood for multiple years of study at Wells Dam because collection of brood for a 2021 study would precede the releases for a 2020 study, and results from a 2020 study will not be available until fall of that year following spawning of the brood for the 2022 releases.

Kahler provided these clarifications to Geris, which Geris incorporated into the revised meeting minutes. HCP Coordinating Committees members present approved the April 24, 2018 meeting minutes, as revised. U.S. Fish and Wildlife Service (USFWS) abstained, because a USFWS representative was not present during the April 24, 2018 conference call.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees conference call on April 24, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on April 24, 2018):*

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Douglas PUD will provide results from the most recent spring and summer Chinook salmon smolt-to-smolt comparative studies conducted by Douglas PUD to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  Tom Kahler provided these results to Geris on May 21, 2018, which Geris distributed to the HCP Coordinating Committees that same day.
- *Kristi Geris will forward to the HCP Coordinating Committees the Washington Department of Fish and Wildlife (WDFW) document outlining ongoing discussions on the Broodstock Collection Protocols, which was distributed to the HCP Hatchery Committees by Sarah Montgomery on April 19, 2018 (Item II-A).*
  Geris forwarded this document to the HCP Coordinating Committees following the conference call on April 24, 2018.
- *Douglas PUD will inquire with Jeff Fryer (CRITFC) about the feasibility of using the anesthetic, Aqui-S, during CRITFC's proposed annual sockeye salmon tagging effort at Wells Dam in 2018 (Item V-A).*
  This will be discussed during today's meeting.
- *Keely Murdoch will inquire internally within the YN about the feasibility of using the anesthetic, Aqui-S, during CRITFC's proposed annual sockeye salmon tagging effort at Wells Dam in 2018 (Item V-A).*
  Murdoch determined that the YN have no issues with using Aqui-S for this tagging effort, as distributed to the HCP Coordinating Committees by Kristi Geris on April 25, 2018.
- *Scott Carlon will inquire internally within NMFS about the required permitting process for using coho salmon as a study species in the Douglas PUD 2020 Survival Verification Study (Item V-B).*
  This will be discussed during today's meeting.
- *Kristi Geris will notify Jim Craig and Chad Jackson that the Wells HCP Coordinating Committee representatives present approved the Wells Project Land-Use Permit Application for Landscaping in Tract 333; and will request USFWS and WDFW approval via email, as discussed (Item V-C).*
  Geris provided this notification to Craig and Jackson following the HCP Coordinating Committees conference call on April 24, 2018.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman reported that the HCP Tributary Committees will next meet on May 23, 2018. Hillman said there will be more updates on the General Salmon Program Draft Proposals during the next HCP Coordinating Committees meeting on June 26, 2018.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on May 16, 2018:

- *Wells Hatchery Steelhead Production in the Dirt Ponds During Winter 2018-2019*: Douglas PUD contracted hydrogeologists to conduct surveys in the dirt ponds and found there is no sinkhole. Dirt Pond No. 3 is still leaking; therefore, Douglas PUD plans to re-line the pond in 2019. The pond cannot be re-lined in 2018 due to the time required to complete the bidding and contracting process. Given that Douglas PUD cannot re-line Dirt Pond No. 3, it will not be used this winter for steelhead rearing; rather, Dirt Pond No. 2 will be used to rear Columbia River steelhead. A transmission tower in Dirt Pond No. 2 prevents installing bird netting over the pond. Therefore, Douglas PUD plans to overstock the pond by 40,000 steelhead based on an assumption that bird predation will harvest approximately 20% of the fish in the pond. The pond will be stocked with 200,000 juvenile steelhead with a release goal of 160,000 steelhead. Kirk Truscott asked what happens if birds do not harvest 20%? Hillman said the number of fish to be released will be monitored to avoid releasing more than allowed in the permit. Hillman added that Douglas PUD may install in-pond structures to provide in-water protection. Truscott asked if the failure of Dirt Pond No. 3 constitutes an emergency situation, would that allow Douglas PUD to implement emergency procurement actions to re-line the pond earlier than is currently scheduled? He said there is no certainty that birds will remove that many fish. Tom Kahler said maybe and added that any overages would be stocked into a local lake at the discretion of WDFW and the Wells Hatchery Committee (e.g., Alta Lake, located 2 miles southwest of Pateros, Washington). Truscott also asked if there is a way to configure Dirt Pond No. 2 and isolate the tower in order to install netting over this pond. Truscott requested that Kahler inquire internally about expediting contracting to re-line Dirt Pond No. 3 at Wells Fish Hatchery to avoid overstocking steelhead during winter 2018-2019.
- *NMFS Consultation Update*: The Environmental Assessment for Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids) is undergoing internal review. The Environmental Assessment will be sent to the applicants in July and then out for a 30-day public review. Applicants have reviewed the draft Wells and Winthrop steelhead permits. NMFS is currently addressing comments received on those permits.

- *PRESENTATION: Expanded Sampling at the Off-Ladder Adult Fish Trap*: Andrew Murdoch (WDFW) provided a presentation on estimating escapement at various spatial scales using passive integrated transponder (PIT) tags. The goal is to expand the steelhead escapement project to other Plan Species, except sockeye salmon, by PIT-tagging a representative sample of fish at Priest Rapids Dam. This will provide real-time escapement monitoring for collecting broodstock and adult management, run escapements by population and origin at different spatial scales, and reduce uncertainty in dam counts. This approach will provide an unbiased approach for estimating run escapement and pre-spawn mortality of spring and summer Chinook and coho salmon. Andrew Murdoch discussed the cost of expanding the tagging program and identified cost shares. If implemented, the program could reduce or eliminate the need for stock assessment at Dryden, Tumwater, and Wells dams. The HCP Hatchery Committees are evaluating the implementation of the tagging program to other Plan Species.
- *PRESENTATION: Optical Density Values and Bacterial Kidney Disease*: Dr. Betsy Bamberger (Douglas PUD Fish Health Specialist) provided a presentation on the challenges of bacterial kidney disease and its management. She discussed the significance of the disease, the causative agent (*Renibacterium salmoninarum*), its hosts, and its spread. She indicated that detection of the disease can be difficult. Tests include enzyme-linked immunosorbent assay, quantitative polymerase chain reaction, and direct fluorescent antibody. These tests detect different things and therefore can produce different results. Unfortunately, there is no gold standard assay exhibiting error-free classification of results and detection of the disease agent does not always indicate active infection. Therefore, from a management perspective, it is important to understand the limitations of the different tests and embrace the trinity of requirements for disease manifestation (pathogen, susceptible host, and favorable environment), be flexible with disease management strategies, and use multiple assays and tissue analyses for broodstock surveillance.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on June 20, 2018, if necessary.
- *HCP Hatchery Committees Support Staff*: John Ferguson recalled that Anchor QEA supports the HCP Hatchery Committees through Sarah Montgomery. Ferguson said Montgomery will be attending graduate school at the University of Washington in fall 2018, and Larissa Rohrbach (Anchor QEA Wenatchee Washington office) will take over supporting the HCP Hatchery Committees. Ferguson said Rohrbach will begin shadowing Montgomery in June 2018, and the transition will be complete by January 2019.

III. Douglas PUD

A. DECISION: CRITFC Annual Request for Sockeye Tagging at Wells (Tom Kahler)

Tom Kahler said CRITFC's annual request to tag sockeye salmon at Wells Dam in 2018 was distributed to the Wells HCP Coordinating Committee for review by Kristi Geris on April 13, 2018. Kahler said Keely Murdoch determined the YN are already using Aqui-S. Murdoch said the YN used Aqui-S exclusively in 2017; therefore, there is no problem using Aqui-S for CRITFC's annual sockeye salmon tagging effort at Wells Dam in 2018. Kahler said he also discussed using Aqui-S with Jeff Fryer who indicated this will be okay.

The Wells HCP Coordinating Committee representatives present approved CRITFC's annual request to tag sockeye salmon at Wells Dam in 2018.

Kirk Truscott asked about access to the reports generated from these PIT-tagged sockeye salmon. Kahler said he is unsure about the lag time between a tagging event and a report being generated and added that he believes the 2017 report is in draft form. He said he will provide a hyperlink to access reports from CRITFC's annual sockeye salmon tagging efforts at Wells Dam. (*Note: Kahler provided this hyperlink to Geris following the meeting on May 22, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

B. HCP-CC Email List and Extranet Access – Andrew Gingerich (Tom Kahler)

Tom Kahler said Andrew Gingerich will be replacing Shane Bickford as the Douglas PUD HCP Coordinating Committees Alternate Representative; therefore, Douglas PUD is requesting to add Gingerich to the HCP Coordinating Committees email distribution list and provide Gingerich with access to the HCP Coordinating Committees extranet site. Kahler said Bickford has not yet provided a designation letter. Douglas PUD will provide a representation designation letter to John Ferguson (and copy Kristi Geris), replacing Bickford with Gingerich as the Douglas PUD HCP Coordinating Committees Alternate Representative.

HCP Coordinating Committees representatives present agreed to add Gingerich to the HCP Coordinating Committees email distribution list and provide Gingerich with access to the HCP Coordinating Committees extranet site. Geris will add Gingerich to the HCP Coordinating Committees email distribution list and will coordinate with Julene McGregor to provide Gingerich with member access to the HCP Coordinating Committees extranet site. *(Note: Geris added Gingerich to the email list and requested extranet access from McGregor following the meeting on May 22, 2018.)*

C. Wells Dam Bypass Update (Tom Kahler)

Tom Kahler reviewed recent bypass barrier removals at Wells Dam, as follows:

Bypass Barrier	Removal Date (2018)
6	April 23
8	May 10
4	May 11
10	May 14

Kahler said the bypass barriers were removed per the 2018 Wells Dam Bypass Operating Plan (approved by the Wells HCP Coordinating Committee on February 2, 2018). He recalled the plan stipulates thresholds for dam safety and outlines removal of barriers under various river flow scenarios. He said incoming river flow met these criteria to remove bypass barriers and Douglas PUD does not foresee river conditions changing for at least another week.

Kahler said from a fish perspective there is plenty of flow through non-turbine routes, and he noted that Wells Dam is spilling 150,000 cubic feet per second (150 kcfs) daily. He said Douglas PUD is trying to lower the Wells reservoir; however, high river flow has made this difficult. He said even with the state water quality standards waived due to the 7-day, 10-year-frequency (7Q10) flow at Wells Dam, Douglas PUD does not want to increase total dissolved gas (TDG) by spilling more than necessary but needs to lower the reservoir elevation to avoid flooding Pateros, Washington. Kahler said 2 weekends ago, peak river flow out of the Methow River was 22 kcfs. He said if the elevation of the Wells reservoir is too high, this could cause flooding and silt build-up at the mouth of the Methow River. He said ideally, the Wells reservoir is maintained below 775 feet above mean sea level when the Methow River discharge is so high; however, high Columbia River flow is preventing Douglas PUD from being able to lower the Wells reservoir to that elevation. He said with the Wells Dam tailwater being so high, the head differential on the turbine units is reduced. This results in a reduced hydraulic capacity for the 9 (of 10) turbines that are available for operation at this time, which forces more flow through the spillway and affects Douglas PUD's ability to lower Wells Reservoir.

Kahler said there has been high TDG out of Chief Joseph Dam, Wells Dam is adding to the high incoming TDG, and this water is continuing downstream to Chelan PUD. Kahler said Andrew Gingerich has been conducting gas bubble trauma (GBT) sampling at the Rocky Reach Dam bypass system sampler every day. Kahler said to date, Douglas PUD has examined 521 fish on 7 days with the following results:

Species	Number Examined	Results
Sockeye salmon	142	15% mild GBT
Steelhead	36	17% mild, moderate, and severe GBT
Coho salmon	214*	49.5% mild, moderate, and severe GBT
Spring Chinook salmon	128	14% mild GBT

*Reported as 241 during the meeting; however, the number was corrected via an email following the meeting.

Kirk Truscott asked about the duration fish are held in the sampler. Lance Keller said fish are held in the sampler as short a period as is possible. He said these four samples were examined from 4- to 30-minute sample periods from 0800 hours to 1130 hours, and fish were examined shortly after the completion of each 30-minute sample period. He said recovery time is typically 3 hours; however, due to high numbers, fish were released sooner based on visual inspection. Truscott said he asked with respect to fish developing GBT symptoms while holding. Keller said he is unsure how long this would take if fish are held at a shallow depth; however, he said with high confidence that fish were entering the facility with signs of GBT. Kahler said this is a primary motivation for not aggressively dropping the Wells reservoir and spilling more water; Douglas PUD does not want to add to these numbers. Keely Murdoch asked what TDG was in the Wells Dam tailrace during this sampling, and Gingerich said values were exceeding 130% from Chief Joseph Dam.

D. Wells Project 2020 Survival Verification Study – Study Species (Tom Kahler)

Tom Kahler said a report titled, “Comparison: Rocky Reach to John Day Dam Survival of Spring and Summer Yearling Chinook Released above Wells Dam, 2010-2017,” (Attachment B) was distributed to the HCP Coordinating Committees by Kristi Geris on May 21, 2018.

Kahler said the data in Table 1a of Attachment B seem to suggest that 1 year drives a possible difference in survival of juvenile spring and summer Chinook salmon. He said these values were produced by averaging all releases in a given year. He said Appendices A and B of Attachment B help interpret the results in Table 1a. Keely Murdoch said it seems a difference may be linked to more than just 1 year. She said, for example, both 2015 and 2017 may be important years. John Ferguson said most years are highly insignificant. He said 2015 had issues, and 2017 is not significant but is close. He said results for each stock changed each year, and he does not see a pattern.

Murdoch noted the annual z-test comparison for each year between the two species; however, she asked about a comparison between means for all years. Andrew Gingerich clarified paired *t*-tests were used to compare survival between stocks, which is included in the report text on report page 3 (page 5 of the Adobe file) of Attachment B. He said the results indicated no significant differences.

Scott Carlon said he does not yet have an update on Endangered Species Act permitting for coho salmon. He said Brett Farman (NMFS) is still reviewing permitting requirements for spring Chinook salmon (springers) and needs to clarify a few items with Craig Busack (NMFS). Carlon said one issue is whether NMFS can permit anything beyond 2 years. He said another issue is the potential for excess hatchery spawners returning to spawning grounds. He said Farman believes NMFS cannot permit anything beyond 2 years, which will eliminate springers from being one option for the verification study. Carlon said he hopes to track down this information soon and believes NMFS will be ready to vote on a study species by June 2018. Carlon will inquire internally within NMFS about the required permitting process for using coho and spring Chinook salmon as study species in the Douglas PUD 2020 Survival Verification Study.

Kirk Truscott asked if springers are used, does this mean an additional production of 100,000-fish in addition to the current production out of the Methow River? Kahler said this is correct. Truscott said he has not yet had time to review Attachment B. He said the CCT hope this will be a 1-year survival study. He said it seems the probability of under-mitigating for springers in a 1-year survival study is a real concern, if summer Chinook salmon (summers) are used as the study species.

Regarding the report with comparisons between summer Chinook and spring Chinook salmon released in the same years, Kahler said these were not studies, but were simply releases that occurred in the same year but likely experienced major differences in release timing and migration conditions that could bias survival. For a true comparison, the study fish need to experience the same river and project operating conditions at the time of release (i.e., summer and spring Chinook salmon from the same facility released at the same place and time). Douglas PUD expects summer Chinook salmon released in May to experience better migration conditions than spring Chinook salmon released in April. Truscott asked if releasing fish only 1 week later makes a difference, and Kahler said yes. Kahler recalled for the 15 release groups of study fish in 2010, the first release was during the third week in April and the last release was during mid-May (similar to typical differences in release timing for spring and summer Chinook salmon, respectively), and there was a dramatic difference in survival between the earlier releases compared to the later releases. He said the earlier releases were during colder conditions and fish initially did not move, and suddenly they all left. He also noted that for some reason, the first couple release groups were underfed (i.e., had no mesenteric fat), and he guessed the fish may have held in the reservoir to feed before initiating their migration.

Murdoch said she discussed this topic internally with the YN, and if permittable, springers are the YN's preference, even if the study needs to be postponed for 1 year. She said the YN are also supportive of using coho salmon or yearling summer Chinook salmon as done in the past. She said if coho salmon are used, it may also be ideal to postpone the study for 1 year to wait out the effects of "the Blob[1]."

Truscott said the CCT echo the YN's desire to study springers but are concerned the permitting and adult management issues may prevent this. Truscott recalled previously discussing using acoustic tags. He said Chelan and Grant PUDs used acoustic tags. He said he realizes the desire to remain consistent with past methodology, but wondered if springers are used, can they be double-tagged?

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[1] The warming of sea surface temperatures in the offshore northern Pacific Ocean, which became evident to scientists in the spring of 2013.

Kahler said as long as an acoustic tag is a surgical procedure, they are a nonstarter for Douglas PUD. Because of the larger tag and the surgical procedure used for even the "injectable" acoustic tag, the study is not simply measuring survival of a group of study fish, but also adds confounding effects of the study method associated with tagging effects and battery life and demonstrated increased susceptibility to injury and mortality with travel distance and in turbine passage. He said research is on track for a true injectable tag, so there is possibility to use acoustic tags in the future. He recalled Shane Bickford discussing this (during the HCP Coordinating Committees meeting on March 27, 2018), and asked, what is actually being measured in an acoustic study? Kahler said with acoustic telemetry the study design needs to factor in the effects of dead fish being detected, and that there are multiple considerations which need to be mathematically accounted for, which creates a lot more chance for error. He said he understands why managers use acoustic tags to understand where fish are passing in the reservoir and at the dam; however, Douglas PUD does not need that additional information provided by acoustic tags and does not support the use of acoustic tags to verify continued conformance to survival standards the achievement of which was demonstrated by PIT-tag studies. He said if the Wells HCP Coordinating Committee feels strongly about this route, there will need to be a lot more discussion of it.

Truscott said he just wants to build the data and suggested developing a correction factor for acoustics. Kahler said he knows Chelan PUD conducted a comparison study along the same lines of what Truscott is referring to; however, he recalls the study involved a much larger effort (two full studies in one: full acoustic and full PIT tag study). The intent of those studies was not to verify whether passage survival remained similar to that observed in previous studies, but to determine whether a different technology was an acceptable study method. Lance Keller said the study Chelan PUD conducted occurred fairly early in the history of acoustic technology development; it was two stand-alone studies using the same fish (conducted in 2004 using 150,000 PIT tagged fish and 1,500 acoustically-tagged fish, side-by-side).

Truscott suggested tagging enough fish and installing enough arrays to achieve statistical rigor using acoustic-tagged fish. He said in year 1 (2020), PIT-tag 100,000 study fish and acoustic-tag a small number of study fish. He said its only 1 year, but he is only trying to figure out how to use acoustics to reduce the need for such large samples sizes.

Regarding the Wells HCP requirement to measure delayed mortality (which acoustic tags cannot measure), Truscott asked what happens if there are large delayed mortality results? He said he does not foresee the PUDs agreeing to conduct consecutive survival studies based on larger than anticipated delayed mortality results of a study. Kahler said the Wells HCP is not clear on this topic. He recalled historical Anadromous Fish Evaluation Programs where delayed mortality was a huge topic. He said he is unaware of any actions to modify dams or dam operations that followed these discussions, but the parties negotiating the HCP included the delayed-mortality provision in the Wells HCP. Truscott said there is nothing tangible to take from it. Kahler said it provides assurance that there is not a problem. Little-to-no delayed mortality results confirm that fish performed well after leaving the hydropower system, supporting the conclusion that dam operations are not producing a loss of fish that was not apparent within the juvenile-migration phase. However, the observation of substantial delayed mortality would warrant an investigation of structural or operational issues that could contribute to that delayed effect.

Returning the report comparing survival of summer and spring Chinook salmon releases, Kahler suggested reviewing the standard errors in Appendix Tables A1 and A2 of Attachment B. He noted the 99% survival and approximately 20% standard error that resulted from a detection rate of 5% at McNary Dam. He said these results suggest there is little confidence in detecting differences among small release groups, since such results can dramatically influence the calculated annual mean survival estimate and standard error. Murdoch said these results show how little is known about these data.

Jim Craig said USFWS appreciates the simplicity of using summers; however, it is troubling that springers are not performing as well as summer Chinook salmon. He said ultimately it will be good to study springer survival.

Chad Jackson said WDFW has similar thoughts as others. He said considering 2020 is approaching soon and the complications with using other species, WDFW is in favor of studying summers in 2020. He suggested stipulating using summers in 2020 and also building a case to study springers in the next survival study if the migration is better or conduct a study along the lines of what Truscott suggested. Ferguson asked if WDFW is indicating support for summers in 2020, contingent that Douglas PUD agrees to studying springers in 2030, and in the interim investigate how to prepare to use springers in 2030? Jackson said this is correct and suggested framing the Statement of Agreement such that at a minimum, Douglas PUD will do something to prepare for testing springers in the 2030 verification study.

Carlon said NMFS does not have a strong inclination to study springers and supports studying summers; however, also supports studying springers if the Wells HCP Coordinating Committee choses so. He said this may be resolved once he hears back from NMFS permitting staff.

IV. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 Maintenance Update (Lance Keller)

Lance Keller recalled reporting during the last HCP Coordinating Committees meeting on April 24, 2018, that the initial trunnion seal replacement failed to stop oil from leaking from the unit hub. Keller said since then, a Rocky Reach Dam Turbine Unit C1 Maintenance update was distributed to the HCP Coordinating Committees by Kristi Geris on May 9, 2018, which summarized the parallel paths identified for moving forward (hydraulically locking Turbine Unit C1 or a sole-source contract to design an engineered seal). Keller said in this update he is explaining why Chelan PUD is now choosing not to hydraulically lock Turbine Unit C1. He summarized that this approach not only removes oil from the hub, but it may also allow water into the hub, causing damage to the hub components. At the same time, Chelan PUD engineering staff noted that oil is needed for other operating components of Turbine Unit C1, and they cannot ensure that that oil will be 100% isolated from the hub, thus they cannot assure that operating in a hydraulically locked configuration will not result in an oil leak with a failed trunnion seal. He said this determination now leaves a single path forward for addressing the oil leak at Turbine Unit C1, which is to enter into a sole-source contract to formally begin the design and manufacture of engineered seals for Turbine Unit C1 at Rocky Reach Dam. Keller said on May 14, 2018, the Chelan PUD Board of Commissioners approved this path forward and efforts are now underway to finalize a contract with Voith Hydro, who will also be assessing existing and future wear on the seals to help design a solution that keeps everything working properly over time.

Keller said he will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Geris for distribution to the HCP Coordinating Committees. Keller said he also plans to continue providing updates on progress during monthly meetings. He said the early estimate has the seal on site in August 2018; therefore, it is a reasonable expectation to not expect to have Turbine Unit C1 return to service during 2018 juvenile bypass season. He said the unit will be operational by the 2019 season.

Kirk Truscott asked if there is a chance the other units will have this same problem? Keller said Turbine Unit C1 is designed the same as Turbine Units C2 through C7; therefore, if this engineered seal works, this fix will be applicable to the other units if the same issue occurs. Chad Jackson asked if all turbines have this same configuration, why do some systems have longer longevity? Keller said he is unsure why Turbine Unit C1 has excessive wear and the other trunnion seals do not. Truscott asked if the seal works, will Chelan PUD purchase a few of them? Keller said the goal at Rocky Reach Dam is to have as many units online as possible and the engineers know everything needs to be operational come 2021 for the survival study.

B. Entiat Marina Application Consultation (Lance Keller)

Lance Keller said a Rocky Reach Project Land-Use Permit Application for the City of Entiat was distributed to the Rocky Reach HCP Coordinating Committee by Kristi Geris on May 10, 2018. This application is available for a 30-day review with comments or indication of no comments due to Keller, Jeff Osborn, and Geris no later than Monday, June 11, 2018.

Keller acknowledged this application includes a lot of documents and said this application has been in process since 2012. He said any permit larger than 10 slips on the Rocky Reach reservoir is required to submit the application to FERC. He said for this application, Chelan PUD is basically the middleman. He said the City of Entiat went through the permitting process, is now passing the application by Chelan PUD, which will then be passed to FERC. Keller said Chelan PUD has a flowage easement and a landowner has the ability to complete the Joint Aquatic Resource Permit Application process to install a permitted dock. He said the application for Rocky Reach HCP Coordinating Committee review is the draft final product before submittal to FERC. He said this application has already been consulted on by USFWS and NMFS. He said FERC will then have the application out for a 30-day review. He said currently, the application is also under review by the fish forums.

Geris summarized that all Rocky Reach HCP Coordinating Committee representatives have indicated 'no comment,' except the CCT and YN, which have not yet responded. Kirk Truscott said he needs to coordinate internally with the CCT cultural resources staff before commenting on the application. He asked what is the purpose of a 64-slip dock in that area of the Columbia River? Keller said he believes this is part of the City of Entiat's desire to attract more recreation to the area. He said currently, there is no boat fueling capability in the reservoir, or any additional boat services. He said this dock will provide these amenities. Jim Craig added that another motivator is to attract recreation to the new park in the City of Entiat.

Truscott asked about measures taken to ensure adequate mitigation for the habitat being displaced. Keller said snorkel and hook and line surveys were conducted to assess what species are present in the area. Chad Jackson said there are requirements to use surfaces that are light-penetrating. Truscott said the new dock will likely create predator issues. Jackson said WDFW surveyed a similar dock in Lake Washington and increased predation was not a huge issue. Keller said Chelan PUD also conducted similar investigations in the Rocky Reach reservoir and did not find a significant impact.

Keely Murdoch said the last page in the application for review is an email correspondence between Larry Lehman (Grette Associates) and Jacalen Printz (U.S. Army Corp of Engineers), which says:

> Lehman: "Any word on the section 106 correspondence for this project, per our discussion"
>
> Printz: "We closed out our Section 106 review with the determination of little likelihood to cause effects to Historic Properties without consultation with the SHPO or Affected Tribes. That being said, we did request comments from Tribe through our Public Notice process"

Murdoch said this sounds like comments were requested, but not received? Truscott said it appears the City of Entiat has not consulted with SHPO or affected tribes. He said he will provide Keller with questions from the CCT regarding SHPO consultation on the Rocky Reach Project Land-Use Permit Application for the City of Entiat, including: 1) did this application undergo SHPO consultation; and 2) if not, what is Chelan PUD's policy regarding approval for an application that has not undergone SHPO consultation? *(Note: Truscott's questions were addressed and the CCT have no further comments on this application, as distributed to the HCP Coordinating Committees by Geris on June 5, 2018; ultimately, Chelan PUD does not have any authority to approve/disapprove an application that does not involve District Property.)*

Scott Carlon asked if FERC has the authority to prevent this dock from being constructed, and Keller said he is unsure. Keller said he will inquire internally within Chelan PUD about the CCT's questions regarding SHPO consultation on the Rocky Reach Project Land-Use Permit Application for the City of Entiat, as well as what authority FERC has over this application; and will report back to the HCP Coordinating Committees prior to Monday, June 11, 2018.

The CCT and the YN will submit comments or indication of no comments on the Rocky Reach Project Land-Use Permit Application for the City of Entiat to Keller, Osborn, and Geris no later than Monday, June 11, 2018. *(Note: the CCT and the YN submitted indication of no comments on June 4 and 5, 2018, respectively, as distributed to the HCP Coordinating Committees by Geris on June 5, 2018.)*

V. HCP Administration

A. Michelle Rub Pinniped Presentation (John Ferguson)

John Ferguson will coordinate with Michelle Rub regarding availability and timing of a presentation by Rub on pinniped predation during the HCP Coordinating Committees meeting on June 26, 2018. *(Note: Ferguson coordinated with Rub, who will present during the next HCP Coordinating Committees meeting on June 26, 2018.)*

B. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on June 26, 2018, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The July 24 and August 28, 2018 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Comparison: Rocky Reach to John Day Dam Survival of Spring and Summer Yearling Chinook Released above Wells Dam, 2010-2017

Attachment A
List of Attendees

Name	Organization
John Ferguson†	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich†	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

Attachment B

COLUMBIA BASIN RESEARCH

Comparison: Rocky Reach to John Day Dam Survival of Spring and Summer Yearling Chinook Released above Wells Dam, 2010-2017

18 May 2018

TO: TOM KAHLER
Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway, East Wenatchee, Washington 98802

FROM: JOHN R. SKALSKI AND RICHARD L. TOWNSEND
Columbia Basin Research, School of Aquatic and Fishery Sciences, University of Washington
1325 Fourth Avenue, Suite 1515, Seattle, Washington 98101-2540

1 Introduction

The purpose of this statistical analysis is to compare reach survival of spring and summer yearling Chinook salmon in reaches below Rocky Reach Dam using release groups from above Wells Dam, 2010–2017. Smolt passage survival is estimated in the reach from Rocky Reach Dam to McNary Dam and from McNary Dam to John Day Dam using PIT-tagged Chinook salmon smolts.

2 Methods

Within each year, available PIT-tagged release groups above Wells Dam were examined and tested for comparability between spring and summer releases (Appendix A). Among comparable release groups identified, a weighted annual mean survival was estimated separately for spring and summer Chinook salmon. Survivals within year were weighted by the inverse CV^2 (Coefficient of Variance). Asymptotic *Z*-tests were used to compare spring and summer Chinook salmon survival within a year. Across the eight years of data, a paired *t*-test was used to test for equal survival between stocks. Separate analyses were performed for Rocky-Reach-to-McNary reach and from McNary-to-John-Day reach.

3 Results

For the seven available years of Rocky-Reach-to-McNary reach survival, only 2015 had a significant difference between fish stocks at $P < 0.05$ (Table 1). However, the 2015 estimate of precision for summer Chinook salmon is misleading. Replicate releases in 2015 had similar survival values of 0.92–0.96, but large standard errors (SEs), due to lower than usual detection rates (5-6%) at McNary (Appendix A). Any method of averaging those two individual estimates results in an annual estimate with higher precision (0.0195) than what the data indicates. The estimates of mean survival were 0.7392 ($\widehat{\mathrm{SE}}$ = 0.0254) and 0.81028 ($\widehat{\mathrm{SE}}$ = 0.0440) for spring and summer Chinook, respectively, using all years of available data. Excluding the possible specious 2015 results, mean survival was 0.7431 ($\widehat{\mathrm{SE}}$ = 0.0297) and 0.7877 ($\widehat{\mathrm{SE}}$ = 0.0448) for spring and summer Chinook, respectively (Table 1).

Reach survival between McNary and John Day Dam was estimated less precisely than Rocky Reach to McNary because of the low PIT-tag detection probabilities in the lower Columbia River. None of the within-year comparisons between spring and summer Chinook salmon were significant for the McNary to John Day reach. The estimates of mean survival were 0.9284 ($\widehat{\mathrm{SE}}$ = 0.0309) and 0.9403 ($\widehat{\mathrm{SE}}$ = 0.0620) for spring and summer Chinook salmon smolts, respectively.

Table 1. Weighted annual estimates of reach survival for a) Rocky Reach to McNary and b) McNary to John Day Dam for spring and summer yearling Chinook salmon, 2010–2017. Within-year tests of equal survival were performed with *P*-values reported.

a. Rocky Reach to McNary

Year	Spring Chinook Survival (SE)	Summer Chinook Survival (SE)	Annual Comparison *P* (<|*Z*|)
2010	0.7718 (0.0101)	0.8153 (0.0297)	0.1655
2011	0.6278 (0.0235)	0.6393 (0.1378)	0.9344
2012	0.7241 (0.0332)	NA	NA
2013	0.8414 (0.0254)	0.9330 (0.0978)	0.3647
2014	0.7537 (0.0776)	0.7283 (0.0721)	0.8105
2015	0.7157 (0.0162)	0.9447 (0.0195)	**<0.0001**
2016	0.7662 (0.0052)	0.7276 (0.0377)	0.3105
2017	0.6977 (0.0201)	0.8830 (0.1091)	0.0949
Mean*	0.7392 (0.0254)	0.8102 (0.0440)	
Mean* (w/o 2015)	0.7431 (0.0297)	0.7877 (0.0448)	

b. McNary to John Day

Year	Spring Chinook Survival (SE)	Summer Chinook Survival (SE)	Annual Comparison *P*(<|*Z*|)
2010	1.0305 (0.0428)	1.0105 (0.0522)	0.7670
2011	1.0075 (0.0415)	0.7960 (0.1625)	0.2073
2012	0.7889 (0.0527)	NA	NA
2013	0.8678 (0.0485)	0.8906 (0.1929*)	0.9087
2014	0.9589 (0.1472)	1.2640 (0.2428*)	0.2826
2015	0.8744 (0.1712)	0.7855 (0.2190)	0.7491
2016	0.8050 (0.0457)	0.8758 (0.1243)	0.5929
2017	0.9546 (0.0448)	0.9600 (0.0245)	0.9158
Mean*	0.9284 (0.0309)	0.9403 (0.0620)	

*2012 data omitted in calculating cross-year average

Plots of spring vs. summer Chinook salmon reach survival visually indicate a 1:1 ratio for survival in the McNary-to-John-Day reach (Figure 1b), but a slightly off-diagonal relationship in the Rocky-Reach-to-McNary reach (Figure 1a). Paired *t*-tests find similar results across the years of study. The test found a near significant difference ($P = 0.1190$) in Rocky-Reach-to-McNary reach survival for the two fish stocks when the 2015 suspect data were included, but a nonsignificant result ($P = 0.2476$) when the 2015 data were omitted. The paired *t*-test was highly nonsignificant ($P = 0.8484$) when the McNary-to-John-Day reach survival for spring and summer yearling Chinook salmon was compared.

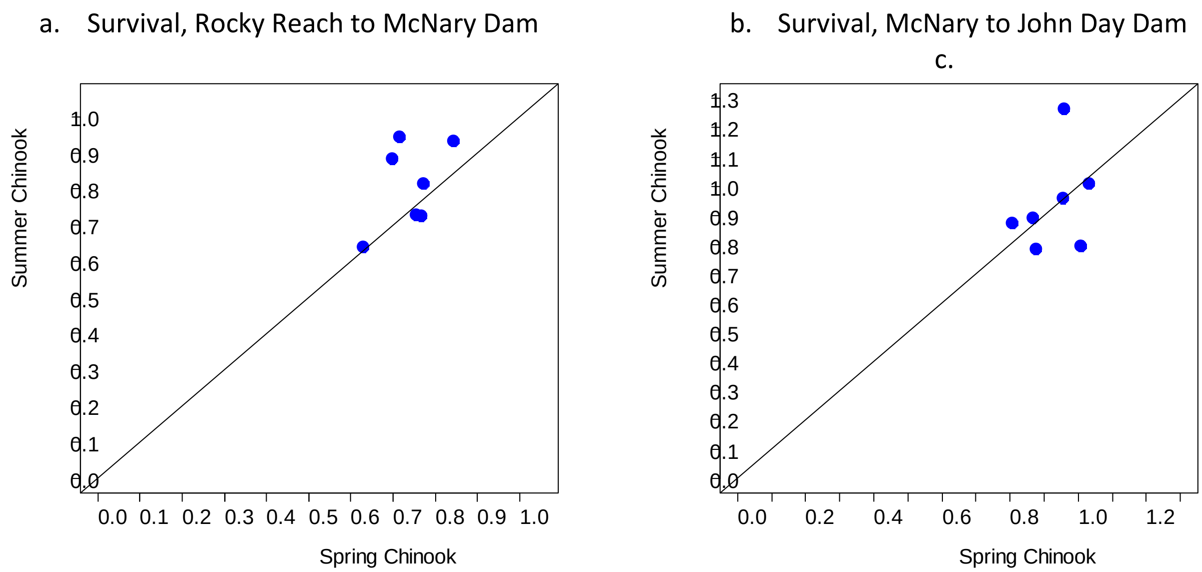

Figure 1. Comparison of average annual survival for yearling spring and summer Chinook salmon, 2010–2017, for a) Rocky Reach to McNary Dam and b) McNary to John Day Dam. The diagonal line represents a 1-to-1 relationship.

4 Conclusion

PIT-tag data suggest reach survival is very similar for spring and summer yearling Chinook salmon. Summer Chinook salmon might have slightly higher survival in the Rocky-Reach-to-McNary reach, but the existing data are inconclusive. As discussed in the Skalski (2017) memo, higher reach survival does not necessarily translate into high project passage survival when a paired-release study is performed. This analysis suggests there is no statistical benefit of using either spring or summer yearling Chinook salmon in a survival compliance study at Wells Dam.

Appendix A

Historical values of reach survival and detection probabilities for PIT-tagged smolts released in the Mid-Columbia River for spring and summer yearling Chinook salmon.

Table A1. Historical values of reach survival probabilities for PIT-tagged spring Chinook salmon released from the Mid-Columbia. Release types are AC = acclimation pond; H = hatchery; R = river.

Year	Hatchery	Stock	Rel. Site	Type	Rel. rkm	Rel. size	$\hat{S}$(R-RR)	SE(R-RR)	$\hat{S}$(RR-MC)	SE(RR-MC)	$\hat{S}$(MC-JD)	SE(MC-JD)
2010	METH	METH	METH	H	843.085	10,001	0.8039	0.0222	0.7592	0.0659	1.0646	0.2121
	METH	METH	WOLFC	R	843.085	9,999	0.7362	0.0163	0.7718	0.0742	0.9566	0.1949
	WINT	WINT	WINT	H	843.081	4,985	0.8549	0.0270	0.7968	0.0972	1.1024	0.3081
2011	METH	METH	BIDDLP	AC	843.085.002	8,000	0.7242	0.0330	0.5949	0.0666	0.9299	0.2063
	METH	METH	METH	H	843.085	7,998	0.7900	0.0332	0.5992	0.0565	0.9585	0.1885
	WINT	METH	WINT	H	843.081	3,993	0.7664	0.0370	0.7013	0.0775	1.0698	0.2687
	WINT	WINT	WINTBC	AC	843.081	6,924	0.6148	0.0297	0.6261	0.0627	1.1019	0.2484
2012	METH	SPR CHIN	MDVAP	AC	843.088	11,980	0.6900	0.0384	0.7488	0.0657	0.8371	0.1166
	METH	SPR CHIN	METH	H	843.085	5,993	0.8873	0.0588	0.7580	0.0859	0.6286	0.1009
	WINT	METH	WINT	H	843.081	2,946	0.8565	0.0627	0.6289	0.0752	0.9161	0.1638
	WINT	WINT	WINT	H	843.081	1,976	0.8516	0.0695	0.6130	0.0823	0.9203	0.1995
	WINT	SPR CHIN	WINTBC	AC	843.081	5,994	0.6849	0.0408	0.7894	0.0764	0.7308	0.1010
2013	METH	METH	METH	H	843.085	5,996	0.6335	0.0319	0.8146	0.1134	0.8474	0.2118
	WINT	METH	WINT	H	843.081	10,889	0.6800	0.0226	0.7968	0.0688	0.9307	0.1526
	WINT	METH	WINTBC	AC	843.081	5,983	0.6956	0.0291	0.8684	0.0921	0.8734	0.1796
			CHEWUP	AC	843.080.010	5,000	0.6598	0.0326	0.8910	0.1448	0.6323	0.1873
	METH	METH	TWISPP	AC	843.066.013	4,996	0.6380	0.0397	0.9733	0.2011	1.0121	0.5233
2014	METH	METH	METH	H	843.085	6,977	0.6203	0.0337	0.6074	0.0906	0.9328	0.2420
	WINT	METH	WINT	H	843.081	4,991	0.7667	0.0396	0.8589	0.1079	0.8265	0.1853
	METH		TWISPP	AC	843.066.013	4,988	0.5596	0.0407	0.7506	0.1373	1.4303	0.5649
2015	WINT	METH	RIVERP	AC	858.064	4,902	0.7860	0.0316	0.6747	0.0947	2.6466	1.5116
	METH		METH	H	843.085	4,998	0.6658	0.0324	0.7746	0.1637	0.6059	0.2269
	WINT	METH	WINT	H	843.081	9,937	0.7410	0.0228	0.7415	0.0831	1.0032	0.2209
	CHEL	METH	CHEWUP	AC	843.080.010	15,077	0.6520	0.0181	0.6988	0.0554	0.7969	0.1048
	METH		TWISPP	AC	843.066.013	4,990	0.6520	0.0344	0.7783	0.1640	0.6374	0.2384
2016			RIVERP	AC	858.064	4,959	0.8000	0.0326	0.7632	0.0612	0.8360	0.1385
	METH		METH	H	843.085	4,998	0.7123	0.0288	0.7503	0.0718	0.5898	0.1052
	WINT	WINT	WINT	H	843.081	17,361	0.7510	0.0157	0.7692	0.0336	0.7990	0.0649
			CHEWUP	AC	843.080.010	4,984	0.7316	0.0268	0.7523	0.0621	0.9798	0.1858
	METH		TWISPP	AC	843.066.013	4,990	0.6186	0.0269	0.7859	0.0670	0.8459	0.1315
2017	CHJO		CHJO	H	868	4,815	0.8070	0.0486	0.7573	0.0978	0.8463	0.1441
	CHJO		RIVERP	AC	858.064	5,036	0.5165	0.0431	0.6582	0.1053	1.1692	0.2874
	METH	MET COMP	GOATWP	AC	843.116	4,934	0.5940	0.0334	0.7948	0.1139	0.8660	0.1754
	METH		METH	H	843.085	4,996	0.6814	0.0389	0.6278	0.0761	1.1373	0.2008
	WINT	METH	WINT	H	843.081	19,918	0.8314	0.0205	0.6988	0.0423	0.9377	0.0784
	METH		CHEWUP	AC	843.080.010	4,990	0.7923	0.0467	0.6299	0.0813	1.0671	0.2005
	METH		TWISPP	AC	843.066.013	4,996	0.7235	0.0474	0.7449	0.1218	0.7671	0.1603

Table A2. Historical values of reach survival probabilities for PIT-tagged summer Chinook salmon released from the Mid-Columbia.

Year	Hatchery	Stock	Rel. Site	Type	Rel. rkm	Rel. size	$\hat{S}$(R-RR)	SE(R-RR)	$\hat{S}$(RR-MC)	SE(RR-MC)	$\hat{S}$(MC-JD)	SE(MC-JD)
2010	WELH		OKANR	R	858	10,062	0.8591	0.0233	0.7334	0.0704	1.1268	0.2249
	WELH		METHR	R	843	30,343	0.8926	0.0140	0.8636	0.0514	0.9209	0.1081
	WELH		WELTAL	R	830	37,577	0.9001	0.0126	0.8041	0.0389	1.0478	0.1070
2011	SIMP	MEOK	SIMILR	R	858.119	5,089	0.8494	0.0475	0.8689	0.1420	0.5470	0.1502
	CHEL	MEOK	CARP	AC	843.058	5,020	0.8676	0.0468	0.5566	0.0546	0.9021	0.1617
2013	SIMP	MEOK	SIMILR	R	858.119	5,036	0.7325	0.0298	0.9330	0.0978	0.8906	0.1929
2014	CHEL	MEOK	CARP	AC	843.058	9,801	0.7743	0.0302	0.7283	0.0721	1.2640	0.2428
2015	CHJO		CHJO	H	868	5,017	0.7107	0.0346	0.9240	0.1912	0.6185	0.1846
	CHEL	MEOK	CARP	AC	843.058	9,825	0.6261	0.0206	0.9630	0.1878	1.0727	0.4198
2016	CHJO		CHJO	H	868	4,951	0.7917	0.0376	0.6655	0.0644	0.9943	0.2006
	CHJO		OMAKP	AC	858.052	4,193	0.5630	0.0421	0.7659	0.1061	1.1508	0.3458
	CHEL		CARP	AC	843.058	4,992	0.8049	0.0392	0.7771	0.0802	0.7067	0.1191
2017	CHJO		CHJO	H	868	5,024	0.7744	0.0608	0.9936	0.1815	0.9849	0.2602
	CHJO		OMAKP	AC	858.052	4,830	0.7851	0.0624	0.7753	0.1398	0.9358	0.2435

FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: July 23, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Revised Minutes of the June 26, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, June 26, 2018, from 10:00 a.m. to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Douglas PUD will provide a representation designation letter to John Ferguson (and copy Kristi Geris), replacing Shane Bickford with Andrew Gingerich (Douglas PUD) as the Douglas PUD HCP Coordinating Committees Alternate Representative (Item I-C). *(Note: this letter was distributed to the HCP Coordinating Committees by Geris on July 23, 2018.)*
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).
- Scott Carlon will discuss with Brett Farman (National Marine Fisheries Service [NMFS]) and Charlene Hurst (NMFS) how to best coordinate among Douglas PUD, the Wells HCP Coordinating and Hatchery Committees, and NMFS, to ensure that the use of spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study is written into the next Section 10 permits for the Wells Project (Item IV-A).
- John Ferguson will discuss with Tracy Hillman how to best coordinate between the Wells HCP Coordinating and Hatchery Committees to ensure that the use of spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study is written into the next Section 10 permits for the Wells Project (Item IV-A). *(Note: Ferguson discussed this with Hillman on July 2, 2018, and Hillman will further discuss this with the HCP Hatchery Committees during the next meeting on July 18, 2018.)*
- Tom Kahler will establish a system to remind the Wells HCP Coordinating Committee to routinely revisit using spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study to ensure this is written into the next Section 10 permits for the Wells Project (Item IV-A).

- Tom Kahler will provide reports on adult summer/fall Chinook salmon fallbacks by Ashbrook et al. (2008) and Mann et al. (2018) to Kristi Geris for distribution to the HCP Coordinating Committees (Item VI-A). *(Note: Kahler provided these reports to Geris following the meeting on June 26, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Kristi Geris will notify Sarah Montgomery (HCP Hatchery Committees support staff) that the HCP Coordinating Committees agreed to add David Clark (Washington Department of Fish and Wildlife [WDFW]), the new Eastbank Complex Manager, to the HCP Hatchery Committees email distribution list and provide Clark with access to the HCP Hatchery Committees extranet site, as requested (Item VII-A). *(Note: Geris notified Montgomery following the meeting on June 26, 2018.)*
- The HCP Coordinating Committees meeting on July 24, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item VI-B).

Decision Summary

- The Wells HCP Coordinating Committee representatives present approved the Statement of Agreement (SOA), "Regarding the Selection of Study Fish for Douglas PUD's 2020 Wells Project Survival Verification Study for Yearling Spring Migrants in Phase III (Standard Achieved)," as revised (Item IV-A).

Agreements

- The HCP Coordinating Committees representatives present agreed to add David Clark to the HCP Hatchery Committees email distribution list and provide Clark with access to the HCP Hatchery Committees extranet site, as requested (Item VII-A).
- The HCP Coordinating Committees representatives agreed via email to add Megan Finley (WDFW), the new fish pathologist for the Eastbank Fish Hatchery complex, including the Chiwawa Acclimation Facility, to select HCP Hatchery Committees email distribution lists and provide Finley with visitor access to the HCP Hatchery Committees extranet site, as follows: Chelan PUD, Douglas PUD, NMFS, U.S. Fish and Wildlife Service (USFWS), WDFW, and the Yakama Nation (YN) agreed on July 17, 2018; and the Colville Confederated Tribes (CCT) agreed on July 18, 2018.

Review Items

- A Wells Project Land-use Permit Application for Wells Tract 115 was distributed to the HCP Coordinating Committees by Kristi Geris on July 21, 2018. This application is available for a 60-day review with comments or indication of no comments due to Tom Kahler and Geris no later than Wednesday, September 19, 2018. This application will also be on the agenda for the

HCP Coordinating Committees meeting on August 28, 2018, for discussion and possible early decision. *(Note: Jim Craig provided USFWS comments on July 23, 2018; and Chad Jackson and Scott Carlon provided indication of no comments on July 23, 2018 and July 24, 2018, respectively.)*

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. Chad Jackson added a request from WDFW to add David Clark, the new WDFW Eastbank Complex Manager, to the HCP Hatchery Committees email distribution and provide Clark with extranet access. Ferguson said this will be covered under the administrative updates.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft May 22, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the HCP Coordinating Committees were incorporated into the revised minutes and there are no outstanding items remaining to be discussed. HCP Coordinating Committees members present approved the May 22, 2018 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on May 22, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on May 22, 2018):*

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Tom Kahler will inquire internally about expediting contracting to re-line dirt pond No. 3 at Wells Fish Hatchery to avoid overstocking steelhead during winter 2018-2019 (Item II-A).*
  Kahler said re-lining dirt pond No. 3 does not constitute an emergency under state bidding laws; therefore, the process cannot be expedited as proposed.

- *Douglas PUD will provide a hyperlink to access reports from the Columbia River Inter-Tribal Fish Commission's (CRITFC's) annual sockeye salmon tagging efforts at Wells Dam (Item III-A).*
  Tom Kahler provided this hyperlink to Kristi Geris following the meeting on May 22, 2018, which Geris distributed to the HCP Coordinating Committees that same day.
- *Douglas PUD will provide a representation designation letter to John Ferguson (and copy Kristi Geris), replacing Shane Bickford with Andrew Gingerich (Douglas PUD) as the Douglas PUD HCP Coordinating Committees Alternate Representative (Item III-B).*
  Tom Kahler said this letter has been drafted and is under manager review. This action item will be carried forward (note: this letter was distributed to the HCP Coordinating Committees by Geris on July 23, 2018).
- *Kristi Geris will add Andrew Gingerich to the HCP Coordinating Committees email distribution list and will coordinate with Julene McGregor (Douglas PUD Information Systems) to provide Gingerich with member access to the HCP Coordinating Committees extranet site (Item III-B).*
  Geris added Gingerich to the email list and requested extranet access from McGregor following the meeting on May 22, 2018.
- *Scott Carlon will inquire internally within the National Marine Fisheries Service (NMFS) about the required permitting process for using coho and spring Chinook salmon as study species in the Douglas PUD 2020 Survival Verification Study (Item III-D).*
  This will be discussed during today's meeting.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item IV-A).*
  This action item will be carried forward.
- *Kirk Truscott will provide Lance Keller with questions from the CCT regarding the State Historic Preservation Office (SHPO) consultation on the Rocky Reach Project Land-Use Permit Application for the City of Entiat, including: 1) did this application undergo SHPO consultation; and 2) if not, what is Chelan PUD's policy regarding approval for an application that has not undergone SHPO consultation (Item IV-B)?*
  Truscott's questions were addressed and the CCT have no further comments on this application, as distributed to the HCP Coordinating Committees by Kristi Geris on June 5, 2018.
- *Lance Keller will inquire internally within Chelan PUD about the CCT's questions regarding SHPO consultation on the Rocky Reach Project Land-Use Permit Application for the City of Entiat, as well as what authority the Federal Energy Regulatory Commission (FERC) has over this application; and will report back to the HCP Coordinating Committees prior to Monday, June 11, 2018 (Item IV-B).*
  Keller said FERC ultimately has the authority to accept or reject the application, and Chelan PUD serves as the middleman.

- *The CCT and the YN will submit comments or indication of no comments on the Rocky Reach Project Land-Use Permit Application for the City of Entiat to Lance Keller, Jeff Osborn (Chelan PUD), and Kristi Geris no later than Monday, June 11, 2018 (Item IV-B).*
  The CCT and the YN submitted indication of no comments on June 4 and 5, 2018, respectively, as distributed to the HCP Coordinating Committees by Geris on June 5, 2018.
- *John Ferguson will coordinate with Michelle Rub (National Oceanic and Atmospheric Administration [NOAA] Northwest Fisheries Science Center) regarding availability and timing of a presentation by Rub on pinniped predation during the HCP Coordinating Committees meeting on June 26, 2018 (Item V-A).*
  Ferguson coordinated with Rub, who will present during the HCP Coordinating Committees meeting today.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees conference call on June 20, 2018:

- *Surplus Wild-by-Wild Steelhead at the Winthrop National Fish Hatchery*: Due to no pre-spawn loss and higher than expected fecundities and survival rates, the Winthrop National Fish Hatchery has about 50,000 excess wild-by-wild (WxW) steelhead on station. If space allows, the Wells HCP Hatchery Committee agreed to rear the surplus WxW steelhead at the Methow Fish Hatchery until fish are about 200 to 250 fish per pound. These fish would then be tagged and released into the Methow River Basin as parr in October 2018. Douglas PUD is determining if there is space to rear the fish at Methow Fish Hatchery, and the YN agreed to look into suitable places in the Methow River basin to release the parr. Hillman said the idea is to release the parr in spring-fed areas where the YN have conducted enhancement work, while also not interfering with ongoing monitoring. Keely Murdoch said she discussed this with Tom Scribner (YN) and both agreed this is a good idea. Murdoch said a couple of locations are being monitored now so parr will not be released in these locations to avoid conflicting with the monitoring results. She said the YN will coordinate internally to find locations that will work.
- *Surplus Columbia River Steelhead (Safety Net Production)*: There is a surplus at Wells Fish Hatchery of about 15,000 excess hatchery-by-hatchery (HxH) Columbia River steelhead. Douglas PUD is coordinating with WDFW on where to plant surplus steelhead. Surplus fish will be planted into non-anadromous lakes.
- *NMFS Consultation Update (joint HCP Hatchery Committees/Priest Rapids Coordinating Committee [PRCC] Hatchery Subcommittee item)*: The Environmental Assessment (EA) for

Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids) is undergoing internal legal review. The EA will be sent to the applicants in August 2018 and then out for a 30-day public review.

- *Genetics Monitoring Associated with PUD Hatchery Programs (joint HCP Hatchery Committees/ PRCC Hatchery Subcommittee item)*: In an effort to standardize genetic monitoring of PUD hatchery programs, Grant PUD proposed that the Committees assemble a panel of geneticists to discuss the most appropriate metrics to monitor. Grant PUD developed a list of questions for the panel to discuss. Each member on the Committees will identify a geneticist to participate on the panel. Additionally, members will review the questions proposed by Grant PUD and will be prepared to discuss them during the July meeting. John Ferguson asked if the YN and the CCT have geneticists? Kirk Truscott said the CCT do not have a geneticist on staff; however, the CCT typically use WDFW and USFWS staff for this. Murdoch said the YN uses CRITFC staff.
- *Surplus Nason Creek Spring Chinook (joint HCP Hatchery Committees/PRCC Hatchery Subcommittee item)*: WDFW indicated there are about 47,000 excess HxH Nason Creek spring Chinook salmon. WDFW provided a plan on what to do with these fish and the Committees are currently reviewing the plan. Hillman said these surpluses in several programs show that the hatchery managers did an excellent job with spawning, incubating, and rearing fish this year.
- *Antibiotic Injections of Broodstock to Control Disease (joint HCP Hatchery Committees/PRCC Hatchery Subcommittee item)*: Grant PUD requested a discussion on injecting antibiotics into broodstock to control disease. WDFW indicated they operate under a prophylactic disease management plan, which was provided to the Committees following the conference call. The Committees are currently reviewing the plan, which will be further discussed during the HCP Hatchery Committees meeting on July 18, 2018.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on July 18, 2018. Hillman said this meeting will likely last all day because there will be several presentations and issues to discuss. Ferguson reminded the HCP Coordinating Committees that Larissa Rohrbach (Anchor QEA) will be replacing Sarah Montgomery (Anchor QEA) as the HCP Hatchery Committees support staff when Montgomery begins graduate school in the fall 2018; and Rohrbach began shadowing Montgomery during the conference call on June 20, 2018, and this will continue with the meeting on July 18, 2018.

Hillman said the HCP Tributary Committees met on May 23, 2018 (1 day after the last HCP Coordinating Committees meeting). Hillman said the HCP Tributary Committees did not officially meet in June 2018; however, the Committees did attend project sponsor presentations on June 13 and 14, 2018. Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting in May 2018:

- *Wenatchee Sleepy Hollow Floodplain Acquisition Project*: The Rock Island HCP Tributary Committee received a time extension request from Chelan-Douglas Land Trust on the Wenatchee Sleepy Hollow Floodplain Acquisition Project, requesting to extend the completion date from December 31, 2017 to June 30, 2019. The extension is needed because of a late start due to the failure by the State legislatures to pass the capital budget in early 2018 (which was needed for the Salmon Recovery Funding Board [SRFB] cost share). The Rock Island HCP Tributary Committee agreed to extend the contract to June 30, 2019.
- *Burns-Garrity Restoration Design Project*: The Rocky Reach HCP Tributary Committee received a time extension request from Cascade Columbia Fisheries Enhancement Group (CCFEG) on the Burns-Garrity Restoration Design Project on the Chewuch River. A change in landownership delayed the project 5 months; therefore, CCFEG asked to extend the completion date from May 1, 2018 to December 1, 2018. The Rocky Reach HCP Tributary Committee agreed to extend the contract to December 1, 2018. Hillman noted that this project is located in a side channel off the Chewuch River.
- *General Salmon Habitat Program Draft Proposals*: The HCP Tributary Committees received 19 General Salmon Habitat Program draft proposals, which were all cost share proposals with SRFB. The HCP Tributary Committees identified 11 projects that did not warrant a full proposal, because they were inconsistent with the intent of the Tributary Fund (e.g., a bull trout assessment project), did not have strong technical merit, or were not cost effective (low benefits per cost). The HCP Tributary Committees solicited full proposals from the remaining eight projects, which are due on June 29, 2018. The proposed projects are in the Wenatchee, Entiat, and Methow river basins.
- *Icicle Fish Screening Projects (joint discussion with the PRCC Habitat Subcommittee)*: Hillman recalled that the HCP Tributary Committees received a General Salmon Habitat Program proposal from WDFW (in January 2018) requesting funding to bring both the Icicle-Peshastin Irrigation District (IPID) and City of Leavenworth screens into compliance to protect all fish species and life stages from injury, entrainment, and mortality. The HCP Tributary Committees ultimately decided that IPID and the City of Leavenworth both need to come up with a 25% cost share. In May 2018, Chelan County Natural Resources Department (CCNRD) asked the HCP Tributary Committees to consider a revised approach for funding the IPID and City of Leavenworth screens in Icicle Creek. The Icicle Work Group has $372,000 from the Office of the Columbia River (OCR), an undisclosed amount from the City of Leavenworth, and an anticipated $100,000 from IPID. The Icicle Work Group would like to use the funds from OCR, combined with the City of Leavenworth cost share, to bring the City of Leavenworth fish screens into compliance. Thus, no HCP Plan Species Account Funds would be used for the City of Leavenworth screens. The anticipated $100,000 from IPID would be the cost share on their screening project. CCNRD asked the HCP Tributary Committees if the requirement of a 25%

cost share would be satisfied under this proposed strategy (i.e., fully funding City of Leavenworth screening with OCR and City funds, and an anticipated $100,000 cost share from IPID for their screen). The HCP Tributary Committees concluded that the proposed strategy does not meet the 25% cost-share requirement. The HCP Tributary Committees view the fish screens as two separate projects, not as a single project. This is because there are two separate diversions owned by two different entities (IPID and City of Leavenworth) and potentially funded by different Committees. Therefore, both diversions need a 25% cost share if funding is requested from the HCP Tributary Committees. This does not mean the Work Group cannot use the OCR funds to fully fund the City of Leavenworth screen. If this happens, IPID will still need a 25% cost share if the Work Group intends to seek funding from the HCP Tributary Committees. The HCP Tributary Committees recommended the Icicle Work Group use the OCR funds to help cover the cost share on both screening projects. Any shortage in the 25% cost share per project would need to be made up by the owners of the diversions or other funds. The HCP Tributary Committees also indicated that funds will not be contributed to the screening project(s) unless there is written permission from both the City of Leavenworth and IPID to allow implementation of the fish passage project at the boulder field. Without fish passage at the boulder field, there will be little benefit to HCP Plan Species in the vicinity of the intake structures. Hillman said the HCP Tributary Committees submitted this response to CCNRD and copied WDFW but have not yet received a response.

Andrew Gingerich asked where the boulder field is located, and Jim Craig said it is located at river mile 5.6 on Icicle Creek, just upstream of the Leavenworth National Fish Hatchery.

- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on July 12, 2018.

III. National Oceanic and Atmospheric Administration

A. PRESENTATION: Survival of adult spring/summer Chinook salmon (Oncorhynchus tshawytscha) through the estuary and lower Columbia River amid a rapidly changing predator population (Michelle Rub)

Michelle Rub shared a presentation titled, "Survival of adult spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) through the estuary and lower Columbia River amid a rapidly changing predator population," (Attachment B), which was distributed to the HCP Coordinating Committees by Kristi Geris following the meeting on June 26, 2018. Rub said efforts for this study began in 2008 and field work commenced by 2010. She said this is a large, complex project with several participating agencies and tribes.

Slide 2 of Attachment B

Rub said the primary goal of this study is to provide estimates of survival and run timing through the estuary and lower Columbia River for spring/summer Chinook salmon returning to the middle and upper Columbia and Snake rivers. She said there is concern that pinnipeds entering the Columbia River during spring are impacting adult salmon through predation. She said there has been a significant increase in pinnipeds, notably from before 2014 to 2015 compared to after.

Slides 3 and 4 of Attachment B

Rub said study fish were collected in tangle nets and passive integrated transponder (PIT)-tagged, and survival is based on PIT-tag detections at Bonneville Dam for fish that were identified as known to be bound for spawning locations above Bonneville Dam. She said in 2016 and 2017, fish and pinnipeds were also tracked using radio-telemetry.

Slide 5 of Attachment B

Rub noted that the number of fish sampled has dropped significantly over the years, partly because there is only one sampling boat compared to the three boats used at the beginning of the research. She said additionally, the run has been smaller in recent years. She said sampling typically followed the Test Fishery regarding timing (note: mainstem test fishing by the states using tangle nets is conducted each spring on the lower Columbia River to evaluate the current run with respect to timing, stock composition, mark rate, and other biological data). She said there has been good coverage of the run except in 2010 and 2013, due to receiving funding late those years. She said the data do not indicate baseline mortality is entirely associated with pinniped predation, which will be further discussed during the 2016 radio telemetry results slides. She said other sources of mortality may be involved, including harvest, straying, and a small percentage of mortality may be due to delayed mortality associated with tagging, handling, or disease.

John Ferguson asked why the baseline mortality was high in 2014? Rub said 2014 is around the time when an influx of predators was observed coming into the river. She said based on river flow, fish can take longer or shorter to travel through that reach. She noted that due to mortality being reported as a proportion of upriver fish only, the magnitude will depend on the overall number of fish entering the system (which includes fish returning to the Willamette River and other lower river tributaries) as well as the proportion of upriver fish contributing to the overall return during spring.

Slide 6 of Attachment B

Rub said in 2016, radio telemetry was used to investigate where these fish were going. She said about 30 California sealions were tagged. She said the yellow data points indicate progress of sealions traveling upriver. She said red data points indicate where Chinook salmon mortalities occurred. She noted that at least half of the Chinook salmon mortalities occurred at Bonneville Dam even though only a small percentage of predators were detected there.

Slide 7 of Attachment B

Rub said in 2017, radio telemetry data indicate a shift in pinniped presence farther down in the estuary. She noted that Chinook salmon mortalities followed this shift, as well. She recalled that 2017 was a high river flow year, which may have kept fish lower in the river for longer periods and the predators stayed with the fish. She said in an average flow year, average travel time to Bonneville Dam is 21 to 22 days. She said in 2017, average travel time to Bonneville Dam was 34 days. She said fish were delayed both in the estuary and at the dams. She said 2016 was a fairly low flow year where average travel time was 16 days.

Slide 8 of Attachment B

Rub said a linear mixed effects model indicated that both predation and harvest are influencing survival. She said the mixed model is a linear regression which incorporates a random component to account for temporal effects and also incorporates fixed effects. She noted that Eulachon indirectly affect salmon survival negatively, presumably by drawing sealions into the river.

Slides 9 and 10 of Attachment B

Rub said model response curves indicate shad abundance has a positive effect on Chinook salmon survival.

Slide 11 of Attachment B

Rub said the data indicate survival is higher later in the year and predator presence is higher earlier. She said it seems fish gradually enter the river and once a critical mass is reached, fish move all at once.

Andrew Gingerich asked whether this may be a "safety in numbers" approach? Rub said she believes so. Ferguson asked what the recent Independent Scientific Advisory Board's Upper Columbia Spring Chinook Salmon Report said on this. Tom Kahler recalled the report mentioning predation was higher earlier and the Upper Columbia River stocks were also entering the river earlier. Gingerich asked if California sealions eat shad? Rub said this is not well-studied; however, anecdotally, she says yes. She said she has observed several shad heads in the tangle nets during sampling.

Slide 12 of Attachment B

Slide 12 shows the annual estimated number of fish lost to natural mortality from the Columbia River Estuary to Bonneville Dam. Rub said the mean number is in the thousands. She said in 2010, for example, modeling indicates about 20% of the total run of upriver spring/summer Chinook salmon was lost, equaling about 77,000 fish. She said 2013 is biased low because there was not good coverage of the entire run. She said this seems to be the big question. She said managers know there is predation, but is it significant and how significant?

Slide 13 of Attachment B

Rub said starting in 2014, the study transitioned to parentage-based genetics with just over 400 fish being typed out from 2014 to 2017. She said the goal was to search for a pattern when fish enter the estuary. She noted that the date is the Julian date and said she expected the earlier groups would be hit the hardest by harvest and predation.

Gingerich asked whether these values are weighted by sample size, and Rub said they are not. Ferguson asked about harvest proportion. Rub said harvest proportions are typically 5 to 8% and differs between groups (i.e., early versus late runs).

Kahler asked about the parent database. Rub said the parent database is a baseline that was developed and this research is working off of it. She said she believes CRITFC was instrumental in developing this baseline, which is made up of markers. Kahler asked whether these are genetic stock identification markers, and Rub said somewhat only more specific. Rub said these markers can identify to a Snake River group or mid- or lower Columbia River group. She said these markers are so defined fish can be identified to the parents and the hatchery. She caveated that this may be based more on a probability.

Slide 14 of Attachment B

Rub shared a summary slide. She noted that regarding mortality, there is handling mortality associated with tangle netting. She said she does not believe this research caused 13% mortality and noted higher survival when river conditions were not conducive to handing effects. She also noted that spill at dams may have a positive effect on survival. She guessed that when spill starts, fish are directed more towards the fish ladders or spill disperses predators differently? Kahler also guessed if there is a lot of spill and higher total dissolved gas, adults may try avoiding this by traveling deeper in the water column? Rub said the data indicate higher survival during higher spill years. Scott Carlon guessed that turbulent water may provide more cover from predators? Rub said whatever the case, this is worth investigating further.

Ferguson asked about funding, and Rub said currently there is no funding to continue this research. Rub said she appreciates any exposure the fisheries community can bring to this research.

IV. Douglas PUD

A. Wells Project 2020 Survival Verification Study – Study Species (Tom Kahler)

John Ferguson suggested starting this discussion with Scott Carlon reporting on his action item about the required NMFS permitting process for using coho and spring Chinook salmon as study species in the Douglas PUD 2020 Survival Verification Study. Carlon said he spoke with Brett Farman, Craig Busack (NMFS), and Charlene Hurst, who indicated using spring Chinook salmon (springers) is not an option for the 2020 study. Carlon said, however, if the Wells HCP Coordinating Committee wants to study springers in 2030, this can be written into the new permit. Carlon said there is too much risk to the stock and associated with a possible second year of study, notably because springers are one of the more difficult stocks to recover. He summarized this decision was made based on the condition of the stock and risk of a second year of study.

Keely Murdoch recalled the 10 years it took to get the current spring Chinook salmon permit in place and asked when Douglas PUD and the Wells HCP Coordinating Committee should start working on the new permit? Carlon suggested starting these conversions soon. Tom Kahler recalled the current permits expire in 2027. Murdoch asked if these discussions should take place within the HCP Coordinating Committees or HCP Hatchery Committees, or both? Ferguson asked additionally, do the YN or the CCT carry this discussion forward or does the Wells HCP Coordinating Committee represent all of the entities on the Committee and carry this forward? Kahler recalled during the last permitting process, NMFS asked each hatchery program to complete Hatchery and Genetic Management Plans (HGMPs) and NMFS would then issue new permits in 2 years. Kahler said this process ended up taking 10 years and some permits are still forthcoming. He said a lot of the hold-up was trying to handle all HGMPs at once. He said this process sounded like it was developed on the fly, but now the process is more dialed in and maybe this 10-year cycle will be shortened to something more reasonable. Kahler said certain components included in the Wells Project's current permit have only recently been implemented and Douglas PUD needs to determine whether these components work before proposing the same activities in a new permit. He said, therefore, Douglas PUD is not quite ready to start working on a new permit. Murdoch said her concern is if this topic is not flagged somehow it will be forgotten.

Ferguson asked if NMFS needs a letter for the record? Murdoch suggested establishing some type of reminder. Kahler noted that these discussions will be included in the Wells HCP Annual Report. Carlon said he will discuss with Farman and Hurst how to best coordinate among Douglas PUD, the Wells HCP Coordinating and Hatchery Committees, and NMFS, to ensure that the use of spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study is written into the next Section 10 permits for the Wells Project. Ferguson said he will also discuss with Tracy Hillman how to best coordinate between the Wells HCP Coordinating and Hatchery Committees. Kahler said he will establish a system to remind the Wells HCP Coordinating Committee to routinely revisit using spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study. *(Note: Ferguson discussed this with Hillman on July 2, 2018, and Hillman will further discuss this with the HCP Hatchery Committees during the next meeting on July 18, 2018.)*

Carlon said regarding coho salmon as a study species in the Douglas PUD 2020 Survival Verification Study, coho salmon are covered under a Section 7 Incidental Take Statement; so, from a permitting standpoint, coho salmon can be used for the study. Kahler said, however, the same rearing-space issue discussed for springers is also true for coho salmon. He said currently, there are multiple rearing issues at Wells Fish Hatchery. He said (in addition to needing to re-line dirt pond No. 3) the new coating applied to the bureau ponds failed. He said the coating bubbles up and flakes off, which is also spalling the concrete. He said this impacts the availability of spare vessels for the verification study. He said adding production will complicate this further. He said Douglas PUD hopes to sort this out within a reasonable time frame, but this means studying coho salmon would be a 2021 study. He said studying summer Chinook salmon (summers) is not an issue because this would not be in addition to normal production.

Carlon said NMFS supports studying summers, but is also not opposed to studying coho salmon. Jim Craig said USFWS likes summers for comparison purposes and supports studying springers in 2030, assuming abundance and logistics work out. He added that USFWS is also not opposed to studying coho salmon in 2020. Chad Jackson said WDFW supports studying summers in 2020, while keeping springers in mind for a future study. He said he is less confident about obtaining adequate fish if coho salmon are studied. Kirk Truscott said considering springers are off the table and given the life history of coho salmon and risk of consecutive years of studies on coho salmon, the CCT support studying summers in 2020. Murdoch said springers were the YN's preference, and the YN like the idea of measuring coho salmon at some time; however, given the current run sizes of coho salmon, the YN support studying summers in 2020, but want to make clear springers are a priority next time and coho salmon are a backup species to the use of springers. Murdoch said the YN also hope that by 2030, Douglas PUD can reconsider using acoustic tags, as well. She said perhaps acoustic tag technology will progress to where Douglas PUD is confident about using this technology.

Kahler said he already spoke with Carlon prior to the meeting and knew springers were not an option. He said additionally, considering the rearing constraints for using coho salmon, he already developed a draft SOA for studying summers. Kahler passed around hard copies of this draft SOA and said this SOA only addresses selecting a study species. He said there will also be a study plan for review and another SOA associated with the plan, as well. The Wells HCP Coordinating Committee reviewed the draft SOA. Ferguson and Murdoch suggested including language about studying springers or coho salmon in 2030. Carlon agreed. Kahler said he prepared such language in case the Wells HCP Coordinating Committee requested this, as follows:

> *"It is the intent of the Wells HCP Coordinating Committee to select yearling spring Chinook salmon as the study species for the 2030 survival verification study of yearling spring migrants. In the interim, Douglas PUD will work with NMFS to obtain permit*

coverage for performing a survival verification study with yearling spring Chinook salmon in 2030."

Ferguson suggested adding:

"In the event spring Chinook salmon are not available for the 2030 study, the Wells HCP Coordinating Committee will consider coho salmon for that study."

Andrew Gingerich asked whether this language limits the Wells HCP Coordinating Committee by prioritizing one species over another, when conditions may change in the next 10 years? Kahler said this is why he used the language, "it is the intent." Carlon said he does not interpret this language as limiting. Ferguson and Murdoch noted that the Wells HCP Coordinating Committee has the authority to update an SOA in the future.

The Wells HCP Coordinating Committee representatives present approved the SOA, "Regarding the Selection of Study Fish for Douglas PUD's 2020 Wells Project Survival Verification Study for Yearling Spring Migrants in Phase III (Standard Achieved)," as revised (Attachment C). *(Note: Geris distributed the final SOA following the meeting on June 26, 2018.)*

B. Wells Dam Bypass Operations Update (Tom Kahler)

Tom Kahler said a Wells Dam Bypass Operations Update was distributed to the HCP Coordinating Committees by Kristi Geris on June 5, 2018. Kahler recalled that bypass barriers were removed at Wells Dam due to high river flow. He said barriers were reinstalled starting on June 4, 2018, as follows:

Bypass Bay	Reinstallation Date
4	June 4, 2018
8 and 10	June 5, 2018
6	June 12, 2018

Kahler said all barriers are now in place. He said the bypass PIT-tag detection system (in bypass bay 2) had very few hits during these high river flows; however, the system is now detecting several fish, many of which are orphan tags.

V. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 Maintenance Update (Lance Keller)

Lance Keller said he essentially has the same update as provided last month. He said there is a contract in place for an engineered seal and expected delivery is in August 2018. He said installation and testing of the new seal is scheduled for week 1 and 2 of September 2018. He said this schedule reaffirms Turbine Unit C1 will not be returning to service for the 2018 juvenile fish bypass season. He said Rocky Reach Dam engineers are anxious to receive and test the new seal. Keller said bringing Turbine Unit C1 back online in time for the 2019 bypass season is a high priority. He said engineers are optimistic this custom seal will work.

VI. NMFS

A. Adult Fallback (Scott Carlon)

Scott Carlon said Ritchie Graves (NMFS) is looking at adult fallbacks for the Interim Biological Opinion and asked if adult fallbacks are an issue in the mid-Columbia River Basin, and if so, how are adult fallbacks addressed? Carlon said he understands Grant PUD addresses fallbacks by spilling extra water until November; however, he is uncertain how Chelan and Douglas PUDs address fallbacks, if at all.

Tom Kahler said adult fallbacks were addressed within the HCP Coordinating Committees back in 2005. Lance Keller said he believes fallbacks were supposed to be tested before juvenile species? Kahler said he was not yet on the HCP Coordinating Committees during this time, but he reviewed the administrative record for meeting minutes or notes. He said in 2005, Douglas PUD produced and distributed a summary memorandum of radio telemetry studies (Attachment D; redistributed to the HCP Coordinating Committees by Kristi Geris following the meeting on June 26, 2018). Kahler said the memorandum was approved and an SOA dated February 2005 indicating fallbacks were adequately addressed by the Wells HCP Coordinating Committee was also approved. He said, therefore, yes there is fallback, but it is not biologically significant.

Keller said Chelan PUD also produced and distributed a summary memorandum of radio telemetry studies (Attachment E; redistributed to the HCP Coordinating Committees by Geris following the meeting on June 26, 2018). Keller said there was evidence of fallback due to overshooting, and additional fish which did fallback were tracked for re-ascending back to the spawning grounds.

Keely Murdoch asked if adult fallbacks have not been revisited since the late 1990s and early 2000s? She said there have been so many more PIT-tagged fish that there must be more recent information. Kahler and Kirk Truscott noted a couple of studies on adult summer/fall Chinook salmon fallbacks. Truscott said fallbacks vary year-to-year and can be dependent on river flow. He suggested taking into consideration environmental conditions when addressing fallbacks. Kahler said he will provide reports on adult summer/fall Chinook salmon fallbacks by Ashbrook et al. (2008) and Mann et al. (2018) to Geris for distribution to the HCP Coordinating Committees. *(Note: Kahler provided these reports to Geris following the meeting on June 26, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

Carlon asked how fallbacks are passed at the dams. Kahler said fallbacks have been detected passing Wells Dam via the PIT-tag detector in bypass bay 2. Keller said data at Chelan PUD projects indicate fallbacks pass the dams using the fishways or the surface collector of the juvenile fish bypass system when operational. He added that Chelan PUD contracts Dr. John Skalski to analyze available PIT-tag data to investigate fallbacks and Skalski has not identified anything alarming.

VII. HCP Administration

A. HCP Hatchery Committees Email Distribution – David Clark (Chad Jackson)

Chad Jackson said Brian Lyon (WDFW Eastbank Complex Manager) requested that David Clark (WDFW) be added to the HCP Hatchery Committees email distribution list because Clark will be the new Eastbank Complex Manager.

The HCP Coordinating Committees representatives present agreed to add Clark to the HCP Hatchery Committees email distribution list and provide Clark with access to the HCP Hatchery Committees extranet site, as requested.

Kristi Geris will notify Sarah Montgomery that the HCP Coordinating Committees agreed to add Clark to the HCP Hatchery Committees email distribution list and provide Clark with access to the HCP Hatchery Committees extranet site, as requested. *(Note: Geris notified Montgomery following the meeting on June 26, 2018.)*

B. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on July 24, 2018, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The August 28 and September 25, 2018 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VIII. List of Attachments

Attachment A	List of Attendees
Attachment B	The presentation, "Survival of adult spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) through the estuary and lower Columbia River amid a rapidly changing predator population"
Attachment C	The SOA, "Regarding the Selection of Study Fish for Douglas PUD's 2020 Wells Project Survival Verification Study for Yearling Spring Migrants in Phase III (Standard Achieved)," as revised
Attachment D	Douglas PUD Summary Memorandum of Radio Telemetry Studies (2004)
Attachment E	Chelan PUD Summary Memorandum of Radio Telemetry Studies (2005)

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Michelle Rub	National Oceanic and Atmospheric Administration Northwest Fisheries Science Center
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Scott Carlon*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

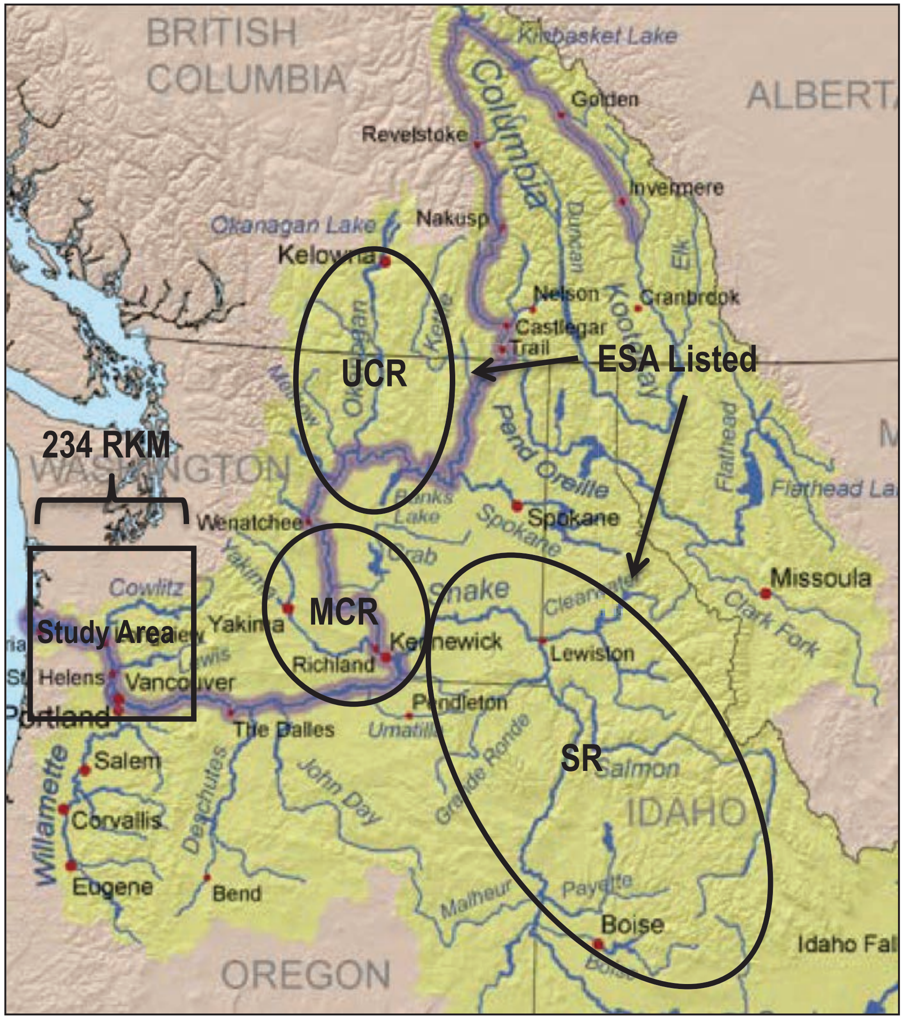
NOAA FISHERIES

Survival of adult spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) through the estuary and lower Columbia River amid a rapidly changing predator population

A. Michelle Wargo Rub, Ben Sandford, Don Van Doornik, David Teel, Matthew Nesbit, Samuel Rambo, Jesse Lamb, Louis Tullos, Kinsey Frick, April Cameron, Nicholas Som, Mark Henderson, and David Huff

NOAA Fisheries Northwest Fisheries Science Center (NWFSC)

The primary goal of this study is to provide estimates of survival and run timing through the estuary and lower CR for spring/summer Chinook salmon returning to the Middle & Upper Columbia & Snake Rivers



There is concern that pinnipeds entering the CR during spring is impacting adult salmon through predation


Photo credit: Washington Department of Fish and Wildlife

March 2015; 6k harbor seals (top) & 2k sea lions (bottom)

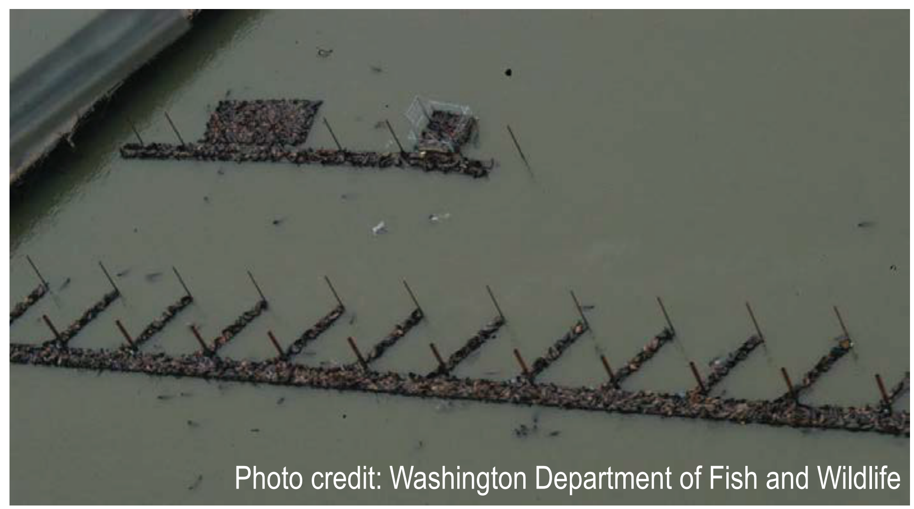
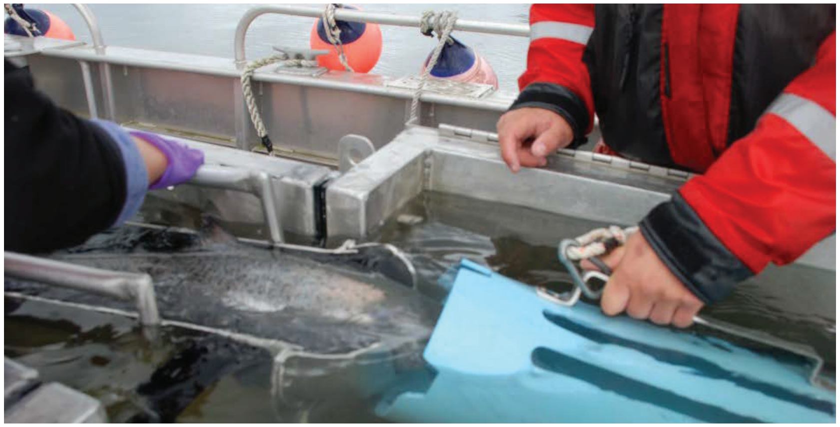


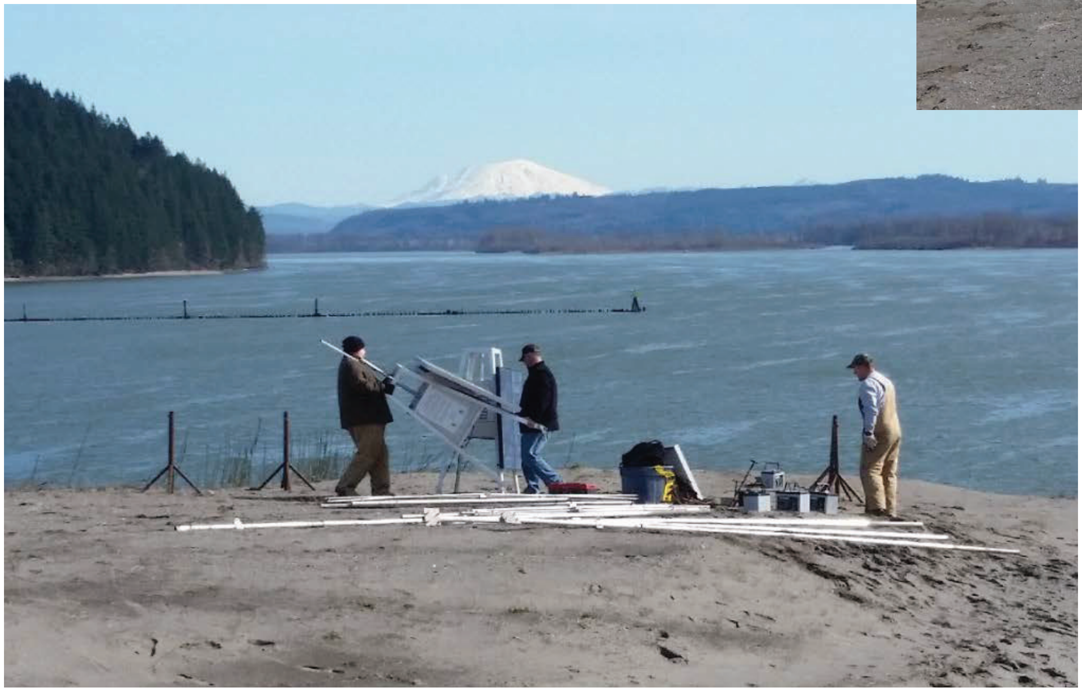
Photo credit: Washington Department of Fish and Wildlife

Commercial tangle–net crew hauling in a Chinook salmon

Fish are captured by CR commercial fishermen, tagged by NOAA Fisheries research biologists, and released. Greater than 2500 adult salmon have been PIT- tagged for this study since 2010.

NOAA & ODFW began tracking fish and pinnipeds using RT in 2016



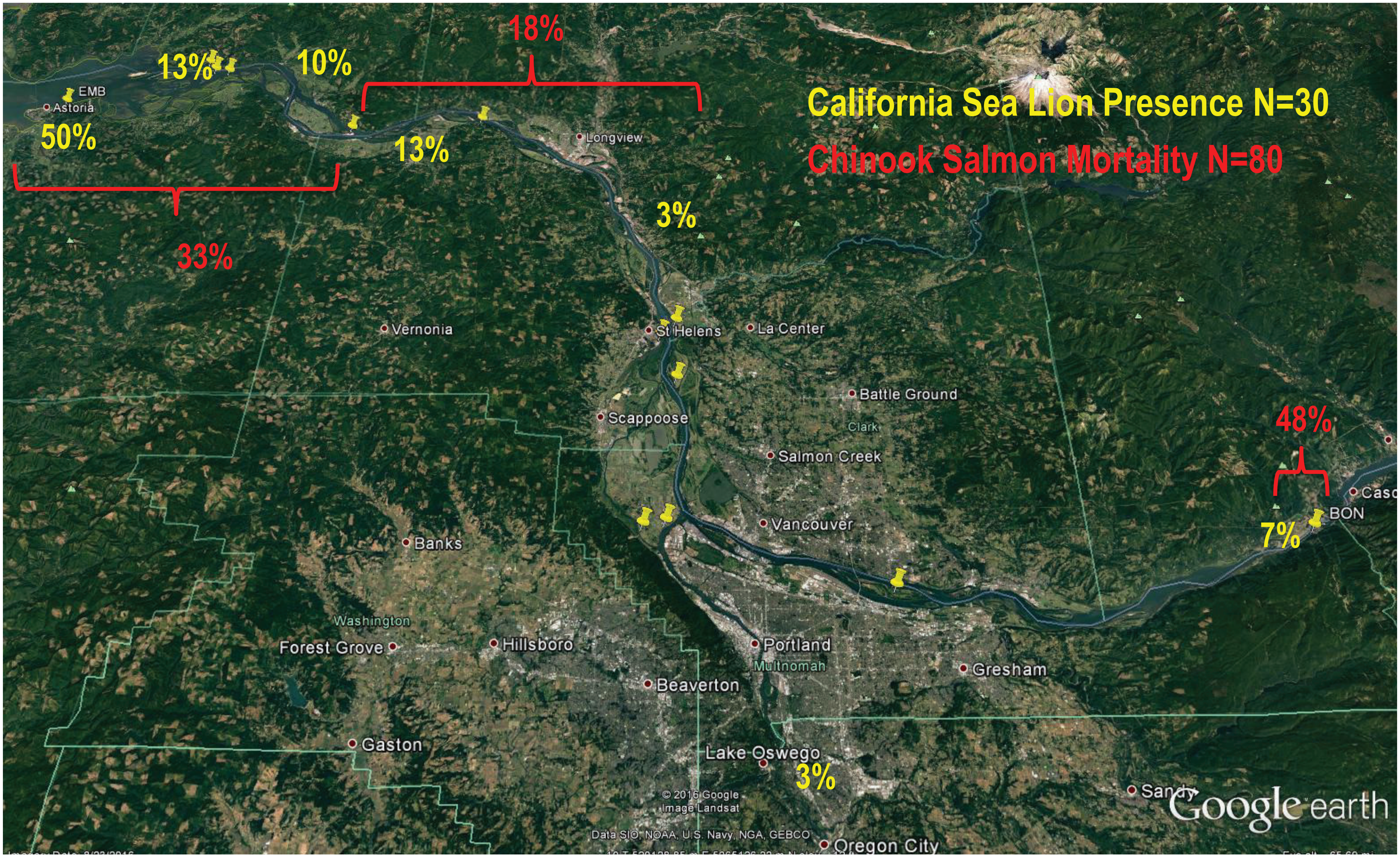


Weighted Mean Survival for Interior CR adults (FL ≥ 56 cm)

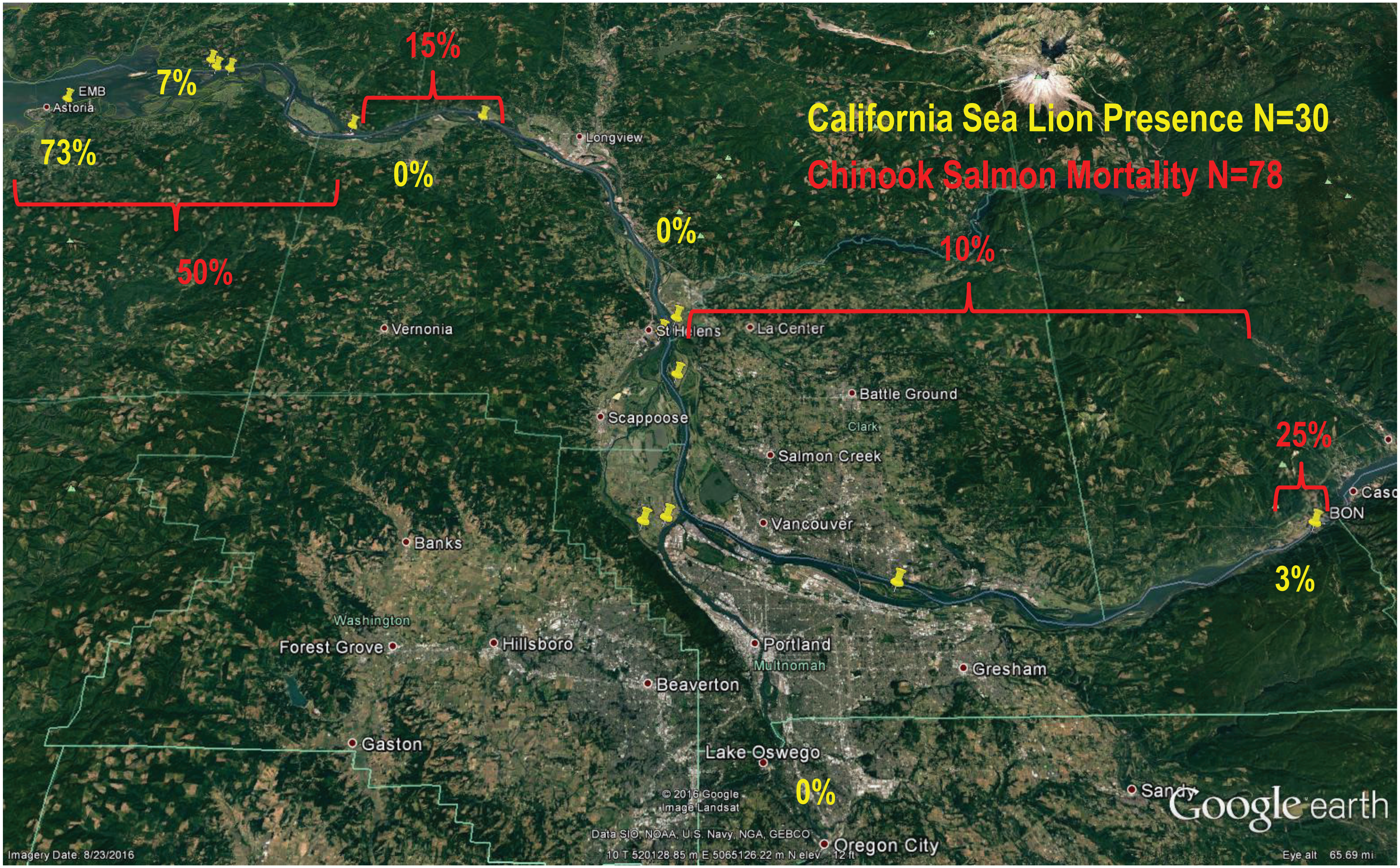
Year	Adult Chinook salmon (N)	Range of sampling dates	Baseline Survival (95% CI)	Baseline Mortality
2010	172	4/14-5/11	.74 (.68-.80)	0.26
2011	381	4/1-5/16	.73 (.69-.77)	0.27
2012	372	3/23-5/31	.69 (.64-.75)	0.31
2013	73	4/19-6/14	.60 (.47-.74)	0.40
2014	297	3/20-5/13	.46 (.38-.53)	0.54
2015	205	3/19-5/8	.52 (.42-.61)	0.48
2016*	70	3/28-5/23	.70 (.58-.82)	0.30
2017*	89	3/21-5/22	.62 (.50-.74)	0.38

*Preliminary estimates and assume 7% harvest

Radio Telemetry Results 2016



Radio Telemetry Results 2017



Linear Mixed Effects Modelling

Random effect:

- Week of tagging nested within year with autoregressive component

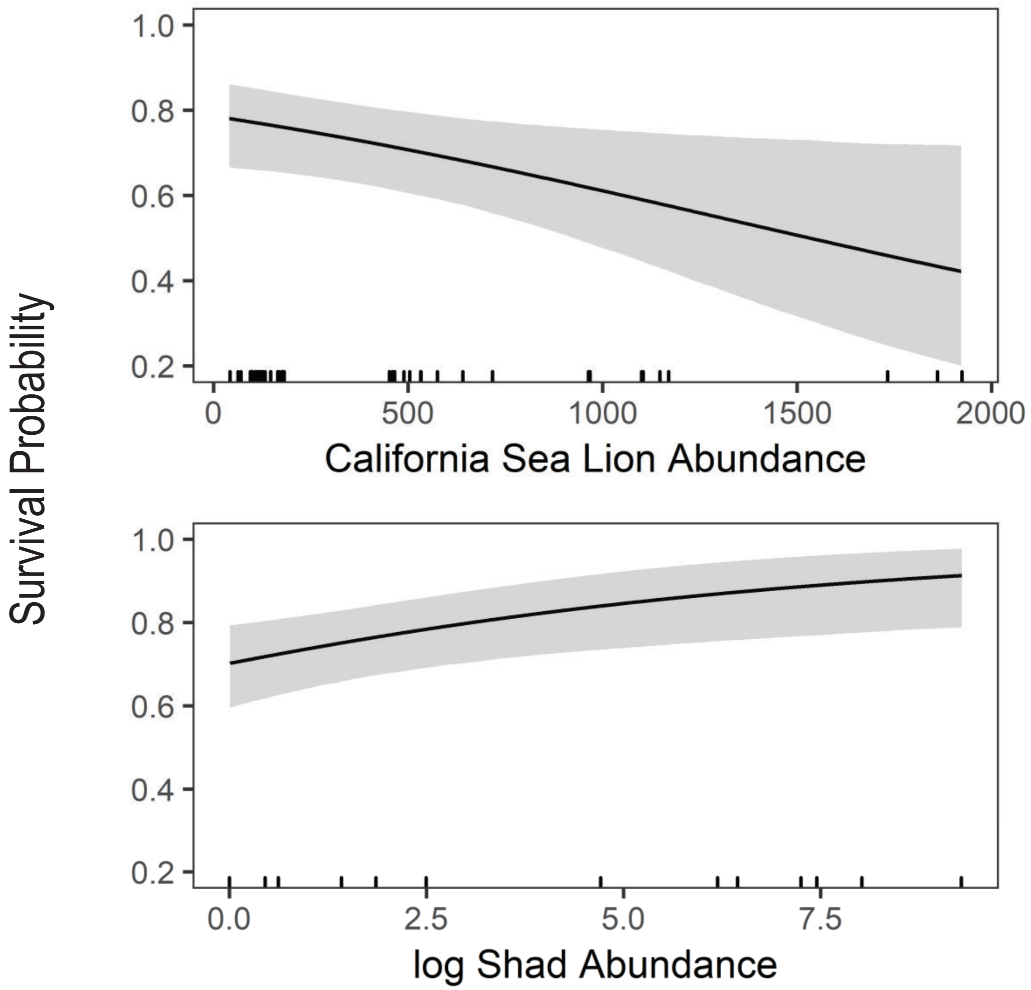
Fixed effects:

- Clip status
- Exposure to California Sea Lions based on EMB abundance during the week fish were tagged
- Abundance of Shad in the estuary during the week fish were tagged

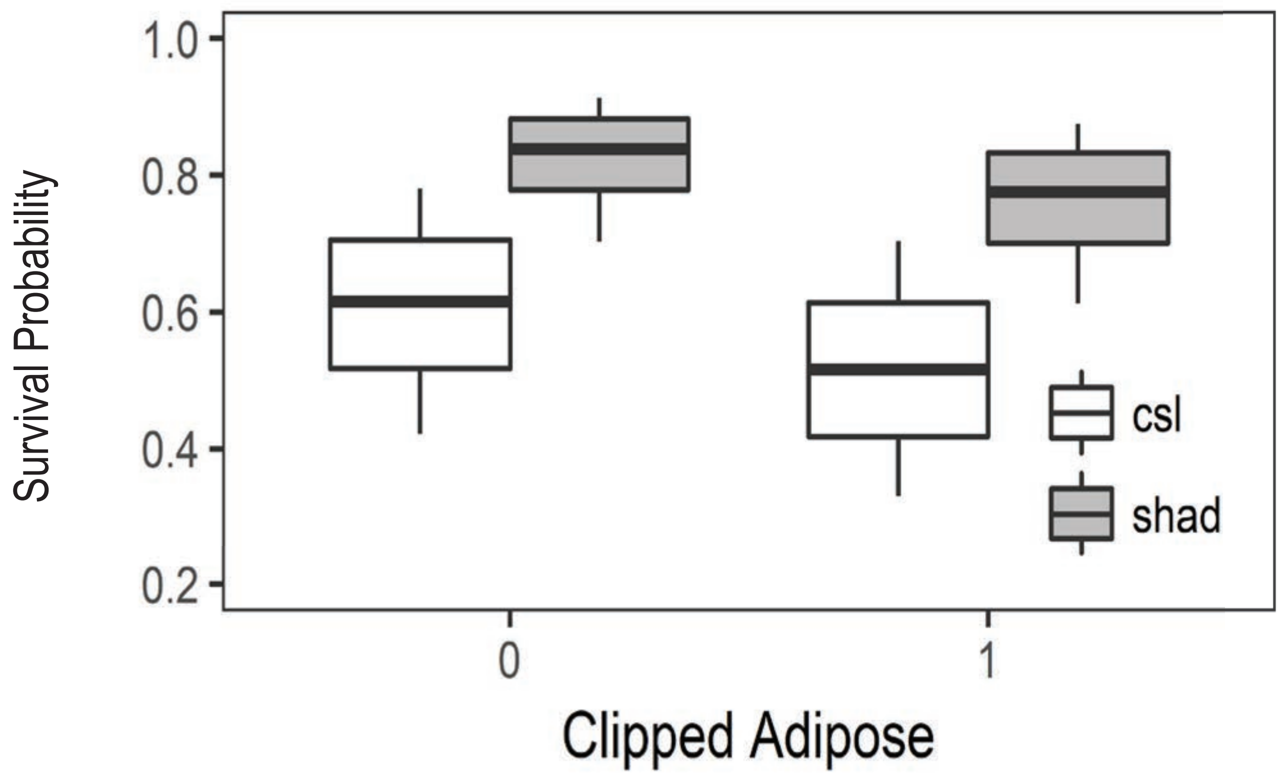
Note: Annual Eulachon abundance is highly correlated (=.83) with annual CSL abundance

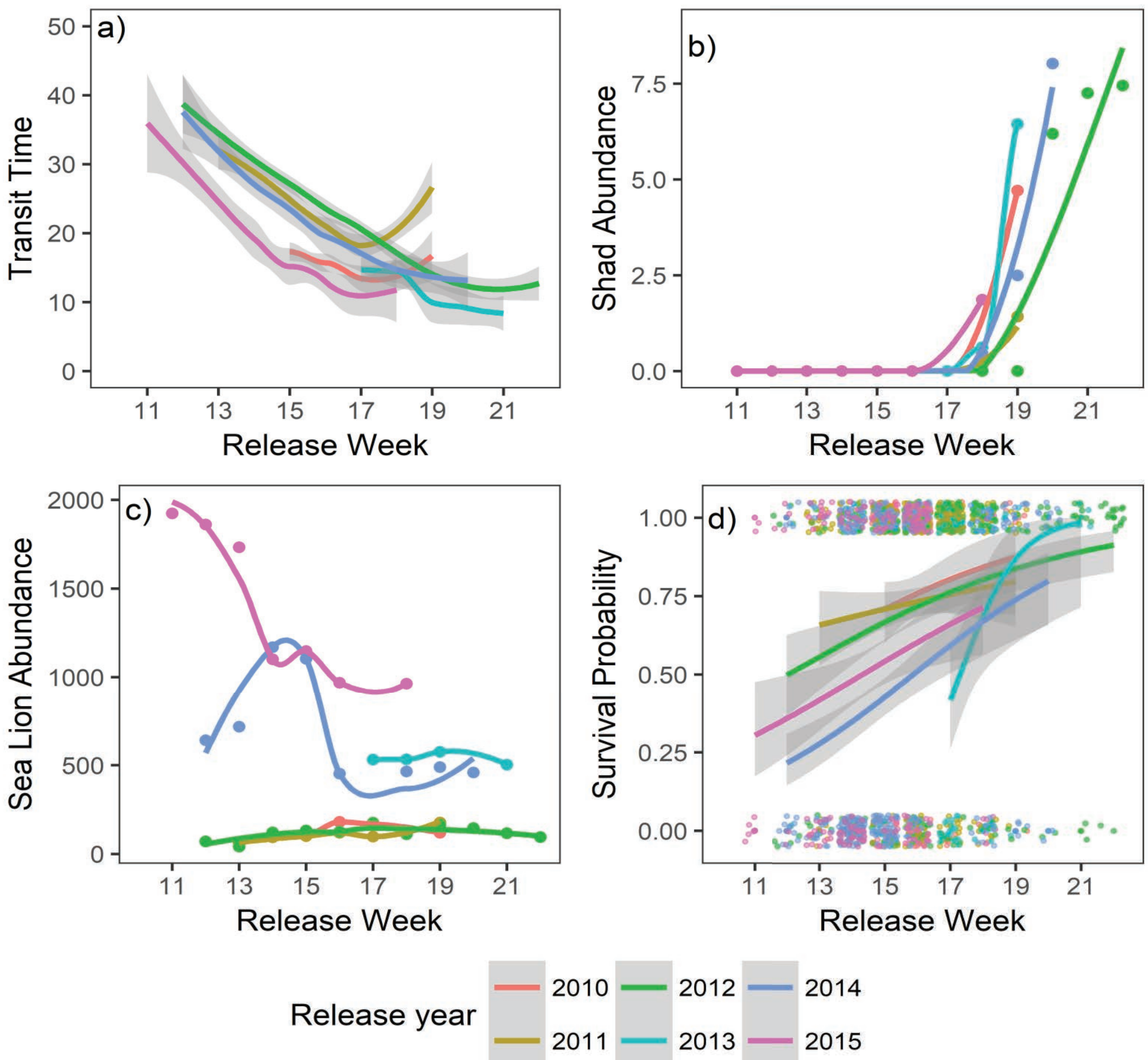
*The area under the ROC was .70 indicating the model is ‘good’ with respect to being able to predict survival

Model response curves:



Model response curves:




a)
Transit Time
Release Week
b)
Shad Abundance
Release Week
c)
Sea Lion Abundance
Release Week
d)
Survival Probability
Release Week
Release year
2010
2011
2012
2013
2014
2015

Upriver spring/summer Chinook salmon mortalities

Year	Mean	Std Dev	2.5%	50%	97.5%	Natural mortality
2010	**77.56**	21.72	43.36	74.71	127.43	**0.20**
2011	**59.48**	16.71	33.18	57.27	97.83	**0.22**
2012	**51.75**	14.39	29.08	49.86	84.80	**0.20**
2013	**35.21**	9.11	20.60	34.11	56.14	**0.22**
2014	**98.47**	26.05	57.30	95.16	158.53	**0.29**
2015	**224.45**	107.98	85.65	201.25	495.21	**0.44**

Table 5. Annual estimated number of fish lost to natural mortality from the Columbia River Estuary to Bonneville Dam. Credible intervals were estimated based on 100000 random draws from the model parameter posteriors. Natural mortality was the mean number of natural mortalities divided by the estimated total number of fish in the estuary in each year.

Parentage-Based Genetics Results for 2014-2017

HATCHERY	COUNT	BASIN	SURVIVAL	MEAN SURVIVAL	TT	MEAN TT	MEAN JUL_DATE OF ESTUARY ENTRY
Powell Satellite	13	SR	0.62		23		95
Winthrop	3	MC	0.00	**0.37**		22	99
Nez Perce	8	SR	0.50		21		99
Lyons Ferry	1	SR	0.00				100
Rapid River	105	SR	0.43		22		102
Umatilla	24	MC	0.50		32		102
Leavenworth	3	MC	1.00		37		102
Methow	4	MC	0.25		21		103
Clearwater	39	SR	0.54	**0.54**	25	27	103
Dworshak	87	SR	0.59		23		103
Little White salmon	8	MC	0.50		28		105
Carson	26	MC	0.54		31		105
Lookinglass	26	SR	0.54		17		108
Parkdale	1	MC	1.00		31		108
Powell	7	SR	0.43	**0.65**	20	25	110
Round Butte	11	MC	0.64		35		110
Klickitat	13	MC	0.62		21		111
Sawtooth	11	SR	0.55		21		120
Warm Springs	10	MC	0.80	**0.72**	17	19	122
Pahsimeroi	5	SR	0.80		19		125
McCall	9	SR	0.67	**0.67**	15	15	128
Wells	1	UC_summ	0.00				137

What have we learned?

- We have identified significant mortality that is unexplained by harvest and handling for upriver spring/summer Chinook salmon
- This mortality appeared to peak during 2015 at approximately 200k fish.
- Pinniped predation is likely the primary source of mortality but not all animals are equal with respect to the impact they are having on returning fish
- Additional covariates potentially influencing survival include the abundance of shad, and clip status, and the abundance of eulachon

Stay tuned…..

- Up close study of tailrace survival
- More population level survival and behavior as we summarize results using parentage-based genetics

Acknowledgements:

Susan Hinton, George McCabe, Paul Bentley, and Bob Emmett of NOAA Fisheries Pt. Adams Research Station, Jim Simonson and crew of NOAA Fisheries Pasco Research Station, Laurie Weitkamp of NOAA Fisheries NWFSC, Newport Research Station, David Kuligowski of NOAA Fisheries NWFSC, Manchester Research Station, John Hess, Doug Hatch & Ryan Brandstetter of CRITFC, Jason Romine and Mike Parsley of USGS, Chris Kern and Geoffrey Whisler, Matt Tennis, Bryan Wright, Robin Brown of ODFW, Steve Jeffries of WDFW, Matt Campbell of IDF&G, Brian, Frank, & Stephanie Tarabochia, and Dan Marvin of Astoria, OR, Sean Hayes of NOAA Fisheries SWFSC, Kane Cunningham & Colleen Reichmuth of the Institute of Marine Sciences, Long Marine Laboratory, UCSC, NOAA Near Term Priority (2010 & 2011) and NOAA Fisheries Cooperative Research (2012, 2013, & 2014), Albert Little, Wyatt Wullger, Ben Rudolph, & Cody May of Ocean Associates, Dave Caton & Lila Charlton of PSMFC

Wells HCP Coordinating Committee
FINAL
Statement of Agreement
Regarding the Selection of Study Fish for Douglas PUD's 2020 Wells Project Survival Verification Study for Yearling Spring Migrants in Phase III (Standard Achieved)

Approved June 26, 2018

The Wells HCP Coordinating Committee selects yearling summer Chinook salmon as the representative species for Douglas PUD's 2020 survival study to verify the continued achievement of Phase III (Standard Achieved) for yearling spring migrants (Chinook, steelhead, and coho salmon) migrating through the Wells Project. These study fish will be incubated and reared at Wells Fish Hatchery, with brood comprising summer Chinook salmon returns to Wells Fish Hatchery in 2018.

It is the intent of the Wells HCP Coordinating Committee to select yearling spring Chinook salmon as the study species for the 2030 survival verification study of yearling spring migrants. In the interim, Douglas PUD will work with NMFS to obtain permit coverage for performing a survival verification study with yearling spring Chinook salmon in 2030. In the event spring Chinook salmon are not available for the 2030 study, the Wells HCP Coordinating Committee will consider coho salmon for that study.

Background

Phase III of the Passage Survival Plan (Wells HCP Section 4.2.5.1) indicates that when the appropriate survival standard has been achieved, periodic monitoring is required to ensure that the survival of Plan Species is maintained and remains in compliance with the survival standards set forth in the plan for the term of the Agreement. Section 4.2.5 states that:

> *…the District shall re-evaluate performance under the applicable standards every 10 years. The Coordinating Committee shall pick representative species for all Plan Species. However, <u>only one species will be utilized to represent spring migrants</u> and one species for summer migrants. <u>This reevaluation will occur over one year</u> and be included in the pertinent average for that particular species. If the survival standard is met, then Phase III (Standards Achieved) status will remain in effect.*

To fulfill their HCP obligation for re-evaluating the juvenile fish-passage performance of the Wells Hydroelectric Project, Douglas PUD proposes to perform in 2020 their second survival verification study of yearling spring migrants. This statement of agreement fulfills the obligation of the Wells HCP Coordinating Committee to select a study species to represent yearling spring migrants currently designated as in Phase III (Standard Achieved) for the 2020 survival verification study.

Wells HCP Coordinating Committee
Fallback Rate and Fate Summary (1992-2002)
Summary of fallback rates and fates for radio-tagged fished monitored at Wells Dam

DEFINITIONS:
Defined categories of fallback:

Voluntary-Fallback: A radio-tagged fish is defined as a "voluntary" fallback when it has fallen back over Wells Dam and is later detected entering a downstream tributary, the Wells Hatchery or is collected for broodstock.

Reascend-Fallback: A radio-tagged fish is defined as a "reascend" fallback fish when it has fallen back over Wells Dam and has either been detected exiting the fish ladder or has been later observed upstream of Wells Dam.

Unknown-Fallback: 1992-1998. A radio-tagged fish is defined as an "unknown" fallback when it has fallen back over Wells Dam and was never observed again primarily resulting from limited monitoring efforts in downstream tributaries and hatcheries. Due to limited off-site monitoring during the 1992-1998 telemetry studies, unknown-fallback fish include fish that reascended the dam undetected, spawned in areas not monitored by the study or spawned in the mainstem sometime after monitoring was terminated for the year. This category also includes fish that died, regurgitated their tag or had a radio-tag malfunction prior to reascending the dam.

Involuntary-Fallback: 1999-2002. A radio-tagged fish is defined as an "involuntary" fallback when it has fallen back over Wells Dam and has not been detected spawning downstream, has not entered the Wells Hatchery or been collected for brood stock, has not reascended the dam or whose life history is not conducive to utilizing the mainstem Columbia River for spawning (ie. only summer/fall have been observed spawning in the tailraces of Columbia River dams). This category of fallback also contains fish, monitored during the 1999 – 2002 studies, that regurgitated their tag, died in deep water habitat, spawned in the mainstem or had radio-tag malfunctions prior to re-ascending the dam.

RESULTS:
1992 Sockeye (NMFS)

In 1992, the National Marine Fisheries Service (NMFS) conducted a radio-telemetry study to determine migration rates and timing of adult sockeye salmon (*Oncorhynchus nerka*) between Rocky Reach Dam and Wells Dam and to the spawning grounds in British Columbia, Canada. Particular emphasis was placed on quantifying travel times at Well Dam and migratory delays at the mouth of the Okanogan River. Fish were trapped and tagged at Rocky Reach Dam and tracking began on 9 July when the first tagged fish was released. This study did not include mobile or fixed station monitoring downstream of Wells Dam.

Species	No. fish In Study	No. fish passing Wells Dam	Voluntary	Involuntary	Reascend	Reascend 2x	Unknown
Sockeye	96	69	0	0	6	2	1 (1%)

Nine (13%) of the 69 fish that passed Wells Dam fell back once. Of the nine fish that fell back over the dam, eight fish successfully reascended the dam including two fish that fell back over the dam twice. One of the nine fish that fell back at Wells Dam moved downstream and outside of the monitoring area. This one fish was categorized as having an unknown fate. All of the sockeye salmon that fell back over Wells Dam in 1992 occurred during periods of forced spill. Spill occurred at Wells Dam during 1-27 July in 1992. The spill rate ranged from 66 to 114 kcfs.

1993 Spring, Summer, Fall Chinook (NMFS)

In 1993, the NMFS funded by the mid-Columbia PUDs (Grant, Chelan, and Douglas), conducted a radio-telemetry research study to document adult fish passage through the mid-Columbia river hydro-facilities. Studies were designed to determine migration rates, passage success, dam-passage behavior, fallback rates, and final destinations of adult spring, summer, and fall chinook salmonids (*Oncorhynchus tshawytscha*) in the main stem and tributaries of the mid-Columbia River. Adult chinook were trapped, tagged and released at John Day (RM 215.6), Priest Rapids (RM 397.1), and Rocky Reach Dam (RM 473.7). A total of 742 spring, 426 summer, and 279 fall chinook were radio-tagged and released during the study. Fixed monitoring stations were established at all of the mid-Columbia River dams (Wanapum, Priest Rapids, Rock Island, Rocky Reach, and Wells Dam) as well as all of the major Columbia River tributaries (John Day, Snake, Yakima, Wenatchee, Methow, and Okanogan river).

Species	No. fish in study	No. fish passing Wells Dam	Voluntary	Involuntary	Reascend	Unknown
Spring	742	56	2	0	0	0
Summer	426	98	4	0	6	4 (4%)
Fall	279	52	3	0	1	7 (13%)

At Wells Dam, two (4%) spring chinook fell back over the dam. Both fish were subsequently detected entering and ultimately spawning in the Entiat River. Both of these fish were categorized as voluntary fallbacks at Wells Dam. No involuntary, reascend or unknown spring chinook fallbacks were document during the 1993 study.

Fourteen summer chinook fell back over Wells Dam. Six of these fish reascended the dam and were last detected upstream of the project. Of the six fish that reascended the dam, three entered the Methow, two entered the Okanogan, and one was captured below Chief Joseph Dam. The eight remaining fallback fish were documented in known spawning locations downstream of the dam including the Wenatchee (1), Entiat (1), Wells Hatchery (2), and Wells tailrace (4). Four (4%) of the run was categorized as voluntary fallbacks (Wenatchee, Entiat and Wells Hatchery) and four (4%) were categorized as unknown fallbacks (Rocky Reach pool).

Eleven fall chinook fallbacks were observed at Wells Dam in 1993. One of the eleven fish reascended Wells Dam and was later observed entering the Okanogan River. Ten of the 11 fallbacks remained below the dam with all but one of the fish found in a known spawning location or was harvested. Six of the eleven fish or (12%) of the radio-tagged fish were documented as remaining in the Wells tailrace, three or (6%) of the tagged population entered the Wells Hatchery, and one or (2%) of the tagged fish was harvested downstream of Wells Dam.

1993 Spring, Summer, Fall Chinook Re-analysis (LGL Limited)

In response to concerns regarding substantial data monitoring gaps in Lotek receivers at Wells Dam during the 1993 Mid-Columbia Chinook Radio Telemetry Study, Douglas PUD retained LGL Limited to conduct an independent analysis of the 1993 chinook study and database. The receiver data were critically examined in detail to identify potential receiver configuration problems, periods where data were missing or when the receivers were not recording, background noise levels, and other factors that could influence the detection of tagged chinook and produce spurious records. In total, 68 mobile tracking records and 5434 fixed station receiver records were identified as spurious and excluded from the analysis. LGL's reanalysis identified substantial discrepancies in the original 1993 study. While detailed examination of these discrepancies using the available data have identified some deficiencies in the 1993 study, reasons for any of the discrepancies, without obtaining the original data showing last detection locations for each tagged fish (basis for numbers presented in the 1993 study), cannot be confidently assessed. Unfortunately, NMFS was unable to provide any additional information.

Since the 1993 report, a large spawning concentration of summer and fall chinook has been observed in the Wells tailrace. Between 440 and 990 redds were estimated to be present in the Wells tailrace in 1999. This discovery may explain the higher percentages of summer and fall chinook last detected in the Wells tailrace relative to spring chinook (Rensel 2000) and may explain the fate of summer and fall chinook fallbacks that are categorized as "unknown" in the table above.

1997 Sockeye and Summer Chinook (LGL Limited)

Radio-tagged adult sockeye and summer chinook were monitored in 1997 to assess passage at Wells Dam and to qualitatively estimate escapement to the spawning ground in the Upper Okanogan River. Of the 577 sockeye and 335 summer chinook that were radio-tagged at Bonneville Dam, 41% and 27% were tracked to Wells Dam, respectively.

Species	No. fish in study	No. fish passing Wells Dam	Voluntary Fallbacks	Involuntary Fallbacks	Reascend	Unknown
Sockeye	577	229	1	0	5	2 (1%)
Summer chinook	335	59	5	0	2	2 (3%)

Of the eight radio-tagged sockeye that fell back below Wells Dam, 5 reascended the project and were tracked to a known spawning area in the upper Okanogan River, two (unknown) fish were last detected in the Rocky Reach reservoir, and one (voluntary) fish was last located below Rocky Reach Dam. Five of the fallback events occurred between 13 and 26 July when the total flow at Wells Dam ranged between 180 and 236 kcfs and spilling ranged between 10 and 57 kcfs

Nine summer chinook fell back over Wells Dam in 1997. Two of the nine fish reascended the dam and were later tracked to spawning destinations upstream of the dam. Of the remaining seven fish, two (3%) were last located in the tailrace of Wells Dam and were categorized as having an unknown fate. Voluntary fallbacks included three (5%) fish tracked to the Wells Hatchery, one fish tracked below Rocky Reach Dam (2%), and one fish tracked to the Wenatchee River (2%).

Four of the summer chinook fallback events occurred between 20 July and 2 August when total flow (135 to 182 kcfs) and spill (9 to 13 kcfs) were high. Of the 9 fallbacks, only one was detected during a non-spilling event (1 September) at Wells Dam. However, it is possible that this fish may have fallen back during a spill period due to a 26 day difference between the last date of detection above the dam and the first date of detection below the dam.

1998 Summer Chinook (LGL Limited)

In 1998, Douglas PUD retained LGL Limited to determine the effect of fishway entrance gate configuration on the time it takes adult summer chinook to pass the project; and secondarily, to assess if broodstock trapping operations in the fishway cause a significant increase in passage time through the project. As part of a separate adult passage study being conducted by the Army Corps of engineers, 279 summer chinook were radio-tagged at Bonneville dam. Based on previous data, an estimated 27% (75) of the summer chinook radio-tagged at Bonneville Dam would reach Wells Dam. The total number of radio-tagged summer chinook detected at Wells Dam was 81.

Species	No. fish in study	No. fish passing Wells Dam	Voluntary Fallbacks	Involuntary Fallbacks	Reascend	Unknown
Summer chinook	279	46	0	0	0	8

At Wells Dam, eight (17%) summer chinook fallbacks were observed. Because this study was limited to monitoring at the dam, and was completed by the end of August, no conclusive assignment to either the voluntary, involuntary or reascend categories could be made. Due to the short duration of this study and the uncertain final fate for all eight fish, all eight fish were assigned to the unknown fallback category.

All fallbacks occurred during spill periods, 7 from 28 July to 15 August when spillway flows ranged from 8-19 kcfs and 1 fish fell back during a brief spill period on 21 August.

1999 Steelhead (LGL Limited)

Radio-telemetry technology was used to assess the upstream and downstream migration of adult steelhead past five dams on the mid-Columbia River and to spawning locations. Tags were placed in 395 steelhead captured at Priest Rapids Dam and released downstream of the project. Detections of tagged adult steelhead at fixed stations monitoring mainstem Columbia River locations from the Hanford Reach to Wells Dam and all major mid-Columbia tributaries were used to estimate passage times and fallback rates. Mobile tracking consisted of periodic boat and aerial surveys throughout the study area during the study period.

Species	No. fish in study	No. fish passing Wells Dam	Voluntary Fallbacks	Involuntary Fallbacks	Reascend	Unknown
Steelhead	395	162	6	1 (1%)	4	n/a

Fish in this study were categorized as voluntary fallback, involuntary fallback, or reascend. Voluntary fallbacks were defined as steelhead that were last tracked to tributaries or reaches below, but not adjacent to the fallback dam. Involuntary fallbacks were defined as steelhead that were last tracked to reaches immediately below the fallback dam. Reascended steelhead were defined as steelhead last tracked to locations above the fallback dam. Because of the comprehensive nature of this study the final fate of virtually every fish was determined. This resulted in no fish being assigned to the unknown fallback category.

At Wells Dam, a total of 11 (7%) fallbacks were observed. Six of the 11 steelhead were categorized as voluntary fallbacks as two of these fish were last detected in the Entiat

River and two last detected below Tumwater Dam on the Wenatchee River. The two remaining voluntary fallbacks were last detected in the Wanupum (1) and Rock Island (1) pools. One (1%) involuntary fallback was last detected in the Rocky Reach pool. All four of the steelhead that fellback and reascended the dam were later detected entering either the Methow River (2) or the Okanogan River (2). Three of the 11 fallbacks events, during this study, were observed during forced spill events that took place in July and August.

2001 Steelhead (LGL Limited)

The success of the 1999 steelhead study, along with some outstanding questions regarding post-spawning behavior and year-to-year variation in migratory success, led to an agreement to repeat the study in 2001-2002. A total of 396 steelhead were captured and tagged at Priest Rapids Dam between July and October, 2001. Tracking methodology and criteria to determine type of fallback was similar to that in the 1999 steelhead study.

Species	No. fish in study	No. fish passing Wells Dam	Voluntary Fallbacks	Involuntary Fallbacks	Reascend	Unknown
Steelhead	396	252	17	3 (1%)	10	n/a

At Wells Dam, 30 (12%) fallbacks were observed. Seventeen of these fallbacks were voluntary with steelhead detected entering the Wells Hatchery (9), the Snake River (1), below Tumwater Dam on the Wenatchee River (3), entering the Entiat River (2), in the Priest Rapids pool (1), and in the Wanapum pool (1). Ten of the 17 fallback steelhead reascended Wells Dam and eight of these fish were detected entering the Methow, one was detected entering the Okanogan, and one steelhead was last detected in the Chief Joseph Dam tailrace. Three (1%) involuntary fallbacks were observed and all three were last detected in the Rocky Reach pool. Eight of the 30 fallback events, observed during this study, were associated with spill events that took place between the months of July and August.

BETWEEN-YEAR COMPARISON OF RESULTS BY SPECIES:

A total of six radio-telemetry studies were implemented at the Wells Hydroelectric Project between 1992 and 2002 to characterize a suite of questions regarding fish passage, migration rates, dam-passage behavior, and escapement of adult fish in the mainstem and tributaries of the mid-Columbia River. It is important to note that fallback rates and the specific fates of these fish were often not the main objective of these studies. In some cases, prior to 1997 in particular, information collected were insufficient to assign particular fates to fish that fell back through Wells Dam leaving it uncertain as to whether these fish were to be identified as voluntary or involuntary fallbacks. In several other cases, the numbers of tagged fish in the study that reached and passed Wells Dam were too small to make meaningful conclusions about fallback rates and final fate assignments. A minimum of two studies were done for each species with the notable exception of spring chinook that were only studies with sufficient sample size in 1993.

A by-species summary of all of the studies has been prepared to provide a between-year comparison in results, any information available that could be used to clarify the results (project operations, etc.), and recommendations regarding which study should be used to more accurately represent fallback rates at Wells Dam are presented below.

Sockeye

Sockeye salmon characteristically pass Wells Dam during periods of spill (July and August) and are destine primarily for the upper Okanogan River. Sockeye also return to the Wenatchee River and small numbers have been found in the Methow River. It is difficult to categorize fish that did not reascend Wells Dam as fallback fish when there is the possibility that these fish are overshoots from the Wenatchee and may be destined for tributaries below the project. In the 1992 study, the ultimate fates of these fish could not be assigned given the limited scope and parameters coved in the study design. This should be considered when comparing the 1992 and 1997 sockeye fallback rates.

The 1992 NMFS study observed a total of 69 unique passage events and 9 fallback events with 8 of these fish reascending the ladder and one fish disappearing downstream. Given this information, the sockeye fallback rate for the 1992 study is 13% (9/69). However, the biological effect of fallback was negligible as all but one of the fallbacks successfully reascended the project. Unfortunately, the fate of the one fish (1/69 = 1%), that did not reascend Wells Dam, is unknown as the last detected was in the Rocky Reach pool. However, because the study was not designed to monitor fish downstream of Wells Dam, the downstream fate of this fish could not be determined. It is likely that this fish was an overshoot from the Wenatchee basin. All fallback events occurred during periods of spill ranging from 66-114 kcfs at Wells Dam.

The 1997 LGL study observed a total of 229 sockeye passing Wells Dam. Even though the study was conducted during an extremely high spill year, a total of eight sockeye fell back over the project, for an average of 3% (8/229) for the run over Wells Dam. Five of the eight fish reascended the dam and entered the Okanogan River. Two of the remaining fallback fish were last detected in the Rocky Reach reservoir (2/229 = 1%) with the remaining fish located downstream of Rocky Reach Dam assigned to the voluntary fallback category. Specific fates for two of these three fish could not be assigned and as such were classified as unknown. The fallback rate for the tagged sockeye population migrating over Wells Dam in 1997 was 3.5% (8/229). However, all but two of the eight fish were assigned to either the voluntary or reascend categories leaving two fish or (1%) of the run to be assigned to the unknown category.

Spring Chinook

One spring chinook radio-telemetry study has been implemented at Wells Dam. Spring chinook that pass Wells Dam are headed for the Methow River, however, the Wenatchee and Entiat River systems also have adult fish returning of this run-type.

The 1993 NMFS study tagged a total of 742 spring chinook with 56 of these fish passing over Wells Dam. Two fallback events were observed with both fish subsequently being detected entered the Entiat River. Fallback rates for spring chinook based upon the NMFS 1993 chinook telemetry study are 3.6% (2/56). The biological significances of fallback for spring chinook appears to be negligible as both fish voluntary fell back over the dam, successfully survived the fallback event and successfully entered the Entiat River.

Summer/Fall Chinook

Three studies have been conducted to examine fish passage issues at Wells Dam with summer/fall chinook salmon. Summer/fall chinook that pass Wells Dam are headed for either the Methow or Okanogan Rivers. However, the Wenatchee, Entiat River and Chelan river systems also have runs of summer/fall chinook. Summer/fall chinook are collected as broodstock at the Wells Hatchery just below Wells Dam, are collected for broodstock in the east ladder and spawn in the tailrace of the dam. In addition, in recent years a large recreational fishery has also existed for this run-type.

The 1993 NMFS study tagged 426 summer chinook with 98 of these tagged fish passing over Wells Dam. In total, 14 summer chinook fallbacks were observed at Wells Dam. Six of these fish reascended the ladder, four other fish were last detected in know spawning locations downstream of the project: Wenatchee (1), Entiat (1), and Wells Hatchery (2) with the four remaining fish last detected in the tailrace where they could have spawned, been a fallback mortality or experienced a tag failure/regurgitation event. Fallback rates for the 1993 summer chinook study were 14% (14/98).

The 1993 NMFS study tagged a total of 279 fall chinook and 52 of these fish passed Wells Dam. Eleven fallbacks were observed with only one fish reascending the ladder. The other ten fallback fish remained in the tailrace (6), entered the Wells Hatchery (3), or were harvested downstream of the project (1). Fallback rates at Wells Dam for fall chinook during the 1993 fall chinook study were 21.2% (11/51).

The 1997 LGL study tagged 335 summer chinook and 59 of these fish passed Wells Dam. Nine summer chinook fallbacks were detected at Wells Dam. Two of these fallback fish reascended the ladder and were tracked to upstream spawning destinations. The remaining seven fish were last detected at the Wells Hatchery trap (3), below Rocky Reach Dam (1), entering the Wenatchee River (1), and in the Wells tailrace (2). All but one fallback event occurred during spill events at Wells Dam. The fallback rate for the 1997 summer chinook study was 15.3% (9/59).

The 1998 LGL study tagged 279 fish and 46 of these fish passed Wells Dam. Eight summer chinook fallbacks were observed at Wells Dam and all were last detected in the tailrace. Fallback rate for the 1998 summer chinook study was 17.4% (8/46). However, it is important to note that during the 1998 summer chinook study the objective of the study was to determine the effect of fishway entrance gate configuration on passage time. As a result, the study ended in August 1998 and did not allow for sufficient monitoring to determine the fates off fallback fish.

Steelhead

Two studies were conducted to examine fish passage issues at Wells Dam for steelhead salmon. Steelhead that pass Wells Dam are destined for the Methow and Okanogan rivers. Other mid-Columbia River tributaries that have runs of steelhead are the Wenatchee and Entiat rivers.

The 1999 LGL Limited study tagged 395 steelhead at Priest Rapids Dam with 162 fish passing Wells Dam. A total of 11 fallbacks were observed with six fallbacks classified as voluntary (fish tracked to downstream tributaries or reservoirs below Rocky Reach Dam). Four steelhead reascended the ladder and were tracked to tributaries above Wells Dam. Only one tagged steelhead could not be assigned a fate outside of the Wells tailrace. The fallback rate for the 1999-2000 steelhead study was 6.8% (11/162).

The 2001 LGL Limited study tagged 396 steelhead at Priest Rapids Dam with 252 fish passing Wells Dam. A total of 30 fallbacks were observed with 17 fallbacks classified as voluntary (fish tracked to downstream tributaries or reservoirs below Rocky Reach Dam). Ten steelhead fallbacks reascended the ladder and remained upstream of the project. Three tagged steelhead could not be assigned a fate outside of the immediate Wells tailrace. The fallback rate for the 2001-2002 steelhead study was 11.9% (30/252).

DISCUSSION

Sockeye:
It is recommended that the 1997 LGL study be used as the primary assessment tool for adult sockeye fallback at Wells Dam. Total fallback at Wells Dam was estimated to be 3.5% with an unknown assignment rate of 1% of the entire tagged population over the dam. This level of fallback and missing fish does not pose a biologically significant impact on adult sockeye passing Wells Dam. Further, the maximum impact estimate based upon the 1997 study (1%) is less than half that allowed under the terms of the Wells HCP.

Spring Chinook:
It is recommended that the 1993 NMFS study be used as the primary assessment tool for spring chinook fallback at Wells Dam. Total fallback at the dam was estimated to be 3.6% with an unknown assignment of 0% of the tagged run over the dam. This level of fallback and missing fish does not pose an impact on the Upper Columbia River spring

chinook ESU, because both of the fish that fell back were destined for the Entiat River the biological significance of fallback at Wells Dam is estimated to be negligible.

Summer/Fall Chinook:
For the three studies, total fallback for the summer chinook component of the summer/fall chinook run at Wells dam was estimated to range from 14% to 17.4%. For the two studies that determine the fate of fallbacks, the unknown assignment rate for summer chinook fallbacks ranged from 3% to 4%. Due to the close proximity and association of the Wells and Turtle Rock hatcheries and the close association with the Wells tailrace and Chelan Falls chinook spawning populations, the biological significance of the 3-4% of the summer chinook that disappeared after falling back over Wells Dam could not be directly ascertained. However, the observed level of unknown fallbacks is, not surprisingly, higher for this population compared to sockeye, steelhead and spring chinook.

Fallback for the fall component of the summer/fall chinook run was only assessed during the 1993 NMFS study and was estimated to be 21.2% with an unknown assignment of 11.5% of the tagged run over the dam. Although fallback for summer/fall chinook is relatively high compared to other species studied at Wells Dam, the biological significance of these rates are difficult to quantify given the fact that this run-type has been observed spawning in large numbers below Wells Dam, in the tailrace and at Chelan Falls. In fact, for all three of the summer/fall chinook studies, fish categorized into "unknown assignment" consisted entirely of fish last detected in the Wells Dam tailrace and as such, the possibility that these fish are tailrace spawners, should be considered when viewing these results.

It is recommended that the 1993 NMFS and the 1997 LGL study be used as the primary assessment tool for summer chinook fallback (14% to 15.3%) and that the 1993 NMFS study be used as the primary assessment tool for fall chinook fallback (21.2%) noting that the unknown assignment was high and that the biological significance of these assignments is difficult to quantify given the life-history and proximity of hatcheries to the area of interest.

Steelhead:
It is recommended that both the 1999 LGL study and the 2001 LGL study be used as the primary assessment tool for steelhead fallback at Wells Dam. Total fallback at the dam was estimated to range from 6.8% to 11.9% with an involuntary fallback assignment ranging from 0.6% to 1.2% of the tagged run over the dam. This level of fallback and missing fish does not pose an impact on the Upper Columbia River ESU. Many of the radio-tagged steelhead that fellback at the dam were of hatchery origin, destined for tributaries downstream of Wells Dam or were successful at reascending the ladder and were later tracked to tributaries upstream of the project. The biological significance of fallback over the entire steelhead run at Wells Dam is estimated to be negligible and averages less than half the level allowed under the terms of the Wells HCP.

Summary of Adult Salmonid Fallback from Telemetry Studies at Rocky Reach and Rock Island dams (1993-2002)

Executive Summary

Adult fish passage at Rocky Reach and Rock Island dams has been evaluated in five radio telemetry investigations. The studies occurred during the 1993, 1997, 1999, 2001 and 2002 upstream spawning migrations. The migrational behavior of spring, summer and fall chinook, sockeye and steelhead have been evaluated in the studies, including fallback and the fate of fallback fish. The early radio-telemetry studies on the mid-Columbia examined the upstream migration of sockeye (Wells Dam study) in 1992 and chinook in 1993 (five mid-Columbia dams). English et al. 2003 reported that a substantial portion of the radio-tagged chinook and sockeye released at Bonneville Dam between 1996 and 1998 migrated to the mid-Columbia, and these fish have formed the basis for adult passage studies for each of the mid-Columbia dams. They also reported that adult steelhead tagged at Bonneville Dam did not provide much information for mid-Columbia dams, because less than 3% of these fish migrated through the mid-Columbia. The first major radio-telemetry study of adult steelhead migration through the mid-Columbia was conducted from 1999 through 2000, and the study was repeated from 2001 through 2002. The observations of fallback and fate of fallback fish are discussed for each study.

Results from Fallback Evaluations

1993 Adult Migration (Table 1): At Rock Island Dam, all five spring chinook salmon fallbacks survived to enter spawning tributaries. Five of the seven summer chinook salmon fallbacks were last detected in the tailrace near the dam. The remaining two fish entered either the Wenatchee River or Wells Hatchery. Of the five fallbacks last detected below the dam, four were detected above the Wenatchee River confluence before returning to below Rock Island Dam. The fall chinook salmon fallbacks were last recorded in the Rock Island Dam tailrace or in the Crescent Bar area (Stuehrenberg et al. 1995).

At Rocky Reach Dam (Table 1), no spring chinook salmon and five summer chinook salmon were fallbacks at Rocky Reach Dam. Four of the five summer chinook salmon fallbacks were apparent overshoots from the Wenatchee River, and the fifth was last detected just upstream from Rock Island Dam. Twenty-two fall chinook salmon fallbacks were observed. Thirteen of these remained in the tailrace, three continued downstream to the Rock Island Dam tailrace, four were last recorded in the Rock Island Dam reservoir, one was harvested from the Rock Island Dam reservoir, and one passed a second time and was last detected in the Wells Dam tailrace (Stuehrenberg et al. 1995).

Stuehrenberg et al. 1995 concluded that with the exception of fish passing Wanapum Dam, at least 10% fall chinook salmon fallbacks were observed at all mid-Columbia River dams. As with spring chinook salmon at Priest Rapids and Wanapum dams, the majority of fall chinook salmon fallbacks were last detected downstream, indicating that some fallbacks may have overshot the dams.

1997 Adult Migration (Table 2): Of the 346 radio-tagged sockeye detected at the exit zones of the Rock Island Dam fishways, 12 fell back below the dam, and one sockeye dropped back down a fishway. Ten of the fallback sockeye and the single dropback sockeye successfully re-ascended a fishway and remained above Rock Island Dam. All of the fallbacks occurred between 14 July and 10 August when spillway flows exceeded 30 kcfs. Of the 234 radio-tagged sockeye detected at the exit zones of Rocky Reach fishway, 33 fell back and were detected below Rocky Reach Dam. There were no sockeye that dropped back down a fishway after being detected at the top of a fishway. Thirty-one of the fallback sockeye successfully re-ascended the fishway and were detected at Wells Dam; the other two fish were last tracked in the Wenatchee River. Most of the fallbacks occurred between 12 July and 1 August when spillway flows exceeded 15 kcfs (English et al. 1998).

Of the 140 radio-tagged summer chinook detected at the exit zones of the Rock Island fishways, 3 fell back and were detected below the dam (Table 2). All of these fish successfully re-ascended one of the fishways and remained above Rock Island Dam. These fallbacks occurred between 17 July and 10 August when spillway flows exceeded 30 kcfs. Of the 90 radio-tagged summer chinook detected at the upstream end of the Rocky Reach fishway, 2 fell back below the dam. Both of these fish re-ascended the fishway and remained above Rocky Reach Dam. These fallbacks occurred on 27 July and 28 July when spillway flows were less than 20 kcfs (English et al. 1998).

Two steelhead fallbacks were detected, one at Rock Island Dam in mid-October and one at Rocky Reach Dam in early November (Table 2). Both fallbacks were detected at respective tailrace zones during no-spill periods, but the fallback event may have actually occurred during an earlier spill period. No fallbacks of spring chinook were detected at either dam (English et al. 1998).

English et al. 1998 concluded that the low fallback rates for summer chinook observed in 1997 at Rocky Reach and Rock Island dams were lower but comparable to the values estimated for the 1993 study.

1999-2000 Steelhead Study (Table 3): Of the 298 radio-tagged steelhead detected at the exits zones of the Rock Island Dam fishways, 22 fell back below the dam. Hatchery fish were 86% of the fallback fish which was similar to that observed at Priest Rapids and Wanapum dams. Of the 22 fish that fell back, 9 were classified as “voluntary” fallbacks, 8 re-ascended a fishway, and 5 were classified as “involuntary” fallbacks. These involuntary fallbacks represent 1.7% of the radio-tagged steelhead that passed Rock Island Dam (English et al. 2001).

Of the 205 radio-tagged steelhead detected at the exit zones of the Rocky Reach fishway, 21 fell back below the dam (Table 3). Hatchery fish were 95% of the fallback fish which was higher than that observed at Priest Rapids, Wanapum and Rock Island dams (86-87%). Of the 21 fish that fell back, 14 were classified as “voluntary” fallbacks, 5 re-ascended a fishway, and 2 were classified as “involuntary” fallbacks. These involuntary fallbacks represent 1.0% of the radio-tagged steelhead that passed Rocky Reach Dam (English et al. 2001).

Fish that fell back and were last tracked below the dam where the fallback occurred were classified as “involuntary” fallbacks. The 25 involuntary fallbacks detected for all Mid-Columbia dams combined represented 2% of the unique dam passage events and all of these were hatchery fish. On average 5% of the unique fish passage events were classified as “voluntary” fallbacks (range 3-7% for the different dams) and 3% were classified as reascents (range 1-6%). An examination of the fates for all fallbacks revealed that 62% of the radio-tagged steelhead that fell back at a dam were either tracked to known spawning areas or successfully passed and remained above the fallback dam (57% for hatchery fish and 100% for “wild” fish; English et al. 2001).

2001-2002 Steelhead Study (Table 4): Of the 326 radio-tagged steelhead that passed through the Rock Island fishways, 16 fell back below the dam. Hatchery fish were 69% of the fallback fish at Rock Island, which was lower to that observed at Priest Rapids and Wanapum dams. Of the 16 fish that fell back, 7 were classified as “voluntary” fallbacks, 4 re-ascended a fishway and 5 were classified as “involuntary” fallbacks. These involuntary fallbacks represent 1.5% of the radio-tagged steelhead that passed Rock Island Dam.

Of the 276 radio-tagged steelhead detected at the exits zones of the Rocky Reach fishway, 18 fell back below the dam (Table 4). Hatchery fish comprised 78% of the fallbacks at Rocky Reach, but 88% of the fish detected at Rocky Reach were hatchery fish. Of the 18 fish that fell back, 10 were classified as “voluntary” fallbacks, 3 re-ascended a fishway and 5 were classified as “involuntary” fallbacks. These involuntary fallbacks represent 1.8% of the radio-tagged steelhead that passed Rocky Reach Dam.

The 27 involuntary fallbacks detected for all Mid-Columbia dams combined represented 1.8% of the unique dam passage events, and most of these, (21 or 78%) were hatchery fish. On average, 2.9% of the unique fish passage events were classified as “voluntary” fallbacks (range 2.1-3.6% for the different dams) and 3.1% were classified as “re-ascents” (range 1.1-5.9%) An examination of the fates for all fallbacks revealed that 68% of the radio-tagged steelhead that fell back at a dam were either tracked to known spawning areas or successfully passed and remained above the fallback dam (71% for hatchery fish and 61% for "wild" fish; English et al. 2003).

English et al. 2004 concluded that of the studies which LGL Limited has conducted on summer-run steelhead in British Columbia rivers and the Columbia River, the Mid-Columbia River steelhead studies (1999-2000 and 2001-2002) had the highest proportion of tagged fish that resumed their upstream migration after release and remained upstream until the spawning period (80-87%). They also concluded that the travel times and migration rates for Mid-Columbia summer-run steelhead were significantly faster than those of summer-run steelhead on the Nass and Skeena rivers, thus indicating that the challenges presented by the dams and reservoirs on the Mid-Columbia are no more severe than those faced by adult steelhead during their upstream migrations in some naturally-flowing rivers.

2002 Adult Steelhead Study at Rocky Reach (Table 5): Of the 56 unique tagged steelhead that passed the dam, 2 (3.6%) fell back below the dam. The two fallback events occurred on 22 August (before juvenile fish bypass construction) and 2 November (after construction) when total dam flow was normal and no spillway flow was occurring. The radio-tagged steelhead that fell back on 22 August re-ascended the dam at a later date. The final fate of these two fallbacks cannot be determined, since the study ended before the spawning period (Alexander et al. 2003). They concluded that the construction activities associated with the juvenile bypass production system did not affect passage times of adult steelhead in 2002.

All adult salmonid telemetry studies combined: Table 6 presents the sample sizes, fallbacks and percent fallback for all five telemetry studies combined. Data are presented for each species.

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FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: September 25, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the August 28, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, August 28, 2018, from 10:00 to 11:15 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).
- Tom Kahler will establish a system to remind the Wells HCP Coordinating Committee to routinely revisit using spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study to ensure this is written into the next Section 10 permits for the Wells Project (Item I-C).
- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART) (Item III-A).
- The HCP Coordinating Committees meeting on September 25, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item V-A).

Decision Summary

- There were no HCP Decision Items approved during today's meeting.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- A Wells Project Land-Use Permit Application for Wells Tract 115 was distributed to the HCP Coordinating Committees by Kristi Geris on July 21, 2018. This application is available for a 60-day review with comments or indication of no comments due to Tom Kahler and Geris no later than Wednesday, September 19, 2018 (Item IV-B). *(Note: Jim Craig provided U.S. Fish and Wildlife Service [USFWS] comments on July 23, 2018; and Chad Jackson [Washington Department of Fish and Wildlife (WDFW)] and Scott Carlon [National Marine Fisheries Service (NMFS)] provided indication of no comments on July 23, 2018 and July 24, 2018, respectively.)*

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. Tom Kahler added a Wells Dam bypass operations update.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft June 26, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the HCP Coordinating Committees were incorporated into the revised minutes. She said she also added the Wells Project Land-Use Permit Application for Wells Tract 115 for review, including a track record of comments to date. Kirk Truscott corrected a comment he made under the HCP Hatchery Committees update, Genetics Monitoring Associated with PUD Hatchery Programs topic. He said the Colville Confederated Tribes (CCT) do not have a geneticist on staff; however, the CCT typically use WDFW and USFWS staff for this (not the Columbia River Inter-Tribal Fish Commission [CRITFC]).

HCP Coordinating Committees members present approved the June 26, 2018 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on June 26, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on June 26, 2018):*

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  Tom Kahler said he has not yet completed the review of detection data from the lower-Methow detection array necessary to perform the desired analysis; however, he will ask Dr. John Skalski (Columbia Basin Research) to start on the post-season bypass report for Wells Dam following the cessation of bypass operations at Rocky Reach Dam at the end of this week. This report is a component of this action item. This action item will be carried forward.
- *Douglas PUD will provide a representation designation letter to John Ferguson (and copy Kristi Geris), replacing Shane Bickford with Andrew Gingerich (Douglas PUD) as the Douglas PUD HCP Coordinating Committees Alternate Representative (Item I-C).*
  This letter was distributed to the HCP Coordinating Committees by Geris on July 23, 2018.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Scott Carlon will discuss with Brett Farman (NMFS) and Charlene Hurst (NMFS) how to best coordinate among Douglas PUD, the Wells HCP Coordinating and Hatchery Committees, and NMFS, to ensure that the use of spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study is written into the next Section 10 permits for the Wells Project (Item IV-A).*
  John Ferguson said Carlon discussed this action item with Farman.
- *John Ferguson will discuss with Tracy Hillman how to best coordinate between the Wells HCP Coordinating and Hatchery Committees to ensure that the use of spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study is written into the next Section 10 permits for the Wells Project (Item IV-A).*
  Ferguson discussed this with Hillman on July 2, 2018, and Hillman further discussed this with the HCP Hatchery Committees during the meeting on July 18, 2018. Hillman said this is now on the HCP Hatchery Committee's radar.
- *Tom Kahler will establish a system to remind the Wells HCP Coordinating Committee to routinely revisit using spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study to ensure this is written into the next Section 10 permits for the Wells Project (Item IV-A).*

Kahler said planning for the next permit will likely begin around 2023. This action item will be carried forward.

- *Tom Kahler will provide reports on adult summer/fall Chinook salmon fallbacks by Ashbrook et al. (2008) and Mann and Snow (2018) to Kristi Geris for distribution to the HCP Coordinating Committees (Item VI-A).*
  Kahler provided these reports to Geris following the meeting on June 26, 2018, which Geris distributed to the HCP Coordinating Committees that same day.
- *Kristi Geris will notify Sarah Montgomery (HCP Hatchery Committees support staff) that the HCP Coordinating Committees agreed to add David Clark (WDFW), the new Eastbank Complex Manager, to the HCP Hatchery Committees email distribution list and provide Clark with access to the HCP Hatchery Committees extranet site, as requested (Item VII-A).*
  Geris notified Montgomery following the meeting on June 26, 2018.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman said the HCP Tributary Committees did not officially meet in August 2018; however, the Committees did receive a General Salmon Habitat Program proposal, which the Committees evaluated via email. Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during August 2018:

- *Chiwawa Nutrient Enhancement*: The Cascade Columbia Fisheries Enhancement Group (CCFEG) submitted a proposal to apply salmon carcasses or salmon carcass analogs to the Chiwawa River to increase direct and indirect food sources for juvenile salmonids. The sponsor proposes to treat a 5-mile reach of the Chiwawa River (river miles 17 to 22) twice per year for 5 years. CCFEG will perform water quality and effectiveness monitoring (in partnership with WDFW) through the entire project. The total cost of the project is $267,650 ($53,530 per year). The sponsor requested the entire amount from the Plan Species Account Funds. The Rock Island HCP Tributary Committee approved funding for the project. Hillman said nutrient enhancement with carcass analogs is considered experimental because the benefits are relatively short term and they have rarely translated into increased smolts and have not translated into increased adults. He said the HCP Tributary Committees first became involved in this project in 2012 or 2013. He recalled the key issue was difficulty in obtaining permits to do the work and USFWS concerns about the effects of applying analogs on bull trout. Jim Craig said he was relieved to hear the USFWS Ecological Services Office finally signed off on this work. Hillman said CCFEG hopes to begin this work in fall 2018. Kirk Truscott said there is an adult management strategy already planned for this area. Hillman said this has been discussed and the proposal was modified to align with these plans. John Ferguson asked what the analogs are made of, and Hillman said the analogs are ground up salmon carcasses that have been dried and, with the addition of a binder, pelletized. Truscott asked if monitoring is covered under the total cost. Hillman said the cost covers monitoring and other project-related items such as reporting, project management, lab analytics, and supplies. Truscott asked if the Chiwawa River is nitrogen or phosphorous limited, and Hillman said the river is both nitrogen and phosphorous limited.

- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on September 13, 2018. Hillman said the HCP Tributary Committees will be discussing funding and proposals.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on August 18, 2018 (note: joint HCP Hatchery Committees/Priest Rapids Coordinating Committee [PRCC] Hatchery Subcommittee items are noted by "joint"):

- *ELISA Sampling for Spring and Summer Chinook Salmon*: Douglas PUD has a plan to send virology samples (consisting of ovarian fluid, kidney, and spleen samples) to the Washington State Animal Disease Diagnostic Lab (WADDL) for processing, and kidney samples to WDFW for traditional bacterial kidney disease ELISA (enzyme-linked immunosorbent assay) testing. This applies to both the Methow spring Chinook salmon and Wells summer Chinook salmon 2018 programs.
- *Draft 2019 Monitoring and Evaluation Implementation Plan*: The Rock Island and Rocky Reach HCP Hatchery Committees reviewed and approved proposed edits to the Chelan PUD 2019 Hatchery Monitoring and Evaluation Implementation Plan. Approved changes included discontinuing Chiwawa spring Chinook parr estimates, discontinued observer efficiency data collection, and adding language to increase flexibility in adult steelhead monitoring.
- *Expanded Sampling at the OLAFT (joint)*: Andrew Murdoch (WDFW) provided an update on adult steelhead monitoring including sampling, tagging, and funding at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam. Currently, the Bonneville Power Administration (BPA) funds tagging at Priest Rapids Dam and operations and maintenance for several PIT-tag antenna arrays within the Upper Columbia River basin. Based on recent funding negotiations with BPA, WDFW will receive funding for adult steelhead tagging and monitoring through brood year 2019. Without a cost share of about $100,000, WDFW will not be able to PIT tag adult steelhead at Priest Rapids Dam or maintain arrays after brood year 2019. This will affect tributary escapement estimates. Because of reduced BPA funding, rather than expand sampling at Priest Rapids Dam, WDFW will be seeking a cost-share agreement with the PUDs to continue existing steelhead monitoring. If funding is not available to continue the current level of steelhead monitoring, the HCP Hatchery Committees and PRCC Hatchery Subcommittee will need to consider conducting steelhead spawning ground surveys. The HCP

Hatchery Committees and PRCC Hatchery Subcommittee will evaluate options and make a decision before March 1, 2019.

- *Genetic Monitoring (joint)*: The HCP Hatchery Committees and PRCC Hatchery Subcommittee reviewed and approved the list of five geneticists, who will participate on the genetics monitoring panel. The HCP Hatchery Committees and PRCC Hatchery Subcommittee also reviewed, edited, and approved the questions for the geneticists. The geneticists will be invited to attend or call into the HCP Hatchery Committees meeting on September 19, 2018, so the HCP Hatchery Committees and PRCC Hatchery Subcommittee can explain the purpose of the panel and answer any questions the geneticists may have. The geneticists will then address the questions from the HCP Hatchery Committees and PRCC Hatchery Subcommittee and present their responses either during the HCP Hatchery Committees meeting on October 17, 2018 or November 21, 2018. Hillman said the HCP Hatchery Committees are currently in the process of sending an email to the geneticists containing all the information needed.
- *NMFS Consultation (joint)*: The NMFS reported that the Environmental Assessment for the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids) is undergoing internal legal review. NMFS is also working on the Methow steelhead permit.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on September 19, 2018.

III. Chelan PUD

A. Rocky Reach and Rock Island Summer Spill Update (Lance Keller)

Lance Keller reviewed summer spill updates at Rocky Reach Dam and Rock Island Dam, as follows:

Rocky Reach Dam

Keller said typically, he tees up this discussion during the July meeting; however, the HCP Coordinating Committees meeting on July 24, 2018 was canceled (Keller did provide the update, *Status of Summer Fish Spill at Rocky Reach and Rock Island Dams*, via email, which was distributed by John Ferguson on August 6, 2018).

Keller said summer spill at Rocky Reach Dam started on May 25, 2018, at 0000 and spilled continuously through August 6, 2018, at midnight. He said early in the spill season, there were a lot of fish sampled at the RRJSF, but from July 22 to August 1, 2018, fish counts ranged from 39 to 8 fish. He said the 95th percentile was achieved on July 27, 2018, and at this point, the daily index counts had been below 0.3% of the cumulative index counts for the past 3 of 5 consecutive days. He said, however, Chelan PUD felt July was too early to shutdown spill, so the decision was made to continue monitoring. He said on August 3, 2018, fish counts were in the 20s and the shutdown criteria were still met; therefore, Chelan PUD chose to end spill on August 6, 2018, at midnight. He said in summary, Rocky Reach Dam spilled for 74 days and for 22.3% of the daily average river flow. He said this is a bit above the targeted 9% of the daily average river flow, but he also noted the very high river flow experienced in 2018.

Keller said Thad Mosey (Chelan PUD) will likely have a draft fish spill program report ready to present during the HCP Coordinating Committees meeting on September 25, 2018. Kirk Truscott asked if this report can include adipose (ad)-present and ad-absent data, and Keller said these data can be included.

Truscott noted that the sample period for summer migrants at the RRJSF does not correspond well with the typical time period when subyearlings pass a project. He said sampling takes place during daytime hours and subyearlings generally pass during nighttime periods. He recommended considering how representative these numbers are. Keller said sampling takes place at the top of each hour at 0800, 0900, 1000, and 1100. He said this involves collecting instantaneous samples out of the bypass at Rocky Reach Dam. He said the reasoning behind these sample times is for comparability to historical data. He said consistency of these sample times allows DART to review data with statistical certainty. He said if the times change this statistical certainty will be lost. He said this is a snapshot of passage at a certain time of year. Truscott said there may be a way to review historical data to determine the correlation between sample periods, such as reviewing estimates of total passage for a day to verify a correlation.

Keller said he will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART.

Truscott said this is important to get correct, notably if management decisions on spill are being made that might otherwise not be made. He clarified he is not saying this is 'not correct,' but that changes can be made, if needed. He said changes have been implemented before.

Rock Island Dam

The email, *Update on Summer Fish Spill at Rock Island Dam*, was distributed by Ferguson on August 14, 2018). Keller said summer spill at Rock Island Dam started on May 25, 2018 and ended on August 14, 2018. He said Rock Island Dam spilled for 82 days and the daily average spill volume was 26%. He caveated that this is a preliminary number. He said bypass counts after ending spill have been supportive of when the decision to end spill was made. He said again, Mosey will have a summary completed to present during the HCP Coordinating Committees meeting on September 25, 2018.

B. Rocky Reach Dam Turbine Unit C1 Maintenance Update (Lance Keller)

Lance Keller recalled that Rocky Reach Dam Turbine Unit C1 is the unit where there were leaky trunnion seals causing leaks of oil into the Columbia River; therefore, the unit was taken out of service for repair. He recalled that Chelan PUD considered a number of temporary fixes to return Unit C1 back to operation for the 2018 fish passage season. He recalled the initial trunnion seal replacement failed to stop oil from leaking from the unit hub. He said Chelan PUD then looked into hydraulically locking the blades into place; however, engineers were not confident that operating in a hydraulically locked configuration would not result in an oil leak with a failed trunnion seal. He said at this point, Chelan PUD elected to proceed with an engineered fix. He said the engineered seal is estimated to arrive in the first part of September 2018; therefore, Unit C1 will not return to service for the 2018 season. He said this schedule is still intact. He said once the seal arrives on site, mechanics will immediately install and pressure test the new seal to verify its functionality.

John Ferguson asked about the contractor engineering the seal, and Keller said the contractor is Voith Hydro located in Germany.

C. Rock Island Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said a lot has been going on since the last Rock Island Powerhouse 1 maintenance update. He recalled the main driver in the past has been the rehabilitation of Rock Island Dam Powerhouse 1 Turbine Units B1, B2, B3, and B4. He recalled metallurgy results indicated these units were unsafe to run. He said these results and proposed repairs were discussed with the Federal Energy Regulatory Commission (FERC) who deemed the repairs as maintenance. He said Chelan PUD also consulted the Rock Island HCP Coordinating Committee about these repairs in Q1 2017 (see the Statement of Agreement titled, *Acknowledgement of Rock Island Powerhouse 1 Units B1-B4 Consultation*, approved by the Rock Island HCP Coordinating Committee on February 3, 2017).

Keller said currently, Unit B4 and new wicket gates for Unit B4 have been delivered to Rock Island Dam. He said the new turbine and generator shafts for Unit B4 have been fabricated and are being prepped for shipping from Italy, while the new turbine is undergoing final inspection at the factory.

Keller said at the same time, rehabilitation of Rock Island Dam Powerhouse 1 Turbine Units B5, B6, B7, and B8 are underway. He recalled that Units B9 and B10 were rehabilitated in 2008 and 2012, respectively, and the rehabilitation of Unit B6 was recently completed in 2018.

Keller said the rehabilitation schedule for Units B1 to B4 is already tight, given that ideally, repairs will be complete for these units in a short time frame. He said the original estimated return-to-service dates were as follows:

Repair	Estimated Date
Unit B1	Q1 2020
Unit B2	Q3 2019
Unit B3	Q2 2019
Unit B4	Q1 2019

Keller said, unfortunately, events over the last 8 to 10 months have impacted the overall schedule. He said an air gap issue has developed in Unit B7. He explained that this refers to the space between the stator and the rotor; as tolerance shrinks or grows this creates an issue with the air gap. He said an initial analysis shows that the stator needs adjusting, and the unit has been declared out-of-service. He said Unit B8 is experiencing a turbine oil leak, which is contained to the powerhouse. He said crews are monitoring this on a weekly basis to ensure the leak remains internal to the powerhouse and does not leak into the tailrace or compromise the operational availability of Unit B8. He said Unit B6 was rehabilitated in 2018; however, the contractor Andritz Hydro (based in Austria, with a location in the United States) did not meet their schedule and returned the parts for repair later than was scheduled. Keller said Unit B9 also had air gap/clearance issues upon commissioning in August 2018. He said Andritz Hydro is also the contractor for these repairs, as well as the repairs to Units B1 to B4. Keller said additionally, on August 22, 2018, he received an update that smoke was observed originating from Unit B6, resulting in a forced outage. He said mechanics are currently investigating what is happening in this unit.

Keller said there have been a lot of unfortunate activities in Rock Island Dam Powerhouse 1, which have been compounded by conflicting schedules. He said in June 2018, there was also a fatality on the Spillway and Chelan PUD is currently reevaluating how crews are staffed and assigned to multiple and repetitive tasks. He said Chelan PUD will continue to update the HCP Coordinating Committees in the coming months, including how this repair timeline will change. He said there are quite a few unit issues and adjustments to workload to manage. He said Chelan PUD is trying to figure out how to reserve a portion of the repair schedule for both large and small units, simultaneously, while also creating a safe work environment.

John Ferguson asked if the contractor is making adjustments to the air gap? Keller said Chelan PUD is currently investigating this and reworking a solution with Andritz Hydro. Keller said this definitely should not have happened.

IV. Douglas PUD

A. Wells Dam Bypass Operations Update (Tom Kahler)

Tom Kahler said bypass operations at Wells Dam were terminated on August 19, 2018, at 2400, per the Douglas PUD 2018 Bypass Operating Plan.

B. Wells Project Land-Use Permit Application for Wells Tract 115 (Tom Kahler)

A Wells Project Land-Use Permit Application for Wells Tract 115 was distributed to the HCP Coordinating Committees by Kristi Geris on July 21, 2018, and Jim Craig provided USFWS comments on July 23, 2018 (Attachment B). Chad Jackson (WDFW) and Scott Carlon (NMFS) provided indication of no comments on July 23, 2018 and July 24, 2018, respectively.

Tom Kahler said Keely Murdoch indicated via email that she has specific questions on the permit application. Murdoch said she does not fully understand this application request. She said an actual permit application was not provided; rather, only a photograph and text describing the activities were provided. She said the email described spraying apple seedlings and mowing for managing for wildlife. She said, however, she does not understand how this is managing for wildlife. She said she agrees with Craig's comments (Attachment B) about instead of just spraying and mowing, plant vegetation that would benefit wildlife. Murdoch said it is not clear what is happening in the riparian zone, but the Yakama Nation requests that no activities occur in the riparian zone. Murdoch said she is not clear about what authority the Wells HCP Coordinating Committee has in these applications. She asked if the Wells HCP Coordinating Committee can make specific requests? She asked if the Wells HCP Coordinating Committee has this kind of latitude?

Kahler said the Wells HCP does not indicate the type of latitude the Wells HCP Coordinating Committee has; rather, it just states that Douglas PUD will consult with the Wells HCP Coordinating Committee. Kahler said specifically, (Section 5.1 of) the Wells HCP states:

> *When making land use or related permit decisions on Project owned lands that affect reservoir habitat, the District shall consider the cumulative impact effects in order to meet the conservation objectives of the Agreement, requirements of the FERC license, and other applicable laws and regulations. The District further agrees to notify and consider comments from the Parties to the Agreement regarding any land use permit application on Project owned lands.*

Craig said it is interesting that the applicant expressed a liking for the wildlife and then proposes to spray the sprouts the wildlife like to eat. John Ferguson asked what authority Douglas PUD has with these applications. Kahler said Douglas PUD owns the land, which was formerly an orchard. He said Douglas PUD's interest was managing the land for fish and wildlife use. He said the property was once irrigated, which maintained the orchard. He said Douglas PUD does not require the applicant to maintain the land as an orchard. He said the applicant let the orchard go and removed the trees to avoid creating a haven for orchard pests. He said the applicant is now trying to get rid of root sprouts by spraying. He said based on the photograph (Attachment B), it does not appear that any activities are taking place within the riparian zone. He guessed there may be a setback in place. He said the applicant only indicated plans to mow, rake, and continue spraying.

Murdoch asked if the Wells HCP Coordinating Committee approves this permit application request, can the Wells HCP Coordinating Committee recommend maintaining the riparian buffer and planting native vegetation? Kirk Truscott said the applicant had a permit which authorized having an orchard and now that the land is no longer an orchard, and asked what is Douglas PUD's policy for having a permit for an activity that no longer exists? Kahler said this is a case where the applicant is requesting permission from Douglas PUD to perform a certain activity on the land. Murdoch asked if Douglas PUD will be spraying and raking? Kahler said no, the applicant will be spraying and raking (note: Kahler corrected his statement via email clarifying that the applicant will be mowing and raking, but Douglas PUD has the legal obligation to spray until the roots cease sprouting, and to control noxious weeds). Murdoch asked what the applicant will be spraying? Kahler said if the applicant is managing seedlings, the spray would be an herbicide. Truscott asked what Douglas PUD would do with this parcel were it not receiving a request for use by the adjacent land owner? Kahler said the parcel is upland so it cannot be converted to riparian without irrigation. Truscott asked about returning the land to natural vegetation? Kahler said this would be grassland and shrub-steppe. Ferguson asked if the current permit is expired? Kahler said he is unsure of the terms of the current permit. Truscott said it seems what the applicant is proposing would be inconsistent with the original purpose of the permit. He said the land utilization is no longer consistent with the original permit. Kahler said he can inquire internally about these questions. He said some plants included on the list of vegetation Craig provided (Attachment B) would not tolerate this environment; although, some would be part of the natural community had it never been disturbed.

Murdoch asked what would motivate the applicant to plant native vegetation? Kahler agreed this is a good point. Murdoch asked whether the Wells HCP Coordinating Committee could ask Douglas PUD to plant native vegetation? Kahler said the spraying would be a prudent application to avoid apple maggots. He said this is standard protocol in the area; farmers spray until the roots stop producing shoots.

Patrick Verhey said he is unsure about the specifics of the permit application, but he understands the land is owned by Douglas PUD and it is a terrestrial issue. He suggested consulting Douglas PUD wildlife staff to develop a plan to restore the property and have the Wells HCP Coordinating Committee review this plan. He said the Wells HCP Coordinating Committee primarily consists of fisheries experts, so having a wildlife biologist involved in the process would be beneficial. Kahler said he can discuss this with Beau Patterson and Jason Schilling (Douglas PUD wildlife biologists).

Kahler said he appreciates these discussions and comments, which is exactly what Douglas PUD is seeking when consulting the Wells HCP Coordinating Committee. Ferguson suggested Kahler discuss these questions raised by the Wells HCP Coordinating Committee internally with Douglas PUD staff, and bring the responses back to the Wells HCP Coordinating Committee during the meeting on September 25, 2018. Geris noted that the 60-day review for this application ends on September 19, 2018. Kahler said this deadline can be adjusted, as needed, to adequately address these questions. *(Note: Kahler provided responses to these questions via email on August 29, 2018.)*

V. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on September 25, 2018, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The October 23 and November 27, 2018 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A List of Attendees
Attachment B Wells Project Land-Use Permit Application for Wells Tract 115 and USFWS comments

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman	BioAnalysts
Lance Keller*	Chelan PUD
Alene Underwood††	Chelan PUD
Tom Kahler*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Patrick Verhey*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the Chelan PUD agenda items

From:	Kristi Geris
To:	Kristi Geris
Subject:	RE: New Land Use Permit Application Wells Tract 115
Date:	Thursday, August 30, 2018 8:43:00 AM

From: Craig, Jim <jim_l_craig@fws.gov>
Sent: Monday, July 23, 2018 10:29 AM
To: Tom Kahler <tomk@dcpud.org>
Cc: Jackson, Chad S (DFW) <Chad.Jackson@dfw.wa.gov>; John Ferguson <jferguson@anchorqea.com>; Keely Murdoch (murk@yakamafish-nsn.gov) <murk@yakamafish-nsn.gov>; Keller, Lance <Lance.Keller@chelanpud.org>; kirk.truscott@colvilletribes.com; Scott Carlon <scott.carlon@noaa.gov>; Tom Kahler (tkahler@dcpud.org) <tkahler@dcpud.org>; Andrew Gingerich (andrewg@dcpud.org) <andrewg@dcpud.org>; Mike Tonseth <tonsemat@dfw.wa.gov>; william_gale@fws.gov; Beau Patterson (beaup@dcpud.org) <beaup@dcpud.org>; Kristi Geris <kgeris@anchorqea.com>
Subject: Re: [EXTERNAL] FW: New Land Use Permit Application Wells Tract 115

Tom,

I reviewed the proposal and FWS is supportive. I would agree action should be taken to remove or minimize the non-native Chinese Elm (via mowing and/or raking). I do not think chemical treatment of the apple sprouts is a good idea - certainly can't be that good for the deer that are eating the treated sprouts (why not cease treatment and let the deer eat the sprouts or do some occasional mechanical removal before tree gets old enough to bear fruit).To increase wildlife (deer, birds etc) why not consider native veg planting that supports wildlife (see examples below) in the Permit Area (if not the Subject Property as well).

Achillea millefolium	Yarrow
Agropyron caninum	Bearded wheatgrass
Agrostis idahoensis	Idaho bentgrass
Amelanchier utahensis	Utah serviceberry
Arctostaphylos nevadensis	Kinnikinnik
Artemesia tridentata	Big sagebrush
Balsamorhiza sagittata	Arrow-leaf balsamroot
Berberis nervosa	Cascade Oregongrape
Ceanothus velutinus	Snowbrush
Crataegus douglasii	Black hawthorn
Chrysothamnus nauseosus	Gray rabbit-brush
Danthonia intermedia	Timber oatgrass
Elymus cinereus	Giant rye grass
Eriogonum compositum	Northern buckwheat
Eriogonum niveum	Snow buckwheat
Festuca occidentalis	Western fescue
Festuca scabrella	Rough fescue
lyallii	Alpine lupine

That's about it.

From: Kristi Geris
Sent: Saturday, July 21, 2018 10:51 AM
To: Jackson, Chad S (DFW) <Chad.Jackson@dfw.wa.gov>; Jim Craig (jim_l_craig@fws.gov) <jim_l_craig@fws.gov>; John Ferguson <jferguson@anchorqea.com>; Keely Murdoch (murk@yakamafish-nsn.gov) <murk@yakamafish-nsn.gov>; Keller, Lance <Lance.Keller@chelanpud.org>; kirk.truscott@colvilletribes.com; Kristi Geris <kgeris@anchorqea.com>; Scott Carlon <scott.carlon@noaa.gov>; 'Tom Kahler (tkahler@dcpud.org)' <tkahler@dcpud.org>
Cc: Aaron Beavers <Aaron.Beavers@noaa.gov>; Alene.Underwood@chelanpud.org; Andrew Gingerich (andrewg@dcpud.org) <andrewg@dcpud.org>; Bill Tweit <tweitwmt@dfw.wa.gov>; Bob Rose <rosb@yakamafish-nsn.gov>; Casey Baldwin <Casey.Baldwin@colvilletribes.com>; Catherine Willard <Catherine.Willard@chelanpud.org>; Dale Bambrick <dale.bambrick@noaa.gov>; Gallaher, Becky <becky.gallaher@chelanpud.org>; Justin Yeager <Justin.Yeager@noaa.gov>; 'Mary Mayo' <marym@dcpud.org>; Mike Tonseth <tonsemat@dfw.wa.gov>; Ritchie Graves <ritchie.graves@noaa.gov>; Shane Bickford (sbickford@dcpud.org) <sbickford@dcpud.org>; Steve Hemstrom (steven.hemstrom@chelanpud.org) <steven.hemstrom@chelanpud.org>; Steve Parker <pars@yakamafish-nsn.gov>; Verhey, Patrick M (DFW) <Patrick.Verhey@dfw.wa.gov>; 'william_gale@fws.gov' <william_gale@fws.gov>; Beau Patterson (beaup@dcpud.org) <beaup@dcpud.org>
Subject: FW: New Land Use Permit Application Wells Tract 115

Hi HCP-CC: please see the emails below from Tom and Beau and the attached Land-use Permit Application figure. This permit application is available for a 60-day review with comments or indication of no comments due to Tom (and copy me) no later than **Wednesday, September 19, 2018**.

The attached application figure is also available for download from the HCP Coordinating Committees Extranet Site, under: Draft Documents (instructions below). Thanks! –kristi

Wells HCP-CC member	Comments -or- No comments
NMFS	
USFWS	
WDFW	
CCT	
YN	

Instructions:

To gain access to the HCP Coordinating Committees Extranet Homepage, please use the following procedure:

- Visit: https://extranet.dcpud.net/sites/nr/hcpcc/
- Login using "Forms Authentication" (for non-Douglas PUD employees)

You should now be at the HCP CC homepage.

If you encounter problems, or need a login username and password to access the site: Please feel free to contact me or Julene McGregor [jmcgregor@dcpud.org; (509) 881-2236] and we will gladly assist you with questions or issues.

Kristi Geris
ANCHOR QEA, LLC
kgeris@anchorqea.com
C 360.220.3988

From: Tom Kahler <tomk@dcpud.org>
Sent: Friday, July 20, 2018 5:57 PM
To: Kristi Geris <kgeris@anchorqea.com>
Cc: John Ferguson <jferguson@anchorqea.com>
Subject: FW: New Land Use Permit Application Wells Tract 115

Hi Kristi,

Here's a rather benign land-use action for which we've received a permit application. The proposed action is consistent with our policy of managing reservoir lands for wildlife habitat. Please circulate to the CC and start the 60-day review period. Also, please add this to the agenda for the August meeting as a potential decision item, in case folks are OK with a shorter review period.

Thanks,

Tom

From: Beau Patterson
Sent: Wednesday, July 18, 2018 4:39 PM
To: Tom Kahler
Cc: John Brown; Scott Kreiter; Lisa Keane
Subject: New Land Use Permit Application Wells Tract 115

Tom,

We have received a new land use permit application for mowing and raking of 5.3 acres of fallow orchard. The location is along the Okanogan River in Wells Tract 115, adjacent to 1090A Old Highway 97 (see attached figure). The purpose is to improve foraging habitat for deer and Canada geese. The applicant states when the orchard was removed it was initially used extensively by deer and geese but as succession has occurred they rarely see deer, and geese no longer use the area for foraging. The applicant desires to increase wildlife viewing opportunities for a disabled homebound resident who enjoyed watching deer and geese. The current condition of the fallow orchard is an understory composed primarily of orchardgrass with an overstory of wavyleaf thistle (native), scattered apple root sprouts and colonizing Chinese elm seedlings. The applicants proposed action is likely to increase use by deer and geese; currently the only desirable deer forage is the few apple sprouts, which are regularly sprayed with a goal of eradication to avoid creating habitat for orchard insect pests. In its current state it has some value as potential nesting cover for ducks and foraging habitat for quail and some seed eating songbirds (e.g., goldfinches). Similar habitat would remain on fallow orchard north and south of the proposed goose and deer pasture. None of the habitat which would be altered is likely to be limiting for any native wildlife species. I would assess the proposed use as slightly positive for upland bird, waterfowl and big game foraging, and positive for increased viewing of deer and geese.

Please provide this information to the HCP Coordinating Committee Representatives for 60 days review.

Thank you,

Beau

Wells Project
Tract 115-01 Land Use Permit

This map is for display purposes only, all locations are approximate.
Data may have changed since the publication of this map.

Lambert confromal Conic, Washington State Plane North NAD 83 - Feet

Wells Base Map

Okanogan_Parcels_Current

G Line Current

FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: October 24, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the September 25, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, September 25, 2018, from 10:00 to 11:30 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Tom Kahler will establish a system to remind the Wells HCP Coordinating Committee to routinely revisit using spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study to ensure this is written into the next Section 10 permits for the Wells Project (Item I-C).
- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Chelan PUD will compare fish spill coverage data from 2011 and 2012 to data from 2018 and will report back to the HCP Coordinating Committees (Item III-A).
- Chelan PUD will update the draft 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report to report consistent data for Rocky Reach and Rock Island fish spill programs and a more detailed explanation of spill coverage and will provide a revised draft report for HCP Coordinating Committees review (Item III-A). *(Note: Lance Keller provided a revised report to Kristi Geris on October 19, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Lance Keller will provide the test results from the engineered trunnion seals for Rocky Reach Unit C1 as soon as the results are available (Item III-B). *(Note: Keller provided an update to*

Kristi Geris on October 16, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)

- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-B).
- Tom Kahler will discuss with Beau Patterson (Douglas PUD Land Use Specialist) the Colville Confederated Tribes (CCT) and the Yakama Nation (YN) comments on the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item IV-A).
- Kristi Geris will notify Tracy Hillman (HCP Hatchery Committees Chairman), Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator), and Grant PUD office building staff that the HCP Coordinating Committees meeting in December 2018 will be held via conference call on December 18, 2018, if needed (Item V-A). *(Note: Geris provided this notification, as discussed.)*
- The HCP Coordinating Committees meeting on October 23, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item V-A).

Decision Summary

- There were no HCP Decision Items approved during today's meeting.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- The draft 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report for review was distributed to the HCP Coordinating Committees by Kristi Geris on September 24, 2018 (Item III-A). *(Note: Lance Keller provided a revised report to Geris on October 19, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- The draft 2020 Wells Project Survival Verification Study Plan was distributed to the HCP Coordinating Committees by Kristi Geris on September 24, 2018. The draft plan is available for a 63-day review with edits and comments due to Tom Kahler by Tuesday, November 27, 2018 (Item IV-B).
- A Douglas PUD Spill Prevention Control and Counter Measures (SPCC) Plan was distributed to the HCP Coordinating Committees by Kristi Geris on October 3, 2018. This plan is available for a 30-day review with edits and comments due to Tom Kahler by Friday, November 2, 2018.

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. Lance Keller said Chelan PUD has no additions; however, he requested discussing Chelan PUD items first due to time constraints in the afternoon. Tom Kahler said Douglas PUD has no issues with this request and the agenda was rearranged.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft August 28, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the HCP Coordinating Committees were incorporated into the revised minutes. HCP Coordinating Committees members present approved the August 28, 2018 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on August 28, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on August 28, 2018):*

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  Tom Kahler said run-timing data for wild yearling Chinook salmon has been reviewed; however, data for hatchery yearling Chinook salmon has not. Kahler said he hopes to report these data during the HCP Coordinating Committees meeting on October 23, 2018. This action item will be carried forward.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  This will be discussed during today's meeting.
- *Tom Kahler will establish a system to remind the Wells HCP Coordinating Committee to routinely revisit using spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study to ensure this is written into the next Section 10 permits for the Wells Project (Item I-C).*

Kahler said he and Andrew Gingerich plan to establish a reminder system on the Douglas PUD internal SharePoint site. This action item will be carried forward.

- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item III-A).*
  This action item will be carried forward.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on September 13, 2018:

- *Time Extension Request*: The Rock Island HCP Tributary Committee received a time extension request from Cascade Columbia Fisheries Enhancement Group on the Derby Creek Fish Passage Project. The sponsor is waiting for Washington Department of Fish and Wildlife (WDFW) to finish the 60% design; therefore, the sponsor requested to extend the completion date from December 31, 2018 to December 1, 2019. The Rock Island HCP Tributary Committee approved the time extension request.
- *Targeted Solicitations*: The HCP Tributary Committees discussed identifying high-priority projects within each of the subbasins (Wenatchee, Entiat, Methow, and Okanogan) and calling for proposals. This is similar to the Bonneville Power Administration's Targeted Solicitation Process. Although the HCP Tributary Committees will continue to accept project applications from sponsors anytime throughout the year, the HCP Tributary Committees would like to take a more active role in identifying and funding targeted projects within each subbasin. Therefore, members will start identifying priority projects within each subbasin for discussion during the next HCP Tributary Committees meeting. John Ferguson asked what precipitated change in approach? Hillman said there were several things. He said the HCP Tributary Committees have been receiving and reviewing quite a few proposals that ultimately are not funded because they lack biological benefit, the proposals are not meeting requirements of the HCPs, or are too expensive for the anticipated benefit. Hillman said the HCP Tributary Committees think it may be better to identify projects themselves instead of waiting to receive projects with limited biological benefit. He said the HCP Tributary Committees want to be sure a project has high biological benefit and is cost-effective.
- *Site Visits*: The HCP Tributary Committees discussed the need to start visiting completed projects. The HCP Tributary Committees are currently reviewing the list of completed projects

in each subbasin and will identify those to visit on October 11, 2018 (the date of the next HCP Tributary Committees meeting). Hillman said the HCP Tributary Committees would like to see what has been accomplished with HCP Tributary Committees funds over the past few years.

- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on October 11, 2018.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on September 19, 2018 (note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint"):

- *Egg Incubation Treatment Study*: Douglas PUD provided the Wells HCP Hatchery Committee with an updated plan to examine the efficacy of hydrogen peroxide and salt in controlling *Saprolegnia spp*. infestations during salmonid egg incubation under hatchery conditions at the Methow Fish Hatchery. The study will compare Formalin, the chemical traditionally used for prophylactic management of *Saprolegnia spp*., with hydrogen peroxide, salt, and no treatment (control) on the growth of *Saprolegnia spp*. on summer Chinook salmon eggs. Formalin has long been associated with worker safety and environmental hazards and according to Dr. Betsy Bamberger (Douglas PUD Fish Health Specialist), using Formalin may be met with increasing scrutiny by regulatory agencies. Therefore, this study will determine the effectiveness of alternatives to Formalin that can be used as safe therapeutic substitutes at the hatchery. The Wells HCP Hatchery Committee approved the study, which will begin fall 2018.
- *2018 Chiwawa Broodstock Collection Summary*: WDFW reported an issue with collection of natural-origin spring Chinook salmon broodstock at the Chiwawa Weir. All broodstock collected at the weir are supposed to be natural-origin fish (adipose [ad]-present and no coded wire tag [CWT]). However, several of the adult Chinook salmon collected at the weir in 2018 were hatchery-origin fish (ad-present with CWTs). Somehow the CWTs were not detected during collection (false negatives); therefore, the program ended up with 31 natural-origin fish, which is less than the target of 76 natural-origin fish. Nevertheless, the program was able to meet its broodstock collection goal by backfilling with hatchery-origin fish. WDFW is working with Chelan PUD on ways to prevent this from happening in the future.
- *Genetic Monitoring (joint)*: The HCP Hatchery Committees developed a list of genetics experts and four of the five genetics experts participated in the HCP Hatchery Committees meeting on September 19, 2018. The HCP Hatchery Committees described the purpose of the expert panel, which is to help the HCP Hatchery Committees develop a robust genetics monitoring plan, and then reviewed the specific questions the HCP Hatchery Committees have for the geneticists. The geneticists requested additional information, which Hillman will provide. The geneticists will work on answering the questions and report back to the HCP Hatchery Committees in November 2018.

- *NMFS Consultation (joint)*: The Environmental Assessment (EA) for the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids) is nearly complete. General Counsel is currently reviewing the EA. After the review is complete, the EA will go to the HCP Hatchery Committees for review, and then to the public for review.
- *Chief Joseph Hatchery Update (joint):* Kirk Truscott reported good news and bad news. The good news is that to date, very few summer Chinook salmon broodstock have died. Summer Chinook salmon were inoculated for Columnaris. The bad news is that a significant loss of spring Chinook salmon broodstock occurred this year. About 66% of the spring Chinook salmon broodstock were lost, resulting in a shortage of about 350,000 eyed eggs (50% of the 700,000 eyed-egg goal). The reason for the loss remains unknown. There was no apparent bacterial disease; although, fish were heavily infected with copepods. Managers are waiting for virology results. Hillman asked if Truscott has any further updates on this, and Truscott said he has not yet received the virology report. Ferguson asked when the report can be expected, and Truscott said the Chief Joseph Hatchery Manager contacted WDFW this morning asking about the report.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on October 17, 2018.

III. Chelan PUD

A. 2018 Rocky Reach and Rock Island Fish Spill Report (Lance Keller and Thad Mosey)

Lance Keller introduced Thad Mosey (Chelan PUD Senior Fisheries Biologist) who manages the Rocky Reach and Rock Island fish spill programs. Keller said Mosey compiled the draft 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report (Attachment B), which was distributed to the HCP Coordinating Committees by Kristi Geris on September 24, 2018.

<u>2018 Rock Island Spring Fish Spill</u>

Mosey reviewed page 2 of Attachment B. He said the target species include yearling Chinook salmon, steelhead, and sockeye salmon. He said the requirement is to spill 10% of the daily average river flow. He said spill started on April 17, 2018, at 0001 hours and ended on May 24, 2018, at 2400 hours. He said the percent of run with spill was filled covering 99.8% for yearling Chinook salmon, 99.9% for steelhead, and 99.2% for sockeye salmon (combined spring and summer fish spill). He said as of August 31, 2018, the cumulative index counts included 49,702 yearling Chinook salmon, 24,731 steelhead, and 76,245 sockeye salmon. He said the spring spill percentage was 40.44%, which comprised 9.76% fish spill and 30.68% forced spill. He said the average river flow at Rock Island Dam was about 249,000 cubic feet per second (249 kcfs), and the average spill was about 100 kcfs. He said there were 38 total spill days.

Mosey said as background information, the bypass was opened on April 1, 2018. He said the first sockeye salmon, yearling Chinook salmon, and steelhead were observed on April 7, April 2, and April 4, 2018, respectively. He said through April 16, 2018, the daily Chinook salmon and steelhead numbers were 20 and 11 fish or less, respectively. He said sockeye salmon were the first to reach 100 fish daily. He said on April 14, 2018, there were 106 sockeye salmon counted which was the driver to start fish spill at Rock Island Dam. He said on Friday, April 13, 2018, DART indicated 0.6% of the sockeye salmon run had passed Rock Island Dam. He explained that during the fish spill season data are reviewed on a Friday for execution of action the following Tuesday. He said based on review of the numbers on April 13, 2018, he was confident to initiate spring fish spill on April 17, 2018. He said if numbers drastically changed, he would have initiated spill sooner. He said from April 1 to 16, 2018, the cumulative sockeye salmon passage at Rock Island Dam was estimated to be 2.7%, which further confirmed April 17, 2018, as a proper start spill date. He said 5% passage was ultimately achieved on April 23, 2018, for sockeye and Chinook salmon, and on April 21, 2018, for steelhead.

2018 Rock Island Summer Fish Spill

Mosey reviewed page 3 of Attachment B. He said the summer spill target percentage at Rock Island Dam is 20% of the daily average river flow. He said spill started on May 25, 2018, at 0001 hours and ended on August 14, 2018, at 2400 hours. He said the 95% estimated passage date was July 31, 2018. He said spill coverage was provided for 99.3% of the subyearling run. He said the cumulative index count was around 27,500 fish. He said the summer spill percentage was 26% with fish and forced spill. He said the average river flow at Rock Island Dam was about 154 kcfs and the average spill was about 40 kcfs. He said total spill days were 82.

2018 Rocky Reach Summer Fish Spill

Mosey said hydraulic spill at Rocky Reach Dam had been ongoing since late April 2018. He said on May 12, 2018, Rocky Reach Dam was spilling as much as 50% of the total river flow due to hydraulic capacity of the dam. He said around mid-May 2018, he was coordinating with Chief Joseph Fish Hatchery about release dates for hatchery fish. He said on May 15, 2018, the first subyearlings were counted at Rocky Reach Dam and by May 23, 2018, about 0.5% of the subyearling run had passed Rocky Reach Dam. He said on May 24, 2018, about 1% of the subyearling run had passed; therefore, on May 25, 2018, summer spill was initiated at Rocky Reach Dam.

Mosey reviewed page 1 of Attachment B. He said the summer spill target percentage at Rocky Reach Dam is 9% of the daily average river flow. He said spill started on May 25, 2018, at 0001 hours and ended on August 6, 2018, at 2400 hours. He said the 95% estimated passage date was July 28, 2018. He said spill coverage was provided for 94.1% of the run, with a designated fish spill cumulative count of around 9,000 subyearlings. He said the summer spill percentage was 22.29%, which comprised 9.14% fish spill and 13.15% forced spill. He said the average river flow from May 25 to August 6, 2018, was about 155 kcfs, with a total of 74 spill days.

Mosey said regarding the 94.1% spill coverage, spill and fish numbers were watched closely in late July 2018 as numbers started dropping off for subyearlings. He said on July 24, 2018, the daily index counts began dropping below 0.3% of the cumulative index counts, and in early August 2018, DART estimated that 95% of the juvenile subyearling Chinook salmon run had passed the project. He said on Friday, August 3, 2018, the data showed no indication of change; therefore, the decision was made to end spill on Monday, August 6, 2018. He said after August 3, 2018, over the next 10 days there was a slight uptick in subyearling numbers. He said although counts remained at or below 0.3% of the cumulative index counts, he had not anticipated these days of higher numbers. He said additionally, DART predicted that 20,000 subyearlings would be collected and only 9,000 were ultimately collected, resulting in a small sample size. Mosey said if passage provided during the ongoing hydraulic spill at Rocky Reach Dam prior to the start of summer spill on May 25, 2018, is combined with the official "fish spill" dates, this would mean fish spill coverage was provided for more than 95% of the subyearling run.

John Ferguson asked if the green line on page 1 of Attachment B represents forced spill. Keller said this is correct, the green line is intended to note the hydraulic spill before requesting the start of fish spill. He added that he wanted to illustrate spill was occurring before the "fish spill start date" was requested. He said Rocky Reach Dam was not spilling water any differently before the fish spill start date; rather, there is just an internal accounting difference. He said continuous spill started around May 6, 2018, at 1445 hours.

Ferguson asked what the spill coverage would be for subyearlings if the hydraulic spill was included in the estimate by DART. Mosey said spill coverage for subyearlings would be 96.85% if calculated from when subyearlings were first collected at Rocky Reach Dam until the spill stop date of August 6, 2018. Ferguson said the question is then, does Chelan PUD report to the Federal Energy Regulatory Commission (FERC) spill coverage for 94.1% of the subyearling run during the "spill season," when the biological reality is, with forced hydraulic spill, coverage was really provided for 96.85% of the subyearling run. Keller said Chelan PUD reports these data to FERC via the HCP Coordinating Committees meeting minutes and HCP annual reports, and he believes the discussion has been framed well.

Ferguson asked if this has happened before, and Keller said this is a unique situation. Keller said 2018 was a high-water year, Rocky Reach Dam had slightly diminished powerhouse capacity, and there was a very small cumulative sample size. He said as new data are added to DART, the program is constantly updating the run estimate. He said all data indicated criteria were met and coverage was provided via spill; however, with the index counts being so low, ultimately there was larger volatility in the DART estimates.

Jim Craig asked if there was anything unusual about the season that may have caused this uptick in fish in early August 2018. Keller said he was unable to identify anything environmentally or operationally that may have caused this uptick.

Kirk Truscott suggested updating this draft report to more clearly describe the percentage of run with fish spill versus the percentage of run with forced and fish spill. He also asked how this was handled in 2011 and 2012 (other high-water years). Keller said he does not recall encountering this issue in those years. He said he believes spill coverage was provided above and beyond. He said, however, to verify, Chelan PUD will review fish spill coverage data from 2011 and 2012 compared to data from 2018 and will report back to the HCP Coordinating Committees.

Ferguson suggested making Truscott's same Rocky Reach Dam revisions to the Rock Island Dam data for consistency. Keller said Chelan PUD can make these revisions. Ferguson noted the trend of early runoff in recent years and suggested structuring future fish spill reports in the same fashion (i.e., describing both percentage of run with fish spill versus the percentage of run with forced and fish spill). Truscott said the CCT do not have an issue with structuring future reports in this way; however, he also does not want to get into a situation where fish spill is terminated sooner because managers are relying on hydraulic spill prior to summer fish spill to make up the 95% coverage. Keller agreed and said Chelan PUD agreed to implement and follow the Final 2018 Rock Island and Rocky Reach Fish Spill Plan, as approved by the Rock Island and Rocky Reach HCP Coordinating Committees (on March 27, 2018). Truscott said he does not want to lose protection on the back end because it was provided on the front end. Keller assured Truscott that the Final 2018 Rock Island and Rocky Reach Fish Spill Plan includes criteria for both. Keller said management decisions are based on fish handled, current trends and passage rates, and data in-hand.

Keely Murdoch asked if this distinction between fish spill and combined hydraulic and fish spill can be shown graphically? Keller said this can be shown with two separate lines and maybe a footnote providing clarification. Chelan PUD will update the draft 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report to report consistent data for Rocky Reach and Rock Island fish spill programs and a more detailed explanation of spill coverage and will provide a revised draft report for HCP Coordinating Committees review. *(Note: Keller provided a revised report to Geris on October 19, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

Keller thanked Mosey for following the spill season so closely and examining all data to provide adequate spill coverage throughout the season. Keller said this is a complicated process and Mosey executes it well.

B. Rocky Reach Unit C1 Update (Lance Keller)

Lance Keller said the engineered trunnion seals arrived from Germany last week. Keller said the mechanic crew installed the new seal in Unit C1 and is now testing the seal, and the superintendent indicated the test results should be available within 1 week. Keller said he will provide the test results from the engineered trunnion seals for Rocky Reach Unit C1 as soon as the results are available. He said testing involves installing the new seal, filling the hub with oil, actuating the blades up and down while looking for leaks, and pressurizing the hubs while looking for leaks. *(Note: Keller provided an update to Kristi Geris on October 16, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

Kirk Truscott asked what "Plan B" is if the engineered seal does not work? Keller said Chelan PUD is already discussing this. He said he hopes the seal works and if it does not, he will bring Plan B to the HCP Coordinating Committees next month. He said the 2019 bypass season is quickly approaching, and Chelan PUD is well-aware this fix needs to happen soon.

Keely Murdoch asked if this is the first time this has happened? Keller said yes, that the only other time Unit C1 and Unit C2 were out of service for the bypass season was due to issues with the wedge carriers which resulted in the units being down for part of a summer.

John Ferguson asked if Chelan PUD is ready to provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals? Keller asked to carry this action item forward.

C. Rock Island Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller reported that scheduling staff are continuing drafting reiterations of outage schedules trying to determine what works best with the new guidelines for minimum unit outages to allow more workspace while addressing workload and safety concerns. He said the issues with Unit B6 and Unit B9 appear to be the same and can hopefully be resolved together. He recalled that Chelan PUD has an agreement with Andritz Hydro. He said there have been multiple meetings and discussions to determine what went wrong and how, and a decision was finally reached to continue moving forward with Andritz Hydro. Keller said this agenda item will be reoccurring as the maintenance continues and he will keep the HCP Coordinating Committees updated on schedule as it becomes available.

IV. Douglas PUD

A. DECISION: Wells Project Land-Use Permit Application for Wells Tract 115 (Tom Kahler)

Tom Kahler recalled that a Wells Project Land-Use Permit Application for Wells Tract 115 was distributed to the HCP Coordinating Committees by Kristi Geris on July 21, 2018. Kahler said after discussing the application during the HCP Coordinating Committees meeting on August 28, 2018, he discussed

Wells HCP Coordinating Committee comments with Beau Patterson and provided a response to these comments via email on August 29, 2018 (Attachment C). Kahler asked the Wells HCP Coordinating Committee if Patterson's response adequately addressed the outstanding questions.

Kirk Truscott said the CCT are more comfortable with the application knowing that Douglas PUD is conducting the spraying as opposed to the landowner. Keely Murdoch noted that the landowner is still mowing and raking, yet the application also mentions allowing the natural succession of vegetation to proceed and mowing and raking seems counterproductive to natural succession. Truscott agreed noting that both of these are ground-disturbing activities that allow for more noxious weeds. He proposed instead, that Douglas PUD sprays for apple shoots and noxious weeds as opposed to mowing and raking. Kahler agreed mowing weeds reduces seed production, but also does so for native plants. Truscott asked about the landscape in the proposed area. Kahler said there is a ton of thistle and upland grass. Murdoch agreed with Truscott's suggestion for spraying over raking and mowing.

Kahler summarized that some Wells HCP Coordinating Committee representatives provided indication of no comment, while some provided comments. He said he will discuss with Patterson the CCT and the YN comments on the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees.

B. Douglas PUD 2020 Verification Survival Study Plan (Tom Kahler)

Tom Kahler said a draft 2020 Wells Project Survival Verification Study Plan (Attachment D) was distributed to the HCP Coordinating Committees by Kristi Geris on September 24, 2018. Kahler said this study plan is essentially the same study plan Douglas PUD has implemented since 1998 (used in each successive study since 1998).

Kahler reviewed Attachment D. He said the details of each verification survival study conducted by Douglas PUD are included in this plan. He said key components that have changed from past plans are the sample sizes and release numbers, which are based on current estimates by Drs. John Skalski and Richard Townsend (Columbia Basin Research). Kahler said the study needs to maintain the same density in each vessel (i.e., there cannot be 1.5 containers), and each release location will have a predetermined number of full containers (556 fish per container). He said the various formulas describing model calculations are the same and the release locations are the same. He said the target is to have a minimum of 100,000 PIT-tagged yearling Chinook salmon to achieve the estimated level of precision for the study. He recalled in the previous study in 2010, there were just under the target amount of study fish planned but precision targets were still met. He said there is concern with having a river flow year similar to 2018, which could affect PIT detections. He said release numbers are described on page 3 of Attachment D. He said the releases are staggered in time so the fish for each release mix as they migrate downstream through the PIT detection stations.

He said in this way each replicate is subjected to the same river influences and same detection probability. He said page 13 of Attachment D (Section 3.4) describes the assumptions, all of which are standard procedure for a paired release and are necessary to validate the study. He said page 16 of Attachment D (Section 3.5) describes anticipated precision, which includes a graph from Skalski's report that was distributed to the HCP Coordinating Committees earlier in 2018 (*Sample Size Calculations for a 2020 Check-In Study of Project Passage Survival at Wells Dam* [Skalski and Townsend 2018], final distributed April 13, 2018).

Kahler said this plan is available for a 60-day review period. He said this should be ample time to formulate questions and discuss these at future meetings. John Ferguson suggested further discussing this plan during the HCP Coordinating Committees meetings on October 23, 2018, and November 27, 2018; therefore, adjusting the review period to a 63-day review with edits and comments due to Kahler by Tuesday, November 27, 2018. *(Note: the HCP Coordinating Committees meeting on November 27, 2018 was subsequently rescheduled to December 4, 2018.)*

Kirk Truscott said, as he has commented in the past, the release locations in the tributaries do not account for full project effects. He recalled the response he has received that there is a need to maintain the same release locations as past studies for comparability. He said he does not agree with this. Kahler said the release locations are stipulated in the Wells HCP.

Ferguson said Figure 1 in Attachment D shows the release locations and he asked where exactly were the locations before? Kahler said in the same locations and added that this is the same figure used for past studies. He said fish are loaded into containers and onto barges and released in the tailrace. He said the same is true for the mouths of the Methow and Okanogan rivers. He said fish are also trucked the same amount of time regardless of release location. He said at Wells Dam, six containers are released in the tailrace. He said the containers are opened sequentially one at time as the barge moves across the tailrace as close to the dam as safely possible given the tailrace conditions on any given release date.

V. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on October 23, 2018, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

John Ferguson recalled about 1 year ago, he received a phone call from Melody Kreimes (Executive Director for Upper Columbia Salmon Recovery Board [UCSRB]) and Greer Maier (Science Program Manager for UCSRB) provided an update to the HCP Coordinating Committees on the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan, notably the recovery strategies integrated across all four Hs (habitat, harvest, hydropower, and hatcheries). Ferguson recalled at that time, work was wrapping up on the draft UCSRB Hatchery Background Summary and starting on the draft UCSRB Hydropower Background Summary. Ferguson said Kreimes recently contacted him notifying him the draft UCSRB Hydropower Background Summary will be completed in early October 2018 and asked that Maier be scheduled to present an update on the Hydropower Background Summary. Ferguson said Maier is tentatively scheduled to present the summary during the HCP Coordinating Committees meeting on October 23, 2018, if time allows.

Kristi Geris noted that the regularly scheduled HCP Coordinating Committees meeting in December 2018 lands on the Christmas holiday this year. The HCP Coordinating Committees agreed to move the meeting up 1 week to Tuesday, December 18, 2018, to be convened via conference call, if needed. Geris said she will notify Tracy Hillman (HCP Hatchery Committees Chairman), Denny Rohr (PRCC Facilitator), and Grant PUD office building staff that the HCP Coordinating Committees meeting in December 2018 will be held via conference call on December 18, 2018, if needed. *(Note: Geris provided this notification, as discussed.)*

The November 27, 2018 meeting will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, and the December 18, 2018 meeting will be held by conference call, if needed. *(Note: the HCP Coordinating Committees meeting on November 27, 2018, was subsequently rescheduled to December 4, 2018, to accommodate attendance to the annual U.S. Army Corps of Engineers Anadromous Fish Evaluation Program conference in Portland, Oregon, from November 27 to 28, 2018.)*

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report
Attachment C	Wells Project Land-Use Permit Application for Wells Tract 115 – response to comments
Attachment D	Draft 2020 Wells Project Survival Verification Study Plan

Attachment A
List of Attendees

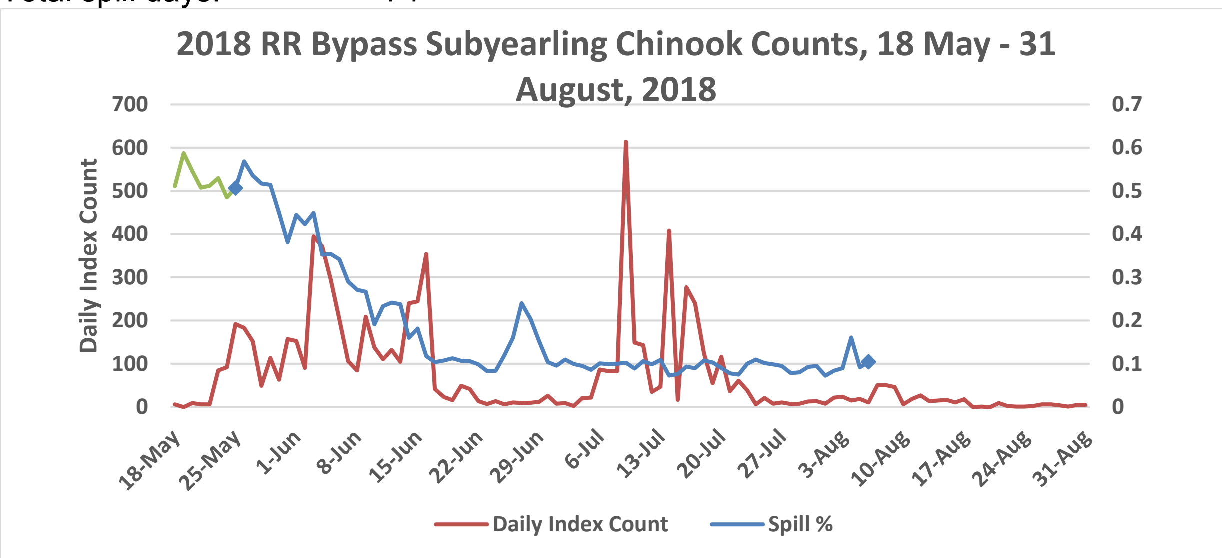
Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Thad Mosey	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

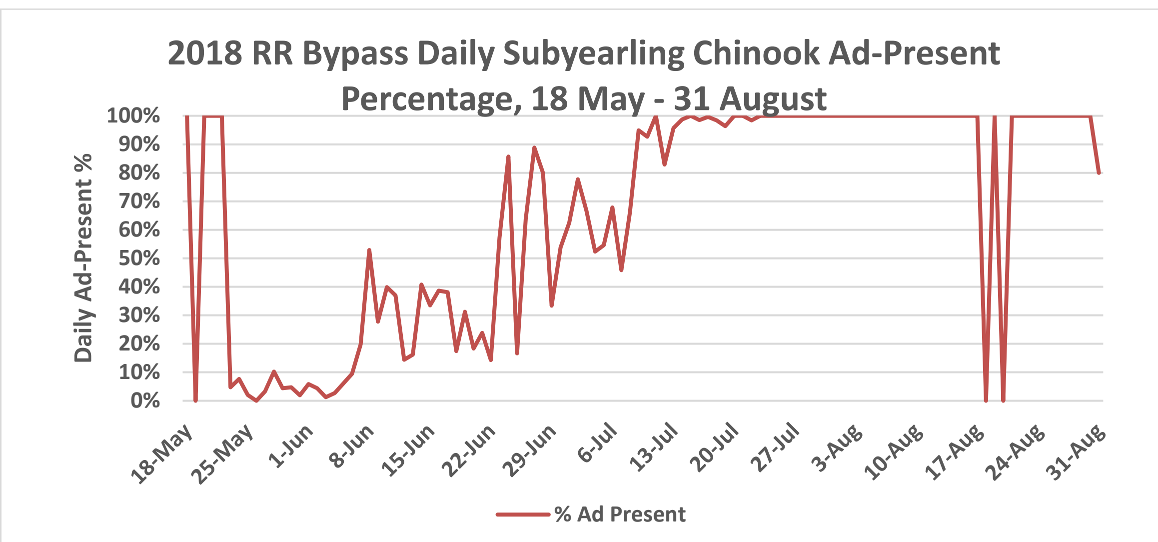
Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

Chelan PUD
Rocky Reach and Rock Island HCPs
Draft 2018 Fish Spill Report

2018 ROCKY REACH
Summer Spill

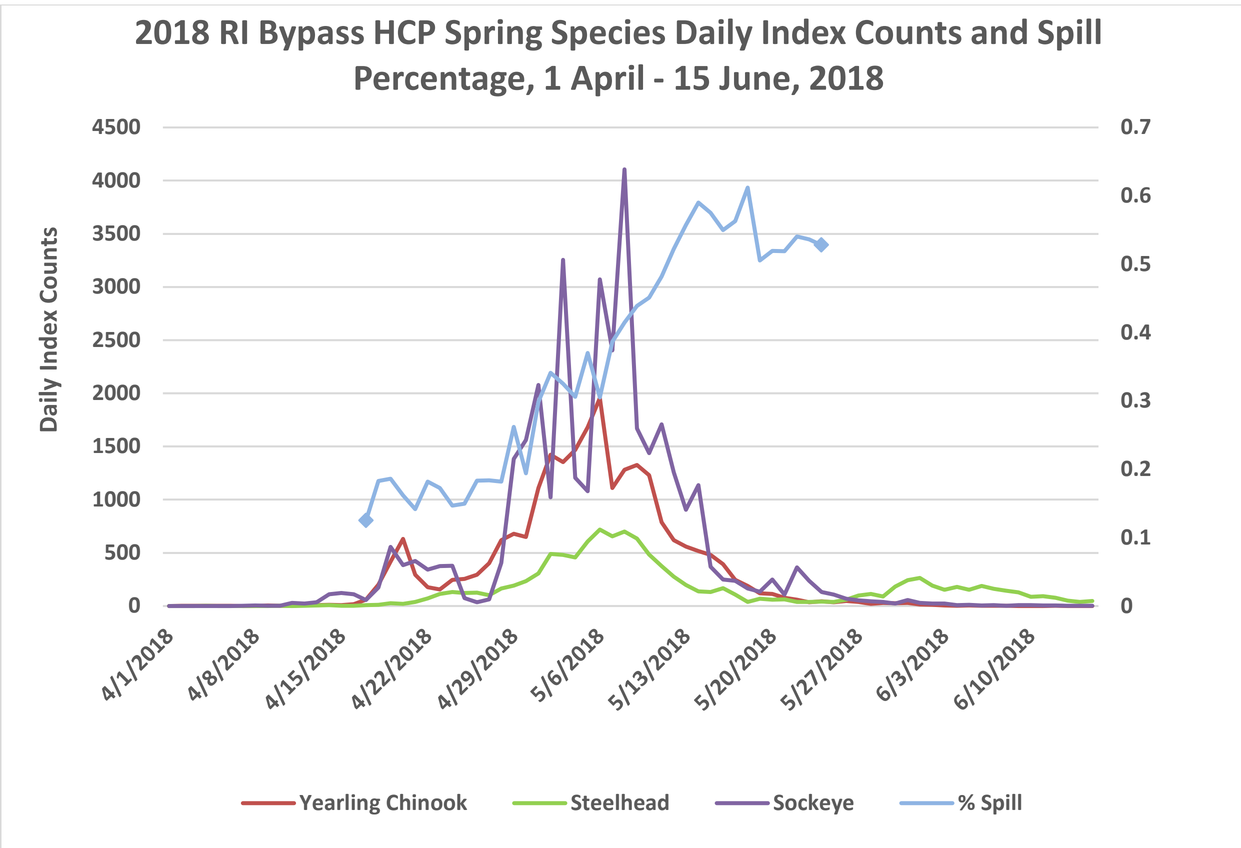
Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	25 May, 0001 hours
Spill stop date:	6 August, 2400 hours
95% Est. passage date:	28 July
Percent of run with spill:	94.1% on 6 August (estimated as of 31 August)
Cumulative index count:	9,122 subyearling Chinook (as of 31 August)
Summer spill percentage:	22.29% (9.14% fish spill, plus 13.15% forced spill)
Avg river flow at RR:	154,663 cfs (25 May - 6 August)
Avg spill rate at RR:	34,471 cfs (25 May - 6 August)
Total spill days:	74





<u>2018 ROCK ISLAND</u>
Spring Spill

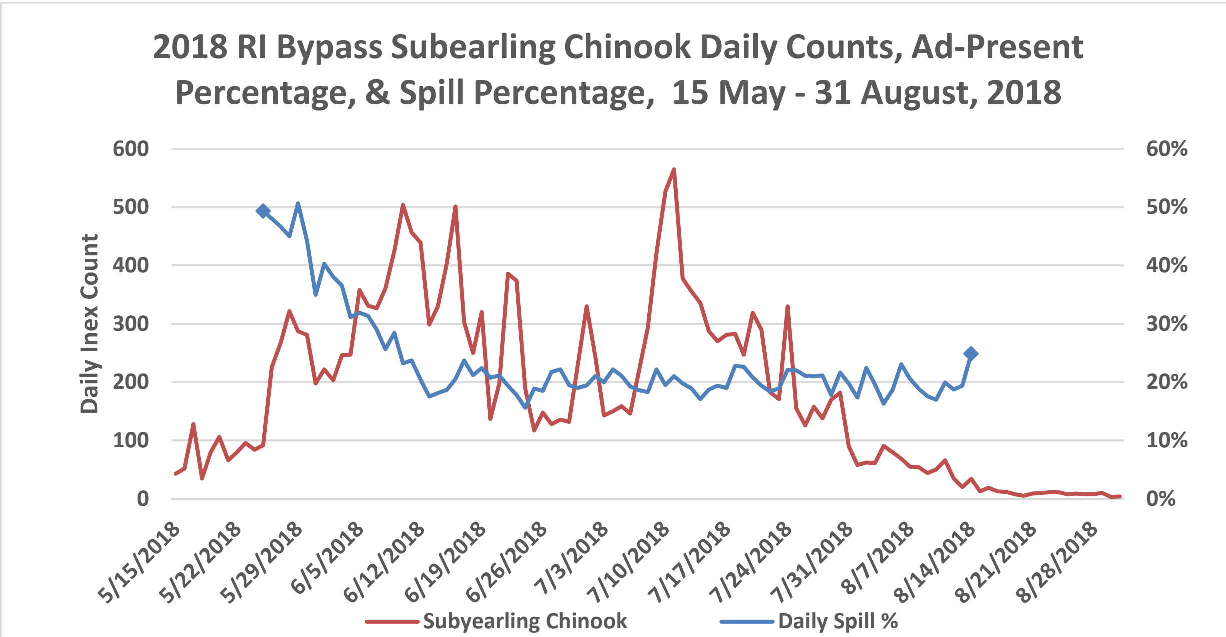
Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	17 April, 0001 hours
Spill stop date:	24 May, 2400 hours (*immediate increase to 20% summer spill at 0001 hours on 25 May*)
Percent of run with spill:	Yearling Chinook – 99.8%; steelhead – 99.9%; sockeye – 99.2% (*spring and summer fish spill combined*)
Cumulative index count:	49,702 yearling Chinook**;** 24,731 steelhead**;** 76,245 sockeye (as of 31 August)
Spring spill percentage:	40.44% (9.76% fish spill, plus 30.68% forced spill)
Avg river flow at RI:	248,592 cfs (17 April – 24 May)
Avg spill flow at RI:	100,524 cfs (17 April – 24 May)
Total spill days:	38

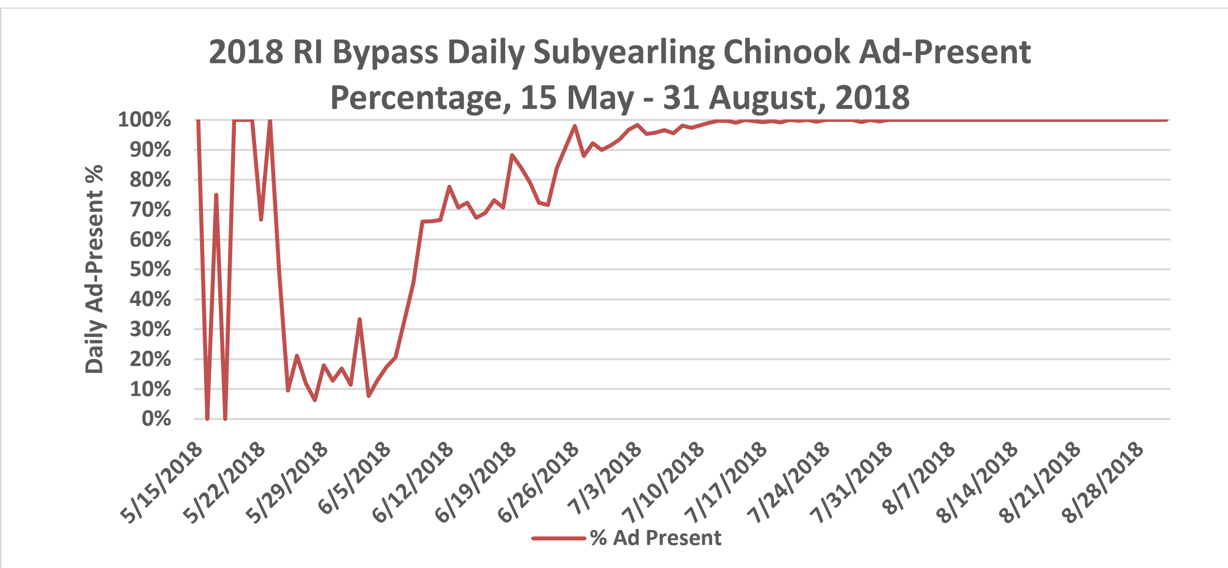


2018 ROCK ISLAND

Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	25 May, 0001 hours
Spill stop date:	14 August, 2400 hours
95% Est. passage date:	31 July
Percent of run with spill:	99.3% on 14 August (estimated as of 31 August)
Cumulative index count:	27,540 subyearling Chinook (as of 31 August)
Summer spill percentage:	26.00% (19.86% fish spill, plus 6.14% forced spill)
Avg river flow at RI:	153,685 cfs (25 May - 14 August)
Avg spill flow at RI:	39,964 cfs (25 May - 14 August)
Total spill days:	82





Juvenile Index Counts 2008-2018 from the Rocky Reach Juvenile Fish Bypass Sampling Facility and Rock Island Bypass Trap Smolt Monitoring Program (SMP) 1 April – 31 August (Tables 1 and 2).

Table 1. Rocky Reach Juvenile Bypass index sample counts, 2008-2018

Species	2008	2009	2010	2011	2012	2013	2014*	2015	2016	2017	2018
Sockeye	136,206	40,758	724,394	67,879	384,224	199,497	553,645	53,575	1,374,418	**60,432**	**597,162**
Steelhead	8,721	6,309	4,931	5,683	4,902	2,528	5,270	4,157	1,478	**2,928**	**1,458**
Yearling Chinook	38,394	18,946	33,840	24,400	95,207	29,018	15,871	32,220	41,676	**37,302**	**23,274**
Subyearling Chinook	11,820	11,944	59,751	17,246	5,774	22,073	22,327	37,104	8,905	**27,404**	**9,122**

Table 2. Rock Island Smolt Monitoring Program index sample counts, 2008-2018

Species	2008	2009	2010	2011	2012	2013	2014*	2015	2016	2017	2018
Sockeye	38,965	4,926	37,404	18,697	46,788	25,111	38,596	4,128	56,638	**11,117**	**76,245**
Steelhead	22,780	17,636	17,194	28,408	16,957	15,099	28,299	12,549	17,663	**32,135**	**24,731**
Yearling Chinook	22,562	9,225	11,802	26,407	25,759	28,324	26,429	16,762	44,784	**50,604**	**49,702**
Subyearling Chinook	15,940	8,189	23,205	27,397	27,298	17,170	34,527	15,349	13,270	**63,579**	**27,540**

* In 2014, as directed by the HCP, Chelan PUD conducted bypass operations outside of the normal operating period of 1 April to 31 August to assess achievement of bypass operations for 95% of the subyearling Chinook outmigration. The Rocky Reach juvenile fish bypass operated from 1 April through 15 September, and the Rock Island bypass facility at powerhouse 2 operated from 1 April through 15 September.

From:	Kristi Geris
To:	Jackson, Chad S (DFW); Jim Craig (jim_l_craig@fws.gov); John Ferguson; Keely Murdoch (murk@yakamafish-nsn.gov); Keller, Lance; kirk.truscott@colvilletribes.com; Kristi Geris; Scott Carlon; "Tom Kahler (tkahler@dcpud.org)"
Cc:	Andrew Gingerich (andrewg@dcpud.org); Bob Rose; Casey Baldwin; Justin Yeager; Shane Bickford (sbickford@dcpud.org); Steve Hemstrom (steven.hemstrom@chelanpud.org); Verhey, Patrick M (DFW); "william_gale@fws.gov"
Subject:	FW: Land-use questions from yesterday
Date:	Wednesday, August 29, 2018 12:11:04 PM

Hi HCP-CC reps/alts: please see the email below from Tom regarding the Wells Project Land-use Permit Application for Wells Tract 115. Thanks! -kristi

Kristi Geris

ANCHOR QEA, LLC
kgeris@anchorqea.com
C 360.220.3988

From: Tom Kahler <tomk@dcpud.org>
Sent: Wednesday, August 29, 2018 11:57 AM
To: Kristi Geris <kgeris@anchorqea.com>
Cc: John Ferguson <jferguson@anchorqea.com>; Andrew Gingerich <andrewg@dcpud.org>
Subject: Land-use questions from yesterday

Hi Kristi,

Please share with the CC abbreviated distribution list.

Thanks,

Tom

I talked with Beau about the questions posed by the committee yesterday regarding the land-use application. The property was an active orchard, a use that was grandfathered at the time the PUD acquired the property, rather than something permitted later (thus, no permit terms continue to apply). Of course, the trees were removed, and the law requires us to spray the apple shoots originating from remaining roots until those roots no longer produce shoots. We are also required to control noxious weeds on the property, which would be facilitated by the proposed mowing. The original land owner owned the water rights for the orchard, and they have sold those rights, so irrigation is no longer an option. Our practice in cases of cessation of agricultural activities on upland property is to allow succession of the plant community while controlling noxious weeds. The cases where we require the restoration of native vegetation are when the adjacent landowner using the property under permit has removed existing vegetation in violation of permit conditions. That is not the case with the subject property.

In the case of the subject property, none of the proposed actions would occur in the currently vegetated riparian zone. That zone is demarcated by an access road for Okanogan PUD that runs between the former orchard and the riparian vegetation. The width of the vegetated riparian zone ranges between 91-feet wide at the north end, and 70-feet wide at the south end, with the minimum width of 25 feet at some point in between those measurements. Expansion of the zone of riparian vegetation is precluded by the need to maintain the OPUD access road and the lack of irrigation water. Without this application, we would not plant additional vegetation but would continue to spray the apple shoots and noxious weeds; however, we would not mow and rake. On approving this application, we would allow the applicant to mow and rake as proposed, and we would continue our obligatory spraying of noxious weeds and apple shoots.

WELLS PROJECT SURVIVAL VERIFICATION STUDY

Phase III (Standard Achieved)
2020 Study Plan

Study Proposal

September 24, 2018

Prepared By:
Andrew Gingerich
Tom Kahler

Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, WA 98802

And

John R. Skalski
Columbia Basin Research
School of Aquatic and Fishery Sciences
University of Washington
1325 Fourth Avenue, Suite 1820
Seattle, Washington 98101-2509

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1.0 INTRODUCTION

The Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP) was developed to ensure that the Wells Project has No Net Impact (NNI) on juvenile and adult salmon and steelhead migrating through the Wells Hydroelectric Project (Wells Project). The five species of anadromous fish covered by the HCP are defined as Plan Species, and include spring and summer/fall Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), steelhead (*O. mykiss*) and coho (*O. kisutch*). As part of measuring whether or not NNI is being achieved and maintained, the Wells HCP requires the Public Utility District No. 1 of Douglas County (Douglas PUD) to periodically conduct studies of juvenile salmon survival at the Wells Project. The results of these studies are subsequently used to guide passage and mitigation programs for Plan Species migrating through the Wells Project. The Passage Survival Plan included in the HCP was structured with a phased implementation plan. Phase I (1998 through 2002) required, "juvenile and adult operating plans and criteria to meet the survival standards set forth in HCP sub-Section 4.1, and a monitoring and evaluation program to determine compliance with the standards" (Section 4.2.1). During Phase I, Douglas conducted three years of valid juvenile project survival studies with steelhead and yearling Chinook salmon. Results from these studies consistently exceeded the 93% juvenile project survival standard and the precision and accuracy requirements of the HCP (Bickford et al. 1999; 2000; 2001). The average juvenile project survival for yearling Chinook and steelhead over the three years of study was 96.2%. The results from the Phase I juvenile project survival studies, coupled with the results from the adult passage studies, provided the necessary information for the HCP Coordinating Committee to determine that the Wells Project had achieved Phase III (Standard Achieved) for yearling Chinook and steelhead.

Phase III of the Passage Survival Plan (Section 4.2.5) indicates that following achievement of the survival standard, periodic monitoring is required to ensure that the survival of Plan Species is maintained in compliance with the survival standards set forth in the plan for the term of the Agreement. Therefore, Douglas is required to "re-evaluate performance under the applicable standards every 10 years," by means of a one-year reevaluation of juvenile project survival for yearling spring-migrant species. The results from the one-year juvenile project survival reevaluation study will be included in the pertinent multi-year average for yearling spring migrants. If the survival standard is verified, Douglas will remain in Phase III (Standard Achieved). Otherwise, additional testing will occur, followed by Phase II (Interim or Additional Tools) if the standard cannot be achieved within three years of reevaluation. Douglas PUD performed the first Survival Verification Study (SVS) during the 2010 juvenile migration, demonstrating continued achievement of Phase III (Standard Achieved) with estimated juvenile Project survival of 96.4% (Bickford et al. 2011). This result was statistically similar to the three years of the Phase I studies (1998-2000), and combined with the survival estimates from those studies, resulted in a four-year-average Juvenile Project Survival value for of 96.3% for yearling Chinook and steelhead.

Douglas PUD proposes to conduct a Phase III (Standard Achieved) Survival Verification Study in 2020, on the 10th anniversary of Douglas PUD's 2010 SVS and the 20th anniversary of Douglas PUD's third and final year of Phase I survival studies. Similar to prior years of study, the 2020 SVS is designed to meet the precision and accuracy requirements found in Section 4.1.4

of the Wells HCP. With the Wells HCP Coordinating Committee's addition in 2015 (Wells HCP CC 2015) of Methow River coho to the Plan Species designated as in Phase III (Standard Achieved), Douglas PUD's 2020 SVS is intended to verify continued achievement of the Juvenile Project Survival Standard for spring-migrating yearling coho, steelhead, and Chinook.

1.1 Study Area

The Wells Project is located at river kilometer (Rkm) 830 on the upper Columbia River. Wells Dam, the principal component of the Wells Project, includes ten Kaplan-turbine generating units, with an installed nameplate capacity of 774.3 MW and a maximum generating capacity of 840 MW. The design of the Wells Project is unique in that the generating units, spillways, switchyard and fish passage facilities are combined into a single structure referred to as a hydrocombine. The hydrocombine is 1,130 feet long and 168 feet wide with a top deck elevation of 795 feet above mean sea level (MSL). The Wells juvenile fish bypass system (JBS) is located in the spillways at Wells Dam. The JBS is designed to bypass fish away from the turbines via a highly effective surface collection system. The Wells JBS provides a safe, non-turbine passage route through the dam for over 92% of the spring and 96% of the summer migrants (Johnson et al. 1992; Skalski et al. 1996). Wells Dam is the uppermost generating project on the Columbia River through which anadromous Chinook, steelhead, sockeye, and coho migrate on their way to and from the Pacific Ocean. Adult fish passage is provided by two fish ladders located at either end of the hydrocombine.

The reservoir formed by Wells Dam, has two primary tributaries with substantial natural and hatchery production of Plan Species. The Methow River enters Lake Pateros at Rkm 843, and produces the majority of yearling Chinook salmon, coho, and steelhead upstream of Wells Dam. The Okanogan River enters Lake Pateros at Rkm 870, and supports a major population of summer/fall Chinook, nearly all of which migrate as subyearlings. Most of the yearling steelhead and Chinook salmon smolts migrating out of the Okanogan River are hatchery fish planted into this system as mitigation for impacts associated with the construction and operation of various Columbia River dams. The Okanogan River has neither natural nor hatchery production of coho.

1.2 Study Goals

The primary goal of the 2020 SVS is to confirm that survival through the Wells Project for yearling Chinook, coho, and steelhead remains equal to or above the 93% Juvenile Project Survival Standard. Toward supporting the primary goal of the study, the SVS is also designed to test the assumptions of the Single (SR) and Paired-Single (PSR) release-recapture models, and estimate capture and reach-specific survival probabilities through the mid-Columbia River, including delayed mortality, to the extent that it can be measured. The SVS will also provide additional information related to the physiology, behavior, migration speed and survival of yearling Chinook (see Section 2.1, below) through the mid-Columbia River.

2.0 METHODS

This section provides the study methods, including study fish and physical field approach proposed to implement the 2020 SVS.

2.1 Study Fish

Following adult collection and spawning in 2018, yearling summer Chinook salmon (brood year 2018) would be reared on station at the Wells Fish Hatchery (WFH) for use in the SVS. Chinook parr will be PIT-tagged during February of 2020 and will be held in raceways until transfer to release containers in April and May of 2020 one day prior to release. Tagging two months before release gives ample recovery time for study fish prior to the spring outmigration. Early tagging will also allow researchers to closely monitor fish for tag shed and diseases that would introduce study bias. Planned fish collection, transportation, and physiological monitoring techniques are summarized as follows:

Juvenile Chinook salmon will be collected from raceways and tagged according to criteria described in Prentice et al. (1987). Occurring on five tagging days, small groups of untagged Chinook, will be held in one of the pre-tagging raceways, and crowded into a pint-sized-pescalator (PRA Manufacturing, Nanaimo, British Columbia, Canada). As the pescalator rotates, it will capture and transport water and fish up and out of the raceway, deposit fish into a 10-cm transport pipe, and deliver the fish into Biomark's tagging trailer where the fish will be held until anesthetized using a solution of water and Methanosulfonate-222 (MS-222). Once anesthetized, diseased and mortally wounded Chinook salmon smolts will be removed from the study group. Remaining healthy Chinook will be tagged with 12.5-mm, 134.2-kHz ISO FDX-B PIT tags (Biomark APT12 or replacement) preloaded in single-use needles packaged in Biomark HPT12 Pre-load Trays, and injected using hand-held injection devices (Biomark MK-25 or equivalent). All fish will be tagged with a single-use needle to reduce the chance of disease transmission, injuries caused by dull needles, and the number of personnel required on the project. Immediately following tagging, fish will be randomly assigned to one of the 15 replicate release groups and held in common with the rest of the fish assigned to that release replicate. In addition to the tag code, date of tag implantation, tag personnel identification code, fork length, fish condition, water temperature, and release-group assignment will be recorded and stored using P4 software. Upon release of tagged fish, tagging files for each tag group will be uploaded to the PTAGIS database maintained by the Pacific States Marine Fisheries Commission. Each tagged replicate (i.e., treatment and control paired-release groups) of study fish will be held within one large-volume rearing container at the Wells Fish Hatchery. The common rearing environment reduces differences in fish health and physiology between treatment and control groups.

Starting on April 20, 2020 and continuing every other day through May 19, 2020, n = 15 replicate release groups of Chinook will be re-collected using the pescalator, interrogated for PIT-tags codes, and then placed into a release container randomly assigned to one of the three release sites (Okanogan, Methow, or tailrace). Each release container will hold approximately 1,100 L of water and loaded with no more than 556 PIT-tagged fish. Loading densities will be limited to no more than 0.023 Kg of fish per liter of water (Kg fish/L). During the interrogation and pre-release holding phases of the study, release containers will be supplied with 80-100 L/min of river water through a 5-cm flex-hose. Water temperatures and dissolved oxygen levels inside each release container will be closely monitored and recorded hourly throughout the duration of the study to ensure that the pre-release recovery history of each container is similar within and between release sites and replicate release groups.

The treatment release groups will comprise fish destined for release at the Okanogan and Methow release sites. The control release groups will comprise fish destined for release into the tailrace of Wells Dam. In order to represent the migration of yearling Chinook salmon, coho, and steelhead passing through the Wells Project originating from these two river systems, treatment fish will be released at each river mouth in approximate proportion to the historic natural and hatchery production originating from that river. The Okanogan River produces approximately 33% of that total combined production, and the Methow River produces approximately 67%. These proportions result in six release containers for each tailrace release, four for each Methow release, and 2 for each Okanogan release (see Section 3.2, below).

As a final measure towards representing the run-at-large, we propose a release schedule to match the average migration timing of yearling Chinook passing Wells Dam. Because of the requirement to have the Okanogan, Methow, and tailrace release groups comingle and experience similar downstream river conditions, the Okanogan River releases will take place at 1700 hours on even days starting on April 20, 2020 and ending on May 18, 2020. Methow and tailrace releases will take place at 1000 hours and 1400 hours, respectively on odd days starting on April 21, 2020 and ending on May 19, 2020. Each replicate release will take two days and consist of loading all of the replicate pair release containers on even days (Table 1).

Table 1. Proposed Survival Verification Study release schedule (April 20 to May 19)

	Day 1		Day 2		Day 2	
	Okanogan Release		Methow Release		Tailrace Release	
Activity	**Start time**	**Duration**	**Start time**	**Duration**	**Start time**	**Duration**
On location ready to go	3:00 PM	0:20	8:00 AM	0:20	Noon	0:20
Load truck at hatchery	3:20 PM	0:20	8:20 AM	0:20	12:20 PM	0:20
Transport to barge loading site	3:40 PM	0:30	8:40 AM	0:30	12:40 PM	0:30
Load barge (boom or crane)	4:10 PM	0:20	9:10 AM	0:20	1:10 PM	0:20
Barge to release site	4:30 PM	0:30	9:30 AM	0:30	1:30 PM	0:30
Release fish	5:00 PM	0:10	10:00 AM	0:10	2:00 PM	0:10
Return to barge loading site	5:10 PM	0:30	10:10 AM	0:10	2:10 PM	0:00
Return to hatchery	5:40 PM		10:20 AM		2:10 PM	

In order to transport release groups, release containers will be disconnected from the river water supply lines at the Wells Hatchery and transported with a forklift to a flatbed truck. Once all of the release containers for a release event are affixed to the flatbed truck, metered compressed oxygen bottles affixed to each release container, will supply flow rates of less than 1.0 L/minute of oxygen. To compensate for differences in travel distances between the Okanogan, Methow and tailrace barge loading sites, the transport vehicle destined for each site will make purposeful excursions to equalize the amount of time fish spend on the truck in transport. These excursions will be used to ensure that the total travel times, dissolved oxygen and stress levels for each release group are similar.

At the barge loading stations, oxygen supplementation will be turned off and release containers hoisted off the transport trucks and loaded onto barges for final release. Once each release container is affixed to the barge, the on-barge river-water supply system will be connected and the valve turned on. Desired dissolved oxygen concentrations inside each container will be manually adjusted to maintain 9 to 12 mg O_2/L. River-water flow through each container on the barge will approximate 60-80 L/minute. After all of the release containers are loaded onto the barge, 10 PIT-tagged fish will be randomly netted out of a randomly assigned release container and screened for various physiological parameters (See Section 2.2 Pathology, Physiology, below). The barge will be subsequently towed to the release sites by a tow boat. Immediately prior to release, water temperatures and dissolved oxygen levels will be recorded from each release container and from the river. Qualitative fish activity levels will also be recorded, and injured or moribund fish removed (all PIT tags recorded). Following the pre-release inspection, the fish will be released from the release container through a 20 x 15 cm eccentric reducer. In general, all of the fish used in this study are expected to be released within 2 hours after the water lines at the Wells Hatchery are disconnected prior to loading.

After release, each tank will be emptied and the release site examined for dead or moribund fish and tanks inspected for shed tags. Release files will be submitted to the PSMFC PTAGIS 24-48 hours after each release to allow for removal of any tank mortalities, physiology-sample fish, or for changes to the release-group information.

2.2 Pathology, Physiology

To document potential differences within and between replicate release groups, an assessment of relative morphology, physiology, and pathology will be conducted. To do so, ten fish from each of the 45 release groups will be collected prior to release. Measures of morphology (length, weight), indices of fish health (color and texture of internal organs, fin erosion, descale, mesentery fat) and disease (bacterial kidney disease, flagtail, cold water disease, flukes, Ich), physiological status of smoltification (gill ATPase and smolt index), and measures of acute stress (plasma cortisol) and chronic stress (plasma glucose), will be collected by Douglas PUD's DMV or trained staff. The information collected will be used to determine whether or not there are differences in fish health, condition, smoltification and stress within each replicate release pair that might bias the replicate survival estimates. In addition, comparisons will be made between replicate release groups in an attempt to document seasonal trends in fish physiology and survival. Additional information to be collected from the post-mortem examination of Chinook include observations of tag placement and counting fish with missing tags, which will generate estimates of PIT-tag retention. Methods used to collect and analyze the morphological, physiological and pathological samples will follow those described in Bickford et al. (2011).

For the purposes of comparing physical attributes between the treatment and the control release groups, within a replicate pairing, the samples means for the two treatment release groups (Okanogan and Methow) will be pooled and subsequently compared to the single control (tailrace) release group. A two-way ANOVA will be used to determine whether or not there were differences between the treatment and control release groups. Where appropriate, either a two-sample Z-test or a Paired t-test will be used to compare physiological sample means. All of the statistical comparisons between the treatment and control release groups will be conducted at a significance level of $\alpha = 0.10$.

2.3 Release Locations

Treatment fish will be released at Pateros and at the mouth of the Okanogan River, and control fish will be released into the Wells Tailrace (Figure 1).

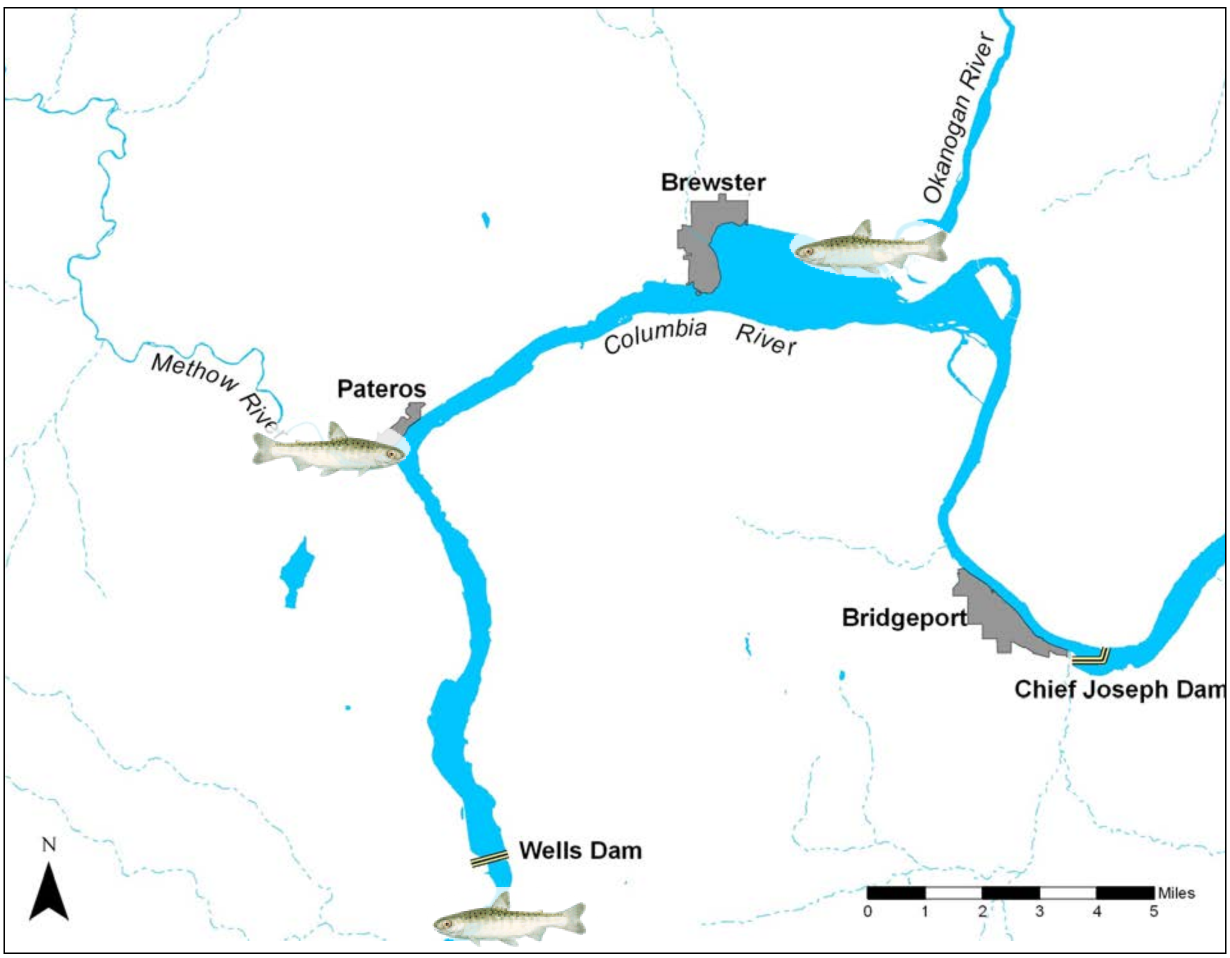

Figure 1 Proposed release locations for the 2020 Survival Verification Study on the Columbia River. Both treatment and control (Wells Dam tailrace) release sites are approximately indicated with juvenile salmon markers.

3.0 Statistical Methodolgy

3.1 Estimation Methodology

Survival estimates generated for the survival reevaluation study will be based upon the SR and PSR models (Cormack 1964; Jolly 1965; Seber 1965; Burnham et al. 1987). Figure 2 provides a schematic of the models approach. These methodologies have been used extensively to accurately estimate project-specific survival for juvenile salmon passing through Columbia River Basin hydroelectric projects (Iwamoto et al. 1994; Muir et al. 1996; Smith et al. 2000). Specifically, these models were used multiple times to successfully generate precise survival estimates of migrating juvenile Chinook and steelhead at Wells Dam (Bickford et al. 1999; 2000; 2001; 2010).

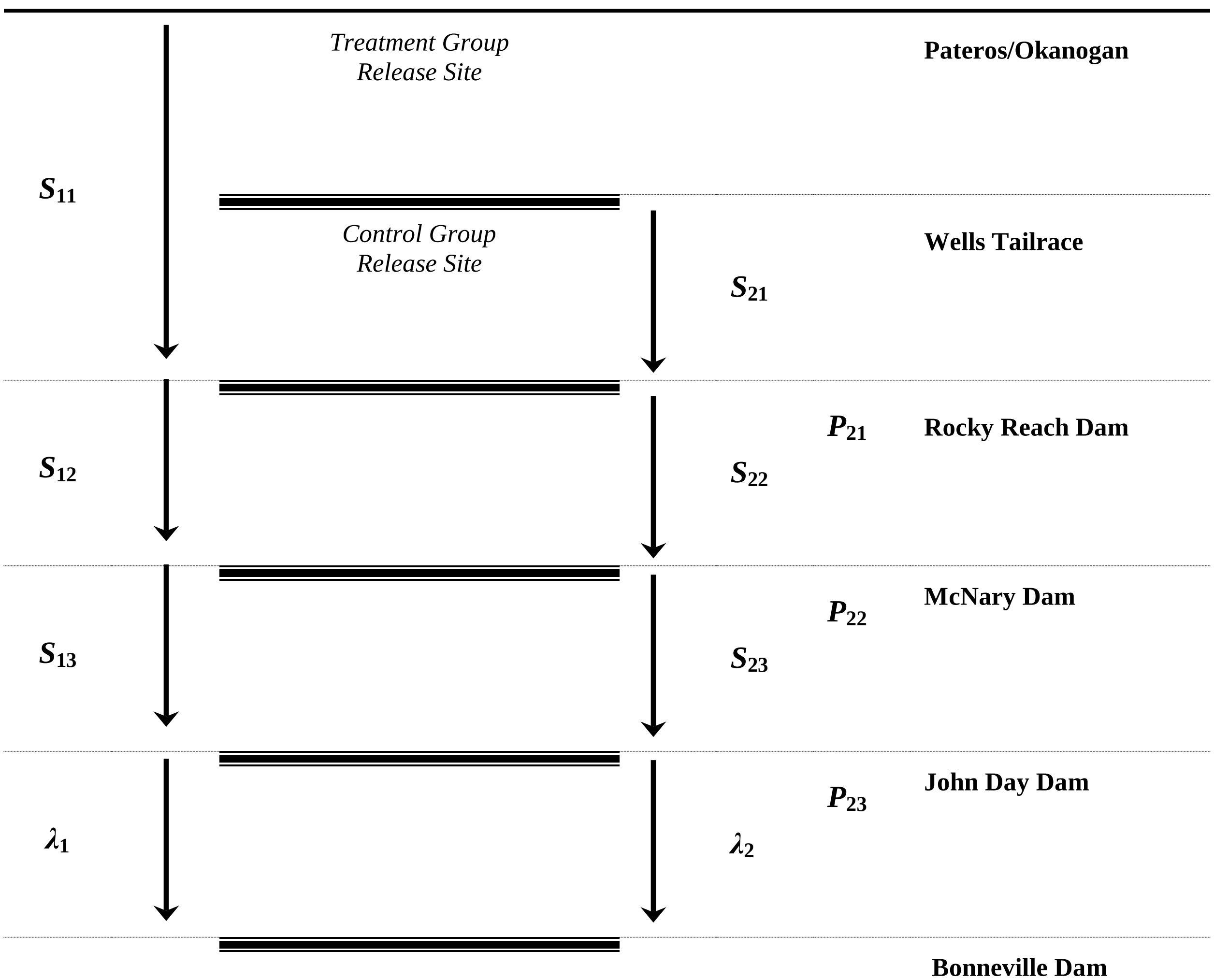

Figure 2 Schematic of release sites and PIT-tag detection facilities used for the 2010 and proposed 2020 SVS at Wells Dam. Parameters that will be estimated from the release-recapture data are indicated alongside.

3.2 Precision Objectives and Sample Size

The primary objective of the 2020 SVS will be to confirm Phase III (Standard Achieved) survival estimates of yearling Chinook, coho, and steelhead migrating through the Wells Project at a 95% confidence level with a standard error that will not exceed ± 2.5% (i.e., $\varepsilon = 0.05$). A minimum of 100,000 PIT-tagged yearling Chinook salmon will be required to achieve the estimated level of precision for the study. The proposed model design requires the release of 15 replicates of PIT-tagged fish at the Okanogan confluence (Okanogan), Methow confluence (Pateros), and the Wells tailrace, at 1:2:3 ratios, respectively.

Each of the 15 replicate release groups will contain approximately 6,666 fish split evenly between treatment (3,333) and control (3,333), and each of the treatment release groups will be further spilt into Pateros (2,222 fish) and Okanogan (1,111 fish) according to the 1:2:3 ratio of Okanogan:Pateros:Tailrace release sites. Each paired release of treatment and control fish will be collected from the same rearing vessel, interrogated for PIT-tag codes, and released on a staggered schedule to allow the treatment groups to join the control group at downstream recapture facilities. Release sites and PIT-tag detection facilities used for the SVS are illustrated in Figures 1 and 2, above.

Proposed total release numbers of yearling Chinook salmon smolts will be approximately 33,500 and 16,500 at the Methow and Okanogan release sites, respectively. While from separate release locations, data from these two releases will be pooled to represent a single fish source comprising fish from the two release locations (Figure 3). A total of 50,000 fish will be released at the Wells tailrace to serve as the downstream control group (Figure 3). The tailrace releases will be within approximately 1,000 feet downstream of the dam. PIT-tag detection sites used in the release-recapture study will be at Rocky Reach, McNary, John Day, and Bonneville dams and the towed estuary array.

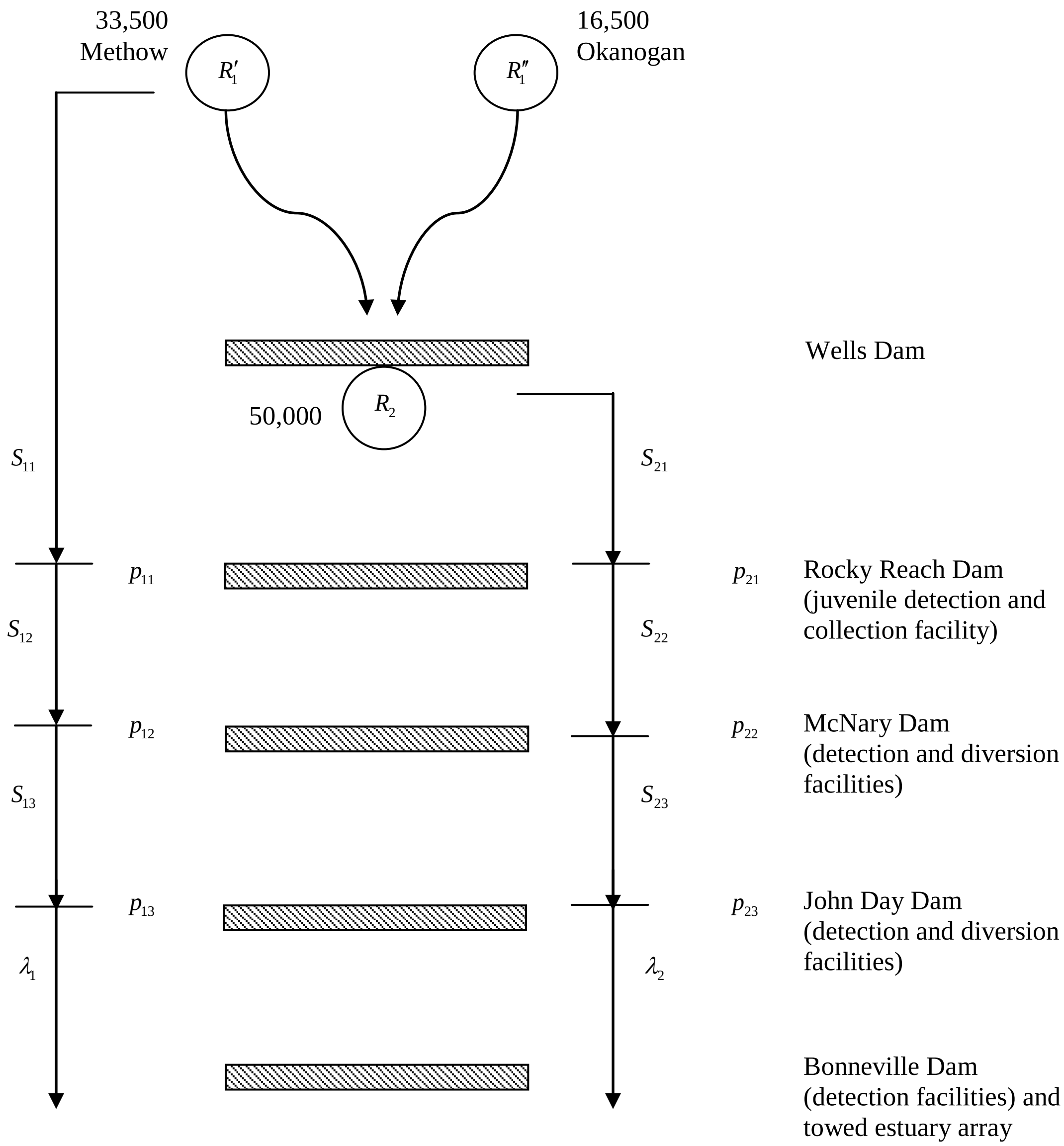

Figure 3. Schematic of release and PIT-tag detection facilities used in the 2020 Wells Dam survival verification study. Parameters that will be estimated from the release-recapture data are indicated.

3.3 Survival Estimation

The estimate of survival through the Wells project $\left(\hat{S}_W\right)$ will be estimated from the result of the upstream and downstream releases by the expression

$$\hat{S}_W = \frac{\hat{S}_{11}}{\hat{S}_{21}} \qquad (1)$$

with an associated variance estimate, based on the delta method (Seber 1982:7-9) of

$$\widehat{\text{Var}}\left(\hat{S}_W\right) = \left(\frac{\hat{S}_{11}}{\hat{S}_{21}}\right)^2 \left[\frac{\text{Var}\left(\hat{S}_{11}\right)}{\hat{S}_{11}^2} + \frac{\text{Var}\left(\hat{S}_{21}\right)}{\hat{S}_{21}^2}\right]$$

$$= \hat{S}_W^2 \left[\widehat{\text{CV}}\left(\hat{S}_{11}\right)^2 + \widehat{\text{CV}}\left(\hat{S}_{21}\right)^2\right] \qquad (2)$$

and where

$$\widehat{\text{CV}}\left(\hat{\theta}\right) = \frac{\sqrt{\text{Var}\left(\hat{\theta}\right)}}{\left(\hat{\theta}\right)}.$$

Capture histories will be pooled across the replicate Methow and Okanogan releases in estimating S_{11}. The data from the replicate tailrace releases will be pooled in estimating S_{21}.

The most efficient estimator of S_W will depend on the relationship between the releases (R_1 and R_2) and the downstream survival and capture probabilities. If all downstream parameters are different between releases, survival will be estimated by Equation (1). This is model $H_{k-1,\phi}$ of Burnham et al. (1987:117-120). Intermediate models may also exist (Burnham et al. 1987:116,120-126). The most efficient estimate of Wells survival (S_W) will be based on the statistical model for the releases R_1 and R_2 that properly share all common parameters. The best representation for the survival and capture processes of releases R_1 and R_2 can be found using Program SURPH.4. Sequential modeling will be performed to determine the most appropriate and precise estimate of S_W and its associated variance estimate.

The capture rates at John Day and Bonneville dams (and the towed estuary array) may be low. If this is indeed the case, capture data at the lower sites may be pooled to provide more precise estimates to fewer, more relevant parameters. Data analyses will explore the statistical benefits of pooling some of the downriver sites to improve the precision of $\hat{S}_W$.

3.4 Tests of Assumptions

Assumptions of the paired release-recapture design (Burnham et al. 1987) include the following:

A1. The test fish are representative of the population of inference.
A2. Test conditions are representative of the conditions of interest.
A3. The number of fish released is exactly known.
A4. PIT-tag codes are accurately recorded at the time of tagging and at all detection sites.
A5. The fate of each individual fish is independent of the fates of all other fish.
A6. All fish in a release group have equal survival and detection probabilities.
A7. Prior detection history has no effect on subsequent survival and detection probabilities.

In order to estimate S_W, the survival S_{11} is assumed to be of the form:

$$S_{11} = S_W \cdot S_{21}, \quad (3)$$

leading to the relationship

$$\frac{S_{11}}{S_{21}} = \frac{S_W \cdot S_{21}}{S_{21}} = S_W .$$

The equality (3) implies two additional assumptions for valid estimation of Wells project survival. These are:

A8. Survival in the Wells project (S_W) is conditionally independent of survival in the Rocky Reach (S_{21}) project.
A9. Releases (R_1) and (R_2) experience the same survival probability in the Rocky Reach (S_{21}) project.

Assumptions A1 and A2 regard making valid inferences from the test fish to the survival process of run-of-river fish. Wells hatchery fish will be used in the survival investigations, and are assumed to have similar survival as run-of-river fish. Conducting the study over the course of the yearling Chinook salmon outmigration should also assure test conditions are similar to those experienced by run-of-river fish. Another implied assumption is the 2:1 ratio of Methow to Okanogan release numbers is representative of the actual proportions of these fish sources to the run-of-river fish.

Careful fish handling and data processing should assure Assumptions A3 and A4 that the release-recapture data are accurate. Assumption A5 is essential for mathematically modeling the release-recapture investigation. Furthermore, in a system of tens of thousands of migrating smolts, the death of one fish should not influence the fate of other fish in the system.

Assumption A6 will be violated by the pooling of the Methow and Okanogan upstream releases (R_1' and R_1''). Fish from these different locations can be expected to have different survival probabilities because of the differences in travel distances, etc. Nevertheless, the release-recapture model will provide a weighted estimate of dam passage survival:

$$\frac{S'_W R'_1 + S''_W R''_1}{R'_1 + R''_1} = S'_W P_{METH} + S''_W P_{OKAN}$$

where

S'_W = survival of released fish from Methow through the Wells project,

S''_W = survival of released fish from Okanogan through the Wells project,

$P_{METH} = \dfrac{R'_1}{R'_1 + R''_1} =$ proportion of fish released from Methow,

$P_{OKAN} = \dfrac{R''_1}{R'_1 + R''_1} =$ proportion of fish released from Okanogan.

The survival of fish released at the Methow and Okanogan will be a pooled survival probability. However, independent but not identically distributed survival probabilities will affect the variance estimates produced by the model. The actual variance will be smaller than that produced by the mark-recapture model (Feller 1968). Consequently, the point estimate will be unbiased (i.e., as long as the proportions P_{METH} and P_{OKAN} are representative of the system) and the variance estimate biased but conservative (i.e., too big).

Assumption A7 will be evaluated using Burnham et al. (1987) tests T_2 and T_3. Conformance to assumptions A8 and A9 will be facilitated by staggering the release times in order for downstream mixing of the test fish.

3.4.1 Tests between Releases

At each downstream PIT-tag recapture site (i.e., Rocky Reach, McNary, John Day, Bonneville, towed estuary array), the assumption of mixing among the releases of smolts R_1 and R_2 will be tested. An R x C contingency table test of homogeneous recoveries over time will be performed using a table of the form:

Day of		R'_1	R''_1	R_2
	1			
	2			
	3			
	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	D			

(4)

A contingency table of the form (4) will be calculated for each of the PIT-tag detection sites. Each test will be performed at α = 0.10 significance level. Invariably, these tests of mixing are significant. More revealing are plots of the arrival distributions to assess important departures from mixing.

3.4.2 Tests within a Release

For the single release-recapture model to be valid, certain data patterns should be evident from the capture histories. For each release group, a series of tests of assumptions can be performed to determine the validity of the model (i.e., goodness-of -fit). The data from a single release can be summarized by an m-array matrix of the form below:

	Recovery Site			
Release Site	Rocky Reach (2)	McNary (3)	John Day (4)	Bonneville (5)
Initial (1)	m_{12}	m_{13}	m_{14}	m_{15}
Rocky Reach (2)		m_{23}	m_{24}	m_{25}
McNary (3)			m_{34}	m_{35}
John Day (4)				m_{45}

The value m_{ij} is the number of fish detected at site i that are next detected at site j.

Burnham et al. (1987: p. 65, pp. 71-74) presents a series of tests of assumptions called Test 2 that examine whether upstream detections affect downstream survival and/or detection. For each of the R_1', R_1'', and R_2 releases, the contingency table tests are as follows:

Test 2.2

m_{13}	m_{14}	m_{15}
m_{23}	m_{24}	m_{25}

χ_2^2 (5)

Test 2.3

$m_{14} + m_{24}$	$m_{15} + m_{25}$
m_{34}	m_{35}

χ_1^2 (6)

Overall significance of Test 2 will be based on the sum of the chi-square statistics $\chi_2^2 + \chi_1^2 = \chi_3^2$. Test-wise error rates will be adjusted for the experimental-wise error rate of $\alpha_{EX} = 0.10$.

Burnham et al. (1987: p. 65, pp.74-77) also present a series of test assumptions called Test 3 which also examine whether upstream capture histories affect downstream survival and/or capture. For each of the releases R_1 and R_2, contingency tables can be constructed of the form:

Capture History to McNary Dam

Capture History at John Day and Bonneville Dams		101	111
	11		
	10		
	01		
	00		

χ^2_3 (7)

Contingency table (7) tests whether capture at McNary Dam has a subsequent effect on capture histories at John Day and Bonneville dams. To test whether capture at McNary Dam and/or John Day Dam has a subsequent effect on the capture history at Bonneville Dam, a contingency table can be constructed of the form:

Capture History at John Day Dam

Capture History at Bonneville		1111	1101	1011	1001
	1				
	0				

χ^2_3 (8)

Contingency tables (7) and (8) are slight modifications from Burnham et al. (1987) to take into account more of the information from the individual capture histories.

3.5 Anticipated Precision

Skalski and Townsend (2018) performed precision calculations considering a Project survival probability through Wells Dam of 0.93 or higher, a required precision of $\mathrm{SE}(\hat{s}_w) \leq 0.025$, and a range of detection probabilities at downstream detection facilities. Survival probabilities between projects and detection probability at dams were based on releases of PIT-tagged yearling summer Chinook salmon from sites above Rocky Reach Dam during emigration years 2010-2016. Most detection probabilities at Rocky Reach Dam observed during that period ranged from 0.20 to 0.40, with a range of 0.10 to 0.60 for all observations. Plotting precision as a function of release size ($R_T = R_C$) revealed that a study with a release size of approximately 45,000 treatment fish (and equivalent number of control fish) is likely to produce results achieving the HCP precision standard within the range of historic detection probabilities at Rocky Reach Dam (Figure 4). Therefore, the proposed sample size of 100,000 combined treatment and control fish should prove adequate for achieving the required precision standard of $\mathrm{SE}(\hat{s}_w) \leq 0.025$.

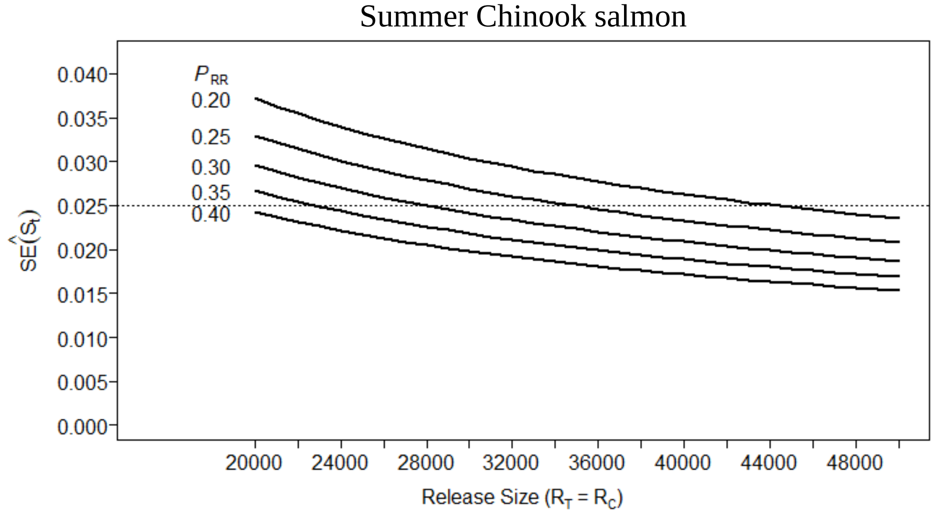

Figure 4. Anticipated precision (i.e., $SE(\hat{S})$) as a function of release size ($R_T = R_C$) for a) spring Chinook salmon, b) summer Chinook salmon, and c) coho salmon as the detection probabilities at Rocky Reach Dam (i.e., P_{RR}) were varied. Dashed horizontal line set at SE = 0.025. Adapted from Figure 2 of Skalski and Townsend (2018).

4.0 SUMMARY

Douglas PUD proposes to conduct a Phase III (Standard Achieved) Survival Verification Study in 2020. The study will utilize in excess of 100,000 Chinook smolts released over 15 replicates at three release locations. The goal of the study is to reaffirm that project survival for yearling Chinook, coho, and steelhead remains greater than or equal to the 93% Juvenile Project Survival Standard. Should the survival estimates obtained during this study meet the study methodology requirements contained within Section 4.1.4 of the HCP, then the results will be included in the pertinent average survival estimate for yearling Chinook, coho, and steelhead, per Section 4.2.5.1 of the HCP, toward adjusting hatchery compensation levels for yearling Chinook, coho and steelhead.

5.0 REFERENCES

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Wells HCP CC. 2015. Wells HCP Coordinating Committee statement of agreement designating coho salmon as in Phase III (Standard Achieved). October 27, 2015.

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: December 5, 2018

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the October 23, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, October 23, 2018, from 10:00 a.m. to 1:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine the following: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high-flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).
- Tom Kahler will determine the final outcome of the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item I-C).
- Tracy Hillman (HCP Tributary Committees Chairman) will provide additional information regarding design and implementation funding for the Icicle Creek Boulder Field Passage Project (Item II-A). *(Note: Hillman provided this information following the meeting on October 23, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.)*
- Tom Kahler will provide the Final 2010 Wells Project Survival Verification Study Report (Bickford et. al 2011[1]) to Kristi Geris for redistribution to the HCP Coordinating Committees

[1] Bickford, S.A., T. Kahler, J.R. Skalski, R.L. Townsend, R. Richmond, S. McCutcheon, and R. Fechhelm, 2011. *Project Survival Estimates for Yearling Chinook Migrating through the Wells Hydroelectric Project, 2010. 2010 Spring Migrant Survival Verification Study.* Prepared for Public Utility District No. 1 of Douglas County. June 2011.

(Item III-A). *(Note: Kahler provided this report following the meeting on October 23, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

- Tom Kahler will consult Shane Bickford (Douglas PUD HCP Policy Representative) about the following: 1) the impetus for selecting study fish release locations at the mouths of the Methow and Okanogan rivers (versus farther upstream) for Douglas PUD survival verification studies; and 2) if and how the Wells HCP can be amended or modified based on new data (Item III-A).
- Lance Keller will consult Alene Underwood (Chelan PUD HCP Policy Representative) about if and how the Rock Island and Rocky Reach HCPs can be amended or modified based on new data (Item III-A).
- Andrew Gingerich will determine whether a draft Douglas PUD Spill Prevention Control and Counter Measures (SPCC) Plan is available in tracked changes to clearly show updates in the current draft for review (2018) compared to the last Federal Energy Regulatory Commission (FERC)-approved final plan (2013) and will provide this redlined draft to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-B). *(Note: Gingerich provided a list of changes between the two plans to Geris on November 9, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Greer Maier (Upper Columbia Salmon Recovery Board [UCSRB] Chief Scientist) will provide the Draft UCSRB Hydropower Background Summary email, including the Doodle Poll request to schedule the next Integrated Recovery Technical Advisory Group (IRTAG) meeting, to Kristi Geris and Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) for distribution to the HCP Coordinating Committees and PRCC, respectively (Item IV-A). *(Note: Maier provided this email to Geris and Rohr following the meeting on October 23, 2018. Geris distributed this email to the HCP Coordinating Committees that same day.)*
- Lance Keller will determine the threshold whereby operations at Rock Island Dam under summer spill operations begin to shift from Powerhouse 2 and spill to Powerhouse 1 (Item V-B).
- Kristi Geris will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) and Julene McGregor (Douglas PUD Information Systems Staff) to add Bill Towey (Chelan PUD Senior Fisheries Scientist) to select HCP Hatchery and Coordinating Committees email distribution lists and provide Towey with visitor access to the HCP Hatchery and Coordinating Committees extranet sites (Item V-D). *(Note: Geris contacted Montgomery and McGregor, as discussed, following the meeting on October 23, 2018.)*
- The HCP Coordinating Committees meeting on December 4, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item VI-A).

Decision Summary

- The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report, as revised (Item V-C). *(Note: Jim Craig provided U.S. Fish and Wildlife Service [USFWS] approval of the report via email on November 20, 2018.)*

Agreements

- HCP Coordinating Committees representatives present agreed to add Bill Towey, Chelan PUD Senior Fisheries Scientist, to select HCP Hatchery and Coordinating Committees email distribution lists and provide Towey with visitor access to the HCP Hatchery and Coordinating Committees extranet sites (Item V-D).

Review Items

- The draft 2020 Wells Project Survival Verification Study Plan was distributed to the HCP Coordinating Committees by Kristi Geris on September 24, 2018. The draft plan is available for a 63-day review with edits and comments due to Tom Kahler by Tuesday, November 27, 2018 (Item III-A).
- A Douglas PUD SPCC Plan was distributed to the HCP Coordinating Committees by Kristi Geris on October 3, 2018. This plan is available for a 30-day review with edits and comments due to Tom Kahler by Friday, November 2, 2018 (Item III-B).
- A Wells Project Land-Use Permit Application for a Joint-Use Dock on Tract 75 was distributed to the HCP Coordinating Committees by Kristi Geris on November 13, 2018. This application is available for a 60-day review with edits, comments, or indication of no comments due to Tom Kahler by Monday, January 14, 2018.
- A Wells Project Land-Use Permit Application for a Joint-Use Dock (Repo LLC) was distributed to the HCP Coordinating Committees by Kristi Geris on November 13, 2018. This application is available for a 60-day review with edits, comments, or indication of no comments due to Tom Kahler by Monday, January 14, 2018.
- The Statement of Agreement (SOA), *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021*, was distributed to the HCP Coordinating Committees by Kristi Geris on November 20, 2018. Chelan PUD will request approval of this SOA during the HCP Coordinating Committees meeting on December 4, 2018.
- A Wells Project Land-Use Permit Application for a Single-Use Dock (LeSage) was distributed to the HCP Coordinating Committees by Kristi Geris on November 29, 2018. This application is available for a 60-day review with edits, comments, or indication of no comments due to Tom Kahler by Monday, January 28, 2018.

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. No additions or changes were requested.

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft September 25, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the HCP Coordinating Committees were incorporated into the revised minutes. Geris said she also noted completion of a few action items and updated distribution of review items. She said Jim Craig provided USFWS approval of the minutes via email prior to the meeting on October 23, 2018. HCP Coordinating Committees members present approved the September 25, 2018 meeting minutes, as revised.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on September 25, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on September 25, 2018):*

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  Tom Kahler said this document is still undergoing internal review and will hopefully be available for HCP Coordinating Committees review by the next meeting on December 4, 2018. This action item will be carried forward.
- *Tom Kahler will establish a system to remind the Wells HCP Coordinating Committee to routinely revisit using spring Chinook salmon as the study species for the Wells Project 2030 Survival Verification Study to ensure this is written into the next Section 10 permits for the Wells Project (Item I-C).*
  Kahler said he and Andrew Gingerich will complete this action item.
- *Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high*

flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).

Keller said this action item is still in progress. This action item will be carried forward.

- *Chelan PUD will compare fish spill coverage data from 2011 and 2012 to data from 2018 and will report back to the HCP Coordinating Committees (Item III-A).*

  This action item will be discussed during today's meeting.
- *Chelan PUD will update the draft 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report to report consistent data for Rocky Reach and Rock Island fish spill programs and a more detailed explanation of spill coverage and will provide a revised draft report for HCP Coordinating Committees review (Item III-A).*

  Lance Keller provided a revised report to Kristi Geris on October 19, 2018, which Geris distributed to the HCP Coordinating Committees that same day.
- *Lance Keller will provide the test results from the engineered trunnion seals for Rocky Reach Unit C1 as soon as the results are available (Item III-B).*

  Keller provided an update to Kristi Geris on October 16, 2018, which Geris distributed to the HCP Coordinating Committees that same day.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-B).*

  This action item will be discussed during today's meeting and will also be carried forward.
- *Tom Kahler will discuss with Beau Patterson (Douglas PUD Land Use Specialist) the Colville Confederated Tribes (CCT) and the Yakama Nation (YN) comments on the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item IV-A).*

  Kahler said the comments received from the CCT and the YN were noted and Douglas PUD will likely approve the permit application, as proposed. He said because this application addresses an upland feral orchard with no effect on HCP Plan Species, comments received by the Wells HCP Coordinating Committee are weighted differently than if the application applied to, for example, in-water or riparian zone work with potential impacts to HCP Plan Species. He said maintaining good relations between Douglas PUD and shoreline residents is also a factor. Kirk Truscott asked if no action is expected from Wells HCP Coordinating Committee comments, then what was the point in having the Wells HCP Coordinating Committee review the application? Kahler said the Wells HCP includes a requirement which states, "When making land use or related permit decisions on Project owned lands that affect reservoir habitat, the District shall consider the cumulative impact effects in order to meet the conservation objectives of the Agreement, requirements of the FERC license, and other applicable laws and regulations. The District further agrees to notify and consider comments from the Parties to the Agreement regarding any land use permit application on Project owned lands." Kahler said Truscott's comment raises an interesting question and said there may be certain items the Wells HCP Coordinating Committee does not care to review. Truscott said the CCT do not want to review documents if it will be a waste of time. Keely Murdoch added, however, that the Wells HCP Coordinating Committee would want to decide if review will be a waste of time. John Ferguson said the first question would be whether Plan Species are involved. Kahler said perhaps in the future, Douglas PUD can present these types of documents as such. Truscott said if Douglas PUD presents a proposal which does not affect Plan Species, this suggests a high probability Douglas PUD will default to the original proposal anyway. Kahler said this is not necessarily true for all proposals. Andrew Gingerich said, for example, there may be a situation where Douglas PUD rejects a land-use permit and it will be of value to let the landowner know Douglas PUD consulted with the appropriate agencies, these agencies are highly qualified, and these are the reasons why the permit was rejected. Gingerich said he suspects this is why this language was included in the Wells HCP. Truscott said he is still interested in knowing what Douglas PUD's final decision was regarding Wells Project Land-Use Permit Application for Wells Tract 115. Kahler said the application is still not closed; rather, there has only been a motion to accept the original proposal. He said he does not know what the Douglas PUD Board of Commissioners has provided in terms of comments. Kahler said he will determine the final outcome of the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees.

- *Kristi Geris will notify Tracy Hillman (HCP Hatchery Committees Chairman), Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator), and Grant PUD office building staff that the HCP Coordinating Committees meeting in December 2018 will be held via conference call on December 18, 2018, if needed (Item V-A).*
  Geris provided this notification, as discussed.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on October 11, 2018:

- *Time Extension Request*: The Rock Island HCP Tributary Committee received a time extension request from Trout Unlimited (TU) on the Icicle Boulder Field Project. The sponsor is waiting on permits for this project; therefore, the sponsor requested to extend the completion date from September 30, 2018, to December 15, 2019. Once permits are received, TU plans to begin construction next summer. The Rock Island HCP Tributary Committee approved the time extension request. Kirk Truscott asked if the sources of funding for the project have been identified and recalled previous discussions of multiple sources to help move the project forward. Hillman said the Rock Island HCP Tributary Committee funds what is outlined in the contract with TU. He said he is unsure whether TU has secured all of the funding needed to complete this project. He said he believes TU approached the Bonneville Power Administration (BPA) to help fund; however, he is unsure of the outcome. Tom Kahler said TU is short of what is needed to complete the project. Truscott asked if the Rock Island HCP Tributary Committee funds will in part support the implementation of fish passage at Icicle Boulder Field? Kahler recalled approval of Rock Island HCP Tributary Committee funds was contingent upon the applicants (Icicle-Peshastin Irrigation District and City of Leavenworth) providing a funding match. Kahler asked if this funding decision came back to the Rock Island HCP Tributary Committee to decide whether to fund, or was funding assured if the applicants provided the match? Hillman clarified these are two different projects. He said there is passage at Icicle Boulder Field, and screening of the irrigation district canal and City of Leavenworth canal. He said there has been no further discussion on the latter; therefore, the Rock Island HCP Tributary Committee has not yet made a decision on screening. He said the Rock Island HCP Tributary Committee did approve the passage at Icicle Boulder Field. John Ferguson asked if HCP Tributary Committees votes need to be unanimous. Hillman said yes and Kahler added that agencies can abstain. Hillman said he will provide additional information regarding design and implementation funding for the Icicle Creek Boulder Field Passage Project. He added that TU would not request a time extension if the project was not already approved. He said there was some level of funding approved; however, he cannot recall how much. Truscott said he is not only interested in design funding, but also dollars to implement. Hillman said he believes the approved funding was for design and implementation. *(Note: Hillman provided additional information regarding design and implementation funding for the Icicle Creek Boulder Field Passage Project following the meeting on October 23, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.)*

- *General Salmon Habitat Program Proposal*: The HCP Tributary Committees received a General Salmon Habitat Program proposal from the YN titled: *Twisp Confluence Habitat Complexity Project*. The purpose of the project is to use large wood to stabilize a bank at the confluence of the Twisp River where bank erosion is threatening sewer line infrastructure for the town of Twisp. The large wood will not only protect the bank from further erosion, it will increase habitat complexity for juvenile and adult salmonids and will prevent the U.S. Army Corps of Engineers (USACE) from riprapping the bank. The total cost of the project is $299,300. The sponsor requested $269,600 from the Plan Species Account Funds. The HCP Tributary Committees did not make a funding decision at this time and asked the YN to secure a cost share from USACE that is equivalent to the amount USACE would spend on placing riprap along the eroding bank. Given that USACE is willing to stabilize the bank with riprap, the HCP Tributary Committees believe USACE should be able to contribute to the proposed project at the level of their original proposal to the City of Twisp for riprap bank protection. The HCP Tributary Committees are waiting to hear back from the YN on a cost share. Truscott said he thought the HCP Tributary Committees spend a lot of funding on reestablishing natural processes and access to off-channel habitat by removing berms, and now the HCP Tributary Committees are supporting installing riprap? Hillman said in this case, the YN understands there will be some form of bank protection to protect the sewer line structure and the YN are saying it would be better to use wood to create better habitat for salmonids, versus USACE riprapping the bank. He said the HCP Tributary Committees typically do not fund bank protection, but in this situation the bank is going to be protected no matter what. He said if the YN can secure a cost share, the HCP Tributary Committees are opting for wood. He said if there is no cost share the HCP Tributary Committees need to further discuss options. Truscott asked about the stipulation on a cost share. He asked if this would be USACE's responsibility. Kahler said it is difficult to say because USACE offers to riprap in an emergency but not to install large wood. He said this was initially an emergency action. Truscott asked if the agencies can stipulate conditions with an emergency action. Kahler said one can end-dump rock; however, with logs this requires excavation. Kahler said USACE has funds for emergency actions like this; however, the HCP Tributary Committees suspect that USACE is not authorized to pull money from other sources for bank protections outside of emergency conditions.

- *Targeted Solicitations*: The HCP Tributary Committees are in the process of identifying high-priority projects within each of the subbasins (Wenatchee, Entiat, Methow, and Okanogan). Once projects are identified, the Committees will call for proposals. The HCP Tributary Committees will also continue to accept project applications from sponsors anytime during the year. Truscott asked what data sources the HCP Tributary Committees are utilizing to identify high-priority projects? He said the CCT have done work in the Methow River basin, and Carmen Andonaegui (Washington Department of Fish and Wildlife [WDFW]) has also conducted similar work. Truscott said he is curious if this literature and these data sources are being used to develop this list of priorities. Hillman said yes, these sources are being utilized. He said the Upper Columbia Regional Technical Team (UCRTT) has a regional strategy and is currently updating the strategy based on life cycle modeling, the Ecosystem Diagnosis and Treatment tool, and food web modeling in the Methow River basin, among other data sources. Hillman asked Truscott if he is interested in working on this, and Truscott said he was just making sure the HCP Tributary Committees are utilizing these data sources. Ferguson said he believes that Truscott wants to be sure this process is an information-based approach rather than opinion-based. Truscott said this is correct and added that this is important to the CCT and the YN because these details are required by BPA to participate in cost sharing. Ferguson asked about the Accords process? Truscott said the CCT have signed a 4-year extension of their Accord with BPA. Hillman said the HCP Tributary Committees are relying on the UCRTT who is developing a robust, multi-criteria decision framework for prioritizing enhancement actions. Truscott stated that the HCP Tributary Committees are relying on output from the UCRTT, and Hillman confirmed that to a large degree this is the case.

- *Site Visits*: The HCP Tributary Committees identified completed projects to visit next year. There are 10 to 12 projects that members would like to see. The HCP Tributary Committees will coordinate with project sponsors and landowners to identify a date for the tours, which will likely be in late summer or early fall 2019.
- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on November 8, 2018, if necessary. *(Note: due to lack of agenda items, the HCP Tributary Committees will not meet in November; if necessary, the HCP Tributary Committees will meet on December 13, 2018.)*

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on October 17, 2018 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint"*):

- *National Marine Fisheries Service (NMFS) Consultation (joint)*: NMFS provided the HCP Hatchery Committees with the Draft Environmental Assessment for Upper Columbia River Steelhead and Summer/Fall Chinook Salmon Programs. Comments are due to NMFS by November 2, 2018.
- *Presentation: Orcas and Hatchery Production (joint):* Eric Kinne (WDFW) provided a presentation to the HCP Hatchery Committees titled, "Southern Resident Killer Whales." Kinne described the current status, range, and diet of the Southern Resident Killer Whale population and noted that Chinook salmon can make up 96% of the whales' diet. He also described the Governor's Executive Order, which established a Task Force charged with developing an action plan. The Task Force set up three working groups: vessels, contaminants, and prey groups. The prey group identified actions for habitat restoration and protection, predation, hatcheries, harvest, hydropower, and food webs. Modeling determined that lower Columbia, upper Columbia, and Snake River Chinook salmon are important prey for the whales. Thus, among other things, the working group is looking for opportunities to increase hatchery production within existing facilities. The goal is to increase fish production by 50 million fish coastwide. Following the presentation, the HCP Hatchery Committees discussed issues associated with managing the proportion of hatchery-origin spawners and proportionate natural influence, variable ocean conditions, No Net Impact calculations, permitting, Endangered Species Act constraints, broodstock availability, and costs. Hillman said the

HCP Hatchery Committees will continue discussing this topic pending more information from the Task Force. Ferguson asked if Kinne's presentation is available for distribution. Hillman said it is uploaded on the HCP Hatchery Committees extranet site and he can also email Ferguson a copy. Ferguson asked if density dependence was discussed. Hillman said yes, related to variable ocean condition.

- *Conservation Program Size (joint):* The HCP Hatchery Committees are looking at the possibility of revising the size of the conservation programs. Only the allocation of production between the conservation and safety net programs may change (total hatchery production will not change). Keely Murdoch (YN HCP Hatchery Committees Representative) shared with the HCP Hatchery Committees the work she and Mike Tonseth (WDFW HCP Hatchery Committees Representative) are doing to estimate the size of the conservation programs. Murdoch and Tonseth resurrected the tool used during the No Net Impact recalculation, updated several but not all of the parameters with recent data, and ran it for the Nason spring Chinook salmon program. The HCP Hatchery Committees are reviewing the tool and its outputs and will look to populate all the model parameters with the most recent information. Discussion on this topic will continue over the next few months.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on November 15, 2018.

III. Douglas PUD

A. Douglas PUD 2020 Verification Survival Study Plan (Tom Kahler)

Tom Kahler recalled, the draft 2020 Wells Project Survival Verification Study Plan was distributed to the HCP Coordinating Committees by Kristi Geris on September 24, 2018. The draft plan is available for a 63-day review with edits and comments due to Kahler by Tuesday, November 27, 2018. John Ferguson said Douglas PUD will request a vote for approval during the HCP Coordinating Committees meeting on December 4, 2018. Kahler asked the Wells HCP Coordinating Committee if there are questions at this time.

Kirk Truscott said one possible issue is the assessment of potential differences between treatment and control groups relative to physiological conditions (e.g., injuries and disease). He recognized that there is a need for this but how it relates to the run at large without producing a bias one way or another is a question. He said a survival estimate is being determined by testing control groups consisting of the best of the best, when clearly the run at large will have something less robust. He said, for example, average fish size is different across species and even within species for natural-origin versus hatchery-origin fish. He said size can matter, for example, if large summer Chinook salmon (summers) are released, then would result in a survival estimate that is biased high. He also noted that this draft 2020 Wells Project Survival Verification Study Plan includes a fair number of references on this; however, not all of these references are included in the reference section. He said the referenced Bickford et. al 2011 report might provide more information. Kahler clarified that the Bickford et. al 2011 report is the last survival report (i.e., Final 2010 Wells Project Survival Verification Study Report). Truscott said the question is how to avoid biasing high and low, or how to ensure the two study groups are representative of the run at large fish. Kahler clarified that there will be no size grading during tagging; rather, all fish set aside for the study will be used. He said fish will go into common vessels following handling and tagging (which will include the full range of fish sizes available), and only immediately prior to release will fish be randomly assigned to release containers, and those containers will be randomly assigned to release location. Truscott asked about the fish per pound at release, noting that the condition factor for hatchery fish will likely be different than for at large in-river migrants. He also asked about feeding regimes to obtain length targets. Kahler said the Bickford et. al 2011 report includes details on the size ranges used in 2010, and he anticipated that the details in that report would answer many of the questions posed today.

Keely Murdoch said Truscott made good comments and she has similar concerns; however, she is also unsure how to easily resolve these issues. Murdoch said she also has concerns about what these survival studies may and may not represent. She said these fish are representing hatchery yearling summer Chinook salmon, which can match the size of hatchery spring Chinook salmon, but how representative of natural fish is of question and the run timing is different. She said some data are indicating that wild fish are entering the system early. She asked if these survival studies are representing these wild fish? She recognized that the HCPs do not stipulate between hatchery- and natural-origin fish; however, she said at the core, the HCPs are about protecting natural-origin fish. She said she is unsure how to resolve these questions, but she believes it is important to address these questions and begin thinking and talking about them.

Ferguson said Truscott and Murdoch noted several variables embedded in these survival studies, and he asked the HCP Coordinating Committees for preferences on how to proceed in shaping these tests to be as representative of the run at large as possible.

Kahler said the idea behind this study design, as in all previous efforts, is to minimize the effect of the study on the behavior of the fish. He said really the careful study design is to provide a study that is just testing how fish behave without introducing study effects. He said Truscott and Murdoch raise an interesting question—are the sizes representative of the run at large? He said however this is addressed should be in a manner that does not introduce bias.

Andrew Gingerich said another consideration to keep in mind is these fish have been handled and have a tag burden. He said based on the literature, regardless of what tag is used, any tag negatively impacts survival of the fish. Truscott agreed and said, how does the study effect negative bias as well as positively bias—it goes both ways. Murdoch said she is unsure this is true because these fish will be raised in-hatchery and PIT-tagging will occur fairly well in advance; therefore, if a fish is in poor condition at tagging it will likely already be dead before release. She said that is, tag burden would be resolved by the time of release. Ferguson said the treatment and control fish are treated the same, so the difference is project effects (not tagging and handling). He asked if the tagged fish represent the Plan Species in the way the HCP Coordinating Committees want, and Murdoch said yes, if the range of conditions and tagging are spread the same. Kahler said this is the case, and he said he will provide the Final 2010 Wells Project Survival Verification Study Report (Bickford et. al 2011) to Geris for redistribution to the HCP Coordinating Committees, which goes into great detail on how these aspects of the study design are addressed. *(Note: Kahler provided this report following the meeting on October 23, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

Ferguson asked what is the next step? Truscott said he is just interested in ensuring that fish are representative in size. Kahler said the plan is to release 15 replicates from mid-April to mid-May 2019, and the Wells HCP Coordinating Committee can discuss if this is representative. Truscott asked at what point in time and what is the process for addressing this situation where fish are released at the mouth of the Okanogan River when project effects extend upstream 15 kilometers. He said those fish, in his opinion, are underrepresented. Kahler asked if there is something about this inundation zone that is different? Truscott said in early- to mid-May, river temperatures are fairly cold for nonnative predators. He said if anything, perhaps migrations are longer. He said walleye, pikeminnow, and small mouth bass feed in fairly cold water; however, water velocity will likely affect their ability to prey on juvenile salmonids. He suggested testing this by calculating relative survival at two release sites. He asked what level of predation is needed to detect differences? He added that he is unsure about sample size requirements to test this. Ferguson said this may require a different study design. Truscott said conceptually this is not different; rather, it is just an additional site. Ferguson said a power analysis would be needed to get at predation questions. Gingerich said cormorants, white sturgeon, and bull trout would be added to the list of predators.

Truscott restated his question as follows: what is the process for discussing and implementing a potential change to the HCPs? He said he is unaware of any language which explains how to change the HCPs. Kahler said he does not believe the topic has come up before. He said SOAs are amendments to the HCPs. Ferguson said another option is to consult the HCP Policy Committees. He suggested asking whether the HCP Coordinating Committees can make this type of change to the HCPs without policy-level approval.

Gingerich said he believes there may be some concern about the Lower Okanogan River Basin. He asked how to separate project effects from other things going on in the lower basin, such as warmer water temperatures, more sediment, and industrial effects. Truscott said this is true for any location. Gingerich said in the Methow River Basin, there is less concern. He asked what makes the

Okanogan River Basin more of a predator location? Truscott said the reservoir is a good location for predators. Murdoch said she is unsure if project effects and non-project effects need to be separated. She said the PUDs are responsible for the zone of influence. She said a lot is happening in the Columbia River the PUDs are not responsible for, including nonnative predators. She said she does not see where this argument makes sense because these things cannot be separated anywhere. Truscott said there must be some way to address this information or certain issues.

Ferguson recalled that comments on the draft 2020 Wells Project Survival Verification Study Plan are due November 27, 2018, with discussion and a vote on December 4, 2018. He suggested considering how representative the study is and reporting this in the comments. He asked if there is room in the schedule to approve the study design and if the representativeness issue needs more thought and discussion, can this be ongoing after the vote? Kahler said from a fish cultural standpoint, Douglas PUD needs to know right away if the Wells HCP Coordinating Committee is seeking a different size trajectory for the fish. He said the study fish are eggs now, so there is time; however, once the fish leave the start tanks Douglas PUD needs to know. Truscott said he doubts the Wells HCP Coordinating Committee will conclude making the fish larger. Kahler said reviewing the Bickford et. al 2011 report may answer questions.

Kahler will consult Shane Bickford (Douglas PUD HCP Policy Representative) about: 1) the impetus for selecting study fish release locations at the mouths of the Methow and Okanogan rivers (versus farther upstream) for Douglas PUD survival verification studies; and 2) if and how the Wells HCP can be amended or modified based on new data. Lance Keller will consult Alene Underwood (Chelan PUD HCP Policy Representative) about if and how the Rock Island and Rocky Reach HCPs can be amended or modified based on new data.

Kahler said the selected release sites may have something to do with release methods. He said Douglas PUD has attempted releases in the Okanogan River and the water is so turbid it put a lot of stress on the fish at release.

B. Douglas PUD Spill Prevention Control and Counter Measures Plan (Andrew Gingerich)

Andrew Gingerich said a Douglas PUD SPCC Plan was distributed to the HCP Coordinating Committees by Kristi Geris on October 3, 2018. Gingerich said Douglas PUD's Clean Water Act Section 401 Water Quality Certification includes a requirement to update a SPCC Plan, and then FERC adopted this into Douglas PUD's FERC License, stipulated consultation with various agencies, and filing within 1 year. Gingerich said Douglas PUD filed the initial Douglas PUD SPCC Plan on October 1, 2013, and FERC approved the plan on January 24, 2014. Gingerich said there is also a requirement to update this document every 5 years or more frequently as necessary. He said Douglas PUD recently updated the plan, which includes feedback from the U.S. Environmental

Protection Agency following a tour of the Wells Project. He said the plan is currently available for a 30-day review with edits and comments due by Friday, November 2, 2018. He said the document is also out for Aquatic Settlement Work Group review, which is important notably because the Washington Department of Ecology is represented in this work group. He said FERC also requires consultation with the Bureau of Indian Affairs and NMFS, who are not represented on the Aquatic Settlement Work Group.

Gingerich said this plan is designed to be a preventative and response document. He said it outlines where oil products are used and stored on site. He said the plan outlines rules to prevent an oil release to the river. He said in the event of an oil spill the plan outlines the steps and approach for dealing with the spill and who to contact.

Gingerich suggested a vote via email following the review period rather than approval waiting until the HCP Coordinating Committees meeting on December 4, 2018. John Ferguson asked what changed in the updated plan versus the original? Gingerich said he is unsure, but Lori Morris (Douglas PUD Safety Specialist) would have the best information on the revisions. Kirk Truscott said a tracked changes version would be nice for an expedited review. Gingerich said he will determine whether a draft Douglas PUD SPCC Plan is available in tracked changes to clearly show updates in the current draft for review (2018) compared to the last FERC-approved final plan (2013) and will provide this redlined draft to Geris for distribution to the HCP Coordinating Committees. Gingerich said Douglas PUD will either request a vote via email, or depending on comments received, may request approval during the HCP Coordinating Committees meeting on December 4, 2018. *(Note: Gingerich provided a list of changes between the two plans to Geris on November 9, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

IV. Upper Columbia Salmon Recovery Board

A. Draft UCSRB Hydropower Background Summary (Melody Kreimes and Greer Maier)

Melody Kreimes (UCSRB Executive Director) provided a brief background about UCSRB and the Integrated Recovery effort and introduced Greer Maier (UCSRB Chief Scientist). Maier shared a presentation titled, "UCSRB Integrated Recovery" (Attachment B), which was distributed to the HCP Coordinating Committees by Kristi Geris following the meeting on October 23, 2018.

<u>Slide 2 of Attachment B</u>

Maier recalled this integrated recovery process was first laid out in the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan in 2007. She said UCSRB (the Board) initially set up a report card process and grading system which evaluated different management areas; however, this process was not well-supported. She said the Board then took another approach geared at compiling information on these different management areas and checking in with resource managers in terms of progress in accomplishing established objectives and goals. She said the Habitat Summary Report is finished (2014), and the Hatchery Summary Report was also just adopted by the Board in December 2017. She reviewed the Integrated Recovery goals and said these are the same goals for this process (Hydropower Summary Report).

Slide 3 of Attachment B

Maier reviewed the process chart. She said resource managers are working together through this process, which involves multiple steps where partners are engaged along the way. She said ultimately these steps feed into a single workplan.

Slide 4 of Attachment B

Maier reviewed the levels of certainty. She said the Board did not want to get into contentious issues in these summaries; rather, these summaries are more about information. She said hydropower was a challenge regarding compiling all the available information because there are so many components to hydropower.

Slide 5 of Attachment B

Maier said one meeting was convened to discuss what direction to take, and the draft Hydropower Summary Report was compiled in coordination with the Mid-Columbia PUDs (Grant, Chelan, and Douglas PUDs), the YN, and the CCT, among others. She said the final draft is on a tight timeline, with final approval targeted for December 13, 2018. She said the approval process will be similar to the Hatchery Summary Report.

Slide 6 of Attachment B

Maier reviewed the reporting timeline, which concludes in 2019/2020 with discussions with partners.

Slide 7 of Attachment B

Maier reviewed priorities for this process. She wants everything to be clear, and for this to be a collaborative process. She said she is not the expert, and she really appreciates the opinions of the HCP Committees members.

Slide 8 of Attachment B

Maier reviewed members of the Hydropower IRTAG. She said hopefully all of these members will be actively involved in the review process. She said a draft Hydropower Summary Report will also be distributed to HCP Coordinating Committees for review.

Slide 9 of Attachment B

Maier said the first draft Hydropower Summary Report was distributed a little while ago. She said the draft was distributed without a lot of preamble and she apologized for this. She requested that reviewers not to get into the weeds on editorial edits; rather, to focus on the technical information, content, missing information, etc. She asked that IRTAG members bring comments and edits back to the next IRTAG meeting in November 2018. She said she will provide the Draft UCSRB Hydropower Background Summary email, including the Doodle Poll request to schedule the next IRTAG meeting, to Geris and Denny Rohr (PRCC Facilitator) for distribution to the HCP Coordinating Committees and PRCC, respectively. *(Note: Maier provided this email to Geris and Rohr following the meeting on October 23, 2018. Geris distributed this email to the HCP Coordinating Committees that same day.)*

Slide 10 of Attachment B

Maier reviewed their next steps. Kreimes reiterated the request for IRTAG members to bring substantive comments to the next IRTAG meeting to be discussed, as opposed to addressing and coordinating comments in writing. She said members can provide comments in redline strikeout; however, she prefers discussing these in-person during the next IRTAG meeting. Greer said the key points at the beginning of the report will be revised after all comments and edits are incorporated. Kreimes said there will not be another draft report distributed until after the next IRTAG meeting. Greer said she will have a list of comments received to date.

V. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 Update (Lance Keller)

Lance Keller said, as reported during the HCP Coordinating Committees meeting on September 25, 2018, Rocky Reach Dam mechanics received the engineered trunnion seals from the contractor. Keller said Rocky Reach Dam mechanics installed the seals and initial testing occurred from September 29 to 30, 2018. He said the unit was pressurized and inspected for leaks. He said no leaks were detected and the draft tube gate was removed allowing the turbine pit to be occupied by water to a level equal with tailrace water elevation. He said the unit remained in this status over the weekend and was not operational during this time. He said on Monday, October 1, 2018, the unit was dewatered to inspect for loss of oil and no oil leak was found. He said mechanics returned the unit to service with periodic inspections for oil in the tailrace. He said almost 24 hours later, oil loss from the unit was observed and the unit was immediately taken offline.

Keller said Rocky Reach Dam mechanics believe the issue is leaky trunnion seals due to trunnion bushing wear; however, everything is being inspected to verify this is the case. He said the plan forward is to start dismantling the unit to inspect the trunnion bushing seal, which is designed to take up any wear of the bushing. He said mechanics believe the issue may be the bushing itself, which will be replaced if this is the case. He said mechanics will also be looking for other sources of oil loss during the effort. He said the timeline is tentative; however, current estimates are for Turbine Unit C1 to be returned to service from May to June 2019. He said in order to replace the bushing, mechanics need to dismantle the unit and place the turbine hub on the powerhouse floor. He said the bushing is on order, if not already on site, and the mechanics need to reshuffle other scheduled unit work to complete this fix. He said because of this outcome, it is likely to expect that the 2019 fish bypass season will start without Turbine Unit C1 being in service.

B. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said over the past month and a half, Chelan PUD has held one-on-one discussions about this topic with John Ferguson and the individual Rock Island HCP Coordinating Committee representatives. Keller shared five Gantt charts with the Committee. The charts depicted different maintenance timelines for discussion. *(Note: These timelines are tentative and are not available for distribution.)*

Keller said the first Gantt chart shows how Turbine Units B1 to B4 were originally scheduled for repair starting in April 2016. He said these units were very aggressively scheduled and each unit was supposed to be in and out of repair in a little over 1 year, with multiple units being worked on simultaneously. He said based on recent events and safety concerns, Chelan PUD needs to have these units unstacked moving forward. He said the second Gantt chart shows the original schedule for upcoming work, as well as current risks that are present in other Powerhouse 1 units. He explained the color-coding status, as follows:

Color	Definition
Red	Risk of units coming out of service
Yellow	Mothballed
Blue	Dewatering
Green	Work
Purple	Commissioning after maintenance

Keller said the vertical bright blue represents the HCP check-in study scheduled in 2020.

Keller said Chelan PUD has also been closely looking into safety concerns at the Rock Island Dam Powerhouse 1, such as considering how many times staff are tasked with completing repetitive projects in a short time period. He said considering this, among other things, the third, fourth, and fifth Gantt charts show a reworking of the maintenance schedules. He said all maintenance activities for Turbine Units B1 to B4 are now unstacked. He said there is a slight variation for how to address Units B5 and B8. He said the dotted vertical line shows there will be significant work underway when the survival study is scheduled to take place in 2020. He said one question Chelan PUD is discussing is how these outages will affect powerhouse operations and unit availability during the check-in survival study. He said, therefore, Chelan PUD is considering the need to possibly move the check-in study to 2021, when Project operations will be more representative of its typical operational state. He said the goal is to complete most repairs before May 2021. He said risks have been calculated and incorporated into these schedules, and if Chelan PUD had to choose a schedule it would be the third schedule where three of the small units (Turbine Units B1 to B4) would be online the 2021 survival verification test, as well as addressing the possible risk that is present in Turbine Unit B5.

Keller shared a figure depicting the proportion of fish passing each route at Rock Island Dam during the spring fish passage season under normal project operating conditions where all units and spill bays are available for operation (page 1 of Attachment C), which was distributed to the HCP Coordinating Committees by Kristi Geris on October 24, 2018. Keller explained that Powerhouse 2 is on the left, the center adult fishway is in the middle of the spillway separating Spillway 2 and Spillway 1, and Powerhouse 1 is on the right. He said the majority of river flow approaches the area near Powerhouse 2 and Spillway 2 at Rock Island Dam and given the bathymetry in the forebay and these flow patterns, the majority of fish approach the project from the middle of the spillway to river-right. He said Powerhouse 2 Turbine Unit U1 (green dot closest to spillway river-right) is the first unit to come online and the last unit offline. He said Powerhouse 2 is sequentially loaded from Turbine Unit U1 to river-right until fully loaded. He said Powerhouse 2 operation is the priority during the fish passage season. He said if additional units are brought online after all available units in Powerhouse 2 are operating, Turbine Unit B10 (green dot closest to the spillway on river-left) is the first online in Powerhouse 1, and further unit operation occurs sequentially, moving from Turbine Unit B10 to B1. He said the dots on the spill bays represent modified spill gates, which provide a spill route to fish while not impacting or adding to total dissolved gas (TDG) produced from the spillway. He said most of these modified spill bays are between the center adult fish ladder and Powerhouse 2, while there is one next to Powerhouse 1. He said when considering prioritizing work between Turbine Units B5 and B8 (i.e., if there has to be one unit offline in Powerhouse 1, which would be the case), Chelan PUD would select Turbine Unit B8 to be offline, giving the maintenance priority to Turbine Unit B5. He explained their reasoning is that if fish approach Powerhouse 1 and Turbine Unit B8 is offline, Turbine Units B9 and B10 have the spillway and a modified spill bay right next to these units, which provides fish with a good opportunity to pass the project through the spillway. He said if Turbine Unit B5 is offline, fish that approach the middle of the Powerhouse 1 near Turbine Unit B5 are going to be more likely to pass through a turbine unit than the spillway.

Keller reviewed the route-specific passage percentages presented in Page 1 of Attachment C. He noted that the spring freshet dictates how many units are online and passage percentages can change across years; however, the majority of juvenile yearling Chinook salmon passage occurs via Powerhouse 2 and Spillway 2 at Rock Island Dam.

Kirk Truscott asked what proportion of fish pass via Turbine Units B10 to B7 in Powerhouse 1. Keller said this resolution is not available for Rock Island Dam. He said he assumes that fish passage via Turbine Units B10 to B7 is higher than via Turbine Units B6 to B4 because the majority of fish are approaching the project from the center to river-right and based on the unit operating sequence of Powerhouse 1, Turbine Units B10 to B7 have a higher probability of operating more than Turbine Units B6 to B4. John Ferguson asked if river flow is higher through Turbine Units B5 to B10, and Keller said yes compared to Turbine Units B1 to B4. Truscott asked if there is any indication of whether subyearlings follow suit, and Keller said no information is available on this. Keller said the majority of fish pass via right-river passage routes and Chelan PUD's preference is to avoid creating gaps in Powerhouse passage routes.

Keller recalled Truscott's past comments that Rock Island Dam's current operations are different than in the past and how can Chelan PUD be certain the current operations are good for fish passage. Keller said the overall powerhouse capacity at Rock Island Dam when all units are available in both powerhouses is 220,000 cubic feet per second (220 kcfs). He said during spring 2018, overall powerhouse capacity at Rock Island Dam was just under 174 kcfs, resulting in additional spill beyond the 10% target due to diminished project capacity. He shared a figure showing Columbia River usable storage (Page 2 of Attachment C). He said as river flow increases at Rock Island Dam, operators have two choices with the incoming water due to a lack of reservoir storage; operators either need to spill or generate. He said with decreased powerhouse capacity, there is only so much that can be generated, and this results in additional hydraulic spill through additional gates, providing additional non-turbine routes for fish. He said if the Project is up against its TDG limits, additional units will be brought online to not further increase TDG levels, even if Chelan PUD has to sell power at negative pricing. He said the early portion of the 2018 subyearling run most likely benefited from additional spill due to higher flows well-above the diminished generational capacity of Rock Island Dam. He said over the last few years, there have been greater contributions in spill due to diminished powerhouse capacity.

Keller said Keely Murdoch brought up a good question about how a shift from 2020 to 2021 would affect recalculation of the HCP hatchery programs. Keller said he spoke with Alene Underwood and Catherine Willard (Chelan PUD HCP Hatchery Committees Representative) and reviewed the Rock Island HCP. Keller said the timelines for the check-in studies and hatchery recalculations are not connected. He said the HCP stipulates that recalculation will occur in 2013 and in 10-year intervals, and the confirmation timeline is based on when Phase III Standards Achieved is reached, which was in 2010 for Rock Island Dam. He said, therefore, these are not connected in terms of a formal timeline; however, the check-in results do inform recalculation. Murdoch said it would be helpful to have the latest data opposed to the same data from 10 years prior, because this would essentially mean recalculating hatchery programs with the same data for 20 years. She asked if there are no new data is recalculation performed anyway? Keller said there will still be updated smolt-to-adult ratios and other hatchery performance data.

John Ferguson asked about a Rock Island HCP representative water year clause. Keller said yes, Steve Hemstrom has been working on an updated flow duration curve, which he is close to bringing to the HCP Coordinating Committees for decision. Keller recalled this topic came up in 2013, and then the Wanapum Dam incident happened which postponed working on the flow duration curve. He said he believes Douglas PUD also relies on Chelan PUD's flow duration curve. Tom Kahler said Douglas PUD does not have a requirement for a flow duration curve; rather, the Wells HCP includes language that Douglas PUD will consider these data. Kahler said Douglas PUD decided to wait to see what Chelan PUD comes up with.

Keller said another consideration is if the Rock Island Dam check-in study moves to 2021, will the next verification study be conducted in 9 or 10 years? Keller said Chelan PUD would propose it would be in 10 years, because the timeline does not start until results are confirmed. He said, for example, as stated in the Rock Island HCP, if targets are missed Chelan PUD has two additional years to reach targets before a change in phase designation occurs, reinitiating phase designation studies. He said if there are no results until 2022, then the next confirmation study would be 10 years later in 2032.

Keller asked if the Rock Island HCP Coordinating Committee would be supportive of allowing Chelan PUD to defer the check-in study 1 year to 2021? He said an SOA is currently being drafted, but he is curious of Committee members' initial thoughts. Truscott said it makes sense to conduct the study under test conditions that are closest to the normal operating conditions, otherwise the results may be questioned. Murdoch said she agrees with Truscott, that it is worth waiting. Chad Jackson said WDFW supports further discussions about pushing the check-in study from 2020 to 2021; however, he is not yet ready to make a decision. Scott Carlon said NMFS is supportive of moving the study to 2021 to be more representative.

Truscott said he still has questions about whether something needs to be done to assure adequate survival is being obtained, for summer migrants in particular. He asked if Rock Island Dam should be spilling more than 20%? He said most river flow at Rock Island Dam is passed through the powerhouses with 20% spill; however, with a different configuration in the powerhouses, should this be adjusted? He said in his experience, summers are more shoreline-oriented than spring migrants. Kahler said fyke net data at Wells Dam indicate more summers pass Wells Dam at the historic river thalweg (left bank) compared to springers which pass via the right bank. Truscott recalled work for Douglas PUD years ago where summers were not found in the middle of the river. Andrew Gingerich said seining data from 2013 showed fish feeding at the surface, not migrating. Keller said unfortunately, there is a large data gap here. Truscott asked if there is something more to do? Keller said 20% spill is quite a bit of spill and was determined to be above required levels to meet spring migrant survival targets, as Chelan PUD achieved survival standards under both 20% and reduced 10% spill operations at Rock Island Dam for all spring migrating Plan Species. He said until Phase designation survival studies are conducted for subyearing Chinook salmon this data gap will be present; however, Chelan PUD feels that 20% spill is most likely more than adequate and that a spill reduction may be possible should survival evaluations be possible for subyearling Chinook salmon for the Rock Island Project area in the future. Ferguson pointed out that in recent years runoff has occurred earlier, which results in lower flow during summer and less operation of Powerhouse 1 as Powerhouse 2 and the 20% spill can accommodate the lower flow. Keller said he will determine the threshold whereby operations at Rock Island Dam under summer spill operations begin to shift from Powerhouse 2 and spill to Powerhouse 1.

C. 2018 Rocky Reach and Rock Island Fish Spill Report (Lance Keller and Thad Mosey)

Lance Keller said the draft 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report was distributed for review to the HCP Coordinating Committees by Kristi Geris on September 24, 2018, and a revised report was distributed on October 19, 2018. Keller said changes included consistently reporting Rocky Reach Dam and Rock Island Dam summer spill data. He recalled discussing missing the initiation of summer spill at Rocky Reach Dam to provide spill coverage for 95% of the subyearling run based on dates; however, there was prior biological benefit in the form of hydraulic spill and the Rocky Reach HCP Coordinating Committee was supportive of capturing this biological benefit in the report while preserving the dates when summer spill was turned on and off. He said the Rock Island Dam graph now shows hydraulic spill in a format similar to the Rocky Reach Dam graph. He said the numbers changed slightly, as follows:

Project	Declared Summer Spill	All Spill (including hydraulic spill)
Rocky Reach Dam	May 25 to August 6 – 94.1% coverage	May 18 to August 6 – 96.5% coverage
Rock Island Dam	May 25 to August 14 – 99.3% coverage	May 15 to August 14 – 99.4% coverage

Keller recalled that Chelan PUD had an action item to compare fish spill coverage data from 2011 and 2012 to data from 2018. Keller said in 2011, Rocky Reach Dam spilled from June 4 to August 12 and covered 96.8% of the juvenile outmigration, and the summer spill percentage was 28.5%. He said in 2012, Rocky Reach Dam spilled from May 26 to August 9 and covered 97.2% of the juvenile outmigration, and the summer spill percentage was 38.6%. He said there were no issues of 1 day making a difference for spill in either year. Andrew Gingerich said in 2018, there was a high runoff from March to May. He said 2011 and 2012 has a more normal peak freshet in June and July.

The Rocky Reach and Rock Island HCP Coordinating Committees representatives present approved the 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report, as revised. *(Note: Jim Craig provided USFWS approval of the report via email on November 20, 2018.)*

D. HCP Coordinating and Hatchery Committees Email Distribution List and Extranet Access – Bill Towey (Lance Keller)

Lance Keller said Bill Towey is a relatively new Senior Fisheries Scientist for Chelan PUD. Keller said Towey is a backfill for Steve Hays (Fish & Wildlife Senior Advisor) and is assisting with the HCP committees and fish forums. Keller said Chelan PUD is requesting that Towey be added to the HCP Hatchery and Coordinating Committees email distribution lists and provided access to the respective extranet sites. HCP Coordinating Committees representatives present agreed to add Towey to select HCP Hatchery and Coordinating Committees email distribution lists and provide Towey with visitor access to the HCP Hatchery and Coordinating Committees extranet sites.

Kristi Geris will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) and Julene McGregor (Douglas PUD Information Systems Staff) to add Towey to select HCP Hatchery and Coordinating Committees email distribution lists and provide Towey with visitor access to the HCP Hatchery and Coordinating Committees extranet sites. *(Note: Geris contacted Montgomery and McGregor, as discussed, following the meeting on October 23, 2018.)*

VI. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on December 4, 2018, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington. *(Note: the HCP Coordinating Committees agreed to reschedule the "November 2018" meeting to accommodate attendance to the annual USACE Anadromous Fish Evaluation Program conference in Portland, Oregon, from November 27 to 28, 2018.)*

The December 18, 2018 meeting will be held by conference call, if needed. *(Note: this meeting date was rescheduled from December 25, 2018, to accommodate the holiday.)*

The January 22, 2019 meeting will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	UCSRB Integrated Recovery Presentation
Attachment C	Route-Specific Fish Passage at Rock Island Dam and Columbia River Usable Storage

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Scott Carlon*†	National Marine Fisheries Service
Chad Jackson*†	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation
Greer Maier***	Upper Columbia Salmon Recovery Board
Melody Kreimes***	Upper Columbia Salmon Recovery Board
Denny Rohr***†	D. Rohr & Associates, Inc.
Peter Graf***	Grant PUD
Tom Skiles***†	Columbia River Inter-Tribal Fish Commission

Notes:

* Denotes HCP Coordinating Committees member or alternate

† Joined by phone

†† Joined by phone for the HCP Tributary and Hatchery Committees Update

*** Joined for Upper Columbia Salmon Recovery Board agenda item

Attachment B

UPPER COLUMBIA SALMON RECOVERY BOARD

INTEGRATED RECOVERY

GREER MAIER
Chief Scientist

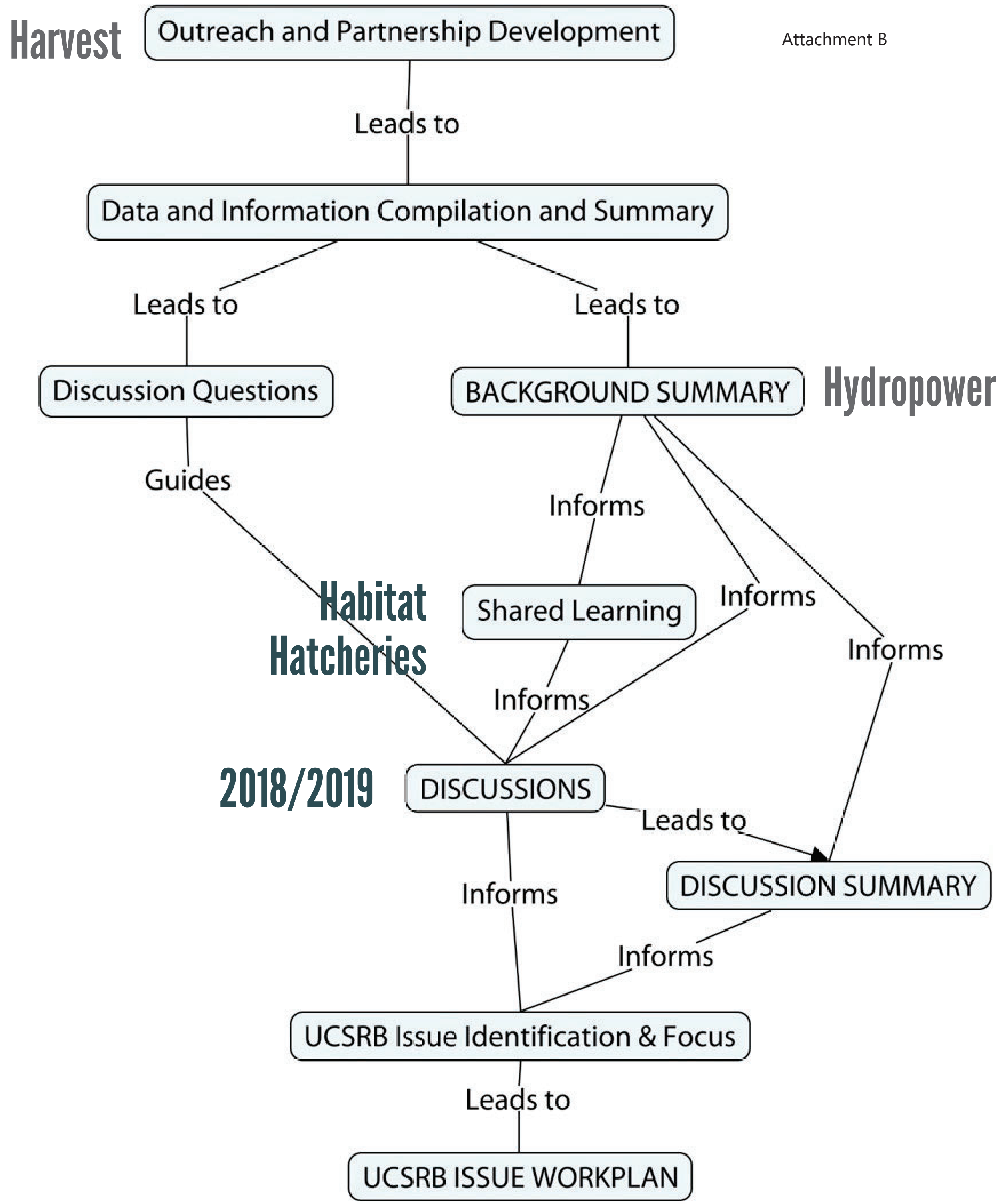
WWW.UCSRB.ORG

INTEGRATED RECOVERY GOALS

1. Achieve recovery of Upper Columbia spring Chinook salmon and of Upper Columbia steelhead, which will require coordinated actions in all of the management sectors affecting salmon.

2. Engage and collaborate with sector managers in finding and implementing solutions to identified issues.

Attachment B



Process

Attachment B

BACKGROUND SUMMARY

Management and policy

Programs and operations

Documented outcomes

Uncertainties and Data gaps

SHARED LEARNING

Concepts

Science

Policy

Management

DISCUSSIONS

Interpretation

Challenges

Progress toward recovery

Attachment B

UPPER COLUMBIA SALMON RECOVERY BOARD

HYDROPOWER

BACKGROUND SUMMARY

STEPS:

1. OUTREACH AND COMPILATION
2. WORKING DRAFT- IRTAG
3. REVIEW DRAFT- IRTAG, RTT, OTHERS
4. FINAL DRAFT- UCSRB APPROVAL
5. OUTREACH AND DISCUSSION

Attachment B

REPORTING TIMELINE

2014

HABITAT

DECEMBER 2017

HATCHERIES

DECEMBER 2018

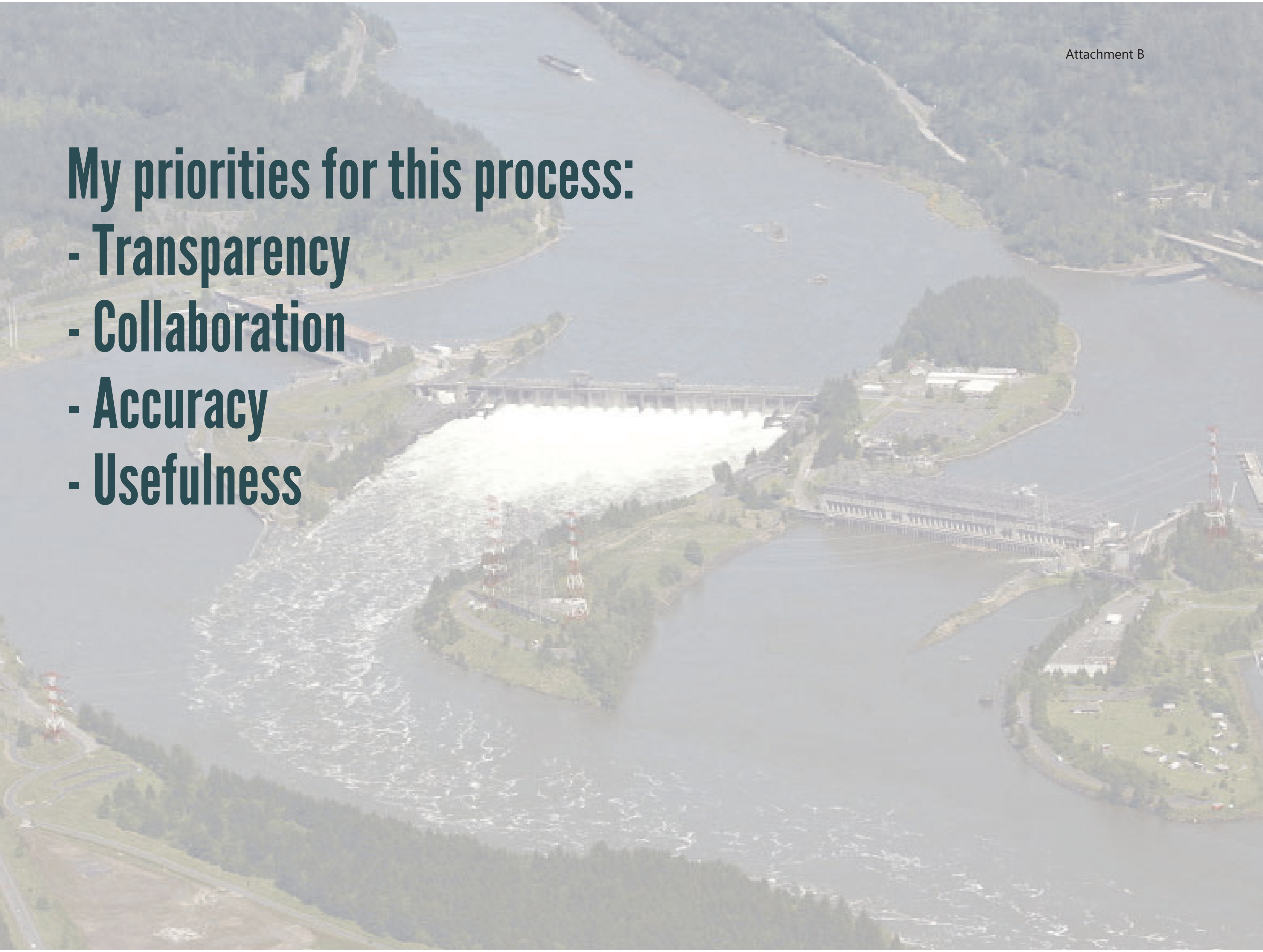
HYDROPOWER

SPRING 2019

HARVEST

2019/2020

Discussions with Partners



My priorities for this process:

- Transparency
- Collaboration
- Accuracy
- Usefulness

IRTAG

The role of the IRTAG is to provide input into the IR process and products and review documents

Hydropower Member Organizations:

WDFW
CCT
YN
CPUD, DPUD, and GPUD
BPA
NOAA
MSRF
GSRO
USACE
NWPCC
BOR

HYDROPOWER SUMMARY

NEXT STEPS

OCTOBER

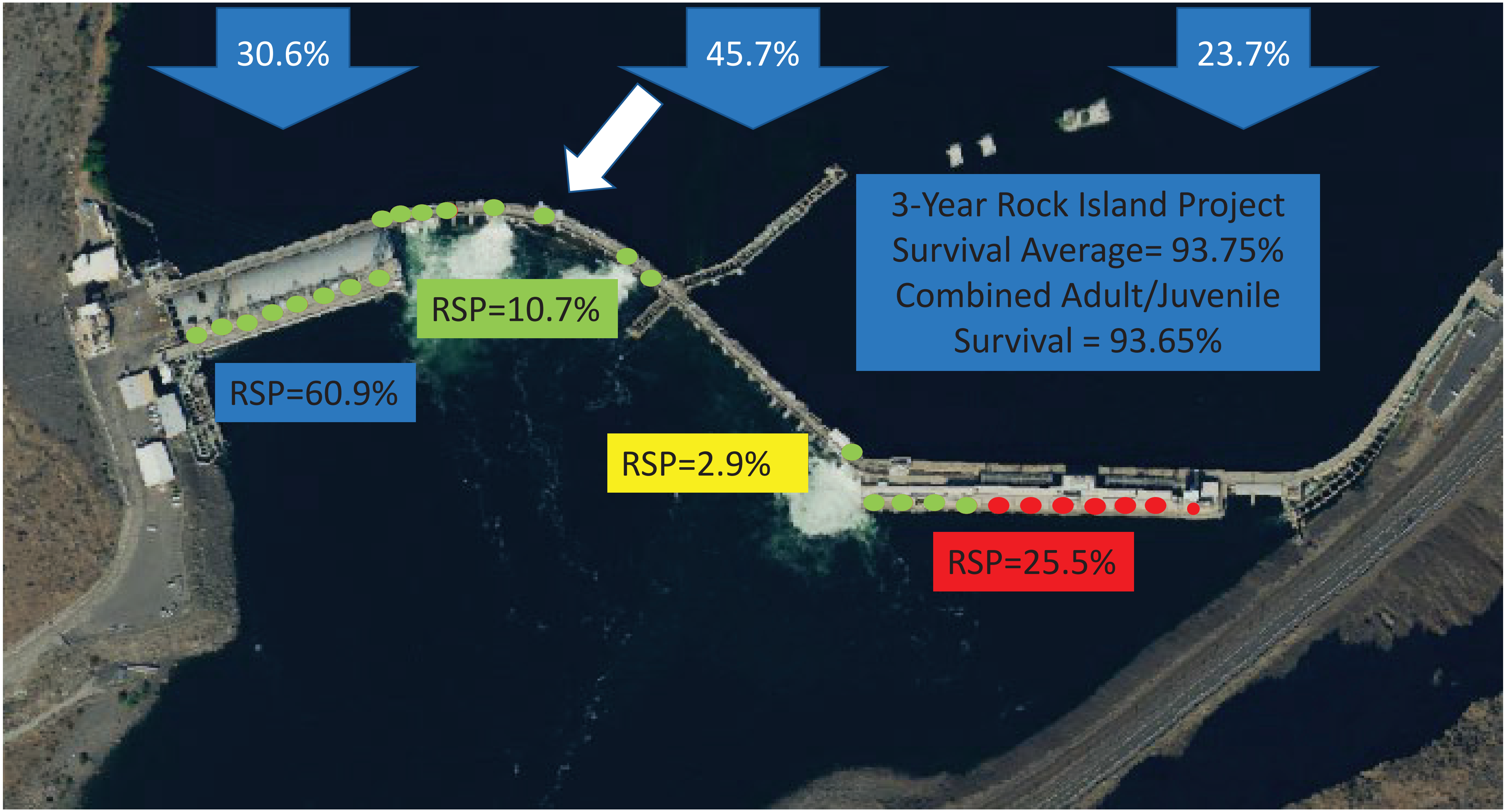
Review Draft
Coordinating Committee
RTT

NOVEMBER

IRTAG
Final Draft

DECEMBER

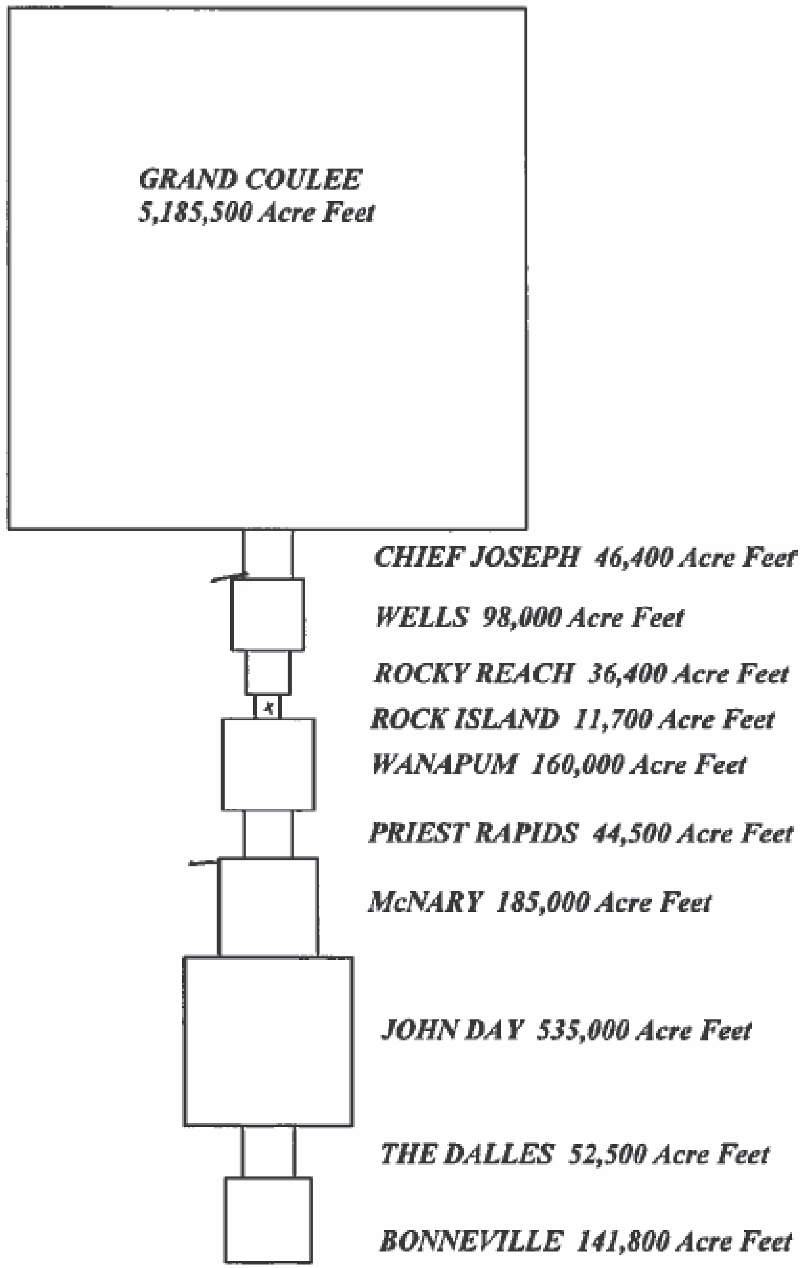
UCSRB BOD approval



30.6%
45.7%
23.7%
3-Year Rock Island Project
Survival Average= 93.75%
Combined Adult/Juvenile
Survival = 93.65%
RSP=10.7%
RSP=60.9%
RSP=2.9%
RSP=25.5%

Columbia River Usable Storage

Attachment C



FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees

Date: January 27, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the December 4, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD Office in Wenatchee, Washington, on Tuesday, December 4, 2018, from 10:00 a.m. to 1:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).
- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).
- Tom Kahler will determine the final outcome of the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item I-C).
- Lance Keller will consult Alene Underwood (Chelan PUD HCP Policy Representative) about if and how the Rock Island and Rocky Reach HCPs can be amended or modified based on new data (Item I-C).
- Lance Keller will revise the Statement of Agreement (SOA), *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021*, as discussed, and will provide the final SOA to Kristi Geris for distribution to the HCP Coordinating Committees (Item II-A). *(Note: Keller provided the final SOA to Geris on December 5, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*
- Kristi Geris will coordinate with Tracy Hillman (HCP Tributary Committees Chairman) and Julene McGregor (Douglas PUD Information Systems Staff) to add Mary Mayo (Douglas PUD

Support Staff) to select HCP Tributary Committees email distribution lists and provide Mayo with administrator access to the HCP Tributary Committees extranet site, as approved by the HCP Coordinating Committees (Item IV-A). *(Note: Geris contacted Hillman and McGregor, as discussed, on December 5, 2018, and Mayo was added to the distribution lists and extranet site.)*

- Tom Kahler will inquire internally about measures Douglas PUD plans to employ to reduce fish size at release for the Douglas PUD 2020 Survival Verification Study, including what fish size might be achieved, and will report back to the HCP Coordinating Committees (Item IV-E).
- Tom Kahler will inquire internally about alternative start and end dates for the Douglas PUD 2020 Survival Verification Study to ensure the release schedule matches the run timing of target species as much as possible and will provide different scenarios for consideration to the HCP Coordinating Committees (Item IV-E).
- The HCP Coordinating Committees meeting on December 18, 2018, will be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington (Item V-B).

Decision Summary

- The Rock Island HCP Coordinating Committee representatives present approved the SOA, *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021*, as revised (Item II-A).
- The Wells HCP Coordinating Committee representatives present approved the Douglas PUD Spill Prevention Control and Counter Measures (SPCC) Plan, as revised (Item IV-C).

Agreements

- HCP Coordinating Committees representatives present agreed to add Mary Mayo to select HCP Tributary Committees email distribution lists and provide Mayo with administrator access to the HCP Tributary Committees extranet site (Item IV-A).

Review Items

- A Wells Project Land-Use Permit Application for a Joint-Use Dock on Tract 75 (Gebbers Farm) was distributed to the HCP Coordinating Committees by Kristi Geris on November 13, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Tom Kahler by Monday, January 14, 2019 (Item IV-D).
- A Wells Project Land-Use Permit Application for a Joint-Use Dock on Tract 1131 (Repo LLC) was distributed to the HCP Coordinating Committees by Kristi Geris on November 13, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Tom Kahler by Monday, January 14, 2019 (Item IV-D).

- A Wells Project Land-Use Permit Application for a Single-Use Dock (LeSage) was distributed to the HCP Coordinating Committees by Kristi Geris on November 29, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Tom Kahler by Monday, January 28, 2019 (Item IV-D).
- A Draft 2018 Post-Season Bypass Report and Passage-Dates Analysis was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which is available for a 60-day review with edits and comments due to Tom Kahler by Tuesday, February 12, 2019.
- A Draft 2017 Pikeminnow Report was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which is available for a 30-day review with edits and comments due to Lance Keller or Scott Hopkins (Chelan PUD) by Monday, January 14, 2019.
- The revised draft 2020 Wells Project Survival Verification Study Plan was distributed to the HCP Coordinating Committees by Tom Kahler on December 18, 2018. A final revised draft plan for approval was distributed to the HCP Coordinating Committees by Kristi Geris on January 15, 2019. Douglas PUD will request approval of this plan during the HCP Coordinating Committees meeting on January 22, 2019 (Item III-E).
- A Draft 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on January 16, 2019, which is available for a 30-day review with edits and comments due to Tom Kahler by Friday, February 15, 2019.
- A draft *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* was distributed to the HCP Coordinating Committees by Kristi Geris on January 21, 2019 and is available for review with edits and comments due to Douglas PUD by Monday, February 11, 2019.

Finalized Documents

- The final SOA, *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021*, was distributed to the HCP Coordinating Committees by Kristi Geris on December 5, 2018 (Item II-A).
- The Final Douglas PUD SPCC Plan was distributed to the HCP Coordinating Committees by Kristi Geris on December 11, 2018 (Item IV-C).
- The Final 2018 Rock Island and Rocky Reach HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on December 11, 2018.
- The Final 2017 Rocky Reach Juvenile Fish Bypass System Report was distributed to the HCP Coordinating Committees by Kristi Geris on December 11, 2018.
- The Final 2017 Rock Island Smolt and Gas Bubble Trauma Evaluation Report was distributed to the HCP Coordinating Committees by Kristi Geris on December 11, 2018.
- The Final 2018 Rock Island Bypass Monitoring Plan was distributed to the HCP Coordinating Committees by Kristi Geris on December 11, 2018.

- The Final 2018 Rocky Reach Juvenile Fish Bypass System Operations Plan was distributed to the HCP Coordinating Committees by Kristi Geris on December 11, 2018.
- The Final 2018 HCP Rocky Reach and Rock Island Fish Spill Program Report was distributed to the HCP Coordinating Committees by Kristi Geris on December 11, 2018.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. The following revisions were requested:

- Lance Keller added: 1) Rocky Reach and Rock Island Adult Fishway Maintenance updates; and 2) Upper Columbia Salmon Recovery Board (UCSRB) Hydropower Summary Report
- Tom Kahler added: 1) HCP Tributary Committees Email Distribution List and Extranet Access request for Mary Mayo; 2) Wells Dam Fishway Maintenance update; and 3) Wells Project Land-Use Permit Applications available for review

B. Meeting Minutes Approval (John Ferguson)

The HCP Coordinating Committees reviewed the revised draft October 23, 2018 meeting minutes. Kristi Geris said all comments and revisions received from members of the HCP Coordinating Committees were incorporated into the revised minutes. Geris said she also updated distribution of review items. Lance Keller said he has one additional edit under the Rock Island Dam Powerhouse 1 Maintenance Update. Keller clarified when considering prioritizing work between Turbine Units B5 and B8 (i.e., if there has to be one unit offline in Powerhouse 1, which would be the case), Chelan PUD would select Turbine Unit B8 to be offline, giving the *maintenance* priority to Turbine Unit B5. Geris said this edit will be incorporated into the final minutes. HCP Coordinating Committees members present approved the October 23, 2018 meeting minutes, as revised. U.S. Fish and Wildlife Service abstained, because a U.S. Fish and Wildlife Service representative was not present during the meeting on October 23, 2018.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on October 23, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on October 23, 2018):*

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.

- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine the following: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high-flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item I-C).*
  This action item will be carried forward.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  This action item will be discussed during today's meeting and will also be carried forward.
- *Tom Kahler will determine the final outcome of the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Tracy Hillman (HCP Tributary Committees Chairman) will provide additional information regarding design and implementation funding for the Icicle Creek Boulder Field Passage Project (Item II-A).*
  Hillman provided this information following the meeting on October 23, 2018, which Kristi Geris distributed to the HCP Coordinating Committees that same day.
- *Tom Kahler will provide the Final 2010 Wells Project Survival Verification Study Report (Bickford et. al 2011[1]) to Kristi Geris for redistribution to the HCP Coordinating Committees (Item III-A).*
  Kahler provided this report following the meeting on October 23, 2018, which Geris distributed to the HCP Coordinating Committees that same day.
- *Tom Kahler will consult Shane Bickford (Douglas PUD HCP Policy Representative) about the following: 1) the impetus for selecting study fish release locations at the mouths of the Methow and Okanogan rivers (versus farther upstream) for Douglas PUD survival verification studies; and 2) if and how the Wells HCP can be amended or modified based on new data (Item III-A).*
  This action item will be discussed during today's meeting.
- *Lance Keller will consult Alene Underwood (Chelan PUD HCP Policy Representative) about if and how the Rock Island and Rocky Reach HCPs can be amended or modified based on new data (Item III-A).*
  This action item will be carried forward.
- *Andrew Gingerich will determine whether a draft Douglas PUD SPCC Plan is available in tracked changes to clearly show updates in the current draft for review (2018) compared to the last Federal Energy Regulatory Commission (FERC)-approved final plan (2013) and will provide this redlined draft to Kristi Geris for distribution to the HCP Coordinating Committees (Item III-B).*

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[1] Bickford, S.A., T. Kahler, J.R. Skalski, R.L. Townsend, R. Richmond, S. McCutcheon, and R. Fechhelm, 2011. *Project Survival Estimates for Yearling Chinook Migrating through the Wells Hydroelectric Project, 2010. 2010 Spring Migrant Survival Verification Study.* Prepared for Public Utility District No. 1 of Douglas County. June 2011.

Gingerich provided a list of changes between the two plans to Geris on November 9, 2018, which Geris distributed to the HCP Coordinating Committees that same day.

- *Greer Maier (UCSRB Chief Scientist) will provide the Draft UCSRB Hydropower Background Summary email, including the Doodle Poll request to schedule the next Integrated Recovery Technical Advisory Group (IRTAG) meeting, to Kristi Geris and Denny Rohr (Priest Rapids Coordinating Committee [PRCC] Facilitator) for distribution to the HCP Coordinating Committees and PRCC, respectively (Item IV-A).*
  Maier provided this email to Geris and Rohr following the meeting on October 23, 2018. Geris distributed this email to the HCP Coordinating Committees that same day.
- *Lance Keller will determine the threshold whereby operations at Rock Island Dam under summer spill operations begin to shift from Powerhouse 2 and spill to Powerhouse 1 (Item V-B).*
  Keller said during summer spill operations when river flow passing Rock Island Dam reaches roughly 140,000 cubic feet per second (140 kcfs), the total number of units online at Rock Island Dam shifts from 8 units to 9 units (operations shift from Powerhouse 2 spill only to also include some operation of Powerhouse 1). He said caveats to this shift include unit efficiency curves and whether the reservoir is draining or filling.
- *Kristi Geris will coordinate with Sarah Montgomery (HCP Hatchery Committees support staff) and Julene McGregor (Douglas PUD Information Systems Staff) to add Bill Towey (Chelan PUD Senior Fisheries Scientist) to select HCP Hatchery and Coordinating Committees email distribution lists and provide Towey with visitor access to the HCP Hatchery and Coordinating Committees extranet sites (Item V-D).*
  Geris contacted Montgomery and McGregor, as discussed, following the meeting on October 23, 2018.

II. Chelan PUD

A. DECISION: Statement of Agreement, Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021 (Lance Keller)

Lance Keller said the SOA, *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021*, was distributed to the HCP Coordinating Committees by Kristi Geris on November 20, 2018. Keller said this SOA was drafted to be straight forward and include an explanation of the driver behind this proposed deferment. He then welcomed edits or comments on the draft SOA.
Kirk Truscott suggested adding to the end of the Agreement Statement, "and allow for testing under representative project operations in 2021." Keller said he can make this edit, as requested.

The Rock Island HCP Coordinating Committee representatives present approved the SOA, *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021*, as revised. Keller will revise the SOA, as discussed, and will provide the final SOA to Geris for distribution to the HCP Coordinating

Committees. *(Note: Keller provided the final SOA [Attachment B] to Geris on December 5, 2018, which Geris distributed to the HCP Coordinating Committees that same day.)*

B. Rocky Reach Dam Turbine Unit C1 Update (Lance Keller)

Lance Keller said there are no significant updates to report at this time because Rocky Reach Dam mechanics are working out schedules for unit work and maintenance, fishway outages, and crew schedules to be able to complete the dismantling of Turbine Unit C1. He said he will have another update on this progress during the next HCP Coordinating Committees meeting.

C. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Rock Island Dam Powerhouse 1 maintenance was in a holding pattern until the SOA, *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to* 2021, was approved by the Rock Island HCP Coordinating Committee. Keller said he will report approval of the SOA to the Rock Island Dam Maintenance Superintendent; the next steps will include submitting change orders and setting the maintenance schedule moving forward.

D. Rocky Reach and Rock Island Adult Fishway Maintenance Updates (Lance Keller)

Lance Keller reviewed adult fishway maintenance updates at Rock Island Dam and Rocky Reach Dam, as follows:

<u>Rock Island Dam</u>

Keller recalled there are three adult fish ladders at Rock Island Dam, which allows operators to maintain fish passage at one fish ladder while the other two ladders are offline for maintenance. He said having three fish ladders also provides a longer maintenance window, which typically starts around December 1 and ends around February 28 each year.

Keller said the right adult fish ladder at Rock Island Dam was taken offline for annual winter maintenance on December 3, 2018, and a fish rescue was conducted in the upper ladder that same day. He said a fish rescue was planned for the lower ladder, as well; however, the gates installed at the exits allowing the fishway to drain down to an elevation equal to the tailwater did not seal well and the lower ladder did not fully drain in time to conduct a fish rescue. He said a fish rescue is planned for the lower ladder tomorrow, December 5, 2018.

Jim Craig asked if fish encountered in the fishway are netted out, and Keller said yes. Keller further explained that the upper fish ladder is all orifice passage and crews climb through each orifice during the rescue. He reviewed the species recovered from the upper fish ladder, as follows:

Species	Stage/Length	Clip	Count
Chinook salmon	adult	ad-present	1

Species	Stage/Length	Clip	Count
	juvenile	ad-present	10
Steelhead	juvenile	ad-present	6
		ad-clipped	2
Coho salmon	juvenile	ad-present	12
Pikeminnow	NR	NA	23
Sucker	NR	NA	1
Chiselmouth	NR	NA	9

Notes:
ad: adipose
NA: not applicable
NR: not reported

Keller said the recovered adult Chinook salmon was female, not PIT-tagged, and was in prime shape. He said the fish was not scanned for a coded wire tag (CWT), and he recalled a few years ago similar fish were encountered during a fish rescue. Chad Jackson recalled hearing about oddities during fish rescues before and said it would be interesting to collect photographs of these fish. Keller said this may be challenging but is possible. He said Thad Mosey (Chelan PUD Senior Fish Biologist) maintains a tracking sheet of these oddities encountered over the years. Andrew Gingerich asked if the fish might have been from Lake Chelan? Keller said this fish had too much body mass to be from Lake Chelan and said he believes it was anadromous. Jackson suggested in future years, considering securing authority to lethally take these fish to determine what they are. Jim Craig also suggested at least collecting genetic samples. Keller agreed this is a possibility and recalled encountering hatchery-origin *O. mykiss* between 12 and 18 inches in length during fish rescues for the 2017/2018 winter maintenance outages. He said Mike Tonseth (Washington Department of Fish and Wildlife [WDFW] HCP Hatchery Committees Representative) requested approval from the HCP Hatchery Committees to lethally remove these fish to determine what they are. Keller said the HCP Hatchery Committees approved this request on February 21, 2018, and Chelan PUD coordinated with Tonseth before this current fish rescue in case *O. mykiss* between 12 and 18 inches long were again encountered. Keller said, however, none of these fish were encountered when the right ladder was dewatered this year. He said all juvenile steelhead encountered were less than 12 inches in length and had no CWT or PIT tag. He said steelhead will be measured and scanned for CWTs and PIT tags during rescues in the other two fish ladders at Rock Island Dam and the Rocky Reach Dam fish ladder.

Keller noted that typically, only 1 to 3 pikeminnow are encountered, so this year was fairly high in terms of numbers. He said no fish were large in size; rather, they were all within 10 to 14 inches in length.

John Ferguson asked about Pacific lamprey, and Keller said no Pacific lamprey were encountered during this fish rescue. Keller said if Pacific lamprey are encountered, it is typically in the lower ladder.

Keller said when fish rescues are conducted, lockout tagout clearances are required. He said the upper fish ladder only has a few clearance points; however, the lower fish ladder has about 52 clearance points, which requires some time to get through. Ferguson asked which fish ladder is scheduled next for maintenance? Keller said he believes the middle fish ladder is next and then the left fish ladder. He said both ladders require minimal maintenance this outage and will occur after January 1, 2019. He said Biomark will also be on site to investigate a "noise" issue with the PIT-tag detection system.

Rocky Reach Dam

Keller said the adult fishway at Rocky Reach Dam will taken offline for annual winter maintenance after the holidays around January 2 or 3, 2019. He said maintenance and inspections should be routine and straight forward, and the fishway should be back online before February 28, 2019.

E. Upper Columbia Salmon Recovery Board Hydropower Summary Report (Lance Keller)

Lance Keller recalled that Greer Maier, UCSRB Chief Scientist, presented on the UCSRB Hydropower Summary Report during the last HCP Coordinating Committees meeting on October 23, 2018. Keller said the IRTAG then convened on November 29, 2018, and Chelan PUD felt the meeting was positive. He said Maier is approaching the final draft phase to present to UCSRB. He said this window for comments is rapidly closing. He said there were action items from the IRTAG meeting to provide additional background information, and overall, the report is headed in a good direction.

John Ferguson asked when the deadline for comments is. Tom Kahler said Maier is leaving on vacation soon and she wanted to distribute the final draft before she leaves. Keller agreed and recalled the schedule is fairly aggressive. Keely Murdoch suggested submitting comments as soon as possible. Kahler said the next UCSRB meeting is on December 13, 2018, and he believes Maier would like to have comments before then; however, this may not be feasible. Ferguson suggested contacting Maier about a comment deadline.

Ferguson asked who is represented on the IRTAG. Keller said he, Murdoch, Kahler, and Peter Graf (Grant PUD) participate on the committee; and Murdoch added that Maier encouraged everyone in the local fish forums and committees to participate. Keller said there was good representation at the last IRTAG meeting, including National Marine Fisheries Service (NMFS), WDFW, Bonneville Power Administration, and Grant, Chelan, and Douglas PUDs, among others.

III. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman reported that the HCP Tributary Committees did not meet in November 2018 and will next meet on December 13, 2018, when the HCP Tributary Committees will review six General Salmon Habitat Program proposals.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Hatchery Committees meeting on November 15, 2018 (*note: joint HCP Hatchery Committees/PRCC Hatchery Subcommittee items are noted by "joint"*):

- *Research on Excess Hatchery-by-Hatchery Steelhead*: In early November 2018, about 21,000 excess Hatchery-by-Hatchery Wenatchee steelhead were brought to the attention of the HCP Hatchery Committees. Chelan PUD suggested using some of these excess fish to evaluate the effects of different temperature regimes on precocial maturation. A sample of 500 steelhead will be reared at each of the three facilities (1,500 fish total among Chelan Fish Hatchery, Eastbank Fish Hatchery, and the Chiwawa Acclimation Facility) from mid-November 2018 until early March 2019. Each facility has a different temperature regime; therefore, there is a unique opportunity to evaluate the effects of temperature on precocial maturation. Steelhead from the three groups will be lethally sampled to assess maturation. John Ferguson asked if the HCP Hatchery Committees approved this request, and Hillman said approval was not required because these fish are surplus to the program.
- *Coho Salmon Acclimation at the Twisp Pond in 2019*: The Yakama Nation (YN) will begin the natural production implementation phase of their coho salmon reintroduction plan in 2019. To support this phase of the reintroduction plan, the YN requested to acclimate 110,000 coho salmon in the Twisp Acclimation Pond during spring 2019. Acclimation densities will remain low and fish are expected to be between 15 to 18 fish per pound upon release. The Wells HCP Hatchery Committee approved the request.
- *Wells Implementation Monitoring and Evaluation Plan*: Douglas PUD provided the Wells HCP Hatchery Committee with the 2019 Wells Hatchery Complex Programs Monitoring and Evaluation Implementation Plan. Comments are due to Douglas PUD on December 10, 2018. For contracting purposes, the Wells HCP Hatchery Committee will approve the plan by December 15, 2018.
- *Update from the Geneticists (joint)*: Recall, five independent geneticists are addressing the HCP Hatchery Committees questions on how to monitor the effects of hatchery programs on genetics of natural-origin and hatchery-origin fish. One geneticist indicated that all geneticists are in the process of responding to questions and a draft response document should be available to the HCP Hatchery Committees in early 2019.

- *NMFS Consultation (joint)*: NMFS received and is addressing comments on the draft Environmental Assessment for Upper Columbia River Steelhead and Summer/Fall Chinook Salmon Programs. The draft Environmental Assessment will be available for public comments soon.
- *Next Meeting*: The next meeting of the HCP Hatchery Committees will be on December 19, 2018.

IV. Douglas PUD

A. HCP Tributary Committees Email Distribution List and Extranet Access – Mary Mayo (Tom Kahler)

Tom Kahler said Becky Gallaher (Chelan PUD) uploads Wells HCP Tributary Committees-related documents to the Douglas PUD HCP Tributary Committees extranet site. Kahler said the Douglas PUD Clean Water Act Section 401 Water Quality Certification also requires that these documents be uploaded to the Douglas PUD website. He said Mary Mayo (Douglas PUD Support Staff) will be responsible for uploading documents to the website and needs access to these files. Kahler said the request is to add Mayo to select email distribution lists to receive final agendas, meeting minutes, plans, and reports to upload to the Douglas PUD website.

HCP Coordinating Committees representatives present agreed to add Mayo to select HCP Tributary Committees email distribution lists and provide Mayo with administrator access to the HCP Tributary Committees extranet site. Kristi Geris will coordinate with Tracy Hillman and Julene McGregor to add Mayo to select HCP Tributary Committees email distribution lists and provide Mayo with administrator access to the HCP Tributary Committees extranet site, as approved by the HCP Coordinating Committees. *(Note: Geris contacted Hillman and McGregor, as discussed, on December 5, 2018, and Mayo was added to the distribution lists and extranet site.)*

B. Wells Dam Fishway Maintenance Update (Tom Kahler)

Tom Kahler said the east fishway will be taken offline for winter maintenance next week and will be the longer of the two outages this season. He said a contractor is scheduled to polish the fishway windows during this outage. He said the west fishway will be taken offline for winter maintenance after the east fishway is back in service around mid- to late-January 2019.

Jim Craig asked why window polishing is not part of the routine annual maintenance. Kahler said the windows are routinely cleaned; however, over time the windows become scratched and pitted, which requires the more extensive polishing. Lance Keller said this is the same process for Chelan PUD.

C. DECISION: Douglas PUD SPCC Plan (Andrew Gingerich)

Andrew Gingerich recalled a request by Kirk Truscott to determine whether a draft Douglas PUD SPCC Plan is available in tracked changes to clearly show updates in the current draft for review

(2018) compared to the last FERC-approved final plan (2013) and to provide this redlined draft to Kristi Geris for distribution to the HCP Coordinating Committees. Gingerich said he provided a redline version showing the changes between the two plans to Geris on November 9, 2018, which Geris distributed to the HCP Coordinating Committees that same day, along with a note indicating Douglas PUD's intention to request approval of this plan during today's HCP Coordinating Committees meeting. Gingerich said this SPCC Plan was also reviewed and approved by the Aquatic Settlement Work Group and the Washington Department of Ecology.

The Wells HCP Coordinating Committee representatives present approved the Douglas PUD SPCC Plan, as revised. The Final Douglas PUD SPCC Plan was distributed to the HCP Coordinating Committees by Geris on December 11, 2018.

D. Wells Project Land-Use Permit Applications (Tom Kahler)

Tom Kahler recalled that the Wells HCP includes a requirement to consider comments from the Parties to the Agreement regarding any land use permit application on Wells Project owned lands. Kahler reviewed the following Wells Project Land-Use Permit Applications available for comment:

Gebbers Farm and Repo LLC

Kahler said two Wells Project Land-Use Permit Applications (for Gebbers Farm and Repo LLC) were distributed to the HCP Coordinating Committees by Kristi Geris on November 13, 2018, with edits, comments, or an indication of no comments due to Kahler by Monday, January 14, 2019. Kahler noted that Douglas PUD already provided these two joint-use dock permit applications to representatives of the Parties back in 2007 or 2008 and received no comments. He explained that when Douglas PUD updated their land-use policies in 2007, landowners within the city limits of Brewster, Pateros, and Bridgeport would be grandfathered into the old regulations and could continue to apply for new dock permits. He said these landowners need to adhere to the new methods and materials approved under the various dock consulting agencies. He said the Gebbers Farm and Repo LLC applications are outside the city limits of Brewster, Pateros, and Bridgeport, but are on the "yellow list," which means these applications were in the works at the time Douglas PUD created the new land-use policies, and thus could proceed through permitting. He said these applications have been reviewed, as noted above, and permitted by WDFW and the U.S. Army Corps of Engineers, but for some reason they languished, and now they are ready to move forward. He said location maps were provided for both applications. He said the Repo LLC application is located about 0.75 mile upstream of Washburn Island on the Colville Indian Reservation side. He said the Gebbers Farm application is near a location where Douglas PUD experienced highly productive beach seining during their 2011 to 2013 Subyearling Study (referred to as Gebbers Landing). He said Douglas PUD set up net pens just upstream from the Gebbers Farm application location where the landowner proposes to install the dock and beach seined upstream from this location.

Kahler said Douglas PUD has concerns about the Gebbers Landing location because it is a staging location for early subyearlings out of the Okanogan River. He said the Repo LLC location is steep with cobble at the toe and drops off quickly into a fast current. He said schools of fry have been observed along the shoreline in early May, but the distribution of these was patchy.

LeSage

Kahler said a Wells Project Land-Use Permit Application for a Single-Use Dock (LeSage) was distributed to the HCP Coordinating Committees by Geris on November 29, 2018, with edits, comments, or indication of no comments due to Kahler by Monday, January 28, 2019. Kahler said this application is for an existing dock that washed away during the high river flows experienced during spring 2018. He said when Douglas PUD lowered the pool elevation to conduct work on the old channels at the mouth of the Okanogan River, components of the washed-out dock were retrieved and will be reused. He said the float will be reconstructed and instead of a sea anchor system, piles will be installed.

Jim Craig asked if there are restrictions on lighting, and Kahler said he is unsure about electrical restrictions. Kahler said the application materials indicate that activities will conform with the terms and conditions in all overseeing government agencies. Chad Jackson asked about spacing between the slats or boards, and Kahler said these details will conform with WDFW criteria.

Discussion

Scott Carlon asked if these applications have already been through the Joint Aquatic Resource Permit Application review process. Kahler said they have and added that Douglas PUD does not process land-use permit applications until the landowner obtains permits from the U.S. Army Corp of Engineers and a Hydraulic Project Approval from the State. Kirk Truscott said landowners also need to obtain a permit from the tribes to install a dock on tribal land.

Truscott said it seems the U.S. Army Corp of Engineers and tribes permits for the Repo LLC application have expired. Kahler said Douglas PUD will not issue anything until the permits are current.

Kahler said he suspects the Douglas PUD Natural Resource Department will comment on the Gebbers Farm application considering the area is heavily used by early subyearlings. He said the Colville Confederated Tribes also use the beach just upstream for seining. Truscott said there is already in-water habitat present for predators and additional structures are also conducive to predators. Andrew Gingerich said this is also a fishing location and landowners may be requesting no trespassing.

E. Douglas PUD 2020 Survival Verification Study Plan (Tom Kahler)

Tom Kahler said the draft 2020 Wells Project Survival Verification Study Plan was distributed to the HCP Coordinating Committees by Kristi Geris on September 24, 2018, with edits and comments due to Kahler by Tuesday, November 27, 2018. Kahler said Douglas PUD received verbal comments during the HCP Coordinating Committees meeting on October 23, 2018, and written comments were received from the YN (Attachment C) and WDFW (Attachment D) on November 21, and 27, 2018, respectively, as distributed to the HCP Coordinating Committees by Geris those same days. Kahler reviewed comments received, as follows:

Fish Size

Kahler said WDFW's first comment is regarding fish size (see page 1 of Attachment D [2.1 Study Fish]). He said the question is how to select a fish size that represents the size range of three spring migrants (yearling Chinook salmon, steelhead, and coho salmon). Kahler distributed a hard copy of a table with fish size ranges (Attachment E), which was also distributed electronically during the meeting on December 4, 2018. John Ferguson noted that the YN had a similar comment regarding fish size (see page 5 of Attachment C [2.1 Study Fish]).

Kahler said the data in Attachment E are from the Methow and Twisp rivers screw traps from 2014 to 2017. He said fish lengths are in millimeters (mm), the combined row is all stocks together, and the bottom row represents fish sizes from the 2010 Wells Project Survival Verification Study. He said numbers with asterisks are estimates. He said Attachment E points out the challenge of selecting a target fish size that represents all stocks, and he noted the means range from S1 Shd (1-salt steelhead) at 84 mm to H Sth (hatchery steelhead) at 189 mm. He said it is not reasonable to match the range of all fish and instead suggested to target matching the range of the study fish (summer Chinook salmon).

Keely Murdoch said she does not disagree with anything Kahler is saying; however, she does believe the HCPs intend to protect both hatchery and wild fish. She said it is the duty of the HCP Coordinating Committees to investigate whether these studies represent wild fish and/or how closely they represent wild fish. She asked within this framework, what can, and cannot the HCP Coordinating Committees do in 2020? She said she believes this is worth discussing further moving forward.

Kahler said if spring Chinook salmon are studied in 2030, study fish will need to be even smaller. Chad Jackson clarified that WDFW's comment was not intended to suggest that Douglas PUD represent the entire size range of spring migrants with the study fish; rather, WDFW thought the average release size would be smaller. Jackson said he believes the actual release size was 160 or 158 mm, and WDFW is wondering if this can be reduced to 134 to 145 mm. Kahler said Douglas PUD is discussing what can be done at Wells Fish Hatchery to hold back fish growth. Jackson said WDFW understands the culture logistics in doing this, and the reason behind 134 mm is based on 2010 sizes at tagging. Kahler said other sizes include size at screw trap collection, which span March to May. He said Douglas PUD tagged 2010 study fish in early March, so there was time to grow. He said the fish for the physiology monitoring are larger. He noted that in 2010, Douglas PUD truncated tagging size to 100 mm. He said if this is not done with 2020 study fish there will be a broader range.

Ferguson said back to Murdoch's question and when looking at 1SD (one standard deviation away from the mean value) for Comb. (combined stocks), in 2020 is it feasible to achieve the 1SD for Comb. (i.e., 99 to 177 mm) given hatchery practices? Kahler asked if this is attempted, will this affect performance? He said mini jacks cannot be used in the study because they will impact smolt-to-adult return (SAR) data, among other things. Jackson asked if there is a way to slightly push toward the center of the distribution. He agreed it is unreasonable to find a fish size that represents all spring migrants; however, he hopes to get to a size that is closer. Kahler said Douglas PUD plans to talk to Brian Beckman and Donald Larsen (NMFS Northwest Fisheries Science Center) about how to reduce the number of mini jacks.

Kirk Truscott said in a hatchery setting, there needs to be some direction for median size targets and ranges. He said in general, there needs to be a target fish size in fish per pound and fork length, and this needs to be clear for hatchery personnel sooner than later. Kahler said Douglas PUD is currently discussing possibly using circular tanks to raise a leaner fish that will be ready to migrate. He said he hesitates to modify the median target right now; however, Douglas PUD is willing to work toward reducing overall fish size. He said the median target right now is 10 fish per pound. He said Andrew Gingerich looked up all recaptures at the Rocky Reach Juvenile Sampling Facility of Plan Species from above Wells Dam in 2018, and the mean was 137 mm for 200 fish. Kahler also caveated there was a small sample size associated with this mean.

Gingerich reminded the HCP Coordinating Committees that available technical information about PIT-tagged fish indicates there is a burden with these fish, which is supportive of using slightly larger fish. He said these study fish may be slightly larger than the run at large, but this may also be okay given their tag burden. Truscott said from the standpoint of relative survival and comparing two different release groups, he is not sure he agrees with this statement. Gingerich said a PIT-tagged fish passing via turbine passage has a higher percent of mortal injury compared to a fish that is untagged.

Kahler said he will inquire internally about measures Douglas PUD plans to employ to reduce fish size at release for the Douglas PUD 2020 Survival Verification Study, including what fish size might be achieved, and will report back to the HCP Coordinating Committees. Truscott said he does not believe the Colville Confederated Tribes have ever achieved a target release of 10 fish per pound and suggested 115 to 117 mm fork length may be more feasible. Kahler said the study plan does not include details on fish size, and asked if the Wells HCP Coordinating Committee is proposing to include fish size in the plan? Truscott suggested appending a document to the study plan, if necessary.

Pathology, Physiology

Kahler said WDFW's second comment is regarding fish pathology (see page 2 of Attachment D [2.2 Pathology, Physiology]). Kahler said conducting an assessment of relative morphology, physiology, and pathology is consistent with what Douglas PUD has done in the past. He said which model to use has never come into play; rather, if something goes strongly wrong with the study, Douglas PUD wants to understand why. He said if there is a physiology issue, Douglas PUD will have collected the data to detect it. He said if the study fails and needs to be repeated, Douglas PUD wants to understand what went wrong. He said this is how this element of the study design is tracked. Truscott said this also provides information for the HCP Coordinating Committees to consider when asked if this is a valid study. Kahler noted that in 2010, one thing this assessment found is that fish had no mesenteric fat for the first two releases. He said because of this finding of the physiological assessment, Douglas PUD investigated and discovered that hatchery staff had quit feeding the fish, and then instructed hatchery staff to resume feeding. He said this assessment identified an issue and it was resolved for the remaining releases. Kahler said the text in the study plan will be modified to include this explanation.

Precision Objectives and Sample Size

Kahler said WDFW's third comment is regarding whether the planned 2:1 Methow to Okanogan release ratio is reflective of the run-of-the-river fish (see page 2 of Attachment D [3.2 Precision Objectives and Sample Size]). Kahler said this comment raised a question about Chief Joseph Fish Hatchery releases. He said the concern raised was whether the releases of yearling Chinook salmon from Chief Joseph Fish Hatchery directly to the mainstem Columbia River had been incorporated into the ratio calculation. Kahler said he was unsure whether the direct releases to the Columbia River had been included in the calculations but did not believe they had.

Kahler noted that release vessel loading capacity is a constraint in achieving a precise ratio. He said each replicate is approximately 3,300 fish for both treatment and control releases. He said the release barges can only hold a maximum of six release vessels; therefore, for the control releases each release vessel is loaded with 556 fish. He said the split for the Methow and Okanogan rivers needs to be a multiple of 556 because there cannot be partially filled vessels. He said the initial split was not exactly 2:1 but was as close to 2:1 as possible given these logistical constraints. He said next, the Chief Joseph direct releases need to be incorporated and the split recalculated, which will result in a slightly different ratio where more Okanogan fish will be released. Jackson asked how the split will compare to 2010, and Kahler said it will be different than 2010.

Release Timing

Kahler said WDFW's fourth comment is regarding release timing (see page 2 of Attachment D [3.4 Tests of Assumptions]). Kahler said what is proposed is the standard post-hoc analysis used in all survival studies in the Federal Columbia River Power and Mid-Columbia River systems. He said this consists of a series of tests by Dr. John Skalski (Columbia Basin Research), which compares arrival timing both graphically and statically. Kahler said this is outlined in the 2010 study report. Lance Keller agreed and said there is a test group and an evaluation at a common test point. Murdoch noted that the common test point is at Rocky Reach Dam, and she thinks this can be more specific. She said a lot can happen between Wells Dam and Rocky Reach Dam and asked how to verify the arrival time to the Wells Dam tailrace. Kahler said there is the WEJ (Wells juvenile; Bypass Bay 2) PIT-tag detection site now. Murdoch asked if the WEJ site can be discussed in the study plan, and Kahler said he can do this. He added that this detection site will help inform release timing. Murdoch asked in the absence of these data, how were decisions on release timing made? Kahler said decisions were based on previous studies using freeze branded fish and fyke net data.

Mixing Across the Tailrace

Ferguson said the YN had a comment about mixing across the tailrace (see page 6 of Attachment C [Table 1]). Kahler explained that fish are placed in release containers which release fish across the entire tailrace.

Tests Between Releases

Kahler said WDFW's fifth comment is regarding tests between releases (see page 3 of Attachment D [3.4.1 Tests Between Releases]). Kahler asked if WDFW is requesting to embellish this section, and Jackson said yes. Kahler said he will do this, as requested.

Size Grading

Ferguson said the YN had a comment about size grading (see page 5 of Attachment C [2.1 Study Fish]). Kahler said Murdoch's point in this comment is correct. He said fish are tagged well-before release and what survives to be released should be healthy fish. He said additionally, severely wounded fish after loading into the release containers are netted out. He said other than this, fish do not receive special treatment.

Release Location

Ferguson said the YN had a comment about release location (see page 8 of Attachment C [2.3 Release Locations]). Kahler recalled that Truscott also had this same comment, and said he discussed this comment with Shane Bickford (Douglas PUD HCP Policy Representative). Kahler explained that there is a line of demarcation referred to as the "G line" or inundation zone. He said this line represents a worst-case scenario flood, which is 800 kcfs at Wells Dam combined with extreme flood discharge from the Methow and Okanogan rivers (conditions which have never occurred since the construction of Wells Dam), and Douglas PUD purchased any land within this flood zone boundary (with few exceptions). He said this G line extends about 10.5 miles up the

Okanogan River; however, the actual routine zone of influence under normal runoff conditions does not extend very far. He said additionally, there are logistical constraints of towing a release vessel barge up the Okanogan River. He said Douglas PUD has also experienced challenges with testing releases in the Okanogan River when hooking up to the river water and stressing the fish. He said when the HCPs were negotiated everyone had high ideals and settled on what all could agree to, and these release locations at the mouths of the tributaries were one thing everyone agreed to. Truscott said he still disagrees, and Kahler said he understands.

<u>Run Timing and Study Start and End Dates</u>

Kahler said the YN and WDFW had a number of comments regarding run timing and study start and end dates (see Attachments C and D, respectively). Kahler distributed a hard copies of run timing graphs (Attachment F), which were also distributed electronically during the meeting on December 4, 2018. Kahler said page 1 of Attachment F shows the percent of total detected at Rocky Reach Dam and page 2 of Attachment F shows the cumulative percentage detected at Rocky Reach Dam.

Kahler suggested reviewing page 2 of Attachment F while considering release timing. He noted how closely hatchery and wild Chinook salmon line up, and also that yearling Chinook salmon have a 5-day travel time from Wells Dam to Rocky Reach Dam. He said this travel time can also be shorter, and Keller said he believes it can be as short as 2 to 3 days. Kahler said the mean gets pushed out to 5 days due to variability but agreed that most fish can travel the distance within 2 to 3 days.

Murdoch asked what years are represented in Attachment F, and Kahler said these data include 2010 through 2018. Kahler said this represents 60,000 hatchery steelhead, but the sample sizes of other stocks are smaller.

Kahler said the questions when trying to determine a spread of replicates are how much of the tails is reasonable to include and how can all stocks be replicated. He said these are the same questions for release size.

Murdoch asked when the proposed release dates start, and Ferguson said April 20. Murdoch said it looks like 50% of wild spring Chinook salmon have already passed on or before the survival study even starts. She said she understands the steelhead run is much later; however, this goes back to the Endangered Species Act-listed fish concern that maybe this study should try to encompass more of the wild spring Chinook salmon run. Ferguson noted that the graphs in Attachment F need to shift to the left because they represent detections at Rocky Reach Dam, not Wells Dam. He said based on this shift, he guessed only about 25% of the wild spring Chinook salmon run has passed by April 20.

Kahler asked that the Wells HCP Coordinating Committee consider potential release dates. He said there will be replicate releases every day, so 45 total releases. He noted that the tails of these graphs represent a diminished portion of fish, and if the proposed releases spread out too much into the tails then Douglas PUD will propose to weight the tails.

Ferguson noted how different wild coho salmon are. Murdoch said hatchery coho salmon tend to migrate later than hatchery spring Chinook salmon, and wild coho salmon have more normal (later) migration timing than those forced out of the ponds in May. Ferguson noted that an earlier release timing may affect the representativeness of the study for coho salmon. Murdoch said she thinks Endangered Species Act-listed wild spring Chinook salmon are the bigger issue right now than coho salmon.

The Wells HCP Coordinating Committee discussed various start and end dates to capture certain percentiles of run timing of the different stocks. Ferguson asked if there are logistical issues with shifting the start and end dates up or back (e.g., barge costs, crew). Gingerich said there may be logistical issues with water temperatures, noting that 2 weeks earlier in April in the Columbia River will result in water being colder. He said logistical issues aside, is the Wells HCP Coordinating Committee okay with what an earlier start date means for coho salmon, and in 2030, will the dates be moved around again in hopes of capturing coho salmon? Murdoch said theoretically, in 2030 there will be a higher number of wild coho salmon in the system and there is also discussion of studying spring Chinook salmon, which may more closely mimic the coho salmon run.

Jackson suggested release dates from the 15th to the 85th percentile, capturing 70% of the run. He said this shifts the start and end dates 4 days to the left. Ferguson noted that NMFS uses the middle 90% of the hydrological record when designing fish facilities. Jackson noted that shifting forward also helps with fish size.

Scott Carlon recalled in Grant PUD studies that differential survival occurred later in the season. Gingerich said this could be due to avian predation, and Keller also suggested it could be due to warmer water. Kahler said this was not observed in the Douglas PUD studies; however, for tailrace releases there is more consistent survival later in the run and a few higher survival numbers earlier in the run. He caveated that the latter may not be comparing the same things.

Kahler said he will inquire internally about alternative start and end dates for the Douglas PUD 2020 Survival Verification Study to ensure the release schedule matches the run timing of target species as much as possible and will provide different scenarios for consideration to the HCP Coordinating Committees. He said the current dates encompass about the 35th to 95th percentile, so 60% of the wild spring Chinook salmon run and less than that for hatchery summer Chinook salmon (about 50% of the run). Truscott suggested not losing too much of the wild steelhead run, since this run is not doing so well either. Jim Craig said it seems the consistent message is to shift the start and end dates to capture the more sensitive species.

V. HCP Administration

A. 2018 HCP Annual Reports (John Ferguson)

John Ferguson reviewed upcoming review timelines for the 2018 HCP Annual Reports, as follows:

- 2018 Wells HCP Annual Report due to the Wells HCP Coordinating Committee for a 30-day review on Wednesday, February 6, 2019
- 2018 Rock Island and Rocky Reach HCP Annual Reports due to the Rock Island and Rocky Reach HCP Coordinating Committees for a 30-day review on Monday, February 18, 2019

Kristi Geris noted that the 2018 Wells HCP Annual Report schedule is still a draft pending Douglas PUD approval. Tom Kahler said the proposed schedule is good.

Andrew Gingerich also noted that the 2018 Wells Dam Gas Abatement Plan and Bypass Operating Plan Report and 2019 Wells Dam Gas Abatement Plan and Bypass Operating Plan are due to Washington Department of Ecology each year on February 28. Gingerich said these draft documents will be distributed for review in early January 2019. He recalled that Douglas PUD has a requirement to consult with the Aquatic Settlement Work Group and Wells HCP Coordinating Committee on both of these documents.

B. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on December 18, 2018, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington. *(Note: this meeting date was rescheduled from December 25, 2018, to accommodate the holiday.)*

Scott Carlon notified the HCP Coordinating Committees that he will be unable to attend the meeting on December 18, 2018.

The January 22 and February 26, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Final SOA, *Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021*
Attachment C	2020 Wells Project Survival Verification Study Plan – YN comments
Attachment D	2020 Wells Project Survival Verification Study Plan – WDFW comments
Attachment E	2020 Wells Project Survival Verification Study Plan – fish size ranges
Attachment F	2020 Wells Project Survival Verification Study Plan – run timing graphs

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Jim Craig*	U.S. Fish and Wildlife Service
Scott Carlon*†	National Marine Fisheries Service
Chad Jackson*	Washington Department of Fish and Wildlife
Patrick Verhey*†	Washington Department of Fish and Wildlife
Kirk Truscott*†	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:

*****	**Denotes HCP Coordinating Committees member or alternate**
†	Joined by phone
††	Joined by phone for the HCP Tributary and Hatchery Committees Update

Final
Rock Island Habitat Conservation Plan
Coordinating Committee

Statement of Agreement
December 4, 2018

Deferment of the Rock Island Project
Confirmation Survival Study from 2020 to 2021

Agreement Statement

The Rock Island HCP Coordinating Committee (CC) agrees to defer for one year the 2020 Rock Island HCP confirmation study, to 2021, allowing Chelan PUD additional time to address ongoing turbine maintenance and rehabilitation, and allow for testing under representative project operations in 2021.

Background

The HCP Rock Island Phase Designation survival studies were completed in 2010 for both yearling Chinook and steelhead, setting the Rock Island confirmation survival study to occur in 2020 (November 16, 2010 Phase Designation SOA's). The goal of the HCP confirmation study is to re-evaluate survival under the applicable standard every 10 years (HCP Section 5.3.3), confirming Phase designation for HCP Plan Species under representative project operations for the next 10 years. Maintenance that was previously scheduled to be completed prior to the 2020 Rock Island HCP confirmation study now directly overlaps the scheduled confirmation study. Rescheduling the confirmation study will allow Chelan PUD to address changes in the maintenance and rehabilitation work schedule, and allow for testing under representative project operations in 2021.

Beginning in April 2016, the CC was made aware of the maintenance activities proposed to occur to rehabilitate units B1-B4 in Powerhouse 1 at Rock Island Dam (February 7, 2017 SOA). The proposed timeline for rehabilitating units B1-B4 was initially aggressive, with the work being conducted from March 2018-December 2019. Simultaneously and since 2008, Chelan PUD has also been rehabilitating units B5-B10 in Powerhouse 1, with B6, B9, and B10 completed to date.

Several events occurred in 2018 impacting the overall rehabilitation schedule of Powerhouse 1: 1) additional units experienced unforeseen mechanical issues, 2) contracted work has taken longer to complete than scheduled, and 3) safety concerns regarding staff burden as well as a lack of space in Powerhouse 1 to have multiple units dismantled concurrently. This has resulted in the rehabilitation work schedule extending into the spring of 2020 and overlapping with the 2020 Rock Island HCP confirmation study.

WELLS PROJECT SURVIVAL VERIFICATION STUDY

Phase III (Standard Achieved)
2020 Study Plan

Study Proposal

September 24, 2018

Prepared By:
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1.0 INTRODUCTION

The Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP) was developed to ensure that the Wells Project has No Net Impact (NNI) on juvenile and adult salmon and steelhead migrating through the Wells Hydroelectric Project (Wells Project). The five species of anadromous fish covered by the HCP are defined as Plan Species, and include spring and summer/fall Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), steelhead (*O. mykiss*) and coho (*O. kisutch*). As part of measuring whether or not NNI is being achieved and maintained, the Wells HCP requires the Public Utility District No. 1 of Douglas County (Douglas PUD) to periodically conduct studies of juvenile salmon survival at the Wells Project. The results of these studies are subsequently used to guide passage and mitigation programs for Plan Species migrating through the Wells Project. The Passage Survival Plan included in the HCP was structured with a phased implementation plan. Phase I (1998 through 2002) required, "juvenile and adult operating plans and criteria to meet the survival standards set forth in HCP sub-Section 4.1, and a monitoring and evaluation program to determine compliance with the standards" (Section 4.2.1). During Phase I, Douglas conducted three years of valid juvenile project survival studies with steelhead and yearling Chinook salmon. Results from these studies consistently exceeded the 93% juvenile project survival standard and the precision and accuracy requirements of the HCP (Bickford et al. 1999; 2000; 2001). The average juvenile project survival for yearling Chinook and steelhead over the three years of study was 96.2%. The results from the Phase I juvenile project survival studies, coupled with the results from the adult passage studies, provided the necessary information for the HCP Coordinating Committee to determine that the Wells Project had achieved Phase III (Standard Achieved) for yearling Chinook and steelhead.

Phase III of the Passage Survival Plan (Section 4.2.5) indicates that following achievement of the survival standard, periodic monitoring is required to ensure that the survival of Plan Species is maintained in compliance with the survival standards set forth in the plan for the term of the Agreement. Therefore, Douglas is required to "re-evaluate performance under the applicable standards every 10 years," by means of a one-year reevaluation of juvenile project survival for yearling spring-migrant species. The results from the one-year juvenile project survival reevaluation study will be included in the pertinent multi-year average for yearling spring migrants. If the survival standard is verified, Douglas will remain in Phase III (Standard Achieved). Otherwise, additional testing will occur, followed by Phase II (Interim or Additional Tools) if the standard cannot be achieved within three years of reevaluation. Douglas PUD performed the first Survival Verification Study (SVS) during the 2010 juvenile migration, demonstrating continued achievement of Phase III (Standard Achieved) with estimated juvenile Project survival of 96.4% (Bickford et al. 2011). This result was statistically similar to the three years of the Phase I studies (1998-2000), and combined with the survival estimates from those studies, resulted in a four-year-average Juvenile Project Survival value for of 96.3% for yearling Chinook and steelhead.

Douglas PUD proposes to conduct a Phase III (Standard Achieved) Survival Verification Study in 2020, on the 10^{th} anniversary of Douglas PUD's 2010 SVS and the 20^{th} anniversary of Douglas PUD's third and final year of Phase I survival studies. Similar to prior years of study, the 2020 SVS is designed to meet the precision and accuracy requirements found in Section 4.1.4

of the Wells HCP. With the Wells HCP Coordinating Committee's addition in 2015 (Wells HCP CC 2015) of Methow River coho to the Plan Species designated as in Phase III (Standard Achieved), Douglas PUD's 2020 SVS is intended to verify continued achievement of the Juvenile Project Survival Standard for spring-migrating yearling coho, steelhead, and Chinook.

1.1 Study Area

The Wells Project is located at river kilometer (Rkm) 830 on the upper Columbia River. Wells Dam, the principal component of the Wells Project, includes ten Kaplan-turbine generating units, with an installed nameplate capacity of 774.3 MW and a maximum generating capacity of 840 MW. The design of the Wells Project is unique in that the generating units, spillways, switchyard and fish passage facilities are combined into a single structure referred to as a hydrocombine. The hydrocombine is 1,130 feet long and 168 feet wide with a top deck elevation of 795 feet above mean sea level (MSL). The Wells juvenile fish bypass system (JBS) is located in the spillways at Wells Dam. The JBS is designed to bypass fish away from the turbines via a highly effective surface collection system. The Wells JBS provides a safe, non-turbine passage route through the dam for over 92% of the spring and 96% of the summer migrants (Johnson et al. 1992; Skalski et al. 1996). Wells Dam is the uppermost generating project on the Columbia River through which anadromous Chinook, steelhead, sockeye, and coho migrate on their way to and from the Pacific Ocean. Adult fish passage is provided by two fish ladders located at either end of the hydrocombine.

The reservoir formed by Wells Dam, has two primary tributaries with substantial natural and hatchery production of Plan Species. The Methow River enters Lake Pateros at Rkm 843, and produces the majority of yearling Chinook salmon, coho, and steelhead upstream of Wells Dam. The Okanogan River enters Lake Pateros at Rkm 870, and supports a major population of summer/fall Chinook, nearly all of which migrate as subyearlings. Most of the yearling steelhead and Chinook salmon smolts migrating out of the Okanogan River are hatchery fish planted into this system as mitigation for impacts associated with the construction and operation of various Columbia River dams. The Okanogan River has neither natural nor hatchery production of coho.

1.2 Study Goals

The primary goal of the 2020 SVS is to confirm that survival through the Wells Project for yearling Chinook, coho, and steelhead remains equal to or above the 93% Juvenile Project Survival Standard. Toward supporting the primary goal of the study, the SVS is also designed to test the assumptions of the Single (SR) and Paired-Single (PSR) release-recapture models, and estimate capture and reach-specific survival probabilities through the mid-Columbia River, including delayed mortality, to the extent that it can be measured. The SVS will also provide additional information related to the physiology, behavior, migration speed and survival of yearling Chinook (see Section 2.1, below) through the mid-Columbia River.

2.0 METHODS

This section provides the study methods, including study fish and physical field approach proposed to implement the 2020 SVS.

2.1 Study Fish

Following adult collection and spawning in 2018, yearling summer Chinook salmon (brood year 2018) would be reared on station at the Wells Fish Hatchery (WFH) for use in the SVS. Chinook parr will be PIT-tagged during February of 2020 and will be held in raceways until transfer to release containers in April and May of 2020 one day prior to release. Tagging two months before release gives ample recovery time for study fish prior to the spring outmigration. Early tagging will also allow researchers to closely monitor fish for tag shed and diseases that would introduce study bias. Planned fish collection, transportation, and physiological monitoring techniques are summarized as follows:

Juvenile Chinook salmon will be collected from raceways and tagged according to criteria described in Prentice et al. (1987). Occurring on five tagging days, small groups of untagged Chinook, will be held in one of the pre-tagging raceways, and crowded into a pint-sized-pescalator (PRA Manufacturing, Nanaimo, British Columbia, Canada). As the pescalator rotates, it will capture and transport water and fish up and out of the raceway, deposit fish into a 10-cm transport pipe, and deliver the fish into Biomark's tagging trailer where the fish will be held until anesthetized using a solution of water and Methanosulfonate-222 (MS-222). Once anesthetized, diseased and mortally wounded Chinook salmon smolts will be removed from the study group. Remaining healthy Chinook will be tagged with 12.5-mm, 134.2-kHz ISO FDX-B PIT tags (Biomark APT12 or replacement) preloaded in single-use needles packaged in Biomark HPT12 Pre-load Trays, and injected using hand-held injection devices (Biomark MK-25 or equivalent). All fish will be tagged with a single-use needle to reduce the chance of disease transmission, injuries caused by dull needles, and the number of personnel required on the project. Immediately following tagging, fish will be randomly assigned to one of the 15 replicate release groups and held in common with the rest of the fish assigned to that release replicate. In addition to the tag code, date of tag implantation, tag personnel identification code, fork length, fish condition, water temperature, and release-group assignment will be recorded and stored using P4 software. Upon release of tagged fish, tagging files for each tag group will be uploaded to the PTAGIS database maintained by the Pacific States Marine Fisheries Commission. Each tagged replicate (i.e., treatment and control paired-release groups) of study fish will be held within one large-volume rearing container at the Wells Fish Hatchery. The common rearing environment reduces differences in fish health and physiology between treatment and control groups.

Starting on April 20, 2020 and continuing every other day through May 19, 2020, n = 15 replicate release groups of Chinook will be re-collected using the pescalator, interrogated for PIT-tags codes, and then placed into a release container randomly assigned to one of the three release sites (Okanogan, Methow, or tailrace). Each release container will hold approximately 1,100 L of water and loaded with no more than 556 PIT-tagged fish. Loading densities will be limited to no more than 0.023 Kg of fish per liter of water (Kg fish/L). During the interrogation and pre-release holding phases of the study, release containers will be supplied with 80-100 L/min of river water through a 5-cm flex-hose. Water temperatures and dissolved oxygen levels inside each release container will be closely monitored and recorded hourly throughout the duration of the study to ensure that the pre-release recovery history of each container is similar within and between release sites and replicate release groups.

The treatment release groups will comprise fish destined for release at the Okanogan and Methow release sites. The control release groups will comprise fish destined for release into the tailrace of Wells Dam. In order to represent the migration of yearling Chinook salmon, coho, and steelhead passing through the Wells Project originating from these two river systems, treatment fish will be released at each river mouth in approximate proportion to the historic natural and hatchery production originating from that river. The Okanogan River produces approximately 33% of that total combined production, and the Methow River produces approximately 67%. These proportions result in six release containers for each tailrace release, four for each Methow release, and 2 for each Okanogan release (see Section 3.2, below).

As a final measure towards representing the run-at-large, we propose a release schedule to match the average migration timing of yearling Chinook passing Wells Dam. Because of the requirement to have the Okanogan, Methow, and tailrace release groups comingle and experience similar downstream river conditions, the Okanogan River releases will take place at 1700 hours on even days starting on April 20, 2020 [1] ending on May 18, 2020. Methow and tailrace releases will take place at 1000 hours and 1400 hours, respectively on odd days starting on April 21, 2020 and ending on May 19, 2020. Each replicate release will take two days and consist of loading all of the replicate pair release containers on even days (Table 1).

Table 1. Proposed Survival Verification Study release schedule (April 20 to May 19)

	Day 1		Day 2		Day 2	
	Okanogan Release		Methow Release		Tailrace Release	
Activity	**Start time**	**Duration**	**Start time**	**Duration**	**Start time**	**Duration**
On location ready to go	3:00 PM	0:20	8:00 AM	0:20	Noon	0:20
Load truck at hatchery	3:20 PM	0:20	8:20 AM	0:20	12:20 PM	0:20
Transport to barge loading site	3:40 PM	0:30	8:40 AM	0:30	12:40 PM	0:30
Load barge (boom or crane)	4:10 PM	0:20	9:10 AM	0:20	1:10 PM	0:20
Barge to release site	4:30 PM	0:30	9:30 AM	0:30	1:30 PM	0:30
Release fish	5:00 PM	0:10	10:00 AM	0:10	2:00 PM	0:10 [2]
Return to barge loading site	5:10 PM	0:30	10:10 AM	0:10	2:10 PM	0:00
Return to hatchery	5:40 PM		10:20 AM		2:10 PM	

In order to transport release groups, release containers will be disconnected from the river water supply lines at the Wells Hatchery and transported with a forklift to a flatbed truck. Once all of the release containers for a release event are affixed to the flatbed truck, metered compressed oxygen bottles affixed to each release container, will supply flow rates of less than 1.0 L/minute of oxygen. To compensate for differences in travel distances between the Okanogan, Methow and tailrace barge loading sites, the transport vehicle destined for each site will make purposeful excursions to equalize the amount of time fish spend on the truck in transport. These excursions will be used to ensure that the total travel times, dissolved oxygen and stress levels for each release group are similar.

At the barge loading stations, oxygen supplementation will be turned off and release containers hoisted off the transport trucks and loaded onto barges for final release. Once each release container is affixed to the barge, the on-barge river-water supply system will be connected and the valve turned on. Desired dissolved oxygen concentrations inside each container will be manually adjusted to maintain 9 to 12 mg O_2/L. River-water flow through each container on the barge will approximate 60-80 L/minute. After all of the release containers are loaded onto the barge, 10 PIT-tagged fish will be randomly netted out of a randomly assigned release container and screened for various physiological parameters (See Section 2.2 Pathology, Physiology, below). The barge will be subsequently towed to the release sites by a tow boat. Immediately prior to release, water temperatures and dissolved oxygen levels will be recorded from each release container and from the river. Qualitative fish activity levels will also be recorded, and injured or moribund fish removed (all PIT tags recorded). Following the pre-release inspection, the fish will be released from the release container through a 20 x 15 cm eccentric reducer. In general, all of the fish used in this study are expected to be released within 2 hours after the water lines at the Wells Hatchery are disconnected prior to loading.

After release, each tank will be emptied and the release site examined for dead or moribund fish and tanks inspected for shed tags. Release files will be submitted to the PSMFC PTAGIS 24-48 hours after each release to allow for removal of any tank mortalities, physiology-sample fish, or for changes to the release-group information.

2.2 Pathology, Physiology

To document potential differences within and between replicate release groups, an assessment of relative morphology, physiology, and pathology will be conducted. To do so, ten fish from each of the 45 release groups will be collected prior to release. Measures of morphology (length, weight), indices of fish health (color and texture of internal organs, fin erosion, descale, mesentery fat) and disease (bacterial kidney disease, flagtail, cold water disease, flukes, Ich), physiological status of smoltification (gill ATPase and smolt index), and measures of acute stress (plasma cortisol) and chronic stress (plasma glucose), will be collected by Douglas PUD's DMV or trained staff. The information collected will be used to determine whether or not there are differences in fish health, condition, smoltification and stress within each replicate release pair that might bias the replicate survival estimates. In addition, comparisons will be made between replicate release groups in an attempt to document seasonal trends in fish physiology and survival. Additional information to be collected from the post-mortem examination of Chinook include observations of tag placement and counting fish with missing tags, which will generate estimates of PIT-tag retention. Methods used to collect and analyze the morphological, physiological and pathological samples will follow those described in Bickford et al. (2011).

For the purposes of comparing physical attributes between the treatment and the control release groups, within a replicate pairing, the samples means for the two treatment release groups (Okanogan and Methow) will be pooled and subsequently compared to the single control (tailrace) release group. A two-way ANOVA will be used to determine whether or not there were differences between the treatment and control release groups. Where appropriate, either a two-sample Z-test or a Paired t-test will be used to compare physiological sample means. All of the statistical comparisons between the treatment and control release groups will be conducted at a significance level of α = 0.10.

2.3 Release Locations

Treatment fish will be released at Pateros and at the mouth of the Okanogan River, and control fish will be released into the Wells Tailrace (Figure 1).

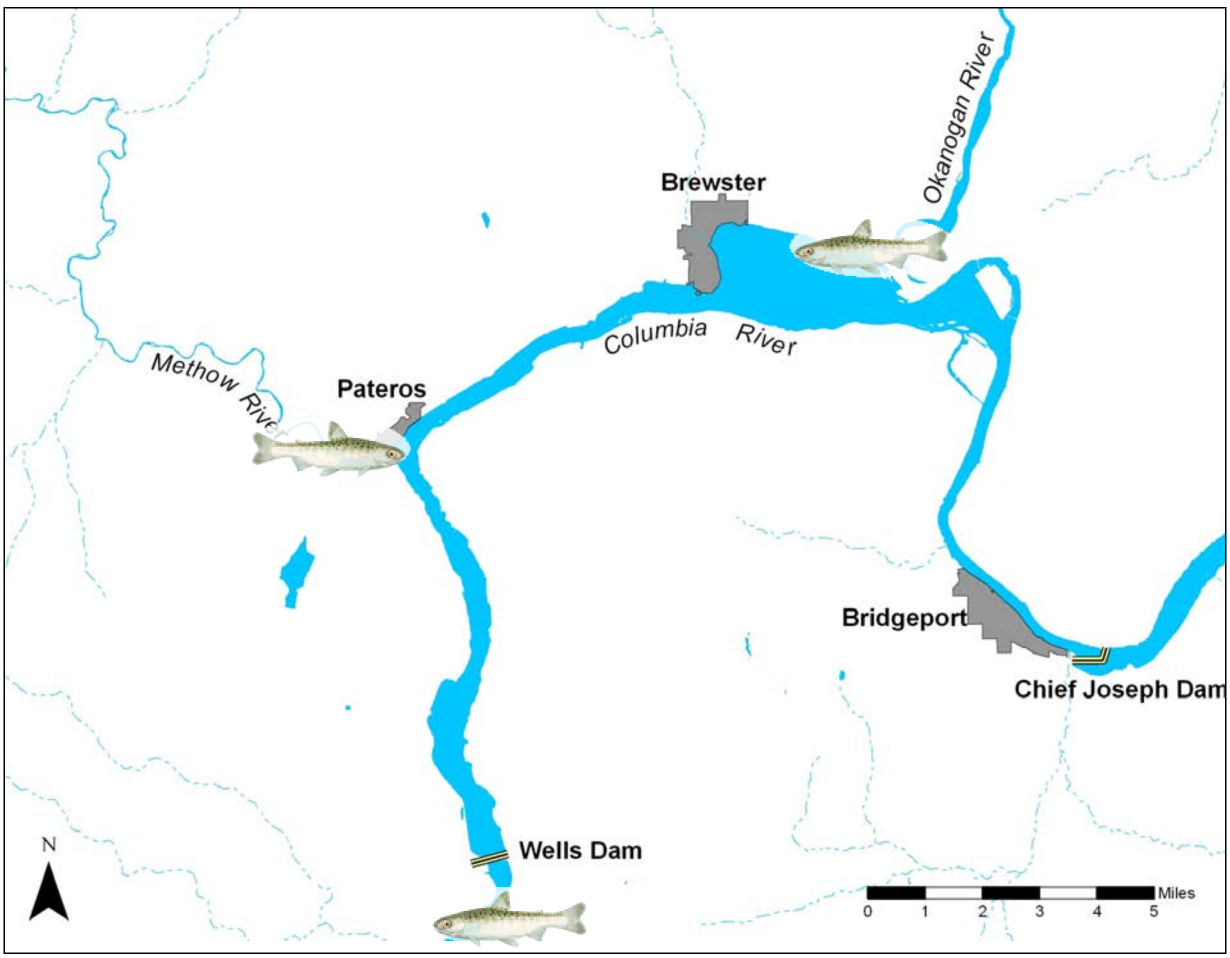

Figure 1 Proposed release locations for the 2020 Survival Verification Study on the Columbia River. Both treatment and control (Wells Dam tailrace) release sites are approximately indicated with juvenile salmon markers.

3.0 Statistical Methodolgy

3.1 Estimation Methodology

Survival estimates generated for the survival reevaluation study will be based upon the SR and PSR models (Cormack 1964; Jolly 1965; Seber 1965; Burnham et al. 1987). Figure 2 provides a schematic of the models approach. These methodologies have been used extensively to accurately estimate project-specific survival for juvenile salmon passing through Columbia River Basin hydroelectric projects (Iwamoto et al. 1994; Muir et al. 1996; Smith et al. 2000). Specifically, these models were used multiple times to successfully generate precise survival estimates of migrating juvenile Chinook and steelhead at Wells Dam (Bickford et al. 1999; 2000; 2001; 2010).

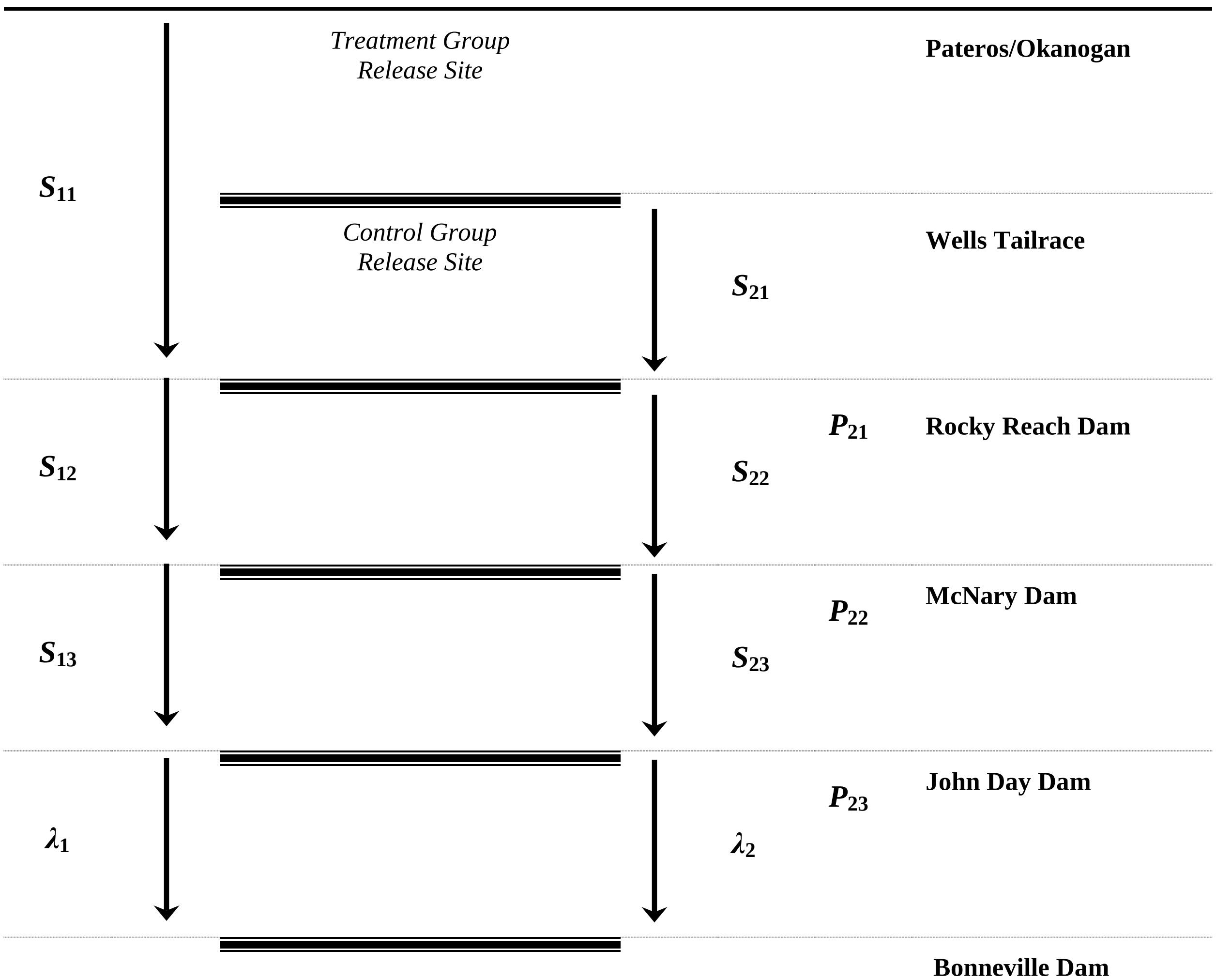

Figure 2 Schematic of release sites and PIT-tag detection facilities used for the 2010 and proposed 2020 SVS at Wells Dam. Parameters that will be estimated from the release-recapture data are indicated alongside.

3.2 Precision Objectives and Sample Size

The primary objective of the 2020 SVS will be to confirm Phase III (Standard Achieved) survival estimates of yearling Chinook, coho, and steelhead migrating through the Wells Project at a 95% confidence level with a standard error that will not exceed ± 2.5% (i.e., $\varepsilon = 0.05$). A minimum of 100,000 PIT-tagged yearling Chinook salmon will be required to achieve the estimated level of precision for the study. The proposed model design requires the release of 15 replicates of PIT-tagged fish at the Okanogan confluence (Okanogan), Methow confluence (Pateros), and the Wells tailrace, at 1:2:3 ratios, respectively.

Each of the 15 replicate release groups will contain approximately 6,666 fish split evenly between treatment (3,333) and control (3,333), and each of the treatment release groups will be further spilt into Pateros (2,222 fish) and Okanogan (1,111 fish) according to the 1:2:3 ratio of Okanogan:Pateros:Tailrace release sites. Each paired release of treatment and control fish will be collected from the same rearing vessel, interrogated for PIT-tag codes, and released on a staggered schedule to allow the treatment groups to join the control group at downstream recapture facilities. Release sites and PIT-tag detection facilities used for the SVS are illustrated in Figures 1 and 2, above.

Proposed total release numbers of yearling Chinook salmon smolts will be approximately 33,500 and 16,500 at the Methow and Okanogan release sites, respectively. While from separate release locations, data from these two releases will be pooled to represent a single fish source comprising fish from the two release locations (Figure 3). A total of 50,000 fish will be released at the Wells tailrace to serve as the downstream control group (Figure 3). The tailrace releases will be within approximately 1,000 feet downstream of the dam. PIT-tag detection sites used in the release-recapture study will be at Rocky Reach, McNary, John Day, and Bonneville dams and the towed estuary array.

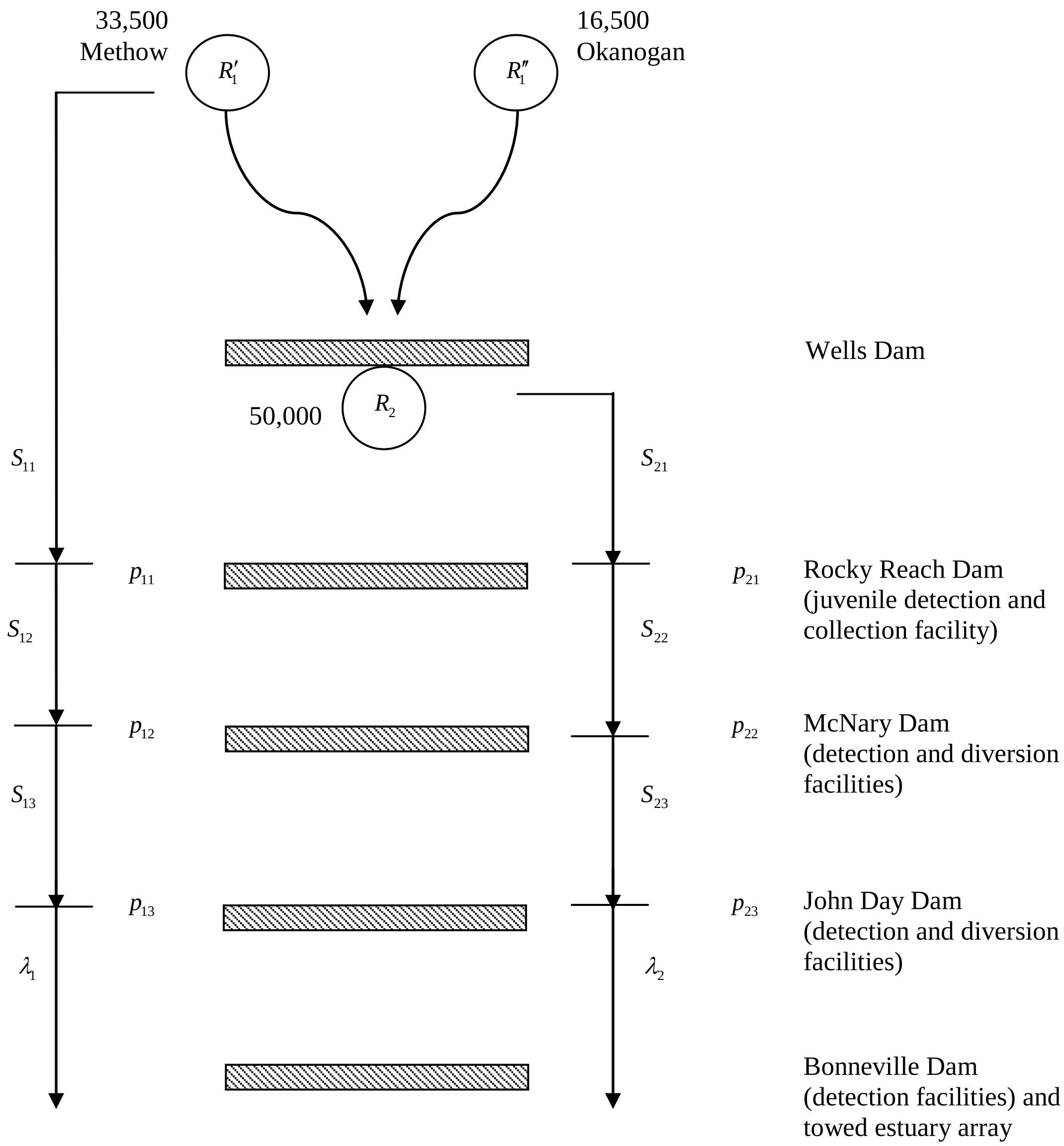

Figure 3. Schematic of release and PIT-tag detection facilities used in the 2020 Wells Dam survival verification study. Parameters that will be estimated from the release-recapture data are indicated.

3.3 Survival Estimation

The estimate of survival through the Wells project $\left(\hat{S}_W\right)$ will be estimated from the result of the upstream and downstream releases by the expression

$$\hat{S}_W = \frac{\hat{S}_{11}}{\hat{S}_{21}} \qquad (1)$$

with an associated variance estimate, based on the delta method (Seber 1982:7-9) of

$$\widehat{\text{Var}}\left(\hat{S}_W\right) \approx \left(\frac{\hat{S}_{11}}{\hat{S}_{21}}\right)^2 \left[\frac{\text{Var}\left(\hat{S}_{11}\right)}{\hat{S}_{11}^2} + \frac{\text{Var}\left(\hat{S}_{21}\right)}{\hat{S}_{21}^2}\right]$$

$$\approx \hat{S}_W^2 \left[\widehat{\text{CV}}\left(\hat{S}_{11}\right)^2 + \widehat{\text{CV}}\left(\hat{S}_{21}\right)^2\right] \qquad (2)$$

and where

$$\widehat{\text{CV}}\left(\hat{\theta}\right) = \frac{\sqrt{\text{Var}\left(\hat{\theta}\right)}}{\left(\hat{\theta}\right)}.$$

Capture histories will be pooled across the replicate Methow and Okanogan releases in estimating S_{11}. The data from the replicate tailrace releases will be pooled in estimating S_{21}.

The most efficient estimator of S_W will depend on the relationship between the releases (R_1 and R_2) and the downstream survival and capture probabilities. If all downstream parameters are different between releases, survival will be estimated by Equation (1). This is model $H_{k-1,\phi}$ of Burnham et al. (1987:117-120). Intermediate models may also exist (Burnham et al. 1987:116,120-126). The most efficient estimate of Wells survival (S_W) will be based on the statistical model for the releases R_1 and R_2 that properly share all common parameters. The best representation for the survival and capture processes of releases R_1 and R_2 can be found using Program SURPH.4. Sequential modeling will be performed to determine the most appropriate and precise estimate of S_W and its associated variance estimate.

The capture rates at John Day and Bonneville dams (and the towed estuary array) may be low. If this is indeed the case, capture data at the lower sites may be pooled to provide more precise estimates to fewer, more relevant parameters. Data analyses will explore the statistical benefits of pooling some of the downriver sites to improve the precision of $\hat{S}_W$.

3.4 Tests of Assumptions

Assumptions of the paired release-recapture design (Burnham et al. 1987) include the following:

A1. The test fish are representative of the population of inference.
A2. Test conditions are representative of the conditions of interest.
A3. The number of fish released is exactly known.
A4. PIT-tag codes are accurately recorded at the time of tagging and at all detection sites.
A5. The fate of each individual fish is independent of the fates of all other fish.
A6. All fish in a release group have equal survival and detection probabilities.
A7. Prior detection history has no effect on subsequent survival and detection probabilities.

In order to estimate S_W , the survival S_{11} is assumed to be of the form:

$$S_{11} = S_W \cdot S_{21}, \quad (3)$$

leading to the relationship

$$\frac{S_{11}}{S_{21}} = \frac{S_W \cdot S_{21}}{S_{21}} = S_W .$$

The equality (3) implies two additional assumptions for valid estimation of Wells project survival. These are:

A8. Survival in the Wells project (S_W) is conditionally independent of survival in the Rocky Reach (S_{21}) project.
A9. Releases (R_1) and (R_2) experience the same survival probability in the Rocky Reach (S_{21}) project.

Assumptions A1 and A2 regard making valid inferences from the test fish to the survival process of run-of-river fish. Wells hatchery fish will be used in the survival investigations, and are assumed to have similar survival as run-of-river fish. Conducting the study over the course of the yearling Chinook salmon outmigration should also assure test conditions are similar to those experienced by run-of-river fish. Another implied assumption is the 2:1 ratio of Methow to Okanogan release numbers is representative of the actual proportions of these fish sources to the run-of-river fish.

Careful fish handling and data processing should assure Assumptions A3 and A4 that the release-recapture data are accurate. Assumption A5 is essential for mathematically modeling the release-recapture investigation. Furthermore, in a system of tens of thousands of migrating smolts, the death of one fish should not influence the fate of other fish in the system.

Assumption A6 will be violated by the pooling of the Methow and Okanogan upstream releases (R_1' and R_1''). Fish from these different locations can be expected to have different survival probabilities because of the differences in travel distances, etc. Nevertheless, the release-recapture model will provide a weighted estimate of dam passage survival:

$$\frac{S'_W R'_1 + S''_W R''_1}{R'_1 + R''_1} = S'_W P_{METH} + S''_W P_{OKAN}$$

where

S'_W = survival of released fish from Methow through the Wells project,

S''_W = survival of released fish from Okanogan through the Wells project,

$P_{METH} = \frac{R'_1}{R'_1 + R''_1} =$ proportion of fish released from Methow,

$P_{OKAN} = \frac{R''_1}{R'_1 + R''_1} =$ proportion of fish released from Okanogan.

The survival of fish released at the Methow and Okanogan will be a pooled survival probability. However, independent but not identically distributed survival probabilities will affect the variance estimates produced by the model. The actual variance will be smaller than that produced by the mark-recapture model (Feller 1968). Consequently, the point estimate will be unbiased (i.e., as long as the proportions P_{METH} and P_{OKAN} are representative of the system) and the variance estimate biased but conservative (i.e., too big).

Assumption A7 will be evaluated using Burnham et al. (1987) tests T_2 and T_3. Conformance to assumptions A8 and A9 will be facilitated by staggering the release times in order for downstream mixing of the test fish.

3.4.1 Tests between Releases

At each downstream PIT-tag recapture site (i.e., Rocky Reach, McNary, John Day, Bonneville, towed estuary array), the assumption of mixing among the releases of smolts R_1 and R_2 will be tested. An R x C contingency table test of homogeneous recoveries over time will be performed using a table of the form:

Day of		R'_1	R''_1	R_2
	1			
	2			
	3			
	⋮	⋮	⋮	⋮
	D			

(4)

A contingency table of the form (4) will be calculated for each of the PIT-tag detection sites. Each test will be performed at α = 0.10 significance level. Invariably, these tests of mixing are significant. More revealing are plots of the arrival distributions to assess important departures from mixing.

3.4.2 Tests within a Release

For the single release-recapture model to be valid, certain data patterns should be evident from the capture histories. For each release group, a series of tests of assumptions can be performed to determine the validity of the model (i.e., goodness-of -fit). The data from a single release can be summarized by an m-array matrix of the form below:

	Recovery Site			
Release Site	Rocky Reach (2)	McNary (3)	John Day (4)	Bonneville (5)
Initial (1)	m_{12}	m_{13}	m_{14}	m_{15}
Rocky Reach (2)		m_{23}	m_{24}	m_{25}
McNary (3)			m_{34}	m_{35}
John Day (4)				m_{45}

The value m_{ij} is the number of fish detected at site i that are next detected at site j.

Burnham et al. (1987: p. 65, pp. 71-74) presents a series of tests of assumptions called Test 2 that examine whether upstream detections affect downstream survival and/or detection. For each of the R_1', R_1'', and R_2 releases, the contingency table tests are as follows:

Test 2.2

m_{13}	m_{14}	m_{15}
m_{23}	m_{24}	m_{25}

χ_2^2 (5)

Test 2.3

$m_{14}+m_{24}$	$m_{15}+m_{25}$
m_{34}	m_{35}

χ_1^2 (6)

Overall significance of Test 2 will be based on the sum of the chi-square statistics $\chi_2^2+\chi_1^2=\chi_3^2$. Test-wise error rates will be adjusted for the experimental-wise error rate of α_{EX} = 0.10.

Burnham et al. (1987: p. 65, pp.74-77) also present a series of test assumptions called Test 3 which also examine whether upstream capture histories affect downstream survival and/or capture. For each of the releases R_1 and R_2, contingency tables can be constructed of the form:

Capture History to McNary Dam

Capture History at John Day and Bonneville Dams		101	111
	11		
	10		
	01		
	00		

$$\chi^2_3 \qquad (7)$$

Contingency table (7) tests whether capture at McNary Dam has a subsequent effect on capture histories at John Day and Bonneville dams. To test whether capture at McNary Dam and/or John Day Dam has a subsequent effect on the capture history at Bonneville Dam, a contingency table can be constructed of the form:

Capture History at John Day Dam

Capture History at Bonneville		1111	1101	1011	1001
	1				
	0				

$$\chi^2_3 \qquad (8)$$

Contingency tables (7) and (8) are slight modifications from Burnham et al. (1987) to take into account more of the information from the individual capture histories.

3.5 Anticipated Precision

Skalski and Townsend (2018) performed precision calculations considering a Project survival probability through Wells Dam of 0.93 or higher, a required precision of $\mathrm{SE}(\hat{s}_w) \leq 0.025$, and a range of detection probabilities at downstream detection facilities. Survival probabilities between projects and detection probability at dams were based on releases of PIT-tagged yearling summer Chinook salmon from sites above Rocky Reach Dam during emigration years 2010-2016. Most detection probabilities at Rocky Reach Dam observed during that period ranged from 0.20 to 0.40, with a range of 0.10 to 0.60 for all observations. Plotting precision as a function of release size (R_T = R_C) revealed that a study with a release size of approximately 45,000 treatment fish (and equivalent number of control fish) is likely to produce results achieving the HCP precision standard within the range of historic detection probabilities at Rocky Reach Dam (Figure 4). Therefore, the proposed sample size of 100,000 combined treatment and control fish should prove adequate for achieving the required precision standard of $\mathrm{SE}(\hat{s}_w) \leq 0.025$.

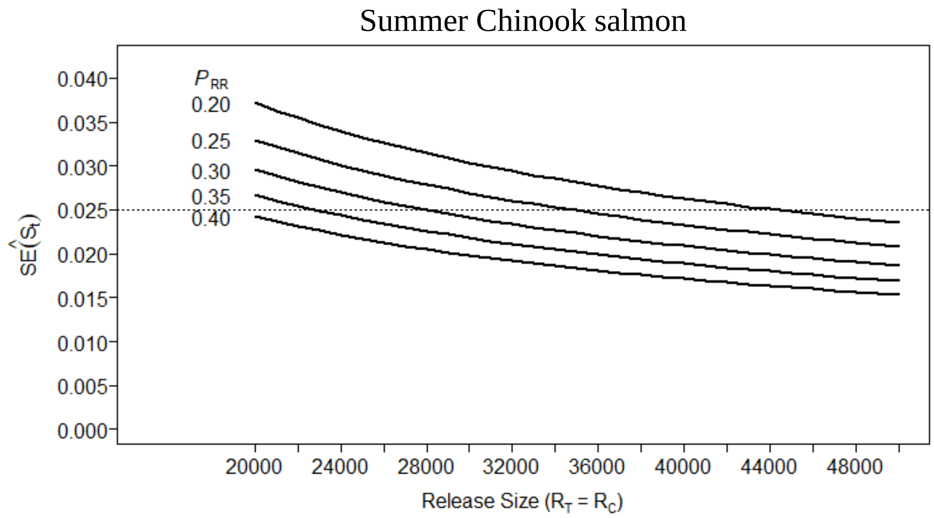

Figure 4. Anticipated precision (i.e., $\mathrm{SE}(\hat{S})$) as a function of release size ($R_T = R_C$) for a) spring Chinook salmon, b) summer Chinook salmon, and c) coho salmon as the detection probabilities at Rocky Reach Dam (i.e., P_{RR}) were varied. Dashed horizontal line set at SE = 0.025. Adapted from Figure 2 of Skalski and Townsend (2018).

4.0 SUMMARY

Douglas PUD proposes to conduct a Phase III (Standard Achieved) Survival Verification Study in 2020. The study will utilize in excess of 100,000 Chinook smolts released over 15 replicates at three release locations. The goal of the study is to reaffirm that project survival for yearling Chinook, coho, and steelhead remains greater than or equal to the 93% Juvenile Project Survival Standard. Should the survival estimates obtained during this study meet the study methodology requirements contained within Section 4.1.4 of the HCP, then the results will be included in the pertinent average survival estimate for yearling Chinook, coho, and steelhead, per Section 4.2.5.1 of the HCP, toward adjusting hatchery compensation levels for yearling Chinook, coho and steelhead.

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Page: 5

Number: 1 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 10:47:14 AM

I am not finding information on what size the hatchery fish will be and how this size compares to that of wild fish or of other species of fish that are being represented by this study (did I miss it?). A discussion of how size may bias survival results could be warranted.

Number: 2 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 10:45:43 AM

obvious fish injured in the process should not be pit tagged but survival should represent survival of the run at large which undoubtedly will include both sick and injured fish. How do we insure that we are not 'high-grading' and that survival rates are representative of the run at large. I realize this is a difficult thing to do when using solely hatchery reared fish?

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Number: 1 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 10:53:31 AM

While I recognize that this time frame represents "yearling Chinook migration, I also recognize that this run timing is the direct result of large hatchery releases and likely does not represent the run timing of wild fish, particularly wild spring Chinook which have never been tested (except in 1997 with poor results). Based on the Methow smolt trap data, it is probably that in some or all years between half and most of the wild spring Chinook have already passed Wells Dam by the time this study starts. I also understand that that the HCP does not differentiate between wild and hatchery fish but it is the intent of the HCP to provide equal protections to wild and hatchery fish. If we don't understand survival of wild fish it is not possible to understand if we are providing them equal protections as hatchery fish. Using hatchery fish when hatchery fish run gives does not give us any indication of how the HCP may or may not be protecting wild fish.

Number: 2 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 10:54:25 AM

How will we evaluate whether or not the tailrace released fish are truly co-mingling with the upstream releases or if there is a possibility that they may be released either a bit too early or a bit too late?

Page: 8

Number: 1 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 10:56:04 AM

Should we consider the whole zone of innundation/forebay influence to understand how the Wells project may affect survival of migrating fish? Rather than just releasing at the mouths of the rivers?

Page: 13

Number: 1 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 11:08:18 AM

Will there be an attempt to determine the arrival timing of Methow/OK released fish with the release of tailrace fish, in the tailrace specifically? Concern of tailrace fish potentially arriving in the tailrace prior to the arrival of upstream released fish rather than at the same time (to the extent possible). An analysis of arrival/passage time of the upstream releases would be beneficial to understanding if there could be any survival biases inherent in the release locations due to differential predation rates in the tailrace or other factors.

Number: 2 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 11:09:01 AM

Hatchery yearling Chinook represent hatchery yearling Chinook when hatchery yearling Chinook are migrating. I do not believe that the survival of these fish adequately represents the survival of wild fish. I also understand that the HCP doesn't differentiate, however it is the intent of the HCP to benefit both wild fish and hatchery fish and we have no way of knowing that wild fish are receiving the same survival benefit if we do not attempt at some point to make the studies more representative of wild fish (fish size, timing, species selection etc).

Number: 3 Author: k.murdoch Subject: Sticky Note Date: 11/21/2018 11:04:48 AM

Based on smolt trap data, most (half-nearly all) wild yearling spring Chinook have likely passed Wells Dam by the time the study starts on 4/20. Smolt trap data shows migration starting as early as Feb with and peaking in March- early or mid April (depending on the year). even if you allow a week for these fish to arrive at Wells dam a April 20- May 18 data does not adequately capture the run timing of wild yearling spring Chinook. therefore there is no way to understand if the wild component of the run is being adequately protected under the HCP.

From:	Kristi Geris
To:	Jackson, Chad S (DFW); Jim Craig (jim_l_craig@fws.gov); John Ferguson; Keely Murdoch (murk@yakamafish-nsn.gov); kirk.truscott@colvilletribes.com; Kristi Geris; Scott Carlon; "Tom Kahler (tkahler@dcpud.org)"
Cc:	Rawding, Daniel J (DFW); Andrew Gingerich (andrewg@dcpud.org); Lance.Keller@chelanpud.org; Andrew Murdoch (Andrew.Murdoch@dfw.wa.gov); Mike Tonseth
Subject:	FW: WDFW Comments on DPUD"s SVS
Date:	Tuesday, November 27, 2018 01:21:50 PM
Attachments:	image001.png image002.png image004.png

Thanks Chad!

Tom and Wells HCP-CC: please see the email below from Chad regarding WDFW comments on the Wells Survival Verification Study Plan, for discussion during the CC 12/4 meeting. Thanks! -kristi

Kristi Geris

ANCHOR QEA, LLC
kgeris@anchorqea.com
C 360.220.3988

From: Jackson, Chad S (DFW) <Chad.Jackson@dfw.wa.gov>
Sent: Tuesday, November 27, 2018 12:00
To: Kristi Geris <kgeris@anchorqea.com>
Cc: Rawding, Daniel J (DFW) <Daniel.Rawding@dfw.wa.gov>
Subject: WDFW Comments on DPUD's SVS

Hi Kristi,

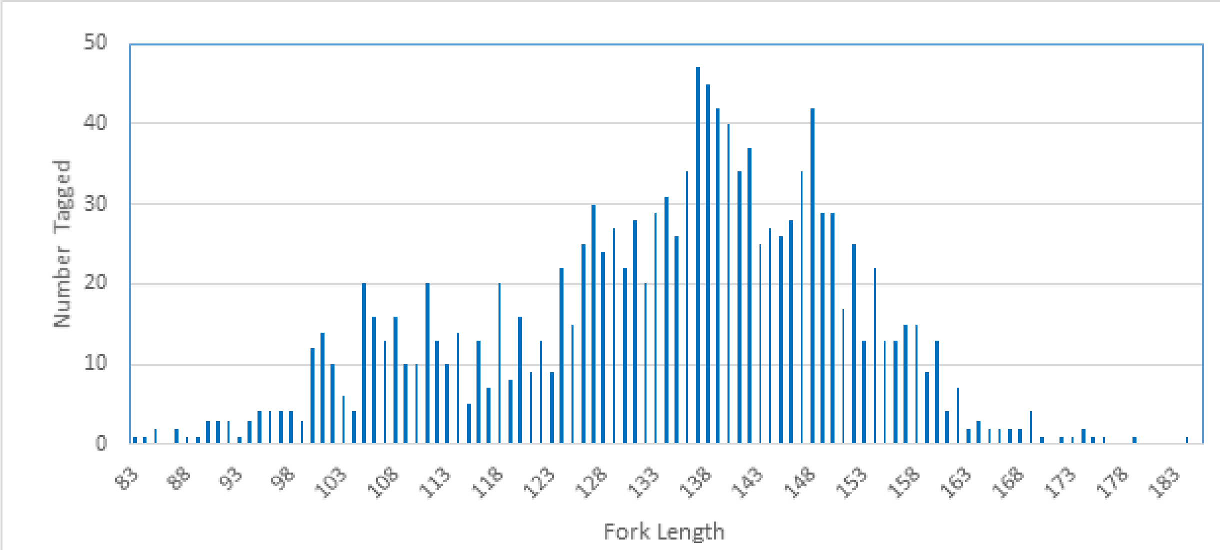
Please find below WDFW's comments on DPUD's SVS design. FYI….Dan Rawding (WDFW Science Division) was the principle reviewer of the SVS study design for WDFW, but others including Andrew Murdoch, Mike Tonseth, and myself contributed. My plan is to have Dan present or call in when/if we address all the comments. Thanks and have a great rest of the week.

WDFW Comments on DPUD's Wells Project SVS Design:

2.1 Study Fish

The WDFW still has concerns that hatchery-origin yearling summer Chinook do not represent upper Columbia River (UCR) run-of-the river spring migrants both in size and behavior. This topic was thoroughly discussed in past HCP-CC meetings and members generally agreed a different surrogate fish (e.g., spring Chinook) might better estimate survival of HCP Plan Species. However, because the use of a different surrogate fish (e.g., spring Chinook) could not be permitted under ESA in 2018 for use in 2020, the WDFW still approves the use of hatchery-origin yearling summer Chinook for this SVS. The WDFW appreciates DPUD's efforts to set up a "reminder system" for future HCP-CC membership of the current members' wishes to use a different surrogate fish for the 2030 SVS.

Regarding the study fish planned for use, the WDFW recommends best culture practices be used to make sure yearling summer Chinook release sizes mimic run-of-the river spring migrants (see graph below). In the 2010 SVS the average release size of yearling summer Chinook was >150mm.



Length frequency of spring Chinook PIT tagged at Rock Island Dam, 2011.

In addition, the authors should provide data/evidence used to calculate that 95% of the run migrated between April 20 and May 19.

2.2 Pathology, Physiology

The purpose of the secondary study to assess differences in morphology, physiology, and pathology within and between replicate release groups using a two-way ANOVA is not stated. If it is to be used to identify releases that are not to be used in testing, the authors should identify how these releases will be identified before conducting the experiment including the significance level. In addition, the authors should note the ANOVA assumptions of normality, equal variance, and independence and how they will test for these assumptions.

3.2 Precision Objectives and Sample Size

The authors should provide data/evidence that the planned 2:1 Methow to Okanogan release ratio still reflects run-of-the-river fish. The 2:1 ratio does not appear to account for high abundances of Sockeye (HCP Plan Species) migrating from the Okanogan River, increased Chinook releases into the Okanogan River, Chinook releases from Chief Joseph Hatchery, and decreased Chinook releases into the Methow River. Developing PIT tag release groups that are representative of run-of-the-river fish is needed for an unbiased estimate of survival because several factors including timing (Evans et al. 2014), length (Zabel et al. 2005), origin (Newman 1997), and external condition (Evans et al. 2014) influence survival.

3.4 Tests of Assumptions

Concerning A9, the authors assume that R1 and R2 releases experience the same survival. This would occur if R1 and R2 releases had the same spatial and temporal distribution. The authors propose to stagger the R1 and R2 releases so they arrive at Rocky Reach tailrace at approximately the same time. However, the authors only note the release of the R2 group is 1,000 feet below the dam and do not describe the spatial pattern of the release. Previous work has demonstrated that predation in the tailrace area may be higher than the reservoir due to higher predator densities in the tailrace

(Petersen 1994, Ward et al. 1995). If the R2 release group does not have the same spatial distribution of the R1 group, there may be differential mortality of the R1 group relative to the R2 group.

3.4.1 Tests between Releases

The analysis section of the study design focuses on the development of CJS estimates and contingency table analyses. The analysis section could be improved if the authors provided more details on model selection, development of a single survival estimate without CJS assumption violations, and development of a single survival estimate if assumption violations are detected in the contingency table analysis, which may be due to lack of independence/over dispersion.

References

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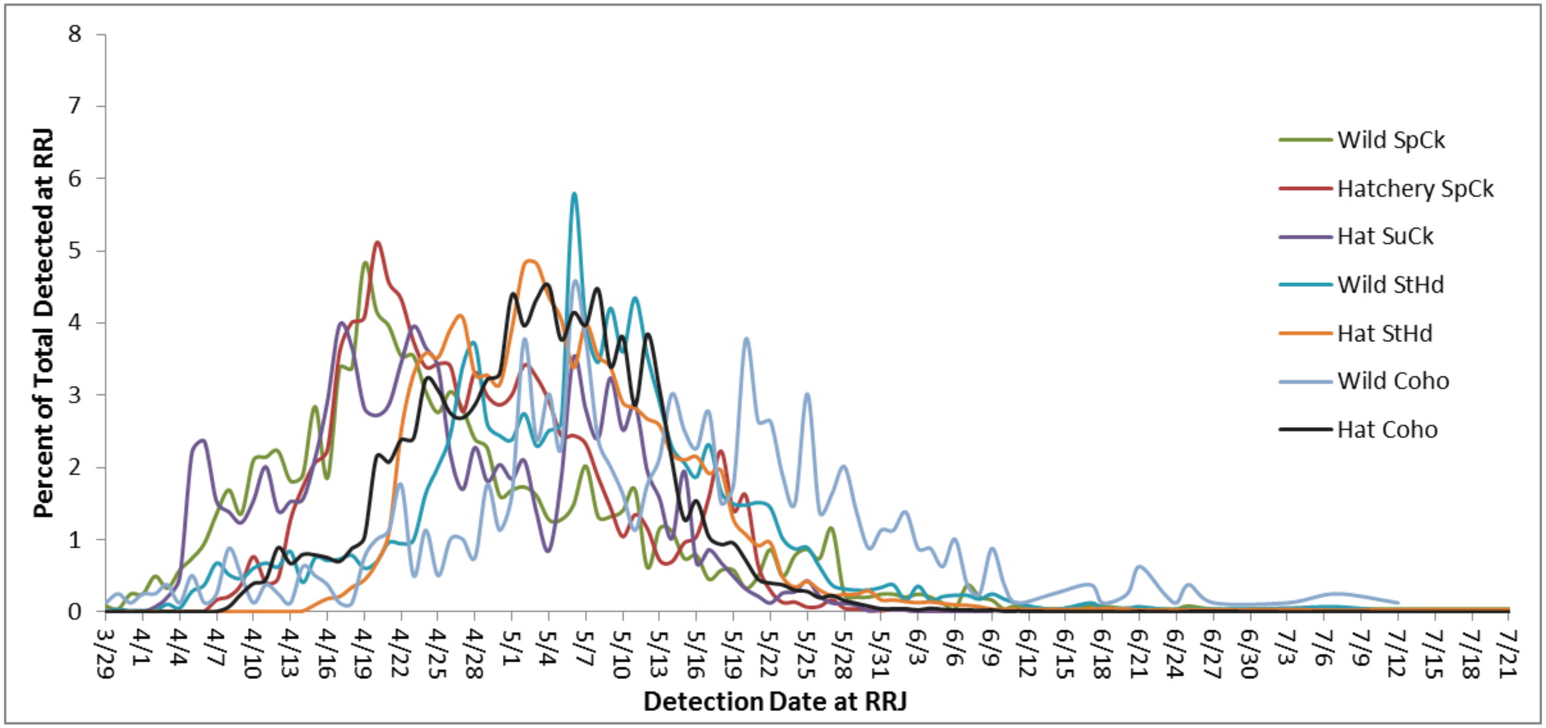
1439

Chad Jackson
Region 2 Fish Program Manager, WDFW
http://wdfw.wa.gov/about/regions/region2/
509-754-4624, ext 250

Stock	Range	Med.	Mode	Mean	SD	1SD	2SD
W Chk	57-192	95	95	95	9	86-104	77-113
H Chk	75-242	132	130	133	12	121-145	109-157
W Coho	51-152	105	110	104	16	88-120	72-136
H Coho	98-182	132	130	132	10	122-142	112-152
S1 W Shd	42-120	83	80	84	15	69-99	54-114
S2 W Shd	121-294	164	155	165	20	145-185	125-205
H Shd	77-289	189	190	189	20	169-209	149-229
Comb.	42-294	134	95, 130, 180	138	39	99-177	60-216
2010 SVS	79-200	138	148	134	8*	126-142*	118-150*



Percent of Total Detected at RRJ
Detection Date at RRJ
8
7
6
5
4
3
2
1
0
3/29
4/1
4/4
4/7
4/10
4/13
4/16
4/19
4/22
4/25
4/28
5/1
5/4
5/7
5/10
5/13
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6/27
6/30
7/3
7/6
7/9
7/12
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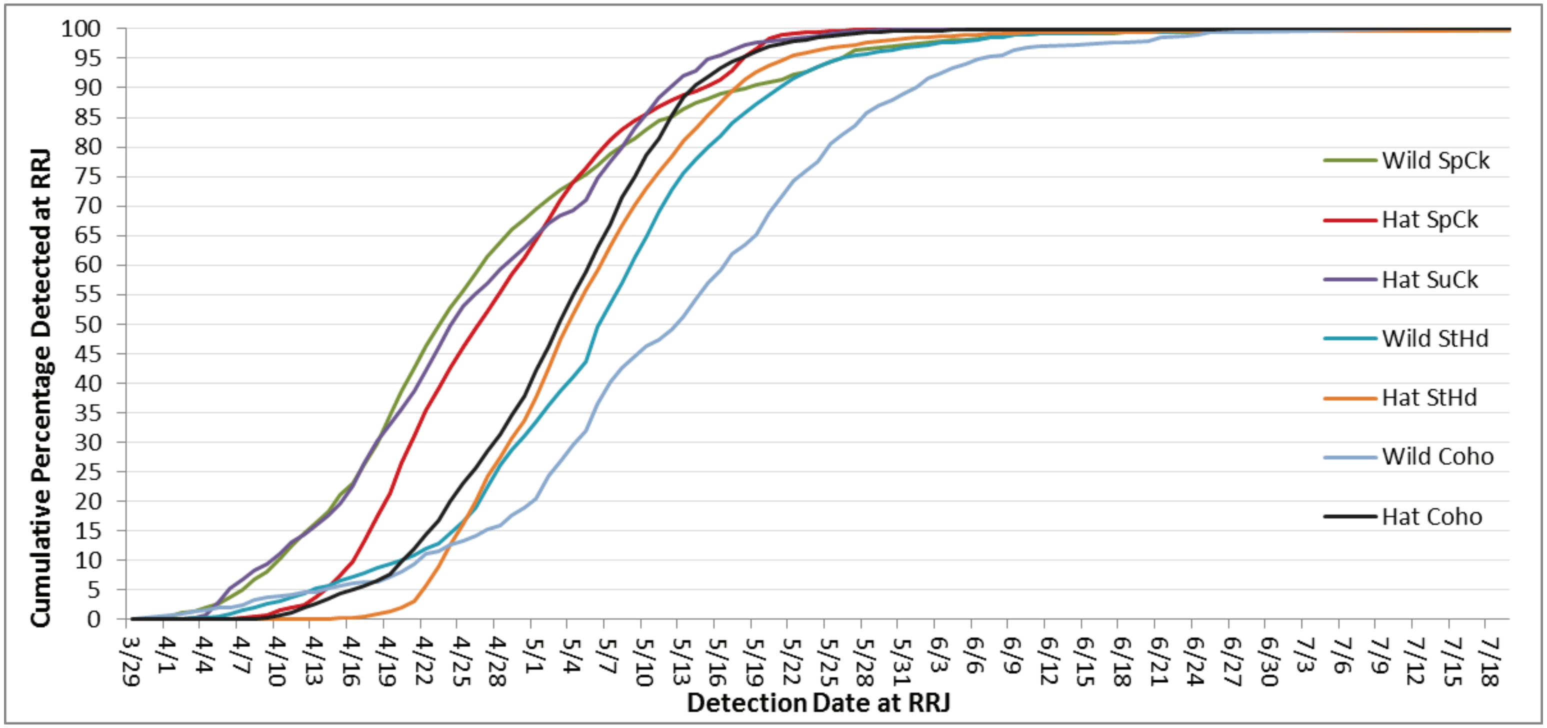
Wild SpCk
Hatchery SpCk
Hat SuCk
Wild StHd
Hat StHd
Wild Coho
Hat Coho



Cumulative Percentage Detected at RRJ
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3/29
4/1
4/4
4/7
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6/12
6/15
6/18
6/21
6/24
6/27
6/30
7/3
7/6
7/9
7/12
7/15
7/18
Detection Date at RRJ
Wild SpCk
Hat SpCk
Hat SuCk
Wild StHd
Hat StHd
Wild Coho
Hat Coho

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Coordinating Committees   Date: January 22, 2019

From: John Ferguson, HCP Coordinating Committees Chairman

cc: Kristi Geris

Re: Final Minutes of the December 18, 2018 HCP Coordinating Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Coordinating Committees met at the Grant PUD office in Wenatchee, Washington, on Tuesday, December 18, 2018, from 10:00 a.m. to 1:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Lance Keller will review subyearling Chinook salmon sampled at the Rocky Reach Juvenile Sampling Facility (RRJSF) during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on passive integrated transponder (PIT)-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in the Columbia River Data Access in Real Time database (DART; Item I-C).
- Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).
- Tom Kahler will determine the final outcome of the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item I-C).
- On the behalf of the HCP Coordinating Committees, regarding the General Salmon Habitat Program Proposal titled, *Scaffold Camp Acquisition #2 Project*, which is under discussion in the HCP Tributary Committees, Keely Murdoch and Kirk Truscott will request from their respective HCP Policy representatives that a policy level discussion take place between the Yakama Nation (YN) and the Colville Confederated Tribes (CCT) to reach agreement outside of the formal HCP dispute resolution process (Item II-A).
- The HCP Coordinating Committees meeting on January 22, 2019, will be held in-person at the Grant PUD Wenatchee office in Wenatchee, Washington (Item V-A).

Decision Summary

- There were no HCP Decision Items approved during today's meeting.

Agreements

- There were no HCP Agreements discussed during today's meeting.

Review Items

- A Wells Project Land-Use Permit Application for a Joint-Use Dock on Tract 75 (Gebber's Farm) was distributed to the HCP Coordinating Committees by Kristi Geris on November 13, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Tom Kahler by Monday, January 14, 2019 (Item III-C).
- A Wells Project Land-Use Permit Application for a Joint-Use Dock on Tract 1131 (Repo LLC) was distributed to the HCP Coordinating Committees by Kristi Geris on November 13, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Tom Kahler by Monday, January 14, 2019 (Item III-C).
- A Wells Project Land-Use Permit Application for a Single-Use Dock (LeSage) was distributed to the HCP Coordinating Committees by Kristi Geris on November 29, 2018. This application is available for a 60-day review with edits, comments, or an indication of no comments due to Tom Kahler by Monday, January 28, 2019 (Item III-C).
- A Draft 2018 Post-Season Bypass Report and Passage-Dates Analysis was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which is available for a 60-day review with edits and comments due to Tom Kahler by Tuesday, February 12, 2019 (Item III-B).
- A Draft 2017 Pikeminnow Report was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which is available for a 30-day review with edits and comments due to Lance Keller or Scott Hopkins (Chelan PUD) by Monday, January 14, 2019.
- The revised draft 2020 Wells Project Survival Verification Study Plan was distributed to the HCP Coordinating Committees by Tom Kahler on December 18, 2018. A final revised draft plan for approval was distributed to the HCP Coordinating Committees by Kristi Geris on January 15, 2019. Douglas PUD will request approval of this plan during the HCP Coordinating Committees meeting on January 22, 2019 (Item III-A).
- A Draft 2018 Wells HCP Action Plan was distributed to the HCP Coordinating Committees by Kristi Geris on January 16, 2019, which is available for a 30-day review with edits and comments due to Tom Kahler by Friday, February 15, 2019.
- A draft *2019 Total Dissolved Gas Abatement Plan Wells Hydroelectric Project FERC Project No. 2149* was distributed to the HCP Coordinating Committees by Kristi Geris on January 21, 2019 and is available for review with edits and comments due to Douglas PUD by Monday, February 11, 2019.

Finalized Documents

- There are no documents that have been recently finalized.

I. Welcome

A. Review Agenda (John Ferguson)

John Ferguson welcomed the HCP Coordinating Committees and reviewed the agenda. Ferguson asked for any additions or changes to the agenda. Lance Keller added Tumwater Dam fishway activities.

B. Meeting Minutes Approval (John Ferguson)

John Ferguson said comments and revisions on the draft December 4, 2018 meeting minutes have been received from Tracy Hillman (HCP Tributary and Hatchery Committees Chairman), Washington Department of Fish and Wildlife (WDFW), and U.S. Fish and Wildlife Service (USFWS). Ferguson said because the draft December 4, 2018 meeting minutes were just distributed last Thursday, December 13, 2018, providing only a 5-day review period to date, he proposed providing additional review time and postponing approval of the minutes until the HCP Coordinating Committees meeting on January 22, 2019. The HCP Coordinating Committees agreed with this suggestion.

C. Last Meeting Action Items (John Ferguson)

Action items from the HCP Coordinating Committees meeting on December 4, 2018, and follow-up discussions, were as follows. *(Note: italicized text corresponds to agenda items from the conference call on December 4, 2018):*

- *Douglas PUD will further review run-timing data for wild and hatchery yearling Chinook salmon with regard to Wells Dam bypass operation dates and will report back to the HCP Coordinating Committees (Item I-C).*
  Tom Kahler recalled since 2012, the Wells Dam bypass operating timing is based on detections at Rocky Reach Dam, where passage dates are back-calculated to Wells Dam based on previous passage and travel time studies. He said the Wells HCP Coordinating Committee expressed concern that the current Wells Dam bypass operation dates may not be accounting for a portion of the wild yearling Chinook salmon run. He said to investigate this, fish detections at the Lower Methow PIT-Tag Array (LMR) were reviewed. He said, however, these data are really sparse, noting that from 2012 to 2018, there are only 123 detections of wild fish out of the Methow River Basin on this array. He said annual detections ranged from 34 fish in 2014 to 6 fish in 2018, and very few of these fish were detected at Rocky Reach Dam (RRJ). He said two fish were detected at both sites in 2012, two in 2013, four in 2014, two in 2015, two in 2017, and one in 2018 (zero in 2016). He said these data and the number of fish

detected at RRJ but not at LMR indicate that most fish are not being detected at LMR. He said detection rates are affected by whether the array remains in place during the freshet, and further, detections decrease during a freshet as water depth increases over the array. He recalled in 2018, the array was moved to an upstream location to improve detection rates; however, only six fish were detected that year. He said in recent years the low detection numbers were also a function of how many fish were tagged in the Methow River Basin. He said in 2017 and 2018, Douglas PUD did not conduct tagging in the Twisp River, which in the past has been the bulk of tagged wild fish out of the Methow River Basin. He said ultimately there are insufficient data to evaluate whether the current Wells Dam bypass operation dates need to be adjusted to account for the wild yearling Chinook salmon run. He said the new array location may provide higher detection rates in the future; however, this is also subject to discharge levels. He said typically, there are detections of fish in March and April, but then no more. He said this year, the latest detection date was April 20, 2018, and most detections occurred earlier in March 2018. John Ferguson said fish detections are needed at both LMR and Rocky Reach Dam to align timing of when fish are likely passing Wells Dam, and Kahler said this is correct. Kirk Truscott asked if Douglas PUD completely suspended fall parr tagging in the Twisp River. Kahler said no, that tagging was only suspended in recent years because Douglas PUD is currently sorting out several things related to capture efficiency and expansions before continuing this effort. Andrew Gingerich said in 2018, the fire in the Twisp River Basin also precluded tagging efforts. Kahler said Douglas PUD intends to continue tagging in the Twisp River once the data are dialed in. Truscott said reinitiating this effort will provide the data to represent the emigration at large. Keely Murdoch asked, regarding detections at LMR and Rocky Reach Dam, which ones are disappearing? She asked if it is the early detections at LMR, or is it everything at LMR? Kahler said 4 of 13 detections at both sites were during winter, 8 of 13 were during spring, and 1 of 13 were during fall. He said most detections occur in March. He said winter includes December through February, and spring includes March through May. Gingerich said over a 7-year period, of about 2,100 wild fish that were tagged in the Methow River Basin and subsequently detected at the Rocky Reach Juvenile Bypass System, only 13 of these have been detected at LMR, which suggests the detection probability at LMR for these wild Chinook salmon is less than 1% over this 7-year period. Gingerich surmised that these data suggest using LMR detections are, therefore, biologically irrelevant. Ferguson asked if the data for LMR are too sparse, what other methods can be used to address this question of run-timing other than using detections at Rocky Reach Dam and back-calculating based on assumptions on travel time, which is 5 days for Chinook salmon? Kahler said fish are detected passing LMR during the winter and are subsequently detected passing Rocky Reach Dam during the spring (travel times of 100+ days). Gingerich said Rocky Reach Dam bypass operations start on April 1, and it is the period before this date that is in question. He added that detections at Rocky Reach Dam over a 7-year period consistently indicate that the bulk of the wild migration passes Rocky Reach Dam from April 15 to May 15. Kahler said of the thousands of PIT-tagged hatchery fish released during this same 7-year period, only 273 fish were detected at LMR. Truscott noted the PIT-tag detection system at Wells Dam bypass bay 2 has been installed recently and suggested operating this system earlier than normal to make an assessment of what the shape of distribution looks like at Wells Dam. Gingerich noted that during the non-fish spill season if there is an early freshet that initiates spill, operators would not necessarily spill out of bypass bay 2; rather, operators would load up spill through bypass bay 6 to address total dissolved gas. Ferguson said Wells Dam bypass operations typically start on April 9, and he asked what alternative is being proposed? Truscott said it is difficult to pick a single date, which would also vary year-to-year depending on conditions. Kahler said this also gets back to the fact that the HCPs do not parse out wild versus hatchery migration runs. Gingerich said further, the Wells HCP may not include language to support spill operations earlier than April 1. Truscott suggested reviewing historical reports from rotary screw traps to determine whether fish have been trapped prior to April and whether these fish were categorized as parr, transitional, or smolts. He said this may provide data to support pursuing this further. Kahler agreed.

- *Lance Keller will review subyearling Chinook salmon sampled at the RRJSF during the summer spill season at Rocky Reach Dam, to determine: 1) whether the index samples collected represent overall passage trends based on PIT-tag detections in the bypass across the season, notably during high flow years such as that experienced in 2018; and 2) whether any adjustments are needed while also maintaining continuity with historical data in DART (Item I-C).*
  This action item will be carried forward.
- *Chelan PUD will provide a final timeline for repairing Rocky Reach Dam Turbine Unit C1 hub seals to Kristi Geris for distribution to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Tom Kahler will determine the final outcome of the Wells Project Land-Use Permit Application for Wells Tract 115 and will report back to the HCP Coordinating Committees (Item I-C).*
  This action item will be carried forward.
- *Lance Keller will consult Alene Underwood (Chelan PUD HCP Policy Representative) about if and how the Rock Island and Rocky Reach HCPs can be amended or modified based on new data (Item I-C).*
  Keller said he discussed this with Underwood and Chelan PUD agrees with what Tom Kahler described during the last HCP Coordinating Committees meeting on December 4, 2018, that the language in the HCPs was negotiated and agreed upon by the Parties and is to be implemented as agreed upon.

- *Lance Keller will revise the Statement of Agreement (SOA), Deferment of the Rock Island Project Confirmation Survival Study from 2020 to 2021, as discussed, and will provide the final SOA to Kristi Geris for distribution to the HCP Coordinating Committees (Item II-A).*
  Keller provided the final SOA to Geris on December 5, 2018, which Geris distributed to the HCP Coordinating Committees that same day.
- *Kristi Geris will coordinate with Tracy Hillman (HCP Tributary Committees Chairman) and Julene McGregor (Douglas PUD Information Systems Staff) to add Mary Mayo (Douglas PUD Support Staff) to select HCP Tributary Committees email distribution lists and provide Mayo with administrator access to the HCP Tributary Committees extranet site, as approved by the HCP Coordinating Committees (Item IV-A).*
  Geris contacted Hillman and McGregor, as discussed, on December 5, 2018, and Mayo was added to the distribution lists and extranet site.
- *Tom Kahler will inquire internally about measures Douglas PUD plans to employ to reduce fish size at release for the Douglas PUD 2020 Survival Verification Study, including what fish size might be achieved, and will report back to the HCP Coordinating Committees (Item IV-E).*
  This will be discussed during today's meeting.
- *Tom Kahler will inquire internally about alternative start and end dates for the Douglas PUD 2020 Survival Verification Study to ensure the release schedule matches the run timing of target species as much as possible and will provide different scenarios for consideration to the HCP Coordinating Committees (Item IV-E).*
  This will be discussed during today's meeting.

II. HCP Tributary and Hatchery Committees Update

A. HCP Tributary and Hatchery Committees Update (Tracy Hillman)

Tracy Hillman said the HCP Hatchery Committees will next meet on December 19, 2019.

Hillman updated the HCP Coordinating Committees on the following actions and discussions that occurred during the HCP Tributary Committees meeting on December 13, 2018:

- *Small Project Program Proposal*: The Rocky Reach HCP Tributary Committees received a Small Project Program Proposal from Chelan County Natural Resources Department titled, *Peshastin Creek RM 8.8 Channel Reconnection: Environmental Site Assessment*. The purpose of the project is to conduct a Phase I Environmental Site Assessment (ESA) and, if necessary, a Phase II ESA within a potential channel reconnection project near river mile (RM) 8.8 on Peshastin Creek. The site appears to have been contaminated with petroleum products and possibly other contaminants; therefore, an assessment is needed to evaluate the levels of contaminants within the project site. The total cost of the project is $17,700. The sponsor requested the entire amount from HCP Plan Species Account Funds. The Rocky Reach HCP Tributary Committee approved $11,100 for this project, including $4,400 for Phase I and $6,700 for Phase II. The Rocky Reach HCP Tributary Committee elected not to fund the appraisal, because the Rocky Reach HCP Tributary Committee will hire their own appraiser to evaluate the value of the properties depending on the results of the ESAs.

- *General Salmon Habitat Program Proposal – Icicle Creek Fish Passage Wild Fish to Wilderness Project*: The HCP Tributary Committees received a General Salmon Habitat Program (GSHP) proposal from Trout Unlimited titled, *Icicle Creek Fish Passage – Wild Fish to Wilderness Project*. The purpose of the project is to enhance fish passage at the Boulder Field (RM 5.6) on Icicle Creek and thereby provide access to more than 23 miles of habitat, which will be accomplished by creating a 160-foot fishway along the left bank. This project is likely to have a large positive effect on steelhead abundance, productivity, and spatial structure. The total cost of the project is $2,275,000. The sponsor requested $375,000 from HCP Plan Species Account Funds. The amount requested from the HCP Tributary Committees would be in addition to the $250,000 approved by the Rock Island HCP Tributary Committee in 2015. All members except the CCT approved funding for the project at this time. The CCT requested additional time before providing their vote on the project. The YN approved the request with the caveat that a memorandum of understanding (MOU) regarding anadromous fish management in the Icicle watershed is signed by the YN, the CCT, WDFW, National Marine Fisheries Service (NMFS), and USFWS. The CCT delay is also a function of ongoing discussions regarding the MOU. A decision on this project was tabled until the CCT are able to submit their vote. Jim Craig said he and Bill Gale (USFWS Deputy Project Leader) met with Jim Brown (WDFW), Steve Parker (YN), and Dale Bambrick (NMFS) on Friday, December 14, 2018. Craig said the MOU includes problematic language, which makes agreements such as the Icicle watershed fish management agreement difficult to execute. He said, however, the agencies and tribes had a productive meeting and reached a potential solution. He said he and Gale are working on a framework agreement, which invites interested parties to review seasonal operations in Icicle Creek. Craig said he hopes to have a draft document available for review in January 2019. John Ferguson asked if approval of this GSHP proposal is contingent on the framework agreement Craig and Gale are drafting. Craig said yes, that essentially, approval of this GSHP proposal depends on the tribes' comfort level regarding how anadromous fish are to be managed in the Icicle watershed. Kirk Truscott said he also plans to present an issue paper on the proposal to the CCT Natural Resource Committee (NRC) on January 15, 2019.
- *General Salmon Habitat Program Proposal – Twisp Confluence Habitat Complexity Project*: In October 2018, the HCP Tributary Committees received a GSHP proposal from the YN titled, *Twisp Confluence Habitat Complexity Project*. The purpose of the project is to use large wood to stabilize a bank at the confluence of the Twisp River where bank erosion is threatening

sewer line infrastructure for the town of Twisp, Washington. The large wood will not only protect the bank from further erosion, it will increase habitat complexity for juvenile and adult salmonids and will prevent the U.S. Army Corps of Engineers (USACE) from riprapping the bank, which they have offered to do. The total cost of the project is $299,300. The sponsor requested $269,600 from HCP Plan Species Account Funds. In October 2018, the HCP Tributary Committees tabled the proposal and requested that the YN try and secure a cost share from USACE equivalent to the amount USACE would spend on placing riprap along the eroding bank. In December 2018, the YN reported they were unable to secure funding from USACE. Emergency funding from USACE is not available outside of an existing emergency declaration. This money can only be spent under USACE direction on an emergency action such as riprapping. Because there is no cost share from USACE and this is a bank stabilization project, which the HCP Tributary Committees generally do not fund, the HCP Tributary Committees declined the opportunity to fund the project.

- *General Salmon Habitat Program Proposal – Upper Kahler Stream and Floodplain Enhancement Project*: The HCP Tributary Committees received a GSHP proposal from the YN titled, *Upper Kahler Stream and Floodplain Enhancement Project*. The purpose of the project is to reduce the risk of an avulsion near RM 8.6 on Nason Creek by constructing a large, buried, logjam at the upstream inlet of the developing avulsion channel and filling the avulsion channel with large substrate. The project will also construct additional buried bank jams and enhance fish habitat at the downstream end of the avulsion channel. In addition to minimizing the risk of an avulsion, the proposed placement of wood and enhancement of the downstream end of the avulsion channel will improve spring Chinook salmon and steelhead habitat. The total cost of the project is $482,500. The sponsor requested $231,500 from HCP Plan Species Account Funds. The HCP Tributary Committees elected to not fund this project as currently designed. The HCP Tributary Committees understand the benefits associated with efforts to minimize risk of avulsion. Indeed, an avulsion at this site would reduce the amount of available habitat by disconnecting the existing meander. However, the HCP Tributary Committees do not support filling the avulsion channel with large sediments; rather, they believe the risk of an avulsion could be reduced by placement of wood structures within the main channel that would result in deposition at the potential site of avulsion. Proper placement of these structures would also divert flow away from the left bank and thereby reduce the risk of an avulsion. Finally, to reduce enhancement costs, the HCP Tributary Committees recommend the use of pilings and racked wood (similar to the lower White River) to improve fish habitat in the reach. These structures would replace the proposed buried bank jams at an expected reduced cost. Ferguson asked about next steps. Hillman said the HCP Tributary Committees submitted a letter to the YN explaining the decision to not fund the project at this time;

however, the HCP Tributary Committees invited the YN to a future meeting to further discuss the importance of filling the avulsion and using pilings instead of logjams.

- *General Salmon Habitat Program Proposal – Stormy Project Area "A" Stream and Floodplain Enhancement Project*: The HCP Tributary Committees received a GSHP proposal from the YN titled, *Stormy Project Area "A" Stream and Floodplain Enhancement Project*. The purpose of the project is to maintain salmon and steelhead spawning habitat within the middle Entiat River, improve mainstem juvenile rearing and adult holding habitat, and improve off-channel juvenile rearing habitat. This will be accomplished by constructing mainstem log structures and two perennial side channels. Large wood will also be placed throughout the side channels. The total cost of the project is $1,652,218.15. The sponsor requested $1,140,968.15 from HCP Plan Species Account Funds. The HCP Tributary Committees elected to not fund this project as currently designed. On several occasions in the past, the HCP Tributary Committees reviewed similar designs prepared by the Bureau of Reclamation (BOR) for the Entiat River. During the reviews, the HCP Tributary Committees consistently said they supported removing levees and enhancing the Cottonwood Flats site. The HCP Tributary Committees also said they do not support the proposed large wood projects, many of which appeared to be designed to stabilize banks. There are several large wood elements in the Stormy Project Area "A" proposal that are similar to elements in the BOR designs. As with the BOR designs, the HCP Tributary Committees do not support these structures identified in the Stormy Project Area "A" proposal. That said, the HCP Tributary Committees do support the activation of the longer side channel (not the proposed excavated channel) on river right. The HCP Tributary Committees believe that activating the longer side channel will provide greater biological benefit than the excavated channels. The feasibility and cost effectiveness of activating the longer side channel is unclear given the need for wetland mitigation; however, the HCP Tributary Committees recommend that this action be explored and invited the YN to further discuss this during a future meeting.
- *General Salmon Habitat Program Proposal – Scaffold Camp Acquisition #2 Project*: The HCP Tributary Committees received a GSHP proposal from the YN titled, *Scaffold Camp Acquisition #2 Project*. The purpose of the project is to acquire and protect a 1.3-acre parcel of floodplain/riparian habitat at RM 15.7 on the Twisp River. This project, along with the already protected 13-acre adjacent parcel, will not only protect high quality habitat, but it will allow the enhancement of a side channel, which would provide biological benefit for HCP Plan Species. The total cost of the project is $104,950. The sponsor requested $94,500 from HCP Plan Species Account Funds. The HCP Tributary Committees elected not to fund this project. On a technical level, the HCP Tributary Committees support protecting the 1.3 acres of floodplain and riparian habitat along the Twisp River. On a policy level, however, this project was not supported by the CCT and therefore HCP Plan Species Account funds cannot be used by the YN to acquire

the property. In an effort to avoid the possibility of the current landowner selling the 1.3-acre parcel to someone who is not interested in the conservation value of the property, the HCP Tributary Committees recommend that the YN discuss the acquisition of the parcel with other conservation-minded entities such as the Methow Salmon Recovery Foundation, Methow Conservancy, WDFW, or the CCT. The HCP Tributary Committees would be able to provide funds to one of these entities if the entity is willing to hold the fee title for the parcel and coordinate enhancement work on the property with the YN. Following the funding decision on the proposed project, the YN indicated they will dispute the HCP Tributary Committees' decision and elevate this issue to the HCP Coordinating Committees and HCP Policy Committees. In order to avoid a dispute, members asked whether the YN would be willing to ask another conservation group to hold the fee title for the parcel. The YN indicated they want to hold the fee title. Members asked whether the policy representatives from the YN and the CCT could discuss and resolve this issue without going through the "formal" dispute resolution process. The YN indicated this will not happen. The YN will dispute the decision based on principle. Hillman said an official letter from the YN indicating a dispute has not yet been received; however, once one is received, Hillman will coordinate with Ferguson and at that point in time the HCP Coordinating Committees will have 20 days to resolve the dispute, and if a resolution cannot be achieved in the HCP Coordinating Committees, the HCP Policy Committees will then have 30 days to resolve the dispute. Ferguson said the timeline Hillman just described is outlined in Section 11 of the Wells, Rock Island, and Rocky Reach HCPs. Ferguson said if a resolution cannot be reached in the HCP Policy Committees, Section 11.1.3 (Options following Stage 2) of the HCPs indicates, "If there is no resolution of a matter following completion of Stage 1 and 2 of this Procedure, then any Party may pursue any other right that they might otherwise have. The Parties agree that the inability of the (HCP) Coordinating Committee and (HCP) Policy Committee to make a decision shall be considered a dispute. The Parties are encouraged to resolve disputes through alternative dispute resolution." Keely Murdoch asked which HCPs this dispute affects, and Ferguson said all three (Wells, Rock Island, and Rocky Reach HCPs). Craig asked if the 1.3 acres is eligible to be developed? Hillman said he believes gravel can be added to elevate the floodplain and build a house. He said the current landowner illegally built a cabin on the property and now the county is requiring him to remove the structure; therefore, the landowner approached the YN about purchasing the property. Hillman said the YN viewed this as a good opportunity to obtain a parcel with good habitat adjacent to another already protected property. He said owning this property would allow the restoration of the side channel through the properties. Craig said considering the county's effort to remove the existing structure, he guessed the county would not be amenable to additional development of the property. Tom Kahler clarified that the cabin was built directly nearby the river within the floodplain. Murdoch asked if it was clear during voting that the no vote was non-technical. Hillman said yes, that the no vote was based on a policy decision handed down by the CCT NRC. He said the CCT HCP Tributary Committees representative did not explain why the CCT voted no from the policy level. Ferguson suggested discussing this dispute enough today such that HCP Coordinating Committees members feel comfortable enough with the details so that if a letter is received from the YN, the dispute can be addressed via conference call opposed to an in-person meeting, due to the tight timeline. Murdoch said a key concern for the YN is that this decision is not based on the merits of the proposal, but rather due to a policy level issue. She said the bigger concern is the implications this has on the HCP process and future decisions. Kirk Truscott said this topic was presented to the CCT NRC to receive direction for voting. Truscott said the CCT view the Methow River Basin, in this instance, to be CCT territory and the CCT do not want the YN buying property in CCT territory. He said the CCT hoped having a third party hold the title would be a reasonable work around if the main concern is to hold property to help HCP Plan Species. He said from a functional standpoint, having a third party hold the title still allows the HCP Tributary Committees to function for the benefit of the resource. Ferguson said it is important that all HCP members weigh in on this issue in the interest of: 1) upholding the integrity and objectives of the HCPs; 2) protecting HCP Plan Species; and 3) the proper functioning of the HCP Committees. He said his concern is that if the dispute proceeds it could diminish how the HCP Tributary Committees function. He said that in his view, this is a pivotal moment for the HCP Tributary Committees where they have a lot of money banked to implement big projects for HCP Plan Species. He said he does not want to see the integrity and good function of the HCP Tributary Committees decrease because of this dispute or have this somehow affect the HCP Coordinating Committees. Hillman suggested that on the behalf of the HCP Coordinating Committees, Murdoch and Truscott request from their respective HCP Policy representatives that a policy level discussion take place between the YN and the CCT to reach agreement outside of the formal HCP dispute resolution process. Truscott said he can relay this message; however, he does not foresee this being resolved at the policy level considering this decision is coming from the Tribal Council. Chad Jackson asked who the representatives are on the HCP Policy Committees. Ferguson replied, Alene Underwood (Chelan PUD), Shane Bickford (Douglas PUD), Steve Parker (YN), Randy Friedlander (CCT), Ritchie Graves (NMFS), Jim Brown (WDFW), and Craig (USFWS). Truscott said he will be on annual leave from December 19, 2018 to January 2, 2019. Ferguson asked who Truscott's alternate is, and Truscott said it is Casey Baldwin (CCT). Lance Keller said he will also be on leave from December 19, 2018 to January 2, 2019, and he will make sure a Chelan PUD representative will be available in his absence, if needed. Truscott noted that he is fairly certain this dispute will not be resolved within the HCP Coordinating Committees. Ferguson asked, based on today's discussions, are the

HCP Coordinating Committees comfortable addressing this potential dispute by conference call should a letter be sent, and the HCP Coordinating Committees agreed. Jackson asked if there is a deadline as to when the YN need to submit a letter, and Ferguson said there is not.

- *Next Meeting*: The next meeting of the HCP Tributary Committees will be on January 10, 2019.

III. Douglas PUD

A. Douglas PUD 2020 Survival Verification Study Plan (Tom Kahler)

Tom Kahler distributed hard copies of the revised draft 2020 Wells Project Survival Verification Study Plan, in tracked changes, which Kristi Geris distributed electronically on December 19, 2018. Kahler said revisions were based on discussions during the last HCP Coordinating Committees meeting on December 4, 2018. He asked that the Wells HCP Coordinating Committee review the redlines to verify comments were adequately addressed. Kahler reviewed specific items, as follows:

Precision Objectives and Sample Size

Kahler said he reviewed the split between Methow and Okanogan releases, and slightly adjusted the split from 65/35 to 67/33, to closer reflect a 2:1 ratio. He provided hard copies of a summary table used to calculate the Methow and Okanogan release ratio (Attachment B), which includes all releases from Chief Joseph Dam, including to the Okanogan River and direct releases to the mainstem Columbia River. Geris distributed this table electronically on December 19, 2018.

Release Timing

Kahler said he incorporated language about the Wells juvenile bypass bay 2 (WEJ) PIT-tag detection site, as requested. He said detections at WEJ can provide a sense of when fish pass Wells Dam. He said, however, the general question of concern for the paired-release model assumptions is whether test fish are mixed with the tailrace releases in the reaches shared in common (e.g., Rocky Reach reservoir), and to determine that the study compares the distribution of arrival times at RRJ for both groups and for each replicate. Andrew Gingerich said the WEJ site is good for evaluating test assumptions, but not for estimating survival due to the low detections.

Run Timing and Study Start and End Dates

Kahler distributed hard copies of run timing graphs corrected from Rocky Reach Dam detections to Wells Dam passage dates (Attachment C). He said Wells Dam passage dates were estimated using a 5-day travel time between dams for Chinook and coho salmon and a 2-day travel time for steelhead. He said these graphs depict what proportion of various stocks will be covered under different study start and end date scenarios, including Douglas PUD’s proposed study dates (April 20 to May 19; page 1 of Attachment C), “Option No. 2” (April 13 to May 12; page 2 of Attachment C), “Option No. 3” (April 10 to May 9; page 3 of Attachment C), and “Option No. 4” (April 2 to May 1; page 4 of

Attachment C). Kahler also distributed hard copies of sensitivity analysis tables for each of these options (Attachment D). Geris distributed Attachment C and Attachment D electronically on December 19, 2018.

Kahler said Douglas PUD's proposed study dates (April 20 to May 19; page 1 of Attachment C) covers all stocks well except wild spring Chinook salmon. He said Option No. 2 (April 13 to May 12; page 2 of Attachment C) shifts release dates 1 week earlier relative to Option No. 1 and picks up more wild spring Chinook salmon and has decent coverage for other stocks; however, wild coho salmon start to suffer. He said Option No. 3 (April 10 to May 9; page 3 of Attachment C) shifts release dates earlier relative to Option No. 2 and covers even more wild spring Chinook salmon, but the coverage of other stocks start diminishing.

Keely Murdoch asked if Option No. 2 (April 13 to May 12; page 2 of Attachment C) could also extend 1 week longer (later), ending instead on May 19, 2019? Kahler said extending the study 1 week would affect the release schedule for the 15 replicates, specifically, skipping 1 day sometimes but not every day. He said additionally, the study is already holding back fish that are ready to migrate, and if the release dates are more spread out, this increases the probability that the later releases will be held back too long, creating concern for fish residualizing. He said if the study goes beyond 30 days, this starts risking the smoltification of study fish and Douglas PUD is reluctant to do that. Murdoch asked what is problematic with skipping days between releases? Kahler said he would need to verify skipping days will not change anything. He said the main concern is holding back fish too long.

John Ferguson asked about Douglas PUD's preferred study dates (April 20 to May 19; page 1 of Attachment C). Kahler said spring Chinook salmon will be studied in 2030, and that study will be geared toward spring Chinook salmon timing and fish size. He said the 2020 study is studying summer Chinook salmon, which are best covered by Douglas PUD's preferred study dates. He said, however, Douglas PUD understands the Wells HCP Coordinating Committee's interest in representing all stocks to the extent practical. He said Douglas PUD may be reluctant to shift the study 7 to 10 days earlier, and Andrew Gingerich noted this timing starts to lose steelhead at this point. Kahler said Option No. 2 (April 13 to May 12; page 2 of Attachment C) is not as good for summer Chinook salmon compared to Douglas PUD's preferred study dates (April 20 to May 19; page 1 of Attachment C); however, Douglas PUD could still accept 65% coverage of summer Chinook salmon with Option No. 2 (Table 2 of Attachment D). Truscott noted that the total percentages would improve if Option No. 2 was extended to a May 19 end date. Kahler said extending the end date will result in a larger fish size in the last replicates. Truscott said he does not necessarily agree that an additional 7 days of rearing will result in a substantially different sized fish. He said for the benefit of representing a larger portion of the migration, extending the study an additional 7 days outweighs the risk of releasing larger fish.

Gingerich said if the intent is to better capture wild spring Chinook salmon, the study can be moved up a few days to include more wild spring Chinook salmon. He said logistically, it may be difficult to add additional time at the end of the study when crews are already burnt out. Kahler agreed and said these survival studies are a huge effort and are very labor intensive. Murdoch said she understands survival studies are a huge production; however, these only occur once every 10 years and she believes efforts should be made to create the best study possible. She said the YN prefers Option No. 2 (April 13 to May 12; page 2 of Attachment C) but also extending Option 2 to the end week for Option 1 (May 19). She said if this is absolutely not possible, the YN can support Option No. 2, as is.

Kahler recalculated total percentages including the additional 7 days to Option No. 2 (Table 2 of Attachment D). He said he thinks this may be doable; however, he needs to review this with policy staff. Chad Jackson, Jim Craig, and Truscott also indicated support for the YN proposal (Option No. 2 plus 7 days).

Fish Size

Kahler distributed hard copies of spring Chinook salmon lengths measured at the RRJSF (Attachment E). Geris distributed Attachment E electronically on December 19, 2018. Gingerich said Attachment E shows two distributions for fish lengths at tagging for hatchery and wild fish. He qualified that these data are from 2013 to 2018 and include spring migrants tagged in the Methow River Basin and detected and measured at the RRJSF. He said all of these fish were measured at recapture. He said the hatchery-reared fish had a mean fork length of 140 millimeters (mm) from a sample of 234 fish. He said the wild-origin fish had a mean fork length of 104 mm from a sample size of 26 fish. He said if travel times between Rocky Reach and Wells dams are fairly quick, these lengths may be similar for active spring migrants at Wells Dam. He noted that the other spring migrating fish will likely be larger.

Kahler said he plans to coordinate with hatchery staff to target a certain fish size, attempting to hold the fish back as best as possible. He said an exact plan is not yet in place; however, hatchery staff are working on one. Jackson asked how shifting the study dates may affect rearing and fish size. Kahler said the shift earlier will result in smaller fish and a shift later will result in larger fish. Gingerich guessed fish growth will be about 1 mm per day. Ferguson said the goal is to rear fish as small as possible without negatively affecting them. Jackson recalled during the 2010 study, fish at release were close to 160 mm fork length, and there were concerns the fish were larger than ideal. He suggested rearing fish closer to 136 to 140 mm fork length. Kahler said this can be a goal.

Next Steps

Ferguson asked if the Wells HCP Coordinating Committee is ready to approve the study plan. Murdoch said the YN would first like resolution on the study start and end dates. Kahler noted that if the study extends into the extreme tails of the run distribution, the estimates of survival might have to incorporate a way of weighting the data. Murdoch said generally, the study does not seem to extend into the extreme tails except perhaps for hatchery steelhead and coho salmon.

Ferguson said the Wells HCP Coordinating Committee provided guidance on study dates and fish size for Douglas PUD to discuss internally. He suggested postponing a vote until the HCP Coordinating Committees meeting on January 22, 2019, which will also provide NMFS time to review the discussions (NMFS was unable to participate in today's meeting).

B. 2018 Wells Dam Post-Season Bypass Report (Tom Kahler)

Tom Kahler said a Draft 2018 Post-Season Bypass Report and Passage-Dates Analysis was distributed to the HCP Coordinating Committees by Kristi Geris on December 14, 2018, which is available for a 60-day review with edits and comments due to Kahler by Tuesday, February 12, 2019. Kahler also distributed hard copies of the draft report for review and asked if there were questions or comments at this time. John Ferguson asked if there is anything remarkable about 2018? Kahler said one thing to note is that only 40 wild PIT-tagged yearling Chinook salmon were detected (page 8, Table 5, of the draft report). He said this is consistent with the earlier discussion about dealing with limited available data. Andrew Gingerich said since 2015, the Wells Dam bypass has operated quite a bit longer than necessary to meet the 95% passage requirement for subyearling Chinook salmon (page 7, Table 4, of the draft report). Gingerich noted the earlier freshets experienced in the past 4 years may be a factor. He said this is true for both wild and hatchery subyearling Chinook salmon. Kahler said he initially thought this was due to hatchery releases; however, this trend shows up for wild fish, too.

C. Wells Project Land-Use Permit Applications (Tom Kahler)

Tom Kahler reminded the Wells HCP Coordinating Committee there are three Wells Project Land-Use Permit Applications available for review (see Review Items). He said this is on the agenda to provide the opportunity to comment or ask questions. Kirk Truscott said the CCT only have the same comments that were shared during the last HCP Coordinating Committees meeting on December 4, 2018. He said there are a lot of juvenile summer Chinook salmon in the Gebber's Landing area and already existing structure there for predators to use when staging. He said additional structures will not help the predation that already exists in the area. He said this area is also an active staging area for adult sockeye salmon. He said there is also the issue with the expired NMFS and USACE permits. He said even if the applications are approved, he expects the applicants will need to reapply for permits and then re-consult. He said lastly, the access road to the area is fairly steep and the CCT would not be in favor of road improvements at that location.

D. Wells Dam Fishway Maintenance Update (Tom Kahler)

Tom Kahler said the schedule to start annual winter maintenance on the Wells Dam east fish ladder has been pushed back until early January 2019. He said the east ladder will receive the long overhaul and there should be no issues with this new schedule. He said the west fishway outage will begin once the east ladder is back online and will be quick. He said there should be no issues with completing the west ladder outage during the normal outage period (i.e., before March 2019).

IV. Chelan PUD

A. Rocky Reach Dam Turbine Unit C1 Update (Lance Keller)

Lance Keller said Rocky Reach Dam mechanics are still working out schedules for maintenance requests and he hopes to have more of an update in January 2019. He said he will relay updates via email if he receives any before the next meeting.

B. Rock Island Dam Powerhouse 1 Maintenance Update (Lance Keller)

Lance Keller said Rock Island Dam mechanics have started disassembling Turbine Unit B4. He said the maintenance schedule is not yet firmly established; however, the mechanical staff understand the priority is the small units starting with Turbine Unit B4 and moving toward the Douglas County riverbank with Turbine Unit B3, Turbine Unit B2, and then Turbine Unit B1. He said the rotor has been removed from Turbine Unit B4 for disposal, the rotor poles are ready for refurbishing, and work is being conducted on the turbine pit. He said mechanical staff will also be evaluating all components of the turbines to understand what needs to be refurbished and replaced. He said the current return-to-service date for Turbine Unit B4 is July 2019.

C. Rocky Reach and Rock Island Adult Fishway Maintenance Updates (Lance Keller)

Lance Keller reviewed adult fishway maintenance updates at Rock Island Dam and Rocky Reach Dam, as follows:

<u>Rock Island Dam</u>

Keller recalled reporting during the last HCP Coordinating Committees meeting on December 4, 2018, that the upper fishway of the right adult fish ladder was dewatered on December 3, 2018. He said 2 days later on December 5, 2018, the lower fishway of the right adult fish ladder was dewatered. He said very few fish were encountered during this fish rescue, as follows:

Species	Stage/Length	Clip	Count
Steelhead	juvenile	ad-present	2
Pikeminnow	NR	NA	4
sucker	NR	NA	1

Species	Stage/Length	Clip	Count
sculpin	NR	NA	2

Notes:
ad: adipose
NA: not applicable
NR: not reported

Keller said the pikeminnow were added to the Chelan PUD Pikeminnow Removal Program. He said low numbers have been encountered in the past when dewatering the upper and lower fishways was completed over longer periods of time. He said it was surprising that no Pacific lamprey were encountered, considering the large adult return observed in 2018. He said ultimately, low fish numbers are ideal because fish volitionally leave as opposed to being handled.

Keller said on December 13, 2018, the juvenile fish collection channel was dewatered. He said this channel leads to the right bank juvenile bypass trap where monitoring and indexing take place. He said fish rescued from this area included:

Species	Stage/Length	Clip	Count
Rainbow/steelhead	<12 inches	ad-present	8
		ad-clipped	4
Atlantic salmon	NR	NR	1
sculpin	NR	NA	1

Notes:
ad: adipose
NA: not applicable
NR: not reported

Keller noted that the hatchery-origin *Oncorhynchus mykiss* encountered fell outside the 12- to 18-inch range in length. He said it was surprising to encounter an Atlantic salmon; however, he understands this has also occurred at Wells Dam. Chad Jackson asked if a genetic sample was collected on the Atlantic salmon and Keller said no, that the fish was netted and immediately returned to the river.

Keller said currently, only the right adult fish ladder is offline for maintenance. He said on January 7, 2019, the left adult fish ladder will be taken out-of-service for maintenance and returned prior to the center adult fish ladder going out-of-service on January 28, 2019. He said the right adult fish ladder will remain dewatered for a large duration of the 2018/2019 winter maintenance outage to allow Biomark to conduct PIT-tag detection equipment efficiency improvements in the dry. Keller pointed out that at least one fish ladder will be operational at all times during the winter maintenance period.

Rocky Reach Dam

Keller said the adult fishway at Rocky Reach Dam will be taken offline for annual winter maintenance on January 2 or 3, 2019, depending on annual leave schedules for mechanical staff. He said the upper fishway will be dewatered similar to those at Rock Island Dam, where headgates will be installed at the exits allowing the fishway to drain down to an elevation equal to the tailwater. He said hopefully within 1 to 3 days the lower fishway will also be dewatered. Jackson said if additional unique species are encountered during this fish rescue it would be helpful to collect them. He said he does not believe there is anything permit-wise that would preclude Chelan PUD from doing this. Keller said Chelan PUD can do this if WDFW can provide something in writing permitting these activities. Jackson said WDFW may be able to amend Chelan PUD's permit, if needed. He recalled the release of hatchery-reared Atlantic salmon from net pens in Puget Sound early this year and said it would be interesting to know if these fish migrated all the way to the mid-Columbia River.

D. Tumwater Dam Fishway Activities (Lance Keller)

Lance Keller said in September 2018, to support goals in the Chelan PUD Pacific Lamprey Management Plan, Steve Hemstrom coordinated with BioAnalysts to conduct night snorkeling at the Tumwater Dam fishway in an effort to determine if adult Pacific lamprey may be staging at the ladder entrance. Keller said this was the first underwater survey conducted at Tumwater Dam in a long time. He said erosion at the base of the end of the fishway was observed and Chelan PUD is notifying the HCP Coordinating Committees that starting December 26, 2018, public access to Tumwater Dam will be closed and a private contractor will be drilling core samples within the footprint of the fishway. He said Chelan PUD has already completed the required Hydraulic Project Approval and State Environmental Policy Act processes, and there is no need for a USACE permit for these activities, as all of the work activities will be occurring inside the footprint of the fishway itself, not the dam structure. He said this work will inform a scope for additional work that will involve installation of pin piles in February 2019. He said he believes pin piles are collar-installed and this allows the installation of grout. He said the work for the pin piles was scheduled in February 2019 because there is minimal fish passage at the dam during this time. He said the work will not require an outage and the fishway will remain operational. He said he only recently heard about this work and it was not anticipated.

V. HCP Administration

A. Next Meetings (John Ferguson)

The next scheduled HCP Coordinating Committees meeting is on January 22, 2019, to be held in-person at the Grant PUD Wenatchee Office in Wenatchee, Washington.

The February 26 and March 26, 2019 meetings will be held by conference call or in-person at the Grant PUD Wenatchee office in Wenatchee, Washington, as is yet to be determined.

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	2020 Wells Project Survival Verification Study Plan – Methow and Okanogan Release Ratio
Attachment C	2020 Wells Project Survival Verification Study Plan – Run Timing Graphs Corrected to Wells Dam Passage Dates
Attachment D	2020 Wells Project Survival Verification Study Plan – Sensitivity Analysis Tables
Attachment E	2020 Wells Project Survival Verification Study Plan – Spring Chinook Salmon Lengths Measured at the Rocky Reach Juvenile Bypass Sampling Facility

Attachment A
List of Attendees

Name	Organization
John Ferguson	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Tracy Hillman††	BioAnalysts
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich*	Douglas PUD
Jim Craig*	U.S. Fish and Wildlife Service
Chad Jackson*	Washington Department of Fish and Wildlife
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

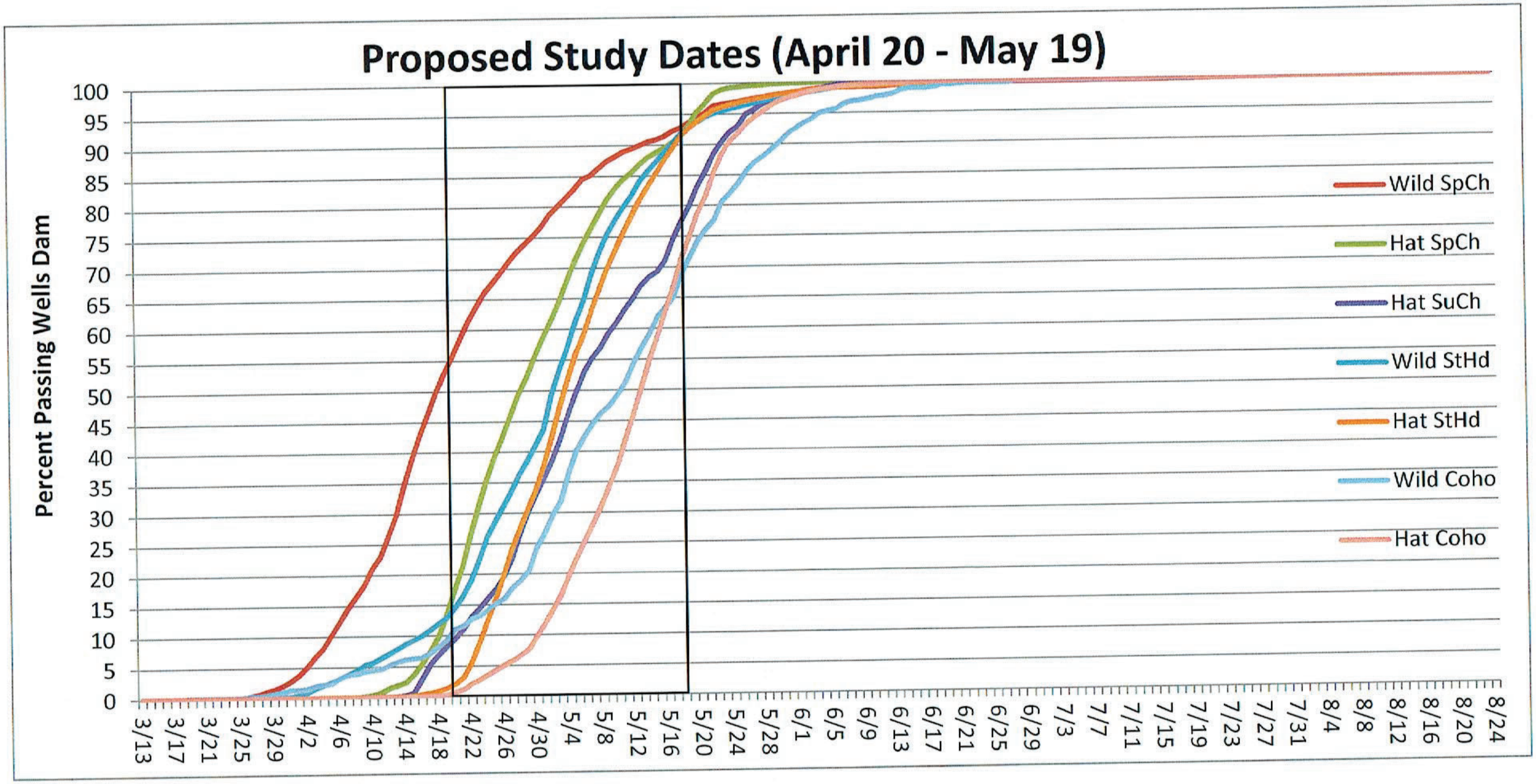
Notes:
* Denotes HCP Coordinating Committees member or alternate
† Joined by phone
†† Joined by phone for the HCP Tributary and Hatchery Committees Update

2020 - includes all releases from CJH in the Okanogan values (i.e., releases both to the Okanogan and direct to the Columbia)

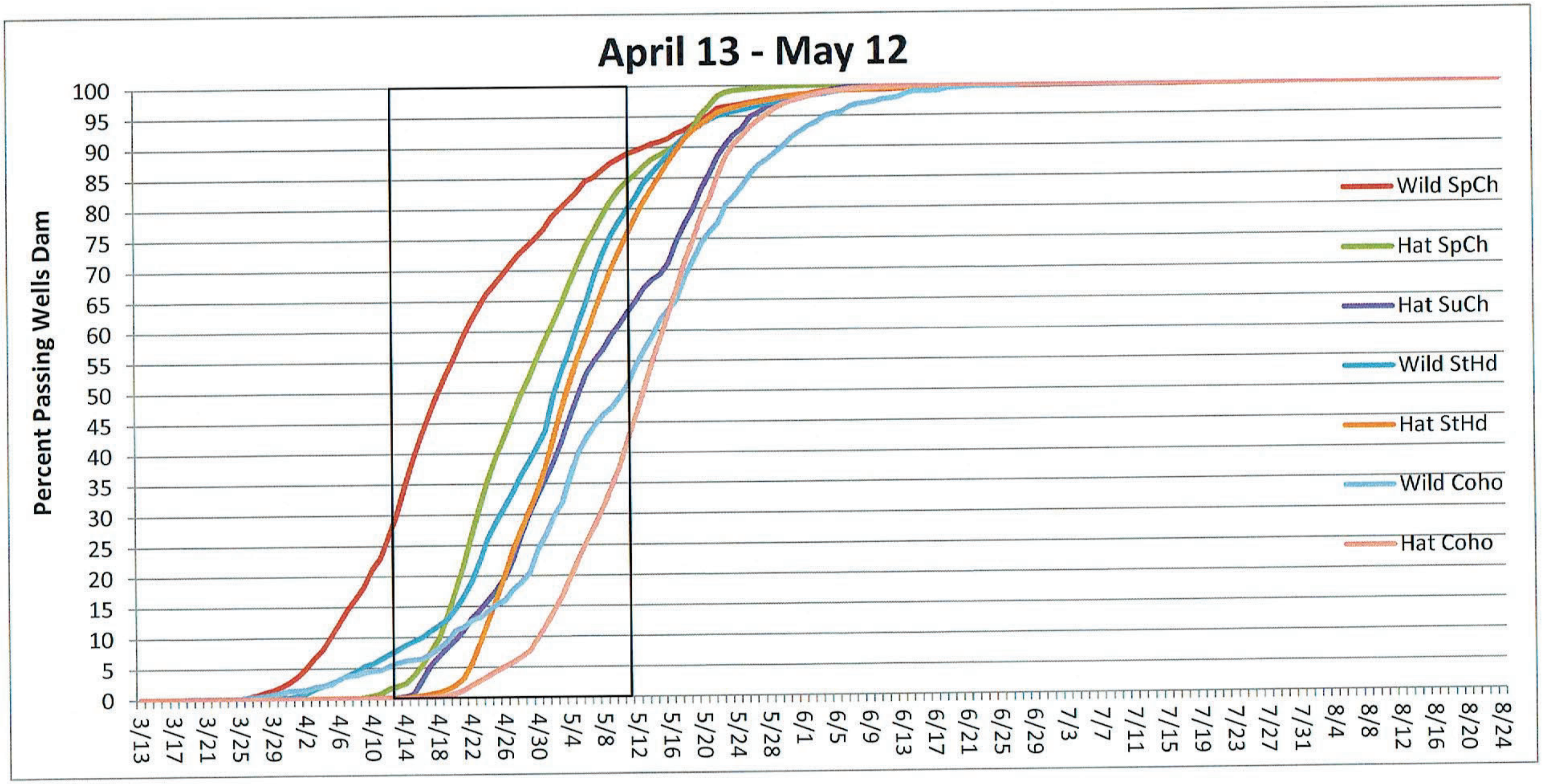
	Methow River						Okanogan River						Percent						Percent	
Species	Chinook-1		Coho		Steelhead		Chinook-1		Coho		Steelhead		Methow			Okanogan			All	
Year	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	N/A	N/A	Wild	Hatchery	Chinook	Coho	Steelhead	Chinook	Coho	Steelhead	Methow	Okanogan
2009	126,068	1104921		424682	90586	410930		615795	0	0	16517	162138	66.7%	100.0%	73.7%	33.3%	0.0%	26.3%	73%	27%
2010	126,068	1538619		409049	90586	78130		529125	0	0	16517	124708	75.9%	100.0%	54.4%	24.1%	0.0%	45.6%	77%	23%
2011	126,068	1434009		377569	90586	373776		837431	0	0	16517	159929	65.1%	100.0%	72.5%	34.9%	0.0%	27.5%	70%	30%
2012	126,068	1549891		415987	90586	305852		617950	0	0	16517	121907	73.1%	100.0%	74.1%	26.9%	0.0%	25.9%	77%	23%
2013	126,068	1361297		463389	90586	210570		627978	0	0	16517	77462	70.3%	100.0%	76.2%	29.7%	0.0%	23.8%	76%	24%
2014	126,068	987744		510353	90586	248102		158267	0	0	16517	73003	87.6%	100.0%	79.1%	12.4%	0.0%	20.9%	89%	11%
2015	126,068	656848		469097	90586	228396		1624359	0	0	16517	113068	32.5%	100.0%	71.1%	67.5%	0.0%	28.9%	47%	53%
2016	126,068	848278		344456	90586	286410		1619309	0	0	16517	128450	37.6%	100.0%	72.2%	62.4%	0.0%	27.8%	49%	51%
2017	126,068	835500		383514	90586	383000		1521760	0	0	16517	127000	38.7%	100.0%	76.7%	61.3%	0.0%	23.3%	52%	48%
2018	126,068	862509		491335	90586	292065		1904700	0	0	16517	117126	34.2%	100.0%	74.1%	65.8%	0.0%	25.9%	48%	52%
Sum	1,260,680	11,179,616	0	4,289,431	905,860	2,817,231	0	10,056,674	0	0	165,170	1,204,791							64%	36%

OPTION #1

Attachment C

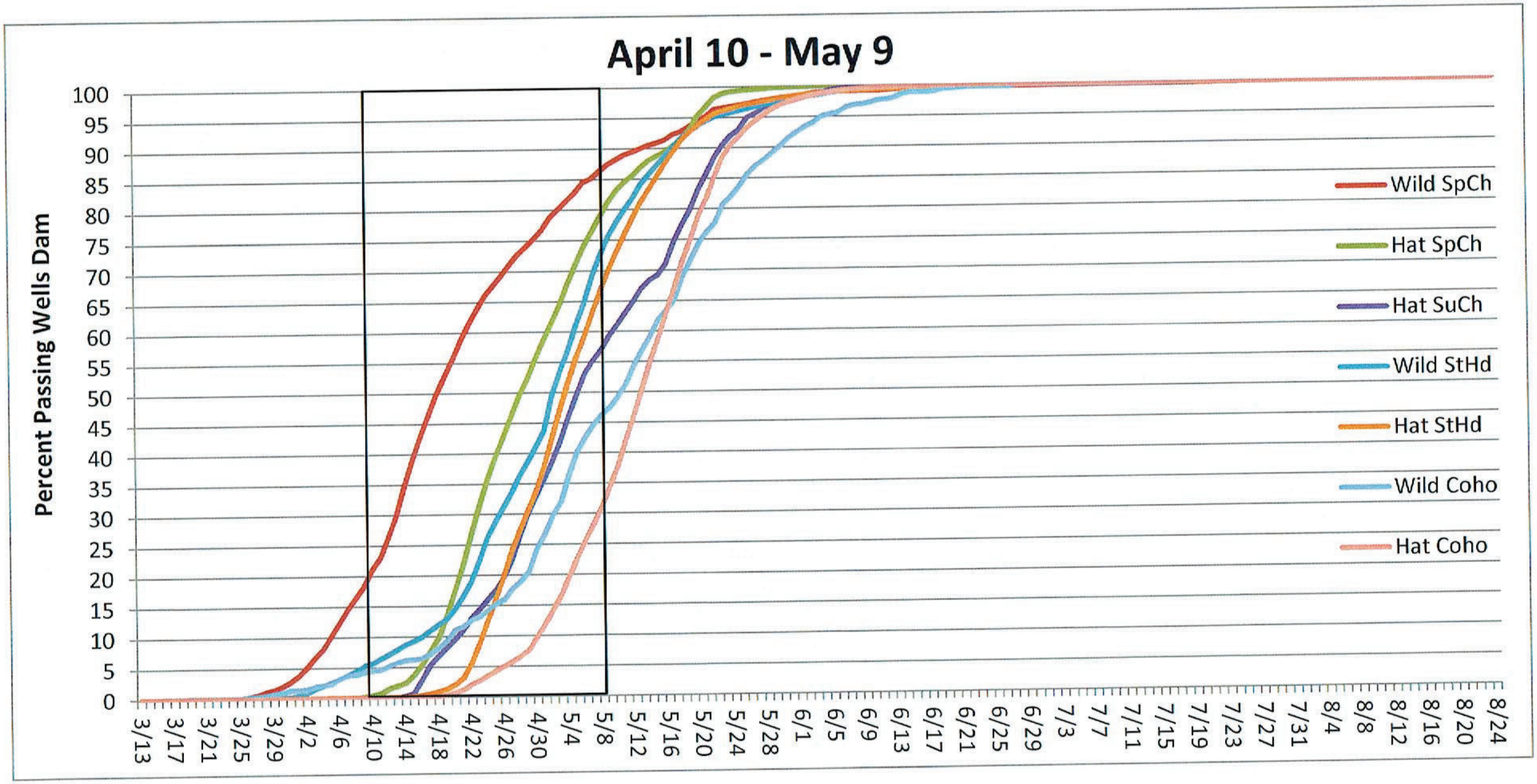


OPTION #2



April 13 - May 12
Percent Passing Wells Dam
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3/13
3/17
3/21
3/25
3/29
4/2
4/6
4/10
4/14
4/18
4/22
4/26
4/30
5/4
5/8
5/12
5/16
5/20
5/24
5/28
6/1
6/5
6/9
6/13
6/17
6/21
6/25
6/29
7/3
7/7
7/11
7/15
7/19
7/23
7/27
7/31
8/4
8/8
8/12
8/16
8/20
8/24
Wild SpCh
Hat SpCh
Hat SuCh
Wild StHd
Hat StHd
Wild Coho
Hat Coho

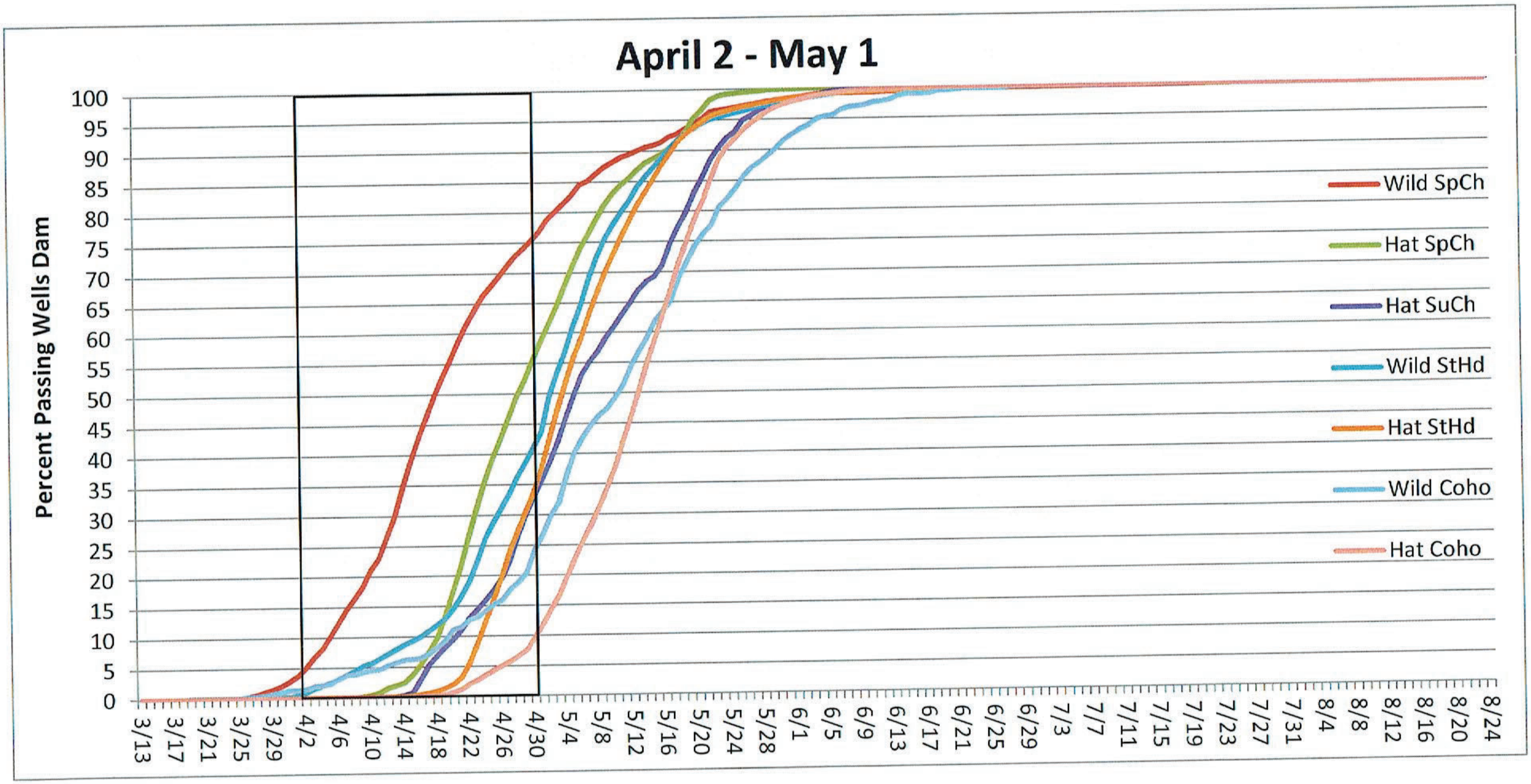
OPTION #3



April 10 - May 9
Percent Passing Wells Dam
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3/13
3/17
3/21
3/25
3/29
4/2
4/6
4/10
4/14
4/18
4/22
4/26
4/30
5/4
5/8
5/12
5/16
5/20
5/24
5/28
6/1
6/5
6/9
6/13
6/17
6/21
6/25
6/29
7/3
7/7
7/11
7/15
7/19
7/23
7/27
7/31
8/4
8/8
8/12
8/16
8/20
8/24
Wild SpCh
Hat SpCh
Hat SuCh
Wild StHd
Hat StHd
Wild Coho
Hat Coho

OPTION #4

Attachment C



Sensitivity analysis of percentages of the cumulative passage distributions that various study dates would include, for stocks of yearling Plan Species passing Wells Dam. Data adjusted from RRJ detections, 2013-2018, by the mean travel time for yearling Chinook and coho (5 days) and combined yearling and age-2 steelhead (2 days), to simulate Wells Dam passage date. See accompanying graphs for visual representation of the data.

Table 1. Percentages by stock of cumulative passage distributions at Wells Dam included in a study starting on April 20 and ending on May 19 (proposed study dates).

		Percentages Passed By Stock					
	Dates	**W-SpCh**	**H-SpCh**	**H-SuCh**	**W-StHd**	**H-StHd**	**W-Coho**
Passed Before	20-Apr	52.8	13.3	8.3	12.9	1.4	9.3
Passed On	19-May	93.5	93	79.8	92.7	92.6	71.6
Percent Included		40.7	79.7	71.5	79.8	91.2	62.3

Table 2. Percentages by stock of cumulative passage distributions at Wells Dam included in a study starting on April 13 and ending on May 12. add 7 days to May 19

		Percentages Passed By Stock					
	Dates	**W-SpCh**	**H-SpCh**	**H-SuCh**	**W-StHd**	**H-StHd**	**W-Coho**
Passed Before	13-Apr	26.4	1.6	0.02	7.2	0.1	5.3
Passed On	12-May	89.4	85.5	64.9	81.8	78.5	54.3
Percent Included		63	83.9	64.88	74.6	78.4	49
		67.1	91.4	79.8	85.5	92.5	66.3

Table 3. Percentages by stock of cumulative passage distributions at Wells Dam included in a study starting on April 10 and ending on May 9.

		Percentages Passed By Stock					
	Dates	**W-SpCh**	**H-SpCh**	**H-SuCh**	**W-StHd**	**H-StHd**	**W-Coho**
Passed Before	10-Apr	18.3	0.2	0	5.3	0.08	4.3
Passed On	9-May	87.4	81.2	59.2	75.6	70.1	47.4
Percent Included		69.1	81	59.2	70.3	70.02	43.1

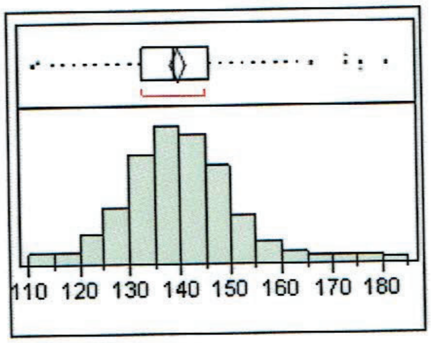
Table 4. Percentages by stock of cumulative passage distributions at Wells Dam included in a study starting on April 2 and ending on May 1.

		Percentages Passed By Stock					
	Dates	**W-SpCh**	**H-SpCh**	**H-SuCh**	**W-StHd**	**H-StHd**	**W-Coho**
Passed Before	2-Apr	3.7	0.01	0	0.6	0.03	1.5
Passed On	1-May	76.8	58.5	35.8	43.7	37.7	26.7
Percent Included		73.1	58.49	35.8	43.1	37.67	25.2

Spring Chinook Lengths at Rocky Reach Juvenile Bypass Sampling Facility, 2013-2018

Distributions Rear Type Name=Hatchery Reared

Recap Length mm



Quantiles

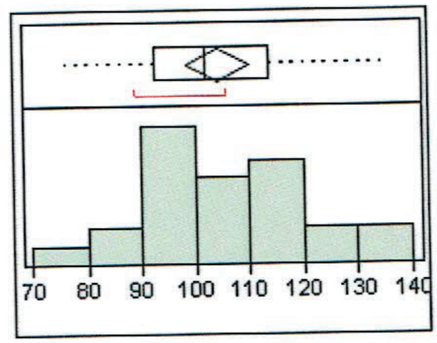
100.0%	maximum	181
99.5%		180.125
97.5%		166.875
90.0%		153
75.0%	quartile	146
50.0%	median	139
25.0%	quartile	133
10.0%		126
2.5%		118.875
0.5%		111.175
0.0%	minimum	111

Moments

Mean	139.59402
Std Dev	10.984271
Std Err Mean	0.7180643
Upper 95% Mean	141.00875
Lower 95% Mean	138.17929
N	234

Distributions Rear Type Name=Wild Fish or Natural Production

Recap Length mm



Quantiles

100.0%	maximum	136
99.5%		136
97.5%		136
90.0%		127.2
75.0%	quartile	113.5
50.0%	median	102
25.0%	quartile	92.75
10.0%		88.4
2.5%		76
0.5%		76
0.0%	minimum	76

Moments

Mean	104.15385
Std Dev	14.393588
Std Err Mean	2.8228149
Upper 95% Mean	109.96754
Lower 95% Mean	98.34015
N	26

Appendix B
Habitat Conservation Plan Hatchery Committees 2018 Meeting Minutes and Conference Call Minutes

FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To:	Wells, Rocky Reach, and Rock Island HCP Hatchery Committees	Date: February 26, 2018
From:	Tracy Hillman, HCP Hatchery Committees Chairman	
cc:	Sarah Montgomery, Anchor QEA, LLC	
Re:	**Final Minutes of the January 17, 2018 HCP Hatchery Committees Meeting**	

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held at the Grant PUD office in Wenatchee, Washington, on Wednesday, January 17, 2018, from 9:00 to 12:00 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A). *(Note: this item is ongoing.)*
- Sarah Montgomery will distribute the approved Chelan PUD Coho Obligation Statement of Agreement (SOA) to the Hatchery Committees (Item II-A). *(Note: Montgomery distributed the SOA on January 22, 2018.)*
- Tom Kahler will send Douglas PUD's 2018 Wells HCP Action Plan to the Hatchery Committees for review (Item IV-A). *(Note: Montgomery distributed the plan on January 22, 2018.)*
- The Methow Basin Steelhead Small Working Group will revise their memorandum, "Management alternatives for Methow Basin conservation steelhead programs," to incorporate backup broodstock collection locations for Twisp River steelhead and will distribute a revised version for review (Item IV-C).
- Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Management alternatives for Methow Basin conservation steelhead programs," before the February 21, 2018 Hatchery Committees meeting (Item IV-C).
- Brett Farman will coordinate with Craig Busack (National Marine Fisheries Service [NMFS]) regarding reviewing the memorandum, "Management alternatives for Methow Basin conservation steelhead programs," before the February 21, 2018 Hatchery Committees meeting (Item IV-C).

- Mike Tonseth and Sarah Montgomery will compile permits and Biological Opinions (BiOps) applicable to HCP programs and post them to the Extranet site (Item VI-A).
- Hatchery Committees representatives will continue to provide historical information to Tracy Hillman for incorporation in program and species timelines, particularly regarding Wenatchee steelhead, Methow steelhead, and Methow summer Chinook salmon (Item VI-C).
- Sarah Montgomery will poll the Hatchery Committees and Priest Rapids Coordinating Committee (PRCC) Hatchery Sub-Committee to determine the March meeting date (Item VII-A). *(Note: Montgomery sent a Doodle poll on January 31, 2018. A date has not been finalized yet.)*

Decision Summary

- The Rocky Reach and Rock Island Hatchery Committees approved Chelan PUD's SOA "Regarding District's Coho Obligation" as follows: Chelan PUD, WDFW, U.S. Fish and Wildlife Service (USFWS), NMFS, Yakama Nation (YN), and Colville Confederated Tribes (CCT) approved on January 17, 2018 (Item II-A). *(Note: Montgomery distributed the Final SOA to the Hatchery Committees on January 22, 2018.)*
- The Rocky Reach and Rock Island Hatchery Committees approved the hatchery portion of the 2018 Rock Island and Rocky Reach HCP Action Plan, as follows: Chelan PUD, WDFW, USFWS, NMFS, YN, and CCT approved on January 17, 2018 (Item II-C).
- The Wells Hatchery Committee approved piloting Alternative 3 in the memorandum, "Management alternatives for Methow Basin conservation steelhead programs," for broodstock collection and management of the Twisp steelhead program in 2018, as follows: Douglas PUD, WDFW, USFWS, NMFS, YN, and CCT approved on January 17, 2018 (Item IV-C).

Agreements

- The Hatchery Committees approved Chelan PUD's request to collect four female and four male surplus steelhead broodstock from the Wells Fish Hatchery volunteer channel to support their egg-to-emergence evaluation in 2018 (Item II-B).
- The Rocky Reach and Rock Island Hatchery Committees approved Chelan PUD's request to move approximately 25,000 hatchery-by-hatchery (HxH) steelhead, destined for final acclimation at Blackbird Island Pond, from the "Enzyme-Linked Immunosorbent Assay (ELISA)" Pond to Raceway No. 2 at the Chiwawa Acclimation Facility and forego final acclimation at Blackbird Pond in 2018 (Item II-D).
- The Rocky Reach and Rock Island Hatchery Committees agreed to cull part of the brood year (BY) 2017 Chelan Falls summer Chinook salmon program to manage disease concerns. The progeny of hatchery females with ELISA values over 0.12 will be culled, approximately 35,000 eyed-eggs (Item III-A).

Review Items

- Sarah Montgomery sent an email to the Wells Hatchery Committee on January 22, 2018, notifying them that the draft 2018 Wells HCP Action Plan is available for review, with comments due to Tom Kahler prior to the February 21, 2018 Hatchery Committees meeting.

Finalized Documents

- Sarah Montgomery sent an email to the Rocky Reach and Rock Island Hatchery Committees on January 22, 2018, notifying them that the Final SOA, "Regarding District's Coho Obligation," is now available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the November 15, 2017 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following items were added:

- Mike Tonseth added an item for BY 2017 Chelan Falls culling.
- Greg Mackey added an update on Douglas PUD hatcheries.
- Kirk Truscott added an update on Chief Joseph Hatchery.
- Tracy Hillman added the revised timelines for program changes.

The Hatchery Committees representatives reviewed the revised draft November 15, 2017 meeting minutes. Sarah Montgomery said there are no outstanding comments. Hatchery Committees representatives present approved the draft November 15, 2017 meeting minutes as revised.

Action items from the Hatchery Committees meeting on November 15, 2017, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on November 15, 2017)*:

- *Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam (Item I-A).*
  This item is ongoing. Mike Tonseth indicated the overview may be available in April or May 2018 for review.
- *Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A).*
  This item is ongoing.

- *Bill Gale, Matt Cooper, Charlie Snow (WDFW), Tom Kahler, and Greg Mackey will develop management alternatives for the Twisp River and Winthrop National Fish Hatchery steelhead programs (Item I-A).*
  This item is complete and will be discussed today.
- *Greg Mackey will revise the Douglas PUD steelhead surplus document and send it to the Hatchery Committees (Item III-A).*
  This item is complete. Mackey sent the revision to Sarah Montgomery, which she forwarded to the Hatchery Committees following the meeting on November 15, 2017.
- *Greg Mackey will provide an update on the Wells and Methow fish hatcheries transition process, particularly regarding fish health and marking strategies, near the end of the transition period (Item III-C).*
  This item is complete. Mackey provided this update via email on December 7, 2017.
- *Greg Mackey will provide an update on summer Chinook salmon spawning numbers for the Douglas PUD programs to the Hatchery Committees (Item IV-A).*
  This item is complete.
- *Tracy Hillman will revise non-target taxa of concern language in the draft Monitoring and Evaluation (M&E) Plan for PUD Hatchery Programs (2017 Update) and provide the final approved version to the Hatchery Committees, the Independent Scientific Advisory Board (ISAB), and Greer Maier (Upper Columbia Salmon Recovery Board [UCSRB]; Item V-C).*
  This item is complete. Hillman revised and sent the final Plan to Sarah Montgomery, which she distributed to the Hatchery Committees and Maier on November 17, 2017. Hillman also sent the plan to the ISAB on November 17, 2017.
- *Tracy Hillman will distribute the draft timelines for Wenatchee and Methow spring Chinook salmon programs for Hatchery Committees review (Item V-D).*
  This item is complete—Hillman sent the timelines to Sarah Montgomery, which she forwarded to the Hatchery Committees on November 15, 2017—and will be further discussed today.
- *Tracy Hillman will draft timelines for summer Chinook salmon, steelhead, and sockeye salmon, and for hatchery programs in the Entiat River basin (Item V-D).*
  This item is complete and will be discussed today.
- *Sarah Montgomery will distribute Greer Maier's presentation, "Integrated Recovery," from the November 15, 2017 Hatchery Committees meeting (Item IV-E).*
  This item is complete. Montgomery sent the presentation to the Hatchery Committees following the meeting on November 15, 2017.

II. Chelan PUD

A. Coho Obligation Statement of Agreement (Catherine Willard)

Catherine Willard shared the draft SOA, "Regarding Chelan PUD's Coho Salmon Obligation," which Sarah Montgomery distributed to the Hatchery Committees on January 3, 2018 (Attachment B). Willard said this SOA is directly related to the SOA, "Regarding Chelan PUD's Coho Obligation," which the Hatchery Committees approved on November 15, 2017 and described the methodology for calculating the District's coho hatchery obligation for brood years 2017 to 2021. Willard reviewed the content of the SOA. Kirk Truscott suggested clarifying language about how Chelan PUD is meeting their obligation by funding the Mid-Columbia Coho Salmon Reintroduction Project. Truscott also questioned the language about future recalculated hatchery compensation obligations. Willard and Keely Murdoch clarified that the mitigation should be consistent with recalculation, so if recalculation methods change, the coho salmon obligation will change, too. Representatives present revised the language in the SOA and consulted two previous coho salmon SOAs (November 15, 2017, and December 14, 2011) for consistency.

Truscott said facility use is specifically mentioned in the SOA and he has concerns that facility use may influence other HCP actions. Knowing which facilities will be used and the purpose of using those facilities would be helpful in understanding the scope of the SOA. Murdoch said the agreement between YN and Chelan PUD primarily regards funding, and use of the Rocky Reach Annex has also been discussed. She said trapping facilities such as Dryden Dam and Tumwater Dam will also be important to implementing the project. Truscott said using Dryden Dam and Tumwater Dam for broodstock is agreeable; however, YN using those facilities for harvest under an agreement related to this SOA would not be agreeable. Further edits were made to the SOA specifying "facility use for propagation purposes." The Rocky Reach and Rock Island Hatchery Committees approved Chelan PUD's SOA "Regarding District's Coho Obligation" as follows:
Chelan PUD, WDFW, USFWS, NMFS, YN, and CCT approved on January 17, 2018.

B. Request for Steelhead Gametes for 2018 Egg-to-Emergence Evaluation (Catherine Willard)

Catherine Willard said Chelan PUD is requesting steelhead gametes in order to conduct a steelhead egg-to-emergence evaluation in the habitat channel of the Chelan River. The evaluation is used to evaluate the effectiveness of Chelan PUD's Chelan River Biological Evaluation and Implementation Plan, a requirement of their Federal Energy Regulatory Commission license for the Lake Chelan Hydroelectric Project. Willard said 2018 is the second year of this study. In the first year, researchers used green eggs from Wells Fish Hatchery; this year the study will use eyed eggs. She said the study requires 2,800 eggs total, from four pairs of fish. Greg Mackey asked if Chelan PUD is requesting the eyed eggs from Douglas PUD, or if Chelan PUD plans to spawn the fish and incubate the eggs at their own facility. Willard said Chelan PUD will spawn the hatchery-origin fish in March and plant the eyed-eggs in mid-April.

Mackey said steelhead at Wells Fish Hatchery also have Columnaris this year. He said Douglas PUD has been losing broodstock. He said the Columbia program is being spawned now and will be back-up broodstock for the Okanogan and Methow programs pending spring collections in those locations. He said the program will barely meet egg-take goals under current conditions. Mackey said he expects hatchery staff will be able to collect brood for Chelan PUD in the Wells Fish Hatchery volunteer channel once the channel is open, and supplemental brood for the Wells programs can also be collected.

Mike Tonseth said he agrees with collecting brood for the Chelan River egg-to-emergence evaluation, but collecting brood to offset production shortfalls in the Wells programs would need to be further discussed with the Hatchery Committees. He said collecting surplus fish for adult management is agreed to, but using those surplus fish for broodstock is not agreed to yet. He said as in the past, collecting additional broodstock to meet production shortfalls would need to be discussed. Mackey said he will have more information regarding this potential production shortfall in February. Tonseth said due to disease issues and a slow run, meeting spring broodstock collection goals may be more challenging than usual for the Methow safety net and Okanogan programs. He said he is not opposed to collecting additional broodstock, just that it would need to be agreed to in committee to deviate from the Broodstock Collection Protocols.

Kirk Truscott asked about the fate of the gametes that are not planted in the boxes. Willard said they are reared in the hatchery as a control, then culled because they are progeny of surplus fish. Tonseth said the fry in the egg boxes are also culled, which is standard in egg-to-fry survival studies. Truscott noted that only surplus fish should be used as a brood source for this study. Mackey asked if there is a backup plan for brood source if surplus fish are not collected in the Wells Fish Hatchery volunteer channel in March. Willard said the study would be postponed.

The Hatchery Committees approved Chelan PUD's request to collect four female and four male surplus steelhead broodstock from the Wells Fish Hatchery volunteer channel to support their egg-to-emergence evaluation in 2018 as follows: Chelan PUD, Douglas PUD, NMFS, USFWS, WDFW, YN, and CCT approved on January 17, 2018.

C. Draft 2018 Rock Island and Rocky Reach Action Plan (Catherine Willard)

Catherine Willard shared the draft 2018 Rock Island and Rocky Reach HCP Action Plan, which Sarah Montgomery distributed to the Hatchery Committees on January 15, 2018 (Attachment C). Willard said many items are ongoing from previous years. She said new items include the following:

- Chelan Falls Canal Trap Engineering Feasibility: Chelan PUD is considering a more permanent structure. Design would occur in 2019, and it would be installed in 2020.
- Chelan Hatchery Rehabilitation Engineering Feasibility.
- Chiwawa Weir Maintenance Engineering Feasibility: the left abutment needs to be replaced, and permits are in process. Maintenance would also include moving accumulated gravel and cobble material so that the weir lays flat.
- New Eastbank Well Generator Installation: Chelan PUD plans to install a second backup power source in 2018.
- Steelhead Residualism Plan: discussed in Section II-D.
- Receive permit for Wenatchee and Chelan Falls unlisted summer Chinook salmon programs.

Mike Tonseth suggested adding development of the Broodstock Collection Protocols. It was added, and the Rock Island and Rocky Reach Hatchery Committees approved the Hatchery Committees section of the plan as follows: CPUD, USFWS, NMFS, WDFW, YN, and CCT approved on January 17, 2018. The plan will be discussed by the Coordinating Committees for final approval.

D. Wenatchee Steelhead Final Acclimation (Catherine Willard)

Catherine Willard said Chelan PUD typically transfers 25,000 HxH steelhead from Chiwawa Acclimation Facility to Blackbird Pond in March for final acclimation. She said Chelan PUD is developing the draft 2018 Steelhead Release Plan, which will be available for review soon. She said there are a lot of covariates to consider when evaluating steelhead survival, such as type of release, type of tank or raceway, and parental source. She said in an attempt to reduce covariates and more effectively examine residualism as part of the Wenatchee steelhead permit (NMFS No. 18583) received in December 2017, Chelan PUD plans to passive integrated transponder (PIT)-tag three size classes of steelhead in the Wenatchee program in 2018. She said Chelan PUD wants to take fish that are in the “ELISA” pond (these are the HxH fish that were destined for Blackbird Pond) and transfer them to Raceway No. 2 at the Chiwawa Acclimation Facility. Thus, these fish will be reared in the same vessel type and in the same water as other fish in the evaluation. She said Chelan PUD is requesting approval for this action now because the fish need to be moved soon, but it will also be described in the Steelhead Release Plan.

Keely Murdoch asked where the fish will be released. Mike Tonseth said the fish will be released in locations consistent with previous years, namely Nason Creek, Chiwawa River, upper Wenatchee

River, lower Wenatchee River, and Blackbird Pond (however, this release will not occur as part of the plan). Murdoch asked if examining differences between HxH and wild-by-wild (WxW) fish is part of the study. Tonseth said it is part of the study plan. There are three size groups per parental cross for a total of six groups. Kirk Truscott asked how many HxH fish are planned to be released in the upper Wenatchee Basin. Tonseth said the majority of the late group released in the upper Wenatchee Basin in previous years comprised WxW fish. Willard said the plan is that WxW fish will continue to be released in the upper Wenatchee Basin. Truscott said he wants to make sure management strategies are not being compromised by releasing more HxH fish in the upper basin. Tonseth said there is an increase in the total number of fish released in the upper Wenatchee Basin as part of this plan, but the plan provides more reliability in the removal of HxH adults at Tumwater Dam.

Willard said this plan will likely include a total of 20,000 to 30,000 PIT-tagged fish; but she is waiting for sample size calculations from Dr. John Skalski. Tonseth summarized that the new steelhead permit provides guidance to evaluate potential rates of residualism for the Wenatchee steelhead program, and in the near-term, Chelan PUD plans to reduce covariates by maintaining the entire program at the Chiwawa Acclimation Facility and not final acclimating and volitionally releasing steelhead from Blackbird Pond for 3 years. This will inform whether residualism is linked to fish size or parental source. Willard said Chelan PUD asks the Hatchery Committees to approve moving the fish now, and not releasing fish at Blackbird Pond for 3 years. Hillman asked what would happen if the fish are moved now, but then the release plan is not approved. Tonseth said in that case, releases would occur as planned except for the Blackbird Pond release. Truscott said he is okay with moving these fish from the ELISA pond to Raceway No. 2, because Raceway No. 2 is already a mixture of differentially marked fish. Brett Farman asked if the tagging groups are individually identifiable. Tonseth said the different parental groups are differentially marked, and the number of fish by parental group released at each site will be tracked and distributed. He said the difference in this plan is that the PIT-tagging component will be structured so that three size groups for each parental group are targeted.

The Rocky Reach and Rock Island Hatchery Committees approved Chelan PUD's request to move approximately 25,000 HxH steelhead from the "ELISA" Pond to Raceway No. 2 at the Chiwawa Acclimation Facility, as follows: Chelan PUD, WDFW, NMFS, USFWS, YN, and CCT agreed on January 17, 2018.

III. WDFW/Chelan PUD

A. Brood Year 2017 Chelan Falls Summer Chinook Salmon Culling (Mike Tonseth)

Mike Tonseth said the Hatchery Committees need to discuss culling part of the Chelan Falls summer Chinook salmon program due to disease concerns. He said the program is short due to prespawn mortality, poor eye-up rates, and lower than anticipated fecundities. ELISA levels are also higher than usual in females, so culling may be necessary to manage for disease. Tonseth said the program collected the 179 females called for in the Broodstock Collection Protocols, and 168 were spawned, though fish sustained higher than expected prespawn mortality (6%). He said the average fecundity was 300 eggs lower than expected, resulting in a shortage of approximately 30,000 to 35,000 eggs. He said the Broodstock Collection Protocols identify a cull allowance of 2% or less, and the number of high-ELISA females (greater than 0.12 optical density [OD]) is about 6%. Tonseth proposed culling all eggs from progeny of high-ELISA females to manage the risk of bacterial kidney disease (BKD). He said the Broodstock Collection Protocols and other permits identify culling criteria for spring Chinook salmon, but not for summer Chinook salmon. He suggested applying the same principle—culling all eggs from hatchery females with ELISA values of 0.12 OD or higher—to summer Chinook salmon as for spring Chinook salmon. He said for the Chelan Falls program, the number culled would amount to approximately 35,000 eyed eggs. Tonseth summarized that the total egg-take goal for the Chelan Falls summer Chinook salmon program is 634,000 eggs, the smolt release goal is 576,000 smolts, and there are currently 573,000 eyed eggs on station. Removing 35,000 eyed eggs would result in a projected smolt release of 492,000 smolts. He said an additional consideration in culling these eggs is that they are the progeny of hatchery parents, and it is not possible to rear them separately from any other portion of the program. So, maintaining these fish on station would be a risk to the rest of the program. He also mentioned that females from Entiat National Fish Hatchery made up 11% of the broodstock and did not have significantly different ELISA values. The Rocky Reach and Rock Island Hatchery Committees agreed to cull part of the BY 2017 Chelan Falls summer Chinook salmon program to manage disease concerns. The progeny of hatchery females with ELISA values over 0.12 will be culled, approximately 35,000 eyed-eggs. Chelan PUD, WDFW, YN, CCT, USFWS, and NMFS agreed to this on January 17, 2018.

IV. Douglas PUD

A. Wells HCP Action Plan (Tom Kahler)

Tom Kahler shared a hard copy of the Draft 2018 Wells HCP Action Plan and said he will distribute a revised version for the committees to review soon. (Sarah Montgomery distributed the revised version on January 22, 2018; Attachment D.) Tracy Hillman asked Kahler to explain Douglas PUD’s Twisp spring Chinook egg-to-fry study. Kahler said Cramer Fish Sciences and WDFW performed a pilot study for 2 years in the Twisp River, and in 2017 used the same methodology, but with more redds per site. The hope was that the data from 2017 when combined with those from the pilot years would serve adequate for analysis and inference purposes. The inclusion of an additional study year in the 2018 Action Plan serves as a contingency in case we need another year of data. Kahler requested that representatives review the action plan and provide any comments to him, prior to approval at the Hatchery Committees February 21, 2018 meeting.

B. Hatcheries Update (Greg Mackey)

Greg Mackey said Douglas PUD hired Betsy Bamberger, Doctor of Veterinary Medicine, to support the Wells Hatchery and Methow Hatchery programs. Mackey said Bamberger started in early January and will focus on immediate fish health issues, long-term biosecurity plans, and analyzing fish culture environments that might relate to fish health issues.

Mackey said the contractual work on the Wells Fish Hatchery modernization will soon be complete, as few warranty and contractor items remain.

Mackey said National Pollutant Discharge Elimination System permits are in place for the Wells programs. He said Douglas PUD will need to obtain Hydraulic Project Approvals for the Methow Fish Hatchery volunteer trap.

C. Twisp Steelhead (Tom Kahler)

Tom Kahler shared the memorandum, "Management alternatives for Methow Basin conservation steelhead programs," which Sarah Montgomery distributed to the Hatchery Committees on January 12, 2018 (Attachment E). Kahler said the impetus for developing these alternatives is concern of a Ryman-Laikre effect occurring in the Twisp steelhead population. He said a subgroup has developed a draft proposal, including a preferred alternative, for the Twisp steelhead program.

Michael Humling (USFWS) said he and Charlie Snow (WDFW) developed the general points in the memorandum. He summarized the key pieces: alternative 3 (preferred alternative) aims to maintain local genetic structure in the Twisp River and does not change any release numbers in the Methow Basin for steelhead conservation programs. Specifically, alternative 3 proposes to 1) collect half of the current Twisp WxW broodstock program number in the Twisp River at the weir (approximately 6 to 8 pairs of known Twisp stock), 2) collect half the Twisp program WxW broodstock in the Methow River mainstem downstram of the Twisp River confluence (approximately 6 to 8 pairs of composite Methow stock that would include Twisp fish at approximately the proportion in the overall Methow population), and 3) collect the WNFH broodstock (WxW plus WNFH hatchery fish as needed) in the Methow River ranging throughout the length of the Methow mainstem. The releases would entail: 1) approximately 24,000 1S Twisp WxW progeny (raised at Wells Hatchery) and approximately 24,000 Methow composite WxW 2S progeny (raised at WNFH) released at Buttermilk Bridge in the Twisp River, and 2) approximately 24,000 Methow composite WxW 1S progeny (raised at Wells Hatchery) coupled with approximately 24,000 Methow composite WxW 2S progeny (raised at WNFH) released in the Methow Basin (not in the Twisp), location to be determined, and 3) release of the remainder of the WNFH 1S and/or 2S production at locations to be determined by the USFWS and co-managers, but not in the Twisp River. This program maintains the Twisp releases at 48,000 with the Twisp stock continuing to be represented as a separate stock with the addition of a composite mix of smolts representing the Methow Basin (many parents). This approach maintains the Twisp numbers while injecting genentic diversity by way of releasing progeny from many more parents collected outside the Twisp (the idea is to have representation from almost all parents at WNFH). The degree to which the Twisp and the Methow composite fish mix in the Twisp will be determined through natural selection, removing artificial compositing of the stocks. Alternative 3 also maintains Douglas PUD's conservation number at 48,000. The difference is that half of these fish will remain Twisp, while the other half become a Methow Composite program that is released elsewhere in the basin. Both Douglas releases of one year old smolts will be paired with two year old smolts from WNFH. The remainder of the WNFH releases will be managed by the USFWS and co-managers. Humling said this plan resembles the tactic agreed to in 2017. Matt Cooper said alternative 3 also includes juvenile releases higher in the basin. Greg Mackey said the Twisp River releases will be truck-planted at Buttermilk Bridge. Broodstock collection for alternative 3 includes angling and use of the Twisp Weir, and Methow and WNFH outfall channels.

Keely Murdoch asked how many pairs were targeted in the past for broodstock collection in the Twisp River. Mackey said 13 pairs. Mike Tonseth said the broodstock target could vary based on annual biological assumptions (e.g., fecundity, returns). Humling said the total broodstock collection target is 61 to 65 pairs collected mostly through angling, which would be transferred to Winthrop National Fish Hatchery for spawning. He said because fish are individually PIT-tagged during broodstock collection, known-Twisp-origin fish can be separated from other groups. After spawning, sufficient fish would be reared to maintain the 48,000 smolt release in the Twisp River, and 24,000 of those fish would be known-Twisp-origin, transferred to Wells Fish Hatchery. The Winthrop National Fish Hatchery program would be maintained at 100,000 to 200,000 fish per the *United States v. Oregon* agreement. Keely Murdoch said she is concerned that this alternative would release fewer conservation fish in the Methow Basin than previous plans. Tonseth said the number of fish targeted for removal at the Twisp weir under alternative 3 would be half as many as the current level, but each year an additional 6 to 8 pair would be collected by angling. Murdoch said that would still result in fewer combined pairs than if the program was collecting its full component at the Twisp weir. Tonseth said Douglas PUD is responsible for collecting additional fish per their permits in the Methow River with hook-and-line. Murdoch said extra fish cannot always be collected by hook-and-line and calling them "extra" is not accurate. Tonseth said compositing the programs is advantageous because natural-origin brood can be collected above and below the Twisp Confluence, allowing broodstock collection to be expanded spatially and temporally, likely resulting in more natural-origin brood collected, and higher proportion of natural origin broodstock (pNOB) over time.

Kirk Truscott asked who is responsible for the angling in the Methow Basin. Humling said USFWS, WDFW, and YN have performed the task in the past. Truscott suggested increasing the level of effort since more of the river will be fished for broodstock. Mackey said angling will occur in late winter and spring, and if a shortfall occurs, collections at the Twisp weir could be increased.

Murdoch said she is concerned about collecting fewer WxW broodstock under alternative 3 than what was implemented in 2017 with fully composited broodstock. She said alternative 3 appears to be lessening the number of broodstock. She said by increasing the geographic area where collection occurs in the Methow River, it is not certain that increased broodstock will be collected unless a commitment is also made to increase anglers or angler hours.

Tonseth said alternative 3 aims to avoid genetically mining the Twisp aggregate, which may have unique genetic traits. Alternative 3 provides an opportunity to address the diversity component of the recovery plan by not precluding subpopulation structure development. Murdoch asked if Todd Seamons (WDFW geneticist) has reviewed these alternatives. Tonseth said no, but he will coordinate with Seamons to review it. Hillman asked if Craig Busack (NMFS) has reviewed the composite approach recently. Tonseth recalled that Busack did not see a risk in compositing Methow steelhead, and Brett Farman agreed. Farman said he would coordinate with Busack to review this approach. Cooper added that alternative 3 is an opportunity to move portions of the Winthrop National Fish Hatchery program off-station to evaluate S1 and S2 releases to determine long-term benefits and results.

Tonseth said broodstock collection for 2018 needs to be decided soon. Truscott asked if broodstock for the Methow safety net program is collected at Wells Dam. Tonseth said yes, and those fish are differentially marked. Truscott said the 2018 broodstock collection identified in alternative 3 is 256 fish collected by hook-and-line in the Methow River. He asked how many broodstock were collected in previous years using this method. Tonseth said for the Winthrop National Fish Hatchery program, enough broodstock have been collected for the full 200,000 fish release with a pNOB of 0.7 or 0.8, and now, even more fish are available due to spawning channel studies being completed. Tonseth said he thinks there is a high probability of meeting the broodstock collection targets for alternative 3, and the Twisp weir can be used as a backup location if there is a shortfall (*note: this detail should be added to the plan*). Mackey said Douglas PUD will partcipate in the broodstock collection, increasing the overall effort. Murdoch asked how these changes will intersect with the kelt reconditioning program. Tonseth said he expects the kelt reconditioning activities will occur similarly to those in 2017.

Murdoch acknowledged that the Hatchery Committees need to develop a longer-term management plan and suggested selecting alternative 3 for implementation as a trial in 2018, then the committees can address needed changes in a final plan in 2019. She said there are additional contingencies and backup plans that will need to be included in a final management plan, but alternative 3 can be put into the protocols for 2018. Tonseth said he will add language to the draft 2018 Broodstock Collection Protocols about the 2019 broodstock collection methods pending the outcome of the spring collection efforts for the 2018 brood.

The Wells Hatchery Committee approved piloting Alternative 3 in the memorandum, "Management alternatives for Methow Basin conservation steelhead programs," for broodstock collection and management of the Twisp steelhead program in 2018, as follows: Douglas PUD, WDFW, USFWS, NMFS, YN, and CCT approved on January 17, 2018.

V. CCT

A. Chief Joseph Hatchery Update (Kirk Truscott)

Kirk Truscott said some of the summer/fall Chinook salmon brood being held at Chief Joseph Hatchery have Columnaris. He said there have been significant mortalities to natural-origin fish, more than hatchery-origin fish. He said there have been more mortalities to female than male fish, and the integrated natural-origin brood suffered about 50% mortality. He said the program will shifting from a subyearling component to a yearling component this year due to the losses—there will be no subyearling releases for this brood. He said Columnaris is a recurring issue at Chief Joseph Hatchery, perhaps due to groundwater temperatures. He said the well water in October was approximately 61°F. He said CCT are examining operational actions that could reduce stressors. Todd Pearsons said the Grant PUD programs have had issues with BKD. Truscott said the ELISA values were on par with previous years, so there is no immediate concern about BKD. He said the hatchery and fish health staff are working together to determine operational ways to decrease water temperatures and reduce stress on the fish.

Pearsons said the Wells summer Chinook salmon program also had a Columnaris issue this year. Greg Mackey agreed, and said it was not as bad as the Chief Joseph issue, likely due to lower water temperatures, approximately 54 degrees. Truscott mentioned that these are similar problems to 2015, when river temperatures were high. Mike Tonseth said in 2017, summer/fall Chinook salmon and steelhead were held up in the lower Columbia River due to a thermal barrier coming out of the Snake River, which may be contributing to the steelhead issue this year. He said he is not sure whether the thermal barrier would affect disease issues, but it did delay fish. Tracy Hillman asked if fish in the Snake River Basin are experiencing disease issues. Tonseth said yes. For example, the Tucannon program lost approximately 30% of their spring Chinook salmon broodstock due to BKD.

VI. Joint HCP-HC/PRCC HSC

A. NMFS Consultation Update (Brett Farman)

Brett Farman said Emi Kondo (NMFS) distributed the BiOp for the unlisted summer/fall Chinook salmon programs in the upper Columbia River after it was signed on December 26, 2017. He said permit approvals are still needed, but he does not know the permitting timeline.

Farman said Chuck Peven (NMFS) is working on the National Environmental Protection Act (NEPA) consultation for Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids).

Mike Tonseth noted that the Wenatchee steelhead permit was issued in late December 2017. Tracy Hillman suggested that permits and BiOps could be saved on the Extranet site for reference. Sarah Montgomery and Tonseth agreed to compile permits and BiOps and save them to the Extranet site.

B. USFWS Bull Trout Consultation Update (Matt Cooper)

Matt Cooper said Karl Halupka (USFWS) has no consultation updates for the Hatchery Committees because all section 7 consultations are complete with the submission of BiOps or letters of sufficiency. Todd Pearsons asked if the consultation pathway for the BiOp for the unlisted summer/fall Chinook salmon programs in the Columbia River was a letter of sufficiency. Cooper said yes.

Cooper asked if the Hatchery Committees would like any further updates from USFWS regarding consultation. Representatives present stated updates are not needed at this time.

Mike Tonseth noted that permits for the Methow steelhead program and for the unlisted summer/fall Chinook salmon programs are still pending.

C. Timelines of Changes in Programs (Tracy Hillman)

Tracy Hillman shared the most recent version of the timelines for program changes. He reviewed the different draft timelines. Specifically, regarding the Methow spring Chinook salmon timeline, more information is needed from Douglas PUD. The Wenatchee steelhead timeline also needs more details. The Entiat steelhead timeline may need additional details regarding state releases, which Mike Tonseth will look into. The Methow steelhead and summer Chinook salmon timelines also need more information. Hillman said the next steps are incorporating more details provided by representatives, making tables with this same information, and then deciding the statistical break periods for each program. Kirk Truscott suggested adding a timeline for sockeye salmon in the Okanogan River. Hillman replied that he would need to consult with his funding sources before moving ahead with an additional timeline. Representatives present said they would continue providing input to Hillman for the timelines.

VII. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are on February 21, 2018 (Grant PUD), March 12, 2018 (Grant PUD), and April 18, 2018 (tentatively planned for Wells Fish Hatchery).

VIII. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft SOA Regarding District's Coho Obligation
Attachment C	Draft 2018 Rock Island and Rocky Reach HCP Action Plan
Attachment D	Draft 2018 Wells HCP Action Plan
Attachment E	Management alternatives for Methow Basin conservation steelhead programs

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Alene Underwood†	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel†‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Chris Moran†	Washington Department of Fish and Wildlife
Charlie Snow†	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Michael Humling	U.S. Fish and Wildlife Service
Brett Farman*†	National Marine Fisheries Service
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Rocky Reach and Rock Island HCP Hatchery Committees
DRAFT Statement of Agreement
Regarding Chelan PUD's Coho Salmon Obligation
January 17, 2018

Statement

On November 15, 2017, the Rocky Reach and Rock Island HCP Hatchery Committees (hereafter "Committees") agreed to the methodology used to calculate Chelan PUD's coho salmon obligation. In order to meet this obligation, Chelan PUD and the Yakama Nation intend to enter into an agreement where Chelan PUD will provide funding for the Mid-Columbia Coho Salmon Reintroduction Project (facility use may be included as part of the agreement). As long as Chelan PUD is meeting the terms of the agreement with the Yakama Nation, and remains consistent with any future recalculated hatchery compensation obligations, the Committees agree that Chelan PUD is fulfilling its coho salmon hatchery obligation for the term of the Rocky Reach and Rock Island Habitat Conservation Plans.

2018 Rocky Reach and Rock Island
HCP Action Plan - Draft

COORDINATING COMMITTEE

Activity	Jan 2018–Dec 2018
Deliver 2017 RR Bypass Evaluation Report	D (Feb 1) — F (Mar 15)
Deliver 2018 RR Bypass Operations Plan	D (Feb 1) — F (Mar 31)
Deliver 2017 RI Bypass Evaluation Report	D (Feb 1) — F (Mar 31)
Deliver 2018 RI Bypass Operations Plan	D (Feb 1) — F (Mar 15)
Update HCP CC on RR Large Unit Repairs	
Update HCP CC on RI PH1 B1-B4 Unit Repairs	
Pikeminnow long-line control programs	S (Feb 1) — C (Nov 30)
Pikeminnow angling control programs	S (May 1) — C (Oct 15)
Avian Predation programs	S (Apr 1) — C (Aug 31)
Piscivorous Bird Monitoring	S (Apr 1) — C (Dec 31)
Deliver 2018 RR/RI Spill Plan	D (Mar 1) — F (Apr 1)
Deliver 2018 RR/RI Spill Report	D (Sep 15) — F (Oct 15)
RR 9% Summer Spill	S (Jun 1) — C (Aug 15)
RI 10% Spring Spill	S (Apr 15) — C (Aug 15)
RI 20% Summer Spill	S (Jun 1) — C (Aug 15)
RR Juvenile Fish Bypass Operations	S (Apr 1) — C (Aug 31)
RI Juvenile Bypass Trap Operations	S (Apr 1) — C (Aug 31)
2017 HCP Annual Report	D (Mar 1) — F (Apr 1)

HATCHERY COMMITTEE

Activity	Jan 2018–Dec 2018
2017 Hatchery M & E Report	D (Jun 15) — F (Sep 1)
2019 Hatchery M & E work plans	D (Aug 1) — F (Oct 1)
Dryden Water Quality Monitoring (Year 7)	S (Mar 1) — C (May 1)
Coho NNI Mitigation SOA	D (Jan 1) — F (Jan 31)
Chelan Falls Canal Trap Engineering Feasibility	S (Feb 1) — C (Sep 1)
Chelan Hatchery Rehabilitation Engineering Feasibility	S (Jan 1)
Chiwawa Weir Maintenance Engineering Feasibility	S (Feb 1)
Eastbank Well Generator Installation	S (May 15) — C (Nov 30)
Pilot Outplant adult MetComp spr Chinook to Chewuch	S (Aug 15) — C (Sep 30)
Steelhead Residualism Plan - *Permit No. 18583*	D (Jan 1) — F (Sep 1)
Hatchery Program Broodstock Collection	S (May 1) — C (Dec 15)
Hatchery Releases	S (Apr 15) — C (May 1)
Receive Unlisted Permit (Wenatchee and Chelan Falls summer Chinook)	S (Jan 15) — C (Sep 1)

TRIBUTARY COMMITTEE

Activity	Jan 2018–Dec 2018
RR and RI Plan Species Account Annual Deposit	C (Jan 31)
General Salmon Fund Approval	→ Ongoing
General Salmon Fund Implementation	→ Ongoing
Small Project Review and Approval	→ Ongoing
Small Project Implementation	→ Ongoing

D = Draft Document
F = Final Document

S = Start Project
C = Complete Project

DRAFT 2018 ACTION PLAN
WELLS HCP

WELLS HCP COORDINATING COMMITTEE

1. Juvenile Fish Bypass
   a. Gas Abatement Plan (GAP) and Bypass Operating Plan (BOP) to CC...... 17 January 2018
   b. CC comments on GAP/BOP to DCPUD .... 12 February 2018
   c. CC approval of GAP/BOP .... 21 February 2018
   d. Submit final GAP/BOP to FERC for approval .... 28 February 2018
   e. 2018 Bypass operations at Wells ....9 April 2018 – 19 August 2018

2. Annual Monitoring of Juvenile Migration Run Timing
   a. 2018 draft passage-dates analysis and post-season bypass report to CC.........October 2018
   b. CC approval of 2018 final report ....November 2018

3. Fishway Outage Schedule for Fishway Inspection, Maintenance, and Fishway Projects
   a. West Fishway..27 December 2017 – 18 January 2018
   b. East Fishway ....29 January – 15 February 2018
   c. Adult Fishway Trap Coordination Meeting .... April 2018

4. Multi-Year Sub-yearling Chinook Life-history Study
   a. Draft juvenile life-history report to CC .... April 2018
   b. Final juvenile life-history report ....July 2018

5. Review and Approval of 2018 Hatchery Broodstock Collection Protocol
   a. Draft protocol to CC for review... 16 February 2018
   b. CC approval of draft protocol .... 27 March 2018
   c. Deadline for submission of protocol to NMFS .... 13 April 2018

6. Pikeminnow Control Program
   a. Draft 2017 pikeminnow report to HCP CC .... April 2018
   b. Final 2017 pikeminnow report..June 2018
   c. 2018 Pikeminnow removal – Wells Project................................. March – November 2018

7. Avian Protection Plan
   a. Bird Wire Inspection and Replacement .... February 2018
   b. Bird Hazing...April – August 2018

8. 2020 Survival Verification Study
   a. Select study species... February 2018
   b. Study Plan to HCP CC... April 2018
   c. CC approval of Study Plan .... June 2018
   d. Collect Brood Stock for 2020 SVS 2018

9. HCP Annual Report

a. Draft 2017 annual report to DCPUD for review.. 11 January 2018
b. Draft 2017 annual report to CC for 30-day review..................................... 7 February 2018
c. CC comments on draft 2017 report due to Anchor QEA................................ 7 March 2018
d. Final 2017 annual report to DCPUD .... 22 March 2018
e. Final 2017 annual report due to FERC .... 30 March 2018

WELLS HCP HATCHERY COMMITTEE

1. Implement 5-year Hatchery Monitoring and Evaluation (M&E) Plan

a. Ongoing implementation .... January – December 2018
b. Draft annual report for 2017 to Douglas PUD .... June 2018
c. Draft annual report to Hatchery Committee (HC) .... August 2018
d. Final annual report to HC .... September 2018
e. Draft 2019 implementation plan to HC .... July 2018
f. HC approval of final 2019 implementation plan .... October 2018

2. Assessment of Precocial Maturation

a. Methow Hatchery spring Chinook lethal sampling .... March 2018
b. Wells steelhead visual assessment .... April 2018

3. Twisp Population Study

c. Implementation .... September – October 2018
d. 2014, 2015, 2016, 2017 Reports .... May 2018

4. Twisp Spring Chinook Egg-to-Fry Study

a. Implement study............ January – June 2018
b. Draft report............ July 2018
c. Year-2 implementation (if necessary)............ August 2018 – June 2019

5. 2018 Broodstock Collection Protocol

a. Draft to HC for review............ 9 February 2018
b. HC approval of draft protocols .... 21 March 2018
c. CC approval of Wells Dam trapping operations............ 27 March 2018
d. Deadline for submission to NMFS .... 13 April 2018

6. Annual Implementation – Okanagan Sockeye Fish/Water Management Tools

a. Water Year 2017-2018............ October 2017 – September 2018

7. Modernization of the Okanagan Sockeye Fish/Water Management Tools

a. Phase 3 (Final) .... July 2017 – October 2018

8. Methow Steelhead Relative Reproductive Success Study

a. Implementation .... March 2010 – December 2021
b. Annual report on genetic analysis............ September/October 2018
c. Biological data in Annual M&E Report (above) .... September 2018
d. Final report............ 2021/2022

9. Hatchery Genetic Management Plans

a. Receive new Wells steelhead hatchery permit............ *to be determined, 2018*
b. Receive new Wells summer Chinook hatchery permit............ *to be determined, 2018*

10. Wells Hatchery Modernization

a. Complete construction punch-list .... June 2018
b. Warranty items .... June 2018-June 2019
c. As-Record Drawings .... June 2018
d. Operations Manual .... July 2018
e. Emergency Procedures Document .... December 2018
f. Groundwater Optimization Program .... December 2018

11. Coho Hatchery Program

a. Collect broodstock .... September/October 2018
b. Incubate/rear at Wells Hatchery .... November 2018 – March 2019
c. Divide Twisp Acclimation Pond to accommodate coho .... Fall 2018

12. Chief Joseph Hatchery Production

a. Fund hatchery production (spring/summer Chinook) 2018
b. Fund monitoring and evaluation 2018

13. Hatchery Biosecurity Program

a. Wells Hatchery .... April 2018
b. Methow Hatchery .... April 2018
c. Carlton Acclimation Pond .... April 2018

14. Methow Hatchery

a. Operations Manual .... July 2018
b. Methow Outfall Trap Modification .... June 2018
c. Emergency Procedures Document .... December 2018
d. Groundwater Optimization Program .... December 2018

WELLS HCP TRIBUTARY COMMITTEE

1. **Plan Species Account Annual Contribution**
   a. $176,178 in 1998 dollars ($275,968.08 in 2018 dollars) .... 15 January 2018

2. **Annual Report - Plan Species Account Status**
   a. Submittal of 2017 account-status report to Tributary Committee (TC): .... 22 January 2018
   b. Integration into 2017 HCP Annual Report: .... February 2018

3. **General Salmon Habitat Program**
   a. Project review and funding .... January-December 2018

4. **Small Project Program**
   a. Project review and funding Decision .... January-December 2018

MEMORANDUM

TO: **Wells HCP HC**

FROM: **Methow Subbasin Steelhead Small Working Group**

DATE: **DRAFT Jan 10 2018**

RE: **Management alternatives for Methow Basin conservation steelhead programs.**

INTRODUCTION

The objective of this memo is to provide background, illustrate consideration of several feasible alternatives for mitigating genetic concerns specifically in the Twisp Conservation program, and describe our preferred alternative for future implementation (2018 and beyond) for Methow Subbasin conservation steelhead programs (Twisp and Winthrop NFH). Direction herein is general with seasonal/run-specific technical details to be worked out annually between operators and formalized through broodstock collection protocols and steelhead-specific management plans. Our intent for this memo is to serve as a vehicle for the Hatchery Committee to approve this direction by vote.

Our preferred alternative (Alternative 3) attempts to balance genetic concerns associated with small population/program size against attaining terms & conditions in the recent Biological Opinion (NOAA 2017; hereafter, “BiOp”), while meeting mitigation requirements. No proposed modifications to program size or release numbers are proposed – only modification of rearing strategies and parentage.

BACKGROUND

Hatcheries are commonly used to mitigate for lost fish production, provide for harvest, and rebuild depressed stocks. However, they can have unintended negative effects on natural populations including reduced fitness (Christie et al. 2014), increased competition (Einum and Fleming 2001), and a reduction in the effective population size (N_e) of the naturally-spawning cohort (Ryman and Laikre 1991). Managers should consider and mitigate these negative effects to reduce probability of unintended harm to natural populations, particularly for those programs intended to support recovery of depressed populations (i.e., conservation programs).

Genetic analysis of returning adult steelhead at the Twisp River weir indicated that relatedness among the returning hatchery origin adults was high (T. Seamons, WDFW Genetics Lab, pers. comm.). This is not surprising given the small program size (**Table 1**), and may result in a reduction in genetic diversity and N_e, consistent with effects described in Ryman and Laikre (1991), hereafter “Ryman-Laikre” or “RL” effects.

Recent environmental conditions consistent with strong PDO and anomalously warm sea surface conditions (i.e., “the Blob”) likely exacerbated above concerns by disproportionately affecting juvenile cohort survival and subsequent representation on the spawning grounds as these cohorts return to spawn. Peterson et al. (2014, 2015, and 2016) have suggested that generally poor conditions have reduced survival for juvenile salmonids entering the ocean between 2014 through as late as 2016. Consistent with these observed ocean conditions, abundance of returning steelhead adults in summer 2016 was the lowest seen since 1998 at Bonneville Dam (www.fpc.org).

Substantially reduced survival of specific migrant cohorts resulted in a 2017 spawning escapement that was extremely "lopsided", highly biased towards 2-salt adults with poor representation of 1-salt adults (93% 2-salt: 7% 1-salt; Winthrop NFH broodstock collection sampling). PIT data from returning adults at Bonneville Dam in summer 2017 suggest the 2018 spawning escapement will again be lopsided, this time dominated by 1-salt fish with very low 2-salt representation. These types of cohort failure events can reduce the number and diversity of contributing parents (including related effects to N_e) and increase spawner relatedness as recruits return from a small number of parents.

In response to the aforementioned concerns, the HCP-HC and co-managers adopted a 1-year strategy for 2017 to address suspected RL effects in the Twisp population. Mitigating actions were selected with goals to increase genetic diversity, reduce risk of inbreeding on the spawning grounds, and increase N_e. Actions included release of about 11,000 WNFH conservation program juveniles (BY'2015 age-2 smolts) into the Twisp River and compositing of the Twisp and WNFH conservation program broodstock. This strategy will affect the Twisp steelhead spawning aggregate when released juveniles return as adults and spawn primarily from 2019-2021 (**Table 3**). Specifically, returning spawners will originate from a greater number of less-related parents compared to the resulting return had 2017 actions not been taken.

To continue to mitigate above-noted concerns beyond 2017, the Wells HCP HC directed a workgroup (DPUD, USFWS, WDFW) to develop management alternatives for the Twisp and WNFH steelhead conservation hatchery programs (Action Item I-A from the 15 November, 2017 HC meeting).

Current Hatchery Programs

Two conservation programs and one safety-net program annually supplement the Methow Subbasin with up to 348,000 hatchery steelhead smolt under full program production levels (**Table 1**).

Table 1. Current Methow Subbasin steelhead hatchery programs.

Program	Hatchery	Funding entity	Release site	Release goal	Broodstock	Genetic crosses	Age at release
WNFH Conservation	WNFH	Reclamation	Methow R.	200,000	110[1]	WxW	2
Twisp Conservation	Wells	Douglas PUD	Twisp R.	48,000	26	WxW	1
Methow Safety-net	Wells		Methow R.	100,000	68[2]	HxH	1
Total				348,000	204		

[1]WNFH program targets pNOB=1 broodstock as feasible but is permitted under its Biological Opinion for a sliding scale that meets mitigation objectives (minimum 100K) and scales up to 200K smolt release subject to meeting increasing pNOB goals consistent with run strength.

[2]Conservation program returns are prioritized for use as Methow Safety-net broodstock according to “Stepping Stone” model.

General Genetic Management in Conservation Programs

Management of genetic effects associated with Methow Subbasin hatchery programs can occur at five primary stages; 1) broodstock collection (composition of broodstock, collection dates, etc.), 2) spawning (mating scheme, fitness, epigenetic effects), 3) rearing affects (artificial selection and epigenetic effects), 4) juvenile release strategies (timing, location, age at releases, origin of release groups), and 5) through adult management (e.g. removing hatchery origin adults to affect pHOS). Management actions associated with returning adults (i.e., spawning ground geneflow metrics) are covered extensively in the recently completed BiOp (NMFS 2017). Thus, our objective in this document is to focus on management alternatives regarding the adult collection, spawning, and release of juveniles, within sideboards established in the BiOp.

Conservation hatchery programs should seek to remain as neutral as possible in terms of artificial selection. However, conservation hatchery programs face competing concerns. On one hand, the hatchery program should attempt to maintain relatively high effective population size to avoid in-breeding and loss of genetic diversity. This may be accomplished by incorporating more individuals from another population(s) or spawning aggregate. However, artificial outbreeding strategies (for a small population at risk of losing genetic diversity) may counter the local adaptation natural selection process. Therefore, increasing effective population size may reduce the probability of local adaptation occurring while maintaining a small effective population size to promote local adaptation may result in unacceptably low effective population size. Of primary concern is the Twisp conservation program which requires a relatively low number of broodstock and thus is at relatively high risk from negative genetic effects (Ryman and Laikre 1991).

MANAGEMENT ALTERNATIVES CONSIDERED

Actions discussed by the workgroup considered both the DPUD steelhead program and the USFWS steelhead program and were restricted to those actions that could occur within sideboards established by existing management guidance, specifically the 2017 BiOp, HCP, and US v OR management agreement. Broodstock collection protocols (BCPs) developed annually for HCP-governed programs (e.g., Tonseth 2017) specify basic collection and spawning procedures required to comply with permit conditions (e.g., extraction rates, M:F ratios, etc.), and to follow generally accepted practices to maximize genetic diversity with hatchery broodstocks (e.g., 2x2 factorial mating). Heretofore, federal Upper Columbia programs have not been guided by these protocols; however, US Fish & Wildlife Service recognizes that these programs, particularly those for which a stepping stone model has been applied, are highly intertwined and cannot be implemented without coordination across programs/operators. As such, the WNFH steelhead program has been generally described in recent BCPs.

We collectively considered the following alternatives and propose Alternative 3 as the preferred alternative.

<u>Alternative 1: Co-managed Conservation Program, Broodstock Compositing, and Split-Broodyear Release Strategy for Twisp sub-component.</u>

Alternative 1 is continued application of the 2017 strategy. Under this alternative, broodstock collection and spawning for both conservation programs would be fully composited. The Twisp release component would continue to exist as a sub-component of a composited Methow Steelhead Conservation program. The total annual smolt release targets for the conservation programs would remain 48,000 in the Twisp (DPUD) and up to 200,000 in the Methow (USFWS), but the broodstock for both release groups would be composited as opposed to maintaining the Twisp as a separate Twisp-only broodstock. The 48,000 Twisp release number is consistent with the average annual escapement proportion of the Twisp Watershed, which comprises approximately 20% of the Methow Subbasin.

Broodstock would be collected via angling, the Twisp River weir, and at all pertinent hatchery infrastructure (MFH trap, WNFH ladder/traps and Spring Creek weir). All broodstock would be held and spawned at WNFH as a single population. At approximately the eyed egg stage, a representative portion of all families to target total 24,000 smolt release would be transferred to Wells Hatchery for rearing to the age-1 (S1) smolt stage, then released into the Twisp River at the Buttermilk Bridge (Rkm 21). A portion (to target 24,000 smolts) of remaining production at WNFH would be reared and released as age-2 (S2) smolts in the Twisp River, also at Buttermilk Bridge. As such, release total to the Twisp River would remain unchanged but consist of a 50/50 mix of S1/S2 rearing strategies (different broodyears and more broadly unrelated parents).

Allocation to Twisp/non-Twisp would be consistent with WDFW spawning escapement estimates:

- Approximately 20% Twisp release/80% non-Twisp release
- Broodstock collection would target the same distribution
    - Twisp - 20%; 26 adults; 13x4000=52K for 48K smolt release
        - 24K WNFH S2; 24K Wells S1
    - Non-Twisp – 80%; 92 adults; 46x4000=184K for 176K smolt release
    - Broodstock production would be guided by the 2017 BiOp pNOB sliding scale approach.

Discussion

This composited strategy would provide the following benefits:

- Common broodstock collection would likely allow for higher average pNOB annually through expanded broodstock collection options/timeframes.
    - A likely increase in effective pHOS management through increased removal af adult hatchey steelhead during hook and line broodstock collection, particularly lower in the river

- N_e increase for broodstock and on spawning grounds due to larger, merged conservation program - particular benefit to geneflow in the Twisp Watershed.
  - N_e of each hatchery brood is larger
  - Adult returns would include three cohorts (1.1, 1.2 and 2.1 [same broodyear], and 2.2) instead of two (1.1 and 1.2).
- Reduced potential spawner relatedness (in broodstock and on spawning grounds) via above-mentioned mechanisms.

WNFH production is currently an approximate maximum of 200,000 S2 steelhead. Collective conservation program broodstock collection targets would increase slightly to total approximately 118 adults. Consequently, the 24,000 Twisp component would need to become part of WNFH's rearing responsibility. Douglas PUD would need to adjust its rearing program to compensate or transfer an additional 24,000 to the Methow Safety-net or other appropriate program.

This alternative was employed in spring 2017, so logistics of broodstock collection, sampling, spawning, and fish transfer have been worked out between the hatchery facilities. The juvenile steelhead currently being reared at Wells Hatchery for release into the Twisp River in 2018 (BY'2017 S1) are the result of the broodstock composite and transfer scenario described above. **Table 3**, under the discussion of Alternative 3, illustrates the effects, as measured by age composition on the spawning grounds, of status quo, single-year application (i.e., 2017 strategy), and continued application of a strategy similar to 2017 into the future.

This scenario is beneficial primarily to the Twisp program, because it strategically increases N_e of the broodstock through expanded parentage consisting of less-related parents (**Table 3**). Reciprocal benefit to the WNFH component may be minimal. The potential downside of this alternative would be that local stock structure, to the extent it exists or is developing, would be sacrificed or delayed. Previous genetic evaluations have not identified genetic stock separation within Methow Sub-basin tributary steelhead populations (Snow et al. 2009), suggesting that decreasing negative genetic effects from low N_e in the hatchery broodstock probably outweighs concerns about diluting the genetic uniqueness of the Twisp spawning population. However, differentiation for traits that are under selection is unknown.

<u>Alternative 2: Similar approach to Alternative 1 with Wells S1 supplementation outside (in addition to) the Twisp Watershed.</u>

Alternative 2 would apply the 2017 strategy (i.e., Alt. 1) including composited broodstock collection and spawning and transfer of sufficient eyed eggs to Wells Hatchery for ***48,000*** yearling release annually. Of these, 24,000 smolts would be released in the Twisp River while the remaining 24,000 smolts would be returned to WNFH for on-station or alternative release locations in the subbasin to provide some of the benefits of multi-brood year release in supplemented areas outside the Twisp Watershed.

Following evaluation of their performance and ongoing geneflow metrics on the spawning grounds, S1 releases from WNFH (24K group reared at and transferred from Wells Hatchery) may be allocated to additional release strategies (as guided and recommended by the JFP) including off-site juvenile releases subject to geneflow guidelines and escapement manipulation within BiOp terms and conditions. For example, regularly under-escaped areas may benefit from direct supplementation through point releases. Any offsite supplementation would consider inter-annual pHOS/PNI trends and, in particular, escapement conditions from the previous two spawning escapements (i.e., those migration cohorts being supplemented).

Discussion (Alt. 2)

Alternative 2 would provide all of the multi-broodyear benefits to N_e, potential spawner relatedness (in hatchery brood and on spawning grounds), and for program goal achievement. No change in the size of conservation and safety net program sizes would be necessary for DPUD. Alt. 2 would require additional coordination to select areas for offsite supplementation. In reality, depending on trends in geneflow metrics on the spawning grounds, implementation of Alt 2. may closely resemble Alt. 1, with the exception of a small release group of S1 smolts at WNFH. However, we suspect that geneflow (PNI/pHOS) targets will be difficult to achieve and it may not be feasible to conduct offsite supplementation without jeopardizing permit conditions.

Alternative 3 (Preferred): Hybrid approach between Alternatives 1 and 2 that aims to retain Twisp genetics within the Twisp basin but includes incorporation of non-Twisp conservation program genetics.

Alternative 3 was developed based on the group’s desire to protect any remaining or developingTwisp genetic stock structure while balancing and mitigating for genetic concerns by managing N_e and potential spawner relatedness concerns. It incorporates parts of Alternatives 1 and 2. **The major point by which Alt. 3 differs is that a small Twisp x Twisp broodstock would continue to be operated instead of full compositing.** No overall changes to current production and release levels would occur. Approximately six Twisp x Twisp crosses would produce approximately 24K smolts for release back to the Twisp River. Annual Twisp releases would also include a 24K co-release of S2 smolts from the WNFH conservation program, allowing for unrelated returning adults to provide an increased level of genetic diversity into the Twisp to combat low N_e and reduce risk of inbreeding. This strategy would also provide an evaluative opportunity where potential Twisp stock performance could be evaluated against WNFH conservation program WxW smolts, providing management guidance for continued future direction.

Implementation details for Alternative 3 follow:

Broodstock Collection

- Combined broodstock collection (joint DPUD/WDFW & USFWS effort)
    - Collection occurs throughout Methow, including below-Twisp River

        - Angling, Twisp Weir, and WNFH/MFH hatchery infrastructure
    - Broodstock Targets
        - approximately 6-8* pairs NORs collected at Twisp Weir (half of Twisp program)
        - approximately 61-65* NOR pairs (WNFH program plus half of Twisp program) collected throughout the Methow River via angling
        - *Flexibility required in targets for variation in escapement, fecundity, inclusion of hatchery-origin brood (as per BiOp), etc.
    - All broodstock transferred to WNFH for holding and spawning
        - DPUD may collect up to 37 pairs of conservation program returns (Ad+CWT and CWT-only) at Wells Dam and/or via angling and direct-transfer to Wells Hatchery for use in safety-net program
    - Data management for broodstock collection and spawning will be primary responsibility of USFWS MCFWCO (all data would be shared with WDFW and DPUD to allow completion of HCP-HC related reports):
        - All broodstock uniquely PIT-tagged upon capture/transfer for assignment on spawn days
        - PIT data tied to collection date/location, mark, DNA samples
        - USFWS will provide standardized <u>effort</u> collection information to all angling participants
    - Adult management will continue to be a large part of broodstock collection efforts
        - Guided by terms and conditions for minimum escapement, pNOB, and mitigation requirements in BiOp
        - Supported generally in annual broodstock collection protocols (e.g. Tonseth 2017)
        - Supported specifically by annual FMEP and targets/goals established by small Methow Steelhead Working Group

Spawning

- All conservation program spawning will occur at WNFH
    - Spawning will be 2x2 factorial crosses
    - Half of Twisp program will be Twisp weir collected NOR x Twisp weir collected NOR as feasible
    - WNFH program and remaining half of Twisp program will be Methow Subbasin NOR x NOR as feasible
    - All NOR females will be live-spawned & transferred to YN Kelt Program
    - USFWS MCFWCO will collect and provide all spawning biological and cross data to WDFW M&E staff.

Gamete Management & Smolt Release

- Maintain 48K total smolt release in Twisp River
    - 24K would be known-Twisp NOR x NOR spawned at WNFH but sent to Wells for S1 rearing
    - 24K would be representative cross-section of WNFH component, reared as S2 smolts at WNFH

- All releases would be direct smolt plants at Buttermilk Bridge (RKm 21)

- Maintain 100K-200K total conservation program smolt release to Methow Sub-basin outside Twisp
    - 24K cross-section of WNFH population will be transferred to Wells Hatchery for S1 rearing for WNFH on-station or alternative release sites in Methow Subbasin.
    - 24K cross-section of WNFH population will be reared as S2 on-station as paired release for 24K S1 group (above) for potential alternative release strategies, as per above. Any alternative release strategies will also consider need for gradual implementation and patience in awaiting environmental response to management changes.
    - Remaining 76-176K of WNFH population will be reared as S2 smolts for on-station release.

Table 2. Methow Subbasin steelhead hatchery programs under Alternative 3 (for comparison to Table 1, above).

Program	Rearing Hatchery	Funding entity	Release site	Release goal	Broodstock	Genetic crosses	Age at release
Methow Subbasin Conservation	WNFH	Reclamation	Methow R. @ WNFH	48-148K[1]	60-65	WxW	2
			Methow Subbasin[2]	24,000			2
	Wells	DPUD		24,000			1
Twisp Conservation	Wells	DPUD	Twisp R. @ Buttermilk Br	24,000	6-8	WxW	1
	WNFH	Reclamation		24,000	6-8	WxW	2
Methow Safety-net	Wells	DPUD	Methow R.[3]	100,000	68[2]	HxH	1
Total				348,000			

[1]WNFH program subject to pNOB/production sliding scale in BiOp.
[2]Initially Methow R. at WNFH but may include alternative offsite release strategies subject to JFP and HCP- HC guidance and BiOp terms and conditions. Would be paired S1 and S2 release.
[3]Methow Safety-net program released in Methow River at Lower Burma Bridge.

Discussion (Alt. 3)

Alternative 3 was selected as it appears to provide the best compromise between benefits described for Alternatives 1 and 2 while also including measures to address the Spatial Structure and Diversity VSPs, by attempting to maintain (or allow) development of local stock structure in the Twisp Watershed. In addition, Alternative 3 provides a higher probability of finding an effective conservation hatchery strategy for the Twisp River, and elsewhere in the Methow Basin because it uses three conservation hatchery strategies: 1) local WxW Twisp Program, 2) Methow Composite S1 program, and 3) Methow Composite S2 program.

Table 3. Illustration of out-year effects of 2017 actions and proposed Alternative 3 on Twisp River spawning ground age/program composition.

Spawn/ Escapement Yr.	Age/Program composition of spawners (HOR only) on spawning grounds - Twisp Watershed only		
	Status Quo - S1 smolt supplementation only (all fish are Twisp Program only)	Additional spawners resulting from 2017-only, single-year Alt. mgmt. (juvenile release & brood compositing)	Spawner composition resulting from 2017 actions plus implementation of Alt. 3
2014	BY'10 1.2, BY'11 1.1	N/A	N/A
2015	BY'11 1.2, BY'12 1.1	N/A	N/A
2016	BY'12 1.2, BY'13 1.1	N/A	N/A
2017	BY'13 1.2, BY'14 1.1	N/A	N/A
2018	BY'14 1.2, BY'15 1.1	N/A	N/A
2019	BY'15 1.2, BY'16 1.1	BY'15 2.1 (WNFH)	BY'15 2.1 (WNFH)
2020	BY'16 1.2	BY'15 2.2 (WNFH), BY'17 1.1 (Met[1])	BY'15 2.2 & BY'16 2.1 (WNFH), BY'17 1.1 (Met+Twisp[1])
2021	*BY'18 1.1[2]*	BY'17 1.2 (Met[1])	BY'16 2.2 (WNFH) BY'17 2.1, BY'18 1.1 (Met+Twisp[1])
2022	*BY'18 1.2, BY'19 1.1[2]*	N/A	BY'17 2.2, BY'18 1.2 & 2.1, BY'19 1.1 (Met+Twisp[1])
2023	*BY'19 1.2, BY'20 1.1[2]*	N/A	BY'18 2.2, BY'19 1.2 & 2.1, BY'20 1.1 (Met+Twisp[1])
2024	*BY'20 1.2, BY'21 1.1[2]*	N/A	BY'19 2.2, BY'20 1.2 & 2.1, BY'21 1.1 (Met+Twisp[1])

[1]Combined Methow Subbasin Conservation Programs (yearlings raised at Wells Hatchery, 2-year smolts raised at WNFH).
[2]No BY'17 Twisp Program was developed; brood were composited. This column displays return composition if status quo were to return in 2018.

Alternative 4: Return to Independent Operation of Discrete Twisp and WNFH Conservation Programs (Local Stock Structure Approach).

Alternative 4 is the return to pre-2017 independent operation of separate Twisp and WNFH conservation programs. Broodstock collection efforts would return to previous operations where WNFH efforts are restricted to areas above Twisp River and recoveries from Twisp Weir provide all broodstock for Twisp releases. Adult brood transfers between programs would be minimal (known Twisp PITs intercepted by USFWS would be transferred to DPUD and Ad+CWT adults collected in the Twisp would be transferred from Twisp Weir to WNFH). Juvenile releases would return to traditional locations (WNFH and Twisp), with S2 and S1 rearing strategies, respectively.

Discussion

Alternative 4 would provide the best protection of any existing local stock structure in the Twisp Watershed, if present. The Working Group noted this as an important concern in these discussions; however it is noted that only until very recently (2010) steelhead management in the Twisp Watershed had been composited, and in fact, prior steelhead supplementation in the Methow Subbasin included incorporation of natural-origin broodstock from Wells Dam likely including a broad range of Upper Columbia and

Snake River tributary genetics. Still, it was agreed that future management should not preclude development or maintenance of local stock structure.

The return-to-status quo alternative would provide simplicity as both programs have operated in this manner for a number of years. It would require acceptance of the risks of RL and related concerns associated with small program size in the Twisp Watershed. Ancillary benefits of more collaborative alternatives would be absent, such as potential higher brood pNOB overall (and consequently PNI in returning spawner escapements) and opportunistic pHOS manipulation through spatially/temporally-expanded broodstock collection would be missed.

It is noted that return to the status quo (i.e. not compositing the programs) would not necessarily exclude additional measures that may combat RL and related concerns (see following section).

<u>Mitigating Measures Common to or Applicable to Any Option</u>

There are a number of measures that may be employed concurrent with or within most of these management alternatives) to mitigate genetic risks. These measures are shown below to stimulate discussion but should not be considered standalone proposals:

A. Develop hybrid/adaptive approach that could be employed under which pre-season run assessment could drive a decision point:
    1) "Low escapement strategy" in years when escapement suggests risk of RL or other N_e concerns, managers shift to composite strategy.
    2) "High escapement strategy" in years when escapement is more robust, management switches to strategy that promotes and supports continued development of local stock structure.
    3) The above two strategies could be merged into a single sliding scale approach, complimentary to DPUD and USFWS HGMP geneflow approaches; under low escapement scenarios, the focus would remain on $N_{e,}$ maximizing genetic diversity, and minimizing inbreeding. As run strength/diversity increased, management would shift towards pHOS/PNI management and could support stock structure as deemed appropriate.
B. Measures that are complimentary and could be employed under either management pathway:
    1) Use of early rearing size-grading to split broodyear production into S1 and S2 release components. This strategy may use intra-cohort variability in growth/life-history "programming" to hedge bets by splitting broodyears across two release years. The tactic may provide a biologically-sound mechanism for splitting a cohort. WNFH is planning a pilot study in 2018 to assess this feasibility. This may be a viable nuance to Alts. 1 & 2 in the future.

2) Direct pre-spawn measure of relatedness at hatcheries could be assessed with more strategic crossings on spawn days to maximize N_e/family numbers and reduce/eliminate spawning of siblings.
3) Adult out-planting – with accompanying evaluation to assess whether this could be effective at manipulating localize pHOS/PNI.

Monitoring & Evaluation and Collaborative BiOP Implementation

- M&E tasks and BiOp implementation will continue to require increasing collaboration and information sharing between WDFW, DPUD, and USFWS M&E staff/programs. Discussions around annual steelhead implementation planning are ongoing and describe a need for integration of BiOp guidance, annual broodstock protocols, and developing annual management plans to describe program targets (fishery goals, broodstock collection, adult management and information sharing).
- M&E will continue to focus on straying, residualism, and geneflow on the spawning grounds as described in BiOp and other management guidance.
- M&E will focus on comparison of Twisp NOR x NOR S1 smolts vs WNFH (Methow) NOR x NOR S2, intended for Twisp River.
- M&E will focus on appropriateness of offsite, alternative release locations for the split broodyear S1/S2 group described above.

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FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: March 15, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the February 21, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held at the Grant PUD office in Wenatchee, Washington, on Wednesday, February 21, 2018, from 9:00 to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons regarding reviewing the memo, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will send his revised version of the memo, "Alternatives for Methow Basin conservation steelhead programs" to Brett Farman (Item I-A).
- Brett Farman will coordinate with Craig Busack (National Marine Fisheries Service [NMFS]) regarding reviewing the memo, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will invite Andrew Murdoch to the March 12, 2018 Hatchery Committees meeting to discuss steelhead escapement methodology (Item I-A).
- Sarah Montgomery will reconfigure the Extranet site to sort permits and Biological Opinions (BiOps) by species and date and upload the related documents (Item I-A).
- Todd Pearsons will ascertain fish salvage activities at Priest Rapids and Wanapum dams, and report back to the Hatchery Committees for coordination purposes regarding lethal removal of 12- to 18-inch hatchery-origin *Oncorhynchus mykiss* (Item IV-A).
- Kirk Truscott will work with Casey Baldwin (Colville Confederated Tripes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item IV-D).

- Tracy Hillman will distribute the Draft Hatchery Program Timelines for Hatchery Committees review (Item IV-E). *(Note: Hillman sent these to Montgomery who distributed them to the Hatchery Committees on February 21, 2018.)*
- Tom Kahler and Greg Mackey will provide historical program information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item IV-E).
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB)'s *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item IV-F).

Decision Summary

- The Wells Hatchery Committee approved the hatchery portion of the 2018 Wells HCP Action Plan, as follows: Douglas PUD, WDFW, U.S. Fish and Wildlife Service (USFWS), NMFS, Yakama Nation (YN) and CCT approved on February 21, 2018 (Item II-A).

Agreements

- The Hatchery Committees approved the lethal removal of all known hatchery-origin *O. mykiss* between 12 and 18 inches at Chelan PUD and Douglas PUD hydroelectric projects during fish rescues associated with fishway maintenance outages (Item IV-A). *(Note: This effort is part of adult management. Grant PUD [PRCC HSC] stated they would need to follow up with facility staff about feasibility.)*

Review Items

- Sarah Montgomery sent an email to the Rocky Reach and Rock Island Hatchery Committees on February 21, 2018, notifying them that the draft Chelan PUD 2018-2020 Steelhead Release Plan is available for review, with comments due to Catherine Willard by March 7, 2018.

Finalized Documents

- No documents have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the January 17, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following items were added:

- Kirk Truscott added an update on genetic sampling for HCP program species
- Hillman added a discussion about the ISAB's recent report
- Hillman also added an item for his revised timelines for HCP program species

The Hatchery Committees representatives reviewed the revised draft January 17, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft January 17, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on January 17, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on January 17, 2018)*:

- *Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam (Item I-A).*
  Mike Tonseth suggested inviting Andrew Murdoch to the March 12, 2018 Hatchery Committees meeting to discuss changes in methodology to estimate steelhead escapement, and then again to the April 18, 2018 Hatchery Committees meeting to discuss proposed expanded sampling at the OLAFT. He said changes in escapement methodology are based on sampling at the OLAFT. Hatchery Committees representatives present stated that this would be helpful, and Tonseth said he would invite Andrew Murdoch to the March 12, 2018 Hatchery Committees meeting.
- *Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A).*
  This item is ongoing. Tracy Hillman suggested Tonseth review the ISAB's comments regarding genetic monitoring.
- *Sarah Montgomery will distribute the approved Chelan PUD Coho Obligation Statement of Agreement (SOA) to the Hatchery Committees (Item II-A).*
  This item is complete. Montgomery distributed the SOA on January 22, 2018.
- *Tom Kahler will send Douglas PUD's 2018 Wells HCP Action Plan to the Hatchery Committees for review (Item IV-A).*

This item is complete. Sarah Montgomery distributed the plan on January 22, 2018.

- *The Methow Basin Steelhead Small Working Group will revise their memorandum, "Management alternatives for Methow Basin conservation steelhead programs," to incorporate backup broodstock collection locations for Twisp River steelhead and will distribute a revised version for review (Item IV-C).*

  This item is complete. Mike Tonseth said he made revisions to the memorandum after the Hatchery Committees January 17, 2018 meeting, and sent it to Todd Seamons for review (see following action item). Based on feedback from Seamons, Tonseth said the Methow Basin Steelhead Small Working Group can further revise the memorandum. Keely Murdoch said she thought the pilot study is currently planned and agreed-to for only one season. Tonseth agreed and said the purpose of the geneticists' review is to identify any long-term red flags in continuing the alternative, should it be agreed to for future years.
- *Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Management alternatives for Methow Basin conservation steelhead programs," before the February 21, 2018 Hatchery Committees meeting (Item IV-C).*

  This item is ongoing. Tonseth sent the revised memorandum to Seamons, who is reviewing it.
- *Brett Farman will coordinate with Craig Busack (National Marine Fisheries Service [NMFS]) regarding reviewing the memorandum, "Management alternatives for Methow Basin conservation steelhead programs," before the February 21, 2018 Hatchery Committees meeting (Item IV-C).*

  This item is ongoing. Mike Tonseth will send the revised memorandum to Farman so that Busack can review it.
- *Mike Tonseth and Sarah Montgomery will compile permits and Biological Opinions (BiOps) applicable to HCP programs and post them to the Extranet site (Item VI-A).*

  This item is ongoing. Montgomery said she has been coordinating with Julene McGregor (Douglas PUD) to change the organization of the permitting section of the Extranet site. She asked for feedback on how the permits and BiOps should be organized and stated that McGregor is currently updating the site so that permits can be sorted by "active" or "expired." Suggestions included organizing that section of the site by species and by date. Montgomery said she would work with McGregor to make these changes to the site, then upload the applicable documents.
- *Hatchery Committees representatives will continue to provide historical information to Tracy Hillman for incorporation in program and species timelines, particularly regarding Wenatchee steelhead, Methow steelhead, and Methow summer Chinook salmon (Item VI-C).*

  This item is complete. Hillman said he received most but not all of the needed information, and this will be discussed today.

- *Sarah Montgomery will poll the Hatchery Committees and Priest Rapids Coordinating Committee (PRCC) Hatchery Sub-Committee to determine the March meeting date (Item VII-A).* This item is complete. The Hatchery Committees plan to meet on March 12, 2018.

II. Douglas PUD

A. Decision: 2018 Wells HCP Action Plan (Tom Kahler)

Tom Kahler said the draft 2018 Wells HCP Action Plan (Attachment B) has been available for review and asked for any input. (Note: Sarah Montgomery distributed the draft 2018 Wells HCP Action Plan on January 22, 2018.) Tracy Hillman asked if review and approval of the broodstock collection protocols were added the plan. Kahler said yes. No further input was provided, and the Wells HCP Hatchery Committee approved the hatchery portion of the 2018 Wells HCP Action Plan as follows: Douglas PUD, WDFW, USFWS, NMFS, YN and CCT approved on February 21, 2018. Hillman said the action plan will be discussed in the Wells HCP Coordinating Committee.

B. Methow Steelhead Broodstock Collection Update (Tom Kahler)

Tom Kahler said Michael Humling (USFWS) sent an update via email to the representatives of the Wells HCP Hatchery Committee pertaining to broodstock collection for the Methow combined steelhead programs. (Note: Sarah Montgomery received the email and distributed the update to the full distribution list following the meeting on February 21, 2018.) Kahler summarized the update. He said so far, broodstock collection for the programs via angling is going well, though it is difficult to directly compare with prior years because similar broodstock collection efforts have never been initiated so early in the season (several weeks earlier than usual) nor as low in the river. In summary, collection is going better than previous years. Matt Cooper said the fishing crew has collected 63 steelhead to date, with the plan that approximately 90% of the NOR target will be sourced from this angling effort, and 10% of the NOR target will be sourced from the Twisp River Weir (collection at the weir will begin in the next few weeks). Mike Tonseth said just over 50% of the target number of Safety-Net broodstock have been collected so far via angling. Cooper said the USFWS is assuming the conservation programs will achieve 100% natural-origin broodstock.

C. Steelhead Broodstock Collection at Wells Hatchery Volunteer Channel (Tom Kahler)

Tom Kahler said due an unexpected outbreak of *Columnaris* in the 2018 brood of steelhead at Wells Fish Hatchery, additional broodstock may be trapped as needed in the Wells Fish Hatchery volunteer channel. He said some of the programs should have enough broodstock, but it would be helpful to have backup or “insurance” broodstock for other programs. Mike Tonseth said a group of backup broodstock steelhead were collected in 2017 for the same purpose, and females from that group have already been used. Additionally, many other females died from *Columnaris*, which is not common in steelhead. Tonseth said even if spring collection efforts are completed as planned, there may be a shortfall in broodstock with no ability to satisfy the shortfall unless back-up fish are collected now. Kahler said the facility is not currently operating for surplussing fish, but could be opened immediately so that fish can be held in ponds. Tonseth said the volunteer trap can be operated for adult management, so the steelhead can be collected under adult management but held until a decision is required on their fate (broodstock versus lethal removal or transfer to nonanadromous waters). If needed for broodstock, Tonseth said the National Oceanic and Atmospheric Administration would have to provide input. Tonseth summarized that WDFW and Douglas PUD plan to collect steelhead at the Wells Fish Hatchery volunteer channel and hold them in ponds until deciding whether the fish are needed as broodstock or should be treated as adult management. Tonseth said once WDFW and Douglas PUD know if and how many steelhead are needed for broodstock from this effort, they will update the Hatchery Committees; WDFW will also decide what to do with any fish that are held but not used for broodstock. Questions and comments followed.

Catherine Willard reminded Tonseth and Kahler that Chelan PUD requested steelhead from the volunteer channel. Kirk Truscott asked if the fish held at Wells Fish Hatchery would be treated in the holding ponds. Tonseth said they would be treated with peroxide and salt. Truscott suggested that any disease treatments applied to the fish would influence what WDFW decides to do with these fish after they are held and not used for broodstock. Kahler asked Tonseth if this collection and holding plan is included in the draft 2018 Broodstock Collection Protocols. Tonseth said the protocols are specific about how many fish are retained for collection, but these fish would be initially considered adult management fish. If some of the adult management fish being held at the hatchery are needed for broodstock and are transferred from the adult management holding area, further discussion would be necessary.

III. Chelan PUD

A. Draft 2018-2020 Steelhead Release Plan (Catherine Willard)

Catherine Willard shared Chelan PUD's draft 2018-2020 Steelhead Release Plan, which Sarah Montgomery sent to the Hatchery Committees on February 21, 2018, before the meeting. (Note: an updated version for review [Attachment C] was distributed following the meeting on February 21, 2018.) Willard summarized the plan, and questions and comments followed.

Willard said current steelhead release plans include overwinter acclimation at the Chiwawa Acclimation Facility (AF). This may have resulted in tradeoffs between minimizing stray rates and maximizing survival. Overwinter acclimation at the Chiwawa AF has likely reduced stray rates; however, mean juvenile survival to McNary Dam is generally lower for fish that are overwinter acclimated than previous releases that were not overwinter acclimated at Chiwawa AF (see the background section of Attachment C for further details). Willard said the body size of steelhead smolts affects their post-release survival. Fish released from Chiwawa AF are smaller on average due to colder water, and this smaller size is correlated with lower survival. She said NMFS issued Permit No. 18583 to Chelan PUD and WDFW in December 2017, including a special condition to minimize residualism and maximize downstream migration. She said confounding variables at Chiwawa AF make it difficult to evaluate survival to McNary Dam.

Willard summarized the 2018 to 2020 release strategy objectives as follows:

- Evaluate survival based on size at release to McNary Dam to inform best hatchery management practices for hatchery releases that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (NMFS Wenatchee River Steelhead Section 10 Permit No. 18583).
- Evaluate rearing vessel Raceway 2 (RCY 2) (traditional flow through raceway) and partial water reuse circular vessel (RAS 1 and RAS 3).
- Minimize confounding variables (i.e., rearing vessel, release timing, flow conditions, release strategy, release location) to evaluate size at release.
- Use data collected from the 2018 to 2020 Wenatchee River Steelhead release to assess applicable monitoring and evaluation (M&E) objectives (i.e., Objectives 4 and 6) for the Wenatchee River summer steelhead hatchery program (Hillman et al. 2017[1]).

She said passive integrated transponder (PIT) tagging and analysis for this program will focus on two comparisons: body size and vessel type. She reviewed the PIT-tagging numbers for each group and said John Skalski (Columbia Basin Research) provided a power analysis and sample size calculation to inform these numbers. The release plan is to truck-plant all PIT-tagged fish on the same day at the same location and Willard asked that the Hatchery Committees representatives consider where the fish should be released.

Tracy Hillman asked if large fish are being studied alongside the medium and small-size groups identified in the plan. Willard said, after further consideration there are not very many fish in the "large" size category, but large fish encountered will be PIT-tagged. Mike Tonseth said the size break between small and medium is a 140-millimeter (mm) fork length, and the groups have fish of mixed parental origin because there are not enough fish and tags to do a size comparison by parental origin alone.

Tonseth said one concern discussed during the January 17, 2018 Hatchery Committees meeting was where fish would be released in the basin. He said this plan would continue to release fish in the lower

[1] Hillman, T., T. Kahler, G. Mackey, A. Murdoch, K. Murdoch, T. Pearsons, M. Tonseth, and C. Willard, 2017. Monitoring and evaluation plan for PUD Hatchery Programs, 2017 update. Report to the HCP and PRCC Hatchery Committees, Wenatchee, WA.

Wenatchee basin, but they would be direct-planted instead of spring-acclimated at Blackbird Pond. Kirk Truscott said there is potential for more residuals from this program comingling with wild cohorts if fish are planted above Tumwater Dam. Tonseth said if the fish are released in the Chiwawa River, they could be planted upstream from the PIT-tag antenna array and smolt trap for evaluation purposes. Tonseth said for post-release evaluation, electrofishing could be more easily completed in the Chiwawa River than in the upper Wenatchee River, for comparison. Truscott said because residuals could go anywhere in the Wenatchee basin, he suggests electrofishing and angling for residuals in more than just the river that the fish are released in. Willard said the literature suggests steelhead mainly residualize near their release location, but also up to 8 kilometers away. Tonseth said residuals hold in Tumwater Canyon, for instance.

Tonseth said the plan also incorporates non-lethal evaluation of early maturation, with a long-term plan to lethally measure early maturation. The non-lethal evaluation will help determine baseline conditions for the program to which future results can be compared.

Regarding Table 1 of the plan, Truscott said even if a difference in survival is found between medium and small fish, this plan would not determine whether that is related to parental origin or size (i.e., low survival for small hatchery-by-hatchery fish only would draw down the survival for the whole small size group). Hillman said the linear model used to evaluate these data will produce an interaction term between parental origin and size. Tonseth said a within-year evaluation of the influence of parental origin would be difficult to complete, but over the 3-year period, it could be analyzed. If there is an indication that parental origin is a factor in survival, the study design can be modified in future years (by adding or reassigning PIT tags) to better analyze that influence. Hillman said with 3 years of data, an analysis of variance can be completed, and if the effect of parental origin is large, it will likely be detected; however, if the effect of parental origin is small, it will likely not be detected because of small sample size. Willard said adding enough PIT tags to evaluate the effects of parental origin on survival is not feasible due to the time it would take to hold and tag that many fish.

Keely Murdoch said analyzing the effects of parental origin and size on survival might be more robust over multiple years anyway, because results may be different under a variety of conditions. Hillman agreed and said if there is a year effect, it can be evaluated using the data.

Hillman asked if there is a predefined cutoff for small versus medium, or if the cutoff will be a percentile of the fish sampled. Willard said the cutoff is 140 mm length at release, so the cutoff is back-calculated based on expected growth. Keely Murdoch asked if the Methow program has the same methodology, suggesting another potential comparison. Tonseth said the Methow program's permit has not been issued by NMFS yet, but will include requirements for measuring and monitoring residualism. Tonseth said the Methow programs include Winthrop National Fish

Hatchery's 2-year smolt conservation program, so there is an effect of being a 2-year smolt regardless of the size of the smolt. Hillman asked if NMFS directs how to measure residualism and survival and how to determine baseline conditions. Tonseth said no, the Hatchery Committees decide on the methodology as the permit itself does not state specific guidance.

Truscott asked if a difference in tag burden needs to be considered for the small compared to medium fish. Tonseth said the PIT-tagging protocols include a cutoff that fish less than 65 or 70 mm should not be tagged. Truscott suggested considering tag burden, and one way to normalize tag burden would be to put smaller tags in the smaller fish. Tom Kahler said because there are detection differences for tags of different sizes, using different tag sizes is not a feasible solution for normalizing tag burden in this study.

Willard said tagging for this plan will start soon, and Chelan PUD would like feedback on release location. Tonseth said the fish should not be released straight from the Chiwawa AF because the fish would overwhelm the PIT-tag array with detections. He said the fish should be released upstream of the array—far enough upstream that they would not pass in a shoal—and the smolt trap downstream of the array should be pulled during the release.

Hillman made slight revisions to the document based on input from the representatives present, and Montgomery said she will send the revised version out for review. Willard requested comments and revisions by March 7, 2018, and said the plan will be discussed again at the March 12, 2018 Hatchery Committees meeting.

IV. Joint HCP-HC/PRCC HSC

A. Lethal Removal of Steelhead and Section 10 Permits (Mike Tonseth)

Mike Tonseth said during the Coordinating Committee's January meeting, Chelan PUD presented results of fish salvage activities due to ladder dewatering. He said there was a substantial number of ad-clipped *O. mykiss* collected, varying in size. He said because hatchery-reared rainbow trout are not released in the Columbia River, other than in the Lake Roosevelt area, WDFW is concerned about hatchery steelhead remaining in the river. He added that the fish collected by Chelan PUD did not appear to be triploids (triploid trout are released in Rufus Woods Reservoir). Tonseth said WDFW proposes to lethally remove these 12- to 18-inch fish and examine their tags to determine origin. Tonseth said WDFW's permits allow for lethal removal of hatchery-origin steelhead at dams, traps, and weirs. He said because the fish are obviously of hatchery origin, this activity would fall under adult management. If removed, the fish would be measured and weighed, gender would be determined, and they would be scanned for coded wire tags. Tags would be removed and read, and other basic information would be collected. Tonseth asked about fish salvage and dewatering activities at Priest Rapids and Wanapum dams. Pearsons said he would check and report back to the committees.

Tonseth said regarding recreational fishery collection of these fish, the 12- to 18-inch fish are too small to be collected by anglers. However, WDFW may add an element in the steelhead fishery in future years to lower the retention size to target these hatchery-origin fish. Keely Murdoch agreed that it would be good to know the origin of these hatchery fish, and no matter where they are coming from, it is beneficial to remove them. Tracy Hillman said he does not think there are many of these fish in the reservoirs, as Grant PUD collected only seven rainbow trout in a recent intensive sampling effort. Tonseth suggested that the fish may prefer ladders and gather there. Tom Kahler said that *O. mykiss* of the size that Chelan PUD reported are routinely encountered in the Wells fishways, but during the last dewatering of the Wells Dam east collection gallery, staff found 8 to 10 large cutthroat trout, and fewer *O. mykiss* than normally encountered. Tonseth said dewatering and fish salvage occurs annually, so while this would not be a regular collection effort, it is an opportunity to remove fish, recover tags, and determine their origin. When asked about Section 10 permit coverage for this activity, Tonseth said the activity falls under adult management, so no permit changes would be needed. An expansion or ability to retain or lethally remove these fish as part of a conservation fishery (something WDFW is pursuing) would be a separate consultation, though. Brett Farman agreed with Tonseth about permit coverage and said he would provide further input if he finds anything in current permits that would be inconsistent with allowing this activity. Tonseth said the final fate of these fish (e.g., placement in nonanadromous waters or donated to tribes or food banks) has not yet been determined and would be influenced by how the fish are handled. He also added that knowing the dewatering schedule for PUD facilities would be helpful so WDFW can assign staff and coordinate the removal effort.

The Hatchery Committees approved the lethal removal of all known hatchery-origin *O. mykiss* between 12 and 18 inches at Chelan PUD and Douglas PUD hydroelectric projects during fish rescues associated with fishway maintenance outages. Grant PUD (PRCC HSC) stated they would need to follow up with facility staff about feasibility.

B. 2018 Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth said the draft 2018 Broodstock Collection Protocols will be available for review soon, but the federal spring Chinook salmon forecast for Leavenworth and Winthrop national fish hatcheries and the spring Chinook salmon forecast for the Wenatchee basin are still pending. Todd Pearsons asked if the protocols are similar to 2017 excepting the high incidence of disease and need to collect additional broodstock. Tonseth said most programs will see very little change from 2017. Additional trapping is proposed at the Chiwawa Weir based on new bull trout information, and a lower probability of meeting broodstock collection goals if the trapping schedule is not modified. Tonseth said he expects to distribute the draft protocols for review by March 2, 2018, depending on the federal forecast for spring Chinook salmon. Tonseth said the steelhead forecast is produced by the Technical Advisory Committee, and he expects it to be not very robust. He said summer Chinook salmon may have a more surprising forecast or run than other species in 2018. Tonseth summarized that the draft plan will be available for review soon and will be a discussion item at the Hatchery Committees March 12, 2018 meeting, with the final deadline of approving it by April 15, 2018. Tonseth suggested that during review, representatives need to check the marking appendix to be certain it reflects anticipated mark types. Pearsons asked if the first review period for the protocols is the first time that hatchery staff and managers see the contents of the protocols, as they might have major changes to incorporate like fecundity. Tonseth said data included in the protocols are sourced from M&E documentation associated with each program, so as long as numbers being reported as part of M&E are correct, the protocols should be accurate. Kirk Truscott asked if the methods for forecasting runs are the same between USFWS and WDFW. Tonseth said the estimates will be consistent with previous years, but he is not sure whether WDFW and USFWS use the same models in their forecasting. Truscott suggested reviewing the models prior to development of the protocols in 2019.

C. NMFS Consultation Update on National Environmental Policy Act Process (Emi Kondo)

Emi Kondo (NMFS) said she has updates regarding the National Environmental Policy Act (NEPA) process for NMFS consultations. She said NMFS retained Chuck Peven (Peven Consulting, Inc.) to write the Environmental Assessment (EA) for Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids). She said the first draft will likely be available for internal review soon. After that, applicants will have a chance to review it, then it will be available for public comment. Kondo said during the EA process, NMFS generally reaches out to any tribes involved for informal discussion, and asked Kirk Truscott and Keely Murdoch whether she should coordinate with anyone other than them. Truscott and Murdoch said no, they will distribute the information internally as needed. Kondo said this general approach mirrors that for the Methow spring Chinook EA. After the NEPA process is complete, she said Section 10 permits can be issued.

D. Genetic Sampling for HCP Program Species (Kirk Truscott)

Tracy Hillman said Casey Baldwin emailed him asking about the genetic sampling and analysis plan for HCP program species, which was a topic of discussion in the Hatchery Committees in 2017. Baldwin asked about progress on the protocols for sample size, selection of subpopulations, and other items, to inform a baseline genetics evaluation for Okanogan steelhead. Mike Tonseth said he has been coordinating with Todd Seamons to review the genetic sampling and analysis timeline and said he would check in with Seamons again. Hillman suggested Tonseth and Seamons also consider recommendations and questions from the ISAB in their report (see page 222, and executive summary).

Todd Pearsons said McLain Johnson (WDFW) compiled data and proposed a schedule, which the Hatchery Committees reviewed and discussed, but sample sizes and analysis intervals needed further input from geneticists. Pearsons said the 10-year comprehensive review is coming up, and it would be helpful to include the 2019 and 2020 genetic analyses in that report. Tonseth said the original genetic baselines for HCP program species are no longer relevant, so the timelines need to be reviewed to determine appropriate baselines. Pearsons said as long as all the programs are collecting the needed samples, the analyses and reporting can be flexible. Kirk Truscott said CCT are collecting samples from juveniles through M&E activities, but more exact methods would help determine how many need to be collected, at which life stage, and other specifics. Pearsons suggested the lead on this task for CCT could coordinate with Dave Duvall (Grant PUD) regarding collection methods.

E. Draft Hatchery Program Timelines (Tracy Hillman)

Tracy Hillman shared the most recent Draft Timelines for HCP Program Species. He summarized the status of each timeline as follows:

- Wenatchee spring Chinook salmon – complete but needs to be reviewed by the Hatchery Committees
- Methow spring Chinook salmon – needs more information from Douglas PUD and further review by the Hatchery Committees
- Entiat spring Chinook salmon – new, complete but needs to be reviewed by the Hatchery Committees
- Okanogan spring Chinook salmon – this program does not have a timeline as it is not under the purview of the Hatchery Committees
- Wenatchee summer steelhead – nearly complete
- Methow summer steelhead – needs more information from Douglas PUD
  - Mike Tonseth said this program was largely unchanged until steelhead were listed and then it changed significantly after recalculation and when the conservation program was added.
  - Tom Kahler said the USFWS' 2-year smolt program was also a significant change, as was the WNFH transition to local brood rather than relying on collection at Wells Hatchery.
- Entiat steelhead – Hillman said steelhead were released in the Entiat until about 1999. He asked if any other programs are putting steelhead in the Entiat River. Tonseth said no, therefore this timeline is complete.
- Wenatchee summer Chinook salmon – complete but needs to be reviewed by the Hatchery Committees

   - Hillman said this timeline was straightforward because it is not a listed population
- Methow summer Chinook salmon – needs more information from Chelan PUD
- Entiat summer Chinook salmon – complete but needs to be reviewed by the Hatchery Committees
- Wenatchee sockeye – complete, but needs to be reviewed by the Hatchery Committees
- Methow sockeye – complete
   - Hillman said there were very few releases of sockeye into the Methow River, but there are still annual returns.
- Entiat sockeye – complete
   - Hillman said there was one documented release of sockeye salmon into the Entiat River.
- Okanogan sockeye – more information from Douglas PUD and CCT is needed
   - Kahler said this program continued and overlapped in time with the development of the Okanagan Fish Water Management Tool.

Questions and comments followed Hillman's summary. Kahler said in 2015, which was an abnormal water year, there were many sockeye spawning in the Twisp River. He said these fish are likely strays from another area, but there may also be a local stock. Hillman said Fred Utter (University of Washington) did genetic work on sockeye in the Methow River in the 1990s and found there was a blend of Wenatchee and Okanogan genetics in the fish. Matt Cooper said many sockeye were reared in the area on local water sources, but transported for release to other areas, so they may be homing to a natal water source. Cooper said sockeye numbers in the Entiat and Twisp rivers are variable, but at least a few fish spawn there every year. Hillman added that sockeye spawn in the Methow River in a few areas every year.

Hillman said it is difficult to determine the precise year a statistical break should occur because many of the major decisions and changes to programs happened over multiple years.

Hillman said he will distribute the timelines for review and asked for further input, specifically from Douglas PUD.

F. Independent Scientific Advisory Board Report (Tracy Hillman)

Tracy Hillman said the ISAB completed the report, *Review of Spring Chinook Salmon in the Upper Columbia River*. Hillman said the executive summary includes several recommendations, one of which is to convene an oversight committee for all of the committees working on different pieces of spring Chinook salmon recovery. Tom Kahler said there is not one entity with oversight over everything going on in the basin besides NMFS due to the various agreements such as HCPs, settlement agreements, harvest agreements, recovery plan, and permits.

Hillman said another recommendation is to develop an all-H research, monitoring, and evaluation plan. The report indicated that there is a lot of monitoring occurring in the basin, but each group has their own M&E plan with little coordination among groups.

Hillman said the report compares upper Columbia River spring Chinook salmon populations to Snake River spring/summer populations and to upper Columbia River summer Chinook salmon. He said there has been greater loss of genetic diversity in upper Columbia populations because of loss of populations upstream from Chief Joseph Dam and hatchery programs. He said the ISAB identified conserving genetic diversity as very important and suggests that supplementation programs focus on diversity. He said the ISAB specifically identified the loss of local adaptation of Chewuch River spring Chinook salmon. He said the overall report is supportive and provides recommendations to consider.

Hillman said the ISAB also reviewed the 2017 Hatchery M&E Plan and its appendices. Carl Schwarz (Simon Fraser University) specifically provided feedback on Appendix E. He said Schwarz recommends setting up hypotheses for equivalence testing, which would require the committees to determine in advance what effect size should be analyzed. Hillman said Schwarz also provided recommendations about Before-After-Control-Impact (BACI) designs and selecting reference populations based on biology rather than statistics. Hillman said Schwarz provided a mixed additive model for analyzing BACI data. Hillman will follow up with Schwarz and the Hatchery Committees about potential changes to analyses. Todd Pearsons said the statistical approach was used to determine reference populations, because it was not possible to identify whether or not populations were tracking similar biological factors. So, while statistics were used, the reference populations were still chosen based on biology—they were chosen based on which populations were responding to similar biological, geographical, and climatological factors. Hillman said Schwarz' linear model can also analyze the populations one-to-one, and as a composite. Another recommendation was to log-transform the data, because the data follow a multiplicative process. He said the ISAB reviewers had a different understanding of stray rates than the Hatchery Committees, who have generally adopted Technical Recovery Team guidelines.

Hillman suggested that he read through the report and start updating M&E Plan appendices and analyses as needed. Those requiring additional input might warrant reconvening the Hatchery Evaluation Technical Team, or further discussions by the Hatchery Committees.

Pearsons said Grant PUD also plans to do a thorough read of the report and its recommendations. He said different statisticians can have varying opinions about Bayesian statistics, and Grant PUD may not support moving to Bayesian analyses right away. He asked for Hillman to wait on making edits or discussing this in much depth with Schwarz until Grant PUD has read the suggestions and compiled any specific questions. Hillman agreed and said he would not recommend moving to a Bayesian approach immediately, but it is something to consider.

Hillman said the ISAB also provided other recommendations and he encouraged Hatchery Committees members to review the ISAB report.

V. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are on March 12, 2018 (Grant PUD), April 18, 2018 (tentatively planned for Wells Fish Hatchery), and May 16, 2018 (Grant PUD).

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft 2018 Wells HCP Action Plan
Attachment C	Draft 2018-2020 Steelhead Release Plan

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Alf Haukenes†	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Michael Humling†	U.S. Fish and Wildlife Service
Brett Farman*†	National Marine Fisheries Service
Emi Kondo†	National Marine Fisheries Service
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

DRAFT 2018 ACTION PLAN
WELLS HCP

WELLS HCP COORDINATING COMMITTEE

1. **Juvenile Fish Bypass**
    a. Gas Abatement Plan (GAP) and Bypass Operating Plan (BOP) to CC...... 17 January 2018
    b. CC comments on GAP/BOP to DCPUD .... 12 February 2018
    c. CC approval of GAP/BOP .... 21 February 2018
    d. Submit final GAP/BOP to FERC for approval .... 28 February 2018
    e. 2018 Bypass operations at Wells ....9 April 2018 – 19 August 2018

2. **Annual Monitoring of Juvenile Migration Run Timing**
    a. 2018 draft passage-dates analysis and post-season bypass report to CC.........October 2018
    b. CC approval of 2018 final report ....November 2018

3. **Fishway Outage Schedule for Fishway Inspection, Maintenance, and Fishway Projects**
    a. West Fishway...27 December 2017 – 18 January 2018
    b. East Fishway ....29 January – 15 February 2018
    c. Adult Fishway Trap Coordination Meeting .... April 2018

4. **Multi-Year Sub-yearling Chinook Life-history Study**
    a. Draft juvenile life-history report to CC .... April 2018
    b. Final juvenile life-history report ....July 2018

5. **Review and Approval of 2018 Hatchery Broodstock Collection Protocol**
    a. Draft protocol to CC for review... 16 February 2018
    b. CC approval of draft protocol .... 27 March 2018
    c. Deadline for submission of protocol to NMFS.. 13 April 2018

6. **Pikeminnow Control Program**
    a. Draft 2017 pikeminnow report to HCP CC .... April 2018
    b. Final 2017 pikeminnow report.. June 2018
    c. 2018 Pikeminnow removal – Wells Project.................................. March – November 2018

7. **Avian Protection Plan**
    a. Bird Wire Inspection and Replacement .... February 2018
    b. Bird Hazing...April – August 2018

8. **2020 Survival Verification Study**
    a. Select study species... February 2018
    b. Study Plan to HCP CC... April 2018
    c. CC approval of Study Plan .... June 2018
    d. Collect Brood Stock for 2020 SVS...2018

9. HCP Annual Report

a. Draft 2017 annual report to DCPUD for review.. 11 January 2018
b. Draft 2017 annual report to CC for 30-day review.................................... 7 February 2018
c. CC comments on draft 2017 report due to Anchor QEA............................... 7 March 2018
d. Final 2017 annual report to DCPUD .... 22 March 2018
e. Final 2017 annual report due to FERC .... 30 March 2018

WELLS HCP HATCHERY COMMITTEE

1. **Implement 5-year Hatchery Monitoring and Evaluation (M&E) Plan**
   a. Ongoing implementation ....January – December 2018
   b. Draft annual report for 2017 to Douglas PUD... June 2018
   c. Draft annual report to Hatchery Committee (HC) ....August 2018
   d. Final annual report to HC .... September 2018
   e. Draft 2019 implementation plan to HC ....July 2018
   f. HC approval of final 2019 implementation plan ....October 2018

2. **Assessment of Precocial Maturation**
   a. Methow Hatchery spring Chinook lethal sampling .... March 2018
   b. Wells steelhead visual assessment .... April 2018

3. **Twisp Population Study**
   c. Implementation ....September – October 2018
   d. 2014, 2015, 2016, 2017 Reports .... May 2018

4. **Twisp Spring Chinook Egg-to-Fry Study**
   a. Implement study...January – June 2018
   b. Draft report...July 2018
   c. Year-2 implementation (if necessary)...August 2018 – June 2019

5. **2018 Broodstock Collection Protocol**
   a. Draft to HC for review... 9 February 2018
   b. HC approval of draft protocols .... 21 March 2018
   c. CC approval of Wells Dam trapping operations.. 27 March 2018
   d. Deadline for submission to NMFS .... 13 April 2018

6. **Annual Implementation – Okanagan Sockeye Fish/Water Management Tools**
   a. Water Year 2017-2018..October 2017 – September 2018

7. **Modernization of the Okanagan Sockeye Fish/Water Management Tools**
   a. Phase 3 (Final) ....July 2017 – October 2018

8. **Methow Steelhead Relative Reproductive Success Study**
   a. Implementation ....March 2010 – December 2021
   b. Annual report on genetic analysis.. September/October 2018
   c. Biological data in Annual M&E Report (above) .... September 2018
   d. Final report.. 2021/2022

9. **Hatchery Genetic Management Plans**
   a. Receive new Wells steelhead hatchery permit.................................*to be determined, 2018*
   b. Receive new Wells summer Chinook hatchery permit.....................*to be determined, 2018*

10. Wells Hatchery Modernization

a. Complete construction punch-list .... June 2018
b. Warranty items .... June 2018-June 2019
c. As-Record Drawings .... June 2018
d. Operations Manual .... July 2018
e. Emergency Procedures Document .... December 2018
f. Groundwater Optimization Program .... December 2018

11. Coho Hatchery Program

a. Collect broodstock .... September/October 2018
b. Incubate/rear at Wells Hatchery .... November 2018 – March 2019
c. Divide Twisp Acclimation Pond to accommodate coho .... Fall 2018

12. Chief Joseph Hatchery Production

a. Fund hatchery production (spring/summer Chinook) 2018
b. Fund monitoring and evaluation 2018

13. Hatchery Biosecurity Program

a. Wells Hatchery .... April 2018
b. Methow Hatchery .... April 2018
c. Carlton Acclimation Pond .... April 2018

14. Methow Hatchery

a. Operations Manual .... July 2018
b. Methow Outfall Trap Modification .... June 2018
c. Emergency Procedures Document .... December 2018
d. Groundwater Optimization Program .... December 2018

WELLS HCP TRIBUTARY COMMITTEE

1. **Plan Species Account Annual Contribution**
   a. $176,178 in 1998 dollars ($275,968.08 in 2018 dollars) .... 15 January 2018

2. **Annual Report - Plan Species Account Status**
   a. Submittal of 2017 account-status report to Tributary Committee (TC): .... 22 January 2018
   b. Integration into 2017 HCP Annual Report: .... February 2018

3. **General Salmon Habitat Program**
   a. Project review and funding .... January-December 2018

4. **Small Project Program**
   a. Project review and funding Decision .... January-December 2018

DRAFT Memorandum

Date: February 21, 2018

To: Rock Island and Rocky Reach HCP Hatchery Committees

From: Catherine Willard (CPUD), Scott Hopkins (CPUD), and Chris Moran (WDFW)

Re: 2018 Wenatchee Steelhead Release Plan (Brood Year 2017)

Background

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin as part of the Rock Island and Rocky Reach HCP requirements. Through the end of January 2018, approximately 257,142 Wenatchee summer steelhead (128,585 HxH and 128,557 WxW) are on station at the Chiwawa Acclimation Facility (Chiwawa AF).

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa AF following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank and Chelan Fish Hatcheries to the Chiwawa AF in November and released in April through May. Overwinter acclimation at the Chiwawa AF may have resulted in tradeoffs between program objectives associated with minimizing stray rates and those associated with maximizing survival. Overwinter acclimation at the Chiwawa AF has likely reduced stray rates. Based on PIT-tag analyses, on average for brood years 2011 and 2012 (overwinter acclimated at Chiwawa AF), about 4% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River Basin. This is compared to an average stray rate of 25% for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF). Mean juvenile survival from release to McNary Dam for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF) was 54.3% compared to brood years 2011 to 2015 (overwinter acclimated at Chiwawa AF) of 30.1% (Figure 1).

The body size of smolts of steelhead originating from hatchery releases has long been believed to affect their post release survival and therefore the number of adult returns (Larson and Ward 1955; Wagner et al. 1963; Tipping 1997). Juveniles released at a larger size generally survive to maturity at a higher rate (Clarke et al. 2014). Size at release data from the Wenatchee steelhead program indicates that as fish size at release increases, juvenile survival to McNary also increases (Figure 2). The mean size at release for brood years 2005 to 2010 (not overwintered at Chiwawa AF) was 6 FPP compared to 10 FPP for brood years 2011 to 2016 (overwinter acclimated at Chiwawa AF).

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of 2017. A special condition of

this permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. The presence of multiple confounding variables, including brood origin, smolt size, rearing vessel, water source, release date, release location, and release strategy has made it challenging to fully evaluate survival to McNary based on the size of release of the Wenatchee steelhead program.

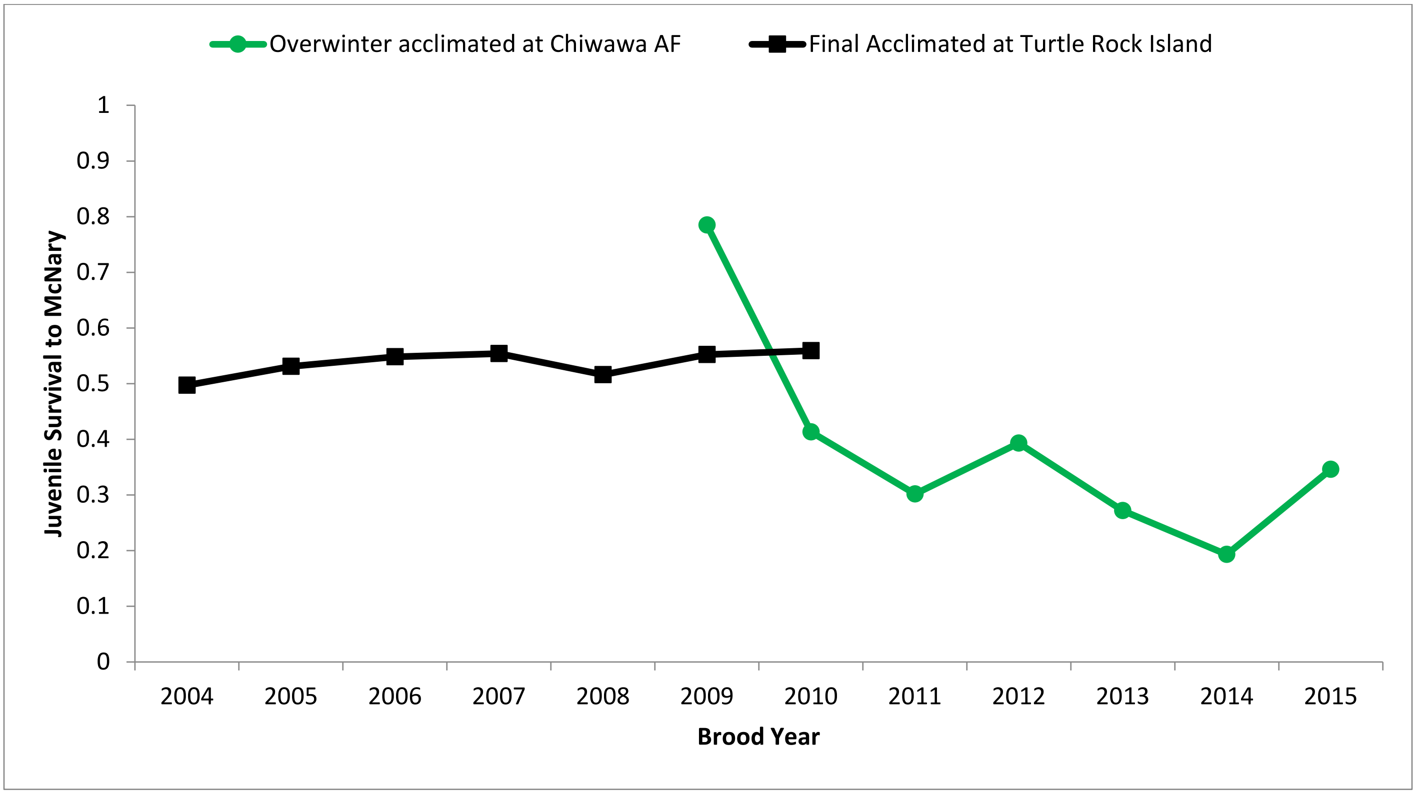

Figure 1. Juvenile outmigration survival to McNary for the Wenatchee summer steelhead program final acclimated at Turtle Rock Island and overwinter acclimated at Chiwawa Acclimation Facility.

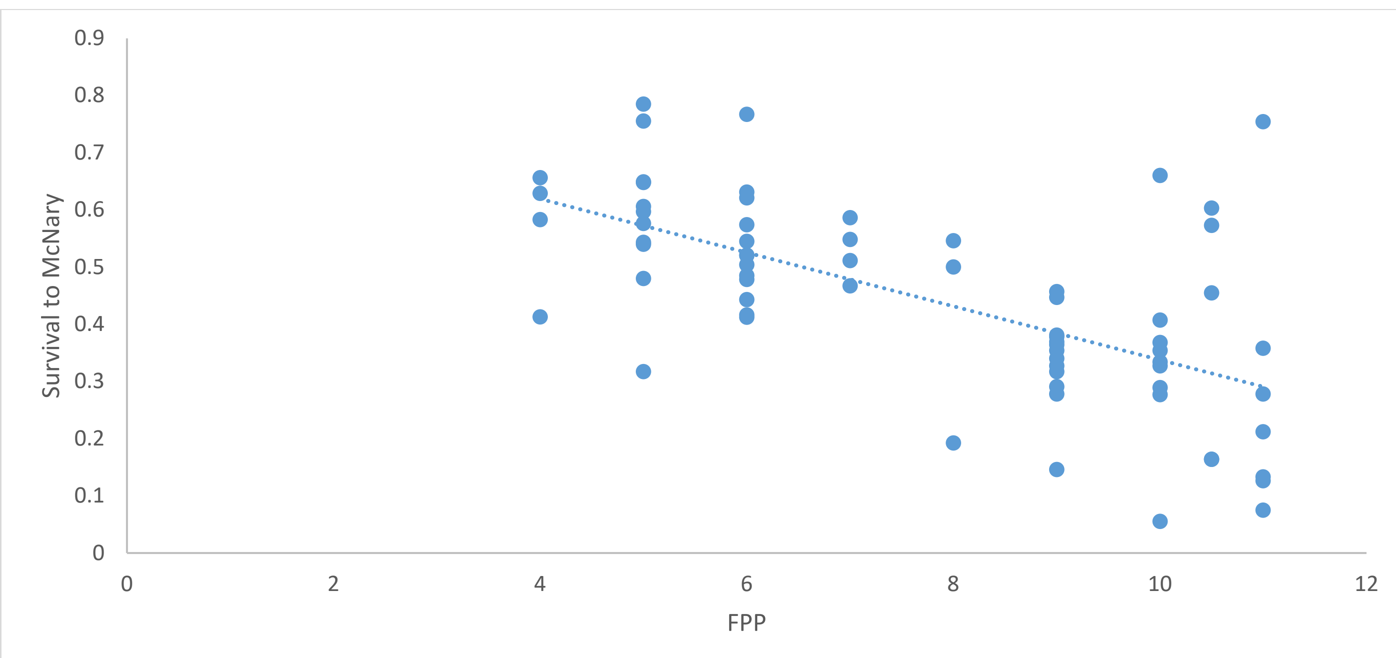

Figure 2. Juvenile outmigration survival to McNary and size of release data for the Wenatchee steelhead program, brood years 2005 to 2016.

Post-release performance of steelhead reared in the partial water reuse circular vessels (RAS) and traditional flow through raceways (RCY) have not consistently or thoroughly compared due to confounding variables present. RAS versus RCY comparisons may aid in future management decisions and improved performance of the Wenatchee steelhead program.

2018-2020 Release Strategy Objectives

- Evaluate survival based on size at release to McNary Dam to inform best hatchery management practices for hatchery releases that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (NMFS Wenatchee River Steelhead Section 10 Permit #18583).
- Evaluate rearing vessel Raceway 2 (RCY 2) (traditional flow through raceway) and partial water reuse circular vessel (RAS 1 and RAS 3).
- Minimize confounding variables (i.e. rearing vessel, release timing, flow conditions, release strategy, release location.) to evaluate size at release.
- Utilize data collected from the 2018-2020 Wenatchee River Steelhead release to assess applicable monitoring and evaluation objectives (i.e., Objectives 4 and 6) for the Wenatchee River summer steelhead hatchery program (Hillman et al. 2017).

Methods

Through January 2018, RCY 2 contain 232,388 steelhead (103,803 WxW and 128,585 HxH) and RAS 1 and 3 contain 24,754 WxW steelhead. PIT-tagged WxW and HxH steelhead located in RCY 2 will be evaluated based on size at release. PIT-tagged WxW steelhead located in RCY 2 and RAS 1/RAS 3 will be used to evaluate rearing vessel type. RAS 1/RAS 3 steelhead will be PIT tagged mid-February. RCY 2 fish will be PIT-tagged beginning the last week of February and two size classes will be targeted for PIT-tagging (small and medium). Each treatment group will contain approximately 11,000 PIT-tagged fish (($\text{statistical power } 1 - \beta = 0.80$; $\alpha = 0.10$, two-tailed) (Skalski 2018)) (Table 1). To minimize confounding variables, all PIT-tagged fish will be directly released at one release location on the same day.

- Cormack-Jolly–Seber survival probabilities to MCN will be calculated for each release group using recaptures of PIT-tagged fish.
- The percentage of PIT-tagged fish detected in the Wenatchee sub-basin after July 1 of the year of release will be calculated to estimate potential residualism for each release group.

Table 1. Treatments for evaluation.

Vessel	Brood Origin	Treatment	Estimated # PIT-tagged	Treatment PIT release size
RCY2	HxH	Size	5,500 small	11,000 small/mixed origin
RCY2	HxH	Size	5,500 medium	
RCY2	WxW	Size	5,500 small	11,000 medium/mixed origin
RCY2	WxW	Size	5,500 medium	
RCY 2	WxW	Vessel Type	11,000	11,000 WxW RCY 2
RAS1/RAS 3	WxW	Vessel Type	11,000	11,000 RAS1/RAS 3

Release Timing

In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase juvenile outmigration survival, all fish located at the Chiwawa AF will be released by May 8th. In addition, every attempt will be made to release all of the program within the shortest feasible window possible, when optimal river conditions exist, and during the afternoon/early evening.

Release Location

Release locations in 2018 will be the same as the previous two years for non-PIT tagged fish. PIT-tagged fish will be released at one release location (Table 1).

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2017). Additionally, an extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. In addition to measuring fork length, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. The pre-release fork length data will be used to create a linear regression equation to predict fork length at release of fish not measured during the pre-release sample.

Table 2. Steelhead release numbers and locations, 2018.

Vessel	Origin[1]	Estimated Number Released[2]	Estimated # PIT-tagged	Destination	rkm
RCY2	Mixed	33,313	TBD	Nason	7
		58,067		**Total**	
RCY2	Mixed	97,749	TBD	U. Wenatchee	79.2
		97,749		**Total**	
RAS 1+3	WxW	24,754	11,000	Chiwawa	11.4
RCY2	Mixed	41,572	22,000	Chiwawa	11.4
		66,326		**Total**	
RCY2	Mixed	35,000	TBD	L. Wenatchee	40.2
		35,000			

[1]Mixed = HxH and WxW.
[2]Releases will occur between April 20 - May 8.

Additional Considerations

- To eliminate release location as a potential confounding variable, releasing all of the PIT-tagged fish into one release location is recommended.
  Which release location should be utilized?
- A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements:
  - Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard.

  Input on post-release sampling to conduct GSI sampling and assessment of smolt index?

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FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: April 19, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the March 12, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held at the Grant PUD office in Wenatchee, Washington, on Monday, March 12, 2018, from 9:00 to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A). *(Note: this item is ongoing.)*
- Brett Farman will coordinate with Craig Busack (National Marine Fisheries Service [NMFS]) regarding reviewing the memorandum, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A). *(Note: this item is ongoing.)*
- Sarah Montgomery will reconfigure the Extranet site to sort permits and Biological Opinions (BiOps) by species and date and upload the related documents (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A). *(Note: this item is ongoing.)*
- Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB's) *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*

- Hatchery Committees representatives and alternates will review the draft *Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program* and consider options for discussion at the April 18, 2018 Hatchery Committees meeting (Item II-B).
- Greg Mackey will revise the Wells and Methow Hatchery 2018 Program Projected Releases document (Item III-C). *(Note: Mackey revised the document and Sarah Montgomery distributed it to the Hatchery Committees on March 13, 2018.)*
- Sarah Montgomery and Mike Tonseth will coordinate as needed to potentially schedule a conference call to discuss comments and questions on the draft 2018 Broodstock Collection Protocols (Item V-B).
- The Hatchery Committees will hold their April 18, 2018 meeting at Wells Fish Hatchery (Item VI-A).

Decision Summary

- The Rocky Reach and Rock Island HCP Hatchery Committees approved the Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019) as follows: Chelan PUD, WDFW, U.S. Fish and Wildlife Service (USFWS), NMFS, Yakama Nation (YN) and CCT approved on March 12, 2018 (Item II-A).

Agreements

- There were no agreements besides the decision listed above.

Review Items

- Sarah Montgomery sent an email to the Hatchery Committees on April 17, 2018, notifying them that the draft 2018 Broodstock Collection Protocols (version 4) are available for review, with comments to be discussed at the April 18, 2018 Hatchery Committees meeting (Item V-C).

Finalized Documents

- Sarah Montgomery sent an email to the Rocky Reach and Rock Island HCP Hatchery Committees on March 13, 2018, notifying them that the Final Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019) is now available for download from the Hatchery Committees Extranet site (Item II-A).
- Sarah Montgomery sent an email to the Wells HCP Hatchery Committee on March 13, 2018, notifying them that the Final 2018 Wells HCP Action Plan was approved by the Wells HCP

Coordinating Committee on February 27, 2018, and is available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the February 21, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The following items were added:

- Greg Mackey added two items: spring release targets and a sinkhole at Wells Fish Hatchery.
- Keely Murdoch added an item for steelhead acclimation.

The Hatchery Committees representatives reviewed the revised draft February 21, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft February 21, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on February 21, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on February 21, 2018)*:

- Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam (Item I-A). *Mike Tonseth said today's discussion about advancements in estimating steelhead escapement methodology is a precursor to the discussion in April or May about expanded sampling at the OLAFT.*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A). *Tonseth said this item is ongoing.*
- Mike Tonseth will coordinate with Todd Seamons regarding reviewing the memo, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A). *Tonseth said he sent the memorandum to Seamons and this item is ongoing.*
- Mike Tonseth will send his revised version of the memo, "Alternatives for Methow Basin conservation steelhead programs" to Brett Farman (Item I-A). *Tonseth said this item is complete.*
- Brett Farman will coordinate with Craig Busack (National Marine Fisheries Service [NMFS]) regarding reviewing the memo, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A). *This item is ongoing.*
- Mike Tonseth will invite Andrew Murdoch to the March 12, 2018 Hatchery Committees meeting to discuss steelhead escapement methodology (Item I-A). *This item will be discussed today.*

- Sarah Montgomery will reconfigure the Extranet site to sort permits and Biological Opinions (BiOps) by species and date and upload the related documents (Item I-A). *This item is ongoing.*
- Todd Pearsons will ascertain fish salvage activities at Priest Rapids and Wanapum dams, and report back to the Hatchery Committees for coordination purposes regarding lethal removal of 12- to 18-inch hatchery-origin *Oncorhynchus mykiss* (Item IV-A). *Pearsons said there are not enough of these fish encountered during fish salvage activities to warrant coordinating a collection effort.*
- Kirk Truscott will work with Casey Baldwin (Colville Confederated Tripes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item IV-D). *This item is ongoing.*
- Tracy Hillman will distribute the Draft Hatchery Program Timelines for Hatchery Committees review (Item IV-E). *Hillman sent these to Sarah Montgomery who distributed them to the Hatchery Committees on February 21, 2018.*
- Tom Kahler and Greg Mackey will provide historical program information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item IV-E). *Kahler said there was a species sharing agreement in the Methow Basin that will inform the timelines, and he will send information about the agreement to Hillman.*
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB)'s *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item IV-F). *This item is ongoing. Hillman said there were many comments about the Monitoring and Evaluation (M&E) program in the appendices to the report which will need to be reviewed for important information and recommendations. He said, for example, the ISAB recommends analyzing abundance data by brood year instead of by return year.*

II. Chelan PUD

A. Draft 2018-2020 Steelhead Release Plan (Catherine Willard)

Catherine Willard shared Chelan PUD's draft 2018-2020 Steelhead Release Plan, which Sarah Montgomery sent to the Hatchery Committees on February 21, 2018. Matt Cooper asked if the brood year 2017 steelhead have been passive integrated transponder (PIT) tagged. Willard responded yes. Tracy Hillman asked if the release location was decided. Willard said the Chiwawa River would be a good place to release the fish because they could be placed above the PIT-tag array and smolt trap, which would help evaluate migrants. Keely Murdoch said there is also a PIT-tag array in Nason Creek. Willard said releasing in two locations would introduce a release site variable to the study, and there are not large enough sample sizes to statistically evaluate release sites and size at release. Hillman asked if the details from this plan are included in the draft 2018 Broodstock Collection Protocols. Mike Tonseth said this information is not yet in the draft protocols but will be added.

Willard asked that the Rocky Reach and Rock Island Hatchery Committees vote on the plan with a planned release 11.4 river kilometers upstream of the confluence of the Chiwawa River with the Wenatchee River. Kirk Truscott said the plan does not address all questions related to origin, release strategy, and location. Willard agreed and said those data are available for past releases but confounded by different variables. This plan aims to narrow the variables and increase statistical power by releasing all fish in the same location. Bill Gale asked if this plan increases the number of fish released in the Chiwawa River compared to previous years. Tonseth said it does not change the total number of fish released in the Chiwawa River, and the significant deviation from prior years is not acclimating fish at Blackbird Pond. Willard noted that the plan is a 3-year study beginning with the 2018 release year (brood year 2017).

The Rocky Reach and Rock Island HCP Hatchery Committees approved the Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019) as follows: Chelan PUD, WDFW, USFWS, NMFS, YN and CCT approved on March 12, 2018. The final approved plan was distributed to the Hatchery Committees after the meeting on March 13, 2018 (Attachment B).

B. Proposed Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program (Catherine Willard)

Catherine Willard shared the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program* document (Attachment C), which Sarah Montgomery distributed following the meeting on March 13, 2018. Willard said a special condition in the new Wenatchee steelhead permit is to minimize residualism rates and maximize downstream migration of steelhead. Willard said the Hatchery Committees are responsible as a group for developing the methodology for establishing baseline conditions, and she drafted this document as a starting point. Willard summarized the options she drafted: a PIT-tag evaluation; post-release sampling; and an electrofishing and angling study (see Attachment C).

Bill Gale said for an electrofishing and angling study, one issue is how to expand collection to develop an estimate of residualism. He asked would multiple passes and index reaches be used? Willard said she has not developed a sampling design, but one idea is to use index reaches around the release site and perform a mark-recapture estimate of residuals. Keely Murdoch said mark-recapture might work for this evaluation, but there may be a bias with angling. She said surveys for residualized coho salmon have been conducted using snorkeling, where residual coho salmon were observed in Nason Creek. She said snorkel surveys allow for systematically sampling reaches, especially during low water in the summer, and some of the hatchery fish were distinguishable by physical characteristics.

Mike Tonseth said these discussions have two facets. First, the Hatchery Committees should develop a methodology to evaluate what the rate of residualism is. Then, the Hatchery Committees should discuss whether that rate is reasonable and if changes need to be made.

Bill Gale said in order to estimate a rate, one will need to know the total number of steelhead that residualize and this is very difficult to estimate. Hillman agreed and said this is a complex problem for a couple of reasons. First, we need a reliable technique to estimate the number of residuals within sampling sites, such as removal/depletion or mark-recapture, and second, sites need to be selected in such a way that allow us to extrapolate to the entire population. He said residuals are likely not uniformly distributed throughout the rivers, noting that there is likely a higher concentration of residualized fish near the release site and in high quality habitat such as Tumwater Canyon. Gale agreed and said he thinks an estimate of residualism may be made without intensive sampling. He said while electrofishing and angling might not be the most accurate way to estimate residualism for the entire release group, it might still be informative to sample one index site near the release location for year-to-year tracking.

Gale suggested studying apparent survival to the first, downstream Columbia River hydroelectric facility, which would provide a year-to-year indicator of survival. Keely Murdoch asked if residualized steelhead are observed during snorkel surveys in the Chiwawa River. Hillman said yes, but some are difficult to distinguish from wild steelhead. Hillman asked how NMFS defines residuals for the purposes of the steelhead permit. Willard said the BiOp states that a fish is considered a residual if it is found in the system 21 days after release, or July 1, whichever is later. Tonseth suggested sampling sites periodically to examine rate of decay for residualism. Keely Murdoch said it may be helpful to do initial surveys (an exploratory year) to identify where residual steelhead are holding. Gale said a PIT-tag evaluation could similarly determine how quickly the fish migrate. Andrew Murdoch suggested that one way to locate hatchery-reared steelhead is to sample in areas where the water profile is similar to a hatchery (i.e., laminar flow and uniform depth). Keely Murdoch said it may be helpful to examine data from past WDFW angling efforts in the Chiwawa River to put these ideas for sampling into context. Andrew Murdoch said rearing and release conditions have changed so much over the years that it might be difficult to query those data in a meaningful way.

Greg Mackey suggested using a repeated sightings population estimate approach. He said if enough PIT-tagged fish remain in the system and are able to be detected, a raft with a PIT-tag array could be floated down the river multiple times to determine the proportion of the release group that did not migrate. Gale asked about detection efficiency. Mackey said this method involves detecting the same individuals and new individuals with each pass, allowing for the population to be estimated. Mackey said he is not certain of all the statistical properties of this type of study, but it would not rely on capture efficiency. Such methods are used to estimate relatively small populations of animals that are difficult to capture. Andrew Murdoch said repeated surveys with a PIT-tag detection boat could be completed at different flows to potentially detect more fish. Truscott asked how this type of study would account for dead fish whose PIT tags are detected. Hillman said a snorkeler could follow the boat and note any carcasses. He said repeated surveys in the same sites could provide information needed to calculate detection efficiencies, but fish movement could complicate the estimate. Mackey agreed and said the study reaches would need defined boundaries. Andrew Murdoch said WDFW developed similar equipment for studying overwinter distribution and used ghost PIT tags to calibrate the equipment, with two boats used for detecting tags. He said this methodology can be further refined. The basic strategy is that each boat has a PIT tag antenna, or a larger boat has two antennas (one on the front and one on the back), but maneuvering boats is difficult.

Willard summarized that the draft plan contains three components: 1) PIT Tag evaluation, 2) Post release GSI and maturation lethal sampling, and 3) electrofishing/angling. She said doing a PIT-tag evaluation certainly seems like an easy and logical method. She asked if anyone had thoughts about a post-release sampling study. She said it would involve pre-release non-lethal sampling and post-release lethal sampling and would be coordinated with the USFWS. She also asked the Hatchery Committees if an electrofishing and angling study should be pursued. Keely Murdoch said representatives should review the options presented today and discuss further at the April 18, 2018 Hatchery Committees meeting.

III.Douglas PUD

A. Fish Health and Production at Wells and Methow Hatcheries (Betsy Bamberger)

Greg Mackey introduced Betsy Bamberger, the fish health and evaluation specialist at Douglas PUD. Bamberger shared a presentation, *Columnaris at Wells Fish Hatchery—A Case Review* (Attachment D). (Sarah Montgomery distributed the presentation to the Hatchery Committees following the meeting on March 13, 2018.) Bamberger said Columnaris affected summer Chinook salmon and summer steelhead programs at Wells Fish Hatchery the past year, and this presentation describes the management strategies undertaken and insight about fish health.

A summary of the presentation and the questions and comments that followed are included in the following sections.

<u>Introduction to Columnaris (Slides 1-3)</u>

Bamberger said columnaris is a disease affecting freshwater finfish that is caused by a bacteria, *Flavobacterium columnare*. Outbreaks are more frequent in warm water and when fish are stressed. It presents as white-gray spots, usually below the dorsal fin, and can progress to tail rot and ulcerations, as well as gill necrosis. In the gills, it can disrupt filament functionality. It can also present as a yellow-brown film, such as in the oral cavity. Columnaris is transmitted horizontally between fish, and generally becomes more virulent under the following circumstances: crowding, low dissolved oxygen, handling, physical injury, and poor water quality.

Wells Fish Hatchery Summer Chinook Salmon (Slides 4-5)

Bamberger said the Wells summer Chinook salmon 2017 brood were collected from late July to early September. While there were few pre-spawn mortalities observed by mid-October, losses quickly escalated in late October and the brood was diagnosed with columnaris disease on October 24, 2017. The management strategy for this outbreak was to spawn the fish as soon as possible and interfere as little as possible. The no-interference strategy was chosen because spawning goals had nearly been met, stress from treatments would have likely been fatal, and physical injuries were beyond benefit from therapeutic intervention. There were relatively low water temperatures and no known history of columnaris disease for this brood. Bamberger noted that columnaris disease was a regional issue for spring and summer Chinook salmon in fall 2017.

Wells Fish Hatchery Steelhead (Slides 6-10)

Bamberger said Wells Fish Hatchery summer steelhead were observed exhibiting odd behavior in the water column at the beginning of spawning efforts in late November, and were diagnosed with columnaris disease on November 27, 2017. She said spawning was expected to continue for weeks, so treating the columnaris disease was important to minimize losses. The first management strategy implemented was treatments of potassium permanganate and solar salt. This treatment prevented mortality events from worsening, but losses still occurred. Chloramine-T was considered as an option but decided against it due to National Pollutant Discharge Elimination System (NPDES) regulations. A second management strategy using an aquatic herbicide, Diquat (Reward®), was implemented beginning in late January. Diquat is more expensive than most other chemotherapeutics used in aquaculture but has a better safety margin and higher potential benefit. Diquat is an experimental drug made available by an investigational new animal drug (INAD) exemption granted by the Aquatic Animal Drug Approval Paternship Program (AADAP). At Wells Fish Hatchery it was used at a lower dose for a prolonged exposure. Bamberger said 0.72 gallons were used per daily treatment (three successive treatments were administered weekly for three weeks), and it was helpful to be able to shut water flow off to use less herbicide. After Diquat treatment began, mortalities declined and there were no further losses after February 7.

Bamberger summarized that the incidence of columnaris disease can be cyclical from year to year, and she emphasized the importance of diagnosing it as soon as possible. It is also important to implement more stringent biosecurity and disinfection measures and keep treatment materials (like Diquat) stocked. Another step Douglas PUD might take is to become an accredited lab through the

Washington State Department of Ecology, which would allow for use of alternative chemicals such as Chloramine-T.

Questions and Comments

Todd Pearsons asked how Diquat treats columnaris disease. Bamberger said it is an experimental chemical for treating columnaris disease, and she is not certain of the theory behind its use. She clarified that it kills the bacteria which causes columnaris disease, but sometimes the disease has progessed so far that full recovery is not possible. Mike Tonseth asked if Diquat has any effects on copepods. Bamberger said she is not aware of any effects to copepods. She said some people advise using peroxide to treat copepods, but techniques vary between saltwater and freshwater species and success is tenuous.

Pearsons asked why Columnaris was such a problem in the 2017 brood year. Bamberger said it was abundant in the river system whereby most or all hatcheries in the region experienced significant outbreaks, and the hatcheries cannot control exposure to river water. There are different strains with varying virulence. Keely Murdoch said copepods have been an issue in the kelt reconditioning program and are treated with emamectin benzoate (Slice®). Bamberger said emamectin might be one idea for future copepod treatments, but that copepods are not too concerning as long as gill tissue is still viable. Willard asked if other facilities also did not use Chloramine-T due to NPDES regulations and perhaps this is why Columnaris disease seemed more prevalent in other hatchery stocks in Washington state. Bamberger said some facilities used Chloramine-T, but she is not sure how many are aware of the regulations. She said it is best used as a prophylactic treatment but that there are some anecdotal toxicity concerns with repeated, long-term use. Hatchery Committees representatives thanked Bamberger for her presentation.

B. Sinkhole at Wells Fish Hatchery (Greg Mackey)

Greg Mackey said a sinkhole recently developed in the downstream corner of Dirt Pond 3 at Wells Fish Hatchery. Low water was observed in the pond, and upon investigation, a sinkhole was discovered with approximately 1,000 gallons of water per minute going into the ground. Mackey said the old pond liner may be gone or disintegrated, allowing for the hole to develop. He said roads at the hatchery were recently re-graveled, and the vibratory compactor used for that work could have triggered the hole. Less than an hour after the sinkhole was discovered, a contractor was able to pack boulders and material into the hole and slow or stop the leak. Mackey said it appears the pond has stabilized, and fish were likely not going down the sinkhole because they were at the head of the pond. The pond currently holds Columbia safety-net program steelhead, and they will be released soon. Mackey said the pond will be repaired or rebuilt after fish are released. Keely Murdoch asked if the number of fish released from the pond will be known. Mackey said it may be possible to estimate the number of fish released. He said the fish are usually brought into a release raceway and pumped into a truck, and a PIT-tag reader is used to estimate the number of fish. Mike Tonseth said given the uncertainty about fish going into the sinkhole, it is important to develop an estimate of loss according to terms and conditions in permits. Kirk Truscott added that the number could be roughly estimated based on how fish are feeding. Mackey said the surrounding area was inspected for plumes of water related to the leak and none were discovered.

C. Release Targets (Greg Mackey)

Greg Mackey shared a document, Wells and Methow Hatchery 2018 Program Projected Release (revised version distributed following the meeting on March 13, 2018; Attachment E). Mackey described which Wells and Methow programs have projected releases over and under their respective targets.

Mackey shared a second document, which showed steelhead broodstock collection targets for the Methow safety-net, Columbia safety-net, and Okanogan programs. Mackey said broodstock collection targets have nearly been met for the Methow safety-net and Columbia safety-net programs. Spring collection via angling is still occurring. Matt Cooper said steelhead will also be collected in the Winthrop National Fish Hatchery (NFH) outfall, which can be used as backup broodstock for Douglas PUD's programs. Mackey said additional broodstock can also be collected from the Twisp Weir. He said Methow safety-net eggs could be transferred to the Columbia safety-net program, and a proportion of Columbia safety-net eggs spawned from the fall broodstock collection could be discarded. He said eggs are hatching each day, so decisions should be made as soon as possible to optimize the programs and allow for disposal of surplus eggs. Mike Tonseth asked if the Methow safety-net program is supposed to be comprised of conservation program brood from the Twisp River and Winthrop NFH programs. Mackey said yes, some of the brood is sourced from the Twisp River and the Winthrop NFH, but the majority of the brood has come from collections at Wells Dam since the new program began. Tonseth said backup fish are collected in the fall for broodstock in case not enough fish can be collected in the spring, but broodstock collected in the spring are higher priority for using in the programs. Bill Gale asked if a fall collection period even needs to occur in future years. Tonseth said that will be discussed as part of the broodstock collection protocols discussion. He said the Methow safety-net program should be made up of adult returns from the Winthrop and Twisp programs, and if eggs currently on station are not from those programs, the eggs should be moved into a different program or discarded. If the eggs have hatched, however, decisions are more complicated, as the fish need to be reared until they are large enough to be released to resident waters. Mackey summarized that eggs that are a result of crosses between Methow safety-net or Twisp River steelhead should be kept and transferred to the Columbia safety-net program. Tonseth said it appears all Methow safety-net program brood can be met through hook-and-line collection so the entire backup brood for Methow safety-net can be transferred to the Columbia safety-net program, and extra eggs in the Columbia program can be discarded. Tonseth also recommended decreasing spawn takes so that spawn timing is narrower, and fish are more similarly sized. Gale asked about the Okanogan program. Mackey said they need approximately 150,000 eggs, and Truscott said he is not sure if they have collected brood or started spawning fish yet.

Mackey said he would coordinate the outcome of this discussion with hatchery staff. He summarized that any Methow safety-net crosses that are Winthrop NFH- or Twisp-origin brood should be kept. Hatched fish in the Methow safety-net program should be moved to the Columbia safety-net program. Any fish in the Columbia safety-net program that have hatched should also be kept and reared. Of the eggs in the Methow safety-net program, move all that are advantageous to the Columbia safety-net program, and discard the rest. Any additional Columbia safety-net program or Methow safety-net program eggs that do not help optimize spawn takes should also be discarded. Tonseth said this involves moving a lot of fish, but the outcome is that the Methow safety-net program starts fresh with broodstock from spring collections.

Tonseth said the Joint Fishery Parties have also discussed this, as well as continuing the S1/S2 approach with the Twisp and Winthrop steelhead programs. Tonseth asked if the Twisp steelhead received 5,000 PIT tags as planned. Tom Kahler said yes. Tonseth said there is a higher number of juvenile releases in the Twisp River in 2018, but in future years, 48,000 fish will be released. Tonseth said one issue in transferring fish from Winthrop NFH to their release site in the Twisp River, is truck capacity for moving smolts, and asked if Douglas PUD could assist in moving those fish to Buttermilk Bridge for release. Mackey said yes.

Mackey asked if there are any issues with the proposed plan for moving eggs between program allocations. None were raised, and a vote was not needed for this item. Keely Murdoch asked for a summary of how many fish and eggs are being transferred or culled, and if any additional broodstock collection efforts will be needed. Mackey said he will provide a summary once numbers are more certain, and he does not anticipate any broodstock collection in addition to what is already planned. Mackey and Tonseth agreed that it will be helpful to have this plan described more thoroughly in the broodstock collection protocols, and for future permitting efforts.

IV. YN

A. Steelhead Acclimation (Keely Murdoch)

Keely Murdoch said coho salmon and steelhead were once comingled at the Rohlfings Pond site on Nason Creek. This practice was discontinued by the YN due to space constraints. She said the YN now plans to construct a new pond near the old Rohlfings Pond site for the coho and steelhead acclimation programs. Construction is planned for summer 2018 with testing in 2019. In 2020, she said there will be space for steelhead acclimation. She said once that space is available, YN will be interested in using the pond for steelhead acclimation. .

V. Joint HCP-HC/PRCC HSC

A. Advancements in Estimating Steelhead Escapement Methodology (Andrew Murdoch)

Andrew Murdoch (WDFW) shared the presentation, Estimating Steelhead Escapement in the Upper Columbia Distinct Population Segment (DPS) (Attachment F), which Sarah Montgomery distributed to the Hatchery Committees following the meeting on March 13, 2018. Andrew Murdoch said this presentation is a culmination of methodologies to estimate run escapement and spawning escapement for the Upper Columbia DPS of steelhead. Andrew Murdoch presented the different methods for estimating escapement, and there were questions and comments as described below.

Todd Pearsons asked for clarification about spring-run fish in the Entiat River being equated to spawners (slide 21). Andrew Murdoch said radio-telemetry data suggest that spring-run steelhead do not die before spawning. Part of the study included looking at overwinter mortality, which was found to occur mainly in January and February, so if fish survive the winter, they generally spawn. He said it would be incorrect to use run escapement as a surrogate for spawn escapement in some cases. Run escapement cannot be assumed to equal spawning escapement because some fish that enter in the fall or winter experience pre-spawn mortality. Pearsons asked if fish move into the Entiat River in the fall and then leave again. Andrew Murdoch said some steelhead enter the Entiat River in the fall when the Columbia River is warm, but then leave when the Entiat River becomes cooler. For fish entering the Entiat River in the spring, run escapement can be equated to spawning escapement.

Regarding the spawning distribution of Entiat River steelhead (slide 23), Bill Gale commented that there are many hatchery steelhead in the Entiat River, but no hatchery releases occurring there.

Regarding overshoot at Priest Rapids Dam (slide 26), Gale asked if most of the Snake River steelhead that overshoot Rock Island move back downstream, or do they go to Wells Dam? Andrew Murdoch said many drop back down, but some are seen going into tributaries like the Wenatchee and Entiat rivers. Gale asked if any upper Columbia fish turn into the Snake River then turn around. Andrew Murdoch said no, mostly the mid-Columbia fish overshoot.

Regarding the “black box” of fish that cannot be assigned to a spawning location (slide 32), Pearsons asked how redd surveys are used to standardize the unknown group. Andrew Murdoch replied redd surveys are not used, and the method requires accurate estimates of overwinter mortality and harvest, and that all other spawning tributaries be monitored for PIT tags. Peter Graf asked, for tributaries with PIT-tag arrays, is there a difference in detection ability between tributaries with one array and two arrays? Andrew Murdoch said most tributaries in this study have two arrays, but tributaries with single versus double arrays perform similarly for this work.

Regarding model selection for the Gaussian Area Under the Curve method (slide 45), Catherine Willard asked how level of effort is measured. Andrew Murdoch replied it is measured by minutes per river kilometer, so it is standardized by distance. Pearsons asked why when redd density is higher, accuracy is higher. Andrew Murdoch said he thinks redds are more difficult to see at lower densities. Pearsons asked if redds are clustered. Andrew Murdoch said yes, some imposition occurs, and redds are clustered but not to the same degree as with spring and summer Chinook salmon. Kirk Truscott asked if a model would have to be specifically developed for the Okanogan due to its turbidity issue. Andrew Murdoch said water clarity was positively related to efficiency in his study, and said it would be helpful to sit down with CCT staff to share knowledge.

Gale said the estimates of hatchery fish are aggregated, but in several cases, it would be helpful to understand the contributions of individual programs or components of programs. He asked if the accuracy in the model can work with that much variability. Andrew Murdoch said it works because adults are tagged at Priest Rapids Dam. He said, if the programs were tagged at the same rate, then it would be easier to derive the composition of juvenile tagged fish. Gale said it would also be useful to have a minimum tagging number or rate for each program. Mike Tonseth agreed that analyses would be much simpler if tagging was completed at a consistent rate, say, 10%. Andrew Murdoch said tagging at Priest Rapids Dam also provides a total estimate of hatchery fish.

Regarding the 2014 spawning escapement estimates (slide 67), Truscott asked if these estimates are generated by redd surveys. Andrew Murdoch said they are generated through tributary PIT-tag estimates, and redd surveys in the mainstem Wenatchee River. Truscott asked how the PIT-tag-based tributary spawning estimates compare to redd survey estimates. Andrew Murdoch said he has not compared those data yet, but it is possible to use models to do that. Gale said, looking at the 2014 estimates, the ratio of hatchery and wild spawners would result in a proportion of hatchery-origin spawners of approximately 0.3. He asked how that compares with other estimates. Andrew Murdoch said older methods such as those used in 2014 do not account for overshoot, and static values were used for fish turning into the Okanogan and Methow rivers. He said he hopes to pull all the data together for 2011 to 2017 and compare the existing method and the new method, but he has not found a consistent difference between the two yet. Over time, he said the models should be able to be applied back to 2004 to develop spawner abundance estimates using just the redd model.

Regarding the 2017 spawning escapement estimates (slide 68), Gale asked how much juvenile tagging helps to determine estimates. Andrew Murdoch said it does not help very much, as the statistics involved in determining what proportion of a program each fish represents are complicated. Truscott said if all programs tagged juvenile fish at the same rate, this would be easier. Andrew Murdoch agreed and said returning fish could be assigned by release location and adult estimates could be determined. Hillman said that is based on juvenile tagging at the hatcheries, whereas a fish's hatchery of origin is unknown if it is tagged as an adult at Priest Rapids Dam (unless genetic samples are taken or there is another way to determine the origin of hatchery fish tagged at the dam).

Andrew Murdoch said this is an ongoing effort and welcomed any feedback from the Hatchery Committees. He said this may help inform upcoming discussions about expanded sampling at the OLAFT at Priest Rapids Dam.

B. NMFS Consultation Update (Brett Farman)

Brett Farman said he does not have an update on the National Environmental Policy Act process for consultations. He said the Environmental Assessment for Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids) is undergoing more internal review, and he does not know of a revised timeline for its distribution.

C. 2018 Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth said the draft 2018 Broodstock Collection Protocols will be discussed during the PRCC HSC meeting following this meeting. He said he does not expect that much discussion about the protocols will be required this year. He said if the National Oceanic and Atmospheric Administration is amenable, the protocols could be submitted on April 20, 2018, which would allow for approval at the next Hatchery Committees meeting on April 18, 2018.

Notes from PRCC HSC March 12, 2018 Meeting – Joint HCP-HC/PRCC HSC Topic

The following notes were collected during the PRCC HSC meeting on March 12, 2018, by Andy Chinn and Elizabeth McManus (Ross Strategic), and are provided here as a joint item. The HCP Hatchery Committees revised and edited the minutes as follows:

- Notable Items in 2018 Protocols – Details on notable items in the 2018 broodstock collection protocols are listed on pages 1 through 3 of the draft document. Examples include:
    - Expansion of spring Chinook salmon trapping at the Wells Dam East and West ladders to provide flexibility to trap up to 7 days per week
    - Addition of Appendix H, which describes a draft preferred approach to integration of the Methow conservation steelhead programs
    - Further refinement to Upper Columbia River surplus steelhead management

    - Expansion of the Chiwawa weir operation to ensure sufficient natural origin fish for the Chiwawa program. This will require an expansion of the total number of trapping days and an increase in bull trout encounters. The proposed action is consistent with the sideboards for bull trout impacts as described in the BiOp.
    - Management plan for excess production from Wenatchee spring Chinook salmon programs
    - Contingency for changing operations at Tumwater Dam beginning September 1 to allow for lamprey passage
- Other notes:
    - WDFW suggests that all of the fish managers' data collection begin to include fish girth, as measured behind the pectoral fins. For various reasons, including climate change trends, fish may be reaching appropriate size at length, but not appropriate weight, which could be affecting fecundity. Girth may provide a better measure than POH to determine fecundity.
    - Last year and this year the steelhead returns were low but WDFW still had to manage for excess fish. WDFW recommends eliminating all contingency collections for above-Wells steelhead programs to mitigate the surplus fish issue.
- Next Steps
    - PRCC HSC and HC Hatchery Committee members will provide comments to WDFW on the draft 2018 broodstock collection protocols by March 30. If there are any comments that require further discussion with the Committees, WDFW will either request a conference call and/or request an extension of the submission deadline for the protocols.

VI. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are April 18, 2018 (Wells Fish Hatchery), May 16, 2018 (Grant PUD), and June 20, 2018 (Grant PUD).

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	Final Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)
Attachment C	Draft Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program
Attachment D	Columnaris at Wells Fish Hatchery—A Case Review
Attachment E	Wells and Methow Hatchery 2018 Program Projected Release
Attachment F	Estimating Steelhead Escapement in the Upper Columbia DPS

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Betsy Bamberger	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel†‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Andrew Murdoch	Washington Department of Fish and Wildlife
Alf Haukenes†	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Bill Gale*	U.S. Fish and Wildlife Service
Brett Farman*†	National Marine Fisheries Service
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation
Cory Kamphaus†	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Final Memorandum

Date: March 12, 2018

To: Rock Island and Rocky Reach HCP Hatchery Committees

From: Catherine Willard (CPUD), Scott Hopkins (CPUD), and Chris Moran (WDFW)

Re: Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)

Background

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin as part of the Rock Island and Rocky Reach HCP requirements. Through the end of January 2018, approximately 257,142 Wenatchee summer steelhead (128,585 HxH and 128,557 WxW) are on station at the Chiwawa Acclimation Facility (Chiwawa AF).

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa AF following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank and Chelan Fish Hatcheries to the Chiwawa AF in November and released in April through May. Overwinter acclimation at the Chiwawa AF may have resulted in tradeoffs between program objectives associated with minimizing stray rates and those associated with maximizing survival. Overwinter acclimation at the Chiwawa AF has likely reduced stray rates. Based on PIT-tag analyses, on average for brood years 2011 and 2012 (overwinter acclimated at Chiwawa AF), about 4% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River Basin. This is compared to an average stray rate of 25% for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF). Mean juvenile survival from release to McNary Dam for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF) was 54.3% compared to brood years 2011 to 2015 (overwinter acclimated at Chiwawa AF) of 30.1% (Figure 1).

The body size of smolts of steelhead originating from hatchery releases has long been believed to affect their post release survival and therefore the number of adult returns (Larson and Ward 1955; Wagner et al. 1963; Tipping 1997). Juveniles released at a larger size generally survive to maturity at a higher rate (Clarke et al. 2014). Size at release data from the Wenatchee steelhead program indicates that as fish size at release increases, juvenile survival to McNary also increases (Figure 2). The mean size at release for brood years 2005 to 2010 (not overwintered at Chiwawa AF) was 6 FPP compared to 10 FPP for brood years 2011 to 2016 (overwinter acclimated at Chiwawa AF).

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of 2017. A special condition of

this permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. The presence of multiple confounding variables, including brood origin, smolt size, rearing vessel, water source, release date, release location, and release strategy has made it challenging to fully evaluate survival to McNary based on the size of release of the Wenatchee steelhead program.

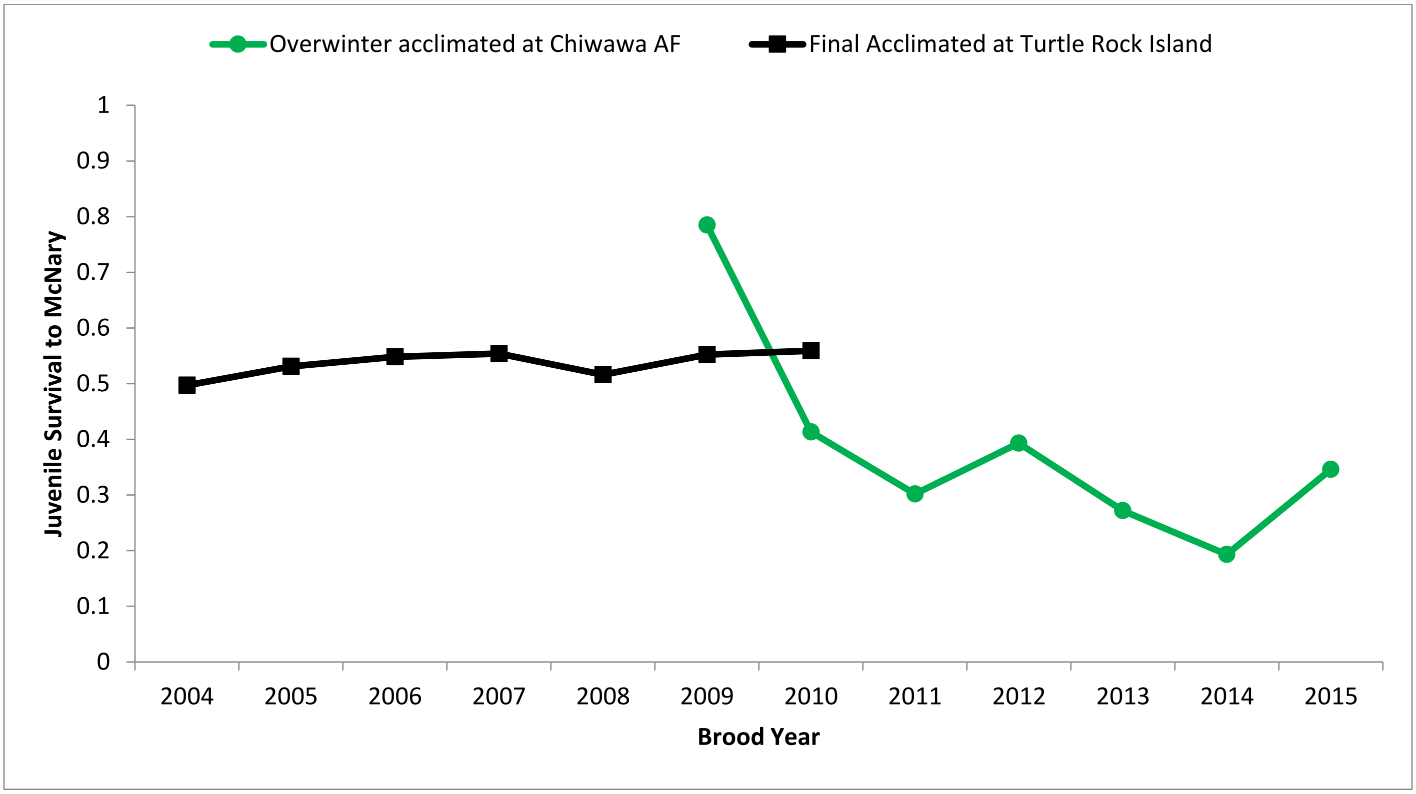

Figure 1. Juvenile outmigration survival to McNary for the Wenatchee summer steelhead program final acclimated at Turtle Rock Island and overwinter acclimated at Chiwawa Acclimation Facility.

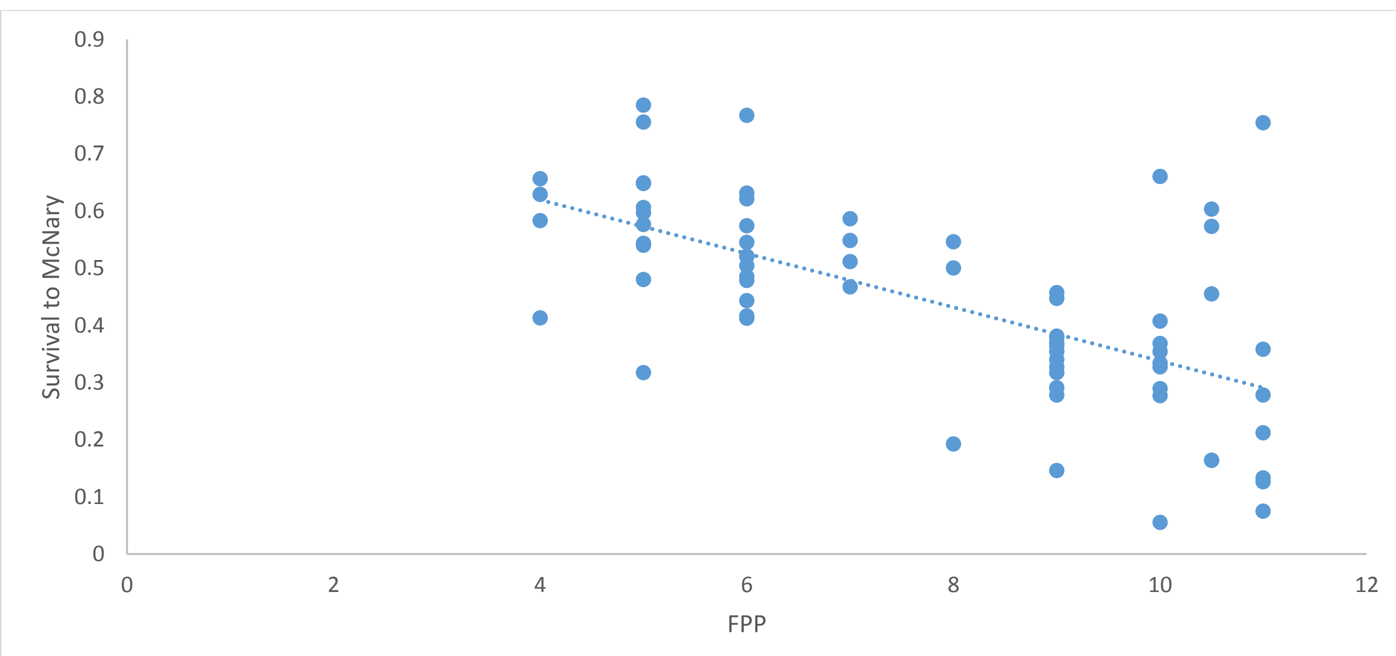

Figure 2. Juvenile outmigration survival to McNary and size of release data for the Wenatchee steelhead program, brood years 2005 to 2016.

Post-release performance of steelhead reared in the partial water reuse circular vessels (RAS) and traditional flow through raceways (RCY) have not consistently or thoroughly compared due to confounding variables present. RAS versus RCY comparisons may aid in future management decisions and improved performance of the Wenatchee steelhead program.

2018-2020 Release Strategy Objectives

- Evaluate survival based on size at release to McNary Dam to inform best hatchery management practices for hatchery releases that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (NMFS Wenatchee River Steelhead Section 10 Permit #18583).
- Evaluate rearing vessel Raceway 2 (RCY 2) (traditional flow through raceway) and partial water reuse circular vessel (RAS 1 and RAS 3).
- Minimize confounding variables (i.e. rearing vessel, release timing, flow conditions, release strategy, release location.) to evaluate size at release.
- Utilize data collected from the 2018-2020 Wenatchee River Steelhead release to assess applicable monitoring and evaluation objectives (i.e., Objectives 4 and 6) for the Wenatchee River summer steelhead hatchery program (Hillman et al. 2017).

Methods

Through January 2018, RCY 2 contain 232,388 steelhead (103,803 WxW and 128,585 HxH) and RAS 1 and 3 contain 24,754 WxW steelhead. PIT-tagged WxW and HxH steelhead located in RCY 2 will be evaluated based on size at release. PIT-tagged WxW steelhead located in RCY 2 and RAS 1/RAS 3 will be used to evaluate rearing vessel type. RAS 1/RAS 3 steelhead will be PIT tagged mid-February. RCY 2 fish will be PIT-tagged beginning the last week of February and two size classes will be targeted for PIT-tagging (small and medium). Each treatment group will contain approximately 11,000 PIT-tagged fish ((statistical power $1-\beta = 0.80$; $\alpha = 0.10$, two-tailed) (Skalski 2018)) (Table 1). To minimize confounding variables, all PIT-tagged fish will be directly released at one release location on the same day.

- Cormack-Jolly–Seber survival probabilities to MCN will be calculated for each release group using recaptures of PIT-tagged fish.
- The percentage of PIT-tagged fish detected in the Wenatchee sub-basin after July 1 of the year of release will be calculated to estimate potential residualism for each release group.

Table 1. Treatments for evaluation.

Vessel	Brood Origin	Treatment	Estimated # PIT-tagged	Treatment PIT release size
RCY2	HxH	Size	5,500 small	11,000 Small Mixed
RCY2	WxW	Size	5,500 small	
RCY2	HxH	Size	5,500 medium	11,000 Medium Mixed
RCY2	WxW	Size	5,500 medium	
RCY 2	WxW	Vessel Type	11,000	11,000 WxW RCY 2
RAS1/RAS 3	WxW	Vessel Type	11,000	11,000 RAS1/RAS 3

Release Timing

In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase juvenile outmigration survival, all fish located at the Chiwawa AF will be released by May 8th. In addition, every attempt will be made to release all of the program within the shortest feasible window possible, when optimal river conditions exist, and during the afternoon/early evening.

Release Location

Release locations in 2018 will be the same as the previous two years for non-PIT tagged fish. PIT-tagged fish will be released at one release location on the same day to the Chiwawa River (Table 2).

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2017). Additionally, an extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. In addition to measuring fork length, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. The pre-release fork length data will be used to create a linear regression equation to predict fork length at release of fish not measured during the pre-release sample.

Table 2. Steelhead release numbers and locations, 2018.

Vessel	Origin[1]	Estimated Number Released[2]	Estimated # PIT-tagged	Destination	rkm
RCY2	Mixed	58,067	TBD	Nason	7
		58,067		**Total**	
RCY2	Mixed	97,749	TBD	U. Wenatchee	79.2
		97,749		**Total**	
RAS 1+3	WxW	24,754	11,000	Chiwawa	11.4
RCY2	Mixed	41,572	22,000	Chiwawa	11.4
		66,326		**Total**	
RCY2	Mixed	35,000	TBD	L. Wenatchee	40.2
		35,000			

[1]Mixed = HxH and WxW.
[2]Releases will occur between April 20 - May 8.

Additional Considerations

- To eliminate release location as a potential confounding variable, releasing all of the PIT-tagged fish into one release location is recommended.
  Which release location should be utilized? All PIT-tags released in Chiwawa River well upstream from the detection array (RK 11.4).
- A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements:
  - Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard.

  Input on post-release sampling to conduct GSI sampling and assessment of smolt index? See "Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program" March 12, 2018, Rock Island and Rocky Reach HCPs HCs notes.

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DRAFT Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program

March 12, 2018

Rocky Reach and Rock Island HCP Hatchery Committees

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of 2017. A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements

- Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard; and an appropriate time series for data collection and evaluation.

<u>PIT Tag Evaluation</u>

Evaluation of the number and proportion of PIT tagged hatchery steelhead detected within tributaries of the Wenatchee sub-basin within the same year of release, but after the typical smolt outmigration period, will be used as an indicator of residualism. Analogous with NMFS's Wenatchee River summer steelhead hatchery program steelhead Biological Opinion (2016), PIT-tagged hatchery-origin steelhead still detected within the Wenatchee sub-basin 21 days after release or July 1st, whichever is later, will indicate residualization.

<u>Post Release Sampling</u>

An extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. Fork length and body weight will be measured, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. Additionally, a group of HxH brood-origin (n=300) and WxW brood-origin (n=300) steelhead will be held for a minimum of one month post-release to assess maturation of initiating precocial parr via lethal sampling. Because parr that have initiated maturation may begin to senescence, fish that are expressing milt will not be held for the post-release sampling. Fork length, body weight, smolt index, sex, visual maturation and GSI data will be collected for each fish. Condition factor will be calculated.

Electrofishing and Angling

Electrofishing and angling will be conducted to assess the number of hatchery smolts that did not out-migrate. Sampling will begin July 1st or when river conditions are suitable for sampling, whichever occurs first. Sampling efforts will be focused at the point of release, but will extend within 8 km of release. Studies examining the distribution of steelhead residuals within stream systems in the Snake basin report that in most cases these residuals set up residence near their release point (Whitesel et al. 1993; Jonasson et al.1996). Partridge (1986) noted that most residual steelhead were within about 8 km of the upper Salmon River release site and Whitesel et al. (1993) found steelhead residual densities were highest within 8 km of release sites and decreased quickly above and below these sites in the Grande Ronde and Imnaha Rivers in Oregon. All fish sampled will be evaluated for marks/tags in addition to measuring fork length and body weight.

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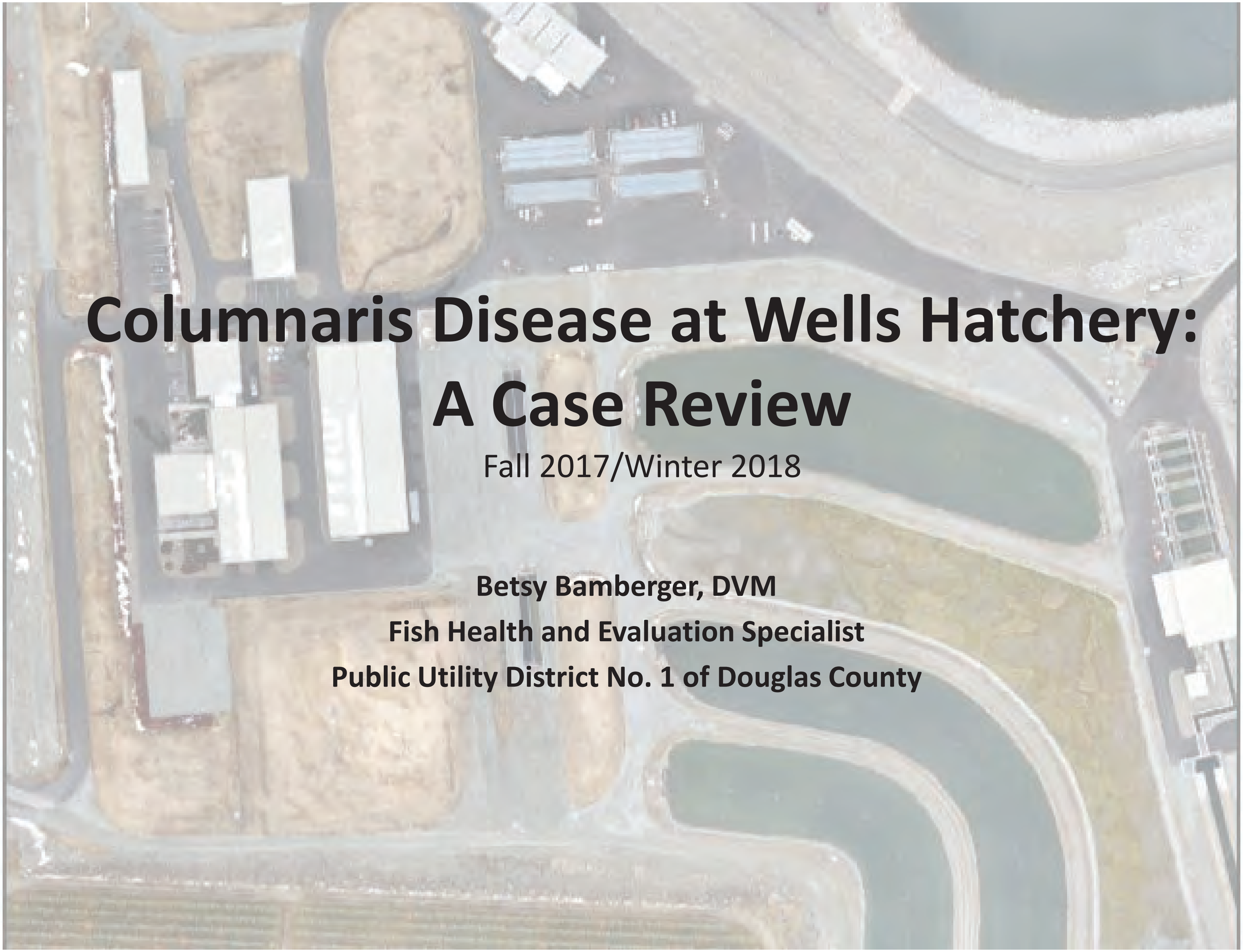


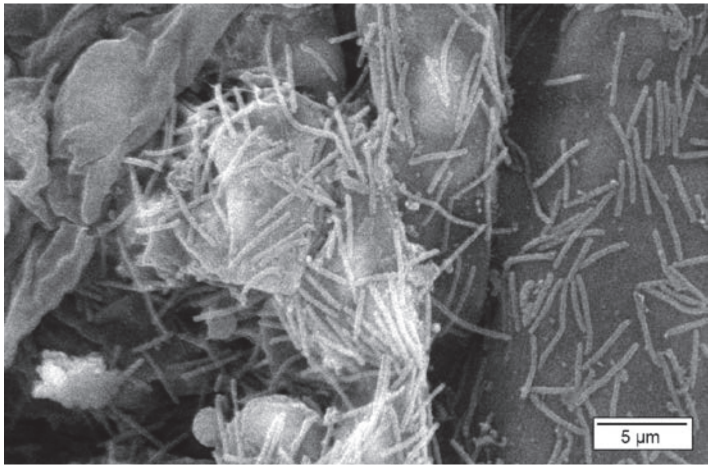
Columnaris Disease at Wells Hatchery: A Case Review

Fall 2017/Winter 2018

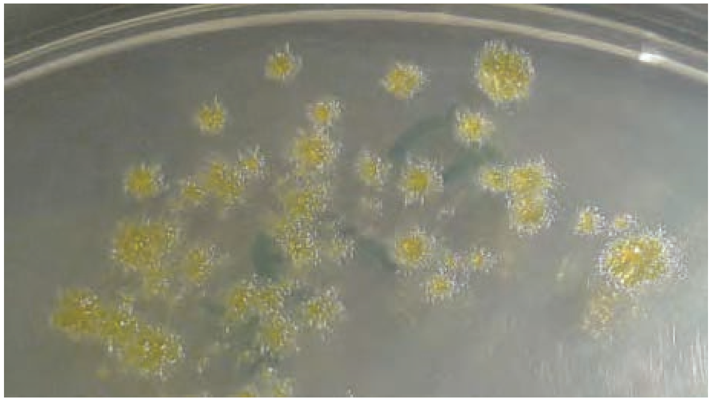
Betsy Bamberger, DVM
Fish Health and Evaluation Specialist
Public Utility District No. 1 of Douglas County

What is Columnaris Disease?

Significance: Chronic to acute disease affecting freshwater finfish (including salmonids). Wide host range with worldwide distribution (*generally thought to be ubiquitous in temperate freshwater, including the Columbia River basin*).

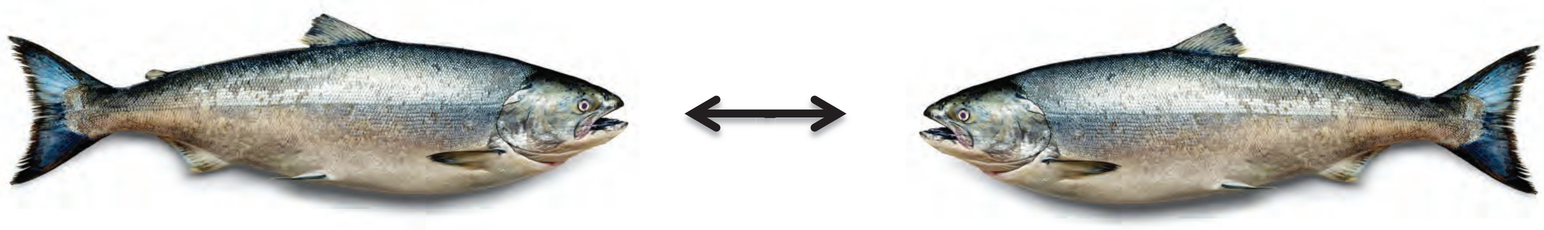


Causative agent: ***Flavobacterium columnare***
- Gram negative, aerobic bacteria

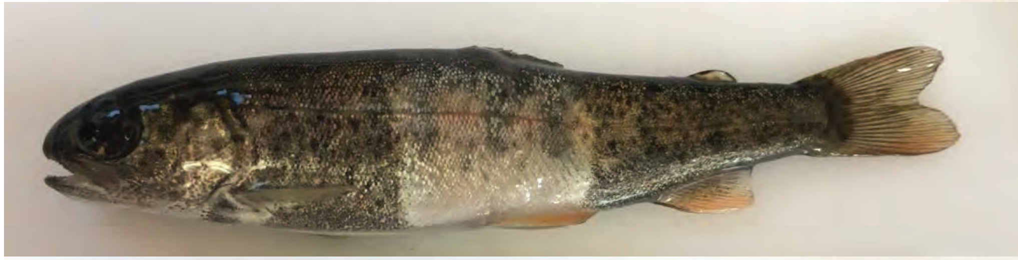


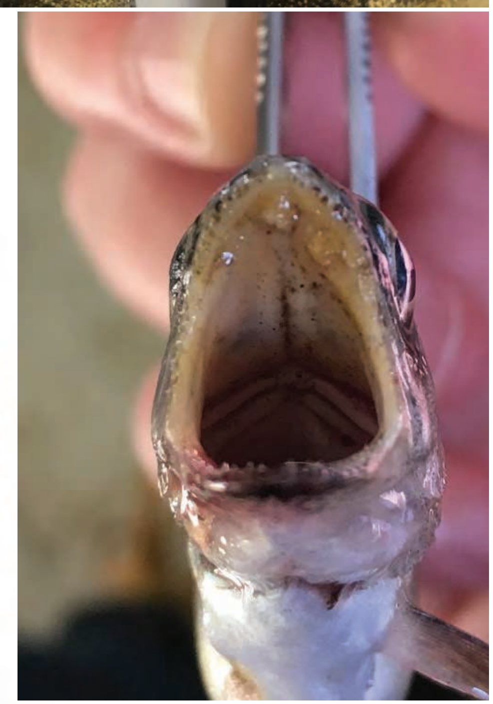
Risk Factors/Virulence Mechanisms
- Usually pathogenic above 59°F
- Crowding, reduced dissolved oxygen, handling, physical injury (abrasions), poor water quality (high nitrite)

Transmission: Horizontal (fish to fish)



Attachment D





Wells Hatchery Summer Chinook

1. CK:SU:WELL:2017:H, Pond 1, ~200 total broodstock:
    - Collected late July though early September.
    - Few pre-spawning mortalities observed before and on Oct 19th; by the 23rd losses had jumped to 30^{+} in one day (hens disproportionately affected)
    - Necrotic gill tissue and observation of *F. columnare* in wet mount preparation → Diagnosed with columnaris disease 10/24/17
2. Management Strategy
    - No interference (stress from treatments likely fatal; severity of lesions beyond benefit of therapeutic intervention). Spawn fish as soon as possible!
3. Resolution: Spawning cycle ended after egg program goals reached

We're not alone - regional and state-wide issue

Spring Chinook, Lyons Ferry 8/29/17

Spring Chinook, Lyons Ferry 9/12/17

Summer Chinook, Wallace 8/7/17

Summer Chinook, Wallace 9/6/17

Wells Hatchery Summer Steelhead

1. Summer Steelhead (SH:SU:WELL:2018:H), Pond 5, ~160 adult broodstock
   - Odd behavior observed, few mortalities noted late Nov 2017
   - Diagnosed with columnaris disease Nov 27th
2. Management Strategy – Phase 1
   - Successive three day 0.5 ppm potassium permanganate ($KMnO_4$) treatment repeated the following week at 1.0 ppm (post-acclimation adjustment); continued until Dec 7th.
     - ➢ Chloramine-T (Halamid® Aqua) considered but dismissed due to current DOE NPDES regulations for total free chlorine
   - 150 lbs of solar salt (every other day)
   - Prevented mortality escalation but losses continued to trickle in . . .

Date	Total Morts	Sex(es)	Marking(s)
11/24/17	1	F	Adipose Fin + Code Wire Tag
11/25/17	1	F	Adipose Fin
11/27/17	1	F	Adipose Fin + Code Wire Tag
12/19/17	1	F	Adipose Fin
12/20/17	2	F,M	Ad+CWT (F), Ad (M)
12/26/17	1	F	Adipose Fin + Code Wire Tag
12/27/17	1	F	Adipose Fin + Code Wire Tag
12/29/17	1	M	Adipose Fin
1/3/18	1	F	Adipose Fin + Right Ventral Fin
1/6/18	3	F,F,M	Adipose Fin (all)
1/8/18	2	F,F	Adipose Fin (all)

Wells Hatchery Summer Steelhead

Meanwhile, the condition of the females spawned remained good with little evidence of clinical manifestation of columnaris disease.

But, it still lurked in the background and handling events were to continue for weeks yet. Additional therapeutic options were considered.

Wells Hatchery Summer Steelhead

3. Management Strategy - Phase 2
   - Diquat (Reward®) was considered for its reported efficacy against cases of external flavobacteriosis in freshwater-reared finfish and higher margin of safety than other oxidizing chemicals
   - Use in food fish evaluated by the AADAP (Aquatic Animal Drug Approval Partnership Program) of the USFWS (INAD #10-969)
     - OTC product manufactured by Syngenta Corp Protection, LLC
     - T&E forms available for listed species
   - Two approved treatment protocols:
     - 2 – 18 mg/L for 1-4 h up to 4x on consecutive or alternate days
     - 19 – 28 mg/L for 0.5 – 1 h up to 3x on consecutive days
   - Three weekly treatments (18 ppm, 3 hrs, 3 days):
     - Jan 24th-26th; Jan 31st-Feb 3rd; Feb 8th-10th
   - ~10,000 ppm 5-10 min salt bath in spawning lift

Wells Hatchery Summer Steelhead

4. Resolution
   - Losses began to slowly decline after treatments
   - Disease progression halted; no mortalities recorded after Feb. 7th
   - Spawning has continued (last event on March 7th) without issue

Diquat Treatments

❶Jan 24th-26th

❷Jan 31st-Feb 3rd

❸Feb 8th-10th

Date	Total Morts	Sex(es)	Marking(s)
1/10/18	1	F	Adipose Fin + Code Wire Tag
1/14/18	1	F	Adipose Fin + Right Ventral Fin
1/17/18	1	F	Adipose Fin
1/19/18	1	F	Adipose Fin
1/20/18	2	F,F	Ad+CWT, Adipose Fin
1/24/18	1	F	Adipose Fin + Code Wire Tag
1/25/18	1	F	Adipose Fin
1/26/18	1	F	Adipose Fin
1/29/18	1	F	Adipose Fin
1/30/18	1	M	Adipose Fin + Code Wire Tag
2/7/18	1	F	Adipose Fin

5. Future Prevention
   - Consider prophylatic treatments if risk still deemed high
   - Precautionary vigilance – look for external signs and morbidity early
   - Heightened biosecurity and disinfection protocols between stocks
   - Treatment preparedness
     - Chemicals ready on site (stockpile of Diquat maintained)
     - DOE Lab Accreditation completed and approved for specific analyate analysis (for Chloramine-T use)


Questions?
http://barfblog.com/wp-content/uploads/2015/10/salmon_head.jpg

Wells and Methow Hatchery 2018 Program Projected Releases

March 12, 2018

Program	Release Target	Projected Releases 2018	Projected Releases % of Program	Notes
Summer Chinook Yearling	320,000	356,000	111%	
Summer Chinook Subyearling	484,000	460,000	95%	
Columbia Summer Steelhead	160,000	210,400	132%	As per previous HC adjustment
Methow Safety Net	100,000	72,700	73%	
Twisp Conservation	48,000	54,300	113%	
Methow Spring Chinook	109,126	124,000	114%	High fecundities and survival
Goat Wall Spring Chinook	25,000	30,000	120%	
Chewuch Spring Chinook	60,516	71,000	117%	
Twisp Spring Chinook	29,123	29,000	100%	

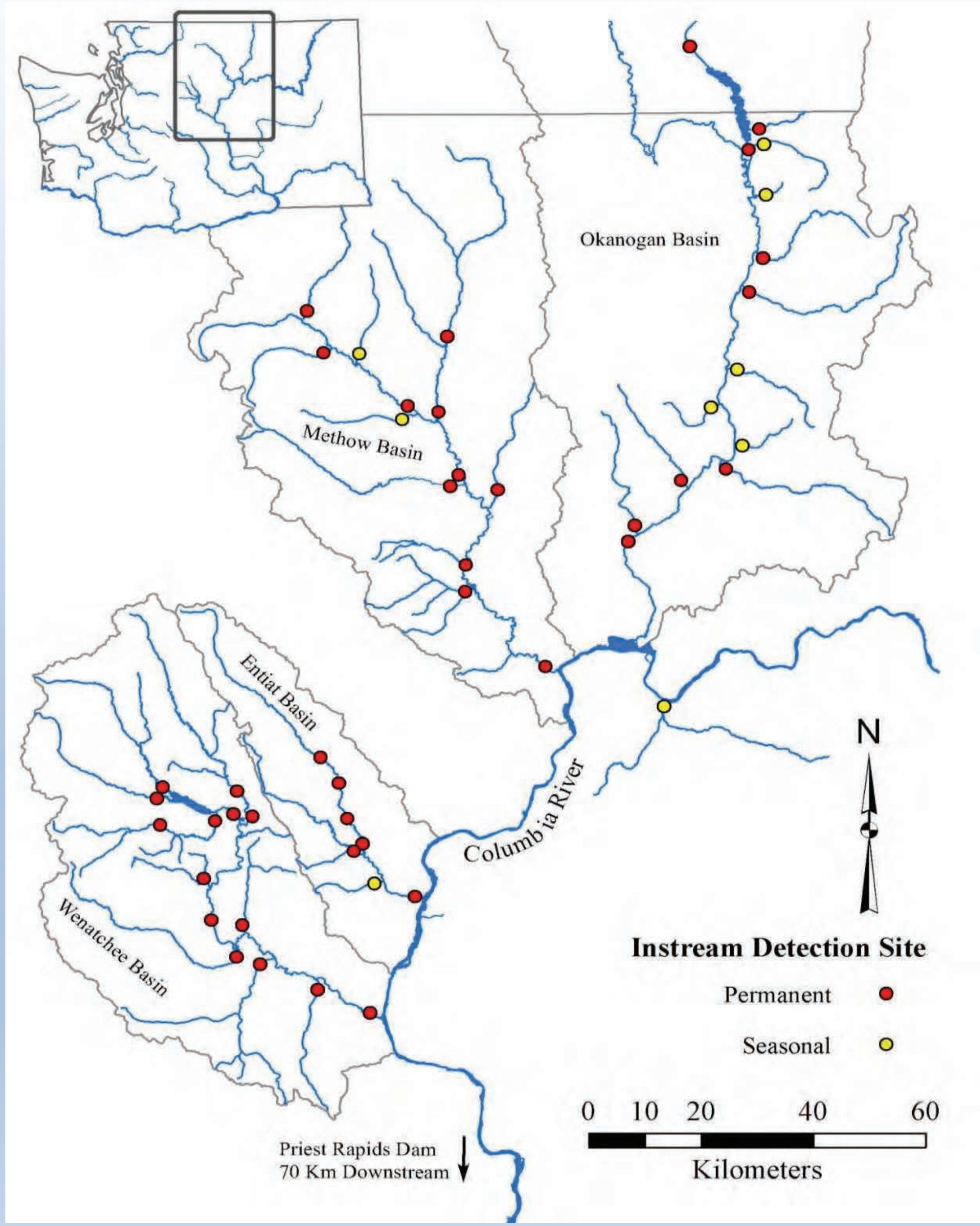
Estimating Steelhead Escapement in the Upper Columbia DPS

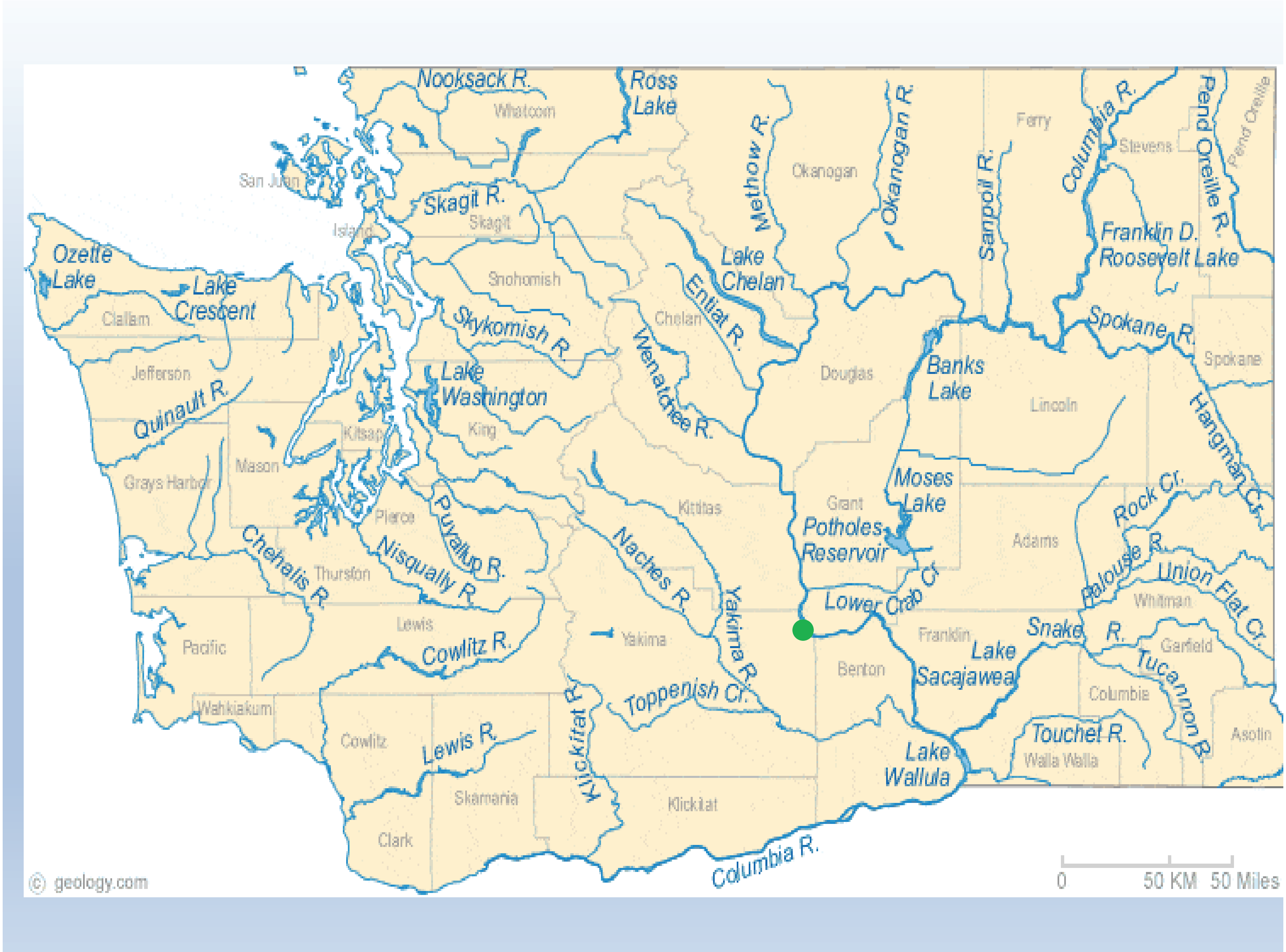
Andrew Murdoch, Ben Truscott, Charles Frady, Chad Herring (WDFW)
and
Kevin See (QCI)

Funded by
Bonneville Power Administration
Chelan County PUD
Grant County PUD
Douglas County PUD

Outline

- Estimate run escapement to each population
  - Wenatchee, Entiat, Methow and Okanogan
  - PIT tag based approach
- Estimate spawning escapement
  - Spring migration only (PIT tag approach)
  - Overwintering areas
    - Black Box (PIT)
    - Redds (GAUC)


Okanogan Basin
Methow Basin
Entiat Basin
Wenatchee Basin
Columbia River
N
Instream Detection Site
Permanent
Seasonal
0 10 20 40 60
Kilometers
Priest Rapids Dam
70 Km Downstream



Nooksack R.
Whatcom
Ross Lake
Methow R.
Okanogan
Okanogan R.
Ferry
Columbia R.
Stevens
Pend Oreille R.
Pend Oreille
San Juan
Skagit R.
Skagit
Island
Ozette Lake
Lake Crescent
Clallam
Snohomish
Lake Chelan
Entiat R.
Chelan
Sanpoil R.
Franklin D. Roosevelt Lake
Spokane R.
Spokane
Skykomish R.
Jefferson
Lake Washington
King
Wenatchee R.
Douglas
Banks Lake
Lincoln
Hangman Cr.
Quinault R.
Kitsap
Mason
Grays Harbor
Kittitas
Moses Lake
Grant
Potholes Reservoir
Adams
Rock Cr.
Pierce
Puyallup R.
Nisqually R.
Chehalis R.
Thurston
Naches R.
Yakima R.
Lower Crab Cr.
Palouse R.
Union Flat Cr.
Whitman
Lewis
Cowlitz R.
Yakima
Franklin
Snake R.
Lake Sacajawea
Garfield
Pacific
Benton
Tucannon R.
Columbia
Wahkiakum
Toppenish Cr.
Klickitat R.
Cowlitz
Lewis R.
Touchet R.
Walla Walla
Asotin
Lake Wallula
Skamania
Klickitat
Clark
Columbia R.
© geology.com
0
50 KM
50 Miles

PIT Tag Methodology

- Tag fish from run at large at Priest Rapids Dam
  - 3 days/week ~ 15% sample rate
  - Total counts adjusted by fallback/reascension rates

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- Examine detection histories for each fish to assign location
- Bayesian hierarchal patch occupancy model (POM)
  - Detection and occupancy probabilities
  - Estimate abundance
  - Waterhouse et al. *in prep*

Attachment F

Attachment F

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Patch Occupancy Model (POM)

- Requires representative adult sample
  - Priest Rapids, Prosser, Lower Granite

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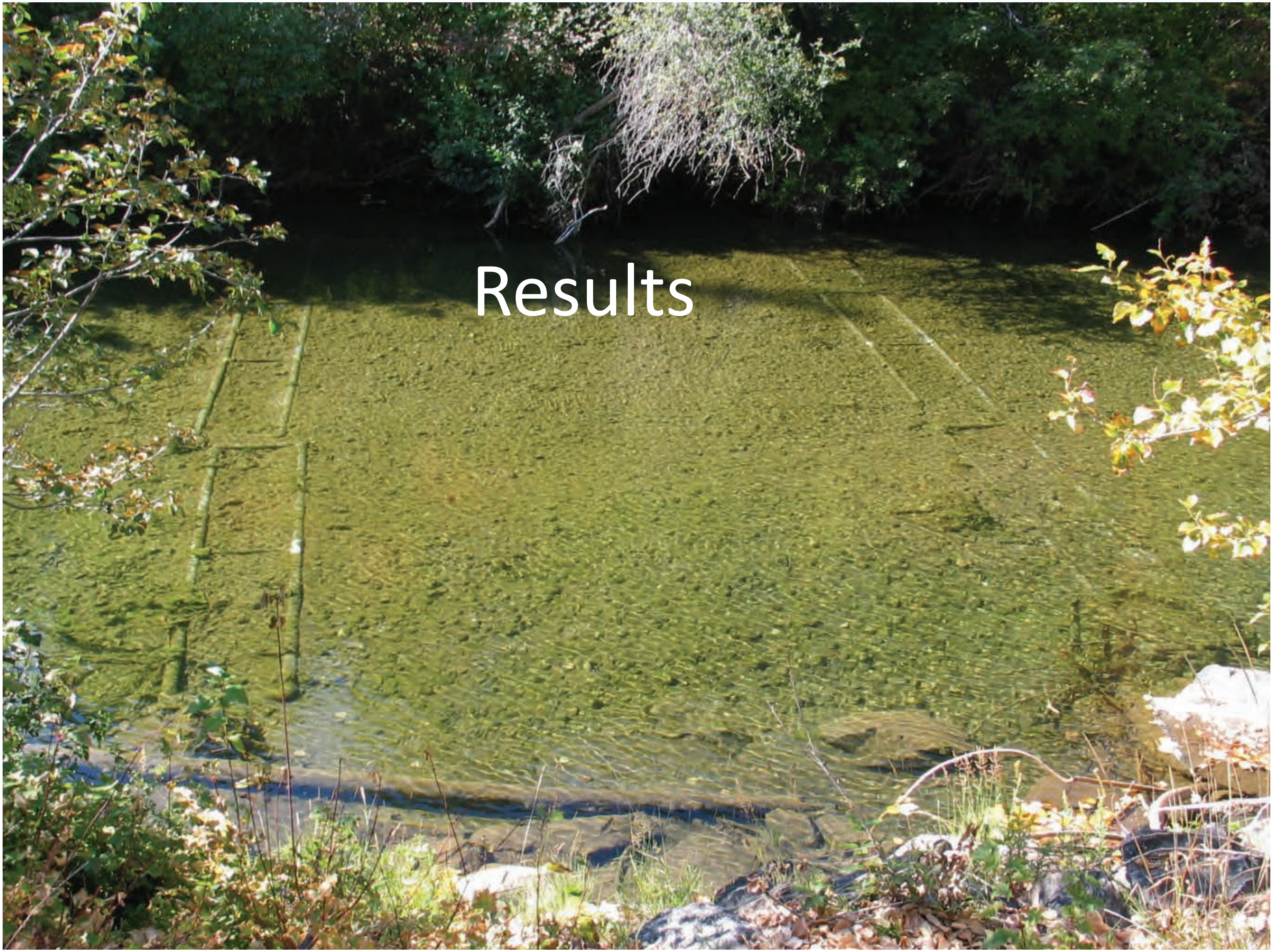
- Precision inversely related to sample size
  - N = Number of PIT tag resights
- Upstream arrays inform downstream array detection probabilities
- Streams with spring run fish only = spawners
  - RT study supports this assumption
  - Estimate spawner distribution
    - Based on PIT array locations


Results

2014 BY Run Escapement

Population	Population Run Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
Entiat River	67	22	31%		451	52	12%
Okanogan River	654	66	10%		458	55	11%
Methow River	2,005	104	5%		1,132	80	7%
Wenatchee River	981	77	8%		1,222	82	7%

2017 BY Run Escapement

Population	Population Run Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
Entiat River	63	17	27%		155	26	17%
Okanogan River	533	46	9%		69	17	25%
Methow River	1105	63	6%		443	41	9%
Wenatchee River	260	33	13%		240	32	13%

Run escapement may not = Spawner escapement

2017 BY Run Escapement

Population	Population Run Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
Entiat River	63	17	27%		155	26	17%
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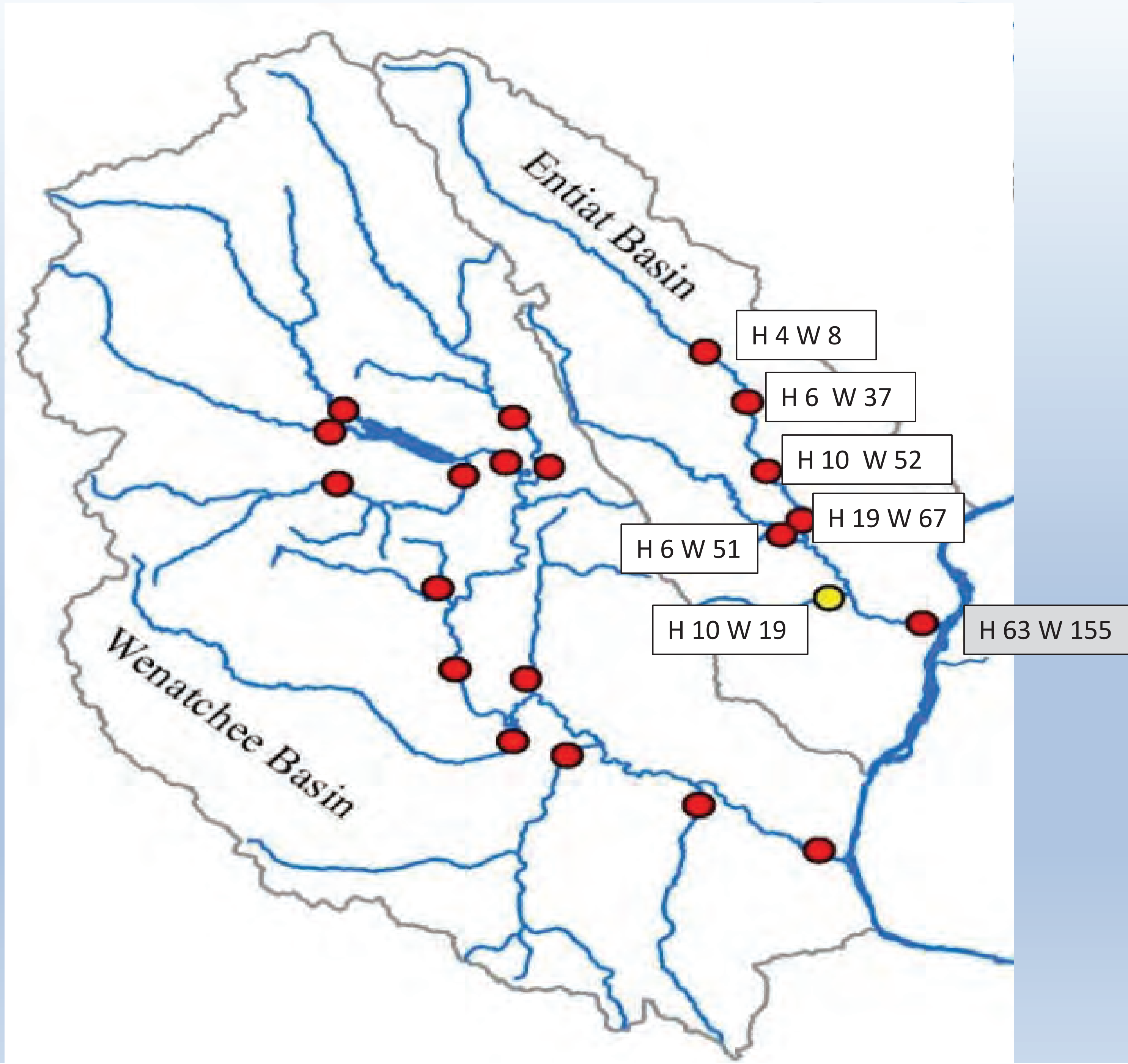
Wenatchee River	260	33	13%		240	32	13%

Entiat River

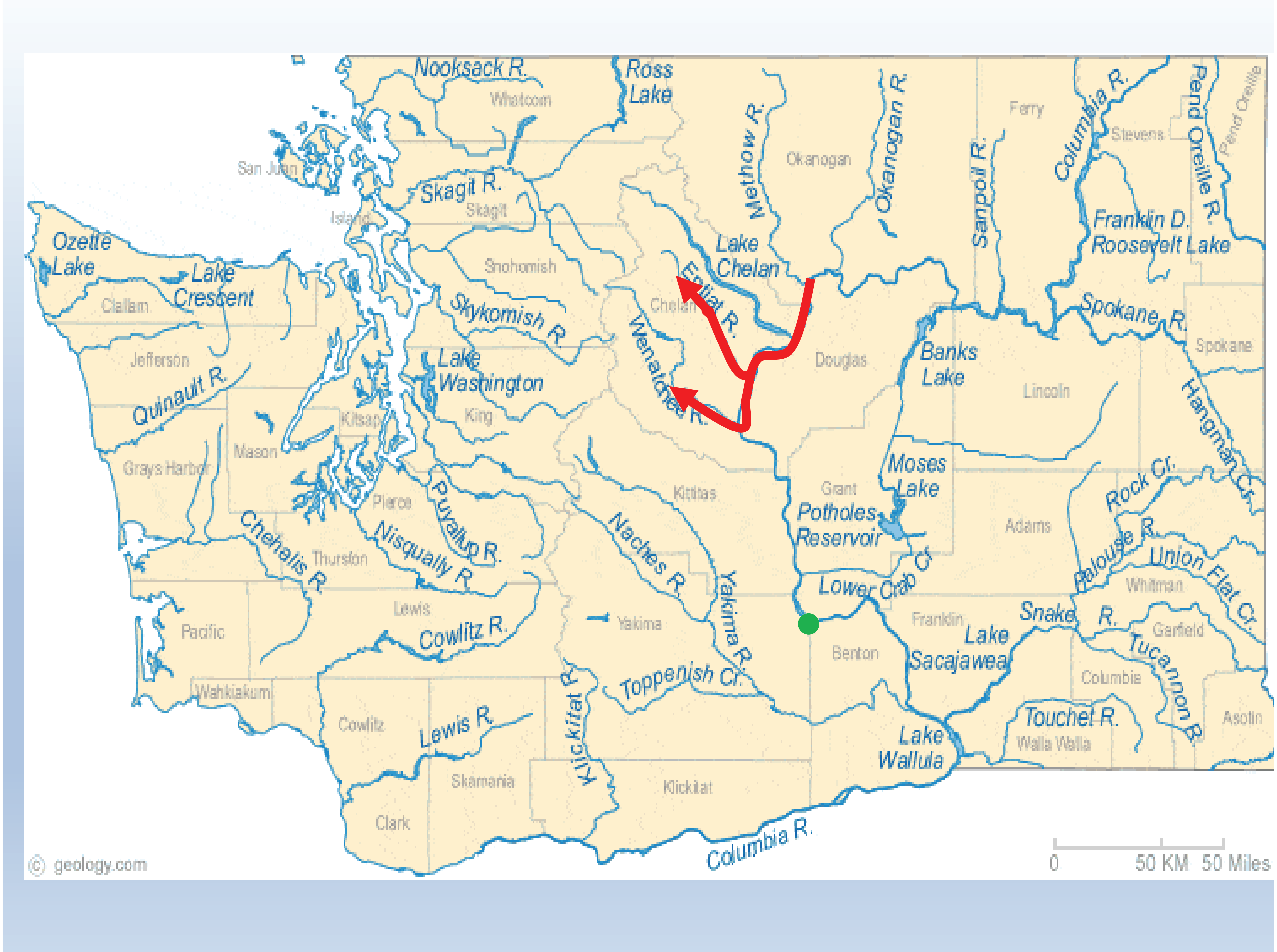
- PIT and RT data confirm no overwintering in the Entiat
- Spring run fish = Spawners
  - RT data supported this assumption
- Biological data from PRD also informs stock recruitment analysis
  - Sex, age, length, origin
- Can also derive reach scale spawner distribution

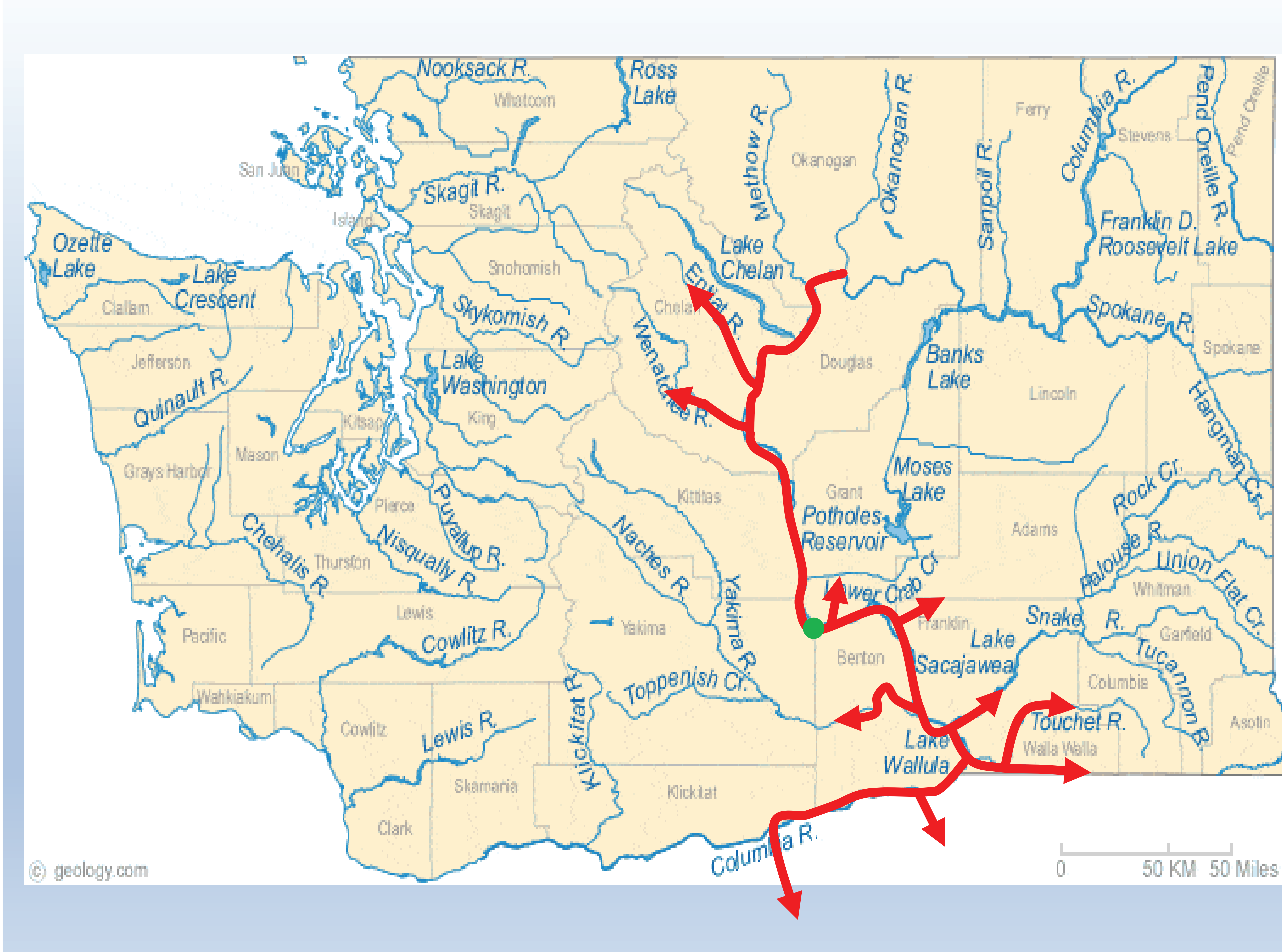

Entiat Basin
Wenatchee Basin
H 4 W 8
H 6 W 37
H 10 W 52
H 19 W 67
H 6 W 51
H 10 W 19
H 63 W 155

Entiat Steelhead Spawning Distribution

Reach/River KM	Hatchery	Wild
2 – 17	44%	12%
Roaring Ck.	16%	12%
Mad River	10%	33%
17 – 26	14%	10%
26 – 36	6%	10%
36 – 41	3%	12%
41 – 45	6%	12%

Attachment F





Nooksack R.
Whatcom
Ross Lake
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Okanogan
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Ferry
Columbia R.
Stevens
Pend Oreille R.
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Ozette Lake
Lake Crescent
Clallam
Lake Chelan
Franklin D. Roosevelt Lake
Snohomish
Skykomish R.
Entiat R.
Chelan
Spokane R.
Spokane
Jefferson
Wenatchee R.
Douglas
Banks Lake
Lincoln
Quinault R.
Lake Washington
King
Kitsap
Mason
Grays Harbor
Moses Lake
Hangman Cr.
Grant
Kittitas
Potholes Reservoir
Adams
Rock Cr.
Pierce
Puyallup R.
Chehalis R.
Nisqually R.
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Lower Crab Cr.
Palouse R.
Union Flat Cr.
Whitman
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Columbia R.
0
50 KM
50 Miles
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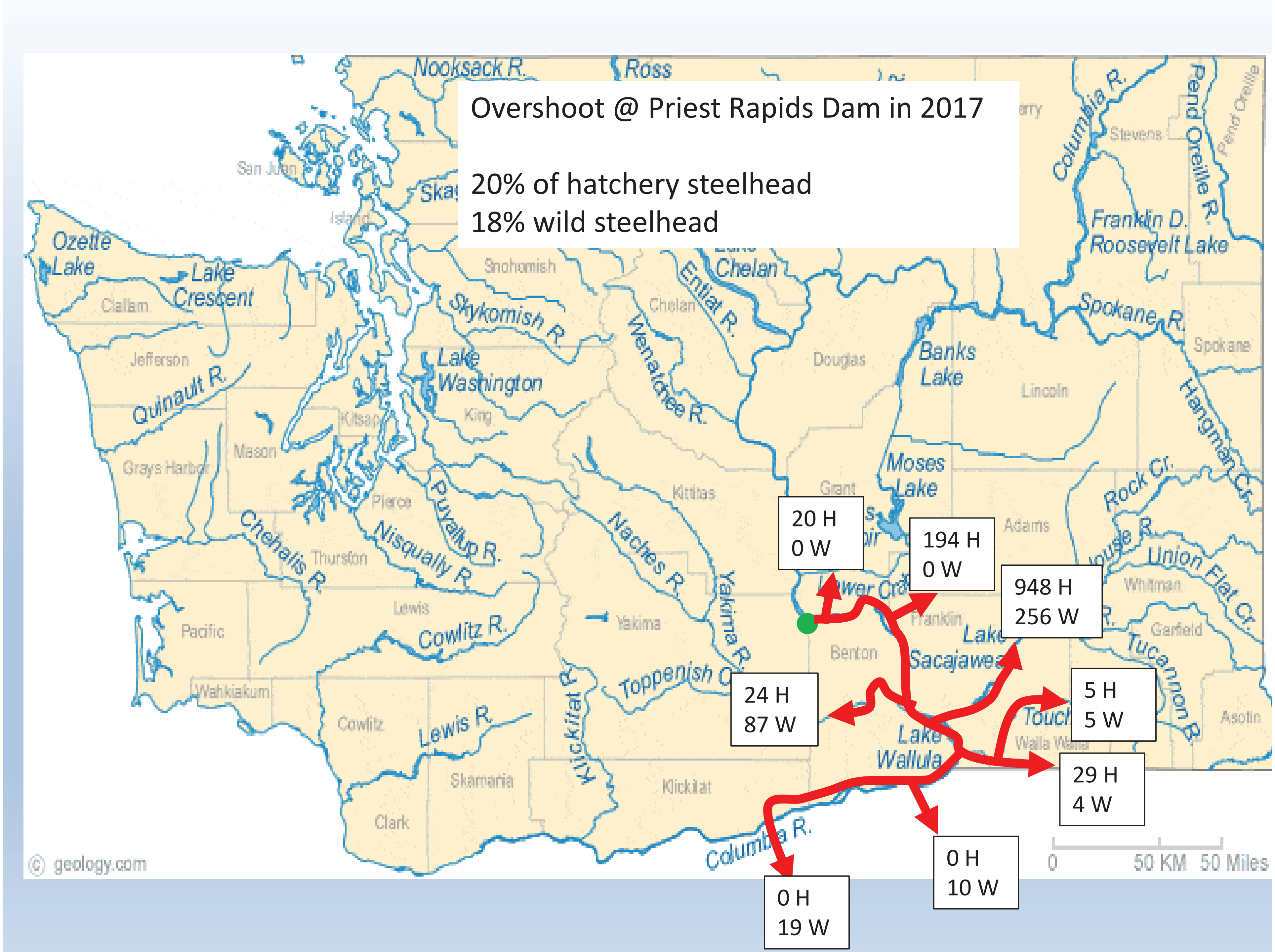

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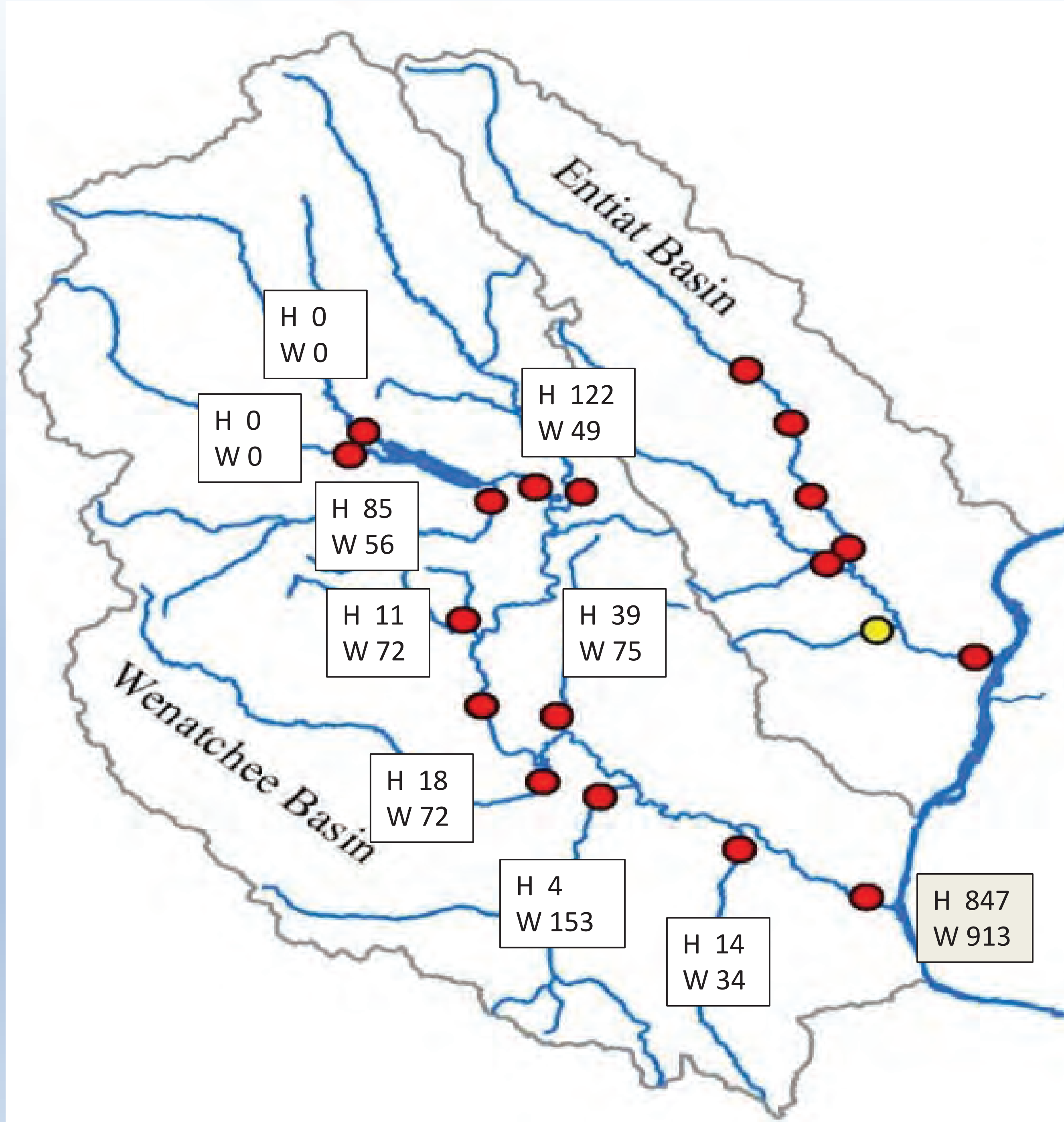
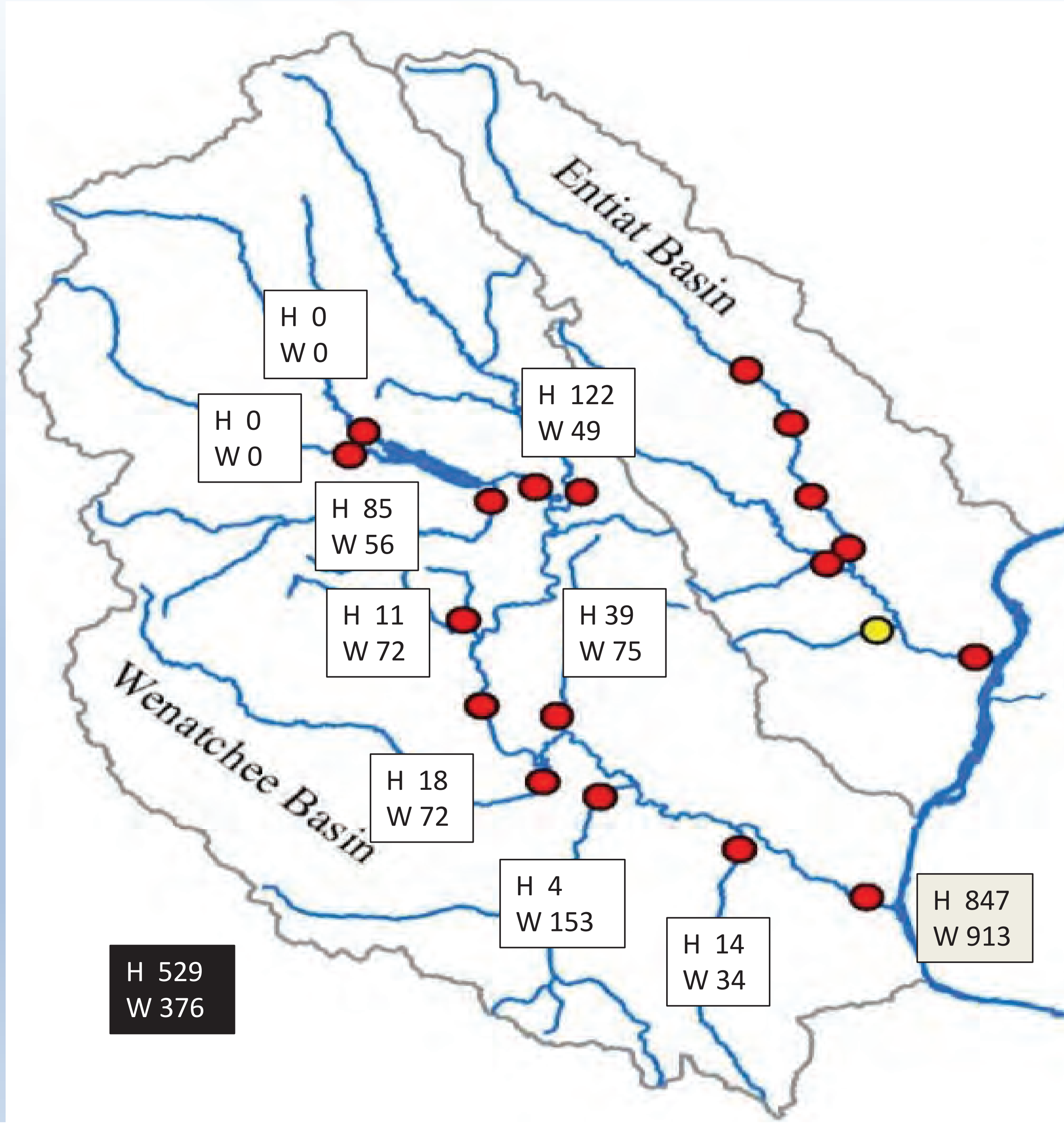
- Similar complex migration patterns have been documented for all species in the upper Columbia
  - Downstream or out of basin detection sites may be necessary to quantify fall back (i.e., reduce the black box)
- Does not directly estimate migration, overwinter or harvest related mortality
- For larger populations…….
  - Steelhead may overwinter and die or spawn in the same reach and never be detected again.
  - Downstream migration detection probabilities are lower than upstream.
  - Kelting rates are not 100% (RT study = 57%)



Entiat Basin
Wenatchee Basin
H 0
W 0
H 0
W 0
H 122
W 49
H 85
W 56
H 11
W 72
H 39
W 75
H 18
W 72
H 4
W 153
H 14
W 34
H 847
W 913


Entiat Basin
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H 0
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H 11
W 72
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W 75
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H 4
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W 376

Estimates of spawners derived from the “Black Box”

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  - Natural mortality
  - Mainstem spawners

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- When you simply cannot conduct redd surveys

Black Box Methodology

Group		Hatchery	Wild
Fall Run (PIT estimate*)		695	749
Broodstock (Hatchery)		-66	-67
Harvest (Creel) or Surplus		-290	0
Overwinter mortality (RT data)	22%/14%	-75	-96
Overwinter survivors		264	586
Spring Run (PIT estimate*)		152	164
Total spawners		416	750
Tributary spawners (PIT estimate)		296	519
Mainstem spawners (BB)		120	231

* Run escapement multiplied by proportion of fish entering before Jan 1 using RT data

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“A Primer”

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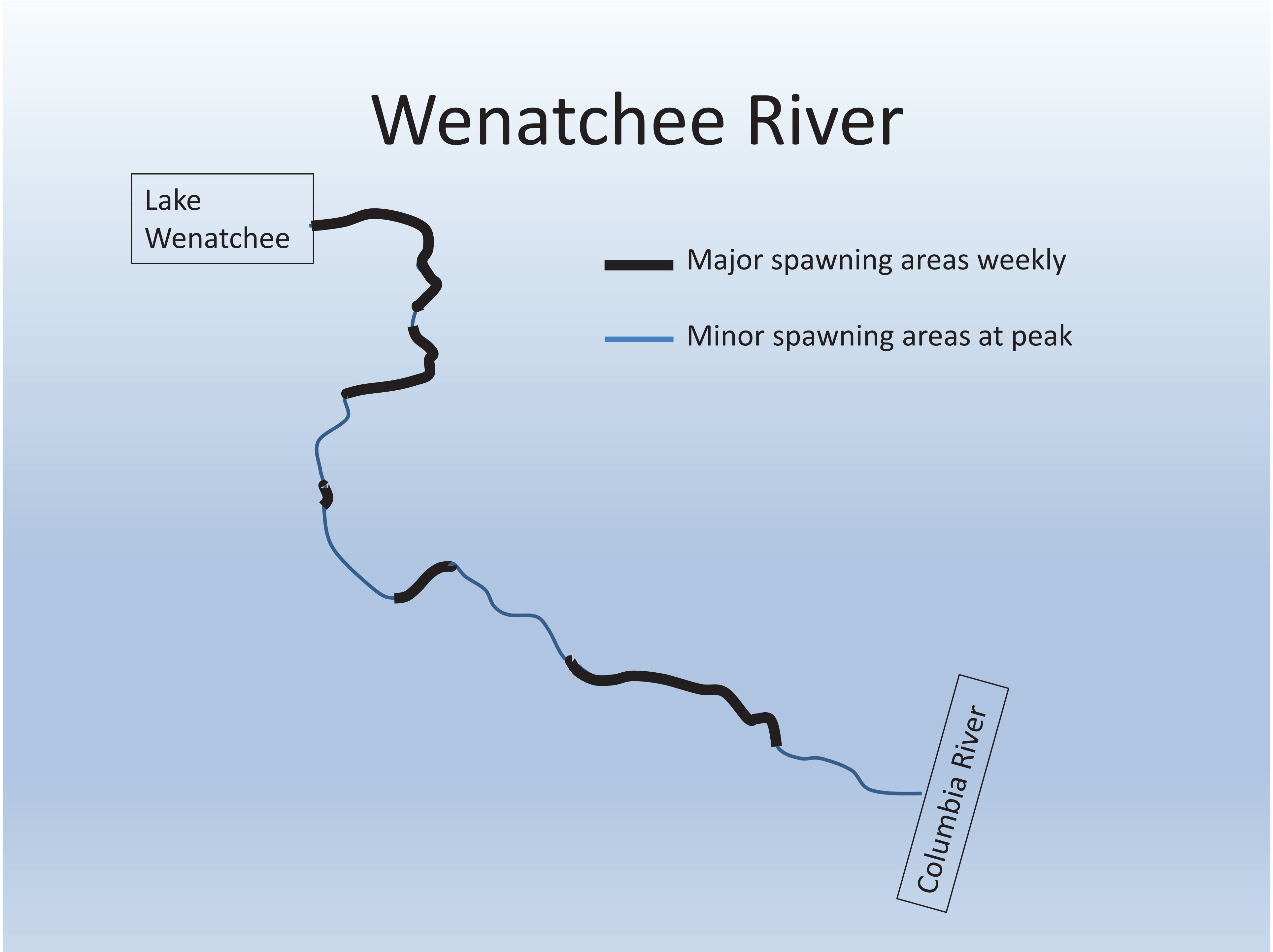
- Observer error is estimated using a model(s)


Wenatchee River
Lake Wenatchee
Major spawning areas weekly
Minor spawning areas at peak
Columbia River

Redd Surveys using a GAUC Framework

- Weekly redd surveys of major spawning reaches

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  - Use thalweg CV of major spawning area
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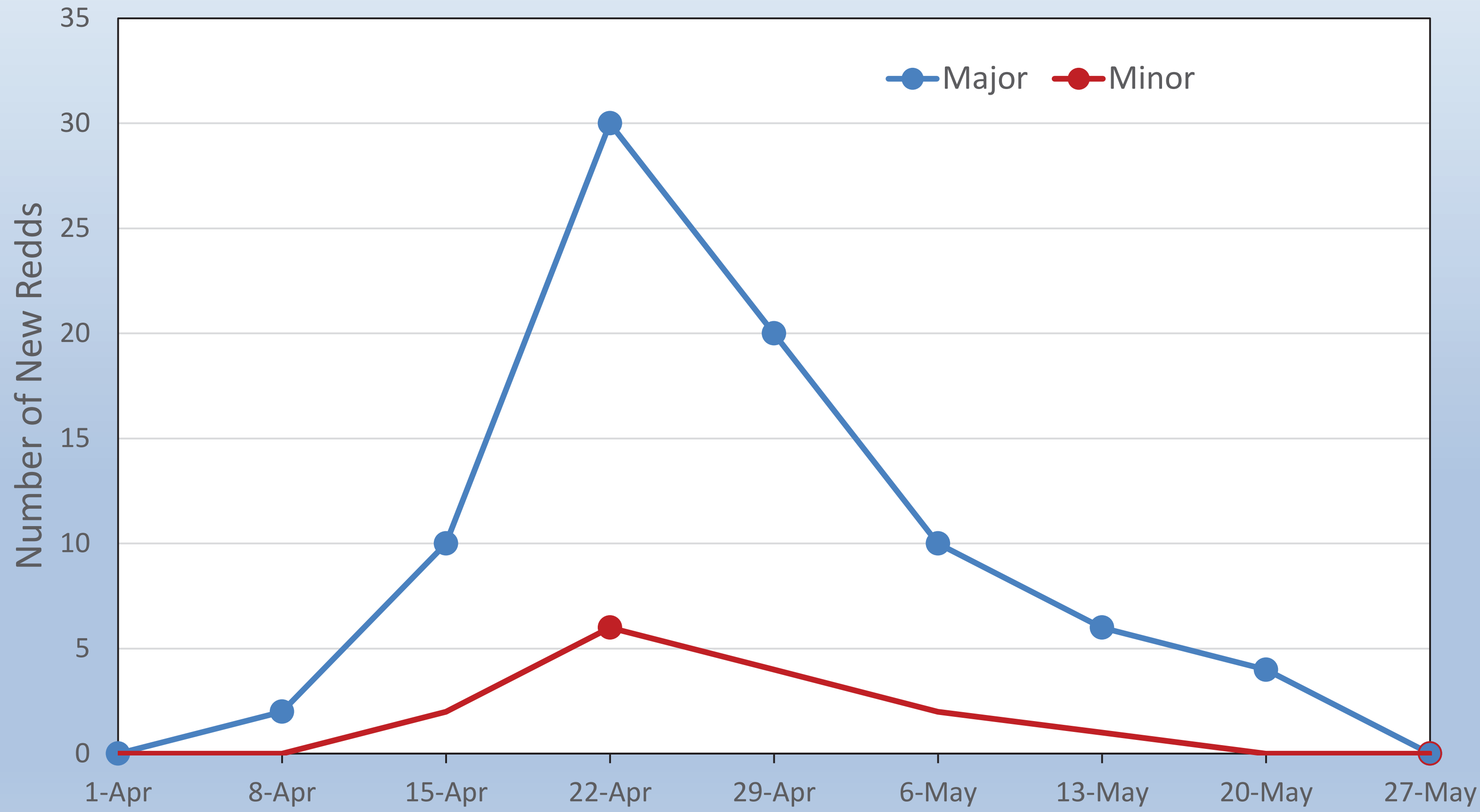
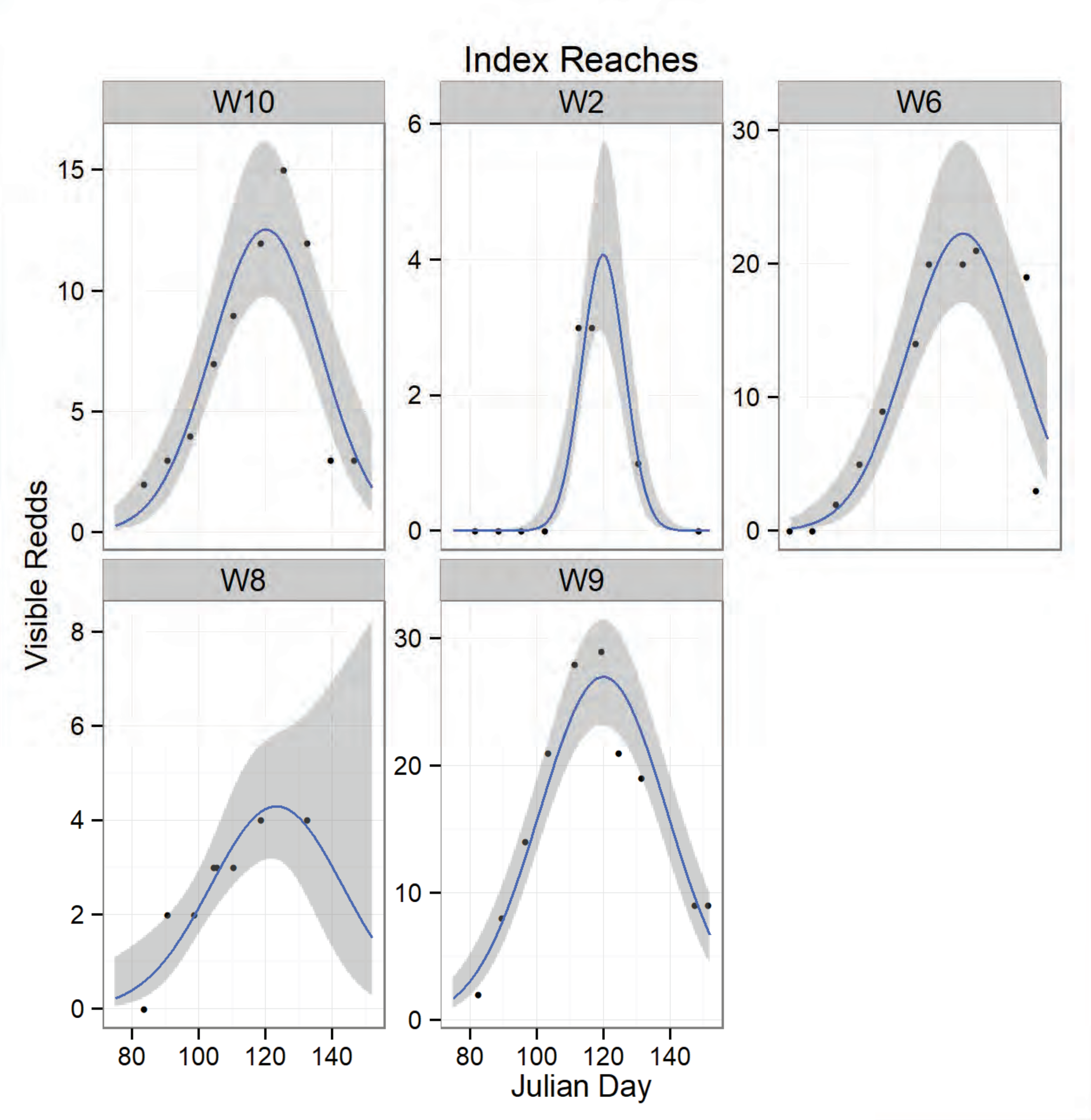
  - Same redd observers as major spawning area
  - Use thalweg CV of major spawning area
  - Other model covariates are reach specific
- Developed models to estimate observer error
  - 1 or 2 observers
  - Murdoch et al. 2018

Spawning Curve Examples

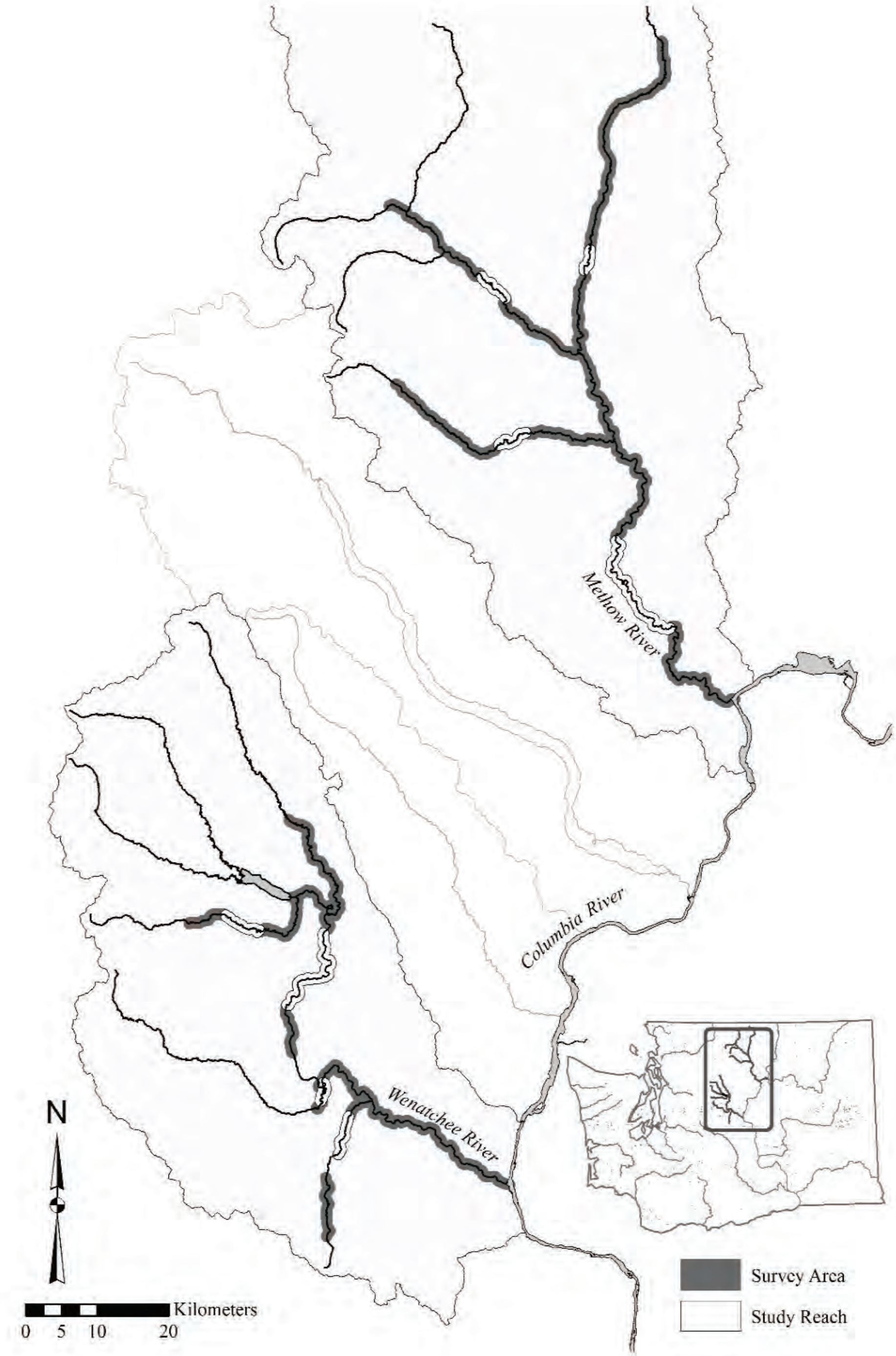




Index Reaches
W10
W2
W6
W8
W9
Visible Redds
Julian Day
0
5
10
15
0
2
4
6
0
10
20
30
0
2
4
6
8
0
10
20
30
80
100
120
140
80
100
120
140

Observer Error Models

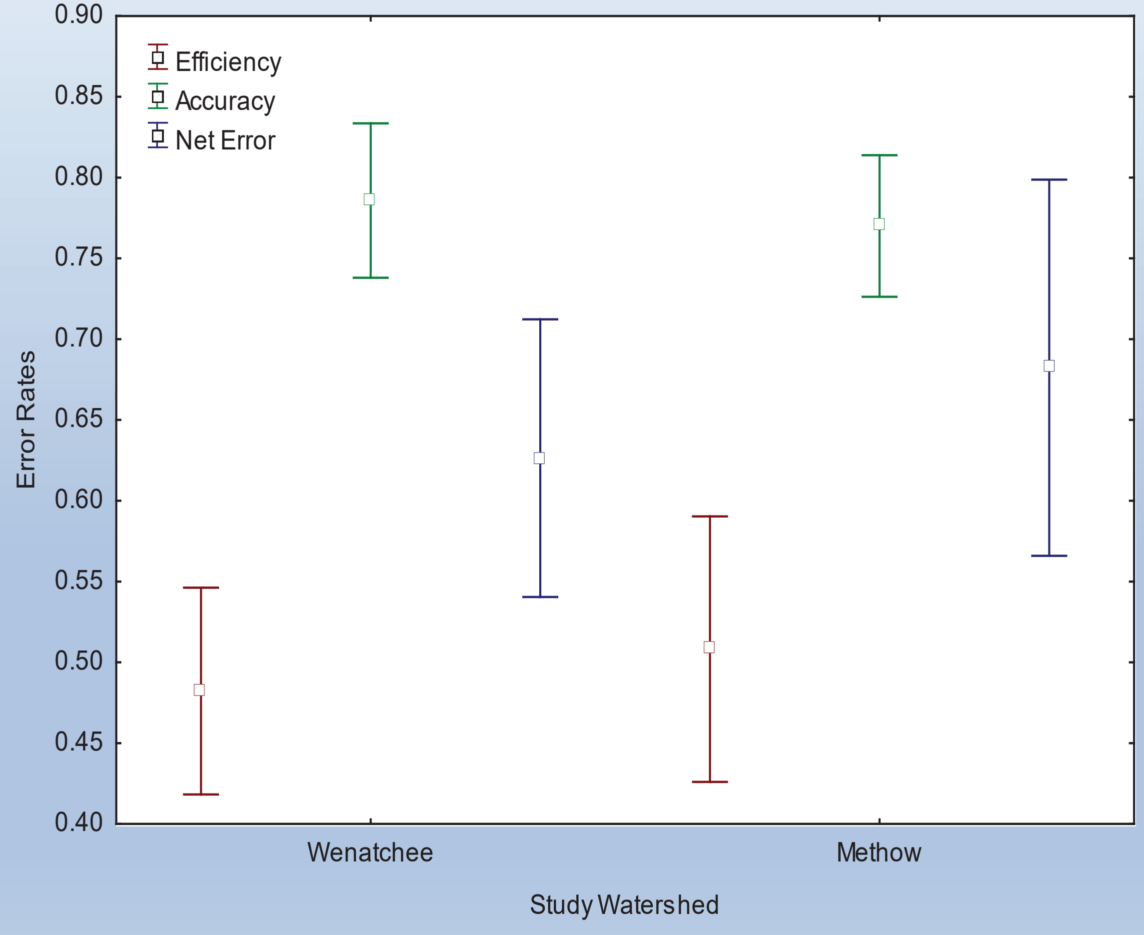
- Census surveys of study reaches every 3 days
  - No error or “the truth”
- Protocols
  - Wenatchee – single redd observer
  - Methow – two redd observers
- Naïve surveyors
  - Visible redds only
  - Wide range of experience
- Error rates
  - Omission, commission, net error
  - Adapted from Thurow’s work on MFSR



Methow River
Columbia River
Wenatchee River
N
Kilometers
0 5 10 20
Survey Area
Study Reach

Error Rates
(Model Development)

- Accuracy/Efficiency
  - 2 step process
  - Estimate accuracy
  - Estimate efficiency
- Net error
  - Error type cancel each other
  - 1 model



Model Selection

- Model averaging (Δ AIC < 2)
- All models performed similarly
  - Unbiased estimates of redds
- 2 observer net error model
  - One step
  - Greater 95% coverage probability
    - River condition on day of surveys (Discharge)
    - Habitat complexity in that reach (Thalweg CV)
    - Surveyor experience (Total salmon spawning ground)
    - Observed redd density (Population status)
    - River size (Stream width)

Model Covariates

One observer				Two observers		
Accuracy	Efficiency	Net Error		Accuracy	Efficiency	Net Error
Effort	Water depth	Water depth		Gradient	Gradient	Experience
	Thalweg CV	Thalweg CV		Experience	Experience	Thalweg CV
	Redd density	Redd density		Thalweg CV	Thalweg CV	Redd density
					Redd density	Discharge
					Water depth	Mean width

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	Thalweg CV	Thalweg CV	Experience	Experience	Thalweg CV
	Redd density	Redd density	Thalweg CV	Thalweg CV	Redd density
				Redd density	Discharge
				Water depth	Mean width

Red = Negative influence on error rates
Green = Positive influence on error rates

Net Error = 1 or a perfect survey
Average ~ 0.7

Estimated Number of Redds

Reach	Type	Redds Counted	Net Error	Net Error SE	Estimated redds Number	Estimated redds SE
W10	Major	16	0.62	1.13	30	22
W2	Major	4	0.75	1.28	5	5
W6	Major	25	0.42	1.46	63	39
W8	Major	4	0.49	0.92	16	8
W9	Major	46	0.61	1.45	78	70
W1	Minor	0	0.81	0.38	0	0
W3	Minor	2	0.88	0.38	2	1
W4	Minor	0	0.85	0.39	0	0
W5	Minor	0	0.85	0.39	0	0
All		**97**	**0.70**	**0.17**	**195**	**43**

Redds to Spawners

- Estimated number of redds from GAUC

Redds to Spawners

- Estimated number of redds from GAUC
- Estimated sex ratio of PIT tagged fish in black box
  - Assumes one redd per female
    - RT data support assumption but small sample size
  - Male to female ratio + 1 = # fish per redd
  - Example - 50% M 50% F = 2 fish per redd

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  - Example - 50% M 50% F = 2 fish per redd
- H/W ratio is also derived from PIT tags in black box


Spawner Escapement Estimates

Methods Review

- Spawning tributaries = POM estimates
- Overwintering reaches
  - GAUC redd estimates converted to spawners or
  - Spawners derived from POM black box estimates
- Population spawner escapement estimate
  - Tributary + Overwintering reaches

2016 Spawning Escapement

Tributary/Reach	Population Spawning Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
Wenatchee River Basin							
Mission Creek	13	9	0.69		33	13	0.38
Peshastin Creek	0	0	0.00		151	29	0.19
Chumstick Creek	39	14	0.37		74	20	0.27
Icicle Creek	18	10	0.53		72	18	0.25
Chiwaukum Creek	11	11	1.00		64	23	0.36
Chiwawa River	134	47	0.35		45	20	0.44
White River	0	0	0.00		8	6	0.80
Nason Creek	94	30	0.32		57	22	0.39
Wenatchee 1	0	0	0		0	0	0
Wenatchee 2	0	0	0		0	0	0
Wenatchee 3	0	0	0		0	0	0
Wenatchee 4	0	0	0		0	0	0
Wenatchee 5	0	0	0		0	0	0
Wenatchee 6	6	9	1.43		12	17	1.42
Wenatchee 8	1	1	0.6		1	1	0.6
Wenatchee 9	21	31	1.48		27	40	1.48
Wenatchee 10	63	88	1.39		78	108	1.39
Wenatchee Basin Total	**400**	**124**	**0.31**		**621**	**155**	**0.25**

2016 Spawning Escapement

Tributary/Reach	Population Spawning Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
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Chiwaukum Creek	11	11	1		64	23	0.36
Chiwawa River	134	47	0.35		45	20	0.44
White River	0	0	0		8	6	0.8
Nason Creek	94	30	0.32		57	22	0.39
Wenatchee 1	0	0	0		0	0	0
Wenatchee 2	0	0	0		0	0	0
Wenatchee 3	0	0	0		0	0	0
Wenatchee 4	0	0	0		0	0	0
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Wenatchee 6	6	9	1.43		12	17	1.42
Wenatchee 8	1	1	0.60		1	1	0.60
Wenatchee 9	21	31	1.48		27	40	1.48
Wenatchee 10	63	88	1.39		78	108	1.39
Wenatchee Basin Total	**400**	**124**	**0.31**		**621**	**155**	**0.25**

2016 Spawning Escapement

Tributary/Reach	Population Spawning Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
Wenatchee River Basin							
Mission Creek	13	9	0.69		33	13	0.38
Peshastin Creek	0	0	0.00		151	29	0.19
Chumstick Creek	39	14	0.37		74	20	0.27
Icicle Creek	18	10	0.53		72	18	0.25
Chiwaukum Creek	11	11	1.00		64	23	0.36
Chiwawa River	134	47	0.35		45	20	0.44
White River	0	0	0.00		8	6	0.80
Nason Creek	94	30	0.32		57	22	0.39
Wenatchee 1	0	0	0		0	0	0
Wenatchee 2	0	0	0		0	0	0
Wenatchee 3	0	0	0		0	0	0
Wenatchee 4	0	0	0		0	0	0
Wenatchee 5	0	0	0		0	0	0
Wenatchee 6	6	9	1.43		12	17	1.42
Wenatchee 8	1	1	0.60		1	1	0.60
Wenatchee 9	21	31	1.48		27	40	1.48
Wenatchee 10	63	88	1.39		78	108	1.39
Wenatchee Basin Total	**400**	**124**	**0.31**		**621**	**155**	**0.25**

Black Box vs. Redds

- GAUC will incorporates more interannual variability and provides spatial distribution data
- Estimates of redds (GAUC) provide an unbiased estimates of redds and is the preferred approach in overwintering reaches:
  - Wenatchee (Mouth to Lake)
  - Methow (Mouth to Winthrop)
  - Okanogan (Mouth to Lake)
- In some years redd surveys cannot be conducted per protocol (i.e., mother nature)
  - Black box approach is an alternative method

Black Box Methodology

		Hatchery	Wild
Fall Run (PIT estimate*)		695	749
Broodstock (Hatchery)		-66	-67
Harvest (Creel) or Surplus		-290	0
Overwinter mortality (RT data)	22%/14%	-75	-96
Spring Run (PIT estimate*)		152	164
Total spawners		416	750
Tributary spawners (PIT estimate)		296	519
Mainstem spawners (BB)		**120**	**231**

Black Box Methodology

		Hatchery	Wild	Total
Fall Run (PIT estimate*)		695	749	1,444
Broodstock (Hatchery)		-66	-67	-133
Harvest (Creel) or Surplus		-290	0	-290
Overwinter mortality (RT data)	22%/14%	-75	-96	-171
Spring Run (PIT estimate*)		152	164	316
Total spawners		416	750	1,166
Tributary spawners (PIT estimate)		296	519	815
Mainstem spawners (BB)		**120**	**231**	**351**
Mainstem Spawners (Redds)		**130**	**167**	**297**

Black Box Methodology

		Hatchery	Wild	Total
Fall Run (PIT estimate*)		695	749	1,444
Broodstock (Hatchery)		-66	-67	-133
Harvest (Creel) or Surplus		-290	0	-290
Overwinter mortality (RT data)	22%/14%	-75	-96	-171
Spring Run (PIT estimate*)		152	164	316
Total spawners		416	750	1,166
Tributary spawners (PIT estimate)		296	519	815
Mainstem spawners (BB)		**120**	**231**	**351**
Mainstem Spawners (Redds)		**130**	**167**	**297**

PIT/Redd = 1,110 spawners
PIT/BB = 1,166 spawners (+5% bias)

2014 Spawning Escapement

Tributary/Reach	Population Spawning Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
Wenatchee River Basin							
Mission Creek	31	16	0.406		94	24	0.259
Peshastin Creek	6	10	0.733		226	39	0.174
Chumstick Creek	7	10	0.701		78	23	0.286
Icicle Creek	45	19	0.357		76	24	0.275
Chiwaukum Creek	9	9	0.683		37	17	0.372
Chiwawa River	103	26	0.238		142	31	0.207
Nason Creek	148	31	0.210		190	34	0.180
W1	0	0	0.320		0	0	0.320
W2	5	5	0.960		3	3	0.960
W3	2	1	0.354		1	0	0.354
W4	0	0	0.421		0	0	0.421
W5	0	0	0.421		0	0	0.421
W6	69	43	0.621		38	24	0.621
W8	15	7	0.465		12	6	0.465
W9	74	67	0.901		58	52	0.901
W10	29	21	0.728		22	16	0.728
Wenatchee Basin Total	**545**	**97**	**0.178**		**978**	**96**	**0.098**

2017 Spawning Escapement

Tributary/Reach	Population Spawning Escapement Estimate						
	Hatchery				Wild		
	Estimate	SE	CV		Estimate	SE	CV
Wenatchee River Basin							
Mission Creek	12	8	0.642		20	10	0.480
Peshastin Creek	0	0	0.000		37	13	0.349
Chumstick Creek	0	0	0.000		11	8	0.709
Icicle Creek	21	9	0.484		11	7	0.645
Chiwaukum Creek	0	0	0.000		0	0	0.000
Chiwawa River	34	20	0.594		12	9	0.742
Nason Creek	26	10	0.400		24	10	0.421
W1	0	0	0.000		0	0	0.000
W2	1	0	0.260		2	0	0.210
W3	0	0	0.000		0	0	0.000
W4	0	0	0.000		0	0	0.000
W5	0	0	0.000		0	0	0.000
W6	8	3	0.370		12	4	0.330
W8	2	0	0.190		2	0	0.210
W9	54	17	0.310		44	14	0.320
W10	73	26	0.350		57	21	0.360
Wenatchee Basin Total	**231**	**88**	**0.380**		**232**	**88**	**0.380**

Future work

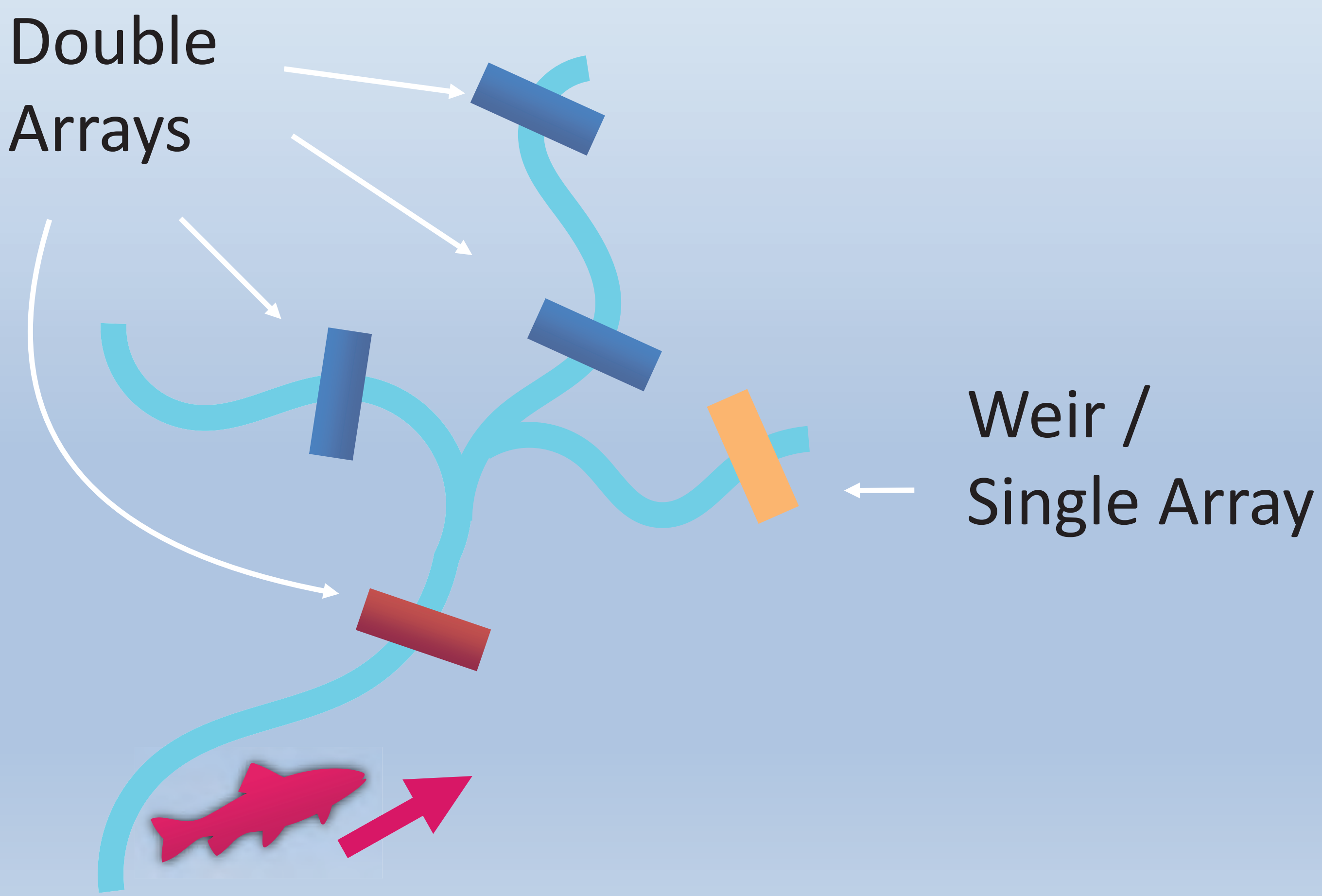
- Representative adult samples are not available everywhere
  - Current locations
    - Priest Rapids
    - Lower Granite
    - Prosser (Chris Fredrickson YN)
  - Possible future locations
    - Klickitat-Lyle Falls
    - Umatilla-Three Mile Dam
    - Others?
- WDFW will be developing models that can use smolt trap and hatchery data in a POM framework

Acknowledgements

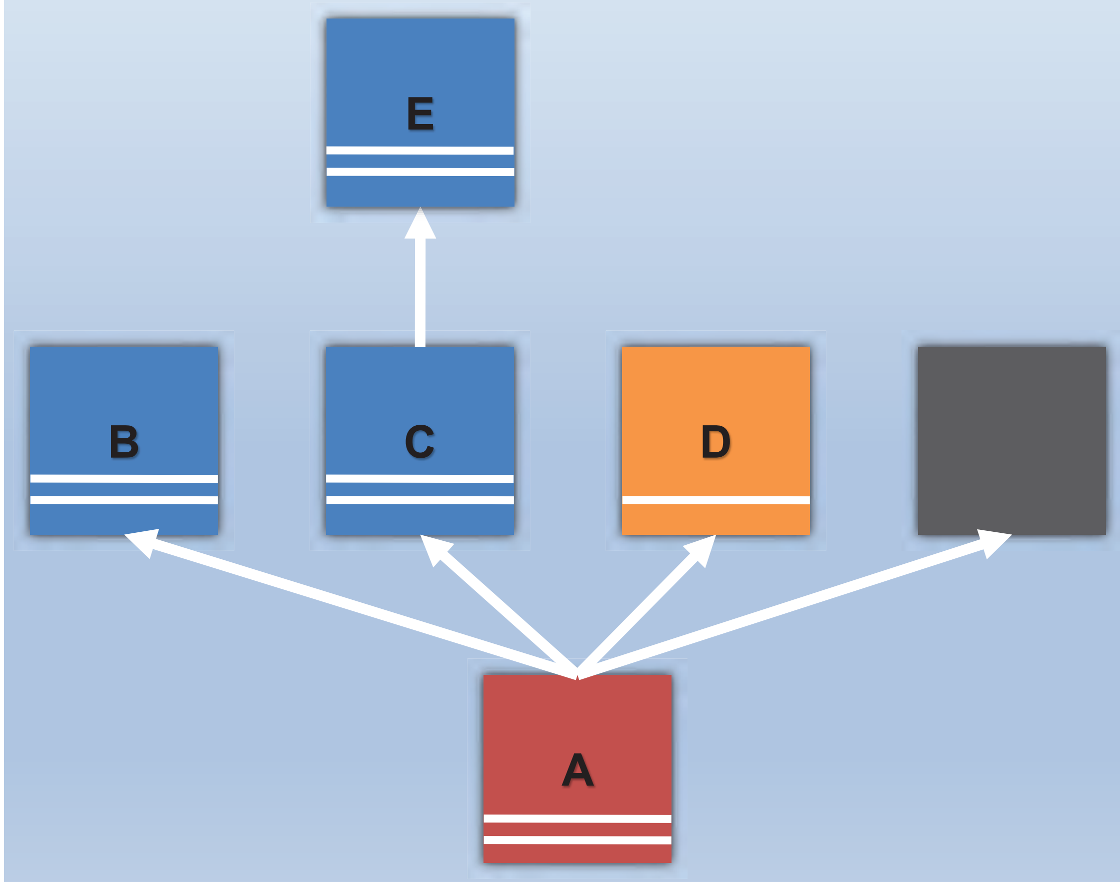
- QCI for developing original POM (Brice Semmens and Jody White)
- Russel Thurow and Claire McGrath for pioneering research on redd observer error rates.
- CCT for O & M of PIT arrays in tributaries of the Okanogan
- CRSSE for funding lower PIT arrays in Wenatchee, Methow and Okanogan
- GCPUD for new OLAFT and access at PRD.
- Susannah Iltis (DART) for PRD fallback/ reascension query


Questions

Model



Model Pieces



Movement Probabilities (Ψ)

A $\rightarrow$ B

A $\rightarrow$ C

A $\rightarrow$ D

A $\rightarrow$

C $\rightarrow$ E

$$A \rightarrow E = (A \rightarrow C) \times (C \rightarrow E)$$

Detection Probabilities (p)

Estimate: A, B, C, E

Fixed: D

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: May 19, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the April 18, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held at the Wells Hatchery at Wells Dam on Wednesday, April 18, 2018, from 9:00 to 12:15 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam and present this information at the Hatchery Committees May 16, 2018 meeting (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A). *(Note: this item is ongoing.)*
- Sarah Montgomery will reconfigure the Extranet site to sort permits and Biological Opinions (BiOps) by species and date and upload the related documents (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A). *(Note: this item is ongoing.)*
- Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB's) *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will send Mary Conner et al.'s 2016 paper, "Evaluating impacts using a BACI design, ratios, and a Bayesian approach with a focus on restoration," to the Hatchery Committees (Item I-A). *(Note: Hillman distributed the paper following the meeting on April 18, 2018.)*

- Matt Cooper will invite Chris Tatara (National Oceanic and Atmospheric Administration [NOAA]) to the Hatchery Committees May or July 2018 meeting to discuss steelhead residualism (Item II-A). *(Note: Tatara plans to attend the July 18, 2018 Hatchery Committees meeting.)*
- Matt Cooper will ask Penny Swanson (NOAA) about how feeding patterns during a 2-month holding period might compromise studying early maturation in steelhead (Item II-A).
- Charlene Hurst will send a Word version of the final steelhead BiOp to Greg Mackey and Matt Cooper (Item III-A).
- Keely Murdoch will invite Melinda Davis and Mark Johnston (Yakama Nation [YN]) to the Hatchery Committees July meeting to discuss the YN summer Chinook salmon program (Item III-B).
- Sarah Montgomery will distribute the document, "Emerging Discussions from draft 2018 Broodstock Collection Protocols," to the Hatchery Committees (Item III-B). *(Note: Montgomery distributed this document on April 19, 2018.)*
- Greg Mackey will research the second item in the Emerging Discussions document, whether to include age-3 males in broodstock, prior to the Hatchery Committees May 16, 2018 meeting for further discussion (Item III-B).
- Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (BKD) (Item III-B).
- Betsy Bamberger will present information on optical density values and BKD to the Hatchery Committees during their May 2018 meeting (Item III-B).
- Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item III-B).
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item III-B).

Decisions

- The HCP Hatchery Committees approved the draft 2018 Broodstock Collection Protocols as follows: WDFW, Douglas PUD, Chelan PUD, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), YN, and CCT approved on April 18, 2018 (Item III-B). *(Note: the Wells HCP Coordinating Committee approved the Wells portion of this document during their April 24, 2018, meeting.)*

Agreements

- The Rocky Reach and Rock Island HCP Hatchery Committees agreed to implement lethal, post-release, early maturation sampling for steelhead as described in the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program* (Item II-A).

Review Items

- There are no items currently available for review.

Finalized Documents

- Sarah Montgomery sent an email to the HCP Hatchery Committees on April 19, 2018, notifying them that the Final 2018 Broodstock Collection Protocols are now available for download from the Hatchery Committees Extranet site (Item III-B). *(Note: the final version approved by the Wells HCP Coordinating Committee was provided to NOAA on April 24, 2018.)*

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the March 12, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. There were no changes.

The Hatchery Committees representatives reviewed the revised draft March 12, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft March 12, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on March 12, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on March 12, 2018)*:

- *Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam (Item I-A)*. Mike Tonseth said Andrew Murdoch will present this information at the Hatchery Committees May 16, 2018 meeting.
- *Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A)*. Tonseth said this item is ongoing.

- *Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A).* Tonseth said he received an update on this from Seamons and will provide his review to the Hatchery Committees soon. He said Seamons identified no major issues from a genetic standpoint with the alternatives but preferred alternative 1 to alternative 3.
- *Brett Farman will coordinate with Craig Busack (National Marine Fisheries Service [NMFS]) regarding reviewing the memorandum, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A).* Farman said he and Busack discussed this and Busack communicated no major issues.
- *Sarah Montgomery will reconfigure the Extranet site to sort permits and Biological Opinions (BiOps) by species and date and upload the related documents (Item I-A).* Montgomery said Julene McGregor (Douglas PUD) updated the website and this item is ongoing.
- *Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A).* Truscott said this item is ongoing.
- *Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A).* Hillman said this item is ongoing.
- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB's) Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A)*. Hillman said this item is ongoing. He said he will begin editing the Monitoring and Evaluation Plan soon and plans to work with Carl Schwarz at Simon Fraser University regarding his feedback to the plan. Hillman said one consideration for revision includes Bayesian analyses for Before–After Control-Impact (BACI)-type designs (for which he will distribute an interesting recent paper, Conner et al. 2016[1]). Another consideration is setting up null hypotheses as differences between treatment groups, which is the concept of bioequivalence (i.e., the hatchery programs are "guilty" until proven "innocent"). Currently, null hypotheses are set up as no differences between treatment groups (i.e., hatchery programs are "innocent" until proven "guilty"). For example, the Hatchery Committees could decide that a 4-centimeter (cm) or greater mean difference in size-at-return of hatchery versus wild fish would be a biologically significant effect, so any results within less than a 4 cm mean difference would maintain the null hypothesis (no significant effect). Hillman summarized that he will continue working with ISAB members on these topics and the ISAB was encouraged that the Hatchery Committees are considering their feedback.

[1] Conner, M.M., W.C. Saunders, N. Bouwes, and C. Jordan. 2016. Evaluating impacts using a BACI design, ratios, and a Bayesian approach with a focus on restoration. Environmental Monitoring and Assessment (2016) 188:555.

- *Hatchery Committees representatives and alternates will review the draft Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program and consider options for discussion at the April 18, 2018 Hatchery Committees meeting (Item II-B).* This item will be discussed today.
- *Greg Mackey will revise the Wells and Methow Hatchery 2018 Program Projected Releases document (Item III-C).* Mackey revised the document and Sarah Montgomery distributed it to the Hatchery Committees on March 13, 2018.
- *Sarah Montgomery and Mike Tonseth will coordinate as needed to potentially schedule a conference call to discuss comments and questions on the draft 2018 Broodstock Collection Protocols (Item V-B).* A call was not scheduled.
- *The Hatchery Committees will hold their April 18, 2018 meeting at Wells Fish Hatchery (Item VI-A).* This item is complete.

II. Chelan PUD

A. Proposed Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program (Catherine Willard)

Catherine Willard said the Hatchery Evaluation Technical Team convened to discuss the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program* (Attachment B). Willard said the two components requiring Hatchery Committees discussion are a passive integrated transponder (PIT)-tag evaluation and lethal sampling. She said Chelan PUD plans to complete a PIT-tag evaluation, which is a requirement of the permit, and Chelan PUD requests approval from the Hatchery Committees for the Gonad Somatic Index and maturation sampling outlined in the plan. She said the plan entails sampling 600 steelhead (300 wild-by-wild and 300 hatchery-by-hatchery) held at Chiwawa Acclimation Facility.

Tom Kahler asked if the purpose of limiting residualism, from NMFS' permitting perspective, is to limit competition with wild fish and predation on wild fish. Willard said the first step that NMFS identifies is to determine an indication of residualism. If there appears to be a problem, measures to limit residualism should be implemented to minimize it.

Kirk Truscott said maturation sampling can be used to assess precocity. Greg Mackey suggested considering ATPase for gill filament activity. Tonseth said ATPase methods have been used previously in this system and the study found that ATPase levels have not spiked sufficiently at the time of sampling to determine whether juveniles are residualizing.

Matt Cooper said there is also work occurring at Winthrop National Fish Hatchery (NFH) to assess residualism. He said determining an early maturation residual is difficult for steelhead that are holding (not emigrating volitionally). He said there are correlations between residuals and size—after multiple years of volitional releases, staff at Winthrop NFH found that the fish holding at the hatchery were smaller and there was a higher male-to-female ratio. He asked representatives present if he should invite Dr. Chris Tatara (NOAA) to discuss this with the Hatchery Committees. Representatives present agreed, and Cooper said he will invite Tatara.

Mike Tonseth noted that holding fish for 2 months would produce differences in feeding between held and released fish. During the warm-water months, steelhead will have greater appetites. He asked if continuing to feed the fish will affect maturation rates. Cooper said once maturation begins, it does not reverse. Tracy Hillman said the study assumes the fish released from the hatchery are also feeding under similar temperature regimes, so the effects of temperature and feeding on maturation should be similar. Betsy Bamberger said the differences in feeding and potential effects to maturation are based in physiology. Tonseth asked if the fish held for 2 months will be fed to satiation or just a maintenance diet. Pat Phillips (Douglas PUD) said it would depend on the water source. Truscott summarized that Tonseth's concern is that during the 2-month holding period, feeding and growth may elicit a maturation response that would not occur if the fish were released. He said he understands that precocious Chinook salmon start to become precocious the fall prior to their release, so conditions immediately leading up to their migration would have little effect on their precocity. He said this may or may not be true for steelhead. Cooper said he will ask Penny Swanson (NOAA) for more information about this.

Truscott observed that the program aims to make hatchery-origin steelhead as similar to wild steelhead as possible, except for precocity (a natural juvenile life history trait). Keely Murdoch agreed that the Hatchery Committees should limit precocity but remain aware of what natural populations do. Hillman asked if the document needs to be amended to direct hatchery managers to maintain maintenance rations only (i.e., not feed to satiation). No changes were made to the document.

The Rocky Reach and Rock Island HCP Hatchery Committees agreed to implement lethal, post-release, early maturation sampling for steelhead as described in the draft *Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program* as follows: Chelan PUD, YN, CCT, WDFW, USFWS, and NOAA approved.

III.Joint HCP-HC/PRCC HSC

A. NMFS Consultation Update (Brett Farman)

Emi Kondo (NMFS) said she has an update on the National Environmental Protection Act (NEPA) process for the Methow steelhead consultation and the unlisted programs consultation (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and Priest Rapids). She said completion of the Environmental Assessment (EA) will depend on other pending consultation pieces, mainly the commenting period for Hatchery Genetic Management Plans (HGMPs) and permit drafting. She said Chuck Peven (Peven Consulting, Inc.) has drafted all chapters except Chapter 5, cumulative impacts. She said the next steps are internal review (approximately 45 days), applicant review, then a 30-day public comment period.

Charlene Hurst said she has an update on the permitting process for the Wells Complex and Winthrop NFH summer steelhead programs. She said she expects to review the permits and distribute them to applicants for review in early to mid-May. Hurst said the Wells Complex steelhead HGMP and the Winthrop NFH steelhead HGMP should go out for public comment at the same time as the Methow steelhead EA. She said the HGMPs likely do not need to be revised, although the proposed action identified in the BiOp should be appended to the HGMPs. Douglas PUD and USFWS should provide a letter to NMFS requesting the addendum to the HGMPs. She said one potential concern is that the Winthrop HGMP identifies many alternatives, so it may elicit public comments that slow down the permitting process. She said anything that can be done in advance to make the proposed action and HGMPs clear should be completed prior to public comment.

Kondo said she plans to use the same approach (appending the proposed action described in the BiOp to the HGMPs) for putting the HGMPs for the unlisted summer/fall programs out for public comment in tandem with the EA being available for public review. Greg Mackey asked if NMFS is drafting the proposed action sections to be appended to the HGMPs. Hurst said these sections are in the BiOps, so the applicants should extract the proposed action from the final BiOp and send it back to NMFS to be included with the HGMP. Hurst said she will send a Word version of the steelhead BiOp to the applicants to make this process easier. Kondo summarized the NEPA process for the Methow steelhead and unlisted summer/fall Chinook salmon programs is underway and permitting is progressing for the Wells Complex and Winthrop NFH steelhead programs.

B. 2018 Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth said the version 4 draft 2018 Broodstock Collection Protocols were distributed on April 17, 2018 by Sarah Montgomery (Attachment C). He said he received further edits from Keely Murdoch after the draft was distributed and those are included in the version for review today. He said the majority of comments were received during review of the first version and addressed in the second version. Most edits since the second draft version was distributed were editorial. Tonseth also provided a document for discussion during the meeting, Emerging Discussions from draft 2018 Broodstock Collection Protocols (Attachment D), which Montgomery distributed to the Hatchery Committees following the meeting on April 19, 2018. He said these topics will require discussion in 2018 before the 2019 protocols are drafted. He reviewed the discussion items and asked the Hatchery Committees to provide feedback on how and when each item should be addressed. A summary of each item is included in the paragraphs below along with continued discussion on the draft protocols following the emerging discussion items.

Yakama Nation Summer Chinook Egg Requests at Wells Fish Hatchery

Tonseth suggested that Murdoch coordinate an update or presentation to the Hatchery Committees about the YN summer Chinook salmon program and future program direction. He said the program has been in place for 10 years and is still receiving eggs from Wells Fish Hatchery (FH). Murdoch agreed that an update is needed and said she will invite Melinda Davis and Mark Johnston (YN) to the Hatchery Committees July 2018 meeting to discuss this item.

Age-3 Males in the Broodstock, Include or Exclude?

Tonseth said Greg Mackey commented on including age-3 males in broodstock during review of the draft 2018 Broodstock Collection Protocols. Tonseth said this discussion and decision will not necessarily delay approval of the 2018 protocols, but a literature review should be performed and this item should be discussed further. Mackey said he will take the lead on researching this item. He said he brought this up in part because of discussions on Twisp River steelhead and a Ryman-Laikre effect. He said for a harvest program, the goal is often to maximize the size of fish; however, managers should be careful not to limit population diversity by size-selecting broodstock in conservation programs . Tonseth said data should be evaluated to determine whether excluding age-3 males (based on size selection) is limiting the diversity of the program. He said past hatchery programs have over-incorporated age-3 males, and those fish made up a large portion of the hatchery spawning population. He said from WDFW's perspective, fish incorporated into broodstock should resemble what is expected in the natural environment. Tonseth said the current version of the protocols is consistent with past years, but this should be discussed for the 2019 protocols. Matt Cooper asked if this discussion only pertains to hatchery returns used for broodstock. Tonseth said no, it also applies to natural-origin returning fish. He said age-3 fish are not purposefully included in broodstock.

Brett Farman asked how the proportion of age-3 fish in the population is estimated. Tonseth said age classes are based on the size of fish. He said during broodstock collection, age-3 determination is based on the size of both hatchery- and natural-origin fish, and age is confirmed via scale analysis after collection and spawning. Mackey said spawning-ground survey data could be used to estimate the proportion of natural age-3 fish in the population. Tonseth said the natural age-3 population estimate is determined by a run composition assessment. Catherine Willard asked if there is an estimate of age-3 fish incorporated into the brood based on size. Tonseth said this information is in the annual report.

Pat Phillips said protocols for including age-3 fish in broodstock have changed often over time. Tonseth said recent literature suggests younger age-at-maturity adults produce progeny with younger age-at-maturity juveniles. Mackey also suggested that in addition to environmental and genetic influences on age-at-maturity, there may be epigenetic influences to consider. Kirk Truscott said age-3 fish should not be eliminated entirely from broodstock, but due to concerns about over-representation, a discussion is warranted. Tonseth said the solution may be a size cutoff that still allows a certain percentage of age-3 fish in the broodstock to help maintain a natural age structure. Willard said in the Chiwawa program, the percentages of age-3 fish is 5.5% for wild fish and 11.3% for hatchery fish, and before 2011, percentages were higher. Tonseth said changes were made to the program in 2011 to limit age-3 males being included in the broodstock. Truscott said changes to water source were also made that were intended to minimize age-3 fish being included. Todd Pearsons suggested also examining literature on reproductive success of age-3 fish. He said one reason age-3 males were excluded from broodstock in the past is that they have not performed as well in the natural environment as older fish. Murdoch said even if age-3 fish are incorporated into the broodstock at the same rate as appears in the wild, age-3 fish pass on genes at a higher rate in hatcheries than the in the wild—another consideration to limit inclusion of age-3 males. Mackey said in the wild, age-3 males reproduce at a frequency-dependent rate. That is, if there are few age-3 fish, they tend to proportionally perform better; if there are many age-3 fish, they tend to proportionally perform worse.

<u>Bacterial Kidney Disease Risk Assessment Criteria and Management/Data Series Implications</u>

Tonseth said a question was raised about BKD risk assessment criteria and management implications. Betsy Bamberger said Douglas PUD is now using WADDL's diagnostic services and WADDL does not numerically report optical density values for *Renibacterium salmonarium* (or Rsal, the causative agent of BKD) in the same manner as WDFW or USFWS laboratories. Because WADDL is a lab accredited by the American Association of Veterinary Laboratory Diagnosticians (AAVLD), their protocols and processes are reviewed to ensure they are in conformance with ISO-international standards and consequently every positive result needs to be confirmed by a secondary assay. She said WADDL requires that Rsal be detected in any given sample by both an enzyme-linked immunosorbent assay (ELISA) and a molecular based test (i.e., a polymerase chain reaction test) before it is reported as either a "positive" or "negative" result. She said the different assays target different macromolecules and do not necessarily produce the same test results but corroboration between the two methods provides greater assurance that Rsal is indeed present. She said management decisions and culling in the past have been based only on optical density values.

Tonseth said he is concerned that this new method prevents looking at trends in BKD over time. He said as program changes are made, it is important to compare to past data. And, consultations completed for these hatchery programs included specific titer levels by which programs are managed. He said these new methods may be inconsistent with Section 10 permits. He said it also creates an issue regarding previous decisions and conversations about specific optical density levels by which programs will be managed. He added that wild fish (in conservation programs such as spring Chinook salmon) also have a higher standard of care than hatchery fish, and it took a long time to come to agreement on the culling protocols due to WDFW's policy on culling viable fish. He asked if changing the way results are presented (and interpreted) compromises the agreement? He said it is important to maintain confidence that these programs can be managed in the manner by which they have been managed in the past. Truscott said the 2006 SOA and culling protocol considers below-low, low, moderate, and high optical density values and management actions associated with each level. He said only having positive/negative results from WADDL changes how these fish are managed. Tonseth added that WDFW does not favor culling more fish and collecting additional broodstock as a solution.

Pearsons asked if WADDL produces an optical density value and if they could provide the results with the understanding that data are unverified. Bamberger said WADDL expressed willingness to develop tests that fit the program's needs with the understanding that the results reported would not be validated by a secondary assay. Bamberger warned that these data would have to be interpreted with caution. She also added that ELISA testing detects the antigen of the RsaI bacteriabut does not necessarily relate to risk of pathogen transference or a given fish's current infection status.. Tonseth said it would be helpful to have optical density values and positive/negative results to compare and consider side-by-side at least in the first year of this change. Truscott suggested that it might be preferable to even keep fish with high ELISA results but low transference. Tonseth said his concern is that fish are managed in a way that is consistent with terms of conditions of permits and SOAs. He said a new SOA may need to be developed that makes allowances for interpreting fish health results, with the help of NOAA to ensure the approach is consistent with the spirit and intent of permits. Pearsons suggested asking WADDL to provide optical density values and recommended the Hatchery Committees discuss this further throughout 2018 and 2019. Phillips added that historically, there is no correlation between culling to the agreed-to titer levels and outbreaks of BKD. Bamberger said ELISA data are just one piece of information that informs us about the health status of a population. Tonseth said lower rearing densities often produce healthier fish. Mackey also suggested that Bamberger present information on BKD and ELISA testing during an upcoming Hatchery Committees meeting. Representatives present agreed.

<u>Differentiating Natural-Origin Okanogan Spring Chinook Salmon During Methow Program Broodstock Collection at Wells Dam</u>

Tonseth said Truscott brought up the question of naturally spawning spring Chinook salmon in the Okanogan Basin and the potential for returning fish to be collected at Wells Dam instead of allowing to pass upstream to spawn as part of the Okanogan 10j reintroduction program. Truscott said as spawning fish are recovered in the Okanogan, genetic samples could be taken. Potential ideas to differentiate Okanogan spring Chinook salmon from Methow spring Chinook salmon were stated as follows:

- Genetic samples
- Parentage-based approach
- Elemental scale analysis
- Otoliths
- Fin rays
- Scale pattern analysis

Discussions about this item will continue.

Priest Rapids Hatchery Fall Chinook Salmon Integration – How to Achieve It Without Fish from Alternative Collection Sites/Methodology

This item does not pertain to the Hatchery Committees, therefore was not discussed.

Re-Evaluating the Size of Upper Columbia Spring Chinook Salmon Conservation Programs

Tonseth said an ongoing discussion will include the appropriate size of spring Chinook salmon conservation programs. He said WDFW and YN drafted the Wenatchee Basin spring Chinook Salmon management plan, which set the standard for conservation program size in the Wenatchee Basin. He said WDFW and YN will revisit the models used to develop this plan, update information in the models, and reassess assumptions that were made to determine if adjustments to conservation programs are warranted (in the Wenatchee Basin and other areas). He said he plans for this assessment to be completed in time to be incorporated into the 2019 Broodstock Collection Protocols. Truscott said reproductive success study results should be incorporated into this assessment. Tonseth said Andrew Murdoch has also been working to develop more accurate estimates of pre-spawn survival in the Wenatchee Basin (data that were lacking in the first management plan). Keely Murdoch said estimates of pre-spawn mortality were made at the time to determine the sliding proportion of natural influence (PNI) scale for Nason Creek. She said now that more years of data are available, pre-spawn mortality assumptions and estimates need to be updated. Results from safety-net program returns will also be incorporated. She said after the PNI sliding scale was made, a split was determined for the safety-net and conservation programs based on previous years' return rates. She summarized that the management plan is a living document and adjustments should be considered, which she and Tonseth will take the lead on and report back to the Hatchery Committees around October 2018. Tonseth said additional modeling results are available for the Wenatchee Basin (but not yet for the Methow basin). Hillman asked if proposed adjustments would only affect the proportion of safety-net versus conservation program fish and not total hatchery production. Tonseth said that is correct. Truscott said changes to these program sizes could influence how readily PNI targets in the basins are achieved.

Pearsons said this topic was raised based on the number of fish predicted to return to hatchery programs in the Wenatchee Basin. He said in Nason Creek, the number of hatchery-origin fish predicted to return was much higher than the number of natural-origin fish. He asked if more natural-origin fish are being used to populate programs than are needed. Keely Murdoch said there is a lot of uncertainty in the 2018 run forecast. Peter Graf asked if programs could be sized along a sliding scale to account for varying run forecasts. Tonseth said the permits provide some flexibility in that the programs should not exceed more than 33% of the natural-origin component.

Tonseth said the updated analysis will incorporate, at a minimum, modeling, reproductive success data, estimates of capacity, stray rates, and adult management at Tumwater Dam. Pearsons suggested also considering how much of the conservation program is needed on the spawning grounds each year, with the safety-net program hardly being used. He said the safety-net programs can be evaluated to ensure they are not segregated programs (i.e., not allowed on spawning grounds). Farman said he does not have any immediate input on these discussion pieces from the NMFS perspective, but he sees value in re-evaluating the size of the programs and will provide input throughout the process.

<u>Reviewing Edits and Comments in the Draft Broodstock Collection Protocols</u>

Tonseth said he did not receive feedback from USFWS about the Tumwater Dam operations plan for lamprey passage. He said this plan includes at least an 8-hour open period for lamprey passage from 10 pm to 6 am, which is a compromise to meet other permit requirements. Willard said the open passage period is based on lamprey passage distribution at Rocky Reach Dam.

Tonseth said he also did not receive any feedback regarding modifications to the trapping schedule at the Chiwawa Weir.

In the draft document, Tonseth pointed out one unresolved comment from Douglas PUD regarding the number of PIT-tagged yearling summer Chinook salmon, which will depend on the outcome of an HCP Coordinating Committees discussion about a survival study. No further edits were needed in this section.

Tonseth noted that significant edits were made to the Wells steelhead section by Michael Humling (USFWS) and others. He asked if everyone saw those edits and if there are any questions. None were raised.

Mackey said there is a known shortage of summer Chinook salmon yearlings to be released in 2019 and proposed increasing the subyearling production for the 2019 release to make up the mitigation gap. He said Tonseth noted in response to this idea that it would result in an exceedance of the allowable release number for subyearlings. Mackey asked for feedback on this idea and said Douglas PUD is willing to produce extra subyearling fish to make up the gap but would not want to overproduce fish if it is not allowed by permits. Murdoch asked how much of an exceedance it would be for the subyearling release. Tonseth said the allowed subyearling release is 484,000 fish and overproducing to meet the mitigation gap would result in approximately 648,000 fish. Tonseth asked Farman to provide feedback, because production levels identified in permits are specific to production element (yearling versus subyearling), not just species. Tonseth said Craig Busack previously communicated concern about entities liberally interpreting release numbers. Farman agreed. Mackey said based on this feedback, Douglas PUD plans to produce as many yearling summer Chinook salmon as possible to meet release goals, but not overproduce subyearlings to make up the mitigation gap.

Mackey also suggested adding flexible language for in-season decisions based on fecundity, age-at-return, size-at-return, prespawn mortality, and other items. Mackey said even with this flexibility added, field staff would need to discuss and describe over- or under-collection with the Hatchery Committees, but was seeking scope to allow broodstock collection staff to make minor adjustments in real time. Phillips asked if hatchery fish are being removed for broodstock and for surplus, is there a difference between collecting for broodstock or surplus? Tonseth said there is a difference if the fish are listed because permits are specific to the number of broodstock that can be collected. He said incidental and direct impacts are associated with a certain activity for a specific fish. He said there are different take components for surplussing. Tonseth said if there is something happening at a facility or program that is outside the expected norm, it should be understood and discussed before more fish are collected. Phillips said one issue in 2017 was that prespawn mortality did not become an issue until it was too late to collect more fish. He said the mitigation program requires the program to produce a certain number of fish, while the permit limits broodstock collection, so it is odd that additional fish cannot be collected for broodstock as a buffer, and later converted to surplus if not needed. Tonseth said if the fish produced from those extra broodstock become fry, it becomes a WDFW responsibility. Phillips said 220 brood were lost in 2017 before spawning was completed, and he would like to prevent that from happening in the future. Tonseth said collecting extra broodstock may be within permit conditions for unlisted fish, and could be considered, but for listed programs or programs based on natural-origin fish, it is not allowable. Truscott said an additional consideration to collecting extra broodstock is the impacts of the collection activity—collecting out of the Wells west ladder for a longer period of time has impacts, for example. Phillips clarified that he is advocating additional brood collection from the Wells volunteer channel for the Columbia River safety-net program. Truscott said for that discussion, NOAA should provide input. Tonseth said there should still be a Hatchery Committees' nexus to those decisions, and in the past, collecting extra fish was allowed but should not be allowed as a substitute for good fish-culture practices. Farman said ongoing discussions like these suggest the program may not have been fully described in the permits. Phillips said the hatchery programs in the region continue to see considerable impacts from Columnaris disease on summer Chinook salmon brood and lower fecundities. He said this is perhaps cyclical, but he would like to take a cautious approach to making sure the program meets its production goals.

Regarding changes to the Okanogan steelhead program, Pearsons said he thought backup collections for Okanogan steelhead were occurring in the spring instead of the fall. Tonseth said the protocols state any steelhead with a coded wire tag from the Okanogan program that is collected as part of the Columbia River program collection in the fall can be allocated to the Okanogan program. Tonseth said 60 adults are collected as backup for the Methow steelhead program in the fall, but no backup adults for the Okanogan program are intentionally collected (some are allocated based on coded wire tags). Tonseth made clarifying edits in the document. Phillips noted that the newly designed Omak Creek weir may result in changes to this section in the future.

Regarding spring Chinook salmon management in the Methow Basin, Pearsons said Michael Humling provided comments about trapping at Methow FH. Pearsons said to be consistent with permits, additional trapping requirements should not be placed on trapping at Methow FH. Pearsons asked if natural-origin fish are returning and attempting to spawn, should the trap be operating? Tonseth said the Methow FH and Winthrop NFH facilities need to operate in conjunction to meet PNI goals in the Methow Basin. So even if enough conservation program fish have been collected to meet production obligations, and Winthrop NFH-origin fish are still volunteering to the facility, they should continue to be removed. Tonseth suggested possibly implementing adult translocation for natural-origin fish that are collected in the facility under these conditions. Pearsons said he would prefer flexibility in closing the trap so that the conservation fish can spawn naturally without being handled. Pearsons said in order to prioritize the program, translocation is not currently being implemented and fish collected are brought into the safety-net program, but it is unknown what the fish would do if the trap were closed. Tonseth said relocating the fish would be beneficial in comparison to the fish spawning very near or in the hatchery channel. Pearsons agreed and said it is just an unknown. Willard asked if Pearsons wants to see the benefits of translocating fish (spawning naturally). Pearsons said yes and translocation is not currently being implemented for multiple reasons, one of them being it is unknown how well the fish would perform (so they are brought into the safety-net program). Willard said she understood that the safety-net broodstock was prioritized because it is a higher priority than translocating fish to spawn naturally, not because spawning success is unknown. She said if there are enough fish to fill the safety-net program on site, additional returning fish should be translocated. Mackey said running the trap at Methow FH is not a lot of work due to partnership and collaboration with USFWS, where spring Chinook are transported as surplus to from Methow Hatchery to WNFH. Truscott said he thinks the USFWS will continue to operate the ladder at Winthrop NFH to collect Methow-origin fish, so it is a reciprocal activity. Cooper said the Methow FH and Winthrop NFH staff holistically manage the Methow population and collect fish for both facilities. Tonseth agreed and said the basin is expected to be managed to a basin-wide PNI level, regardless of which program is contributing. He said both hatcheries need to trap aggressively to meet this target.

Pearsons said his concern is about permit conditions. Mackey said Douglas PUD is amenable to continue trapping after broodstock and adult management targets are met. However, he said there is a concern that trapping and handling conservation fish may diminish their potential natural contribution.He also asked if they had not been trapped, would they have remained and spawned in the location they were collected, or would they have spawned elsewhere? Tonseth clarified that once safety-net and adult management targets are met, fish recruiting to the trap are available for translocation. Tonseth said there is a caveat in the translocation plan that PNI and proportion of hatchery-origin spawners could exceed permit conditions during the adjustment period. He suggested that a short-term study of translocation could fit into the adjustment period. Murdoch agreed and suggested prioritizing translocation over closing the trap. Graf clarified that the permit is not very restrictive to trapping operations and allows for closing the trap based on runs and conditions. Tonseth said the protocols are a living document and there is a placeholder in the current year for trap operations after safety-net and adult management goals are met. Mackey said in 2017, the trap was operated for a long time and then closed when fish ceased recruiting to it due to spawning and it is difficult to meet adult management targets in most years. Tonseth said based on the current forecast, there will be little to no adult management on the conservation program in 2018. Farman asked if there is a risk of collecting excess fish and not translocating them? And, are there good spawning areas for translocation where production would be better than below the trap? Willard said the translocation plan includes up to 200 fish with a sex ratio similar to the run at large. Pearsons said there is a chance that too many fish would be collected. Mackey said there is also a chance that the hatchery attracts a skewed sex ratio, and there would be excess males needing to be released back to the river. Tonseth said there will be a better understanding of the run and what to expect at the trap this year once fish start arriving at Wells Dam. Pearsons suggested using more flexible language to account for this adaptive management approach. Tonseth agreed and revised the document.

Murdoch said Tonseth has historically put a placeholder for coho salmon broodstock collection protocols in the Broodstock Collection Protocols document. Murdoch said the coho salmon protocols are due in mid-June each year and asked if it would be helpful to have those protocols included as part of this document in future years. Representatives present were generally in favor of adding the coho salmon protocols and Murdoch said she will coordinate internally and with Tonseth to incorporate the coho salmon protocols in 2019.

The HCP Hatchery Committees approved the draft 2018 Broodstock Collection Protocols as follows: WDFW, Douglas PUD, Chelan PUD, USFWS, NMFS, YN, and CCT approved on April 18, 2018. Tonseth noted that the section pertaining to Priest Rapids Hatchery may change during the PRCC HSC meeting and he will distribute a final version on April 19, 2018. (Note: the Wells HCP Coordinating Committee will vote on the Wells portion of this document during their April 24, 2018 meeting.)

Hillman noted that the protocols are a very large document with information that expands every year. He asked about the possibility for decreasing detail in some sections to facilitate earlier approval of the protocols and less arduous reviewing. Tonseth said adult management plans are often held up by receiving the spring Chinook salmon forecast, but the main body of the document could likely be streamlined and reviewed earlier, with adult management information being added for review later. Representatives present were generally in favor of reducing the size of the protocols document. Hillman noted that many of the details and back-up plans need to be discussed by the Hatchery Committees each year anyway, so those details may not need to be included in the document or could be attached as appendices.

IV. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are May 16, 2018 (Grant PUD), June 20, 2018 (Grant PUD), and July 18, 2018 (Grant PUD).

V. List of Attachments

Attachment A	List of Attendees
Attachment B	Draft Methodology for Establishing Baseline Conditions in the Wenatchee Steelhead Program
Attachment C	Draft 2018 Broodstock Collection Protocols (v4)
Attachment D	Emerging Discussions from draft 2018 Broodstock Collection Protocols

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Pat Phillips	Douglas PUD
Betsy Bamberger	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Alf Haukenes†	Washington Department of Fish and Wildlife
Chris Moran	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Brett Farman*†	National Marine Fisheries Service
Charlene Hurst*†‡	National Marine Fisheries Service
Emi Kondo†‡	National Marine Fisheries Service
Kirk Truscott*	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

DRAFT Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program

March 12, 2018

Rocky Reach and Rock Island HCP Hatchery Committees

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of 2017. A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements

- Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard; and an appropriate time series for data collection and evaluation.

PIT Tag Evaluation

Evaluation of the number and proportion of PIT tagged hatchery steelhead detected within tributaries of the Wenatchee sub-basin within the same year of release, but after the typical smolt outmigration period, will be used as an indicator of residualism. Analogous with NMFS's Wenatchee River summer steelhead hatchery program steelhead Biological Opinion (2016), PIT-tagged hatchery-origin steelhead still detected within the Wenatchee sub-basin 21 days after release or July 1st, whichever is later, will indicate residualization.

Post Release Sampling

An extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. Fork length and body weight will be measured, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. Additionally, a group of HxH brood-origin (n=300) and WxW brood-origin (n=300) steelhead will be held for a minimum of one month post-release to assess maturation of initiating precocial parr via lethal sampling. Because parr that have initiated maturation may begin to senescence, fish that are expressing milt will not be held for the post-release sampling. Fork length, body weight, smolt index, sex, visual maturation and GSI data will be collected for each fish. Condition factor will be calculated.

Electrofishing and Angling

Electrofishing and angling will be conducted to assess the number of hatchery smolts that did not out-migrate. Sampling will begin July 1st or when river conditions are suitable for sampling, whichever occurs first. Sampling efforts will be focused at the point of release, but will extend within 8 km of release. Studies examining the distribution of steelhead residuals within stream systems in the Snake basin report that in most cases these residuals set up residence near their release point (Whitesel et al. 1993; Jonasson et al.1996). Partridge (1986) noted that most residual steelhead were within about 8 km of the upper Salmon River release site and Whitesel et al. (1993) found steelhead residual densities were highest within 8 km of release sites and decreased quickly above and below these sites in the Grande Ronde and Imnaha Rivers in Oregon. All fish sampled will be evaluated for marks/tags in addition to measuring fork length and body weight.

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April 17, 2018

To: HCP HC and PRCC HSC

From: Mike Tonseth, WDFW

Subject: **DRAFT UPPER COLUMBIA RIVER 2018 BY SALMON AND 2019 BY STEELHEAD HATCHERY PROGRAM MANAGEMENT PLAN AND ASSOCIATED PROTOCOLS FOR BROODSTOCK COLLECTION, REARING/RELEASE, AND MANAGEMENT OF ADULT RETURNS**

The attached protocol was developed for hatchery programs rearing spring Chinook salmon, summer Chinook salmon and summer steelhead associated with the mid-Columbia HCPs; spring Chinook salmon, summer Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project and Salmon and Steelhead Settlement Agreement (FERC No. 2114); and fall Chinook salmon consistent with Grant County Public Utility District and Federal mitigation obligations associated with Priest Rapids and John Day dams (ACOE funded), respectively. These programs are funded by Chelan, Douglas, Grant County Public Utility Districts (PUDs), and ACOE and are operated by the Washington Department of Fish and Wildlife (WDFW), with the exception of the Omak Creek/Okanogan Basin steelhead broodstock collection, and acclimation/release of Omak Creek steelhead which is implemented by the Confederated Tribes of the Colville Reservation (CTCR).

This protocol is intended to be a guide for 2018 collection of salmon (2018BY) and steelhead (2019BY) broodstocks in the Methow, Okanogan, Wenatchee, and Columbia River basins. It is consistent with previously defined program objectives such as program operational intent (i.e., conservation and/or harvest augmentation), mitigation production levels (e.g., HCPs and Priest Rapids Salmon and Steelhead Settlement Agreement/2008 BiOp), changes to programs as approved by the HCP-HC and PRCC-HSC, and to comply with ESA permit provisions, USFWS consultation requirements.

Notable in this year's protocols are:

- Continuing for 2018, no age-2 or 3 males will be incorporated into spring or summer/fall Chinook programs unless necessary to maintain effective population size (minimum female to male ratio of 1:0.75; conservation programs only).

- Use of ultrasonography to determine the sex of each fish retained for brood to ensure achieving the appropriate number of females for program production (does not include Priest Rapids Hatchery).

- Utilization of genetic sampling/assessment to differentiate Twisp River and Methow River Basin natural-origin spring Chinook adults collected at Wells Dam, and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir and Methow FH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components for the GPUD, CPUD and DPUD programs.

- Expansion of spring Chinook trapping effort at the Wells Dam East and West ladder traps.

- Addition of Appendix H which describes a draft preferred approach to integration of the Methow conservation steelhead programs as well as minimize the potential for or increase the risk of a Ryman-Laikre effect in the Twisp River watershed.

- Collection of only hatchery adult steelhead at Wells Dam/Hatchery for the Lower Methow safety-net (WFH/MFH), and Wells Hatchery Okanogan and mainstem Columbia safety-net programs.

- Refinement of surplus UCR juvenile steelhead management plan.

- Collection of spring Chinook for the Nason Creek and Chiwawa programs using combination of Tumwater Dam and the Chiwawa Weir.

- Expansion of Chiwawa Weir operation sideboards for bull trout to increase probability of meeting broodstock targets for the Chiwawa conservation program.

- Management plan for excess production from Wenatchee Sub-basin spring Chinook hatchery programs.

- Targeted collection of 100% of the Wenatchee summer Chinook and Wenatchee hatchery origin steelhead broodstock at Dryden Dam to reduce the number of activities that may contribute to delays in fish passage at Tumwater Dam (some adult collections at Tumwater may be necessary if sufficient adults cannot be acquired at Dryden Dam).

- Targeted collection of 100% of the natural origin steelhead broodstock at Tumwater Dam.

- Collection of summer Chinook broodstock from the Chelan Falls Canal Trap (CFCT), sufficient to meet the entire Chelan Falls yearling program of 576K. Summer Chinook collections at Wells or Entiat Hatchery may be used to support the Chelan Falls program if broodstock collection efforts at the CFCT fall short.

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow safety-net on-station-released smolts (up to 17 adults). The remainder of the broodstock (51) will be WNFH returns collected at WNFH (or by angling/trapping for WNFH program) and/or Methow Hatchery and surplus to the WNFH program needs. Collection of Wells stock may be used if WNFH and Twisp returns are insufficient. The collection of adults will occur in spring of 2019.

- Summer Chinook collections at Wells Dam to support the CJH program may occur if CCT broodstock collection efforts fail to achieve broodstock collection objectives.

- Collection of ad-clipped only (no wire) spring Chinook adults (or possibly eggs identified through CWTs from ad-clipped +CWT CJH segregated returns) may occur from facilities in the Methow basin and/or Wells Dam. These alternative collection locations will only be used if CCT and USFWS broodstock collection efforts fail to achieve broodstock collection objectives for the CJH segregated program, or if conditions (e.g., spill at CJD, ladder/trap efficiency) appear unconducive to efficient collection of broodstock. Collection will run concurrent with spring Chinook broodstock collection for Methow Hatchery.

- Collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the YN, Yakima River summer Chinook program.

- Targeted collection of 1,000 adipose present, non-coded wire tagged fall Chinook from the PRD OLAFT.

- Targeted collection of about 400 adipose present, non-coded wire tagged fall Chinook using hook and line efforts in the Hanford Reach.

- Modification of the Tumwater trap operations to facilitate lamprey passage. Using Rocky Reach and Rock Island lamprey passage data as a surrogate, it is proposed to open the Tumwater Dam fishway to passage between 10PM and 6AM daily from September 1 to mid-December. This should allow open passage for at least 60%-70% of the lamprey while still accommodating coho and steelhead broodstocking and steelhead adult management. Because this is a trial year, some in-season adjustments may need to be made based on lamprey observations (during trapping periods) and the magnitude of steelhead adult management required.

These protocols may be adjusted in-season, based on actual run monitoring at mainstem dams and/or other sampling locations. Additional adaptive management actions as they relate to broodstock objectives may be implemented as determined by the HCP-HC or PRCC-HSC and within the boundaries of applicable permits.

Also included in the 2018 Broodstock Collection Protocols are:

Appendix A: 2018 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2019 BY Summer Steelhead Hatchery Programs

Appendix B: Current Brood Year Juvenile Production Targets, Marking Methods, Release Locations
Appendix C: Return Year Adult Management Plans
Appendix D: Site Specific Trapping Operation Plans
Appendix E: Columbia River TAC Forecast
Appendix F: Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans
Appendix G: DRAFT Hatchery Production Management Plan
Appendix H: DRAFT Preferred Alternative for 2019 BY and beyond, Methow Sub-basin Conservation Steelhead Programs

Methow River Basin

Spring Chinook

Inclusion of natural-origin fish in the broodstock will be prioritized for the aggregate conservation program in the Methow Basin. Collections of natural-origin fish will not exceed 33% of the Methow Composite (i.e., non-Twisp) and Twisp natural-origin run escapement consistent with take provisions in Section 10 (a)(1)(A) Permits 18925 and 20533.

Hatchery-origin spring Chinook, if needed, will be collected in numbers excess to program production requirements to facilitate BKD management, comply with ESA Section 10 permit take provisions, and to meet programmed production shortfalls. Based on historical Methow FH spring Chinook ELISA levels above 0.12, any hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 20% (based upon the most recent 5-year mean ELISA results for the Methow/Chewuch/Twisp programs). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permits 18925 and 20533, culling will include the destruction of eggs from hatchery-origin females with ELISA levels greater than 0.12 and/or that number of hatchery origin eggs required to maintain an aggregate production of 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by DPUD Fish Health and the Wells, Rocky Reach, and Rock Island HCP-HCs and the Priest Rapids CC -HSC to be a substantial risk to the program. Progeny of natural-origin females, with ELISA levels greater than 0.12, may be differentially tagged for evaluation purposes. Annual monitoring and evaluation of the prevalence and level of BKD and the efficacy of culling returning hatchery- and natural-origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

WDFW genetic assessment of natural-origin Methow spring Chinook (Small et al. 2007) indicated that Twisp natural-origin spring Chinook can be distinguished, via genetic analysis, from non-Twisp spring Chinook with a high degree of certainty. The Wells HCP Hatchery Committee accepted that Twisp-origin fish could be genetically assigned with sufficient confidence and that natural origin collections can occur at Wells Dam. Scale samples and non-lethal tissue samples (fin clips) for genetic/stock analysis will be obtained from adipose-present, non-CWT, non-ventral-clipped spring Chinook (suspected natural-origin spring Chinook) collected at Wells Dam, and origins assigned based on genetic analysis. Natural-origin fish retained for broodstock will be PIT tagged (pelvic girdle) for cross-referencing tissue samples/genetic analyses. Tissue samples will be preserved and sent to the WDFW genetics lab in Olympia Washington for genetic/stock analysis. Spring Chinook collected from Wells will be held until genetic analysis results are received then transferred to and retained at Methow Hatchery and spawned for each program depending on results of DNA analysis. Brood collection of NORs at Wells will be based upon assignment of Twisp NORs to the Twisp program and non-Twisp NORs being used to support Methow and Chewuch River releases. Spring Chinook collected at Methow Hatchery will be held at MFH until genetic analysis results are received and then handled accordingly.

The number of natural-origin Twisp and Methow Composite (non-Twisp) spring Chinook retained will be dependent upon the number of natural-origin adults returning and the collection objective limiting extraction to no greater than 33% of the natural-origin spring Chinook return to the Methow Basin. Natural origin fish not assigning to the Twisp or Methow Composite will be released back into the Columbia River.

Weekly estimates of the passage of Wells Dam by natural-origin spring Chinook will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%. Hatchery origin adults trapped at the Winthrop NFH may be included, if needed, in the event of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook to Wells Dam during 2018 is estimated at 3,235 spring Chinook, including 2,366 hatchery and 869 natural origin spring Chinook (Table 1 and Table 2). In-season estimates of natural-origin spring Chinook will be adjusted proportional to the estimated returns to Wells Dam at weekly intervals and may result in adjustments to the broodstock collection targets presented in this document. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

The following broodstock collection protocol was developed based on BKD management strategies, projected return for BY 2018 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and biological assumptions listed in Appendix A.

The 2018 aggregate Methow spring Chinook broodstock collection will target up to 126 adult spring Chinook (18 Twisp, 108 Methow; Table 3). Based on the pre-season run forecast, Twisp fish are expected to represent about 3.5% of the CWT tagged hatchery adults and 23% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin spawning escapement to the Twisp, the 2018 Twisp origin broodstock collection will total 18 wild fish, representing 100% of the broodstock necessary to meet Twisp program production of 30,000 smolts. Methow Composite fish are expected to represent about 34% of the CWT tagged hatchery adults and 77% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin recruits, the 2018 aggregate Methow/Chewuch broodstock collection will total 108 natural-origin spring Chinook. Broodstock collected for the aggregate Methow conservation programs represents 100% of the broodstock necessary to meet the Methow programs production of 223,765 smolts. The Twisp River releases will be limited to releasing progeny of broodstock identified as wild Twisp and or known Twisp hatchery origin fish, per ESA Permit 18925. The MetComp releases will include progeny of broodstock identified as wild non-Twisp origin (or known Methow Composite hatchery origin if needed to meet shortfalls in the production goal) fish. Age-3 males ("jacks") will not be collected for broodstock.

Table 1. Brood year 2013-2015 age class-at-return projection for wild spring Chinook above Wells Dam, 2018.

Brood year	Smolt Estimate		Age-at-return									
			Twisp Basin					Methow Basin				
	Twisp[1]	Methow Basin[2]	Age-3	Age-4	Age-5	Total	SAR[3]	Age-3	Age-4	Age-5	Total	SAR[4]
2013	24,605	36,242	19	142	**21**	182	0.0074	48	619	**127**	794	0.0219
2014	28,380	41,353	21	**164**	25	210	0.0074	54	**707**	145	906	0.0219
2015	22,738	26,491	**17**	131	20	168	0.0074	**35**	453	92	580	0.0219
Estimated 2018 Return			**17**	**164**	**21**	**202**		**35**	**707**	**127**	**869**	

[1] *Smolt estimate is based on sub-yearling and yearling emigration (Charlie Snow, personal communication).*
[2] *Estimated Methow Basin smolt emigration based on Twisp Basin smolt emigration, proportional redd deposition in the Twisp River and Twisp Basin smolt production estimate.*
[3] *Geometric mean Twisp NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*
[4] *Geometric mean Methow NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*

Table 2. Brood year 2013-2015 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2018.

Stock	Projected Escapement											
	Origin								Total			
	Hatchery				Wild				Methow Basin			
	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total
MetComp	124	673	12	**809**	18	543	106	**667**	142	1,216	118	**1,476**
%Total				34.2%				76.8%				45.6%
Twisp	18	55	11	**84**	17	164	21	**202**	35	219	32	**286**
%Total				3.5%				23.2%				8.9%

Winthrop (MetComp)	318	1,125	30	**1,473**					248	886	21	**1,473**
%Total				62.3%								45.5%
Total	460	1,853	53	**2,366**	35	707	127	**869**	495	2,560	180	**3,235**

Table 3. Number of broodstock needed for the combined Methow spring Chinook conservation program production obligation of 223,765 smolts, collection location, and mating strategy.

By obligation	Production target	Number of Adults		**Total**		
		Hatchery	Wild			
Chelan PUD	60,516		17F/17M	**34**		
Douglas PUD	29,123		8F/8M	**16**		
Grant PUD	134,126		38F/38M	**76**		
Total	**223,765**		**64F/64/M**	**126**		
By program		Number of Adults			Collection location	Mating protocol
		Hatchery	Wild	**Total**		
Twisp	**30,000**		**9F/9M**	**18**	Wells Dam/Twisp Weir	2x2 factorial
MetComp	**193,765**		**54F/54M**	**108**	Wells Dam/Methow Hatchery	2x2 factorial
Total	**223,765**		**63F/63M**	**126**		

Trapping at Wells Dam will occur at the East and West ladder traps beginning on May 1, or at such time as the first spring Chinook are observed passing Wells Dam, and continue through June 30, 2017 (collection quotas will be prioritized for the May 1-June 22 time frame). Spring Chinook broodstock collection and stock assessment sampling activities authorized through the 2018 Douglas PUD Hatchery M&E Implementation Plan will utilize a combination of trapping on the East and West ladders as per the detailed descriptions of the modified trapping operations for spring Chinook collection in Appendix D. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quota). Collection goals will be developed by Wells M&E staff to identify the most appropriate spatial and temporal approach to achieving the overall brood target. All natural origin spring Chinook collected at Wells Dam for broodstock will initially be held at Wells FH (or immediately transferred to Methow FH taking into account the status of adult holding during the modernization project) pending genetic results and then transferred to Methow FH. Fish collected at MFH will remain at MFH or be transferred to WNFH.

Collection of ad-clipped only (no wire) spring Chinook adults (or possibly eggs identified through CWTs from ad-clipped +CWT CJH segregated returns) may occur from facilities in the Methow basin and/or Wells Dam. These alternative collection locations will only be used if CCT and USFWS broodstock collection efforts fail to achieve broodstock collection objectives for the CJH 10j program, or if conditions (e.g., spill at CJD, ladder/trap efficiency) appear unconducive to efficient collection of broodstock. Collection will run concurrent with spring Chinook broodstock collection for Methow Hatchery.

Trapping at the Twisp Weir for spring Chinook may begin May 1 or at such time as spring Chinook are observed passing Wells Dam and may continue through August 23. The trap may be operated up to seven days per week/16 hours per day (provided it is manned during active trapping).

However, trapping at the Methow Hatchery Outfall trap may continue beyond the Twisp Weir operations as needed to meet basin wide PNI/pHOS objectives. Hatchery-origin adults captured at the Methow Hatchery Outfall (surplus to the Methow Hatchery program) will be: 1) used for adult out-planting to increase natural production and secondarily 2) transferred to the WNFH for incorporation into WNFH brood, or 3) removed as surplus as supported by the HGMP's of both facilities.

Steelhead

Douglas PUD and Grant PUD steelhead mitigation programs above Wells Dam utilize adult broodstock collections from multiple sources and locations such as at Wells Hatchery, Wells Dam, Twisp Weir, Methow Hatchery volunteer trap, WNFH volunteer traps, Omak Weir, Wild horse Creek box trap and angling in the Methow River and Okanagan River (Table 5). Generally incubation/rearing occur for the DPUD conservation program, Methow safety net, Okanogan, and Columbia River releases at Wells Fish Hatchery (FH). Methow Hatchery may be used to temporarily hold broodstock that are ultimately transferred to Wells Hatchery or WNFH. Broodstock for the conservation programs (USFWS and DPUD) is achieved via angling in the Methow Basin and trapping at the Twisp Weir (as needed), respectively. Broodstock for the Methow safety net program is achieved primarily through returns to WNFH (including hook and line-caught HOR steelhead) and surplus fish removed at Methow Hatchery and the Twisp Weir. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin summer steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Presently the HCP HC and Joint Fisheries Parties are working to develop, approve, and implement an alternative to past programmatic approaches to more fully integrate the collective Methow sub-basin steelhead conservation programs as well as address concerns over potential RL effects in the Twisp River watershed. Some elements of a preferred alternative (see Appendix H), are still being piloted for the 2018 brood. The HC parties have not approved a long-term plan for the Twisp program pending results of the 2018 pilot year brood collection efforts. , the broodstock collection protocols for the 2019 brood will remain the same as those described in the 2017 Broodstock Collection Protocols. If the alternative in Appendix H or other alternative is approved prior to implementation of the 2019 BY conservation programs, the 2018 Broodstock Collection Protocols will be updated to reflect the new direction.

Specific program brood sources are structured as follows:

Broodstock collection for the DPUD summer steelhead program has been optimized to provide a high probability of collecting sufficient broodstock of the proper origin to meet program production goals while minimizing the probability of producing overages. The following broodstock collection logic provides a step-by-step process whereby DPUD and WNFH summer steelhead broodstock will be collected.

1. September-November 2018: Collect ad clip + CWT hatchery origin steelhead from Wells dam and Wells Volunteer channel sufficient to meet the Methow Safety-Net program (100,000 release; 60 broodstock). Go to #2.

2. Subsequent broodstock collections (see below) for the Methow Safety-Net program will prompt the transfer of the fall collected broodstock progeny to the Columbia Safety-Net Program (160,000 release target), up to the entire fall-collected production (equal to approximately 100,000 smolts). This will leave as few as 60,000 smolts to be produced by subsequent collections for the Columbia Safety-Net. Any Okanogan-origin broodstock spawned from this fall collection group will be transferred to the Okanogan production (CCT to collect broodstock in the Okanogan basin in spring 2019). Go to #3.

3. February 2019-April 2019: Hook-and Line collections in the Methow mainstem: target sufficient natural origin summer steelhead for the Twisp Conservation component (24,000 release; 12 broodstock collected downstream of Twisp) and the WNFH (up to 200,000 release; 110 broodstock collected throughout Methow mainstem). These natural origin fish are to be transported to WNFH, spawned collectively, and a portion of the progeny sufficient to meet the 24,000 release target will be transferred to Wells Hatchery as eyed eggs. By-catch of hatchery origin fish will be retained as broodstock for the WNFH program (Ad+CWT), the Methow Safety-Net (CWT only, Ad+CWT), and the Columbia Safety-Net (Ad only, Ad_CWT), as needed. Adults in excess of broodstock needs will be managed as surplus. Go to #4.

4. March- May 2019: Twisp Weir collection. Target sufficient natural origin summer steelhead for the Twisp Conservation component (24,000 release). Hatchery-origin fish to be removed at a rate to meet pHOS management target. CWT-only fish to be used as broodstock for the Methow Safety-Net up to 25% (approximately 15 broodstock). Additional CWT-only broodstock may be used in the Columbia Safety-Net. CWT+Ad may be used in the Columbia Safety-Net. Go to # 5.

5. March-May 2019: WNFH Volunteer Channel and Methow Hatchery Volunteer channel. Natural origin fish may be collected if present and included in the WNFH and Methow River collected component of the Twisp Conservation Program. Hatchery origin fish will be collected and used as broodstock in the WNFH program (Ad+CWT), Methow Safety-Net program (Ad+CWT), and the Columbia Safety-Net program (Ad+CWT, Ad only). Such fish will be used to augment the fish previously collected described in #s 1 and 2, above. Go to #6.

6. March-May 2019: The Wells Volunteer Channel will be used to collect AD+CWT, Ad only, and CWT only hatchery origin adult summer steelhead to be used as backfill for Methow Safety-Net, Columbia Safety-Net, Okanogan Program, and WNFH program (if desired by USFWS) should any of these program lack sufficient broodstock for the collections described above. Adult hatchery origin steelhead in excess of broodstock needs will be surplused.

Twisp River – Conservation Releases

Due to the recent increased concern for inbreeding depression risk (Ryman-Laikre) for the Twisp program as a result of low N_e and other confounding issues, the design of the Twisp program is currently under review.

The HC and JFP are working to redefine the scope and nature of the 2019 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan can be implemented.

The current plan (BY 2018) collects approximately 12 natural origin fish as broodstock from the Methow Mainstem (hook and line) and approximately 12 natural origin fish as broodstock from the Twisp River (weir).

Wells Hatchery – Methow River Release

The Wells Hatchery Methow River release (Methow safety net program) uses locally collected hatchery origin broodstock representative of the Twisp and WNFH conservation programs and as needed, the Methow safety-net program. Adults are collected in concert with adult management and broodstock collection (including hook-and-line) activities at the Twisp Weir, Methow Hatchery, and WNFH.. As a backup to potential collection shortfalls in the Methow safety-net program , a portion of the Methow program may be augmented with collection of hatchery origin adults (60) occurring in the fall at Wells Dam. These fall-collected fish will be considered surplus to any spring-collected Methow broodstock (hook and line, Twisp Weir, WNFH and Methow Hatchery volunteer channels), and surplus eggs and/or fry from the Methow Safety-Net broodstock may be utilized for other programs in the upper Columbia. As a final backup strategy, hatchery origin broodstock may be collected from Wells Hatchery Volunteer Channel in spring 2019 if other broodstock collection measures fall short. Beginning with the 2018 release, fish will be truck planted at Effy Bridge (RKM 13) in the lower Methow.

Wells Hatchery-Columbia River Release

The Wells Hatchery Columbia River releases will use progeny from the fall-collected Methow Safety-Net broodstock (described above) to the extent that spring collections partially or completely fulfill this program. The remaining production for the Columbia Safety-Net may include hatchery origin broodstock collected via hook-and-line in the Methow River, Twisp Weir, adult returns to the Methow Hatchery and Winthrop NFH, and may be augmented with fish collected in spring 2019 from the Wells Volunteer channel if needed to fulfill the program. Surplus eggs and/or fry from the Columbia and Okanogan broodstock may be utilized for other programs in the upper Columbia. Fish are released to the Columbia River, immediately downstream of Wells Dam.

Winthrop NFH – Methow River Release

The USFWS Methow River release will primarily use natural-origin fish collected through hook-and-line collection efforts in the Methow River each spring. In the event NO collection falls short of the target, WNFH hatchery-origin returns will be prioritized, followed by safety-net hatchery returns. Transfer of adult and/or gametes/eggs between program will be carefully choreographed to ensure fish are being utilized in the most efficient and effective manner. Fish may be released throughout the Methow basin.

Okanogan River and Tributary Releases

The Okanogan River conservation program uses a combination of natural and hatchery-origin adults collected in Omak Creek and elsewhere in the Okanogan Basin through CCT collection efforts. As a backup to potential spring collection shortfalls in the Okanogan, 30 hatchery origin fish will be collected in the fall of 2018at Wells Dam. Fish collected in the fall 2018 for the Methow Safety-Net program that are subsequently identified as Okanogan origin will be used as the priority for the Okanogan program followed by unknown hatchery origin adults as a backup, if necessary to meet production levels for the Okanogan. Surplus eggs and/or fry from the Okanogan River program broodstock may possibly be utilized for other programs in the upper Columbia or otherwise surplused at the earliest time when overages are apparent.

Should the combined Okanogan Basin spring period collection and Wells Dam fall period collection fail to achieve sufficient broodstock to meet programmed production, steelhead will be collected from the Wells Hatchery volunteer ladder in the spring of 2019, sufficient to meet broodstock needs. Fish with positive CWT or PIT tag for Okanogan origin will be the priority to fill the shortfall in broodstock, followed by unknown hatchery origin fish.

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2019 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Locations
DPUD Conservation[2]	TBD	Douglas PUD	Buttermilk Bridge, TBD	48,000 (S_1)	TBD
Methow Safety-Net	Wells Hatchery	Douglas PUD	Effy Bridge – Lower Methow River	100,000	HxH: Twisp Weir (up to 25%) + WNFH Hatchery (75%) or WNFH 1st, MFH 2nd to make up balance

Mainstem Columbia Safety-Net	Wells Hatchery	Douglas PUD	Wells Hatchery	160,000	HxH: Wells FH/Dam returns (1st option); Methow FH/WNFH (2nd option)
WNFH Conservation Program	WNFH	USFWS	WNFH or other locations as determined by the JFP	Up to 200,000 (S_2)	Maximize use of NOR, up to 55 pair captured by hook and line in the Methow River and Spring Creek Weir.
Okanogan[1]	Wells Hatchery/ St. Mary's Pond	Grant PUD/CCT	Okanogan tributaries	100,000[1]	Okanogan Basin, Wells Dam

[1] CCT received approval for the Okanogan steelhead HGMP as part of their Tribal Resource Management Plan in February, 2017. Omak Creek and Wells Fish Hatchery are no longer separate hatchery programs. Up to 58 broodstock (NOB or HOB) may be collected from throughout the Okanogan basin (or Wells Dam if necessary) to meet the 100k program.
[2] The DPUD Twisp conservation program is currently under re-development after detection of inbreeding depression risk. The HC and JFP have committed to developing an approved plan in sufficient time for implementation.

The following broodstock collection protocol was developed based on mitigation program production objectives (Table 6), biological assumptions (Appendix A), and the probability that sufficient adult steelhead will return in 2018/2019 to meet production objectives absent a preseason forecast at the present time.

For the 2019 brood steelhead programs operating above Wells Dam, a total of 346 adults (192 natural origin and 154 hatchery origin adults) are estimated to be needed to fulfill the respective mitigation obligations (Table 6). To support these obligations and to ensure sufficient backup adults are available in the event tributary based collection efforts fall short of targets, fall 2018 and spring 2019 trapping at Wells Dam and/or Wells FH may selectively retain up to 214 hatchery origin steelhead (west [and east, as necessary] ladder and volunteer trap collection; Table 5). As a note, all potential broodstock will be scanned for PIT tags at collection and PIT tagged fish will be returned to the river to meet their monitoring objective. Any adult determined to have been part of the Yakama Nation's kelt reconditioning program will be released in the vicinity it was collected.

Twisp Conservation Program (DPUD)

The HC and JFP are working to redefine the scope and nature of the 2019 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan (the current draft plan be reviewed in Appendix H) can be implemented.

Methow Safety Net Program

Up to 14 surplus hatchery-origin Twisp-stock steelhead (to meet up to 25% of the 100K Methow Safety-Net release) will be targeted at collective locations including the Twisp Weir and moved as live adults to Wells Hatchery for spawning. No less than 46 hatchery adults will be targeted at WNFH and through angling efforts, and if needed/available, Methow Hatchery volunteer traps to meet the balance of the program needs (Table 6). Up to 60 hatchery origin Wells stock may be collected in fall 2018 and held at the Wells Hatchery to be used as broodstock for the Methow

Safety-Net. Should spring collection fulfill or partially fulfill the broodstock needs for the Methow Safety-Net, then the surplus progeny from the fall collected fish will be transferred to the Columbia Safety-Net program. If collection via hook-and-line, at the Twisp Weir, and WNFH and MH traps/collection efforts are unsuccessful (Table 5) then broodstock will be trapped in the Wells Volunteer channel in spring 2019.). Coordination between USFWS, DPUD, and WDFW staff will occur during the season to determine prioritization.

Methow Conservation Program (USFWS)

Approximately 110 natural origin adults (55 pair) will be targeted for retention through hook–and-line collection efforts in the Methow River (Table 6). In the event of a shortage, excess hatchery steelhead from the Twisp Weir and volunteer returns to the WNFH (including angle-caught fish) will be utilized as needed to augment WNFH broodstock. Should there be inadequate surplus steelhead from these sources, excess hatchery steelhead (presumed Methow Safety-Net origin) captured at the Methow Hatchery volunteer trap will be used to fulfill the program. Natural-Origin females will be live-spawned and reconditioned by YN.

Okanogan Conservation Program (GPUD/CCT)

Up to 58 adult steelhead will be targeted in the Okanogan Basin, including up to 100% natural-origin adults (dependent on run size and within the 33% natural origin extraction rate) (Table 5). Additionally, progeny of adult steelhead collected in the fall for the Methow Safety-Net and subsequently identified as Okanogan-origin will be transferred to the Okanogan program. Due to unknown broodstock collection efficiencies in the Okanogan River Basin (Table 5) further broodstock shortfalls for the Okanogan may be supplemented with broodstock collected in the spring of 2019 at the Wells Fish Hatchery Volunteer Ladder mayto meet the production obligation.

Table 5. Broodstock collection locations, number, and origin by program.

Program	Number of Adults[1]		Primary collection location	Number of backup adults[2]	Backup collection location(s)	Total adult collection[1]	
	Hatchery	Wild				Hatchery	Wild
DPUD Columbia R. SN	94		Wells FH/Dam, Methow River, WNFH, Methow Hatchery, Twisp Weir		Wells Hatchery	94	
DPUD Methow R. SN	60		Twisp weir (14), Methow RiverWNFH[3]W NFH[3] (46)	Up to 60	Wells Hatchery	120	
DPUD Met. Conservation		24	Twisp weir	NA	NA		24
GPUD Okanogan R.	0-58[6]	0-58[7]	Wells Dam, Omak Cr., Okanogan R. and tributaries.	0[5]	Wells FH[5]	(Backup) 0-58	(1st priority) 0-58

USFWS Methow R.		110	Methow R. WNFH[4]	NA	Methow FH	Up to 54[8]	110[8]
Total (PUD programs)	**154-212**	**24-82**		**Up to 60**		**214-294**	**24-82**
Total (All programs)	**154-212**	**134-192**		**Up to 60**		**214-326**	**134-192**

[1] Assumes a 1:1 sex ratio (see table 6). Natural origin females will be live spawned and reconditioned.
[2] All backup broodstock are hatchery origin adults collected in fall.
[3] Primarily uses hatchery origin adults collected via the USFWS hook and line efforts for natural origin fish in the Methow River and adult returns to WNFH. May include Methow safety net adults collected via angling, or adult returns to WNFH and Methow FH.
[4] May also include excess hatchery origin adults collected via angling and at Methow FH and the Twisp Weir.
[5] Fall collection of MSN will contribute any Okanogan origin brood production. Spring collection of hatchery origin steelhead as needed to meet program for the Okanogan Program. Shortfall, if encountered, to be met with Wells Hatchery Volunteer Channel collection in spring.
[6] Dependent upon number of NOR broodstock collected in the Okanogan Basin, age structure and fecundity to achieve sufficient brood for a100k smolt program for the Okanogan.
[7] Depending upon NOR abundance and trapping efficiency
[8] Broodstock composition for the WNFH conservation program is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Table 6. Number of broodstock needed to produce approximately 608,000 smolts for the above Wells Dam 2019 brood summer steelhead programs. Includes primary collection location(s) and mating strategy. *Broodstock totals do not include additional fish that may be collected at other locations as a backup for shortfalls from primary collection sources.*

Program	Production target/request	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
DPUD[1] Columbia R.	160,000	47F/47M		**94**	Wells Dam/Twisp Weir/	1:1
DPUD[2] Methow R.	100,000	30F/30M		**60[4]**	Twisp Weir, MFH, WNFH, Wells Dam	1:1
DPUD Methow Conservation	48,000		12F/12M	**24**	Twisp Weir/Methow River	2x2 Factorial
GPUD Okanogan R.[3]	100,000		29F/29M	**58[5]**	Okanogan R./Omak Creek	1:1/2x2[7]
USFWS Conservation[8]	200,000[8]		55F/55M	**110**	Methow River[6]	2X2 Factorial
Total[4]	**608,000**	**77F/77M**	**96F/96M**	**346**		

[1] Mainstem Columbia releases at Wells Dam. Target HxH parental adults as the hatchery component.
[2] Methow hatchery release of HxH fish produced from either adults returning from the Winthrop conservation program, adults trapped at MFH, and/or surplus hatchery adults from the Twisp weir.
[3] CCT intends to achieve greater than 0.5 pNOB in both 2018 and 2019, but the actual number will be dependent upon run size and trap efficiency, per the HGMP. Numbers of hatchery and wild males and females in this table should not be taken as the goal or limit for any collection effort, as it could be up to 100% pNOB or pHOB.
[4] Up to an additional 30 hatchery adults may be collected at Wells FH as a fall back to shortfalls in collections for the Methow safety net.
[5] Up to an additional 30 hatchery origin adults may be collected at Wells Dam as backup to potential shortfalls in Okanogan Basin collection efforts.
[6] Collection priority: 1) hook and line, 2) adult returns to WNFH, 3) excess adult returns to Methow Hatchery.
[7] A 1:1 mating protocol will be used for all HxH/HxW crosses within the Okanogan. The Okanogan locally-adapted natural stock (WxW) will utilize a minimum 2x2 factorial mating to minimize potential negative effects associated with a small effective population size.
[8] Production is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Overall collection for the PUD programs will be 236 fish (a combination of program specific and back-up adults; Table 6) and limited to no more than 33% of the entire run and/or 33% of the natural origin return. Hatchery and natural origin collections will be consistent with the respective run-timing of hatchery and natural origin steelhead at Wells Dam, Omak Weir and the Twisp Weir. Trapping at the Wells Dam ladders may occur between 01 August, 2018 and 30 April, 2019, up to three days per week, and up to 16 hours per day, as required to meet broodstock objectives. Trapping will be concurrent with summer Chinook broodstocking efforts through 15 September, 2018 on the west ladder (Appendix D). Operational criteria and dates for the Twisp Weir are still under development.

Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and Wells dams. Broodstock collection adjustments may be made based on in-season monitoring and evaluation. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

Surplus UCR Juvenile Steelhead Management

In the event excess HxH juveniles are produced from the over-collection efforts to support the Methow Safety-Net and /or Okanogan programs which rely on spring adult collections, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Progeny transferred to the Columbia Safety-Net program provided fish health and/or marking requirements for the program can be met.

2. Used to support shortfalls in the WNFH production obligation provided fish health and/or marking requirements for the program can be met and provided basin wide pHOS/PNI allow for a decrease in program pNOB.

3. Used to support shortfalls in the Ringold SHD program provided fish health and/or marking requirements for the program can be met.

4. Out-planted to landlocked lakes within Okanogan County and/or Colville Reservation provided fish health requirements can be met or provided stocking allotments are not exceeded (as determined by WDFW, YN and CCT fishery managers, as applicable; Banks Lake may be utilized as a last resort if stocking allotments for area lakes have already been met and/or if access to appropriate locations is inhibited – i.e., snow, ice, washouts, etc.).

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy. If excess WxW production from any of the conservation programs occurs, the priority will be to incorporate those progeny either into an available conservation program (if a shortfall exists) or into the closest safety net program (in this case it would be the Methow safety net [MSN]). Excess safety net fish from the MSN will then be managed in accordance with the guidelines above.

Summer/fall Chinook

The summer/fall Chinook mitigation program in the Methow River utilizes adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 200,000 summer/fall Chinook smolts for acclimation and release from the Carlton Acclimation Facility.

The TAC 2018 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2013, 2014, and 2015 spawn escapement to tributaries above Wells Dam indicate sufficient summer Chinook will return past Wells Dam to achieve full broodstock collection for supplementation programs above Wells Dam. The following broodstock collection protocol for the Methow summer Chinook program was developed based on initial run expectations of summer Chinook to the Columbia River, program objectives, and program assumptions (Appendix A).

For 2018, up to 136 natural-origin summer Chinook at Wells Dam west (and east, if necessary) ladder(s), including 68 females for the Methow summer Chinook program (Table 7). Collection will be proportional to return timing between 01 July and 15 September. Summer Chinook stock assessment will run concurrent with summer Chinook broodstock collection at the west ladder trap. Trapping may occur up to 3-days/week, 16 hours/day (48 cumulative hours per week). Age-3 males (“jacks”) will not be collected for broodstock.

Should use of Wells Dam be needed to meet any shortfalls in Chief Joseph Hatchery broodstock for summer/fall Chinook programs , the CCT will notify the HCP-HC and Wells HCP Coordinating Committee/PRCC-HSC and coordinate with Douglas PUD, Grant PUD, and WDFW to facilitate additional broodstock collection effort. Summer Chinook broodstock collection efforts at Wells Dam, should they be required to meet CJH program objectives, will be conducted concurrent with broodstock collection efforts for the Methow summer Chinook program and or steelhead collection efforts for steelhead programs above Wells Dam.

If the probability of achieving the broodstock goal is reduced based on passage at the west ladder or actual natural-origin escapement levels, broodstock collections may be expanded to the east ladder trap and/or origin composition will be adjusted to meet the broodstock collection objective. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 7. Number of broodstock needed for Grant PUDs Methow summer Chinook production obligation of 200,000 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			

Methow	200,000	68F/68M	**136**	Wells Dam	1:1
Total	**200,000**	**136**	**136**		

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - The summer Chinook salmon acclimated at the Carlton Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),
- all fish will be released when Columbia River and Methow River flows are predicted to be satisfactory,
- all fish will be released no later than May 7 regardless of flow conditions,
- attempts will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in the Methow River are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Methow River flows are not satisfactory due to insufficient snow pack.

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Collection at the Wells FH volunteer channel will be used to collect the broodstock necessary for the Wells FH yearling (320,000) and sub-yearling (484,000) programs.

Because of CCT concerns about sufficient natural origin fish reaching spawning grounds and to ensure sufficient NOR's being available to meet the CCT summer Chinook program, incorporation of natural origin fish for the Wells program or programs with broodstock originating from the Wells volunteer channel, will be limited to fish collected in the Wells volunteer channel. The following broodstock collection protocol was developed based on mitigation objectives and program assumptions (Appendix A).

DPUD will target 556 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall for the Wells sub-yearling and yearling programs, and up to 194 for the YN 275K-350K green egg request for the Yakima summer Chinook program (Table 8). Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin July 1 and terminate by August 31. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not exceeding 10% representation of natural origin fish in the summer Chinook broodstock collection. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

For 2018, broodstock collection for the Chelan Falls summer Chinook program will be prioritized at the Chelan Falls Canal Trap (CFCT) which was successfully piloted in 2016 and continued in 2017, beginning July 1 through September 15. Due to a spawning gravel augmentation project, the collection period ended before September 15 in 2017 and subsequently collection efforts in the CFCT were insufficient to meet the adult requirements for the Chelan Falls program necessitating development of alternate collection locations/strategies. If shortfalls in adult needs are expected and the number of females needed to meet program has not been reached by August 15th, the HCP HC will discuss whether broodstock collection may default to surplus summer Chinook collected from, in order of priority, 1) Wells FH, 2) Entiat NFH, 3) Chief Joseph Hatchery, or other HCP approved location to make up the difference. The 2018 broodstock target for the Chelan Falls program is 384 adults (Table 8). The total production level supported by this collection is up to 576,000 yearlings for the Chelan Falls program.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 8. Number of broodstock needed for the combined Chelan and Douglas PUD Columbia River below Wells summer Chinook production obligations of 1,380,000 smolts, collection location, and mating strategy. Also includes broodstock necessary for outside programs that rely on adult collection at Well Hatchery in 2018.

Program	Production target	Number of Adults[2]		Total	Collection location	Mating protocol
		Hatchery	Wild			
Wells 1+	320,000	102F/102M		**204**	Wells VC[3]	1:1
Wells 0+	484,000	166F/166M		**332**	Wells VC[3]	1:1
Chelan Falls 1+	576,000	192F/192M		**384**	CFCT[4]	1:1
Yakama Nation	350,000[1]	97F/97M		**194**	Wells VC[3]	NA
Total	**1,730,000**	**557F/557M**		**1,114**		

[1] The YN request is for between 275K and 350K green eggs to support the Yakima River summer Chinook program.
[2] The number of adults collected for these programs may indirectly incorporate natural origin fish; however, because they are volunteers, the number is likely to be less than 10% of the total.
[3] Wells Hatchery volunteer channel trap.
[4] Chelan Falls Canal Trap

Wenatchee River Basin

In 2018 the Eastbank Fish Hatchery (FH) is expecting to rear spring Chinook salmon for the Chiwawa River and Nason Creek acclimation facilities located on the Chiwawa River and Nason Creek. The program production level target for the Chiwawa program (Chelan PUD obligation) in 2018 is 144,026 smolts, and based upon the biological assumptions (Appendix A) will require a total broodstock collection of about 76 natural origin spring Chinook (Table 10). The spring Chinook production obligation for Grant PUD in the Wenatchee Basin is 223,670 smolts (125,000 conservation and 98,670 safety net) and based upon the biological assumptions (Appendix A) will require a total broodstock collection of 130 adults (64 natural origin and 66 hatchery origin; Table 10).

Pre-season run-escapement of Wenatchee spring Chinook to Tumwater Dam during 2018 is estimated at 5,664 spring Chinook, including 4,888 hatchery and 776 natural origin spring Chinook (does not include age-3 males; Table 9). In-season estimates of natural-origin spring Chinook to Tumwater Dam will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 9. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2018.

	Chiwawa Basin			Nason Cr. Basin			Wenatchee Basin to Tumwater Dam		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return	461	66	**527**	125	18	**143**	679	97	**776**
Estimated hatchery return	3,240	63	**3,303**	1,522	63	**1,585**	4,762	126	**4,888**
Total	3,701	129	**3,830**	1,647	81	**1,728**	**5,441**	**223**	**5,664**

Table 10. Number of broodstock needed for the combined Wenatchee spring Chinook production obligation of 367,969 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			

Chiwawa Conservation[4]	144,026	19F/19M	38F/38M	**76[1]**	Chiwawa Weir and Tumwater Dam[4]	2x2 factorial
Nason Conservation	125,000	0	32F/32M	**74[2]**	Tumwater Dam[4]	2x2 factorial
Nason Safety net	98,670	33F/33M[3]	0	**66**	Tumwater Dam	1:1
Total	**367,969**	**104**	**140**	**254[5]**		

[1] Does not include an additional 38 hatchery origin adults (19 females; represents ~50% of the adult target) to ensure the Chiwawa production goal is met if insufficient NO adults are collected).
[2] Includes ~10% additional NO fish for the Nason program to account for fish that may assign back to the White River spawning aggregate. No more than 64 NO fish will be retained for spawning.
[3] Chiwawa hatchery fish will only be collected to satisfy the Nason Cr. safety net program if in-season estimates of returning Nason conservation fish fall short of expectations.
[4] Collection of NO fish at Tumwater for the Chiwawa program will include previously PIT tagged adults (NO juveniles PIT tagged at the Chiwawa smolt trap) and/or excess NO adults/eggs/progeny originating from females with assignments >95% to the Chiwawa from the Nason conservation program.
5 Total includes the 10% over-collection as part of the genetic assignment variance for the Nason conservation program and approximately 38 HO adults collected as a contingency for production shortfalls in the Chiwawa conservation program if insufficient NO adults are collected.

Chiwawa River Conservation Program Broodstocking:

Since implementing a highly restrictive weir operations plan beginning in 2014 to limit bull trout encounters while still trying to achieve the broodstock target, the average number of bull trout handled was 70. Over this same period the average broodstock collection shortfall was 17.8% but was as high as 32.4% in 2017, a low NO abundance year. The 2018 pre-season forecast for NO adults back to the Chiwawa is similar to the 2017 forecast (526 and 527 for 2017 and 2018 forecasts respectively). It is under these circumstances that WDFW is proposing to increase the number of bull trout encounters (and subsequent number of trappings days) to facilitate meeting the Chiwawa spring Chinook broodstock collection target as agreed to by the HCP HC. Consistent with the realized shortfall in NO broodstock in 2017, the 2018 operations plan seeks to increase the number of bull trout encounters by about 33%, from 70 to about 93 (this theoretically increases the number of trapping days available from 15 to about 20). Any in-season modification of this plan would require concurrence on the part of the HC and the USFWS prior to implementation. The increase in bull trout encounters would result in an approximate impact to the adult bull trout population of about 6.2%, well below the desired maximum threshold of 10%.

- Based upon estimates of returning previously PIT tagged NO fish to Tumwater Dam (Table 11), approximately 26 previously PIT-tagged NO spring Chinook from the Chiwawa River could be collected at TWD between June 1 and July 15, concurrent with Nason Creek brood stocking, adult management, RM&E, and the RRS Study.
- The balance of adults needed to meet the Chiwawa Conservation program (up to ~76 total or ~38 females) would be collected at the Chiwawa Weir.

- Weir operations would be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.
- Using the most recent 3-year redd count data (2014-2017; 2016 survey data was not collected due to widlfires), the 10% threshold is 148 bull trout as determined by an average number of redds in the Chiwawa sub-basin of 739 (expands to 1,147 adults at a 1:1 sex ratio).
- No more than 10 percent of the estimated mean number of adult bull trout in the Chiwawa Basin (using up to a rolling five year average derived from expanded redd counts) may be encountered during broodstock collection without concurrence from the USFWS. Sufficient redd data to calculate a full five year average is expected to be available as early as 2018.
- To ensure the production target is met for the Chiwawa program, in the event that insufficient NO adults are collected for the conservation program, HO adults (presently estimated at 50% of the total broodstock requirement, however may be adjusted up or down depending on the run) would be collected at TWD to make up the shortfall (see Table 10) between June 1 and July 15.
- For additional assurance and to help reduce effort at the Chiwawa Weir, during broodstock collection for the Nason conservation program, any excess adult not genotyping to the White River will be retained for the Nason program and an equivalent number of adults that have assignment probabilities >95% for Chiwawa, will be transferred to the Chiwawa program.
- Historic and in-season data for NO spring Chinook timing to the lower Chiwawa array from TWD will be used to determine optimal dates for collection.
- Any bull trout that are caught at the Chiwawa trap will be immediately removed and released at a site ~10KM upstream of the weir to prevent fallback/impingement and to mitigate for potential delay. Handling and transport will be conducted by WDFW hatchery staff.
- If a bull trout is killed during trapping, despite implementing conservation measures, trapping activities will cease and not continue until additional measures to minimize risks to bull trout can be discussed with the USFWS.

Table 11. PIT tagged natural origin adults to Tumwater Dam for the most recent 5-years (2013-2017) with conversion rates from Bonneville Dam.

Detections at Bonneville Dam	Detections at Tumwater Dam

Return year	Nason	Chiwawa	Nason	Conversion rate	Chiwawa	Conversion rate
2013	2	29	2	1.000	22	0.759
2014	6	66	1	0.167	29	0.439
2015	9	42	6	0.667	28	0.667
2016	8	34	8	1.000	24	0.706
2017	5	31	3	0.600	31	1.000
Mean	6.0	40.4	4.0	0.687	26.8	0.714
Geomean	5.3	38.5	3.1	0.582	26.6	0.690

Nason Creek Conservation Program Broodstocking:

- Up to ~74 NO spring Chinook (to allow for up to 10 percent of White River NO fish estimated to be encountered at Tumwater Dam MSA; Table 10) would be collected at TWD between June 1 and July 15.
    - Only 64 NO adults (32 females) will be retained to produce the 125K Nason Conservation program.
    - Collection of additional HO fish may occur in the event NO collection/retention falls short of expectation.
    - Brood stock collection would run concurrent with adult management, RM&E, and the Spring Chinook Relative Reproductive Success Study. The GAPS microsatellite panel and existing GAPS plus WDFW spring Chinook Wenatchee baseline will be used for genotyping and GSI analyses similar to methods used beginning in 2013.

- Decision Rules:
    - Any fish that assigns to the White River with greater than 90% surety will be released in the White River.
    - Unassigned fish (individuals that can't be assigned to the Wenatchee Population or Leavenworth NFH), will be released upstream of Tumwater Dam.
    - In the event more fish assign to Nason or Chiwawa than are needed to meet the conservation program, the excess with the highest assignment probabilities (>95%) to the Chiwawa will be incorporated into the Chiwawa conservation program if needed or otherwise returned to the river upstream of Tumwater Dam.

Nason Creek Safety Net Program Broodstocking:

- Up to ~66 HO spring Chinook adults (from conservation program – identified by snout wire + body wire) would be targeted at TWD (Table 10) between June 1 and July 15, concurrent with NO brood stock collection, adult management, RM&E, and the Spring Chinook Relative Reproductive Success (RRS) Study.

Nason Creek spring Chinook Rearing/Release Strategy:

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - Spring Chinook salmon acclimated at the Nason Creek Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),
- all fish will be released when Columbia River and Nason Creek flows/conditions are predicted to be satisfactory,
- all fish will be released no later than May 7 regardless of flow conditions,
- attempts will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in Nason Creek are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Nason Creek flows are not satisfactory due to insufficient snow pack.

Surplus Wenatchee Sub-basin Juvenile Spring Chinook Management

In the event excess juveniles are produced from Wenatchee Sub-basin spring Chinook programs, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Excess progeny from the Chiwawa conservation program may be used to support shortfalls in the Nason conservation program provided fish health and/or marking requirements for the program can be met.
2. Excess progeny from the Nason conservation program may be used to support the Chiwawa conservation program provided they are progeny from females with assignment probabilities >95%. Additionally, it will require that fish health and/or marking requirements for the program can be met.
3. In the event excess NO production from the Nason program is not needed to or cannot support the Chiwawa (for reasons of fish health, marking, or ability to identify assignment probability), they will be incorporated into the Nason safety net program and prioritized over HxH progeny.

4. Excess progeny from the HO contingency broodstock collected for the Chiwawa program may be used to support any potential shortfall in the Nason safety net program provided fish health and/or marking requirements for the program can be met.

5. In the event no other option exists for excess hatchery progeny within the Wenatchee Sub-basin, Banks Lake may be utilized as a last resort provided fish health requirements can be met.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy.

Steelhead

The steelhead mitigation program in the Wenatchee Basin uses broodstock collected at Dryden and Tumwater dams located on the Wenatchee River. Per ESA section 10 Permit 18583 provisions, broodstock collection will target adults necessary to meet a natural origin – conservation (WxW) oriented program, not to exceed 33% of the natural origin steelhead return to the Wenatchee Basin and a hatchery origin (HxH) – safety net program. The conservation and safety net programs each make up approximately half of the 247,300 production obligation. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain a total of 136 mixed origin steelhead for broodstock for a smolt release objective of 247,300 smolts (Table 12). The 70 hatchery origin adults will be targeted at Dryden Dam and if necessary Tumwater dam. The 66 natural origin adults will be targeted for collection at Tumwater Dam. Collection will be proportional to return timing between 01 July and 14 November. Collection may also occur between 15 November and 5 December at both traps, concurrent with the Yakama Nation coho broodstock collection activities. Only adipose present coded wire tagged hatchery fish (or previously PIT tagged WxW hatchery progeny) will be retained for the safety net program. Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and at Dryden Dam. In-season broodstock collection adjustments may be made based on this monitoring and evaluation. To better ensure achieving the appropriate female equivalents for program production, the collection will include the use of ultrasonography to determine the sex of each fish retained for broodstock.

In the event steelhead collections fall substantially behind schedule, WDFW may initiate/coordinate adult steelhead collection in the mainstem Wenatchee River by hook and line. In addition to trapping and hook and line collection efforts, Tumwater and Dryden dams may be operated between February and early April the subsequent spring to supplement broodstock numbers if the fall trapping effort provides fewer than the required number of adults.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 12. Number of broodstock needed for the combined 2019 BY Wenatchee summer steelhead production obligation of 247,300 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
Wenatchee Conservation[1]	123,650	0	33F/33M	**66**	TWD[3]/Dryden LBT-RBT[4]	2x2 factorial
Wenatchee Safety net[2]	123,650	35F/35M	0	**70**	Dryden LBT-RBT[4] /TWD[4]	1:1
Total	**247,300**	**70**	**70**	**136**		

[1] Broodstock collection for the conservation program will occur primarily at Tumwater Dam and will only fall back to Dryden Dam trapping facilities if a shortfall is expected.
[2] Broodstock collection for the safety net program will occur primarily at the Dryden Dam trapping facilities to minimize activities at TWD that could increase unintended delays on non-target fish. Collection at Tumwater Dam will only occur if shortfalls in broodstock are expected at Dryden Dam.
[3] TWD=Tumwater Dam.
[4] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.

Summer/fall Chinook

Summer/fall Chinook mitigation programs in the Wenatchee River Basin utilize adult broodstock collections at Dryden and Tumwater dams, incubation/rearing at Eastbank Fish Hatchery (FH) and acclimation/release from the Dryden Acclimation Pond. The total production level target for BY 2018 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2018 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2013, 2014 and 2015 spawner escapement to the Wenatchee River indicate sufficient summer Chinook will return to the Wenatchee River to achieve full broodstock collection for the Wenatchee River summer Chinook supplementation program. Review of recent summer/fall Chinook run-timing past Dryden and Tumwater dams indicates that previous broodstock collection activities have omitted the early returning summer/fall Chinook, primarily due to limitations imposed by ESA Section 10 Permit 1347 to minimize impacts to listed spring Chinook. In an effort to incorporate broodstock that better represent the summer/fall Chinook run timing in the Wenatchee Basin, the broodstock collection will front-load the collection to account for the disproportionate collection timing. Approximately 43% of the summer/fall Chinook destined for the upper Basin (above Tumwater Dam) occurs prior to the end of the first week of July; therefore, the collection will provide 43% of the objective by the end of the first week of July. Weekly collection after the first week of July will be consistent with run timing of summer/fall Chinook during the remainder of the trapping period. With concurrence from NMFS, summer Chinook collections at Dryden Dam may begin up to one week earlier. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain up to 264 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 132 females (Table 13). To better ensure achieving the appropriate females for program production, the collection will implement the draft Production Management Plan, including ultrasonography to determine the sex of each fish retained for broodstock. Trapping at

Dryden Dam may begin 24 June and terminate no later than 15 September and operate up to 7-days/week, 24-hours/day. Trapping at Tumwater Dam if needed may begin 15 July and terminate no later than 15 September and operate up to 48 hours per week for broodstock related activities.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 13. Number of broodstock needed for the combined 2017 BY Chelan and Grant PUD Wenatchee summer Chinook production obligations of 500,001 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Chelan PUD	318,185		84F/84M	**168**		
Grant PUD	181,816		48F/48M	**96**		
Total	**500,001**		**132F/132M**	**264**	Dryden LBT-RBT[1] /TWD[2]	1:1

[1] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.
[2] TWD=Tumwater Dam.

Priest Rapids Fall Chinook

Collection of fall Chinook broodstock at Priest Rapids Hatchery (PRH) will generally begin in early September and continue through about mid-November. Juvenile release objectives specific to Grant PUD (5,599,504 sub-yearlings), and Federal (1,700,000 sub-yearlings at PRH + 3,500,000 smolts at Ringold Springs Hatchery – collection of broodstock for the federal programs are conditional upon having contracts in place with the ACOE), mitigation commitments. Biological assumptions are detailed in Appendix A. For the Ringold Springs production, adult collection, holding, spawning and incubation occurs at PRH until the eyed-egg stage. Eyed eggs are transferred to Bonneville Hatchery until they are transferred for spring acclimation and release at Ringold Springs.

For 2018 up to 1,000 adipose present, non-coded wire tagged (high proportion of natural origin) fall Chinook adults will be targeted at the OLAFT). Additional NO adults targeted as a continued pilot evaluation through hook-and-line angling efforts in the Hanford Reach to increase the proportion of natural origin adults in the broodstock to meet integration of the hatchery program will also be incorporated into the program. It is estimated that approximately 400 adults may be collected through the hook-and-line efforts. Close coordination between broodstock collections at the volunteer channel, the OLAFT and through hook-and-line efforts in the Hanford Reach will need to occur so over collection is minimized. Fish surplus to production needs will be culled at the earliest possible life-stage (e.g, brood collected, brood spawned, eggs). Presumed NOR's collected and spawned from either hook-and-line caught broodstock or OLAFT collections will be prioritized for PRH programs (i.e. OLAFT and Hanford Reach angler caught fish will be externally marked, held in a separate pond from volunteer collected fish, spawned first each week, and to the extent possible segregated and reserved for the GPUD program).

Grant PUD staff will work closely with WDFW hatchery and M&E staff to maintain separation of gametes/progeny of OLAFT and angling collected adults at spawning and through incubation/early rearing.

Based upon the biological assumptions in Appendix A, an estimated 4,599 females will need to be collected to meet the 10,799,054 smolts required to meet the current three up-river bright (URB) programs which rely on adults collected at the Priest Rapids Hatchery volunteer channel trap, hook-and-line efforts on the Hanford Reach, and/or the Priest Rapids Dam off ladder trap (OLAFT; Table 14).

To increase the probability of incorporating a higher percentage of NOR's from the volunteer channel, adipose present, non-CWT males and females will be prioritized for retention and males older than 3 will be prioritized. In addition, preliminary information suggests that the pNORs is higher in the later part of the trapping period than the earlier period. As data become available, the PRCC-HSC may choose, in-season, to retain a disproportionately high number of broodstock from the latter half of the returns to the volunteer trap.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Implementation Assumptions

1) Broodstock may be collected at any or all of the following locations/means: the PRD off ladder trap (OLAFT – operated 4-days per week/8 hrs/day to collect up to 1,000 presumed NOR's), hook-and-line angling (ABC) in the Hanford Reach (actual numbers collected are uncertain but will contribute to the overall brood program and pNOB), and the Priest Rapids Hatchery volunteer channel trap.

2) Assumptions used to determine egg/adult needs is based upon current program performance metrics.

3) Broodstock retained from the volunteer channel will exclude to the degree possible, age-2 and 3 males (using length at age; i.e. retain males ≥ 75 cm) to address genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and also decrease the probability of using hatchery origin fish in the broodstock that are skewed towards earlier ages at maturity.

4) Only adipose present, non-CWT males and females will be retained for broodstock from volunteer channel collected broodstock unless a shortage is expected.

5) Only progeny of adipose present, non-wired fish encountered through hook-and-line angling and at the OLAFT will be prioritized for retention into the program.

6) Broodstock collected from the OLAFT and by hook-and-line will exclude age-2 and to the degree possible age-3 fish (<75 cm) to minimize genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and to ensure the highest proportion of NOR's in the collection (e.g. collection of 1 in 5 age-3 fish for broodstock from the OLAFT).

7) All gametes of fish spawned from hook-and-line broodstocking efforts and/or OLAFT collections will be incorporated into the PRH based programs.

8) Real time otolith reading and an alternative mating strategy will be implemented in 2018 consistent with previous years unless the PRCC-HSC agrees that the PNI objective in 2018 can be met without implementing 1x4 matings. Otoliths from males from the OLAFT and ABC collections will be collected during the peak spawning week and read prior to spawning. If the male is natural origin, then it will be spawned with 4 females, otherwise it will be spawned with two females or the milt discarded if it is a known hatchery male and there are sufficient numbers of unknown males available for spawning.

9) All eggs or juveniles leaving PRH (including surplus) will have a unique otolith mark so that returning adults can be identified. Exceptions to this could occur if there are guarantees of a suitable mark/tag from a receiving hatchery.

10) Natural origin broodstock collection at the volunteer trap will be prioritized for the GPUD program by collecting fish when the probability of encountering natural origin fish is highest and balancing run-time representation.

Table 14. Number of broodstock needed for the combined Grant PUD and ACOE fall Chinook production obligations of 10,799,504 sub-yearling smolts at Priest Rapids and Ringold Springs hatcheries, collection location, and mating strategy in 2018.

Program	Production target	Number of Adults	**Total**	Collection location	Mating protocol
Grant PUD	5,599,504	2,297F/1,387M	**3,684**		
ACOE-PRH	1,700,000	697F/421M	**1,118**		
ACOE – Ringold[1]	3,500,000	1,605F/969M	**2,574**		
Total	**10,799,504**	**4,599F/2,777M**	**7,376**		

Collection location	Estimated number of adults		Total
	Hatchery	Wild	

Priest Rapids Hatchery	**3,669F/2,104M**	**127F/76M**	**5,976**	PRH volunteer trap	1:2
OLAFT[2]	**307F/153M**	**360F/180M**	**1,000**	PRD off-ladder trap	1:2, 1:4
ABC[2,3]	**23F/45M**	**113F/219M**	**400**	Hanford Reach	1:2, 1:4
Total	**3,999F/2,302M** (6,301; 85.4%)	**600F/475M** (1,075; 14.6%)	**7,376**		

[1] As of brood year 2009, Priest Rapids Hatchery is taking sufficient eggs to meet the 3,500,000 sub-yearling smolt release at Ringold-Meseberg Hatchery funded by the ACOE – late incubation of this program occurs at Bonneville.
[2] Estimated number of fall Chinook females and males to be acquired from the OLAFT in 2018. F/M ratios were derived through run at large data. Estimates of H/W were derived through otolith results.
[3] ABC fish are adults collected from hook and line collection efforts on the Hanford Reach. Estimates of F/M were derived through 2012-2014 spawn numbers. Estimates of and H/W were derived through otolith results from 2012 and 2014.

Appendix A

2018 Biological Assumptions for UCR spring, summer, and Fall Chinook and Summer Steelhead Hatchery Programs

Program	Mean Values for 2013-2017 (where applicable)								Mean Values 2011-2015 Brood
	ELISAs		Fecundity		Prespawn Survival				
	H	W			H		W		
	≥ 0.12	≥ 0.2	H	W	M	F	M	F	G-E-R Survival[1]
Methow SPC	0.199	0.070	3,755	4,238	0.935	0.957	0.983	0.970	0.874
Chewuch SPC	0.199	0.070	3,755	4,238	0.935	0.957	0.983	0.970	0.874
Twisp SPC	0.200	0.060	3,631	4,115	1.000	1.000	1.000	1.000	0.912
Twisp SHD	[redacted]	[redacted]	[redacted]	5,281	[redacted]	[redacted]	1.000	0.997	0.758
Wells SHD	[redacted]	[redacted]	5,786	NA	0.953	0.968	NA	NA	0.608
Okanogan SHD	[redacted]	[redacted]	5,809	[redacted]	[redacted]	NA	[redacted]	[redacted]	0.608
Wells SUC 1+	0.025	0.000	3,785[2]	4,467	0.978	0.982	NA	NA	0.870
Wells SUC 0+	0.025	0.000	3,785[2]	4,467	0.978	0.982	NA	NA	0.800
YN Green Eggs	0.025	0.000	3,785[2]	4,467	0.978	0.982	NA	NA	NA
Methow SUC	0.000	0.048	[redacted]	3,858[2]	[redacted]	[redacted]	0.988	0.973	0.831
Chelan Falls 1+[a]	0.037		4,024	[redacted]	0.988	0.948	[redacted]	[redacted]	0.819
Wenatchee SUC	0.000	0.011	[redacted]	4,697	[redacted]	[redacted]	0.965	0.950	0.857
Wenatchee SHD	[redacted]	[redacted]	5,685	6,012	1.000	0.937	0.973	0.937	0.668
Nason SPC[b]	0.049	0.025	[redacted]	4,622	[redacted]	[redacted]	0.992	0.976	0.888
ChiwawaSPC	0.145	0.013	4,023	4,726	0.987	0.990	0.987	0.975	0.849
Priest Rapids FAC 0+[c,d]	[redacted]	[redacted]	3,500	[redacted]	0.828	0.832	[redacted]	[redacted]	0.837
ACOE @PRH	[redacted]	[redacted]	3,500	[redacted]	0.828	0.832	[redacted]	[redacted]	0.837
ACOE @Ringold	[redacted]	[redacted]	3,500	[redacted]	0.828	0.832	[redacted]	[redacted]	0.749

[1] Green egg to release survival.
[2] Only uses 2017 mean fecundity.

Appendix B
Projected Brood Year Juvenile Production Targets, Marking Methods, Release Locations, Release Size, Release Type

Brood Year	Production Group	Program Size	Marks/Tags[3]	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
Summer Chinook								
2018	Methow SUC 1+ (GPUD)	200,000	Ad +CWT	5,000 PIT minimum	Methow River at CAF	2020	13-18	Forced
2018	Wells SUC 0+ (DPUD)	480,000	Ad + CWT	3K-5K PIT	Columbia R. at Wells Dam	2019	50	Forced
2018	Wells SUC 1+ (DPUD)	320,000	Ad + CWT	5,000 PIT	Columbia R. at Wells Dam	2020	10	Volitional
2018	Chelan Falls SUC 1+ (CPUD)	576,000	Ad + CWT	10,000 PIT	Columbia R. at CFAF	2020	13	Forced
2018	Wenatchee SUC 1+ (CPUD/GPUD)	500,001	Ad + CWT	20,000 PIT	Wenatchee R. at DAF	2020	18	Volitional
2018	CJH SUS 1+	500,000	Ad + 100K CWT	5,000 PIT	CJH	2020	10	Volitional
2018	CJH SUS 0+	400,000	Ad + 100K CWT	5,000 PIT	CJH	2019	50	Volitional
2018	Okanogan SUS 1+	266,666	Ad + CWT	5,000 PIT	Omak Pond	2020	10	Volitional
2018	Okanogan SUS 1+	266,666	Ad + CWT		Riverside Pond	2020	10	Volitional
2018	Okanogan SUS 1+	266,666	Ad + CWT		Similkameen Pond	2020	10	Volitional
2018	Okanogan SUS 0+	300,000	Ad + CWT	5,000 PIT	Omak Pond	2019	50	Forced
Spring Chinook								
2018	Methow SPC (PUD)	108,249	CWT only	5,000 PIT	Methow R. at MFH	2020	15	Volitional
2018	Methow SPC (PUD)	25,000[1]	CWT only	7,000 PIT	Methow R. at GWP (YN)	2020	15	Volitional
2018	Methow SPC (PUD)	60,516	CWT only	5,000 PIT	Chewuch R. at CAF	2020	15	Volitional
2018	Twisp SPC (PUD)	30,000	CWT only	5,000 PIT	Twisp R. at TAF	2020	15	Volitional
2018	Methow SPC (USFWS)	400,000	Ad + CWT	20,000 PIT	Methow River at WNFH	2020	17	Forced (2-day)

2018	Okanogan SPC[4] (CCT)	200,000	CWT only	5,000 PIT	Okanogan R. at Tonasket Pond/Riverside	2020	15	Volitional
2018	Chief Joe SPC[5] (CCT)	700,000	Ad + 200K CWT	5,000 PIT	Columbia R. at CJH	2020	15	Forced
2018	Chiwawa R. SPC (CPUD) (conservation)	144,026	CWT only	10,000 PIT	Chiwawa River at CPD	2020	18	Short term volitional
2018	Nason Cr. SPC (GPUD) (conservation)	125,000	CWT body tag	5,000 PIT	Nason Cr. at NAF	2020	18	Forced
2018	Nason Cr. SPC (GPUD) (safety net)	98,670	Ad + CWT		Nason Cr. at NAF[9]	2020	18	Forced
Fall Chinook								
2018	Priest Rapids FAC 0+ (ACOE)	1.7M	Ad + Oto	Approximately 43,000 spread across the fish released from PRH	Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	600,000	Ad+CWT+ Oto		Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	600,000	CWT + Oto		Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	1M[2]	Ad + Oto		Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	3.4M	Oto only		Columbia River at PRH	2019	50	Forced
2018	Ringold Springs FAC 0+ (ACOE)	3.5M	Ad + 400K CWT		Columbia River at RSH	2019	50	Forced
Steelhead								
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	35,451	Ad + CWT (HxH) CWT only (WxW)	33,000 PIT	Nason Cr. direct release	2020	6	Direct Plant
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	70,582	Ad + CWT (HxH) CWT only (WxW)		Chiwawa R. direct release	2020	6	Direct Plant
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	104,021	Ad + CWT (HxH) CWT only (WxW)		Upper Wenatchee R. direct release	2020	6	Direct Plant

2019	Wenatchee HxH (CPUD)	37,246	Ad + CWT		Lower Wenatchee R. direct release	2020	6	Direct Plant
2019	Twisp Conservation (DPUD)[11]	48,000	CWT only	5,000[7]	Twisp River at Buttermilk Bridge/TBD	2020	6	Direct Plant
2019	Wells HxH (DPUD)	100,000	Ad only	5,000 PIT	Methow River at Effy Bridge	2020	6	Direct Plant
2019	Wells HxH (DPUD)	160,000	Ad only	5,000 PIT	Columbia R. at Wells Dam	2020	6	Volitional
2019	MetComp WxW (USFWS)	Up to 200,000	Ad + CWT	20,000 PIT	Methow R. at WNFH and other locations TBD	2021[12]	4-6	(WNFH)other locations TBD
2019	Okanogan HxH/HxW (CCT/GPUD)	Up to 100K [6]	Ad /CWT snout	Up to 20,000 PIT ,[9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2020	5-8	Volitional capture Wells; truck planted in Salmon Creek, Similkameen R., and possibly other tributaries, TBD by fall of 2018.
2019	Okanogan WxW (CCT/GPUD)	Up to 100K [6]	Body and snout CWT[8]	Up to 20,000 PIT ,[9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2020	5-8	Volitional from St. Mary's pond. The numbers going to Omak Creek and other tributaries will be determined by fall of 2018.

[1] Release of fish at the Goat Wall Pond remote acclimation site operated by the YN is conditional upon HC and HSC approval.
[2] Externally marking of this group is presently funded by WDFW. Marking of this 1M fish is contingent on *US v. Oregon* Policy Committee approval for 2018.
[3] Presently all CWT's are applied to the snout.
[4] The Okanogan SPC program derives its juveniles from a 200K transfer of Methow SPC from WNFH as part of a reintroduction effort. Fish are released into the Okanogan Basin.
[5] The Chief Joe Hatchery SPC program presently receives surplus adults from the Leavenworth NFH as needed. Juveniles are released on station from CJH.
[6] Total Okanogan release not to exceed 100K + 10%.
[7] DPUD will tag 2,500 of the Twisp Only S1's and 2,500 of the Methow S1's. USFWS will tag 2,500 of the Methow S2's for release into the Twisp and 2,500 of the Methow S2's, which will accompany the DPUD Methow S1's for an off station release.
[8] The Okanogan steelhead HGMP and NOAA's BiOp for the TRMP state that WxW progeny will receive a unique internal tag (CWT or PIT) and/or receive an alternative fin clip. At this time, CCT does not intend to use an alternative fin clip until/unless a high proportion of the released fish have WxW parents and there is an acceptable survival risk/benefit of the alternative fin clip.
[9] Total PIT tag release in the Okanogan 20,000
[10] Beginning with the 2017 brood, adult returns from the Nason conservation program will be utilized to meet the Nason safety net program and will receive a supplemental body tag (blank wire either at the base of the adipose or the caudal peduncle) in addition to the adipose clip.
[11] With the recent detection of potential inbreeding depression effects in the Twisp conservation program, parties are continuing to develop a new plan for the program. Once developed and agreed to, this table will be updated to reflect any changes.
[12] Winthrop NFH steelhead program produces 2-year (S2) smolts.

Appendix C

Return Year Adult Management Plans

At a gross scale, adult management plans will include all actions that *may* be taken within the current run year to address surplus hatchery fish (if any). At the time of submission for this document, spring Chinook will probably be the only group where a reasonable pre-season forecast may be available to lay out what the expected surplus is, how many can be expected to be removed through each action, etc. Preseason forecasts for steelhead will be available in September.

Wenatchee Spring Chinook

Pre-season estimates for age-4 and age-5 adults project a total of 5,664 (776 natural origin [13.7%] and 4,888 hatchery origin [86.3%]) spring Chinook back to Tumwater Dam in the Wenatchee Basin. Approximately 3,830 Chiwawa and 1,728 Nason spring Chinook are to reach Tumwater Dam in 2018, of which about 670 (12.1%) and 4,888 fish (87.9%) are expected to be natural and hatchery origin spring Chinook, respectively. The balance of about 106 natural origin spring Chinook expected back are destined to the remaining spawning aggregates (Table 1). In-season assessment of the magnitude and origin composition of the spring Chinook return above Tumwater Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18118 and 18121.

Table 1. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2018.

	Chiwawa Basin			Nason Cr. Basin			Wenatchee Basin to Tumwater Dam[2]		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return[1]	461	66	**527**	125	18	**143**	679	97	**776**
Estimated hatchery return	3,240	63	**3,303**	1,522	63	**1,585**	4,762	126	**4,888**
Total	3,701	129	**3,830**	1,647	81	**1,728**	**5,441**	**223**	**5,664**

[1] Reflects NOR estimates to Tumwater Dam and has not been adjusted for pre-spawn mortality.
[2] Wenatchee Basin to Tumwater Dam total includes NORs to the White, Little Wenatchee, and Chiwawa rivers and Nason Creek.

Absent conservation fisheries or adult removal at Tumwater Dam (TWD), the expected number of age-4 and age-5 Hatchery Origin Returns (HOR) for the upper Wenatchee River Basin as a whole is estimated to be approximately 6.3 times the expected number of Natural Origin Returns (NORs; 7.3 times the number of NOR's in the Chiwawa River and 11.1 times the number of NOR's in Nason Creek). The combined HO and NO returns will represent about 4.3 times the number of adults needed to meet the interim Chiwawa run escapement to TWD of 900 fish indicating a disproportionate number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2018 (Table 2). The combined HO and NO returns will represent about 3.5 times the number of adults needed to meet the interim Nason run escapement to TWD of 500 fish indicating a disproportionate number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2018 (Table 3).

Additional Adult Management

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Wenatchee Spring Chinook BiOp (2013; 2105) and Permits #18118, #18129 and #18121. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

2018 adult management actions are intended to provide for near 100% removal of age-3 hatchery males (jacks), and unknown hatchery origin adults (ad-/cwt-) and up to about 64% of the age-4 and age-5 hatchery origin adults (about 1,036 males and 2,078 females according to current models, Table 2). In addition, approximately 104 HO and 140 NO adults will be removed between TWD and the Chiwawa Weir and retained for broodstock to support meeting the combined Grant and Chelan PUD Wenatchee spring Chinook obligation, the balance will be surplused at TWD and used for tribal and/or food bank disbursements or nutrient enhancement projects.

Table 2. Run escapement and spawning escapement of Chiwawa River hatchery and natural origin fish to Tumwater Dam and the Chiwawa River in 2018.

	To Tumwater Dam		To Chiwawa River		Adults surplused at TWD[3]	Total Chiwawa spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	290	2,246	187	245	1,334	**432**
Males[4]	237	1,057	142	74	693	**216**
Sub-total	527	3,303	329	319	2,027	**648**
Pre-spawn survival[6]			0.85	0.55		
Expected PNI						**0.67**
Expected pHOS						**0.49**

[1] Wild broodstock needs of 76 wild NO fish (38 females/38 males) for the Chiwawa conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality.
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD or through a conservation fishery.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 432 redds in the Chiwawa Basin under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Table 3. Run escapement and spawning escapement of Nason Creek hatchery and natural origin fish to Tumwater Dam and Nason Creek in 2018.

	To Tumwater Dam		To Nason Creek		Adults surplused at TWD[3]	Total Nason spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	79	1,078	69	165	744	**234**
Males[4]	64	507	46	72	343	**118**
Sub-total	143	1,585	115	237	1,087	**352**
Pre-spawn survival[6]			0.80	0.55		
Expected PNI						**0.60**
Expected pHOS						**0.67**

[1] Wild broodstock needs of 64 wild NO fish (32 females/32 males) for the Nason conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality and HO broodstock needs of 66 fish (33 females/33 males).
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD or through a conservation fishery.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 234 redds in Nason Creek under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Wenatchee Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Wenatchee Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at Tumwater Dam or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2018. Adult management plans, if needed, will be finalized then and appended to this document.

Methow Spring Chinook

Pre-season estimates project a total of 3,235 (869 natural origin [26.9%] and 2,366 hatchery origin [73.1%]) spring Chinook back to Methow Basin. Of the 2,366 hatchery returns, about 893 are estimated to be from the conservation program with the balance of 1,473 from the WNFH safety net program (Table 5).

Table 5. Brood year 2013-2015 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2018.

	Projected Escapement											
	Origin								**Total**			
	Hatchery				**Wild**				**Methow Basin**			
Stock	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**
MetComp	124	673	12	**809**	18	543	106	**667**	142	1,216	118	**1,476**

%Total				34.2%				76.8%				45.6%
Twisp	18	55	11	**84**	17	164	21	**202**	35	219	32	**286**
%Total				3.5%				23.2%				8.9%
Winthrop (MetComp)	318	1,125	30	**1,473**					248	886	21	**1,473**
%Total				62.3%								45.5%
Total	460	1,853	53	**2,366**	35	707	127	**869**	495	2,560	180	**3,235**

Some level of adult management will be required to limit the number of hatchery spring Chinook on the spawning grounds. Because a conservation fishery is not yet possible under current permit limitations, adult management will need to occur through operation of the volunteer channel traps located at both the Methow Hatchery (MH) and Winthrop NFH (WNFH).

Presently hatchery fish from MH are prioritized to: a) contribute to the supplementation of the natural populations (up to either the escapement objectives or PNI/pHOS goal), b) make up shortfalls in natural-origin brood for the MH conservation program, and c) to support the 400K safety-net program at WNFH. As such both hatcheries will operate volunteer hatchery ladders to support removal of excess safety-net and conservation fish (when needed). MH will operate its volunteer trap and will provide surplus hatchery adults (in excess to the MH and conservation needs) to WNFH to support the safety-net program, to support removal of excess safety-net and conservation fish, or retain adults to facilitate testing translocation of conservation fish to under-seeded spawning areas as approved by the HCP HC and PRCC HSC. The translocation of conservation program adults will be prioritized over their use as broodstock for the safety net program as long as both programs can meet full production and gene flow (pHOS/PNI) terms and conditions on the spawning grounds. The intention of adult translocation is to increase natural production which is the primary function of the Methow Hatchery.

Specific actions are as follows:

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Methow Spring Chinook BiOp (2017) and Permits #18925, #18927 and #20533. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

Twisp River Spring Chinook: spring Chinook in the Twisp River will be managed separately from the rest of the basin.

a. Adipose-clipped fish encountered at the Twisp Weir will be removed (putative WNFH returns or strays from outside of the basin).
b. Age-3 hatchery males will be removed and euthanized or transported to WNFH for surplusing.
c. Adult management will be performed to maintain pHOS ≤0.50. pNOB will be >0.50 and may be allowed to fluctuate between 0.50 and 1.0 in order to achieve a pHOS ≤0.50.

d. Wild fish will be collected as broodstock – up to ~18 individuals, but not to exceed 33% of the wild run. Hatchery fish may be collected as broodstock dependent on collection success of wild fish and provided that Twisp-program pNOB may not be less than 0.50.
e. The Twisp Weir will be fished for the duration of the broodstock collection, only, in 2018. Adult management activities will be incidental to broodstock collection. Once broodstock collection is completed, the weir will be opened to fish passage to limit delay/trapping effects on bull trout. Tentatively, during broodstock collection, the weir will be fished from 6:00 AM to 9:00 PM on a daily basis. Deviation from this schedule may be implemented based on the run size and catch efficiency for broodstock.

Methow River (MFH and WNFH) and Chewuch River Spring Chinook (MetComp):

a. Stock assessment will be performed at Wells Dam during the spring Chinook broodstock collection. This information on stock, hatchery:wild, and male:female composition in conjunction with fish counts at Wells Dam will be used to adjust in-season adult management targets.
b. MetComp returns will be managed by removing volunteers at WNFH and Methow Hatchery using the outfall traps at these facilities.
    i. All hatchery-origin age-3 males will be removed
        1. Gender identified by ultrasound.
    ii. The Methow FH and Winthrop NFH volunteer traps will be fished continuously (24 h per day/7 d per week) throughout the run and fish removed at least once daily (depending on specific facility limitations), or as often as needed when fish are present. Adjustments to the operation of the trapping facilities will be made based upon capture/extraction rates as well as bull trout encounters and take limitations.
    iii. Trapping will cease at Methow Hatchery if:
        1. Removal of MFH and WNFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season), or
        2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.
    iv. Trapping will cease at Winthrop NFH if:
        1. Removal of WNFH and MFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season), or
        2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.
    v. All adipose clipped returns encountered at WNFH and MFH volunteer traps will be removed.
        1. Returns to WNFH will be retained at WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.

2. Returns to MFH will be transferred to WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.

vi. Conservation program returns may also be transported to specific reaches of the Methow and/or Chewuch Rivers (or other locations as determined by the HC/HSC) to meet the minimum spawning escapement objective or to experimentally augment spawner distribution (such an action will require an approved study or implementation plan by the HCP HC and PRCC HSC, and be permissible under current ESA permits).

Based on the preseason forecast for wild and hatchery spring Chinook to the Methow Basin, once NO broodstock requirements are fulfilled and accounting for an estimated prespawn mortality for NO fish of 50% (42% for HO fish), there will be approximately 372 NO spawners. Based upon the sliding PNI scale for NO run sizes >300 fish, the initial goal for 2018 will be to manage for a minimum spawning escapement of 576 spawners; to achieve this, an estimated 79% of the hatchery returns (1,170 HO fish) will need to be removed (does not include adults removed for broodstock; Table 6). This will result in approximately 205 hatchery origin spawners on the spawning grounds after accounting for prespawn mortality.

Table 6. Calculated targets and projected adult management expectations for Methow spring Chinook in 2018 based on current run forecast.

Wild Spawning Escapement[1]		pNOB[2]	pHOS	PNI [3]	Hatchery Spawners[1,4]	Hatchery surplus[4]	Hatchery Broodstock (WNFH + 10j)	Proportion of Hatchery Fish to Remove	Total spawnin escapeme
Twisp	92	0.79	0.26	0.75	32	0 MH		0	124
Methow/Chewuch	280	0.75	0.38	0.66	173	1,170 WNFH	472 (316 MH+156 WH)	0.79	453
Total	372	0.77	0.36	0.68	205	1,170	472 (316 MH+156 WH)	0.49	576

[1] Adjusted for prespawn mortality.
[2] pNOB of conservation program only averaged for BY13, 14, and 15. pNOB target for BY18 is 1.0 for both programs.
[3] Because of the uncertainty around run forecasts, PNI was provisionally estimated using the PNI=pNOB/(pNOB+pHOS) equation.
[4] Assumes a 90% conversion of hatchery fish to hatchery outfalls. Value already considers hatchery adults needed to meet WNFH and Okanogan 10(j) production components.

In-season assessment of the magnitude and origin composition of the spring Chinook return above Wells Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18925, 18927, and 20533.

Methow Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Methow Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at the Twisp Weir to meet an overall pHOS = 0.25 with 0.20 allocated to the Twisp Conservation program returns (the exception to this would be if a higher pHOS is still need to wrap up the remaining time series on the Relative Reproductive Success Study as approved), the Wells Hatchery Volunteer Channel, volunteer returns to the Methow Hatchery and Winthrop NFH, during broodstock collection efforts (including angling), or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2018. Adult management plans, if needed, will be finalized then and appended to this document.

Okanogan Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Okanogan Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Okanogan tributary weir operations.

A more detailed run forecast will be available in September 2018. Adult management plans, if needed, will be finalized then and appended to this document.

Appendix D

Site Specific Trapping Operation Plans

Tumwater Dam

For 2018, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for Tumwater Dam is summarized in Table 1):

1) **Real-time monitoring and trap operations:** Throughout all trapping activities described in this plan, the two PIT tag antennae arrays within the Tumwater Dam ladder (weir 15 and 18 see Appendix 2), will be monitored by WDFW and Chelan PUD and detections of previously PIT tagged fish will be evaluated to determine the median passage time of fish between first detection at weir 15 and last detection at weir 15 or weir 18. Median passage estimates will be updated with every 10 PIT-tagged fish encountering weir 15. If the median passage time is greater than 48 hours, trapping will cease and fish will be allowed to exit via the ladder (i.e., bypass the trap). If trapping has been stopped, PIT tag passage monitoring will continue and trapping will resume if and when the median passage time is less than 24 hours. In summary, real-time PIT tag monitoring will occur both when the trap is operational and when fish are bypassed. This will provide an opportunity to evaluate trapping effects versus baseline passage rates through the ladder for future operations.

2) **Enhanced effort for Tumwater trapping operations from June 1 and July 15**: The Tumwater trap will be operated in an active-manned trapping condition (the ladder bypass will not be used however, fish may still ascend the denil [steep pass] unimpeded). The trap will be checked a minimum of 1x per day. More frequent trap checks will be made as fish numbers increase. Between June 16 and July 15 the Tumwater trap will be actively manned 24 hours/day 7 days/week utilizing two- three person crews (two people will sample fish and the third will maintain operation of the steep pass so that it will not be closed to passage). This represents an additional person to keep the denil operating constantly. If during this period staff are not available (due to logistical, funding, or other issues) to keep the denil operating continuously, the trap will be opened to allow for nighttime passage (this is in addition to passage required under a detected delay event).

3) **Enhanced effort and limited Tumwater trapping operations from July 16 to August 31**: The trap will be operated 3 days/week for up to 16 hours/day (not to exceed 48 hours per week) to support broodstock collection activities for summer Chinook and sockeye run composition sampling (CRITFC) and sockeye spawner escapement PIT tagging. Video enumeration and full passage will occur when trapping is not occurring.

4) **Planned Tumwater trapping operations from September 1 until mid-December:** To facilitate lamprey passage and meet coho and steelhead broodstocking and steelhead

adult management needs, the trap is being proposed to operate up to 16 hours per day from 6AM to 10PM 7days/week manned or unmanned active trapping. The trap will be open for lamprey passage between the hours of 10PM and 6AM. During this time period bull trout are rare and spring Chinook are not present at Tumwater. For this trapping period, real-time monitoring will be implemented with video enumeration when opened.

5) **Operations at Tumwater from mid-December until about mid-February:** During this period the trapping facility is not operated due to having been winterized. Only video enumeration and full passage are available during this period.

6) **Planned Tumwater trapping operations from mid-February through May:** The trap may return to a 24 hours/7days/week manned or unmanned active trapping for adult steelhead management and/or broodstock collection as needed. Beginning on or about May 1, limited spring Chinook broodstocking, run comp sampling, etc. may also occur. For this trapping period, real-time monitoring will continue to be implemented.

7) **Limitation in staffing or other unforeseen problems**: If WDFW staff are not available to operate the trapping facility (according to this plan) for any reason, then full passage will be allowed (fish will be allowed to bypass the trap and exit the ladder directly), until staff are able to return.

8) **Unforeseen scenarios and in season observations**: If during the trapping period, observations from field staff warrant reconsideration of any part of the plan as described above, WDFW and Chelan PUD will alert the Hatchery Committee and work cooperatively with the Services to determine whether changes are needed to further minimize incidental take or otherwise ensure that take is maintained at the manner and extent previously approved by the Services.

Table 1. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and reproductive success activities anticipated to be conducted at Tumwater Dam in 2018. Blue denotes steelhead, brown spring Chinook, orange sockeye, pink summer Chinook, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD pHOS mgt[1]		15 Feb				15 June			1 Sep			15 Dec
Su. SHD BS collection[2]									1 Sep		15 Nov	
Su. SHD Spawner Esc. tagging[3]		15 Feb				15 June			1 Sep			15 Dec
Spring Chinook RSS[4]					1 May		15 Jul					
Sp Chinook run comp[5]					1 May		15 Jul					
Sp Chinook pHOS mgt[6]					1 May		15 Jul					
Sp Chin stray mgt[7]					1 May		15 Jul					
Sp Chin BS collection					1 May		15 Jul					

Activity	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Sockeye run comp[8]							15 Jul	15 Aug				
Sockeye spawner esc tagging[9]							15 Jul	15 Aug				
Su. Chin BS collection[10]							1 Jul		15 Sep			
Coho BS collection[11]									1 Sep		30 Nov	

[1] Adult management of the 2018 brood will end in June 2018. However it is anticipated that adult management will occur for the 2019 brood (if needed) beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at Tumwater Dam for other species.
[2] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities.
[3] SHD spawner composition tagging at Tumwater Dam will run concurrent with SHD adult management and other (broodstock) activities at Tumwater Dam.
[4] The spring Chinook RSS will run from 1 May through about 15 July or at such time or at such time the sockeye return develops at Tumwater Dam.
[5] Spring Chinook run composition sampling will run concurrent with the RSS.
[6] Spring Chinook pHOS management will end in July consistent with the arrival of the sockeye return and run concurrent with RSS activities.
[7] Removal of unknown hatchery origin spring Chinook strays at Tumwater Dam will run concurrent with the RSS.
[8] Sockeye run composition sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for run composition sampling will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[9] Sockeye spawner escapement sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for spawner escapement tagging will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[10] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Tumwater Dam for summer Chinook broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[11] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Tumwater Dam for Coho broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 7 of each year but typically ceases by the end of November.

Dryden Dam

For 2018, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the right and left bank Dryden Dam traps is summarized in Table 2):

The Dryden Dam left and right bank trapping facilities will operate up to five days per week, 24 hours per day beginning June 24 and continue until as late as November 15. Both traps, if operated, will do so on concurrent days and will be checked and cleared every 24 hours, or sooner if it appears that run contribution to the facilities exceeds reasonable limits for adult holding.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 2. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Dryden Dam trapping facilities in 2018. Blue denotes steelhead, pink summer Chinook, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Left Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul				15 Nov	

Su. SHD spawner esc. Tagging[2]							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection									1 Sep		30 Nov	
Right Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul					
Su. SHD spawner esc. Tagging2							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection[4]									1 Sep		30Nov	

[1] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities.
[2] SHD spawner composition tagging at Dryden Dam will run concurrent with other (broodstock or M&E) activities at Dryden Dam.
[3] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Dryden Dam for summer Chinook broodstock will follow an up to 5d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Dryden Dam for Coho broodstock will follow an up to 5d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 7 of each year but typically ceases by the end of November.

Chiwawa Weir

For 2018, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the Chiwawa Weir is summarized in Table 3):

Weir operations will be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.

Table 3. Summary of broodstock collection activities anticipated to be conducted at the Chiwawa Weir in 2018. Brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Sp Chin BS collection						1 June		15 Aug				

Wells Dam Ladder and Hatchery Volunteer Traps

For 2018, WDFW and Douglas PUD are proposing the following plan (activities by month for the Wells Dam East/West ladder and Wells FH volunteer traps are summarized in Table 4):

1). **East Ladder Trap:**

The East ladder trap will only be operated as needed to meet broodstock collection objectives and other management activities if they cannot be adequately fulfilled through the West ladder and Wells FH volunteer trap operations or if construction activities on the hatchery modernization preclude use of either the West ladder or volunteer traps.

If the East ladder trap is used, it may begin as early as May 1 and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week and will run concurrent with any trapping activities occurring at the West ladder trap. The first exception to the above is that for spring Chinook between May 1 and June 20, the trap may operate a maximum of 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the West ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the East ladder trap may be operated, concurrent with the West ladder trap, 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC will also trap sockeye at Wells Dam for tagging and stock assessment. Their request for trapping in 2018 did not specify trapping details other than timing (late June through early August), but their preference in past years has been to use the East ladder.

If daily river temperatures meet or exceed 21^{o} C (69.8^{o} F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

2). **West Ladder Trap:**

The West ladder may begin as early as May 1 for spring Chinook broodstock collection and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week. The first exception to the above is that for spring Chinook between May 1 and June 20, the trap may operate under a maximum 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the East ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the West ladder trap may be operated 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC may also trap sockeye at Wells Dam for tagging and stock assessment and may use the west ladder; however, their preference in past years has been to use the East ladder. CRITFC has proposed trapping from late June through early August.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

3). **Wells FH Volunteer Trap:** The Wells FH volunteer trap may begin as early as July 1 for summer Chinook broodstock collection and operate through mid-June of the following year for steelhead broodstock collection and adult management if needed. The trap may operate up to seven days per week/24 hours per day to facilitate broodstock collection and adult management actions.

If water temperatures in the trapping facility meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Wells Dam in 2018. Blue denotes steelhead, brown spring Chinook, pink summer Chinook, orange sockeye, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
East/West Ladders												
Su. SHD BS collection[1]									1 Sep		15 Nov	
Su. SHD run comp.									1 Sep		15 Nov	
Su. SHD Spawner Esc. Tagging[2]									1 Sep		15 Nov	
Sp Chinook BS collection					1 May	30 Jun						
Sp Chinook run comp					1 May		15 Jul					
Sockeye SA tagging[4]						25 June		17 Aug				
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection[5]									15 Sep		15 Nov	
Wells Volunteer Trap												
Su. SHD BS collection[1]									1 Sep		15 Nov	
SHDBS/pHOS mgt.[6]		15 Feb				15 June			1 Sep			15 Dec
Su. Chin BS collection[7]							1 Jul		15 Sep			
Su. Chin Surplussing							1 Jul			30 Oct		

[1] Summer steelhead broodstock collection will be prioritized at West ladder and volunteer traps. However if broodstock objectives cannot be met at either of those two locations then trapping may occur at the East ladder concurrent with other activities.
[2] SHD spawner composition tagging at Wells Dam will run concurrent with other (broodstock or M&E) activities at Wells Dam.
[3] Summer Chinook broodstock collection for the Methow (Carlton) program will be prioritized at the West ladder trap. However if broodstock objectives cannot be met at the West ladder then trapping may occur at the East ladder. Trapping at the west and/or East ladders for summer Chinook broodstock will follow an up to 3d/week 16hr/day (48 cumulative hours) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] CRITFC trapping of sockeye for stock assessment and tagging typically begins the last week of June and extends through the third week of August, following an up to 3d/week 16hr/day (48 cumulative hours) coordinated with WDFW spring or summer Chinook and steelhead broodstock collection and stock assessment trapping, preferring to trap on the East ladder.

[5] Coho trapping may be conducted at both East and/or West ladders. Trapping at Wells Dam ladder traps for Coho broodstock will follow an up to 5d/week 9hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Trapping at the Wells Dam ladder will cease no later than November 15.
[6] Adult management of the 2018 brood will end in June 2018. However it is anticipated that adult management will occur for the 2019 brood beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at the Wells Hatchery volunteer channel for other species.
[7] Summer Chinook broodstock collection for the Wells Hatchery programs will be prioritized at the Wells Hatchery volunteer trap. Trapping at the volunteer channel may occur up to 7 days per week, 24 hours per day and may include broodstock collection and/or adult management.

Methow Hatchery Volunteer and Twisp Weir Traps

For 2018, WDFW and Douglas PUD propose the following plan (A summary of activities by month for Methow Hatchery volunteer trap and the Twisp Weir is summarized in Table 4):

Specific operation details for the Methow Hatchery volunteer trap and Twisp Weir are still being worked through. Once those details have been fleshed out more thoroughly, this section will be updated.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Methow Hatchery and the Twisp Weir in 2018. Blue denotes steelhead and brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Methow Hatchery[1]												
SHD pHOS mgt.			1 Mar			15 Jun			1 Sep		15 Nov	
Sp. Chinook BS collection					1 May			30 Aug				
Sp. Chinook pHOS mgt.[2]					1 May			30 Aug				
Twisp Weir[3]												
Steelhead RSS			1 Mar		30 May							
Su. SHD BS collection				1-30 Apr								
SHD pHOS mgt.			1 Mar		30 May							
Sp. Chinook BS collection						1 June		15 Aug				
Sp. Chinook pHOS mgt.						1 June		22 Aug				

[1] Specific details on how operation of the Methow Hatchery volunteer trap will work for SHD adult management are still being worked out at this time.
[2] Adult management for spring Chinook at the Methow Hatchery volunteer trap will run concurrent with broodstock collection.
[3] Specific details on how operation of the Twisp Weir will work for 2018 to include the steelhead RSS, broodstock collection, and adult management and spring Chinook broodstock collection and adult management is still being worked out at this time.

Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT)

Table 5. Summary of broodstock collection, VSP monitoring, and/or run composition sampling activities anticipated to be conducted at the Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT) in 2018. Blue denotes steelhead, purple fall Chinook, and orange sockeye. All users of the OLAFT must have a signed Facility Use Agreement with GPUD.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD VSP Monitoring[1]							1 Jul				15 Nov	
Fall Chin. BS collection[2]									1 Sep		15 Nov	
Fall Chinook Run Comp.[3]									1 Sep		15 Nov	
Sockeye BS Collection[4]						22 Jun	10 Jul					

[1] Steelhead VSP monitoring targets up to 15% of the annual return over Priest Rapids Dam. Presently that requires operation of the OLAFT up to 3 days/ week, 8 hours per day. The trap is opened to passage each night.
[2] To acquire the target 1,000 adipose present, non-CWT adult fall Chinook for broodstock, the OLAFT is operated up to 5 days per week, 8 hours per day. Three of the five days are concurrent with the SHD VSP monitoring. The trap is opened to passage each night.
[3] Fall Chinook run composition runs concurrent with SHD VSP monitoring and/or fall Chinook broodstock collection activities.
[4] Sockeye broodstock collection to support YN reintroduction efforts in the Yakima is based upon abundance based sliding scale. Depending on the strength of the return and allowable allocation, the trap may be operated up to 5 days per week, 8 hours per day beginning about 22 June and running through about 10 July. The trap is opened to passage each night.

Appendix E

Columbia River TAC Forecast

Table 1. 2018 Columbia River at mouth salmon returns – actual and forecast.

Columbia River Adult Salmon Returns: Actual and Forecasted				
		2017 Forecast	**2017 Return**	**2018 Forecast**
Spring Chinook	***Upriver Total***	**160,400**	**115,821**	166,700
Summer Chinook	***Upper Columbia***	**63,100**	**68,204**	67,300
Sockeye	***Total***	**198,500**	**88,263**	99,000
Provided by the *U.S. v Oregon* Technical Advisory Committee (TAC)				

Appendix F

Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans

Chelan PUD
The Final 2018 Chelan Hatchery Monitoring and Evaluation Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/

* Login using "Forms Authentication" (for non-Douglas PUD employees)

Douglas PUD
The Final 2018 DCPUD ME Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/

* Login using "Forms Authentication" (for non-Douglas PUD employees)

Grant PUD

2018 GPUD Hatchery ME Implementation Plan for the Wenatchee Basin and Methow Summer Chinook Salmon
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/2016%20GPUD%20Hatchery%20ME%20Implementation%20Plan%20for%20the%20Wenatchee%20Basin_FINAL.pdf?Web=1

2018 Priest Rapids Hatchery Implementation Plan
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/PRH%20ME%202016-17%20Implementation%20plan%20final.pdf?Web=1

Appendix G

DRAFT
Hatchery Production Management Plan

The following management plan is intended to provide life-stage-appropriate management options for Upper Columbia River (UCR) PUD salmon and steelhead mitigation programs. Consistent, significant over-production or under-production risks the PUD's not meeting the production objectives required by FERC and overages in excess of 110% of program release goals violates the terms and conditions set forth for the implementation of programs under ESA and poses potentially significant ecological risks to natural origin salmon communities.

Under RCW 77.95.210 (Appendix A) as established by House Bill 1286, the Washington Department of Fish and Wildlife has limited latitude in disposing of salmon and steelhead eggs/fry/fish. While this RCW speaks more specifically to the sale of fish and/or eggs, WDFW takes a broader application of this statute to include any surplus fish and/or eggs irrespective of being sold or transferred.

We propose implementing specific measures during the different life-history stages to both improve the accuracy of production levels and make adjustments if over-production occurs. These measures include (1) Improved Fecundity Estimates, (2) Adult Collection Adjustments, (3) Within-Hatchery Program Adjustments, and (4) Culling at the earliest life-stage.

<u>Improved Fecundity Estimates</u>

A) Develop broodstock collection protocols based upon the most recent 5-year mean in-hatchery performance values for female to spawn, fecundity, green egg to eye, and green egg to release.
B) Use portable ultrasound units to confirm gender of broodstock collected (broodstock collection protocols assume a 1:1 male-to-female ratio). Ultrasonography, when used by properly trained staff will ensure the 1:1 assumption is met (or that the female equivalents needed to meet production objective are collected). Spawning matrices can be developed such that if broodstock for any given program are male limited sufficient gametes are available to spawn with the females.

<u>Adult Collection Adjustments</u>

C) Make in-season adjustments to adult collections based upon a fecundity-at-length regression model for each population/program and origin composition need (hatchery/wild). This method is intended to make in-season allowances for the age structure of the return (i.e. age-5 fish are larger and therefore more fecund than age-4 fish), but will also make allowances for age-4 fish that experienced more growth through better ocean conditions compared to an age-5 fish that reared in poorer ocean conditions.

<u>Within-Hatchery Program Adjustments</u>

D) At the eyed egg inventory (first trued inventory), after adjustments have been made for culling to meet BKD management objectives, the over production will be managed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:
- Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
- Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
- Salmon culture programs requested by lead entities and approved by the salmon funding recovery board under chapter 77.85 RCW;
- Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
- Governmental hatcheries in Washington, Oregon, and Idaho; or
- Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
- Distribution to approved organizations/projects for research.

E) At tagging (second inventory correction) fish will be tagged up to 110% of production level at that life stage. If the balance of the population combined with the tagged population amounts to more than 110% of the total release number allowed by Section 10 permits then the excess will be distributed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:
- Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
- Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
- Salmon culture programs requested by lead entities and approved by the salmon recovery funding board under chapter 77.85 RCW;
- Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
- Transfer to another resource manager program such as CCT, YN, or USFWS program;
- Governmental hatcheries in Washington, Oregon, and Idaho;
- Placement of fish into a resident fishery (lake) zone, provided disease risks are within acceptable guidelines; or
- Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
- Distribution to approved organizations/projects for research.

F) In the event that a production overage occurs after the above actions have been implemented or considered, and deemed non-viable for fish health reasons in accordance with agency aquaculture disease control regulations (i.e. either a pathogen is detected in a population that may pose jeopardy to the remaining population or other programs if retained or could introduce a pathogen to a watershed where it had not previously been detected) then culling of those fish may be considered.

All, provisions, distributions, or transfers shall be consistent with the department's egg transfer and aquaculture disease control regulations as now existing or hereafter amended. Prior to department determination that eggs of a salmon stock are surplus and available for sale, the department shall assess the productivity of each watershed that is suitable for receiving eggs.

Appendix H

DRAFT

Preferred Alternative Plan for 2019 BY and beyond, for Methow Sub-basin Conservation Steelhead Programs

Introduction

The objective of this draft plan is to provide a thumbnail approach for mitigating genetic concerns specifically in the Twisp Conservation program, and describe our preferred alternative for future implementation (2018 and beyond) for Methow Subbasin conservation steelhead programs (Twisp and Winthrop NFH). Direction herein is general with seasonal/run-specific technical details to be worked out annually between operators and formalized through broodstock collection protocols and steelhead-specific management plans. Our intent for this memo is to serve as a vehicle for the Hatchery Committee to approve this direction by vote. While this plan is being presented as a preferred course of action by the parties, approval (and further refinement of a long term plan) is contingent upon successful broodstock collection of the 2018 brood. No modifications to program size or release numbers are proposed – only modification of brood stocking methodology, rearing/release strategies and parentage.

Genetic analysis of returning adult steelhead at the Twisp River weir as part of the Relative Reproductive Success Study, indicated that relatedness among the returning hatchery origin adults was high (T. Seamons, WDFW Genetics Lab, pers. comm.). This is not surprising given the small program size (Table 1), and may result in a reduction in genetic diversity and N_e, consistent with effects described in Ryman and Laikre (1991), hereafter “Ryman-Laikre” or “RL” effects.

In response to concerns about minimizing the potential long term risks/effects associated with RL, the HCP-HC and co-managers are looking to adopt a strategy to address potential (or increased) RL effects in the Twisp population as well as having a more integrated approach to steelhead conservation programs in the Methow sub-basin. Mitigating actions were selected with goals to increase genetic diversity, reduce risk of inbreeding on the spawning grounds, and increase N_e. Actions includes release of age-2 (S2) WNFH conservation program juveniles into the Twisp River and compositing a portion of the Twisp and WNFH conservation program broodstock (while retaining a small Twisp WxW (S1) release. Specifically, returning spawners will originate from a greater number of less-related parents compared to the resulting return if these actions are not undertaken.

From the alternatives discussed by a small work group, a hybrid approach (hereafter referred to as alterative 3) between a couple alternatives was developed (and is preferred) that aims to retain Twisp genetics within the Twisp basin but includes incorporation of non-Twisp conservation program genetics.

Alternative 3 was developed based on the desire to protect any remaining or developing Twisp genetic stock structure while balancing and mitigating for genetic concerns by managing N_e and potential spawner relatedness concerns. The major point by which Alt. 3 differs from other alternatives discussed is that a small Twisp x Twisp broodstock would continue to be operated instead of full compositing. No overall changes to current production and release levels would occur. Approximately six Twisp x Twisp (NOR) crosses would produce approximately 24K smolts for release back to the Twisp River. Annual Twisp releases would also include a 24K co-release of S2 smolts from the WNFH conservation program, allowing for unrelated returning adults to provide an increased level of genetic diversity into the Twisp to combat low N_e and reduce risk of inbreeding. This strategy would also provide an evaluation opportunity where potential Twisp stock performance could be evaluated against WNFH conservation program smolts, providing management guidance for continued future direction.

Implementation details for Alternative 3 follow:

Broodstock Collection

- Combined broodstock collection (joint DPUD, WDFW, USFWS, and YN effort)
    - Collection occurs throughout the Methow River, including below-Twisp River angling, Twisp Weir, and WNFH/MFH hatchery infrastructure
    - Broodstock Targets
        - Approximately 6-8* pairs NORs collected at Twisp Weir (half of Twisp program)
        - Approximately 61-65* NOR pairs (WNFH program plus half of Twisp program) collected throughout the Methow River via angling
        - As a contingency for under-collection of broodstock sufficient to fulfil the two components of Twisp-release production, broodstock collection at Twisp Weir could be increased to the traditional collection target of 13 pairs, as needed.
        - *Flexibility required in targets for variation in escapement, fecundity, inclusion of hatchery-origin brood (as per BiOp), etc.
    - All broodstock transferred to WNFH for holding and spawning
        - DPUD may collect up to 37 pairs of conservation program returns (Ad+CWT and CWT-only) at Wells Dam and/or via angling consistent with conservation program efforts and direct-transfer to Wells Hatchery for use in safety-net program
    - Data management for broodstock collection and spawning at WNFH will be primary responsibility of USFWS MCFWCO (all data would be shared with WDFW and DPUD to allow completion of HCP-HC related reports):
        - All broodstock uniquely PIT-tagged upon capture/transfer for assignment on spawn days
        - PIT data tied to collection date/location, mark, DNA samples
        - USFWS will provide standardized <u>effort</u> collection information to all angling participants
    - Adult management will continue to be a large part of broodstock collection efforts
        - Guided by terms and conditions for minimum escapement, pNOB, and mitigation requirements in BiOp
        - Supported generally (i.e. without run-specific details) in annual broodstock collection protocols (e.g. Tonseth 2017)

- Supported specifically (i.e. includes run-specific details) by annual FMEP and targets/goals established by small Methow Steelhead Working Group

Spawning

- All conservation program spawning will occur at WNFH
  - Spawning will be 2x2 factorial crosses
  - Half of Twisp program will be Twisp weir collected NOR x Twisp weir collected NOR as feasible. Individuals PIT-tagged as juveniles in the Twisp will be treated the same.
  - WNFH program and remaining half of Twisp program will be Methow Subbasin NOR x NOR as feasible
  - All NOR females will be live-spawned & transferred to YN Kelt Program
  - USFWS MCFWCO will collect and provide all spawning biological and cross data to WDFW M&E staff.

Gamete Management & Smolt Release

- Maintain 48K total smolt release in Twisp River
  - 24K will be known-Twisp NOR x NOR spawned at WNFH but sent to Wells for S1 rearing
  - 24K will be representative cross-section of WNFH component, reared as S2 smolts at WNFH
  - All releases will be direct smolt plants at Buttermilk Bridge (RKm 21)
- Maintain 100K-200K total conservation program smolt release to Methow Sub-basin outside Twisp
  - 24K cross-section of WNFH population will be transferred to Wells Hatchery for S1 rearing for WNFH on-station or alternative release sites in Methow Subbasin.
  - 24K cross-section of WNFH population will be reared as S2 on-station as paired release for 24K S1 group (above) for potential alternative release strategies, as per above. Any alternative release strategies will guided by JFP and consider need for gradual implementation and patience in awaiting environmental response to management changes.
  - Remaining 52-152K of WNFH population will be reared as S2 smolts for on-station release.

Table 1. Methow Subbasin steelhead hatchery programs under Alternative 3.

Program	Rearing Hatchery	Funding entity	Release site	Release goal	Broodstock	Genetic crosses	Age at release
Methow Subbasin Conservation	WNFH	Reclamation	Methow R. @ WNFH	52-152K[1]	60-65	WxW	2
			Methow Subbasin[2]	24,000			2
	Wells	DPUD		24,000			1
	Wells	DPUD		24,000	6-8	WxW	1

Twisp Conservation	WNFH	Reclamation	Twisp R. @ Buttermilk Br	24,000	6-8	WxW	2
Methow Safety-net	Wells	DPUD	Methow R.[3]	100,000	68[2]	HxH	1
Total				348,000			

[1]WNFH program subject to pNOB/production sliding scale in BiOp.
[2]Initially Methow R. at WNFH but may include alternative offsite release strategies subject to JFP and HCP- HC guidance and BiOp terms and conditions. Would be paired S1 and S2 release.
[3]Methow Safety-net program released in Methow River at Lower Burma Bridge.

Discussion

Alternative 3 was proposed by the working group as it appears to provide the best compromise while also including measures to address the Spatial Structure and Diversity VSPs, by attempting to maintain (or allow) development of local stock structure in the Twisp Watershed. In addition, Alternative 3 provides a higher probability of finding an effective conservation hatchery strategy for the Twisp River, and elsewhere in the Methow Subbasin because it uses three conservation hatchery strategies: 1) local WxW Twisp Program, 2) Methow Composite S1 program, and 3) Methow Composite S2 program.

Table 2. Illustration of out-year effects of 2017 actions and proposed Alternative 3 on Twisp River spawning ground age/program composition.

Spawn/ Escapement Yr.	Age/Program composition of spawners (HOR only) on spawning grounds - Twisp Watershed only		
	Status Quo - S1 smolt supplementation only (all fish are Twisp Program only)	Additional spawners resulting from 2017-only, single-year Alt. mgmt. (juvenile release & brood compositing)	Spawner composition resulting from 2017 actions plus implementation of Alt. 3
2014	BY'10 1.2, BY'11 1.1	N/A	N/A
2015	BY'11 1.2, BY'12 1.1	N/A	N/A
2016	BY'12 1.2, BY'13 1.1	N/A	N/A
2017	BY'13 1.2, BY'14 1.1	N/A	N/A
2018	BY'14 1.2, BY'15 1.1	N/A	N/A
2019	BY'15 1.2, BY'16 1.1	BY'15 2.1 (WNFH)	BY'15 2.1 (WNFH)
2020	BY'16 1.2	BY'15 2.2 (WNFH), BY'17 1.1 (Met[1])	BY'15 2.2 & BY'16 2.1 (WNFH), BY'17 1.1 (Met+Twisp[1])
2021	*BY'18 1.1*[2]	BY'17 1.2 (Met[1])	BY'16 2.2 (WNFH) BY'17 2.1, BY'18 1.1 (Met+Twisp[1])
2022	*BY'18 1.2, BY'19 1.1*[2]	N/A	BY'17 2.2, BY'18 1.2 & 2.1, BY'19 1.1 (Met+Twisp[1])
2023	*BY'19 1.2, BY'20 1.1*[2]	N/A	BY'18 2.2, BY'19 1.2 & 2.1, BY'20 1.1 (Met+Twisp[1])
2024	*BY'20 1.2, BY'21 1.1*[2]	N/A	BY'19 2.2, BY'20 1.2 & 2.1, BY'21 1.1 (Met+Twisp[1])

[1]Combined Methow Subbasin Conservation Programs (yearlings raised at Wells Hatchery, 2-year smolts raised at WNFH).
[2]No BY’17 Twisp Program was developed; brood were composited. This column displays return composition if status quo were to return in 2018.

Topics for HC/HSC discussion born from comments to the Draft 2018 Broodstock Collection Protocols. Text in italics are direct comment quotes.

- **YN Summer Chinook Egg Requests at Wells Hatchery:** "*YN has been getting summer Chinook eggs from Wells since the 2008 BY (11 years). As a reintroduction program, I'd expect that YN would by now be collecting some, it not all the brood required for this program within the YN basin as an integrated program or at the very least a combined integrated and stepping-stone program.*

  This issue came up a couple of years ago, but has not been discussed recently. Notwithstanding this year, future eggs for this program should be determined by the current status of the YN reintroduction program and an updated schedule provided to the Committees as to when and to what degree YN intends upon collecting broodstock with in the Yakama Basin.

  The intent of the initial egg transfer for this program was to provide an egg source to assist with the reintroduction, not to be a perpetual egg source. I'm not advocating we decide to pull the rug out from under the program, but the egg requests should be consistent with the intended need". An update/presentation on the YN Summer Chinook program and future program direction seems appropriate when considering supporting future egg transfers for this program.

- **Age-3 Males in the Broodstock, Include or Exclude?:** "*We'd like to have the HC discuss this guidance. The standard is to incorporate jacks at a rate similar to the wild population or at a rate that will at least allow that life history tactic to not be completely selected against in captivity. While maintaining low precocious maturation may be desirable, it may be at the cost of genetic diversity and also note that families that are more likely to produce jacks also tend to be the fastest growing and the females in such families would also have the trait. Some technical review by the HC of policies and the latest science seems warranted here*".

- **BKD Risk Assessment Criteria and Management/Data Series Implications:** "*Is there any chance we could make this cut-off more flexible? I feel culling actions should be dependent upon results from that specific brood year and current program needs. Ideally, interpretation of ELISA results (or any other pathogen detection data that informs disease risk assessment) and determination of necessary action (.e. culling or cohort segregation) would be at the discretion of fish health. Now is a good time to mention that all upcoming broodstock samples collected at DCPUD facilities will be submitted to the WA Animal Disease Diagnostic Laboratory (WADDL) at WSU's Pullen campus. Their reporting protocols are different from what has historically been released by WDFW's Olympia lab. At this time, WADDL doesn't generate numerical OD values for ELISAs, only a binary +/- result (confirmed via a nested PCR) because of consistency and validation concerns. They're used to generating pathogen detection results for regulatory purposes (note: BKD is not a regulated disease) and in accordance with those guidelines, they must be able to confirm a positive result via culture or PCR to abide by AFS BlueBook standards, something they (and I will mention other labs) cannot consistently do for all Rsal ELISA positives. They say that "optical density values can and do vary based on the species, reagents, equipment and standard operating procedure being used. In WADDL's case, those don't necessarily align with those of the USFWS or WDFW". In other words, some "positive" or high ELISA values do not come back positive via PCR or culture, hence the problem and their concerns about reporting. In light of this, and other concerns about strict ELISA culling cut-offs, I think this would be a good time to reevaluate how we can and should interpret ELISA results (and detect Rsal in general) to inform our existing culling programs*".

- **Differentiating NO Okanogan Spring Chinook during MFH Broodstock Collection at Wells Dam:** "*Not that it is necessarily relevant this year, but in future years, it is expected that natural origin spring Chinook produced in the Okanogan will begin to return (return year 2021). Collecting NOR at Wells will need to determine how and if non-Twisp NOR fish can be distinguished from Okanogan NORs. Inadvertently* *collecting Okanogan NORs as non-Twisp NORs at Wells will detract from the success of the Okanogan 10j reintroduction program*".

- **PRH Fall Chinook Integration – How to Achieve it Without Fish from Alternative Collection Sites/Methodology:** "*OLAFT and hook-and-line collections for NOR fish for broodstock have been the norm recently. During these years of OLAFT and hook-and-line collections, substantial numbers of NOR fall Chinook have been included in the portion of fall Chinook surplused from Priest Rapids Hatchery. If seems inappropriate to remove NOR fall Chinook from the run past PRD and from the spawning population in the Hanford Reach when these fish (or at least a good portion) exist in the hatchery volunteer collection of which some are surplused and make no contribution to the hatchery NOB or natural spawning population*.

  Tagging strategies at PRD could provide the necessary means to selectively retain NOR brood from the PRD volunteer collections, such that NOR extractions from the Hanford Reach (hook-and-line) and OLAFT are minimized and the best use of NORs returning in the volunteer collections is maximized.

  An assessment of the number of NORs excessed/surplused annually should be assessed and a discussion occur relative to the appropriateness of continued hook-and-line and OLAFT NOR collections post 2018".

- **Re-evaluating the Size of UC Spring Chinook Conservation Programs:** Initially prompted by a comment from Todd Pearsons regarding the Nason Creek program. WDFW believes that if the effort is going to be made for one program then due diligence dictates we evaluate all programs for biological defensibility.

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: June 20, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the May 16, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held at the Grant PUD office in Wenatchee, Washington, on Wednesday, May 16, 2018, from 9:00 am to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Mike Tonseth will coordinate with Todd Seamons (Washington Department of Fish and Wildlife [WDFW]) to produce an outline or recommended approach for genetic monitoring (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons regarding reviewing the memorandum, "Alternatives for Methow Basin Conservation Steelhead Programs" (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A). *(Note: this item is ongoing.)*
- Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Charlene Hurst will send a Word version of the steelhead Biological Opinion (BiOp) to Greg Mackey and Matt Cooper (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item III-B). *(Note: this item is ongoing.)*
- Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (BKD; Item III-C). *(Note: this item is ongoing.)*

- Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- The Hatchery Committees will discuss genetic monitoring in June and July 2018 (Item I-A).
- Sarah Montgomery will schedule a longer meeting on July 18, 2018, with times in the agenda, and coordinate with the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC-HSC) facilitator (Item I-A).
- Betsy Bamberger will research the practicality of assessing BKD by culturing (Item III-C).
- Permit applicants will send public comment distribution lists to Charlene Hurst (Item III-D).

Decision Summary

- There were no decision items approved during today's meeting.

Agreements

- There were no agreements made during today's meeting.

Review Items

- Sarah Montgomery sent an email to the Rocky Reach and Rock Island Hatchery Committees on June 16, 2018, notifying them that the Draft 2017 Chelan PUD and Grant PUD M&E Annual Report and its appendices are available for a 30-day review, with edits and comments due to Tracy Hillman by July 16, 2018.

Finalized Documents

- No items have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the April 18, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. There were no changes.

The Hatchery Committees representatives reviewed the revised draft April 18, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft April 18, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on April 18, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on April 18, 2018)*:

- *Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will write an overview of proposed expanded sampling at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam and present this information at the Hatchery Committees May 16, 2018 meeting (Item I-A).*
  This item will be discussed today.
- *Mike Tonseth will coordinate with Todd Seamons (WDFW) to produce an outline or recommended approach for genetic monitoring (Item I-A).*
  Tonseth said this item is still ongoing. Todd Pearsons asked when the genetic monitoring approach should be determined in order to incorporate it into the program review. Tonseth said the data needed for genetic analyses are still being collected, but the timelines for processing and analyzing the genetic samples could change. Pearsons asked if the analyses are staged to accommodate lab processing, or if all samples could be processed in the same year. Tonseth said the WDFW lab would not be able to process all the samples in the same year. He said baseline information and analysis methods still need to be discussed. Running baseline data again would be expensive and would take time. Pearsons said it would be helpful to know the budget for genetic monitoring and when funds need to be available. Pearsons suggested resolving anything requiring little input from the geneticists soon, such as during the June Hatchery Committees meeting, in order make progress on some topics.
- *Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Alternatives for Methow Basin conservation steelhead programs" (Item I-A).*
  Tonseth said this item is ongoing. He said he received a response from Seamons and will distribute it to the Hatchery Committees. He noted that Seamons did not prefer alternative 3.
- *Sarah Montgomery will reconfigure the Extranet site to sort permits and Biological Opinions (BiOps) by species and date and upload the related documents (Item I-A).*
  Montgomery said this item is complete. She said she will work with Julene McGregor to change the view on the site, so it is more user-friendly. Mike Tonseth said he has a permit to add and will send it to Montgomery.
- *Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A).*
  This item is ongoing.

- *Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A).*
  This item is ongoing.
- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB's) Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).*
  Hillman said this item is ongoing. He said he will contact the statistician who helped with the review regarding suggestions for multivariate Before-After-Control-Impact (BACI) analyses.
- *Tracy Hillman will send Mary Conner et al.'s 2016 paper, "Evaluating impacts using a BACI design, ratios, and a Bayesian approach with a focus on restoration," to the Hatchery Committees (Item I-A).*
  This item is complete. Hillman distributed the paper following the meeting on April 18, 2018.
- *Matt Cooper will invite Chris Tatara (National Oceanic and Atmospheric Administration [NOAA]) to the Hatchery Committees May or July 2018 meeting to discuss steelhead residualism (Item II-A).*
  Cooper said Tatara plans to attend the July 18, 2018 Hatchery Committees meeting. Due to the many topics already identified for the July Hatchery Committees meeting, representatives present suggested making the meeting longer, delaying the PRCC HSC meeting, and adding times to the agenda. Montgomery said she will work on these items and coordinate with the PRCC HSC facilitator.
- *Matt Cooper will ask Penny Swanson (NOAA) about how feeding patterns during a 2-month holding period might compromise studying early maturation in steelhead (Item II-A).*
  Mike Tonseth said he spoke to Don Larsen (NOAA) about feeding patterns. He said Larsen indicated that holding the fish would likely not compromise an early maturation study and suggested putting the fish on a maintenance diet to replicate stream behavior.
- *Charlene Hurst will send a Word version of the final BiOp for the steelhead to Greg Mackey and Matt Cooper (Item III-A).*
  Brett Farman said he will check on the status of this item.
- *Keely Murdoch will invite Melinda Davis and Mark Johnston (Yakama Nation [YN]) to the Hatchery Committees July meeting to discuss the YN summer Chinook salmon program (Item III-B).*
  This item is complete. Keely Murdoch said Davis plans to attend the July 18, 2018 Hatchery Committees meeting.
- *Sarah Montgomery will distribute the document, "Emerging Discussions from draft 2018 Broodstock Collection Protocols," to the Hatchery Committees (Item III-B).*
  Montgomery distributed this document on April 19, 2018.

- *Greg Mackey will research the second item in the Emerging Discussions document, whether to include age-3 males in broodstock, prior to the Hatchery Committees May 16, 2018 meeting for further discussion (Item III-B).*
  This item will be discussed today.
- *Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (BKD) (Item III-B).*
  Bamberger said the WADDL is still working internally to decide how to report optical density values. Due to recent contracts with U.S. Fish and Wildlife Service (USFWS), WADDL expects to develop a fit-for-purpose test, and Bamberger said she will update the Hatchery Committees when she has more information.
- *Betsy Bamberger will present information on optical density values and BKD to the Hatchery Committees during their May 2018 meeting (Item III-B).*
  This item will be discussed today.
- *Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item III-B).*
  This item is ongoing.
- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item III-B).*
  This item is ongoing.

II. Douglas PUD

A. Wells Hatchery Steelhead Production in the Dirt Ponds During Winter 2017-2018 (Greg Mackey)

Greg Mackey said there was loss of some Wells (Columbia River Safety Net) steelhead held in Pond 3 at Wells FH over the winter. He stated that a hydrogeologist conducted surveys in the dirt ponds and found that the issue was not a true sink hole but rather erosion. Nevertheless, Pond 3 did leak and the PUD plans to reline the pond in 2019. They cannot reline in 2018 because of the length of time it takes to conduct design, bidding and contracting.. Therefore, they will not be able to use Pond 3 next year to rear Wells steelhead. He indicated that Pond 4 holds Methow Safety Net steelhead and Pond 1 holds Summer Chinook salmon. They propose to rear Wells steelhead in Pond 2 this winter. A transmission tower in Pond #2 means they cannot place bird netting over the pond. Therefore, the PUD proposes to overstock the pond by 40,000 steelhead, assuming birds will harvest about 20% of the fish in the pond. Thus, the pond will be stocked with 200,000 juvenile steelhead with a release goal of 160,000 steelhead. He said at the time of release, feed conversion will be used to estimate the number in the pond.

Mike Tonseth suggested netting the pond. Mackey said that is not an option because of the location of the transmission tower within the pond. Hillman asked if cover could be placed in the pond to reduce predation. Mackey said he will look into that. Tonseth said he expects Douglas PUD to perform sufficient monitoring such that the Columbia release is no more than 10% of the program goal. He said as the fish are being released, the gate should be closed once the production target number have exited the pond.

III.Joint HCP-HC/PRCC HSC

A. Proposed Expanded Sampling at the Off-Ladder Adult Fish Trap (Andrew Murdoch)

Andrew Murdoch shared the presentation *Estimating Escapement at Various Spatial Scales Using PIT* (passive integrated transponder) *Tags* (Attachment B), which Sarah Montgomery distributed to the Hatchery Committees following the meeting. Andrew Murdoch summarized that expanded sampling at the OLAFT at Priest Rapids Dam could benefit other HCP Plan species (except sockeye), would provide real-time escapement monitoring for broodstocking and adult management purposes, and would provide estimates of run escapement by population and origin at various spatial scales for monitoring and management purposes. The majority of the information Andrew Murdoch presented is included in the presentation slides. Questions and comments are included below.

Slide 1: Regarding similar work in other basins, Todd Pearsons asked what types of models are used in the Snake, Willamette, or Deschutes rivers for studying steelhead. Andrew Murdoch said in the Snake River, three models are used to estimate steelhead escapement because there is less information available compared to the upper Columbia River. For example, there are not spawning ground surveys in the Grande Ronde River, and in the Snake River, hatchery fish are not PIT-tagged and wild fish are. In other places, it is difficult to make the analysis more consistent due to run timing. Some locations also have issues with maintaining PIT tag infrastructure in the water, or with vandalism.

Slide 6: Catherine Willard asked what sampling is currently being performed at the OLAFT. Andrew Murdoch said captured fish are scanned with ultrasound, scanned for coded wire tags, scale samples are taken, and some caudal fins are clipped for genetic sampling. Origin, sex, and age are also recorded for each fish that is PIT tagged. Mike Tonseth said this sampling is consistent with what is performed at Dryden Dam and Wells Dam. Keely Murdoch asked if all species of fish are scanned with ultrasound, particularly coho salmon. Andrew Murdoch replied that coho salmon are not examined with ultrasound, but other species are. He said ultrasound is sometimes used to determine the difference between spring- and summer-run Chinook salmon, and also used to determine gender for fish used for broodstock.

Slide 14: Regarding the escapement model, Pearsons asked what the funding source was. Andrew Murdoch said the Bonneville Power Administration (BPA) funded the PIT-tag array and model development and WDFW continues to work on the model using other funds. Andrew Murdoch said the website is useful for tracking how many fish have escaped to each basin.

Slide 23: Regarding carcass recovery bias and female overrepresentation, Greg Mackey asked if females are overrepresented in absolute terms. Andrew Murdoch said females are overrepresented relative to males. Females are more likely to be captured after spawning due to post-spawning behavior. He said larger males are also more likely to be captured than smaller males, but this can be predicted and incorporated into the model.

Slide 26: Hillman asked if Andrew Murdoch has considered using unadjusted fish-per-redd counts to estimate spawning escapement, then compare those to the modeled results. Andrew Murdoch said the run escapement is always much higher than the spawning escapement. Hillman suggested using adjusted and unadjusted fish-per-redd counts to estimate spawning escapements, and then calculate the size of the bias of the unadjusted estimate to the adjusted estimate. Andrew Murdoch said this is a similar method to the one used in the model. He said they corrected the carcass data for bias and estimated the number of fish per redd based on the number of spawners. Pearsons asked why the model does not focus solely on female counts, which drives production. Andrew Murdoch said males need to be included for reporting purposes and for calculating the percent natural influence (PNI). Pearsons said it would be helpful to move away from using data with a high carcass recovery bias, because it adds so much error. Pearsons suggested that a tighter estimate could be determined using just females.

Andrew Murdoch noted that a major benefit of using the OLAFT for this work would be to look at the entire spring-run Chinook salmon evolutionarily significant unit (ESU) in the upper Columbia River. Sampling at Tumwater Dam, for example, does not account for the entire Wenatchee Basin population. He said a sampling scheme farther downstream helps to estimate population size and structure at the level needed for making adaptive management decisions. Tonseth noted this method would help with hatchery effectiveness monitoring. It can provide a better estimate of PNI, which is a permit condition, and provide a better estimate of adult returns so hatchery fish excesses can be managed.

Slide 27: Keely Murdoch suggested that coho salmon also be added to the cost estimate for plan species.

Peter Graf asked what the costs presented represent. Andrew Murdoch said the costs cover operation of the OLAFT and analysis. This includes data management and reporting as well.

Graf asked why spring-run Chinook salmon in particular should be added to the OLAFT sampling. He said work is already funded at Tumwater Dam for spring-run Chinook salmon. Andrew Murdoch said sampling and analyzing the entire upper Columbia River ESU of spring-run Chinook salmon would be efficient and help gain a larger perspective on the population. He asked if there is a potential negative impact to the population from increased sampling and handling at the OLAFT. Pearsons asked how this method addresses a monitoring and evaluation (M&E) need that is not currently addressed. Andrew Murdoch said the alternative would be increasing effort at existing facilities, such as running both ladder traps at Wells Dam. He said handling the fish lower in the river at Priest Rapids Dam would be less impactful than at Tumwater Dam, for example, because Tumwater Dam is closer to spawning grounds and therefore more disruptive.

Catherine Willard said, from the Chelan PUD perspective, it would be helpful to discuss a concurrent plan for how M&E activities at Tumwater Dam, Dryden Dam, and Wells Dam would change with implementation of the OLAFT activities. Keely Murdoch agreed and said the discussion influences management of hatchery programs across the upper Columbia River.

Mackey asked if this model will be presented in a journal or white paper. He noted the the Hatchery Committee should review a technical document on the model. Andrew Murdoch said yes, he is working on writing a paper about the model and the original developers are also working on a manuscript.

Tonseth said the overall goal of this proposal is to increase the quality of data sources from sampling and analysis procedures and reduce potential effects from activities on listed fish species.

Pearsons asked if the costs presented in Slide 27 are in addition to the funding provided by BPA. Andrew Murdoch said yes, the funding from BPA is used to maintain infrastructure (arrays).

Hillman asked what the next steps for the Hatchery Committees are regarding this topic.
Andrew Murdoch said there is uncertainty as to how the recreational fisheries and M&E at Tumwater Dam would be worked out, so that should be discussed. He also suggested increasing knowledge about life stage survival and understanding capacity limitations, especially density-dependence.

Pearsons asked if the model can be back-casted to estimate pre-spawn mortality. Andrew Murdoch said yes, to 2008. Pearsons asked if those data can be made available, particularly for Keely Murdoch and Mike Tonseth so they can work on the program size for spring Chinook conservation programs. Andrew Murdoch said yes, and while there is no explicit funding for this work, he will continue working on prespawn mortality data. This will include working with Jeff Jorgensen (NOAA) to predict pre-spawn mortality and its factors within the life-cycle modeling construct. He will also work to incorporate data from the relative reproductive success study into the model, to help determine escapement goals for each major spawning area and predict gaps that need to be filled with hatchery fish. He said working together to develop the upper Columbia River model will help gain more funding. He said the funding coming from BPA to WDFW is currently under one umbrella. Being able to use the upper Columbia Basin as a model for other basins would put the basin in a good negotiating place for gaining funding. He said there is a lot of potential for this method because it is realistic and the managers agree on using fisheries to manage returning adults. He said there is still much left to determine such as changes to activities at Tumwater and Wells dams, but this method has a lot of potential and even cost-savings. The Hatchery Committees representatives present thanked Andrew Murdoch for the presentation and said this should be discussed again at an upcoming meeting.

B. Age-3 Males in Broodstock (Greg Mackey)

Greg Mackey said he performed a literature search on the use of age-3 males in broodstock and contacted staff at NOAA for additional information. He said he plans to discuss M&E data with Charlie Snow (WDFW) to assess how many age-3 males have been included in broodstock in recent years, then present the information to the Hatchery Committees. Todd Pearsons asked if it would be helpful to invite Craig Busack (NOAA) to participate in this discussion. He said Busack has previously worked on this topic with stakeholders helping with the Cle Elum Supplementation Research of spring Chinook in the Yakima Basin, and he may have a helpful perspective. Andrew Murdoch recalled there was also a hatchery workgroup that gathered in Portland to discuss this topic. Mackey said he will continue gathering information for a more detailed discussion.

C. Optical Density Values and Bacterial Kidney Disease (Betsy Bamberger)

Betsy Bamberger shared a presentation titled *The Challenges of* Renibacterium salmoninarum *Detection and BKD Management* (Attachment C), which Sarah Montgomery distributed to the Hatchery Committees following the meeting. The majority of the information Bamberger presented is included in the presentation slides. Questions and comments are included below.

Regarding culling of fish with the bacteria, Todd Pearsons asked whether fish can recover and become healthy if successfully treated. Bamberger said yes; however, in some cases there is permanent loss of tissue functionality. In those cases, the fish is no longer diseased, but is maimed.

Regarding the Elliott et al. paper published in *Journal of Fish Diseases* in 2013, Pearsons asked which detection strategy performed better. Bamberger said the enzyme-linked immunosorbent assay (ELISA) test detected more diseased fish; however, in an ideal scenario, the various methods would detect the same percentage of diseased fish. Bamberger said the two polymerase chain reaction (PCR) methods had the highest concordance with percent diseased fish. Bamberger emphasized that detecting the bacteria does not mean a fish is diseased.

Bamberger said Douglas PUD intends to perform ELISA and qPCR (quantitative polymerase chain reaction) testing, combined with gross examinations, on spring Chinook this fall. Greg Mackey said females will be examined during spawning, and lesions will be recorded, plus the females will be tested for the bacteria using ELISA and qPCR. Mackey said the eggs need to be culled in late August before they mature and suggested culture as a potential way to test for BKD. Bamberger said she will check on the potential for using culture to test for BKD, but she thinks it would take too long to grow the culture. Bamberger emphasized that there are many options to explore for managing BKD, and as programs change, it is important to be flexible with disease management strategies. She said using multiple strategies to detect BKD and make culling decisions will help manage against acting on false positives or false negatives.

Hatchery Committees representatives present thanked Bamberger for her presentation and summarized that the next steps for this discussion depend on further input from WADDL.

D. NMFS Consultation Update (Brett Farman)

Brett Farman said Charlene Hurst sent the steelhead permits for the Wells program and Winthrop National Fish Hatchery program to applicants and received comments. Farman said Hurst will revise the permits and coordinate with USFWS on implementation terms, then the permits will be provided for review again.

Emi Kondo (NOAA) provided an update on the National Environmental Policy Act (NEPA) process for the Columbia River unlisted programs. She said the Environmental Assessment is being reviewed internally, and she expects it to be provided to General Counsel in June and then to the applicants in July. After the applicants' review, the document will be available for public comment. She said if anyone has email distribution lists to use for the public comment notification, please send the lists to Hurst.

E. 2019 Hatchery M&E Implementation Plan (Todd Pearsons/Catherine Willard)

Todd Pearsons shared Grant PUD's draft 2019 Hatchery M&E Implementation Plan (made available to PRCC HSC representatives). Pearsons said it will be distributed for a 30-day review and discussed the revisions pertaining to the HCP Hatchery Committees.

Regarding Wenatchee summer-run Chinook salmon, there was a change to the field work outlined in the Implementation Plan to eliminate the data collected to inform the observer efficiency model. The data collection will still be consistent with what is already being collected in the Okanogan, Methow, and Chelan rivers. He said in 2014 to 2018, field data was collected to inform and develop an observer efficiency model and 2018 is the last scheduled year of data collection to inform the model.

He said data collection will continue to be consistent with other basins where summer-run Chinook salmon surveys are conducted and there will be no interruption to the data time series.

Catherine Willard said Chelan PUD's draft 2019 Hatchery M&E Implementation Plan is similar and will contain the same change for Wenatchee summer-run Chinook salmon data collection. She said the Chelan PUD plan will also be provided for a 30-day review. Willard said the observer efficiency model has not been run yet, but there are enough data to inform the model then review the results.

IV. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are June 20, 2018 (conference call), July 18, 2018 (Grant PUD), and August 15, 2018 (Grant PUD).

V. List of Attachments

Attachment A List of Attendees
Attachment B Estimating Escapement at Various Spatial Scales Using PIT Tags
Attachment C The Challenges of *Renibacterium salmoninarum* Detection and BKD Management

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Betsy Bamberger	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Rod O'Conner‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Andrew Murdoch	Washington Department of Fish and Wildlife
Alf Haukenes†	Washington Department of Fish and Wildlife
Charlie Snow†	Washington Department of Fish and Wildlife
Chris Moran†	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Michael Humling†	U.S. Fish and Wildlife Service
Brett Farman*†	National Marine Fisheries Service
Emi Kondo†‡	National Marine Fisheries Service
Keely Murdoch*	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
† Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Estimating escapement at various spatial scales using PIT tags

Andrew Murdoch
Ben Truscott
Mike Hughes
Kevin See

Project Objectives

- Expand steelhead escapement project to other Plan Species, except sockeye.
- Provide real time escapement monitoring for broodstocking and adult management purposes.
- Estimate run escapement by population and origin at various spatial scales for monitoring and management purposes.

Why?

- Reduce uncertainty in dam counts
  - Origin – Conservation program not ad clipped
  - Fallback – Overshoot behavior observed in all species
    - Influenced by numerous factors both within and outside UCR
  - Reascension – Variable through time
    - Species – Chinook vs. Coho vs. Steelhead
    - Chinook races – spring vs. summer vs. fall

Why?

- Reduce uncertainty in tributary run escapement
  - Run escapement by origin is unknown
    - Changes in hatchery programs
      - Reduced production levels
      - New programs– Chelan Falls, Entiat NFH, Chief Joe.
    - Columbia River harvest – Regulations change through time and space
    - Overshoot behavior within tributaries is alos variable
  - Estimate tributary escapement at various spatial scales
    - Species dependent
  - Tributary entry timing comparable across populations
  - Run – Spawners = Prespawn Mortality

Why?

- Current stock assessment sampling is inadequate or biased
  - Not conducted for every population in UCR
  - Sampling bias unknown with no measure of uncertainty
- Representative random sample of adults at PRD
    - Adjusted for fallback/ascension (DART query)
    - POM model accounts for overshoots
  - Eliminate Dryden and Wells sampling
  - Standardized population summary statistics based on PIT tags detected in each subbasin

Steelhead Example

- Run escapement into 4 populations
  - Origin specific
  - CV < 15%
- Spawning escapement into tributaries
  - Origin specific
  - CV < 30%
- PIT tagged fish served a random sample
  - Sex and age
    - Stock reconstruction
    - Fish per redd

Spring Chinook

- Lower Wenatchee
  - Icicle River and Peshastin Creek
  - Tumwater
    - Chiwaukum, Chiwawa, Upper Wen., Nason, White, Little Wen.
- Lower Entiat
  - Mad
  - Upper Entiat
- Lower Methow
  - Middle Methow (Carlton)
    - Twisp, Chewuch, Upper Methow
- Lower Okanogan
  - Omak and Salmon

Summer Chinook

- Lower Wenatchee
  - Tumwater
- Lower Entiat
  - Ardenvoir
- Lower Methow
  - Middle Methow (Carlton)
    - Upper Methow
    - Lower Chewuch
- Lower Okanogan
  - Zosel Dam

Coho

- Lower Wenatchee
  - Mission
  - Chumstick
  - Peshastin
  - Icicle
  - Tumwater
    - Nason, Chiwawa
- Lower Methow
  - Middle Methow (Carlton)
  - Upper Methow
  - Chewuch

Columbia River

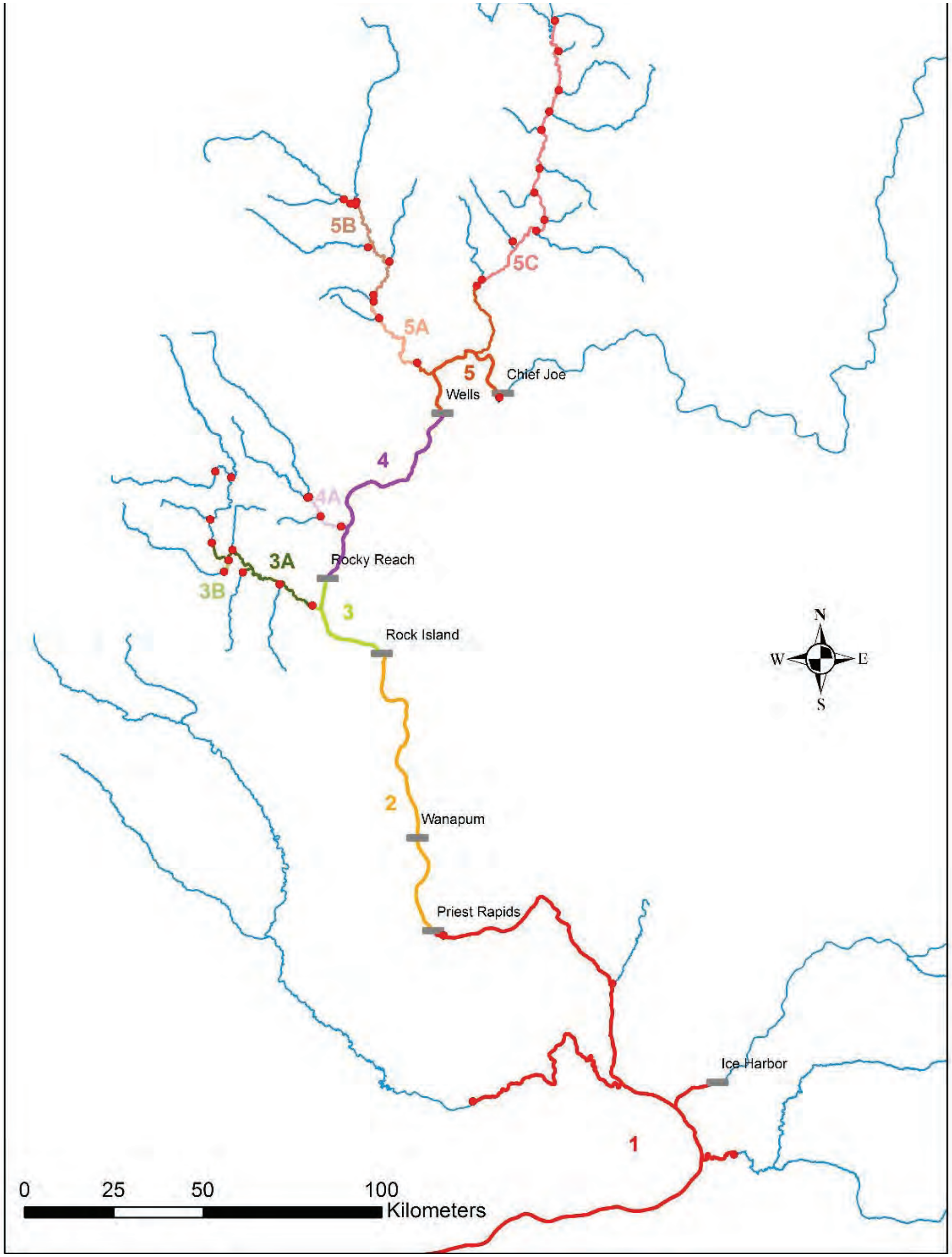
- Priest Rapids, Rock Island, Rocky Reach, Wells
- Compare PIT tag estimates to dam counts
  - Species
  - Origin
  - Develop correction factors?
- Better understand overshoot behavior

Results

- Real-time abundance estimates
  - Broodstocking
  - Adult management
- Unbiased estimates of run escapement
  - Summary Statistics
  - Origin, sex, age, length from PIT tag resights
- Compare run to spawning escapement to estimate prespawn mortality
  - Unbiased estimates at tributary level
  - Influence of density, flow and temperature on survival

Real-time Escapement

- Weekly estimates for Columbia River and lower tributary reaches
- Developed with CRSSE funding to refine fishery impacts to wild fish
- Reduce uncertainty in broodstock collection
- Refocus adult management priorities


5B
5C
5A
5
Chief Joe
Wells
4
4A
3A
Rocky Reach
3B
3
Rock Island
N
W
E
S
2
Wanapum
Priest Rapids
Ice Harbor
1
0 25 50 100
Kilometers

Attachment B

https://shiny.test.wdfw-fish.us/UpperColumbiaEscapement/

UC Steelhead Escape... | WDFW Intranet | Google

WDFW Intranet | Discharge | WDFW Favorites | Fish counts

Upper Columbia Steelhead Escapement

QCI Quantitative Consultants Inc.

Escapement | Area Map

Date

- Mar 29, 2018
- Apr 11, 2018
- Apr 18, 2018
- Apr 25, 2018
- May 02, 2018
- (selected) May 09, 2018

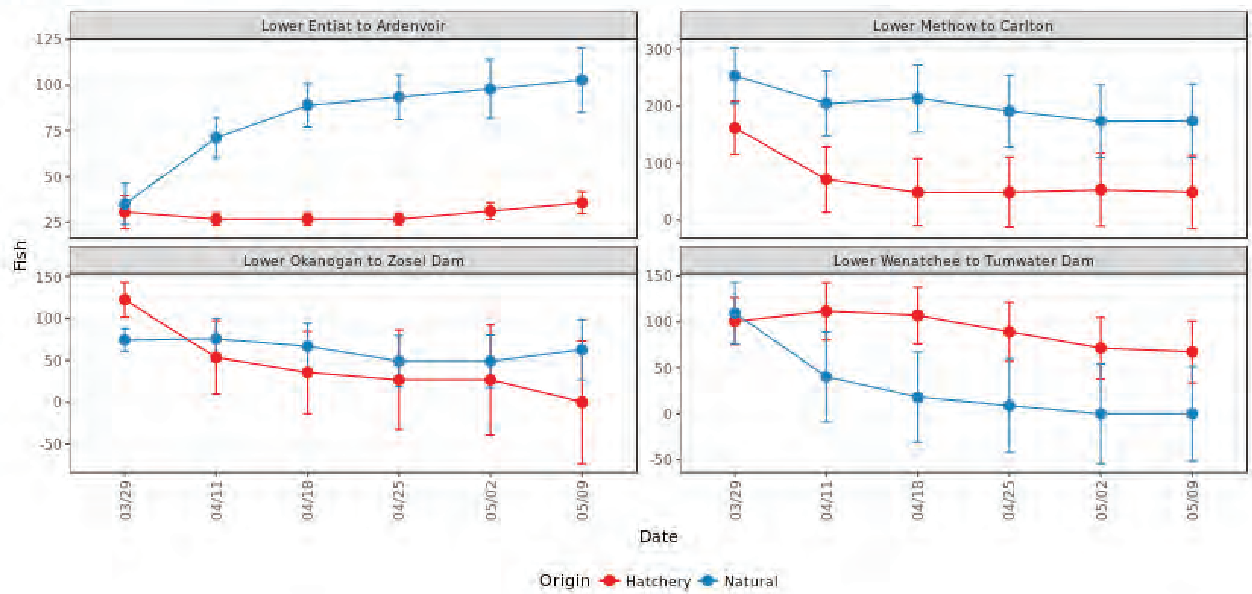
Fishing Areas

- [ ] Downstream of Priest Rapids Dam
- [ ] Priest Rapids to Rock Island Dam
- [ ] Rock Island to Rocky Reach Dam
- [x] Lower Wenatchee to Tumwater Dam
- [ ] Icicle River
- [ ] Rocky Reach to Wells Dam
- [x] Lower Entiat to Ardenvoir
- [ ] Wells to Chief Joseph Dam
- [x] Lower Methow to Carlton
- [ ] Carlton to Winthrop
- [x] Lower Okanogan to Zosel Dam

Current Status

Area	Natural	SE (Natural)	Hatchery	SE (Hatchery)
Lower Entiat to Ardenvoir	102.78	9	35.75	3
Lower Methow to Carlton	174.28	33	49.16	33
Lower Okanogan to Zosel Dam	62.56	18	0.00	37
Lower Wenatchee to Tumwater Dam	0.00	26	67.03	17

Trend

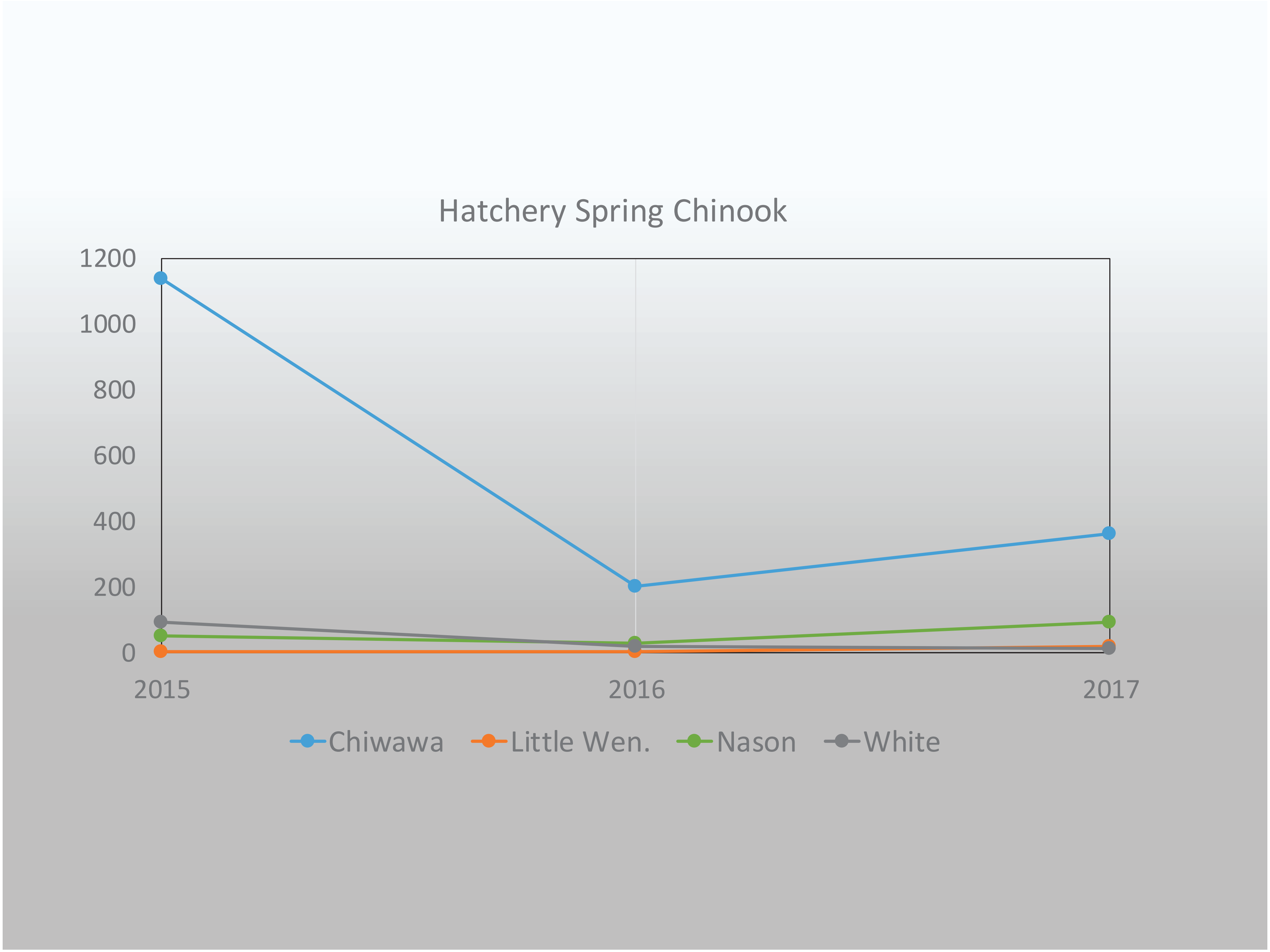


2015 Tumwater Run Escapement

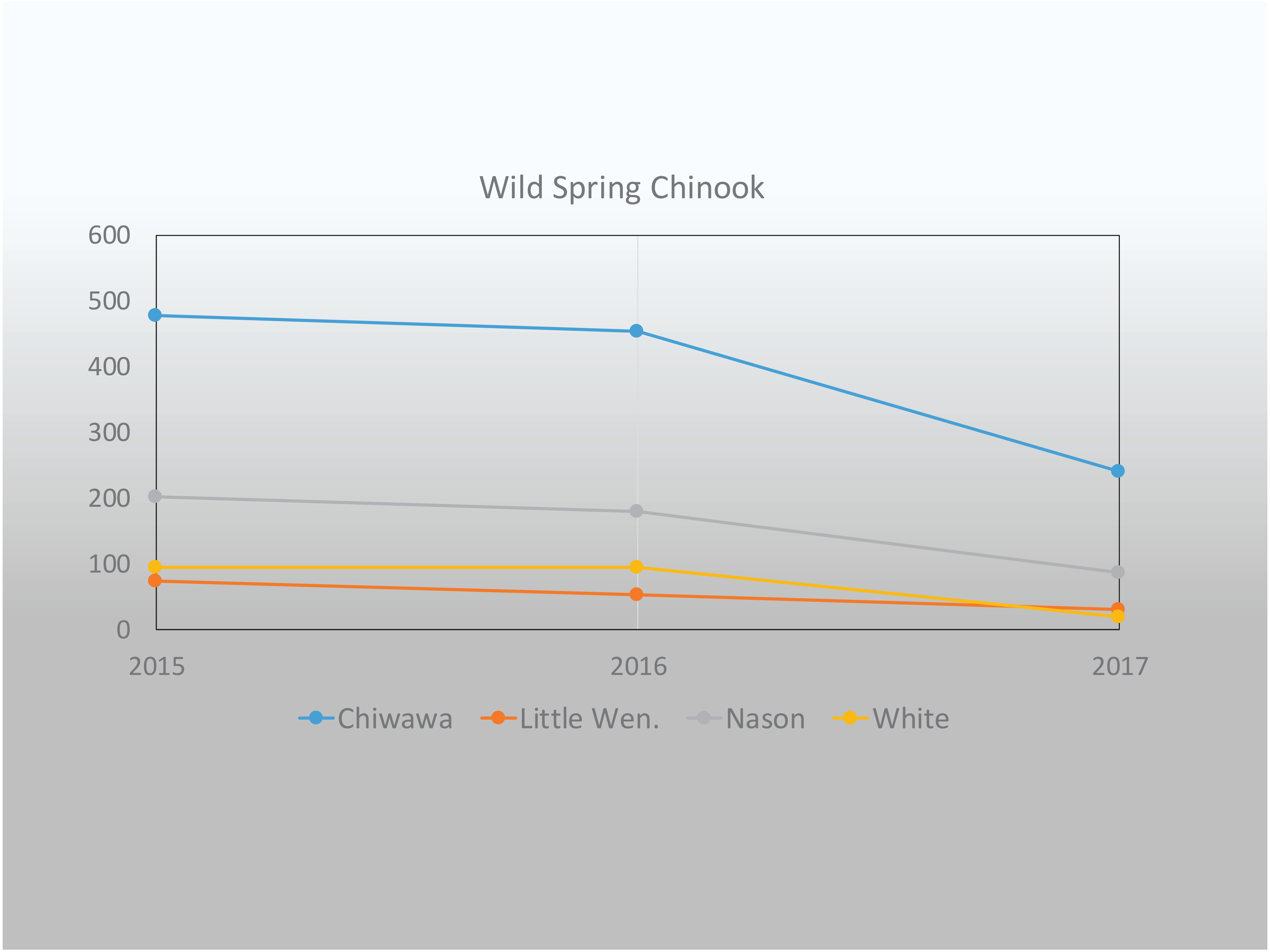
Stream	Hatchery	CV	Wild	CV
Chiwawa	1141	2%	479	5%
Nason	52	15%	203	7%
Little Wenatchee	5	63%	74	29%
White	96	20%	95	19%
Chiwaukum	9	38%	6	45%
Icicle	*15*	*29%*	*5*	*50%*
Peshastin	*6*	*188%*	*3*	*229%*

Italics represent stream downstream of Tumwater Dam

Precision related to abundance
Accuracy related to resight upstream of lower array (IPDS or carcasses)

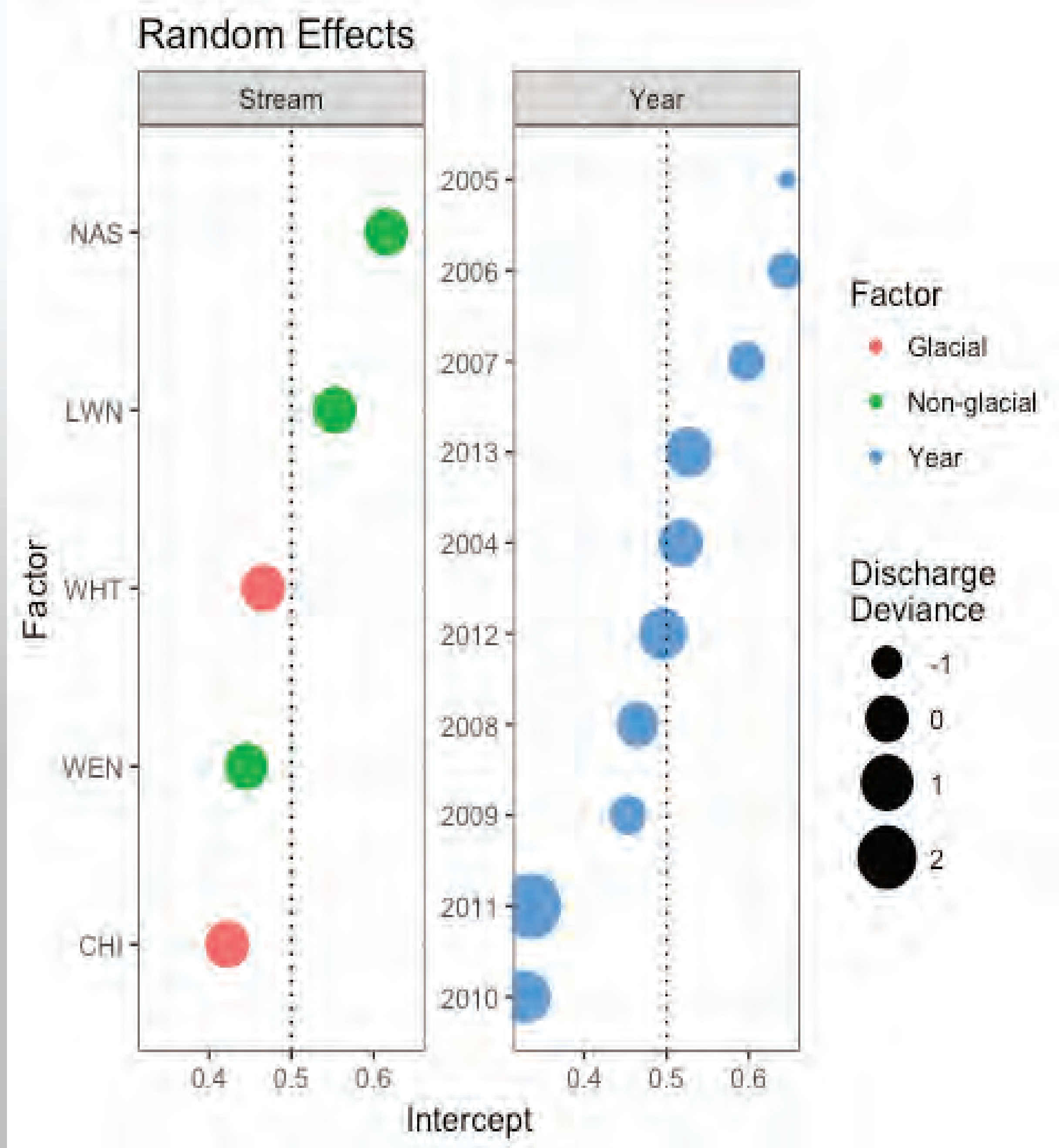

Hatchery Spring Chinook
1200
1000
800
600
400
200
0
2015
2016
2017
Chiwawa
Little Wen.
Nason
White

Attachment B

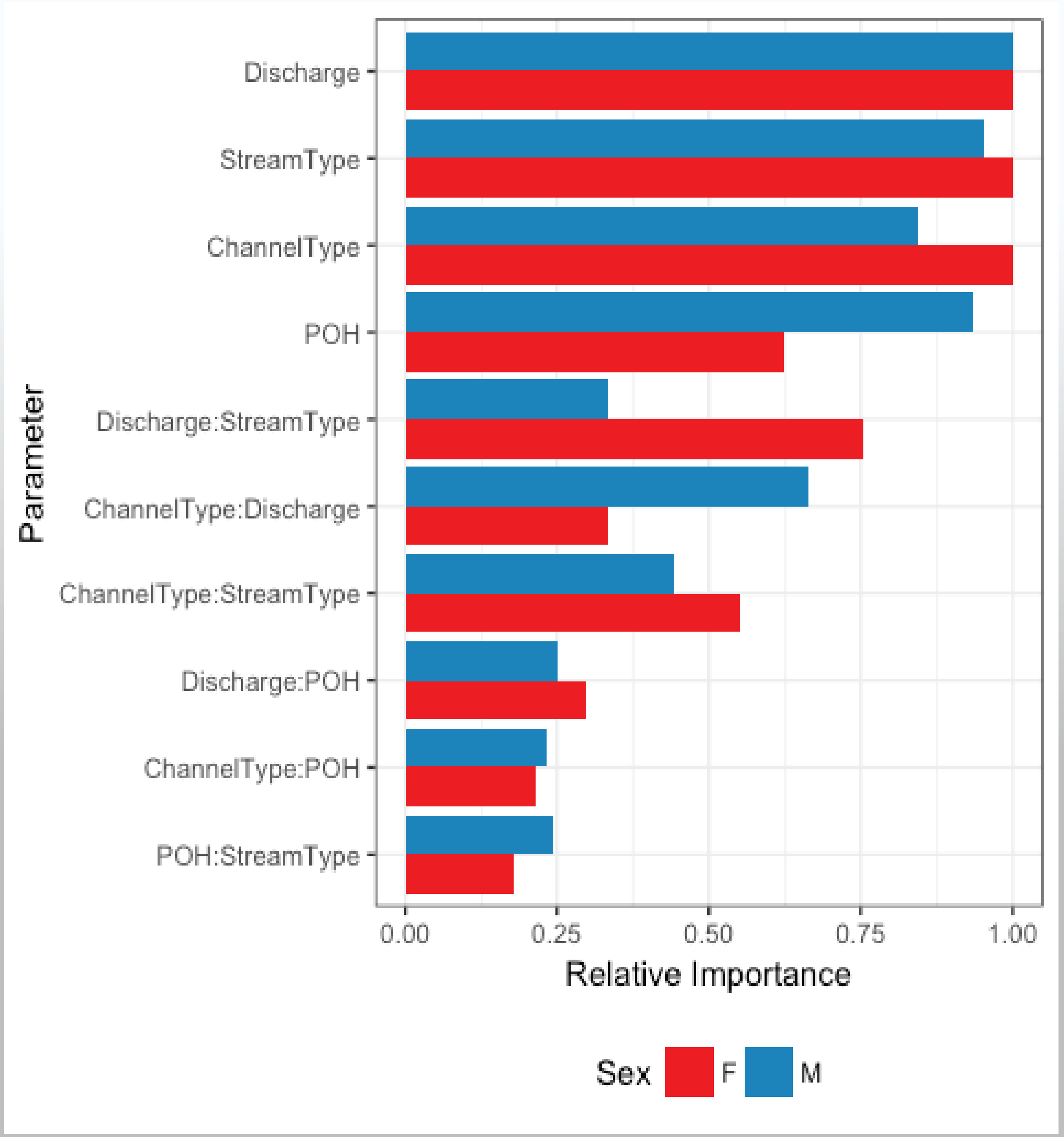


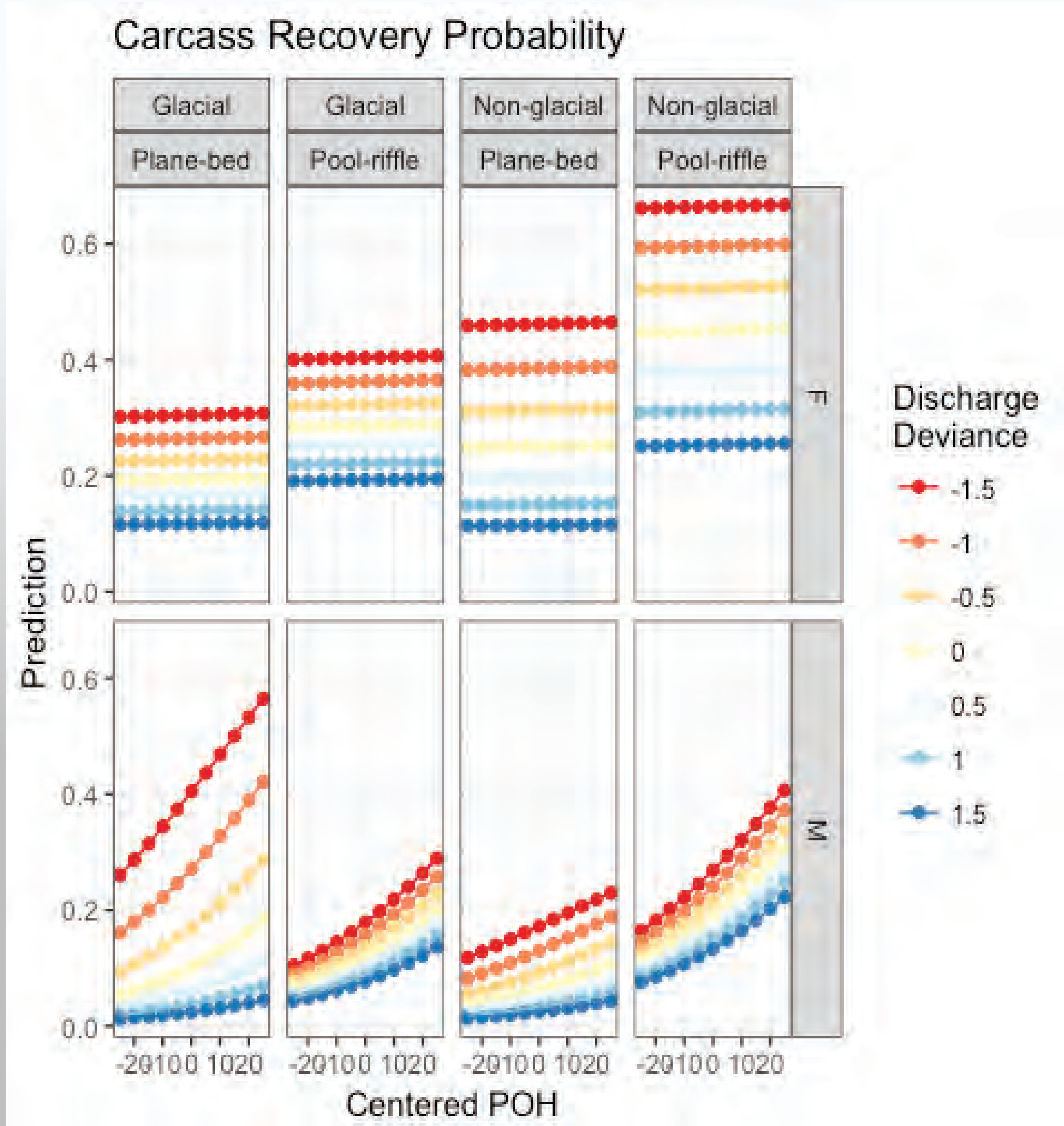
Prespawn Mortality

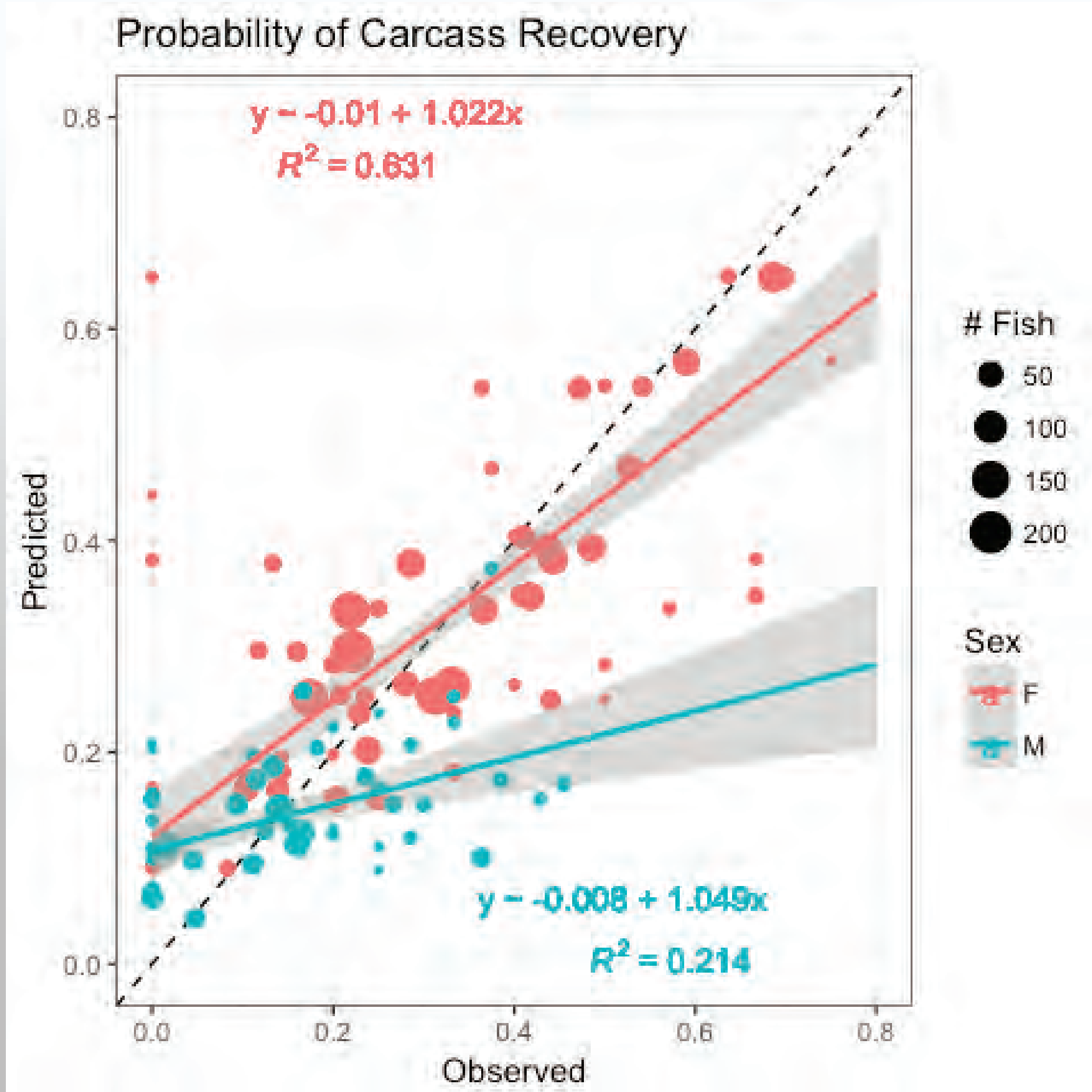
- Dataset from live hits of spawners (~3,300) recovered as carcasses (2004-2013)
- Run – Spawner = PSM
  - Correct carcass sample for recovery probability bias
  - Calculate new fish per redd values (sex ratio)
  - Calculate new estimate of spawner
    - Estimated redds (GAUC) x FPR_{cc} = Spawners
  - Decompose by origin (raw carcasses)
    - Sex
    - Age
- Run – $Spawner_{cc}$ = PSM
  - Origin
  - Sex



Random Effects
Stream
Year
NAS
LWN
WHT
WEN
CHI
Factor
2005
2006
2007
2013
2004
2012
2008
2009
2011
2010
0.4
0.5
0.6
0.4
0.5
0.6
Intercept
Factor
Glacial
Non-glacial
Year
Discharge Deviance
-1
0
1
2


Parameter
Discharge
StreamType
ChannelType
POH
Discharge:StreamType
ChannelType:Discharge
ChannelType:StreamType
Discharge:POH
ChannelType:POH
POH:StreamType
0.00
0.25
0.50
0.75
1.00
Relative Importance
Sex
F
M

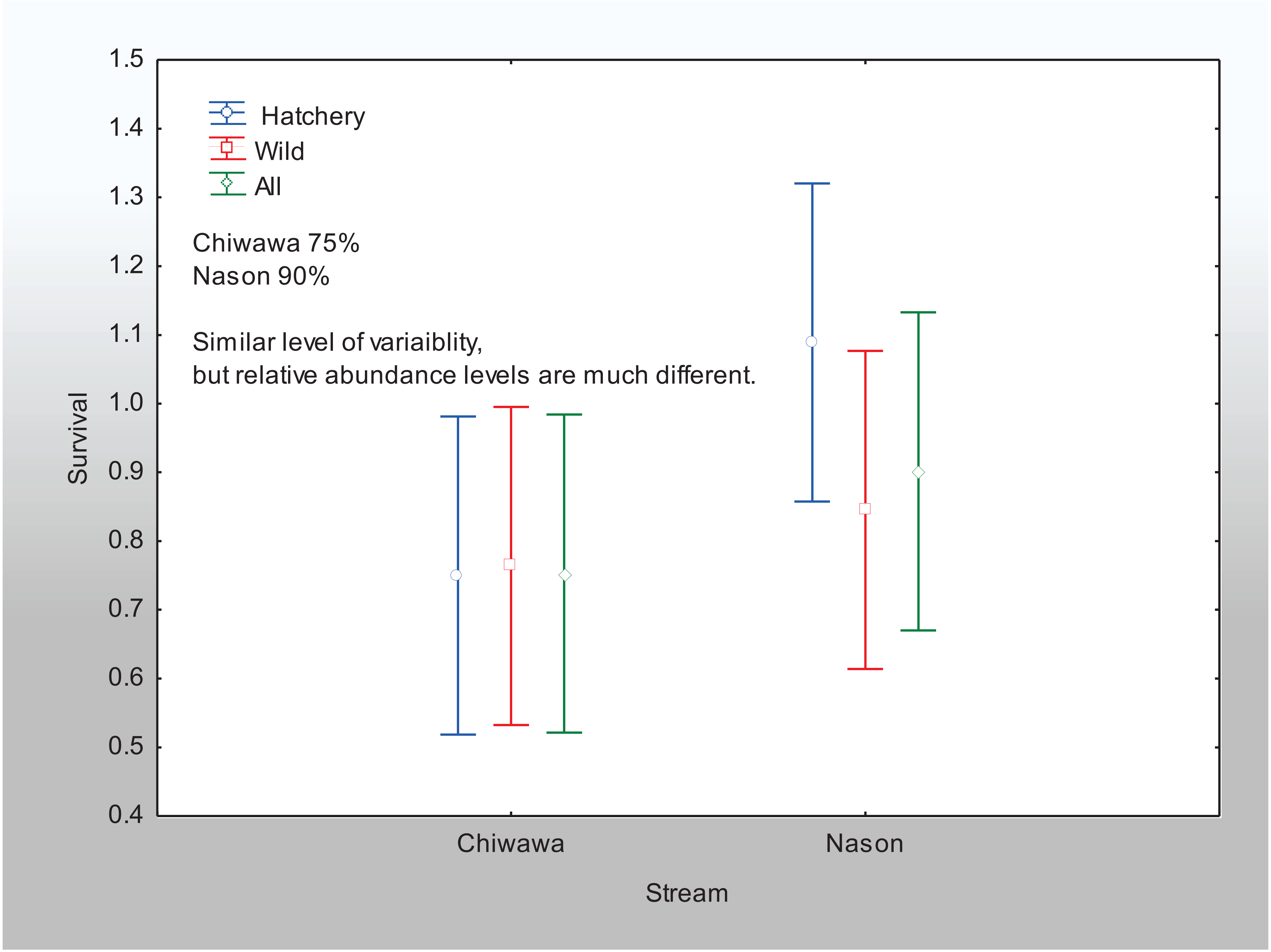

Carcass Recovery Probability
Glacial
Plane-bed
Glacial
Pool-riffle
Non-glacial
Plane-bed
Non-glacial
Pool-riffle
F
M
Prediction
0.0
0.2
0.4
0.6
-20100 1020
Centered POH
Discharge Deviance
-1.5
-1
-0.5
0
0.5
1
1.5

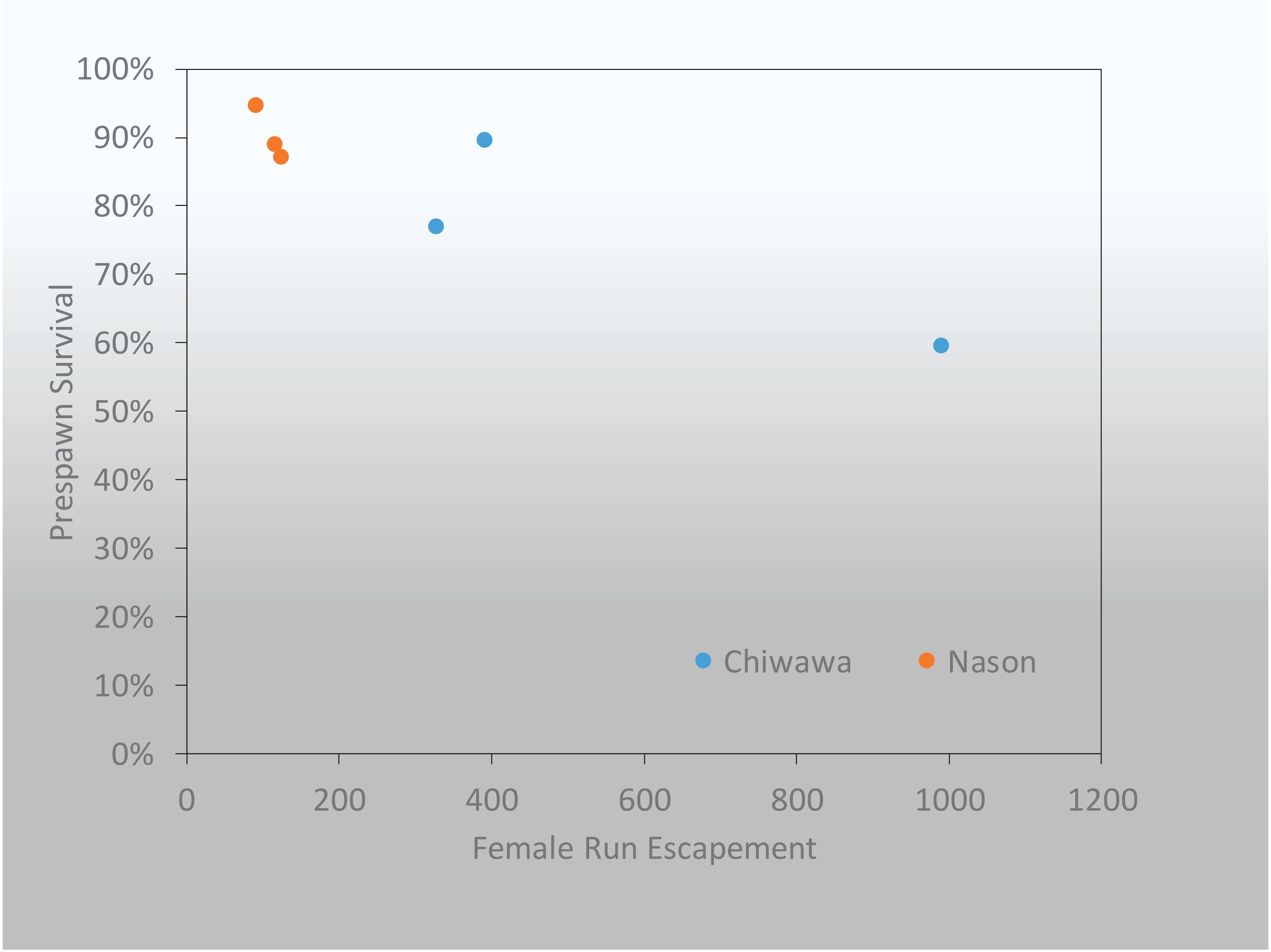


Probability of Carcass Recovery
y = -0.01 + 1.022x
R^2 = 0.631
y = -0.008 + 1.049x
R^2 = 0.214
Predicted
Observed
0.0
0.2
0.4
0.6
0.8
Fish
50
100
150
200
Sex
F
M

Carcass Recovery Bias

- Females over-represented (big time), large males over-represented compared to smaller males. Consistent with Murdoch et al 2010.
- Visibility, relative discharge, and channel type are all important factors
- Size more important for males than females
- Origin has no effect.
- Female predictions good
- Males predictions – work in progress
- PSM examples use females with most parsimonious model


1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
Survival
Hatchery
Wild
All
Chiwawa 75%
Nason 90%
Similar level of variaiblity,
but relative abundance levels are much different.
Chiwawa
Nason
Stream


Prespawn Survival
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
200
400
600
800
1000
1200
Female Run Escapement
Chiwawa
Nason

PSM Next Step

- Figure out males carcass recovery bias
- Go back in time as many years possible
- Extremely dependent on carcass data
  - Past and future
  - Never have too many carcasses. MORE IS BETTER!!!!
- Possibly develop new sample rate target for small v. large populations.

Costs

- Depends on species and desired level of precision
  - Steelhead $101k
  - Steelhead and Spring Chinook $234k
  - Steelhead, Spring and Summer Chinook $345k
  - All four plan species $380k
- WDFW cost shares ~$350k/year on O & M
- CCT cost shares ~$150k/year on O & M
- Stock assessment at Tumwater, Dryden and Wells no longer needed (except sockeye needs)
- Existing fall Chinook OLAFT work possible cost share

Questions?

Attachment C

What is Bacterial Kidney Disease?

Significance: Prevalent (often enzootic) disease that impacts the sustainable production of salmonid fish for consumption and species conservation efforts in coldwater areas (especially Pacific Northwest!)

Causative agent: ***Renibacterium salmoninarum***

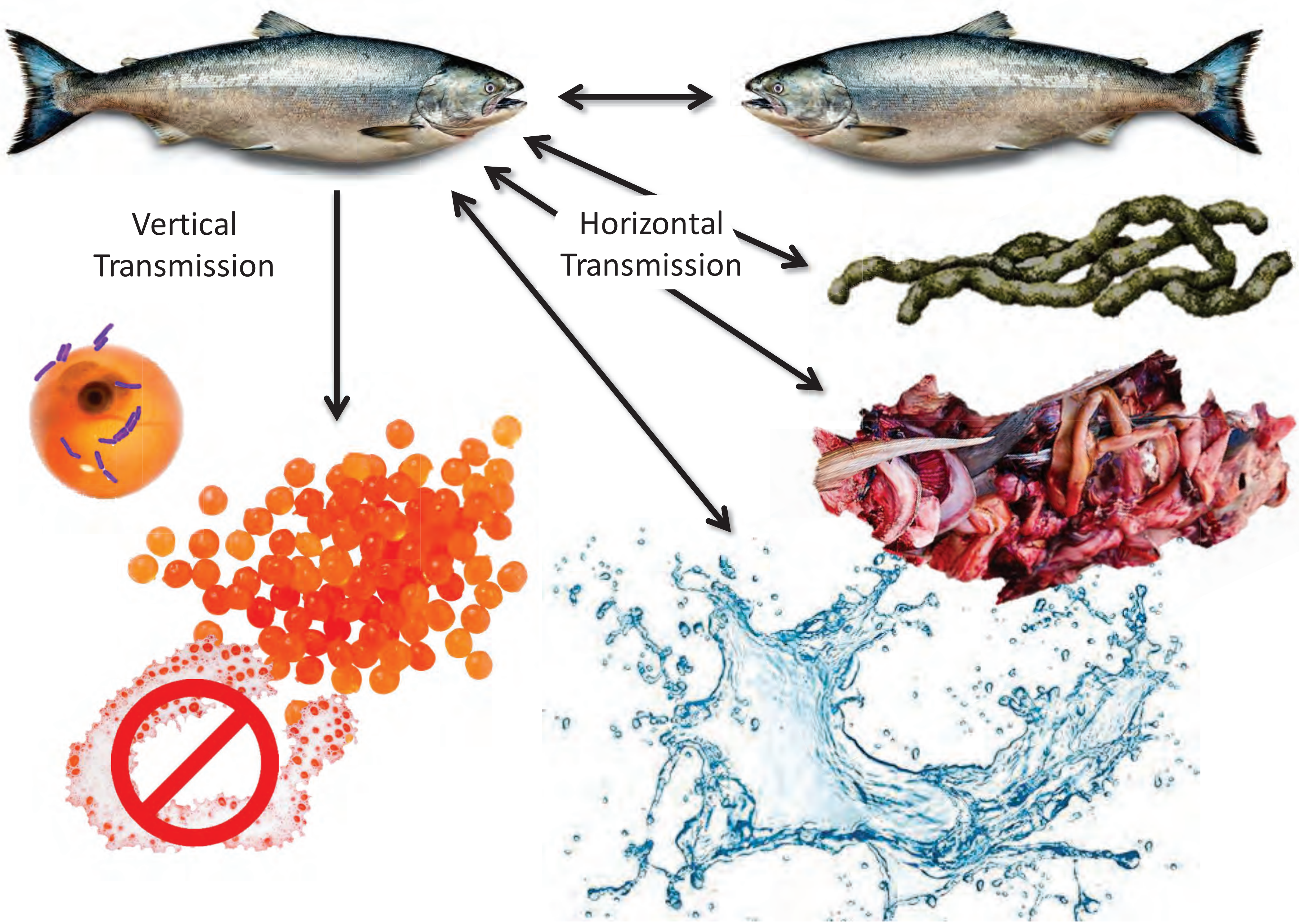
- Small, gram positive diplobacillus bacteria
  - Slow-growing and fastidious obligate pathogen of salmonids

Host:

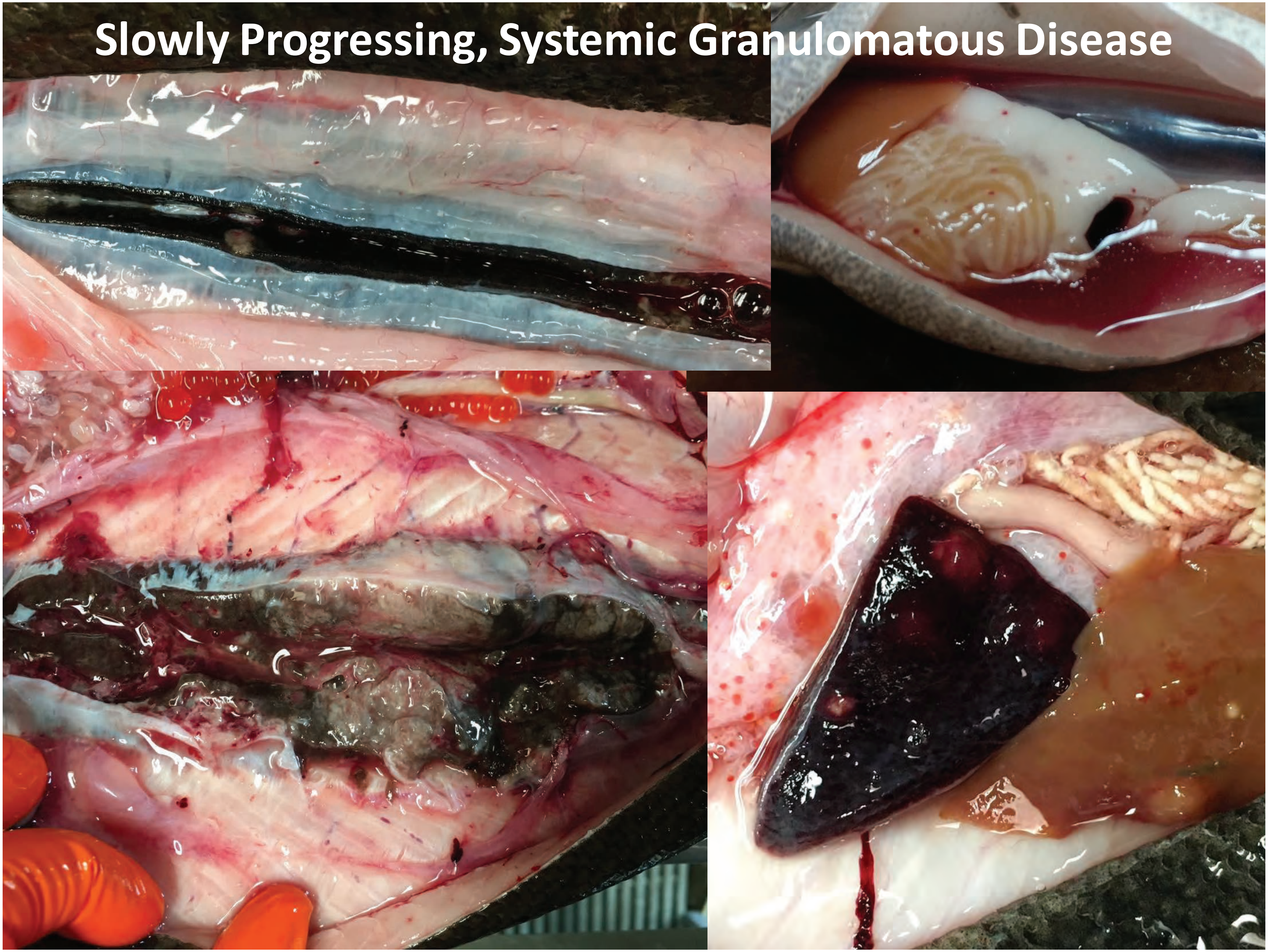
- Most often occurs in 6- to 12-month-old juveniles or pre-spawning adults
- Species susceptibility varies

<

Main Ways BKD is Spread



Attachment C



Challenges

Why is BKD such a pain?

- Dual modes of transmission → Risk mitigation on multiple fronts
  - Hatcheries are not closed systems
    - Free interactions with environment and feral populations
- Chronic, insidious clinical progression
  - Fish with no obvious external signs can be morbidly infected or exist as subclinical carriers
- Confirmatory diagnosis, even in the presence of gross lesions, is sometimes elusive
  - Immunodiagnostic or molecular assays required and often inconclusive/contradictory
- Treatment difficult
  - Intracellular (survives within macrophages outside of phagosome)
    - Evades immune system

Management Strategies

1.) Treatment

- Macrolide antibiotics, usually used prophylactically
  - Injection of adult salmon with Draxxin® (Tulathromycin) (off-label) or Erymicin 200 (erythromycin) (INAD #12-781) 1-3x prior to spawning (10-25 mg/kg), 21 days between injections
    - Control pre-spawning mortality and vertical transmission
    - Cons: Site reactions (↓fecundity), stress imposed from handling
  - Oral application (feed additive) of Aquamycin-100® (erythromycin thiocyanate) (INAD #6013), daily 100 mg/kg 21 to 28 days.
    - Cons: reported drug toxicity, poor palatability (variable intake)
- Controversial at best . . .
  - Inconsistent efficacy
  - More harm than good?
  - Antimicrobial resistance
    - Reduced Rsal macrolide susceptibility already documented (Rhodes et al., 2008)

Management Strategies

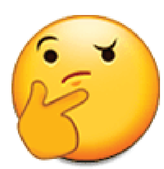
2.) Screening and detection

- Test female spawners for the presence of Rsal with a variety of laboratory tests including:
  - enzyme-linked immunosorbent assay (ELISA)
  - quantitative polymerase chain reaction (PCR, nPCR, qPCR)
  - Direct Fluorescent Antibody Test (DFAT)
- Culling of eggs originating from females determined to have moderate-to-high "infection" levels
- Segregated rearing of progeny based on test values

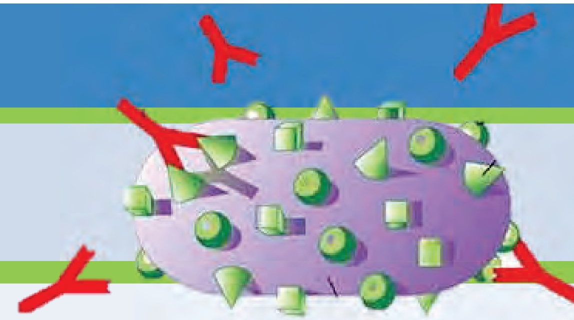
BUT! Things to remember:

- Methodologies, by design, employ different techniques and detect different things (re: macromolecules)
  - So – which one is better? Are they interchangable?
- Questions remain regarding the **accuracy** and **biological significance** of some Rsal detection methods

Let's compare . . .



ELISA



Target

Major soluble proteins (mainly p57 antigen) of Rsal

Method

Produces visible signal read by a spectrophotometer and results reported as optical density (OD) absorbance values *proportional* to Rsal antigens

Advantages

- 96-well format permits processing of large sample numbers
- Commercially available reagents facilitate inter-laboratory calibration (**theoretically**)
- Simple sample preparation
- Target antigens stable and abundant
- Relatively high diagnostic specificity (Jaramillo et al. 2017)

Disadvantages

- Antigen concentration does not increase linearly with bacterial load (Hamal 2002)
- Persistence of cellular products (i.e. antigen) of nonviable bacteria (Pascho et al. 1997)
- Validation and consistency concerns
  - discrepancies between labs and batches & poor quality control of antibodies/reagents used (Scott and Johnson, 2001)
  - Limited sensitivity at lower levels **compared to other molecular methods**
- Some cross-reactivity to other pathogens (Brown et al. 1995 and Elliot et al 2013) and fish IgM (Wood et al. 1995, Kim et al. 2007)
- Lethal sampling required to get to target tissues (kidney)

Attachment C

PCR

Target

Nucelic acid sequence in the genome (re: DNA) of Rsal (msa or abc transporter permease)

Method

Amplification of targeted DNA fragment

Advantages

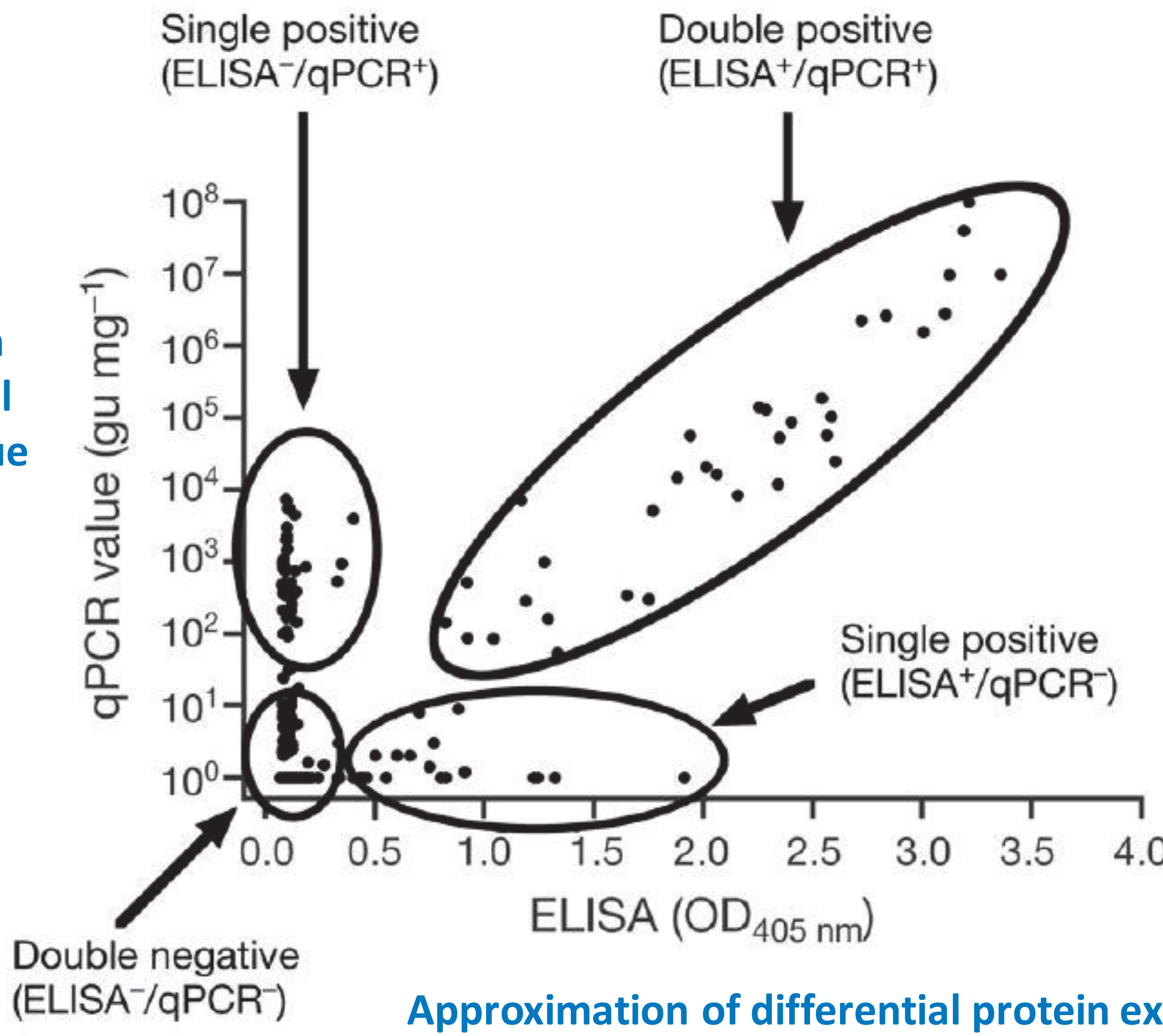
- Provides explicit evidence of current or past presence of bacteria
- Detection success in wide variety of sample types, including some non-lethal (mucus, uro-fecal, blood)
- High sensitivity, even at extremely low values
- Rapid method and easily validated between different testing facilities

Disadvantages

- Cost (~3x that of ELISA)
- Can detect non-viable bacteria (Josephson et al. 1993)
- Only certain variations supply a quantitative output of “infection intensity” (qPCR)
- False positives can be a problem with certain variations (nPCR) because the amplified product (an msa gene segment) poses a contamination risk in ongoing assays

Not Simply "Positive" or "Negative"

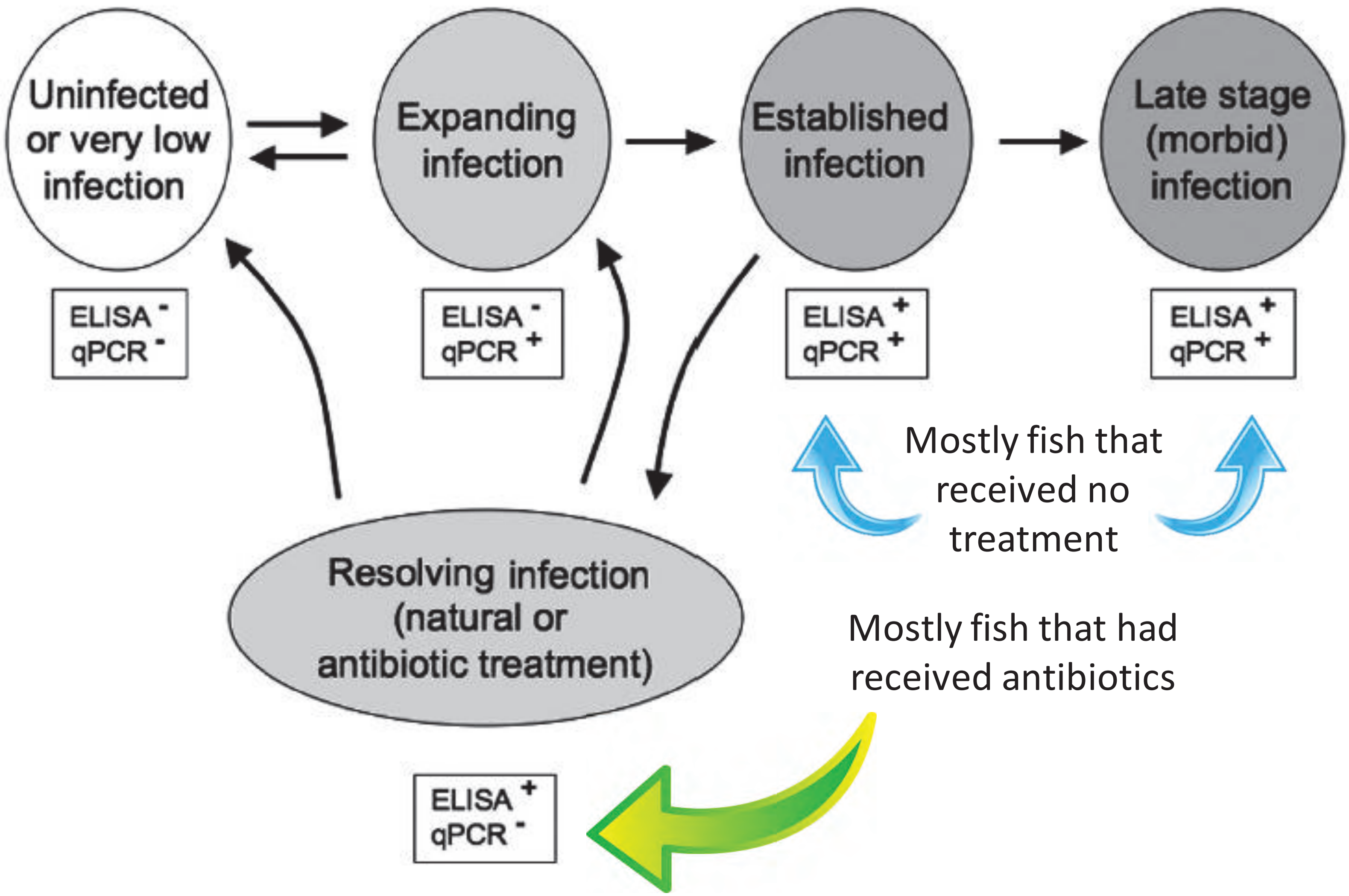
Estimation of bacterial load in tissue



Approximation of differential protein expression

Nance, Shelly & Riederer, Michael & Zubkowski, Tyler & Trudel, Marc & Rhodes, Linda. (2010). *Interpreting dual ELISA and qPCR data for bacterial kidney disease of salmonids*. Diseases of aquatic organisms. 91. 113-9. 10.3354/dao02252.

Not Simply "Positive" or "Negative"



Nance, Shelly & Riederer, Michael & Zubkowski, Tyler & Trudel, Marc & Rhodes, Linda. (2010). *Interpreting dual ELISA and qPCR data for bacterial kidney disease of salmonids*. Diseases of aquatic organisms. 91. 113-9. 10.3354/dao02252.

Not Simply "Positive" or "Negative"

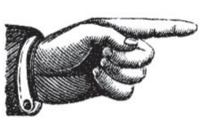
D. Jaramillo et al. *Aquaculture 476 (2017) 86–93*

Table 2
Cross-tabulated result combinations for the tests and populations included in this analysis. Default analysis with cut-off point of 2 for ELISA and without a cut-off point for PCR (Ct < 45). Only combinations with positive counts for at least one test were included in the table. The remaining 16 combinations that had zero counts are excluded for brevity.

		Tabulated results																Total
Tests	PCR1	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	
	PCR2	+	+	+	+	+	+	+	+	−	−	+	+	+	+	−	−	
	ELISA	+	+	+	+	−	−	−	−	−	−	+	−	−	−	−	−	
	Culture	+	+	−	−	+	+	−	−	+	−	−	+	−	−	−	−	
	IFAT	+	−	+	−	+	−	+	−	−	−	−	−	+	−	+	−	
Populations	I (a)	0	0	0	0	0	0	0	0	0	2	0	0	1	8	3	86	100
	II & III with severe lesions (b)	29	3	1	1	0	0	0	1	0	1	0	0	0	2	0	10	48
	II & III with mild lesions (c)	11	3	0	3	6	1	0	5	1	4	1	2	2	12	1	61	113
	II & III without lesions (d)	3	1	0	2	1	2	5	11	2	9	1	1	1	34	4	116	161
	II & III with any lesion (b + c)	40	6	1	4	6	1	0	6	1	5	1	2	2	14	1	71	193
	Total (a + b + c + d)	43	7	1	6	7	3	5	17	3	16	2	3	4	56	8	273	454

Mild lesions: fish with a lesion score in kidney or major organ of 1.
Severe lesions: fish with a lesion score in kidney or major organ of 2 or 3.

Moderately dichotomized tests results



BKD kidney lesions are not directly linked to positive Rsal bacterium results for a number of assays

Jaramillo, Diana, et al. "Bayesian latent class analysis of diagnostic sensitivity and specificity of tests for surveillance for bacterial kidney disease in Atlantic salmon Salmo salar." *Aquaculture* 476 (2017): 86-93.

Attachment C

Not Simply "Positive" or "Negative"

Journal of Fish Diseases 2013, 36, 779–809 *D G Elliott* et al. Renibacterium salmoninarum *diagnostic methods*

Table 11 *Renibacterium salmoninarum* infection or antigen levels determined by quantitative tests (culture and qPCR #1) and semi-quantitative tests (smear FAT and ELISA) in homogenized kidney tissue from juvenile Chinook salmon that had been injected intraperitoneally with 1.1×10^6 *R. salmoninarum* per fish 15 days before sampling

Assay	Number of positive fish of 149 (%)	Infection or antigen level category[a]	Number of fish in category (% of positive fish)
Culture	56 (38)	Log_{10} 2.00–2.99 CFU g^{-1}	23 (41)
		Log_{10} 3.00–3.99 CFU g^{-1}	17 (31)
		Log_{10} 4.00–4.99 CFU g^{-1}	16 (29)
Smear FAT	113 (76)	Log_{10} 0.00–0.99 cells 100 fields^{-1}	109 (96)
		Log_{10} 1.00–1.99 cells 100 fields^{-1}	3 (4)
qPCR #1	37 (25)	Log_{10} 2.00–2.99 cells g^{-1}	6 (16)
		Log_{10} 3.00–3.99 cells g^{-1}	16 (43)
		Log_{10} 4.00–4.99 cells g^{-1}	7 (19)
		Log_{10} 5.00–5.99 cells g^{-1}	5 (14)
		Log_{10} 6.00–6.99 cells g^{-1}	3 (8)
ELISA			
Cut-off OD 0.064[b]	148 (99)	Low (OD 0.064–0.199	82 (55)
		Moderate (OD 0.200–0.999)	63 (43)
		High (OD ≥ 1.000)	3 (2)
Cut-off OD 0.072	139 (93)	Low (OD 0.072–0.199	73 (53)
		Moderate (OD 0.200 – 0.999)	63 (45)
		High (OD ≥ 1.000)	3 (2)
Cut-off OD 0.095	111 (74)	Low (OD 0.095–0.199	45 (40)
		Moderate (OD 0.200–0.999)	63 (57)
		High (OD ≥ 1.000)	3 (3)
Cut-off OD 0.100	105 (70)	Low (OD 0.100–0.199	39 (37)
		Moderate (OD 0.200–0.999)	63 (60)
		High (OD ≥ 1.000)	3 (3)

[a]Values for infection or antigen level categories were: culture, colony forming units (CFU) g^{-1}; qPCR #1, *R. salmoninarum* cells g^{-1}; smear FAT, *R. salmoninarum* cells per 100 microscope fields (1000× magnification); ELISA, $OD_{405\ nm}$.
[b]For explanation of ELISA OD cut-off values, see Table 10.

Not Simply "Positive" or "Negative"

Journal of Fish Diseases 2013, 36, 779–809 *D G Elliott* et al. Renibacterium salmoninarum *diagnostic methods*

Table 12 Observed agreement (concordance) of positive and negative results between assays for detection of *Renibacterium salmoninarum* in homogenized kidney tissue from juvenile Chinook salmon that had been injected intraperitoneally with 1.1×10^6 *R. salmoninarum* per fish 15 days before sampling (149 fish) or left untreated (100 fish). The κ statistic is the ratio of the observed agreement beyond chance to the maximum possible agreement beyond chance

Assay comparison	Observed % agreement	κ value	Strength of agreement[a]
Culture and smear FAT	63	0.27	Fair
Culture and nPCR	79	0.33	Fair
Culture and qPCR #1	88	0.59	Moderate
Culture and ELISA (OD 0.064 cut-off)[b]	47	0.17	Slight
Culture and ELISA (OD 0.72 cut-off)	67	0.37	Fair
Culture and ELISA (OD 0.095 cut-off)	75	0.47	Moderate
Culture and ELISA (OD 0.100 cut-off)	78	0.51	Moderate
Smear FAT and nPCR	56	0.13	Slight
Smear FAT and qPCR #1	58	0.17	Slight
Smear FAT and ELISA (OD 0.064 cut-off)	69	0.38	Fair
Smear FAT and ELISA (OD 0.72 cut-off)	78	0.56	Moderate
Smear FAT and ELISA (OD 0.095 cut-off)	74	0.48	Moderate
Smear FAT and ELISA (OD 0.100 cut-off)	71	0.42	Moderate
nPCR and qPCR #1	84	0.37	Fair
nPCR and ELISA (OD 0.064 cut-off)	37	0.06	Slight
nPCR and ELISA (OD 0.72 cut-off)	51	0.10	Slight
nPCR and ELISA (OD 0.095 cut-off)	61	0.17	Slight
nPCR and ELISA (OD 0.100 cut-off)	61	0.17	Slight
qPCR #1 and ELISA (OD 0.064 cut-off)	39	0.11	Slight
qPCR #1 and ELISA (OD 0.72 cut-off)	59	0.24	Fair
qPCR #1 and ELISA (OD 0.095 cut-off)	69	0.35	Fair
qPCR #1 and ELISA (OD 0.100 cut-off)	72	0.38	Fair

[a]Strength of agreement (Smith 2006): κ 0 = no better than chance; κ 0.01–0.20 = slight; κ 0.21–0.40 = fair; κ 0.41–0.60 = moderate; κ 0.61–0.80 = substantial; κ 0.81–0.99 = almost perfect; κ 1.00 = perfect.

[b]For explanation of ELISA OD cut-off values, see Table 10.

Criteria for Suspicion and Confirmation of BKD

Field observations Characteristic gross pathology	**Histopathology** Presence of Gram positive bacteria observed by light microscopy	**Histopathology** Evidence of pathological lesions but no bacteria observed	**Immuno-diagnostics**		**Molecular Genetics** PCR	**Bacteriology** Agar culture plates	
			ELISA	IFAT			
						+	Confirmation
	+		+				Confirmation
		+	+		+		Confirmation
			+	+	+		Confirmation
+			+		+		Confirmation
		+	+	+			Confirmation
+							Suspicion
	+						Suspicion
		+					Suspicion
			+				Suspicion
			+		+		Suspicion
		+	+				Suspicion
			+	+			Suspicion

"Bacterial Kidney Disease (BKD) – Detection and control in Great Britain", Fisheries Research Services (Scotland)

Other recommendations:

World Organization for Animal Health (OIE, 2003)

Screen using ELISA or FAT, confirm with culture and PCR

American Fisheries Society-Fish Health Section Blue Book (AFS-FHS, 2012)

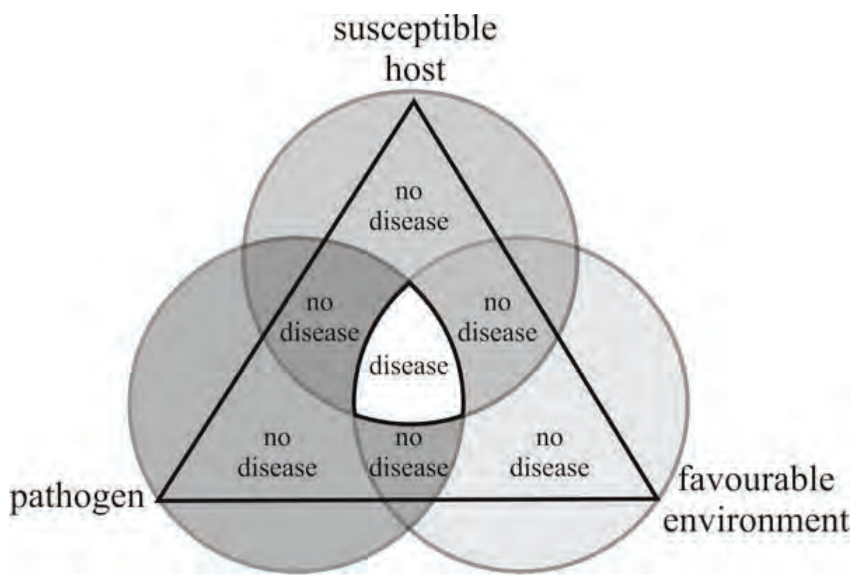
FAT, ELISA, culture, PCR (use two assays) for detecting subclinical infections or monitoring of moribund fish in seemingly healthy stocks

Food for Thought

- **No gold standard assay exhibiting error-free classification of results has been identified for detection of Rsal**
  a) Antigen-positive samples (re: ELISA OD values) not confirmed using another technique should be interpreted with CAUTION
- **Detection ≠ equal disease (or require active management)**
  a) General rule: confirmation of a potential pathogen's presence does not necessarily signify active infection status!
  b) Environmental and host response factors need to be considered for context
- **Relative importance of infections in various organs to the success of vertical transmission is still poorly understood** (Pascho 1998)
- Yes, there are reported successes with ELISA culling (Pascho 1991, Munson 2010)
  a) Many are field studies with little control or consideration for a number of variables like water source, predation, rearing vessels, other pathogens/stressors
  b) Many coincide with significant improvements in fish culture practices, better feed, reductions in programs, transition from yearling to zeros (subyearlings)

Where Do We Go From Here?

- ✓ Recognize inherent limitations of tests
  - View them as tools, not black and white absolutes
- ✓ Embrace the trinity of disease manifestation – pathogen, host, and environment
  - IT'S COMPLICATED – especially on a population scale
  - Do not dismiss the importance of stress mitigation and good fish culture practices
  - Program adjustments (densities, elimination of yearling programs) and/or other big changes might make a bigger difference than culling
  - Avoid bug fever - adjust tolerance thresholds for Rsal to reflect risk



Where Do We Go From Here?

- ✓ Be flexible with fish disease management strategies as our program needs change
  - Not all data is useful - "data loss aversion" syndrome
  - Inaction IS an action!
  - Utilize segregation to give borderline fish a chance
- ✓ Hedge our bets – use multiple assays/tissue analyses for broodstock surveillance
  - Combination of ELISA, PCR, and gross examinations should reduce the chance of acting on false positives and negatives

This Fall –

1. Review WADDL results and see how many reported positives we get
2. Since recent incidence of BKD-related mortalities is very low at Methow Hatchery, consider segregating positives first before culling
3. Keep track of positives and see how they fair compared to other groups
4. Remember – we are not bound to test for BKD by the Salmonid Disease Control policy, WA state guidelines, or other regulating entity! We have options . . .

https://www.nationalgeographic.com/photography/photo-of-the-day/2016/3/coho-salmon-fry/

FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: July 18, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the June 20, 2018 HCP Hatchery Committees Conference Call

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held via conference call on Wednesday, June 20, 2018, from 9:00 to 11:00 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Mike Tonseth will coordinate with Todd Seamons (Washington Department of Fish and Wildlife [WDFW]) to produce an outline or recommended approach for genetic monitoring (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Alternatives for Methow Basin Conservation Steelhead Programs" (Item I-A). *(Note: this item is ongoing.)*
- Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A). *(Note: this item is ongoing.)*
- Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A). *(Note: this item is ongoing.)*

- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Sarah Montgomery will schedule a longer Hatchery Committees meeting on July 18, 2018, with times in the agenda, and coordinate with the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC) facilitator (Item I-A). *(Note: This item is complete and Larissa Rohrbach distributed the revised agenda for this meeting on July 12, 2018.)*
- Betsy Bamberger will research the practicality of assessing bacterial kidney disease by culturing (Item I-A). *(Note: this item is ongoing.)*
- Tom Scribner will discuss internally the potential to release surplus Winthrop National Fish Hatchery (NFH) brood year (BY) 2018 wild-by-wild steelhead parr at Yakama Nation (YN) restoration sites in the Methow Basin in October (Item II-A).
- The Hatchery Committees representatives will nominate geneticists to participate on a panel that will help identify appropriate genetics monitoring and evaluation protocols for the upper Columbia River hatchery programs (Item III-A). *(Note: Bill Gale provided a nomination for the USFWS on July 6, 2018.)*
- Hatchery Committees representatives will review Todd Pearson's list of questions regarding genetics monitoring, which Sarah Montgomery distributed to the Hatchery Committees on June 19, 2018 (Item IV-A).
- Hatchery Committees representatives will review WDFW's 2018-2020 Brood-Year Adult Prophylactic Disease Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Hatchery Programs, which was distributed on June 20, 2018, and provide comments to Mike Tonseth (Item III-D).
- Hatchery Committees representatives will review Mike Tonseth's email regarding the Nason spring Chinook overage (distributed on June 20, 2018) and provide feedback to him by July 5, 2018 (Item IV-C).

Decision Summary

- There were no decision items approved during today's meeting.

Agreements

- The Wells Hatchery Committee agreed that Methow Hatchery has the capacity to rear the approximately 50,000 surplus Winthrop NFH BY 2018 wild-by-wild steelhead to 200 to 250 fish per pound for release in October 2018., and rearing these fish would not affect the Methow Hatchery spring Chinook production. (Item II-A).

Review Items

- Sarah Montgomery sent an email to the Rocky Reach and Rock Island Hatchery Committees on June 16, 2018, notifying them that the Draft 2017 Chelan PUD and Grant PUD Monitoring and Evaluation (M&E) Annual Report and its appendices are available for a 30-day review, with edits and comments due to Tracy Hillman by July 16, 2018.

Finalized Documents

- No items have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the May 16, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. Todd Pearsons added an additional item, genetic monitoring. Greg Mackey added an update on Columbia safety-net steelhead. Todd Pearsons also added an item for an overage in the Nason program.

The Hatchery Committees representatives reviewed the revised draft May 16, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft May 16, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on May 16, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on May 16, 2018)*:

- *Mike Tonseth will coordinate with Todd Seamons (Washington Department of Fish and Wildlife [WDFW]) to produce an outline or recommended approach for genetic monitoring (Item I-A).*
  Tonseth said this is still ongoing.
- *Mike Tonseth will coordinate with Todd Seamons regarding reviewing the memorandum, "Alternatives for Methow Basin Conservation Steelhead Programs" (Item I-A).*
  Tonseth said this is still ongoing.
- *Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A).*
  This item is ongoing.

- *Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A).*
  This item is ongoing.
- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).*
  This item is ongoing.
- *Charlene Hurst will send a Word version of the steelhead Biological Opinion (BiOp) to Greg Mackey and Matt Cooper (Item I-A).*
  This item is complete.
- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item III-B).*
  Mackey said Busack has been busy, but he will discuss this with him soon.
- *Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (BKD; Item III-C).*
  Greg Mackey said this item is ongoing.
- *Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A).*
  This item is ongoing.
- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).*
  This item is ongoing.
- *The Hatchery Committees will discuss genetic monitoring in June and July 2018 (Item I-A).*
  This item will be discussed today.
- *Sarah Montgomery will schedule a longer meeting on July 18, 2018, with times in the agenda, and coordinate with the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC-HSC) facilitator (Item I-A).*
  This item is ongoing.
- *Betsy Bamberger will research the practicality of assessing BKD by culturing (Item III-C).*
  Greg Mackey said this item is ongoing.
- *Permit applicants will send public comment distribution lists to Charlene Hurst (Item III-D).*
  This item is complete.

II. USFWS

A. Brood Year 2018 Winthrop National Fish Hatchery Steelhead Egg Overage (Matt Cooper)

Matt Cooper said the cooperative broodstock collection effort between U.S. Fish and Wildlife Service (USFWS), Douglas PUD, WDFW, YN, and volunteers was successful in collecting 61 wild steelhead pairs. With no prespawn mortality and higher fecundity than anticipated, Cooper said the Winthrop NFH steelhead program now has an overage in wild-by-wild progeny. He said the Joint Fisheries Parties (JFP) discussed options for the overage, which exceeds the Methow conservation program production target by 50,000 eggs. Cooper said holding the eggs at Winthrop NFH is not an option due to space. Other programs are also at or above capacity. Wells FH, for example, has similar space-water constraints, and it would be difficult to combine the progeny at Wells FH due to large developmental differences. Cooper said the JFP made a request to Douglas PUD to consider transferring the approximately 50,000 fry to Methow FH for short-term rearing until they are sufficient size (for marking) for a fall parr release.

Greg Mackey asked if the fish will reach a size at which they can be tagged or marked in October. Mike Tonseth said the fish could be reared to 200 to 250 fish per pound, so they could be ad-clipped or marked with a coded wire tag by October in preparation for a fall parr plant. Mackey asked if there are any other marking strategies for fish that size. Tonseth said due to the need for a marking strategy that allows for a selective fishery or identification in the field, ad-clipping and/or marking with a coded wire tag are the only suitable options.

Mackey asked what the approximate overage is. Michael Humling said it would be approximately 45,000 fish if the overage above 100% of the program target were to be transferred. He said fewer could be transferred if the 10% overage buffer allowed in permits was used. He said the preference is to release 100% of the program and to transfer the overage. He recommended against the release of 110% of the program.

Mackey said there are small circular tanks at Methow FH that were installed for the YN kelt program (now based out of Winthrop NFH). He asked if using those tanks for a few months to rear the excess steelhead would be acceptable to YN. Tom Scribner said yes. Scribner also asked if there are data showing that parr released in the fall survive better than fry. He asked if there is a logistically creative way to rear those excess fish until the spring, when they are larger and have a better chance of survival. He said the fall parr release strategy being discussed has the potential to result in very low survival. Humling said based on past work by WDFW, fry plants are not very successful and parr plants are slightly more successful, resulting in approximately half of the returning adults compared to a smolt release. Scribner suggested combining various facilities and rearing vessels to try to rear the surplus fish until spring.

Mackey brought up the concern of proportion of hatchery origin spawner (pHOS) management. He said some steelhead from the Winthrop NFH already need to be removed as adults by angling and catching at the outfall trap. He said releasing this surplus at the smolt stage would result in even more fish needing to be removed as adults to meet pHOS targets. Mackey suggested stocking the surplus fish as fry at a feeding stage in vacant habitat where M&E assessments show that there is not much spawning. Scribner suggested performing selective removal at Wells Dam when fish return as adults. Mackey said while stocking fry is a different strategy, putting these fish in good habitat where they might return to may have a better effect on the overall population because they would behave more like wild fish and contribute intergenerationally. Mackey said steelhead do not spawn in every spawning location in the Methow River every year, so there is good habitat available where stocking these steelhead as fry could be beneficial.

Tracy Hillman asked for input from Brett Farman from a permitting perspective. Farman said rearing the fish to a parr stage and releasing them is preferable to rearing the fish to a larger size based on the effects considered in the BiOp. He said this overage is above what was considered in the BiOp, so adjustments should be made in the future to avoid it. He said NMFS can respond to this plan with a letter of concurrence as long as additional impacts do not occur.

Bill Gale said the JFP's first choice was to rear the fish to a smolt size and move program releases around so that the approximately 45,000 fish overage would be taken from the Columbia safety-net release and placed into nonanadromous waters. He said that was not viable due to rearing space. The second choice is to release the fish as parr. Tracy Hillman asked if the parr could be released into YN restoration sites. He said this might provide an additional survival boost, especially in the winter. Tom Scribner said he will check internally about the potential for releasing parr in these sites. The release in some sites may interfere with ongoing monitoring work.

Mackey stated that the programs should be planned to address such overages in advance. He said for 2018, the overage can probably be reared at Methow FH, but other options would be egg planting or fry stocking. He suggested conducting a follow-up assessment to determine the survival of these progeny and said he will coordinate with Methow FH staff regarding space limitations. Farman said the typical plan for these fish would be to not exceed the target by more than 10%. In this case, additional flexibility is required, but fish in excess of 110% of the program target should not be reared to the spring and released. Tonseth pointed out that Hatchery Committees do not have oversight for this program, so the consideration is about using available capacity at Methow FH for short-term rearing until they can be released.

The Wells Hatchery Committee agreed that Methow Hatchery has the capacity to rear the approximately 50,000 surplus Winthrop NFH BY 2018 wild-by-wild steelhead to 200 to 250 fish per pound for release in October 2018 and rearing these fish would not affect the Methow Hatchery spring Chinook production, as follows: USFWS, YN, WDFW, Douglas PUD, and NMFS agreed on June 20, 2018, and the CCT provided an email vote the prior day.

III. Douglas PUD

A. Surplus Columbia River Safety-Net Program Steelhead (Greg Mackey)

Greg Mackey said there is an overage of approximately 15,000 hatchery-by-hatchery steelhead in the Columbia River safety-net program. He said Douglas PUD will work with WDFW to identify a local lake to put these fish in, consistent with what is described in the Broodstock Collection Protocols. Mackey said Douglas PUD is also working on pond modifications where these fish are currently held.

IV. Joint HCP-HC/PRCC HSC

A. Genetic Monitoring (Todd Pearsons)

Todd Pearsons shared the document, "Genetics Monitoring Associated with PUD Hatchery Programs," which Sarah Montgomery distributed to the Hatchery Committees on June 19, 2019 (Attachment B). Pearsons said the document is a draft list of questions for geneticists, addressing the best way or standard approaches for genetic monitoring. He asked that each representative nominate a geneticist from their respective organization (if possible) to participate on a panel about the appropriate genetics M&E strategies for the upper Columbia River PUD programs. Hatchery Committees representatives present said they would discuss this internally and review Pearsons' document. This will be further discussed during the July Hatchery Committees meeting.

B. Nason Creek Spring Chinook Salmon Overage (Todd Pearsons)

Todd Pearsons said he heard that there may be an overage of approximately 50,000 wild-by-wild fry in the Nason Creek spring Chinook salmon program. He said he would like more information on this from Mike Tonseth [who had to leave the meeting prior to this agenda item] and said the Broodstock Collection Protocols discuss how to handle overages such as this. Catherine Willard said the Broodstock Collection Protocols state that an overage of wild-by-wild Nason Creek spring Chinook salmon could be used to replace hatchery-by-hatchery fish in the Chiwawa conservation program.

C. NMFS Consultation Update (Brett Farman)

Brett Farman said the National Environmental Policy Act (NEPA) process for Methow steelhead and the unlisted programs (summer/fall Chinook salmon for Wells, Methow, Chelan Falls, Dryden, and

Priest Rapids) is nearly complete. He said the Environmental Assessment (EA) will be sent to applicants in August and then will be made available for public comment.

Greg Mackey said if Farman travels to the next meeting in person, the PUDs would be happy to give him a tour of facilities and rivers and opened the invitation to other interested parties.

D. Eastbank FH Disease Management (Tonseth)

Tonseth said he is also working on a disease management plan for Eastbank FH. He said he will send this plan out for review soon. He said WDFW's lead veterinarian is working on this approach. Todd Pearsons asked about how adult broodstock are prophylactically handled. He also asked what is the role of the Hatchery Committees and PRCC HSC in using best management practices to minimize disease in adult handling? Tonseth said WDFW's position is that the managers decide how to minimize disease and the committees do not have oversight. He said he will send the guidance to the committees, then continue the discussion over email and at future meetings. Pearsons said he is concerned that Tonseth's proposed prophylactic injection study may need a decision soon and if guidelines are not laid out in the Broodstock Collection Protocols for this specific instance, it will need to be discussed.

V. HCP Administration

A. HCP-HC Support: Larissa Rohrbach (Hillman)

Tracy Hillman welcomed Larissa Rohrbach (Anchor QEA) to the meeting and said she will be taking over the Hatchery Committees support role. Sarah Montgomery said the plan is for Rohrbach to shadow her in June, July, and August 2018. Rohrbach will then be on leave from September to December and will take over the role full time in January 2019.

B. Next Meetings

The next Hatchery Committees meetings are on July 18, 2018 (Grant PUD), August 15, 2018 (Grant PUD), and September 19, 2018 (Grant PUD).

VI. List of Attachments

Attachment A List of Attendees
Attachment B Genetics Monitoring Associated with PUD Hatchery Programs

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Alf Haukenes†	Washington Department of Fish and Wildlife
Charlie Snow†	Washington Department of Fish and Wildlife
McLain Johnson	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Bill Gale*	U.S. Fish and Wildlife Service
Michael Humling	U.S. Fish and Wildlife Service
Chris Pasley	U.S. Fish and Wildlife Service
Brett Farman*	National Marine Fisheries Service
Tom Scribner*	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Genetics Monitoring Associated with PUD Hatchery Programs

Geneticists from different organizations often have different interpretations about genetic data and how genetic monitoring should occur. We recommend that geneticists from different organizations on the HC and HSC committees come to agreement on the most appropriate way to conduct long-term genetic monitoring so that results can be used to inform hatchery management action. Below are questions that can be posed to a team of geneticists to help inform the PUD genetic M&E plan. The desire is to have a consensus opinion to each of the questions by the genetic experts.

Questions for geneticists

1) Are the long-term M&E Objectives and questions (see below) in the PUD M&E plan appropriate to evaluate the effects of hatchery programs on the genetics of natural origin fish? If not, how should they be changed?

2) What are the best standardized practices (e.g., standard of care) for long-term genetics monitoring (e.g., phenotype measurements such as age at maturity, genetic indices such as PNI, stray rate, population size, genotype measurements using tissues, combination of methods)? Are genetic analyses of tissues necessary for long-term genetic monitoring or are other approaches sufficient (e.g., monitoring indices that are common requirements of ESA permits)?

3) If genetic analyses of tissues is necessary, please address the following questions:

(a) Are there standardized approaches for using genotypes to monitor the effects of hatchery programs on natural origin populations (e.g., estimates of genetic distance), and if so, can you provide examples of those approaches providing the impetus for changed management actions?

(b) What level of effect is genetically significant and can that level be sufficiently detected using genetic methods?

(c) Is a fixed interval for genetic processing analysis (e.g., 10 years) better than an interval based upon population characteristics such as population size (e.g., population sizes of <100 every 5 years, 100-500 every 10 years, and >500 every 20 years)? What is the most appropriate sampling interval?

(d) What samples should be collected and processed to determine hatchery effects on natural origin genotypes (e.g., collect and process samples every 10 years, collect samples annually and analyze annual samples representationally over a specified period)?

From Hillman et al. 2017 M&E update.

1.1 Population Genetics

<u>Objective 7</u>: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program.

The genetic component of the M&E Plan specifically addresses the potential for changes in genetic diversity in natural populations as a result of a hatchery program(s). The long-term fitness of populations is assumed to be related to maintaining the genetic diversity of natural populations. However, hatchery programs select a subset of individuals from the population to pass on genetic material to the next generation. This is often a relatively small number of individuals that produce a large number of offspring, and can result in changes in allele frequencies and reductions of effective population size. Therefore, it is important to monitor the genetic status of the natural populations to determine if there are signs of changes in genetic distance among populations, changes in allele frequencies, and to estimate effective population size. Assessing the genetic effects of the hatchery program does not require annual sampling, but does require regular sampling at generational scales. Meeting stray-rate targets (hypotheses tested under Objective 5) should reduce significant changes in population genetics. Stray rates may inform population genetic analyses. Testing statistical hypotheses associated with genetic components (Hypotheses 3.1, 3.2, and 3.3) should be conducted every ten years or two generations.

Allele Frequency

Monitoring Questions:

Q7.1.1: Is the allele frequency of hatchery fish similar to the allele frequency of naturally produced and donor (broodstock) fish?

Target Species/Populations:

- Q7.1.1 applies to all conservation stocks.

Statiscial Hypotheses 7.1.1:

- $Ho_{7.1.1.1}$: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop.}}$
- $Ha_{7.1.1.1}$: Allele frequency $_{\text{Hatchery}}$ ≠ Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop.}}$ or
- $Ha_{7.1.1.1}$: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ ≠ Allele frequency $_{\text{Donor pop.}}$ or
- $Ha_{7.1.1.1}$: Allele frequency $_{\text{Hatchery}}$ ≠ Allele frequency $_{\text{Naturally produced}}$ ≠ Allele frequency $_{\text{Donor pop.}}$

Measured Variables:

- SNP genotypes

Derived Variables:

- Allele frequency

Spatial/Temporal Scale:

- Analyze as a time series, initially comparing pre- and post-hatchery samples and thereafter every 10 years.
- Compare samples within drainages.

Possible Statistical Analysis:

- Population differentiation tests, analysis of molecular variance (AMOVA), and relative genetic distances.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Genetic Distance Between Populations

Monitoring Questions:

Q7.2.1: Does the genetic distance among subpopulations within a supplemented population remain the same over time?

Target Species/Populations:

- Q7.2.1 applies to all conservation and safety-net stocks.

Statistical Hypothesis 7.2.1:

- $Ho_{7.2.1.1}$: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Measured Variables:

- SNP genotypes

Derived Variables:

- Allele frequencies

Spatial/Temporal Scale:

- Analyze as a time series, initially comparing pre- and post-hatchery samples and thereafter every 10 years.
- Compare samples among spawning aggregates.

Possible Statistical Analysis:

- Population differentiation tests, AMOVA, and relative genetic distances.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Effective Spawning Population

Monitoring Questions:

Q7.3.1: Is the ratio of effective population size (N_e) to spawning population size (N) constant over time?

Target Species/Populations:

- Q7.3.1 applies to all supplemented stocks.

Statistical Hypothesis 3.3:

- $Ho_{7.3.1.1}$: $(N_e/N)_{t0} = (N_e/N)_{t1}$ for each population

Measured Variables:

- SNP genotypes

Derived Variables:

- Allele frequencies

Spatial/Temporal Scale:

- Analyze as a time series, initially comparing pre- and post-hatchery samples and thereafter every 10 years.

Possible Statistical Analysis:

- Population differentiation tests, relative genetic distances, statistics to calculate effective population size (e.g., harmonic means).

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

1.2 Phenotypic Traits

Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological, and behavioral components.[1] Maintaining the long-term fitness of supplemented populations requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location, and stray rates) is addressed under Objective 5. Objective 8 assess the potential effects of domestication, including size at maturity, age at maturity, sex ratio, and fecundity. Age and size at maturity shall be assessed for both fish arriving in the Columbia system, and those recovered on the spawning grounds. Size (or age) selective mortality during migration through the Columbia system, such as through fisheries, could alter the age and size of fish on the spawning grounds.

[1] These metrics are difficult to measure, and phenotypic expression of these traits may be all we can measure and evaluate.

Age at Maturity

Monitoring Questions:

Q8.1.1: Is the age at maturity of hatchery and natural-origin fish similar at the time they enter the Columbia River and when they spawn?

Target Species/Populations:

- Q8.1.1 applies to all conservation program stocks.

Statistical Hypotheses 8.1.1:

- $Ho_{8.1.1.1}$: Age at Maturity $_{\text{Hatchery produced spawners Gender X}}$ = Age at Maturity $_{\text{Naturally produced spawners Gender X}}$
- $Ho_{8.1.1.2}$: Age at Maturity $_{\text{All hatchery produced adults Gender X}}$ = Age at Maturity $_{\text{All naturally produced adults Gender X}}$

Measured Variables:

- Total and salt (ocean) age of hatchery and natural-origin salmon carcasses collected on spawning grounds.
- Total and salt age of broodstock.
- Total and salt age of fish at stock assessment locations (e.g., Dryden, Tumwater, Wells, Priest Rapids).
- Whenever possible, age at maturity will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling).
- Assess age of fish, including harvested fish.

Derived Variables:

- Total age and saltwater age
- Age of fish entering the Columbia River.

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and Yates' Chi-square.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Size at Maturity

Monitoring Questions:

Q8.2.1: Is the size (length) at maturity of a given age and sex of hatchery fish similar to the size at maturity of a given age and sex of natural-origin fish?

Target Species/Populations:

- Q8.2.1 applies to all conservation and safety-net stocks.

Statistical Hypothesis 8.2.1:

- $Ho_{8.2.1.1}$: Size (length) at Maturity $_{\text{Hatchery Age X and Gender Y}}$ = Size (length) at Maturity $_{\text{Naturally produced Age X and Gender Y}}$
- $Ho_{8.2.1.2}$: Size (length) at Maturity $_{\text{All hatchery adults Gender X}}$ = Size (length) at Maturity $_{\text{All naturally produced adults Gender X}}$

Measured Variables:

- Size (length), age, and gender of hatchery and natural-origin salmon carcasses collected on spawning grounds.
- Size (length), age, and gender of broodstock.
- Size (length), age, and gender of fish at stock assessment locations (e.g., Priest Rapids, Dryden, Tumwater, Wells, Twisp Weir).
- Whenever possible, size at maturity will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling).

Derived Variables:

- Total age and saltwater age

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and three-way ANOVA by origin, gender, and age

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Fecundity at Size[2]

Monitoring Questions:

Q8.3.1: Is the fecundity vs. size relationship of hatchery and natural-origin fish similar?

[2] May not apply to all programs.

Q8.3.2: Is the gonadal mass vs. size relationship of hatchery and natural-origin fish similar?

Target Species/Populations:

- Both Q8.3.1 and Q8.3.2 apply to all conservation stocks using both natural- and hatchery-origin broodstock.

Statistical Hypothesis 8.3.1:

- $Ho_{8.3.1.1}$: Slope of Fecundity vs. Size $_{\text{Hatchery}}$ = Slope of Fecundity vs. Size $_{\text{Naturally produced}}$

Statistical Hypothesis 8.3.2:

- $Ho_{8.3.2.1}$: Gonadal Mass vs. Size $_{\text{Hatchery}}$ = Gonadal Mass vs. Size $_{\text{Naturally produced}}$

Measured Variables:

- Length, weight, and age (covariate) of hatchery and natural-origin broodstock after eggs have been removed.
- Number and weight of eggs

Derived Variables:

- Total age and saltwater age.
- Mean weight per egg.

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis, regression, t-test, and ANCOVA.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

Sex Ratio

Monitoring Questions:

Q8.4.1: Is the sex ratio of hatchery and natural-origin fish similar?

Target Species/Populations:

- Q8.4.1 applies to all conservation stocks.

Statistical Hypothesis 8.4.1:

- $Ho_{8.4.1.1}$: Sex Ratio $_{\text{Hatchery}}$ = Sex Ratio $_{\text{Naturally produced}}$

Measured Variables:

- Age and sex of hatchery and natural-origin salmon carcasses collected on spawning grounds or sampled at dams or weirs.
- Whenever possible sex ratio will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling or ultrasound on live fish).

Derived Variables:

- Ratio of sexes based on brood year returns

Spatial/Temporal Scale:

- Calculate annually based on brood year.
- Time series.

Possible Statistical Analysis:

- Use graphic analysis and Yates'Chi-square.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: August 16, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery and Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the July 18, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held in Wenatchee, Washington, on Wednesday, July 18, 2018, from 9:00 a.m. to 4:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A). *(Note: this item is ongoing.)*
- Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Tom Scribner will discuss internally the potential to release surplus Winthrop National Fish Hatchery (NFH) brood year 2018 wild-by-wild steelhead parr at Yakama Nation (YN) restoration sites in the Methow Basin in October (Item I-A). *(Note: this item is ongoing.)*

- Hatchery Committees representatives will review and edit Todd Pearson's list of questions regarding genetics monitoring, which Sarah Montgomery distributed to the Hatchery Committees on June 19, 2018, and provide revisions to Tracy Hillman (Item II-E).
- Brett Farman will nominate a National Oceanic and Atmospheric Administration (NOAA) geneticist to participate on a panel that will help identify appropriate genetics monitoring and evaluation protocols for the upper Columbia River hatchery programs (Item II-E). (*Note: Farman has nominated Morgan Robinson and provided contact information in an email to the HCP-HC on 8/7/2018)*.
- Keely Murdoch will send contact information for the Columbia River Inter-Tribal Fish Commission (CRITFC) geneticists she nominated for inclusion in the Genetic Monitoring panel to Larissa Rohrbach and Sarah Montgomery (Item II-E). (*Note: Keely Murdoch confirmed contact information for CRITFC gentecists Dr. Shawn Narum and Dr. Ilana Koch in an email to Larissa Rohrbach on 8/7/2018*)
- Larissa Rohrbach and Sarah Montgomery will make an HCP Hatchery Committees distribution list for the geneticist panel (Item II-E). (*Note: Action Item to be completed at the close of the 8/15/2018 meeting pending additional nominations or approval of existing nominees from DPUD and CCT*)
- Tracy Hillman will provide an email update to the geneticist panel based on discussions during the July 18, 2018 Hatchery Committees meeting (Item II-E).
- Hatchery Committees representatives present will review the Priest Rapids Dam (PRD) OLAFT Sampling Expansion Project document, which Larissa Rohrbach distributed to the Hatchery Committees on July 10, 2018, and provide questions and comments to Mike Tonseth and Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]; Item II-I). (*Note: feedback was provided via email to the HCP-HC by USFWS [8/10/2018] and GPUD [8/9/2018*]).
- Greg Mackey will revise the Draft 2018 Methow Basin Spring Chinook Adult Management Plan and provide it to the Hatchery Committees (Item IV-C).
- Greg Mackey will coordinate with Charles Frady (WDFW), Charlie Snow (WDFW), Michael Humling (U.S. Fish and Wildlife Service [USFWS]), and the WDFW Methow Field Office to provide weekly updates on adult management of spring Chinook salmon in the Methow Basin to the Hatchery Committees (Item IV-C).
- Tracy Hillman will request the CCT vote on the Wells Hatchery Committees item regarding collecting 110% of the brood year 2018 brood stock collection target for Wells summer Chinook salmon (Item IV-E). *(Note: Hillman obtained a positive vote from Truscott on July 24, 2018, as described in the Agreements section below.)*
- Betsy Bamberger (Douglas PUD) will research past occurrences of *Saprolegnia* spp. at Wells Fish Hatchery (FH) (Item IV-F).

Decision Summary

- The Wells Hatchery Committee approved Douglas PUD's pilot study, Control of *Saprolegnia* spp. Growth on Spring Chinook (*Oncorhynchus tshawytscha*) Eggs, provided fish are in excess to other needs previously identified, as follows: Douglas PUD, WDFW, USFWS, NOAA, and YN approved on July 18, 2018, and CCT approved via email on July 17, 2018 (Item IV-F).

Agreements

- The PRCC HSC representatives present (and CCT via email) agreed to retain the overage in the brood year 2017 wild-by-wild component of the Nason Creek spring Chinook salmon conservation program, and reduce the brood year 2017 hatchery-by-hatchery component of the Nason Creek safety-net program by an equivalent amount with the excess hatchery-by-hatchery fish to be released in non-anadromous waters and the total Nason Creek program release not to exceed 110% of its target (Item II-G).
- The Wells Hatchery Committee representatives present agreed that Douglas PUD can collect 110% of the brood year 2018 summer Chinook salmon target identified for the Wells yearling summer Chinook program in the 2018 Broodstock Collection Protocols, to ensure enough fish are available for the survival study planned for 2020 (Item IV-B). (*Note: Kirk Truscott also provided approval from the CCT via email on July 24, 2018*.)

Review Items

- Larissa Rohrbach sent an email to the Rocky Reach and Rock Island Hatchery Committees on July 19, 2018, notifying them that the Draft 2019 Chelan PUD Hatchery Monitoring and Evaluation Implementation Plan is available for a 30-day review, with edits and comments due to Catherine Willard by August 17, 2018 (Item III-A).

Finalized Documents

- No items have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the June 20, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. Mike Tonseth added an item for Nason/Chiwawa spring Chinook salmon Broodstock Collection Update. Greg Mackey added an item for Chewuch Canal Company Water Rights issue.

The Hatchery Committees representatives reviewed the revised draft June 20, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft June 20, 2018 meeting minutes as revised. Tonseth noted that he only approves the portion of the minutes taken while he was present at the meeting.

Action items from the Hatchery Committees meeting on June 20, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on June 20, 2018)*:

- *Mike Tonseth will coordinate with Todd Seamons (Washington Department of Fish and Wildlife [WDFW]) to produce an outline or recommended approach for genetic monitoring (Item I-A).* Tonseth said Seamons will participate on the panel for genetic monitoring, so this item is complete.
- *Mike Tonseth will coordinate with Todd Seamons (WDFW) regarding reviewing the memorandum, "Alternatives for Methow Basin Conservation Steelhead Programs" (Item I-A).* Tonseth said this item is complete.
- *Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A).*
  Tracy Hillman said this item is ongoing.
- *Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A).*
  Hillman said this item is ongoing. He noted that the Wells Program has gone through several changes over time and therefore some of the historical information may not be needed. Mackey agreed.
- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's* Review of Spring Chinook Salmon in the Upper Columbia River *under Hatchery Committees' purview (Item I-A).*
  Hillman said this item is ongoing. He said he has been working on developing generalized linear models for doing multiple before-after-control-impact (BACI) design analyses and has successfully replicated analyses conducted by others. He said he will next work on the statistical component of the Monitoring and Evaluation (M&E) Plan.
- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Mackey said this item is ongoing and suggested it be discussed during the August 15, 2018 Hatchery Committees meeting.

- *Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (Item I-A).*
  Bamberger said she spoke with the aquatic lab manager at WADDL. The lab reported that they will not be able to receive samples until September 1 due to setting up new equipment and accommodating federal protocols. The lab has not yet decided whether optical density values can be released with caveats as to their interpretation. She said for spring Chinook salmon, managers will not be able to use a similar enzyme-linked immunosorbent assay (ELISA) results test that has been previously used to make culling decisions. Bamberger said she will continue to provide updates on coordination with WADDL. Mike Tonseth asked if the lab processes fresh or frozen samples. Bamberger said it depends on the test; for example, ELISA tests are typically performed on fresh samples and polymerase chain reaction (PCR) tests can be performed on frozen or fresh samples.
- *Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A).*
  Murdoch said this item is ongoing.
- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).*
  Murdoch said this item is ongoing.
- *Sarah Montgomery will schedule a longer Hatchery Committees meeting on July 18, 2018, with times in the agenda, and coordinate with the Priest Rapids Coordinating Committee Hatchery Sub-Committee (PRCC HSC) facilitator (Item I-A).*
  Montgomery said this item is complete.
- *Betsy Bamberger will research the practicality of assessing bacterial kidney disease by culturing (Item I-A).*
  Bamberger said it depends on the lab. It takes 2 to 19 weeks to culture *Renibacterium* spp., and there is a lot of concern regarding contamination for this assessment method. She said it is not an appropriate screening assay and is generally used as a confirmation assay. Megan Finley (WDFW) asked if WADDL performs a secondary test for *Renibacterium*. Bamberger confirmed they do. Bamberger added that staff at WADDL communicated to her that it takes special equipment and training to culture *Renibacterium* spp.
- *Tom Scribner will discuss internally the potential to release surplus Winthrop National Fish Hatchery (NFH) brood year (BY) 2018 wild-by-wild steelhead parr at Yakama Nation (YN) restoration sites in the Methow Basin in October (Item II-A).*
  Keely Murdoch said this item is ongoing and she will be meeting with hatchery staff to discuss this. She said she will provide a draft release plan for these surplus fish to the Hatchery Committees to review.

- *The Hatchery Committees representatives will nominate geneticists to participate on a panel that will help identify appropriate genetics monitoring and evaluation protocols for the upper Columbia River hatchery programs (Item III-A).*
  Tracy Hillman said Bill Gale nominated a geneticist and this item is ongoing for other representatives and will be discussed today.
- *Hatchery Committees representatives will review Todd Pearson's list of questions regarding genetics monitoring, which Sarah Montgomery distributed to the Hatchery Committees on June 19, 2018 (Item IV-A).*
  This item will be discussed today.
- *Hatchery Committees representatives will review WDFW's 2018-2020 Brood-Year Adult Prophylactic Disease Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Hatchery Programs, which was distributed on June 20, 2018, and provide comments to Mike Tonseth (Item III-D).*
  This item will be discussed today.
- *Hatchery Committees representatives will review Mike Tonseth's email regarding the Nason spring Chinook overage (distributed on June 20, 2018) and provide feedback to him by July 5, 2018 (Item IV-C).*
  This item will be discussed today.

II. Joint HCP-HC/PRCC HSC

A. Factors Influencing Steelhead Residualism (Chris Tatara/Matt Cooper)

Matt Cooper introduced Chris Tatara (NOAA Fisheries Northwest Fisheries Science Center [NWFSC]). Tatara gave a presentation entitled, "*Factors affecting residualism in hatchery steelhead trout*" coauthored by scientists from NOAA Fisheries, USFWS, and the University of Washington. Larissa Rohrbach sent the presentation (Attachment B) to the Hatchery Committees following the meeting on July 19, 2018.

<u>Background – Slides (2 – 9)</u>

Tatara described the natural steelhead (*Oncorhynchus mykiss*) life history cycle and the problem of residualism. He said it is the preference of hatchery managers to produce only anadromous fish. Hatcheries occasionally produce parr and mature males, which collectively become residuals that remain in freshwater streams.

Problems with producing residual hatchery steelhead include the following:

- Decreased efficiency of hatchery production, increased cost

- Producing residuals could lead to domestication selection
- Competition, predation with natural populations
- Complicates genetic management (e.g., accuracy of proportion of hatchery origin spawner (pHOS) estimates; mature males are difficult to observe spawning and do not need to survive long to spawn)

Tatara described a management experiment published in the *North American Journal of Fisheries Management* in which mortality and residualism were confounded (Tatara et al. 2017)[1].

Additional Data Analysis and Results (Slides 9-25)

Additional data were analyzed (21,598 fish total) to inform management. Residualism was characterized using the following:

- Passive integrated transponder (PIT) tags and tracking fish using PTAGIS records
- Residuals collected near Winthrop NFH; lethally sampled and identified by coded wire tags
- Putative residuals were tracked 1 year later (by PIT tag detections)

Tatara said non-lethal sampling was carried out at the end of March prior to release from the hatchery. Metrics included size, sex, and qualitative phenotype (parr, transitional, smolt, mature male). Differences between S1 and S2[2] rearing types were compared. Many more parr were observed among S1 and many more mature males among S2. Results indicated that residual phenotypes could occur among both groups.

Tatara said fish were tracked post-release using mark-recapture methods (PIT tags, coded wire tags, lethal collection in Spring Creek). Any fish detected in the Columbia River was considered a migrant. Anything not detected was categorized as a potential residual. Of all parr identified in pre-release sampling, 95% were never detected as migrants. Of fish identified as transitional, a greater proportion became known migrants (35 to 36%). Of fish identified as smolts, 60% were migrants. Mature males were rarely detected migrating from the Methow River. Size of transitionals and smolts was similar; size was not a significant factor. Most mature males were from the S2 program. It was determined that mature males were likely to be residuals.

Todd Pearsons asked whether fish are observed moving downriver and back upriver. Tatara responded no; this differs from precocious male Chinook salmon that have been observed moving

[1] Tatara, C.P., M.R. Cooper, W. Gale, B.M. Kennedy, C.R. Pasley, and B.A. Berejikian, 2017. "Age and method of release affect migratory performance of hatchery steelhead." *North American Journal of Fisheries Management* 37(4):700-713, DOI: 10.1080/02755947.2017.1317676

[2] S1 describes steelhead released from the hatchery at smolt age-1, S2 are released at smolt age-2

down and back up through Columbia River dams. He said steelhead seem to residualize and stay in natal streams.

A logistic regression determined that size was a significant factor determining whether parr residualize. To enumerate putative residuals, the number of parr measuring less than146 mm and mature males were summed. Age was a significant factor (S1 versus S2) determining residualization.

To collect direct evidence of residuals, electrofishing and angling surveys were conducted in August and September in Spring Creek (near Winthrop NFH) after the smolt migration period. Residuals were lethally sampled to confirm size and maturity. Abundance was used to calculate a residual index (number of residuals captured/number of fish released x 100). Data were standardized by catch per unit effort (CPUE) to compare across years. Little difference in the residual index was observed over years or by age (S1 versus S2); there was always a male bias in the residual population. Maturation criteria were determined by looking at Gonadosomatic Index (GSI) distribution. The distribution was trimodal, and it was determined that a threshold GSI of approximately 0.138 occurred below which fish were immature. Higher modes represent fish that would become mature or were already mature. Approximately 20% of the population were mature; a 10-fold larger number than observed in pre-release sampling, suggesting many more fish than expected were staying in the river to mature.

To collect indirect evidence of residuals, PTAGIS was queried for PIT detections after July 1 (after the smolt migration season) of the release year. Parr-phenotype residuals were mostly S1s, half were never detected again, and half were only detected in Spring Creek. Of these, approximately 1% migrated in the release year, approximately 1% became avian predation mortalities, less than 1% attempted migration in a subsequent year, one fish became a mature adult, and 1 to 2% were detected in upriver areas (Methow and Chewuch rivers). Of mature male-phenotype residuals, very few were migrants, most stayed in Spring Creek (75%) or were never detected (25%). Some were eaten by birds, none migrated the following year, no adult returns were observed, and more were detected upstream than downstream (in Methow and Chewuch rivers) coincident with the natural spawning period.

Recaptured residuals had instantaneous growth rates similar to natural-origin *O. mykiss* from the Methow River (Martens et al. 2014)[3]. Tatara said this suggests residuals effectively compete with natural-origin fish.

<u>Conclusions (Slides 26 – 27)</u>

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[3] Martens, K.D. and P.J. Connolly, 2014. "Juvenile anadromous salmonid production in Upper Columbia River side channels with different levels of hydrological connection." *Transactions of the American Fisheries Society* 143(3):757-767, DOI: 10.1080/00028487.2014.880740

- Age at release (S1 versus S2) did not affect number of residuals but did affect type of residuals. Both have poor overwinter survival and negligible contribution to anadromous production (smolt to adult return [SAR] ratio = 0.06%). It would be prudent to reduce residualism rates.
- Methods to reduce residualism include: 1) volitional release: most effective for retaining parr as mature males tend to leave to spawn; or 2) manual sorting: effective for removing both types but labor intensive and stressful for fish.

<u>Rearing methods to reduce residual production (Slides 28-35)</u>

Preliminary experiments at NWFSC Manchester station underway with natural-origin Winthrop NFH fish raised by the S1 method. How early can we tell if a fish will not smolt?

Experiment 1: Fish were marked with colored elastomer tags based on size and PIT tagged later when they achieve taggable size to track growth over time. Results: small fish tend to remain small. The size distribution was bimodal suggesting there are two different types of fish that grow two different ways.

Experiment 2: Small and large fish were sorted and separated and compared with an unsorted control group. After 1 year the size distribution among the large fish stayed unimodal and large fish tended to become smolts. Size distributions of control and small size groups tended to become and stay bimodal and the small group did not smolt, suggesting small fish needed another year of growth before smolting. Not all steelhead will grow rapidly enough to smolt, but fast growers tend to become mature males.

Experiment 3: Fish were raised as S1s (high ration, growth rate) and sorted at 9 weeks to create a large body size S1 group and a small size S2 group. Lower mortality was observed in the S1 group. The S2 group is currently being tracked.

<u>Questions</u>

Mike Tonseth asked about the length of time when residuals were observed upriver. Tatara responded they were mostly observed in the same year of release.

Pearsons asked how much of this is idiosyncratic to the Methow Basin and whether the results can be applied to warmer environments. Tatara replied that there is a sliding scale depending on water temperature. Warmer hatcheries would be more successful at raising S1 smolts. Accumulation of thermal units and broodstock source determines spawn timing and juvenile growth. One could do the math to determine if a program has enough accumulated temperature units to have an S1 program. An experiment is ongoing to repeat the Manchester lab experiment (size tracking and sorting) at Winthrop NFH to determine if this is feasible on a hatchery scale. The hatchery is using auto-sorting trailers to separate by size and hoping to replicate a couple of years to determine if number of residuals could be reduced on the program scale.

Pearsons asked what percentage of fish that are maturing are milting at the time of pre-release sampling. Tatara replied that almost all that have the residual coloration are milting.

The Hatchery Committees thanked Tatara for his presentation.

B. Early Maturation Monitoring (Katy Pfannenstein/Matt Cooper)

Matt Cooper introduced Katy Pfannenstein (USFWS). Pfannenstein gave a presentation entitled, "*Early Maturation Monitoring: Gonadosomatic Index (GSI) Methodology & USFWS Three Year Monitoring Results*" (Attachment C), which Larissa Rohrbach distributed to the Hatchery Committees following the meeting on July 19, 2018.

<u>Background (Slides 2-7)</u>

Early male maturation is hard to quantify and less than 5% of wild fish, depending on genetics and environmental conditions like water temperature and food availability, become precociously mature. Producing precocious males may negatively affect economic efficiency, increase competition with native stocks, affect genetics of natural and hatchery stocks, reduce return rates for harvest/broodstock, and skew sex ratios in anadromous returns.

Monitoring for early male maturation is directed in the Leavenworth NFH terms and conditions. Applying early maturation information to hatchery management depends upon program goals such as maximizing SAR ratio or producing fewer early maturing males.

<u>Monitoring using the GSI methodology (Slides 8-14)</u>

For this project, Pfannenstein said staff lethally sampled 300 fish per facility at time of release (April). This sampling follows methods developed by Larsen (2004)[4]; other methods can include testicular histology or plasma 11-ketotestosterone (11KT) measurement. Six to seven experienced samplers could process 100 fish per hour for GSI sampling with startup costs of approximately $3,700, with the primary cost being the microbalance. Data collected include fish size, sex, visual maturation call (testes are thickened in mature males), and gonad weight. Determining the stage of maturation

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[4] Larsen, D.L. et al., 2004. "Assessment of High Rates of Precocious Male Maturation in a Spring Chinook Salmon Supplementation Hatchery Program." *Transactions of the American Fisheries Society* 133(1): 98-120, DOI:10.1577/T03-031.

visually can be difficult for fish that are "in-between." The cost of 11KT assays are approximately $10 per fish for supplies without accounting for labor.

USFWS Monitoring Methods and Results (Slides 9-30)

Three USFWS facilities (Leavenworth NFH, Winthrop NFH, and Entiat NFH) were sampled for spring Chinook salmon, summer Chinook salmon, and steelhead. Change in gonad development (GSI) is exponential. Spring Chinook salmon early maturing males were easiest to determine compared to summer Chinook salmon and steelhead. Spring Chinook salmon were 4 months from maturation, summer Chinook salmon were 6 months from maturation, steelhead were mature in May but fish that would mature in the following year were difficult to identify. A mixture model developed by Dr. Lea Medeiros (University of Idaho) was used to statistically determine the difference between modes in the GSI distribution.

Chinook salmon were sampled at time of release (April), and a subset was held to confirm maturation rates (in May). Early male maturation rates were 7% for Leavenworth NFH spring Chinook salmon, 8.5% for Winthrop NFH spring Chinook salmon, and 18.4% for Entiat NFH summer Chinook salmon (originally 23.4% in 2014 at Entiat NFH; however, hatchery managers reduced feed in the fall and reduced the rate to 14.6% by 2016). A large separation between GSI modes was observed at Entiat NFH, similar to Methow FH. Holding fish increased the detection rate because it was easier to determine differences between mature and immature testes; however, there was not a large difference between maturation rates estimated pre-and post-release. The influence of fork length on maturation depended on the stock. Results show that simple visual assessment of testis maturation may be possible in some stocks without measuring GSI.

Steelhead were similarly sampled at the time of release and 1 month post-release at Winthrop NFH. Results indicated that 21% were initiating maturation and 8.4% were milting. Sampling steelhead after holding for 1 month provided some separation between immature and mature males but not as much as Chinook salmon, because they still have 13 months until spawning. Pfannenstein said the visual assessment for "initiating" fish is not recommended for steelhead because the accuracy of visual detection was poor (65% to 80%). Initiation of maturation occurred across all sizes.

Conclusions (Slides 31-34)

Pfannenstein recommended that the results be considered in the broader scheme of each stock and rearing environment. She said sampling recommendations include holding fish for 1 month post-release and developing a 3-year baseline of monitoring to understand specific stocks. She said sampling with simple visual assessments can create efficiency.

Chris Moran (WDFW) asked if the steelhead sampled were S1s or S2s. Pfannenstein replied they were S2s.

The Hatchery Committees thanked Pfannenstein for her presentation.

C. Chewuch Canal Company Water Rights Issue (Greg Mackey)

Greg Mackey said that on Friday afternoon he received an email from the Chewuch Canal Company. The related newspaper article from the *Methow Valley News* was sent to the Committees by Larissa Rohrbach following the meeting on July 18, 2018. Mackey said a private group of investors is trying to buy the historic water rights of a ranch downstream of the Chewuch Acclimation Pond and trying to claim 33 of the 34 cubic feet per second (cfs) of water running through the canal as part of the purchase. He said Chewuch Canal Company is in opposition, and the Washington Department of Ecology asks that letters of support or opposition be submitted by Friday, July 20, 2018. Mackey said he does not think the investor group realistically thinks they will get all 33 cfs of water rights, but they will try to get as much as they can.

Keely Murdoch asked who are the parties involved? Mackey answered that the investors are retired partners of Goldman Sachs; it is made to look like a water conservation measure to put water rights into a state trust water program, but there is a sunset date allowing them to sell to the highest bidder. Murdoch said it seems like a major habitat issue. Mackey and Tom Kahler agreed that it could be seen as a conservation issue for keeping water in tributaries, but ultimately it is a money-making venture. Murdoch asked if the sale would affect water to Chewuch Pond? Mackey answered that this is unclear because the pond gets water prior to the typical irrigation season, but the pond could lose the ability to use the Chewuch Canal water later in the season. He said those water rights may not even be available to the Methow Valley; they could be sold to users in other regions or to municipalities. Bill Gale asked if 33 cfs of water goes into a trust, would it be unavailable for use? Mackey answered yes. He noted that further details on pond operations are unknown at this time.

D. NMFS Consultation Update (Brett Farman)

Brett Farman said the draft permit for the Wells Complex Summer Steelhead Program is available for Hatchery Committees review. He said Charlene Hurst (NOAA) drafted the permit. (*Note: the permit was distributed to the Hatchery Committees by Larissa Rohrbach on July 19, 2018, and previously by Farman on July 13, 2018*.) Farman requested comments and edits by July 27, if possible by July 25. It was determined that this permit pertains only to the Wells Complex and that USFWS still needs to review the Winthrop NFH steelhead permit. Farman noted that Hurst will be on detail after July 27, only working 1 day per week on permitting tasks.

Regarding the Biological Opinion for the Columbia River unlisted programs that Emi Kondo (NOAA) has been working on, Farman said the current plan is to update the Proposed Action in the Project Planning Database instead of the Hatchery and Genetic Management Plans, which he thinks will be faster.

E. Genetic Monitoring (Todd Pearsons)

Todd Pearsons shared the document entitled, "*Genetics monitoring questions for hatchery programs,*" which Sarah Montgomery distributed to the Hatchery Committees on June 19, 2018. He led the discussion on the most appropriate and efficient ways to engage geneticists to streamline genetic monitoring among hatchery programs in the upper Columbia River

Pearsons suggested that the goal should be to do something similar to the White River program because it worked well. A lot of time was spent on genetic planning; major gains were made by talking to a panel of geneticists with continued discussions and questions. The process resulted in 2 to 3 calls with the geneticists. There was some need for facilitation for initial contact among the geneticists, then the geneticists found time amongst themselves to discuss. A final presentation was facilitated by the PRCC Hatchery Sub-Committee. He suggested using this model so that hatchery M&E and reporting answers the correct genetic questions for all programs. Keely Murdoch said she supports the approach and that Shawn Narum (CRITFC) would like to participate with staff geneticist Ilana Koch (CRITFC).

Bill Gale said he is in favor of facilitation to keep participants focused. Mike Tonseth said that the first step is to agree upon a reasonable set of questions to keep the process focused. Tonseth suggested inviting the geneticists to a meeting to explain what the questions are about and remove some ambiguity. Gale asked whether Tracy Hillman could facilitate the communication, instead of asking geneticists to attend in person, for efficiency. Tonseth and Hillman supported geneticists attending a meeting in person to provide context and history prior to reviewing the genetics M&E plan, then to give them their assignment; the goal is to set them up to provide wise counsel. Pearsons questioned if an in-person introductory meeting would be necessary and said he wants to make this a workload the geneticists can accommodate so participation is good. Hillman agreed and suggested a half-day introductory meeting, so all the geneticists receive the same messaging. Gale agreed to keep the scope limited to Hatchery Committees programs, but said that at the end it would be great to have a set of guidelines and standard approach to apply to the broader set of mid- and upper-Columbia River hatcheries. Tonseth supported the goal of broad application. Pearsons agreed there are no consistent genetic monitoring principles across agencies; a broad goal could be a long-term approach to genetic monitoring. Gale noted that emerging and changing [molecular genetics] technologies prevent the accumulation of a long-term dataset. Representatives present thought a set of questions should be developed from which the geneticists can start.

Some baseline questions were proposed as follows:

1. (Pearsons) Sampling interval: There are genetic data collected on an annual basis, how can these be used?

2. (Tonseth) Do baselines based on microsats need to be rerun to keep up with modern technology/information?

Greg Mackey said there is a need to help the geneticists understand how the data will be used to serve the program outcomes. The main goal is to figure out if the hatchery programs affect native species. Is using a population genetics approach the correct approach to be looking for genetic drift that takes a long time? Perhaps a parentage-based analysis is needed to assess each generation. Pearsons said that right now programs are monitoring phenotype and genotype indices. The NMFS approach has been to contain the risk using indices like proportionate natural influence (PNI) and stray rate. Mackey asked whether results from molecular genetics may not be informative when a program is already using wild by wild breeding and containing stray rates as much as possible: what would be the management application? Gale answered we may learn whether programs that are closely related are coming closer together genetically.

Hillman said the Hatchery Committees should explain to the geneticists the history of the programs, current status, and future goals. He said future goals could come from the recovery plan; however, achieving those goals may be difficult if the hatchery programs are not allowing local adaptation within populations as described in the recovery plan. He said appropriate genetic monitoring could tell us whether we are achieving recovery goals, maintaining current genetic structure and diversity, or reducing genetic structure and diversity. Hillman said we can provide the geneticists with the current M&E Plan and ask them whether it is sufficient to assess within-population structure. If it isn't, they can offer recommendations to improve the M&E Plan. Catherine Willard noted that there are questions identified in the M&E Plan, but it is unclear whether these are the right questions. Tonseth noted that recovery plans only cover listed species; similar monitoring for unlisted species is needed.

Peter Graf (Grant PUD) noted there seems to be two different issues on the table: 1) reducing genetic risk to natural populations; and 2) directing hatchery programs toward some future goal. Mackey said that both risk aversion and goals are valid questions to ask. Gale asked if we want to be able to observe drift caused by hatchery programs or local adaptation? Hillman answered that according to the recovery plan, hatchery programs should not preclude local adaptation within populations; M&E should help us determine whether the hatchery programs are increasing, reducing, or maintaining within-population structure. He said conservation biologists at the NOAA NWFSC would like to see more within-population structure in the upper Columbia River. Mackey noted that old objectives (e.g., Objective 7) focus more on preventing the loss of what structure exists. Pearsons said the core basis of the M&E Plan was to prevent adverse effects on wild populations. Graf noted that by compositing stocks, diversity will be limited. Hillman responded that compositing is intended to help meet abundance targets, but if abundance is increasing, then hatchery programs should do what they can to allow local adaptation. Gale said that the ultimate goal would be to remove hatchery production once programs like the Chiwawa and Nason programs achieve abundance goals. Hillman suggested that managing genetics—which the programs currently try to do through broodstock collection, adult management, and reducing straying—should occur before abundance goals are met. Hillman summarized the need to identify the goals and questions for monitoring.

Pearsons suggested that the original intent of the genetics monitoring questions document was to try to figure out a common approach, and he requested comments and edits to the document. He wondered whether an accepted approach exists in another region that could be applied locally. Pearsons noted there is a timeline challenge to include some genetic data in the 2020 comprehensive report.

Willard, Murdoch, and Gale all supported the need for geneticists to weigh in on asking the appropriate questions. They support an approach to create broader questions with supporting discussion points to provide geneticists freedom to weigh in on whether the right questions are being asked of the programs.

Hatchery Committees representatives will review the questions for geneticists presented by Pearsons and provide comments to Hillman via email. Hillman will discuss the proposed process with Kirk Truscott (not in attendance). The Hatchery Committees will have a focused session during the August meeting to finalize the questions to geneticists. Representatives will come prepared with comments and nominations of geneticists. USFWS will not have a representative at the meeting; they will provide comments prior to meeting, then will review the approved set of questions after the meeting to provide their approval. Farman will discuss this process with Mike Ford (NMFS) and Craig Busack and see whether one or both are willing to serve on the genetics panel. Douglas PUD will consider whether they will nominate a geneticist. Chelan PUD approved the proposed nominees. Hillman will send a summary of this plan to nominated geneticists after this meeting to sustain their engagement.

F. WDFW’s Adult Prophylactic Disease Management Plan (Mike Tonseth)

Mike Tonseth summarized WDFW’s Adult Prophylactic Disease Management Plan for Eastbank FH Complex Spring and Summer Chinook Programs in 2018-2020, which Sarah Montgomery distributed to the Hatchery Committees on June 20, 2018 (Attachment D). He said there has not been a consistent prophylactic treatment pattern at Eastbank FH, and WDFW supports moving away from using antibiotics when they are not necessary. However, last year, Tonseth was unaware that prophylactic antibiotic use ended, and he is not supportive of ending its use without further study or consideration. High rates of disease and culling individuals resulted last year, prompting the need to develop a plan to either move away from or provide management direction for use of prophylactic antibiotics. There have been many conversations on what to do with infected fish/eggs in the Hatchery Committees, and it is appropriate for the Hatchery Committees to review disease management plans. However, in the past, the Hatchery Committees have not discussed which fish are treated and with what drug. That is decided by the health experts and should remain a decision made by the health experts.

Brett Farman asked whether moving away from prophylactic antibiotic use is a state policy. Tonseth answered that the trend is driven by broader U.S. Food and Drug Administration recommendations. For instance, azithromycin is no longer an option for treatment. Bill Gale noted that USFWS considers it a higher priority to address the root causes of disease rather than rely on prophylactic uses of antibiotics.

Gale said this is an Hatchery Committees discussion and decision issue because it has been proposed as a study/experiment and he has concerns with the study design. USFWS generally defers to fish health guidance from the veterinarians, but in this case, there is conflicting guidance. Some are saying not to use prophylactic treatments, while others are saying go ahead. Tonseth disagreed that this is a Hatchery Committees issue. He noted that some hatchery programs may not have the liberty to cull individuals (because of Endangered Species Act status) and leaving prophylactic treatments off the table is posing an unknown risk.

Betsy Bamberger said the decision not to prophylactically inject adults last year was made independently without knowledge of the Hatchery Committees. Based on her understanding, there were no data either through necropsy or other records to suggest that without prophylactic use there would be significant problems. She noted that for food animals, prophylactic use is not the preferred action and should require proof to support use.

Tonseth acknowledged communication was poor last year. Tracy Hillman said any proposed experiments should be reviewed by the Hatchery Committees, because these reviews not only improve study designs, but they keep the Committees apprised of various hatchery activities. He added, if a disease outbreak occurs, there is no need for the Committees to review and approve any treatment plan. That is the job of the health experts. However, the Committees should be informed of the issues and the prescribed treatments. Tonseth asked whether any deviation from past practices constitutes an experiment and a need for Hatchery Committees approval? Farman answered that one should consider the underlying driver—if guidance and policy poses the need to assess risk, it’s a different case than a curiosity or hypothesis driven experiment.

Megan Finley (WDFW Fish Health Veterinarian) said it would be informative to know whether prophylactic use is useful for a given population or not. Matt Cooper noted that USFWS carried out a similar experiment 4 to 5 years ago that did not provide very informative results; instead, other improvements were made in fish rearing to reduce stress over several seasons. Tonseth noted that Leavenworth NFH and the Winthrop NFH programs (prior to brood year 2006) are heavily domesticated with heavy culling historically and low bacterial kidney disease incidence. Wenatchee, Similkameen, and other integrated stocks would not be expected to perform the same as other programs.

Gale said the Hatchery Committees should examine facilities and rearing practices to be able to minimize stress and disease transmission in order to move away from prophylactic antibiotic uses. Bamberger and Finley fully support this goal.

Willard said Chelan PUD defers to fish health professionals, but asks for improved and earlier communication. Truscott (in an email sent to Hillman prior to the meeting) supports improved communication between fish health experts and the Hatchery Committees and supports 100% prophylactic inoculation of spring Chinook salmon because of their Endangered Species Act status. He suggests that results of the proposed study are likely to be confounded by stock origins. Todd Pearsons asked whether the fish will be prophylactically treated this year? Tonseth answered that inoculations have happened and WDFW is not planning to handle fish to inoculate again.

For future years, Tonseth proposes adding another appendix to the annual Broodstock Collection Protocols that can be reviewed by the Hatchery Committees. He will draft the report with Bamberger, Finley, Jed Varney (WDFW), and Trista Welsh-Becker (USFWS). Bamberger expressed concern that they will be locked into a protocol without flexibility to treat disease. Tonseth explained that the Broodstock Collection Protocol is intended to be a dynamic document with a basic level of detail. Having a protocol in the document doesn't preclude change within a year. Gale agreed and said this will provide a historical record of disease management, which will be useful when there is staff turnover.

G. Nason Creek Spring Chinook Salmon Overage (Mike Tonseth)

Mike Tonseth said he notified the Hatchery Committees about an overage in the Nason Creek spring Chinook salmon program for broodyear 2017, which was discussed over email. He said Brett Farman provided input indicating that his recommendation was to keep all wild-by-wild fish in the conservation component of the program. Farman said he was comfortable with the conservation component being 130% of the conservation production goal as long as the overall program (conservation and safety-net components combined) is no more than 110% of the program production goal. Tonseth said WDFW's preference is to move the overage from the conservation program into the safety-net program. Chelan PUD suggested moving the wild by wild overage to the Chiwawa conservation program. Tonseth said overages should have an avenue to be moved into other programs, but in this case, fish originating from the Chiwawa River can be moved into the

Nason program but not from the Nason program into the Chiwawa program (unless genetic assignment is 95% certain to be of Chiwawa origin, starting in 2018). This is because the Chiwawa program is not composited. He said by the time the overage in the Nason conservation program was discovered, the progeny had been comingled, so separation of Chiwawa-origin fish was not feasible. Catherine Willard said in 2018, the brood will be kept separate until genetic assignment is complete.

Tonseth said WDFW prefers moving the excess conservation fish to the safety-net program (and ad-clipping them to appear as safety-net fish) and releasing excess fish from the safety-net program into nonanadromous waters. He said WDFW does not support retaining the fish as unmarked conservation program fish; however, he said since this is just for the 2017 broodyear, and contingencies are already in place for future years, WDFW will go along with NOAA's suggestion to retain the overage in the conservation program. He said this complicates the adult management strategy when these fish return. Having a full safety-net program may allow for a conservation fishery to manage for pHOS and PNI. With a significant reduction in the size of the safety-net program, a conservation fishery might not be implemented, and all adult management would need to occur at Tumwater Dam. He said Grant PUD would need to fund those additional efforts to collect adults at Tumwater Dam. Willard said Chelan PUD and Grant PUD fund adult management at Tumwater Dam to whatever level is required to meet terms and conditions of permits. Tonseth reiterated the WDFW's preference for implementing a conservation fishery. Keely Murdoch said the YN is not supportive of ad-clipping conservation fish. Tonseth said WDFW continues to want to provide an opportunity at removing these fish using recreational anglers as management tools.

Tracy Hillman summarized that no representatives have opposed the current plan to retain the overage of wild-by-wild Nason Creek spring Chinook salmon in the conservation program, subtract an equal amount of fish from the safety-net program, which will be released in nonanadromous waters, and not exceed the total program release of 110%. He said all wild-by-wild fish would be ad-present and wire tagged. Bill Gale added that in the same release year, the Chiwawa program will meet their production targets with a mix of hatchery-by-hatchery and wild-by-wild fish in opposite proportions to the Nason program. Gale said with the same amount of hatchery-by-hatchery fish leaving the basin, he does not see an overall change to adult management practices at Tumwater Dam. Todd Pearsons and Deanne Pavlik-Kunkel agreed and said Grant PUD is not sure whether WDFW is asking to put an additional caveat on how adult management is paid for. Murdoch added that a caveat does not seem reasonable because there are other factors contributing to potential adult management at Tumwater, such as the contribution of Leavenworth NFH-origin fish and overlapping brood years of returning fish. Tonseth said he is not asking for an additional caveat to be added. He cautioned that the amount of effort for adult management might be higher if more conservation program fish are released. Farman said adult management is a permit condition regardless of this decision.

Tom Scribner said he does not favor releasing hatchery-by-hatchery spring Chinook salmon in nonanadromous waters and asked whether there are any alternatives. He asked whether incorporating them into the Leavenworth program is an option or are there other options outside of the constraints of the PUD permits. Matt Cooper said the Leavenworth program is already at capacity for brood year 2017. Gale said the segregated Carson stock also needs to be kept separate from the Nason program stock because it would not be desirable for the Nason program hatchery-by-hatchery fish to be incorporated into the Leavenworth broodstock which could negatively influence the low stray rates into the upper Wenatchee River currently observed for the LNFH program. Scribner suggested marking the fish so they can be removed at Tumwater Dam, and Gale said he is concerned about the future progeny of Nason program hatchery by hatchery fish straying into the upper river. Farman said moving the overage to Leavenworth NFH is not an option from a permitting perspective.

Tonseth said the overage is relatively insignificant, only approximately 20,000 to 30,000 smolts. Scribner said even though that is a relatively small number of fish, there is a political stigma to putting the fish in nonanadromous waters. Pavlik-Kunkel agreed and asked what is being done to prevent this overage from happening again in the future? Tonseth said the overage was an operational error; the fish should have been destroyed at the eyed-egg stage. There are contingency plans in 2018 to prevent this from happening again.

Hillman summarized that the plan for Nason Creek spring Chinook overage is to retain all wild-by-wild fish as part of the conservation program and release an equal amount of hatchery-by-hatchery fish from the safety-net program into nonanadromous waters. Tonseth said he should have final numbers of fish soon and he will distribute that information. The PRCC Hatchery Subcommittee representatives present agreed to retaining the Nason Creek conservation program overage and releasing an equivalent amount of the safety-net program to nonanadromous waters as follows: WDFW, Grant PUD, NMFS, USFWS, and YN approved on July 18, 2018. Hillman said Kirk Truscott also provided approval from the CCT for this item via email on July 17, 2018.

H. Nason/Chiwawa Spring Chinook Broodstock Collection Update (Mike Tonseth)

Mike Tonseth said he received notice that the bull trout incidental take limit at the Chiwawa Weir was met on July 7, 2018. He said Chris Moran and Catherine Willard drafted a letter to USFWS anticipating request for the incidental take. He said he reviewed the current run escapement and numbers of fish already collected. The collection consists of 37% natural origin fish, exceeding the 33% extraction limit, so he decided to stop collecting based on permit conditions. He said there are 32 wild females on hand for the Nason program; however, some are summer Chinook salmon or assign as out of basin fish. He said the collection is at 29 of the 32 fish goal for the conservation program and 31 of the 33 fish goal for the safety-net program. He said for the Chiwawa program, 27 of the 38 targeted fish goal has been collected. He said there was also a hatchery-origin component; these hatchery origin progeny will be held to backfill production shortfall. He said the Nason safety-net program can be backfilled with these additional collections and there are sufficient females to meet production obligations for both the Chiwawa and Nason programs even though there are fewer wild-by-wild brood than were targeted. He said the discussion about increasing bull trout takes at the weir was not pursued.

Brett Farman asked what is the typical bull trout encounter rate at the Chiwawa Weir? Tonseth said it has increased recently with 99 bull trout encountered in 6 days this year. He said PIT-tag detections at the Chiwawa Weir are used to time spring Chinook salmon broodstock trapping, and Chinook salmon and bull trout have similar migration timing and there is a robust spawning bull trout population in the Chiwawa River. Bill Gale recognized that the bull trout take limits make broodstock collection challenging in low abundance years. Tonseth said he and Keely Murdoch are assessing the size of conservation programs, so if there is potential to reduce the program size it might ease up broodstock collection restraints. He said a long-term strategy for collecting broodstock for these programs will also account for the long-term trajectory of spring Chinook salmon returns.

I. Expanded Sampling at the OLAFT (Mike Tonseth)

Mike Tonseth said during the May 16, 2018 Hatchery Committees meeting, Andrew Murdoch (WDFW) presented schemes for how sampling could be expanded at the off-ladder adult fish trap (OLAFT) at Priest Rapids Dam. He shared the document, PRD Expansion Project (Attachment E), which Larissa Rohrbach distributed to the Hatchery Committees on July 10, 2018. He said the discussion about expanding sampling at the OLAFT initiated further discussions and questions. He said Andrew Murdoch summarized answers to these questions in the document, and Tonseth asked the Hatchery Committees to review the document and provide any follow-up questions or comments to himself and Andrew Murdoch. He said Andrew Murdoch would like a decision soon about whether the Hatchery Committees favor expanding the sampling at the OLAFT and said this should be discussed again at the August 15, 2018 Hatchery Committees meeting.

III. Chelan PUD

A. Draft 2019 Implementation Plan (Catherine Willard)

Catherine Willard shared the draft document, Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2019 (Attachment F), which Larissa Rohrbach distributed to the Hatchery Committees on July 18, 2018. Willard said there are two main changes in the plan from the previous year. She said Chelan PUD does not plan to collect summer Chinook salmon survey data to inform the observer efficiency model, nor conduct snorkel surveys in the Chiwawa River Basin.

Snorkel surveys are used to estimate spring Chinook salmon and steelhead parr in the Chiwawa River Basin, and to estimate carrying capacity the Chiwawa River which additional years of data will not cause the estimates to be more accurate. Smolt data collected at the Chiwawa smolt trap are also used to evaluate freshwater productivity according to the M&E Plan. She said outmigration estimates, outmigration timing, and length and weight data obtained from the Chiwawa smolt trap will still be available for these fish, so duplicative field efforts in snorkel surveys are not needed.

Mike Tonseth said the snorkel survey dataset is robust with a long time series and asked if Chelan PUD has considered funding this work for a longer period, perhaps with Tributary Committees Funds. Willard said that has not been discussed internally. Tracy Hillman said in the early 1990s, it was unknown whether the smolt trap would provide reliable estimates of juvenile fish, so snorkel surveys were initiated. In terms of evaluating the hatchery program, the surveys have provided as much information as possible. He said the data are precise and carrying capacity estimates would not change unless there was a significant change in the environment or the hatchery program. He added there is no more information to be gained from the snorkel surveys that would benefit the Hatchery Committees; however, the surveys provide abundance, distribution, and habitat of different fish species in the basin, which have benefits outside the scope of the Hatchery M&E Plan. Hillman said the Chiwawa smolt trap has very high capture efficiencies and provides information on migration timing, length, weight, and condition, which snorkel surveys cannot provide.

Keely Murdoch acknowledged the duplication between the snorkel surveys and sampling at the trap and said the snorkel surveys have provided a lot of insight into the Chiwawa River, particularly for observations of other species such as cutthroat trout and bull trout. Murdoch suggested continuing the snorkel surveys at intervals other than every year. Tonseth asked when the surveys began. Willard said the surveys have been performed every year from 1992 to present except 2000.

Tonseth asked whether the snorkel survey data have been incorporated into the life cycle modeling work for the Wenatchee Basin. Hillman said yes, the data have been used for modeling carrying capacity and life-stage survivals. He said egg-to-parr and parr-to-smolt survival rates likely will not change much unless there is an environmental change in the basin or a major change in the hatchery program. He said the data have also been used to model density dependence. He summarized that the snorkel data are interesting, robust, and certainly have informed modeling efforts, but they provide little information beyond trapping data that will inform management of the hatchery program. The Committees will review the proposed changes to the 2019 M&E implementation plan and discuss it during the August meeting.

IV. Douglas PUD

A. Yakama Nation Summer Chinook Salmon Program (Melinda Goudy/ Keely Murdoch)

Keely Murdoch introduced Melinda Goudy, who is a YN biologist studying summer/fall Chinook salmon. Goudy shared the presentation, "*Yakima River Summer Chinook Re-Introduction*," (Attachment G), which Larissa Rohrbach distributed to the Hatchery Committees following the meeting on July 19, 2018. A summary of the presentation and questions and comments are included below.

<u>Introduction and objectives (slides 1-5)</u>

Summer Chinook salmon were extirpated from the Yakima River in the early 1970s, partly due to flow augmentation for irrigation. The YN endeavors to bring summer Chinook salmon back to the basin and began the process in 2006 with the ultimate goal of establishing a naturally spawning population.

<u>Stock selection and rearing (slides 6-12)</u>

There are multiple stocks and distinct spawning areas of mid-Columbia River summer Chinook salmon. The Wells FH "integrated" stock was chosen as broodstock based on fish health recommendations and logistics. Reintroduction began in 2008, when eggs and milt from broodstock were collected at Wells FH. Fertilization occurs at YN's Marion Drain Hatchery. Rearing also occurs at Marion Drain, after which fish are transported to acclimation sites throughout the basin (slide 11). The Wapatox acclimation site at river mile 17 on the Naches River is new for 2018, and the Nelson Springs site will be phased out. Fish are PIT-tagged at the acclimation sites and then released.

<u>Results (slides 13-25)</u>

Goudy summarized summer Chinook salmon survival to the mouth of the Yakima River by release year, and Prosser-to-McNary-Dam survival for fall Chinook salmon releases. Regarding the table on slide 13, Murdoch asked what the difference in release period represents. Goudy said the summer Chinook salmon are released in early May, mid-May, or late May. She said the fish need to be large enough to PIT tag before they can be released, but earlier release timing is preferred.

Goudy showed results for fall and summer Chinook salmon returning above Prosser from 2013 to 2017, PIT-tag data for returning adults, and migration timing for fall, spring, and summer Chinook salmon.

Goudy showed redd survey results from 2017, a year in which 592 summer Chinook salmon adults returned upstream from Prosser Dam. Todd Pearsons asked where redd surveys were conducted.

Goudy said in the Yakima River from Roza Dam to the confluence with the Naches River, and she acknowledged that the redd counts from the survey (33 redds) likely do not fully characterize all summer Chinook salmon spawning in the basin. She noted that redd surveys show the Naches River being used more in 2017 than in past years, where most of the spawning occurred near Cowiche Dam.

Murdoch asked whether staff have observed overlap in time and space between summer and fall Chinook salmon on the spawning grounds. Goudy said there are few to no fall Chinook salmon redds in the Naches River, and they mostly spawn in separate areas (slide 25). She said there could be overlap in the Union Gap area.

Mike Tonseth asked what is the frequency for summer Chinook salmon redd surveys and the sex of fish or carcasses observed? Goudy said surveys are performed approximately weekly from mid-September in the lower reaches to the first week of November in the upper reaches, with peak spawning occurring in late October. They are unable to collect adults or carcasses; therefore, they are unable to determine sex ratios. Tonseth asked whether the redd counts have been expanded. Goudy said Bill Bosch (YN) performs those calculations to determine fish per redd estimates.

<u>Next steps (slides 26-27)</u>

Goudy said ongoing plans for the reintroduction program include using Wells summer Chinook salmon as broodstock and continuing to acclimate fish at both the Roza and Wapatox sites. Redd surveys on the Yakima River will also continue. She said the ultimate goal of the program is to convert to a local brood and discontinue using Wells summer Chinook salmon broodstock. Habitat restoration work and keeping temperatures as low as possible will also help the reintroduction project.

Pearsons asked what size the fish are upon release. Goudy said they are PIT tagged at approximately 65 to 70 millimeters and released shortly after tagging.

Tonseth noted that 2018 is the 11th year of requesting adult broodstock at Wells Dam for the reintroduction program, which has successfully produced approximately 1,300 returning adults. He asked whether there are plans to collect adults in the Yakima River to support this program. Goudy said adults are counted at Prosser Dam. She said there is a Denil fishway at Prosser Dam; however, water temperatures are generally high and opening the Denil to collect fish would stress the fish. Other options being considered are Roza Dam and Sunnyside Dam, but there are not yet enough fish returning to those two sites. Tonseth asked whether there is a timeline for the program to become self-sufficient in broodstock collection. Goudy said the program plans to rely on Wells summer Chinook salmon broodstock in the short-term. She does not expect that a collection facility would be funded soon, but noted that reintroduction has proven to be feasible and broodstock targets could probably be met in most years.

Murdoch said that the program started as a feasibility study, based on experience with coho salmon, and transitioned to a long-term plan. Goudy agreed and added that predation is a concern for the program in the Yakima Basin, especially in the lower part of the river.

Bill Gale asked what number of redds or adults would be considered successful for the program to end or transition to local broodstock. Goudy said an escapement of 11,000 summer Chinook salmon would be considered a success, which would provide approximately 6,000 for harvest and 5,000 for escapement. She said the end goal for broodstock collection at Wells FH is when enough summer Chinook salmon can be collected in the Yakima River to suffice for program broodstock. Gale noted that the program sounds like it might eventually transition to an integrated program. He asked whether a segregated hatchery program would provide better survival rates, given predation issues in the basin. Tonseth asked whether long-term plans include broadening the hatchery component of the program, or if Goudy expects that natural production will provide the desired escapement. Goudy said the summer Chinook salmon reintroduction program is part of a larger master plan to achieve 1,000,000 summer and fall Chinook salmon smolts released to the river, with at least 11,000 adult summer and fall Chinook salmon adults returning to the river. She clarified that for summer Chinook salmon, 5,000 fish returning on a regular basis would be considered successful.

Pearsons asked whether Goudy has any ideas as to why there is such a discrepancy between the number of fish returning to Prosser and the number of redds surveyed. Goudy said visibility can be poor in the Yakima River during survey periods, especially when flows are lower. Then, in October, when most of the fish are in the river, flows are too high. She said the Naches River also has low visibility and she expects many redds are present there.

The Hatchery Committees thanked Goudy for her presentation.

B. Broodstock Collection for the Summer Chinook Survival Study (Greg Mackey)

Greg Mackey said the Wells HCP Coordinating Committee approved the use of summer Chinook salmon as the study species for survival studies at Wells Dam in 2020. He said broodstock for this study will be collected at Wells Dam in fall of 2018 and 100,000 fish are needed for the study. The HCP Coordinating Committees also agreed that those 100,000 fish would be part of the summer Chinook yearling salmon production component (out of 320,000 total). Mackey said Douglas PUD will be keeping a close watch on fish health of broodstock and may want to increase collections to ensure enough fish are available for the study.

Betsy Bamberger said the health of broodstock in the Wells program looks good so far and last week the first mortality was observed. She said the fish had abrasions with some *Flavobacteria* present, consistent with a columnaris infection. She said the pond where this fish was found will be treated with Diquat to protect from prespawn mortality losses. She said it was not clear that the bacteria were the primary cause of death, but there was enough evidence to warrant therapeutic intervention.

Mike Tonseth suggested collecting additional broodstock (up to 110%, as described in terms and conditions of permits) as a buffer to potential losses, especially considering warm river forecasts. He said if those fish are on hand and available early, they can be treated and used for broodstock if needed, or surplused. He said collecting additional fish later in the season presents the risk that they are harder to treat and may have a short life expectancy. Bamberger said the fish collected so far look healthy and she was surprised to see the single mortality. Matt Cooper asked whether the fish looked healthy last year. Tonseth said some of the fish looked healthy, but there were higher flows and more dissolved oxygen in the river in 2017.

Mackey proposed that Douglas PUD proceed with Tonseth's suggestion to collect 110% of the broodstock collection target and noted that extra fish would likely be available for the YN summer Chinook salmon program. Tonseth said by the time fish are spawned, broodstock numbers will likely be final and decisions can be made about any surplus fish. Brett Farman cautioned that surplus broodstock should not produce excess juveniles for the hatchery programs. Tracy Hillman asked whether the Wells Hatchery Committee approves Douglas PUD's request to collect up to 110% of the broodstock target for the Wells Chinook salmon yearling program. Representatives present agreed as follows: Douglas PUD, WDFW, NMFS, USFWS, and YN approved. Hillman said he will ask Kirk Truscott if the CCT also approves this item. *(Note: Truscott provided CCT approval via email on July 24, 2018.)*

C. Spring Chinook Adult Management (Greg Mackey)

Greg Mackey shared the document, *Methow Basin Spring Chinook Adult Management Plan 2018,* which Larissa Rohrbach distributed to the Hatchery Committees on July 17, 2018 (Attachment H). Mackey said the tools used for adult management in the Methow Basin in previous years were the outfall at the Methow FH and the outfall at Winthrop NFH. He said a sliding scale from the new ESA permit (18925; 20533) was used to determine removal targets based on projections of wild spawners. He said the Methow Basin Spring Chinook Adult Management Plan 2018 shows calculations based on this curve and provide the best estimates of removal targets in the Methow Basin for 2018. He said with approximately 447 wild spring Chinook salmon spawners expected, the pHOS target is 0.32. Murdoch asked whether 0.32 represents Douglas PUD's programs, or the entire basin? Mackey said 0.32 is the partial pHOS as identified in Douglas PUD's permits.

Mackey noted that adult management in reality is imprecise and these targets give the operators, staff, and Methow Field Office staff who evaluate fish origin and tally adult management numbers a threshold at which they should cease adult management. He said the calculations also include an assumption of 25% prespawn mortality. He summarized that the removal target is 196 hatchery fish, or allowing 214 hatchery-origin fish to spawn. Tonseth said some hatchery-origin fish are already on station and he noted that adults and progeny used for the egg-to-fry survival study should not come from conservation program adults. Tonseth said it would be helpful to have a weekly update of which fish are being held on station because ad-present broodstock should be used for the safety-net program. Michael Humling (USFWS) said the Winthrop NFH program would still like to collect more conservation program fish for its broodstock needs. Bill Gale suggested updating the document to add Winthrop NFH removal numbers and safety-net escapement goals. Mackey said he will work with Charles Frady, Charlie Snow, and Humling to revise the plan and distribute it to the Committee. He will also coordinate with those staff and the Methow Field Office to provide weekly updates on adult management.

D. Winthrop NFH Wild-by-Wild Steelhead Surplus Update (Greg Mackey/ Matt Cooper)

Greg Mackey said Douglas PUD met with USFWS staff to discuss the Winthrop NFH wild-by-wild steelhead overage, which the Hatchery Committees agreed can be reared at Methow FH. He said Douglas PUD's General Manager and attorney required that a Memorandum of Understanding (MOU) be agreed to by USFWS and Douglas PUD in order for the fish to be reared at Methow FH. Mackey said this MOU is under internal review and he hopes it will be signed quickly by both Douglas PUD and USFWS. Tom Kahler said the scope of the MOU is general and language specifies that this agreement is necessary for achieving permit conditions and implementing the comingled steelhead programs. Bill Gale said he also hopes the MOU will be signed quickly, though the broad focus of the MOU may cause delay during internal review.

E. Use of Spring Chinook for the 2030 Wells Verification Survival Study (Tracy Hillman)

Tracy Hillman said the Wells HCP Coordinating Committee asked that the Wells HCP Hatchery Committee be aware that a verification survival study with spring Chinook salmon is planned for 2030. Keely Murdoch said the Coordinating Committee was concerned about permitting limitations to using spring Chinook salmon in 2020 for the survival study. She said permits will need to be updated to allow for this study before 2030, and the Hatchery Committees should work with NMFS to update the Methow spring Chinook salmon permit accordingly and make sure the Hatchery and Genetic Management Plan is accurate so that use of spring Chinook salmon for the survival study is permitted.

F. Saprolegnia spp. Egg Incubation Treatment Study Proposal (Greg Mackey/ Betsy Bamberger) - DECISION

Greg Mackey said Douglas PUD is interested in optimizing fish health and fish culture and proposes to study the egg incubation and treatment of *Saprolegnia*, a water mold with fungus-like properties. He shared the document, *Control of Saprolegnia spp. Growth on Spring Chinook (Oncorhynchus tshawytscha) Eggs*, which Larissa Rohrbach distributed to the Hatchery Committees on July 16, 2018 (Attachment I). Mackey said this proposed pilot study is an example of a study Douglas PUD wants to implement to treat and incubate eggs using prophylactic management. He said the approaches in the pilot study include formalin, ambient water, hydrogen peroxide, and salt. He identified a goal of performing this study on multiple species in different locations. Methow FH was chosen because there is a spare incubation room available, and staff are interested in participating. Spring Chinook salmon were chosen because they are of great interest in the basin. He said the goal of the pilot study is to determine how best to assess different treatments and obtain qualitative results so that the study can be expanded in the future. He said 45 replicates would be the sample size needed for a full study.

Mackey said the source of fish for the study will be extra spring Chinook salmon that happen to swim into facilities after surplusing is completed for Winthrop NFH and after broodstock needs are met. These fish would otherwise be surplused to a landfill. He said 24 pairs are desired for the pilot study. The study would run through the eyed-egg stage at which point live and dead eggs would be counted and the tray would be photographed (for a quantitative estimate of mold) and then shocked.

Mike Tonseth said he does not recall Methow FH having an issue with *Saprolegnia* in eggs, whereas Wells FH has had issues with it. Tonseth suggested looking for a facility with a history of fungus issues and using summer Chinook salmon instead. Betsy Bamberger said Methow FH has not had issues with fungus, but all eggs in the facility are treated with formalin, so not treating with formalin may produce interesting results. She said Methow FH was chosen specifically due to the staff being interested and committed to the project and the facility having capacity. She suggested that the study also move to Wells FH eventually, but there are logistical constraints to implementing the study there immediately. Tonseth questioned whether there would be an outbreak of *Saprolegnia* at Methow FH and asked whether performing the study at Methow FH would produce meaningful results compared to Wells FH, where it seems an outbreak is more likely. Bamberger said she is not sure what the historical rate of *Saprolegnia* is at Wells FH, but she will check.

Megan Finley asked what is the concentration of hydrogen peroxide proposed in the study? Bamberger said the pilot study will use 35% Perox-Aid and the exact amount is both indicated in the study protocol and consistent with label dosing recommendations. She said if there is no significant difference between formalin and Perox-Aid, Perox-Aid is likely the preferred method because it is not a carcinogen. Bill Gale asked if there are difficulties in obtaining Perox-Aid and storing it. Finley said large amounts of hydrogen peroxide need to be registered and stored in a locked container. Bamberger said it is not difficult to obtain but requires certain documentation. Gale, Keely Murdoch, and Brett Farman expressed interest in the study and agreed that even if there is no outbreak, the investment is low, and infrastructure is already available. Bamberger said the study is proposed as a pilot study and could be moved to Wells FH in later years. Mackey reiterated interest in comparing multiple species and treatment types in one study. Bamberger agreed but cautioned that facility variables such as water quality and egg quality often differ significantly.

Gale asked about the specific fish to be used in this pilot study. He encouraged Douglas PUD to retain Winthrop NFH-origin fish that are returning to Methow FH and said he is not sure if Winthrop NFH has a surplus of adults to transfer to Methow FH. Bamberger said based on conversations with staff at Methow FH and Winthrop NFH, there may not be enough fish available this year, but Douglas PUD wanted to bring this to the Hatchery Committees to start the process.

Regarding the study design, Tracy Hillman suggested randomly assigning egg trays to treatment groups. Mackey said the plan is to pool all eggs per spawn date to reduce the family effect and distribute the eggs among the treatments. Hillman noted that the proposed study resembles a block design, because a given treatment flows from one tray to the next in the stack of three trays. Thus, the three trays within each experimental group do not appear to be independent. He suggested treating the three stacks of trays as blocks (because they are not truly independent), so differences among stacks or treatments can be assessed with analysis of variance (ANOVA).

Tonseth asked whether there is a plan to obtain baseline water quality data for the well water at Methow FH, such as chemical composition and pH. He said differences in water quality could affect the treatments and water quality varies greatly between facilities, influencing the applicability of results obtained at one facility to another facility. Bamberger said water quality measurements are not included for the pilot study but would be considered for the full study. Tonseth suggested taking multiple water quality measurements throughout the study. Gale asked whether dissolved oxygen and pH are monitored at the hatcheries. Mackey said dissolved oxygen and pH are automatically monitored at Wells FH; he is not sure about measurements at Methow FH. Matt Cooper said water quality is occasionally measured at Winthrop NFH. Tonseth said water quality varies greatly between surface water and groundwater so it could be an important variable through the study.

Mackey summarized that logistics are in place to begin this pilot study at Methow FH, with the potential to move it to Wells FH in future years. Hillman asked whether the Wells Hatchery Committee approves the pilot study provided there are enough fish available and any transfer details between hatcheries are successfully determined. It was approved as follows: Douglas PUD, WDFW, USFWS, YN, and NMFS approved on July 18, 2018. CCT provided approval of this item prior to the meeting on July 17, 2018. Kirk Truscott noted in an email to Hillman that fish should be in excess to all other needs.

V. HCP Administration

A. Introducing Megan Finley, WDFW

Tracy Hillman welcomed Megan Finley to the Hatchery Committees meeting. She is a Doctor of Veterinary Medicine working for WDFW. She works with the Eastbank FH programs and Chiwawa Acclimation Facility and therefore has been added to the HCP HC: cc: email distribution list. Todd Pearsons asked about her geographic scope of work. Finley said she supports the Chelan PUD facilities (Eastbank, Chelan and acclimation facilities - Dryden, Similkameen, Chiwawa, Nason), WDFW facilities (Omak, Naches, Wallace), and the Colville facilities (Colville, Chief Joe).

B. Next Meetings

The next Hatchery Committees meetings are on August 15, 2018 (Grant PUD), September 19, 2018 (Grant PUD), and October 17, 2018 (Grant PUD).

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Factors affecting residualism in hatchery steelhead trout
Attachment C	Early Maturation Monitoring: Gonadosomatic Index (GSI) Methodology & USFWS Three Year Monitoring Results
Attachment D	Adult Prophylactic Disease Management Plan for Eastbank FH Complex Spring and Summer Chinook Programs in 2018-2020
Attachment E	PRD Expansion Project
Attachment F	Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2019
Attachment G	Yakima River Summer Chinook Re-Introduction
Attachment H	Methow Basin Spring Chinook Adult Management Plan 2018
Attachment I	Control of *Saprolegnia* spp. Growth on Spring Chinook (*Oncorhynchus tshawytscha*) Eggs

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Betsy Bamberger	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Alf Haukenes°	Washington Department of Fish and Wildlife
Charlie Snow°	Washington Department of Fish and Wildlife
Chris Moran	Washington Department of Fish and Wildlife
Megan Finley	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Bill Gale*	U.S. Fish and Wildlife Service
Michael Humling	U.S. Fish and Wildlife Service
Katy Pfannenstein	U.S. Fish and Wildlife Service
Brett Farman*	National Marine Fisheries Service
Chris Tatara	National Marine Fisheries Service
Keely Murdoch*	Yakama Nation
Tom Scribner*°	Yakama Nation
Melinda Goudy	Yakama Nation

Notes:
* Denotes Hatchery Committees member or alternate
° Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Factors affecting residualism in hatchery steelhead trout

NOAA
FISHERIES
Northwest Fisheries Science Center

Christopher Tatara

NOAA
Don Larsen
Barry Berejikian
Penny Swanson
Deb Harstad

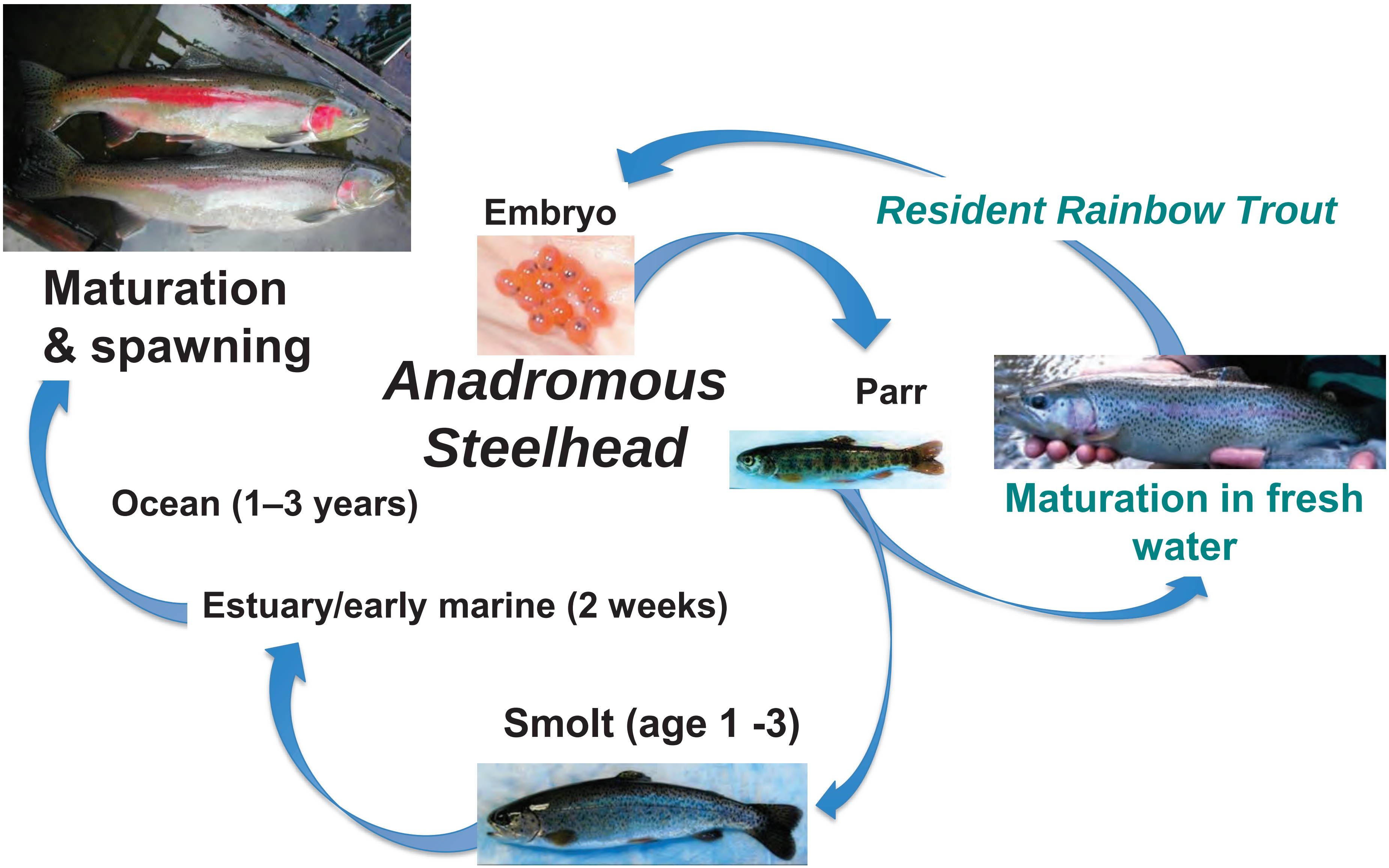
USFWS
Matt Cooper
Chris Pasley
Michael Humling

UW
Mollie Middleton
Jon Dickey

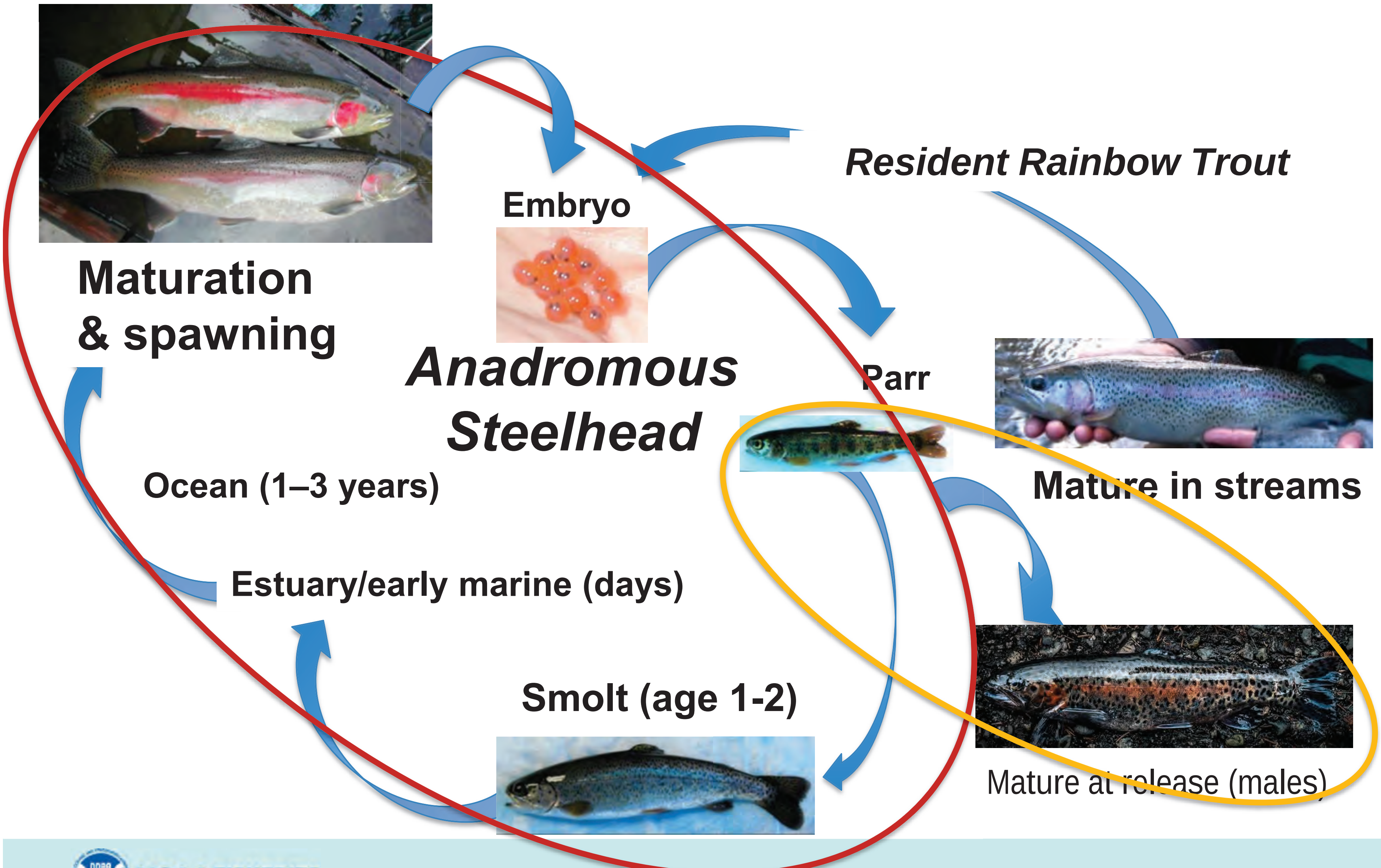
U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Mid-Columbia HCP-HC Meeting
Wenatchee, Washington July 18, 2018

Natural *Oncorhynchus mykiss* life history



Hatchery steelhead life history



Problems with residual hatchery steelhead

- Decreased efficiency of hatchery production
  - Fewer migration ready smolts
  - Increased cost per migration ready smolt
- Domestication selection & fitness loss
- Ecological interactions with natural populations
  - Competition, Predation
- Complicates genetic management (integrated)
  - Difficult to control or estimate pHOS
  - Mature males do not need to survive long to spawn

Background

- WNFH transition to NOR broodstock RYs 2010-2015
  - Paired release groups
  - Age-1 (S1) & Age-2 (S2)
- Compared survival and migration speed found that S2 ≥ S1
- Mortality and residualism were confounded.
- Additional data available to inform management of residual steelhead

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ARTICLE

Age and Method of Release Affect Migratory Performance of Hatchery Steelhead

Christopher P. Tatara*
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Environmental and Fisheries Sciences Division, Manchester Research Station, Post Office Box 130, Manchester, Washington 98353, USA

Matt R. Cooper and William Gale
U.S. Fish and Wildlife Service, Mid-Columbia Fish and Wildlife Conservation Office, 7501 Icicle Road, Leavenworth, Washington 98826, USA

Benjamen M. Kennedy
U.S. Fish and Wildlife Service, Abernathy Fish Technology Center, 1440 Abernathy Creek Road, Longview, Washington 98632, USA

Chris R. Pasley
U.S. Fish and Wildlife Service, Winthrop National Fish Hatchery, 453A Twin Lakes Road, Winthrop, Washington 98862, USA

Barry A. Berejikian
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Environmental and Fisheries Sciences Division, Manchester Research Station, Post Office Box 130, Manchester, Washington 98353, USA

Data: characterize, quantify, compare residuals

- 21,598 PIT-tagged fish pre-release sampling
  - 5 release years (2011-15)
  - Roughly equal representation
    - 10,888 S1 steelhead & 10,710 S2 steelhead
    - Every PIT-tagged fish released
  - Detection history from PTAGIS
- Summer residual collections near WNFH (2010-2015)
  - Lethal sampling: S1 or S2, RY, body mass, fork length, sex, gonad weight (males)
- Putative residual PIT tag detections in Methow and Columbia after primary migration period (from PTAGIS)

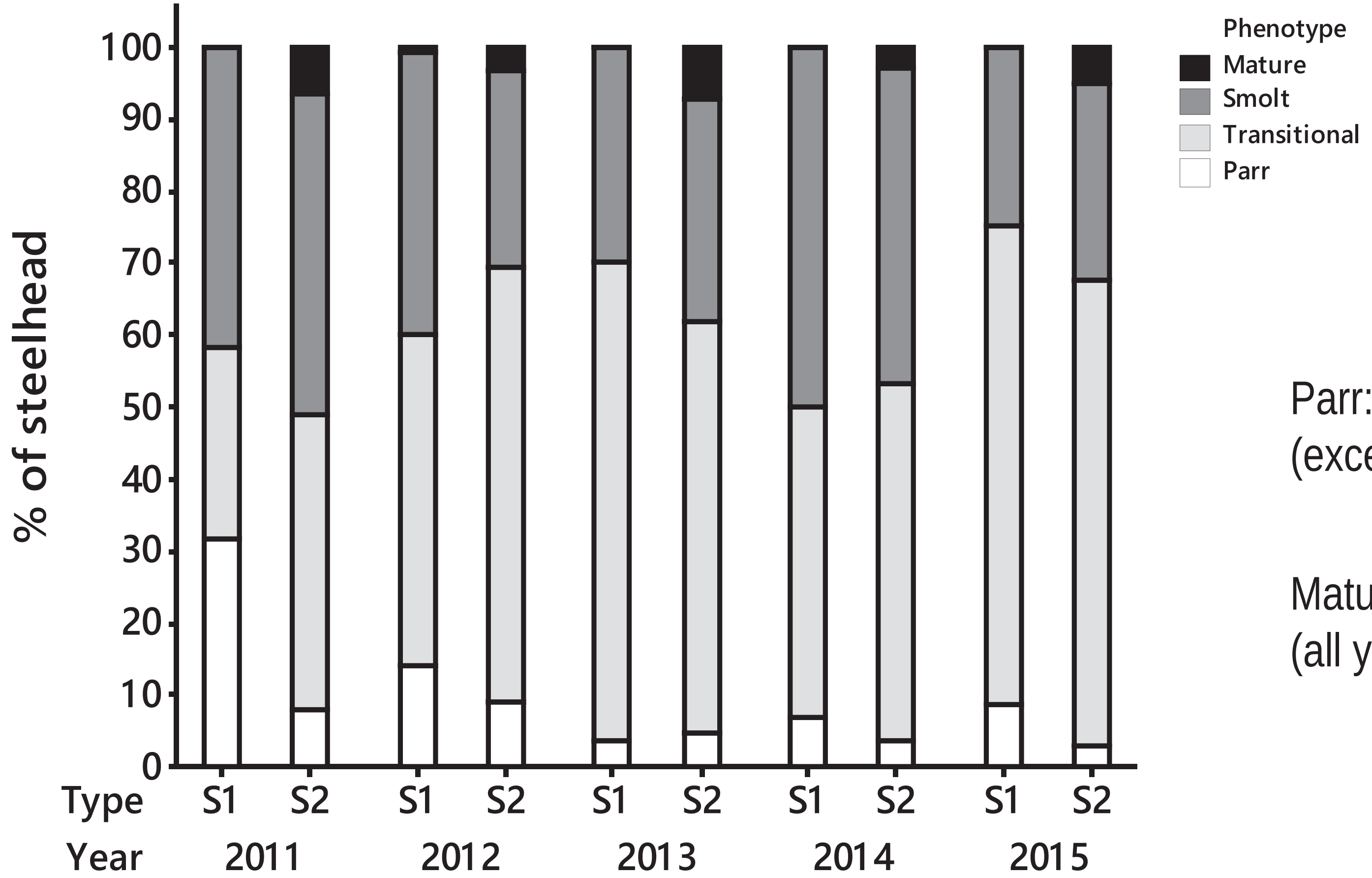
Pre-release sampling of PIT-tagged steelhead

- Conducted 3 weeks prior to release (last week of March)
- Sort PIT-tagged fish from raceways
- Mass, Fork length, Qualitative phenotype determination, (genetic sex identification 2011-13)

Rearing effects on phenotype

- Four phenotypes
  - Parr
    - Distinct parr marks
  - Transitional
    - Fading parr marks
  - Smolt
    - No parr marks & silver coloration
  - Mature male
    - Secondary sexual characteristics / milt

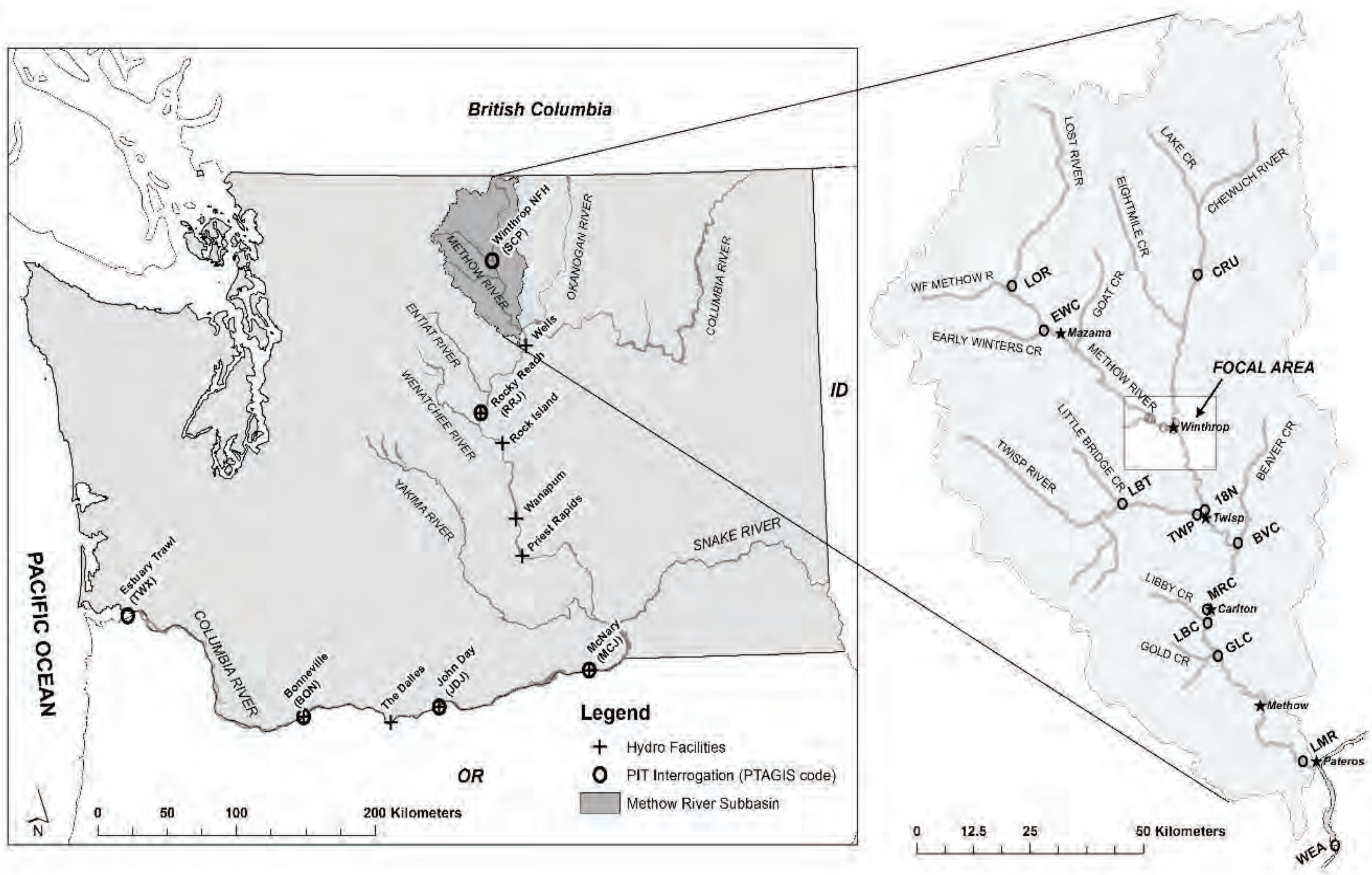
Age-at-release and phenotype



Parr: S1 > S2
(except 2013)

Mature: S1 < S2
(all years)

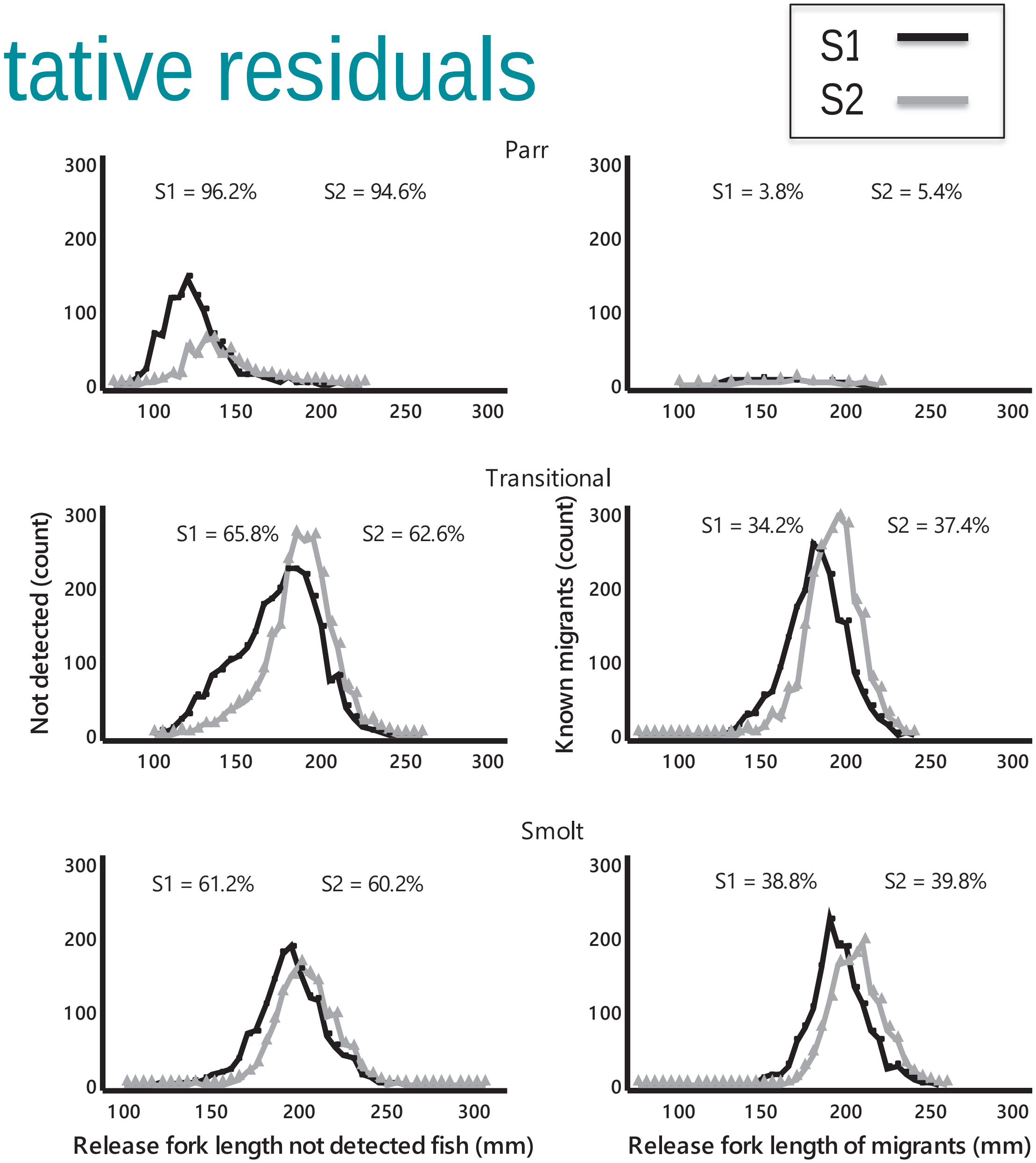
Columbia and Methow Rivers



Map credit: Michael Humling

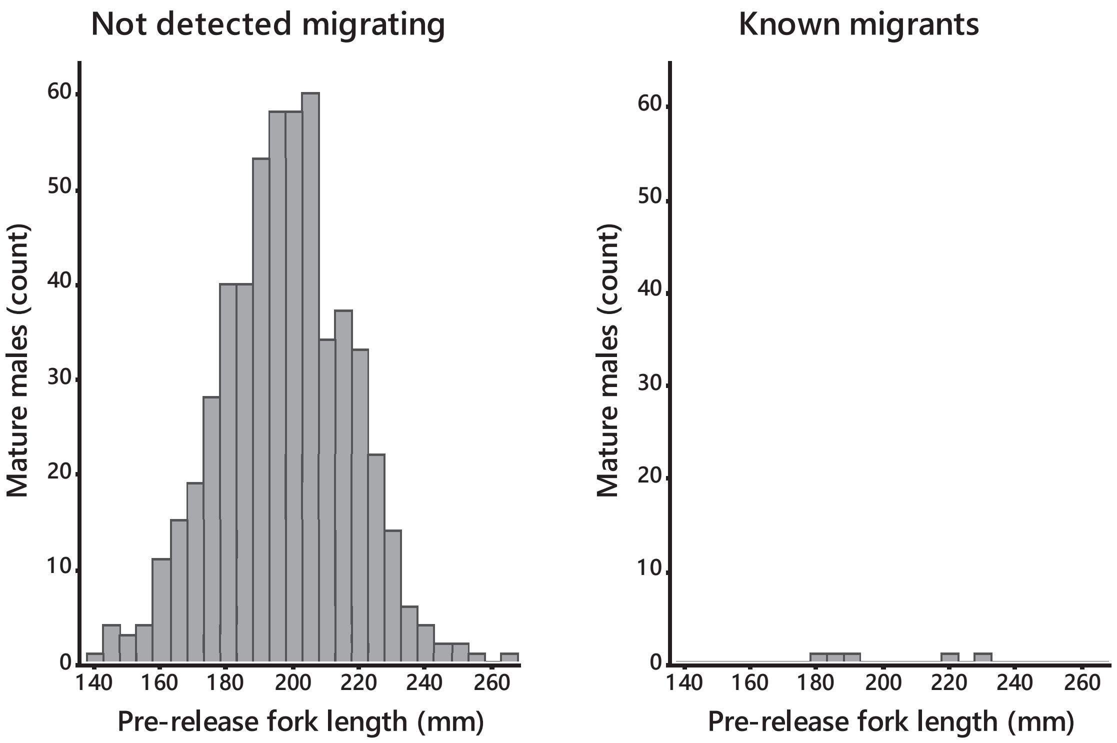
Determining putative residuals

- 21,598 PIT tagged fish from pre-release
- All years combined
- By phenotype
- Not detected
    - Migrated
    - Died
    - Residualize
- Known migrants – detected at least once in Columbia River



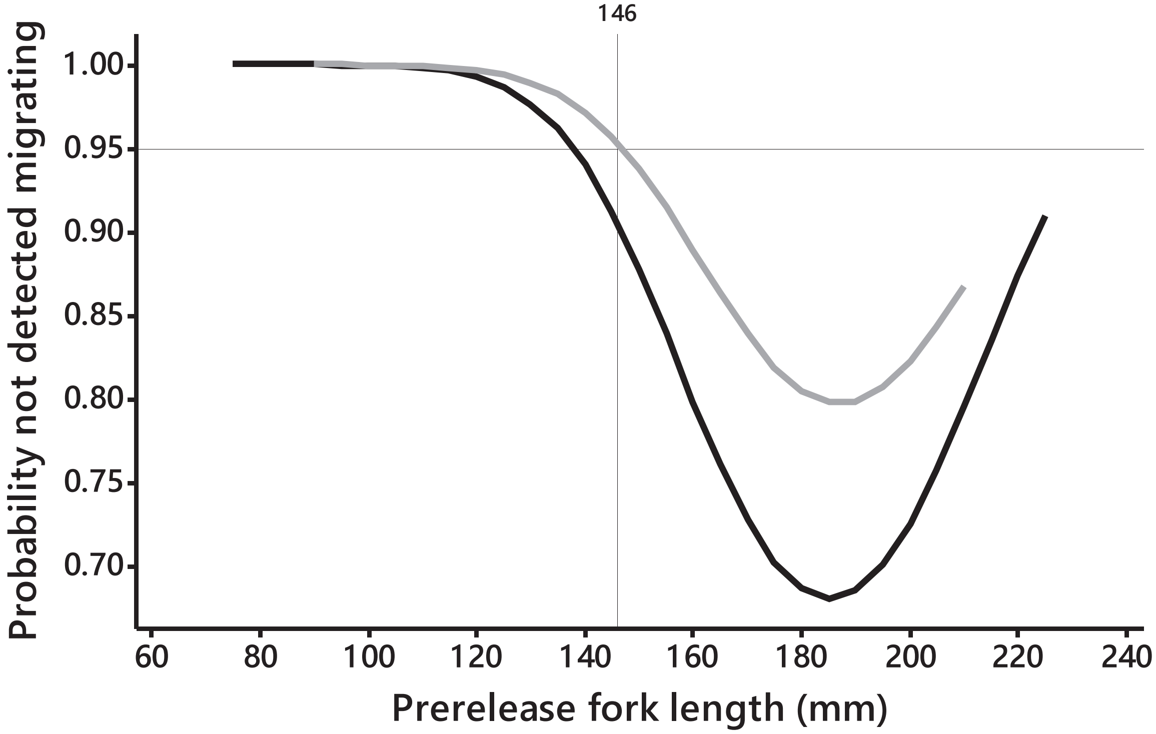
Determining putative residuals: mature males

- Mature males were rarely detected migrating from the Methow River
- Size was not a significant factor
- Age was, S2 > S1

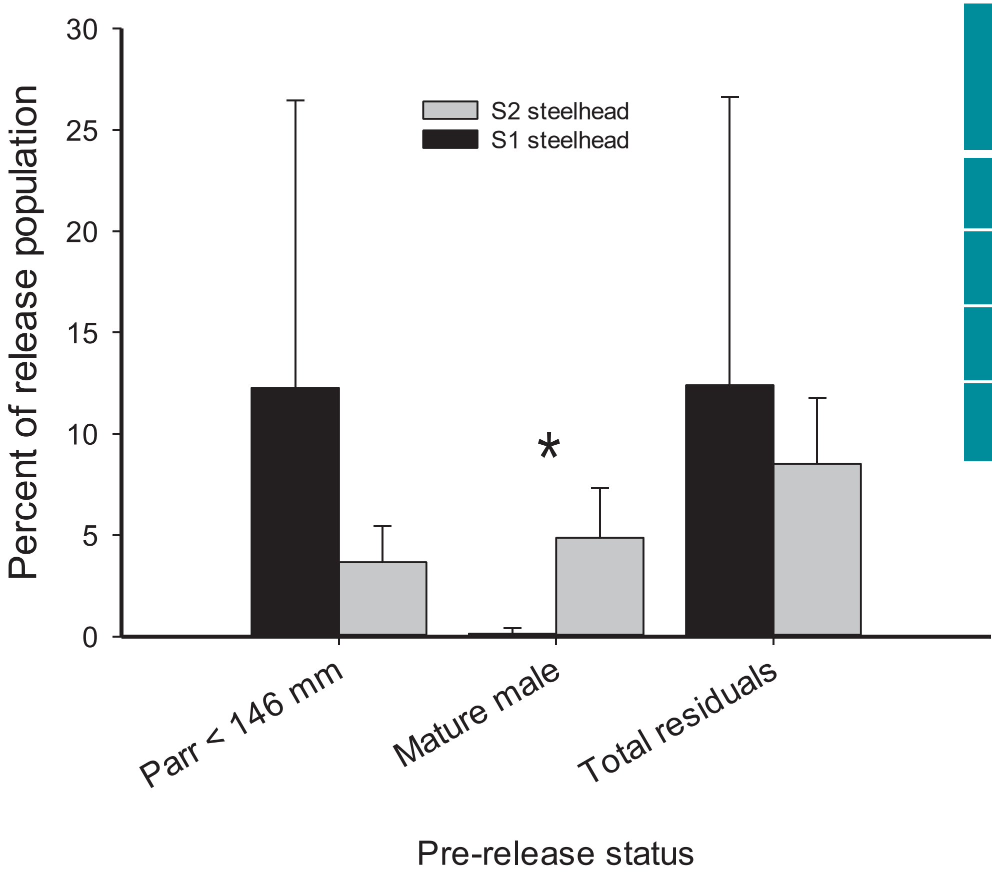


Determining putative residuals: parr

- Size was a significant factor for the parr
- Parr < 146 mm had < 5% probability of migrating from the Methow
- Age was a factor S1 > S2



PIT-tagged putative residual summary

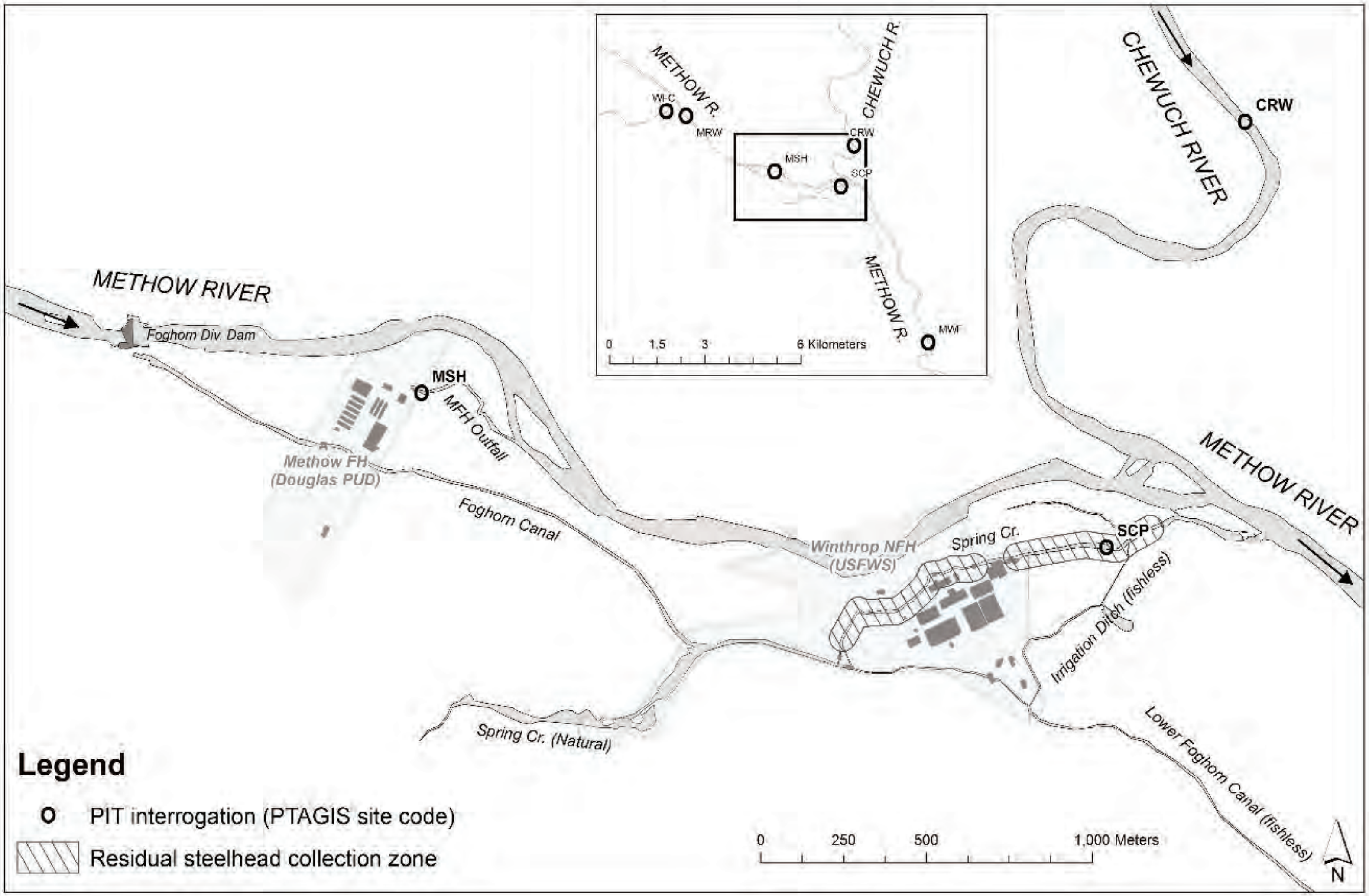


Rearing type	Parr residuals		Mature male residuals		Total residuals (Parr + Mature)	
	N	%	N	%	N	%
S1	916	75%	12	2%	928	52%
S2	312	25%	543	98%	855	48%
Total	1,228	100%	555	100%	1,783	100%

Direct evidence of residualism near WNFH

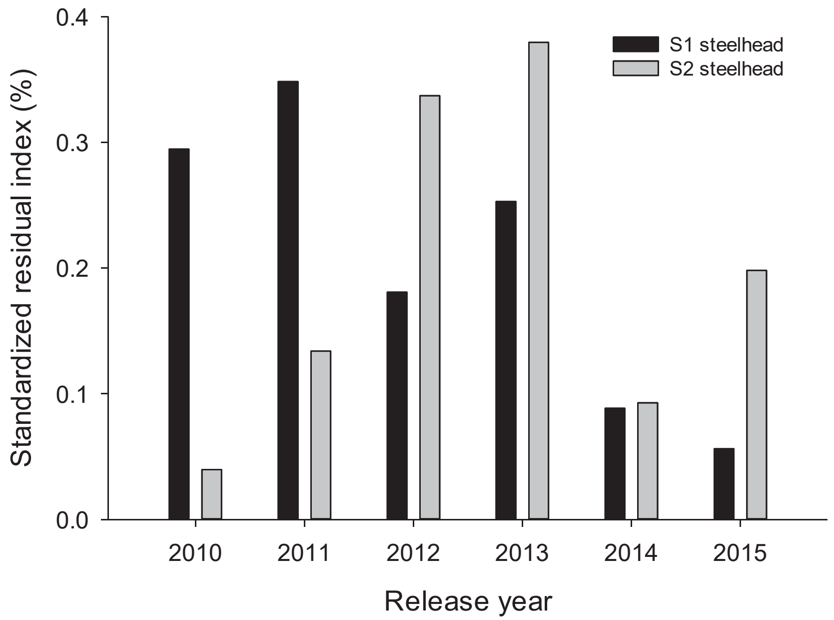
- Residual surveys
- Spring Creek
- Summer & fall after release
- Electrofishing and angling
- Lethal sampling
    - S1/S2, sex, mass, FL, testis weight, GSI
- Residual index

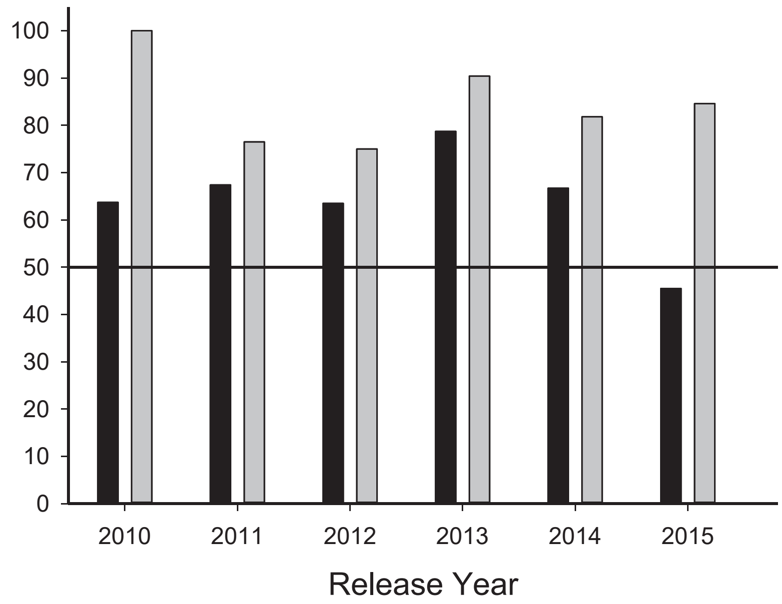
Vicinity of Winthrop National Fish Hatchery



Map credit: Michael Humling

Residual index and sex ratio of residuals





Residual index = Number release / number captured $\times$100

- Calculated separately for S1 & S2
- Standardized by CPUE to compare years

Maturation in steelhead

Image: Michael Humling

GSI = testis mass/body mass X 100

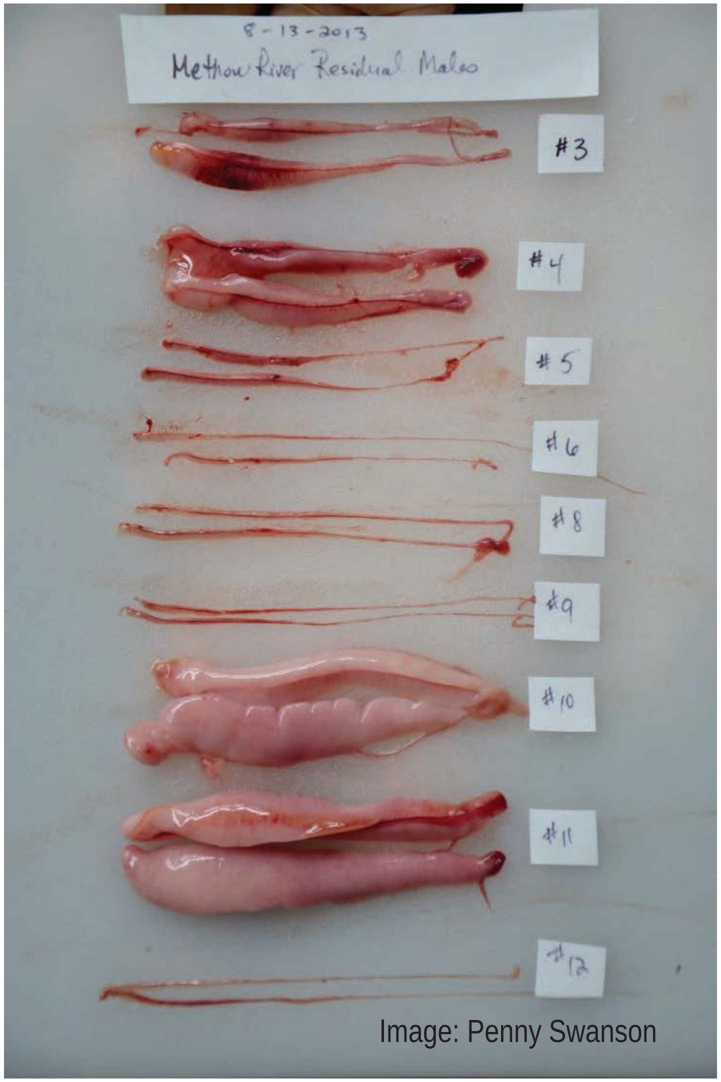
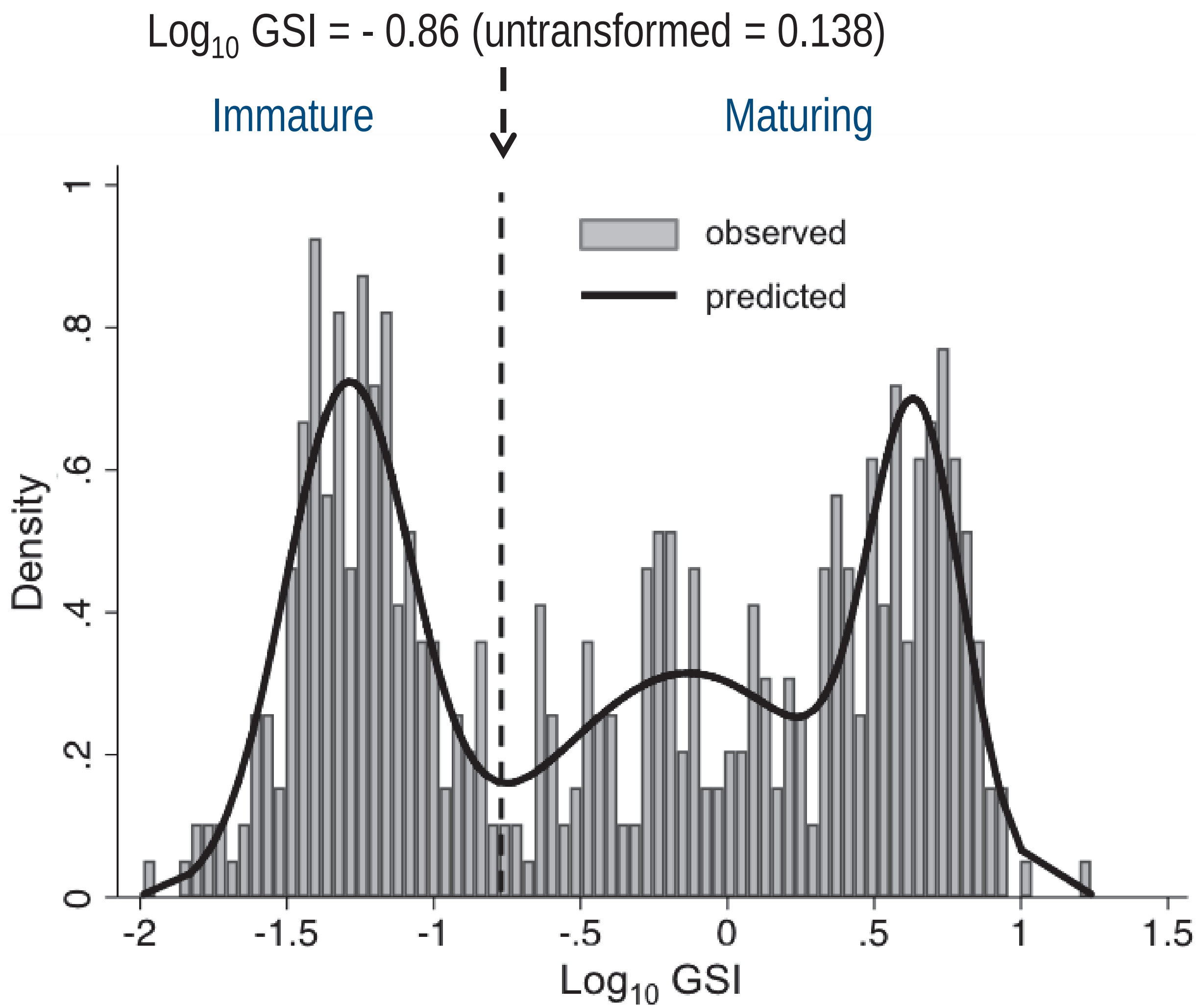
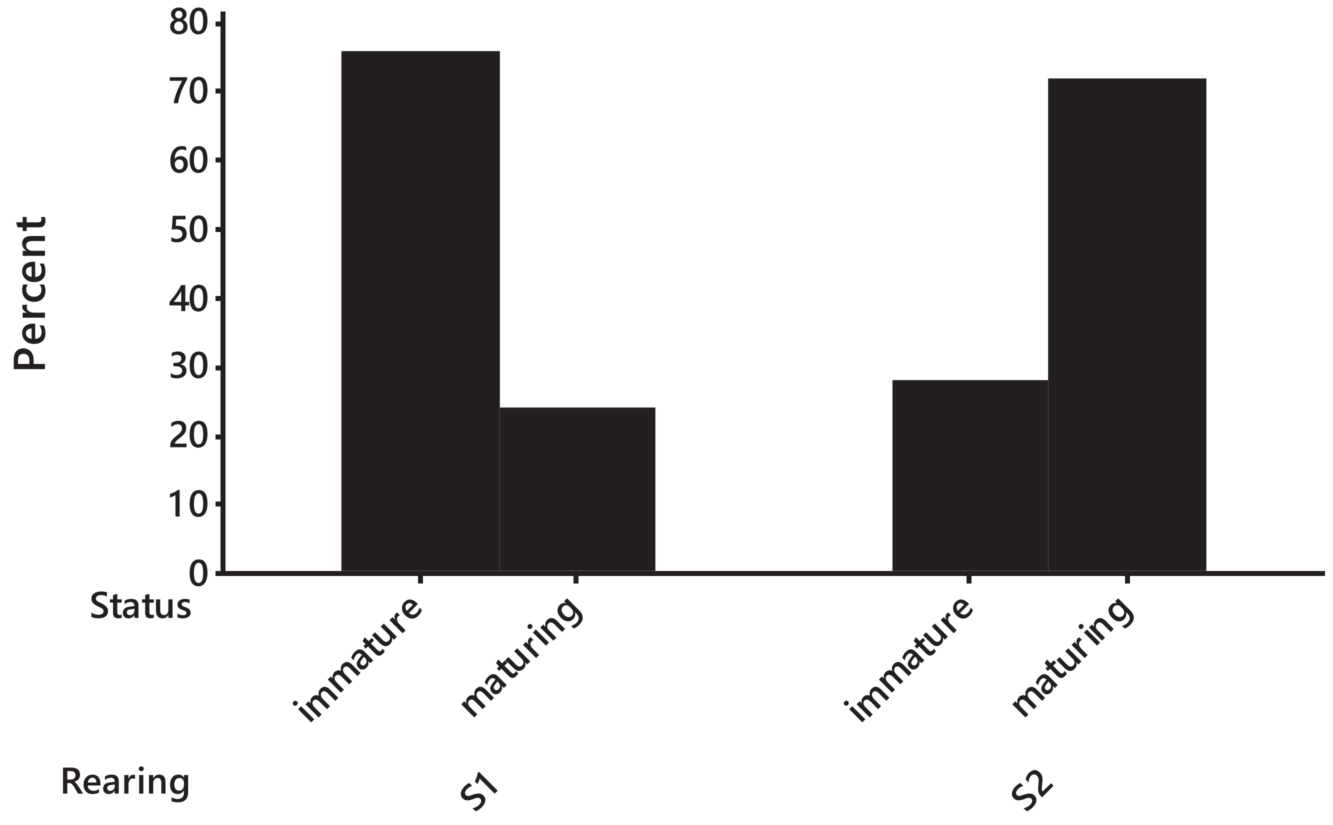


Image: Penny Swanson

Maturation status of captured male residuals



Maturation status of captured male residuals



Indirect evidence of residualism in rivers

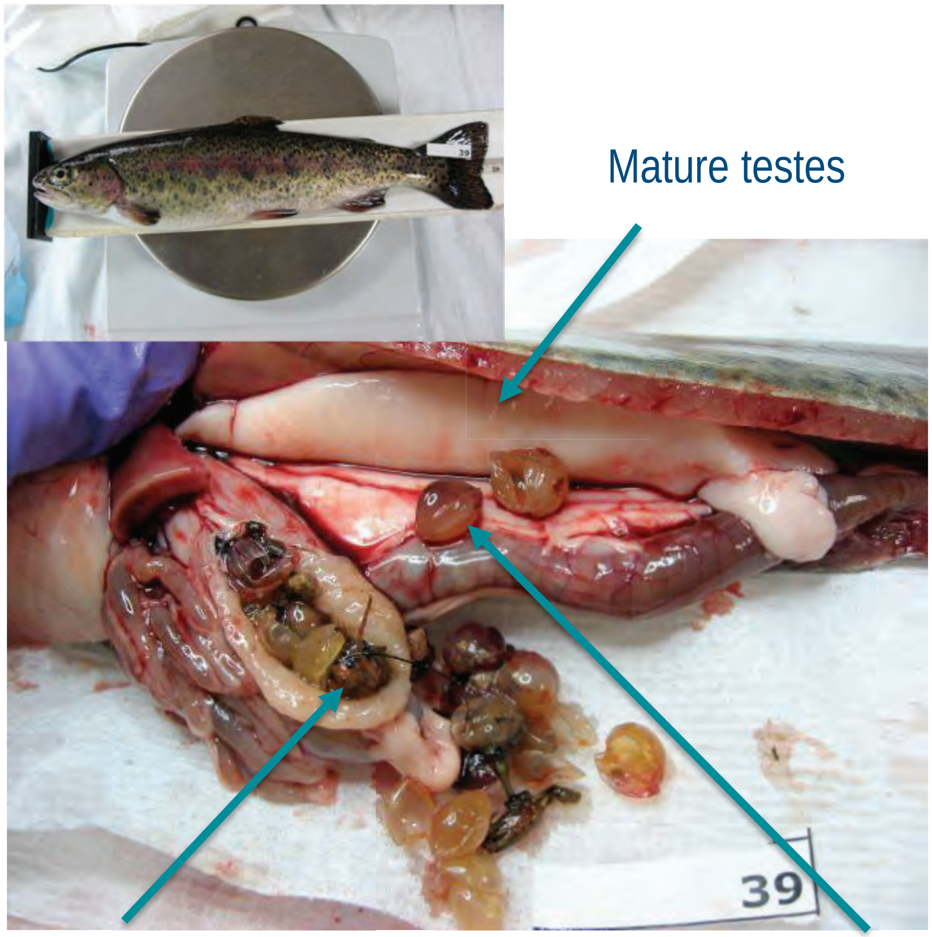
- Queried list of 1,783 PIT tags for putative residuals in PTAGIS
- Separate queries by phenotype
  - Parr & Mature
- PIT detections after July 1 of release year (primary migration period ended)

Rearing type	Parr residuals		Mature male residuals		Total residuals (Parr + Mature)	
	N	%	N	%	N	%
S1	916	75%	12	2%	928	52%
S2	312	25%	543	98%	855	48%
Total	1,228	100%	555	100%	1,783	100%

Ecological interactions & genetic risks

Mature testes

Precocious hatchery males

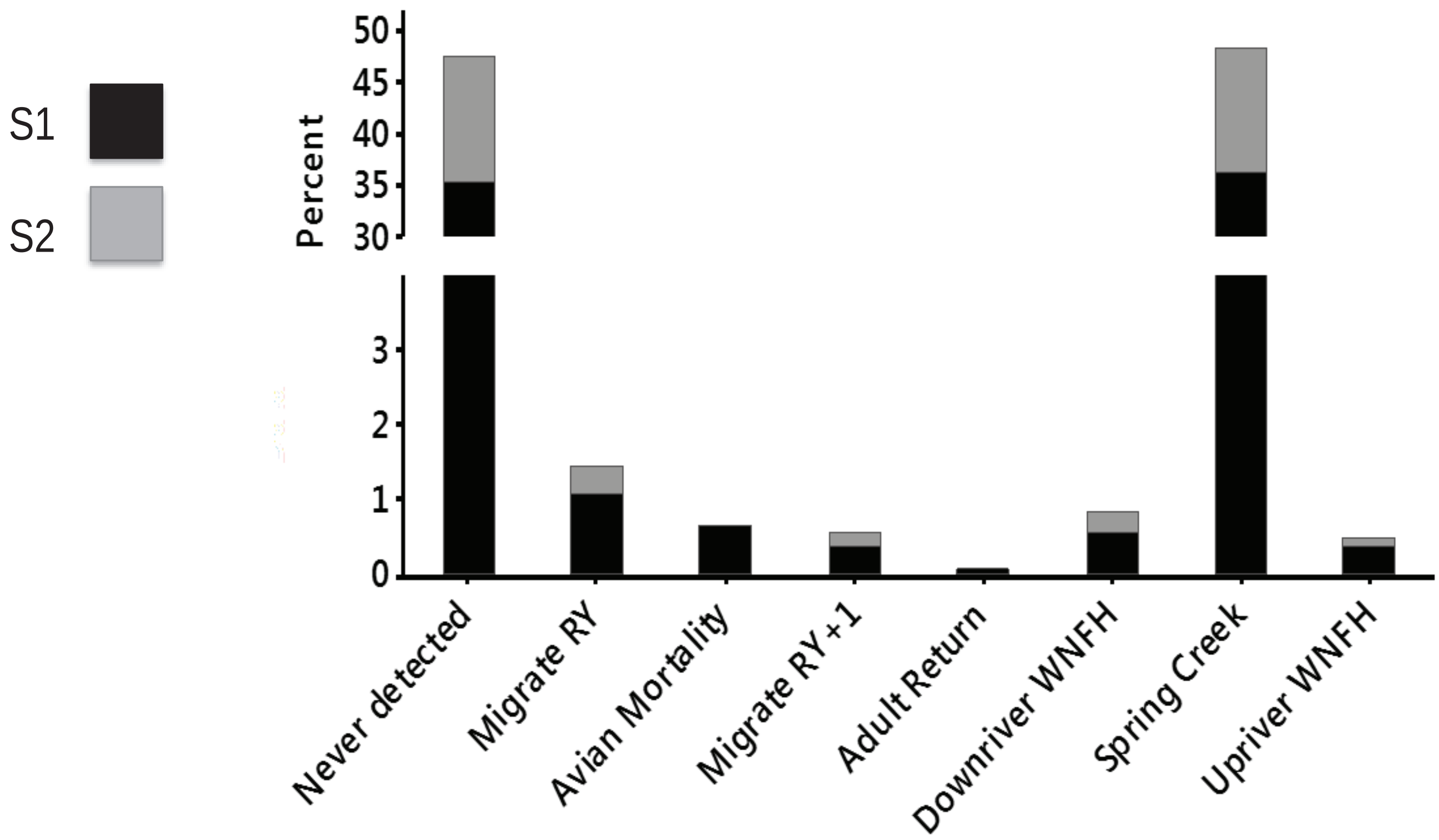


Yellow jackets

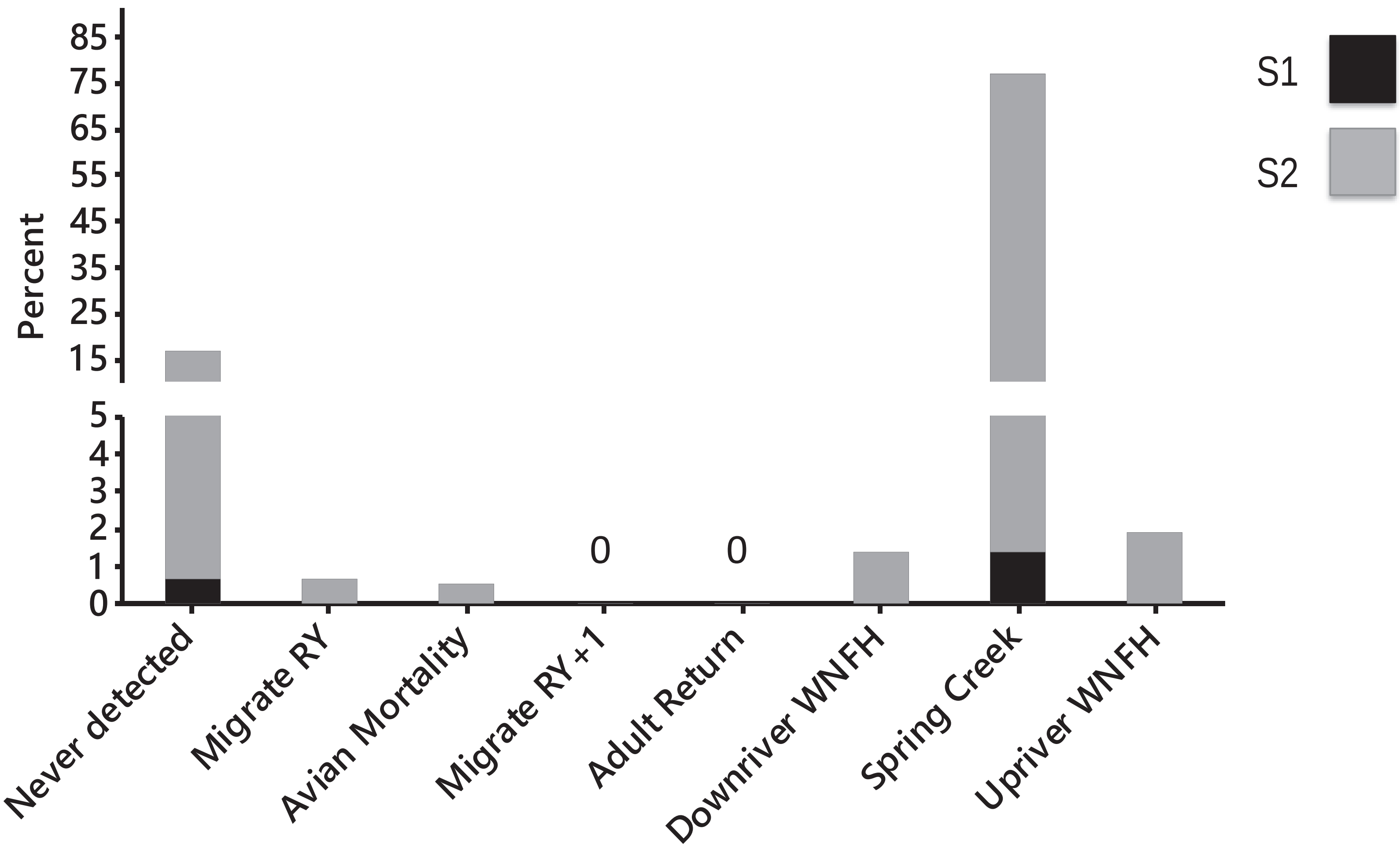
Chinook eggs

Anadromous female on redd

Fate of parr phenotype residuals

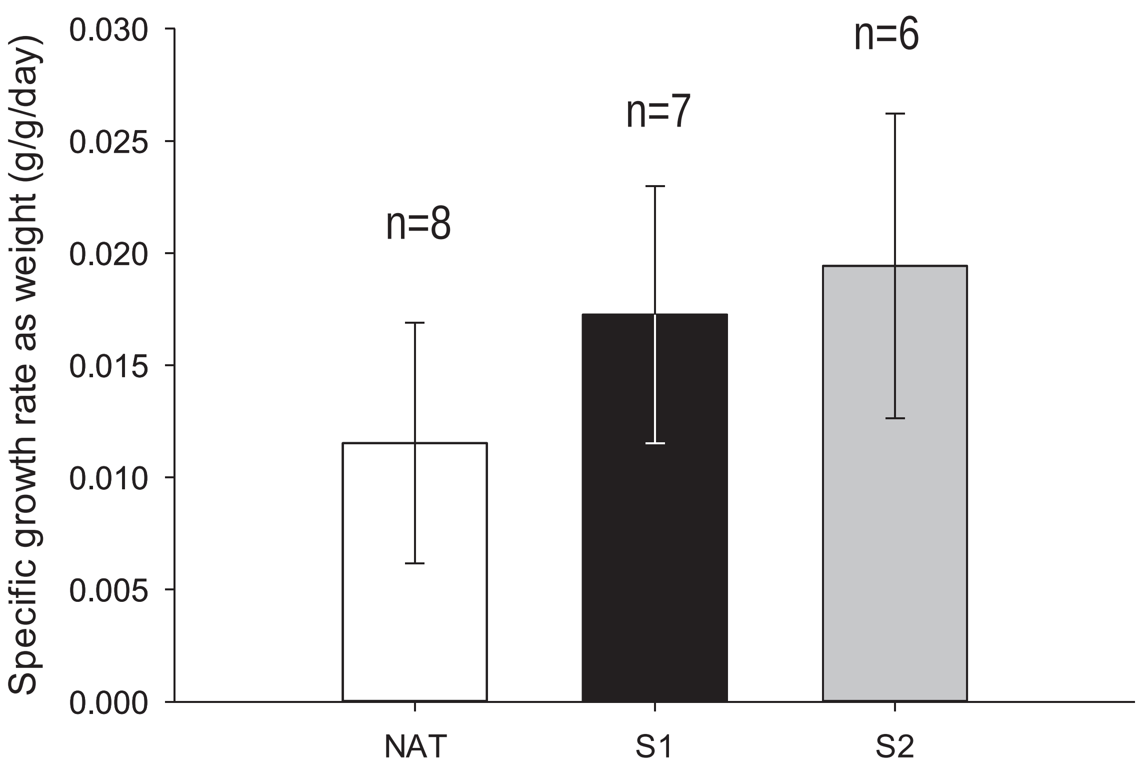


Fate of mature male residuals



Growth of residuals

- Instantaneous growth rate of captured residuals
- Compared to natural-origin *O. mykiss* from Methow River (Martens et al. 2014)



Conclusions

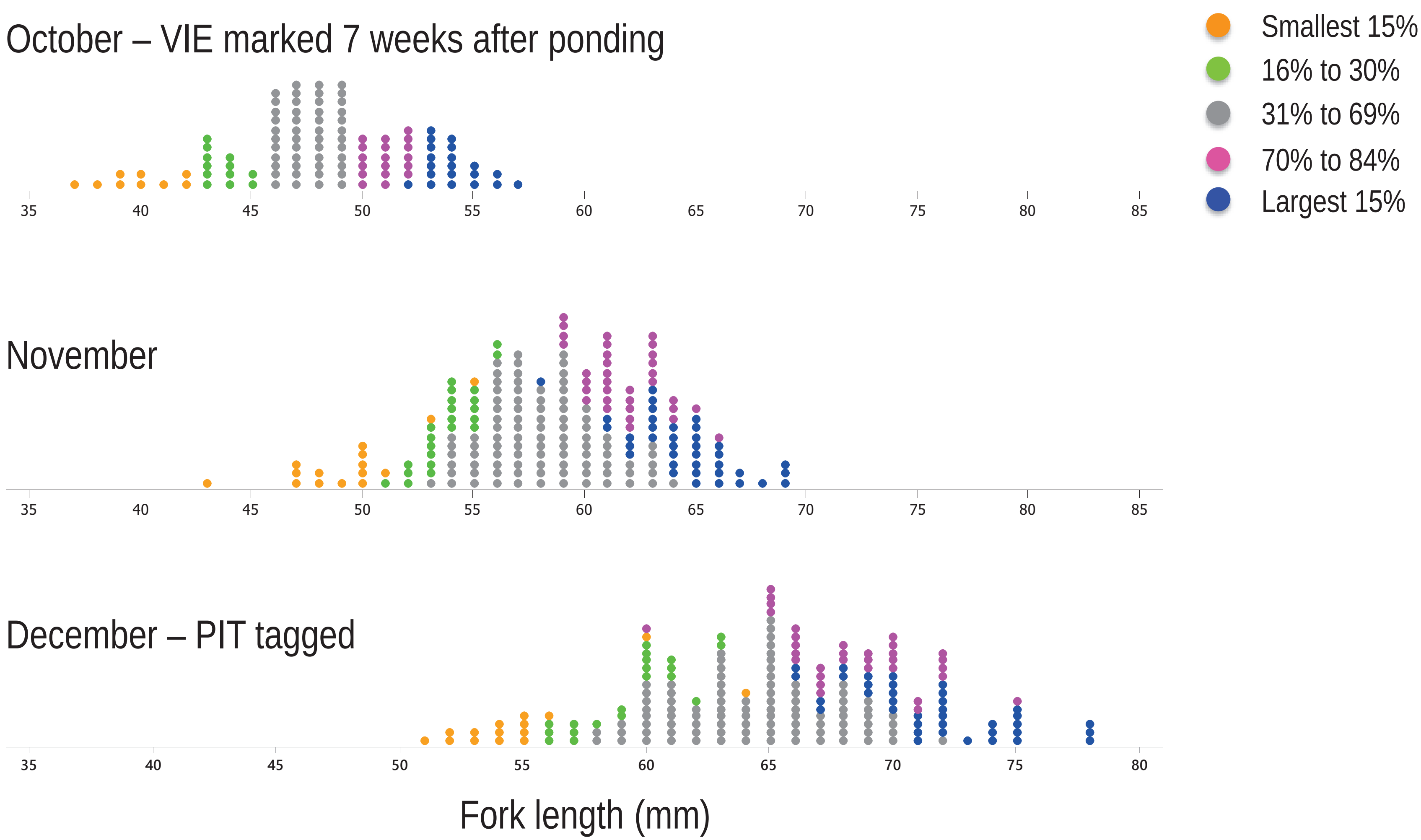
- Age-at-release does not impact the percentage of residuals produced, only residual phenotypes
- Both phenotypes have poor overwinter survival and contribute negligibly to anadromous production
- Ecological and genetic risks of residuals outweigh their contribution to anadromous production (SAR = 0.06%)
- Prevent release of residuals or change hatchery rearing practices to reduce residual production

Methods to prevent release of residuals

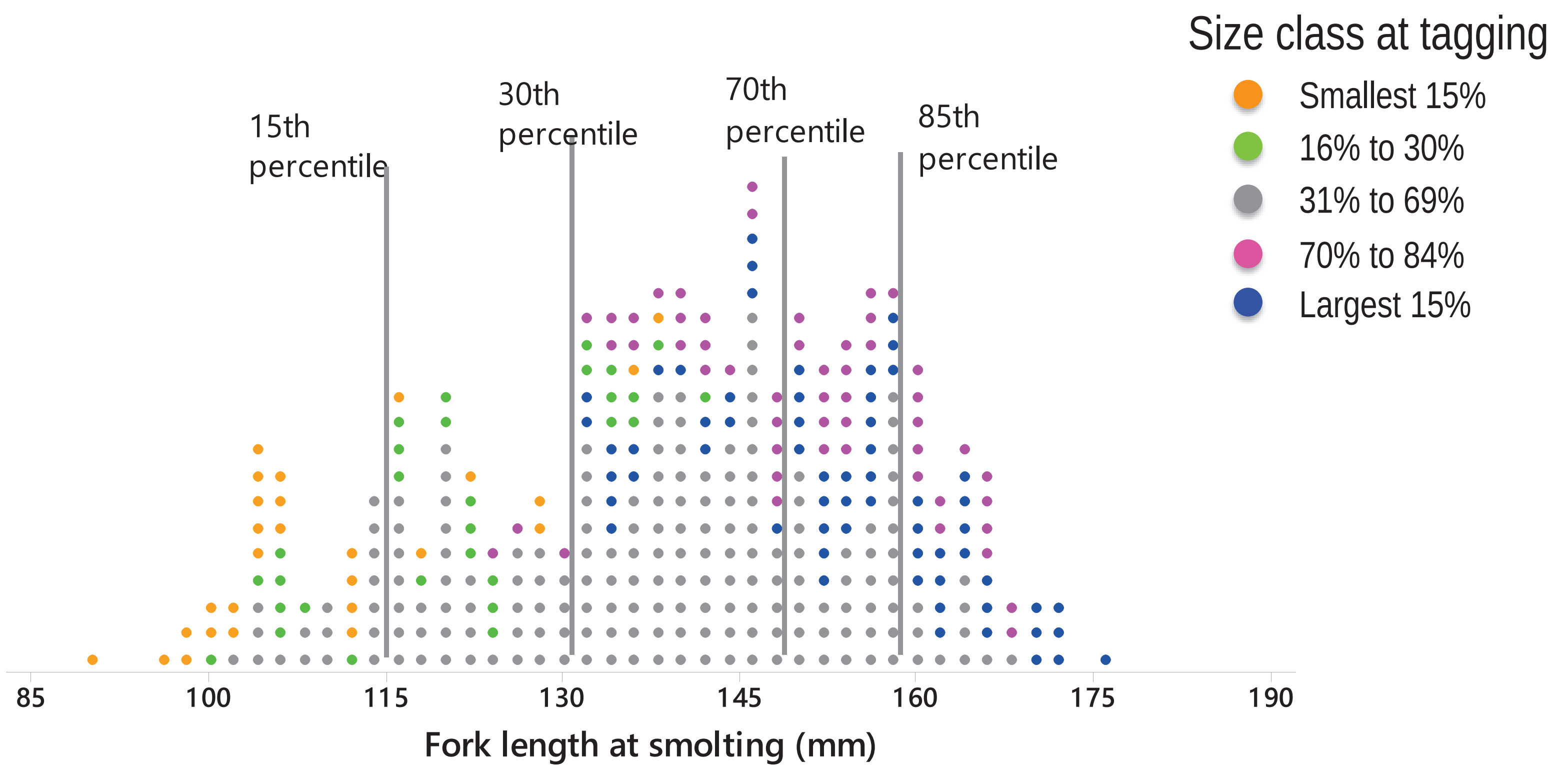
- Volitional release
  - Most effective for parr phenotype
  - Mature males leave
- Manual sorting
  - Extremely effective for removing both residual phenotypes
  - Labor intensive
  - Stressful for fish

Rearing methods to reduce residual production

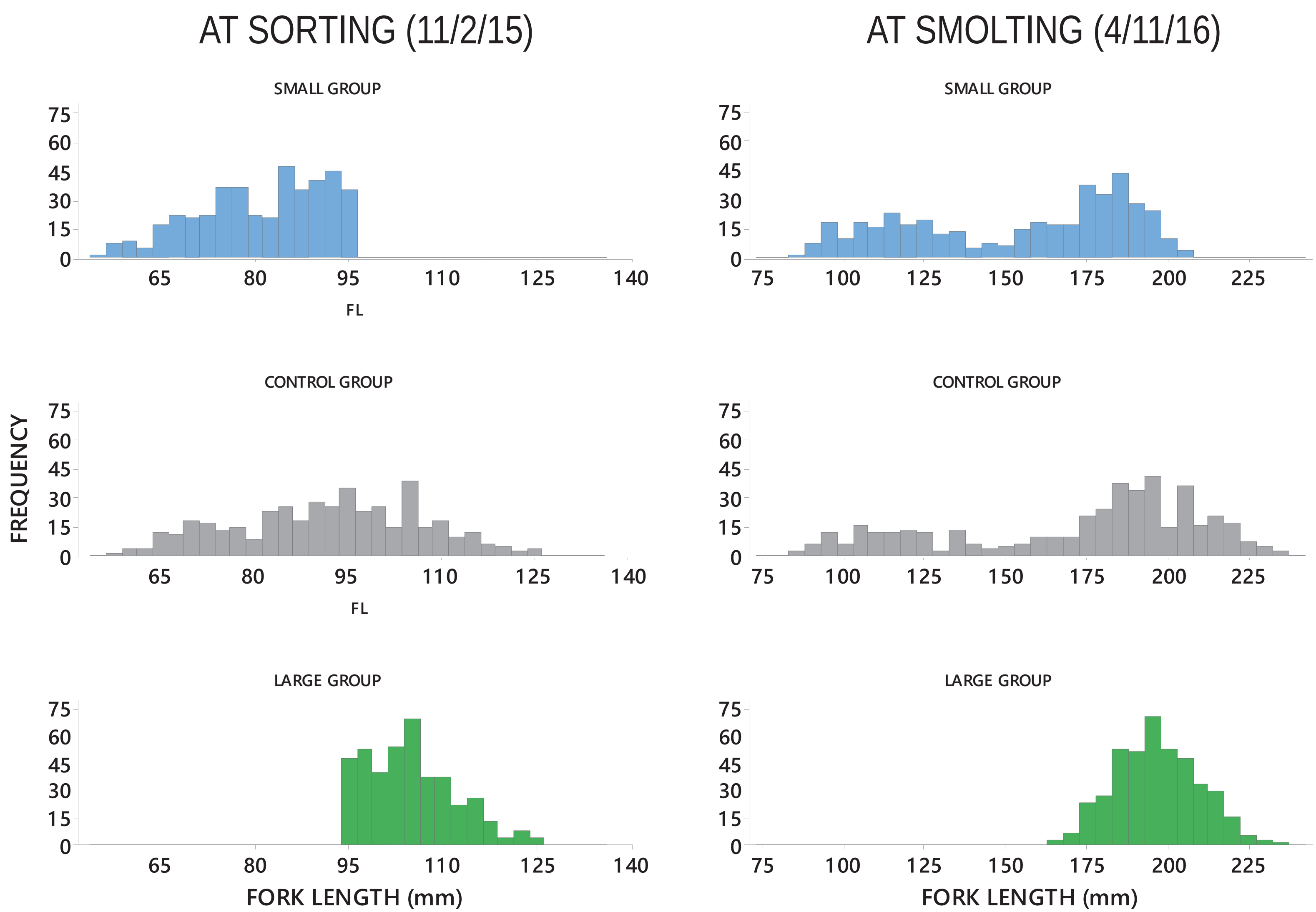
How early can we tell if a fish will not smolt?



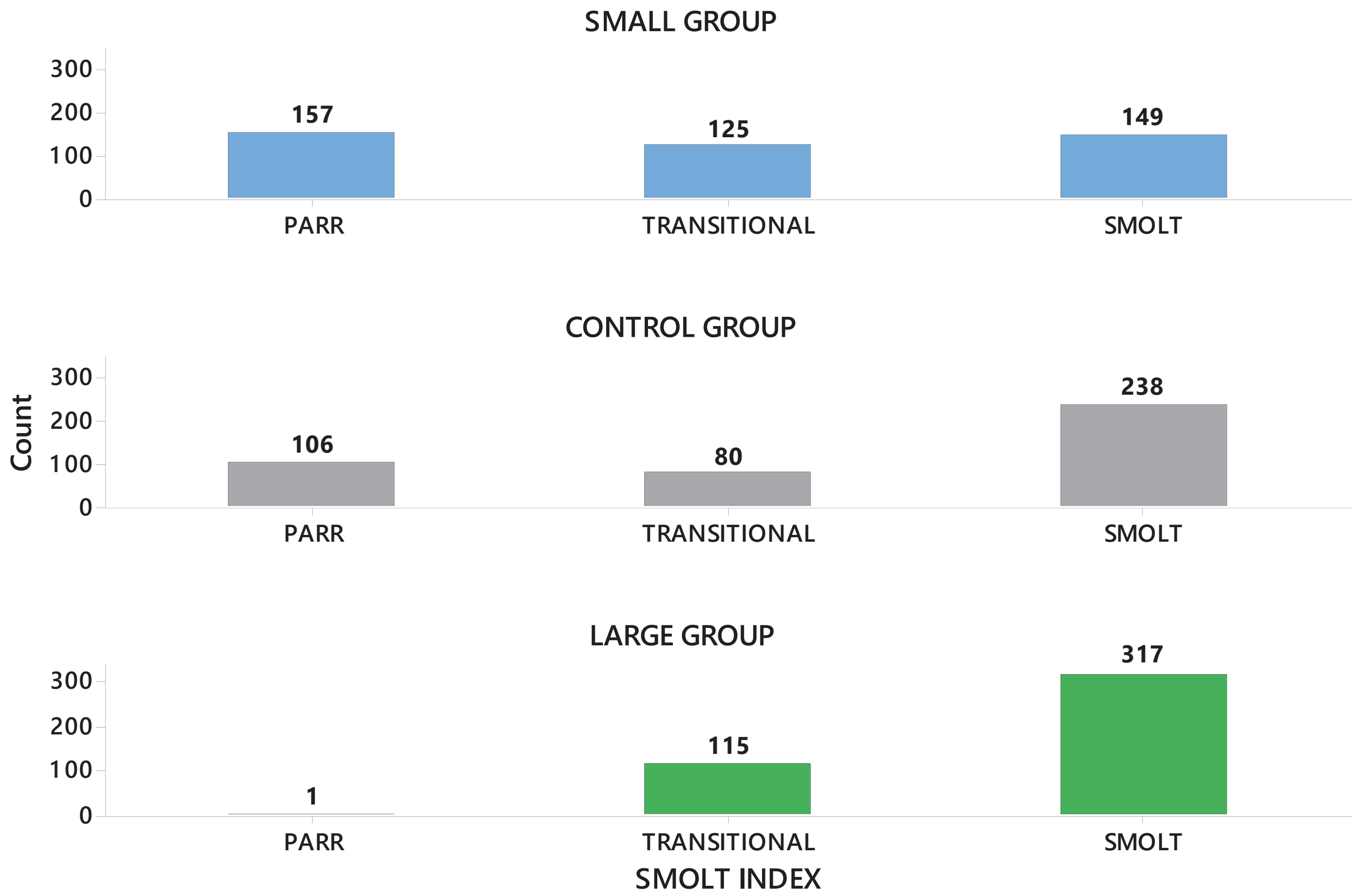
Early growth correlates with size at age-1 smolting



Does size sorting improve growth of small fish?



Does size sorting improve smoltification rate?

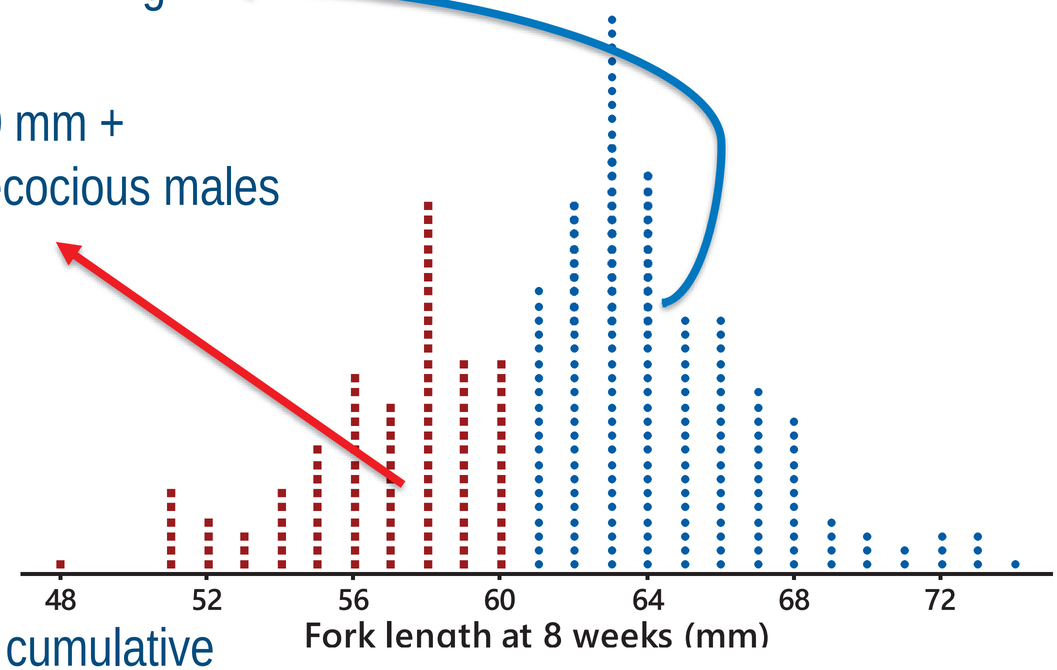


Optimizing smolt production with NOR broodstock

- Not all steelhead will grow rapidly enough to smolt at age-1, resulting in size selective mortality and residualism (~20%)
- Growing all steelhead as age-2 smolts relieves selection for rapid growth, but increases rate of precocious male maturation (~10% of males)
- Growth rate (and age at smoltification) is an individual characteristic established soon after emergence.
- Sort fish @ 9 weeks post-ponding, raise 2 groups: S1 & S2.

Optimizing smolt production with NOR broodstock

- Three treatments established 8 weeks post ponding after determining size distribution:
  - Control: unsorted + high ration raised S1
  - S1: largest 67% of fish ≥ 61mm + high ration
  - S2: smallest 33% of fish ≤60 mm + modulate growth, reduce precocious males
- Three replicate tanks
  - 250 fry per tank
  - Target smolt size = 90 g
  - SWC at smoltification
- Percentage of S2 is a function of cumulative TUs of broodstock and juveniles.



Acknowledgements


Image: Michael Humling

Collaborators

- USFWS – staff of WNFH and Mid Columbia FRO
- NOAA/NWFSC - Manchester and Montlake
- UW
- WDFW

Funding: BPA (project 1993-056-00), USFWS, NOAA

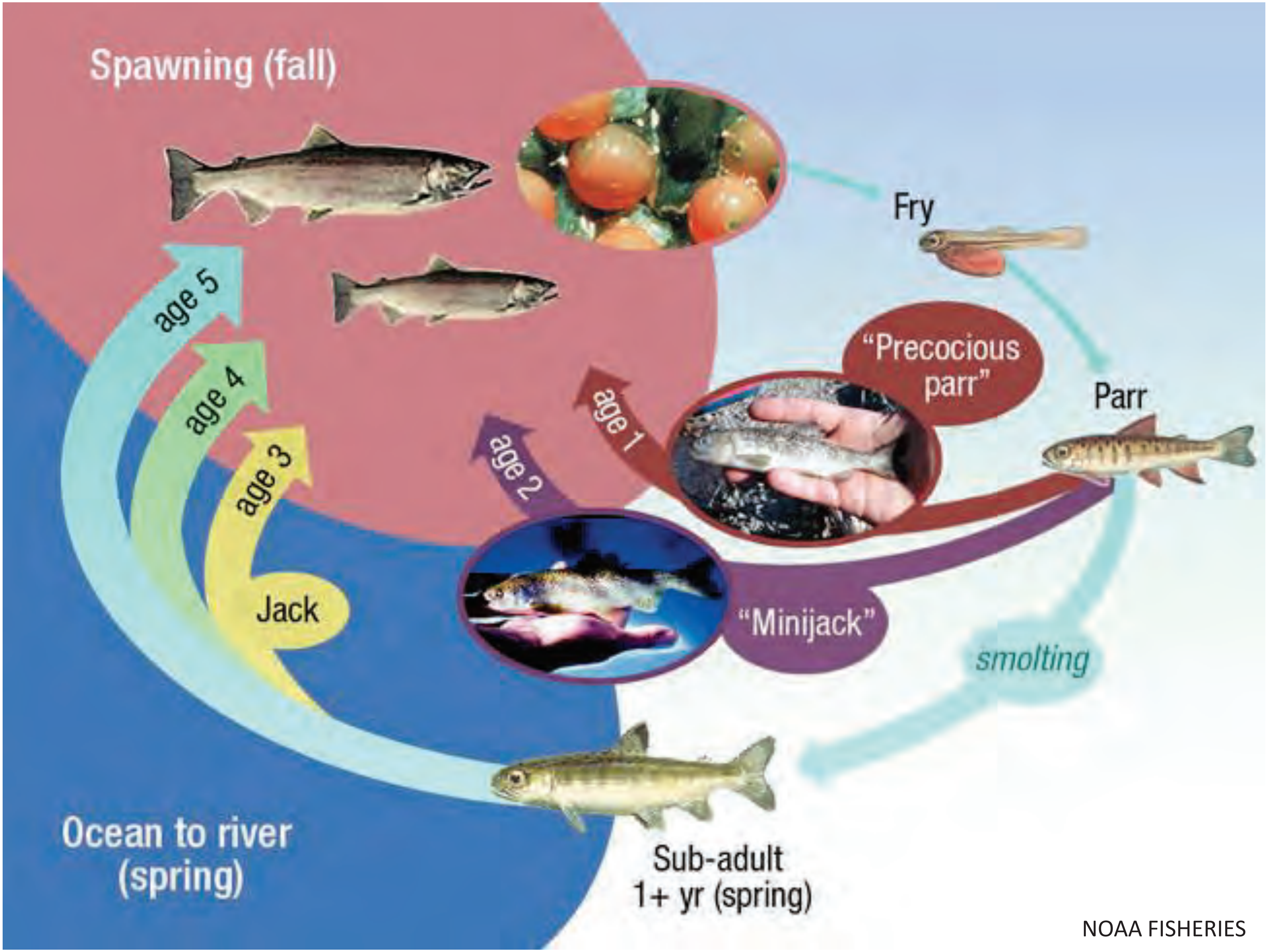
Early Maturation Monitoring

Gonadosomatic Index (GSI) Methodology
&
USFWS Three Year Monitoring Results

Katy Pfannenstein
USFWS-MCFWCO
July, 2018

Overview

- Early male maturation background
- Why monitor at hatcheries?
- GSI methodology
- USFWS results – three year effort
  - Spring Chinook (Leavenworth, Winthrop NFH)
  - Summer Chinook (Entiat NFH)
  - Steelhead (Winthrop NFH)
- Sampling recommendations for other facilities



NOAA FISHERIES

Residualism

Non-migrating individuals: Why they stuck around…

- Fish did not smolt; not ready to migrate to ocean
- Fish mature early, ready to spawn, no need to migrate
- Chinook residuals: majority are early maturing
- Steelhead residuals: not as clear
    - Non-migrating, non-maturing
    - Early maturing

Early Male Maturation

- <5% in wild salmonids, hard to quantify
  - Screw trap, spawning ground surveys
- Genetics and environmental conditions
  - Water temp, food availability
- Negative Impacts of Hatchery Production
  - Economic, genetic and ecological
  - Lower return rates for harvest/broodstock
  - F:M ratio skewed, more females return
  - Compete with native fish for food/habitat

Why Monitor Early Male Maturation?

- Hatchery Terms and Conditions

- *LNFH: 3d. Post-release survival of LNFH-spring Chinook salmon smolts shall be monitored and evaluated to determine the speed of emigration and level of residualism.*

Hatchery Management

What to do with this information

- What are your program goals?
  - Produce fewer early maturing males?
  - Produce higher SAR?
  - What’s the ideal size of fish for your facility?
  - Terms and Conditions may dictate how you move forward

GSI Methodology

[Gonad Weight/Body Weight] x 100

(males only)

- Lethal sampling method
- 300 fish at each facility
  - Approx. 150 males
- Fish sampled around release (April)
- Easy, effective, produces consistent results

GSI Methodology

- Used for numerous fish species
- Originated with Nikolski 1963
- Following Larson et al. 2004 methods
- Other methods for assessing maturation
  - Testicular Histology
  - 11-Ketotestosterone
  - Both are more expensive, greater expertise needed and time intensive

GSI Sampling Time Commitment

- 6-7 total experienced samplers, 4 dissecting
- Approx. 100 fish an hour
- Increase efficiency - gather fish before crew arrives!

GSI Method Start-Up Costs

- Micro Balance to 0.0001g - $3,400/unit
- Scissors/Forceps - $200 (set of 4)
- Absorbent Lab Paper - $65/roll
- Rite-in-the-Rain Paper - $30/100 sheets
- Small weigh boats - $20/500

Initial Investment: ~$3,700

Annual Costs: ~$100

- Items you already have:
  - Small scale, length board
  - Tubs, dip nets, anesthetic
  - Etc…

11-KT Costs
$10/fish for supplies
+ ??? Lab Costs

Data Collection

Lethally sample 300 fish (~150 males)

- Fork length (mm)
- Body weight (g)
- Sex (M/F)
- Visual maturation call
  - 1- immature, 2- mature
- Gonad weight (g)

(Mature Male)

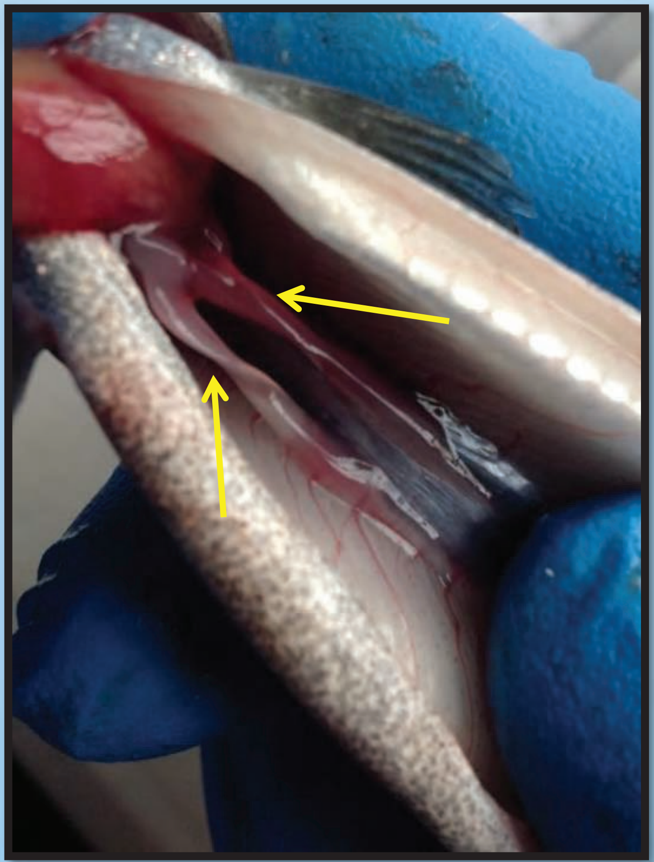
Male Identification

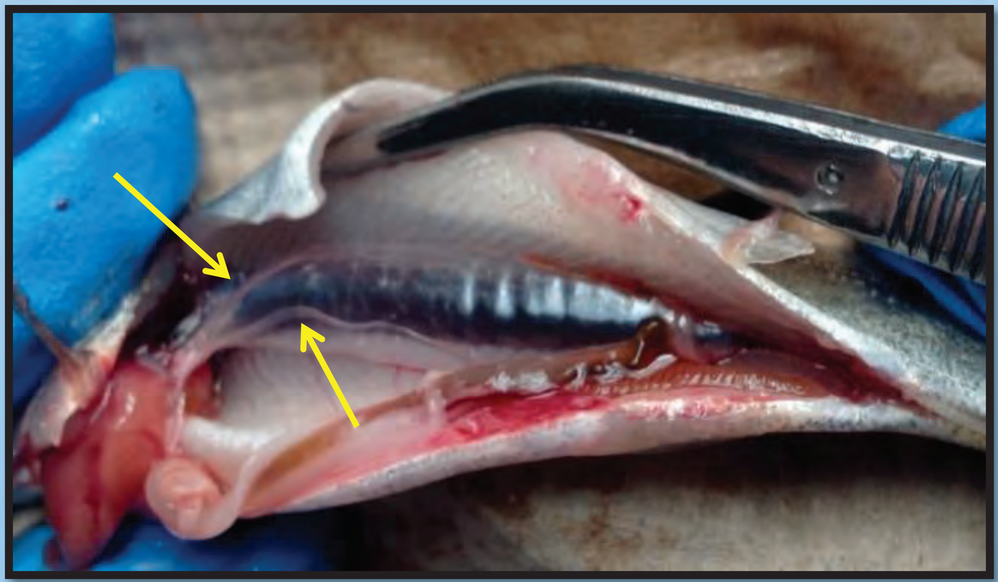
Immature Male

- Testes thread-like throughout
- Smooth and round
- No development or thickness

Mature Male

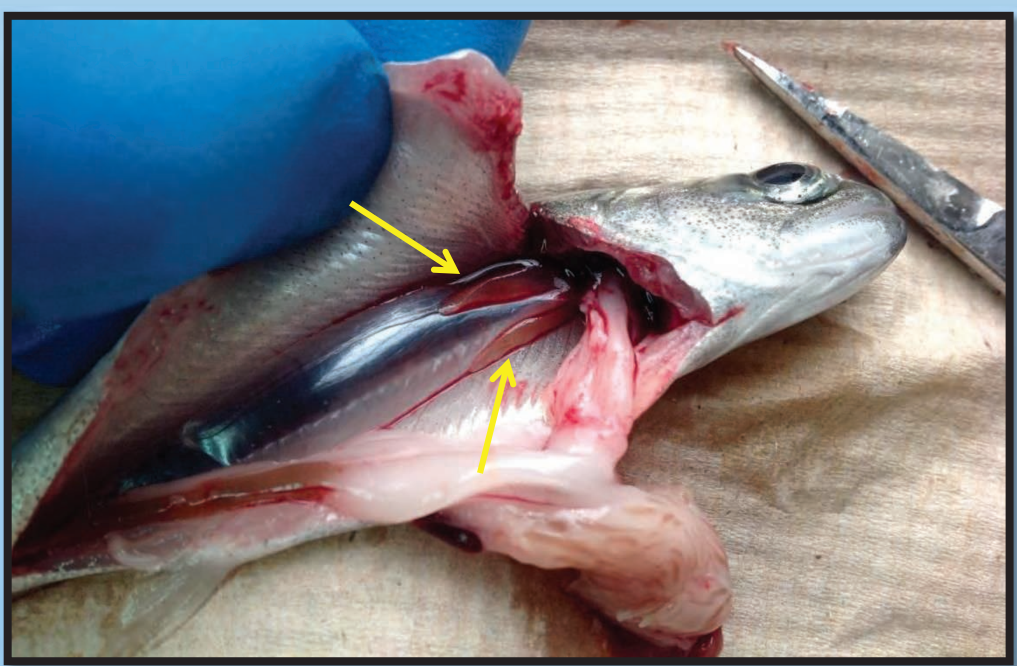
- Testes thicken
- Become white/opaque
- Smooth
- Tapers to tail

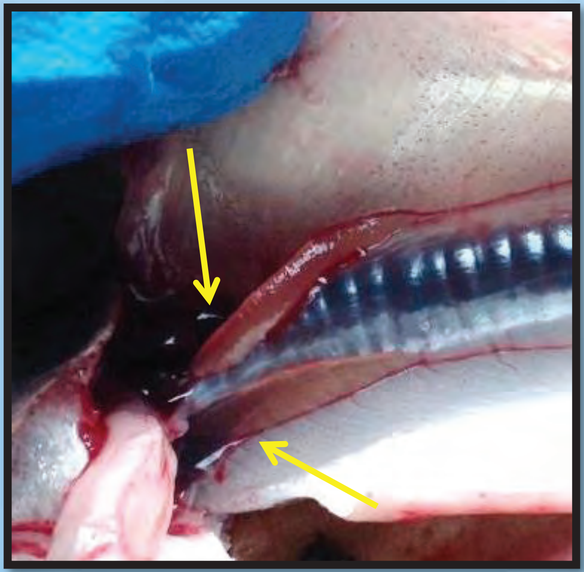




Female Identification

- Ovary forms a point and then narrows to oviduct – thread-like
- Ovary is angular, has ridge
- Granulated
- Color varies from pink to white, is not a good indicator





Gonad Development

- Fish body weight/length: develop linear
- Gonad weight: develop exponentially once signaled

- Spring Chinook spawn in August
  - 4 months from release
- Summer Chinook spawn in October
  - 6 months from release
- Steelhead spawn in May
  - 1 month (milting), 13 months (initiating) from release

USFWS Facilities Sampled

Leavenworth NFH

Spring Chinook , HxH

Winthrop NFH

Spring Chinook, HxH

Steelhead, S2, WxW

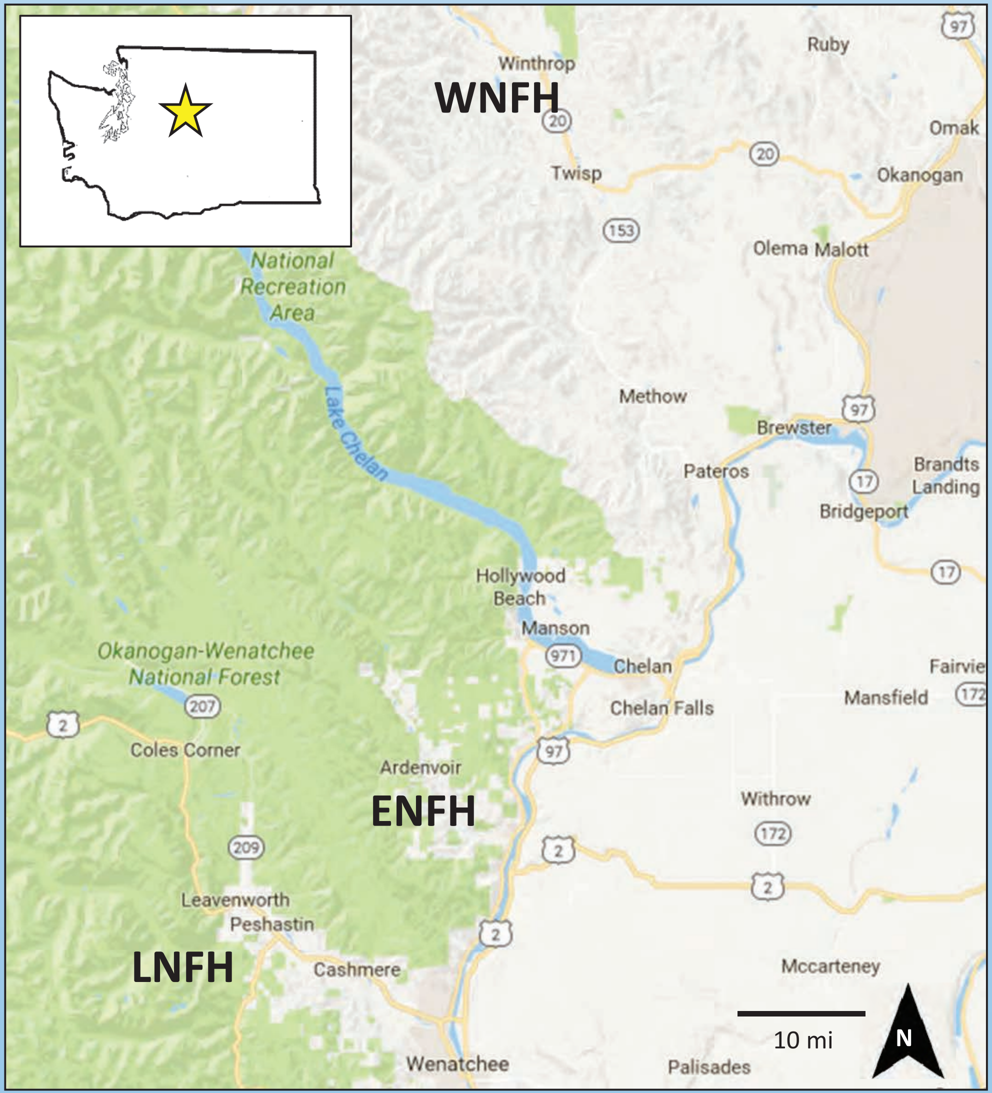
Entiat NFH

Summer Chinook, HxH

April Pre-Release

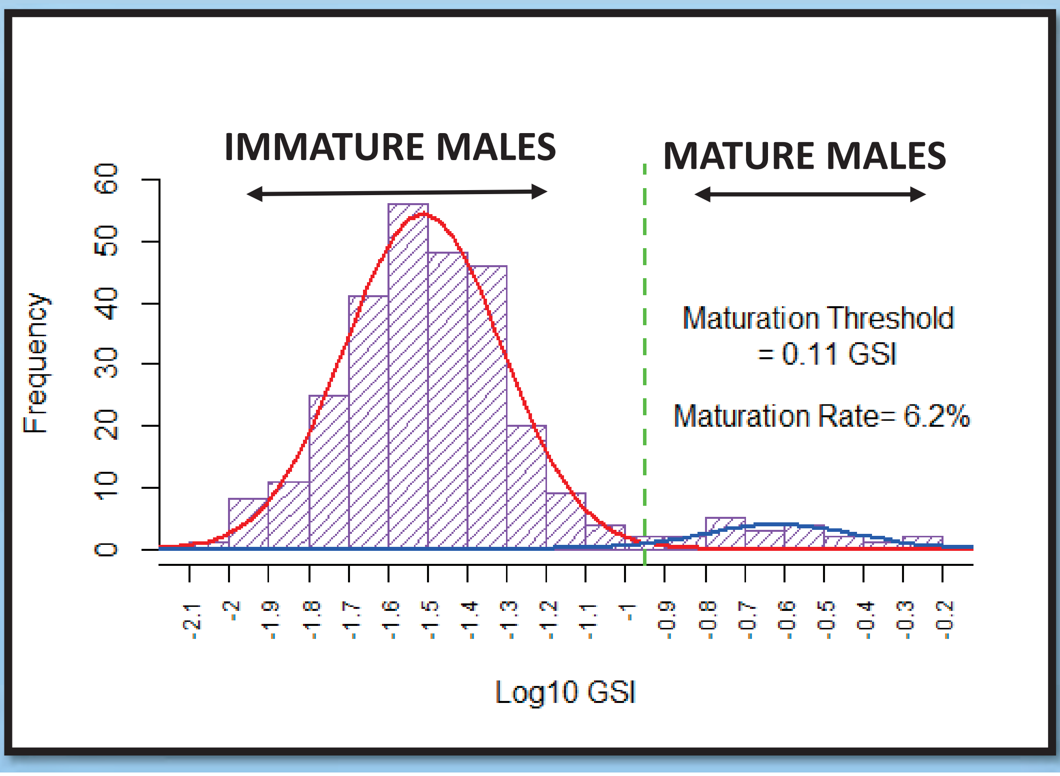
May Post-Release (samples held a month)

Brood Years 2014-2016



Data Analysis

- Summary Statistics
- Log10 transform GSI data
- Mixture Models used to statistically identify the maturation threshold
    - Thanks to Dr. Lea Medeiros from U of Idaho for mixture model code



Chinook **MALE** Maturation Rates

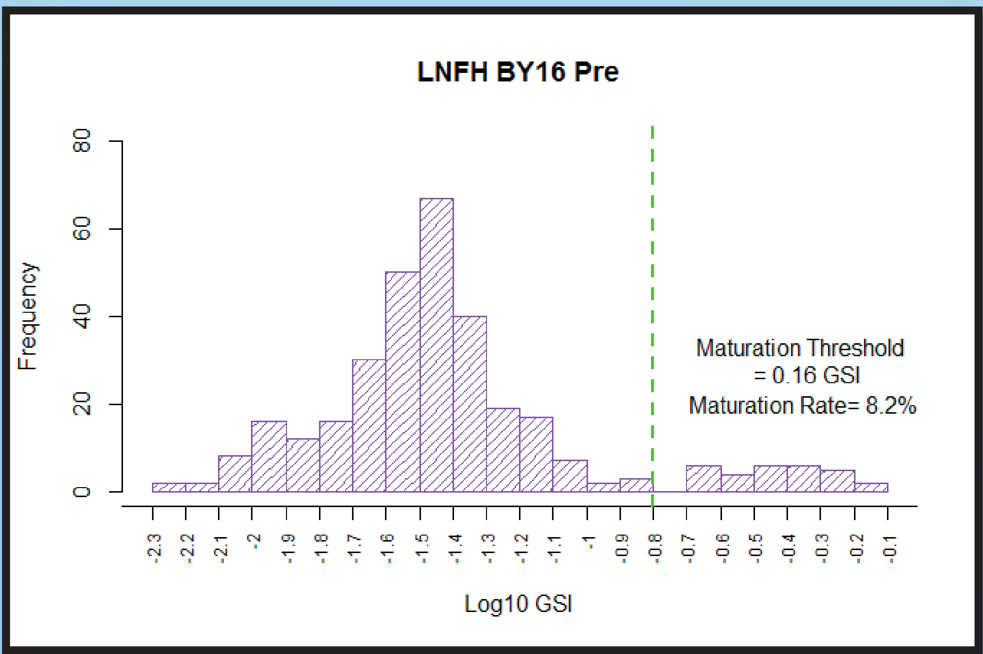
Three year average (range)

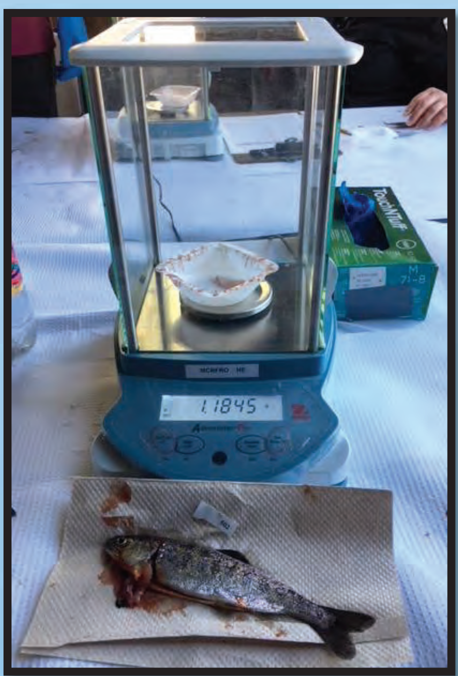
- LNFH Spring Chinook 7.0% (3.8-9.5%)
- WNFH Spring Chinook 8.5% (6.7-9.7%)
- ENFH Summer Chinook 18.4% (14.5-23.4%)

LNFH Spring Chinook

7% (3.8-9.5%)

- Sampled pre- and post- release for all three years
- Increased sample size to n=600 for BY 15 & 16 due to low maturation rates (3.8% pre-release BY14)

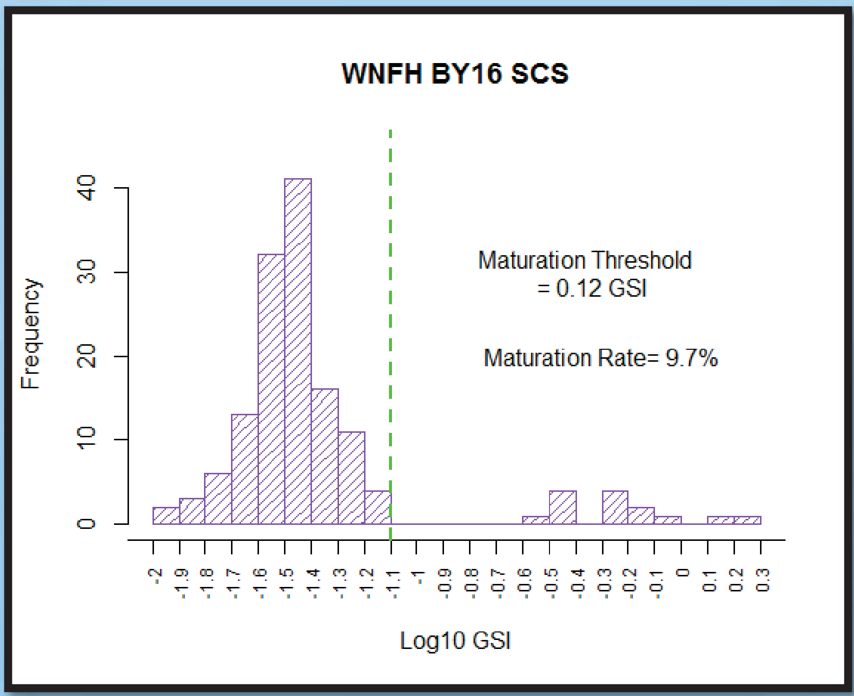




WNFH Spring Chinook

8.5% (6.7-9.7%)

- All pre-release sampling
- Distinct visual difference between immature and mature gonads
  - Gonad size pattern also seen at Methow Fish Hatchery



ENFH Summer Chinook

18.4% (14.5-23.4%)

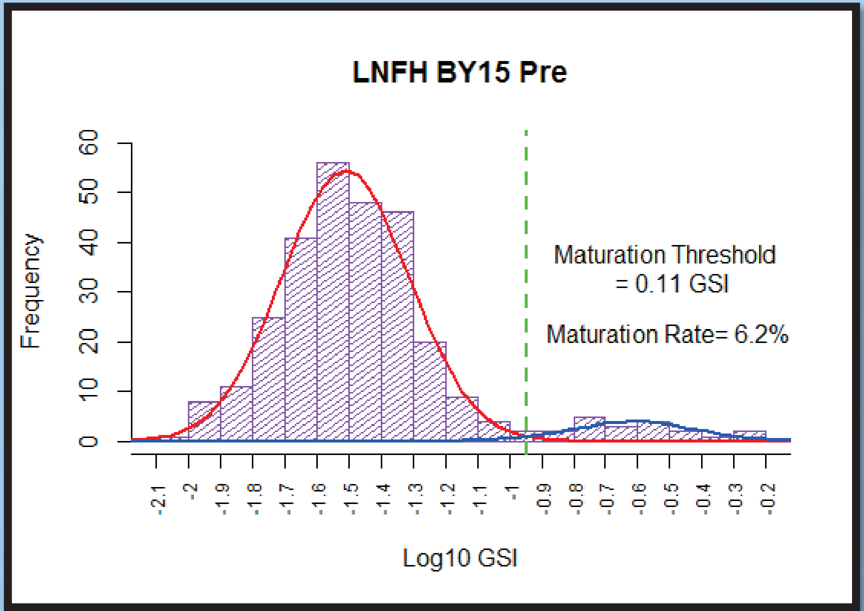
- Sampled pre- and post- release BY 14
- Sampled post-release BY 15 & 16
- Male maturation rates reduced by ~5% between BY 15 and 16

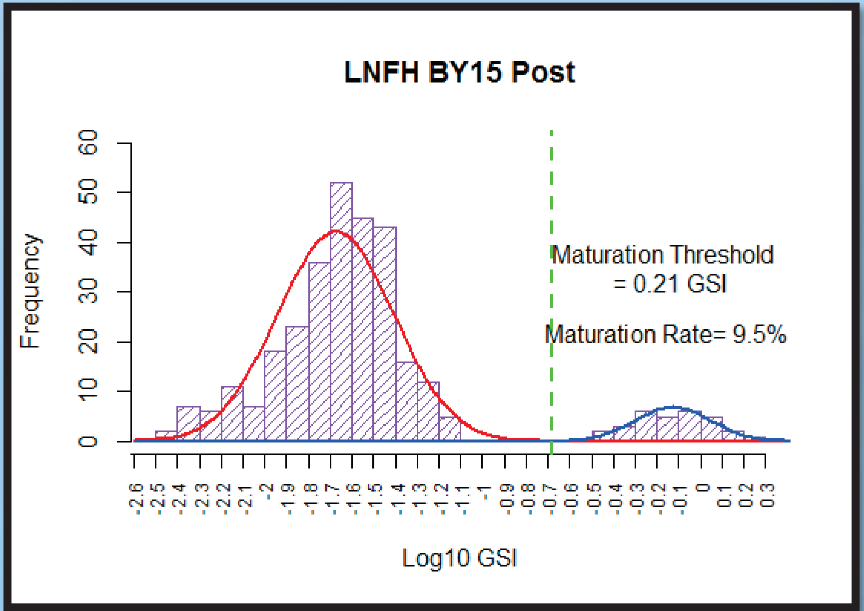
"We try to reduce feed, growth, and size rates going into the fall in an effort to naturalize their growth cycle (not a lot of growth on wild fish during that time period). … Feed rates were trimmed in September and further reduced into October. …"
–Craig Chisam, ENFH Hatchery Manager

Brood Year	Maturation Rate	End of October Fish Per Pound	April Release Fish Per Pound
2014 Pre	23.4%	21	-
2014 Post	20.5%	21	15.6
2015 Post	15.1%	28	16.0
2016 Post	14.5%	27	16.9

Does Holding Fish Increase Maturation Detection Levels?

- Yes
- Larger separation visually while dissecting
- Larger separation between GSI values for immature and mature Chinook





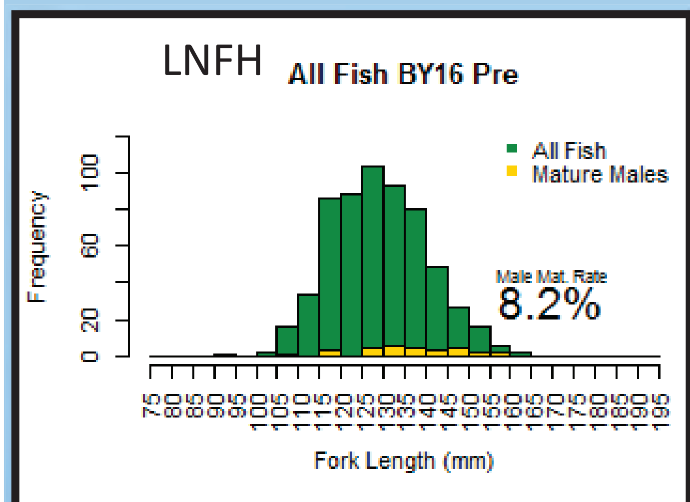
Pre- and Post- Rate Comparison

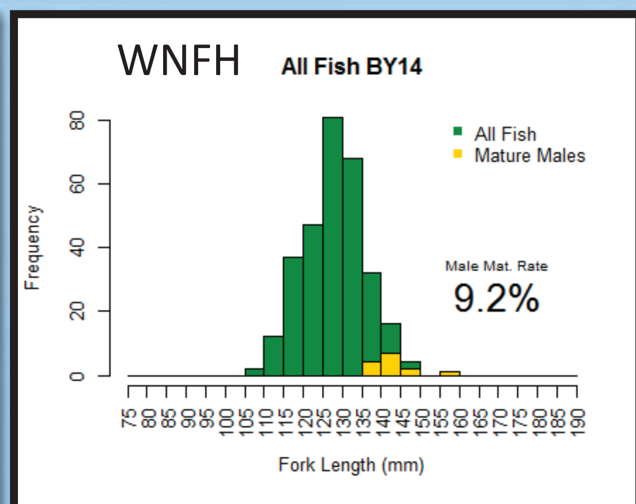
- Not a large difference between pre- and post- results
- Half slightly higher, half slightly lower
- Captures sample variation

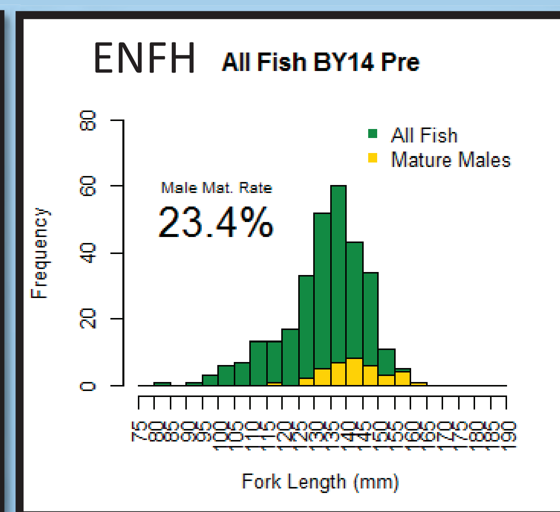
Facility	Brood Year	Male Maturation Rate Pre- Release	Male Maturation Rate Post- Release
LNFH	14	3.8%	8.6%
	15	6.2%	9.5%
	16	8.2%	5.5%
ENFH	14	23.4%	20.5%

Does Fork Length Help Determine Maturation?

- Depends on the stock
- LNFH: Mature at all lengths, domesticated stock
- WNFH: Mature at larger lengths, partially integrated stock
- ENFH: Mature fish at all lengths, tend to be larger







Can We Visually Assess Maturation?

Facility	Type	BY14	BY15	BY16
LNFH	Pre	100%	*99%	97%
	Post	*98%	99%	*99%
WNFH	Pre	99%	100%	100%
ENFH	Pre	96%	-	-
	Post	100%	100%	99%
				*overestimate

- Need an experienced crew
- Accuracy reflects maturation rates, not individual calls
- Potential sampler bias by writing down visual call after weighing
- WNFH pre- visual accuracy due to the large separation between immature and mature male gonad size
- Holding fish a month improves visual accuracy

Chinook GSI Conclusions

- Holding fish a month increases visual and graphical separation of immature and mature fish
- Pre-and post- maturation rates similar
- No smoking gun for fork length vs. maturation
- With an *experienced* crew, visual assessment has potential to be accurate
  - 99% accurate in 10 out of 13 sampling events

Steelhead Maturation Rate Results

Three year average (range)

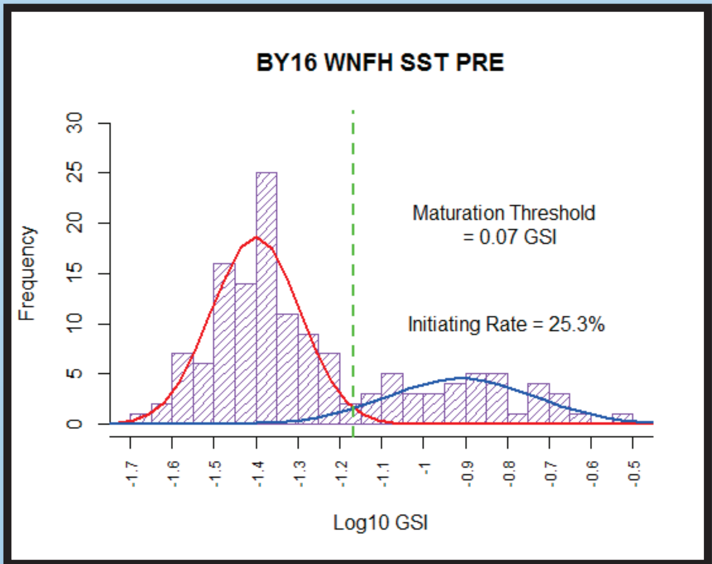
Pre- and Post-Held

- Initiating
  - 20.7% (8.6-29.6%)
- Milting
  - 8.4% (5.5-12.6%)

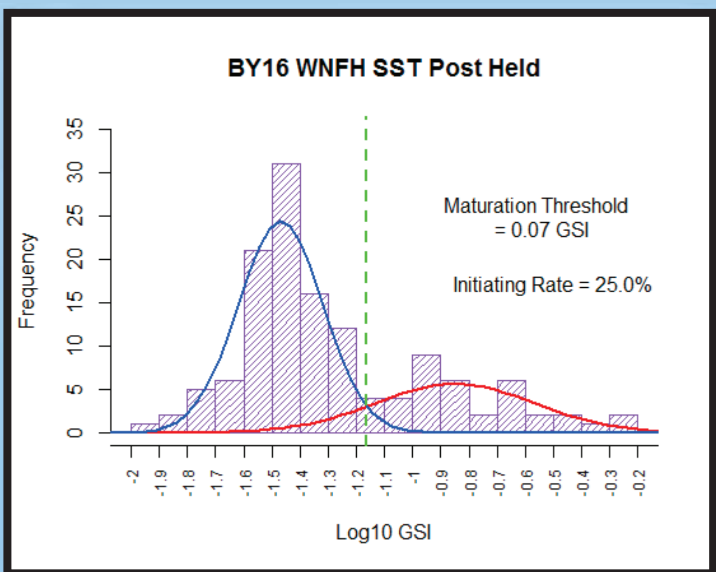
Post-Volitional

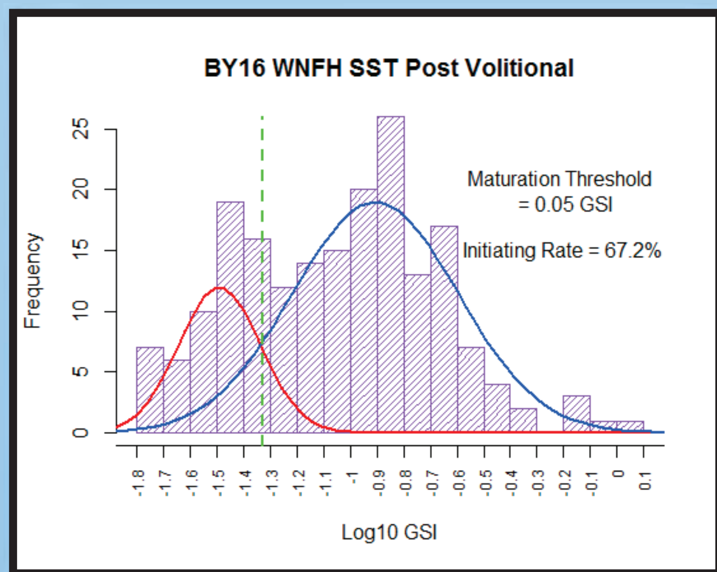
- Initiating
  - 71.9% (66.2-82.4%)
- Milting
  - 6.8% (3.9-10.1%)

WNFH Steelhead

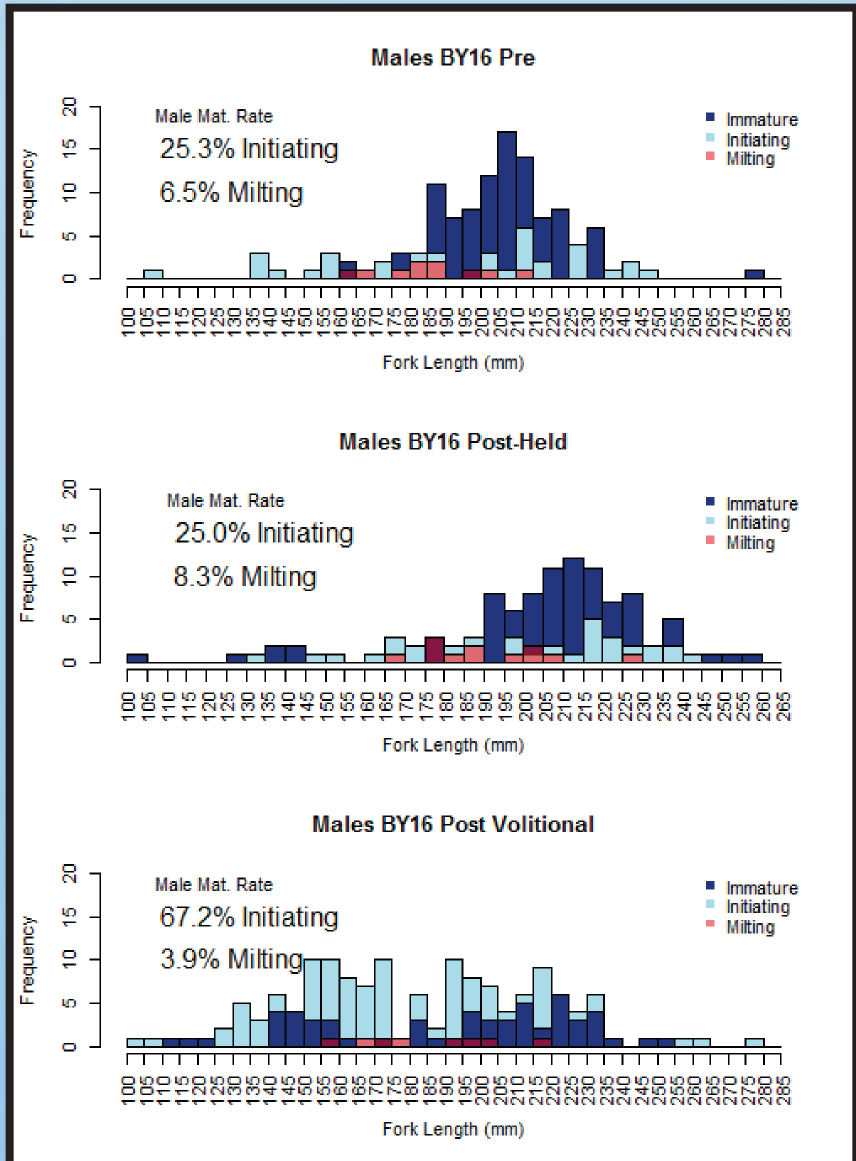


- Milting fish not shown on these graphs
- Mixture Models very helpful, especially for post-volitional samples
- Holding fish one month showed some separation, but less than Chinook
- Visual accuracy consistently underestimated initiating fish
    - Average 88% accurate (64%-99%)





Steelhead Fork Length



- Milting Males: All lengths
- Initiating Males: All lengths
- No smoking gun for fork length vs. maturation

*overlaid histograms

Steelhead GSI Conclusions

- Holding steelhead for a month improves separation slightly between immature and initiating males
- Fork Length does not indicate maturation
- Visual assessment is not accurate

Each Facility is Different
Each Stock is Different

Current Research:

- Variations in Rearing Conditions
  - Spangenberg et al. 2014
  - One stock, three hatcheries
  - Different release sizes, different early male maturation rates

- Common Garden Experiment
  - Spangenberg et al. 2015
  - Two stocks, one hatchery
  - Different release sizes, different early male maturation rates

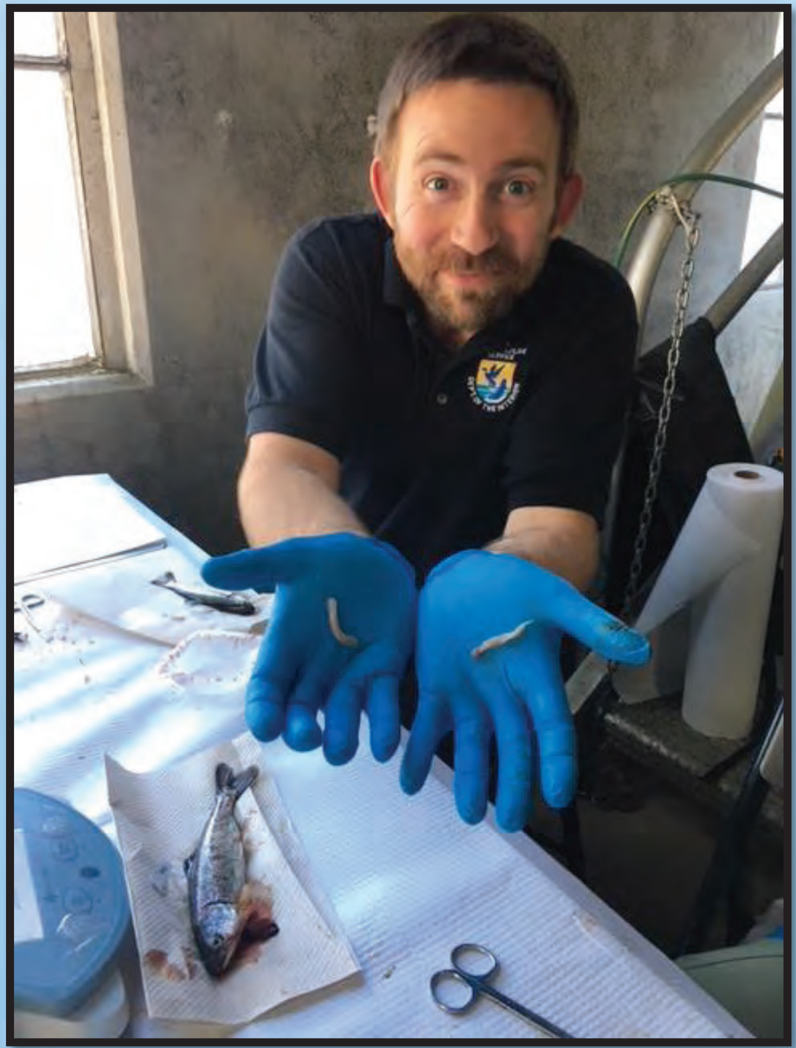
Sampling Recommendations for Other Facilities

- Most Accurate - Recommended
  - Hold fish for a month
  - Weigh all male gonads
- Know Your Fish! Sample for three years
  - Develop a baseline
  - Can you hold fish?
  - What is the annual variation?
  - Is there a distinct visual difference between immature and mature males?

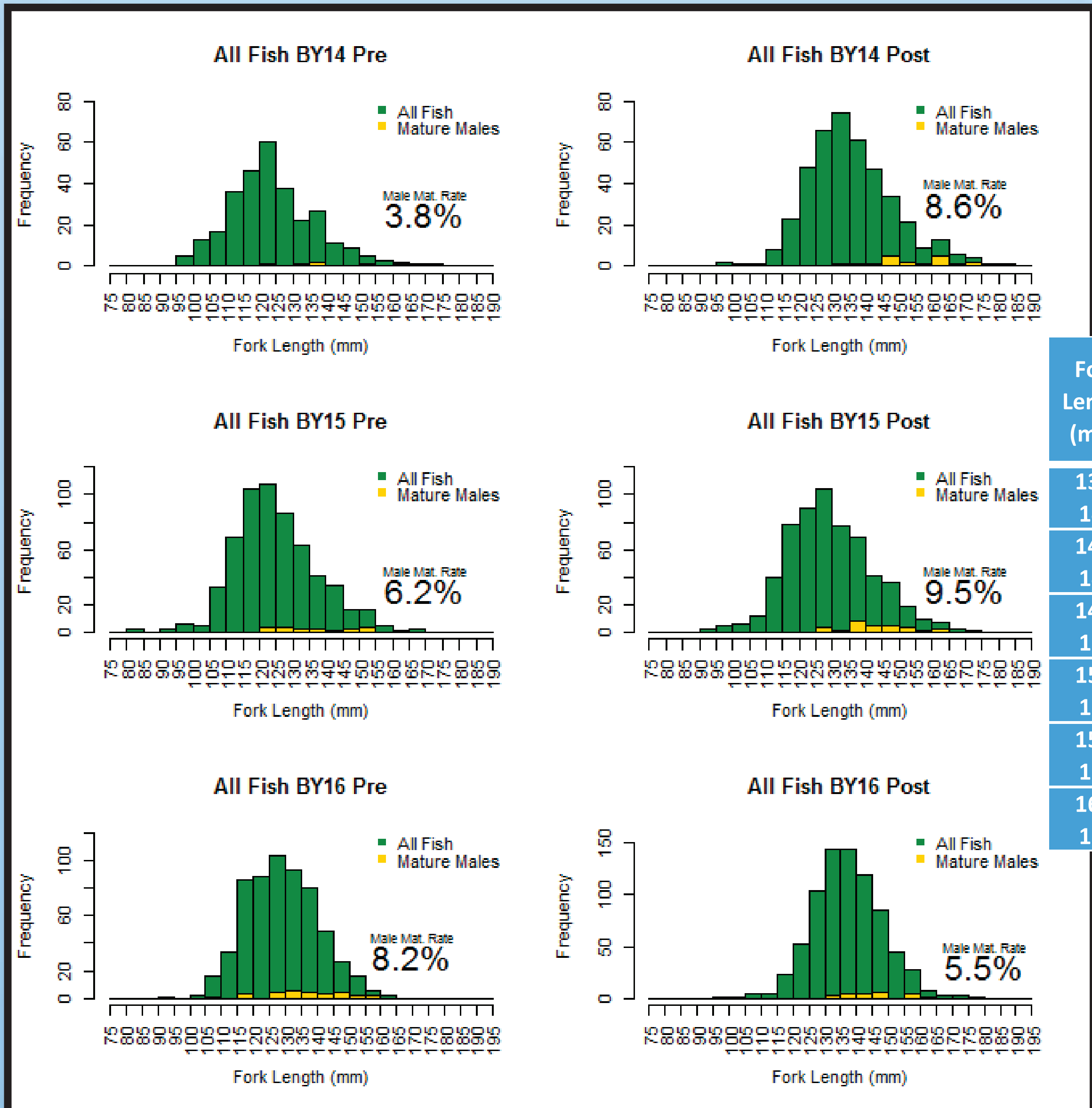
Thank You

- Everyone who dissected fish ‘nads in the last three years!
- NOAA Fisheries, Beckman and Larson
- USFWS, Matt Cooper
- WDFW, Chris Moran
- U of Idaho, Dr. Lea Medeiros
- Chelan, Grant, and Douglas PUDs

Questions?



LNFH Fork Lengths



Fork Length (mm)	BY14 Pre	BY14 Post	BY15 Pre	BY15 Post	BY16 Pre	BY16 Post
135-140	7.4%	1.6%	4.9%	11.6%	5.0%	2.8%
140-145	0.0%	2.1%	2.9%	12.2%	6.1%	3.4%
145-150	0.0%	14.7%	12.5%	13.9%	14.8%	7.1%
150-155	20.0%	9.5%	25.0%	21.1%	12.5%	0.0%
155-160	0.0%	11.1%	0.0%	11.1%	33.3%	14.8%
160-165	50.0%	38.5%	0.0%	28.6%	0.0%	14.3%

*stacked histograms

LNFH PIT Residuals

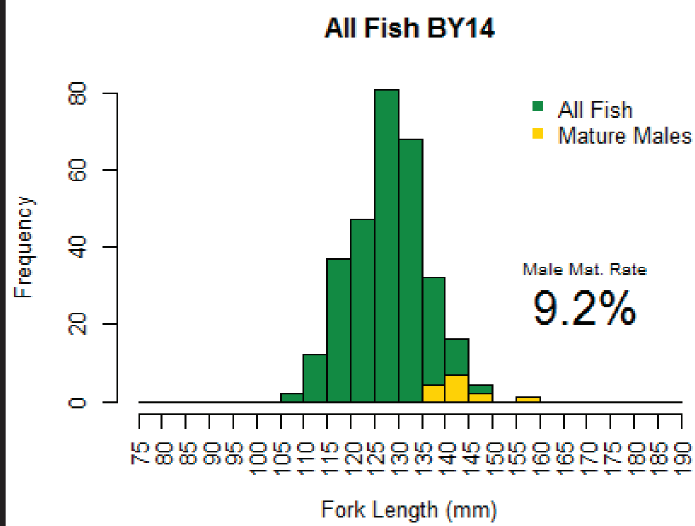
- From LNFH Annual Report (Potter et al. 2017)

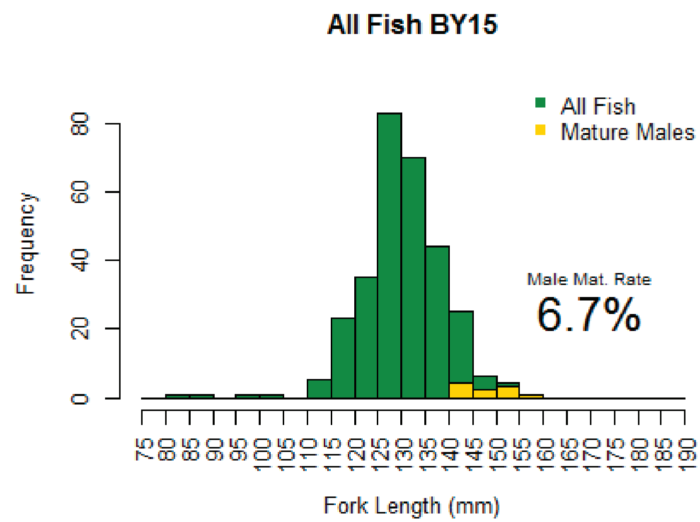
Table 7. Rate of early maturation (minijacks and precocity by GSI) of LNFH-origin fish by release year, 2005–2017.

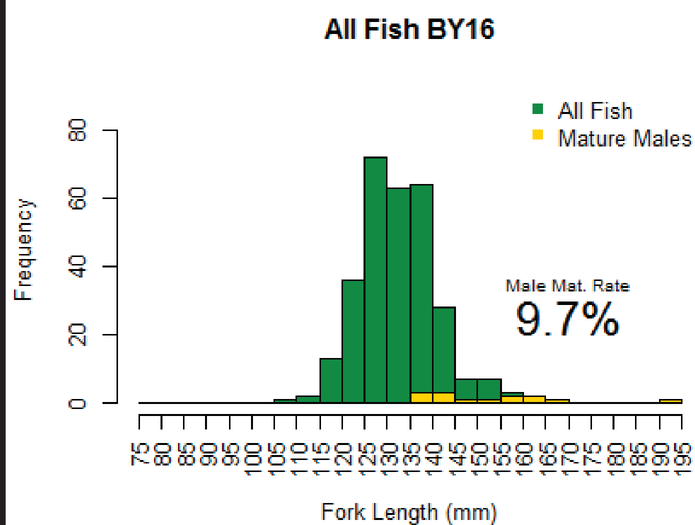
Release Year	Release Number	# PIT	PIT Ratio	Observed Minijacks	Expanded Minijacks[a]	Minijack Rate (%)	Release Precocity Rate by GSI (%)
2017	1,131,913	20,158	60	2	120	0.011	0.095
2016	945,277	19,957	53	2	106	0.011	0.086
2015	1,139,567	14,994	76	4	306	0.027	na
2014	1,239,025	13,380	93	13	1206	0.097	na
2013	1,289,293	14,951	87	13	1127	0.087	na
2012	1,186,622	14,901	80	9	718	0.061	na
2011	1,189,400	14,875	83	9	751	0.063	0.214*
2010	1,284,653	14,948	86	41	3533	0.275	0.220*
2009	1,685,038	14,931	113	21	2370	0.141	0.162*
2008	1,539,668	15,968	96	36	3471	0.225	0.288*
2007	1,177,568	14,969	79	15	1180	0.100	0.331*
2006	1,005,505	14,700	68	2	137	0.014	0.142*
2005	1,476,046	14,825	100	1	100	0.007	0.094*
Min	945,277	13,380	53	1	100	0.007	0.086
Max	1,685,038	19,957	113	41	3,533	0.275	0.331
Mean (05-16)	1,263,139	15,283	85	14	1,250	0.092	0.192

*From Harstad et al. 2014.

WNFH Fork Lengths



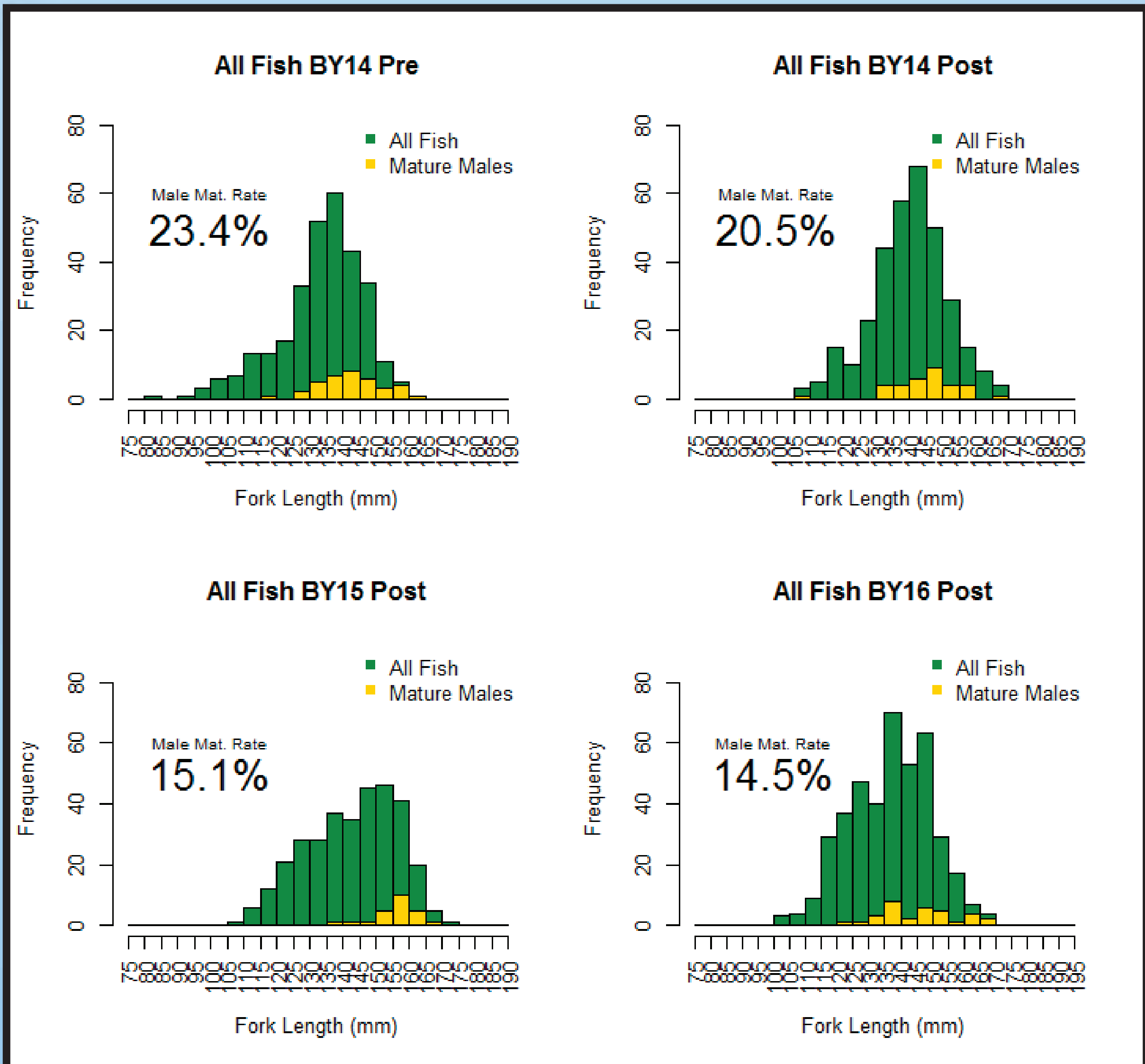




Fork Length (mm)	BY14 Pre	BY15 Pre	BY16 Pre
135-140	12.5%	0.0%	4.7%
140-145	43.8%	16.0%	10.7%
145-150	50.0%	33.3%	14.3%
150-155	0.0%	75.0%	14.3%
155-160	100.0%	100.0%	66.7%
160-165	0.0%	0.0%	100.0%

*stacked histograms

ENFH Fork Lengths



Fork Length (mm)	BY14 Pre	BY14 Post	BY15 Post	BY16 Post
135-140	11.7%	6.9%	2.8%	11.4%
140-145	18.6%	8.8%	2.9%	3.8%
145-150	18.2%	18.0%	2.2%	9.5%
150-155	27.3%	13.8%	10.9%	17.2%
155-160	80.0%	26.7%	24.4%	5.9%
160-165	100.0%	0.0%	25.0%	57.1%

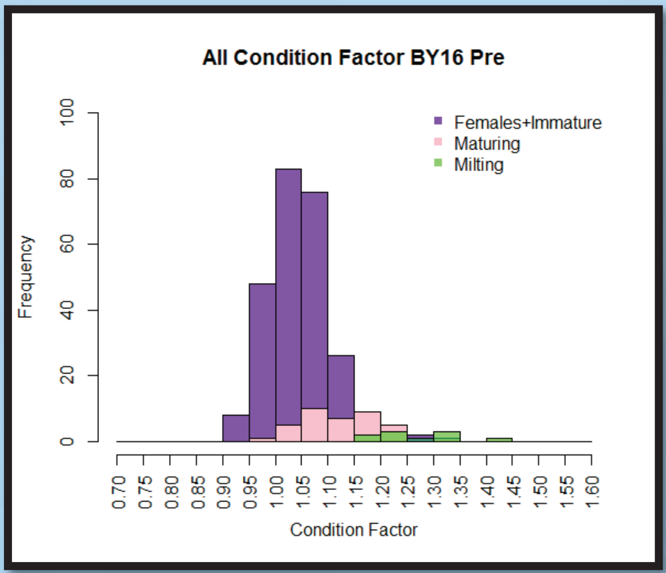
*stacked histograms

Chinook 0.02g Weight Cutoff Accuracy

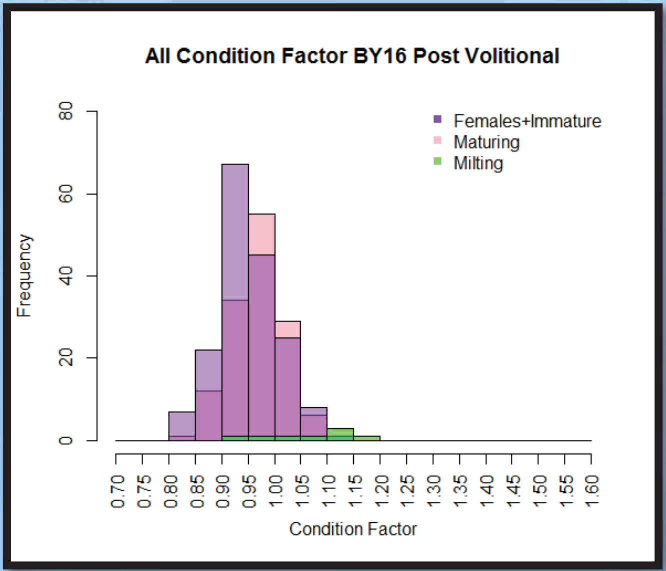
- LNFH: average +3.6%
  - +1.5 to +6.5% overestimate
- WNFH: average +1.7%
  - accurate to +4% overestimate
- ENFH: average +0.4%
  - -0.6% to +1.2%

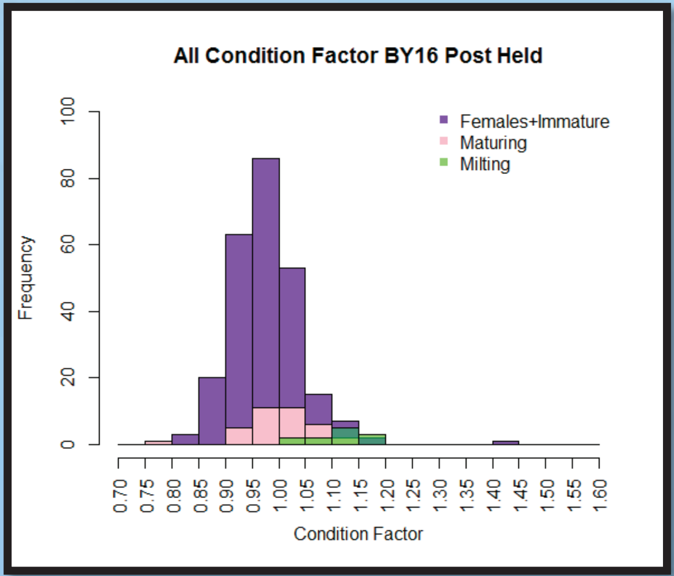
- Overall, weight cut-off overestimates maturation

Steelhead Condition Factor



- Milting males: higher K values
- Maturing males: mid-high K values
- Still no smoking gun





Weight Cut-off for Steelhead?

- No consistent gonad weight cut-off for maturing males
- Highly variable sizes

2018-2020 Broodyear Adult Prophylactic Disease Management Plan for Eastbank Fish Hatchery Complex Spring and Summer Chinook Hatchery Programs.

Background: Hatchery broodstock disease profiles observed in some programs operating out of the Eastbank FH complex in 2017 (as well as other hatchery programs throughout the Columbia River Basin) resulted in higher than expected prespawn mortality and/or BKD ELISA results which required (under the terms and conditions of the Section 10 permits) culling eggs/fish at a higher rate than anticipated which put several programs considerably below the respective production targets. The inability to determine whether the deviation in performance in 2017 was the result of eliminating prophylactic antibiotic injection practices, as was historically conducted, or was related to environmental conditions (or a combination of both) has prompted WDFW to develop and implement a fish health treatment plan (adult broodstock only) beginning with the 2018 brood and running for at least three (3) consecutive brood years.

The overall goals are to primarily ensure integrated and/or recovery programs make the most efficient use of natural origin broodstock to avoid mining as well as maximize natural origin spawners while minimizing handling/unnecessary activities on broodstock. In addition where practical, we (WDFW) would like to see the use of antibiotics and other therapeutics reduced or eliminated over time. Having a controlled approach to evaluating the use of prophylactic treatments in these programs will allow the operators/managers to determine which programs may benefit from prophylactic treatments and which programs may be able to shift away from this practice, all of which is designed to reduce overall handling and associated effects as much as possible.

Methods: To minimize handling events, injections will be scheduled to occur either at collection or during sorting (such as during genetic sorting that occurs for the Nason spring Chinook program). Only females will be injected, in the intraperitoneal cavity (IP) with Tulathromycin for BKD and long acting Oxytetracycline for gram negative bacteria. Generally, injections will be prioritized for natural origin females as the control and hatchery origin females as the treatment for the spring Chinook programs. A slightly different approach will be used for each of the summer Chinook programs. All females receiving the injections will be considered the control given that this was the standard hatchery practice by which current disease result data sets and decisions are built on. All females will be PIT tagged at time of collection or injection to facilitate tracking of individual females (and possibly their progeny).

The results will be evaluated annually to determine if modifications to the current plan are necessary.

Program Specific Plans:

Methow (Carlton/MEOK) Summer Chinook:

1) Collected at Wells Dam
2) 68 NO females are targeted for collection in 2018 with every other female will be injected at collection.
    a. Since the Twisp M&E staff are conducting run comp and broodstock collection activities at the Wells Dam East/West ladders, it makes sense for them to inject while the fish are sedated.

Chelan Falls Summer Chinook:

1) Collected at the Chelan Falls Canal Trap
2) Because of extremely warm water temperatures at time of collection, adults collected over the course of a weeks will be placed at the head of the adult pond. At the end of the week, females will be PIT tagged and every other female will be injected then placed over the net and not handled again until spawning.
3) 192 HO females are targeted for collection and up to 96 will be injected.
4) Disease management may vary somewhat depending upon the determination of the pathogen in play (i.e., *Columnaris* may play a larger role than BKD which require different approaches).

Wenatchee Summer Chinook:

1) Collected at Dryden dams or Tumwater Dam.
2) No injections planned at this time. The Wenatchee summer Chinook program was the only EB program in 2017 which did not see a negative deviation in disease/prespawn mortality outcomes from the predicted so the 2018 plan is to stay consistent with the 2017 approach of no injections. If during the three year period, it appears the Wenatchee summer Chinook may benefit by evaluation of injection versus non-injection then we will make plans to accommodate that evaluation.
3) 132 NO females are targeted for collection and will not be injected.

Chiwawa Spring Chinook:

1) Collected at Tumwater Dam
    a. All previously PIT tagged Chiwawa NOR's collected will be combined with Nason Spring Chinook weekly collections at Eastbank.
    b. All Chiwawa NO females collected at Tumwater Dam will be injected during genetic sorting of the Nason Fish.
    c. Back up HO females collected at Tumwater will not be injected.
2) Collected at Chiwawa Weir
    a. All female NO females collected at the weir will be injected at the time of collection.

3) 38 NO females are targeted for collection between the two locations and will be injected.
4) 19 HO females targeted for retention as part of the production shortfall backup, collected at Tumwater Dam will not be injected.

Nason Spring Chinook:

1) Collected at Tumwater Dam.
2) 32 NO females are targeted for retention and will be injected during genetic sorting.
3) 33 HO females are targeted for retention. HO females will not be injected.

PRD Expansion Project

Follow up responses to questions at the May 2018 presentation.

1. **What M & E objectives would data from this project address?**

   The proposed project would provide unbiased steelhead and Coho data for most M & E objectives (Table 1). Spring and summer Chinook data address fewer M & E objectives as data for these species are currently collected under the existing M & E Program. However, the prosed project would greatly improve the probability of achieving pHOS goals for all species (i.e., adult management via sport fisheries) by providing real time abundance estimates by river reach.

Table 1. M & E data provided by the proposed PIT tag/modeling project.

M & E Objective	Steelhead	Spring Chinook	Summer Chinook	Coho*	Metric/Mechanism/Analysis
NRR	✓	✓	✓	✓	Abundance and prespawn mortality (Chinook)
Juv. Prod.	✓			✓	Spawner abundance and pHOS
HRR	✓	✓	✓	✓	Abundance and prespawn mortality (Chinook)
pHOS	✓	✓	✓	✓	Execution of fisheries
Run timing	✓	✓	✓	✓	PIT tag analysis
Spawning Distribution	✓			✓	Major and minor spawning areas. Some tributaries have 2 arrays (i.e., lower and upper Nason)
Stray rates	✓			✓	Decompose abundance estimate by hatchery program PIT tags
Genetics	✓	✓	✓	✓	High quality samples collected at PRD
Phenotypic traits	✓	✓	✓	✓	PIT tag analysis (unbiased data)
Harvest rates	✓		✓	✓	Greater frequency and duration of fisheries

* Funding provided by YN

2. **What current tasks would no longer be required as a result of this project and what is the estimate costs savings?**

Stock Assessment

Stock assessment of Plan species included in the proposal would no longer occur at local trapping sites (Tumwater, Dryden and Wells Dam). However, because broodstock collection occurs simultaneously cost savings would be modest (Dryden/Tumwater = $17,744; Wells = $9,904), but would result in less fish (i.e., those not collected for broodstock) being sampled (See Question 3). Video monitoring of spring Chinook and steelhead at Tumwater would be no longer required. At Wells Dam, WDFW staff would no longer have to differentiate spring Chinook from Summer Chinook using video.

Broodstock Collection

Under the proposed project, much uncertainty related to broodstock collection would be eliminated. Estimates of abundance by origin at each dam or instream array will provide greater certainty as to when trapping is required or specifically not required. It would presumably take a few years of tagging a Priest Rapids Dam in order to refine broodstock collection protocols based on actual run timing and abundance data of target species. Hence, refined broodstock protocols may result in future cost savings.

Adult Management

The greatest potential cost savings of this project is related to adult management activities, some of which have not been implemented (i.e., Methow spring Chinook) or consistently (i.e. steelhead, Wenatchee spring Chinook), in order to obtain pHOS/PNI goals as specified in permits. Accurate abundance estimates of hatchery and wild fish by reach, will provide the greatest possible opportunity for sport anglers to remove excess hatchery fish (while minimizing incidental take of natural origin fish). Estimates of cost savings are difficult until sport fisheries have matured (i.e., higher CPUE) and are dependent on run size and the proportion of hatchery fish available to be harvested (i.e., ad-clipped). Potential fisheries and associated creel will need to take into account the location of instream PIT arrays. In addition, the project will also serve to help evaluate the effectiveness of release location. Do safety net fish stay near the release location long enough to be removed? Future modifications of current release locations of safety net programs may be required to increase the probability of removal through conservation fisheries. Conversely, failure to execute fisheries that are effective in removing excess hatchery fish will result in added costs to the PUDs through the operation of trapping locations or acclimation ponds to spatially segregate fish.

3. What reductions in handling or sampling would there be as a result of the proposed PRD expansion project?

Reductions in handling and sampling would be commensurate with the reduction in stock assessment, broodstock and adult management activities. However, data is available to estimate the reduction in the number of fish sampled during stock assessment activities (Table 2).

Table 2. Estimated number of fish (mostly hatchery some wild) that will not be sampled for stock assessment purposes under the proposed project.

Species	Dryden	Tumwater	Wells
Steelhead	97		100 - 418
Spring Chinook		Up to 1,846	1,113
Summer Chinook	364		340

Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2019

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Prepared by:

Catherine Willard

June 2018

Deleted: July 2017

Contents

1. Introduction

The Habitat Conservation Plan (HCP) specifies that a monitoring and evaluation plan will be developed for the hatchery program. The approach to monitoring the hatchery programs was guided by the "*Monitoring and Evaluation Plan for PUD Hatchery Programs: 2017 Update*" (Hillman et al. 2017) and the "*Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Programs*" (Murdoch and Peven 2005).

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The purpose of this document is to define the tasks associated with the approved scope of work to implement Chelan PUD's (CPUD's) hatchery monitoring and evaluation (M&E) plan for 2019. Additionally, monitoring and evaluation activities for Lake Wenatchee sockeye in 2019 are included in this document. As monitoring tasks are completed in 2018 and are evaluated for their efficacy, methodologies to accomplish the tasks defined in the 2019 Implementation Plan may be modified [with Habitat Conservation Plan's Hatchery Committee (HCP-HC) approval].

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The work described in this plan has Endangered Species Act (ESA) coverage provided by NMFS Section 10(a)(1)(A) permits 18121 and 1395 and Section 10(a)(1)(B) permit 1347. All activities conducted under this Implementation Plan shall adhere to all terms and conditions as specified in the referenced permits. These permits allow for changes to monitoring or research protocols with the caveat that such modifications are approved by NMFS prior to implementing those changes. Terms and conditions relevant to monitoring and evaluating the hatchery programs have been used to inform the various measurements below and associated scopes of work with entities performing the work. A report summarizing compliance with the terms and conditions set forth under the above-references permits is required for submittal to NMFS; a copy of this completed report will be provided to the HCP HC.

The Implementation Plan includes all four components of the hatchery M&E Program including: (1) aquaculture monitoring; (2) juvenile monitoring; (3) adult monitoring; and (4) data, analysis and reporting. Under each component are study design elements that will be used to inform the overarching program components. Figure 1 illustrates the relationship of the components and study design elements used to address each component. Table 1 depicts which study design element is being performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2017. For Lake Wenatchee sockeye salmon, the proposed M&E activities cover juvenile and adult life history stages and provide the data necessary to track or estimate viable salmonid population parameters (VSP) and is described in Section 6.0.

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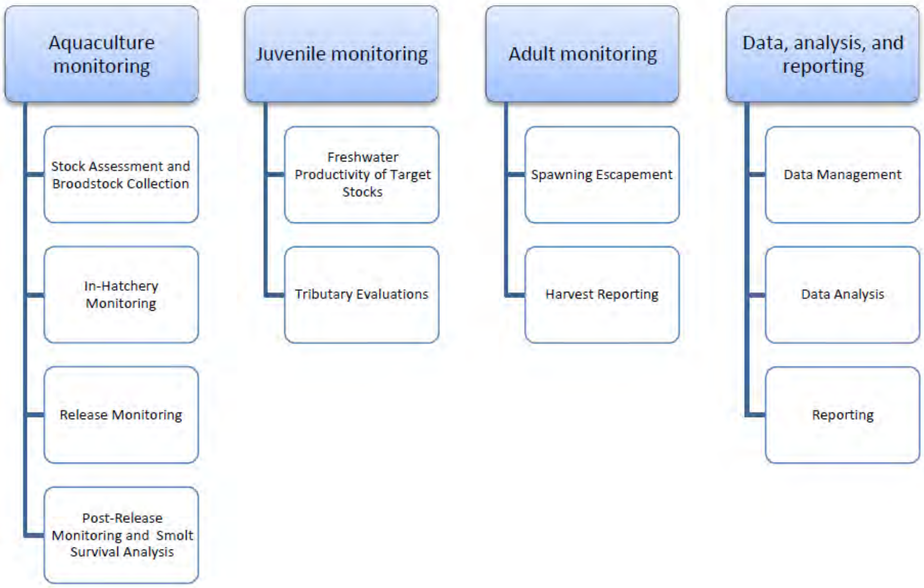

Figure 1. The four components of the hatchery monitoring and evaluation program and the study design elements within each component.

Table 1. Study design elements performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2017.

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Monitoring and evaluation component	Objectives[1]	Study Design Elements	Chiwawa spring Chinook	Wenatchee summer Chinook	Methow spring Chinook[4]	Chelan Falls summer Chinook[5]	Wenatchee Steelhead
Aquaculture Monitoring	3,5,8	Stock assessment and broodstock collection	WDFW	WDFW	WDFW	WDFW	WDFW
	5, 8	In-hatchery monitoring	WDFW CPUD[2]	WDFW CPUD[2]	WDFW Biomark[3]	WDFW CPUD[2]	WDFW CPUD[2]
	9	Release monitoring	WDFW	WDFW	WDFW	WDFW	WDFW
	9	Post-release monitoring and smolt survival analysis	WDFW	WDFW	WDFW	WDFW	WDFW
Juvenile monitoring	2	Freshwater productivity of stocks	WDFW	WDFW	WDFW	NA	WDFW
		Tributary evaluations	WDFW	WDFW	WDFW	NA	WDFW
Adult monitoring	1,2,3,4,5,6, 8,10	Spawning escapement	CPUD	WDFW	WDFW	BioAnalysts	WDFW
	8	Harvest reporting	WDFW	WDFW	WDFW	WDFW	WDFW
Data, analysis, and reporting	All	Data management	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts
		Data analysis	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts
		Reporting	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts

[1] Monitoring questions relative to Objective 7 will be addressed at the next 10 year HCP check-in.
[2]CPUD crews will PIT tag in-hatchery fish.
[3]Biomark will PIT tag in-hatchery fish.
[4]In 2019, monitoring and evaluation for the Methow spring Chinook program is described in "Implementation of Comprehensive Monitoring and Evaluation of Wells Hatchery Complex Programs".
[5]Because the Chelan summer Chinook program is primarily an augmentation program, monitoring and evaluation efforts focus on straying, release characteristics, and harvest.

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2. AQUACULTURE MONITORING

The aquaculture monitoring component is comprised of two basic elements: (1) stock assessment and broodstock collection at adult trapping locations and (2) in-hatchery monitoring including spawning, rearing, and release of juveniles. Data collected during these elements primarily support monitoring questions 5.1.1, 5.2.1, 8.1.1, 8.2.1, 8.3.1, 8.3.2, 8.4.1, 9.1.1, 9.2.1, 9.3.1 and 9.4.1, but also contribute data to monitoring questions 3.2.1, and 3.2.2 (Hillman et al. 2017). Table 2 below provides a summary of the variables to be measured in 2019 under the aquaculture monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

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Table 2. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the aquaculture monitoring component.

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Objectives	Measured Variables *(Applicable Study Component(s))*
Objective 3: Determine if the hatchery adult-to adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.	• Number of hatchery and naturally produced fish collected for broodstock (*Broodstock Collection and Stock Assessment*) • Number of broodstock used by brood year (hatchery and naturally produced fish) (*Broodstock Collection and Stock Assessment*)
Objective 5: Determine if the run timing, spawn timing, and spawning distribution of the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.	• Ages of hatchery and naturally produced fish sampled via PIT tags or stock assessment monitoring (*Broodstock Collection and Stock Assessment*) • Time (Julian date) of ripeness of hatchery and natural origin steelhead captured for broodstock (*Broodstock Collection and Stock Assessment*)
Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of the natural populations.	• Size (length), gender, and total/salt age of broodstock (*Broodstock Collection and Stock Assessment*) • Assess age of fish (*Broodstock Collection and Stock Assessment*) • Length, weight, and age (covariate) of hatchery and natural-origin broodstock after eggs have been removed (*Broodstock Collection and Stock Assessment*) • Number and weight of eggs (*Broodstock Collection and Stock Assessment*)
Objective 9: Determine if hatchery fish were released at the programmed size and number.	• Fork length and weights of random samples of hatchery juveniles at release (*Release Monitoring*) • Monthly individual lengths and weights of random samples of hatchery juveniles (*In-Hatchery Monitoring*) • Numbers of smolts released from the hatchery (*Release Monitoring*)

2.1 Broodstock Collection and Stock Assessment

Broodstock collection and stock assessment for Wenatchee summer steelhead, Wenatchee summer Chinook, Methow spring Chinook, Chelan Falls summer Chinook, and Chiwawa River spring Chinook, hatchery programs will, in most instances, occur concurrent to and consistent with the Broodstock Collection Protocol approved annually by the HCP-HC and relevant permits. Data collection during broodstock collection will be consistent with Murdoch and Peven (2005). A representative sample of fish trapped throughout the entire run, either collected for broodstock or released back to the river, will be sampled for origin, age, sex, size, and migration timing. Biological sampling of all fish trapped will include presence of internal (CWT or PIT) and external (VIE) tags or marks, scales, length, and sex (determined by ultrasound). PIT tags will be injected into all target species (Chinook and steelhead), whether collected for broodstock or released back to the river to monitor for potential fallbacks. All non-target species will be enumerated daily. Measures of central tendency and spread will be calculated and reported for each metric.

2.2 In-Hatchery Monitoring

The in-hatchery monitoring component will begin when adult fish are collected and retained for broodstock and ends when juvenile fish are released. Life stage specific in-hatchery survival and growth rates, disease monitoring, and an estimate of the number of fish released will be collected and analyzed according to Murdoch and Peven (2005). Additional data to be collected includes individual lengths and weights of juveniles during monthly sampling, and the weight of gonadal mass and body of spawned broodstock. Measures of the central tendency and spread will be calculated and reported for each metric.

Fish Marking

All of Chelan PUD's hatchery fish will be coded-wire tagged (CWT) and externally marked or marked as otherwise agreed to by the HCP HC. A comprehensive marking strategy will be developed by the HCP-HC and included as an Addendum to this Plan. The identification of these hatchery-produced fish is needed for a suite of adult metrics and may be used for adult management and/or fisheries as contemplated by the co-managers.

Using methods described in Keller and Murauskas (2012), hatchery fish will be PIT-tagged (Table 3) at Eastbank Hatchery approximately two to four weeks before the fish are transferred to acclimation ponds or in the spring prior to release. Additional PIT-tagging may occur for program specific studies/comparisons as approved by the HCP-HC. The data collected from the PIT-tags will assist in release monitoring, migration timing, juvenile survival, and smolt-to-adult survival. For all fish marking, quality control check will be performed during and immediately following tagging and prior to release.

Table 3. Chelan PUD's hatchery program release goals and recommended number of fish PIT tagged.

Program	Release goals	Number of fish PIT tagged[1]	PIT tag rate (%)
Chiwawa spring Chinook	144,026	10,000	6.9
Wenatchee steelhead	247,300	30,000	8.2
Wenatchee summer Chinook	318,816 (CPUD Program) 181,184 (GPUD Program)	20,600	4.1
Methow spring Chinook	60,156	5,000	8.3
Chelan Falls summer Chinook	576,000	10,000	1.7

[1] Additional PIT tagging may take place for Chelan PUD approved studies and/or comparisons.

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2.3 Release Monitoring

Hatchery fish will be released during smoltification in the spring, typically between 15 April and 1 June. Whenever possible, the exact release dates will coincide with environmental conditions that promote a rapid emigration that minimizes both the potential negative ecological interactions of hatchery fish with naturally produced fish and predation on hatchery fish by avian or other predators. The default release method will incorporate a volitional approach, as approved by the HCP HC, unless it can be demonstrated other approaches are better. The monitoring data collected for each stock are described below.

Chiwawa and Methow Spring Chinook

Pre-release sampling data will be conducted consistent with Murdoch and Peven (2005), including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan (Hillman et al. 2017). PIT tag monitoring of spring Chinook released in the Chiwawa River will occur during the release period (April). Juvenile Chinook will pass through two 92-cm diameter PIT-tag antennas connected to Allflex 310 readers and Quantitative Sampling Technologies (QST) QuBE data logger. The release location and type (i.e., volitional, forced, or trucked) are recorded for each observation file created and uploaded to the PTAGIS database maintained by the Pacific States Marine Fisheries Commission after each year of release. PIT-tagged fish in each observation (release) file are assumed to represent untagged fish. Observation files contain the PIT tags associated with the original tag files and will be used for analysis (see Post-release Monitoring Section). The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

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Wenatchee Summer Steelhead–
Pre-release sampling will be conducted consistent with Murdoch and Peven (2005), including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan. Monitoring of steelhead released in the Wenatchee River sub-basin will occur during loading of fish into transport trucks, unless fish are released directly into the Chiwawa River. Steelhead will pass through a series of PIT-tag antennas, each connected to a data logger, thereby allowing the creation of a PIT-tag observation file for each truckload of steelhead consisting of unique tag records. The release location (stream and rkm), release type (volitional or forced), and hatchery group (HxH or WxW) will be recorded for each tag file created. PIT-tagged fish in each observation (release) file are assumed to represent untagged fish. However, because PIT-detection efficiency during loading will not be 100%, the number of fish in each truckload will be estimated using volumetric displacement. Observation files contain the PIT tags associated with the original tag files and will be used for analysis (see Post-release Monitoring Section). The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

Wenatchee and Chelan Falls Summer Chinook
Pre-release sampling will be conducted consistent with Murdoch and Peven (2005), including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan. Should PIT tagging occur, a monitored release strategy consistent with other Chinook stocks (i.e., Chiwawa Spring Chinook) will be implemented. The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

2.4 Post-Release Monitoring and Survival Analysis
Data will be collected during rearing, acclimation, release, and the emigration period that may prove valuable in explaining variability in adult survival (Murdoch and Peven 2005). Rearing densities have been reported to influence the survival of hatchery fish (Martin and Wertheimer 1989; Banks 1994) and may also be linked to disease prevalence during rearing (Banks 1994; Ogut and Reno 2004). Acclimation of hatchery fish before release has been found to increase survival and reduce stray rates when the duration of the acclimation period is sufficient (Clarke et al. 2010, 2012; Rosenberger et al. 2013). These metrics (i.e., rearing density and acclimation period) will be collected annually to determine their influence on fish survival.

PIT-tagged groups of hatchery fish will be used to estimate survival during their emigration. Variation in survival during the emigration period may also inform observed adult survival rates. Survival during emigration and travel will be estimated using interrogation or release files and the standard Cormack-Jolly-Seber (CJS) estimator. CJS estimates are termed apparent survival estimates because it is unknown whether fish suffered mortality (e.g., size or time of release) or simply failed to emigrate (i.e., residualized or were precocial males). In the latter case, the proportion of PIT-tagged fish detected in the Methow sub-basin, Wenatchee or Columbia rivers after the emigration period is complete may explain variation in smolt survival rates. The post-release performance of PIT-tag groups will be estimated and monitored annually, consistent with methods in Murdoch and Peven (2005). Additionally, precocity of hatchery releases will be evaluated by examining the proportion of PIT tag releases detected in adult fish ladders and tributaries within the same year as release.

3. Juvenile Monitoring

Data collected during these elements primarily support monitoring questions 2.1.1 and 2.2.1. and the monitoring objectives described in Table 4 (Hillman et al. 2017). Table 4 below provides a summary of the variables to be measured in 2019 under the juvenile monitoring component and what objective the measure supports. The text that follows in this section further describes the activities.

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Table 4. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the juvenile monitoring component.

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Objective	Measured Variables *(Applicable Study Component(s))*
Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	• Number of juveniles (smolts and emigrants) (*Freshwater Productivity of Supplemented Stocks*)

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3.1 Freshwater productivity of Supplemented Stocks

Steelhead, Spring Chinook, and Summer Chinook

The freshwater productivity of supplemented stocks in the Wenatchee sub-basin will be monitored using smolt traps in the Chiwawa River and the lower Wenatchee River consistent with historical trapping efforts. Additionally, a newly derived analytical method which uses PIT-tag mark-recapture data will be utilized that reduces bias and increases precision by including estimates of emigration during the winter non-trapping periods. Up to 3,000 parr will be PIT tagged in the Chiwawa River in the fall, based on the spatial distribution and abundance estimated during parr snorkel surveys, to generate estimates of migration during the non-trapping periods. A random sample of a minimum of 10 percent of fish per remote site will be held in a live box for 24 hours to evaluate tag loss and delayed mortality. Using PIT tagged parr detections at the lower Chiwawa PIT array during the non-trapping period, the total number of PIT-tagged parr that emigrated will be estimated, and then expanded by the tag rate. Overwinter mortality of PIT-tagged parr is assumed to be the same as non-PIT-tagged parr. Overwinter survival estimates of Chiwawa River parr will be derived by estimating survival to the lower Wenatchee PIT tag array and analyses with the TribPit Survival software program and/or estimating survival of fall parr and spring smolts to McNary. PIT-tag mark-recapture trials conducted during the trapping period in the fall will also be used to estimate detection probabilities of the PIT-tag array at a given discharge level. Abundance and variance will be estimated using the same methods as those used in the smolt trap estimate. The estimated abundance and variance from each method and time period (trapping and non-trapping periods) will be summed to estimate a total production estimate. Under the proposed methodology, unbiased estimates of abundance during the entire migration period will be generated with relatively high precision (PSE < 15%), which is consistent with NOAA Fisheries' recommendations (Crawford and Rumsey 2011). Historical estimates will be revised using the new estimation techniques.

Deleted: Specific actions to monitor the freshwater productivity of supplemented spring Chinook salmon in the Methow sub-basin have yet to be determined. As these become available, the plan will be amended and presented to the HC by December.¶

Deleted: **3.2 Tributary Evaluations¶**
Chiwawa River¶
Snorkel surveys will be utilized to estimate parr abundance within the Chiwawa subwatershed during the summer. This approach has been used in the Chiwawa subwatershed since 1992. In parallel to addressing Objective 2, additional juvenile data can help to assess the habitat carrying capacity in each tributary. This information can add value to the overall M&E plans and help inform management decisions.¶
¶
Sampling will follow a stratified random sampling design. Landscape classification will be used to stratify streams in the Chiwawa subwatershed that support juvenile Chinook salmon. In the Chiwawa subwatershed, WDFW found that classification "explained" most of the variability in fish numbers caused by geology, land type, valley bottom type, stream state condition, and habitat type (Hillman 2013). The same classification method was used to identify sections of the Little Wenatchee River (reference area) that corresponded to discrete reaches in the supplemented subwatersheds, but that had no release of hatchery Chinook. Consistent with previous efforts, habitat types within each land-class or reach will be identified and quantified annually. At least three units of each habitat type within each reach will be randomly selected for estimating densities of salmon and trout. Thus, overall sampling consists of a stratified- random sampling design, which increases the accuracy and precision of population estimates.¶
¶
Densities of salmon and trout will be estimated in August and September by direct underwater observation within the randomly-selected habitat units. Underwater methods will follow those described by Thurow (1994), Dolloff et al. (1996), and O'Neal (2007). Habitat surface areas and volumes will be estimated during fish sampling. Numbers of fish counted will be adjusted for detection probabilities using the models published in Hillman et al. (1992). For each habitat type within a state type and reach stratum, the mean density of salmon and trout will be calculated as the ratio of mean numbers to mean area or volume sampled (Cochran 1977). Total numbers of fish will be estimated per habitat type within a state type and reach stratum¶
as the product of mean density of fish in a given habitat type, times total area or volume of that¶
habitat type within the stratum (Cochran 1977). Total numbers of fish within the supplemented subwatershed will be estimated as the sum of all population numbers per habitat type in state type/reach strata. Bootstrapping methods will be utilized to estimate variance and percent errors (based on 95% confidence interval) for total numbers of fish.¶

4. Adult Monitoring

The adult monitoring component is comprised of two basic elements: (1) estimating spawning escapement and (2) harvest monitoring. Data collected during these elements primarily support monitoring questions 1.1.1, 1.2.1, 2.1.1, 2.2.1, 3.2.1, 3.2.2, 4.1.1, 5.1.1, 5.2.1, 5.3.1, 5.3.2, 6.3.1, but also contribute data to monitoring questions 6.1.1, 6.2.1, 8.1.1, 8.2.1, 8.4.1, 10.1.1, 10.1.2, 10.1.3 and 10.1.4. Table 5 below provides a summary of the variables to be measured in 2019 under the adult monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

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Table 5. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the adult monitoring component.

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Objective	Measured Variables *(Applicable Study Component(s))*
Objective 1: Determine if conservation programs have increased the number of naturally spawning and naturally produced adults of the target population and if the program has reduced the natural replacement rate (NRR) of the supplemented population.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)* • Number of hatchery and naturally produced fish taken for broodstock (*Broodstock Collection and Stock Assessment*) • Number of hatchery and naturally produced fish taken in harvest (if recruitment is to the Columbia) *(Harvest Reporting)*
Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	• Number of hatchery and naturally produced fish on the spawning grounds (*Spawning Escapement Estimates*) • Number of redds *(Spawning Escapement Estimates)*
Objective 3: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)* • Number of hatchery and naturally produced fish harvested *(Harvest Reporting)*
Objective 4: Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)*
Objective 5: Determine if the run timing, spawn timing, and spawning distribution of the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.	• Time (Julian date) of hatchery and naturally produced salmon carcasses or marked steelhead detected on spawning grounds within defined reaches *(Spawning Escapement Estimates)* • Time (Julian date) of arrival at mainstem projects and within tributaries (e.g., traps, PIT arrays) with

Objective	Measured Variables *(Applicable Study Component(s))*
	the intent to identify biologically significant differences *(Spawning Escapement Estimates)* • Location (GPS coordinates) of female salmon carcasses observed on spawning grounds *(Spawning Escapement Estimates)*
Objective 6: Determine if stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.	• Number of hatchery fish collected for broodstock (*Broodstock Collection and Stock Assessment*) • Number of hatchery fish taken in fishery (*Harvest Reporting*) • Locations of live and dead strays (used to tease out overshoot) *(Spawning Escapement Estimates)* • Number of hatchery carcasses (PIT-tagged and/or CWT) found in non-target and target spawning areas or number of returning spawners counted via PIT-tag detection or at weirs in close temporal proximity to spawning areas (stray data into the Entiat sub-basin will be obtained from USFWS Fisheries Resource Office-Leavenworth) *(Spawning Escapement Estimates)*
Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	• Total and salt (ocean) age and gender of hatchery and naturally produced salmon carcasses collected on spawning grounds *(Spawning Escapement Estimates)* • Whenever possible, age at maturity and sex ratio will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling or ultrasound on live fish) *(Spawning Escapement Estimates)* • Assess age of fish, including harvested fish *(Spawning Escapement Estimates and Harvest Reporting)*
Objective 10: Determine if appropriate harvest rates have been applied to conservation, safety-net, and segregated harvest programs to meet the HCP/SSSA goal of providing harvest opportunities while also contributing to population management and minimizing risk to natural populations.	• Numbers of hatchery fish taken in harvest *(Harvest Reporting)* • Numbers of natural-origin fish taken in harvest *(Harvest Reporting)*

4.1 Spawning Escapement Estimates

Chelan Summer/Fall Chinook

Chinook spawning ground surveys will be conducted in the Chelan River and (see Appendix A for survey reaches). Spawning ground surveys will be conducted via foot or raft beginning late September and continuing until spawning has ended (usually mid-November). Frequency of surveys will vary depending on method.

Summer Chinook carcass surveys will be conducted in the Chelan River beginning in September and ending in November consistent with methods described in Murdoch and Peven (2005). A representative sample (i.e., 20%) of spawners as determined by spawner abundance and distribution (typically 100% of the carcasses encountered in the Chelan River) will be sampled. Biological data will include collection of scale samples for age analysis, length measurements (POH and FKL), gender, egg voidance, and a check for tags or marks. DNA samples (five-hole punches from operculum) will be collected as needed to address different objectives. These data will be used to assess length-at-age, size-at-age, egg voidance, origin (hatchery or naturally produced), stray rates, and genetics. All carcass surveys will be conducted within the historical reaches.

Wenatchee Steelhead

The number of hatchery and naturally produced steelhead returning to the Wenatchee sub- basin will be estimated using a PIT tag mark recapture model. The estimated spawner abundance for the Wenatchee steelhead population will be a combination of PIT tag-based tributary and redd-based mainstem Wenatchee River estimates. Steelhead redd counts will be conducted weekly in all major spawning areas in the mainstem Wenatchee River (see Appendix A for survey reaches); minor spawning areas in the mainstem Wenatchee River will be surveyed once, based on the spawn timing in adjacent major spawning areas, to estimate redd abundance at peak spawning. The estimated total number of redds in the Wenatchee River mainstem will be expanded by the sex ratio of the population to estimate spawner abundance. Spawner abundance in tributaries of the Wenatchee River will be estimated using a PIT tag mark recapture model.

Chiwawa Spring Chinook

Chiwawa spring Chinook spawning escapement will be estimated based on the total number of redds found in each tributary (Murdoch et al. 2010) using methods described in Murdoch and Peven (2005). Weekly redd and carcass surveys will be conducted simultaneously from the first week of August through September (see Appendix A for survey reaches). Redd-based estimates assume that each female constructs one redd, which WDFW has found to be appropriate for this population (Murdoch et al. 2009). The total number of redds in each reach will be estimated using methods described in Millar et al. (2012) and using the observer efficiency model currently under development by WDFW. Redd counts will be expanded and the number of hatchery and naturally produced fish will be estimated using methods in Murdoch et al. (2010). Carcasses encountered during surveys will be sampled according to methods outlined in Murdoch and Peven (2005). All CWTs (i.e., snout or adipose) from carcasses will be read and the data entered into the Regional Mark Processing Center database within one year of collection.

Additionally, all redds and female carcasses will be geo-referenced using hand-held GPS devices. Carcass recovery bias has been detected in the Chiwawa spring Chinook population (Murdoch et al. 2010) and if not corrected will bias estimates of hatchery and naturally produced fish on the spawning grounds. While it may be appropriate to correct for carcass recovery bias for some monitoring questions (e.g., 2.2), when comparisons to reference populations are made in monitoring questions 1.1.and 1.2, carcass bias will not be corrected because other monitoring programs have not corrected for a similar bias.

Wenatchee Summer Chinook

Wenatchee summer Chinook spawning ground counts will begin the first week in September and continue through the end of spawning in November (see Appendix A for survey reaches). Total census redd counts will be conducted by foot or raft depending on stream size, flow, and density of spawners within the stream reach (see Appendix A for survey reaches). All stream reaches will be surveyed once per week. Redd data will be collected using methods described in Murdoch and Peven (2005). Salmon carcass data collected during spawning ground surveys will be consistent with Murdoch and Peven (2005). All CWTs (i.e., snout or adipose) from carcasses will be sent to the WDFW lab in Olympia. The CWT lab will extract and read CWTs and submit all required information to RMIS within one year of collection.

Deleted: The total number of redds in each reach will be estimated using methods described in Millar et al. (2012) and using the observer efficiency model currently under development by WDFW. Weekly ground-based census counts and the true number of redds (determined via intensive surveys) will be compared in order to generate observer efficiency. River characteristics (e.g., channel width, water depth, discharge, visibility, and habitat complexity), observer experience, and survey effort will be incorporated into a model to predict observer efficiency in all river reaches. Predicted redd generate observer efficiency for each river reach will be used to adjust ground-based redd counts to estimate the total reach redd count. Ground-based surveys will also be used to estimate redd life for each river reach. The estimated spawner abundance in the Wenatchee River and an associated level of precision will be calculated using the estimated total redd count for each reach, mean redd life, and the sex ratio of the population similar to methods described in Millar et al. (2012).

4.2 Harvest Reporting

In years when the expected hatchery adult returns are in excess of the levels needed to meet the hatchery program goals (i.e., broodstock and/or escapement), surplus fish may be available for harvest. Harvesting or removal of surplus hatchery fish may have benefits to the natural populations by reducing potential negative ecological and genetic impacts (e.g., density dependent effects, loss of fitness, and loss of genetic variation). The contribution of hatchery fish to fisheries will be monitored using CWT recoveries on a brood-year basis supporting Objective 10.

To obtain the necessary data to determine if the harvest rates are meeting objectives, a statistically valid creel program will be designed and implemented for all sport and/or conservation fisheries in the Upper Columbia River to estimate harvest of hatchery fish from both Chelan and Grant County PUD funded hatchery programs (Murdoch and Peven 2005). Information collected during creel surveys are an integral component to calculating the HRR (Objective 3), particularly given most CWT recoveries for PUD mitigation programs occur in the Upper Columbia River and its tributaries, with the exception of summer Chinook where most CWT recoveries occur in ocean fisheries. Because of considerable time lags in reporting of CWT's to the Regional Marking Information System (RMIS) database, it requires an ongoing query of recovery data until the number of estimated fish does not change.

5. Data Management , Analysis, and Reporting

5.1 Data Management

A Microsoft Access database maintained by WDFW will contain all the monitoring data collected for hatchery evaluations. The database will contain and manage all data associated with aquaculture monitoring, juvenile monitoring, and adult monitoring.

All data entered into the database are evaluated for quality control and quality assurance by WDFW. Quality control checks using analyses such as modified Z-scores, boxplots, and the Generalized Extreme Studentized Deviate Procedure (Iglewicz and Hoaglin 1993) will be conducted for all data entry. In the event outliers are identified, discussion will occur on whether identified outliers are true data points or transcription errors. This process ensures that the data used to test statistical hypotheses are correct and accurate.

5.2 Data Analysis

The analyses proposed are consistent with the Monitoring and Evaluation Plan for PUD Hatchery Programs: 2017 Update (Hillman et al. 2017). Each of the objectives will be addressed using the appropriate statistical tests, as well as graphic analyses that convey relevant information.

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5.3 Reporting

An annual M&E report will be generated following the completion of each calendar year and will be available for HCP-HC review by June 1 of the following year. Additionally, monthly progress reports will be made available to the HCP-HC.

6. Lake Wenatchee Sockeye Salmon

The Chelan PUD will conduct monitoring and evaluation (M&E) activities to track key population attributes related to Lake Wenatchee sockeye salmon in 2019(Table 6). In the absence of a sockeye hatchery program, M&E activities are no longer rooted in the context of evaluating the effects of sockeye salmon supplementation, but instead focus directly on the performance of the natural population, which is a unique departure from historic monitoring obligations. Broadly, the proposed M&E activities cover juvenile and adult life history stages and provide the data necessary to track or estimate viable salmonid population parameters (VSP): abundance, productivity, spatial structure and diversity (McElhaney et al. 2000). The data collected may also have utility in future hatchery compensation recalculation efforts.

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Chelan PUD is conducting these M&E activities to support commitments made under the 2011 hatchery recalculation effort, which also included a steelhead production commitment for a sockeye species swap (SOA 2011). This section of the implementation plan describes the specific commitments by juvenile and adult life history stages.

6.1 Juvenile Monitoring

Chelan PUD will conduct or fund activities to monitor and evaluate the temporal distribution and age/size of out-migrating smolts, and estimate smolt production (Table 6). Smolt production will be estimated from data collected at the lower Wenatchee smolt trap and via back calculations based on collected adult return data (i.e., age-at-return estimates, SARs, and adult escapement to the tributaries). Collectively, these activities include: (1) funding of the lower Wenatchee River smolt trap concurrent with efforts aimed at evaluating Chelan PUD funded supplemented populations in the Wenatchee River sub-basin; (2) tagging up to 5,000 PIT tags for natural-origin juveniles encountered during smolt trapping activities and collecting scale samples at this location; and (3) estimating adult escapement estimates to the tributaries, and collection of adult return data at Tumwater (see the *Adult Monitoring* section for details) to back-calculate smolt production.

The monitoring data obtained will provide a useful set of tools for evaluating the performance of natural origin sockeye salmon within the sub-basin and downstream and also support the evaluation of VSP parameters [e.g., outmigration timing and size (diversity); and PIT tagging juveniles for SAR estimates (productivity)].

6.2 Adult Monitoring

Several M&E activities associated with adult returns of Lake Wenatchee sockeye salmon will be conducted and/or funded by Chelan PUD (Table 6). These efforts include (1) continuation of accurate adult counts at Rock Island, Rocky Reach, and Tumwater dams; (2) sampling of scales for age distribution, sex ratio determination, and returns of PIT-tagged adults at Tumwater Dam; (3) reach-specific conversion estimates between Rock Island Dam and spawning grounds in the White and Little Wenatchee rivers (i.e., Rock Island to Tumwater Dam to spawning tributaries); and (4) providing between 250 to 1,000 PIT tags to estimate adult spawning escapement in the Little Wenatchee and White rivers utilizing PIT tags and mark-recapture techniques (the software program Sample Size 2.0.7, developed by the University of Washington School of Aquatic and Fisheries Science (P. Westhagen, J. Lady, and J. Skalski) was used to determine the minimum number of tags required (i.e., 250) to estimate adult sockeye escapement at a +/- 7 percent confidence interval). Chelan PUD will adjust the number of PIT-tagged individuals in order to maintain precision in estimates at the lowest rate of interference to migrating populations, if it is warranted due to annual changes in escapement and detection probabilities. In an effort to PIT tag the run at large, adults will be PIT tagged at Tumwater consistent with the Tumwater Operations Protocol, daily throughout the run.

Collectively, these data will provide reliable metrics of adult returns and spawning escapement (abundance), recruits-per-spawner (productivity), distribution of spawners among tributaries (spatial structure), and run-timing and age structure for adult immigrants (diversity).

Table 6. Chelan PUD's proposed Lake Wenatchee sockeye salmon monitoring and evaluation activities.

Life History Stage	M&E Activity	Entity Performing the Activity	Related analysis	VSP parameter addressed
Juvenile	Concurrent operation of the lower Wenatchee smolt trap to collect juvenile outmigration data	WDFW	Generate distribution of outmigration timing, estimate smolt production and determine average smolt size.	Diversity and productivity
Juvenile	PIT tagging smolts at lower Wenatchee smolt trap (up to 5,000 fish annually) and collecting/aging scale samples	WDFW	Estimate smolt-to-adult returns.	Productivity
Juvenile	Develop adult return based smolt production estimates	WDFW	Use collected data (i.e., adult age-at-return data, SARs, adult escapement to the tributaries) to back-calculate smolt production.	Productivity
Adult	Rock Island and Rocky Reach Dam adult counts	CPUD	Initial spawner abundance (Okanogan stock separation)	Abundance and spatial structure
Adult	PIT tag subsample (250 adults) of returning adults at Tumwater Dam to support mark-recapture evaluation	WDFW	Calculate spawner abundance and relative distribution among ~~in~~ tributaries	Abundance and spatial structure
Adult	Collect and age scales[1] and determine sex via ultrasound from returning adults at Tumwater Dam	WDFW	Estimate age-at-return, sex ratio, and relative productivity of contributing spawner cohorts	Productivity and diversity
Adult	Tumwater Dam adult counts	WDFW	Estimate potential spawner abundance (pre Lake-Wenatchee harvest), potential productivity (recruits/spawner), and run timing distribution	Abundance and diversity
Adult	Operate PIT detection arrays on Little Wenatchee and White River	WDFW	Calculate spawner abundance (post-Lake Wenatchee harvest and other mortality), actual productivity (recruits/spawner), and entry-to-spawning-habitat timing distribution, and spatial spawner distribution among tributaries	Abundance, productivity, spatial structure, and diversity
All	Data management, analysis, and reporting	BioAnalysts CPUD	------	NA

[1] Scales would be collected concurrently from adults that are PIT tagged at Tumwater Dam.

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Appendix A

Designated survey reaches for Methow subbasin summer Chinook spawning ground surveys.

River	Reach	Code	RM
Methow	Mouth to Methow Bridge	M1	0.0-14.78
	Methow Bridge to Carlton Bridge	M2	14.78-27.17
	Carlton Bridge to Twisp Bridge	M3	27.17-39.55
	Twisp Bridge to MVID	M4	39.55-44.85
	MVID to Winthrop Bridge	M5	44.85-49.80
	Winthrop Bridge to Hatchery Dam	M6	49.80-51.55

Designated survey reaches for Wenatchee River basin summer Chinook spawning grounds surveys. Asterisks denotes reaches where redd observer efficiency will be assessed.

Reach Code	Reach Section	River Mile
W10	Lake Wenatchee to Bridge	54.20-53.58
	Bridge to Swamp *	53.58-52.66
	Swamp to Chiwawa River	52.66-48.39
W9	Chiwawa River to Schugart Flats	48.39-47.93
	Schugart Flats to Old Plain Bridge	47.93-46.21
	Old Plain Bridge to RR Bridge	46.21-41.91
	RR Bridge to RR Tunnel	41.91-39.28
	RR Tunnel to Swing Pool *	39.28-36.67
	Swing Pool to Tumwater Br	36.67-35.55
W8	Tumwater Br to Swiftwater Campground *	35.55-33.50
	Swiftwater Campground to Unimproved Campground	33.50-33.08
	Unimproved Campground to Tumwater Dam	33.08-30.91
W7	Tumwater Dam to Penstock Br	30.91-28.66
	Penstock Br to Icicle Road Br *	28.66-26.43
W6	Icicle Road Br to Icicle Mouth	26.43-25.61
	Icicle Mouth to Boat Takeout *	25.61-24.49
	Boat Takeout to Leavenworth Br	24.49-23.90
W5	Leavenworth Br to Irrigation Flume *	23.90-22.77
	Irrigation Flume to Peshastin Br	22.77-20.00
W4	Peshastin Br to Dryden Dam *	20.00-17.76
W3	Dryden Dam to Williams Canyon	17.76-15.54
	Williams Canyon to Upper Cashmere Br	15.54-10.22
	Upper Cashmere Br to Lower Cashmere Br	10.22-9.49
W2	Lower Cashmere Br to Old Monitor Br *	9.49-7.12
	Old Monitor Br to Sleepy Hollow Br	7.12-3.27
W1	Sleepy Hollow Br to River Bend *	3.27-1.73
	River Bend to Siphon	1.73-1.29
	Siphon to Mouth	1.29-0.45

Designated survey reaches for Wenatchee Basin spring Chinook spawning grounds surveys.

Reach Code	Reach Section	River Mile
Chiwawa River and Tributaries (Rock and Chikamin)		
C7	Buck Cr to Phelps Cr	36.39-33.46
C6	Phelps Cr (Trinity) to Maple Cr Br	33.46-29.64
C5	Maple Cr Br to Atkinson Flats	29.64-26.59
C4	Atkinson Flats to Schaefer Cr	26.59-24.24
C3	Schaefer Cr to Rock Cr Campground	24.24-22.97
R1 - Rock	Mouth to Chiwawa River Road Bridge	0.00-1.05
C2	Rock Cr Campground to Grouse Cr	22.97-12.27
K1 - Chikamin	Mouth to Chiwawa River Road Bridge	0.00-0.68
C1	Grouse Cr to Mouth	12.27-0.00
Nason Creek		
N4	White Pine Creek to Lower R.R. Bridge	16.09-13.68
N3	Lower R.R. Bridge to Hwy 2 Bridge	13.68-9.13
N2	Hwy 2 Bridge to Kahler Cr	9.13-4.46
N1	Kahler Cr to Mouth	4.46-0.00
White River and Tributaries (Panther and Napeaqua)		
H4	Falls to Grasshopper Meadows	21.16-19.78
T1 - Panther	Boulder field to Mouth	0.43-0.00
H3	Grasshopper Meadows to Napeaqua River	19.78-17.59
Q1 - Napeaqua	Take out to Mouth	0.91-0.00
H2	Napeequa River to Sears Cr Bridge	17.59-11.97
H1	Sears Cr Bridge to Mouth	11.97-0.00
Little Wenatchee River		
L3	Rainy Cr to Lost Cr	10.78-6.74
L2	Lost Cr to Old Fish Weir	6.74-2.13
L1	Old Fish Weir to Mouth	2.13-0.00
Upper Wenatchee River		
W10	Lake Wenatchee to Chiwawa River	54.20-48.39
Chiwaukum Creek		
U1	Metal bridge to Mouth	1.0 – 0.0
Icicle River		
I1	Hatchery to Mouth	3.02-0.00
Peshastin Creek and Tributaries (Ingalls Creek)		
D1 - Ingalls	Trailhead to mouth	0.64-0.00
P2	Ingalls Creek to Camas Cr	9.14-5.63
P1	Camas Cr to Mouth	5.63-0.00

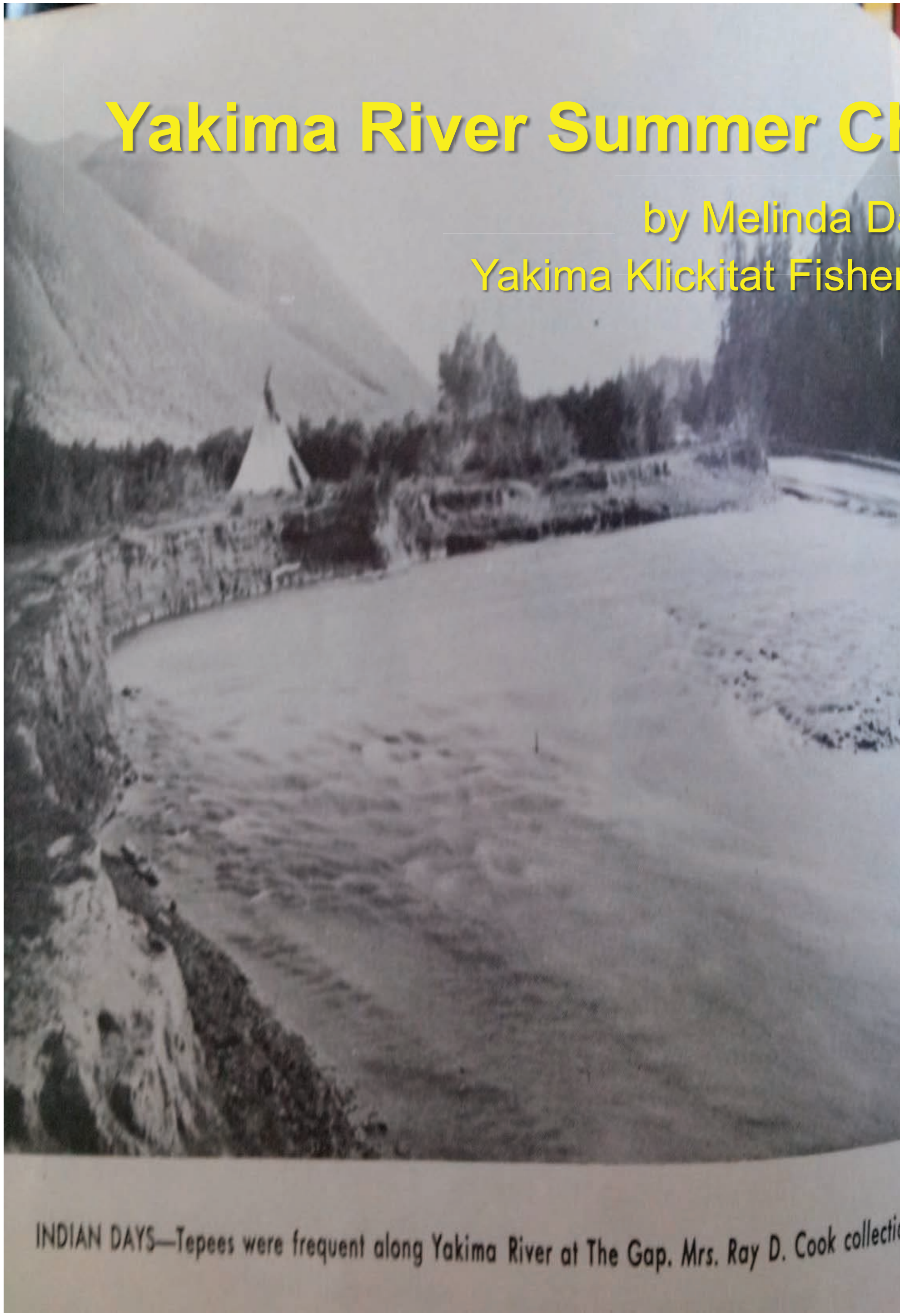
Designated survey reaches for Wenatchee River basin steelhead spawning grounds surveys. Asterisks denote index reaches. Spawning escapements in tributaries will be estimates using PIT-tag arrays.

Reach Code	Reach Section	River Mile
W10	Lake Wenatchee to Chiwawa River*	54.20-48.39
W9	Chiwawa River to Tumwater Bridge*	48.39-35.55
W8	Tumwater Br to Swiftwater Campground	35.55-33.50
	Swiftwater Campground to Unimproved Campground*	33.50-33.08
	Unimproved Campground to Tumwater Dam	33.08-30.91
W7	Tumwater Dam to Icicle Road Bridge	30.91-26.43
W6	Icicle Road Br to Leavenworth boat ramp*	26.43-24.49
	Boat Takeout to Leavenworth Bridge	24.49-23.90
W5	Leavenworth Bridge to Peshastin Bridge	23.90-20.00
W4	Peshastin Bridge to Dryden Dam	20.00-17.76
W3	Dryden Dam to Lower Cashmere Bridge	17.76-9.49
W2	Lower Cashmere Bridge to Sleepy Hollow Bridge *	9.49-3.27
W1	Sleepy Hollow Bridge to Mouth	3.27-0.45

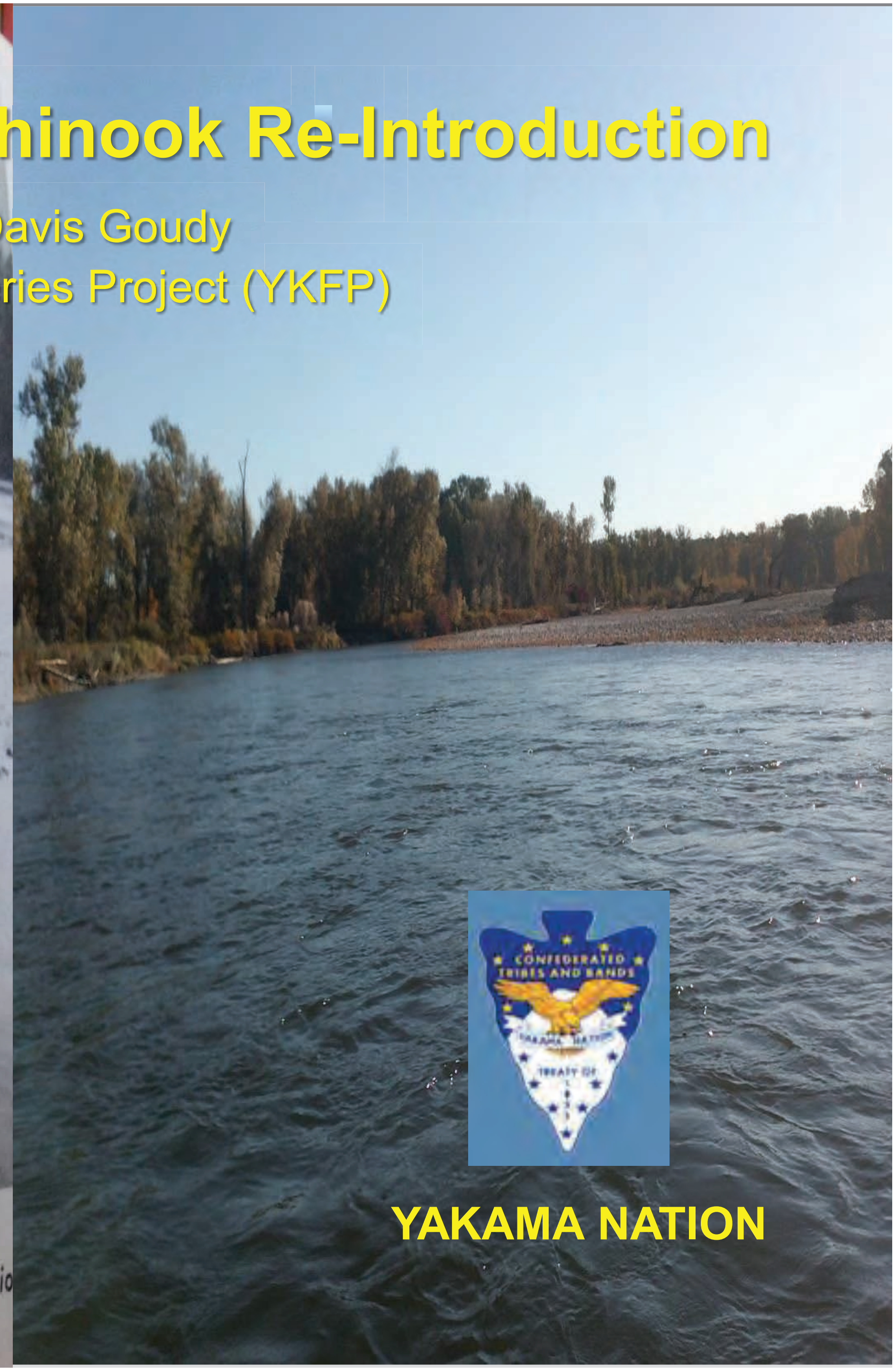
Tributary	River mile of PIT tag array
Mission Creek	0.54
Peshastin Creek	1.91
Chumstick Creek	0.31
Icicle River	0.26
Chiwaukum Creek	0.24
Chiwawa River	0.58
Nason Creek	0.52
Little Wenatchee River	1.74
White River	1.65

Yakima River Summer Chinook Re-Introduction

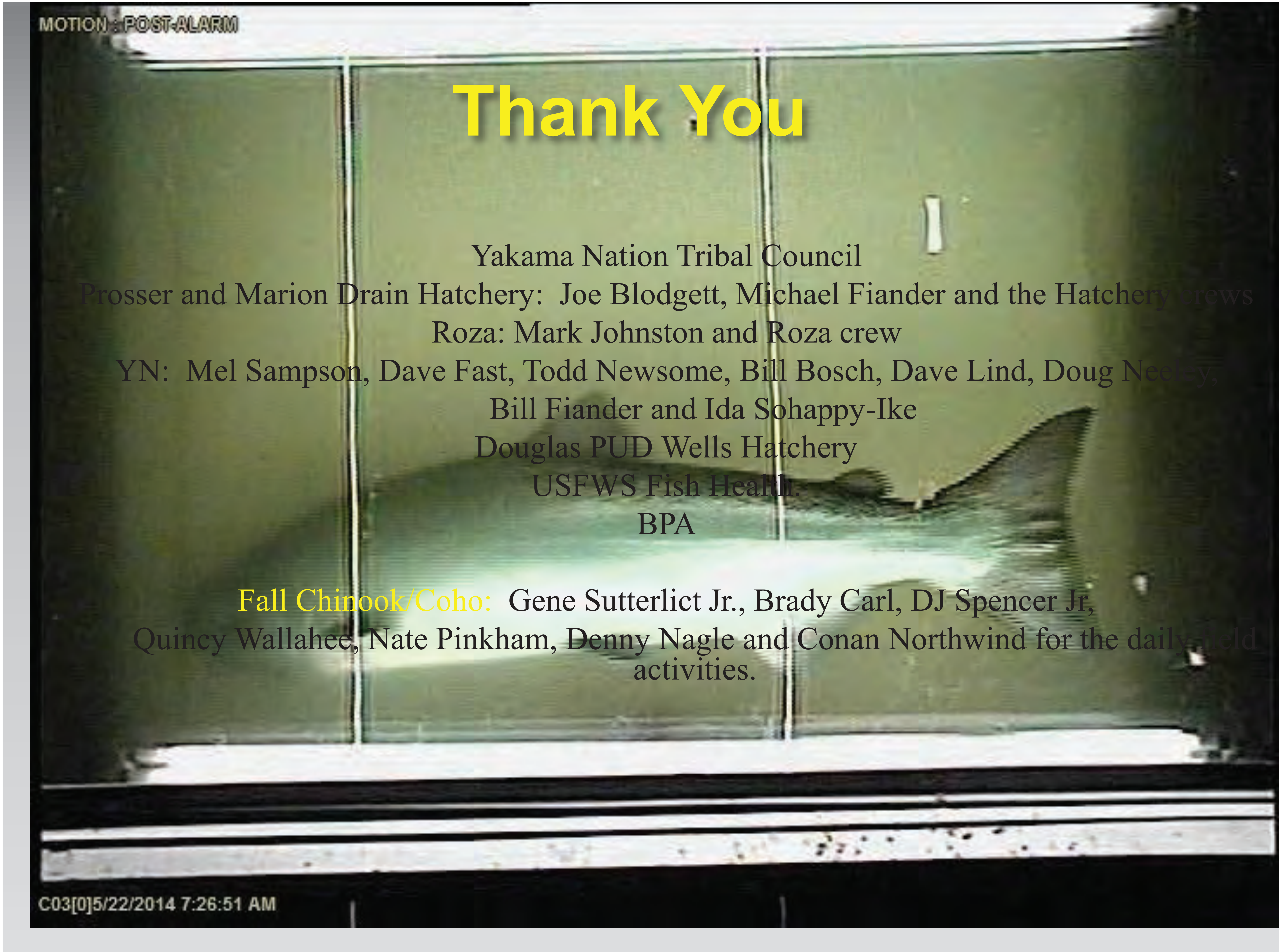
by Melinda Davis Goudy
Yakima Klickitat Fisheries Project (YKFP)

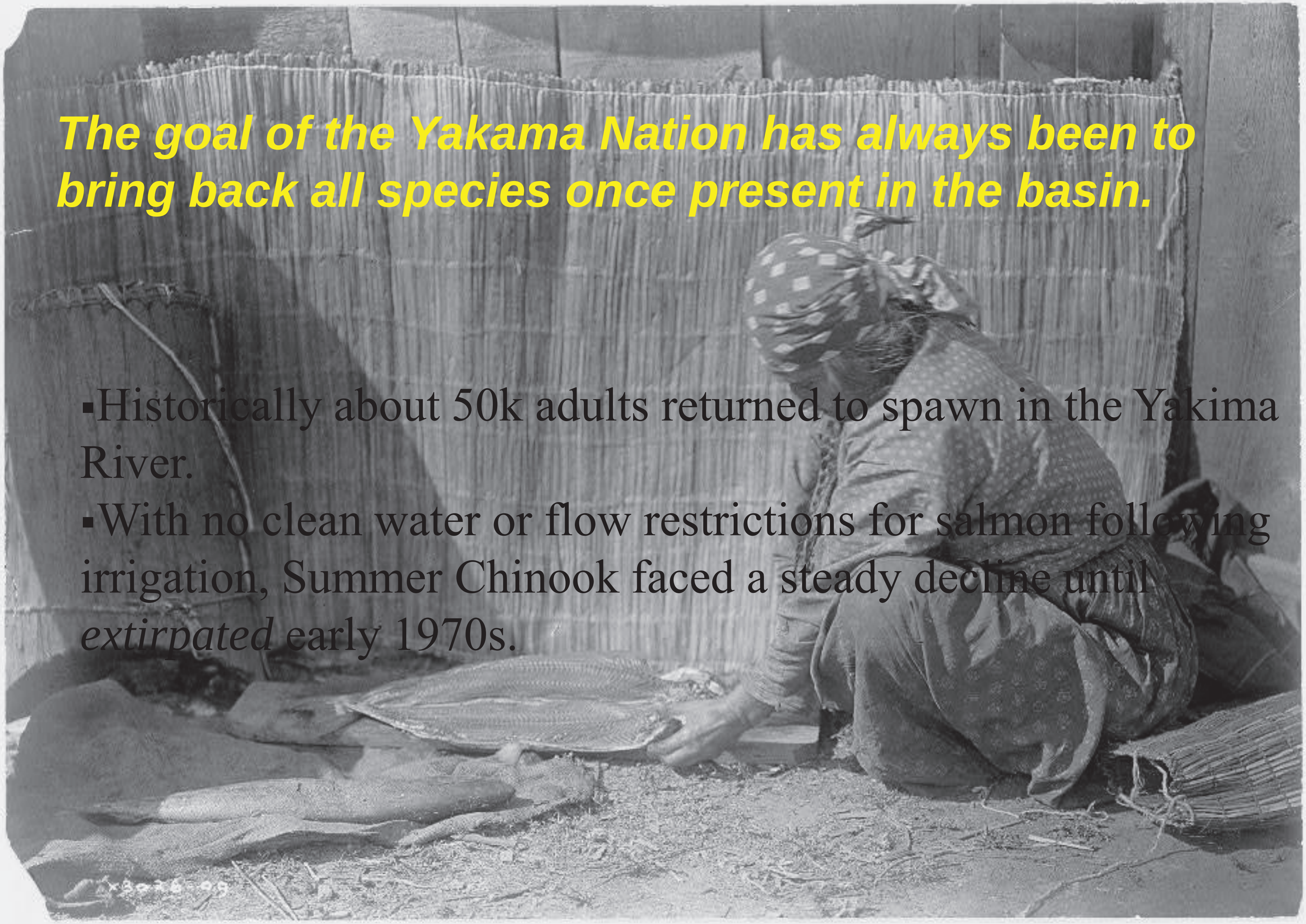


INDIAN DAYS—Tepees were frequent along Yakima River at The Gap. Mrs. Ray D. Cook collectio



YAKAMA NATION


MOTION : POST-ALARM
Thank You
Yakama Nation Tribal Council
Prosser and Marion Drain Hatchery: Joe Blodgett, Michael Fiander and the Hatchery crews
Roza: Mark Johnston and Roza crew
YN: Mel Sampson, Dave Fast, Todd Newsome, Bill Bosch, Dave Lind, Doug Neeley,
Bill Fiander and Ida Sohappy-Ike
Douglas PUD Wells Hatchery
USFWS Fish Health.
BPA
Fall Chinook/Coho: Gene Sutterlict Jr., Brady Carl, DJ Spencer Jr,
Quincy Wallahee, Nate Pinkham, Denny Nagle and Conan Northwind for the daily field activities.
C03[0]5/22/2014 7:26:51 AM



The goal of the Yakama Nation has always been to bring back all species once present in the basin.

- Historically about 50k adults returned to spawn in the Yakima River.
- With no clean water or flow restrictions for salmon following irrigation, Summer Chinook faced a steady decline until *extirpated* early 1970s.

2006 YN began feasibility conversation to bring them back

Re-Establishing Summer Chinook in the Yakima River

- **Objective:** **<u>To initiate investigation of the feasibility of establishing an early-run fall Chinook population in the Yakima River, with the goals being to:</u>**

- Develop a naturally spawning adult population in the Yakima River between Sunnyside Dam and Roza Dam, and in the lower Naches River from the mouth to the Tieton River, and,
- Increase the number of natural-origin returning summer-run adults in the lower Columbia, Zone 6, and the lower Yakima River contributing to harvest augmentation for both the tribal and sports fishery.

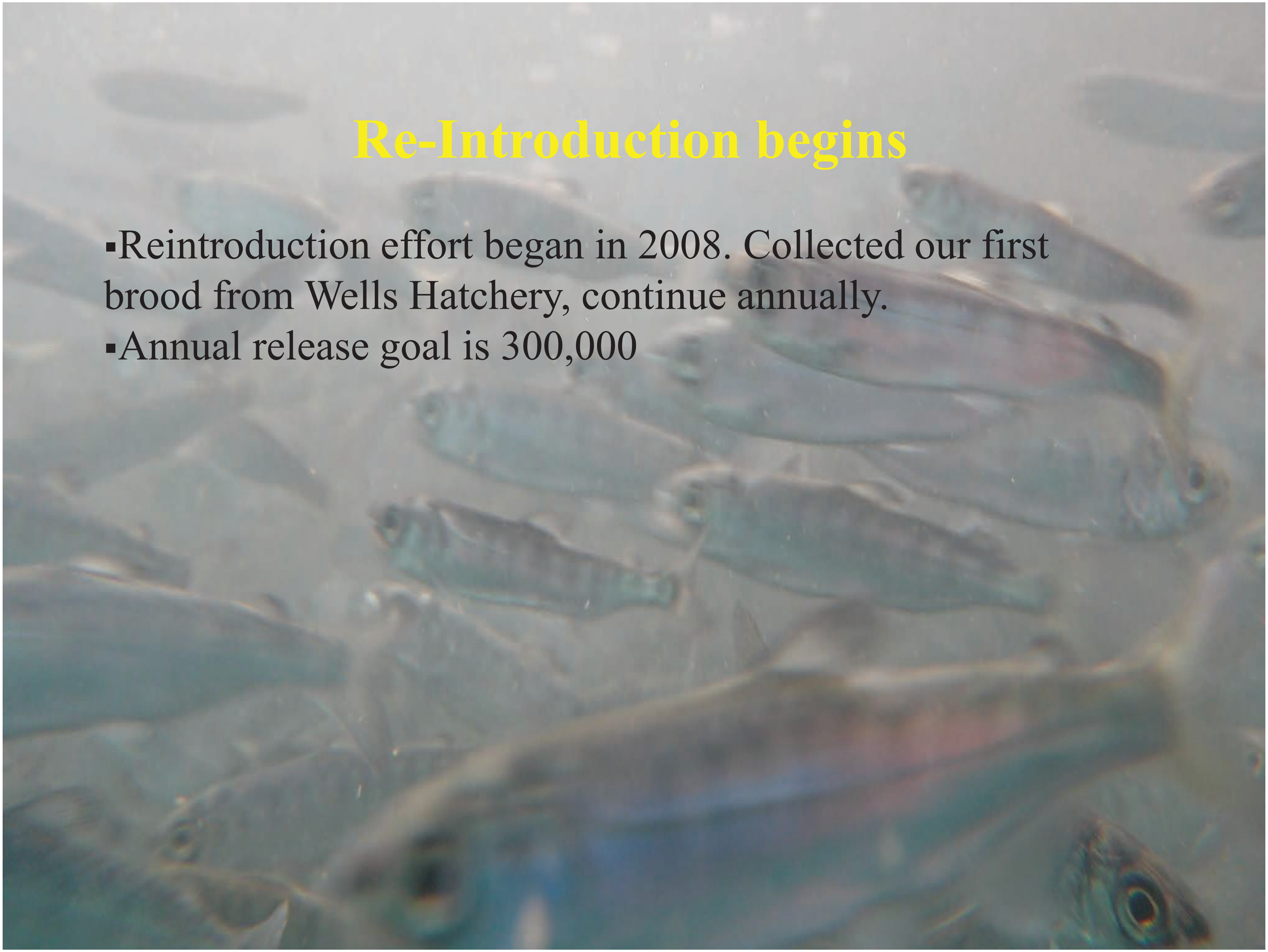
Choosing a stock

- 2 distinct spawning areas within the Mid-Columbia R
  - Tributaries in the Snake AND in tributaries above Rock Island Dam
  - The two are reproductively isolated from each other by differences in migration, spawning and rearing times, as well as geographic separation.

MCR summer chinook are part of a larger ESU that includes all late run (summer and fall) ocean type Chinook and its tributaries.

- 2 stocks that return to the MCR-1) Wells H "integrated" and 2) the Wenatchee stock.
- Chose Wells stock based on recommendations of our Fish Health team

Less "BKD" in juveniles compared to Wenatchee stock.



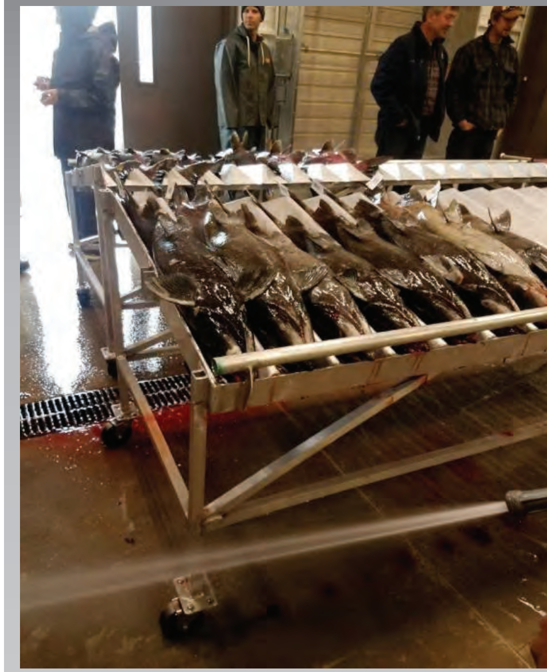
Re-Introduction begins

- Reintroduction effort began in 2008. Collected our first brood from Wells Hatchery, continue annually.
- Annual release goal is 300,000

Douglass PUD Wells Hatchery

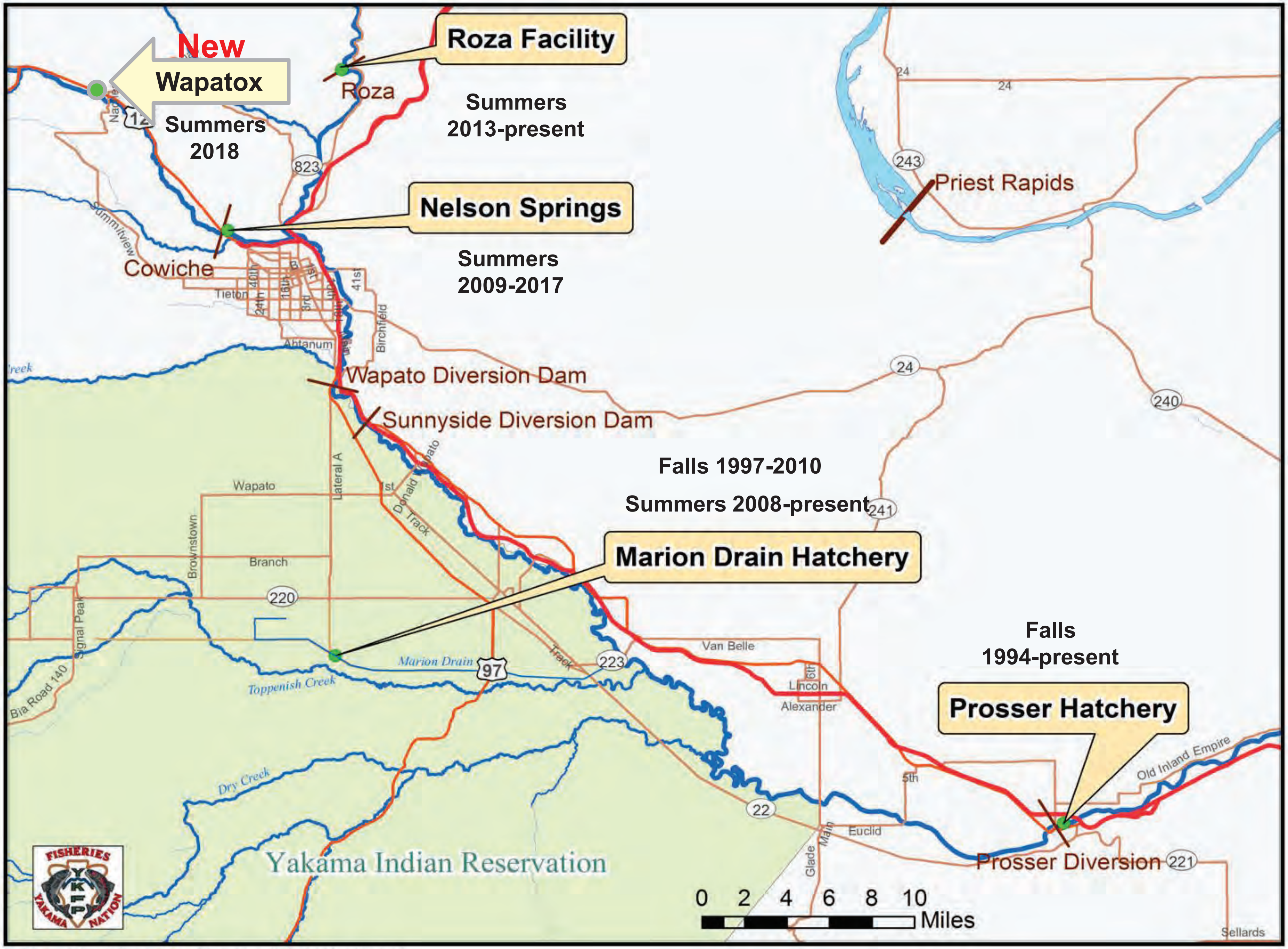





02

YN Marion Drain Hatchery



Paul Huffman, Yakama Nation Fisheries, 3/08/2013 C:\avdata\subbasinyak\fallchinooksites2.mxd

Attachment G

Release Site		Stiles		Prosser		Buckskin			Marion Drain	Below Roza			Yakima Mouth
Release Period		Mid**	Late***	Early*	Mid**	Early*	Mid**	Late***	Mid**	Early*	Mid**	Late***	Mid**
2009	Survival		1.5%										
	Released		30,037										
2010	Survival	19.7%											
	Released	5,669											
2011	Survival	39.7%				43.7%							
	Released	20,000				29,894							
2012	Survival				20.8%		37.2%		35.8%				
	Released				9,999		9,999		9,998				
2013	Survival						20.7%					29.8%	
	Released						15,084					15,065	
2014	Survival						18.3%	3.2%				4.8%	
	Released						10,086	10,102				10043	
2015	Survival			2.6%			0.00%			0.07%	0.00%		
	Released			4,031			10,266			10,034	10,027		
2016	Survival												31.2%
	Released												35,619
2017	Survival				19.6%						19.4%		
	Released				2,513						15,026		

Yellow highlighted under 5% survival

* through May 10.

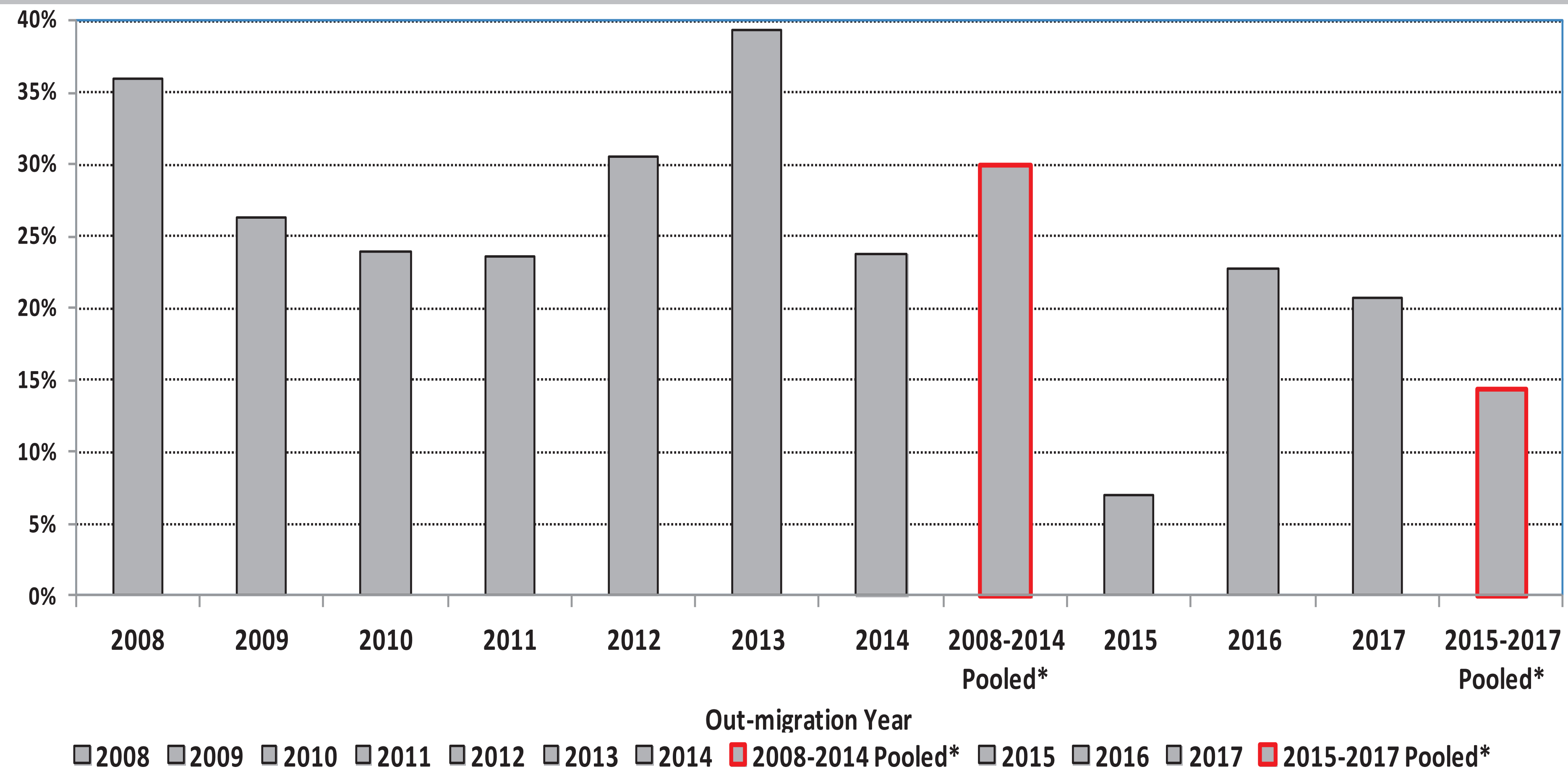
** After May 10 through May 25

*** After May 25

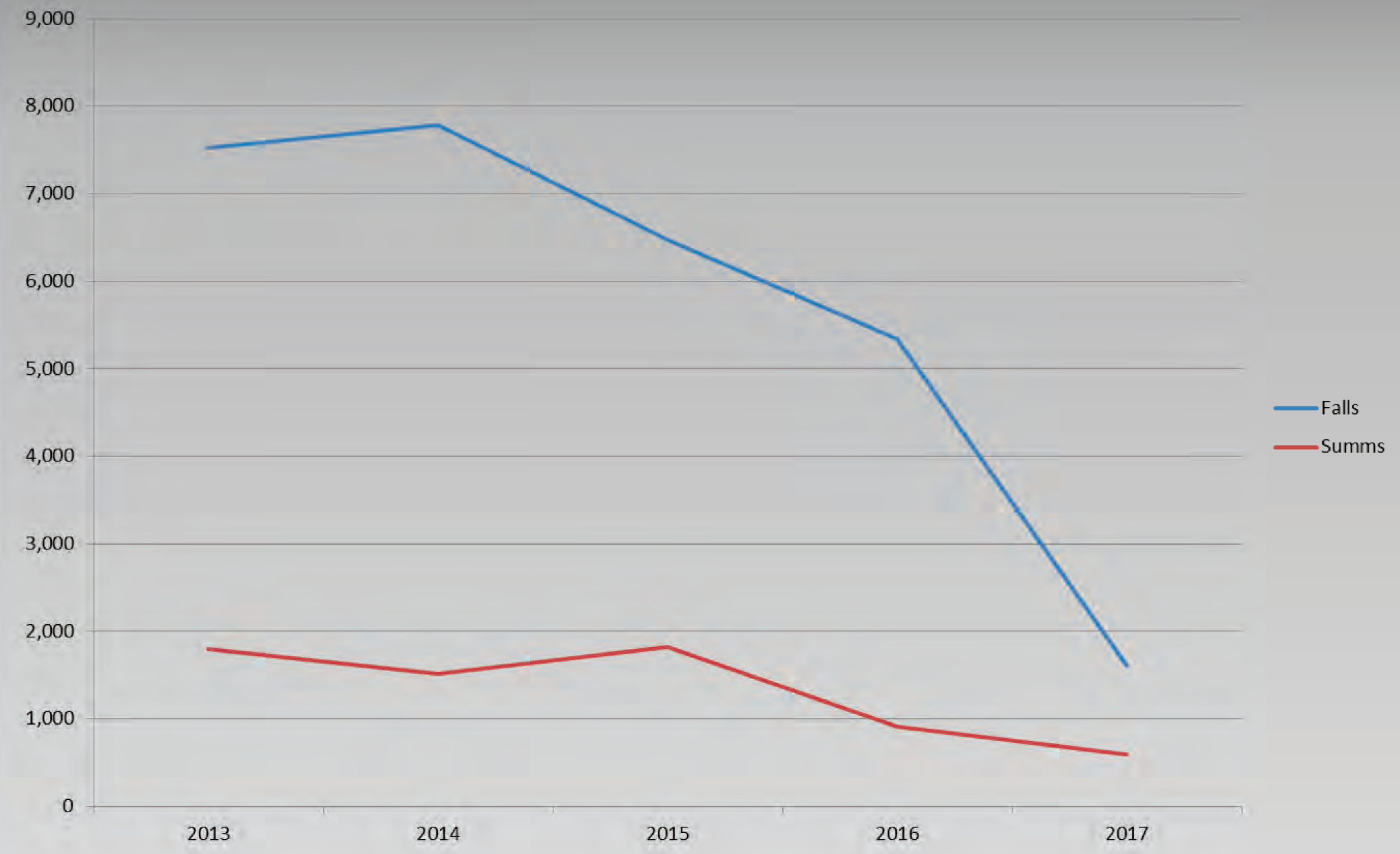
Pooled Prosser-to-McNary Survival for Yakima Stock Subyearling Fall Chinook Releases made in 2008 -2017

Doug Neeley, 2018

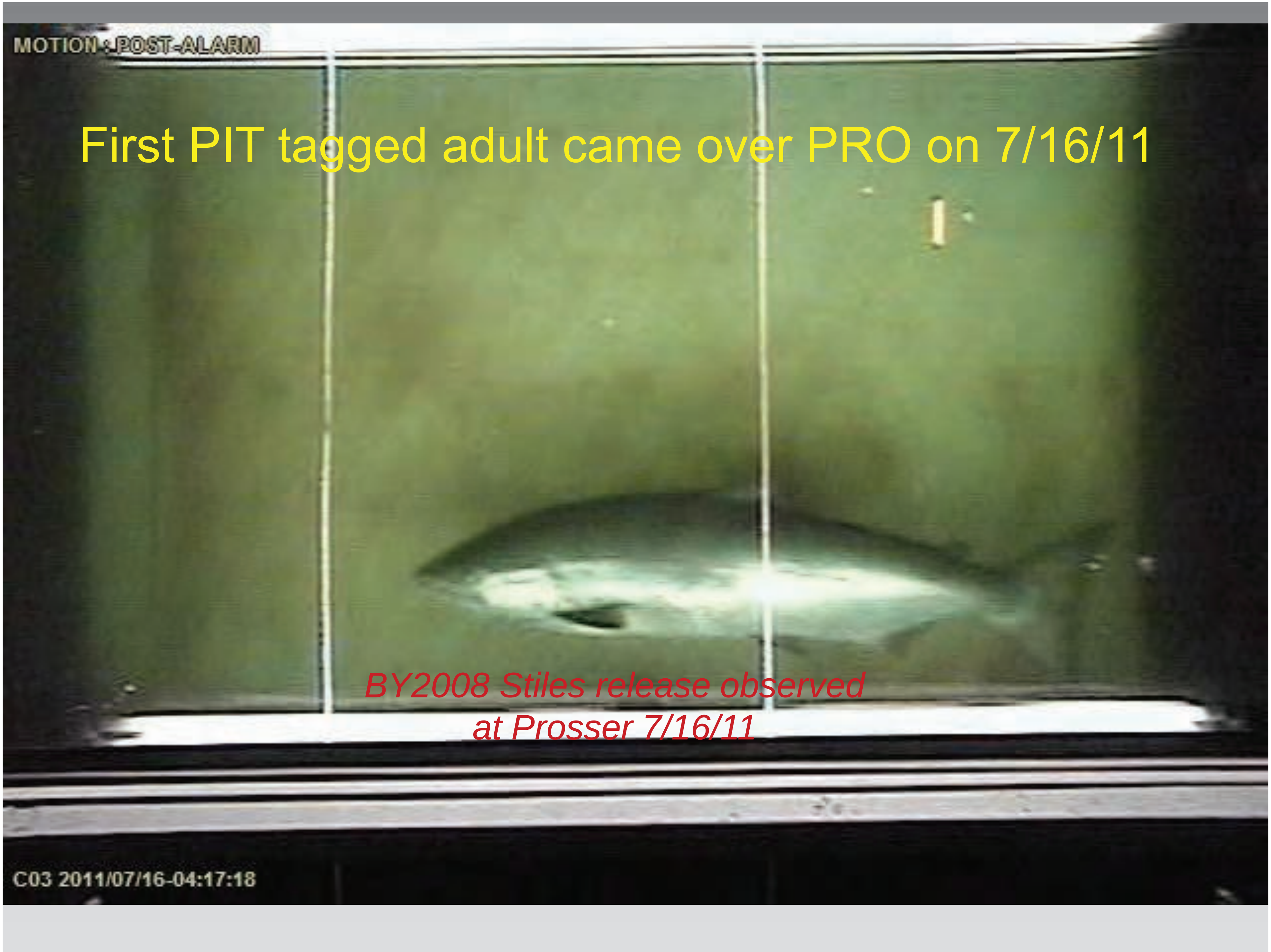
		Release Year													
Age	Measure	2008	2009	2010	2011	2012	2013	2014	2008-2014 Pooled	2015	2016	2017	2015-2017 Pooled	Minimum 2008-2013	Maximum 2014-2017
Subyearling	Survival	36.0%	26.3%	24.0%	23.6%	30.5%	39.3%	23.7%	30.0%	6.9%	22.8%	20.7%	14.4%	23.6%	22.8%
	Tagged	10,001	7,565	13,685	22,790	9,264	22,966	4,025	90,296	4,998	2,531	2,503	10,032		



Adults above Prosser



2013-17 avg- 5,751 falls 1,329 summers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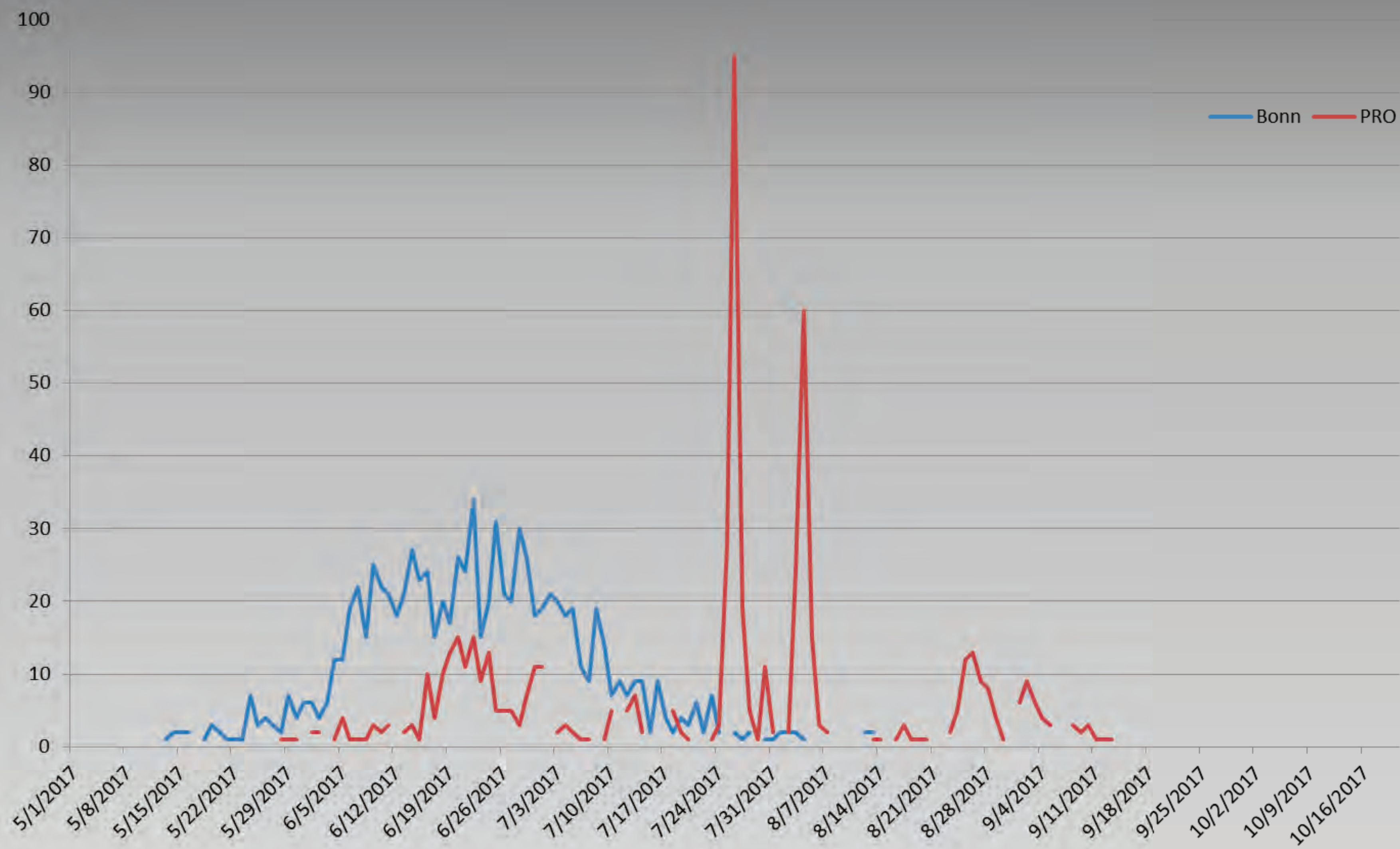
First PIT tagged adult came over PRO on 7/16/11
BY2008 Stiles release observed
at Prosser 7/16/11
C03 2011/07/16-04:17:18



902	total unique PITs to Bonn.
592	total unique PITs to PRO
65.6%	Cumulative conversion Bonn to Prosser
34.4%	<--implied harvest & mort. rate Bonn to Prosser

OcnAge	N		
1	36	4.0%	OcnAge= ocean age = year of Bonn. detection
2	252	27.9%	minus year of release
3	521	57.8%	
4	91	10.1%	
5	2	0.2%	
	902		

(Bosch, 2018)

Prosser Adult Returns

ReleaseY	#PITS	#Released	*SAR	
2009	30,045	200,747	0.023	
2010	29,997	180,911	0.280	
2011	29,893	39,406	1.034	
2012	29,996	269,359	0.203	
2013	40,203	136,565	0.174	
2014	30,278	254,881	**0.043	
2015	30,427	222,448		
2016	37,000	37,000		
2017	17,530	244,499		
			0.343	mean

*preliminary

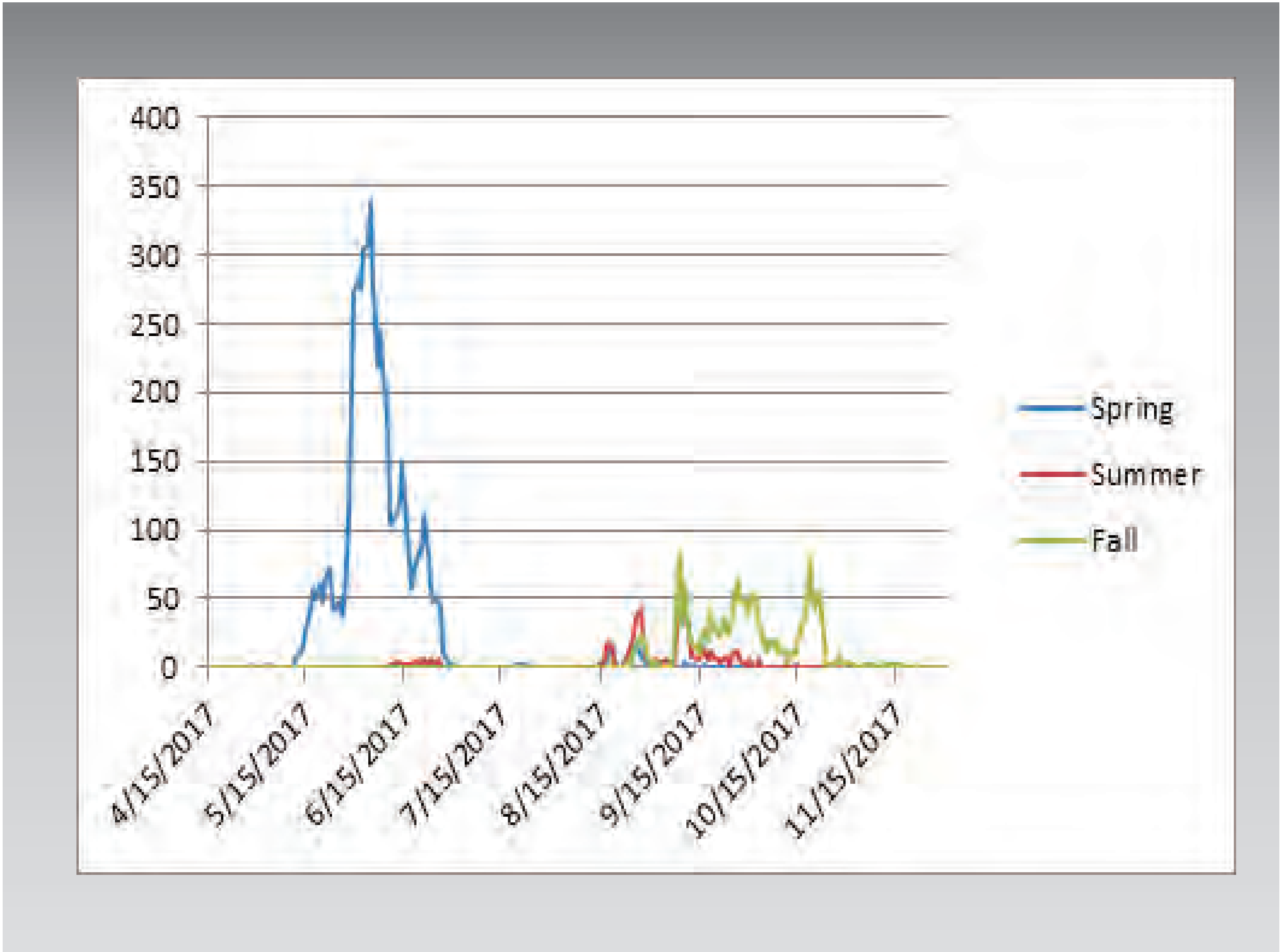
**Incomplete brood return

Table 11. Average combined hatchery- and natural-origin smolt counts at Prosser for fish returning at age-3, -4, and -5, combined adult returns to Prosser Dam of all age classes, and estimated Prosser smolt-to-adult return indices for Yakima River fall-run Chinook for adult return years 1988-2016.

Adult Return Year	Prosser Average Smolts[1]	Prosser Total Adults	Prosser Smolt-to-Adult Return Index (SAR)
1988	1,029,429	224	0.02%
1989	1,469,019	670	0.05%
1990	1,664,378	1,504	0.09%
1991	1,579,989	971	0.06%
1992	1,811,088	1,612	0.09%
1993	2,034,865	1,065	0.05%
1994	1,976,301	1,520	0.08%
1995	1,329,664	1,322	0.10%
1996	1,023,053	1,392	0.14%
1997	1,097,032	1,120	0.10%
1998	1,533,093	1,148	0.07%
1999	1,786,511	1,896	0.11%
2000	1,716,156	2,293	0.13%
2001	1,867,966	4,311	0.23%
2002	1,946,676	6,241	0.32%
2003	2,108,238	4,875	0.23%
2004	2,653,056	2,947	0.11%
2005	2,707,132	1,942	0.07%
2006	2,724,824	1,528	0.06%
2007	2,312,562	1,132	0.05%
2008	2,450,308	2,863	0.12%
2009	2,353,675	2,972	0.13%
2010	2,118,702	2,888	0.14%
2011	1,780,670	2,718	0.15%
2012	1,806,572	4,477	0.25%
2013	1,939,754	7,706	0.40%
2014	2,411,076	7,792	0.32%
2015	2,476,483	7,380	0.30%
2016	2,436,111	5,355	0.22%
2017			
Mean	1,936,013	2,892	0.14%

Average combined hatchery- and natural-origin smolt counts for the years which would comprise the age-3, -4, and -5 adult return components for each adult return year. For example, the "Prosser Average Smolts" for adult return year 1988 is the average of hatchery- and natural-origin Prosser smolt estimates for juvenile migration years 1983-1985.

Bosch, 2018


400
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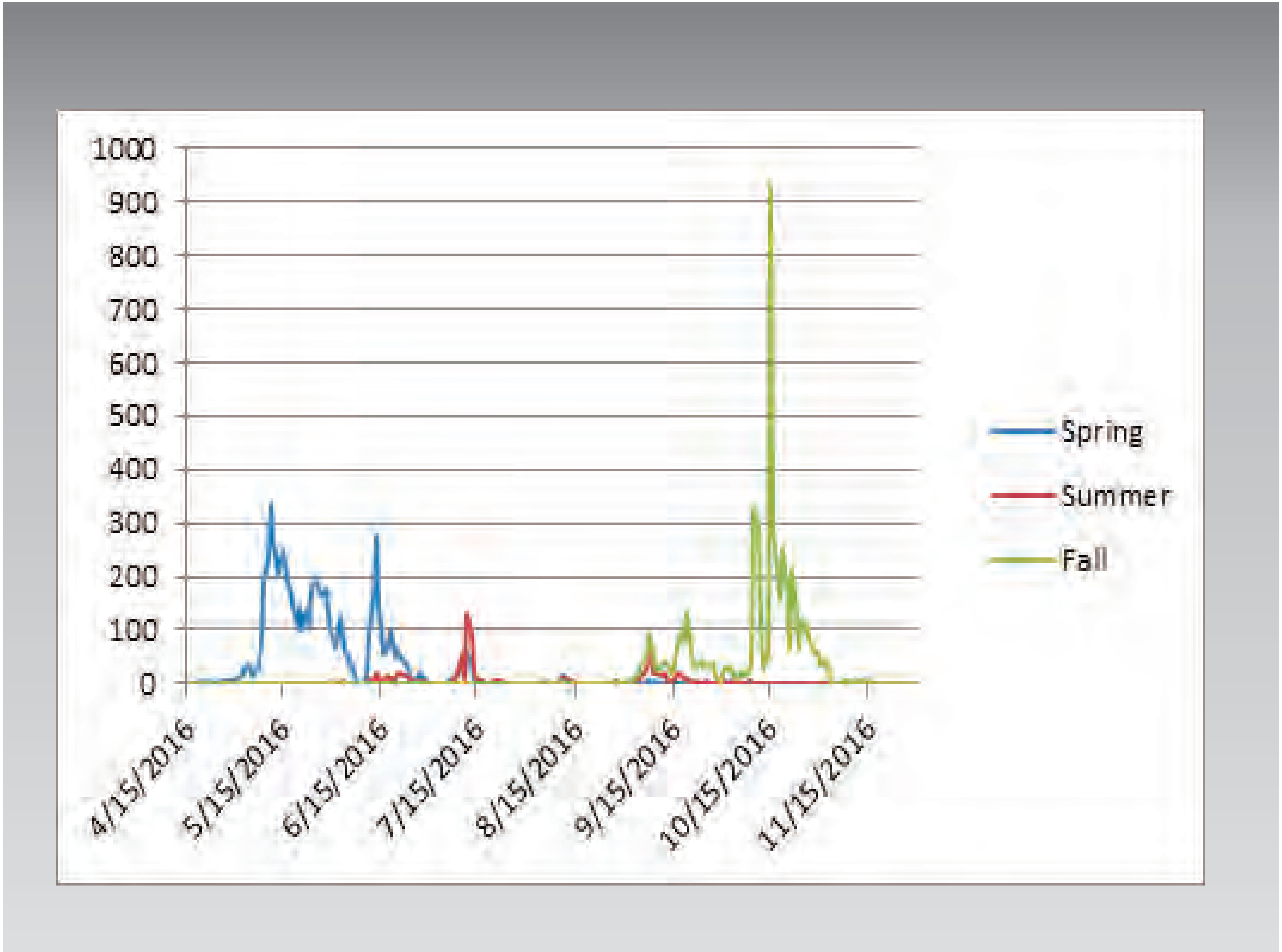
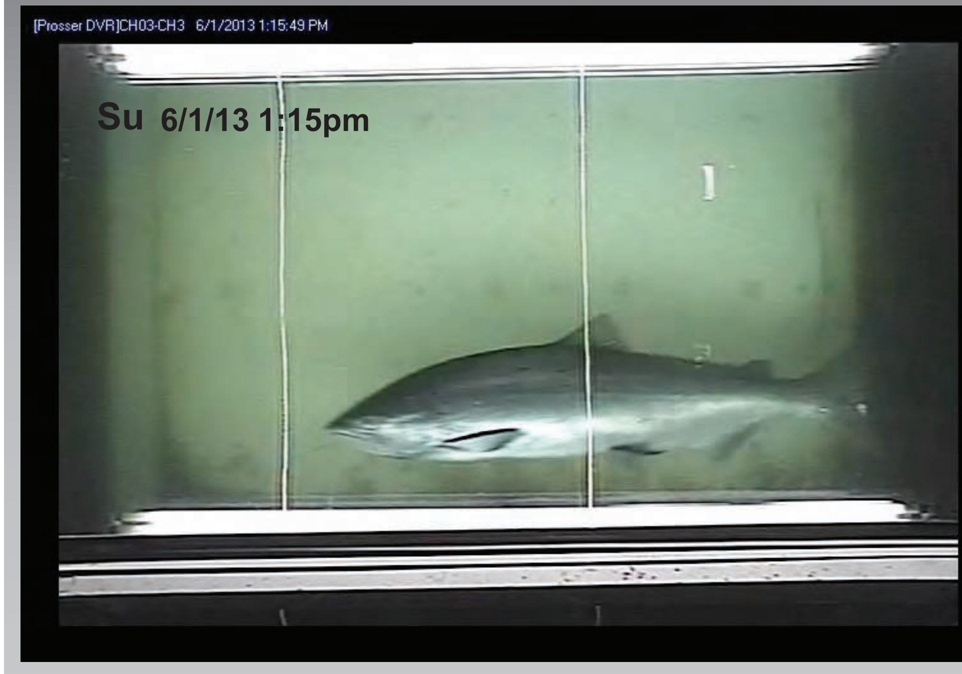
11/15/2017
Spring
Summer
Fall


1000
900
800
700
600
500
400
300
200
100
0
4/15/2016
5/15/2016
6/15/2016
7/15/2016
8/15/2016
9/15/2016
10/15/2016
11/15/2016
Spring
Summer
Fall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Su 6/1/13 1:15pm


MOTION : POST-ALARM
SU 5/28/14 1:56:27pm
Eastbank Stiles 5/16/11 BY09
C03[0]5/28/2014 1:56:27 PM


[Prosser DVR]CH03-CH3 6/1/2013 1:24:49 PM
Sp 6/1/13 1:24pm


MOTION : POST-ALARM
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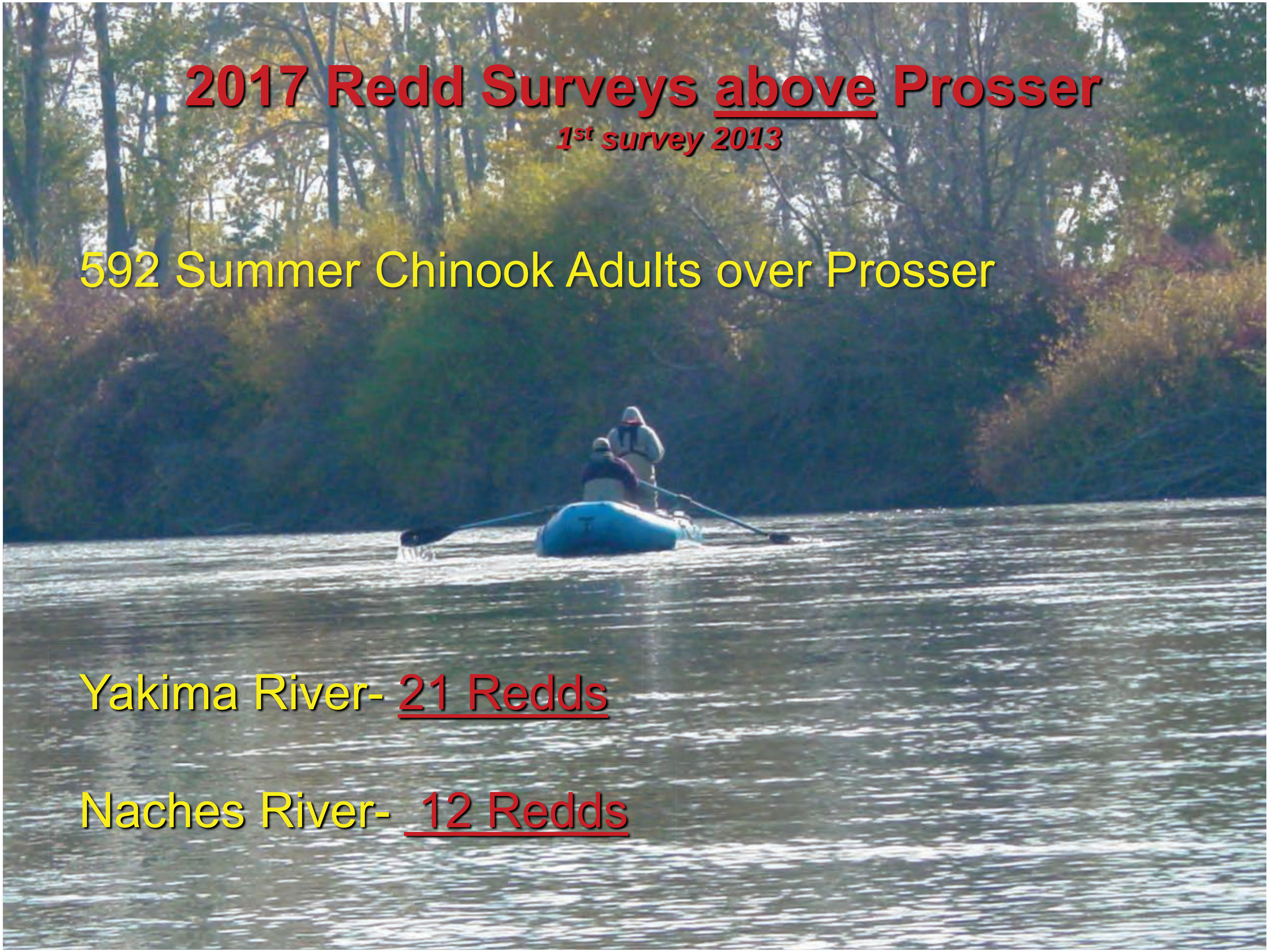
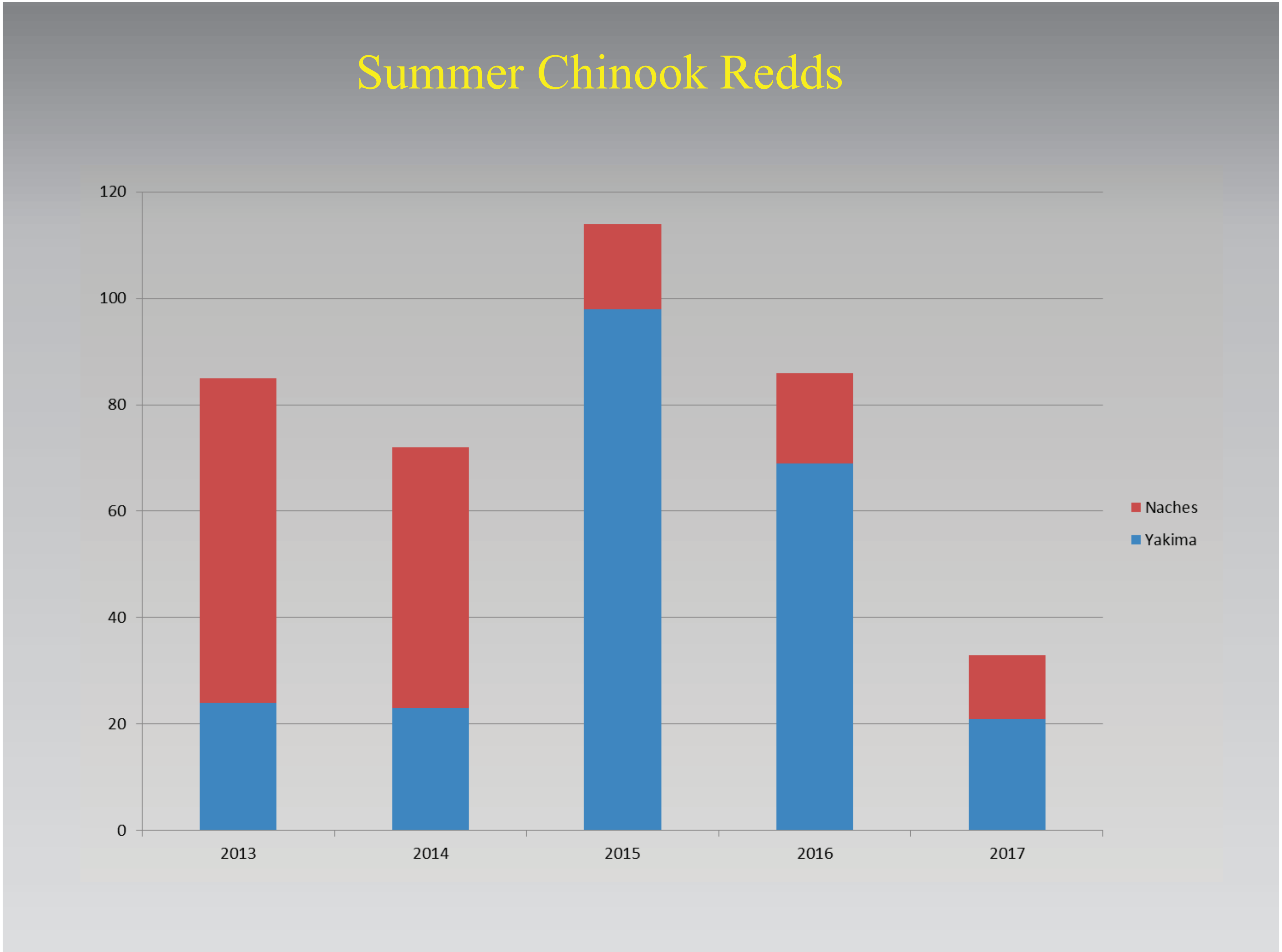
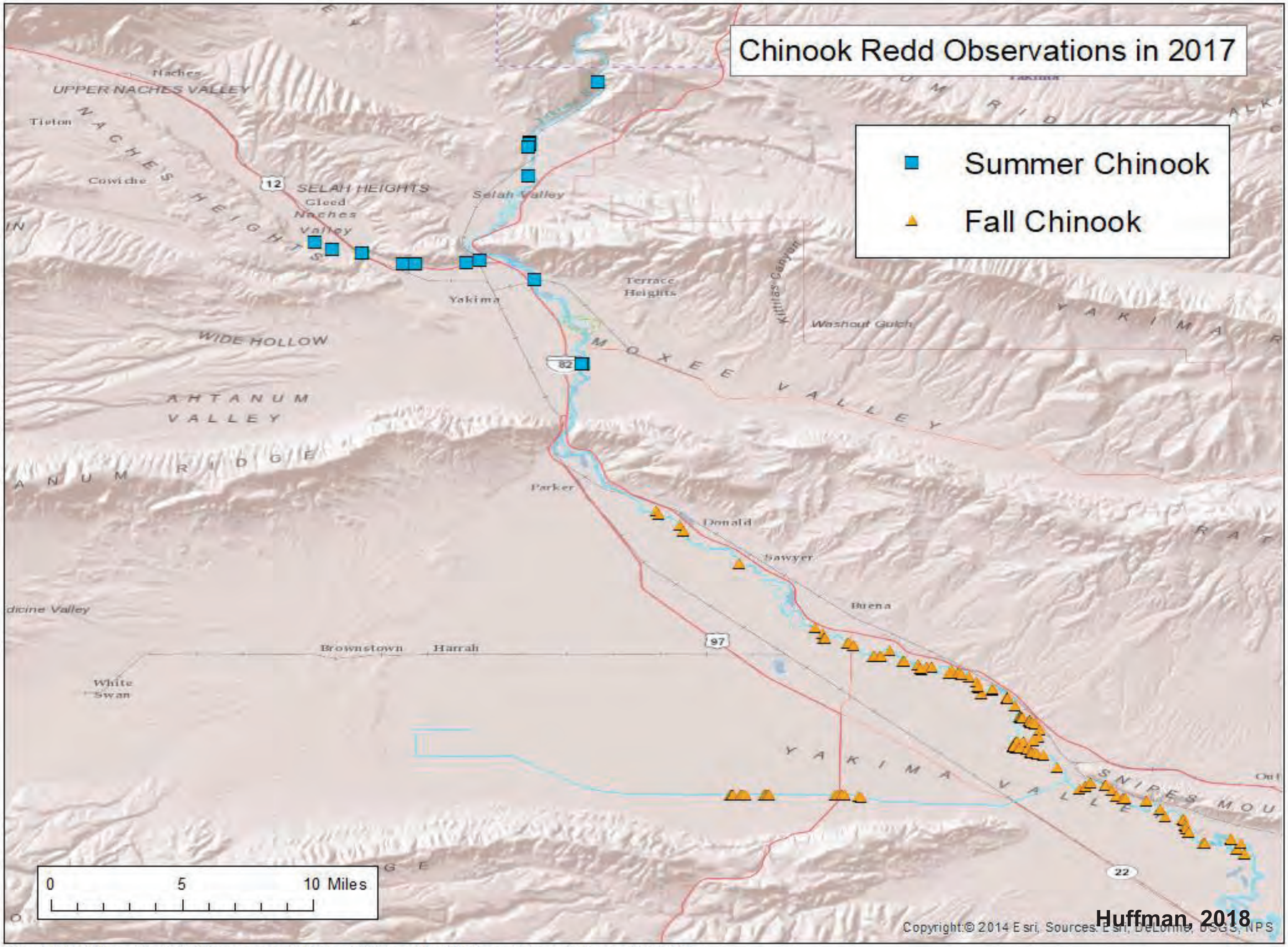
Easton 3/15/12 BY11
C03[0]5/28/2014 1:56:13 PM


2017 Redd Surveys above Prosser
1st survey 2013
592 Summer Chinook Adults over Prosser
Yakima River- 21 Redds
Naches River- 12 Redds


Summer Chinook Redds
120
100
80
60
40
20
0
2013
2014
2015
2016
2017
Naches
Yakima



C:\avdata\FallChinookRedds\2017\summerandfallchinook2017.mxd Paul Huffman, Yakama Fisheries, 6/14/2016

Ongoing Plans

- Bring in green eggs/milt from Wells Hatchery to MarionD for incubation and early rearing.
- Continue acclimation at both Roza and Wapatox sites.
- Redd Surveys on the Yakima River between Prosser and Roza Dams and lower Naches River.

Ultimately-Transition Phase

Convert to a local brood and discontinue import

Questions/Comments?

Methow Basin Spring Chinook Adult Management Plan: 2018

Last updated on July 16, 2018

Methow Spring Chinook adult management activities at PUD facilities authorized by the NMFS ESA Section 10 Permit for Spring Chinook

Synopsis of the adult management plan for 2018:

The Methow Spring Chinook BiOP (2017) and Permit 18925 describe the sliding scale for spring Chinook gene flow in the Methow. The real time run data were applied to this sliding scale to determine adult manage targets for the Methow Hatchery returning adults.

The Wells Dam run assessment conducted during broodstock collection and stock assessment at Wells Dam suggested a preliminary estimate of:

Wild Spawners:	447
Hatchery Spawners (Methow Hatchery):	547
Assumed Pre-Spawn Mortality (PSM): 25% (C. Frady, WDFW, personal communication)	
pNOB (brood years 2013 and 2014 (C. Snow, WDFW, personal communication):	0.95

This resulted in a sliding scale PNI target of:	0.7453
pHOS target derived from PNI target:	0.3247

Projected Hatchery spawners after PSM:	410
Allowable Hatchery Spawners:	214
Hatchery Fish to remove:	196
Proportion of hatchery fish to remove:	0.36

Total wild + Methow Hatchery spawning escapement:	661

All fish captured at the Methow Hatchery are being transferred to WNFH for broodstock or surplusing.

Trapping to date at Methow Hatchery Outfall Trap (provisional data):

Females		Males		Jacks	
Wild	Hatchery	Wild	Hatchery	Wild	Hatchery
0	25	0	29	3	63

As of July 16, 2018, 28 hatchery adults (9 F and 19 M) and 63 hatchery jacks have been shipped to WNFH for a total of 91 (provisional data; fish for use as WNFH broodstock or surplus). Methow Hatchery has 6 hatchery females for BKD backup, and 20 (10 F and 10 M) hatchery fish for the WDFW egg to fry study.

The total hatchery fish removed is 117 to date. 79 more Methow Hatchery fish should be removed this year.

Control of Saprolegnia spp. Growth on Spring Chinook (*Oncorhynchus tshawytscha*) Eggs

Experimental Protocol – Pilot Study

Written by Betsy Bamberger, DCPUD Fish Health and Evaluation Specialist

Purpose: To investigate the efficacy of hydrogen peroxide and salt in controlling water mold infestations during salmonid egg incubation under hatchery conditions at Methow Fish Hatchery (MFH). The chemical traditionally used for prophylactic management of Saprolegnia spp., formalin, has long been associated with worker safety and environmental hazards and may be met with increasing scrutiny by regulatory agencies in the immediate future. This effort is made to determine the effectiveness of purported alternatives to formalin that can be used as safe therapeutic substitutes at MFH.

Hypothesis: There will be no difference found between test treatment groups (hydrogen peroxide, sodium chloride, no treatment [water]) and the formalin group in the control of egg mortality caused by Saprolegniasis.

Experimental design: Twenty-four (24) pairs of Winthrop National Fish Hatchery (WNFH)-origin (hatchery) Spring Chinook will be collected at the Methow Outfall Trap and/or transported from WNFH in mid-late July, 2018 and spawned when ripe at MFH. Spawning and incubation will follow the standard procedure used at MFH. The unfertilized eggs and milt from one respective female, male, and backup male will be combined in a plastic bucket until sufficiently mixed, gently rinsed with water, and then added to a large receptacle that contains all fertilized eggs collected from the day. The eggs will be divided into equal parts, containing roughly 3,800 eggs per group (the assumed average fecundity of one hen). Each group will be placed in a designated individual Heath vertical incubator tray within a stack assigned to one of four treatment groups (formalin, salt, hydrogen peroxide, and water [no treatment]). Eight stacks total will be used, two for each treatment group, with utilization of an empty mixing tray on top of each stack, below which are three staggered trays reserved for eggs (see treatment-specific information and schematic representation of experimental set-up in Figure 1 below). The formalin stacks will be kept in a separate room to avoid adverse chemical reactions between compounds. Each tray will be numbered in advance, and egg clutches will be placed in sequential order until all are occupied. The fertilized eggs will be then water-hardened in a 100 ppm buffered iodophor (Ovadine®) solution (static bath) for 30 minutes. Following this surface disinfection, fresh well water (averaging 47°F) will be introduced into the stacks, effectively draining away the used iodophor solution from each tray. Flow will be set at 3 gallons per minute.

Formalin, salt, and hydrogen peroxide will be added to the top tray of the designed stacks and delivered via a metered peristaltic pump (model TBD). Dosages of hydrogen peroxide, formalin, and salt are calculated to consider flow rate, treatment time, final desired concentration of chemical used, and chemical strength and are consistent with FDA-label instructions or previously published data (see Figure 1). Salt will be pre-dissolved before administration; salinity will be monitored during treatment with an Apera 5052 saltwater salinity tester with the probe placed in the topmost empty tray and recorded at multiple time points during administration (0, 5, 10, 15, and 20 minutes). Daily 15-minute flow-through treatments with the test compounds will be initiated on the day following fertilization and continue on alternate days until day 39 of incubation (assuming approximately 15 temperature units/day), just prior to the initiation of hatching. On day 39 of incubation, the incubator trays will be opened and photographed; the eggs will be shocked by mechanical agitation within the trays and returned to the stacks. On day 40, the trays will again be opened and any dead and Saprolegnia-infected eggs will be removed by hand, sorted, and live and dead eggs counted. All eggs used for this study will then be destroyed.

The criterion used to evaluate the success of each compound is total egg mortality (which includes both water mold-infected eggs and dead uninfected eggs throughout the 40 day incubation period). In addition, the extent of water mold infection will be qualitatively (photograph) and quantitatively (number of eggs that appear infected) estimated.

Statistical Analysis: The statistical analysis described here is the study design and analysis that would be used in a full scale study. Researchers will target approximately 24 pairs of spawning adults to provide enough eggs to meet density and sample size requirements. Gametes will be reared at similar densities that are normally employed at Methow Hatchery. During experimental development, power analysis determined that n = 45 samples per treatment group would be required at an effect size of 0.25 to detect a difference at alpha = 0.05. However, given the pilot nature of the study proposed in 2018, sample sizes may be reduced to as little as n = 3 samples per treatment. Treatment (formalin, salt, hydrogen peroxide, water [no treatment]) will serve as a categorical variable and total egg mortality represented by the percentage of dead eggs at study completion will serve as the continuous response variable.

Since family groups generated during the study are likely to occur across multiple egg take (spawn) days, all eggs from each egg take will be combined into one population and subsequently divided into equal densities in each treatment-specific tray. Combining family groups on each spawn day is expected to eliminate any genetic or familial effects. Nevertheless, spawning fish on multiple days precludes combining all family groups over the course of the study and therefore requires examination for “spawn day effects” prior to examining treatment effects. As such, following the completion of the study a 1-way ANOVA (if more than two spawn days are needed) or t-test will be used to ensure that spawn day has no statistical influence on egg survival. If no difference among egg takes is found, total study survival results will be combined into treatment bins to maximize sample sizes in each treatment, thereby ignoring spawn day.

A 1-way ANOVA will be used to examine similarities or differences between treatment groups. Upon finding significant results, a Tukey-Kramer HSD post hoc analysis will be used to isolate significant differences among treatment groups and towards recommending a treatment to researchers, managers, and aquaculture staff. P-values will be assessed at $\alpha = 0.05$. If the response variable does not satisfy the assumption of homogeneous variance, an alternative analysis such as beta regression will be used. All statistical analysis will be conducted in R, JMP, or SAS software.

Figure 1:

Room 3		Room 3		Room 3		Room 1 or 2	
Stack 1	**Stack 2**	**Stack 3**	**Stack 4**	**Stack 5**	**Stack 6**	**Stack 7**	**Stack 8**
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
1	5	2	6	3	7	4	8
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
9	13	10	14	11	15	12	16
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
17	21	18	22	19	23	20	24
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty

No Treatment

100% Well Water

Hydrogen Peroxide

35% PEROX-AID®

Dosing regimen: 1000 mg/L for 15 minutes (~488 mls H2O2) in a continuous flow system once per day on alternate days until day 39 (consistent with FDA label).

Sodium Chloride

Diamond Crystal® Solar Naturals®

Dosing regimen: 20,000 ppm for 15 minutes (~7.5 lbs salt per stack) in a continuous flow system once per day on alternate days until day 39 (based on findings in Waterstrat, 1995 and Edgell, P. and D. Lawseth, 1993).

Formalin

Parasite-S®

Dosing regimen: 1/600 (1,666 ppm) for 15 minutes (~740 ml per stack) in a continuous flow system once per day on alternate days until day 39 (consistent with FDA label).

FINAL

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Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: September 20, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery and Larissa Rohrbach, Anchor QEA, LLC

Re: Final Minutes of the August 15, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held in Wenatchee, Washington, on Wednesday, August 15, 2018, from 9:00 a.m. to 12:15 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A). *(Note: this item is ongoing.)*
- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Tom Scribner will discuss internally the potential to release surplus Winthrop National Fish Hatchery (NFH) brood year 2018 wild-by-wild steelhead parr at Yakama Nation (YN) restoration sites in the Methow Basin in October (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will revise the Draft 2018 Methow Basin Spring Chinook Adult Management Plan and provide it to the Hatchery Committees (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will coordinate with Charles Frady (Washington Department of Fish and Wildlife [WDFW]), Charlie Snow (WDFW), Michael Humling (U.S. Fish and Wildlife Service [USFWS]), and the WDFW Methow Field Office to provide weekly updates on adult management of spring Chinook salmon in the Methow Basin to the Hatchery Committees (Item I-A). *(Note: this item is ongoing.)*

- Andrew Murdoch (WDFW) will give a presentation at the October 17, 2018 Hatchery Committees meeting on prespawn mortality modeling results (Item III-A).
- Tracy Hillman will obtain a decision from Matt Cooper whether to accept revisions to the Draft Chelan County PUD Monitoring and Evaluation Implementation Plan 2019 (Item IV-A).
- Tracy Hillman will provide an update and email the revised version of the "Genetics monitoring questions for hatchery programs" to the panel of geneticists and will provide the email to the Hatchery Committees for review prior to distribution (Item II-B).
- The Hatchery Committees will invite the geneticist panel to the September 19 and October 17 or November 21, 2018 Hatchery Committees meetings to discuss goals and expectations and then present conclusions (Item II-B).
- Brett Farman will remind the Hatchery Committees representatives to send public comment distribution lists to Emi Kondo (Item III-C).

Decision Summary

- The Rocky Reach and Rock Island HCP Hatchery Committees approved Chelan PUD's 2019 Hatchery M&E Implementation Plan as follows: Chelan PUD, WDFW, YN, CCT, and NMFS approved on August 15, 2018, and USFWS approved via email on August 24, 2018 (Item IV-A).

Agreements

- There were no agreements during today's meeting.

Review Items

- Sarah Montgomery sent an email to the Hatchery Committees on August 31, 2018, notifying them that the Douglas PUD's Draft 2017 Annual Monitoring and Evaluation Report is available for a 60-day review with edits and comments due to Greg Mackey by October 30, 2018.

Finalized Documents

- Sarah Montgomery sent an email to Hatchery Committees on August 31, 2018 notifying them that the Final 2019 Chelan PUD M&E Implementation Plan is available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the July 18, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. The Hatchery Committees representatives reviewed the revised draft July 18, 2018 meeting minutes. Larissa Rohrbach said there are some outstanding comments and revisions, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives present approved the draft July 18, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on July 18, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on July 18, 2018)*:

- *Kirk Truscott will work with Casey Baldwin (Colville Confederated Tribes [CCT]) to summarize the CCT's current protocols for genetic sampling (Item I-A).*
  Truscott said this item is complete because the geneticist panel is convening.
- *Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A).*
  Kahler said this item is ongoing.
- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).*
  Hillman said this item is ongoing.
- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Kahler said this item is ongoing.
- *Betsy Bamberger (Douglas PUD) will coordinate with the Washington Animal Disease Diagnostic Lab (WADDL) to obtain optical density values to inform culling for bacterial kidney disease (Item I-A).*
  Tom Kahler added this as an agenda item and an email from Bamberger was distributed to the Hatchery Committees by Larissa Rohrbach on August 16, 2018. This item is complete.
- *Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A).*
  Keely Murdoch said this item is ongoing.
- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).*
  Keely Murdoch said this item is ongoing.

- *Tom Scribner will discuss internally the potential to release surplus Winthrop National Fish Hatchery (NFH) brood year 2018 wild-by-wild steelhead parr at Yakama Nation (YN) restoration sites in the Methow Basin in October (Item I-A).*
  Keely Murdoch said this item is ongoing.
- *Hatchery Committees representatives will review and edit Todd Pearson's list of questions regarding genetics monitoring, which Sarah Montgomery distributed to the Hatchery Committees on June 19, 2018, and provide revisions to Tracy Hillman (Item II-E).*
  This item will be discussed today,
- *Brett Farman will nominate a National Oceanic and Atmospheric Administration (NOAA) geneticist to participate on a panel that will help identify appropriate genetics monitoring and evaluation protocols for the upper Columbia River hatchery programs (Item II-E).*
  Farman nominated Morgan Robinson and provided contact information in an email to the Hatchery Committees on August 7, 2018.
- *Keely Murdoch will send contact information for the Columbia River Inter-Tribal Fish Commission (CRITFC) geneticists she nominated for inclusion in the Genetic Monitoring panel to Larissa Rohrbach and Sarah Montgomery (Item II-E).*
  Keely Murdoch confirmed contact information for CRITFC geneticists Dr. Shawn Narum and Dr. Ilana Koch in an email to Rohrbach on August 7, 2018.
- *Larissa Rohrbach and Sarah Montgomery will make an HCP Hatchery Committees distribution list for the geneticist panel (Item II-E).*
  This item will be discussed today.
- *Tracy Hillman will provide an email update to the geneticist panel based on discussions during the July 18, 2018 Hatchery Committees meeting (Item II-E).*
  This item is will be discussed today.
- *Hatchery Committees representatives present will review the Priest Rapids Dam (PRD) OLAFT Sampling Expansion Project document, which Larissa Rohrbach distributed to the Hatchery Committees on July 10, 2018, and provide questions and comments to Mike Tonseth and Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]; Item II-I).*
  This item is complete and will be discussed today.
- *Greg Mackey will revise the Draft 2018 Methow Basin Spring Chinook Adult Management Plan and provide it to the Hatchery Committees (Item IV-C).*
  Tom Kahler said this item is ongoing.
- *Greg Mackey will coordinate with Charles Frady (WDFW), Charlie Snow (WDFW), Michael Humling (U.S. Fish and Wildlife Service [USFWS]), and the WDFW Methow Field Office to provide weekly updates on adult management of spring Chinook salmon in the Methow Basin to the Hatchery Committees (Item IV-C).*
  Tom Kahler said this item is ongoing.

- *Tracy Hillman will request the CCT vote on the Wells Hatchery Committees item regarding collecting 110% of the brood year 2018 brood stock collection target for Wells summer Chinook salmon (Item IV-E).*

  Hillman obtained an affirmative vote from Kirk Truscott on July 24, 2018.
- *Betsy Bamberger (Douglas PUD) will research past occurrences of Saprolegnia spp. at Wells Fish Hatchery (FH) (Item IV-F).*

  Tom Kahler provided an update during the meeting and an email from Bamberger was distributed to the Hatchery Committees by Larissa Rohrbach on August 16, 2018. This item is complete.

II. Douglas PUD

A. Enzyme-Linked Immunosorbent Assay Sampling for Spring and Summer Chinook Salmon Update (Tom Kahler)

Tom Kahler summarized an update from Betsy Bamberger (Douglas PUD) regarding enzyme-linked immunosorbent assay (ELISA) sampling for spring and summer Chinook salmon and Saprolegnia as follows:

- WADDL was not able to commit to providing optical density values for ELISA sampling in 2018, so Douglas PUD has contracted with WDFW for this task in 2018.
- Douglas PUD's current plan is to send virology samples (consisting of ovarian fluid, kidney, and spleen samples) to WADDL for processing and kidney samples to WDFW for traditional Bacterial Kidney Disease ELISA testing. This strategy applies to both the Methow spring Chinook and Wells summer Chinook salmon 2018 programs.
- Kahler said Bamberger also looked into the history of Saprolegnia at Wells and Methow hatcheries and did not find data beyond egg mortality numbers (cause of loss was not specified). He said there are no records of Formalin not being used.

III.Joint HCP-HC/PRCC HSC

A. Expanded Sampling at the Off-Ladder Adult Fish Trap (Mike Tonseth)

Mike Tonseth said during the May 16, 2018 Hatchery Committees meeting, Andrew Murdoch presented schemes for how sampling could be expanded at the off-ladder adult fish trap (OLAFT) at PRD. He shared the document, PRD Expansion Project, which Larissa Rohrbach distributed to the Hatchery Committees on July 10, 2018.

Tracy Hillman said that if there is a conflict of interest with an entity seeking funding, the Hatchery Committees will determine if a representative should recuse themselves. According to the Statement on Conflict of Interest, which is outdated, a conflict of interest may occur because of employment, personal relationship, professional relationship, or financial benefit. Keely Murdoch said she has a personal relationship with Andrew Murdoch, who is proposing the OLAFT sampling expansion. She said she does not feel she has a personal bias but will let the Hatchery Committees decide if she should recuse herself from voting on funding the expansion of sampling at the OLAFT. Hillman asked whether Mike Tonseth also had a conflict of interest. Tonseth said yes.

Tom Kahler said this solicitation for funding support has been an unexpected development of this topic from what was initially a presentation on results from implementation of the action for steelhead. Kahler asked whether this is a proposal to the Hatchery Committees and a request for funding from the public utility districts (PUDs), and stated that the traditional and appropriate approach to requesting funding from the PUDs for any changes to the M&E contracts is to work directly with the PUDs. Hillman referred to an email from Deanne Pavlik-Kunkel (Grant PUD; distributed by Hillman to the Hatchery Committees on August 9, 2018), which indicated that Grant PUD would not be interested in funding expanded sampling at the OLAFT. Tonseth said WDFW's interest is whether the PUDs are in support of expansion prior to investing in development of a formal proposal. Tonseth said that it appears from Grant PUD and Chelan PUD responses that there is no interest in the cost sharing for expanded OLAFT sampling between WDFW and the PUDs.

Andrew Murdoch then provided an update on funding for the steelhead monitoring programs in the Upper Columbia. He said negotiations with the Bonneville Power Administration (BPA) on proposals are finished, so there is less uncertainty on where funding for this sampling will come from. The operations and maintenance (O&M) part of the project (e.g., passive integrated transponder (PIT)-tagging steelhead and maintaining arrays) comes from the WDFW Steelhead Viable Salmonid Population (VSP) project and has taken up most of the budget over time. The status quo of tagging and determining spatial extent of steelhead may end after 2019 because of reductions in BPA funding. Todd Pearsons asked for clarification on reduced funding. Tonseth said that in total, the funding from BPA for upper Columbia programs will be reduced by $100,000.

Andrew Murdoch reviewed the programs that are currently BPA-funded, which include Steelhead VSP (which includes the funding for PIT tagging and PIT-tag antenna O&M) and the spring Chinook salmon relative reproductive success study. The spring Chinook salmon relative reproductive success study is considered a research project, so BPA prioritized it for reduction in funding. The 2018 brood year is the last brood year of sampling, but there are still genetic analyses to be completed. Tonseth said the reduction in funding will extend the genetic analyses out several years longer than previously scoped (led by Mike Ford at the Northwest Fisheries Science Center [NWFSC]).

Andrew Murdoch reviewed how the potential reduction in funding could affect current monitoring for steelhead as part of the PUDs monitoring and evaluation (M&E) programs. He listed:

- Steelhead tagging at the OLAFT
- Origin of steelhead passage/escapement estimates over dams
- A drastic reduction in steelhead tributary escapement estimates

Andrew Murdoch said there is a large PIT-tag antenna infrastructure in the upper Columbia in its eighth year of operation that is difficult to continue to justify to BPA. He said the scope has been justifiable with automated data management, but modernization is increasing costs due to the need to upgrade from 3G modems no longer supported by Verizon and upgrades to technologies and higher costs of Biomark supplied materials and data management services. He said instead of a proposal to expand sampling at PRD, WDFW is now proposing a cost-sharing arrangement with the PUDs to continue the existing monitoring program at PRD for steelhead brood year 2020 and beyond. Keely Murdoch asked to clarify that the loss of BPA funding would not affect monitoring of brood year 2019, but it would affect monitoring of brood year 2020. Andrew Murdoch said this is correct.

Andrew Murdoch said that during the summer of 2019 in tributaries, WDFW would propose eliminating old systems (MUX systems with PVC antennas) and replacing them with acrylonitrile/high density polyethylene (ACN/HDPE) systems. However, there are so many old systems in the tributaries, it's not cost effective to replace them all at once. Barring a cost share, WDFW will have to start reducing tributary monitoring sites beginning with MUX systems. This would include systems in the Chewuch River, Methow River, Twisp River, Nason Creek, and Chiwawa River and maybe in the upper Wenatchee River. These would be prioritized for removal because these are where spawning ground surveys occur. He said by reducing these O&M costs, WDFW would try to maintain systems in small tributaries where spawning surveys are not conducted, such as Mission Creek, Gold Creek, Chumstick Creek, and Beaver Creek. The status quo would be maintained at PRD (for monitoring steelhead). He said for developing tributary escapement estimates for all tributaries, WDFW would need funding help to maintain the status quo.

Andrew Murdoch said BPA wants to remove PIT-tag arrays across the basin as part of cutting funding on their research M&E program. Eventually they would have their entire Columbia River PIT-tag array system under one umbrella for cost efficiencies. Contracting with Biomark has worked well in the past for data management, but WDFW is now considering other options to reduce costs. For the upper Columbia steelhead VSP program, brood year 2019 will be the last year WDFW will have status quo funding for the steelhead monitoring program. The easiest piece to separate is OLAFT sampling in its entirety. He said a decision is not needed today, but a decision is needed by the Committees on what level of steelhead monitoring is needed for brood year 2020 and beyond.

Tonseth said for the PUDs M&E programs, if WDFW is unable to maintain arrays to estimate tributary escapement, the alternative would be conducting steelhead spawning ground surveys. He said this needs to be a consideration and acknowledgement in the PUDs' 2019 M&E implementation plans for moving toward brood year 2020.

Hillman summarized that the issue before the Hatchery Committees is not the expansion of OLAFT sampling to other species, but the need to maintain an appropriate level of steelhead monitoring that meets the objectives of the M&E Plan beginning with brood year 2020. Currently, the steelhead M&E program is funded for brood year 2019. He said the PIT-tag arrays are also used for sockeye, Chinook salmon, lamprey, and other species. Catherine Willard said the data are also used by the HCP Tributary Committees.

Willard asked if WDFW still has money for Steelhead VSP monitoring that must be divided among OLAFT sampling, PIT tagging, and monitoring PIT-tagged fish in tributaries. Andrew Murdoch answered yes, as well as for other sampling. He said the best place for a cost share is OLAFT sampling. WDFW and others want to maintain high-quality data management. He said so far, the WDFW approach is similar to the Integrated Status and Effectiveness Monitoring Program. To sustain the current level of high-quality data, WDFW will need a cost share. Otherwise, they will have to cut interrogation sites.

Kirk Truscott asked when would the reduction in sites occur? Andrew Murdoch said after the 2019 outmigration, sites would be reduced or replaced. Truscott asked what is the cost difference over time between upgrading interrogation sites versus conducting annual spawning ground surveys? Willard said arrays are also used to monitor spring Chinook salmon return timing. Keely Murdoch said there is a need to consider data quality—steelhead spawner surveys are difficult to do because of high water and turbidity. Truscott said the Hatchery Committees would need more information from WDFW post-2019 outmigration season to determine the long-term cost tradeoffs.
Andrew Murdoch said there is a need to figure out costs and decisions prior to sending contract information to BPA by March 1, 2019.

Tonseth said maintaining the status quo may include sampling at OLAFT for 2019, but activities carried out in fall of 2019 that affect the 2020 brood need to be included in the 2019 M&E plan, which is currently being discussed.

Andrew Murdoch said the ask is a $100,000 cost share to do the OLAFT sampling at PRD and data analysis. He believes this would be enough to cover the OLAFT O&M needs. Tonseth said monitoring at the OLAFT is the easiest to demonstrate the value and certainty of the data. Having uncertainty around O&M costs at the OLAFT is preferable to uncertainty around O&M costs in the tributaries.

Truscott said this is why the cost analysis is needed. Tonseth said there is a need to examine the value of other analyses dependent on the arrays to understand the total value versus cost.

Andrew Murdoch said Entiat River monitoring will be reduced. PIT-tagged fish will not be monitored upstream and downstream of Ardenvoir. He said USFWS will not be able to staff the Entiat River smolt trap because of new hiring policies, so WDFW is taking over smolt trapping in the Entiat River starting October 1, 2018.

Willard said the next step will be for the PUDs to discuss budgets with WDFW outside of the Hatchery Committees and that budget discussions are not a purview of the Hatchery Committees.

Andrew Murdoch also gave an update on spring Chinook salmon prespawn mortality modeling. He said WDFW is compiling data and Jeff Jorgensen (NOAA Fisheries NWFSC) is doing the modeling to figure out what factors affect mortality. He is starting by modeling Wenatchee spring Chinook salmon for the 2008 and 2009 brood years. There have been some challenges with high variances in tributary estimates because of few resights. Members present indicated interest in Andrew Murdoch presenting this work at an upcoming meeting. Andrew Murdoch said he may be able to present the data to the Hatchery Committees in October.

B. Genetic Monitoring (Tracy Hillman)

Todd Pearsons shared the document entitled, "*Genetics monitoring questions for hatchery programs,*" which Sarah Montgomery distributed to the Hatchery Committees on June 19, 2018. Tracy Hillman led the discussion to finalize the panel of geneticists invited to answer monitoring questions and refine the monitoring questions being proposed.

Tom Kahler said Douglas PUD approves of the existing panel of geneticists nominated. Pearsons said a glaring omission would be that NMFS geneticists Craig Busack and Mike Ford, who both have a long history working in the upper Columbia Basin, are not participating. Brett Farman said he asked Busack, who suggested Morgan Robinson. Farman said it's outside of their influence to ask Mike Ford who is a NWFSC research scientist. Hillman said the panel is complete and he will contact them with follow-up information.

Tracy Hillman asked whether there are comments or revisions to the questions proposed by the PUDs. USFWS provided their input in an email to Hillman. Hillman showed the existing questions during the meeting to ensure all agree with wording. All Hatchery Committees members approved of the language of questions No. 1 and No. 2. Language in question No. 3 was revised.

Question No. 3a: Mike Tonseth said using the language "management actions" is problematic because that is not what we want the geneticists to decide. Kahler said that the actual intent of the meaning is to determine approaches that provide the information necessary for managers to act upon. Pearsons agreed and said they are looking for information to be able to interpret how reliable different methods may be. Pearsons asked whether there have been long-term genetic monitoring plans that have changed the way programs manage themselves? He said he is unaware of a western regional program with standardized methodologies used for management. He suggested that if the geneticists can land on some consistent monitoring, it should be written up in a paper, so methods can be used across large areas consistently. Kahler said he is aware of some Atlantic Salmon programs where genetic monitoring guides program management. Tonseth said the challenge is that the technology changes. He said the geneticists can answer 'what is the appropriate test?'. Pearsons said, for instance, in notes from the White River program, geneticists concluded the power of single-nucleotide polymorphism and microsats was noted as being similar, which was surprising. Tonseth said to ensure comprehension of the questions, we will go through these questions with the geneticists and allow them to ask questions prior to convening.

Question No. 3b: Tonseth suggested changing language to "level of biological change." Kirk Truscott asked whether the Hatchery Committees want the geneticists to indicate at what level there is a link between genetic change and biological change? Pearsons said yes, and agreed that it is context and population specific. Pearsons said geneticists may punt on this question, but it's worth asking. It's the combination of tradeoffs that may be most important when evaluating risk of extinction. Tonseth said an example is monitoring for the Ryman-Laikre effect in Methow steelhead. That change is likely to occur in any population supplemented by a hatchery program, so perhaps we should be concerned about the rate at which the change is occurring rather than whether it is occurring. He emphasized that we need to have an understanding that we need to know how genetics will affect abundance and survival. Pearsons agreed and said this information should be in the existing M&E Objectives section leading to the questions. Hillman said this document will hopefully get them engaged and asking questions. All agreed that these questions are intended to be a conversation starter. Tonseth said the intent is these questions could be refined after Hillman engages with geneticists.

Question No. 3c/d: Pearsons said this question is trying to get at sampling intervals and sample sizes and asked if they should be different for large and small programs? Tonseth said the Hatchery Committees should be prepared to offer examples of the different programs. Catherine Willard asked about sample size. Tonseth and Truscott agreed and said sample size may depend on size of population too. Hillman recorded revisions to each subpart of question No. 3 with input during the meeting to reflect intent.

Pearsons said the interesting outcome in the White River process was the areas of consensus; what we want to know is where all the geneticists agree. Hillman said he will send the latest M&E Report to the geneticists as background information, along with the list of questions.

Hillman asked whether the Hatchery Committees want to invite the geneticists to an upcoming meeting. Pearsons suggested they could join the October meeting to present their findings. Tonseth recommended they attend or call in to the September meeting so that representatives can explain the purpose of this panel and answer any initial questions. Andrew Murdoch suggested they call in to the September meeting for an introduction, and then attend the meeting in October or November to present their findings. Representatives present concurred with this suggestion and Hillman said he will coordinate with the geneticists accordingly.

C. NMFS Consultation Update (Brett Farman)

Brett Farman said the National Environmental Policy Act consultation for the unlisted Columbia River summer and fall Chinook salmon programs is still in review internally and James Archibald (NOAA) has been working on permits.

He said Charlene Hurst has more work to do on the Methow steelhead permit and will be coordinating with individuals who need to provide input or comments. Catherine Willard asked whether there is a timeline on commenting? Farman asked whether the Hatchery Committees representatives responded to Emi Kondo regarding public comment distribution lists? Farman said he will remind representatives in an email to send their lists to Kondo.

IV. Chelan PUD

A. Draft 2019 Implementation Plan (Catherine Willard)

Catherine Willard shared the draft document, *Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2019*, which Larissa Rohrbach distributed to the Hatchery Committees on July 18, 2018.

Tracy Hillman asked the Hatchery Committees whether they agree with edits proposed so far, which include the following topics:

1. Discontinue Chiwawa spring Chinook salmon parr estimates (developed with snorkel survey data) because there is a correlation between parr estimates and smolt estimates (developed with smolt trap data). Parr estimates were carried out to support estimates of carrying capacity, but enough years of data have been collected to precisely estimate capacity. Adding more years will not improve the capacity estimates unless there is a very low or very high spawning escapement, or there is a large change in habitat conditions (e.g., major forest fire in the Chiwawa River Basin).

2. Discontinue observer efficiency data collection.

Kirk Truscott asked whether one could still get estimates on parr metrics from fall smolt trapping. Hillman answered that there is a correlation between parr and trapping estimates. He added that the M&E plan still plans for capturing fry, summer/fall migrants and yearling migrants. Hillman said that the NWFSC uses the parr data in their lifecycle models. Given that they are the largest consumer of the parr data, perhaps they can fund the work in the future.

Truscott said one would expect the Chiwawa spring Chinook salmon program to become more integrated with more wild by wild crosses over time and increased productivity due to managing percent of natural influence, percent of hatchery origin spawners, etc. If no improvement is observed in emigrant numbers, changes in the program could be considered. Would the data be sufficient to show that? Hillman said past program effects were observed in both parr and smolts. Thus, he expects that any changes in the program would likely be detected in data collected at the smolt trap. He said a weakness in the juvenile monitoring program is a lack of pretreatment data and suitable reference areas. However, this affects both parr and smolt monitoring programs. He added that density-dependence occurs sometime between the fry and parr stages. Jason Lundgren (Cascade Columbia Fisheries Enhancement Group) may be doing nutrient enhancement work in the Chiwawa River, which may address the factor most limiting juvenile production in the basin. The effects of nutrient enhancement (e.g., changes in condition, growth, size) are more likely to be observed in data collected at the smolt trap. Hillman said the smolt trap on the Chiwawa River is one of the best in the state with precise estimates.

Hillman asked whether the Rocky Reach and Rock Island Hatchery Committees representatives approve the proposed edits to the Chelan PUD M&E Implementation Plan for 2019 (with the exception of finalizing language around steelhead VSP monitoring). All members present approved the proposed edits. USFWS sent an email to Hillman indicating that they approved the edits.

1. For Wenatchee steelhead monitoring, language was added during the meeting to make the language more flexible for brood year 2020.

Mike Tonseth suggested indicating where methods are still relevant for the 2019 brood and adding a paragraph that addresses the uncertainty around 2020 brood monitoring. Willard and Truscott agreed but noted that the methods and scope of monitoring the 2020 brood may change depending on funding developments. Tonseth agreed and suggested adding language that allows for a later amendment and Rocky Reach and Rock Island Hatchery Committees' approval of this implementation plan. Keely Murdoch said similar language should be added to the M&E Plans from Douglas PUD and Grant PUD when they are prepared.

Hillman recorded revisions to scope and potential methods of steelhead monitoring in the Chelan PUD M&E Implementation Plan for 2019. The Rocky Reach and Rock Island Hatchery Committees representatives approved the M&E Implementation Plan as follows: Chelan PUD, NMFS, YN, CCT, and WDFW approved during the meeting on August 15, 2018. Hillman said he will follow up with USFWS to obtain their vote. *Note: USFWS provided an affirmative vote on August 24, 2018.)*

V. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are on September 19, 2018 (Grant PUD), October 17, 2018 (Grant PUD), and November 21, 2018 (TBD).

VI. List of Attachments

Attachment A List of Attendees

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Larissa Rohrbach	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡ º	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Andrew Murdoch	Washington Department of Fish and Wildlife
Alf Haukenesº	Washington Department of Fish and Wildlife
Mclain Johnsonº	Washington Department of Fish and Wildlife
Brett Farman*º	National Marine Fisheries Service
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes

Notes:
* Denotes Hatchery Committees member or alternate
º Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: October 15, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the September 19, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held in Wenatchee, Washington, on Wednesday, September 19, 2018, from 9:00 a.m. to 11:00 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Charlie Snow (Washington Department of Fish and Wildlife [WDFW]) and Michael Humling (U.S. Fish and Wildlife Service [USFWS]) will provide a summary of 2018 Methow Basin spring Chinook salmon adult management to the Hatchery Committees (Item I-A).
- Mike Tonseth will coordinate with Andrew Murdoch (WDFW) regarding presenting prespawn mortality modeling results for spring Chinook salmon at an upcoming Hatchery Committees meeting (Item I-A). *(Note: this item is scheduled for the November 15, 2018 Hatchery Committees meeting.)*
- Tracy Hillman will provide background documents including Monitoring and Evaluation (M&E) Annual Reports to the panel of geneticists (Item II-A). *(Note: Hillman provided additional background documents to the geneticists via email on September 25, 2018.)*
- Mike Tonseth will draft a description or diagram of program and population linkages in the upper Columbia River to accompany the tables of species, programs, program purpose, and

type of program for the panel of geneticists to review (item IV-A). *(Note: Hillman provided this spreadsheet to the geneticists on October 10, 2018.)*

- Mike Tonseth will send contact information for the WDFW Salmon in the Classroom program coordinator to Kirk Truscott (Item III-A). *(Note: Tonseth sent Josh Nicholas' contact information to Truscott on September 20, 2018.)*

Decision Summary

- The Wells Hatchery Committee approved Douglas PUD's revised pilot study, Control of *Saprolegnia* spp. Growth on Summer Chinook (*Oncorhynchus tshawytscha*) Eggs, as follows: Douglas PUD, Yakama Nation (YN), Colville Confederated Tribes (CCT), WDFW, USFWS, and NMFS approved on September 19, 2018 (Item IV-A).
- The Wells Hatchery Committee approved the transfer of up to 150,000 additional surplus summer Chinook green eggs from Wells FH to the YN summer Chinook salmon program should they become available as excess to Upper Columbia River program production needs during spawning. The eggs may also be transferred as eyed eggs if survival and fecundities within the Douglas PUD programs result in surplus eggs to Upper Columbia River program production needs during rearing. Approvals were via email as follows: YN approved on October 1, 2018, Douglas PUD approved on October 3, 2018, USFWS approved on October 4, 2018, WDFW and NMFS approved on October 5, 2018, and the CCT approved on October 8, 2018.

Agreements

- The Hatchery Committees agreed to move their November 2018 meeting to Thursday November 15, 2018 (Item VI-A).

Review Items

- Sarah Montgomery sent an email to the Hatchery Committees on August 31, 2018, notifying them that Douglas PUD's Draft 2017 Annual Monitoring and Evaluation Report is available for a 60-day review with edits and comments due to Greg Mackey by October 30, 2018.

Finalized Documents

- No items have been recently finalized.

I. Welcome

II. Joint HCP-HC/PRCC HSC

A. Review Agenda, Review Last Meeting Action Items, and Approve the August 15, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. Kirk Truscott added an item regarding Chief Joseph Hatchery spring and summer Chinook broodstock.

The Hatchery Committees representatives reviewed the revised draft August 15, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments and revisions, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives approved the draft August 15, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on August 15, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on August 15, 2018)*:

- *Tom Kahler and Greg Mackey will provide historical information to Tracy Hillman for incorporation in the Draft Hatchery Program Timelines (Item I-A).*
  Tom Kahler said Douglas PUD is continuing to work on this action item and it can be removed from the list. Tracy Hillman said it would be helpful to include historical events on the timeline and then decide which items are statistically most important for breaking up the timeline. Mackey said finalizing the timelines will help with future data interpretation. Todd Pearsons said breaking up the timelines for analysis will result in lost statistical power and suggested analyzing the entire dataset as an adaptively managed hatchery program and providing historical changes as supplemental information regarding how the program has changed or has been adaptively managed to provide context for inference of the results.
- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).*
  Hillman said the 2017 Annual Report is complete and this item will be finished next.
- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Mackey said this item is ongoing.
- *Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A).*

Murdoch said she and Tonseth are continuing to work on this item. She said they will provide an updated version of the analysis they had done for the Nason Creek programs previously. She said additional information about differential pre-spawn mortality will also be available in late 2018 or early 2019, so those data can be incorporated into the discussion and analysis when available. Tonseth said discussions in October can focus on choosing a general direction for the conservation programs, and refined data analyses later in the year will help the Hatchery Committees come to decisions regarding the programs. Pearsons asked if the life cycle model updates and prespawn mortality data will be incorporated into the 2019 Broodstock Collection Protocols. Murdoch said she is not sure if they will be ready in time, but based on the updated model, an interim recommendation could probably be made for the 2019 Broodstock Collection Protocols and then refined later.

- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).*

  Murdoch said this item is ongoing.
- *Tom Scribner will discuss internally the potential to release surplus Winthrop National Fish Hatchery (NFH) brood year 2018 wild-by-wild steelhead parr at Yakama Nation (YN) restoration sites in the Methow Basin in October (Item I-A).*

  Keely said the Joint Fishery Parties (JFP) have been discussing this item. She said Yakama Nation staff and additional staff in the Methow River basin suggested sites and the JFP reviewed a summary table of potential release locations. She said this is not a Hatchery Committee item because it involves production from the USFWS program. She added Chris Pasley (USFWS) is prepared to scatter plant the fish in small numbers at multiple sites. Cooper said the surplus totals approximately 27,000 steelhead, which will be clipped during the last week of October and released in late October or early November. He said a few thousand fish will be released across about eight sites.
- *Andrew Murdoch (WDFW) will give a presentation at the October 17, 2018 Hatchery Committees meeting on prespawn mortality modeling results (Item III-A).*

  Mike Tonseth said this item is ongoing, and he will check with Andrew Murdoch whether it will be complete by the October Hatchery Committees meeting.
- *Tracy Hillman will obtain a decision from Matt Cooper whether to accept revisions to the Draft Chelan County PUD Monitoring and Evaluation Implementation Plan 2019 (Item IV-A).*

  Hillman said this item is complete.
- *Tracy Hillman will provide an update and email the revised version of the "Genetics monitoring questions for hatchery programs" to the panel of geneticists and will provide the email to the Hatchery Committees for review prior to distribution (Item II-B).*

  Hillman said this item is complete.

- *The Hatchery Committees will invite the geneticist panel to the September 19 and October 17 or November 21, 2018 Hatchery Committees meetings to discuss goals and expectations and then present conclusions (Item II-B).*
  This item will be discussed today.
- *Brett Farman will remind the Hatchery Committees representatives to send public comment distribution lists to Emi Kondo (Item III-C).*
  Hillman said this item is complete.

B. Genetic Monitoring (Tracy Hillman)

Tracy Hillman welcomed the geneticist panel (Table 1) to the meeting and thanked them for their participation. He provided an overview of the programs under the Hatchery Committees purview and the M&E Plan. He said during the most recent update of the M&E Plan, Hatchery Committees representatives recognized that input from expert geneticists could help determine whether the plan asks the correct questions of the programs and stipulates the correct monitoring procedures for these programs.

Table 1. HCP-HC/PRCC HSC Upper Columbia Genetic Monitoring Panel

Name	Organization	Contact Information
Morgan Robinson	National Oceanic and Atmospheric Administration	morgan.robinson@noaa.gov (360) 534-9338
Christian Smith	U.S. Fish and Wildlife Service	Christian_Smith@fws.gov (360) 442-7980
Ilana Koch	Columbia River Inter-Tribal Fish Commission	koci@critfc.org (208) 837-9096 x1117
Shawn Narum	Columbia River Inter-Tribal Fish Commission	nars@critfc.org (208) 837-9096 x1120
Todd Seamons*	Washington State Department of Fish and Wildlife	Todd.Seamons@dfw.wa.gov (360) 902-2765

*Did not attend this meeting

Hillman reviewed the questions that the Hatchery Committees asked of the geneticists via email and asked whether representatives present have anything to add. Todd Pearsons said the Hatchery Committees are hoping to achieve a consensus opinion from the geneticists, which will be important for long-term genetics monitoring and interpretation of results.

Hillman asked each geneticist if they have any initial questions. Morgan Robinson (National Oceanic and Atmospheric Administration [NOAA]) asked what is the best source to read for an overview of the status of these populations. Hillman said the Upper Columbia Salmon Recovery Board's (UCSRB)

Hatchery Summary Report will be a good source. In addition, the Hatchery M&E Annual Report provides a good summary of the different hatchery programs and their sizes.

Christian Smith (USFWS) said additional information regarding which populations the committees are concerned about would be helpful. Hillman identified spring Chinook, summer/fall Chinook, summer steelhead, and sockeye populations within the upper Columbia River. He said the committees are generally concerned with straying among populations in the upper Columbia River. He said there are some hatchery fish that stray into the Snake and Deschutes rivers, but the biggest concern is straying among the upper Columbia populations. He said an additional concern is maintaining diversity within and among populations. Smith indicated the USFWS generally tries to come to a consensus about which populations are of most concern before starting a genetic hatchery evaluation. He said that helps define the genetic analyses and sampling if populations can be identified as of concern. Hillman said the M&E Plan does not provide much detail about the level of concern for each population but suggested keeping in mind that summer/fall Chinook are considered one population (i.e. sub-populations should be considered at the management scale). Greg Mackey suggested that the geneticist panel be provided with the older genetic population reports for steelhead and spring Chinook salmon. Hillman said genetics reports are appended to the annual report. Pearsons said some of the programs are supplementation programs. For these programs, genetic monitoring needs to evaluate effects to the target population (the population being supplemented), and the second concern is for populations that the fish may stray into. Hillman also noted that Nason Creek and Chiwawa River spring Chinook salmon are subpopulations and maintaining subpopulation or within population structure is also important to the committees.

Ilana Koch (Columbia Inter-Tribal Fish Commission [CRITFC]) had no questions. Shawn Narum (CRITFC) said it would be helpful for the different programs to be collated into a single list with summary information about the type of program, which populations it may affect, and the size. Pearsons said the Upper Columbia Salmon Recovery Board (UCSRB) report has a table with this information that provides an overview of all the hatchery programs in the upper Columbia River. Hillman said Table 3 in the M&E Report also identifies all programs in the upper Columbia River, including the purpose of each program and their production goals. Hillman asked if coho salmon should be included in this discussion. Keely Murdoch said coho salmon have a separate M&E Plan, so they should not be included. The genetic questions asked about that program are different because it is a reintroduction program. Narum agreed that coho should be excluded from these discussions.

Narum said it would be helpful to understand the committees' expectations of what the geneticist panel will be providing. He said it is difficult to come up with blanket answers for many of these questions. Pearsons asked if there are genetics M&E programs already in place outside the upper Columbia River that have discussed these types of questions and developed relevant protocols. He said it would be ideal to develop something that is useful in the upper Columbia River and also at a broader scale for genetic monitoring of hatchery programs. Narum said a widely useful protocols document is unlikely because every program has specific differences. Pearsons said perhaps there is some categorizing that can occur; e.g., integrated programs have certain things in common from a genetics perspective compared to segregated programs. Narum said this is a significant effort and having categorical information about each program and population will be an important starting point. Mike Tonseth said Todd Seamons (WDFW) provided input to him that a protocols document is impractical to develop under this timeline; he suggested focusing on specific questions that could potentially lead to a broader discussion in the future. Tonseth said Seamons indicated that a comprehensive document such as Pearsons suggests would be substantial and would require many more geneticists to provide input. Pearsons asked whether there are any other plans or documents that discuss similar questions that could be used as a starting point. Narum said there are some review papers that discuss certain practices pertaining to these programs that can be drawn from, but not at the level of detail that Pearsons hopes.

Smith said USFWS' protocol is to collect minimum genetic criteria across all programs, and then add on additional sampling for programs with specific risks identified. He said it would be unnecessarily expensive to do the same sampling across all hatcheries, but it is helpful to have a minimum standard.

Hillman brought up the M&E Plan and showed the questions pertaining to genetic monitoring (starting on page 27). He said these questions might be a good starting point. Mackey said the committees have struggled with the concept of adaptive management in the M&E program. He said the population's genetic traits and parameters are monitored and results become available, but it does not inform whether an observed shift is big enough to warrant a change in how the program is managed. He said the committees are looking for information they can use to actively manage the programs—that is, waiting too long to act on changing a program because there are not enough data available can result in compromising the population beyond recovery. Hillman said it will also be helpful to review previous genetic reports and historical stock information. The committees are generally interested in improving diversity since the Grand Coulee Fish Maintenance Program homogenized populations in the upper Columbia River. Pearsons said some of this information is in the UCSRB report.

Hillman asked the geneticist panel whether they are comfortable with the proposed timeline. He said the committees will start performing comprehensive genetic analyses in 2019. He asked whether the panel can work together via conference calls and emails, and perhaps provide feedback to the committees in November. The geneticists were in favor of this plan, and Hillman said he will provide the documents discussed today to them for review. He said any questions can be directed to him. Representatives present thanked the geneticists for their participation.

C. NMFS Consultation Update (Emi Kondo)

Emi Kondo said NMFS is working to finish the Environmental Assessment (EA) for the summer/fall Chinook salmon programs and steelhead programs. She said the next steps are for the applicants to send Hatchery and Genetic Management Plan addenda to her for the summer/fall Chinook salmon programs, and for the steelhead programs to Charlene Hurst. Then, the Hatchery and Genetic Management Plans (HGMPs) will be available for public comment at the same time as the EA. She said the EA is currently in General Counsel review, after which the Hatchery Committees will review, and finally it will be available for public comment. She asked for any email contacts for local stakeholders, such as the UCSRB, to be sent to her. She said the draft permits will be available for Hatchery Committees review after the EA, so that the review periods are staggered. Greg Mackey said he does not recall providing stakeholder contact information during previous consultations and asked why NMFS is requesting that information. Kondo said one purpose of the National Environmental Policy Act (NEPA) process is to get public input on agency actions, so there is a responsibility to contact stakeholders and the public who may be interested in reviewing the documents. She said NMFS has identified public outreach as an area for improvement in the NEPA process.

Kondo said in order to issue the Section 10 permits for the summer/fall Chinook salmon programs and the Douglas PUD portion of the steelhead program, NMFS needs to complete consultation with USFWS, then finish the associated EA. She said the EA needs to be finished before the Section 10 permits are complete. She said USFWS will also be issued a 4(d) determination for their steelhead program.

III.Chelan PUD/WDFW

A. 2018 Chiwawa Broodstock Collection Update (Mike Tonseth)

Mike Tonseth said Chris Moran (WDFW) prepared this update regarding broodstock collection at the Chiwawa Weir for him (Tonseth) to provide to the Hatchery Committees. He said broodstock for the Chiwawa program is collected by targeting previously PIT-tagged natural-origin fish at Tumwater Dam and natural-origin spring Chinook (that may or may not have been previously PIT-tagged) at the Chiwawa Weir. Through that collection effort, he said WDFW reached the bull trout take limits for operating the Chiwawa Weir in July 2018 and ceased collection. At the time, it appeared the Chiwawa program was at or slightly above the 33% extraction rate for natural-origin spring Chinook in the Wenatchee sub-basin, with 17 natural-origin fish collected at Tumwater Dam and 37 natural-origin fish collected at the Chiwawa Weir. He said these numbers were later found to be incorrect. He said the process at Chiwawa Weir includes targeting ad-present fish, picking the fish up, and scanning the fish for a coded wire tag (CWT) tag. If the fish is tagged with a CWT, it is released upstream of the weir, and if the fish does not beep when scanned with the CWT reader, it is presumed to be of natural origin and sent to the hatchery for broodstock. Fish number, gender, and origin are confirmed at the hatchery during the first week of spawning to minimize handling stress. Tonseth said there were false negatives for CWTs in the broodstock, so there are far fewer natural-origin fish in the broodstock than initially thought. He said the current numbers are 31 natural-origin fish spawned out of the 70 needed for the program, and the balance will be made up of hatchery-origin fish. He said the program's production obligation was met, but the composition is not what was expected. He said M&E staff, hatchery staff, and Chelan PUD met and discussed this issue, but the exact source of the problem has not been determined because staff were using the same protocols as in past years.

Catherine Willard said there may have been noise with the CWT reader at the trap, because fish are not anaesthetized at the trap. She said one difference this year compared to prior years is that staff typically have the list of which PIT-tagged fish were scanned at Tumwater Dam when they are anaesthetized. Without that list, there is no way to double-check origin based on the PIT-tag code. She said in future years, staff will use P4 to perform a PIT-tag lookup and if the fish does not have a PIT tag, it should be anaesthetized and scanned for a CWT. Tonseth said that will work in the near term while the reproductive success study is still active at Tumwater Dam. He said after that study ends, there will need to be a standard anaesthetization setup so that every ad-present fish is evaluated outside of the trap box. He said interference in the trap may have caused errors this year. Tonseth said WDFW will be assessing the CWT wands and to see if there have been any malfunctions.

The Hatchery Committees discussed potentially implementing collection at Tumwater Dam instead of the Chiwawa Weir to reduce fish handling and bull trout encounters, and this discussion will continue at future meetings. Tonseth noted that in years like 2018 with extremely low spring Chinook returns, the Chiwawa Weir should be relied on less. With higher runs though, he said it makes sense to use the weir to achieve brood targets. He said this conversation will include permitting, USFWS coordination, and what may or may not be included in the Biological Opinions. Peter Graf asked if a shortfall in Chiwawa River natural-origin spring Chinook broodstock will be filled with Chiwawa River hatchery-origin spring Chinook, or if other natural-origin spring Chinook salmon with high genetic assignment to the Chiwawa River (but are collected at Tumwater Dam) can be used for broodstock instead of hatchery-origin fish. He suggested natural-origin spring Chinook salmon with a high probability of returning to the Chiwawa River are a better choice for broodstock compared to hatchery-origin fish that have returned to the Chiwawa River. Tonseth said that discussion should happen soon and in coordination with broodstock collection protocols.

Tracy Hillman asked what are the percentages of hatchery-origin and natural-origin spring Chinook in the 2018 brood? Tonseth said there are 14 natural-origin females and 31 hatchery-origin females being used for brood this year. He said one consideration is that the spring Chinook management plan took into consideration that there are some return years where the natural-origin component will not be met. He also added that the 33% extraction limit for natural-origin spring Chinook was not exceeded.

IV. Douglas PUD

A. Egg Incubation Treatment Study Update (Greg Mackey)

Greg Mackey shared the revised document "Control of *Saprolegnia spp*. Growth on Spring Chinook (*Oncorhynchus tshawytscha*) Eggs" (Attachment B). He said the planned egg incubation treatment pilot study has been revised to use hatchery-origin summer Chinook salmon eggs instead of spring Chinook eggs. He said the long-term intention is for this study to be conducted on spring Chinook, steelhead, and summer Chinook, and this year the pilot study will be implemented to determine protocols and acquire preliminary data. He said the impetus for the study is to find the best way to treat eggs for Saprolegnia and limit the use of Formalin. He said this is the same study plan as presented to the Hatchery Committees previously but it substitutes summer Chinook hatchery brood collected at Wells Dam. He reviewed the treatments: Formalin, salt, hydrogen peroxide, and no treatment (ambient water). He said the only other change is that the plan also incorporates Hillman's suggestion to use a block analysis of variance (ANOVA) for the statistical analysis. Hillman suggested an edit to the diagram for the block design—every treatment group must occur in each block, or a two-factor ANOVA can be used. Mackey noted during the pilot year, the study does not target a statistically meaningful number of fish—only eggs from 24 pairs—and more fish per group will be needed in future years. Mike Tonseth said broodstock for this pilot study are on hand due to a planned and approved overcollection at Wells Dam to satisfy production obligations and the Wells Dam survival study.

Mackey said Betsy Bamberger (Douglas PUD) is also working with Tonseth to determine how the eggs will be discarded. He said once the eggs are eye-up, the study will be over and the eggs will be available for other uses such as WDFW's Salmon in the Classroom program. Tonseth said WDFW hopes to use 6,000 eggs from this study for a Salmon in the Classroom program. Kirk Truscott asked to whom requests for Salmon in the Classroom eggs should be made. Tonseth said he will find the contact information and send it to Truscott. Tonseth said one condition of Salmon in the Classroom is that females providing eggs for the salmon need to be 100% sampled for viruses. He said this will be completed in pooled samples, so if any pooled samples test positive for virus infections, the entire pool will be discarded. Using this method, there is a chance that no eggs will be available.

Regarding the pilot study design, Truscott noted that hydrogen peroxide has been used for a few years at different facilities and suggested that there is likely literature available on its efficacy. He asked what the impetus is for doing this study. Mackey said there is some literature available but not much. He said Bamberger researched this topic and found that other studies do not adequately compare different treatments, so there is no relative basis for choosing one treatment over another. Tonseth said one purpose of this study is to determine a backup plan for using Formalin; however, hydrogen peroxide is also challenging from a handling perspective.

Tonseth asked what is the prespawn mortality at Wells Fish Hatchery so far for the summer Chinook program? Mackey said it has been low. He said the fish have been treated with Diquat in response to minor Columnaris observances, but there have been no significant mortality events. Mackey said facility staff are also working to identify places where fish can get injured, and to help improve the movement of fish through the facility. Tonseth noted that during surplusing efforts, some of the fish were in poor condition. Mackey said one reason for that is that surplus fish were not being treated in contrast to fish used for broodstock, which look much healthier.

Wells Hatchery Committee representatives approved the revised study plan as follows: Douglas PUD, WDFW, NMFS, YN, CCT, and USFWS approved during the meeting on September 19, 2019.

Mackey noted that Douglas PUD will be relining the dirt ponds at Wells Fish Hatchery in spring 2019.

V. CCT

A. 2018 Spring and Summer Chinook Brood at Chief Joseph Hatchery

Kirk Truscott provided an update on 2018 spring and summer Chinook brood at Chief Joseph Hatchery.

Regarding the summer Chinook brood, Truscott said very few fish have been lost to date. He said mortality is low and the fish appear healthy. He said the brood was inoculated for Columnaris when the fish arrived, which could be positively contributing to the health of the fish this year. He said CCT will continue to consult with fish health staff to determine any treatments.

Regarding the spring Chinook brood, Truscott said there has been significant prespawn mortality. He said virology results are pending. The fish are heavily infected with copepods but do not have a bacterial infection (so the mortality is not due to Columnaris). He said he is not familiar with epizootic mortality associated with copepods. Todd Pearsons asked how the fish appeared before spawning. Truscott said there was not much mortality until the second and third spawn takes. Tonseth suggested mortality could be associated with handling stress, dissolved oxygen issues, water quality, or high temperatures. Truscott said temperatures were around 58 degrees Fahrenheit, dissolved oxygen readings were acceptable, and the water source is not suspect. In fact, the summer Chinook brood were on the same water source in adjacent ponds. He said the spring Chinook arrived with the copepods and hatchery staff are working with fish health staff to determine the cause of the mortalities. Every dead fish coming out of the spring Chinook pond is being necropsied. Pearsons asked if anyone has heard of similar mortality events in other programs this year. Truscott said no.

Truscott said the total spring Chinook program is at 50% of the eyed-egg target, a shortage of 350,000 out of 700,000 eyed-eggs for the segregated program. He said fish were even over collected by 20% to account for enzyme-linked immunosorbent assay (ELISA) testing, and there was good survival right until spawning. He said this is surprising because summer Chinook have generally had more of an issue with pre-spawn mortality in recent years due to Columnaris, and there were no obvious warning signs for this mortality event in spring Chinook. Hillman asked what the water temperature in the river was when the fish were collected. Truscott said they were collected at the fish ladder to Chief Joseph Hatchery when mainstem river temperatures were approximately 66 to 68 degrees Fahrenheit.

He asked if there is potential to backfill the spring Chinook program with excess production at Carson NFH or Leavenworth NFH. Matt Cooper said all fish available for the Carson program were spawned and staff are hoping for good ELISA results. If there are excess fish, they can be used to backfill the CCT program.

VI. HCP Administration

A. Next Meetings

Tracy Hillman asked the Hatchery Committees if they would like to reschedule the November meeting to avoid the Thanksgiving holiday week. Hatchery Committees representatives present agreed to move the meeting to November 15, 2018.

The next Hatchery Committees meetings are on October 17, 2018 (Grant PUD), November 15, 2018 (Grant PUD), and December 19, 2018 (TBD).

VII. List of Attachments

Attachment A	List of Attendees
Attachment B	Control of Saprolegnia spp. Growth on Spring Chinook (Oncorhynchus tshawytscha) Eggs - Revised

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Brett Farman*	National Marine Fisheries Service
Emi Kondoº‡	National Marine Fisheries Service
Morgan Robinsonº‡	National Oceanic and Atmospheric Administration
Matt Cooper*	U.S. Fish and Wildlife Service
Christian Smithº‡	U.S. Fish and Wildlife Service
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes
Ilana Kochº‡	Columbia River Inter-Tribal Fish Commission
Shawn Narumº‡	Columbia River Inter-Tribal Fish Commission

Notes:
* Denotes Hatchery Committees member or alternate
º Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Control of Saprolegnia spp. Growth on Spring Chinook (*Oncorhynchus tshawytscha*) Eggs

Experimental Protocol – Pilot Study

Written by Betsy Bamberger, DCPUD Fish Health and Evaluation Specialist

Purpose: To investigate the efficacy of hydrogen peroxide and salt in controlling water mold infestations during salmonid egg incubation under hatchery conditions at Methow Fish Hatchery (MFH). The chemical traditionally used for prophylactic management of Saprolegnia spp., formalin, has long been associated with worker safety and environmental hazards and may be met with increasing scrutiny by regulatory agencies in the immediate future. This effort is made to determine the effectiveness of purported alternatives to formalin that can be used as safe therapeutic substitutes at MFH.

Hypothesis: There will be no difference found between test treatment groups (hydrogen peroxide, sodium chloride, no treatment [water]) and the formalin group in the control of egg mortality caused by Saprolegniasis.

Experimental design: Twenty-four (24) pairs of Wells Hatchery-origin (hatchery) summer Chinook (collected at Wells Fish Hatchery (WFH) in mid-late July, 2018) will be spawned when ripe at WFH in October 2018. All gametes will be harvested on the same day to eliminate temporal bias. Eggs will be weighed then poured into a new Ziploc® bag and placed in an ice-filled cooler lined with burlap. Ovarian fluid will be collected from the spawned females for disease testing. Milt will be collected in Whirl-Pak® bags and placed in a separate chilled cooler. Once all have been collected, the gametes will be transported to Methow Fish Hatchery (MFH) via truck. Upon arrival at MFH, the unfertilized eggs and milt from one respective female, male, and backup male will be combined in a plastic bucket until sufficiently mixed, gently rinsed with water, weighed, and then added to a large receptacle that contains all fertilized eggs. The eggs will be divided into equal parts, containing roughly 3,800 eggs per group (the assumed average fecundity of one hen). Each group will be placed in a designated individual Heath vertical incubator tray within a stack assigned to one of four treatment groups (formalin, salt, hydrogen peroxide, and water [no treatment]). Eight stacks total will be used, two for each treatment group, with utilization of an empty mixing tray on top of each stack, below which are three staggered trays reserved for eggs (see treatment-specific information and schematic representation of experimental set-up in Figure 1 below). The formalin stacks will be kept in a separate room to avoid adverse chemical reactions between compounds. Each tray will be numbered in advance, and egg clutches will be placed in sequential order until all are occupied. The fertilized eggs will be then water-hardened in a 100 ppm buffered iodophor (Ovadine®) solution (static bath) for 60 minutes. Following this surface disinfection, fresh well water (averaging 47°F) will be introduced into the stacks, effectively draining away the used iodophor solution from each tray. Flow will be set at 3 gallons per minute except in the salt treatment stacks, where it will be set at 3.2 gal/min to accommodate the added volume of saline solution introduced into the system.

Formalin, salt, and hydrogen peroxide will be added to the top tray of the designed stacks and delivered via a metered peristaltic pump (INTLLAB™ or MasterFlex easy-load® II). Dosages of hydrogen peroxide, formalin, and salt are calculated to consider flow rate, treatment time, final desired concentration of chemical used, and chemical strength and are consistent with FDA-label instructions or previously published data (see Figure 1). Salt will be pre-dissolved before administration; salinity will be monitored during treatment with an Apera 5052 saltwater salinity tester with the probe placed in the topmost empty tray and recorded at multiple time points during administration (0, 5, 10, 15, and 20 minutes). Daily 15-minute flow-through treatments with hydrogen peroxide, well water, and salt will be initiated on the day following fertilization and continue on alternate days until day 39 of incubation (assuming approximately 15 temperature units/day), just prior to the initiation of hatching. Formalin treatments will be administered on the second day following fertilization to avoid undesirable exposure to other oxidizing compounds used in this study, and continued on alternate days until day 40 of incubation. On day 39 of incubation, the incubator trays in the hydrogen peroxide, well water, and salt stacks will be opened and photographed; the eggs will be shocked by mechanical agitation within the trays and returned to the stacks. The same will occur on day 40 for the formalin group. On day 40, the trays in the hydrogen peroxide, well water, and salt stacks will again be opened and any dead and Saprolegnia-infected eggs will be removed by hand, sorted, and live and dead eggs counted. All trays will be disinfected with Ovadine® for 10 minutes at 100 ppm before being placed back in the stacks. The sorting, enumeration, and second round of disinfection will occur as described on day 41 for the formalin group. On day 45 and 46 for the hydrogen peroxide, salt, and well water groups and formalin group, respectively, trays will again be opened and photographed, and any dead and Saprolegnia-infected eggs will be removed by hand, sorted, and live and dead eggs counted.

Approximately five-to-fifteen thousand eggs used in this study will be donated to the Kalispel, Spokane, and/or Coeur d'alene tribes for their "Salmon in the Classroom" program. The rest of the eggs used for this study will then be destroyed.

The criterion used to evaluate the success of each compound is total egg mortality (which includes both water mold-infected eggs and dead uninfected eggs throughout the 40 day incubation period). In addition, the extent of water mold infection will be qualitatively (photograph) and quantitatively (number of eggs that appear infected) estimated.

Statistical Analysis: The statistical analysis described here is the study design and analysis that would be used in a full scale study. Researchers will target approximately 24 pairs of spawning adults to provide enough eggs to meet density and sample size requirements. Gametes will be reared at similar densities that are normally employed at Methow Hatchery. During experimental development, power analysis determined that $n = 45$ samples per treatment group would be required at an effect size of 0.25 to detect a difference at $\alpha = 0.05$. However, given the pilot nature of the study proposed in 2018, sample sizes may be reduced to as little as $n = 3$ samples per treatment. Treatment (formalin, salt, hydrogen peroxide, water [no treatment]) will serve as a categorical variable and total egg mortality represented by the percentage of dead eggs at study completion will serve as the continuous response variable.

Since family groups generated during the study are likely to occur across multiple egg take (spawn) days, all eggs from each egg take will be combined into one population and subsequently divided into equal densities in each treatment-specific tray. Combining family groups on each spawn day is expected to eliminate any genetic or familial effects. Nevertheless, spawning fish on multiple days precludes combining all family groups over the course of the study and therefore requires examination for "spawn day effects" prior to examining treatment effects. As such, a block ANOVA design will be used with spawn day as a block. The assumption is that spawn day has no statistical influence on egg survival, but the block design will allow examination of this assumption. If no difference among egg takes is found, total study survival results may be combined into treatment bins to maximize sample sizes in each treatment, thereby ignoring spawn day.

A block ANOVA will be used to examine similarities or differences between treatment groups. Upon finding significant results, a Tukey-Kramer HSD post hoc analysis will be used to isolate significant differences among treatment groups and towards recommending a treatment to researchers, managers, and aquaculture staff. P-values will be assessed at α = 0.05. If the response variable does not satisfy the assumption of homogeneous variance, an alternative analysis such as beta regression will be used. All statistical analysis will be conducted in R, JMP, or SAS software.

Figure 1:

Room 3		Room 3		Room 3		Room 1 or 2	
Stack 1	**Stack 2**	**Stack 3**	**Stack 4**	**Stack 5**	**Stack 6**	**Stack 7**	**Stack 8**
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
1	5	2	6	3	7	4	8
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
9	13	10	14	11	15	12	16
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
17	21	18	22	19	23	20	24
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty
Empty	Empty	Empty	Empty	Empty	Empty	Empty	Empty

No Treatment	Hydrogen Peroxide	Sodium Chloride	Formalin
100% Well Water	35% PEROX-AID®	Diamond Crystal® Solar Naturals®	Parasite-S®
	Dosing regimen: 1000 mg/L for 15 minutes (~488 mls H_2O_2) in a continuous flow system once per day on alternate days until day 39 (consistent with FDA label).	Dosing regimen: 20,000 ppm for 15 minutes (~8 lbs salt per stack) in a continuous flow system once per day on alternate days until day 39 (based on findings in Waterstrat, 1995 and Edgell, P. and D. Lawseth, 1993).	Dosing regimen: 1/600 (1,666 ppm) for 15 minutes (~770 ml per stack) in a continuous flow system once per day on alternate days until day 40 (consistent with FDA label).
	32.5 ml/minute (or 0.54 ml/second)	Make a salt 3 lb of salt/1 gallon of water stock solution; 0.2 gal/min	51.3 ml/minute (or 0.85 ml/second)

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: December 20, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the October 17, 2018 HCP Hatchery Committees Meeting

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held in Wenatchee, Washington, on Wednesday, October 17, 2018, from 9:00 a.m. to 12:30 p.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting prespawn mortality modeling results for spring Chinook salmon at the November 15, 2018 Hatchery Committees meeting (Item I-A). *(Note: Tonseth indicated that Andrew Murdoch is not available for the November Hatchery Committees meeting.)*
- Eric Kinne (WDFW) will ask Mike Ford (Northwest Fisheries Science Center) about the near-term extinction risk for Pacific salmon stocks and killer whales (Item II-D).
- Keely Murdoch will send the conservation program size spreadsheets to the Hatchery Committees (Item II-E).
- Michael Humling will provide mortality data for spring Chinook salmon that were transferred from Methow Fish Hatchery (FH) to Winthrop National Fish Hatchery (NFH) (Item II-F).

Decision Summary

- There were no decisions approved during today's meeting.

Agreements

- There were no agreements made during today's meeting.

Review Items

- Sarah Montgomery sent an email to the Hatchery Committees on November 9, 2018, notifying them that Douglas PUD's Draft 2019 Methow Monitoring and Evaluation Implementation Plan is available for a 30-day review, with edits due to Greg Mackey by December 10, 2018. (Note: the 30-day review period was approved by the Wells Hatchery Committee on November 15, 2018.)

Finalized Documents

- Sarah Montgomery sent an email to the Hatchery Committees on November 5, 2018 notifying them that Douglas PUD's Final 2017 Monitoring and Evaluation Report for the Wells and Methow Hatchery Programs is now available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the August 15, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. There were no changes.

The Hatchery Committees representatives reviewed the revised draft September 19, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments and revisions, which the Hatchery Committees reviewed and addressed. Hatchery Committees representatives approved the draft September 19, 2018 meeting minutes as revised.

Action items from the Hatchery Committees meeting on September 19, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on September 19, 2018)*:

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).* Hillman said this item is ongoing.
- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Mackey said this item is ongoing.
- *Keely Murdoch and Mike Tonseth will provide an update on their evaluation of the size of conservation programs in October 2018 (Item I-A).*
  This item will be discussed today.
- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).*
  Murdoch said this item is ongoing.
- *Charlie Snow (Washington Department of Fish and Wildlife [WDFW]) and Michael Humling (U.S. Fish and Wildlife Service [USFWS]) will provide a summary of 2018 Methow Basin spring Chinook salmon adult management to the Hatchery Committees (Item I-A).*
  This item will be discussed today.
- *Mike Tonseth will coordinate with Andrew Murdoch (WDFW) regarding presenting prespawn mortality modeling results for spring Chinook salmon at an upcoming Hatchery Committees meeting (Item I-A).*
  Tonseth said this item is scheduled for the November 15, 2018 Hatchery Committees meeting and he will coordinate with Andrew Murdoch.
- *Tracy Hillman will provide background documents including Monitoring and Evaluation (M&E) Annual Reports to the panel of geneticists (Item II-A).*
  This item is complete. Hillman provided additional background documents to the geneticists via email on September 25, 2018.
- *Mike Tonseth will draft a description or diagram of program and population linkages in the upper Columbia River to accompany the tables of species, programs, program purpose, and type of program for the panel of geneticists to review (item IV-A).*
  This item is complete. Hillman provided this spreadsheet to the geneticists on October 10, 2018.
- *Mike Tonseth will send contact information for the WDFW Salmon in the Classroom program coordinator to Kirk Truscott (Item III-A).*
  This item is complete. Tonseth sent Josh Nicholas' contact information to Truscott on September 20, 2018.

II. Joint HCP-HC/PRCC HSC

A. Genetic Monitoring (Tracy Hillman)

Tracy Hillman welcomed Christian Smith (USFWS) to the meeting. Hillman asked how the review of materials is progressing and whether Smith has any questions for the Hatchery Committees. Smith said he has no questions yet about the background material. Hillman asked whether any further coordination is required between the geneticists. Smith said the geneticists have coordinated some and plan to set up a meeting soon. Hillman said if they would like any help with organizing people or meetings to please let him or Sarah Montgomery know.

Mike Tonseth said he will also talk with Todd Seamons (WDFW) soon about this item.

Ilana Koch also joined the call. She similarly did not have any further questions. Smith said he will contact the rest of the geneticist panel to set up a meeting.

B. NMFS Consultation Update (Brett Farman)

Emi Kondo said she provided two documents to the Hatchery Committees this morning. The first is the Draft Environmental Assessment for Upper Columbia River Steelhead and Summer/Fall Chinook Salmon Programs, and the second is a comment template for reviewing the Environmental Assessment. She said the Environmental Assessment is the pathway for these programs to receive coverage under the Endangered Species Act (ESA), as part of the National Environmental Policy Act process. She asked that the Hatchery Committees closely review her email for instructions because it identifies sections of the Environmental Assessment where review should focus and to please provide comments to her and Chuck Peven by Friday, November 2, 2018.

Tracy Hillman asked Kondo to explain the comment matrix. Kondo said the example comment included on the template is an example for how to provide a comment on a specific section and includes the page number and section number of the EA for which the reviewer has a comment. Kondo specified that the page number on the bottom of the document should be used as the page number in the comment matrix. Per her email, Kondo said reviews should focus on sections through Chapter 5, as the sections after that are general and not specific to these programs.

Kondo also asked the permit applicants whether there are any questions or concerns about submitting Hatchery and Genetic Management Plan addenda. There were no questions.

C. Orcas and Hatchery Production (Eric Kinne)

Tracy Hillman welcomed Eric Kinne, WDFW Hatchery Division Manager, to the meeting. Kinne said he will provide an update on the Southern Resident Killer Whale (SRKW) Task Force and describe how

WDFW is working with fisheries co-managers to increase hatchery production in Washington. He shared the presentation, "Southern Resident Killer Whales" (Attachment B), which Sarah Montgomery distributed to the Hatchery Committees following the meeting on October 23, 2018. A summary of the presentation, questions, and comments are included in the following sections.

<u>Slides 1-8: Introduction and Status</u>

SRKW range from southeast Alaska to central California, with most of their time spent along the coast of Washington, Oregon, and southern British Columbia. Kinne reviewed SRKW diet, ESA listing status, and population decline. Prey availability, contaminants, noise and vessel disturbance, and a lack of breeding-aged females have contributed to recent declines in the population.

<u>Slides 9-14: SRKW Task Force and Prey Working Group</u>

In response to population decline, Governor Inslee issued an executive order establishing the SRKW Task Force and charged the task force with developing an action plan to recover the population. Kinne described the Task Force, its subgroups, and its next steps. The Prey Working Group modeled priority SRKW Chinook salmon stocks to determine areas for the working group to focus salmon production and restoration. Kinne summarized the Prey Working Group's potential recommendations. Regarding hatchery production, Kinne said the group recommends increasing production and pilot studies analyzing time and size at release. There also appears to be a diet preference for older-aged fish, so the group is interested in manipulating spawning protocols to produce older-aged fish.

<u>Slides 15-17: Funding and Production Requests</u>

Kinne said supplemental funding for increased hatchery production is being worked into the legislative budget for fiscal year 2019. This money would fund things like hatchery improvements, fish screens, and operational costs for producing salmon. Kinne said he is working to develop a biennial hatchery production plan by the end of the year. He said he is looking for opportunities to increase production within existing facilities. Particularly, he asked whether No Net Impact recalculation generated additional space and asked for other ideas or potential issues. He preliminarily identified ESA constraints, United States v. Oregon area constraints, costs, and broodstock availability as potential issues.

<u>Questions and Comments</u>

Todd Pearsons asked how increased hatchery production factors into evaluation of genetic targets like percent natural influence (PNI) and proportion of hatchery origin spawners. Kinne said provisions 1, 2, and 3 in the Hatchery Scientific Review Group recommendations are suspended for 1 year while the policy is being rewritten. He said any targets identified in existing consultation or Hatchery and Genetic Management Plans remain, but WDFW is looking to push programs to the upper bounds of their available production, especially in areas with fewer ESA constraints. Kinne said salmon species and SRKW are conflicting ESA-listed species, and their recovery is linked. He said WDFW is looking to increase production by 50 million fish coast-wide. Pearsons asked where the balance is to increasing hatchery production at the risk to native stocks in order to increase prey for SRKW. Kinne said habitat restoration is the long-term key to salmon restoration, so increased hatchery production can be viewed as a short-term balancing act.

Bill Gale asked if the Task Force has considered whether changing ocean conditions and ocean carrying capacity due to climate change is more of an issue to salmon habitat and recovery than tributary or freshwater habitat. He said increasing hatchery production in a way that does not affect PNI still increases density effects in the ocean to listed populations as a whole. Kinne agreed that this is a concern and said the Task Force is considering increasing production while evaluating those potential negative effects. Catherine Willard asked what are the preliminary results of the public comment regarding this topic? Kinne said public comments favor the recovery of wild fish. He said WDFW is working on education regarding the timeline of salmon recovery. Willard said monitoring the potential negative effects of hatchery fish on wild fish should be a key part of Task Force discussions. Truscott asked what is the near-term extinction risk of SRKW? Kinne said it is very high and he will ask Mike Ford for the details.

Betsy Bamberger (Douglas PUD) said her initial impression on increasing hatchery production is that the scale of consequences could be negative to many listed fish, with a potential benefit to few orcas. She said salmon are managed very carefully and questioned whether the impacts will be fully analyzed before production is increased. Kinne said production increases are being analyzed carefully. WDFW is considering options such as adult management, increased terminal fisheries, and establishing weirs in new areas. He said production increases will occur, and evaluation of those increases will happen in the first 5 years of their implementation.

Pearsons asked what is the evidence that abundance of prey is the key to SRKW recovery. He said SRKW appeared to increase during the time when salmon populations were very low. Kinne said SRKW are starving to death. He said over time, there has been a change in the life stages in Chinook salmon. He said spring, summer, and fall Chinook salmon populations in the 1960s and 1970s had a wide range of life stages. The range of diversity has declined. He said WDFW is highly focused on spring and summer yearlings and subyearlings, which will help feed the SRKW when they most need prey. Peter Graf said Mike Ford has also pointed out that recent trends show huge fish returns in the lower Columbia River while SRKW are starving. He asked whether these are the wrong fish at the wrong time and where production is being prioritized. Kinne said WDFW is looking to increase production in the top prey stocks for SRKW, which include mostly upper and mid-Columbia River stocks as well as north and south Puget Sound stocks and Tule production.

Bamberger asked whether restrictions to marine harvest are being implemented. Kinne said he is not sure. Mike Tonseth said the Pacific Salmon Treaty is being renegotiated, which will have major changes to marine harvest.

Tonseth asked what is the primary driver that will help SRKW avoid extinction? He said, for example, if toxins are driving calf survival, increasing production will not ultimately help the species avoid extinction. Kinne said the contaminants group is studying that. Tonseth said managing hatchery fish in terminal zones results in increased take on listed populations. Hillman asked whether there is a team evaluating the risks to listed fish populations. He said increasing hatchery fish for SRKW may not help SRKW avoid extinction and may preclude recovery of ESA-listed fish. Is this risk being analyzed? Kinne said managing adult returns of hatchery fish is going to be a big task. He said the ESA side of these discussions is complicated, but the bottom line is that production will be increased. The details will be worked out in a plan with adaptive management considerations.

Tonseth said it appears that contaminants and genetic introgression are the biggest risks to the SRKW. He said it is hard to understand how conversations about protecting wild fish are occurring at a broader level. Kinne said regarding contaminants, the SRKW do not metabolize the toxins in their blubber if there are plenty of food sources.

Pearsons asked what Kinne has in mind for production increases in the upper Columbia River. Tonseth said in terms of feasibility and capacity, summer/fall and fall Chinook are most reasonable for increasing production. There are sufficient adults to meet broodstock for production increases, there is capacity because programs used to have higher production targets, and there are fewer ESA complications. Keely Murdoch asked if capacity exists, does WDFW have funding? Kinne said there is funding available ($837,000 for 2019 and 2020) plus additional funding requests to be considered by the legislature in January. Tonseth said increased hatchery production and evaluation will be dependent on the legislature approving this funding request. Kinne said the Task Force is also considering where to build additional hatchery facilities in Puget Sound or the Columbia River.

Gale said an additional consideration to funding is the permitting and consultation process. Kinne said he has been in contact with Allyson Purcell (National Oceanic and Atmospheric Administration [NOAA]) regarding the consultation process. He said NOAA has preliminarily approved a production increase of 800,000 hatchery fish. He said few programs in Puget Sound have ESA permits (the rest are undergoing consultation), so amendments are being made to include upper bounds of hatchery production. He said consultation in the Snohomish and Dungeness rivers is also being reinitiated.

Truscott asked what Leavenworth NFH's production was before recalculation. Gale said the program used to be 2.2 million fish and is now 1.4 million fish. Truscott said with its facility improvements, that program is a good segregated harvest program from an ESA-risk perspective. Gale said he would like to see the Leavenworth program increased to 2.2 million with fixed infrastructure, but straying targets set by NMFS and National Pollutant Discharge Elimination System constraints set by the Washington Department of Ecology would also need to be relaxed. He said all facilities will have various constraints at some level. Kinne said if the program was permitted at the 2.2 million size before recalculation, there may be an ability to permit that production level again. Truscott said there is not as much capacity to be gained as one might think by just looking at one program's reduction without considering how other programs have backfilled production. Tonseth said the Hatchery Committees should evaluate whether or not additional capacity exists throughout the basin, then, if there is funding, where is the capacity and within which program. Next, whether the increased production would compromise other programs should be considered. Greg Mackey said an additional consideration is the implementation period. He said, for example, infrastructure and staffing changes would be different for a 5-year increase compared to a 25-year increase. Truscott agreed and said the timeline would impact whether to bring back old facilities such as Turtle Rock or Cassimer Bar. Tonseth said outside of the PUD programs, co-managers should put more pressure on entities that have not met their mitigation responsibilities. Gale summarized that there is likely not capacity for millions of additional fish to be produced in the upper Columbia and he asked whether there is an easier implementation target in the lower river. Kinne said a Tule program in Spring Creek is a consideration. Gale added that much of the high hatchery production years occurred when mass-marking was not completed, so marking costs should also be considered. Truscott asked whether opening up unoccupied habitat is being considered to increase salmon production. Kinne said dam removal and other actions are certainly being discussed. Hillman questioned whether removing the Snake River dams will reduce or eliminate funding for Snake River hatchery compensation programs.

Hatchery Committees representatives present thanked Kinne for his presentation.

D. Conservation Program Size (Keely Murdoch and Mike Tonseth)

Keely Murdoch said she and Mike Tonseth have been working to determine what data are needed to update the conservation program size analysis. She said she performed a retrospective analysis on the Nason Creek conservation program and safety-net program using the current management plan, which she shared in a presentation, "Updated Retrospective Analysis" (Attachment C, distributed following the meeting). The slides mostly showed data and analysis, so the summary below focuses on Murdoch's summary slides and questions and comments.

Murdoch said WDFW, Yakama Nation (YN), and NOAA developed a sliding scale for PNI in 2009 for the Nason Creek conservation and safety-net programs. They also modeled different sizes for the programs. Murdoch said the 2009 retrospective analysis considered what might have occurred if the draft management plan were implemented over the previous 10 years. She shared the results of this analysis (slides 3-5).

For the 2018 update, Murdoch said the analysis was updated with the most recent 10-year smolt-to-adult returns, with broodstock needs based on the latest protocols, with updated natural origin returns at Tumwater Dam, and the analysis was rerun with the new composition of the safety-net program (Nason only and Nason-Chiwawa composite). She said the new analysis still needs updated pre-spawn mortality information. Tonseth said this modeling will get complicated because there is differential mortality between hatchery and natural-origin fish. He said the strength of returns in some years will dictate how many hatchery fish are on spawning grounds. Tonseth said he expects that the latest data on pre-spawn mortality will result in recommended changes to the size of the conservation program and an anticipated adjustment to escapement goals and how those goals are managed. Murdoch said the new analysis also will be updated with new escapement goals and new stock-recruit models. Pearsons said that the hatchery M&E reports have estimates of carrying capacity that can be used to inform escapement goals. She presented the data and tables for the revised analysis. In summary, Murdoch said reducing program size can result in more fish on spawning grounds. She said adjusting escapement goals has a greater potential to increase escapement and recruitment and this should be done at the same time or in conjunction with adjustments to the conservation program size. She said she also discussed this with Steve Parker (YN), who had the opinion that if reducing the conservation program allows for more fish on spawning grounds, then YN would likely be in favor of the reduction only if there is agreement amongst all parties to supporting regular use of safety-net fish in broodstock and on spawning grounds.

Tonseth said new information regarding spawner-recruits from life cycle modeling will also factor into this analysis. He said the expected outcome of the reproductive success study will indicate that, unlike steelhead, the allowance of safety-net fish into the program is unlikely to result in more genetic concerns. He said the reproductive success studies indicate that Chinook salmon are not as susceptible to this problem as steelhead. Gale asked whether the committees should also consider whether results of this analysis would significantly change if the multi-population PNI model was used. Murdoch and Tonseth stated that it might change the results. Tonseth said the next step for this analysis will be to update the major assumptions, including the PNI model used. He said the Section 10 permit for these programs does not require use of the multi-population PNI model, however. Murdoch said because this analysis does not model the safety-net program, it would be difficult to incorporate the multi-population model into the analysis. Tonseth agreed and said the incorporation of F2 and F1 fish in programs and on spawning grounds might be too complicated for the model. Gale asked how different these programs are from those in the Methow. Murdoch said there is more distinct separation in the Methow between the Winthrop NFH program and the conservation program, for example. Tonseth added that the Wenatchee programs are sequentially stacked—that is, there is Tumwater Dam, then everything upstream from it. Gale said there is greater precision in the multi-population model, so even if the permit does not require its use, the committees should use it if it applies. Tonseth said changing how PNI is calculated in the Wenatchee Basin will likely result in a modification to how PNI was calculated in the past so that it is comparable.

Tonseth said the next steps for this analysis are to work on updating assumptions and incorporating additional data. Kirk Truscott said if there are more wild fish on the spawning grounds, then more hatchery fish could also be allowed on the spawning grounds. He said he hesitates to downsize the escapement targets not knowing whether capacity is a function of the variety of fish on spawning grounds, especially considering the large contribution of Chiwawa River fish. Tracy Hillman said he thinks the opposite would be true. He said the greater the spawning escapement, the greater the effects of density dependence, which results in higher mortality and reduced growth rates. He said if hatchery fish spawn in less suitable habitat, like they do in the Chiwawa River, then more adults are needed to fully seed existing habitat.

Murdoch said the next steps for this process are for her and Tonseth to continue working on the analysis, and to incorporate pre-spawn mortality data. She said she will also share the spreadsheets that are shown in the presentation, even though they are draft. Todd Pearsons asked the committees when they will discuss the size of conservation programs in the Methow Basin. Tonseth said the Wenatchee programs should be addressed first, for the 2019 Broodstock Collection Protocols, and a timeline for discussing the Methow Basin programs has not been determined. Tonseth said there is not a management plan for the Methow Basin programs yet, and discussions have not begun regarding reductions in program size. Pearsons said the committees discussed this item earlier in 2018. He said evaluating the size of Methow conservation programs was discussed as a next step. Tonseth said first, the co-managers need to agree on escapement targets before analyzing the size of the programs. Tonseth said WDFW has not committed to a timeline for these discussions because there is no management plan or escapement goal in place. Mackey said PNI targets can be used in lieu of escapement targets to determine how big a hatchery program should be, which can be used in discussions on program size. Tonseth agreed that PNI targets can be used in the interim to begin analyses for program size in the Methow Basin. Gale recollected that discussions on PNI management included analyses of how likely programs were to meet certain targets at different goals and rates and this information can also inform discussions about program size.

E. Methow Basin Spring Chinook Salmon Adult Management (Greg Mackey and Charlie Snow)

Greg Mackey said when the adult management targets for spring Chinook salmon were reviewed earlier in the season, it was expected that 447 wild Chinook salmon spawners would return to the Methow Basin. Using the sliding scale, managers targeted a PNI of 0.74 with approximately 214 hatchery spawners allowed to spawn in the basin. Mackey said a low number of projected hatchery spawners was used and based on that, the goal was to remove 196 Methow hatchery adult returns so that the PNI target could be met. He said managers successfully removed 188 hatchery returns at Methow FH and the run was not as large as expected.

Mackey shared the summary document, "Preliminary Methow Basin spring Chinook escapement and adult management summary," which Sarah Montgomery distributed to the Hatchery Committees on October 16, 2018 (Attachment D). Charlie Snow explained this document is a summary and shows that the target was based on run evaluation data. He said based on permit conditions, managers targeted 100% removal of Winthrop NFH hatchery-origin returns plus Methow hatchery-origin returns. They used pre-spawn mortality estimates to determine a preliminary spawning escapement of 511 fish. He said Winthrop NFH was successful in removing 96% of their returning fish and the overall PUD hatchery-origin returning fish were reduced by 73%. Using the three-population PNI model, this results in a PNI of 0.62 basin-wide.

Snow summarized some of the lessons learned in 2018. He said the conversion rate from Wells Dam to the spawning grounds was lower than the initially assumed 25% pre-spawn mortality because of higher than expected pre-spawn mortality or other factors. He said Methow FH and Winthrop NFH staff combined were performing redd counts but not finding redds, so managers targeted a minimum escapement. He said there was a small proportion (about 10%) of Winthrop NFH fish on spawning grounds. He said, for this reason, managers cannot plan on removing 100% of the desired fish. Snow said there were also 13 adipose-fin-clipped-only fish that could have been from Chief Joseph Hatchery. Kirk Truscott said Chief Joseph Hatchery spring Chinook are an ad-clipped segregated harvest component and approximately 200,000 fish from that program have coded wire tags. He surmised that if ad-clipped fish without wire are found in the Methow basin they are more likely to be fish of Methow basin origin that lost their coded wire tags. Snow said that would be a high tag loss rate, so staff preliminarily assigned those fish to the programs that most closely match the marking strategy. Bill Gale asked who is pulling the coded wire tags. Snow said his staff pull wire from fish during spawning at Methow Fish Hatchery and Michael Humling (USFWS) will have information for wire from fish spawned at Methow FH.

Tom Kahler asked Truscott whether the Colville Confederated Tribes perform spawning ground surveys in the Okanogan River. Truscott said surveys are performed in the United States portion of the Okanogan River and staff found some spring Chinook salmon carcasses from the 10(j) program with coded wire tags, but there were only a few redds. He said there is more spawning habitat in Canada and he is not sure whether Okanagan Nation Alliance performed surveys in these reaches. Truscott said they rely on passive integrated transponder (PIT) tag arrays throughout the Okanogan Basin, but many were not functional this year due to spring floods.

Todd Pearsons asked whether all the fish brought into the hatchery were used for culture. Snow said broodstock at Methow FH was generally full by the time hatchery fish were swimming into the facility, but a few were kept for broodstock. He said the Methow hatchery conservation fish are sent to Winthrop NFH to be incorporated into broodstock and the rest are surplussed to tribes at Winthrop NFH. Gale said Winthrop NFH may also have surplussed some conservation program fish after broodstock needs were met. Mackey said many of those fish were jacks. Pearsons asked whether natural-origin fish are used to produce conservation program fish. Gale said conservation program fish are used for broodstock and the rest are surplussed. Pearsons asked whether the data for conservation fish surplussed are available. Humling said there were very few conservation fish, which were in poor condition and were surplussed (he estimated 10 fish). He said the jacks that were ad-present were also surplussed. In summary, nearly all the Methow-origin fish were used for broodstock. He said of the component that will remain for production on station at Winthrop NFH for release in the Methow basin, 75% of the broodstock are Methow FH returns, which is the Biological Opinion target.

Gale said in a low return year like 2018, meeting these goals is a success. Truscott asked whether meeting these targets is more difficult in a low-return year. Snow said the adult management plan is based on the number of fish returning to Wells Dam, so there is no estimate of escapement until staff are no longer able to collect fish. The conversion rate between Wells Dam and spawning grounds is important and can be affected by fire. For example, he said fire was a particularly challenging factor in 2018 because staff were unable to conduct spawning surveys and redd counts early in the season.

Truscott asked whether the conversion rate between Wells Dam and Methow Basin PIT arrays is used to inform the management plan. Snow said those data are not used much except to inform a location where there are few surveys such as Gold Creek. He said mainstem Methow River PIT arrays are often not repaired until August, which is too late to help decide adult management. Tonseth added that the PIT-tag arrays only detect fish with PIT tags, so the low rate of PIT-tagged wild fish limits the utility of using PIT-tag arrays for adult management.

Betsy Bamberger asked whether fish transferred from Methow FH to Winthrop NFH survived until spawning. Humling said the mortality of those transferred fish was higher than those that were held entirely at Winthrop NFH, but most of the fish survived to spawning. He said some fish had fungus and others did not look very healthy but most fish survived. He said caudal punches identified fish that were transferred from Methow FH, so mortality data are available, and he will send those data to Bamberger.

Gale summarized that fish were arriving at the hatchery prior to and during early spawing ground survey counts, and the decision to stop trapping at Methow FH turned out to be well-timed. He asked the Hatchery Committees to consider a model where fish are held for outplanting. He explained that would allow continued operation of both traps throughout the season with continued removal of Winthrop NFH fish. He said in years where Winthrop NFH fish need to be removed but Methow FH fish do not, the conservation fish could be held and outplanted. Keely Murdoch said she likes the idea of holding broodstock. Snow said holding broodstock might provide managers reassurance. He said an issue would be if the fish are not needed and they have to be spawned while at the hatchery—then, unanticipated eggs are at the hatchery. Tonseth suggested that under this scenario, eggs could be used to implement a study. He suggested considering this approach in advance of the next low-return year so that there is an understanding of the expected effort, outcome, and logistics. Gale said a year with low natural-origin return abundance and high hatchery-origin return abundance would be a good fit for this approach. Snow said a portion of Methow conservation fish are already not released at the facility and so are not very susceptible to removal at the hatchery. For example, he said in 2018, 185 fish were estimated to be on the spawning grounds and staff at Methow FH trapped the balance of the fish that arrived at the facility. Gale said this approach would most apply in years where both traps need to be operated to remove Winthrop NFH fish.

III. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are on November 15, 2018 (Grant PUD), and December 19, 2018 (conference call), and January 16, 2019 (Grant PUD).

IV. List of Attachments

Attachment A	List of Attendees
Attachment B	Southern Resident Killer Whales
Attachment C	Updated Retrospective Analysis
Attachment D	Preliminary Methow Basin spring Chinook escapement and adult management summary

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Betsy Bamberger	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Charlie Snow	Washington Department of Fish and Wildlife
Eric Kinne	Washington Department of Fish and Wildlife
Alf Haukenes°	Washington Department of Fish and Wildlife
Brett Farman*°	National Marine Fisheries Service
Emi Kondo°‡	National Marine Fisheries Service
Bill Gale*	U.S. Fish and Wildlife Service
Christian Smith°‡	U.S. Fish and Wildlife Service
Michael Humling°	U.S. Fish and Wildlife Service
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes
Ilana Koch°‡	Columbia River Inter-Tribal Fish Commission

Notes:
* Denotes Hatchery Committees member or alternate
° Joined by phone
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Southern Resident Killer Whales

Dave Ellifrit, Center for Whale Research

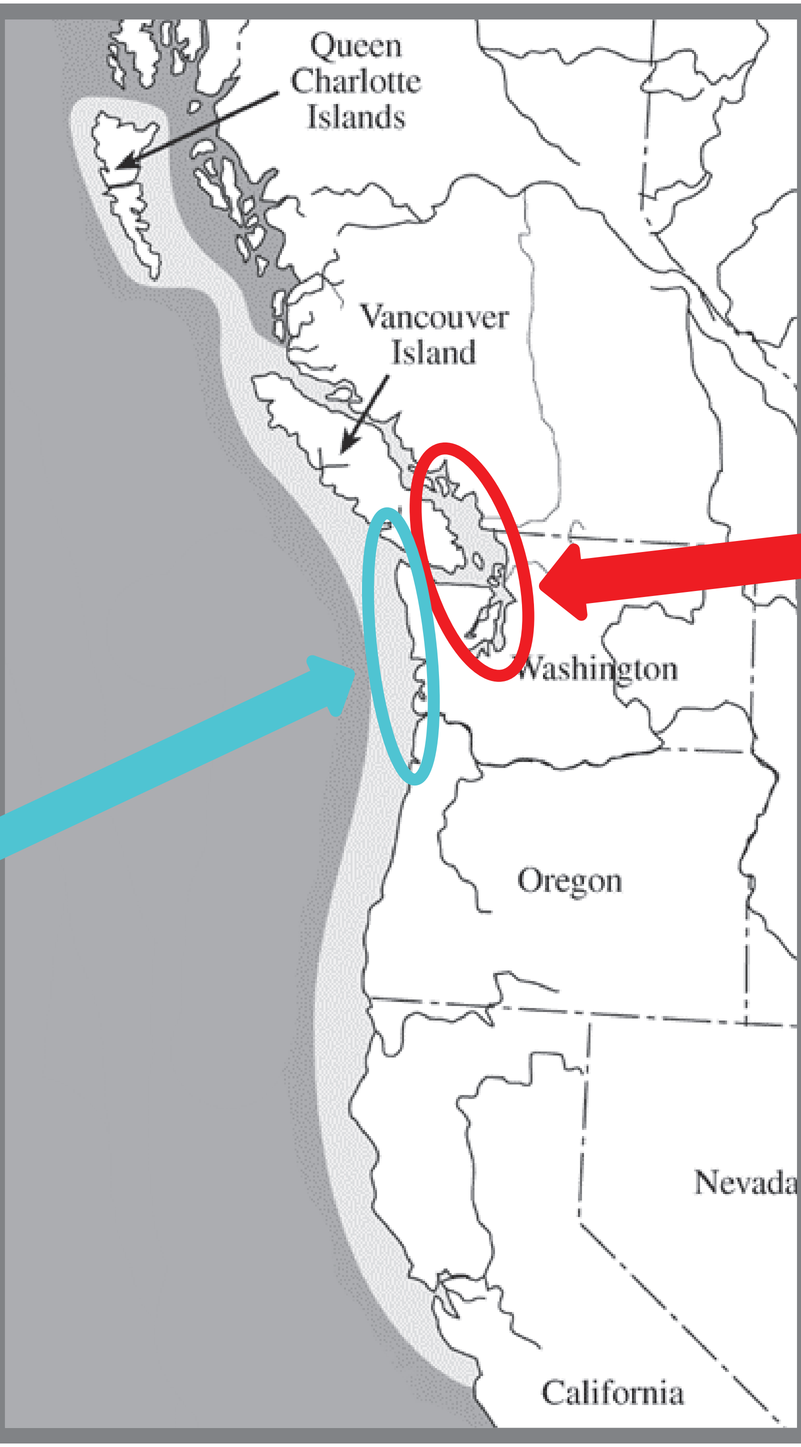
Eric Kinne, WDFW – Hatchery Division Manager

Southern Resident Killer Whales

Top: Astrid van Ginneken, Bottom: Center for Whale Research

- Highly stable social organization: J, K, L pods
- Pod size: 15-60 whales
- Diet dominated by salmon

Southern Resident Range



J Pod Summer & Winter

K & L Pod Winter

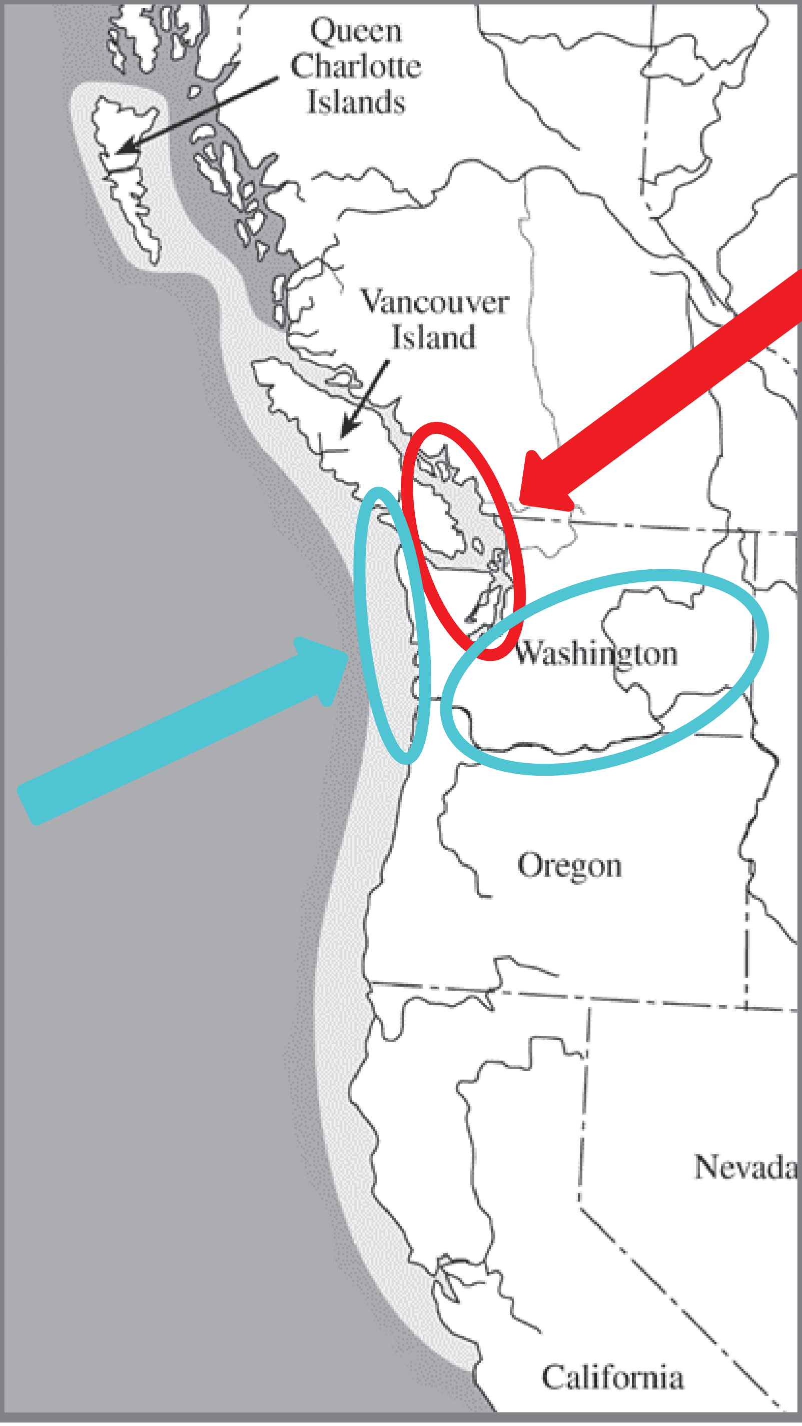
Attachment B

Southern Residents and Salmon

OUTER COAST

Oct- Dec:

Jan-April:
67-80% Chinook
5-16% Steelhead
0-14% Lingcod
2-12% Halibut



PUGET SOUND/ SJ ISLANDS

May-Sept:
65-96% Chinook
0-35% Steelhead (May)
0-29% Coho (Sept)

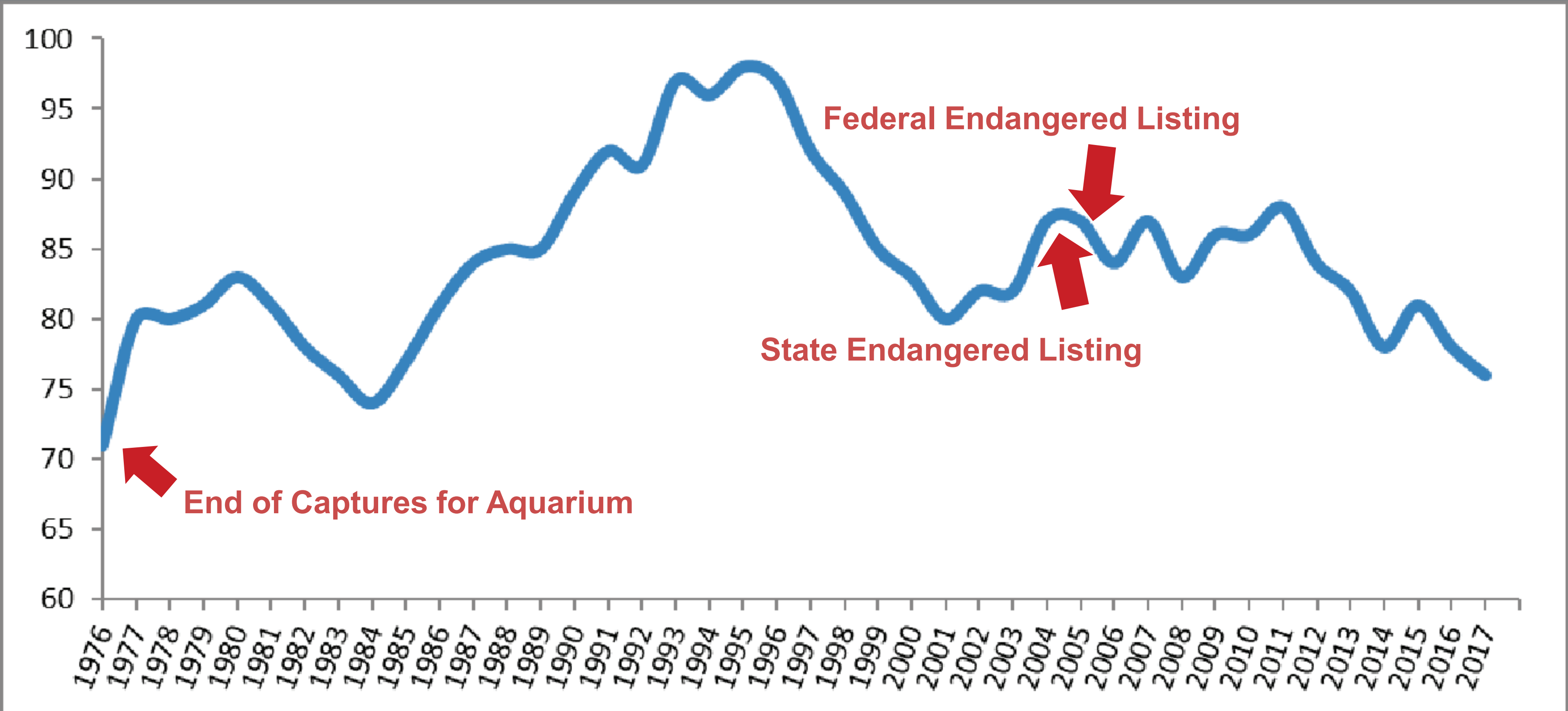
Oct-Dec:
39-62% Chum
21-45% Chinook
5-13% Coho
2-5% Steelhead

Listing Status

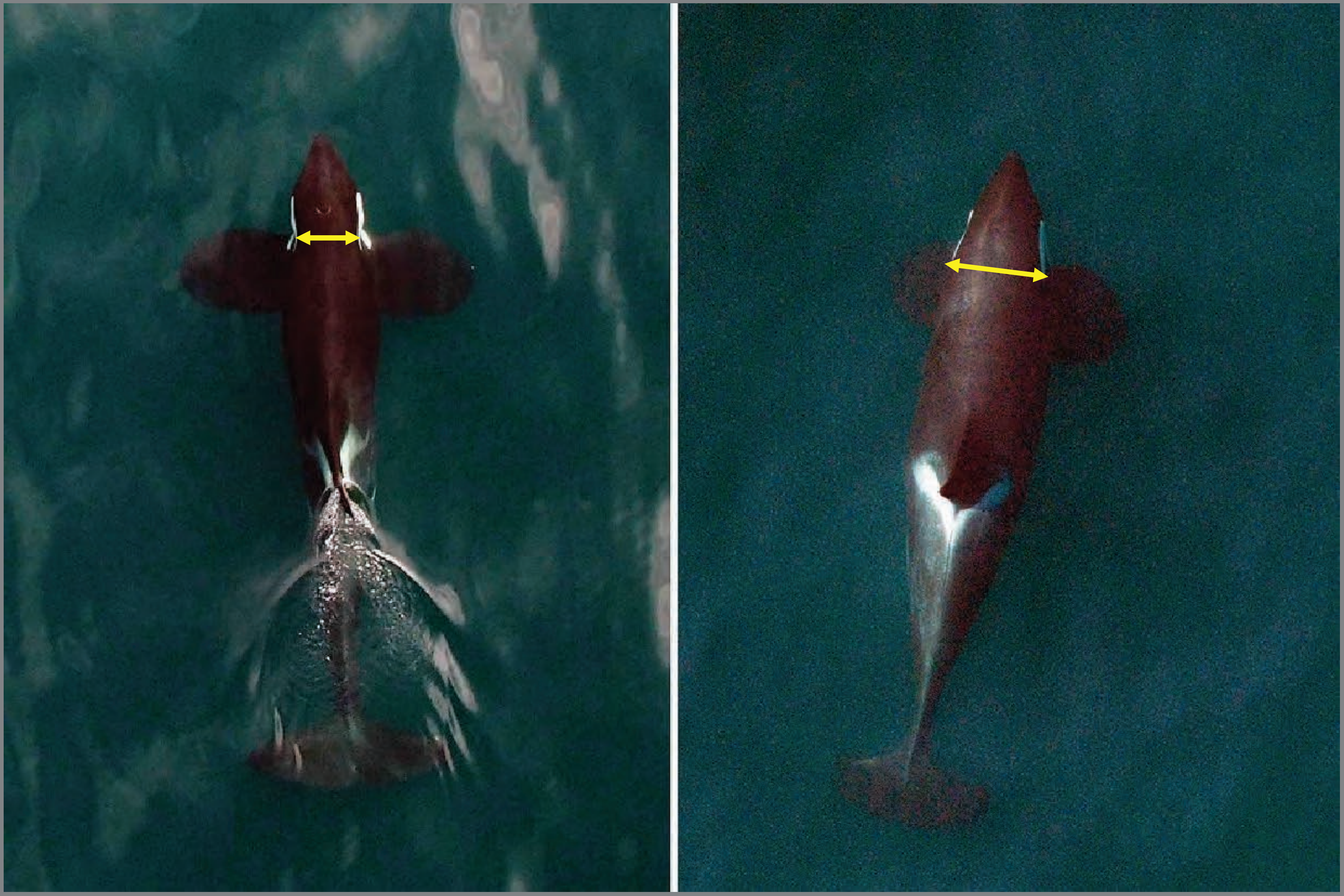
	Southern residents	Transients	Offshores
State status	Endangered	Endangered	Endangered
Federal status	Endangered	-	-
Critical habitat	Yes	-	-
Marine Mammal Protection Act protections	Yes	Yes	Yes
Canada status	Endangered	Threatened	Threatened

Population in Decline

- Historic population estimated ~200 animals
- Current population: 74 animals



Body Condition Concerns



NOAA

Population in Decline

Associated Press photo

Governor's Executive Order

March 2018

- Immediate actions for state agencies
- Established Task Force
  - ✓Charged with developing action plan
  - ✓Year 1 report due November 16, 2018
  - ✓Year 2 report due October 1, 2019

Task Force

- Stephanie Solien & Les Purce, co-chairs
- Diverse membership
- Three Working Groups
  - ✓Vessels (Todd Hass, PSP)
  - ✓Contaminants (Derek Day & Tom Laurie, ECY)
  - ✓Prey [Penny Becker (WDFW) & Steve Martin (GSRO)]

Task Force: Next Steps

- Public comment: 3,405 comments recieved
- Upcoming Task Force Meetings-
  - October 17-18- Tacoma
  - November 6- Tacoma/Olympia
- Year 1 Report to Governor November 16
  - Recommendations need to be implemented through:
    - Governor's Budget, Legislative Budget, Legislative Bills
    - Congressional Actions
    - Local Governments and Organizations
- Year 2 follow-up (more TF work through Oct 1, 2019)

Prey Working Group

- Habitat protection & restoration
- Predation
- Hydropower
- Harvest
- Hatcheries
- Forage fish/food web

Modelled Priority SRKW Chinook Stocks

Puget Sound, Fraser River, Thompson River, Lower Columbia, Central Valley, WA coast, Upper Columbia, Snake River, East Vancouver Island, Klamath

- LCR (fall, tules) & (spring)
- UCR (summer/fall (upriver fall bright)) & (spring, summer)
- Snake R spring/summer

Potential Prey Recommendations

- Hatchery- increase production, pilot studies
- Habitat- protection, restoration, incentives
- Hydro- re-establish runs above dams, remove dams, increase spill
- Predation- artificial haul-out removal, predatory fish removal, support Columbia R. MMPA amendments & salmon survival studies, PS/Outer Coast science and management panels
- Harvest- bycatch reductions, gear swaps, implement Pacific Salmon Treaty, commercial buy-backs, develop ‘real-time’ fishing closure area

Legislative Language – FY19 Supplemental Funding

Operating Budget –

- $837,000 for hatchery operational costs related to increasing the production of Chinook salmon and other key prey species throughout Puget Sound, coastal Washington, and in the Columbia River.

- Work with Governor, Federal Partners, Tribal Co-managers, HSRG and other interested parties in developing a biennial hatchery production plan by Dec. 31, 2018.

Capital Budget –

- $130,000 provided to review state hatcheries to identify opportunities to increase hatchery production with the focus on the needs of SRKW.

- $30,000 for 15 fish screen

- $664,000 for hatchery improvements to increase Chinook production to support Southern Residence Orca recovery.

Request

- Looking for opportunity to increased production within existing facilities
  - NNI re-calculation space?
  - Other

- Issues and hurdles
  - Agreement among parties
  - ESA constraints/consultation
  - Estimated costs
  - Broodstock availability

Background Picture Credit: J. Durban, NOAA, SWFSC

Updated Retrospective Analysis

Nason Creek Conservation + Safety Net Program and current management plan

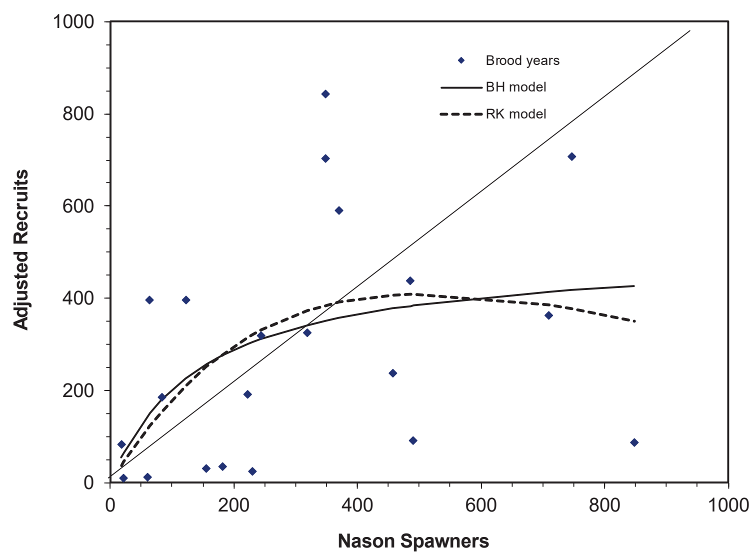
Retrospective Analysis 2009

- A look back at ‘what might have been’ based on the draft management plan
  - Estimates of NOR spring Chinook at Tumwater by spawning location
  - Draft Escapement goal (Beverton Holt Curve)
  - Sliding Scale of PNI (as per Wentachee Spring Chinook Management Plan
  - Chiwawa SARs (10 year: mean, min, max)
  - Conservation and Safety Net program sized to:
    - Maximize PNI
    - Maximize Escapement
    - Maximize Recruits
    - Minimize use of Safety Net fish on the spawning grounds and in the broodstock

BY	Spawners	Recruits	AdjRecruits	RperS
1981	349	549	842	2.41
1982	370	386	591	1.60
1983	746	462	708	0.95
1984	349	387	703	2.02
1985	710	236	362	0.51
1986	318	203	326	1.02
1987	457	169	238	0.52
1988	486	304	437	0.90
1989	222	132	193	0.87
1990	231	21	25	0.11
1991	156	29	31	0.20
1992	181	34	36	0.20
1993	491	89	91	0.19
1994	60	11	12	0.19
1995	18	79	83	4.73
1996	83	169	185	2.22
1997	122	357	397	3.25
1998	64	381	396	6.18
1999	22	9	10	0.44
2000	244	312	319	1.31
2001	848	73	87	0.10
			Geomean:	0.76
			Mean:	1.42

			BH model			RK model
			2.96E-01			**1.96E-03**
BY	**Spawners**	**AdjRecruits**	**2.00E-03**			**2.19E+00**
1995	18	83	54	39	0.965	38
1999	22	10	65	48	0.957	46
1994	60	12	145	132	0.888	118
1998	64	396	151	140	0.882	124
1996	83	185	180	183	0.849	155
1997	122	397	226	267	0.787	210
1991	156	31	257	342	0.736	251
1992	181	36	276	397	0.700	278
1989	222	193	300	487	0.646	314
1990	231	25	305	505	0.636	321
2000	244	319	311	534	0.619	331
1986	318	326	342	697	0.535	373
1984	349	703	351	763	0.504	385
1981	349	842	351	763	0.504	385
1982	370	591	357	809	0.484	391
1987	457	238	378	1000	0.408	408
1988	486	437	384	1064	0.385	409
1993	491	91	385	1073	0.382	410
1985	710	362	414	1553	0.248	385
1983	746	708	418	1633	0.231	377
2001	848	87	426	1855	0.189	351
		254.743565				

	Asymptote	Slope
BH	501	3.37
Ricker	509	0.46



Neq = 352

OPTION 1. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

Brood Goal	132		
Nason Creek Escapement Goal	542		
Target Extraction Rate	33%		
Conservation Program Size		**250,000**	**100%**
Safety Net Program Size		**0**	**0%**

Conservation Program:	SAR (BY1996-2002)		SAR (BY 1989-2002)	
Mean HOR run size:	**2000**	0.008	**1163**	0.00465
Minimum HOR runs size:	**1163**	0.00465	**90**	0.00036
Maximum HOR run size:	**3905**	0.01562	**3905**	0.01562

Mean HO R Needed	**212**	
Minimum HOR Needed	**91**	
Maximum HOR Needed	**634**	
Mean / Total Escapement	**350**	**3495**
Mean/ Total Recruits	**333.71**	**3337**
Mean PNI	**0.58**	**0.63**

Year	Estimated Nason NOR Run Size at TWD	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total Esc'nt	pHOS	PNI	Est. No. Adult NOR Recruits	2.96E-01 2.00E-03
1999	40	0.333	13	119	0.10	27	515	542	0.95	0.10	393	
2000	237	0.333	79	53	0.60	158	68	226	0.30	0.67	302	
2001	560	0.333	132	0	1.00	428	114	542	0.21	0.83	393	
2002	442	0.333	132	0	1.00	310	100	410	0.24	0.80	368	
2003	411	0.333	132	0	1.00	279	91	370	0.25	0.80	358	
2004	289	0.333	132	0	1.00	157	143	300	0.48	0.68	335	
2005	143	0.333	48	84	0.36	95	105	200	0.52	0.41	288	
2006	208	0.333	69	63	0.52	139	403	542	0.74	0.41	393	
2007	85	0.333	28	104	0.21	57	26	83	0.32	0.40	180	
2008	280	0.333	93	39	0.71	187	93	280	0.33	0.68	327	
Mean	**269**		**86**	**46**	**0.65**	**184**	**166**	**350**	**0.43**	**0.58**	**333.71**	Average (1999 Included)
										0.63	**327.09**	Average (1999 Excluded)

Summary of Option 1: This option has the potential to produces the lowest PNI, lowest Escapement, and lowest total Recruits. Hatchery returns are in excess of what is needed in all years.

OPTION 4. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

Brood Goal	44		
Nason Creek Escapement Goal	542		
Target Extraction Rate	33%		
Conservation Program Size		**82,500**	**33%**
Safety Net Program Size		**167,500**	**67%**

Conservation Program:	SAR (BY1996-2002)		SAR (BY 1989-2002)	
Mean HOR run size:	**660**	0.008	**383.625**	0.00465
Minimum HOR runs size:	**383.625**	0.00465	**29.7**	0.00036
Maximum HOR run size:	**1288.65**	0.01562	**1288.65**	0.01562
Mean HO R Needed	**281**			
Minimum HOR Needed	**26**			
Maximum HOR Needed	**546**			
Mean / Total Escapement	**506**	**5060**		
Mean/ Total Recruits	**386.57**	**3866**		
Mean PNI	**0.64**	**0.68**		

Year	Estimated Nason NOR	Target Extraction	NOB	HOB	pNOB	Theoretical NOS	Theoretical HOS	Total Esc'nt	pHOS	PNI	Est. No. Adult NOR Recruits	2.96E-01 2.00E-03
1999	40	0.333	13	31	0.30	27	515	542	0.95	0.24	393	
2000	237	0.333	44	0	1.00	193	187	380	0.49	0.67	360	
2001	560	0.333	44	0	1.00	516	26	542	0.05	0.95	393	
2002	442	0.333	44	0	1.00	398	132	530	0.25	0.80	391	
2003	411	0.333	44	0	1.00	367	123	490	0.25	0.80	384	
2004	289	0.333	44	0	1.00	245	230	475	0.49	0.67	382	
2005	143	0.333	44	0	1.00	99	443	542	0.82	0.55	393	
2006	208	0.333	44	0	1.00	164	378	542	0.70	0.59	393	
2007	85	0.333	28	16	0.64	57	485	542	0.90	0.42	393	
2008	280	0.333	44	0	1.00	236	239	475	0.50	0.67	382	
Mean	**269**		**39**	**5**	**0.89**	**230**	**276**	**506**	**0.54**	**0.64**	**386.57**	Average (1999 Included)
										0.67996518	**385.83**	Average (1999 Excluded)

Summary of Option 4: This option has the potential to produce the highest PNI, Escapement, and total Recruits, however the conservation program is so small that it may not produce enough hatchery fish to meet escapement and broodstock needs in low return years.

2018 Update

- Updated SARS with most recent 10 years (still Chiwawa)
- Updated NORs at Tumwater – all years
- Updated Broodstock needs
- Re-ran analysis with new safety net splits
  - Nason Only
  - Nason Chiwawa Composite

2018 Update

- Did not use a new prespawn mortality level
- Did not use a new escapement goal (as a result of new prespawn mortality information)
- Did not use new stock-recruit models
- <u>To make the update complete new prespawn mortality rates and resulting escapement goals need to be updated!</u>

Brood Year	Wilds at TWD	NASON Number	NASON Percent	CHIWAWA Number	CHIWAWA Percent	WHITE Number	WHITE Percent	LI'L WENATCHEE Number	LI'L WENATCHEE Percent	WENATCHEE MS Number	WENATCHEE MS Percent	Total wild spawners	% Wild spawners to Tumwater Total	Nason+ Ch Combined
		Wild Spawners in Individual Major Spawning Areas												
1999	173	22	12.8%	88	50.6%	3	1.6%	8	4.8%	0	0.0%	121	0.698	110
2000	651	223	34.3%	263	40.3%	27	4.1%	22	3.3%	31	4.8%	566	0.869	486
2001	2073	294	14.2%	497	24.0%	126	6.1%	95	4.6%	49	2.4%	1,061	0.512	791
2002	1033	347	33.6%	281	27.2%	80	7.7%	96	9.3%	66	6.4%	870	0.842	628
2003	919	193	21.0%	205	22.3%	38	4.1%	26	2.8%	21	2.3%	482	0.525	398
2004	898	297	33.1%	573	63.8%	54	6.0%	39	4.3%	46	5.1%	1,009	1.124	870
2005	594	83	13.9%	140	23.5%	119	20.1%	38	6.4%	9	1.5%	388	0.653	222
2006	573	118	20.6%	116	20.2%	41	7.1%	26	4.5%	6	1.1%	307	0.536	234
2007	324	82	25.2%	157	48.4%	62	19.2%	79	24.3%	9	2.7%	388	1.199	239
2008	631	139	22.1%	196	31.1%	20	3.1%	13	2.1%	0	0.0%	368	0.583	335
2009	777	164	21.1%	305	39.3%	81	10.5%	43	5.6%	0	0.0%	594	0.764	469
2010	880	59	6.8%	416	47.3%	26	3.0%	31	3.5%	3	0.3%	535	0.608	476
2011	1225	252	20.5%	795	64.9%	26	2.2%	71	5.8%	8	0.7%	1,152	0.941	1047
2012	1470	222	15.1%	575	39.1%	89	6.1%	44	3.0%	4	0.2%	934	0.635	797
2013	938	72	7.6%	414	44.2%	45	4.8%	79	8.4%	0	0.0%	610	0.650	486
2014	991	199	20.1%	545	55.0%	48	4.9%	68	6.8%	9	0.9%	869	0.877	744
2015	1177	145	12.4%	404	34.3%	105	8.9%	62	5.3%	28	2.4%	745	0.633	549
2016	927	143	15.4%	410	44.2%	74	7.9%	61	6.6%	4	0.4%	691	0.746	553
2017	499	90	18.1%	191	38.3%	20	4.0%	33	6.6%	12	2.5%	347	0.695	282

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal (Conservation Programs Only - Safety Net Excluded)	74			**Conservation Program:**	SAR (BY2002-2011)		SAR (89-11)	
Nason Creek Escapement Goal	542			**Mean HOR run size:**	**608**	0.004864	**581**	0.00465
NOR Target Extraction Rate	33%			**Minimum HOR runs size:**	**384**	0.003076	**45**	0.00036
Conservation Program Size		**125,000**	**56%**	**Maximum HOR run size:**	**792**	0.006334	**1953**	0.01562
Safety Net Program Size		**98,670**	**0%**		**10 year**	**All**		
		223,670		**Mean HO R Needed**	**429**	**376**		
				Minimum HOR Needed	**139**	**116**		
				Maximum HOR Needed	**557**	**594**		
				Mean / Total Escapement	**503**	5033	**469**	**8744**
				Mean/ Total Recruits	**366**	3795	**365.51**	**6945**
				Mean PNI*	**0.44**		**0.46**	
				***PNI Calcuated for the whole basin may be higher**				

Year	Estimated Nason NOR Run Size at TWD	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	**2.96E-01** / **2.00E-03**
1999	22	0.333	7	67	0.10	15	527	594	542	0.97	Any	0.09	393	
2000	223	0.333	74	0	0.99	149	393	466	542	0.72	0.50	0.58	393	
2001	294	0.333	74	0	1.00	220	220	294	440	0.50	0.67	0.67	375	
2002	347	0.333	74	0	1.00	273	257	257	530	0.48	0.67	0.67	391	
2003	193	0.333	64	10	0.86	129	413	423	542	0.76	0.50	0.53	393	
2004	297	0.333	74	0	1.00	223	222	222	445	0.50	0.67	0.67	376	
2005	83	0.333	28	46	0.37	55	70	116	125	0.56	0.40	0.40	229	
2006	118	0.333	39	35	0.53	79	341	376	420	0.81	0.40	0.40	370	
2007	82	0.333	27	47	0.37	55	70	117	125	0.56	0.40	0.40	229	
2008	139	0.333	46	28	0.63	93	449	477	542	0.83	0.40	0.43	393	
2009	164	0.333	55	19	0.74	109	433	452	542	0.80	0.40	0.48	393	
2010	59	0.333	20	54	0.27	39	503	557	542	0.93	Any	0.22	393	
2011	252	0.333	74	0	1.00	178	364	364	542	0.67	0.50	0.60	393	
2012	222	0.333	74	0	1.00	148	394	394	542	0.73	0.50	0.58	393	
2013	72	0.333	24	50	0.32	48	494	544	542	0.91	Any	0.26	393	
2014	199	0.333	66	8	0.90	133	409	417	542	0.76	0.50	0.54	393	
2015	145	0.333	48	26	0.65	97	445	471	542	0.82	0.40	0.44	393	
2016	143	0.333	48	26	0.64	95	447	473	542	0.82	0.40	0.44	393	
2017	90	0.333	30	44	0.41	60	95	139	155	0.61	0.40	0.40	256	
Mean	**165**		**50**	**23**	**0.69**	**116**	**347**	**376**	**469**	**0.72**		**0.46**	**365.51**	Average All (1999 Included)
10-Year Mean	**149**		**48**	**26**	**0.65**	**100**	**403**	**429**	**503**	**0.79**		**0.44**	**366**	Average Last 10 years

Summary of Option 1: This option has the potential to produces the lowest PNI, lowest Escapement, and lowest total Recruits. Hatchery returns are in excess of what is needed in all years.

Reduced Conservation Program and increased Safety-Net

Brood Goal	59			**Conservation Program:**	SAR (BY2002-2011)		SAR (89-11)	
Nason Creek Escapement Goal	542			**Mean HOR run size:**	**486** 0.004864		**465** 0.00465
Target Extraction Rate	33%			**Minimum HOR runs size:**	**308** 0.003076		**36** 0.00036
Conservation Program Size		**100,000**	**45%**	**Maximum HOR run size:**	**633** 0.006334		**1562** 0.01562
Safety Net Program Size		**123,670**	**55%**		**10 year**	**All**	
		223,670		**Mean HO R Needed**	**422**	**380**	
				Minimum HOR Needed	**209**	**166**	
				Maximum HOR Needed	**542**	**579**	
				Mean / Total Escapement	**512**	5118	**487**	**9118**
				Mean/ Total Recruits	**375**	3849	**375.17**	**7128**
				Mean PNI*	**0.48**		**0.49**	
				***PNI Calcuated for the whole basin may be higher**				

Year	Estimated Nason NOR Run Size at TWD	Target Extraction Rate	NOB	HOB	pNOB	Theoretical NOS	Theoretical HOS	Total	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	2.96E-01 2.00E-03
1999	22	0.333	7	52	0.12	15	527	579	542	0.97	Any	0.11	393	
2000	223	0.333	59	0	1.00	164	378	437	542	0.70	0.50	0.59	393	
2001	294	0.333	59	0	1.00	235	225	284	460	0.49	0.67	0.67	379	
2002	347	0.333	59	0	1.00	288	254	254	542	0.47	0.67	0.68	393	
2003	193	0.333	59	0	1.00	134	408	408	542	0.75	0.50	0.57	393	
2004	297	0.333	59	0	1.00	238	222	222	460	0.48	0.67	0.67	379	
2005	83	0.333	28	31	0.47	55	135	166	190	0.71	0.40	0.40	281	
2006	118	0.333	39	20	0.67	79	463	483	542	0.85	0.40	0.44	393	
2007	82	0.333	27	32	0.46	55	125	157	180	0.70	0.40	0.40	275	
2008	139	0.333	46	13	0.78	93	449	462	542	0.83	0.40	0.49	393	
2009	164	0.333	55	4	0.93	109	433	437	542	0.80	0.40	0.54	393	
2010	59	0.333	20	39	0.33	39	503	542	542	0.93	Any	0.26	393	
2011	252	0.333	59	0	1.00	193	349	349	542	0.64	0.50	0.61	393	
2012	222	0.333	59	0	1.00	163	379	379	542	0.70	0.50	0.59	393	
2013	72	0.333	24	35	0.41	48	494	529	542	0.91	Any	0.31	393	
2014	199	0.333	59	0	1.00	140	402	402	542	0.74	0.50	0.57	393	
2015	145	0.333	48	11	0.82	97	445	456	542	0.82	0.40	0.50	393	
2016	143	0.333	48	11	0.81	95	447	458	542	0.82	0.40	0.49	393	
2017	90	0.333	30	29	0.51	60	180	209	240	0.75	0.40	0.40	310	
Mean	**165**		**44**	**15**	**0.77**	**121**	**359**	**380**	**487**	**0.73**		**0.49**	**375.17**	Average All (1999 Included)
10-Year Mean	**149**		**45**	**14**	**0.76**	**104**	**408**	**422**	**512**	**0.79**		**0.48**	**375**	Average Last 10 years

Summar 2: Increased PNI, Increased escapement, Increased recruitment. In below average years will need to use safety net fish in broodstock and/or spawning grounds (may not be a bad thing).

Reduced Conservation Program and increased Safety-Net

Brood Goal	50			**Conservation Program:**	SAR (BY2002-2011)		SAR (89-11)	
Nason Creek Escapement Goal	542			**Mean HOR run size:**	**413**	0.004864	**395**	0.00465
Target Extraction Rate	33%			**Minimum HOR runs size:**	**261**	0.003076	**31**	0.00036
Conservation Program Size		**85,000**	**38%**	**Maximum HOR run size:**	**538**	0.006334	**1328**	0.01562
Safety Net Program Size		**138,670**	**0%**		**10 year**	**All**		
		223,670		**Mean HO R Needed**	**444**	**426**		
				Minimum HOR Needed	**502**	**509**		
				Maximum HOR Needed	**533**	**570**		
				Mean / Total Escapement	**542**	5420	**535**	**10179**
				Mean/ Total Recruits	**393**	3933	**392.19**	**7452**
				Mean PNI*	**0.50**		**0.52**	
				***PNI Calcuated for the whole basin may be higher**				

Year	Estimated Nason NOR Run Size at TWD	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed From Conservation Program	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	2.96E-01 / 2.00E-03
1999	22	0.333	7	43	0.15	15	527	570	542	0.97	Any	0.13	393	
2000	223	0.333	50	0	1.00	173	369	419	542	0.68	0.50	0.59	393	
2001	294	0.333	50	0	1.00	244	241	291	485	0.50	0.67	0.67	384	
2002	347	0.333	50	0	1.00	297	245	245	542	0.45	0.67	0.69	393	
2003	193	0.333	50	0	1.00	143	399	399	542	0.74	0.50	0.58	393	
2004	297	0.333	50	0	1.00	247	233	233	480	0.49	0.67	0.67	383	
2005	83	0.333	50	0	1.00	33	509	509	542	0.94	0.40	0.52	393	
2006	118	0.333	50	0	1.00	68	474	474	542	0.87	0.40	0.53	393	
2007	82	0.333	50	0	1.00	32	510	510	542	0.94	0.40	0.52	393	
2008	139	0.333	46	4	0.93	93	449	453	542	0.83	0.40	0.53	393	
2009	164	0.333	50	0	1.00	114	428	428	542	0.79	0.40	0.56	393	
2010	59	0.333	20	30	0.39	39	503	533	542	0.93	Any	0.30	393	
2011	252	0.333	50	0	1.00	202	340	340	542	0.63	0.50	0.61	393	
2012	222	0.333	50	0	1.00	172	370	370	542	0.68	0.50	0.59	393	
2013	72	0.333	24	26	0.48	48	494	520	542	0.91	Any	0.34	393	
2014	199	0.333	50	0	1.00	149	393	393	542	0.73	0.50	0.58	393	
2015	145	0.333	48	2	0.97	97	445	447	542	0.82	0.40	0.54	393	
2016	143	0.333	48	2	0.95	95	447	449	542	0.82	0.40	0.54	393	
2017	90	0.333	30	20	0.60	60	482	502	542	0.89	0.40	0.40	393	
Mean	**165**		**43**	**5**	**0.92**	**122**	**405**	**426**	**535**	**0.75**		**0.52**	**392.19**	Average All (1999 Included)
10-Year Mean	**149**		**42**	**8**	**0.83**	**107**	**435**	**444**	**542**	**0.80**		**0.50**	**393**	Average Last 10 years

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal (Conservation Programs Only - Safety Net Excluded)	150 (76 Chiwawa, 74 Nason)			**Conservation Program:**	SAR (BY2002-2011)		SAR (89-11)	
Nason/Chiwawa Escapement Goal	1129			**Mean HOR run size:**	**1308**	0.004864	**1251**	0.00465
NOR Target Extraction Rate	33%			**Minimum HOR runs size:**	**827**	0.003076	**97**	0.00036
Combined Conservation Program Size (125K Nason, 144K Chi		**269,000**	**73%**	**Maximum HOR run size:**	**1704**	0.006334	**4202**	0.01562
Nason Safety Net Program Size		**98,670**	**27%**		**10 year**	**All**		
		367,670		**Mean HO R Needed**	**613**	**702**		
				Minimum HOR Needed	**397**	**397**		
				Maximum HOR Needed	**997**	**1169**		
				Mean / Total Escapement	**1036**	10363	**1074**	**19907**
				Mean/ Total Recruits	**1258**	12536	**1260.93**	**23958**
				Mean PNI*	**0.63**		**0.58**	
				***PNI Calcuated for the whole basin may be higher**				

Year	**Estimated NOR Run Size at TWD - whole basin**	**Target Extraction Rate**	**NOB**	**HOB**	**pNOB**	**Theoretical Escapement NOS**	**HOS**	**Total HOR Needed**	**Total Esc'nt**	**pHOS**	PNITarget	**PNI**	Est. No. Adult NOR Recruits	**3.45E-01** **4.61E-04**
1999	110	0.333	37	113	0.24	73	1056	1169	1129	0.94	Any	0.21	1305	
2000	486	0.333	150	0	1.00	336	793	943	1129	0.70	0.50	0.59	1305	
2001	791	0.333	150	0	1.00	641	209	359	850	0.25	0.80	0.80	1154	
2002	628	0.333	150	0	1.00	478	472	472	950	0.50	0.67	0.67	1214	
2003	398	0.333	133	17	0.88	265	864	881	1129	0.76	0.50	0.54	1305	
2004	870	0.333	150	0	1.00	720	250	250	970	0.26	0.80	0.80	1225	
2005	222	0.333	74	76	0.49	148	981	1057	1129	0.87	Any	0.36	1305	
2006	234	0.333	78	72	0.52	156	973	1045	1129	0.86	Any	0.38	1305	
2007	239	0.333	80	70	0.53	159	970	1040	1129	0.86	Any	0.38	1305	
2008	335	0.333	112	38	0.74	223	906	944	1129	0.80	0.40	0.48	1305	
2009	469	0.333	150	0	1.00	319	810	810	1129	0.72	0.50	0.58	1305	
2010	476	0.333	150	0	1.00	326	803	803	1129	0.71	0.50	0.58	1305	
2011	1047	0.333	150	0	1.00	897	232	232	1129	0.21	0.80	0.83	1305	
2012	797	0.333	150	0	1.00	647	213	213	860	0.25	0.80	0.80	1160	
2013	486	0.333	150	0	1.00	336	793	793	1129	0.70	0.50	0.59	1305	
2014	744	0.333	150	0	1.00	594	535	535	1129	0.47	0.67	0.68	1305	
2015	549	0.333	150	0	1.00	399	401	401	800	0.50	0.67	0.67	1121	
2016	553	0.333	150	0	1.00	403	397	397	800	0.50	0.67	0.67	1121	
2017	282	0.333	94	56	0.63	188	941	997	1129	0.83	0.40	0.43	1305	
Mean	**511**		**127**	**39**	**0.76**	**385**	**679**	**702**	**1074**	**0.62**		**0.58**	**1260.93**	Average All (1999 Included)
10-Year Mean	**574**		**141**	**9**	**0.94**	**433**	**603**	**613**	**1036**	**0.57**		**0.63**	**1258**	Average Last 10 years

Summary of Option 1: This option has the potential to produces the lowest PNI, lowest Escapement, and lowest total Recruits. Hatchery returns are in excess of what is needed in all years.

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal	135 (76 Chiwawa, 59 Nason)			**Conservation Program:**	SAR (BY2002-2011)		SAR (89-11)	
Nason Creek Escapement Goal	1129			**Mean HOR run size:**	**1187**	0.004864	**1135**	0.00465
NOR Target Extraction Rate	33%			**Minimum HOR runs size:**	**750**	0.003076	**88**	0.00036
Combined Conservation Program Size (100K Nason, 144K Chiwawa)		**244,000**	**66%**	**Maximum HOR run size:**	**1545**	0.006334	**3811**	0.01562
Nason Safety Net Program Size		**123,670**	**34%**		**10 year**	**All**		
		367,670		**Mean HO R Needed**	**603**	**691**		
				Minimum HOR Needed	**258**	**1042**		
				Maximum HOR Needed	**982**	**1154**		
				Mean / Total Escapement	**1042**	10418	**1077**	**20007**
				Mean/ Total Recruits	**1262**	12572	**1264.21**	**24020**
				Mean PNI*	**0.64**		**0.59**	

Year	Estimated NOR Run Size at TWD - whole basin	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	HOS	Total HOR Needed From	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	3.45E-01 4.61E-04
1999	110	0.333	37	98	0.27	73	1056	1154	1129	0.94	Any	0.22	1305	
2000	486	0.333	135	0	1.00	351	778	913	1129	0.69	0.50	0.59	1305	
2001	791	0.333	135	0	1.00	656	214	349	870	0.25	0.80	0.80	1166	
2002	628	0.333	135	0	1.00	493	482	482	975	0.49	0.67	0.67	1228	
2003	398	0.333	133	2	0.98	265	864	866	1129	0.76	0.50	0.56	1305	
2004	870	0.333	135	0	1.00	735	235	235	970	0.24	0.80	0.80	1225	
2005	222	0.333	74	61	0.55	148	981	1042	1129	0.87	Any	0.39	1305	
2006	234	0.333	78	57	0.58	156	973	1030	1129	0.86	Any	0.40	1305	
2007	239	0.333	80	55	0.59	159	970	1025	1129	0.86	Any	0.41	1305	
2008	335	0.333	112	23	0.83	223	906	929	1129	0.80	0.40	0.51	1305	
2009	469	0.333	135	0	1.00	334	795	795	1129	0.70	0.50	0.59	1305	
2010	476	0.333	135	0	1.00	341	788	788	1129	0.70	0.50	0.59	1305	
2011	1047	0.333	135	0	1.00	912	217	217	1129	0.19	0.80	0.84	1305	
2012	797	0.333	135	0	1.00	662	213	213	875	0.24	0.80	0.80	1169	
2013	486	0.333	135	0	1.00	351	778	778	1129	0.69	0.50	0.59	1305	
2014	744	0.333	135	0	1.00	609	520	520	1129	0.46	0.67	0.68	1305	
2015	549	0.333	135	0	1.00	414	386	386	800	0.48	0.67	0.67	1121	
2016	553	0.333	135	0	1.00	418	422	422	840	0.50	0.67	0.67	1147	
2017	282	0.333	94	41	0.70	188	941	982	1129	0.83	0.40	0.45	1305	
Mean	**511**		**117**	**30**	**0.80**	**394**	**673**	**691**	**1077**	**0.61**		**0.59**	**1264.21**	Average All (1999 Included)
10-Year Mean	**574**		**129**	**6**	**0.95**	**445**	**597**	**603**	**1042**	**0.56**		**0.64**	**1262**	Average Last 10 years
Summary of 2:		increased PNI, increased escapment, increased recruitment												

Attachment C

Current Program back-cast. Theoretical Nason Creek backcast (1999-2008) of broodstock, escapement, and PNI objectives.

NOR Brood Goal	126 (76 Chiwawa, 50 Nason)			**Conservation Program:**	SAR (BY2002-2011)		SAR (89-11)	
Nason Creek Escapement Goal	1129			**Mean HOR run size:**	**1114**	0.004864	**1065**	0.00465
NOR Target Extraction Rate	33%			**Minimum HOR runs size:**	**704**	0.003076	**82**	0.00036
Combined Conservation Program Size (85K Nason, 144K Chiwawa)		**229,000**	**62%**	**Maximum HOR run size:**	**1450**	0.006334	**3577**	0.01562
Nason Safety Net Program Size		**138,670**	**38%**		**10 year**	**All**		
		367,670		**Mean HO R Needed**	**602**	**687**		
				Minimum HOR Needed	**413**	**1033**		
				Maximum HOR Needed	**973**	**1145**		
				Mean / Total Escapement	**1049**	10493	**1082**	**20132**
				Mean/ Total Recruits	**1266**	12620	**1268.23**	**24096**
				Mean PNI*	**0.64**		**0.60**	
				***PNI Calcuated for the whole basin may be higher**				

Year	Estimated NOR Run Size at TWD - whole basin	Target Extraction Rate	NOB	HOB	pNOB	Theoretical Escapement NOS	Theoretical Escapement HOS	Total HOR Needed From Conservation Program	Total Esc'nt	pHOS	PNITarget	PNI	Est. No. Adult NOR Recruits	3.45E-01 4.61E-04
1999	110	0.333	37	89	0.29	73	1056	1145	1129	0.94	Any	0.24	1305	
2000	486	0.333	126	0	1.00	360	769	895	1129	0.68	0.50	0.59	1305	
2001	791	0.333	126	0	1.00	665	225	351	890	0.25	0.80	0.80	1179	
2002	628	0.333	126	0	1.00	502	473	473	975	0.49	0.67	0.67	1228	
2003	398	0.333	126	0	1.00	272	857	857	1129	0.76	0.50	0.57	1305	
2004	870	0.333	126	0	1.00	744	256	256	1000	0.26	0.80	0.80	1241	
2005	222	0.333	74	52	0.59	148	981	1033	1129	0.87	Any	0.40	1305	
2006	234	0.333	78	48	0.62	156	973	1021	1129	0.86	Any	0.42	1305	
2007	239	0.333	80	46	0.63	159	970	1016	1129	0.86	Any	0.42	1305	
2008	335	0.333	112	14	0.89	223	906	920	1129	0.80	0.40	0.52	1305	
2009	469	0.333	126	0	1.00	343	786	786	1129	0.70	0.50	0.59	1305	
2010	476	0.333	126	0	1.00	350	779	779	1129	0.69	0.50	0.59	1305	
2011	1047	0.333	126	0	1.00	921	208	208	1129	0.18	0.80	0.84	1305	
2012	797	0.333	126	0	1.00	671	229	229	900	0.25	0.80	0.80	1185	
2013	486	0.333	126	0	1.00	360	769	769	1129	0.68	0.50	0.59	1305	
2014	744	0.333	126	0	1.00	618	511	511	1129	0.45	0.67	0.69	1305	
2015	549	0.333	126	0	1.00	423	427	427	850	0.50	0.67	0.67	1154	
2016	553	0.333	126	0	1.00	427	413	413	840	0.49	0.67	0.67	1147	
2017	282	0.333	94	32	0.75	188	941	973	1129	0.83	0.40	0.47	1305	
Mean	**511**		**111**	**25**	**0.82**	**400**	**672**	**687**	**1082**	**0.61**		**0.60**	**1268.23**	Average All (1999 I
10-Year Mean	**574**		**121**	**5**	**0.96**	**452**	**597**	**602**	**1049**	**0.56**		**0.64**	**1266**	Average Last 10 ye

Actual Returns and Surplus

Return Year	Total Run Predicted to Tumwater	NOR Predicted to Tumwater	Basin Target PNI	Actual Total Return to Tumwater (NOR+HOR)	Actual Return to Tumwater (NOR)	HOR Surplussed
2017	5,410	773	**0.67 (0.40)**	1,553	499	382
2016	2,101	752	**0.67 (0.8)**	2,223	927	788
2015	3,851	935	**0.8 (0.8)**	2,951	1,177	290
2014	3,263	931	**0.8 (0.8)**	3,478	991	1,146

Basin NOR run escapment	Basin HOR run escapement	Target PNI based on actual NORs to Tumwater	Wenatchee Basin Actual PNI		Nason NOR run escapment	Nason HOR run escapement	Target PNI based on NORs to Nason	Nason Actual PNI
347	452	0.4	**0.509**		90	80	0.4	**0.52055993**
691	296	0.8	**0.652**		145	32	0.4	**0.740054952**
745	867	0.8	**0.513**		143	38	0.4	**0.697290238**
869	646	0.8	**0.471**		199	90	0.5	**0.320449865**

Summary

- Reducing the program can result in more fish on the spawning grounds (marginally)
- Adjust the escapement goal has greater potential to increase escapement and recruitment – this should be done at the same time or in conjunction with adjustments to the conservation program size
- Need updated prespawn mortality data and habitat capacity info to update the escapement goals
- Composite broodstock was not modeled in 2009 but appears to give us better flexibility in adjusting the conservation program size
- All parties would need to support potentially regular use of safety net fish in broodstock and on spawning grounds.

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
METHOW FIELD OFFICE
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To: Wells HCP Hatchery Committee 16 October, 2018

From: Charlie Snow, Charles Frady, and Michael Humling (USFWS)

Subject: Preliminary Methow Bain spring Chinook escapement and adult management summary.

Spring Chinook Salmon returning to Wells Dam were sampled to collect adult natural origin (wild) fish for broodstock, and to evaluate the age, sex ratio, and stock structure of returning fish. After accounting for 125 wild fish removed for broodstock at Wells Dam, we estimated that 1,122 PUD HORs, 1,051 WNFH HORs, and 638 wild fish were destined for Methow basin spawning grounds based on a total run size at Wells Dam of 5,000 fish. Although the veracity of these estimates are difficult to confirm real-time, they suggested that adult management activities target the removal of all WNFH HORs, and 350 PUD HORs which would yield an expected spawning ground PNI of 0.74 (Busack 3-pop model) as suggested in Table 2 of Permit 18925.

We assumed a 25% pre-spawn mortality (PSM) rate, and surplus adult spring Chinook were removed at the Methow (PUD) and Winthrop (USFWS) hatcheries. An estimated 191 wild fish (PSM) and 1,926 hatchery fish were removed using these methods (Table 1). Subsequent spawning ground surveys estimated an overall escapement of 511 fish including approximately 262 wild fish, 185 PUD HORs, 51 WNFH HORs, and 13 stray HORs (Table 1). Using these observed values, PNI for the Methow basin in 2018 is estimated as 0.62 using the Busack 3-population model. These results are preliminary and assume that all Ad+CWT carcasses were WNFH fish, Ad-only carcasses were Okanogan basin (CCT) fish, and CWT-only carcasses were PUD fish. Carcasses without detectable marks or tags were assumed to be wild. Adult removals reduced the proportion of WNFH HORs by 96% and reduced PUD HORs by 73%. Overall pHOS was reduced from 0.83 (actual run) to 0.49 (spawning grounds).

Table 1. Estimated run and spawning escapement, proportion hatchery origin spawners (pHOS), and Proportionate Natural Influence (PNI) of Methow basin spring Chinook based on preliminary redd counts and an estimated value of 2.06 fish per redd. PSM = Pre-spawn mortality, and SRP = fish removed as surplus.

Group		Run eval est.		Removed			Actual run		Spawning ground		Reduction (%)
		N	%	*N*	%	Method	*N*	%	*N*	%	
Wild		638	0.23	191	0.09	PSM	453	0.17	262	0.51	42.16
PUD HORs		1,122	0.40	501	0.24	PSM+SRP	686	0.26	185	0.36	73.03
WNFH HORs		1,051	0.37	1,425	0.67	PSM+SRP	1,476	0.56	51	0.10	96.54
Stray HORs		0	0.00	0	0.00		13	0.00	13	0.03	0.00
	Total	2,811		2,117			2,628		511		
pHOS()	3-pop PNI	(0.77)	0.74				(0.83)		(0.49)	0.62	

FINAL

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ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: December 20, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the November 15, 2018 HCP Hatchery Committees Conference Call

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held via conference call on Thursday, November 15, 2018, from 9:00 to 11:00 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB's) *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting prespawn mortality modeling results for spring Chinook salmon at an upcoming Hatchery Committees meeting (Item I-A). *(Note: this item is ongoing.)*
- Eric Kinne (WDFW) will ask Mike Ford (Northwest Fisheries Science Center) about the near-term extinction risk for Pacific salmon stocks and killer whales (Item I-A). *(Note: Mike Tonseth will check on this item.)*
- Keely Murdoch will send the conservation program size spreadsheets to the Hatchery Committees (Item I-A). *(Note: this item is ongoing.)*
- Sarah Montgomery will distribute revised (version 2) minutes from the Hatchery Committees October 17, 2018 meeting, which are available for review by Tuesday, November 20, 2018 (Item I-A). *(Note: Montgomery distributed these following the meeting on November 15, 2018.)*
- Deanne Pavlik-Kunkel and Catherine Willard will distribute the Draft Hatchery and Genetic Management Plan (HGMP) Preamble and Addendum for the Wenatchee summer Chinook

salmon program to the Hatchery Committees for a 2-week review (Item II-B). *(Note: Sarah Montgomery distributed this item on November 16, 2018.)*

- Keely Murdoch will research past comingling ratios of coho salmon to spring Chinook salmon at Winthrop National Fish Hatchery (NFH) or other locations (Item II-C).
- Keely Murdoch will provide information about the passive integrated transponder (PIT)-tagging strategy for the coho salmon that will be acclimated at Twisp Pond (Item II-C).

Decision Summary

- The Wells Hatchery Committee approved the Yakama Nation (YN) request, "Acclimate 110,000 coho smolts in the Twisp Acclimation pond in spring 2019," which Sarah Montgomery distributed to the Hatchery Committees on November 15, 2018, as follows: YN, Douglas PUD, Colville Confederated Tribes (CCT), NMFS, WDFW, and U.S. Fish and Wildlife Service (USFWS) approved during the meeting on November 15, 2018 (Item II-C).
- The Wells Hatchery Committee approved via email the transfer of approximately 73,380 surplus Wells Hatchery summer Chinook salmon eggs (2018 sub-yearling program brood) from Wells Fish Hatchery (FH) to Chief Joseph Hatchery on November 19, 2018, as follows: Douglas PUD approved via email on November 16, 2018 and CCT, WDFW, YN, USFWS, and NMFS approved via email on November 19, 2018.

Agreements

- The Wells Hatchery Committee agreed to a 30-day review period for Douglas PUD's 2019 Monitoring and Evaluation Implementation Plan (Item III-A).

Review Items

- Sarah Montgomery sent an email to the Rocky Reach and Rock Island Hatchery Committees on November 16, 2018, notifying them that the Wenatchee summer Chinook salmon HGMP Addenda is available for a 2-week review with edits due to Catherine Willard and Deanne Pavlik-Kunkel by November 30, 2018 (Item II-B).
- Sarah Montgomery sent an email to the Wells Hatchery Committee on November 9, 2018, notifying them that Douglas PUD's Draft 2019 Methow Monitoring and Evaluation Implementation Plan is available for a 30-day review, with edits due to Greg Mackey by December 10, 2018 (Item III-A).

Finalized Documents

- Sarah Montgomery sent an email to the Hatchery Committees on November 5, 2018, notifying them that Douglas PUD's Final 2017 Monitoring and Evaluation Report for the Wells and Methow Hatchery Programs is now available for download from the Hatchery Committees Extranet site.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the October 17, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. Additions were requested as follows:

- Greg Mackey added an item for Douglas PUD's Draft 2019 Monitoring and Evaluation Implementation Plan.
- Catherine Willard added an item for an overage in the Wenatchee steelhead program.

The Hatchery Committees representatives reviewed the revised draft October 17, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments and revisions, which the Hatchery Committees reviewed and addressed. Additional edits were also made. Hatchery Committees representatives asked for more time to review the revised minutes, and Montgomery said she would provide a revised (version 2) draft of the minutes for review, with edits due back by November 20, 2018. (Note: no further edits were received. The revised draft October 17, 2018 meeting minutes were approved via email on December 20, 2018.)

Action items from the Hatchery Committees meeting on October 17, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on October 17, 2018)*:

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).*
  Hillman said one ISAB recommendation he has been considering is the use of Bayesian analysis. He said this would not change how data are currently analyzed in the reporting process but could be an additional analysis that informs the relationship between treatment and controls specifically in regard to estimating the probabilities of effect sizes. Hillman said he could provide an example of this analysis using the Chiwawa program. Todd Pearsons said he is concerned that the likelihood of having a Type 1 error might increase if more tests are

performed on the data. Hillman said the Monitoring and Evaluation Plan discusses Type 1 error and the number of tests performed. He said this can be discussed with Carl Schwarz (Simon Fraser University) if there are further concerns.

- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Mackey said this item is ongoing.
- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).*
  Murdoch said this item is ongoing.
- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting prespawn mortality modeling results for spring Chinook salmon at the November 15, 2018 Hatchery Committees meeting (Item I-A).*
  Mike Tonseth said Andrew Murdoch was not available for this meeting and he will coordinate with Andrew Murdoch to present at a future meeting.
- *Eric Kinne (WDFW) will ask Mike Ford (Northwest Fisheries Science Center) about the near-term extinction risk for Pacific salmon stocks and killer whales (Item II-D).*
  Mike Tonseth said he will check on the status of this item.
- *Keely Murdoch will send the conservation program size spreadsheets to the Hatchery Committees (Item II-E).*
  Murdoch said she is working to clean up the spreadsheets so that they can be distributed.
- *Michael Humling will provide mortality data for spring Chinook salmon that were transferred from Methow Fish Hatchery (FH) to Winthrop National Fish Hatchery (NFH) (Item II-F).*
  Bill Gale said this item is complete. Humling sent the data to Betsy Bamberger via email. Todd Pearsons asked for an explanation of the data. Bamberger said some spring Chinook salmon were transferred from Methow FH to Winthrop NFH and she questioned whether there was a difference in mortality (perhaps due to transport stress) between the transferred fish and those that volunteered to Winthrop NFH. Gale said anecdotal evidence suggests there was higher mortality in the transferred fish, but it is unknown whether the difference is significant or concerning. He said there were 112 fish of Methow origin that were collected at Winthrop NFH and 108 that were transferred from Methow FH to Winthrop NFH. He said it appeared anecdotally that fish sourced from the Methow FH trap had higher fungus rates and were of lower quality, but he is not sure whether there were differences in pre-spawn mortality. Bamberger said approximately 16 fish that were being held at Methow FH were transferred to Winthrop NFH and she questioned whether the majority of the mortality in the Methow-origin fish was a result of those 16 fish that were transferred. She posed this question because staff at Methow FH were experimenting with fungus control techniques (such as salt),

so any data on mortality of those fish after their transfer could inform future treatment strategies. Gale said his impression is that later transfers in general have worse condition, so even if there was higher mortality, it would be hard to tell whether the mortality was due to fungus treatment techniques or the timing of the transfer. Bamberger said staff at both hatcheries will improve communication in future years so that more fish health information can be gained from transfers. Sarah Montgomery said she will forward Humling's summary email to the Hatchery Committees.

II. Joint HCP-HC/PRCC HSC

A. Genetic Monitoring (Tracy Hillman)

Tracy Hillman welcomed Ilana Koch (Columbia River Inter-Tribal Fish Commission) to the call and asked for an update from the geneticist panel. Koch said the geneticist panel is working on the questions posed by the Hatchery Committees. She said they are continuing to share information and draft responses and do not have a set date to report back to the Hatchery Committees with their findings. Hillman asked whether she has any questions for the committees, or the committees have any questions for the geneticists. There were no questions. Hillman asked Koch to please let him know if the geneticists need any further information and to please communicate with him when a draft product will be available, so the committees can schedule a time to discuss it.

B. NMFS Consultation Update (Brett Farman)

Brett Farman thanked the Hatchery Committees for their comments on the draft Environmental Assessment for the Upper Columbia River Steelhead and Summer/Fall Chinook Salmon programs. He said HGMP addenda are complete for these programs and should reflect what is described in the Biological Opinion. He said next, the Environmental Assessment will go out for public comment along with the HGMPs that are ready. He said for the HGMPs that are not complete yet, the next step is review by the Hatchery Committees. Deanne Pavlik-Kunkel said the Wenatchee summer Chinook salmon HGMP was initially approved in 2009 but has been updated to focus solely on the Wenatchee program. She said a preamble has also been added per Emi Kondo's request and there are no other substantial changes to the document. Pavlik-Kunkel said the Wenatchee HGMP and the Priest Rapids fall Chinook salmon HGMP were both sent to Kondo.

Todd Pearsons said the Hatchery Committees are being asked to review the Wenatchee summer Chinook salmon HGMP because it is a shared program with Chelan PUD. He said the Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) will be asked to review the Methow summer Chinook salmon and Priest Rapids fall Chinook salmon HGMPs. Pearsons said the primary change throughout is that each HGMP now addresses a single program. Hillman asked what is the review period for the HGMP? Pavlik-Kunkel said aligning public comment on the HGMP and Environmental Assessment would be ideal; therefore, she requested comments back within 2 weeks of the HGMP being distributed. She said she will coordinate with Catherine Willard to distribute the document for review. She clarified that the content of the HGMP has already been through consultation and is included in the Biological Opinion, so it is unlikely that any major changes will be made based on review. She said the PRCC HSC is required to approve any addenda to HGMPs; therefore, a review period is needed. Farman clarified that the Biological Opinion has already been signed, so the addenda to the HGMP should be approved in its current state—changing the HGMP would reopen consultation. Willard said the Rocky Reach and Rock Island Hatchery Committees are not required to approve HGMP addenda; however, approval by the committees will be tracked as a decision item regardless.

C. Coho Salmon Acclimation at Twisp Pond (Keely Murdoch)

Keely Murdoch welcomed Tom Scribner (YN) to the call to provide additional information about the request to acclimate coho salmon at Twisp Pond. She said YN's coho salmon reintroduction project is ready to begin the natural implementation phase. As part of making this phase successful, YN has been considering acclimating coho salmon in the Twisp Pond, as described in the memorandum, "Request Committee approval to acclimate 110,000 coho smolts in the Twisp Acclimation Pond in spring 2019" (Attachment B), which was distributed to the Hatchery Committees on November 15, 2018. She said the Hatchery Committees have previously approved co-acclimating spring Chinook salmon in the Twisp Pond with steelhead and coho salmon. Specifically, she said the committees approved acclimating Douglas PUD's 37,000 coho salmon with an option to acclimate additional fish. She said the Twisp Pond will not have any coho production component from Douglas PUD in 2019, because that component will start in 2020. She said YN requests approval to acclimate a total of 110,000 coho salmon (YN production only) in the Twisp Ponds in 2019 along with spring Chinook salmon. She said YN and Douglas PUD have discussed this and the density indices would be at a low (i.e., acceptable) range.

Greg Mackey said Douglas PUD staff have discussed the densities and the intent of the Twisp Pond. He said the pond was designed to acclimate 225,000 spring Chinook salmon, so acclimating 110,000 coho salmon plus about 30,000 spring Chinook is well below a density that would be concerning. He said while touring the Twisp Pond and surrounding area, Douglas PUD staff noticed extensive fire damage in the Twisp River Basin, particularly, evidence of fire damage on the high slopes above the Twisp Pond. He cautioned that the Twisp River may have a heavy debris load of mud, ash, and fire debris over the next 5 years (depending on how the landscape recovers), so fish managers should plan for the potential to release fish early if fish health becomes compromised. Mackey said one contributing factor to the concern about debris is Douglas PUD's experience with the Twisp Pond last year. He said a small stream enters the Twisp River above the pond and weir site. A large load of mud from this stream filled a quarter of the pond last spring, which had to be excavated. He said Douglas PUD is interested in working with YN on this acclimation strategy and plans to acclimate the Douglas PUD coho program component there in 2020.

Mike Tonseth asked whether different species of fish were comingled in past instances of multispecies acclimation and whether a barrier net is proposed for this acclimation. Murdoch said a divider net was initially proposed when the Statement of Agreement for Douglas PUD's coho salmon mitigation was approved [note: the SOA states, "…accommodate the YN's actions to modify that pond to allow co-acclimation of coho with spring Chinook and steelhead in a manner that allows the separate release of co-acclimated species."]. She said the Hatchery Committees decided that divider nets were not needed nor desirable for steelhead or spring Chinook, and this may apply to coho as well. She said she envisioned this acclimation as comingled (as previously approved for other species) but the decision to use a divider net is up to the Hatchery Committees and hatchery managers. She said coho and Chinook salmon are much closer in size to each other than the larger steelhead, so there might be less concern about negative interactions. Mackey said when steelhead and Chinook salmon were comingled, staff monitored for fin-nipping and unusual mortality but did not find anything out of the ordinary. He said the intent of the divider described in the original Statement of Agreement was to facilitate releasing fish at different times, not to limit interaction. He said a divider in the pond is difficult to maintain and can complicate release strategies. Without a divider, both species undergo volitional release over the same period—an approach Douglas PUD and YN are both comfortable with. He said WDFW was operating the ponds at the time of comingling Chinook and steelhead, so he assumes WDFW was also comfortable with this approach. Scribner said spring Chinook and coho salmon have been comingled in the backchannel at Winthrop NFH and there were no indications of health or growth issues. Tonseth asked what the ratio was between spring Chinook and coho salmon at Winthrop NFH. Murdoch said she will find that information and distribute it. She said she expects fin-nipping would be more related to the overall density than the ratio of species, and the ratio of species proposed at Twisp Pond is four coho salmon to one spring Chinook salmon.

Regarding ponding, sampling, and release, Murdoch said if the fish are going to be monitored and sampled, more coho salmon will need to be handled than spring Chinook salmon due to the ratio. Tom Kahler asked whether coho salmon are ponded at a smaller size than spring Chinook salmon. Tonseth said spring Chinook salmon are ponded at 15 to 18 fish per pound (fpp) and coho salmon are ponded around 20 to 23 fpp. Tonseth asked what the PIT-tag component of the comingled fish is. Mackey said there will be 5,000 PIT-tagged spring Chinook salmon. Murdoch said she is not sure about the PIT-tagging strategy for the coho salmon, but she will find out and communicate it to the committees. Mackey said there is a PIT-tag reader at the pond outlet. Kirk Truscott asked why the ponding size and release size is the same (15 to 18 fpp) for spring Chinook salmon. Mackey said the river is cold and the fish are only in the pond for approximately 1 month, so they do not grow much. Truscott asked Murdoch and Scribner where the fish would otherwise be reared and released if not at the Twisp Pond. He suggested spreading the production to different areas to protect them from environmental conditions. Murdoch said the coho salmon component at Twisp Pond is new and intended to distribute fish into spawning habitat. She said some of these fish would have been released in the lower (Twisp Pond (owned by the Methow Salmon Recovery Foundation), further downstream, and some perhaps would be released from Winthrop NFH. She said the natural production phase involves increasing the total release in the basin, so some of the production is new. She said acclimation options in the Twisp River are limited for access to spawning habitat; therefore, Twisp Pond is the only proposed location. Truscott asked whether all the spring Chinook salmon are sourced from fish with nondetectable or very low enzyme-linked immunosorbent assay (ELISA) results. Tonseth said yes. Truscott said he is comfortable with the densities proposed. He asked whether Douglas PUD staff will operate the pond. Mackey confirmed. Bill Gale asked whether the Hatchery Committees are being asked to approve this for 2019 only, or for multiple years. Murdoch says the 2015 Statement of Agreement addressing acclimation at Twisp Pond states acclimation can occur with annual approval. The Wells Hatchery Committee approved acclimation of 110,000 coho salmon at Twisp Pond as follows: WDFW, NMFS, CCT, USFWS, Douglas PUD, and YN approved during the meeting on November 15, 2018.

III. Douglas PUD

A. Draft 2019 Monitoring and Evaluation Implementation Plan (Greg Mackey/Tom Kahler)

Greg Mackey said Douglas PUD's Draft 2019 Methow Monitoring and Evaluation Implementation Plan is available for review. He said the draft version distributed to the Hatchery Committees on November 9, 2018, shows highlighted passages where language has been changed from the previous year. He summarized the primary changes as follows:

- Mackey and Charlie Snow (WDFW) updated the steelhead sections to clarify the hatchery data collection and management process.
- The within-hatchery monitoring section about Okanogan steelhead will now only be located in the Grant PUD report instead of in both reports.
- Pilot work to estimate the population in the Twisp River using electrofishing will be analyzed and reported to inform future efforts.

Mackey said while plans are generally available for a 60-day review, Douglas PUD is requesting a 30-day review so that contracting can be completed before January 1, 2019. The Wells Hatchery

Committee agreed to a 30-day review period for Douglas PUD's 2019 Monitoring and Evaluation Implementation Plan. Representatives present said they will email Mackey with approval of the plan (or questions or comments) by December 10, 2018. Tracy Hillman asked whether the implementation plan will be distributed earlier in future years. Mackey said yes.

IV. Chelan PUD

A. Wenatchee Overage (Catherine Willard)

Catherine Willard said there is an overage in the Wenatchee steelhead program, approximately 21,000 excess hatchery-by-hatchery steelhead destined for ponds along Rock Island reservoir. (*Note: Mike Tonseth communicated this overage in an email to the Hatchery Committees on November 2, 2018.*) Willard said Chelan PUD plans to study the effects of temperature regime on early maturation. She said gonadosomatic index (GSI) sampling in spring 2018 showed high maturation rates in steelhead that were held for 1 month after the rest of the program was released. She said approximately 50% of hatchery-by-hatchery steelhead and 36% of wild-by-wild steelhead showed signs of early maturation. Discussions with Barry Berejikian and Chris Tatara (National Oceanic and Atmospheric Administration [NOAA]) and analysis of the temperature profiles yielded a recommendation to apply different temperature regimes to overwintering fish. She said transferring fish to Chiwawa and rearing steelhead on colder water in November may be contributing to early maturation. She said this overage of steelhead presents an opportunity to rear 500 steelhead in each of three different locations at similar densities through early March, then all would be transferred to the Chiwawa Acclimation Facility. These fish will be sampled lethally in June to determine temperature effects on precocial maturation.

Mike Tonseth said he received a few questions about the overage. He summarized that even with the surplus fish being transferred to the Chiwawa Acclimation Facility in March, there are no concerns about rearing densities because the steelhead that are going to be released are all in pond 2. He said WDFW and Chelan PUD are working with staff at the Eastbank Hatchery and Chiwawa Acclimation Facility to determine how to rear the fish at the same densities. A plan will be developed by the time the fish are transferred to Chelan Hatchery next week. Tracy Hillman noted that no vote is required on this item.

Kirk Truscott asked what was the proportion of early maturation fish at each facility in 2018? Willard said the hatchery-by-hatchery fish were reared at Eastbank Hatchery and the wild-by-wild fish were reared at Chelan Hatchery. Both groups were brought to the Chiwawa Acclimation Facility in November and sampled in June. Truscott asked whether growth rates at the two facilities might explain the difference in early maturation. Willard said early maturation is not necessarily linked to growth rate. She said recent research suggests that rearing steelhead in warm water and then transferring them to colder water may contribute to early maturation; however, she is still gathering literature about the mechanisms affecting early maturation. Willard summarized that the plan is to rear three groups of 500 steelhead in three different ponds then transfer them to the Chiwawa Acclimation Facility in March. Lethal sampling would occur in June to determine early maturation. She said Chelan PUD is working on a more comprehensive study plan to share with the Hatchery Committees, but a decision was made quickly to perform this study because the fish will be moved next week. She asked for additional feedback or questions.

Bill Gale asked whether GSI sampling is lethal. Willard confirmed that all the study fish will be lethally sampled. Gale asked what other data will be collected in addition to GSI? Willard said lengths, weights, smolt index, and visual measures of maturation will be collected in addition to GSI. Gale said one additional data collection option is to PIT-tag a portion of fish at the beginning of the study and measure lengths and weights on the PIT-tagged fish throughout the study to match up with GSI results at the end of the study. He said this would provide a robust assessment of how growth and early maturation are linked. He also suggested discussing with NOAA staff whether to incorporate lipid level monitoring (ideally, monthly). Gale said he generally supports the study and would like to see a study plan.

V. HCP Administration

A. Next Meetings

The next Hatchery Committees meetings are on December 19, 2018 (conference call), January 16, 2019 (Grant PUD), and February 20, 2019 (Grant PUD).

VI. List of Attachments

Attachment A	List of Attendees
Attachment B	Memorandum re: Request Committee approval to acclimate 110,000 coho smolts in the Twisp Acclimation Pond in spring 2019

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Betsy Bamberger	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
Mike Tonseth*	Washington Department of Fish and Wildlife
Alf Haukenes	Washington Department of Fish and Wildlife
Brett Farman*	National Marine Fisheries Service
Matt Cooper*	U.S. Fish and Wildlife Service
Bill Gale*	U.S. Fish and Wildlife Service
Tom Scribner*	Yakama Nation
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes
Ilana Koch‡	Columbia River Inter-Tribal Fish Commission

Notes:
* Denotes Hatchery Committees member or alternate
‡ Joined for the joint HCP-HC/PRCC HSC discussion

YAKAMA NATION FISHERIES RESOURCE MANAGEMENT, MCCRP

10 PINEY WOODS ROAD, TWISP, WA 98856; 509-996-9857

Date: 11/5/2018

From: Rick Alford, Mid-Columbia Coho Reintroduction Program (MCCRP), Methow Basin

To: Wells Habitat Compensation Plan Hatchery Committee

RE: Request Committee approval to acclimate 110,000 coho smolts in the Twisp Acclimation pond in spring 2019

The Mid-Columbia Coho Reintroduction Project (MCCRP) plans to begin the Natural Production Implementation Phase (NPIP) in spring of 2019, as described in YN's coho reintroduction Master Plan. To support NPIP, YN is requesting to co-acclimate 110,000 coho in the Twisp pond along-side 30,000 spring Chinook in 2019. The Wells HCP has previously approved co-acclimating DCPUD-NNI coho in the Twisp Pond with an option to acclimate additional coho with annual Hatchery Committee approval (Final Coho NNI hatchery – compensation SOA approved December 16, 2015).

The discontinuation of steelhead acclimation in the pond has freed up additional rearing space. Density indices have been reviewed by DCPUD hatchery managers and would remain low under this request. Size at release for both coho and spring Chinook is expected to be between 15-18 fish per pound. The resulting rearing values for pond loading of 110,000 coho and 30,000 spring Chinook are within safe, conservative parameters, and are calculated in Table 1.

Table 1. Flow and density indices for Twisp pond with 110,000 coho and 30,000 spring chinook at 18 and 15 fish per pound (FPP).

	18 FPP	15 FPP
Lbs per gallon	2.9	3.5
Flow Index	0.53	0.60
Density Index	0.06	0.07

Discussions with DCPUD staff on this matter have been ongoing and it is understood that, due to extreme fire damage the drainage incurred this summer, contingency plans (i.e., early release) may be employed should water quality/sediment loads become a factor. YN will work/coordinate closely with DCPUD staff to ensure both programs' objectives are achieved.

Your consideration on this matter would be greatly appreciated.

Rick Alford
Fisheries Biologist
Yakama Nation

FINAL

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees

Date: January 17, 2018

From: Tracy Hillman, HCP Hatchery Committees Chairman

cc: Sarah Montgomery, Anchor QEA, LLC

Re: Final Minutes of the December 19, 2018 HCP Hatchery Committees Conference Call

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan (HCP) Hatchery Committees meeting was held via conference call on Wednesday, December 19, 2018, from 9:00 to 10:00 a.m. Attendees are listed in Attachment A to these meeting minutes.

Action Item Summary

- Tracy Hillman will review aspects of the Independent Scientific Advisory Board's *Review of Spring Chinook Salmon in the Upper Columbia River* under Hatchery Committees' purview (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A). *(Note: this item is ongoing.)*
- Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting prespawn mortality modeling results for spring Chinook salmon at an upcoming Hatchery Committees meeting (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will send the conservation program size spreadsheets to the Hatchery Committees (Item I-A). *(Note: Murdoch provided the 2018 Sliding Scale and Safety Net Update spreadsheet to the Hatchery Commitees via email on January 3, 2019.)*
- Keely Murdoch will research past comingling ratios of coho salmon to spring Chinook salmon at Winthrop National Fish Hatchery or other locations (Item I-A). *(Note: this item is ongoing.)*
- Keely Murdoch will provide information about the passive integrated transponder (PIT)-tagging strategy for the coho salmon that will be acclimated at Twisp Pond (Item I-A). *(Note: Murdoch provided this update via email to the Hatchery Committees on January 3, 2019.)*

- Sarah Montgomery will obtain approval for the October and November 2018 meeting minutes from NMFS (Item I-A). *(Note: this item is complete; the final versions were distributed on December 20, 2018.)*
- Hatchery Committees representatives will review recommendations provided by the geneticist panel and send any additional questions to Tracy Hillman by January 7, 2019 (Item II-A).
- Sarah Montgomery and Tracy Hillman will compile potential March 2019 conference call dates and send a poll to the Hatchery Committees representatives (Item IV-A). *(Note: Montgomery sent the poll following the meeting on December 19, 2018, requesting feedback by January 4, 2019.)*

Decision Summary

- The Rocky Reach and Rock Island HCP Hatchery Committees approved the Final Wenatchee Summer Chinook Salmon Hatchery and Genetic Management Plan (HGMP) Addendum and Preamble as follows: Chelan PUD, Yakama Nation (YN), Colville Confederated Tribes (CCT), NMFS, WDFW, and U.S. Fish and Wildlife Service (USFWS) approved via email and phone from December 13 to December 20, 2018 (Item I-A). (Note: The PRCC HSC also approved this item.)

Agreements

- There were no agreements besides the decision listed above.

Review Items

- There are no decision items currently available for review.

Finalized Documents

- No items have been recently finalized.

I. Welcome

A. Review Agenda, Review Last Meeting Action Items, and Approve the October 17, 2018 and November 15, 2018 Meeting Minutes (Tracy Hillman)

Tracy Hillman welcomed the Hatchery Committees and asked for any additions or changes to the agenda. Catherine Willard added an item for Tumwater Dam Fishway Maintenance, and Sarah Montgomery suggested scheduling a call in March to discuss broodstock collection protocols. Representatives from NMFS were not in attendance, so Hillman removed the NMFS Consultation Update item.

The Hatchery Committees representatives reviewed the revised draft October 17, 2018 meeting minutes and the revised draft November 15, 2018 meeting minutes. Sarah Montgomery said there are some outstanding comments and revisions, which the Hatchery Committees reviewed and addressed. Additional edits were also made. Both sets of minutes were approved by Hatchery Committees representatives present (Douglas PUD, Chelan PUD, YN, USFWS) and by Mike Tonseth and Charlene Hurst via email. Casey Baldwin (CCT) abstained from approving both sets of minutes.

Action items from the Hatchery Committees meeting on November 15, 2018, and follow-up discussions were addressed *(note: italicized text below corresponds to agenda items from the meeting on November 15, 2018)*:

- *Tracy Hillman will review aspects of the Independent Scientific Advisory Board's (ISAB's) Review of Spring Chinook Salmon in the Upper Columbia River under Hatchery Committees' purview (Item I-A).*
  Hillman said he developed a mixed linear model with both fixed and random effects to analyze data from Before-After-Control-Impact (BACI) designs. He said all the BACI analyses, whether randomized or not, are ready to be analyzed in an analysis of variance (ANOVA) model. He said the next step is to retrieve data for reference streams; however, the National Oceanic and Atmospheric Administration (NOAA) Salmon Population Summary database is not up to date so this might be more complicated than initially expected. He said he will work with Rishi Sharma (NOAA) and others to obtain these data. He said he is also working to review the Monitoring and Evaluation (M&E) Plan and will include the mixed linear models in the plan. He summarized that Bayesian statistics will not be used to analyze programs in the M&E Plan and his work will continue on this topic in 2019.
- *Greg Mackey will continue researching whether to include age-3 males in broodstock and discuss it with Craig Busack (National Marine Fisheries Service [NMFS]; Item I-A).*
  Mackey said this item is ongoing. He said broodstock collection protocols will soon be a topic of discussion again and incorporating age-3 males in broodstock can be discussed in the context of Broodstock Protocol development. He said that while there is a desire to minimize the effects of spawning age-3 fish in a hatchery program due to the possibility of increasing the rate of early returning fish in some programs, particularly small conservation programs, whether to include age-3 fish in the broodstock needs to be considered. He said from a pragmatic standpoint, some programs sometimes have difficulty meeting broodstock collection targets for natural-origin fish. In those cases, he posed the discussion topic, would it be preferable to incorporate into the broodstock a natural-origin age-3 male or a hatchery-origin male that has spent more than 1 year at sea? He said it would seem advantageous to incorporate natural-origin age-3 males instead of using hatchery-origin fish, particularly when a small program is only one or two male broodstock short in some years. Todd Pearsons

suggested discussing a sliding scale for incorporating age-3 males in broodstock. He said in years with many fish returning, there is more opportunity to reject fish that are less desirable for program goals, but in years with fewer returning natural-origin fish, more age-3 males would likely be incorporated to meet targets such as proportionate natural influence (PNI).

- *Keely Murdoch will provide coho salmon broodstock collection protocols to Mike Tonseth by late February or early March 2019 for inclusion in the 2019 Broodstock Collection Protocols (Item I-A).* Murdoch said this item is ongoing.
- *Mike Tonseth will coordinate with Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) regarding presenting prespawn mortality modeling results for spring Chinook salmon at an upcoming Hatchery Committees meeting (Item I-A).*
  Hillman said this item is ongoing. Todd Pearsons asked for an update on discussing the size of hatchery programs. Keely Murdoch and Tracy Hillman both said they will follow up on this.
- *Eric Kinne (WDFW) will ask Mike Ford (Northwest Fisheries Science Center) about the near-term extinction risk for Pacific salmon stocks and killer whales (Item I-A).*
  Mike Tonseth provided an email update regarding this item on December 17, 2018.
- *Keely Murdoch will send the conservation program size spreadsheets to the Hatchery Committees (Item I-A).*
  Murdoch said this item is ongoing.
- *Sarah Montgomery will distribute revised (version 2) minutes from the Hatchery Committees October 17, 2018 meeting, which are available for review by Tuesday, November 20, 2018 (Item I-A).*
  Montgomery said this item is complete.
- *Deanne Pavlik-Kunkel and Catherine Willard will distribute the Draft Hatchery and Genetic Management Plan (HGMP) Preamble and Addendum for the Wenatchee summer Chinook salmon program to the Hatchery Committees for a 2-week review (Item II-B).*
  This item is complete. Tracy Hillman said the HGMP Preamble and Addenda has been approved by all parties except NMFS. Sarah Montgomery said she will follow up with Charlene Hurst to obtain approval of this item.
- *Keely Murdoch will research past comingling ratios of coho salmon to spring Chinook salmon at Winthrop National Fish Hatchery (NFH) or other locations (Item II-C).*
  Murdoch said this item is ongoing.
- *Keely Murdoch will provide information about the passive integrated transponder (PIT)-tagging strategy for the coho salmon that will be acclimated at Twisp Pond (Item II-C).*
  Murdoch said this item is ongoing.

II. Joint HCP-HC/PRCC HSC

A. Genetic Monitoring (Tracy Hillman)

Tracy Hillman said the Hatchery Committees received recommendations from the geneticist panel on December 10, 2018 in a document titled, "Response to questions posed by the HCP Hatchery Committee regarding the PUD M&E Plan" (Attachment B). Hillman suggested the Hatchery Committees representatives review the recommendations and discuss genetic monitoring again in January. He asked if there are any initial questions or comments.

Greg Mackey said he understands the geneticists' feedback is that the M&E Plan is relatively comprehensive and they recommend a few additional monitoring pieces, some of which are already being done (like relative reproductive success studies). He said one question the geneticists did not address is about effect size and what is biologically important. He said the geneticists reported that effect size is situation specific and it is not clear what would be needed to estimate effect size in all scenarios. Mackey said this is one piece the committees might want to discuss further with the geneticists. He said the geneticists also brought up conducting genetic risk assessments on key populations or programs of interest. They state it can be done, but not how to do it. Mackey suggested genetic risk assessments as another area for further discussion.

McLain Johnson said he appreciates the thoughtful feedback from the geneticists. He said their suggestion to measure linkage disequilibrium stood out to him. He said emerging technology is making linkage disequilibrium easier to measure within hatcheries. He said this metric could be formalized and incorporated into monitoring for upper Columbia hatchery programs if others agree. Mackey said estimates of linkage disequilibrium were generally used in previous M&E reports to determine if populations are within Hardy-Weinberg equilibrium. He said linkage disequilibrium is an analysis, so it would not necessarily take extra sampling or loci analysis to complete.

Todd Pearsons said he has not looked at the previous M&E plans recently, but he recalls that linkage disequilibrium was performed on natural-origin but not hatchery-origin fish. If that is the case, incorporating this analysis to hatchery programs could double tissue sampling efforts.

Casey Baldwin said his takeaway from reading the recommendations is that the current status of genetic monitoring is close to adequate. He said he looks forward to completing genetic analyses for the next 10-year report.

Hillman proposed that the Hatchery Committees representatives review the recommendations and provide any follow-up questions to him by January 7, 2019. Then, he can pass along the questions and coordinate with the geneticists for potentially discussing these questions at the January 16, 2019

Hatchery Committees meeting. Representatives present said they will review the plan and provide questions to Hillman.

III. Chelan PUD

A. Tumwater Dam Fishway Maintenance in 2019 (Catherine Willard)

Catherine Willard said results from recent snorkel surveys around Tumwater Dam show that undercutting and erosion is occurring under the fishway. She said to address these issues, Chelan PUD plans to drive piles into the structural foundation and fill voids with grout. She said the work will be available for contractors to bid on soon and she expects the work will be completed by the end of February 2019. She said while maintenance is occurring, the fishway will be operational and open for fish passage. However, disturbance from the maintenance may influence fish behavior and their desire to move over the fishway. She said the work is intended to be completed before steelhead start passing the dam in large numbers. There were no questions or comments.

IV. HCP Administration

A. Next Meetings

Hillman asked the Hatchery Committees whether they want to schedule an additional conference call in March to potentially discuss broodstock collection protocols. Representatives present assented and began discussing potential dates. Hillman said he and Sarah Montgomery will send a poll to schedule the additional meeting.

The next Hatchery Committees meetings are on January 16, 2019 (Grant PUD), February 20, 2019 (Grant PUD), potential March conference call (date TBD), and March 20, 2019 (Grant PUD).

V. List of Attachments

Attachment A	List of Attendees
Attachment B	Geneticist Panel Recommendations (Response to questions posed by the HCP Hatchery Committee regarding the PUD M&E Plan)

Attachment A
List of Attendees

Name	Organization
Tracy Hillman	BioAnalysts, Inc.
Sarah Montgomery	Anchor QEA, LLC
Catherine Willard*	Chelan PUD
Tom Kahler*	Douglas PUD
Greg Mackey*	Douglas PUD
Betsy Bamberger	Douglas PUD
Todd Pearsons‡	Grant PUD
Peter Graf‡	Grant PUD
Deanne Pavlik-Kunkel‡	Grant PUD
McLain Johnson	Washington Department of Fish and Wildlife
Matt Cooper*	U.S. Fish and Wildlife Service
Keely Murdoch*	Yakama Nation
Casey Baldwin*	Colville Confederated Tribes

Notes:
* Denotes Hatchery Committees member or alternate
‡ Joined for the joint HCP-HC/PRCC HSC discussion

Response to questions posed by the HCP Hatchery Committee regarding the PUD M&E Plan

December 10, 2018

Prepared by:

Ilana Koch (Columbia River Inter-Tribal Fish Commission)

Shawn Narum (Columbia River Inter-Tribal Fish Commission)

Morgan Robinson (NOAA Fisheries)

Todd Seamons (Washington Department of Fish and Wildlife)

Christian Smith (U.S. Fish and Wildlife Service)

The questions posed by the HCP are written below, along with consensus responses from the authors of this response (in blue).

Are the long-term M&E Objectives and questions in the PUD M&E plan appropriate to evaluate the effects of hatchery programs on the genetics of natural-origin fish? If not, how should they be changed?

Objective 7 (population genetics) and Objective 8 (domestication effects on phenotypic traits), and associated Monitoring Questions, are appropriate to evaluate the effects of hatchery programs. We recommend two additional Monitoring Questions:

1) Is linkage disequilibrium (LD) in the hatchery fish similar to that of naturally produced fish? LD is a measure of increased inbreeding / family structure which changes in hatchery populations over time. Since LD will generally change faster than allele frequencies in response to culture practices, adding LD to the standard parameters would provide an earlier indication of genetic change.
2) Is reproductive success of naturally-spawning hatchery-produced fish similar to that of naturally-produced fish? Estimating Relative Reproductive Success (RRS) allows for direct estimation of effects of hatchery rearing on fitness of hatchery-produced fish. This can be approached by comparing the average offspring number of hatchery-origin fish to that of natural-origin fish in systems where parentage analysis might be possible (e.g., those where dams or weirs allow for sampling most or all of the spawners). We understand that evaluating RRS is difficult, but we believe it should be done when possible.

What are the best standardized practices (e.g., standard of care) for long-term genetics monitoring (e.g., phenotype measurements such as age-at-maturity, genetic indices such as PNI, stray rate, population size, genotype measurements using tissues, combination of methods)?

There are no official standards and guidelines for long-term genetics monitoring of hatchery production, but we are in agreement that the practices outlined in the PUD M&E Plan are appropriate and, with the identified additional Monitoring Questions, fairly comprehensive. In the upper Columbia Basin are a large group of programs with divergent objectives, goals, methods of operation, and associated risks. We expect that an efficient approach would be to define a basic set of parameters that would be measured across all programs, and then specific parameters which might need to be added based on the needs of individual programs. Under such a scenario, we think that the metrics outlined in the PUD M&E Plan, with the addition of recommended Monitoring Question #1 above, constitutes a core set of standardized practices for all programs.

Ideally, the HCP would conduct genetic risk assessments of each individual program to determine whether additional monitoring is necessary. If this is not feasible, then perhaps programs for which the HCP or its partners have identified specific genetic risks to the hatchery populations or adjacent naturally spawning populations could be the subjects of specific risk assessments. A workshop with the HCP and Genetics Group might be a useful forum for developing criteria that could be used to assess and rank factors associated with risk. Ideally, the criteria could then be presented to and discussed with the broader conservation genetics community prior to being applied. For programs determined to have higher risk, additional monitoring recommendations could be provided by the genetics group.

Are genetic analyses of tissues necessary for long-term genetic monitoring or are other approaches sufficient (e.g., monitoring indices that are common requirements of ESA permits)?

Genetic analysis of tissues is necessary for long-term monitoring of hatchery populations. DNA analysis substantially improves our ability to detect genetic changes in hatchery and naturally-spawning populations. Changes in allelic frequencies, genetic distance between populations, or the presence of genetically identified hybrids can indicate that fish dispersing from a hatchery program to natural spawning grounds are affecting the genetic integrity of natural populations. These indicators can signal that changes to a hatchery program are necessary and/or that increased monitoring of the affected population(s) is warranted.

Approaches that do not require analysis of tissues may provide additional useful information, and may be required for addressing specific management information needs, but biological interpretation of the results of these approaches is less clear. Proportionate Natural Influence (PNI; Paquet et al. 2011), for example, a commonly used monitoring index intended to measure negative effects of hatchery-production on wild fish populations, is useful in theory, but has yet to be empirically connected to fitness effects and its precision and accuracy are unknown. More importantly, PNI is limited in its inference. If we used only PNI (or other non-DNA based indices), we could not distinguish, for example, environmental from genetic effects. That said, it may be **sufficient** to use non-DNA indices for monitoring low-risk hatchery programs. However, programs determined to have higher risk should include DNA analysis to evaluate genetic effects on the natural population over time.

If genetic analyses of tissues are necessary, please address the following questions:

Are there standardized approaches for using genotypes to monitor and manage the effects of hatchery programs on natural-origin populations (e.g., estimates of genetic distance)?

As stated above, we are not aware of a single set of standardized approaches to M&E for hatcheries in general. We believe that the PUD M&E Plan, as written, encapsulates most of the commonly used approaches, and would thus be an appropriate strategy to apply across a number of programs. We have recommended adding two Monitoring Questions, which cover minor gaps in approaches.

It is also important to point out that the effect of a hatchery program on the naturally spawning population will likely be dependent on the type of program in place (i.e. integrated versus segregated). The expectation is that genetic divergence from the natural population will be minimal in an integrated program compared to a segregated program. Therefore, genetic monitoring of fully segregated populations might benefit from more frequent sampling efforts.

What level of genetic change is biologically significant and can that level of change be detected sufficiently using genetic methods?

The term "biologically significant" is too broad and vague for this question to be answered as it is written. We expect that this is no different than would be the case if the word "genetic" in the question was replaced with "ecological" or "environmental", for example. A related question that can be addressed more broadly is one of statistical significance (e.g., Waples 2006), but we expect that addressing this question in a meaningful way that can be applied to management or conservation will require specific biological context of each case.

Is a fixed interval for genetic processing analysis (e.g., 10 years) better than an interval based upon population characteristics such as population size (e.g., population sizes of <100 every 5 years, 100-500 every 10 years, and >500 every 20 years)? What is the most appropriate sampling interval?

This question conflates two ideas – the time it takes for change to occur and how much change may occur in a given amount of time, and it is obviously related to your question of biological significance. Genetic changes occur on a generational timescale regardless of population size. Population size is related to how much genetic drift to expect from one generation to the next. For example, a large population (if effective population size is also large) would likely experience very little genetic drift from one generation to the next. Is that small amount of drift "biologically significant"? Is it significant (i.e., important) enough to sample every one or two generations? These really are excellent questions without clear-cut answers.

Often the trends are what is important rather than any one individual point estimate. Are changes (positive or negative) occurring? Ten years is currently called for in the M&E plan. An optimal design would include collections of samples that would facilitate 1) detection of temporal structure within populations or localities, and 2) changes in structure among populations over time. Number one requires collection of samples representing all returning spawn years, or cohorts, within a generation. For example, samples from a hatchery program or naturally-spawning population would be taken in three to five consecutive years, depending on the biology of the species. Number two requires that sampling be repeated at approximately two to four generation (8-20 year) intervals. Ideally, all sampling of a given species would occur in the same calendar or spawn year, which would facilitate comparison among populations and programs, and allow comparison of local versus system-wide patterns.

What samples (e.g., samples from juveniles or adults or both) and how many (sample size) should be collected and processed to determine hatchery effects on natural-origin genotypes (e.g., collect and process samples every 10 years, collect samples annually and analyze annual samples representationally over a specified period)?

The questions being asked should be used to determine which life-history stage should be collected. The metrics described in the PUD M&E Plan require an assumption that samples are representative of the populations from which they are taken. In practice, which life-history stage provides the most confidence that this assumption is being met will vary by population or species based on biology and on our ability to collect samples from a large enough pool of individuals. Our general recommendation would be to collect samples from adult returns where possible, and collect samples from juveniles (i.e., any young life stage in freshwater; fry, parr, smolts) 1) as required to provide confidence that the assumption above is being met, and 2) to address program-specific questions that need to be addressed.

The number of individuals in a sample will (in addition to contributing to our confidence in the assumption above) determine statistical power and resolution for several metrics described in the PUD M&E Plan. Because power and resolution depend not only on sample size, but also on effect size, the specific metric being calculated, and the marker panel being used for genotyping, no single number could be justifiably recommended for all programs covered by the PUD M&E Plan. This is a common issue for population genetic studies in general, not just those of population monitoring. In an ideal world, the appropriate number of samples would be tailored to the population(s) being studied and the questions being asked given the marker panel being used. Because we often lack critical information on the population(s), population/conservation geneticists routinely choose somewhat arbitrary sample numbers for analysis, often based on laboratory processing efficiency. If a single target number of samples is required, then our recommendation for the basic plan, based on laboratory processing efficiency, would be 46 or 94 per putative population or cohort. We believe these numbers are large enough to accurately estimate allele frequencies, especially for SNP markers, but small enough as to be tractable in the field. To get a more definitive and statistically defensible number would require certain knowledge of the marker panel to be used, some at least preliminary knowledge of baseline levels of genetic diversity among populations at those markers, and extensive modeling (including simulations), for each species and hatchery program. Work of this nature and of this extent is beyond the purview of this review.

Literature Cited

Paquet, P. J., Flagg, T. , Appleby, A. , Barr, J. , Blankenship, L. , Campton, D. , Delarm, M. , Evelyn, T. , Fast, D. , Gislason, J. , Kline, P. , Maynard, D. , Mobrand, L. , Nandor, G. , Seidel, P. and Smith, S. (2011), Hatcheries, Conservation, and Sustainable Fisheries—Achieving Multiple Goals: Results of the Hatchery Scientific Review Group's Columbia River Basin Review. Fisheries, 36: 547-561.

Waples, R. S., and Gaggiotti, O. (2006) What is a population? An empirical evaluation of some genetic methods for identifying the number of gene pools and their degree of connectivity. Molecular Ecology, 15(6):1419-1439.

Appendix C
Habitat Conservation Plan Tributary Committees 2018 Meeting Minutes

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 11 January 2018

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator). Jenni Novak (WDFW), Aaron Penvose (Trout Unlimited), Shawn Stanley (WDFW), Denny Rohr (PRCC Habitat Subcommittee Facilitator), and Dave Duvall (Grant PUD) joined the meeting for the presentation on the Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screens.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 11 January 2018 from 10:00 am to 1:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 9 November 2017 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Clear Creek Fish Passage and Instream Flow Project – The sponsor (Trout Unlimited; TU) is preparing to re-advertise the construction work. The sponsor is also working with the landowner to secure an additional $40,000-$50,000 for the project.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) is working on the bid package. The sponsor has prepared three proposals hoping to secure funds to close the gap in Phase 1 of the project.
- Icicle Boulder Field Project – The sponsor (TU) facilitated a review of the geotech report with the engineers and provided comments back to the consultant. In addition, the sponsor, working with the Upper Columbia Salmon Recovery Board, facilitated a meeting with the Action Agencies to discuss project implementation and how to best encourage support from the Icicle-Peshastin Irrigation District and the City of Leavenworth. The meeting was productive and led to decision targets.

- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – The sponsor (Washington Department of Fish and Wildlife; WDFW) will submit the second-year monitoring report on work conducted in 2017.
- Permitting Nutrient Enhancement Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) did not provide an update this month.
- Burns-Garrity Design Project – The sponsor (CCFEG) did not provide an update this month.
- Beaver Fever Project – The sponsor (TU) reported there was no new activity on this project.
- Wenatchee Sleepy Hollow Floodplain Acquisition Project – The sponsor (Chelan-Douglas Land Trust; CDLT) reported there was no new activity on this project.
- M2 Mid-Sugar Acquisition Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported there was no new activity on this project.

IV. Review of Tributary Committees' Policies and Procedures

Policies and Procedures for Funding Projects

The Committees reviewed their Policies and Procedures document and made edits to clarify language in Sections 3.2 (General Salmon Habitat Program), 3.6 (Permits), 4.2 (Eligible Projects and Elements), 6.5 (Site Inspections), 6.7 (Project Reimbursements). In addition, the Committees rearranged some sections to reflect a more logical order.

Tributary Committee Operating Procedures

The Committees reviewed and updated their operating procedures. Chelan PUD designated Catherine Willard as their voting member and Scott Hopkins as the alternate on the Rock Island and Rocky Reach Tributary Committees. The Yakama Nation designated Brandon Rogers as the alternate on all three committees.

V. General Salmon Habitat Program Proposal

Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screens Project

The Committees received a General Salmon Habitat Program proposal from Washington Department of Fish and Wildlife titled: *Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screen Project*. In addition, Jenni Novak, WDFW, with support from Shawn Stanley, WDFW, and Aaron Penvose, TU, gave a presentation to the Committees regarding the screening project (see Attachment 1). The purpose of this project is to bring both the Icicle-Peshastin Irrigation District and City of Leavenworth screens into compliance to protect all fish species and life stages from injury, entrainment, and mortality. The diversions are located at RM 5.8 on Icicle Creek. The proposed work will complement the Icicle Creek – Boulder Field – Wild Fish to Wilderness Project. The total cost of the screening project is $2,468,000. The sponsor requested $476,000 from HCP Plan Species Account Funds.

Although the Committees support fish passage at the boulder field and screening the intakes, they found the application incomplete and requested that the sponsor provide the following information:

1. IPID and the City of Leavenworth need to demonstrate that they are financially committed to the project by covering at least 25% of the overall project cost. Their contribution can be "in-kind" (contributing workers, equipment, etc.) or dollars or both. Regardless of the form of contribution, the Committees would like to see IPID and the City's contributions as line-items in the budget.
2. There can be no strings attached to the funding and implementation of the screening project. That is, in their letter of support, IPID stated: "This agreement would have to have an incidental take permit and hold harmless agreement to cover our continued diversion with our current screens

until our new screens are constructed at no cost to the Districts." This is unacceptable and for the Committees to consider funding the screening project, they would need a letter from IPID stating that installation of the screens is not contingent on any other agreements.

Once the Committees receive the additional information, they will reevaluate the proposal.

VI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from November to January:

   Rock Island Plan Species Account:

   - $162.50 to Clifton Larson Allen for Rock Island financial administration in November 2017.
   - $21,600 to Chelan County Natural Resources Department for the Poison Canyon Restoration Project. This was the final payment request.
   - $78.00 to Clifton Larson Allen for Rock Island financial administration in December 2017.
   - $360.69 to Chelan County PUD for project coordination and administration during the fourth quarter of 2017.

   Rocky Reach Plan Species Account:

   - $162.50 to Clifton Larson Allen for Rocky Reach financial administration in November 2017.
   - $78.00 to Clifton Larson Allen for Rocky Reach financial administration in December 2017.
   - $361.50 to Chelan County PUD for project coordination and administration during the fourth quarter of 2017.

   Wells Plan Species Account:

   - $275.89 to Chelan County PUD for project coordination and administration during the fourth quarter of 2017.
   - $4,979.94 to Trout Unlimited for the MVID Instream Flow Improvement Project.
2. Tracy Hillman reminded the Committees that the Upper Columbia Science Conference, which is hosted by the Upper Columbia Salmon Recovery Board, will be on 24 and 25 January 2018 in Wenatchee.
3. Tracy Hillman reported that he and Becky Gallaher completed Section 2.3 (Tributary Committees and Plan Species Accounts) for the Annual Report of Activities under the Anadromous Fish Agreement and Habitat Conservation Plan for each hydroelectric project. Tracy said he sent the draft reports to Anchor QEA, who is compiling the draft annual reports. The draft reports will be sent to the HCP Coordinating Committees for review. The PUDs will submit the final reports to the Federal Energy Regulatory Commission in April.
4. Last year, members of the Committees began identifying possible funded projects they would like to visit. Given the long list of possible projects that the Committees generated last year, Tracy Hillman asked each member to identify five projects they would like to visit. Tracy will then compile the list and the Committees will select projects to tour in 2018. The tour is to take no

more than two days (one day for Okanogan/Methow projects and one day for Entiat/Wenatchee projects).

5. Tracy Hillman said the Tributary Committees will continue to meet on the second Thursday of each month in 2018. Those meeting dates are as follows:

- Jan 11
- Feb 8
- Mar 8
- Apr 12
- May 10
- Jun 14
- Jul 12
- Aug 9
- Sep 13
- Oct 11
- Nov 8
- Dec 13

VII. Next Steps

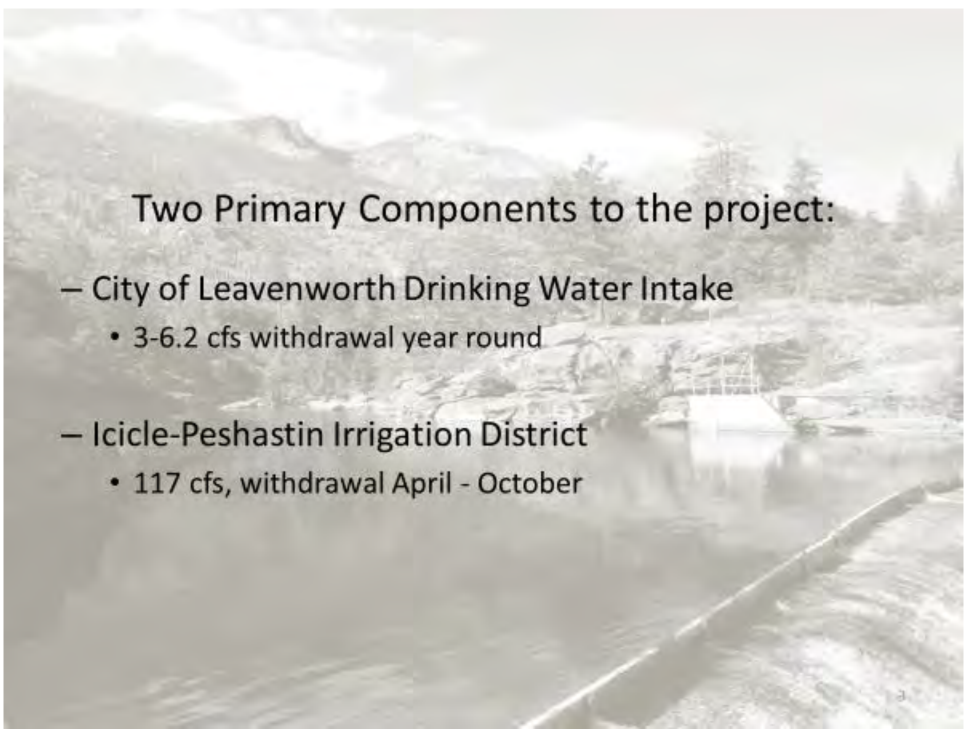
The next meeting of the Tributary Committees will be on Thursday, 8 March 2018 at Grant PUD in Wenatchee. The Committees will not meet in February.

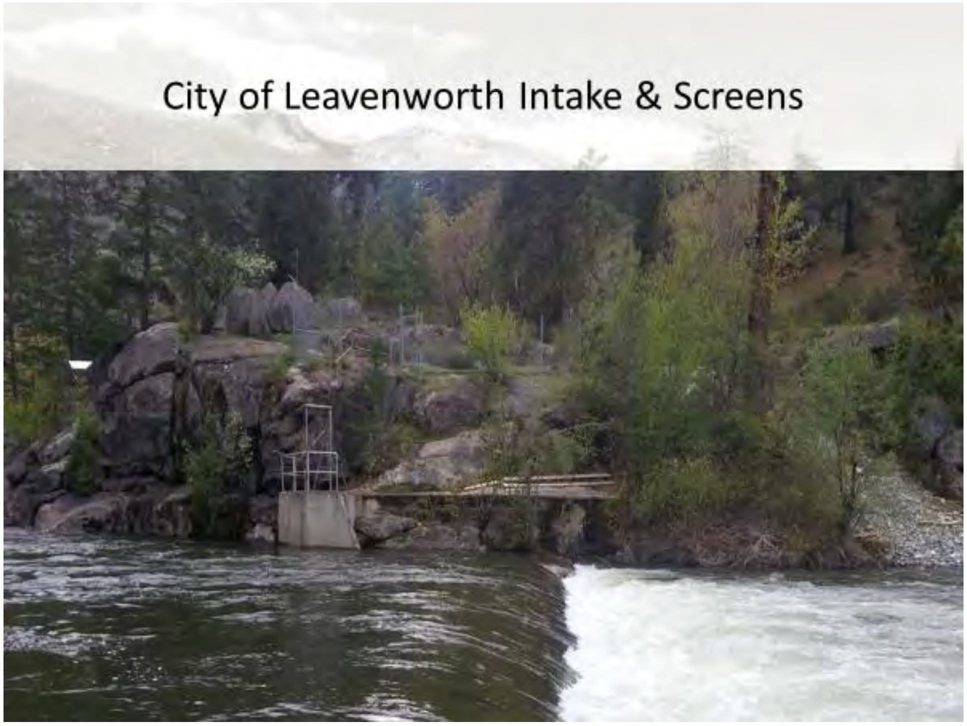
Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

Presentation by Jenni Novak on the Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screens


Tumwater Mountain
Leavenworth Ski Hill
SOUTH Leavenworth
Icicle Ridge
Sleeping Lady Resort
Snow Lakes Trailhead
Vicinity Map


Two Primary Components to the project:
– City of Leavenworth Drinking Water Intake
• 3-6.2 cfs withdrawal year round
– Icicle-Peshastin Irrigation District
• 117 cfs, withdrawal April - October


City of Leavenworth Intake & Screens

City Progress

- Survey and preliminary hydraulic modeling complete
- 3 Options proposed to the City at an on-site meeting in November
  - Two configurations at the existing intake/point of diversion
    - Incorporated into the wingwall – most risk of damage to screen & components and likely most expensive approach to construct and maintain
    - Behind intake bay wingwall – more protected, moderate difficulty for construction, medium for install and maintenance costs
  - One configuration in-line or in an existing structure down the transmission line
    - Easier construction and permitting, reduced construction and maintenance costs, and will reduce icing issues compared to the first two options

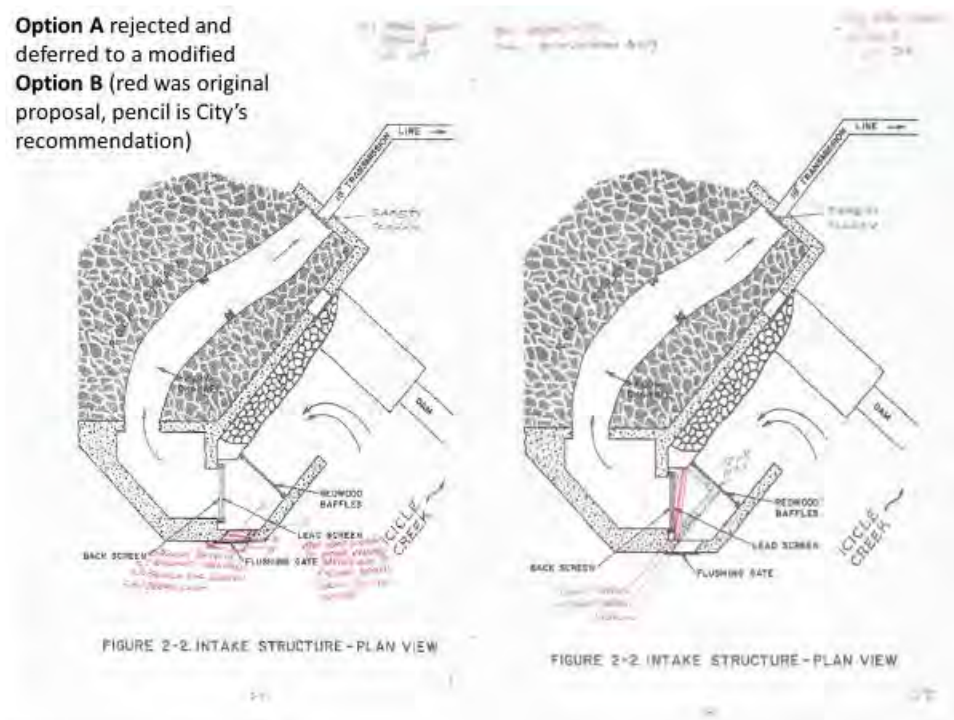
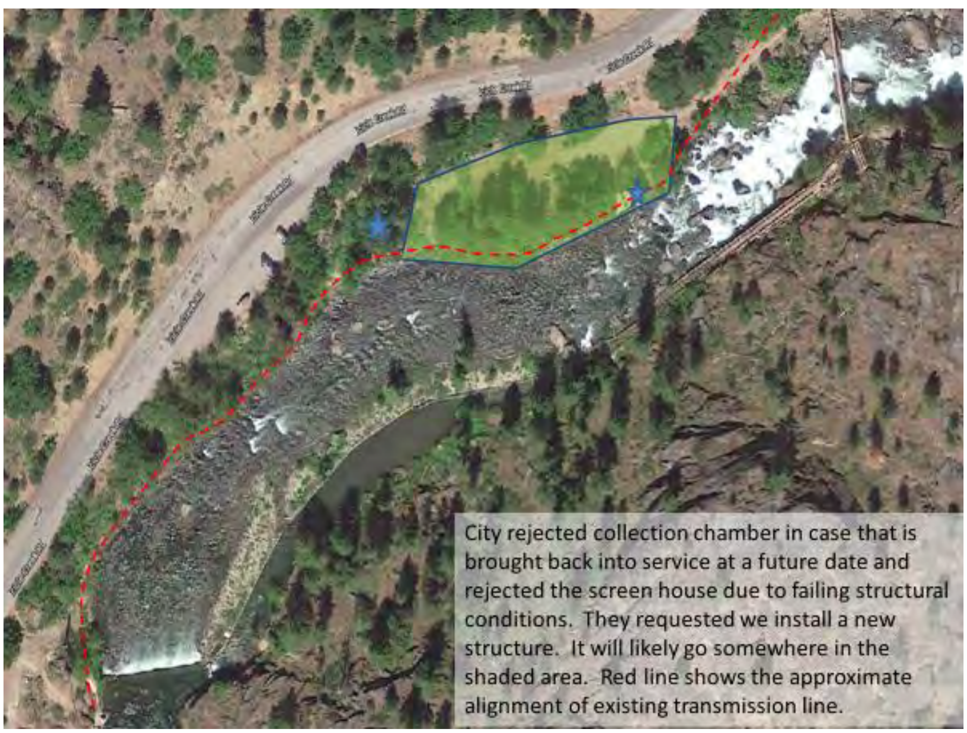
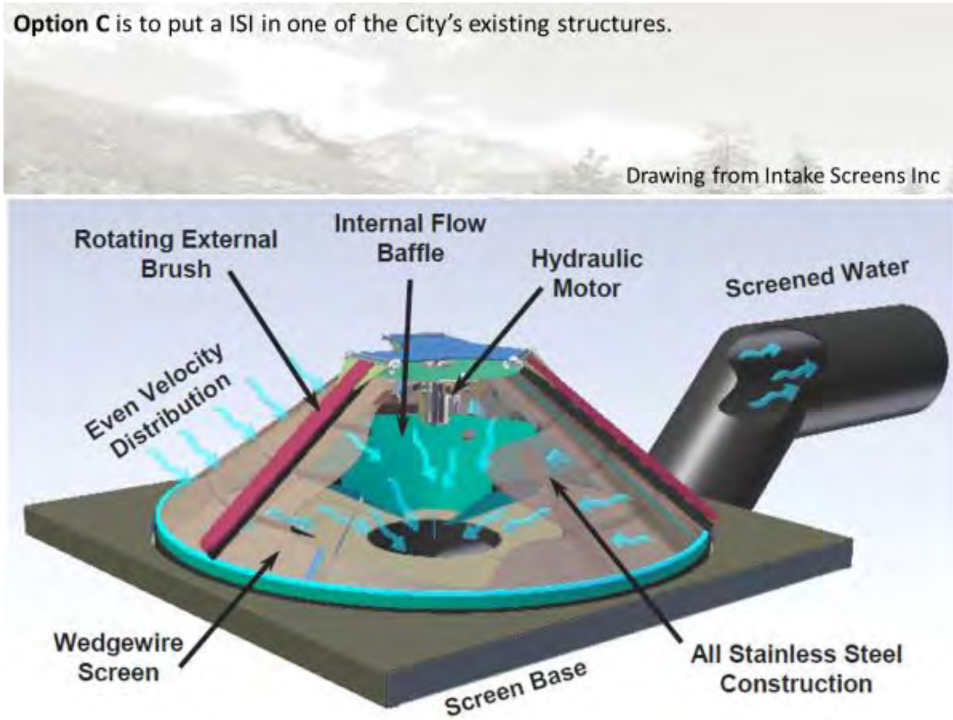


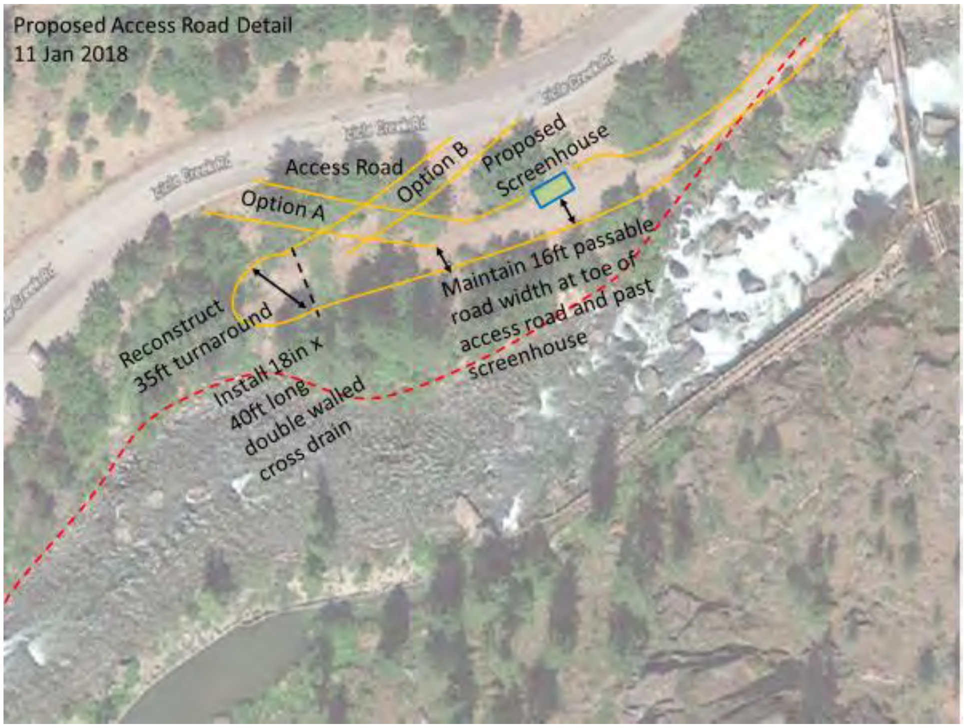
Photo from IntegriTech report Collection Chamber C3

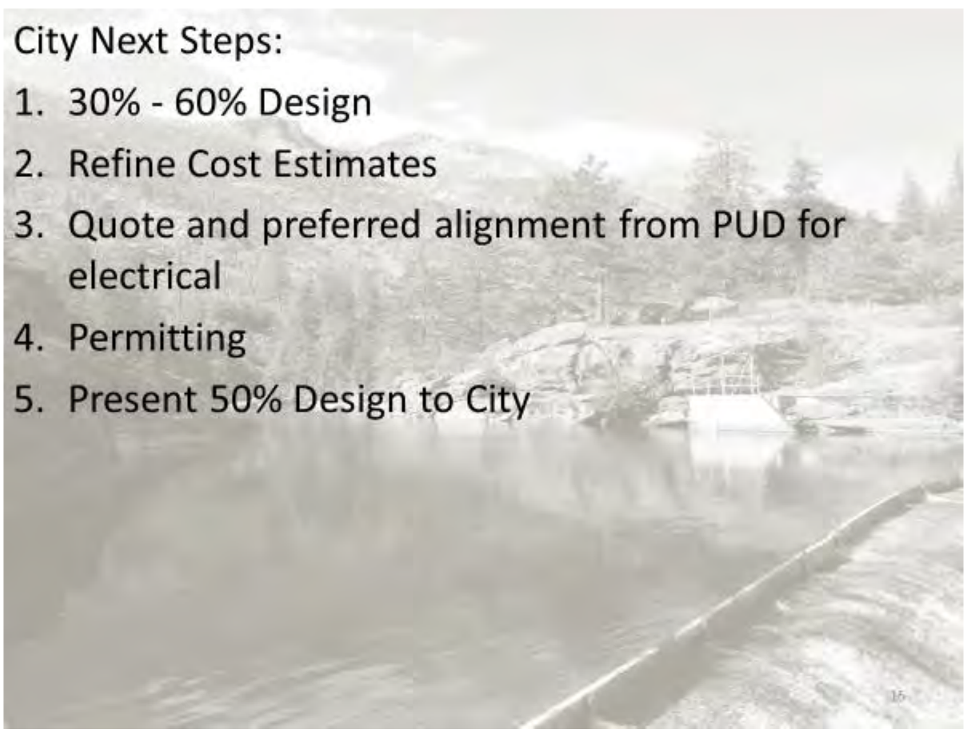
Photo from IntegriTech report Screenhouse C4




Option C is to put a ISI in one of the City's existing structures.
Drawing from Intake Screens Inc
Rotating External Brush
Internal Flow Baffle
Hydraulic Motor
Screened Water
Even Velocity Distribution
Wedgewire Screen
Screen Base
All Stainless Steel Construction

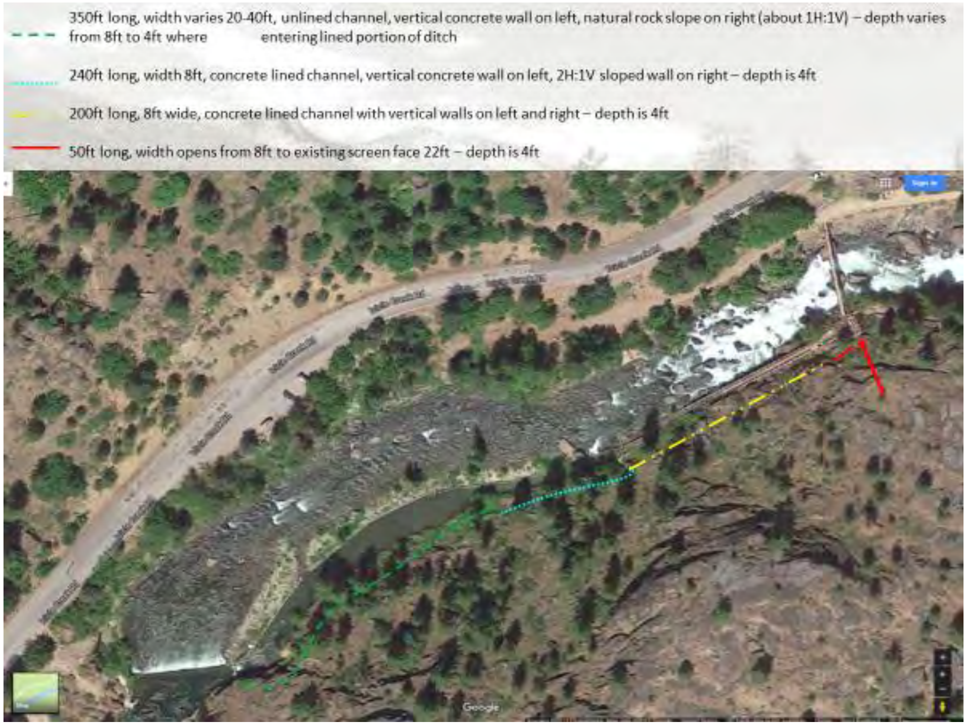

Proposed Piping Detail
11 Jan 2018
Proposed location of screenhouse (20ft Long x 10ft Wide)
Connect screenhouse to existing line with ~125ft, 18in ductile iron
Option A
Tie existing line to screenhouse with 300/75ft, 18in ductile iron
Option B
Fish bypass pipe 60ft, 12in HDPE
Existing 16in steel line

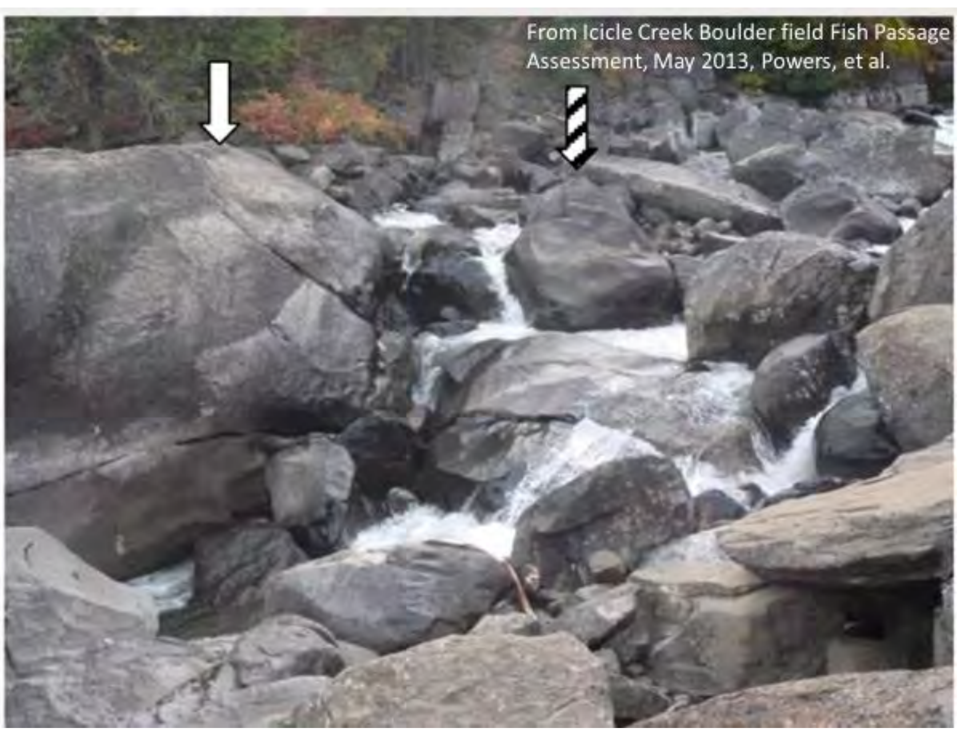

Proposed Access Road Detail
11 Jan 2018
Access Road
Option A
Option B
Proposed Screenhouse
Maintain 16ft passable road width at toe of access road and past screenhouse
Reconstruct 35ft turnaround
Install 18in x 40ft long double walled cross drain


City Next Steps:
1. 30% - 60% Design
2. Refine Cost Estimates
3. Quote and preferred alignment from PUD for electrical
4. Permitting
5. Present 50% Design to City


Irrigation District Intake & Screens

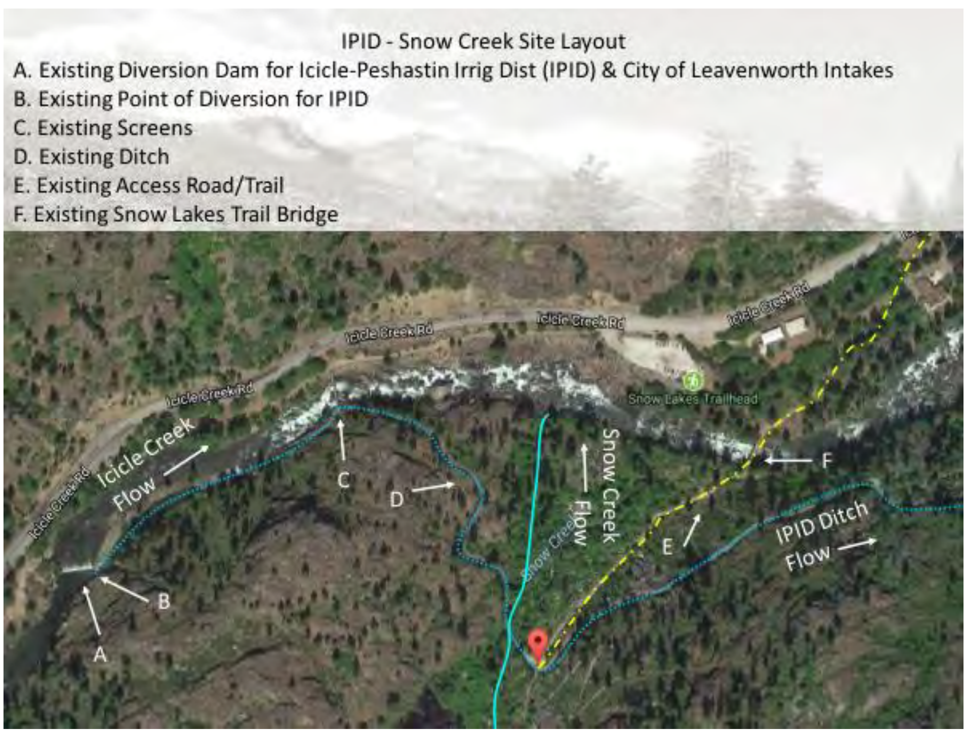

08/04/2013


350ft long, width varies 20-40ft, unlined channel, vertical concrete wall on left, natural rock slope on right (about 1H:1V) – depth varies from 8ft to 4ft where entering lined portion of ditch
240ft long, width 8ft, concrete lined channel, vertical concrete wall on left, 2H:1V sloped wall on right – depth is 4ft
200ft long, 8ft wide, concrete lined channel with vertical walls on left and right – depth is 4ft
50ft long, width opens from 8ft to existing screen face 22ft – depth is 4ft


From Icicle Creek Boulder field Fish Passage Assessment, May 2013, Powers, et al.

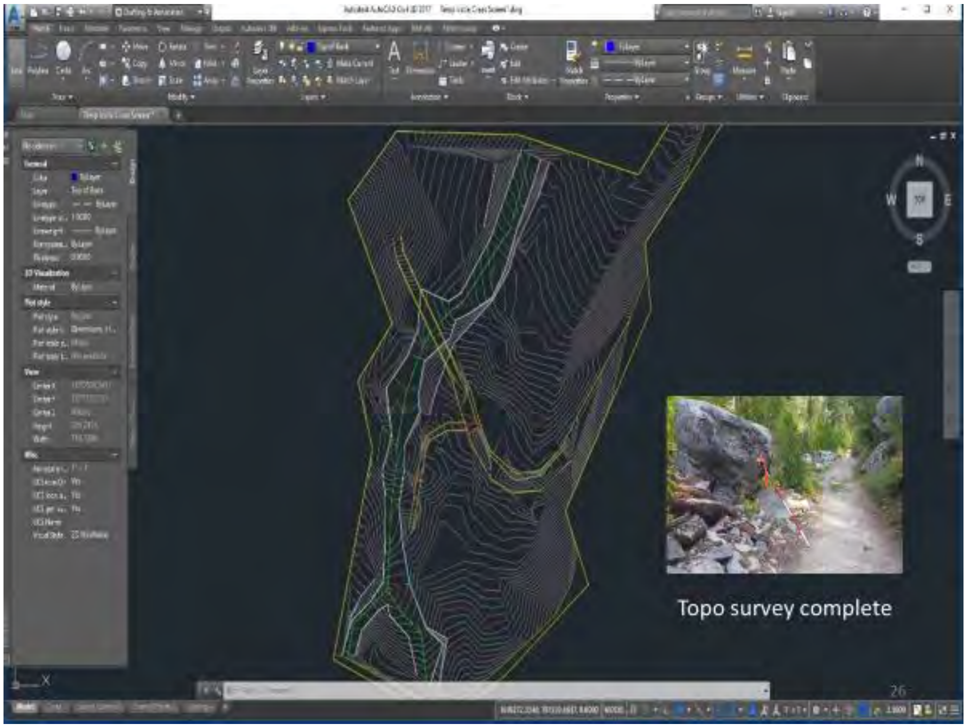

12,000cfs


5,000cfs


IPID - Snow Creek Site Layout
A. Existing Diversion Dam for Icicle-Peshastin Irrig Dist (IPID) & City of Leavenworth Intakes
B. Existing Point of Diversion for IPID
C. Existing Screens
D. Existing Ditch
E. Existing Access Road/Trail
F. Existing Snow Lakes Trail Bridge
Icicle Creek Rd
Icicle Creek Flow
Snow Creek Flow
Snow Lakes Trailhead
IPID Ditch Flow
A
B
C
D
E
F

Progress

- Forest Service has verbally committed to work with us to improve site access for maintenance.
- Survey complete but still outstanding data to be processed. Preliminary hydraulic modeling completed but will be revised
- Narrowing down what screening technology options are viable at the location. Evaluating sizing and configuration.


Topo survey complete
26


Bridge is only sized and rated for light pickup/small maintenance equipment. Determine whether we can reuse existing bridge supports. Design/spec replacement.


Concept Snow Creek Site Layout
Bypass channel – in pipe exiting ditch alignment and under access road and parking area but then open channel back to Snow Creek
Concept Maintenance Turnaround/ Construction Staging Area. To be brought level up from native with material excavated for screen bay. Approx 40 ft long x 30 ft wide.
Icicle Peshastin Ditch Flow
Snow Creek Diversion Flow
Concept Screen Footprint Bay: 5-6 ft deep x 20-40ft wide x 60ft long. Gantry to pick screen. Traveling or self-contained brush to clean screens depending on selected screen type.
Snow Creek

Ditch Next Steps:

1. Size all screen options and configure on available footprint
2. Quote and discuss expected power draw and maintenance for screen
3. Quote and preferred alignment from PUD for electrical to site
4. Present options to ditch and narrow the field for further evaluation and/or select design option
5. Structural evaluation of existing bridge footings and design new bridge
6. Refine cost estimates
7. Permitting
8. Discuss 50% design with IPID

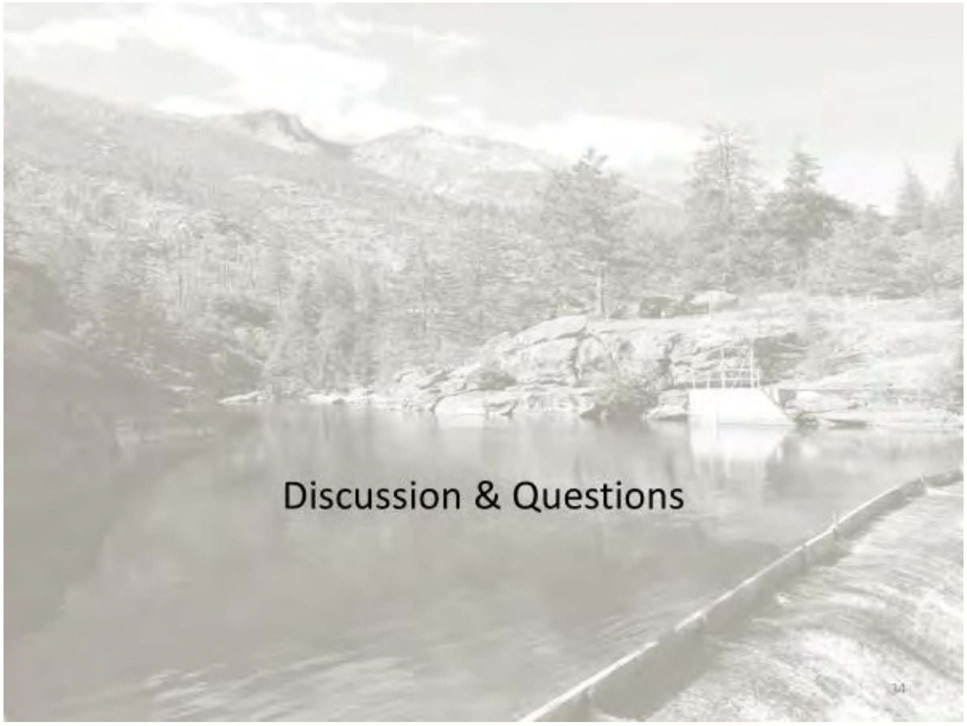
Estimated Timeline

Item/Milestone	Outcome	Target Date (Month/Year)
City Permitting	All Permits – Co, state, Fed	08/2018
City Design	Plans, Specs, Bidding	08/2018
City Construction	Construction, Oversight	10/2018
IPID Permitting	All Permits – Co, state, Fed	08/2018
IPID Design	Plans, Specs, Bidding	08/2018
	Construction, Oversight	10/2018
	Construction, Oversight	10/2019

Estimated Itemized Budget

Item	Cost/unit	Units	Total Fund Request	PRCC Fund Request	TRIB Fund Request	Donated/Other Source (received)
IPID						
Permitting	$70	714	$50k	$50k		
Design/Project Mgmt						$228k – BPA $5k – PRCC
Bridge/Access Construction			$450k	$450k		
Bridge/Access Construction Mgmt	$100	450	$45k	$45k		
Screen Construction			$1M	$1M		
Screen Const Mgmt	$90	1,111	$100k	$100k		
IPID Subtotal			$1.645M	$1.645M		$233k
City of Leavenworth						
Permitting	$70	357	$25k		$25k	
Design/Project Mgmt						$114k – BPA
Screen Construction			$410k		$410k	
Screen Construction Mgmt	$90	455	$41k		$41k	
City Subtotal			$476k		$476k	$114k
Total Budget Request			$2.121M	$1.645M	$476k	$347k

* IPID has stated they plan to assist with construction labor and equipment towards screens; their contribution has yet to be determined.


Discussion & Questions
34

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 6 March 2018

Members Present: Lee Carlson (Yakama Nation), Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator). Scott Hopkins (Chelan PUD) and Larry Rees (Tributary Committees' Appraiser).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 6 March 2018 from 1:30 to 4:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the addition of the Chelan-Douglas Land Trust Monitoring Proposal.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 11 January 2018 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- <u>Clear Creek Fish Passage and Instream Flow Project</u> – The sponsor (Trout Unlimited; TU) received construction bids by 22 February and they have selected a low bid that meets all required qualifications. The sponsor intends to finalize the contract in early March. The sponsor also received a Drinking Water Providers Partnership grant and a commitment of additional financial resources from the landowner.
- <u>Barkley Irrigation – Under Pressure Project</u> – The sponsor (TU) attended a meeting with the Barkley and MVID Boards. All representatives committed to work together to get some construction completed during spring and summer this year. Becky noted that the sponsor is about $700,000 short of having the funds needed to complete the project. The sponsor may seek additional funding from the Tributary Committees.
- <u>Icicle Boulder Field Project</u> – The sponsor (TU) is making progress on permitting and they continue to work on fishway and waterline designs. They will next meet with Washington Department of Fish and Wildlife, City of Leavenworth, and engineers on 15 March.

- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – By 31 December 2018, the sponsor (Washington Department of Fish and Wildlife; WDFW) will submit the third-year monitoring report on work conducted in 2018.
- Permitting Nutrient Enhancement Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) is working on the draft Quality Assurance Project Plan and they hope to submit it to Ecology in March. They are also waiting to hear back from the Forest Service and Fish and Wildlife Service on the project plan.
- Burns-Garrity Design Project – The sponsor (CCFEG) reported that their contractor is working on the 30% design for the perennial side channel. The design should be completed by 1 April.
- Beaver Fever Project – The sponsor (TU) continues landowner outreach. They are also coordinating with the Forest Service to conduct baseline work during summer 2018.
- Wenatchee Sleepy Hollow Floodplain Acquisition Project – The sponsor (Chelan-Douglas Land Trust; CDLT) began the appraisal process and is surveying for a boundary-line adjustment to separate the house from the property. In addition, an archaeologist is documenting the historical status of the barn before it is removed.
- M2 Mid-Sugar Acquisition Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) is drafting a purchase and sale agreement. Members of the Committees indicated that drafting the agreement may be premature.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) will begin field work in May or June.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) did not provide an update on this project.

IV. Small Project Proposal

Larsen Creek Tributary Enhancement Project

The Committees received a Small Project proposal from Chelan County Natural Resource Department titled: *Larsen Creek Tributary Enhancement Project*. The purpose of this project is to increase channel length in lower Larsen Creek, which is an intermittent tributary to Peshastin Creek. This will be accomplished by constructing a 450-foot new channel across the floodplain. Currently, the lower 150-feet of Larsen Creek is a straight incised channel. Increasing channel length across the floodplain should improve fish passage, peripheral and transitional habitat, and habitat complexity for juvenile steelhead. The total cost of the project is $59,100. The sponsor requested $44,200 from HCP Plan Species Account Funds.

After careful review, the Committees declined the opportunity to fund the project. This is because the Committees believe the project will exacerbate the duration and/or frequency of channel dewatering. That is, lengthening the channel across the alluvial fan will likely cause more of the limited stream flow to go subsurface, increasing the occurrence of fish stranding and entrapment. If the sponsor can demonstrate that relocating the channel across the alluvial fan will not increase intermittency or reduce stream flows in the enhanced reach, the Committees would be willing to review a revised proposal.

V. Monitoring Proposal

Proposal to Provide Supplemental Effectiveness Monitoring in the Grey and Stormy Reaches of the Entiat River

The Committees received a Monitoring proposal from Chelan-Douglas Land Trust (CDLT) titled: *Proposal to Provide Supplemental Effectiveness Monitoring in the Grey and Stormy Reaches of the Entiat River*. The Bureau of Reclamation and their partners will fund the implementation of a variety of treatments aimed at increasing habitat complexity, quality, and availability in the Grey and Stormy Reaches between RM 16.1 and 21.1 on the Entiat River. Enhancement actions include installation of large wood, excavation of new side channels and/or improving access to existing side channels, levee removal, and riparian vegetation plantings. Because most of these actions will be implemented on CDLT properties, CDLT would like answers to the following questions:

1. Wood Dynamics
    a. What is the fate of large wood added to the system? Does it increase or decrease in volume and what is its retention time?
    b. What is the temporal and spatial variability of large wood added to the system?
    c. If large wood structures were anchored using different techniques (e.g., pile-based jams versus natural analog trees) how did these different large wood structures perform over time with respect to the habitat unit response, broader-scale channel response, stability, longevity, rack, or shed of new flotsam?
2. Floodplain Connectivity
    a. What is the frequency and duration of floodplain activation because of increased connectivity?
    b. What changes have occurred in the vegetation communities and their structure across the floodplain as connectivity is increased?
3. Channel Bed Changes
    a. Were there vertical and lateral channel bed changes because of the restoration actions?

The total cost of the project over the 11-year monitoring period is $386,523.

After careful review, the Committees declined the opportunity to fund the project. This is because Assessment Funds can only be used to evaluate enhancement actions funded by Plan Species Accounts. At this time, the Committees have not approved funding for any of the proposed actions to be implemented in the Entiat River. In addition, although an understanding of geomorphic and riparian responses to enhancement is important, the Committees are more interested in understanding fish responses. The Committees have also been informed that ISEMP/CHaMP in the Entiat may not proceed because of reduced funding. Therefore, it is unlikely the monitoring work will have a cost share. As a final note, however, members of the Committees are willing to work with the sponsor on developing a cost-effective monitoring plan to assess geomorphic responses to enhancement actions in the Entiat River.

VI. M2 Mid-Sugar Appraisal

In January, Chris Johnson, MSRF, asked the Wells Tributary Committee to review the M2 Mid-Sugar Appraisal conducted by Larry Rees. After reviewing the appraisal, the Committee identified the following questions/concerns:

1. It appears that 7.78 acres that are owned by the State of Washington (State Owned Aquatic Land) is appraised as part of the property being acquired.

2. The Committee did not see any discussion regarding the hundred-year floodplain or the fact that no building can occur on it. Please provide a discussion indicating that large parts of the property are in the floodway and therefore unbuildable.
3. The appraiser valued the property as two larger parcels. The Committee is not sure this meets Yellow Book standards. Also, the improvements were not appraised as they contribute to the property as a whole and what is being reserved.
4. There appears to be some analytical errors. The value of the property being acquired is appraised at the same value as the property reserved, even though the property being acquired is approximately 11 acres smaller than the property being reserved.
5. The Yakama Nation conducted a Yellow Book appraisal last year on the same property and appraised it at about $54,000. The Committee wonders why there is such a large difference in appraised values.

In an email dated 4 February 2018, Chris Johnson provided the following responses:

1. WA DNR has never asserted or defined their ownership in this reach. In non-adjudicated areas, we can infer that DNR has a vested interest in the bed of the river, where meaningful commercial navigation occurred at that time of statehood - and gradual changes that have occurred thereafter. The state statutes specifically state that navigability does not travel with the river in the event of avulsion or dramatic changes in course that do not occur over time. The best I can conclude for this reach is that the Methow River's location at the time of statehood would most likely be defined as lying west of the current Hwy 20 location. Given that the flood record and course changes are well documented, and that DNR has not asserted, we cannot provide a basis for reducing acreage
2. The appraiser included the flood elevation survey that identifies a number of building spots as lying sufficiently above the BFE to satisfy Okanogan County Building requirements - Is the committee requesting that we seek confirmation from the county that these sites are buildable?
3. I will leave this to the appraiser to address.
4. I will leave this to the appraiser.
5. Yes, and the Yakama Nation's appraiser ignored a 2011 appraisal, which concluded a value of $253,00 for 17.32 acres. Based on the relative consistency of the 2011 and 2017 values, it appears that the YN appraisal is the outlier rather than the current one.

Larry Rees, appraiser, joined the meeting in person to answer additional questions from the Committee. Larry agreed with Chris's responses and noted that his appraisal followed and met Yellow Book standards. Larry also showed the Committee an elevation map, which demonstrated the location of possible building sites on the property. Larry describe the appraisal process and showed that there were no analytical errors in the appraisal. With regard to the Yakama Nation appraisal, Larry said he has not seen the appraisal and therefore could not comment on how they came up with a value of $54,000. He said he has asked for the appraisal, but the Yakama Nation declined to share it with him.

Following Larry's visit with the Committee, Lee Carlson reviewed the Yakama Nation appraisal and noted that the value of $54,000 appears to represent the difference between the 2011 appraisal and the Yakama Nation appraisal. It does not represent the appraised value of the property. Following this revelation and responses from Larry Rees and Chris Johnson, the Wells Tributary Committee approved the appraisal conducted by Larry.

The Committee directed Tracy Hillman to send Chris and Larry an email thanking them for their responses and discussions with the Committee.

VII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from November to January:

   Rock Island Plan Species Account:

   - $162.50 to Clifton Larson Allen for Rock Island financial administration in January 2018.
   - $80.00 to Clifton Larson Allen for Rock Island financial administration in February 2018.
   - $895.79 to Trout Unlimited for the Beaver Fever – Restoring Ecosystem Function Project.
   - $2,662.40 to Cascade Columbia Fisheries Enhancement Group for the White River Floodplain Connection Project. This was the final payment request.

   Rocky Reach Plan Species Account:

   - $162.50 to Clifton Larson Allen for Rocky Reach financial administration in January 2018.
   - $80.00 to Clifton Larson Allen for Rocky Reach financial administration in February 2018.

2. Tracy Hillman reported that the PUDs deposited funds into each of the Plan Species Accounts at the end of January 2018. Chelan PUD deposited $759,967 into the Rock Island Account and $359,935 into the Rocky Reach Account. Douglas PUD deposited $275,968 into the Wells Account. As of March 2018, the unallocated balances within each account were $6,501,189 in the Rock Island Account, $2,854,244 in the Rocky Reach Account, and $1,765,256 in the Wells Account. Thus, among the three accounts, there is about $11,120,689 available.
3. Tracy Hillman shared with the Committees a summary of the different projects funded by the different Plan Species Accounts and the status of those projects (see Attachment 1).
4. The Committees continued to identify completed projects they would like to visit this summer. The tour is to take no more than two days (one day for Okanogan/Methow projects and one day for Entiat/Wenatchee projects).
5. Tracy Hillman said the Independent Scientific Advisory Board (ISAB) completed the report, *Review of Spring Chinook Salmon in the Upper Columbia River* (https://www.nwcouncil.org/fw/isab/isab2018-1). He encouraged members to read the report as it provides some useful recommendations. He added that the ISAB stressed that the Upper Columbia develop a tool for evaluating cost effectiveness of habitat actions. The ISAB provided an example in their report (see Box 4.1 on pages 113-114 in their report).
6. Tracy Hillman shared the Salmon Recovery Funding Board (SRFB) and Tributary Committees Proposed Funding Schedule with the Committees. He said draft proposals are due on Friday, 13 April. Project tours will be on 8 May (Wenatchee), 9 May (Entiat), 15 May (Methow), and 16 May (Okanogan). The Committees will evaluate the draft proposals on Thursday, 10 May and decide which projects should be submitted as final proposals. Sponsors will give presentations on Wednesday, 13 June. Final proposals are due on Friday, 29 June. The Committees will evaluate final proposals and make funding decisions on Thursday, 12 July.
7. Tracy Hillman reported that he and Becky Gallaher completed Section 2.3 (Tributary Committees and Plan Species Accounts) for the Annual Report of Activities under the Anadromous Fish

Agreement and Habitat Conservation Plan for each hydroelectric project. Tracy said he sent the draft reports to Anchor QEA, who is compiling the draft annual reports. The draft reports have been sent to the HCP Coordinating Committees for review. The PUDs will submit the final reports to the Federal Energy Regulatory Commission in April.

8. Tracy Hillman shared with the Committees an email he received from Aaron Pinvose, TU, regarding the Icicle Fish Screens. Aaron noted that WDFW and TU have been working with the City of Leavenworth and the Irrigation District on meeting the 15% cost share. They believe they are close to having the cost share and hope to have a revised proposal to the Committees in a few weeks.

VIII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 12 April 2018 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

Projects Funded by Plan Species Accounts

Rock Island Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 White River Floodplain & Habitat Protection	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$1,986,200	$693,548	$693,548	Complete
05 Nason Creek Off-Channel Habitat Restoration	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, St	$125,034	$18,787	$18,787	Complete
05 Alder Creek Culvert Replacement	Chelan County NRD	General	Fish Passage	Spr Ch, St	$89,804	$89,804	$89,804	Complete
05 McDevitt Diversion Project	Cascadia Conservation District	Small	Fish Passage	Spr Ch, St	$5,278	$5,278	$2,831	Complete
07 LWD Removal and Relocation	Chelan County NRD	Small	Instream Structures	NA	$5,000	$5,000	$871	Complete
07 WRIA's 45/46 Riparian Restoration	Cascadia Conservation District	Small	Riparian Habitat	Spr Ch, Sum Ch, St	$50,000	$25,000	$24,779	Complete
07 Entiat PUD Canal System Conversion	Cascadia Conservation District	General	Instream Flows	Spr Ch, Sum Ch, St	$496,584	$99,360	$99,360	Complete
07 Roaring Creek Flow Enhancement	Cascadia Conservation District	General	Instrm Flows/Fish Passage		$147,069	$25,000	$987	Cancelled
07 Wildhorse Spring Creek Conservation Easement	Colville Confederated Tribes	General	Protection	St	$67,826	$62,826	$63,523	Complete
08 Twisp River Conservation Acquisition II	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$481,814	$220,000	$200,500	Complete
08 Twisp River Riparian Protection (Zinn)	Methow Conservancy	General	Protection	Spr Ch, St	$349,988	$104,996	$104,996	Complete
08 Cashmere Pond Off-Channel Habitat Project	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$914,076	$249,110	$240,139	Complete
08 Keystone Canyon Habitat Project	Cascadia Conservation District	General	Off-Channel Habitat		$0	$0	$0	Cancelled
09 LWD/Rootwad Acquisition and Transport II	Cascadia Conservation District	Small	Instream Structures	NA	$35,000	$35,000	$35,000	Complete

Rock Island Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
09 Sleepy Hollow Reserve Protection Feasibility	Chelan-Douglas Land Trust	Small	Assessment	Spr Ch, Sum Ch, St	$25,000	$20,000	$16,600	Complete
09 White River Nason View Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$639,000	$76,635	$76,635	Complete
09 Upper Methow II (Tawlks) Riparian Protection	Methow Conservancy	General	Protection	Spr Ch, St	$411,943	$61,948	$61,948	Complete
09 Nason Creek UWP Floodplain Reconnection - PUD Powerline Reconnection Alternatives Analysis	Chelan County NRD	General	Assessment	Spr Ch, St	$53,500	$53,500	$45,569	Complete
09 Lower Wenatchee Instream Flow Enhancement	Washington Rivers Conservancy	General	Instream Flows	Spr Ch, Sum Ch, St	$4,954,466	$167,500	$167,500	Complete
10 White River Dally-Wilson Conservation Easement	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$194,000	$120,000	$120,000	Complete
10 Mission Creek Fish Passage	Cascadia Conservation District	Small	Fish Passage/Instrm Structures		$0	$0	$0	Cancelled
10 Assessing Nutrient Enhancement	CC Fisheries Enhancement Group	Small	Assessment	Spr Ch, St	$9,875	$9,875	$6,670	Complete
11 Boat Launch Off-Channel Pond Reconnection	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$136,500	$62,000	$62,000	Complete
11 White River Van Dusen Conservation Easement	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St, Sock	$440,000	$60,000	$60,000	Complete
12 Wenatchee Nutrient Enhancement - Treatment Design	CC Fisheries Enhancement Group	General	Assessment/Instream Structures	Spr Ch, St	$240,000	$80,000	$80,000	Complete
12 White River Large Wood Atonement	CC Fisheries Enhancement Group	General	Instream Structures	Spr Ch, St, Sock	$352,392	$100,000	$100,000	Complete
12 Wenatchee Levee Removal & Riparian Restoration	Chelan County NRD	Small	Off-Channel Habitat	Spr Ch, Sum Ch, St	$67,450	$56,700	$20,386	Complete
14 Twisp to Carlton Reach Assessment	CC Fisheries Enhancement Group	General	Assessment	Spr Ch, Sum Ch, St	$173,016	$46,500	$46,483	Complete
14 Post Fire Landowner Assist/Habitat Protection	Methow Salmon Recovery Found	Small	Fish Passage	Spr Ch, St	$100,000	$57,328	$50,796	Complete
14 Icicle Irrigation District Flow Control Structure	Chelan County NRD	General	Instream Flows	Spr Ch, St	$140,633	$70,000	$30,653	Complete
14 Lehman Riparian Restoration	Methow Conservancy	Small	Riparian Habitat	Spr Ch, St	$40,267	$9,053	$9,053	Complete
14 MVID Instream Flow Improvement	TU - Washington Water Project	General	Instream Flows	Spr Ch, Sum Ch, St	$9,747,000	$300,000	$242,222	Complete

Rock Island Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
15 Barkley Irrigation Company - Under Pressure	TU - Washington Water Project	General	Instream Flows	Spr Ch, Sum Ch, St	$3,293,180	$300,000	$0	In progress
15 White River Floodplain Connection (RM 3.4)	CC Fisheries Enhancement Group	Small	Off-Channel Habitat	Spr Ch, St, Sock	$35,500	$35,500	$30,877	Complete
16 Icicle Creek-Boulder Field-Wild Fish to Wilderness	TU - Washington Water Project	General	Fish Passage	St	$1,571,189	$250,000	$0	In progress
16 Peshastin Creek RM 10.5 PIT-Tag Detection Site	WA Dept of Fish & Wildlife	Small	Assessment	St	$62,872	$32,269	$30,875	Complete
16 Permitting Nutrient Enhancement in the Chiwawa	CC Fisheries Enhancement Group	Small	Assessment	Spr Ch, St	$11,348	$11,348	$11,348	In progress
16 Wenatchee Sleepy Hollow Floodplain Acquisition	Chelan-Douglas Land Trust	General	Protection	St	$661,000	$165,250	$0	In progress
16 Beaver Fever: Restoring Ecosystem Function	TU - Washington Water Project	General	Channel Restoration	Spr Ch, St	$135,850	$108,226	$2,191	In progress
16 Ecommunity Place Locatee Lands Acquisition	Okanagan Nation Alliance	General	Protection	Sock	$456,514	$59,676	$44,485	Complete
17 Poison Canyon Restoration	Chelan County NRD	Small	Instream Structures	St	$37,918	$21,600	$21,600	Complete
18 Derby Crreek Fish Passage - Collins	CC Fisheries Enhancement Group	General	Fish Passage	St	$180,000	$65,000	$0	In progress
Total					**$28,924,086**	**$4,033,617**	**$2,913,016**	

Current Rock Island Plan Species Account Balance (unallocated): $6,501,189
Contribution to the Rock Island Account is made annually (January 31): $485,200 (in 1998 dollars)

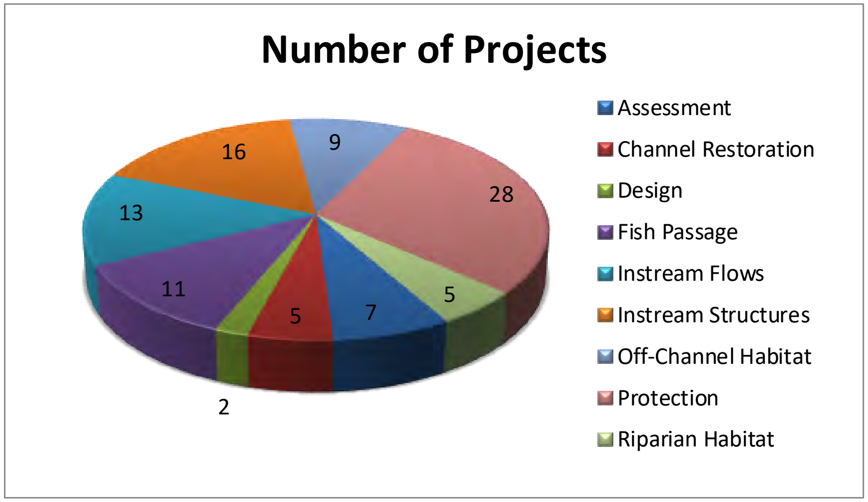
Rocky Reach Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 Entiat Instream Structure Engineering	Cascadia Conservation District	General	Instream Structures	Spr Ch, Sum Ch, St	$59,340	$59,340	$48,659	Complete
05 Twisp River Conservation Acquisition	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$200,835	$40,000	$40,000	Complete
05 Clees Well and Pump	Okanogan Conservation District	General	Instream Flows	Spr Ch, Sum Ch, St	$40,875	$15,000	$14,924	Complete
05 Entiat Instream Habitat Improvements	Chelan County NRD	General	Instream Structures	Spr Ch, Sum Ch, St	$250,000	$37,500	$37,500	Complete
06 Entiat PUD Canal Juv Habitat Enhancement	Cascadia Conservation District	Small	Instream Structures	Spr Ch, Sum Ch, St	$23,640	$23,640	$6,218	Complete
07 LWD Removal & Relocation	Chelan County NRD	Small	Instream Structures	NA	$5,000	$5,000	$871	Complete
07 LWD/Rootwad Acquisition & Transport	Cascadia Conservation District	Small	Instream Structures	NA	$24,600	$24,600	$24,600	Complete
07 Harrison Side Channel	Chelan County NRD	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$797,300	$90,105	$68,647	Complete
08 Entiat PUD Canal Log-Boom Installation	Cascadia Conservation District	Small	Instream Structures	Spr Ch, Sum Ch, St	$10,660	$7,160	$4,527	Complete
08 Twisp River Riparian Protection (Buckley)	Methow Conservancy	General	Protection	Spr Ch, St	$299,418	$89,825	$89,825	Complete
08 Below the Bridge	Cascadia Conservation District	General	Instream Structures	Spr Ch, Sum Ch, St	$398,998	$150,000	$115,353	Complete
09 Foreman Floodplain Reconnection	Chelan County NRD	General	Off-Channel Habitat		$0	$0	$0	Cancelled
09 Entiat NFH Habitat Improvement Project	Cascadia Conservation District	General	Off-Channel Habitat	Spr Ch, Sum Ch, St	$285,886	$61,373	$61,373	Complete
10 Methow Subbasin LWD Acquisition & Stockpile	Methow Salmon Recovery Found	Small	Instream Structures	NA	$50,000	$50,000	$49,914	Complete
11 Chewuch River Permanent Instream Flow Project	TU – Washington Water Project	General	Instream Flow	Spr Ch, St	$1,200,000	$325,000	$306,752	Complete
11 Christianson Conservation Easement	Methow Conservancy	Small	Protection	Spr Ch, St	$16,350	$15,000	$15,000	Complete
12 Entiat Stormy Reach Phase 2 Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, Sum Ch, St	$165,000	$46,800	$44,003	Complete
12 Silver Protection	WA Dept. of Fish & Wildlife	General	Protection		$660,000	$0	$0	Cancelled

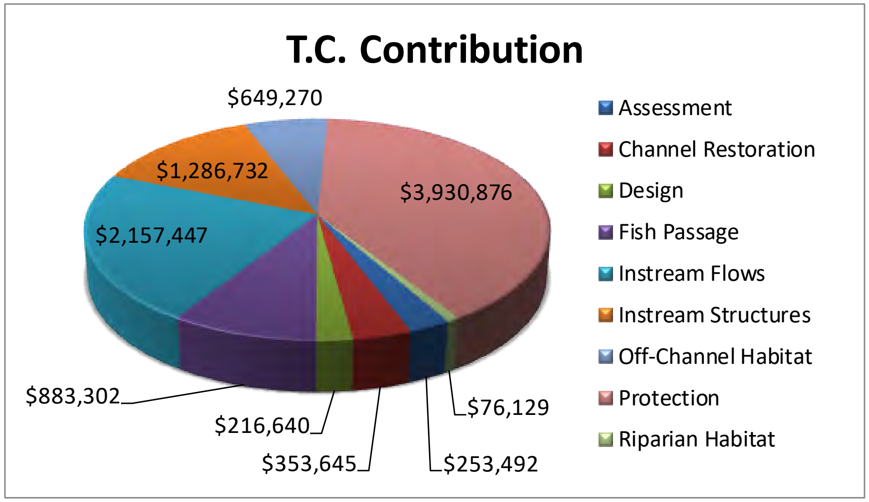
Rocky Reach Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
12 Nason Creek Lower White Pine Coulter Creek Barrier Replacement	Chelan County NRD	General	Fish Passage	Spr Ch, St	$83,126	$12,469	$12,469	Complete
12 Nason Creek LWP Alcove Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St	$353,000	$72,000	$72,000	Complete
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	Spr Ch, St, Sock	$59,225	$180,950	$59,225	Complete
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	Spr Ch, St	$674,600	$102,613	$68,982	Complete
13 Okanogan Basin Stream Discharge Monitoring	Colville Confederated Tribes	Small	Instream Flows	NA	$90,954	$74,984	$74,980	Complete
14 Silver Side Channel Design	CC Fisheries Enhancement Group	General	Design	Spr Ch, Sum Ch, St	$180,733	$132,000	$132,000	Complete
14 Similkameen RM 3.8 Design	Okanogan Conservation District	General	Design	Sum Ch, St	$84,640	$84,640	$79,483	Complete
14 Entiat Stillwaters Gray Reach Acquisition	Chelan-Douglas Land Trust	General	Protection	Spr Ch, St	$559,625	$174,000	$53,500	Complete
14 Clear Creek Fish Passage & Flow Enhancement	TU – Washington Water Project	Small	Fish Passage/Instrm Flows	St	$96,116	$69,500	$17,082	In progress
14 MVID Instream Flow Improvement	TU – Washington Water Project	General	Instream Flows	Spr Ch, Sum Ch, St	$9,747,000	$300,000	$203,592	Complete
15 Similkameen RM 3.8 Rehabilitation	Okanogan Conservation District	General	Instream Structures	Sum Ch, St	$392,370	$92,221	$64,477	Complete
16 Burns-Garrity Restoration Design	CC Fisheries Enhancement Group	General	Instream Structures	Spr Ch, St	$177,335	$45,550	$12,084	In progress
17 Cottonwood Bridge Removal	Chelan-Douglas Land Trust	Small	Protection	Spr Ch, St	$95,000	$21,000	$21,000	Complete
Total					**$17,081,626**	**$2,402,270**	**$1,799,039**	
Current Rocky Reach Plan Species Account Balance (unallocated): $2,854,244 **Contribution to the Rocky Reach Account is made annually (January 31): $229,800 (in 1998 dollars)**								

Wells Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
05 Okanagan River Restoration – Phase III	Okanagan Nation Alliance	General	Instream Structures	Spr Ch, St, Sock	$219,121	$219,121	$197,681	Complete
05 Methow Riparian Protection (Heath)	Methow Conservancy	General	Protection	Spr Ch, St	$2,684,500	$1,177,500	$812,700	Complete
05 Methow Riparian Protection (Prentice)	Methow Conservancy	General	Protection				$1,749	Complete
05 Methow Riparian Protection (MacDonald)	Methow Conservancy	General	Protection				$345,400	Complete
07 Lower Beaver Creek Livestock Exclusion	Okanogan Conservation District	Small	Riparian Habitat	Spr Ch, St	$24,670	$18,559	$16,561	Complete
07 Heath Floodplain Restoration	Methow Salmon Recovery Found	Small	Off-Channel Habitat	Spr Ch, St	$48,695	$48,695	$43,915	Complete
07 Okanogan River Restoration – Phase IV	Okanagan Nation Alliance	General	Instream Structures	Spr Ch, St, Sock	$1,022,000	$411,000	$411,000	Complete
08 Riparian Regeneration & Restoration Initiative	Methow Conservancy	Small	Riparian Habitat	Spr Ch, St, Sock	$22,737	$15,537	$15,537	Complete
08 Fort Thurlow Pump Project	Methow Salmon Recovery Found	Small	Instream Flows	Spr Ch, St	$48,150	$7,000	$7,009	Complete
08 Goodman Livestock Exclusion Project	Okanogan Conservation District	Small	Riparian Habitat	St	$8,080	$7,980	$6,829	Complete
08 Poorman Creek Barrier Removal	Methow Salmon Recovery Found	General	Fish Passage	Spr Ch, St	$191,579	$53,748	$53,748	Complete
08 Twisp River Riparian Protection (Pampanin)	Methow Conservancy	General	Protection	Spr Ch, St	$119,720	$48,649	$48,649	Complete
08 Twisp River Riparian Protection (Neighbor)	Methow Conservancy	General	Protection	Spr Ch, St	$260,000	$55,000	$55,000	Complete
08 Twisp River Riparian Protection (Speir)	Methow Conservancy	General	Protection	Spr Ch, St	$79,976	$23,993	$23,993	Complete
10 Prevent Fish Entrainment on Inkaneep Creek	Okanagan Nation Alliance	Small	Instream Flows		$24,000	$0	$0	Cancelled
11 Methow River Acquisition MR 39.5 (Hoffman)	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$195,048	$74,415	$74,415	Complete
11 Methow River Acquisition MR 48.7 (Bird)	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$292,140	$111,680	$109,786	Complete
11 Methow River Acquisition MR 41.5 (Risley)	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$148,210	$31,854	$26,518	Complete

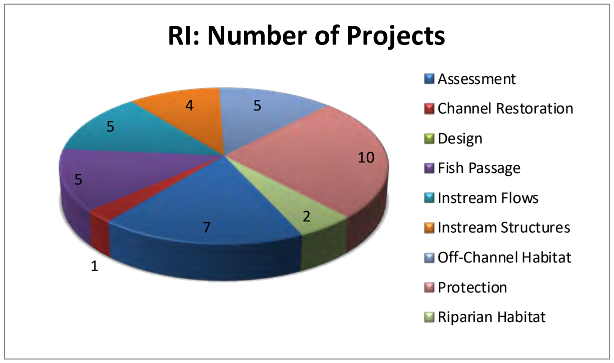
Wells Plan Species Account								
Project Name	**Sponsor**	**Fund Type**	**Project Type**	**Target Species**	**Total Cost**	**Tributary Contribution**	**Tributary Contribution (actual to date)**	**Project Status**
12 Twisp River Acquisition 2011 (Hovee)	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$140,700	$29,000	$1,074	Complete
12 Silver Protection	WA Dept. of Fish & Wildlife	General	Protection		$660,000	$0	$0	Cancelled
12 Twisp River Well Conversion	Trout Unlimited	Small	Instream Flows	Spr Ch, St	$87,739	$68,023	$68,023	Complete
13 Twisp River Poorman Crk Wetland Acquisition	Methow Salmon Recovery Found	General	Protection		$423,000	$338	$338	Cancelled
13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	General	Fish Passage	Spr Ch, St, Sock	$180,950	$59,225	$59,224	Complete
13 Methow/Chewuch Groundwater Monitoring	Cascade Columbia Fisheries Enhancement	Small	Instream Flows	NA	$34,180	$30,580	$29,962	Complete
13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	General	Channel Restoration	Spr Ch, St	$674,600	$102,613	$68,982	Complete
13 Lower Chewuch Beaver Restoration	Methow Conservancy	General	Off-Channel Habitat	Spr Ch, St	$247,985	$27,000	$27,000	Complete
13 MVID Instream Flow Improvement Project	Trout Unlimited	General	Instream Flows	Spr Ch, Sum Ch, St	$9,747,000	$400,000	$395,679	Complete
14 Remove Collapsed Bridge from Shingle Creek	Okanagan Nation Alliance	Small	Channel Restoration	Spr Ch, St	$8,193	$6,693	$6,689	Complete
15 Methow Watershed Beaver Reintroduction	Methow Salmon Recovery Found	General	Channel Restoration	Spr Ch, St	$216,000	$33,500	$33,500	Complete
15 M2 Sugar Acquisition	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$119,652	$15,185	$15,185	Complete
16 Silver Side Channel Acqusition	Methow Salmon Recovery Found	General	Protection	Spr Ch, St	$801,470	$236,406	$0	In progress
17 M2 Mid Sugar Acquisition	Methow Salmon Recovery Found	General	Protection	Spr Ch, Sum Ch, St	$291,268	$43,690	$0	In progress
18 Methow Basin Barrier Diversion Assessment	Cascade Columbia Fisheries Enhancement	General	Fish Passage	St, Spr Ch	$206,650	$40,000	$0	In progress
Total					**$19,228,013**	**$3,396,984**	**$2,956,146**	
Current Wells Plan Species Account Balance (unallocated): $1,765,256 **Contribution to the Wells Account will be made annually beginning in 2010: $176,178 (in 1998 dollars)**								

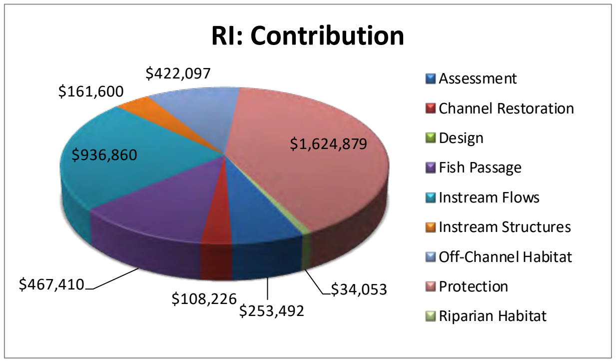
Projects Funded by the Tributary Committees

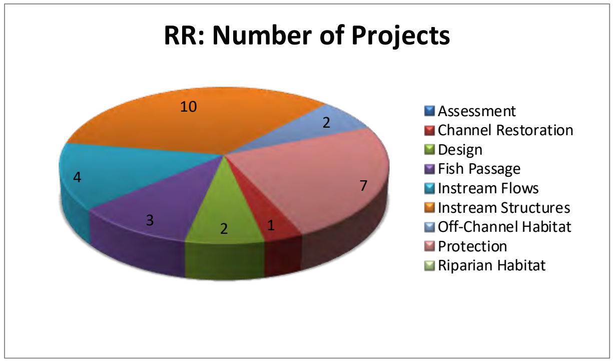


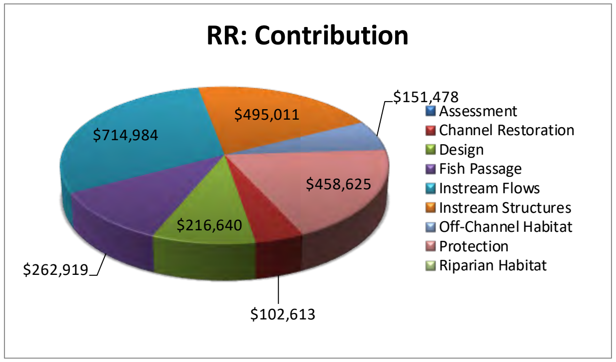


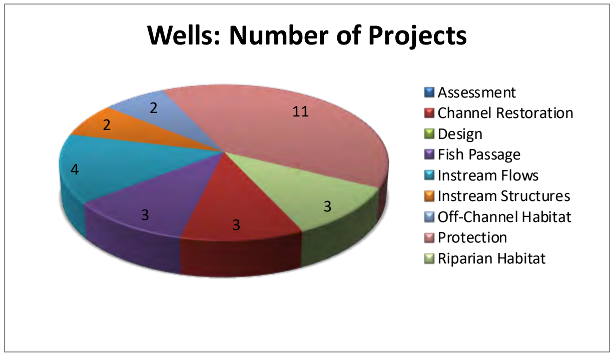
Projects Funded by each Plan Species Account

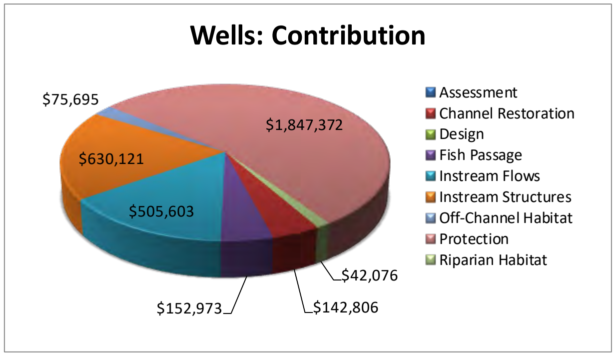












Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 23 May 2018

Members Present: Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Lee Carlson (Yakama Nation) and Jeremy Cram (WDFW).[1]

Others Present: Becky Gallaher (Tributary Project Coordinator). Denny Rohr (PRCC Habitat Subcommittee Facilitator) and Dave Duvall (Grant PUD) joined the meeting for the Icicle-Peshastin Irrigation District and City of Leavenworth Fish Screens discussion.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Wednesday, 23 May 2018 from 8:30 am to 1:40 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 6 March 2018 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Clear Creek Fish Passage and Instream Flow Project – The sponsor (Trout Unlimited; TU) reported that construction with lighter equipment near the well and treatment building is scheduled to begin the week of 14 May. Heavy equipment will be brought in a few weeks later after the seasonal weight restrictions on Chiwawa Loop Road are lifted.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) has been working on final design review and final modifications to the plans. They also have been working on securing an easement near the diversion. The easement should be secured by mid-May.
- Icicle Boulder Field Project – The sponsor (TU) continues working on permits for both passage and waterline replacement. They expect to submit permits in May. Design is complete on the boulder field. They are close to finishing the design on the City of Leavenworth waterline.

[1] Both Lee and Jeremy provided their votes on decision items following the meeting.

- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – By 31 December 2018, the sponsor (Washington Department of Fish and Wildlife; WDFW) will submit the third-year monitoring report on work conducted in 2018.
- Permitting Nutrient Enhancement Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) is currently working on issues raised by the USFWS (see Information Updates below).
- Burns-Garrity Design Project – The sponsor (CCFEG) reported the contractor has completed the 30% design. The contractor and Bureau of Reclamation collected topographic data on the relic channel, which is being proposed as a perennial side channel.
- Beaver Fever Project – The sponsor (TU) reported that there is no new activity on this project.
- Wenatchee Sleepy Hollow Floodplain Acquisition Project – The sponsor (Chelan-Douglas Land Trust; CDLT) did not provide an update this month. However, they did request a time extension on the project (see Time Extensions below).
- M2 Mid-Sugar Acquisition Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) completed their review of the appraisal. The Purchase and Sale Agreement was delivered to the landowner for review.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) reported they have been coordinating with the Forest Service to gather data on roads and other known barriers. They will also coordinate with other agencies who may have information that can be used to inform survey logistics.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) did not provide an update on this project.

IV. Time Extensions

Wenatchee Sleepy Hollow Floodplain Acquisition Project

The Rock Island Tributary Committee received a time extension request from CDLT on the Wenatchee Sleepy Hollow Floodplain Acquisition Project. The sponsor asked the Committee to extend the completion date from 31 December 2017 to 30 June 2019. The extension is needed because of a late start due to the failure by the State legislatures to pass the capital budget in early 2018 (which was needed for the SRFB cost share). After review and discussion, ***the Rock Island Tributary Committee agreed to extend the contract to 30 June 2019***.

Burns-Garrity Restoration Design Project

The Rocky Reach Tributary Committee received a time extension request from CCFEG on the Burns-Garrity Restoration Design Project. Because a change in landownership delayed the project five months, CCFEG asked to extend the completion date from 1 May 2018 to 1 December 2018. After review and discussion, ***the Rocky Reach Tributary Committee agreed to extend the contract to 1 December 2018***.

V. General Salmon Habitat Program Draft Proposals

The Committees received 19 General Salmon Habitat Program draft proposals. They dismissed one draft proposal because it addressed bull trout, which is not a Plan Species. The Committees reviewed each draft proposal and selected those they believe warranted a final proposal. Projects the Committees dismissed were either inconsistent with the intent of the Tributary Fund, did not have strong technical merit, or had low benefits per cost (not cost effective). The Committees assigned draft proposals to one of two categories: Fundable and Not Fundable. It is important to note that these are ratings of draft proposals and do not reflect ratings of final proposals. The Committees directed Tracy Hillman to notify sponsors with appropriate projects to submit a final proposal, with a discussion of the questions/comments identified for each draft proposal listed below. Tracy will also notify sponsors with projects that have no chance or a low likelihood of receiving funding from the Tributary Committees.

Monitor Side Channel Design and Construction Project (Fundable)

The Committees recommend that the project sponsor (Chelan County Natural Resources Department) address the following comments/suggestions as they develop the full proposal:

- Identify how the log jams will be anchored to the channel.
- Include a safety plan for recreational river users (boaters, rafters, swimmers, etc.).
- Describe how the pools will be maintained over time.
- Describe why riparian vegetation planting is critical to the success of this project.

Chumstick Creek Fish Passage Barrier Replacement – Motteler Road Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe the project will provide little biological benefit given the structure is 67% passable.
- It is also unclear if the culvert is at risk of failure due to watershed processes.
- As a final suggestion, the Committees recommend that Chelan County vacate the road.

Wenatchee EDT Model Development Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees want to see how well the tool works in the Methow before implementing it in the Wenatchee.
- They also question who will fund the maintenance of the model, will the model be available publicly, and what will this tool provide that the current Wenatchee life-cycle model does not?

Lower Entiat Tributaries – Aquatic Habitat Assessments Project (Fundable)

The Committees recommend that the project sponsor (Cascadia Conservation District) address the following comments/suggestions as they develop the full proposal:

- Describe what information is currently available from the Forest Service (or other entities) and what additional information will be collected by the Forest Service as part of their pre-NEPA work.
- Identify what information the proposed assessment will provide that is not already covered under #1 above.
- Indicate whether the assessment covers both public and private lands or only public lands.
- Based on existing information, describe possible opportunities for habitat enhancement in the two streams. The Committees understand that important factors limiting fish production have largely been addressed in the two streams.

Sand Creek Fish Passage Improvement Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reason:

- This project is a low priority for the Committees and they believe it will have low benefit for Plan Species.

Mill Creek Fish Passage Project (Fundable)

The Committees recommend that the project sponsor (Chelan County Natural Resources Department) address the following comments/suggestions as they develop the full proposal:

- Although the project should have biological benefit, it is currently not cost effective. After discussing fish passage projects similar to this one with a contractor, the Committees believe the project can be completed for less than $300,000. The sponsor needs to find ways to reduce the total budget to $300,000 or less.
- The Committees question whether a temporary bridge is necessary. It may be less expensive to place a firetruck on site and provide hotel rooms for residents for a couple of days.

Entiat Basin Fish Passage and Screening Assessment Project (Fundable)

The Committees recommend that the project sponsor (Cascade Columbia Fisheries Enhancement Group) address the following comments/suggestions as they develop the full proposal:

- Given the limited number of streams and possible barriers in the anadromous portion of the Entiat (Plan Species Account Funds can only be used in anadromous zones), the cost of the project seems too high. The sponsor needs to evaluate ways to reduce the cost of the project.
- Identify any known barriers that do not need to be evaluated. The Committees suggest the sponsor discuss this with local experts (e.g., Phil Archibald).
- Describe what is included in the physical habitat surveys.

Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project (Fundable)

The Committees recommend that the project sponsor (Methow Salmon Recovery Foundation) address the following comment/suggestion as they develop the full proposal:

- Consider replacing the undersized culvert with a ford.

Burns-Garrity Perennial Side-Channel Project (Fundable)

The Committees recommend that the project sponsor (Cascade Columbia Fisheries Enhancement Group) address the following comments/suggestions as they develop the full proposal:

- The Committees question whether there is enough water in the Chewuch River during low flows to support perennial side channels on both sides of the river. The Committees do not want to dewater existing perennial side channels.
- Given #1, the sponsor should consider developing a seasonal channel that is active at 1.5-2.0-year flow events.
- The project is too expensive. The sponsor needs to find ways to reduce the cost.

Methow Watershed Riparian Stewardship Program II Project (Not Fundable)

The Committees recommend that this project, sponsored by the Methow Salmon Recovery Foundation, should not be submitted as a full proposal to the Tributary Committees for the following reason:

- The Committees believe the project has limited or questionable biological benefit at the scale of the proposed action and therefore it is not cost effective.

Methow Beaver Project – Beaver and Anadromy Project (Not Fundable)

The Committees recommend that this project, sponsored by the Methow Salmon Recovery Foundation, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe the project is too expensive and the Plan Species Account Funds would go primarily to fund program capacity[2], without much certainty regarding biological benefit.
- In addition, it is unclear how long the project will last.

Peshastin Creek Barrier Removal Project (Not Fundable)

The Committees recommend that this project, sponsored by Chelan County Natural Resources Department, should not be submitted as a full proposal to the Tributary Committees for the following reason:

- Given that fish can pass through the culvert at most flows, the Committees believe the project will have little biological benefit to Plan Species.

Cottonwood Flats Floodplain Restoration Entiat River (RM 17.65) Project (Fundable)

The Committees recommend that the project sponsor (Chelan County Natural Resources Department) submit a full proposal. The Committees had no comments on this project.

Methow River Watershed LiDAR Acquisition Project (Fundable)

The Committees recommend that the project sponsor (Trout Unlimited) address the following comments/suggestions as they develop the full proposal:

- Explain why the Department of Natural Resources is not funding the entire project.
- Remove the wilderness area from the assessment.
- Consider evaluating only high priority watersheds identified in the Regional Technical Team Biological Strategy.
- The sponsor should ask for no more than $30,000 from the Committees. In addition, the sponsor needs to review the detailed budget carefully. There appear to be errors in the budget.

Upper Methow Goat Creek Acquisition Project (Not Fundable)

The Committees recommend that this project, sponsored by the Methow Conservancy, should not be submitted as a full proposal to the Tributary Committees for the following reason:

- The Committees are not interested in funding a conservation easement. Rather, they would be interested in funding a fee simple acquisition.

Merritt Oxbow Design Project (Not Fundable)

The Committees recommend that this project, sponsored by Cascade Columbia Fisheries Enhancement Group, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees believe the side channel should remain a high-flow channel.

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[2] Here, the Committees use "capacity" to mean that they would not fund salaries for a team of people knowing that the project will not necessarily result in $500,000 worth of biological benefit. Since 2014, the Committees have elected to fund tangible components of similar projects, such as installing BDAs. They are not interested in funding the existence of beaver restoration programs.

- The Committees are concerned that a perennial channel will become disconnected in the near future (questionable longevity) and they wonder how a perennial channel will be maintained over time.
- The Committees question whether the transmission towers will be an issue.
- Finally, the sponsor needs to make sure all landowners are on board with the project (need signed landowner agreements).

Goodwin Side Channel Design Project (Not Fundable)

The Committees recommend that this project, sponsored by Cascade Columbia Fisheries Enhancement Group, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees would like to see the channel remain as a high-flow channel. Because this channel is functioning as a high-quality, high-flow side channel, transforming it into a perennial channel may reduce or destroy the existing high-quality habitat.
- The Committees believe the cost of the project is too high.

MC Hancock Springs Restoration Phase 4 Project (Not Fundable)

The Committees recommend that this project, sponsored by the Methow Conservancy, should not be submitted as a full proposal to the Tributary Committees for the following reason:

- The cost of the project is too high given the possible benefits identified in the draft proposal (i.e., the project is not cost effective).

VI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from March to May:

   Rock Island Plan Species Account:

   - $87.50 to Clifton Larson Allen for Rock Island financial administration in March 2018.
   - $117.50 to Clifton Larson Allen for Rock Island financial administration in April 2018.
   - $591.65 to Chelan County PUD for project coordination and administration during the first quarter of 2018.
   - $6,500.00 to Cascade Chelan Appraisal for the appraisal of the Wenatchee Sleepy Hollow Floodplain Acquisition Project.

   Rocky Reach Plan Species Account:

   - $87.50 to Clifton Larson Allen for Rocky Reach financial administration in March 2018.
   - $117.50 to Clifton Larson Allen for Rocky Reach financial administration in April 2018.
   - $591.20 to Chelan County PUD for project coordination and administration during the first quarter of 2018.
   - $13,090.00 to Cascade Columbia Fisheries Enhancement Group for the Burns-Garrity Restoration Design Project.

Wells Plan Species Account:

- $395.23 to Chelan County PUD for project coordination and administration during the first quarter of 2018.
- $600.00 to Cascade Chelan Appraisal for preparation and meeting with the Tributary Committees to discuss the M2-Mid Sugar Acquisition Project.
- $720.49 to Cascade Columbia Fisheries Enhancement Group for the Methow Basin Barrier and Diversion Assessment Project.

2. Tracy Hillman reported that he received an email from Jason Lundgren (CCFEG) asking the Committees for direction on how to proceed with the Chiwawa Nutrient Enhancement Project. In his email, Jason indicated that he received an email from the Forest Service (Kathy McMillan) stating that Judy Neibauer (USFWS) does not support the project and has raised enough concerns that the Forest Service is unwilling to move forward with the project. In her email to the Forest Service, Judy stated, "*Adverse effects to bull trout would likely occur with the current treatment sites directly in the spawning habitat…There are likely other higher priority areas we should think about for first, like Nason Creek or the Little Wenatchee, where we know numbers of salmon and bull trout are really low…If you are still thinking of this as a pilot project, prior to completing a larger feasibility assessment, my suggestion is to complete this somewhere where there are no adverse effects to bull trout.*" Jason is very concerned that Judy's comments have derailed a proposed project, which is based on solid scientific information and a large investment in time and money (the Rock Island Committee has invested about $90,000 into this project).

   Catherine Willard noted that the USFWS completed a Biological Opinion on hatchery programs within the Wenatchee River basin. In that Opinion, the USFWS evaluated the effects of nutrient enhancement on bull trout. In the Opinion, the USFWS states, "*Our analysis of Project effects in the enclosed biological opinion leads us to conclude that implementation of the proposed Project will not jeopardize the continued existence of the bull trout, nor will it destroy or adversely modify designated critical habitat for the bull trout.*" In short, as long as the reasonable and prudent measures are followed, there is no jeopardy. Thus, what Judy is saying appears to be in contrast to the USFWS Biological Opinion for the PUD hatchery programs in the Wenatchee River basin.

   After further discussion, the Committees recommended that Jason elevate this issue to the Regional Director in Lacy, WA. In addition, Justin Yeager will set up a conference call with Jason Lundgren, Emily Johnson (USFS), and Catherine Willard to discuss ways to move the project forward.

3. Tracy Hillman reminded the Committees that project sponsors will give presentations on 13 and 14 June. Final proposals are due on Friday, 29 June. The Committees will evaluate final proposals and make funding decisions on Thursday, 12 July.

VII. Icicle Fish Screening Projects (Joint Discussion with the PRCC Habitat Subcommittee)

Tracy Hillman said he and Denny Rohr (PRCC HSC Facilitator) received an email from Mike Kaputa (CCNRD) on 15 May asking the Committees to consider a revised approach for funding the Icicle Irrigation District (IID) and City of Leavenworth screens in Icicle Creek. Tracy shared the email with the Committees on 17 May and reviewed it with the Committees during the meeting.

In his email, Mike indicated that the Icicle Work Group has $372,000 from the Office of the Columbia River (OCR), an undisclosed amount from the City of Leavenworth, and an anticipated $100,000 from IID. Mike stated further that the Work Group would like to use the funds from OCR, combined with the

City of Leavenworth cost share, to bring the City of Leavenworth fish screen into compliance. Thus, no HCP Plan Species Account Funds would be used for the City of Leavenworth screen. The anticipated $100,000 from IID would be the cost share on the IID screening project. In his email, Mike asked if the Committees' requirement of a 25% cost share would be satisfied under this proposed strategy (i.e., fully funding City of Leavenworth screen with OCR and City funds, and an anticipated $100,000 from IID for their screen).

After a lengthy discussion, the Committees concluded that the proposed strategy does not meet their 25% cost-share requirement. The Committees view the fish screens as two separate projects, not as a single project. This is because there are two separate diversions owned by two different entities (IID and City of Leavenworth) and potentially funded by different Committees. Therefore, both diversions need a 25% cost share if funding is requested from the Committees. This does not mean the Work Group cannot use the OCR funds to fully fund the City of Leavenworth screen. If that happens, IID will still need a 25% cost share if the Work Group intends to seek funding from the Committees. The Committees recommend that the Work Group use the OCR funds to help cover the cost share on both screening projects. Any shortage in the 25% cost share per project will need to be made up by the owners of the diversions or other funds.[3]

The Committees also offered the following comments/requirements:

1. It is not clear if CCNRD is helping WDFW with their proposal or if CCNRD is considering submitting their own proposal to address screens in Icicle Creek. In January, the Committees determined that the Icicle screening proposal from WDFW was incomplete and the Committees requested additional information. Because WDFW has not withdrawn their proposal (and the Committees did not reject it), CCNRD needs to work with WDFW on updating the WDFW proposal. If WDFW decides to withdraw their proposal, CCNRD can submit a new proposal.
2. The HCP Tributary Committees will <u>not</u> contribute funds to the screening project(s) unless there is written permission from both the City of Leavenworth and IID to allow implementation of the fish passage project at the boulder field. Indeed, without fish passage at the boulder field, there will be little benefit to HCP Plan Species in the vicinity of the intake structures. These projects are not cost effective if very few steelhead benefit from the screening efforts. Fish passage at the boulder field is a requirement in order to secure funding from HCP Plan Species Account Funds.
3. Related to #2 above, there can be no strings attached to the funding and implementation of the fish passage and screening projects. That is, in their letter of support for fish passage, IID stated: "*This agreement would have to have an incidental take permit and hold harmless agreement to cover our continued diversion with our current screens until our new screens are constructed at no cost to the Districts*" (from the WDFW proposal). This is unacceptable and for the Committees to consider funding the screening project, they would need a letter from IID stating that the fish passage and screening projects are not contingent on any other agreements

The Committees directed Tracy to share this information with Mike.

VIII. Next Steps

The Committees will not meet officially in June. Rather, they will attend the presentations by project sponsor on 13 and 14 June. The next meeting of the Tributary Committees will be on Thursday, 12 July 2018 at Grant PUD in Wenatchee. At that time, they will evaluate final proposals.

[3] Based on the proposal received from WDFW, the cost of the IID screen is $1,645,000 and the cost for the City of Leavenworth screen is $476,000. A 25% cost share for each would equate to $411,250 for the IID screen and 119,000 for the City of Leavenworth screen. Given that the Work Group has secured about $472,000, the cost share is short by about $58,250.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 12 July 2018

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 12 July 2018 from 9:00 am to 12:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the following additions:

- Review email from Chelan County on the Peshastin Creek RM 8.8 Reconnection Project.
- Review email from WDFW on Icicle Creek Screening Projects.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 23 May 2018 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Clear Creek Fish Passage and Instream Flow Project – The sponsor (Trout Unlimited; TU) reported that the new water line connecting the well with the existing storage tank and distribution system is complete and passed the pressure test. The new water treatment building is nearing completion.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) continues to work on the final design review. They are also working on private landowner easements. With financial help from the Colville Confederated Tribes, they were able to purchase pipe for the project (cost of pipe was about $2 million).
- Icicle Boulder Field Project – The sponsor (TU) will soon submit draft permits to the regulatory agencies. They received feedback from the City of Leavenworth on the passage project and are waiting to hear from the Icicle Peshastin Irrigation District.

- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – By 31 December 2018, the sponsor (Washington Department of Fish and Wildlife; WDFW) will submit the third-year monitoring report on work conducted in 2018.
- Permitting Nutrient Enhancement Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) reported that the issues raised by the USFWS and USFS have mostly been resolved. It also appears they will receive about 40,000 pounds of nutrient analogs for free. Thus, they would like to begin treating the Chiwawa River this year. To that end, they asked the Rock Island Tributary Committee if they need to submit a scope and budget change for the project, or submit a new proposal. Recall that the Rock Island Tributary Committee approved the implementation of the project in 2013, but the contract was never signed because the sponsor did not have a cost share. Given the long time period since the approval of the original project, the Committee said the sponsor will need to submit a new proposal for implementing the project.
- Burns-Garrity Design Project – The sponsor (CCFEG) did not provide an update on this project.
- Beaver Fever Project – The sponsor (TU) reported they are making progress on installing beaver dam analogs (BDAs) in Derby Creek. After several site visits to collect data and photos, they met with the landowner, who supports the installation of BDAs in 5-7 locations on his property. The sponsor is also working with the Forest Service on installing BDAs in Potato Creek. Installation will likely occur in 2019. The sponsor still needs to address NEPA issues.
- Wenatchee Sleepy Hollow Floodplain Acquisition Project – The sponsor (Chelan-Douglas Land Trust; CDLT) reported there is no new activity on this project. However, they did request a budget increase of about $131,000, which will cover the increased value of the acquisition, required building demolition, and stewardship (see budget amendment and time extension request below).
- M2 Mid-Sugar Acquisition Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that the Purchase and Sale Agreement was delivered to the landowner for review.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) did not provide an update on this project.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) did not provide an update on this project.

IV. Budget Amendment and Time Extension

Wenatchee Sleepy Hollow Floodplain Acquisition Project

The Rock Island Tributary Committee received a budget amendment and time extension request from CDLT on the Wenatchee Sleepy Hollow Floodplain Acquisition Project. Because of increased land value and other incidental changes (required demolition of existing buildings), the sponsor requested a budget increase of $65,560, which includes $10,000 for stewardship. Thus, the total contribution from the Rock Island Plan Species Account Fund would increase from $156,250 to $221,810. The sponsor also asked the Committee to extend the completion date from 30 June 2019 to 30 November 2019.

After review and discussion, the Committee agreed to contribute an additional $55,560 to the acquisition project. The Committee elected not to contribute $10,000 for stewardship. They believe the landowner should cover that cost. Thus, the approved budget amendment increases the total contribution from the Committee to $211,810. The Committee also approved the time extension request. The approved completion date for the project is 30 November 2019.

V. General Salmon Habitat Program Proposals

The Committees received 11 General Salmon Habitat Program proposals. Before reviewing the proposals and consistent with the Committees' Operating Procedures, members of the Committees identified potential conflicts of interest. No members identified conflicts of interest.

Burns-Garrity Perennial Side-Channel Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Burns-Garrity Perennial Side-Channel Project. The purpose of this project is to construct a half-mile, perennial, side channel on private property (with conservation easement) and WDFW property located at RM 3.2 on the Chewuch River. This project will create year-round, off-channel, rearing habitat for juvenile Chinook, steelhead, bull trout, and other native fish. The total cost of the project is $735,000. The sponsor requested $316,000 from HCP Plan Species Account Funds. ***The Wells Tributary Committee approved funding for this project.***

The Committee believes the cost of $97,000 for vegetation planting is excessive. They asked the sponsor to consider seeding the area with herbaceous vegetation (native seed mix) immediately after the project is completed to minimize the establishment of noxious weeds and surface erosion. They also recommended that the sponsor delay planting of riparian woody vegetation at least one growing season after the project is complete. The Committee believes that most native woody vegetation will respond aggressively post-ground disturbance and may save the project a considerable amount of money.

Cottonwood Flats Floodplain Restoration Entiat River (RM 17.65) Project

Chelan County Natural Resources Department is the sponsor of the Cottonwood Flats Floodplain Restoration Entiat River Project. The purpose of this project is to complete final designs and permitting, and reconnect six acres of floodplain habitat and side channels near RM 17.7 on the Entiat River. This project will increase seasonal, high-flow rearing and refugia habitat for juvenile Chinook and steelhead and increase alcove habitat during low flows. The total cost of the project is $600,598. The sponsor requested $90,090 from HCP Plan Species Account Funds. ***The Rocky Reach Tributary Committee approved funding for this project.***

The Committee recommended that the sponsor maximize the inlet connection, include a perennial connection at the outlet, and remove the road fill and let the stream cut its own channels through the floodplain. As part of funding for this project, the Committee requires that they have an opportunity to review the 80% design.

Entiat Basin Fish Passage and Screening Assessment Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Entiat Basin Fish Passage and Screening Assessment Project. The purpose of the project is to conduct a comprehensive fish passage and screening assessment throughout the Entiat Subbasin. The total cost of the project is $76,142. The sponsor requested $25,500 from HCP Plan Species Account Funds. ***The Rocky Reach Tributary Committee approved funding for this project.*** The Committee noted that funds from the Plan Species Account can only be used to assess barriers within the distribution of Plan Species.

Goodwin Side Channel Design Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Goodwin Side Channel Design Project. The purpose of this project is to collect data, work through feasibility, and produce a preliminary design for an upstream connection to an existing 1,200-foot side channel at RM 12 on the Wenatchee River. The total cost of the project is $102,500. The sponsor requested $45,000 from HCP Plan Species Account Funds. ***The Tributary Committees elected not to fund this project***.

Although the Committees generally support floodplain reconnection projects, they believe this project is too expensive and they are concerned that the resulting project may reduce or destroy existing riparian habitat, which is currently functioning properly.

Lower Entiat Tributaries – Aquatic Habitat Assessments Project

Cascadia Conservation District is the sponsor of the Lower Entiat Tributaries – Aquatic Habitat Assessments Project. The purpose of the project is to work with the Forest Service on conducting assessments in the Mad River and Roaring Creek within the Entiat Subbasin. This work will help identify enhancement and protection projects within the two streams. The total cost of the project is $211,010. The sponsor requested $45,000 from HCP Plan Species Account Funds. ***The Tributary Committees elected not to fund this project***.

The Committees believe there are few opportunities to significantly improve habitat conditions and biological benefit within the two streams. The Forest Service road system is likely the factor most affecting habitat conditions within the Mad River. Stream flows and possible fish passage barriers are or have been addressed in Roaring Creek.

Merritt Oxbow Design Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Merritt Oxbow Design Project. The purpose of this project is to collect data, work through feasibility, and produce a preliminary design to improve connectivity of two oxbows located at RM 10.4 on Nason Creek. The total cost of the project is $110,500. The sponsor requested $30,000 from HCP Plan Species Account Funds. ***The Tributary Committees elected not to fund this project***.

Although the Committees generally support floodplain reconnection projects, they questioned the certainty of success and longevity of this project. They were also concerned that the outlet of the proposed project may not be connected at low flows because of the actively aggrading bar near the outlet of the side channel.

Methow Beaver Project – Beaver and Anadromy

Methow Salmon Recovery Foundation is the sponsor of the Methow Beaver Project – Beaver and Anadromy. The purpose of the project is to use beavers to help enhance salmonid habitat within the anadromous zone in the Methow River basin. Nuisance beavers will be captured and relocated to areas where they can improve habitat conditions. Beaver dam analogs will be installed at release locations to increase certainty of success. The total cost of the project is $499,576. The sponsor requested $180,574 from HCP Plan Species Account Funds. ***The Tributary Committees elected not to fund this project***.

The Committees believe the project is too expensive and the Plan Species Account Funds would go primarily to fund program capacity, without much certainty regarding biological benefit. At this time, the Committees are not interested in funding the existence of beaver restoration programs.

Methow Watershed Riparian Stewardship Program II Project

Methow Salmon Recovery Foundation is the sponsor of the Methow Watershed Riparian Stewardship Program II Project. The purpose of the project is to provide additional maintenance to riparian restoration sites within the Methow Subbasin. The goal is to increase riparian plant survival from 60% to 80%. The total cost of the project is $116,721. The sponsor requested $19,373 from HCP Plan Species Account Funds. ***The Tributary Committees elected not to fund this project***.

The Committees were unable to determine the cost effectiveness of this project because the application lacked information on the size of the proposed action, including existing site characteristics and conditions, and the suite of enhancement actions that had been implemented at those locations.

Monitor Side Channel Design and Construction Project

Chelan County Natural Resources Department is the sponsor of the Monitor Side Channel Design and Construction Project. The purpose of the project is to design, permit, and install 5-6 engineered log jams in the Monitor side channel located at RM 6 on the Wenatchee River. This work will provide additional juvenile salmonid rearing habitat at lower flows. The total cost of the project is $294,000. The sponsor requested $44,100 from HCP Plan Species Account Funds. ***The Rock Island Tributary Committee approved funding for this project.***

The Committee indicated that funds from the Plan Species Account can only be used to prepare designs. The Committee believes the side channel would benefit from adding complexity and narrowing and deepening the channel; however, they are not convinced the proposed level of effort will successfully narrow and deepen the channel. Therefore, they recommend that the sponsor increase the number of elements necessary to narrow and deepen the channel without over-engineering the project. As part of funding for this project, the Committee requires that they have an opportunity to review the designs.

Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project

Methow Salmon Recovery Foundation is the sponsor of the Twisp River Floodplain Left Bank Spring-fed Alcove Restoration Project. The purpose of the project is to enhance water quality in a spring-fed alcove by establishing fencing to exclude livestock grazing, provide off-channel watering equipment, replace two undersized road culverts, and restore riparian vegetation to address existing noxious weeds on the sites. The project is located at RM 4.1 on the Twisp River. The total cost of the project is $42,348. The sponsor requested $17,779 from HCP Plan Species Account Funds. ***The Wells Tributary Committee approved funding for this project.***

Wenatchee EDT Model Development Project

Chelan County Natural Resources Department is the sponsor of the Wenatchee EDT Model Development Project. The purpose of the project is to build a model-based synthesis platform for ecological monitoring data to support habitat status and trends reporting and aid restoration planning and prioritization. The total cost of the project is $273,000. The sponsor requested $92,500 from HCP Plan Species Account Funds. ***The Tributary Committees elected not to fund this project***.

Before funding additional model work in the Wenatchee River basin, the Committees would like to see how successful EDT is in identifying and guiding restoration work in the Methow Subbasin. The Committees acknowledge that EDT has been used successfully in the Okanogan Subbasin; however, practitioners collected monitoring data specifically for EDT there. Such data have not been collected in the Methow Subbasin and the Committees would like to see if EDT performs in the Methow as well as it does in the Okanogan Subbasin.

Summary of Review of 2018 General Salmon Habitat Program Projects

Project Name	Sponsor[1]	Total Cost	Request from T.C.	T.C. Contribution[2]
Burns Garrity Perennial Side Channel	CCFEG	$735,000	$316,000	W: $316,000
Cottonwood Flats Floodplain Restoration Entiat River	CCNRD	$600,598	$90,090	RR: $90,090
Entiat Basin Fish Passage and Screening Assessment	CCFEG	$76,142	$25,500	RR: $25,500
Goodwin Side Channel	CCFEG	$120,500	$45,000	$0
Lower Entiat Tributaries Aquatic Habitat Assessment	CCD	$211,010	$45,000	$0
Merritt Oxbow	CCFEG	$110,500	$30,000	$0
Methow Beaver Project – Beavers and Anadromy	MSRF	$499,576	$180,574	$0
Methow Watershed Riparian Stewardship Program II	MSRF	$116,721	$19,373	$0
Monitor Side Channel Design and Construction	CCNRD	$294,000	$44,100	RI: $44,100
Twisp River Floodplain Spring-fed Alcove Restoration	MSRF	$42,348	$17,779	W: $17,779
Wenatchee EDT Model Development	CCNRD	$273,000	$92,500	$0
Total:		**$3,079,395**	**$905,916**	**$493,469**

[1] CCD = Cascadia Conservation District; CCFEG = Cascade Columbia Fisheries Enhancement Group; CCNRD = Chelan County Natural Resources Department; MSRF = Methow Salmon Recovery Foundation.

[2] RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.

VI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from June and July:

   Rock Island Plan Species Account:

   - $120.00 to Clifton Larson Allen for Rock Island financial administration in May 2018.
   - $110.00 to Clifton Larson Allen for Rock Island financial administration in June 2018.
   - $521.24 to Chelan County PUD for project coordination and administration during the second quarter of 2018.
   - $900.00 to Walters Appraisal Service for the appraisal of the Wenatchee Sleepy Hollow Floodplain Acquisition Project.
   - $1,049.68 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project.
   - $1,512.92 to Trout Unlimited – Washington Water Project for the Beaver Fever – Restoring Ecosystem Function Project.

   Rocky Reach Plan Species Account:

   - $120.00 to Clifton Larson Allen for Rocky Reach financial administration in May 2018.
   - $110.00 to Clifton Larson Allen for Rocky Reach financial administration in June 2018.
   - $434.07 to Chelan County PUD for project coordination and administration during the second quarter of 2018.
   - $12,698.01 to Cascade Columbia Fisheries Enhancement Group for the Burns-Garrity Restoration Design Project.
   - $91,692.41 to Trout Unlimited – Washington Water Project for the Clear Creek Fish Passage and Instream Flow Enhancement Project.

   Wells Plan Species Account:

   - $289.11 to Chelan County PUD for project coordination and administration during the second quarter of 2018.
   - $43,690.00 to Inland Professional Title for the M2-Mid Sugar Acquisition Project.
   - $2,023.99 to Cascade Columbia Fisheries Enhancement Group for the Methow Basin Barrier and Diversion Assessment Project.

2. Tracy Hillman shared with the Committees an email he received from Jennifer Hadersberger (CCNRD) regarding the Peshastin Creek RM 8.8 (Blewett Rock and Gravel) project. As a bit of background, several years ago, CCNRD secured funds from the SRFB to design a channel

reconnection project near RM 8.8 on Peshastin Creek. The conceptual design was completed and proposed a full reconnection of Peshastin Creek to the historical channel at an estimated cost of $14 million. Because of the high cost of the project, the County did not pursue funding for implementation of the project. The County is now considering a scaled-down version of the design. To that end, Jennifer would like to give a presentation to the Committees describing the scaled-down design and cost estimates for land protection (conservation easement or acquisition).

After discussion, the Committees decided they do not want to hear a presentation on this project until a contamination survey is completed. Once the survey is completed, they would entertain a presentation on the project. In addition, the Committees indicated they are not interested in funding the contamination survey. They recommend the sponsor seek those funds from Washington Department of Ecology.

3. Tracy Hillman shared with the Committees an email he received from Jeff Dengel (WDFW) regarding the Icicle Creek Fish Screening Projects. In the email, Jeff describes how WDFW is attending to the screening projects and how the projects fit within the Icicle Strategy. At the end of the email, Jeff asked the Committees two questions: (1) *Beyond landowner permissions and Tribal concurrence in the form of a MOU, can you please define what the Committees need to indicate their assurance of boulder field passage before funding screen construction?* and (2) *You state that the Committees need a letter from IID asserting that fish passage and screening projects, "are not contingent on any other agreements." We are unclear of what the committee members were considering in this regard. There may, in fact need to be a MOU/MOA between Trout Unlimited, WDFW, and IID in order to achieve permissions from IID. While the specifics of this MOU are still under deliberation, it will likely attend to the implementation timing. Would such an agreement violate this stipulation?* The Committees reviewed these questions and offered the following responses.

    1. *Beyond landowner permissions and Tribal concurrence in the form of a MOU, can you please define what the Committees need to indicate their assurance of boulder field passage before funding screen construction?*

       The Committees require a letter from both the Icicle Irrigation District and the City of Leavenworth indicating that they support the boulder field passage project and that they will allow access to the boulder field, so the fish passage project can be completed. The reason for this is because Plan Species Account Funds can only be used to enhance conditions that benefit HCP Plan Species (summer steelhead, spring and summer Chinook, coho salmon, and sockeye salmon). Without fish passage at the boulder field, HCP Plan Species will benefit little from the screening projects. Thus, the screening projects will neither be cost effective nor eligible for funding by the Committees unless HCP Plan Species are allowed access to habitat upstream from the boulder field. The letters should be addressed to my attention and include the MOU.

    2. *You state that the Committees need a letter from IID asserting that fish passage and screening projects, "are not contingent on any other agreements." We are unclear of what the committee members were considering in this regard. There may, in fact need to be a MOU/MOA between Trout Unlimited, WDFW, and IID in order to achieve permissions from IID. While the specifics of this MOU are still under deliberation, it will likely attend to the implementation timing. Would such an agreement violate this stipulation?*

       No, the MOU/MOA will not violate the Committees' stipulation that fish passage and screening projects are not contingent on any other agreements. The Committees were responding to a letter submitted by the Icicle and Peshastin Irrigation Districts that accompanied the WDFW proposal. In the letter (see Attachment 1), written by Mr. Jantzer (dated January 11, 2018), IPID stated: "*We would be willing to allow construction to start on* *the boulder field prior to the completion of our fish screens if we could get a concrete agreement with funders, the state, and federal fisheries folks. This agreement needs to cover who will fund, what will be built where, when, and the effects of not having the screens updated in the interim. This agreement would have to have an incidental take permit and hold harmless agreement to cover our continued diversion with our current screens until our new screens are constructed at no cost to the Districts.*" Specifically, the Committees were responding to the last sentence indicating that IPID would have to have an incidental take permit and hold harmless agreement. The Committees have no regulatory authority and therefore cannot provide such an agreement. In addition, the Committees understand that the federal agencies with regulatory authority cannot provide such an agreement. Therefore, the Committees asked for a letter from IPID stating that the implementation of the boulder fish passage and screening projects are not contingent on an incidental take permit and hold harmless agreement.

The Committees directed Tracy to share these responses with Jeff.

VII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 9 August 2018 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
Letter from IPID

Icicle Directors
Melvin Weythman
Dennis Rudolph
Craig Christensen

Peshastin Directors
James Koempel
Richard Smithson
Daryl Harnden

Anthony Jantzer, Secretary Manager
Levi Jantzer, Assistant Manager
Telephone: (509) 782-2561
Fax: (509) 782-8233

Icicle & Peshastin Irrigation Districts
Chelan County
5594 Westcott · Post Office Box 371
Cashmere Washington 98815-0371

January 11, 2018

Potential Funders
Icicle Creek Boulder Field Fish Passage
And Fish Screens

Subject: Icicle Creek Boulder Field Fish Passage

Dear Committee Member

Icicle and Peshastin Irrigation Districts have been very consistent in our support of fish passage at the boulder field in Icicle Creek. Trout Unlimited has been through several renditions of plans for passage at the boulder field and the district is on board with what we believe is the latest design. Our major concern currently is that there is a push to complete the boulder field project ahead of updating the fish screens for the City of Leavenworth and our diversions. Our fish screens were not upgraded like all other major diverters in the state due to the boulder field impassability. We would be willing to allow construction to start on the boulder field prior to the completion of our fish screens if we could get a concrete agreement with funders, the state, and federal fisheries folks. This agreement needs to cover who will fund, what will be built where, when, and the effects of not having the screens updated in the interim. This agreement would have to have an incidental take permit and hold harmless agreement to cover our continued diversion with our current screens until our new screens are constructed at no cost to the Districts.

Attached are two pervious letters that I have sent on this matter. We do not want to hold up the boulder field project; we feel that it is a great project with much potential, but we do not want to put fish or our selves in jeopardy. We feel that there has been plenty of time since the start of the project to address our screen issue, but little has been done to address this part of the project. We stated back in June of 2012 that replacement of our screens had to be an integral part of the project. If you would like to discuss this further, please contact me. My cell phone number is 509 433-4064 and my email address is tony.iid.pid@nwi.net.

Sincerely

Anthony D. Jantzer
Secretary, Manager

2 Attached
Letter dated Jun 2012
Letter dated Nov 2015

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 13 September 2018

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 13 September 2018 from 10:00 am to 12:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 12 July 2018 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- <u>Clear Creek Fish Passage and Instream Flow Project</u> – The sponsor (Trout Unlimited; TU) reported that construction is complete. They are waiting for the civil engineer to stamp and sign the Department of Health (DOH) Construction Completion Report. Once the report is signed, they will send it to DOH for approval. This will complete Phase I of the project.
- <u>Barkley Irrigation – Under Pressure Project</u> – The sponsor (TU) reported they are dividing the project into nine different phases. They intend to contract the phases over the next three years. The first phase will include the satellite well system, which will go to bid in 2018. The sponsor continues to work on permitting, funding coordination, and easements.
- <u>Icicle Boulder Field Project</u> – The sponsor (TU) reported they finally received all of the approvals they need for permits. The Joint Aquatic Resource Permit Application (JARPA) and Biological Assessment have been submitted to the Army Corps of Engineers. Construction is planned for 2019. Kate Terrell indicated that the project is short about $1,000,000.
- <u>Peshastin Creek RM 10.5 PIT-Tag Detection Site Project</u> – By 31 December 2018, the sponsor (Washington Department of Fish and Wildlife; WDFW) will submit the third-year monitoring report on work conducted in 2018.

- Permitting Nutrient Enhancement Project – This project is complete. The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) submitted the final report and the Treatment and Effectiveness Monitoring Plan. These reports were uploaded to the Extranet Site.
- Burns-Garrity Design Project – The sponsor (CCFEG) reported that WDFW approved the 30% design; however, WDFW expressed concern about the effects of the project on mature riparian vegetation and they (WDFW) may not support the placement of spoils onsite.[1] The sponsor continues to work with WDFW on these issues. In the meantime, the consultant is working on the 60% design. The sponsor is also in the final stages of contracting with BPA, which, along with Tributary Committee funding, will fully fund construction in 2019.
- Beaver Fever Project – The sponsor (TU) reported that in August they received the Hydraulic Project Approval (HPA) permit to install beaver dam analogs (BDAs) in Derby Creek, a tributary to the Wenatchee River. Installation occurred the week of August 13th. The sponsor is looking for the next site to install BDAs.
- Wenatchee Sleepy Hollow Floodplain Acquisition Project – The sponsor (Chelan-Douglas Land Trust; CDLT) submitted a payment request for acquisition of the property.
- M2 Mid-Sugar Acquisition Project – The sponsor (Methow Salmon Recovery Foundation; MSRF) reported that the project is complete. We should receive the final report soon.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) did not provide an update on this project.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) did not provide an update on this project.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported that they anticipate receiving salmon carcass analogs soon and will place the analogs in the river this year. They are waiting on final approval from the USFS; however, the Forest Service told them to move forward with placing analogs in the river. The sponsor will meet with WDFW to discuss effectiveness monitoring efforts and CCFEG is working with Peter Burgoon (PACE Engineers) to set up the water-quality monitoring plan.

IV. Time Extension Request

Derby Creek Fish Passage Project

The Rock Island Tributary Committee received a time extension request from CCFEG on the Derby Creek Fish Passage Project. Because the sponsor is waiting on WDFW to complete the 60% designs, the sponsor asked the Committee to extend the completion date from 31 December 2018 to 1 December 2019. After consideration, the Rock Island Tributary Committee approved the time extension request.

V. Salmon Recovery Funding Board Proposal Rankings

Tracy Hillman shared with the Committees the ranking of SRFB proposals by the Citizens Advisory Committees (CAC) (see Attachment 1). Several of these projects were cost shares with the Tributary Committees. Tracy noted that the CAC decided to reduce funding for the top projects by 10% to allow more projects to be funded. Specifically, the CAC wanted to make sure there was enough funding available to support the Methow Watershed Riparian Stewardship Program II project. Thus, some of the

[1] Following the meeting, CCFEG indicated that WDFW is concerned about the effects of placing spoils on-site without a long-term maintenance/weed-management commitment from CCFEG. It appears the sponsor will have to consider hauling spoils off site, which will increase cost and vehicle traffic on local roads.

top projects will need an additional cost share. As a result, sponsors may ask the Tributary Committees for additional funding. This is yet to be determined.

Tracy noted that the Upper Columbia Regional Technical Team (UCRTT) was not pleased with the CAC's decision to reduce funding for the top projects. If project sponsors cannot find sufficient cost shares, they may have to reduce the scope of their projects. This means the biological benefits estimated by the UCRTT will change and that could affect the overall ranking of projects.

VI. General Salmon Habitat Program Application

Chiwawa Nutrient Enhancement Project

In August, the Committees received a General Salmon habitat Program proposal from CCFEG titled: *Chiwawa Nutrient Enhancement*. The purpose of the project is to apply carcasses or salmon carcass analogs to the river to increase direct and indirect food sources for juvenile salmonids. The sponsor proposes to treat a five-mile reach of the Chiwawa River (RM 17-22) twice per year for five years. They will perform water quality and effectiveness monitoring (in partnership with WDFW) through the entire project. The total cost of the project is $267,650 ($53,530 per year). The sponsor requested the entire amount from the Plan Species Account Funds. In August, the Rock Island Tributary Committee approved funding for the project.

VII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from August and September:

   Rock Island Plan Species Account:

   - $110.00 to Clifton Larson Allen for Rock Island financial administration in July 2018.
   - $140.00 to Clifton Larson Allen for Rock Island financial administration in August 2018.
   - $211,810.00 to First American Title for the Wenatchee Sleepy Hollow Floodplain Acquisition Project.
   - $237.27 to Cascade Columbia Fisheries Enhancement Group for the Permitting Nutrient Enhancement in the Chiwawa Project. This is the final payment on this project.
   - $461.15 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project.

   Rocky Reach Plan Species Account:

   - $110.00 to Clifton Larson Allen for Rocky Reach financial administration in July 2018.
   - $140.00 to Clifton Larson Allen for Rocky Reach financial administration in August 2018.
   - $32,924.28 to Trout Unlimited – Washington Water Project for the Clear Creek Fish Passage and Instream Flow Enhancement Project.

   Wells Plan Species Account:

   - $2,160.00 to Douglas County PUD for Wells Administration.

- $23,300.00 to Cascade Columbia Fisheries Enhancement Group for the Methow Basin Barrier and Diversion Assessment Project.

2. The Committees talked about the possibility of identifying high-priority projects within each of the subbasins (Wenatchee, Entiat, Methow, and Okanogan) and calling for proposals. This is similar to the Bonneville Power Administration Targeted Solicitation Process. Although the Committees will continue to accept project applications from sponsors anytime during the year, they would like to take a more active role in identifying and funding targeted projects within each subbasin. To that end, each member of the Committees will identify priority projects within each subbasin. Tracy will compile the recommendations and the Committees will discuss targeted projects during their next meeting.
3. The Committees discussed the need to visit completed projects. In 2016 the Committees developed a list of possible projects they would like to visit. They reviewed that list and requested that Tracy and Becky update the list with recently completed projects and resend it to the Committees. Tracy will send the updated list to members by Monday, 17 September. Each member will then select ten projects they would like to visit and return the list to Tracy by Friday, 21 September. Tracy and Becky will then identify the top ranked projects for a site visit. They will coordinate with project sponsors and attempt to set up site visits on 11 October (date of the next Tributary Committees meeting).
4. Chris Fisher reported there will be no tour of projects or potential projects in Canada this year. Identification of potential projects in the upper Okanagan River basin is not far enough along to justify a field trip. A tour will likely occur in 2019.

VIII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 11 October 2018 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
SRFB Project Scores and Ranks

2018 SRFB/TRIB Project Scores & Ranks

				Amount Requested					
Sponser	Project Name	Subbasin	Project Type	SRFB Request	SRFB Allocation	SRFB Running Total*	RTT Score	Joint CAC Ranking (Regional List)	County Rank
MC	MC Hancock Springs Restoration Phase 4*	Methow	Restoration	$567,068	$510,361	$510,361	87	1	1
CCD	Middle Entiat River Restoration – Gray Reach – Area F – River Mile 16.2-16.7*	Entiat	Restoration/ Protection	$401,637	$361,473	$871,835	81	2	1
MSRF	Methow Watershed Riparian Stewardship Program II	Methow	Restoration	$97,348	$97,348	$969,183	57	3	2
CCNRD	Cottonwood Flats Floodplain Restoration Entiat River (RM 17.65)*	Entiat	Restoration	$510,508	$459,457	$1,428,640	73	4	2
~~CCFEG~~	~~Burns-Garrity Perennial Side Channel***~~	~~Methow~~	~~Restoration~~	$0	$0	$1,428,640	78	5	3
CCFEG	Entiat Basin Fish Passage and Screening Assessment	Entiat	Assessment	$45,142	$45,142	$1,473,782	72	6	3
MSRF	Methow Beaver Project - Beavers and Anadromy	Methow	Restoration	$205,294	$205,294	$1,679,076	67	7	4
CCNRD	Mill Creek Fish Passage Project	Wenatchee	Restoration	$131,476	$131,476	$1,810,552	67	8	5
MSRF	Twisp River Floodplain Left Bank Spring-fed Alcove Restoration	Methow	Restoration	$41,822	$41,822	$1,852,374	72	9	5
CCFEG	Merritt Oxbow	Wenatchee	Design	$80,500	$80,500	$1,932,874	70	10	4
MSRF	Upper Beaver Feasibility & Design	Methow	Design	$133,793	$133,793	$2,066,667	62	11	6
CCNRD	Wenatchee EDT Model Development**	Wenatchee	Monitoring*	$180,000	$180,000	$2,246,667	22/30	12	6
MC	Upper Methow Goat Creek Conservation Easement	Methow	Protection	$214,700	$214,700	$2,461,367	56	13	7
CCNRD	Peshastin Mill-Larsen Reach Side Channel	Wenatchee	Design	$99,010	$99,010	$2,560,377	67	14	7
CCNRD	Squilchuck Creek Fish Passage Barrier Removal Design	Wenatchee	Design	$40,000	$40,000	$2,600,377	64	15	8
CCNRD	Sleepy Hollow Side Channel Design	Wenatchee	Design	$125,504	$125,504	$2,725,881	60	16	9
CCNRD	Monitor Side Channel Design and Construct	Wenatchee	Restoration	$249,900	$249,900	$2,975,781	59	17	10
CCFEG	Goodwin Side Channel	Wenatchee	Design	$105,000	$105,000	$3,080,781	64	18	11
CCNRD	Larsen Creek Tributary Enhancement	Wenatchee	Restoration	$58,863	$58,863	$3,139,644	59	19	12
CCD	Lower Entiat Tributaries - Aquatic Habitat Assessments	Entiat	Assessment	$185,660	$185,660	$3,325,304	58	20	13
CCNRD	Chumstick Creek Fish Passage Barrier Replacement - Motteler Road	Wenatchee	Restoration	$86,162	$86,162	$3,411,466	52	21	14
CCNRD	Sand Creek Fish Passage Improvement Project	Wenatchee	Restoration	$186,691	$186,691	$3,598,157	48	22	15
CCNRD	The Ecology of Fear**: Does habitat diversity in Lk Wen lead to behavioral responses by spring Ch that reduce predation and increase growth rates?	Wenatchee	Monitoring	$139,120	$139,120	$3,737,277	22/30	23	16
CCNRD	Peshastin Creek Barrier Removal	Wenatchee	Restoration	$205,000	$205,000	$3,942,277	47	24	17
CCFEG	Wenatchee Basin Bull Trout Assessment	Wenatchee	Assessment	$105,937	$105,937	$4,048,214	54	25	18
			TOTAL	$4,196,135	$4,048,214				

* The Joint CAC decided to redude the amount funded by 10% to allow for more projects to receive funding.

** A maximum of 10% of the Upper Columbia allocation can be used for monitoring, therefore only one project can be selected.

	~~Burns-Garrity Perennial Side Channel~~	~~Methow~~	Pulled
~~TU~~	~~Methow River Watershed LiDAR Acquisition~~	~~Methow~~	Pulled
~~CCFEG~~	~~Napeequa Side Channel Connection~~	~~Wenatchee~~	Pulled

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 11 October 2018

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Members Absent: Kate Terrell (USFWS).

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 11 October 2018 from 10:00 am to 12:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the following additions:

- Retention of Tributary Committees documents
- Burns-Garrity Conference Call
- Partnering with the Bureau of Reclamation on future enhancement projects

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 13 September 2018 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Clear Creek Fish Passage and Instream Flow Project – This project is complete. The sponsor (Trout Unlimited; TU) will submit a final report soon.
- Barkley Irrigation – Under Pressure Project – The sponsor (TU) reported they continue to work on bid documents. In addition, they hope to secure the easements on MVID ROW by mid-October. Pipe will be delivered the first week of November.
- Icicle Boulder Field Project – The sponsor (TU) reported they have submitted permit applications and are coordinating with WDFW on fish screening. Construction is planned for summer 2019.

- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – By 31 December 2018, the sponsor (Washington Department of Fish and Wildlife; WDFW) will submit the third-year monitoring report on work conducted in 2018.
- Burns-Garrity Design Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) reported that their consultant (Rio ASE) is working on the 60% design. During a recent site visit, the consultant noticed the inlet to the side channel was altered during high flows. Wood has accumulated in a jam upstream from the inlet to the side channel. The jam is now diverting most of the flow into a side channel on the opposite side of the river (river right). The consultant is considering possible alternatives to address this shift. The Sponsor is proposing a meeting or conference call with all stakeholders to discuss the alternatives.
- Beaver Fever Project – The sponsor (TU) is preparing to install beaver dam analogs (BDAs) in Derby Creek in early October. In addition, the sponsor is evaluating Potato Creek (post fire) to see if they can install BDAs there before the end of the year.
- Wenatchee Sleepy Hollow Floodplain Acquisition Project – The sponsor (Chelan-Douglas Land Trust; CDLT) did not provide an update on this project.
- M2 Mid-Sugar Acquisition Project – This project is complete. The sponsor (Methow Salmon Recovery Foundation; MSRF) will submit a final report soon.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) reported their crews continue to survey fish-passage barriers on private and public lands in the Methow River basin. They plan to pause their surveys in late October and resume them next summer.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) reported they should have permit-ready designs completed by the end of October.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported they received final regulatory approval from USFWS. Analogs will be added to the Chiwawa River during 15 October through 12 November.

IV. Time Extension Request

Icicle Creek Boulder Field Passage Project

The Rock Island Tributary Committee received a time extension request from Trout Unlimited on the Icicle Creek Boulder Field Passage Project. Because the sponsor is waiting on permits, the sponsor asked the Committee to extend the completion date from 30 September 2018 to 15 December 2019. After consideration, the Rock Island Tributary Committee approved the time extension request. The sponsor noted that construction will begin next summer.

V. General Salmon Habitat Program Application

Twisp Confluence Habitat Complexity Project

The Committees received a General Salmon Habitat Program proposal from the Yakama Nation (YN) titled: *Twisp Confluence Habitat Complexity Project*. The purpose of the project is to use large wood to stabilize a bank at the confluence of the Twisp River where bank erosion is threatening sewer line infrastructure for the town of Twisp. The large wood will not only protect the bank from further erosion, it will increase habitat complexity for juvenile and adult salmonids and will prevent the Army Corps of Engineers from riprapping the bank, which they have offered to do. The total cost of the project is $299,300. The sponsor requested $269,600 from the Plan Species Account Funds. The Committees tabled the proposal and requested that YN try and secure a cost share from the Army Corps of Engineers equivalent to the amount the Corps would spend on placing riprap along the eroding bank.

Although the Committees generally do not support bank stabilization projects, where stabilization is necessary, they prefer the use of wood over boulder riprap. Because the Corps of Engineers (COE) offered to protect the City of Twisp's infrastructure at the site with boulder riprap, the Committees recommend that the City of Twisp accept the COE's offer for bank protection with the stipulation that the COE fund installation of a wood structure in lieu of boulder riprap. The Committees offer to fund (pending necessary review of proposed designs) the outstanding costs of the project beyond the COE's costs for the original riprap protection. That is, the Committees would be interested in funding the difference in project costs resulting from a change in design from riprap to wood structures, if the COE (or other funding entity) contributes an amount equal to the cost of placing riprap along the eroding bank. Given that the COE is willing to stabilize the bank with riprap, the Committees believe the Corps should be able to contribute to the proposed project at the level of their original proposal to the City of Twisp for riprap bank protection.

VI. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from September and October:

   Rock Island Plan Species Account:

   - $50.00 to Clifton Larson Allen for Rock Island financial administration in September 2018.
   - $676.45 to Chelan PUD for Rock Island project coordination and administration during the third quarter of 2018.
   - $4,106.15 to Cascade Columbia Fisheries Enhancement Group for the Permitting Nutrient Enhancement in the Chiwawa Project. This is the final payment on this project.

   Rocky Reach Plan Species Account:

   - $50.00 to Clifton Larson Allen for Rocky Reach financial administration in September 2018.
   - $491.92 to Chelan PUD for Rocky Reach project coordination and administration during the third quarter of 2018.
   - $3,360.49 to Trout Unlimited – Washington Water Project for the Clear Creek Fish Passage and Instream Flow Enhancement Project.

   Wells Plan Species Account:

   - $492.00 to Chelan PUD for Wells project coordination and administration during the third quarter of 2018.
   - $13,955.52 to Cascade Columbia Fisheries Enhancement Group for the Methow Basin Barrier and Diversion Assessment Project.

2. The Committees continued their discussion on the possibility of identifying high-priority projects within each of the subbasins (Wenatchee, Entiat, Methow, and Okanogan) and calling for proposals. At this time, the Committees have identified the following possible projects:

   - Wenatchee River Basin
     - Icicle Creek Boulder Field Project

    - Upper Wenatchee (between Tumwater Canyon and Lake Wenatchee) Habitat Complexity Projects
    - Peshastin Creek Off-Channel Reconnection Project (BRG Project)
    - Peshastin-Icicle Pump-back Project
    - Upper Little Wenatchee Fish-passage Project
  - Entiat River Basin
    - Habitat Protection Projects
  - Methow River Basin
    - Sugar Dike Removal and Habitat Restoration Project
    - Chewuch Canal Company Irrigation Efficiency Project
  - Okanogan River Basin
    - Passage at Enloe Dam
    - Salmon Creek/Okanogan Irrigation District Streamflow Project
    - Johnson Creek Fish Passage Project (upstream from Riverside)
    - Fish Passage into Okanagan Lake (includes passage projects in tributaries draining into Okanagan Lake)

   The Committees will continue to identify and discuss targeted projects within each subbasin.

3. The Committees identified a short list of completed projects they would like to visit in 2019. Those include:
   - Nason Creek Off-Channel Habitat Restoration Project
   - White River Large Wood Atonement Project
   - Poison Canyon Restoration Project
   - Wenatchee Levee Removal and Riparian Restoration Project
   - Lower Chewuch Beaver Restoration Project
   - White River Floodplain Connection (RM 3.4) Project
   - Boat Launch Off-Channel Pond Reconnection Project
   - Entiat Instream Habitat Improvements Project
   - Heath Floodplain Restoration Project
   - Harrison Side Channel Project
   - Upper Beaver Habitat Improvement Channel Restoration Project

   Tracy Hillman and Becky Gallaher will work with project sponsors and landowners to schedule site visits next summer.

4. Becky Gallaher asked the Committees how long she should retain documents related to projects funded by the Committees. She indicated she has documents (including payment requests, contract amendments, communications, etc.) for every project funded by the Committees. Several of these projects have been closed for many years. The Committees recommended that Becky check with Chelan PUD's Public Records Department to see whether the Committees should

retain the documents indefinitely or if the Committees can remove documents after a certain period of time (say, seven years).

5. Tracy Hillman reported that he received an email from Kristen Kirkby (CCFEG) asking if representatives from the Rocky Reach Tributary Committee could participate on a conference call to discuss the status of the Burns-Garrity Project and proposed alternatives. Several members indicated they would like to participate on the call. Tracy will send members the doodle poll, which was prepared by Kristen to schedule the conference call.
6. Tracy Hillman stated that Steve Kolk (Bureau of Reclamation) has approached the Committees to see if there are possible teaming opportunities to fund and implement large-scale enhancement projects. Steve believes most of the smaller, easier-to-implement projects are nearly complete. This leaves larger, more complex projects to be completed, which will require extensive coordination, planning, and a funding commitment. Steve would like to meet with the Committees early next year to discuss teaming opportunities. Several members advised that the Committees proceed cautiously but agreed to invite Steve to a future meeting.

VII. Next Steps

If necessary, the next meeting of the Tributary Committees will be on Thursday, 8 November 2018 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 13 December 2018

Members Present: Jeremy Cram (WDFW), Chris Fisher (Colville Tribes), Tom Kahler (Douglas PUD), Brandon Rogers (Yakama Nation), Kate Terrell (USFWS), Catherine Willard (Chelan PUD), Justin Yeager (NOAA Fisheries), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at Grant PUD in Wenatchee, Washington, on Thursday, 13 December 2018 from 9:00 am to 12:15 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 11 October 2018 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher gave an update on funded projects. Most are progressing well or had no salient activity in the past month.

- Barkley Irrigation – Under Pressure Project – The sponsor (Trout Unlimited; TU) reported construction has started on Phase 1 (piping). They also have signed easements for MVID ROW.
- Icicle Boulder Field Project – The sponsor (TU) reported they continue to work through the permitting process. Construction is planned for summer 2019.
- Peshastin Creek RM 10.5 PIT-Tag Detection Site Project – By 31 December 2018, the sponsor (Washington Department of Fish and Wildlife; WDFW) will submit the third-year monitoring report on work conducted in 2018.
- Burns-Garrity Design Project – The sponsor (Cascade Columbia Fisheries Enhancement Group; CCFEG) reported that after meeting with project funders and the Upper Columbia Regional Technical Team, they decided to move forward with a seasonal side channel. Given the uncertainty in the evolution of the channel upstream from the project site, as well as cost and other risks, the sponsor will not consider a change in the inlet location. The sponsor will continue to work with landowners and the Methow Salmon Recovery Foundation to identify possible enhancement actions upstream from the project site.
- Beaver Fever Project – The sponsor (TU) continues to work with the Forest Service on installation of beaver dam analogs (BDAs) in Potato and Roaring creeks.

- M2 Mid-Sugar Acquisition Project – This project is complete. The final report and Stewardship Plan have been uploaded to the Extranet site.
- Methow Basin Barrier Diversion Assessment Project – The sponsor (CCFEG) reported no new activity on this project. The sponsor plans to resume surveys next summer.
- Derby Creek Fish Passage Project – The sponsor (CCFEG) reported they have permit-ready designs and will begin the permitting process this month.
- Chiwawa Nutrient Enhancement Project – The sponsor (CCFEG) reported they distributed analogs throughout the target reaches within the Chiwawa River this fall. Once water quality monitoring is complete, they will share the results with the Tributary Committees.
- Monitor Side Channel Design Project – The sponsor (Chelan County Natural Resources Department; CCNRD) reported they selected Natural Systems Design to help with designing enhancement actions within the side channel.

IV. Time Extension Request

Burns-Garrity Restoration Design Project

In November, the Rocky Reach Tributary Committee received a time extension request from Cascade Columbia Fisheries Enhancement Group on the Burns-Garrity Restoration Design Project. Because of an avulsion in the mainstem Chewuch River near the entrance to the proposed side channel, the sponsor requested additional time to identify and discuss alternatives, and, if necessary, modify the enhancement design. They asked to extend the completion date from 1 December 2018 to 1 December 2019. After review and discussion, the Rocky Reach Tributary Committee approved the time extension.

V. Budget Amendment Request

Chiwawa Nutrient Enhancement Project

In November, the Rock Island Tributary Committee received a budget amendment request from Cascade Columbia Fisheries Enhancement Group on the Chiwawa Nutrient Enhancement Project. The sponsor asked to move $20,500 from Professional Services to other line items as follows: $2,500 to Project Materials and Equipment, $15,000 to Rentals and Leases, and $3,000 to Travel. This would result in a final budget of $20,500 in Professional Services, $5,000 in Project Materials and Equipment, $20,000 in Rentals and Leases, and $6,750 in Travel. Travel includes both mileage and lodging/meals. After careful consideration, the Rock Island Tributary Committee approved the budget amendment. The total budget amount ($267,650) will not change as a result of this amendment.

VI. Small Project Application

Peshastin Creek RM 8.8 Channel Reconnection: Environmental Site Assessment

The Committees received a Small Projects proposal from Chelan County Natural Resources Department titled: *Peshastin Creek RM 8.8 Channel Reconnection: Environmental Site Assessment*. The purpose of the project is to conduct a Phase I Environmental Site Assessment (ESA) and, if necessary, a Phase II ESA within a potential channel reconnection project near RM 8.8 on Peshastin Creek. The site appears to have been contaminated with petroleum products and possibly other contaminants. Therefore, an assessment is needed to evaluate the levels of contaminates within the project site. This work is needed before funds are spent on reconnecting the channel. The total cost of the project is $17,700. The sponsor requested the entire amount from HCP Plan Species Account Funds. The Rocky Reach Tributary Committee approved $11,100 for this project ($4,400 for Phase I and $6,700 for Phase II). The Committee elected not to fund the appraisal, because the Committee will hire their own appraiser to evaluate the value of the properties depending on the results of the ESAs.

Although the Rocky Reach Tributary Committee approved funding for both the Phase I and II ESAs, they require review of Phase I results before approving the Phase II ESA.

VII. General Salmon Habitat Program Application

Icicle Creek Fish Passage – Wild Fish to Wilderness Project

The Committees received a General Salmon Habitat Program proposal from Trout Unlimited titled: *Icicle Creek Fish Passage – Wild Fish to Wilderness Project*. The purpose of the project is to enhance fish passage at the Boulder Field (RM 5.6) on Icicle Creek and thereby provide access to more than 23 miles of high-quality habitat. This will be accomplished by creating a 160-foot fishway (14% slope, step-pool channel) along the left bank. This project is likely to have a large positive effect on steelhead abundance, productivity, and spatial structure. The total cost of the project is $2,275,000. The sponsor requested $375,000 from HCP Plan Species Account Funds. The amount requested from the Tributary Committees would be in addition to the $250,000 approved by the Rock Island Tributary Committee in 2015. All members except the Colville Confederated Tribes (CCT) approved funding for the project at this time. The CCT asked for additional time before providing their vote on the project. The Yakama Nation (YN) approved the request with the caveat that an agreement regarding anadromous fish management in the Icicle watershed is signed by the YN, CCT, WDFW, NOAA Fisheries, and USFWS. The CCT delay is also a function of ongoing discussions regarding the fish-management agreement. A decision on this project was tabled until all parties can provide votes.

Twisp Confluence Habitat Complexity Project[1]

In October, the Committees received a General Salmon Habitat Program proposal from the Yakama Nation (YN) titled: *Twisp Confluence Habitat Complexity Project*. The purpose of the project is to use large wood to stabilize a bank at the confluence of the Twisp River where bank erosion is threatening sewer line infrastructure for the town of Twisp. The large wood will not only protect the bank from further erosion, it will increase habitat complexity for juvenile and adult salmonids and will prevent the Army Corps of Engineers (COE) from riprapping the bank, which they have offered to do. The total cost of the project is $299,300. The sponsor requested $269,600 from HCP Plan Species Account Funds. In October, the Committees tabled the proposal and requested that YN secure a cost share from COE equivalent to the amount COE would spend on placing riprap along the eroding bank.

In December, YN reported they were unable to secure funding from COE. Emergency funding from COE is not available outside of an existing emergency declaration. This money can only be spent under COE direction on an emergency action. There are other COE non-emergency programs available; however, under those programs, COE takes the lead on a 4 to 5-year design process and requires a 35% funding match from the requesting entity. COE design and implementation funding can only be used for bank stabilization with a requirement that the project be based on the lowest cost alternative. Thus, YN believes COE would not be able to fund fish habitat structures.

Because there is no cost share from COE and the fact that this is a bank stabilization project, which the Committees generally do not fund, the Committees declined the opportunity to fund the project.

Upper Kahler Stream and Floodplain Enhancement Project

The Committees received a General Salmon Habitat Program proposal from the Yakama Nation titled: *Upper Kahler Stream and Floodplain Enhancement Project*. The purpose of the project is to reduce the risk of an avulsion near RM 8.6 on Nason Creek by constructing a large, buried, log jam at the upstream inlet of the developing avulsion channel and filling the avulsion channel with large substrate. The project will also construct three additional buried bank jams and enhance fish habitat at the downstream end of

[1] During discussions on YN proposals, the YN representative on the HCP Tributary Committees recused himself by leaving the conference room.

the avulsion channel. In addition to minimizing the risk of an avulsion, the proposed placement of wood and enhancement of the downstream end of the avulsion channel will improve spring Chinook and steelhead habitat. The total cost of the project is $482,500. The sponsor requested $231,500 from HCP Plan Species Account Funds. The Tributary Committees elected to not fund this project as currently designed.

The Committees understand efforts to minimize risk of avulsion. Indeed, an avulsion at this site would reduce the amount of available habitat by disconnecting the existing meander. However, they do not support filling the avulsion channel with large sediments. Rather, they believe the risk of an avulsion could be reduced by placement of wood structures within the main channel that encourage deposition at the potential site of avulsion. Proper placement of these structures would also divert flow away from the left bank and thereby reduce the risk of an avulsion. Finally, to reduce enhancement costs, they recommend the use of pilings and racked wood to improve fish habitat in the reach. These structures would replace the proposed buried bank jams at an expected reduced cost.

The Committees understand that a lot of work went into developing the current designs. Therefore, they would entertain a presentation during a future meeting describing why filling the avulsion channel is necessary and why buried bank jams are the preferred solutions in this site.

Stormy Project Area "A" Stream and Floodplain Enhancement Project

The Committees received a General Salmon Habitat Program proposal from the Yakama Nation titled: *Stormy Project Area "A" Stream and Floodplain Enhancement Project*. The purpose of the project is to maintain salmon and steelhead spawning habitat within the middle Entiat River, improve mainstem juvenile rearing and adult holding habitat, and improve off-channel juvenile rearing habitat. This will be accomplished by constructing ten mainstem log structures and two perennial side channels. One side channel will be 200 feet long; the other will be 2,500 feet long. Large wood will also be placed throughout the side channels. The total cost of the project is $1,652,218.15. The sponsor requested $1,140,968.15 from HCP Plan Species Account Funds. The Tributary Committees elected to not fund this project as currently designed.

On several occasions in the past, the Committees reviewed similar designs prepared by the Bureau of Reclamation (BOR) for the Entiat River. During the reviews, the Committees consistently said they supported removing levees and enhancing the Cottonwood Flats site. They also said they do not support the proposed large wood projects, many of which appeared to be designed to stabilize banks (recall that the Independent Scientific Advisory Board also questioned these large wood projects). There are several large wood elements in the Stormy Project Area "A" proposal that are similar to elements in the BOR designs. As with the BOR designs, the Committees do not support these structures identified in the Stormy Project Area "A" proposal. That said, the Committees do support the activation of the longer existing side channel (not the excavated channel) on river right. The Committees believe that activating the longer side channel will provide greater biological benefit than the excavated channels. The feasibility and cost effectiveness of activating the longer side channel is unclear given the need for wetland mitigation; however, the Committees recommend that this action be explored. The Committees would entertain discussions with the project sponsor regarding this action during future meetings.

Scaffold Camp Acquisition #2 Project

The Committees received a General Salmon Habitat Program proposal from the Yakama Nation titled: *Scaffold Camp Acquisition #2 Project*. The purpose of the project is to acquire and protect a 1.3-acre parcel of floodplain/riparian habitat at RM 15.7 on the Twisp River. This project, along with the already protected 13-acre adjacent parcel, will not only protect high quality habitat, but it will allow the enhancement of a side channel, which would provide biological benefit for HCP Plan Species. The total cost of the project is $104,950. The sponsor requested $94,500 from HCP Plan Species Account Funds. The Tributary Committees elected not to fund this project.

On a technical level, the Committees support protecting the 1.3 acres of floodplain and riparian habitat along the Twisp River. On a policy level, however, this project was not supported by CCT and therefore HCP Plan Species Account funds cannot be used by YN to acquire the property. In an effort to avoid the possibility of the current landowner selling the 1.3-acre parcel to someone who is not interested in the conservation value of the property, the Committees recommend that YN discuss the acquisition of the parcel with other conservation-minded entities such as the Methow Salmon Recovery Foundation, Methow Conservancy, WDFW, or CCT. The Committees would be able to provide funding to one of these entities if the entity is willing to hold the fee title for the parcel and coordinate enhancement work on the property with YN.

Following the funding decision on the proposed project, Brandon Rogers indicated YN will dispute the Tributary Committees' decision and elevate this issue to the HCP Coordinating Committees and HCP Policy Committees. In order to avoid a dispute, members asked Brandon whether YN would be willing to ask another conservation group to hold the fee title for the parcel. Brandon indicated that YN wants to hold the fee title. Members asked Brandon whether the policy representatives from YN and CCT could discuss and resolve this issue without going through the "formal" dispute resolution process. Brandon indicated this will not happen. He said YN will dispute the decision based on principle.

Tracy Hillman reviewed the HCP dispute resolution process with the Tributary Committees. He asked Brandon to provide him with an official letter from YN. He said the letter should include a brief description of the issue under dispute (Scaffold Camp Acquisition proposal), the reason for the dispute, and the reason why YN is disputing the Tributary Committees' decision to not fund the project. Tracy said the letter will provide the basis for initiating the dispute resolution process. Tracy said he will contact Dr. John Ferguson, Chair of the HCP CC and HCP PC, and inform him of the likely dispute. Tracy also asked Tributary Committees members to contact their HCP CC and HCP PC representatives and let them know that they will likely be dealing with a dispute.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests from October, November, and December:

   Rock Island Plan Species Account:

   - $150.00 to Clifton Larson Allen for Rock Island financial administration in October 2018.
   - $52.50 to Clifton Larson Allen for Rock Island financial administration in November 2018.
   - $19,100.85 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project (September-November).
   - $9,214.35 to Cascade Columbia Fisheries Enhancement Group for the Chiwawa Nutrient Enhancement Project (November-December).
   - $241.67 to Cascade Columbia Fisheries Enhancement Group for the Derby Creek Fish Passage Project.
   - $595.77 to Chelan County Treasurer for the Monitoring Side Channel Design Project.

   Rocky Reach Plan Species Account:

   - $150.00 to Clifton Larson Allen for Rocky Reach financial administration in October 2018.

- $52.50 to Clifton Larson Allen for Rocky Reach financial administration in November 2018.

2. During the October meeting, Becky Gallaher asked the Committees how long she should retain documents related to projects funded by the Committees. She indicated she has documents (including payment requests, contract amendments, communications, etc.) for every project funded by the Committees. Several of these projects have been closed for many years. The Committees recommended that Becky check with Chelan PUD's Public Records Department to see whether the Committees should retain the documents indefinitely or if the Committees can remove documents after a certain period of time. Becky reported she only needs to keep records for the past six years. Records older than six years can be destroyed.
3. Tracy Hillman reminded the Committees that Steve Kolk (Bureau of Reclamation) would like to discuss possible teaming opportunities to fund and implement large-scale enhancement projects. Tracy said Steve would like to meet with the Committees early next year to discuss teaming opportunities. The Committees agreed to invite Steve to the January meeting.

IX. Next Steps

If necessary, the next meeting of the Tributary Committees will be on Thursday, 10 January 2019 at Grant PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Appendix D
List of Rocky Reach Habitat Conservation Plan Committee Members

Rocky Reach Mid-Columbia HCP Committees, 2018

Policy Committee

Name	Organization
John Ferguson (Chairman)	Anchor QEA, LLC
Randy Friedlander	Colville Confederated Tribes
Alene Underwood	Chelan PUD
Ritchie Graves	National Marine Fisheries Service
Jim Craig	U.S. Fish and Wildlife Service
Jim Brown	Washington Department of Fish and Wildlife
Steve Parker	Yakama Nation

Coordinating Committee

Name	Organization
John Ferguson (Chairman)	Anchor QEA, LLC
Kirk Truscott	Colville Confederated Tribes
Lance Keller	Chelan PUD
Scott Carlon	National Marine Fisheries Service
Jim Craig	U.S. Fish and Wildlife Service
Chad Jackson	Washington Department of Fish and Wildlife
Keely Murdoch	Yakama Nation

Hatchery Committee

Name	Organization
Tracy Hillman (Chairman)	BioAnalysts, Inc.
Kirk Truscott	Colville Confederated Tribes
Catherine Willard	Chelan PUD
Brett Farman	National Marine Fisheries Service
Matt Cooper	U.S. Fish and Wildlife Service
Mike Tonseth	Washington Department of Fish and Wildlife
Tom Scribner	Yakama Nation

Tributary Committee

Name	Organization
Tracy Hillman (Chairman)	BioAnalysts, Inc.
Chris Fisher	Colville Confederated Tribes
Catherine Willard	Chelan PUD
Justin Yeager	National Marine Fisheries Service
Kate Terrell	U.S. Fish and Wildlife Service
Jeremy Cram	Washington Department of Fish and Wildlife
Lee Carlson	Yakama Nation

Appendix E
Statements of Agreement for Habitat Conservation Plan Hatchery Committees

Rocky Reach and Rock Island HCP Hatchery Committees
FINAL Statement of Agreement
Regarding Chelan PUD's Coho Salmon Obligation
January 17, 2018

Approved as follows: Chelan PUD, WDFW, USFWS, NMFS, YN, and CCT approved on January 17, 2018.

Statement

On November 15, 2017, the Rocky Reach and Rock Island HCP Hatchery Committees (hereafter "Committees") agreed to the methodology used to calculate Chelan PUD's coho salmon obligation. In order to meet this obligation, Chelan PUD and the Yakama Nation intend to enter into an agreement where Chelan PUD will provide funding for the Mid-Columbia Coho Salmon Reintroduction Project (facility use may be included for propagation). As long as Chelan PUD is meeting the terms of the agreement for funding their obligation of the Mid-Columbia Coho Salmon Reintroduction Project, and the obligation is based on No Net Impact Recalculation Methodology used to calculate hatchery compensation levels for coho, the Committees agree that Chelan PUD is fulfilling its coho salmon hatchery obligation for the term of the Rocky Reach and Rock Island Habitat Conservation Plans.

Appendix F
2018 Rock Island and Rocky Reach HCP Action Plan – Final

2018 Rocky Reach and Rock Island
HCP Action Plan - Final

COORDINATING COMMITTEE

		Jan 2018			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec	
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
Deliver 2017 RR Bypass Evaluation Report				D				F																												
Deliver 2018 RR Bypass Operations Plan				D					F																											
Deliver 2017 RI Bypass Evaluation Report				D					F																											
Deliver 2018 RI Bypass Operations Plan				D				F																												
Update HCP CC on RR Large Unit Repairs																																				
Update HCP CC on RI PH1 B1-B4 Unit Repairs																																				
Pikeminnow long-line control programs				S																													C			
Pikeminnow angling control programs													S																C							
Avian Predation programs										S														C												
Piscivorous Bird Monitoring										S																										C
Deliver 2018 RR/RI Spill Plan							D			F																										
Deliver 2018 RR/RI Spill Report																										D			F							
RR 9% Summer Spill																S							C													
RI 10% Spring Spill											S												C													
RI 20% Summer Spill																S							C													
RR Juvenile Fish Bypass Operations										S														C												
RI Juvenile Bypass Trap Operations										S														C												
2017 HCP Annual Report							D			F																										

HATCHERY COMMITTEE

		Jan 2018			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec	
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
2017 Hatchery M & E Report																	D								F											
2019 Hatchery M & E work plans																						D						F								
Broodstock Collection Protocols	S										C																									
Dryden Water Quality Monitoring (Year 7)							S						C																							
Coho NNI Mitigation SOA	D		F																																	
Chelan Falls Canal Trap Engineering Feasibility				S																					C											
Chelan Hatchery Rehabilitation Engineering Feasibility	S																																			
Chiwawa Weir Maintenance Engineering Feasibility				S																																
Eastbank Well Generator Installation														S																			C			
Pilot Outplant adult MetComp spr Chinook to Chewuch																							S				C									
Steelhead Residualism Plan - *Permit No. 18583*	D																								F											
Hatchery Program Broodstock Collection													S																						C	
Hatchery Releases											S		C																							
Receive Unlisted Permit (Wenatchee and Chelan Falls summer Chinook)		S																							C											

TRIBUTARY COMMITTEE

		Jan 2018			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec	
Activity	1	15	31	1	15	29	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31
RR and RI Plan Species Account Annual Deposit			C																																	
General Salmon Fund Approval	→ Ongoing																																			
General Salmon Fund Implementation	→ Ongoing																																			
Small Project Review and Approval	→ Ongoing																																			
Small Project Implementation	→ Ongoing																																			

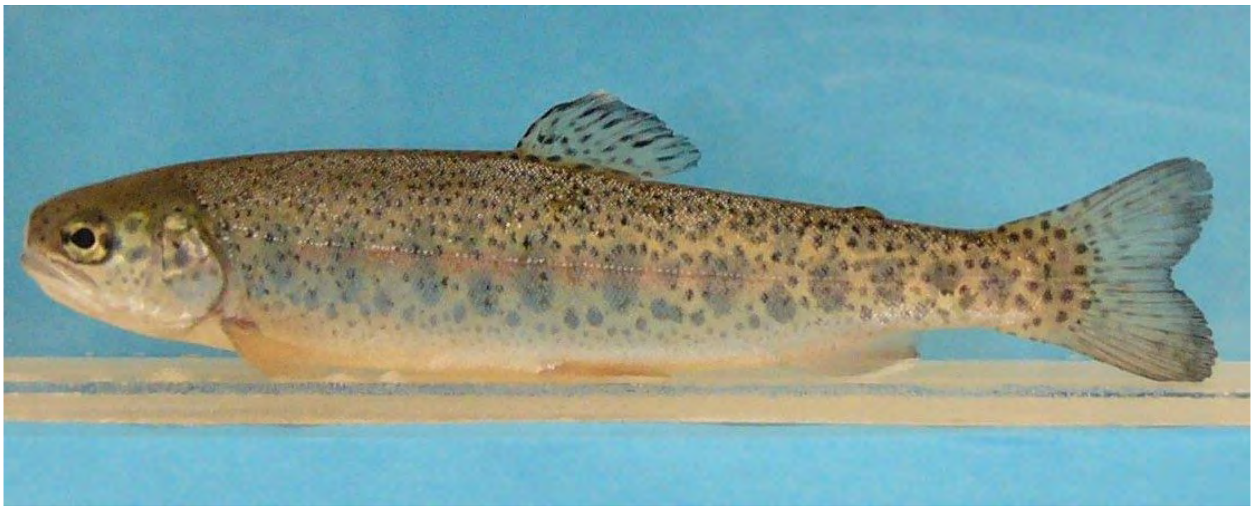
D = Draft Document
F = Final Document

S = Start Project
C = Complete Project

Appendix G
2017 Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System Final Report

2017
Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System

Final Report



Steelhead *(Oncorhynchus mykiss)* Chelan County PUD, Juvenile Bypass Facility, 2004.

Chelan County Public Utility District #1
Wenatchee, Washington

By

Scott A. Hopkins
&
Lance M. Keller

December 2017

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Glossary of Abbreviations, Acronyms, and Terms
For the 2017 Report

	Acoustic Tag. A surgically implanted device that offers an efficient means of remotely tracking fish in three dimensions with sub-meter resolution.
BC	Bypass Conduit. Fish transportation pipe that includes all fish conveyance structures (pipe, flumes, channels, and outfall) downstream of the ring-follower gates on the forebay wall to the discharge point in the tailrace.
	Diversion Screen. The inclined section of the intake screen system, extending from the bottom of the VBS used to divert fish from water entering the turbine intake.
FBE	Fish Bypass Efficiency. The percentage of fish passing the project through the fish bypass system (surface collector and screens).
FPE	Fish Passage Efficiency. The percentage of fish passing the project through non-turbine routes.
IS	Intake screen. The combined diversion screen and vertical barrier screen system installed in a turbine intake to divert fish from the flow entering the turbine.
ISS	Intake Screen System. Screens (diversion and vertical barrier) and associated screen cleaner, bulkheads, closures, roof seals, weir boxes, slide gates, and controls which are found within the turbine intakes of units 1 and 2.
JFBS	Juvenile Fish Bypass System. The overall fish bypass system consisting of the surface collector and the intake screen system.
JSF	Juvenile Sampling Facility. A structure that includes conduits, channels, a raceway, pumping equipment, and systems used for fish monitoring and sampling activities.
PIT	Passive Integrated Transponder. Small radio frequency tags with unique identification codes that are injected into fish for identification at specific monitoring locations after releases.
ROR	Run of River. Used in reference to actively outmigrating smolts that are captured at the JSF.
SC	Surface Collector. A structure positioned in the forebay to collect juvenile salmon and steelhead from surface flows, before the flows dive and enter a turbine intake. The structure includes components such as an entrance, dewatering screens, weir box, and transportation channel.
VBS	Vertical Barrier Screen. The vertical section of the intake screen.

Summary

The District constructed and installed a permanent bypass system from September 2002 to March 2003. The system consists of one surface collector (SC) and the intake screen system (ISS) in turbine units 1 and 2. Flow through the current SC entrance is designed for 6 thousand cubic feet per second (kcfs). For additional information referring to the construction and configuration of the juvenile fish bypass system, please refer to the *Biological Evaluation of the Rocky Reach Juvenile Fish Bypass System 2005* (Schoolcraft and Mosey 2006).

Multiple studies were conducted during the 2017 biological evaluation. The first priority and primary goal was to assure that the system was safe for fish prior to and during the juvenile outmigration. Marked fish releases with hatchery yearling Chinook Salmon yearlings were conducted in late March to verify that the system was working properly and to locate any areas where descale, injury, and mortality might occur. The District's goal was to find and immediately repair any problems prior to the 1 April start date. Ongoing sampling at the juvenile sampling facility (JSF) occurred throughout the outmigration to: 1) assure that the system remained safe for migrating juveniles and 2) provide standardized juvenile fish capture rate data to supplement Program RealTime's (University of Washington) run-timing predictions at Rocky Reach. The bypass capture rate, along with Program RealTime and species composition data, guided decisions about initiating 2017 operations for the timing of summer fish spill.

A total of 71,509 fish were collected during the 2017 sampling season; 52,991 fish were collected in the spring (1 April to 4 June) and 18,518 fish were collected in the summer (5 June to 31 August). The season-wide species composition for 2017 is as follows: 33.8% yearling Chinook Salmon (*Oncorhynchus tshawytscha*), 28.8% subyearling Chinook Salmon (*O. tshawytscha*), 2.9% steelhead (*O. mykiss*), 28.9% Sockeye Salmon (*O. nerka*), and 5.6% Coho Salmon (*O. kisutch*).

The season-wide estimates for all species in 2017 for descale, injury, and mortality are as follows: descale (0.11%), injury (0.19%), and mortality (0.04%). None of the three metrics, (descale, injury, mortality) exceeded the critical thresholds over three consecutive days of sampling, and no marked fish releases through the bypass system were required during bypass operations in 2017.

Introduction

In 2017, the Rocky Reach juvenile fish bypass system (JFBS) began operation on 1 April. The Chelan County Public Utility District (District) used the JSF for monitoring the physical condition of fish and species composition. The District also used the facility to evaluate seasonal run timing for target species. For additional history and developmental test of the juvenile fish bypass system, please refer to Schoolcraft and Mosey (2006).

Juvenile salmonids were routinely sampled to determine run timing and to visually examine fish for any descale, injury, and mortality. Species that were monitored on a daily basis during the 2017 out-migration for species composition and species condition included yearling and subyearling Chinook Salmon, steelhead, Sockeye Salmon and Coho Salmon.

Major objectives for the 2017 biological evaluations were:

- to examine the daily species composition of fish using the JFBS
- to use bypass capture rate data, along with Program RealTime and species composition data to guide decisions about initiating 2017 operations for the timing of summer fish spill (Mosey, 2017), and
- to evaluate the physical condition of fish using the JFBS.

Materials and Methods

Guidance Equipment

Surface Collector (SC)
The SC is located in the cul-de-sac of Rocky Reach Dam, adjacent to the forebay wall and generating units 1, 2, and 3. The SC consists of three major subparts: entrance, dewatering and passage channels, and pump station (Figures 1 and 2). These components were designed to meet specific hydraulic performance criteria which provided for collection of outmigrating juvenile fish. For more detail about SC configuration and operations, please refer to Schoolcraft and Mosey (2006).

Intake Screen System (ISS) – Units 1 & 2
The ISS encompasses the intake screens in Generating Units 1 and 2 (Figure 3). This system is designed to guide fish that have been drawn into the intakes up into the gate well slot for collection. For more detail about ISS configuration and operations, please refer to Schoolcraft and Mosey (2006).

Debris accumulations on the diversion and Vertical Barrier Screens (VBS) were monitored by measuring head loss across the screens and by visual observations with an underwater camera. The screens in Units 1 and 2 were cleaned by an automated screen cleaner system.

Juvenile Fish Bypass System Operations

SC and ISS operations for the JFBS began on 1 April and continued through 31 August 2017.

Sampling Protocol
Sampling at the juvenile collection facility began on 1 April 2017. Juvenile salmonids were collected during four 30 minute periods each day (7 days/week). In 2017, no collections were performed outside of the primary collection period (0800 to 1100 hours). In previous years, during afternoon and late-night collections (outside of the aforementioned periods), the juvenile facility was routinely monitored to avoid collecting and holding more fish than necessary for daily acoustic tagging and releases. The length of time needed to collect adequate numbers of fish for District studies varied depending on the number of spring migrants in the river. The collection and sampling schedules conformed to the schedules developed for acoustic tag evaluations and descale and injury evaluations. Please refer to Schoolcraft and Mosey (2006) to review the procedure for handling and sampling fish at the juvenile facility.

In 2017, collections occurred every day from 1 April to 31 August except on 31 May. An electrical storm that occurred the night of 30 May caused damage to some of the facilities programmable logic controllers (PLCs) as well as knocking out power to the Rocky Reach JSF including the fish handling building. All systems were restored and repaired in time for collections the following day.

Species Composition
The primary collection period was used as the index to estimate daily run timing for each species. Sampling occurred seven days a week, April through August.

Run-of-River Fish Condition Evaluations
Fish that entered the JFBS were routinely monitored for descale, injury, and mortality from 1 April to 31 August. Please refer to Pacific States Marine Fisheries Commission (2003) for classification of descale and injury guidelines. Fish condition evaluations were conducted by trained surface collector personnel to maintain consistency in interpretations. All fish from species of interest were examined from each day's primary collection period.

Marked Fish Condition Evaluations
To determine if the JFBS was causing descale, injury, or mortality prior to system start-up on 1 April, hatchery fish were marked with either a right or left ventral fin clip and released into the bypass system at established release sites. Only fish with no previous descale or injury were used in these evaluations. Upon recapture, marked fish were re-examined and levels of descale, injury, and mortality were summarized using the same guidelines and procedures as described above for ROR condition evaluations.

The four locations for marked fish releases in 2017 included: 1) the SC north channel upstream from trashrack, 2) the SC south channel upstream of trashrack, 3) Unit C1, and 4) Unit C-2. Releases were conducted with hatchery yearling Chinook Salmon prior to the 1 April start date to determine if the JFBS was working properly and to help isolate potential sources of descale, injury, and mortality. Routine marked fish releases were not done after initial evaluations and were not resumed because the percentage of descale, injury, or mortality never exceeded the levels established in the 2004 Rocky Reach study plan for the biological evaluation (Mosey et al. 2004).

Results

<u>Hydraulic Conditions</u>

Juvenile Fish Bypass System (JFBS) Flows
The 24-hr average entrance flows for the SC (both channels) and ISS weir box flows (combined flow for the 12 weirs) are presented in Appendix A along with river temperatures. Actual SC entrance flow at the North Channel averaged 3,064.1 cfs and flow at the south channel averaged 3,094.7 cfs; ISS collection flow averaged 116.6 cfs from 1 April to 31 August.

<u>Juvenile Fish Bypass System (JFBS) Sampling</u>

Overview of 2017 JFBS Operations
The SC and ISS operated throughout the season, except when they were temporarily shut down for repairs or debris removal. Unit 1 and 2 intake screens were cleaned with an automated screen cleaner. The units were not shut down while the intake screens were cleaned, however a reduction in load (12.5 kcfs to 7.0 kcfs) was necessary to move the screen cleaner across the screens. As the amount of debris increased with spring runoff and growth of milfoil, frequency of cleaning was adjusted accordingly to keep up with the influx of debris. The JFBS was monitored 24-hours/7-days a week for debris build-up on the SC trash racks, SC dewatering screens, and turbine unit intake screens. Racks, screens, gates, and pipes were cleaned daily as needed by District bypass attendants. When high differentials were observed at the trashracks in units 1 and 2, an outage period of 5 to 6 hours was usually required for divers to manually remove debris from the trashracks in both units.

Species Composition
A total of 71,509 fish were collected during the 2017 sampling season; 52,991 fish were collected in the spring (1 April to 4 June) and 18,518 fish were collected in the summer (5 June to 31 August). The season-wide species composition for 2017 was as follows: 33.8% yearling Chinook Salmon, 28.8% subyearling Chinook Salmon, 2.9% steelhead, 28.9% Sockeye Salmon, and 5.6% Coho Salmon (Figure 4). For the entire 2017 outmigration, the collection of fish from the JFBS for the biological evaluation took approximately 268 hours. Species composition of smolts in daily samples is summarized for the spring and summer study periods in Appendix B. In general, yearling Chinook Salmon and Sockeye Salmon were the predominant species captured during April into early June. Steelhead and Coho Salmon migrated through Rocky Reach Dam in early April through late May. Subyearling Chinook Salmon were the dominant species collected in June through the end of August comprising 97.7% of the daily totals during the summer months. Proportions of adipose-clipped salmonids sampled at Rocky Reach Dam (2003-2017) are summarized in Table 1, and daily adipose-clipped rates can be found in Appendix B.

Table 1. Proportions of adipose-clipped juvenile salmonids sampled at the Rocky Reach JSF from 2003-2017.

Percent of Adipose-Clipped Fish Sampled					
Year	**Chinook Yearlings**	**Chinook Subyearlings**	**Steelhead**	**Sockeye**	**Coho**
2017	87.6%	29.1%	58.1%	0.1%	0.2%
2016	91.8%	34.7%	34.9%	0.0%	0.3%
2015	91.6%	30.5%	68.5%	0.0%	1.2%
2014	88.8%	37.7%	51.8%	0.0%	0.3%
2013	84.8%	15.2%	62.6%	0.1%	0.0%
2012	75.4%	65.4%	52.5%	1.0%	6.7%
2011	74.2%	47.3%	56.5%	2.9%	0.3%
2010	76.7%	28.9%	60.1%	0.03%	0.1%
2009	86.3%	34.6%	66.0%	0.1%	0.1%
2008	79.9%	29.0%	70.6%	2.1%	1.7%
2007	82.9%	43.1%	62.6%	0.01%	0.4%
2006	79.7%	22.9%	47.4%	0.7%	2.4%
2005	78.9%	27.9%	60.7%	3.3%	1.1%
2004	70.8%	18.7%	59.0%	0.1%	1.1%
2003	59.5%	9.4%	76.7%	0.2%	0.5%
Average	**79.2%**	**31.6%**	**61.2%**	**0.8%**	**1.2%**

During the spring migration, salmonid species were the primary species captured. During the summer migration, other 'resident' fishes were captured, including Chiselmouth minnows (*Acrocheilus alutaceus*), Peamouth minnows *(Mylocheilus caurinus)*, Northern Pikeminnows (*Ptychocheilus oregonensis),* Mountain Whitefish (*Prosopium williamsoni*), Redside Shiners (*Richardsonius balteatus*), Threespine Sticklebacks (*Gasterosteus aculeatus),* sucker species (*Catostomas sp.*), Rainbow Trout (*Oncorhynchus mykiss*), kokanee (*Oncorhynchus nerka*), and Bluegill (*Lepomis marcochirus*).

Other resident fish of special interest include juvenile and adult Pacific Lamprey (*Entosphenus tridentatus*), Bull Trout (*Salvelinus confluentus*), and White Sturgeon (*Acipenser transmontanus*). During 2017, a total of five juvenile Pacific Lamprey (1 migratory, 4 non-migratory) and two juvenile Bull Trout were collected. Seven adult Pacific Lamprey were collected in 2017 and were released upstream at Lincoln Rock Park. There was also one juvenile White Sturgeon collected in 2017. Any fish exposed to anesthesia was allowed to recover for 2 hours before being released back into the bypass (Appendix C).

Run-of-River Fish Condition Evaluations

Yearling and subyearling Chinook Salmon, steelhead, Sockeye Salmon, and Coho Salmon were collected at the juvenile facility from the JFBS and routinely inspected for descale, injury, and mortality. The results from daily samples are reported in Appendix D. The District, with guidance from the Habitat Conservation Plan Coordinating Committee (HCPCC), set descale, injury, and mortality critical threshold levels at 5%, 3% and 2%, respectively. For more information about the threshold levels for fish condition, please refer to Schoolcraft and Mosey (2006). Descale estimates for combined species was below 0.2% in 2017. Figure 5 compares the season-wide descale percentage for each species from 2008 to 2017.

Injury is characterized by lacerations or bruises occurring to any part of the head or body. These types of injuries as well as severe descaling can lead to mortality. Injury estimates for combined species was below 0.2% in 2017. Figure 6 compares the season-wide injury percentage for each species from 2008-2017.

Mortalities collected during the spring and summer sampling were categorized as being *river*, *facility*, *sample*, or *research* mortalities. A *river* mortality is any fish "long-dead" on arrival in the raceway and defined by body characteristics such as pale or blotchy coloration and soft body condition. A *facility* mortality is classified as any fish recently dead, or near death upon arrival in the raceway, and exhibits fresh descale or injury. A *sample* mortality is any fish that dies as a result of the sampling activity itself. A *research* mortality is any fish that dies as a result of transferring and/or holding fish in research holding tanks for the purpose of further study or evaluation. In 2017, the percent mortality (Figure 7) estimate was below 0.3%. The results from daily samples are reported in Appendix D. Proportions of descale, injury, and mortality of salmonids sampled at the Rocky Reach JSF (2008-2017) are summarized in Table 2.

***Table 2. Comparison of descale, injury, and, mortality rates at the Rocky Reach JSF* Years 2008 through 2017.**

Descale %										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Yearlings	0.08%	0.12%	0.12%	0.06%	0.04%	0.21%	0.05%	0.15%	0.05%	0.10%
Subyearling	0.16%	0.31%	0.17%	0.07%	0.13%	0.16%	0.09%	0.19%	0.89%	0.10%
Steelhead	0.27%	0.20%	0.51%	0.31%	0.07%	0.65%	0.23%	0.42%	0.66%	0.48%
Sockeye	0.04%	0.03%	0.01%	0.05%	0.01%	0.01%	0.00%	0.05%	0.05%	0.08%
Coho	0.08%	0.11%	0.11%	0.11%	0.11%	0.31%	0.00%	0.51%	0.15%	0.20%
Injury %										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Yearlings	0.18%	0.17%	0.17%	0.07%	0.00%	0.24%	0.12%	0.15%	0.13%	0.19%
Subyearling	0.38%	0.30%	0.14%	0.10%	0.26%	0.08%	0.08%	0.19%	0.26%	0.16%
Steelhead	0.57%	0.50%	0.70%	0.47%	0.17%	0.32%	0.90%	0.42%	0.99%	0.57%
Sockeye	0.09%	0.06%	0.00%	0.08%	0.01%	0.07%	0.05%	0.05%	0.06%	0.11%
Coho	0.45%	0.18%	0.19%	0.09%	0.16%	0.40%	0.39%	0.51%	0.67%	0.65%
Mortality %										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Yearlings	0.07%	0.05%	0.00%	0.01%	0.05%	0.01%	0.01%	0.01%	0.00%	0.02%
Subyearling	0.11%	0.12%	0.08%	0.11%	0.09%	0.06%	0.05%	0.04%	0.06%	0.09%
Steelhead	0.00%	0.00%	0.00%	0.03%	0.00%	0.41%	0.00%	0.03%	0.00%	0.00%
Sockeye	0.05%	0.01%	0.01%	0.00%	0.04%	0.05%	0.02%	0.02%	0.01%	0.03%
Coho	0.00%	0.09%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%

Marked Fish Condition Evaluations

Fish recovered from marked fish releases (prior to bypass operation on 1 April) were examined for descale, injury, and mortality associated with passage through the JFBS. Results from individual test groups are summarized in Appendix E. On March 23, 2017, the District conducted four marked fish releases. Of the initial 389 fish released, 387 were recaptured. All of the recaptured fish were examined for descale, injury, and mortality. There were no signs of descale or injury and no mortality occurred in the 387 recaptured fish. Fish appeared healthy and energetic.

Discussion

Juvenile Fish Bypass System Species Composition and Observations

Species composition of smolts migrating through Rocky Reach Dam in 2017 varied somewhat from that observed in 2016. Yearling Chinook Salmon comprised the largest percentage of smolts sampled in the JFBS, with the percentage increasing from last year (33.8% of the total composition in 2017 compared with 25.1% in 2016). Steelhead increased from 1.0% to 2.9% in 2017. The proportion of Coho Salmon also increased from 2.1% to 5.6% in 2017. There was a decrease in the percentage of adipose-clipped yearling Chinook Salmon from 2016 to 2017, 91.8% to 87.7% respectively, while subyearling Chinook Salmon also decreased from 34.7% to 29.1% respectively. Steelhead smolts increased from 34.9% proportion of adipose-clipped smolts in 2016 to 58.1% in 2017. The proportion of adipose-clipped Sockeye Salmon increased slightly from 0.01% in 2016 to 0.10% in 2017, and Coho Salmon decreased from 0.3% in 2016 to 0.2% in 2017.

Season-wide estimates of descale, injury, and mortality for all species combined was 0.11%, 0.19%, and 0.04% respectively (Appendix D). At no time during the 2017 spring and summer sampling months did fish condition reach critical threshold levels triggering marked fish releases.

Observed incidence of predations marks on smolts utilizing the JFBS in 2017 was 0.4%.

Conclusions from the 2017 Evaluations

- Flow spreaders with PIT antennas continue to be fish-friendly
- Season-wide estimates of descale, injury, and mortality did not exceed 0.2% for all species during the sixteenth year of operation of the permanent bypass system.

2018 Bypass Operations and Survival Studies

In 2018, the District will not be conducting a survival study at Rocky Reach, as Phase 3 Standards Achieved has been reached for all planned spring migrants. The District will continue to evaluate seasonal run-timing, species composition, and physical condition of ROR fish at the JSF in 2018.

Acknowledgements

Several District employees assisted in the implementation of the 2017 evaluations. Alene Underwood, Todd West, and Thad Mosey provided logistical and administrative help. Chris Nystrom and the bypass operators oversaw day to day operation of the JFBS. CM mechanics and wiremen performed critical maintenance and repairs. Fish and Wildlife personnel assisting with the 2017 Rocky Reach evaluations included: Dennis Litchfield, Dave Beardsley, Todd Jackson, Josh Boyd, Nathan Clark, Chris VanWey, and Paul Edwards.

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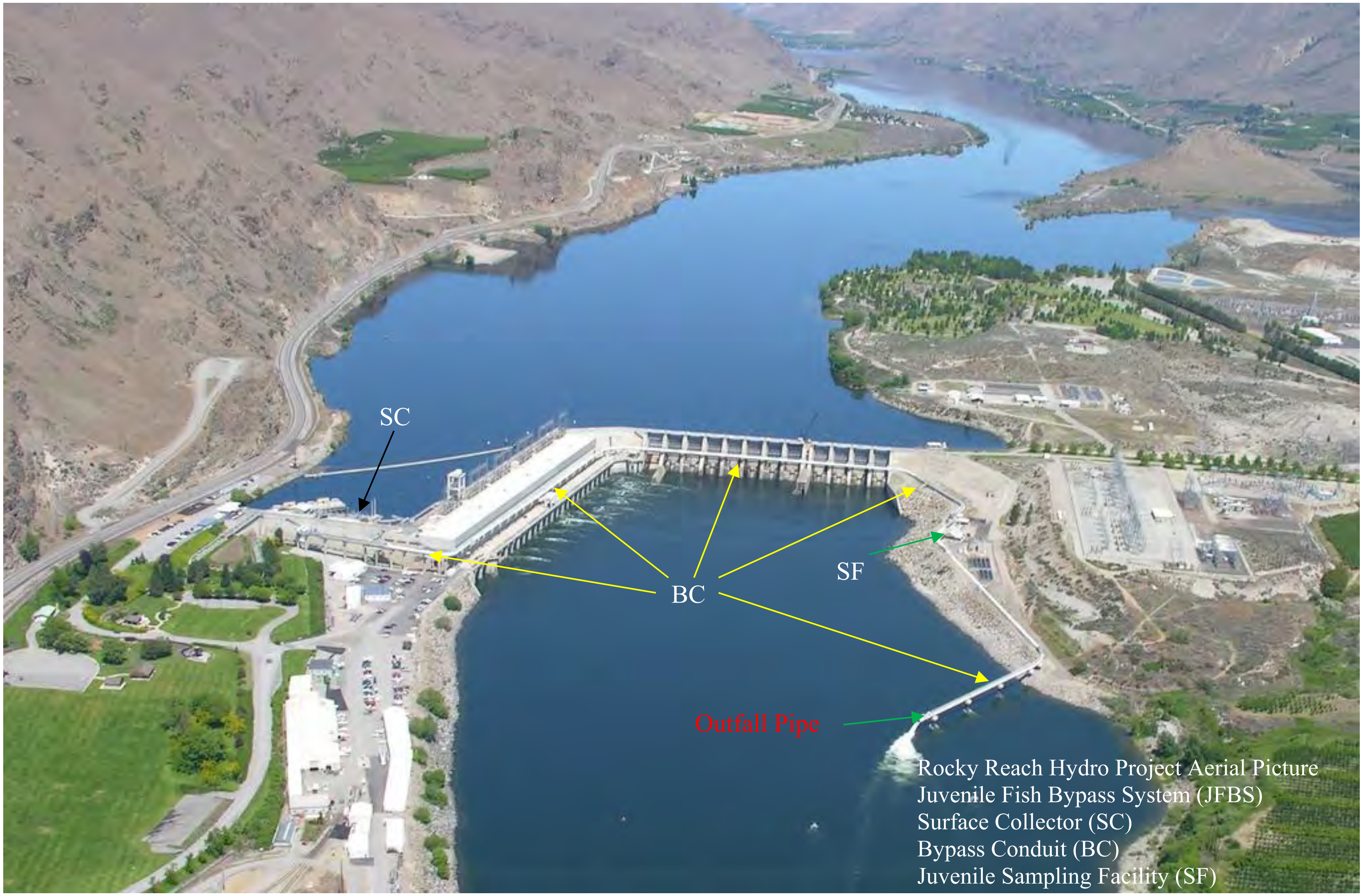


Figure 1. Aerial view of Rocky Reach Dam and the JFBS.

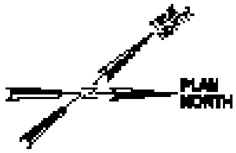


Figure 2. Plan view of Rocky Reach Dam and the JFBS

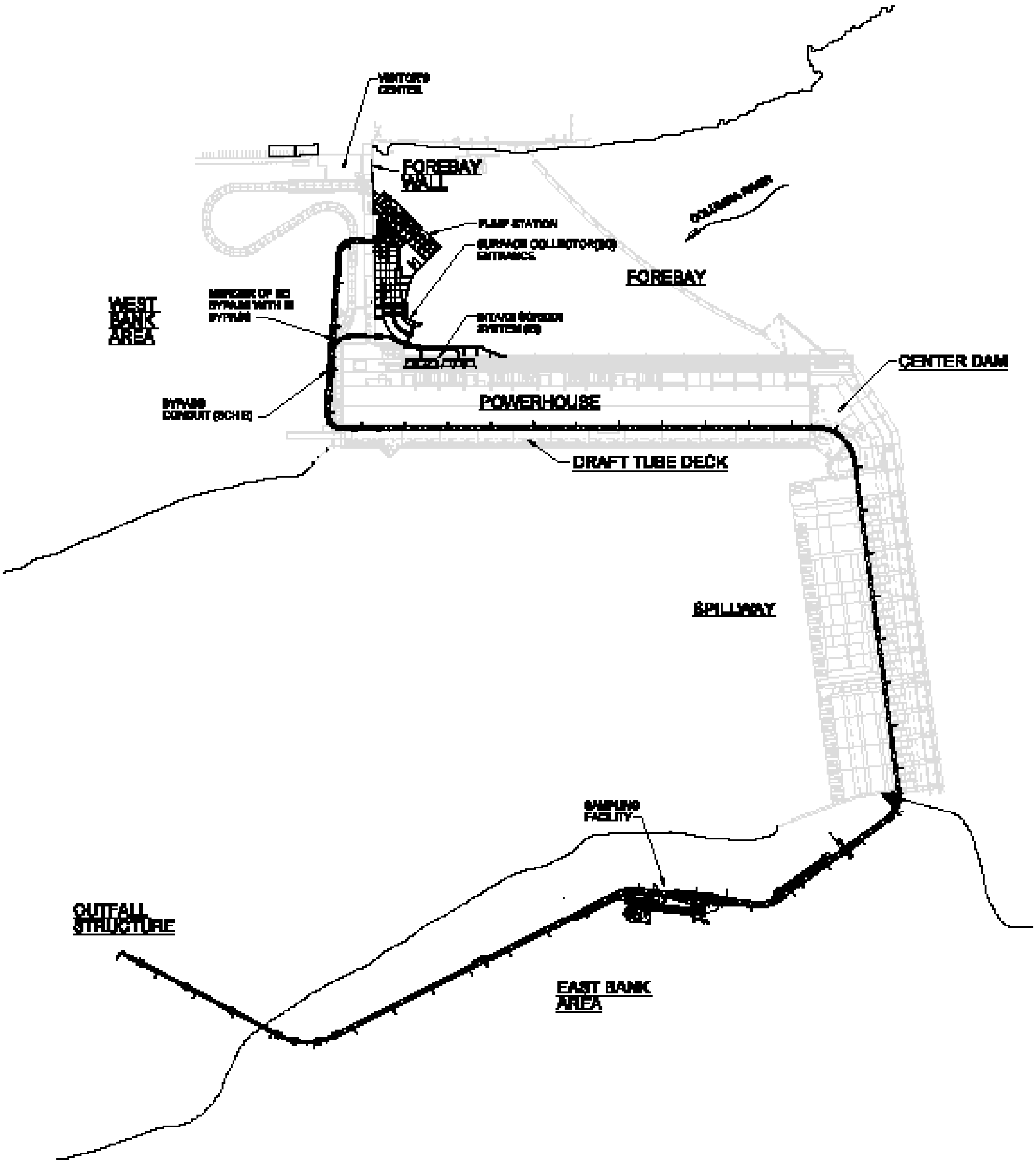
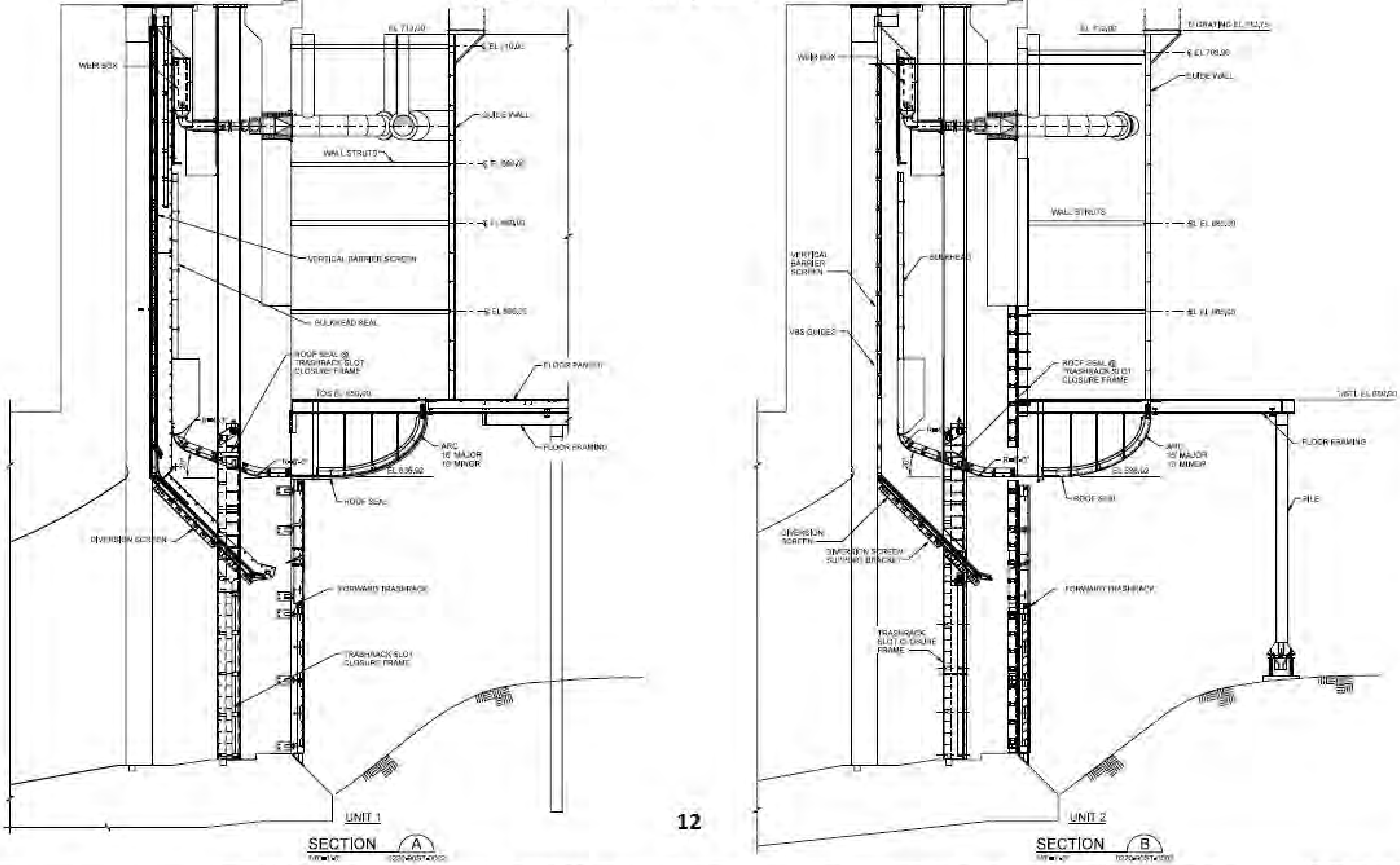


Figure 3. Intake screen system, units 1 and 2.



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PUBLIC UTILITY DISTRICT NO. 1 OF CHELAN COUNTY

SURFACE COLLECTOR - SCHEDULE A
GENERAL ARRANGEMENT
GENERAL ARRANGEMENT
POWERHOUSE GENERAL SECTIONS

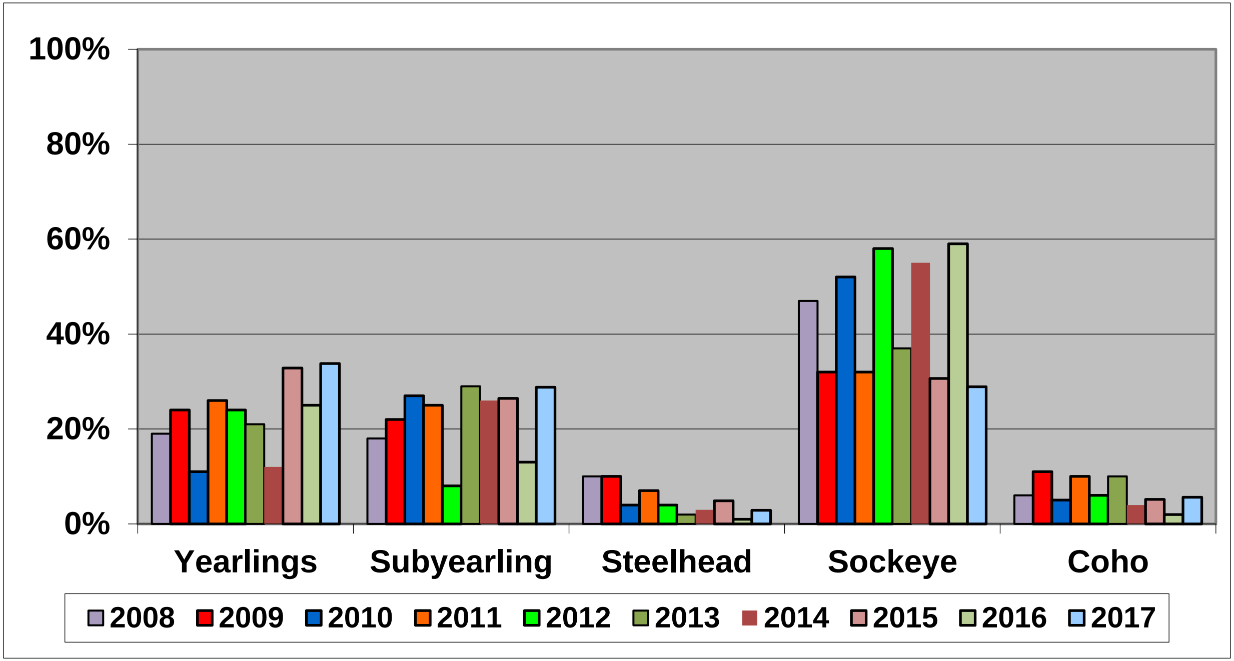

Figure 4. Ten year annual species percent composition of fish collected at the RRJSF 2008-2017.

	Yearlings	Subyearling	Steelhead	Sockeye	Coho
2017	34%	29%	3%	29%	6%
2016	25%	13%	1%	59%	2%
2015	33%	26%	5%	31%	5%
2014	12%	26%	3%	55%	4%
2013	21%	29%	2%	37%	10%
2012	24%	8%	4%	58%	6%
2011	26%	25%	7%	32%	10%
2010	11%	27%	4%	52%	5%
2009	24%	22%	10%	32%	11%
2008	19%	18%	10%	47%	6%

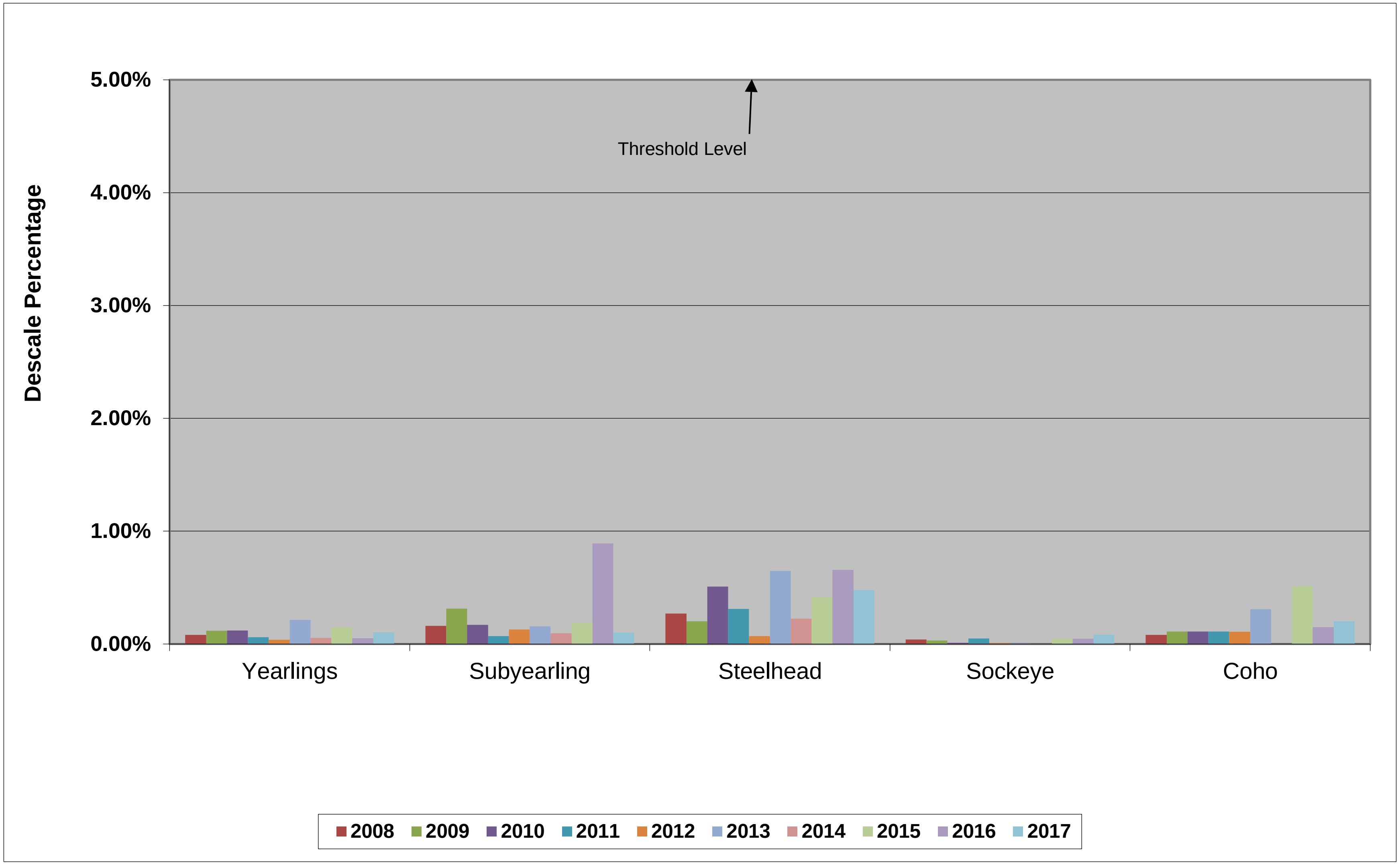

Figure 5. Ten year annual percent descale for salmon and steelhead at the RRJSF, 2008-2017.

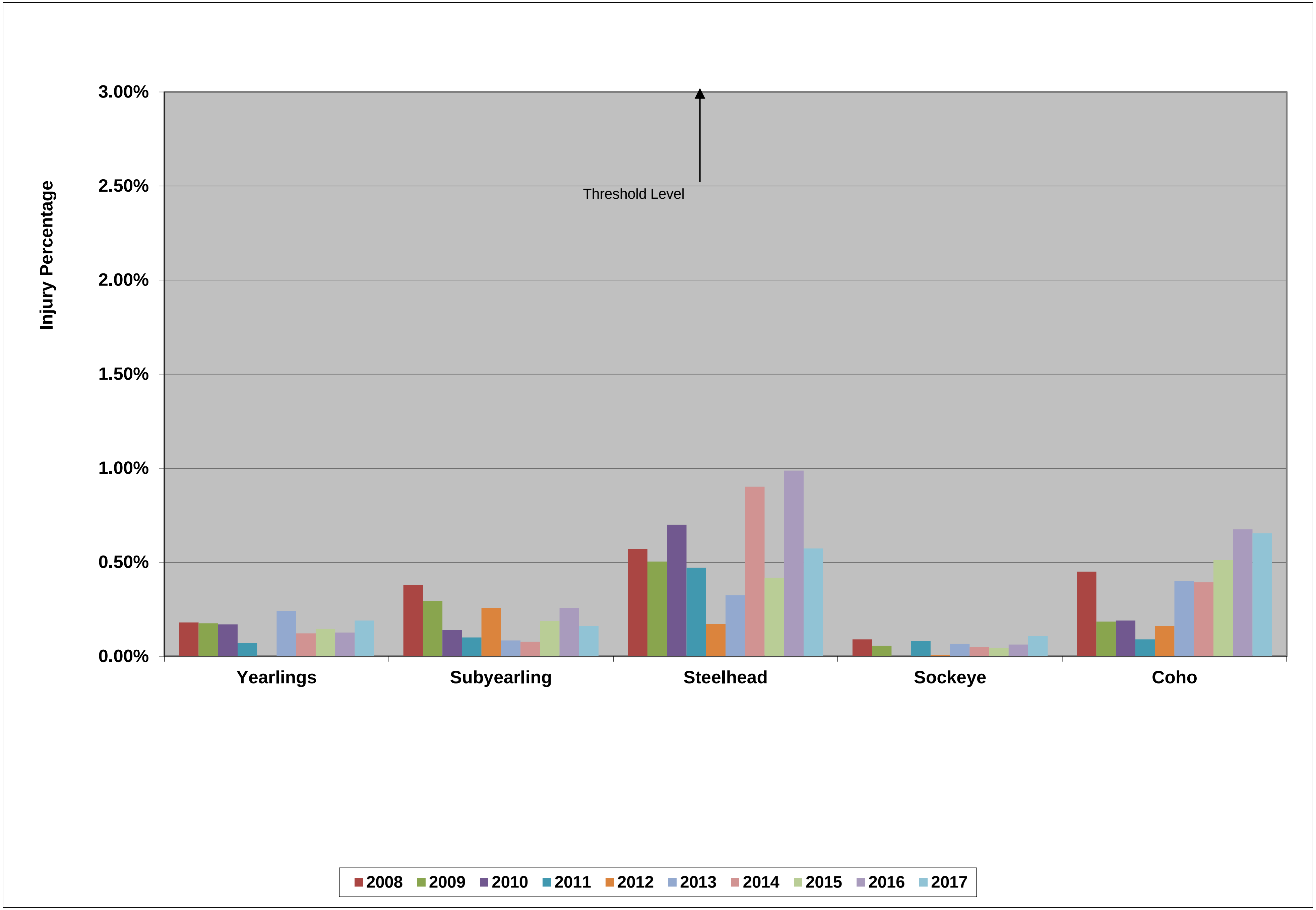

Figure 6. Ten year annual percent injury for salmon and steelhead at the RRJSF, 2008-2017.

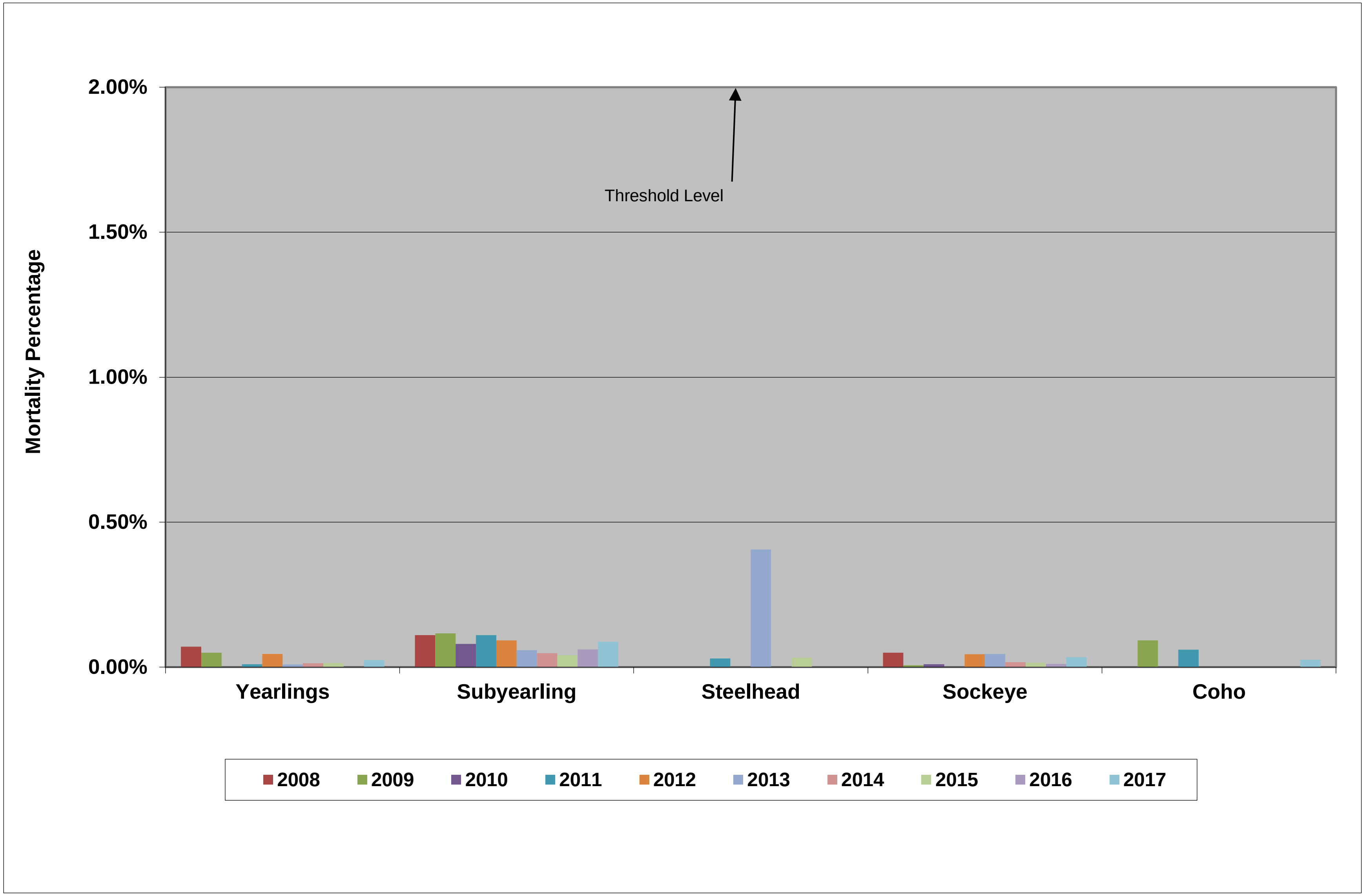

Figure 7. Ten year annual percent mortality for salmon and steelhead at the RRJSF, 2008-2017.

APPENDIX A. COLLECTION FLOWS IN THE JFBS, 2017.

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2017.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
4/1/17	2905.3	3047.3	119.6	5.0
4/2/17	2840.5	3016.0	119.6	5.3
4/3/17	2905.0	3045.5	119.4	5.3
4/4/17	2905.4	3033.0	118.7	5.3
4/5/17	2861.0	3000.9	118.7	5.3
4/6/17	2921.4	3024.4	118.5	8.3
4/7/17	2957.5	3044.0	118.9	5.5
4/8/17	2912.1	3002.2	119.3	5.7
4/9/17	2927.2	3029.8	119.3	5.7
4/10/17	2845.4	2966.9	119.4	5.8
4/11/17	2855.3	2962.7	119.2	5.8
4/12/17	2796.5	2946.7	117.9	6.0
4/13/17	2874.5	2985.3	118.3	6.1
4/14/17	2848.6	2978.2	118.3	6.3
4/15/17	2908.8	3019.1	118.4	6.4
4/16/17	2888.9	3017.5	117.0	6.6
4/17/17	2932.8	3041.8	117.4	6.6
4/18/17	2898.7	2990.6	117.0	6.9
4/19/17	2872.6	2947.3	115.2	7.0
4/20/17	2860.4	2970.3	117.0	7.2
4/21/17	2879.5	2996.0	113.7	7.4
4/22/17	2950.4	3080.1	119.5	7.5
4/23/17	3093.7	3191.5	119.7	7.6
4/24/17	3028.6	3149.0	119.6	7.6
4/25/17	2967.3	3132.6	119.7	7.7
4/26/17	2937.7	3114.9	119.3	7.8
4/27/17	2930.2	3136.8	119.7	7.9
4/28/17	3024.9	3176.0	118.8	7.9
4/29/17	3020.6	3185.5	119.7	8.0
4/30/17	2980.4	3165.7	119.7	8.0
5/1/17	3058.8	3176.7	119.5	8.0
5/2/17	3035.7	3135.1	119.0	8.1
5/3/17	3089.0	3200.5	118.6	8.3
5/4/17	3012.9	3145.8	119.2	8.6
5/5/17	3027.7	3144.2	119.5	9.0
5/6/17	3011.0	3186.6	119.3	9.2
5/7/17	3083.9	3214.7	112.5	9.1
5/8/17	3045.4	3156.2	108.1	9.1
5/9/17	3070.6	3208.2	114.6	9.1
5/10/17	3089.8	3191.7	119.3	9.3

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2017.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
5/11/17	3046.1	3136.8	119.4	9.5
5/12/17	3128.0	3203.7	119.7	9.4
5/13/17	3078.6	3175.8	119.6	9.4
5/14/17	3102.5	3192.1	119.4	9.5
5/15/17	3106.7	3175.1	114.4	9.3
5/16/17	3108.4	3185.4	119.6	9.4
5/17/17	3130.8	3189.2	119.6	9.5
5/18/17	3089.4	3187.2	119.5	9.9
5/19/17	3058.6	3197.5	119.6	10.2
5/20/17	3032.3	3214.0	119.2	10.5
5/21/17	2975.2	3168.7	119.6	10.6
5/22/17	3046.0	3190.0	119.7	10.6
5/23/17	3090.4	3214.2	119.5	10.9
5/24/17	2996.4	3143.2	119.6	11.1
5/25/17	3091.8	3184.3	119.6	11.1
5/26/17	3083.9	3172.2	119.4	11.1
5/27/17	3122.1	3188.7	119.6	11.1
5/28/17	3098.0	3174.3	119.7	11.3
5/29/17	3095.0	3154.7	119.7	11.7
5/30/17	3120.5	3163.4	119.6	11.7
5/31/17	3132.3	3213.8	119.7	11.8
6/1/17	3077.0	3176.8	119.7	11.7
6/2/17	3104.2	3208.2	119.5	11.7
6/3/17	3095.8	3188.2	119.6	11.7
6/4/17	3075.6	3148.2	119.6	12.0
6/5/17	3119.6	3211.3	119.4	12.2
6/6/17	3069.3	3170.6	119.7	12.5
6/7/17	3024.6	3161.2	119.6	12.7
6/8/17	3113.1	3202.3	119.6	12.8
6/9/17	3133.9	3203.9	119.6	12.8
6/10/17	3093.5	3156.8	119.9	12.8
6/11/17	3080.0	3131.1	119.6	12.8
6/12/17	3085.6	3114.2	119.6	13.2
6/13/17	3071.4	3120.2	119.7	13.4
6/14/17	3144.3	3176.6	119.6	13.6
6/15/17	3175.6	3201.3	119.6	13.6
6/16/17	3094.9	3154.1	119.6	13.4
6/17/17	3115.1	3227.6	119.7	13.5
6/18/17	3099.5	3230.8	119.6	13.7
6/19/17	3040.5	3192.8	119.6	14.0

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2017.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
6/20/17	3029.5	3150.8	119.6	14.3
6/21/17	3039.6	3162.3	118.7	14.5
6/22/17	3084.7	3207.1	119.6	14.6
6/23/17	3091.4	3169.3	119.6	14.8
6/24/17	3043.0	3173.5	119.6	15.1
6/25/17	3027.9	3172.9	119.6	15.0
6/26/17	3017.0	3156.1	119.7	15.1
6/27/17	3072.7	3161.5	119.6	15.2
6/28/17	3006.7	3156.2	119.7	15.6
6/29/17	3033.9	3194.5	119.6	15.8
6/30/17	3036.6	3143.0	113.5	16.0
7/1/17	2988.7	3099.0	111.5	16.2
7/2/17	3091.8	3132.9	119.3	16.1
7/3/17	3065.6	3129.2	117.3	16.3
7/4/17	3070.5	3167.5	112.4	16.4
7/5/17	3084.1	3129.4	119.7	16.5
7/6/17	3112.4	3102.4	119.7	17.0
7/7/17	3137.5	3111.2	119.2	16.9
7/8/17	3180.8	3087.6	118.5	16.8
7/9/17	3080.5	2997.1	115.1	17.5
7/10/17	2999.7	3139.3	116.3	17.3
7/11/17	3097.2	3208.1	119.6	17.2
7/12/17	3114.0	3191.0	119.6	17.0
7/13/17	3084.7	3169.7	119.5	17.0
7/14/17	3122.6	3149.8	117.9	16.8
7/15/17	3099.5	3088.3	119.6	17.4
7/16/17	3026.1	3147.7	119.4	17.5
7/17/17	3034.4	3136.3	116.2	17.3
7/18/17	3064.9	3114.8	106.9	17.1
7/19/17	3133.5	3116.4	104.4	17.4
7/20/17	2972.6	3076.1	104.3	17.4
7/21/17	3047.7	3126.3	107.2	17.1
7/22/17	3125.9	3084.9	109.4	17.4
7/23/17	3096.4	3032.2	115.7	17.9
7/24/17	3161.3	3018.5	114.7	18.1
7/25/17	3154.5	3050.5	108.2	17.9
7/26/17	3136.5	2985.1	108.6	17.8
7/27/17	3160.6	3021.6	117.4	18.1
7/28/17	3217.6	2934.7	113.1	18.1
7/29/17	3215.3	2854.0	111.5	18.2

Appendix A. Collection Flows in the JFBS from 1 April to 31 August, 2017.

24 Hour Averages				
Date	Surface Collector		ISS	River Temp
	North Entrance Flows (cfs)	South Entrance Flows (cfs)	Flows (cfs)	Degrees (C)
7/30/17	3217.7	2931.0	113.8	18.3
7/31/17	3134.9	3030.9	108.5	18.5
8/1/17	3062.9	3014.8	111.0	18.9
8/2/17	3128.1	2956.7	104.8	18.8
8/3/17	3126.1	2993.5	112.3	18.8
8/4/17	3088.3	2939.0	108.3	18.7
8/5/17	3188.1	2891.1	103.4	18.5
8/6/17	3198.6	2866.5	103.0	18.9
8/7/17	3212.2	2970.2	103.8	18.7
8/8/17	3230.8	2960.8	101.4	18.7
8/9/17	3293.9	2891.9	103.8	19.0
8/10/17	3222.9	2852.5	101.1	19.1
8/11/17	2997.2	2718.9	118.1	19.1
8/12/17	3253.2	2876.3	116.1	18.9
8/13/17	3038.3	3035.5	115.7	19.5
8/14/17	3175.3	3000.8	112.5	19.6
8/15/17	3211.4	2907.2	112.1	19.9
8/16/17	3052.9	3082.5	119.3	20.2
8/17/17	3217.5	3024.0	119.7	20.2
8/18/17	3104.6	3126.7	119.6	20.4
8/19/17	3116.8	3069.3	119.5	20.2
8/20/17	3209.2	3062.5	119.5	19.8
8/21/17	3215.6	3054.7	118.3	19.9
8/22/17	3166.8	3069.5	119.6	19.9
8/23/17	3208.2	3004.9	113.0	20.1
8/24/17	3061.6	3107.8	110.9	20.1
8/25/17	3156.4	3145.7	117.8	19.8
8/26/17	3110.4	3090.8	114.8	19.5
8/27/17	3138.4	3060.6	119.2	19.6
8/28/17	3080.8	2974.8	103.6	19.5
8/29/17	3151.0	2930.2	101.6	19.7
8/30/17	3092.9	3069.4	118.1	19.8
8/31/17	2986.4	2967.5	115.6	19.4
Average	**3064.1**	**3094.7**	**116.6**	**13.4**

APPENDIX B. ROCKY REACH JSF DAILY COUNTS AND AD-CLIP %, SPRING AND SUMMER, 2017.

Appendix B. Rocky Reach JSF daily counts and ad-clip %, spring and summer, 2017.

Numbers of Smolts Handled and Ad-Clip %											
Date	Yearlings		Subyearling		Steelhead		Sockeye		Coho		Total Handled
1-Apr	15	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	15
2-Apr	21	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	21
3-Apr	19	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	19
4-Apr	24	0.00%	0	N/A	3	0.00%	0	N/A	0	N/A	27
5-Apr	26	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	26
6-Apr	27	0.00%	0	N/A	2	50.00%	0	N/A	1	0.00%	30
7-Apr	15	0.00%	0	N/A	0	N/A	0	N/A	0	N/A	15
8-Apr	23	0.00%	0	N/A	3	0.00%	1	0.00%	0	N/A	27
9-Apr	29	0.00%	0	N/A	10	0.00%	0	N/A	0	N/A	39
10-Apr	57	5.26%	0	N/A	10	0.00%	1	0.00%	1	0.00%	69
11-Apr	14	28.57%	0	N/A	0	N/A	1	0.00%	0	N/A	15
12-Apr	106	43.40%	0	N/A	2	0.00%	0	N/A	1	0.00%	109
13-Apr	231	86.58%	0	N/A	7	0.00%	3	0.00%	0	N/A	241
14-Apr	1770	97.34%	0	N/A	7	28.57%	0	N/A	0	N/A	1777
15-Apr	1280	95.86%	0	N/A	4	0.00%	2	0.00%	0	N/A	1286
16-Apr	1103	94.74%	0	N/A	3	0.00%	4	0.00%	0	N/A	1110
17-Apr	890	97.42%	0	N/A	10	10.00%	16	0.00%	1	0.00%	917
18-Apr	381	92.91%	0	N/A	10	0.00%	6	0.00%	0	N/A	397
19-Apr	1570	96.50%	0	N/A	1	0.00%	3	0.00%	0	N/A	1574
20-Apr	1379	97.61%	0	N/A	6	0.00%	2	0.00%	0	N/A	1387
21-Apr	1346	95.54%	0	N/A	5	0.00%	2	0.00%	0	N/A	1353
22-Apr	1280	91.33%	0	N/A	14	0.00%	71	2.82%	3	0.00%	1368
23-Apr	1381	92.32%	0	N/A	15	0.00%	30	13.33%	7	0.00%	1433
24-Apr	1192	94.88%	0	N/A	30	10.00%	18	0.00%	38	7.89%	1278
25-Apr	731	93.16%	0	N/A	23	30.43%	32	3.13%	24	4.17%	810
26-Apr	1081	94.08%	0	N/A	24	12.50%	64	0.00%	83	0.00%	1252
27-Apr	467	88.87%	0	N/A	37	24.32%	96	1.04%	48	0.00%	648
28-Apr	437	83.07%	0	N/A	90	48.89%	83	0.00%	65	0.00%	675
29-Apr	315	79.68%	0	N/A	96	62.50%	193	0.52%	29	0.00%	633
30-Apr	300	82.00%	0	N/A	54	72.22%	365	0.55%	20	0.00%	739
1-May	284	85.56%	0	N/A	82	57.32%	266	0.00%	49	0.00%	681
2-May	113	77.88%	0	N/A	45	71.11%	102	0.00%	14	0.00%	274
3-May	247	81.38%	0	N/A	123	69.11%	851	0.00%	40	0.00%	1261
4-May	132	78.03%	0	N/A	50	70.00%	1273	0.00%	13	0.00%	1468
5-May	304	88.16%	0	N/A	44	70.45%	781	0.00%	40	0.00%	1169
6-May	95	84.21%	0	N/A	36	75.00%	1479	0.00%	30	0.00%	1640
7-May	429	71.56%	0	N/A	52	55.77%	774	0.00%	179	0.00%	1434
8-May	172	57.56%	0	N/A	34	50.00%	1229	0.08%	88	0.00%	1523
9-May	75	69.33%	0	N/A	3	33.33%	1705	0.00%	36	0.00%	1819
10-May	203	78.33%	0	N/A	14	42.86%	1168	0.00%	105	0.00%	1490
11-May	299	78.26%	0	N/A	18	88.89%	943	0.00%	131	0.00%	1391
12-May	166	78.92%	0	N/A	22	63.64%	1107	0.00%	115	0.00%	1410

13-May	399	74.44%	0	N/A	51	70.59%	836	0.00%	176	0.00%	1462
14-May	242	74.79%	0	N/A	42	54.76%	950	0.00%	219	0.00%	1453
15-May	131	70.23%	0	N/A	10	30.00%	1046	0.00%	181	0.00%	1368
16-May	301	77.08%	2	0.00%	28	50.00%	633	0.00%	280	0.00%	1244
17-May	155	67.74%	1	0.00%	34	67.65%	187	0.00%	96	0.00%	473
18-May	234	74.79%	5	80.00%	42	69.05%	100	0.00%	102	0.00%	483
19-May	418	68.42%	2	50.00%	343	88.34%	290	0.00%	240	0.00%	1293
20-May	280	70.36%	20	90.00%	49	83.67%	195	0.00%	164	0.00%	708
21-May	238	76.05%	36	94.44%	31	54.84%	425	0.00%	214	0.47%	944
22-May	143	66.43%	10	70.00%	26	46.15%	157	0.00%	110	0.91%	446
23-May	188	78.19%	14	57.14%	38	47.37%	318	0.00%	162	0.00%	720
24-May	266	78.57%	11	81.82%	74	37.84%	452	0.00%	215	0.00%	1018
25-May	509	76.23%	54	72.22%	61	31.15%	362	0.28%	172	0.00%	1158
26-May	203	71.43%	48	89.58%	20	50.00%	601	0.00%	92	0.00%	964
27-May	142	67.61%	138	98.55%	17	70.59%	171	1.75%	81	1.23%	549
28-May	80	73.75%	217	95.85%	7	28.57%	246	0.00%	67	0.00%	617
29-May	55	76.36%	192	97.92%	19	47.37%	217	0.00%	47	0.00%	530
30-May	48	75.00%	277	98.56%	16	43.75%	209	0.48%	33	0.00%	583
31-May*	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
1-Jun	43	76.74%	567	96.30%	22	31.82%	155	0.65%	27	0.00%	814
2-Jun	22	68.18%	235	94.47%	26	53.85%	68	0.00%	39	0.00%	390
3-Jun	18	100.00%	290	97.93%	6	50.00%	59	0.00%	14	0.00%	387
4-Jun	26	92.31%	409	93.64%	15	60.00%	75	0.00%	12	0.00%	537
5-Jun	4	75.00%	477	94.76%	13	46.15%	32	0.00%	21	0.00%	547
6-Jun	3	100.00%	302	96.03%	17	52.94%	38	0.00%	10	0.00%	370
7-Jun	4	100.00%	220	96.36%	14	42.86%	14	0.00%	7	0.00%	259
8-Jun	2	100.00%	306	91.50%	13	84.62%	19	0.00%	5	0.00%	345
9-Jun	2	100.00%	507	84.02%	16	25.00%	18	0.00%	8	0.00%	551
10-Jun	0	N/A	492	62.40%	2	50.00%	0	N/A	5	0.00%	499
11-Jun	0	N/A	429	62.47%	6	33.33%	21	0.00%	3	0.00%	459
12-Jun	0	N/A	507	60.16%	5	40.00%	7	14.29%	1	0.00%	520
13-Jun	0	N/A	491	43.99%	3	33.33%	6	16.67%	2	0.00%	502
14-Jun	0	N/A	663	25.19%	2	100.00%	3	0.00%	0	N/A	668
15-Jun	0	N/A	446	14.35%	1	0.00%	6	0.00%	0	N/A	453
16-Jun	0	N/A	463	29.37%	0	N/A	4	0.00%	0	N/A	467
17-Jun	0	N/A	554	36.82%	3	66.67%	0	N/A	1	0.00%	558
18-Jun	0	N/A	200	30.50%	1	0.00%	2	0.00%	3	0.00%	206
19-Jun	0	N/A	77	15.58%	6	100.00%	5	0.00%	0	N/A	88
20-Jun	0	N/A	42	19.05%	3	66.67%	2	0.00%	1	0.00%	48
21-Jun	0	N/A	505	10.30%	3	33.33%	3	0.00%	1	0.00%	512
22-Jun	0	N/A	444	9.23%	3	100.00%	1	0.00%	0	N/A	448
23-Jun	0	N/A	431	4.87%	1	0.00%	2	0.00%	1	0.00%	435
24-Jun	0	N/A	141	5.67%	1	0.00%	2	0.00%	1	0.00%	145
25-Jun	0	N/A	93	10.75%	3	100.00%	1	0.00%	1	0.00%	98
26-Jun	0	N/A	192	5.73%	0	N/A	4	0.00%	0	N/A	196
27-Jun	0	N/A	473	3.38%	0	N/A	3	0.00%	0	N/A	476
28-Jun	0	N/A	358	3.07%	0	N/A	0	N/A	0	N/A	358

29-Jun	0	N/A	229	1.31%	2	50.00%	4	0.00%	1	0.00%	236
30-Jun	0	N/A	36	2.78%	0	N/A	0	N/A	0	N/A	36
1-Jul	0	N/A	16	0.00%	0	N/A	1	0.00%	0	N/A	17
2-Jul	0	N/A	8	0.00%	3	0.00%	1	0.00%	0	N/A	12
3-Jul	0	N/A	5	0.00%	1	100.00%	0	N/A	0	N/A	6
4-Jul	0	N/A	6	0.00%	0	N/A	0	N/A	0	N/A	6
5-Jul	0	N/A	19	15.79%	0	N/A	1	0.00%	0	N/A	20
6-Jul	0	N/A	7	0.00%	1	100.00%	0	N/A	0	N/A	8
7-Jul	0	N/A	13	0.00%	0	N/A	5	0.00%	0	N/A	18
8-Jul	0	N/A	26	3.85%	0	N/A	2	0.00%	1	0.00%	29
9-Jul	0	N/A	16	0.00%	1	0.00%	1	0.00%	1	0.00%	19
10-Jul	0	N/A	36	2.78%	0	N/A	2	0.00%	0	N/A	38
11-Jul	0	N/A	15	20.00%	1	100.00%	0	N/A	0	N/A	16
12-Jul	0	N/A	16	0.00%	1	100.00%	1	0.00%	0	N/A	18
13-Jul	0	N/A	22	0.00%	0	N/A	0	N/A	0	N/A	22
14-Jul	0	N/A	15	6.67%	0	N/A	0	N/A	0	N/A	15
15-Jul	0	N/A	103	0.00%	0	N/A	0	N/A	0	N/A	103
16-Jul	0	N/A	15	6.67%	1	100.00%	0	N/A	0	N/A	16
17-Jul	0	N/A	17	0.00%	0	N/A	0	N/A	0	N/A	17
18-Jul	0	N/A	149	0.00%	0	N/A	0	N/A	0	N/A	149
19-Jul	0	N/A	68	1.47%	0	N/A	0	N/A	0	N/A	68
20-Jul	0	N/A	53	0.00%	0	N/A	0	N/A	0	N/A	53
21-Jul	0	N/A	71	0.00%	0	N/A	0	N/A	0	N/A	71
22-Jul	0	N/A	78	0.00%	0	N/A	0	N/A	0	N/A	78
23-Jul	0	N/A	131	1.53%	0	N/A	0	N/A	0	N/A	131
24-Jul	0	N/A	192	0.00%	0	N/A	0	N/A	0	N/A	192
25-Jul	0	N/A	231	0.43%	0	N/A	0	N/A	0	N/A	231
26-Jul	0	N/A	707	0.28%	0	N/A	0	N/A	0	N/A	707
27-Jul	0	N/A	551	0.18%	0	N/A	0	N/A	0	N/A	551
28-Jul	0	N/A	493	0.41%	0	N/A	0	N/A	0	N/A	493
29-Jul	0	N/A	332	0.00%	0	N/A	0	N/A	0	N/A	332
30-Jul	0	N/A	563	0.00%	0	N/A	0	N/A	0	N/A	563
31-Jul	0	N/A	419	0.00%	0	N/A	0	N/A	0	N/A	419
1-Aug	0	N/A	460	0.00%	0	N/A	0	N/A	0	N/A	460
2-Aug	0	N/A	198	0.00%	0	N/A	0	N/A	0	N/A	198
3-Aug	0	N/A	241	0.83%	0	N/A	0	N/A	0	N/A	241
4-Aug	0	N/A	243	0.00%	0	N/A	0	N/A	0	N/A	243
5-Aug	0	N/A	67	0.00%	0	N/A	1	0.00%	0	N/A	68
6-Aug	0	N/A	62	0.00%	0	N/A	0	N/A	0	N/A	62
7-Aug	0	N/A	200	0.00%	0	N/A	0	N/A	0	N/A	200
8-Aug	0	N/A	515	0.00%	0	N/A	1	0.00%	0	N/A	516
9-Aug	0	N/A	237	0.00%	0	N/A	1	0.00%	0	N/A	238
10-Aug	0	N/A	209	0.00%	0	N/A	0	N/A	0	N/A	209
11-Aug	0	N/A	306	0.00%	0	N/A	0	N/A	0	N/A	306
12-Aug	0	N/A	132	0.00%	0	N/A	0	N/A	0	N/A	132
13-Aug	0	N/A	150	0.00%	0	N/A	0	N/A	0	N/A	150
14-Aug	0	N/A	470	0.00%	1	100.00%	0	N/A	0	N/A	471

15-Aug	0	N/A	75	0.00%	0	N/A	0	N/A	0	N/A	75
16-Aug	0	N/A	87	0.00%	0	N/A	0	N/A	0	N/A	87
17-Aug	0	N/A	118	0.00%	0	N/A	0	N/A	0	N/A	118
18-Aug	0	N/A	88	0.00%	0	N/A	0	N/A	0	N/A	88
19-Aug	0	N/A	113	0.00%	0	N/A	0	N/A	0	N/A	113
20-Aug	0	N/A	82	0.00%	0	N/A	0	N/A	0	N/A	82
21-Aug	0	N/A	41	2.44%	0	N/A	0	N/A	0	N/A	41
22-Aug	0	N/A	90	0.00%	0	N/A	0	N/A	0	N/A	90
23-Aug	0	N/A	89	0.00%	0	N/A	0	N/A	0	N/A	89
24-Aug	0	N/A	77	0.00%	0	N/A	0	N/A	0	N/A	77
25-Aug	0	N/A	35	0.00%	0	N/A	0	N/A	0	N/A	35
26-Aug	0	N/A	46	0.00%	0	N/A	0	N/A	0	N/A	46
27-Aug	0	N/A	73	0.00%	0	N/A	0	N/A	0	N/A	73
28-Aug	0	N/A	31	0.00%	0	N/A	2	0.00%	0	N/A	33
29-Aug	0	N/A	18	0.00%	0	N/A	0	N/A	0	N/A	18
30-Aug	0	N/A	23	0.00%	0	N/A	0	N/A	0	N/A	23
31-Aug	0	N/A	38	0.00%	0	N/A	0	N/A	0	N/A	38
Totals	**24185**		**20613**		**2094**		**20639**		**3978**		**71509**

***No collection on 31-May due to power outage caused by lightning strike near the facility.**

APPENDIX C. ANNUAL COLLECTION OF LAMPREY AND BULL TROUT AT THE ROCKY REACH JSF, 2003 TO 2017.

Appendix C. Annual Collections of lamprey and Bull Trout at the Rocky Reach JSF, 2003 to 2017.

Lamprey		
Year	Number of Juveniles	Number of Adults
2003	122	5
2004	6	8
2005	11	3
2006	35	0
2007	3	0
2008	10	1
2009	13	3
2010	70	0
2011	1147	0
2011	5	0
2013	6	0
2014	7	7
2015	4	5
2016	3	5
2017	5	6

Bull Trout	
Year	Number of Juveniles
2003	Not Available
2004	Not Available
2005	1
2006	1
2007	1
2008	14
2009	30
2010	11
2011	9
2011	0
2013	0
2014	0
2015	0
2016	1
2017	2

APPENDIX D. DAILY DESCALE, INJURY, AND MORTALITY DATA FOR JUVENILE RUN-OF-RIVER SALMONIDS, SPRING AND SUMMER, 2017.

Appendix D. Daily descale, injury, and mortality data for juvenile run-of-river salmonids, April to August, 2017.

All Species								
Date	Number Examined	Number OK	Number Descaled >2	Percent Descale	Number Injured	Percent Injured	Mortality	Percent Mortality
1-Apr	15	15	0	0.00%	0	0.00%	0	0.00%
2-Apr	21	20	0	0.00%	1	4.76%	0	0.00%
3-Apr	19	19	0	0.00%	0	0.00%	0	0.00%
4-Apr	27	27	0	0.00%	0	0.00%	0	0.00%
5-Apr	26	26	0	0.00%	0	0.00%	0	0.00%
6-Apr	30	29	1	3.33%	0	0.00%	0	0.00%
7-Apr	15	15	0	0.00%	0	0.00%	0	0.00%
8-Apr	27	27	0	0.00%	0	0.00%	0	0.00%
9-Apr	39	39	0	0.00%	0	0.00%	0	0.00%
10-Apr	69	67	0	0.00%	2	2.90%	0	0.00%
11-Apr	15	15	0	0.00%	0	0.00%	0	0.00%
12-Apr	109	109	0	0.00%	0	0.00%	0	0.00%
13-Apr	241	241	0	0.00%	0	0.00%	0	0.00%
14-Apr	1777	1775	1	0.06%	0	0.00%	1	0.06%
15-Apr	1286	1284	0	0.00%	2	0.16%	0	0.00%
16-Apr	1110	1109	0	0.00%	0	0.00%	1	0.09%
17-Apr	917	917	0	0.00%	0	0.00%	0	0.00%
18-Apr	397	397	0	0.00%	0	0.00%	0	0.00%
19-Apr	1574	1572	0	0.00%	0	0.00%	2	0.13%
20-Apr	1387	1386	0	0.00%	1	0.07%	0	0.00%
21-Apr	1353	1349	0	0.00%	4	0.30%	0	0.00%
22-Apr	1368	1362	0	0.00%	6	0.44%	0	0.00%
23-Apr	1433	1420	1	0.07%	12	0.84%	0	0.00%
24-Apr	1278	1269	5	0.39%	4	0.31%	0	0.00%
25-Apr	810	805	1	0.12%	4	0.49%	0	0.00%
26-Apr	1252	1250	0	0.00%	2	0.16%	0	0.00%
27-Apr	648	646	0	0.00%	2	0.31%	0	0.00%
28-Apr	675	668	1	0.15%	6	0.89%	0	0.00%
29-Apr	633	628	1	0.16%	4	0.63%	0	0.00%
30-Apr	739	738	0	0.00%	0	0.00%	1	0.14%
1-May	681	679	2	0.29%	0	0.00%	0	0.00%
2-May	274	273	1	0.36%	0	0.00%	0	0.00%
3-May	1261	1256	3	0.24%	1	0.08%	1	0.08%
4-May	1468	1465	0	0.00%	2	0.14%	1	0.07%
5-May	1169	1169	0	0.00%	0	0.00%	0	0.00%
6-May	1640	1632	2	0.12%	6	0.37%	0	0.00%
7-May	1434	1431	2	0.14%	1	0.07%	0	0.00%
8-May	1523	1520	2	0.13%	0	0.00%	1	0.07%
9-May	1819	1815	2	0.11%	0	0.00%	2	0.11%
10-May	1490	1487	1	0.07%	2	0.13%	0	0.00%
11-May	1391	1388	0	0.00%	3	0.22%	0	0.00%

12-May	1410	1410	0	0.00%	0	0.00%	0	0.00%
13-May	1462	1461	1	0.07%	0	0.00%	0	0.00%
14-May	1453	1447	0	0.00%	5	0.34%	1	0.07%
15-May	1368	1363	1	0.07%	4	0.29%	0	0.00%
16-May	1244	1241	0	0.00%	3	0.24%	0	0.00%
17-May	473	471	0	0.00%	2	0.42%	0	0.00%
18-May	483	481	1	0.21%	1	0.21%	0	0.00%
19-May	1293	1289	3	0.23%	1	0.08%	0	0.00%
20-May	708	705	1	0.14%	2	0.28%	0	0.00%
21-May	944	940	1	0.11%	3	0.32%	0	0.00%
22-May	446	443	0	0.00%	3	0.67%	0	0.00%
23-May	720	712	3	0.42%	3	0.42%	2	0.28%
24-May	1018	1015	1	0.10%	1	0.10%	1	0.10%
25-May	1158	1144	13	1.12%	1	0.09%	0	0.00%
26-May	964	959	1	0.10%	4	0.41%	0	0.00%
27-May	549	541	5	0.91%	3	0.55%	0	0.00%
28-May	617	616	1	0.16%	0	0.00%	0	0.00%
29-May	530	528	1	0.19%	1	0.19%	0	0.00%
30-May	583	580	1	0.17%	2	0.34%	0	0.00%
31-May*	0	0	0	#DIV/0!	0	#DIV/0!	0	#DIV/0!
1-Jun	814	810	1	0.12%	3	0.37%	0	0.00%
2-Jun	390	386	0	0.00%	4	1.03%	0	0.00%
3-Jun	387	387	0	0.00%	0	0.00%	0	0.00%
4-Jun	537	531	2	0.37%	4	0.74%	0	0.00%
5-Jun	547	547	0	0.00%	0	0.00%	0	0.00%
6-Jun	370	370	0	0.00%	0	0.00%	0	0.00%
7-Jun	259	259	0	0.00%	0	0.00%	0	0.00%
8-Jun	345	345	0	0.00%	0	0.00%	0	0.00%
9-Jun	551	550	0	0.00%	0	0.00%	1	0.18%
10-Jun	499	496	0	0.00%	3	0.60%	0	0.00%
11-Jun	459	459	0	0.00%	0	0.00%	0	0.00%
12-Jun	520	519	0	0.00%	1	0.19%	0	0.00%
13-Jun	502	500	0	0.00%	2	0.40%	0	0.00%
14-Jun	668	667	0	0.00%	1	0.15%	0	0.00%
15-Jun	453	452	0	0.00%	0	0.00%	1	0.22%
16-Jun	467	466	0	0.00%	1	0.21%	0	0.00%
17-Jun	558	558	0	0.00%	0	0.00%	0	0.00%
18-Jun	206	206	0	0.00%	0	0.00%	0	0.00%
19-Jun	88	88	0	0.00%	0	0.00%	0	0.00%
20-Jun	48	47	0	0.00%	1	2.08%	0	0.00%
21-Jun	512	510	2	0.39%	0	0.00%	0	0.00%
22-Jun	448	448	0	0.00%	0	0.00%	0	0.00%
23-Jun	435	435	0	0.00%	0	0.00%	0	0.00%
24-Jun	145	144	0	0.00%	0	0.00%	1	0.69%
25-Jun	98	97	0	0.00%	1	1.02%	0	0.00%
26-Jun	196	196	0	0.00%	0	0.00%	0	0.00%
27-Jun	476	471	5	1.05%	0	0.00%	0	0.00%

28-Jun	358	358	0	0.00%	0	0.00%	0	0.00%
29-Jun	236	235	0	0.00%	1	0.42%	0	0.00%
30-Jun	36	36	0	0.00%	0	0.00%	0	0.00%
1-Jul	17	17	0	0.00%	0	0.00%	0	0.00%
2-Jul	12	12	0	0.00%	0	0.00%	0	0.00%
3-Jul	6	6	0	0.00%	0	0.00%	0	0.00%
4-Jul	6	6	0	0.00%	0	0.00%	0	0.00%
5-Jul	20	20	0	0.00%	0	0.00%	0	0.00%
6-Jul	8	8	0	0.00%	0	0.00%	0	0.00%
7-Jul	18	18	0	0.00%	0	0.00%	0	0.00%
8-Jul	29	29	0	0.00%	0	0.00%	0	0.00%
9-Jul	19	19	0	0.00%	0	0.00%	0	0.00%
10-Jul	38	38	0	0.00%	0	0.00%	0	0.00%
11-Jul	16	16	0	0.00%	0	0.00%	0	0.00%
12-Jul	18	18	0	0.00%	0	0.00%	0	0.00%
13-Jul	22	22	0	0.00%	0	0.00%	0	0.00%
14-Jul	15	15	0	0.00%	0	0.00%	0	0.00%
15-Jul	103	102	1	0.97%	0	0.00%	0	0.00%
16-Jul	16	16	0	0.00%	0	0.00%	0	0.00%
17-Jul	17	17	0	0.00%	0	0.00%	0	0.00%
18-Jul	149	149	0	0.00%	0	0.00%	0	0.00%
19-Jul	68	66	1	1.47%	1	1.47%	0	0.00%
20-Jul	53	53	0	0.00%	0	0.00%	0	0.00%
21-Jul	71	71	0	0.00%	0	0.00%	0	0.00%
22-Jul	78	78	0	0.00%	0	0.00%	0	0.00%
23-Jul	131	130	0	0.00%	1	0.76%	0	0.00%
24-Jul	192	190	0	0.00%	2	1.04%	0	0.00%
25-Jul	231	231	0	0.00%	0	0.00%	0	0.00%
26-Jul	707	707	0	0.00%	0	0.00%	0	0.00%
27-Jul	551	550	0	0.00%	0	0.00%	1	0.18%
28-Jul	493	492	1	0.20%	0	0.00%	0	0.00%
29-Jul	332	331	0	0.00%	1	0.30%	0	0.00%
30-Jul	563	561	0	0.00%	1	0.18%	1	0.18%
31-Jul	419	419	0	0.00%	0	0.00%	0	0.00%
1-Aug	460	458	2	0.43%	0	0.00%	0	0.00%
2-Aug	198	198	0	0.00%	0	0.00%	0	0.00%
3-Aug	241	239	2	0.83%	0	0.00%	0	0.00%
4-Aug	243	240	0	0.00%	2	0.82%	1	0.41%
5-Aug	68	66	1	1.47%	1	1.47%	0	0.00%
6-Aug	62	62	0	0.00%	0	0.00%	0	0.00%
7-Aug	200	200	0	0.00%	0	0.00%	0	0.00%
8-Aug	516	516	0	0.00%	0	0.00%	0	0.00%
9-Aug	238	238	0	0.00%	0	0.00%	0	0.00%
10-Aug	209	209	0	0.00%	0	0.00%	0	0.00%
11-Aug	306	306	0	0.00%	0	0.00%	0	0.00%
12-Aug	132	132	0	0.00%	0	0.00%	0	0.00%
13-Aug	150	150	0	0.00%	0	0.00%	0	0.00%

14-Aug	471	471	**0**	0.00%	**0**	0.00%	**0**	0.00%
15-Aug	75	74	**0**	0.00%	**1**	1.33%	**0**	0.00%
16-Aug	87	87	**0**	0.00%	**0**	0.00%	**0**	0.00%
17-Aug	118	117	**0**	0.00%	**1**	0.85%	**0**	0.00%
18-Aug	88	82	**1**	1.14%	**0**	0.00%	**5**	5.68%
19-Aug	113	112	**0**	0.00%	**0**	0.00%	**1**	0.88%
20-Aug	82	80	**1**	1.22%	**1**	1.22%	**0**	0.00%
21-Aug	41	39	**0**	0.00%	**0**	0.00%	**2**	4.88%
22-Aug	90	90	**0**	0.00%	**0**	0.00%	**0**	0.00%
23-Aug	89	89	**0**	0.00%	**0**	0.00%	**0**	0.00%
24-Aug	77	75	**0**	0.00%	**0**	0.00%	**2**	2.60%
25-Aug	35	35	**0**	0.00%	**0**	0.00%	**0**	0.00%
26-Aug	46	44	**0**	0.00%	**0**	0.00%	**2**	4.35%
27-Aug	73	72	**0**	0.00%	**1**	1.37%	**0**	0.00%
28-Aug	33	33	**0**	0.00%	**0**	0.00%	**0**	0.00%
29-Aug	18	18	**0**	0.00%	**0**	0.00%	**0**	0.00%
30-Aug	23	22	**1**	4.35%	**0**	0.00%	**0**	0.00%
31-Aug	38	38	**0**	0.00%	**0**	0.00%	**0**	0.00%
Totals	**71509**	**71257**	**81**	**0.11%**	**139**	**0.19%**	**32**	**0.04%**

***No collection on 31-May due to power outage caused by lightning strike near the facility.**

Descale = 5% for 3 consecutive days
Injury = 3% for 3 consecutive days
Mortality = 2% for 3 consecutive days

APPENDIX E. SUMMARY OF MARKED FISH RELEASES (MFR) WITHIN THE JFBS FOR EVALUATION OF DESCALE, INJURY, AND MORTALITY, SPRING, 2017.

Appendix E. Summary of Marked Fish Releases (MFR) within the JFBS for evaluation of descale, injury, and mortality, spring, 2017.

Purpose: Locate potential source of descale, injury, and mortality in bypass system pryor to season startup.

Date	Release Location	Number Released	Number Recaptured	Number Partially Descaled (<10%)	Number Descaled (>20%)	Percent Descaled	Injured	Percent Injured	Mortality	Percent Mortality	"Apparent" Conclusion
3/23/17	SC (upstream of trashrack, north channel)	100	100	0	0	0.00%	0	0.00%	0	0.00%	No injury or mortality observed. No descale greater than 10% for either channel.
	SC (upstream of trashrack, south channel)	89	89	0	0	0.00%	0	0.00%	0	0.00%	
3/23/17	Unit 1	100	198	0	0	0.00%	0	0.00%	0	0.00%	No injury or mortality observed. No descale greater than 10% for either unit.
	Unit 2	100		0	0	0.00%	0	0.00%	0	0.00%	

SC - surface collector

APPENDIX F. SUMMARY OF HISTORIC FISH BYPASS EFFICIENCY (FBE) FOR ROCKY REACH DAM, 2003 TO 2011.

Appendix F. Summary of Historic Fish Bypass Efficiency (FBE) for Rocky Reach Dam JFBS, 2003-2011.

Fish Bypass Efficiency					
		Radio Tags (2003) Acoustic Tags (2004-2011)			
Year	Species-(river mile release site)	SC	ISS	SC2/GCS	Total
2003[1]	Chinook Yearlings-RM 484	44.2%	9.8%	N/A	54.0%
2003[1]	Steelhead-RM 484	51.5%	7.3%	N/A	58.8%
2003[1]	Sockeye Salmon-RM 484	10.6%	6.7%	N/A	17.3%
2003[1]	Subyearling Chinook-RM 484	31.0%	6.4%	N/A	37.4%
2004	Chinook Yearlings-RM 515.8	26.8%	5.8%	N/A	32.6%
2004	Steelhead-RM 515.8	66.8%	3.6%	N/A	70.4%
2004	Sockeye Salmon-RM 515.8	38.3%	1.2%	N/A	39.5%
2004	Subyearling Chinook-RM 515.8	24.7%	6.4%	N/A	31.1%
2005	Chinook Yearlings-RM 515.8	31.7%	9.2%	N/A	40.9%
2005	Steelhead-RM 515.8	67.5%	6.3%	N/A	73.8%
2005	Sockeye Salmon-RM 515.8	31.0%	8.2%	N/A	39.2%
2006	Steelhead-RM 515.8	64.0%	4.1%	N/A	68.1%
2006	Sockeye Salmon-RM 515.8	38.9%	3.4%	N/A	42.3%
2007	Sockeye Salmon-RM 515.8	36.9%	3.5%	N/A	40.4%
2008	Sockeye Salmon-RM 515.8	41.2%	4.5%	N/A	45.7%
2009	Sockeye Salmon-RM 515.9	56.3%	3.4%	N/A	59.7%
2010	Yearling Chinook Salmon-RM 515.9	48.4%	5.2%	N/A	53.6%
2011	Yearling Chinook Salmon-RM 515.9	42.6%	6.5%	N/A	49.1%

SC = Surface Collector; ISS = Intake Screen System; GCS = Gatewell Collection System; RM = River Mile

[1] First year of FBE studies with the permanent juvenile fish bypass system.

APPENDIX G. HISTORICAL DESCALE, INJURY, AND MORTALITY PATTERNS OBSERVED AT THE ROCKY REACH JSF (2005).

Appendix G. Historical descale, injury, and mortality patterns observed at Rocky Reach JSF (2005).

<u>Scratch Pattern Descale</u>

<u>Circular Pattern Descale</u>

Patch Pattern Descale

Injury (Herring Bone Injury)

Mortality

APPENDIX H. HISTORICAL PIKEMINNOW PREDATION EVENTS OBSERVED AT THE ROCKY REACH JSF (2005).

Appendix H. Historical pikeminnow predation events observed at the Rocky Reach JSF (2005).

Left side of smolt showing descale and lacerations

Pikeminnow (350 mm) and smolt (144 mm) size comparison

Appendix H
2018 Rocky Reach Juvenile Fish Bypass System Operations Plan – Final Plan

2018 Rocky Reach Juvenile Fish Bypass System Operations Plan

Final Plan

Prepared By:

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&
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January 2018

Introduction

The Public Utility District of Chelan County (District) constructed and installed a permanent fish bypass system (FBS) in 2002/2003. The bypass system is designed to guide juvenile salmon and steelhead away from turbine intakes at Rocky Reach Dam. The system consists of one surface collector entrance (SC) and the intake screen (IS) system in turbine units 1 and 2. Please refer to Mosey (2004) for a detailed description of the bypass production system.

Studies and data collection at the Rocky Reach FBS fall under one of two general categories "Standard Operations" or "Special Operations" for bypass evaluations. Activities and data collection under standard operations include day to day sampling of run-of-river (ROR) fish to evaluate run timing, species composition, and fish condition after passage. Special operations may include additional sampling time to supply fish for marked fish releases.

2018 Evaluation Requirements

Run-of-river fish collected at the Juvenile Sampling Facility (JSF) to evaluate and provide fish for the following:

1. Run timing of target species:
    a. Provide standardized juvenile capture rate data to supplement Program RealTime (UW) run-timing predictions
    b. Guide decisions about initiating summer fish spill

2. Fish species composition:
    a. Guide decisions about starting or stopping spill
        i. Currently summer fish spill occurs at Rocky Reach (9% of the daily average river flow).

3. Origin of fish stock:
    a. Fin clips/marks

4. Interrogate for tags:
    a. PIT tags
    b. Acoustic tags (sutures)

5. Fish condition:
    a. Ensure that the bypass system remains safe for migrating juvenile salmon and steelhead by evaluating:
        i. Descale: 20% or more scale loss on either side
        ii. Injury: Scratches, bruises, or hemorrhages
        iii. Mortality: Any fish dead on arrival to sampling facility

2018 Study Methods

For more information about the study methods please refer to Mosey (2004).

Standard Operations:

1. Sampling Periods (1 April to 31 August):
    a. Monday through Sunday
    b. Collections Times
        i. 30 minute maximum **(or)**
            i. 0800-0830
            ii. 0900-0930
            iii. 1000-1030
            iv. 1100-1130
        ii. Target number of fish
            i. 350 spring species
            ii. 125 summer species
2. Fish Length:
    a. Up to 100 fish of each species will be measured for fork length (mm).

3. Fish Condition:
    a. All fish of each species are examined for condition:
        i. Descale
        ii. Injury
        iii. Mortality

4. Species Composition:
    a. ROR fish collected are enumerated by species
    b. Collect data for Program RealTime to determine start and end of spill
    c. Currently summer fish spill occurs at Rocky Reach

5. Origin of fish stocks and identification of marked individuals:
    a. PIT tags
    b. Fin clips

Special Operations:

1. Marked Fish Releases (Prior 1 April):
    a. Prior to the 1 April system start-up, hatchery yearling Chinook will be used for marked fish releases to determine if the JFBS is causing descale, injury, or mortality.
        i. Releases will be conducted with hatchery summer chinook prior to the 1 April start date to determine if the JFBS is working properly and to help isolate potential sources of descale, injury, and mortality.
        ii. Fish (n = 100/release) of varying sizes will be randomly selected from hatchery chinook. Only those with no scale loss or injury will be marked.
        iii. Marked fish will be systematically released at locations upstream of the sampling screen in the bypass system and into both intake screens in units C1 and C2.
        iv. If potential problems are identified, resolve problems by 1 April system start-up.

2. Marked Fish Releases (1 April to 31 August):
    a. A phased approach will be used to evaluate the descaling rate, injury rate, and mortality rate of fish passing through the bypass system. We developed a sampling protocol and threshold percentages (Table 1) for descale, injury and mortality that will trigger study phases.
    b. Identify "ambient" rates of descale, injury and mortality.
    c. Once the ambient rate is estimated and if further sampling shows descale problems continuing at 5%, (3% for injury, 2% for mortality) *above* ambient level for three consecutive samples.
        i. If variable rates of descale, injury or mortality do occur between species, then collection of yearling chinook, sockeye, or steelhead may be necessary for marked releases.
        ii. Fish (n = 100/release) of varying sizes will be randomly selected at the juvenile facility and only those migrants with no scale loss or injury will be marked.
        iii. Marked fish will be systematically released at locations upstream of the sampling screen in the bypass system until the problem area is isolated.
    d. Identify circumstances when we would refer to the HCP Coordinating Committee.
    e. The District will consult with the Coordinating Committee if any abnormal fish conditions (within values outlined in Table 1) are observed in the sample population.

Table 1. Flow diagram of phased approach and threshold values for conducting marked-fish releases in the juvenile bypass system at Rocky Reach Dam *(Skalski and Townsend 2003)*

	Phase 1		Phase 2		Phase 3		Phase 4
Threshold		**5% initl**		**A*+5%**		**A*+15%**	
Descale	Index sampling for for descale rate	→	Mark-releases to est. ambient descale	→	In-system mark-releases to isolate descale problem	→	refer to HCP Coord. Comm.
Threshold		**3% initl**		**A*+3%**		**A*+10%**	
Injury	Index sampling for for inury rate	→	Mark-releases to est. ambient injury	→	In-system mark-releases to isolate injury problem	→	Temp. bypass shutdown refer to HCP Coord. Comm.
Threshold		**2% initl**		**A*+2%**		**A*+4%**	
Mortality	Index sampling for for mortality rate	→	Mark-releases to est ambient mortality	→	In-system mark-releases to isolate mortality problem	→	Temp. bypass shutdown refer to HCP Coord. Comm.

A* = Ambient percentage

3. Collection of Bull Trout:
    a. Document:
        i. Fork Length and weight measurements
        ii. Condition (descale, injury, or mortality)
        iii. Interrogate for PIT tags
        iv. Examine for fin clips/marks
    b. Allow to recover, then release

Daily Protocol for Fish Collection

Standard Operations:

1. Deploy sampling screen at beginning of each hour (0800, 0900, 1000, 1100 hours).
2. Use direct enumeration to count fish entering the sampling facility
3. Collect for 30 minutes **or** until approximately 350 spring migrants/125 summer migrants have been collected, whichever comes first. RETRACT SCREEN IF 200 TO 300 FISH ARE COLLECTED IN FIRST TWO MINUTES.
4. Retract screen when time period or target number of fish has been reached.
5. Determine species composition of all collected fish in the hourly sample.
6. Scan/examine each fish for PIT tags, fin clips, and acoustic tags.
7. Evaluate fish length (first 100 fish per species) and condition (all fish).
8. If needed, collect and hold fish for marked releases (Special Operations).
9. Return to step 1 for next sample period. After the 1100 hour sample, go to step 11.
10. See Special Operations (if applicable).
11. Allow anesthetized fish (examined for species composition and fish condition) to recover in the facility's holding tank for at least 1.5 hours.

Special Operations:

1. If fish are collected for marked fish releases, verify that the required number of target species has been set aside from the four sample periods.
2. If the required number of fish are not collected by the 1100 hour sample period, deploy the sampling screen and repeat steps 2 and 4 under standard operations.
3. Scan/check all anesthetized fish for PIT and acoustic tags.
4. Collect and hold fish at the facility for transport and/or marking (marked fish releases).
5. Determine species composition for any remaining anesthetized fish and scan for PIT tags.
6. After fish have been collected to meet study needs, estimate the number of fish remaining in the raceway (by species to the extent practical), record the number, and immediately release the fish back into the bypass pipe.
7. Return to step 11 under Standard Operations.

Contingencies:

1. If, after start-up of the bypass system, we encounter any unforeseen problem(s) with fish collection, we will immediately consult with the HCP Coordinating Committee on how to correct the problem(s).
2. If we accumulate many fish during a collection period (e.g. just after a hatchery release), we will only handle/sample the number of fish needed to satisfy the study requirements and then immediately release the remaining fish back into the bypass pipe.

Diversion Screen and Trashrack Cleaning (Units 1 and 2):
During the last week of March, the trashracks in front of Units 1 and 2 (six intakes total) will be cleaned by divers and clammed to remove any dislodged debris. The trash rack cleaning will be repeated as differentials increase across the racks due to debris load. A mid-season cleaning will be scheduled in June. Starting 1 April, the vertical barrier and diversion screens (IS system) will be cleaned one to two times per week or as needed with an automated screen cleaner. Careful observation of trash build up will also be monitored and the screens will be cleaned on a more regular basis if warranted. Frequency of the cleanings may increase depending on debris load during spring run-off and aquatic plant load in the summer. The District will log each screen cleaning, and in the event of high descaling/injury in a single sample, the vertical barrier and diversion screens will be inspected prior to releasing marked fish.

Discussion
The 2018 biological studies at Rocky Reach will encompass the following: 1) a continuing evaluation of the juvenile bypass system, and 2) a daily sampling program to monitor fish passage for run timing. Representatives of various research agencies and the HCP Coordinating Committee will be consulted about the development of detailed study plans and protocols. A time line showing important activities and deadlines for these activities has been developed and is presented in Table 2.

Table 2. Tasks and deadlines for the Rocky Reach 2018 biological evaluations.

Task	Deadline
Present 2018 study plan to Committee	**Winter 2017-2018**
Committee discussion/comments on study plan	**Jan. 27, 2018-Mar. 24, 2018**
Pre-season JFB operations testing (marked fish releases prior to 1 April)	March 15, 2018-March 31, 2018
Begin biological evaluation of JFB	April 1, 2018
Complete 2018 biological evaluation	August 31, 2018
Present 2018 evaluation report to Committee	**December 31, 2018**
Committee comments on 2018 report	**February 1, 2019**
Present 2018 report to Committee	March 1, 2019

****Tasks printed in bold text require action by the HCP Coordinating Committee.**

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Skalski, J. R., and R. L. Townsend. 2003. Protocol for conducting marked-releases in the bypass system at Rocky Reach Dam. Prepared for Chuck Peven and Thad Mosey, Chelan County Public Utility District. Columbia Basin Research School of Aquatic and Fishery Sciences, University of Washington.e

Appendix I
Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)

Final Memorandum

Date: March 12, 2018

To: Rock Island and Rocky Reach HCP Hatchery Committees

From: Catherine Willard (CPUD), Scott Hopkins (CPUD), and Chris Moran (WDFW)

Re: Wenatchee Steelhead Release Plan (Brood Years 2017 to 2019)

Background

Chelan PUD is required to produce 247,300 steelhead smolts for release into the Wenatchee River Basin as part of the Rock Island and Rocky Reach HCP requirements. Through the end of January 2018, approximately 257,142 Wenatchee summer steelhead (128,585 HxH and 128,557 WxW) are on station at the Chiwawa Acclimation Facility (Chiwawa AF).

Beginning in winter 2011 the Chelan PUD Wenatchee River steelhead program was relocated to the Chiwawa AF following significant upgrades to accommodate tributary based overwinter acclimation for the Wenatchee steelhead program. Steelhead are transferred from Eastbank and Chelan Fish Hatcheries to the Chiwawa AF in November and released in April through May. Overwinter acclimation at the Chiwawa AF may have resulted in tradeoffs between program objectives associated with minimizing stray rates and those associated with maximizing survival. Overwinter acclimation at the Chiwawa AF has likely reduced stray rates. Based on PIT-tag analyses, on average for brood years 2011 and 2012 (overwinter acclimated at Chiwawa AF), about 4% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River Basin. This is compared to an average stray rate of 25% for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF). Mean juvenile survival from release to McNary Dam for brood years 2005 to 2010 (not overwinter acclimated at Chiwawa AF) was 54.3% compared to brood years 2011 to 2015 (overwinter acclimated at Chiwawa AF) of 30.1% (Figure 1).

The body size of smolts of steelhead originating from hatchery releases has long been believed to affect their post release survival and therefore the number of adult returns (Larson and Ward 1955; Wagner et al. 1963; Tipping 1997). Juveniles released at a larger size generally survive to maturity at a higher rate (Clarke et al. 2014). Size at release data from the Wenatchee steelhead program indicates that as fish size at release increases, juvenile survival to McNary also increases (Figure 2). The mean size at release for brood years 2005 to 2010 (not overwintered at Chiwawa AF) was 6 FPP compared to 10 FPP for brood years 2011 to 2016 (overwinter acclimated at Chiwawa AF).

Chelan PUD and WDFW (the Permit Holders) were issued Permit 18583 (Section 10) for operation, monitoring and evaluation of the Wenatchee River summer steelhead hatchery program in December of 2017. A special condition of

this permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. The presence of multiple confounding variables, including brood origin, smolt size, rearing vessel, water source, release date, release location, and release strategy has made it challenging to fully evaluate survival to McNary based on the size of release of the Wenatchee steelhead program.

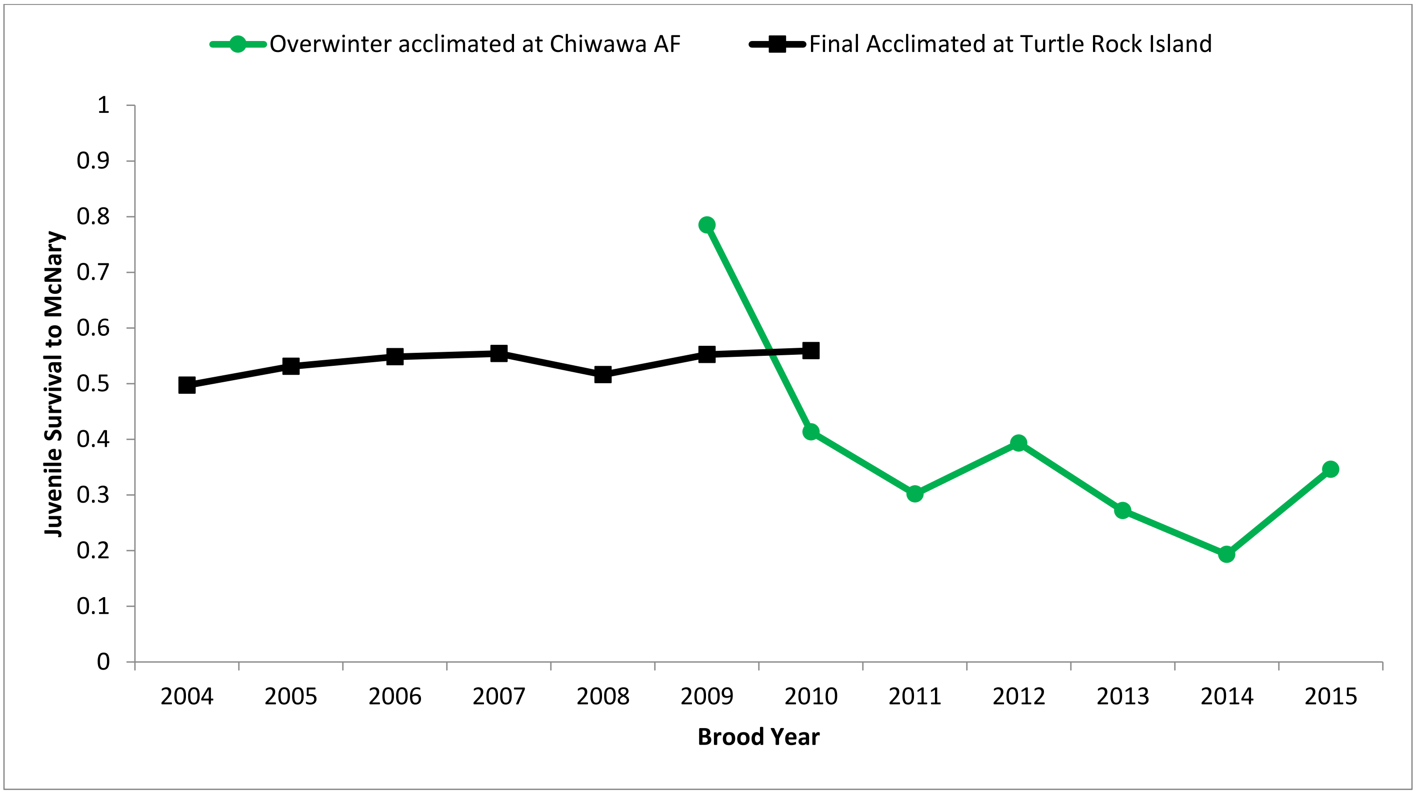

Figure 1. Juvenile outmigration survival to McNary for the Wenatchee summer steelhead program final acclimated at Turtle Rock Island and overwinter acclimated at Chiwawa Acclimation Facility.

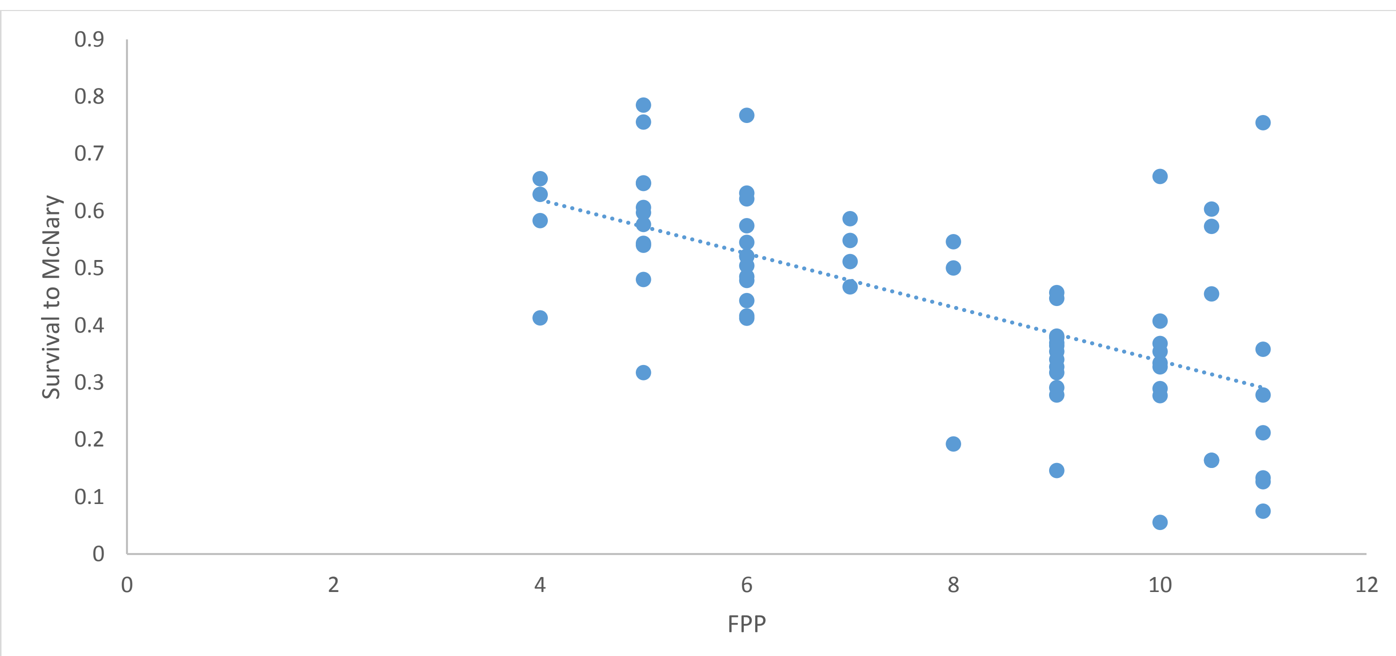

Figure 2. Juvenile outmigration survival to McNary and size of release data for the Wenatchee steelhead program, brood years 2005 to 2016.

Post-release performance of steelhead reared in the partial water reuse circular vessels (RAS) and traditional flow through raceways (RCY) have not consistently or thoroughly compared due to confounding variables present. RAS versus RCY comparisons may aid in future management decisions and improved performance of the Wenatchee steelhead program.

2018-2020 Release Strategy Objectives

- Evaluate survival based on size at release to McNary Dam to inform best hatchery management practices for hatchery releases that optimize homing fidelity, minimize residualism, maximize out-migration survival, and minimize negative ecological interactions (NMFS Wenatchee River Steelhead Section 10 Permit #18583).
- Evaluate rearing vessel Raceway 2 (RCY 2) (traditional flow through raceway) and partial water reuse circular vessel (RAS 1 and RAS 3).
- Minimize confounding variables (i.e. rearing vessel, release timing, flow conditions, release strategy, release location.) to evaluate size at release.
- Utilize data collected from the 2018-2020 Wenatchee River Steelhead release to assess applicable monitoring and evaluation objectives (i.e., Objectives 4 and 6) for the Wenatchee River summer steelhead hatchery program (Hillman et al. 2017).

Methods

Through January 2018, RCY 2 contain 232,388 steelhead (103,803 WxW and 128,585 HxH) and RAS 1 and 3 contain 24,754 WxW steelhead. PIT-tagged WxW and HxH steelhead located in RCY 2 will be evaluated based on size at release. PIT-tagged WxW steelhead located in RCY 2 and RAS 1/RAS 3 will be used to evaluate rearing vessel type. RAS 1/RAS 3 steelhead will be PIT tagged mid-February. RCY 2 fish will be PIT-tagged beginning the last week of February and two size classes will be targeted for PIT-tagging (small and medium). Each treatment group will contain approximately 11,000 PIT-tagged fish ((statistical power $1 - \beta = 0.80$; $\alpha = 0.10$, two-tailed) (Skalski 2018)) (Table 1). To minimize confounding variables, all PIT-tagged fish will be directly released at one release location on the same day.

- Cormack-Jolly–Seber survival probabilities to MCN will be calculated for each release group using recaptures of PIT-tagged fish.
- The percentage of PIT-tagged fish detected in the Wenatchee sub-basin after July 1 of the year of release will be calculated to estimate potential residualism for each release group.

Table 1. Treatments for evaluation.

Vessel	Brood Origin	Treatment	Estimated # PIT-tagged	Treatment PIT release size
RCY2	HxH	Size	5,500 small	11,000 Small Mixed
RCY2	WxW	Size	5,500 small	
RCY2	HxH	Size	5,500 medium	11,000 Medium Mixed
RCY2	WxW	Size	5,500 medium	
RCY 2	WxW	Vessel Type	11,000	11,000 WxW RCY 2
RAS1/RAS 3	WxW	Vessel Type	11,000	11,000 RAS1/RAS 3

Release Timing

In an effort to more closely align hatchery steelhead releases with the peak outmigration period for wild steelhead and potentially increase juvenile outmigration survival, all fish located at the Chiwawa AF will be released by May 8^{th}. In addition, every attempt will be made to release all of the program within the shortest feasible window possible, when optimal river conditions exist, and during the afternoon/early evening.

Release Location

Release locations in 2018 will be the same as the previous two years for non-PIT tagged fish. PIT-tagged fish will be released at one release location on the same day to the Chiwawa River (Table 2).

Pre-release Monitoring and Evaluation

Throughout acclimation and release, established sampling, transfer and release protocols will be followed (Hillman et al. 2017). Additionally, an extensive pre-release sample of 10% of the PIT-tagged fish will occur within one week prior to release. In addition to measuring fork length, an assessment of smolt index and precocial maturation will be conducted via non-lethal sampling. The pre-release fork length data will be used to create a linear regression equation to predict fork length at release of fish not measured during the pre-release sample.

Table 2. Steelhead release numbers and locations, 2018.

Vessel	Origin[1]	Estimated Number Released[2]	Estimated # PIT-tagged	Destination	rkm
RCY2	Mixed	58,067	TBD	Nason	7
		58,067		**Total**	
RCY2	Mixed	97,749	TBD	U. Wenatchee	79.2
		97,749		**Total**	
RAS 1+3	WxW	24,754	11,000	Chiwawa	11.4
RCY2	Mixed	41,572	22,000	Chiwawa	11.4
		66,326		**Total**	
RCY2	Mixed	35,000	TBD	L. Wenatchee	40.2
		35,000			

[1]Mixed = HxH and WxW.
[2]Releases will occur between April 20 - May 8.

Additional Considerations

- To eliminate release location as a potential confounding variable, releasing all of the PIT-tagged fish into one release location is recommended.
  Which release location should be utilized? All PIT-tags released in Chiwawa River well upstream from the detection array (RK 11.4).
- A special condition of the permit is to minimize residualism rates for hatchery releases and maximize the rate and probability of downstream migration. To ensure the program works towards minimizing potential long term effects of residuals, the Permit Holders, through the HC process, will develop a plan that limits the number of residuals produced and attempts to identify an acceptable rate of residualism in the Wenatchee steelhead program by brood year 2018. This plan may include the following elements:
  - Methodology for establishing baseline conditions; concurrence of a performance standard threshold; criteria for determining exceedance/compliance with the performance standard.

  Input on post-release sampling to conduct GSI sampling and assessment of smolt index? See "Methodology for Establishing Residualism Baseline Conditions of the Wenatchee River Summer Steelhead Hatchery Program" March 12, 2018, Rock Island and Rocky Reach HCPs HCs notes.

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Appendix J
2018 Fish Spill Plan Rock Island and Rocky Reach Dams

2018 Fish Spill Plan

Rock Island and Rocky Reach Dams

Public Utility District No. 1 of Chelan County

Prepared By:

Thad Mosey
Fisheries Biologist

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

Final
February 27, 2018

Introduction and Summary

In 2018, Public Utility No. 1 of Chelan County (Chelan PUD) will implement spill operations for fish passage at the Rock Island and Rocky Reach and projects. Spill timing and spill percentages are specified by the anadromous Habitat Conservation Plans (HCP) for each respective project. Chelan PUD conducted juvenile project survival studies from 2002 through 2011 at Rocky Reach and Rock Island under varying spill levels in order to achieve HCP survival standards. The Rock Island Project completed multiple survival studies over a nine year period (17 total studies) for spring migrating Plan Species (yearling Chinook, steelhead, sockeye), first using a 20 percent spill level, then a 10 percent spill level. Rock Island will continue to spill 10 percent of day average flow during the spring outmigration period through at least year 2020. The Rocky Reach Project completed its suite of HCP survival studies for spring migrating Plan Species in 2011 (14 studies), under spill and no-spill operation at the dam. HCP juvenile survival standards were achieved for species tested with a no spill operation (yearling Chinook, steelhead, sockeye). Project spill levels are summarized in Tables 2 and 4 of this plan. Chelan PUD holds valid Incidental Take Statements (ITS) from National Oceanic and Atmospheric Administration Fisheries (NOAA) and the United States Fish and Wildlife Service (USFWS) for HCP fish spill operations at Rocky Reach and Rock Island dams.

For the 2018 juvenile outmigration, Chelan PUD will operate the Rocky Reach juvenile fish bypass system (JFBS) starting 1 April for the spring juvenile outmigration of yearling Chinook, steelhead, and sockeye. Spring spill at Rocky Reach Dam will consist of hydraulic spill for reservoir control only. HCP Project survival standards were achieved with bypass-only operations. During the subyearling Chinook outmigration in 2018, Rocky Reach will spill 9 percent of day average river flow for a duration covering 95 percent of subyearling outmigration past the dam.

At Rock Island Dam in 2018, Chelan PUD will operate the Project with a 10 percent day-average spill level for the spring outmigration period. Rock Island has also completed HCP spring Plan Species survival testing for all Plan Species with a 10 percent spill level at the dam and has achieved juvenile survival standards for yearling Chinook, steelhead and sockeye and combined adult-juvenile survival for all three species.

During the summer period in 2018, Rock Island Dam will spill 20 percent of the day-average river flow for the outmigration of subyearling (summer) Chinook. Spill is the primary means of juvenile salmon and steelhead passage at Rock Island per Section 5.4.1(a) of the Rock Island HCP. Spring and summer spill will cover 95 percent of the juvenile fish outmigration for yearling/subyearling Chinook, steelhead, and sockeye in 2018.

Rocky Reach Juvenile Fish Bypass Operations

Rocky Reach will operate its JFBS continuously through the spring outmigration period, beginning 1 April 2018. Daily index sampling (for steelhead, yearling Chinook, and sockeye) will be performed at the bypass sampling facility to estimate the outmigration percentiles for each species through the spring period. During “index sampling” each day, a total of four 30-minute samples (Table 1) will be taken beginning at the top of each hour, 0800 to 1100 hours. Spring spill for fish passage is not required at Rocky Reach, but periods of forced spill may occur under high river flows. Some level of forced spill (river flow above 201 kcfs turbine capacity) normally occurs at Rocky Reach in the spring. Over the past 20 years, forced spill has occurred approximately 28 percent of all hours, April through June. With the current rehabilitation work on turbine units 8 through 11, instances of forced spill may occur more frequently in spring 2018 due to reduced turbine or powerhouse capacity.

Sampling protocols at the Rocky Reach bypass system in 2018 will remain consistent with those used in 2004-2017. Daily sampling in spring and summer periods (Monday through Sunday) will use four 30-minute “index periods” at 0800, 0900, 1000, and 1100 hours (Table 1). The sample target for each 30-minute sample will be 350 smolts during the spring period (yearling Chinook, steelhead, and sockeye combined), and 125 smolts for summer period (subyearling Chinook). If the number of fish collected in the bypass sampling raceway is estimated to reach the maximum number prior to completion of the 30-minute sample, the sampling screen will be retracted from the bypass conduit, and the number of fish collected in the shortened sample period will be proportionately expanded to the entire 30-minute period.

Table 1. Index sampling times at the Rocky Reach juvenile fish bypass and the number of smolts per sample. Sample times and sample targets have remained consistent since 2004.

Time	Sample Duration	Number of Smolts	Day of Week
08:00-08:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
09:00-09:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
10:00-10:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
11:00-11:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday

*Sample duration may be less than 30 minutes if smolt numbers are met prior to full 30-minute sample time

Rocky Reach 2018 Summer Spill Operations

Rocky Reach Dam will spill 9 percent of the estimated day average river flow for the subyearling Chinook outmigration (Table 2). Spill will commence in late May to early June upon arrival of subyearling Chinook smolts in the Rocky Reach bypass samples. Juvenile run-timing information at Rocky Reach will be used to estimate subyearling Chinook passage percentiles (from the University of Washington's Program RealTime run forecaster) and guide spill operations to cover 95 percent of the summer outmigration. Actual subyearling counts in combination with juvenile passage estimates from the University of Washington's Program RealTime run forecaster will determine start and stop dates for the summer spill program.

The HCP guidelines for starting and ending summer spill at Rocky Reach are as follows:

1. Summer spill will start at midnight no later than the day on which the estimated 1-percentile passage point is reached, as indicated by Program RealTime run-forecast model. Subyearling Chinook will be defined as any Chinook having a fork length from 76 to 150 mm.

2. Summer spill season will generally end no later than 15 August, but not until subyearling index counts from the juvenile bypass sampling facility are 0.3 percent or less of the cumulative run for three out of any five consecutive days (same protocol used 2004-2017) and Program RealTime is estimating that the 95^{th} percentile passage point has been reached. In addition, spill operations must cover at least 95% of the subyearling outmigration

Diel Spill Shaping at Rocky Reach and Rock Island Dams

Daily spill volumes will be shaped within each 24-hour period at Rocky Reach Dam during the summer spill period, and at Rock Island Dam during both spring and summer spill periods (Tables 2 and 4).

Spill-shaping attempts to optimize spill water volume to maximize spill passage effectiveness for smolts. The diel spill shape functions to provide either higher or lower spill volume during periods of either higher or lower fish passage. Spill-shaping is based on the observed diel (24-hour) passage distributions of smolts at each project during spring and summer (Steig et al. 2009, Steig et al. 2010, Skalski et al. 2008, Skalski et al. 2010, Skalski et al. 2011, Skalski et al. 2012). The different spill percentages and time blocks are shaped such that the summation of water volume from all time blocks within the day equals the volume of water that would have been spilled under a constant, unshaped spill level (i.e. spill at 9 percent day-average river flow at Rocky Reach with no shaping). The hourly spill shape in 2018 will remain consistent with previous years, 2004-2017. Spill gates 2 through 8 will be used to meet daily spill percentage targets.

Table 2. Fish spill percentages and spill shape for the Rocky Reach spill program, 2018.

Project	Season	Daily Spill Average	Within-Day Spill Levels	Duration (# of hours each day)	Hourly Blocks of Spill	Spill Shape %
Rocky Reach	Spring	none	--	--	--	--
Rocky Reach	Summer*	9%	Med	1	0000-0100	9.0
			Low	6	0100-0700	6.0
			Med	2	0700-0900	9.0
			High	6	0900-1500	12.0
			Med	9	1500-2400	9.0

*Spill for subyearling Chinook

2018 Run-Timing Predictions

Chelan PUD contracts with the University of Washington (UW) to provide run-timing predictions and year-end observed values for spring and summer out-migrating percentiles for salmon and steelhead. UW's Program RealTime run-time forecasting model is used for this purpose. Program Real-Time provides daily forecasts and cumulative passage percentiles for steelhead, yearling/subyearling Chinook and sockeye at both Rocky Reach and Rock Island dams. This program enables Chelan PUD to better predict the time when a selected percentage of these species will arrive, and when a given percentage of any stock has passed. The program utilizes daily fish counts from the Rocky Reach bypass sampling facility and the juvenile fish bypass trap at Rock Island Dam. Estimates of passage percentiles are generated with the model's forecast error and are displayed with the daily predictions at:

http://www.cbr.washington.edu/crisprt/

Historic Run Timing

Estimated mean passage dates (first percentile to the 95th percentile) for each species at Rocky Reach and Rock Island dams are summarized in Table 3. Run-timing dates are estimated from daily index sample counts at the Rocky Reach JFBS (2004-2017), and from the Rock Island bypass trap, (2002-2017). At Rocky Reach Dam, the subyearling Chinook run generally begins the last week of May, with the one-percentile passage date on 30 May (mean date for years 2004-2017). Rocky Reach subyearling passage reaches the 95th percentile, on average, around 8 August (2004-2017, range: 21 July to 24 August).

Rock Island Dam juvenile salmon and steelhead sampling from the Smolt Monitoring Program (SMP; 2002-2017) indicates that the first percentile (one-percent passage) mean passage date for combined spring migrants (yearling Chinook, steelhead, and sockeye) occurs around 18 April (Table 3). The latest start date for spring spill at Rock Island Dam per the HCP is 17 April. The summer outmigration of subyearling Chinook smolts at Rock Island Dam generally begins in early June (although fry are encountered earlier), and on average, reaches the 95th percentile passage point around 6 August (range: 22 July to 19 August, 2002-2017).

Table 3. Spill percentages, bypass operation dates, and mean passage percentile dates (2002-2017) for the 1st and 95th percentile passage points for HCP spring and summer outmigrants at Rocky Reach and Rock Island dams.

Rocky Reach	**steelhead**	**yearling Chinook**	**sockeye**	**subyearling Chinook**
Percent Spill	0% Spring	0% Spring	0% Spring	9% Summer
1st, 95th percentile Passage Dates	4/15, 5/30	4/15, 5/27	5/4, 5/24	5/30, 8/8
RR Bypass System Operation	4/1 – 8/31	4/1 – 8/31	4/1 – 8/31	4/1 – 8/31
Rock Island	**steelhead**	**yearling Chinook**	**sockeye**	**subyearling Chinook**
Percent Spill	10% Spring	10% Spring	10% Spring	20% Summer
1st, 95th percentile Passage Dates	4/22, 6/7	4/15, 6/1	4/16, 6/5	6/2, 8/6
RI Bypass Trap Operation	4/1 - 8/31	4/1 - 8/31	4/1 - 8/31	4/1 - 8/31

Source - Rock Island: http://www.cbr.washington.edu/crisprt/index_midcol2_pi.html

Source- Rocky Reach: http://www.cbr.washington.edu/crisprt/index_midcol2_che.html

Rock Island 2018 Spring Spill Operations

In 2018, Rock Island Dam will spill 10 percent of the estimated day average river flow starting no later than 17 April and will end spill after 95 percent of spring outmigrants have passed the dam (usually the first week of June), with spill being provided for at least 95% of the spring species outmigration. Spill volume will be shaped to maximize spill efficiency (Table 4). Chelan PUD personnel will operate the Rock Island bypass trap, an upper Columbia SMP site, continuously from 1 April through 31 August (seven days per week) to provide daily smolt counts. Index counts will provide the basis to determine the start and end of the spring and summer outmigration periods. The HCP guidelines to start and end the spring spill program at Rock Island Dam are as follows:

1. The Rock Island spring spill program will begin when the daily smolt passage index count exceeds 400 fish for more than 3 days (this corresponds to the approximately 5 percent passage date), or no later than 17-April, as outlined in Section 5.4.1. (a) of the Rock Island HCP.

2. Rock Island spring spill will end 1) following completion of the spring outmigration (95 percent passage point), and 2) when subyearling (summer) Chinook have arrived at the Project.

Operators will utilize the following spill gate sequence to meet daily spill percentage targets in 2018: 32, 31, 30, 1, 26*, 16, 18*, 24, 29, 19, 20, 22, 27, 6, 7, and 8.

*Gates 26 and 18 will be converted to full-gate function prior to the spring spill season and remain in place until increased spring runoff has passed Rock Island, at which point they will be returned to notched gate operations. This change provides project flexibility to address periods of high flows while automatic gate capacity is reduced.

Rock Island 2018 Summer Spill Operations

Rock Island will spill 20 percent of the estimated daily average river flow for a duration covering 95 percent of the summer outmigration of subyearling Chinook. Daily smolt counts from the Rock Island bypass trap will inform decisions on when to start and stop spill. The HCP guidelines to start and stop summer spill at Rock Island Dam are outlined as follows:

1. Rock Island summer spill in 2018 will begin immediately after completion of the spring spill. The summer spill level will be 20 percent of day average flow, shaped to increase spill efficiency. Spill will continue for a duration covering 95 percent of the subyearling Chinook outmigration.

2. Summer spill will generally end no later than 15 August, or when subyearling Chinook counts from the Rock Island trap are 0.3 percent or less of the cumulative run total for three out of any five consecutive days, and UW's Program RealTime is estimating 95 percent run completion (same protocol used in 2004-2017).

Operators will utilize the following spill gate sequence to meet daily spill percentage targets in 2018: 32, 31, 30, 1, 26*, 16, 18*, 24, 29, 19, 20, 22, 27, 6, 7, and 8.

*Gates 26 and 18 will be converted to full-gate function prior to the spring spill season and remain in place until increased spring runoff has passed Rock Island, at which point they will be returned to notched gate operations. This change provides project flexibility to address periods of high flows while automatic gate capacity is reduced.

Table 4. Spill percentages and hourly spill shape for the Rock Island spring and summer fish spill program, 2018.

Project/Season	Daily Spill Average	With-in Day Spill Levels	Duration (# of hours each day)	Hourly Blocks of Spill	Spill Shape %
Rock Island Spring*	10%	High	4	0000-0400	12.5
		Med	3	0400-0700	10.0
		Low	5	0700-1200	6.0
		Med	8	1200-2000	10.0
		High	4	2000-2400	12.5
Rock Island Summer**	20%	High	1	0000-0100	23.0
		Med	1	0100-0200	19.0
		low	8	0200-1000	15.0
		Med	1	1000-1100	19.0
		High	13	1100-2400	23.0

*Spring spill for yearling Chinook, steelhead, and sockeye; **summer spill for subyearling Chinook.

Spill Program Communication

Chelan PUD's HCP representative will notify the HCPCC not less than once per week when fish passage numbers indicate that specific triggers for starting or stopping spill are likely to occur in the immediate future. Chelan PUD will notify the HCPCC regarding any unforeseen issues that pertain to the spill program as the season progresses. Communications with the HCPCC on spill information will generally be made by email, pre-scheduled conference calls, and HCPCC monthly meetings.

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Appendix K
Final Upper Columbia River 2018 BY Salmon and 2019 BY Steelhead Hatchery Program Management Plan and Associated Protocols for Broodstock Collection, Rearing/Release, and Management of Adult Returns

STATE OF WASHINGTON
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April 24, 2018

To: NMFS, HCP HC's, and PRCC HSC

From: Mike Tonseth, WDFW

Subject: **FINAL UPPER COLUMBIA RIVER 2018 BY SALMON AND 2019 BY STEELHEAD HATCHERY PROGRAM MANAGEMENT PLAN AND ASSOCIATED PROTOCOLS FOR BROODSTOCK COLLECTION, REARING/RELEASE, AND MANAGEMENT OF ADULT RETURNS**

The attached protocol was developed for hatchery programs rearing spring Chinook salmon, summer Chinook salmon and summer steelhead associated with the mid-Columbia HCPs; spring Chinook salmon, summer Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project and Salmon and Steelhead Settlement Agreement (FERC No. 2114); and fall Chinook salmon consistent with Grant County Public Utility District and Federal mitigation obligations associated with Priest Rapids and John Day dams (ACOE funded), respectively. These programs are funded by Chelan, Douglas, Grant County Public Utility Districts (PUDs), and ACOE and are operated by the Washington Department of Fish and Wildlife (WDFW), with the exception of the Omak Creek/Okanogan Basin steelhead broodstock collection, and acclimation/release of Omak Creek steelhead which is implemented by the Confederated Tribes of the Colville Reservation (CTCR).

This protocol is intended to be a guide for 2018 collection of salmon (2018BY) and steelhead (2019BY) broodstocks in the Methow, Okanogan, Wenatchee, and Columbia River basins. It is consistent with previously defined program objectives such as program operational intent (i.e., conservation and/or harvest augmentation), mitigation production levels (e.g., HCPs and Priest Rapids Salmon and Steelhead Settlement Agreement/2008 BiOp), changes to programs as approved by the HCP-HC and PRCC-HSC, and to comply with ESA permit provisions, USFWS consultation requirements.

Notable in this year's protocols are:

- Continuing for 2018, no age-2 or 3 males will be incorporated into spring or summer/fall Chinook programs unless necessary to maintain effective population size (minimum female to male ratio of 1:0.75; conservation programs only).

- Use of ultrasonography to determine the sex of each fish retained for brood to ensure achieving the appropriate number of females for program production (does not include Priest Rapids Hatchery).

- Utilization of genetic sampling/assessment to differentiate Twisp River and Methow River Basin natural-origin spring Chinook adults collected at Wells Dam, and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir and Methow FH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components for the GPUD, CPUD and DPUD programs.

- Expansion of spring Chinook trapping effort at the Wells Dam East and West ladder traps.

- Addition of Appendix H which describes a draft preferred approach to integration of the Methow conservation steelhead programs as well as minimize the potential for or increase the risk of a Ryman-Laikre effect in the Twisp River watershed.

- Collection of only hatchery adult steelhead at Wells Dam/Hatchery for the Lower Methow safety-net (WFH/MFH), and Wells Hatchery Okanogan and mainstem Columbia safety-net programs.

- Refinement of surplus UCR juvenile steelhead management plan.

- Collection of spring Chinook for the Nason Creek and Chiwawa programs using combination of Tumwater Dam and the Chiwawa Weir.

- Expansion of Chiwawa Weir operation sideboards for bull trout to increase probability of meeting broodstock targets for the Chiwawa conservation program.

- Management plan for excess production from Wenatchee Sub-basin spring Chinook hatchery programs.

- Targeted collection of 100% of the Wenatchee summer Chinook and Wenatchee hatchery origin steelhead broodstock at Dryden Dam to reduce the number of activities that may contribute to delays in fish passage at Tumwater Dam (some adult collections at Tumwater may be necessary if sufficient adults cannot be acquired at Dryden Dam).

- Targeted collection of 100% of the natural origin steelhead broodstock at Tumwater Dam.

- Collection of summer Chinook broodstock from the Chelan Falls Canal Trap (CFCT), sufficient to meet the entire Chelan Falls yearling program of 576K. Summer Chinook collections at Wells or Entiat Hatchery may be used to support the Chelan Falls program if broodstock collection efforts at the CFCT fall short.

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow safety-net on-station-released smolts (up to 17 adults). The remainder of the broodstock (51) will be WNFH returns collected at WNFH (or by angling/trapping for WNFH program) and/or Methow Hatchery and surplus to the WNFH program needs. Collection of Wells stock may be used if WNFH and Twisp returns are insufficient. The collection of adults will occur in spring of 2019.

- Summer Chinook collections at Wells Dam to support the CJH program may occur if CCT broodstock collection efforts fail to achieve broodstock collection objectives.

- Collection of ad-clipped only (no wire) spring Chinook adults (or possibly eggs identified through CWTs from ad-clipped +CWT CJH segregated returns) may occur from facilities in the Methow basin and/or Wells Dam. These alternative collection locations will only be used if CCT and USFWS broodstock collection efforts fail to achieve broodstock collection objectives for the CJH segregated program, or if conditions (e.g., spill at CJD, ladder/trap efficiency) appear unconducive to efficient collection of broodstock. Collection will run concurrent with spring Chinook broodstock collection for Methow Hatchery.

- Collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the YN, Yakima River summer Chinook program.

- Targeted collection of 1,000 adipose present, non-coded wire tagged fall Chinook from the PRD OLAFT.

- Targeted collection of about 400 adipose present, non-coded wire tagged fall Chinook using hook and line efforts in the Hanford Reach.

- Modification of the Tumwater trap operations to facilitate lamprey passage. Using Rocky Reach and Rock Island lamprey passage data as a surrogate, it is proposed to open the Tumwater Dam fishway to passage between 10PM and 6AM daily from September 1 to mid-December. This should allow open passage for at least 60%-70% of the lamprey while still accommodating coho and steelhead broodstocking and steelhead adult management. Because this is a trial year, some in-season adjustments may need to be made based on lamprey observations (during trapping periods) and the magnitude of steelhead adult management required.

These protocols may be adjusted in-season, based on actual run monitoring at mainstem dams and/or other sampling locations. Additional adaptive management actions as they relate to broodstock objectives may be implemented as determined by the HCP-HC or PRCC-HSC and within the boundaries of applicable permits.

Also included in the 2018 Broodstock Collection Protocols are:

Appendix A: 2018 BY Biological Assumptions for UCR Spring, Summer, and Fall Chinook and 2019 BY Summer Steelhead Hatchery Programs
Appendix B: Current Brood Year Juvenile Production Targets, Marking Methods, Release Locations
Appendix C: Return Year Adult Management Plans
Appendix D: Site Specific Trapping Operation Plans
Appendix E: Columbia River TAC Forecast
Appendix F: Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans
Appendix G: DRAFT Hatchery Production Management Plan
Appendix H: DRAFT Preferred Alternative for 2019 BY and beyond, Methow Sub-basin Conservation Steelhead Programs

Methow River Basin

Spring Chinook

Inclusion of natural-origin fish in the broodstock will be prioritized for the aggregate conservation program in the Methow Basin. Collections of natural-origin fish will not exceed 33% of the Methow Composite (i.e., non-Twisp) and Twisp natural-origin run escapement consistent with take provisions in Section 10 (a)(1)(A) Permits 18925 and 20533.

Hatchery-origin spring Chinook, if needed, will be collected in numbers excess to program production requirements to facilitate BKD management, comply with ESA Section 10 permit take provisions, and to meet programmed production shortfalls. Based on historical Methow FH spring Chinook ELISA levels above 0.12, any hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 20% (based upon the most recent 5-year mean ELISA results for the Methow/Chewuch/Twisp programs). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permits 18925 and 20533, culling will include the destruction of eggs from hatchery-origin females with ELISA levels greater than 0.12 and/or that number of hatchery origin eggs required to maintain an aggregate production of 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by DPUD Fish Health and the Wells, Rocky Reach, and Rock Island HCP's- and the Priest Rapids CC - HSC to be a substantial risk to the program. Progeny of natural-origin females, with ELISA levels greater than 0.12, may be differentially tagged for evaluation purposes. Annual monitoring and evaluation of the prevalence and level of BKD and the efficacy of culling returning hatchery- and natural-origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

WDFW genetic assessment of natural-origin Methow spring Chinook (Small et al. 2007) indicated that Twisp natural-origin spring Chinook can be distinguished, via genetic analysis, from non-Twisp spring Chinook with a high degree of certainty. The Wells HCP Hatchery

Committee accepted that Twisp-origin fish could be genetically assigned with sufficient confidence and that natural origin collections can occur at Wells Dam. Scale samples and non-lethal tissue samples (fin clips) for genetic/stock analysis will be obtained from adipose-present, non-CWT, non-ventral-clipped spring Chinook (suspected natural-origin spring Chinook) collected at Wells Dam, and origins assigned based on genetic analysis. Natural-origin fish retained for broodstock will be PIT tagged (pelvic girdle) for cross-referencing tissue samples/genetic analyses. Tissue samples will be preserved and sent to the WDFW genetics lab in Olympia Washington for genetic/stock analysis. Spring Chinook collected from Wells will be held until genetic analysis results are received then transferred to and retained at Methow Hatchery and spawned for each program depending on results of DNA analysis. Brood collection of NORs at Wells will be based upon assignment of Twisp NORs to the Twisp program and non-Twisp NORs being used to support Methow and Chewuch River releases. Spring Chinook collected at Methow Hatchery will be held at MFH until genetic analysis results are received and then handled accordingly.

The number of natural-origin Twisp and Methow Composite (non-Twisp) spring Chinook retained will be dependent upon the number of natural-origin adults returning and the collection objective limiting extraction to no greater than 33% of the natural-origin spring Chinook return to the Methow Basin. Natural origin fish not assigning to the Twisp or Methow Composite will be released back into the Columbia River.

Weekly estimates of the passage of Wells Dam by natural-origin spring Chinook will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%. Hatchery origin adults trapped at the Winthrop NFH may be included, if needed, in the event of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook to Wells Dam during 2018 is estimated at 3,235 spring Chinook, including 2,366 hatchery and 869 natural origin spring Chinook (Table 1 and Table 2). In-season estimates of natural-origin spring Chinook will be adjusted proportional to the estimated returns to Wells Dam at weekly intervals and may result in adjustments to the broodstock collection targets presented in this document. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

The following broodstock collection protocol was developed based on BKD management strategies, projected return for BY 2018 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and biological assumptions listed in Appendix A.

The 2018 aggregate Methow spring Chinook broodstock collection will target up to 126 adult spring Chinook (18 Twisp, 108 Methow; Table 3). Based on the pre-season run forecast, Twisp fish are expected to represent about 3.5% of the CWT tagged hatchery adults and 23% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin spawning escapement to the Twisp, the 2018 Twisp origin broodstock collection will total 18 wild fish, representing 100% of the broodstock necessary to meet Twisp program production of 30,000 smolts. Methow Composite fish are expected to represent about 34% of the CWT tagged hatchery adults and 77% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33% of the age-4 and age-5 natural-origin recruits, the 2018 aggregate Methow/Chewuch broodstock collection will total 108 natural-origin spring Chinook. Broodstock collected for the aggregate Methow conservation programs represents 100% of the broodstock necessary to meet the Methow programs production of 223,765 smolts. The Twisp River releases will be limited to releasing progeny of broodstock identified as wild Twisp and or known Twisp hatchery origin fish, per ESA Permit 18925. The MetComp releases will include progeny of broodstock identified as wild non-Twisp origin (or known Methow Composite hatchery origin if needed to meet shortfalls in the production goal) fish. Age-3 males ("jacks") will not be collected for broodstock.

Table 1. Brood year 2013-2015 age class-at-return projection for wild spring Chinook above Wells Dam, 2018.

			Age-at-return									
Brood year	**Smolt Estimate**		**Twisp Basin**					**Methow Basin**				
	Twisp[1]	Methow Basin[2]	Age-3	Age-4	Age-5	Total	SAR[3]	Age-3	Age-4	Age-5	Total	SAR[4]
2013	24,605	36,242	19	142	**21**	182	0.0074	48	619	**127**	794	0.0219
2014	28,380	41,353	21	**164**	25	210	0.0074	54	**707**	145	906	0.0219
2015	22,738	26,491	**17**	131	20	168	0.0074	**35**	453	92	580	0.0219
Estimated 2018 Return			**17**	**164**	**21**	**202**		**35**	**707**	**127**	**869**	

[1] *Smolt estimate is based on sub-yearling and yearling emigration (Charlie Snow, personal communication).*

[2] *Estimated Methow Basin smolt emigration based on Twisp Basin smolt emigration, proportional redd deposition in the Twisp River and Twisp Basin smolt production estimate.*

[3] *Geometric mean Twisp NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*

[4] *Geometric mean Methow NOR spring Chinook SAR to Wells Dam estimated using natural origin PIT tag returns (BY 2003-2009; David Grundy, personal communication).*

Table 2. Brood year 2013-2015 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2018.

	Projected Escapement											
	Origin								Total			
	Hatchery				Wild				Methow Basin			
Stock	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**
MetComp	124	673	12	**809**	18	543	106	**667**	142	1,216	118	**1,476**
%Total				34.2%				76.8%				45.6%
Twisp	18	55	11	**84**	17	164	21	**202**	35	219	32	**286**
%Total				3.5%				23.2%				8.9%
Winthrop (MetComp)	318	1,125	30	**1,473**					248	886	21	**1,473**
%Total				62.3%								45.5%
Total	460	1,853	53	**2,366**	35	707	127	**869**	495	2,560	180	**3,235**

Table 3. Number of broodstock needed for the combined Methow spring Chinook conservation program production obligation of 223,765 smolts, collection location, and mating strategy.

By obligation	Production target	Number of Adults: Hatchery	Number of Adults: Wild	Total		
Chelan PUD	60,516		17F/17M	**34**		
Douglas PUD	29,123		8F/8M	**16**		
Grant PUD	134,126		38F/38M	**76**		
Total	**223,765**		**64F/64M**	**126**		
By program		**Number of Adults: Hatchery**	**Number of Adults: Wild**	**Total**	**Collection location**	**Mating protocol**
Twisp	**30,000**		**9F/9M**	**18**	Wells Dam/Twisp Weir	2x2 factorial
MetComp	**193,765**		**54F/54M**	**108**	Wells Dam/Methow Hatchery	2x2 factorial
Total	**223,765**		**63F/63M**	**126**		

Trapping at Wells Dam will occur at the East and West ladder traps beginning on May 1, or at such time as the first spring Chinook are observed passing Wells Dam, and continue through June 30, 2017 (collection quotas will be prioritized for the May 1-June 22 time frame). Spring Chinook broodstock collection and stock assessment sampling activities authorized through the 2018 Douglas PUD Hatchery M&E Implementation Plan will utilize a combination of trapping on the East and West ladders as per the detailed descriptions of the modified trapping operations for spring Chinook collection in Appendix D. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quota).

Collection goals will be developed by Wells M&E staff to identify the most appropriate spatial and temporal approach to achieving the overall brood target. All natural origin spring Chinook collected at Wells Dam for broodstock will initially be held at Wells FH (or immediately transferred to Methow FH taking into account the status of adult holding during the modernization project) pending genetic results and then transferred to Methow FH. Fish collected at MFH will remain at MFH or be transferred to WNFH.

Collection of ad-clipped only (no wire) spring Chinook adults (or possibly eggs identified through CWTs from ad-clipped +CWT CJH segregated returns) may occur from facilities in the Methow basin and/or Wells Dam. These alternative collection locations will only be used if CCT and USFWS broodstock collection efforts fail to achieve broodstock collection objectives for the CJH 10j program, or if conditions (e.g., spill at CJD, ladder/trap efficiency) appear unconducive to efficient collection of broodstock. Collection will run concurrent with spring Chinook broodstock collection for Methow Hatchery.

Trapping at the Twisp Weir for spring Chinook may begin May 1 or at such time as spring Chinook are observed passing Wells Dam and may continue through August 23. The trap may be operated up to seven days per week/16 hours per day (provided it is manned during active trapping).

However, trapping at the Methow Hatchery Outfall trap may continue beyond the Twisp Weir operations as needed to meet basin wide PNI/pHOS objectives. Hatchery-origin adults captured at the Methow Hatchery Outfall (surplus to the Methow Hatchery program) will be: 1) used for adult out-planting to increase natural production and secondarily 2) transferred to the WNFH for incorporation into WNFH brood, or 3) removed as surplus as supported by the HGMP's of both facilities.

Steelhead

Douglas PUD and Grant PUD steelhead mitigation programs above Wells Dam utilize adult broodstock collections from multiple sources and locations such as at Wells Hatchery, Wells Dam, Twisp Weir, Methow Hatchery volunteer trap, WNFH volunteer traps, Omak Weir, Wild horse Creek box trap and angling in the Methow River and Okanagan River (Table 5). Generally incubation/rearing occur for the DPUD conservation program, Methow safety net, Okanogan, and Columbia River releases at Wells Fish Hatchery (FH). Methow Hatchery may be used to temporarily hold broodstock that are ultimately transferred to Wells Hatchery or WNFH. Broodstock for the conservation programs (USFWS and DPUD) is achieved via angling in the Methow Basin and trapping at the Twisp Weir (as needed), respectively. Broodstock for the Methow safety net program is achieved primarily through returns to WNFH (including hook and line-caught HOR steelhead) and surplus fish removed at Methow Hatchery and the Twisp Weir. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin summer steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Presently the HCP HC and Joint Fisheries Parties are working to develop, approve, and implement an alternative to past programmatic approaches to more fully integrate the collective Methow sub-basin steelhead conservation programs as well as address concerns over potential RL effects in the Twisp River watershed. Some elements of a preferred alternative (see Appendix H), are still being piloted for the 2018 brood. The HC parties have not approved a long-term plan for the Twisp program pending results of the 2018 pilot year brood collection efforts. , the broodstock collection protocols for the 2019 brood will remain the same as those described in the 2017 Broodstock Collection Protocols. If the alternative in Appendix H or other alternative is approved prior to implementation of the 2019 BY conservation programs, the 2018 Broodstock Collection Protocols will be updated to reflect the new direction.
Specific program brood sources are structured as follows:

Broodstock collection for the DPUD summer steelhead program has been optimized to provide a high probability of collecting sufficient broodstock of the proper origin to meet program production goals while minimizing the probability of producing overages. The following broodstock collection logic provides a step-by-step process whereby DPUD and WNFH summer steelhead broodstock will be collected.

1. September-November 2018: Collect ad clip + CWT hatchery origin steelhead from Wells dam and Wells Volunteer channel sufficient to meet the Methow Safety-Net program (100,000 release; 60 broodstock). Go to #2.

2. Subsequent broodstock collections (see below) for the Methow Safety-Net program will prompt the transfer of the fall collected broodstock progeny to the Columbia Safety-Net Program (160,000 release target), up to the entire fall-collected production (equal to approximately 100,000 smolts). This will leave as few as 60,000 smolts to be produced by subsequent collections for the Columbia Safety-Net. Any Okanogan-origin broodstock spawned from this fall collection group will be transferred to the Okanogan production (CCT to collect broodstock in the Okanogan basin in spring 2019). Go to #3.

3. February 2019-April 2019: Hook-and Line collections in the Methow mainstem: target sufficient natural origin summer steelhead for the Twisp Conservation component (24,000 release; 12 broodstock collected downstream of Twisp) and the WNFH (up to 200,000 release; 110 broodstock collected throughout Methow mainstem). These natural origin fish are to be transported to WNFH, spawned collectively, and a portion of the progeny sufficient to meet the 24,000 release target will be transferred to Wells Hatchery as eyed eggs. By-catch of hatchery origin fish will be retained as broodstock for the WNFH program (Ad+CWT), the Methow Safety-Net (CWT only, Ad+CWT), and the Columbia Safety-Net (Ad only, Ad_CWT), as needed. Adults in excess of broodstock needs will be managed as surplus. Go to #4.

4. March- May 2019: Twisp Weir collection. Target sufficient natural origin summer steelhead for the Twisp Conservation component (24,000 release). Hatchery-origin fish to be removed at a rate to meet pHOS management target. CWT-only fish to be used as broodstock for the Methow Safety-Net up to 25% (approximately 15 broodstock). Additional CWT-only

broodstock may be used in the Columbia Safety-Net. CWT+Ad may be used in the Columbia Safety-Net. Go to # 5.

5. March-May 2019: WNFH Volunteer Channel and Methow Hatchery Volunteer channel. Natural origin fish may be collected if present and included in the WNFH and Methow River collected component of the Twisp Conservation Program. Hatchery origin fish will be collected and used as broodstock in the WNFH program (Ad+CWT), Methow Safety-Net program (Ad+CWT), and the Columbia Safety-Net program (Ad+CWT, Ad only). Such fish will be used to augment the fish previously collected described in #s 1 and 2, above. Go to #6.

6. March-May 2019: The Wells Volunteer Channel will be used to collect AD+CWT, Ad only, and CWT only hatchery origin adult summer steelhead to be used as backfill for Methow Safety-Net, Columbia Safety-Net, Okanogan Program, and WNFH program (if desired by USFWS) should any of these program lack sufficient broodstock for the collections described above. Adult hatchery origin steelhead in excess of broodstock needs will be surplused.

Twisp River – Conservation Releases

Due to the recent increased concern for inbreeding depression risk (Ryman-Laikre) for the Twisp program as a result of low N_e and other confounding issues, the design of the Twisp program is currently under review.

The HC and JFP are working to redefine the scope and nature of the 2019 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan can be implemented.

The current plan (BY 2018) collects approximately 12 natural origin fish as broodstock from the Methow Mainstem (hook and line) and approximately 12 natural origin fish as broodstock from the Twisp River (weir).

Wells Hatchery – Methow River Release

The Wells Hatchery Methow River release (Methow safety net program) uses locally collected hatchery origin broodstock representative of the Twisp and WNFH conservation programs and as needed, the Methow safety-net program. Adults are collected in concert with adult management and broodstock collection (including hook-and-line) activities at the Twisp Weir, Methow Hatchery, and WNFH.. As a backup to potential collection shortfalls in the Methow safety-net program , a portion of the Methow program may be augmented with collection of hatchery origin adults (60) occurring in the fall at Wells Dam. These fall-collected fish will be considered surplus to any spring-collected Methow broodstock (hook and line, Twisp Weir, WNFH and Methow Hatchery volunteer channels), and surplus eggs and/or fry from the Methow Safety-Net broodstock may be utilized for other programs in the upper Columbia. As a final backup strategy, hatchery origin broodstock may be collected from Wells Hatchery Volunteer Channel in spring 2019 if other broodstock collection measures fall short. Beginning with the 2018 release, fish will be truck planted at Effy Bridge (RKM 13) in the lower Methow.

Wells Hatchery-Columbia River Release

The Wells Hatchery Columbia River releases will use progeny from the fall-collected Methow Safety-Net broodstock (described above) to the extent that spring collections partially or completely fulfill this program. The remaining production for the Columbia Safety-Net may include hatchery origin broodstock collected via hook-and-line in the Methow River, Twisp Weir, adult returns to the Methow Hatchery and Winthrop NFH, and may be augmented with fish collected in spring 2019 from the Wells Volunteer channel if needed to fulfill the program. Surplus eggs and/or fry from the Columbia and Okanogan broodstock may be utilized for other programs in the upper Columbia. Fish are released to the Columbia River, immediately downstream of Wells Dam.

Winthrop NFH – Methow River Release

The USFWS Methow River release will primarily use natural-origin fish collected through hook-and-line collection efforts in the Methow River each spring. In the event NO collection falls short of the target, WNFH hatchery-origin returns will be prioritized, followed by safety-net hatchery returns. Transfer of adult and/or gametes/eggs between program will be carefully choreographed to ensure fish are being utilized in the most efficient and effective manner. Fish may be released throughout the Methow basin.

Okanogan River and Tributary Releases

The Okanogan River conservation program uses a combination of natural and hatchery-origin adults collected in Omak Creek and elsewhere in the Okanogan Basin through CCT collection efforts. As a backup to potential spring collection shortfalls, up to 30 hatchery origin fish will be collected in the fall of 2018 at Wells Dam. Fish collected in the fall 2018 for the Methow Safety-Net program that are subsequently identified as Okanogan origin will be used as the priority for the Okanogan program followed by unknown hatchery origin adults as a backup, if necessary to meet production levels for the Okanogan. Surplus eggs and/or fry from the Okanogan River program broodstock may possibly be utilized for other programs in the upper Columbia or otherwise surplused at the earliest time when overages are apparent.

Should the combined Okanogan Basin spring period collection and Wells Dam fall period collection fail to achieve sufficient broodstock to meet programmed production, steelhead will be collected from the Wells Hatchery volunteer ladder in the spring of 2019, sufficient to meet broodstock needs. Fish with positive CWT or PIT tag for Okanogan origin will be the priority to fill the shortfall in broodstock, followed by unknown hatchery origin fish.

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2019 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Locations
DPUD Conservation[2]	TBD	Douglas PUD	Buttermilk Bridge, TBD	48,000 (S_1)	TBD
Methow Safety-Net	Wells Hatchery	Douglas PUD	Effy Bridge – Lower Methow River	100,000	HxH: Twisp Weir (up to 25%) + WNFH Hatchery (75%) or WNFH 1st, MFH 2nd to make up balance
Mainstem Columbia Safety-Net	Wells Hatchery	Douglas PUD	Wells Hatchery	160,000	HxH: Wells FH/Dam returns (1st option); Methow FH/WNFH (2nd option)
WNFH Conservation Program	WNFH	USFWS	WNFH or other locations as determined by the JFP	Up to 200,000 (S_2)	Maximize use of NOR, up to 55 pair captured by hook and line in the Methow River and Spring Creek Weir.
Okanogan[1]	Wells Hatchery/ St. Mary's Pond	Grant PUD/CCT	Okanogan tributaries	100,000[1]	Okanogan Basin, Wells Dam

[1] CCT received approval for the Okanogan steelhead HGMP as part of their Tribal Resource Management Plan in February, 2017. Omak Creek and Wells Fish Hatchery are no longer separate hatchery programs. Up to 58 broodstock (NOB or HOB) may be collected from throughout the Okanogan basin (or Wells Dam if necessary) to meet the 100k program.
[2] The DPUD Twisp conservation program is currently under re-development after detection of inbreeding depression risk. The HC and JFP have committed to developing an approved plan in sufficient time for implementation.

The following broodstock collection protocol was developed based on mitigation program production objectives (Table 6), biological assumptions (Appendix A), and the probability that sufficient adult steelhead will return in 2018/2019 to meet production objectives absent a preseason forecast at the present time.

For the 2019 brood steelhead programs operating above Wells Dam, a total of 346 adults (192 natural origin and 154 hatchery origin adults) are estimated to be needed to fulfill the respective mitigation obligations (Table 6). To support these obligations and to ensure sufficient backup adults are available in the event tributary based collection efforts fall short of targets, fall 2018 and spring 2019 trapping at Wells Dam and/or Wells FH may selectively retain up to 214 hatchery origin steelhead (west [and east, as necessary] ladder and volunteer trap collection; Table 5). As a note, all potential broodstock will be scanned for PIT tags at collection and PIT tagged fish will be returned to the river to meet their monitoring objective. Any adult determined to have been part of the Yakama Nation's kelt reconditioning program will be released in the vicinity it was collected.

Twisp Conservation Program (DPUD)

The HC and JFP are working to redefine the scope and nature of the 2019 brood and future Twisp program. Parties will complete this task no later than October 1 (or sooner) of the current year such that an approved plan (the current draft plan be reviewed in Appendix H) can be implemented.

Methow Safety Net Program

Up to 14 surplus hatchery-origin Twisp-stock steelhead (to meet up to 25% of the 100K Methow Safety-Net release) will be targeted at collective locations including the Twisp Weir and moved as live adults to Wells Hatchery for spawning. No less than 46 hatchery adults will be targeted at WNFH and through angling efforts, and if needed/available, Methow Hatchery volunteer traps to meet the balance of the program needs (Table 6). Up to 60 hatchery origin Wells stock may be collected in fall 2018 and held at the Wells Hatchery to be used as broodstock for the Methow Safety-Net. Should spring collection fulfill or partially fulfill the broodstock needs for the Methow Safety-Net, then the surplus progeny from the fall collected fish will be transferred to the Columbia Safety-Net program. If collection via hook-and-line, at the Twisp Weir, and WNFH and MH traps/collection efforts are unsuccessful (Table 5) then broodstock will be trapped in the Wells Volunteer channel in spring 2019.). Coordination between USFWS, DPUD, and WDFW staff will occur during the season to determine prioritization.

Methow Conservation Program (USFWS)

Approximately 110 natural origin adults (55 pair) will be targeted for retention through hook–and-line collection efforts in the Methow River (Table 6). In the event of a shortage, excess hatchery steelhead from the Twisp Weir and volunteer returns to the WNFH (including angle-caught fish) will be utilized as needed to augment WNFH broodstock. Should there be inadequate surplus steelhead from these sources, excess hatchery steelhead (presumed Methow Safety-Net origin) captured at the Methow Hatchery volunteer trap will be used to fulfill the program. Natural-Origin females will be live-spawned and reconditioned by YN.

Okanogan Conservation Program (GPUD/CCT)

Up to 58 adult steelhead will be targeted in the Okanogan Basin, including up to 100% natural-origin adults (dependent on run size and within the 33% natural origin extraction rate) (Table 5). Additionally, progeny of adult steelhead collected in the fall for the Methow Safety-Net and subsequently identified as Okanogan-origin will be transferred to the Okanogan program. Due to unknown broodstock collection efficiencies in the Okanogan River Basin (Table 5) further broodstock shortfalls for the Okanogan may be supplemented with broodstock collected in the spring of 2019 at the Wells Fish Hatchery Volunteer Ladder to meet the production obligation.

Table 5. Broodstock collection locations, number, and origin by program.

Program	Number of Adults[1]		Primary collection location	Number of backup adults[2]	Backup collection location(s)	Total adult collection[1]	
	Hatchery	Wild				Hatchery	Wild
DPUD Columbia R. SN	94		Wells FH/Dam, Methow River, WNFH, Methow Hatchery, Twisp Weir		Wells Hatchery	94	
DPUD Methow R. SN	60		Twisp weir (14), Methow RiverWNFH[3]W NFH[3] (46)	Up to 60	Wells Hatchery	120	
DPUD Met. Conservation		24	Twisp weir	NA	NA		24
GPUD Okanogan R.	0-58[6]	0-58[7]	Wells Dam, Omak Cr., Okanogan R. and tributaries.	0[5]	Wells FH[5]	(Backup) 0-58	(1st priority) 0-58
USFWS Methow R.		110	Methow R. WNFH[4]	NA	Methow FH	Up to 54[8]	110[8]
Total **(PUD programs)**	**154-212**	**24-82**		**Up to 60**		**214-294**	**24-82**
Total **(All programs)**	**154-212**	**134-192**		**Up to 60**		**214-326**	**134-192**

[1] Assumes a 1:1 sex ratio (see table 6). Natural origin females will be live spawned and reconditioned.
[2] All backup broodstock are hatchery origin adults collected in fall.
[3] Primarily uses hatchery origin adults collected via the USFWS hook and line efforts for natural origin fish in the Methow River and adult returns to WNFH. May include Methow safety net adults collected via angling, or adult returns to WNFH and Methow FH.
[4] May also include excess hatchery origin adults collected via angling and at Methow FH and the Twisp Weir.
[5] Fall collection of MSN will contribute any Okanogan origin brood production. Spring collection of hatchery origin steelhead as needed to meet program for the Okanogan Program. Shortfall, if encountered, to be met with Wells Hatchery Volunteer Channel collection in spring.
[6] Dependent upon number of NOR broodstock collected in the Okanogan Basin, age structure and fecundity to achieve sufficient brood for a100k smolt program for the Okanogan.
[7] Depending upon NOR abundance and trapping efficiency
[8] Broodstock composition for the WNFH conservation program is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Table 6. Number of broodstock needed to produce approximately 608,000 smolts for the above Wells Dam 2019 brood summer steelhead programs. Includes primary collection location(s) and mating strategy. *Broodstock totals do not include additional fish that may be collected at other locations as a backup for shortfalls from primary collection sources*.

Program	Production target/request	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
DPUD[1] Columbia R.	160,000	47F/47M		**94**	Wells Dam/Twisp Weir/	1:1
DPUD[2] Methow R.	100,000	30F/30M		**60[4]**	Twisp Weir, MFH, WNFH, Wells Dam	1:1
DPUD Methow Conservation	48,000		12F/12M	**24**	Twisp Weir/Methow River	2x2 Factorial
GPUD Okanogan R.[3]	100,000		29F/29M	**58[5]**	Okanogan R./Omak Creek	1:1/2x2[7]
USFWS Conservation[8]	200,000[8]		55F/55M	**110**	Methow River[6]	2X2 Factorial
Total[4]	**608,000**	**77F/77M**	**96F/96M**	**346**		

[1] Mainstem Columbia releases at Wells Dam. Target HxH parental adults as the hatchery component.
[2] Methow hatchery release of HxH fish produced from either adults returning from the Winthrop conservation program, adults trapped at MFH, and/or surplus hatchery adults from the Twisp weir.
[3] CCT intends to achieve greater than 0.5 pNOB in both 2018 and 2019, but the actual number will be dependent upon run size and trap efficiency, per the HGMP. Numbers of hatchery and wild males and females in this table should not be taken as the goal or limit for any collection effort, as it could be up to 100% pNOB or pHOB.
[4] Up to an additional 30 hatchery adults may be collected at Wells FH as a fall back to shortfalls in collections for the Methow safety net.
[5] Up to an additional 30 hatchery origin adults may be collected at Wells Dam as backup to potential shortfalls in Okanogan Basin collection efforts.
[6] Collection priority: 1) hook and line, 2) adult returns to WNFH, 3) excess adult returns to Methow Hatchery.
[7] A 1:1 mating protocol will be used for all HxH/HxW crosses within the Okanogan. The Okanogan locally-adapted natural stock (WxW) will utilize a minimum 2x2 factorial mating to minimize potential negative effects associated with a small effective population size.
[8] Production is subject to a sliding production/pNOB scale where full 200K production is targeted only when broodstock pNOB is >0.75. Under run/environmental conditions where collection is unable to support extraction of 110 NORs, HOR broodstock are incorporated subject to a sliding scale (with a minimum release of 100K) as authorized in the 2017 Biological Opinion.

Overall collection for the PUD programs will be 236 fish (a combination of program specific and back-up adults; Table 6) and limited to no more than 33% of the entire run and/or 33% of the natural origin return. Hatchery and natural origin collections will be consistent with the respective run-timing of hatchery and natural origin steelhead at Wells Dam, Omak Weir and the Twisp Weir. Trapping at the Wells Dam ladders may occur between 01 August, 2018 and 30 April, 2019, up to three days per week, and up to 16 hours per day, as required to meet broodstock objectives. Trapping will be concurrent with summer Chinook broodstocking efforts through 15 September, 2018 on the west ladder (Appendix D). Operational criteria and dates for the Twisp Weir are still under development

Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and Wells dams. Broodstock collection adjustments may be made based on in-season monitoring and evaluation. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

Surplus UCR Juvenile Steelhead Management

In the event excess HxH juveniles are produced from the over-collection efforts to support the Methow Safety-Net and /or Okanogan programs which rely on spring adult collections, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Progeny transferred to the Columbia Safety-Net program provided fish health and/or marking requirements for the program can be met.

2. Used to support shortfalls in the WNFH production obligation provided fish health and/or marking requirements for the program can be met and provided basin wide pHOS/PNI allow for a decrease in program pNOB.

3. Used to support shortfalls in the Ringold SHD program provided fish health and/or marking requirements for the program can be met.

4. Out-planted to landlocked lakes within Okanogan County and/or Colville Reservation provided fish health requirements can be met or provided stocking allotments are not exceeded (as determined by WDFW, YN and CCT fishery managers, as applicable; Banks Lake may be utilized as a last resort if stocking allotments for area lakes have already been met and/or if access to appropriate locations is inhibited – i.e., snow, ice, washouts, etc.).

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy. If excess WxW production from any of the conservation programs occurs, the priority will be to incorporate those progeny either into an available conservation program (if a shortfall exists) or into the closest safety net program (in this case it would be the Methow safety net [MSN]). Excess safety net fish from the MSN will then be managed in accordance with the guidelines above.

Summer/fall Chinook

The summer/fall Chinook mitigation program in the Methow River utilizes adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 200,000 summer/fall Chinook smolts for acclimation and release from the Carlton Acclimation Facility.

The TAC 2018 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2013, 2014, and 2015 spawn escapement to tributaries above Wells Dam indicate sufficient summer Chinook will return past Wells Dam to achieve full broodstock collection for supplementation programs above Wells Dam. The following broodstock collection protocol for the Methow summer Chinook program was developed based on initial run expectations of summer Chinook to the Columbia River, program objectives, and program assumptions (Appendix A).

For 2018, up to 136 natural-origin summer Chinook at Wells Dam west (and east, if necessary) ladder(s), including 68 females for the Methow summer Chinook program (Table 7). Collection will be proportional to return timing between 01 July and 15 September. Summer Chinook stock assessment will run concurrent with summer Chinook broodstock collection at the west ladder trap. Trapping may occur up to 3-days/week, 16 hours/day (48 cumulative hours per week). Age-3 males ("jacks") will not be collected for broodstock.

Should use of Wells Dam be needed to meet any shortfalls in Chief Joseph Hatchery broodstock for summer/fall Chinook programs , the CCT will notify the HCP-HC and Wells HCP Coordinating Committee/PRCC-HSC and coordinate with Douglas PUD, Grant PUD, and WDFW to facilitate additional broodstock collection effort. Summer Chinook broodstock collection efforts at Wells Dam, should they be required to meet CJH program objectives, will be conducted concurrent with broodstock collection efforts for the Methow summer Chinook program and or steelhead collection efforts for steelhead programs above Wells Dam.

If the probability of achieving the broodstock goal is reduced based on passage at the west ladder or actual natural-origin escapement levels, broodstock collections may be expanded to the east ladder trap and/or origin composition will be adjusted to meet the broodstock collection objective. If collection of adults from the east ladder trap is necessary, access will be coordinated with staff at Wells Dam due to the rotor rewind project.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 7. Number of broodstock needed for Grant PUDs Methow summer Chinook production obligation of 200,000 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Methow	200,000		68F/68M	**136**	Wells Dam	1:1
Total	**200,000**		**136**	**136**		

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - The summer Chinook salmon acclimated at the Carlton Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),

- all fish will be released when Columbia River and Methow River flows are predicted to be satisfactory,

- all fish will be released no later than May 7 regardless of flow conditions,

- attempts will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in the Methow River are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Methow River flows are not satisfactory due to insufficient snow pack.

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Collection at the Wells FH volunteer channel will be used to collect the broodstock necessary for the Wells FH yearling (320,000) and sub-yearling (484,000) programs.

Because of CCT concerns about sufficient natural origin fish reaching spawning grounds and to ensure sufficient NOR's being available to meet the CCT summer Chinook program, incorporation of natural origin fish for the Wells program or programs with broodstock originating from the Wells volunteer channel, will be limited to fish collected in the Wells volunteer channel. The following broodstock collection protocol was developed based on mitigation objectives and program assumptions (Appendix A).

DPUD will target 556 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall for the Wells sub-yearling and yearling programs, and up to 194 for the YN 275K-350K green egg request for the Yakima summer Chinook program (Table 8). Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin July 1 and terminate by August 31. In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not exceeding 10% representation of natural origin fish in the summer Chinook broodstock collection. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

For 2018, broodstock collection for the Chelan Falls summer Chinook program will be prioritized at the Chelan Falls Canal Trap (CFCT) which was successfully piloted in 2016 and continued in 2017, beginning July 1 through September 15. Due to a spawning gravel augmentation project, the collection period ended before September 15 in 2017 and subsequently collection efforts in the CFCT were insufficient to meet the adult requirements for the Chelan Falls program necessitating development of alternate collection locations/strategies. If shortfalls in adult needs are expected and the number of females needed to meet program has not been reached by August 15th, the HCP HC will discuss whether broodstock collection may default to surplus summer Chinook collected from, in order of priority, 1) Wells FH, 2) Entiat NFH, 3) Chief Joseph Hatchery, or other HCP approved location to make up the difference. The 2018 broodstock target for the Chelan Falls program is 384 adults (Table 8). The total production level supported by this collection is up to 576,000 yearlings for the Chelan Falls program.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 8. Number of broodstock needed for the combined Chelan and Douglas PUD Columbia River below Wells summer Chinook production obligations of 1,380,000 smolts, collection location, and mating strategy. Also includes broodstock necessary for outside programs that rely on adult collection at Well Hatchery in 2018.

Program	Production target	Number of Adults[2]		Total	Collection location	Mating protocol
		Hatchery	Wild			
Wells 1+	320,000	102F/102M		**204**	Wells VC[3]	1:1
Wells 0+	484,000	166F/166M		**332**	Wells VC[3]	1:1
Chelan Falls 1+	576,000	192F/192M		**384**	CFCT[4]	1:1
Yakama Nation	350,000[1]	97F/97M		**194**	Wells VC[3]	NA
Total	**1,730,000**	**557F/557M**		**1,114**		

[1] The YN request is for between 275K and 350K green eggs to support the Yakima River summer Chinook program.
[2] The number of adults collected for these programs may indirectly incorporate natural origin fish; however, because they are volunteers, the number is likely to be less than 10% of the total.
[3] Wells Hatchery volunteer channel trap.
[4] Chelan Falls Canal Trap

Wenatchee River Basin

In 2018 the Eastbank Fish Hatchery (FH) is expecting to rear spring Chinook salmon for the Chiwawa River and Nason Creek acclimation facilities located on the Chiwawa River and Nason Creek. The program production level target for the Chiwawa program (Chelan PUD obligation) in 2018 is 144,026 smolts, and based upon the biological assumptions (Appendix A) will require a total broodstock collection of about 76 natural origin spring Chinook (Table 10). The spring Chinook production obligation for Grant PUD in the Wenatchee Basin is 223,670 smolts (125,000 conservation and 98,670 safety net) and based upon the biological assumptions (Appendix A) will require a total broodstock collection of 130 adults (64 natural origin and 66 hatchery origin; Table 10).

Pre-season run-escapement of Wenatchee spring Chinook to Tumwater Dam during 2018 is estimated at 5,664 spring Chinook, including 4,888 hatchery and 776 natural origin spring Chinook (does not include age-3 males; Table 9). In-season estimates of natural-origin spring

Chinook to Tumwater Dam will be provided through stock-assessment and broodstock-collection activities. This information will facilitate in-season adjustments to collection composition so that extraction of natural-origin spring Chinook remains no more than 33%.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 9. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2018.

	Chiwawa Basin			Nason Cr. Basin			Wenatchee Basin to Tumwater Dam		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return	461	66	**527**	125	18	**143**	679	97	**776**
Estimated hatchery return	3,240	63	**3,303**	1,522	63	**1,585**	4,762	126	**4,888**
Total	3,701	129	**3,830**	1,647	81	**1,728**	**5,441**	**223**	**5,664**

Table 10. Number of broodstock needed for the combined Wenatchee spring Chinook production obligation of 367,969 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Chiwawa Conservation[4]	144,026	19F/19M	38F/38M	**76[1]**	Chiwawa Weir and Tumwater Dam[4]	2x2 factorial
Nason Conservation	125,000	0	32F/32M	**74[2]**	Tumwater Dam[4]	2x2 factorial
Nason Safety net	98,670	33F/33M[3]	0	**66**	Tumwater Dam	1:1
Total	**367,969**	**104**	**140**	**254[5]**		

[1] Does not include an additional 38 hatchery origin adults (19 females; represents ~50% of the adult target) to ensure the Chiwawa production goal is met if insufficient NO adults are collected).
[2] Includes ~10% additional NO fish for the Nason program to account for fish that may assign back to the White River spawning aggregate. No more than 64 NO fish will be retained for spawning.
[3] Chiwawa hatchery fish will only be collected to satisfy the Nason Cr. safety net program if in-season estimates of returning Nason conservation fish fall short of expectations.
[4] Collection of NO fish at Tumwater for the Chiwawa program will include previously PIT tagged adults (NO juveniles PIT tagged at the Chiwawa smolt trap) and/or excess NO adults/eggs/progeny originating from females with assignments >95% to the Chiwawa from the Nason conservation program.
5 Total includes the 10% over-collection as part of the genetic assignment variance for the Nason conservation program and approximately 38 HO adults collected as a contingency for production shortfalls in the Chiwawa conservation program if insufficient NO adults are collected.

Chiwawa River Conservation Program Broodstocking:

Since implementing a highly restrictive weir operations plan beginning in 2014 to limit bull trout encounters while still trying to achieve the broodstock target, the average number of bull trout handled was 70. Over this same period the average broodstock collection shortfall was 17.8% but was as high as 32.4% in 2017, a low NO abundance year. The 2018 pre-season forecast for NO adults back to the Chiwawa is similar to the 2017 forecast (526 and 527 for 2017 and 2018 forecasts respectively). It is under these circumstances that WDFW is proposing to increase the number of bull trout encounters (and subsequent number of trappings days) to facilitate meeting the Chiwawa spring Chinook broodstock collection target as agreed to by the HCP HC. Consistent with the realized shortfall in NO broodstock in 2017, the 2018 operations plan seeks to increase the number of bull trout encounters by about 33%, from 70 to about 93 (this theoretically increases the number of trapping days available from 15 to about 20). Any in-season modification of this plan would require concurrence on the part of the HC and the USFWS prior to implementation. The increase in bull trout encounters would result in an approximate impact to the adult bull trout population of about 6.2%, well below the desired maximum threshold of 10%.

- Based upon estimates of returning previously PIT tagged NO fish to Tumwater Dam (Table 11), approximately 26 previously PIT-tagged NO spring Chinook from the Chiwawa River could be collected at TWD between June 1 and July 15, concurrent with Nason Creek brood stocking, adult management, RM&E, and the RRS Study.
- The balance of adults needed to meet the Chiwawa Conservation program (up to ~76 total or ~38 females) would be collected at the Chiwawa Weir.

    - Weir operations would be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.
    - Using the most recent 3-year redd count data (2014-2017; 2016 survey data was not collected due to widlfires), the 10% threshold is 148 bull trout as determined by an average number of redds in the Chiwawa sub-basin of 739 (expands to 1,147 adults at a 1:1 sex ratio).
    - No more than 10 percent of the estimated mean number of adult bull trout in the Chiwawa Basin (using up to a rolling five year average derived from expanded redd counts) may be encountered during broodstock collection without concurrence from the USFWS. Sufficient redd data to calculate a full five year average is expected to be available as early as 2018.
    - To ensure the production target is met for the Chiwawa program, in the event that insufficient NO adults are collected for the conservation program, HO adults

(presently estimated at 50% of the total broodstock requirement, however may be adjusted up or down depending on the run) would be collected at TWD to make up the shortfall (see Table 10) between June 1 and July 15.

- For additional assurance and to help reduce effort at the Chiwawa Weir, during broodstock collection for the Nason conservation program, any excess adult not genotyping to the White River will be retained for the Nason program and an equivalent number of adults that have assignment probabilities >95% for Chiwawa, will be transferred to the Chiwawa program.
- Historic and in-season data for NO spring Chinook timing to the lower Chiwawa array from TWD will be used to determine optimal dates for collection.
- Any bull trout that are caught at the Chiwawa trap will be immediately removed and released at a site ~10KM upstream of the weir to prevent fallback/impingement and to mitigate for potential delay. Handling and transport will be conducted by WDFW hatchery staff.
- If a bull trout is killed during trapping, despite implementing conservation measures, trapping activities will cease and not continue until additional measures to minimize risks to bull trout can be discussed with the USFWS.

Table 11. PIT tagged natural origin adults to Tumwater Dam for the most recent 5-years (2013-2017) with conversion rates from Bonneville Dam.

Return year	Detections at Bonneville Dam		Detections at Tumwater Dam			
	Nason	Chiwawa	Nason	Conversion rate	Chiwawa	Conversion rate
2013	2	29	2	1.000	22	0.759
2014	6	66	1	0.167	29	0.439
2015	9	42	6	0.667	28	0.667
2016	8	34	8	1.000	24	0.706
2017	5	31	3	0.600	31	1.000
Mean	6.0	40.4	4.0	0.687	26.8	0.714
Geomean	5.3	38.5	3.1	0.582	26.6	0.690

Nason Creek Conservation Program Broodstocking:

- Up to ~74 NO spring Chinook (to allow for up to 10 percent of White River NO fish estimated to be encountered at Tumwater Dam MSA; Table 10) would be collected at TWD between June 1 and July 15.
  - Only 64 NO adults (32 females) will be retained to produce the 125K Nason Conservation program.
  - Collection of additional HO fish may occur in the event NO collection/retention falls short of expectation.
  - Brood stock collection would run concurrent with adult management, RM&E, and the Spring Chinook Relative Reproductive Success Study. The GAPS

microsatellite panel and existing GAPS plus WDFW spring Chinook Wenatchee baseline will be used for genotyping and GSI analyses similar to methods used beginning in 2013.

- Decision Rules:
  - Any fish that assigns to the White River with greater than 90% surety will be released in the White River.
  - Unassigned fish (individuals that can't be assigned to the Wenatchee Population or Leavenworth NFH), will be released upstream of Tumwater Dam.
  - In the event more fish assign to Nason or Chiwawa than are needed to meet the conservation program, the excess with the highest assignment probabilities (>95%) to the Chiwawa will be incorporated into the Chiwawa conservation program if needed or otherwise returned to the river upstream of Tumwater Dam.

Nason Creek Safety Net Program Broodstocking:

- Up to ~66 HO spring Chinook adults (from conservation program – identified by snout wire + body wire) would be targeted at TWD (Table 10) between June 1 and July 15, concurrent with NO brood stock collection, adult management, RM&E, and the Spring Chinook Relative Reproductive Success (RRS) Study.

Nason Creek spring Chinook Rearing/Release Strategy:

Rearing – Early rearing growth will be modulated for a targeted size at release of approximately 18 fpp. Beginning on or about February 1, fish will be fed to satiation to maximize spring growth regardless of end size.

Release - Spring Chinook salmon acclimated at the Nason Creek Acclimation Facility will be forced released using the following criteria.

- all fish will be released during darkness (e.g., 9:00 PM or later),

- all fish will be released when Columbia River and Nason Creek flows/conditions are predicted to be satisfactory,

- all fish will be released no later than May 7 regardless of flow conditions,

- attempts will be made to have a steady release of fish to reduce collisions on the PIT antenna array.

Satisfactory flows in the Columbia occur when spilling flows are started and flows in Nason Creek are satisfactory when flows are high and turbid. Releases will not occur until satisfactory flows in the Columbia occur, but could occur if Nason Creek flows are not satisfactory due to insufficient snow pack.

Surplus Wenatchee Sub-basin Juvenile Spring Chinook Management

In the event excess juveniles are produced from Wenatchee Sub-basin spring Chinook programs, the parties agree that distribution of juveniles will follow the following priority matrix:

1. Excess progeny from the Chiwawa conservation program may be used to support shortfalls in the Nason conservation program provided fish health and/or marking requirements for the program can be met.

2. Excess progeny from the Nason conservation program may be used to support the Chiwawa conservation program provided they are progeny from females with assignment probabilities >95%. Additionally, it will require that fish health and/or marking requirements for the program can be met.

3. In the event excess NO production from the Nason program is not needed to or cannot support the Chiwawa (for reasons of fish health, marking, or ability to identify assignment probability), they will be incorporated into the Nason safety net program and prioritized over HxH progeny.

4. Excess progeny from the HO contingency broodstock collected for the Chiwawa program may be used to support any potential shortfall in the Nason safety net program provided fish health and/or marking requirements for the program can be met.

5. In the event no other option exists for excess hatchery progeny within the Wenatchee Sub-basin, Banks Lake may be utilized as a last resort provided fish health requirements can be met.

In addition, surplus fish, including broodstock, will be distributed at the earliest possible life-stage (e.g., prespawn adults, eyed-egg, fry) per WDFW policy.

Steelhead

The steelhead mitigation program in the Wenatchee Basin uses broodstock collected at Dryden and Tumwater dams located on the Wenatchee River. Per ESA section 10 Permit 18583 provisions, broodstock collection will target adults necessary to meet a natural origin – conservation (WxW) oriented program, not to exceed 33% of the natural origin steelhead return to the Wenatchee Basin and a hatchery origin (HxH) – safety net program. The conservation and safety net programs each make up approximately half of the 247,300 production obligation. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain a total of 136 mixed origin steelhead for broodstock for a smolt release objective of 247,300 smolts (Table 12). The 70 hatchery origin adults will be targeted at Dryden

Dam and if necessary Tumwater dam. The 66 natural origin adults will be targeted for collection at Tumwater Dam. Collection will be proportional to return timing between 01 July and 14 November. Collection may also occur between 15 November and 5 December at both traps, concurrent with the Yakama Nation coho broodstock collection activities. Only adipose present coded wire tagged hatchery fish (or previously PIT tagged WxW hatchery progeny) will be retained for the safety net program. Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and at Dryden Dam. In-season broodstock collection adjustments may be made based on this monitoring and evaluation. To better ensure achieving the appropriate female equivalents for program production, the collection will include the use of ultrasonography to determine the sex of each fish retained for broodstock.

In the event steelhead collections fall substantially behind schedule, WDFW may initiate/coordinate adult steelhead collection in the mainstem Wenatchee River by hook and line. In addition to trapping and hook and line collection efforts, Tumwater and Dryden dams may be operated between February and early April the subsequent spring to supplement broodstock numbers if the fall trapping effort provides fewer than the required number of adults.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin steelhead. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 12. Number of broodstock needed for the combined 2019 BY Wenatchee summer steelhead production obligation of 247,300 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		**Total**	Collection location	Mating protocol
		Hatchery	Wild			
Wenatchee Conservation[1]	123,650	0	33F/33M	**66**	TWD[3]/Dryden LBT-RBT[4]	2x2 factorial
Wenatchee Safety net[2]	123,650	35F/35M	0	**70**	Dryden LBT-RBT[4] /TWD[4]	1:1
Total	**247,300**	**70**	**70**	**136**		

[1] Broodstock collection for the conservation program will occur primarily at Tumwater Dam and will only fall back to Dryden Dam trapping facilities if a shortfall is expected.
[2] Broodstock collection for the safety net program will occur primarily at the Dryden Dam trapping facilities to minimize activities at TWD that could increase unintended delays on non-target fish. Collection at Tumwater Dam will only occur if shortfalls in broodstock are expected at Dryden Dam.
[3] TWD=Tumwater Dam.
[4] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.

Summer/fall Chinook

Summer/fall Chinook mitigation programs in the Wenatchee River Basin utilize adult broodstock collections at Dryden and Tumwater dams, incubation/rearing at Eastbank Fish Hatchery (FH) and acclimation/release from the Dryden Acclimation Pond. The total production level target for BY 2018 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2018 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix D) and BY 2013, 2014 and 2015 spawner escapement to the Wenatchee River indicate sufficient summer Chinook will return to the Wenatchee River to achieve full broodstock collection for the Wenatchee River summer Chinook supplementation program. Review of recent summer/fall Chinook run-timing past Dryden and Tumwater dams indicates that previous broodstock collection activities have omitted the early returning summer/fall Chinook, primarily due to limitations imposed by ESA Section 10 Permit 1347 to minimize impacts to listed spring Chinook. In an effort to incorporate broodstock that better represent the summer/fall Chinook run timing in the Wenatchee Basin, the broodstock collection will front-load the collection to account for the disproportionate collection timing. Approximately 43% of the summer/fall Chinook destined for the upper Basin (above Tumwater Dam) occurs prior to the end of the first week of July; therefore, the collection will provide 43% of the objective by the end of the first week of July. Weekly collection after the first week of July will be consistent with run timing of summer/fall Chinook during the remainder of the trapping period. With concurrence from NMFS, summer Chinook collections at Dryden Dam may begin up to one week earlier. Based on these limitations and the assumptions listed in Appendix A, the following broodstock collection protocol was developed:

WDFW will retain up to 264 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 132 females (Table 13). To better ensure achieving the appropriate females for program production, the collection will implement the draft Production Management Plan, including ultrasonography to determine the sex of each fish retained for broodstock. Trapping at Dryden Dam may begin 24 June and terminate no later than 15 September and operate up to 7-days/week, 24-hours/day. Trapping at Tumwater Dam if needed may begin 15 July and terminate no later than 15 September and operate up to 48 hours per week for broodstock related activities.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs, within the constraint of not collecting more the 33% of the natural origin spring Chinook. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Table 13. Number of broodstock needed for the combined 2017 BY Chelan and Grant PUD Wenatchee summer Chinook production obligations of 500,001 smolts, collection location, and mating strategy.

Program	Production target	Number of Adults		Total	Collection location	Mating protocol
		Hatchery	Wild			
Chelan PUD	318,185		84F/84M	**168**	Dryden LBT-RBT[1] /TWD[2]	1:1
Grant PUD	181,816		48F/48M	**96**		
Total	**500,001**		**132F/132M**	**264**		

[1] Dryden LBT-RBT= Dryden Dam left and right bank trapping facilities.
[2] TWD=Tumwater Dam.

Priest Rapids Fall Chinook

Collection of fall Chinook broodstock at Priest Rapids Hatchery (PRH) will generally begin in early September and continue through about mid-November. Juvenile release objectives specific to Grant PUD (5,599,504 sub-yearlings), and Federal (1,700,000 sub-yearlings at PRH + 3,500,000 smolts at Ringold Springs Hatchery – collection of broodstock for the federal programs are conditional upon having contracts in place with the ACOE), mitigation commitments. Biological assumptions are detailed in Appendix A. For the Ringold Springs production, adult collection, holding, spawning and incubation occurs at PRH until the eyed-egg stage. Eyed eggs are transferred to Bonneville Hatchery until they are transferred for spring acclimation and release at Ringold Springs.

For 2018 up to 1,000 adipose present, non-coded wire tagged (high proportion of natural origin) fall Chinook adults will be targeted at the OLAFT). Additional NO adults targeted as a continued pilot evaluation through hook-and-line angling efforts in the Hanford Reach to increase the proportion of natural origin adults in the broodstock to meet integration of the hatchery program will also be incorporated into the program. It is estimated that approximately 400 adults may be collected through the hook-and-line efforts. Close coordination between broodstock collections at the volunteer channel, the OLAFT and through hook-and-line efforts in the Hanford Reach will need to occur so over collection is minimized. Fish surplus to production needs will be culled at the earliest possible life-stage (e.g, brood collected, brood spawned, eggs). Presumed NOR's collected and spawned from either hook-and-line caught broodstock or OLAFT collections will be prioritized for PRH programs (i.e. OLAFT and Hanford Reach angler caught fish will be externally marked, held in a separate pond from volunteer collected fish, spawned first each week, and to the extent possible segregated and reserved for the GPUD program).

Grant PUD staff will work closely with WDFW hatchery and M&E staff to maintain separation of gametes/progeny of OLAFT and angling collected adults at spawning and through incubation/early rearing.

Based upon the biological assumptions in Appendix A, an estimated 4,599 females will need to be collected to meet the 10,799,054 smolts required to meet the current three up-river bright (URB) programs which rely on adults collected at the Priest Rapids Hatchery volunteer channel trap, hook-and-line efforts on the Hanford Reach, and/or the Priest Rapids Dam off ladder trap (OLAFT; Table 14).

To increase the probability of incorporating a higher percentage of NOR's from the volunteer channel, adipose present, non-CWT males and females will be prioritized for retention and males older than 3 will be prioritized. In addition, preliminary information suggests that the pNORs is higher in the later part of the trapping period than the earlier period. As data become available, the PRCC-HSC may choose, in-season, to retain a disproportionately high number of broodstock from the latter half of the returns to the volunteer trap.

In-season data for fish age, size, and estimated fecundity may be used to adjust the number of broodstock collected to meet program production needs. Adjustments made to broodstock collection targets based on pre-spawn mortality exceeding current year assumptions will require review and concurrence on the additional number and composition of the broodstock necessary to backfill shortfalls.

Implementation Assumptions

1) Broodstock may be collected at any or all of the following locations/means: the PRD off ladder trap (OLAFT – operated 4-days per week/8 hrs/day to collect up to 1,000 presumed NOR's), hook-and-line angling (ABC) in the Hanford Reach (actual numbers collected are uncertain but will contribute to the overall brood program and pNOB), and the Priest Rapids Hatchery volunteer channel trap.

2) Assumptions used to determine egg/adult needs is based upon current program performance metrics.

3) Broodstock retained from the volunteer channel will exclude to the degree possible, age-2 and 3 males (using length at age; i.e. retain males ≥ 75 cm) to address genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and also decrease the probability of using hatchery origin fish in the broodstock that are skewed towards earlier ages at maturity.

4) Only adipose present, non-CWT males and females will be retained for broodstock from volunteer channel collected broodstock unless a shortage is expected.

5) Only progeny of adipose present, non-wired fish encountered through hook-and-line angling and at the OLAFT will be prioritized for retention into the program.

6) Broodstock collected from the OLAFT and by hook-and-line will exclude age-2 and to the degree possible age-3 fish (<75 cm) to minimize genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity) and to ensure the highest proportion of NOR's in the collection (e.g. collection of 1 in 5 age-3 fish for broodstock from the OLAFT).

7) All gametes of fish spawned from hook-and-line broodstocking efforts and/or OLAFT collections will be incorporated into the PRH based programs.

8) Real time otolith reading and an alternative mating strategy will be implemented in 2018 consistent with previous years unless the PRCC-HSC agrees that the PNI objective in 2018 can be met without implementing 1x4 matings. Otoliths from males from the OLAFT and ABC collections will be collected during the peak spawning week and read prior to spawning. If the male is natural origin, then it will be spawned with 4 females, otherwise it will be spawned with two females or the milt discarded if it is a known hatchery male and there are sufficient numbers of unknown males available for spawning.

9) All eggs or juveniles leaving PRH (including surplus) will have a unique otolith mark so that returning adults can be identified. Exceptions to this could occur if there are guarantees of a suitable mark/tag from a receiving hatchery.

10) Natural origin broodstock collection at the volunteer trap will be prioritized for the GPUD program by collecting fish when the probability of encountering natural origin fish is highest and balancing run-time representation.

Table 14. Number of broodstock needed for the combined Grant PUD and ACOE fall Chinook production obligations of 10,799,504 sub-yearling smolts at Priest Rapids and Ringold Springs hatcheries, collection location, and mating strategy in 2018.

Program	Production target	Number of Adults	**Total**	Collection location	Mating protocol
Grant PUD	5,599,504	2,297F/1,387M	**3,684**		
ACOE-PRH	1,700,000	697F/421M	**1,118**		
ACOE – Ringold[1]	3,500,000	1,605F/969M	**2,574**		
Total	**10,799,504**	**4,599F/2,777M**	**7,376**		

Collection location	Estimated number of adults: Hatchery	Estimated number of adults: Wild	Total		
Priest Rapids Hatchery	**3,669F/2,104M**	**127F/76M**	**5,976**	PRH volunteer trap	1:2
OLAFT[2]	**307F/153M**	**360F/180M**	**1,000**	PRD off-ladder trap	1:2, 1:4
ABC[2,3]	**23F/45M**	**113F/219M**	**400**	Hanford Reach	1:2, 1:4
Total	**3,999F/2,302M** (6,301; 85.4%)	**600F/475M** (1,075; 14.6%)	**7,376**		

[1] As of brood year 2009, Priest Rapids Hatchery is taking sufficient eggs to meet the 3,500,000 sub-yearling smolt release at Ringold-Meseberg Hatchery funded by the ACOE – late incubation of this program occurs at Bonneville.
[2] Estimated number of fall Chinook females and males to be acquired from the OLAFT in 2018. F/M ratios were derived through run at large data. Estimates of H/W were derived through otolith results.
[3] ABC fish are adults collected from hook and line collection efforts on the Hanford Reach. Estimates of F/M were derived through 2012-2014 spawn numbers. Estimates of and H/W were derived through otolith results from 2012 and 2014.

Appendix A

2018 Biological Assumptions for UCR spring, summer, and Fall Chinook and Summer Steelhead Hatchery Programs

Program	Mean Values for 2013-2017 (where applicable)								Mean Values 2011-2015 Brood
	ELISAs		Fecundity		Prespawn Survival				
	H	W			H		W		
	≥ 0.12	≥ 0.2	H	W	M	F	M	F	G-E-R Survival[1]
Methow SPC	0.199	0.070	3,755	4,238	0.935	0.957	0.983	0.970	0.874
Chewuch SPC	0.199	0.070	3,755	4,238	0.935	0.957	0.983	0.970	0.874
Twisp SPC	0.200	0.060	3,631	4,115	1.000	1.000	1.000	1.000	0.912
Twisp SHD	[redacted]	[redacted]	[redacted]	5,281	[redacted]	[redacted]	1.000	0.997	0.758
Wells SHD	[redacted]	[redacted]	5,786	NA	0.953	0.968	NA	NA	0.608
Okanogan SHD	[redacted]	[redacted]	5,809	[redacted]	[redacted]	NA	[redacted]	[redacted]	0.608
Wells SUC 1+	0.025	0.000	3,785[2]	4,467	0.978	0.982	NA	NA	0.870
Wells SUC 0+	0.025	0.000	3,785[2]	4,467	0.978	0.982	NA	NA	0.800
YN Green Eggs	0.025	0.000	3,785[2]	4,467	0.978	0.982	NA	NA	NA
Methow SUC	0.000	0.048	[redacted]	3,858[2]	[redacted]	[redacted]	0.988	0.973	0.831
Chelan Falls 1+[a]	0.037		4,024	[redacted]	0.988	0.948	[redacted]	[redacted]	0.819
Wenatchee SUC	0.000	0.011	[redacted]	4,697	[redacted]	[redacted]	0.965	0.950	0.857
Wenatchee SHD	[redacted]	[redacted]	5,685	6,012	1.000	0.937	0.973	0.937	0.668
Nason SPC[b]	0.049	0.025	[redacted]	4,622	[redacted]	[redacted]	0.992	0.976	0.888
ChiwawaSPC	0.145	0.013	4,023	4,726	0.987	0.990	0.987	0.975	0.849
Priest Rapids FAC 0+[c,d]	[redacted]	[redacted]	3,500	[redacted]	0.828	0.832	[redacted]	[redacted]	0.837
ACOE @PRH	[redacted]	[redacted]	3,500	[redacted]	0.828	0.832	[redacted]	[redacted]	0.837
ACOE @Ringold	[redacted]	[redacted]	3,500	[redacted]	0.828	0.832	[redacted]	[redacted]	0.749

[1] Green egg to release survival.
[2] Only uses 2017 mean fecundity.

Appendix B

Projected Brood Year Juvenile Production Targets, Marking Methods, Release Locations, Release Size, Release Type

Brood Year	Production Group	Program Size	Marks/Tags[3]	Additional Tags	Release Location	Release Year	Release Size (fpp)	Release Type
Summer Chinook								
2018	Methow SUC 1+ (GPUD)	200,000	Ad +CWT	5,000 PIT minimum	Methow River at CAF	2020	13-18	Forced
2018	Wells SUC 0+ (DPUD)	480,000	Ad + CWT	3K-5K PIT	Columbia R. at Wells Dam	2019	50	Forced
2018	Wells SUC 1+ (DPUD)	320,000	Ad + CWT	55,000 PIT	Columbia R. at Wells Dam	2020	10	Volitional
2018	Chelan Falls SUC 1+ (CPUD)	576,000	Ad + CWT	10,000 PIT	Columbia R. at CFAF	2020	13	Forced
2018	Wenatchee SUC 1+ (CPUD/GPUD)	500,001	Ad + CWT	20,000 PIT	Wenatchee R. at DAF	2020	18	Volitional
2018	CJH SUS 1+	500,000	Ad + 100K CWT	5,000 PIT	CJH	2020	10	Volitional
2018	CJH SUS 0+	400,000	Ad + 100K CWT	5,000 PIT	CJH	2019	50	Volitional
2018	Okanogan SUS 1+	266,666	Ad + CWT	5,000 PIT	Omak Pond	2020	10	Volitional
2018	Okanogan SUS 1+	266,666	Ad + CWT		Riverside Pond	2020	10	Volitional
2018	Okanogan SUS 1+	266,666	Ad + CWT		Similkameen Pond	2020	10	Volitional
2018	Okanogan SUS 0+	300,000	Ad + CWT	5,000 PIT	Omak Pond	2019	50	Forced
Spring Chinook								
2018	Methow SPC (PUD)	108,249	CWT only	5,000 PIT	Methow R. at MFH	2020	15	Volitional
2018	Methow SPC (PUD)	25,000[1]	CWT only	7,000 PIT	Methow R. at GWP (YN)	2020	15	Volitional
2018	Methow SPC (PUD)	60,516	CWT only	5,000 PIT	Chewuch R. at CAF	2020	15	Volitional
2018	Twisp SPC (PUD)	30,000	CWT only	5,000 PIT	Twisp R. at TAF	2020	15	Volitional
2018	Methow SPC (USFWS)	400,000	Ad + CWT	20,000 PIT	Methow River at WNFH	2020	17	Forced (2-day)

2018	Okanogan SPC[4] (CCT)	200,000	CWT only	5,000 PIT	Okanogan R. at Tonasket Pond/Riverside	2020	15	Volitional
2018	Chief Joe SPC[5] (CCT)	700,000	Ad + 200K CWT	5,000 PIT	Columbia R. at CJH	2020	15	Forced
2018	Chiwawa R. SPC (CPUD) (conservation)	144,026	CWT only	10,000 PIT	Chiwawa River at CPD	2020	18	Short term volitional
2018	Nason Cr. SPC (GPUD) (conservation)	125,000	CWT body tag	5,000 PIT	Nason Cr. at NAF	2020	18	Forced
2018	Nason Cr. SPC (GPUD) (safety net)	98,670	Ad + CWT		Nason Cr. at NAF[9]	2020	18	Forced
Fall Chinook								
2018	Priest Rapids FAC 0+ (ACOE)	1.7M	Ad + Oto	Approximately 43,000 spread across the fish released from PRH	Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	600,000	Ad+CWT+ Oto		Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	600,000	CWT + Oto		Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	1M[2]	Ad + Oto		Columbia River at PRH	2019	50	Forced
2018	Priest Rapids FAC 0+ (GPUD)	3.4M	Oto only		Columbia River at PRH	2019	50	Forced
2018	Ringold Springs FAC 0+ (ACOE)	3.5M	Ad + 400K CWT		Columbia River at RSH	2019	50	Forced
Steelhead								
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	35,451	Ad + CWT (HxH) CWT only (WxW)		Nason Cr. direct release	2020	6	Direct Plant
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	70,582	Ad + CWT (HxH) CWT only (WxW)	33,000 PIT	Chiwawa R. direct release	2020	6	Direct Plant
2019	Wenatchee Mixed (HxH/WxW) (CPUD)	104,021	Ad + CWT (HxH) CWT only (WxW)		Upper Wenatchee R. direct release	2020	6	Direct Plant

2019	Wenatchee HxH (CPUD)	37,246	Ad + CWT		Lower Wenatchee R. direct release	2020	6	Direct Plant
2019	Twisp Conservation (DPUD)[11]	48,000	CWT only	5,000[7]	Twisp River at Buttermilk Bridge/TBD	2020	6	Direct Plant
2019	Wells HxH (DPUD)	100,000	Ad only	5,000 PIT	Methow River at Effy Bridge	2020	6	Direct Plant
2019	Wells HxH (DPUD)	160,000	Ad only	5,000 PIT	Columbia R. at Wells Dam	2020	6	Volitional
2019	MetComp WxW (USFWS)	Up to 200,000	Ad + CWT	20,000 PIT	Methow R. at WNFH and other locations TBD	2021[12]	4-6	(WNFH)other locations TBD
2019	Okanogan HxH/HxW (CCT/GPUD)	Up to 100K [6]	Ad /CWT snout	Up to 20,000 PIT ,[9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2020	5-8	Volitional capture Wells; truck planted in Salmon Creek, Similkameen R., and possibly other tributaries, TBD by fall of 2018.
2019	Okanogan WxW (CCT/GPUD)	Up to 100K [6]	Body and snout CWT[8]	Up to 20,000 PIT ,[9]	Okanogan/Similkameen Omak, Salmon, Wildhorse Ck., other tribs. (TBD)	2020	5-8	Volitional from St. Mary's pond. The numbers going to Omak Creek and other tributaries will be determined by fall of 2018.

[1] Release of fish at the Goat Wall Pond remote acclimation site operated by the YN is conditional upon HC and HSC approval.
[2] Externally marking of this group is presently funded by WDFW. Marking of this 1M fish is contingent on *US v. Oregon* Policy Committee approval for 2018.
[3] Presently all CWT's are applied to the snout.
[4] The Okanogan SPC program derives its juveniles from a 200K transfer of Methow SPC from WNFH as part of a reintroduction effort. Fish are released into the Okanogan Basin.
[5] The Chief Joe Hatchery SPC program presently receives surplus adults from the Leavenworth NFH as needed. Juveniles are released on station from CJH.
[6] Total Okanogan release not to exceed 100K + 10%.
[7] DPUD will tag 2,500 of the Twisp Only S1's and 2,500 of the Methow S1's. USFWS will tag 2,500 of the Methow S2's for release into the Twisp and 2,500 of the Methow S2's, will accompany the DPUD Methow S1's for an off station release.
[8] The Okanogan steelhead HGMP and NOAA's BiOp for the TRMP state that WxW progeny will receive a unique internal tag (CWT or PIT) and/or receive an alternative fin clip. At this time, CCT does not intend to use an alternative fin clip until/unless a high proportion of the released fish have WxW parents and there is an acceptable survival risk/benefit of the alternative fin clip.
[9] Total PIT tag release in the Okanogan 20,000
[10] Beginning with the 2017 brood, adult returns from the Nason conservation program will be utilized to meet the Nason safety net program and will receive a supplemental body tag (blank wire either at the base of the adipose or the caudal peduncle) in addition to the adipose clip.
[11] With the recent detection of potential inbreeding depression effects in the Twisp conservation program, parties are continuing to develop a new plan for the program. Once developed and agreed to, this table will be updated to reflect any changes.
[12] Winthrop NFH steelhead program produces 2-year (S2) smolts.

Appendix C

Return Year Adult Management Plans

At a gross scale, adult management plans will include all actions that *may* be taken within the current run year to address surplus hatchery fish (if any). At the time of submission for this document, spring Chinook will probably be the only group where a reasonable pre-season forecast may be available to lay out what the expected surplus is, how many can be expected to be removed through each action, etc. Preseason forecasts for steelhead will be available in September.

Wenatchee Spring Chinook

Pre-season estimates for age-4 and age-5 adults project a total of 5,664 (776 natural origin [13.7%] and 4,888 hatchery origin [86.3%]) spring Chinook back to Tumwater Dam in the Wenatchee Basin. Approximately 3,830 Chiwawa and 1,728 Nason spring Chinook are to reach Tumwater Dam in 2018, of which about 670 (12.1%) and 4,888 fish (87.9%) are expected to be natural and hatchery origin spring Chinook, respectively. The balance of about 106 natural origin spring Chinook expected back are destined to the remaining spawning aggregates (Table 1). In-season assessment of the magnitude and origin composition of the spring Chinook return above Tumwater Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18118 and 18121.

Table 1. Age-4 and age-5 class return projection for wild and hatchery spring Chinook to Tumwater Dam during 2018.

	Chiwawa Basin			Nason Cr. Basin			Wenatchee Basin to Tumwater Dam[2]		
	Age-4	Age-5	Total	Age-4	Age-5	Total	Age-4	Age-5	Total
Estimated wild return[1]	461	66	**527**	125	18	**143**	679	97	**776**
Estimated hatchery return	3,240	63	**3,303**	1,522	63	**1,585**	4,762	126	**4,888**
Total	3,701	129	**3,830**	1,647	81	**1,728**	**5,441**	**223**	**5,664**

[1] Reflects NOR estimates to Tumwater Dam and has not been adjusted for pre-spawn mortality.
[2] Wenatchee Basin to Tumwater Dam total includes NORs to the White, Little Wenatchee, and Chiwawa rivers and Nason Creek.

Absent conservation fisheries or adult removal at Tumwater Dam (TWD), the expected number of age-4 and age-5 Hatchery Origin Returns (HOR) for the upper Wenatchee River Basin as a whole is estimated to be approximately 6.3 times the expected number of Natural Origin Returns (NORs; 7.3 times the number of NOR's in the Chiwawa River and 11.1 times the number of NOR's in Nason Creek). The combined HO and NO returns will represent about 4.3 times the number of adults needed to meet the interim Chiwawa run escapement to TWD of 900 fish indicating a disproportionate number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2018 (Table 2). The combined HO and NO returns will represent about 3.5 times the number of adults needed to meet the interim Nason run escapement to TWD of 500 fish indicating a disproportionate number of hatchery origin spring Chinook will be on the spawning grounds in the fall of 2018 (Table 3).

Additional Adult Management

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Wenatchee Spring Chinook BiOp (2013; 2105) and Permits #18118, #18129 and #18121. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

2018 adult management actions are intended to provide for near 100% removal of age-3 hatchery males (jacks), and unknown hatchery origin adults (ad-/cwt-) and up to about 64% of the age-4 and age-5 hatchery origin adults (about 1,036 males and 2,078 females according to current models, Table 2). In addition, approximately 104 HO and 140 NO adults will be removed between TWD and the Chiwawa Weir and retained for broodstock to support meeting the combined Grant and Chelan PUD Wenatchee spring Chinook obligation, the balance will be surplused at TWD and used for tribal and/or food bank disbursements or nutrient enhancement projects.

Table 2. Run escapement and spawning escapement of Chiwawa River hatchery and natural origin fish to Tumwater Dam and the Chiwawa River in 2018.

	To Tumwater Dam		To Chiwawa River		Adults surplused at TWD[3]	Total Chiwawa spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	290	2,246	187	245	1,334	**432**
Males[4]	237	1,057	142	74	693	**216**
Sub-total	527	3,303	329	319	2,027	**648**
Pre-spawn survival[6]			0.85	0.55		
Expected PNI						**0.67**
Expected pHOS						**0.49**

[1] Wild broodstock needs of 76 wild NO fish (38 females/38 males) for the Chiwawa conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality.
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD or through a conservation fishery.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 432 redds in the Chiwawa Basin under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Table 3. Run escapement and spawning escapement of Nason Creek hatchery and natural origin fish to Tumwater Dam and Nason Creek in 2018.

	To Tumwater Dam		To Nason Creek		Adults surplused at TWD[3]	Total Nason spawners[5]
	Wild	Hatchery	Wild[1,2]	Hatchery[2]		
Females[4]	79	1,078	69	165	744	**234**
Males[4]	64	507	46	72	343	**118**
Sub-total	143	1,585	115	237	1,087	**352**
Pre-spawn survival[6]			0.80	0.55		
Expected PNI						**0.60**
Expected pHOS						**0.67**

[1] Wild broodstock needs of 64 wild NO fish (32 females/32 males) for the Nason conservation program have already been accounted for in this total as well as pre-spawn mortality.
[2] Adjusted for pre-spawn mortality and HO broodstock needs of 66 fish (33 females/33 males).
[3] Does not include age-3 hatchery males "jacks" removed during adult management activities at TWD or through a conservation fishery.
[4] Age-4 and age-5 fish only. Gender proportions were made based upon a 5-year average sex ratio for hatchery and wild fish of the same age class.
[5] This should result in approximately 234 redds in Nason Creek under the assumption that each female produces only one redd.
[6] Estimated survival from Tumwater to spawn.

Wenatchee Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Wenatchee Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at Tumwater Dam or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2018. Adult management plans, if needed, will be finalized then and appended to this document.

Methow Spring Chinook

Pre-season estimates project a total of 3,235 (869 natural origin [26.9%] and 2,366 hatchery origin [73.1%]) spring Chinook back to Methow Basin. Of the 2,366 hatchery returns, about 893 are estimated to be from the conservation program with the balance of 1,473 from the WNFH safety net program (Table 5).

Table 5. Brood year 2013-2015 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2018.

	Projected Escapement											
	Origin								**Total**			
	Hatchery				**Wild**				**Methow Basin**			
Stock	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**
MetComp	124	673	12	**809**	18	543	106	**667**	142	1,216	118	**1,476**
%Total				34.2%				76.8%				45.6%
Twisp	18	55	11	**84**	17	164	21	**202**	35	219	32	**286**
%Total				3.5%				23.2%				8.9%
Winthrop (MetComp)	318	1,125	30	**1,473**					248	886	21	**1,473**
%Total				62.3%								45.5%
Total	460	1,853	53	**2,366**	35	707	127	**869**	495	2,560	180	**3,235**

Some level of adult management will be required to limit the number of hatchery spring Chinook on the spawning grounds. Because a conservation fishery is not yet possible under current permit limitations, adult management will need to occur through operation of the volunteer channel traps located at both the Methow Hatchery (MH) and Winthrop NFH (WNFH).

Presently hatchery fish from MH are prioritized to: a) contribute to the supplementation of the natural populations (up to either the escapement objectives or PNI/pHOS goal), b) make up shortfalls in natural-origin brood for the MH conservation program, and c) to support the 400K safety-net program at WNFH. As such both hatcheries will operate volunteer hatchery ladders to support removal of excess safety-net and conservation fish (when needed). MH will operate its volunteer trap and will provide surplus hatchery adults (in excess to the MH and conservation needs) to WNFH to support the safety-net program, to support removal of excess safety-net and conservation fish, or retain adults to facilitate testing translocation of conservation fish to under-seeded spawning areas as approved by the HCP HC and PRCC HSC. The translocation of conservation program adults may be prioritized over their use as broodstock for the safety net program as long as both programs can meet full production and gene flow (pHOS/PNI) terms and conditions on the spawning grounds. The intention of adult translocation is to increase natural production which is the primary function of the Methow Hatchery.

Specific actions are as follows:

Adult management actions will be used to support achieving hatchery production levels and escapement/sliding-scale PNI targets identified in the Methow Spring Chinook BiOp (2017) and Permits #18925, #18927 and #20533. Adult management removal targets identified in this document may be revised based on best available in-season run estimates.

Twisp River Spring Chinook: spring Chinook in the Twisp River will be managed separately from the rest of the basin.

a. Adipose-clipped fish encountered at the Twisp Weir will be removed (putative WNFH returns or strays from outside of the basin).
b. Age-3 hatchery males will be removed and euthanized or transported to WNFH for surplusing.
c. Adult management will be performed to maintain pHOS ≤0.50. pNOB will be >0.50 and may be allowed to fluctuate between 0.50 and 1.0 in order to achieve a pHOS ≤0.50.
d. Wild fish will be collected as broodstock – up to ~18 individuals, but not to exceed 33% of the wild run. Hatchery fish may be collected as broodstock dependent on collection success of wild fish and provided that Twisp-program pNOB may not be less than 0.50.
e. The Twisp Weir will be fished for the duration of the broodstock collection, only, in 2018. Adult management activities will be incidental to broodstock collection. Once broodstock collection is completed, the weir will be opened to fish passage to limit delay/trapping effects on bull trout. Tentatively, during broodstock collection, the weir will be fished from 6:00 AM to 9:00 PM on a daily basis. Deviation from this schedule may be implemented based on the run size and catch efficiency for broodstock.

Methow River (MFH and WNFH) and Chewuch River Spring Chinook (MetComp):

a. Stock assessment will be performed at Wells Dam during the spring Chinook broodstock collection. This information on stock, hatchery:wild, and male:female composition in conjunction with fish counts at Wells Dam will be used to adjust in-season adult management targets.
b. MetComp returns will be managed by removing volunteers at WNFH and Methow Hatchery using the outfall traps at these facilities.
    i. All hatchery-origin age-3 males will be removed
        1. Gender identified by ultrasound.
    ii. The Methow FH and Winthrop NFH volunteer traps will be fished continuously (24 h per day/7 d per week) throughout the run and fish removed at least once daily (depending on specific facility limitations), or as often as needed when fish are present. Adjustments to the operation of the trapping facilities will be made based upon capture/extraction rates as well as bull trout encounters and take limitations.
    iii. Trapping may cease at Methow Hatchery if:
        1. Removal of MFH and WNFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season), or
        2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.
    iv. Trapping will cease at Winthrop NFH if:

1. Removal of WNFH and MFH origin adults meets the broodstock and/or adult management targets established (in this document and as adjusted in-season), or
2. If overall hatchery bull trout take is likely to be exceeded. However, in-season adjustment may be made to reduce the likelihood of bull trout encounters including, but not limited to: limiting 1) the time of day trap is fished, 2) hours per day fished, 3) days per week fished.

v. All adipose clipped returns encountered at WNFH and MFH volunteer traps will be removed.
   1. Returns to WNFH will be retained at WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.
   2. Returns to MFH will be transferred to WNFH for broodstock (WNFH safety net and Okanogan 10(j) programs) or surplusing.

vi. Conservation program returns may also be transported to specific reaches of the Methow and/or Chewuch Rivers (or other locations as determined by the HC/HSC) to meet the minimum spawning escapement objective or to experimentally augment spawner distribution (such an action will require an approved study or implementation plan by the HCP HC and PRCC HSC, and be permissible under current ESA permits).

Based on the preseason forecast for wild and hatchery spring Chinook to the Methow Basin, once NO broodstock requirements are fulfilled and accounting for an estimated prespawn mortality for NO fish of 50% (42% for HO fish), there will be approximately 372 NO spawners. Based upon the sliding PNI scale for NO run sizes >300 fish, the initial goal for 2018 will be to manage for a minimum spawning escapement of 576 spawners; to achieve this, an estimated 79% of the hatchery returns (1,170 HO fish) will need to be removed (does not include adults removed for broodstock; Table 6). This will result in approximately 205 hatchery origin spawners on the spawning grounds after accounting for prespawn mortality.

Table 6. Calculated targets and projected adult management expectations for Methow spring Chinook in 2018 based on current run forecast.

Wild Spawning Escapement[1]		pNOB[2]	pHOS	PNI [3]	Hatchery Spawners[1,4]	Hatchery surplus[4]	Hatchery Broodstock (WNFH + 10j)	Proportion of Hatchery Fish to Remove	Total spawning escapement
Twisp	92	0.79	0.26	0.75	32	0 MH		0	124
Methow/Chewuch	280	0.75	0.38	0.66	173	1,170 WNFH	472 (316 MH+156 WH)	0.79	453
Total	372	0.77	0.36	0.68	205	1,170	472 (316 MH+156 WH)	0.49	576

[1] Adjusted for prespawn mortality.
[2] pNOB of conservation program only averaged for BY13, 14, and 15. pNOB target for BY18 is 1.0 for both programs.
[3] Because of the uncertainty around run forecasts, PNI was provisionally estimated using the PNI=pNOB/(pNOB+pHOS) equation.
[4] Assumes a 90% conversion of hatchery fish to hatchery outfalls. Value already considers hatchery adults needed to meet WNFH and Okanogan 10(j) production components.

In-season assessment of the magnitude and origin composition of the spring Chinook return above Wells Dam will be used to provide in-season adjustments to hatchery/wild composition and total broodstock collection, consistent with ESA Section 10 Permits 18925, 18927, and 20533.

Methow Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Methow Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may occur at the Twisp Weir to meet an overall pHOS = 0.25 with 0.20 allocated to the Twisp Conservation program returns (the exception to this would be if a higher pHOS is still need to wrap up the remaining time series on the Relative Reproductive Success Study as approved),the Wells Hatchery Volunteer Channel, volunteer returns to the Methow Hatchery and Winthrop NFH, during broodstock collection efforts (including angling), or in combination with a conservation fishery.

A more detailed run forecast will be available in September 2018. Adult management plans, if needed, will be finalized then and appended to this document.

Okanogan Summer Steelhead

Depending on the outcome of preseason and in-season estimates of hatchery and natural origin steelhead to the Okanogan Basin during the annual run cycle monitoring at the Priest Rapids Dam Off Ladder Trap (OLAFT), removal of surplus adult steelhead may utilize a conservation fishery or in combination with removal through spring Okanogan tributary weir operations.

A more detailed run forecast will be available in September 2018. Adult management plans, if needed, will be finalized then and appended to this document.

Appendix D

Site Specific Trapping Operation Plans

Tumwater Dam

For 2018, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for Tumwater Dam is summarized in Table 1):

1) **Real-time monitoring and trap operations:** Throughout all trapping activities described in this plan, the two PIT tag antennae arrays within the Tumwater Dam ladder (weir 15 and 18 see Appendix 2), will be monitored by WDFW and Chelan PUD and detections of previously PIT tagged fish will be evaluated to determine the median passage time of fish between first detection at weir 15 and last detection at weir 15 or weir 18. Median passage estimates will be updated with every 10 PIT-tagged fish encountering weir 15. If the median passage time is greater than 48 hours, trapping will cease and fish will be allowed to exit via the ladder (i.e., bypass the trap). If trapping has been stopped, PIT tag passage monitoring will continue and trapping will resume if and when the median passage time is less than 24 hours. In summary, real-time PIT tag monitoring will occur both when the trap is operational and when fish are bypassed. This will provide an opportunity to evaluate trapping effects versus baseline passage rates through the ladder for future operations.

2) **Enhanced effort for Tumwater trapping operations from June 1 and July 15**: The Tumwater trap will be operated in an active-manned trapping condition (the ladder bypass will not be used however, fish may still ascend the denil [steep pass] unimpeded). The trap will be checked a minimum of 1x per day. More frequent trap checks will be made as fish numbers increase. Between June 16 and July 15 the Tumwater trap will be actively manned 24 hours/day 7 days/week utilizing two- three person crews (two people will sample fish and the third will maintain operation of the steep pass so that it will not be closed to passage). This represents an additional person to keep the denil operating constantly. If during this period staff are not available (due to logistical, funding, or other issues) to keep the denil operating continuously, the trap will be opened to allow for nighttime passage (this is in addition to passage required under a detected delay event).

3) **Enhanced effort and limited Tumwater trapping operations from July 16 to August 31**: The trap will be operated 3 days/week for up to 16 hours/day (not to exceed 48 hours per week) to support broodstock collection activities for summer Chinook and sockeye run composition sampling (CRITFC) and sockeye spawner escapement PIT tagging. Video enumeration and full passage will occur when trapping is not occurring.

4) **Planned Tumwater trapping operations from September 1 until mid-December:** To facilitate lamprey passage and meet coho and steelhead broodstocking and steelhead

adult management needs, the trap is being proposed to operate up to 16 hours per day from 6AM to 10PM 7days/week manned or unmanned active trapping. The trap will be open for lamprey passage between the hours of 10PM and 6AM. During this time period bull trout are rare and spring Chinook are not present at Tumwater. For this trapping period, real-time monitoring will be implemented with video enumeration when opened.

5) **Operations at Tumwater from mid-December until about mid-February:** During this period the trapping facility is not operated due to having been winterized. Only video enumeration and full passage are available during this period.

6) **Planned Tumwater trapping operations from mid-February through May:** The trap may return to a 24 hours/7days/week manned or unmanned active trapping for adult steelhead management and/or broodstock collection as needed. Beginning on or about May 1, limited spring Chinook broodstocking, run comp sampling, etc. may also occur. For this trapping period, real-time monitoring will continue to be implemented.

7) **Limitation in staffing or other unforeseen problems**: If WDFW staff are not available to operate the trapping facility (according to this plan) for any reason, then full passage will be allowed (fish will be allowed to bypass the trap and exit the ladder directly), until staff are able to return.

8) **Unforeseen scenarios and in season observations**: If during the trapping period, observations from field staff warrant reconsideration of any part of the plan as described above, WDFW and Chelan PUD will alert the Hatchery Committee and work cooperatively with the Services to determine whether changes are needed to further minimize incidental take or otherwise ensure that take is maintained at the manner and extent previously approved by the Services.

Table 1. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and reproductive success activities anticipated to be conducted at Tumwater Dam in 2018. Blue denotes steelhead, brown spring Chinook, orange sockeye, pink summer Chinook, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD pHOS mgt[1]		15 Feb				15 June			1 Sep			15 Dec
Su. SHD BS collection[2]									1 Sep		15 Nov	
Su. SHD Spawner Esc. tagging[3]		15 Feb				15 June			1 Sep			15 Dec
Spring Chinook RSS[4]					1 May		15 Jul					
Sp Chinook run comp[5]					1 May		15 Jul					
Sp Chinook pHOS mgt[6]					1 May		15 Jul					
Sp Chin stray mgt[7]					1 May		15 Jul					
Sp Chin BS collection					1 May		15 Jul					

Sockeye run comp[8]	15 Jul	15 Aug
Sockeye spawner esc tagging[9]	15 Jul	15 Aug
Su. Chin BS collection[10]	1 Jul	15 Sep
Coho BS collection[11]	1 Sep	30 Nov

[1] Adult management of the 2018 brood will end in June 2018. However it is anticipated that adult management will occur for the 2019 brood (if needed) beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at Tumwater Dam for other species.
[2] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities.
[3] SHD spawner composition tagging at Tumwater Dam will run concurrent with SHD adult management and other (broodstock) activities at Tumwater Dam.
[4] The spring Chinook RSS will run from 1 May through about 15 July or at such time or at such time the sockeye return develops at Tumwater Dam.
[5] Spring Chinook run composition sampling will run concurrent with the RSS.
[6] Spring Chinook pHOS management will end in July consistent with the arrival of the sockeye return and run concurrent with RSS activities.
[7] Removal of unknown hatchery origin spring Chinook strays at Tumwater Dam will run concurrent with the RSS.
[8] Sockeye run composition sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for run composition sampling will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[9] Sockeye spawner escapement sampling will occur at Tumwater Dam beginning no earlier than 15 July. Trapping at Tumwater Dam for spawner escapement tagging will follow a 3d/week, 16hrs/d (48 hrs/week) trapping schedule consistent with permit 1347.
[10] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Tumwater Dam for summer Chinook broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[11] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Tumwater Dam for Coho broodstock will follow a 3d/week 16hr/day (48 hrs/week) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 7 of each year but typically ceases by the end of November.

Dryden Dam

For 2018, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the right and left bank Dryden Dam traps is summarized in Table 2):

The Dryden Dam left and right bank trapping facilities will operate up to five days per week, 24 hours per day beginning June 24 and continue until as late as November 15. Both traps, if operated, will do so on concurrent days and will be checked and cleared every 24 hours, or sooner if it appears that run contribution to the facilities exceeds reasonable limits for adult holding.

If daily river temperatures meet or exceed 21º C (69.8º F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 2. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Dryden Dam trapping facilities in 2018. Blue denotes steelhead, pink summer Chinook, and green Coho.

Activity	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Left Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul				15 Nov	
Su. SHD spawner esc. Tagging[2]							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection									1 Sep		30 Nov	
Right Bank												
Su. SHD BS collection[1]							1 Jul				15 Nov	
Su. SHD Run Comp.							1 Jul					
Su. SHD spawner esc. Tagging2							1 Jul				15 Nov	
Su. Chinook run comp							1 Jul		15 Sep			
Su. Chin BS collection[3]							1 Jul		15 Sep			
Coho BS collection[4]									1 Sep		30Nov	

[1] Summer steelhead broodstock collection will be prioritized at Dryden Dam traps. However if broodstock objectives cannot be met at Dryden then trapping may occur at Tumwater concurrent with other activities.
[2] SHD spawner composition tagging at Dryden Dam will run concurrent with other (broodstock or M&E) activities at Dryden Dam.
[3] Summer Chinook broodstock collection will be prioritized at Dryden Dam. However if broodstock objectives cannot be met at Dryden Dam then trapping may occur at Tumwater Dam. Trapping at Dryden Dam for summer Chinook broodstock will follow an up to 5d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] Coho trapping will be conducted at both Dryden and Tumwater Dams. Trapping at Dryden Dam for Coho broodstock will follow an up to 5d/week 24hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Collection is permitted through December 7 of each year but typically ceases by the end of November.

Chiwawa Weir

For 2018, WDFW and Chelan PUD are proposing the following plan (a summary of activities by month for the Chiwawa Weir is summarized in Table 3):

Weir operations will be on a 24 hour up/24 hour down schedule from about June 1 through August 15 (not to exceed 20 cumulative trapping days and/or 93 bull trout encounters). Timing of trap operation would be based on NO fish passage at TWD and would use estimated travel times (derived from PIT tags) to the lower Chiwawa PIT tag antenna array.

Table 3. Summary of broodstock collection activities anticipated to be conducted at the Chiwawa Weir in 2018. Brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Sp Chin BS collection						1 June		15 Aug				

Wells Dam Ladder and Hatchery Volunteer Traps

For 2018, WDFW and Douglas PUD are proposing the following plan (activities by month for the Wells Dam East/West ladder and Wells FH volunteer traps are summarized in Table 4):

1). **East Ladder Trap:**

The East ladder trap will only be operated as needed to meet broodstock collection objectives and other management activities if they cannot be adequately fulfilled through the West ladder and Wells FH volunteer trap operations or if construction activities on the hatchery modernization preclude use of either the West ladder or volunteer traps.

If the East ladder trap is used, it may begin as early as May 1 and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week and will run concurrent with any trapping activities occurring at the West ladder trap. The first exception to the above is that for spring Chinook between May 1 and June 20, the trap may operate a maximum of 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the West ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the East ladder trap may be operated, concurrent with the West ladder trap, 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC will also trap sockeye at Wells Dam for tagging and stock assessment. Their request for trapping in 2018 did not specify trapping details other than timing (late June through early August), but their preference in past years has been to use the East ladder.

If daily river temperatures meet or exceed 21º C (69.8º F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

2). **West Ladder Trap:**

The West ladder may begin as early as May 1 for spring Chinook broodstock collection and, with two exceptions, will operate under a maximum 3-day per week/16 hours per day or 48 cumulative hours per week. The first exception to the above is that for spring Chinook between

May 1 and June 20, the trap may operate under a maximum 7-days per week/16 hours per day and will run concurrent with any trapping activities occurring at the East ladder trap. The second exception is for coho trapping after September 26. Anticipated trap operation is not expected to go beyond November 15.

For coho trapping, the West ladder trap may be operated 5 days per week/ 9 hours per day September 27 through October 9, and 7 days per week/16 hours per day beginning October 10. Trap operators will bypass Chinook, steelhead, and sockeye during coho trapping. Anticipated trap operation is not expected to go beyond November 15.

The CRITFC may also trap sockeye at Wells Dam for tagging and stock assessment and may use the west ladder; however, their preference in past years has been to use the East ladder. CRITFC has proposed trapping from late Junethrough early August.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

3). **Wells FH Volunteer Trap:** The Wells FH volunteer trap may begin as early as July 1 for summer Chinook broodstock collection and operate through mid-June of the following year for steelhead broodstock collection and adult management if needed. The trap may operate up to seven days per week/24 hours per day to facilitate broodstock collection and adult management actions.

If waterwater temperatures in the trapping facility meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Wells Dam in 2018. Blue denotes steelhead, brown spring Chinook, pink summer Chinook, orange sockeye, and green Coho.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
East/West Ladders												
Su. SHD BS collection[1]									1 Sep		15 Nov	
Su. SHD run comp.									1 Sep		15 Nov	
Su. SHD Spawner Esc. Tagging[2]									1 Sep		15 Nov	
Sp Chinook BS collection					1 May	30 Jun						
Sp Chinook run comp					1 May		15 Jul					
Sockeye SA [4]tagging[4]						2525 June		1717 Aug				
Su. Chin BS [3]collection[3]							1 Jul		15 Sep			

Coho BS collection[5]			15 Sep	15 Nov
Wells Volunteer Trap				
Su. SHD BS collection[1]			1 Sep	15 Nov
SHDBS/pHOS mgt.[6]	15 Feb	15 June	1 Sep	15 Dec
Su. Chin BS collection[7]			1 Jul	15 Sep
Su. Chin Surplussing			1 Jul	30 Oct

[1] Summer steelhead broodstock collection will be prioritized at West ladder and volunteer traps. However if broodstock objectives cannot be met at either of those two locations then trapping may occur at the East ladder concurrent with other activities.
[2] SHD spawner composition tagging at Wells Dam will run concurrent with other (broodstock or M&E) activities at Wells Dam.
[3] Summer Chinook broodstock collection for the Methow (Carlton) program will be prioritized at the West ladder trap. However if broodstock objectives cannot be met at the West ladder then trapping may occur at the East ladder. Trapping at the west and/or East ladders for summer Chinook broodstock will follow an up to 3d/week 16hr/day (48 cumulative hours) trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities.
[4] CRITFC trapping of sockeye for stock assessment and tagging typically begins the last week of June and extends through the third week of August, following an up to 3d/week 16hr/day (48 cumulative hours) coordinated with WDFW spring or summer Chinook and steelhead broodstock collection and stock assessment trapping, preferring to trap on the East ladder.
[5] Coho trapping may be conducted at both East and/or West ladders. Trapping at Wells Dam ladder traps for Coho broodstock will follow an up to 5d/week 9hr/day trapping schedule and may run concurrent with other broodstock collection, run sampling, or adult management activities. Trapping at the Wells Dam ladder will cease no later than November 15.
[6] Adult management of the 2018 brood will end in June 2018. However it is anticipated that adult management will occur for the 2019 brood beginning 1 September or earlier if conducted in conjunction with broodstock collection activities at the Wells Hatchery volunteer channel for other species.
[7] Summer Chinook broodstock collection for the Wells Hatchery programs will be prioritized at the Wells Hatchery volunteer trap. Trapping at the volunteer channel may occur up to 7 days per week, 24 hours per day and may include broodstock collection and/or adult management.

Methow Hatchery Volunteer and Twisp Weir Traps

For 2018, WDFW and Douglas PUD propose the following plan (A summary of activities by month for Methow Hatchery volunteer trap and the Twisp Weir is summarized in Table 4):

Specific operation details for the Methow Hatchery volunteer trap and Twisp Weir are still being worked through. Once those details have been fleshed out more thoroughly, this section will be updated.

If daily river temperatures meet or exceed 21° C (69.8° F) trapping activities and fish handling will cease until temperatures drop below this threshold. This may require reducing trap operation to only nighttime hours with early morning traps checks to ensure the safety of the fish.

Table 4. Summary of broodstock collection, spawner escapement tagging, adult management, run composition sampling, and/or reproductive success activities anticipated to be conducted at Methow Hatchery and the Twisp Weir in 2018. Blue denotes steelhead and brown denotes spring Chinook.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Methow Hatchery[1]												
SHD pHOS mgt.			1 Mar			15 Jun			1 Sep		15 Nov	
Sp. Chinook BS collection					1 May			30 Aug				
Sp. Chinook pHOS mgt.[2]					1 May			30 Aug				
Twisp Weir[3]												
Steelhead RSS			1 Mar		30 May							
Su. SHD BS collection				1-30 Apr								
SHD pHOS mgt.			1 Mar		30 May							
Sp. Chinook BS collection						1 June		15 Aug				
Sp. Chinook pHOS mgt.						1 June		22 Aug				

[1] Specific details on how operation of the Methow Hatchery volunteer trap will work for SHD adult management are still being worked out at this time.
[2] Adult management for spring Chinook at the Methow Hatchery volunteer trap will run concurrent with broodstock collection.
[3] Specific details on how operation of the Twisp Weir will work for 2018 to include the steelhead RSS, broodstock collection, and adult management and spring Chinook broodstock collection and adult management is still being worked out at this time.

Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT)

Table 5. Summary of broodstock collection, VSP monitoring, and/or run composition sampling activities anticipated to be conducted at the Priest Rapids Dam Off-Ladder-Adult-Fish-Trap (OLAFT) in 2018. Blue denotes steelhead, purple fall Chinook, and orange sockeye. All users of the OLAFT must have a signed Facility Use Agreement with GPUD.

Activity	Month											
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
SHD VSP Monitoring[1]							1 Jul				15 Nov	
Fall Chin. BS collection[2]									1 Sep		15 Nov	
Fall Chinook Run Comp.[3]									1 Sep		15 Nov	
Sockeye BS Collection[4]						22 Jun	10 Jul					

[1] Steelhead VSP monitoring targets up to 15% of the annual return over Priest Rapids Dam. Presently that requires operation of the OLAFT up to 3 days/ week, 8 hours per day. The trap is opened to passage each night.
[2] To acquire the target 1,000 adipose present, non-CWT adult fall Chinook for broodstock, the OLAFT is operated up to 5 days per week, 8 hours per day. Three of the five days are concurrent with the SHD VSP monitoring. The trap is opened to passage each night.
[3] Fall Chinook run composition runs concurrent with SHD VSP monitoring and/or fall Chinook broodstock collection activities.
[4] Sockeye broodstock collection to support YN reintroduction efforts in the Yakima is based upon abundance based sliding scale. Depending on the strength of the return and allowable allocation, the trap may be operated up to 5 days per week, 8 hours per day beginning about 22 June and running through about 10 July. The trap is opened to passage each night.

Appendix E

Columbia River TAC Forecast

Table 1. 2018 Columbia River at mouth salmon returns – actual and forecast.

Columbia River Adult Salmon Returns: Actual and Forecasted				
		2017 Forecast	**2017 Return**	**2018 Forecast**
Spring Chinook	***Upriver Total***	**160,400**	**115,821**	166,700
Summer Chinook	***Upper Columbia***	**63,100**	**68,204**	67,300
Sockeye	***Total***	**198,500**	**88,263**	99,000
Provided by the *U.S. v Oregon* Technical Advisory Committee (TAC)				

Appendix F

Annual Chelan, Douglas, and Grant County PUD RM&E Implementation Plans

Chelan PUD
The Final 2018 Chelan Hatchery Monitoring and Evaluation Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

Douglas PUD
The Final 2018 DCPUD ME Implementation Plan (PDF) is available at the HCP Hatchery Committees Extranet Homepage. Please use the following procedure:

* Visit: https://extranet.dcpud.net/sites/nr/hcphc/
* Login using "Forms Authentication" (for non-Douglas PUD employees)

Grant PUD

2018 GPUD Hatchery ME Implementation Plan for the Wenatchee Basin and Methow Summer Chinook Salmon
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/2016%20GPUD%20Hatchery%20ME%20Implementation%20Plan%20for%20the%20Wenatchee%20Basin_FINAL.pdf?Web=1

2018 Priest Rapids Hatchery Implementation Plan
https://partner.gcpud.org/sites/ResCom/PRCCHatchery/Final/PRH%20ME%202016-17%20Implementation%20plan%20final.pdf?Web=1

Appendix G

DRAFT

Hatchery Production Management Plan

The following management plan is intended to provide life-stage-appropriate management options for Upper Columbia River (UCR) PUD salmon and steelhead mitigation programs. Consistent, significant over-production or under-production risks the PUD's not meeting the production objectives required by FERC and overages in excess of 110% of program release goals violates the terms and conditions set forth for the implementation of programs under ESA and poses potentially significant ecological risks to natural origin salmon communities.

Under RCW 77.95.210 (Appendix A) as established by House Bill 1286, the Washington Department of Fish and Wildlife has limited latitude in disposing of salmon and steelhead eggs/fry/fish. While this RCW speaks more specifically to the sale of fish and/or eggs, WDFW takes a broader application of this statute to include any surplus fish and/or eggs irrespective of being sold or transferred.

We propose implementing specific measures during the different life-history stages to both improve the accuracy of production levels and make adjustments if over-production occurs. These measures include (1) Improved Fecundity Estimates, (2) Adult Collection Adjustments, (3) Within-Hatchery Program Adjustments, and (4) Culling at the earliest life-stage.

<u>Improved Fecundity Estimates</u>

A) Develop broodstock collection protocols based upon the most recent 5-year mean in-hatchery performance values for female to spawn, fecundity, green egg to eye, and green egg to release.
B) Use portable ultrasound units to confirm gender of broodstock collected (broodstock collection protocols assume a 1:1 male-to-female ratio). Ultrasonography, when used by properly trained staff will ensure the 1:1 assumption is met (or that the female equivalents needed to meet production objective are collected). Spawning matrices can be developed such that if broodstock for any given program are male limited sufficient gametes are available to spawn with the females.

<u>Adult Collection Adjustments</u>

C) Make in-season adjustments to adult collections based upon a fecundity-at-length regression model for each population/program and origin composition need (hatchery/wild). This method is intended to make in-season allowances for the age structure of the return (i.e. age-5 fish are larger and therefore more fecund than age-4 fish), but will also make allowances for age-4 fish that experienced more growth through better ocean conditions compared to an age-5 fish that reared in poorer ocean conditions.

<u>Within-Hatchery Program Adjustments</u>

D) At the eyed egg inventory (first trued inventory), after adjustments have been made for culling to meet BKD management objectives, the over production will be managed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:
    - Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
    - Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
    - Salmon culture programs requested by lead entities and approved by the salmon funding recovery board under chapter 77.85 RCW;
    - Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
    - Governmental hatcheries in Washington, Oregon, and Idaho; or
    - Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
    - Distribution to approved organizations/projects for research.

E) At tagging (second inventory correction) fish will be tagged up to 110% of production level at that life stage. If the balance of the population combined with the tagged population amounts to more than 110% of the total release number allowed by Section 10 permits then the excess will be distributed in one or more of the following actions as approved by the HCP-HC or PRCC-HSC:
    - Voluntary cooperative salmon culture programs under the supervision of the department under chapter 77.100 RCW;
    - Regional fisheries enhancement group salmon culture programs under the supervision of the department under this chapter;
    - Salmon culture programs requested by lead entities and approved by the salmon recovery funding board under chapter 77.85 RCW;
    - Hatcheries of federally approved tribes in Washington to whom eggs are moved, not sold, under the interlocal cooperation act, chapter 39.34 RCW; and
    - Transfer to another resource manager program such as CCT, YN, or USFWS program;
    - Governmental hatcheries in Washington, Oregon, and Idaho;
    - Placement of fish into a resident fishery (lake) zone, provided disease risks are within acceptable guidelines; or
    - Culling for diseases such as BKD and IHN, consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State; or
    - Distribution to approved organizations/projects for research.

F) In the event that a production overage occurs after the above actions have been implemented or considered, and deemed non-viable for fish health reasons in accordance with agency aquaculture disease control regulations (i.e. either a pathogen is detected in a population that may pose jeopardy to the remaining population or other programs if retained or could introduce a pathogen to a watershed where it had not previously been detected) then culling of those fish may be considered.

All, provisions, distributions, or transfers shall be consistent with the department's egg transfer and aquaculture disease control regulations as now existing or hereafter amended. Prior to department determination that eggs of a salmon stock are surplus and available for sale, the department shall assess the productivity of each watershed that is suitable for receiving eggs.

Appendix H

DRAFT

Alternative Plan for 2019 BY and beyond, for Methow Sub-basin Conservation Steelhead Programs

Introduction

The objective of this draft plan is to provide a thumbnail approach for mitigating genetic concerns specifically in the Twisp Conservation program, and describe our alternative for future implementation (2018 and beyond) for Methow Subbasin conservation steelhead programs (Twisp and Winthrop NFH). Direction herein is general with seasonal/run-specific technical details to be worked out annually between operators and formalized through broodstock collection protocols and steelhead-specific management plans. Our intent for this memo is to serve as a vehicle for the Hatchery Committee to approve this direction by vote. While this plan is being presented as a preferred course of action by the parties, approval (and further refinement of a long term plan) is contingent upon successful broodstock collection of the 2018 brood. No modifications to program size or release numbers are proposed – only modification of brood stocking methodology, rearing/release strategies and parentage.

Genetic analysis of returning adult steelhead at the Twisp River weir as part of the Relative Reproductive Success Study, indicated that relatedness among the returning hatchery origin adults was high (T. Seamons, WDFW Genetics Lab, pers. comm.). This is not surprising given the small program size (Table 1), and may result in a reduction in genetic diversity and N_e, consistent with effects described in Ryman and Laikre (1991), hereafter "Ryman-Laikre" or "RL" effects.

In response to concerns about minimizing the potential long term risks/effects associated with RL, the HCP-HC and co-managers are looking to adopt a strategy to address potential (or increased) RL effects in the Twisp population as well as having a more integrated approach to steelhead conservation programs in the Methow sub-basin. Mitigating actions were selected with goals to increase genetic diversity, reduce risk of inbreeding on the spawning grounds, and increase N_e. Actions includes release of age-2 (S2) WNFH conservation program juveniles into the Twisp River and compositing a portion of the Twisp and WNFH conservation program broodstock (while retaining a small Twisp WxW (S1) release. Specifically, returning spawners will originate from a greater number of less-related parents compared to the resulting return if these actions are not undertaken.

From the alternatives discussed by a small work group, a hybrid approach (hereafter referred to as alterative 3) between a couple alternatives was developed (and is preferred) that aims to retain Twisp genetics within the Twisp basin but includes incorporation of non-Twisp conservation program genetics.

Alternative 3 was developed based on the desire to protect any remaining or developing Twisp genetic stock structure while balancing and mitigating for genetic concerns by managing N_e and potential spawner relatedness concerns. The major point by which Alt. 3 differs from other alternatives discussed is that a small Twisp x Twisp broodstock would continue to be operated instead of full compositing. No overall changes to current production and release levels would occur. Approximately six Twisp x Twisp (NOR) crosses would produce approximately 24K smolts for release back to the Twisp River. Annual Twisp releases would also include a 24K co-release of S2 smolts from the WNFH conservation program, allowing for unrelated returning adults to provide an increased level of genetic diversity into the Twisp to combat low N_e and reduce risk of inbreeding. This strategy would also provide an evaluation opportunity where potential Twisp stock performance could be evaluated against WNFH conservation program smolts, providing management guidance for continued future direction.

Implementation details for Alternative 3 follow:

Broodstock Collection

- Combined broodstock collection (joint DPUD, WDFW, USFWS, and YN effort)
    - Collection occurs throughout the Methow River, including below-Twisp River angling, Twisp Weir, and WNFH/MFH hatchery infrastructure
    - Broodstock Targets
        - Approximately 6-8* pairs NORs collected at Twisp Weir (half of Twisp program)
        - Approximately 61-65* NOR pairs (WNFH program plus half of Twisp program) collected throughout the Methow River via angling
        - As a contingency for under-collection of broodstock sufficient to fulfil the two components of Twisp-release production, broodstock collection at Twisp Weir could be increased to the traditional collection target of 13 pairs, as needed.
        - *Flexibility required in targets for variation in escapement, fecundity, inclusion of hatchery-origin brood (as per BiOp), etc.
    - All broodstock transferred to WNFH for holding and spawning
        - DPUD may collect up to 37 pairs of conservation program returns (Ad+CWT and CWT-only) at Wells Dam and/or via angling consistent with conservation program efforts and direct-transfer to Wells Hatchery for use in safety-net program
    - Data management for broodstock collection and spawning at WNFH will be primary responsibility of USFWS MCFWCO (all data would be shared with WDFW and DPUD to allow completion of HCP-HC related reports):
        - All broodstock uniquely PIT-tagged upon capture/transfer for assignment on spawn days
        - PIT data tied to collection date/location, mark, DNA samples
        - USFWS will provide standardized <u>effort</u> collection information to all angling participants
    - Adult management will continue to be a large part of broodstock collection efforts
        - Guided by terms and conditions for minimum escapement, pNOB, and mitigation requirements in BiOp
        - Supported generally (i.e. without run-specific details) in annual broodstock collection protocols (e.g. Tonseth 2017)

- Supported specifically (i.e. includes run-specific details) by annual FMEP and targets/goals established by small Methow Steelhead Working Group

Spawning

- All conservation program spawning will occur at WNFH
  - Spawning will be 2x2 factorial crosses
  - Half of Twisp program will be Twisp weir collected NOR x Twisp weir collected NOR as feasible. Individuals PIT-tagged as juveniles in the Twisp will be treated the same.
  - WNFH program and remaining half of Twisp program will be Methow Subbasin NOR x NOR as feasible
  - All NOR females will be live-spawned & transferred to YN Kelt Program
  - USFWS MCFWCO will collect and provide all spawning biological and cross data to WDFW M&E staff.

Gamete Management & Smolt Release

- Maintain 48K total smolt release in Twisp River
  - 24K will be known-Twisp NOR x NOR spawned at WNFH but sent to Wells for S1 rearing
  - 24K will be representative cross-section of WNFH component, reared as S2 smolts at WNFH
  - All releases will be direct smolt plants at Buttermilk Bridge (RKm 21)
- Maintain 100K-200K total conservation program smolt release to Methow Sub-basin outside Twisp
  - 24K cross-section of WNFH population will be transferred to Wells Hatchery for S1 rearing for WNFH on-station or alternative release sites in Methow Subbasin.
  - 24K cross-section of WNFH population will be reared as S2 on-station as paired release for 24K S1 group (above) for potential alternative release strategies, as per above. Any alternative release strategies will guided by JFP and consider need for gradual implementation and patience in awaiting environmental response to management changes.
  - Remaining 52-152K of WNFH population will be reared as S2 smolts for on-station release.

Table 1. Methow Subbasin steelhead hatchery programs under Alternative 3.

Program	Rearing Hatchery	Funding entity	Release site	Release goal	Broodstock	Genetic crosses	Age at release
Methow Subbasin Conservation	WNFH	Reclamation	Methow R. @ WNFH	52-152K[1]	60-65	WxW	2
			Methow Subbasin[2]	24,000			2
	Wells	DPUD		24,000			1
	Wells	DPUD		24,000	6-8	WxW	1

Twisp Conservation	WNFH	Reclamation	Twisp R. @ Buttermilk Br	24,000	6-8	WxW	2
Methow Safety-net	Wells	DPUD	Methow R.[3]	100,000	68[2]	HxH	1
Total				348,000			

[1]WNFH program subject to pNOB/production sliding scale in BiOp.
[2]Initially Methow R. at WNFH but may include alternative offsite release strategies subject to JFP and HCP- HC guidance and BiOp terms and conditions. Would be paired S1 and S2 release.
[3]Methow Safety-net program released in Methow River at Lower Burma Bridge.

Discussion

Alternative 3 was proposed by the working group as it appears to provide the best compromise while also including measures to address the Spatial Structure and Diversity VSPs, by attempting to maintain (or allow) development of local stock structure in the Twisp Watershed. In addition, Alternative 3 provides a higher probability of finding an effective conservation hatchery strategy for the Twisp River, and elsewhere in the Methow Subbasin because it uses three conservation hatchery strategies: 1) local WxW Twisp Program, 2) Methow Composite S1 program, and 3) Methow Composite S2 program.

Table 2. Illustration of out-year effects of 2017 actions and proposed Alternative 3 on Twisp River spawning ground age/program composition.

Spawn/ Escapement Yr.	Age/Program composition of spawners (HOR only) on spawning grounds - Twisp Watershed only		
	Status Quo - S1 smolt supplementation only (all fish are Twisp Program only)	Additional spawners resulting from 2017-only, single-year Alt. mgmt. (juvenile release & brood compositing)	Spawner composition resulting from 2017 actions plus implementation of Alt. 3
2014	BY'10 1.2, BY'11 1.1	N/A	N/A
2015	BY'11 1.2, BY'12 1.1	N/A	N/A
2016	BY'12 1.2, BY'13 1.1	N/A	N/A
2017	BY'13 1.2, BY'14 1.1	N/A	N/A
2018	BY'14 1.2, BY'15 1.1	N/A	N/A
2019	BY'15 1.2, BY'16 1.1	BY'15 2.1 (WNFH)	BY'15 2.1 (WNFH)
2020	BY'16 1.2	BY'15 2.2 (WNFH), BY'17 1.1 (Met[1])	BY'15 2.2 & BY'16 2.1 (WNFH), BY'17 1.1 (Met+Twisp[1])
2021	*BY'18 1.1*[2]	BY'17 1.2 (Met[1])	BY'16 2.2 (WNFH) BY'17 2.1, BY'18 1.1 (Met+Twisp[1])
2022	*BY'18 1.2, BY'19 1.1*[2]	N/A	BY'17 2.2, BY'18 1.2 & 2.1, BY'19 1.1 (Met+Twisp[1])
2023	*BY'19 1.2, BY'20 1.1*[2]	N/A	BY'18 2.2, BY'19 1.2 & 2.1, BY'20 1.1 (Met+Twisp[1])
2024	*BY'20 1.2, BY'21 1.1*[2]	N/A	BY'19 2.2, BY'20 1.2 & 2.1, BY'21 1.1 (Met+Twisp[1])

[1]Combined Methow Subbasin Conservation Programs (yearlings raised at Wells Hatchery, 2-year smolts raised at WNFH).
[2]No BY'17 Twisp Program was developed; brood were composited. This column displays return composition if status quo were to return in 2018.

Appendix L
Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2019 – Final

Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2019 – Final

Prepared by:

Catherine Willard

August
2018

Contents

1. INTRODUCTION

The Habitat Conservation Plan (HCP) specifies that a monitoring and evaluation plan will be developed for the hatchery program. The approach to monitoring the hatchery programs was guided by the "*Monitoring and Evaluation Plan for PUD Hatchery Programs: 2017 Update"* (Hillman et al. 2017) and the "*Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Programs*" (Murdoch and Peven 2005).

The purpose of this document is to define the tasks associated with the approved scope of work to implement Chelan PUD's (CPUD's) hatchery monitoring and evaluation (M&E) plan for 2019. Additionally, monitoring and evaluation activities for Lake Wenatchee sockeye in 2019 are included in this document. As monitoring tasks are completed in 2018 and are evaluated for their efficacy, methodologies to accomplish the tasks defined in the 2019 Implementation Plan may be modified [with Habitat Conservation Plan's Hatchery Committee (HCP-HC) approval].

The work described in this plan has Endangered Species Act (ESA) coverage provided by NMFS Section 10(a)(1)(A) permits 18121 and 1395 and Section 10(a)(1)(B) permit 1347. All activities conducted under this Implementation Plan shall adhere to all terms and conditions as specified in the referenced permits. These permits allow for changes to monitoring or research protocols with the caveat that such modifications are approved by NMFS prior to implementing those changes. Terms and conditions relevant to monitoring and evaluating the hatchery programs have been used to inform the various measurements below and associated scopes of work with entities performing the work. A report summarizing compliance with the terms and conditions set forth under the above-references permits is required for submittal to NMFS; a copy of this completed report will be provided to the HCP HC.

The Implementation Plan includes all four components of the hatchery M&E Program including: (1) aquaculture monitoring; (2) juvenile monitoring; (3) adult monitoring; and (4) data, analysis and reporting. Under each component are study design elements that will be used to inform the overarching program components. Figure 1 illustrates the relationship of the components and study design elements used to address each component. Table 1 depicts which study design element is being performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2017. For Lake Wenatchee sockeye salmon, the proposed M&E activities cover juvenile and adult life history stages and provide the data necessary to track or estimate viable salmonid population parameters (VSP) and is described in Section 6.0.

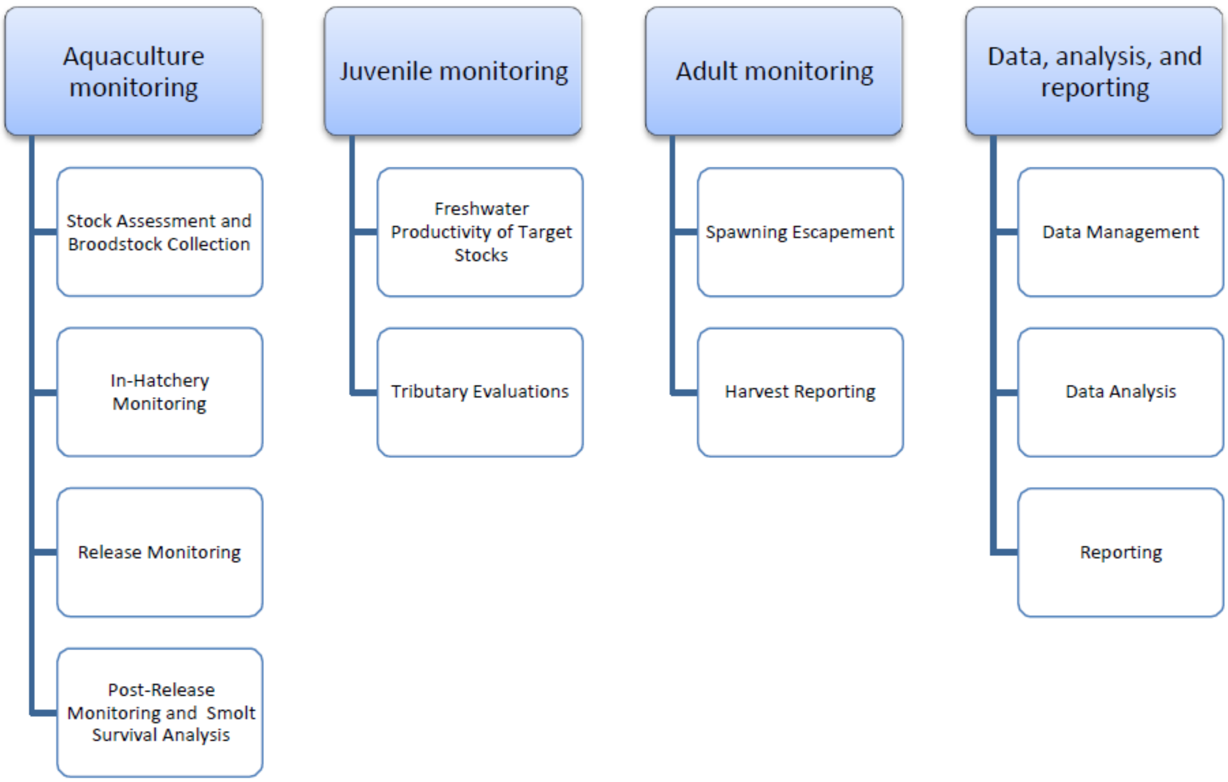

Figure 1. The four components of the hatchery monitoring and evaluation program and the study design elements within each component.

Table 1. Study design elements performed by entity, and the associated objectives for each study design element as referred to in Hillman et al. 2017.

Monitoring and evaluation component	Objectives[1]	Study Design Elements	Chiwawa spring Chinook	Wenatchee summer Chinook	Methow spring Chinook[4]	Chelan Falls summer Chinook[5]	Wenatchee Steelhead
Aquaculture Monitoring	3,5,8	Stock assessment and broodstock collection	WDFW	WDFW	WDFW	WDFW	WDFW
	5, 8	In-hatchery monitoring	WDFW CPUD[2]	WDFW CPUD[2]	WDFW Biomark[3]	WDFW CPUD[2]	WDFW CPUD[2]
	9	Release monitoring	WDFW	WDFW	WDFW	WDFW	WDFW
	9	Post-release monitoring and smolt survival analysis	WDFW	WDFW	WDFW	WDFW	WDFW
Juvenile monitoring	2	Freshwater productivity of stocks	WDFW	WDFW	WDFW	NA	WDFW
		Tributary evaluations	WDFW	WDFW	WDFW	NA	WDFW
Adult monitoring	1,2,3,4,5,6, 8,10	Spawning escapement	CPUD	WDFW	WDFW	BioAnalysts	WDFW
	8	Harvest reporting	WDFW	WDFW	WDFW	WDFW	WDFW
Data, analysis, and reporting	All	Data management	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts
		Data analysis	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts
		Reporting	WDFW CPUD BioAnalysts	WDFW BioAnalysts	WDFW	WDFW BioAnalysts	WDFW BioAnalysts

[1] Monitoring questions relative to Objective 7 will be addressed at the next 10 year HCP check-in.
[2]CPUD crews will PIT tag in-hatchery fish.
[3]Biomark will PIT tag in-hatchery fish.
[4]In 2019, monitoring and evaluation for the Methow spring Chinook program is described in "Implementation of Comprehensive Monitoring and Evaluation of Wells Hatchery Complex Programs".
[5]Because the Chelan summer Chinook program is primarily an augmentation program, monitoring and evaluation efforts focus on straying, release characteristics, and harvest.

2. AQUACULTURE MONITORING

The aquaculture monitoring component is comprised of two basic elements: (1) stock assessment and broodstock collection at adult trapping locations and (2) in-hatchery monitoring including spawning, rearing, and release of juveniles. Data collected during these elements primarily support monitoring questions 5.1.1, 5.2.1, 8.1.1, 8.2.1, 8.3.1, 8.3.2, 8.4.1, 9.1.1, 9.2.1, 9.3.1 and 9.4.1, but also contribute data to monitoring questions 3.2.1, and 3.2.2 (Hillman et al. 2017). Table 2 below provides a summary of the variables to be measured in 2019 under the aquaculture monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

Table 2. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the aquaculture monitoring component.

Objectives	**Measured Variables** *(Applicable Study Component(s))*
Objective 3: Determine if the hatchery adult-to adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.	• Number of hatchery and naturally produced fish collected for broodstock (*Broodstock Collection and Stock Assessment*) • Number of broodstock used by brood year (hatchery and naturally produced fish) (*Broodstock Collection and Stock Assessment*)
Objective 5: Determine if the run timing, spawn timing, and spawning distribution of the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.	• Ages of hatchery and naturally produced fish sampled via PIT tags or stock assessment monitoring (*Broodstock Collection and Stock Assessment*) • Time (Julian date) of ripeness of hatchery and natural origin steelhead captured for broodstock (*Broodstock Collection and Stock Assessment*)
Objective 8: Determine if hatchery programs have caused changes in phenotypic characteristics of the natural populations.	• Size (length), gender, and total/salt age of broodstock (*Broodstock Collection and Stock Assessment*) • Assess age of fish (*Broodstock Collection and Stock Assessment*) • Length, weight, and age (covariate) of hatchery and natural-origin broodstock after eggs have been removed (*Broodstock Collection and Stock Assessment*) • Number and weight of eggs (*Broodstock Collection and Stock Assessment*)
Objective 9: Determine if hatchery fish were released at the programmed size and number.	• Fork length and weights of random samples of hatchery juveniles at release (*Release Monitoring*) • Monthly individual lengths and weights of random samples of hatchery juveniles (*In-Hatchery Monitoring*) • Numbers of smolts released from the hatchery (*Release Monitoring*)

2.1 Broodstock Collection and Stock Assessment

Broodstock collection and stock assessment for Wenatchee summer steelhead, Wenatchee summer Chinook, Methow spring Chinook, Chelan Falls summer Chinook, and Chiwawa River spring Chinook, hatchery programs will, in most instances, occur concurrent to and consistent with the Broodstock Collection Protocol approved annually by the HCP-HC and relevant permits. Data collection during broodstock collection will be consistent with Murdoch and Peven (2005). A representative sample of fish trapped throughout the entire run, either collected for broodstock or released back to the river, will be sampled for origin, age, sex, size, and migration timing. Biological sampling of all fish trapped will include presence of internal (CWT or PIT) and external (VIE) tags or marks, scales, length, and sex (determined by ultrasound). PIT tags will be injected into all target species (Chinook and steelhead), whether collected for broodstock or released back to the river to monitor for potential fallbacks. All non-target species will be enumerated daily. Measures of central tendency and spread will be calculated and reported for each metric.

2.2 In-Hatchery Monitoring

The in-hatchery monitoring component will begin when adult fish are collected and retained for broodstock and ends when juvenile fish are released. Life stage specific in-hatchery survival and growth rates, disease monitoring, and an estimate of the number of fish released will be collected and analyzed according to Murdoch and Peven (2005). Additional data to be collected includes individual lengths and weights of juveniles during monthly sampling, and the weight of gonadal mass and body of spawned broodstock. Measures of the central tendency and spread will be calculated and reported for each metric.

Fish Marking

All of Chelan PUD's hatchery fish will be coded-wire tagged (CWT) and externally marked or marked as otherwise agreed to by the HCP HC. A comprehensive marking strategy will be developed by the HCP-HC and included as an Addendum to this Plan. The identification of these hatchery-produced fish is needed for a suite of adult metrics and may be used for adult management and/or fisheries as contemplated by the co-managers.

Using methods described in Keller and Murauskas (2012), hatchery fish will be PIT-tagged (Table 3) at Eastbank Hatchery approximately two to four weeks before the fish are transferred to acclimation ponds or in the spring prior to release. Additional PIT-tagging may occur for program specific studies/comparisons as approved by the HCP-HC. The data collected from the PIT-tags will assist in release monitoring, migration timing, juvenile survival, and smolt-to-adult survival. For all fish marking, quality control check will be performed during and immediately following tagging and prior to release.

Table 3. Chelan PUD's hatchery program release goals and recommended number of fish PIT tagged.

Program	Release goals	Number of fish PIT tagged[1]	PIT tag rate (%)
Chiwawa spring Chinook	144,026	10,000	6.9
Wenatchee steelhead	247,300	30,000	8.2
Wenatchee summer Chinook	318,816 (CPUD Program) 181,184 (GPUD Program)	20,600	4.1
Methow spring Chinook	60,156	5,000	8.3
Chelan Falls summer Chinook	576,000	10,000	1.7

[1] Additional PIT tagging may take place for Chelan PUD approved studies and/or comparisons.

2.3 Release Monitoring

Hatchery fish will be released during smoltification in the spring, typically between 15 April and 1 June. Whenever possible, the exact release dates will coincide with environmental conditions that promote a rapid emigration that minimizes both the potential negative ecological interactions of hatchery fish with naturally produced fish and predation on hatchery fish by avian or other predators. The default release method will incorporate a volitional approach, as approved by the HCP HC, unless it can be demonstrated other approaches are better. The monitoring data collected for each stock are described below.

Chiwawa and Methow Spring Chinook

Pre-release sampling data will be conducted consistent with Murdoch and Peven (2005), including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan (Hillman et al. 2017). PIT tag monitoring of spring Chinook released in the Chiwawa River will occur during the release period (April). Juvenile Chinook will pass through two 92-cm diameter PIT-tag antennas connected to Allflex 310 readers and Quantitative Sampling Technologies (QST) QuBE data logger. The release location and type (i.e., volitional, forced, or trucked) are recorded for each observation file created and uploaded to the PTAGIS database maintained by the Pacific States Marine Fisheries Commission after each year of release. PIT-tagged fish in each observation (release) file are assumed to represent untagged fish. Observation files contain the PIT tags associated with the original tag files and will be used for analysis (see Post-release Monitoring Section). The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

Wenatchee Summer Steelhead–

Pre-release sampling will be conducted consistent with Murdoch and Peven (2005), including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan. Monitoring of steelhead released in the Wenatchee River sub-basin will occur during loading of fish into transport trucks, unless fish are released directly into the Chiwawa River. Steelhead will pass through a series of PIT-tag antennas, each connected to a data logger, thereby allowing the creation of a PIT-tag observation file for each truckload of steelhead consisting of unique tag records. The release location (stream and rkm), release type (volitional or forced), and hatchery group (HxH or WxW) will be recorded for each tag file created. PIT-tagged fish in each observation (release) file are assumed to represent untagged fish. However, because PIT-detection efficiency during loading will not be 100%, the number of fish in each truckload will be estimated using volumetric displacement. Observation files contain the PIT tags associated with the original tag files and will be used for analysis (see Post-release Monitoring Section). The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

Wenatchee and Chelan Falls Summer Chinook

Pre-release sampling will be conducted consistent with Murdoch and Peven (2005), including individual weights to the nearest 0.1 gram. Data collected will support monitoring questions 9.1, 9.2, 9.3 and 9.4 in the updated monitoring and evaluation plan. Should PIT tagging occur, a monitored release strategy consistent with other Chinook stocks (i.e., Chiwawa Spring Chinook) will be implemented. The total number of fish released will be based on the population size at CWT tagging (100%), subtracting mortality enumerated by hatchery staff that occurred from tagging to release.

2.4 Post-Release Monitoring and Survival Analysis

Data will be collected during rearing, acclimation, release, and the emigration period that may prove valuable in explaining variability in adult survival (Murdoch and Peven 2005). Rearing densities have been reported to influence the survival of hatchery fish (Martin and Wertheimer 1989; Banks 1994) and may also be linked to disease prevalence during rearing (Banks 1994; Ogut and Reno 2004). Acclimation of hatchery fish before release has been found to increase survival and reduce stray rates when the duration of the acclimation period is sufficient (Clarke et al. 2010, 2012; Rosenberger et al. 2013). These metrics (i.e., rearing density and acclimation period) will be collected annually to determine their influence on fish survival.

PIT-tagged groups of hatchery fish will be used to estimate survival during their emigration. Variation in survival during the emigration period may also inform observed adult survival rates. Survival during emigration and travel will be estimated using interrogation or release files and the standard Cormack-Jolly-Seber (CJS) estimator. CJS estimates are termed apparent survival estimates because it is unknown whether fish suffered mortality (e.g., size or time of release) or simply failed to emigrate (i.e., residualized or were precocial males). In the latter case, the proportion of PIT-tagged fish detected in the Methow sub-basin, Wenatchee or Columbia rivers after the emigration period is complete may explain variation in smolt survival rates. The post-release performance of PIT-tag groups will be estimated and monitored annually, consistent with methods in Murdoch and Peven (2005). Additionally, precocity of hatchery releases will be evaluated by examining the proportion of PIT tag releases detected in adult fish ladders and tributaries within the same year as release.

3. Juvenile Monitoring

Data collected during these elements primarily support monitoring questions 2.1.1 and 2.2.1. and the monitoring objectives described in Table 4 (Hillman et al. 2017). Table 4 below provides a summary of the variables to be measured in 2019 under the juvenile monitoring component and what objective the measure supports. The text that follows in this section further describes the activities.

Table 4. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the juvenile monitoring component.

Objective	Measured Variables *(Applicable Study Component(s))*
Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	• Number of juveniles (smolts and emigrants) (*Freshwater Productivity of Supplemented Stocks*)

3.1 Freshwater productivity of Supplemented Stocks

Steelhead, Spring Chinook, and Summer Chinook

The freshwater productivity of supplemented stocks in the Wenatchee sub-basin will be monitored using smolt traps in the Chiwawa River and the lower Wenatchee River consistent with historical trapping efforts. Additionally, a newly derived analytical method which uses PIT-tag mark-recapture data will be utilized that reduces bias and increases precision by including estimates of emigration during the winter non-trapping periods. Up to 3,000 parr will be PIT tagged in the Chiwawa River in the fall, based on the spatial distribution and abundance estimated during parr snorkel surveys, to generate estimates of migration during the non-trapping periods. A random sample of a minimum of 10 percent of fish per remote site will be held in a live box for 24 hours to evaluate tag loss and delayed mortality. Using PIT tagged parr detections at the lower Chiwawa PIT array during the non-trapping period, the total number of PIT-tagged parr that emigrated will be estimated, and then expanded by the tag rate. Overwinter mortality of PIT-tagged parr is assumed to be the same as non-PIT-tagged parr. Overwinter survival estimates of Chiwawa River parr will be derived by estimating survival to the lower Wenatchee PIT tag array and analyses with the TribPit Survival software program and/or estimating survival of fall parr and spring smolts to McNary. PIT-tag mark-recapture trials conducted during the trapping period in the fall will also be used to estimate detection probabilities of the PIT-tag array at a given discharge level. Abundance and variance will be estimated using the same methods as those used in the smolt trap estimate. The estimated abundance and variance from each method and time period (trapping and non-trapping periods) will be summed to estimate a total production estimate. Under the proposed methodology, unbiased estimates of abundance during the entire migration period will be generated with relatively high precision (PSE < 15%), which is consistent with NOAA Fisheries' recommendations (Crawford and Rumsey 2011). Historical estimates will be revised using the new estimation techniques.

4. Adult Monitoring

The adult monitoring component is comprised of two basic elements: (1) estimating spawning escapement and (2) harvest monitoring. Data collected during these elements primarily support monitoring questions 1.1.1, 1.2.1, 2.1.1, 2.2.1, 3.2.1, 3.2.2, 4.1.1, 5.1.1, 5.2.1, 5.3.1, 5.3.2, 6.3.1, but also contribute data to monitoring questions 6.1.1, 6.2.1, 8.1.1, 8.2.1, 8.4.1, 10.1.1, 10.1.2, 10.1.3 and 10.1.4. Table 5 below provides a summary of the variables to be measured in 2019 under the adult monitoring component and what objective the measure(s) supports. The text that follows in this section further describes the activities.

Table 5. Monitoring and Evaluation Plan (Hillman et al. 2017) objectives and the associated measured variables for the adult monitoring component.

Objective	Measured Variables *(Applicable Study Component(s))*
Objective 1: Determine if conservation programs have increased the number of naturally spawning and naturally produced adults of the target population and if the program has reduced the natural replacement rate (NRR) of the supplemented population.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)* • Number of hatchery and naturally produced fish taken for broodstock (*Broodstock Collection and Stock Assessment*) • Number of hatchery and naturally produced fish taken in harvest (if recruitment is to the Columbia) *(Harvest Reporting)*
Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.	• Number of hatchery and naturally produced fish on the spawning grounds (*Spawning Escapement Estimates*) • Number of redds *(Spawning Escapement Estimates)*
Objective 3: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)* • Number of hatchery and naturally produced fish harvested *(Harvest Reporting)*
Objective 4: Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.	• Number of hatchery and naturally produced fish on spawning grounds *(Spawning Escapement Estimates)*
Objective 5: Determine if the run timing, spawn timing, and spawning distribution of the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.	• Time (Julian date) of hatchery and naturally produced salmon carcasses or marked steelhead detected on spawning grounds within defined reaches *(Spawning Escapement Estimates)* • Time (Julian date) of arrival at mainstem projects and within tributaries (e.g., traps, PIT arrays) with

Objective	Measured Variables *(Applicable Study Component(s))*
	the intent to identify biologically significant differences *(Spawning Escapement Estimates)* • Location (GPS coordinates) of female salmon carcasses observed on spawning grounds *(Spawning Escapement Estimates)*
<u>Objective 6:</u> Determine if stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.	• Number of hatchery fish collected for broodstock (*Broodstock Collection and Stock Assessment*) • Number of hatchery fish taken in fishery (*Harvest Reporting*) • Locations of live and dead strays (used to tease out overshoot) *(Spawning Escapement Estimates)* • Number of hatchery carcasses (PIT-tagged and/or CWT) found in non-target and target spawning areas or number of returning spawners counted via PIT-tag detection or at weirs in close temporal proximity to spawning areas (stray data into the Entiat sub-basin will be obtained from USFWS Fisheries Resource Office-Leavenworth) *(Spawning Escapement Estimates)*
<u>Objective 8:</u> Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	• Total and salt (ocean) age and gender of hatchery and naturally produced salmon carcasses collected on spawning grounds *(Spawning Escapement Estimates)* • Whenever possible, age at maturity and sex ratio will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling or ultrasound on live fish) *(Spawning Escapement Estimates)* • Assess age of fish, including harvested fish *(Spawning Escapement Estimates and Harvest Reporting)*
<u>Objective 10:</u> Determine if appropriate harvest rates have been applied to conservation, safety-net, and segregated harvest programs to meet the HCP/SSSA goal of providing harvest opportunities while also contributing to population management and minimizing risk to natural populations.	• Numbers of hatchery fish taken in harvest *(Harvest Reporting)* • Numbers of natural-origin fish taken in harvest *(Harvest Reporting)*

4.1 Spawning Escapement Estimates

Chelan Summer/Fall Chinook

Chinook spawning ground surveys will be conducted in the Chelan River and (see Appendix A for survey reaches). Spawning ground surveys will be conducted via foot or raft beginning late September and continuing until spawning has ended (usually mid-November). Frequency of surveys will vary depending on method.

Summer Chinook carcass surveys will be conducted in the Chelan River beginning in September and ending in November consistent with methods described in Murdoch and Peven (2005). A representative sample (i.e., 20%) of spawners as determined by spawner abundance and distribution (typically 100% of the carcasses encountered in the Chelan River) will be sampled. Biological data will include collection of scale samples for age analysis, length measurements (POH and FKL), gender, egg voidance, and a check for tags or marks. DNA samples (five-hole punches from operculum) will be collected as needed to address different objectives. These data will be used to assess length-at-age, size-at-age, egg voidance, origin (hatchery or naturally produced), stray rates, and genetics. All carcass surveys will be conducted within the historical reaches.

Wenatchee Steelhead

The number of BY 2019 hatchery and naturally produced steelhead returning to the Wenatchee sub- basin will be estimated using a PIT tag mark recapture model. The estimated spawner abundance for the Wenatchee steelhead population will be a combination of PIT tag-based tributary and redd-based mainstem Wenatchee River estimates. Steelhead redd counts will be conducted weekly in all major spawning areas in the mainstem Wenatchee River (see Appendix A for survey reaches); minor spawning areas in the mainstem Wenatchee River will be surveyed once, based on the spawn timing in adjacent major spawning areas, to estimate redd abundance at peak spawning. The estimated total number of redds in the Wenatchee River mainstem will be expanded by the sex ratio of the population to estimate spawner abundance. Spawner abundance in tributaries of the Wenatchee River will be estimated using a PIT tag mark recapture model (Truscott et al. 2018).

For BY 2020 steelhead, methods used to estimate spawner abundance and distribution may need to be modified depending on new information. The Hatchery Committees will evaluate the new information and approve changes in methods if necessary.

Chiwawa Spring Chinook

Chiwawa spring Chinook spawning escapement will be estimated based on the total number of redds found in each tributary (Murdoch et al. 2010) using methods described in Murdoch and Peven (2005). Weekly redd and carcass surveys will be conducted simultaneously from the first week of August through September (see Appendix A
for survey reaches). Redd-based estimates assume that each female constructs one redd, which WDFW has found to be appropriate for this population (Murdoch et al. 2009). The total number of redds in each reach will be estimated using methods described in Millar et al. (2012) and using the observer efficiency model currently under development by WDFW. Redd counts will be expanded and the number of hatchery and naturally produced fish will be estimated using methods in Murdoch et al. (2010). Carcasses encountered during surveys will be sampled

according to methods outlined in Murdoch and Peven (2005). All CWTs (i.e., snout or adipose) from carcasses will be read and the data entered into the Regional Mark Processing Center database within one year of collection.

Additionally, all redds and female carcasses will be geo-referenced using hand-held GPS devices. Carcass recovery bias has been detected in the Chiwawa spring Chinook population (Murdoch et al. 2010) and if not corrected will bias estimates of hatchery and naturally produced fish on the spawning grounds. While it may be appropriate to correct for carcass recovery bias for some monitoring questions (e.g., 2.2), when comparisons to reference populations are made in monitoring questions 1.1.and 1.2, carcass bias will not be corrected because other monitoring programs have not corrected for a similar bias.

Wenatchee Summer Chinook

Wenatchee summer Chinook spawning ground counts will begin the first week in September and continue through the end of spawning in November (see Appendix A for survey reaches). Total census redd counts will be conducted by foot or raft depending on stream size, flow, and density of spawners within the stream reach (see Appendix A for survey reaches). All stream reaches will be surveyed once per week. Redd data will be collected using methods described in Murdoch and Peven (2005). Salmon carcass data collected during spawning ground surveys will be consistent with Murdoch and Peven (2005). All CWTs (i.e., snout or adipose) from carcasses will be sent to the WDFW lab in Olympia. The CWT lab will extract and read CWTs and submit all required information to RMIS within one year of collection.

4.2 Harvest Reporting

In years when the expected hatchery adult returns are in excess of the levels needed to meet the hatchery program goals (i.e., broodstock and/or escapement), surplus fish may be available for harvest. Harvesting or removal of surplus hatchery fish may have benefits to the natural populations by reducing potential negative ecological and genetic impacts (e.g., density dependent effects, loss of fitness, and loss of genetic variation). The contribution of hatchery fish to fisheries will be monitored using CWT recoveries on a brood-year basis supporting Objective 10.

To obtain the necessary data to determine if the harvest rates are meeting objectives, a statistically valid creel program will be designed and implemented for all sport and/or conservation fisheries in the Upper Columbia River to estimate harvest of hatchery fish from both Chelan and Grant County PUD funded hatchery programs (Murdoch and Peven 2005). Information collected during creel surveys are an integral component to calculating the HRR (Objective 3), particularly given most CWT recoveries for PUD mitigation programs occur in the Upper Columbia River and its tributaries, with the exception of summer Chinook where most CWT recoveries occur in ocean fisheries. Because of considerable time lags in reporting of CWT's to the Regional Marking Information System (RMIS) database, it requires an ongoing query of recovery data until the number of estimated fish does not change.

5. Data Management , Analysis, and Reporting

5.1 Data Management

A Microsoft Access database maintained by WDFW will contain all the monitoring data collected for hatchery evaluations. The database will contain and manage all data associated with aquaculture monitoring, juvenile monitoring, and adult monitoring.

All data entered into the database are evaluated for quality control and quality assurance by WDFW. Quality control checks using analyses such as modified Z-scores, boxplots, and the Generalized Extreme Studentized Deviate Procedure (Iglewicz and Hoaglin 1993) will be conducted for all data entry. In the event outliers are identified, discussion will occur on whether identified outliers are true data points or transcription errors. This process ensures that the data used to test statistical hypotheses are correct and accurate.

5.2 Data Analysis

The analyses proposed are consistent with the Monitoring and Evaluation Plan for PUD Hatchery Programs: 2017 Update (Hillman et al. 2017). Each of the objectives will be addressed using the appropriate statistical tests, as well as graphic analyses that convey relevant information.

5.3 Reporting

An annual M&E report will be generated following the completion of each calendar year and will be available for HCP-HC review by June 1 of the following year. Additionally, monthly progress reports will be made available to the HCP-HC.

6. Lake Wenatchee Sockeye Salmon

The Chelan PUD will conduct monitoring and evaluation (M&E) activities to track key population attributes related to Lake Wenatchee sockeye salmon in 2019(Table 6). In the absence of a sockeye hatchery program, M&E activities are no longer rooted in the context of evaluating the effects of sockeye salmon supplementation, but instead focus directly on the performance of the natural population, which is a unique departure from historic monitoring obligations. Broadly, the proposed M&E activities cover juvenile and adult life history stages and provide the data necessary to track or estimate viable salmonid population parameters (VSP): abundance, productivity, spatial structure and diversity (McElhaney et al. 2000). The data collected may also have utility in future hatchery compensation recalculation efforts.

Chelan PUD is conducting these M&E activities to support commitments made under the 2011 hatchery recalculation effort, which also included a steelhead production commitment for a sockeye species swap (SOA 2011). This section of the implementation plan describes the specific commitments by juvenile and adult life history stages.

6.1 Juvenile Monitoring

Chelan PUD will conduct or fund activities to monitor and evaluate the temporal distribution and age/size of out-migrating smolts, and estimate smolt production (Table 6). Smolt production will be estimated from data collected at the lower Wenatchee smolt trap and via back calculations based on collected adult return data (i.e., age-at-return estimates, SARs, and adult escapement to the tributaries). Collectively, these activities include: (1) funding of the lower Wenatchee River smolt trap concurrent with efforts aimed at evaluating Chelan PUD funded supplemented populations in the Wenatchee River sub-basin; (2) tagging up to 5,000 PIT tags for natural-origin juveniles encountered during smolt trapping activities and collecting scale samples at this location; and (3) estimating adult escapement estimates to the tributaries, and collection of adult return data at Tumwater (see the *Adult Monitoring* section for details) to back-calculate smolt production.

The monitoring data obtained will provide a useful set of tools for evaluating the performance of natural origin sockeye salmon within the sub-basin and downstream and also support the evaluation of VSP parameters [e.g., outmigration timing and size (diversity); and PIT tagging juveniles for SAR estimates (productivity)].

6.2 Adult Monitoring

Several M&E activities associated with adult returns of Lake Wenatchee sockeye salmon will be conducted and/or funded by Chelan PUD (Table 6). These efforts include (1) continuation of accurate adult counts at Rock Island, Rocky Reach, and Tumwater dams; (2) sampling of scales for age distribution, sex ratio determination, and returns of PIT-tagged adults at Tumwater Dam; (3) reach-specific conversion estimates between Rock Island Dam and spawning grounds in the White and Little Wenatchee rivers (i.e., Rock Island to Tumwater Dam to spawning tributaries); and (4) providing between 250 to 1,000 PIT tags to estimate adult spawning escapement in the Little Wenatchee and White rivers utilizing PIT tags and mark-recapture techniques (the software program Sample Size 2.0.7, developed by the University of Washington School of Aquatic and Fisheries Science (P. Westhagen, J. Lady, and J. Skalski) was used to determine the minimum number of tags required (i.e., 250) to estimate adult sockeye escapement at a +/- 7 percent confidence interval). Chelan PUD will adjust the number of PIT-tagged individuals in order to maintain precision in estimates at the lowest rate of interference to migrating populations, if it is warranted due to annual changes in escapement and detection probabilities. In an effort to PIT tag the run at large, adults will be PIT tagged at Tumwater consistent with the Tumwater Operations Protocol, daily throughout the run.

Collectively, these data will provide reliable metrics of adult returns and spawning escapement (abundance), recruits-per-spawner (productivity), distribution of spawners among tributaries (spatial structure), and run-timing and age structure for adult immigrants (diversity).

Table 6. Chelan PUD's proposed Lake Wenatchee sockeye salmon monitoring and evaluation activities.

Life History Stage	M&E Activity	Entity Performing the Activity	Related analysis	VSP parameter addressed
Juvenile	Concurrent operation of the lower Wenatchee smolt trap to collect juvenile outmigration data	WDFW	Generate distribution of outmigration timing, estimate smolt production and determine average smolt size.	Diversity and productivity
Juvenile	PIT tagging smolts at lower Wenatchee smolt trap (up to 5,000 fish annually) and collecting/aging scale samples	WDFW	Estimate smolt-to-adult returns.	Productivity
Juvenile	Develop adult return based smolt production estimates	WDFW	Use collected data (i.e., adult age-at-return data, SARs, adult escapement to the tributaries) to back-calculate smolt production.	Productivity
Adult	Rock Island and Rocky Reach Dam adult counts	CPUD	Initial spawner abundance (Okanogan stock separation)	Abundance and spatial structure
Adult	PIT tag subsample (250 adults) of returning adults at Tumwater Dam to support mark-recapture evaluation	WDFW	Calculate spawner abundance and relative distribution among ~~in~~ tributaries	Abundance and spatial structure
Adult	Collect and age scales[1] and determine sex via ultrasound from returning adults at Tumwater Dam	WDFW	Estimate age-at-return, sex ratio, and relative productivity of contributing spawner cohorts	Productivity and diversity
Adult	Tumwater Dam adult counts	WDFW	Estimate potential spawner abundance (pre-Lake-Wenatchee harvest), potential productivity (recruits/spawner), and run timing distribution	Abundance and diversity
Adult	Operate PIT detection arrays on Little Wenatchee and White River	WDFW	Calculate spawner abundance (post-Lake Wenatchee harvest and other mortality), actual productivity (recruits/spawner), and entry-to-spawning-habitat timing distribution, and spatial spawner distribution among tributaries	Abundance, productivity, spatial structure, and diversity
All	Data management, analysis, and reporting	BioAnalysts CPUD	------	NA

[1] Scales would be collected concurrently from adults that are PIT tagged at Tumwater Dam.

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Appendix A

Designated survey reaches for Methow subbasin summer Chinook spawning ground surveys.

River	Reach	Code	RM
Methow	Mouth to Methow Bridge	M1	0.0-14.78
	Methow Bridge to Carlton Bridge	M2	14.78-27.17
	Carlton Bridge to Twisp Bridge	M3	27.17-39.55
	Twisp Bridge to MVID	M4	39.55-44.85
	MVID to Winthrop Bridge	M5	44.85-49.80
	Winthrop Bridge to Hatchery Dam	M6	49.80-51.55

Designated survey reaches for Wenatchee River basin summer Chinook spawning grounds surveys. Asterisks denotes reaches where redd observer efficiency will be assessed.

Reach Code	Reach Section	River Mile
W10	Lake Wenatchee to Bridge	54.20-53.58
	Bridge to Swamp *	53.58-52.66
	Swamp to Chiwawa River	52.66-48.39
W9	Chiwawa River to Schugart Flats	48.39-47.93
	Schugart Flats to Old Plain Bridge	47.93-46.21
	Old Plain Bridge to RR Bridge	46.21-41.91
	RR Bridge to RR Tunnel	41.91-39.28
	RR Tunnel to Swing Pool *	39.28-36.67
	Swing Pool to Tumwater Br	36.67-35.55
W8	Tumwater Br to Swiftwater Campground *	35.55-33.50
	Swiftwater Campground to Unimproved Campground	33.50-33.08
	Unimproved Campground to Tumwater Dam	33.08-30.91
W7	Tumwater Dam to Penstock Br	30.91-28.66
	Penstock Br to Icicle Road Br *	28.66-26.43
W6	Icicle Road Br to Icicle Mouth	26.43-25.61
	Icicle Mouth to Boat Takeout *	25.61-24.49
	Boat Takeout to Leavenworth Br	24.49-23.90
W5	Leavenworth Br to Irrigation Flume *	23.90-22.77
	Irrigation Flume to Peshastin Br	22.77-20.00
W4	Peshastin Br to Dryden Dam *	20.00-17.76
W3	Dryden Dam to Williams Canyon	17.76-15.54
	Williams Canyon to Upper Cashmere Br	15.54-10.22
	Upper Cashmere Br to Lower Cashmere Br	10.22-9.49
W2	Lower Cashmere Br to Old Monitor Br *	9.49-7.12
	Old Monitor Br to Sleepy Hollow Br	7.12-3.27
W1	Sleepy Hollow Br to River Bend *	3.27-1.73
	River Bend to Siphon	1.73-1.29
	Siphon to Mouth	1.29-0.45

Designated survey reaches for Wenatchee Basin spring Chinook spawning grounds surveys.

Reach Code	Reach Section	River Mile
Chiwawa River and Tributaries (Rock and Chikamin)		
C7	Buck Cr to Phelps Cr	36.39-33.46
C6	Phelps Cr (Trinity) to Maple Cr Br	33.46-29.64
C5	Maple Cr Br to Atkinson Flats	29.64-26.59
C4	Atkinson Flats to Schaefer Cr	26.59-24.24
C3	Schaefer Cr to Rock Cr Campground	24.24-22.97
R1 - Rock	Mouth to Chiwawa River Road Bridge	0.00-1.05
C2	Rock Cr Campground to Grouse Cr	22.97-12.27
K1 - Chikamin	Mouth to Chiwawa River Road Bridge	0.00-0.68
C1	Grouse Cr to Mouth	12.27-0.00
Nason Creek		
N4	White Pine Creek to Lower R.R. Bridge	16.09-13.68
N3	Lower R.R. Bridge to Hwy 2 Bridge	13.68-9.13
N2	Hwy 2 Bridge to Kahler Cr	9.13-4.46
N1	Kahler Cr to Mouth	4.46-0.00
White River and Tributaries (Panther and Napeaqua)		
H4	Falls to Grasshopper Meadows	21.16-19.78
T1 - Panther	Boulder field to Mouth	0.43-0.00
H3	Grasshopper Meadows to Napeaqua River	19.78-17.59
Q1 - Napeaqua	Take out to Mouth	0.91-0.00
H2	Napeequa River to Sears Cr Bridge	17.59-11.97
H1	Sears Cr Bridge to Mouth	11.97-0.00
Little Wenatchee River		
L3	Rainy Cr to Lost Cr	10.78-6.74
L2	Lost Cr to Old Fish Weir	6.74-2.13
L1	Old Fish Weir to Mouth	2.13-0.00
Upper Wenatchee River		
W10	Lake Wenatchee to Chiwawa River	54.20-48.39
Chiwaukum Creek		
U1	Metal bridge to Mouth	1.0 – 0.0
Icicle River		
I1	Hatchery to Mouth	3.02-0.00
Peshastin Creek and Tributaries (Ingalls Creek)		
D1 - Ingalls	Trailhead to mouth	0.64-0.00
P2	Ingalls Creek to Camas Cr	9.14-5.63
P1	Camas Cr to Mouth	5.63-0.00

Designated survey reaches for Wenatchee River basin steelhead spawning grounds surveys. Asterisks denote index reaches. Spawning escapements in tributaries will be estimates using PIT-tag arrays.

Reach Code	Reach Section	River Mile
W10	Lake Wenatchee to Chiwawa River*	54.20-48.39
W9	Chiwawa River to Tumwater Bridge*	48.39-35.55
W8	Tumwater Br to Swiftwater Campground	35.55-33.50
	Swiftwater Campground to Unimproved Campground*	33.50-33.08
	Unimproved Campground to Tumwater Dam	33.08-30.91
W7	Tumwater Dam to Icicle Road Bridge	30.91-26.43
W6	Icicle Road Br to Leavenworth boat ramp*	26.43-24.49
	Boat Takeout to Leavenworth Bridge	24.49-23.90
W5	Leavenworth Bridge to Peshastin Bridge	23.90-20.00
W4	Peshastin Bridge to Dryden Dam	20.00-17.76
W3	Dryden Dam to Lower Cashmere Bridge	17.76-9.49
W2	Lower Cashmere Bridge to Sleepy Hollow Bridge *	9.49-3.27
W1	Sleepy Hollow Bridge to Mouth	3.27-0.45

Tributary	River mile of PIT tag array
Mission Creek	0.54
Peshastin Creek	1.91
Chumstick Creek	0.31
Icicle River	0.26
Chiwaukum Creek	0.24
Chiwawa River	0.58
Nason Creek	0.52
Little Wenatchee River	1.74
White River	1.65

Appendix M
Rocky Reach and Rock Island HCPs Final 2018 Fish Spill Report

Chelan PUD
Rocky Reach and Rock Island HCPs
Final 2018 Fish Spill Report

2018 ROCKY REACH

Summer Spill

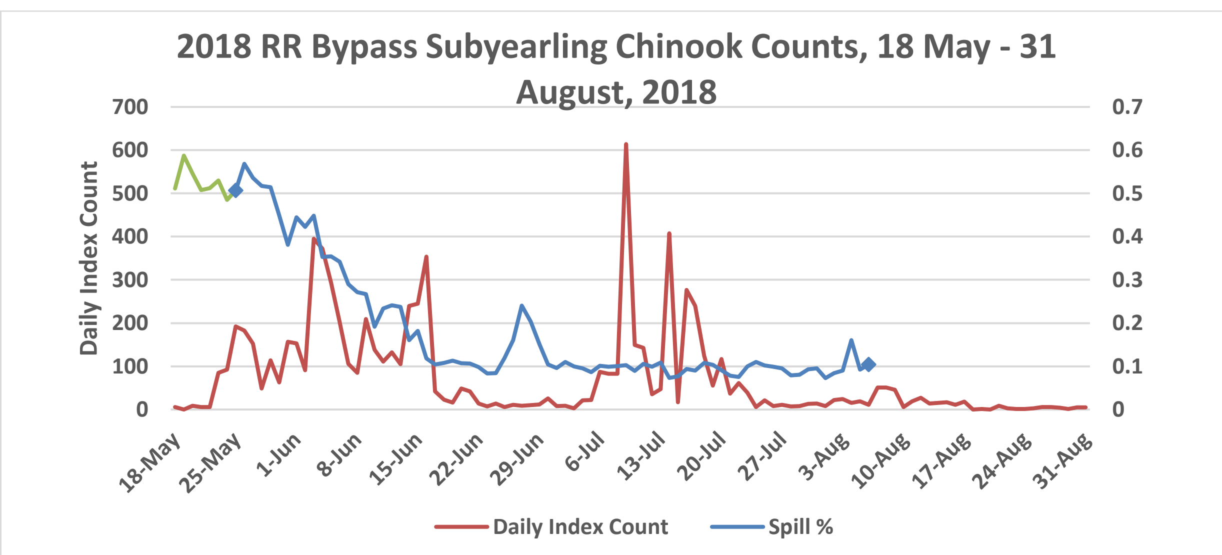
Declared Summer Fish Spill (25 May – 6 August)

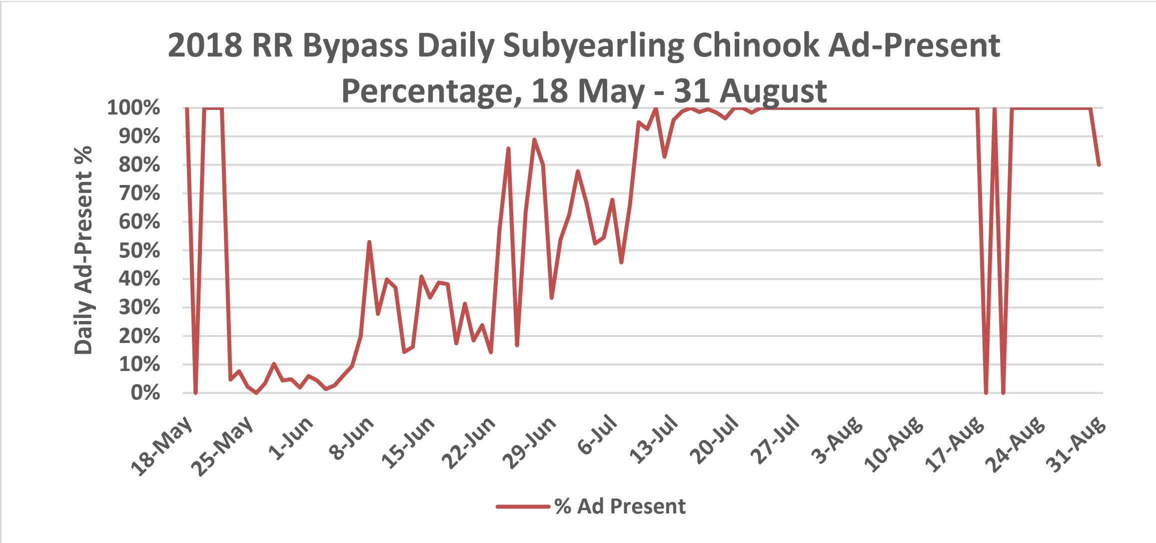
Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	25 May, 0001 hours
Spill stop date:	6 August, 2400 hours
95% Est. passage date:	28 July
Percent of run with spill:	94.1% (25 May – 6 August; ***blue*** *spill % line only*)
Cumulative index count:	9,122 subyearling Chinook (18 May - 31 August)
Summer spill percentage*:	22.29% (9.14% fish spill, plus 13.15% forced spill)
Avg river flow at RR:	154,663 cfs (25 May - 6 August)
Avg spill rate at RR:	34,471 cfs (25 May - 6 August)
Total spill days:	74

All Spill (18 – 24 May: Forced spill only/25 May – 6 August: Forced and Fish Spill)

Target species:	Subyearling Chinook
Spill start date:	18 May, 0001 hours (*Arrival date of first subyearling Chinook*)
Spill stop date:	6 August, 2400 hours
95% Est. passage date:	28 July
Percent of run with spill:	96.5% (18 May – 6 August; *combined* ***green/blue*** *spill % line*)
Cumulative index count:	9,122 subyearling Chinook (18 May - 31 August)
Summer spill percentage#:	27.17%
Avg river flow at RR:	168,200 cfs (18 May - 6 August)
Avg spill rate at RR:	45,706 cfs (18 May - 6 August)
Total spill days:	81

*During declared summer fish spill only. #Before and during declared summer fish spill.

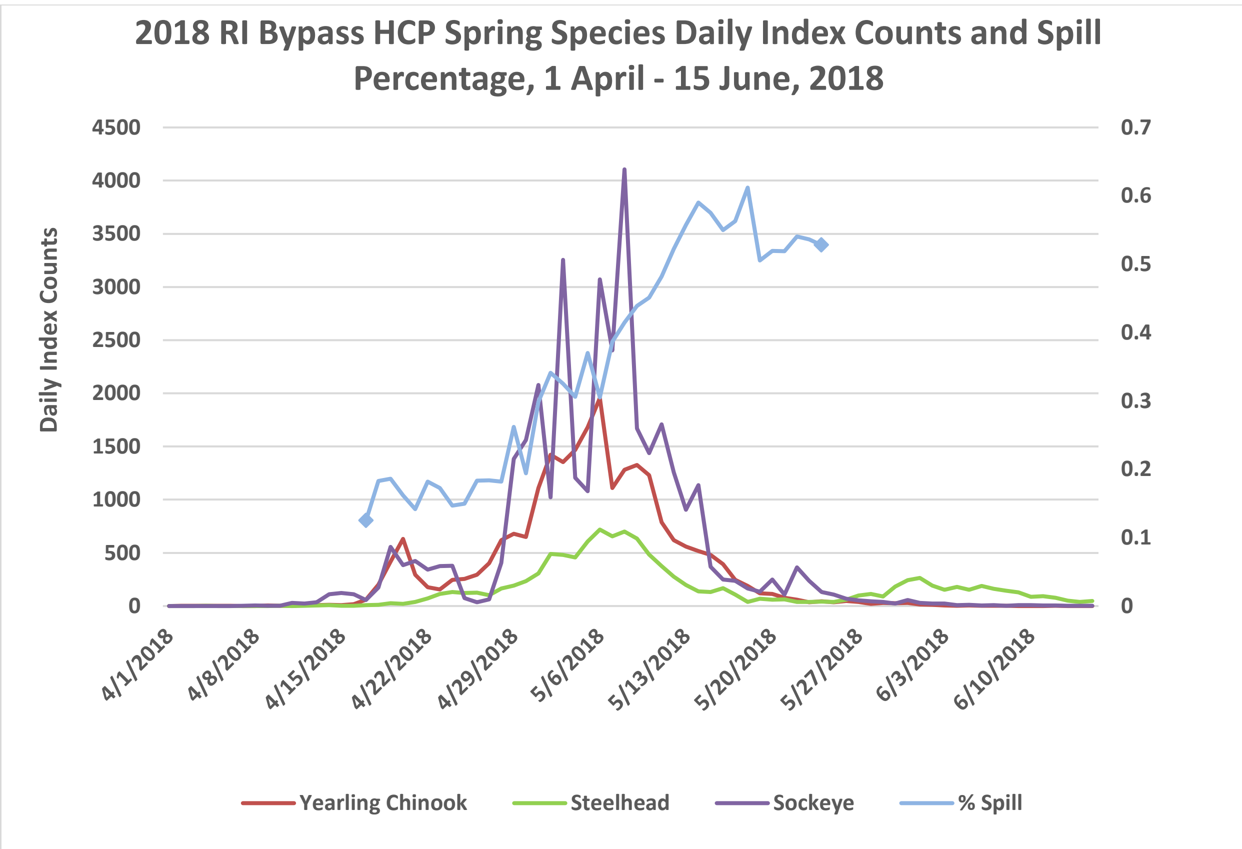



2018 RR Bypass Daily Subyearling Chinook Ad-Present Percentage, 18 May - 31 August
Daily Ad-Present %
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
18-May
25-May
1-Jun
8-Jun
15-Jun
22-Jun
29-Jun
6-Jul
13-Jul
20-Jul
27-Jul
3-Aug
10-Aug
17-Aug
24-Aug
31-Aug
% Ad Present

2018 ROCK ISLAND

Spring Spill

Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	17 April, 0001 hours
Spill stop date:	24 May, 2400 hours (*immediate increase to 20% summer spill at 0001 hours on 25 May*)
Percent of run with spill:	Yearling Chinook – 99.8%; steelhead – 99.9%; sockeye – 99.2% (*spring and summer fish spill combined*)
Cumulative index count:	49,702 yearling Chinook**;** 24,731 steelhead**;** 76,245 sockeye (as of 31 August)
Spring spill percentage:	40.44% (9.76% fish spill, plus 30.68% forced spill)
Avg river flow at RI:	248,592 cfs (17 April – 24 May)
Avg spill flow at RI:	100,524 cfs (17 April – 24 May)
Total spill days:	38



2018 ROCK ISLAND

Summer Spill

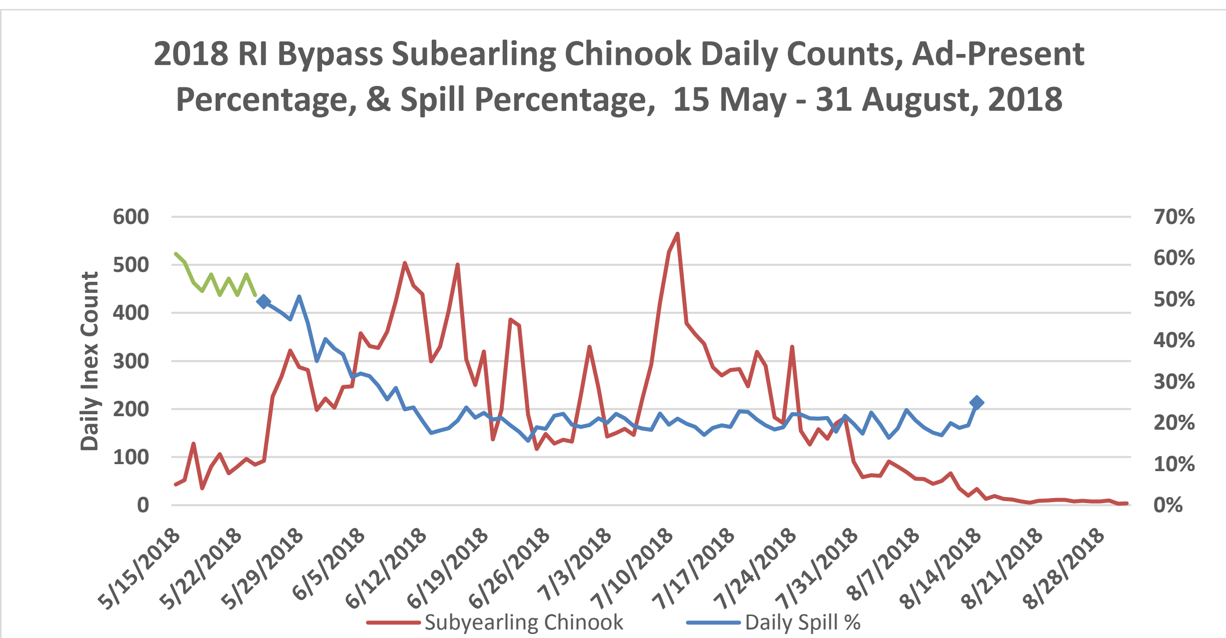
Declared Summer Fish Spill (25 May – 14 August)

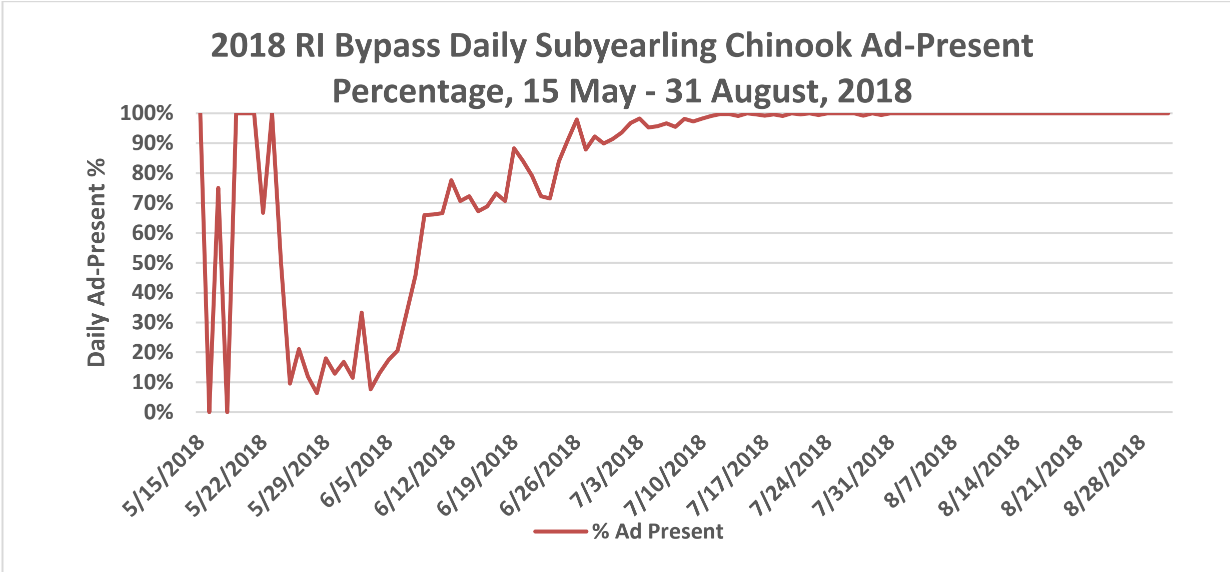
Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	25 May, 0001 hours
Spill stop date:	14 August, 2400 hours
95% Est. passage date:	31 July
Percent of run with spill:	99.3% (25 May – 14 August; ***blue*** *spill % line only)*
Cumulative index count:	27,540 subyearling Chinook (1 June - 31 August)
Summer spill percentage*:	26.00% (19.86% fish spill, plus 6.14% forced spill)
Avg river flow at RI:	153,685 cfs (25 May - 14 August)
Avg spill flow at RI:	39,964 cfs (25 May - 14 August)
Total spill days:	82

All Spill (15 – 24 May: Forced and Spring Fish Spill/25 May – 14 August: Forced and Summer Fish Spill)

Target species:	Subyearling Chinook
Spill start date:	15 May, 0001 hours (*Arrival date of first subyearling Chinook*)
Spill stop date:	14 August, 2400 hours
95% Est. passage date:	31 July
Percent of run with spill:	99.4% (15 May – 14 August; *combined* ***green/blue*** *spill % line*)
Cumulative index count:	34,038 subyearling Chinook (15 May - 31 August)
Summer spill percentage#:	31.88%
Avg river flow at RR:	172,561 cfs (15 May - 14 August)
Avg spill rate at RR:	55,020 cfs (15 May - 14 August)
Total spill days:	92

*During declared summer fish spill only. #During declared spring and summer fish spill.




2018 RI Bypass Daily Subyearling Chinook Ad-Present Percentage, 15 May - 31 August, 2018
Daily Ad-Present %
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
5/15/2018
5/22/2018
5/29/2018
6/5/2018
6/12/2018
6/19/2018
6/26/2018
7/3/2018
7/10/2018
7/17/2018
7/24/2018
7/31/2018
8/7/2018
8/14/2018
8/21/2018
8/28/2018
% Ad Present

Juvenile Index Counts 2008-2018 from the Rocky Reach Juvenile Fish Bypass Sampling Facility and Rock Island Bypass Trap Smolt Monitoring Program (SMP) 1 April – 31 August (Tables 1 and 2).

Table 1. Rocky Reach Juvenile Bypass index sample counts, 2008-2018

Species	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014***	**2015**	**2016**	**2017**	**2018**
Sockeye	136,206	40,758	724,394	67,879	384,224	199,497	553,645	53,575	1,374,418	**60,432**	**597,162**
Steelhead	8,721	6,309	4,931	5,683	4,902	2,528	5,270	4,157	1,478	**2,928**	**1,458**
Yearling Chinook	38,394	18,946	33,840	24,400	95,207	29,018	15,871	32,220	41,676	**37,302**	**23,274**
Subyearling Chinook	11,820	11,944	59,751	17,246	5,774	22,073	22,327	37,104	8,905	**27,404**	**9,122**

Table 2. Rock Island Smolt Monitoring Program index sample counts, 2008-2018

Species	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014***	**2015**	**2016**	**2017**	**2018**
Sockeye	38,965	4,926	37,404	18,697	46,788	25,111	38,596	4,128	56,638	**11,117**	**76,245**
Steelhead	22,780	17,636	17,194	28,408	16,957	15,099	28,299	12,549	17,663	**32,135**	**24,731**
Yearling Chinook	22,562	9,225	11,802	26,407	25,759	28,324	26,429	16,762	44,784	**50,604**	**49,702**
Subyearling Chinook	15,940	8,189	23,205	27,397	27,298	17,170	34,527	15,349	13,270	**63,579**	**27,540**

* In 2014, as directed by the HCP, Chelan PUD conducted bypass operations outside of the normal operating period of 1 April to 31 August to assess achievement of bypass operations for 95% of the subyearling Chinook outmigration. The Rocky Reach juvenile fish bypass operated from 1 April through 15 September, and the Rock Island bypass facility at powerhouse 2 operated from 1 April through 15 September.

Appendix N
Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs 2017 Annual Report

MONITORING AND EVALUATION OF THE CHELAN AND GRANT COUNTY PUDs HATCHERY PROGRAMS

2017 ANNUAL REPORT

September 15, 2018

Prepared by:

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Prepared for:
HCP Hatchery Committees and the PRCC Hatchery Sub-Committee
Wenatchee and Ephrata, WA

Citation: Hillman, T., M. Miller, M. Johnson, M. Hughes, C. Moran, J. Williams, M. Tonseth, C. Willard, S. Hopkins, B. Ishida, C. Kamphaus, T. Pearsons, and P. Graf. 2018. Monitoring and evaluation of the Chelan and Grant County PUDs hatchery programs: 2017 annual report. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, WA.

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PREFACE

This annual report is the result of coordinated field efforts conducted by Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation), Chelan County Public Utility District (Chelan PUD), the Confederated Tribes of the Colville Reservation (Colville Tribes), the U.S. Fish and Wildlife Service (USFWS), and BioAnalysts, Inc. An extensive amount of work was conducted in 2006 through 2017 to collect the data needed to monitor the effects of the Chelan and Grant County PUD Hatchery Programs. This work was directed and coordinated by the Habitat Conservation Plans (HCP) Hatchery Committees, consisting of the following members: Matt Cooper and Bill Gale, USFWS; Brett Farman, National Marine Fisheries Service (NMFS); Catherine Willard, Chelan PUD; Keely Murdoch and Tom Scribner, the Yakama Nation; Mike Tonseth, WDFW; Kirk Truscott, Colville Tribes; and Tracy Hillman, BioAnalysts (Chair). This report also includes monitoring efforts funded by Grant County Public Utility District (Grant PUD). Grant PUD funds the Nason and White spring Chinook and Methow summer Chinook monitoring programs as well as co-funds the Wenatchee Summer Chinook program. Work funded by Grant PUD was directed and coordinated by the Priest Rapids Coordinating Committee (PRCC) Hatchery Sub-Committee, which consists of the same agency and tribal representatives listed for the HCP Hatchery Committee and replaces Chelan PUD representatives with Grant PUD representatives, Todd Pearsons, Peter Graf, and Deanne Pavlik-Kunkel.

The approach to monitoring the hatchery programs was guided by the updated monitoring and evaluation plan for PUD hatchery programs (Hillman et al. 2017). Technical aspects of the updated monitoring and evaluation program were developed by the Hatchery Evaluation Technical Team (HETT), which consisted of the following scientists: Matt Cooper, USFWS; Tracy Hillman, BioAnalysts; McLain Johnson, WDFW; Tom Kahler, Douglas PUD; Greg Mackey, Douglas PUD; Andrew Murdoch, WDFW; Keely Murdoch, Yakama Nation; Todd Pearsons, Grant PUD; Mike Tonseth, WDFW; and Catherine Willard, Chelan PUD. The updated plan also directs the analyses of hypotheses developed by the HETT. Most of the analyses outlined in the updated plan will be conducted in the comprehensive reports.

Chelan and Grant PUDs funded most of the work reported in this document. Bonneville Power Administration purchased some of the Passive Integrated Transponder (PIT) tags that were used to mark juvenile Chinook and steelhead captured in tributaries and helped fund a portion of the screw trap efforts in Nason Creek. We thank Charlie Paulsen for analyzing PIT-tag data for each program. This is the 12th annual report written under the direction of the HCP.

"I often say that when you can measure something and express it in numbers, you know something about it. When you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science, whatever it may be."

Lord Kelvin

SECTION 1: INTRODUCTION

Chelan and Grant PUDs implement hatchery programs as part of their respective agreements related to the operation of Rocky Reach, Rock Island, Wanapum, and Priest Rapids Hydroelectric Projects. The fish resource management agencies developed the following general goal statements for the hatchery programs, which were adopted by the HCP Hatchery Committees and PRCC Hatchery Sub-Committee (hereafter, Hatchery Committees):

1. *Support the recovery of ESA-listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.*

    Includes the Wenatchee spring Chinook, Wenatchee summer steelhead, and Methow spring Chinook programs.

2. *Increase the abundance of the natural adult population of unlisted plan species, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity. In addition, provide harvest opportunities in years when spawning escapement is sufficient to support harvest.*

    Includes the Wenatchee sockeye, Wenatchee summer/fall Chinook, Methow summer/fall Chinook, Okanogan summer/fall Chinook, and Okanogan sockeye programs.

3. *Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural tributary spawning populations.*

    Includes the Chelan Falls summer Chinook program.

Following the development of the Hatchery and Genetic Management Plans (HGMPs), artificial propagation programs are now characterized into three categories. The first type, integrated conservation programs, are intended to support or restore natural populations. These programs focus on increasing the natural production of targeted fish populations. A fundamental assumption of this strategy is that adults spawned in the hatchery will produce more adult offspring than if they were left to spawn in the river and ultimately provide a demographic boost to the natural population. The second type, safety-net programs, are extensions of conservation programs, but are intended to function as reserve capacity for conservation programs in years of low returns. The safety-net provides a demographic and genetic reserve for the natural population. That is, in years of abundant returns, they function like segregated programs, and in years of low returns, they can be managed as conservation programs. Lastly, harvest augmentation programs are intended to increase harvest opportunities while limiting interactions with wild-origin counterparts.

Monitoring is needed to determine if the hatchery programs are meeting the intended management objectives of conservation, safety-net, or harvest augmentation programs. Objectives for hatchery programs are generally grouped into three categories of performance indicators:

1. In-Hatchery Indicators: Are the programs meeting the hatchery production objectives?

2. In-Nature Indicators: How do hatchery fish from the programs perform after release?

a. Conservation Programs:
   - How do the programs affect target population abundance and productivity?
   - How do the programs affect target population long-term fitness?

b. Safety-Net Programs:
   - How do the programs affect target population long-term fitness?

c. Harvest Augmentation Programs:
   - Do the programs provide harvest opportunities?

3. Risk Assessment Indicators: Do the programs pose risks to other populations?

The specific objectives identified in the updated monitoring and evaluation plan are as follows:

1. *Determine if conservation programs have increased the number of naturally spawning and naturally produced adults of the target population and if the program has reduced the natural replacement rate (NRR) of the supplemented population.*
2. *Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.*
3. *Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and the target hatchery survival rate.*
4. *Determine if the proportion of hatchery-origin spawners (pHOS or PNI) is meeting management target.*
5. *Determine if the run timing, spawn timing, and spawning distribution of both the hatchery component is similar to the natural component of the target population or is meeting program-specific objectives.*
6. *Determine if stray rate of hatchery fish is below the acceptable levels to maintain genetic variation among stocks.*
7. *Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program.*
8. *Determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.*
9. *Determine if hatchery fish were released at the programmed size and number.*
10. *Determine if appropriate harvest rates have been applied to conservation, safety-net, and segregated harvest programs to meet the HCP/SSSA goal of providing harvest opportunities while also contributing to population management and minimizing risk to natural populations*

Two additional regional objectives that were not explicit in the goals specified above but were included in the updated monitoring and evaluation plan because they relate to goals and concerns of all artificial production programs include:

11. *Determine if the incidence of disease has increased in the natural and hatchery populations.*
12. *Determine if the release of hatchery fish affects non-target taxa of concern (NTTOC) within acceptable limits.*

Objective 12 was completed using an extensive risk assessment that concluded risks from the PUD hatchery programs were within containment objectives approved by the Hatchery Committees (Pearsons et al. 2012; Mackey et al. 2014).

Objectives in the updated plan have been organized in a hierarchy where productivity indicators are the primary metrics used to assess if conservation and safety-net program goals have been met; harvest rates and effects on non-targeted populations are used for harvest programs. In cases where productivity indicators are not available, or results are equivocal, monitoring indicators may be used to help evaluate the performance of the program. Evaluations of monitoring indicators may not provide sufficiently powerful conclusions on which to base management actions; although they may provide insight as to why a productivity indicator did or did not meet the program goal. Therefore, the relationship between hatchery programs and indicators can be viewed in a chain-of-causation: management actions within the hatchery programs affect the status of monitoring indicators, which in turn influence productivity indicators (Figure 1.1).

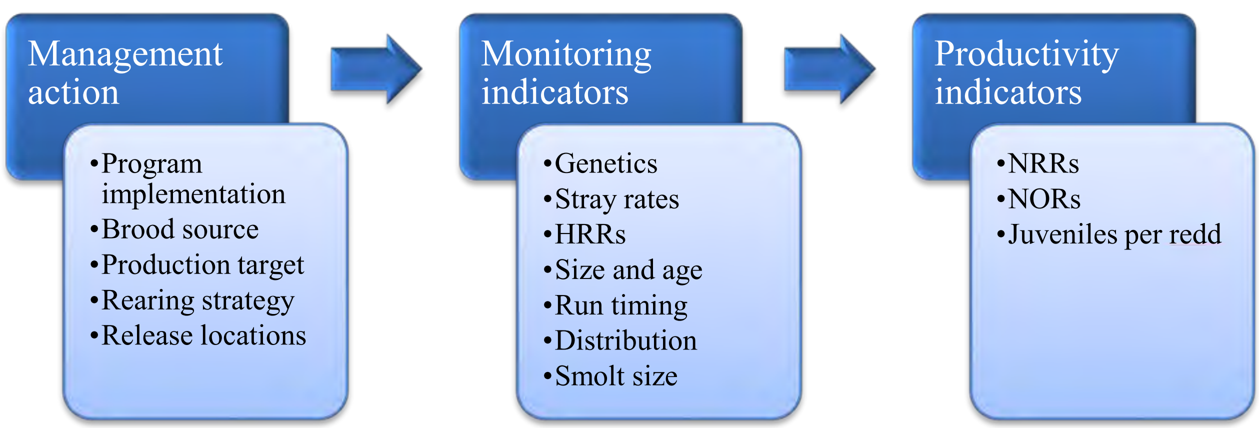


Figure 1.1. Relationship of indicators to the assessment of propagation programs. Management actions affect monitoring indicators, which influence productivity indicators. Monitoring indicators may be used to hypothesize the magnitude of influence on productivity.

Attending each objective is one or more testable hypotheses (see Hillman et al. 2017). Each hypothesis will be tested statistically following the routines identified in the updated monitoring and evaluation plan. Most of these analytical routines will be conducted at the end of five-year monitoring blocks, as outlined in the updated plan.

Both monitoring and productivity indicators will be used to evaluate the success of the hatchery programs. If the statistical power of tests that involve productivity indicators is insufficient to inform sound management decisions, some of the monitoring indicators may be used to guide management. Figure 1.2 shows the categories of indicators associated with each component of monitoring.

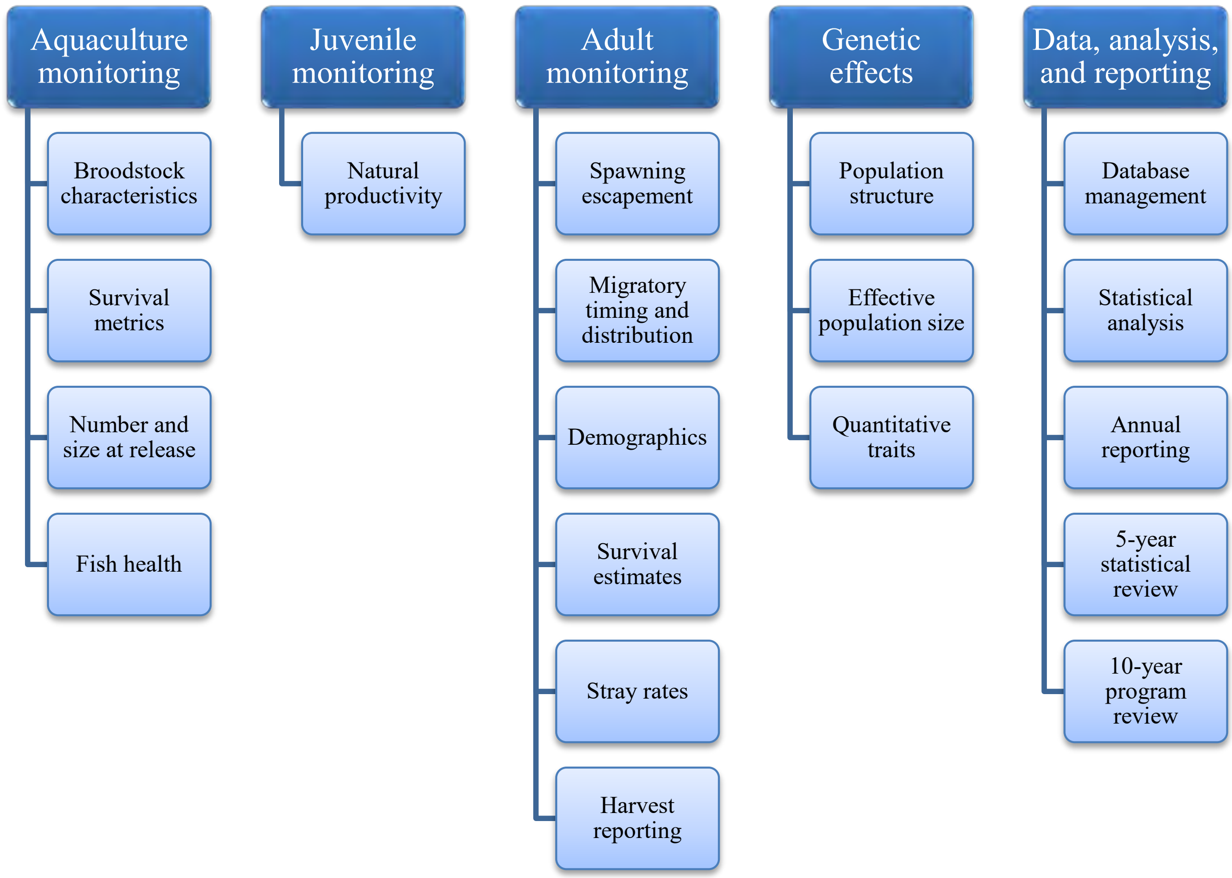


Figure 1.2. Overview of monitoring and evaluation plan categories and components (not including regional objectives).

Throughout each five-year, statistical, monitoring period, annual reports will be generated that describe the monitoring and evaluation data collected during a specific year. This is the 12th annual report developed under the direction of the Hatchery Committees. The purpose of this report is to describe monitoring activities conducted in 2017. Activities included broodstock collection, collection of life-history information, within hatchery spawning and rearing activities, juvenile monitoring within streams, and redd and carcass surveys. Data from reference areas are not included in this annual report (reference data are in the five-year reports). To the extent currently possible, we have included information collected before 2017.

This report is divided into several sections, each representing a different species, stock, or spawning aggregate (i.e., steelhead, sockeye salmon, spring Chinook salmon, and summer Chinook salmon). For all species, we provide annual broodstock information; hatchery rearing history, release data, and survival estimates; disease information; juvenile migration and productivity estimates; redd counts, distribution, and spawn timing; spawning escapements; and life-history characteristics. For salmon species, we also provide information on carcasses. Brood year 2011 was the final sockeye salmon hatchery release, and beginning in 2013, only natural adult and juvenile sockeye productivity monitoring results are reported. Beginning in 2013, we added a separate section on Nason Creek spring Chinook salmon and in 2014 we added a separate section on White River spring Chinook salmon. The Colville Tribes began conducting monitoring of

Okanogan summer Chinook in 2013; however, we retained the Okanogan summer Chinook section in this report because the PUDs have summer Chinook mitigation obligations in the Okanogan River basin. The Okanogan summer Chinook section includes monitoring information up to the return of brood year 2013 Chinook. Monitoring results for brood years 2013 to present can be found in annual reports prepared by the Colville Tribes to Bonneville Power Administration (BPA). Monitoring results of Grant PUD's fall Chinook salmon mitigation produced at Priest Rapids Hatchery can be found in annual reports written by WDFW and Grant PUD.

Finally, we end each section by addressing compliance issues with ESA/HCP mandates. For each Hatchery Program, WDFW and the PUDs are authorized annual take of ESA-listed spring Chinook and steelhead through Section 10 of the Endangered Species Act (ESA), including:

1. ESA Section 10(a)(1)(A) Permit No. 1395, which authorizes the annual take of adult and juvenile endangered upper Columbia River (UCR) spring Chinook and endangered UCR steelhead associated with implementing artificial propagation programs for the enhancement of UCR steelhead. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, monitoring and evaluation activities, and management of adult returns related to UCR steelhead artificial propagation programs in the UCR region (NMFS 2003a).
2. ESA Section 10(a)(1)(A) Amended Permit No. 18121, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and endangered UCR steelhead associated with implementing artificial propagation programs in the Chiwawa River for the enhancement of UCR spring Chinook. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities supporting UCR spring Chinook artificial propagation programs in the UCR region (NMFS 2003, amended in 2015).
3. ESA Section 10(a)(1)(A) Permit No. 18118, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and endangered UCR steelhead associated with implementing artificial propagation programs in Nason Creek for the enhancement of UCR spring Chinook. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities supporting UCR spring Chinook artificial propagation programs in the UCR region (NMFS 2003, amended in 2015).
4. ESA Section 10(a)(1)(A) Permit No. 18119, which authorizes the annual take of adult and juvenile endangered UCR spring Chinook and endangered UCR steelhead associated with implementing artificial propagation programs in the White River for the enhancement of UCR spring Chinook. The authorization includes takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities supporting UCR spring Chinook artificial propagation programs in the UCR region (NMFS 2003, amended in 2015).
5. ESA Section 10(a)(1)(A) Permit No. 1347, which authorizes the annual incidental take of adult and juvenile endangered UCR spring Chinook and endangered UCR steelhead through actions associated with implementing artificial propagation programs for the enhancement of non-listed anadromous fish populations in the UCR. The authorization includes incidental takes associated with adult broodstock collection, hatchery operations, juvenile fish releases, and monitoring and evaluation activities associated with non-listed

summer Chinook, fall Chinook, and sockeye salmon artificial propagation programs in the UCR region (NMFS 2003b).

These permits are relevant for the brood years included in this report.

SECTION 2: SUMMARY OF METHODS

Sampling in 2017 followed the methods and protocols described in Hillman et al. (2017). In this section, we only briefly review the methods and protocols. More detailed information can be found in the updated monitoring and evaluation plan (Hillman et al. 2017).

2.1 Broodstock Collection and Sampling

Methods for collecting broodstock are described in the Annual Broodstock Collection Protocols (WDFW 2017). Generally, broodstock were collected over the migration period (to the extent allowed in ESA-permit provisions) in proportion to their temporal occurrence at collection sites, with in-season adjustments dictated by 2017 run timing and trapping success relative to achieving weekly and annual collection objectives. Pre-season weekly collection objectives are shown in Table 2.1 and assumptions associated with broodstock trapping are provided in Table 2.2.

Table 2.1. Weekly collection objectives for steelhead and Chinook in 2017.

Collection week beginning day	Chiwawa/Nason Spring Chinook[a]		Hatchery Chelan Falls Summer Chinook	Wild Wenatchee Summer Chinook	Wild Methow Summer Chinook	Wenatchee Steelhead	
	Hatchery	Wild				Hatchery	Wild
29 May	10	10					
5 June	18	12					
12 June	22	14					
19 June	28	18					
26 June	18	12		80			
3 Jul	10	7	80	64	14	1	1
10 Jul	2	4	70	32	22	1	1
17 Jul			64	30	24	1	2
24 Jul			64	20	20	1	2
31 Jul			50	18	12	2	4
7 Aug			30	10	8	2	4
14 Aug				8	6	2	4
21 Aug					4	4	4
28 Aug					4	4	4
4 Sep					2	6	4
11 Sep					2	6	6
18 Sep						7	8
25 Sep						7	8
2 Oct						10	8
9 Oct						10	4
16 Oct						3	4
23 Oct						3	2
Total	**108**	**152**	**358**	**262**	**118**	**70**	70

[a] Chiwawa NOR spring Chinook (n = up to 74) were collected from the Chiwawa Weir with no specific weekly objectives generated, which is consistent with the Broodstock Collection Protocols. Previously PIT-tagged Chiwawa NOR spring Chinook were also targeted at Tumwater Dam. All Nason Creek spring Chinook were collected at Tumwater Dam from the week of 1 June

through the week of 15 July proportionate to run timing. For 2016, HOR Chiwawa spring Chinook were collected for the Nason spring Chinook safety net program.

Table 2.2. Biological and trapping assumptions associated with collecting broodstock for the Chelan and Grant PUD Hatchery Programs, 2017.[1]

Assumptions	Wenatchee Steelhead	Chiwawa Spring Chinook	Nason Spring Chinook		Wenatchee Summer Chinook	Chelan Falls Summer Chinook	Methow Summer Chinook
			Conservation Program	Safety Net Program			
Production level	247,300 yearling smolts	144,026 yearling smolts	125,000 yearling smolts	98,670 yearling smolts	500,001 yearling smolts	576,000 yearling smolts	200,000 yearling smolts
Broodstock required	140 adults (not to exceed 33% of population)	74 adults (not to exceed 33% of NOR population)	77 adults (not to exceed 33% of population)	68 adults	262 adults (not to exceed 33% of the population)	358 adults	118 adults (not to exceed 33% of the population)
Trapping period	1 July-14 Nov	1 June – 15 July (Tumwater) 1 June-15 Aug (Chiwawa Weir)	1 June – 15 July	1 June – 15 July	27 June – 15 Sept (Dryden) 15 July- 15 Sept (Tumwater)	1 July – 15 Sep	1 July – 15 Sept
# days/week	5	7 (Tumwater) Not to exceed 15 cumulative trapping days (Chiwawa Weir)	7	7	7 (Dryden) 2 (Tumwater)	7	3
# hours/day	24	24 (Tumwater) 24 up/24 down (Chiwawa Weir)	24	24	24	24	16
Broodstock composition	50% WxW; 50% HxH	100% WxW	100% WxW	100% HxH	100% WxW	100% HxH	100% WxW
Trapping site	Dryden Dam for HxH; Tumwater for WxW. (Tumwater will be used if weekly quota not achieved for WxW (hatchery) at Dryden Dam)	Tumwater Dam and Chiwawa Weir	Tumwater Dam	Tumwater Dam	Dryden Dam (Tumwater will be used if weekly quota not achieved at Dryden Dam)	Chelan River Water Conveyance Canal Trap	Wells Dam east or west ladder

Several biological parameters were measured during broodstock collection at adult collection sites. Those parameters included the date and start and stop time of trapping; number of each species

[1] Throughout this document, "HxH" refers to hatchery-origin by hatchery-origin crosses and "WxW" refers to natural-origin by natural-origin crosses.

collected for broodstock; origin, size, and sex of trapped fish; age from scale analysis; and pre-spawn mortality. For each species, trap efficiency, extraction rate, and trap operation effectiveness were estimated following procedures in Hillman et al. (2017). In addition, a representative sample of most species trapped but not taken for broodstock were sampled for origin, sex, age, and size (stock assessment).

2.2 Within Hatchery Monitoring

Methods for monitoring hatchery activities are described in Hillman et al. (2017). Biological information collected from all spawned adult fish included age at maturity, length at maturity, spawn time, and fecundity of females. In addition, all fish were checked for tags and females were sampled for pathogens.

Throughout the rearing period in the hatchery, fish were sampled for growth, health, and survival. Each month, lengths and weights were collected from a sample of fish and rearing density indices were calculated. In addition, fish were examined monthly for health problems following standard fish health monitoring practices for hatcheries. Various life-stage survivals were estimated for each hatchery stock. These estimates were then compared to the "standard" survival rates identified in Table 2.3 to provide insight as to how well the hatchery operations were performing. Failure to achieve a survival standard could indicate a problem with some part of the hatchery program. However, failure to meet a standard may not be indicative of the overall success of the program to meet the goals identified in Section 1.

Table 2.3. Standard life-stage survival rates for fish reared within the Chelan PUD hatchery programs (from Hillman et al. 2017).

Life stage	Standard survival rate (%)
Collection-to-spawning (females)	90
Collection-to-spawning (males)	85
Unfertilized egg-to-eyed	92
Unfertilized egg-to-ponding	98
30 d after ponding	97
100 d after ponding	93
Ponding-to-release	90
Transport-to-release	95
Unfertilized egg-to-release	81

Nearly all hatchery fish from each stock were marked (adipose fin clip) or tagged (coded-wire tag) in 2017. Different combinations of marks and tags were used depending on the stock. In addition, Chelan PUD personnel PIT tagged 10,100 juvenile WxW Chiwawa spring Chinook and 10,104 juvenile Nason Creek spring Chinook (5,052 WxW and 5,050 HxH); 11,110 Wenatchee WxW steelhead (Circular Ponds) and 22,220 Wenatchee WxW and HxH steelhead (Raceway); and 10,500 Chelan River summer Chinook, 4,424 Methow (Carlton) summer Chinook, and 21,000 Wenatchee summer Chinook (10,500 Raceway and 10,500 Circular Ponds). PIT tags will be used to estimate migration timing and survival rates (e.g., smolt-to-adult) outside the hatchery.

Lastly, the size and number of fish released were assessed and compared to programmed production levels. Numbers released, and their sizes, should fall within 10% of the programmed targets identified in Table 2.4. However, because of constraints due to run size and proportions of wild and hatchery adults, production levels may not be achieved every year.

Table 2.4. Targets for fish released from the PUD hatchery programs; CV = coefficient of variation.

Hatchery stock	Release targets	Size targets		
		Fork length (CV)	Weight (g)	Fish/pound
Wenatchee Summer Chinook	500,001	163 (9.0)	45.4	18[a]
Methow Summer Chinook	200,000	163 (9.0)	45.4	13-17
Chelan Falls Summer Chinook (yearlings)	576,000	161 (9.0)	45.4	13[b]
Chiwawa Spring Chinook	144,026	155 (9.0)	37.8	18
Nason Spring Chinook	223,670	155 (9.0)	37.8	18[c]
Wenatchee Steelhead	247,300	191 (9.0)	75.6	6

[a]An experimental release size of 30-45 grams (10-15 FPP) was in place for brood years 2012-2014.
[b]An experimental release size of 20-45 grams (10-22 FPP) was in place for brood years 2012-2014.
[c] This is an approximate goal.

2.3 Juvenile Sampling

Juvenile sampling within streams included operation of rotary screw traps, snorkel observations, and PIT tagging. Methods for sampling juvenile fish are described in Hillman et al. (2017).

A smolt trap operated on the Wenatchee River near the town of Cashmere at RM 8.3 (Lower Wenatchee Trap), in Nason Creek about 0.6 miles upstream from the mouth, in the White River about 5.8 miles upstream from the mouth, and in the Chiwawa River about 0.4 miles upstream from the mouth (Chiwawa Trap). All traps operated throughout the smolt migration period. The Chiwawa Trap operated between 23 March and 29 November 2017, the Nason Creek Trap operated from 1 March to 30 November 2017, the White River trap operated from 1 March through 30 November 2017, and the Lower Wenatchee Trap operated between 24 February and 31 July 2017. Throughout the trapping period, the traps were briefly inoperable during periods when flows were too high or low, during high water temperatures, during large hatchery releases, and because of heavy debris loads, ice, and mechanical malfunctions.

The following data were collected at each trap site: water temperature, discharge, number and identification of all species captured, degree of smoltification for anadromous fish, presence of marks and tags, size (fork lengths and weights), and scales from smolts. Trap efficiencies at each trap site were estimated by using mark-recapture trials conducted over a wide range of discharges. Linear regression models relating discharge and trap efficiencies were developed to estimate daily trap efficiencies during periods when no mark-recapture trials were conducted. The total number of fish migrating past the trap each day was estimated as the quotient of the daily number of fish captured and the estimated daily trap efficiency. Summing the daily totals resulted in the total emigration estimate.

Snorkel observations were used to estimate the number of juvenile spring Chinook salmon, juvenile rainbow/steelhead, and bull trout within the Chiwawa River basin. The focus of the study was on juvenile spring Chinook salmon. Sampling followed a stratified random design with proportional allocation of sites among strata. Strata were identified based on unique combinations of geology, land type, valley bottom type, stream state condition, and habitat types. A total of 208 randomly selected sites were surveyed during August (Table 2.5). Counts of fish within each sampling site were adjusted based on detection efficiencies, which were related to water temperature. That is, non-linear models that described relationships between water temperatures and detection efficiencies (Hillman et al. 1992) were used to estimate total numbers of fish within sampling sites. These numbers were then converted to densities by dividing total fish numbers by the wetted surface area and water volume of sample sites. Total numbers within a stratum were estimated as the product of fish densities times the total wetted surface or water volume for the stratum. The sum of fish numbers across strata resulted in the total number of fish within the basin. The calculation of total numbers, densities, and degrees of certainty are explained fully in Hillman and Miller (2004).

Table 2.5. Location of strata and numbers of randomly sampled snorkel sites within each stratum that were sampled in the Chiwawa River Basin in 2017.

Reach/stratum	River miles (RM)	Number of randomly selected sites
Chiwawa River		
1	0.0-3.8	11
2	3.8-5.5	5
3	5.5-7.9	8
4	7.9-8.9	6
5	8.9-10.8	5
6	10.8-11.8	6
7	11.8-20.0	29
8	20.0-25.4	24
9	25.4-28.8	11
10	28.8-31.1	23
Phelps Creek		
1	0.0-0.4	1
Chikamin Creek (includes Minnow Creek)		
1	0.0-1.5	25
Rock Creek		
1	0.0-0.7	12
Unnamed stream on USGS map		
1	0.0-0.1	1
Big Meadow Creek		
1	0.0-1.0	15
Alder Creek		
1	0.0-0.1	2
Brush Creek		
1	0.0-0.1	2
Clear Creek		
1	0.0-0.1	3

Working in collaboration with the Comparative Survival Study (CSS) funded by BPA, crews PIT tagged juvenile wild Chinook, wild steelhead, wild sockeye, and in some instances wild coho salmon collected at the smolt traps and collected within the Chiwawa River and Nason Creek using electrofishing techniques. The proposed number of wild spring Chinook and steelhead to be tagged at each location is provided in Table 2.6. The goal of this tagging program is to estimate freshwater juvenile productivity, better understand life-history characteristics, overwinter movement, and survival of salmonids, and to calculate SARs for spring Chinook salmon in the Wenatchee River basin. The PIT-tagging effort funded by the PUDs in the Chiwawa River and Nason Creek is specifically directed at addressing uncertainties of estimating abundance using screw traps (e.g., fish passage during times when trapping is not possible).

Table 2.6. Number of wild spring Chinook, steelhead (≥65 mm), and sockeye proposed for PIT tagging at different locations within the Wenatchee River basin, 2016. NT = no sample size target.

Sampling location	Target sample size		
	Wild spring Chinook	Wild steelhead	Wild Sockeye
Chiwawa Trap	2,500-8,000	500-2,000	NT
Nason Creek Trap	2,500-8,000	500-2,000	NT
White River Trap	200-500	NT	NT
Lower Wenatchee Trap	1,000-2,500	50-250	3,000-5,000
Chiwawa Remote Sampling	3,000	NT	NT
Nason Remote Sampling	3,000	NT	NT

Survival rates for various juvenile life-stages were calculated based on estimates of seeding levels (total egg deposition), parr abundance, numbers of emigrants, and smolt abundance. Total egg deposition was estimated as the product of the number of redds counted in the basin times the mean fecundity of female spawners. Fecundity was estimated from females collected for broodstock using an electronic egg counter. Numbers of emigrants and smolts were estimated at trapping sites and numbers of parr were estimated using snorkel observations only in the Chiwawa River basin. Survival estimates could not be calculated for some stocks (e.g., summer Chinook) because specific life-stage abundance estimates were lacking.

2.4 Spawning/Carcass Surveys

Methods for conducting carcass and spawning ground surveys are detailed in Hillman et al. (2017). Information collected during spawning surveys included spawn time, redd location, and redd abundance. Data collected during carcass surveys included sex, size (fork length and postorbital-to-hypural length), scales for aging[2], degree of egg voidance, DNA samples, and identification of marks or tags. The sampling goal for carcasses was 20% of the spawning population.

[2] In this report, we use two methods of describing age. One is termed the "European Method." This method has two digits, separated by a period. The first digit represents the number of winters the fish spent in freshwater before migrating to the sea. The second digit indicates the number of winters the fish spent in the ocean. For example, a fish designated as 1.2 spent one winter in freshwater and two in the ocean. A fish designated as 0.3 migrated to the ocean in its first year and spent three winters in the ocean. The other method describes the total age of the fish (egg-to-spawning adult, i.e., gravel-to-gravel), so fish demarcated as 0.3 or 1.2 are considered 4-year-olds, from the same brood.

Steelhead surveys were conducted throughout the mainstem Wenatchee River and downstream from PIT-tag interrogation systems on the Chiwawa River, Nason Creek, and Peshastin Creek. These surveys were conducted during March through June in reaches and index areas described in Table 2.7. Total redd counts in these reaches were estimated by expanding counts within non-index areas by expansion factors developed within index areas.

Table 2.7. Description of reaches and index areas surveyed for steelhead redds in the Wenatchee River basin.

Stream	Code	Reach*	Index/reference area
Wenatchee River	W1	Mouth to Sleepy Hollow Br	River Bend to Sleepy Hollow Br
	W2	Sleepy Hollow Br to L. Cashmere Br	Sleepy Hollow Br to Cashmere Boat Rmp
	W3	L. Cashmere Br to Dryden Dam	Williams Canyon to Dryden Dam
	W5	Peshastin Br to Leavenworth Br	Irrigation Flume to Leavenworth Br
	W6	Leavenworth Br to Icicle Rd Br	Leavenworth Boat Ramp to Icicle Ck
	W7	Icicle Rd Br to Tumwater Dam	Icicle Br to Penstock Br
	W8	Tumwater Dam to Tumwater Br	Island below Swiftwater to Swiftwater CG
	W9	Tumwater Br to Chiwawa R	Tumwater Br to Plain
	W10	Chiwawa R to Lk Wenatchee	Chiwawa Pump St. to Lk Wenatchee
Peshastin Creek	P1	Mouth to PIT Detection Site	Mouth to PIT Detection Site
Chiwawa River	C1	Mouth to Rd 62 Br RM 6.4	Mouth to PIT Detection Site
Nason Creek	N1	Mouth to PIT Detection Site	Mouth to PIT Detection Site

* Reaches 2, 6, 8, 9, and 10 (major spawning areas) are surveyed weekly, while Reaches 1, 3, 5, and 7 (minor survey areas) are surveyed during peak spawning.

Beginning in 2014, adult steelhead escapement estimates in the majority of tributaries in the Wenatchee River basin were generated using mark-recapture techniques based on steelhead PIT tagged at Priest Rapids Dam.[3] Mark-recapture estimates in the tributaries were then added to the estimates based on redd surveys to generate a total spawning escapement to the Wenatchee River basin.

Spring Chinook redd and carcass surveys were conducted during August through September in the Chiwawa River (including Rock and Chikamin creeks), Nason Creek, Icicle Creek, Peshastin Creek (including Ingalls Creek), upper Wenatchee River, Little Wenatchee River, and the White River (including the Napeequa River and Panther Creek). Survey reaches for spring Chinook are described in Table 2.8.

Table 2.8. Description of reaches surveyed for spring Chinook redds and carcasses in the Wenatchee River basin.

Stream	Code	Reach	River mile (RM)
Chiwawa River	C1	Mouth to Grouse Creek	0.0-11.7
	C2	Grouse Creek to Rock Creek	11.7-19.3
	C3	Rock Creek to Schaefer Creek	19.3-22.4
	C4	Schaefer Creek to Atkinson Flats	22.4-25.6

[3] We assume steelhead escapement to tributaries based on mark-recapture techniques represents spawning escapement.

Stream	Code	Reach	River mile (RM)
	C5	Atkinson Flats to Maple Creek	25.6-27.0
	C6	Maple Creek to Phelps Creek	27.0-30.3
	C7	Phelps Creek to Buck Creek	30.3-31.4
Rock Creek	R1	Mouth to Chiwawa River Road Bridge	0.0-0.5
Chikamin Creek	K1	Mouth to Chiwawa River Road Bridge	0.0-0.5
Nason Creek	N1	Mouth to Kahler Creek Bridge	0.0-3.9
	N2	Kahler Creek Bridge to Hwy 2 Bridge	3.9-8.3
	N3	Hwy 2 Bridge to Lower RR Bridge	8.3-13.2
	N4	Lower RR Bridge to Whitepine Creek	13.2-15.4
Little Wenatchee River	L1	Mouth to Old Fish Weir	0.0-2.7
	L2	Old Fish Weir to Lost Creek	2.7-5.2
	L3	Lost Creek to Rainy Creek	5.2-9.2
	L4	Rainy Creek to Falls	9.2-12.4
White River	H1	Mouth to Sears Creek Bridge	0.0-6.4
	H2	Sears Creek Bridge to Napeequa River	6.4-11.0
	H3	Napeequa River to Grasshopper Meadows	11.0-12.9
	H4	Grasshopper Meadows to Falls	12.9-16.1
Napeequa River	Q1	Mouth to Take Out	0.0-1.0
Panther Creek	T1	Mouth to Boulder Field	0.0-1.0
Wenatchee River	W8	Tumwater Dam to Tumwater Bridge	30.9-35.6
	W9	Tumwater Bridge to Chiwawa River	35.6-48.4
	W10	Chiwawa River to Lake Wenatchee	48.4-54.2
Chiwaukum Creek	U1	Mouth to Metal Bridge	0.0-1.0
Icicle Creek	I1	Mouth to Hatchery	0.0-2.8
	I2	Hatchery to Sleeping Lady	2.8-3.3
	I3	Sleeping Lady to Snow Creek	3.3-3.8
Peshastin Creek	P1	Mouth to Camas Creek	0.0-5.9
	P2	Camas Creek to Mouth of Scotty Creek	5.9-16.3
Ingalls Creek	D1	Mouth to Trailhead	0.0-1.0

The sockeye salmon hatchery program ended after the 2011 brood year. As a result, monitoring activities that focused on evaluating the effects of the supplementation program on the natural population switched to monitoring the abundance and productivity of the natural population (McElhaney et al. 2000). Thus, estimation of spawn time and carcass surveys were discontinued in 2014. Nevertheless, this report retains the results of carcass sampling during the period 1993-2013. Survey reaches in which carcasses and live fish (for area-under-the-curve estimates) were conducted are identified in Table 2.9.

From 2009-2013, mark-recapture methods were used to estimate sockeye spawning escapement within the White River, while area-under-the-curve (AUC) methods were used to estimate spawning escapement within the Little Wenatchee River. Beginning in 2014, mark-recapture methods were used to estimate the spawning escapement of sockeye in both the White River and Little Wenatchee watersheds.

Table 2.9. Description of reaches surveyed for sockeye salmon carcasses and live fish in the Wenatchee River basin during survey years 1993-2013.

Stream	Code	Reach	River mile (RM)
Little Wenatchee River	L1	Mouth to Old Fish Weir	0.0-2.7
	L2	Old Fish Weir to Lost Creek	2.7-5.2
	L3	Lost Creek to Rainy Creek	5.2-9.2
White River	H1	Mouth to Sears Creek Bridge	0.0-6.4
	H2	Sears Creek Bridge to Napeequa River	6.4-11.0
	H3	Napeequa River to Grasshopper Meadows	11.0-12.9
Napeequa River	Q1	Mouth to End	0.0-1.0

Wenatchee summer Chinook redd and carcass surveys were conducted from September through November throughout the entire mainstem Wenatchee River, which was divided into ten reaches (Table 2.10). Surveys were conducted weekly in all reaches. All redds were enumerated during weekly census counts.

Table 2.10. Description of reaches surveyed for summer Chinook redds in the Wenatchee River basin.

Code	Reach	River mile
W1	Mouth to Sleepy Hollow Br	0.0-3.3
W2	Sleepy Hollow Br to L. Cashmere Br	3.3-9.5
W3	L. Cashmere Br to Dryden Dam	9.5-17.8
W4	Dryden Dam to Peshastin Br	17.8-20.0
W5	Peshastin Br to Leavenworth Br	20.0-23.9
W6	Leavenworth Br to Icicle Rd Br	23.9-26.4
W7	Icicle Rd Br to Tumwater Dam	26.4-30.9
W8	Tumwater Dam to Tumwater Br	30.9-35.6
W9	Tumwater Br to Chiwawa River	35.6-47.9
W10	Chiwawa River to Lake Wenatchee	47.9-54.2

Summer Chinook redd and carcass surveys were also conducted in the Methow and Chelan rivers from September through November. Total (map) redd counts were conducted in these rivers. Table 2.11 describes the survey reaches on the Methow River. The Colville Tribes conducted summer Chinook redd and carcass surveys in the Okanogan River basin. Those results are reported in a separate report (annual report to BPA).

Table 2.11. Description of reaches surveyed for summer Chinook redds and carcasses on the Methow, Chelan, Okanogan, and Similkameen rivers.

Stream	Code	Reach	River mile (RM)
Methow River	M1	Mouth to Methow Bridge	0.0-14.8
	M2	Methow Bridge to Carlton Bridge	14.8-27.2
	M3	Carlton Bridge to Twisp Bridge	27.2-39.6
	M4	Twisp Bridge to MVID	39.6-44.9
	M5	MVID to Winthrop Bridge	44.9-49.8
	M6	Winthrop Bridge to Hatchery Dam	49.8-51.6
Chelan River	CoT	Columbia Tailrace	0.0-0.1
	ChT	Chelan Tailrace	0.1-0.3
	HC	Habitat Channel	0.2-0.6
	HP	Habitat Pool	0.6-0.7
Okanogan River	O1	Mouth to Mallot Bridge	0.0-16.9
	O2	Mallot Bridge to Okanogan Bridge	16.9-26.1
	O3	Okanogan Bridge to Omak Bridge	26.1-30.7
	O4	Omak Bridge to Riverside Bridge	30.7-40.7
	O5	Riverside Bridge to Tonasket Bridge	40.7-56.8
	O6	Tonasket Bridge to Zosel Dam	56.8-77.4
Similkameen River	S1	Driscoll Channel to Oroville Bridge	0.0-1.8
	S2	Oroville Bridge to Enloe Dam	1.8-5.7

For summer and spring Chinook, total spawning escapements for each population were estimated as the product of total number of redds times the ratio of fish per redd for a specific stock.[4] Fish per redd ratios were estimated as the ratio of males to females sampled at broodstock collection sites and monitoring sites (e.g., Leavenworth National Fish Hatchery, Dryden Dam, Tumwater Dam, Chiwawa Weir, etc.). For steelhead, spawning escapement was estimated with a combination of PIT-tag-based tributary and redd-based mainstem Wenatchee River estimates. Total spawning escapement for sockeye salmon in the Little Wenatchee and White River watersheds was estimated using mark-recapture methods. Adult sockeye were PIT tagged at Tumwater Dam and Bonneville Dam[5] and detected in the Little Wenatchee and White rivers with stationary PIT-tag interrogation systems.

Derived metrics calculated from carcass surveys, broodstock sampling, stock assessments, and harvest records included proportion of hatchery spawners, stray rates, age-at-maturity, length-at-age, smolt-to-adult survival (SAR), hatchery replacement rates (HRR), harvest rates, and natural replacement rates (NRR). The target HRRs (from Hillman et al. 2017) for different stocks raised in the PUD hatchery programs are provided in Table 2.12. Methods for calculating derived variables are described in Hillman et al. (2017) and in "White Papers" developed by the Hatchery Evaluation Technical Team (HETT) (see Appendices in Hillman et al. 2012). The abundance of

[4] Expansion factor = (1 + (number of males/number of females)).

[5] Adult sockeye that were tagged at Bonneville Dam and detected at Tumwater Dam were included in the mark-recapture analyses.

hatchery and natural-origin Chinook salmon spawners was based upon the proportion of carcasses by origin that were collected on the spawning grounds.

Table 2.12. Hatchery replacement rate (HRR) targets for stocks raised in the PUD Hatchery Programs.

Program	Number of broodstock	Smolts released	HRR targets
Chiwawa Spring Chinook	74	144,026	6.7
Nason Creek Spring Chinook (conser.)	77	125,000	6.7
Wenatchee Summer Chinook	262	500,001	5.7
Methow Summer Chinook	118	200,000	3.0
Wenatchee Steelhead	140	247,300	6.9

Derived data that rely on CWTs (e.g., HRR, SAR, stray rates, etc.) are five or more years behind release information because of the lag time for returning adult fish to enter the fishery and spawning grounds, and the processing of tags. Consequently, complete information on rates and ratios based on CWTs is generally only available for brood years before 2012.

In addition to the data required in the M&E Plan, this report contains data and analyses that go beyond the requirements of the M&E Plan. We include information on broodstock collection efforts including numbers of adult fish collected, mortalities, and numbers spawned. We also include the size, age, and sex ratios of broodstock; egg take, acclimation days, and tagging information; and incidence of disease. For natural-origin fish, we estimate juvenile carrying capacities and calculate the change in precision of stock-recruitment parameters as additional years of data are added to the time series. Finally, we include estimates of PNI, post-release survival and travel times (from release location to McNary Dam), and SARs. Although these data and analyses are not a requirement of the M&E Plan, they provide information that supports the M&E Plan and are used to help manage the hatchery programs.

SECTION 3: WENATCHEE STEELHEAD

The goal of summer steelhead supplementation in the Wenatchee Basin is to use artificial production to replace adult production lost because of mortality at Rock Island and Rocky Reach dams, as well as inundation compensation for Rocky Reach Dam, while not reducing the natural production or long-term fitness of steelhead in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Rock Island and Rocky Reach Anadromous Fish Agreement and Habitat Conservation Plans.

Prior to 1998, steelhead eggs were received from Wells Hatchery (adult broodstock were collected at Wells Dam); fish were reared at Eastbank Fish Hatchery and then released into the Wenatchee River. Beginning in 1998, the program changed to collecting broodstock within the Wenatchee River basin. Currently, adult hatchery steelhead are collected from the run-at-large at the right and left-bank traps at Dryden Dam, and at Tumwater Dam if the weekly quotas cannot be achieved at Dryden Dam. Natural-origin (WxW) adult steelhead are collected from the run-at-large at Tumwater and Dryden dams if the weekly quotas cannot be achieved at Dryden Dam.

Before 2012, the goal was to collect up to 208 adult steelhead (50% natural-origin fish and 50% hatchery-origin fish) for the Wenatchee steelhead program. In 2011, the Hatchery Committees reevaluated the amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was revised. The current goal (which began in 2012) is to collect 130 adult steelhead (64 natural-origin and 66 hatchery-origin fish) for a 247,300 smolt program, but the number of broodstock collected cannot exceed 33% of the natural Wenatchee steelhead population. Broodstock collection occurs from about 1 July through 15 November at Dryden and Tumwater dams, with trapping occurring up to 24 hours per day, five days a week. The intent of the current program is to target adults necessary to meet a 50% natural-origin, conservation-oriented program and a 50% hatchery-origin safety-net program.

Before the 2012 brood year, adult steelhead were held and spawned at Wells Fish Hatchery because of unsuitable adult holding temperatures at Eastbank Fish Hatchery. Beginning with the 2012 brood year, holding and spawning of adult steelhead have occurred at Eastbank Fish Hatchery with the installation of a water chiller system. Before 2012, juvenile steelhead were reared at a combination of facilities including Eastbank, Chelan, Turtle Rock, Rocky Reach Annex, and Chiwawa facilities. Juvenile steelhead reared in these facilities were trucked to release locations on the Wenatchee River, Chiwawa River, and Nason Creek. A percentage of the fish have also been released volitionally from Blackbird Pond and Rolfing Pond. Beginning in the fall of 2012, the entire Wenatchee steelhead program overwinters at the Chiwawa Acclimation Facility. Some of these fish are transferred to short-term remote acclimation sites (e.g., Blackbird Pond and Rolfing Pond), while others are planted from trucks throughout the Wenatchee, Nason, and Chiwawa basins.

Before 2012, the production goal for the Wenatchee steelhead supplementation program was to release 400,000 yearling smolts into the Wenatchee Basin at six fish per pound. Since 2012, the revised production goal is to release 247,300 smolts (123,650 for conservation and 123,650 for safety net). Targets for fork length and weight are 191 mm (CV = 9.0) and 75.6 g, respectively; the target size at release is six fish per pound. Over 96% of these fish receive CWTs. In addition, since 2006, juvenile steelhead from different parental-cross groups (e.g., WxW, HxW, and HxH) have been PIT tagged annually. No HxW crosses have occurred since brood year 2009.

Beginning in 2010 and consistent with ESA Section 10(a)(1)(A) permit 1395, adult management activities have been conducted to remove excess hatchery-origin steelhead before they spawn in the natural environment. This is accomplished through removal at Tumwater Dam and/or through conservation fisheries. The objective of these activities is to achieve proportion of hatchery-origin spawners (pHOS) and Proportionate Natural Influence (PNI) goals for the Wenatchee steelhead program. Results of adult management activities are submitted to NOAA Fisheries in a separate annual report by 31 August of the year the adult management was concluded.

3.1 Broodstock Sampling

This section focuses on results from sampling 2016 and 2017 brood years of Wenatchee steelhead, which were collected at Dryden and Tumwater dams. The 2016 brood begins the tracking of the life cycle of steelhead released in 2017. The 2017 brood is included because juveniles from this brood are still maintained within the hatchery.

Origin of Broodstock

A total of 133 Wenatchee steelhead from the 2015 return (2016 brood) were collected at Dryden and Tumwater dams (Table 3.1). About 50.4% of these were natural-origin (adipose fin present and no CWT) fish and the remaining 49.6% were hatchery-origin (adipose fin present and CWT) adults. Origin was determined by analyzing scales and/or otoliths. The total number of steelhead spawned from the 2016 brood was 132 adults (50% natural-origin and 50% hatchery-origin).

A total of 126 steelhead were collected from the 2016 return (2017 brood) at Dryden and Tumwater dams; 55 (43.7%) natural-origin (adipose fin present and no CWT) and 71 (56.3%) hatchery-origin (adipose fin present and CWT) adults. A total of 119 steelhead were spawned; 44.5% were natural-origin fish and 55.5% were hatchery-origin fish (Table 3.1). Origin was confirmed by sampling scales and/or otoliths.

Table 3.1. Numbers of wild and hatchery steelhead collected for broodstock, numbers that died before spawning, and numbers of steelhead spawned, 1998-2017. Unknown origin fish (i.e., undetermined by scale analysis, no elastomer, no CWT, no fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes surplus broodstock that were culled.

Brood year	Wild steelhead					Hatchery steelhead					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1998	35	0	0	35	0	43	4	2	37	0	72
1999	58	5	1	52	0	67	1	2	64	0	116
2000	39	2	1	36	0	101	9	12	60	20	96
2001	64	5	8	51	0	114	5	6	103	0	154
2002	99	0	1	96	2	113	1	0	64	48	160
2003	63	10	4	49	0	92	2	0	90	0	139
2004	85	3	0	75	7	132	1	0	61	70	136
2005	95	8	0	87	0	114	7	1	104	2	191
2006	101	5	0	93	3	98	0	0	69	29	162
2007	79	0	2	76	1	97	0	14	58	25	134
2008	104	0	3	77	22	107	0	28	54	25	131

Brood year	Wild steelhead					Hatchery steelhead					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
2009	101	2	0	86	13	107	1	4	73	29	159
2010	106	1	1	96	8	105	2	23	75	5	171
2011	104	8	1	91	4	104	13	2	70	0	161
Average[b]	***81***	***4***	***2***	***71***	***4***	***100***	***3***	***7***	***70***	***18***	***142***
Median	***95***	***3***	***1***	***77***	***2***	***105***	***2***	***2***	***67***	***13***	***147***
2012	63	3	0	59	1	66	0	1	65	0	124
2013	63	8	1	49	5	84	9	7	68	0	117
2014	65	0	1	64	0	70	0	2	68	0	132
2015	76	5	0	58	13	60	0	8	52	0	110
2016	67	0	1	66	0	66	0	0	66	0	132
2017	55	1	1	53	0	71	2	3	66	0	119
Average[c]	***65***	***3***	***1***	***58***	***3***	***70***	***2***	***4***	***64***	***0***	***122***
Median	***64***	***2***	***1***	***59***	***1***	***68***	***0***	***3***	***66***	***0***	***122***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] This average and median represent the program before recalculation in 2011.
[c] This average and median represent the current program, which began in 2012.

Age/Length Data

Broodstock ages were determined from examination of scales and/or otoliths. For the 2016 brood year, natural-origin and hatchery-origin steelhead consisted primarily of 2-salt adults (Table 3.2). For the 2017 brood year, natural and hatchery-origin steelhead consisted primarily of 2-salt adults (Table 3.2).

Table 3.2. Percent of hatchery and wild steelhead of different ages (saltwater ages) collected from broodstock, 1998-2017.

Brood year	Origin	Saltwater age		
		1	2	3
1998	Wild	39.4	60.6	0.0
	Hatchery	20.9	79.1	0.0
1999	Wild	50.0	48.3	1.7
	Hatchery	81.8	18.2	0.0
2000	Wild	56.4	43.6	0.0
	Hatchery	67.9	32.1	0.0
2001	Wild	51.7	48.3	0.0
	Hatchery	14.9	85.1	0.0
2002	Wild	55.6	44.4	0.0
	Hatchery	94.6	5.4	0.0
2003	Wild	13.1	85.3	1.6
	Hatchery	29.4	70.6	0.0
2004	Wild	94.8	5.2	0.0
	Hatchery	95.2	4.8	0.0

Brood year	Origin	Saltwater age		
		1	2	3
2005	Wild	22.1	77.9	0.0
	Hatchery	20.5	79.5	0.0
2006	Wild	28.7	71.3	0.0
	Hatchery	60.3	39.7	0.0
2007	Wild	40.3	59.3	0.0
	Hatchery	62.1	37.9	0.0
2008	Wild	65.4	33.7	0.9
	Hatchery	88.8	11.2	0.0
2009	Wild	39.8	57.8	2.4
	Hatchery	23.4	76.6	0.0
2010	Wild	65.2	33.7	1.1
	Hatchery	76.5	23.5	0.0
2011	Wild	27.5	72.5	0.0
	Hatchery	36.0	64.0	0.0
2012	Wild	42.4	52.5	5.1
	Hatchery	40.9	59.1	0.0
2013	Wild	40.7	57.4	1.9
	Hatchery	45.5	54.5	0.0
2014	Wild	47.5	50.8	1.6
	Hatchery	29.4	70.6	0.0
2015	Wild	15.9	82.5	1.6
	Hatchery	47.2	52.7	0.0
2016	Wild	33.8	66.2	0.0
	Hatchery	42.4	57.6	0.0
2017	Wild	9.3	83.3	7.4
	Hatchery	11.3	87.3	1.4
Average	***Wild***	***42.0***	***56.7***	***1.3***
	Hatchery	***49.5***	***50.5***	***0.1***
Median	***Wild***	***40.5***	***57.6***	***0.5***
	Hatchery	***44.0***	***56.1***	***0.0***

There was little difference between mean lengths of hatchery and natural-origin steelhead in the 2016 and 2017 brood years (Table 3.3). Natural-origin fish were on average 3 to 4 cm larger than hatchery-origin fish for 1 and 2-salt fish. For 3-salt steelhead, the one hatchery-origin fish was 14 cm larger than the average natural-origin fish for the 2017 brood year.

Table 3.3. Mean fork length (cm) at age (saltwater ages) of hatchery and wild steelhead collected from broodstock, 1998-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1998	Wild	63	15	4	79	20	5	-	0	-
	Hatchery	61	9	4	73	34	4	-	0	-
1999	Wild	65	29	5	74	28	5	77	1	-
	Hatchery	62	54	4	73	12	4	-	0	-
2000	Wild	64	22	3	74	17	5	-	0	-
	Hatchery	60	57	3	71	27	4	-	0	-
2001	Wild	61	33	6	77	31	5	-	0	-
	Hatchery	62	17	4	72	97	4	-	0	-
2002	Wild	64	55	4	77	44	4	-	0	-
	Hatchery	63	106	4	73	6	4	-	0	-
2003	Wild	69	8	6	77	52	5	91	1	-
	Hatchery	66	27	4	75	65	4	-	0	-
2004	Wild	63	73	6	78	4	2	-	0	-
	Hatchery	61	59	3	73	3	1	-	0	-
2005	Wild	59	21	4	74	74	5	-	0	-
	Hatchery	59	23	4	72	89	4	-	0	-
2006	Wild	63	27	5	75	67	6	-	0	-
	Hatchery	61	41	4	72	27	5	-	0	-
2007	Wild	64	31	6	76	46	5	-	0	-
	Hatchery	60	60	4	71	36	5	-	0	-
2008	Wild	64	68	4	77	35	4	80	1	-
	Hatchery	60	95	4	72	12	2	-	0	-
2009	Wild	65	33	5	76	48	6	81	2	0
	Hatchery	63	18	4	75	59	5	-	-	-
2010	Wild	64	60	5	74	31	5	76	1	-
	Hatchery	61	53	5	73	23	5	-	-	-
2011	Wild	62	28	5	76	74	5	-	0	-
	Hatchery	60	36	4	74	64	4	-	0	-
2012	Wild	63	25	3	74	31	5	74	3	2
	Hatchery	59	27	3	74	39	4	-	0	-
2013	Wild	61	22	5	77	31	5	74	1	-
	Hatchery	60	35	3	74	42	4	-	0	-
2014	Wild	61	29	4	75	31	4	61	1	-
	Hatchery	60	20	3	72	48	4	-	0	-
2015	Wild	61	10	3	77	52	4	85	1	-

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	59	26	3	76	29	5	-	0	-
2016	Wild	63	22	4	74	43	4	-	0	-
	Hatchery	61	28	4	71	38	5	-	0	-
2017	Wild	63	5	3	78	45	5	77	4	8
	Hatchery	59	8	2	75	62	5	93	1	-
Average	***Wild***	***63***	***31***	***5***	***76***	***40***	***5***	***78***	***1***	***3***
	Hatchery	***61***	***40***	***4***	***73***	***41***	***4***	***93***	***0***	***-***

Sex Ratios

Male steelhead in the 2016 brood year made up about 50.4% of the adults collected, resulting in an overall male to female ratio of 1.02:1.00 (Table 3.4). For the 2017 brood year, males made up 50.0% of the adults collected, resulting in an overall male to female ratio of 1.00:1.00. On average (1998-2017), the sex ratio is slightly less than the 1:1 ratio assumed in the broodstock protocol (Table 3.4).

Table 3.4. Numbers of male and female wild and hatchery steelhead collected for broodstock, 1998-2017. Ratios of males to females are also provided.

Brood year	Number of wild steelhead			Number of hatchery steelhead			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1998	13	22	0.59:1.00	15	28	0.54:1.00	0.56:1.00
1999	22	36	0.61:1.00	35	32	1.09:1.00	0.84:1.00
2000	18	21	0.86:1.00	60	41	1.46:1.00	1.26:1.00
2001	38	26	1.46:1.00	40	74	0.54:1.00	0.78:1.00
2002	32	67	0.48:1.00	81	32	2.53:1.00	1.14:1.00
2003	19	44	0.43:1.00	44	48	0.92:1.00	0.68:1.0
2004	43	42	1.02:1.00	90	42	2.14:1.00	1.58:1.00
2005	36	59	0.61:1.00	46	68	0.68:1.00	0.65:1.00
2006	38	63	0.60:1.00	47	51	0.92:1.00	0.75:1.00
2007	36	43	0.84:1.00	49	48	1.02:1.00	0.93:1.00
2008	61	43	1.42:1.00	68	39	1.74:1.00	1.57:1.00
2009	44	57	0.77:1.00	54	53	1.02:1.00	0.89:1.00
2010	49	57	0.86:1.00	62	43	1.44:1.00	1.11:1.00
2011	44	60	0.73:1.00	50	54	0.93:1.00	0.82:1.00
2012	30	33	0.91:1.00	31	35	0.89:1.00	0.90:1.00
2013	33	30	1.10:1.00	38	46	0.83:1.00	0.93:1.00
2014	30	33	0.91:1:00	36	36	1.00:1.00	0.96:1.00
2015	34	42	0.81:1.00	34	26	1.31:1.00	1.00:1.00
2016	34	33	1.03:1.00	33	33	1.00:1.00	1.02:1.00

Brood year	Number of wild steelhead			Number of hatchery steelhead			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2017	29	26	1.12:1.00	34	37	0.92:1.00	1.00:1.00
Total	***683***	***837***	***0.82:1.00***	***947***	***866***	***1.09:1.00***	***0.96:1.00***

Fecundity

Fecundities for Wenatchee steelhead in brood years 2016 and 2017 averaged 5,174 and 6,425 eggs per female, respectively (Table 3.5). Mean fecundity for the 2017 brood year was greater, while the 2016 brood year was less than the 5,678 eggs per female assumed in the broodstock protocol.

Table 3.5. Mean fecundity of wild, hatchery, and all female steelhead collected for broodstock, 1998-2017.

Brood year	Mean fecundity		
	Wild	Hatchery	Total
1998	6,202	5,558	5,924
1999	5,691	5,186	5,424
2000	5,858	5,729	5,781
2001	5,951	6,359	6,270
2002	5,776	5,262	5,626
2003	6,561	6,666	6,621
2004	5,118	5,353	5,238
2005	5,545	6,061	5,832
2006	5,688	5,251	5,492
2007	5,840	5,485	5,660
2008	5,693	5,153	5,433
2009	6,199	6,586	6,408
2010	5,458	5,423	5,442
2011	6,276	6,100	6,203
2012	5,309	6,388	5,891
2013	5,749	5,770	5,762
2014	5,831	5,847	5,839
2015	6,220	5,532	5,895
2016	5,392	4,956	5,174
2017	6,655	6,255	6,425
Average	***5,851***	***5,746***	***5,817***
Median	***5,804***	***5,644***	***5,807***

To estimate fecundities by length, weight, and age[6], hatchery staff collected fecundity, fork length, weight, and age data from a subsample of steelhead females during the spawning of 2013 through

[6] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

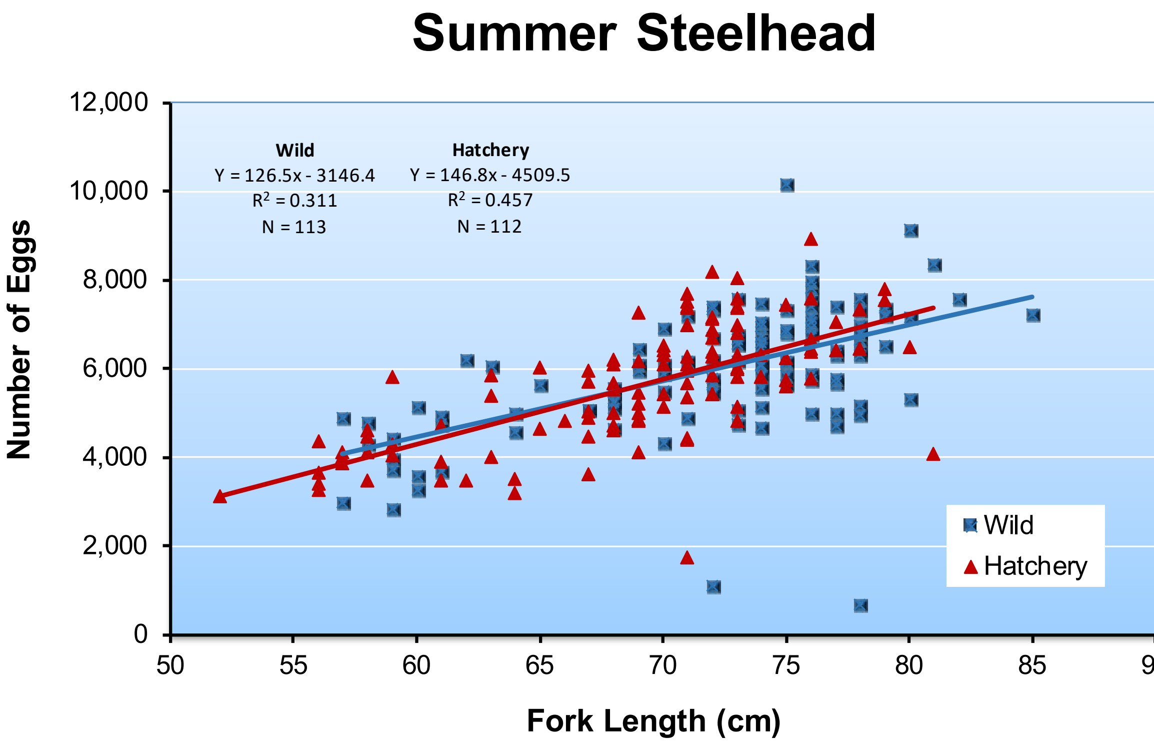
2017 broodstock. For those brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin steelhead. For these years, hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between female size and fecundity.

Mean fecundity by salt age varied between hatchery and natural-origin steelhead and over time (Table 3.6). On average, mean fecundities varied between hatchery and natural-origin steelhead by 120 eggs for 1-salt fish and 326 eggs for 2-salt fish. There were no hatchery-origin 3-salt steelhead.

Table 3.6. Mean fecundity by age (saltwater ages) for hatchery and wild steelhead collected from broodstock, brood years 2013-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Steelhead fecundity								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
2013	Wild	4,035	5	260.7	6,224	20	858.1	-	0	-
	Hatchery	4,496	10	866.2	6,320	24	1096	-	0	-
2014	Wild	4,924	10	530.9	6,528	18	1,225.2	6,896	1	-
	Hatchery	4,732	3	957.4	5,831	28	1,095.2	-	0	-
2015	Wild	3,879	2	1,492.7	6,361	26	1,565.1	7,238	1	-
	Hatchery	3,951	6	636.3	6,144	19	1,102.4	-	0	-
2016	Wild	4,151	8	1,049.1	5,790	25	866.7	-	0	-
	Hatchery	4,654	8	992.1	5,191	24	1,014.7	-	0	-
2017	Wild	-	0	-	6,755	23	1,032.3	5,888	3	1,003.2
	Hatchery	4,000	4	409.2	6,546	31	1,147.5	-	0	-
Average	***Wild***	***4,247***	***5***	***833.4***	***6,332***	***22***	***1,109.5***	***6,874***	***1***	***-***
	Hatchery	***4,367***	***6***	***772.2***	***6,006***	***25***	***1,091.2***	***-***	***0***	***-***

We pooled fecundity data from brood years 2013 through 2017 to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery and natural-origin females are shown in Figures 3.1, 3.2, and 3.3. All fecundity variables increase linearly with fork length and weight. In addition, the relationships between fish size and fecundity data were similar for hatchery and natural-origin steelhead.



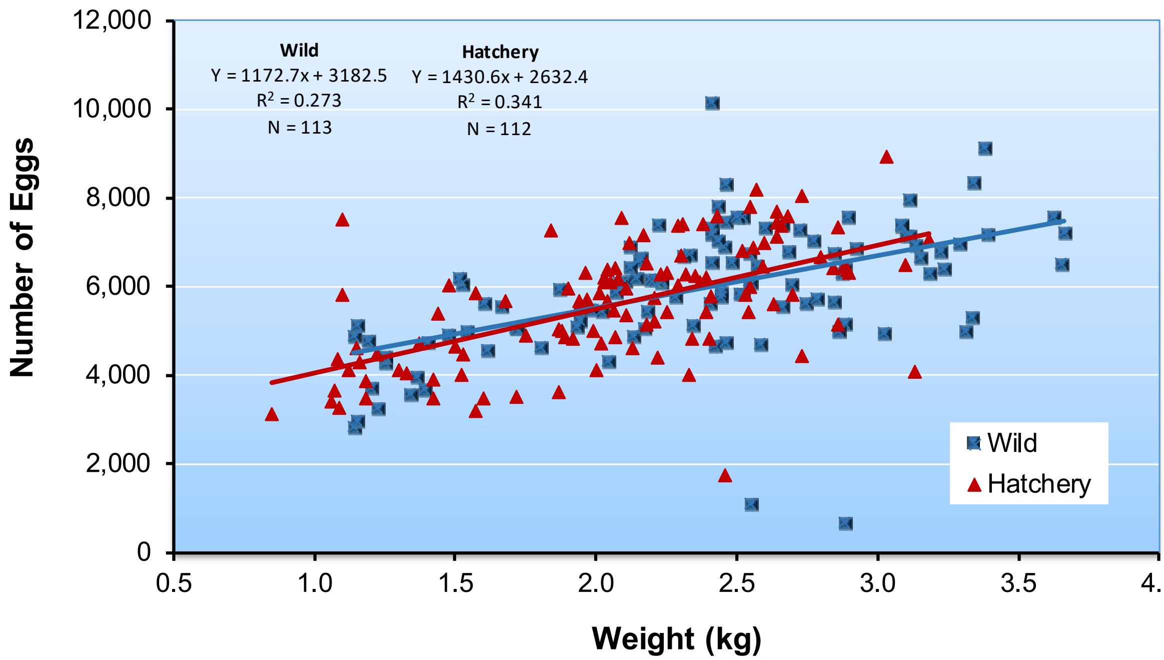


Figure 3.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural and hatchery-origin summer steelhead for return years 2013-2017.

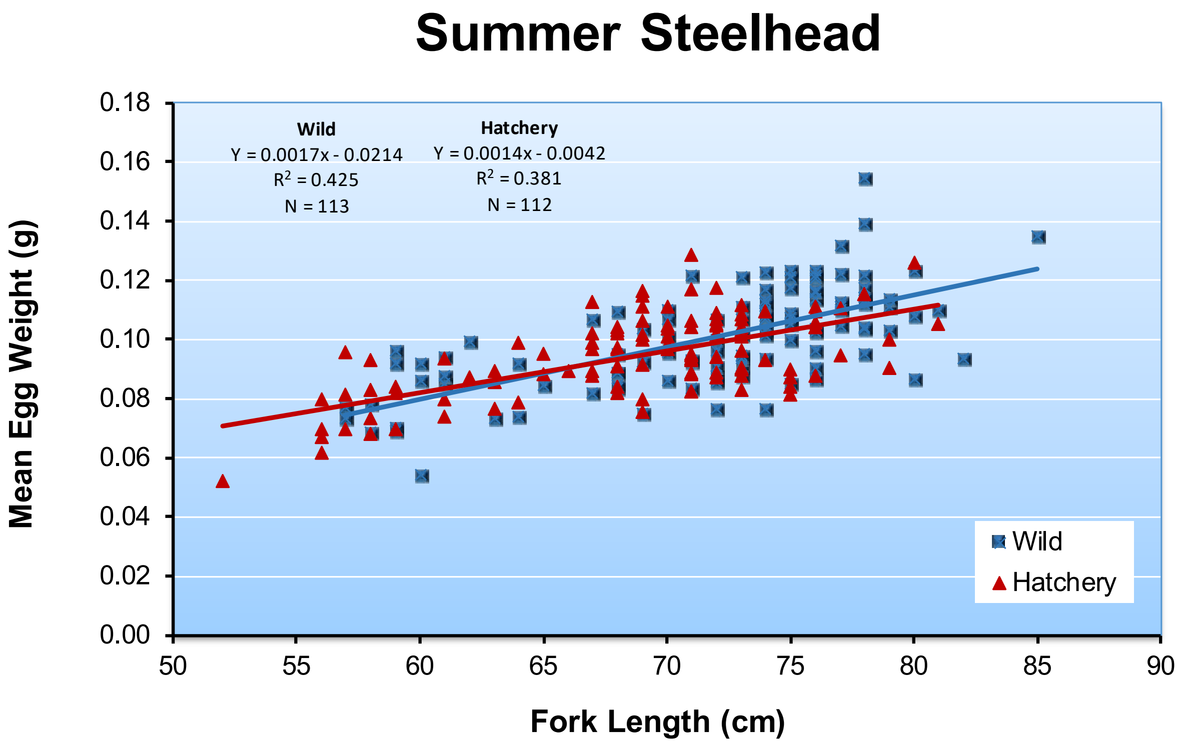


Figure 3.2. Relationships between mean egg weight and fork length for natural and hatchery-origin summer steelhead for return years 2013-2017.

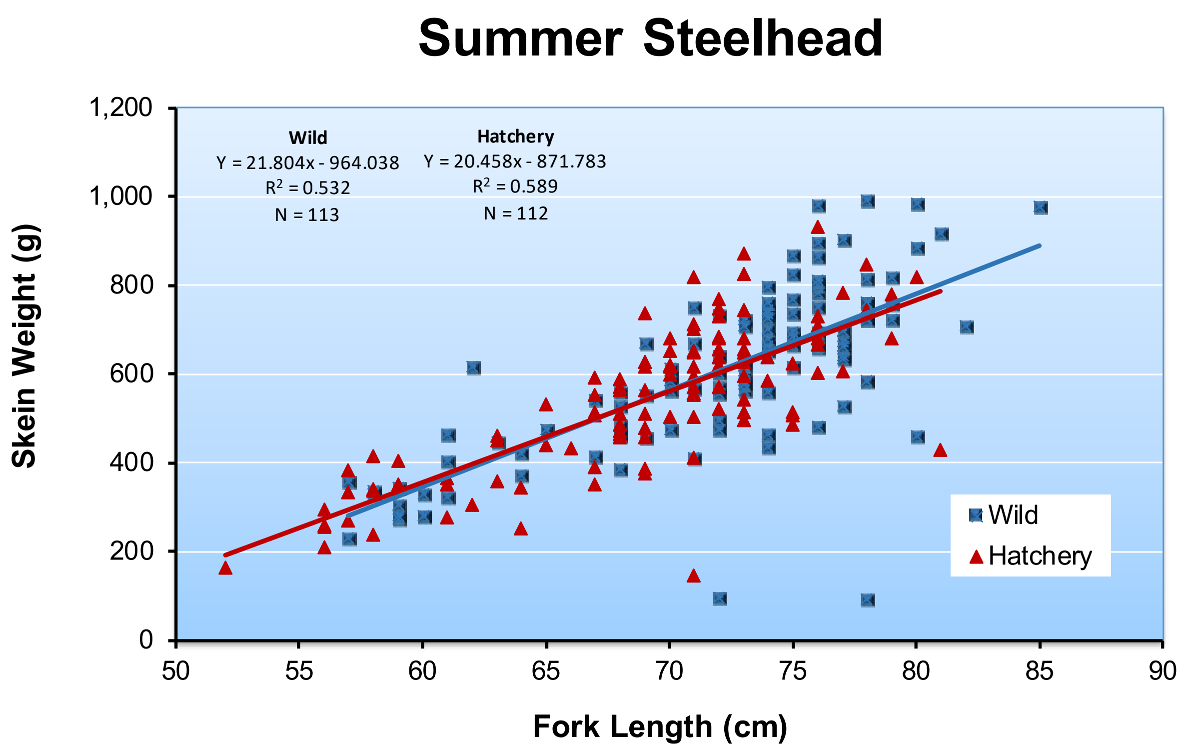


Figure 3.3. Relationships between skein weight and fork length for natural and hatchery-origin summer steelhead for return years 2013-2017.

3.2 Hatchery Rearing

Rearing History

Number of eggs taken

From 1998-2011, a total of 493,827 eggs were required to meet the program release goal of 400,000 smolts. This was based on the unfertilized egg-to-release survival standard of 81%. Since 2011, the egg take target has ranged from 352,280-380,651[7] in order to meet the revised release target of 247,300 smolts. Between 1998 and 2011, the egg take goal was reached 57% of the time (Table 3.7). Since 2011, the target has been reached or exceeded 100% of the time (Table 3.7).

Table 3.7. Numbers of eggs taken from steelhead broodstock, 1998-2017.

Brood year	Number of eggs taken
1998	224,315
1999	303,083
2000	280,872
2001	549,464

7 The egg take target varies from year to year because of variability in fecundity.

Brood year	Number of eggs taken
2002	503,030
2003	532,708
2004	408,538
2005	672,667
2006	546,382
2007	462,662
2008	439,980
2009	633,229
2010	499,499
2011	522,049
Average (1998-2011)	***488,782***
Median (1998-2001)	***501,265***
2012	371,151
2013	339,949
2014	395,453
2015	324,212
2016	341,511
2017	391,950
Average (2012-present)	***360,704***
Median (2012-present)	***356,331***

Number of acclimation days

Juvenile WxW steelhead from the Chelan Fish Hatchery and HxH steelhead from the Eastbank Fish Hatchery were transferred to Chiwawa Acclimation Facility in November 2016. In March 2017, about 25,000 HxH steelhead were transferred from the Chiwawa Acclimation Facility to Blackbird Pond near Leavenworth for final acclimation on Wenatchee River water. Fish were acclimated for 18 d at Blackbird Pond before a volitional release was initiated on 20 April. The remainder stayed at the Chiwawa Acclimation Facility until they were volitionally and forced released from the facility during late April to early-May.

Juvenile Wenatchee steelhead at the Chiwawa Acclimation Facility were acclimated and reared on Wenatchee and Chiwawa River water. Before 2012, Wenatchee steelhead were reared on Columbia River water from January through May before being trucked and released into the Wenatchee River basin (Table 3.8).

Table 3.8. Water source and mean acclimation period for Wenatchee steelhead, brood years 1998-2017.

Brood year	Release year	Parental origin	Water source	Number of Days
1998	1999	H x H	Wenatchee/Chiwawa	36
		H x W	Wenatchee/Chiwawa	36
		W x W	Wenatchee/Chiwawa	36
1999	2000	H x H	Wenatchee/Chiwawa	138

Brood year	Release year	Parental origin	Water source	Number of Days
		H x W	Wenatchee/Chiwawa	138
		W x W	Wenatchee/Chiwawa	138
		H x W	Eastbank	0
		W x W	Eastbank	0
2000	2001	H x H	Wenatchee/Chiwawa	122
		H x W	Wenatchee/Chiwawa	122
		H x W	Wenatchee/Chiwawa	122
		W x W	Wenatchee/Chiwawa	122
2001	2002	H x H	Columbia	92
		H x H	Wenatchee/Chiwawa	63
		H x W	Columbia	92
		H x W	Wenatchee/Chiwawa	63
		W x W	Columbia	153
2002	2003	H x H	Columbia	98
		H x W	Columbia	98
		W x W	Columbia	117
2003	2004	H x H	Columbia	88
		H x W	Wenatchee/Chiwawa	84
		W x W	Columbia	148
2004	2005	H x H	Columbia	160
		H x W	Columbia	160
		W x W	Columbia	160
2005	2006	H x H	Columbia	116
		H x W	Columbia	113
		W x W	Columbia	141
2006	2007	Early H x W	Columbia	111
		Late H x W	Columbia	112
		W x W	Columbia	148
2007	2008	Early H x W	Columbia	94-95
		Late H x W	Columbia	91-93
		W x W	Columbia	138
2008	2009	Early H x W	Columbia	120-121
		Early H x W	Columbia/Wenatchee	120-121/28-95
		Late H x W	Columbia	114-115
		W x W	Columbia	152-153
2009	2010	Early H x W	Columbia	93-94
		Early H x W	Columbia/Wenatchee	99-111

Brood year	Release year	Parental origin	Water source	Number of Days
		Early H x W	Wenatchee	31-129
		Late H x W	Columbia	84-87
		W x W	Columbia/Nason	118-120/28
2010	2011	H x H	Wenatchee	188-192
		H x H	Wenatchee	37-87
		H x H	Columbia	181
		W x W	Columbia	148-149
		W x W	Columbia/Nason	113-114/42-101
		W x W	Columbia	148-149
2011	2012	W x W	Wenatchee	160-201
		W x W	Wenatchee	179-188
		W x W	Wenatchee	21-72
		W x W	Nason	56-107
2012	2013	H x H	Wenatchee	168-189
		H x H	Wenatchee	168-225
		W x W	Wenatchee	168-225
		W x W	Wenatchee	168-189
		W x W	Chiwawa	187
2013	2014	H x H	Wenatchee[a]	7-67
		H x H	Wenatchee	168-169
		W x W	Wenatchee	176-197
		W x W	Wenatchee	179-204
2014	2015	H x H	Wenatchee[a]	41-110
		H x H	Wenatchee	161-179
		W x W	Wenatchee	157-172
		W x W	Wenatchee	168-171
2015	2016	H x H	Wenatchee[a]	23-81
		H x H	Wenatchee	156-172
		W x W	Wenatchee	162-178
		W x W	Wenatchee	160-176
2016	2017	H x H	Wenatchee[a]	16-83
		H x H	Wenatchee	166-185
		W x W	Wenatchee	166-185
		W x W	Wenatchee	169-183

[a] Steelhead overwintered in Pond 3 at the Chiwawa Acclimation Facility on Chiwawa River water before they were transferred to Blackbird Pond.

Release Information

Numbers released

In 2011, the HCP Hatchery Committee agreed to reduce the Wenatchee summer steelhead program from 400,000 smolts to 247,300 smolts. Based on this new goal and the number of WxW steelhead present, all HxH steelhead were transferred to the Ringold Fish Hatchery to be included in their production program for the 2012 release.

The release of 2016 brood Wenatchee steelhead achieved 103% of the 247,300 target with about 255,168 smolts released into the Wenatchee and Chiwawa rivers and Nason Creek (Table 3.9). Distribution of juvenile steelhead released in each of the three streams was determined by the mean proportion of steelhead redds in each basin. About 18.3% and 18.1% of the steelhead were released in Nason Creek and the Chiwawa River, respectively. The balance of the program was split between the Wenatchee River downstream from Tumwater Dam (16.0%) and the Wenatchee River upstream from the dam (47.6%).

Table 3.9. Numbers of steelhead smolts released from the hatchery, brood years 1998-2016. Before brood year 2011, the release target for steelhead was 400,000 smolts. Beginning with brood year 2011, the release target is 247,300 smolts.

Brood year	Release year	Number of smolts
1998	1999	172,078
1999	2000	175,701
2000	2001	184,639
2001	2002	335,933
2002	2003	302,060
2003	2004	374,867
2004	2005	294,114
2005	2006	452,184
2006	2007	299,937
2007	2008	306,690
2008	2009	327,143
2009	2010	484,772
2010	2011	354,314
Average (1998-2010)		***312,649***
Median (1998-2010)		***306,690***
2011	2012	206,397
2012	2013	249,004
2013	2014	229,836
2014	2015	264,758
2015	2016	195,344
2016	2017	255,168
Average (2011-present)		***233,418***
Median (2011-present)		***239,420***

Numbers marked

The 2016 brood conservation program for Wenatchee hatchery steelhead were marked with coded wire tags (CWT) in the snout (no adipose clip). The safety net program was marked with CWT in the snout and adipose fin clipped. The safety net program made up 47% of the juveniles released (Table 10).

Table 3.10. Release location and marking scheme for the 1998-2016 brood Wenatchee steelhead.

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	Number released
1998	Chiwawa River	H x H	0.000	Red Left	0.994	52,765
	Chiwawa River	H x W	0.000	Green Left	0.990	37,013
	Chiwawa River	W x W	0.000	Orange Left	0.827	82,300
1999	Wenatchee River	H x H	0.000	Green Left	0.911	45,347
	Wenatchee River	H x W	0.000	Orange Left	0.927	30,713
	Chiwawa River	H x H	0.000	Red Right	0.936	25,622
	Chiwawa River	H x W	0.000	Green Right	0.936	43,379
	Chiwawa River	W x W	0.000	Orange Right	0.936	30,600
2000	Chiwawa River	H x H	0.000	Red Left	0.963	33,417
	Chiwawa River	H x W	0.000	Green Left	0.963	57,716
	Chiwawa River	H x W	0.000	Green Right	0.949	48,029
	Chiwawa River	W x W	0.000	Orange Right	0.949	45,477
2001	Nason Creek	H x W	0.000	Green Right	0.934	75,276
	Nason Creek	W x W	0.000	Orange Right	0.934	48,115
	Chiwawa River	H x W	0.000	Green Left	0.895	92,487
	Chiwawa River	H x H	0.000	Red Left	0.895	120,055
2002	Chiwawa River	H x H	0.000	Red Left	0.920	156,145
	Chiwawa River	H x W	0.000	Green Left	0.928	33,528
	Nason Creek	W x W	0.000	Orange Right	0.928	112,387
2003	Wenatchee River	H x H	0.000	Red Left	0.968	117,663
	Chiwawa River	H x W	0.000	Green Left	0.927	191,796
	Nason Creek	W x W	0.000	Orange Right	0.962	65,408
2004	Wenatchee River	H x H	0.500	Red Left	0.804	39,636
	Chiwawa River	H x W	0.000	Green Left	0.977	153,959
	Nason Creek	W x W	0.000	Pink Right	0.940	100,519
2005	Wenatchee River	H x H	1.000	Red Left	0.983	104,552

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	Number released
	Wenatchee River	H x W	0.616	Green Left	0.979	190,319
	Chiwawa River	H x W	0.616	Green Left	0.979	18,634
	Chiwawa River	W x W	0.000	Pink Right	0.969	14,124
	Nason Creek	W x W	0.000	Pink Right	0.969	124,555
2006	Wenatchee River	H x W (early)	1.000	Green Right	0.918	66,022
	Wenatchee River	H x W (late)	0.671	Green Left	0.935	92,176
	Chiwawa River	H x W (late)	0.671	Green Left	0.935	41,240
	Chiwawa River	W x W	0.000	Pink Right	0.945	7,500
	Nason Creek	W x W	0.000	Pink Right	0.945	92,999
2007	Wenatchee River	H x W (early)	0.967	Green Right	0.950	64,310
	Wenatchee River	H x W (late)	0.586	Green Left	0.951	97,549
	Chiwawa River	H x W (late)	0.586	Green Left	0.951	43,011
	Chiwawa River	W x W	0.000	Pink Right	0.952	7,026
	Nason Creek	W x W	0.000	Pink Right	0.952	94,794
2008	Blackbird Pond	HxW (early)	0.917	Green Right	0.910	49,878
	Wenatchee River	H x W (early)	0.917	Green Right	0.910	48,624
	Wenatchee River	H x W (late)	0.595	Green Left	0.908	74,848
	Chiwawa River	H x W (late)	0.595	Green Left	0.908	25,835
	Chiwawa River	W x W	0.000	Pink Right	0.904	25,778
	Nason Creek	W x W	0.000	Pink Right	0.904	102,170
2009	Blackbird Pond	H x W (early)	0.969	Green Right	0.934	50,248
	Wenatchee River	H x W (early)	0.969	Green Right	0.934	105,239
	Wenatchee River	H x W (late)	0.973	Green Left	0.975	27,612
	Wenatchee River	H x W (late)	0.000	Green Left	0.975	45,435
	Chiwawa River	H x W (early)	0.969	Green Right	0.934	23,835
	Chiwawa River	H x W (late)	0.973	Green Left	0.975	33,047
	Chiwawa River	H x W (late)	0.000	Green Left	0.975	54,381
	Nason Creek	W x W	0.000	Pink Right	0.979	145,029
2010	Wenatchee River	H x H	0.994	-	0.984	24,838
	Wenatchee River	H x H	0.994	-	0.984	45,000
	Wenatchee River	H x H	0.994	-	0.984	92,113
	Chiwawa River	W x W	0.000	Pink Right	0.917	81,174

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	Number released
	Nason Creek	W x W	0.000	Pink R/Pink L	0.884	20,000
	Nason Creek	W x W	0.000	Pink Right	0.917	91,189
2011	Wenatchee River	W x W	0.985	CWT	0.953	70,885
	Wenatchee River	W x W	0.985	CWT	0.953	24,992
	Wenatchee River	W x W	0.000	CWT	0.987	25,569
	Chiwawa River	W x W	0.985	CWT	0.953	31,050
	Nason Creek	W x W	0.000	CWT	0.989	18,254
	Nason Creek	W x W	0.985	CWT	0.953	36,225
2012	Wenatchee River	W x W	0.000	CWT	0.965	14,824
	Wenatchee River	H x H	1.000	AD/CWT	0.920	9,841
	Wenatchee River	W x W	0.000	CWT	0.965	28,362
	Wenatchee River	H x H	1.000	AD/CWT	0.920	76,695
	Chiwawa River	W x W	0.000	CWT	0.965	12,760
	Chiwawa River	H x H	1.000	AD/CWT	0.920	34,503
	Nason Creek	W x W	0.000	CWT	0.965	43,854
	Nason Creek	W x W	0.000	CWT	0.965	28,165
2013	Wenatchee River	W x W	0.000	CWT	0.963	36,736
	Wenatchee River	H x H	0.998	AD/CWT	0.990	55,055
	Wenatchee River	H x H	0.998	AD/CWT	0.990	25,316
	Chiwawa River	W x W	0.000	CWT	0.963	9,360
	Chiwawa River	H x H	0.998	AD/CWT	0.990	14,040
	Nason Creek	W x W	0.000	CWT	0.963	50,503
	Nason Creek	H x H	0.998	AD/CWT	0.990	38,826
2014	Wenatchee River	W x W	0.000	CWT	0.968	72,345
	Wenatchee River	H x H	0.996	AD/CWT	0.996	58,130
	Wenatchee River	H x H	0.996	AD/CWT	0.996	28,122
	Chiwawa River	W x W	0.000	CWT	0.968	20,443
	Chiwawa River	H x H	0.996	AD/CWT	0.996	14,599
	Nason Creek	W x W	0.000	CWT	0.968	41,188
	Nason Creek	H x H	0.996	AD/CWT	0.996	29,931
2015	Wenatchee River	W x W	0.000	CWT	0.972	52,446
	Wenatchee River	H x H	0.993	AD/CWT	0.980	28,633

Brood year	Release location	Parental origin	Proportion Ad-clip	CWT or VIE color/side	Tag rate	Number released
	Wenatchee River	H x H	0.993	AD/CWT	0.980	21,386
	Chiwawa River	W x W	0.000	CWT	0.972	20,022
	Chiwawa River	H x H	0.993	AD/CWT	0.980	17,752
	Nason Creek	W x W	0.000	CWT	0.972	35,148
	Nason Creek	H x H	0.993	AD/CWT	0.980	19,957
2016	Wenatchee River	W x W	0.000	CWT	0.968	68,976
	Wenatchee River	H x H	0.998	AD/CWT	0.963	92,387
	Wenatchee River	H x H	1.000	AD/CWT	0.999	933
	Chiwawa River	W x W	0.000	CWT	0.968	21,292
	Chiwawa River	H x H	0.998	AD/CWT	0.963	24,741
	Chiwawa River	H x H	1.000	AD/CWT	0.960	251
	Nason Creek	W x W	0.000	CWT	0.968	34,403
	Nason Creek	H x H	0.998	AD/CWT	0.963	12,063
	Nason Creek	H x H	1.000	AD/CWT	0.967	122

Numbers PIT tagged

Table 3.11 summarizes the number of hatchery steelhead of different parental origins that have been PIT-tagged and released into the Wenatchee River basin.

Table 3.11. Summary of PIT-tagging activities for Wenatchee hatchery steelhead, brood years 2006-2016.

Brood year	Release location	Parental origin	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2006	Wenatchee River	H x W (early)	10,036	479	24	9,533
	Wenatchee/Chiwawa rivers	H x W (late)	10,031	922	20	9,089
	Chiwawa River/Nason	W x W	10,019	152	352	9,515
2007	Wenatchee River	H x W (early)	9,852	22	10	9,820
	Wenatchee/Chiwawa rivers	H x W (late)	10,063	73	78	9,912
	Chiwawa River/Nason	W x W	10,038	55	1	9,982
2008	Wenatchee River	H x W (early)	10,101	59	15	10,027
	Wenatchee/Chiwawa rivers	H x W (late)	10,104	106	17	9,981
	Chiwawa River/Nason	W x W	10,101	159	80	9,862
2009	Wenatchee/Chiwawa rivers	H x W (early)	10,114	574	11	9,529
	Wenatchee (Blackbird)	H x W (early)	8,100	0	0	8,100

Brood year	Release location	Parental origin	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
	Wenatchee/Chiwawa rivers	H x W (late)	10,115	271	11	9,833
	Chiwawa pilot	H x W (early)	10,107	532	103	9,472
	Chiwawa River/Nason	W x W	10,101	38	3	10,060
2010	Wenatchee River	HxH	10,100	624	21	9,455
	Chiwawa River/Nason	WxW	10,100	206	0	9,894
	Wenatchee (Blackbird)	HxH	10,101	235	8	9,858
	Wenatchee River	HxH	10,100	46	28	10,026
2011	Wenatchee/Chiwawa/Nason	WxW (circular)	10,101	139	30	9,932
	Wenatchee/Chiwawa/Nason	WxW (raceway)	20,220	121	35	20,064
2012	Wenatchee/Chiwawa/Nason	WxW (circular)	15,244	176	4	15,064
	Wenatchee/Chiwawa/Nason	HxH (raceway)	10,223	140	13	10,070
2013	Wenatchee/Chiwawa/Nason	WxW	5,100	95	1	5,004
	Wenatchee/Chiwawa/Nason	HxH	10,201	84	12	10,105
2014	Wenatchee/Chiwawa/Nason	WxW	9,051	53	0	8,998
	Wenatchee/Chiwawa/Nason	HxH	10,129	243	76	9,810
2015	Wenatchee/Chiwawa/Nason	WxW	12,101	60	0	12,041
	Wenatchee/Chiwawa/Nason	HxH	11,115	55	0	11,060
2016	Wenatchee/Chiwawa/Nason	WxW	5,050	183	3	4,864
	Wenatchee/Chiwawa/Nason	HxH & WxW	12,626	204	7	12,415
	Wenatchee (Blackbird)	HxH	2,525	2	11	2,512

2017 Brood Wenatchee WxW Summer Steelhead (Circular Ponds)—A total of 11,110 Wenatchee WxW summer steelhead were PIT tagged at the Chiwawa Acclimation Facility on 20-23 March 2018. These fish were tagged in circular ponds. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 150-151 mm in length and 34-39 g at time of tagging.

2017 Brood Wenatchee HxH and WxW Summer Steelhead (Raceway)—A total of 22,220 Wenatchee HxH and WxW summer steelhead were PIT tagged at the Chiwawa Acclimation Facility on 26 February to 8 March 2018. These fish were tagged in raceway #2. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 108-146 mm in length and 14-35 g at time of tagging.

Fish size and condition at release

Except for the Blackbird Pond release, all 2016 brood steelhead were trucked and released in April and May 2017. The Blackbird Pond group was released volitionally beginning on 20 April. Both

WxW and HxH fish did not meet the targets for length, weight, or coefficient of variation (CV) for fork length (Table 3.12). The HxH group was combined with the WxW group in Pond 2 once they were transferred to Chiwawa Acclimation Facility. The HxH fish were larger than the WxW fish at the time of transfer but smaller at the time of release.

Table 3.12. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of steelhead smolts released from the hatchery, brood years 1998-2016. Size targets are provided in the last row of the table.

Brood year	Release year	Parental origin	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
1998	1999	H x H	201	11.1	92.3	5
		H x W	190	12.8	76.9	6
		W x W	173	12.0	55.3	8
1999	2000	H x H	181	8.9	70.6	6
		H x W	187	7.2	75.3	6
		W x W	184	11.3	71.5	6
2000	2001	H x H	218	15.2	122.4	4
		H x W	209	10.6	107.5	4
		W x W	205	10.7	100.9	5
2001	2002	H x H	179	17.4	67.0	7
		H x W	192	15.6	82.8	6
		W x W	206	11.6	102.6	4
2002	2003	H x H	194	13.1	83.0	6
		H x W	191	13.0	77.4	6
		W x W	180	19.1	70.3	7
2003	2004	H x H	191	14.4	73.1	6
		H x W	199	12.9	83.9	5
		W x W	200	11.1	90.1	5
2004	2005	H x H	204	11.3	87.2	6
		H x W	202	13.5	71.9	5
		W x W	198	12.4	76.6	6
2005	2006	H x H	215	12.6	116.6	4
		H x W	198	11.8	86.3	5
		W x W	189	15.4	55.3	6
2006	2007	H x H (early)	213	12.1	109.6	4
		H x W (late)	186	11.8	68.3	7
		W x W	178	11.1	58.6	8
2007	2008	H x W (early)	192	17.4	77.1	6
		H x W (late)	179	19.3	63.8	7

Brood year	Release year	Parental origin	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
		W x W	183	12.3	62.8	7
2008	2009	H x W (early)	184	11.6	68.0	7
		H x W (late)	186	11.6	73.5	6
		W x W	181	13.0	59.7	8
2009	2010	H x W (early)	197	11.3	84.2	5
		H x W (late)	192	11.1	72.7	6
		W x W	190	9.6	70.5	6
2010	2011	H x H	183	14.1	68.9	4
		W x W	188	10.5	68.1	7
2011	2012	H x H	NA	NA	NA	NA
		W x W	156	17.1	45.2	10
2012	2013	H x H / W x W	150	16.1	40.8	11
		H x H / W x W	157	16.4	45.0	10
		W x W	156	18.7	49.0	9
2013	2014	H x H / W x W	157	14.5	49.4	9
		H x H	127	16.2	26.8	17
		W x W	162	20.4	55.8	8
2014	2015	H x H / W x W	152	15.4	40.9	11
		H x H	145	13.5	36.6	12
		W x W	162	15.3	50.6	9
2015	2016	H x H / W x W	163	16.1	53.1	9
		H x H	162	9.4	46.1	10
		W x W	180	13.8	70.6	6
2016	2016	H x H / W x W	155	19.3	44.6	10
		H x H	147	11.0	32.6	14
		W x W	152	19.9	42.6	9
Targets			***191***	***9.0***	***75.6***	***6***

Survival Estimates

Overall survival of Wenatchee steelhead (WxW and HxH) from green (unfertilized) egg to release was below the standard set for the program. This is largely because of lower unfertilized egg to eyed egg survival and ponding to release survival (Table 3.13).

The Wenatchee steelhead program, from its inception, has experienced highly variable fertilization rates. It is unknown at this time what mechanisms may be influencing stock performance at these stages.

Table 3.13. Hatchery life-stage survival rates (%) for steelhead, brood years 1998-2016. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1998	92.0	100.0	85.5	91.7	99.2	98.8	97.8	99.9	76.7
1999	91.2	100.0	66.9	93.0	95.9	94.9	93.1	99.7	58.0
2000	83.9	96.2	77.6	86.7	99.3	98.9	97.7	99.5	65.7
2001	90.0	100.0	73.0	91.8	99.1	97.8	91.3	99.7	61.1
2002	99.0	100.0	69.2	93.1	95.9	94.4	89.6	89.6	60.0
2003	87.0	96.8	86.3	83.8	97.2	94.8	97.6	85.3	70.4
2004	97.6	98.5	83.4	93.7	97.8	94.1	92.2	99.9	72.0
2005	91.3	95.1	81.3	92.1	95.6	91.8	89.7	99.6	67.2
2006	99.1	95.3	73.2	85.4	95.4	94.6	87.8	98.5	54.9
2007	100.0	100.0	80.3	92.0	95.7	92.7	89.8	99.1	66.3
2008	100.0	100.0	87.1	88.4	99.0	97.4	96.6	99.5	74.4
2009	97.3	100.0	89.0	97.2	96.0	95.2	88.6	96.6	76.6
2010	96.7	100.0	93.8	93.9	91.0	86.2	80.6	96.0	70.9
2011[a]	96.3	94.4	74.2	97.7	96.6	89.5	86.4	98.4	62.7
2012	95.2	98.4	74.7	99.7	97.8	94.0	90.1	98.9	67.1
2013	80.8	97.0	75.0	96.5	97.8	96.6	93.4	99.2	67.6
2014	100.0	100.0	83.3	96.7	95.8	89.9	87.9	98.7	70.8
2015	93.3	98.6	68.5	94.9	96.6	95.8	92.7	97.8	60.3
2016	100	100	86.9	97.5	99	97.4	88.2	94.7	74.7
Average	***94.2***	***98.4***	***79.4***	***92.9***	***96.9***	***94.5***	***91.1***	***97.4***	***67.2***
Median	***96.3***	***100.0***	***80.3***	***93.1***	***96.6***	***94.8***	***90.1***	***98.9***	***67.2***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival estimates are only for WxW steelhead.

3.3 Disease Monitoring

Rearing of the 2016 brood Wenatchee summer steelhead was similar to previous years with fish being held on Chelan spring water, Eastbank well water, and Chelan well water before being transferred for overwinter acclimation at the Chiwawa Acclimation Facility. Volitional and force-released fish were released into Nason Creek, Chiwawa River, and the Wenatchee River. The 2016 WxW Wenatchee steelhead had no significant health issues during the rearing period.

3.4 Natural Juvenile Productivity

During 2017, juvenile steelhead were sampled at the Lower Wenatchee, Chiwawa, and Nason Creek traps and counted during snorkel surveys within the Chiwawa River basin. Because the snorkel surveys targeted juvenile Chinook salmon, the entire distribution of juvenile steelhead in the Chiwawa River basin was not surveyed. Therefore, the parr numbers presented below represent a minimum estimate.

Parr Estimates

A total of 17,296 (±10%) age-0 (<100 mm) and 6,923 (±7%) age-1+ (100-200 mm)[8] steelhead/rainbow were estimated in the Chiwawa River basin in August 2017 (Table 3.14 and 3.15). During the survey period 1992-2017, numbers of age-0 and 1+ steelhead/rainbow have ranged from 1,410 to 45,727 and 754 to 22,130, respectively, in the Chiwawa River basin (Table 3.14 and 3.15; Figure 3.4). Numbers of all fish counted in the Chiwawa River basin are reported in Appendix A.

Juvenile steelhead/rainbow were distributed primarily throughout the lower seven reaches of the Chiwawa River (downstream from Rock Creek). Their densities were highest in the lower portions of the river and in tributaries. Age-0 steelhead/rainbow most often used riffle and multiple channel habitats in the Chiwawa River, although they also associated with woody debris in pool and glide habitat. In tributaries, they were generally most abundant in small pools. Those that were observed in riffles selected stations in quiet water behind small and large boulders, or occupied stations in quiet water along the stream margin. In pool and multiple-channel habitats, age-0 steelhead/rainbow used the same kinds of habitat as age-0 Chinook salmon.

Age-1+ steelhead/rainbow most often used pool, riffle, and multiple-channel habitats. Those that used pools were usually in deeper water than subyearling steelhead/rainbow and Chinook salmon. Like age-0 steelhead/rainbow, age-1+ steelhead/rainbow generally selected stations in quiet water behind boulders in riffles, but the two age groups rarely occurred together. Age-1+ steelhead/rainbow used deeper and faster water than did subyearling steelhead/rainbow.

Table 3.14. Total numbers of age-0 steelhead/rainbow trout estimated in different steams in the Chiwawa River basin during snorkel surveys in August 1992-2017; NS = not sampled.

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
1992	4,927	NS	NS	NS	NS	NS	NS	NS	NS	**4,927**
1993	3,463	0	356	185	NS	NS	NS	NS	NS	**4,004**
1994	953	0	256	24	0	177	0	0	0	**1,410**
1995	6,005	0	744	90	0	371	40	107	0	**7,357**
1996	3,244	0	71	40	0	763	127	0	0	**4,245**
1997	6,959	224	84	324	0	1,124	58	50	0	**8,823**
1998	2,972	22	280	96	113	397	18	22	0	**3,921**
1999	5,060	20	253	189	0	255	34	27	0	**5,838**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	35,759	192	1,449	1,826	0	6,345	156	0	0	**45,727**
2002	12,137	0	2,252	889	0	4,948	277	18	0	**20,521**
2003	9,911	296	996	1,166	96	5,366	73	116	0	**18,020**
2004	8,464	110	583	113	40	957	35	78	0	**10,380**
2005	4,852	120	2,931	477	45	2,973	65	0	0	**11,463**
2006	10,669	21	858	872	34	3,647	73	71	0	**16,245**
2007	8,442	53	2,137	348	11	2,955	65	28	34	**14,073**
2008	9,863	0	2,260	859	0	1,987	57	168	36	**15,230**

[8] A steelhead/rainbow trout larger than 200 mm (8 in) was considered a resident trout.

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
2009	13,231	0	1,183	449	0	2,062	170	67	17	**17,179**
2010	17,572	0	2,870	1,478	5	2,843	182	35	33	**25,018**
2011	35,825	0	1,503	804	0	1,066	56	152	40	**39,446**
2012	21,537	0	1,817	1,501	0	2,164	42	54	19	**27,134**
2013	17,889	0	602	816	0	2,189	44	99	43	**21,682**
2014	12,256	21	1,617	1,039	0	1,005	32	56	57	**16,083**
2015	4,532	0	1,989	1,675	0	1,761	170	62	19	**10,208**
2016	10,971	0	1,419	996	0	2,721	50	62	25	**16,244**
2017	10,120	0	2,127	1,025	0	3,954	36	22	12	**17,296**
Average	***11,105***	***45***	***1,277***	***720***	***15***	***2,262***	***81***	***56***	***15***	***15,299***
Median	***9,863***	***0***	***1,301***	***810***	***0***	***2,062***	***57***	***54***	***0***	***15,230***

Table 3.15. Total numbers of age-1+ steelhead/rainbow trout estimated in different steams in the Chiwawa River basin during snorkel surveys in August 1992-2017; NS = not sampled.

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
1992	2,533	NS	NS	NS	NS	NS	NS	NS	NS	**2,533**
1993	2,530	0	228	102	NS	NS	NS	NS	NS	**2,860**
1994	4,972	0	476	296	5	107	0	0	0	**5,856**
1995	8,769	0	494	71	0	183	0	0	0	**9,517**
1996	11,381	0	6	27	0	435	0	0	0	**11,849**
1997	6,574	160	0	105	0	66	0	0	0	**6,905**
1998	10,403	0	133	49	0	0	0	0	0	**10,585**
1999	21,779	0	68	201	0	82	0	0	0	**22,130**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	9,368	16	186	407	0	646	0	0	0	**10,623**
2002	7,200	0	199	165	0	1,526	0	0	0	**9,090**
2003	4,745	362	426	599	0	47	0	0	0	**6,179**
2004	7,700	107	209	0	0	174	0	0	0	**8,190**
2005	4,624	63	957	257	0	287	0	0	0	**6,188**
2006	7,538	76	748	1,186	0	985	0	0	0	**10,533**
2007	6,976	0	945	96	0	431	0	0	0	**8,448**
2008	8,317	0	1,168	298	0	793	0	0	0	**10,576**
2009	4,998	16	320	102	0	167	21	0	5	**5,629**
2010	8,324	32	366	393	0	780	21	0	0	**9,916**
2011	13,329	0	415	470	0	689	0	0	0	**14,903**
2012	7,671	0	285	410	0	210	0	0	0	**8,576**
2013	6,439	0	0	48	0	766	0	0	0	**7,253**
2014	4,568	13	96	211	0	165	0	0	31	**5,084**
2015	614	0	40	100	0	0	0	0	0	**754**

Sample Year	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
2016	3,418	0	256	40	0	309	0	8	0	**4,031**
2017	5,535	0	415	76	0	897	0	0	0	**6,923**
Average	***7,212***	***35***	***352***	***238***	***0***	***424***	***2***	***0***	***2***	***8,205***
Median	***6,976***	***0***	***271***	***135***	***0***	***287***	***0***	***0***	***0***	***8,190***

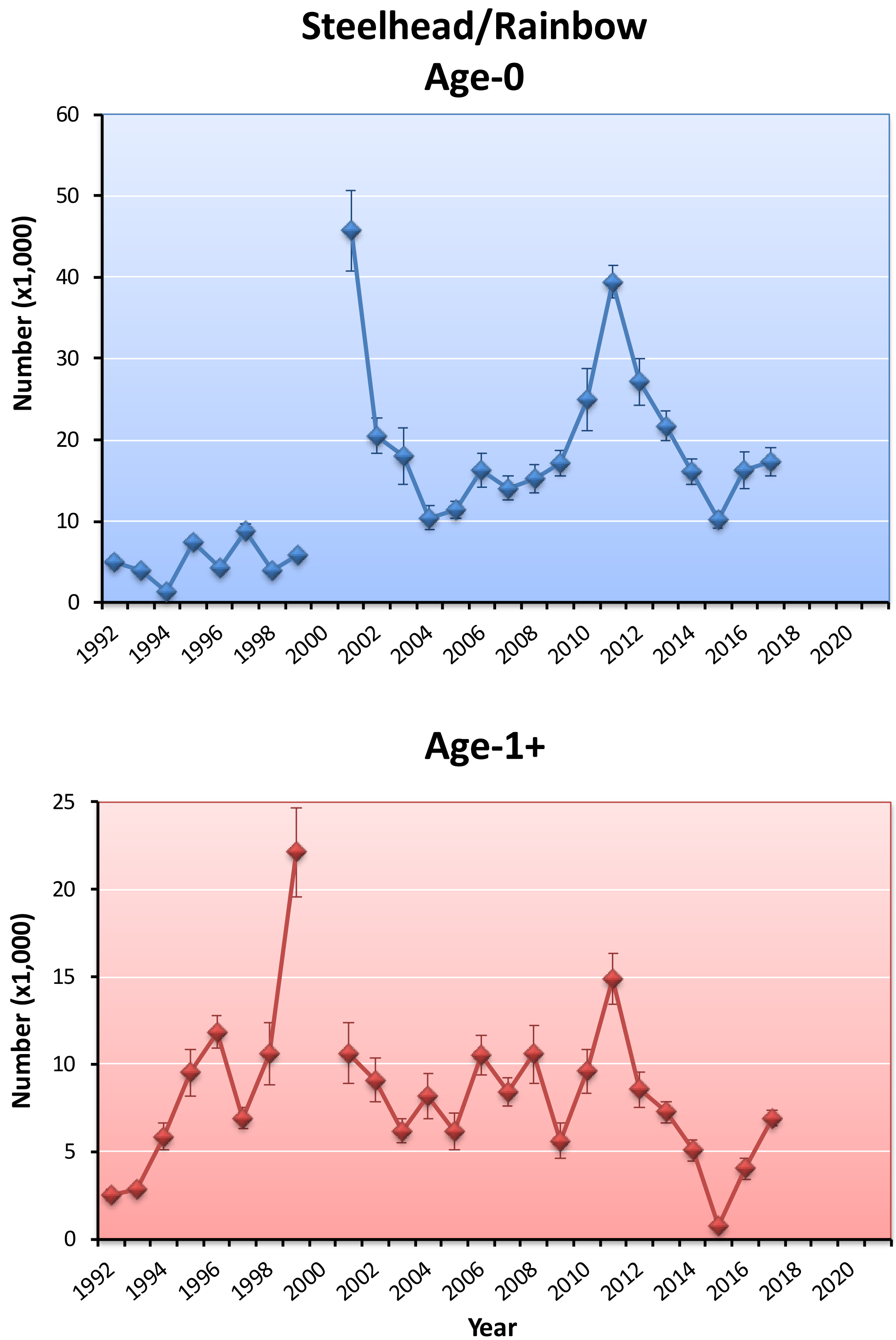


Figure 3.4. Numbers of subyearling and yearling steelhead/rainbow trout within the Chiwawa River basin in August 1992-2017; ND = no data. Vertical bars indicate 95% confidence bounds.

Emigrant and Smolt Estimates

Numbers of steelhead smolts and emigrants were estimated at the Chiwawa, Nason, and Lower Wenatchee traps in 2017.

Chiwawa Trap

The Chiwawa Trap operated between 23 March and 29 November 2017. During the trapping period, the trap was inoperable for 36 days because of high or low river discharge, debris, major hatchery releases, and mechanical issues. Throughout the trapping season, the trap operated in two positions, the standard position, and a new, low-flow position. Monthly captures of all fish collected at the Chiwawa Trap are reported in Appendix B.

A total of 244 wild steelhead/rainbow smolts, 3,901 hatchery smolts, 837 wild parr and fry, and 4 hatchery parr were captured at the Chiwawa Trap in 2017. Based on capture efficiencies, the total number of wild steelhead (including fry, parr, and smolts/transitionals) from the Chiwawa River basin was 28,142 (95% CI = ±91,356). Removing fry from the estimate, a total of 27,849 (±129,192) juvenile steelhead emigrated from the Chiwawa River basin in 2017 (Table 3.16). Most (61%) of the hatchery steelhead were collected in May, while most (75%) of the wild steelhead smolts were captured in April through June (Figure 3.5). Although steelhead/rainbow parr and fry emigrated throughout the sampling period, peaks in emigration were observed in April through June and in October (Figure 3.5). Of the total number of wild steelhead captured, 77% were classified as parr and fry. No mark-recapture efficiency trials were conducted in 2017.

Table 3.16. Estimated numbers of wild steelhead that emigrated from the Chiwawa River basin during migration years 2015-2017. Estimates are provided with and without fry. Numbers in parentheses indicate 95% confidence intervals.

Migration year	Numbers of wild steelhead migrants	
	Migrants (excluding fry)	Migrants (including fry)
2015	46,500 (±156,250)	52,274 (±156,251)
2016	32,277 (±108,458)	34,092 (±114,557)
2017	27,849 (±129,192)	28,142 (±91,356)
Average	***35,542***	***38,168***
Median	***32,277***	***34,092***

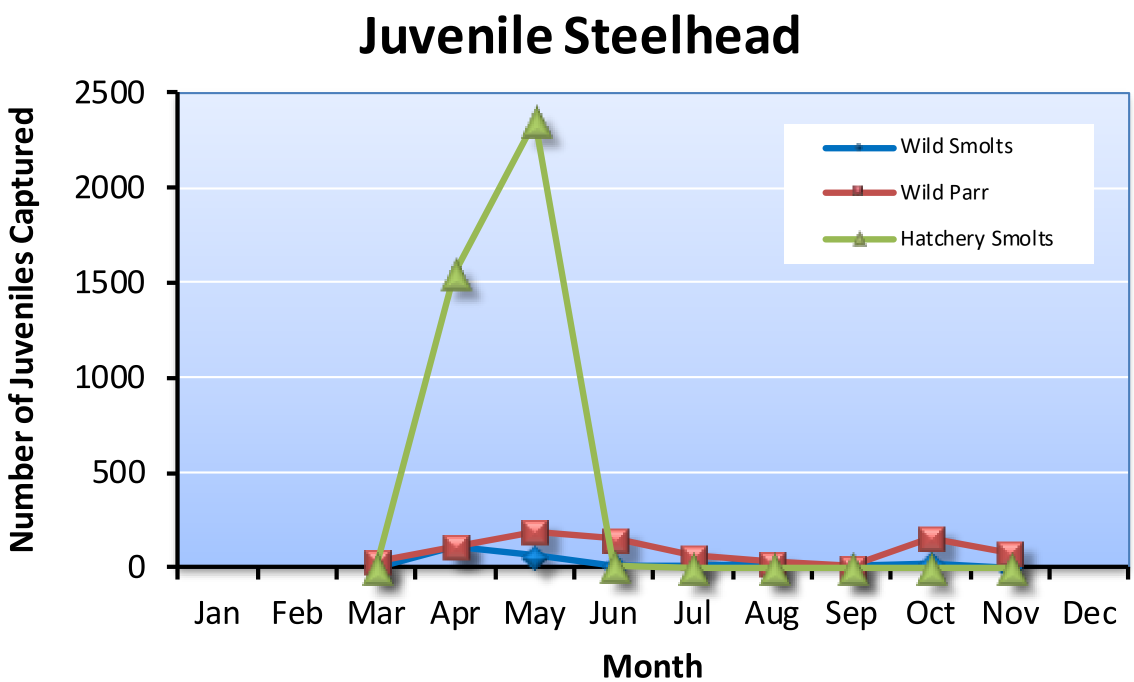


Figure 3.5. Monthly captures of wild smolts, wild parr, and hatchery smolt steelhead/rainbow at the Chiwawa Trap, 2017.

Wild steelhead smolts/transitionals sampled in 2017 averaged 156 mm in length, 39.4 g in weight, and had a mean condition of 0.97 (Table 3.17). These size estimates were similar to the overall mean of steelhead smolts/transitionals sampled in previous years (overall means: 157 mm, 42.3 g, and condition of 1.03). Wild steelhead parr sampled in 2017 at the Chiwawa Trap averaged 85 mm in length, averaged 7.6 g, and had a mean condition of 1.03 (Table 3.17). Parr sampled in 2017 were similar to the overall mean of parr sampled in previous years (overall means, 82 mm, 7.1 g, and condition of 1.15).

Table 3.17. Mean fork length (mm), weight (g), and condition factor of wild juvenile steelhead collected in the Chiwawa Trap, 2015-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2015	Fry	345	37 (9)	0.7 (0.5)	1.42 (0.94)
	Parr	2,280	76 (23)	6.0 (7.9)	1.37 (1.05)
	Smolt/Transitional	258	167 (22)	50.1 (19.1)	1.07 (1.02)
2016	Fry	112	37 (8)	0.6 (0.4)	0.90 (0.21)
	Parr	1,406	84 (23)	7.8 (9.4)	1.06 (0.38)
	Smolt/Transitional	195	147 (33)	37.3 (23.7)	1.04 (0.20)
2017	Fry	18	37 (8)	0.7 (0.4)	0.98 (0.29)
	Parr	784	85 (24)	7.6 (7.9)	1.03 (0.08)
	Smolt/Transitional	244	156 (24)	39.4 (17.3)	0.97 (0.09)
Average	***Fry***	***158***	37	0.7	1.10

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Parr	***1,490***	82	7.1	1.15
	Smolt/Transitional	***232***	157	42.3	1.03
Median	***Fry***	***112***	37	0.7	0.98
	Parr	***1,406***	84	7.6	1.06
	Smolt/Transitional	***244***	156	39.4	1.04

[a] Sample size represents the number of fish that were measured for both length and weight.

White River Trap

The White River Trap operated between 1 March and 30 November 2017. During that period, the trap was intentionally pulled for four days during periods of high discharge. Because so few steelhead are capture in the trap and there is no flow-efficiency model for the trap, there are no estimates of total steelhead emigration. However, the few steelhead captured with the trap were enumerated and measured. In 2017, wild steelhead parr averaged 141 mm in length, 29.2 g in weight, and had a mean condition of 1.02 (Table 3.18). These size estimates were less than the overall mean of steelhead parr sampled in previous years (overall means: 156 mm, 47.1 g, and condition of 1.04). No wild steelhead smolts/transitionals were collected in the White River in 2017.

Table 3.18. Mean fork length (mm), weight (g), and condition factor of steelhead smolts collected in the White River Trap, 2007-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2007	Fry	0	–	–	–
	Parr	8	166 (32)	50.2 (21.3)	1.06 (0.37)
	Smolt/Transitional	0	–	–	–
2008	Fry	0	–	–	–
	Parr	14	150 (50)	47.8 (42.3)	1.06 (0.21)
	Smolt/Transitional	0	–	–	–
2009	Fry	0	–	–	–
	Parr	12	180 (30)	64.1 (30.7)	1.02 (0.13)
	Smolt/Transitional	0	–	–	–
2010	Fry	0	–	–	–
	Parr	11	155 (40)	57.6 (30.9)	1.12 (0.15)
	Smolt/Transitional	0	–	–	–
2011	Fry	0	–	–	–
	Parr	5	141 (20)	32.9 (12.7)	1.12 (0.04)
	Smolt/Transitional	0	–	–	–
2012	Fry	1	30	0.1	0.37
	Parr	3	177 (10)	56.5 (10.9)	1.01 (0.01)

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Smolt/Transitional	2	200 (13)	78.6 (19.2)	0.98 (0.04)
2013	Fry	0	–	–	–
	Parr	7	141 (50)	39 (44.4)	1.05 (0.11)
	Smolt/Transitional	1	153	38.8	1.08
2014	Fry	0	–	–	–
	Parr	5	165 (50)	56.9 (40.4)	1.04 (0.07)
	Smolt/Transitional	0	–	–	–
2015	Fry	0	–	–	–
	Parr	5	156 (61)	51.3 (43.1)	0.95 (0.10)
	Smolt/Transitional	1	167	57.5	1.23
2016	Fry	0	–	–	–
	Parr	5	145 (23)	32.9 (12.6)	1.02 (0.06)
	Smolt/Transitional	0	–	–	–
2017	Fry	0	–	–	–
	Parr	2	141 (13)	29.2 (10.9)	1.02 (0.10)
	Smolt/Transitional	0	–	–	–
Average	***Fry***	***0 (0)***	***30***	***0.1***	***0.37***
	Parr	***7 (4)***	***156 (14)***	***47.1 (11.8)***	***1.04 (0.05)***
	Smolt/Transitional	***0 (1)***	***173 (24)***	***58.3 (19.9)***	***1.10 (0.13)***
Median	***Fry***	***0 (0)***	***30***	***0.1***	***0.37***
	Parr	***5 (4)***	***155 (14)***	***50.2 (11.8)***	***1.04 (0.05)***
	Smolt/Transitional	***0 (1)***	***167 (24)***	***57.5 (19.9)***	***1.08 (0.13)***

Nason Creek Trap

The Nason Creek Trap operated between 1 March and 30 November 2017. During the nine-month sampling period the trap was inoperable for 71 days because of low discharge and flooding. The trap captured a total of 36 wild steelhead smolts, 1,122 hatchery steelhead smolts, 1,379 wild steelhead parr, and 147 wild steelhead fry. Because a flow-efficiency regression model for steelhead has not yet been developed at the current trap location, a pooled efficiency was used to estimate emigrate abundance. The estimated wild steelhead smolt/transitional emigration for 2017 was 772 (±1,165) (Table 3.19).

Table 3.19. Estimated numbers of wild and hatchery steelhead smolts/transitionals that emigrated from Nason Creek during migration years 2003-2017; NS = no data. Numbers in parentheses indicate 95% confidence intervals.

Migration year	Numbers of steelhead smolts/transitionals	
	Wild smolts	Hatchery smolts
2003	187 (±461)	7,798 (±5,830)
2004	0 (±0)	8,362 (±2,436)

Migration year	Numbers of steelhead smolts/transitionals	
	Wild smolts	Hatchery smolts
2005	858 (±256)	11,880 (±3,664)
2006[a]	35 (±35)	NS
2007	1,703 (±808)	34,159 (±10,445)
2008	6,603 (±3,469)	131,118 (±104,661)
2009	272 (±119)	53,758 (±17,124)
2010	1,269 (±873)	76,660 (±42,095)
2011	488 (±618)	36,010 (±29,600)
2012	5,438 (±3,812)	64,423 (±61,848)
2013	1,599 (±2,221)	63,001 (±95,002)
2014	1,198 (±1,263)	62,890 (±47,205)
2015[b]	1,392 (±7,741)	51,968 (±287,566)
2016[b]	648 (±2,367)	7,056 (±25,398)
2017[b]	772 (±1,165)	23,108 (±34,159)
Average	***1,497***	***45,157***
Median	***858***	***43,989***

[a] Hatchery-origin steelhead not enumerated

[b]Pooled estimate used.

Wild steelhead smolts/transitionals sampled in 2017 averaged 153 mm in length, 37.1 g in weight, and had a mean condition of 1.01 (Table 3.20). These size estimates were greater than the overall mean of steelhead smolts/transitionals sampled in previous years (overall means: 131 mm, 26.7 g, and condition of 1.00). Wild steelhead parr sampled in 2017 at the Nason Creek Trap averaged 86 mm in length, averaged 8.0 g, and had a mean condition of 1.08 (Table 3.20). Parr sampled in 2017 were greater than the overall mean of parr sampled in previous years (overall means, 80 mm, 6.7 g, and condition of 1.06).

Table 3.20. Mean fork length (mm), weight (g), and condition factor of steelhead smolts collected in the Nason Creek Trap, 2003-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2003	Fry	NS	NS	NS	NS
	Parr	63	74 (12)	5.3 (3.1)	1.23 (0.50)
	Smolt/Transitional	3	122 (42)	21.1 (17.6)	0.93 (0.16)
2004	Fry	4	45 (5)	1.0 (0.5)	1.03 (0.30)
	Parr	678	92 (30)	10.4 (11.0)	1.05 (0.23)
	Smolt/Transitional	0	–	–	–
2005	Fry	236	38 (7)	0.6 (0.5)	0.90 (0.68)
	Parr	850	76 (18)	5.4 (4.3)	1.04 (0.19)
	Smolt/Transitional	207	143 (21)	31.1 (14.6)	1.01 (0.22)
2006	Fry[a]	NS	NS	NS	NS

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Parr	1,162	89 (28)	8.9 (11.4)	0.92 (0.14)
	Smolt/Transitional	2	81 (17)	4.5 (2.1)	0.83 (0.12)
2007	Fry	121	43 (4)	1.0 (0.3)	1.16 (0.32)
	Parr	1,534	81 (19)	6.5 (5.8)	1.06 (0.16)
	Smolt/Transitional	97	136 (27)	28.0 (13.2)	1.03 (0.19)
2008	Fry	378	43 (5)	0.8 (0.3)	0.95 (0.21)
	Parr	2,343	80 (20)	6.3 (6.5)	1.06 (0.12)
	Smolt/Transitional	206	129 (32)	25.6 (17.7)	1.04 (0.10)
2009	Fry	106	48 (1.4)	1.1 (0.1)	1.02 (0.10)
	Parr	1,085	75 (27)	6.5 (10.4)	1.05 (0.10)
	Smolt/Transitional	16	153 (28)	38.7 (15.6)	1.00 (0.05)
2010	Fry	117	46 (3)	1.1 (0.3)	1.13 (0.17)
	Parr	1,907	79 (23)	6.9 (8.1)	1.10 (0.12)
	Smolt/Transitional	56	149 (26)	37.2 (16.3)	1.05 (0.15)
2011	Fry	517	39 (6)	0.6 (0.3)	0.93 (0.30)
	Parr	1,096	73 (22)	5.5 (12.2)	1.08 (0.14)
	Smolt/Transitional	7	114 (42)	19.7 (15.6)	1.02 (0.10)
2012	Fry	29	46 (3)	0.8 (0.3)	0.82 (0.29)
	Parr	1,166	80 (20)	6.6 (6.5)	1.06 (0.13)
	Smolt/Transitional	83	134 (30)	27.6 (14.8)	1.03 (0.16)
2013	Fry	152	44 (4)	0.8 (0.3)	0.96 (0.23)
	Parr	2,396	74 (16)	4.7 (4.2)	1.01 (0.10)
	Smolt/Transitional	22	115 (33)	19.2 (14.3)	1.02 (0.06)
2014	Fry	155	44 (4)	0.8 (0.2)	0.96 (0.17)
	Parr	991	78 (17)	5.7 (5.2)	1.02 (0.09)
	Smolt/Transitional	18	139 (24)	29.8 (12.1)	1.03 (0.10)
2015	Fry	24	43 (5)	0.9 (0.3)	1.03 (0.24)
	Parr	389	84 (19)	7.3 (6.5)	1.05 (0.08)
	Smolt/Transitional	12	145 (23)	33.0 (15.7)	0.99 (0.08)
2016	Fry	275	41 (5)	0.8 (0.3)	0.99 (0.19)
	Parr	631	79 (21)	6.3 (6.1)	1.05 (0.11)
	Smolt/Transitional	9	120 (30)	20.7 (15.6)	1.02 (0.15)
2017	Fry	76	38 (5)	0.6 (0.3)	1.05 (0.16)
	Parr	1,377	86 (19)	8.0 (6.4)	1.08 (0.09)
	Smolt/Transitional	36	153 (18)	37.1 (12.5)	1.01 (0.08)
Average	***Fry***	***168 (149)***	***43 (3)***	***0.8 (0.2)***	***0.99 (0.09)***
	Parr	***1,178 (661)***	***80 (6)***	***6.7 (1.5)***	***1.06 (0.06)***
	Smolt/Transitional	***52 (69)***	***131 (20)***	***26.7 (9.2)***	***1.00 (0.06)***
Median	***Fry***	***121 (149)***	***43 (3)***	***0.08 (.02)***	***0.99 (0.09)***

Sample year	Life Stage	Sample size	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Parr	***1,096 (661)***	***80 (6)***	***6.7 (1.5)***	***1.05 (0.06)***
	Smolt/Transitional	***18 (69)***	***135 (20)***	***27.8 (9.2)***	***1.02 (0.06)***

Lower Wenatchee Trap

The Lower Wenatchee River Trap operated between 24 February and 31 July 2017. During that time, the trap was inoperable for 38 days because of high or low river discharge, debris, elevated river temperatures, large hatchery releases, and mechanical issues. During the sampling period, a total of 111 wild steelhead parr and fry, 52 wild steelhead smolts, and 336 hatchery steelhead were captured at the trap. Because of the low numbers of steelhead encountered at the trap, it was not possible to carry out mark-recapture trials using steelhead. In addition, because there was a poor relationship between trap efficiency and river flow, a pooled estimate was used to derive the number of steelhead emigrants. Using this pooled method, it was estimated that 5,784 (±58,303) steelhead >50 mm FL emigrated out of the Wenatchee during the trapping season (Table 3.21). Figure 3.6 shows the monthly captures of all steelhead collected at the Lower Wenatchee Trap. All fish captured in the trap are reported in Appendix B.

Table 3.21. Estimated numbers of wild steelhead that emigrated from the Wenatchee River basin during migration years 2015-2017. Estimates are provided with and without fry. Numbers in parentheses indicate 95% confidence intervals.

Migration year	Numbers of wild steelhead migrants	
	Migrants (excluding fry)	Migrants (including fry)
2015	8,632 (±45,053)	12,207 (±123,032)
2016	10,135 (±102,145)	18,400 (±185,447)
2017	5,784 (±58,303)	7,532 (±75,918)
Average	***9,072***	***12,713***
Median	***10,135***	***12,207***

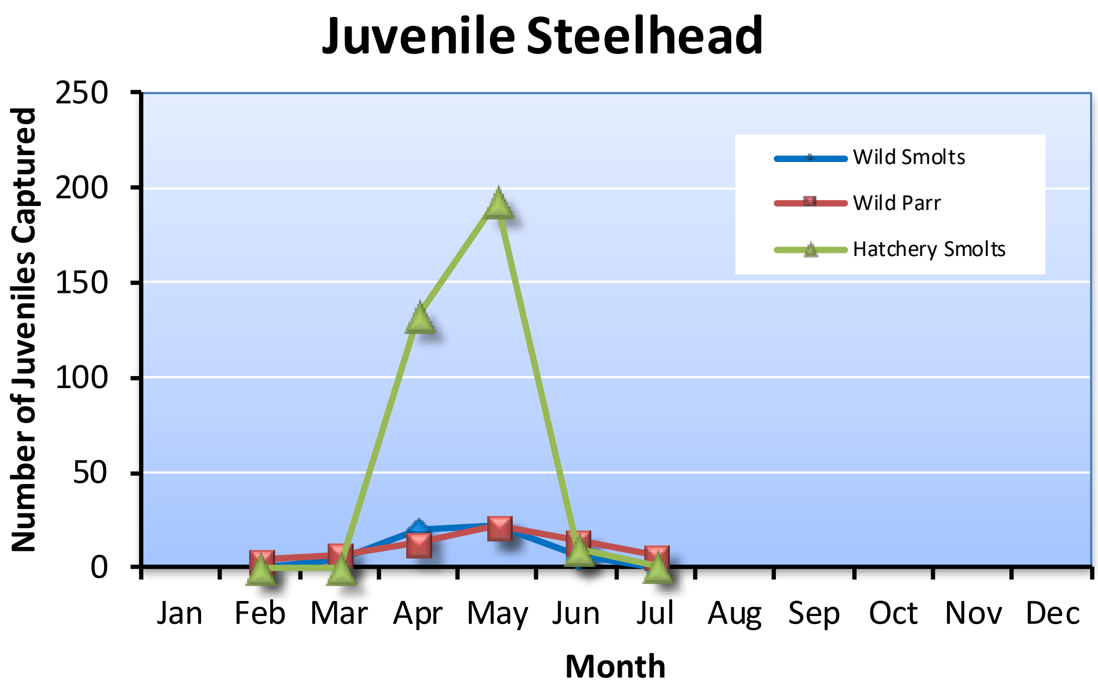


Figure 3.6. Monthly captures of wild smolts, wild parr, and hatchery smolt steelhead/rainbow at the Lower Wenatchee Trap, 2017.

Wild steelhead smolts/transitionals sampled in 2017 averaged 149 mm in length, 37.0 g in weight, and had a mean condition of 1.00 (Table 3.22). These size estimates were less than the overall mean of steelhead smolts/transitionals sampled in previous years (overall means: 163 mm, 47.7 g, and condition of 1.03). Wild steelhead parr sampled in 2017 at the Chiwawa Trap averaged 91 mm in length, averaged 8.9 g, and had a mean condition of 1.03 (Table 3.22). Parr sampled in 2017 were similar to the overall mean of parr sampled in previous years (overall means, 90 mm, 9.0 g, and condition of 1.10).

Table 3.22. Mean fork length (mm), weight (g), and condition factor of wild juvenile steelhead collected in the Lower Wenatchee River Trap, 2015-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2015	Fry	25	33 (6)	0.4 (0.3)	1.15 (0.95)
	Parr	75	94 (23)	10.4 (9.4)	1.24 (1.08)
	Smolt/Transitional	230	179 (25)	60.3 (25.5)	1.05 (1.00)
2016	Fry	223	34 (7)	0.4 (0.3)	0.94 (0.22)
	Parr	102	83 (24)	7.7 (6.6)	1.04 (0.13)
	Smolt/Transitional	66	159 (30)	45.7 (27.4)	1.03 (0.07)
2017	Fry	28	31 (4)	0.3 (0.2)	0.74 (0.24)
	Parr	64	91 (19)	8.9 (5.7)	1.03 (0.07)
	Smolt/Transitional	52	149 (30)	37.0 (21.8)	1.00 (0.09)
Average	***Fry***	***92***	34	0.4	0.94

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
	Parr	*80*	90	9.0	1.10
	Smolt/Transitional	*116*	163	47.7	1.03
Median	*Fry*	*28*	33	0.4	0.94
	Parr	*75*	91	8.9	1.04
	Smolt/Transitional	*66*	159	45.7	1.03

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 2,373 juvenile steelhead/rainbow trout (2,371 wild and 2 hatchery) were PIT tagged and released in 2017 in the Wenatchee River basin (Table 3.23). Most of these were tagged at the Nason Creek and Chiwawa traps. See Appendix C for a complete list of all fish captured, tagged, lost, and released.

Table 3.23. Numbers of wild and hatchery steelhead/rainbow trout that were captured, tagged, and released at different locations within the Wenatchee River basin, 2017. Numbers of fish that died or shed tags are also given.

Sampling location	Origin	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Wild	1,081	2	909	3	0	909	0.28
	Hatchery	3,907	0	2	1	0	2	0.03
	Total	**4,988**	**2**	**911**	**4**	**0**	**911**	**0.08**
Nason Creek Trap	Wild	1,562	64	1,353	1	0	1,353	0.06
	Hatchery	1,122	138	0	49	0	0	4.37
	Total	**2,684**	**202**	**1,353**	**50**	**0**	**1,353**	**1.86**
White River Trap	Wild	6	0	3	0	0	3	0.00
	Hatchery	0	0	0	0	0	0	0.00
	Total	**6**	**0**	**3**	**0**	**0**	**3**	**0.00**
Lower Wenatchee Trap	Wild	163	0	106	2	0	106	1.23
	Hatchery	337	0	0	1	0	0	0.30
	Total	**500**	**0**	**106**	**3**	**0**	**106**	**0.60**
Total:	**Wild**	**2,812**	**66**	**2,371**	**6**	**0**	**2,371**	**0.21**
	Hatchery	**5,366**	**138**	**2**	**51**	**0**	**2**	**0.95**
Grand Total:		**8,178**	**204**	**2,373**	**57**	**0**	**2,373**	**0.70**

Numbers of steelhead/rainbow PIT-tagged and released as part of CSS and PUD studies during the period 2006-2017 are shown in Table 3.24.

Table 3.24. Summary of the numbers of wild and hatchery steelhead/rainbow trout that were tagged and released at different locations within the Wenatchee River basin, 2006-2017.

Sampling location	Origin	Numbers of PIT-tagged steelhead/rainbow released											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chiwawa Trap	Wild	1,366	832	1,431	1,127	930	1,012	1,011	1,228	1,186	1,795	1,313	909
	Hatchery	0	3	2	1	2	1	2	0	3	1	1	2
	Total	**1,366**	**835**	**1,433**	**1,128**	**932**	**1,013**	**1,013**	**1,228**	**1,189**	**1,796**	**1,314**	**911**
Chiwawa River (Angling or Electrofish)	Wild	33	167	94	35	99	0	0	0	23	0	0	0
	Hatchery	1	47	35	43	64	0	0	0	0	0	0	0
	Total	**34**	**214**	**129**	**78**	**163**	**0**	**0**	**0**	**23**	**0**	**0**	**0**
Upper Wenatchee Trap[1]	Wild	21	37	24	46	69	82	70	43	--	--	--	--
	Hatchery	0	0	0	0	0	0	0	0	--	--	--	--
	Total	**21**	**37**	**24**	**46**	**69**	**82**	**70**	**43**	**--**	**--**	**--**	**--**
Nason Creek Trap	Wild	1,167	1,335	2,154	753	1,557	805	1,087	1,998	838	383	530	1,353
	Hatchery	0	0	0	0	0	0	538	0	0	0	0	0
	Total	**1,167**	**1,335**	**2,154**	**753**	**1,557**	**805**	**1,625**	**1,998**	**838**	**383**	**530**	**1,353**
Nason Creek (Angling or Electrofish)	Wild	174	452	255	459	318	0	0	0	0	0	0	0
	Hatchery	26	75	87	197	32	0	0	0	0	0	0	0
	Total	**200**	**527**	**342**	**656**	**350**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
White River Trap	Wild	0	0	0	12	10	5	5	6	5	6	5	3
	Hatchery	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**12**	**10**	**5**	**5**	**6**	**5**	**6**	**5**	**3**
Upper Wenatchee (Angling or Electrofish)	Wild	413	1,001	21	7	30	--	--	--	--	--	--	--
	Hatchery	2	64	26	23	9	--	--	--	--	--	--	--
	Total	**415**	**1,065**	**47**	**30**	**39**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Middle Wenatchee (Angling or Electrofish)	Wild	0	0	981	867	1,517	0	0	850	--	--	--	--
	Hatchery	0	0	11	5	57	0	0	2	--	--	--	--
	Total	**0**	**0**	**992**	**872**	**1,574**	**0**	**0**	**852**	**--**	**--**	**--**	**--**
Lower Wenatchee (Angling or Electrofish)	Wild	0	0	102	69	--	--	--	--	--	--	--	--
	Hatchery	0	0	10	9	--	--	--	--	--	--	--	--
	Total	**0**	**0**	**112**	**78**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Peshastin Creek (Angling or Electrofish)	Wild	0	0	0	92	307	--	--	--	--	--	--	--
	Hatchery	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**92**	**307**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Wild	131	461	285	227	465	0	0	613	133	290	131	106
	Hatchery	0	0	0	1	0	0	0	0	4	1	0	0
	Total	**131**	**461**	**285**	**228**	**465**	**0**	**0**	**613**	**137**	**291**	**131**	**106**
Total:	**Wild**	**3,305**	**4,285**	**5,347**	**3,694**	**5,302**	**1,904**	**2,173**	**4,738**	**2,185**	**2,474**	**1,979**	**2,371**
	Hatchery	**29**	**189**	**171**	**279**	**164**	**1**	**540**	**2**	**7**	**2**	**1**	**2**

Sampling location	Origin	Numbers of PIT-tagged steelhead/rainbow released											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Grand Total:		**3,334**	**4,474**	**5,518**	**3,973**	**5,466**	**1,905**	**2,713**	**4,740**	**2,192**	**2,476**	**1,980**	**2,373**

[1] 2013 was the last year that the Upper Wenatchee Trap operated.

3.5 Spawning Surveys

Surveys for steelhead redds were conducted during March through late May 2017, in the mainstem Wenatchee River and portions of select tributaries (Chiwawa River, Nason Creek, and Peshastin Creek). Beginning in 2014, adult steelhead escapement estimates in the majority of tributaries in the Wenatchee River basin were generated using mark-recapture techniques based on steelhead PIT tagged at Priest Rapids Dam (BPA funded; see Appendix D and Truscott et al. 2017 for details).

Redd Counts

A total estimate of 191 steelhead redds were counted in the Wenatchee River and the lower portions of select tributaries in 2017 (Table 3.25). Because steelhead escapement estimates in tributaries are based on mark-recapture techniques, there are no or limited redd counts in tributaries beginning in 2014. Additionally, mainstem redd counts since 2014 were expanded based on estimates of observer efficiency (see Appendix D). Thus, evaluation of trends in redd counts is appropriate only before 2014.

Table 3.25. Numbers of steelhead redds estimated within different streams/watersheds within the Wenatchee River basin, 2001-2017; NS = not surveyed. Redd counts from 2004-2013 have been conducted within the same areas and with the same methods. Beginning in 2014, complete redd counts were conducted only within the mainstem Wenatchee River. Therefore, trends in redd counts are only appropriate for the mainstem Wenatchee River from 2004 through 2013.

Survey year	Number of steelhead redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River[a]	Icicle	Peshastin	Total
2001	25	27	NS	NS	116	19	NS	**187**
2002	80	80	1	0	315	27	NS	**503**
2003	64	121	5	3	248	16	15	**472**
2004	62	127	0	0	151	23	34	**397**
2005	162	412	0	2	459	8	97	**1,140**
2006	19	77	NS	0	191	41	67	**395**
2007	11	78	0	1	46	6	17	**159**
2008	11	88	NS	1	100	37	49	**286**
2009	75	126	0	0	327	102	32	**662**
2010	74	270	4	3	380	120	118	**969**
2011	77	235	2	0	323	180	115	**932**
2012	8	158	0	0	137	47	65	**415**
2013	27	135	NS	NS	200	48	62	**472**
2014	5	0	NS	NS	195[b]	NS	5	**205**
2015	1	1	NS	NS	258[b]	NS	1	**262**

Survey year	Number of steelhead redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River[a]	Icicle	Peshastin	Total
2016	0	0	NS	NS	126[b]	NS	0	**126**
2017	0	1	NS	NS	189[b]	NS	1	**191**

[a] Includes redds in Beaver and Chiwaukum creeks.
[b] Steelhead redd counts in the mainstem Wenatchee River were expanded based on estimated observer efficiency (see Appendix D).

Redd Distribution

Steelhead redds were not evenly distributed among survey reaches on the Wenatchee River in 2017 (Table 3.26). Most of the spawning (90.0% of observed redds) in the Wenatchee River occurred upstream from Tumwater Dam.

Table 3.26. Numbers and percentages of steelhead redds counted within different reaches on the Wenatchee River during March through late May 2017; CV = coefficient of variation, NA = not available, NS = not surveyed.

Reach	Reach type	Number of redds counted	Expanded redd counts		Percent of redds within stream/watershed
			Estimated	CV	
Wenatchee 1 (W1)	Non-index	0	0	-	0.0
Wenatchee 2 (W2)	Index	1	2	0.13	1.1
Wenatchee 3 (W3)	Non-index	0	0	-	0.0
Wenatchee 4 (W4)	Non-index	0	0	-	0.0
Wenatchee 5 (W5)	Non-index	0	0	-	0.0
Wenatchee 6 (W6)	Index	8	14	0.29	7.4
Wenatchee 6 (W6)	Non-index	0	0	-	0.0
Wenatchee 7 (W7)	NS	NS	-	-	NS
Wenatchee 8 (W8)	Index	2	3	0.14	1.5
Wenatchee 9 (W9)	Index	38	71	0.28	37.6
Wenatchee 9 (W9)	Non-index	1	2	0.13	1.1
Wenatchee 10 (W10)	Index	38	92	0.32	48.7
Wenatchee 10 (W10)	Non-index	2	5	0.23	2.6
Total		**90**	**189**	**0.25**	**100.0**

Spawn Timing

Steelhead began spawning during mid-March in the Wenatchee River in 2017. Spawning activity appeared to begin once the mean daily stream temperature reached about 3.0°C and was observed in water temperatures ranging from 2.7-8.9°C. Steelhead spawning peaked during the first week of May in the Wenatchee River and surveys concluded during the first week of June (Figure 3.7).

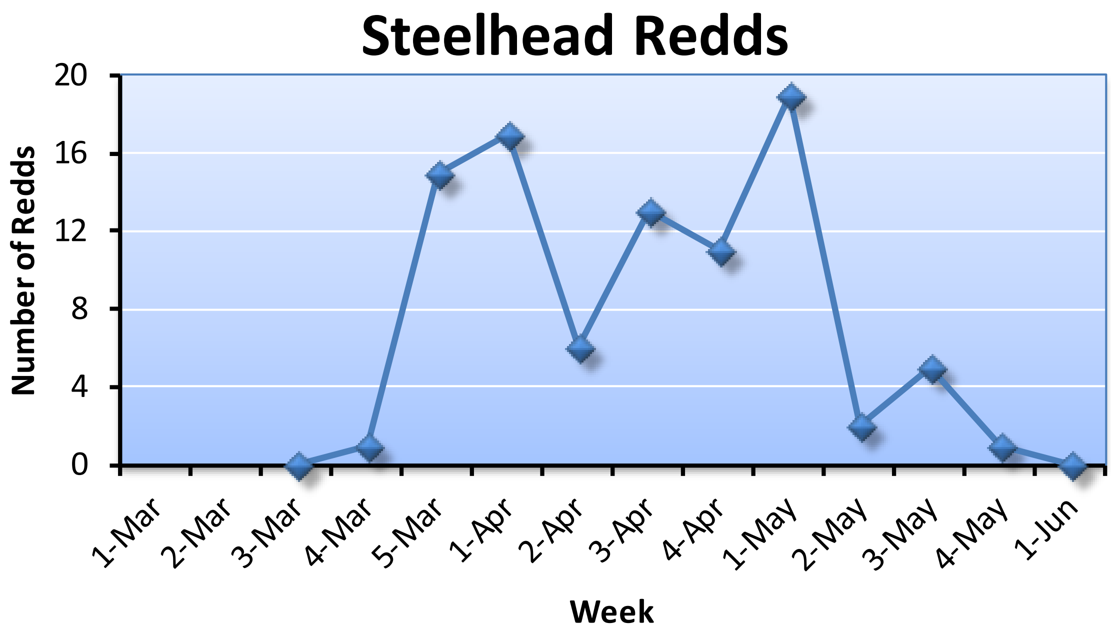


Figure 3.7. Numbers of steelhead redds counted during different weeks on the Wenatchee River, March through early June 2017.

Spawning Escapement

Before 2014, steelhead spawning escapement upstream from Tumwater Dam was calculated as the number of redds (in the Wenatchee River and tributaries upstream from the dam) times the fish per redd ratio (based on sex ratios estimated at Tumwater Dam using video surveillance).[9] Beginning in 2014, escapement in tributaries was estimated using PIT-tag mark-recapture techniques (Truscott et al. 2017; Table 3.27), while observer-efficiency-expanded redd counts were used to estimate escapement in the mainstem Wenatchee River (Appendix D). Total redd counts were also used to estimate escapement in the lower portions of the main tributaries (downstream from the PIT interrogation sites).

Table 3.27. Spawning escapement estimates for natural-origin and hatchery-origin steelhead within tributaries of the Wenatchee River, brood year 2017. Escapement estimates were based on PIT-tag mark-recapture techniques (Truscott et al. 2017). CV = coefficient of variation and NA = not available.

Tributary	Natural-origin steelhead		Hatchery-origin steelhead	
	Estimate	CV	Estimate	CV
Mission Creek	20	0.48	12	0.64
Peshastin Creek	37	0.35	0	NA
Chumstick Creek	11	0.71	0	NA
Icicle Creek	11	0.65	19	0.48
Chiwaukum Creek	0	NA	0	NA
Chiwawa River	12	0.74	34	0.59

[9] Expansion factor = (1 + (number of males/number of females)).

Tributary	Natural-origin steelhead		Hatchery-origin steelhead	
	Estimate	CV	Estimate	CV
Nason Creek	24	0.42	26	0.40

The estimated fish per redd ratio for steelhead in 2017 was 2.11 (Table 3.28). Multiplying this ratio by the total number of redds estimated in the Wenatchee River upstream from Tumwater Dam (173) resulted in a spawning escapement of 365 steelhead (Table 3.28). Adding this estimate to the mark-recapture estimates of tributary escapement (36 natural-origin and 60 hatchery-origin) indicates that 461 steelhead (CV = 0.38) escaped to spawning areas upstream from Tumwater Dam in 2017 (see Appendix D).

Table 3.28. Numbers of steelhead counted at Tumwater Dam, fish/redd estimates (based on male-to-female ratios estimated at Tumwater Dam), numbers of steelhead redds counted upstream from Tumwater Dam, total spawning escapement upstream from Tumwater Dam (estimated as the total number of redds times the fish/redd ratio), and the proportion of the Tumwater Dam count that made up the spawning escapement. Beginning in 2014, escapements include estimates from redd counts in the Wenatchee River and mark-recapture techniques in tributaries.

Survey year	Total count at Tumwater Dam	Fish/redd	Number of redds			Spawning escapement[a]	Proportion of Tumwater count that spawned
			Index area	Non-index area	Total redds		
2001	820	2.08	118	19	137	285	0.35
2002	1,720	2.68	296	179	475	1,273	0.74
2003	1,810	1.60	353	88	441	706	0.39
2004	1,869	2.21	277	92	369	815	0.44
2005	2,650	1.61	828	136	964	1,552	0.59
2006	1,053	2.05	192	34	226	463	0.44
2007	657	1.94	105	29	134	260	0.40
2008	1,328	2.81	124	35	159	447	0.34
2009	1,781	1.83	284	107	391	716	0.40
2010	2,270	2.33	546	95	641	1,494	0.66
2011	1,130	1.79	427	33	460	823	0.73
2012	1,055	2.00	273	22	295	590	0.56
2013	1,087	1.65	276	9	285	470	0.43
Average[b]	***1,488***	***2.02***	***333***	***59***	***392***	***763***	***0.50***
Median	***1,328***	***2.00***	***277***	***35***	***369***	***706***	***0.44***
2014	865	1.70	124	0	124	839	0.97
2015	1,009	1.78	232	11	243	1,123	1.11
2016	1,017	1.65	120	6	126	572	0.56
2017	452	2.11	166	7	173	365	0.81
Average[c]	***834***	***1.81***	***160.5***	***6***	***166.5***	***724.75***	***0.865***
Median	***937***	***1.74***	***145***	***6.5***	***149.5***	***705.5***	***0.895***

[a] Escapement estimates before 2014 were based on expanded redd counts in the Wenatchee River and tributaries; escapement estimates beginning in 2014 were based on expanded redd counts within the Wenatchee River and mark-recapture techniques in tributaries.
[b] The average and median are based on estimates from 2004 to 2013.
[c] The average and median are based on estimates from 2014 to present.

3.6 Life History Monitoring

Life history characteristics of steelhead were assessed by examining fish collected at broodstock collection sites, examining videotape at Tumwater Dam, and by reviewing tagging data and fisheries statistics. Before brood year 2011, some statistics could not be calculated because few steelhead were tagged with CWTs. Since brood year 2011, all steelhead released from the hatchery program have been tagged with CWTs. In addition, about 20,201 of the 2016 brood were PIT tagged. With the placement of remote PIT tag detectors in spawning streams in 2007 and 2008, statistics such as origin on spawning grounds, stray rates, and SARs can be estimated more accurately.

Migration Timing

Sampling at Tumwater Dam indicates that steelhead migrate throughout the year; however, the migration distribution is bimodal, indicating that steelhead migrate past Tumwater Dam in two pulses: one pulse during summer-autumn the year before spawning and another during winter-spring the year of spawning (Figure 3.8). Most steelhead passed Tumwater Dam during July through October and April. The highest proportion of both wild and hatchery fish migrated during October.

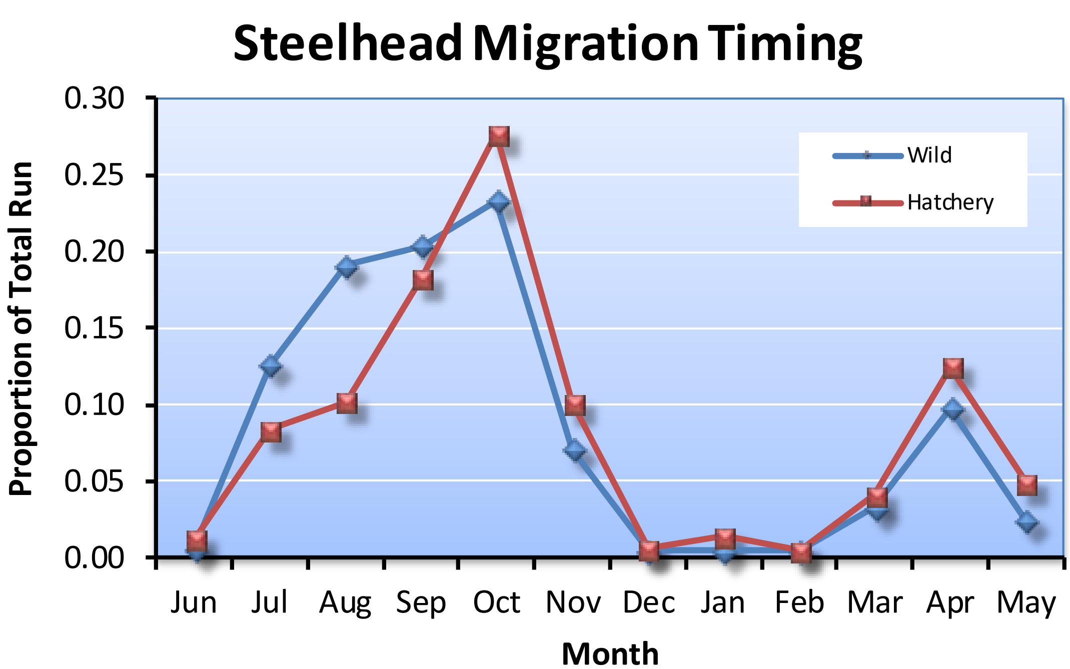


Figure 3.8. Proportion of wild and hatchery steelhead sampled at Tumwater Dam for the combined brood years of 1999-2017.

Because the migration of steelhead is bimodal, we estimated migration statistics separately for each migration pulse (i.e., summer-autumn migration and winter-spring migration). That is, we compared migration statistics for wild and hatchery steelhead passing Tumwater Dam during the summer-autumn period independent of those for the winter-spring migration period. We estimated the week and month that 10%, 50% (median), and 90% of the wild and hatchery steelhead passed Tumwater Dam during the two migration periods. We also estimated the mean weekly and monthly migration timing for wild and hatchery steelhead.

Migration timing of wild and hatchery fish at Tumwater Dam varied depending on the migration season (Table 3.29a and b; Figure 3.5). For the summer-autumn migration period, wild steelhead arrived at the dam about one week earlier than hatchery steelhead. In contrast, there was little difference in migration timing of wild and hatchery steelhead during the winter-spring migration period.

Table 3.29a. The week that 10%, 50% (median), and 90% of the wild and hatchery steelhead passed Tumwater Dam during their summer-autumn migration (June through December) and during their winter-spring migration (January through May), 1999-2017. The average week is also provided for both migration periods. Migration timing is based on video sampling at Tumwater. The presence of eroded fins and/or missing adipose fins was used to distinguish hatchery fish from wild fish during video monitoring at Tumwater Dam. Estimates also include steelhead collected for broodstock.

Spawn year	Origin	Steelhead Migration Time (week)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
1999	Wild	27	32	47	35	81	12	16	17	15	29
	Hatchery	25	31	47	34	47	12	16	18	15	27
2000	Wild	31	36	41	36	238	11	14	18	14	40
	Hatchery	31	34	41	36	194	12	14	16	14	69
2001	Wild	29	34	41	35	391	13	15	17	15	84
	Hatchery	30	38	41	36	227	12	16	17	15	156
2002	Wild	29	39	46	38	810	13	14	17	14	181
	Hatchery	35	42	46	41	610	12	15	18	15	124
2003	Wild	30	33	40	35	731	3	9	16	9	193
	Hatchery	30	35	51	37	372	3	9	15	9	538
2004	Wild	30	40	45	39	644	13	16	18	16	222
	Hatchery	29	40	44	38	677	11	17	19	16	361
2005	Wild	30	39	43	38	986	10	15	17	15	206
	Hatchery	27	38	42	36	1,112	12	16	18	15	377
2006	Wild	29	40	43	39	428	12	15	17	15	191
	Hatchery	29	41	43	39	334	4	13	16	12	181
2007	Wild	30	36	41	35	277	11	17	17	15	108
	Hatchery	29	38	43	36	90	11	17	18	16	214
2008	Wild	30	38	43	38	397	13	15	18	16	123
	Hatchery	33	41	45	40	554	14	18	19	17	311

Spawn year	Origin	Steelhead Migration Time (week)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
2009	Wild	30	37	46	37	338	13	15	19	15	87
	Hatchery	29	35	46	36	1,133	13	16	19	16	229
2010	Wild	31	37	45	38	648	11	15	18	15	171
	Hatchery	31	40	45	40	1,207	12	16	19	16	309
2011	Wild	29	36	44	36	797	13	17	19	17	118
	Hatchery	31	39	45	39	991	15	18	19	18	240
2012	Wild	31	34	41	35	642	15	20	20	17	83
	Hatchery	32	39	43	38	715	15	19	19	17	223
2013	Wild	31	36	43	37	755	13	16	18	15	55
	Hatchery	31	42	45	40	1,431	16	17	18	16	210
2014	Wild	29	35	41	35	549	14	18	19	17	57
	Hatchery	32	40	42	38	511	15	17	19	17	78
2015	Wild	29	38	43	37	714	11	14	17	14	48
	Hatchery	32	39	43	39	928	12	16	17	15	57
2016	Wild	34	41	45	39	610	13	16	19	16	58
	Hatchery	36	41	44	40	692	12	16	19	15	56
2017	Wild	28	39	43	36	300	16	17	19	17	15
	Hatchery	29	42	44	39	233	16	17	18	17	20
Average	***Wild***	***30***	***37***	***43***	***37***	***544***	***12***	***15***	***18***	***15***	***109***
	Hatchery	***31***	***39***	***44***	***38***	***635***	***12***	***16***	***18***	***15***	***199***
Median	***Wild***	***30***	***37***	***43***	***37***	***610***	***13***	***15***	***18***	***15***	***87***
	Hatchery	***31***	***39***	***44***	***38***	***610***	***12***	***16***	***18***	***16***	***210***

Table 3.29b. The month that 10%, 50% (median), and 90% of the wild and hatchery steelhead passed Tumwater Dam during their summer-autumn migration (June through December) and during their winter-spring migration (January through May), 1999-2017. The average month is also provided for both migration periods. Migration timing is based on video sampling at Tumwater. The presence of eroded fins and/or missing adipose fins was used to distinguish hatchery fish from wild fish during video monitoring at Tumwater Dam. Estimates also include steelhead collected for broodstock.

Spawn year	Origin	Steelhead Migration Time (month)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
1999	Wild	7	8	11	8	81	3	4	4	4	29
	Hatchery	6	8	11	8	47	3	4	4	4	27
2000	Wild	8	9	10	9	238	3	4	5	4	40
	Hatchery	8	8	10	9	194	3	4	4	4	69
2001	Wild	7	8	10	8	391	3	4	4	4	84

Spawn year	Origin	Steelhead Migration Time (month)									
		Summer-Autumn Migration (Jun-Dec)					Winter-Spring Migration (Jan-May)				
		10%	50%	90%	Mean	Sample size	10%	50%	90%	Mean	Sample size
	Hatchery	7	9	10	9	227	3	4	4	4	156
2002	Wild	7	9	11	9	810	3	4	4	4	181
	Hatchery	9	10	11	10	610	3	4	5	4	124
2003	Wild	7	8	10	8	731	1	3	4	3	193
	Hatchery	7	8	12	9	372	1	3	4	2	538
2004	Wild	7	10	11	9	644	3	4	4	4	222
	Hatchery	7	10	10	9	677	3	4	5	4	361
2005	Wild	7	9	10	9	986	3	4	4	4	206
	Hatchery	7	9	10	9	1,112	3	4	5	4	377
2006	Wild	7	10	10	10	428	3	4	4	4	191
	Hatchery	7	10	10	9	334	1	3	4	3	181
2007	Wild	7	9	10	9	277	3	4	4	4	108
	Hatchery	7	9	10	9	90	3	4	5	4	214
2008	Wild	7	9	10	9	397	3	4	5	4	123
	Hatchery	8	10	11	10	554	4	4	5	4	311
2009	Wild	7	9	11	9	338	3	4	5	4	87
	Hatchery	7	8	11	9	1,133	3	4	5	4	229
2010	Wild	8	9	11	9	648	3	4	5	4	171
	Hatchery	8	10	11	10	1,207	3	4	5	4	309
2011	Wild	7	9	11	9	797	4	4	5	4	118
	Hatchery	8	9	11	9	991	4	5	5	5	240
2012	Wild	8	8	10	9	642	4	4	5	4	83
	Hatchery	8	9	10	9	715	4	4	5	4	223
2013	Wild	8	9	10	9	755	4	4	5	4	55
	Hatchery	8	10	11	10	1,431	4	4	5	4	210
2014	Wild	7	9	10	9	549	4	4	5	4	57
	Hatchery	8	10	10	9	511	4	4	5	4	78
2015	Wild	7	9	10	9	714	3	4	4	4	48
	Hatchery	8	9	10	9	928	3	4	4	4	57
2016	Wild	8	10	11	9	610	3	4	5	4	58
	Hatchery	9	10	10	10	692	3	4	5	4	56
2017	Wild	7	9	10	9	300	4	4	5	4	15
	Hatchery	7	10	11	9	233	4	4	5	4	20
Average	***Wild***	***7***	***9***	***10***	***9***	***544***	***3***	***4***	***5***	***4***	***109***
	Hatchery	***8***	***9***	***11***	***9***	***635***	***3***	***4***	***5***	***4***	***199***
Median	***Wild***	***7***	***9***	***10***	***9***	***610***	***3***	***4***	***5***	***4***	***87***
	Hatchery	***8***	***9***	***10***	***9***	***610***	***3***	***4***	***5***	***4***	***210***

Age at Maturity

Nearly all steelhead broodstock collected at Tumwater and Dryden dams lived in saltwater 1 to 2 years (saltwater age) (Table 3.30). Very few saltwater age-3 fish returned and those that did were typically wild fish. On average, there was a difference between the saltwater age at return of wild and hatchery fish. A greater proportion of hatchery fish returned as saltwater age-1 fish than did wild fish. In contrast, a greater number of wild fish returned as saltwater-2 fish than did hatchery fish (Figure 3.9). For the 2017 brood year, fewer saltwater age-1 fish were observed with proportionally more saltwater age-2 and some saltwater age-3 fish present.

Table 3.30. Proportions of wild and hatchery steelhead broodstock of different ages collected at Tumwater and Dryden dams, brood years 1998-2017. Age represents the number of years the fish lived in salt water.

Brood year	Origin	Saltwater age			Sample size
		1	2	3	
1998	Wild	0.39	0.61	0.00	35
	Hatchery	0.21	0.79	0.00	43
1999	Wild	0.50	0.48	0.02	58
	Hatchery	0.82	0.18	0.00	67
2000	Wild	0.56	0.44	0.00	39
	Hatchery	0.68	0.32	0.00	101
2001	Wild	0.52	0.48	0.00	64
	Hatchery	0.15	0.85	0.00	114
2002	Wild	0.56	0.44	0.00	99
	Hatchery	0.95	0.05	0.00	113
2003	Wild	0.13	0.85	0.02	63
	Hatchery	0.29	0.71	0.00	92
2004	Wild	0.95	0.05	0.00	85
	Hatchery	0.95	0.05	0.00	132
2005	Wild	0.22	0.78	0.00	95
	Hatchery	0.21	0.79	0.00	114
2006	Wild	0.29	0.71	0.00	101
	Hatchery	0.60	0.40	0.00	98
2007	Wild	0.40	0.59	0.00	79
	Hatchery	0.62	0.38	0.00	97
2008	Wild	0.65	0.34	0.01	104
	Hatchery	0.89	0.11	0.00	107
2009	Wild	0.40	0.58	0.20	83
	Hatchery	0.23	0.77	0.0	77
2010	Wild	0.65	0.34	0.01	92
	Hatchery	0.77	0.23	0.00	98
2011	Wild	0.28	0.73	0.00	102

Brood year	Origin	Saltwater age			Sample size
		1	2	3	
	Hatchery	0.36	0.64	0.00	100
2012	Wild	0.42	0.53	0.05	59
	Hatchery	0.41	0.59	0.00	66
2013	Wild	0.41	0.57	0.02	54
	Hatchery	0.46	0.55	0.00	77
2014	Wild	0.48	0.51	0.02	61
	Hatchery	0.29	0.71	0.00	68
2015	Wild	0.16	0.83	0.02	63
	Hatchery	0.47	0.53	0.00	55
2016	Wild	0.34	0.66	0.00	65
	Hatchery	0.42	0.58	0.00	66
2017	Wild	0.10	0.84	0.06	54
	Hatchery	0.11	0.87	0.02	71
Average	***Wild***	***0.43***	***0.55***	***0.02***	***74***
	Hatchery	***0.52***	***0.48***	***0.00***	***88***
Median	***Wild***	***0.42***	***0.57***	***0.01***	***65***
	Hatchery	***0.45***	***0.55***	***0.00***	***95***

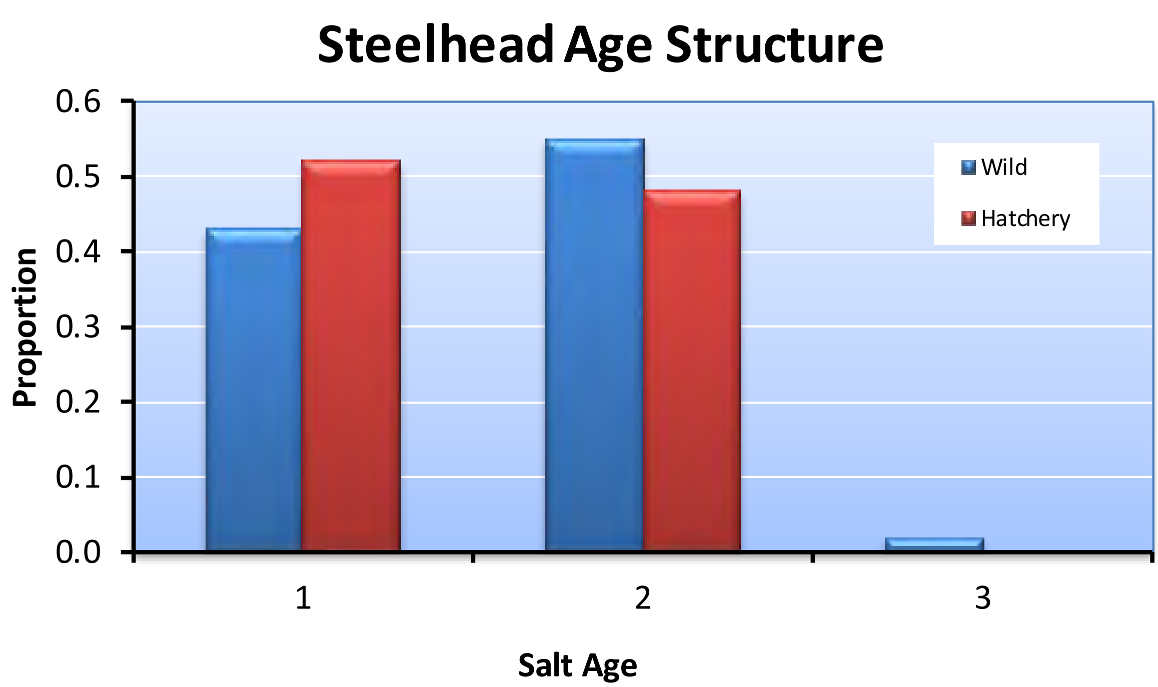


Figure 3.9. Proportions of wild and hatchery steelhead of different saltwater ages sampled at Tumwater Dam for the combined years 1998-2017.

Size at Maturity

On average, hatchery steelhead collected at Tumwater and Dryden dams were about 2 to 3 cm smaller than wild steelhead (Table 3.31).

Table 3.31. Mean fork length (cm) at age (saltwater ages) of hatchery and wild steelhead collected from broodstock, brood years 1998-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1998	Wild	63	15	4	79	20	5	-	0	-
	Hatchery	61	9	4	73	34	4	-	0	-
1999	Wild	65	29	5	74	28	5	77	1	-
	Hatchery	62	54	4	73	12	4	-	0	-
2000	Wild	64	22	3	74	17	5	-	0	-
	Hatchery	60	57	3	71	27	4	-	0	-
2001	Wild	61	33	6	77	31	5	-	0	-
	Hatchery	62	17	4	72	97	4	-	0	-
2002	Wild	64	55	4	77	44	4	-	0	-
	Hatchery	63	106	4	73	6	4	-	0	-
2003	Wild	69	8	6	77	52	5	91	1	-
	Hatchery	66	27	4	75	65	4	-	0	-
2004	Wild	63	73	6	78	4	2	-	0	-
	Hatchery	61	59	3	73	3	1	-	0	-
2005	Wild	59	21	4	74	74	5	-	0	-
	Hatchery	59	23	4	72	89	4	-	0	-
2006	Wild	63	27	5	75	67	6	-	0	-
	Hatchery	61	41	4	72	27	5	-	0	-
2007	Wild	64	31	6	76	46	5	-	0	-
	Hatchery	60	60	4	71	36	5	-	0	-
2008	Wild	64	68	4	77	35	4	80	2	-
	Hatchery	60	95	4	72	12	2	-	0	-
2009	Wild	65	33	5	76	48	6	81	2	0
	Hatchery	63	18	4	75	59	5	-	0	-
2010	Wild	64	60	5	74	31	5	76	1	-
	Hatchery	61	53	5	73	23	5	-	0	-
2011	Wild	62	28	5	76	74	5	-	0	-
	Hatchery	60	36	4	74	64	4	-	0	-
2012	Wild	63	25	3	74	31	5	74	3	2
	Hatchery	59	27	3	74	39	4	-	0	-
2013	Wild	61	22	5	77	31	5	74	1	-
	Hatchery	60	35	3	74	42	4	-	0	-

Brood year	Origin	Steelhead fork length (cm)								
		1-Salt			2-Salt			3-Salt		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
2014	Wild	61	29	4	75	31	4	61	1	-
	Hatchery	60	20	3	72	48	4	-	0	-
2015	Wild	61	10	3	77	52	4	85	1	-
	Hatchery	59	26	3	76	29	5	-	0	-
2016	Wild	63	22	4	74	43	4	-	0	-
	Hatchery	61	28	4	71	38	5	-	0	-
2017	Wild	63	5	3	78	45	5	77	4	8
	Hatchery	59	8	2	75	62	5	93	1	-
Average	***Wild***	***63***	***31***	***5***	***76***	***40***	***5***	***78***	***1***	***3***
	Hatchery	***61***	***40***	***4***	***73***	***41***	***4***	***93***	***0***	***-***
Median	***Wild***	***63***	***28***	***5***	***76***	***39***	***5***	***77***	***1***	***2***
	Hatchery	***61***	***32***	***4***	***73***	***37***	***4***	***93***	***0***	***-***

Contribution to Fisheries

Nearly all harvest on Wenatchee steelhead occurs within the Columbia basin. Harvest rates on steelhead in the Lower Columbia River fisheries (both tribal and non-tribal) are generally less than 5-10% (NMFS 2004). A sport fishery may be opened on Upper Columbia River steelhead when the natural-origin steelhead run is predicted to exceed 1,300 fish at Priest Rapids Dam and the total Upper Columbia River steelhead run is predicted to exceed 9,550 steelhead. To minimize effects on natural-origin steelhead in the tributary fisheries, a three-tiered system as outlined in Permit 1395 is used to determine maximum allowable natural-origin steelhead take during the fishery (Table 3.32).

Table 3.32. Three-tiered system for determining natural-origin effects during the recreational fishery on steelhead in tributaries upstream from Rock Island Dam.

Tier	Wenatchee		Methow		Okanogan	
	NOR[1]	Effect[2]	NOR[1]	Effect[2]	NOR[1]	Effect[2]
No Fishery	≤ 599	0%	≤ 499	0%	≤ 119	0%
Tier 1	600	2%	500	2%	120	5%
Tier 2	1700	4%	1600	4%	120	7%
Tier 3	2500	6%	2500	6%	600	10%

[1] Estimated natural-origin escapement to tributaries.
[2] Maximum allowable take on natural-origin fish.

No selective recreational steelhead fishery was implemented in the upper Columbia River during fall 2016 through winter 2017 (Table 3.33). Over the eight years that the Wenatchee River had a recreational fishery, average harvest has been about 183 hatchery steelhead and 16 wild steelhead hook-and-release mortalities. In the mixed population fishery within the mainstem Columbia from Priest Rapids Dam to Chief Joseph Dam, the average harvest of hatchery steelhead has been 861steelhead with 17 wild hook-and-release mortalities.

Table 3.33. Harvest and mortality estimates for Upper Columbia steelhead in the Wenatchee and mainstem Columbia River (Priest Rapids Dam to Chief Joseph Dam). Estimated steelhead sport harvest on Wenatchee hatchery steelhead and hook-and-release mortality on wild steelhead (WDFW 2016). The wild steelhead mortality estimate is based on a hook-and-release mortality rate of 5%. Mainstem harvest from Priest Rapids Dam to Chief Joseph Dam is a mixed-population steelhead fishery that may contain fish from the Wenatchee, Entiat, Methow, and Okanogan rivers.

Year	Priest Rapids Escapement			Wenatchee			Mainstem Columbia		
	H	W	Total	H	W	Total	H	W	Total
2006-2007	8,738	1,677	10,415	-	-	-	694	3	697
2007-2008	12,160	3,097	15,257	444	15	459	1,137	13	1,150
2008-2009	13,528	3,030	16,558	-	-	-	921	10	931
2009-2010	32,557	7,439	39,996	251	17	268	1,448	29	1,477
2010-2011	18,792	7,639	26,431	106	12	118	1,412	40	1,452
2011-2012	15,910	4,896	20,806	250	19	269	855	22	877
2012-2013	13,908	3,284	17,192	125	26	151	722	20	744
2013-2014	10,415	4,657	15,072	135	17	152	506	9	515
2014-2015	13,836	5,930	19,766	99	14	113	99	14	113
2015-2016	9,955	4,348	14,303	56	8	64	678	13	690
2016-2017	4,991	1,516	6,507	-	-	-	-	-	-
Average	***14,072***	***4,319***	***18,391***	***183***	***16***	***199***	***861***	***17***	***865***
Median	***13,528***	***4,348***	***16,558***	***130***	***16***	***152***	***855***	***13***	***811***

Origin on Spawning Grounds

With the implementation of PIT-tag mark-recapture techniques in 2014, we can estimate the contribution of natural-origin and hatchery-origin fish on the spawning grounds (Table 3.34). Based on mark-recapture estimates, naturally produced steelhead made up about 50.1% of the escapement in 2017. Importantly, the abundance of hatchery fish in the upper Wenatchee Basin was regulated through surplusing (removal) at Tumwater Dam. A total of 18 hatchery steelhead were surplused at the dam resulting in the passage of 434 steelhead over the dam in 2017. Natural-origin steelhead comprised 55.3% (N = 240) of the steelhead that passed the dam.

Table 3.34. Spawning escapement estimates for natural-origin and hatchery-origin steelhead within the Wenatchee River, brood years 2014-2017. Escapement estimates were based on PIT-tag mark-recapture techniques (see Appendix D).

Tributary	Natural-origin steelhead				Hatchery-origin steelhead			
	2014	2015	2016	2017	2014	2015	2016	2017
Mission Creek	94	71	33	20	31	23	13	12
Peshastin Creek	226	206	151	37	6	40	0	0
Chumstick Creek	78	38	74	12	7	0	39	0
Icicle Creek	76	83	72	11	45	52	18	21
Chiwaukum Creek	37	48	64	0	9	12	11	0
Chiwawa River	142	168	45	12	103	168	134	34
Nason Creek	190	237	57	24	148	68	94	26

Tributary	Natural-origin steelhead				Hatchery-origin steelhead			
	2014	2015	2016	2017	2014	2015	2016	2017
Wenatchee River	340	252	118	116	251	298	91	138
Total	***978***	***1,103***	***614***	***232***	***545***	***661***	***400***	***231***

Straying

Stray rates of Wenatchee steelhead can be estimated by examining the locations where PIT-tagged hatchery steelhead were last detected. PIT tagging of steelhead began with brood year 2005, which allows estimation of stray rates by return year and brood return. These data only provide estimates for brood years 2005 through 2012, because later brood years are still rearing in the ocean. The most recent completed brood year is 2012. Targets for strays based on return year (recovery year) outside the Wenatchee River basin should be less than 5%.

Based on return year and PIT-tag analysis, hatchery-origin Wenatchee steelhead have strayed into the Entiat, Methow, and Okanogan basins[10] (Table 3.35). Before 2014, hatchery-origin Wenatchee steelhead generally made up more than 5% of the escapement in the Entiat and Methow rivers. Since then, they have made up less than 5% of the escapement in those basins. (Table 3.35). Few have strayed into the Okanogan River.

Table 3.35. Number and percent of PIT-based run escapements within non-target basins that consisted of hatchery-origin Wenatchee steelhead, spawn years 2011-2016. For example, for spawn year 2014, 1.9% of the steelhead escapement in the Entiat River basin consisted of hatchery-origin Wenatchee steelhead. Percent strays should be less than 5%.

Return year	Entiat River		Methow River		Okanogan River	
	Number	Percent	Number	Percent	Number	Percent
2011	94	11.0	238	6.2	0	0.0
2012	161	26.1	108	3.9	0	0.0
2013	49	13.3	151	5.8	10	1.1
2014	9	1.9	109	3.7	0	0.0
2015	17	2.7	11	0.3	0	0.0
2016	0	0.0	70	2.5	0	0.0
Average	***55***	***9.2***	***115***	***3.7***	***2***	***0.2***
Median	***33***	***6.9***	***109***	***3.8***	***0***	***0.0***

* Run escapement estimated at Wells Dam.

Based on brood year and PIT-tag analyses, about 4.3% of brood year 2012 was last detected in streams outside of the Wenatchee River basin. Beginning with brood year 2011, steelhead have been overwinter-acclimated at the Chiwawa Acclimation Facility. This may be the reason for the observed reduction in stray rates since 2011. On average, for brood years 2011 through 2012, about 3% of the hatchery steelhead returns were last detected in streams outside the Wenatchee River basin (Table 3.36). Steelhead have been detected in the Entiat and Methow rivers as well as in the Deschutes and Tucannon rivers. Several were last detected at Wells Dam. The numbers in Table

[10] Number of strays to each basin were expanded by tag rate and detection efficiency of individual interrogation arrays where steelhead were last detected.

3.36 should be considered rough estimates because they are not based on confirmed spawning (only last detections).

Table 3.36. Number and percent of hatchery-origin Wenatchee steelhead that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and hatchery programs for brood years 2005-2012. Estimates were based on last detections of PIT-tagged hatchery steelhead.

Brood Year	Homing				Straying			
	Target streams		Target hatchery*		Non-target stream		Non-target hatchery	
	Number	%	Number	%	Number	%	Number	%
2005	76	73.0	1	1.0	27	26.0	0	0.0
2006	818	60.4	3	2.4	504	37.2	0	0.0
2007	2,829	67.4	2	0.5	1,349	32.1	0	0.0
2008	1,389	88.1	2	1.4	165	10.5	0	0.0
2009	2,585	86.8	2	0.7	371	12.5	0	0.0
2010	712	78.8	1	1.0	182	20.2	0	0.0
2011	948	89.6	13	8.4	21	2.0	0	0.0
2012	1,573	90.6	9	5.1	75	4.3	0	0.0
Average	***1,366***	***79.3***	***4***	***2.6***	***381***	***18.1***	***0***	***0.0***
Median	***1,169***	***82.8***	***2***	***1.2***	***182***	***16.4***	***0***	***0.0***

* Homing to the target hatchery includes Wenatchee hatchery steelhead that are captured and included as broodstock in the Wenatchee Hatchery program. These hatchery fish are typically collected at Dryden and Tumwater dams.

Genetics

Genetic studies were conducted in 2012 to determine the potential effects of the Wenatchee Supplementation Program on natural-origin summer steelhead in the Wenatchee River basin (Seamons et al. 2012; the entire report is appended as Appendix E). Temporal collections were obtained from hatchery and natural-origin adult summer steelhead captured at Dryden and Tumwater dams during summer and fall of 1997 through 2009 (excepting 2004 and 2005). Natural-origin steelhead consisted of a mixed collection representing all the spawning subpopulations located upstream. Therefore, to determine population substructure within the basin, samples were also taken from juvenile steelhead collected at smolt traps located within the Chiwawa River, Nason Creek, and Peshastin Creek, and from the Entiat River. Samples were also taken from juvenile steelhead collected at the smolt trap in the lower Wenatchee River. These, like natural-origin adult collections, consisted of a mixed collection representing all subpopulations located upstream. A total of 1,468 hatchery-origin and natural-origin adults were processed and 1,542 juvenile steelhead from the Wenatchee and Entiat Rivers were processed for genetic variation with 132 genetic (single nucleotide polymorphism loci; SNPs) markers. Peshastin Creek and the Entiat River served as no-hatchery-outplant controls. Genetic data were interrogated for the presence or absence of spatial and temporal trends in allele frequencies, genetic distances, and effective population size.

Allele Frequencies—Changes to the summer steelhead hatchery supplementation program had no detectable effect on genetic diversity of wild populations. On average, hatchery-origin adults had higher minor allele frequencies (MAF) than natural-origin adults, which may simply reflect the mixed ancestry of hatchery adults. Both hatchery and natural-origin adults had MAF similar to juveniles collected in spawning tributaries and in the Entiat River. There was no temporal trend in allele frequencies or observed heterozygosity in adult or juvenile collections and allele frequencies in control populations were no different than those still receiving hatchery outplants. This suggests that the hatchery program has had little effect on allele frequencies since broodstock sources changed in 1998 from mixed-ancestry broodstock collected in the Columbia River to using broodstock collected in the Wenatchee River.

Genetic Distances—As intended, interbreeding of Wenatchee River hatchery and natural-origin adults reduced the genetic differences between Wells Hatchery adults and Wenatchee River natural-origin adults observed in the first few years after changing the broodstock collection protocol. Although there were detectable genetic differences between hatchery and natural-origin adults, the magnitude of that difference declined over time. Hatchery adults were genetically different from natural-origin adults and juveniles based on pair-wise F_{ST} and principal components analysis, most likely because of the smaller effective population size (N_b) in the hatchery population (see below). Pair-wise F_{ST} estimates and genetic distances between hatchery and natural-origin adults collected the same year declined over time suggesting that the interbreeding of hatchery and natural-origin adults in the hatchery (and presumably in the wild) is slowly homogenizing Wenatchee River summer steelhead. Analyses using brood year were inconclusive because of limitations in the data.

Effective Population Size—Although the effective population size of the Wenatchee River hatchery steelhead program was consistently small, it does not appear to have caused a reduction in the effective population size of wild populations. On average, estimates of N_b were much lower and varied less for hatchery adults than for natural-origin adults and juveniles. Estimates of N_b for hatchery adults declined from the earliest brood years to a stable new low value after broodstock practices were changed in 1998. There was no indication that this had any effect on N_b in natural-origin adults and juveniles; N_b estimates for natural-origin adults and juveniles were, on average, higher and varied considerably over the 1998-2010 period and showed no temporal trend.

It is important to note that no new information will be reported on genetics until the next five-year report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford’s (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[11] The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004). For the Wenatchee steelhead program, PNI is managed with the

[11] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

goal of achieving a five-year running average of PNI ≥ 0.67 basin-wide. In years when the natural-origin escapement is low (i.e., < 433 fish), the Wenatchee steelhead population will be managed to meet escapement goals rather than PNI.

For brood years 2001-2017, PNI values were less than 0.67 (Table 3.37), suggesting that the hatchery environment has a greater influence on adaptation of Wenatchee steelhead than does the natural environment.

Table 3.37. Proportionate Natural Influence (PNI) values for the Wenatchee steelhead supplementation program for brood years 2001-2017. NOS = number of natural-origin steelhead on the spawning grounds; HOS = number of hatchery-origin steelhead on the spawning grounds; NOB = number of natural-origin steelhead collected for broodstock; and HOB = number of hatchery-origin steelhead included in hatchery broodstock.

Brood year	Spawners[a]			Broodstock			PNI[b]	PNI (5-yr mean)
	NOS	HOS	pHOS	NOB	HOB	pNOB		
2001	158	127	0.45	51	103	0.33	0.45	--
2002	731	542	0.43	96	64	0.60	0.59	--
2003	355	350	0.50	49	90	0.35	0.43	--
2004	371	445	0.55	75	61	0.55	0.51	--
2005	690	862	0.56	87	104	0.46	0.47	0.49
2006	253	210	0.45	93	69	0.57	0.57	0.51
2007	145	115	0.44	76	58	0.57	0.58	0.51
2008	168	279	0.62	77	54	0.59	0.50	0.53
2009	171	545	0.76	86	73	0.54	0.43	0.51
2010	524	970	0.65	96	75	0.56	0.48	0.51
2011	351	472	0.57	91	70	0.57	0.51	0.50
2012	381	209	0.35	59	65	0.48	0.59	0.50
2013	322	148	0.31	49	68	0.42	0.59	0.52
2014	476	363	0.46	64	68	0.48	0.54	0.54
2015	639	484	0.43	58	52	0.53	0.57	0.56
2016	280	324	0.54	66	66	0.50	0.50	0.56
2017	138	189	0.58	53	66	0.45	0.45	0.53
Average	***362***	***390***	***0.51***	***72***	***71***	***0.50***	***0.52***	***0.52***
Median	***353***	***357***	***0.48***	***76***	***68***	***0.54***	***0.51***	***0.51***

[a] The presence of eroded fins or missing adipose fins was used to distinguish hatchery fish from wild fish during video monitoring at Tumwater The PNI estimates are appropriate for steelhead spawning upstream from Tumwater Dam but may not represent PNI for steelhead spawning downstream from Tumwater Dam. Dam. Because not all hatchery fish have eroded fins or missing adipose fins, it is likely we are underestimating WxW hatchery steelhead returns based on video monitoring.

[b] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery steelhead from release sites (e.g., Chiwawa River, Nason Creek, and Wenatchee River) to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam

(Table 3.38).[12] Over the 14 brood years for which PIT-tagged hatchery fish are available, survival rates from the release sites to McNary Dam ranged from 0.055 to 0.785 (note that survival rates of 0.000 were associated with very small sample sizes); SARs from release to detection at Bonneville Dam ranged from 0.000 to 0.038. Average travel time from the release sites to McNary Dam ranged from 10 to 100 days.

Some of the variation in survival rates and travel time was related to release location, type of release, and rearing scenario. For example, on average, steelhead released in the Chiwawa River appeared to have higher survival rates to McNary Dam than did steelhead released in the lower and upper Wenatchee River or Nason Creek. Within the Chiwawa River, steelhead identified as "movers" had the highest survival rates to McNary Dam, while those identified as "non-screened" had the lowest survival. For steelhead released into Nason Creek and the Wenatchee River, fish released from circulars had higher survival rates than those released from raceways. On average, steelhead released from Blackbird Pond had lower survival rates to McNary Dam than those released from circulars. Based on the available data, SARs varied little among the release locations or rearing scenarios.

Travel time from release to McNary Dam varied among release locations and rearing scenario. In general, steelhead released into the Chiwawa River and Nason Creek appeared to travel more quickly to McNary Dam than did steelhead released into the Wenatchee River. Of those released into the Chiwawa River, steelhead released volitionally from raceways appeared to travel to McNary Dam more quickly than those forced released; although there are few replicates and differences in travel times are small. On average, there appeared to be little differences in travel times for steelhead reared in raceways or circulars that were released into Nason Creek.

Table 3.38. Total number of Wenatchee hatchery summer steelhead released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2005-2015. SARs were estimated to Bonneville Dam. Standard errors are shown in parentheses. NA = not available (i.e., for SARs, not all the adults from the release groups have returned to the Columbia River).

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2003	Chiwawa	HxW	NA	Turtle Rock	29,801	0.755 (0.029)	18.2 (16.7)	0.003 (0.000)
	Nason	WxW	NA	Turtle Rock	34,823	0.648 (0.026)	19.3 (19.6)	0.004 (0.000)
	Wenatchee	HxH	NA	Turtle Rock	30,018	0.767 (0.030)	18.1 (20.6)	0.003 (0.000)
2004	Chiwawa	HxW	NA	Turtle Rock	2,439	0.480 (0.037)	26.9 (59.5)	0.011 (0.002)
	Chiwawa	WxW	NA	Turtle Rock	853	0.485 (0.054)	21.1 (8.8)	0.008 (0.003)
	Nason	WxW	NA	Turtle Rock	8,826	0.412 (0.017)	26.7 (56.1)	0.010 (0.001)
	Wenatchee	HxH	NA	Turtle Rock	9,705	0.621 (0.022)	15.8 (6.3)	0.033 (0.002)
	Wenatchee	HxW	NA	Turtle Rock	7,379	0.606 (0.029)	19.3 (7.4)	0.013 (0.001)
2005	Chiwawa	HxW	NA	Turtle Rock	3,448	0.540 (0.065)	22.6 (27.2)	0.017 (0.002)
	Chiwawa	WxW	NA	Turtle Rock	717	0.521 (0.128)	22.2 (8.0)	0.013 (0.004)

[12] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
	Nason	WxW	NA	Turtle Rock	7,306	0.416 (0.031)	21.3 (9.2)	0.009 (0.001)
	Wenatchee	HxH	NA	Turtle Rock	8,610	0.656 (0.057)	20.1 (35.8)	0.017 (0.001)
	Wenatchee	HxW	NA	Turtle Rock	5,021	0.649 (0.074)	20.2 (9.0)	0.014 (0.002)
2006	NA	NA	NA	NA	NA	NA	NA	NA
2007	Chiwawa	HxW	NA	Turtle Rock	2,882	0.520 (0.057)	22.3 (7.9)	0.020 (0.003)
	Chiwawa	WxW	NA	Turtle Rock	785	0.467 (0.069)	18.7 (9.0)	0.038 (0.007)
	Nason	WxW	NA	Turtle Rock	8,060	0.505 (0.030)	22.3 (24.1)	0.030 (0.002)
	Wenatchee	HxW	NA	Turtle Rock	9,047	0.631 (0.041)	18.2 (17.2)	0.038 (0.002)
2008	Chiwawa	HxW L	NA	Turtle Rock	2,008	0.574 (0.080)	20.3 (7.0)	0.006 (0.002)
	Chiwawa	WxW	NA	Turtle Rock	1,457	0.546 (0.090)	31.6 (108.5)	0.010 (0.003)
	Nason	WxW	NA	Turtle Rock	7,951	0.500 (0.037)	21.4 (17.5)	0.014 (0.001)
	Wenatchee	HxW E	NA	Turtle Rock	4,517	0.511 (0.044)	19.5 (7.7)	0.008 (0.001)
	Wenatchee	HxW L	NA	Turtle Rock	6,710	0.545 (0.038)	19.3 (6.8)	0.010 (0.001)
2009	Chiwawa	HxW E	Forced	Turtle Rock	4,874	0.576 (0.076)	24.3 (8.3)	0.012 (0.002)
	Chiwawa	HxW E	Volitional	Chiw. Circ	8,653	0.785 (0.100)	19.4 (26.0)	0.007 (0.001)
	Nason	WxW	Forced	Turtle Rock	8,918	0.504 (0.042)	27.2 (26.6)	0.017 (0.001)
	Wenatchee	HxW E	Forced	Turtle Rock	11,300	0.543 (0.041)	25.8 (54.8)	0.014 (0.001)
	Wenatchee	HxW E	Forced	Turtle Rock	6,681	0.597 (0.063)	28.9 (72.2)	0.013 (0.001)
	Wenatchee	HxW L	Forced	Turtle Rock	4,619	0.478 (0.052)	21.7 (7.6)	0.015 (0.002)
	Wenatchee	HxW E	Volitional	Blackbird	2,184	0.317 (0.054)	NA	0.010 (0.002)
	Wenatchee	WxW	Volitional	Rohlfing	566	0.443 (0.187)	NA	0.014 (0.005)
2010	Chiwawa	WxW	Forced	Turtle Rock	4,226	0.586 (0.057)	24.4 (60.1)	0.009 (0.001)
	Nason	WxW	Forced	Turtle Rock	5,256	0.548 (0.044)	23.5 (53.3)	0.010 (0.001)
	Wenatchee	HxH	Forced	Turtle Rock	8,506	0.583 (0.053)	30.2 (50.1)	0.004 (0.001)
	Wenatchee	HxH	Volitional	Blackbird	9,858	0.629 (0.046)	NA	0.006 (0.001)
	Wenatchee	HxH	Volitional	Chiw. Circ	10,031	0.413 (0.043)	21.6 (66.1)	0.001 (0.000)
2011	Chiwawa	WxW	Volitional	RCY	3,603	0.403 (0.056)	15.1 (8.3)	0.005 (0.001)
	Nason	WxW	Volitional	RCY	4,065	0.330 (0.042)	20.9 (60.9)	0.005 (0.001)
	Wenatchee	WxW	Non-movers	Circular	1,122	0.341 (0.220)	40.6 (89.1)	0.000 (--)
	Wenatchee	WxW	Non-movers	RCY	2,395	0.312 (0.071)	22.7 (57.0)	0.004 (0.001)
	Wenatchee	WxW	Volitional	Blackbird	2,099	0.378 (0.067)	NA	0.010 (0.002)
	Wenatchee	WxW	Volitional	Circular	7,206	0.275 (0.042)	31.6 (74.3)	0.006 (0.001)
	Wenatchee	WxW	Volitional	RCY	4,422	0.323 (0.032)	15.2 (25.6)	0.008 (0.001)

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
	All	WxW	NA	Circular	1,628	0.055 (0.016)	100.4 (151.7)	0.002 (0.001)
	All	WxW	NA	RCY	3,479	0.229 (0.031)	13.6 (8.4)	0.004 (0.001)
2012	Chiwawa	HxH	Volitional	RCY	2,891	0.397 (0.055)	15.2 (7.2)	0.010 (0.002)
	Nason	WxW	Forced	Circular	4,271	0.376 (0.064)	25.0 (33.1)	0.007 (0.001)
	Nason	WxW	Volitional	Circular	5,404	0.364 (0.048)	24.9 (31.6)	0.007 (0.001)
	L Wenatchee	HxH	Forced	RCY	587	0.146 (0.086)	52.2 (114.7)	0.000 (--)
	U Wenatchee	HxH	Volitional	RCY	2,224	0.573 (0.138)	18.7 (8.4)	0.010 (0.002)
	U Wenatchee	HxH	Forced	RCY	1,969	0.603 (0.140)	24.7 (42.5)	0.012 (0.002)
	Wenatchee	HxH	Volitional	Blackbird	1,658	0.400 (0.095)	NA	0.004 (0.002)
	All	HxH	NA	RCY	769	0.293 (0.146)	97.3 (286.2)	0.004 (0.002)
	All	WxW	NA	Circular	5,397	0.327 (0.049)	25.4 (45.0)	0.007 (0.001)
2013	Chiwawa	Mixed	Volitional	RCY	1,567	0.356 (0.064)	15.2 (7.0)	NA
	Nason	Mixed	Volitional	RCY	3,796	0.448 (0.115)	20.2 (9.4)	NA
	Nason	Mixed	Volitional	Circ or RCY	308	0.146 (0.053)	17.4 (2.9)	NA
	Nason	WxW	Non-movers	Circular	74	0.000 (-)	0.0 (-)	NA
	Nason	WxW	Volitional	Circular	1,286	0.190 (0.062)	18.4 (6.4)	NA
	L Wenatchee	Mixed	Non-movers	RCY	3,275	0.317 (0.131)	35.3 (69.5)	NA
	U Wenatchee	Mixed	Volitional	RCY	2,862	0.455 (0.080)	16.3 (9.7)	NA
	Wenatchee	HxH	Volitional	Blackbird	819	0.337 (0.128)	NA	NA
	All	HxH	NA	RCY	907	0.000 (--)	36.7 (17.6)	NA
	All	WxW	NA	Circ or RCY	232	0.000 (--)	38.0 (--)	NA
2014	Chiwawa	Mixed	Movers	RCY	793	0.754 (0.497)	27.7 (7.6)	NA
	Chiwawa	Mixed	Non-screen	RCY	915	0.367 (0.236)	25.0 (8.1)	NA
	Nason	Mixed	Movers	RCY	1,553	0.216 (0.084)	28.4 (29.4)	NA
	Nason	Mixed	Non-screen	RCY	1,653	0.076 (0.018)	24.2 (7.1)	NA
	Nason	WxW	Movers	Circular	949	0.244 (0.104)	47.4 (91.0)	NA
	Nason	WxW	Non-screen	Circular	873	0.369 (0.190)	20.8 (6.9)	NA
	L Wenatchee	Mixed	Non-movers	RCY	2,596	0.139 (0.026)	26.4 (59.5)	NA
	U Wenatchee	Mixed	Movers	RCY	2,042	0.278 (0.051)	21.9 (8.2)	NA
	U Wenatchee	Mixed	Non-screen	RCY	1,563	0.126 (0.026)	28.7 (8.2)	NA
	U Wenatchee	WxW	Movers	Circular	356	0.278 (0.165)	17.0 (6.5)	NA
	U Wenatchee	WxW	Non-movers	Circular	596	0.381 (0.192)	15.8 (6.8)	NA
	U Wenatchee	WxW	Non-screen	Circular	1,230	0.349 (0.104)	25.8 (57.4)	NA

Brood year	Release location[a]	Crosses[b]	Type of release	Rearing scenario[c]	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
	Wenatchee	HxH	Volitional	Blackbird	1,814	0.225 (0.055)	NA	NA
	All	Mixed	NA	Circ or RCY	1,884	0.113 (0.030)	41.7 (61.8)	NA
2015	Chiwawa	Mixed	Movers	RCY	4,365	0.423 (0.040)	13.6 (5.7)	NA
	Nason	Mixed	Mixed	RCY	675	0.173 (0.037)	30.5 (61.8)	NA
	Nason	Mixed	Movers	RCY	2,427	0.332 (0.053)	18.6 (6.7)	NA
	Nason	Mixed	Non-movers	RCY	2,123	0.278 (0.057)	20.0 (7.6)	NA
	Nason	WxW	Movers	Circular	1,105	0.416 (0.083)	15.5 (5.3)	NA
	Nason	WxW	Non-movers	Circular	916	0.408 (0.113)	14.9 (5.1)	NA
	L Wenatchee	Mixed	Non-movers	RCY	1,658	0.252 (0.075)	13.0 (6.5)	NA
	U Wenatchee	Mixed	Movers	RCY	2,773	0.342 (0.032)	16.3 (7.9)	NA
	U Wenatchee	Mixed	Non-movers	RCY	1,435	0.469 (0.094)	19.7 (8.9)	NA
	U Wenatchee	WxW	Movers	Circular	1,061	0.555 (0.079)	13.9 (7.3)	NA
	U Wenatchee	WxW	Non-movers	Circular	849	0.359 (0.065)	12.7 (5.5)	NA
	Wenatchee	HxH	Vlitional	Blackbird	2,337	0.364 (0.039)	NA	NA
	All	Mixed	NA	Circ or RCY	1,381	0.167 (0.105)	19.4 (10.8)	NA
2016	Chiwawa	Mixed	Movers	RCY	2,254	0.380 (0.092)	16.9 (9.8)	NA
	Nason	Mixed	Mixed	RCY	1,084	0.392 (0.136)	21.8 (9.9)	NA
	Nason	WxW	Movers	Circular	3,436	0.225 (0.044)	21.1 (11.5)	NA
	Nason	WxW	Non-movers	Circular	753	--	21.3 (6.1)	NA
	L Wenatchee	Mixed	Non-movers	RCY	2,134	0.250 (0.099)	12.8 (7.7)	NA
	M Wenatchee	Mixed	Non-movers	RCY	3,452	0.113 (0.025)	17.2 (9.5)	NA
	U Wenatchee	Mixed	Movers	RCY	2,712	0.312 (0.063)	14.8 (6.5)	NA
	Wenatchee	HxH	Volitional	Blackbird	2,512	0.209 (0.055)	25.9 (11.1)	NA
	All	Mixed	NA	Circ or RCY	1,481	0.198 (0.094)	9.7 (7.7)	NA

[a] All = Chiwawa River, Nason Creek, and the Wenatchee River.
[b] HxH = hatchery by hatchery cross; WxW = wild by wild cross; Mixed = both HxH and WxW crosses; E = early; and L = late.
[c] Circ = circulars; RCY = raceway.

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). For brood years 1998-2013, NRR for summer steelhead in the Wenatchee

River basin averaged 0.64 (range, 0.13-3.10) if harvested fish were included in the estimate (Table 3.39).

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 6.9 (the calculated target value in Hillman et al. 2017). The target value of 6.9 includes harvest. In nearly all years, HRRs were greater than NRRs (Table 3.39). HRRs exceeded the estimated target value of 6.9 in 12 of the 16 years.

Table 3.39. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR with harvest) for summer steelhead in the Wenatchee River basin, brood years 1998-2013.

Brood year	Broodstock Collected	Spawning Escapement	Harvest included			
			HOR	NOR	HRR	NRR
1998	78	602	148	1,867	1.89	3.10
1999	125	343	1,944	334	15.55	0.97
2000	120	1,030	312	878	2.60	0.85
2001	178	1,655	10,335	1,050	58.06	0.66
2002	162	5,000	1,905	515	11.76	0.13
2003	155	2,598	956	504	6.17	0.27
2004	217	2,949	2,538	728	11.70	0.25
2005	209	3,609	3,106	904	14.86	0.25
2006	199	2,219	1,454	1,007	7.31	0.45
2007	176	880	535	430	3.04	0.49
2008	107	1,835	1,121	714	10.48	0.39
2009	107	1,733	1,024	709	9.57	0.41
2010	105	6,236	3,999	2,237	38.09	0.36
2011	104	3,049	859	2,189	8.26	0.72
2012	129	2,514	1,094	1,420	8.48	0.56
2013	147	1,986	1,050	936	7.14	0.47
Average	145	2,390	2,024	1,026	13.43	0.64
Median	138	2,103	1,108	891	9.03	0.46

Smolt-to-Adult Survivals

Smolt-to-adult ratios (SARs) are calculated as the number of returning hatchery adults divided by the number of tagged hatchery smolts released. SARs are generally based on CWT returns. However, prior to brood year 2011, Wenatchee steelhead were not extensively tagged with CWTs. Therefore, elastomer-tagged fish were used to estimate SARs from release to capture at Priest Rapids Dam. With the return of brood year 2011, SARs are based on PIT-tag detections at Bonneville Dam.

SARs (not adjusted for tag loss) for Wenatchee steelhead ranged from 0.0009 to 0.0315 (mean = 0.0093) for brood years 1996-2010 (Table 3.40). For brood years 2011 to present, SARs (to Bonneville Dam) averaged 0.0051 (Table 3.40).

Table 3.40. Smolt-to-adult ratios (SARs) for Wenatchee hatchery steelhead. Estimates for brood years 1996-2010 were based on elastomer tags recaptured at Priest Rapids Dam. SARs were not adjusted for tag loss after release. For brood years 2011 to present, SARs are based on PIT-tag detections to Bonneville Dam.

Brood year	Number of tagged smolts released	SAR
1996	348,693	0.0034
1997	429,422	0.0041
1998	172,078	0.0009
1999	175,661	0.0111
2000	184,639	0.0017
2001	335,933	0.0308
2002	302,060	0.0063
2003	374,867	0.0025
2004	294,114	0.0038
2005	452,184	0.0107
2006	258,697	0.0100
2007	306,690	0.0315
2008	327,133	0.0090
2009	484,826	0.0080
2010[a]	192,363	0.0054
Average	***309,291***	***0.0093***
Median	***306,690***	***0.0063***
2011	30,019	0.0057
2012	25,134	0.0055
2013	15,109	0.0042
Average	***23,421***	***0.0051***
Median	***25,134***	***0.0055***

[a] Only 192,363 WxW progeny from brood year 2010 were elastomer tagged; 161,951 HxH steelhead were released.

3.7 ESA/HCP Compliance

Broodstock Collection

Collection of brood year 2016 broodstock for Wenatchee summer steelhead at Dryden and Tumwater dams began on 26 June and ended on 27 October 2015 at Dryden Dam and 31 October 2015 at Tumwater Dam consistent with the collection period identified in the 2015 broodstock collection protocol. The broodstock collection achieved a total collection of 133 steelhead, including 67 natural-origin steelhead.

About 564 steelhead were handled and released (or surplused) at Tumwater and Dryden dams during brood year 2016 Wenatchee steelhead broodstock collection. Most were hatchery-origin fish handled at Tumwater Dam and ultimately surplused to meet the pHOS objective upstream from Tumwater Dam. Fish released at Dryden Dam were released because the weekly quota for hatchery or wild steelhead had been attained, but not for both hatchery and wild fish, or because they were non-target fish (adipose clipped), or they were unidentifiable hatchery-origin steelhead. All steelhead released were allowed to fully recover from the anesthesia and released immediately upstream from the trap sites.

In addition to steelhead encountered at Dryden Dam during steelhead broodstock collection, an estimated 74 spring Chinook salmon were captured and released unharmed immediately upstream from the trap facility. Consistent with ESA Section 10 Permit 1395 impact minimization measures, all ESA species handled were subject of water-to-water transfers.

Hatchery Rearing and Release

The 2016 brood Wenatchee steelhead reared throughout all life stages without significant mortality (defined as >10% population mortality associated with a single event). Despite actual fecundities being 89.7% and 84.9% for wild and hatchery females, respectively, compared to the biological assumptions, higher than expected survival at nearly every life stage resulted in production slightly above the targets (see Section 3.2).

Juvenile rearing occurred at three separate facilities including Eastbank Fish Hatchery, Chelan Fish Hatchery, and the Chiwawa Acclimation Facility. Multiple facilities were used to take advantage of variable water temperatures to manipulate growth of juveniles from different parental crosses. Typically, wild steelhead spawn later than their hatchery cohort and are therefore reared at Chelan Fish Hatchery on warmer water to accelerate their growth so they achieve a size-at-release similar to HxH parental cross progeny reared on cooler water at Eastbank Fish Hatchery. All parental cross groups received final rearing and over-winter acclimation at the Chiwawa Acclimation Facility on Wenatchee River and Chiwawa River surface water before direct release (scatter planting) in the Wenatchee River basin.

The 2016 brood steelhead smolt release in the Wenatchee River basin totaled 255,163 smolts, representing about 103.2% of the program target of 247,300 smolts identified in the Rocky Reach and Rock Island Dam HCPs and within the maximum 110% allowed in ESA Section 10 Permit 1395. As specified in ESA Section 10 Permit 1395, all steelhead smolts released were externally marked or internally tagged and a representative number were PIT tagged (see Section 3.2).

Hatchery Effluent Monitoring

Per ESA Permits 1347, 1395, 18118, 18120, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank or Chelan hatcheries. There were four violations at the Chiwawa acclimation facility for samples not being collected during the period 1 January 2017 through 31 December 2017. NPDES monitoring and reporting for PUD Hatchery Programs during 2017 are provided in Appendix F.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit No. 1395, the permit holders are authorized a direct take of up to 20% of the emigrating steelhead population and a lethal take not to exceed 2% of the fish captured (NMFS 2003). Based on the estimated wild steelhead population (smolt trap expansion) and hatchery juvenile steelhead population estimate (hatchery release data) for the Wenatchee River basin, the reported steelhead encounters during the 2016 emigration complied with take provisions in the Section 10 permit and are detailed in Table 3.41. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 1395 Section B.

Table 3.41. Estimated take of Upper Columbia River steelhead resulting from juvenile emigration monitoring in the Wenatchee River basin, 2017. NA = not available.

Trap location	Population estimate				Number trapped				Total	Take allowed by Permit
	Wild	Hatchery[a]	Parr	Fry	Wild	Hatchery	Parr	Fry		
Chiwawa Trap										
Population	NA	46,284	NA	NA	244	3,905	812	25	4,986	
Encounter rate	NA	NA	NA	NA	NA	0.0844	NA	NA	NA	0.20
Mortality[b]	NA	NA	NA	NA	0	1	3	0	4	
Mortality rate	NA	NA	NA	NA	0.0000	0.0003	0.0037	0.0000	0.0008	0.02
Lower Wenatchee Trap										
Population	NA	255,168	NA	NA	52	337	66	45	500	
Encounter rate	NA	NA	NA	NA	NA	0.0013	NA	NA	NA	0.20
Mortality[b]	NA	NA	NA	NA	0	1	2	0	3	
Mortality rate	NA	NA	NA	NA	0.0000	0.0030	0.0303	0.0000	0.0060	0.02
Wenatchee River Basin Total										
Population	NA	255,168	NA	NA	296	4,242	878	70	5,486	
Encounter rate	NA	NA	NA	NA	NA	0.0166	NA	NA	NA	0.20
Mortality[b]	NA	NA	NA	NA	0	2	5	0	7	
Mortality rate	NA	NA	NA	NA	0.0000	0.0006	0.0073	0.0147	0.0044	0.02

[a] 2017 smolt release data for the Wenatchee River basin.
[b] Mortality includes trapping and PIT-tag mortalities.

Spawning Surveys

Steelhead spawning ground surveys were conducted in the Wenatchee River basin during 2017, as authorized by ESA Section 10 Permit No. 1395. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Stock Assessment at Priest Rapids Dam

Upper Columbia River steelhead stock assessment sampling at Priest Rapids Dam (PRD) is authorized through ESA Section 10 Permit No. 1395 (NMFS 2003). Permit authorizations include interception and biological sampling of up to 15% of the Upper Columbia River steelhead passing PRD to determine upriver adult population size, estimate hatchery to wild ratios, determine age-class contribution, and evaluate the need for managing hatchery steelhead consistent with ESA recovery objectives, which include fully seeding spawning habitat with naturally produced Upper Columbia River steelhead supplemented with artificially propagated steelhead (NMFS 2003). The 2015-2016 run-cycle report (BY 2016) for stock assessment sampling at Priest Rapids Dam was compiled under provisions of ESA Section 10 Permit 1395. Data and reporting information are included in Appendix G.

SECTION 4: WENATCHEE SOCKEYE SALMON

The goal of sockeye salmon supplementation in the Wenatchee Basin was to use artificial production to replace adult production lost because of mortality at Rock Island Dam, while not reducing the natural production or long-term fitness of sockeye in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans.

Adult sockeye were collected for broodstock from the run-at-large at Tumwater Dam. Beginning in 2011, because of passage delays at Tumwater Dam during trapping operations, sockeye broodstock were collected at Dryden Dam. The goal was to collect up to 260 natural-origin adult sockeye for the program. Broodstock collection occurred from about 7 July through 28 August with trapping occurring no more than 16 hours per day, three days a week at Tumwater Dam and up to seven days per week at the Dryden Dam left and right-bank facilities.

Adult sockeye were held and spawned at Eastbank Fish Hatchery. The fertilized eggs were also incubated at the hatchery. For brood years 1989 through 1998, unfed fry were transferred from the hatchery to Lake Wenatchee net pens. From 1998 to 2011, juvenile sockeye were reared at Eastbank Fish Hatchery until July when they were transferred to the net pens. The initial rearing at Eastbank was to increase growth rates. During most years up through 2005, juvenile sockeye were released from net pens at two different times, August and November. From 2006-2012, all juvenile sockeye were released in late October.

The production goal for the Wenatchee sockeye supplementation program was to release 200,000 subyearlings into Lake Wenatchee at 20 fish per pound. Targets for fork length and weight were 133 mm (CV = 9.0) and 22.7 g, respectively. Over 90% of these fish were marked with CWTs. In addition, from 2006-2011, about 15,000 juvenile sockeye were PIT tagged annually. Following an evaluation of the supplementation program in 2011, the Hatchery Committees decided to convert the Wenatchee sockeye hatchery program to summer steelhead in 2012. Currently, monitoring occurs annually to track the status of the natural sockeye population.

4.1 Broodstock Sampling

As noted above, the Wenatchee sockeye program was terminated in 2012. Thus, no broodstock have been collected since 2011 and the release of juvenile sockeye into Lake Wenatchee in 2012 (2011 brood) was the last. This section presents the history of the program.

Origin of Broodstock

Wenatchee sockeye broodstock have not been collected since 2011. Table 4.1 shows the history of the number of broodstock that were collected during the period 1989 to 2011.

Table 4.1. Numbers of wild and hatchery sockeye salmon collected for broodstock, numbers that died before spawning, and numbers of sockeye spawned, 1989-2011. Unknown origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes sockeye that died of natural causes typically near the end of spawning and were not needed for the program, surplus sockeye killed at spawning, sockeye that died but were not recovered from the net pens, and sockeye that may have jumped out of the net pens.

Brood year	Wild sockeye					Hatchery sockeye					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989	299	93	47	115	44	0	0	0	0	0	115
1990	333	7	7	302	17	0	0	0	0	0	302
1991	357	18	16	199	124	0	0	0	0	0	199
1992	362	18	5	320	19	0	0	0	0	0	320
1993	307	79	21	207	0	0	0	0	0	0	207
1994	329	15	9	236	69	5	0	0	5	0	241
1995	218	5	7	194	12	3	0	0	3	0	197
1996	291	2	0	225	64	20	0	0	0	20	225
1997	283	12	3	192	76	19	0	0	19	0	211
1998	225	37	25	122	41	6	0	0	6	0	128
1999	90	7	1	79	3	60	0	0	60	0	139
2000	256	19	1	170	66	5	0	0	5	0	175
2001	252	27	10	200	15	8	1	0	7	0	207
2002	257	0	1	256	0	0	0	0	0	0	256
2003	261	12	9	198	42	0	0	0	0	0	198
2004	211	13	12	177	9	0	0	0	0	0	177
2005	243	29	12	166	36	0	0	0	0	0	166
2006	260	2	4	214	40	0	0	0	0	0	214
2007	248	15	3	210	20	0	0	0	0	0	210
2008	258	4	11	243	0	2	0	0	2	0	245
2009	258	5	14	239	0	3	0	3	0	0	239
2010	256	3	0	198	55	0	0	0	0	0	198
2011	204	0	8	196	0	0	0	0	0	0	196
Average	***263***	***18***	***10***	***203***	***33***	***6***	***0***	***0***	***5***	***1***	***208***
Median	***258***	***12***	***8***	***199***	***20***	***0***	***0***	***0***	***0***	***0***	***207***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.

Age/Length Data

Ages of sockeye were determined from scales and otoliths collected from broodstock and are shown in Table 4.2.

Table 4.2. Percent of hatchery and wild sockeye salmon of different ages (total age) collected from broodstock, 1994-2011.

Return year	Origin	Total age		
		4	5	6
1994	Wild	57.3	41.7	1.0
	Hatchery	40.0	60.0	0.0
1995	Wild	77.3	20.7	2.0
	Hatchery	66.7	33.3	0.0
1996	Wild	65.8	34.2	0.0
	Hatchery	0.0	0.0	0.0
1997	Wild	86.5	13.5	0.0
	Hatchery	57.9	42.1	0.0
1998	Wild	9.9	88.6	1.5
	Hatchery	66.7	33.3	0.0
1999	Wild	21.8	74.7	3.5
	Hatchery	90.0	8.3	1.7
2000	Wild	97.7	2.3	0.0
	Hatchery	100.0	0.0	0.0
2001	Wild	69.9	29.6	0.5
	Hatchery	71.4	28.6	0.0
2002	Wild	31.6	67.6	0.8
	Hatchery	0.0	0.0	0.0
2003	Wild	2.6	90.5	6.9
	Hatchery	0.0	0.0	0.0
2004	Wild	97.5	2.0	0.5
	Hatchery	0.0	0.0	0.0
2005	Wild	74.2	25.8	0.0
	Hatchery	0.0	0.0	0.0
2006	Wild	34.0	65.5	0.5
	Hatchery	0.0	0.0	0.0
2007	Wild	1.9	88.4	9.7
	Hatchery	0.0	0.0	0.0
2008	Wild	95.0	4.0	1.0
	Hatchery	100.0	0.0	0.0
2009	Wild	78.5	21.5	0.0
	Hatchery	100.0	0.0	0.0
2010	Wild	67.4	32.6	0.0
	Hatchery	0.0	0.0	0.0
2011	Wild	53.7	44.3	2.0
	Hatchery	0.0	0.0	0.0

Return year	Origin	Total age		
		4	5	6
Average	***Wild***	***56.8***	***41.5***	***1.7***
	Hatchery	***38.5***	***11.4***	***0.1***
Median	***Wild***	***66.6***	***33.4***	***0.7***
	Hatchery	***20.0***	***0.0***	***0.0***

Lengths and ages of sockeye sampled during the life of the program are provided in Table 4.3.

Table 4.3. Mean fork length (cm) at age (total age) of hatchery and wild sockeye salmon collected for broodstock, 1994-2011; SD = 1 standard deviation.

Return year	Origin	Sockeye fork length (cm)								
		Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1994	Wild	56	125	3	55	91	3	54	2	3
	Hatchery	57	2	1	56	3	1	-	0	-
1995	Wild	51	153	2	55	41	4	54	4	5
	Hatchery	53	2	4	59	1	-	-	0	-
1996	Wild	52	146	4	53	76	3	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-
1997	Wild	50	166	3	53	26	5	-	0	-
	Hatchery	54	11	4	59	8	2	-	0	-
1998	Wild	51	13	4	55	117	3	53	2	3
	Hatchery	52	4	2	55	2	8	-	0	-
1999	Wild	52	19	4	50	65	4	56	3	1
	Hatchery	50	54	3	56	5	4	56	1	-
2000	Wild	52	167	2	54	4	3	-	0	-
	Hatchery	54	5	1	-	0	-	-	0	-
2001	Wild	54	151	3	56	65	4	58	1	-
	Hatchery	51	5	5	55	2	4	-	0	-
2002	Wild	54	77	2	56	165	4	57	2	0
	Hatchery	-	0	-	-	0	-	-	0	-
2003	Wild	54	5	4	60	172	2	60	13	4
	Hatchery	-	0	-	-	0	-	-	0	-
2004	Wild	53	192	3	56	4	3	63	1	-
	Hatchery	-	0	-	-	0	-	-	0	-
2005	Wild	51	132	3	57	46	4	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-
2006	Wild	52	70	3	56	135	4	54	2	3
	Hatchery	-	0	-	-	0	-	-	0	-
2007	Wild	57	4	2	58	182	5	58	20	5

Return year	Origin	Sockeye fork length (cm)								
		Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	-	0	-	-	0	-
2008	Wild	52	245	3	52	11	3	62	2	6
	Hatchery	53	2	3	-	-	-	-	-	-
2009	Wild	54	197	3	59	54	4	-	-	-
	Hatchery	54	2	1	-	-	-	-	-	-
2010	Wild	55	130	2	57	63	4	-	-	-
	Hatchery	-	-	-	-	-	-	-	-	-
2011	Wild	55	109	2	59	90	3	61	4	3
	Hatchery	-	-	-	-	-	-	-	-	-
Average	***Wild***	***53***	***116***	***3***	***55***	***78***	***4***	***57***	***3***	***3***
	Hatchery	***53***	***5***	***3***	***57***	***2***	***4***	***56***	***1***	***-***

Sex Ratios

Sex ratios of wild and hatchery sockeye collected during the life of the sockeye hatchery program are presented in Table 4.4.

Table 4.4. Numbers of male and female wild and hatchery sockeye collected for broodstock, 1989-2011. Ratios of males to females are also provided.

Return year	Number of wild sockeye			Number of hatchery sockeye			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989	162	137	1.18:1.00	0	0	-	1.18:1.00
1990	177	156	1.13:1.00	0	0	-	1.13:1.00
1991	260	97	2.68:1.00	0	0	-	2.68:1.00
1992	180	182	0.99:1.00	0	0	-	0.99:1.00
1993	130	177	0.73:1.00	0	0	-	0.73:1.00
1994	162	167	0.97:1.00	1	4	0.25:1.00	0.95:1.00
1995	102	116	0.88:1.00	1	2	0.50:1.00	0.87:1.00
1996	150	161	0.93:1.00	0	0	-	0.93:1.00
1997	139	144	0.97:1.00	10	9	1.11:1.00	0.97:1.00
1998	115	110	1.05:1.00	2	4	0.50:1.00	1.03:1.00
1999	22	68	0.32:1.00	37	23	1.61:1.00	0.65:1.00
2000	155	101	1.53:1.00	3	2	1.50:1.00	1.53:1.00
2001	114	138	0.83:1.00	4	4	1.00:1.00	0.83:1.00
2002	128	129	0.99:1.00	0	0	-	0.99:1.00
2003	161	100	1.61:1.00	0	0	-	1.61:1.00
2004	108	103	1.05:1.00	0	0	-	1.05:1.00
2005	130	113	1.15:1.00	0	0	-	1.15:1.00
2006	130	130	1.00:1.00	0	0	-	1.00:1.00

Return year	Number of wild sockeye			Number of hatchery sockeye			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2007	127	121	1.05:1.00	0	0	-	1.05:1.00
2008	127	131	0.97:1.00	1	1	1.00:1.00	0.97:1.00
2009	133	125	1.06:1.00	0	3	0.00:1.00	1.04:1.00
2010	127	129	0.98:1.00	0	0	-	0.98:1.00
2011	106	98	1.08:1.00	0	0	-	1.08:1.00
Total	***2,074***	***2,017***	***1.03:1.00***	***58***	***48***	***1.21***	***1.03:1.00***

Fecundity

Fecundities of sockeye collected throughout the duration of the hatchery program are presented in Table 4.5.

Table 4.5. Mean fecundity of female sockeye salmon collected for broodstock, 1989-2011. Fecundities were determined from pooled egg lots and were not identified for individual females.

Return year	Mean fecundity
1989	2,344
1990	2,225
1991	2,598
1992	2,341
1993	2,340
1994	2,798
1995	2,295
1996	2,664
1997	2,447
1998	2,813
1999	2,319
2000	2,673
2001	2,960
2002	2,856
2003	3,511
2004	2,505
2005	2,718
2006	2,656
2007	3,115
2008	2,555
2009	2,459
2010	2,782
2011	2,960
Average	***2,649***
Median	***2,656***

4.2 Hatchery Rearing

Rearing History

Number of eggs taken

Numbers of eggs taken from sockeye broodstock throughout the duration of the sockeye hatchery program are shown in Table 4.6.

Table 4.6. Numbers of eggs taken from sockeye broodstock, 1989-2011.

Return year	Number of eggs taken
1989	133,600
1990	326,267
1991	231,254
1992	381,561
1993	231,700
1994	338,562
1995	247,900
1996	314,390
1997	254,459
1998	163,278
1999	190,732
2000	227,234
2001	301,925
2002	356,982
2003	319,470
2004	225,499
2005	211,985
2006	292,136
2007	302,363
2008	316,476
2009	304,963
2010	278,171
2011	290,046
Average	***271,389***
Median	***290,046***

Number of acclimation days

During the life of the program, Wenatchee sockeye were acclimated on Lake Wenatchee water in net pens. Acclimation days are presented in Table 4.7.

Table 4.7. Water source and mean acclimation period for Wenatchee sockeye, brood years 1989-2011.

Brood year	Release year	Transfer date	Release date	Number of Days	Water source
1989	1990	5-Apr	24-Oct	202	Lake Wenatchee
1990	1991	10-Apr	19-Oct	192	Lake Wenatchee
1991	1992	1-Apr	20-Oct	202	Lake Wenatchee
1992	1993	5-Apr	7-Sep	155	Lake Wenatchee
		5-Apr	26-Oct	204	Lake Wenatchee
1993	1994	5-Apr	1-Sep	149	Lake Wenatchee
		5-Apr	17-Oct	195	Lake Wenatchee
1994	1995	4-Apr	15-Sep	164	Lake Wenatchee
		4-Apr	23-Oct	202	Lake Wenatchee
1995	1996	4-Apr	25-Oct	204	Lake Wenatchee
1996	1997	4-Apr	22-Oct	201	Lake Wenatchee
1997	1998	1-Apr	9-Nov	222	Lake Wenatchee
1998	1999	1-Apr	29-Oct	211	Lake Wenatchee
1999	2000	25-Jul	28-Aug	34	Lake Wenatchee
		26-Jul	1-Nov	98	Lake Wenatchee
2000	2001	2-Jul	27-Aug	56	Lake Wenatchee
		3-Jul	27-Sep	86	Lake Wenatchee
2001	2002	15-Jul	28-Aug	44	Lake Wenatchee
		16-Jul	22-Sep	68	Lake Wenatchee
2002	2003	30-Jun	25-Aug	56	Lake Wenatchee
		1-Jul	22-Oct	113	Lake Wenatchee
2003	2004	6-Jul	25-Aug	50	Lake Wenatchee
		7-Jul	3-Nov	119	Lake Wenatchee
2004	2005	5-Jul	29-Aug	55	Lake Wenatchee
		6-Jul	2-Nov	120	Lake Wenatchee
2005	2006	11-Jul	30-Oct	111	Lake Wenatchee
2006	2007	9-10 Jul	31-Oct	113-114	Lake Wenatchee
2007	2008	7-8 Jul	29-Oct	113-114	Lake Wenatchee
2008	2009	21-Jul	28-Oct	100	Lake Wenatchee
2009	2010	19-20, 23-Jul	27-Oct	97-101	Lake Wenatchee
2010	2011	6, 11-12-Jul	26-Oct	107-113	Lake Wenatchee
2011	2012	9-10-Jul	29-Oct	112-113	Lake Wenatchee

Release Information

Numbers released

Numbers of juvenile sockeye released into Lake Wenatchee throughout the duration of the program are shown in Table 4.8. Coded wire tag marking rates and numbers of PIT-tagged juvenile sockeye released are also shown in Table 4.8.

Table 4.8. Total number of sockeye parr released and numbers of released fish with CWTs and PIT tags for brood years 1989-2011. The release target for sockeye was 200,000 fish.

Brood year	Release year	CWT mark rate	Number of released fish with PIT tags	Number released
1989	1990	Not marked	0	108,400
1990	1991	0.9308	0	270,802
1991	1992	0.8940	0	167,523
1992	1993	0.9240	0	340,597
1993	1994	0.7278	0	190,443
1994	1995	0.8869	0	252,859
1995[a]	1996	1.0000	0	150,808
1996[a]	1997	0.9680	0	284,630
1997[a]	1998	0.9642	0	197,195
1998[a]	1999	0.8713	0	121,344
1999	2000	0.9527	0	167,955
2000	2001	0.9558	0	190,174
2001	2002	0.9911	0	200,938
2002	2003	0.9306	0	315,783
2003	2004	0.9291	0	240,459
2004	2005	0.8995	0	172,923
2005	2006	0.9811	14,859	140,542
2006	2007	0.9735	14,764	225,670
2007	2008	0.9863	14,947	252,133
2008	2009	0.9576	14,858	154,772
2009	2010	0.9847	14,486	227,743
2010	2011	0.9564	5,039	241,918
2011	2012	0.9690	5,074	256,120
Average		***0.9379***	***11,994[b]***	***208,271***
Median		***0.9561***	***14,764[b]***	***197,195***

[a] These groups were only adipose fin clipped.
[b] Average and median are based on brood years 2004 to 2010.

Fish size and condition at release

The size and condition of the juvenile sockeye released into Lake Wenatchee throughout the duration of the hatchery program are presented in Table 4.9.

Table 4.9. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of sockeye released, brood years 1989-2011. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1990	128	-	18.2	25
1990	1991	131	-	18.9	24
1991	1992	117	3.0	20.6	22
1992	1993	73	6.8	4.2	44
1993	1994	103	-	13.6	40
1994	1995	75	6.1	4.5	38
1995	1996	137	8.2	14.7	30
1996	1997	107	5.6	15.1	30
1997	1998	122	6.1	21.3	21
1998	1999	112	5.4	17.0	27
1999	2000	94	9.5	9.5	48
		134	11.5	31.3	15
2000	2001	123	6.5	22.3	20
		146	8.4	26.0	12
2001	2002	118	7.4	20.7	22
		135	7.3	30.5	15
2002	2003	73	5.6	4.4	104
		118	7.7	13.7	23
		145	9.4	38.6	13
2003	2004	79	4.6	4.8	96
		118	5.9	17.0	26
		158	8.1	44.3	10
2004	2005	116	4.5	17.2	18
		151	7.0	39.3	12
2005	2006	149	7.5	43.7	10
2006	2007	138	10.6	32.4	14
2007	2008	137	9.3	33.0	14
2008	2009	138	9.6	34.6	13

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
2009	2010	143	8.9	35.5	13
2010	2011	132	14.3	30.7	15
2011	2012	142	9.6	35.3	13
Targets		***133***	***9.0***	***22.7***	***20***

Survival Estimates

Life-stage survival estimates for juvenile sockeye throughout the duration of the hatchery program are shown in Table 4.10.

Table 4.10. Hatchery life-stage survival rates (%) for sockeye salmon, brood years 1989-2011. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989	41.6	100.0	88.1	63.9	99.2	98.9	98.1	65.2	83.0
1990	96.2	99.4	90.8	96.3	99.9	99.2	98.4	98.4	81.1
1991	91.8	94.1	79.2	94.8	99.8	99.3	96.4	96.4	72.4
1992	91.1	98.8	92.3	98.0	99.9	99.8	98.6	98.8	89.2
1993	57.1	99.2	89.2	98.3	99.6	99.1	93.7	93.8	82.2
1994	89.8	99.2	79.2	96.0	99.5	98.6	98.3	98.2	74.7
1995	97.5	99.1	87.5	95.0	99.0	93.3	73.2	73.2	60.8
1996	99.2	100.0	95.1	98.7	99.7	99.3	96.4	96.5	90.5
1997	92.8	99.3	84.8	97.9	97.9	97.6	95.5	94.9	77.5
1998	75.4	95.5	77.7	98.4	98.6	98.2	97.1	97.2	74.3
1999	92.3	100.0	92.2	97.3	99.6	99.3	98.2	99.7	88.1
2000	84.5	98.1	93.8	97.7	96.7	96.1	91.4	96.8	83.7
2001	75.4	99.2	78.5	97.6	98.0	97.6	86.9	95.1	66.6
2002	100.0	100.0	95.7	97.8	99.6	99.2	94.6	99.8	88.5
2003	91.0	98.1	87.2	96.9	99.0	98.2	94.8	95.5	74.6
2004	88.7	92.6	88.0	93.1	97.9	97.4	93.7	96.1	76.7
2005	98.5	98.5	85.3	94.9	97.8	96.6	95.5	99.2	66.3
2006	95.3	99.1	73.2	85.4	95.4	94.6	87.8	98.5	54.9
2007	88.4	99.2	89.1	98.6	97.0	95.9	94.9	99.0	83.4
2008	97.0	100.0	59.0	88.3	99.1	97.2	93.8	97.4	48.9
2009	95.8	98.3	89.1	94.8	96.9	96.2	88.4	92.3	74.7
2010	99.0	98.0	92.6	98.2	97.5	96.5	95.6	99.6	87.0
2011	100.0	100.0	92.6	100.0	96.8	96.0	95.4	99.7	88.3
Average	***88.6***	***98.5***	***86.1***	***94.7***	***98.5***	***97.6***	***93.8***	***94.8***	***76.8***

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
Median	*92.3*	*99.2*	*88.1*	*97.3*	*99.0*	*97.6*	*95.4*	*97.2*	*77.5*
Standard	*90.0*	*85.0*	*92.0*	*98.0*	*97.0*	*93.0*	*90.0*	*95.0*	*81.0*

4.3 Disease Monitoring

Because the sockeye hatchery program ended in 2012, there are no disease-monitoring results.

4.4 Natural Juvenile Productivity

Sockeye smolt abundance was estimated at a rotary screw trap located near the mouth of Lake Wenatchee during the period 1997 to 2011. Because the efficiency of the trap was difficult to assess, the operation was terminated in 2011. In 2012, the trap was relocated downstream near the mouth of the Chiwawa River and operated there for two years. Again, because few marked sockeye smolts were recaptured, the operation was terminated in 2013. Beginning in 2013, smolt abundance has been estimated at the Lower Wenatchee Trap located near Cashmere, WA.

Emigrant and Smolt Estimates

The Lower Wenatchee Trap operated between 24 February and 31 July 2017. During that time, the trap was inoperable for 36 days because of high and low river discharge, debris, elevated river temperature, large hatchery releases, and mechanical issues. During the sampling period, a total of 1,045 wild juvenile sockeye were captured at the Lower Wenatchee Trap. A significant relationship between trap efficiency and river discharge was created ($R^2 = 0.52$, $P < 0.043$). Using this model, the number of juvenile sockeye emigrants was estimated at 121,825 (95% CI = ±22,904) during the 2017 trapping season (Table 4.11). Figure 4.1 shows the monthly captures of sockeye collected at the Lower Wenatchee Trap in 2017. All fish captured in the Lower Wenatchee trap are reported in Appendix B.

Table 4.11. Estimated numbers of wild and hatchery sockeye smolts that emigrated from Lake Wenatchee during run years 1997-2017; NS = no data. Estimates for the run years 1997-2011 were based on sampling at the Upper Wenatchee smolt trap; estimates beginning in 2013 were based on sampling at the Lower Wenatchee smolt trap.

Run year	Numbers of sockeye smolts	
	Wild smolts	Hatchery smolts
1997	55,359	28,828
1998	1,447,259	55,985
1999	1,944,966	112,524
2000	985,490	24,684
2001	39,353	94,046
2002	729,716	121,511
2003	5,439,032	140,322
2004	5,771,187	216,023
2005	723,413	122,399

Run year	Numbers of sockeye smolts	
	Wild smolts	Hatchery smolts
2006	1,266,971	159,500
2007	2,797,313	140,542
2008[a]	549,682	121,843
2009[a]	355,549	119,908
2010[a]	3,958,888	126,326
2011	1,500,730	159,089
2012	ND	ND
2013	873,096 (±95,132)	No program
2014	1,275,027 (±211,615)	No program
2015	1,065,614 (±238,901)	No program
2016	208,250 (±29,447)	No program
2017	121,825 (±22,904)	No program
Average	***1,55,436***	***116,235[b]***
Median	***1,025,552***	***121.511[b]***

[a] Estimates refined based on PIT tag survival to McNary Dam.
[b] Summary statistics were calculated for years in which hatchery fish were being released (1997-2011).

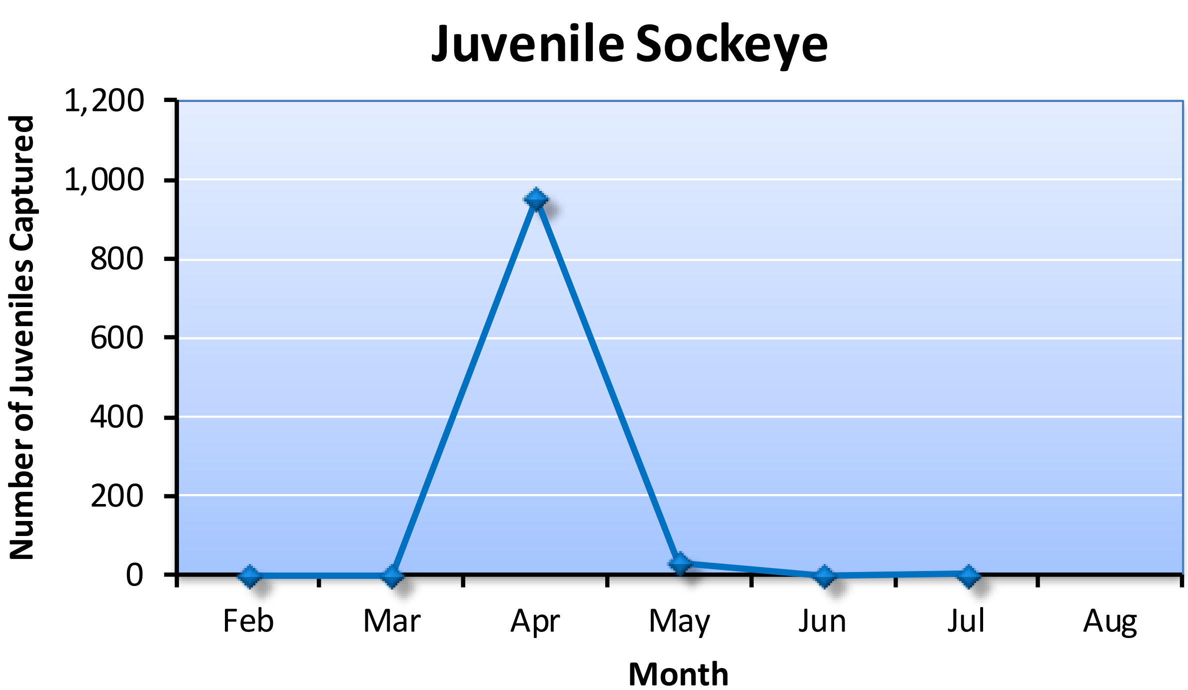


Figure 4.1. Monthly captures of wild sockeye salmon smolts at the Lower Wenatchee Trap, 2017.

Age classes of wild sockeye smolts were determined from a length frequency analysis based on scales collected randomly each year since 1997 (Table 4.12). Each year, a small number of markedly smaller sockeye (<50 mm FL) are collected, and starting with run year 2013, an age-0 class was retroactively assigned based on catch records. For the available run years, most wild sockeye smolts migrated as age 1+ fish. Only in two years (1997 and 2005) did more smolts migrate as age 2+ fish. Relatively few smolts migrated at age 3+.

Table 4.12. Age structure and estimated number of wild sockeye smolts that emigrated from Lake Wenatchee, 1997-2017; ND = no data. Estimates for the run years 1997-2011 were based on sampling at the Upper Wenatchee smolt trap; estimates beginning in 2013 were based on sampling at the Lower Wenatchee smolt trap.

Run year	Proportion of wild smolts				Total wild emigrants
	Age 0	Age 1+	Age 2+	Age 3+	
1997	ND	0.075	0.906	0.019	55,359
1998	ND	0.955	0.037	0.008	1,447,259
1999	ND	0.619	0.381	0.000	1,944,966
2000	ND	0.599	0.400	0.001	985,490
2001	ND	0.943	0.051	0.006	39,353
2002	ND	0.961	0.039	0.000	729,716
2003	ND	0.740	0.026	0.000	5,439,032
2004	ND	0.929	0.071	0.000	5,771,187
2005	ND	0.230	0.748	0.022	723,413
2006	ND	0.994	0.006	0.000	1,266,971
2007	ND	0.996	0.004	0.000	2,797,313
2008	ND	0.804	0.195	0.001	549,682
2009	ND	0.927	0.073	0.000	355,549
2010	ND	0.963	0.036	0.001	3,958,888
2011	ND	0.786	0.214	0.000	1,500,730
2012	ND	ND	ND	ND	ND
2013	0.008	0.919	0.073	0.000	873,096
2014	0.003	0.948	0.049	0.000	1,275,027
2015	0.003	0.777	0.220	0.000	1,065,614
2016	0.046	0.895	0.059	0.000	208,250
2017	0.053	0.868	0.079	0.000	121,825
Average	***0.023***	***0.796***	***0.183***	***0.003***	***1,555,436***
Median	***0.008***	***0.907***	***0.072***	***0.000***	***1,025,552***

Freshwater Productivity

Egg-smolt survival estimates for wild sockeye salmon are provided in Table 4.13. Estimates of egg deposition were calculated based on the spawner escapement at Tumwater Dam and the sex ratio and fecundity of the broodstock. For brood years 2012 - 2015 in which brood was not collected, a linear relationship with post-orbital to hypural length as the independent variable was used to calculate mean fecundity of sockeye sampled at Tumwater Dam ($r^2 = 0.36$, $P < 0.01$). No smolt estimates are available for brood year 2010. Egg-smolt survival rates for brood years 1995-2015 have ranged from 0.012 to 0.212 (mean = 0.081).

Table 4.13. Estimated egg deposition (estimated as mean fecundity times estimated number of females), numbers of smolts, and survival rates for wild Wenatchee sockeye salmon, brood years 1995-2015; ND = no data.

Brood year	Number of females	Mean fecundity	Total eggs	Numbers of wild smolts					Egg-smolt survival
				Age 0	Age 1+	Age 2+	Age 3+	Total	
1995	2,136	2,295	4,902,120	ND	4,152	53,549	0	57,701	0.012
1996	3,767	2,664	10,035,288	ND	1,382,133	741,032	985	2,124,150	0.212
1997	5,404	2,447	13,223,588	ND	1,203,934	394,196	236	1,598,366	0.121
1998	2,024	2,813	5,693,512	ND	590,309	2,007	0	592,316	0.104
1999	513	2,319	1,189,647	ND	37,110	28,459	0	65,569	0.055
2000	11,413	2,673	30,506,949	ND	701,257	1,414,148	0	2,115,405	0.069
2001	21,685	2,960	64,187,600	ND	4,024,884	409,754	15,915	4,450,553	0.069
2002	17,226	2,856	49,197,456	ND	5,361,433	541,113	0	5,902,546	0.120
2003	2,158	3,511	7,576,738	ND	166,385	7,602	0	173,987	0.023
2004	15,469	2,505	38,749,845	ND	1,259,369	11,189	550	1,270,833	0.033
2005	5,867	2,718	15,946,506	ND	2,786,123	107,243	0	2,893,366	0.181
2006	2,747	2,656	7,296,032	ND	442,164	25,919	3,959	472,042	0.065
2007	2,001	3,115	6,232,804	ND	329,629	142,916	0	472,545	0.076
2008	11,775	2,555	30,084,691	ND	3,814,226	321,156	ND	4,135,382	0.138
2009	3,939	2,459	9,684,965	ND	1,179,569	ND	0	ND	ND
2010	11,918	2,785	33,190,467	ND	ND	58,497	0	ND	ND
2011	9,722	2,970	28,873,491	ND	802,375	96,902	0	899,277	0.031
2012	14,753	2,693	39,245,089	6,985	1,208,726	234,435	0	1,450,146	0.037
2013	9,477	2,729	25,862,733	3,825	827,982	12,287	0	844,094	0.033
2014	31,203	2,520	78,631,560	3,197	186,384	--	--	--	--
2015	12,953	2,771	35,892,763	9,579	--	--	--	--	--
Average	***9,436***	***2,715***	***25,533,516***	***5,897***	***1,384,639***	***255,689***	***1,203***	***1,736,369***	***0.081***
Median	***9,477***	***2,693***	***25,862,733***	***5,405***	***827,982***	***102,072***	***0***	***1,270,833***	***0.069***

Juvenile survival rates for hatchery sockeye salmon are provided in Table 4.14. Release-smolt survival rates for brood years 1995-2010 have ranged from 0.000 to 1.000 (mean = 0.570). Egg-smolt survival rates for the same brood years ranged from 0.000 to 0.710 (mean = 0.294). On average, egg-smolt survival of hatchery sockeye is about three times greater than egg-smolt survival of wild sockeye.

Table 4.14. Juvenile survival rates for hatchery Wenatchee sockeye, brood years 1995-2010.

<table>
<tr><th>Brood year</th><th>Number of eggs</th><th>Number of parr released</th><th>Date of release</th><th>Estimated number of smolts</th><th>Egg-smolt survival</th><th>Release-smolt survival</th></tr>
<tr><td>1995</td><td>247,900</td><td>150,808</td><td>10/25/96</td><td>28,828</td><td>0.116</td><td>0.191</td></tr>
<tr><td>1996</td><td>314,390</td><td>284,630</td><td>10/22/97</td><td>55,985</td><td>0.178</td><td>0.197</td></tr>
<tr><td>1997</td><td>254,459</td><td>197,195</td><td>11/9/98</td><td>112,524</td><td>0.442</td><td>0.571</td></tr>
<tr><td>1998</td><td>163,278</td><td>121,344</td><td>10/27/99</td><td>24,684</td><td>0.151</td><td>0.203</td></tr>
<tr><td rowspan="2">1999</td><td rowspan="2">190,732</td><td>84,466</td><td>8/28/00</td><td>30,326</td><td>0.159</td><td>0.359</td></tr>
<tr><td>83,489</td><td>11/1/00</td><td>63,720</td><td>0.334</td><td>0.763</td></tr>
<tr><td rowspan="2">2000</td><td rowspan="2">227,234</td><td>92,055</td><td>8/27/01</td><td>30,918</td><td>0.136</td><td>0.336</td></tr>
<tr><td>98,119</td><td>9/27/01</td><td>90,593</td><td>0.399</td><td>0.923</td></tr>
<tr><td rowspan="2">2001</td><td rowspan="2">301,925</td><td>96,486</td><td>8/28/02</td><td>36,484</td><td>0.121</td><td>0.378</td></tr>
<tr><td>104,452</td><td>9/23/02</td><td>103,838</td><td>0.344</td><td>0.994</td></tr>
<tr><td rowspan="3">2002</td><td rowspan="3">356,982</td><td>98,509</td><td>6/16/03</td><td>5,192</td><td>0.015</td><td>0.053</td></tr>
<tr><td>104,855</td><td>8/25/03</td><td>98,412</td><td>0.276</td><td>0.939</td></tr>
<tr><td>112,419</td><td>10/22/03</td><td>112,419</td><td>0.315</td><td>1.000</td></tr>
<tr><td rowspan="3">2003</td><td rowspan="3">319,470</td><td>32,755</td><td>6/15/04</td><td>0</td><td>0.000</td><td>0.000</td></tr>
<tr><td>104,879</td><td>8/25/04</td><td>19,574</td><td>0.061</td><td>0.187</td></tr>
<tr><td>102,825</td><td>11/3/04</td><td>102,825</td><td>0.322</td><td>1.000</td></tr>
<tr><td rowspan="2">2004</td><td rowspan="2">225,499</td><td>81,428</td><td>8/29/05</td><td rowspan="2">159,500</td><td rowspan="2">0.707</td><td rowspan="2">0.922</td></tr>
<tr><td>91,495</td><td>11/2/05</td></tr>
<tr><td rowspan="2">2005</td><td rowspan="2">211,985</td><td>70,386</td><td>10/30/06</td><td rowspan="2">140,542</td><td rowspan="2">0.663</td><td rowspan="2">1.000</td></tr>
<tr><td>70,156</td><td>10/30/06</td></tr>
<tr><td>2006</td><td>292,136</td><td>225,670</td><td>10/31/07</td><td>121,843</td><td>0.412</td><td>0.540</td></tr>
<tr><td>2007</td><td>302,363</td><td>252,133</td><td>10/29/08</td><td>119,908</td><td>0.397</td><td>0.476</td></tr>
<tr><td>2008</td><td>316,476</td><td>154,772</td><td>10/28/09</td><td>126,326</td><td>0.399</td><td>0.813</td></tr>
<tr><td>2009</td><td>304,963</td><td>227,743</td><td>10/27/10</td><td>159,089</td><td>0.522</td><td>0.699</td></tr>
<tr><td>2010</td><td>278,171</td><td>241,918</td><td>10/26/11</td><td>ND[a]</td><td></td><td></td></tr>
<tr><td>2011</td><td>290,046</td><td>256,120</td><td>10/29/12</td><td>ND[a]</td><td></td><td></td></tr>
</table>

[a] There are no emigrant estimates for the 2010 and 2011 brood years (not enough recaptures for valid estimate).

PIT Tagging Activities

A total of 968 wild juvenile sockeye salmon were PIT tagged and released in 2017 at the Lower Wenatchee Trap. Numbers of wild sockeye salmon PIT-tagged and released as part of the Comparative Survival Study and PUD studies during the period 2006-2017 are shown in Table 4.15. See Appendix C for a complete list of all fish captured, tagged, lost, and released.

Table 4.15. Summary of the numbers of wild sockeye salmon that were tagged and released at the Upper and Lower Wenatchee Traps within the Wenatchee River basin, 2006-2017.

Sampling Location	Numbers of PIT-tagged sockeye salmon released									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Upper Wenatchee Trap	3,165	3,683	10,006	--	--	--	--	--	--	--
Lower Wenatchee Trap	0	0	0	0	0	0	4,821	3,922	1,065	968

4.5 Spawning Escapement

The sockeye salmon hatchery program ended after the 2011 brood year. As a result, monitoring activities that focused on evaluating the effects of the supplementation program on the natural population switched to monitoring the abundance and productivity of the natural population. Broadly, the proposed monitoring and evaluation activities cover juvenile and adult life-history stages and provide the data necessary to track or estimate viable salmonid population (VSP) parameters; abundance, productivity, spatial structure, and diversity (McElhaney et al. 2000).

From 2009-2013, mark-recapture methods were used to estimate spawning escapement within the White River, while area-under-the-curve (AUC) methods were used to estimate spawning escapement within the Little Wenatchee River. Beginning in 2014, mark-recapture methods were used to estimate the spawning escapement of sockeye in both the White River and Little Wenatchee watersheds (see Appendix H for more details).

Mark-Recapture Estimates

Spawning escapement of sockeye salmon in 2017 was estimated using mark-recapture methods. This method relied on PIT tags to estimate sockeye spawning escapement (see Appendix H for more details).

Using mark-recapture methods, the estimated total escapement of sockeye in the Upper Wenatchee River basin in 2017 was 20,521 (Table 4.16). About 86% of the escapement entered the White River watershed (including the Napeequa River).

Table 4.16. Estimated escapement of adult sockeye into the Little Wenatchee and White River watersheds for return years 2009-2017. Escapement was based on recapture of PIT-tagged fish.

Return year	Tumwater Dam count	Recreational harvest	Little Wenatchee escapement	White River escapement	Total spawning escapement
2009	16,034	2,285	576	13,876	14,452
2010	35,821	4,129	2,062	19,542	21,604
2011[a]	18,634	0	2,431	14,582	17,013
2012	66,520	12,107	4,607	23,866	28,473
2013[a]	29,015	6,262	2,426	14,294	16,720
2014	99,898	16,281	4,319	49,021	53,340
2015	51,435	7,916	2,707	20,097	22,804
2016	73,697	14,630	6,747	38,802	45,549

Return year	Tumwater Dam count	Recreational harvest	Little Wenatchee escapement	White River escapement	Total spawning escapement
2017	23,854	0	2,085	18,436	20,521
Average	***46,101***	***7,068***	***3,107***	***23,613***	***26,720***
Median	***35,821***	***6,262***	***2,431***	***19,542***	***21,604***

[a] Spawning escapements in 2011 and 2013 were calculated using AUC counts and a regression model.

The spawning escapement of 20,521 Wenatchee sockeye was less than the overall average of 26,720 (Table 4.17).

Table 4.17. Spawning escapements for sockeye salmon in the Wenatchee River basin for return years 1989-2017; NA = not available and AUC = area under the curve.

Return year	Escapement estimation method	Spawning escapement		
		Little Wenatchee	White	Total
1989	Counts at Tumwater Dam	NA	NA	**21,802**
1990	Counts at Tumwater Dam	NA	NA	**27,325**
1991	Counts at Tumwater Dam	NA	NA	**26,689**
1992	Counts at Tumwater Dam	NA	NA	**16,461**
1993	Counts at Tumwater Dam	NA	NA	**27,726**
1994	Counts at Tumwater Dam	NA	NA	**7,330**
1995	Counts at Tumwater Dam	NA	NA	**3,448**
1996	Counts at Tumwater Dam	NA	NA	**6,573**
1997	Counts at Tumwater Dam	NA	NA	**9,693**
1998	Counts at Tumwater Dam	NA	NA	**4,014**
1999	Counts at Tumwater Dam	NA	NA	**1,025**
2000	Counts at Tumwater Dam	NA	NA	**20,735**
2001	Counts at Tumwater Dam	NA	NA	**29,103**
2002	Counts at Tumwater Dam	NA	NA	**27,565**
2003	Counts at Tumwater Dam	NA	NA	**4,855**
2004	Counts at Tumwater Dam	NA	NA	**27,556**
2005	Counts at Tumwater Dam	NA	NA	**14,011**
2006	AUC	574	5,634	**6,208**
2007	AUC	150	1,720	**1,870**
2008	AUC	3,491	16,757	**20,248**
2009	AUC and Mark-Recap	763	7,004	**7,767**
2010	AUC and Mark-Recap	2,543	19,157	**21,700**
2011	AUC and Mark-Recap	2,431	14,582	**17,013**
2012	AUC and Mark-Recap	4,607	23,866	**28,473**
2013	AUC and Mark-Recap	2,426	14,294	**16,720**
2014	Mark-Recapture	4,391	49,021	**53,340**
2015	Mark-Recapture	2,707	20,097	**22,804**
2016	Mark-Recapture	6,747	38,321	**45,068**

Return year	Escapement estimation method	Spawning escapement		
		Little Wenatchee	White	Total
2017	Mark-Recapture	2,085	18,436	**20,521**
Average		***2,743***	***19,074***	***18,539***
Median		***2,487***	***17,596.5***	***20,248***

4.6 Carcass Surveys

As described earlier, carcass surveys were not conducted in 2016. The information contained in this section represents carcass data collected before 2014.

Number sampled

Table 4.18 shows the number of carcasses sampled within different survey streams during the period 1993-2013.

Table 4.18. Numbers of sockeye carcasses sampled within different streams/watersheds within the Wenatchee River basin, 1989-2013.

Survey year	Numbers of sockeye carcasses			
	Little Wenatchee	White	Napeequa	Total
1993	90	195	0	**285**
1994	121	165	0	**286**
1995	0	56	0	**56**
1996	43	1,387	3	**1,433**
1997	69	1,425	41	**1,535**
1998	61	524	4	**589**
1999	40	186	0	**226**
2000	821	5,494	0	**6,315**
2001	650	3,127	0	**3,777**
2002	506	7,258	55	**7,819**
2003	86	1,002	14	**1,102**
2004	625	6,960	138	**7,723**
2005	1	7	0	**8**
2006	101	2,158	38	**2,297**
2007	17	363	3	**383**
2008	476	5,132	125	**5,733**
2009	84	3,103	103	**3,290**
2010	217	7,832	70	**8,119**
2011	372	3,322	48	**3,742**
2012	1,309	7,479	31	**8,819**
2013	179	2,996	27	**3,202**
Average	***279***	***2,865***	***33***	***3,178***
Median	***101***	***2,158***	***14***	***2,297***

Carcass Distribution and Origin

Based on the available data (1993-2013), the largest percentage of both wild and hatchery sockeye spawned in Reach 2 on the White River (Table 4.19 and Figure 4.2). However, a greater percentage of wild fish was found in Reach 2 than hatchery fish.

Table 4.19. Numbers of wild and hatchery sockeye carcasses sampled within different reaches in the Wenatchee River basin, 1993-2013. Reach codes are described in Table 2.9.

Survey year	Origin	Numbers of sockeye carcasses					
		Little Wenatchee		White River			Total
		L2	L3	H1	H2	Q1	
1993	Wild	86	0	0	183	0	**269**
	Hatchery	4	0	0	12	0	**16**
1994	Wild	112	0	0	155	0	**267**
	Hatchery	9	0	0	9	0	**18**
1995	Wild	0	0	0	55	0	**55**
	Hatchery	0	0	0	1	0	**1**
1996	Wild	41	0	0	1,299	3	**1,343**
	Hatchery	2	0	0	88	0	**90**
1997	Wild	65	0	0	1,411	40	**1,516**
	Hatchery	4	0	0	11	1	**16**
1998	Wild	61	0	0	515	4	**580**
	Hatchery	0	0	0	9	0	**9**
1999	Wild	30	0	0	164	0	**194**
	Hatchery	10	0	0	22	0	**32**
2000	Wild	694	0	3	5,239	0	**5,936**
	Hatchery	127	0	0	252	0	**379**
2001	Wild	625	0	0	3,063	0	**3,688**
	Hatchery	25	0	0	64	0	**89**
2002	Wild	504	0	0	7,207	55	**7,766**
	Hatchery	2	0	0	51	0	**53**
2003	Wild	81	0	0	993	14	**1,088**
	Hatchery	5	0	0	9	0	**14**
2004	Wild	606	0	0	6,755	166	**7,527**
	Hatchery	19	0	0	205	22	**246**
2005	Wild	201	0	5	2,966	21	**3,193**
	Hatchery	1	0	0	8	0	**9**
2006	Wild	80	0	0	2,112	36	**2,228**
	Hatchery	21	0	0	46	2	**69**
2007	Wild	17	0	0	346	3	**366**
	Hatchery	0	0	0	17	0	**17**
2008	Wild	472	0	0	5,118	124	**5,714**
	Hatchery	4	0	0	14	1	**19**

Survey year	Origin	Numbers of sockeye carcasses					
		Little Wenatchee		White River			Total
		L2	L3	H1	H2	Q1	
2009	Wild	80	0	0	3,084	103	**3,267**
	Hatchery	4	0	0	19	0	**23**
2010	Wild	210	0	0	7,711	69	**7,990**
	Hatchery	7	0	0	121	1	**129**
2011	Wild	266	0	0	3,079	43	**3,388**
	Hatchery	106	0	0	243	5	**354**
2012	Wild	1,270	0	21	7,368	30	**8,689**
	Hatchery	39	0	3	87	1	**130**
2013	Wild	174	0	1	2,936	26	**3,137**
	Hatchery	3	0	0	56	1	**60**
Average	***Wild***	***270***	***0***	***1***	***2,941***	***35***	***3,248***
	Hatchery	***18***	***0***	***0***	***61***	***2***	***81***
Median	***Wild***	***112***	***0***	***0***	***2,936***	***21***	***3,137***
	Hatchery	***4***	***0***	***0***	***22***	***0***	***32***

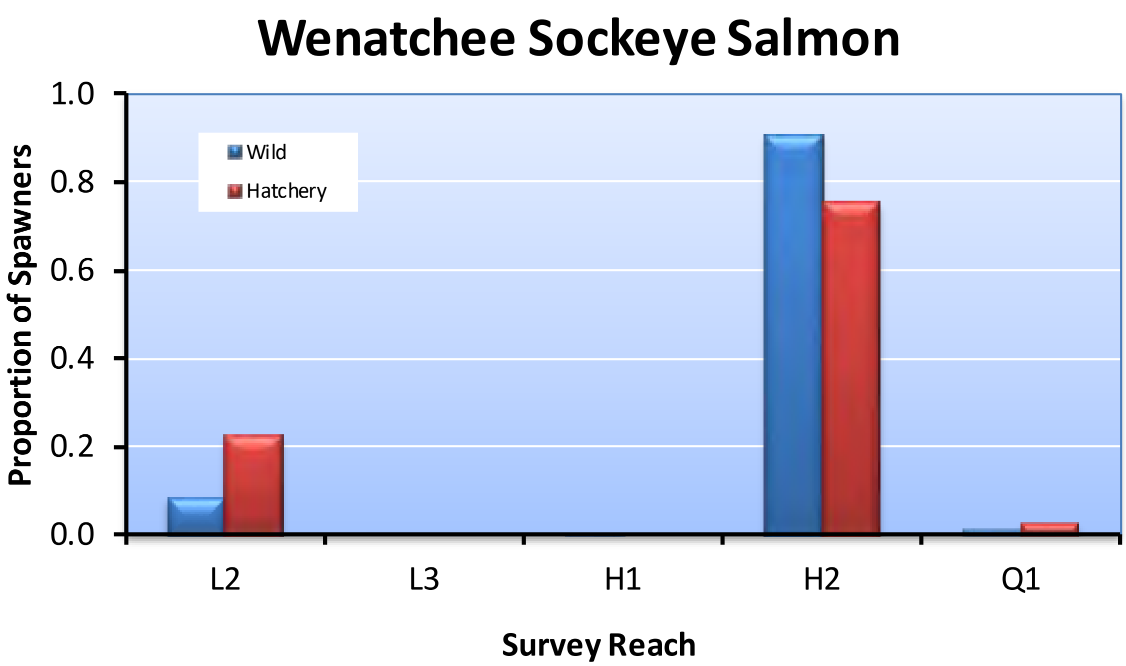


Figure 4.2. Distribution of wild and hatchery produced carcasses in different reaches in the Wenatchee River basin, pooled data from 1993-2013. Reach codes are described in Table 2.9; L = Little Wenatchee, H = White River, and Q = Napeequa River.

4.7 Life History Monitoring

Life history characteristics of Wenatchee sockeye were assessed by examining carcasses on spawning grounds and fish sampled at broodstock collection sites or during stock assessment, and by reviewing tagging data and fisheries statistics.

Migration Timing

There was little difference in migration timing of hatchery and wild sockeye past Tumwater Dam (Table 4.20a and b; Figure 4.3). On average, early in the run, hatchery and wild sockeye arrived at the dam at about the same time. Toward the end of the migration period, hatchery sockeye tended to arrive at the dam slightly later than did wild sockeye. Most hatchery and wild sockeye migrated upstream past Tumwater Dam during July through early August. The peak migration time for both hatchery and wild sockeye was the last two weeks of July (Figure 4.3).

Table 4.20a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery sockeye salmon passed Tumwater Dam, 1998-2017. The average Julian day and date are also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery sockeye salmon. All sockeye were visually examined during trapping from 2004 to present.

Survey year	Origin	Sockeye Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
1998	Wild	195	14-Jul	201	20-Jul	208	27-Jul	202	21-Jul	4,173
	Hatchery	196	15-Jul	204	23-Jul	220	8-Aug	206	25-Jul	31
1999	Wild	226	14-Aug	233	21-Aug	241	29-Aug	234	22-Aug	908
	Hatchery	228	16-Aug	234	22-Aug	242	30-Aug	235	23-Aug	264
2000	Wild	200	18-Jul	206	24-Jul	213	31-Jul	207	25-Jul	18,390
	Hatchery	199	17-Jul	206	24-Jul	213	31-Jul	206	24-Jul	2,589
2001	Wild	189	8-Jul	194	13-Jul	214	2-Aug	198	17-Jul	32,554
	Hatchery	199	18-Jul	212	31-Jul	240	28-Aug	214	2-Aug	79
2002	Wild	204	23-Jul	208	27-Jul	219	7-Aug	210	29-Jul	27,241
	Hatchery	204	23-Jul	209	28-Jul	222	10-Aug	211	30-Jul	580
2003	Wild	194	13-Jul	200	19-Jul	208	27-Jul	201	20-Jul	4,699
	Hatchery	194	13-Jul	201	20-Jul	211	30-Jul	203	22-Jul	375
2004	Wild	191	9-Jul	196	14-Jul	207	25-Jul	198	16-Jul	31,408
	Hatchery	189	7-Jul	194	12-Jul	203	21-Jul	196	14-Jul	1,758
2005	Wild	192	11-Jul	199	18-Jul	227	15-Aug	204	23-Jul	14,176
	Hatchery	187	6-Jul	200	19-Jul	251	8-Sep	212	31-Jul	42
2006	Wild	201	20-Jul	204	23-Jul	214	2-Aug	206	25-Jul	9,151
	Hatchery	202	21-Jul	219	7-Aug	228	16-Aug	215	3-Aug	507
2007	Wild	201	20-Jul	210	29-Jul	227	15-Aug	213	1-Aug	2,542
	Hatchery	205	24-Jul	213	1-Aug	231	19-Aug	216	4-Aug	65
2008	Wild	200	18-Jul	207	25-Jul	219	6-Aug	208	26-Jul	29,229
	Hatchery	201	19-Jul	206	24-Jul	215	2-Aug	208	26-Jul	103

Survey year	Origin	Sockeye Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2009	Wild	198	17-Jul	204	23-Jul	213	1-Aug	206	25-Jul	15,552
	Hatchery	199	18-Jul	205	24-Jul	215	3-Aug	207	26-Jul	534
2010	Wild	199	18-Jul	205	24-Jul	220	8-Aug	208	27-Jul	34,519
	Hatchery	200	19-Jul	215	3-Aug	244	1-Sep	218	6-Aug	1,302
2011	Wild	213	1-Aug	216	4-Aug	224	12-Aug	217	5-Aug	17,680
	Hatchery	213	1-Aug	213	1-Aug	231	19-Aug	216	4-Aug	954
2012[a]	Wild	207	25-Jul	212	30-Jul	216	3-Aug	212	30-Jul	21,246
	Hatchery	207	25-Jul	207	25-Jul	228	15-Aug	213	31-Jul	348
2013	Wild	196	15-Jul	200	19-Jul	207	26-Jul	201	20-Jul	28,245
	Hatchery	197	16-Jul	201	20-Jul	211	30-Jul	203	22-Jul	770
2014	Wild	194	13-Jul	199	18-Jul	210	29-Jul	201	20-Jul	97,670
	Hatchery	196	15-Jul	201	20-Jul	211	30-Jul	203	22-Jul	2,229
2015	Wild	191	10-Jul	199	18-Jul	215	3-Aug	203	22-Jul	49,628
	Hatchery	181	30-Jun	199	18-Jul	212	31-Jul	200	19-Jul	1,782
2016	Wild	190	8-Jul	196	14-Jul	208	26-Jul	198	16-Jul	73,619
	Hatchery	192	10-Jul	195	13-Jul	207	25-Jul	197	15-Jul	78
2017	Wild	198	17-Jul	204	23-Jul	211	30-Jul	204	23-Jul	23,845
	Hatchery	202	21-Jul	205	24-Jul	212	31-Jul	207	26-Jul	9
Average	***Wild***	***199***		***205***		***216***		***207***		***26,824***
	Hatchery	***200***		***207***		***222***		***209***		***720***
Median	***Wild***	***198***		***204***		***214***		***205***		***22,546***
	Hatchery	***199***		***206***		***218***		***208***		***441***

[a] The origin of sockeye passing Tumwater Dam during 8 through 11 August 2012 was not assessed. The total number of sockeye passing Tumwater Dam in 2012 was 30,617 adults. Thus, about 9,023 adults of unknown origin passed Tumwater Dam in 2012.

Table 4.20b. The week that 10%, 50% (median), and 90% of the wild and hatchery sockeye salmon passed Tumwater Dam, 1998-2017. The average week is also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery sockeye salmon. All sockeye were visually examined during trapping from 2004 to present.

Survey year	Origin	Sockeye Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
1998	Wild	28	29	30	29	4,173
	Hatchery	28	30	32	30	31
1999	Wild	33	34	35	34	908
	Hatchery	33	34	35	34	264
2000	Wild	29	30	31	30	18,390
	Hatchery	29	30	31	30	2,589

Survey year	Origin	Sockeye Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2001	Wild	27	28	31	29	32,554
	Hatchery	29	31	35	31	79
2002	Wild	30	30	32	30	27,241
	Hatchery	30	30	32	31	580
2003	Wild	28	29	30	29	4,699
	Hatchery	28	29	31	29	375
2004	Wild	28	28	28	29	31,408
	Hatchery	27	28	29	28	1,758
2005	Wild	28	29	33	30	14,176
	Hatchery	27	29	36	31	42
2006	Wild	29	29	31	30	9,151
	Hatchery	29	32	33	31	507
2007	Wild	29	30	33	31	2,542
	Hatchery	30	31	33	31	65
2008	Wild	29	30	32	30	29,229
	Hatchery	29	30	31	30	103
2009	Wild	29	30	31	30	15,552
	Hatchery	29	29	31	30	534
2010	Wild	29	30	32	30	34,519
	Hatchery	29	31	35	32	1,302
2011	Wild	31	31	32	31	17,680
	Hatchery	31	31	33	31	954
2012[a]	Wild	30	31	31	31	21,246
	Hatchery	30	30	33	31	348
2013	Wild	28	29	30	29	28,245
	Hatchery	29	29	31	29	770
2014	Wild	28	29	30	29	97,670
	Hatchery	28	29	29	29	2,229
2015	Wild	28	29	31	30	49,628
	Hatchery	26	29	31	29	1,782
2016	Wild	28	28	30	29	73,619
	Hatchery	28	28	30	29	78
2017	Wild	29	30	31	30	23,845
	Hatchery	29	30	31	30	9
Average	***Wild***	***29***	***30***	***31***	***30***	***26,824***
	Hatchery	***29***	***30***	***32***	***30***	***720***
Median	***Wild***	***29***	***30***	***31***	***30***	***22,546***
	Hatchery	***29***	***30***	***32***	***30***	***441***

[a] The origin of sockeye passing Tumwater Dam during 8 through 11 August 2012 was not assessed. The total number of sockeye passing Tumwater Dam in 2012 was 30,617 adults. Thus, about 9,023 adults of unknown origin passed Tumwater Dam in 2012.

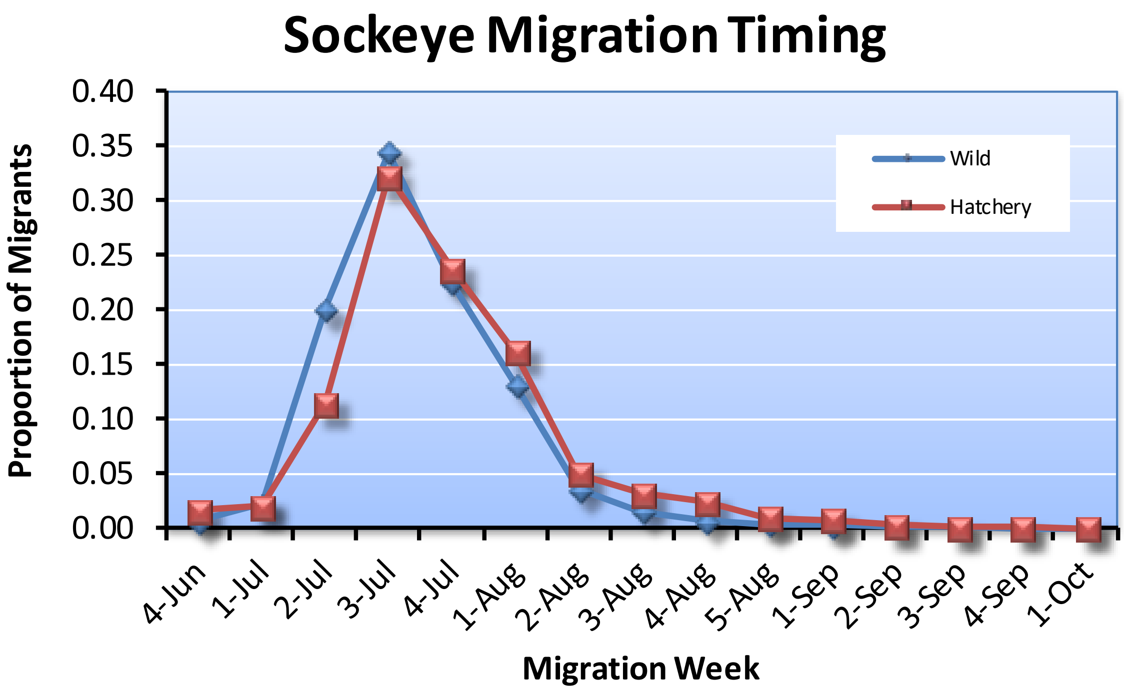


Figure 4.3. Proportion of wild and hatchery sockeye observed (using video) passing Tumwater Dam each week during their migration period late-June through early-October; data were pooled over survey years 1998-2017.

Age at Maturity

Although sample sizes are small, most hatchery sockeye returned as age-4 fish, while most wild sockeye returned as age-4 and 5 fish (Table 4.21; Figure 4.4). Only wild fish have returned at age-6. No hatchery fish were observed in 2017.

Table 4.21. Proportions of wild and hatchery sockeye of different ages (total age) sampled in broodstock (1994-2011), on spawning grounds (1994-2012), and at Tumwater Dam (2013-2017).

Survey year	Origin	Total age						Sample size
		2	3	4	5	6	7	
1994	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	0.88	0.13	0.00	0.00	16
1995	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	0.00	1.00	0.00	0.00	1
1996	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	82
1997	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	0.77	0.23	0.00	0.00	13

Survey year	Origin	Total age						Sample size
		2	3	4	5	6	7	
1998	Wild	0.00	0.08	0.85	0.08	0.00	0.00	26
	Hatchery	0.00	0.00	0.64	0.36	0.00	0.00	11
1999	Wild	0.00	0.00	0.18	0.73	0.10	0.00	113
	Hatchery	0.00	0.00	0.65	0.35	0.00	0.00	31
2000	Wild	0.00	0.00	0.00	1.00	0.00	0.00	1
	Hatchery	0.00	0.00	0.98	0.02	0.00	0.00	359
2001	Wild	0.00	0.00	0.76	0.24	0.00	0.00	29
	Hatchery	0.00	0.00	0.75	0.25	0.00	0.00	171
2002	Wild	0.00	0.00	0.20	0.80	0.00	0.00	5
	Hatchery	0.00	0.00	0.29	0.71	0.00	0.00	63
2003	Wild	0.00	0.00	0.00	1.00	0.00	0.00	5
	Hatchery	0.00	0.33	0.67	0.00	0.00	0.00	6
2004	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.02	0.93	0.05	0.00	0.00	244
2005	Wild	0.00	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.13	0.75	0.13	0.00	0.00	8
2006	Wild	0.00	0.00	0.34	0.65	0.01	0.00	207
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	65
2007	Wild	0.00	0.00	0.02	0.88	0.10	0.00	206
	Hatchery	0.00	0.00	0.35	0.65	0.00	0.00	17
2008	Wild	0.00	0.00	0.95	0.04	0.01	0.00	258
	Hatchery	0.00	0.08	0.92	0.00	0.00	0.00	12
2009	Wild	0.00	0.00	0.79	0.21	0.00	0.00	251
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	2
2010	Wild	0.00	0.00	0.67	0.33	0.00	0.00	193
	Hatchery	0.00	0.00	0.98	0.02	0.00	0.00	130
2011	Wild	0.00	0.00	0.63	0.36	0.01	0.00	270
	Hatchery	0.00	0.02	0.96	0.02	0.00	0.00	274
2012	Wild	0.00	0.00	0.92	0.08	0.00	0.00	13
	Hatchery	0.00	0.00	0.96	0.03	0.01	0.00	128
2013	Wild	0.00	0.002	0.56	0.44	0.002	0.00	457
	Hatchery	0.00	0.00	0.50	0.50	0.00	0.00	2
2014	Wild	0.00	0.00	0.88	0.12	0.00	0.00	1,332
	Hatchery	0.00	0.03	0.95	0.02	0.00	0.00	40
2015	Wild	0.00	0.00	0.81	0.19	0.00	0.00	882
	Hatchery	0.00	0.00	1.00	0.00	0.00	0.00	53
2016	Wild	0.00	0.00	0.77	0.23	0.00	0.00	765
	Hatchery	0.00	0.00	0.00	1.00	0.00	0.00	1

Survey year	Origin	Total age						Sample size
		2	3	4	5	6	7	
2017	Wild	0.00	0.00	0.49	0.47	0.04	0.00	472
	Hatchery	0.00	0.00	0.00	0.00	0.00	0.00	0
Average	***Wild***	***0.00***	***0.00***	***0.70***	***0.29***	***0.01***	***0.00***	***229***
	Hatchery	***0.00***	***0.01***	***0.90***	***0.09***	***0.00***	***0.00***	***72***
Median	***Wild***	***0.00***	***0.00***	***0.71***	***0.29***	***0***	***0***	***71***
	Hatchery	***0.00***	***0.00***	***0.91***	***0.09***	***0***	***0***	***24***

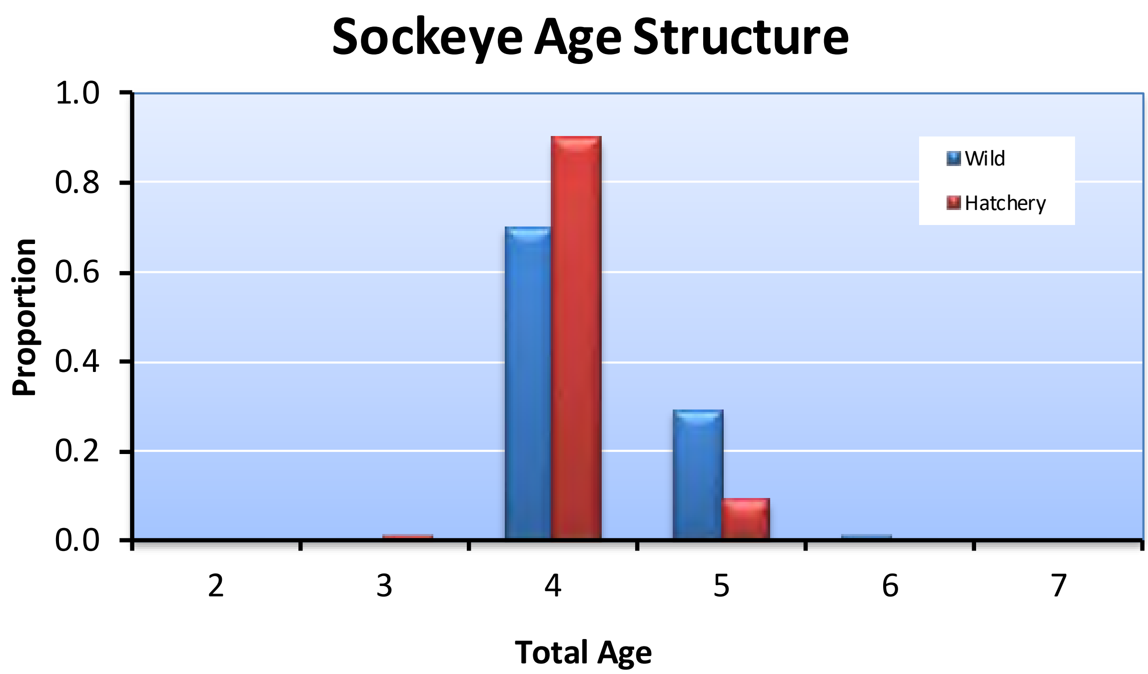


Figure 4.4. Proportions of wild and hatchery sockeye salmon of different total ages sampled at Tumwater Dam and on spawning grounds in the Wenatchee River basin for the combined years 1994-2017.

Size at Maturity

Because no hatchery sockeye returned in 2017, there are no comparisons in sizes between hatchery and wild sockeye in 2017 (Table 4.22). However, the pooled data indicate that there is little difference in mean sizes of hatchery and wild sockeye salmon, with wild fish slightly greater in length (Table 4.22). Analyses for the five-year statistical reports will compare sizes of hatchery and wild fish of the same age groups and sex.

Table 4.22. Mean lengths (POH; cm) and variability statistics for wild and hatchery sockeye salmon sampled at Dryden Dam (broodstock) and on spawning grounds in the Wenatchee River basin, 1994-2017; SD = 1 standard deviation. From 2014 to present, data are collected from sockeye sampled at Tumwater Dam.

Survey year	Origin	Sample size	Sockeye length (POH; cm)			
			Mean	SD	Minimum	Maximum
1994	Wild	0	-	-	-	-
	Hatchery	14	42	3	37	47
1995	Wild	0	-	-	-	-
	Hatchery	1	53	-	53	53
1996	Wild	0	-	-	-	-
	Hatchery	5	51	3	49	55
1997	Wild	6	40	3	38	45
	Hatchery	17	41	3	37	50
1998	Wild	585	43	3	34	50
	Hatchery	20	43	3	40	51
1999	Wild	99	42	3	36	50
	Hatchery	31	41	3	36	47
2000	Wild	1	48	-	48	48
	Hatchery	377	40	2	30	49
2001	Wild	29	42	2	38	47
	Hatchery	184	43	3	35	51
2002	Wild	5	42	1	40	43
	Hatchery	52	44	3	37	49
2003	Wild	5	44	4	38	47
	Hatchery	13	42	5	30	48
2004	Wild	0	-	-	-	-
	Hatchery	230	40	3	33	49
2005	Wild	0	-	-	-	-
	Hatchery	8	43	9	35	64
2006	Wild	248	45	4	34	52
	Hatchery	17	41	5	31	48
2007	Wild	248	45	3	32	52
	Hatchery	16	41	5	31	48
2008	Wild	261	52	3	44	66
	Hatchery	20	39	3	30	41
2009	Wild	260	43	3	33	53
	Hatchery	22	41	2	36	46
2010	Wild	200	56	3	48	66
	Hatchery	131	41	2	35	45
2011	Wild	277	43	3	35	51

Survey year	Origin	Sample size	Sockeye length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	282	40	3	32	49
2012	Wild	15	40	4	34	48
	Hatchery	130	40	3	31	48
2013	Wild	2	49	3	47	51
	Hatchery	64	50	4	43	65
2014	Wild	1,367	42	2	31	51
	Hatchery	43	41	3	32	45
2015	Wild	920	43	2	37	53
	Hatchery	54	43	2	39	47
2016	Wild	798	43	3	36	51
	Hatchery	1	38	-	38	38
2017	Wild	495	44	3	35	52
	Hatchery	0	-	-	-	-
Pooled	***Wild***	***5,821***	***45***	***4***	***31***	***66***
	Hatchery	***1,732***	***43***	***4***	***30***	***65***

Contribution to Fisheries

The total number of hatchery and wild sockeye captured in different fisheries is provided in Tables 4.23 and 4.24. Harvest on hatchery-origin sockeye has been less than the harvest on wild sockeye.

Table 4.23. Estimated number and percent (in parentheses) of hatchery-origin Wenatchee sockeye captured in different fisheries, brood years 1989-2011.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
1989	0 (0)	279 (30)	4 (0)	639 (69)	922
1990	0 (0)	23 (100)	0 (0)	0 (0)	23
1991	0 (0)	6 (100)	0 (0)	0 (0)	6
1992	0 (0)	38 (97)	1 (3)	0 (0)	39
1993	0 (0)	4 (100)	0 (0)	0 (0)	4
1994	0 (0)	3 (100)	0 (0)	0 (0)	3
1995	0 (0)	10 (100)	0 (0)	0 (0)	10
1996	0 (0)	62 (82)	9 (12)	5 (7)	76
1997	0 (0)	69 (73)	11 (12)	15 (16)	95
1998	0 (0)	7 (100)	0 (0)	0 (0)	7
1999	0 (0)	3 (20)	0 (0)	12 (80)	15
2000	0 (0)	59 (12)	9 (2)	414 (86)	482
2001	0 (0)	0 (0)	0 (0)	3 (100)	3
2002	0 (0)	16 (100)	0 (0)	0 (0)	16

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
2003	0 (0)	3 (100)	0 (0)	0 (0)	3
2004	0 (0)	6 (3)	1 (1)	192 (96)	199
2005	0 (0)	61 (41)	8 (5)	79 (54)	147
2006	0 (0)	124 (23)	2 (0)	409 (76)	535
2007	0 (0)	96 (81)	13 (11)	9 (8)	118
2008	0 (0)	96 (19)	12 (2)	400 (79)	508
2009	0 (0)	20 (16)	2 (2)	104 (83)	126
2010	0 (0)	97 (36)	5 (2)	170 (63)	272
2011	0 (0)	261 (49)	13 (2)	257 (48)	531
Average	***0 (0)***	***58 (60)***	***4 (2)***	***118 (38)***	***180***
Median	***0 (0)***	***23 (73)***	***1 (0)***	***9 (16)***	***76***

[a] Includes the Lake Wenatchee fishery.

Table 4.24. Estimated number and percent (in parentheses) of wild Wenatchee sockeye captured in different fisheries, brood years 1989-2011.

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
1989	0 (0)	2,192 (31)	26 (0)	4,838 (69)	7,056
1990	0 (0)	191 (100)	0 (0)	0 (0)	191
1991	0 (0)	293 (99)	2 (1)	0 (0)	295
1992	0 (0)	345 (99)	5 (1)	0 (0)	350
1993	0 (0)	661 (99)	4 (1)	0 (0)	665
1994	0 (0)	146 (100)	0 (0)	0 (0)	146
1995	0 (0)	63 (85)	4 (5)	7 (9)	74
1996	0 (0)	1,553 (56)	247 (9)	993 (36)	2,793
1997	0 (0)	3,060 (54)	376 (7)	2,266 (40)	5,702
1998	0 (0)	937 (98)	7 (1)	10 (1)	954
1999	0 (0)	22 (19)	3 (3)	90 (78)	115
2000	0 (0)	1,188 (19)	165 (3)	4,881 (78)	6,234
2001	0 (0)	827 (100)	1 (0)	0 (0)	828
2002	0 (0)	379 (83)	2 (0)	73 (16)	454
2003	0 (0)	129 (24)	15 (3)	383 (73)	527
2004	0 (0)	1,559 (24)	175 (3)	4,825 (74)	6,559
2005	0 (0)	2,499 (44)	198 (3)	2,996 (53)	5,693
2006	0 (0)	2,845 (52)	136 (2)	2,505 (46)	5,486
2007	0 (0)	1,534 (57)	216 (8)	976 (36)	2,726
2008	0 (0)	5,068 (25)	598 (3)	13,560 (71)	19,226

Brood year	Ocean fisheries	Columbia River Fisheries			Total
		Tribal	Commercial (Zones 1-5)	Recreational[a] (sport)	
2009	0 (0)	1,204 (20)	89 (1)	5,336 (80)	6,665
2010	0 (0)	5,303 (26)	256 (1)	15,615 (74)	21,174
2011	0 (0)	6,692 (40)	379 (2)	9,566 (57)	16,637
Average	***0 (0)***	***1,684 (60)***	***126 (3)***	***2,997 (38)***	***4,807***
Median	***0 (0)***	***1,188 (54)***	***26 (2)***	***976 (40)***	***2,726***

[a] Includes the Lake Wenatchee fishery.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin. In addition, PIT tagging of hatchery sockeye, which began with brood year 2005, allows estimation of stray rates by return year and brood return. Targets for strays based on return year (recovery year) outside the Wenatchee River basin should be less than 5%.

Based on return year and PIT-tag analysis, hatchery-origin Wenatchee sockeye have strayed into the Methow and Okanogan basins, but these hatchery fish made up less than 1% of the run escapement upstream from Wells Dam (Table 4.25).

Table 4.25. Number and percent of run escapement within other non-target basins that consisted of hatchery-origin Wenatchee sockeye salmon, return years 2008-2016. For example, for return year 2015, 0.46% of the sockeye run escapement upstream of Wells Dam consisted of hatchery-origin Wenatchee sockeye. Percent strays should be less than 5%.

Return year	Methow and Okanogan Run Escapement		
	Run escapement*	Expanded detections	Percent
2008	165,334	0	0.00
2009	134,937	57	0.04
2010	291,764	183	0.06
2011	111,508	51	0.05
2012	326,107	75	0.02
2013	129,993	78	0.06
2014	490,804	0	0.00
2015	187,055	858	0.46
2016	216,036	0	0.00
Average	***228,171***	***145***	***0.08***
Median	***187,055***	***57***	***0.04***

* Run escapement estimated at Wells Dam.

Based on CWTs and brood-year analysis, virtually no hatchery-origin Wenatchee sockeye strayed into non-target spawning areas or hatchery programs before brood year 2006 (Table 4.26).[13]

[13] This is likely because few sockeye surveys were conducted in non-target streams (e.g., Entiat and Methow rivers) before the return of brood year 2016.

However, sockeye from brood years 2006 through 2011 strayed into the Entiat River and a few into the Methow River (non-target streams) and non-target hatcheries (Umpqua Trap, Chief Joseph Hatchery, and Entiat National Fish Hatchery) (Table 4.26). The number of returning hatchery sockeye has decreased since brood year 2008. Because carcass surveys in the Wenatchee River basin ended in 2013, the last brood-year homing estimate based on CWTs is 2009.

Table 4.26. Number and percent of hatchery-origin Wenatchee sockeye that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and hatchery programs, by brood years 1990-2009. Hatchery-origin sockeye from brood years 1995-1998 were not tagged because of columnaris disease (NA = not available).

Brood year	Homing				Straying			
	Target streams		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1990	402	99.5	2	0.5	0	0.0	0	0.0
1991	1	100.0	0	0.0	0	0.0	0	0.0
1992	92	98.9	0	0.0	0	0.0	1	1.1
1993	29	96.7	1	3.3	0	0.0	0	0.0
1994	66	94.3	4	5.7	0	0.0	0	0.0
1995	NA	NA	NA	NA	NA	NA	NA	NA
1996	NA	NA	NA	NA	NA	NA	NA	NA
1997	NA	NA	NA	NA	NA	NA	NA	NA
1998	NA	NA	NA	NA	NA	NA	NA	NA
1999	65	100.0	0	0.0	0	0.0	0	0.0
2000	571	100.0	0	0.0	0	0.0	0	0.0
2001	17	100.0	0	0.0	0	0.0	0	0.0
2002	251	100.0	0	0.0	0	0.0	0	0.0
2003	11	100.0	0	0.0	0	0.0	0	0.0
2004	56	100.0	0	0.0	0	0.0	0	0.0
2005	67	97.1	2	2.9	0	0.0	0	0.0
2006	117	41.9	0	0.0	160	57.3	2	0.7
2007	260	82.0	1	0.3	56	17.7	0	0.0
2008	86	90.5	0	0.0	9	9.5	0	0.0
2009	11	73.3	0	0.0	4	26.7	0	0.0
2010	NA	NA	0	0.0	2	100.0	0	0.0
2011	NA	NA	0	0.0	2	8.0	23	92.0
Average	***131***	***92.1***	***1***	***0.7***	***13***	***12.2***	***1***	***5.2***
Median	***67***	***99.2***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

* Homing to the target hatchery includes Wenatchee hatchery sockeye that are captured and included as broodstock in the Wenatchee Hatchery program. These hatchery fish were collected at Tumwater Dam.

Based on PIT-tags and brood-year analyses, on average, about 11% of the hatchery sockeye returns were last detected in streams outside the Wenatchee River basin (Table 4.27). The numbers in

Table 4.27 should be considered rough estimates because they are not based on confirmed spawning (only last detections). Nevertheless, these data do indicate that some hatchery sockeye from the Wenatchee program have strayed into the Entiat and Methow rivers and possibly into the Okanogan system (based on sockeye detected at Wells Dam but not in the Methow River).

Table 4.27. Number and percent of hatchery-origin Wenatchee sockeye that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and hatchery programs for brood years 2005-2011. Estimates were based on last detections of PIT-tagged hatchery sockeye.

Brood Year	Homing				Straying			
	Target streams		Target hatchery*		Non-target stream		Non-target hatchery	
	Number	%	Number	%	Number	%	Number	%
2005	1,561	92.2	0	0.0	132	7.8	0	0.0
2006	6,680	94.6	0	0.0	382	5.4	0	0.0
2007	3,239	95.0	0	0.0	169	5.0	0	0.0
2008	1,281	89.1	0	0.0	156	10.9	0	0.0
2009	645	82.0	0	0.0	141	18.0	0	0.0
2010	2,544	100.0	0	0.0	0	0.0	0	0.0
2011	3,331	72.5	0	0.0	1,262	27.5	0	0.0
Average	***2,754***	***89.4***	***0***	***0.0***	***320***	***10.6***	***0***	***0.0***
Median	***2,544***	***92.2***	***0***	***0.0***	***156***	***7.8***	***0***	***0.0***

* Homing to the target hatchery includes Wenatchee hatchery sockeye that are captured and included as broodstock in the Wenatchee Hatchery program. These hatchery fish were collected at Tumwater Dam.

Genetics

Genetic studies were conducted in 2008 to determine the potential effects of the Wenatchee sockeye supplementation program on natural-origin sockeye in the upper Wenatchee River basin (Blankenship et al. 2008; the entire report is appended as Appendix I). Specifically, the objective of the study was to determine if the genetic composition of the Lake Wenatchee sockeye population had been altered by the supplementation program, which was based on the artificial propagation of a small subset of the Wenatchee population. Microsatellite DNA allele frequencies were used to differentiate between temporally replicated collections of natural and hatchery-origin sockeye in the Wenatchee River basin. A total of 13 collections of Wenatchee sockeye were analyzed; eight temporally replicated collections of natural-origin sockeye (N = 786) and five temporally replicated collections of hatchery-origin sockeye (N = 248). Paired natural-hatchery collections were available from return years 2000, 2001, 2004, 2006, and 2007. All collections were taken at Tumwater Dam and consisted of dried scales and fin clips.

Overall, the study showed that allele frequency distributions were consistent over time, regardless of origin, resulting in small, insignificant measures of genetic differentiation among collections. This indicates that there were no year-to-year differences in allele frequencies between natural and hatchery-origin sockeye. In addition, the analyses found no differences between pre- and post-supplementation collections. Thus, it was concluded that the allele frequencies of the broodstock collections equaled the allele frequency of the natural collections.

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

The PNI values for the life of the program (brood years 1989-2011) are shown in Table 4.28. Throughout the program, PNI was consistently greater than 0.67. The hatchery program was terminated in 2012.

Table 4.28. Proportionate Natural Influence (PNI) values for the Wenatchee sockeye supplementation program for brood years 1989-2017. NOS = number of natural-origin sockeye counted at Tumwater Dam; HOS = number of hatchery-origin sockeye counted at Tumwater Dam; NOB = number of natural-origin sockeye collected for broodstock; and HOB = number of hatchery-origin sockeye included in hatchery broodstock. NP = no hatchery program.

Brood year	Escapement[a]			Broodstock			PNI[b]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	21,802	0	0.00	115	0	1.00	1.00
1990	27,325	0	0.00	302	0	1.00	1.00
1991	26,689	0	0.00	199	0	1.00	1.00
1992	16,461	0	0.00	320	0	1.00	1.00
1993	25,064	2,662	0.10	207	0	1.00	0.91
1994	6,934	396	0.05	236	5	0.98	0.95
1995	3,262	186	0.05	194	3	0.98	0.95
1996	6,027	546	0.08	225	0	1.00	0.93
1997	8,376	68	0.01	192	19	0.91	0.99
1998	3,982	32	0.01	122	6	0.95	0.99
1999	961	64	0.06	79	60	0.57	0.91
2000	19,620	1,164	0.06	170	5	0.97	0.94
2001	28,288	815	0.03	200	7	0.97	0.97
2002	27,371	193	0.01	256	0	1.00	0.99
2003	4,797	58	0.01	198	0	1.00	0.99
2004	26,095	1,460	0.05	177	0	1.00	0.95
2005	13,983	28	0.00	166	0	1.00	1.00
2006	9,182	255	0.03	214	0	1.00	0.97
2007	2,320	59	0.02	210	0	1.00	0.98
2008	22,931	92	0.00	243	2	0.99	1.00
2009	13,043	445	0.03	239	0	1.00	0.97

Brood year	Escapement[a]			Broodstock			PNI[b]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
2010	30,357	1,134	0.04	198	0	1.00	0.96
2011	17,490	940	0.05	196	0	1.00	0.95
Average	***15,755***	***461***	***0.03***	***203***	***5***	***0.97***	***0.97***
Median	***16,461***	***186***	***0.03***	***199***	***0***	***1.00***	***0.97***
2012	30,903	502	0.02	NP	NP	NP	NP
2013	22,118	614	0.03	NP	NP	NP	NP
2014	81,804	1,840	0.02	NP	NP	NP	NP
2015	42,132	1,528	0.03	NP	NP	NP	NP
2016	59,008	59	0.00	NP	NP	NP	NP
2017	23,844	10	0.00	NP	NP	NP	NP
Average	***43,302***	***759***	***0.02***	***NP***	***NP***	***NP***	***NP***
Median	***36,518***	***558***	***0.02***	***NP***	***NP***	***NP***	***NP***

[a] Proportions of natural-origin and hatchery-origin spawners were determined from reading video tape at Tumwater Dam, adjusted for fish harvested in the Lake Wenatchee recreational fishery.

[b] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery sockeye salmon from Lake Wenatchee to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 4.29).[14] Over the seven brood years for which PIT-tagged hatchery fish were released, survival rates from Lake Wenatchee to McNary Dam ranged from 0.211 to 0.370; SARs from release to detection at Bonneville Dam ranged from 0.005 to 0.044. Average travel time from Lake Wenatchee to McNary Dam ranged from 176 to 202 days.

Table 4.29. Total number of hatchery sockeye parr released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2005-2011. Standard errors are shown in parentheses.

Brood year	Number of sockeye released with PIT tags	Survival to McNary Dam	Travel time[1] to McNary Dam (d)	SAR to Bonneville Dam
2005	14,859	0.334 (0.013)	176.4 (61.9)	0.020 (0.001)
2006	14,764	0.370 (0.030)	202.0 (9.1)	0.044 (0.002)
2007	14,947	0.312 (0.013)	199.9 (8.6)	0.024 (0.001)
2008	14,858	0.307 (0.020)	192.9 (35.7)	0.015 (0.001)
2009	14,486	0.211 (0.015)	194.2 (29.1)	0.005 (0.001)
2010	5,039	0.302 (0.048)	191.7 (26.6)	0.014 (0.002)
2011	5,074	0.318 (0.038)	196.7 (7.3)	0.036 (0.003)

[14] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

[1] Travel time is calculated from the date of release from the net pens in the fall, overwintering in Lake Wenatchee, to spring outmigration.

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population. Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on a brood year harvest rates from the hatchery program. For brood years 1989-2011, NRR in the Wenatchee averaged 1.64 (range, 0.13-5.72) if harvested fish were not included in the estimate and 1.97 (range, 0.14-6.86) if harvested fish were included in the estimate (Table 4.30).

Hatchery replacement rates (HRR) were estimated as hatchery adult-to-adult returns. These rates should be greater than the NRRs and greater than or equal to 5.4 (the calculated target value in Hillman et al. 2017). The target value of 5.4 includes harvest. HRRs exceeded NRRs in 15 or 16 of the 23 years of data depending on if harvest was or was not included in the estimates (Table 4.30). Hatchery replacement rates for Wenatchee sockeye have equaled or exceeded the estimated target value of 5.4 in six of the 23 years (Table 4.30).

Table 4.30. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for sockeye salmon in the Wenatchee River basin, 1989-2011.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	255	21,802	2,757	23,616	10.81	1.08	3,680	30,672	14.43	1.41
1990	316	27,325	401	3,509	1.27	0.13	423	3,701	1.34	0.14
1991	233	26,689	95	4,820	0.41	0.18	101	5,116	0.43	0.19
1992	343	16,461	576	5,336	1.68	0.32	615	5,685	1.79	0.35
1993	307	27,726	71	11,151	0.23	0.40	75	11,815	0.24	0.43
1994	265	7,330	47	1,191	0.18	0.16	50	1,337	0.19	0.18
1995	209	3,448	121	840	0.58	0.24	131	913	0.63	0.26
1996	227	6,573	1,351	28,093	5.95	4.27	1,427	30,886	6.29	4.70
1997	226	8,444	739	36,097	3.27	4.27	834	41,798	3.69	4.95
1998	190	4,014	104	16,165	0.55	4.03	111	17,120	0.58	4.27
1999	147	1,025	68	566	0.46	0.55	83	682	0.56	0.67
2000	195	20,784	1,425	29,082	7.31	1.40	1,907	35,316	9.78	1.70
2001	245	29,103	24	17,241	0.10	0.59	28	18,068	0.11	0.62
2002	257	27,564	281	5,752	1.09	0.21	297	6,207	1.16	0.23
2003	219	4,855	32	2,054	0.15	0.42	35	2,590	0.16	0.53
2004	202	27,555	94	23,589	0.47	0.86	293	30,149	1.45	1.09
2005	207	14,011	460	20,793	2.22	1.48	606	26,487	2.93	1.89
2006	220	9,437	1,147	26,966	5.21	2.86	1,682	32,452	7.65	3.44
2007	228	2,379	917	13,619	4.02	5.72	1,037	16,312	4.55	6.86
2008	260	23,023	808	38,327	3.11	1.66	1,314	57,553	5.05	2.50

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
2009	261	13,488	344	22,202	1.32	1.65	469	28,867	1.80	2.14
2010	201	31,491	1,748	80,037	8.70	2.54	2,020	101,212	10.05	3.21
2011	204	18,430	1,658	48,079	8.13	2.61	2,190	64,671	10.74	3.51
Average	***236***	***16,216***	***664***	***19,962***	***2.92***	***1.64***	***844***	***24,766***	***3.72***	***1.97***
Median	***227***	***16,461***	***401***	***17,241***	***1.32***	***1.08***	***469***	***18,068***	***1.79***	***1.41***

Juvenile-to-Adult Survivals

When possible, both parr-to-adult ratios (PAR) and smolt-to-adult ratios (SAR) were calculated for hatchery sockeye salmon. Ratios were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery parr released or the estimated number of smolts emigrating from Lake Wenatchee. Here, survival ratios were based on CWT returns, when available, or on the estimated number of hatchery adults recovered on the spawning grounds, in broodstock, and harvested. For the available brood years, PARs have ranged from 0.0001 to 0.0339 for hatchery sockeye salmon and SARs have ranged from 0.0002 to 0.0255 (Table 4.31).

Table 4.31. Parr-to-adult ratios (PAR) and smolt-to-adult ratios (SAR) for Wenatchee hatchery sockeye salmon, brood years 1990-2011; NA = not available.

Brood year	Number of parr released	Number of smolts	Estimated adult recaptures	PAR	SAR
1989	108,400	NA	3,680	0.0339	NA
1990	270,802	NA	423	0.0016	NA
1991	167,523	NA	101	0.0006	NA
1992	340,597	NA	615	0.0018	NA
1993	190,443	NA	75	0.0004	NA
1994	252,859	NA	50	0.0002	NA
1995	150,808	28,828	131	0.0009	0.0045
1996	284,630	55,985	1,427	0.0050	0.0255
1997	197,195	112,524	834	0.0042	0.0074
1998	121,344	24,684	111	0.0009	0.0045
1999	167,955	94,046	83	0.0005	0.0009
2000	190,174	121,511	1,907	0.0100	0.0157
2001	200,938	140,322	28	0.0001	0.0002
2002	315,783	216,023	297	0.0009	0.0014
2003	240,459	122,399	35	0.0001	0.0003
2004	172,923	159,500	293	0.0017	0.0018
2005	140,542	140,542	606	0.0043	0.0043
2006	225,670	121,843	1,682	0.0075	0.0138
2007	252,133	119,908	1,037	0.0041	0.0086
2008	154,772	126,326	1,314	0.0085	0.0104

Brood year	Number of parr released	Number of smolts	Estimated adult recaptures	PAR	SAR
2009	227,743	159,089	469	0.0021	0.0027
2010	241,918	NA	2,020	0.0083	NA
2011	256,120	NA	2,190	0.0086	NA
Average	***211,814***	***116,235***	***844***	***0.0046***	***0.0068***
Median	***200,938***	***121,843***	***469***	***0.0018***	***0.0045***

4.8 ESA/HCP Compliance

Smolt and Emigrant Trapping

ESA-listed spring Chinook and steelhead were encountered during operation of the Lower Wenatchee trap. ESA takes are reported in the steelhead (Section 3.8) and spring Chinook (Section 5.8) sections and will not be repeated here.

SECTION 5: WENATCHEE (CHIWAWA) SPRING CHINOOK

The goal of Chiwawa spring Chinook salmon supplementation is to achieve "No Net Impact" to the productivity of spring Chinook caused by the operation of the Rock Island Hydroelectric Project. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Rock Island and Rocky Reach Anadromous Fish Agreement and Habitat Conservation Plans.

Adult spring Chinook are collected for broodstock at the Chiwawa Weir and Tumwater Dam. From 2011 through 2013, all spring Chinook broodstock were collected at the Chiwawa Weir in order to reduce passage delays caused by trapping at Tumwater Dam. Before 2009, the goal was to collect up to 379 adult spring Chinook for the program with natural-origin fish making up not less than 33% of the broodstock. In 2011, the Hatchery Committees reevaluated the amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was revised. The current goal (beginning with brood year 2013) is to collect 74 natural-origin spring Chinook. The number collected cannot exceed 33% of the natural-origin spring Chinook returns to Tumwater. Beginning in 2014, previously PIT-tagged hatchery-origin Chiwawa spring Chinook are collected at Tumwater Dam, while the Chiwawa Weir is used to collect natural-origin brood for the Chiwawa spring Chinook program. Broodstock collection occurs from May through 15 July at Tumwater with trapping occurring up to 24 hours per day, seven days a week and at the Chiwawa Weir with trapping occurring from 15 June to 1 August (not to exceed 15 cumulative trapping days) on a 24-hour-up/24-hour-down schedule consistent with annual broodstock collection protocols.

Adult spring Chinook are spawned and reared at Eastbank Fish Hatchery. Juvenile spring Chinook are transferred from the hatchery to the Chiwawa Acclimation Facility in late September or early October. Volitional releases are initiated in April of the following spring and any fish that remain are forced out by late May.

The production goal for the Chiwawa spring Chinook supplementation program up to brood year 2009 was to release 672,000 yearling smolts into the Chiwawa River at 12 fish per pound. Brood years 2010-2011, and 2012 were transition years to a reduced program of 298,000 smolts and 205,000 smolts, respectively. Beginning with the 2013 brood, the revised production goal is to release 144,026 smolts as part of a conservation program at 18 fish per pound. Targets for fork length and weight are 155 mm (CV = 9.0) and 37.8 g, respectively. Over 90% of these fish are marked with CWTs. In addition, since 2006, juvenile spring Chinook have been PIT tagged annually.

With issuance of new ESA Section 10 permits in 2013, adult management (i.e., removal of excess hatchery-origin adults at dams, traps, and weirs, and in conservation fisheries) was implemented in 2014 to achieve pHOS and PNI goals for the Chiwawa spring Chinook program.

Although this section of the report focuses on results from monitoring the Chiwawa spring Chinook program, information on spring Chinook collected throughout the Wenatchee River basin is also provided. Information specific to the Nason Creek spring Chinook conservation program is presented in Section 6 and the White River Captive Broodstock Program is presented in Section 7.

5.1 Broodstock Sampling

This section focuses on results from sampling 2015-2017 Chiwawa spring Chinook broodstock, which were collected at the Chiwawa Weir and at Tumwater Dam, consistent with methods in the broodstock collections protocols (Tonseth 2017). Some information for the 2017 return is not available at this time (e.g., age structure and final origin determination). This information will be provided in the 2018 annual report.

Origin of Broodstock

Natural-origin adults made up between 62.6% and 73.5% of the Chiwawa spring Chinook broodstock spawned for brood years 2015-2017 (Table 5.1). Natural and hatchery-origin adults were collected at Tumwater Dam and the Chiwawa Weir for return year 2017. Broodstock were trapped at Tumwater Dam from end of-May through mid-July 2017, and at the Chiwawa Weir from mid-June through early August. Hatchery-origin broodstock were collected at Tumwater Dam in 2017 to meet the Nason Creek Conservation and Safety Net broodstock requirements and to fill potential shortfalls of natural-origin broodstock requirements for the Chiwawa River Conservation program. Additional hatchery-origin broodstock were collected to ensure production obligations were achieved in the event that insufficient natural-origin collections could be made. A total of 21 hatchery-origin fish collected in 2017 were surplused at Eastbank Fish Hatchery.

Table 5.1. Numbers of wild and hatchery Chiwawa spring Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned, 1989-2017. Unknown origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced.

Brood year	Wild spring Chinook					Hatchery spring Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989	28	0	0	28	0	0	0	0	0	0	28
1990	19	1	0	18	0	0	0	0	0	0	18
1991	32	0	5	27	0	0	0	0	0	0	27
1992	113	0	0	78	35	0	0	0	0	0	78
1993	100	3	3	94	0	0	0	0	0	0	94
1994	9	0	1	8	0	4	0	0	4	0	12
1995	No Program										
1996	8	0	0	8	0	10	0	0	10	0	18
1997	37	0	5	32	0	83	1	3	79	0	111
1998	13	0	0	13	0	35	1	0	34	0	47
1999	No Program										
2000	10	0	1	9	0	38	1	16	21	0	30
2001	115	2	0	113	0	267	8	0	259	0	372
2002	21	0	1	20	0	63	1	11	51	0	71
2003	44	1	2	41	0	75	2	20	53	0	94
2004	100	1	16	83	0	196	30	34	132	0	215
2005	98	1	6	91	0	185	3	1	181	0	279
2006	95	0	4	91	0	303	0	29	224	50	315
2007	45	1	1	43	0	124	2	18	104	0	147
2008	88	2	3	83	0	241	5	16	220	0	303
2009	113	6	11	96	0	151	3	37	111	0	207

Brood year	Wild spring Chinook					Hatchery spring Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
2010	83	0	6	77	0	103	0	5	98	0	175
2011	80	0	0	80	0	101	2	6	93	0	173
Average[b]	***60***	***1***	***3***	***54***	***2***	***94***	***3***	***9***	***80***	***2***	***134***
Median[b]	***45***	***0***	***1***	***43***	***0***	***75***	***1***	***3***	***53***	***0***	***94***
2012	75	1	1	73	0	41	3	0	38	0	111
2013	170	5	0	70	95	52	1	50	0	1	70
2014[d]	61	0	0	61	0	203	1	68	134	0	195
2015[e]	81	1	7	72	1	47	0	3	37	7	109
2016	62	0	0	62	0	61	2	24	37	0	99
2017	50	0	0	50	0	66	0	25	18	23	68
Average[c]	***83.2***	***1.2***	***1.3***	***64.7***	***16***	***78.3***	***1.2***	***28.3***	***44***	***5.2***	***108.7***
Median[c]	***68.5***	***0.5***	***0***	***66***	***0***	***56.5***	***1***	***24.5***	***37***	***0.5***	***104***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] The average and median represent the program before recalculation in 2011.
[c] The average and median represent the current program, which began in 2012. Origin determinations should be considered preliminary pending scale analyses.
[d] HOR Chiwawa spring Chinook were collected to meet both Chiwawa and Nason Creek obligations; broodstock and subsequent progeny were pooled together in the hatchery. About 12 Chiwawa HOR's were used to fulfill the Chiwawa Program; about 122 Chiwawa HOR's were used to fulfill the Nason Creek safety net obligation.
[e] For the Chiwawa program, 36 hatchery-origin returns were collected in case the program fell short on natural-origin returns. After eye-up, all of the hatchery-origin recruit eggs were culled because fecundity of natural-origin recruits was high enough to meet the WxW program.

Age/Length Data

Ages were determined from scales and/or coded wire tags (CWT) collected from broodstock. For both the 2016 and 2017 returns, most adults, regardless of origin, were age-4 Chinook (Table 5.2). Most age-5 Chinook were natural-origin fish. There were a few age-3 natural and hatchery-origin Chinook collected for broodstock in 2017.

Table 5.2. Percent of hatchery and wild spring Chinook of different ages (total age) collected from broodstock, 1991-2017.

Return year	Origin	Total age			
		2	3	4	5
1991	Wild	0.0	0.0	22.0	78.0
	Hatchery	0.0	0.0	0.0	0.0
1992	Wild	0.0	0.0	28.6	71.4
	Hatchery	0.0	0.0	50.0	50.0
1993	Wild	0.0	0.0	22.0	78.0
	Hatchery	0.0	0.0	0.0	0.0
1994	Wild	0.0	0.0	28.6	71.4
	Hatchery	0.0	0.0	50.0	50.0
1995	Wild	No program			
	Hatchery				
1996	Wild	0.0	28.6	71.4	0.0

Return year	Origin	Total age			
		2	3	4	5
	Hatchery	0.0	50.0	50.0	0.0
1997	Wild	0.0	0.0	87.5	12.5
	Hatchery	0.0	1.2	98.8	0.0
1998	Wild	0.0	0.0	63.6	36.4
	Hatchery	0.0	0.0	62.9	37.1
1999	Wild	No program			
	Hatchery				
2000	Wild	0.0	20.0	70.0	10.0
	Hatchery	0.0	59.1	40.9	0.0
2001	Wild	0.0	2.8	94.4	2.8
	Hatchery	0.0	1.5	98.5	0.0
2002	Wild	0.0	0.0	66.7	33.3
	Hatchery	0.0	0.0	93.4	6.6
2003	Wild	0.0	27.0	2.7	70.3
	Hatchery	0.0	21.3	5.3	73.3
2004	Wild	1.0	6.1	88.8	4.1
	Hatchery	0.0	40.4	59.6	0.0
2005	Wild	0.0	1.0	85.0	14.0
	Hatchery	0.0	4.4	95.6	0.0
2006	Wild	0.0	2.0	70.4	27.6
	Hatchery	0.0	1.3	81.2	17.4
2007	Wild	0.0	15.6	53.3	31.1
	Hatchery	0.0	27.4	60.5	12.1
2008	Wild	0.0	6.3	78.8	15.0
	Hatchery	0.0	8.2	86.8	4.9
2009	Wild	0.0	8.6	79.0	12.4
	Hatchery	0.0	18.5	79.5	2.0
2010	Wild	0.0	5.3	94.7	0.0
	Hatchery	0.0	0.0	99.0	1.0
2011	Wild	0.0	2.7	52.7	44.6
	Hatchery	0.0	20.4	60.2	19.4
2012	Wild	0.0	0.0	79.0	21.0
	Hatchery	0.0	4.3	95.7	0.0
2013	Wild	0.0	0.0	65.7	34.3
	Hatchery	0.0	2.2	86.7	11.1
2014	Wild	0.0	0.0	91.2	8.8
	Hatchery[a]	0.0	0.0	98.5	1.5
2015	Wild	0.0	0.0	88	11.0

Return year	Origin	Total age			
		2	3	4	5
	Hatchery[a]	0.0	0.0	100	0.0
2016	Wild	0.0	0.0	82.6	17.4
	Hatchery[a]	0.0	0.0	85.0	15.0
2017	Wild	0.0	4.3	87.2	8.5
	Hatchery[a]	0.0	9.5	88.1	2.4
Average	***Wild***	***0.0***	***5.2***	***66.2***	***28.6***
	Hatchery	***0.0***	***10.8***	***69.1***	***12.2***
Median	***Wild***	***0.0***	***1.0***	***71.4***	***17.4***
	Hatchery	***0.0***	***1.5***	***81.2***	***2.0***

[a] Comprised of age results for both Chiwawa and Nason Creek obligations.

There was a small difference in mean lengths between hatchery and natural-origin broodstock of age-4 and age-5 Chinook in 2016 and 2017. Age-4 hatchery-origin Chinook were slightly larger than natural-origin fish, whereas age-5 natural-origin Chinook were larger than hatchery-origin fish during both years. In 2017, some age-3 fish were included in the broodstock, and size differences were negligible (Table 5.3).

Table 5.3. Mean fork length (cm) at age (total age) of hatchery and wild spring Chinook collected from broodstock, 1991-2016; N = sample size and SD = 1 standard deviation.

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
1991	Wild	-	0	-	-	5	-	-	19	-	-	8	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
1992	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
1993	Wild	-	0	-	-	0	-	79	4	3	92	8	4
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
1994	Wild	-	0	-	-	0	-	79	2	3	96	5	6
	Hatchery	-	0	-	-	0	-	82	2	11	92	2	2
1995	Wild	No program											
	Hatchery												
1996	Wild	-	0	-	51	2	1	79	5	7	-	0	-
	Hatchery	-	0	-	56	5	4	74	5	6	-	0	-
1997	Wild	-	0	-	-	0	-	80	28	5	99	4	8
	Hatchery	-	0	-	56	1	-	82	82	4	-	0	-
1998	Wild	-	0	-	-	0	-	78	7	13	83	4	18
	Hatchery	-	0	-	-	0	-	77	22	8	93	13	7
1999	Wild	No program											

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery												
2000	Wild	-	0	-	51	2	3	82	7	4	98	1	-
	Hatchery	-	0	-	59	13	4	79	9	8	-	0	-
2001	Wild	-	0	-	49	3	6	82	101	6	95	3	3
	Hatchery	-	0	-	56	4	7	83	261	5	-	0	-
2002	Wild	-	0	-	-	0	-	79	12	4	96	6	10
	Hatchery	-	0	-	-	0	-	81	57	6	94	4	9
2003	Wild	-	0	-	55	10	5	83	1	-	99	26	6
	Hatchery	-	0	-	59	16	5	86	4	18	96	55	6
2004	Wild	47	1	-	60	6	6	80	87	5	99	4	3
	Hatchery	-	0	-	51	80	7	80	118	5	-	0	-
2005	Wild	-	0	-	49	1	-	80	85	6	96	14	8
	Hatchery	-	0	-	56	8	5	82	175	6	-	0	-
2006	Wild	-	0	-	50	2	2	79	69	7	97	27	5
	Hatchery	-	0	-	46	1	-	80	205	6	95	43	7
2007	Wild	-	0	-	54	7	3	79	24	6	93	14	7
	Hatchery	-	0	-	59	34	8	81	75	5	93	15	7
2008	Wild	-	0	-	54	5	9	83	63	5	93	12	6
	Hatchery	-	0	-	56	20	10	82	211	6	96	12	7
2009	Wild	-	0	-	52	9	6	81	83	5	94	13	6
	Hatchery	-	0	-	56	28	6	82	120	5	87	3	11
2010	Wild	-	0	-	58	4	9	80	72	6	-	0	-
	Hatchery	-	0	-	-	0	-	82	102	6	101	1	-
2011	Wild	-	0	-	56	2	3	79	39	5	95	33	7
	Hatchery	-	0	-	63	21	7	80	62	6	95	20	6
2012	Wild	-	0	-	-	0	-	81	49	6	97	13	8
	Hatchery	-	0	-	51	2	0	80	41	5	-	0	-
2013	Wild	-	0	-	-	1	-	74	44	6	92	23	8
	Hatchery	-	0	-	60	1	-	78	39	6	88	5	7
2014	Wild	-	0	-	-	0	-	82	52	7	93	5	6
	Hatchery[a]	-	0	-	-	0	-	81	192	6	85	3	2
2015	Wild	-	0	-	-	0	-	83	45	4	93	10	5
	Hatchery	-	0	-	-	0	-	80	35	6	-	0	-
2016	Wild	-	0	-	-	-	-	80	38	6	97	8	5
	Hatchery	-	0	-	-	-	-	83	51	6	94	9	4
2017	Wild	-	0	-	65	2	1	82	41	6	98	4	6
	Hatchery	-	0	-	65	4	1	85	37	7	95	1	-

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
Average	*Wild*	*47*	0	*-*	*54*	*2*	*5*	*80*	*39*	*6*	*95*	*10*	*7*
	Hatchery	*-*	*-*	*-*	*57*	*9*	*6*	*81*	*76*	*7*	*93*	*7*	*6*

[a] Comprised of age results from HOR's used for both Chiwawa and Nason Creek obligations.

Sex Ratios

Male spring Chinook in the 2015-2017 return years made up 53.5%, 47.2%, and 50.9%, respectively, of the adults collected. This resulted in overall male to female ratios of 1.15:1.00, 0.89:1.00, and 1.04:1.00, respectively (Table 5.4). For the 2017 return year, natural-origin and hatchery-origin fish both consisted of a slightly lower proportion of males than females (Table 5.4).

Table 5.4. Numbers of male and female wild and hatchery spring Chinook collected for broodstock, 1989-2017. Ratios of males to females are also provided.

Return year	Number of wild spring Chinook			Number of hatchery spring Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989	11	17	0.65:1.00	-	-	-	0.65:1.00
1990	7	12	0.58:1.00	-	-	-	0.58:1.00
1991	13	19	0.68:1.00	-	-	-	0.68:1.00
1992	39	39	1.00:1.00	-	-	-	1.00:1.00
1993	50	50	1.00:1.00	-	-	-	1.00:1.00
1994	5	4	1.25:1.00	2	2	1.00:1.00	1.17:1.00
1995	No program						
1996	6	2	3.00:1.00	8	2	4.00:1.00	3.50:1.00
1997	14	23	0.61:1.00	34	49	0.69:1.00	0.67:1.00
1998	9	4	2.25:1.00	18	17	1.06:1.00	1.29:1.00
1999	No program						
2000	5	5	1.00:1.00	32	6	5.33:1.00	3.36:1.00
2001	45	70	0.64:1.00	90	177	0.51:1.00	0.55:1.00
2002	9	12	0.75:1.00	30	33	0.91:1.00	0.87:1.00
2003	28	16	1.75:1.00	42	33	1.27:1.00	1.43:1.00
2004	58	42	1.38:1.00	102	94	1.09:1.00	1.18:1.00
2005	58	40	1.45:1.00	89	96	0.93:1.00	1.08:1.00
2006	49	46	1.07:1.00	123	179	0.69:1.00	0.77:1.00
2007	20	25	0.80:1.00	66	58	1.14:1.00	1.04:1.00
2008	41	47	0.87:1.00	109	132	0.83:1.00	0.84:1.00
2009	53	60	0.88:1.00	79	72	1.10:1.00	1.00:1.00
2010	41	42	0.98:1.00	53	50	1.06:1.00	1.02:1.00
2011	38	42	0.90:1.00	53	48	1.10:1.00	1.01:1.00
2012	35	40	0.87:1.00	20	21	0.95:1.00	0.90:1.00

Return year	Number of wild spring Chinook			Number of hatchery spring Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2013	83	87	0.95:1.00	26	26	1.00:1.00	0.96:1.00
2014[a]	29	32	0.91:1.00	101	102	0.99:1.00	0.97:100
2015	44	36	1.22:1.00	24	23	1.04:1.00	1.15:1.00
2016	29	33	0.88:1.00	29	32	0.90:1.00	0.89:1.00
2017	24	26	0.92:1.00	35	31	1.13:1.00	1.04:1.00
Total	***843***	***871***	***0.97:1.00***	***1165***	***1283***	***0.91:1.00***	***0.93:1.00***

[a] Comprised of HOR's used for both Chiwawa and Nason Creek obligations.

Fecundity

Mean fecundities for the 2015-2017 returns of spring Chinook ranged from 4,467 to 4,847 eggs per female (Table 5.5). These fecundities were close to the overall average of 4,653 eggs per female and near the expected fecundity of 4,272 to 4,429 eggs per female assumed in the broodstock protocols. For the 2017 return year, natural-origin Chinook produced less eggs per female than did hatchery-origin fish. This could be attributed to differences in size and age of hatchery and natural-origin fish described above (Tables 5.2 and 5.3).

Table 5.5. Mean fecundity of wild, hatchery, and all female spring Chinook collected for broodstock, 1989-2017; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
1989*	NA	NA	2,832
1990*	NA	NA	5,024
1991*	NA	NA	4,600
1992*	NA	NA	5,199[a]
1993*	NA	NA	5,249
1994*	NA	NA	5,923
1995	No program		
1996*	NA	NA	4,645
1997	4,752	4,479	4,570
1998	5,157	5,376	5,325
1999	No program		
2000	5,028	5,019	5,023
2001	4,530	4,663	4,624
2002	5,024	4,506	4,654
2003	6,191	5,651	5,844
2004	4,846	4,775	4,799
2005	4,365	4,312	4,327
2006	4,773	4,151	4,324
2007	4,656	4,351	4,441
2008	4,691	4,560	4,592

Return year	Mean fecundity		
	Wild	Hatchery	Total
2009	4,691	4,487	4,573
2010	4,548	4,114	4,314
2011	4,969	3,884	4,385
2012	4,522	3,682	4,223
2013	4,716	No program	4,716
2014	4,467	3,834	4,045
2015	5,132	4,278	4,847
2016	4,674	4,126	4,467
2017	4,574	4,747	4,615
Average	***4,815***	***4,473***	***4,653***
Median	***4,704***	***4,479***	***4,608***

* Individual fecundities were not tracked with females until 1997.
[a] Estimated as the mean of fecundities two years before and two years after 1992.

To estimate fecundities by length, weight, and age[15], hatchery staff collected fecundity, fork length, weight, and age data from a subsample of spring Chinook females during the spawning of 1997 through 2017 broodstock (complete data for all variables are available for years 2014-2017). For the available brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin spring Chinook. Hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between size and fecundity.

Mean fecundity by total age varied between hatchery and natural-origin spring Chinook and over time (Table 5.6). On average, mean fecundities varied between hatchery-origin and natural-origin spring Chinook by 195 eggs for age-4 fish and 208 eggs for age-5 fish. Too few age-3 fish were collected to evaluate fecundity relationships.

Table 5.6. Mean fecundity by age (total age) for hatchery and wild spring Chinook collected from broodstock for the Chiwawa River program, brood years 1997-2017; N = sample size and SD = 1 standard deviation.

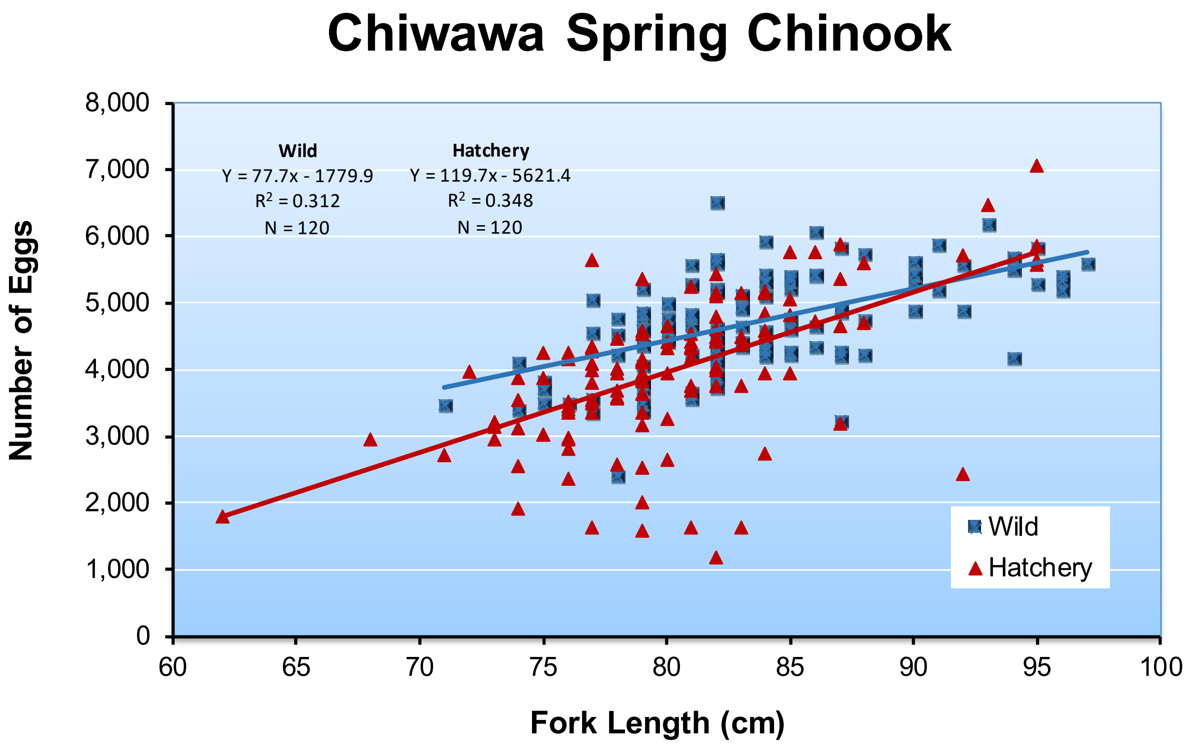
Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
1997	Wild	-	0	-	4,663	15	671	5,972	2	1,520
	Hatchery	-	0	-	4,479	44	551	-	0	-
1998	Wild	-	0	-	4,739	1	-	5,153	2	245
	Hatchery	-	0	-	5,023	9	794	6,171	4	433
1999	Wild	No Program								
	Hatchery									

15 Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
2000	Wild	-	0	-	4,801.	4	866	5,936	1	-
	Hatchery	-	0	-	5,019	6	611	-	0	-
2001	Wild	-	0	-	4,460	61	712	5,579	3	597
	Hatchery	-	0	-	4,663	164	631	-	0	-
2002	Wild	-	0	-	4,616	9	660	5,614	1	-
	Hatchery	-	0	-	4,444	28	582	5,368	2	583
2003	Wild	-	0	-	4,209	1	-	6,217	12	882
	Hatchery	-	0	-	-	0	-	5,651	27	685
2004	Wild	-	0	-	4,846	40	694	-	0	-
	Hatchery	-	0	-	4,775	81	791	-	0	-
2005	Wild	-	0	-	4,045	28	568	5,642	7	1,327
	Hatchery	-	0	-	4,312	84	590	-	0	-
2006	Wild	-	0	-	4,386	29	716	5,450	18	837
	Hatchery	-	0	-	3,911	90	565	4930	25	711
2007	Wild	-	0	-	4,592	17	690	4,996	8	981
	Hatchery	-	0	-	4,244	48	815	4,746	8	1,217
2008	Wild	-	0	-	4,563	36	996	4,542	9	1,643
	Hatchery	-	0	-	4,381	121	961	5,257	4	1,098
2009	Wild	-	0	-	4,437	42	745	5,929	9	1,146
	Hatchery	-	0	-	4,460	66	4,460	4,905	3	1,241
2010	Wild	-	0	-	4,621	36	758	-	0	-
	Hatchery	-	0	-	4,193	47	783	-	0	-
2011	Wild	-	0	-	4,262	15	430	5,697	16	933
	Hatchery	3,055	1	-	3,793	32	773	4,364	11	679
2012	Wild	-	0	-	4,278	22	586	5,219	9	899
	Hatchery	-	0	-	3,715	23	906	-	0	-
2013	Wild	-	0	-	4,085	17	608	5,574	15	997
	Hatchery	-	0	-	3,614	1	-	-	0	-
2014	Wild	-	0	-	4,329	25	660	5,575	4	233
	Hatchery	-	0	-	3,708	61	981	5,373	1	-
2015	Wild	-	0	-	5,049	23	599	5,561	6	457
	Hatchery	-	0	-	4,149	15	545	-	0	-
2016	Wild	-	0	-	4,313	18	641	5,411	4	143
	Hatchery	-	0	-	4,196	19	805	5,746	5	840
2017	Wild	-	0	-	4,574	26	620	5,202	1	-
	Hatchery	-	0	-	4,587	7	1,112	5,862	1	-
Average	***Wild***	***-***	***0***	***-***	***4,493***	***23***	***79***	***5,515***	***6***	***856***

Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	***3055***	***0***	***-***	***4,298***	***47***	***959***	***5,307***	***5***	***832***

We pooled fecundity data from brood years 2014 through 2017 (only brood years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery and natural-origin females are shown in Figures 5.1, 5.2, and 5.3. All fecundity variables increase linearly with fork length. In addition, except for fish size and mean egg weight, the relationships between fish size and fecundity data were similar for hatchery and natural-origin spring Chinook.



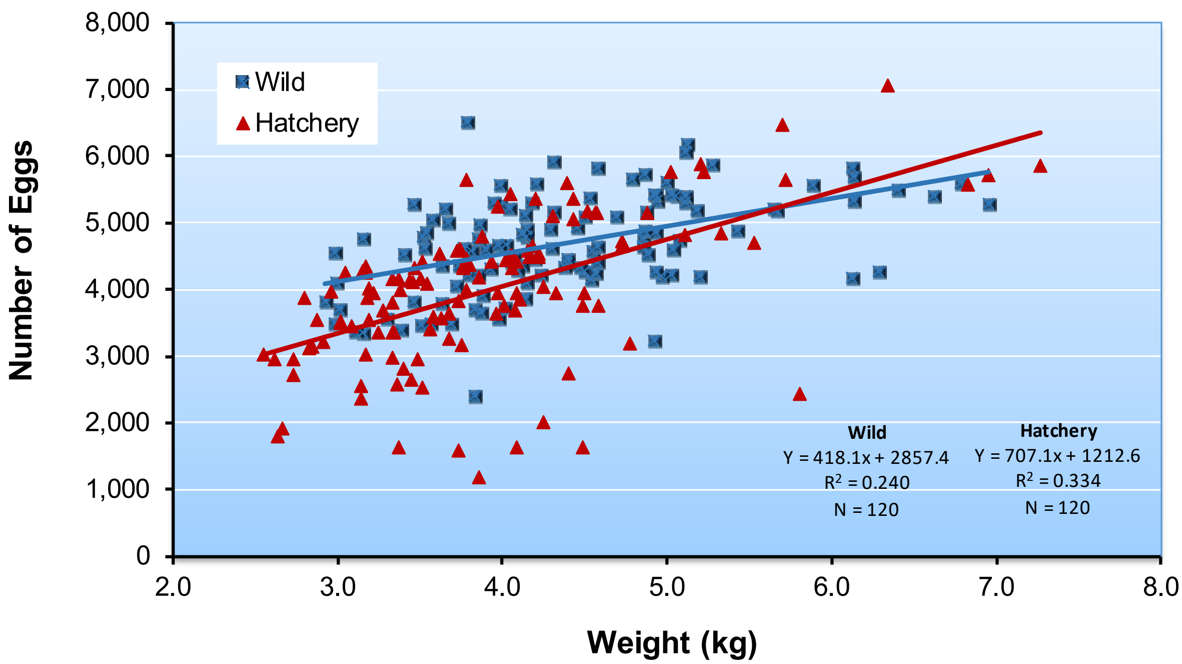


Figure 5.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural and hatchery-origin, Chiwawa spring Chinook for return years 2014-2017.

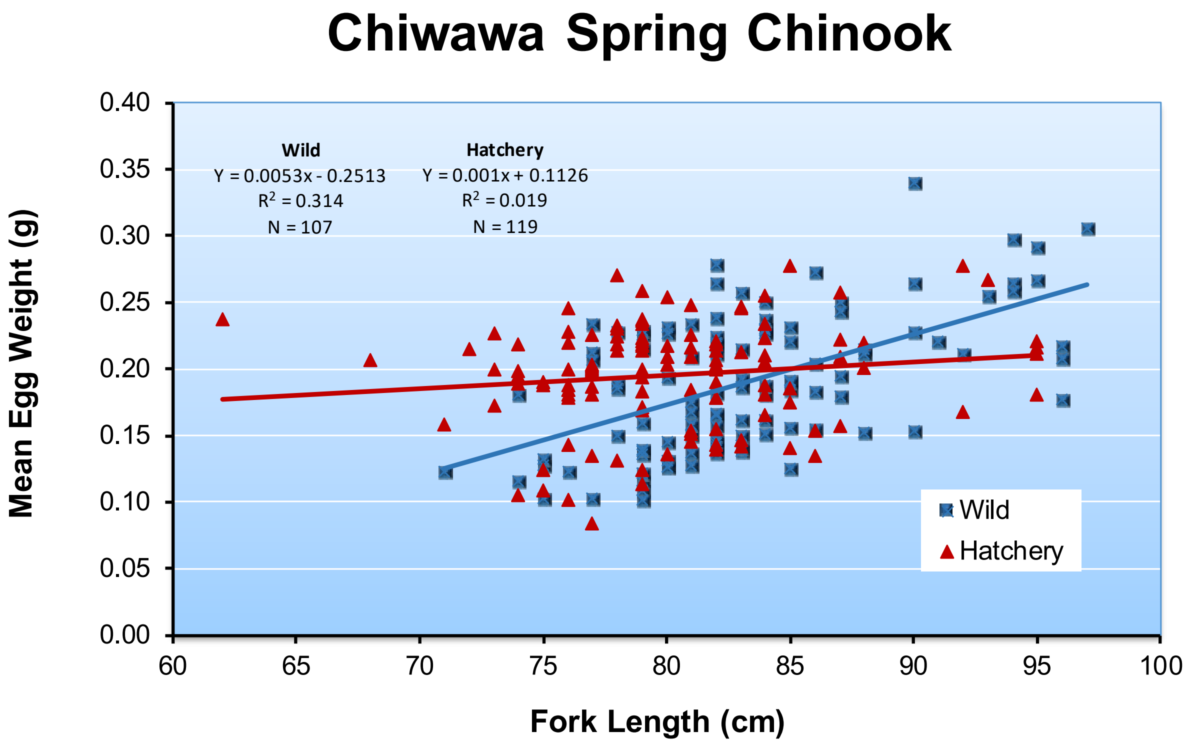


Figure 5.2. Relationships between mean egg weight and fork length for natural and hatchery-origin, Chiwawa spring Chinook for return years 2014-2017.

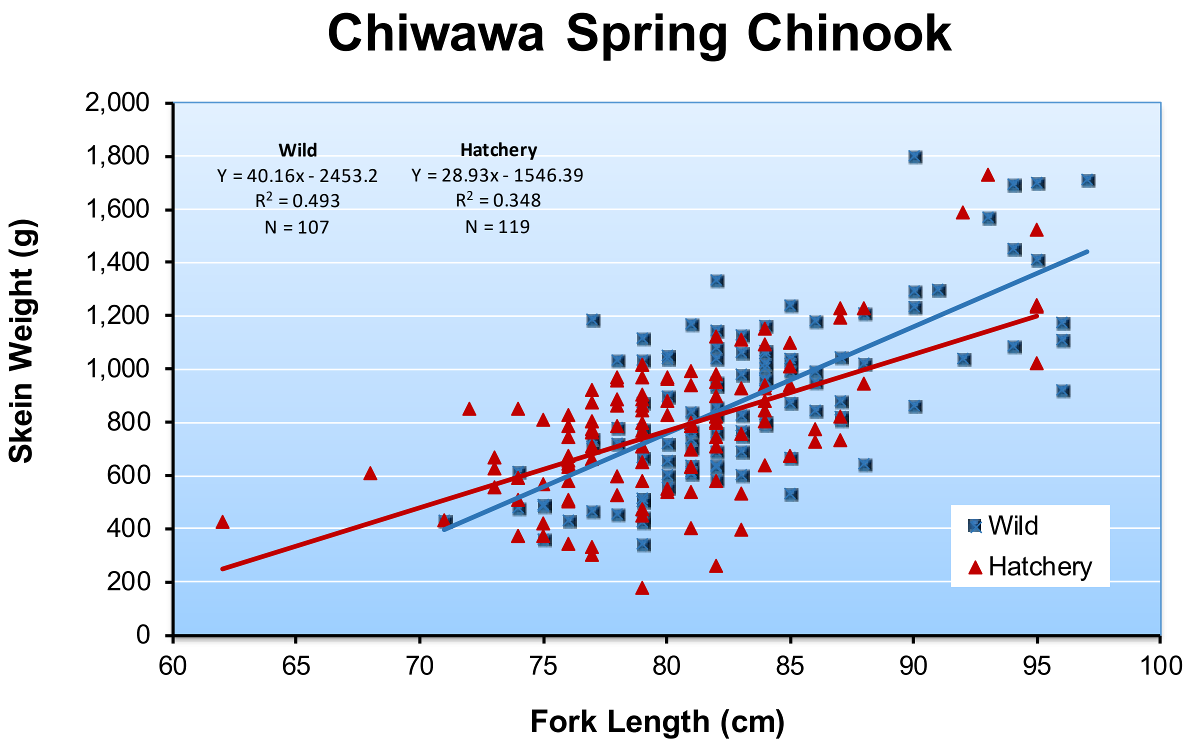


Figure 5.3. Relationships between skein weight and fork length for natural and hatchery-origin, Chiwawa spring Chinook for return years 2014-2017.

5.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 829,630 eggs were required to meet the program release goal of 672,000 smolts for brood years 1989-2010. For the 2011 and 2012 brood years, a total of 367,536 and 252,410 eggs were required to meet the release goals of 298,000 and 204,452 smolts, respectively. Since 2013, 155,067-169,442 eggs have been required to achieve a release goal of 144,026 smolts for the Chiwawa spring Chinook Program. Between 1989 and 2017, the egg take goal was reached only in 2001, 2015, and 2016[16] (Table 5.7). The green egg takes for 2015-2017 brood years were 109.0%, 109.0%, and 88.8% of program goals, respectively.

At the beginning of the Chiwawa spring Chinook program, the production level was set at 372,000 smolts. The primary reason for not meeting the egg take requirements included a lack of returning hatchery adults (because of program start up) and low wild fish abundance (along with no weir in the Chiwawa for the first few years). Post-ESA listing and issuance of Section 10(a)(1(A) permit

[16] In 2016, the natural-origin egg-take goal was not achieved, but the program egg-take goal was achieved.

1196 in 1999, continued low abundance (hatchery and natural origin), as well as the permit limitation requiring a minimum of 33% natural-origin fish in the broodstock further constrained meeting the requisite egg take goal for a 672,000 program. In 2010, it was expected that recalculation of the mitigation obligation beginning with the 2012 brood year was going to result in a significant reduction in the production level and the Hatchery Committees subsequently agreed to reduce the production target to 298,000 in advance of recalculation to increase the likelihood of meeting the overall production goal. In 2011, the Joint Fisheries Parties developed the Wenatchee Basin Spring Chinook Management Plan, which split the program into a conservation and safety-net component; the conservation program using natural-origin fish to meet recovery objectives and the safety net using returning adults from the conservation program to satisfy the balance of the production requirement.

Per amended Section 10(a)(1)(A) permit 18121, natural-origin broodstock is currently collected for the Chiwawa spring Chinook Program using PIT-tagged wild fish (tagged as juveniles) intercepted at Tumwater Dam and at the Chiwawa Weir. Operational limitations (e.g., flows, days per season, and bull trout encounters) reduce the opportunity to meet the natural-origin broodstock requirement, particularly in years of low adult abundance. Subsequently, to ensure the mitigation obligation is met, a component of hatchery adult returns is trapped and retained from Tumwater Dam during broodstock collection for the Nason Creek Program, which uses a composited broodstock (for the conservation component) identified through genetic analysis. The genetic analysis is used to prioritize those adults assigned with the highest probability to either the Nason or Chiwawa spawning aggregates and excludes those assigned to the White River spawning aggregate.

Table 5.7. Numbers of eggs taken from spring Chinook broodstock, 1989-2017; NP = no program.

Return year	Number of eggs taken for the Chiwawa Program
1989	45,311
1990	60,287
1991	73,601
1992	111,624
1993	257,208
1994	35,539
1995	NP
1996	18,579
1997	312,182
1998	90,521
1999	NP
2000	55,256
2001	1,099,630
2002	196,186
2003	247,501

Return year	Number of eggs taken for the Chiwawa Program
2004	538,176
2005	536,490
2006	744,344
2007	359,739
2008	761,821
2009	564,912
2010	383,944
2011	366,244
Average (1989-2011)	***326,624***
Median (1989-2011)	***257,208***
2012	250,695
2013	165,047
2014	163,358
2015	184,734
2016*	184,712
2017	150,419
Average (2012-present)	***183,161***
Median (2012-present)	***174,880***

* Although the program egg-take goal was achieved, the natural-origin egg-take goal was not.

Number of acclimation days

Early rearing of the 2015 brood Chiwawa spring Chinook was similar to previous years with fish being held on well water before being transferred to the Chiwawa Acclimation Facility for final acclimation. Beginning in 2006 (2005 brood acclimation), modifications were made to the Chiwawa Acclimation Facility intakes so that Wenatchee River water could be applied to the Chiwawa River intakes during severe cold periods to prevent the formation of frazzle ice. During acclimation of the 2015 brood, fish were acclimated for 198 to 205 days on Chiwawa River water (Table 5.8).

Table 5.8. Number of days spring Chinook broods were acclimated and water source, brood years 1989-2015; NA = not available.

Brood year	Release year	Transfer date	Release date	Number of days and water source		
				Total	Chiwawa	Wenatchee
1989	1991	19-Oct	11-May	204	NA	NA
1990	1992	13-Sep	27-Apr	227	NA	NA
1991	1993	24-Sep	24-Apr	212	NA	NA

Brood year	Release year	Transfer date	Release date	Number of days and water source		
				Total	Chiwawa	Wenatchee
1992	1994	30-Sep	20-Apr	202	NA	NA
1993	1995	28-Sep	20-Apr	204	NA	NA
1994	1996	1-Oct	25-Apr	207	NA	NA
1995	1997	No Program				
1996	1998	25-Sep	29-Apr	216	NA	NA
1997	1999	28-Sep	22-Apr	206	NA	NA
1998	2000	27-Sep	24-Apr	210	NA	NA
1999	2001	No Program				
2000	2002	26-Sep	25-Apr	211	NA	NA
2001	2003	22-Oct	1-May	191	NA	NA
2002	2004	25-Sep	2-May	220	NA	NA
2003	2005	30-Sep	3-May	215	NA	NA
		30-Sep	18-Apr-18-May	200	NA	NA
2004	2006	3-Sep	1-May	240	88-104	124
		3-Sep	17-Apr-17-May	226	NA	NA
2005	2007	25-Sep	1-May	217	217	98[a]
		26-Sep	16-Apr-15-May	202-232	202-232	98[a]
2006	2008	24-27-Sep	14-Apr-13-May	231	231	95[a]
2007	2009	1-Oct	15-Apr-13-May	223	223	103[a]
2008	2010	14-15-Sep	14-Apr-12-May	212-241	212-241	129
2009	2011	14-15-Sep	26-Apr-19-May	225-249	225-249	88
2010	2012	3, 5-6-Oct	17-Apr-1-May	195-212	195-212	132
2011	2013	24-26-Sep	16-22-Apr	202-210	202-210	40
2012	2014	23-25-Sep	14-21-Apr	204-211	204-211	107[a]
2013	2015	29-Sep	13-20-Apr	196-203	196-203	0
2014	2016	5-8-Oct	15-20-Apr	190-198	190-198	0
2015	2017	26-27 Sept	12-19 Apr	198-205	198-205	0

[a] Represents the number of days Wenatchee River water was applied to the Chiwawa River intake screen to prevent the formation of frazzle ice.

Release Information

Numbers released

The 2015 brood Chiwawa spring Chinook program achieved 114% of the 144,026 goal with about 163,411 WxW smolts released volitionally into the Chiwawa River in 2017 (Table 5.9).

Table 5.9. Numbers of spring Chinook smolts tagged and released from the hatchery, brood years 1989-2014. The release target for Chiwawa spring Chinook is 144,026 smolts. For brood years 2012 to present, conservation program fish are not adipose fin clipped (they receive CWT only).

Brood year	Release year	Type of release	CWT mark rate	Number released that were PIT tagged	Number of smolts released	Total number of smolts released
1989	1991	Volitional	0.9932	0	43,000	43,000
1990	1992	Volitional	0.9931	0	53,170	53,170
1991	1993	Volitional	0.9831	0	62,138	62,138
1992	1994	Volitional	0.9747	0	85,113	85,113
1993	1995	Volitional	0.9892	0	223,610	223,610
1994	1996	Volitional	0.9967	0	27,226	27,226
1995	1997	No program				
1996	1998	Forced	0.8413	0	15,176	15,176
1997	1999	Volitional	0.9753	0	266,148	266,148
1998	2000	Volitional	0.9429	0	75,906	75,906
1999	2001	No program				
2000	2002	Volitional	0.9920	0	47,104	47,104
2001	2003	Forced	0.9961	0	192,490[a]	377,544
		Volitional	0.9856	0	185,054[a]	
2002	2004	Volitional	0.9693	0	149,668	149,668
2003	2005	Forced	0.9783	0	69,907	222,131
		Volitional	0.9743	0	152,224	
2004	2006	Forced	0.9533	0	243,505	494,517
		Volitional	0.9493	0	251,012	
2005	2007	Forced	0.9882	4,993	245,406	494,012
		Volitional	0.9864	4,988	248,606	
2006	2007	Direct	0.0000	0	12,977[b]	612,482
	2008	Volitional	0.9795	9,894	612,482	
2007	2008	Direct	0.0000	0	9,494	305,542
	2009	Volitional	0.9948	10,035	296,048	
2008	2010	Volitional	0.9835	10,006	609,789	609,789
2009	2011	Forced	0.9874	0	241,181	438,561
		Volitional	0.9874	9,412	197,380	
2010[c]	2012	Volitional	0.9904	5,020	346,248	346,248
2011	2013	Volitional	0.9902	9,945	281,821	281,821
2012[d]	2014	Volitional	0.9841	5,061	222,504	222,504
2013[d]	2015	Volitional	0.9753	10,021	147,480	147,480

Brood year	Release year	Type of release	CWT mark rate	Number released that were PIT tagged	Number of smolts released	Total number of smolts released
2014[d]	2016	Volitional	0.9818	10,179	144,360	341,226[e]
		Volitional	0.9853	0	196,866[f]	
2015[d]	2017	Volitional	0.9571	10,149	163,411	163,411

[a] This does not include the 226,456 eyed eggs that were planted in the Chiwawa River.
[b] This high ELISA group was only adipose fin clipped and directly planted into Big Meadow Creek in May.
[c] This does not include 18,480 eyed eggs that were culled because of high ELISA.
[d] For brood years 2013 to present, WxW spring Chinook are not adipose fin clipped (they receive CWT only); HxH Chinook are adipose fin clipped and receive a CWT.
[e] The total number of smolts released includes the HxH Nason Creek program that was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 because of water-intake concerns at the Nason Creek Acclimation Facility.
[f] The HxH Nason Creek program that was released from the Chiwawa Acclimation Facility.

Numbers tagged

The 2015 brood Chiwawa spring Chinook were 95.7% CWT (Table 5.9).

On 12-15 March 2018, a total of 10,100 WxW Chiwawa spring Chinook from the 2016 brood were tagged at the Chiwawa Acclimation Facility. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 124 mm in length and 23 g at time of tagging.

Table 5.10 summarizes the number of hatchery spring Chinook that have been PIT-tagged and released into the Chiwawa River.

Table 5.10. Summary of PIT-tagging activities for Chiwawa hatchery spring Chinook, brood years 2005-2015.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2005	2007	10,063	74	8	9,981[a]
2006	2008	10,055	134	27	9,894
2007	2009	10,112	61	16	10,035
2008	2010	10,101	81	14	10,006
2009	2011	10,101	655	34	9,412
2010	2012	5,102	82	0	5,020
2011	2013	10,200	254	1	9,945
2012	2014	5,100	37	2	5,061
2013	2015	10,114	93	0	10,021
2014	2016	10,200	21	0	10,179
2015	2017	10,207	58	0	10,149

[a] This release consisted of 4,988 tagged Chinook that were released volitionally and 4,993 that were forced released.

Fish size and condition at release

Spring Chinook from the 2015 brood were released as yearling smolts between 12 and 19 April 2017. Size at release (18 fpp) met the target of 18 fpp established for the program. The CV for fork length was 12.2% over the target (Table 5.11).

Table 5.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of spring Chinook smolts released from the hatchery, brood years 1989-2015. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1991	147	4.4	37.8	12
1990	1992	137	5.0	32.4	14
1991	1993	135	4.2	30.3	15
1992	1994	133	5.0	28.4	16
1993	1995	136	4.5	30.2	15
1994	1996	139	7.1	34.4	13
1995	1997	No Program			
1996	1998	157	5.3	52.1	9
1997	1999	146	7.2	38.7	12
1998	2000	143	9.1	39.5	12
1999	2001	No Program			
2000	2002	150	6.8	46.7	10
2001	2003	142	7.1	37.6	12
2002	2004	146	8.5	40.3	11
2003	2005	167[a]	5.9	59.4	8
		151[b]	7.4	44.2	10
2004	2006	146[a]	6.4	39.1	12
		139[b]	5.7	34.3	13
2005	2007	136[a]	4.6	30.8	15
		129[b]	5.8	26.6	17
2006	2008	124	8.8	23.5	19
2007	2008	70[a]	4.0	3.7	122
	2009	140[b]	11.0	33.6	14
2008	2010	141	10.7	36.0	13
2009	2011	167	12.9	56.8	8
2010	2012	129	8.1	25.8	18
2011	2013	134	6.4	29.5	15
2012	2014	130	6.7	28.5	16
2013	2015	130	8.2	25.3	18
2014[c]	2016	141	16.3	34.8	13
2015	2017	127[b]	10.1	25.4	17.8

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
Average		***136***	***8.3***	***31.12***	***21.30***
Median		***130***	***7.8***	***30.15***	***15***
Targets		***155***	***9***	***37.8***	***18.0***

[a] Forced-release group.
[b] Volitional-release group.
[c] This represents the combination of the WxW Chiwawa, HxH Chiwawa, and the HxH Nason Creek programs. The HxH Nason Creek program was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 because of water-intake concerns at the Nason Creek Acclimation Facility.

Survival Estimates

Overall survival of the 2015 brood Chiwawa spring Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 5.12). There was higher than expected survivals throughout most stages except eyed-egg to ponding, contributing to increased program performance. Pre-spawn survival of adults was also above the standard set for the program.

Table 5.12. Hatchery life-stage survival rates (%) for spring Chinook, brood years 1989-2015. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989	100.0	100.0	98.0	99.1	99.1	99.0	96.4	99.3	94.8
1990	100.0	85.7	91.8	98.1	99.5	98.9	97.9	99.2	88.2
1991	100.0	100.0	94.4	96.1	99.6	97.9	93.2	95.0	84.4
1992	100.0	100.0	98.4	96.7	99.9	99.9	80.0	80.6	76.2
1993	96.0	98.0	89.7	98.0	99.7	99.3	98.9	99.7	86.9
1994	100.0	100.0	98.6	100.0	99.8	99.4	77.0	78.9	76.6
1995	No program								
1996	100.0	100.0	88.3	100.0	93.8	93.0	89.9	97.7	81.7
1997	98.6	100.0	93.2	95.7	98.3	99.6	95.6	99.3	85.3
1998	95.2	100.0	94.5	99.0	98.5	98.3	89.6	99.1	83.9
1999	No program								
2000	100.0	100.0	91.0	98.1	97.2	96.6	95.4	99.3	85.2
2001	97.6	97.0	88.9	98.1	99.7	99.6	51.3	51.8	34.3
2002	97.8	100.0	82.1	98.0	97.4	96.7	94.8	99.1	76.3
2003	93.9	100.0	93.2	97.7	99.5	99.3	98.5	98.1	89.7
2004	97.8	82.5	93.3	98.4	98.8	94.3	93.9	97.2	91.9
2005	97.1	100.0	95.9	98.0	99.2	99.0	97.9	99.1	92.1
2006	100.0	100.0	90.1	98.1	99.2	99.0	95.3	97.7	84.2
2007	98.8	97.7	92.9	97.2	99.4	99.0	98.0	99.4	88.5
2008	96.6	99.3	90.8	93.2	97.4	97.1	95.6	97.6	80.0
2009	94.4	97.6	92.5	88.3	97.6	97.4	89.2	92.8	77.6
2010[a]	98.9	100.0	99.2	100.0	97.9	97.5	95.6	98.2	94.8

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2011	98.9	98.9	93.2	88.4	96.8	96.4	93.4	97.1	76.9
2012	98.3	100.0	94.6	98.3	99.7	99.3	98.5	99.4	91.6
2013	91.7	94.6	96.5	97.0	97.9	96.8	95.5	98.9	89.4
2014[b]	100.0	100.0	91.1	98.8	99.6	99.1	98.0	99.3	88.3
2015	98.2	100.0	94.5	97.9	99.0	98.6	97.9	99.6	90.5
Average	***97.7***	***98.4***	***92.7***	***97.0***	***98.3***	***97.8***	***92.1***	***95.0***	***82.9***
Median	***98.3***	***100.00***	***93.2***	***98.1***	***98.7***	***98.5***	***95.5***	***98.6***	***85.3***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival estimates do not include the 18,840 eyed eggs that were culled because of high ELISA levels.
[b] Survival estimates do not include the HxH Nason Creek program that was transferred to the Chiwawa Acclimation Facility because of water-intake concerns at the Nason Creek Acclimation Facility.

5.3 Disease Monitoring

Results of 2017 adult broodstock bacterial kidney disease (BKD) monitoring indicated that all females had ELISA values less than 0.099. Because all females had ELISA values less than 0.119, juveniles were reared at less than 0.125 fish per pound (Table 5.13).

The 2015 brood had no significant health issues during the juvenile rearing period.

Table 5.13. Proportion of bacterial kidney disease (BKD) titer groups for the Chiwawa spring Chinook broodstock, brood years 1996-2017. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1996	0.0000	0.2500	0.2500	0.5000	0.0000	1.0000
1997	0.1176	0.7353	0.0588	0.0882	0.3529	0.6471
1998	0.1176	0.8235	0.0588	0.0000	0.4706	0.5294
1999	No Program					
2000	0.0000	0.9091	0.0909	0.0000	0.1818	0.8182
2001	0.4066	0.5436	0.0373	0.0124	0.6515	0.3485
2002	0.2195	0.6585	0.0732	0.0488	0.5610	0.4390
2003	0.6957	0.1087	0.0652	0.1304	0.7174	0.2826
2004	0.8182	0.1515	0.0227	0.0076	0.8939	0.1061
2005	0.9084	0.0916	0.0000	0.0000	0.9695	0.0305
2006	0.7222	0.2556	0.0000	0.0222	0.8444	0.1556
2007	0.5854	0.3415	0.0244	0.0488	0.7073	0.2927
2008	0.8304	0.1520	0.0058	0.0117	0.9357	0.0643
2009	0.7600	0.1840	0.0080	0.0480	0.8480	0.1520

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
2010	0.8791	0.0769	0.0000	0.0439	0.9451	0.0549
2011	0.7640	0.2022	0.0000	0.0337	0.8764	0.1236
2012	0.8333	0.1333	0.0167	0.0167	0.9170	0.0830
2013	0.8285	0.1429	0.0286	0.0000	0.8857	0.1143
2014[c]	0.8282	0.1720	0.0000	0.0000	0.8889	0.1111
2015	0.9818	0.0000	0.0000	0.0182	0.9818	0.0182
2016	0.7547	0.2075	0.0189	0.0189	0.8113	0.1887
2017	1.0000	0.0000	0.0000	0.0000	0.1000	0.0000
Average	***0.6215***	***0.2924***	***0.0362***	***0.0500***	***0.6924***	***0.2648***
Median	***0.7600***	***0.1840***	***0.0189***	***0.0182***	***0.8444***	***0.1520***

[a] Individual ELISA samples were not collected before the 1996 brood.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.
[c] Comprised of HOR's used for both Chiwawa and Nason Creek obligations.

5.4 Natural Juvenile Productivity

During 2017, juvenile spring Chinook were sampled at the Lower Wenatchee, Nason Creek, White River, and Chiwawa River traps, and counted during snorkel surveys within the Chiwawa River basin. Results from sampling at the Nason Creek Trap are provided in Section 6 and from the White River Trap in Section 7.

Parr Estimates

Based on snorkel surveys, a total of 102,106 (±9%) subyearling and 526 (±32%) yearling spring Chinook were estimated in the Chiwawa River basin in August 2017 (Table 5.14 and 5.15). During the survey period 1992-2017, numbers of subyearling and yearling Chinook have ranged from 5,815 to 149,563 and 5 to 967, respectively, in the Chiwawa River basin (Table 5.14 and 5.15; Figure 5.4). Numbers of all fish counted in the Chiwawa River basin are reported in Appendix A.

Table 5.14. Total numbers of subyearling spring Chinook estimated in different streams in the Chiwawa River basin during snorkel surveys in August 1992-2017; NS = not sampled.

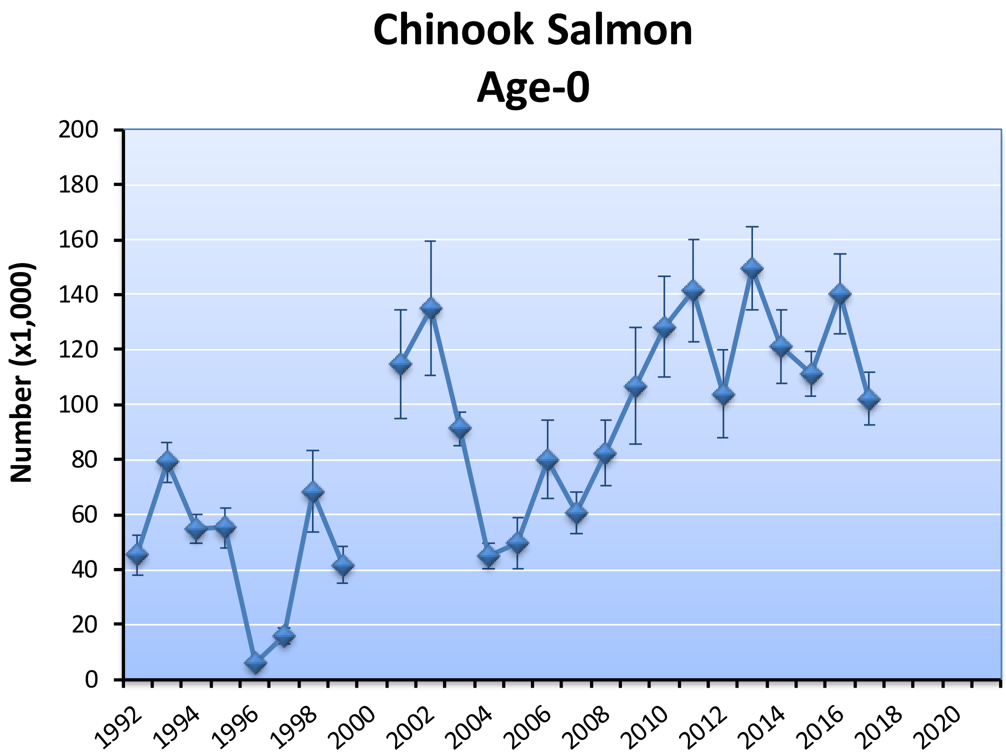
Sample Year	Number of subyearling spring Chinook									
	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
1992	45,483	NS	NS	NS	NS	NS	NS	NS	NS	**45,483**
1993	77,269	0	1,258	586	NS	NS	NS	NS	NS	**79,113**
1994	53,492	0	398	474	68	624	0	0	0	**55,056**
1995	52,775	0	1,346	210	0	683	67	160	0	**55,241**
1996	5,500	0	29	10	0	248	28	0	0	**5,815**
1997	15,438	0	56	92	0	480	0	0	0	**16,066**
1998	65,875	0	1,468	496	57	506	0	13	0	**68,415**

Sample Year	Number of subyearling spring Chinook									
	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Clear Creek	Total
1999	40,051	0	366	592	0	598	22	0	0	**41,629**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	106,753	168	2,077	2,855	354	2,332	78	0	0	**114,617**
2002	117,230	75	8,233	2,953	636	5,021	429	0	297	**134,874**
2003	80,250	4,508	1,570	3,255	118	1,510	22	45	0	**91,278**
2004	43,360	102	717	215	54	637	21	71	0	**45,177**
2005	45,999	71	2,092	660	17	792	0	0	0	**49,631**
2006	73,478	113	2,500	1,681	51	1,890	62	127	0	**79,902**
2007	53,863	125	5,235	870	51	538	20	28	22	**60,752**
2008	72,431	214	3,287	4,730	163	1,221	28	255	22	**82,351**
2009	101,085	125	2,486	1,849	14	1,082	29	18	17	**106,705**
2010	117,499	526	4,571	4,052	0	1,449	56	42	25	**128,220**
2011	136,424	64	2,762	1,330	53	581	42	214	40	**141,510**
2012	96,036	78	4,125	2,227	49	1,322	35	31	37	**103,940**
2013	140,485	120	3,301	3,214	0	2,345	31	21	46	**149,563**
2014	113,869	361	2,384	3,124	28	1,367	11	28	68	**121,240**
2015	103,710	285	1,917	4,158	0	1,013	71	62	8	**111,224**
2016	135,819	107	1,644	991	0	1,508	20	58	25	**140,172**
2017	94,401	120	3,069	2,349	18	2,026	13	96	14	**102,106**
Average	***79,543***	***298***	***2,370***	***1,791***	***75***	***1,294***	***47***	***55***	***27***	***85,203***
Median	***77,269***	***105***	***2,085***	***1,506***	***28***	***1,082***	***28***	***28***	***8***	***82,351***

Table 5.15. Total numbers of yearling spring Chinook estimated in different streams in the Chiwawa River basin during snorkel surveys in August 1992-2017; NS = not sampled.

Sample Year	Number of yearling spring Chinook									
	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Y Creek	Total
1992	563	NS	NS	NS	NS	NS	NS	NS	NS	**563**
1993	174	0	0	0	NS	NS	NS	NS	NS	**174**
1994	14	0	0	4	0	0	0	0	0	**18**
1995	13	0	0	0	0	0	0	0	0	**13**
1996	22	0	0	0	0	0	0	0	0	**22**
1997	5	0	0	0	0	0	0	0	0	**5**
1998	63	0	0	0	0	0	0	0	0	**63**
1999	41	0	0	0	0	0	0	0	0	**41**
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
2001	66	0	3	0	0	0	0	0	0	**69**
2002	32	0	0	0	0	0	0	0	0	**32**
2003	134	0	0	0	0	0	0	0	0	**134**
2004	14	0	0	0	0	7	0	0	0	**21**

Sample Year	Number of yearling spring Chinook									
	Chiwawa River	Phelps Creek	Chikamin Creek	Rock Creek	Unnamed Creek	Big Meadow Creek	Alder Creek	Brush Creek	Y Creek	Total
2005	62	0	17	0	0	0	0	0	0	**79**
2006	345	0	0	43	0	0	0	0	0	**388**
2007	41	0	0	0	0	0	0	0	0	**41**
2008	144	0	45	0	0	0	0	0	0	**189**
2009	49	0	0	5	0	0	0	0	0	**54**
2010	207	27	19	38	0	0	0	0	0	**291**
2011	645	0	71	194	0	57	0	0	0	**967**
2012	748	0	0	19	0	0	0	0	0	**767**
2013	836	0	0	8	0	8	0	0	0	**852**
2014	867	28	4	38	0	2	0	0	0	**939**
2015	488	0	22	110	0	0	0	0	0	**620**
2016	254	0	0	0	0	28	0	0	0	**282**
2017	483	0	0	43	0	0	0	0	0	**526**
Average	***252***	***2***	***8***	***21***	***0***	***4***	***0***	***0***	***0***	***286***
Median	***134***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***134***



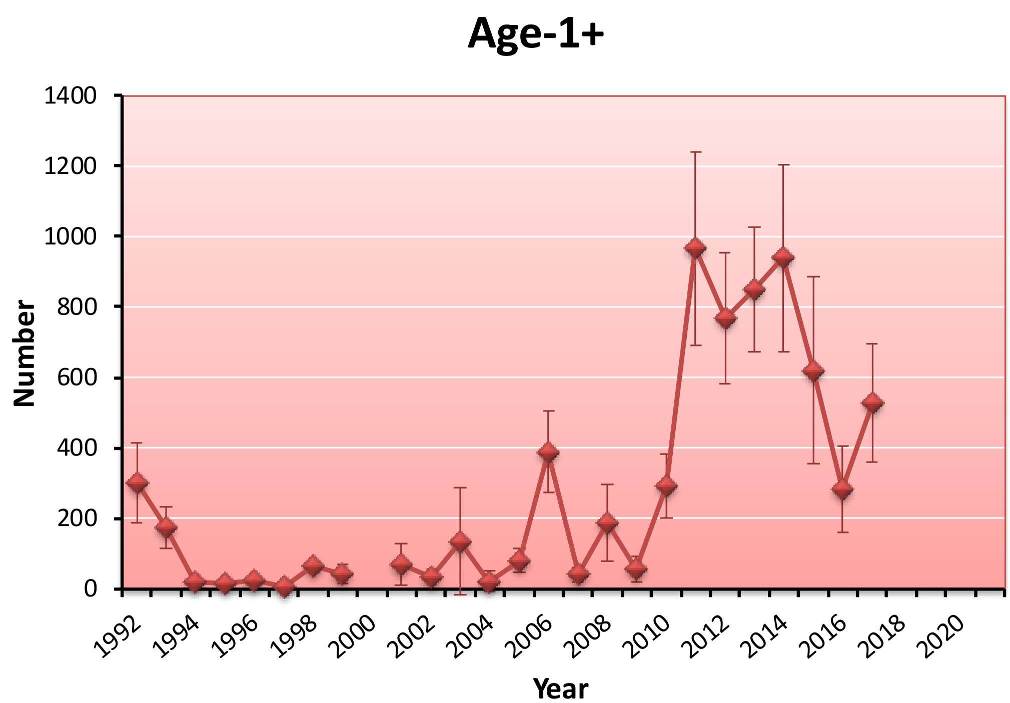


Figure 5.4. Numbers of subyearling and yearling Chinook salmon within the Chiwawa River Basin in August 1992-2017; ND = no data. Vertical bars indicate 95% confidence bounds.

Juvenile Chinook were distributed contagiously among reaches in the Chiwawa River. Their densities were highest in the upper portions of the basin, with the highest densities within tributaries. Juvenile Chinook were most abundant in multiple channels and pools, and least abundant in glides and riffles. Most Chinook associated closely with woody debris in multiple channels. These sites (multiple channels) made up 16% of the total area of the Chiwawa River basin, but they provided habitat for 44% of all subyearling Chinook in the basin in 2017. In contrast, riffles made up 54% of the total area, but provided habitat for only 12% of all juvenile Chinook in the Chiwawa River basin. Pools made up 23% of the total area and provided habitat for 43% of all juvenile Chinook in the basin. Few Chinook used glides that lacked woody debris.

Mean densities of juvenile Chinook in two reaches of the Chiwawa River were generally less than those in corresponding reference areas on the Little Wenatchee River (Figure 5.5). Within both the Chiwawa River and its reference areas, pools and multiple channels consistently had the highest densities of juvenile Chinook.

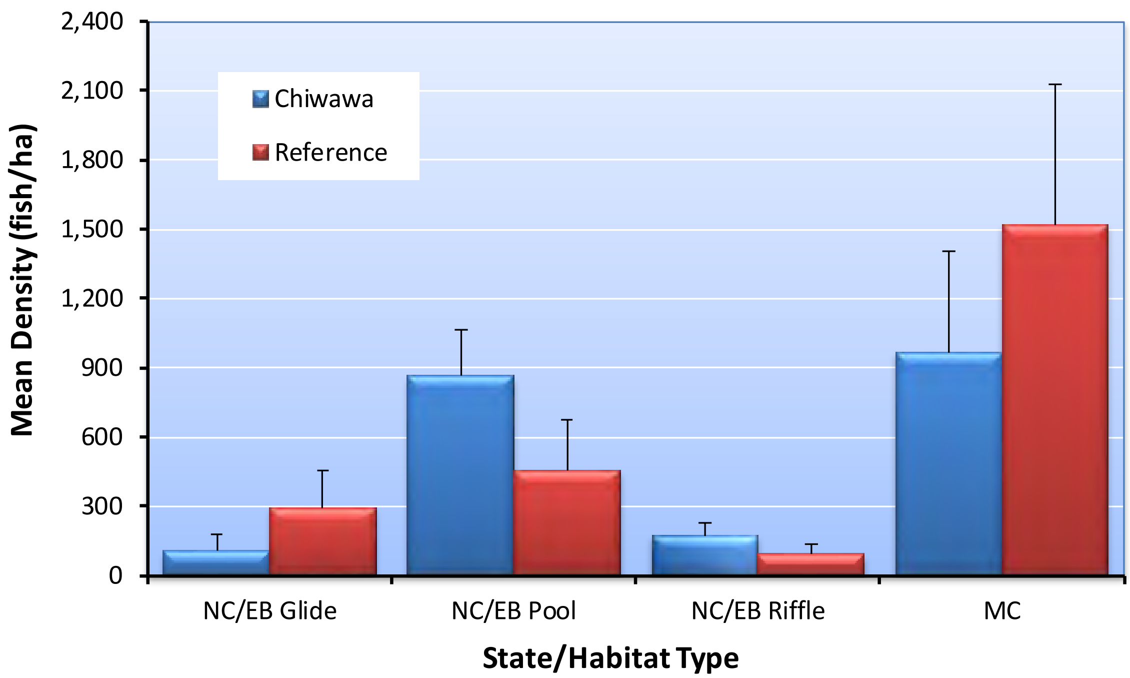


Figure 5.5. Comparison of the 24-year means of subyearling spring Chinook densities within state/habitat types in reaches 3 and 8 of the Chiwawa River and their matched reference areas on the Little Wenatchee River. NC = natural channel; S = straight channel; EB = eroded banks; MC = multiple channel. There was no sampling in 2000 and no sampling within reference areas in 1992.

Smolt and Emigrant Estimates

Numbers of spring Chinook smolts and emigrants were estimated at the Chiwawa and Lower Wenatchee traps in 2017.

Chiwawa Trap

The Chiwawa Trap operated between 23 March and 29 November 2017. During that time, the trap was inoperable for 36 days because of high and low river flows, debris, major hatchery releases, and mechanical issues. Throughout the trapping season the trap operated in two positions, the normal position and a new, low-flow position. Daily trap efficiencies were estimated for each age class of fish (e.g., subyearling and yearling). The daily number of fish captured was expanded by the estimated trap efficiency to estimate daily total emigration. Monthly captures of all fish and results of mark-recapture efficiency tests at the Chiwawa Trap are reported in Appendix B.

Wild yearling spring Chinook (2015 brood year) were primarily captured in March and April 2017 (Figure 5.6). Because we were unable to develop a significant relationship between trap efficiency and river flow ($R^2 = 0.462$; $P > 0.05$), a pooled estimate was used. The total number of wild yearling Chinook emigrating from the Chiwawa River was estimated at 53,344 (95 CI = ±15,037). Combining the total number of subyearling spring Chinook (80,543 ±27,967) that emigrated during the fall of 2016 with the total number of yearling Chinook (53,344 ±15,037) that emigrated during 2017, the total emigrant estimate for brood year 2015 was 133,887 (± 42,019) (Table 5.16). No non-trapping estimate was calculated for brood year 2016 (see Appendix B).

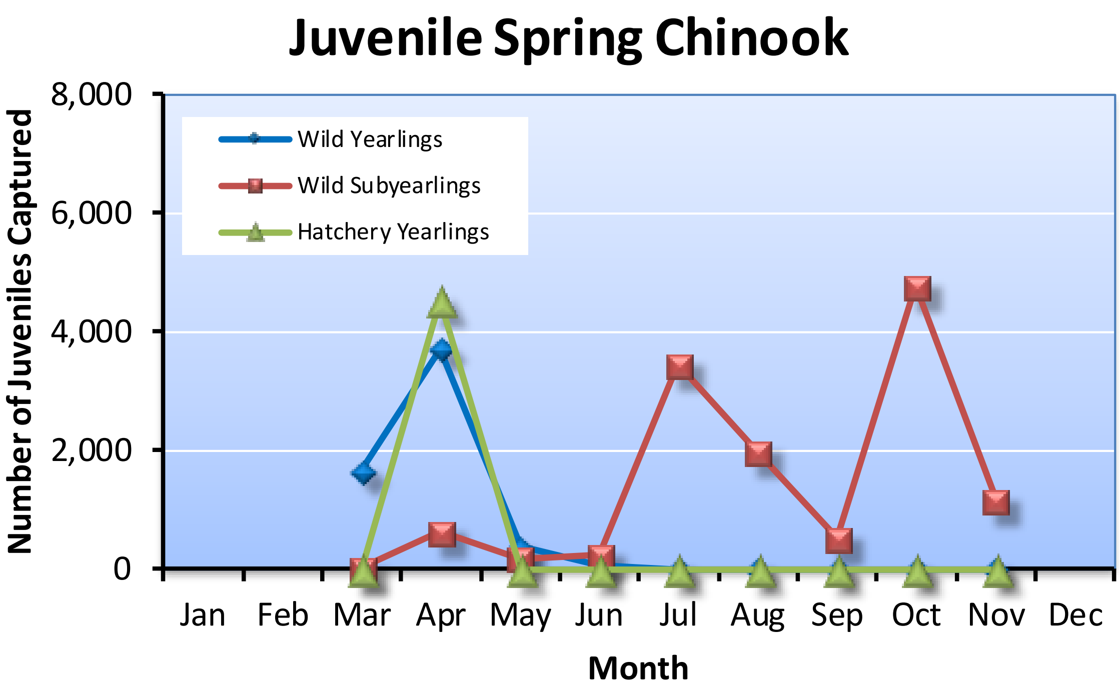


Figure 5.6. Monthly captures of wild subyearling, wild yearling, and hatchery yearling spring Chinook at the Chiwawa Trap, 2017.

Table 5.16. Numbers of redds and juvenile spring Chinook at different life stages in the Chiwawa River basin for brood years 1991-2016; NS = not sampled. Parr were estimated using snorkel techniques, while smolts and total emigrants were estimated using smolt traps.

Brood year	Number of redds	Egg deposition	Number of parr	Number of smolts produced within Chiwawa River basin[a]	Number of emigrants
1991	104	478,400	45,483[b]	42,525	NS
1992	302	1,570,098	79,113	39,723	65,541
1993	106	556,394	55,056	8,662	22,698
1994	82	485,686	55,240	16,472	25,067
1995	13	66,248	5,815	3,830	5,951
1996	23	106,835	16,066	15,475	19,183
1997	82	374,740	68,415	28,334	44,562
1998	41	218,325	41,629	23,068	25,923
1999	34	166,090	NS	10,661	15,649
2000	128	642,944	114,617	40,831	55,685
2001	1,078	4,984,672	134,874	86,482	546,266
2002	345	1,605,630	91,278	90,948	184,279
2003	111	648,684	45,177	16,755	33,637
2004	241	1,156,559	49,631	72,080	116,158
2005	332	1,436,564	79,902	69,064	177,659
2006	297	1,284,228	60,752	45,050	107,972
2007	283	1,256,803	82,351	25,809	86,006
2008	689	3,163,888	106,705	35,023	120,184
2009	421	1,925,233	128,220	30,959	61,955
2010	502	2,165,628	141,510	47,511	101,130
2011	492	2,157,420	103,940	37,185	108,832
2012	880	3,716,240	149,563	34,334	109,413
2013	714	3,367,224	121,240	39,396	113,091
2014	485	1,961,825	111,224	37,170	114,680
2015	543	2,631,921	140,172	53,344	193,516
2016	312	1,393,704	102,106	-	-
Average	***332***	***1,519,874***	***85,203***	***38,028***	***102,293***
Median	***300***	***1,338,966***	***82,351***	***37,170***	***93,568***

[a] The estimated number of smolts (yearlings) that are produced entirely within the Chiwawa River basin. Smolt estimates for brood years 1992-1996 were calculated with a mark-recapture model; brood years 1997-present were calculated with a flow model.
[b] Estimate only includes numbers of Chinook in the Chiwawa River. Tributaries were not sampled at that time.

Wild subyearling spring Chinook (2016 brood year) were captured between March and November 2017 (Figure 5.6). Based on capture efficiencies, the total number of wild subyearling (fry and parr) Chinook from the Chiwawa River basin was 111,566 (95% CI = ±22,090). Removing fry from the estimate, a total of 95,063 (±21,247) subyearling parr emigrated from the Chiwawa River basin in 2017. Although subyearling parr migrated during all months of sampling, the majority (92%) migrated after 1 July (Figure 5.6).

Yearling spring Chinook sampled in 2017 averaged 93 mm in length, 8.7 g in weight, and had a mean condition of 1.06 (Table 5.17). These size estimates were similar to the overall mean of yearling spring Chinook sampled in previous years (overall means: 93 mm, 9.0 g, and condition of 1.08). Subyearling spring Chinook sampled in 2017 at the Chiwawa Trap averaged 74 mm in length, averaged 4.2 g, and had a mean condition of 1.09 (Table 5.17). In general, subyearlings were slightly smaller than previous years (overall means, 76 mm, 5.2 g, and condition of 1.09).

Table 5.17. Mean fork length (mm), weight (g), and condition factor of subyearling (excluding fry) and yearling spring Chinook collected in the Chiwawa Trap, 1996-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
1996	Subyearling	514	78 (25)	6.9 (4.2)	1.11 (0.11)
	Yearling	1,589	94 (9)	9.5 (3.0)	1.11 (0.08)
1997	Subyearling	840	86 (8)	7.5 (2.1)	1.16 (0.08)
	Yearling	1,114	100 (7)	10.2 (2.6)	1.02 (0.10)
1998	Subyearling	3,743	82 (11)	6.2 (2.2)	1.08 (0.09)
	Yearling	2,663	97 (7)	10.3 (2.8)	1.12 (0.23)
1999	Subyearling	569	89 (9)	8.5 (2.4)	1.15 (0.07)
	Yearling	3,664	95 (8)	9.6 (3.4)	1.09 (0.19)
2000	Subyearling	1,810	85 (10)	7.4 (2.4)	1.15 (0.10)
	Yearling	1,891	97 (8)	10.5 (5.2)	1.13 (0.07)
2001	Subyearling	4,657	82 (11)	6.6 (3.4)	1.14 (0.09)
	Yearling	2,935	97 (7)	10.5 (2.4)	1.15 (0.08)
2002	Subyearling	6,130	64 (12)	3.0 (1.6)	1.06 (0.10)
	Yearling	1,735	94 (8)	9.0 (2.3)	1.09 (0.08)
2003	Subyearling	3,679	64 (12)	3.2 (1.7)	1.08 (0.10)
	Yearling	2,657	87 (9)	7.2 (3.5)	1.07 (0.10)
2004	Subyearling	2,278	75 (16)	4.3 (2.1)	0.92 (0.16)
	Yearling	1,032	91 (9)	8.5 (2.7)	1.09 (0.10)
2005	Subyearling	2,702	73 (12)	4.6 (2.2)	1.08 (0.09)
	Yearling	803	96 (9)	9.9 (2.8)	1.08 (0.08)
2006	Subyearling	3,462	76 (11)	5.1 (2.0)	1.12 (0.21)
	Yearling	4,645	95 (7)	9.4 (2.3)	1.10 (0.13)
2007	Subyearling	1,718	72 (12)	4.5 (2.1)	1.13 (0.16)
	Yearling	2,245	91 (8)	8.6 (2.5)	1.10 (0.09)
2008	Subyearling	10,443	79 (12)	5.9 (2.3)	1.15 (0.15)
	Yearling	8,792	93 (7)	8.8 (2.1)	1.08 (0.10)
2009	Subyearling	10,536	75 (10)	5.0 (2.2)	0.91 (0.11)
	Yearling	3,630	92 (7)	8.8 (2.1)	0.89 (0.07)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2010	Subyearling	3,888	77 (12)	5.4 (2.3)	1.11 (0.16)
	Yearling	5,799	91 (8)	8.9 (2.2)	1.15 (0.14)
2011	Subyearling	6,870	73 (11)	4.8 (2.2)	1.15 (0.16)
	Yearling	4,734	94 (8)	8.7 (2.2)	1.04 (0.10)
2012	Subyearling	8,756	75 (10)	4.8 (2.2)	1.13 (0.28)
	Yearling	7,290	90 (7)	8.0 (2.6)	1.06 (0.24)
2013	Subyearling	10,181	71 (10)	4.1 (1.7)	1.09 (0.39)
	Yearling	3,135	88 (9)	7.7 (2.8)	1.09 (0.20)
2014	Subyearling	7,122	71 (10)	3.7 (1.6)	1.08 (0.10)
	Yearling	3,956	89 (8)	7.7 (2.2)	1.05 (0.08)
2015	Subyearling	15,241	71 (11)	4.2 (2.4)	1.10 (0.39)
	Yearling	6,304	93 (9)	8.8 (2.9)	1.09 (0.15)
2016	Subyearling	12,198	71 (13)	4.5 (2.3)	1.08 (0.08)
	Yearling	2,789	91 (9)	8.3 (3.1)	1.06 (0.26)
2017	Subyearling	11,508	74 (12)	4.2 (2.2)	1.09 (0.20)
	Yearling	5,822	93 (7)	8.6 (2.1)	1.06 (0.06)
Average	***Subyearling***	***5,857***	***76***	***5.2***	***1.09***
	Yearling	***3,601***	***93***	***9.0***	***1.08***
Median	***Subyearling***	***4,273***	***75***	***4.8***	***1.11***
	Yearling	***3,035***	***93***	***8.8***	***1.09***

[a] Sample size represents the number of fish that were measured for both length and weight.

Lower Wenatchee Trap

The Lower Wenatchee Trap operated between 24 February and 31 July 2017. During that time, the trap was inoperable for 38 days because of high and low river discharge, debris, elevated river temperature, large hatchery releases, and mechanical issues. During the sampling period, a total of 1,333 wild yearling Chinook, 46,801 wild subyearling Chinook (mostly summer Chinook), and 12,131 hatchery yearling Chinook were captured at the Lower Wenatchee Trap. Based on capture efficiencies and river discharge, a significant model was developed ($R^2 = 0.823$, $P < 0.01$). The flow efficiency model estimated the total number of wild yearling Chinook that emigrated past the Lower Wenatchee Trap at 130,537 (95% CI = ±30,692) (Table 5.18). Monthly captures of all fish collected at the Lower Wenatchee Trap are reported in Appendix B.

Table 5.18. Numbers of redds and wild spring Chinook smolts produced in the Wenatchee River basin for brood years 2000-2015; NS = not sampled. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere.

Brood year	Number of redds	Egg deposition	Number of smolts produced within Wenatchee River basin
2000	350	1,758,050	76,643
2001	2,109	8,674,624	243,516

Brood year	Number of redds	Egg deposition	Number of smolts produced within Wenatchee River basin
2002	1,139	5,300,906	165,116
2003	323	1,887,612	70,738
2004	574	2,663,445	55,619
2005	830	3,587,083	302,116
2006	588	2,542,512	85,558
2007	466	2,069,506	60,219
2008	1,411	6,479,312	82,137
2009	733	NS	NS
2010	968	NS	NS
2011	872	3,823,720	89,917
2012	1,704	7,195,992	67,973
2013	1,159	5,512,204	58,595
2014	969	4,263,600	36,752
2015	1,047	4,685,325	130,537
Average	***953***	***4,317,421***	***108,960***
Median	***920***	***4,043,660***	***79,390***

Yearling spring Chinook sampled in 2017 at the Lower Wenatchee Trap averaged 97 mm in length, 9.7 g in weight, and had a mean condition of 1.05 (Table 5.19). These size estimates were similar to the overall mean of yearling spring Chinook sampled in previous years (overall means: 98 mm, 10.5 g, and condition of 1.10).

Table 5.19. Mean fork length (mm), weight (g), and condition factor of yearling spring Chinook collected in the Lower Wenatchee Trap, 2000-2017. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere. Numbers in parentheses indicate 1 standard deviation.

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2000	29	111 (15.1)	15.6 (7.4)	1.15 (0.1)
2001	204	106 (9.6)	13.0 (3.6)	1.10 (0.1)
2002	301	99 (10.0)	10.7 (3.3)	1.11 (0.1)
2003	1,427	96 (9.4)	9.7 (10.0)	1.11 (0.1)
2004	1,046	97 (10.3)	10.0 (3.4)	1.11 (0.1)
2005	325	101 (10.5)	11.3 (3.7)	1.08 (0.1)
2006	642	99 (9.5)	10.6 (4.9)	1.08 (0.1)
2007	1,902	94 (8.4)	9.4 (2.5)	1.12 (0.1)
2008	615	97 (9.3)	10.5 (3.1)	1.14 (0.1)
2009	483	98 (10.8)	10.8 (3.9)	1.16 (0.1)
2010	1,057	98 (9.4)	10.5 (3.1)	1.10 (0.1)
2011	ND	ND	ND	ND

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2012	ND	ND	ND	ND
2013	1729	94 (9.6)	9.0 (2.9)	1.07 (0.1)
2014	1,643	94 (9.8)	8.7 (2.8)	1.04 (0.1)
2015	1,491	96 (9.8)	9.4 (3.7)	1.06 (0.1)
2016	598	94 (9.4)	9.0 (2.9)	1.08 (0.1)
2017	1,320	97 (8.4)	9.7 (2.6)	1.05 (0.1)
Average	***926***	***98.2 (10.0)***	***10.5 (3.9)***	***1.10 (0.1)***
Median	***844***	***97.1 (9.6)***	***10.3 (3.3)***	***1.10 (0.1)***

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 21,115 wild juvenile Chinook (14,184 subyearling and 6,931 yearlings) were PIT tagged and released in 2017 in the Wenatchee River basin (Table 5.20). Most of these (66%) were tagged at the Chiwawa trap. See Appendix C for a complete list of all fish captured, tagged, lost, and released.

Table 5.20. Numbers of wild Chinook that were captured, tagged, and released at different locations within the Wenatchee River basin, 2017. Numbers of fish that died or shed tags are also given.

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Subyearling	12,938	296	8,241	187	0	8,241	1.45
	Yearling	5,824	169	5,711	15	0	5,711	0.26
	Total	**18,762**	**465**	**13,952**	**202**	**0**	**13,952**	**1.08**
Chiwawa River (Electrofishing)	Subyearling	2,740	24	2,703	3	0	2,703	0.11
	Yearling	0	0	0	0	0	0	0.00
	Total	**2,740**	**24**	**2,703**	**3**	**0**	**2,703**	**0.11**
Nason Creek Trap	Subyearling	2,490	190	1,877	5	0	1,877	0.20
	Yearling	357	29	346	1	0	346	0.28
	Total	**2,847**	**219**	**2,223**	**6**	**0**	**2,223**	**0.21**
Nason Creek (Electrofishing)	Subyearling	3,401	63	3,242	42	2	3,240	1.23
	Yearling	0	0	0	0	0	0	0.00
	Total	**3,401**	**63**	**3,242**	**42**	**2**	**3,240**	**1.23**
White River Trap	Subyearling	539	40	507	8	0	507	1.48
	Yearling	41	0	41	0	0	41	0.00
	Total	**580**	**40**	**548**	**8**	**0**	**548**	**1.38**
Lower Wenatchee Trap	Subyearling	46,801	36	0	360	0	0	0.77
	Yearling	1,332	8	1,220	7	0	1,220	0.53
	Total	**48,133**	**44**	**1,220**	**367**	**0**	**1,220**	**0.76**
Total:	**Subyearling**	65,880	419	14,186	592	2	14,184	0.90

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
	Yearling	7,156	177	6,931	22	0	6,931	0.31
Grand Total:		***73,036***	***596***	***21,117***	***614***	***2***	***21,115***	***0.84***

Numbers of wild Chinook salmon PIT-tagged and released as part of CSS and PUD studies during the period 2006-2017 are shown in Table 5.21.

Table 5.21. Summary of the numbers of wild Chinook that were tagged and released at different locations within the Wenatchee River basin, 2006-2017.

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chiwawa Trap	Subyearling	5,130	6,137	8,755	8,765	3,324	6,030	7,644	9,086	11,358	10,471	7,354	8,241
	Yearling	2,793	4,659	8,397	3,694	6,281	4,318	7,980	3,093	4,383	6,204	2,729	5,711
	Total	**7,923**	**10,796**	**17,152**	**12,459**	**9,605**	**10,348**	**15,624**	**12,179**	**15,741**	**16,675**	**10,083**	**13,952**
Chiwawa River (Angling or Electro-fishing)	Subyearling	111	20	43	128	531	0	3,181	3,017	1,032	1,054	1,776	2,703
	Yearling	0	0	0	3	4	0	0	0	0	0	0	0
	Total	**111**	**20**	**43**	**131**	**535**	**0**	**3,181**	**3,017**	**1,032**	**1,054**	**1,776**	**2,703**
Upper Wenatchee Trap	Subyearling	0	15	0	37	3	1	1	0	--	--	--	--
	Yearling	81	1,434	159	296	486	714	75	94	--	--	--	--
	Total	**81**	**1,449**	**159**	**333**	**489**	**715**	**76**	**94**	**--**	**--**	**--**	**--**
Nason Creek Trap	Subyearling	1,434	545	1,741	1,890	2,828	822	1,939	3,290	1,113	219	434	1,877
	Yearling	365	577	894	185	364	147	357	237	456	142	61	346
	Total	**1,799**	**1,122**	**2,635**	**2,075**	**3,192**	**969**	**2,296**	**3,527**	**1,569**	**361**	**495**	**2,223**
Nason Creek (Angling or Electro-fishing)	Subyearling	68	6	4	701	595	0	0	0	1,816	1,089	802	3,240
	Yearling	1	7	0	13	3	0	0	0	0	0	0	0
	Total	**69**	**13**	**4**	**714**	**598**	**0**	**0**	**0**	**1,816**	**1,089**	**802**	**3,240**
White River Trap	Subyearling	0	0	0	441	143	144	285	374	156	149	136	507
	Yearling	0	0	0	265	359	65	180	22	49	34	3	41
	Total	**0**	**0**	**0**	**706**	**502**	**209**	**465**	**396**	**205**	**183**	**139**	**548**
Upper Wenatchee (Angling or Electro-fishing)	Subyearling	0	61	1	0	2	--	--	--	--	--	--	--
	Yearling	27	0	0	0	0	--	--	--	--	--	--	--
	Total	**27**	**61**	**1**	**0**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Middle Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	65	284	233	--	--	--	--	--	--	--
	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**65**	**284**	**233**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	0	0	0	--	--	--	--	--	--	--
	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
	Subyearling	0	0	0	0	1	--	--	--	--	--	--	--

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Peshastin Creek (Angling or Electro-fishing)	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Subyearling	0	0	2	0	0	0	0	0	36	0	18	0
	Yearling	522	1,641	506	468	917	0	0	1,712	1,506	1,301	538	1,220
	Total	**522**	**1,641**	**508**	**468**	**917**	**0**	**0**	**1,712**	**1,542**	**1,301**	**556**	**1,220**
Total:	**Subyearling**	**6,743**	**6,784**	**10,611**	**12,246**	**7,660**	**6,997**	**13,050**	**15,767**	**15,511**	**12,982**	**10,520**	**14,184**
	Yearling	**3,789**	**8,318**	**9,956**	**4,924**	**8,414**	**5,244**	**8,592**	**5,158**	**6,394**	**7,681**	**3,331**	**6,931**
Grand Total:		***10,532***	***15,102***	***20,567***	***17,170***	***16,074***	***12,241***	***21,642***	***20,925***	***21,905***	***20,663***	***13,851***	***21,115***

Freshwater Productivity

Both productivity and survival estimates for different life stages of spring Chinook in the Chiwawa River basin are provided in Table 5.22. Estimates for brood year 2015 fall within the ranges estimated over the period of brood years 1991-2015. During that period, freshwater productivities ranged from 125-1,015 parr/redd, 39-673 smolts/redd, and 124-834 emigrants/redd. Survivals during the same period ranged from 2.7-19.1% for egg-parr, 0.9-14.5% for egg-smolt, and 2.9-18.0% for egg-emigrants. Overwinter survival rates for juvenile spring Chinook within the Chiwawa River basin have ranged from 15.7-100.0%.

Table 5.22. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the Chiwawa River basin for brood years 1991-2015; ND = no data. These estimates were derived from data in Table 5.16.

Brood year	Parr/Redd	Smolts/Redd[a]	Emigrants/ Redd	Egg-Parr (%)	Parr-Smolt[b] (%)	Egg-Smolt[a] (%)	Egg-Emigrant (%)
1991	437	409	ND	9.5	93.5	8.9	ND
1992	262	132	217	5.0	50.2	2.5	4.2
1993	519	82	214	9.9	15.7	1.6	4.1
1994	674	201	306	11.4	29.8	3.4	5.2
1995	447	295	458	8.8	65.9	5.8	9.0
1996	699	673	834	15.0	96.3	14.5	18.0
1997	834	346	543	18.3	41.4	7.6	11.9
1998	1,015	563	632	19.1	55.4	10.6	11.9
1999	ND	314	460	ND	ND	6.4	9.4
2000	895	319	435	17.8	35.6	6.4	8.7
2001	125	80	507	2.7	64.1	1.7	11.0
2002	265	264	534	5.7	99.6	5.7	11.5
2003	407	151	303	7.0	37.1	2.6	5.2
2004	206	299	482	4.3	100.0	6.2	10.0
2005	241	208	535	5.6	86.4	4.8	12.4

Brood year	Parr/Redd	Smolts/Redd[a]	Emigrants/ Redd	Egg-Parr (%)	Parr-Smolt[b] (%)	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2006	205	152	364	4.7	74.2	3.5	8.4
2007	291	91	304	6.6	31.3	2.1	6.8
2008	155	51	174	3.4	32.8	1.1	3.8
2009	305	74	147	6.7	24.1	1.6	3.2
2010	282	95	201	6.5	33.6	2.2	4.7
2011	211	76	221	4.8	35.8	1.7	5.0
2012	170	39	124	4.0	23.0	0.9	2.9
2013	170	55	158	3.6	32.5	1.2	3.4
2014	229	77	236	5.7	33.4	1.9	5.8
2015	258	98	356	5.3	38.1	2.0	7.4
Average	***388***	***206***	***365***	***8.0***	***51.2***	***4.3***	***7.7***
Median	***273***	***151***	***331***	***6.1***	***37.6***	***2.6***	***7.1***

[a] These estimates include Chiwawa smolts produced only within the Chiwawa River basin.
[b] These estimates represent overwinter survival within the Chiwawa River basin. It does not include Chiwawa smolts produced outside the Chiwawa River basin.

Seeding level (egg deposition) explained most of the variability in productivity and survival of juvenile spring Chinook in the Chiwawa River basin. That is, for estimates based on "within-Chiwawa-Basin" life stages (e.g., parr and smolts), survival and productivity decreased as seeding levels increased (Figure 5.7). This suggests that density dependence regulates juvenile productivity and survival within the Chiwawa River basin. This form of population regulation is less apparent with total emigrants. However, one would expect the number of emigrants to increase as seeding levels exceed the rearing capacity of the Chiwawa River basin.

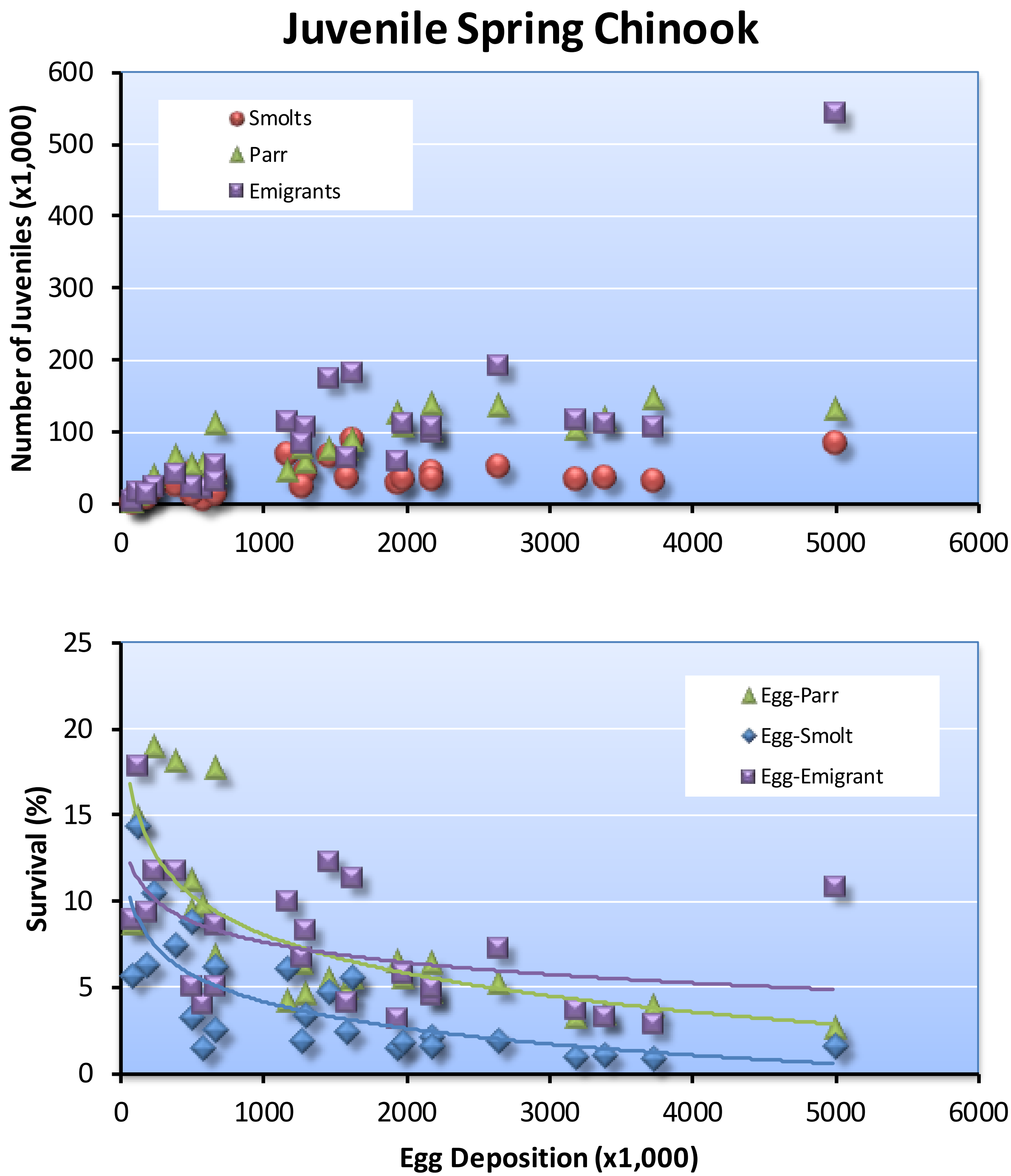


Figure 5.7. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for Chiwawa spring Chinook, brood years 1991-2015. Smolts represent yearling Chinook produced within the Chiwawa River basin.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[17] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we estimate parr and smolt carrying capacities using the smooth hockey stick stock-recruitment model (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods). This model explains most of the information contained in the juvenile spring Chinook data (see Appendix A).

Based on the smooth hockey stick model, the population carrying capacity for spring Chinook parr in the Chiwawa River basin is 114,362 parr (95% CI: 95,228 – 138,528) (Figure 5.8). The capacity for spring Chinook smolts is 45,780 (95% CI: 35,062 – 55,623) (Figure 5.9). Here, smolts are defined as the number of yearling spring Chinook produced entirely within the Chiwawa River basin. These estimates reflect current conditions (most recent two decades) within the Chiwawa River basin. Land use activities such as logging, mining, roads, development, and recreation have altered the historical conditions of the watershed. Thus, the estimated population capacity estimates may not reflect historical capacities for spring Chinook parr and smolts in the Chiwawa River basin.

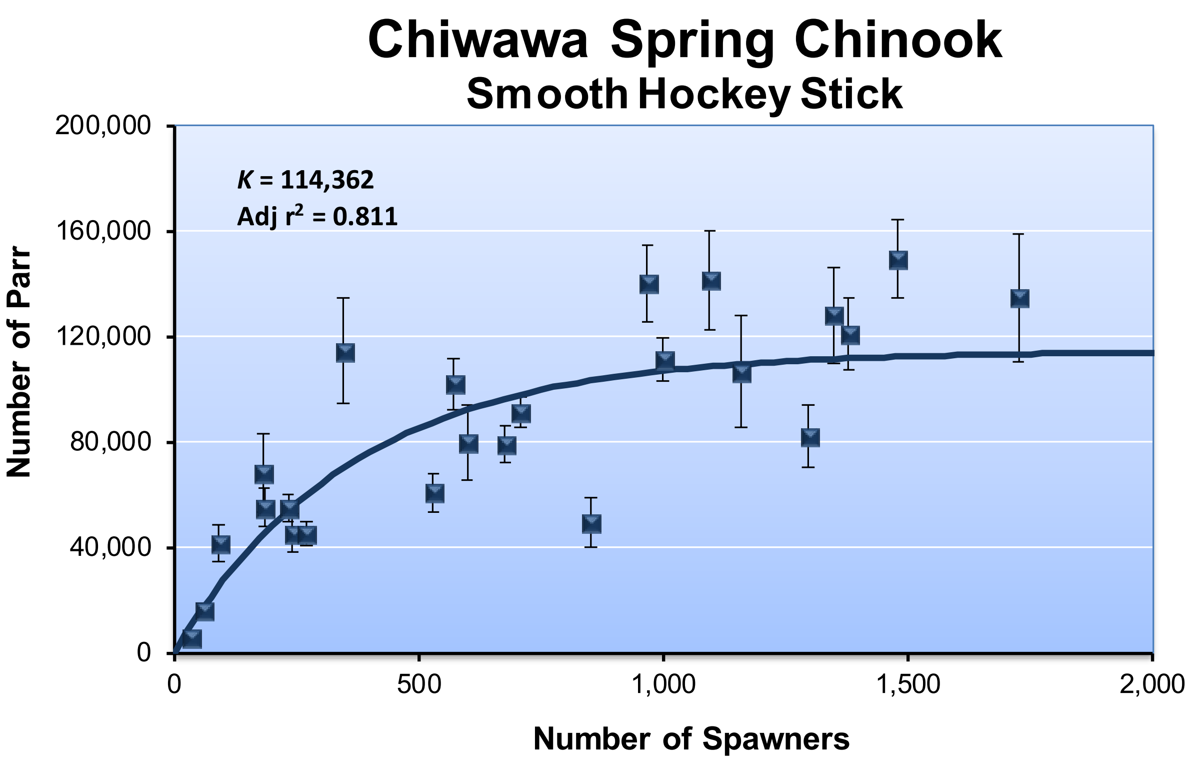


Figure 5.8. Relationship between spawners and number of parr produced in the Chiwawa River basin. Population carrying capacity (*K*) was estimated using the smooth hockey stick model, which explained most of the information in the data. Vertical bars represent 95% confidence intervals on parr estimates.

[17] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

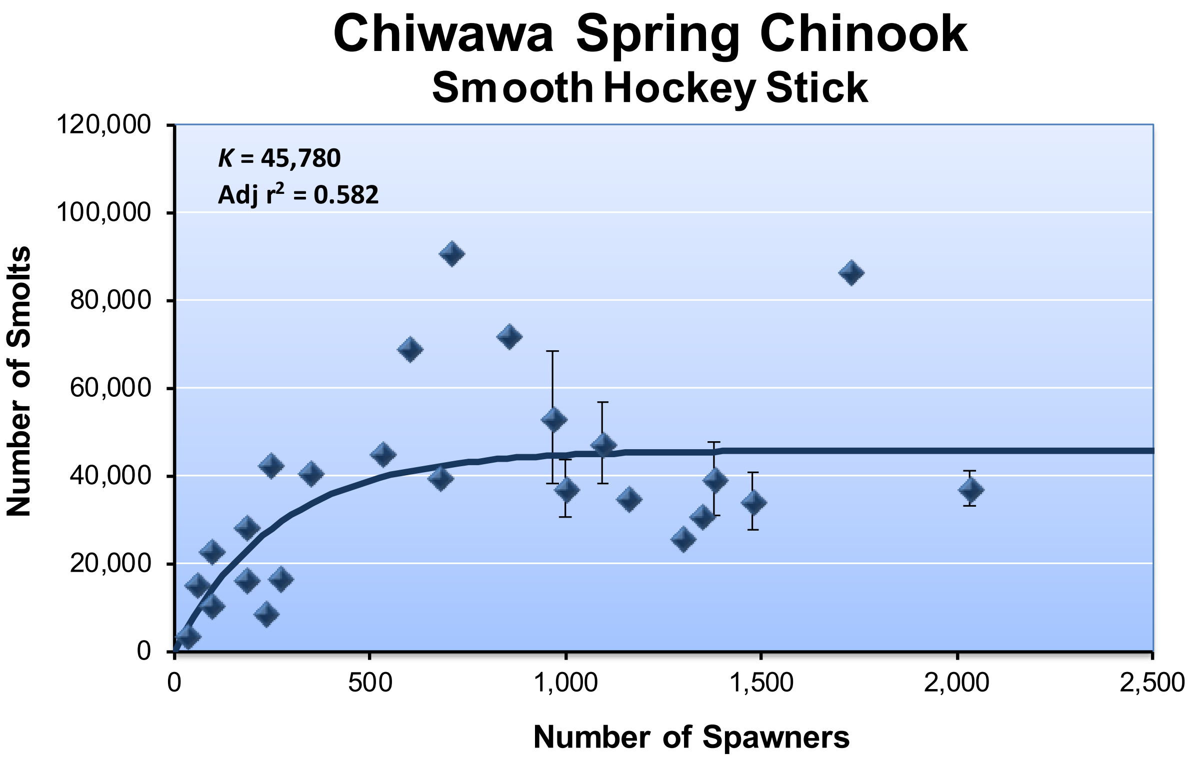


Figure 5.9. Relationship between spawners and number of yearling smolts produced in the Chiwawa River basin. Population carrying capacity (*K*) was estimated using the smooth hockey stick model, which explained most of the information in the data. At this time, 95% confidence intervals have only been calculated for the most recent six years of smolt data.

We tracked the precision of the smooth hockey stick parameters for Chiwawa spring Chinook smolts over time to see if precision improves with additional years of data, and the parameters and statistics stabilize over time. Examination of variation in the alpha (*A*) and beta (*B*) parameters of the smooth hockey stick model and their associated standard errors and confidence intervals indicates that the parameters appear to stabilize after 19 years of smolt and spawning escapement data (Table 5.23; Figure 5.10). This was also apparent in the estimates of population carrying capacity (Figure 5.11). That is, after 19 years of data, additional years of data had relatively little effect on the parameters of the smooth hockey stick model and its statistics. This observation will change if more extreme spawning escapements occur in the future or density independent factors overwhelm the influence of density dependent factors.

Table 5.23. Estimated parameters and statistics associated with fitting the smooth hockey stick model to spawning escapement and smolt data. Smolts represent numbers of smolts produced entirely within the Chiwawa River basin. *A* = alpha parameter; *B* = beta parameter; SE = standard error (estimated from 5,000 bootstrap samples); and r^2 = coefficient of determination. Spawners represent the stock size needed to achieve population capacity.

Years of data	Parameter				Population capacity	Intrinsic productivity	Spawners	r^2
	A	*A* SE	*B*	*B* SE				
5	10.80	11.51	110.23	942.46	49,257	110	1,339	0.706
6	10.43	30.61	163.03	28174.86	34,022	163	625	0.562
7	10.47	70.66	173.00	1918.57	35,362	173	613	0.567
8	10.40	13.26	206.97	41705.63	32,750	207	474	0.513
9	10.43	16.70	190.98	96463.71	33,727	191	529	0.518
10	10.56	41.60	184.83	719.39	38,590	185	625	0.564
11	11.10	8.98	154.07	246309.06	66,371	154	1,291	0.653
12	11.31	71.48	150.98	2254.06	81,605	151	1,620	0.701
13	11.28	43.85	142.41	236.06	79,572	142	1,674	0.664
14	11.34	5.26	141.43	118.39	84,292	141	1,786	0.699
15	11.40	15.61	141.76	35.71	89,256	142	1,887	0.718
16	11.38	2.77	141.35	37.66	87,522	141	1,856	0.723
17	11.02	3.10	155.71	38.89	60,965	156	1,173	0.651
18	10.92	0.79	160.92	38.85	55,020	161	1,023	0.635
19	10.82	0.25	166.78	39.68	50,150	167	901	0.614
20	10.82	0.20	166.99	39.58	49,972	167	897	0.622
21	10.78	0.17	169.82	38.50	48,142	170	849	0.618
22	10.75	0.15	172.32	39.35	46,494	172	809	0.611
23	10.73	0.13	173.36	40.07	45,815	173	792	0.612
24	10.73	0.13	173.36	39.82	45,815	173	792	0.612
25	10.72	0.12	174.08	41.00	45,161	174	777	0.610
26	10.72	0.12	174.08	41.29	45,161	174	777	0.610
27	10.73	0.12	173.45	38.05	45,780	173	791	0.617

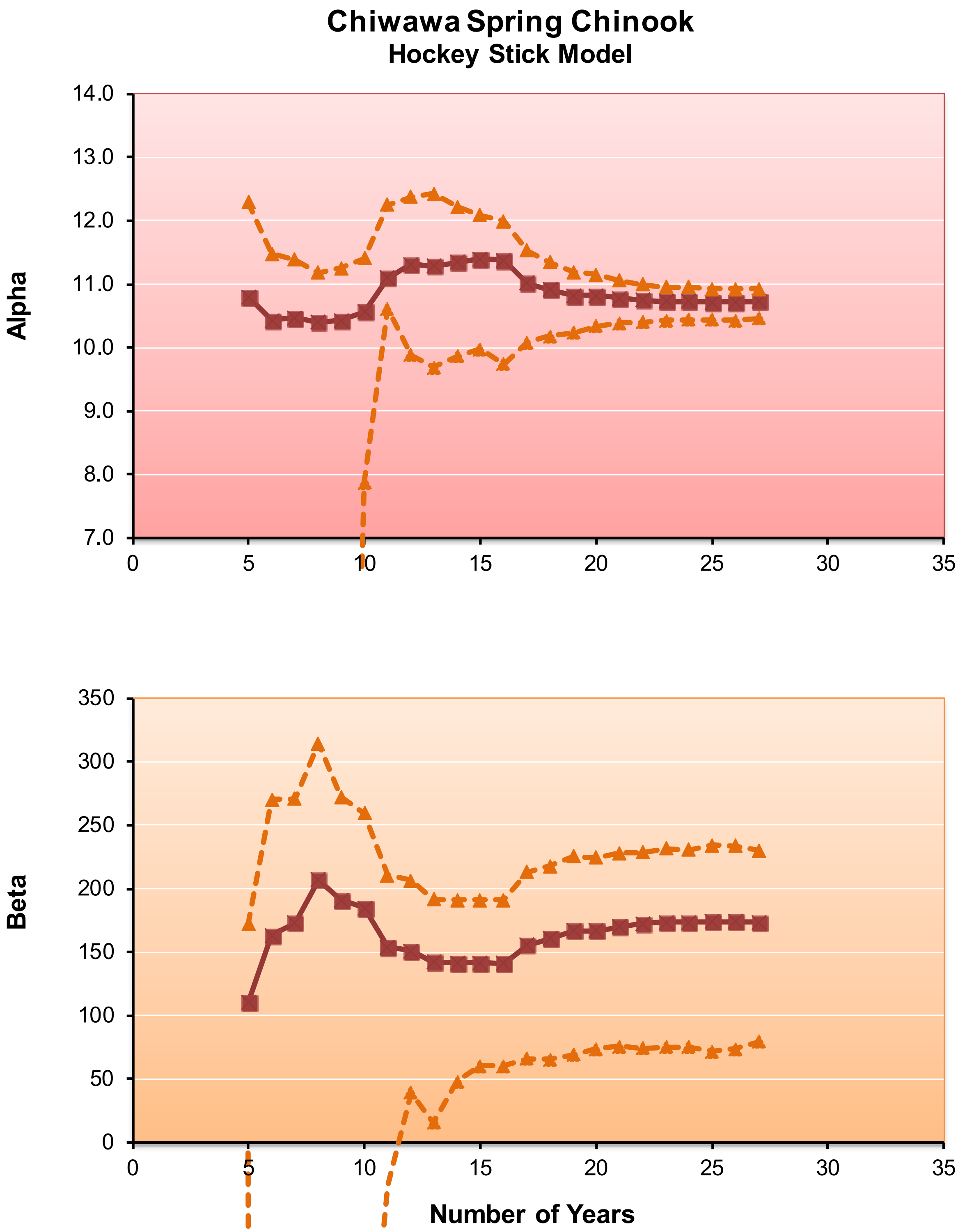


Figure 5.10. Time series of alpha and beta parameters and 95% confidence intervals for the smooth hockey stick model that was fit to Chiwawa spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

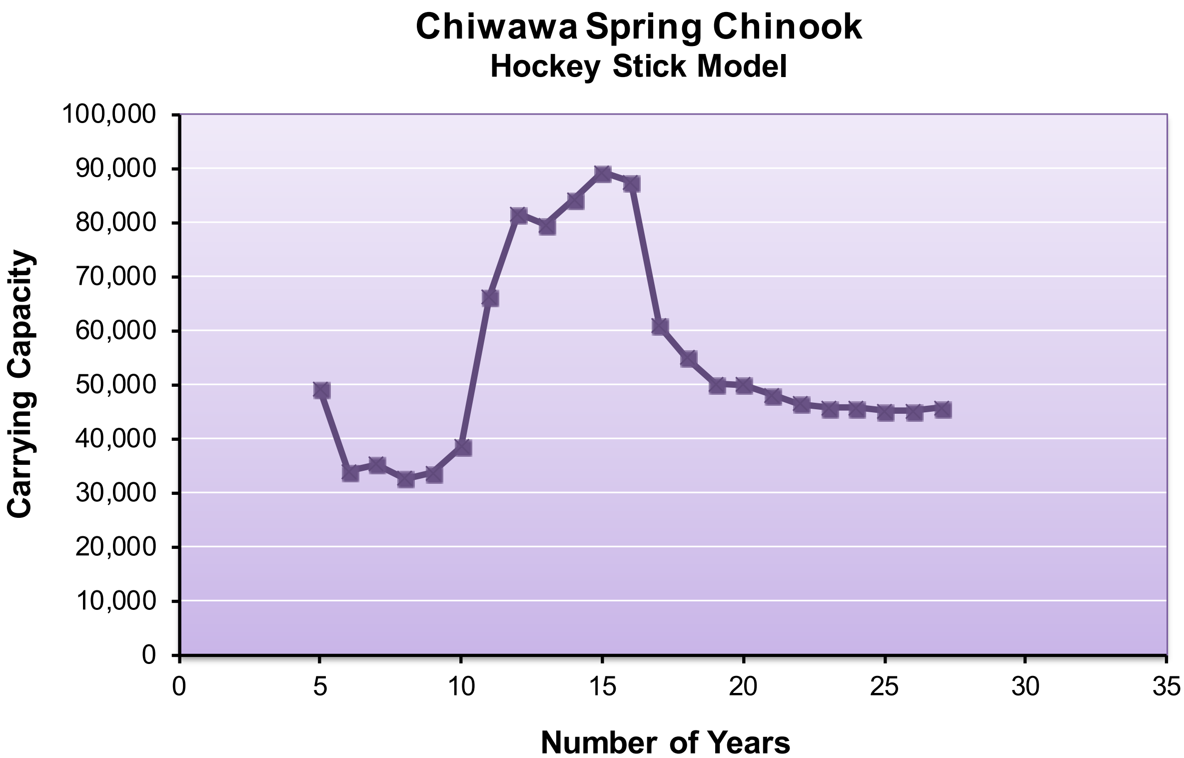


Figure 5.11. Time series of population carrying capacity estimates derived from fitting the smooth hockey stick model to Chiwawa spring Chinook smolt and spawning escapement data.

5.5 Spawning Surveys

Surveys for spring Chinook redds were conducted during the last week of July through September 2017 in the Chiwawa River (including Rock, Chikamin, and Phelps creeks), Nason Creek, Icicle Creek, Peshastin Creek (including Ingalls Creek), Upper Wenatchee River (including Chiwaukum Creek), Little Wenatchee River, and the White River (including the Napeequa River and Panther Creek).

Spawning escapement for spring Chinook was calculated as the total number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[18] Beginning with return year 2015, WDFW used the Gaussian area-under-the-curve (AUC) method (Millar et al. 2012) to estimate the number of redds within survey reaches (see Appendix J). The number of redds within each reach were then divided by the mean net error (ratio of observed redds to true number of redds) to estimate the "true" number of redds within each reach. The Mean net error was modeled based on covariates such as surveyor experience, channel complexity (mean thalweg CV), and observed redd density (number of redds per km).

[18] Expansion factor = (1 + (number of males/number of females)).

Redd Counts

A total of 367 spring Chinook redds were counted in the Wenatchee River basin in 2017 (Table 5.24). This is lower than the average of 670 redds counted during the period 1989-2016 in the Wenatchee River basin. Most spawning occurred in the Chiwawa River (60.5% or 222 redds) (Table 5.24; Figure 5.12). Nason Creek contained 18.5% (68 redds), Icicle Creek contained 10.9% (72 redds), White River contained 4.1% (15 redds), Little Wenatchee contained 2.7% (10 redds), the Upper Wenatchee River 2.5% (9 redds), and Peshastin Creek contained 0.8% (3 redds).

Table 5.24. Numbers of spring Chinook redds counted (not "true" estimates) within different streams or watersheds within the Wenatchee River basin, 1989-2017. WDFW began full implementation of adult management in 2014.

Sample year	Number of spring Chinook redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
1989	314	98	45	64	94	24	NS	**639**
1990	255	103	30	22	36	50	4	**500**
1991	104	67	18	21	41	40	1	**292**
1992	302	81	35	35	38	37	0	**528**
1993	106	223	61	66	86	53	5	**600**
1994	82	27	7	3	6	15	0	**140**
1995	13	7	0	2	1	9	0	**32**
1996	23	33	3	12	1	12	1	**85**
1997	82	55	8	15	15	33	1	**209**
1998	41	29	8	5	0	11	0	**94**
1999	34	8	3	1	2	6	0	**54**
2000	128	100	9	8	37	68	0	**350**
2001	1,078	374	74	104	218	88	173*	**2,109**
2002	345	294	42	42	64	245	107*	**1,139**
2003	111	83	12	15	24	18	60	**323**
2004	239	169	13	22	46	30	55	**574**
2005	333	193	64	86	143	8	3	**830**
2006	297	152	21	31	27	50	10	**588**
2007	283	101	22	20	12	17	11	**466**
2008	689	336	38	31	180	116	21	**1,411**
2009	421	167	39	54	5	32	15	**733**
2010	502	188	38	33	47	155	5	**968**
2011	492	170	30	20	12	122	26	**872**
2012	880	413	43	86	73	199	10	**1,704**
2013	714	212	51	54	17	107	4	**1,159**
2014	485	115	25	26	23	211	0	**885**
2015	543	85	28	70	55	132	10	**923**
2016	312	85	22	44	17	72	2	**554**

Sample year	Number of spring Chinook redds							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
2017	222	68	10	15	9	40	3	**367**
Average	***325***	***139***	***28***	***35***	***46***	***69***	***10***	***660***
Median	***297***	***101***	***25***	***26***	***27***	***40***	***3.5***	***574***

* Redd counts in Peshastin Creek in 2001 and 2002 were elevated because the U.S. Fish and Wildlife Service planted 487 and 350 spring Chinook adults, respectively, into the stream. These counts were not included in the average and median calculations.

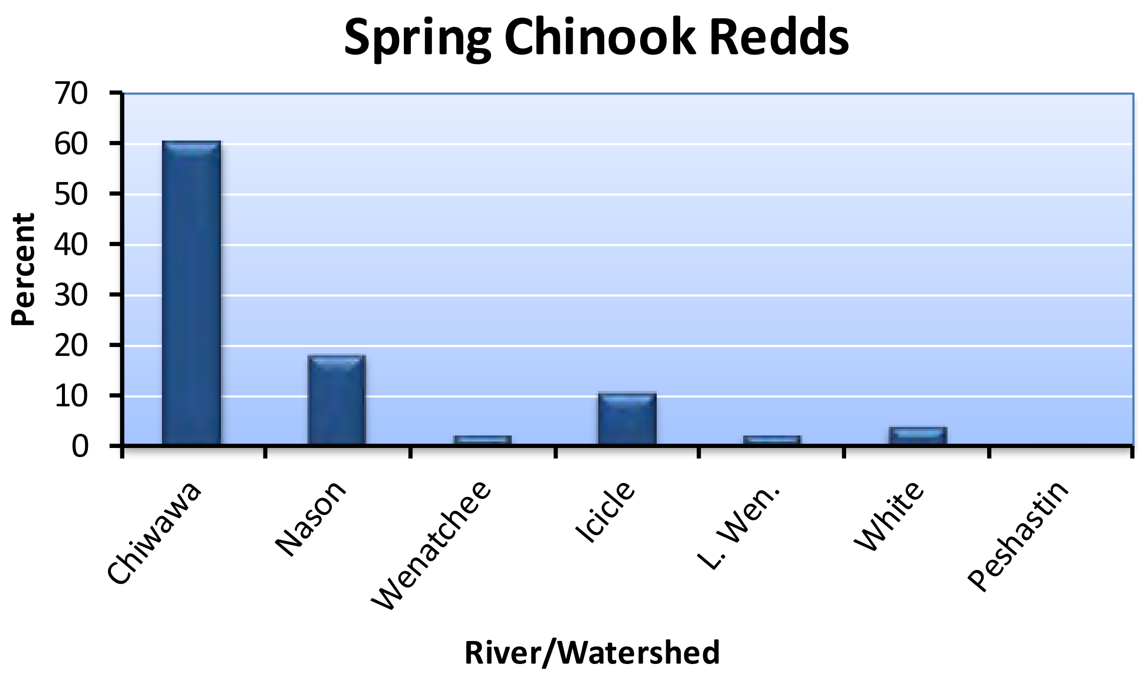


Figure 5.12. Percent of the total number of spring Chinook redds counted in different streams/watersheds within the Wenatchee River basin during August through September 2017.

As noted above, since 2015, WDFW has estimated the "true" number of redds within survey areas in the Wenatchee River basin using the Gaussian area-under-the-curve method. Based on three years of data, the average difference between the observed (counted) and true estimate is about 90 redds (Table 5.25).

Table 5.25. Comparison of the observed number and estimated "true" number of spring Chinook redds within different streams/watersheds within the Wenatchee River basin, 2015-2017.

Survey stream	Survey year					
	2015		2016		2017	
	Observed	Estimated	Observed	Estimated	Observed	Estimated
Chiwawa	543	607	312	354	222	254
Nason	85	103	85	100	68	87
Little Wenatchee	28	38	22	35	10	16

Survey stream	Survey year					
	2015		2016		2017	
	Observed	Estimated	Observed	Estimated	Observed	Estimated
White	70	91	44	53	15	19
Wenatchee	55	66	17	22	9	11
Peshastin	--	--	2	2	3	3
Icicle	--	--	72	72	40	40
Total	***781***	***905***	***554***	***638***	***367***	***430***

Redd Distribution

Spring Chinook redds were not evenly distributed among reaches within survey streams in 2017 (Table 5.26). Most of the spawning in the Chiwawa River basin occurred in Reaches 1 through 6. About 69% of the spawning in the Chiwawa River basin occurred in the lower two reaches (RKM 0.0-36.97; from the mouth to Rock Creek). Relatively few fish spawned in Rock and Chikamin creeks. The spatial distribution of redds in Nason Creek was weighted towards Reaches 1, 3, and 4 having 93% of the Nason Creek redds. In the Little Wenatchee River, about 94% of all spawning occurred in Reach 3 (RKM 9.2-14.0; Lost Creek to Falls). On the White River, 74% of the spawning occurred in Reach 3 (RKM 20.3-23.3; Napeequa River to Grasshopper Meadows). In the Wenatchee River about 27% of the fish spawned downstream from the mouth of the Chiwawa River, 45% spawned upstream from the mouth, and about 27% spawned in Chiwaukum Creek. In Icicle Creek, about 75% of spawning occurred in Reach 2 (RKM 4.9-6.7; Hatchery to Sleeping Lady). All the spawning in Peshastin Creek occurred downstream from the mouth of Scotty Creek.

Table 5.26. Numbers (both observed and estimated) and proportions of spring Chinook redds estimated within different streams/watersheds within the Wenatchee River basin during August through September 2017. NS = not surveyed. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Observed number of redds	Estimated number of redds	Proportion of estimated redds within stream/watershed
Chiwawa	Chiwawa 1 (C1)	44	52	0.20
	Chiwawa 2 (C2)	99	124	0.49
	Chiwawa 3 (C3)	7	7	0.03
	Chiwawa 4 (C4)	23	20	0.08
	Chiwawa 5 (C5)	17	14	0.06
	Chiwawa 6 (C6)	18	22	0.09
	Chiwawa 7 (C7)	1	2	0.01
	Phelps 1 (S1)	0	0	0.00
	Rock 1 (R1)	5	5	0.02
	Chikamin 1 (K1)	8	8	0.03
	Total	**222**	**254**	**1.00**
Nason	Nason 1 (N1)	17	27	0.31
	Nason 2 (N2)	7	6	0.07

Stream/watershed	Reach	Observed number of redds	Estimated number of redds	Proportion of estimated redds within stream/watershed
	Nason 3 (N3)	27	33	0.38
	Nason 4 (N4)	17	21	0.24
	Total	**68**	**87**	**1.00**
Little Wenatchee	Little Wen 1 (L1)	0	0	--
	Little Wen 2 (L2)	1	1	0.06
	Little Wen 3 (L3)	9	15	0.94
	Total	**10**	**16**	**1.00**
White	White 1 (H1)[a]	0	0	--
	White 2 (H2)	2	3	0.15
	White 3 (H3)	11	14	0.74
	White 4 (H4)	0	0	--
	Napeequa 1 (Q1)	2	2	0.11
	Panther 1 (T1)	0	0	--
	Total	**15**	**19**	**1.00**
Wenatchee River	Wen 9 (W9)	2	3	0.27
	Wen 10 (W10)	4	5	0.45
	Chiwaukum (A1)	3	3	0.27
	Total	**9**	**11**	**1.00**
Icicle	Icicle 1 (I1)	2	2	0.05
	Icicle 2 (I2)	30	30	0.75
	Icicle 3 (I3)	8	8	0.20
	Total	**40**	**40**	**1.00**
Peshastin	Peshastin 1 (P1)	2	2	0.67
	Peshastin 2 (P2)	1	1	0.33
	Ingalls (D1)	0	0	--
	Total	**3**	**3**	**1.00**
Grand Total		***367***	***430***	***1.00***

[a] Reach H1 of the White River was surveyed once during the peak of the season to verify that no spawning was occurring in the lower portion of the river.

Spawn Timing

Spring Chinook began spawning during the second week of August in Nason Creek and the third week of August in the Chiwawa River. Spawning began the fourth week of August in the Little Wenatchee River and Icicle Creek, and the last week of August in Peshastin Creek, White River, and the Wenatchee River (Figure 5.13). Spawning peaked the last week of August in the Chiwawa River, White River, Nason Creek, Icicle Creek, Little Wenatchee River, and Peshastin Creek. Spawning in the Wenatchee River peaked in September. Chinook completed spawning by the end of September.

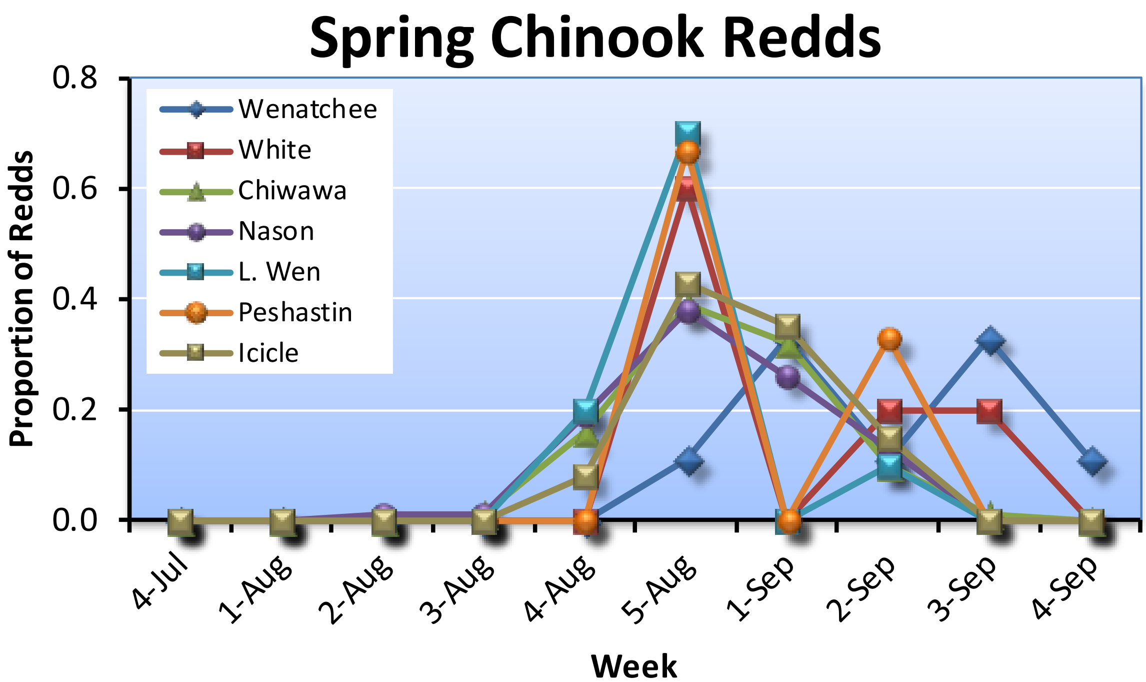


Figure 5.13. Proportion of spring Chinook redds counted during different weeks in different sampling streams within the Wenatchee River basin, August through September 2017.

Spawning Escapement

Spawning escapement for spring Chinook was calculated as the observed number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[19] The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2017 was 2.06 (based on sex ratios estimated at Tumwater Dam). The estimated fish per redd ratio for spring Chinook downstream from Tumwater (Icicle and Peshastin creeks) was 1.81 (derived from broodstock collected at the Leavenworth National Fish Hatchery). Multiplying these ratios by the number of redds counted in the Wenatchee River basin resulted in a total spawning escapement of 745 spring Chinook (Table 5.27). The Chiwawa River basin had the highest spawning escapement (457 Chinook), while Peshastin Creek had the lowest (5 Chinook).

Table 5.27. Number of observed redds, fish per redd ratios, and total spawning escapement for spring Chinook in the Wenatchee River basin, 2017. Spawning escapement was estimated as the product of redds times fish per redd.

Sampling area	Total number of redds	Fish/redd	Total spawning escapement*
Chiwawa	222	2.06	457
Nason	68	2.06	140
Upper Wenatchee River	9	2.06	19
Icicle	40	1.81	72
Little Wenatchee	10	2.06	21

[19] Expansion factor = (1 + (number of males/number of females)).

Sampling area	Total number of redds	Fish/redd	Total spawning escapement*
White	15	2.06	31
Peshastin	3	1.81	5
Total	***367***	***--***	***745***

* Spawning escapement estimate is based on total number of observed redds by stream. If escapement is calculated at the reach scale, then the total escapement may vary from what is shown here because of rounding errors.

The estimated total spawning escapement of 745 spring Chinook in 2017 was less than the overall average of 1,345 spring Chinook (Table 5.28). The escapement in the Chiwawa River basin in 2017 was 3.3 times the escapement in Nason Creek, the second most abundant escapement in the Wenatchee River basin (Table 5.28).

Table 5.28. Spawning escapements for spring Chinook in the Wenatchee River basin for return years 1989-2017; NA = not available.

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
1989	2.27	713	222	102	145	213	1.56	37	NA	**1,419**
1990	2.24	571	231	67	49	81	1.71	86	7	**1,053**
1991	2.33	242	156	42	49	96	1.73	69	2	**626**
1992	2.24	676	181	78	78	85	1.65	61	0	**1,135**
1993	2.20	233	491	134	145	189	1.66	88	8	**1,250**
1994	2.24	184	60	16	7	13	2.11	32	0	**295**
1995	2.51	33	18	0	5	3	2.01	18	0	**68**
1996	2.53	58	83	8	30	3	2.09	25	2	**195**
1997	2.22	182	122	18	33	33	1.69	56	2	**422**
1998	2.21	91	64	18	11	0	1.81	20	0	**195**
1999	2.77	94	22	8	3	6	2.06	12	0	**139**
2000	2.70	346	270	24	22	100	1.68	114	0	**830**
2001	1.60	1,725	598	118	166	349	1.72	151	298	**3,217**
2002	2.05	707	603	86	86	131	1.55	380	166	**1,965**
2003	2.43	270	202	29	36	58	1.93	35	116	**673**
2004[a]	3.56/3.00	851	507	39	66	138	1.76	53	97	**1,686**
2005	1.80	599	347	115	155	257	1.67	13	5	**1,484**
2006	1.78	529	271	37	55	48	1.68	84	17	**1,000**
2007	4.58	1,296	463	101	92	55	1.91	32	21	**2,035**
2008	1.68	1,158	565	64	52	302	1.78	206	37	**2,278**
2009	3.20	1,347	534	125	173	16	2.22	71	33	**2,299**
2010	2.18	1,094	410	83	72	102	1.56	242	8	**1,921**
2011	4.13	2,032	702	124	83	50	2.60	317	68	**3,139**
2012	1.68	1,478	694	72	144	123	1.60	318	16	**2,720**
2013	1.93	1,378	409	98	104	33	1.98	212	8	**2,133**
2014	2.06	999	237	52	54	47	1.93	407	0	**1,600**
2015	1.78	967	151	50	125	98	1.87	247	19	**1,533**
2016	1.83	571	156	40	81	31	1.81	130	4	**953**

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
2017	2.06	457	140	21	31	19	1.81	72	5	**745**
Average	--	***720***	***307***	***61***	***74***	***92***	--	***124***	***34***	***1345***
Median	--	***599***	***237***	***52***	***66***	***58***	--	***72***	***7.5***	***1250***

[a] In 2004, the fish/redd expansion estimate of 3.56 was applied to the Chiwawa River only and 3.00 fish/redd was applied to the rest of the upper basin.

5.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September 2017 in the Chiwawa River (including Rock, Chikamin, and Phelps creeks), Nason Creek, Icicle Creek, Peshastin Creek (including Ingalls Creek), Upper Wenatchee River (including Chiwaukum Creek), Little Wenatchee River, and White River (including the Napeequa River and Panther Creek).

Number sampled

A total of 260 spring Chinook carcasses were sampled during August through September in the Wenatchee River basin (Table 5.29). Most were sampled in the Chiwawa River basin (54% or 140 carcasses) and Nason Creek (30% or 78 carcasses) (Figure 5.14). A total of 22 carcasses were sampled in Icicle Creek, 5 in the Wenatchee River, 9 in the White River, 3 in the Little Wenatchee River, and 3 in Peshastin Creek.

Table 5.29. Numbers of spring Chinook carcasses sampled within different streams/watersheds within the Wenatchee River basin, 1996-2017.

Survey year	Number of spring Chinook carcasses							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
1996	22	3	0	2	0	1	0	**28**
1997	17	42	3	8	1	28	1	**100**
1998	24	25	3	2	1	6	0	**61**
1999	15	5	0	0	2	1	0	**23**
2000	122	110	8	1	37	52	0	**330**
2001	763	388	68	81	213	163	63	**1,739**
2002	210	292	30	25	34	91	65	**747**
2003	70	100	8	8	11	37	64	**298**
2004	178	186	1	13	29	16	40	**463**
2005	391	217	48	52	120	2	0	**830**
2006	241	190	13	25	15	7	0	**491**
2007	250	201	16	13	24	15	6	**525**
2008	386	243	15	13	94	67	5	**823**
2009	240	128	20	20	1	67	2	**478**
2010	192	141	7	11	29	39	2	**421**
2011	177	98	7	4	3	40	3	**332**

Survey year	Number of spring Chinook carcasses							
	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Icicle	Peshastin	Total
2012	390	332	24	21	23	61	3	**854**
2013	396	142	20	22	8	28	1	**671**
2014	320	68	15	8	19	44	0	**474**
2015	275	43	12	25	25	67	3	**450**
2016	211	95	5	13	13*	25	0	**362**
2017	140	78	3	9	5	22	3	**260**
Average	***229***	***142***	***15***	***17***	***32***	***40***	***12***	***489***
Median	***211***	***119***	***10***	***13***	***17***	***32.5***	***2***	***457***

* The number of carcasses sampled in the Wenatchee River in 2016 include two recovered in reach (W6) just downstream from the mouth of Icicle Creek.

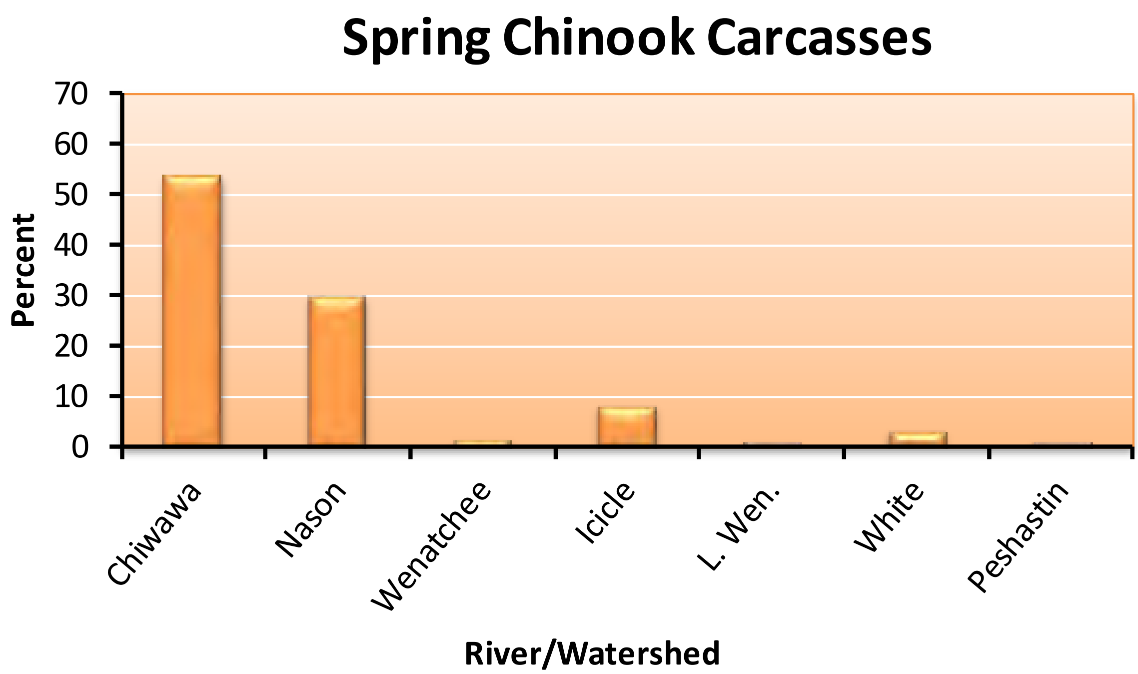


Figure 5.14. Percent of the total number of spring Chinook carcasses sampled in different streams/watersheds within the Wenatchee River basin during August through September 2017.

Carcass Distribution and Origin

Spring Chinook carcasses were not evenly distributed among reaches within survey streams in 2017 (Table 5.30). Most of the carcasses (70%) in the Chiwawa River basin occurred in Reaches 1 and 2 (downstream from Rock Creek). In Nason Creek, most carcasses (42%) were collected in Reach 3 and the fewest (9%) in Reach 1. Most carcasses in the Little Wenatchee River were sampled in Reach 3 (Lost Creek to Rainy Creek). On the White River, most (67%) occurred in Reach 3 (Napeequa River to Grasshopper Meadows). On the Wenatchee River, 40% of the carcasses were found upstream from the confluence of the Chiwawa River and 60% were found downstream from the confluence. Most of the carcasses in Icicle Creek (55%) were found in Reach 1 (Mouth to Hatchery). Three carcasses were found in Peshastin Creek (Mouth to Scotty Creek).

Table 5.30. Numbers and proportions of carcasses sampled within different streams/watersheds within the Wenatchee River basin during August through September 2017. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of carcasses	Proportion of carcasses within stream/watershed
Chiwawa	Chiwawa 1 (C1)	36	0.26
	Chiwawa 2 (C2)	67	0.48
	Chiwawa 3 (C3)	3	0.02
	Chiwawa 4 (C4)	7	0.05
	Chiwawa 5 (C5)	8	0.06
	Chiwawa 6 (C6)	8	0.06
	Chiwawa 7 (C7)	0	0.00
	Phelps 1 (S1)	0	0.00
	Rock 1 (R1)	3	0.02
	Chikamin 1 (K1)	8	0.06
	Total	**140**	**1.00**
Nason	Nason 1 (N1)	7	0.09
	Nason 2 (N2)	25	0.32
	Nason 3 (N3)	33	0.42
	Nason 4 (N4)	13	0.17
	Total	**78**	**1.00**
Little Wenatchee	Little Wen 1 (L1)	--	--
	Little Wen 2 (L2)	0	0.00
	Little Wen 3 (L3)	3	1.00
	Total	**3**	**1.00**
White	White 1 (H1)	0	0.00
	White 2 (H2)	2	0.22
	White 3 (H3)	6	0.67
	White 4 (H4)	0	0.00
	Napeequa 1 (Q1)	1	0.11
	Panther 1 (T1)	0	0.00
	Total	**9**	**1.00**
Wenatchee River	Wen 9 (W9)	3	0.60
	Wen 10 (W10)	2	0.40
	Chiwaukum 1 (U1)	0	0.00
	Total	**5**	**1.00**
Icicle	Icicle 1 (I1)	12	0.55
	Icicle 2 (I2)	7	0.32
	Icicle 3 (I3)	3	0.14

Stream/watershed	Reach	Number of carcasses	Proportion of carcasses within stream/watershed
	Total	**22**	**1.00**
Peshastin	Peshastin 1 (P1)	2	0.67
	Peshastin 2 (P2)	1	0.33
	Ingalls (D1)	0	0.00
	Total	**3**	**0.00**
Grand Total		**260**	**1.00**

Origin was determined for the 140 carcasses sampled in the Chiwawa River basin in 2017. Of those sampled in the Chiwawa River basin, 66% were hatchery fish (Table 5.31). In the Chiwawa River basin, the spatial distribution of hatchery and wild fish was not equal (Table 5.31). A larger percentage of hatchery fish were found in the lower reaches (C1 and C2; i.e., Mouth to Rock Creek). This general trend was also apparent in the pooled data (Figure 5.15).

Table 5.31. Numbers of wild and hatchery spring Chinook carcasses sampled within different reaches in the Chiwawa River basin, 1993-2017. Numbers represent recovered carcasses that had definitive origins. See Table 2.8 for description of survey reaches.

Survey year	Origin	Survey Reach									Total
		C-1	C-2	C-3	C-4	C-5	C-6	C-7	Chikamin	Rock	
1993	Wild	0	0	0	0	0	0	--	0	0	**0**
	Hatchery	1	0	0	0	0	0	--	0	0	**1**
1994	Wild	0	6	0	2	0	2	--	0	0	**10**
	Hatchery	1	1	0	2	0	0	--	0	0	**4**
1995	Wild	0	0	0	0	0	0	--	0	0	**0**
	Hatchery	2	3	0	1	0	0	--	0	0	**6**
1996	Wild	13	1	1	1	0	0	--	0	0	**16**
	Hatchery	6	0	0	0	0	0	--	0	0	**6**
1997	Wild	5	2	0	1	0	0	--	0	0	**8**
	Hatchery	3	1	0	0	0	1	--	1	3	**9**
1998	Wild	0	3	6	1	2	4	--	0	0	**16**
	Hatchery	1	3	2	0	1	1	--	0	0	**8**
1999	Wild	1	8	0	5	0	0	--	0	0	**14**
	Hatchery	0	0	0	0	1	0	--	0	0	**1**
2000	Wild	29	29	1	1	1	1	--	0	0	**62**
	Hatchery	42	12	0	0	0	2	--	0	0	**56**
2001	Wild	27	60	15	43	16	21	--	1	3	**186**
	Hatchery	164	284	19	58	14	21	--	8	0	**568**
2002	Wild	22	15	10	6	9	7	--	1	0	**70**
	Hatchery	46	41	12	5	1	15	--	15	4	**139**
2003	Wild	7	13	0	12	4	2	--	0	0	**38**
	Hatchery	14	14	0	3	1	0	--	0	0	**32**
2004	Wild	25	50	2	12	7	2	--	0	1	**99**
	Hatchery	48	21	1	1	1	4	--	0	2	**78**

Survey year	Origin	Survey Reach									Total
		C-1	C-2	C-3	C-4	C-5	C-6	C-7	Chikamin	Rock	
2005	Wild	18	36	3	5	3	2	--	0	0	**67**
	Hatchery	170	132	7	7	4	3	--	0	1	**324**
2006	Wild	10	17	2	8	4	3	--	1	0	**45**
	Hatchery	84	75	5	7	6	13	--	3	3	**196**
2007	Wild	3	15	3	4	2	2	--	0	0	**29**
	Hatchery	42	118	15	14	18	12	--	2	0	**221**
2008	Wild	4	23	0	4	4	8	--	0	0	**43**
	Hatchery	174	122	2	9	15	15	--	4	1	**342**
2009	Wild	3	21	4	8	4	1	--	0	3	**44**
	Hatchery	89	70	6	14	7	5	--	0	5	**196**
2010	Wild	4	30	7	8	10	3	--	0	0	**62**
	Hatchery	64	35	2	10	7	5	--	0	5	**128**
2011	Wild	8	26	10	6	8	6	--	0	1	**65**
	Hatchery	43	40	4	5	5	10	--	1	4	**112**
2012	Wild	11	74	6	21	13	18	0	0	3	**146**
	Hatchery	94	91	9	13	16	16	0	0	6	**245**
2013	Wild	8	38	7	21	16	14	1	0	3	**108**
	Hatchery	101	112	19	23	13	15	0	5	3	**291**
2014	Wild	18	77	9	28	19	21	0	0	0	**172**
	Hatchery	64	48	6	10	6	9	1	2	2	**148**
2015	Wild	14	37	6	12	12	13	0	0	0	**94**
	Hatchery	65	89	7	9	6	5	0	0	0	**181**
2016	Wild	13	73	8	18	15	10	0	2	0	**139**
	Hatchery	25	37	1	4	2	1	1	0	0	**71**
2017	Wild	5	31	2	4	5	1	0	0	0	**48**
	Hatchery	31	36	1	3	3	7	0	8	3	**92**
Average	***Wild***	***10***	***27***	***4***	***9***	***6***	***6***	***0***	***0***	***1***	***63***
	Hatchery	***55***	***55***	***5***	***8***	***5***	***6***	***0***	***2***	***2***	***138***
Median	***Wild***	***8***	***23***	***3***	***6***	***4***	***2***	***0***	***0***	***0***	***48***
	Hatchery	***43***	***37***	***2***	***5***	***3***	***5***	***0***	***0***	***1***	***112***

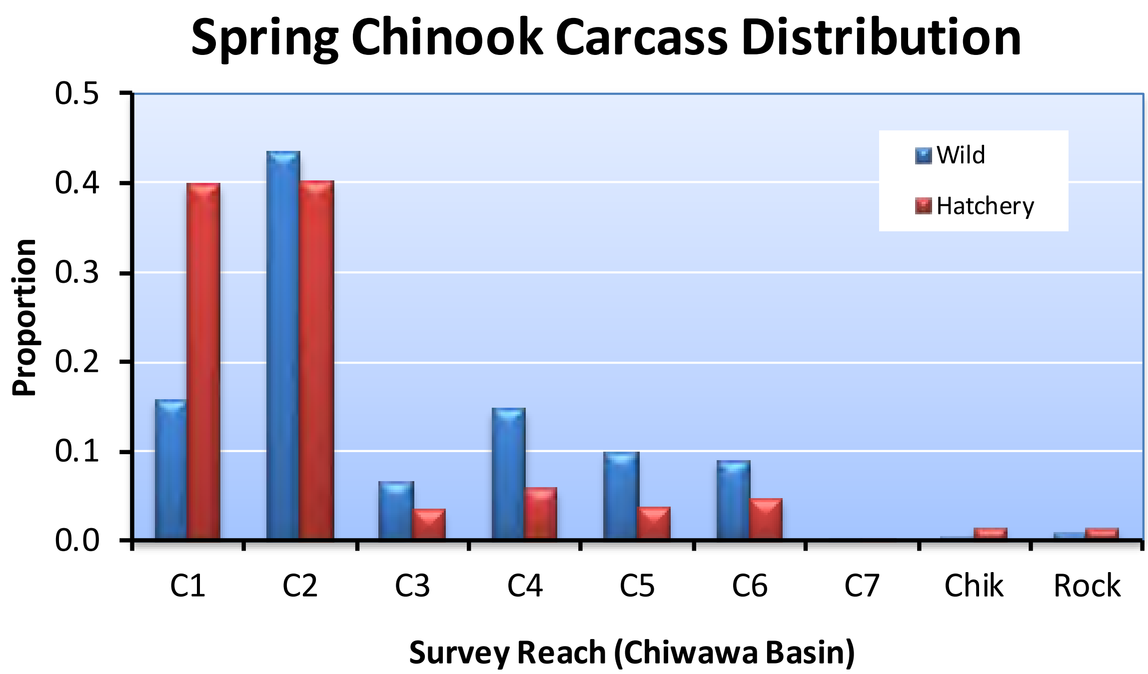


Figure 5.15. Distribution of wild and hatchery produced carcasses in different reaches in the Chiwawa River basin, 1993-2017; Chik = Chikamin Creek and Rock = Rock Creek. Reach codes are described in Table 2.8.

Sampling Rate

Overall, 35% of the estimated total spawning escapement of spring Chinook in the Wenatchee River basin was sampled in 2017 (Table 5.32). Sampling rates among streams/watershed varied from 0 to 61%.

Table 5.32. Number of redds and carcasses, total spawning escapement, and sampling rates for spring Chinook salmon in the Wenatchee River basin, 2017.

Sampling area	Total number of observed redds	Total number of carcasses	Total spawning escapement	Sampling rate
Chiwawa	222	140	457	0.31
Nason	68	78	140	0.56
Upper Wenatchee	9	5	19	0.26
Icicle	40	22	72	0.31
Little Wenatchee	10	3	21	0.14
White	15	9	31	0.29
Peshastin	3	3	5	0.60
Total	***367***	***260***	***745***	***0.35***

Length Data

Mean lengths (POH, cm) of male and female spring Chinook carcasses sampled during surveys in the Wenatchee River basin in 2017 are provided in Table 5.33. The average size of males and females sampled in the Wenatchee River basin was 62 cm and 63 cm, respectively.

Table 5.33. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female spring Chinook carcasses sampled in different streams/watersheds in the Wenatchee River basin, 2017.

Stream/watershed	Mean lengths (cm)	
	Male	Female
Chiwawa	65 (8.6)	63 (5.3)
Nason	59 (9.7)	63 (5.9)
Upper Wenatchee	0	64 (4.4)
Icicle	59 (9.8)	65 (5.1)
Little Wenatchee	68 (9.9)	60 (--)
White	69 (0.7)	63 (2.5)
Peshastin	0	58 (3.2)
Total	***62 (9.4)***	***63 (5.3)***

5.7 Life History Monitoring

Life history characteristics of spring Chinook were assessed by examining carcasses on spawning grounds and fish collected at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

In 2017, there was a small difference in migration timing of hatchery and wild spring Chinook past Tumwater Dam (Table 5.34a and b; Figure 5.16). On average, hatchery fish arrived at the dam later than did wild fish but ended their migration earlier than did wild fish. This same pattern was also observed in the overall average. Most hatchery and wild spring Chinook migrated upstream past Tumwater Dam during June and July (Figure 5.16).

Table 5.34a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2017. The average Julian day and date are also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
1998	Wild	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	49
	Hatchery	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	25
1999	Wild	192	11-Jul	207	26-Jul	224	12-Aug	207	26-Jul	173
	Hatchery	200	19-Jul	211	30-Jul	229	17-Aug	213	1-Aug	25
2000	Wild	171	19-Jun	186	4-Jul	194	12-Jul	184	2-Jul	651

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
	Hatchery	179	27-Jun	189	7-Jul	201	19-Jul	190	8-Jul	357
2001	Wild	154	3-Jun	166	15-Jun	185	4-Jul	167	16-Jun	2,073
	Hatchery	157	6-Jun	169	18-Jun	185	4-Jul	170	19-Jun	4,244
2002	Wild	174	23-Jun	189	8-Jul	204	23-Jul	189	8-Jul	1,033
	Hatchery	178	27-Jun	189	8-Jul	199	18-Jul	189	8-Jul	1,363
2003	Wild	162	11-Jun	181	30-Jun	200	19-Jul	181	30-Jun	919
	Hatchery	157	6-Jun	179	28-Jun	192	11-Jul	178	27-Jun	423
2004	Wild	156	4-Jun	172	20-Jun	189	7-Jul	172	20-Jun	969
	Hatchery	161	9-Jun	177	25-Jun	189	7-Jul	177	25-Jun	1,295
2005	Wild	153	2-Jun	172	21-Jun	193	12-Jul	173	22-Jun	1,038
	Hatchery	153	2-Jun	173	22-Jun	187	6-Jul	172	21-Jun	2,808
2006	Wild	177	26-Jun	184	3-Jul	193	12-Jul	185	4-Jul	577
	Hatchery	178	27-Jun	185	4-Jul	194	13-Jul	186	5-Jul	1601
2007	Wild	169	18-Jun	185	4-Jul	203	22-Jul	185	4-Jul	351
	Hatchery	174	23-Jun	192	11-Jul	209	28-Jul	192	11-Jul	3,232
2008	Wild	173	21-Jun	188	6-Jul	209	27-Jul	189	7-Jul	634
	Hatchery	177	25-Jun	193	11-Jul	210	28-Jul	193	11-Jul	5,368
2009	Wild	174	23-Jun	186	5-Jul	201	20-Jul	187	6-Jul	1,008
	Hatchery	175	24-Jun	187	6-Jul	202	21-Jul	188	7-Jul	4,106
2010	Wild	173	22-Jun	190	9-Jul	214	2-Aug	191	10-Jul	977
	Hatchery	180	29-Jun	194	13-Jul	213	1-Aug	195	14-Jul	4,450
2011	Wild	183	2-Jul	198	17-Jul	213	1-Aug	198	17-Jul	1,433
	Hatchery	187	6-Jul	200	19-Jul	210	29-Jul	199	18-Jul	4,707
2012	Wild	180	28-Jun	191	9-Jul	205	23-Jul	192	10-Jul	1,482
	Hatchery	182	30-Jun	194	12-Jul	206	24-Jul	194	12-Jul	4,449
2013	Wild	163	12-Jun	182	1-Jul	199	18-Jul	183	2-Jul	1,106
	Hatchery	164	13-Jun	181	30-Jun	195	14-Jul	181	30-Jun	3,681
2014	Wild	171	20-Jun	188	7-Jul	202	21-Jul	187	6-Jul	1,329
	Hatchery	167	16-Jun	182	1-Jul	195	14-Jul	181	30-Jun	2,510
2015	Wild	150	30-May	170	19-Jun	184	3-Jul	170	19-Jun	1,370
	Hatchery	148	28-May	168	17-Jun	180	29-Jun	167	16-Jun	1,773
2016	Wild	158	6-Jun	180	28-Jun	200	18-Jul	181	29-Jun	1,252
	Hatchery	160	8-Jun	179	27-Jun	191	9-Jul	178	26-Jun	1,284
2017	Wild	175	24-Jun	184	3-Jul	195	14-Jul	184	3-Jul	483
	Hatchery	177	26-Jun	185	4-Jul	196	15-Jul	187	6-Jul	1,035
Average	Wild	***168***		***183***		***198***		***183***		***945***
	Hatchery	***171***		***184***		***197***		***184***		***2,437***
Median	Wild	***171***		***185***		***200***		***185***		***993***
	Hatchery	***175***		***185***		***196***		***187***		***2,142***

Table 5.34b. The week that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2017. The average week is also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
1998	Wild	23	23	23	23	49
	Hatchery	23	23	23	23	25
1999	Wild	28	30	32	30	173
	Hatchery	29	31	34	31	25
2000	Wild	24	27	27	27	651
	Hatchery	26	27	29	28	357
2001	Wild	22	24	27	24	2,073
	Hatchery	23	25	27	25	4,244
2002	Wild	25	27	30	27	1,033
	Hatchery	26	27	29	27	1,363
2003	Wild	24	26	29	26	919
	Hatchery	23	26	28	26	423
2004	Wild	23	25	27	25	969
	Hatchery	23	26	27	26	1,295
2005	Wild	22	25	28	25	1,038
	Hatchery	22	25	27	25	2,808
2006	Wild	26	27	28	27	577
	Hatchery	26	27	28	27	1,601
2007	Wild	25	27	29	27	351
	Hatchery	25	28	30	28	3,232
2008	Wild	25	27	30	27	634
	Hatchery	26	28	30	28	5,368
2009	Wild	25	27	29	27	1,008
	Hatchery	25	27	29	27	4,106
2010	Wild	25	28	31	28	977
	Hatchery	26	28	31	28	4,450
2011	Wild	27	29	31	29	1,433
	Hatchery	27	29	30	29	4,707
2012	Wild	26	28	30	28	1,482
	Hatchery	26	28	30	28	4,449
2013	Wild	24	26	29	27	1,106
	Hatchery	24	26	28	26	3,681
2014	Wild	25	27	29	27	1,329
	Hatchery	24	26	28	26	2,510

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2015	Wild	22	25	27	25	1,370
	Hatchery	22	24	26	24	1,773
2016	Wild	23	26	29	26	1,252
	Hatchery	23	26	28	26	1,284
2017	Wild	25	27	28	27	483
	Hatchery	26	27	28	27	1,035
Average	Wild	***24***	***27***	***29***	***27***	***970***
	Hatchery	***25***	***27***	***29***	***27***	***2,511***
Median	Wild	***25***	***27***	***29***	***27***	***1,008***
	Hatchery	***25***	***27***	***28***	***27***	***2,510***

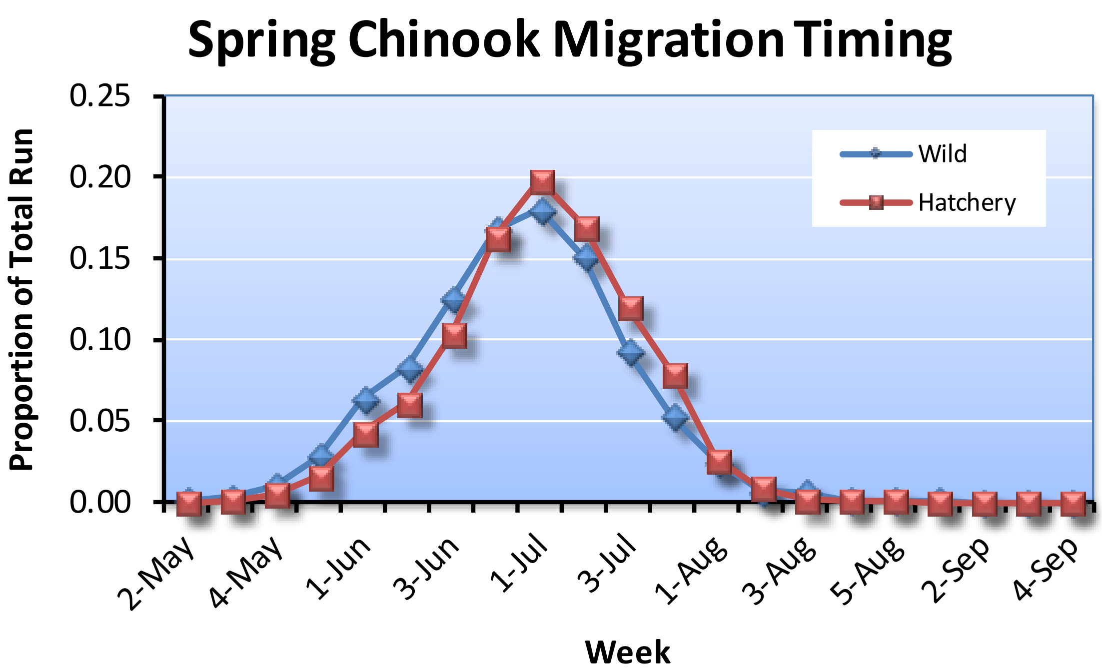


Figure 5.16. Proportion of wild and hatchery spring Chinook observed (using video) passing Tumwater Dam each week during their migration period May through September; data were pooled over survey years 1998-2017.

Age at Maturity

Most of the wild and hatchery spring Chinook sampled during the period 1994-2017 in the Chiwawa River basin were age-4 fish (total age) (Table 5.35; Figure 5.17). On average, hatchery fish made up a higher percentage of age-3 Chinook than did wild fish. In contrast, a higher proportion of age-5 wild fish returned than did age-5 hatchery fish. Thus, wild fish tended to return at an older age than hatchery fish.

Table 5.35. Proportions of wild and hatchery spring Chinook of different ages (total age) sampled on spawning grounds in the Chiwawa River basin, 1994-2017.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
1994	Wild	0.00	0.00	0.33	0.67	0.00	9
	Hatchery	0.00	0.20	0.00	0.80	0.00	5
1995	Wild	0.00	0.00	0.00	0.00	0.00	0
	Hatchery	0.00	0.00	1.00	0.00	0.00	5
1996	Wild	0.00	0.36	0.64	0.00	0.00	14
	Hatchery	0.00	0.83	0.17	0.00	0.00	6
1997	Wild	0.00	0.00	0.75	0.25	0.00	8
	Hatchery	0.00	0.00	1.00	0.00	0.00	9
1998	Wild	0.00	0.00	0.00	1.00	0.00	15
	Hatchery	0.00	0.00	0.13	0.88	0.00	8
1999	Wild	0.00	0.07	0.50	0.43	0.00	14
	Hatchery	0.00	0.00	0.00	1.00	0.00	1
2000	Wild	0.00	0.02	0.95	0.04	0.00	56
	Hatchery	0.00	0.50	0.50	0.00	0.00	52
2001	Wild	0.00	0.01	0.95	0.04	0.00	176
	Hatchery	0.00	0.02	0.98	0.00	0.00	571
2002	Wild	0.00	0.00	0.56	0.44	0.00	54
	Hatchery	0.00	0.00	0.91	0.09	0.00	129
2003	Wild	0.00	0.08	0.00	0.92	0.00	36
	Hatchery	0.00	0.19	0.03	0.78	0.00	32
2004	Wild	0.00	0.05	0.94	0.01	0.00	99
	Hatchery	0.00	0.42	0.58	0.00	0.00	78
2005	Wild	0.00	0.02	0.78	0.21	0.00	67
	Hatchery	0.00	0.04	0.96	0.00	0.00	324
2006	Wild	0.02	0.02	0.51	0.44	0.00	45
	Hatchery	0.01	0.04	0.78	0.18	0.00	196
2007	Wild	0.00	0.10	0.24	0.67	0.00	29
	Hatchery	0.00	0.35	0.59	0.06	0.00	221
2008	Wild	0.02	0.02	0.81	0.14	0.00	43
	Hatchery	0.00	0.07	0.89	0.05	0.00	340
2009	Wild	0.00	0.09	0.86	0.05	0.00	44
	Hatchery	0.00	0.24	0.75	0.02	0.00	196
2010	Wild	0.00	0.00	0.90	0.10	0.00	63
	Hatchery	0.00	0.07	0.91	0.02	0.00	127
2011	Wild	0.00	0.08	0.38	0.54	0.00	65
	Hatchery	0.00	0.26	0.45	0.30	0.00	112

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2012	Wild	0.00	0.01	0.80	0.19	0.00	141
	Hatchery	0.00	0.03	0.96	0.02	0.00	243
2013	Wild	0.00	0.09	0.60	0.31	0.00	105
	Hatchery	0.00	0.13	0.78	0.09	0.00	275
2014	Wild	0.00	0.04	0.89	0.07	0.00	169
	Hatchery	0.00	0.08	0.90	0.02	0.00	148
2015	Wild	0.00	0.01	0.83	0.16	0.00	96
	Hatchery	0.00	0.06	0.93	0.01	0.00	185
2016	Wild	0.00	0.04	0.67	0.29	0.00	138
	Hatchery	0.00	0.04	0.80	0.16	0.00	71
2017	Wild	0.00	0.02	0.65	0.33	0.00	45
	Hatchery	0.00	0.03	0.91	0.06	0.00	88
Average	***Wild***	***0.00***	***0.04***	***0.74***	***0.22***	***0.00***	***64***
	Hatchery	***0.00***	***0.11***	***0.83***	***0.06***	***0.00***	***143***
Median	***Wild***	***0.00***	***0.03***	***0.70***	***0.28***	***0.00***	***50***
	Hatchery	***0.00***	***0.08***	***0.89***	***0.04***	***0.00***	***120***

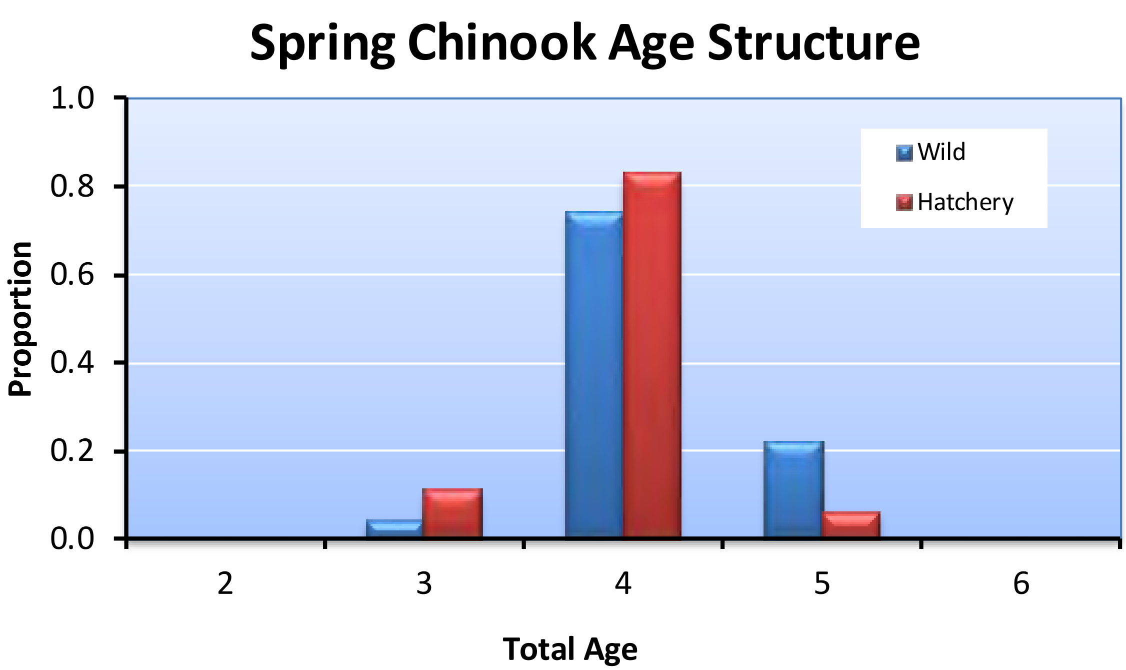


Figure 5.17. Proportions of wild and hatchery spring Chinook of different total ages sampled at the Chiwawa Weir and on spawning grounds in the Chiwawa River basin for the combined years 1994-2017.

Size at Maturity

On average, hatchery and wild spring Chinook of a given age differed slightly in length (Table 5.36). Differences were usually no more than 4 cm between hatchery and wild fish of the same age.

Table 5.36. Mean lengths (POH in cm; ±1SD) and sample sizes (in parentheses) of different ages (total age) of male and female spring Chinook of wild and hatchery-origin sampled in the Chiwawa River basin, 1994-2017. Return years 2004-2017 include carcasses and live fish PIT-tag detections. In addition, 2005 and 2006 include fish released at the weir.

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
1994	3				43 ±0 (1)
	4			62 ±3 (3)	
	5	76 ±0 (1)		73 ±2 (5)	
	6				
1995	3				
	4		61 ±5 (5)		
	5				
	6				
1996	3	45 ±3 (5)	49 ±7 (10)		
	4	69 ±4 (6)	69 ±0 (1)	67 ±8 (2)	
	5				
	6				
1997	3				
	4	61 ±1 (2)	68 ±0 (1)	67 ±5 (3)	63 ±3 (8)
	5	67 ±5 (2)			
	6				
1998	3				
	4				54 ±0 (1)
	5	77 ±7 (8)	75 ±4 (4)	74 ±4 (7)	76 ±4 (3)
	6				
1999	3	44 ±0 (1)			
	4	61 ±0 (1)		64 ±3 (6)	
	5	76 ±5 (3)		72 ±5 (3)	66 ±0 (1)
	6				
2000	3		46 ±3 (17)		50 ±7 (3)
	4	60 ±8 (23)	62 ±5 (5)	61 ±5 (26)	62 ±3 (20)
	5	77 ±1 (2)			
	6				
2001	3	37 ±0 (1)	42 ±4 (11)	41 ±0 (1)	60 ±0 (1)
	4	63 ±5 (57)	65 ±5 (151)	62 ±4 (110)	63 ±4 (407)
	5	75 ±5 (2)	83 ±0 (1)	76 ±1 (5)	
	6				

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
2002	3				
	4	64 ±4 (14)	66 ±5 (46)	60 ±4 (15)	63 ±4 (71)
	5	80 ±6 (13)	75 ±5 (4)	72 ±3 (12)	73 ±6 (6)
	6				
2003	3	45 ±2 (3)	45 ±1 (6)		
	4		63 ±0 (1)		
	5	78 ±5 (12)	74 ±8 (11)	75 ±3 (19)	72 ±5 (14)
	6				
2004	3	42 ±3 (3)	44 ±5 (33)		
	4	63 ±7 (60)	66 ±5 (9)	63 ±4 (59)	63 ±6 (36)
	5			74 ±0 (1)	
	6				
2005	3		43 ±5 (48)		
	4	61 ±5 (32)	65 ±5 (224)	62 ±4 (61)	62 ±4 (382)
	5	74 ±5 (6)	54±0 (1)	71 ±3 (11)	
	6				
2006	3	45 ±3 (3)	43 ±3 (73)		
	4	64 ±3 (7)	62 ±6 (91)	63 ±5 (41)	60 ±4 (227)
	5	74 ±6 (8)	75 ±6 (17)	71 ±4 (26)	71± 4 (37)
	6				
2007	3	39 ±3 (5)	45 ±6 (90)		50 ±3 (7)
	4	60 ±4 (4)	66 ±5 (45)	61 ±4 (10)	63 ±3 (142)
	5	78 ±6 (15)	76 ±5 (8)	74 ±3 (20)	73 ±5 (12)
	6				
2008	3	43 ±0 (1)	44 ±5 (22)		
	4	65 ±4 (9)	64 ±6 (73)	62 ±4 (26)	64 ±4 (229)
	5	65 ±5 (3)	79 ±5 (10)	73 ±3 (4)	72 ±3 (5)
	6				
2009	3	45 ±3 (8)	46 ±6 (68)		65 ±0 (1)
	4	64 ±4 (38)	65 ±5 (136)	63 ±3 (67)	64 ±4 (202)
	5	79 ±0 (1)		72 ±2 (4)	71 ±4 (10)
	6				
2010	3		46 ±4 (11)		65 ±3 (3)
	4	64 ±5 (31)	66 ±5 (74)	64 ±4 (82)	65 ±3 (196)
	5	77 ±4 (6)		73 ±5 (9)	73 ±6 (4)
	6				
2011	3	43 ±4 (133)	44 ±4 (1374)		53 ±4 (17)
	4	62 ±5 (137)	64 ±5 (169)	64 ±3 (94)	64 ±3 (258)
	5	80 ±5 (78)	79 ±4 (85)	75 ±3 (116)	75 ±3 (63)
	6				
2012	3	56 ±0 (1)	52 ±7 (7)		

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	4	79 ± 6 (37)	80 ±6 (49)	79 ±3 (76)	78 ±4 (180)
	5	97 ±7 (11)	96 ±3 (4)	93 ±4 (16)	87 ±0 (1)
	6				
2013	3	45 ±4 (8)	43 ±4 (32)	35 ±0 (1)	49 ±12 (3)
	4	60 ±6 (29)	63 ±7 (41)	61 ±6 (34)	61 ±4 (171)
	5	75 ±5 (9)	71 ±2 (7)	71 ±3 (24)	69 ±4 (18)
	6				
2014	3	45 ±7 (5)	45±4 (11)	50±0 (1)	47±0 (1)
	4	64 ±7 (60)	62 ±7 (30)	63 ±4 (91)	61 ±4 (99)
	5	81 ±4 (4)		72 ±6 (8)	69 ±4 (3)
	6				
2015	3	56±0 (1)	48±4 (11)		52±0 (1)
	4	65±5 (23)	65±6 (42)	63±5 (57)	63±4 (126)
	5	75±7 (6)	71±0 (1)	69±6 (9)	73±0 (1)
	6				
2016	3	41±5 (5)	43±4 (3)		
	4	63±7 (30)	64±7 (12)	63±5 (62)	61±5 (45)
	5	76±7 (13)	75±0 (1)	73±5 (27)	67±4 (10)
	6				
2017	3	41±0 (1)	47±9 (3)		
	4	66±6 (14)	65±5 (19)	62±5 (15)	62±4 (61)
	5	71±2 (7)	80±4 (3)	70±5 (8)	73±13 (2)
	6				

Contribution to Fisheries

Nearly all the harvest on hatchery-origin Chiwawa spring Chinook occurs within the Columbia River basin. Ocean catch records (Pacific Fishery Management Council) indicate that very few Upper Columbia spring Chinook are taken in ocean fisheries. Most of the harvest on hatchery-origin Chiwawa spring Chinook occurs in the Lower Columbia River fisheries, which are managed by the states and tribes pursuant to management plans developed in *U.S. v Oregon*. The Lower Columbia River fisheries occur during what is referred to in *U.S. v Oregon* as the winter, spring, and summer seasons, which begin in February and ends 31 July of each year. The Tribal fishery occurs upstream from Bonneville Dam, but primarily in Zone 6, the area between Bonneville and McNary dams; the non-treaty commercial fisheries occur in Zones 1-5, which are downstream from Bonneville Dam. The non-treaty recreational (sport) fishery occurs in the lower mainstem.

The total number of hatchery-origin spring Chinook captured in different fisheries has been relatively low (Table 5.37). The largest harvest occurred on the 2008 brood year.

Table 5.37. Estimated number and percent (in parentheses) of hatchery-origin Chiwawa spring Chinook captured in different fisheries, brood years 1989-2012; NP = no hatchery program.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[b]
		Tribal[a]	Commercial (Zones 1-5)	Recreational (sport)		
1989	3 (13)	5 (21)	0 (0)	16 (67)	24	11.8
1990	0 (0)	0 (0)	0 (0)	18 (100)	18	94.7
1991	0 (0)	3 (100)	0 (0)	0 (0)	3	8.6
1992	0 (0)	1 (100)	0 (0)	0 (0)	1	3.1
1993	3 (75)	1 (25)	0 (0)	0 (0)	4	1.4
1994	0 (0)	0 (0)	0 (0)	0 (0)	0	0.0
1995	NP	NP	NP	NP	NP	NP
1996	0 (0)	2 (100)	0 (0)	0 (0)	2	2.5
1997	1 (0)	193 (51)	68 (18)	115 (31)	377	14.4
1998	10 (5)	47 (24)	12 (6)	126 (65)	195	16.4
1999	NP	NP	NP	NP	NP	NP
2000	0 (0)	17 (74)	0 (0)	6 (26)	23	6.1
2001	36 (64)	8 (14)	1 (2)	11 (20)	56	3.0
2002	12 (17)	11 (15)	22 (31)	26 (37)	71	9.1
2003	18 (21)	29 (35)	11 (13)	26 (31)	84	10.6
2004	3 (1)	188 (40)	31 (7)	253 (53)	475	15.8
2005	6 (5)	31 (24)	18 (14)	74 (57)	129	8.5
2006	25 (3)	469 (60)	85 (11)	201 (26)	780	29.8
2007	14 (3)	180 (43)	75 (18)	151 (36)	420	32.2
2008	8 (1)	298 (21)	41 (3)	1,047 (75)	1,394	36.1
2009	6 (2)	92 (23)	73 (18)	228 (57)	399	25.2
2010	0 (0)	372 (57)	45 (7)	231 (36)	648	32.1
2011	3 (0)	393 (53)	138 (19)	205 (28)	739	42.7
2012	1 (0)	88 (42)	43 (20)	80 (38)	212	29.4
Average	***7 (10)***	***110 (42)***	***30 (8)***	***128 (35)***	***275***	***19.7***
Median	***3 (1)***	***30 (37)***	***15 (6)***	***50 (33)***	***107***	***13.1***

[a] Includes the Wanapum fishery and the Icicle and Wenatchee fisheries when they occurred.

[b] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin. Targets for strays based on return year (recovery year) within the Wenatchee River basin should be less than 10% and targets for strays outside the Wenatchee River basin should be less than 5%.

The percentage of the spawning escapement in non-target spawning areas within the Wenatchee River basin made up of hatchery-origin Chiwawa spring Chinook has been high in some years and exceeded the target of 10% (Table 5.38). Over the years of sampling, Chiwawa spring Chinook have strayed into all non-target spawning areas, but, on average, have contributed most to the Nason Creek and Upper Wenatchee spawning escapements.

Table 5.38. Number (No.) and percent (%) of the spawning escapement in other non-target spawning streams within the Wenatchee River basin that consisted of hatchery-origin Chiwawa spring Chinook, return years 1992-2016. For example, for return year 2001, 35.3% of the spring Chinook spawning escapement in Nason Creek consisted of hatchery-origin Chiwawa spring Chinook. Percent strays should be less than 10%.

Return year	Nason Creek		Icicle Creek		Peshastin Creek		Upper Wenatchee		White River		Little Wenatchee	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1992	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1993	61	12.4	0	0.0	0	0.0	34	18.0	7	4.8	0	0.0
1994	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1995	0	0.0	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0
1996	25	30.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1997	55	45.1	8	11.0	0	0.0	0	0.0	0	0.0	0	0.0
1998	3	4.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	45	16.7	0	0.0	0	0.0	31	31.0	0	0.0	6	25.0
2001	211	35.3	0	0.0	0	0.0	271	77.7	46	27.7	52	44.1
2002	188	31.2	10	2.0	0	0.0	60	45.8	14	16.3	21	24.4
2003	14	6.9	0	0.0	0	0.0	30	51.7	0	0.0	0	0.0
2004	139	27.4	0	0.0	0	0.0	54	39.1	6	9.1	0	0.0
2005	252	72.6	7	50.0	0	0.0	256	99.6	106	68.4	65	56.5
2006	131	48.3	13	14.4	0	0.0	28	58.3	9	16.4	12	32.4
2007	303	65.4	0	0.0	0	0.0	37	67.3	7	7.6	6	5.9
2008	381	67.4	48	23.4	15	40.5	258	85.4	30	57.7	52	81.3
2009	289	54.1	8	9.2	0	0.0	16	100.0	63	36.4	56	44.8
2010	272	66.3	58	13.7	11	78.6	86	84.3	23	31.9	59	71.1
2011	397	56.6	61	18.8	0	0.0	41	82.0	0	0.0	53	42.7
2012	398	57.3	49	13.0	7	36.8	98	79.7	45	31.3	15	20.8
2013	281	68.7	15	8.0	0	0.0	24	72.7	5	4.8	10	10.2
2014	154	65.0	19	4.5	0	0.0	35	74.5	0	0.0	1	1.9
2015	11	7.3	12	4.7	0	0.0	50	51.0	8	6.4	0	0.0
2016	15	9.6	0	0.0	0	0.0	25	80.6	0	0.0	0	0.0
Average	***145***	***33.9***	***12***	***6.9***	***1***	***6.2***	***57***	***50.6***	***15***	***12.8***	***16***	***18.4***
Median	***131***	***31.2***	***0***	***0.0***	***0***	***0.0***	***31***	***58.3***	***5***	***4.8***	***1***	***1.9***

Hatchery-origin Chiwawa spring Chinook have strayed into the Methow and Entiat basins (Table 5.39). Based on return year analyses, rates of hatchery-origin Chiwawa spring Chinook straying into these populations have been low in most years; in return years 2014 and 2016, no Chiwawa spring Chinook strayed into the Entiat or Methow rivers. However, during return years 2002, 2006, 2008-2009, and 2011-2013, Chiwawa spring Chinook made up more than 5% of the spawning escapement in the Entiat River basin. In three years, Chiwawa spring Chinook hatchery fish made up more than 20% of the spawning escapement in the Entiat River basin.

Table 5.39. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Chiwawa spring Chinook, return years 1992-2016. For example, for return year 2002, 9.2% of the spring Chinook spawning escapement in the Entiat River basin consisted of hatchery-origin Chiwawa spring Chinook. Percent strays should be less than 5%. NS = not sampled.

Return year	Methow River basin		Entiat River basin	
	Number	%	Number	%
1992	0	0.0	0	0.0
1993	0	0.0	0	0.0
1994	0	0.0	0	0.0
1995	0	0.0	0	0.0
1996	NS	NS	0	0.0
1997	0	0.0	0	0.0
1998	NS	NS	0	0.0
1999	0	0.0	0	0.0
2000	0	0.0	1	0.8
2001	0	0.0	1	0.3
2002	0	0.0	34	18.3
2003	0	0.0	6	3.6
2004	0	0.0	0	0.0
2005	10	0.7	15	5.9
2006	8	0.5	30	18.9
2007	9	0.8	24	12.4
2008	12	1.2	61	26.8
2009	7	0.3	15	7.6
2010	10	0.4	18	5.2
2011	51	1.7	190	37.6
2012	13	1.0	133	33.0
2013	9	0.8	18	9.5
2014	0	0.0	0	0.0
2015	7	0.5	24	5.9
2016	0	0.0	0	0.0
Average	***5***	***0.3***	***23***	***7.4***
Median	***0***	***0.0***	***1***	***0.8***

Based on brood year analyses, on average, about 29% of the hatchery returns have strayed into non-target spawning areas (Table 5.40). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-81%. In most years, few (<2%) have strayed into non-target hatchery programs.

Table 5.40. Number and percent of hatchery-origin Chiwawa spring Chinook that homed to target spawning areas and the target hatchery program, and number and percent that strayed to non-target spawning areas and non-target hatchery programs, by brood years 1989-2012.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1989	74	41.1	1	0.6	102	56.7	3	1.7
1990	0	0.0	1	100.0	0	0.0	0	0.0
1991	29	90.6	0	0.0	2	6.3	1	3.1
1992	2	6.5	4	12.9	25	80.6	0	0.0
1993	134	47.5	82	29.1	63	22.3	3	1.1
1994	4	19.0	14	66.7	3	14.3	0	0.0
1995	No program							
1996	58	75.3	7	9.1	12	15.6	0	0.0
1997	1,242	55.6	298	13.4	687	30.8	5	0.2
1998	553	55.8	109	11.0	329	33.2	0	0.0
1999	No program							
2000	149	42	115	32	90	25	0	0.0
2001	647	35.8	276	15.3	881	48.7	4	0.2
2002	314	44.3	238	33.6	156	22.0	1	0.1
2003	556	78.6	11	1.6	133	18.8	7	1.0
2004	1,198	47.4	203	8.0	1,104	43.7	23	0.9
2005	822	59.3	139	10.0	415	29.9	10	0.7
2006	1,007	54.8	147	8.0	669	36.4	14	0.8
2007	510	57.8	60	6.8	294	33.3	19	2.2
2008	1,160	47.0	62	2.5	1,144	46.4	101	4.1
2009	745	62.9	53	4.5	356	30.0	31	2.6
2010	744	54.4	360	26.3	235	17.2	29	2.1
2011	565	56.9	287	28.9	134	13.5	7	0.7
2012	175	34.4	249	48.9	65	12.8	20	3.9
Average	***486***	***48.5***	***123***	***21.3***	***314***	***29.0***	***13***	***1.2***
Median	***532***	***51.0***	***96***	***12.0***	***145***	***27.7***	***5***	***0.7***

* Homing to the target hatchery includes Chiwawa hatchery spring Chinook that are captured and included as broodstock in the Chiwawa Hatchery program. These hatchery fish are typically collected at the Chiwawa weir and Tumwater Dam.

Ford et al. (2015) used parentage analysis to estimate rates of straying and homing of spring Chinook within the Wenatchee River basin. They found that stray rates of hatchery spring Chinook based on parentage analysis were consistent with rates estimated using physical tag recoveries (the latter estimates are shown in the tables above). They also found that stray rates among the major spawning tributaries were higher than stray rates of tagged fish to areas outside of the Wenatchee

River basin (e.g., Entiat and Methow basins), which is consistent with the results shown in the tables above. Finally, the researchers noted that hatchery spring Chinook homed at a far lower rate than natural-origin fish and stray rates of natural-origin fish ranged from about 0-100%. Rates of straying of natural-origin spring Chinook were affected by spawning tributary and by parental origin (i.e., progeny of naturally spawning hatchery-produced fish strayed at higher rates than progeny whose parents were of natural origin).

Genetics

Genetic studies were conducted in 2007 to determine the potential effects of the Chiwawa Supplementation Program on natural-origin spring Chinook in the upper Wenatchee River basin (Blankenship et al. 2007; the entire report is appended as Appendix K). A total of 32 population collections of adult spring Chinook were obtained from the Wenatchee River basin between 1989 and 2006. This included nine collections of natural-origin Chinook adults from the Chiwawa River (N = 501) and nine collections of Chiwawa hatchery-origin Chinook (N = 595) at the Chiwawa weir. Collections in 1993 and 1994 included hatchery-origin smolts. Additional samples were collected from the White River, Little Wenatchee River, and Nason Creek; six collections of natural-origin Chinook from the White River (N = 179), one collection from the Little Wenatchee (N = 19), and six collections from Nason Creek (N = 268). A single collection was obtained for Chinook spawning in the mainstem Wenatchee River and from the Leavenworth National Fish Hatchery. Finally, an out-of-basin collection from the Entiat River was included in the analysis. Scale, fin clips, or operculum punches were collected from each sample. Microsatellite DNA allele frequencies were used to statistically assign individual fish to specific demes (locations) within the Wenatchee population. In addition, genetic effects of the hatchery program were assessed by examining relationships between census and effective population sizes (N_e) from samples collected before and after supplementation.

Overall, this work showed that although allele frequencies within and between natural and hatchery-origin spring Chinook were significantly different, there was no evidence (i.e., robust signal) that the difference was the result of the hatchery program. Rather, the differences were more likely the result of life history characteristics. However, there was an increasing trend toward homogenization of the allele frequencies of the natural and hatchery-origin fish that comprised the broodstock, even though there was consistent year-to-year variation in allele frequencies among hatchery and natural-origin fish. In addition, there were no robust signals indicating that hatchery-origin hatchery broodstock, hatchery-origin natural spawners, natural-origin hatchery broodstock, and natural-origin natural spawners were substantially different from each other. Finally, the N_e estimate of 387 was only slightly larger than the pre-hatchery N_e (based on demographic data from 1989-1992), which means that the Chiwawa hatchery program has not reduced the N_e of the Wenatchee spring Chinook population.

Significant differences in allele frequencies were observed within and among major spawning areas in the Upper Wenatchee River basin. However, these differences made up only a very small portion of the overall variation, indicating genetic similarity among the major spawning areas. There was no evidence that the Chiwawa program has changed the genetic structure (allele frequency) of spring Chinook in Nason Creek and the White River, despite the presence of hatchery-origin spawners in both systems.

It is important to note that no new information will be reported on genetics until the next five-year report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[20] The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1989-1994, PNI values were greater than or equal to 0.67 (Table 5.41). Since brood year 1994, PNI has been less than 0.67, except for brood year 2016, which was 0.70.

Table 5.41. Proportionate Natural Influence (PNI) values for the Chiwawa spring Chinook supplementation program for brood years 1989-2017. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	713	0	0.00	28	0	1.00	1.00
1990	571	0	0.00	18	0	1.00	1.00
1991	242	0	0.00	27	0	1.00	1.00
1992	676	0	0.00	78	0	1.00	1.00
1993	231	2	0.01	94	0	1.00	0.99
1994	123	61	0.33	8	4	0.67	0.68
1995	0	33	1.00	No Program			
1996	41	17	0.29	8	10	0.44	0.62
1997	60	122	0.67	32	79	0.29	0.32
1998	59	32	0.35	13	34	0.28	0.47
1999	87	7	0.07	No Program			
2000	233	113	0.33	9	21	0.30	0.50
2001	506	1219	0.71	113	259	0.30	0.32
2002	254	453	0.64	20	51	0.28	0.33
2003	168	102	0.38	41	53	0.44	0.55
2004	575	276	0.32	83	132	0.39	0.57
2005	139	460	0.77	91	181	0.33	0.32
2006	114	415	0.78	91	224	0.29	0.29

[20] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
2007	155	1141	0.88	43	104	0.29	0.27
2008	190	968	0.84	83	220	0.27	0.26
2009	297	1050	0.78	96	111	0.46	0.39
2010	419	675	0.62	77	98	0.44	0.43
2011	801	1231	0.61	80	93	0.46	0.45
2012	574	904	0.61	73	38	0.66	0.53
2013	422	956	0.69	70	0	1.00	0.60
2014	538	461	0.46	61	12	0.84	0.65
2015	337	630	0.65	72	0	1.00	0.61
2016	407	164	0.29	62	37	0.63	0.70
2017	171	288	0.63	50	18	0.74	0.55
Average	***314***	***406***	***0.47***	***56***	***66***	***0.59***	***0.57***
Median	***242***	***276***	***0.61***	***62***	***37***	***0.46***	***0.55***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery spring Chinook from the Chiwawa River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 5.42).[21] Over the 11 brood years for which PIT-tagged hatchery fish were released, survival rates from the Chiwawa River to McNary Dam ranged from 0.435 to 0.662; SARs from release to detection at Bonneville Dam ranged from 0.003 to 0.018. Average travel time from the Chiwawa River to McNary Dam ranged from 14 to 44 days. Although there is only one year in which a forced release was compared to a volitional release (brood year 2005), hatchery spring Chinook that were forced out of the Chiwawa Acclimation Facility had slightly higher survival rates and SARs, and a faster travel time to McNary Dam, than did the volitional release.

Table 5.42. Total number of Chiwawa hatchery spring Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2005-2015. Standard errors are shown in parentheses. NA = not available (i.e., not all the adults from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2005	4,993 (forced)	0.662 (0.027)	22.9 (6.6)	0.008 (0.001)
2005	4,988 (volitional)	0.638 (0.027)	43.6 (6.9)	0.003 (0.001)
2006	9,894	0.619 (0.038)	30.6 (7.6)	0.011 (0.001)
2007	10,031	0.435 (0.019)	32.9 (7.7)	0.007 (0.001)

[21] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2008	10,006	0.631 (0.038)	39.9 (10.3)	0.018 (0.001)
2009	9,412	0.547 (0.044)	30.2 (6.7)	0.006 (0.001)
2010	5,020	0.547 (0.038)	18.9 (7.3)	0.008 (0.001)
2011	9,987	0.458 (0.029)	14.2 (7.5)	0.009 (0.001)
2012	5,061	0.478 (0.043)	30.9 (6.5)	0.008 (0.001)
2013	10,021	0.438 (0.041)	29.5 (5.9)	NA
2014	10,179	0.628 (0.029)	24.9 (6.2)	NA
2015	10,148	0.463 (0.030)	32.7 (7.0)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on a brood year harvest rates from the hatchery program. For brood years 1989-2011, NRR for spring Chinook in the Chiwawa averaged 1.02 (range, 0.01-4.40) if harvested fish were not included in the estimate and 1.14 (range, 0.01-4.81) if harvested fish were included in the estimate (Table 5.43). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 6.7 (the calculated target value in Hillman et al. 2017). The target value of 6.7 includes harvest. In nearly all years, HRRs were greater than NRRs, regardless if harvest was or was not included (Table 5.43). HRRs exceeded the estimated target value of 6.7 in 10 of the 21 years.

Table 5.43. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for spring Chinook in the Chiwawa River basin, brood years 1989-2011; NP = no hatchery program.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	28	713	180	194	6.43	0.27	204	282	7.29	0.40
1990	19	571	1	34	0.05	0.06	19	40	1.00	0.07
1991	32	242	32	2	1.00	0.01	35	2	1.09	0.01
1992	78	676	31	46	0.40	0.07	32	48	0.41	0.07

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1993	100	233	282	159	2.82	0.68	286	163	2.86	0.70
1994	13	184	21	37	1.62	0.20	21	38	1.62	0.21
1995	NP	33	--	66	--	2.00	--	69	--	2.09
1996	18	58	77	255	4.28	4.40	79	279	4.39	4.81
1997	120	182	2,232	714	18.60	3.92	2,609	792	21.74	4.35
1998	48	91	991	349	20.65	3.84	1,186	373	24.71	4.10
1999	NP	94	--	10	--	0.11	--	11	--	0.12
2000	48	346	354	695	7.38	2.01	377	740	7.85	2.14
2001	382	1,725	1,808	309	4.73	0.18	1,864	319	4.88	0.18
2002	84	707	709	244	8.44	0.35	780	254	9.29	0.36
2003	119	270	707	107	5.94	0.40	791	115	6.65	0.43
2004	296	858	2,528	276	8.54	0.32	3,003	298	10.15	0.35
2005	283	599	1,386	396	4.90	0.66	1,515	409	5.35	0.68
2006	398	529	1,837	967	4.62	1.83	2,617	1,215	6.58	2.30
2007	169	1,296	883	478	5.22	0.37	1,303	571	7.71	0.44
2008	329	1,158	2,467	740	7.50	0.64	3,861	830	11.74	0.72
2009	264	1,347	1,185	349	4.49	0.26	1,584	378	6.00	0.28
2010	186	1,094	1,368	633	7.35	0.58	2,016	781	10.84	0.71
2011	181	2,032	993	502	5.49	0.25	1,732	677	9.57	0.33
Average	***152***	***654***	***956***	***329***	***6.21***	***1.02***	***1,234***	***379***	***7.70***	***1.14***
Median	***119***	***571***	***883***	***276***	***5.22***	***0.37***	***1,186***	***298***	***6.65***	***0.43***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns. For the available brood years, SARs have ranged from 0.00036 to 0.01563 for hatchery spring Chinook (Table 5.44).

Table 5.44. Smolt-to-adult ratios (SARs) for Chiwawa hatchery spring Chinook, brood years 1989-2012.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	42,707	204	0.00478
1990	52,798	19	0.00036
1991	61,088	35	0.00057
1992	82,976	31	0.00037
1993	221,316	284	0.00128
1994	27,135	21	0.00077
1995	No hatchery program		

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1996	12,767	67	0.00525
1997	259,585	2,549	0.00982
1998	71,571	1,119	0.01563
1999	No hatchery program		
2000	46,726	375	0.00803
2001	374,129	1,849	0.00494
2002	145,074	760	0.00524
2003	216,702	775	0.00358
2004	491,987	2,992	0.00608
2005	489,664	1,506	0.00308
2006	548,777	2,605	0.00475
2007	292,682	1,301	0.00445
2008	609,286	3,861	0.00634
2009	433,608	1,570	0.00362
2010	342,778	2,002	0.00584
2011	278,801	1,719	0.00617
2012	218,968	714	0.00326
Average	***241,869***	***1,198***	***0.00474***
Median	***220,142***	***947***	***0.00476***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

5.8 ESA/HCP Compliance

Broodstock Collection

The collection of 2015 Brood Chiwawa River spring Chinook broodstock was consistent with the 2015 Upper Columbia River salmon and steelhead broodstock objectives and site-based broodstock collection protocols. Specifically, broodstock collection targeted previously PIT-tagged natural-origin fish at Tumwater Dam and operation of the Chiwawa Weir. In-season adjustments were made to the natural-origin spring Chinook collected for broodstock as needed and were based on in-season escapement monitoring at Tumwater Dam and estimated Chiwawa run-escapement.

Trapping at Tumwater Dam began on 29 May 2015 and concluded on 21 July 2015. Operation of the Chiwawa Weir was limited to 15 days between 1 June and 15 August and was further constrained by flows and total available bull trout effects. Broodstock collection targeted natural-origin spring Chinook and hatchery-origin spring Chinook as needed to attain a 100% natural-origin broodstock and a maximum 33% extraction of the estimated natural-origin return to the Chiwawa River.

The 2015 brood collection retained a total of 81 natural-origin spring Chinook. All spring Chinook, steelhead, and 56 bull trout that were captured were anesthetized with tricaine methanesulfonate (MS-222) and subject to water-to-water transfers during handling. All fish were allowed to fully recover before release.

The estimated broodstock extraction rate of natural-origin Chiwawa spring Chinook and overall extraction of spring Chinook upstream from Tumwater Dam comply with provisions of ESA Permit 18121.

Hatchery Rearing and Release

The rearing and release of 2015 brood Chiwawa spring Chinook was completed without incident. No mortality events occurred that exceeded 10% of the population. Fish were acclimated on Chiwawa River water with regulated amounts of Wenatchee River water to prevent frazzle ice formation during the winter months (see Section 5.2).

The release of 2015 brood Chiwawa spring Chinook smolts totaled 163,411 fish, representing 113.5% of the program objective of 144,023 smolts, which was out of compliance with the ESA Section 10 Permit 18121 program not to exceed the maximum level of 158,425 smolts. Higher than expected survival at nearly all life stages and greater than projected fecundities (110.1% of the 2015 biological assumptions) were the primary drivers for the overage.

Hatchery Effluent Monitoring

Per ESA Permits 1347 (expired), 1395 (expired), 18118, 18120, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery. There were four violations (for samples not being taken) at the Chiwawa acclimation facility during the period 1 January through 31 December 2017. NPDES monitoring and reporting for PUD Hatchery Programs during 2017 are provided in Appendix F.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit Nos. 18118, 18120, and 18121, the permit holders are authorized a direct take of up to 20% of the emigrating spring Chinook population during juvenile emigration monitoring and a lethal take not to exceed 2% of the fish captured (NMFS 2013). Based on the estimated wild spring Chinook population (smolt trap expansion) and hatchery juvenile spring Chinook population estimate (hatchery release data) for the Wenatchee River basin, the reported spring Chinook encounters during 2017 emigration monitoring complied with take provisions in the Section 10 permit. Spring Chinook encounter and mortality rates for each trap site (including PIT tag mortalities) are detailed in Table 5.45. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permits 18118, 18120, and 18121, Section B.

Table 5.45. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2017.

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Chiwawa Trap								
Population	53,344	163,411	95,063	5,824	4,518	12,938	23,280	
Encounter rate	NA	NA	NA	0.1092	0.0276	0.1361	0.0747	0.20
Mortality[e]	NA	NA	NA	15	0	187	202	
Mortality rate	NA	NA	NA	0.0026	0.0000	0.0145	0.0087	0.02
Lower Wenatchee Trap								
Population	130,426	406,558	7,593,243	1,332	12,132	46,801	60,265	
Encounter rate	NA	NA	NA	0.0102	0.0298	0.0062	0.0074	0.20
Mortality[d]	NA	NA	NA	7	24	360	391	
Mortality rate	NA	NA	NA	0.0053	0.0020	0.0077	0.0065	0.02
Wenatchee River Basin Total								
Population	130,426	406,558	7,593,243	7,156	16,660	59,739	83,545	
Encounter rate	NA	NA	NA	0.0549	0.0410	0.0079	0.0103	0.20
Mortality[d]	NA	NA	NA	22	24	547	593	
Mortality rate	NA	NA	NA	0.0031	0.0014	0.0092	0.0071	0.02

[a] Smolt population estimate derived from juvenile emigration trap data.
[b] 2017 BY smolt release data for the Wenatchee River basin.
[c] Based on size, date of capture and location of capture, subyearling Chinook encountered at the Lower Wenatchee Trap are categorized as summer Chinook salmon.
[d] Combined trapping and PIT tagging mortality.

Precocity Monitoring

For the purpose of addressing permit requirements, we used the PIT Tag Information System (PTAGIS) to identify probable hatchery-origin mini-jack spring Chinook Salmon from the Chiwawa River in 2015, 2016, and 2017. The query results returned fish that were last detected after 1 July of the year in which they were released. Fish that remained in freshwater during this time period were likely precocious males. We looked for detections in three regions: lower Columbia River mainstem dams (Bonneville, The Dalles, and McNary dam), mid-Columbia mainstem dams (Priest Rapids and Rock Island dams), and within the Wenatchee River basin. The occurrence of mini-jacks was rare, ranging from less than 0.14% to 0.26% of the tagged population (Table 5.46).

Table 5.46. Numbers of Chiwawa River hatchery spring Chinook with final PIT-tag detections after 1 July of the release year. These fish are likely mini-jacks. Lower Columbia River detections occurred at Bonneville, The Dalles, and McNary dam, while Mid-Columbia River detections occurred at Priest Rapids and Rock Island dams.

Year	Number of PIT tags released	Number of tags detected in Lower Columbia River	Number of tags detected in Mid-Columbia River	Number of tags detected within the Wenatchee River basin	Percent of tagged population
2015	10,021	9	0	6	0.15
2016	10,179	22	1	3	0.26
2017	10,148	11	0	3	0.14

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2017, as authorized by ESA Section 10 Permits 18118, 18120, and 18121. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Spring Chinook Reproductive Success Study

ESA Section 10 Permits 18118, 18120, and 18121 specifically provide authorization to capture, anesthetize, biologically sample, PIT tag, and release adult spring Chinook at Tumwater Dam for reproductive success studies and general program monitoring. During 2010 through 2017, all spring Chinook passing Tumwater Dam were enumerated, anesthetized, biologically sampled, PIT tagged, and released (not including hatchery-origin Chinook retained for broodstock) as a component of the reproductive success study (BPA Project No. 2003-039-00). Please refer to Ford et al. (2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2017.

SECTION 6: NASON CREEK SPRING CHINOOK

The goals of the Nason Creek spring Chinook salmon supplementation program are to conserve, aid in the recovery, and prevent the extinction of naturally spawning spring Chinook in Nason Creek, and to meet the mitigation responsibilities of Grant County PUD. In 1998, a spring Chinook captive-broodstock program was initiated for the Nason Creek population to reduce the risk of extinction.[22] Improvements in adult escapement in Nason Creek have reduced the near-term risk of extinction and therefore the captive-broodstock program was discontinued. An adult-based supplementation program began with the collection of broodstock in 2013. The first releases of the program occurred from the Nason Creek Acclimation Facility in the spring of 2015.

In 2013, natural-origin adult spring Chinook were collected for broodstock at Tumwater Dam and from Nason Creek using tangle and dip nets. In 2014, all natural-origin broodstock were collected from Nason Creek using tangle and dip nets. While these brood collection methods were successful at collecting adults from the Nason Creek spawning aggregate, they were unable to collect the necessary number of adults to meet mitigation production goals in 2013 and 2014. The PRCC Hatchery Subcommittee decided to implement the Nason Creek conservation program using a composite of Nason and Chiwawa natural-origin broodstock beginning with brood year 2015 in order to be able to consistently meet program goals. The decision was also made to collect all the brood at Tumwater Dam.

The production goal for the Nason Creek program requires collection of 126 adult spring Chinook (64 natural-origin fish and 66 hatchery-origin fish). However, the Section 10 permit requirements restrict the number of natural-origin adults collected and collection cannot exceed 33% of the natural-origin spring Chinook estimates to Tumwater Dam.

Adult spring Chinook broodstock are spawned and reared at Eastbank Fish Hatchery. Juvenile spring Chinook are transferred from the hatchery to the Nason Creek Acclimation Facility in late September or early October. Fish are reared in 30-foot dual-drain circular tanks throughout winter at the Nason Creek Acclimation Facility. Yearling Chinook were released volitionally during April and May the following year up until 2015. Beginning in 2016, all fish are force released at night to improve survival.

The current production goal is to release 223,670 smolts (125,000 for conservation and 98,670 for safety net). Juveniles released from the Nason facility are 100% marked with CWTs and a minimum of 5,000 fish are PIT tagged annually.

The following information focuses on results from monitoring the Nason Creek spring Chinook program. Information on spring Chinook collected throughout the Wenatchee River basin is presented in Section 5.

6.1 Broodstock Sampling

This section focuses on results from sampling 2015-2017 Nason Creek spring Chinook broodstock, which were collected at Tumwater Dam in 2015, 2016, and 2017.

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[22] A total of 1,054 and 235 eggs or alevins were collected directly from redds in 1988 and 1989, respectively. This resulted in some broodstock being released in 2003 and 8,986 smolts released in 2004.

Origin of Broodstock

Natural-origin adults made up between 48% and 51% of the Nason Creek spring Chinook broodstock for return years 2015-2017 (Table 6.1). Beginning with brood year 2015, natural-origin adults were targeted for collection at Tumwater Dam during trapping operations. Natural-origin fish collected at Tumwater Dam were used for broodstock if genotyping confirmed they were natural-origin fish from the Nason or Chiwawa subpopulation and they were not White River fish. Fish that were genotyped to the White River were returned to the upper Wenatchee River basin to spawn naturally.

Table 6.1. Numbers of wild and hatchery Nason Creek spring Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned, 2013-2017. Unknown origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program or were surplus fish killed at spawning.

Brood year	Wild spring Chinook					Hatchery spring Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
2013	22	0	1	21	0	4	0	0	4	0	25
2014[b]	28	2	5	21	0	0	0	0	0	0	21
2015	78	1	6	59	12	63	0	0	63	0	122
2016	82	0	1	70	11	68	1	1	66	0	136
2017	71	1	0	70	0	70	3	3	67	0	141
Average[c]	***56.2***	***0.8***	***2.6***	***48.2***	***4.6***	***41***	***0.8***	***0.8***	***40***	***0***	***89***
Median[c]	***71***	***1***	***1***	***59***	***0***	***63***	***0***	***0***	***63***	***0***	***122***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] Until sufficient Nason Creek Spring Chinook HOR's are collected to meet broodstock objectives, Chiwawa Spring Chinook HOR's are utilized to fulfill program goals (see table 5.1 and the 2014 Broodstock Protocols). About 12 Chiwawa HORs were used to fulfill the Chiwawa Program; about 122 Chiwawa HORs were used to fulfill the Nason Creek safety-net obligation.
[c] Origin determinations should be considered preliminary pending scale analyses.

Age/Length Data

Ages were determined from scales and/or coded wire tags (CWT) collected from broodstock. For both the 2016 and 2017 returns, most adults, regardless of origin, were age-4 Chinook (Table 6.2). All age-3 fish were hatchery-origin, while the majority of age-5 Chinook were natural-origin.

Table 6.2. Percent of hatchery and wild spring Chinook of different ages (total age) collected from broodstock, 2013-2017.

Return year	Origin	Total age			
		2	3	4	5
2013	Wild	0.0	14.3	85.7	0.0
	Hatchery	0.0	0.0	100.0	0.0
2014	Wild	0.0	18.2	68.2	13.6
	Hatchery[a]	0.0	0.0	98.5	1.5
2015	Wild	0.0	0.0	92.0	8.0
	Hatchery	0.0	0.0	100.0	0.0
2016	Wild	0.0	0.0	69.6	30.4

Return year	Origin	Total age			
		2	3	4	5
	Hatchery	0.0	0.0	93.4	6.6
2017	Wild	0.0	0.0	84.5	15.5
	Hatchery	0.0	25.7	72.9	1.4
Average	***Wild***	***0.0***	***6.5***	***80***	***13.5***
	Hatchery	***0.0***	***5.1***	***93.0***	***1.9***
Median	***Wild***	***0.0***	***0.0***	***84.5***	***13.6***
	Hatchery	***0.0***	***0.0***	***98.5***	***1.4***

[a] Data are from Table 5.2.

Age-4 natural-origin Chinook were slightly smaller in length than hatchery-origin broodstock in 2016; however, in 2017, age-4 natural-origin broodstock were larger than hatchery-origin broodstock (Table 6.3). In 2016, age-5 natural-origin Chinook were larger than hatchery-origin Chinook. In 2017, age-5 hatchery-origin Chinook were larger than natural-origin Chinook, although there was only one age-5 hatchery-origin Chinook.

Table 6.3. Mean fork length (cm) at age (total age) of hatchery and wild spring Chinook collected from broodstock, 2013-2017; N = sample size and SD = 1 standard deviation.

Return year	Origin	Spring Chinook fork length (cm)											
		Age-2			Age-3			Age-4			Age-5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2013	Wild	-	0	-	56	3	2	75	16	6	-	0	-
	Hatchery	-	0	-	-	0	-	79	5	6	-	0	-
2014	Wild	-	0	-	57	4	6	82	15	7	86	3	8
	Hatchery[a]	-	0	-	-	0	-	81	192	6	85	3	2
2015	Wild	-	0	-	-	0	-	82	43	5	97	8	6
	Hatchery	-	0	-	-	0	-	82	55	5	-	0	-
2016	Wild	-	0	-	-	0	-	81	39	5	94	17	6
	Hatchery	-	0	-	-	0	-	84	57	6	89	4	9
2017	Wild	-	0	-	-	0	-	83	60	6	95.8	11	7
	Hatchery	-	0	-	67	18	4	81	51	6	106	1	-
Average	***Wild***	***-***	***0***	***-***	***57***	***1***	***4***	***81***	***35***	***6***	***93***	***8***	***7***
	Hatchery	***-***	***0***	***-***	***67***	***4***	***4***	***81***	***72***	***6***	***93***	***2***	***6***

[a] Data are from Table 5.3.

Sex Ratios

Male spring Chinook in the 2015-2017 return years made up 50%, 49%, and 50%, respectively, of the adults collected. This resulted in overall male to female ratios of 1.01:1.00, 0.95:1.00, and 1.00:1.00, respectively (Table 6.4).

Table 6.4. Numbers of male and female wild and hatchery spring Chinook collected for broodstock, 2013-2017. Ratios of males to females are also provided.

Return year	Number of wild spring Chinook			Number of hatchery spring Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2013	12	10	1.20:1:00	1	3	0.33:1.00	1.00:1.00
2014[a]	18	12	1.50:1.00	0	0	-	1.50:1.00
2015	40	38	1.05:1.00	31	32	0.97:1.00	1.01:1.00
2016	40	42	0.95:1.00	33	35	0.94:1.00	0.95:1.00
2017	35	37	0.95:1.00	36	34	1.06:1.00	1.00:1.00
Total	***145***	***139***	***1.04:1.00***	***101***	***104***	***0.97:1.00***	***1.01:1.00***

[a] Data for HOR brood are in Table 5.4.

Fecundity

The mean fecundities for the 2015-2017 returns of Nason Creek spring Chinook ranged from 4,463 to 4,731 eggs per female (Table 6.5). Fecundities in the 2013 and 2015 natural-origin brood, and in the 2013, 2014, and 2016 hatchery-origin brood were less than the expected fecundity of 4,400 eggs per female assumed in the broodstock protocol.

Table 6.5. Mean fecundity of wild, hatchery, and all female spring Chinook collected for broodstock, 2013-2017.

Return year	Mean fecundity		
	Wild	Hatchery	Total
2013	4,047	4,069	4,052
2014[a]	4,484	3,834	3,787
2015	4,380	4,535	4,463
2016	4,688	4,274	4,487
2017	4,930	4,513	4,731
Average	***4,506***	***4,245***	***4,304***

[a] Average fecundities are from Table 5.5.

To estimate fecundities by length, weight, and age[23], hatchery staff collected fecundity, fork length, weight, and age data from a subsample of spring Chinook females during the spawning of 2013 through 2017 broodstock. For those brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin spring Chinook. Hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between size and fecundity.

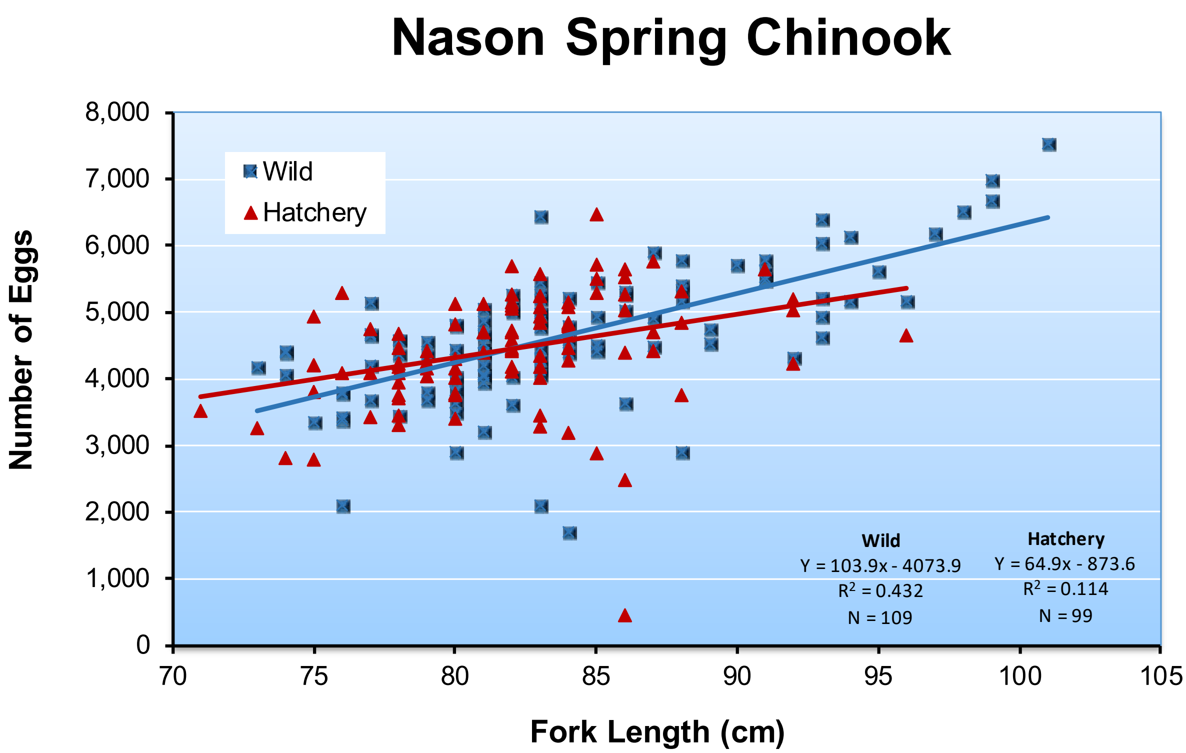
Mean fecundity by total age varied between hatchery and natural-origin spring Chinook and over time (Table 6.6). On average, mean fecundities varied between hatchery and natural-origin spring Chinook by 126 eggs for age-4 fish and 1,337 eggs for age-5 fish. No eggs from age-3 fish were collected.

[23] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

Table 6.6. Mean fecundity by age (total age) for hatchery and wild spring Chinook collected from broodstock for the Nason Creek program, brood years 2013-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Spring Chinook fecundity								
		Age 3			Age 4			Age 5		
		Mean	N	SD	Mean	N	SD	Mean	N	SD
2013	Wild	-	0	-	3,751	10	1,418	-	0	-
	Hatchery		0	-	4,069	3	746	-	0	-
2014	Wild	-	0	-	4,137	7	796	5,551	2	85
	Hatchery	-	0	-	-	0	-	-	0	-
2015	Wild	-	0	-	4,403	21	793	5,711	3	1,202
	Hatchery	-	0	-	4,587	29	569	-	0	-
2016	Wild	-	0	-	4,262	18	795	5,377	10	552
	Hatchery	-	0	-	4,284	29	815	4,414	4	1,113
2017	Wild	-	0	-	4,633	29	589	6,365	6	871
	Hatchery	-	0	-	4,513	32	1,064	-	0	-
Average	***Wild***	***-***	***0***	***-***	***4,237***	***17***	***878***	***5,751***	***4***	***678***
	Hatchery	***-***	***0***	***-***	***4,363***	***19***	***799***	***4,414***	***1***	***1,113***

We pooled fecundity data from brood years 2013 through 2017 to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery and natural-origin females are shown in Figures 6.1, 6.2, and 6.3. All fecundity variables increase linearly with fork length. In addition, the relationships between fish size and fecundity data were similar for hatchery and natural-origin spring Chinook.



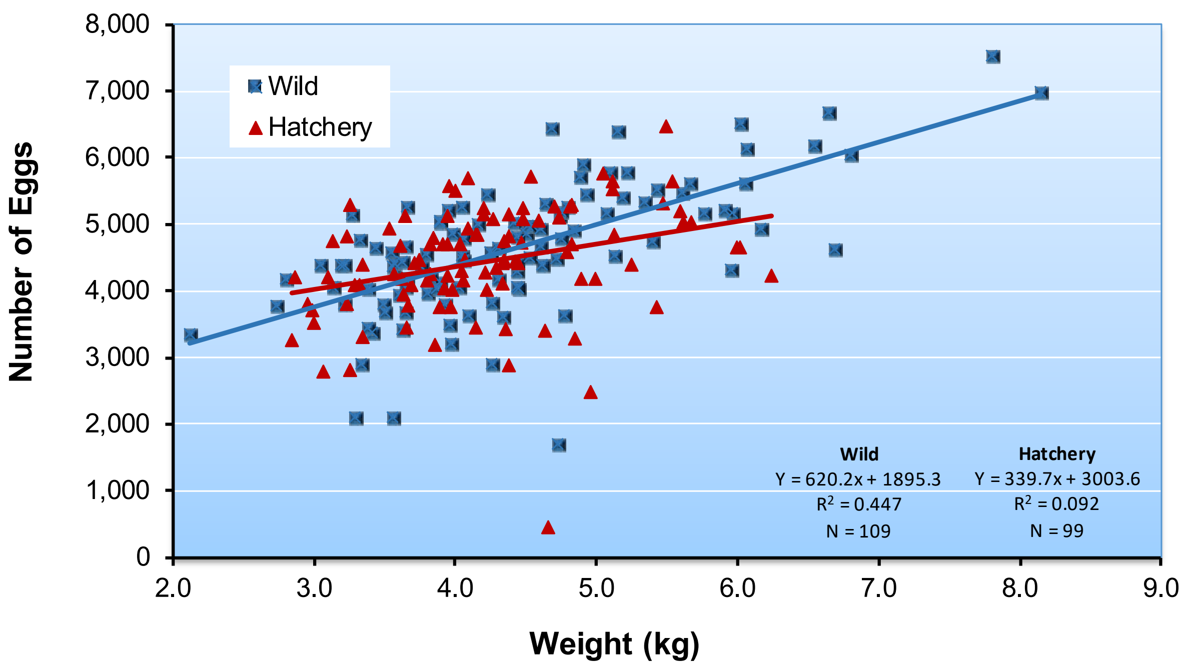


Figure 6.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural and hatchery-origin, Nason Creek, spring Chinook for return years 2013-2017.

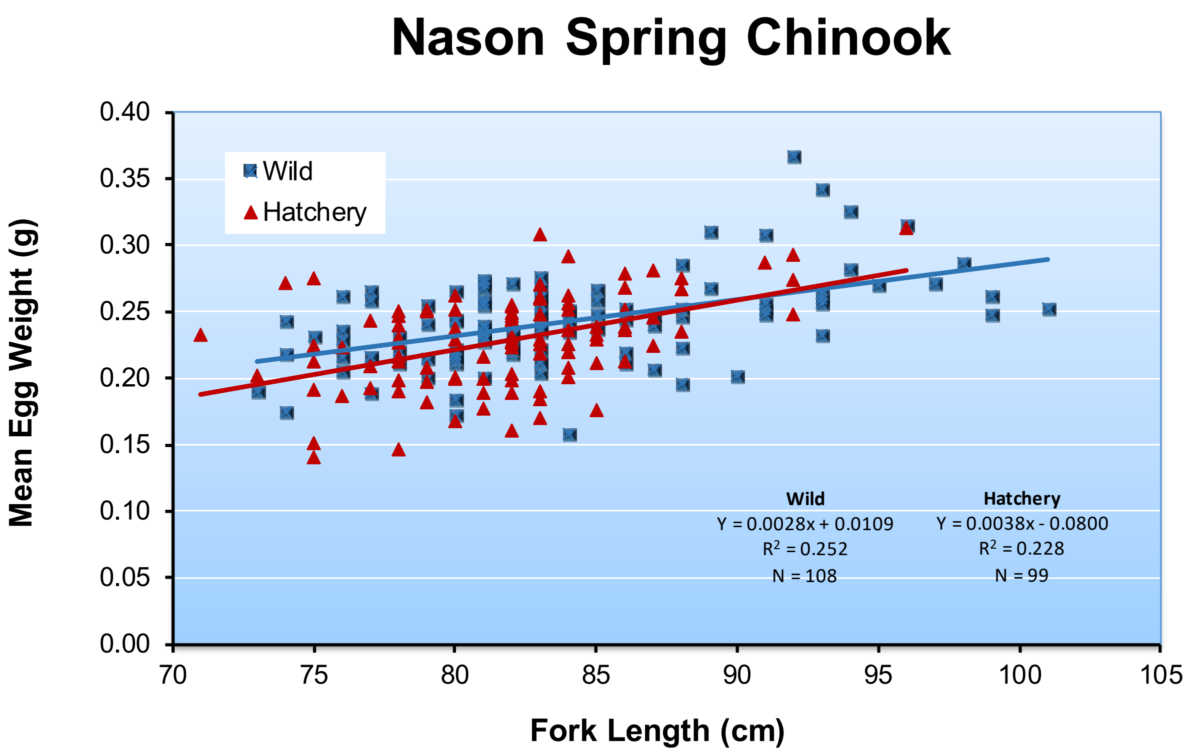


Figure 6.2. Relationships between mean egg weight and fork length for natural and hatchery-origin, Nason Creek, spring Chinook for return years 2013-2017.

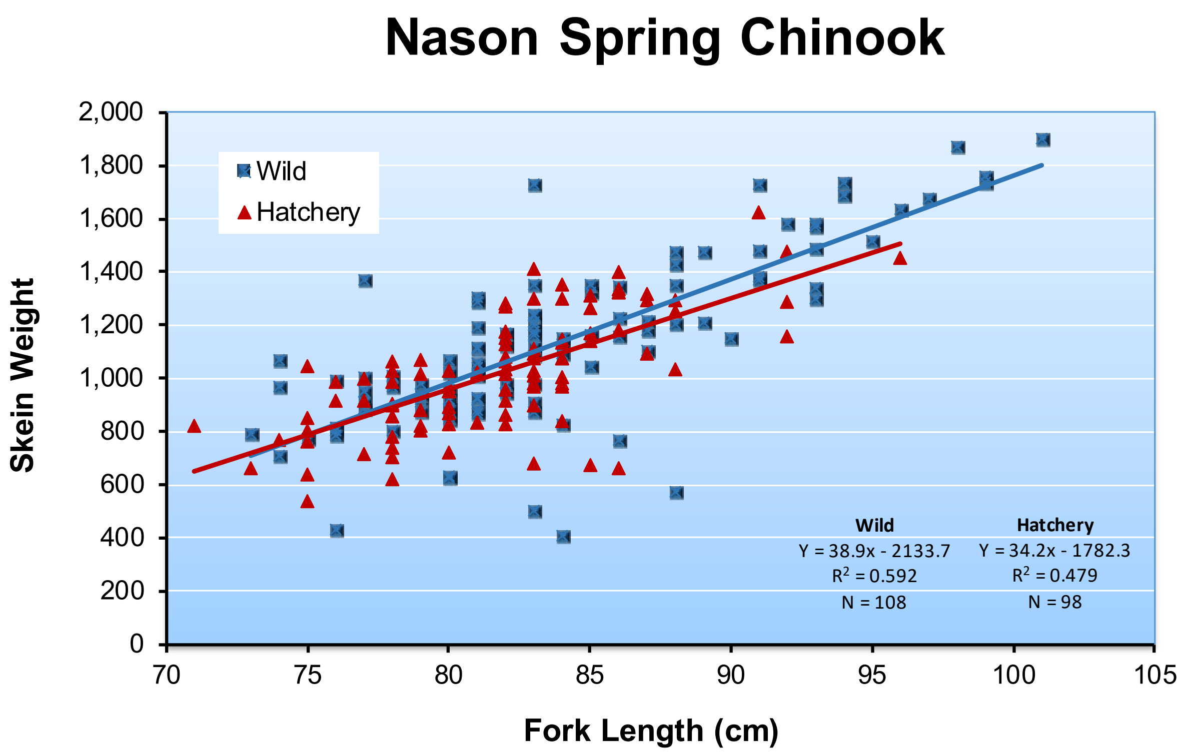


Figure 6.3. Relationships between skein weight and fork length for natural and hatchery-origin, Nason Creek, spring Chinook for return years 2013-2017.

6.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 85%, a total of 263,141 eggs are required to meet the program release goal of 223,670 smolts (Table 6.7). The green egg take for the 2015-2017 brood years was 102%, 119%, and 114% of program goal, respectively.

Table 6.7. Numbers of eggs taken from spring Chinook broodstock, 2013-2017.

Return year	Number of eggs taken
2013[a]	49,720
2014[b]	267,783
2015	268,247
2016	314,090
2017	299,392
Average	***239,846***
Median	***268,247***

[a] Safety-net obligation met through the White River Program. Conservation egg take goal was 116,082.
[b] Includes surrogate Chiwawa HxH egg take calculated from tagging proportions.

Number of acclimation days

Fish from the 2015 brood were acclimated for 166-167 days on Nason Creek water and no days on well water with oxygen (Table 6.8).

Table 6.8. Number of days spring Chinook broods were acclimated on Nason Creek water and well water, brood years 2013-2015.

Brood year	Release year	Transfer date	Release date	Number of acclimation days
2013	2015	13 Oct	13 Apr – 1 May	182-200
2014[a]	2016	21-23 Oct	15-20 Apr	119-122 Nason, 12 Well
2015	2017	2 Nov	17-18 Apr	166-167

[a] Because of water-intake concerns at the Nason Creek Acclimation Facility, the HxH Chinook were transferred to the Chiwawa Acclimation Facility on 2-3 March for final acclimation and release. The WxW fish were on Nason Creek water for 166 days. The HxH fish were on Nason Creek water for 119-122 days and on Chiwawa River water for 43-49 days. WxW and HxH fish were on well water and oxygen for 12 days while rearing at the Nason Creek Acclimation Facility.

Release Information

Numbers released

The 2015 brood Nason Creek spring Chinook program achieved 88.8% of the 125,000 target goal with about 111,040 WxW smolts released into Nason Creek in 2017 (Table 6.9). The remainder of the smolt obligation was fulfilled with HxH progeny. A total of 132,087 HxH smolts were released from the Nason Creek Acclimation Facility for the Nason spring Chinook program.

Table 6.9. Numbers of spring Chinook smolts tagged and released from the hatchery, brood years 2013-2015. The release target for Nason Creek spring Chinook is 223,670 smolts.

Brood year	Release year	Type of release	CWT mark rate	Number released that were PIT tagged	Number of smolts released	Total number of smolts released
2013	2015	Volitional	0.9303	20,139	43,082	43,082
2014[a]	2016	Forced	0.9650	5,009	32,215	32,215
2015	2017	Forced	0.9681	10,009	243,127	243,127

[a] Only the WxW Nason program was released from the Nason Creek Acclimation Facility because of water-intake concerns. The HxH Nason program was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 (see Table 5.9).

Numbers tagged

The 2015 brood Nason spring Chinook were 96.8% CWT and blank CWT adipose tagged (Table 6.9).

On 12-15 March 2018, a total of 10,104 Nason Creek spring Chinook from the 2016 brood were tagged at the Nason Creek Acclimation Facility. Chinook tagged in Ponds 1, 3, 5, and 7 were HxH fish, while Chinook tagged in Ponds 2, 4, 6, and 8 were WxW fish. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 101-110 mm in length and 14-17 g at time of tagging.

Table 6.10 summarizes the number of hatchery spring Chinook that have been PIT-tagged and released into Nason Creek.

Table 6.10. Summary of PIT-tagging activities for Nason Creek hatchery spring Chinook, brood years 2013-2015.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2013	2015	20,234	94	1	20,139
2014	2016	5,010	1	0	5,009
2015	2017	10,104	5	0	10,099

Fish size and condition at release

The WxW spring Chinook from the 2015 brood were force released as yearling smolts from 17-18 April 2017. Size at release (22 fpp) was smaller than the approximate target of 18 fpp established for the program. The CV for fork length was lower than the target (Table 6.11).

The HxH spring Chinook were force released as yearling smolts from 17-18 April 2017 into Nason Creek. Size at release (22 fpp) was smaller than the approximate target of 18 fpp established for the program. The CV for fork length was short of the target (Table 6.11).

Table 6.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of spring Chinook smolts released from the hatchery, brood years 2013-2015. Size targets are provided in the last row of the table.

Brood year	Release year	Origin	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2013	2015	WxW	129	8.3	27.6	16
		HxH	-	-	-	-
2014[a]	2016	WxW	124	7.7	21.7	21
		HxH	134	13	29	16
2015	2017	WxW	120	6.7	21.3	21
		HxH	118	7.7	20	23
Average		***WxW***	***124***	***7.6***	***23.5***	***19***
		HxH	***126***	***10.4***	***24.5***	***20***
Median		***WxW***	***124***	***7.7***	***21.7***	***21***
		HxH	***126***	***10.4***	***24.5***	***19.5***
Targets		***WxW***	***155***	***9.0***	***37.8***	***18***
		HxH	***155***	***9.0***	***37.8***	***18***

[a] This represents only the WxW Nason program released from the Nason Creek Acclimation Facility. The HxH program was transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 for release because of water-intake concerns at the Nason Creek Acclimation Facility. Statistics on the 2014 brood HxH program pre-release sample at the Chiwawa Acclimation Facility were 134 mean length, 17.5 length CV, 28.6g mean wt., and 16 fpp.

Survival Estimates

Overall survival of Nason Creek spring Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 6.12). There was higher than expected survivals throughout most stages (except unfertilized egg to eyed-egg) contributing to increased program performance. Pre-spawn survival of adults was also above the standard set for the program.

Table 6.12. Hatchery life-stage survival rates (%) for spring Chinook, brood years 2013-2015. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2013	100.0	100.0	93.5	98.8	99.4	98.2	93.8	99.1	86.6
2014[a]	97.3	100.0	91.3	97.6	99.5	99.0	98.1	99.5	87.4
2015	91.9	97.1	94.5	97.9	99.5	99.2	97.9	99.4	90.6
Average	***96.4***	***99.0***	***93.1***	***98.1***	***99.5***	***98.8***	***96.6***	***99.3***	***88.2***
Median	***97.3***	***100***	***93.5***	***97.9***	***99.5***	***99***	***97.9***	***99.4***	***87.4***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] The survival estimates are a combination of the WxW and HxH Nason programs. The WxW program was reared at the Nason Creek Acclimation Facility until release. The HxH Chinook that were reared at the Nason Creek Acclimation Facility until transferred to the Chiwawa Acclimation Facility on 2-3 March 2016 because of water-intake concerns at the Nason Creek Acclimation Facility. The HxH fish were released from the Chiwawa Acclimation Facility on 15-20 April 2016.

6.3 Disease Monitoring

Results of 2017 adult broodstock bacterial kidney disease (BKD) monitoring indicated that most females (94%) had ELISA values less than 0.199. Three percent of the females had ELISA values greater than 0.120, resulting in no limitations to rearing densities (Table 6.13).

For the 2015 brood, a formalin drip treatment was used shortly after transfer to the Nason Creek Acclimation Facility to prevent infection associated with stress caused by the transfer. No significant health issues were encountered for the remainder of juvenile rearing.

Table 6.13. Proportion of bacterial kidney disease (BKD) titer groups for the Nason Creek spring Chinook broodstock by origin, brood years 2013-2017. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year	Optical density values by titer group								Proportion at rearing densities (fish per pound, fpp)[b]			
	Very Low (≤ 0.099)		Low (0.1-0.199)		Moderate (0.2-0.449)		High (≥ 0.450)		≤ 0.125 fpp (<0.119)		≤ 0.060 fpp (>0.120)	
	Wild	Hatch	Wild	Hatch	Wild	Hatch	Wild	Hatch	Wild	Hatch	Wild	Hatch
2013	0.7000	0.3333	0.3000	0.6666	0.0000	0.0000	0.0000	0.0000	0.9231	0.1000	0.0769	0.0000
2014	0.5000	--	0.3000	--	0.0000	--	0.2000	--	0.8000	--	0.2000	--
2015[a]	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.000	0.0000	0.0000
2016	0.8888	0.9118	0.1111	0.0882	0.0000	0.0000	0.0000	0.0000	0.8888	0.9118	0.1111	0.0882
2017	0.9429	0.9375	0.0571	0.0625	0.0000	0.0000	0.0000	0.0000	0.9714	0.9375	0.0286	0.0625
Average	***0.8063***	***0.7957***	***0.1536***	***0.2043***	***0.0000***	***0.0000***	***0.0400***	***0.0000***	***0.9167***	***0.7373***	***0.0833***	***0.0377***
Median	***0.8888***	***0.9247***	***0.1111***	***0.0754***	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.9231***	***0.9247***	***0.0769***	***0.0313***

[a] Determination of origin should be considered preliminary pending scale analyses.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

6.4 Natural Juvenile Productivity

During 2017, juvenile spring Chinook were sampled at the Nason Creek trap.

Smolt and Emigrant Estimates

Numbers of spring Chinook smolts and emigrants were estimated at the Nason Creek trap in 2017. A complete description of trapping operations on Nason Creek can be found in Appendix L.

Nason Creek Trap

The Nason Creek Trap operated between 1 March and 30 November 2017. During that time, the trap was inoperable for 71 days because of low stream discharge or flooding. Daily trap efficiencies were estimated from a flow-efficiency regression model. The daily number of fish captured was expanded by the estimated trap efficiency to estimate total emigration. If a viable flow-efficiency regression model could not be developed, a pooled efficiency was used to expand daily catch. All pooled estimates will be recalculated as flow-efficiency models are developed.

Wild yearling spring Chinook (2015 brood year) were captured primarily from March through April 2017 (Figure 6.4). Because a viable yearling emigrant flow-efficiency regression model could not be established at the downstream trap location, a pooled estimate was employed as a temporary method of expansion. The estimated wild yearling Chinook emigration from the Nason Creek basin was 7,247 (±10,224). Combining the number of subyearling spring Chinook (6,528) that emigrated during the fall of 2016 with the total number of yearling Chinook (7,247) that emigrated during 2017 resulted in an emigrant estimate of 13,775 (±10,330) spring Chinook (Table 6.14). Based on PIT-tag analysis, an additional 4,407 (±1,004) spring Chinook immigrated during the winter (1 December – 28 February) when the trap was inoperable. Thus, the total number of emigrants was 18,182 (±10,379) spring Chinook for the 2015 brood year.

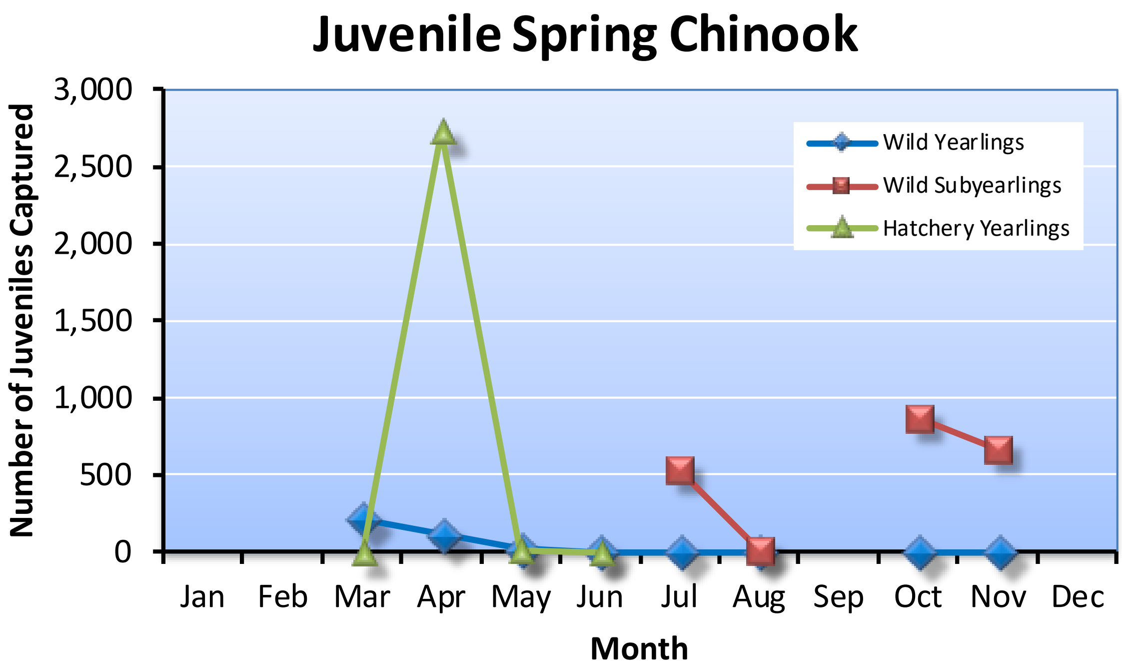


Figure 6.4. Monthly captures of wild subyearling and wild and hatchery yearling spring Chinook at the Nason Creek Trap, 2017.

Table 6.14. Numbers of redds and juvenile spring Chinook at different life stages in the Nason Creek basin for brood years 2002-2016; ND = no data.

Brood year	Number of redds	Egg deposition[a]	Number of subyearling emigrants[b]	Number of smolts produced within Nason Creek basin	Number of emigrants[c]
2002	294	1,368,276	ND	4,683	ND
2003	83	485,052	13,076	6,358	19,425
2004	169	811,031	12,111	2,597	14,708
2005	193	835,111	14,565	8,696	23,261
2006	152	657,248	4,144	7,798	11,942
2007	101	448,541	17,097	5,679	22,776
2008	336	1,542,912	26,284	3,611	29,895
2009	167	763,691	27,720	1,705	29,425
2010	188	811,032	8,685	3,535	12,220
2011	170	745,450	18,457	2,422	20,879
2012	413	1,744,099	34,961	4,561	39,522
2013	212	999,792	21,697	13,814[d]	35,511[d]
2014	115	513,705	7,020	2,372[d]	9,392[d]
2015	85	436,220	6,528	11,654[d]	18,182[d]
2016	85	397,290	26,336	--	--
Average	***184***	***837,297***	***17,049***	***5,678***	***22,088***
Median	***169***	***763,691***	***15,831***	***4,622***	***20,879***

[a] Egg deposition is calculated as the number of redds times the fecundity of both wild and hatchery spring Chinook salmon (from Table 5.5).
[b] Subyearling emigrants does not include fry that left the watershed before 1 July.
[c] Brood years 2002-2012 do not include estimates of numbers of juvenile spring Chinook that emigrated during non-trapping periods (1 Dec to 28 Feb). Brood years 2013 to present include estimates of numbers of juvenile spring Chinook that emigrated during non-trapping periods.
[d] Smolt numbers expanded based on mark-recapture studies during non-trapping periods.

Wild subyearling spring Chinook (2016 brood year) were captured between 3 March and 30 November 2017 (Figure 6.1). Based on capture efficiencies estimated from the flow model, the total number of wild subyearling Chinook emigrating from Nason Creek was 26,336 (±5,213).

Yearling spring Chinook sampled in 2017 averaged 96 mm in length, 9.8 g in weight, and had a mean condition of 1.09 (Table 6.15). Estimated length, weight, and condition for these fish were greater than the overall means of yearling spring Chinook sampled in previous years (overall means, 93 mm, 8.5 g, and 1.05). Subyearling spring Chinook sampled in 2017 at the Nason Creek Trap averaged 74 mm in length, 4.7 g in weight, and had a mean condition of 1.10 (Table 6.15). Fork length and weight estimates were smaller than the overall means of subyearling spring Chinook sampled in previous years (overall means, 77 mm and 5.1 g). Condition factor for subyearlings was greater than the overall mean of previously captured fish (overall mean condition factor = 1.07).

Table 6.15. Mean fork length (mm), weight (g), and condition factor of subyearling and yearling spring Chinook collected in the Nason Creek Trap, 2004-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2004	Subyearling	656	82 (7)	5.9 (1.7)	1.04 (0.11)
	Yearling	323	92 (8)	8.2 (2.3)	1.04 (0.08)
2005	Subyearling	872	76 (9)	4.8 (1.7)	1.02 (0.13)
	Yearling	276	94 (7)	8.7 (2.0)	1.04 (0.12)
2006	Subyearling	1422	73 (9)	3.9 (1.9)	0.92 (0.16)
	Yearling	362	91 (7)	7.5 (1.8)	0.98 (0.11)
2007	Subyearling	609	78 (14)	5.9 (2.6)	1.15 (0.16)
	Yearling	678	88 (9)	7.4 (2.4)	1.05 (0.13)
2008	Subyearling	1,001	75 (14)	5.0 (2.5)	1.10 (0.11)
	Yearling	881	96 (6)	9.5 (2.0)	1.06 (0.09)
2009	Subyearling	2,147	72 (11)	4.4 (2.1)	1.08 (0.08)
	Yearling	162	96 (8)	9.6 (2.4)	1.08 (0.09)
2010	Subyearling	3,032	81 (11)	6.2 (2.3)	1.13 (0.10)
	Yearling	366	97 (7)	10.2 (2.3)	1.10 (0.09)
2011	Subyearling	1,064	72 (13)	4.7 (2.5)	1.13 (0.12)
	Yearling	150	89 (10)	7.7 (1.8)	1.09 (0.12)
2012	Subyearling	2,141	78 (11)	5.3 (2.0)	1.05 (0.09)
	Yearling	363	93 (6)	9.3 (2.2)	1.11 (0.08)

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2013	Subyearling	4,408	70 (11)	3.8 (1.7)	1.03 (0.10)
	Yearling	239	91 (7)	7.9 (2.1)	1.03 (0.07)
2014	Subyearling	1,543	69 (12)	3.8 (2.3)	1.05 (0.06)
	Yearling	464	90 (7)	7.5 (1.8)	1.03 (0.06)
2015	Subyearling	209	84 (8)	6.5 (1.7)	1.08 (0.08)
	Yearling	152	93 (7)	8.4 (2.1)	1.03 (0.09)
2016	Subyearling	490	85 (13)	6.9 (2.5)	1.07 (0.09)
	Yearling	61	96 (6)	9.0 (1.7)	1.01 (0.06)
2017	Subyearling	1,864	74 (12)	4.7 (2.1)	1.10 (0.08)
	Yearling	357	96 (7)	9.8 (2.1)	1.09 (0.07)
Average	***Subyearling***	***1,533***	***76 (5)***	***5.1 (1.0)***	***1.07 (0.06)***
	Yearling	***345***	***93 (3)***	***8.6 (1.0)***	***1.05 (0.04)***
Median	***Subyearling***	***1,243***	***76 (5)***	***4.9 (1.0)***	***1.08 (1.06)***
	Yearling	***340***	***93 (3)***	***8.6 (1.0)***	***1.05 (0.04)***

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 21,115 wild juvenile Chinook (14,184 subyearling and 6,931 yearlings) were PIT tagged and released in 2017 in the Wenatchee River basin (Table 6.16). A total of 5,463 juvenile Chinook were PIT tagged in Nason Creek in 2017. See Appendix C for a complete list of all fish captured, tagged, lost, and released.

Table 6.16. Numbers of wild Chinook that were captured, tagged, and released at different locations within the Wenatchee River basin, 2017. Numbers of fish that died or shed tags are also given.

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Subyearling	12,938	296	8,241	187	0	8,241	1.45
	Yearling	5,824	169	5,711	15	0	5,711	0.26
	Total	**18,762**	**465**	**13,952**	**202**	**0**	**13,952**	**1.08**
Chiwawa River (Electrofishing)	Subyearling	2,740	24	2,703	3	0	2,703	0.11
	Yearling	0	0	0	0	0	0	0.00
	Total	**2,740**	**24**	**2,703**	**3**	**0**	**2,703**	**0.11**
Nason Creek Trap	Subyearling	2,490	190	1,877	5	0	1,877	0.20
	Yearling	357	29	346	1	0	346	0.28
	Total	**2,847**	**219**	**2,223**	**6**	**0**	**2,223**	**0.21**
Nason Creek (Electrofishing)	Subyearling	3,401	63	3,242	42	2	3,240	1.23
	Yearling	0	0	0	0	0	0	0.00
	Total	**3,401**	**63**	**3,242**	**42**	**2**	**3,240**	**1.23**
White River Trap	Subyearling	539	40	507	8	0	507	1.48

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
	Yearling	41	0	41	0	0	41	0.00
	Total	**580**	**40**	**548**	**8**	**0**	**548**	**1.38**
Lower Wenatchee Trap	Subyearling	46,801	36	0	360	0	0	0.77
	Yearling	1,332	8	1,220	7	0	1,220	0.53
	Total	**48,133**	**44**	**1,220**	**367**	**0**	**1,220**	**0.76**
Total:	**Subyearling**	65,880	419	14,186	592	2	14,184	0.90
	Yearling	7,156	177	6,931	22	0	6,931	0.31
Grand Total:		***73,036***	***596***	***21,117***	***614***	***2***	***21,115***	***0.84***

Numbers of wild Chinook salmon PIT-tagged and released as part of CSS and PUD studies during the period 2006-2017 are shown in Table 6.17.

Table 6.17. Summary of the numbers of wild Chinook that were tagged and released at different locations within the Wenatchee River basin, 2006-2017.

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chiwawa Trap	Subyearling	5,130	6,137	8,755	8,765	3,324	6,030	7,644	9,086	11,358	10,471	7,354	8,241
	Yearling	2,793	4,659	8,397	3,694	6,281	4,318	7,980	3,093	4,383	6,204	2,729	5,711
	Total	**7,923**	**10,796**	**17,152**	**12,459**	**9,605**	**10,348**	**15,624**	**12,179**	**15,741**	**16,675**	**10,083**	**13,952**
Chiwawa River (Angling or Electro-fishing)	Subyearling	111	20	43	128	531	0	3,181	3,017	1,032	1,054	1,776	2,703
	Yearling	0	0	0	3	4	0	0	0	0	0	0	0
	Total	**111**	**20**	**43**	**131**	**535**	**0**	**3,181**	**3,017**	**1,032**	**1,054**	**1,776**	**2,703**
Upper Wenatchee Trap	Subyearling	0	15	0	37	3	1	1	0	--	--	--	--
	Yearling	81	1,434	159	296	486	714	75	94	--	--	--	--
	Total	**81**	**1,449**	**159**	**333**	**489**	**715**	**76**	**94**	**--**	**--**	**--**	**--**
Nason Creek Trap	Subyearling	1,434	545	1,741	1,890	2,828	822	1,939	3,290	1,113	219	434	1,877
	Yearling	365	577	894	185	364	147	357	237	456	142	61	346
	Total	**1,799**	**1,122**	**2,635**	**2,075**	**3,192**	**969**	**2,296**	**3,527**	**1,569**	**361**	**495**	**2,223**
Nason Creek (Angling or Electro-fishing)	Subyearling	68	6	4	701	595	0	0	0	1,816	1,089	802	3,240
	Yearling	1	7	0	13	3	0	0	0	0	0	0	0
	Total	**69**	**13**	**4**	**714**	**598**	**0**	**0**	**0**	**1,816**	**1,089**	**802**	**3,240**
White River Trap	Subyearling	0	0	0	441	143	144	285	374	156	149	136	507
	Yearling	0	0	0	265	359	65	180	22	49	34	3	41
	Total	**0**	**0**	**0**	**706**	**502**	**209**	**465**	**396**	**205**	**183**	**139**	**548**
Upper Wenatchee (Angling or Electro-fishing)	Subyearling	0	61	1	0	2	--	--	--	--	--	--	--
	Yearling	27	0	0	0	0	--	--	--	--	--	--	--
	Total	**27**	**61**	**1**	**0**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
	Subyearling	0	0	65	284	233	--	--	--	--	--	--	--

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Middle Wenatchee (Angling or Electro-fishing)	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**65**	**284**	**233**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	0	0	0	--	--	--	--	--	--	--
	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Peshastin Creek (Angling or Electro-fishing)	Subyearling	0	0	0	0	1	--	--	--	--	--	--	--
	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Subyearling	0	0	2	0	0	0	0	0	36	0	18	0
	Yearling	522	1,641	506	468	917	0	0	1,712	1,506	1,301	538	1,220
	Total	**522**	**1,641**	**508**	**468**	**917**	**0**	**0**	**1,712**	**1,542**	**1,301**	**556**	**1,220**
Total:	**Subyearling**	**6,743**	**6,784**	**10,611**	**12,246**	**7,660**	**6,997**	**13,050**	**15,767**	**15,511**	**12,982**	**10,520**	**14,184**
	Yearling	**3,789**	**8,318**	**9,956**	**4,924**	**8,414**	**5,244**	**8,592**	**5,158**	**6,394**	**7,681**	**3,331**	**6,931**
Grand Total:		***10,532***	***15,102***	***20,567***	***17,170***	***16,074***	***12,241***	***21,642***	***20,925***	***21,905***	***20,663***	***13,851***	***21,115***

Freshwater Productivity

Productivity and survival estimates for different life stages of spring Chinook in the Nason Creek watershed are provided in Table 6.18. Estimates for brood year 2015 were generally higher than estimates for brood years 2002-2014. During the period 2002-2015, freshwater productivities ranged from 8-85 smolts/redd and 64-210 emigrants/redd. Survivals during the same period ranged from 0.2-1.7% for egg-smolt and 1.5-4.7% for egg-emigrants.

Table 6.18. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the Nason Creek watershed for brood years 2002-2015; ND = no data. These estimates were derived from data in Table 6.14. Numbers in parentheses are estimates that have been adjusted based on mark-recapture studies conducted during non-trapping periods (for brood years 2013 to present). Summary statistics do not include adjusted estimates.

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2002	16	ND	0.3	ND
2003	77	183	1.3	3.1
2004	15	85	0.3	1.8
2005	45	106	1.0	2.5
2006	51	79	1.2	1.8
2007	56	210	1.3	4.7
2008	11	80	0.2	1.7
2009	10	176	0.2	3.9
2010	19	64	0.4	1.5
2011	14	120	0.3	2.7

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2012	11	96	0.3	2.3
2013	33 (65)	135 (168)	0.7 (1.4)	2.9 (3.6)
2014	8 (21)	69 (82)	0.2 (0.5)	1.5 (1.8)
2015	85 (137)	162 (214)	1.7 (2.7)	3.2 (4.2)
Average	***32***	***128***	***0.7***	***2.6***
Median	***17***	***106***	***0.4***	***2.5***

[a] These estimates include Nason Creek smolts produced only within the Nason Creek basin.

Seeding level (egg deposition) explained most of the variability in productivity and survival of juvenile spring Chinook in the Nason Creek watershed. That is, for estimates based on smolts produced within the Nason Creek watershed (not adjusted for non-trapping periods), survival and productivity decreased as seeding levels increased (Figure 6.5). This suggests that density dependence regulates juvenile productivity and survival within the Nason Creek watershed.

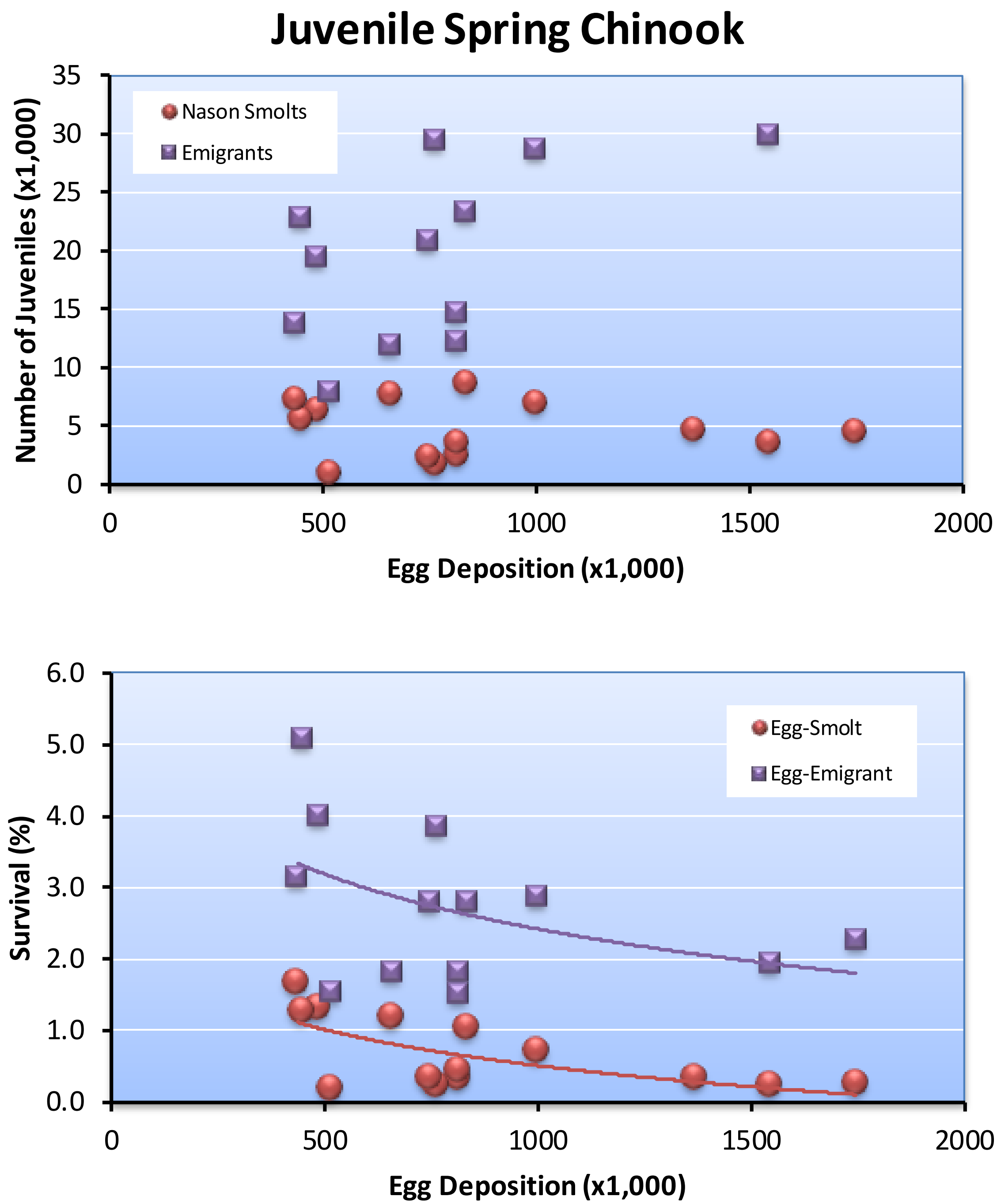


Figure 6.5. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for Nason Creek spring Chinook, brood years 2002-2015. Nason Creek smolts are smolts produced only in the Nason Creek watershed.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[24] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we estimate smolt carrying capacities using the Ricker stock-recruitment model (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods). For consistency, only unadjusted smolt estimates were used to model stock-recruitment relationships (i.e., adjusted estimates based on mark-recapture studies conducted for brood years 2015 to present were not included in the analyses). The Ricker model was the only stock-recruitment model that could be fit to the juvenile spring Chinook data.

Based on the Ricker model, the population carrying capacity for spring Chinook smolts in the Nason Creek watershed is 4,962 smolts (95% CI: -2,042 – 8,625) (Figure 6.6). Here, smolts are defined as the number of yearling spring Chinook produced entirely within Nason Creek. These estimates reflect current environmental conditions (most recent 14 years) within the Nason Creek watershed. Land use activities such as logging, roads, railways, development, and recreation have altered the historical conditions of the watershed. Thus, the estimated population capacity estimates may not reflect historical capacities for spring Chinook smolts in Nason Creek.

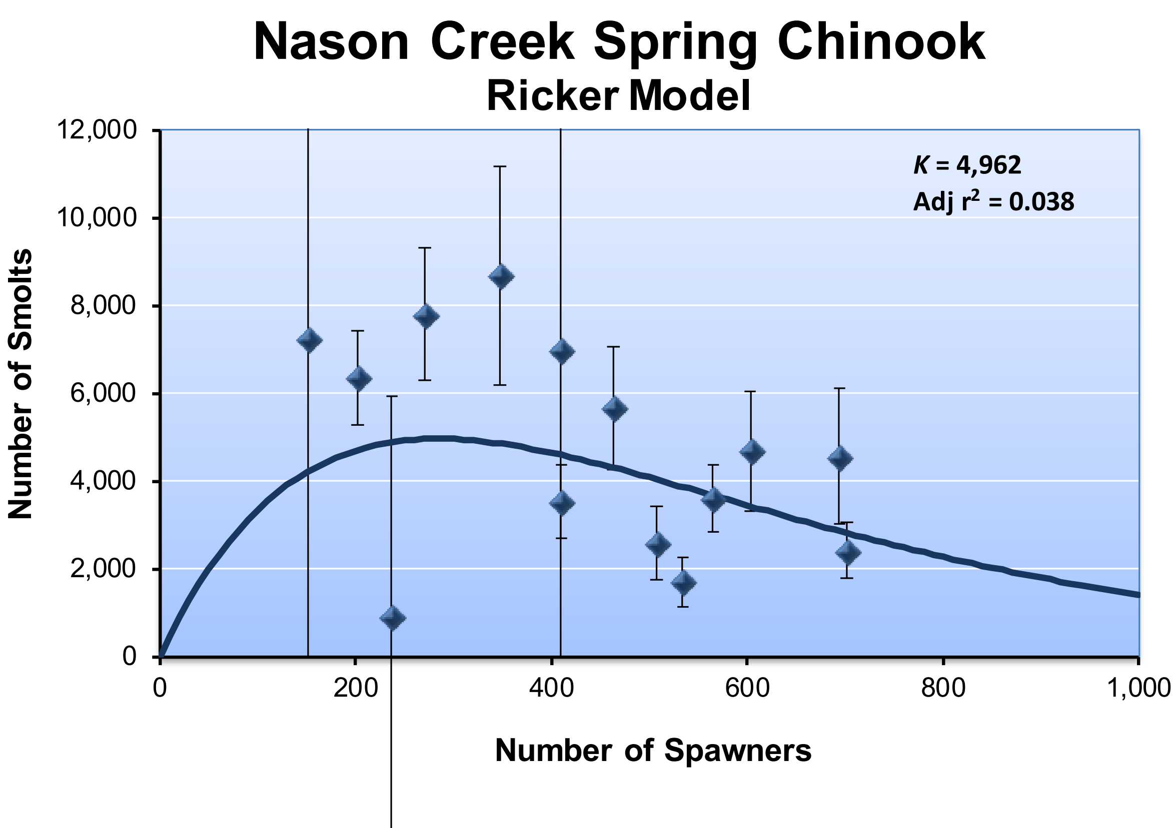


Figure 6.6. Relationship between spawners and number of yearling smolts produced in the Nason Creek watershed. Population carrying capacity (*K*) was estimated using the Ricker model. Vertical bars represent 95% confidence intervals on smolt estimates.

[24] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

We tracked the precision of the Ricker parameters for Nason Creek spring Chinook smolts over time to see if precision improves with additional years of data and the parameters and statistics stabilize over time. Examination of variation in the alpha (*A*) and beta (*B*) parameters of the Ricker model and their associated standard errors and confidence intervals indicates that the parameters have not stabilized, and they lack precision (Table 6.19; Figure 6.7). This was also apparent in the estimates of population carrying capacity (Figure 6.8).

Table 6.19. Estimated parameters and statistics associated with fitting the Ricker model to spawning escapement and smolt data. Smolts represent numbers of smolts produced entirely within the Nason Creek watershed. *A* = alpha parameter; *B* = beta parameter; SE = standard error (estimated from 5,000 bootstrap samples); and r^2 = coefficient of determination. Spawners represent the stock size needed to achieve population capacity.

Years of data	Parameter				Population capacity	Intrinsic productivity	Spawners	r^2
	A	*A* SE	*B*	*B* SE				
5	90.60	87.13	0.0046	0.0015	7,293	91	219	0.453
6	90.02	5618.57	0.0045	0.0014	7,360	90	222	0.442
7	92.67	1696.44	0.0046	0.0009	7,395	93	217	0.517
8	107.07	1208.15	0.0052	0.0012	7,575	107	192	0.454
9	99.89	1125.42	0.0051	0.0012	7,149	100	195	0.409
10	90.35	50.04	0.0049	0.0008	6,825	90	205	0.470
11	72.26	34.50	0.0043	0.0009	6,240	72	235	0.308
12	76.76	31.24	0.0043	0.0008	6,522	77	231	0.337
13	35.98	32.48	0.0030	0.0013	4,412	36	333	0.049
14	47.48	29.79	0.0035	0.0011	4,962	47	284	0.038

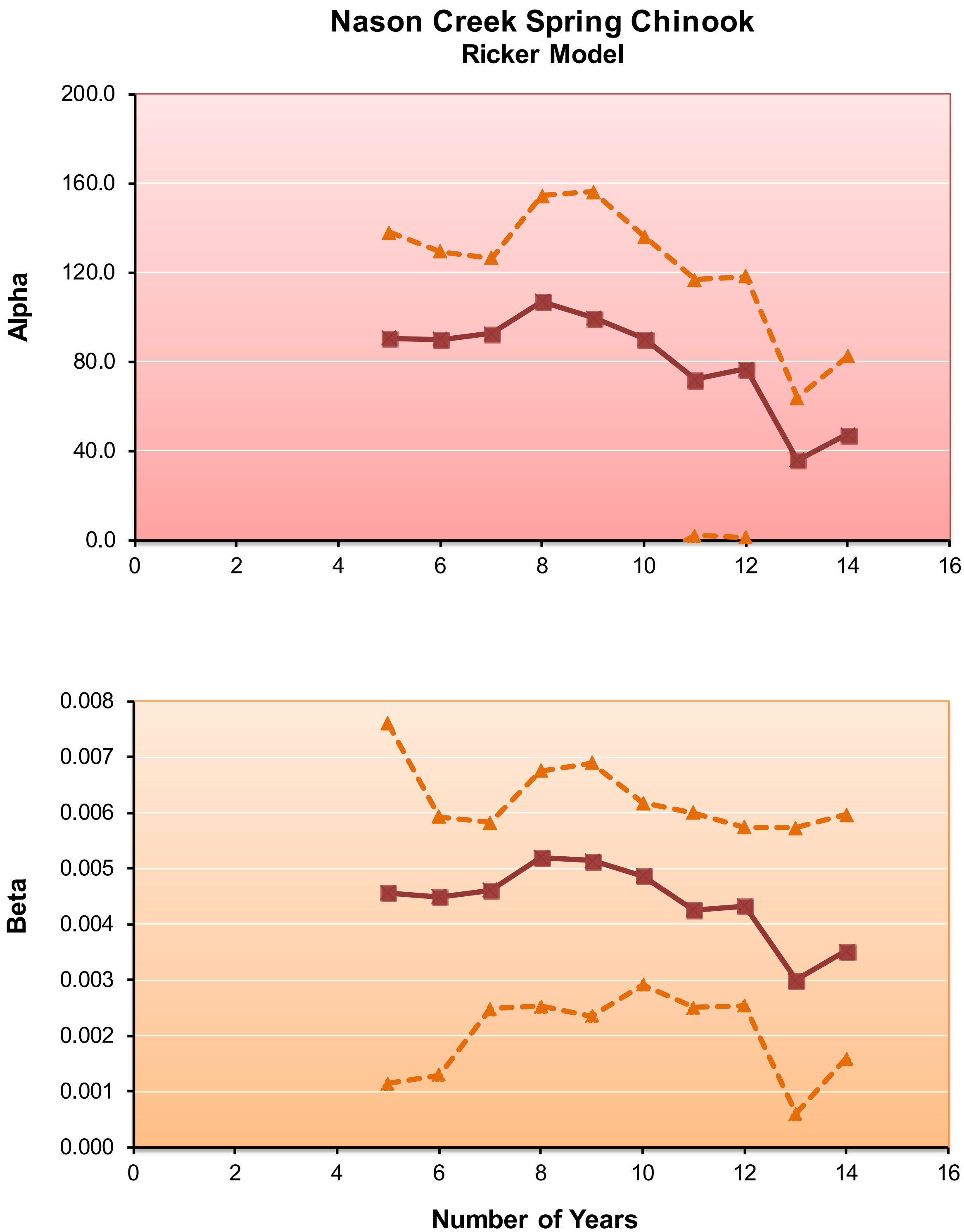


Figure 6.7. Time series of alpha and beta parameters and 95% confidence intervals for the Ricker model that was fit to Nason Creek spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

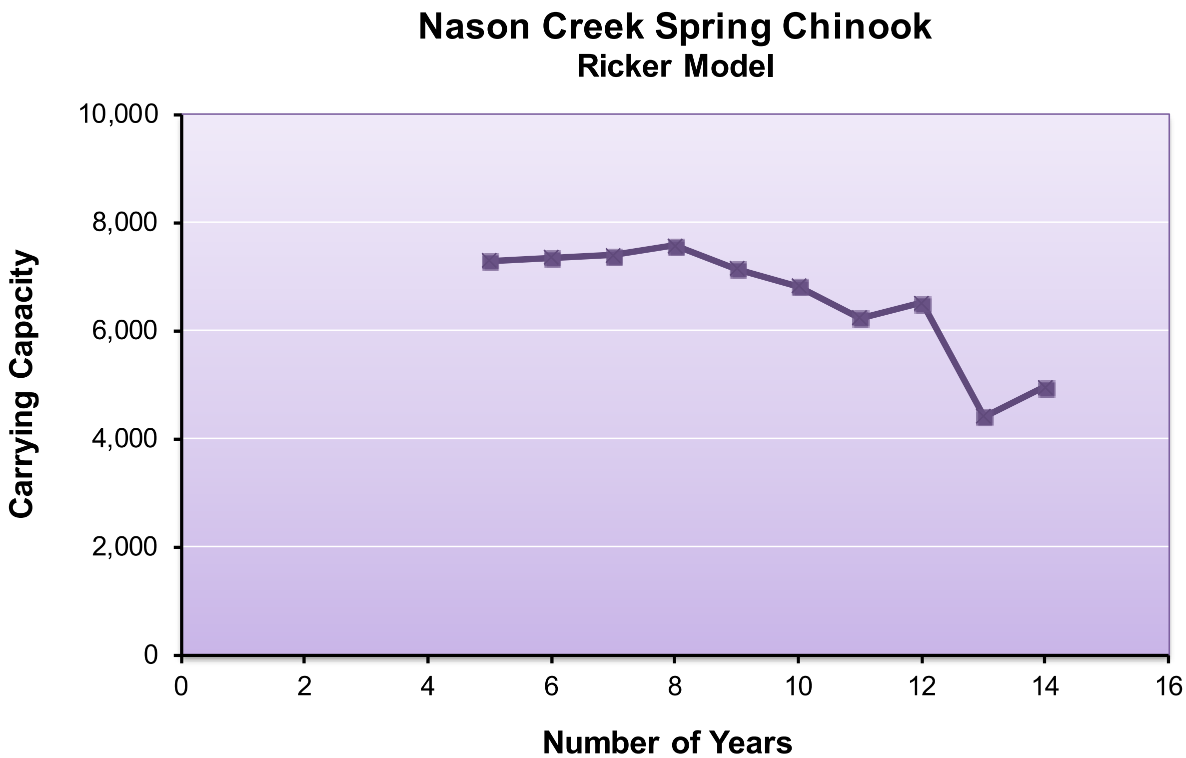


Figure 6.8. Time series of population carrying capacity estimates derived from fitting the Ricker model to Nason Creek spring Chinook smolt and spawning escapement data.

6.5 Spawning Surveys

Surveys for spring Chinook redds were conducted during late July through September 2017 in Nason Creek. In the following section, we describe the number and distribution of redds within the Nason Creek basin.

Redd Counts and Distribution

A total of 68 spring Chinook redds were counted in Nason Creek in 2017 (Table 6.20). This is lower than the average of 142 redds counted during the period 1989-2016 in Nason Creek. Redds were not distributed evenly among the four reaches in Nason Creek. Most redds (93%) were located in Reaches 1, 3, and 4 (Table 6.20).

Table 6.20. Numbers (both counted and estimated) and proportions of spring Chinook redds counted within different reaches within Nason Creek during August through September 2017. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of observed redds	Estimated number of redds*	Proportion of redds estimated within stream/watershed
Nason	Nason 1 (N1)	17	27	0.31
	Nason 2 (N2)	7	6	0.07
	Nason 3 (N3)	27	33	0.38
	Nason 4 (N4)	17	21	0.24
Total		***68***	***87***	***1.00***

* Estimated redds represent the "true" number of redds based on Guassian area-under-the-curve method (see Appendix J).

Spawn Timing

Spring Chinook began spawning during the second week of August in Nason Creek and peaked the last week of August (Figure 6.9). Spawning in Nason Creek ended the third week of September.

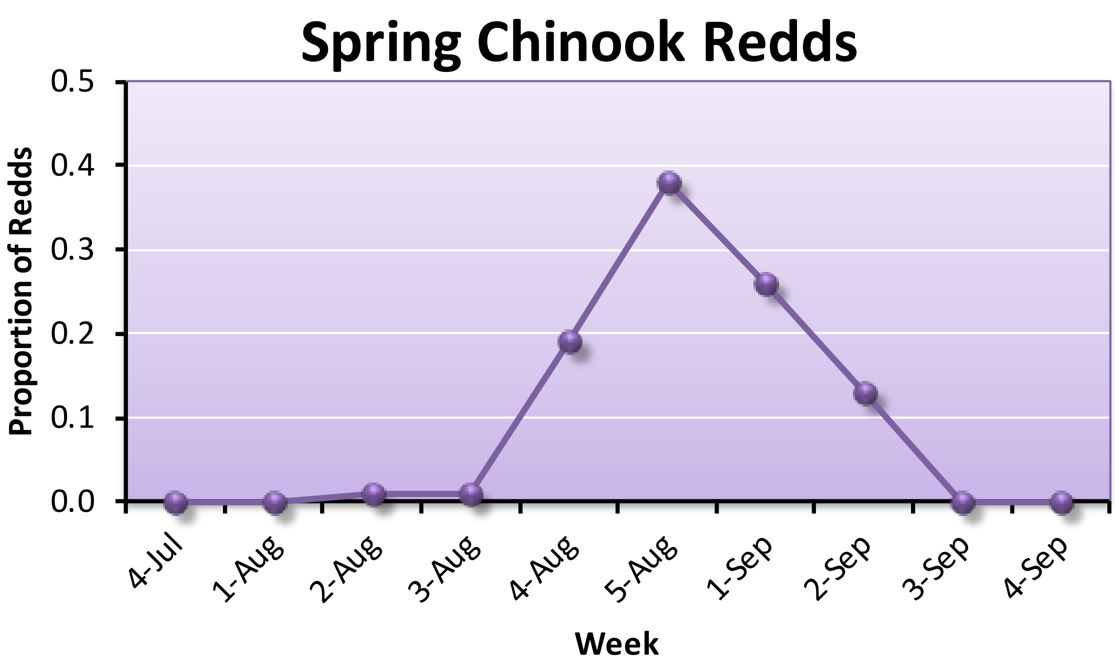


Figure 6.9. Proportion of spring Chinook redds counted during different weeks within Nason Creek, August through September 2017.

Spawning Escapement

Spawning escapement for spring Chinook was calculated as the number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[25] The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2017 was 2.06 (based on sex ratios estimated at Tumwater Dam). Multiplying this ratio by the number of redds counted in Nason Creek resulted in a total spawning escapement of 140 spring Chinook. The estimated total spawning escapement of spring Chinook in 2017 was less than the overall average of 307 spring Chinook in Nason Creek (Table 6.21).

Table 6.21. Spawning escapements for spring Chinook in the Wenatchee River basin for return years 1989-2017; NA = not available.

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
1989	2.27	713	222	102	145	213	1.56	37	NA	**1,419**
1990	2.24	571	231	67	49	81	1.71	86	7	**1,053**
1991	2.33	242	156	42	49	96	1.73	69	2	**626**
1992	2.24	676	181	78	78	85	1.65	61	0	**1,135**
1993	2.20	233	491	134	145	189	1.66	88	8	**1,250**
1994	2.24	184	60	16	7	13	2.11	32	0	**295**
1995	2.51	33	18	0	5	3	2.01	18	0	**68**
1996	2.53	58	83	8	30	3	2.09	25	2	**195**
1997	2.22	182	122	18	33	33	1.69	56	2	**422**
1998	2.21	91	64	18	11	0	1.81	20	0	**195**
1999	2.77	94	22	8	3	6	2.06	12	0	**139**
2000	2.70	346	270	24	22	100	1.68	114	0	**830**
2001	1.60	1,725	598	118	166	349	1.72	151	298	**3,217**
2002	2.05	707	603	86	86	131	1.55	380	166	**1,965**
2003	2.43	270	202	29	36	58	1.93	35	116	**673**
2004[a]	3.56/3.00	851	507	39	66	138	1.76	53	97	**1,686**
2005	1.80	599	347	115	155	257	1.67	13	5	**1,484**
2006	1.78	529	271	37	55	48	1.68	84	17	**1,000**
2007	4.58	1,296	463	101	92	55	1.91	32	21	**2,035**
2008	1.68	1,158	565	64	52	302	1.78	206	37	**2,278**
2009	3.20	1,347	534	125	173	16	2.22	71	33	**2,299**
2010	2.18	1,094	410	83	72	102	1.56	242	8	**1,921**
2011	4.13	2,032	702	124	83	50	2.60	317	68	**3,139**
2012	1.68	1,478	694	72	144	123	1.60	318	16	**2,720**
2013	1.93	1,378	409	98	104	33	1.98	212	8	**2,133**
2014	2.06	999	237	52	54	47	1.93	407	0	**1,600**
2015	1.78	967	151	50	125	98	1.87	247	19	**1,533**
2016	1.83	571	156	40	81	31	1.81	130	4	**953**
2017	2.06	457	140	21	31	19	1.81	72	5	**745**
Average	***--***	***720***	***307***	***61***	***74***	***92***	***--***	***124***	***34***	***1345***
Median	***--***	***599***	***237***	***52***	***66***	***58***	***--***	***72***	***7.5***	***1250***

[25] Expansion factor = (1 + (number of males/number of females)).

[a] In 2004, the fish/redd expansion estimate of 3.56 was applied to the Chiwawa River only and 3.00 fish/redd was applied to the rest of the upper basin.

6.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September 2017 in Nason Creek. In 2017, 78 spring Chinook carcasses were sampled in Nason Creek. Most of these were sampled in Reach 3. The number of carcasses sampled in 2017 was less than the overall average of 145 carcasses sampled during the period 1996-2016.

In the Nason Creek watershed, the spatial distribution of hatchery and wild fish was not equal among survey reaches (Table 6.22). In 2017, more hatchery fish were collected during surveys than wild fish. On average, over the survey years, more hatchery fish were collected than wild fish in each of the reaches except Reach 4 where more wild fish have been collected (Figure 6.10). It should be noted that the hatchery fish spawning in Nason Creek are primarily strays from the Chiwawa spring Chinook Program. Nason Creek hatchery fish began returning to Nason Creek in 2016 as age-3 fish.

Table 6.22. Numbers of wild and hatchery spring Chinook carcasses sampled within different reaches in the Nason Creek watershed, 1999-2017. Numbers represent recovered carcasses that had definitive origins. See Table 2.8 for description of survey reaches.

Survey year	Origin	Survey Reach				Total
		N-1	N-2	N-3	N-4	
1999	Wild	2	3	0	0	**5**
	Hatchery	0	0	0	0	**0**
2000	Wild	19	21	0	9	**49**
	Hatchery	11	9	0	1	**21**
2001	Wild	25	22	0	41	**88**
	Hatchery	91	54	0	22	**167**
2002	Wild	16	34	0	37	**87**
	Hatchery	33	29	0	35	**97**
2003	Wild	6	19	0	22	**47**
	Hatchery	3	9	0	3	**15**
2004	Wild	29	33	18	24	**104**
	Hatchery	42	26	11	3	**82**
2005	Wild	19	6	11	7	**43**
	Hatchery	130	17	22	4	**173**
2006	Wild	24	17	28	9	**78**
	Hatchery	50	31	17	14	**112**
2007	Wild	2	13	8	6	**29**
	Hatchery	54	77	26	15	**172**
2008	Wild	14	13	16	10	**53**
	Hatchery	102	39	36	13	**190**
2009	Wild	1	12	10	16	**39**
	Hatchery	25	21	20	23	**89**
2010	Wild	3	6	6	4	**19**
	Hatchery	47	29	30	16	**122**

Survey year	Origin	Survey Reach				Total
		N-1	N-2	N-3	N-4	
2011	Wild	8	11	11	5	**35**
	Hatchery	22	12	21	8	**63**
2012	Wild	24	11	65	7	**107**
	Hatchery	95	37	70	23	**225**
2013	Wild	4	2	9	8	**23**
	Hatchery	51	12	28	27	**118**
2014	Wild	19	5	13	2	**39**
	Hatchery	25	1	3	0	**29**
2015	Wild	8	4	20	2	**34**
	Hatchery	2	0	7	0	**9**
2016	Wild	9	8	39	15	**71**
	Hatchery	10	0	9	3	**22**
2017	Wild	4	11	15	5	**35**
	Hatchery	3	13	18	8	**42**
Average	***Wild***	***12***	***13***	***14***	***12***	***52***
	Hatchery	***42***	***22***	***17***	***11***	***92***
Median	***Wild***	***9***	***11***	***11***	***8***	***43***
	Hatchery	***33***	***17***	***17***	***8***	***89***

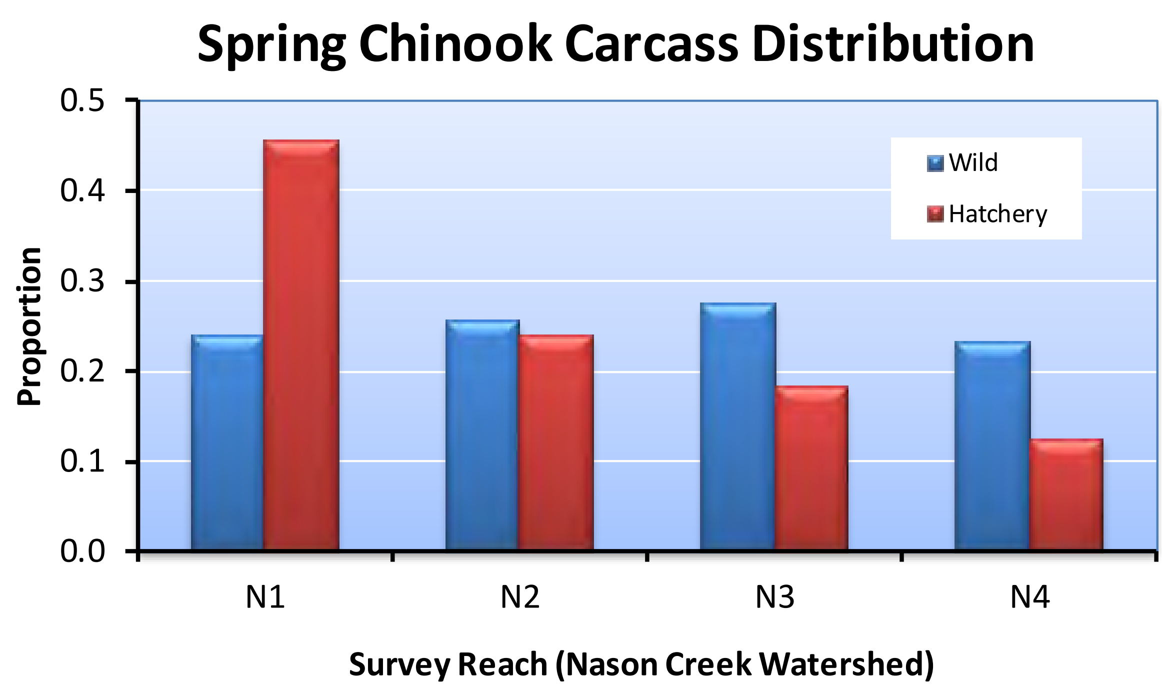


Figure 6.10. Distribution of wild and hatchery produced carcasses in different reaches in the Nason Creek watershed, 1999-2017. Reach codes are described in Table 2.8.

6.7 Life History Monitoring

Life history characteristics of spring Chinook were assessed by examining carcasses on spawning grounds and fish collected at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

In 2017, there was a small difference in migration timing of hatchery and wild spring Chinook past Tumwater Dam (Table 6.23a and b; Figure 6.11). On average, hatchery fish arrived at the dam later than did wild fish but ended their migration earlier than did wild fish. This same pattern was also observed in the overall average. Most hatchery and wild spring Chinook migrated upstream past Tumwater Dam during June and July (Figure 6.11).

Table 6.23a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2017. The average Julian day and date are also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
1998	Wild	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	49
	Hatchery	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	25
1999	Wild	192	11-Jul	207	26-Jul	224	12-Aug	207	26-Jul	173
	Hatchery	200	19-Jul	211	30-Jul	229	17-Aug	213	1-Aug	25
2000	Wild	171	19-Jun	186	4-Jul	194	12-Jul	184	2-Jul	651
	Hatchery	179	27-Jun	189	7-Jul	201	19-Jul	190	8-Jul	357
2001	Wild	154	3-Jun	166	15-Jun	185	4-Jul	167	16-Jun	2,073
	Hatchery	157	6-Jun	169	18-Jun	185	4-Jul	170	19-Jun	4,244
2002	Wild	174	23-Jun	189	8-Jul	204	23-Jul	189	8-Jul	1,033
	Hatchery	178	27-Jun	189	8-Jul	199	18-Jul	189	8-Jul	1,363
2003	Wild	162	11-Jun	181	30-Jun	200	19-Jul	181	30-Jun	919
	Hatchery	157	6-Jun	179	28-Jun	192	11-Jul	178	27-Jun	423
2004	Wild	156	4-Jun	172	20-Jun	189	7-Jul	172	20-Jun	969
	Hatchery	161	9-Jun	177	25-Jun	189	7-Jul	177	25-Jun	1,295
2005	Wild	153	2-Jun	172	21-Jun	193	12-Jul	173	22-Jun	1,038
	Hatchery	153	2-Jun	173	22-Jun	187	6-Jul	172	21-Jun	2,808
2006	Wild	177	26-Jun	184	3-Jul	193	12-Jul	185	4-Jul	577
	Hatchery	178	27-Jun	185	4-Jul	194	13-Jul	186	5-Jul	1601
2007	Wild	169	18-Jun	185	4-Jul	203	22-Jul	185	4-Jul	351
	Hatchery	174	23-Jun	192	11-Jul	209	28-Jul	192	11-Jul	3,232
2008	Wild	173	21-Jun	188	6-Jul	209	27-Jul	189	7-Jul	634
	Hatchery	177	25-Jun	193	11-Jul	210	28-Jul	193	11-Jul	5,368
2009	Wild	174	23-Jun	186	5-Jul	201	20-Jul	187	6-Jul	1,008
	Hatchery	175	24-Jun	187	6-Jul	202	21-Jul	188	7-Jul	4,106

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2010	Wild	173	22-Jun	190	9-Jul	214	2-Aug	191	10-Jul	977
	Hatchery	180	29-Jun	194	13-Jul	213	1-Aug	195	14-Jul	4,450
2011	Wild	183	2-Jul	198	17-Jul	213	1-Aug	198	17-Jul	1,433
	Hatchery	187	6-Jul	200	19-Jul	210	29-Jul	199	18-Jul	4,707
2012	Wild	180	28-Jun	191	9-Jul	205	23-Jul	192	10-Jul	1,482
	Hatchery	182	30-Jun	194	12-Jul	206	24-Jul	194	12-Jul	4,449
2013	Wild	163	12-Jun	182	1-Jul	199	18-Jul	183	2-Jul	1,106
	Hatchery	164	13-Jun	181	30-Jun	195	14-Jul	181	30-Jun	3,681
2014	Wild	171	20-Jun	188	7-Jul	202	21-Jul	187	6-Jul	1,329
	Hatchery	167	16-Jun	182	1-Jul	195	14-Jul	181	30-Jun	2,510
2015	Wild	150	30-May	170	19-Jun	184	3-Jul	170	19-Jun	1,370
	Hatchery	148	28-May	168	17-Jun	180	29-Jun	167	16-Jun	1,773
2016	Wild	158	6-Jun	180	28-Jun	200	18-Jul	181	29-Jun	1,252
	Hatchery	160	8-Jun	179	27-Jun	191	9-Jul	178	26-Jun	1,284
2017	Wild	175	24-Jun	184	3-Jul	195	14-Jul	184	3-Jul	483
	Hatchery	177	26-Jun	185	4-Jul	196	15-Jul	187	6-Jul	1,035
Average	Wild	***168***	--	***183***	--	***198***	--	***183***	--	***945***
	Hatchery	***171***	--	***184***	--	***197***	--	***184***	--	***2,437***
Median	Wild	***171***	--	***185***	--	***200***	--	***185***	--	***993***
	Hatchery	***175***	--	***185***	--	***196***	--	***187***	--	***2,142***

Table 6.23b. The week that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2017. The average week is also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
1998	Wild	23	23	23	23	49
	Hatchery	23	23	23	23	25
1999	Wild	28	30	32	30	173
	Hatchery	29	31	34	31	25
2000	Wild	24	27	27	27	651
	Hatchery	26	27	29	28	357
2001	Wild	22	24	27	24	2,073
	Hatchery	23	25	27	25	4,244
2002	Wild	25	27	30	27	1,033
	Hatchery	26	27	29	27	1,363
2003	Wild	24	26	29	26	919

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	Hatchery	23	26	28	26	423
2004	Wild	23	25	27	25	969
	Hatchery	23	26	27	26	1,295
2005	Wild	22	25	28	25	1,038
	Hatchery	22	25	27	25	2,808
2006	Wild	26	27	28	27	577
	Hatchery	26	27	28	27	1,601
2007	Wild	25	27	29	27	351
	Hatchery	25	28	30	28	3,232
2008	Wild	25	27	30	27	634
	Hatchery	26	28	30	28	5,368
2009	Wild	25	27	29	27	1,008
	Hatchery	25	27	29	27	4,106
2010	Wild	25	28	31	28	977
	Hatchery	26	28	31	28	4,450
2011	Wild	27	29	31	29	1,433
	Hatchery	27	29	30	29	4,707
2012	Wild	26	28	30	28	1,482
	Hatchery	26	28	30	28	4,449
2013	Wild	24	26	29	27	1,106
	Hatchery	24	26	28	26	3,681
2014	Wild	25	27	29	27	1,329
	Hatchery	24	26	28	26	2,510
2015	Wild	22	25	27	25	1,370
	Hatchery	22	24	26	24	1,773
2016	Wild	23	26	29	26	1,252
	Hatchery	23	26	28	26	1,284
2017	Wild	25	27	28	27	483
	Hatchery	26	27	28	27	1,035
Average	Wild	***24***	***27***	***29***	***27***	***970***
	Hatchery	***25***	***27***	***29***	***27***	***2,511***
Median	Wild	***25***	***27***	***29***	***27***	***1,008***
	Hatchery	***25***	***27***	***28***	***27***	***2,510***

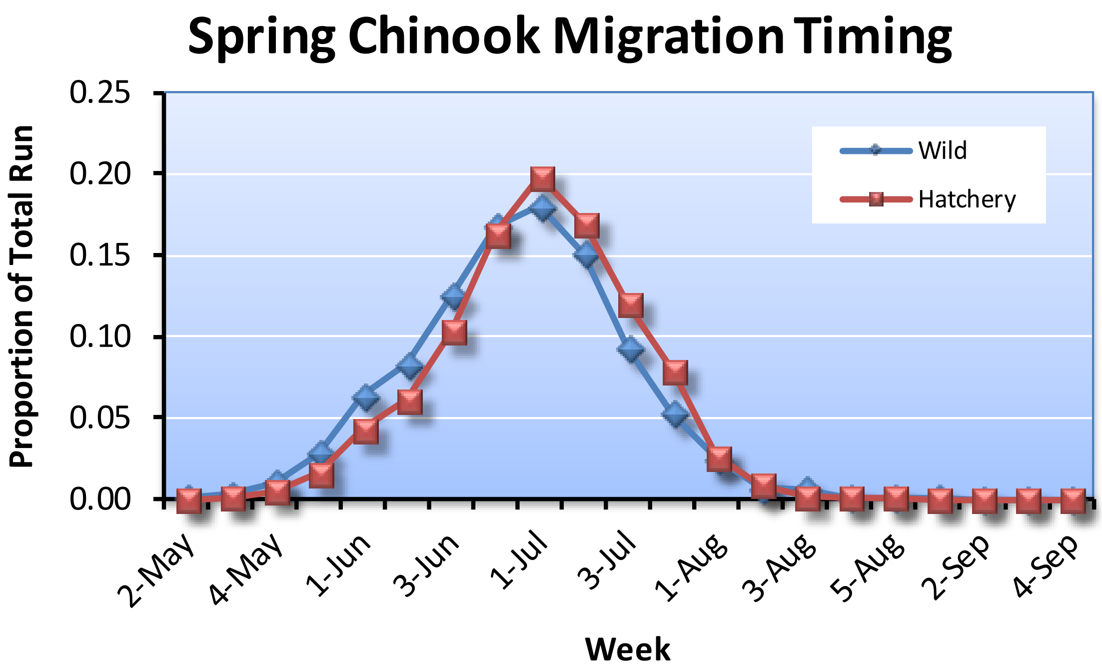


Figure 6.11. Proportion of wild and hatchery spring Chinook observed (using video) passing Tumwater Dam each week during their migration period May through September; data were pooled over survey years 1998-2017.

Age at Maturity

Most of the wild and hatchery spring Chinook sampled during the period 1999-2017 in the Nason Creek watershed were age-4 fish (total age) (Table 6.24; Figure 6.12). Except for 2014 fish, hatchery fish made up a higher percentage of age-3 Chinook than did wild fish. As in other years, a higher proportion of age-5 wild fish returned than did age-5 hatchery fish. Thus, wild fish tended to return at an older age than hatchery fish.

Table 6.24. Numbers of wild and hatchery spring Chinook of different ages (total age) sampled on spawning grounds in the Nason Creek watershed, 1999-2017.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
1999	Wild	0	0	5	0	0	**5**
	Hatchery	0	0	0	0	0	**0**
2000	Wild	0	1	45	0	0	**46**
	Hatchery	0	18	3	0	0	**21**
2001	Wild	0	0	63	13	0	**76**
	Hatchery	0	5	159	3	0	**167**
2002	Wild	0	0	58	23	0	**81**
	Hatchery	0	0	85	11	0	**96**
2003	Wild	0	4	3	36	0	**43**
	Hatchery	0	3	1	5	0	**9**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2004	Wild	0	1	101	1	0	**103**
	Hatchery	0	57	23	2	0	**82**
2005	Wild	0	1	25	17	0	**43**
	Hatchery	0	3	170	0	0	**173**
2006	Wild	0	0	60	18	0	**78**
	Hatchery	0	12	78	22	0	**112**
2007	Wild	0	0	18	11	0	**29**
	Hatchery	0	123	40	9	0	**172**
2008	Wild	0	2	46	4	0	**52**
	Hatchery	0	21	163	6	0	**190**
2009	Wild	0	1	36	2	0	**39**
	Hatchery	0	19	65	4	0	**88**
2010	Wild	0	1	18	0	0	**19**
	Hatchery	0	5	116	1	0	**122**
2011	Wild	0	3	24	8	0	**35**
	Hatchery	0	33	17	13	0	**63**
2012	Wild	0	1	89	17	0	**107**
	Hatchery	0	25	198	2	0	**225**
2013	Wild	0	0	16	7	0	**23**
	Hatchery	0	22	92	5	0	**119**
2014	Wild	0	16	19	3	0	**38**
	Hatchery	0	9	20	0	0	**29**
2015	Wild	0	1	25	4	0	**30**
	Hatchery	0	4	9	0	0	**13**
2016	Wild	0	3	61	7	0	**71**
	Hatchery	0	11	10	0	0	**21**
2017	Wild	0	2	22	8	0	**32**
	Hatchery	0	9	30	2	0	**41**
Average	***Wild***	***0***	***2***	***39***	***9***	***0***	***50***
	Hatchery	***0***	***20***	***67***	***4***	***0***	***92***
Median	***Wild***	***0***	***1***	***25***	***7***	***0***	***43***
	Hatchery	***0***	***11***	***40***	***2***	***0***	***88***

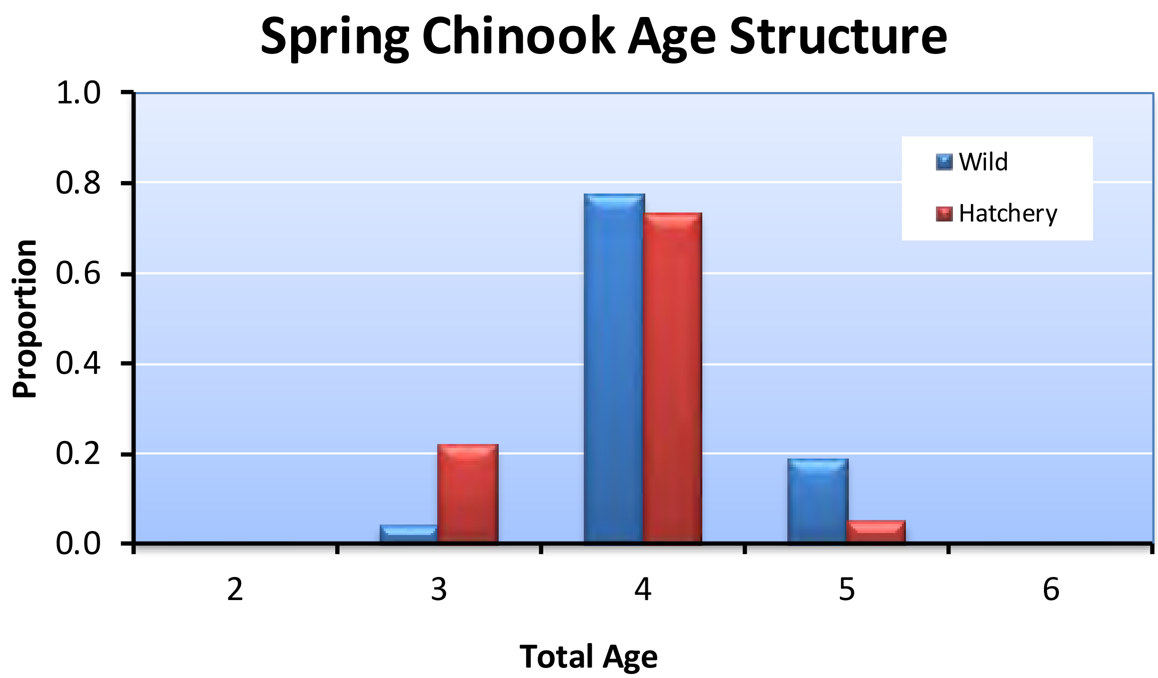


Figure 6.12. Proportions of wild and hatchery spring Chinook of different total ages sampled on spawning grounds in the Nason Creek watershed for the combined years 1999-2017.

Size at Maturity

On average, hatchery and wild spring Chinook of a given age differed little in length (Table 6.25). Differences were usually no more than 5 cm between hatchery and wild fish of the same age.

Table 6.25. Mean lengths (POH in cm; ±1SD) and sample sizes (in parentheses) of different ages (total age) of male and female spring Chinook of wild and hatchery-origin sampled in the Nason Creek watershed, 1999-2017.

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
1999	3	0	0	0	0
	4	71 ±2 (2)	0	64 ±2 (3)	0
	5	0	0	0	0
	6	0	0	0	0
2000	3	46 ±0 (1)	44 ±4 (14)	0	52 ±10 (4)
	4	62 ±4 (19)	0	63 ±3 (25)	60 ±1 (3)
	5	0	0	0	0
	6	0	0	0	0
2001	3	0	47 ±12 (5)	0	0
	4	65 ±4 (21)	66 ±5 (36)	63 ±4 (42)	63 ±4 (123)
	5	81 ±5 (3)	0	72 ±3 (10)	71 ±7 (3)
	6	0	0	0	0

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
2002	3	0	0	0	0
	4	62 ±6 (24)	66 ±5 (35)	63 ±4 (34)	62 ±5 (50)
	5	77 ±4 (12)	81 ±7 (8)	75 ±3 (11)	71 ±5 (3)
	6	0	0	0	0
2003	3	44 ±7 (3)	43 ±5 (3)	0	0
	4	58 ±7 (2)	79 ±0 (1)	67 ±0 (1)	0
	5	75 ±9 (11)	81 ±6 (2)	72 ±6 (25)	71 ±2 (3)
	6	0	0	0	0
2004	3	46 ±0 (1)	43 ±4 (56)	0	0
	4	61 ±4 (35)	60 ±3 (6)	61 ±3 (66)	62 ±4 (17)
	5	0	0	81 ±0 (1)	73 ±4 (2)
	6	0	0	0	0
2005	3	37 ±0 (1)	41 ±7 (3)	0	0
	4	59 ±6 (8)	63 ±4 (54)	61 ±3 (17)	61 ±3 (116)
	5	73 ±5 (4)	0	71 ±1 (13)	0
	6	0	0	0	0
2006	3	0	41 ±3 (12)	0	0
	4	60 ±5 (26)	62 ±3 (29)	61 ±3 (34)	59 ±4 (49)
	5	72 ±5 (10)	73 ±5 (6)	69 ±4 (8)	70 ±4 (16)
	6	0	0	0	0
2007	3	0	44 ±4 (122)	0	51 ±0 (1)
	4	62 ±4 (6)	60 ±7 (13)	63 ±4 (12)	61 ±4 (27)
	5	77 ±5 (7)	67 ±5 (3)	68 ±2 (4)	70 ±2 (6)
	6	0	0	0	0
2008	3	51 ±21 (2)	45 ±5 (20)	0	45 ±0 (1)
	4	60 ±5 (15)	63 ±4 (42)	61 ±3 (31)	63 ±3 (121)
	5	0	77 ±2 (3)	71 ±3 (4)	64 ±7 (3)
	6	0	0	0	0
2009	3	41 ±0 (1)	46 ±5 (18)	0	65 ±0 (1)
	4	60 ±5 (12)	63 ±4 (19)	60 ±3 (24)	61 ±4 (46)
	5	0	71 ±1 (2)	72 ±4 (2)	73 ±3 (2)
	6	0	0	0	0
2010	3	44 ±0 (1)	45 ±5 (5)	0	0
	4	62 ±5 (7)	63 ±4 (42)	61 ±3 (10)	62 ±4 (74)
	5	0	75 ±0 (1)	0	0
	6	0	0	0	0
2011	3	48 ±11 (3)	43 ±4 (31)	0	48 ±2 (2)
	4	61 ±5 (11)	59 ±11 (6)	60 ±5 (12)	63 ±5 (11)
	5	79 ±2 (3)	73 ±3 (6)	75 ±4 (5)	70 ±3 (7)
	6	0	0	0	0
2012	3	41 ±0 (1)	42 ±3 (24)	0	0

Return year	Total age	Mean length (cm)			
		Male		Female	
		Wild	Hatchery	Wild	Hatchery
	4	61 ±7 (35)	60 ±5 (45)	61 ±4 (54)	60 ±4 (151)
	5	77 ±4 (6)	0	66 ±5 (11)	70 ±3 (2)
	6	0	0	0	0
2013	3	0	42 ±4 (21)	0	0
	4	60 ±6 (5)	62 ±4 (23)	60 ±4 (10)	60 ±4 (69)
	5	71 ±0 (1)	75 ±0 (1)	68 ±3 (6)	70 ±4 (4)
	6	0	0	0	0
2014	3	44 ±5 (15)	49 ±4 (9)	60 ±0 (1)	0
	4	64 ±7 (8)	59 ±4 (8)	63 ±3 (11)	60 ±3 (12)
	5	0	0	69 ±8 (3)	0
	6	0	0	0	0
2015	3	44 ±0 (1)	45 ±1 (4)		
	4	61 ±7 (15)	56 ±4 (3)	63 ±5 (10)	58 ±2 (6)
	5	72 ±7 (3)		65 ±0 (1)	
	6				
2016	3	43 ±2 (3)	46 ±5 (10)		45 ±0 (1)
	4	64 ±6 (32)	65 ±1 (3)	64 ±5 (29)	60 ±2 (7)
	5	67 ±0 (1)		71 ±5 (6)	
	6				
2017	3	42 ±1 (2)	48 ±4 (9)		
	4	62 ±6 (9)	64 ±6 (15)	60 ±3 (13)	63 ±4 (15)
	5	71 ±4 (3)		70 ±11 (5)	69 ±1 (2)
	6				

Contribution to Fisheries

Because the Nason Creek program began in 2013, there will be no harvest information on Nason Creek hatchery spring Chinook until 2018, when brood year 2013 fish return.

Straying

Stray rates will be determined by examining CWTs and PIT tags recovered on spawning grounds within and outside the Wenatchee River basin. Targets for strays based on return year (recovery year) within the Wenatchee River basin should be less than 10% and targets for strays outside the Wenatchee River basin should be less than 5%. Straying of Nason Creek spring Chinook will be estimated beginning in 2018 when the 2013 brood fish return.

Genetics

Because the Nason Creek spring Chinook program began in 2013 with the collection of broodstock, there are no studies that examine the effects of the program on the genetics of natural-origin spring Chinook in the Wenatchee River basin. However, genetic studies were conducted to determine the potential effects of the Chiwawa Supplementation Program on natural-origin spring Chinook in the upper Wenatchee River basin (Blankenship et al. 2007; the entire report is appended as Appendix K). This work included the analysis of Nason Creek spring Chinook. Researchers collected microsatellite DNA allele frequencies from temporally replicated natural and hatchery-origin spring Chinook to statistically assign individual fish to specific demes (locations) within the Wenatchee population.

Significant differences in allele frequencies were observed within and among major spawning areas in the Upper Wenatchee River basin. However, these differences made up only a very small portion of the overall variation, indicating genetic similarity among the major spawning areas. There was no evidence that the Chiwawa program has changed the genetic structure (allele frequency) of spring Chinook in Nason Creek and the White River, despite the presence of hatchery-origin spawners in both systems.

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford’s (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[26] The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1989-2012, when no brood stock was collected for the Nason Creek Program, the PNI values ranged from 0.28 to 1.00 (Table 6.26). During this period, PNI values varied over time because of Chiwawa spring Chinook straying into Nason Creek. For brood years 2013-2017, a period when brood stock was collected for the Nason Creek Program, PNI values for the Nason Creek Program ranged from 0.46 to 0.77 (Table 6.26).

Table 6.26. Proportionate Natural Influence (PNI) Index of hatchery spring Chinook spawning in Nason Creek, brood years 1989-2017. See notes below the table for description of each metric.

Brood year	Spawners					Broodstock			PNI
	NOS	HOS_N	HOS_S	$pHOS_N$	$pHOS_{N+S}$	NOB_N	HOB_N	pNOB	
1989	222	0	0	0.00	0.00	0	0	*1.00*	1.00
1990	231	0	0	0.00	0.00	0	0	*1.00*	1.00
1991	156	0	0	0.00	0.00	0	0	*1.00*	1.00
1992	181	0	0	0.00	0.00	0	0	*1.00*	1.00
1993	430	0	61	0.00	0.12	0	0	*1.00*	0.90
1994	60	0	0	0.00	0.00	0	0	*0.67*	1.00
1995	18	0	0	0.00	0.00	0	0	*0.00*	1.00
1996	58	0	25	0.00	0.30	0	0	*0.44*	0.61

[26] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

Brood year	Spawners					Broodstock			PNI
	NOS	HOS_N	HOS_S	$pHOS_N$	$pHOS_{N+S}$	NOB_N	HOB_N	pNOB	
1997	67	0	55	0.00	0.45	0	0	*0.29*	0.42
1998	61	0	3	0.00	0.05	0	0	*0.28*	0.86
1999	22	0	0	0.00	0.00	0	0	*0.00*	1.00
2000	189	0	81	0.00	0.30	0	0	*0.30*	0.52
2001	257	0	341	0.00	0.57	0	0	*0.30*	0.37
2002	313	0	290	0.00	0.48	0	0	*0.28*	0.39
2003	152	0	50	0.00	0.25	0	0	*0.44*	0.65
2004	297	0	210	0.00	0.41	0	0	*0.39*	0.51
2005	81	0	266	0.00	0.77	0	0	*0.33*	0.32
2006	117	0	154	0.00	0.57	0	0	*0.29*	0.36
2007	83	0	380	0.00	0.82	0	0	*0.29*	0.28
2008	139	0	426	0.00	0.75	0	0	*0.27*	0.29
2009	163	0	371	0.00	0.69	0	0	*0.46*	0.42
2010	59	0	351	0.00	0.86	0	0	*0.44*	0.35
2011	250	0	452	0.00	0.64	0	0	*0.46*	0.43
2012	220	0	474	0.00	0.68	0	0	*0.66*	0.50
Average*	***159***	***0***	***166***	***0.00***	***0.36***	***0***	***0***	***0.48***	***0.63***
Median*	***154***	***0***	***71***	***0.00***	***0.36***	***0***	***0***	***0.42***	***0.52***
2013	70	0	339	0.00	0.83	21	4	0.84	0.55
2014	169	0	68	0.00	0.29	21	0	1.00	0.54
2015	28	0	123	0.00	0.81	59	63	0.48	0.46
2016	125	0	31	0.00	0.20	70	66	0.51	0.77
2017	65	10	65	0.07	0.54	70	67	0.51	0.55
Average**	***91***	***2***	***125***	***0.01***	***0.53***	***48***	***40***	***0.67***	***0.57***
Median**	***70***	***0***	***68***	***0.00***	***0.54***	***59***	***63***	***0.51***	***0.55***

HOS_N = hatchery-origin spawners in Nason Creek from the Nason Creek spring Chinook Supplementation Program.
$pHOS_N$ = proportion of hatchery-origin spawners from Nason Creek spring Chinook Supplementation Program.
HOS_S = stray hatchery-origin spawners in Nason Creek.
$pHOS_S$ = proportion of stray hatchery-origin spawners.
NOB_N = natural-origin broodstock spawned in the Nason Creek spring Chinook Supplementation Program.
HOB_N = hatchery-origin broodstock spawned in the Nason Creek spring Chinook Supplementation Program.
pNOB = proportion of hatchery-origin broodstock. Because of the high incidence of strays to Nason Creek from the Chiwawa River spring Chinook program, pNOB values from the Chiwawa program were used to estimate PNI values during the period from 1989 to 2012 (*italicized*). The weighting for those years was 100% based on the Chiwawa program broodstock selection, because there have been no hatchery returns from the Nason Creek spring Chinook program (see Table 5.1 for Chiwawa broodstock selection).
PNI_N = Proportionate Natural Influence for Nason Creek spring Chinook calculated using the gene-flow model for multiple programs.
* Average and median for the period 1989-2012, a period when no brood stock were collected for the Nason Creek Program.
** Average and median for the period 2013-present, a period when brood stock was collected for the Nason Creek Program.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery spring Chinook from the Nason Creek release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 6.27).[27] Over the brood years for which PIT-tagged hatchery fish were released, survival rates from Nason Creek to McNary Dam ranged from 0.346 to 0.572. Average travel time from Nason Creek to McNary Dam ranged from 21 to 38 days. SARs from release to detection at Bonneville Dam will be calculated in 2018 with the return of 2013 brood fish.

Table 6.27. Total number of Nason hatchery spring Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2013-2015. Standard errors are shown in parentheses. NA = not available (i.e., not all the adults from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2013	20,139	0.346 (0.030)	38.1 (5.9)	NA
2014	5,007	0.572 (0.038)	20.6 (5.3)	NA
2015	5,050 (HxH)	0.482 (0.052)	27.3 (6.8)	NA
	5,047 (WxW)	0.515 (0.055)	27.3 (7.0)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on brood-year harvest rates from the Chiwawa Hatchery program. For brood years 1989-2011, NRR for spring Chinook in Nason Creek averaged 0.82 (range, 0.05-5.48) if harvested fish were not included in the estimate and 0.90 (range, 0.05-5.86) if harvested fish were included in the estimate (Table 6.28). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and will be calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 6.7 (the calculated target value in Hillman et al. 2017). The target value of 6.7 includes harvest and was based on HRRs for Chiwawa spring Chinook salmon. HRRs will be calculated beginning in 2018 with the return of 2013 brood fish.

[27] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Table 6.28. Spawning escapements, natural-origin recruits (NOR), and natural replacement rates (NRR; with and without harvest) for spring Chinook in the Nason Creek watershed, brood years 1989-2011.

Brood year	Spawning Escapement	Harvest not included		Harvest included	
		NOR	NRR	NOR	NRR
1989	222	171	0.77	249	1.12
1990	231	15	0.06	18	0.08
1991	156	21	0.13	23	0.15
1992	181	47	0.26	49	0.27
1993	491	133	0.27	137	0.28
1994	60	3	0.05	3	0.05
1995	18	22	1.22	23	1.28
1996	83	229	2.76	250	3.01
1997	122	306	2.51	339	2.78
1998	64	351	5.48	375	5.86
1999	22	14	0.64	15	0.68
2000	270	337	1.25	354	1.31
2001	598	77	0.13	79	0.13
2002	603	123	0.20	128	0.21
2003	202	63	0.31	67	0.33
2004	507	131	0.26	141	0.28
2005	347	155	0.45	160	0.46
2006	271	118	0.44	148	0.55
2007	463	210	0.45	251	0.54
2008	565	244	0.43	274	0.48
2009	534	71	0.13	77	0.14
2010	410	113	0.28	140	0.34
2011	702	195	0.28	263	0.37
Average	***310***	***137***	***0.82***	***155***	***0.90***
Median	***270***	***123***	***0.31***	***140***	***0.37***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) will be calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. SARs will be calculated beginning in 2018 with the return of all 2013 brood fish.

6.8 ESA/HCP Compliance

Broodstock Collection

Collection of brood year 2015 broodstock for Nason Creek spring Chinook targeted a combination of 78 natural-origin adults and 66 hatchery-origin adults intercepted at Tumwater Dam. Total broodstock achieved for the 2015 brood Nason Creek spring Chinook program was 78 and 63 natural and hatchery-origin adults, respectively. A total of 62 bull trout were handled and/or observed during broodstock collection at Tumwater Dam in 2015.

Hatchery Rearing and Release

The 2015 brood Nason Creek spring Chinook reared throughout all life stages without significant mortality (defined as >10% population mortality associated with a single event). A total of 111,040 WxW and 132,087 HxH smolts were released (88.8% of 2015 conservation program goal and 108.7% of the aggregate Nason program goal). Survival from green-egg through release survival was 90.6%, well above the 81.0% target.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18120, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or at the Nason Creek acclimation facility during the period 1 January through 31 December 2017. NPDES monitoring and reporting for PUD Hatchery Programs during 2017 are provided in Appendix F.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit No. 1196, 18118, 18120, and 18121 the permit holders are authorized a direct take of 20% of the emigrating spring Chinook population during juvenile emigration monitoring and a lethal take not to exceed 2% of the fish captured (NMFS 2003). Based on the estimated wild spring Chinook population (smolt trap expansion) and hatchery juvenile spring Chinook population estimate (hatchery release data) for the Wenatchee River basin, the reported spring Chinook encounters during 2017 emigration monitoring complied with take provisions in the Section 10 permit. Spring Chinook encounter and mortality rates for each trap site (including PIT tag mortalities) are detailed in Table 6.29. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permit 18118, 18120, and 18121, Section B. Table 6.24 includes incidental and direct take associated with the Nason Creek smolt trap operated by the Yakama Nation under separate permits.

Table 6.29. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2017.

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Chiwawa Trap								
Population	53,344	163,411	95,063	5,824	4,518	12,928	23,280	
Encounter rate	NA	NA	NA	0.1092	0.0276	0.1361	0.0747	0.20
Mortality[c]	NA	NA	NA	15	0	187	202	
Mortality rate	NA	NA	NA	0.0026	0.0000	0.0145	0.0087	0.02
White River Trap								
Population	2,942	NA	4,851	41	NA	593	634	
Encounter rate	NA	NA	NA	0.0139	NA	0.1222	0.0814	0.20
Mortality[d]	NA	NA	NA	0	NA	8	8	
Mortality rate	NA	NA	NA	0.0000	NA	0.0135	0.0126	0.02

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Nason Creek Trap								
Population	7,247	243,127	26,336	357	1,870	2,490	4,717	
Encounter rate	NA	NA	NA	0.0493	0.0077	0.0945	0.0170	0.20
Mortality[d]	NA	NA	NA	1	0	5	6	
Mortality rate	NA	NA	NA	0.0028	0.0000	0.0020	0.0013	0.02
Lower Wenatchee Trap								
Population	130,426	406,558	7,593,243	1,332	12,132	46,801	60,265	
Encounter rate	NA	NA	NA	0.0102	0.0298	0.0062	0.0074	0.20
Mortality[d]	NA	NA	NA	7	24	360	391	
Mortality rate	NA	NA	NA	0.0053	0.0020	0.0077	0.0065	0.02
Wenatchee River Basin Total								
Population	130,426	406,558	7,593,243	7,554	18,520	62,812	88,896	
Encounter rate	NA	NA	NA	0.0579	0.0456	0.0083	0.0110	0.20
Mortality[d]	NA	NA	NA	23	24	560	607	
Mortality rate	NA	NA	NA	0.0030	0.0013	0.0089	0.0068	0.02

[a] Smolt population estimate derived from juvenile emigration trap data.
[b] 2015 BY smolt release data for the Wenatchee River basin.
[c] Based on size, date of capture and location of capture, subyearling Chinook encountered at the Lower Wenatchee Trap are categorized as summer Chinook salmon.
[d] Combined trapping and PIT tagging mortality.

Precocity Monitoring

For the purpose of addressing permit requirements, we used the PIT Tag Information System (PTAGIS) to identify probable hatchery-origin mini-jack spring Chinook from Nason Creek in 2015, 2016, and 2017. The query results returned fish that were last detected after 1 July of the year in which they were released. Fish that remained in freshwater during this time period were likely precocious males. We looked for detections in three regions: lower Columbia River mainstem dams (Bonneville, The Dalles, and McNary dam), mid-Columbia mainstem dams (Priest Rapids and Rock Island dams), and within the Wenatchee River basin. The occurrence of mini-jacks was rare, ranging from less than 0.04% to 0.27% of the tagged population (Table 6.30).

Table 6.30. Numbers of Nason Creek hatchery spring Chinook with final PIT-tag detections after 1 July of the release year. These fish are likely mini-jacks. Lower Columbia River detections occurred at Bonneville, The Dalles, and McNary dam, while Mid-Columbia River detections occurred at Priest Rapids and Rock Island dams.

Year	Number of PIT tags released	Number of tags detected in Lower Columbia River	Number of tags detected in Mid-Columbia River	Number of tags detected within the Wenatchee River basin	Percent of tagged population
2015	20,139	6	0	49	0.27
2016	5,017	4	0	0	0.08
2017	10,098	3	0	1	0.04

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2017, as authorized by ESA Section 10 Permits 18118, 18120, and 18121. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Spring Chinook Reproductive Success Study

ESA Section 10 Permit 1196 (expired) and new Section 10 Permits 18118, 18120, and 18121 specifically provide authorization to capture, anesthetize, biologically sample, PIT tag, and release adult spring Chinook at Tumwater Dam for reproductive success studies and general program monitoring. During 2010 through 2017, all spring Chinook passing Tumwater Dam were enumerated, anesthetized, biologically sampled, PIT tagged, and released (not including hatchery-origin and natural-origin Chinook retained for broodstock) as a component of the reproductive success study (BPA Project No. 2003-039-00). Please refer to Ford et al. (2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2017.

SECTION 7: WHITE RIVER SPRING CHINOOK

The White River spring Chinook salmon captive brood program began in 1997 with goals to conserve, aid in the recovery, and prevent the extinction of naturally spawning spring Chinook in the White River, and to meet the mitigation responsibilities of Grant County PUD. Collection of eggs or juveniles from the White River (brood years 1997-2009) made up the first-generation (F_1) component of the White River captive brood program. Initially, rearing occurred at AquaSeed in Rochester, Washington, but transitioned to the Little White Salmon National Fish Hatchery near Cook, Washington, in 2006. The F_1 component was reared to maturation and spawned within the hatchery. The resulting progeny (F_2) were then reared in the hatchery until final acclimation and released in the upper Wenatchee Basin. The first large release of F_2 juveniles was in 2008. The last release of juveniles from the captive brood program occurred in 2015 (brood year 2013).

The production goal for the White River captive brood program following the 2013 hatchery recalculation was to release 74,556 yearling smolts into the upper Wenatchee River basin at 18-24 fish per pound. Fish lengths and weights for the recent broods were manipulated to evaluate different approaches for reducing precocious maturation. All fish were marked with CWTs. In addition, from 2008 through 2015, a portion of juvenile spring Chinook were PIT tagged annually.

Since its inception, the captive brood program underwent several adaptive changes designed to improve program success. These changes included: (1) use of a pedigree approach to reduce the use of stray fish in the broodstock, (2) transfer of fish from Aquaseed to the Little White Salmon National Fish Hatchery to improve fish quality, (3) injection of hormones into F_1 females to improve maturation of eggs, (4) manipulation of diet and ration for the F_2 fish to reduce precocious maturation of males, (5) use of temporary tanks and natural enclosures during acclimation to improve homing, and (6) trucking juvenile fish around Lake Wenatchee to improve survival.

The following information focuses on results from monitoring the White River spring Chinook program. More detailed information on the White River program can be found in Lauver et al. (2012).

7.1 Captive Brood Collection

The captive brood program was designed to provide a rapid, short-term demographic boost to the White River spring Chinook spawning aggregate, which was at a high risk of local extinction (Lauver et al. 2012). This section describes the collection of broodstock for the White River program.

Brood Collection and Rearing

A primary objective of the White River program was to collect progeny of naturally spawning spring Chinook in the White River. The progeny (eggs or juveniles) make up the first-generation (F_1) of the captive brood program. However, strays from the Chiwawa supplementation program made this a challenge. As a result, researchers attempted to identify the origin of spawners on redds in the White River and then focused egg and juvenile collection efforts on those redds that had the highest likelihood of being produced from White River parents. During most years, this limited the number of redds from which eggs or juveniles could be collected. Starting with brood year

2006, a pedigree approach was adopted to improve the likelihood that eggs or juveniles used in the captive brood program were of White River origin.

During 1997 to 2009, first-generation broodstock for the captive brood program originated from about 10,353 natural-origin eggs and juveniles collected from 122 redds in the White River. Broodstock from brood year 1997 were trapped as parr with nets in the fall of 1998. Broodstock from brood year 2006 were trapped as fry with nets in the spring of 2007. It was assumed that the parr and fry near known redds were produced from those redds, and origin was confirmed with pedigree analyses. All other brood years were collected as eggs in the fall using redd pumping techniques. Broodstock collection levels were calculated based on the following assumptions and the known number of suitable redds each year (Tonseth and Maitland 2011):

1. 150,000 smolt target/0.70 (green egg to release survival) = 214,000 green eggs
2. 214,000 green eggs/1,500 eggs per female = 143 females/0.50 (sex ratio) = 286 fish
3. 286 fish/0.30 (eyed egg to maturity survival) = 953 eyed eggs
4. 953 eyed eggs/**X** redds = **Y** eyed-eggs per redd

Eyed eggs or juveniles collected in the White River were transported to Aquaseed (brood years 1997-2007) or to the Little White Salmon Hatchery (brood years 2008-2009) and reared to adults. Table 7.1 summarizes the collection of eyed eggs or juveniles for the captive brood program.

Table 7.1. Numbers of eyed eggs or juvenile brood stock collected for the White River captive brood program, brood years 1997-2009 (2009 was the last year for broodstock collection). Also shown are the number of redds that were sampled for eggs or juveniles and the hatchery in which the fish were reared (LWSFH = Little White Salmon Fish Hatchery); NS = no sample.

Brood year	Number of eyed eggs collected	Number of juvenile Chinook collected	Number of redds sampled	Rearing facility
1997	0	527 (parr)	8	Aquaseed
1998	182	0	4	Aquaseed
1999	NS	NS	NS	--
2000	272	0	NS	Aquaseed
2001	NS	NS	NS	--
2002	167	0	3	Aquaseed
2003	250	0	8	Aquaseed
2004	1,216	0	10	Aquaseed
2005	2,733	0	21	Aquaseed/LWSFH[1]
2006	0	1,487 (fry)	29	Aquaseed/ LWSFH[2]
2007	1,153	0	13	Aquaseed/ LWSFH[3]
2008	933	0	11	LWSFH
2009	1,433	0	15	LWSFH
Average	***927***	***1,007***	***12***	

[1] Fish were transferred on 30 June and 2 July 2008 and 20 January 2009.
[2] Fish were transferred on 21 October and 13 November 2008.
[3] Fish were transferred on 26 September and 21 October 2008.

7.2 Hatchery Spawning and Release

Captive Brood Spawning

As noted above, eyed eggs or juveniles collected in the White River were transported to Aquaseed (for brood years 1997-2007) or to the Little White Salmon Hatchery (for brood years 2008-2009) and reared to adults (Lauver et al. 2012). After rearing broodstock to maturity in captivity, adult spring Chinook were spawned and their progeny were grown to smolt size, acclimated to White River water, and ultimately released into the White River, Lake Wenatchee, or trucked and released in the Wenatchee River downstream from Lake Wenatchee.

During spawning, eggs and sperm were collected and those gametes were crossed based on a 2x2 factorial spawning matrix. That is, each female was spawned with two males and each male was spawned with two females. Using pedigree analysis, spawning crosses were arranged to maximize genetic diversity. Because incomplete maturation of ova was an issue in the program, implementation of hormone treatments began in 2011 to facilitate maturation. In addition, following spawning, milt from excess males was collected for cryopreservation. Based on a pilot study, the cryopreserved milt was relatively ineffective at fertilizing eggs, so it was not used widely in the program. There are no plans to use the cryopreserved milt in the future. It is noteworthy that most of the males used in spawning were mini-jacks and there were many females that matured at age 3. Table 7.2 shows the ages of first-generation males and females spawned for the captive brood program.

Table 7.2. Total ages of first-generation (F_1) male and female spring Chinook spawned for the White River captive brood program, spawning years 2001-2011; NA = not available.

Spawning year	Sex	Total age				Total
		2	3	4	5	
2001	Female	0	0	3	0	3
	Male	0	2	0	0	2
2002	Female	0	0	4	4	8
	Male	10	0	0	0	10
2003	Female	0	5	0	0	5
	Male	0	2	0	0	2
2004	Female	0	0	2	0	2
	Male	4	0	0	0	4
2005	Female	0	85*	0	0	85
	Male	90	1	0	0	91
2006	Female	2	104	110	0	216
	Male	104	6	0	0	110
2007	Female	0	21	118	1	140
	Male	113	7	0	0	120
2008	Female	0	58	0	0	58
	Male	NA	NA	NA	NA	NA

Spawning year	Sex	Total age				Total
		2	3	4	5	
2009	Female	0	0	119	0	119
	Male	65	54	0	0	119
2010	Female	0	0	42	0	42
	Male	22	23	0	0	45
2011	Female	0	0	0	150	150
	Male	0	148	2	0	150
Average	***Female***	***0***	***25***	***36***	***14***	***75***
	Male	***41***	***24***	***0***	***0***	***65***
Median	***Female***	***0***	***0***	***3***	***0***	***58***
	Male	***16***	***4***	***0***	***0***	***68***

* Included some unknown number of second-generation females.

Release Information

Numbers released

Several different acclimation and release scenarios were conducted since 1997. Acclimation scenarios have involved naturalized features such as in-channel enclosures, stream-side tanks supplied with pass-through surface water, and net pens in Lake Wenatchee near the mouth of the White River. Release scenarios have included on-site releases from tanks, in-channel enclosures, and net pens in Lake Wenatchee. The low survival of fish released in the lake and White River prompted exploring the release of fish near the mouth of the lake and downstream from the lake. In 2010, acclimated fish were towed in net pens to the mouth of the lake and released there. In 2011, tank and net-pen acclimated fish were loaded into transport trucks and released into the Wenatchee River. In addition, subyearling and yearling Chinook with no acclimation have been released from transport trucks directly into Lake Wenatchee and the White River. A total of 944,591 second-generation (F_2) juvenile spring Chinook have been released from the captive brood program. Table 7.3 summarizes the acclimation and release history of F_2 spring Chinook released into the upper Wenatchee River basin.

Table 7.3. Numbers of White River juvenile spring Chinook released and their acclimation histories for brood years 2002-2013.

Brood year	Acclimation site	Acclimation vessel	Number of smolts released	Release scenario	Release date	Number of acclimation days
2002	WR RM 11.5	Tanks	2,589	White River	4/22/2004	17
2003	WR RM 11.5	Tanks	2,096	White River	5/2/2005	47
2004	WR RM 11.5	Tanks	1,639	White River	4/4/2006	0
2005	Lake Wen	Net Pens	69,032	Lake Wen	5/2/2007	34
2006	NA	NA	139,644*	White River	4/17, 4/25/2007	0
	NA	NA	142,033	White River	3/18, 3/20/2008	0
2007	Lake Wen	Net Pens	87,671	Lake Wen	5/5/2009	35-40

Brood year	Acclimation site	Acclimation vessel	Number of smolts released	Release scenario	Release date	Number of acclimation days
	None	None	44,172	Lake Wen	4/1/2009	0
2008	WR Bridge	Eddy Pen	10,156	Escape	~4/12/2010	~10
	Lake Wen	Net Pens	38,400	Mouth of lake	5/5, 5/6/2010	38-41
2009	WR RM 11.5	Side Channel	12,000	Escape	~3/31/2011	~7
	WR RM 11.5	Tanks	10,000	White River	5/12/2011	49
	WR Bridge	Tanks	28,000	White River	5/14/2011	51
	WR Bridge	Tanks		Wen River	5/13/2011	50
	WR Bridge	Eddy Pen	14,596	Escape	~3/27/2011	~3
	Lake Wen	Net Pens	48,000	Wen River	5/14/2011	46
	Lake Wen	Net Pens		Wen River	5/14/2011	44
2010	WR Bridge	Tanks	18,850	Wen River	5/9/2012	44
2011	WR Bridge	Tanks	42,000	Wen & White R	5/6, 5/7, 5/8/13	49, 50, 51
	Lake Wen	Net Pens	105,000	Wen River	5/8, 5/13, 5/14/13	51, 56, 57
2012	WR Bridge	Tanks	42,000	Wen River	5/6/14	50
	Lake Wen	Net Pens	55,713	Wen River	5/8/14	49
2013	WR Bridge	Tanks	31,000	Wen River	5/4/15	56

* Subyearling release.

Numbers tagged

Brood years 2005 and 2007-2013 spring Chinook were tagged with a CWT in their peduncle. None of these fish were adipose fin clipped.[28] Subyearling fish from the 2006 brood year were tagged with half of a CWT in their snouts. Yearling fish from the 2006 brood year were tagged with CWTs in the peduncle. None of these fish were adipose fin clipped. In addition, beginning in 2008 (brood year 2006), 258,375 juvenile spring Chinook have been PIT tagged before release. Table 7.4 identifies the number of second-generation (F_2) juvenile spring Chinook tagged with PIT tags.

Table 7.4. Numbers of second-generation (F2) White River spring Chinook smolts tagged and released in the upper Wenatchee River basin, brood years 2002-2013.

Brood year	Acclimation site	Acclimation vessel	Release scenario	CWT mark rate	Number released that were PIT tagged	Number of smolts released
2002	WR RM 11.5	Tanks	White River	0.00	0	2,589
2003	WR RM 11.5	Tanks	White River	0.00	0	2,096
2004	WR RM 11.5	Tanks	White River	0.00	0	1,639

[28] Given that juvenile spring Chinook were tagged with CWTs in the peduncle and were not ad-clipped, it is possible that field crews missed hatchery-origin adults on the spawning grounds because they did not know they were supposed to sample fish with adipose fins. Thus, this bias in carcass sampling may bias derived metrics such as spawning distribution of hatchery and natural-origin fish, spawn timing of hatchery and natural-origin fish, age at maturity, size at maturity, contributions to fisheries, HOR, NOR, HRR, NRR, PNI, straying, and SARs.

Brood year	Acclimation site	Acclimation vessel	Release scenario	CWT mark rate	Number released that were PIT tagged	Number of smolts released
2005	Lake Wen	Net Pens	Lake Wen	1.00	0	69,032
2006	NA	NA	White River	0.00	29,881	139,644*
	NA	NA	White River	0.00		142,033
2007	Lake Wen	Net Pens	Lake Wen	1.00	29,863	87,671
	None	None	Lake Wen	1.00	9,957	44,172
2008	WR Bridge	Eddy Pen	Escape	1.00	38,148	10,156
	Lake Wen	Net Pens	Lake Mouth	1.00		38,400
2009	WR RM 11.5	Side Channel	Escape	1.00	41,886	12,000
	WR RM 11.5	Tanks	White River	1.00		10,000
	WR Bridge	Tanks	White River	1.00		28,000
	WR Bridge	Tanks	Wen River	1.00		
	WR Bridge	Eddy Pen	Escape	1.00		14,596
	Lake Wen	Net Pens	Wen River	1.00		48,000
	Lake Wen	Net Pens	Wen River	1.00		
2010	WR Bridge	Tanks	Wen River	1.00	12,283	18,850
2011	WR Bridge	Tanks	Wen & White	1.00	2,490	42,000
	Lake Wen	Net Pens	Wen River	1.00	51,697	105,000
2012	WR Bridge	Tanks	Wen River	1.00	52,097	42,000
	Lake Wen	Net Pens	Wen River	1.00		55,713
2013	WR Bridge	Tanks	Wen River	1.00	19,954	31,000

* Subyearling release.

Fish size and condition at release

Table 7.5 summarizes the size and condition of second-generation White River juvenile spring Chinook released in the upper Wenatchee River basin.

Table 7.5. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of second-generation White River (WR) juvenile spring Chinook released in the upper Wenatchee River basin, brood years 2002-2013. Size targets are provided in the last row of the table. NA = not available.

Brood year	Acclimation site	Release scenario	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2002	WR RM 11.5	White River	NA	NA	NA	NA
2003	WR RM 11.5	White River	166	12.4	53.7	8
2004	WR RM 11.5	White River	207	11.6	117.7	4
2005	Lake Wen	Lake Wen	145	9.7	36.9	31
2006	NA	White River	NA	NA	NA	NA
	NA	White River	NA	NA	NA	NA

Brood year	Acclimation site	Release scenario	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
2007	Lake Wen	Lake Wen	135	7.8	29.2	29
	None	Lake Wen	NA	NA	NA	NA
2008	WR Bridge	Escape	--	--	--	--
	Lake Wen	Mouth of lake	138	10.0	32.5	14
2009	WR RM 11.5	Escape	--	--	--	--
	WR RM 11.5	White River	134	8.7	29.3	16
	WR Bridge	White River	138	9.3	28.6	16
	WR Bridge	Wen River	NA	NA	NA	NA
	WR Bridge	Escape	--	--	--	--
	Lake Wen	Wen River	140	8.9	31.6	14
	Lake Wen	Wen River	142	9.8	39.3	12
2010	WR Bridge	Wen River	125	8.0	22.8	20
2011	WR Bridge	Wen & White	130	8.4	24.1	19
	Lake Wen	Wen River	128	8.2	24.0	19
2012	WR Bridge	Wen River	131	8.1	24.2	18.8
	Lake Wen	Wen River	NA	NA	NA	NA
2013	WR Bridge	Wen River	132	8.7	24.5	19
Average			142	9.3	37.0	17

Post-Release Survival

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of released second-generation (F_2) White River spring Chinook smolts to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam.[29] Based on the available data, post-release survival has been low for fish released into the White River and Lake Wenatchee (Table 7.6). In contrast, survival of fish released in the Wenatchee River tends to be higher than those released in the White River or in Lake Wenatchee. These results suggest that high mortality in Lake Wenatchee may explain why adult returns of program fish have been consistently poor; however, other factors such as high precocious maturation may also contribute to the estimated low survival (e.g., see Ford et al. 2015).

Average travel time from release to McNary Dam ranged from 21 to 82 days (Table 7.6). Spring Chinook released in the Wenatchee River typically traveled faster to McNary Dam than those released in the White River or in Lake Wenatchee. Because of uncertain release times for several groups, we were unable to estimate travel times for all release groups.

[29] It is important to point out that because of fish size differences among rearing net pens, tanks, or raceways, fish PIT tagged in one pen, tank, or raceway may not represent untagged fish rearing in other pens, tanks, or raceways.

Table 7.6. Survival and travel times (mean days) of second-generation (F2) White River spring Chinook smolts to McNary Dam and SARs to Bonneville Dam for different release scenarios, brood years 2006-2013. Values in parentheses represent the standard error of the estimate. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Release scenario	Number of Chinook released with PIT tags	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2006	White River	29,881	0.037 (0.008)	82.3 (16.1)	0.000 (0.000)
2007	Lake Wen Pens	29,863	0.096 (0.010)	NA	0.000 (--)
	Lake Wenatchee	9,957	0.080 (0.015)	NA	0.000 (--)
2008	Lake Wenatchee	38,146	0.065 (0.010)	65.2 (14.0)	0.001 (0.000)
2009	White and Wenatchee rivers	19,913	0.269 (0.027)	22.9 (9.2)	0.002 (0.000)
	White River	21,829	0.055 (0.013)	45.6 (21.0)	0.000 (0.000)
2010	Wenatchee River	12,283	0.267 (0.017)	NA	0.001 (0.000)
2011	Wenatchee River	2,490	0.385 (0.042)	21.7 (6.2)	0.004 (0.001)
	White and Wenatchee rivers	51,697	0.433 (0.010)	23.4 (12.7)	0.003 (0.000)
2012	Wenatchee River	52,113	0.353 (0.013)	20.9 (6.9)	0.001 (0.000)
2013	Wenatchee River	19,954	0.328 (0.026)	20.6 (5.7)	NA

7.3 Disease Monitoring

First-Generation Health Maintenance

First-generation (F_1) adults were fed an azithromycin-medicated feed in the spring to prevent bacterial kidney disease (BKD), which is a common affliction of spring Chinook salmon. As needed, fish received a dose of 20 mg/kg of body weight. The fish also received formalin treatments as needed throughout the year to prevent and treat fungus infections. This was especially important during the pre-spawning period when individual fish were maturing in preparation for spawning. Formalin treatments were conducted three times per week and consist of one hour of flow-through at a concentration of 167 parts per million (ppm).

Second-Generation Health Maintenance

Following fertilization and initial incubation in September, second-generation (F_2) eggs were shocked in October. Eggs were treated with a 1,667 ppm formalin solution in a 15-minute flow-through treatment three times a week to prevent fungus growth. Formalin treatments ended after hatching, and water flow was increased from three to five gallons per minute. Dead and deformed fry were removed before relocating the fry to nursery tanks in late January or early February. Fry were then relocated to raceways in July, where they remained until transfer to the White River for acclimation the following March. Coded-wire tagging was typically conducted in July, and PIT tagging occurred the following January or February, just before the fish were transferred to acclimation facilities on the White River in March.

7.4 Natural Juvenile Productivity

Juvenile productivity estimation began with the monitoring of emigration of spring Chinook in the White River in 2007 (Lauver et al. 2012). A five-foot diameter rotary screw trap is operated annually from about 1 March through November. A second screw trap was installed in 2017 to increase catch and improve capture efficiency estimates. The purpose of the program is to estimate the number and timing of subyearlings and yearling spring Chinook emigrating from the White River basin.

Smolt and Emigrant Estimates

In 2017, the White River Trap operated between 1 March and 30 November 2017. During that period, the trap was intentionally pulled for four days during periods of high discharge. Daily trap efficiencies were estimated by conducting mark-recapture trials. The daily number of fish captured was expanded by the estimated trap efficiency to estimate daily total emigration. If trap efficiencies could not be assessed because of low numbers of juvenile Chinook trapped, a composite model based on efficiency trials from previous years was used to calculate abundance. Daily captures of fish and results of mark-recapture efficiency tests at the White River trap are reported in Appendix M.

Wild yearling spring Chinook (2015 brood year) were captured primarily from March through April 2017 (Figure 7.1). Based on a composite regression model, the total number of wild yearling Chinook emigrating from the White River was 2,942 (±2,625). Combining the total number of subyearling spring Chinook (2,430 ±723) that emigrated during the fall of 2016 with the total number of yearling Chinook (2,942) that emigrated during 2017 resulted in a total emigrant estimate of 5,372 (±2,723) spring Chinook for the 2015 brood year (Table 7.7).

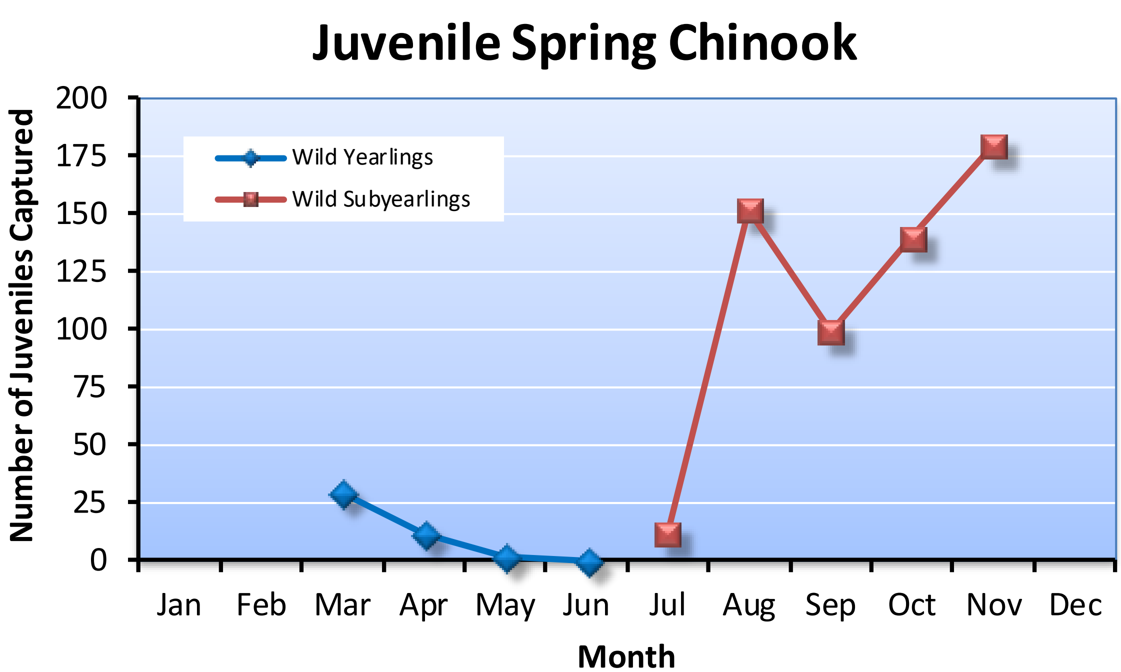


Figure 7.1. Monthly captures of wild subyearling (parr) and yearling spring Chinook at the White River Trap, 2017.

Table 7.7. Numbers of redds and juvenile spring Chinook at different life stages in the White River basin for brood years 2005-2016; ND = no data.

Brood year	Number of redds	Egg deposition[a]	Number of subyearling emigrants[b]	Number of smolts produced within White River basin	Number of emigrants
2005	86	372,122	ND	4,856	ND
2006	31	134,044	652	2,004	2,656
2007	20	88,820	2,309	3,395	5,704
2008	31	142,352	5,560	5,193	10,753
2009	54	246,942	2,428	2,939	5,367
2010	33	142,362	1,859	4,103	5,962
2011	20	87,700	3,128	1,659	4,787
2012	86	363,178	3,816	3,995	7,811
2013	54	254,664	2,461	3,023	5,484
2014	26	105,170	1,950	386	2,336
2015	70	339,290	2,430	2,942	5,372
2016	44	196,548	4,851	--	--
Average[c]	***46***	***206,099***	***2,859***	***3,136***	***5,623***
Median[c]	***39***	***169,455***	***2,430***	***3,023***	***5,428***

[a] Egg deposition is calculated as the number of redds times the fecundity of both wild and hatchery spring Chinook salmon (from Table 5.5.

[b] Subyearling emigrants do not include fry that left the watershed before 1 July.

[c] Average and median are based on the entire time series of data, not just the period 2006 through 2012.

Wild subyearling spring Chinook (2016 brood year) were captured between 16 March and 30 November 2017, with peak catch during October (Figure 7.1). Based on a composite regression model, the total number of wild subyearling Chinook emigrating from the White River was 4,851 (±1,373).

Yearling spring Chinook sampled in 2017 averaged 99 mm in length, 10.7 g in weight, and had a mean condition of 1.11 (Table 7.8). The estimated length and weight were less than the overall means of yearling spring Chinook sampled in previous years, while condition factor was higher (overall means, 100 mm, 11.3 g, and 1.10). Subyearling spring Chinook parr sampled in 2017 at the White River Trap averaged 85 mm in length, averaged 7.1 g, and had a mean condition of 1.09 (Table 7.8). Estimated length, weight, and condition were all less than or equal to the overall means of subyearling spring Chinook sampled in previous years (overall means, 90 mm, 8.5 g, and 1.09).

Table 7.8. Mean fork length (mm), weight (g), and condition factor of subyearling (parr) and yearling spring Chinook collected in the White River Trap, 2007-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Life stage	Sample size[a]	Mean size		
			Length (mm)	Weight (g)	Condition (K)
2007	Subyearling	33	95 (12)	9.8 (4.1)	1.07 (0.11)
	Yearling	173	93 (9)	8.6 (2.2)	1.03 (0.09)
2008	Subyearling	202	95 (9)	9.4 (2.5)	1.08 (0.13)
	Yearling	105	100 (12)	11.3 (3.3)	1.07 (0.13)
2009	Subyearling	499	85 (11)	7.1 (2.6)	1.09 (0.11)
	Yearling	274	104 (6)	12.5 (2.6)	1.11 (0.10)
2010	Subyearling	168	87 (13)	7.8 (3.1)	1.12 (0.11)
	Yearling	346	100 (7)	11.2 (2.4)	1.12 (0.09)
2011	Subyearling	145	94 (9)	9.3 (2.5)	1.10 (0.10)
	Yearling	64	99 (8)	11.3 (2.8)	1.14 (0.09)
2012	Subyearling	285	91 (10)	8.9 (2.7)	1.13 (0.09)
	Yearling	179	98 (8)	10.9 (2.8)	1.14 (0.08)
2013	Subyearling	444	84 (12)	6.6 (2.5)	1.05 (0.09)
	Yearling	20	102 (7)	12.3 (3.0)	1.12 (0.14)
2014	Subyearling	185	86 (14)	7.5 (3.3)	1.10 (0.11)
	Yearling	43	94 (7)	9.4 (2.2)	1.11 (0.13)
2015	Subyearling	148	96 (8)	9.9 (2.3)	1.11 (0.07)
	Yearling	31	104 (7)	13.0 (2.8)	1.14 (0.07)
2016	Subyearling	147	89 (11)	8.3 (2.8)	1.13 (0.10)
	Yearling	3	106 (2)	12.4 (0.3)	1.05 (0.03)
2017	Subyearling	516	85 (10)	7.1 (2.3)	1.09 (0.02)
	Yearling	36	99 (6)	10.7 (2.3)	1.11 (0.08)
Average	***Subyearling***	***252***	***90 (5)***	***8.3 (1.2)***	***1.10 (0.02)***
	Yearling	***116***	***100 (4)***	***11.2 (1.3)***	***1.10 (0.04)***
Median	***Subyearling***	***185***	***89 (5)***	***8.3 (1.2)***	***1.10 (0.02)***
	Yearling	***64***	***100 (4)***	***11.3 (1.3)***	***1.11 (0.04)***

[a] Sample size represents the number of fish that were measured for both length and weight.

PIT Tagging Activities

As part of the Comparative Survival Study (CSS) and PUD studies, a total of 21,115 wild juvenile Chinook (14,184 subyearling and 6,931 yearlings) were PIT tagged and released in 2017 in the Wenatchee River basin (Table 7.9). A total of 548 juvenile Chinook were PIT tagged in the Wihte River in 2017. See Appendix C for a complete list of all fish captured, tagged, lost, and released.

Table 7.9. Numbers of wild Chinook that were captured, tagged, and released at different locations within the Wenatchee River basin, 2017. Numbers of fish that died or shed tags are also given.

Sampling location	Life stage	Number captured	Number of recaptures	Number tagged	Number died	Shed tags	Total tagged fish released	Percent mortality
Chiwawa Trap	Subyearling	12,938	296	8,241	187	0	8,241	1.45
	Yearling	5,824	169	5,711	15	0	5,711	0.26
	Total	**18,762**	**465**	**13,952**	**202**	**0**	**13,952**	**1.08**
Chiwawa River (Electrofishing)	Subyearling	2,740	24	2,703	3	0	2,703	0.11
	Yearling	0	0	0	0	0	0	0.00
	Total	**2,740**	**24**	**2,703**	**3**	**0**	**2,703**	**0.11**
Nason Creek Trap	Subyearling	2,490	190	1,877	5	0	1,877	0.20
	Yearling	357	29	346	1	0	346	0.28
	Total	**2,847**	**219**	**2,223**	**6**	**0**	**2,223**	**0.21**
Nason Creek (Electrofishing)	Subyearling	3,401	63	3,242	42	2	3,240	1.23
	Yearling	0	0	0	0	0	0	0.00
	Total	**3,401**	**63**	**3,242**	**42**	**2**	**3,240**	**1.23**
White River Trap	Subyearling	539	40	507	8	0	507	1.48
	Yearling	41	0	41	0	0	41	0.00
	Total	**580**	**40**	**548**	**8**	**0**	**548**	**1.38**
Lower Wenatchee Trap	Subyearling	46,801	36	0	360	0	0	0.77
	Yearling	1,332	8	1,220	7	0	1,220	0.53
	Total	**48,133**	**44**	**1,220**	**367**	**0**	**1,220**	**0.76**
Total:	**Subyearling**	65,880	419	14,186	592	2	14,184	0.90
	Yearling	7,156	177	6,931	22	0	6,931	0.31
Grand Total:		***73,036***	***596***	***21,117***	***614***	***2***	***21,115***	***0.84***

Numbers of wild Chinook salmon PIT-tagged and released as part of CSS and PUD studies during the period 2006-2017 are shown in Table 7.10.

Table 7.10. Summary of the numbers of wild Chinook that were tagged and released at different locations within the Wenatchee River basin, 2006-2017.

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chiwawa Trap	Subyearling	5,130	6,137	8,755	8,765	3,324	6,030	7,644	9,086	11,358	10,471	7,354	8,241
	Yearling	2,793	4,659	8,397	3,694	6,281	4,318	7,980	3,093	4,383	6,204	2,729	5,711
	Total	**7,923**	**10,796**	**17,152**	**12,459**	**9,605**	**10,348**	**15,624**	**12,179**	**15,741**	**16,675**	**10,083**	**13,952**
Chiwawa River (Angling or Electro-fishing)	Subyearling	111	20	43	128	531	0	3,181	3,017	1,032	1,054	1,776	2,703
	Yearling	0	0	0	3	4	0	0	0	0	0	0	0
	Total	**111**	**20**	**43**	**131**	**535**	**0**	**3,181**	**3,017**	**1,032**	**1,054**	**1,776**	**2,703**
	Subyearling	0	15	0	37	3	1	1	0	--	--	--	--

Sampling location	Life stage	Numbers of PIT-tagged wild Chinook salmon released											
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Upper Wenatchee Trap	Yearling	81	1,434	159	296	486	714	75	94	--	--	--	--
	Total	**81**	**1,449**	**159**	**333**	**489**	**715**	**76**	**94**	**--**	**--**	**--**	**--**
Nason Creek Trap	Subyearling	1,434	545	1,741	1,890	2,828	822	1,939	3,290	1,113	219	434	1,877
	Yearling	365	577	894	185	364	147	357	237	456	142	61	346
	Total	**1,799**	**1,122**	**2,635**	**2,075**	**3,192**	**969**	**2,296**	**3,527**	**1,569**	**361**	**495**	**2,223**
Nason Creek (Angling or Electro-fishing)	Subyearling	68	6	4	701	595	0	0	0	1,816	1,089	802	3,240
	Yearling	1	7	0	13	3	0	0	0	0	0	0	0
	Total	**69**	**13**	**4**	**714**	**598**	**0**	**0**	**0**	**1,816**	**1,089**	**802**	**3,240**
White River Trap	Subyearling	0	0	0	441	143	144	285	374	156	149	136	507
	Yearling	0	0	0	265	359	65	180	22	49	34	3	41
	Total	**0**	**0**	**0**	**706**	**502**	**209**	**465**	**396**	**205**	**183**	**139**	**548**
Upper Wenatchee (Angling or Electro-fishing)	Subyearling	0	61	1	0	2	--	--	--	--	--	--	--
	Yearling	27	0	0	0	0	--	--	--	--	--	--	--
	Total	**27**	**61**	**1**	**0**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Middle Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	65	284	233	--	--	--	--	--	--	--
	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**65**	**284**	**233**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee (Angling or Electro-fishing)	Subyearling	0	0	0	0	0	--	--	--	--	--	--	--
	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Peshastin Creek (Angling or Electro-fishing)	Subyearling	0	0	0	0	1	--	--	--	--	--	--	--
	Yearling	0	0	0	0	0	--	--	--	--	--	--	--
	Total	**0**	**0**	**0**	**0**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lower Wenatchee Trap	Subyearling	0	0	2	0	0	0	0	0	36	0	18	0
	Yearling	522	1,641	506	468	917	0	0	1,712	1,506	1,301	538	1,220
	Total	**522**	**1,641**	**508**	**468**	**917**	**0**	**0**	**1,712**	**1,542**	**1,301**	**556**	**1,220**
Total:	**Subyearling**	**6,743**	**6,784**	**10,611**	**12,246**	**7,660**	**6,997**	**13,050**	**15,767**	**15,511**	**12,982**	**10,520**	**14,184**
	Yearling	**3,789**	**8,318**	**9,956**	**4,924**	**8,414**	**5,244**	**8,592**	**5,158**	**6,394**	**7,681**	**3,331**	**6,931**
Grand Total:		***10,532***	***15,102***	***20,567***	***17,170***	***16,074***	***12,241***	***21,642***	***20,925***	***21,905***	***20,663***	***13,851***	***21,115***

Freshwater Productivity

Productivity and survival estimates for different life stages of spring Chinook in the White River basin are provided in Table 7.11. Estimates for brood year 2015 generally fall within the range of productivity and survival estimates for brood years 2005-2014. During that period, freshwater productivities ranged from 15-170 smolts/redd and 77-347 emigrants/redd. Survivals during the same period ranged from 0.4-3.8% for egg-smolt and 1.6-7.5% for egg-emigrants.

Table 7.11. Productivity (fish/redd) and survival (%) estimates for different juvenile life stages of spring Chinook in the White River basin for brood years 2005-2015. These estimates were derived from data in Table 7.7. ND = no data.

Brood year	Smolts/Redd[a]	Emigrants/ Redd	Egg-Smolt[a] (%)	Egg-Emigrant (%)
2005	56	ND	1.3	ND
2006	65	85	1.5	2.0
2007	170	285	3.8	6.4
2008	168	347	3.6	7.5
2009	54	100	1.2	2.2
2010	125	181	2.9	4.2
2011	83	239	1.9	5.5
2012	46	92	1.1	2.2
2013	56	102	1.2	2.2
2014	15	90	0.4	2.2
2015	42	77	0.9	1.6
Average	***80***	***160***	***1.8***	***3.6***
Median	***56***	***101***	***1.3***	***2.2***

[a] These estimates include White River smolts produced only within the White River basin.

Seeding level (egg deposition) explained part of the variability in productivity and survival of juvenile spring Chinook in the White River basin. That is, for estimates based on smolts produced within the White River basin, survival and productivity decreased as seeding levels increased (Figure 7.2). This suggests that density dependence in part regulates juvenile productivity and survival within the White River basin.

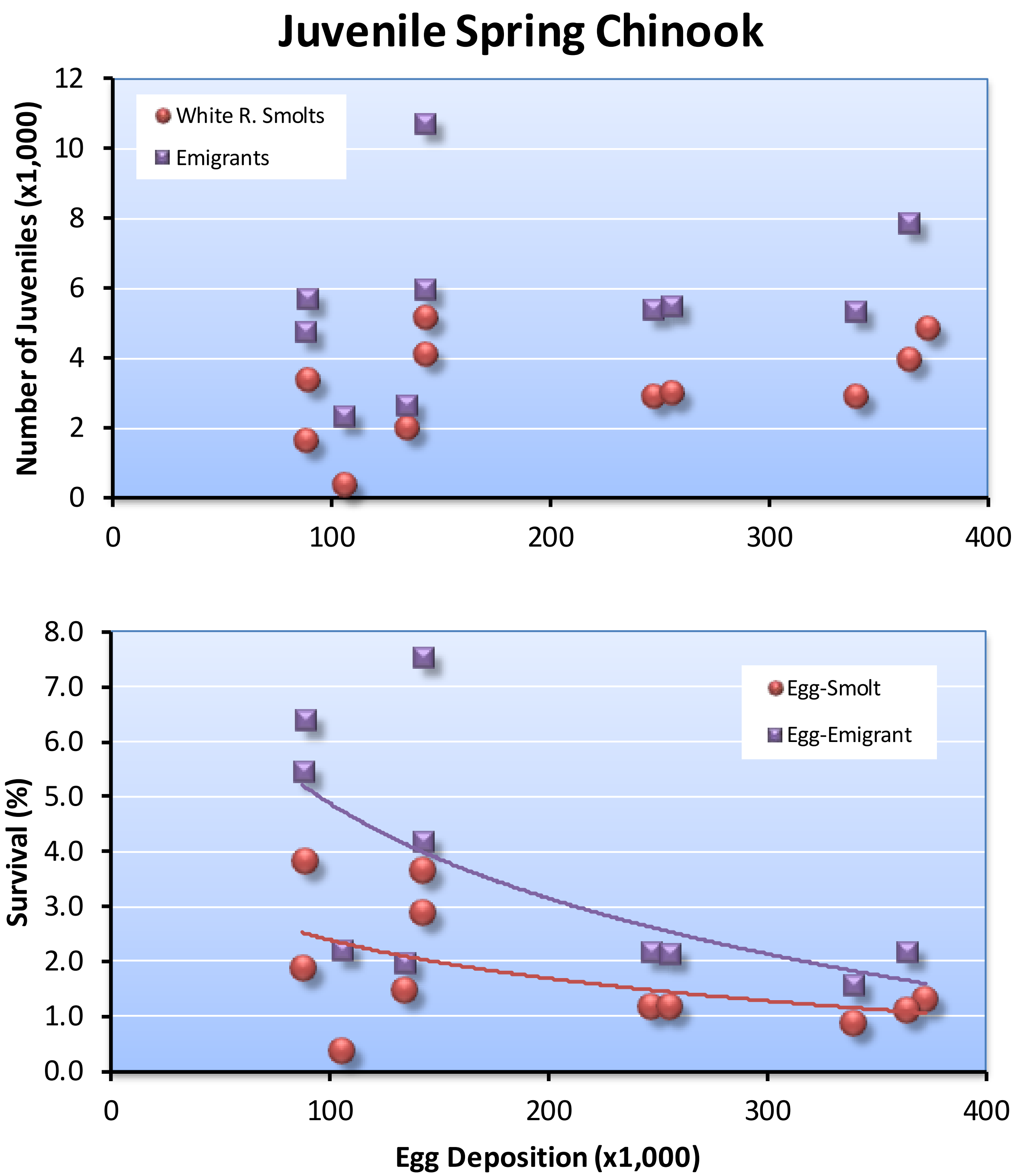


Figure 7.2. Relationships between seeding levels (egg deposition) and juvenile life-stage survivals and productivities for White River spring Chinook, brood years 2005-2015. White River smolts are smolts produced only within the White River basin.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[30] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we estimate smolt carrying capacities using the Ricker stock-recruitment model (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods). The Ricker model was the best fitting stock-recruitment model to the juvenile spring Chinook data.

Based on the Ricker model, the population carrying capacity for spring Chinook smolts in the White River basin is 4,441 smolts (95% CI: -6,260 – 6,730) (Figure 7.3). Here, smolts are defined as the number of yearling spring Chinook produced entirely within the White River basin. These estimates reflect current conditions (most recent decades) within the White River basin. Land use activities such as logging, roads, development, and recreation have altered the historical conditions of the watershed. Thus, the estimated population capacity estimates may not reflect historical capacities for spring Chinook smolts in the White River basin.

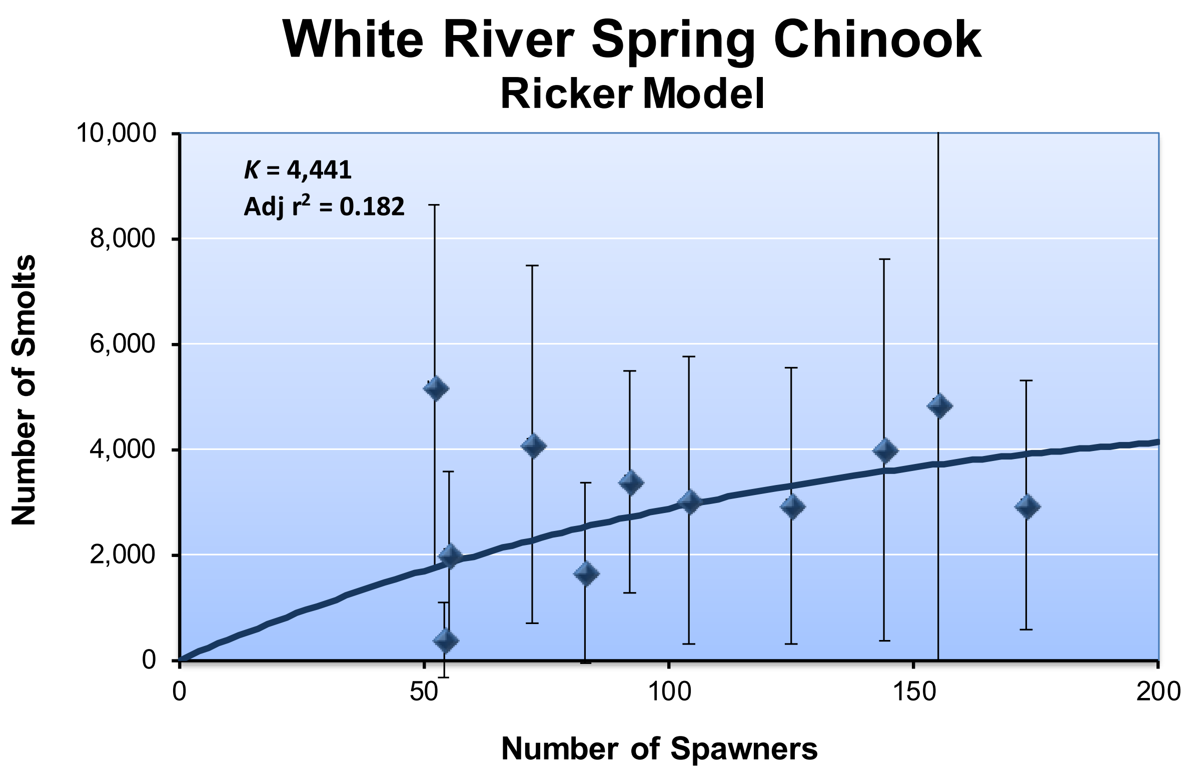


Figure 7.3. Relationship between spawners and number of smolts produced in the White River basin. Population carrying capacity (*K*) was estimated using the Ricker model. Vertical bars represent 95% confidence intervals on smolt estimates.

[30] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

We tracked the precision of the Ricker parameters for White River spring Chinook smolts over time to see if precision improves with additional years of data, and the parameters and statistics stabilize over time. Examination of variation in the alpha (*A*) and beta (*B*) parameters of the Ricker model and their associated standard errors and confidence intervals indicates that the parameters have not stabilized and lack precision (Table 7.12; Figure 7.4). This was also apparent in the estimates of population carrying capacity (Figure 7.5).

Table 7.12. Estimated parameters and statistics associated with fitting the Ricker model to spawning escapement and smolt data. Smolts represent numbers of smolts produced entirely within the White River basin. *A* = alpha parameter; *B* = beta parameter; SE = standard error (estimated from 5,000 bootstrap samples); and r^2 = coefficient of determination. Spawners represent the stock size needed to achieve population capacity.

Years of data	Parameter				Population capacity	Intrinsic productivity	Spawners	r^2
	A	*A* SE	*B*	*B* SE				
5	95.89	44.84	0.0090	0.0040	3,928	96	111	0.001
6	100.65	37.65	0.0092	0.0034	4,007	101	108	0.019
7	81.75	36.97	0.0084	0.0042	3,602	82	120	0.000
8	80.32	32.78	0.0080	0.0036	3,675	80	124	0.000
9	78.79	42.85	0.0080	0.0037	3,605	79	124	0.000
10	40.02	33.48	0.0032	0.0040	4,659	40	316	0.183
11	40.20	32.47	0.0033	0.0040	4,441	40	300	0.182

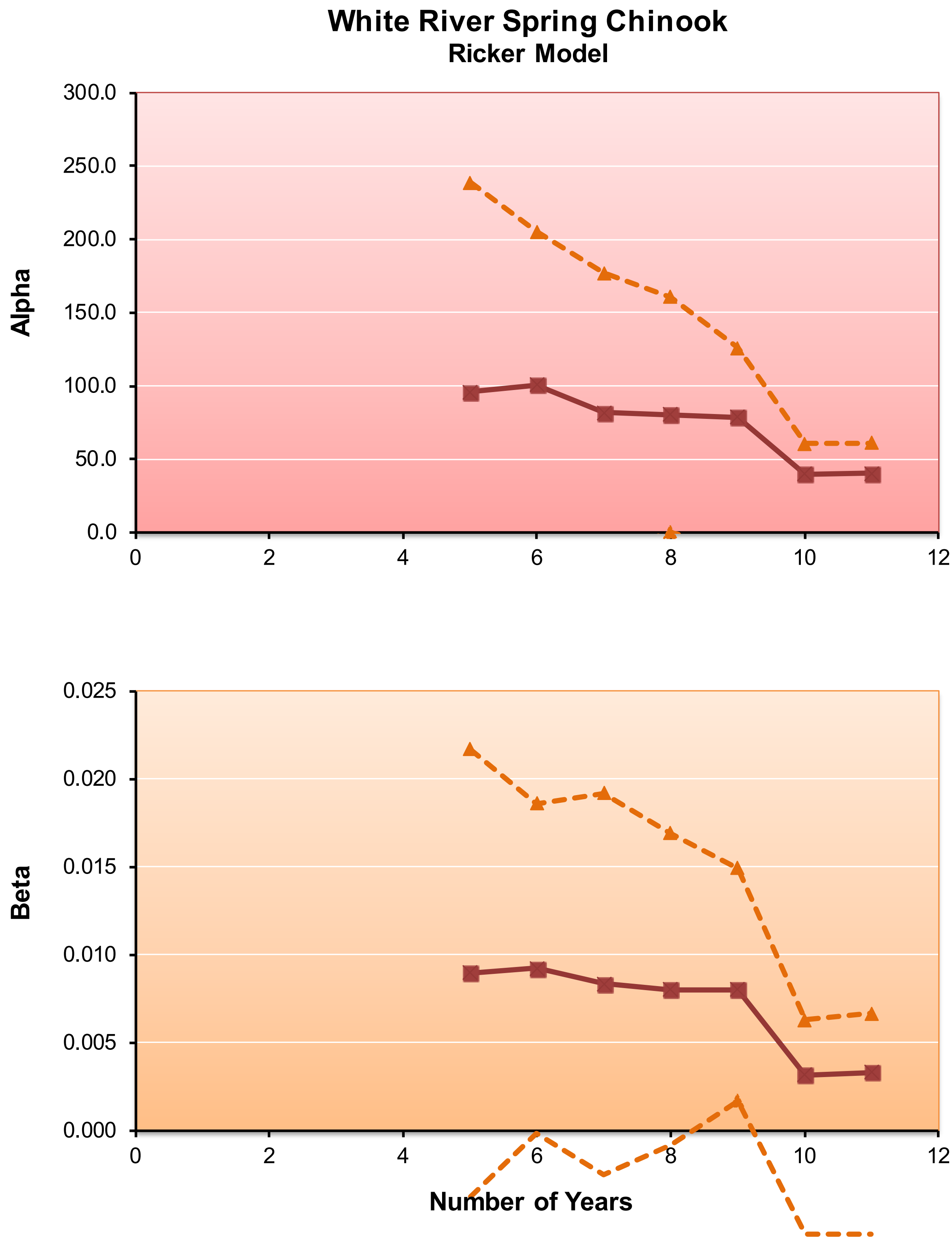


Figure 7.4. Time series of alpha and beta parameters and 95% confidence intervals for the Ricker model that was fit to White River spring Chinook smolt and spawning escapement data. Confidence intervals were estimated from 5,000 bootstrap samples.

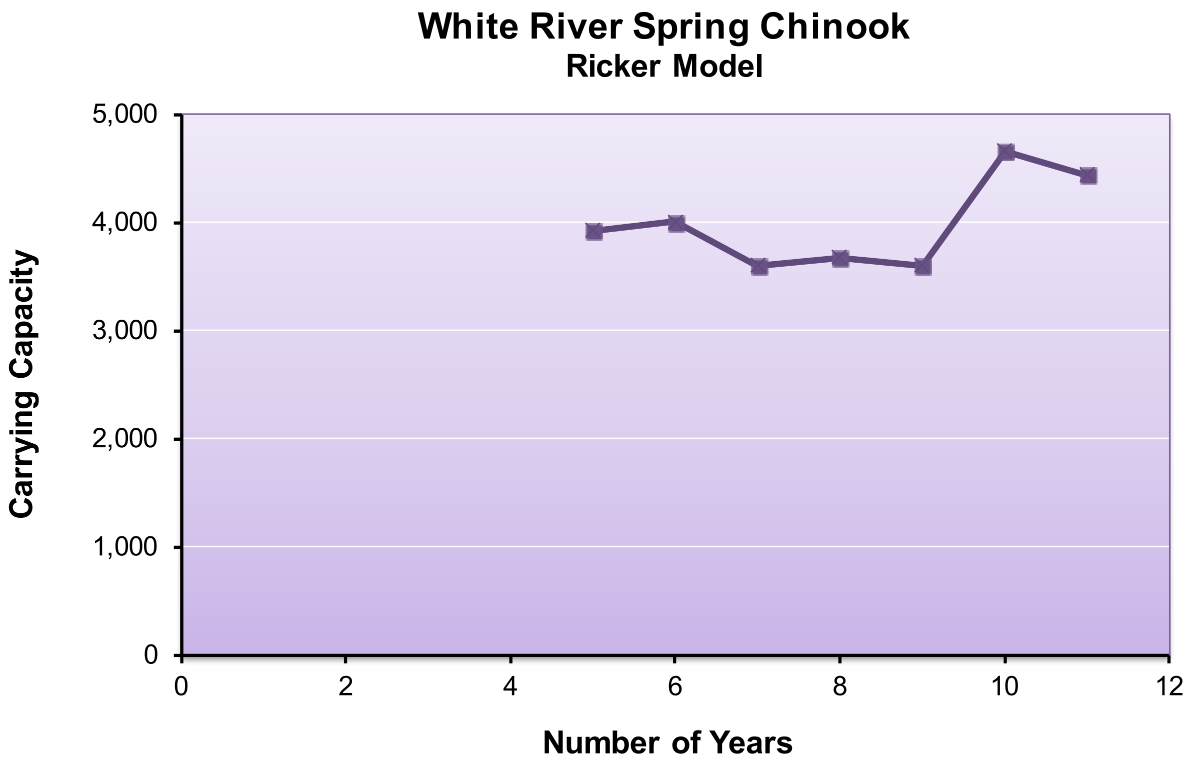


Figure 7.5. Time series of population carrying capacity estimates derived from fitting the Ricker model to White River spring Chinook smolt and spawning escapement data.

7.5 Spawning Surveys

Surveys for spring Chinook redds were conducted during August through September 2017 in the White River (including the Napeequa River and Panther Creek). In the following section, we describe the number and distribution of redds within the White River basin.

Redd Counts and Distribution

A total of 15 spring Chinook redds were counted in the White River basin in 2017 (Table 7.13). This is lower than the average of 35 redds counted during the period 1989-2016 in the White River. Redds were not distributed evenly among the six survey areas in the White River basin. Most redds (74%) were located in Reach 3 (Napeequa River to Grasshopper Meadows) in the White River (Table 7.13).

Table 7.13. Numbers (both observed and estimated) and proportions of spring Chinook redds counted within different survey areas within the White River basin during August through September 2017. See Table 2.8 for description of survey reaches.

Stream/watershed	Reach	Number of observed redds	Estimated number of redds*	Proportion of estimated redds within stream/watershed
White River	White 1 (H1)	0	--	--
	White 2 (H2)	2	3	0.15
	White 3 (H3)	11	14	0.74
	White 4 (H4)	0	0	--
	Napeequa 1 (Q1)	2	2	0.11
	Panther 1 (T1)	0	0	--
Total		***15***	***19***	***1.00***

* Estimated redds represent the "true" number of redds based on Guassian area-under-the-curve method (see Appendix J).

Spawn Timing

Spring Chinook began spawning during the last week of August in the White River and peaked the last week of August (Figure 7.6). Spawning in the White River ended the last week of September.

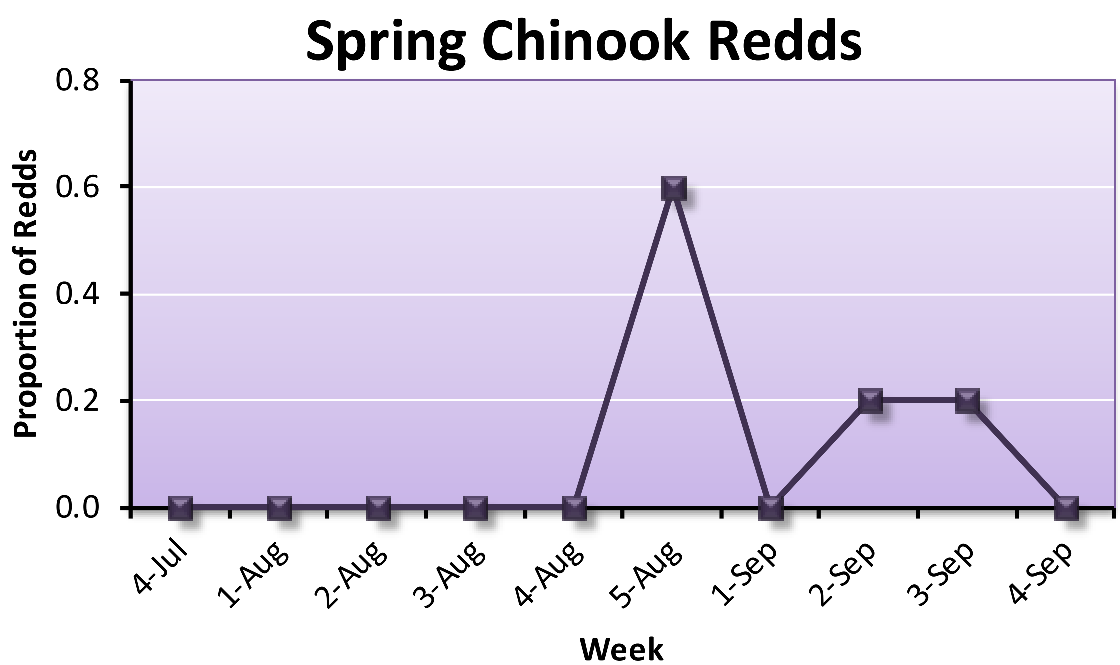


Figure 7.6. Proportion of spring Chinook redds counted during different weeks within the White River basin, August through September 2017.

Spawning Escapement

Spawning escapement for spring Chinook was calculated as the number of redds times the male-to-female ratio (i.e., fish per redd expansion factor) estimated from broodstock and fish sampled at adult trapping sites.[31] The estimated fish per redd ratio for spring Chinook upstream from Tumwater in 2017 was 2.06 (based on sex ratios estimated at Tumwater Dam). Multiplying this ratio by the number of redds counted in the White River basin resulted in a total spawning escapement of 31 spring Chinook. The estimated total spawning escapement of spring Chinook in 2017 was less than the overall average of 74 spring Chinook in the White River basin (Table 7.14).

Table 7.14. Spawning escapements for spring Chinook in the Wenatchee River basin for return years 1989-2017; NA = not available.

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
1989	2.27	713	222	102	145	213	1.56	37	NA	**1,419**
1990	2.24	571	231	67	49	81	1.71	86	7	**1,053**
1991	2.33	242	156	42	49	96	1.73	69	2	**626**
1992	2.24	676	181	78	78	85	1.65	61	0	**1,135**
1993	2.20	233	491	134	145	189	1.66	88	8	**1,250**
1994	2.24	184	60	16	7	13	2.11	32	0	**295**
1995	2.51	33	18	0	5	3	2.01	18	0	**68**
1996	2.53	58	83	8	30	3	2.09	25	2	**195**
1997	2.22	182	122	18	33	33	1.69	56	2	**422**
1998	2.21	91	64	18	11	0	1.81	20	0	**195**
1999	2.77	94	22	8	3	6	2.06	12	0	**139**
2000	2.70	346	270	24	22	100	1.68	114	0	**830**
2001	1.60	1,725	598	118	166	349	1.72	151	298	**3,217**
2002	2.05	707	603	86	86	131	1.55	380	166	**1,965**
2003	2.43	270	202	29	36	58	1.93	35	116	**673**
2004[a]	3.56/3.00	851	507	39	66	138	1.76	53	97	**1,686**
2005	1.80	599	347	115	155	257	1.67	13	5	**1,484**
2006	1.78	529	271	37	55	48	1.68	84	17	**1,000**
2007	4.58	1,296	463	101	92	55	1.91	32	21	**2,035**
2008	1.68	1,158	565	64	52	302	1.78	206	37	**2,278**
2009	3.20	1,347	534	125	173	16	2.22	71	33	**2,299**
2010	2.18	1,094	410	83	72	102	1.56	242	8	**1,921**
2011	4.13	2,032	702	124	83	50	2.60	317	68	**3,139**
2012	1.68	1,478	694	72	144	123	1.60	318	16	**2,720**
2013	1.93	1,378	409	98	104	33	1.98	212	8	**2,133**
2014	2.06	999	237	52	54	47	1.93	407	0	**1,600**
2015	1.78	967	151	50	125	98	1.87	247	19	**1,533**
2016	1.83	571	156	40	81	31	1.81	130	4	**953**
2017	2.06	457	140	21	31	19	1.81	72	5	**745**

31 Expansion factor = (1 + (number of males/number of females)).

Return year	Upper basin spawning escapement						Lower basin spawning escapement			Total
	Fish/redd	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River	Fish/redd	Icicle	Peshastin	
Average	--	*720*	*307*	*61*	*74*	*92*	--	*124*	*34*	*1345*
Median	--	*599*	*237*	*52*	*66*	*58*	--	*72*	*7.5*	*1250*

[a] In 2004, the fish/redd expansion estimate of 3.56 was applied to the Chiwawa River only and 3.00 fish/redd was applied to the rest of the upper basin.

7.6 Carcass Surveys

Surveys for spring Chinook carcasses were conducted during August through September 2017 in the White River (including the Napeequa River and Panther Creek). In 2017, 9 spring Chinook carcasses were sampled in the White River basin. Most of these were sampled in Reach 3. The total number of carcasses sampled in 2017 was less than the overall average of 17 carcasses sampled during the period 1996-2016.

In the White River basin in 2017, the spatial distribution of hatchery strays (primarily from the Chiwawa Spring Chinook program) and wild spring Chinook was not equal (Table 7.15). Only two carcasses were recovered in Reach 2, which were of wild origin, while Reach 3 had primarily hatchery fish (67%). In 2017, most carcasses (67%) were observed in the reach between the Napeequa River and Grasshopper Meadows (Reach 3) (Table 7.15). Over the years, spring Chinook have spawned more often in this reach than in other reaches (Figure 7.7).

Table 7.15. Numbers of wild, hatchery strays, and captive brood spring Chinook carcasses sampled within different reaches in the White River basin, 2000-2017. See Table 2.8 for description of survey reaches.

Survey year	Origin	Survey Reach					Total
		H-2	H-3	H-4	Napeequa	Panther	
2000	Wild	1	0	0	0	0	**1**
	Hatchery Strays	0	0	0	0	0	**0**
2001	Wild	5	40	5	3	1	**54**
	Hatchery Strays	1	19	3	1	2	**26**
2002	Wild	3	15	0	0	0	**18**
	Hatchery Strays	0	6	0	0	1	**7**
2003	Wild	0	6	0	0	0	**6**
	Hatchery Strays	0	1	1	0	0	**2**
2004	Wild	1	9	1	0	0	**11**
	Hatchery Strays	0	1	0	0	1	**2**
2005	Wild	1	10	0	1	0	**12**
	Hatchery Strays	1	35	0	0	0	**36**
	Captive Brood	2	2	0	0	0	**4**
2006	Wild	2	16	0	1	0	**19**
	Hatchery Strays	0	4	0	0	0	**4**
	Captive Brood	0	2	0	0	0	**2**
2007	Wild	1	6	0	0	2	**9**
	Hatchery Strays	0	1	0	0	0	**1**
	Captive Brood	0	2	0	0	0	**2**

Survey year	Origin	Survey Reach					Total
		H-2	H-3	H-4	Napeequa	Panther	
2008	Wild	1	3	0	0	1	**5**
	Hatchery Strays	2	5	0	0	1	**8**
	Captive Brood	0	0	0	0	0	**0**
2009	Wild	0	9	0	0	0	**9**
	Hatchery Strays	0	6	0	0	2	**8**
	Captive Brood	0	2	0	0	1	**3**
2010	Wild	0	4	0	0	0	**4**
	Hatchery Strays	0	6	0	0	0	**6**
	Captive Brood	0	2	0	0	0	**2**
2011	Wild	0	4	0	0	0	**4**
	Hatchery Strays	0	0	0	0	0	**0**
	Captive Brood	0	0	0	0	0	**0**
2012	Wild	0	13	0	0	0	**13**
	Hatchery Strays	0	7	0	0	0	**7**
	Captive Brood	0	1	0	0	0	**1**
2013	Wild	0	8	0	0	0	**8**
	Hatchery Strays	0	3	0	0	1	**4**
	Captive Brood	0	6	0	0	2	**8**
2014	Wild	0	6	0	0	0	**6**
	Hatchery Strays	0	2	0	0	0	**2**
	Captive Brood	0	0	0	0	0	**0**
2015	Wild	0	14	0	0	0	**14**
	Hatchery Strays	4	6	0	0	0	**10**
	Captive Brood	0	1	0	0	0	**1**
2016	Wild	0	10	1	0	0	**11**
	Hatchery Strays	1	1	0	0	0	**2**
	Captive Brood	0	0	0	0	0	**0**
2017	Wild	2	2	0	1	0	**5**
	Hatchery Strays	0	3	0	0	0	**3**
	Captive Brood	0	1	0	0	0	**1**
Average	***Wild***	***1***	***10***	***0***	***0***	***0***	***12***
	Hatchery Stray	***1***	***6***	***0***	***0***	***0***	***7***
	Captive Brood	***0***	***1***	***0***	***0***	***0***	***2***
Median	***Wild***	***0***	***6***	***0***	***0***	***0***	***8***
	Hatchery Stray	***0***	***5***	***0***	***0***	***0***	***5***
	Captive Brood	***0***	***1***	***0***	***0***	***0***	***1***

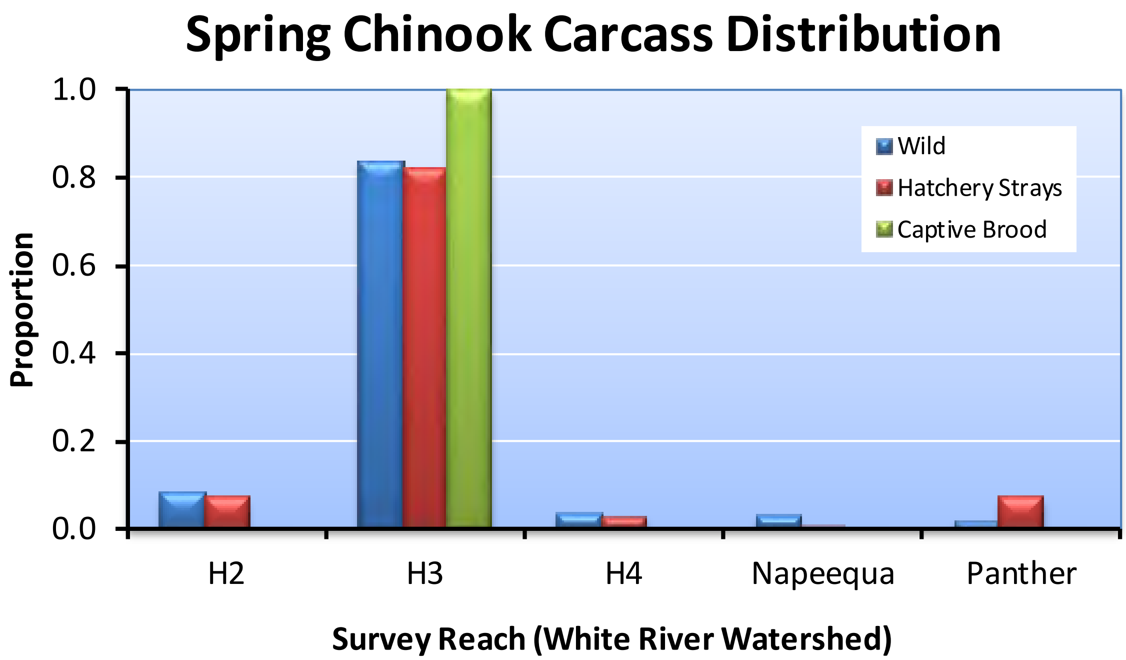


Figure 7.7. Distribution of wild, hatchery strays, and captive brood produced carcasses in different reaches in the White River basin, 2000-2017. Reach codes are described in Table 2.8.

7.7 Life History Monitoring

Life history characteristics of spring Chinook were assessed by examining carcasses on spawning grounds and fish collected at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

In 2017, there was a small difference in migration timing of hatchery and wild spring Chinook past Tumwater Dam (Table 7.16a and b; Figure 7.8). On average, hatchery fish arrived at the dam later than did wild fish but ended their migration earlier than did wild fish. This same pattern was also observed in the overall average. Most hatchery and wild spring Chinook migrated upstream past Tumwater Dam during June and July (Figure 7.8).

Table 7.16a. The Julian day and date that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2017. The average Julian day and date are also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
1998	Wild	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	49
	Hatchery	156	5-Jun	156	5-Jun	156	5-Jun	156	5-Jun	25
1999	Wild	192	11-Jul	207	26-Jul	224	12-Aug	207	26-Jul	173
	Hatchery	200	19-Jul	211	30-Jul	229	17-Aug	213	1-Aug	25
2000	Wild	171	19-Jun	186	4-Jul	194	12-Jul	184	2-Jul	651
	Hatchery	179	27-Jun	189	7-Jul	201	19-Jul	190	8-Jul	357
2001	Wild	154	3-Jun	166	15-Jun	185	4-Jul	167	16-Jun	2,073
	Hatchery	157	6-Jun	169	18-Jun	185	4-Jul	170	19-Jun	4,244
2002	Wild	174	23-Jun	189	8-Jul	204	23-Jul	189	8-Jul	1,033
	Hatchery	178	27-Jun	189	8-Jul	199	18-Jul	189	8-Jul	1,363
2003	Wild	162	11-Jun	181	30-Jun	200	19-Jul	181	30-Jun	919
	Hatchery	157	6-Jun	179	28-Jun	192	11-Jul	178	27-Jun	423
2004	Wild	156	4-Jun	172	20-Jun	189	7-Jul	172	20-Jun	969
	Hatchery	161	9-Jun	177	25-Jun	189	7-Jul	177	25-Jun	1,295
2005	Wild	153	2-Jun	172	21-Jun	193	12-Jul	173	22-Jun	1,038
	Hatchery	153	2-Jun	173	22-Jun	187	6-Jul	172	21-Jun	2,808
2006	Wild	177	26-Jun	184	3-Jul	193	12-Jul	185	4-Jul	577
	Hatchery	178	27-Jun	185	4-Jul	194	13-Jul	186	5-Jul	1601
2007	Wild	169	18-Jun	185	4-Jul	203	22-Jul	185	4-Jul	351
	Hatchery	174	23-Jun	192	11-Jul	209	28-Jul	192	11-Jul	3,232
2008	Wild	173	21-Jun	188	6-Jul	209	27-Jul	189	7-Jul	634
	Hatchery	177	25-Jun	193	11-Jul	210	28-Jul	193	11-Jul	5,368
2009	Wild	174	23-Jun	186	5-Jul	201	20-Jul	187	6-Jul	1,008
	Hatchery	175	24-Jun	187	6-Jul	202	21-Jul	188	7-Jul	4,106
2010	Wild	173	22-Jun	190	9-Jul	214	2-Aug	191	10-Jul	977
	Hatchery	180	29-Jun	194	13-Jul	213	1-Aug	195	14-Jul	4,450
2011	Wild	183	2-Jul	198	17-Jul	213	1-Aug	198	17-Jul	1,433
	Hatchery	187	6-Jul	200	19-Jul	210	29-Jul	199	18-Jul	4,707
2012	Wild	180	28-Jun	191	9-Jul	205	23-Jul	192	10-Jul	1,482
	Hatchery	182	30-Jun	194	12-Jul	206	24-Jul	194	12-Jul	4,449
2013	Wild	163	12-Jun	182	1-Jul	199	18-Jul	183	2-Jul	1,106
	Hatchery	164	13-Jun	181	30-Jun	195	14-Jul	181	30-Jun	3,681
2014	Wild	171	20-Jun	188	7-Jul	202	21-Jul	187	6-Jul	1,329
	Hatchery	167	16-Jun	182	1-Jul	195	14-Jul	181	30-Jun	2,510
2015	Wild	150	30-May	170	19-Jun	184	3-Jul	170	19-Jun	1,370
	Hatchery	148	28-May	168	17-Jun	180	29-Jun	167	16-Jun	1,773

Survey year	Origin	Spring Chinook Migration Time (days)								Sample size
		10 Percentile		50 Percentile		90 Percentile		Mean		
		Julian	Date	Julian	Date	Julian	Date	Julian	Date	
2016	Wild	158	6-Jun	180	28-Jun	200	18-Jul	181	29-Jun	1,252
	Hatchery	160	8-Jun	179	27-Jun	191	9-Jul	178	26-Jun	1,284
2017	Wild	175	24-Jun	184	3-Jul	195	14-Jul	184	3-Jul	483
	Hatchery	177	26-Jun	185	4-Jul	196	15-Jul	187	6-Jul	1,035
Average	Wild	***168***		***183***		***198***		***183***		***945***
	Hatchery	***171***		***184***		***197***		***184***		***2,437***
Median	Wild	***171***		***185***		***200***		***185***		***993***
	Hatchery	***175***		***185***		***196***		***187***		***2,142***

Table 7.16b. The week that 10%, 50% (median), and 90% of the wild and hatchery spring Chinook salmon passed Tumwater Dam, 1998-2017. The average week is also provided. Migration timing is based on video sampling at Tumwater. Data for 1998 through 2003 were based on videotapes and broodstock trapping and may not reflect the actual number of hatchery spring Chinook. All spring Chinook were visually examined during trapping from 2004 to present.

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
1998	Wild	23	23	23	23	49
	Hatchery	23	23	23	23	25
1999	Wild	28	30	32	30	173
	Hatchery	29	31	34	31	25
2000	Wild	24	27	27	27	651
	Hatchery	26	27	29	28	357
2001	Wild	22	24	27	24	2,073
	Hatchery	23	25	27	25	4,244
2002	Wild	25	27	30	27	1,033
	Hatchery	26	27	29	27	1,363
2003	Wild	24	26	29	26	919
	Hatchery	23	26	28	26	423
2004	Wild	23	25	27	25	969
	Hatchery	23	26	27	26	1,295
2005	Wild	22	25	28	25	1,038
	Hatchery	22	25	27	25	2,808
2006	Wild	26	27	28	27	577
	Hatchery	26	27	28	27	1,601
2007	Wild	25	27	29	27	351
	Hatchery	25	28	30	28	3,232
2008	Wild	25	27	30	27	634
	Hatchery	26	28	30	28	5,368

Survey year	Origin	Spring Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2009	Wild	25	27	29	27	1,008
	Hatchery	25	27	29	27	4,106
2010	Wild	25	28	31	28	977
	Hatchery	26	28	31	28	4,450
2011	Wild	27	29	31	29	1,433
	Hatchery	27	29	30	29	4,707
2012	Wild	26	28	30	28	1,482
	Hatchery	26	28	30	28	4,449
2013	Wild	24	26	29	27	1,106
	Hatchery	24	26	28	26	3,681
2014	Wild	25	27	29	27	1,329
	Hatchery	24	26	28	26	2,510
2015	Wild	22	25	27	25	1,370
	Hatchery	22	24	26	24	1,773
2016	Wild	23	26	29	26	1,252
	Hatchery	23	26	28	26	1,284
2017	Wild	25	27	28	27	483
	Hatchery	26	27	28	27	1,035
Average	Wild	***24***	***27***	***29***	***27***	***970***
	Hatchery	***25***	***27***	***29***	***27***	***2,511***
Median	Wild	***25***	***27***	***29***	***27***	***1,008***
	Hatchery	***25***	***27***	***28***	***27***	***2,510***

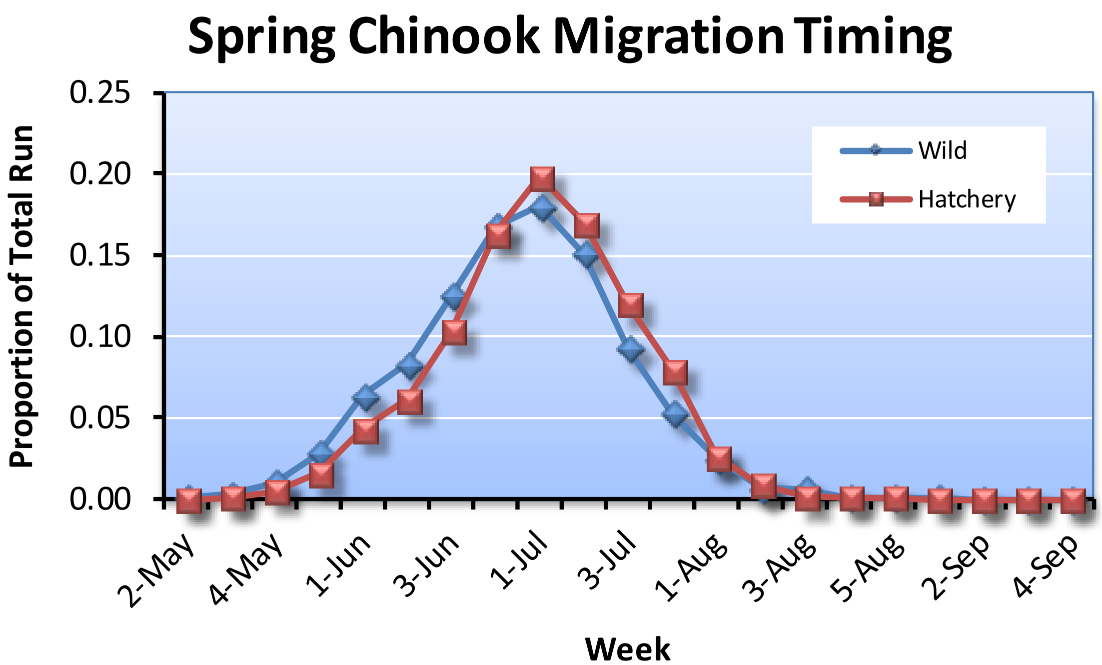


Figure 7.8. Proportion of wild and hatchery spring Chinook observed (using video) passing Tumwater Dam each week during their migration period May through September; data were pooled over survey years 1998-2017.

Age at Maturity

Most of the wild and hatchery stray spring Chinook sampled during the period 2001-2017 in the White River basin were age-4 fish (total age) (Table 7.17; Figure 7.9). A higher proportion of age-5 wild fish returned than did age-5 hatchery strays. Thus, wild fish tended to return at an older age than hatchery strays. Currently, few captive brood carcasses have been identified on the spawning grounds; most were age-4 and one was age-5. There has been a conspicuous absence of age-3 fish recovered as carcasses. In all years except 2007, no age-3 carcasses have been recovered.

Table 7.17. Numbers of wild, hatchery strays, and captive brood spring Chinook of different ages (total age) sampled on spawning grounds in the White River basin, 2001-2017.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2001	Wild	0	0	47	0	0	**47**
	Hatchery Strays	0	0	27	0	0	**27**
2002	Wild	0	0	7	11	0	**18**
	Hatchery Strays	0	0	6	1	0	**7**
2003	Wild	0	0	0	6	0	**6**
	Hatchery Strays	0	0	0	1	0	**1**
2004	Wild	0	0	9	0	0	**9**
	Hatchery Stray	0	0	2	0	0	**2**
2005	Wild	0	0	12	0	0	**12**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
	Hatchery Strays	0	0	40	0	0	**40**
	Captive Brood	0	0	0	0	0	**0**
2006	Wild	0	0	7	12	0	**19**
	Hatchery Strays	0	0	3	3	0	**6**
	Captive Brood	0	0	0	0	0	**0**
2007	Wild	0	0	1	8	0	**9**
	Hatchery Strays	0	2	2	0	0	**4**
	Captive Brood	0	0	0	0	0	**0**
2008	Wild	0	0	4	1	0	**5**
	Hatchery Strays	0	0	8	0	0	**8**
	Captive Brood	0	0	0	0	0	**0**
2009	Wild	0	0	8	1	0	**9**
	Hatchery Strays	1	0	10	0	0	**11**
	Captive Brood	0	0	0	0	0	**0**
2010	Wild	0	0	4	0	0	**4**
	Hatchery Strays	0	0	6	0	0	**6**
	Captive Brood	0	0	0	0	0	**0**
2011	Wild	0	0	0	4	0	**4**
	Hatchery Strays	0	0	0	0	0	**0**
	Captive Brood	0	0	0	0	0	**0**
2012	Wild	0	0	13	0	0	**13**
	Hatchery Strays	0	0	8	0	0	**8**
	Captive Brood	0	0	0	0	0	**0**
2013	Wild	0	0	6	2	0	**8**
	Hatchery Strays	0	0	11	1	0	**12**
	Captive Brood	0	0	1	1	0	**2**
2014	Wild	0	0	54	10	0	**64**
	Hatchery Strays	0	0	21	0	0	**21**
	Captive Brood	0	0	0	0	0	**0**
2015	Wild	0	0	13	1	0	**14**
	Hatchery Strays	0	0	10	0	0	**10**
	Captive Brood	0	0	1	0	0	**1**
2016	Wild	0	0	5	6	0	**11**
	Hatchery Strays	0	0	2	0	0	**2**
	Captive Brood	0	0	0	0	0	**0**
2017	Wild	0	0	1	4	0	**5**
	Hatchery Strays	0	0	3	0	0	**3**
	Captive Brood	0	0	1	0	0	**1**

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
Average	*Wild*	*0*	*0*	*11*	*4*	*0*	*15*
	Hatchery Strays	*0*	*0*	*9*	*0*	*0*	*10*
	Captive Brood	*0*	*0*	*0*	*0*	*0*	*0*
Median	*Wild*	*0*	*0*	*7*	*3*	*0*	*9*
	Hatchery Strays	*0*	*0*	*6*	*0*	*0*	*7*
	Captive Brood	*0*	*0*	*0*	*0*	*0*	*0*

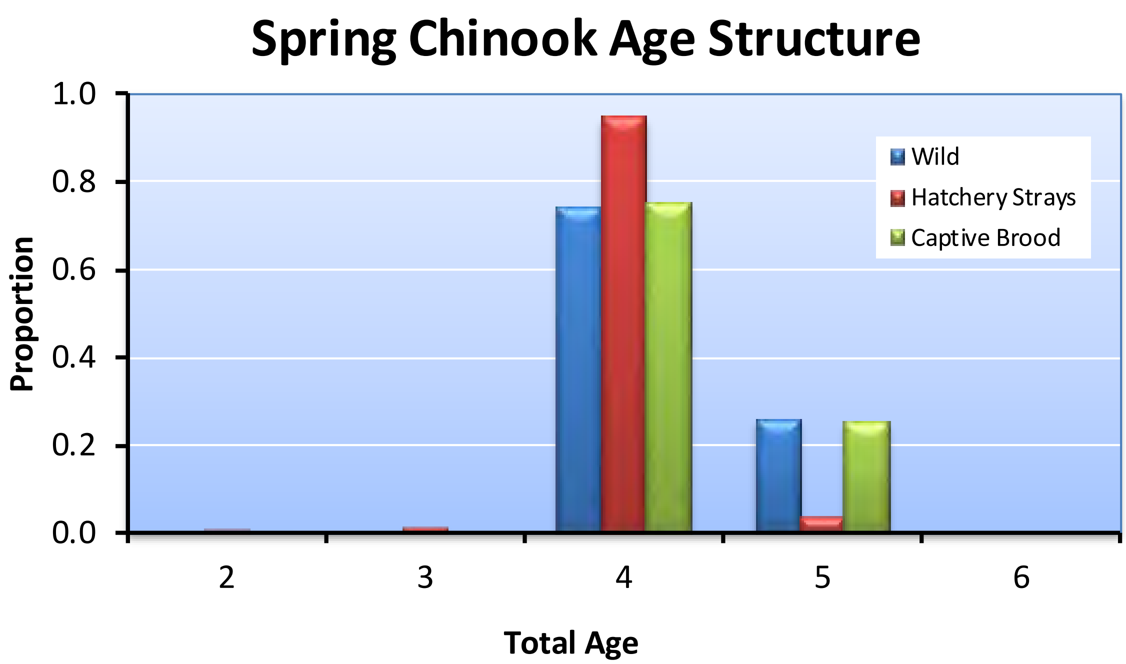


Figure 7.9. Proportions of wild, hatchery strays, and captive brood spring Chinook of different total ages sampled on spawning grounds in the White River basin for the combined years 2000-2017.

For comparison, Table 7.18 and Figure 7.10 show the age structure of spring Chinook carcasses sampled in the Little Wenatchee River. Similar to the White River, most of the wild and hatchery stray spring Chinook sampled during the period 2001-2017 in the Little Wenatchee River basin were age-4 fish (total age). A higher proportion of age-5 wild fish returned than did age-5 hatchery strays. Thus, wild fish tended to return at an older age than hatchery strays. As in the White River, few age-3 fish have been recovered in the Little Wenatchee River.

Table 7.18. Numbers of wild and hatchery stray spring Chinook of different ages (total age) sampled on spawning grounds in the Little Wenatchee River basin, 2001-2017.

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
2001	Wild	0	0	31	2	0	**33**
	Hatchery Strays	0	0	33	1	0	**34**
2002	Wild	0	0	6	8	0	**14**
	Hatchery Strays	0	0	12	2	0	**14**
2003	Wild	0	0	1	3	0	**4**
	Hatchery Strays	0	0	0	4	0	**4**
2004	Wild	0	0	1	0	0	**1**
	Hatchery Stray	0	0	0	0	0	**0**
2005	Wild	0	0	16	0	0	**16**
	Hatchery Strays	0	0	32	0	0	**32**
2006	Wild	0	0	4	4	0	**8**
	Hatchery Stray	0	1	0	3	0	**4**
2007	Wild	0	0	2	10	0	**12**
	Hatchery Strays	0	1	2	0	0	**3**
2008	Wild	0	0	3	0	0	**3**
	Hatchery Stray	0	0	12	0	0	**12**
2009	Wild	0	0	6	0	0	**6**
	Hatchery Strays	0	1	12	0	0	**13**
2010	Wild	0	0	2	0	0	**2**
	Hatchery Stray	0	0	5	0	0	**5**
2011	Wild	0	0	3	1	0	**4**
	Hatchery Strays	0	2	1	0	0	**3**
2012	Wild	0	0	12	2	0	**14**
	Hatchery Stray	0	0	9	1	0	**10**
2013	Wild	0	0	9	7	0	**16**
	Hatchery Strays	0	0	4	0	0	**4**
2014	Wild	0	1	8	2	0	**11**
	Hatchery Stray	0	0	1	0	0	**1**
2015	Wild	0	0	8	3	0	**11**
	Hatchery Strays	0	0	1	0	0	**1**
2016	Wild	0	0	1	3	0	**4**
	Hatchery Strays	0	0	1	0	0	**1**
2017	Wild	0	0	2	1	0	**3**
	Hatchery Strays	0	0	0	0	0	**0**
Average	***Wild***	***0***	***0***	***7***	***3***	***0***	***10***
	Hatchery Strays	***0***	***0***	***7***	***1***	***0***	***8***

Sample year	Origin	Total age					Sample size
		2	3	4	5	6	
Median	*Wild*	*0*	*0*	*4*	*2*	*0*	*8*
	Hatchery Strays	*0*	*0*	*2*	*0*	*0*	*4*

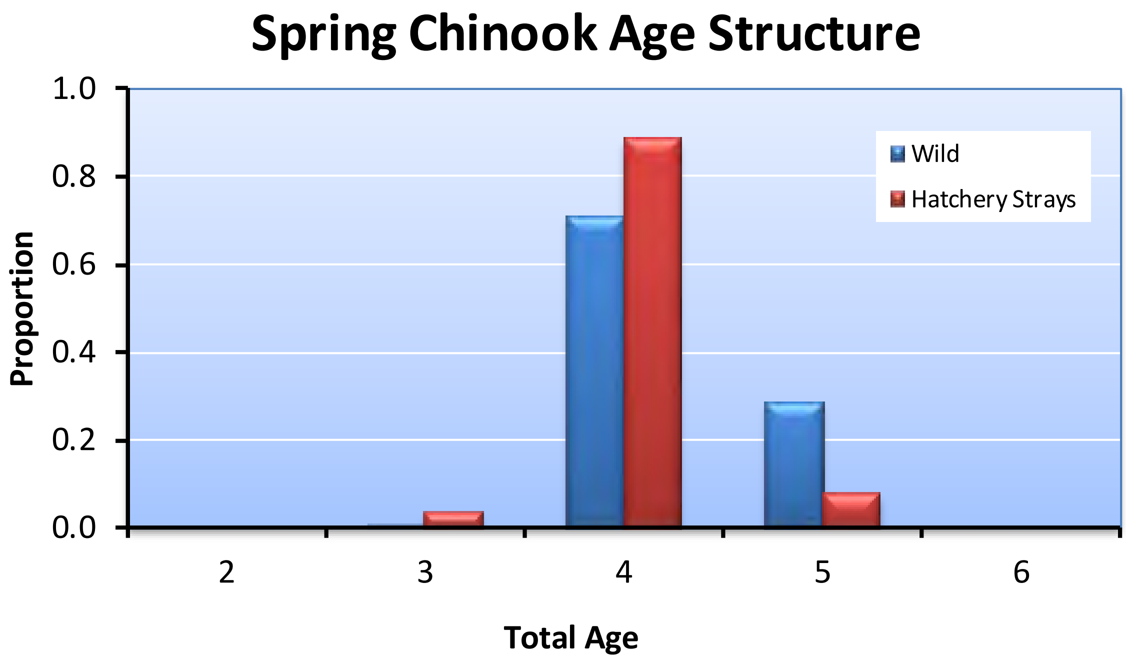


Figure 7.10. Proportions of wild and hatchery stray spring Chinook of different total ages sampled on spawning grounds in the Little Wenatchee River basin for the combined years 2000-2017.

Size at Maturity

On average, hatchery strays and wild spring Chinook of a given age differed little in length (Table 7.19). Differences were generally small (1-2 cm) between hatchery strays and wild fish of the same age. Few captive brood carcasses have been identified on the spawning grounds; most were females. Those fish were about the same size as wild and hatchery strays of the same age.

Table 7.19. Mean lengths (POH in cm; ±1SD) and sample sizes (in parentheses) of different ages (total age) of male and female spring Chinook of wild, hatchery strays, and captive brood origin sampled in the White River basin, 2001-2017.

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
2001	3	0	0	0	0	0	0
	4	65 ±3 (17)	66 ±4 (5)	0	63 ±3 (30)	63 ±4 (21)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2002	3	0	0	0	0	0	0

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
	4	66 ±0 (1)	69 ±0 (1)	0	63 ±4 (6)	59 ±6 (5)	0
	5	75 ±11 (2)	0	0	72 ±3 (9)	72 ±0 (1)	0
	6	0	0	0	0	0	0
2003	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	75 ±5 (6)	73 ±0 (1)	0
	6	0	0	0	0	0	0
2004	3	0	0	0	0	0	0
	4	68 ±3 (3)	0	0	63 ±3 (6)	59 ±2 (2)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2005	3	0	0	0	0	0	0
	4	64 ±5 (3)	62 ±7 (5)	0	63 ±5 (8)	62 ±4 (33)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2006	3	0	0	0	0	0	0
	4	65 ±2 (3)	0	0	61 ±4 (4)	60 ±2 (3)	0
	5	69 ±4 (4)	0	0	67 ±5 (8)	70 ±5 (3)	0
	6	0	0	0	0	0	0
2007	3	0	49 ±5 (2)	0	0	0	0
	4	0	0	0	58 ±0 (1)	66 ±2 (2)	0
	5	75 ±5 (3)	0	0	75 ±1 (5)	0	0
	6	0	0	0	0	0	0
2008	3	0	0	0	0	0	0
	4	56 ±0 (1)	61 ±0 (1)	0	63 ±8 (2)	61 ±2 (7)	0
	5	0	0	0	75 ±0 (1)	0	0
	6	0	0	0	0	0	0
2009	3	0	0	0	0	0	0
	4	61 ±5 (3)	68 ±4 (2)	0	63 ±2 (5)	62 ±2 (8)	0
	5	0	0	0	78 ±0 (1)	0	0
	6	0	0	0	0	0	0
2010	3	0	0	0	0	0	0
	4	0	67 ±0 (1)	0	60 ±3 (3)	61 ±6 (5)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2011	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	73 ±5 (4)	0	0
	6	0	0	0	0	0	0
2012	3	0	0	0	0	0	0

Return year	Total age	Mean length (cm)					
		Male			Female		
		Wild	Hatchery stray	Captive brood	Wild	Hatchery stray	Captive brood
	4	47 ±0 (1)	0	0	62 ±4 (12)	60 ±4 (8)	0
	5	0	0	0	0	0	0
	6	0	0	0	0	0	0
2013	3	0	0	0	0	0	0
	4	64 ±4 (3)	60 ±4 (2)	0	61 ±2 (3)	61 ±4 (7)	63 ±0 (1)
	5	0	0	0	67 ±1 (2)	71 ±0 (1)	71 ±0 (1)
	6	0	0	0	0	0	0
2014	3	0	0	0	0	0	0
	4	0	54 ±0 (1)	0	60 ±2 (4)	58 ±0 (1)	0
	5	0	0	0	74 ±0 (1)	0	0
	6	0	0	0	0	0	0
2015	3	0	0	0	0	0	0
	4	60 ±6 (5)	74 ±0 (1)	61 ±(1)	64 ±5 (8)	63 ±4 (9)	65 ±4 (4)
	5	0	0	0	78 ±0 (1)	0	0
	6	0	0	0	0	0	0
2016	3	0	0	0	0	0	0
	4	65 ±0 (1)	0	0	63 ±4 (4)	59 ±4 (2)	0
	5	7 1 ±4 (2)	0	0	71 ±5 (4)	0	0
	6	0	0	0	0	0	0
2017	3	0	0	0	0	0	0
	4	61 ±0 (1)	0	0	60 ±0 (1)	0	0
	5	75 ±0 (1)	0	0	0	0	0
	6	0	0	0	0	0	0

Contribution to Fisheries

No White River spring Chinook from the captive brood program tagged with CWTs or PIT tags have been recaptured (or reported) in ocean or Columbia River (tribal, commercial, or recreational) fisheries.

Straying

Stray rates of White River spring Chinook from the captive brood program were determined by examining the locations where PIT-tagged Chinook demonstrating anadromy (based on detections at Bonneville Dam) were last detected. PIT tagging of White River spring Chinook began with release year 2008, which allows estimation of stray rates by brood return. Targets for strays based on return year (recovery year) within the Wenatchee River basin should be less than 10% and targets for strays outside the Wenatchee River basin should be less than 5%.

Based on PIT-tag analyses, on average, about 65% of the brood year returns of White River spring Chinook were last detected in streams outside the White River (Table 7.20). The numbers in Table 7.20 should be considered rough estimates because they are not based on confirmed spawning (only last detections) and they represent small sample sizes. In addition, last detections in adult fishways (i.e., Bonneville, Rock Island, and Tumwater dams) were not included, nor were detections in areas outside the distribution of known spring Chinook spawning (i.e., Lower and Middle Wenatchee River). All fish reported in Table 7.20 are at least age-3 fish (total age) and some of them may not have migrated all the way to the ocean but rather resided completely in freshwater downstream from Bonneville Dam.

Table 7.20. Number and percent of White River spring Chinook from the captive brood program that homed to target spawning areas on the White River and the target hatchery program (Little White Salmon Fish Hatchery), and number and percent that strayed to non-target spawning areas and hatchery programs for brood years 2006-2012. Only PIT-tagged fish demonstrating anadromy were included in the analysis. Estimates were based on last detections of PIT-tagged spring Chinook.

Brood year	Homing				Straying			
	Target stream		Target hatchery*		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2006	9	100.0	0	0.0	0	0.0	0	0.0
2007	0	0.0	0	0.0	0	0.0	0	0.0
2008	0	0.0	0	0.0	19	100.0	0	0.0
2009	8	13.8	0	0.0	65	86.2	0	0.0
2010	0	0.0	0	0.0	9	100.0	0	0.0
2011	38	17.1	0	0.0	184	82.9	0	0.0
2012	6	12.0	0	0.0	38	88.0	0	0.0
Average	***9***	***20.4***	***0***	***0.0***	***45***	***65.3***	***0***	***0.0***
Median	***6***	***12.0***	***0***	***0.0***	***19***	***86.2***	***0***	***0.0***

* Homing to the target hatchery includes White River hatchery spring Chinook that are captured and included as broodstock in the White River Hatchery program.

The percentage of the PIT-tagged White River spring Chinook from the captive brood program that were last detected in different watersheds within and outside the Wenatchee River basin are shown in Table 7.21. On average, a small percentage of the PIT-tagged White River spring Chinook homed to the White River. Relatively high percentages of them were last detected in the Little Wenatchee River, Upper Wenatchee River, Nason Creek, and the Chiwawa River.

Few returning adults have strayed into spawning areas outside the Wenatchee River basin. Three were last detected in the Entiat River. No other returning adults were detected outside the Wenatchee River basin. On the other hand, several juveniles were last detected in rivers outside the Wenatchee River basin. Juveniles were last detected in the Deschutes, Walla Walla, Hood, and North Fork Teanaway rivers. Juveniles were also last detected at the Little White Salmon Fish Hatchery. There is no evidence that these fish entered the ocean and returned as adults.

Table 7.21. Number and percent (in parentheses) of PIT-tagged White River spring Chinook from the captive brood program that were last detected in different tributaries within the Wenatchee River basin, return years 2010-2017. Only PIT-tagged fish demonstrating anadromy were included in the analysis.

Return year	Homing	Straying							
	White River	Chiwawa River	Chiwaukum Creek	Icicle Creek	Little Wenatchee	Nason Creek	Peshastin Creek	Upper Wenatchee	Entiat River
2010	9 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
2011	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
2012	3 (16.0)	3 (16.0)	0 (0.0)	0 (0.0)	10 (66.7)	1 (7.6)	0 (0.0)	0 (0.0)	0 (0.0)
2013	5 (7.4)	20 (28.0)	3 (3.7)	5 (7.4)	13 (18.1)	20 (28.0)	0 (0.0)	5 (7.4)	0 (0.0)
2014	11 (8.6)	44 (34.9)	0 (0.0)	3 (2.2)	8 (6.5)	44 (34.9)	0 (0.0)	14 (10.8)	3 (2.2)
2015	24 (22.8)	59 (55.2)	3 (2.5)	0 (0.0)	0 (0.0)	3 (2.5)	0 (0.0)	18 (16.9)	0 (0.0)
2016	8 (23.0)	19 (51.7)	0 (0.0)	3 (7.5)	0 (0.0)	2 (5.2)	0 (0.0)	5 (12.6)	0 (0.0)
2017	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Average	***8 (22.2)***	***18 (23.3)***	***1 (0.8)***	***1 (2.1)***	***4 (16.9)***	***9 (16.1)***	***0 (0.0)***	***5 (6.0)***	***0 (0.3)***
Median	***7 (12.4)***	***11 (22.0)***	***0 (0.0)***	***0 (0.0)***	***1 (3.3)***	***2 (6.4)***	***0 (0.0)***	***2 (3.7)***	***0 (0.0)***

Genetics

At this time, there are no studies that examine the effects of the White River captive brood program on the genetics of natural-origin spring Chinook in the Wenatchee River basin. However, genetic studies were conducted to determine the potential effects of the Chiwawa Supplementation Program on natural-origin spring Chinook in the upper Wenatchee River basin (Blankenship et al. 2007; the entire report is appended as Appendix K). This work included the analysis of White River spring Chinook. Researchers collected microsatellite DNA allele frequencies from temporally replicated natural and hatchery-origin spring Chinook to statistically assign individual fish to specific demes (locations) within the Wenatchee population.

Significant differences in allele frequencies were observed within and among major spawning areas in the Upper Wenatchee River basin. However, these differences made up only a very small portion of the overall variation, indicating genetic similarity among the major spawning areas. There was no evidence that the Chiwawa program has changed the genetic structure (allele frequency) of spring Chinook in the White River, despite the presence of hatchery-origin spawners in both systems.

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations.[32] The larger the

[32] According to authorized annual take permits, PNI is calculated using the PNI approximate equation 11 (HSRG 2009; Appendix A). However, in this report, we used Ford's (2002) equations 5 and 6 with a heritability of 0.3 and a selection strength of three standard deviations to calculate PNI (C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI). This approach is more accurate than using the PNI approximate equation.

PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. In order for the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1989-2000, PNI values ranged from 0.95 to 1.00 (Table 7.22). For brood years 2001-2013, PNI for the White River Program averaged 0.60 (range, 0.33-1.00) (Table 7.22).

Table 7.22. Proportionate Natural Influence (PNI) values for hatchery spring Chinook spawning in the White River, brood years 1989-2013. See notes below the table for description of each metric.

Brood year	Spawners					Broodstock			PNI
	NOS	HOS_W	HOS_S	$pHOS_W$	$pHOS_S$	NOB_N	HOB_N	pNOB	
1989	145	0	0	0.00	0.00	0	0	*1.00*	1.00
1990	49	0	0	0.00	0.00	0	0	*1.00*	1.00
1991	49	0	0	0.00	0.00	0	0	*1.00*	1.00
1992	78	0	0	0.00	0.00	0	0	*1.00*	1.00
1993	138	0	7	0.00	0.05	0	0	*0.99*	0.95
1994	7	0	0	0.00	0.00	0	0	*0.67*	1.00
1995	5	0	0	0.00	0.00	0	0	*1.00*	1.00
1996	30	0	0	0.00	0.00	0	0	*0.60*	1.00
1997	33	0	0	0.00	0.00	0	0	*0.30*	1.00
1998	11	0	0	0.00	0.00	0	0	*0.44*	1.00
1999	3	0	0	0.00	0.00	0	0	*1.00*	1.00
2000	22	0	0	0.00	0.00	0	0	*0.48*	1.00
Average*	***48***	***0***	***1***	***0.00***	***0.00***	***0***	***0***	***0.79***	***1.00***
Median*	***32***	***0***	***0***	***0.00***	***0.00***	***0***	***0***	***1.00***	***1.00***
2001	111	0	55	0.00	0.33	5	0	1.00	0.50
2002	60	0	26	0.00	0.30	18	0	1.00	0.51
2003	31	0	5	0.00	0.14	7	0	1.00	0.77
2004	54	0	12	0.00	0.18	6	0	1.00	0.70
2005	38	11	106	0.07	0.68	103	73	0.59	0.33
2006	41	5	9	0.09	0.16	191	135	0.59	0.61
2007	62	23	7	0.25	0.08	254	6	0.98	0.67
2008	20	2	30	0.04	0.58	116	0	1.00	0.34
2009	81	29	63	0.17	0.36	238	0	1.00	0.53
2010	27	22	23	0.31	0.32	90	0	1.00	0.50
2011	83	0	0	0.00	0.00	306	0	1.00	1.00
2012	89	10	45	0.07	0.31	390	0	1.00	0.73
2013	44	55	5	0.53	0.05	383	0	1.00	0.64
Average**	***57***	***12***	***30***	***0.12***	***0.27***	***162***	***16***	***0.94***	***0.60***
Median**	***54***	***5***	***23***	***0.07***	***0.30***	***116***	***0***	***1.00***	***0.61***

HOS_W = hatchery-origin spawners in White River from the White River spring Chinook Supplementation Program.
$pHOS_W$ = proportion of hatchery-origin spawners from White River spring Chinook Supplementation Program.
HOS_S = stray hatchery-origin spawners in the White River.

pHOS$_S$ = proportion of stray hatchery-origin spawners.
NOB$_W$ = natural origin broodstock spawned for the White River spring Chinook Supplementation Program.
HOB$_W$ = hatchery-origin broodstock spawned in the White River spring Chinook Supplementation Program.
pNOB = proportion of hatchery-origin broodstock. Because of the high incidence of strays to the White River from the Chiwawa River spring Chinook program, pNOB values from the Chiwawa program were used to estimate PNI values during the period from 1989 to 2000 (*italicized*). The weighting for those years was 100% based on the Chiwawa program broodstock selection, because there have been no hatchery returns from the White River spring Chinook program during this period (see Table 5.1 for Chiwawa broodstock selection).
PNI = Proportionate Natural Influence for White River spring Chinook calculated using the gene-flow model for multiple programs.
* Average and median for the period 1989-2000.
** Average and median for the period 2001-2013.

Natural and Hatchery Replacement Rates

In general, natural replacement rates (NRR) are calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs include all returning fish that either returned to the basin or were collected as wild broodstock. For brood years 1989-2011, NRR for spring Chinook in the White River basin averaged 1.04 (range, 0.00-4.91) if harvested fish were not included in the estimate and 1.19 (range, 0.00-5.73) if harvested fish were included in the estimate (Table 7.23a). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and are calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. For brood years 2006-2011, hatchery replacement rates averaged 0.30 (range, 0.00-0.94) if harvest is not included and 0.37 (range, 0.00-1.27) if harvest is included (Table 7.23a). Only for brood year 2009 was HRR greater than the NRR. The HRR values are much higher when they are calculated using the number of adult equivalents taken from the natural environment to initiate the captive brood program (Table 7.23b).

Table 7.23a. Numbers of brood stock spawned, spawning escapements, hatchery-origin recruits (HOR), natural-origin recruits (NOR), hatchery replacement rates (HRR), and natural replacement rates (NRR) with and without harvest for spring Chinook in the White River basin, brood years 1989-2010.

Brood year	Brood stock spawned	Spawning Escapement	Harvest not included				Harvest included			
			HOR[1]	NOR[2]	HRR[1]	NRR[2]	HOR[3]	NOR[4]	HRR[3]	NRR[4]
1989	--	145	--	81	--	0.56	--	118	--	0.81
1990	--	49	--	2	--	0.04	--	2	--	0.04
1991	--	49	--	3	--	0.06	--	3	--	0.06
1992	--	78	--	30	--	0.38	--	32	--	0.41
1993	--	145	--	44	--	0.30	--	45	--	0.31
1994	--	7	--	1	--	0.14	--	1	--	0.14
1995	--	5	--	9	--	1.80	--	9	--	1.80
1996	--	30	--	15	--	0.50	--	16	--	0.53
1997	--	33	--	148	--	4.48	--	173	--	5.24
1998	--	11	--	54	--	4.91	--	65	--	5.91
1999	--	3	--	0	--	0.00	--	0	--	0.00

Brood year	Brood stock spawned	Spawning Escapement	Harvest not included				Harvest included			
			HOR[1]	NOR[2]	HRR[1]	NRR[2]	HOR[3]	NOR[4]	HRR[3]	NRR[4]
2000	--	22	--	54	--	2.45	--	58	--	2.64
2001	5	166	--	64	--	0.39	--	66	--	0.40
2002	18	86	--	70	--	0.81	--	73	--	0.85
2003	7	36	--	11	--	0.31	--	12	--	0.33
2004	6	66	--	25	--	0.38	--	27	--	0.41
2005	176	155	--	72	--	0.46	--	74	--	0.48
2006	326	55	5	110	0.02	2.00	6	138	0.02	2.51
2007	260	92	0	0	0.00	0.00	0	0	0.00	0.00
2008	116	52	30	100	0.26	1.92	34	112	0.29	2.15
2009	238	173	115	39	0.48	0.23	125	42	0.52	0.24
2010	90	72	10	40	0.11	0.56	12	49	0.14	0.68
2011	306	83	288	110	0.94	1.33	389	148	1.27	1.78
Average	**141**	**70**	**75**	**47**	**0.30**	**1.04**	***94***	**54**	**0.37**	**1.19**
Median	**116**	**55**	**20**	**40**	**0.18**	**0.46**	***23***	**45**	**0.21**	**0.48**

[1] HOR and HRR values represented here are detections of PIT-tag hatchery fish detected at Tumwater Dam. These values have been expanded based on the untagged proportion of fish released from the White River spring Chinook Program and PIT-tag detection efficiency at Tumwater Dam.
[2] NOR and NRR values represented here are based on carcasses recovery in the White River adjusted by H:W ratios and age composition and expanded to the escapement in the White River.
[3] Harvest on hatchery-origin White River spring Chinook was estimated based on harvest rates observed for Chiwawa spring Chinook.
[4] Expanded NORs for harvest were based on harvest rates from Chiwawa River spring Chinook.

Table 7.23b. Hatchery-origin recruits (HOR) and hatchery replacement rates (HRR) based on adult equivalents for spring Chinook in the White River basin, brood years 2006-2009. HORs were estimated at Tumwater Dam.

Brood year	Adult equivalents	Harvest not included		Harvest included	
		HOR	HRR	HOR	HRR
2006	1.03	5	4.9	6	5.8
2007	1.21	0	0.0	0	0.0
2008	0.36	30	83.6	34	94.4
2009	1.05	115	109.6	125	119.0
Average	***0.91***	***38***	***50***	***55***	***55***
Median	***1.04***	***18***	***44***	***34***	***50***

For comparison, we calculated NRR for spring Chinook within the Little Wenatchee River basin. Fish from both the White River and Little Wenatchee River must migrate through Lake Wenatchee. Therefore, a comparison between the two subpopulations is appropriate.

NRRs for spring Chinook in the Little Wenatchee River basin were generally less than those for spring Chinook in the White River basin. For brood years 1989-2011, NRR for spring Chinook in the Little Wenatchee River basin averaged 0.82 (range, 0.00-4.50) if harvested fish were not included in the estimate and 0.94 (range, 0.00-5.00) if harvested fish were included in the estimate

(Table 7.24). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Table 7.24. Spawning escapements, natural-origin recruits (NOR), and natural replacement rates (NRR) with and without harvest for spring Chinook in the Little Wenatchee River basin, brood years 1989-2011.

Brood year	Spawning Escapement	Harvest not included		Harvest included	
		NOR	NRR	NOR	NRR
1989	102	84	0.82	122	1.20
1990	67	0	0.00	0	0.00
1991	42	0	0.00	0	0.00
1992	78	8	0.10	8	0.10
1993	134	21	0.16	22	0.16
1994	16	11	0.69	11	0.69
1995	0	10	0.00	10	0.00
1996	8	14	1.75	15	1.88
1997	18	81	4.50	90	5.00
1998	18	31	1.72	36	2.00
1999	8	4	0.50	4	0.50
2000	24	39	1.63	42	1.75
2001	118	51	0.43	53	0.45
2002	86	79	0.92	82	0.95
2003	29	13	0.45	14	0.48
2004	39	13	0.33	14	0.36
2005	115	43	0.37	44	0.38
2006	37	49	1.32	62	1.68
2007	101	59	0.58	70	0.69
2008	64	73	1.14	82	1.28
2009	125	52	0.42	56	0.45
2010	83	44	0.53	54	0.77
2011	124	61	0.49	82	0.77
Average	**62**	**37**	**0.82**	**42**	**0.94**
Median	**64**	**39**	**0.50**	**42**	**0.69**

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adults detected at Tumwater Dam divided by the number of tagged hatchery smolts released. SARs were based on PIT-tag detections. For the available brood years, SARs have ranged from 0.00000 to 0.00196 (Table 7.25).

Table 7.25. Smolt-to-adult ratios (SARs) for White River spring Chinook from the captive brood program, brood years 2006-2012. Detections at Tumwater Dam are adjusted for PIT-tag detection efficiency.

Brood year	Number of smolts released	Number of PIT-tagged smolts released	PIT-tags	
			Adjusted Tumwater Detections	SAR
2006	142,033	29,881	1	0.00003
2007	131,843	39,820	0	0.00000
2008	48,556	38,650	23	0.00060
2009	112,596	41,742	42	0.00101
2010	18,850	12,283	6	0.00049
2011	147,000	54,187	106	0.00196
2012	97,713	52,440	25	0.00047
Average	***99,799***	***38,429***	***29***	***0.00065***
Median	***112,596***	***39,820***	***23***	***0.00049***

7.8 ESA/HCP Compliance

Brood Collection

The last collection of eggs or fry for this program occurred in 2010 (brood year 2009). The hatchery program ended with the last release of juveniles in 2015 (brood year 2013).

Hatchery Rearing, Spawning, and Release

The hatchery program ended with the last release of juveniles in 2015 (brood year 2013). No release of juveniles occurred under Section 10(a)(1)(A) Permit 18120 in 2017.

Hatchery Effluent Monitoring

No juveniles were reared or released as part of the White River captive brood program in 2017 due to sun-setting of the program with the 2013 brood. Therefore, no effluent monitoring was required or conducted in 2017.

Smolt and Emigrant Trapping

Per ESA Section 10 Permit Nos. 18118, 18120, and 18121, the permit holders are authorized a direct take of 20% of the emigrating spring Chinook population during juvenile emigration monitoring and a lethal take not to exceed 2% of the fish captured (NMFS 2003). Based on the estimated wild spring Chinook population (smolt trap expansion) and hatchery juvenile spring Chinook population estimate (hatchery release data) for the Wenatchee River basin, the reported spring Chinook encounters during 2017 emigration monitoring complied with take provisions in the Section 10 permit. Spring Chinook encounter and mortality rates for each trap site (including PIT tag mortalities) are detailed in Table 7.26. Additionally, juvenile fish captured at the trap locations were handled consistent with provisions in ESA Section 10 Permits 18118, 18120, and 18121, Section B. Table 7.26 includes incidental or direct take associated with the White River smolt trap operated by the Yakama Nation under separate permits.

Table 7.26. Estimated take of Upper Columbia River spring Chinook resulting from juvenile emigration monitoring in the Wenatchee River basin, 2017.

Trap location	Population estimate			Number trapped			Total	Take allowed under Permit
	Wild[a]	Hatchery[b]	Sub-yearling[c]	Wild	Hatchery	Sub-yearling		
Chiwawa Trap								
Population	53,344	163,411	95,063	5,824	4,518	12,928	23,280	
Encounter rate	NA	NA	NA	0.1092	0.0276	0.1361	0.0747	0.20
Mortality[e]	NA	NA	NA	15	0	187	202	
Mortality rate	NA	NA	NA	0.0026	0.0000	0.0145	0.0087	0.02
White River Trap								
Population	2,942	NA	4,851	41	NA	593	634	
Encounter rate	NA	NA	NA	0.0139	NA	0.1222	0.0814	0.20
Mortality[d]	NA	NA	NA	0	NA	8	8	
Mortality rate	NA	NA	NA	0.0000	NA	0.0135	0.0126	0.02
Nason Creek Trap								
Population	7,247	243,127	26,336	357	1,870	2,490	4,717	
Encounter rate	NA	NA	NA	0.0493	0.0077	0.0945	0.0170	0.20
Mortality[d]	NA	NA	NA	1	0	5	6	
Mortality rate	NA	NA	NA	0.0028	0.0000	0.0020	0.0013	0.02
Lower Wenatchee Trap								
Population	130,426	406,558	7,593,243	1,332	12,132	46,801	60,265	
Encounter rate	NA	NA	NA	0.0102	0.0298	0.0062	0.0074	0.20
Mortality[d]	NA	NA	NA	7	24	360	391	
Mortality rate	NA	NA	NA	0.0053	0.0020	0.0077	0.0065	0.02
Wenatchee River Basin Total								
Population	130,426	406,558	7,593,243	7,554	18,520	62,812	88,896	
Encounter rate	NA	NA	NA	0.0579	0.0456	0.0083	0.0110	0.20
Mortality[d]	NA	NA	NA	23	24	560	607	
Mortality rate	NA	NA	NA	0.0030	0.0013	0.0089	0.0068	0.02

[a] Smolt population estimate derived from juvenile emigration trap data.
[b] 2017 BY smolt release data for the Wenatchee River basin.
[c] Based on size, date of capture and location of capture, subyearling Chinook encountered at the Lower Wenatchee Trap are categorized as summer Chinook salmon.
[d] Combined trapping and PIT tagging mortality.

Spawning Surveys

Spring Chinook spawning ground surveys were conducted in the Wenatchee River basin during 2017, as authorized by ESA Section 10 Permits 18118, 18120, and 18121. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

Spring Chinook Reproductive Success Study

ESA Section 10 Permit 1196 (expired) and new Section 10 Permits 18118, 18120, and 18121 specifically provide authorization to capture, anesthetize, biologically sample, PIT tag, and release adult spring Chinook at Tumwater Dam for reproductive success studies and general program monitoring. During 2010 through 2017, all spring Chinook passing Tumwater Dam were enumerated, anesthetized, biologically sampled, PIT tagged, and released (not including hatchery-origin and natural-origin Chinook retained for broodstock or removed as part of adult management activities) as a component of the reproductive success study (BPA Project No. 2003-039-00). Please refer to Ford et al. (2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017) for complete details on the methods and results of the spring Chinook reproductive success study for the period 2010-2017.

SECTION 8: WENATCHEE SUMMER CHINOOK

The goal of summer Chinook salmon supplementation in the Wenatchee Basin is to use artificial production to replace adults lost because of mortality at Priest Rapids, Wanapum, and Rock Island dams, while not reducing the natural production or long-term fitness of summer Chinook in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD and subsequently Grant PUD began cost-sharing the program in 2012. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans as well as the Priest Rapids Project Salmon and Steelhead Settlement Agreement.

Adult summer Chinook are collected for broodstock from the run-at-large at the right and left-bank traps at Dryden Dam, and at Tumwater Dam if weekly quotas cannot be achieved at Dryden Dam. Before 2012, the goal was to collect up to 492 natural-origin adult summer Chinook for the Wenatchee program for an annual release of 864,000 smolts. In 2011, the Hatchery Committees reevaluated the amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was reduced. The current goal (beginning in 2012) is to collect up to 256 adult natural-origin summer Chinook for an annual release of 500,001 smolts. Broodstock collection occurs from about 1 July through 15 September with trapping occurring up to 24 hours per day, seven days a week. If natural-origin broodstock collection falls short of expectation, hatchery-origin adults can be collected to make up the difference.

Adult summer Chinook are spawned and reared at Eastbank Fish Hatchery. Juvenile summer Chinook are transferred from the hatchery to Dryden Acclimation Pond in March. They are released from the pond in late April to early May.

Before 2012, the production goal for the Wenatchee summer Chinook supplementation program was to release 864,000 yearling smolts into the Wenatchee River at ten fish per pound. Beginning with the 2012 brood, the revised production goal is to release 500,001 yearling smolts into the Wenatchee River at 18 fish per pound. Targets for fork length and weight are 163 mm (CV = 9.0) and 45.4 g, respectively. Over 95% of these fish are marked with CWTs. In addition, since 2009, about 10,000 juvenile summer Chinook have been PIT tagged annually.

8.1 Broodstock Sampling

This section focuses on results from sampling 2015-2017 Wenatchee summer Chinook broodstock, which were collected at Dryden and Tumwater dams.

Origin of Broodstock

Consistent with the broodstock collection protocol, the 2015-2017 broodstock consisted primarily of natural-origin (adipose fin present and no CWT) summer Chinook (Table 8.1). Since 2012, less than 1% of the broodstock has consisted of hatchery-origin fish (hatchery-origin was determined by examination of scales and/or CWTs).

Table 8.1. Numbers of wild and hatchery summer Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned, 1989-2017. Unknown origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program and surplus fish killed at spawning.

Brood year	Wild summer Chinook					Hatchery summer Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989	346	29	27	290	0	0	0	0	0	0	290
1990	87	6	24	57	0	0	0	0	0	0	57
1991	128	9	14	105	0	0	0	0	0	0	105
1992	341	48	19	274	0	0	0	0	0	0	274
1993	480	28	46	406	0	44	0	0	44	0	450
1994	363	29	1	333	0	55	1	0	54	0	387
1995	382	15	4	363	0	16	0	0	16	0	378
1996	331	34	34	263	0	3	0	0	3	0	266
1997	225	14	6	205	0	15	1	1	13	0	218
1998	378	40	39	299	0	94	4	12	78	0	377
1999	250	7	1	242	0	238	1	1	236	0	478
2000	298	18	5	275	0	194	7	7	180	0	455
2001	311	41	60	210	0	182	8	38	136	0	346
2002	469	28	32	409	0	13	1	2	10	0	419
2003	488	90	61	337	0	8	1	0	7	0	344
2004	494	24	46	424	0	2	0	0	2	0	426
2005	491	29	19	397	46	3	0	0	3	0	400
2006	483	29	21	433	0	5	1	0	4	0	437
2007	415	53	99	263	0	4	0	1	3	0	266
2008	400	11	11	378	0	72	2	1	69	0	447
2009	482	22	8	452	0	9	1	0	8	0	460
2010	427	14	25	388	0	7	2	0	5	0	393
2011	398	11	11	376	0	7	0	0	7	0	405
Average[b]	***368***	***27***	***27***	***312***	***2***	***42***	***1***	***3***	***38***	***0***	***351***
Median[b]	***382***	***28***	***21***	***333***	***0***	***8***	***1***	***0***	***7***	***0***	***387***
2012	273	5	1	267	0	1	0	0	1	0	268
2013	256	12	10	234	0	2	0	0	2	0	236
2014	279	18	0	261	0	2	0	0	2	0	263
2015	252	0	0	245	0	0	0	0	0	0	245
2016	271	9	3	259	0	0	0	0	0	0	259
2017	261	8	1	252	0	1	0	0	1	0	253
Average[c]	***265***	***9***	***3***	***253***	***0***	***1***	***0***	***0***	***1***	***0***	***254***
Median[c]	***266***	***9***	***1***	***256***	***0***	***1***	***0***	***0***	***1***	***0***	***256***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[a] This average represents the program before recalculation in 2011.
[b] This average represents the current program, which began in 2012.

Age/Length Data

Ages of summer Chinook broodstock were determined from analysis of scales and/or CWTs. Broodstock collected from the 2015 return consisted primarily of age-4 and age-5 natural-origin Chinook (92.1%). Age-3 and age-6 natural-origin fish made up 7.8% and 0% of the broodstock, respectively (Table 8.2). No hatchery Chinook were included in broodstock.

Broodstock collected from the 2016 return consisted primarily of age-4 and age-5 natural-origin Chinook (98.4%). Age-3 and age-6 natural-origin fish made up 1.3% and 0.4% of the broodstock, respectively (Table 8.2). No hatchery Chinook were included in broodstock.

Broodstock collected from the 2017 return consisted primarily of age-4 and age-5 natural-origin Chinook (98.8%). Age-3 and age-6 natural-origin fish made up 0.4% and 0.8% of the broodstock, respectively (Table 8.2). One hatchery Chinook was included in broodstock.

Table 8.2. Percent of hatchery and wild Wenatchee summer Chinook of different ages (total age) collected from broodstock in the Wenatchee River basin, 1991-2017.

Return Year	Origin	Total age				
		2	3	4	5	6
1991	Wild	0.0	4.6	36.8	57.5	1.1
	Hatchery	0.0	0.0	0.0	0.0	0.0
1992	Wild	0.0	2.6	40.4	50.9	6.1
	Hatchery	0.0	0.0	0.0	0.0	0.0
1993	Wild	0.0	1.5	35.7	60.4	2.3
	Hatchery	0.0	0.0	93.2	6.8	0.0
1994	Wild	0.0	1.0	33.7	64.3	1.0
	Hatchery	0.0	0.0	1.9	98.1	0.0
1995	Wild	0.0	3.3	19.2	76.3	1.2
	Hatchery	0.0	0.0	0.0	0.0	100.0
1996	Wild	0.0	4.6	40.1	53.3	2.0
	Hatchery	0.0	0.0	33.3	66.7	0.0
1997	Wild	0.0	2.3	42.6	53.2	1.9
	Hatchery	0.0	26.7	66.7	6.7	0.0
1998	Wild	0.0	5.5	34.7	58.6	1.2
	Hatchery	0.0	5.3	68.1	20.2	6.4
1999	Wild	0.5	1.9	39.0	56.3	2.3
	Hatchery	0.0	1.3	23.2	72.2	3.4
2000	Wild	2.6	6.3	24.6	66.5	0.0
	Hatchery	0.0	24.2	14.9	42.8	18.0
2001	Wild	0.3	16.6	53.6	27.7	1.7
	Hatchery	0.0	6.1	80.5	10.4	3.0
2002	Wild	0.7	8.4	61.6	28.5	0.7
	Hatchery	0.0	0.0	41.7	58.3	0.0
2003	Wild	0.9	2.8	31.4	64.8	0.0

Return Year	Origin	Total age				
		2	3	4	5	6
	Hatchery	0.0	12.5	25.0	62.5	0.0
2004	Wild	0.2	3.6	10.1	83.9	2.1
	Hatchery	0.0	0.0	50.0	50.0	0.0
2005	Wild	0.0	4.3	53.5	35.1	7.1
	Hatchery	0.0	0.0	0.0	100.0	0.0
2006	Wild	0.9	0.9	14.9	82.1	1.1
	Hatchery	0.0	0.0	0.0	80.0	20.0
2007	Wild	3.1	15.0	18.7	46.6	16.6
	Hatchery	0.0	0.0	0.0	100.0	0.0
2008	Wild	0.5	6.4	65.5	26.0	1.6
	Hatchery	0.0	2.9	13.0	69.6	14.5
2009	Wild	1.1	6.9	45.8	46.8	0.0
	Hatchery	0.0	0.0	11.1	88.9	0.0
2010	Wild	1.0	6.3	66.1	26.6	0.0
	Hatchery	0.0	0.0	62.5	37.5	0.0
2011	Wild	0.8	8.2	50.3	40.4	0.3
	Hatchery	0.0	42.9	14.3	42.9	0.0
2012	Wild	0.0	3.5	47.2	49.2	0.0
	Hatchery	0.0	0.0	0.0	100.0	0.0
2013	Wild	0.0	12.1	57.1	29.1	1.6
	Hatchery	0.0	0.0	50.0	50.0	0.0
2014	Wild	0.0	4.5	74.7	20.0	0.0
	Hatchery	0.0	0.0	100.0	0.0	0.0
2015	Wild	0.0	7.8	33.0	59.1	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
2016	Wild	0.0	1.3	46.1	52.3	0.4
	Hatchery	0.0	0.0	0.0	0.0	0.0
2017	Wild	0.0	0.4	41.2	57.6	0.8
	Hatchery	0.0	0.0	0.0	0.0	100.0
Average	***Wild***	***0.5***	***5.1***	***39.9***	***49.0***	***1.9***
	Hatchery	***0.0***	***4.4***	***26.8***	***41.6***	***9.5***
Median	***Wild***	***0.0***	***4.5***	***40.4***	***53.2***	***1.1***
	Hatchery	***0.0***	***0.0***	***14.3***	***49.2***	***0.0***

Mean lengths of natural-origin summer Chinook of a given age differed little among return years 2014-2017 (Table 8.3).

Table 8.3. Mean fork length (cm) at age (total age) of hatchery and wild Wenatchee summer Chinook collected from broodstock in the Wenatchee River basin, 1991-2017; N = sample size and SD = 1 standard deviation.

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
1991	Wild	-	0	-	-	4	-	-	32	-	-	50	-	-	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
1992	Wild	-	0	-	66	3	10	69	46	5	81	58	3	87	7	1
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
1993	Wild	-	0	-	68	6	10	84	138	9	98	235	6	100	9	6
	Hatchery	-	0	-	-	0	-	79	41	8	101	3	8	-	0	-
1994	Wild	-	0	-	74	3	5	86	101	8	96	193	7	106	3	7
	Hatchery	-	0	-	-	0	-	75	1	-	90	53	8	-	0	-
1995	Wild	-	0	-	66	11	8	85	64	7	97	255	6	106	4	7
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	91	16	8
1996	Wild	-	0	-	69	14	5	86	121	6	97	161	6	104	6	5
	Hatchery	-	0	-	-	0	-	63	1	-	96	2	4	-	0	-
1997	Wild	-	0	-	54	5	10	85	92	7	98	115	6	97	4	9
	Hatchery	-	0	-	46	4	2	74	10	4	98	1	-	-	0	-
1998	Wild	-	0	-	66	19	9	85	119	7	99	201	7	106	4	7
	Hatchery	-	0	-	53	5	2	77	64	8	95	19	8	98	6	8
1999	Wild	42	1	-	65	4	6	86	83	6	97	120	7	103	5	8
	Hatchery	-	0	-	52	3	6	79	55	7	90	171	6	100	8	6
2000	Wild	43	7	3	60	17	7	84	67	5	98	181	6	-	0	-
	Hatchery	-	0	-	53	47	7	76	29	8	93	83	7	102	35	9
2001	Wild	48	1	-	66	48	7	88	155	7	97	80	6	102	5	3
	Hatchery	-	0	-	51	10	3	75	132	8	91	17	8	100	5	8
2002	Wild	51	3	3	64	37	8	89	270	7	100	125	7	99	7	5
	Hatchery	-	0	-	-	0	-	78	5	8	95	7	5	-	0	-
2003	Wild	41	4	2	58	13	4	87	144	8	100	297	7	-	0	-
	Hatchery	-	0	-	40	1	-	78	2	4	101	5	8	-	0	-
2004	Wild	51	1	-	69	17	5	84	47	8	99	392	6	109	10	7
	Hatchery	-	0	-	-	0	-	84	1	-	108	1	-	-	0	-
2005	Wild	-	0	-	68	20	7	86	247	8	95	162	6	101	33	6
	Hatchery	-	0	-	-	0	-	-	0	-	90	3	9	-	0	-
2006	Wild	44	4	7	63	4	11	88	66	7	99	363	6	96	5	7
	Hatchery	-	0	-	-	0	-	-	0	-	99	4	7	100	1	-
2007	Wild	44	12	5	65	58	7	89	72	8	99	180	7	102	64	6
	Hatchery	-	0	-	-	0	-	-	0	-	90	4	5	-	0	-
2008	Wild	46	2	3	69	24	7	90	247	6	98	98	7	105	6	9
	Hatchery	-	0	-	63	2	14	81	9	7	93	48	6	99	10	5
2009	Wild	46	5	5	68	31	8	89	207	8	101	209	6	-	0	-

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	61	4	7	81	1	-	98	8	14	-	0	-
2010	Wild	45	4	4	70	26	9	89	273	7	99	110	6	-	0	-
	Hatchery	-	0	-	-	0	-	72	5	8	88	3	7	-	0	-
2011	Wild	49	3	3	66	30	7	88	183	7	98	147	7	114	1	-
	Hatchery	-	0	-	55	3	2	90	1	-	81	3	5	-	0	-
2012	Wild	-	0	-	71	9	4	87	120	7	96	125	7	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	83	1	-	-	0	-
2013	Wild	-	0	-	72	30	3	87	141	7	98	72	7	97	4	6
	Hatchery	-	0	-	-	0	-	79	1	-	96	1	-	-	0	-
2014	Wild	-	0	-	74	12	5	88	198	6	98	53	7	-	0	-
	Hatchery	-	0	-	-	0	-	86	2	6	-	0	-	-	0	-
2015	Wild	-	0	-	72	18	3	86	76	6	98	136	6	-	0	-
	Hatchery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Wild	-	0	-	70	3	8	86	106	7	95	121	7	99	1	-
	Hatchery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	Wild	-	0	-	64	103	5	81	103	7	93	144	7	92	2	4
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	98	1	-
Average	***Wild***	***46***	***2***	***4***	***67***	***21***	***7***	***86***	***130***	***7***	***97***	***162***	***6***	***101***	***7***	***6***
	Hatchery	***-***	***0***	***-***	***53***	***4***	***5***	***78***	***16***	***7***	***94***	***18***	***7***	***99***	***5***	***7***

Sex Ratios

Male summer Chinook in the 2015, 2016, and 2017 broodstock made up about 50% of the adults collected, resulting in overall male to female ratios of 0.99:1.00, 0.99:1.00, and 0.98:1.00, respectively (Table 8.4). The ratios in 2015-2017 were nearly equal to the 1:1 ratio goal in the broodstock protocol.

Table 8.4. Numbers of male and female wild and hatchery summer Chinook collected for broodstock in the Wenatchee River basin, 1989-2017. Ratios of males to females are also provided.

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989	166	180	0.92:1.00	0	0	-	0.92:1.00
1990	45	39	1.15:1.00	0	0	-	1.15:1.00
1991	60	68	0.88:1.00	0	0	-	0.88:1.00
1992	154	187	0.82:1.00	0	0	-	0.82:1.00
1993	208	228	0.91:1.00	35	9	3.89:1.00	1.03:1.00
1994	158	179	0.88:1.00	24	31	0.77:1.00	0.87:1.00
1995	169	213	0.79:1.00	1	15	0.07:1.00	0.75:1.00
1996	150	181	0.83:1.00	2	1	2.00:1.00	0.84:1.00
1997	104	121	0.86:1.00	15	0	-	0.98:1.00

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1998	211	167	1.26:1.00	64	30	2.13:1.00	1.40:1.00
1999	130	120	1.08:1.00	108	130	0.83:1.00	0.95:1.00
2000	153	145	1.06:1.00	112	82	1.37:1.00	1.17:1.00
2001	187	124	1.51:1.00	132	50	2.64:1.00	1.83:1.00
2002	266	203	1.31:1.00	5	8	0.63:1.00	1.28:1.00
2003	270	218	1.24:1.00	5	3	1.67:1.00	1.24:1.00
2004	230	264	0.87:1.00	1	1	1.00:1.00	0.87:1.00
2005	291	200	1.46:1.00	2	1	2.00:1.00	1.46:1.00
2006	237	246	0.96:1.00	1	4	0.25:1.00	0.95:1.00
2007	239	176	1.36:1.00	2	2	1.00:1.00	1.35:1.00
2008	208	192	1.08:1.00	29	43	0.67:1.00	1.01:1.00
2009	223	236	0.94:1.00	25	7	3.57:1.00	1.02:1.00
2010	217	198	1.10:1.00	5	2	2.50:1.00	1.12:1.00
2011	198	200	0.99:1.00	4	3	1.33:1.00	0.99:1.00
2012	138	135	1.02:1.00	1	0	-	1.03:1.00
2013	127	130	0.98:1.00	1	1	1.00:1.00	0.98:1.00
2014	140	139	1.01:1.00	0	2	0.00:1.00	0.99:1.00
2015	122	123	0.99:1.00	0	0	--	0.99:1.00
2016	134	136	0.99:1.00	0	0	--	0.99:1.00
2017	130	131	0.99:1.00	0	1	--	0.98:1.00
Total	***5,065***	***4879***	***1.04:1.00***	***574***	***426***	***1.35:1.00***	***1.06:1.00***

Fecundity

Fecundities for the 2015-2017 returns of summer Chinook averaged 4,982, 4,423, and 4,361 eggs per female, respectively (Table 8.5). These values are less than the overall average of 5,085 eggs per female. Mean observed fecundities for the 2015-2017 returns were lower than the expected fecundities of 5,031, 4,902, and 4,834 eggs per female assumed in the broodstock collection protocols, respectively.

Table 8.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock in the Wenatchee River basin, 1989-2017; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
1989*	NA	NA	5,280
1990*	NA	NA	5,436
1991*	NA	NA	4,333
1992*	NA	NA	5,307
1993*	NA	NA	5,177
1994*	NA	NA	5,899

Return year	Mean fecundity		
	Wild	Hatchery	Total
1995*	NA	NA	4,402
1996*	NA	NA	4,941
1997	5,385	5,272	5,390
1998	5,393	4,825	5,297
1999	5,036	4,942	4,987
2000	5,464	5,403	5,441
2001	5,280	4,647	5,097
2002	5,502	5,027	5,484
2003	5,357	5,696	5,361
2004	5,372	6,681	5,377
2005	5,045	6,391	5,053
2006	5,126	5,633	5,133
2007	5,124	4,510	5,115
2008	5,147	4,919	5,108
2009	5,308	4,765	5,291
2010	4,971	3,323	4,963
2011	4,943	2,983	4,913
2012	4,801	NA	4,801
2013	4,987	5,272	4,990
2014	4,788	4,429	4,756
2015	4,982	NA	4,982
2016	4,423	NA	4,423
2017	4,351	5,621	4,361
Average	***5,085***	***5,019***	***5,063***
Median	***5,124***	***4,985***	***5,097***

* Individual fecundities were not tracked with females until 1997.

To estimate fecundities by length, weight, and age[33], hatchery staff collected fecundity, fork length, weight, and age data from summer Chinook females during the spawning of 2003 through 2017 broodstock (complete data for all variables are available for years 2014-2017). For the available brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass for natural-origin summer Chinook (very few hatchery fish were examined because they were not targeted for broodstock). Hatchery staff randomly sampled about fifty females.

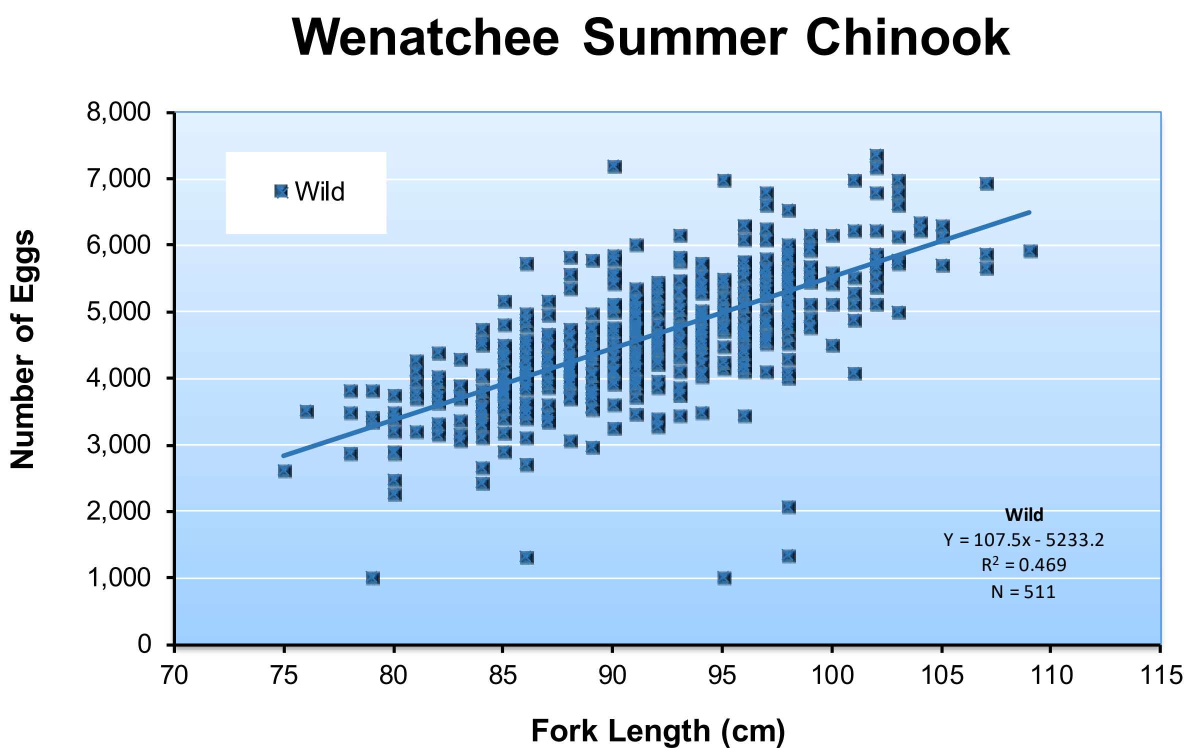
On average, mean fecundities for natural-origin age-3 and age-4 Chinook were 3,897 and 4,494 eggs, respectively. Although hatchery-origin fish were not targeted for inclusion in broodstock, mean fecundity by age varied between natural-origin and the few hatchery-origin summer Chinook over time (Table 8.6).

[33] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

Table 8.6. Mean fecundity by age (total age) for hatchery and wild summer Chinook collected from broodstock for the Wenatchee River program, brood years 2003-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2003	Wild	-	0	-	4,643	23	601	5,463	126	832	-	0	-
	Hatchery	-	0	-	-	0	-	5,696	2	603	-	0	-
2004	Wild	-	0	-	4,419	6	753	5,387	223	746	6,181	4	877
	Hatchery	-	0	-	-	0	-	6,681	1	-	-	0	-
2005	Wild	-	0	-	4,823	56	716	5,047	85	762	5,846	17	778
	Hatchery	-	0	-	-	0	-	6,391	1	-	-	0	-
2006	Wild	-	0	-	4,503	14	791	5,264	186	889	5,000	4	1,049
	Hatchery	-	0	-	-	0	-	5,633	3	224	-	0	-
2007	Wild	-	0	-	4,829	24	952	5,123	73	911	5,445	18	1,023
	Hatchery	-	0	-	-	0	-	4,510	2	685	-	0	-
2008	Wild	-	0	-	5,019	113	807	5,448	57	658	4,756	2	286
	Hatchery	-	0	-	4,124	3	425	4,841	27	714	5,389	8	1,015
2009	Wild	-	0	-	4,947	98	814	5,612	116	822	-	0	-
	Hatchery	-	0	-	-	0	-	3,944	1	-	-	0	-
2010	Wild	1,631	1	-	4,891	123	756	5,219	59	884	-	0	-
	Hatchery	-	0	-	-	0	-	3,323	1	-	-	0	-
2011	Wild	3,780	1	-	4,727	84	739	5,155	91	818	-	0	-
	Hatchery	-	0	-	-	0	-	2,983	3	761	-	0	-
2012	Wild	-	0	-	4,697	39	680	4,857	83	848	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2013	Wild	-	0	-	4,730	61	887	5,280	45	1,048	5,181	3	767
	Hatchery	-	0	-	-	0	-	5,272	1	-	-	0	-
2014	Wild	-	0	-	4,658	87	893	5,164	31	796	-	0	-
	Hatchery	-	0	-	4,429	2	1,906	-	0	-	-	0	-
2015	Wild	-	0	-	4,332	25	761	5,159	92	827	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2016	Wild	-	0	-	4,198	55	596	4,550	69	870	5,690	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2017	Wild	-	0	-	3,897	34	764	4,494	84	803	5,002	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	5,621	1	-
Average	***Wild***	***2,706***	***1***	***-***	***4,621***	***56***	***767***	***5,148***	***95***	***834***	***5,388***	***7***	***797***
	Hatchery	***-***	***0***	***-***	***4,277***	***3***	***1,166***	***4,927***	***3***	***597***	***5,505***	***5***	***1,015***

We pooled fecundity data from brood years 2014 through 2017 (years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg mass for natural-origin females are shown in Figures 8.1, 8.2, and 8.3. All fecundity variables increase linearly with fork length.



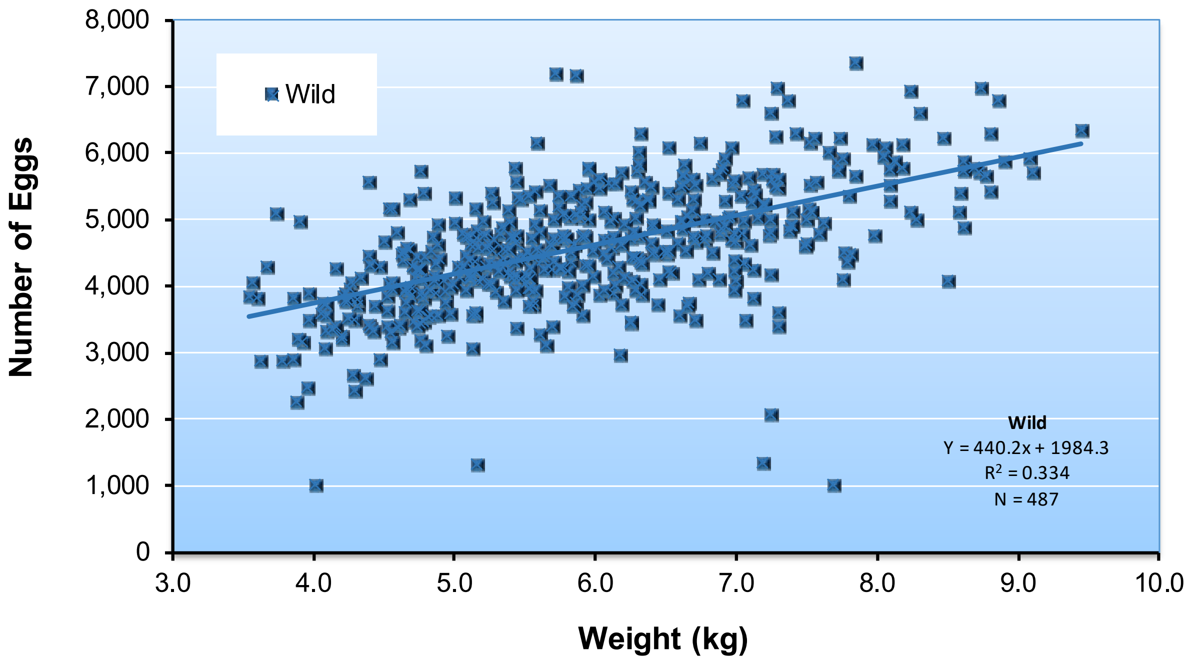


Figure 8.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural-origin summer Chinook for return years 2014-2017.

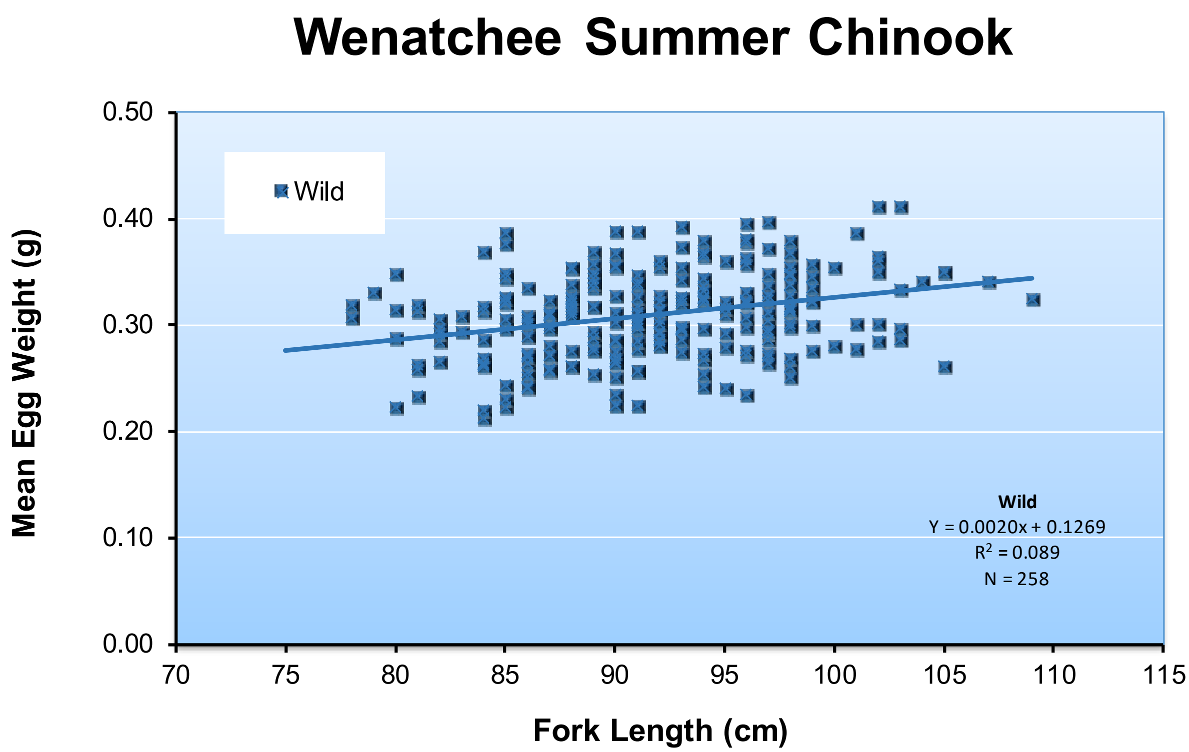


Figure 8.2. Relationships between mean egg weight and fork length for natural-origin summer Chinook for return years 2014-2017.

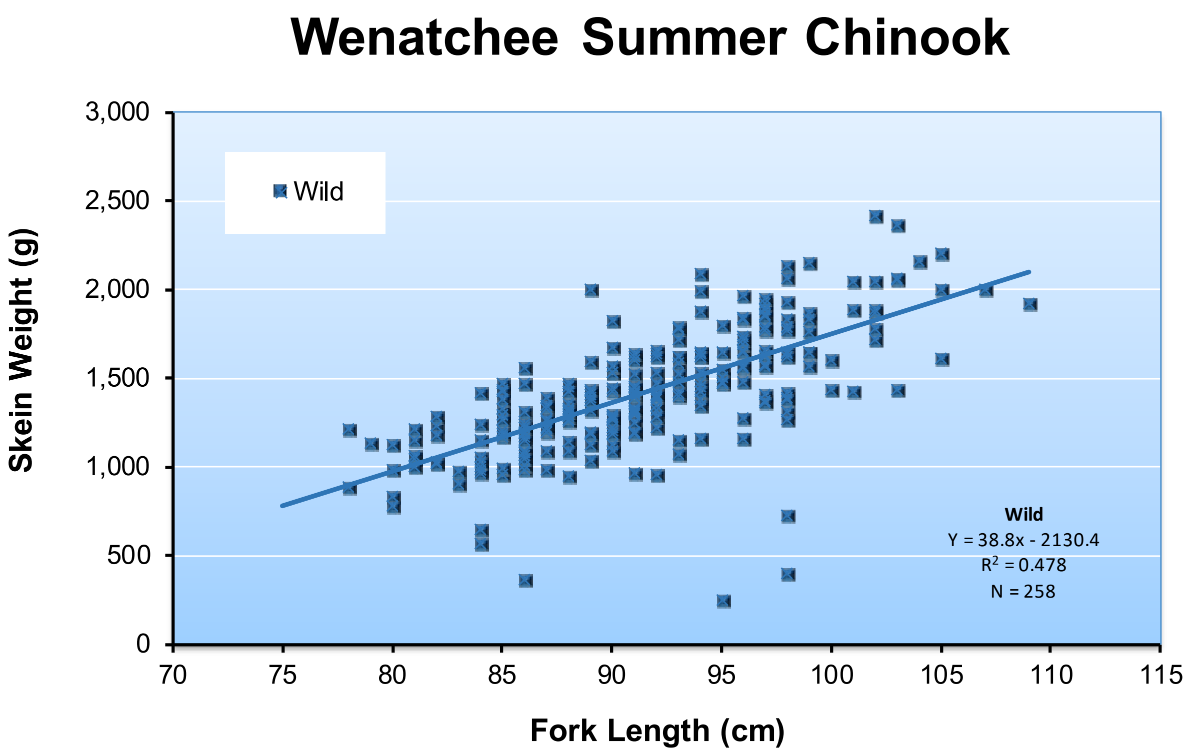


Figure 8.3. Relationships between skein weight and fork length for natural-origin summer Chinook for return years 2014-2017.

8.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 1,066,667 eggs were required to meet the program release goal of 864,000 smolts for brood years 1989-2011. An evaluation of the program in 2011 determined that 617,285 eggs are needed to meet the revised release goal of 500,001 smolts. This revised goal began with brood year 2012. From 1989 to 2011, the egg take goal was reached in seven of those years (Table 8.7). The egg takes from 2013-2017 were lower than the revised goal of 617,285 eggs.

Table 8.7. Numbers of eggs taken from Wenatchee summer Chinook broodstock, 1989-2017.

Return year	Number of eggs taken
1989	829,012
1990	163,109
1991	247,000
1992	827,911
1993	1,133,852
1994	999,364

Return year	Number of eggs taken
1995	949,531
1996	756,000
1997	554,617
1998	854,997
1999	1,182,130
2000	1,113,159
2001	733,882
2002	1,049,255
2003	901,095
2004	1,311,051
2005	883,669
2006	1,190,757
2007	655,201
2008	1,145,330
2009	1,217,028
2010	947,875
2011	959,202
Average (1989-2011)	***895,871***
Median (1989-2011)	***947,875***
2012	633,677
2013	578,513
2014	612,422
2015	610,718
2016	588,606
2017	550,478
Average (2012-present)	***595,736***
Median (2012-present)	***599,662***

Number of acclimation days

The 2015 brood Wenatchee summer Chinook were transferred to the Dryden Acclimation Pond between 13 and 15 March 2017. These fish received 33-44 days of acclimation on Wenatchee River water before being released volitionally from 17-26 April 2017 (Table 8.8).

Table 8.8. Number of days Wenatchee summer Chinook were acclimated at Dryden Acclimation Pond, brood years 1989-2015. Numbers in parenthesis represents the number of days fish reared at Chiwawa Acclimation Facility.

Brood year	Release year	Transfer date	Release date	Number of days
1989	1991	2-Mar	7-May	66
1990	1992	19-Feb	2-May	73
1991	1993	10-Mar	8-May	59
1992	1994	1-Mar	6-May	66
1993	1995	3-Mar	1-May	59
1994	1996	2-Oct	6-May	217 (154)
		5-Mar	6-May	62
1995	1997	16-Oct	8-May	205 (139)
		27-Feb	8-May	70
1996	1998	6-Oct	28-Apr	204 (142)
		25-Feb	28-Apr	62
1997	1999	23-Feb	27-Apr	63
1998	2000	5-Mar	1-May	57
1999	2001	8-Mar	23-Apr	46
2000	2002	1-Mar	6-May	66
2001	2003	19-Feb	23-Apr	63
2002	2004	5-Mar	23-Apr	49
2003	2005	15-Mar	25-Apr	41
2004	2006	25-Mar	27-Apr	33
2005	2007	15-Mar	30-Apr	46
2006	2008	11-14-Mar	28-Apr	45-48
2007	2009	30-31-Mar	29-Apr	29-30
2008	2010	9-12, 15, 22-Mar	28-Apr	38-51
2009	2011	15-18, 21-Mar, 22-Apr	26-Apr	5-43
2010	2012	26-30-Mar	25-Apr	26-30
2011	2013	25-29-Mar	24-Apr	26-30
2012	2014	17-27-Mar	30-Apr	34-44
2013	2015	9-13-Mar, 17-Apr	28-Apr	11-50
2014	2016	21-24-Mar	18-27-Apr	25-37
2015	2017	13-15-Mar	17-26-Apr	33-44

Release Information

Numbers released

The 2015 Wenatchee summer Chinook program achieved 105.1% of the 500,001 goal with 525,366 fish being released in 2017 (Table 8.9). For brood years 2012-2015, the Wenatchee summer Chinook program has averaged 104% of the smolt obligation.

Table 8.9. Numbers of Wenatchee summer Chinook smolts released from the hatchery, brood years 1989-2015. Up to 2012, the release target for Wenatchee summer Chinook was 864,000 smolts. Beginning in 2012, the release target is 500,001 smolts.

Brood year	Release year	CWT mark rate	Number released with PIT tags	Number of smolts released
1989	1991	0.2013	0	720,000
1990	1992	0.9597	0	124,440
1991	1993	0.9957	0	191,179
1992	1994	0.9645	0	627,331
1993	1995	0.9881	0	900,429
1994	1996	0.9697	0	797,350
1995	1997	0.9725	0	687,439
1996	1998	0.9758	0	600,127
1997	1999	0.9913	0	438,223
1998	2000	0.9869	0	649,612
1999	2001	0.9728	0	1,005,554
2000	2002	0.9723	0	929,496
2001	2003	0.9868	0	604,668
2002	2004	0.9644	0	835,645
2003	2005	0.9778	0	653,764
2004	2006	0.9698	0	892,926
2005	2007	0.9596	0	644,182
2006	2008	0.9676	0	51,550[a]
		0.9676	0	899,107
2007	2009	0.9768	0	456,805
2008	2010	0.9664	10,035	888,811
2009	2011	0.9767	29,930	843,866
2010	2012	0.9964	0	792,746
2011	2013	0.9904	5,020	827,709
Average (1989-2011)		***0.9761***	***1,874***	***667,085***
Median (1989-2011)		***0.9727***	***0***	***720,000***
2012	2014	0.9700	19,911	550,877
2013	2015	0.9872	20,486	470,570
2014	2016	0.9639	10,432	535,255
2015	2017	0.9831	20,605	525,366
Average (2012-present)		***0.9761***	***17,859***	***520,517***

Brood year	Release year	CWT mark rate	Number released with PIT tags	Number of smolts released
Median (2012-present)		***0.9766***	***20,199***	***530,311***

[a] Represents high ELISA group planted directly in the Wenatchee River at Leavenworth Boat Launch.

Numbers tagged

The 2015 brood Wenatchee summer Chinook were 98.3% CWT and adipose fin-clipped (Table 8.9).

2016 Brood Wenatchee Summer Chinook (Raceway)—A total of 10,500 Wenatchee summer Chinook were tagged at Eastbank Hatchery on 18-22 September 2017. These were tagged and released into raceway #13. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 79 mm in length and 6.3 g at time of tagging.

2016 Brood Wenatchee Summer Chinook (Reuse Circular Ponds)—A total of 10,500 Wenatchee summer Chinook were tagged at Eastbank Hatchery on 25-29 September 2017. These were tagged and released into water-reuse circular ponds #1 and #2. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 80 mm in length and 6.5 g at time of tagging.

Table 8.10 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Wenatchee River.

Table 8.10. Summary of PIT-tagging activities for Wenatchee hatchery summer Chinook, brood years 2008-2015.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2008	2010	10,100	64	1	10,035
2009	2011	10,108 (Control)	140	3	9,965
		10,100 (R1)	129	0	9,971
		10,099 (R2)	105	0	9,994
2010	2012	0	0	0	0
2011	2013	5,100	80	0	5,020
2012	2014 (Raceway)	5,150 (small-size)	90	12	5,048
		5,153 (big-size)	379	34	4,740
	2014 (Reuse Circular)	5,150 (small-size)	109	0	5,041
		5,151 (big-size)	69	0	5,082
2013	2015 (Raceway)	5,150 (small-size)	44	0	5,116
		5,153 (big-size)	31	0	5,129
	2015 (Reuse Circular)	5,150 (small-size)	41	0	5,120
		5,151 (big-size)	38	1	5,121
2014		5,250 (small-size)	54	0	5,196

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
	2016 (Raceway)	5,250 (big-size)	92	0	5,158
	2016 (Reuse Circular)	5,250 (small-size)	19	0	5,231
		5,250 (big-size)	49	0	5,201
2015	2017 (Raceway)	10,565	213	0	10,352
	2017 (Reuse Circular)	10,429	176	0	10,253

Fish size and condition at release

About 525,366 summer Chinook from the 2015 brood were released volitionally from Dryden Acclimation Pond on 17-26 April 2017. Assessing size-target achievement from pre-release sampling was not practical because of size-target studies on the 2012 and 2013 brood years. However, since the program began, Wenatchee summer Chinook have not met the target length and CV values (Table 8.10). The target weight (fish/pound or FPP) of juvenile fish has been met occasionally (Table 8.11).

Table 8.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Wenatchee summer Chinook smolts released from the hatchery, brood years 1989-2015; NA = not available. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1991	158	13.7	45.4	10
1990	1992	155	14.2	45.4	10
1991	1993	156	15.5	42.3	11
1992	1994	152	13.1	40.1	10
1993	1995	149	NA	34.9	13
1994	1996	138	NA	21.7	21
1995	1997	149	12.2	42.5	11
1996	1998	151	16.6	43.2	10
1997	1999	154	10.1	42.8	11
1998	2000	166	9.7	53.1	9
1999	2001	137	16.1	29.0	16
2000	2002	148	14.6	37.1	12
2001	2003	148	NA	38.9	12
2002	2004	146	15.1	37.3	14
2003	2005	147	13.2	36.5	12
2004	2006	147	10.7	35.4	13
2005	2007	153	16.3	40.6	11
2006	2008	136	21.5	29.2	16

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
2007	2009	163	21.6	49.7	9
2008	2010	166	15.0	52.0	9
2009	2011	152	15.9	39.0	12
2010	2012	154	17.2	43.1	11
2011	2013	149	13.8	41.4	11
Average (1989-2011)		***151***	***14.8***	***40.0***	***12***
Targets (1989-2011)		***176***	***9.0***	***45.4***	***10***
2012	2014	158	12.6	40.7	11
2013	2015	156	10.1	40.7	11
2014	2016	145	10.2	31.1	15
2015	2017	139	9.5	29.8	15
Average (2012-present)		***150***	***10.6***	***35.6***	***13***
Targets (2012-present)[a]		***163***	***9.0***	***45.4***	***18***

[a] For brood year 2012, the fish per pound (fpp) targets were 10 fpp and 15 fpp.

Survival Estimates

Overall survival of the 2015 brood Wenatchee summer Chinook from green (unfertilized) egg to release was higher than the standard set for the program. This was in part because of a high survival at most stages (Table 8.12).

Table 8.12. Hatchery life-stage survival rates (%) for Wenatchee summer Chinook, brood years 1989-2015. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989	90.0	93.4	90.9	97.0	99.7	99.3	98.5	99.4	86.9
1990	89.7	95.6	80.9	96.6	99.6	99.2	97.7	98.8	76.3
1991	88.2	98.3	86.9	96.1	99.3	98.5	94.9	98.1	77.4
1992	84.3	92.2	79.8	97.8	99.9	99.9	97.1	98.1	75.8
1993	92.4	95.9	84.2	97.5	99.6	99.3	96.7	98.8	79.4
1994	90.7	95.3	83.7	100	99.2	97.0	95.3	98.4	79.8
1995	94.7	98.2	86.0	100	96.7	96.4	74.9	90.8	72.4
1996	84.6	96.1	84.1	100	97.9	97.7	94.4	97.7	79.4
1997	89.3	98.3	82.6	97.3	97.1	96.9	98.3	98.2	79.0
1998	85.3	94.6	80.9	98.3	99.4	98.6	95.6	99.8	76.0
1999	98.4	98.3	90.4	97.9	98.1	97.9	96.2	99.4	85.1
2000	93.0	96.6	88.3	98.0	99.6	99.3	96.5	98.9	83.5
2001	87.4	91.5	90.6	97.7	99.8	99.6	93.1	93.3	82.4
2002	93.8	94.1	85.1	99.8	98.1	97.6	93.7	96.5	79.6

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2003	77.4	85.1	80.5	98.1	99.6	99.1	91.9	93.5	72.6
2004	92.8	97.8	85.7	87.8	99.9	99.6	86.6	92.1	65.1
2005	97.3	89.6	83.5	98.0	99.7	99.4	89.1	99.5	72.9
2006	92.4	95.2	85.6	98.4	99.3	98.4	94.8	97.2	79.8
2007	73.6	97.5	73.7	97.9	99.5	98.7	96.6	99.1	69.7
2008	96.6	97.9	90.4	97.3	99.4	98.7	88.2	89.6	77.6
2009	95.1	95.6	92.0	99.6	97.3	97.3	84.8	98.2	78.1
2010	94.7	97.8	96.1	99.3	97.6	97.1	87.2	90.3	83.2
2011	98.0	96.4	92.3	97.9	99.5	98.9	95.9	97.3	86.7
2012	97.8	97.2	92.3	98.1	99.7	99.1	96.1	97.3	86.9
2013	91.5	98.4	87.5	98.8	97.1	96.6	94.1	98.4	81.3
2014	92.2	95.0	92.6	99.4	99.6	98.7	97.8	99.3	90.0
2015	96.2	97.7	89.8	97.8	99.7	99.4	98.2	99.4	86.2
Average	***91.0***	***95.5***	***86.5***	***97.9***	***99.0***	***98.5***	***93.5***	***96.9***	***79.4***
Median	***92.4***	***96.1***	***86.0***	***98.0***	***99.5***	***98.7***	***95.3***	***98.2***	***79.4***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

8.3 Disease Monitoring

Rearing of the 2015 brood Wenatchee summer Chinook was similar to previous years with fish being held on well water before being transferred to Dryden Acclimation Pond for final acclimation in March 2017. Fish were transferred to Dryden Acclimation Pond from 13-15 March. A 10-day prophylactic treatment of formalin occurred at Dryden Acclimation Pond at the beginning of acclimation to prevent a possible outbreak of external fungus.

Results of the 2017 adult broodstock bacterial kidney disease (BKD) monitoring indicated that all females (100%) had ELISA values less than 0.199. Additionally, all females had ELISA values less than 0.120, which means that none of the progeny needed to be reared at densities less than 0.06 fish per pound (Table 8.13).

Table 8.13. Proportion of bacterial kidney disease (BKD) titer groups for the Wenatchee summer Chinook broodstock, brood years 1997-2017. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1997	0.7714	0.0857	0.0381	0.1048	0.8095	0.1905
1998	0.3067	0.2393	0.1656	0.2883	0.4479	0.5521
1999	0.9590	0.0123	0.0123	0.0164	0.9713	0.0287
2000	0.6268	0.1053	0.1627	0.1053	0.7321	0.2679

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
2001	0.6513	0.0263	0.0987	0.2237	0.6776	0.3224
2002	0.7868	0.0457	0.0711	0.0964	0.8325	0.1675
2003	0.9825	0.0000	0.0058	0.0117	0.9825	0.0175
2004	0.9593	0.0081	0.0163	0.0163	0.9675	0.0325
2005	0.9833	0.0056	0.0000	0.0111	0.9833	0.0167
2006	0.9134	0.0563	0.0000	0.0303	0.9351	0.0649
2007	0.9535	0.0078	0.0078	0.0310	0.9535	0.0465
2008	0.9868	0.0088	0.0044	0.0000	0.9868	0.0132
2009	0.9957	0.0000	0.0000	0.0043	0.9957	0.0043
2010	0.9897	0.0025	0.0000	0.0025	0.9949	0.0051
2011	0.9585	0.0363	0.0000	0.0052	0.9896	0.0104
2012	0.9697	0.0303	0.0000	0.0000	1.0000	0.0000
2013	0.8120	0.1790	0.0000	0.0090	0.8890	0.1110
2014	0.9462	0.0154	0.0000	0.0385	0.9462	0.0538
2015	0.9919	0.0000	0.0000	0.0081	0.9919	0.0081
2016	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2017	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
Average	***0.8831***	***0.0412***	***0.0278***	***0.0478***	***0.9089***	***0.0911***
Median	***0.9590***	***0.0123***	***0.0000***	***0.0117***	***0.9713***	***0.0287***

[a] Individual ELISA samples were not collected before the 1997 brood.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

8.4 Natural Juvenile Productivity

During 2017, juvenile summer Chinook were sampled at the Lower Wenatchee Trap located near the town of Cashmere. The Lower Wenatchee Trap was moved to its present location in 2013 and as a result flow-efficiency models are being refined.

Emigrant Estimates

Lower Wenatchee Trap

The Lower Wenatchee Trap operated between 24 February and 31 July 2017. During that time, the trap was inoperable for 36 days because of high and low river discharge, debris, elevated river temperature, large hatchery releases, and mechanical issues. During the sampling period, 46,801 wild subyearling Chinook were captured at the Lower Wenatchee Trap. Based on 24 capture efficiency trials, a significant relationship between trap efficiency and river discharge was created ($R^2 = 0.51$, $P < 0.005$) and an estimate of 7,593,243 (±1,068,936; 95% CI) wild subyearling Chinook passed the trap within the sampling period (Table 8.14).

Table 8.14. Numbers of redds and juvenile summer Chinook emigrants in the Wenatchee River basin for brood years 1999-2016; NS = not sampled. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere.

Brood year	Number of redds	Egg deposition	Number of emigrants upstream from trap	Total number of emigrants
1999	2,738	13,654,406	9,572,392	9,685,591
2000	2,540	13,820,140	1,299,476	1,322,383
2001	3,550	18,094,350	8,229,920	8,340,342
2002	6,836	37,488,624	13,167,855	13,475,368
2003	5,268	28,241,748	20,336,968	20,426,149
2004	4,874	26,207,498	14,764,141	14,935,745
2005	3,538	17,877,514	11,612,939	11,695,581
2006	8,896	45,663,168	9,397,044	9,595,512
2007	1,970	10,076,550	4,470,672	4,546,838
2008	2,800	14,302,400	4,309,496	4,405,473
2009	3,441	18,206,331	6,695,977	6,814,805
2010	3,261	16,184,343	NS	NS
2011	3,078	15,122,214	NS	NS
2012	2,504	12,021,704	9,333,214	10,034,508
2013	3,241	16,162,867	11,936,928	12,605,925
2014	3,458	16,556,904	14,157,778	14,763,064
2015	1,804	11,491,325	4,023,310	4,199,697
2016	2,797	12,371,131	8,113,717	8,407,997
Average	***3,700***	***18,946,634***	***9,435,508***	***9,703,436***
Median	***3,251***	***16,173,605***	***9,365,129***	***9,640,552***

A total of 300 summer Chinook redds were observed downstream from the trap in 2016. Thus, the total number of summer Chinook emigrating from the Wenatchee River in 2017 was expanded using the ratio of the number of redds downstream from the trap to the number upstream from the trap. This resulted in a total summer Chinook emigrant estimate of 8,407,997 fish (Table 8.14). Most of the fish emigrated during April through July (Figure 8.4). Monthly captures and mortalities of all fish collected at the Lower Wenatchee Trap are reported in Appendix B.

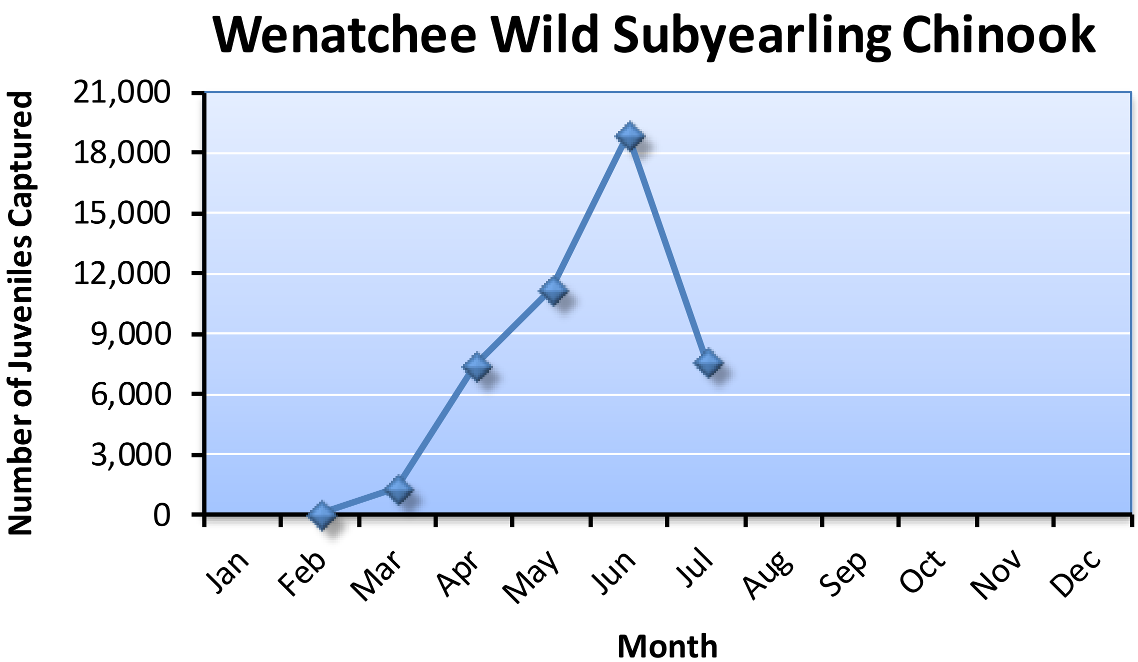


Figure 8.4. Numbers of wild subyearling Chinook captured at the Lower Wenatchee Trap during late January through July 2017.

Subyearling summer Chinook sampled in 2017 averaged 54 mm in length, 1.8 g in weight, and had a mean condition of 1.14 (Table 8.15). These size estimates were similar to the overall mean of subyearling summer Chinook sampled in previous years (overall means: 50 mm, 1.6 g, and condition of 1.28).

Table 8.15. Mean fork length (mm), weight (g), and condition factor of subyearling summer Chinook collected in the Lower Wenatchee Trap, 2000-2017; NS = not sampled. From 2000-2010 the trap operated at Monitor; from 2013 to present the trap operated near Cashmere. Numbers in parentheses indicate 1 standard deviation.

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2000	1,099	49 (14.7)	1.7 (2.2)	1.40 (0.29)
2001	403	56 (15.1)	2.3 (1.9)	1.33 (0.17)
2002	2,337	59 (18.0)	2.9 (2.7)	1.42 (0.17)
2003	818	59 (15.6)	2.8 (2.6)	1.40 (0.16)
2004	1,725	46 (11.2)	1.2 (1.5)	1.23 (0.20)
2005	2,944	45 (9.2)	1.0 (1.0)	1.13 (0.21)
2006	2,873	50 (15.2)	1.8 (2.0)	1.39 (0.21)
2007	2,864	46 (9.1)	1.0 (1.0)	1.10 (0.28)
2008	2,136	46 (11.6)	1.3 (1.4)	1.29 (0.21)
2009	2,185	45 (9.3)	1.0 (0.9)	1.16 (0.21)
2010	2,318	43 (8.3)	0.9 (0.9)	1.11 (0.29)

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2011	NS	NS	NS	NS
2012	NS	NS	NS	NS
2013	4,452	51 (16.9)	2.1 (4.0)	1.52 (0.31)
2014	5,166	45 (10.5)	1.1 (1.3)	1.19 (0.44)
2015	4,560	49 (13.0)	1.5 (1.5)	1.25 (0.18)
2016	5,998	53 (14.8)	2.0 (1.9)	1.34 (0.17)
2017	5,475	50 (12.8)	1.6 (1.8)	1.14 (0.51)
Average	***2,960***	***50 (12.8)***	***1.6 (1.8)***	***1.28 (0.25)***
Median	***2,601***	***49 (12.5)***	***1.6 (1.5)***	***1.27 (0.21)***

[a] Sample size represents the number of fish that were measured for both length and weight.

Freshwater Productivity

Both productivity and survival estimates for juvenile emigrants of summer Chinook in the Wenatchee River basin are provided in Table 8.16. Estimates for brood year 2016 were within the range of estimates for brood years 1999-2015. During the period 1999-2016, freshwater productivities ranged from 521-4,269 emigrants/redd. Survivals during the same period ranged from 9.6-89.2% for egg-emigrants.

Table 8.16. Productivity (emigrants/redd) and survival (egg-emigrant) estimates for summer Chinook in the Wenatchee River basin for brood years 1999-2016; ND = no data. These estimates were derived from data in Table 8.14.

Brood year	Emigrants/ Redd	Egg-Emigrant (%)
1999	3,537	70.9
2000	521	9.6
2001	2,349	46.1
2002	1,971	36.0
2003	3,877	72.3
2004	3,064	57.0
2005	3,306	65.4
2006	1,079	21.0
2007	2,308	45.1
2008	1,573	30.8
2009	1,980	37.4
2010	ND	ND
2011	ND	ND
2012	4,007	83.5
2013	3,890	78.0
2014	4,269	89.2
2015	2,328	36.6
2016	3,006	68.0

Brood year	Emigrants/ Redd	Egg-Emigrant (%)
Average	***2,692***	***52.9***
Median	***2,678***	***51.5***

Numbers of juvenile emigrants increased with increasing egg deposition; however, egg-emigrant survival did not decrease significantly with increasing egg deposition (Figure 8.5). This suggests a density-independent relationship between seeding levels and emigrants within the Wenatchee River basin (see Population Carrying Capacity section below).

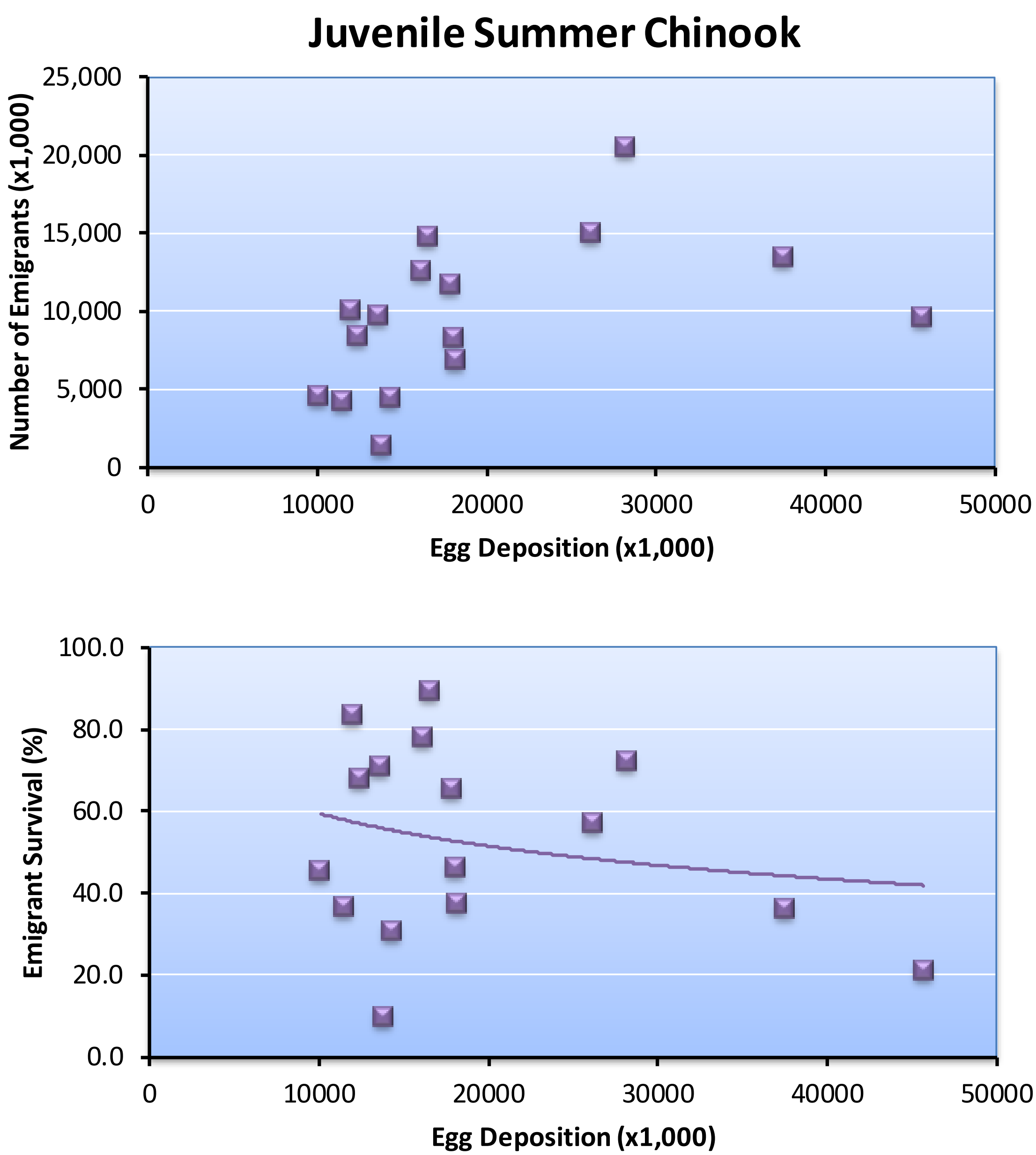


Figure 8.5. Relationships between seeding levels (egg deposition) and juvenile productivity (top figure) and emigrant survival (bottom figure) for Wenatchee summer Chinook, brood years 1999-2016.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the Ricker model).[34] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we used population models to estimate juvenile summer Chinook carrying capacities (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods).

Only the density-independent model adequately fit the juvenile emigrant data for Wenatchee summer Chinook (Figure 8.6). This means that under the range of seeding levels examined, there is no estimate of carrying capacity for juvenile emigrants. This implies that spawning habitat is not currently limiting juvenile productivity within the Wenatchee River basin. It does not mean that there is no limit to juvenile rearing within the Wenatchee River basin. Indeed, there is likely a limit to the number of parr that can rear within the basin; however, there are no parr data to estimate rearing capacity.

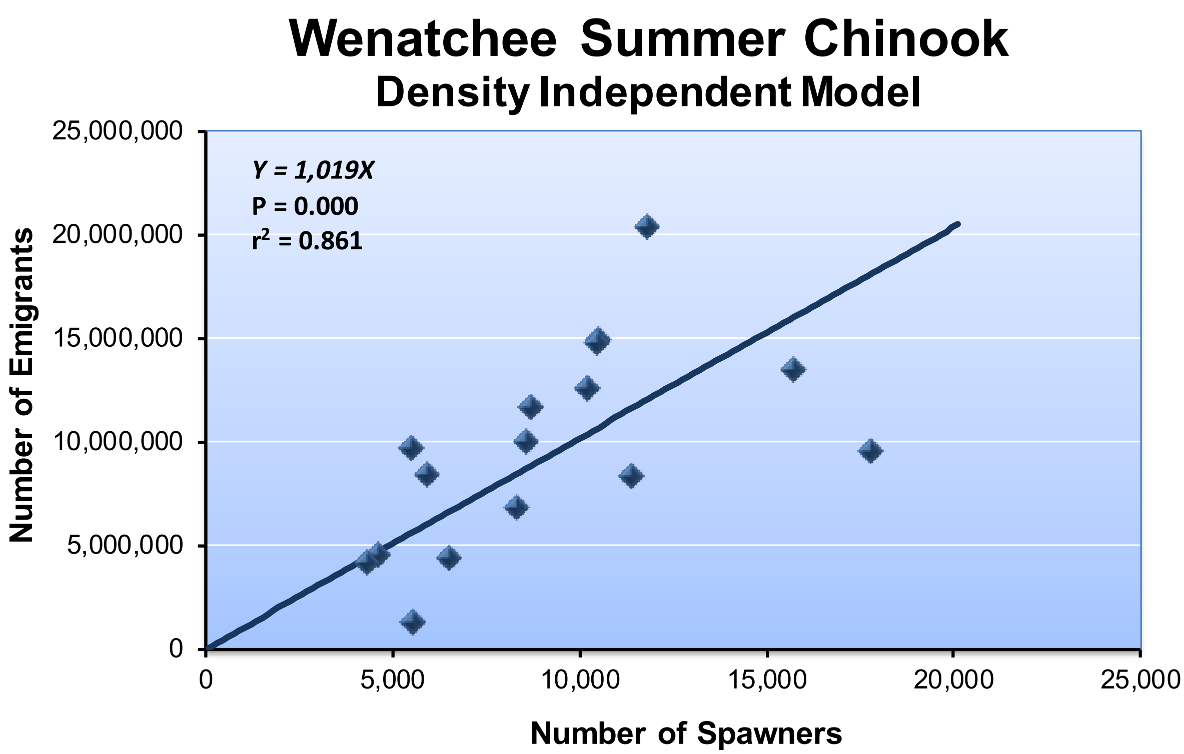


Figure 8.6. Density-independent relationship between spawners and number of juvenile emigrants produced in the Wenatchee River basin.

[34] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

8.5 Spawning Surveys

Surveys for Wenatchee summer Chinook redds were conducted from 4 September to 10 November 2017 in the Wenatchee River and Icicle Creek.

Redd Counts

A total count of summer Chinook redds was estimated in 2017 based on weekly census surveys conducted in the Wenatchee River. Redds were counted in Icicle Creek when feasible. A total of 3,908 summer Chinook redds were counted in the Wenatchee River basin in 2017 (Table 8.17).

In the future, spawning escapement estimates may be derived using the area-under-the-curve (AUC) method described in Millar et al. (2012). WDFW now has four years of data (2014-2017) to inform model parameters (e.g., observer efficiency of redd counts at variable temporal and spatial scales). Model calibration has begun with existing data. After the conclusion of 2018 surveys, WDFW will have a complete model to generate updated spawning escapements with associated variance.

Table 8.17. Numbers of redds counted in the Wenatchee River basin, 1989-2017; ND = no data. From 1989-2013, numbers of redds were based on expanding "peak counts" to generate a Total Count. Since 2014, numbers of redds were based on weekly census surveys that encompass all reaches.

Survey year	Redd counts		Total count
	Wenatchee River	Icicle Creek	
1989	3,331	ND	4,215
1990	2,479	ND	3,103
1991	2,180	ND	2,748
1992	2,328	ND	2,913
1993	2,334	ND	2,953
1994	2,426	ND	3,077
1995	1,872	ND	2,350
1996	1,435	ND	1,814
1997	1,388	ND	1,739
1998	1,660	ND	2,230
1999	2,188	ND	2,738
2000	2,022	ND	2,540
2001	2,857	ND	3,550
2002	5,419	ND	6,836
2003	4,281	ND	5,268
2004	4,003	ND	4,874
2005	2,895	ND	3,538
2006	7,165	68	8,896
2007	1,857	13	1,970
2008	2,338	23	2,800
2009	2,667	21	3,441
2010	2,553	11	3,261

Survey year	Redd counts		Total count
	Wenatchee River	Icicle Creek	
2011	2,583	9	3,078
2012	2,301	2	2,504
2013	2,875	42	3,241
2014	3,383	75	3,458
2015	1,781	23	1,804
2016	2,725	72	2,797
2017	3,872	36	3,908
Average			***3,367***
Median			***3,077***

Redd Distribution

Summer Chinook redds were not evenly distributed among reaches within the Wenatchee River basin in 2017 (Table 8.18; Figure 8.7). Most of the spawning occurred upstream from the Leavenworth Bridge in Reaches 6, 9, and 10. The highest density of redds occurred in Reach 6 near the confluence of the Icicle River.

Table 8.18. Total numbers of summer Chinook redds counted in different reaches in the Wenatchee River basin during September through mid-November 2017.

Survey reach	Reach description	Total redd count
Wenatchee 1 (W1)	Mouth to Sleepy Hollow Br	34
Wenatchee 2 (W2)	Sleepy Hollow Br to L. Cashmere Br	263
Wenatchee 3 (W3)	L. Cashmere Br to Dryden Dam	195
Wenatchee 4 (W4)	Dryden Dam to Peshastin Br	55
Wenatchee 5 (W5)	Peshastin Br to Leavenworth Br	73
Wenatchee 6 (W6)	Leavenworth Br to Icicle Rd Br	1,340
Wenatchee 7 (W7)	Icicle Rd Br to Tumwater Dam	254
Wenatchee 8 (W8)	Tumwater Dam to Tumwater Br	363
Wenatchee 9 (W9)	Tumwater Br to Chiwawa River	759
Wenatchee 10 (W10)	Chiwawa River to Lake Wenatchee	536
Icicle Creek (I1)	Mouth to Hatchery	36
Totals		***3,908***

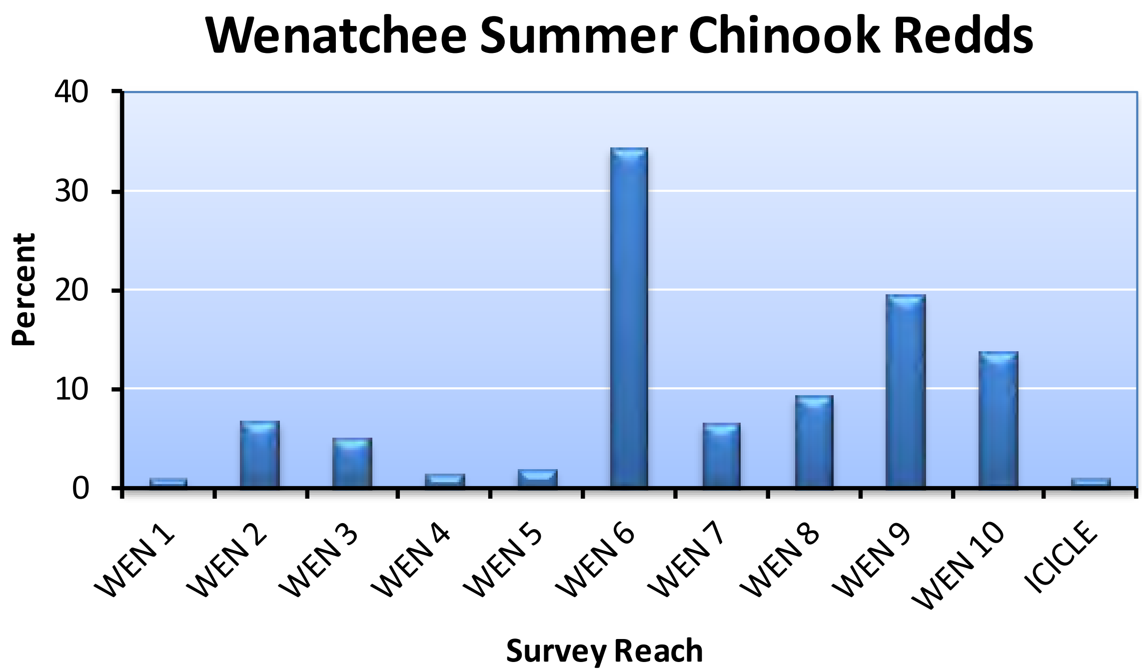


Figure 8.7. Percent of the total number of summer Chinook redds counted in different reaches in the Wenatchee River basin during September through early-November 2017. Reach codes are described in Table 2.10.

Spawn Timing

In 2017, spawning in the Wenatchee River began during the second week of September, peaked the second week of October, and ended the first week of November (Figure 8.8).

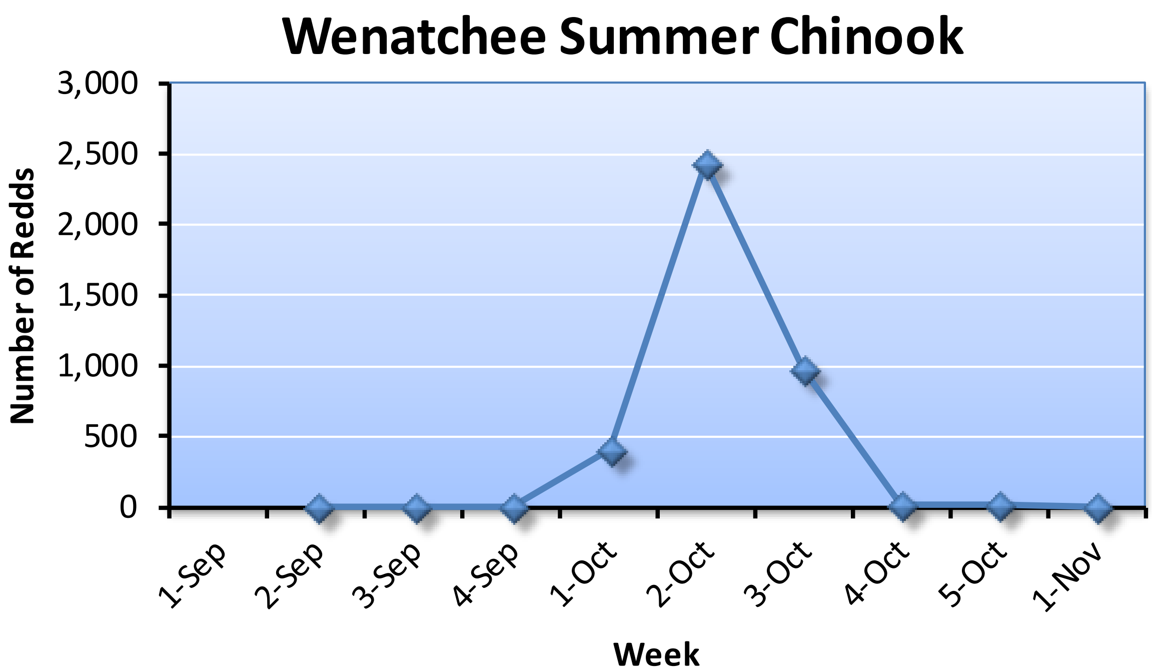


Figure 8.8. Number of new summer Chinook redds counted during different weeks in the Wenatchee River, September through early November 2017.

Spawning Escapement

Spawning escapement for Wenatchee summer Chinook was calculated as the total number of redds (expanded peak counts for return years 1989-2013) times the fish per redd ratio estimated from broodstock and fish sampled at adult trapping sites.[35] The estimated fish per redd ratio for summer Chinook in 2017 was 1.90. Multiplying this ratio by the number of redds counted in the Wenatchee River basin resulted in a total spawning escapement of 7,425 summer Chinook (Table 8.19). This is less than the overall average spawning escapement of 9,042 summer Chinook.

Table 8.19. Spawning escapements for summer Chinook in the Wenatchee River basin, return years 1989-2017. Number of redds is based on expanded peak redd counts for the period 1989-2013.

Return year	Fish/Redd	Redds	Total spawning escapement
1989	3.40	4,215	14,331
1990	3.50	3,103	10,861
1991	3.70	2,748	10,168
1992	4.00	2,913	11,652
1993	3.20	2,953	9,450
1994	3.30	3,077	10,154
1995	3.30	2,350	7,755
1996	3.40	1,814	6,168

[35] Expansion factor = (1 + (number of males/number of females)).

Return year	Fish/Redd	Redds	Total spawning escapement
1997	3.40	1,739	5,913
1998	2.40	2,230	5,352
1999	2.00	2,738	5,476
2000	2.17	2,540	5,512
2001	3.20	3,550	11,360
2002	2.30	6,836	15,723
2003	2.24	5,268	11,800
2004	2.15	4,874	10,479
2005	2.46	3,538	8,703
2006	2.00	8,896	17,792
2007	2.33	1,970	4,590
2008	2.32	2,800	6,496
2009	2.42	3,441	8,327
2010	2.29	3,261	7,468
2011	3.20	3,078	9,850
2012	3.41	2,504	8,539
2013	3.15	3,241	10,209
2014	3.02	3,458	10,443
2015	2.40	1,804	4,330
2016	2.11	2,797	5,902
2017	1.90	3,908	7,425
Average	***2.78***	***3,367***	***9,042***
Median	***2.46***	***3,077***	***8,703***

8.6 Carcass Surveys

Surveys for Wenatchee summer Chinook carcasses were conducted from mid-September to early November 2017 in the Wenatchee River and Icicle Creek.

Number sampled

A total of 1,195 summer Chinook carcasses were sampled during early September through early November in the Wenatchee River basin in 2017 (Table 8.20).

Table 8.20. Numbers of summer Chinook carcasses sampled within each survey reach in the Wenatchee River basin, 1993-2017. Reach codes are described in Table 2.10.

Survey year	Number of summer Chinook carcasses											
	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	Total
1993	68	151	696	13	82	150	215	41	0	0	0	**1,416**
1994	0	6	25	1	21	50	20	49	131	1	0	**304**
1995	0	10	14	0	0	117	50	37	20	0	0	**248**

Survey year	Number of summer Chinook carcasses											
	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	Total
1996	0	5	84	42	10	206	27	37	43	0	0	**454**
1997	1	47	127	5	29	312	8	80	70	13	0	**692**
1998	6	81	159	4	1	270	32	395	354	65	0	**1,367**
1999	0	169	112	16	35	932	68	146	185	79	0	**1,742**
2000	8	118	178	9	85	693	82	121	172	208	0	**1,674**
2001	0	49	138	31	0	338	36	124	101	94	0	**911**
2002	0	249	189	0	205	848	0	341	564	166	6	**2,568**
2003	6	369	195	72	149	768	66	266	537	58	40	**2,526**
2004	8	157	193	177	173	1,086	103	346	493	409	16	**3,161**
2005	8	85	106	39	46	709	70	140	353	258	7	**1,821**
2006	22	140	160	64	112	953	435	343	703	658	18	**3,608**
2007	3	15	49	10	26	475	38	38	96	91	8	**849**
2008	10	34	63	38	36	676	47	42	106	144	8	**1,204**
2009	11	29	43	32	27	389	16	58	240	175	6	**1,026**
2010	3	31	98	57	122	681	135	49	124	194	15	**1,509**
2011	5	88	126	19	38	1,332	77	45	211	289	9	**2,239**
2012	8	82	95	22	40	600	53	62	173	183	0	**1,318**
2013	3	100	149	22	109	767	5	60	353	265	14	**1,847**
2014	3	42	64	18	59	659	89	160	329	282	34	**1,739**
2015	9	7	36	15	19	296	27	110	314	150	5	**988**
2016	7	55	96	33	90	494	27	79	245	178	5	**1,309**
2017	18	75	104	30	49	420	22	123	202	147	4	**1,195**
Average	***8***	***88***	***132***	***31***	***63***	***569***	***70***	***132***	***245***	***164***	***7.8***	***1,509***
Median	***6***	***75***	***106***	***22***	***40***	***600***	***47***	***80***	***202***	***150***	***5***	***1,367***

Carcass Distribution and Origin

Summer Chinook carcasses were not evenly distributed among reaches within the Wenatchee River basin in 2017 (Table 8.20; Figure 8.9). Most of the carcasses in the Wenatchee River basin were found upstream from the Leavenworth Bridge. The highest percentage of carcasses (35.1%) was sampled in Reach 6.

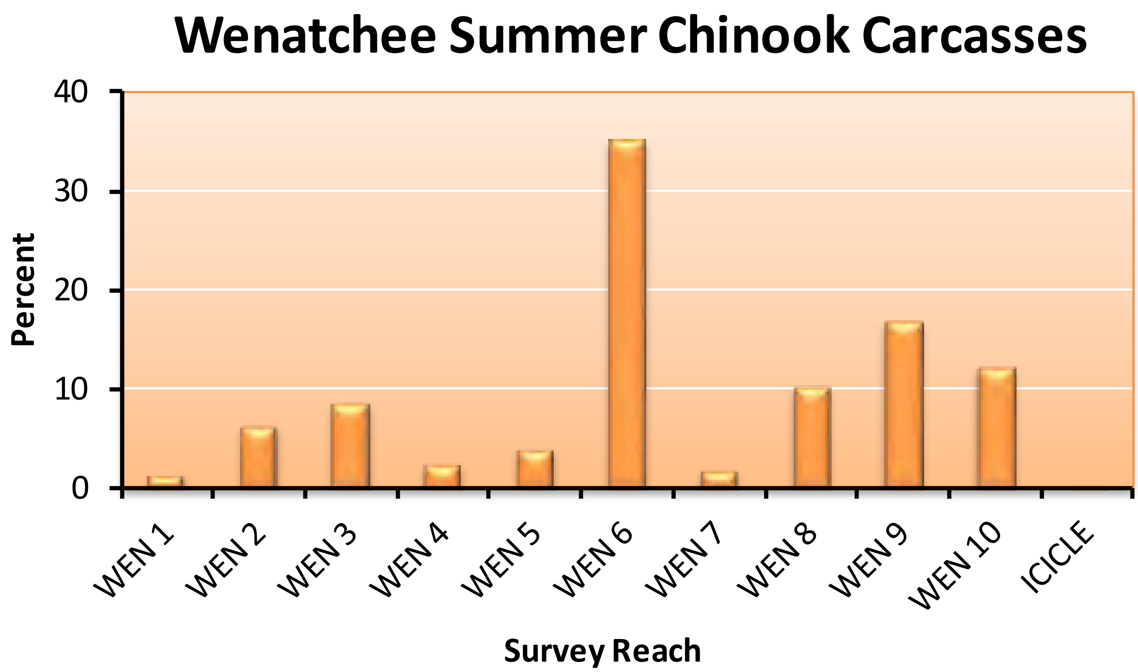


Figure 8.9. Percent of summer Chinook carcasses sampled within different reaches in the Wenatchee River basin during September through mid-November 2017. Reach codes are described in Table 2.10.

As in previous years, regardless of origin, most summer Chinook were found in Reach 6 (Leavenworth Bridge to Icicle Road Bridge) (Table 8.21). In general, a larger percentage of wild fish were found in the upper reaches than were hatchery fish (Figure 8.10). In contrast, a larger percentage of hatchery fish were found in reaches downstream from the Icicle Road Bridge.

Table 8.21. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches in the Wenatchee River basin, 1993-2017.

Survey year	Origin	Survey reach											Total
		W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	
1993	Wild	59	146	660	12	82	133	213	40	0	0	0	**1,345**
	Hatchery	9	5	36	1	0	17	2	1	0	0	0	**71**
1994	Wild	0	2	18	1	19	36	20	49	130	1	0	**276**
	Hatchery	0	4	7	0	2	14	0	0	1	0	0	**28**
1995	Wild	0	4	11	0	0	105	50	35	20	0	0	**225**
	Hatchery	0	6	3	0	0	12	0	2	0	0	0	**23**
1996	Wild	0	5	82	40	9	196	27	37	43	0	0	**439**
	Hatchery	0	0	2	2	1	10	0	0	0	0	0	**15**
1997	Wild	1	38	112	5	22	266	8	80	69	13	0	**614**
	Hatchery	0	9	15	0	7	46	0	0	1	0	0	**78**
1998	Wild	6	62	124	3	1	191	29	374	327	62	0	**1,179**
	Hatchery	0	19	35	1	0	79	3	21	27	3	0	**188**
1999	Wild	0	88	70	8	18	600	58	137	169	75	0	**1,223**

Survey year	Origin	Survey reach											Total
		W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	Icicle	
	Hatchery	0	81	42	8	17	332	10	9	16	4	0	**519**
2000	Wild	5	78	115	8	57	485	75	110	167	200	0	**1,300**
	Hatchery	3	40	63	1	28	208	7	11	5	8	0	**374**
2001	Wild	0	37	100	9	0	245	32	122	97	91	0	**733**
	Hatchery	0	12	38	22	0	93	4	2	4	3	0	**178**
2002	Wild	0	151	127	0	103	479	0	330	558	161	3	**1,912**
	Hatchery	0	98	62	0	102	369	0	11	6	5	3	**656**
2003	Wild	5	261	147	32	111	519	62	252	498	57	15	**1,959**
	Hatchery	1	108	48	40	38	249	4	14	39	1	25	**567**
2004	Wild	7	124	163	120	112	749	90	316	481	399	11	**2,572**
	Hatchery	1	33	30	56	61	337	13	30	12	10	5	**588**
2005	Wild	4	49	78	24	26	399	66	125	336	244	0	**1,351**
	Hatchery	4	36	28	15	20	310	4	15	17	14	7	**470**
2006	Wild	15	91	122	44	75	688	388	309	646	593	5	**2,976**
	Hatchery	7	49	38	20	37	265	47	34	57	65	13	**632**
2007	Wild	1	7	24	1	10	197	34	30	95	81	3	**483**
	Hatchery	2	8	25	9	16	278	4	8	1	10	5	**366**
2008	Wild	7	15	38	24	21	361	41	31	98	133	2	**771**
	Hatchery	3	19	25	14	15	315	6	11	8	11	6	**433**
2009	Wild	6	22	32	23	19	288	13	55	236	173	4	**871**
	Hatchery	5	7	11	9	8	101	3	3	4	2	2	**155**
2010	Wild	2	22	62	44	64	477	125	47	121	192	0	**1,156**
	Hatchery	1	9	36	13	58	204	10	2	3	2	15	**353**
2011	Wild	4	46	75	11	25	914	74	45	211	287	3	**1,695**
	Hatchery	1	42	51	7	13	418	3	0	0	2	6	**543**
2012	Wild	4	49	72	13	24	490	47	62	173	182	0	**1,116**
	Hatchery	4	33	23	9	16	110	6	0	0	1	0	**202**
2013	Wild	1	63	89	16	69	374	5	59	340	261	0	**1,277**
	Hatchery	2	52	60	6	40	395	0	1	13	4	0	**573**
2014	Wild	3	35	57	16	48	572	89	158	329	281	12	**1600**
	Hatchery	0	7	7	2	11	87	0	2	0	0	22	**139**
2015	Wild	6	6	36	13	16	263	26	107	301	148	6	**928**
	Hatchery	3	1	0	2	3	33	1	3	13	2	0	**61**
2016	Wild	5	40	78	29	75	426	27	79	243	175	4	**1,181**
	Hatchery	2	15	18	4	15	68	0	0	3	3	1	**129**
2017	Wild	13	59	88	26	38	329	22	121	201	146	0	**1,043**
	Hatchery	5	16	16	4	11	90	0	2	0	0	4	**148**
Average	***Wild***	***6***	***60***	***103***	***21***	***42***	***391***	***65***	***124***	***236***	***158***	***3***	***1,209***
	Hatchery	***2***	***28***	***29***	***10***	***21***	***177***	***5***	***7***	***9***	***6***	***5***	***299***
Median	***Wild***	***4***	***46***	***78***	***13***	***25***	***374***	***41***	***80***	***201***	***148***	***0***	***1,179***
	Hatchery	***1***	***15***	***28***	***6***	***15***	***110***	***3***	***2***	***4***	***2***	***1***	***202***

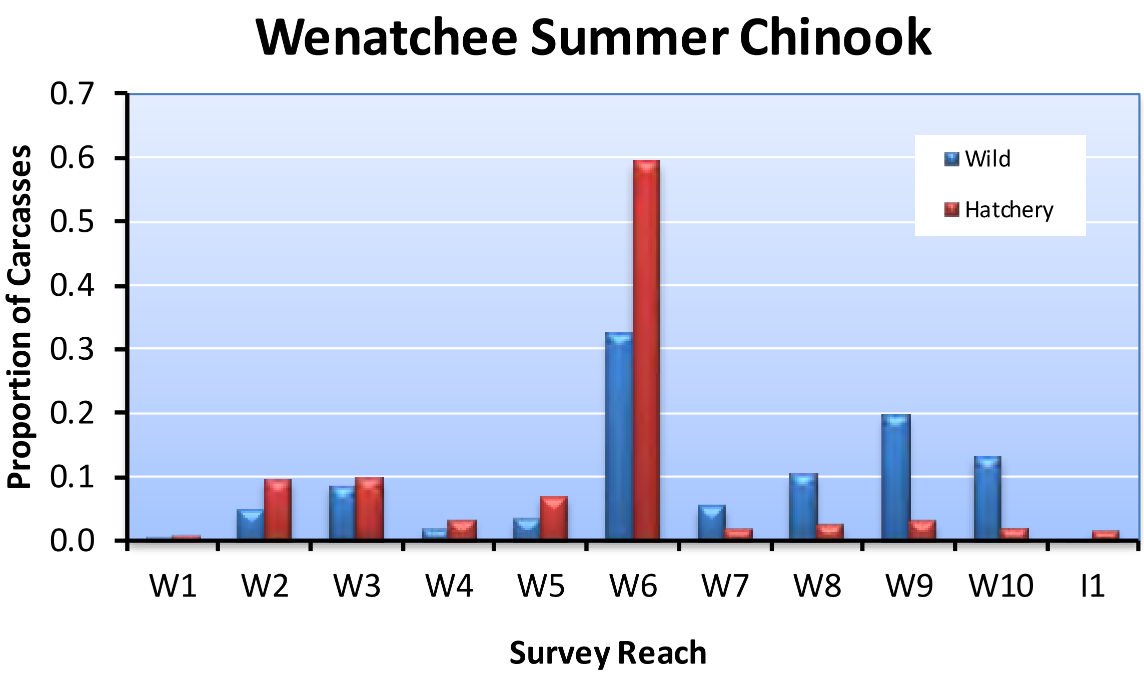


Figure 8.10. Distribution of wild and hatchery produced carcasses in different reaches in the Wenatchee River basin, 1993-2017. Reach codes are described in Table 2.10.

Sampling Rate

If spawning escapement is based on total numbers of redds, then about 16% of the total spawning escapement of summer Chinook in the Wenatchee River basin was sampled in 2017 (Table 8.22). Sampling rates among survey reaches varied from 5 to 35%.

Table 8.22. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Wenatchee River basin, 2017.

Sampling reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Wenatchee 1 (W1)	34	18	65	0.28
Wenatchee 2 (W2)	263	75	500	0.15
Wenatchee 3 (W3)	195	104	371	0.28
Wenatchee 4 (W4)	55	30	105	0.29
Wenatchee 5 (W5)	73	49	139	0.35
Wenatchee 6 (W6)	1,340	420	2,546	0.16
Wenatchee 7 (W7)	254	22	483	0.05
Wenatchee 8 (W8)	363	123	690	0.18
Wenatchee 9 (W9)	759	202	1,442	0.14

Sampling reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Wenatchee 10 (W10)	536	147	1,018	0.14
Icicle Creek (I1)	36	4	68	0.06
Total	***3,908***	***1,195***	***7,425***	***0.16***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys in the Wenatchee River basin in 2017 are provided in Table 8.23. The average size of males and females sampled in the Wenatchee River basin were 70 cm and 69 cm, respectively.

Table 8.23. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female summer Chinook carcasses sampled in different streams/watersheds in the Wenatchee River basin, 2017.

Stream/watershed	Mean length (cm)	
	Male	Female
Wenatchee 1 (W1)	71.0 (11.5)	65.2 (7.3)
Wenatchee 2 (W2)	67.5 (11.5)	69.0 (4.9)
Wenatchee 3 (W3)	71.6 (8.0)	70.5 (6.1)
Wenatchee 4 (W4)	71.6 (9.0)	72.0 (5.7)
Wenatchee 5 (W5)	71.1 (11.0)	72.6 (5.4)
Wenatchee 6 (W6)	66.5 (9.3)	69.4 (5.8)
Wenatchee 7 (W7)	74.5 (11.8)	69.5 (4.5)
Wenatchee 8 (W8)	68.0 (9.8)	70.3 (5.2)
Wenatchee 9 (W9)	68.5 (8.3)	70.9 (5.0)
Wenatchee 10 (W10)	66.0 (9.0)	67.6 (5.7)
Icicle Creek (I1)	-	61.0 (7.6)
Total	***69.6 (9.9)***	***68.9 (5.7)***

8.7 Life History Monitoring

Life history characteristics of Wenatchee summer Chinook were assessed by examining carcasses on spawning grounds and fish collected or examined at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

Migration timing of hatchery and wild Wenatchee summer Chinook was determined from broodstock data and stock assessment data collected at Dryden Dam. Sampling at Dryden Dam occurs from late June through late October. On average, during the early part of the migration, hatchery summer Chinook arrived about two weeks later than wild Chinook (Table 8.24). This pattern carried throughout the migration distribution of summer Chinook at Dryden Dam. By the end of the migration, hatchery fish passed Dryden Dam about two weeks after 90% of the wild fish passed the dam.

Table 8.24. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Dryden Dam, 2007-2017. The average week is also provided. Migration timing is based on collection of summer Chinook broodstock at Dryden Dam.

Survey year	Origin	Wenatchee Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2007	Wild	28	31	37	31	274
	Hatchery	30	33	41	35	305
2008	Wild	29	31	40	32	219
	Hatchery	32	37	41	37	576
2009	Wild	27	29	41	31	469
	Hatchery	28	34	42	35	382
2010	Wild	30	33	35	32	403
	Hatchery	29	30	33	30	268
2011	Wild	30	31	34	32	293
	Hatchery	32	34	39	35	304
2012	Wild	30	32	39	33	247
	Hatchery	31	37	41	36	366
2013	Wild	28	30	34	31	494
	Hatchery	29	33	39	33	570
2014	Wild	29	31	37	32	512
	Hatchery	29	32	40	33	338
2015	Wild	25	30	40	31	511
	Hatchery	28	35	40	35	88
2016	Wild	28	30	40	32	407
	Hatchery	29	34	41	35	184
2017	Wild	27	30	36	31	386
	Hatchery	29	32	32	33	214
Average	***Wild***	***28***	***31***	***38***	***32***	***383***
	Hatchery	***30***	***34***	***39***	***34***	***327***
Median	***Wild***	***28***	***31***	***37***	***32***	***403***
	Hatchery	***29***	***34***	***40***	***35***	***305***

Age at Maturity

Because hatchery summer Chinook are released after one year of rearing and natural-origin summer Chinook migrate primarily as age-0 fish, total ages will differ between hatchery and natural-origin Chinook (see Hillman et al. 2011). Therefore, in this section, we evaluated age at maturity by comparing differences in salt (ocean) ages between the two groups.

Most of the wild and hatchery summer Chinook sampled during the period 1993-2017 in the Wenatchee River basin were salt age-3 fish (Table 8.25; Figure 8.11). Over the survey years, a higher percentage of salt age-4 wild Chinook returned to the basin than did salt age-4 hatchery Chinook. In contrast, a higher proportion of salt age-1 and 2 hatchery fish returned than did salt age-1 and 2 wild fish. Thus, a higher percentage of wild fish returned at an older age than did hatchery fish.

Table 8.25. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Wenatchee River basin, 1993-2017.

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
1993	Wild	0.02	0.24	0.62	0.12	0.00	1,224
	Hatchery	0.03	0.91	0.03	0.03	0.00	64
1994	Wild	0.02	0.21	0.45	0.32	0.00	257
	Hatchery	0.00	0.14	0.86	0.00	0.00	21
1995	Wild	0.02	0.15	0.65	0.18	0.00	216
	Hatchery	0.00	0.00	0.05	0.95	0.00	21
1996	Wild	0.01	0.25	0.66	0.08	0.00	512
	Hatchery	0.00	0.33	0.33	0.29	0.05	21
1997	Wild	0.01	0.24	0.57	0.18	0.00	561
	Hatchery	0.05	0.20	0.67	0.08	0.00	75
1998	Wild	0.02	0.23	0.66	0.09	0.00	1,041
	Hatchery	0.03	0.49	0.38	0.10	0.00	187
1999	Wild	0.01	0.34	0.55	0.10	0.00	1,087
	Hatchery	0.01	0.15	0.79	0.05	0.00	510
2000	Wild	0.02	0.20	0.64	0.15	0.00	1,181
	Hatchery	0.07	0.11	0.66	0.15	0.00	342
2001	Wild	0.01	0.16	0.74	0.08	0.00	653
	Hatchery	0.05	0.76	0.14	0.04	0.00	181
2002	Wild	0.00	0.14	0.62	0.24	0.00	1,744
	Hatchery	0.01	0.16	0.80	0.02	0.00	646
2003	Wild	0.01	0.07	0.51	0.41	0.00	1,653
	Hatchery	0.05	0.07	0.75	0.12	0.00	530
2004	Wild	0.00	0.12	0.32	0.54	0.01	2,233
	Hatchery	0.08	0.57	0.25	0.10	0.00	566
2005	Wild	0.00	0.12	0.75	0.13	0.00	1,190
	Hatchery	0.02	0.09	0.86	0.03	0.00	450
2006	Wild	0.00	0.02	0.27	0.71	0.00	2,972
	Hatchery	0.02	0.16	0.24	0.57	0.00	299
2007	Wild	0.01	0.09	0.31	0.53	0.07	480
	Hatchery	0.00	0.15	0.75	0.07	0.03	275
2008	Wild	0.01	0.06	0.76	0.17	0.00	767

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
	Hatchery	0.02	0.12	0.76	0.11	0.00	329
2009	Wild	0.01	0.07	0.51	0.41	0.00	797
	Hatchery	0.10	0.36	0.49	0.05	0.00	132
2010	Wild	0.01	0.18	0.65	0.16	0.00	1,068
	Hatchery	0.00	0.49	0.47	0.03	0.00	294
2011	Wild	0.01	0.11	0.60	0.29	0.00	1,533
	Hatchery	0.06	0.04	0.90	0.01	0.00	472
2012	Wild	0.00	0.04	0.48	0.48	0.00	1,017
	Hatchery	0.00	0.03	0.88	0.08	0.03	200
2013	Wild	0.00	0.07	0.58	0.34	0.01	1,277
	Hatchery	0.00	0.01	0.13	0.86	0.00	573
2014	Wild	0.00	0.05	0.70	0.25	0.00	1,437
	Hatchery	0.02	0.06	0.20	0.70	0.02	128
2015	Wild	0.00	0.09	0.40	0.51	0.00	819
	Hatchery	0.00	0.10	0.65	0.24	0.00	49
2016	Wild	0.00	0.03	0.66	0.31	0.00	1,023
	Hatchery	0.03	0.11	0.83	0.03	0.00	97
2017	Wild	0.00	0.02	0.35	0.62	0.01	984
	Hatchery	0.01	0.39	0.46	0.14	0.00	120
Average	***Wild***	***0.01***	***0.12***	***0.54***	***0.34***	***0.00***	***1,109***
	Hatchery	***0.03***	***0.21***	***0.59***	***0.18***	***0.00***	***263***
Median	***Wild***	***0.00***	***0.10***	***0.65***	***0.24***	***0.00***	***1,041***
	Hatchery	***0.03***	***0.30***	***0.56***	***0.12***	***0.00***	***200***

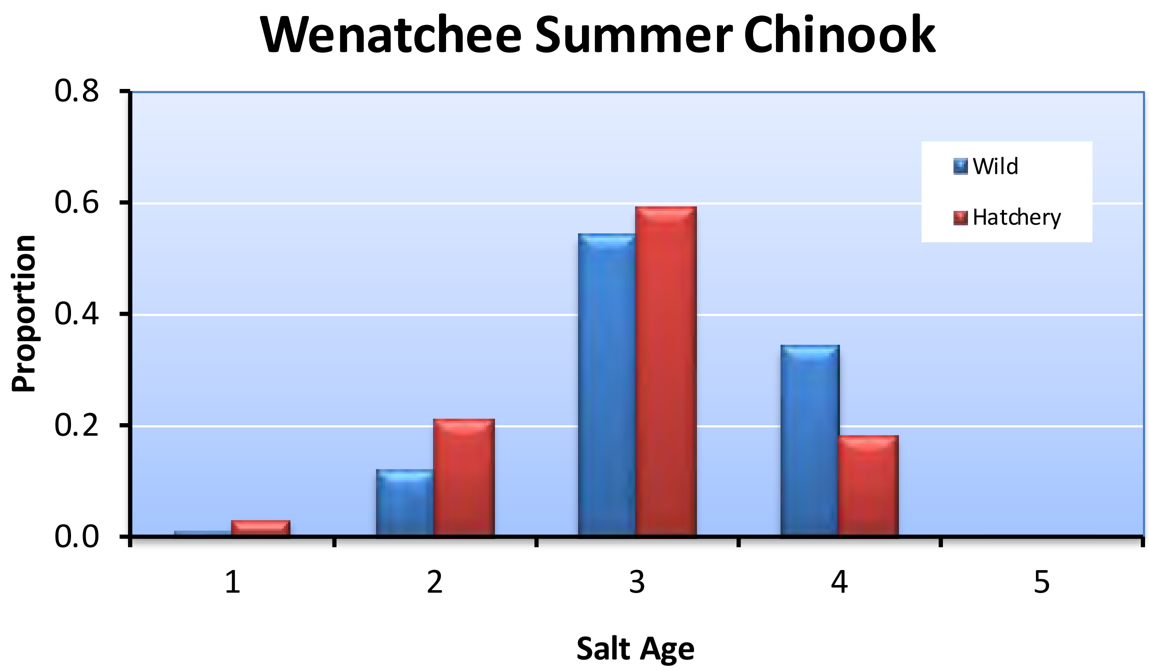


Figure 8.11. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Wenatchee River basin for the combined years 1993-2017.

Size at Maturity

On average, hatchery summer Chinook were about 4 cm smaller than wild summer Chinook sampled in the Wenatchee River basin (Table 8.26). This is likely because a higher percentage of hatchery fish returned as salt age-2 and 3 fish than did wild fish. In contrast, a higher percentage of wild fish returned as salt age-4 fish than did hatchery fish. Analyses for the statistical and comprehensive reports will compare sizes of hatchery and wild fish of the same age groups and sex.

Table 8.26. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Wenatchee River basin, 1993-2017; SD = 1 standard deviation.

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
1993[a]	Wild	1,344	73	8	33	94
	Hatchery	68	61	9	37	83
1994[a]	Wild	276	73	8	31	89
	Hatchery	25	70	8	54	85
1995[a]	Wild	225	75	7	48	87
	Hatchery	23	74	7	57	85
1996[a]	Wild	210	74	7	43	92
	Hatchery	9	66	12	52	84
1997	Wild	614	74	8	29	99

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	79	69	10	29	83
1998	Wild	1,179	73	8	28	97
	Hatchery	188	67	10	37	87
1999	Wild	1,217	72	8	29	95
	Hatchery	518	71	8	26	94
2000	Wild	1,301	71	10	24	94
	Hatchery	369	69	11	33	91
2001	Wild	728	70	9	30	93
	Hatchery	178	63	10	28	86
2002	Wild	1,911	72	8	39	94
	Hatchery	656	71	8	34	95
2003	Wild	1,943	74	9	24	105
	Hatchery	554	69	10	26	97
2004	Wild	2,570	72	9	32	98
	Hatchery	584	59	11	25	91
2005	Wild	1,352	69	7	41	92
	Hatchery	469	69	8	39	91
2006	Wild	3,249	74	6	29	99
	Hatchery	350	71	9	35	90
2007	Wild	566	73	9	29	92
	Hatchery	269	70	7	45	87
2008	Wild	836	69	8	29	89
	Hatchery	363	70	9	24	94
2009	Wild	872	71	8	30	94
	Hatchery	153	64	11	32	84
2010	Wild	1,147	68	8	32	92
	Hatchery	351	65	10	25	87
2011	Wild	1,698	68	8	33	101
	Hatchery	541	66	9	34	85
2012	Wild	1,116	70	7	29	91
	Hatchery	202	60	7	40	79
2013	Wild	1,277	66	9	24	95
	Hatchery	573	67	7	24	85
2014	Wild	1,600	68	7	29	98
	Hatchery	139	66	10	26	85
2015	Wild	928	68	8	39	86
	Hatchery	61	62	9	36	81
2016	Wild	1,180	69	6	43	93

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	129	67	8	37	82
2017	Wild	1,043	70	7	42	91
	Hatchery	144	64	9	32	82
Pooled	***Wild***	***30,382***	***71***	***2***	***24***	***105***
	Hatchery	***6,995***	***67***	***4***	***24***	***97***

[a] These years include sizes reported in annual reports. The data contained in the WDFW database do not include all these data.

Contribution to Fisheries

Most of the harvest on hatchery-origin Wenatchee summer Chinook occurred in the ocean (Table 8.27). Ocean harvest has made up 47% to 100% of all hatchery Wenatchee summer Chinook harvested. Total harvest on early brood years (1990-1996 and 2007) was lower than for brood years 1997-2010.

Table 8.27. Estimated number and percent (in parentheses) of hatchery-origin Wenatchee summer Chinook captured in different fisheries, brood years 1989-2011.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1989	1,510 (51)	1,432 (48)	0 (0)	20 (1)	2,962	58.0
1990	30 (100)	0 (0)	0 (0)	0 (0)	30	25.4
1991	30 (63)	0 (0)	0 (0)	18 (38)	48	67.6
1992	147 (79)	39 (21)	0 (0)	0 (0)	186	29.6
1993	35 (58)	25 (42)	0 (0)	0 (0)	60	39.5
1994	641 (91)	62 (9)	2 (0)	0 (0)	705	36.3
1995	562 (98)	9 (2)	5 (1)	0 (0)	576	36.5
1996	196 (96)	3 (1)	0 (0)	6 (3)	205	35.6
1997	2,982 (95)	49 (2)	12 (0)	106 (3)	3,149	42.0
1998	5,026 (92)	128 (2)	16 (0)	287 (5)	5,457	70.5
1999	1,550 (84)	168 (9)	21 (1)	104 (6)	1,843	74.3
2000	7,966 (73)	1,248 (11)	447 (4)	1,224 (11)	10,885	76.6
2001	1,061 (60)	238 (13)	106 (6)	364 (21)	1,769	73.2
2002	1,527 (56)	557 (21)	189 (7)	430 (16)	2,703	59.7
2003	833 (50)	484 (29)	89 (5)	257 (15)	1,663	53.7
2004	409 (47)	218 (25)	70 (8)	167 (19)	864	59.4
2005	1,329 (58)	481 (21)	187 (8)	287 (13)	2,284	63.0
2006	3,738 (51)	1,983 (27)	406 (6)	1,142 (16)	7,269	68.2
2007	212 (55)	109 (29)	8 (2)	53 (14)	382	75.0
2008	3,747 (52)	1,837 (26)	227 (3)	1,364 (19)	7,175	64.5
2009	1,592 (51)	1,000 (32)	99 (3)	452 (14)	3,143	74.1
2010	1,342 (56)	558 (23)	81 (3)	401 (17)	2,382	80.2

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
2011	3,185 (59)	1,287 (24)	119 (2)	827 (15)	5,418	73.2
Average	***1,724 (69)***	***518 (18)***	***91 (3)***	***326 (11)***	***2,659***	***58.1***
Median	***1,329 (59)***	***218 (21)***	***21 (2)***	***167 (13)***	***1,843***	***63.0***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Wenatchee River basin. Targets for strays based on return year (recovery year) within the Upper Columbia River basin (Priest Rapids Dam to Chief Joseph Dam) should be less than 10% and targets for strays outside the upper Columbia River should be less than 5%.

Within the Upper Columbia summer Chinook population, hatchery-origin Wenatchee summer Chinook have strayed into the Entiat, Chelan, Methow, and Okanogan River basins and onto the Hanford Reach (Table 8.28). In only one year did Wenatchee summer Chinook strays make up more than 10% of the spawning escapement in the Chelan Tailrace. They made up more than 10% of the spawning escapement in the Entiat River basin in seven different years. They made up less than 10% of the spawning escapements in the Methow and Okanogan River basins and the Hanford Reach.

Hatchery-origin Wenatchee summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged hatchery summer Chinook from the Wenatchee have been detected at Lower Granite Dam on the Snake River, at Three Mile Dam on the Umatilla River, in Big Creek, in the Baker and Elway rivers, and at Spring Creek, Lyons Ferry, Cowlitz, and Kalama Falls hatcheries. However, from 1994-present, less than six Wenatchee summer Chinook have strayed into each of these locations.

Table 8.28. Number and percent of spawning escapements within other non-target spawning streams within the upper Columbia River basin that consisted of hatchery-origin Wenatchee summer Chinook, return years 1994-2016. For example, for return year 2000, 3% of the summer Chinook escapement in the Methow River basin consisted of hatchery-origin Wenatchee summer Chinook. Percent strays should be less than 10%.

Return year	Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
1994	0	0.0	75	1.9	--	--	--	--	--	--
1995	0	0.0	0	0.0	--	--	--	--	--	--
1996	0	0.0	0	0.0	--	--	--	--	--	--
1997	0	0.0	0	0.0	--	--	--	--	--	--
1998	25	3.7	0	0.0	0	0.0	0	0.0	0	0.0
1999	20	2.0	3	0.1	0	0.0	0	0.0	13	0.0
2000	36	3.0	13	0.4	0	0.0	0	0.0	0	0.0
2001	163	5.9	57	0.5	30	3.0	0	0.0	0	0.0
2002	153	3.3	53	0.4	40	6.9	74	14.8	0	0.0

Return year	Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
2003	80	2.0	24	0.7	44	10.5	132	19.1	26	0.0
2004	113	5.2	42	0.6	30	7.2	0	0.0	0	0.0
2005	245	9.6	67	0.8	51	9.7	49	13.4	0	0.0
2006	170	6.2	12	0.1	12	2.9	61	15.3	0	0.0
2007	127	9.3	5	0.1	9	4.8	49	34.5	20	0.1
2008	87	4.5	24	0.3	10	2.0	31	14.4	0	0.0
2009	101	5.7	13	0.2	2	0.3	12	6.6	0	0.0
2010	208	8.3	35	0.6	55	4.9	34	13.0	0	0.0
2011	258	8.8	5	0.1	78	6.1	15	5.1	0	0.0
2012	109	3.7	24	0.3	53	4.1	54	8.4	0	0.0
2013	252	7.0	57	0.7	2	0.1	8	1.7	0	0.0
2014	13	0.8	0	0.0	4	0.4	12	2.0	0	0.0
2015	75	1.9	13	0.1	4	0.3	12	3.1	0	0.0
2016	52	2.3	6	0.1	17	1.9	5	0.9	0	0.0
Average	***99***	***4.1***	***23***	***0.3***	***23***	***3.4***	***29***	***8.0***	***3***	***0.0***
Median	***87***	***3.7***	***13***	***0.2***	***12***	***2.9***	***12***	***5.1***	***0***	***0.0***

Based on brood year analyses, on average, about 10% of the hatchery-origin Wenatchee summer Chinook spawners strayed into non-target streams (Table 8.29). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-20%. In addition, on average, about 12.8% of hatchery-origin Wenatchee summer Chinook broodstock have been included in non-target hatchery programs.

Table 8.29. Number and percent of hatchery-origin Wenatchee summer Chinook spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1989-2011.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1989	1,352	62.9	75	3.5	60	2.8	662	30.8
1990	74	84.1	0	0.0	1	1.1	13	14.8
1991	15	65.2	0	0.0	0	0.0	8	34.8
1992	375	84.8	0	0.0	7	1.6	60	13.6
1993	67	72.8	4	4.3	9	9.8	12	13.0
1994	890	71.8	61	4.9	207	16.7	81	6.5
1995	748	74.8	48	4.8	139	13.9	65	6.5
1996	261	70.4	53	14.3	42	11.3	15	4.0

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1997	3,609	83.0	397	9.1	171	3.9	170	3.9
1998	1,790	78.5	416	18.2	11	0.5	64	2.8
1999	507	79.7	121	19.0	0	0.0	8	1.3
2000	2,745	82.5	545	16.4	0	0.0	37	1.1
2001	521	80.4	118	18.2	0	0.0	9	1.4
2002	1,521	83.4	284	15.6	10	0.5	8	0.4
2003	1,268	88.5	114	8.0	42	2.9	9	0.6
2004	497	84.2	72	12.2	3	0.5	18	3.1
2005	1,126	84.0	193	14.4	3	0.2	19	1.4
2006	2,693	79.4	623	18.4	8	0.2	69	2.0
2007	99	78.0	25	19.7	1	0.8	2	1.6
2008	3,260	82.5	458	11.6	61	1.5	173	4.4
2009	720	65.6	106	9.7	54	4.9	218	19.9
2010	158	26.8	16	2.7	47	8.0	368	62.5
2011	471	23.8	173	8.7	49	2.5	1,288	65.0
Average	***1,077***	***73.4***	***170***	***10.2***	***40***	***3.6***	***147***	***12.8***
Median	***720***	***79.4***	***106***	***9.7***	***10***	***1.5***	***37***	***4.0***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Wenatchee River basin.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Wenatchee River basin.

[3] Target hatchery includes broodstock collection at Tumwater and Dryden dams.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Wenatchee summer Chinook hatchery program.

Genetics

Genetic studies were conducted in 2011 to investigate relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin (Kassler et al. 2011; the entire report is appended as Appendix N). A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin. Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River basin (N = 139) and compared to collections of hatchery and natural-origin Chinook from 2006 and 2008 (N = 380). Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to supplementation collections from 2006 and 2008 (N = 362). Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with supplementation collections from 2006 and 2008 (N = 669). A collection of natural-origin summer Chinook from the Chelan River was also analyzed (N = 70). Additionally, hatchery collections from Eastbank Hatchery (Wenatchee and Methow/Okanogan stock; N = 221) and Wells Hatchery (N = 294) were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River (N = 190) were used for comparison. Lastly, data from eight collections of fall Chinook (N = 2,408) were compared to the collections of summer Chinook. Samples of natural and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation programs have affected the genetic structure of these populations. The study also calculated the effective number of breeders for collection locations of natural and hatchery-origin summer Chinook from 1993 and 2008.

In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

It is important to note that no new information will be reported on genetics until the next five-year report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For all brood years the PNI value has been greater than or equal to 0.67 (Table 8.30). This suggests that the natural environment has a greater influence on adaptation of Wenatchee summer Chinook than does the hatchery environment.

Table 8.30. Proportionate Natural Influence (PNI) values for the Wenatchee summer Chinook supplementation program for brood years 1989-2016. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	14,331	0	0.00	290	0	1.00	1.00
1990	10,861	0	0.00	57	0	1.00	1.00
1991	10,168	0	0.00	105	0	1.00	1.00
1992	11,652	0	0.00	274	0	1.00	1.00
1993	8,868	582	0.06	406	44	0.90	0.94
1994	8,476	1,678	0.17	333	54	0.86	0.84
1995	6,862	893	0.12	363	16	0.96	0.89
1996	6,002	166	0.03	263	3	0.99	0.97
1997	5,408	505	0.09	205	13	0.94	0.92
1998	4,611	741	0.14	299	78	0.79	0.85
1999	4,101	1,375	0.25	242	236	0.51	0.68
2000	4,462	1,050	0.19	275	180	0.60	0.77
2001	9,414	1,946	0.17	210	136	0.61	0.79
2002	11,892	3,831	0.24	409	10	0.98	0.81
2003	10,025	1,775	0.15	337	7	0.98	0.87
2004	9,220	1,259	0.12	424	2	1.00	0.90
2005	6,862	1,841	0.21	397	3	0.99	0.83
2006	16,060	1,732	0.10	433	4	0.99	0.91
2007	3,173	1,417	0.31	263	3	0.99	0.77
2008	4,452	2,044	0.31	378	69	0.85	0.74
2009	7,098	1,229	0.15	452	8	0.98	0.87
2010	5,886	1,582	0.21	388	5	0.99	0.83
2011	8,150	1,700	0.17	376	7	0.98	0.86
2012	7,327	1,212	0.14	267	1	1.00	0.88
2013	7,431	2,778	0.27	234	2	0.99	0.79
2014	9,676	767	0.07	261	2	0.99	0.94
2015	4,076	254	0.06	245	0	1.00	0.95
2016	5,416	486	0.08	259	0	1.00	0.93
Average	***7,927***	***1,173***	***0.14***	***302***	***32***	***0.92***	***0.88***
Median	***7,379***	***1,221***	***0.14***	***283***	***5***	***0.99***	***0.88***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery summer Chinook from the Wenatchee River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 8.31).[36] Over the six brood years for which PIT-tagged hatchery fish were released, survival rates from the Wenatchee River to McNary Dam ranged from 0.619 to 0.910; SARs from release to detection at Bonneville Dam ranged from 0.003 to 0.017. Average travel time from the Wenatchee River to McNary Dam ranged from 11 to 29 days.

Most of the variation in survival rates and travel time resulted from releases of different experimental groups (Table 8.31). For example, brood year 2009 was split into three groups (control raceway group, long-term recirculating aquaculture system (RAS) group (R1), and short-term RAS group (R2)). In this case, the control group appeared to have a higher survival rate but a longer travel time from release to McNary Dam than did the two treatment groups. SARs varied little among the three groups.

Another experiment was conducted with brood years 2012 and 2013. These brood years were split into four different treatment groups (small-size fish in raceway, large-size fish in raceway, small-size fish in RAS, and large-size fish in RAS). Although the number of replicates is small, releases from the RAS had higher survival rates to McNary Dam and faster travel times. Large-size fish from the RAS had the highest survival rates and fastest travel times.

Table 8.31. Total number of Wenatchee hatchery summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2008-2015. Standard errors are shown in parentheses. RAS = recirculating aquaculture system; NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2008	10,035	0.847 (0.054)	28.9 (9.6)	0.017 (0.001)
2009	9,965 (Control)	0.702 (0.039)	19.3 (10.3)	0.006 (0.001)
	9,971 (R1)	0.646 (0.030)	16.4 (8.8)	0.005 (0.001)
	9,994 (R2)	0.648 (0.031)	16.0 (8.4)	0.005 (0.001)
2010	0	--	--	--
2011	5,018	0.753 (0.070)	20.9 (8.9)	0.010 (0.001)
2012 (Raceway)	5,047 (small size)	0.724 (0.066)	18.9 (9.2)	0.004 (0.001)
	4,740 (large size)	0.619 (0.061)	16.9 (8.6)	0.004 (0.001)
2012 (RAS)	5,041 (small size)	0.784 (0.060)	11.8 (5.0)	0.003 (0.001)
	5,082 (large size)	0.910 (0.077)	11.1 (4.6)	0.003 (0.001)
2013 (Raceway)	5,196 (small size)	0.692 (0.054)	19.3 (6.1)	NA
	5,158 (large size)	0.823 (0.071)	19.1 (5.6)	NA

[36] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2013 (RAS)	5,229 (small size)	0.788 (0.057)	18.1 (5.6)	NA
	5,201 (large size)	0.859 (0.068)	16.8 (4.8)	NA
2014	10,241 (Circular)	0.800 (0.083)	15.1 (4.9)	NA
	10,243 (Raceway)	0.735 (0.065)	17.1 (6.1)	NA
2015	10,253 (Circular)	0.759 (0.068)	20.9 (6.9)	NA
	10,351 (Raceway)	0.694 (0.054)	25.8 (9.6)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on brood year harvest rates from the hatchery program. For brood years 1989-2010, NRR for summer Chinook in the Wenatchee averaged 0.99 (range, 0.15-2.95) if harvested fish were not included in the estimate and 2.68 (range, 0.33-9.55) if harvested fish were included in the estimate (Table 8.32). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 5.7 (the calculated target value in Hillman et al. 2017). The target value of 5.7 includes harvest. HRRs exceeded NRRs in 17 of the 22 years of data, regardless if harvest was or was not included in the estimate (Table 8.32). Hatchery replacement rates for Wenatchee summer Chinook have exceeded the estimated target value of 5.7 in 11 of the 22 years of data.

Table 8.32. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for summer Chinook in the Wenatchee River basin, brood years 1989-2010.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	346	14,331	2,149	9,181	6.21	0.64	5,111	21,808	14.77	1.52
1990	87	10,861	88	9,595	1.01	0.88	118	12,984	1.36	1.20
1991	128	10,168	23	5,562	0.18	0.55	71	17,167	0.55	1.69
1992	341	11,652	442	5,858	1.30	0.50	628	8,393	1.84	0.72
1993	524	9,450	92	5,385	0.18	0.57	152	8,901	0.29	0.94
1994	418	10,154	1,239	4,219	2.96	0.42	1,944	6,634	4.65	0.65

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1995	398	7,755	1,000	5,329	2.51	0.69	1,576	8,459	3.96	1.09
1996	334	6,168	371	4,441	1.11	0.72	576	6,896	1.72	1.12
1997	240	5,913	4,347	9,761	18.11	1.65	7,496	16,743	31.23	2.83
1998	472	5,352	2,281	15,795	4.83	2.95	7,738	51,117	16.39	9.55
1999	488	5,476	636	12,081	1.30	2.21	2,479	44,253	5.08	8.08
2000	492	5,512	3,327	3,885	6.76	0.70	14,212	15,988	28.89	2.90
2001	493	11,360	648	19,209	1.31	1.69	2,417	70,621	4.90	6.22
2002	482	15,723	1,823	4,954	3.78	0.32	4,526	12,354	9.39	0.79
2003	496	11,800	1,433	1,782	2.89	0.15	3,096	3,874	6.24	0.33
2004	496	10,479	590	7,197	1.19	0.69	1,454	17,468	2.93	1.67
2005	494	8,703	1,341	5,131	2.71	0.59	3,625	13,190	7.34	1.52
2006	488	17,792	3,393	6,814	6.95	0.38	10,662	17,121	21.85	0.96
2007	419	4,590	127	10,733	0.30	2.34	509	30,064	1.21	6.55
2008	472	6,496	3,952	6,282	8.37	0.97	11,127	12,873	23.57	1.98
2009	491	8,327	1,098	7,434	2.24	0.89	4,241	19,667	8.64	2.36
2010	434	7,468	589	9,971	1.36	1.34	2,971	32,061	6.85	4.29
Average	***411***	***9,342***	***1,409***	***7,755***	***3.53***	***0.99***	***3,942***	***20,393***	***9.26***	***2.68***
Median	***472***	***9,077***	***1,049***	***6,548***	***2.38***	***0.70***	***2,725***	***16,366***	***5.66***	***1.59***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns. For the available brood years, SARs have ranged from 0.00037 to 0.01552 for hatchery summer Chinook in the Wenatchee River basin (Table 8.33).

Table 8.33. Smolt-to-adult ratios (SARs) for Wenatchee hatchery summer Chinook, brood years 1989-2011.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	144,905	1,027	0.00709
1990	119,214	115	0.00096
1991	190,371	71	0.00037
1992	605,055	613	0.00101
1993	210,626	152	0.00072
1994	452,340	1,919	0.00424
1995	668,409	1,542	0.00231
1996	585,590	568	0.00097
1997	480,418	7,456	0.01552

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1998	641,109	7,664	0.01195
1999	988,328	2,457	0.00249
2000	903,368	13,861	0.01534
2001	596,618	2,403	0.00403
2002	805,919	4,395	0.00545
2003	639,381	3,048	0.00477
2004	875,758	1,439	0.00164
2005	631,492	3,578	0.00567
2006	931,880	10,484	0.01125
2007	453,719	509	0.00112
2008	859,401	10,803	0.01257
2009	822,986	4,203	0.00511
2010	789,056	2,969	0.00376
2011	819,724	7,363	0.00898
Average	***618,072***	***3,854***	***0.00554***
Median	***639,381***	***2,457***	***0.00424***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

8.8 ESA/HCP Compliance

Broodstock Collection

Per the 2015 broodstock collection protocol, 252 natural-origin (adipose fin present) summer Chinook adults were targeted for collection at Dryden and Tumwater dams. The actual 2015 collection totaled 252 natural-origin summer Chinook in combination from Dryden and Tumwater dams. Trapping began 26 June and ended on 21 September 2015.

Summer Chinook and steelhead broodstock collections occurred concurrently at Dryden Dam. Thus, steelhead and spring Chinook encounters at Dryden Dam during Wenatchee summer Chinook broodstock collection were attributable to steelhead broodstock collections authorized under ESA Permit 1395 take authorizations. No steelhead or spring Chinook takes were associated with the Wenatchee summer Chinook collection. One bull trout was encountered during summer Chinook broodstock collection at Dryden Dam in 2015.

Consistent with impact minimization measures in ESA Permit 1347, all ESA-listed species handled during summer Chinook broodstock collection were subject to water-to-water transfers or anesthetized if removed from the water during handling.

Hatchery Rearing and Release

The 2015 Wenatchee summer Chinook program released an estimated 525,366 smolts, representing 105.1% of the 500,001-programmed production, and was within the 110% overage allowance identified in ESA permit 1347.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18120, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or the Dryden acclimation facility during the period 1 January through 31 December 2017. NPDES monitoring and reporting for PUD Hatchery Programs during 2017 are provided in Appendix F.

Smolt and Emigrant Trapping

ESA-listed spring Chinook and steelhead were encountered during operation of the Lower Wenatchee Trap. ESA takes are reported in the steelhead (Section 3.8) and spring Chinook (Section 5.8) sections and are not repeated here.

Spawning Surveys

Summer Chinook spawning ground surveys conducted in the Wenatchee River basin during 2017 were consistent with ESA Section 10 Permit No. 1347. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

SECTION 9: METHOW SUMMER CHINOOK

The original goal of summer Chinook salmon supplementation in the Methow Basin was in part to use artificial production to replace adult production lost because of mortality at Wells, Rocky Reach, and Rock Island dams[37], while not reducing the natural production or long-term fitness of summer Chinook in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans. Beginning with broodstock collection in 2012, Grant PUD took over the summer Chinook salmon supplementation program in the Methow River basin. Grant PUD constructed a new overwinter acclimation facility adjacent to the Carlton Acclimation Pond and the first fish released from this facility was 2014. The first fish that were overwinter acclimated in the facility were released in 2015. The new facility includes eight, 30-foot diameter dual-drain circular tanks.

Presently, adult summer Chinook are collected for broodstock from the run-at-large at the west-ladder trapping facility at Wells Dam. Before 2012, the goal was to collect up to 222 natural-origin adult summer Chinook for the Methow program. In 2011, the Hatchery Committees reevaluated that amount of hatchery compensation needed to achieve NNI. Based on that evaluation, the goal of the program was revised. The current goal (beginning in 2012) is to collect up to 102 natural-origin summer Chinook for the Methow program. Broodstock collection occurs from about 1 July through 15 September with trapping occurring no more than 16 hours per day, three days a week. If natural-origin broodstock collection falls short of expectation, hatchery-origin adults can be collected to make up the difference.

Adult summer Chinook are spawned and reared at Eastbank Fish Hatchery. Juvenile summer Chinook were transferred from the hatchery to Carlton Acclimation Pond in March until overwinter acclimation was initiated with the 2013 brood year. They are now transferred to the Carlton Acclimation Facility in October or November and released from the new facility in late April to early May.

Before 2012, the production goal for the Methow summer Chinook supplementation program was to release 400,000 yearling smolts into the Methow River at ten fish per pound. Beginning with the 2012 brood, the revised goal is to release 200,000 yearling smolts at 13-17 fish per pound. Targets for fork length and weight are 163 mm (CV = 9.0) and 45.4 g, respectively. Over 90% of these fish are marked with CWTs. In addition, since 2009, juvenile summer Chinook have been PIT tagged annually.

9.1 Broodstock Sampling

This section focuses on results from sampling 2015-2017 Methow summer Chinook broodstock that were collected in the West Ladder of Wells Dam.

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[37] Most of the production at Carlton Acclimation Pond was initial production, which terminated in 2013, and is not necessarily tied to hydro-facility mortality. The balance of the production is the result of a swap between spring and summer Chinook. That is, Chelan PUD is currently producing summer Chinook at Carlton for Douglas PUD in exchange for Douglas PUD producing spring Chinook at the Methow Fish Hatchery for Chelan PUD.

Origin of Broodstock

Broodstock collected in 2015-2017 consisted almost entirely of natural-origin (adipose fin present) summer Chinook (Table 9.1).

Table 9.1. Numbers of wild and hatchery summer Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned for the Methow/Okanogan programs during 1989-2011. Numbers of broodstock collected from 2012 to present are only for the Methow summer Chinook Program. Unknown origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program and surplus fish killed at spawning.

Brood year	Wild summer Chinook					Hatchery summer Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
1989[b]	1,419	72	-	1,297	-	341	17	-	312	-	1,609
1990[b]	864	34	-	828	-	214	8	-	206	-	1,034
1991[b]	1,003	59	-	924	-	341	20	-	314	-	1,238
1992[b]	312	6	-	297	-	428	9	-	406	-	703
1993[b]	813	48	-	681	-	464	28	-	388	-	1,069
1994	385	33	11	341	12	266	15	7	244	1	585
1995	254	13	10	173	58	351	28	9	240	74	413
1996	316	15	11	290	0	234	2	9	223	0	513
1997	214	11	5	198	0	308	24	20	264	0	462
1998	239	28	58	153	0	348	18	119	211	0	364
1999	248	5	19	224	0	307	2	16	289	0	513
2000	184	15	5	164	0	373	17	17	339	0	503
2001	135	8	36	91	0	423	29	128	266	0	357
2002	270	2	21	247	0	285	11	33	241	0	488
2003	449	14	53	381	0	112	2	9	101	0	482
2004	541	23	12	506	0	17	0	1	16	0	522
2005	551	29	76	391	55	12	2	0	9	1	400
2006	579	50	10	500	19	12	2	0	10	0	510
2007	504	22	26	456	0	19	0	2	17	0	473
2008	418	5	9	404	0	41	0	0	41	0	445
2009	553	31	15	507	0	5	5	0	0	0	507
2010	503	13	6	484	0	8	0	0	8	0	492
2011	498	18	13	467	0	30	4	0	26	0	493
Average[c]	***380***	***19***	***22***	***332***	***8***	***175***	***9***	***21***	***141***	***4***	***473***
Median[c]	***434***	***18***	***13***	***391***	***0***	***266***	***8***	***8***	***223***	***0***	***503***
2012	125	5	0	98	22	3	0	0	1	2	99
2013	98	1	0	97	0	4	0	0	4	0	101
2014	100	4	0	96	0	0	0	0	0	0	96
2015	97	0	0	97	0	1	0	0	1	0	98
2016	106	2	1	103	0	0	0	0	0	0	103
2017	118	7	0	111	0	0	0	0	0	0	111
Average[d]	***107***	***3***	***0***	***100***	***4***	***1***	***0***	***0***	***1***	***0***	***101***
Median[d]	***103***	***3***	***0***	***98***	***0***	***1***	***0***	***0***	***1***	***0***	***100***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.

[b] Number of fish spawned and collected during these years included fish retained from the right- and left-bank ladder traps at Wells Dam and fish collected from the volunteer channel. There was no distinction made between fish collected at trap locations and program (i.e., aggregated population used for Wells, Methow, and Okanogan summer Chinook programs).
[c] The average and median represent broodstock collected for the combined Methow and Okanogan programs. Because of bias from aggregating the spawning population from 1989-1993, averages are based on adult numbers collected from 1994-2011.
[d] The average and median represent broodstock collected only for the Methow program.

Age/Length Data

Ages of summer Chinook broodstock were determined from analysis of scales and/or CWTs. Broodstock collected from the 2017 return consisted primarily of age-4 and 5 natural-origin Chinook (98.3%). Age-3 natural-origin Chinook made up 2.6% of the broodstock (Table 9.2).

Table 9.2. Percent of hatchery and wild summer Chinook of different ages (total age) collected from broodstock for the Methow/Okanogan programs, 1991-2017.

Return Year	Origin	Total age				
		2	3	4	5	6
1991	Wild	0.5	6.8	35.1	55.4	2.2
	Hatchery	0.5	5.1	36.2	49.0	9.2
1992	Wild	0.0	13.0	36.2	50.7	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
1993	Wild	0.0	3.9	75.3	20.8	0.0
	Hatchery	0.0	1.0	85.7	13.3	0.0
1994	Wild	3.1	9.7	26.3	60.3	0.6
	Hatchery	0.0	14.7	11.2	74.0	0.0
1995	Wild	0.0	4.6	15.3	75.6	4.6
	Hatchery	0.0	0.4	13.0	25.6	61.0
1996	Wild	0.0	8.4	56.7	30.4	4.6
	Hatchery	0.0	3.0	31.0	47.0	19.0
1997	Wild	0.5	9.4	53.0	35.1	2.0
	Hatchery	0.0	20.6	11.1	61.8	6.5
1998	Wild	1.1	12.1	56.3	30.5	0.0
	Hatchery	2.1	18.9	56.2	16.0	6.8
1999	Wild	4.7	5.1	53.7	36.0	0.5
	Hatchery	0.3	3.5	29.3	65.0	1.9
2000	Wild	0.6	14.0	28.7	56.1	0.6
	Hatchery	0.0	27.0	14.3	54.3	4.3
2001	Wild	0.0	23.5	58.8	11.8	5.9
	Hatchery	1.8	21.1	64.6	10.1	2.4
2002	Wild	0.4	17.4	65.6	16.6	0.0
	Hatchery	0.0	2.4	39.4	58.3	0.0
2003	Wild	0.7	3.9	65.8	29.5	0.0
	Hatchery	0.0	5.6	18.7	70.1	5.6
2004	Wild	0.6	15.4	11.6	72.2	0.2

Return Year	Origin	Total age				
		2	3	4	5	6
	Hatchery	0.0	6.7	53.3	33.3	6.7
2005	Wild	0.0	17.1	69.9	11.0	1.9
	Hatchery	0.0	10.0	40.0	50.0	0.0
2006	Wild	1.7	3.0	41.0	52.9	1.5
	Hatchery	0.0	16.7	25.0	50.0	8.3
2007	Wild	1.8	15.3	8.2	70.3	4.4
	Hatchery	0.0	0.0	21.1	57.9	21.1
2008	Wild	0.3	17.9	67.1	13.3	1.4
	Hatchery	0.0	7.2	62.7	47.7	2.4
2009	Wild	1.3	10.1	68.7	19.9	0.0
	Hatchery	0.0	0.0	16.7	83.3	0.0
2010	Wild	0.2	16.2	51.0	32.6	0.0
	Hatchery	0.0	12.5	50.0	25.0	12.5
2011	Wild	0.1	7.1	75.5	17.0	0.0
	Hatchery	0.0	30.0	20.0	40.0	0.0
2012	Wild	0.0	3.9	49.0	46.1	1.0
	Hatchery	0.0	0.0	0.0	100.0	0.0
2013	Wild	0.0	15.2	70.7	14.1	0.0
	Hatchery	0.0	0.0	50.0	50.0	0.0
2014	Wild	0.0	4.1	71.1	24.7	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
2015	Wild	0.0	12.2	42.2	45.6	0.0
	Hatchery	0.0	0.0	100.0	0.0	0.0
2016	Wild	0.0	1.1	71.7	26.1	1.1
	Hatchery	0.0	0.0	0.0	0.0	0.0
2017	Wild	0.0	2.6	43.9	54.4	0.0
	Hatchery	0.0	0.0	0.0	0.0	0.0
Average	***Wild***	***0.7***	***10.1***	***50.7***	***37.4***	***1.2***
	Hatchery	***0.2***	***7.6***	***31.5***	***40.1***	***6.2***
Median	***Wild***	***0.2***	***9.7***	***53.7***	***32.6***	***0.5***
	Hatchery	***0.0***	***3.5***	***25.0***	***47.7***	***1.9***

Mean lengths of natural-origin summer Chinook of a given age differed little among return years 2015-2017 (Table 9.3). No hatchery-origin adults collected for the 2016 and 2017 brood. Differences in hatchery-origin and natural-origin fish were hard to assess given the small sample size of hatchery-origin fish (i.e., few hatchery fish were included in the broodstock).

Table 9.3. Mean fork length (cm) at age (total age) of hatchery and wild Methow/Okanogan summer Chinook collected from broodstock for the Methow/Okanogan programs, 1991-2017; N = sample size and SD = 1 standard deviation.

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
1991	Wild	47	1	-	68	15	6	82	78	10	94	123	8	97	5	5
	Hatchery	47	1	-	49	10	6	78	71	5	91	96	8	96	18	6
1992	Wild	-	0	-	55	9	5	69	25	6	78	35	6	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
1993	Wild	-	0	-	72	3	4	86	58	7	98	16	5	-	0	-
	Hatchery	-	0	-	42	1	-	75	84	8	88	13	6	-	0	-
1994	Wild	42	10	6	50	31	7	80	84	9	93	193	8	104	2	13
	Hatchery	-	0	-	49	38	5	76	29	7	88	191	7	-	0	-
1995	Wild	-	0	-	67	6	8	79	20	9	96	99	5	94	6	5
	Hatchery	-	0	-	52	1	-	73	32	9	89	63	9	95	150	7
1996	Wild	-	0	-	68	22	9	83	149	8	95	79	7	101	12	5
	Hatchery	-	0	-	52	7	10	77	72	7	90	109	8	100	44	6
1997	Wild	31	1	-	60	19	7	85	107	8	96	71	7	98	4	11
	Hatchery	-	0	-	45	63	5	72	34	9	92	189	7	97	20	7
1998	Wild	39	2	1	59	23	6	83	107	7	96	58	7	-	0	-
	Hatchery	43	7	6	50	64	6	74	190	7	92	54	8	98	23	5
1999	Wild	38	10	3	64	11	8	82	115	7	96	76	6	104	1	-
	Hatchery	37	1	-	53	11	9	75	92	6	91	204	6	98	6	5
2000	Wild	39	1	-	66	23	7	83	47	6	96	92	5	95	1	-
	Hatchery	-	0	-	54	100	7	78	53	8	92	201	6	99	16	6
2001	Wild	-	0	-	63	4	12	88	10	9	90	2	4	94	1	-
	Hatchery	41	9	3	55	107	9	79	327	8	93	51	7	101	12	9
2002	Wild	56	1	-	65	44	7	88	166	6	100	42	7	-	0	-
	Hatchery	-	0	-	45	6	5	76	100	7	95	148	5	-	0	-
2003	Wild	43	3	6	61	16	6	87	268	7	99	120	6	-	0	-
	Hatchery	-	0	-	55	6	9	73	20	8	91	75	7	102	6	9
2004	Wild	51	3	5	67	78	6	81	59	6	97	367	7	99	1	-
	Hatchery	-	0	-	52	1	-	70	8	5	97	5	8	109	1	-
2005	Wild	-	0	-	68	89	6	83	363	7	94	57	6	101	10	7
	Hatchery	-	0	-	55	1	-	70	4	4	89	5	4	-	0	-
2006	Wild	38	9	3	54	16	4	69	221	6	77	286	5	78	8	4
	Hatchery	-	0	-	42	2	1	62	3	2	69	6	6	76	1	-
2007	Wild	39	8	5	53	69	5	67	37	6	78	317	5	77	20	7
	Hatchery	-	0	-	-	0	-	54	4	2	75	11	5	78	4	3
2008	Wild	41	1	-	55	62	4	69	233	6	76	46	4	82	5	3
	Hatchery	-	0	-	59	6	9	67	52	5	73	23	6	79	2	8
2009	Wild	38	7	5	54	54	5	72	367	5	79	106	5	-	0	-

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	-	0	-	-	0	-	59	1	-	71	5	7	-	0	-
2010	Wild	43	1	-	54	78	5	71	246	5	78	157	5	-	0	-
	Hatchery	-	0	-	57	1	-	67	4	5	79	2	1	89	1	-
2011	Wild	43	2	3	66	32	8	87	338	7	97	76	5	-	0	-
	Hatchery	-	0	-	63	9	11	78	9	6	92	12	9	-	0	-
2012	Wild	-	0	-	70	10	3	84	62	5	96	54	6	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	90	1	-	-	0	-
2013	Wild	-	0	-	72	14	5	86	65	7	97	13	5	-	0	-
	Hatchery	-	0	-	-	0	-	76	2	6	92	2	0	-	0	-
2014	Wild	-	0	-	75	4	3	88	69	6	94	24	4	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
2015	Wild	-	0	-	71	11	4	83	38	5	94	41	6	-	0	-
	Hatchery	-	0	-	-	0	-	75	1	0	-	0	-	-	0	-
2016	Wild	-	0	-	72	1	-	84	66	6	96	24	7	102	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
2017	Wild	-	0	-	72	0	1	82	50	8	90	62	8	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
Average	***Wild***	***41.9***	***2.2***	***4.1***	***63.7***	***27.6***	***5.8***	***80.8***	***127.7***	***6.8***	***91.5***	***97.6***	***5.9***	***94.7***	***2.9***	***6.7***
	Hatchery	***42.0***	***0.7***	***4.5***	***51.6***	***16.1***	***7.1***	***72.0***	***44.2***	***5.9***	***87.2***	***54.3***	***6.2***	***94.1***	***11.3***	***6.5***

Sex Ratios

Male summer Chinook in the 2015 broodstock made up about 50.0% of the adults collected, resulting in an overall male to female ratio of 1.00:1.00 (Table 9.4.). In 2016, males made up just under 50.0% of the adults collected, resulting in an overall male to female ratio of 0.96:1.00 (Table 9.4). In 2017, males made up about 50.8% of the adults collected, resulting in an overall male to female ratio of 1.04:1.00 (Table 9.4). The ratios for 2015 and 2017 broodstock were above or at the assumed 1:1 ratio goal in the broodstock protocol.

Table 9.4. Numbers of male and female wild and hatchery summer Chinook collected for broodstock at Wells Dam for the Methow/Okanogan programs, 1991-2017. Ratios of males to females are also provided.

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1989[a]	752	667	1.13:1.00	181	160	1.13:1.00	1.13:1.00
1990[a]	381	482	0.79:1.00	95	120	0.79:1.00	0.79:1.00
1991[a]	443	559	0.79:1.00	151	191	0.79:1.00	0.79:1.00
1992[a]	349	318	1.10:1.00	38	35	1.09:1.00	1.10:1.00
1993[a]	513	300	1.71:1.00	293	171	1.71:1.00	1.71:1.00
1994	205	180	1.14:1.00	165	101	1.63:1.00	1.32:1.00
1995	103	149	0.69:1.00	158	197	0.80:1.00	0.75:1.00
1996	178	138	1.29:1.00	132	102	1.29:1.00	1.29:1.00

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
1997	102	112	0.91:1.00	174	134	1.30:1.00	1.12:1.00
1998	130	109	1.19:1.00	263	85	3.09:1.00	2.03:1.00
1999	138	110	1.25:1.00	161	146	1.10:1.00	1.17:1.00
2000	82	102	0.80:1.00	243	130	1.87:1.00	1.40:1.00
2001	89	46	1.93:1.00	311	112	2.78:1.00	2.53:1.00
2002	166	104	1.60:1.00	149	136	1.10:1.00	1.31:1.00
2003	255	194	1.31:1.00	61	51	1.20:1.00	1.29:1.00
2004	263	278	0.95:1.00	12	5	2.40:1.00	0.97:1.00
2005	365	186	1.96:1.00	6	6	1.00:1.00	1.93:1.00
2006	287	292	0.98:1.00	9	3	3.00:1.00	1.00:1.00
2007	228	276	0.83:1.00	11	8	1.38:1.00	0.84:1.00
2008	210	208	1.01:1.00	13	28	0.46:1.00	0.94:1.00
2009	261	292	0.89:1.00	2	3	0.67:1.00	0.89:1.00
2010	248	255	0.97:1.00	5	3	1.67:1.00	0.98:1.00
2011	236	262	0.90:1.00	23	7	3.29:1.00	0.96:1.00
2012	50	53	0.94:1.00	1	0	--	0.96:1.00
2013	49	49	1.00:1.00	3	1	3.00:1.00	1.04:1.00
2014	50	50	1.00:1.00	0	0	--	1.00:1.00
2015	49	49	1.00:1.00	1	0	--	1.02:1.00
2016	52	54	0.96:1.00	0	0	--	0.96:1.00
2017	60	58	1.04:1.00	0	0	-	1.04:1.00
Total[b]	***6,294***	***5,932***	***1.06:1.00***	***2,661***	***1,935***	***1.38:1.00***	***1.14:1.00***

[a] Numbers and male to female ratios were derived from the aggregate population collected at Wells Fish Hatchery volunteer channel and left- and right-ladder traps at Wells Dam.
[b] Total values were derived from 1994-present data to exclude aggregate population bias from 1989-1993 returns.

Fecundity

Fecundities for the 2015, 2016, and 2017 summer Chinook broodstock averaged 4,410, 4,509, and 3,858 eggs per female, respectively (Table 9.5). These values were below the overall average of 4,863 eggs per female. Mean observed fecundities for the 2015, 2016, and 2017 returns were also below the expected fecundity of 4,861, 4,721, and 4,596 eggs per female assumed in the broodstock protocols, respectively.

Table 9.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock at Wells Dam for the Methow/Okanogan programs, 1989-2017; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
1989*	NA	NA	4,750
1990*	NA	NA	4,838
1991*	NA	NA	4,819
1992*	NA	NA	4,804

Return year	Mean fecundity		
	Wild	Hatchery	Total
1993*	NA	NA	4,849
1994*	NA	NA	5,907
1995*	NA	NA	4,930
1996*	NA	NA	4,870
1997	5,166	5,296	5,237
1998	5,043	4,595	4,833
1999	4,897	4,923	4,912
2000	5,122	5,206	5,170
2001	5,040	4,608	4,735
2002	5,306	5,258	5,279
2003	5,090	4,941	5,059
2004	5,130	5,118	5,130
2005	4,545	4,889	4,553
2006	4,854	4,824	4,854
2007	5,265	5,093	5,260
2008	4,814	4,588	4,787
2009	5,115	--	5,115
2010	5,124	4,717	5,116
2011	4,594	3,915	4,578
2012	4,470	--	4,470
2013	4,700	5,490	4,717
2014	4,685	--	4,685
2015	4,410	--	4,410
2016	4,509	--	4,509
2017	3,858	-	3,858
Average	***4,845***	***4,897***	***4,863***
Median	***4,897***	***4,923***	***4,838***

* Individual fecundities were not assigned to females until 1997 brood.

To estimate fecundities by length, weight, and age[38], hatchery staff collected fecundity, fork length, weight, and age data from summer Chinook females during the spawning of 2003 through 2017 broodstock (complete data for all variables are available for years 2014-2017). For the available brood years, we compare age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass between hatchery and natural-origin summer Chinook. Hatchery staff attempted to stratify the females sampled by fork length categories to obtain fecundity samples for all sizes of fish to better estimate the relationship between size and fecundity.

[38] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

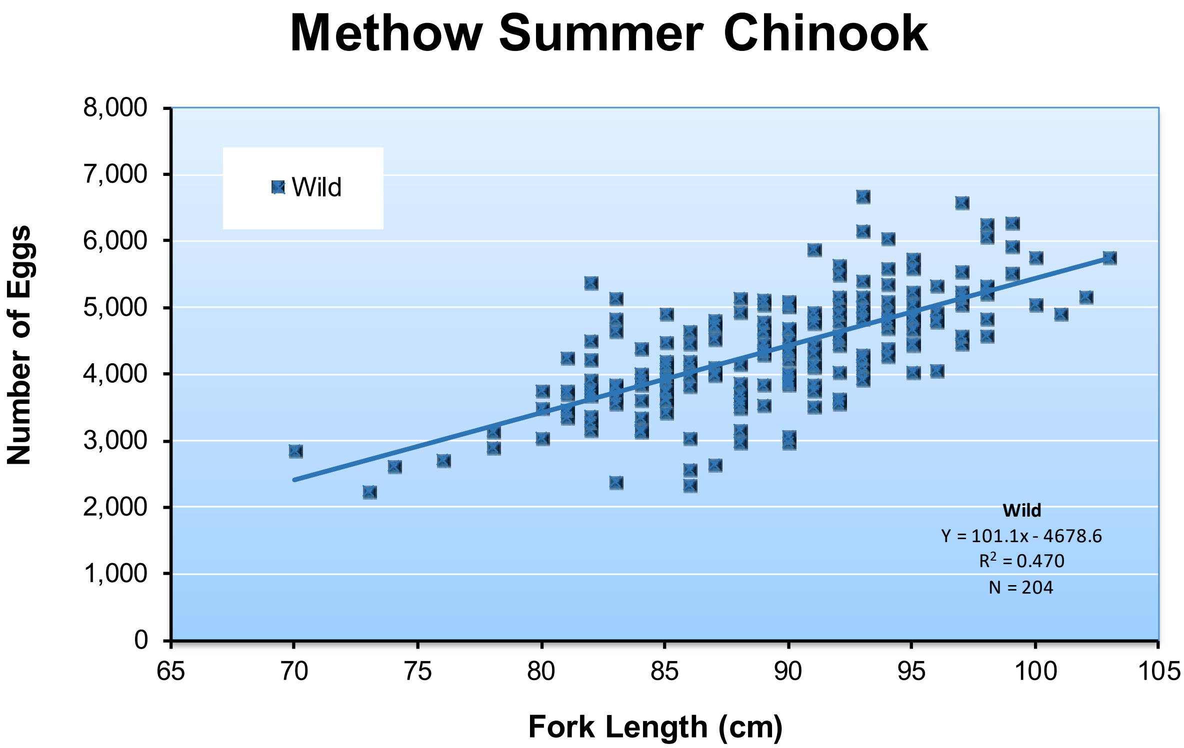
Mean fecundity by age varied between hatchery and natural-origin summer Chinook and over time (Table 9.6). On average, mean fecundities varied between hatchery and natural-origin summer Chinook by 506 eggs for age-4 fish, 231 eggs for age-5 fish, and 77 eggs for age-6 fish.

Table 9.6. Mean fecundity by age (total age) for hatchery and wild summer Chinook collected from broodstock for the Methow River program, brood years 2003-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2003	Wild	-	0	-	4,836	88	935	5,485	74	806	-	0	-
	Hatchery	-	0	-	-	0	-	4,939	41	857	5,186	4	515
2004	Wild	4,984	1	-	4,086	12	644	5,216	223	821	6,005	1	-
	Hatchery	-	0	-	3,673	1	-	5,430	3	152	5,628	1	-
2005	Wild	-	0	-	4,461	108	683	4,722	38	821	4,704	5	491
	Hatchery	-	0	-	-	0	-	4,681	3	546	-	0	-
2006	Wild	-	0	-	4,642	73	824	4,951	167	894	4,808	2	216
	Hatchery	-	0	-	-	0	-	4,824	2	1,957	-	0	-
2007	Wild	-	0	-	4,973	13	974	5,260	191	851	5,394	13	662
	Hatchery	-	0	-	-	0	-	4,955	6	678	5,505	2	13
2008	Wild	4,345	1	-	4,843	115	912	5,155	29	793	5,849	3	414
	Hatchery	4,259	3	852	4,405	42	903	4,882	20	871	5,283	1	-
2009	Wild	3,582	2	96	5,070	186	826	5,491	73	811	-	0	-
	Hatchery	-	0	-	-	0	-	4,151	2	552	-	0	-
2010	Wild	-	0	-	4,887	118	834	5,236	112	719	-	0	-
	Hatchery	-	0	-	3,849	1	-	5,006	2	820	-	0	-
2011	Wild	3,605	1	-	4,508	148	773	5,018	41	801	-	0	-
	Hatchery	3,652	1	-	4,074	1	-	3,950	3	948	-	0	-
2012	Wild	-	0	-	4,216	15	645	4,675	32	704	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2013	Wild	4,173	1	-	4,614	33	787	5,120	11	491	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2014	Wild	-	0	-	4,532	26	864	4,845	18	630	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2015	Wild	-	0	-	3,998	18	525	4,776	26	693	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2016	Wild	-	0	-	4,323	31	672	4,921	15	634	5,182	1	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
2017	Wild	-	0	-	3,608	17	744	3,957	36	895	-	0	-
	Hatchery	-	0	-	-	0	-	-	0	-	-	0	-
Average	***Wild***	***4,138***	***1***	***96***	***4,506***	***67***	***776***	***4,989***	***72***	***758***	***5,324***	***4***	***446***

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
	Hatchery	***3,956***	***2***	***852***	***4,000***	***11***	***903***	***4758***	***8***	***820***	***5,472***	***2***	***13***

We pooled fecundity data from brood years 2014 through 2017 (only brood years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for natural-origin females are shown in Figures 9.1, 9.2, and 9.3. Note that no hatchery-origin Chinook were included in broodstock in 2014-2017. All fecundity variables increase linearly with fork length.



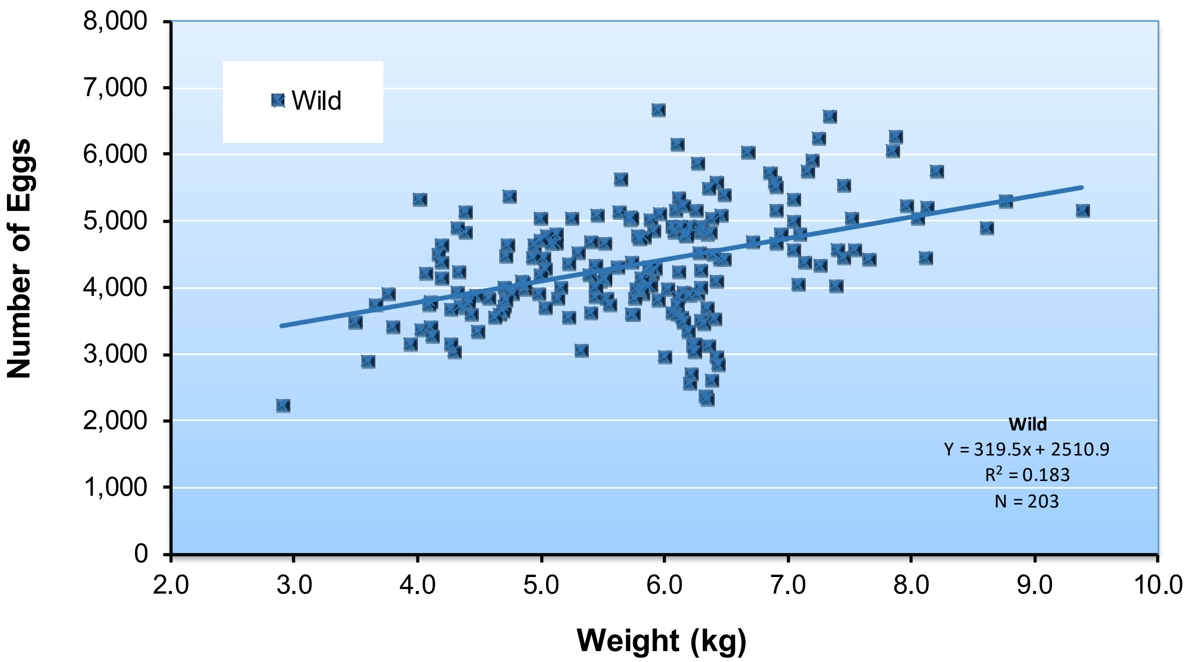


Figure 9.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for natural-origin summer Chinook for return years 2014-2017.

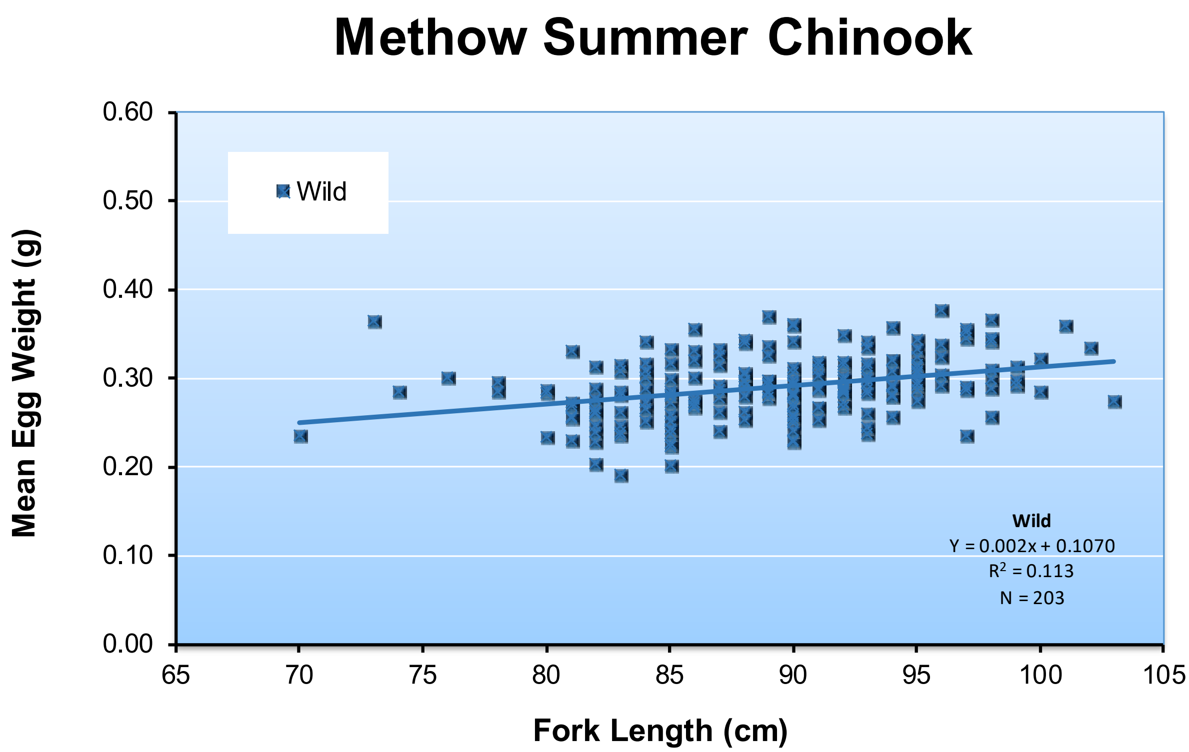


Figure 9.2. Relationships between mean egg weight and fork length for natural-origin summer Chinook for return years 2014-2017.

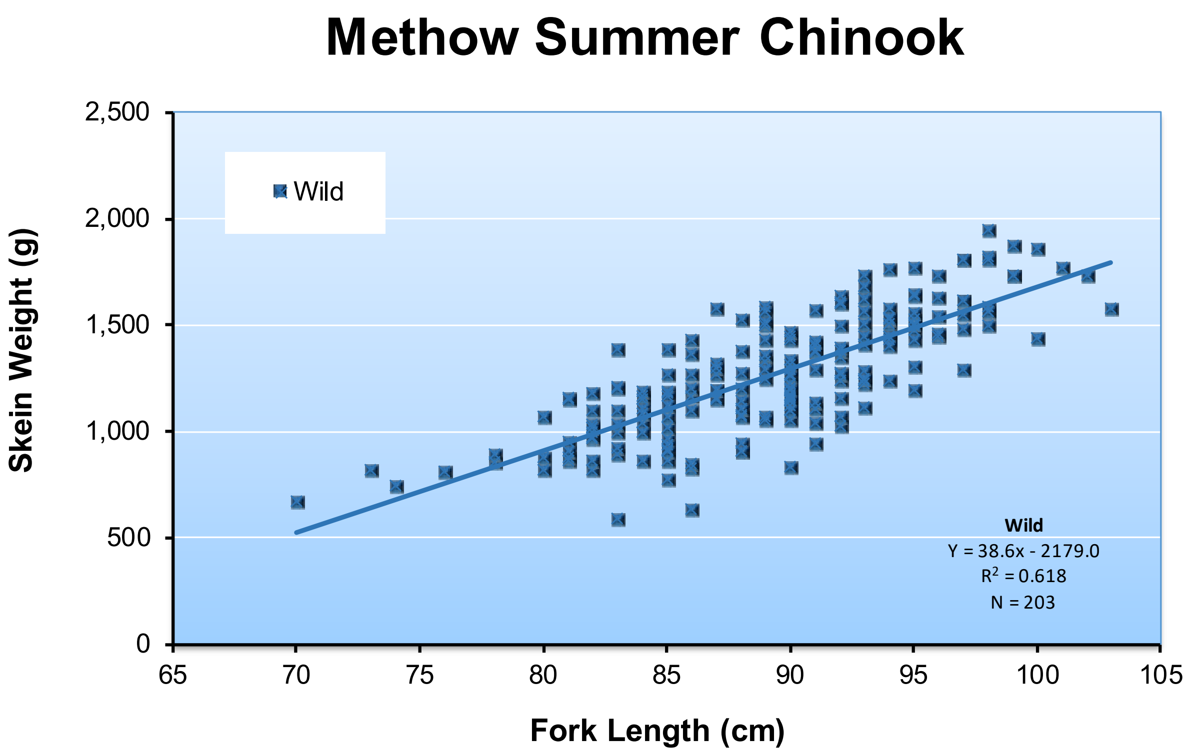


Figure 9.3. Relationships between skein weight and fork length for natural-origin summer Chinook for return years 2014-2017.

9.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 493,827 eggs were needed to meet the program release goal of 400,000 smolts for brood years 1989-2011. An evaluation of the program in 2011 determined that 246,913 eggs are needed to meet the revised release goal of 200,000 smolts. This revised goal began with brood year 2012. From 1989 through 2011, the egg take goal was reached in eight of those years (Table 9.7). From 2012 to present, the egg take goal was not achieved (Table 9.7).

Table 9.7. Numbers of eggs taken from summer Chinook broodstock collected at Wells Dam for the Methow/Okanogan programs, 1989-2017.

Return year	Number of eggs taken
1989	482,800
1990	464,097
1991	586,594
1992	486,260

Return year	Number of eggs taken
1993	531,490
1994	595,390
1995	491,000
1996	448,000
1997	401,162
1998	389,346
1999	483,726
2000	403,268
2001	279,272
2002	466,530
2003	473,681
2004	537,210
2005	305,826
2006	509,334
2007	549,802
2008	441,778
2009	560,602
2010	505,188
2011	488,747
Average (1989-2011)	***473,091***
Median (1989-2011)	***483,726***
2012	245,245
2013	231,136
2014	223,839
2015	216,098
2016	239,025
2017	208,341
Average (2012-present)	***227,281***
Median (2012-present)	***227,488***

Number of acclimation days

Improvements to Carlton Acclimation Pond made overwinter rearing feasible beginning with the 2013 brood Methow summer Chinook. Fish are held on well water at Eastbank Fish Hatchery before being transferred to Carlton Acclimation Pond for final acclimation on Methow River water in October (Table 9.8). Only the 1994 and 1995 broods were reared for longer durations at the Methow Fish Hatchery on Methow River water.

Table 9.8. Number of days Methow summer Chinook were acclimated at Carlton Acclimation Pond, brood years 1989-2015.

Brood year	Release year	Transfer date	Release date	Number of days
1989	1991	15-Mar	6-May	52
1990	1992	26-Feb	28-Apr	61
1991	1993	10-Mar	23-Apr	44
1992	1994	4-Mar	21-Apr	48
1993	1995	18-Mar	2-May	45
1994	1996	25-Sep	28-Apr	215
		19-Mar	28-Apr	40
1995	1997	22-Oct	8-Apr	168
		19-Mar	22-Apr	34
1996	1998	9-Mar	14-Apr	36
1997	1999	10-Mar	20-Apr	41
1998	2000	19-Mar	2-May	44
1999	2001	18-Mar	18-Apr	31
2000	2002	28-Mar	1-May	34
2001	2003	27-Mar	24-Apr	28
2002	2004	16-Mar	24-Apr	39
2003	2005	18-Mar	21-Apr	34
2004	2006	12-Mar	22-Apr	41
2005	2007	12-Mar	15-Apr – 8-May	34-57
2006	2008	4-7-Mar	16-Apr – 2 May	40-59
2007	2009	18-24-Mar	21-Apr	28-34
2008	2010	4-5, 8-9-Mar	4-21-Apr	33-50
2009	2011	25, 29, 31-Mar & 4-Apr	11-25-Apr	8-31
2010	2012	19-21, 24-Mar	23-24-Apr	31-37
2011	2013	13-21-Mar	15-23-Apr	25-41
2012	2014	19-21-Mar	7-Apr – 14 May	18-57
2013	2015	20-21-Oct	13-May	204-205
2014	2016	26 & 28-Oct	18-Apr	173-175
2015	2017	20-21-Oct	18-Apr	179-180

Release Information

Numbers released

The 2015 brood Methow summer Chinook program achieved 88.9% of the 200,000 goal with about 177,762 Chinook being force released from the circular ponds on the night of 18 April 2017 (Table 9.9). Forced releases at night were initiated in 2016 to improve post-release survival.

Table 9.9. Numbers of Methow summer Chinook smolts released from the hatchery, brood years 1989-2015. Beginning with the 2014 release group (brood year 2012), the release target for Methow summer Chinook is 200,000 smolts.

Brood year	Release year	CWT mark rate	Number of smolts released
1989	1991	0.8529	420,000
1990	1992	0.9485	391,650
1991	1993	0.6972	540,900
1992	1994	0.9752	402,641
1993	1995	0.4623	433,375
1994	1996	0.9851	406,560
1995	1997	0.9768	353,182
1996	1998	0.9221	298,844
1997	1999	0.9884	384,909
1998	2000	0.9429	205,269
1999	2001	0.9955	424,363
2000	2002	0.9928	336,762
2001	2003	0.9902	248,595
2002	2004	0.9913	399,975
2003	2005	0.9872	354,699
2004	2006	0.9848	400,579
2005	2007	0.9897	263,723
2006	2008	0.9783	419,734
2007	2009	0.9837	433,256
2008	2010	0.9394	397,554
2009	2011	0.9862	404,956
2010	2012	0.9962	439,000
2011	2013	0.9734	436,092
Average (1989-2011)		***0.9365***	***382,462***
Median (1989-2011)		***0.9837***	***400,579***
2012	2014	0.9987	197,391
2013	2015	0.9903	188,834
2014	2016	0.9921	167,616
2015	2017	0.9923	177,762
Average (2012-present)		***0.9934***	***182,901***
Median (2012-present)		***0.9922***	***183,298***

Numbers tagged

The 2015 brood Methow summer Chinook were 99.2% CWT and adipose fin-clipped (Table 9.9).

On 20-22 March 2018, a total of 4,424 Methow summer Chinook from the 2016 brood were PIT tagged at the Carlton Acclimation Facility. These fish were tagged in circular ponds #1 through #8, but not pond #6 because those fish were not healthy enough to be tagged. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 121 mm in length and 21 g at time of tagging.

Table 9.10 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Methow River.

Table 9.10. Summary of PIT-tagging activities for Methow hatchery summer Chinook, brood years 2008-2015.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2008	2010	10,100	4	0	10,096
2009	2011	5,050	17	9	5,024
2010	2012	0	--	--	0
2011	2013	0	--	--	0
2012	2014	10,099	41	7	10,051
2013	2015	10,159	35	1	10,123
2014	2016	5,000	8	0	4,992
2015	2017	5,064	0	0	5,064

Fish size and condition at release

A forced release of yearling Chinook smolts took place on the night of 18 April 2017. Size at release was within the respective size range for fork length and weight goals (Table 9.11). For this brood year, CV was less than the target CV for length by 7%.

Table 9.11. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Methow summer Chinook smolts released from the hatchery, brood years 1991-2015. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1991	1993	152	13.6	40.3	11
1992	1994	145	16.0	37.2	12
1993	1995	154	8.6	37.1	12
1994	1996	163	8.2	48.2	9
1995	1997	141	9.6	37.0	12
1996	1998	199	13.1	105.1	4

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1997	1999	153	7.6	39.5	12
1998	2000	164	8.7	51.7	9
1999	2001	153	9.3	41.5	11
2000	2002	170	10.2	54.2	8
2001	2003	167	7.4	52.7	9
2002	2004	148	13.1	35.7	13
2003	2005	148	10.1	35.5	13
2004	2006	142	9.8	31.1	15
2005	2007	158	15.0	42.2	11
2006	2008	156	18.0	42.8	11
2007	2009	138	21.0	32.1	14
2008	2010	155	14.2	42.0	11
2009	2011	170	15.8	56.9	8
2010	2012	145	16.7	34.5	13
2011	2013	160	13.0	43.6	6
Average		***156***	***12.3***	***44.8***	***11***
Targets		***163***	***9.0***	***45.4***	***10***
2012	2014	158	12.1	41.6	11
2013	2015	130	12.6	27.2	17
2014	2016	125	10.8	23.0	20
2015	2017	134	8.4	29.4	15
Average		***137***	***11.0***	***30.3***	***16***
Targets		***163***	***9.0***	***45.4***	***13-17***

Survival Estimates

Overall survival of the 2015 brood Methow summer Chinook from green (unfertilized) egg-to-release was just above the standard set for the program (Table 9.12). This was largely because of higher pre-spawn survival.

Table 9.12. Hatchery life-stage survival rates (%) for Methow summer Chinook, brood years 1989-2015. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1989[a]	89.8	99.5	89.9	96.7	99.7	99.4	73.3	98.5	87.0
1990[a]	93.9	99.0	84.9	97.1	81.2	80.6	97.7	99.5	84.4
1991[a]	93.1	95.5	88.2	98.0	99.4	99.1	97.5	99.6	92.2
1992[a]	96.9	99.0	87.8	98.0	99.9	99.9	90.9	98.3	82.8

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
1993[a]	82.2	99.4	85.4	97.6	99.8	99.5	92.0	99.4	81.5
1994	96.1	90.0	86.6	100.0	98.1	97.4	73.1	99.1	68.3
1995	91.9	96.2	98.2	84.1	96.5	96.2	92.7	89.6	71.9
1996	95.4	98.1	83.2	100.0	97.7	96.9	86.5	89.0	66.7
1997	91.9	94.6	86.1	98.4	98.7	98.3	98.8	99.7	95.9
1998	84.0	96.2	54.1	98.0	99.4	98.9	96.6	99.9	52.7
1999	98.8	98.7	92.9	96.9	98.0	97.6	96.9	99.9	87.7
2000	90.5	96.9	89.2	98.1	98.5	98.3	94.6	94.4	83.5
2001	96.2	92.3	89.1	97.6	97.2	97.1	97.5	99.8	89.0
2002	97.1	98.1	88.3	99.9	97.7	97.5	96.7	99.9	85.7
2003	96.7	97.5	82.8	98.2	99.7	99.2	93.7	99.9	74.9
2004	93.6	98.2	84.0	97.8	99.6	99.2	98.3	98.5	74.6
2005	97.0	89.6	88.0	95.5	99.6	98.9	96.6	99.9	86.2
2006	92.9	89.5	86.3	98.3	99.6	98.7	97.2	99.5	82.4
2007	92.6	99.6	84.1	98.5	99.7	99.5	98.9	99.8	81.9
2008	99.6	97.9	91.9	99.5	99.3	98.9	98.5	99.9	90.0
2009[b]	93.6	93.5	91.0	97.7	99.7	99.2	98.8	100.0	87.9
2010[c]	96.5	100.0	91.1	100.0	96.4	96.1	95.4	99.5	86.9
2011	94.9	96.4	93.8	97.8	99.7	99.1	98.6	99.9	90.4
2012	94.3	94.2	93.1	97.8	99.4	99.0	97.0	98.3	88.3
2013	98.0	100.0	89.5	97.8	99.9	99.2	93.4	94.2	81.7
2014	96.0	96.0	94.0	95.8	99.6	99.4	87.1	88.0	78.4
2015	93.1	95.0	89.1	98.0	99.7	99.4	94.2	95.6	82.3
Average	***93.9***	***96.3***	***87.5***	***97.5***	***98.3***	***97.9***	***93.8***	***97.8***	***82.0***
Median	***94.3***	***96.9***	***88.3***	***98***	***99.4***	***98.9***	***96.6***	***99.5***	***83.5***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival rates were calculated from aggregate population collected at Wells Fish Hatchery volunteer channel and left- and right-ladder traps at Wells Dam.

[b] Survival rates were calculated from aggregate collections at Wells east fish ladder for the Methow and Okanogan/Similkameen programs. About 41% of the total fish collected were used to estimate survival rates.

[c] Survival rates were calculated from aggregate collections at Wells West Ladder for the Methow and Similkameen programs. About 71% of the total fish collected were used to estimate survival rates.

9.3 Disease Monitoring

Results of 2017 adult broodstock bacterial kidney disease (BKD) monitoring indicated that 77.8% of females had ELISA values less than 0.120 (Table 9.13).

Table 9.13. Proportion of bacterial kidney disease (BKD) titer groups for the Methow/Okanogan summer Chinook broodstock, brood years 1997-2017. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1997	0.6267	0.1333	0.0622	0.1778	0.6844	0.3156
1998	0.9632	0.0184	0.0123	0.0061	0.9816	0.0184
1999	0.9444	0.0198	0.0238	0.0119	0.9643	0.0357
2000	0.7476	0.0952	0.0238	0.1333	0.8000	0.2000
2001	0.9801	0.0199	0.0000	0.0000	1.0000	0.0000
2002	0.9567	0.0130	0.0130	0.0173	0.9740	0.0260
2003	0.9620	0.0127	0.0169	0.0084	0.9747	0.0253
2004	0.9585	0.0151	0.0075	0.0189	0.9736	0.0264
2005	0.9884	0.0000	0.0000	0.0116	0.9884	0.0116
2006	0.9962	0.0038	0.0000	0.0000	0.9962	0.0038
2007	0.9202	0.0266	0.0152	0.0380	0.9354	0.0646
2008	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2009	0.9891	0.0073	0.0037	0.0000	0.9927	0.0073
2010	0.9960	0.0040	0.0000	0.0000	1.0000	0.0000
2011	0.9766	0.0140	0.0000	0.0093	0.9860	0.0140
2012	0.9341	0.0440	0.0110	0.0110	0.9780	0.0220
2013	0.8776	0.1224	0.0000	0.0000	0.9388	0.0612
2014	0.9170	0.0210	0.0210	0.0420	0.9381	0.0630
2015	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2016	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2017	0.7778	0.0556	0.0556	0.1111	0.7778	0.7407
Average	***0.9292***	***0.0298***	***0.0127***	***0.0284***	***0.9553***	***0.0779***
Median	***0.9620***	***0.0151***	***0.0075***	***0.0093***	***0.9798***	***0.0220***

[a] Individual ELISA samples were not collected before the 1997 brood.
[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

9.4 Natural Juvenile Productivity

During 2017, juvenile summer Chinook were sampled at the Methow Trap located near RM 18.6. Trapping has occurred in this location since 2004.

Emigrant Estimates

Methow Trap

On the Methow River, WDFW used traps with cone diameters of 2.4 m and 1.5 m to increase trap efficiency over a greater range of river discharge. Large variation in discharge and channel configuration required the use of two trapping positions. The 1.5-m trap was deployed in the lower position at discharges less than 45.3 m^3/s. At discharges greater than 45.3 m^3/s, the 2.4-m trap was installed and operated in tandem with the 1.5 m trap.

A pooled-efficiency model estimated the total number of emigrants when the trap was operated in the low trapping position. A flow-efficiency model estimated the total number of emigrants when the trap was operated in the upper trapping position. The pooled-efficiency estimate was based on eight mark-recapture release groups in 2017. The flow-efficiency estimate was based on 15 mark-recapture release groups that were conducted over the period 2007-2016.

The Methow Trap operated at night between 1 March and 6 December 2017. During that time, the trap was inoperable for 33 days because of high river discharge. During the ten-month sampling period, a total of 4,424 wild subyearling summer Chinook were captured at the Methow Trap. Based on the pooled-efficiency model and the flow efficiency model, the total number of wild subyearling summer Chinook that emigrated past the Methow Trap in 2017 was 669,432 (±468,739) (Table 9.13). This value contains an estimated 340,718 fish that likely emigrated past the trapping location during the 33 days in which the trap was not operating. Because 215 summer Chinook redds were observed downstream from the trap in 2016, the total number of summer Chinook emigrating from the Methow River in 2017 was expanded using the ratio of the number of redds downstream from the trap to the number upstream from the trap. This resulted in a total summer Chinook emigrant estimate of 829,352 (±521,732) fish (Table 9.14). Most of these fish emigrated during April and May (Figure 9.4).

Table 9.14. Numbers of redds and juvenile summer Chinook emigrants in the Methow River basin for brood years 2003-2016; NA = not available.

Brood year	Number of redds	Egg deposition	Number of emigrants upstream from trap	Total number of emigrants
2003	1,624	8,215,816	1,454,913	NA
2004*	973	4,991,490	2,016,696	NA
2005*	874	3,979,322	269,870	NA
2006	1,353	6,567,462	2,481,762	3,465,247
2007	620	3,261,200	446,860	664,396
2008	599	2,867,413	385,087	508,077
2009	692	3,539,580	838,989	1,202,030
2010	887	4,537,892	514,724	703,483
2011	941	4,307,898	1,861,614	2,292,904
2012	960	4,291,200	7,533,462	11,212,595
2013	1,551	7,316,067	473,625	709,066
2014	591	2,768,835	706,071	742,505
2015	1,231	5,428,710	761,769	1,219,425
2016	1,115	5,027,535	669,432	829,352

Brood year	Number of redds	Egg deposition	Number of emigrants upstream from trap	Total number of emigrants
Average	*1,001*	*4,792,887*	*1,458,205*	*2,140,825*
Median	*951*	*4,422,895*	*733,920*	*829,352*

* Trap did not operate for entire migration period.

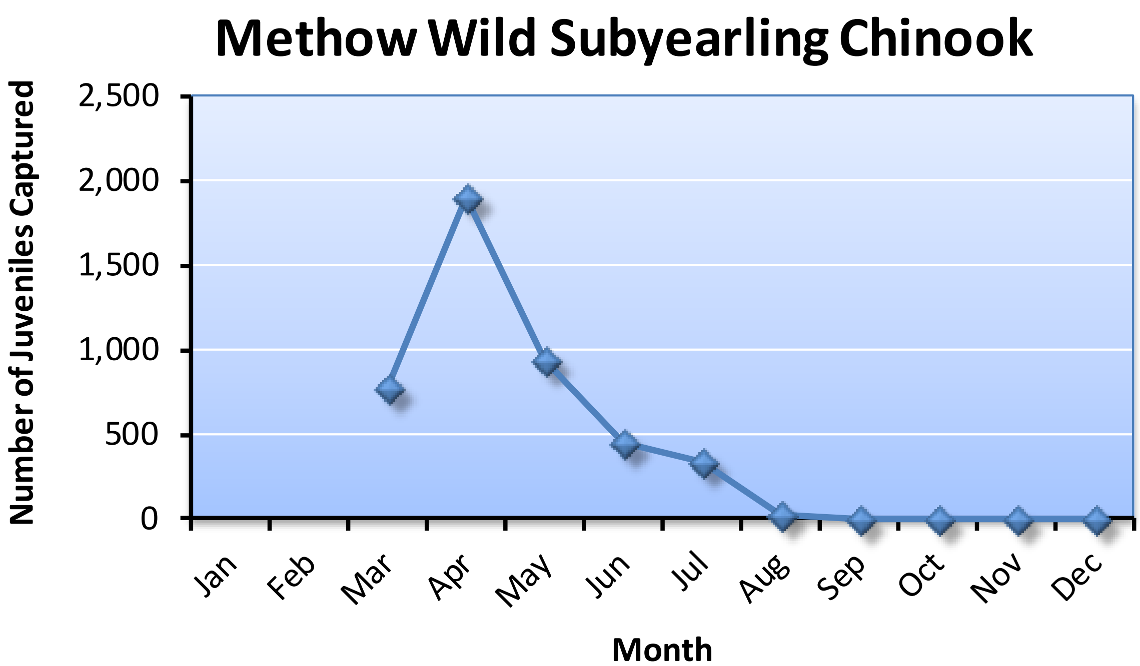


Figure 9.4. Numbers of wild subyearling Chinook captured at the Methow Trap during March to early December 2017.

Subyearling summer Chinook sampled in 2017 averaged 67.1 mm in length, 4.0 g in weight, and had a mean condition of 1.14 (Table 9.15). These size estimates were similar to the overall mean of subyearling summer Chinook sampled in previous years (overall means: 63.6 mm, 3.8 g, and condition of 1.22). Environmental conditions at the trapping location do not allow for accurate weight measurements on fry (i.e., <50 mm fork length), so this size class is underrepresented in the averages.

Table 9.15. Mean fork length (mm), weight (g), and condition factor of subyearling summer Chinook collected in the Methow Trap, 2004-2017. Numbers in parentheses indicate 1 standard deviation.

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2004	506	56.5 (17.5)	2.8 (2.8)	1.29 (0.36)
2005	326	42.6 (6.5)	1.1 (0.6)	1.34 (0.39)
2006	787	38.5 (3.0)	0.6 (0.3)	1.02 (0.28)
2007	437	73.9 (17.3)	5.8 (3.8)	1.24 (0.26)
2008	123	78.8 (16.3)	6.7 (3.9)	1.27 (0.35)

Sample year	Sample size[a]	Mean size		
		Length (mm)	Weight (g)	Condition (K)
2009	162	67.4 (12.4)	4.3 (2.3)	1.31 (0.34)
2010	142	69.7 (14.4)	4.6 (2.9)	1.26 (0.50)
2011	590	70.6 (13.5)	4.9 (2.8)	1.28 (0.31)
2012	373	61.4 (10.9)	2.9 (2.1)	1.16 (0.22)
2013	602	62.0 (11.0)	3.2 (2.1)	1.22 (0.23)
2014	707	67.1 (13.2)	3.9 (2.6)	1.16 (0.18)
2015	633	69.2 (13.6)	4.6 (2.8)	1.25 (0.22)
2016	645	65.6 (12.8)	3.8 (2.6)	1.20 (0.24)
2017	424	67.1 (14.1)	4.0 (3.0)	1.14 (0.23)
Average	***461***	***63.6 (12.6)***	***3.8 (2.5)***	***1.22 (0.29)***
Median	***472***	***67.1 (13.3)***	***3.9 (2.7)***	***1.24 (0.27)***

[a] Sample size represents the number of fish that were measured for both length and weight.

Freshwater Productivity

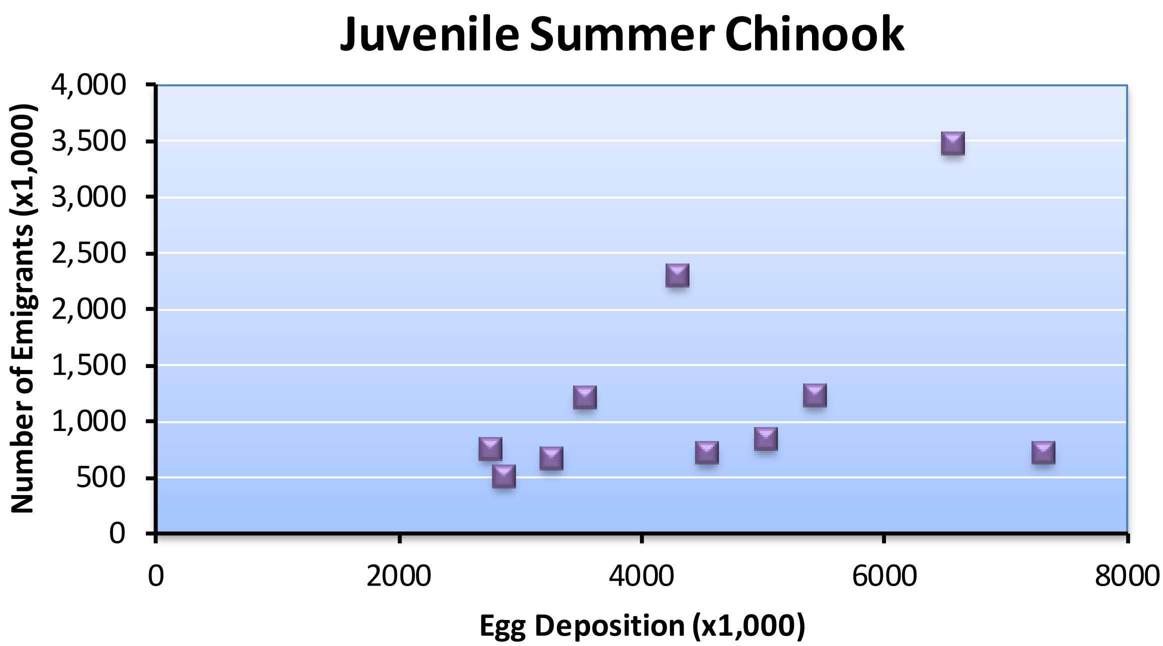
Both productivity and survival estimates for juvenile emigrants of summer Chinook in the Methow River basin are provided in Table 9.16. Estimates for brood year 2016 were within the range of estimates for brood years 2006-2015. During the period 2006-2016, freshwater productivities ranged from 457-2,561 emigrants/redd. Survivals during the same period ranged from 9.7-53.2% for egg-emigrants.

Table 9.16. Productivity (emigrants/redd) and survival (egg-emigrant) estimates for summer Chinook in the Methow River basin for brood years 2006-2016; ND = no data. These estimates were derived from data in Table 9.14.

Brood year	Emigrants/ Redd	Egg-Emigrant (%)
2006	2,561	52.8
2007	1,072	20.4
2008	848	17.7
2009	1,737	34.0
2010	793	15.5
2011	2,437	53.2
2012	11,680[a]	261.3[a]
2013	457	9.7
2014	1,256	26.8
2015	991	22.5
2016	744	16.5
Average	***1,290***	***26.9***
Median	***1,031***	***21.4***

[a] Because these values are extreme outliers (e.g., >100% survival), they are not included in statistical summaries or analyses.

Numbers of juvenile emigrants increased with increasing egg deposition; however, egg-emigrant survival did not decrease significantly with increasing egg deposition (Figure 9.5). This suggests a density-independent relationship between seeding levels and emigrants within the Methow River basin (see Population Carrying Capacity section below).



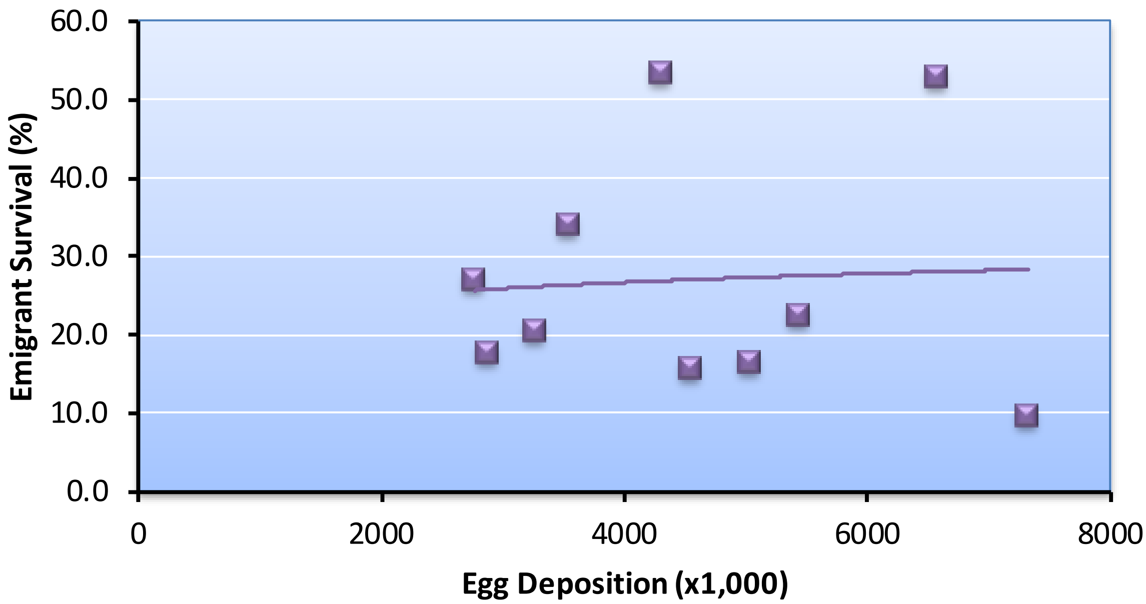


Figure 9.5. Relationships between seeding levels (egg deposition) and juvenile productivity (top figure) and emigrant survival (bottom figure) for Methow summer Chinook, brood years 2006-2016.

Population Carrying Capacity

Population carrying capacity (*K*) is defined as the maximum equilibrium population size estimated with population models (e.g., logistic equation, Beverton-Holt model, hockey stick model, and the

Ricker model).[39] Maximum equilibrium population size is generated from density dependent mechanisms that reduce population growth rates as population size increases (negative density dependence). This is referred to as compensation. Population size fluctuates about the maximum equilibrium size because of variability in vital rates that are unrelated to density (density independent factors) and measurement error. In this section, we used population models to estimate juvenile summer Chinook carrying capacities (see Appendix 6 in Hillman et al. 2017 for a detailed description of methods).

Only the density-independent model adequately fit the juvenile emigrant data for Methow summer Chinook (Figure 9.6). This means that under the range of seeding levels examined, there is no estimate of carrying capacity for juvenile emigrants. This implies that spawning habitat is not currently limiting juvenile productivity within the Methow River basin. It does not mean that there is no limit to juvenile rearing within the Methow River basin. Indeed, there is likely a limit to the number of parr that can rear within the basin; however, there are no parr data to estimate rearing capacity.

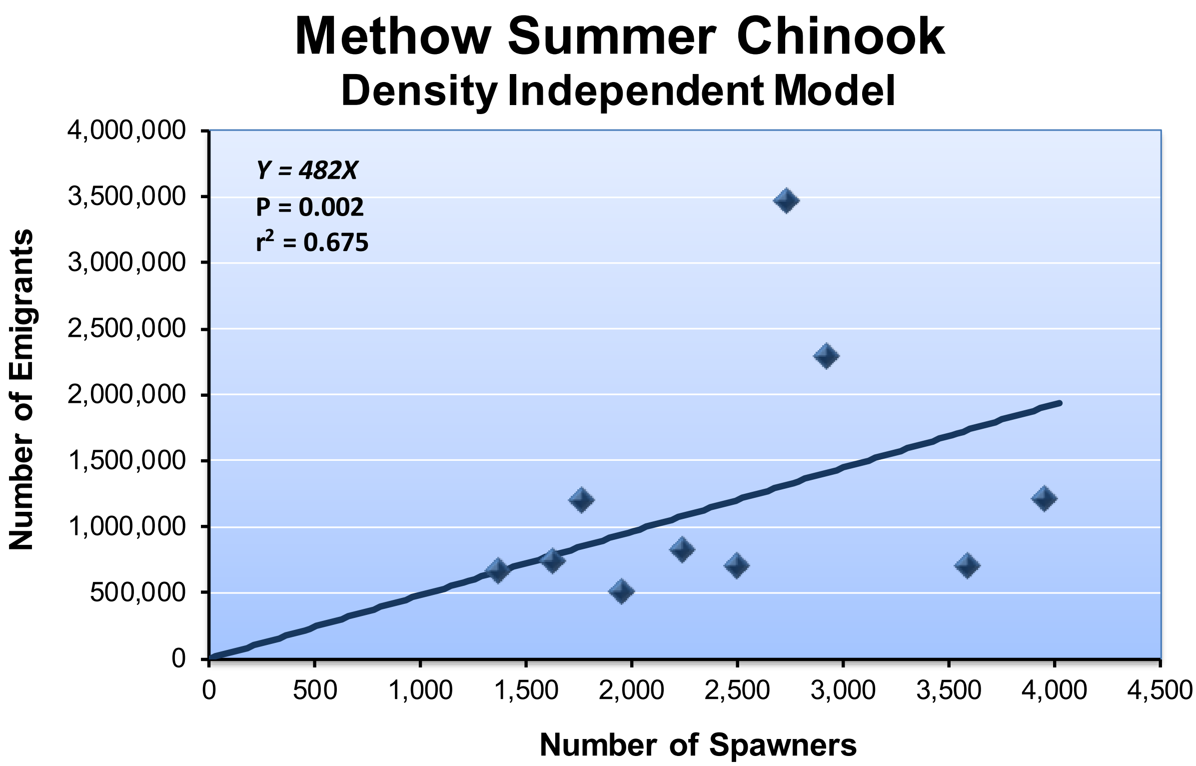


Figure 9.6. Density-independent relationship between spawners and number of juvenile emigrants produced in the Methow River basin.

[39] Population carrying capacity (*K*) should not be confused with habitat carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

9.5 Spawning Surveys

Surveys for Methow summer Chinook redds were conducted from late September to mid-November 2017 in the Methow River. Total redd counts (not peak counts) were conducted in the river (see Appendix O for more details).

Redd Counts

A total of 690 summer Chinook redds were counted in the Methow River in 2017 (Table 9.17). This is less than the overall average of 711 redds.

Table 9.17. Total number of redds counted in the Methow River, 1989-2017.

Survey year	Total redd count
1989	149*
1990	418*
1991	153
1992	107
1993	154
1994	310
1995	357
1996	181
1997	205
1998	225
1999	448
2000	500
2001	675
2002	2,013
2003	1,624
2004	973
2005	874
2006	1,353
2007	620
2008	599
2009	692
2010	887
2011	941
2012	960
2013	1,551
2014	591
2015	1,231
2016	1,115
2017	690
Average	***710***
Median	***620***

* Total counts based on expanded aerial counts.

Redd Distribution

Summer Chinook redds were not evenly distributed among the seven reaches in the Methow River. Most redds (76%) were located within the lower three reaches (downstream from Twisp) (Table 9.18; Figure 9.7). Few Chinook spawned upstream from Winthrop (Reaches 6 and 7).

Table 9.18. Total number of summer Chinook redds counted in different reaches on the Methow River during September through early November 2017. Reach codes are described in Table 2.11.

Survey reach	Total redd count	Percent
Methow 1 (M1)	108	15.7
Methow 2 (M2)	172	24.9
Methow 3 (M3)	246	35.7
Methow 4 (M4)	46	6.7
Methow 5 (M5)	100	14.5
Methow 6 (M6)	3	0.4
Methow 7 (M7)	15	2.2
Totals	***690***	***100***

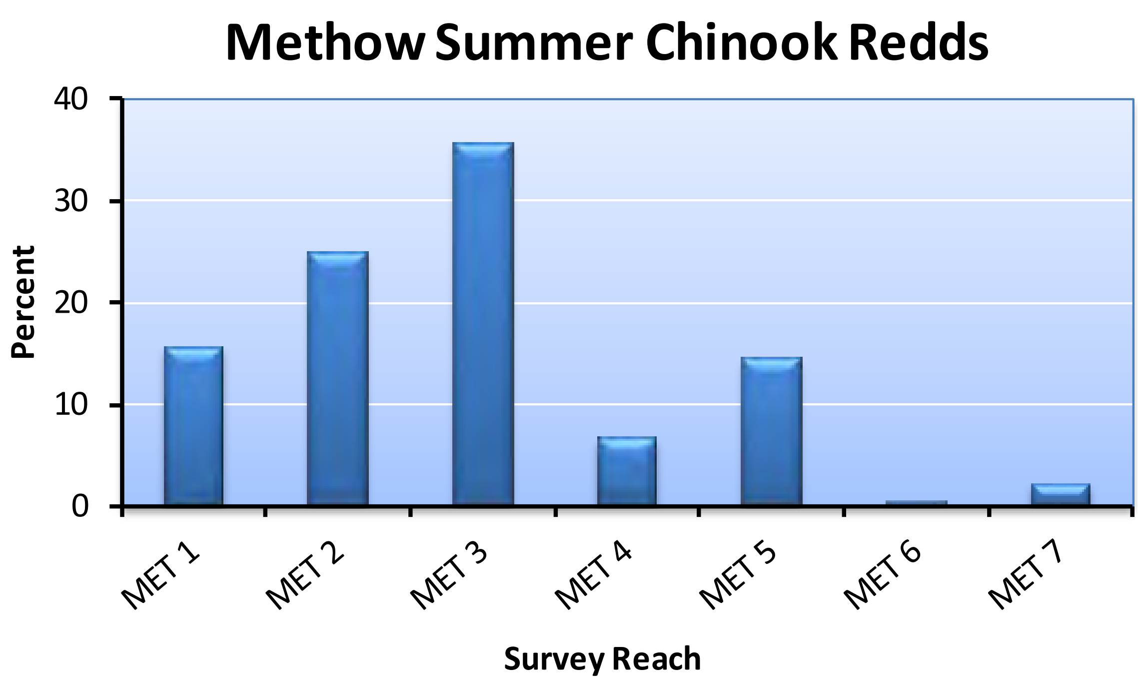


Figure 9.7. Percent of the total number of summer Chinook redds counted in different reaches on the Methow River during September through mid-November 2017. Reach codes are described in Table 2.11.

Spawn Timing

Spawning in 2017 began the last week of September, peaked in early October, and ended the third week of November (Figure 9.8). Stream temperatures in the Methow River, when spawning began, varied from 7.5-11.5°C. Peak spawning occurred during the first week of October in the upper reaches of the Methow River and one-two weeks later in the lower reaches.

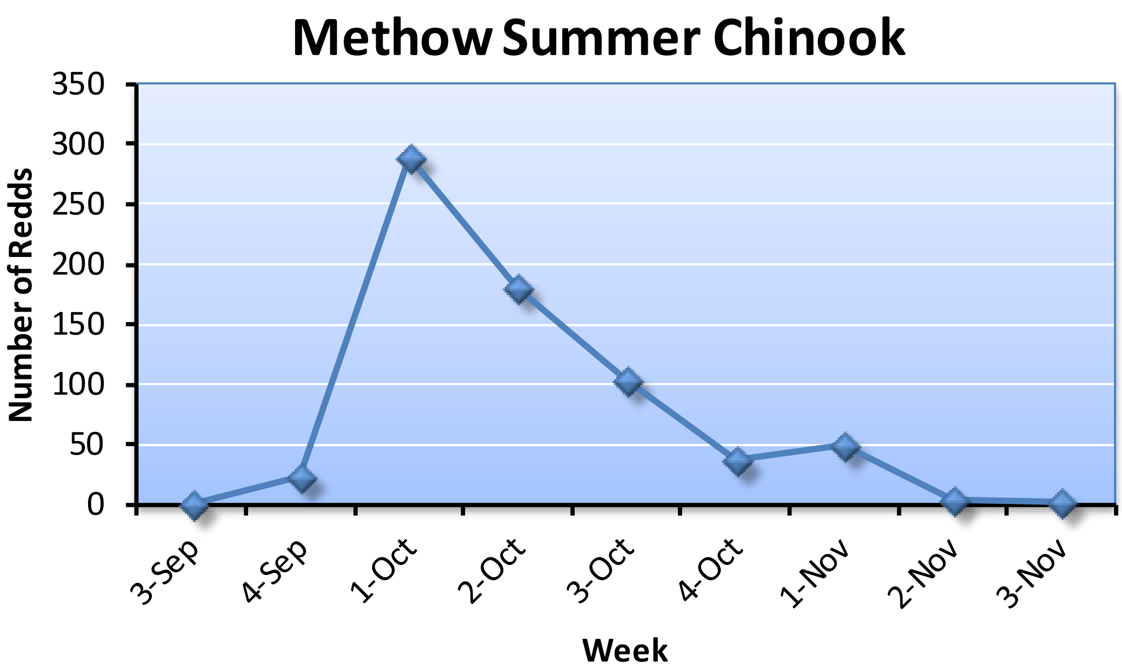


Figure 9.8. Number of new summer Chinook redds counted during different weeks in the Methow River, September through mid-November 2017.

Spawning Escapement

Spawning escapement for Methow summer Chinook was calculated as the total number of redds times the fish per redd ratio estimated from fish sampled at Wells Dam.[40] The estimated fish per redd ratio for Methow summer Chinook in 2017 was 2.04. Multiplying this ratio by the number of redds counted in the Methow River resulted in a total spawning escapement of 1,408 summer Chinook (Table 9.19).

Table 9.19. Spawning escapements for summer Chinook in the Methow River for return years 1989-2017.

Return year	Fish/Redd	Redds	Total spawning escapement
1989*	3.30	149	492
1990*	3.40	418	1,421
1991*	3.70	153	566

[40] Expansion factor = (1 + (number of males/number of females)).

Return year	Fish/Redd	Redds	Total spawning escapement
1992*	4.30	107	460
1993*	3.30	154	508
1994*	3.50	310	1,085
1995*	3.40	357	1,214
1996*	3.40	181	615
1997*	3.40	205	697
1998	3.00	225	675
1999	2.20	448	986
2000	2.40	500	1,200
2001	4.10	675	2,768
2002	2.30	2,013	4,630
2003	2.42	1,624	3,930
2004	2.25	973	2,189
2005	2.93	874	2,561
2006	2.02	1,353	2,733
2007	2.20	620	1,364
2008	3.25	599	1,947
2009	2.54	692	1,758
2010	2.81	887	2,492
2011	3.10	941	2,917
2012	3.07	960	2,947
2013	2.31	1,551	3,583
2014	2.75	591	1,625
2015	3.21	1,231	3,952
2016	2.01	1,115	2,241
2017	2.04	690	1,408
Average	***2.92***	***710***	***1,895***
Median	***3.00***	***610***	***1,625***

* Spawning escapement was calculated using the “Modified Meekin Method” (i.e., 3.1 x jack multiplier).

9.6 Carcass Surveys

Surveys for Methow summer Chinook carcasses were conducted during late September to mid-November 2017 in the Methow River (see Appendix O for more details).

Number sampled

A total of 420 summer Chinook carcasses were sampled during September through mid-November in the Methow River (Table 9.20). This was less than the overall average of 519 carcasses sampled since 1991.

Table 9.20. Numbers of summer Chinook carcasses sampled within each survey reach on the Methow River, 1991-2017. Reach codes are described in Table 2.11.

Survey year	Number of summer Chinook carcasses							
	M-1	M-2	M-3	M-4	M-5	M-6	M-7	Total
1991	0	12	8	4	2	0	0	**26**
1992	8	8	19	0	17	1	0	**53**
1993	19	25	14	2	5	0	0	**65**
1994[a]	43	33	20	5	13	0	0	**114**
1995	14	33	58	7	7	0	0	**119**
1996	6	30	46	5	2	0	0	**89**
1997	6	12	38	2	19	1	0	**78**
1998	90	84	99	17	30	0	0	**320**
1999	47	144	232	32	37	12	2	**506**
2000	62	118	105	9	99	5	0	**398**
2001	392	275	88	14	76	11	1	**857**
2002	551	318	518	164	219	34	10	**1,814**
2003	115	268	317	115	128	5	0	**948**
2004	40	173	187	82	92	2	1	**577**
2005	154	173	182	42	112	3	0	**666**
2006	121	148	110	56	144	3	1	**583**
2007	142	132	108	27	53	0	0	**462**
2008	64	128	197	33	57	3	0	**482**
2009	144	158	159	36	94	0	0	**591**
2010	105	180	184	38	63	5	1	**576**
2011	56	134	201	78	83	5	1	**558**
2012	127	154	169	75	82	14	7	**628**
2013	296	287	385	90	100	7	5	**1,170**
2014	6	14	176	53	148	73	17	**487**
2015	229	194	221	56	95	19	25	**839**
2016	83	168	216	44	70	1	5	**587**
2017	61	149	120	22	51	5	12	**420**
Average	***110***	***132***	***155***	***41***	***70***	***8***	***3***	***519***
Median	***64***	***144***	***159***	***33***	***70***	***3***	***0***	***506***

[a] An additional 113 carcasses were sampled, but reach was not identified.

Carcass Distribution and Origin

Summer Chinook carcasses were not evenly distributed among reaches within the Methow River in 2017 (Table 9.20; Figure 9.9). Most of the carcasses were found in the lower three reaches (downstream from Twisp). Few carcasses were observed upstream from Winthrop (Reaches 6 and 7).

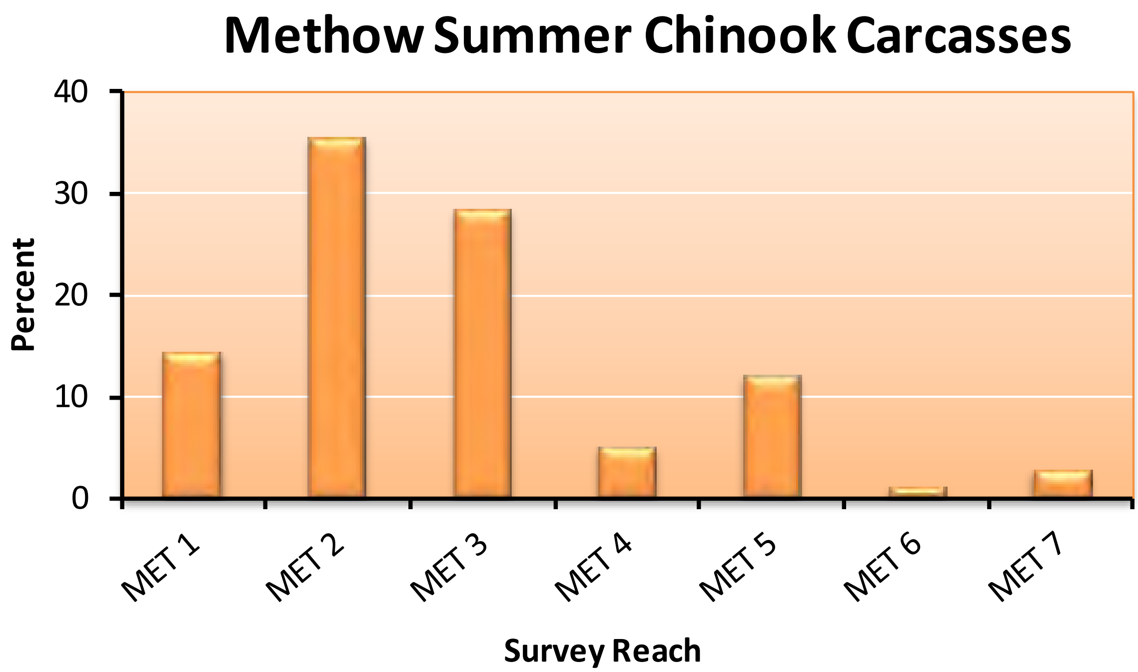


Figure 9.9. Percent of summer Chinook carcasses sampled within different reaches on the Methow River during September through mid-November 2017. Reach codes are described in Table 2.11.

Based on the available data (1991-2017), hatchery and wild summer Chinook carcasses were not distributed equally among the reaches in the Methow River (Table 9.21). A larger percentage of hatchery carcasses occurred in the lower reaches, while a larger percentage of wild summer Chinook carcasses occurred in upstream reaches (Figure 9.10).

Table 9.21. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches on the Methow River, 1991-2017.

Survey year	Origin	Survey reach							Total
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	
1991	Wild	0	12	8	4	2	0	0	**26**
	Hatchery	0	0	0	0	0	0	0	**0**
1992	Wild	8	8	19	0	17	1	0	**53**
	Hatchery	0	0	0	0	0	0	0	**0**
1993	Wild	11	18	9	0	3	0	0	**41**
	Hatchery	8	7	5	2	2	0	0	**24**
1994	Wild	23	18	9	5	10	0	0	**65**
	Hatchery	20	15	11	0	3	0	0	**49**
1995	Wild	7	9	33	7	6	0	0	**62**
	Hatchery	7	24	25	0	1	0	0	**57**
1996	Wild	1	23	35	4	2	0	0	**65**
	Hatchery	5	7	11	1	0	0	0	**24**
1997	Wild	5	8	31	1	17	0	0	**62**
	Hatchery	1	4	7	1	2	1	0	**16**

Survey year	Origin	Survey reach							Total
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	
1998	Wild	42	48	71	11	25	0	0	**197**
	Hatchery	48	36	28	6	5	0	0	**123**
1999	Wild	32	87	130	15	24	4	2	**294**
	Hatchery	15	57	102	17	13	8	0	**212**
2000	Wild	25	85	85	8	83	3	0	**289**
	Hatchery	37	33	20	1	16	2	0	**109**
2001	Wild	62	118	56	10	70	11	1	**328**
	Hatchery	330	157	32	4	6	0	0	**529**
2002	Wild	138	177	380	140	197	34	9	**1,075**
	Hatchery	413	141	138	24	22	0	1	**739**
2003	Wild	33	146	188	76	92	3	0	**538**
	Hatchery	82	122	129	39	36	2	0	**410**
2004	Wild	16	120	155	65	78	1	0	**435**
	Hatchery	24	53	32	17	14	1	1	**142**
2005	Wild	62	99	133	33	107	3	0	**437**
	Hatchery	92	74	49	9	5	0	0	**229**
2006	Wild	52	82	67	44	109	2	1	**357**
	Hatchery	69	66	43	12	35	1	0	**226**
2007	Wild	35	58	59	16	40	0	0	**208**
	Hatchery	107	74	49	11	13	0	0	**254**
2008	Wild	13	62	146	27	52	2	0	**302**
	Hatchery	51	66	51	6	5	1	0	**180**
2009	Wild	45	87	103	27	84	0	0	**346**
	Hatchery	99	71	56	9	10	0	0	**245**
2010	Wild	33	79	101	24	53	5	1	**296**
	Hatchery	72	101	83	14	10	0	0	**280**
2011	Wild	21	56	87	54	56	5	1	**280**
	Hatchery	35	78	114	24	27	0	0	**278**
2012	Wild	59	53	96	58	74	13	7	**360**
	Hatchery	73	101	73	17	8	1	0	**273**
2013	Wild	110	128	178	67	64	7	5	**559**
	Hatchery	186	160	208	23	36	0	0	**613**
2014	Wild	5	10	148	48	140	70	17	**438**
	Hatchery	2	4	27	5	8	3	0	**49**
2015	Wild	169	136	182	50	90	19	25	**671**
	Hatchery	60	58	39	6	5	0	0	**168**
2016	Wild	51	107	126	33	61	1	5	**384**
	Hatchery	32	61	90	11	9	0	0	**203**
2017	Wild	38	97	91	21	43	5	11	**306**
	Hatchery	23	52	29	1	8	0	1	**114**
Average	***Wild***	***41***	***72***	***101***	***31***	***59***	***7***	***3***	***314***

Survey year	Origin	Survey reach							Total
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	
	Hatchery	*70*	*60*	*54*	*10*	*11*	*1*	*0*	*205*
Median	*Wild*	*33*	*79*	*91*	*24*	*56*	*2*	*0*	*302*
	Hatchery	*37*	*58*	*39*	*6*	*8*	*0*	*0*	*180*

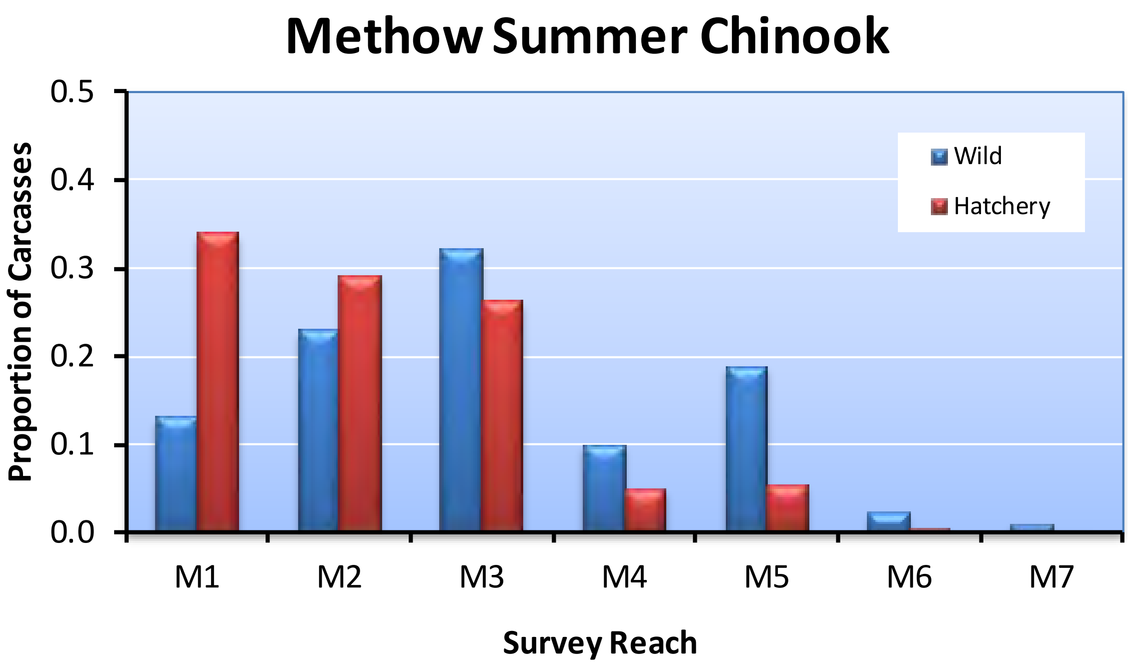


Figure 9.10. Distribution of wild and hatchery produced carcasses in different reaches on the Methow River, 1993-2017. Reach codes are described in Table 2.11.

Sampling Rate

Overall, 30% of the total spawning escapement of summer Chinook in the Methow River basin was sampled in 2017 (Table 9.22). Sampling rates among survey reaches varied from 23 to 82%.

Table 9.22. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Methow River basin, 2017. Reach codes are described in Table 2.11.

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Methow 1 (M1)	108	61	220	0.28
Methow 2 (M2)	172	149	351	0.42
Methow 3 (M3)	246	120	502	0.24
Methow 4 (M4)	46	22	94	0.23
Methow 5 (M5)	100	51	204	0.25
Methow 6 (M6)	3	5	6	0.82

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Methow 7 (M7)	15	12	31	0.39
Total	***690***	***420***	***1,408***	***0.30***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys on the Methow River in 2017 are provided in Table 9.23. The average size of males and females sampled in the Methow River were 66 cm and 69 cm, respectively.

Table 9.23. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female summer Chinook carcasses sampled in different reaches on the Methow River, 2017. Reach codes are described in Table 2.11.

Stream/watershed	Mean length (cm)	
	Male	Female
Methow 1 (M1)	64.7 (11.0)	67.9 (4.2)
Methow 2 (M2)	65.4 (10.0)	69.5 (5.0)
Methow 3 (M3)	67.1 (9.3)	68.5 (5.4)
Methow 4 (M4)	67.8 (11.1)	73.0 (4.7)
Methow 5 (M5)	70.3 (12.0)	69.7 (5.9)
Methow 6 (M6)	67.3 (8.1)	71.0 (4.2)
Methow 7 (M7)	71.4 (10.6)	69.0 (3.2)
Total	***66.3 (10.2)***	***69.2 (5.2)***

9.7 Life History Monitoring

Life history characteristics of Methow summer Chinook were assessed by examining carcasses on spawning grounds and fish collected or examined at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

Migration timing of hatchery and wild Methow/Okanogan summer Chinook was determined from broodstock data collected at Wells Dam. Counting of summer/fall Chinook at Wells Dam occurs from 29 June to 15 November. Broodstock collection at the Dam occurs from early July (week 27) to mid-September (week 37) (see Table 2.1). Based on broodstock sampling in 2017, wild summer Chinook arrived at Wells Dam earlier than hatchery summer Chinook (Table 9.24). This was true throughout most of the migration period. In contrast, there was little difference in migration timing between wild and hatchery summer Chinook when data were pooled for the 2007-2017 survey period.

Table 9.24. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Wells Dam, 2007-2017. The average week is also provided. Migration timing is based on collection of summer Chinook broodstock at Wells Dam.

Survey year	Origin	Methow/Okanogan Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2007	Wild	27	30	34	30	485
	Hatchery	27	30	33	30	433
2008	Wild	28	30	34	30	542
	Hatchery	28	30	36	31	884
2009	Wild	27	29	34	30	585
	Hatchery	27	29	33	29	708
2010	Wild	27	29	33	29	377
	Hatchery	27	29	32	29	801
2011	Wild	30	32	36	32	516
	Hatchery	30	32	35	33	1223
2012	Wild	28	30	34	31	192
	Hatchery	28	31	34	31	591
2013	Wild	27	30	33	30	229
	Hatchery	27	30	33	30	282
2014	Wild	27	31	40	32	316
	Hatchery	27	30	35	30	208
2015	Wild	26	28	30	28	217
	Hatchery	27	28	31	29	164
2016	Wild	26	29	39	30	314
	Hatchery	25	28	34	29	251
2017	Wild	27	30	35	30	228
	Hatchery	28	31	35	31	236
Average	***Wild***	***27***	***30***	***35***	***30***	***364***
	Hatchery	***27***	***30***	***34***	***30***	***526***
Median	***Wild***	***27***	***30***	***34***	***30***	***316***
	Hatchery	***27***	***30***	***34***	***30***	***433***

Age at Maturity

Because hatchery summer Chinook are released after one year of rearing and natural-origin summer Chinook migrate primarily as age-0 fish, total ages will differ between hatchery and natural-origin Chinook (see Hillman et al. 2011). Therefore, in this section, we evaluated age at maturity by comparing differences in salt (ocean) ages between the two groups.

Most of the wild and hatchery summer Chinook sampled during the period 1993-2017 in the Methow River were salt age-3 fish (Table 9.25; Figure 9.11). A higher percentage of salt age-4 wild Chinook returned to the basin than did salt age-4 hatchery Chinook. In contrast, a higher proportion of salt age-1 and 2 hatchery fish returned than did salt age-1 and 2 wild fish. Thus, a higher percentage of wild fish returned at an older age than did hatchery fish.

Table 9.25. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Methow River, 1993-2017.

Sample year	Origin	Salt age						Sample size
		1	2	3	4	5	6	
1993	Wild	0.05	0.08	0.76	0.11	0.00	0.00	38
	Hatchery	0.00	1.00	0.00	0.00	0.00	0.00	20
1994	Wild	0.03	0.26	0.51	0.20	0.00	0.00	101
	Hatchery	0.00	0.07	0.93	0.00	0.00	0.00	111
1995	Wild	0.00	0.09	0.70	0.20	0.00	0.00	54
	Hatchery	0.02	0.04	0.44	0.51	0.00	0.00	55
1996	Wild	0.04	0.30	0.54	0.13	0.00	0.00	56
	Hatchery	0.00	0.05	0.50	0.41	0.05	0.00	22
1997	Wild	0.00	0.22	0.51	0.27	0.00	0.00	55
	Hatchery	0.13	0.06	0.56	0.25	0.00	0.00	16
1998	Wild	0.09	0.38	0.45	0.09	0.00	0.00	188
	Hatchery	0.02	0.52	0.41	0.04	0.00	0.00	123
1999	Wild	0.01	0.51	0.43	0.05	0.00	0.00	252
	Hatchery	0.00	0.07	0.90	0.03	0.00	0.00	210
2000	Wild	0.01	0.09	0.75	0.16	0.00	0.00	257
	Hatchery	0.10	0.16	0.62	0.11	0.00	0.00	97
2001	Wild	0.02	0.20	0.72	0.07	0.00	0.00	292
	Hatchery	0.10	0.60	0.26	0.04	0.00	0.00	526
2002	Wild	0.01	0.17	0.61	0.21	0.00	0.00	1,003
	Hatchery	0.01	0.41	0.57	0.01	0.00	0.00	734
2003	Wild	0.01	0.11	0.50	0.37	0.00	0.00	478
	Hatchery	0.02	0.03	0.90	0.04	0.00	0.00	399
2004	Wild	0.00	0.09	0.35	0.56	0.00	0.00	394
	Hatchery	0.07	0.28	0.30	0.35	0.00	0.00	141
2005	Wild	0.11	0.74	0.14	0.01	0.00	0.00	410
	Hatchery	0.06	0.26	0.65	0.02	0.00	0.00	220
2006	Wild	0.00	0.02	0.33	0.64	0.00	0.00	356
	Hatchery	0.01	0.19	0.50	0.30	0.00	0.00	164
2007	Wild	0.03	0.09	0.24	0.59	0.05	0.00	208
	Hatchery	0.07	0.09	0.75	0.09	0.01	0.00	213
2008	Wild	0.01	0.14	0.71	0.13	0.01	0.00	298
	Hatchery	0.10	0.45	0.30	0.15	0.00	0.00	138
2009	Wild	0.00	0.11	0.41	0.48	0.00	0.00	317
	Hatchery	0.17	0.26	0.53	0.04	0.00	0.00	242

Sample year	Origin	Salt age						Sample size
		1	2	3	4	5	6	
2010	Wild	0.01	0.16	0.59	0.24	0.00	0.00	269
	Hatchery	0.01	0.69	0.29	0.02	0.00	0.00	247
2011	Wild	0.02	0.09	0.60	0.30	0.00	0.00	255
	Hatchery	0.16	0.10	0.74	0.01	0.00	0.00	261
2012	Wild	0.03	0.24	0.53	0.21	0.00	0.00	315
	Hatchery	0.09	0.71	0.16	0.04	0.00	0.00	243
2013	Wild	0.02	0.25	0.62	0.11	0.00	0.00	533
	Hatchery	0.02	0.18	0.79	0.01	0.00	0.00	570
2014	Wild	0.01	0.12	0.69	0.18	0.00	0.00	412
	Hatchery	0.06	0.43	0.47	0.04	0.00	0.00	47
2015	Wild	0.00	0.20	0.45	0.35	0.00	0.00	588
	Hatchery	0.02	0.61	0.35	0.02	0.00	0.00	136
2016	Wild	0.00	0.02	0.77	0.20	0.00	0.00	350
	Hatchery	0.02	0.14	0.84	0.00	0.00	0.00	175
2017	Wild	0.00	0.02	0.24	0.73	0.01	0.00	283
	Hatchery	0.02	0.45	0.36	0.17	0.00	0.00	104
Average	***Wild***	***0.02***	***0.19***	***0.52***	***0.27***	***0.00***	***0.00***	***311***
	Hatchery	***0.05***	***0.32***	***0.57***	***0.06***	***0.00***	***0.00***	***209***
Median	***Wild***	***0.01***	***0.15***	***0.57***	***0.27***	***0.00***	***0.00***	***292***
	Hatchery	***0.04***	***0.27***	***0.63***	***0.06***	***0.00***	***0.00***	***164***

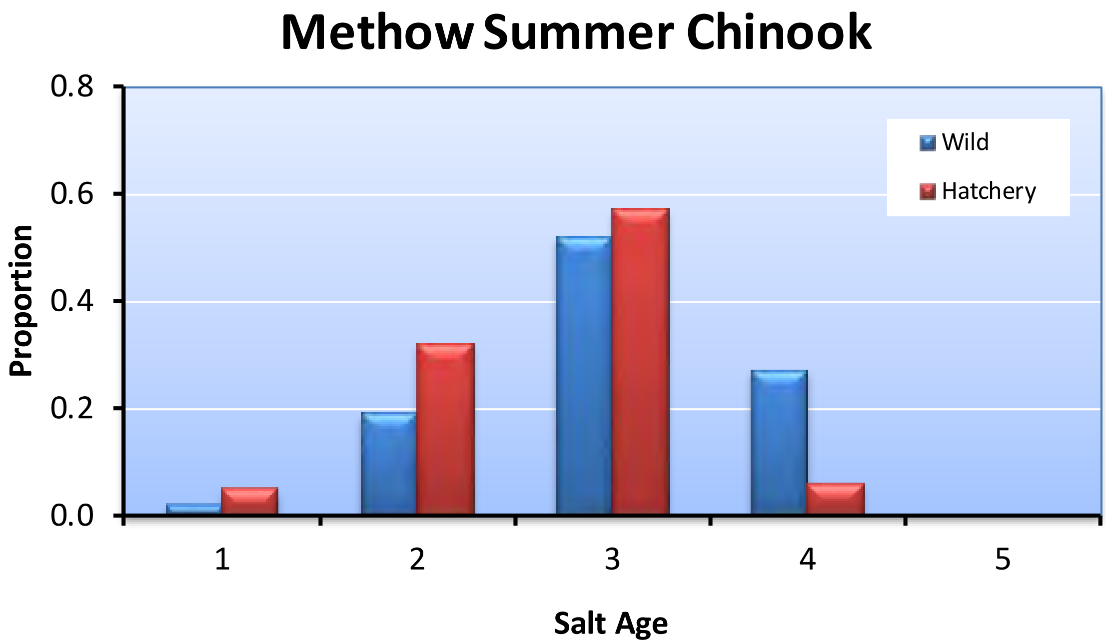


Figure 9.11. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Methow River for the combined years 1993-2017.

Size at Maturity

On average, hatchery summer Chinook were about 5 cm smaller than wild summer Chinook sampled in the Methow River basin (Table 9.26). This is likely because a higher percentage of wild fish returned as salt age-4 fish than did hatchery fish. Future analyses will compare sizes of hatchery and wild fish of the same age groups and sex.

Table 9.26. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Methow River basin, 1993-2017; SD = 1 standard deviation.

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
1993[a]	Wild	41	74	9	51	89
	Hatchery	24	62	8	36	80
1994[a]	Wild	112	69	8	35	87
	Hatchery	114	67	5	43	77
1995	Wild	62	74	6	52	88
	Hatchery	56	73	7	46	85
1996	Wild	64	70	11	34	91
	Hatchery	23	72	7	58	85
1997	Wild	62	76	9	35	90
	Hatchery	16	68	15	33	87
1998	Wild	196	67	10	38	97

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	123	63	10	37	87
1999	Wild	292	66	8	43	99
	Hatchery	212	66	7	26	89
2000	Wild	288	74	8	37	89
	Hatchery	109	68	12	24	87
2001	Wild	328	67	10	29	86
	Hatchery	529	63	10	31	87
2002	Wild	1,075	70	8	37	94
	Hatchery	739	67	9	33	87
2003	Wild	538	71	8	35	88
	Hatchery	410	69	8	35	89
2004	Wild	435	73	7	38	89
	Hatchery	142	65	12	34	85
2005	Wild	437	69	8	45	86
	Hatchery	229	64	9	36	79
2006	Wild	438	73	7	35	92
	Hatchery	149	69	8	38	91
2007	Wild	249	72	11	33	89
	Hatchery	219	69	9	22	84
2008	Wild	384	69	8	30	90
	Hatchery	210	63	15	23	86
2009	Wild	363	71	9	32	88
	Hatchery	228	63	12	30	83
2010	Wild	296	69	8	33	90
	Hatchery	280	62	9	39	81
2011	Wild	280	70	9	31	89
	Hatchery	278	64	11	26	82
2012	Wild	355	68	8	36	85
	Hatchery	273	59	9	21	81
2013	Wild	559	65	9	31	89
	Hatchery	613	66	8	27	83
2014	Wild	438	67	7	31	88
	Hatchery	49	60	10	35	76
2015	Wild	588	66	8	38	87
	Hatchery	136	59	8	38	79
2016	Wild	384	68	6	46	84
	Hatchery	203	66	7	37	83
2017	Wild	306	70	7	47	88

Survey year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	114	63	8	30	78
Pooled	***Wild***	***8,570***	***70***	***8***	***37***	***89***
	Hatchery	***5,478***	***65***	***9***	***34***	***84***

[a] These years include sizes reported in annual reports. The data contained in the WDFW database do not include all these data.

Contribution to Fisheries

Most of the harvest on hatchery-origin Methow summer Chinook occurred in the Ocean (Table 9.27). Ocean harvest has made up 13% to 99% of all hatchery-origin Methow summer Chinook harvested. Brood year 2011 provided the largest harvest, while brood years 1996 and 1999 provided the lowest.

Table 9.27. Estimated number and percent (in parentheses) of hatchery-origin Methow summer Chinook captured in different fisheries, brood years 1989-2011.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1989	1,043 (52)	884 (44)	0 (0)	66 (3)	1,993	58.9
1990	55 (57)	41 (43)	0 (0)	0 (0)	96	25.4
1991	12 (20)	49 (80)	0 (0)	0 (0)	61	32.8
1992	17 (55)	14 (45)	0 (0)	0 (0)	31	22.3
1993	29 (58)	17 (34)	4 (8)	0 (0)	50	37.9
1994	153 (81)	34 (18)	1 (1)	1 (1)	189	26.4
1995	77 (99)	0 (0)	1 (1)	0 (0)	78	33.6
1996	12 (92)	1 (8)	0 (0)	0 (0)	13	17.6
1997	215 (88)	7 (3)	0 (0)	21 (9)	243	37.6
1998	1,765 (83)	101 (5)	14 (1)	234 (11)	2,114	54.8
1999	2 (13)	13 (87)	0 (0)	0 (0)	15	45.5
2000	366 (71)	88 (17)	27 (5)	33 (6)	514	66.7
2001	326 (52)	97 (15)	43 (7)	160 (26)	626	67.0
2002	271 (48)	96 (17)	61 (11)	137 (24)	565	62.9
2003	58 (58)	17 (17)	7 (7)	18 (18)	100	43.1
2004	133 (49)	55 (20)	16 (6)	68 (25)	272	54.5
2005	298 (54)	137 (25)	50 (9)	65 (12)	550	57.2
2006	1,128 (48)	811 (34)	100 (4)	314 (13)	2,353	62.0
2007	205 (56)	94 (25)	16 (4)	54 (15)	369	72.8
2008	1,231 (48)	531 (21)	65 (3)	716 (28)	2,543	56.6
2009	318 (39)	258 (32)	28 (3)	209 (26)	813	75.6
2010	530 (43)	481 (39)	26 (2)	207 (17)	1,244	69.9
2011	1,578 (46)	988 (29)	136 (4)	725 (21)	3,427	72.5

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of the brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
Average	***427 (57)***	***209 (29)***	***26 (3)***	***132 (11)***	***794***	***50.2***
Median	***215 (54)***	***88 (25)***	***14 (3)***	***54 (11)***	***369***	***54.8***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Methow River basin. Targets for strays based on return year (recovery year) within the Upper Columbia River basin (Priest Rapids Dam to Chief Joseph Dam) should be less than 10% and targets for strays outside the upper Columbia River should be less than 5%.

Within the Upper Columbia summer Chinook population, few hatchery-origin Methow summer Chinook have strayed into basins outside the Methow (Table 9.28). Although hatchery-origin Methow summer Chinook have strayed into the Wenatchee River basin, Okanogan River basin, Entiat River basin, Chelan tailrace, and Hanford Reach, on average, they have made up less than 1% of the spawning escapements within those areas.

Hatchery-origin Methow summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged hatchery summer Chinook from the Methow have been detected in Noble Creek in the Coos River watershed, at Big Canyon Trap (for the Wallowa Hatchery), and at Spring Creek, Lyons Ferry, and Marblemount hatcheries. However, from 1994-present, less than three Methow summer Chinook have strayed into each of these locations.

Table 9.28. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Methow summer Chinook, return years 1994-2016. For example, for return year 2002, 0.4% of the summer Chinook escapement in the Okanogan River basin consisted of hatchery-origin Methow summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
1994	0	0.0	72	1.8	-	-	-	-	-	-
1995	0	0.0	9	0.3	-	-	-	-	-	-
1996	0	0.0	0	0.0	-	-	-	-	-	-
1997	0	0.0	0	0.0	-	-	-	-	-	-
1998	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	9	0.2	0	0.0	0	0.0	7	0.0
2000	0	0.0	3	0.1	0	0.0	0	0.0	0	0.0
2001	0	0.0	0	0.0	0	0.0	0	0.0	7	0.0
2002	0	0.0	54	0.4	0	0.0	0	0.0	0	0.0
2003	0	0.0	1	0.0	6	1.4	0	0.0	0	0.0
2004	0	0.0	7	0.1	3	0.7	0	0.0	0	0.0
2005	0	0.0	24	0.3	0	0.0	0	0.0	0	0.0
2006	0	0.0	12	0.1	0	0.0	0	0.0	0	0.0

Return year	Wenatchee		Okanogan		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
2007	0	0.0	17	0.4	2	1.1	3	2.1	0	0.0
2008	0	0.0	12	0.2	0	0.0	0	0.0	0	0.0
2009	0	0.0	14	0.2	0	0.0	0	0.0	0	0.0
2010	6	0.1	44	0.7	22	2.0	0	0.0	0	0.0
2011	0	0.0	45	0.5	8	0.6	0	0.0	0	0.0
2012	0	0.0	31	0.4	0	0.0	0	0.0	0	0.0
2013	0	0.0	10	0.1	0	0.0	0	0.0	0	0.0
2014	0	0.0	15	0.1	0	0.0	0	0.0	0	0.0
2015	0	0.0	40	0.3	4	0.3	0	0.0	0	0.0
2016	0	0.0	20	0.2	0	0.0	0	0.0	0	0.0
Average	***0***	***0.0***	***19***	***0.3***	***2***	***0.3***	***0***	***0.1***	***1***	***0.0***
Median	***0***	***0.0***	***12***	***0.2***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 3.5% of the hatchery-origin Methow summer Chinook spawners strayed into non-target streams (Table 9.29). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-12%. In addition, on average, about 5% of hatchery-origin Methow summer Chinook broodstock have been included in non-target hatchery programs.

Table 9.29. Number and percent of hatchery-origin Methow summer Chinook spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1989-2011.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1989	773	55.7	81	5.8	459	33.0	76	5.5
1990	199	70.6	0	0.0	81	28.7	2	0.7
1991	82	65.6	0	0.0	43	34.4	0	0.0
1992	68	63.0	0	0.0	40	37.0	0	0.0
1993	54	65.9	6	7.3	22	26.8	0	0.0
1994	419	79.7	13	2.5	94	17.9	0	0.0
1995	126	81.8	0	0.0	28	18.2	0	0.0
1996	57	93.4	0	0.0	4	6.6	0	0.0
1997	379	93.8	18	4.5	7	1.7	0	0.0
1998	1,653	94.7	60	3.4	32	1.8	0	0.0
1999	18	100.0	0	0.0	0	0.0	0	0.0
2000	239	93.0	14	5.4	4	1.6	0	0.0

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
2001	272	88.3	29	9.4	6	1.9	1	0.3
2002	315	94.6	14	4.2	4	1.2	0	0.0
2003	131	99.2	0	0.0	1	0.8	0	0.0
2004	194	85.5	27	11.9	6	2.6	0	0.0
2005	373	90.5	23	5.6	13	3.2	3	0.7
2006	1,317	91.3	109	7.6	15	1.0	2	0.1
2007	134	97.1	0	0.0	2	1.4	2	1.4
2008	1,886	96.8	25	1.3	15	0.8	23	1.2
2009	182	69.2	0	0.0	14	5.3	67	25.5
2010	223	41.7	42	7.9	9	1.7	261	48.8
2011	775	59.7	47	3.6	79	6.1	398	30.6
Average	***429***	***81.4***	***22***	***3.5***	***43***	***10.2***	***36***	***5.0***
Median	***223***	***88.3***	***14***	***3.4***	***14***	***2.6***	***0***	***0.0***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Methow River basin.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Methow River basin.

[3] Target hatchery includes broodstock collection at Wells Dam.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Methow summer Chinook hatchery program.

Genetics

Genetic studies were conducted to investigate relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin (Kassler et al. 2011; the entire report is appended as Appendix N). A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin. Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River basin (N = 139) and compared to collections of hatchery and natural-origin Chinook from 2006 and 2008 (N = 380). Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to supplementation collections from 2006 and 2008 (N = 362). Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with supplementation collections from 2006 and 2008 (N = 669). A collection of natural-origin summer Chinook from the Chelan River was also analyzed (N = 70). Additionally, hatchery collections from Eastbank Hatchery (Wenatchee and Methow/Okanogan stock; N = 221) and Wells Hatchery (N = 294) were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River (N = 190) were used for comparison. Lastly, data from eight collections of fall Chinook (N = 2,408) were compared to the collections of summer Chinook. Samples of natural and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation programs have affected the genetic structure of these populations. The study also calculated the effective number of breeders for collection locations of natural and hatchery-origin summer Chinook from 1993 and 2008.

In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

It is important to note that no new information will be reported on genetics until the next five-year report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1993-2003, the PNI values were generally less than 0.67 (Table 9.30). However, since brood year 2003, PNI has generally been greater than 0.67; brood year 2016 had a PNI value of 0.75.

Table 9.30. Proportionate Natural Influence (PNI) values for the Methow summer Chinook supplementation program for brood years 1989-2016. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	492	0	0.00	1,297	312	0.81	1.00
1990	1,421	0	0.00	828	206	0.80	1.00
1991	566	0	0.00	924	314	0.75	1.00
1992	460	0	0.00	297	406	0.42	1.00
1993	314	194	0.38	681	388	0.64	0.64
1994	596	489	0.45	341	244	0.58	0.58
1995	596	618	0.51	173	240	0.42	0.47
1996	435	180	0.29	287	155	0.65	0.70
1997	529	168	0.24	197	265	0.43	0.66
1998	436	239	0.35	153	211	0.42	0.56
1999	573	413	0.42	224	289	0.44	0.53
2000	861	339	0.28	164	337	0.33	0.56
2001	1,122	1,646	0.59	12	345	0.03	0.09
2002	2,572	2,058	0.44	247	241	0.51	0.55
2003	2,307	1,623	0.41	381	101	0.79	0.67
2004	1,622	567	0.26	506	16	0.97	0.79
2005	1,672	889	0.35	391	9	0.98	0.74
2006	1,675	1,058	0.39	500	10	0.98	0.72
2007	660	704	0.52	456	17	0.96	0.66
2008	1,194	753	0.39	359	86	0.81	0.68
2009	1,042	716	0.41	503	4	0.99	0.72
2010	1,326	1,166	0.47	484	8	0.98	0.68
2011	1,503	1,414	0.48	467	26	0.95	0.67
2012	1,593	1,354	0.46	98	1	0.99	0.69
2013	1,693	1,890	0.53	97	4	0.96	0.65
2014	1,451	174	0.11	96	0	1.00	0.90
2015	3,138	814	0.21	97	1	0.99	0.83
2016	1,464	777	0.35	103	0	1.00	0.75
Average	***1,190***	***723***	***0.33***	***370***	***151***	***0.73***	***0.70***
Median	***1,158***	***661***	***0.38***	***319***	***128***	***0.80***	***0.68***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel time (arithmetic mean days) of hatchery summer Chinook from the Methow River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 9.31).[41] Over the six brood years for which PIT-tagged hatchery fish were released, survival rates from the Methow River to McNary Dam ranged from 0.485 to 0.775; SARs from release to detection at Bonneville Dam ranged from 0.001 to 0.016. Average travel time from the Methow River to McNary Dam ranged from 17 to 55 days.

Table 9.31. Total number of Methow hatchery summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2008-2015. Standard errors are shown in parentheses. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2008	10,094	0.747 (0.055)	39.1 (13.0)	0.016 (0.001)
2009	5,020	0.485 (0.037)	30.2 (11.1)	0.002 (0.001)
2010	0	--	--	--
2011	0	--	--	--
2012	9,801	0.545 (0.046)	17.0 (8.1)	0.001 (0.000)
2013	9,825	0.558 (0.101)	54.5 (8.3)	0.003 (0.001)
2014	4,992	0.624 (0.053)	24.5 (8.1)	NA
2015	5,064	0.775 (0.088)	23.8 (9.8)	NA

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on a brood year harvest rates from the hatchery program. For brood years 1989-2010, NRR for summer Chinook in the Methow averaged 1.11 (range, 0.09-4.90) if harvested fish were not included in the estimate and 2.20 (range, 0.16-9.78) if harvested fish were included in the estimate (Table 9.32). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should

[41] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

be greater than the NRRs and greater than or equal to 3.0 (the calculated target value in Hillman et al. 2017). The target value of 3.0 includes harvest. HRRs exceeded NRRs in 14 out of the 22 years of data, regardless if harvest was or was not included in the estimate (Table 9.32). Hatchery replacement rates for Methow summer Chinook have exceeded the estimated target value of 3.0 in 11 of the 22 years of data.

Table 9.32. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for wild summer Chinook in the Methow River basin, brood years 1989-2010.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	202	492	1,389	631	6.88	1.28	3,382	1,532	16.74	3.11
1990	202	1,421	282	978	1.40	0.69	378	1,318	1.87	0.93
1991	266	566	125	287	0.47	0.51	186	429	0.70	0.76
1992	214	460	108	614	0.50	1.33	139	792	0.65	1.72
1993	234	508	82	430	0.35	0.85	132	701	0.56	1.38
1994	260	1,085	526	542	2.02	0.50	715	738	2.75	0.68
1995	242	1,214	154	1,201	0.64	0.99	232	1,809	0.96	1.49
1996	220	615	61	445	0.28	0.72	74	541	0.34	0.88
1997	209	697	404	1,493	1.93	2.14	651	2,315	3.11	3.32
1998	235	675	1,745	3,307	7.43	4.90	3,846	6,601	16.37	9.78
1999	222	986	18	2,862	0.08	2.90	33	5,251	0.15	5.33
2000	222	1,200	257	800	1.16	0.67	771	2,286	3.47	1.91
2001	223	2,768	308	2,574	1.38	0.93	934	6,435	4.19	2.32
2002	222	4,630	333	924	1.50	0.20	898	2,504	4.05	0.54
2003	224	3,930	132	352	0.59	0.09	232	619	1.04	0.16
2004	223	2,189	227	1,540	1.02	0.70	499	3,392	2.24	1.55
2005	225	2,561	412	1,120	1.83	0.44	963	2,489	4.28	0.97
2006	236	2,733	1,441	1,706	6.11	0.62	3,794	3,842	16.08	1.41
2007	209	1,364	136	1,509	0.65	1.11	480	3,992	2.30	2.93
2008	184	1,947	1,929	1,501	10.48	0.77	4,308	2,575	23.41	1.32
2009	223	1,758	199	1,542	0.89	0.88	957	4,047	4.29	2.30
2010	210	2,492	230	2,719	1.10	1.09	1,281	8,857	6.10	3.55
Average	***223***	***1,650***	***477***	***1,322***	***2.21***	***1.11***	***1,131***	***2,867***	***5.26***	***2.20***
Median	***223***	***1,289***	***244***	***1,161***	***1.13***	***0.81***	***683***	***2,402***	***2.93***	***1.52***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns. For the available brood years, SARs have ranged from 0.00008 to 0.01888 for hatchery summer Chinook in the Methow River basin (Table 9.33).

Table 9.33. Smolt-to-adult ratios (SARs) for Methow summer Chinook, brood years 1989-2011.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	358,237	2,871	0.00801
1990	371,483	361	0.00097
1991	377,097	130	0.00034
1992	392,636	138	0.00035
1993	200,345	62	0.00031
1994	400,488	710	0.00177
1995	344,974	229	0.00066
1996	289,880	73	0.00025
1997	380,430	643	0.00169
1998	202,559	3,825	0.01888
1999	422,473	33	0.00008
2000	334,337	770	0.00230
2001	246,159	930	0.00378
2002	310,846	895	0.00288
2003	353,495	232	0.00066
2004	394,490	496	0.00126
2005	262,496	961	0.00366
2006	417,795	3,788	0.00907
2007	426,188	506	0.00119
2008	373,234	4,260	0.01141
2009	450,237	1,071	0.00238
2010	428,458	1,758	0.00410
2011	424,124	4,643	0.01095
Average	***354,890***	***1,278***	***0.00378***
Median	***373,234***	***710***	***0.00177***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

9.8 ESA/HCP Compliance

Broodstock Collection

Summer Chinook adults collected at Wells Dam are used primarily for the Methow supplementation programs. On an as needed basis, adults collected at Wells Dam may be used to augment adult collections for the Okanogan summer Chinook supplementation program. Per the 2015 broodstock collection protocol, 98 natural-origin (adipose fin present) adults were targeted for collection between 1 July and 15 September at the West Ladder of Wells Dam for the Methow summer Chinook program. Actual collections occurred between 3 July and 13 September and totaled 98 summer Chinook. ESA Permit 1347 provides authorization to collect Methow and Okanogan summer Chinook at Wells Dam three days per week and up to 16 hours per day from July through November. During 2015, broodstock collection activities were accomplished within the allowable trapping days authorized under ESA Permit 1347.

Collection of Methow summer Chinook broodstock at Wells Dam occurred concurrently with collection of summer steelhead for the Wells steelhead program authorized under ESA Section 10 Permit 1395. Encounters with steelhead and spring Chinook during Methow summer Chinook broodstock collections did not result in takes that were outside those authorized in Permit 1347 and in Permit 1395 for the Wells Steelhead program. Steelhead encountered during summer Chinook collections that were not required for steelhead broodstock were passed at the trap site and were not physically handled. Any spring Chinook encountered during summer Chinook broodstock activities were also passed without handling. No Chinook were collected at Wells Dam for the 2015 Okanogan summer Chinook program.

Hatchery Rearing and Release

The 2015 brood Methow summer Chinook reared throughout their juvenile life-stages at Eastbank Fish Hatchery and the Carlton Acclimation Pond without incident (see Section 9.2). The 2015 brood smolt release totaled 177,762 summer Chinook, representing 88.9% of the 200,000-production objective and was compliant with the 10% overage allowable in ESA Section 10 Permit 1347. Lower than anticipated fecundity (90.7% of the biological assumption used in the 2015 broodstock collection protocols) and lower than expected fertilization rates (89.1%) were the largest factors in not meeting the full program.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18120, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or at the Carton Acclimation Facility during the period 1 January through 31 December 2017. NPDES monitoring and reporting for PUD Hatchery Programs during 2017 are provided in Appendix F.

Spawning Surveys

Summer Chinook spawning ground surveys conducted in the Methow River basin during 2017 were consistent with ESA Section 10 Permit No. 1347. Because of the difficulty of quantifying the level of take associated with spawning ground surveys, the Permit does not specify a take level associated with these activities, even though it does authorize implementation of spawning ground surveys. Therefore, no take levels are reported. However, to minimize potential effects to established redds, wading was restricted to the extent practical, and extreme caution was used to avoid established redds when wading was required.

SECTION 10: OKANOGAN/SIMILKAMEEN SUMMER CHINOOK

The goal of summer Chinook salmon supplementation in the Okanogan Basin is to use artificial production to replace adult production lost because of mortality at Wells, Rocky Reach, and Rock Island dams, while not reducing the natural production or long-term fitness of summer Chinook in the basin. The Rock Island Fish Hatchery Complex began operation in 1989 under funding from Chelan PUD. The Complex operated originally through the Rock Island Settlement Agreement, but since 2004 has operated under the Anadromous Fish Agreement and Habitat Conservation Plans.

Before 2012, adult summer Chinook were collected for broodstock from the run-at-large at Wells Dam. Since then, the Colville Tribes collect broodstock using purse seines in the Okanogan and Columbia rivers. The goal was to collect up to 334 adult summer Chinook for the Okanogan program. Broodstock collection occurred from about 7 July through 15 September with trapping occurring no more than 16 hours per day, three days a week. If natural-origin broodstock collection fell short of expectation, hatchery-origin adults could be collected to make up the difference.

Before 2012, adult summer Chinook were spawned and reared at Eastbank Fish Hatchery. Juvenile summer Chinook were transferred from the hatchery to Similkameen Acclimation Pond in October. In addition, since 2005, about 20% (100,000) of the juveniles were transferred to Bonaparte Pond. Chinook were released from the ponds in April to early May.

Prior to 2012, the production goal for the Okanogan summer Chinook supplementation program was to release 576,000 yearling smolts into the Similkameen and Okanogan rivers at ten fish per pound. Beginning with the 2012 brood, the revised production goal is to release 166,569 yearling smolts into the rivers. Targets for fork length and weight are 176 mm (CV = 9.0) and 45.4 g, respectively. Over 90% of these fish are marked with CWTs. In addition, since 2009, juvenile summer Chinook have been PIT tagged annually.

The Colville Tribes began monitoring the Okanogan/Similkameen summer Chinook program in 2013. Their monitoring results are published in annual reports to Bonneville Power Administration (BPA). The purpose of retaining this section is to provide readers with monitoring data collected with Chelan PUD funding through brood year 2012. Thus, this section tracks the status and life histories of summer Chinook up to and including brood year 2012. Results from monitoring brood year 2013 and beyond will be included in annual reports to BPA.

10.1 Broodstock Sampling

Summer Chinook broodstock for the Okanogan/Similkameen and Methow programs were typically collected at the East and West Ladders of Wells Dam. In 2012, purse seines were used to collect broodstock at the mouth of the Okanogan River. In 2012, a total of 81 summer Chinook (79 wild Chinook and two hatchery Chinook)[42] were spawned for the Okanogan program. Refer

[42] It is important to point out that some summer Chinook were used for both the Methow and Okanogan programs in 2012 because of the availability of ripe adults at the time of spawning. In addition, some eyed-eggs were split between the two programs

to Section 9.1 for information on the origin, age and length, sex ratios, and fecundity of summer Chinook broodstock collected at Wells Dam before 2013.

10.2 Hatchery Rearing

In this section, we describe the hatchery rearing of the Okanogan summer Chinook program through brood year 2012. The Colville Tribes began operating the program in 2013. Information on rearing history since brood year 2012 can be found in annual reports prepared by the Colville Tribes and submitted to BPA.

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release survival standard of 81%, a total of 711,111 eggs were required to meet the program release goal of 576,000 smolts through the 2011 brood year. An evaluation of the program in 2012 determined that 205,134 eggs were needed to meet the revised release goal of 166,569 smolts. This revised goal began with brood year 2012. From 1989 through 2012, the egg take goal was reached in 13 of those years (Table 10.1).

Table 10.1. Numbers of eggs taken from summer Chinook broodstock for the Okanogan program during 1989-2012. From 1989-2011, broodstock were collected at Wells Dam. In 2012, broodstock were collected in purse seines in the Okanogan River.

Return year	Number of eggs taken
1989	724,200
1990	696,144
1991	879,892
1992	729,389
1993	797,234
1994	893,086
1995	736,500
1996	672,000
1997	601,744
1998	584,018
1999	725,589
2000	645,403
2001	418,907
2002	718,599
2003	710,521
2004	805,814
2005	452,928
2006	757,350
2007	824,703
2008	662,668
2009	840,902
2010	726,979

Return year	Number of eggs taken
2011	683,419
Average (1989-2011)	***708,173***
Median (1989-2011)	***724,200***
2012	201,295
Average (2012)	***201,295***
Median (2012)	***201,295***

Number of acclimation days

Summer Chinook were released volitionally from Similkameen Pond as yearling smolts. Transfer dates, release dates, and the number of acclimation days for Okanogan summer Chinook are shown in Table 10.2.

Table 10.2. Number of days Okanogan summer Chinook broods were acclimated at Similkameen and Bonaparte ponds, brood years 1989-2012.

Brood year	Release year	Rearing facility	Transfer date	Release date	Number of days
1989	1991	Similkameen	29-Oct	7-May	190
1990	1992	Similkameen	5-Nov	25-Apr	171
1991	1993	Similkameen	1-Nov	9-Apr	159
1992	1994	Similkameen	2-Nov	1-Apr	150
			26-Feb	1-Apr	34
1993	1995	Similkameen	24-Oct	1-Apr	159
			24-Feb	1-Apr	36
1994	1996	Similkameen	30-Oct	6-Apr	158
			14-Mar	6-Apr	23
1995	1997	Similkameen	1-Oct	1-Apr	182
1996	1998	Similkameen	10-Oct	15-Mar	156
1997	1999	Similkameen	7-Oct	19-Apr	194
1998	2000	Similkameen	5-Oct	19-Apr	196
1999	2001	Similkameen	5-Oct	18-Apr	195
2000	2002	Similkameen	10-Oct	8-Apr	180
2001	2003	Similkameen	1-Oct	29-Apr	210
2002	2004	Similkameen	9-Nov	23-Apr	165
2003	2005	Similkameen	19-Oct	28-Apr	191
2004	2006	Similkameen	26-Oct	23-Apr	179
2005	2007	Bonaparte	6-Nov	11-Apr	156
		Similkameen	25-Oct	18-Apr – 9-May	179-200

Brood year	Release year	Rearing facility	Transfer date	Release date	Number of days
2006	2008	Similkameen	15-17-Oct	16-Apr – 7-May	182-205
2007	2009	Bonaparte	3-4-Nov	10-22-Apr	157-170
		Similkameen	20-24-Oct	14-Apr – 9-May	172-201
2008	2010	Bonaparte	2-4-Nov	19-Apr – 5-May	167-185
		Similkameen	26-28-Oct	19-Apr – 14-May	176-201
2009	2011	Bonaparte	8-9-Nov	12-Apr	155-156
		Similkameen	25-27-Oct	13-Apr – 5-May	169-193
2010	2012	Bonaparte	No program	No program	No program
		Similkameen	25-27 Oct	16-Apr – 7-May	173-196
2011	2013	Bonaparte	No program	No program	No program
		Similkameen	23-26 Oct	16-Apr – 8-May	175-197
2012	2014	Bonaparte	No program	No program	No program
		Similkameen	28-30 Oct	15 Apr – 5 May	167-189

Release Information

Numbers released

The 2012 Okanogan summer Chinook program achieved 68.4% of the 166,569 target goal with about 114,000 fish being released volitionally into the Similkameen River (Table 10.3).

Table 10.3. Numbers of Okanogan summer Chinook smolts released from the Similkameen and Bonaparte ponds, brood years 1989-2012; NA = not available. For brood years 1998-2012, the release target was 576,000 smolts. Since brood year 2013, the release target for Okanogan summer Chinook is 114,000 smolts.

Brood year	Release year	Rearing facility	CWT mark rate	Number of smolts released
1989	1991	Similkameen	0.5732	352,600
1990	1992	Similkameen	0.6800	540,000
1991	1993	Similkameen	0.5335	675,500
1992	1994	Similkameen	0.9819	548,182
1993	1995	Similkameen	0.6470	586,000
1994	1996	Similkameen	0.4176	536,299
1995	1997	Similkameen	0.9785	587,000
1996	1998	Similkameen	0.9769	507,913
1997	1999	Similkameen	0.9711	589,591
1998	2000	Similkameen	0.9825	293,191
1999	2001	Similkameen	0.9689	630,463
2000	2002	Similkameen	0.9928	532,453
2001	2003	Similkameen	0.9877	26,642

Brood year	Release year	Rearing facility	CWT mark rate	Number of smolts released
2002	2004	Similkameen	0.9204	388,589
2003	2005	Similkameen	0.9929	579,019
2004	2006	Similkameen	0.9425	703,359
2005	2007	Bonaparte	0	0 (assumed)
		Similkameen	0.9862	275,919
2006	2008	Similkameen	0.9878	604,035
2007	2009	Bonaparte	0.9920	102,099
		Similkameen	0.9914	513,039
2008	2010	Bonaparte	0.9947	175,729
		Similkameen	0.9947	343,628
2009	2011	Bonaparte	0.9981	151,382
		Similkameen	0.9953	524,521
2010	2012	Similkameen	0.9886	617,950
2011	2013	Similkameen	0.9956	627,978
Average (1989-2011)		***Bonaparte***	***0.7462***	***143,070***
		Similkameen	***0.8907***	***503,647***
Median (1989-2011)		***Bonaparte***	***0.9819***	***540,000***
		Similkameen	***0.9934***	***151,382***
2012	2014	Bonaparte	No program	No program
		Similkameen	0.9939	114,000
Average (2012-present)		***Bonaparte***	***No program***	***No program***
		Similkameen	***0.9939***	***114,000***
Median (2012-present)		***Bonaparte***	***No program***	***No program***
		Similkameen	***0.9939***	***114,000***

Numbers tagged

The 2012 brood Okanogan summer Chinook from the Similkameen facility were 99.4% CWT and adipose fin-clipped (Table 10.3). Table 10.4 summarizes the number of hatchery summer Chinook that have been PIT-tagged and released into the Okanogan River basin. No fish from the 2012 brood year were PIT tagged.

Table 10.4. Summary of PIT-tagging activities for Okanogan hatchery summer Chinook, brood years 2008-2011.

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2008	2010	5,700 (high density)	1,169	0	4,531
		5,700 (low density)	1,407	0	4,293
2009	2011	5,100	11	0	5,089
2010	2012	0	0	0	0

Brood year	Release year	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2011	2013	5,100	64	0	5,036

Fish size and condition at release

Size at release of the Similkameen population was 73.3% and 56.8% of the fork length and weight targets, respectively. The CV for fork length exceeded the target by 18.9% (Table 10.5). There was no Bonaparte program for the 2014 release year.

Table 10.5. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Okanogan summer Chinook smolts released from the hatchery, brood years 1989-2012. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1989	1991	-	-	41.3	11
1990	1992	143	9.5	37.8	12
1991	1993	125	15.5	22.4	20
1992	1994	120	15.4	20.7	22
1993	1995	132	-	23.2	20
1994	1996	136	16.0	29.6	15
1995	1997	137	8.2	32.8	14
1996	1998	127	12.8	26.2	17
1997	1999	144	9.9	36.0	13
1998	2000	148	5.9	41.0	11
1999	2001	141	15.7	35.4	13
2000	2002	121	13.4	20.4	22
2001	2003	132	8.2	25.7	18
2002	2004	119	13.4	20.8	22
2003	2005	133	10.6	28.9	16
2004	2006	132	9.9	29.8	15
2005	2007	132	9.6	25.9	18
2006	2008	120	12.3	20.9	22
2007	2009	124	12.6	21.9	21
2008	2010	140	12.3	35.1	13
2009	2011	132	11.6	24.7	18
2010	2012	125	10.1	23.2	20
2011	2013	132	9.5	27.9	16
2012	2014	129	7.3	25.8	18
Average		***131***	***11.4***	***28.2***	***17***
Median		***132***	***11.1***	***26.1***	***18***
Targets		***176***	***9.0***	***45.4***	***10***

Survival Estimates

Overall survival of Okanogan summer Chinook from green (unfertilized) egg to release was above the standard set for the program (Table 10.6). Low survival can be attributed to high mortality after ponding through release because of external fungus. Currently, it is unknown if gamete viability is sex biased or is uniform between sexes and more influenced by between-year environmental variations.

Table 10.6. Hatchery life-stage survival rates (%) for Okanogan summer Chinook, brood years 1989-2012. Survival standards or targets are provided in the last row of the table.

Brood year	Rearing facility	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
		Female	Male							
1989[a]	Similkameen	89.8	99.5	89.9	96.7	99.7	99.4	73.3	57.4	48.7
1990[a]	Similkameen	93.9	99.0	84.9	97.1	81.2	80.6	97.7	98.6	77.6
1991[a]	Similkameen	93.1	95.5	88.2	97.1	99.4	99.1	98.4	97.1	76.8
1992[a]	Similkameen	96.9	99.0	87.0	98.0	99.9	99.9	91.7	92.6	75.2
1993[a]	Similkameen	82.2	99.4	85.4	97.6	99.8	99.5	92.0	90.2	73.5
1994	Similkameen	96.1	90.0	86.6	100.0	98.1	97.4	73.1	89.8	60.1
1995	Similkameen	91.9	96.2	98.2	84.1	96.5	96.2	92.7	98.2	79.7
1996	Similkameen	95.4	98.1	83.2	100.0	97.7	96.9	86.5	92.5	75.6
1997	Similkameen	91.9	94.6	86.1	98.4	98.7	98.3	98.8	99.4	98.0
1998	Similkameen	84.0	96.2	54.1	98.0	99.4	98.9	96.6	99.6	50.2
1999	Similkameen	98.8	98.7	92.9	96.9	98.0	97.6	96.9	99.0	86.9
2000	Similkameen	90.5	96.9	89.2	98.5	98.2	98.0	93.6	97.2	82.5
2001	Similkameen	96.2	92.3	89.1	97.6	99.7	99.5	7.4	11.9	6.4
2002	Similkameen	97.1	98.1	89.8	98.0	99.7	99.5	51.6	52.2	54.1
2003	Similkameen	96.7	97.5	86.8	97.6	99.3	98.5	98.0	98.8	81.5
2004	Similkameen	93.6	98.2	84.0	97.6	99.6	99.3	97.8	98.8	80.2
	Bonaparte	93.6	98.2	84.0	97.6	99.6	99.3	97.9	98.9	80.3
2005	Similkameen	97.0	89.6	88.0	99.5	99.5	99.0	93.5	94.6	81.8
	Bonaparte	97.0	89.6	88.0	99.5	99.5	99.0	0.0	0.0	0.0
2006	Similkameen	92.9	89.5	86.3	98.3	99.6	99.3	94.1	95.5	79.8
2007	Similkameen	92.6	99.6	80.8	99.1	99.5	99.1	97.0	98.1	77.7
	Bonaparte	92.6	99.6	80.8	99.1	99.5	99.1	95.6	96.7	76.6
2008	Similkameen	97.9	99.6	91.2	96.8	99.7	99.3	89.8	90.5	79.3
	Bonaparte	97.9	99.6	91.2	96.8	99.7	99.3	86.9	87.8	76.7
2009[b]	Similkameen	93.6	93.5	91.0	98.2	99.7	99.5	97.8	98.6	87.4
	Bonaparte	93.6	93.5	91.0	98.2	99.7	99.5	74.8	75.3	66.8
2010	Similkameen	96.5	100.0	91.2	99.9	97.4	97.1	93.3	96.3	85.0
2011	Similkameen	100.0	90.2	95.9	98.3	99.8	99.1	97.8	98.8	92.2
2012	Similkameen	100.0	100.0	85.1	98.6	99.7	99.3	70.6	71.2	59.3
Mean	***Similkameen***	***94.1***	***96.3***	***86.9***	***97.6***	***98.3***	***97.9***	***86.7***	***88.2***	***72.9***
	Bonaparte	***94.9***	***96.1***	***87.0***	***98.2***	***99.6***	***99.2***	***71.0***	***71.7***	***60.1***
Median	***Similkameen***	***94.7***	***97.8***	***87.5***	***98.0***	***99.5***	***99.1***	***93.6***	***96.7***	***78.5***
	Bonaparte	***93.6***	***98.2***	***88.0***	***98.2***	***99.6***	***99.3***	***86.9***	***87.8***	***76.6***
Standard		***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] Survival rates were calculated from the aggregate population collected at Wells Fish Hatchery volunteer channel and left- and right-ladder traps at Wells Dam.

[b] Survival rates were calculated from aggregate collections at Wells east fish ladder for the Methow and Okanogan/Similkameen programs. About 59% of the total fish collected were used to estimate survival rates.

10.3 Disease Monitoring

Results of adult broodstock bacterial kidney disease (BKD) monitoring for brood years 1997 through 2012 are shown in Table 10.7.

Table 10.7. Proportion of bacterial kidney disease (BKD) titer groups for the Methow/Okanogan summer Chinook broodstock, brood years 1997-2012. Also included are the proportions to be reared at either 0.125 fish per pound or 0.060 fish per pound.

Brood year[a]	Optical density values by titer group				Proportion at rearing densities (fish per pound, fpp)[b]	
	Very Low (≤ 0.099)	Low (0.1-0.199)	Moderate (0.2-0.449)	High (≥ 0.450)	≤ 0.125 fpp (<0.119)	≤ 0.060 fpp (>0.120)
1997	0.6267	0.1333	0.0622	0.1778	0.6844	0.3156
1998	0.9632	0.0184	0.0123	0.0061	0.9816	0.0184
1999	0.9444	0.0198	0.0238	0.0119	0.9643	0.0357
2000	0.7476	0.0952	0.0238	0.1333	0.8000	0.2000
2001	0.9801	0.0199	0.0000	0.0000	1.0000	0.0000
2002	0.9567	0.0130	0.0130	0.0173	0.9740	0.0260
2003	0.9620	0.0127	0.0169	0.0084	0.9747	0.0253
2004	0.9585	0.0151	0.0075	0.0189	0.9736	0.0264
2005	0.9884	0.0000	0.0000	0.0116	0.9884	0.0116
2006	0.9962	0.0038	0.0000	0.0000	0.9962	0.0038
2007	0.9202	0.0266	0.0152	0.0380	0.9354	0.0646
2008	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2009	0.9891	0.0073	0.0037	0.0000	0.9927	0.0073
2010	0.9960	0.0040	0.0000	0.0000	1.0000	0.0000
2011	0.9766	0.0140	0.0000	0.0093	0.9860	0.0140
2012	0.9341	0.0440	0.0110	0.0110	0.9780	0.0220
Average	***0.9542***	***0.0267***	***0.0118***	***0.0277***	***0.9518***	***0.0482***
Median	***0.9632***	***0.0146***	***0.0093***	***0.0102***	***0.9798***	***0.0202***

[a] Individual ELISA samples were not collected before the 1997 brood.

[b] ELISA values from broodstock BKD testing dictate what density the progeny of the broodstock are reared. Progeny of broodstock with high ELISA values are reared at lower density.

10.4 Spawning Surveys

Surveys for Okanogan/Similkameen summer Chinook redds were conducted from late September to mid-November in the Okanogan and Similkameen rivers. Total redd counts (not peak counts) were conducted in the rivers.

Redd Counts

During the survey period 1989 through 2017, the number of summer Chinook redds in the Okanogan River basin averaged 2,215 and ranged from 110 to 6,025 (Table 10.8).

Table 10.8. Total number of redds counted in the Okanogan River basin, 1989-2017. The Colville Tribes provided data for survey years 2013 to present.

Survey year	Number of summer Chinook redds		
	Okanogan River	Similkameen River	Total count
1989	151	370	521
1990	99	147	246
1991	64	91	155
1992	53	57	110
1993	162	288	450
1994	375	777	1,152
1995	267	616	883
1996	116	419	535
1997	158	486	644
1998	88	276	364
1999	369	1,275	1,644
2000	549	993	1,542
2001	1,108	1,540	2,648
2002	2,667	3,358	6,025
2003	1,035	378	1,413
2004	1,327	1,660	2,987
2005	1,611	1,423	3,034
2006	2,592	1,666	4,258
2007	1,301	707	2,008
2008	1,146	1,000	2,146
2009	1,672	1,298	2,970
2010	1,011	1,107	2,118
2011	1,714	1,409	3,123
2012	1,613	1,066	2,679
2013	2,267	1,280	3,547
2014	2,231	2,022	4,253
2015	2,379	1,897	4,276
2016	3,486	1,790	5,276
2017	2,434	787	3,221
Average	***1,174***	***1,041***	***2,215***
Median	***1,108***	***1,000***	***2,118***

* Reach-expanded aerial counts.

Spawning Escapement

Spawning escapement for Okanogan/Similkameen summer Chinook was calculated as the total number of redds times the fish per redd ratio estimated from fish sampled at Wells Dam.[43] During the survey period 1989 through 2017, the summer Chinook spawning escapement within the Okanogan River basin averaged 5,896 and ranged from 473 to 13,857 (Table 10.9).

Table 10.9. Spawning escapements for summer Chinook in the Okanogan and Similkameen rivers for return years 1989-2017. The Colville Tribes provided data for return years 2013 to present.

Return year	Fish/Redd	Spawning escapement		
		Okanogan	Similkameen	Total
1989*	3.30	498	1,221	1,719
1990*	3.40	337	500	837
1991*	3.70	237	337	574
1992*	4.30	228	245	473
1993*	3.30	535	950	1,485
1994*	3.50	1,313	2,720	4,033
1995*	3.40	908	2,094	3,002
1996*	3.40	394	1,425	1,819
1997*	3.40	537	1,652	2,189
1998	3.00	264	828	1,092
1999	2.20	812	2,805	3,617
2000	2.40	1,318	2,383	3,701
2001	4.10	4,543	6,314	10,857
2002	2.30	6,134	7,723	13,857
2003	2.42	2,505	915	3,420
2004	2.25	2,986	3,735	6,721
2005	2.93	4,720	4,169	8,889
2006	2.02	5,236	3,365	8,601
2007	2.20	2,862	1,555	4,417
2008	3.25	3,725	3,250	6,975
2009	2.54	4,247	3,297	7,544
2010	2.81	2,841	3,111	5,952
2011	3.10	5,313	4,368	9,681
2012	3.07	4,952	3,273	8,225
2013	2.31	5,237	2,957	8,194
2014	2.86	6,381	5,783	12,164
2015	3.21	7,637	6,089	13,726
2016	2.01	7,007	3,598	10,605
2017	2.04	4,963	1,605	6,568
Average	***2.92***	***3058***	***2837***	***5,896***

[43] Expansion factor = (1 + (number of males/number of females)).

Return year	Fish/Redd	Spawning escapement		
		Okanogan	Similkameen	Total
Median	***3.00***	***2,862***	***2,805***	***5,952***

* Spawning escapement was calculated using the "Modified Meekin Method" (i.e., 3.1 x jack multiplier).

10.5 Carcass Surveys

Surveys for summer Chinook carcasses were conducted during late September to mid-November in the Okanogan and Similkameen rivers.

Number sampled

During the survey period 1993 through 2017, the number of summer Chinook carcasses sampled in the Okanogan River basin averaged 1,389 and ranged from 115 to 3,293 (Table 10.10). In all years, most were sampled in the upper Okanogan River and lower Similkameen River (Table 10.10).

Table 10.10. Numbers of summer Chinook carcasses sampled within each survey reach in the Okanogan River basin, 1993-2017. Reach codes are described in Table 2.11. The Colville Tribes provided data for survey years 2013 to present.

Survey year	Number of summer Chinook carcasses								
	Okanogan						Similkameen		Total
	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
1993[a]	0	2	3	0	23	13	73	1	115
1994[b]	0	4	4	0	27	5	318	60	418
1995	0	0	2	0	30	0	239	15	286
1996	0	0	0	2	5	2	226	0	235
1997	0	0	2	0	9	3	225	1	240
1998	0	1	8	1	7	7	340	4	368
1999	0	0	3	2	23	53	766	48	895
2000	0	2	20	15	47	16	727	41	868
2001	0	26	75	10	127	112	1,141	105	1,596
2002	10	32	83	35	204	572	1,265	259	2,460
2003[c]	0	0	28	0	17	243	596	381	1,265
2004	0	4	31	24	146	283	1,392	298	2,178
2005	0	8	93	37	371	434	731	276	1,950
2006	4	3	31	16	120	291	508	106	1,079
2007	2	0	55	1	453	519	658	29	1,717
2008	4	10	40	36	248	665	859	157	2,019
2009	2	7	31	32	348	500	703	150	1,773
2010	3	10	30	42	241	352	627	148	1,453
2011	0	0	55	14	361	478	753	114	1,775
2012	1	0	56	15	256	537	495	54	1,414
2013[d]	0	0	30	9	52	432	380	7	910

Survey year	Number of summer Chinook carcasses								
	Okanogan						Similkameen		Total
	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
2014	0	2	79	54	275	783	770	489	2,452
2015	0	10	61	11	283	994	1,702	232	3,293
2016	0	12	14	11	230	1,075	1,214	199	2,755
2017	0	8	9	16	60	628	453	27	1,201
Average	***1***	***6***	***34***	***15***	***159***	***360***	***686***	***128***	***1,389***
Median	***0***	***2***	***30***	***11***	***127***	***352***	***658***	***105***	***1,414***

[a] 25 additional carcasses were sampled on the Similkameen and 46 on the Okanogan without any reach designation.
[b] One additional carcass was sampled on the Similkameen without any reach designation.
[c] 793 carcasses were sampled on the Similkameen before initiation of spawning (pre-spawn mortality) and an additional 40 carcasses were sampled on the Okanogan. The cause of the high mortality (*Ichthyophthirius multifilis* and *Flavobacterium columnarae*) was exacerbated by high river temperatures.
[d] In 2013, the Colville Tribes combined survey reaches O-3 and O-4, and S-1 and S-2. Carcass totals in these reaches were re-apportioned based on redd counts within each reach.

Carcass Distribution and Origin

Based on the available data (1991-2017), most fish, regardless of origin, were found in Reach 1 on the Similkameen River (Driscoll Channel to Oroville Bridge) (Table 10.11). However, a slightly larger percentage of hatchery fish were found in reaches on the Similkameen River than were wild fish (Figure 10.1). In contrast, a larger percentage of wild fish were found in reaches on the Okanogan River.

Table 10.11. Numbers of wild and hatchery summer Chinook carcasses sampled within different reaches in the Okanogan River basin, 1993-2017.

Survey year	Origin	Survey reach								Total
		O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
1993	Wild	0	0	3	0	13	4	48	1	69
	Hatchery	0	2	0	0	10	9	25	0	46
1994	Wild	0	0	1	0	7	1	113	22	144
	Hatchery	0	4	3	0	20	4	205	38	274
1995	Wild	0	0	1	0	10	0	66	4	81
	Hatchery	0	0	1	0	20	0	173	11	205
1996	Wild	0	0	0	1	3	1	53	0	58
	Hatchery	0	0	0	1	2	1	173	0	177
1997	Wild	0	0	1	0	0	3	83	0	87
	Hatchery	0	0	1	0	9	0	142	1	153
1998	Wild	0	1	3	1	6	5	162	4	182
	Hatchery	0	0	5	0	1	2	178	0	186
1999	Wild	0	0	0	0	9	23	293	9	334
	Hatchery	0	0	3	2	14	30	473	39	561
2000	Wild	0	0	8	8	24	11	189	4	244
	Hatchery	0	2	12	7	23	5	538	37	624
2001	Wild	0	10	23	5	67	42	390	54	591

Survey year	Origin	Survey reach								Total
		O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	
	Hatchery	0	16	52	5	60	70	751	51	1,005
2002	Wild	6	14	20	10	81	212	340	72	755
	Hatchery	4	18	63	25	123	360	925	187	1,705
2003	Wild	0	0	13	0	12	152	231	124	532
	Hatchery	0	0	15	0	5	91	365	257	733
2004	Wild	0	2	19	19	108	225	1,125	260	1,758
	Hatchery	0	2	12	5	38	58	267	38	420
2005	Wild	0	5	51	21	256	364	531	176	1,404
	Hatchery	0	3	42	16	115	70	200	100	546
2006	Wild	2	2	22	10	105	247	370	73	831
	Hatchery	2	1	9	6	15	44	138	33	248
2007	Wild	1	0	30	1	284	322	405	20	1,063
	Hatchery	1	0	25	0	169	197	253	9	654
2008	Wild	2	1	14	11	107	324	347	41	847
	Hatchery	2	9	26	25	141	341	512	116	1,172
2009	Wild	2	3	13	14	189	347	330	75	973
	Hatchery	0	4	18	18	159	153	373	75	800
2010	Wild	1	5	19	18	154	180	329	69	775
	Hatchery	2	5	11	24	87	172	296	79	676
2011	Wild	0	0	21	4	201	362	216	19	823
	Hatchery	0	0	34	10	160	116	537	95	952
2012	Wild	0	0	18	9	133	427	206	23	816
	Hatchery	1	0	38	6	123	110	288	31	597
2013	Wild	0	0	22	7	37	352	191	4	613
	Hatchery	0	0	8	2	15	80	188	4	297
2014	Wild	0	1	60	47	233	716	641	425	2,123
	Hatchery	1	0	19	7	42	67	129	64	329
2015	Wild	0	5	39	9	209	931	1,186	176	2,555
	Hatchery	0	5	22	2	74	63	516	56	738
2016	Wild	0	6	13	7	186	1,019	819	121	2,171
	Hatchery	0	6	1	4	44	56	395	78	584
2017	Wild	0	4	4	11	50	562	347	19	997
	Hatchery	0	4	5	5	10	66	106	8	204
Average	***Wild***	***1***	***2***	***17***	***9***	***99***	***273***	***360***	***72***	***833***
	Hatchery	***1***	***3***	***17***	***7***	***59***	***87***	***326***	***56***	***555***
Median	***Wild***	***0***	***1***	***14***	***7***	***81***	***225***	***329***	***23***	***775***
	Hatchery	***0***	***2***	***12***	***5***	***38***	***66***	***267***	***38***	***561***

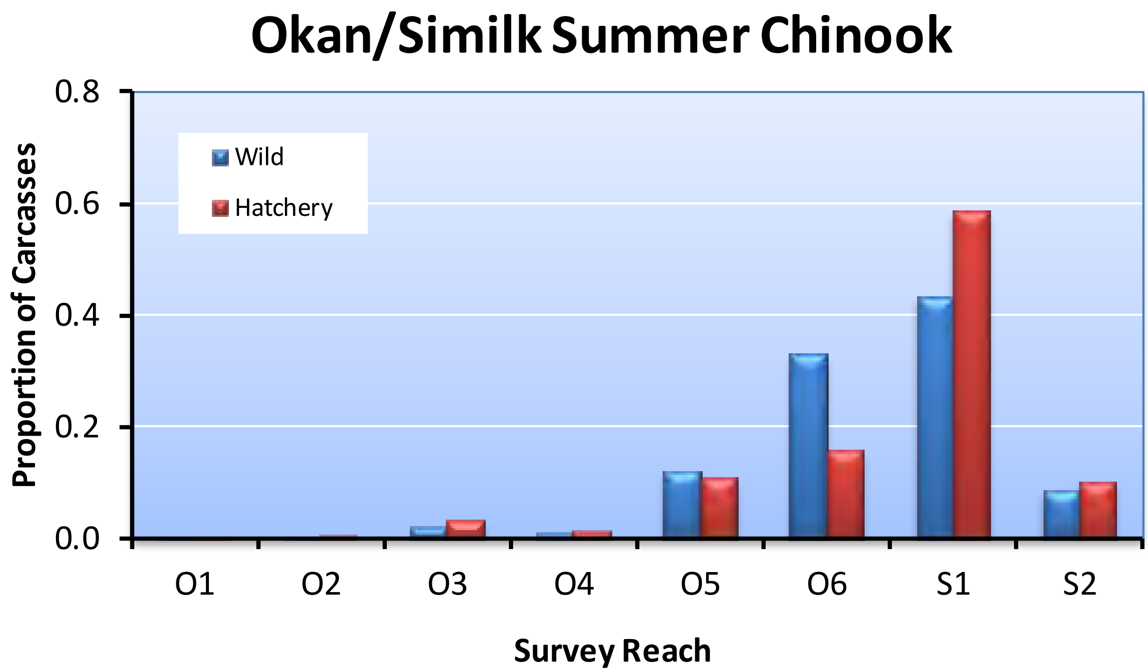


Figure 10.1. Distribution of wild and hatchery produced carcasses in different reaches in the Okanogan River basin, 1993-2017. Reach codes are described in Table 2.11.

10.6 Life History Monitoring

Life history characteristics of Okanogan/Similkameen summer Chinook were assessed by examining carcasses on spawning grounds and fish collected or examined at broodstock collection sites, and by reviewing tagging data and fisheries statistics.

Migration Timing

Migration timing of hatchery and wild Methow/Okanogan summer Chinook was determined from broodstock data collected at Wells Dam. Counting of summer/fall Chinook at Wells Dam occurs from 29 June to 15 November. Broodstock collection at the Dam occurs from early July (week 27) to mid-September (week 37) (see Table 2.1). Based on broodstock sampling in 2017, wild summer Chinook arrived at Wells Dam earlier than hatchery summer Chinook (Table 10.12). This was true throughout most of the migration period. In contrast, there was little difference in migration timing between wild and hatchery summer Chinook when data were pooled for the 2007-2017 survey period.

Table 10.12. The week that 10%, 50% (median), and 90% of the wild and hatchery summer Chinook salmon passed Wells Dam, 2007-2017. The average week is also provided. Migration timing is based on collection of summer Chinook broodstock at Wells Dam.

Survey year	Origin	Methow/Okanogan Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
2007	Wild	27	30	34	30	485
	Hatchery	27	30	33	30	433
2008	Wild	28	30	34	30	542

Survey year	Origin	Methow/Okanogan Summer Chinook Migration Time (week)				Sample size
		10 Percentile	50 Percentile	90 Percentile	Mean	
	Hatchery	28	30	36	31	884
2009	Wild	27	29	34	30	585
	Hatchery	27	29	33	29	708
2010	Wild	27	29	33	29	377
	Hatchery	27	29	32	29	801
2011	Wild	30	32	36	32	516
	Hatchery	30	32	35	33	1223
2012	Wild	28	30	34	31	192
	Hatchery	28	31	34	31	591
2013	Wild	27	30	33	30	229
	Hatchery	27	30	33	30	282
2014	Wild	27	31	40	32	316
	Hatchery	27	30	35	30	208
2015	Wild	26	28	30	28	217
	Hatchery	27	28	31	29	164
2016	Wild	26	29	39	30	314
	Hatchery	25	28	34	29	251
2017	Wild	27	30	35	30	228
	Hatchery	28	31	35	31	236
Average	***Wild***	***27***	***30***	***35***	***30***	***364***
	Hatchery	***27***	***30***	***34***	***30***	***526***
Median	***Wild***	***27***	***30***	***34***	***30***	***316***
	Hatchery	***27***	***30***	***34***	***30***	***433***

Age at Maturity

Because hatchery summer Chinook are released after one year of rearing and natural-origin summer Chinook migrate primarily as age-0 fish, total ages will differ between hatchery and natural-origin Chinook (see Hillman et al. 2011). Therefore, in this section, we evaluated age at maturity by comparing differences in salt (ocean) ages between the two groups.

Most of the wild and hatchery summer Chinook sampled during the period 1993-2017 in the Okanogan River basin were salt age-3 fish (Table 10.13; Figure 10.2). A higher percentage of salt age-4 wild Chinook returned to the basin than did salt age-4 hatchery Chinook. In contrast, a higher proportion of salt age-1 and 2 hatchery fish returned than did salt age-1 and 2 wild fish. Thus, a higher percentage of wild fish returned at an older age than did hatchery fish.

Table 10.13. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled on spawning grounds in the Okanogan River basin, 1993-2017.

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
1993	Wild	0.00	0.21	0.70	0.10	0.00	63
	Hatchery	0.00	0.98	0.02	0.00	0.00	44
1994	Wild	0.02	0.13	0.54	0.31	0.00	134
	Hatchery	0.02	0.09	0.89	0.00	0.00	290
1995	Wild	0.00	0.19	0.59	0.22	0.00	68
	Hatchery	0.01	0.15	0.36	0.49	0.00	200
1996	Wild	0.03	0.28	0.61	0.08	0.00	36
	Hatchery	0.02	0.22	0.56	0.20	0.01	174
1997	Wild	0.04	0.27	0.53	0.15	0.00	73
	Hatchery	0.00	0.02	0.87	0.11	0.00	148
1998	Wild	0.02	0.35	0.52	0.11	0.00	151
	Hatchery	0.05	0.50	0.23	0.22	0.00	185
1999	Wild	0.00	0.20	0.64	0.16	0.00	268
	Hatchery	0.00	0.12	0.85	0.02	0.00	552
2000	Wild	0.03	0.15	0.62	0.20	0.00	216
	Hatchery	0.12	0.02	0.76	0.10	0.00	545
2001	Wild	0.02	0.18	0.76	0.04	0.00	531
	Hatchery	0.05	0.88	0.02	0.05	0.00	1,005
2002	Wild	0.02	0.15	0.62	0.21	0.00	692
	Hatchery	0.01	0.19	0.80	0.01	0.00	1,681
2003	Wild	0.03	0.18	0.63	0.17	0.00	477
	Hatchery	0.03	0.06	0.79	0.12	0.00	653
2004	Wild	0.01	0.17	0.26	0.55	0.00	1,528
	Hatchery	0.01	0.32	0.45	0.23	0.00	382
2005	Wild	0.00	0.12	0.79	0.08	0.01	1,281
	Hatchery	0.02	0.06	0.77	0.15	0.00	530
2006	Wild	0.00	0.02	0.53	0.45	0.00	830
	Hatchery	0.05	0.18	0.24	0.53	0.00	139
2007	Wild	0.02	0.07	0.12	0.78	0.02	1,061
	Hatchery	0.22	0.30	0.42	0.05	0.01	559
2008	Wild	0.01	0.32	0.63	0.04	0.01	846
	Hatchery	0.02	0.60	0.36	0.02	0.00	1,108
2009	Wild	0.01	0.03	0.81	0.15	0.00	926
	Hatchery	0.05	0.05	0.86	0.03	0.00	783
2010	Wild	0.00	0.16	0.45	0.39	0.00	708
	Hatchery	0.02	0.65	0.27	0.06	0.00	619

Sample year	Origin	Salt age					Sample size
		1	2	3	4	5	
2011	Wild	0.01	0.07	0.82	0.10	0.00	787
	Hatchery[a]	0.16	0.08	0.76	0.00	0.00	873
2012	Wild	0.02	0.23	0.41	0.34	0.00	750
	Hatchery	0.05	0.55	0.35	0.05	0.00	532
2013	Wild	0.01	0.17	0.75	0.07	0.00	520
	Hatchery	0.03	0.21	0.74	0.02	0.00	252
2014	Wild	0.02	0.08	0.76	0.14	0.00	1,892
	Hatchery	0.18	0.26	0.55	0.02	0.00	300
2015	Wild	0.00	0.40	0.34	0.25	0.00	2,167
	Hatchery	0.03	0.68	0.26	0.02	0.00	549
2016	Wild	0.00	0.03	0.76	0.21	0.00	1,979
	Hatchery	0.02	0.06	0.87	0.04	0.00	1,255
2017	Wild	0.00	0.02	0.37	0.60	0.00	993
	Hatchery	0.01	0.28	0.40	0.31	0.00	137
Average	***Wild***	***0.01***	***0.15***	***0.56***	***0.27***	***0.00***	***759***
	Hatchery	***0.05***	***0.30***	***0.59***	***0.07***	***0.00***	***532***
Median	***Wild***	***0.01***	***0.12***	***0.72***	***0.16***	***0.00***	***708***
	Hatchery	***0.04***	***0.23***	***0.64***	***0.10***	***0.00***	***532***

[a] There was one salt age-6 hatchery fish that was not included in this table.

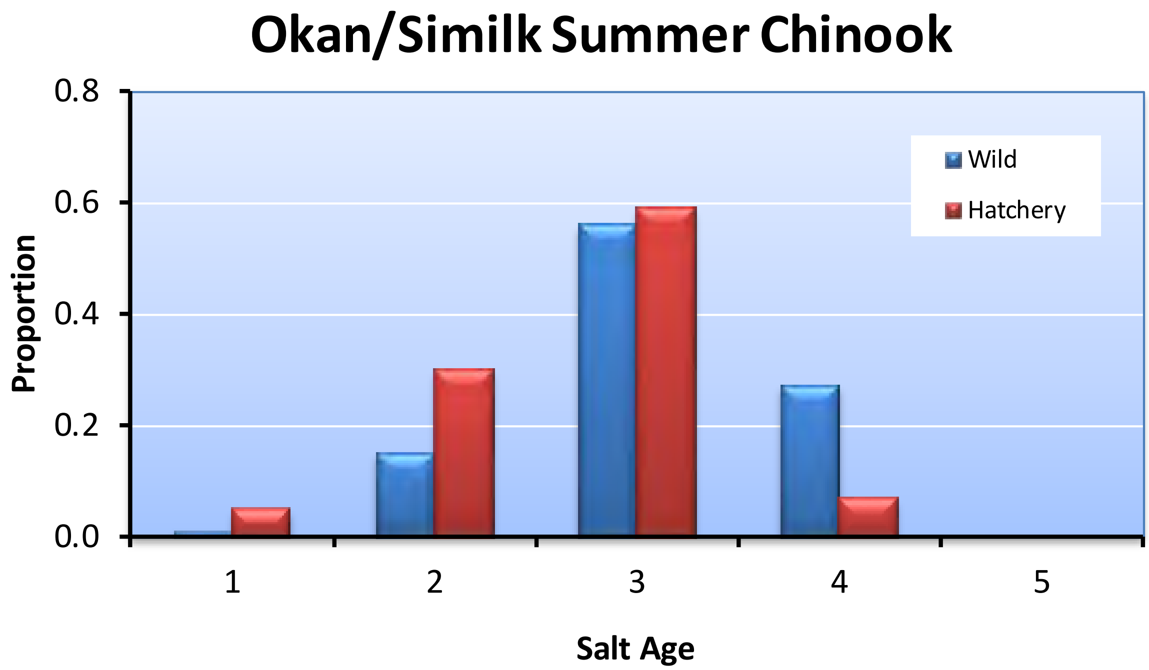


Figure 10.2. Proportions of wild and hatchery summer Chinook of different salt (ocean) ages sampled at broodstock collection sites and on spawning grounds in the Okanogan River basin for the combined years 1993-2017.

Size at Maturity

For the period 1993 through 2017, on average, hatchery summer Chinook were about 2 cm smaller than wild summer Chinook sampled in the Okanogan River basin (Table 10.14). This is likely because a higher percentage of wild fish returned as salt age-4 fish than did hatchery fish.

Table 10.14. Mean lengths (POH; cm) and variability statistics for wild and hatchery summer Chinook sampled in the Okanogan River basin, 1993-2017; SD = 1 standard deviation.

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
1993[a]	Wild	69	73	7	52	90
	Hatchery	59	62	6	47	75
1994	Wild	136	71	7	40	86
	Hatchery	268	69	8	30	84
1995	Wild	81	75	6	54	87
	Hatchery	201	73	8	39	87
1996	Wild	22	68	14	22	85
	Hatchery	26	75	8	60	88
1997	Wild	87	70	7	44	84
	Hatchery	148	74	6	48	88
1998	Wild	182	70	8	45	94

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	186	65	12	30	87
1999	Wild	333	73	7	56	91
	Hatchery	559	71	7	23	84
2000	Wild	241	70	10	32	86
	Hatchery	624	69	12	24	92
2001	Wild	578	67	9	26	86
	Hatchery	997	61	8	32	90
2002	Wild	755	69	9	28	91
	Hatchery	1705	70	8	33	87
2003	Wild	532	68	9	30	93
	Hatchery	733	69	10	26	90
2004	Wild	1756	71	10	33	94
	Hatchery	417	66	9	41	92
2005	Wild	1403	66	7	41	99
	Hatchery	546	68	8	31	85
2006	Wild	831	72	6	31	91
	Hatchery	248	71	9	33	87
2007	Wild	1063	75	9	27	99
	Hatchery	654	64	13	30	87
2008	Wild	847	65	9	29	86
	Hatchery	1172	65	8	32	89
2009	Wild	973	70	7	28	89
	Hatchery	799	70	9	35	86
2010	Wild	775	71	9	43	90
	Hatchery	676	64	10	22	87
2011	Wild	823	68	7	29	89
	Hatchery	952	66	11	26	86
2012	Wild	816	67	10	27	93
	Hatchery	597	63	9	23	86
2013	Wild	642	67	8	23	87
	Hatchery	267	71	8	36	88
2014	Wild	2,134	68	8	30	83
	Hatchery	318	64	13	30	89
2015	Wild	2,572	60	9	24	87
	Hatchery	720	58	8	23	78
2016	Wild	2,171	66	6	28	92
	Hatchery	584	67	6	37	86
2017	Wild	997	71	8	30	96

Sample year	Origin	Sample size	Summer Chinook length (POH; cm)			
			Mean	SD	Minimum	Maximum
	Hatchery	204	68	9	25	92
Pooled	***Wild***	***20,819***	***69***	***8***	***22***	***99***
	Hatchery	***13,660***	***67***	***9***	***22***	***92***

[a] This year includes sizes reported in the annual report. The data contained in the WDFW database do not include all these data.

Contribution to Fisheries

Most of the harvest on hatchery-origin Okanogan/Similkameen summer Chinook occurred in the Ocean (Table 10.15). Ocean harvest has made up 37-100% of all hatchery-origin Okanogan/Similkameen summer Chinook harvested. Brood year 2011 provided the largest harvest, while brood years 1993 and 1996 provided the lowest.

Table 10.15. Estimated number and percent (in parentheses) of hatchery-origin Okanogan/Similkameen summer Chinook captured in different fisheries, brood years 1989-2011.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1989	2,360 (80)	553 (19)	0 (0)	53 (2)	2,966	39.8
1990	355 (89)	34 (8)	0 (0)	12 (3)	401	28.2
1991	220 (86)	37 (14)	0 (0)	0 (0)	257	14.0
1992	422 (91)	28 (6)	2 (0)	10 (2)	462	20.0
1993	24 (80)	6 (20)	0 (0)	0 (0)	30	25.6
1994	372 (92)	23 (6)	2 (0)	7 (2)	404	26.1
1995	643 (93)	9 (1)	12 (2)	25 (4)	689	23.8
1996	6 (100)	0 (0)	0 (0)	0 (0)	6	18.2
1997	6,483 (92)	136 (2)	36 (1)	424 (6)	7,079	37.1
1998	4,414 (89)	251 (5)	45 (1)	223 (5)	4,933	62.8
1999	1,359 (68)	224 (11)	31 (2)	384 (19)	1,998	70.0
2000	3,139 (69)	533 (12)	222 (5)	675 (15)	4,559	67.1
2001	184 (58)	81 (25)	31 (10)	23 (7)	319	74.9
2002	706 (56)	200 (16)	90 (7)	258 (21)	1,254	63.2
2003	711 (38)	568 (30)	130 (7)	466 (25)	1,875	53.3
2004	3,153 (39)	2,162 (26)	694 (8)	2,168 (27)	8,177	60.9
2005	470 (46)	306 (30)	79 (8)	167 (16)	1,022	61.1
2006	3,136 (37)	3,352 (40)	469 (6)	1,419 (17)	8,376	61.0
2007	1,549 (44)	992 (28)	67 (2)	905 (26)	3,513	70.8
2008	4,226 (38)	2,576 (23)	218 (2)	3,969 (36)	10,989	73.5
2009	2,005 (36)	2,155 (39)	207 (4)	1,138 (21)	5,505	77.2
2010	3,193 (38)	3,933 (46)	247 (3)	1,110 (13)	8,483	79.0
2011	5,801 (40)	5,812 (40)	456 (3)	2,598 (18)	14,667	78.0
Average	***1,953 (51)***	***1,042 (27)***	***132 (3)***	***697 (18)***	***3,825***	***51.5***

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
Median	***1,359 (68)***	***251 (19)***	***45 (2)***	***258 (13)***	***1,998***	***61.0***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Stray rates were determined by examining CWTs recovered on spawning grounds within and outside the Okanogan River basin. Targets for strays based on return year (recovery year) within the upper Columbia River basin (Priest Rapids Dam to Chief Joseph Dam) should be less than 10% and targets for strays outside the upper Columbia River should be less than 5%.

Within the Upper Columbia River summer Chinook population, few hatchery-origin Okanogan summer Chinook have strayed into basins outside the Okanogan (Table 10.16). Although hatchery-origin Okanogan summer Chinook have strayed into other spawning areas, they usually made up less than 10% of the spawning escapement within those areas. The Chelan tailrace has received the largest number of Okanogan strays.

Hatchery-origin Okanogan summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged hatchery summer Chinook from the Okanogan have been detected at Lower Granite Dam on the Snake River, at Three Mile Dam on the Umatilla River, at Pelton Dam on the Deschutes River, in the Tucannon River, and at Tumwater Falls, Lyons Ferry, and Bonneville hatcheries. However, from 1994-present, less than five Okanogan summer Chinook have strayed into each of these locations.

Table 10.16. Number and percent of spawning escapements within other non-target basins that consisted of hatchery-origin Okanogan summer Chinook, return years 1994-2016. For example, for return year 2002, 1% of the summer Chinook spawning escapement in the Entiat Basin consisted of hatchery-origin Okanogan summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
1994	0	0.0	0	0.0	-	-	-	-	-	-
1995	0	0.0	0	0.0	-	-	-	-	-	-
1996	0	0.0	0	0.0	-	-	-	-	-	-
1997	0	0.0	0	0.0	-	-	-	-	-	-
1998	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	0	0.0	6	0.5	30	4.5	0	0.0	3	0.0
2001	12	0.1	0	0.0	10	1.0	0	0.0	0	0.0
2002	0	0.0	3	0.1	4	0.7	5	1.0	0	0.0
2003	0	0.0	8	0.2	22	5.3	14	2.0	0	0.0
2004	0	0.0	0	0.0	5	1.2	0	0.0	0	0.0
2005	5	0.1	27	1.1	36	6.9	7	1.9	8	0.0
2006	0	0.0	5	0.2	4	1.0	7	1.8	0	0.0

Return year	Wenatchee		Methow		Chelan		Entiat		Hanford Reach	
	Number	%	Number	%	Number	%	Number	%	Number	%
2007	0	0.0	3	0.2	4	2.1	0	0.0	0	0.0
2008	0	0.0	9	0.5	46	9.3	4	1.9	0	0.0
2009	15	0.2	3	0.2	11	1.8	18	9.9	0	0.0
2010	6	0.1	0	0.0	33	3.0	0	0.0	0	0.0
2011	0	0.0	0	0.0	46	3.6	0	0.0	0	0.0
2012	7	0.1	5	0.2	19	1.5	0	0.0	0	0.0
2013	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2014	0	0.0	3	0.2	8	0.7	0	0.0	0	0.0
2015	4	0.1	5	0.1	4	0.3	0	0.0	0	0.0
2016	0	0.0	4	0.2	4	0.4	0	0.0	0	0.0
Average	***2***	***0.0***	***4***	***0.2***	***15***	***2.3***	***3***	***1.0***	***1***	***0.0***
Median	***0***	***0.0***	***3***	***0.1***	***8***	***1.2***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 1% of the hatchery-origin Okanogan summer Chinook spawners strayed into non-target streams (Table 10.17). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-4%. In addition, on average, about 0.2% of hatchery-origin Okanogan summer Chinook broodstock have been included in non-target hatchery programs.

Table 10.17. Number and percent of hatchery-origin Okanogan summer Chinook spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1989-2011.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1989	3,132	69.7	2	0.0	1,328	29.6	31	0.7
1990	729	71.4	0	0.0	291	28.5	1	0.1
1991	1,125	71.3	0	0.0	453	28.7	0	0.0
1992	1,264	68.5	8	0.4	572	31.0	1	0.1
1993	54	62.1	0	0.0	32	36.8	1	1.1
1994	924	80.8	16	1.4	203	17.7	1	0.1
1995	1,883	85.4	50	2.3	271	12.3	0	0.0
1996	27	100.0	0	0.0	0	0.0	0	0.0
1997	11,659	97.1	34	0.3	309	2.6	3	0.0
1998	2,784	95.4	31	1.1	102	3.5	2	0.1
1999	828	96.7	10	1.2	18	2.1	0	0.0
2000	2,091	93.6	99	4.4	29	1.3	15	0.7

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
2001	105	98.1	0	0.0	2	1.9	0	0.0
2002	702	96.2	11	1.5	17	2.3	0	0.0
2003	1,580	96.2	16	1.0	47	2.9	0	0.0
2004	4,947	94.4	85	1.6	206	3.9	2	0.0
2005	606	93.2	22	3.4	22	3.4	0	0.0
2006	5,220	97.6	68	1.3	60	1.1	0	0.0
2007	1,396	96.4	10	0.7	42	2.9	0	0.0
2008	3,600	90.8	23	0.6	337	8.5	4	0.1
2009	993	61.1	11	0.7	621	38.2	1	0.1
2010	924	40.9	9	0.4	1,314	58.2	10	0.4
2011	2,805	67.8	13	0.3	1,295	31.3	25	0.6
Average	***2,147***	***83.7***	***23***	***1.0***	***329***	***15.2***	***4***	***0.2***
Median	***1,264***	***93.2***	***11***	***0.7***	***203***	***3.9***	***1***	***0.0***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Okanogan River basin.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Okanogan River basin.

[3] Target hatchery includes broodstock collection at Wells Dam.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Okanogan summer Chinook hatchery program.

Genetics

Genetic studies were conducted to investigate relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin (Kassler et al. 2011; the entire report is appended as Appendix N). A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin. Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River basin (N = 139) and compared to collections of hatchery and natural-origin Chinook from 2006 and 2008 (N = 380). Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to supplementation collections from 2006 and 2008 (N = 362). Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with supplementation collections from 2006 and 2008 (N = 669). A collection of natural-origin summer Chinook from the Chelan River was also analyzed (N = 70). Additionally, hatchery collections from Eastbank Hatchery (Wenatchee and Methow/Okanogan stock; N = 221) and Wells Hatchery (N = 294) were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River (N = 190) were used for comparison. Lastly, data from eight collections of fall Chinook (N = 2,408) were compared to the collections of summer Chinook. Samples of natural and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation programs have affected the genetic structure of these populations. The study also calculated the effective number of breeders for collection locations of natural and hatchery-origin summer Chinook from 1993 and 2008.

In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

It is important to note that no new information will be reported on genetics until the next five-year report (data collected through 2018).

Proportionate Natural Influence

Another method for assessing the genetic risk of a supplementation program is to determine the influence of the hatchery and natural environments on the adaptation of the composite population. This is estimated by the proportion of natural-origin fish in the hatchery broodstock (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). We calculated Proportionate Natural Influence (PNI) by iterating Ford's (2002) equations 5 and 6 to equilibrium, using a heritability of 0.3 and a selection strength of three standard deviations. The larger the PNI value, the greater the strength of selection in the natural environment relative to that of the hatchery environment. For the natural environment to dominate selection, PNI should be greater than 0.50, and important integrated populations should have a PNI of at least 0.67 (HSRG/WDFW/NWIFC 2004).

For brood years 1993-2003, the PNI values were less than 0.67 (Table 10.18). However, since brood year 2003, PNI has generally been greater than 0.67, save 2008 and 2011. PNI results reported here end with brood year 2012. Beginning with brood year 2013, the Colville Confederated Tribes report PNI values for Okanogan summer Chinook in their annual reports to BPA.

Table 10.18. Proportionate Natural Influence (PNI) values for the Okanogan/Similkameen summer Chinook supplementation program for brood years 1989-2012. NOS = number of natural-origin Chinook on the spawning grounds; HOS = number of hatchery-origin Chinook on the spawning grounds; NOB = number of natural-origin Chinook collected for broodstock; and HOB = number of hatchery-origin Chinook included in hatchery broodstock.

Brood year	Spawners			Broodstock			PNI[a]
	NOS	HOS	pHOS	NOB	HOB	pNOB	
1989	1,719	0	0	1,297	312	0.81	1.00
1990	837	0	0	828	206	0.80	1.00
1991	574	0	0	924	314	0.75	1.00
1992	473	0	0	297	406	0.42	1.00
1993	915	570	0.38	681	388	0.64	0.64
1994	1,323	2,710	0.67	341	244	0.58	0.48
1995	979	2,023	0.67	173	240	0.42	0.40
1996	568	1,251	0.69	287	155	0.65	0.50
1997	862	1,327	0.61	197	265	0.43	0.43
1998	600	492	0.45	153	211	0.42	0.50
1999	1,274	2,343	0.65	224	289	0.44	0.42
2000	1,174	2,527	0.68	164	337	0.33	0.35
2001	4,306	6,551	0.6	12	345	0.03	0.09
2002	4,346	9,511	0.69	247	241	0.51	0.44
2003	1,933	1,487	0.43	381	101	0.79	0.66
2004	5,309	1,412	0.21	506	16	0.97	0.83
2005	6,441	2,448	0.28	391	9	0.98	0.78
2006	5,507	3,094	0.36	500	10	0.98	0.74
2007	2,983	1,434	0.32	456	17	0.96	0.76
2008	2,998	3,977	0.57	359	86	0.81	0.60
2009	4,204	3,340	0.44	503	4	0.99	0.70
2010	3,189	2,763	0.46	484	8	0.98	0.69
2011	4,642	5,039	0.52	467	26	0.95	0.65
2012	4,494	3,731	0.45	79	2	0.98	0.69
Average	***2,569***	***2,418***	***0.42***	***415***	***176***	***0.69***	***0.64***
Median	***1,826***	***2,183***	***0.45***	***370***	***209***	***0.77***	***0.66***

[a] PNI was calculated previously using PNI approximate equation 11 (HSRG 2009; their Appendix A). All PNI values presented here were recalculated by iterating Ford's (2002) equations 5 and 6 to equilibrium using a heritability of 0.3 and a selection strength of three standard deviations. C. Busack, NOAA Fisheries, 21 March 2016, provided the model for calculating PNI.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel times (arithmetic mean days) of hatchery summer Chinook from the Similkameen River release site to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 10.19).[44] Over the three brood years for which PIT-tagged hatchery fish were released, survival rates from the Similkameen River to McNary Dam ranged from 0.432 to 0.720; SARs from release to detection at Bonneville Dam ranged from 0.016 to 0.031. Average travel time from the Similkameen River to McNary Dam ranged from 41 to 44 days. Although there is only one year in which low densities were compared to high densities (brood year 2008), there was little difference in survival rates and travel times between the two groups (Table 10.19).

Table 10.19. Total number of Okanogan hatchery summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2008-2011. Standard errors are shown in parentheses. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River).

Brood year	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam (d)	SAR to Bonneville Dam
2008	4,531 (high density)	0.445 (0.061)	44.0 (10.2)	0.028 (0.002)
	4,293 (low density)	0.432 (0.050)	41.4 (9.7)	0.030 (0.003)
2009	5,089	0.720 (0.102)	41.5 (10.1)	0.016 (0.002)
2010	0	--	--	--
2011	5,036	0.683 (0.064)	41.9 (12.3)	0.031 (0.002)

Natural and Hatchery Replacement Rates

Natural replacement rates (NRR) were calculated as the ratio of natural-origin recruits (NOR) to the parent spawning population (spawning escapement). Natural-origin recruits are naturally produced (wild) fish that survive to contribute to harvest (directly or indirectly), to broodstock, and to spawning grounds. We do not account for fish that died in route to the spawning grounds (migration mortality) or died just before spawning (pre-spawn mortality) (see Appendix B in Hillman et al. 2012). We calculated NORs with and without harvest. NORs without harvest include all returning fish that either returned to the basin or were collected as wild broodstock. NORs with harvest include all fish harvested and are based on brood year harvest rates from the hatchery program. For brood years 1989-2010, NRR for summer Chinook in the Okanogan averaged 1.06 (range, 0.17-3.82) if harvested fish were not included in the estimate and 2.30 (range, 0.32-9.83) if harvested fish were included in the estimate (Table 10.20). NRRs for more recent brood years will be calculated as soon as all tag recoveries and sampling rates have been loaded into the database.

Hatchery replacement rates (HRR) are the hatchery adult-to-adult returns and were calculated as the ratio of hatchery-origin recruits (HOR) to the parent broodstock collected. These rates should be greater than the NRRs and greater than or equal to 8.6 (the calculated target value in Hillman et al. 2017). The target value of 8.6 includes harvest. HRRs exceeded NRRs in 19 of the 22 years of data, regardless if harvest was or was not included in the estimate (Table 10.20). Hatchery

[44] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

replacement rates for Okanogan summer Chinook have exceeded the estimated target value of 8.6 in 11 of the 22 years of data.

Table 10.20. Broodstock collected, spawning escapements, natural and hatchery-origin recruits (NOR and HOR), and natural and hatchery replacement rates (NRR and HRR; with and without harvest) for wild summer Chinook in the Okanogan River basin, brood years 1989-2010.

Brood year	Broodstock Collected	Spawning Escapement	Harvest not included				Harvest included			
			HOR	NOR	HRR	NRR	HOR	NOR	HRR	NRR
1989	304	1,719	4,493	2,146	14.78	1.25	7,459	3,577	24.54	2.08
1990	288	837	1,021	1,477	3.55	1.76	1,422	2,063	4.94	2.46
1991	364	574	1,578	629	4.34	1.10	1,835	728	5.04	1.27
1992	304	473	1,845	752	6.07	1.59	2,307	942	7.59	1.99
1993	328	1,485	87	1,003	0.27	0.68	117	1,348	0.36	0.91
1994	302	4,033	1,144	2,168	3.79	0.54	1,548	2,942	5.13	0.73
1995	385	3,002	2,204	959	5.72	0.32	2,893	1,262	7.51	0.42
1996	330	1,819	27	466	0.08	0.26	33	574	0.10	0.32
1997	313	2,189	12,005	4,363	38.35	1.99	19,084	6,807	60.97	3.11
1998	352	1,092	2,919	4,166	8.29	3.82	7,852	10,737	22.31	9.83
1999	333	3,617	856	6,641	2.57	1.84	2,854	16,080	8.57	4.45
2000	334	3,701	2,234	1,716	6.69	0.46	6,793	4,727	20.34	1.28
2001	335	10,857	107	8,959	0.32	0.83	426	35,836	1.27	3.30
2002	333	13,857	730	6,077	2.19	0.44	1,984	16,559	5.96	1.19
2003	337	3,420	1,643	566	4.88	0.17	3,518	1,215	10.44	0.36
2004	335	6,721	5,240	3,119	15.64	0.46	13,417	7,977	40.05	1.19
2005	338	8,889	650	6,177	1.92	0.69	1,672	14,707	4.95	1.65
2006	355	8,601	5,348	2,421	15.06	0.28	13,724	5,206	38.66	0.61
2007	314	4,417	1,448	6,241	4.61	1.41	4,961	13,993	15.80	3.17
2008	276	6,975	3,964	2,724	14.36	0.39	14,953	5,582	54.18	0.80
2009	335	7,544	1,626	7,314	4.85	0.97	7,131	20,204	21.29	2.68
2010	301	5,952	2,257	12,073	7.50	2.03	10,740	40,787	35.68	6.85
Average	***327***	***4,626***	***2,428***	***3,734***	***7.54***	***1.06***	***5,760***	***9,721***	***17.99***	***2.30***
Median	***333***	***3,659***	***1,635***	***2,573***	***4.87***	***0.76***	***3,206***	***5,394***	***9.51***	***1.47***

Smolt-to-Adult Survivals

Smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery smolts released. Here, SARs were based on CWT returns. For the available brood years, SARs have ranged from 0.00007 to 0.03243 for hatchery summer Chinook in the Okanogan River basin (Table 10.21).

Table 10.21. Smolt-to-adult ratios (SARs) for Okanogan/Similkameen summer Chinook, brood years 1989-2010.

Brood year	Number of tagged smolts released[a]	Estimated adult captures[b]	SAR
1989	202,125	4,293	0.02124
1990	367,207	972	0.00265
1991	360,380	975	0.00271
1992	537,190	2,282	0.00425
1993	379,139	117	0.00031
1994	217,818	1,526	0.00701
1995	574,197	2,842	0.00495
1996	487,776	32	0.00007
1997	572,531	18,570	0.03243
1998	287,948	7,742	0.02689
1999	610,868	2,782	0.00455
2000	528,639	6,765	0.01280
2001	26,315	424	0.01611
2002	245,997	1,979	0.00804
2003	574,908	3,503	0.00609
2004	676,222	12,960	0.01917
2005	273,512	1,662	0.00608
2006	597,276	13,605	0.02278
2007	610,379	4,943	0.00810
2008	516,533	14,894	0.02883
2009	522,295	7,119	0.01363
2010	610,927	10,666	0.01746
2011	625,234	18,757	0.03000
Average	***452,409***	***6,061***	***0.01288***
Median	***522,295***	***3,503***	***0.00810***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).
[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

10.7 ESA/HCP Compliance

Broodstock Collection

Direct and/or indirect take of ESA-listed species during broodstock collection for the Okanogan summer Chinook outside of Wells Dam is covered by permits held by the Colville Tribes.

Hatchery Rearing and Release

Activities associated with the spawning, rearing, and release of Okanogan summer Chinook that could result in either direct or incidental take of listed species is covered under ESA permits held by the Colville Tribes.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18120, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at the Similkameen Acclimation Facility during the period 1 January through 31 December 2017. NPDES monitoring and reporting for PUD Hatchery Programs during 2017 are provided in Appendix F. NPDES reporting for Okanogan summer Chinook only covers the Similkameen Acclimation Facility and only during the time fish are present.

SECTION 11: CHELAN FALLS SUMMER CHINOOK

Although the Chelan Falls summer Chinook program (formerly the Turtle Rock program) is an augmentation program, the production of 200,000 fish is No Net Impact (NNI) compensation for passage mortalities associated with Rocky Reach Dam. In addition, the conversion of the subyearling program to a 400,000-yearling program is compensation for lost spawning habitat as a result of the construction of Rocky Reach Dam. In 2011, as part of the periodic recalculation of NNI for Rocky Reach Dam, the previous 200,000 NNI program was reduced to 176,000 fish. This reduced the combined Chelan Falls summer Chinook production from 600,000 to 576,000 beginning with the 2012 brood.

Before 2012, broodstock were collected at Wells Dam and consisted of volunteers to the Wells Fish Hatchery. Summer Chinook were spawned at Wells Fish Hatchery and fertilized eggs were then transferred to Eastbank Fish Hatchery for hatching and rearing. In 2012, adults were collected at Wells Fish Hatchery and then transferred to Eastbank Fish Hatchery for spawning, hatching, and rearing. Beginning in 2013, broodstock collection was initiated at the Eastbank Fish Hatchery Outfall. With returns to the Outfall diminishing, a pilot broodstock collection program was initiated in 2016 at the outlet structure of the water conveyance canal for the Chelan Tailrace Pump Station. Because the pilot collection program was successful, future broodstock for the Chelan Falls Program will be collected at the outlet structure of the water conveyance canal.

The original program consisted of both subyearling (normal and accelerated groups) and yearling releases. Subyearlings were transferred to Turtle Rock Fish Hatchery for acclimation in May. These fish were released in June after about 30 days of acclimation on Columbia River water. The goal of this program was to release 1,620,000 subyearling summer Chinook (810,000 normal and 810,000 accelerated subyearlings) into the Columbia River at 40 fish per pound. Targets for fork length and weight were 112 mm (CV = 9.0) and 11.4 g, respectively. Over 50% of both subyearling groups were marked with CWTs. In 2010, the subyearling program was converted to a 400,000-yearling program.

The goal of the yearling program was to release 200,000 summer Chinook smolts into the Columbia River from Turtle Rock Fish Hatchery at 10 fish per pound. Targets for fork length and weight were 176 mm (CV = 9.0) and 45.4 g, respectively. Beginning with the 2006 brood year, yearling summer Chinook were acclimated at both Turtle Rock Fish Hatchery and the Chelan River net pens. With the conversion of the subyearling program to a yearling program and the reduction of the NNI component to 176,000, the current goal is to release 576,000 yearling summer Chinook smolts (176,000 from the NNI program plus 400,000 from the converted subyearling program). Beginning in 2012, the 576,000 yearlings are acclimated overwinter at facilities at Chelan Hatchery on Chelan River water. In 2012, the Turtle Rock program officially became the Chelan Falls summer Chinook program.

Over 90% of yearling summer Chinook have been marked with CWTs and all are ad-clipped. In addition, juvenile summer Chinook were PIT tagged within each of the circular and standard raceways.

11.1 Broodstock Sampling

Before 2013, broodstock for the program were collected as part of the Wells summer Chinook volunteer program. Refer to Snow et al. (2012) for information related to adults collected for those programs. Beginning in 2013, broodstock collection for the Chelan Falls program was piloted at the Eastbank Hatchery Outfall and at the outlet structure of the water conveyance canal for the Chelan Tailrace Pump Station. This section focuses on results from sampling broodstock from 2013 to present.

Origin of Broodstock

Broodstock collected in 2014-2017 consisted entirely of hatchery-origin summer Chinook (Table 11.1). A total of 85 hatchery-origin Chinook collected from Chief Joseph Fish Hatchery were surplused from the 2015 brood year.

Table 11.1. Numbers of wild and hatchery summer Chinook collected for broodstock, numbers that died before spawning, and numbers of Chinook spawned for the Chelan Falls summer Chinook program during 2013-2017. Unknown origin fish (i.e., undetermined by scale analysis, no CWT or fin clips, and no additional hatchery marks) were considered naturally produced. Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program and surplus fish killed at spawning.

Brood year	Wild summer Chinook					Hatchery summer Chinook					Total number spawned
	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	Number collected	Prespawn loss[a]	Mortality	Number spawned	Number released	
2013[c]	-	-	-	-	-	318	4	0	314	0	314
2014[c]	-	-	-	-	-	331	19	15	297	0	297
2015[cd]	-	-	-	-	-	351	17	14[b]	320	0	320
2016[ce]	-	-	-	-	-	350	5	1	344	0	344
2017[fe]	-	-	-	-	-	351	12	0	339	0	339
Average	-	-	-	-	-	***340***	***11***	***4***	***323***	***0***	***323***
Median	-	-	-	-	-	***350***	***12***	***0.5***	***320***	***0***	***320***

[a] Pre-spawn loss represents the number of fish that died during the holding period before spawning. Mortality is the number of fish that were surplused following spawning.
[b] There was an additional 85 fish surplused that were excess from collections at Chief Joseph Fish Hatchery and were not included in mortality estimates.
[c] Broodstock collected from Eastbank Fish Hatchery outfall
[d] Broodstock collected from Chief Joe Fish Hatchery adult fish ladder
[e] Broodstock collected from Entiat National Fish Hatchery
[f] Broodstock collected from Chelan Falls Canal Trap

Age/Length Data

Ages of summer Chinook broodstock were determined from analysis of scales and/or CWTs. Broodstock collected from the 2015 return consisted primarily of age-4 and 5 hatchery-origin Chinook (97.3%). Age-3 hatchery-origin Chinook made up 2.3% of the broodstock. Age-6 hatchery-origin Chinook made up 0.3% of the broodstock (Table 11.2).

Broodstock collected from the 2016 return consisted primarily of age-4 and 5 hatchery-origin Chinook (98.7%). Age-3 hatchery-origin Chinook made up 0.6% of the broodstock (Table 11.2).

Broodstock collected from the 2017 return consisted primarily of age-4 and 5 hatchery-origin Chinook (96.9%). Age-3 hatchery-origin Chinook made up 3.1% of the broodstock (Table 11.2).

Table 11.2. Percent of hatchery and wild summer Chinook of different ages (total age) collected from broodstock for the Chelan Falls summer Chinook program, 2013-2017.

Return Year	Origin	Total age				
		2	3	4	5	6
2013	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	37.0	62.0	1.0
2014	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	37.0	62.0	1.0
2015	Wild	--	--	--	--	--
	Hatchery	0.0	2.3	53.8	43.5	0.3
2016	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	35.4	64.0	0.7
2017	Wild	--	--	--	--	--
	Hatchery	0.0	0.0	47.5	49.4	3.1
Average	***Wild***	***--***	***--***	***--***	***--***	***--***
	Hatchery	***0.0***	***0.0***	***42.1***	***56.2***	***1.2***
Median	***Wild***	***--***	***--***	***--***	***--***	***--***
	Hatchery	***0.0***	***0.0***	***37.0***	***62.0***	***1.0***

Mean lengths of hatchery-origin summer Chinook of a given age differed little among return years 2013-2017 (Table 11.3).

Table 11.3. Mean fork length (cm) at age (total age) of hatchery and wild summer Chinook collected from broodstock for the Chelan Falls program, 2013-2017; N = sample size and SD = 1 standard deviation.

Return year	Origin	Summer Chinook fork length (cm)														
		Age-2			Age-3			Age-4			Age-5			Age-6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2013	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	77	99	6	91	196	5	-	0	-
2014	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	78	114	6	90	191	5	95	3	6
2015	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	70	7	3	78	162	5	87	131	6	107	1	-
2016	Wild	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	77	104	5	88	188	6	89	2	8
2017	Wild	-	0	-	-	0	-	-	-	-	-	0	-	-	0	-
	Hatchery	-	0	-	-	0	-	75	154	5	87.5	160	6	89.1	10	7
Average	***Wild***	***-***	***0***	***-***	***-***	***0***	***-***	***-***	***0***	***-***	***-***	***0***	***-***	***-***	***0***	***-***
	Hatchery	***-***	***0***	***-***	***70***	***1***	***3***	***77***	***127***	***5***	***89***	***173***	***6***	***95***	***3***	***7***

Sex Ratios

Male summer Chinook in the 2015 broodstock made up about 46.0% of the adults collected, resulting in an overall male to female ratio of 0.85:1.00 (Table 11.4.). In 2016, males made up about 50.6% of the adults collected, resulting in an overall male to female ratio of 1.02:1.00 (Table 11.4). In 2017, males made up about 49.9% of the adults collected, resulting in an overall male to female ratio of 0.99:1.00 (Table 11.4). The ratio for 2016 broodstock was above the assumed 1:1 ratio goal in the broodstock protocol. The ratio for 2015 broodstock was below the assumed 1:1 ratio goal in the broodstock protocol.

Table 11.4. Numbers of male and female wild and hatchery summer Chinook collected for broodstock at for the Chelan Falls program, 2013-2017. Ratios of males to females are also provided.

Return year	Number of wild summer Chinook			Number of hatchery summer Chinook			Total M/F ratio
	Males (M)	Females (F)	M/F	Males (M)	Females (F)	M/F	
2013	-	-	-	160	158	1.01:1.00	1.01:1.00
2014	-	-	-	168	163	1.03:1.00	1.03:1.00
2015	-	-	-	149	175	0.85:1.00	0.85:1.00
2016	-	-	-	177	173	1.02:1.00	1.02:1.00
2017	-	-	-	175	176	0.99:1.00	0.99:1.00
Total	**-**	**-**	**-**	***829***	***845***	***0.98:1.00***	***0.98:1.00***

Fecundity

Fecundities for the 2015, 2016, and 2017 summer Chinook broodstock averaged 3,597, 4,008, and 3,779 eggs per female, respectively (Table 11.5). These values are close to the overall average of 4,024 eggs per female. Mean observed fecundities for the 2015-2017 returns were below the expected fecundities of 4,372, 4,372, and 4,072 eggs per female assumed in the broodstock protocol, respectively.

Table 11.5. Mean fecundity of wild, hatchery, and all female summer Chinook collected for broodstock for the Chelan Falls program, 2013-2017; NA = not available.

Return year	Mean fecundity		
	Wild	Hatchery	Total
2013	-	4,462	4,462
2014	-	4,275	4,275
2015	-	3,597	3,597
2016	-	4,008	4,008
2017	-	3,823	3,823
Average	**-**	***4,033***	***4,033***
Median	**-**	***4,008***	***4,008***

To estimate fecundities by length, weight, and age[45], hatchery staff collected fecundity, fork length, weight, and age data from summer Chinook females during the spawning of 2013 through

[45] Although age-fecundity relationships are not specific hypotheses tested within the Monitoring and Evaluation Plan (Hillman et al. 2017), we include them here for descriptive purposes.

2017 broodstock (complete data for all variables are available for years 2014-2017). For the available brood years, we developed age/fecundity, fork length/fecundity, weight/fecundity, fork length/mean egg mass, and fork length/gamete (skein) mass relationships for hatchery-origin summer Chinook. Wild Chinook are not included in broodstock for the Chelan Falls program. Hatchery staff randomly sampled about fifty females.

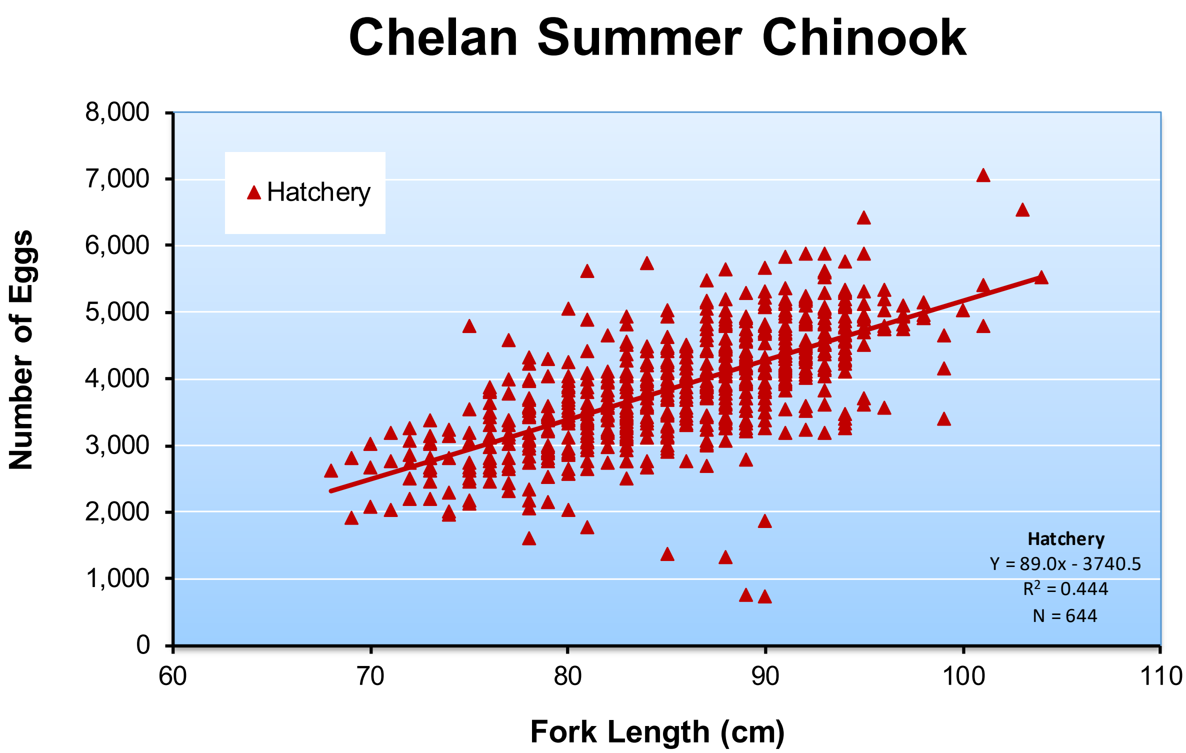
On average, mean fecundities for hatchery-origin age-4 and age-5 Chinook were 3,508 and 4,136 eggs, respectively (Table 11.6).

Table 11.6. Mean fecundity by age (total age) for hatchery summer Chinook collected from broodstock for the Chelan River program, brood years 2013-2017; N = sample size and SD = 1 standard deviation.

Brood year	Origin	Summer Chinook fecundity											
		Age 3			Age 4			Age 5			Age 6		
		Mean	N	SD	Mean	N	SD	Mean	N	SD	Mean	N	SD
2013[a]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,354	16	524	4,593	130	906	-	0	-
2014[a]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,934	9	642	4,301	119	772	5,601	2	2,055
2015[ac]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	2,919	3	193	3,351	57	740	3,809	85	894	-	0	-
2016[ac]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,509	21	679	4,071	123	759	4,037	2	1,079
2017[cd]	Wild	-	0	-	-	0	-	-	0	-	-	0	-
	Hatchery	-	0	-	3,391	45	660	3,908	108	839	-	0	-
Average	***Wild***	***-***	***0***	***-***	***-***	***0***	***-***	***-***	***0***	***-***	***-***	***0***	***-***
	Hatchery	***2,919***	***1***	***193***	***3,508***	***30***	***649***	***4,136***	***113***	***834***	***4,819***	***1***	***1,567***

[a] Broodstock collected from Eastbank Fish Hatchery outfall
[b] Broodstock collected from Chief Joe Fish Hatchery adult fish ladder
[c] Broodstock collected from Entiat National Fish hatchery
[d] Broodstock collected from Chelan Falls Canal Trap

We pooled fecundity data from brood years 2014 through 2017 (only brood years with complete data for all variables) to increase the number of samples for a given fork length. The linear relationships between fork length and fecundity, mean egg weight, and total egg (skein) weight for hatchery-origin females are shown in Figures 11.1, 11.2, and 11.3. All fecundity variables increase linearly with fork length.



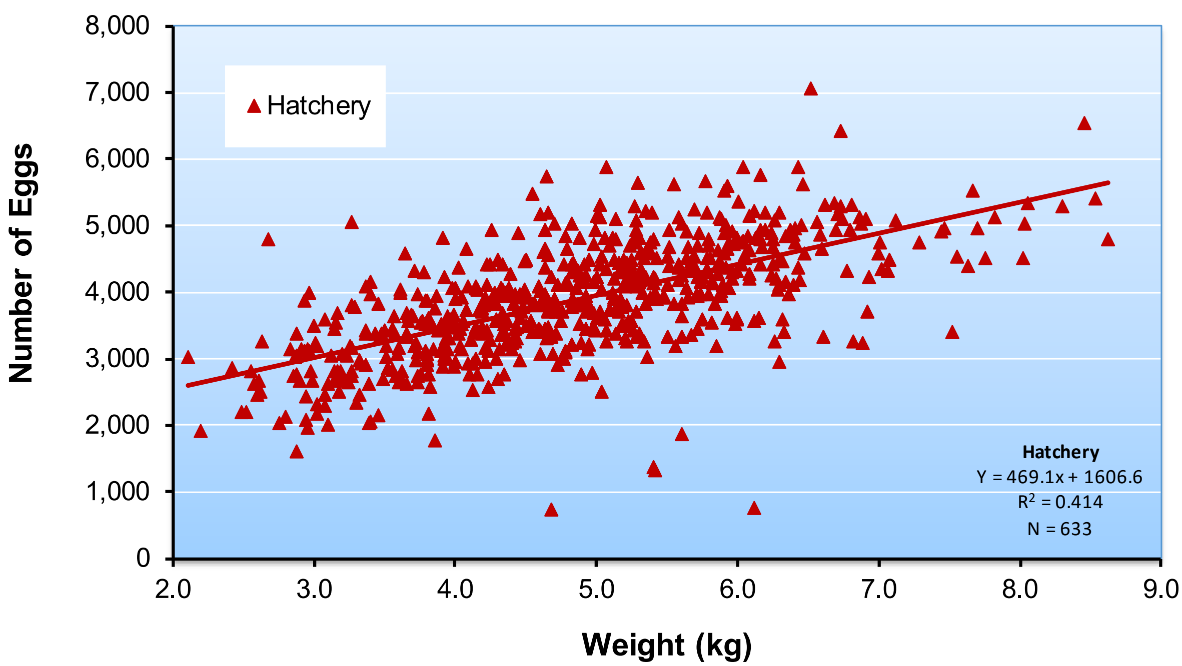


Figure 10.1. Relationships between fecundity and fork length (top figure) and fecundity and weight (bottom figure) for hatchery-origin summer Chinook for return years 2014-2017.

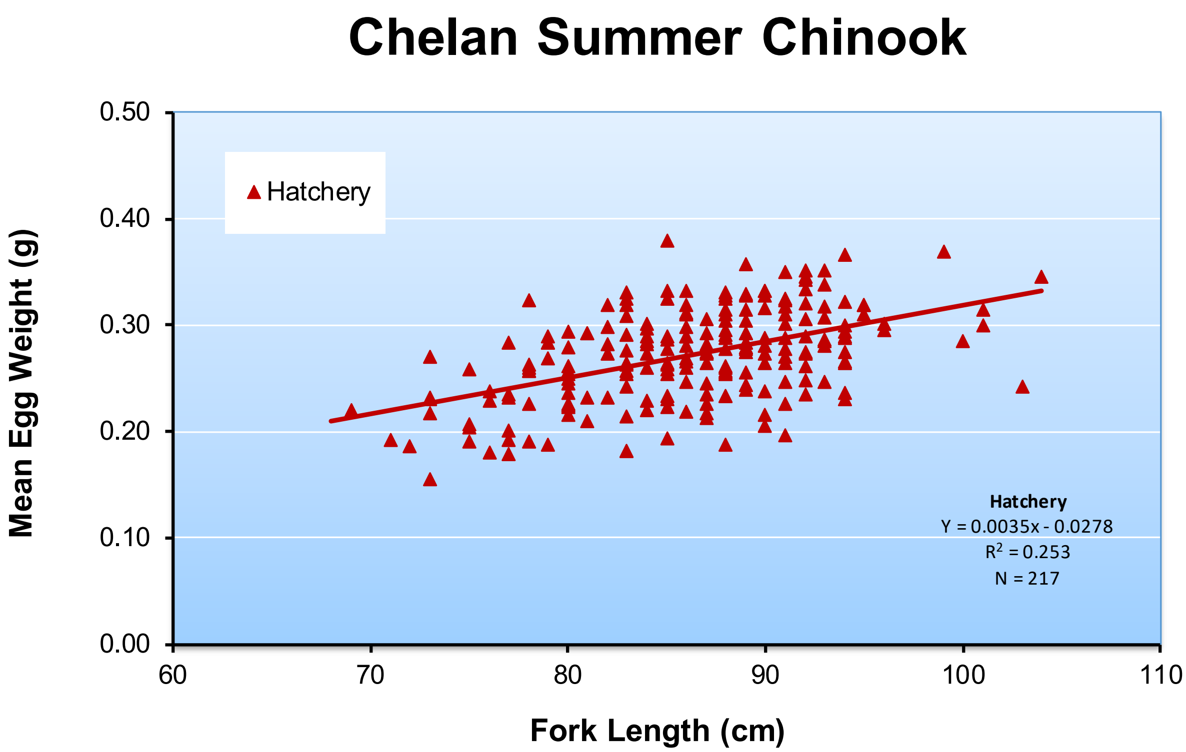


Figure 10.2. Relationships between mean egg weight and fork length for hatchery-origin summer Chinook for return years 2014-2017.

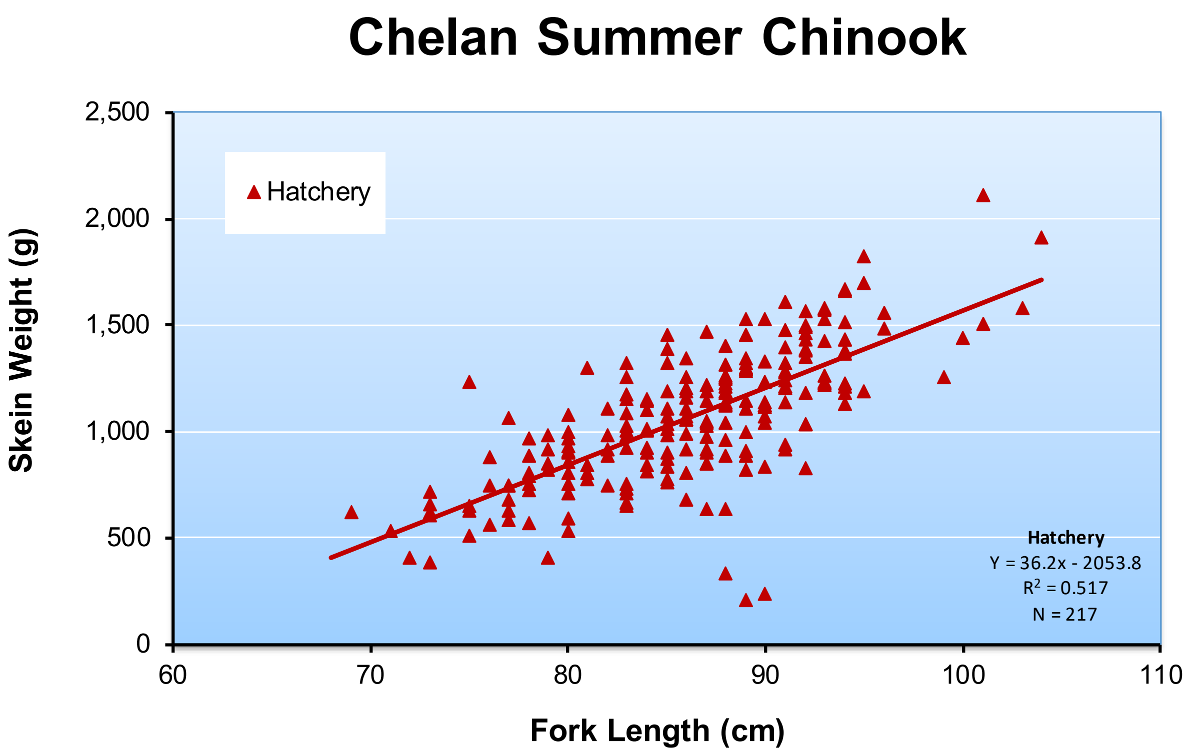


Figure 10.3. Relationships between skein weight and fork length for hatchery-origin summer Chinook for return years 2014-2017.

11.2 Hatchery Rearing

Rearing History

Number of eggs taken

Based on the unfertilized egg-to-release standard of 81%, a total of 688,995 eggs were needed to meet the program goal of 576,000 smolts for brood years 2012 and 2013. An evaluation of the program in 2014 concluded that 696,493 eggs were needed to attain the 576,000 smolts. From 2013-2017, the egg take goal has not been reached (Table 11.7).

Table 11.7. Numbers of eggs taken from summer Chinook broodstock for the Chelan Falls program, 2013-2017.

Return year	Number of eggs taken
2013	696,131
2014	618,092
2015	573,144
2016	680,448
2017	634,843
Average	***640.532***
Median	***634,843***

Number of acclimation days

Rearing of the 2015 brood Chelan Falls summer Chinook was similar to previous years with fish being held on well water at Eastbank Hatchery until transfer to the Chelan Falls Acclimation Facility for overwinter acclimation. This was the fifth year that the whole program was transferred to the Chelan Falls Acclimation Facility for final overwinter acclimation on Chelan River water. Transfer occurred on 1-3 November 2015. Fish were released volitionally on 17 April 2017 after 165-167 days of acclimation (Table 11.8).

Table 11.8. Number of days Chelan summer Chinook were acclimated at Chelan Falls Acclimation Facility, brood years 2013-2015.

Brood year	Release year	Transfer date	Release date	Number of days
2013	2015	3-6 Nov	15 Apr	160-163
2014	2016	2-4-Nov	15-18-Apr	163-168
2015	2017	1-3 Nov	17 Apr	165-167

Release Information

Numbers released

The subyearling Turtle Rock summer Chinook program was discontinued in 2010; however, releases of subyearling Chinook in past years are shown in Tables 11.9 and 11.10. Production from the subyearling programs was converted to the yearling program.

Table 11.9. Numbers of Turtle Rock summer Chinook subyearlings released from the hatchery, brood years 1995-2009. The release target for Turtle Rock summer Chinook subyearlings was 810,000 fish.

Brood year	Release year	CWT mark rate	Number of subyearlings released
1995	1996	0.1873	1,074,600
1996	1997	0.9653	385,215
1997	1998	0.9780	508,060
1998	1999	0.6453	301,777
1999	2000	0.9748	369,026
2000	2001	0.3678	604,892
2001	2002	0.9871	214,059
2002	2003	0.3070	656,399
2003	2004	0.4138	491,480
2004	2005	0.4591	411,707
2005	2006	0.4337	490,074
2006	2007	0.3388	538,392
2007	2008	0.4385	439,806
2008	2009	0.6355	309,003
2009	2010	NA	713,130

Brood year	Release year	CWT mark rate	Number of subyearlings released
Average		***0.6111***	***500,508***
Median		***0.4488***	***490.074***

Table 11.10. Numbers of Turtle Rock summer Chinook accelerated subyearlings released from the hatchery, brood years 1995-2008. The release target for Turtle Rock summer Chinook accelerated subyearlings was 810,000 fish.

Brood year	Release year	CWT mark rate	Number of subyearlings released
1995	1996	0.9834	169,000
1996	1997	0.4163	477,300
1997	1998	0.3767	521,480
1998	1999	0.6033	307,571
1999	2000	0.9556	347,946
2000	2001	0.4331	449,329
2001	2002	0.4086	480,584
2002	2003	0.5492	364,461
2003	2004	0.6414	289,696
2004	2005	0.5471	364,453
2005	2006	0.9783	457,340
2006	2007	0.5510	342,273
2007	2008	0.4745	392,024
2008	2009	0.5295	372,320
Average		***0.6034***	***381,127***
Median		***0.5482***	***368,391***

The 2015 yearling summer Chinook program achieved 75.7% of the 576,000 goal with about 442,063 fish being released from the Chelan River Acclimation Ponds (Table 11.11).

Table 11.11. Numbers of Turtle Rock/Chelan Falls summer Chinook yearling smolts released from the hatchery, brood years 1995-2015. The release target for Turtle Rock summer Chinook was 200,000 smolts for the period before brood year 2010. The current release target is 600,000 smolts.

Brood year	Release year	Acclimation facility	CWT mark rate	Number of smolts released
1995	1997	Turtle Rock	0.9688	150,000
1996	1998	Turtle Rock	0.9582	202,727
1997	1999	Turtle Rock	0.9800	202,989
1998	2000	Turtle Rock	0.9337	217,797
1999	2001	Turtle Rock	0.9824	285,707
2000	2002	Turtle Rock	0.9941	279,969
2001	2003	Turtle Rock	0.9824	203,279

Brood year	Release year	Acclimation facility	CWT mark rate	Number of smolts released
2002	2004	Turtle Rock	0.9799	195,851
2003	2005	Turtle Rock	0.9258	215,366
2004	2006	Turtle Rock	0.9578	206,734
2005	2007	Chelan	0.9810	204,644
2006	2008	Chelan	0.9752	99,271
		Turtle Rock	0.9752	43,943
2007	2009	Chelan Falls	0.9426	112,604
		Turtle Rock	0.9426	61,003
2008	2010	Chelan Falls	0.9818	200,999
		Turtle Rock	0.9818	252,762
2009	2011	Chelan Falls[a]	-	190,449
		Turtle Rock	0.9721	250,667
Average (1995-2009)		***Chelan Falls***	***0.9665***	***137,625***
		Turtle Rock	***0.9745***	***233,429***
Median (1995-2009)		***Chelan Falls***	***0.9737***	***205,007***
		Turtle Rock	***0.9781***	***190,449***
2010	2012	Chelan Falls	0.9702	563,824
2011	2013	Chelan Falls	0.9859	582,460
2012	2014	Chelan Falls	0.9879	566,188
2013	2015	Chelan Falls	0.9917	599,584
2014	2016	Chelan Falls	0.9901	465,450
2015	2017	Chelan Falls	0.9864	442,063
Average (2010-present)		***Chelan Falls***	***0.9854***	***536,595***
Median (2010-present)		***Chelan Falls***	***0.9872***	***565,006***

[a] No CWT mark rate was provided because of the early release of this group.

Numbers tagged

Brood year 2015 yearling Chinook were 98.6% CWT and 99.4% adipose fin-clipped.

On 11-15 September 2017, a total of 10,500 Chelan River summer Chinook from the 2016 brood were tagged at Eastbank Hatchery. These were tagged and released into raceway #11. Fish were not fed during tagging or for two days before and after tagging. Fish averaged 86 mm in length and 8.0 g at time of tagging. These fish were transferred to Chelan Falls Hatchery in early November 2017.

Table 11.12 summarizes the number of yearling summer Chinook that have been PIT-tagged and released from the Turtle Rock/Chelan Falls Program.

Table 11.12. Summary of PIT-tagging activities for Turtle Rock/Chelan Falls yearling summer Chinook, brood years 2007-2015; fpp = fish per pound.

Brood year	Release year	Raceway/Program	Number of fish tagged	Number of tagged fish that died	Number of tags shed	Number of tagged fish released
2007	2009	Circular Reuse	10,104	128	1	9,975
		Standard	10,102	162	3	9,937
2008	2010	Circular Reuse	11,102	20	0	11,082
		Standard	11,100	28	2	11,070
2009	2011	Turtle Rock	5,051	106	0	4,945
		Chelan Net Pens	5,050	2	0	5,048
2010	2012	Chelan Falls	4,200	10	0	4,186
2011	2013	Chelan Falls	4,101	26	0	4,075
2012	2014	Chelan Falls (small)	2,500	17	0	4,983
		Chelan Falls (large)	5,000	40	0	4,960
2013	2015	Chelan Falls (small)	5,000	41	0	4,959
		Chelan Falls (large)	5,000	37	0	4,963
2014	2016	Chelan Falls (18 fpp)	2,500	5	0	2,495
		Chelan Falls (22 fpp)	2,500	19	0	2,481
		Chelan Falls (10 fpp)	2,500	22	0	2,478
		Chelan Falls (13 fpp)	2,500	140	0	2,360
2015	2017	Chelan Falls	10,103	597	0	9,506

Fish size and condition at release

Although the subyearling summer Chinook program was discontinued, sizes of subyearlings released from Turtle Rock Hatchery before 2010 are shown in Tables 11.13 and 11.14.

Table 11.13. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Turtle Rock summer Chinook subyearlings released from the hatchery, brood years 1995-2009. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1995	1996	102	6.3	12.6	36
1996	1997	87	8.0	7.4	62
1997	1998	98	6.2	10.2	45
1998	1999	96	6.3	10.7	43
1999	2000	90	9.0	9.8	46
2000	2001	100	7.1	11.3	40
2001	2002	104	7.2	13.4	34

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
2002	2003	97	7.3	11.8	39
2003	2004	101	8.0	12.0	43
2004	2005	100	7.8	11.4	40
2005	2006	100	6.5	12.5	36
2006	2007	95	7.2	9.5	48
2007	2008	79	7.4	5.6	81
2008	2009	86	7.9	7.9	57
2009[a]	2010	89	7.1	7.0	65
Average		***95***	***7.3***	***10.2***	***48***
Targets		***112***	***9.0***	***11.4***	***40***

[a] Pre-release growth sample was conducted using pond mortalities.

Table 11.14. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Turtle Rock summer Chinook accelerated subyearlings released from the hatchery, brood years 1995-2008. Size targets are provided in the last row of the table.

Brood year	Release year	Fork length (mm)		Mean weight	
		Mean	CV	Grams (g)	Fish/pound
1995	1996	129	7.1	27.3	17
1996	1997	107	6.5	15.6	29
1997	1998	117	6.0	18.9	24
1998	1999	119	8.0	18.9	24
1999	2000	114	6.7	19.0	24
2000	2001	111	7.0	16.8	27
2001	2002	117	8.4	19.5	23
2002	2003	116	11.3	21.2	21
2003	2004	113	14.9	17.0	30
2004	2005	117	11.3	20.1	23
2005	2006	119	9.1	22.2	21
2006	2007	118	8.3	19.1	24
2007	2008	95	7.7	10.0	45
2008[a]	2009	97	8.6	10.6	43
Average		***114***	***8.6***	***18.3***	***27***
Targets		***112***	***9.0***	***11.4***	***40***

[a] The 2008 brood year was the last year of the accelerated subyearling program.

Size at release of the brood year 2015 yearling summer Chinook was 88.2% and 74.5% of the fork length and weight targets, respectively, for the Chelan Falls group. This group exceeded the target CV for length (Table 11.15).

Table 11.15. Mean lengths (FL, mm), weight (g and fish/pound), and coefficient of variation (CV) of Turtle Rock/Chelan summer Chinook yearling releases, brood years 1995-2015. Size targets are provided in the last row of the table.

Brood year	Release year	Acclimation facility	Fork length (mm)		Mean weight	
			Mean	CV	Grams (g)	Fish/pound
1995	1997	Turtle Rock	-	-	-	-
1996	1998	Turtle Rock	166	14.2	60.9	7
1997	1999	Turtle Rock	198	4.6	91.3	5
1998	2000	Turtle Rock	161	11.9	53.9	8
1999	2001	Turtle Rock	164	18.6	59.0	8
2000	2002	Turtle Rock	170	15.3	59.0	8
2001	2003	Turtle Rock	154	22.3	48.6	9
2002	2004	Turtle Rock	157	16.7	44.0	12
2003	2005	Turtle Rock	173	13.8	54.7	8
2004	2006	Turtle Rock	176	20.6	45.3	7
2005	2007	Turtle Rock	158	11.0	43.5	10
2006	2008	Chelan Nets	172	14.5	58.4	8
		Turtle Rock	157	25.8	54.1	8
2007	2009	Chelan Nets	153	18.8	45.7	10
		Turtle Rock	167	14.6	49.3	9
2008	2010	Chelan Nets	146	22.9	40.6	11
		Turtle Rock	172	15.9	58.5	8
2009	2011	Chelan Nets	158	15.1	46.6	10
		Turtle Rock	174	17.5	59.3	8
2010	2012	Chelan Falls	132	27.4	33.2	14
2011	2013	Chelan Falls	148	18.6	42.6	11
2012	2014	Chelan Falls	129	17.1	24.5	19
2013	2015	Chelan Falls	137	9.8	26.8	17
2014	2016	Chelan Falls	141	13.5	31.5	14
2015	2017	Chelan Falls	142	14.0	33.8	13
Average			***159***	***16.4***	***48.5***	***10***
Targets[a]			***161***	***9.0***	***45.4***	***13***

[a] For size-target studies, fish per pound (fpp) targets for brood year 2012 were 10, 13, 18, 22 fpp.

Survival Estimates

Normal subyearling releases

Overall survival of the normal subyearling Turtle Rock summer Chinook program from green egg to release was below the standard set for the program (Table 11.16). Lower than expected survival at ponding and post-ponding reduced the overall program performance. This program was discontinued in 2010.

Table 11.16. Hatchery life-stage survival rates (%) for Turtle Rock subyearling (zero program) summer Chinook, brood years 2004-2009. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2004	NA	NA	93.5	74.4	93.9	91.4	90.8	99.7	63.1
2005	NA	NA	94.4	87.9	85	84.8	84.2	99.4	69.8
2006	NA	NA	97.8	87.9	85.0	84.8	84.2	99.4	72.4
2007	NA	NA	92.7	84.9	88.5	86.7	84.8	99.6	66.7
2008	NA	NA	78.8	95.0	80.7	79.3	79.9	99.8	59.8
2009	NA	NA	95.0	89.4	89.5	89.2	79.7	89.5	67.7
Average	***NA***	***NA***	***92.0***	***86.6***	***87.1***	***86.0***	***83.9***	***97.9***	***66.6***
Median	***NA***	***NA***	***94.0***	***87.9***	***86.8***	***85.8***	***84.2***	***99.5***	***67.2***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

Accelerated subyearling releases

Overall survival of the accelerated subyearling Turtle Rock summer Chinook program from green egg to release was below the standard set for the program (Table 11.17). Lower than expected survival in post-ponding reduced the overall program performance. This program was discontinued in 2010.

Table 11.17. Hatchery life-stage survival rates (%) for Turtle Rock subyearling (accelerated program) summer Chinook, brood years 2004-2009. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
2004	NA	NA	92.5	98.3	93.4	92.4	90.0	97.8	81.8
2005	NA	NA	93.8	94.6	83.7	83.4	81.7	98.8	72.5
2006	NA	NA	86.1	94.6	83.7	83.4	81.7	98.8	66.5
2007	NA	NA	93.4	95.4	78.4	77.5	76.3	98.9	67.9
2008[a]	NA	NA	93.4	95.0	79.8	78.8	78.2	99.3	67.1
Average	***NA***	***NA***	***91.8***	***95.6***	***83.8***	***83.1***	***81.6***	***98.7***	***71.2***
Median	***NA***	***NA***	***93.4***	***95.0***	***83.7***	***83.4***	***81.7***	***98.8***	***67.9***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

[a] The 2008 brood year was the last year of the accelerated subyearling program.

Yearling releases

Overall survival of the 2015 brood yearling Chelan Falls summer Chinook program from green egg to release was below the standard set for the program (Table 11.18). This is largely because of lower unfertilized-egg to eyed-egg survival.

Table 11.18. Hatchery life-stage survival rates (%) for Turtle Rock/Chelan Falls yearling summer Chinook, brood years 2004-2015. Survival standards or targets are provided in the last row of the table.

Brood year	Collection to spawning		Un-fertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Un-fertilized egg-release
	Female	Male							
2004	NA	NA	92.9	97.7	96.8	96.4	95.5	99.6	86.7
2005	NA	NA	89.1	97.5	98.1	97.8	96.6	99.1	83.9
2006	NA	NA	86.2	78.8	97.6	97.1	95.2	98.7	64.8
2007 (Turtle Rock)	NA	NA	80.3	97.6	98.8	98.2	95.4	99.1	74.8
2007 (Chelan Falls)	NA	NA	80.3	97.6	98.8	98.2	94.9	97.1	74.4
2008 (Turtle Rock)	NA	NA	93.5	98.0	99.4	97.2	95.9	98.8	87.8
2008 (Chelan Falls)	NA	NA	93.5	98.0	97.6	98.7	96.4	99.3	88.2
2009 (Turtle Rock)	NA	NA	90.8	96.8	99.7	99.0	97.2	98.1	85.5
2009 (Chelan Falls)	NA	NA	90.9	96.9	99.8	99.0	96.7	97.7	85.2
2010 (Chelan Falls)	NA	NA	94.8	97.7	99.4	95.2	92.4	97.6	85.5
2011 (Chelan Falls)	NA	NA	90.0	99.4	91.7	98.2	83.4	85.2	74.6
2012 (Chelan Falls)	NA	NA	93.5	98.5	99.8	99.3	95.9	96.7	88.3
2013 (Chelan Falls)	100.0	98.1	90.6	96.5	99.5	98.9	98.5	99.7	86.1
2014 (Chelan Falls)	89.6	98.8	83.6	96.3	99.6	98.8	97.0	98.3	78.1
2015 (Chelan Falls)	95.5	97.7	85.6	97.1	99.3	98.9	93.6	95.0	77.7
Average (Chelan)	***95.0***	***98.2***	***89.0***	***96.3***	***98.4***	***98.1***	***95.0***	***97.3***	***84.4***
Median (Chelan)	***95.5***	***98.1***	***90.6***	***97.6***	***99.3***	***98.2***	***95.9***	***98.3***	***85.2***
Standard	***90.0***	***85.0***	***92.0***	***98.0***	***97.0***	***93.0***	***90.0***	***95.0***	***81.0***

11.3 Spawning Surveys

Surveys for summer Chinook redds in the Chelan River were conducted from late September to late-November 2017. Total redd counts were conducted in the river (see Appendix O for more details).

Redd Counts

A total of 421 summer Chinook redds were counted in the Chelan River in 2017 (Table 11.19). This was higher than the overall average of 311 redds.

Table 11.19. Total number of redds counted in the Chelan River, 2000-2017.

Survey year	Total redd count
2000	196
2001	240
2002	253
2003	173
2004	185
2005	179
2006	208

Survey year	Total redd count
2007	86
2008	153
2009	246
2010	398
2011	413
2012	426
2013	729
2014	400
2015	448
2016	448
2017	421
Average	***311***
Median	***250***

Redd Distribution

Summer Chinook redds were not evenly distributed among the four sampling areas within the Chelan River. Most redds (48%) were located in the Chelan Tailrace (Table 11.20. Fewer summer Chinook spawned in the Habitat Pool and Columbia Tailrace.

Table 11.20. Total number of summer Chinook redds counted in different survey areas within the Chelan River during September through early November 2017.

Survey area	Total redd count	Percent
Chelan Tailrace	203	48
Columbia Tailrace	96	23
Habitat Channel	88	21
Habitat Pool	34	8
Totals	***421***	***100***

Spawn Timing

Spawning in 2017 began the first week of October, peaked mid-October, and ended mid-November. Peak spawning occurred in the Habitat Pool in early October and during mid-October in the Chelan Tailrace, Habitat Channel, and Columbia Tailrace (Figure 11.4).

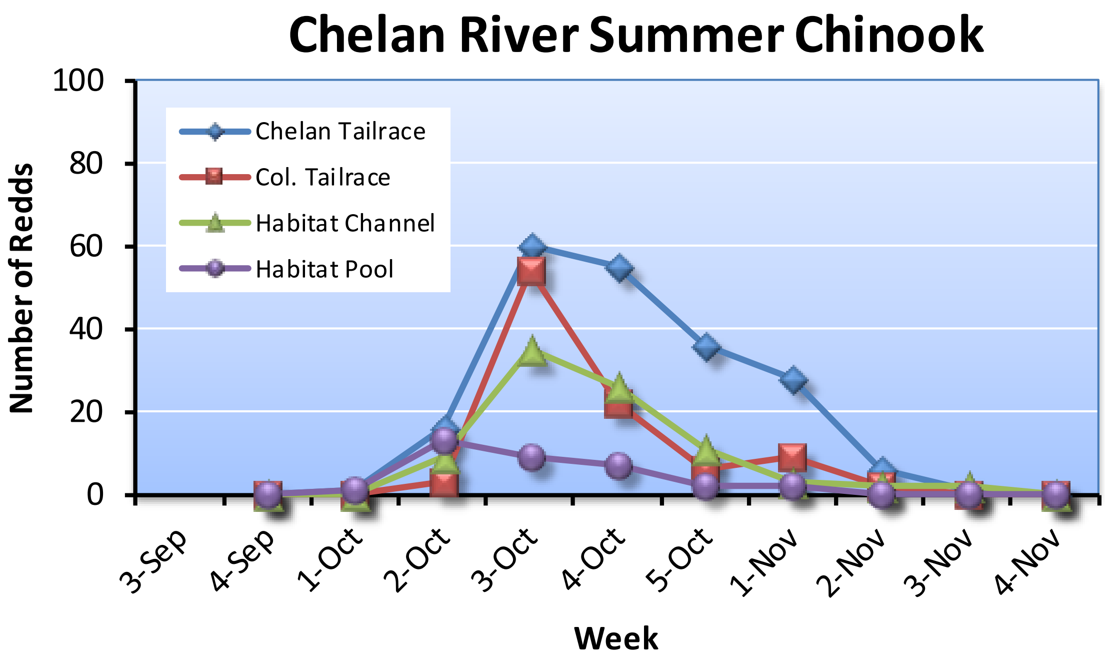


Figure 11.4. Number of new summer Chinook redds counted during different weeks within different sections of the Chelan River, September through November 2017.

Spawning Escapement

Spawning escapement for summer Chinook in the Chelan River was calculated as the total number of redds times the fish per redd ratio estimated from fish sampled at Wells Dam.[46] The estimated fish per redd ratio for Methow summer Chinook in 2017 was 2.04. Multiplying this ratio by the number of redds counted in the Chelan River resulted in a total spawning escapement of 859 summer Chinook (Table 11.21).

Table 11.21. Spawning escapements for summer Chinook in the Chelan River for return years 2000-2017.

Return year	Fish/Redd	Redds	Total spawning escapement
2000	2.40	196	470
2001	4.10	240	984
2002	2.30	253	582
2003	2.42	173	419
2004	2.25	185	416
2005	2.93	179	524
2006	2.02	208	420
2007	2.20	86	189
2008	3.25	153	497
2009	2.54	246	625

[46] Expansion factor = (1 + (number of males/number of females)).

Return year	Fish/Redd	Redds	Total spawning escapement
2010	2.81	398	1,118
2011	3.10	413	1,280
2012	3.07	426	1,308
2013	2.31	729	1,684
2014	2.75	400	1,100
2015	3.21	448	1,438
2016	2.01	448	900
2017	2.04	421	859
Average	***2.65***	***311***	***823***
Median	***2.48***	***250***	***742***

11.4 Carcass Surveys

Surveys for summer Chinook carcasses within the Chelan River were conducted during late September to mid-November 2017 (see Appendix O for more details).

Number sampled

A total of 231 summer Chinook carcasses were sampled during September through late-November in the Chelan River (Table 11.22). This was higher than the overall average of 181 carcasses sampled since 2000.

Table 11.22. Numbers of summer Chinook carcasses sampled within each survey area within the Chelan River, 2000-2017; ND = no data.

Survey year	Number of summer Chinook carcasses				
	Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	Total
2000	ND	ND	ND	ND	**48**
2001	ND	ND	ND	ND	**101**
2002	ND	ND	ND	ND	**145**
2003	ND	ND	ND	ND	**168**
2004	ND	ND	ND	ND	**159**
2005	ND	ND	ND	ND	**103**
2006	ND	ND	ND	ND	**107**
2007	ND	ND	ND	ND	**106**
2008	ND	ND	ND	ND	**132**
2009	ND	ND	ND	ND	**51**
2010	ND	ND	ND	ND	**106**
2011	ND	ND	ND	ND	**201**
2012	ND	ND	ND	ND	**317**
2013	50	120	157	28	**355**
2014	171	82	50	6	**309**

Survey year	Number of summer Chinook carcasses				
	Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	Total
2015	49	255	41	18	**363**
2016	27	128	64	34	**253**
2017	27	124	58	22	**231**
Average	***65***	***142***	***74***	***22***	***181***
Median	***49***	***124***	***58***	***22***	***152***

Carcass Distribution and Origin

In 2017, hatchery and wild summer Chinook carcasses were not distributed equally among the survey areas within the Chelan River (Table 11.23; Figure 11.5). A larger percentage of hatchery carcasses occurred in the Habitat Channel, and Habitat Pool, while a larger percentage of wild summer Chinook carcasses occurred in the Chelan Tailrace and Columbia Tailrace. There was a larger sample size of hatchery than wild summer Chinook carcasses in the Chelan River in 2017.

Table 11.23. Numbers of wild and hatchery summer Chinook carcasses sampled within different survey areas on the Chelan River, 2000-2017; ND = no data.

Survey year	Origin	Survey reach				Total
		Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	
2000	Wild	ND	ND	ND	ND	**17**
	Hatchery	ND	ND	ND	ND	**31**
2001	Wild	ND	ND	ND	ND	**26**
	Hatchery	ND	ND	ND	ND	**75**
2002	Wild	ND	ND	ND	ND	**37**
	Hatchery	ND	ND	ND	ND	**108**
2003	Wild	ND	ND	ND	ND	**33**
	Hatchery	ND	ND	ND	ND	**135**
2004	Wild	ND	ND	ND	ND	**91**
	Hatchery	ND	ND	ND	ND	**68**
2005	Wild	ND	ND	ND	ND	**42**
	Hatchery	ND	ND	ND	ND	**61**
2006	Wild	ND	ND	ND	ND	**69**
	Hatchery	ND	ND	ND	ND	**38**
2007	Wild	ND	ND	ND	ND	**35**
	Hatchery	ND	ND	ND	ND	**71**
2008	Wild	ND	ND	ND	ND	**69**
	Hatchery	ND	ND	ND	ND	**63**
2009	Wild	ND	ND	ND	ND	**2**
	Hatchery	ND	ND	ND	ND	**49**
2010	Wild	ND	ND	ND	ND	**46**
	Hatchery	ND	ND	ND	ND	**60**
2011	Wild	ND	ND	ND	ND	**89**

Survey year	Origin	Survey reach				Total
		Chelan Tailrace	Columbia Tailrace	Habitat Channel	Habitat Pool	
	Hatchery	ND	ND	ND	ND	**112**
2012	Wild	ND	ND	ND	ND	**64**
	Hatchery	ND	ND	ND	ND	**253**
2013	Wild	18	55	51	6	**130**
	Hatchery	23	65	106	22	**225**
2014	Wild	32	142	18	1	**193**
	Hatchery	17	113	23	17	**170**
2015	Wild	35	137	11	0	**183**
	Hatchery	21	117	23	21	**180**
2016	Wild	15	63	26	7	**111**
	Hatchery	12	65	38	27	**142**
2017	Wild	14	58	22	7	**101**
	Hatchery	13	66	36	15	**130**
Average	***Wild***	***23***	***91***	***26***	***4***	***144***
	Hatchery	***17***	***85***	***45***	***20***	***169***
Median	***Wild***	***18***	***63***	***22***	***6***	***130***
	Hatchery	***17***	***66***	***36***	***21***	***170***

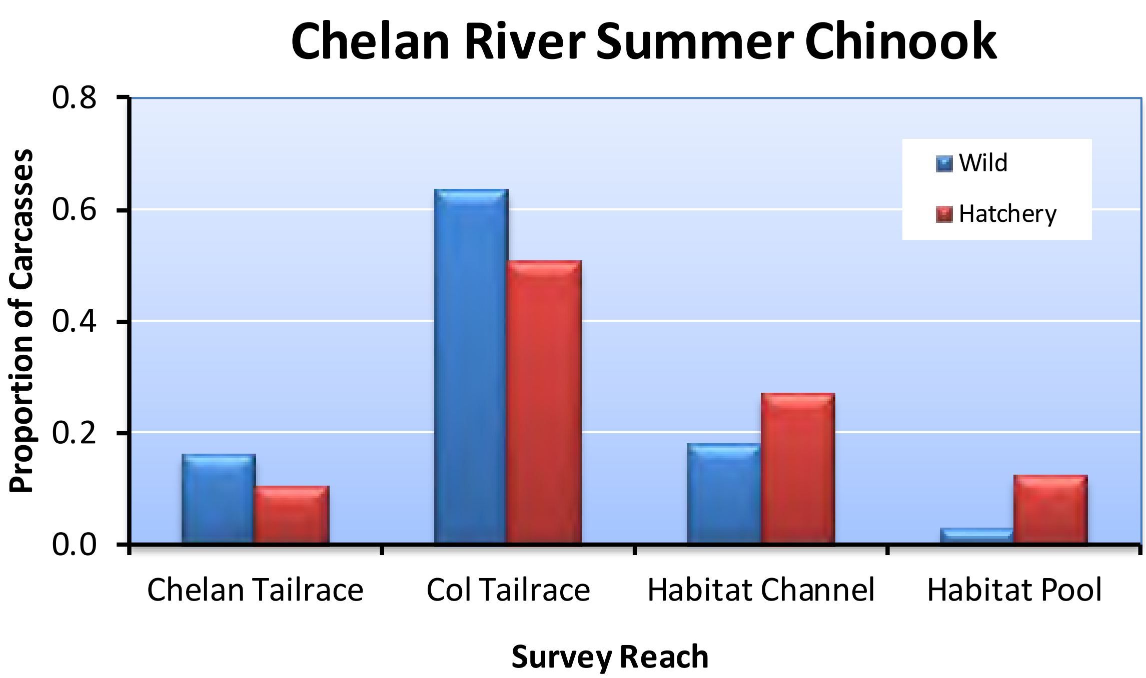


Figure 11.5. Average distribution of wild and hatchery produced carcasses in different survey areas within the Chelan River, 2013-2017.

Sampling Rate

Overall, 27% of the total spawning escapement of summer Chinook in the Chelan River was sampled in 2017 (Table 11.24). Sampling rates among survey reaches varied from 7 to 63%.

Table 11.24. Number of redds and carcasses, total spawning escapement, and sampling rates for summer Chinook in the Chelan River, 2017.

Survey reach	Total number of redds	Total number of carcasses	Total spawning escapement	Sampling rate
Chelan Tailrace	203	27	414	0.07
Columbia Tailrace	96	124	196	0.63
Habitat Channel	88	58	180	0.32
Habitat Pool	34	22	69	0.32
Total	***421***	***231***	***859***	***0.27***

Length Data

Mean lengths (POH, cm) of male and female summer Chinook carcasses sampled during surveys on the Chelan River in 2017 are provided in Table 11.25. The average size of males and females sampled in the Chelan River were 61 cm and 65 cm, respectively.

Table 11.25. Mean lengths (postorbital-to-hypural length; cm) and standard deviations (in parentheses) of male and female summer Chinook carcasses sampled in different areas on the Chelan River, 2017.

Stream/watershed	Mean length (cm)	
	Male	Female
Chelan Tailrace	65.7 (14.6)	66.3 (6.2)
Columbia Tailrace	61.3 (12.2)	65.1 (5.2)
Habitat Channel	59.5 (7.3)	63.9 (5.8)
Habitat Pool	61.5 (2.6)	65.1 (4.9)
Total	***61.3 (11.0)***	***64.9 (5.5)***

11.5 Life History Monitoring

Life history characteristics of Chelan Falls and Turtle Rock summer Chinook were assessed by examining carcasses on spawning grounds and by reviewing tagging data and fisheries statistics.

Contribution to Fisheries

Normal subyearling releases

Most of the harvest on Turtle Rock summer Chinook (normal subyearling releases) occurred in the Ocean (10-100% of the fish harvested; Table 11.26). Brood years 1995 and 2006 provided the largest total harvests, while brood year 1997 and 1998 provided the lowest. The subyearling hatchery program was discontinued after brood year 2009.

Table 11.26. Estimated number and percent (in parentheses) of Turtle Rock summer Chinook (normal subyearling releases) captured in different fisheries, brood years 1995-2009.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1995	688 (84)	106 (13)	11 (1)	16 (2)	821	75.5
1996	71 (80)	0 (0)	5 (6)	13 (14)	89	47.3
1997	11 (100)	0 (0)	0 (0)	0 (0)	11	61.1
1998	21 (100)	0 (0)	0 (0)	0 (0)	21	46.7
1999	184 (64)	26 (9)	4 (1)	75 (26)	289	75.9
2000	36 (55)	8 (12)	8 (12)	14 (21)	66	86.8
2001	162 (63)	30 (12)	20 (8)	44 (17)	256	78.0
2002	23 (20)	33 (29)	3 (3)	56 (49)	115	92.0
2003	9 (10)	55 (61)	2 (2)	24 (27)	90	76.9
2004	42 (37)	29 (25)	2 (2)	42 (37)	115	61.2
2005	100 (38)	95 (36)	24 (9)	44 (17)	263	75.1
2006	305 (41)	288 (38)	53 (7)	104 (14)	750	73.6
2007	110 (34)	91 (28)	20 (6)	104 (32)	325	66.3
2008	42 (31)	32 (24)	4 (3)	56 (42)	134	87.0
2009	82 (36)	89 (39)	6 (3)	52 (23)	229	72.9
Average	***126 (53)***	***59 (22)***	***11 (4)***	***43 (21)***	***238***	***71.8***
Median	***71 (41)***	***32 (24)***	***5 (3)***	***44 (21)***	***134***	***75.1***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Accelerated subyearling releases

Most of the harvest on Turtle Rock summer Chinook (accelerated subyearling releases) occurred in ocean fisheries (Table 11.27). Ocean harvest has made up 0% to 100% of all Turtle Rock summer Chinook harvested. Brood year 1999 provided the largest total harvest, while brood years 1995, 1997, 2002, and 2003 provided the lowest. This program was discontinued after brood year 2008.

Table 11.27. Estimated number and percent (in parentheses) of Turtle Rock summer Chinook (accelerated subyearling releases) captured in different fisheries, brood years 1995-2008.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1995	3 (100)	0 (0)	0 (0)	0 (0)	3	23.1
1996	77 (89)	5 (6)	5 (6)	0 (0)	87	46.0
1997	3 (100)	0 (0)	0 (0)	0 (0)	3	33.3
1998	102 (95)	2 (2)	3 (3)	0 (0)	107	89.9
1999	1,026 (76)	142 (10)	12 (1)	178 (13)	1,358	84.2
2000	117 (100)	0 (0)	0 (0)	0 (0)	117	79.6

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
2001	205 (59)	49 (14)	13 (4)	80 (23)	347	84.4
2002	9 (100)	0 (0)	0 (0)	0 (0)	9	75.0
2003	0 (0)	0 (0)	0 (0)	0 (0)	0	0.0
2004	50 (30)	79 (47)	6 (4)	34 (20)	169	66.5
2005	65 (59)	12 (11)	26 (24)	7 (6)	110	52.6
2006	130 (43)	113 (37)	16 (5)	43 (14)	302	57.2
2007	169 (41)	168 (41)	15 (4)	59 (14)	411	93.0
2008	20 (54)	2 (5)	4 (11)	11 (30)	37	3.4
Average	***141 (68)***	***41 (12)***	***7 (4)***	***29 (9)***	***219***	***56.3***
Median	***71 (67)***	***4 (6)***	***5 (3)***	***4 (3)***	***109***	***61.9***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Yearling releases

Most of the harvest on Turtle Rock/Chelan Falls summer Chinook (yearling releases) occurred in ocean fisheries (Table 11.28). Ocean harvest has made up 39% to 95% of all Turtle Rock/Chelan Falls summer Chinook harvested. Brood year 2010 provided the largest harvest, while brood years 1995 and 1996 provided the lowest.

Table 11.28. Estimated number and percent (in parentheses) of Turtle Rock/Chelan Falls summer Chinook (yearling releases) captured in different fisheries, brood years 1995-2011.

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
1995	456 (75)	51 (8)	31 (5)	70 (12)	608	57.0
1996	771 (95)	14 (2)	2 (0)	21 (3)	808	50.2
1997	2,835 (91)	61 (2)	27 (1)	176 (6)	3,099	63.4
1998	4,284 (90)	224 (5)	16 (0)	230 (5)	4,754	82.2
1999	1,658 (73)	233 (10)	7 (0)	383 (17)	2,281	84.3
2000	1,214 (72)	147 (9)	54 (3)	273 (16)	1,688	82.8
2001	1,952 (59)	453 (14)	178 (5)	729 (22)	3,312	83.2
2002	1,018 (50)	384 (19)	102 (5)	537 (26)	2,041	78.5
2003	758 (46)	449 (27)	70 (4)	378 (23)	1,655	73.4
2004	827 (39)	560 (26)	127 (6)	605 (29)	2,119	80.7
2005	500 (44)	303 (27)	123 (11)	206 (18)	1,132	69.1
2006	1,163 (39)	880 (30)	231 (8)	688 (23)	2,962	73.6
2007	753 (48)	398 (25)	67 (4)	349 (23)	1,567	77.8
2008	3,697 (50)	1,243 (17)	248 (3)	2,168 (30)	7,356	78.9
2009	1,698 (46)	1,106 (30)	122 (3)	743 (22)	3,669	75.4
2010	3,913 (44)	3,175 (36)	394 (4)	1,429 (16)	8,911	79.6

Brood year	Ocean fisheries	Columbia River Fisheries			Total	Percent of brood year escapement harvested[a]
		Tribal	Commercial (Zones 1-5)	Recreational (sport)		
2011	3,078 (44)	2,248 (32)	294 (4)	1,318 (19)	6,938	71.1
Average	***1,799 (59)***	***702 (19)***	***123 (4)***	***606 (18)***	***3,229***	***74.2***
Median	***1,214 (50)***	***398 (19)***	***102 (4)***	***383 (19)***	***2,281***	***77.8***

[a] Percent of brood year escapement harvested = Total brood year harvest / (Total brood year harvest + ∑Hatchery collection + ∑escapement) * 100. In other words, this indicates the percentage of all detected CWTs that ended up in harvest.

Straying

Normal subyearling releases

Assessment of straying was based on evaluating the location of CWT recoveries. There were 17 tag codes used to differentiate Turtle Rock/Chelan normal subyearling releases by brood year, release type, and location. There was one subyearling group released into the Chelan River in 2010 (brood year 2009). There were also six non-associated releases.[47] All tag codes, except brood year 2009, recovered in the Chelan River or other tributaries in the Upper Columbia were considered strays.

Rates of Turtle Rock summer Chinook (normal subyearling releases) straying into spawning areas in the upper basin have been low. Although Turtle Rock summer Chinook have strayed into other spawning areas, they made up less than 10% of the spawning escapement within those areas (Table 11.29). The Chelan tailrace has received the largest number of Turtle Rock strays. This hatchery program was discontinued after brood year 2009.

Table 11.29. Number (No.) and percent of spawning escapements within other non-target basins that consisted of Turtle Rock summer Chinook (normal subyearling releases), return years 1998-2015. For example, for return year 2003, 0.6% of the summer Chinook spawning escapement in the Okanogan River basin consisted of Turtle Rock summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1998	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	8	0.1	3	0.3	13	0.4	63	13.4	0	0.0	0	0.0
2001	0	0.0	5	0.2	13	0.1	0	0.0	0	0.0	0	0.0
2002	0	0.0	0	0.0	13	0.1	0	0.0	0	0.0	0	0.0
2003	7	0.1	7	0.2	19	0.6	6	1.4	0	0.0	0	0.0
2004	5	0.0	4	0.2	13	0.2	6	1.4	0	0.0	0	0.0
2005	5	0.1	0	0.0	5	0.1	0	0.0	2	0.5	0	0.0
2006	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2007	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2008	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2009	0	0.0	16	0.9	0	0.0	2	0.3	9	3.6	0	0.0

[47] Non-associated releases are release groups not containing any coded-wire tagged fish.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
2010	0	0.0	26	1.0	0	0.0	0	0.0	14	3.2	0	0.0
2011	0	0.0	14	0.5	0	0.0	34	2.7	0	0.0	0	0.0
2012	0	0.0	0	0.0	0	0.0	0	0.0	8	0.9	0	0.0
2013	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2014	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2015	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Average	***1***	***0.0***	***4***	***0.2***	***4***	***0.1***	***6***	***1.1***	***2***	***0.5***	***0***	***0.0***
Median	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 29% of the hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) spawners strayed into non-target streams (Table 11.30). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-100%. In addition, on average, about 2% of hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) broodstock have been included in non-target hatchery programs.

Table 11.30. Number and percent of hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1995-2009.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	64	24.1	197	74.1	5	1.9
1996	-	-	44	44.4	54	54.5	1	1.0
1997	-	-	5	71.4	2	28.6	0	0.0
1998	-	-	24	100.0	0	0.0	0	0.0
1999	-	-	52	56.5	40	43.5	0	0.0
2000	-	-	5	50.0	5	50.0	0	0.0
2001	-	-	16	22.2	56	77.8	0	0.0
2002	-	-	0	0.0	10	100.0	0	0.0
2003	-	-	0	0.0	27	100.0	0	0.0
2004	-	-	2	2.7	71	97.3	0	0.0
2005	-	-	7	8.0	80	92.0	0	0.0
2006	-	-	72	26.8	194	72.1	3	1.1
2007	-	-	34	20.6	113	68.5	18	10.9
2008	-	-	0	0.0	16	80.0	4	20.0
2009	27	42.2	8	12.5	29	45.3	0	0.0

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
Average	***27***	***42.2***	***22***	***29.3***	***60***	***65.6***	***2***	***2.3***
Median	***27***	***42.2***	***8***	***22.2***	***40***	***72.1***	***0***	***0.0***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Chelan River. Before 2009, there was no target stream because fish were release directly into the Columbia River.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Chelan River.

[3] Target hatchery includes broodstock collection at Wells Dam and Wells Hatchery.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Chelan River/Turtle Rock summer Chinook hatchery program.

Accelerated subyearling releases

Assessment of straying was based on evaluating the location of CWT recoveries. There were 16 tag codes used to differentiate Turtle Rock accelerated subyearling releases by brood year and release type. There were also four non-associated releases. All tag codes recovered in the Chelan River or other tributaries in the Upper Columbia were considered strays.

Rates of Turtle Rock summer Chinook (accelerated subyearling releases) straying into spawning areas in the upper basin have been low. Although Turtle Rock summer Chinook have strayed into other spawning areas, they made up less than 10% of the spawning escapement within those areas (Table 11.31). The Chelan tailrace, Entiat Basin, and Methow River basin have received the largest numbers of Turtle Rock strays. This hatchery program was discontinued after brood year 2008.

Table 11.31. Number (No.) and percent of spawning escapements within other non-target basins that consisted of Turtle Rock summer Chinook (accelerated subyearling releases), return years 1998-2014. For example, for return year 2001, 0.2% of the summer Chinook spawning escapement in the Methow River basin consisted of Turtle Rock summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1998	3	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1999	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2000	7	0.1	0	0.0	0	0.0	24	3.6	0	0.0	0	0.0
2001	0	0.0	12	0.4	31	0.3	0	0.0	0	0.0	0	0.0
2002	0	0.0	5	0.1	0	0.0	0	0.0	0	0.0	0	0.0
2003	0	0.0	45	1.1	0	0.0	22	5.3	13	1.9	16	0.0
2004	0	0.0	7	0.3	0	0.0	14	3.3	0	0.0	18	0.0
2005	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2006	0	0.0	0	0.0	0	0.0	0	0.0	7	1.3	0	0.0
2007	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2008	0	0.0	7	0.4	0	0.0	27	5.4	0	0.0	0	0.0
2009	19	0.2	0	0.0	0	0.0	2	0.3	0	0.0	0	0.0
2010	0	0.0	19	0.8	0	0.0	0	0.0	10	2.3	0	0.0

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
2011	17	0.2	10	0.3	10	0.1	0	0.0	15	3.2	0	0.0
2012	0	0.0	0	0.0	0	0.0	0	0.0	8	0.9	0	0.0
2013	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2014	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Average	***3***	***0.0***	***6***	***0.2***	***2***	***0.0***	***5***	***1.1***	***3***	***0.6***	***2***	***0.0***
Median	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***	***0***	***0.0***

Based on brood year analyses, on average, about 29.5% of the hatchery-origin Turtle Rock summer Chinook (accelerated subyearling releases) spawners strayed into non-target streams (Table 11.32). Depending on brood year, percent strays into non-target spawning areas have ranged from 0-83%. In addition, on average, about 1.3% of hatchery-origin Turtle Rock summer Chinook (normal subyearling releases) broodstock have been included in non-target hatchery programs.

Table 11.32. Number and percent of hatchery-origin Turtle Rock summer Chinook (accelerated subyearling releases) spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1995-2008.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	3	30.0	7	70.0	0	0.0
1996	-	-	69	67.6	33	32.4	0	0.0
1997	-	-	0	0.0	6	100.0	0	0.0
1998	-	-	10	83.3	2	16.7	0	0.0
1999	-	-	117	45.9	138	54.1	0	0.0
2000	-	-	18	60.0	12	40.0	0	0.0
2001	-	-	7	10.9	57	89.1	0	0.0
2002	-	-	0	0.0	0	0.0	0	0.0
2003	-	-	0	0.0	3	100.0	0	0.0
2004	-	-	29	24.4	90	75.6	0	0.0
2005	-	-	19	22.4	64	75.3	2	2.4
2006	-	-	7	7.1	88	88.9	4	4.0
2007	-	-	81	35.8	133	61.9	12	5.3
2008	-	-	8	25.8	21	84.0	2	6.5
Average	***-***	***-***	***26***	***29.5***	***47***	***63.4***	***1***	***1.3***
Median	***-***	***-***	***9***	***25.1***	***27***	***72.7***	***0***	***0.0***

[1] There was no target stream because fish were release directly into the Columbia River.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Chelan River.

[3] Target hatchery includes broodstock collection at Wells Dam and Wells Hatchery.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Chelan River/Turtle Rock summer Chinook hatchery program.

Yearling releases

Assessment of straying was based on evaluating the location of CWT recoveries. Yearlings have been released in the Columbia River and in the Chelan River. There were 16 tag codes used to differentiate Turtle Rock yearling releases by brood year, release type, and location. All these fish were released into the Columbia River and therefore any tag recoveries in the Chelan River or other tributaries were considered strays. In contrast, there were 21 tag codes[48] used to differentiate Chelan River yearling releases by brood year, release type, and location (there were four non-associated releases). All these fish were released into the Chelan River and therefore any tag recoveries in tributaries other than the Chelan River were considered strays.

Rates of Turtle Rock/Chelan Falls summer Chinook (yearling releases) straying into spawning areas within the Upper Columbia Summer Chinook population have varied widely depending on spawning area. Most of these fish strayed to spawning areas within the Methow River basin, Okanogan River basin, and Chelan tailrace (Turtle Rock released fish). On average, Turtle Rock summer Chinook have made up 1-12% of the spawning escapement within those basins (Table 11.33). Relatively few, on average, have strayed to spawning areas in Wenatchee River basin, and the Hanford Reach (i.e., they made up less than 1% of the spawning escapement in these areas).

Turtle Rock/Chelan Falls summer Chinook have also strayed into areas outside the Upper Columbia population. Tagged Turtle Rock/Chelan Falls hatchery summer Chinook have been detected at Lower Granite Dam on the Snake River, in Sand Hollow Creek, and at Tumwater Falls, Lyons Ferry, and Forks Creek hatcheries. However, from 1998-present, less than three Turtle Rock/Chelan Falls summer Chinook have strayed into each of these locations.

Table 11.33. Number (No.) and percent of spawning escapements within non-target basins that consisted of Turtle Rock/Chelan Falls summer Chinook (yearling releases), return years 1998-2016. For example, for return year 2003, 4.3% of the summer Chinook spawning escapement in the Methow River basin consisted of Turtle Rock summer Chinook. Percent strays should be less than 10%.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1998	0	0.0	2	0.3	0	0.0	0	0.0	0	0.0	0	0.0
1999	3	0.1	2	0.2	0	0.0	0	0.0	0	0.0	0	0.0
2000	18	0.3	57	4.8	167	4.5	73	15.5	0	0.0	10	0.0
2001	109	1.0	523	18.9	334	3.1	316	32.1	0	0.0	7	0.0
2002	92	0.6	437	9.4	194	1.4	191	32.8	136	27.1	0	0.0
2003	64	0.5	170	4.3	14	0.4	165	39.4	180	26.0	9	0.0
2004	10	0.1	55	2.5	116	1.7	75	18.0	0	0.0	0	0.0
2005	5	0.1	73	2.9	78	0.9	88	16.8	46	12.5	0	0.0
2006	0	0.0	100	3.7	25	0.3	64	15.2	30	7.5	0	0.0

[48] The Regional Mark Information System (RMIS) indicates that one tag code was released into Lake Chelan. Interestingly, some of these fish have been reported in ocean and Columbia River fisheries.

Return year	Wenatchee		Methow		Okanogan		Chelan		Entiat		Hanford Reach	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
2007	0	0.0	65	4.8	31	0.7	40	21.2	58	40.8	19	0.1
2008	18	0.3	72	3.7	60	0.9	110	22.1	46	21.4	0	0.0
2009	8	0.1	95	5.4	32	0.4	5	0.8	18	9.9	0	0.0
2010	12	0.2	105	4.2	111	1.9	0	0.0	30	11.5	0	0.0
2011	8	0.1	88	3.0	35	0.4	15	1.2	12	4.1	0	0.0
2012	21	0.2	33	1.1	43	0.5	110	8.4	29	4.5	0	0.0
2013	0	0.0	128	3.6	20	0.2	14	0.8	0	0.0	0	0.0
2014	7	0.1	20	1.2	22	0.2	16	1.5	18	3.0	0	0.0
2015	0	0.0	176	4.5	10	0.1	0	0.0	6	1.6	0	0.0
2016	0	0.0	40	1.8	13	0.1	0	0.0	0	0.0	0	0.0
Average	***20***	***0.2***	***118***	***4.2***	***69***	***0.9***	***67***	***11.9***	***32***	***8.9***	***2***	***0.0***
Median	***8***	***0.1***	***73***	***3.7***	***32***	***0.4***	***40***	***8.4***	***18***	***4.1***	***0***	***0.0***

Based on brood year analyses since 2005, on average, about 14% of the hatchery-origin Turtle Rock/Chelan Falls summer Chinook (yearling releases) spawners strayed into non-target streams (Table 11.34). Depending on brood year, percent strays into non-target spawning areas have ranged from 4-29%. In addition, on average, about 22% of hatchery-origin Turtle Rock/Chelan Falls summer Chinook (yearling releases) broodstock have been included in non-target hatchery programs.

Table 11.34. Number and percent of hatchery-origin Turtle Rock/Chelan Falls summer Chinook (yearling releases) spawners (HOS) that home to the target stream or stray into non-target streams, and the number and percent of hatchery-origin summer Chinook broodstock (HOB) collected for the target hatchery or that were collected for non-target hatcheries, brood years 1995-2011.

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
1995	-	-	278	60.7	180	39.3	0	0.0
1996	-	-	583	72.8	218	27.2	0	0.0
1997	-	-	1,531	85.6	254	14.2	3	0.2
1998	-	-	864	83.8	166	16.1	1	0.1
1999	-	-	243	57.3	181	42.7	0	0.0
2000	-	-	249	70.9	102	29.1	0	0.0
2001	-	-	279	41.8	389	58.2	0	0.0
2002	-	-	254	45.5	303	54.3	1	0.2
2003	-	-	225	37.6	373	62.3	1	0.2
2004	-	-	219	43.2	287	56.6	1	0.2
Average[b]	***-***	***-***	***473***	***59.9***	***245***	***40.0***	***1***	***0.1***
Median[b]	***-***	***-***	***266***	***59.0***	***236***	***41.0***	***1***	***0.0***

Brood year	Hatchery-origin spawner (HOS)				Hatchery-origin broodstock (HOB)			
	Homing		Straying		Broodstock Collection			
	Target stream[1]		Non-target streams[2]		Target hatchery[3]		Non-target hatcheries[4]	
	Number	%	Number	%	Number	%	Number	%
2005	149	29.4	144	28.5	202	39.9	11	2.2
2006	429	40.3	223	21.0	376	35.3	36	3.4
2007	121	27.1	69	15.4	218	48.8	39	8.7
2008	775	39.3	326	16.5	736	37.3	135	6.8
2009	96	8.0	91	7.6	877	73.3	133	11.1
2010	606	26.6	98	4.3	419	18.4	1,154	50.7
2011	364	12.9	199	7.1	276	9.8	1,980	70.2
Average[c]	***363***	***26.2***	***164***	***14.3***	***443***	***37.5***	***498***	***21.9***
Median[c]	***364***	***27.1***	***144***	***15.4***	***376***	***37.3***	***133***	***8.7***

[1] Target stream includes hatchery-origin summer Chinook that spawned in the Chelan River. Before 2005, there was no target stream because fish were release directly into the Columbia River.

[2] Non-target streams include hatchery-origin summer Chinook that spawned outside the Chelan River.

[3] Target hatchery includes broodstock collection at Wells Dam, Wells Hatchery, Eastbank Hatchery outfall, and the Chelan River.

[4] Non-target hatcheries include broodstock collections that may be strays or intercepted summer Chinook used in hatchery programs other than the Chelan River/Turtle Rock summer Chinook hatchery program.

Post-Release Survival and Travel Time

We used PIT-tagged fish to estimate survival rates and travel times (arithmetic mean days) of hatchery summer Chinook from the Turtle Rock/Chelan River release sites to McNary Dam, and smolt to adult ratios (SARs) from release to detection at Bonneville Dam (Table 11.35).[49] Over the nine brood years for which PIT-tagged hatchery fish were released, survival rates from the release sites to McNary Dam ranged from 0.423 to 0.798; SARs from release to detection at Bonneville Dam ranged from 0.010 to 0.028. Average travel times from release sites to McNary Dam ranged from 15 to 33 days.

Much of the variation in survival rates and travel time among brood years resulted from releases of different experimental groups (Table 11.35). For example, brood years 2007 and 2008 were each split into two experimental groups (Circular Reuse group and Standard Raceway group). For both brood years, survival from the release site to McNary Dam and SARs were greater for the Circular Reuse fish than for the Standard Raceway fish. For both brood years, travel time from release to McNary Dam appeared to be longer for the Standard Raceway fish than for the Circular Reuse fish.

Another experiment was conducted with brood years 2012, 2013, and 2014 (Table 11.35). These brood years were split into different treatment groups based on fish size. Based on available information, there were no clear differences in survival rates and travel times to McNary Dam among the different experimental groups. SARs for these fish will be calculated after all fish have returned to the Columbia River.

[49] It is important to point out that because of fish size differences among rearing tanks or raceways, fish PIT tagged in one tank or raceway may not represent untagged fish rearing in other tanks or raceways.

Table 11.35. Total number of Turtle Rock/Chelan Falls yearling summer Chinook released with PIT tags, their survival and travel times (mean days) to McNary Dam, and smolt-to-adult (SAR) ratios for brood years 2007-2015. Standard errors are shown in parentheses. NA = not available (i.e., not all the fish from the release groups have returned to the Columbia River); fpp = fish per pound.

Brood year	Raceway/Program	Number of tagged fish released	Survival to McNary Dam	Travel time to McNary Dam	SAR to Bonneville Dam
2007	Circular Reuse	9,975	0.722 (0.036)	22.4 (8.6)	0.017 (0.001)
	Standard	9,937	0.550 (0.034)	28.4 (11.6)	0.010 (0.001)
2008	Circular Reuse	11,082	0.631 (0.040)	26.5 (9.8)	0.028 (0.002)
	Standard	11,070	0.581 (0.038)	27.9 (18.7)	0.025 (0.001)
2009	Turtle Rock	4,945	0.603 (0.061)	15.4 (8.6)	0.018 (0.002)
	Chelan Net Pens	5,048	0.616 (0.059)	19.5 (10.2)	0.012 (0.002)
2010	Chelan Falls	4,186	0.655 (0.050)	22.5 (12.1)	0.025 (0.002)
2011*	Chelan Falls	4,075	0.552 (0.054)	27.2 (11.5)	0.016 (0.002)
2012	Chelan Falls (Small Fish)	4,983	0.590 (0.049)	25.0 (11.2)	0.010 (0.001)
	Chelan Falls (Big Fish)	4,960	0.579 (0.043)	24.4 (10.1)	0.011 (0.002)
2013	Chelan Falls (Small Fish)	4,958	0.423 (0.068)	33.0 (13.6)	NA
	Chelan Falls (Big Fish)	4,963	0.760 (0.175)	28.6 (12.4)	NA
2014	Chelan Falls (10 fpp)	2,478	0.798 (0.077)	16.4 (5.9)	NA
	Chelan Falls (13 fpp)	2,360	0.672 (0.074)	16.1 (5.6)	NA
	Chelan Falls (18 fpp)	2,495	0.637 (0.064)	18.7 (7.8)	NA
	Chelan Falls (22 fpp)	2,481	0.449 (0.049)	20.6 (9.6)	NA
2015	Chelan Falls	9,506	0.747 (0.063)	16.9 (7.4)	NA

* Brood year 2011 experienced high mortality due to fungus, bacterial cold-water disease, bacterial gill disease, and erythrocytic inclusion body syndrome during April 2013.

Smolt-to-Adult Survivals

Subyearling-to-adult and smolt-to-adult survival ratios (SARs) were calculated as the number of hatchery adult recaptures divided by the number of tagged hatchery subyearling or yearling Chinook released. For these analyses, SARs were based on CWT returns.

Normal subyearling releases

For the available brood years, SARs for normal subyearling-released Chinook have ranged from 0.000036 to 0.001886 (Table 11.36). This hatchery program was discontinued after brood year 2009.

Table 11.36. Subyearling-to-adult ratios (SARs) for Turtle Rock normal subyearling-released summer Chinook, brood years 1995-2009.

Brood year	Number released[a]	Estimated adult captures[b]	SAR
1995	201,230	204	0.001014
1996	371,848	187	0.000503
1997	496,904	18	0.000036
1998	194,723	28	0.000144
1999	197,793	203	0.001026
2000	222,460	28	0.000126
2001	211,306	328	0.001552
2002	200,163	38	0.000190
2003	203,410	49	0.000241
2004	198,019	91	0.000460
2005	197,135	143	0.000725
2006	188,250	355	0.001886
2007	194,437	216	0.001111
2008	152,993	77	0.000503
2009	341,928	133	0.000389
Average	***238,173***	***140***	***0.000660***
Median	***200,163***	***133***	***0.000503***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).

[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

Accelerated subyearling releases

For the available brood years, SARs for accelerated subyearling-released Chinook have ranged from 0.000011 to 0.004614 (Table 11.37). This hatchery program was discontinued after brood year 2008.

Table 11.37. Subyearling-to-adult ratios (SARs) for Turtle Rock accelerated subyearling-released summer Chinook, brood years 1995-2008.

Brood year	Number released[a]	Estimated adult captures[b]	SAR
1995	166,203	13	0.000078
1996	198,720	79	0.000398
1997	196,459	3	0.000015
1998	185,551	72	0.000388
1999	192,665	889	0.004614
2000	194,603	63	0.000324
2001	196,355	169	0.000861

Brood year	Number released[a]	Estimated adult captures[b]	SAR
2002	200,165	5	0.000025
2003	185,834	2	0.000011
2004	203,255	159	0.000782
2005	192,045	82	0.000427
2006	186,324	217	0.001165
2007	188,328	309	0.001641
2008	197,136	35	0.000178
Average	***191,689***	***150***	***0.000779***
Median	***193,634***	***76***	***0.000393***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).

[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

Yearling releases

For the available brood years since 2004, SARs for yearling-released Chinook have ranged from 0.008056 to 0.028164 (Table 11.38).

Table 11.38. Smolt-to-adult ratios (SARs) for Turtle Rock/Chelan Falls yearling-released summer Chinook, brood years 1995-2011.

Brood year	Number released[a]	Estimated adult captures[b]	SAR
1995	145,318	1,047	0.007205
1996	194,251	1,558	0.008021
1997	198,924	4,813	0.024195
1998	215,646	5,764	0.026729
1999	280,683	2,673	0.009523
2000	278,308	2,038	0.007323
2001	199,694	3,937	0.019715
2002	192,234	2,570	0.013369
2003	199,386	2,100	0.010532
2004	202,682	2,594	0.012798
Average[c]	***210,713***	***2,909***	***0.013941***
Median[c]	***199,540***	***2,582***	***0.011665***
2005	202,329	1,630	0.008056
2006	142,699	4,019	0.028164
2007	161,071	1,904	0.011821
2008	447,155	9,258	0.020704
2009	423,565	4,769	0.011259
2010	547,205	10,868	0.019861

Brood year	Number released[a]	Estimated adult captures[b]	SAR
2011	580,057	9,729	0.016772
Average[d]	***357,726***	***6,025***	***0.016663***
Median[d]	***423,565***	***4,769***	***0.016772***

[a] Includes all tag codes and CWT released fish (CWT + Ad Clip fish and CWT-only fish).

[b] Includes estimated recoveries (spawning ground, hatcheries, harvest, etc.) and observed recoveries if estimated recoveries were unavailable.

[c] Summary statistics for yearling Turtle Rock summer Chinook released into the Columbia River (brood years 1995-2004).

[d] Summary statistics for yearling Turtle Rock/Chelan River summer Chinook released into the Chelan River (brood years 2005 to present).

11.6 ESA/HCP Compliance

Broodstock Collection

The 2015 brood Chelan Falls (formerly Turtle Rock) summer Chinook program was supported through adult collections at the Eastbank outfall and surplus adults from Chief Joe Hatchery. During 2015, broodstock collections at the Eastbank outfall were consistent with the 2015 Upper Columbia River Salmon and Steelhead Broodstock Objectives and site-based broodstock collection protocols as required in ESA permit 1347. The 2015 collection target totaled 350 summer Chinook. Actual 2015 broodstock collection was 351 adults.

Hatchery Rearing and Release

The brood year 2015 release totaled 442,063 yearling fish. These releases represented 76.7% of the 576,000 Rocky Reach HCP and ESA Section 10 Permit 1347 production for the Chelan Falls yearling summer Chinook production. Lower than expected fecundities (82.3% of projected) and fertilization rates (85.6%) were the primary factors for not meeting the release goal.

Hatchery Effluent Monitoring

Per ESA Permits 1196, 1347, 1395, 18118, 18120, and 18121, permit holders shall monitor and report hatchery effluents in compliance with applicable National Pollution Discharge Elimination Systems (NPDES) (EPA 1999) permit limitations. There were no NPDES violations reported at Eastbank Hatchery or the Chelan Falls Acclimation Facility during the period 1 January through 31 December 2016. NPDES monitoring and reporting for Chelan PUD Hatchery Programs during 2017 are provided in Appendix F.

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SECTION 13: APPENDICES

Appendix A: **Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River Basin, Washington, 2017.**

Appendix B: **Fish Trapping at the Chiwawa and Wenatchee Smolt Traps during 2017.**

Appendix C: **Summary of CSS PIT-Tagging Activities in the Wenatchee River Basin, 2017.**

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Appendix A

Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River basin, Washington, 2017

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January 25, 2018

TO: HCP Hatchery Committee

FROM: Tracy Hillman

Subject: Abundance and Total Numbers of Chinook Salmon and Trout in the Chiwawa River basin, Washington, 2017

The Chelan County Public Utility District (PUD) hatchery program is operated through a habitat conservation plan (HCP) that was incorporated into the PUD's license in 2004. The HCP directed the signatories to develop a monitoring and evaluation plan within one year of the effective date. This resulted in the development of the Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Hatchery Programs (Murdoch and Peven 2005). In 2017, the Hatchery Committees updated the hatchery monitoring and evaluation plan (Hillman et al. 2017). This study will help the Hatchery Committees determine if it is meeting Objective 2 in the updated monitoring and evaluation plan.

Objective 2: *Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks.*

We estimated densities and total numbers of age-0 spring Chinook salmon *Oncorhynchus tshawytscha,* trout *Oncorhynchus* sp., and char *Salvelinus* sp. in the Chiwawa River basin, Washington, in August 2017. This was the 25th year of an ongoing study to assess the freshwater productivity (juveniles/redd) of Chinook salmon in the Chiwawa River basin. We used landscape classification to stratify streams in the basin that supported juvenile Chinook salmon (Hillman and Miller 2004). Classification "explained" most of the variability in fish numbers caused by geology, land type, valley bottom type, stream state condition, and habitat type. We identified ten reaches on the lower 31 miles (50 km) of the Chiwawa River and one reach in each of Phelps, Rock, Chikamin, Big Meadow, Alder, Brush, Clear, Y, and Unnamed[1] creeks (Figure 1). Each reach consisted of several combinations of state-type and habitat-type strata. We used classification to find reference areas for reaches in the Chiwawa River. We matched Reach 3 and Reach 8 of the Chiwawa River with a moderately-confined section of Nason Creek (RM 0.62-1.70) and an unconfined area of the Little Wenatchee River (RM 4.39-8.55), respectively (Hillman and Miller

[1]Unnamed tributary that drains the eastside of Chiwawa Ridge. Its confluence with the Chiwawa River is about 1 mile (1.6 km) downstream from the mouth of Phelps Creek.

2004). Because of the supplementation program in Nason Creek, the use of Nason Creek as a reference for the Chiwawa River is no longer valid. Therefore, we no longer sample in Nason Creek. Following methods described in Hillman and Miller (2004), we used underwater observations to estimate numbers of fish in 208 randomly selected sites.

During sampling in August 2017, discharge in the Chiwawa River averaged 214 cubic feet per second (cfs) and ranged from 133-329 cfs (Figure 2). Stream temperatures during the study period ranged from 9.0 to 17.0ºC. Fish species observed in the Chiwawa River basin and reference areas during the 1992-2017 survey period[2] included: spring Chinook salmon, coho salmon *O. kisutch*, sockeye salmon *O. nerka*, steelhead/rainbow trout *O. mykiss* (hatchery rainbow were present only in 1992 and 1993), cutthroat trout *O. clarki lewisi*, bull trout *S. confluentus*, brook trout *S. fontinalis*, mountain whitefish *Prosopium williamsoni*, dace *Rhinichthys* sp., northern pikeminnow *Ptychocheilus oregonensis*, suckers *Catostomus* sp., and sculpin *Cottus* sp. The age-0 spring Chinook that we observed in the Chiwawa River basin during the 2017 survey were produced from 312 redds counted in the fall of 2016 (Hillman et al. 2017). Assuming a mean fecundity of 4,467 eggs per female Chinook (from females collected for broodstock), and that no female produced more than one redd (Murdoch et al. 2009), we estimated that the Chiwawa River basin was seeded with 1,393,704 eggs in 2016 (Appendix A).

In 2017, riffles made up the largest fraction of habitat types in reaches of the Chiwawa River basin (54% of the total stream surface area) (Table 1). Pools (23%), glides (7%), and multiple channels (16%) constituted the remaining 46% of the stream surface area. We found woody debris associated with most multiple-channel habitat.

Chinook Salmon Abundance

Chinook salmon were the most abundant salmonid in the Chiwawa River basin. We estimated, based on surface area, that age-0 Chinook salmon numbered 102,106 (±9% of the estimated total) in the Chiwawa River basin in August 2017 (Table 2). Extrapolating based on volume of habitat types, age-0 Chinook numbered 129,574 (±8%) in the Chiwawa River basin. About 8% of the juvenile Chinook were in tributaries to the Chiwawa River. During the 1992-2017 surveys, numbers of age-0 Chinook ranged from 5,815 to 149,563 in the Chiwawa River basin (Figure 3; Appendix A and B). Most of the difference in juvenile numbers among years resulted from different seeding (stock) levels (Figure 4). Numbers of Chinook redds in the Chiwawa River basin during 1992-2017 ranged from 13 to 1,078, resulting in seeding levels of 66,248 to 4,984,672 eggs (Appendix A).

As in most years, age-0 Chinook in 2017 were distributed contagiously among reaches in the Chiwawa River (Table 2). In the Chiwawa River, densities of age-0 Chinook were highest in the upper reaches (Reaches 7-10). The highest densities in the Chiwawa River basin were in tributaries to the Chiwawa River (Table 2). Age-0 Chinook were most abundant in multiple channels and pools, and least abundant in glides and riffles. We found the majority of the Chinook associated with woody debris in multiple channels (multiple channel use index = 2.82)[3]. These sites (multiple

[2] The study period 1992-2017 includes only 25 years of sampling because there was no sampling in 2000.

[3] The habitat use index was calculated as follows: Multiple channel use = $(parr_{mc}/parr_{t})$ / $(area_{mc}/area_{t})$, where parr $_{mc}$

channels) made up 16% of the total surface area of the Chiwawa River basin, but they provided habitat for 44% of all the age-0 Chinook in the basin in 2017 (Appendix C). In contrast, riffles made up 54% of the total surface area, but provided habitat for only 12% of all age-0 Chinook in the Chiwawa River basin (riffle use index = 0.24). Pools made up 23% of the total surface area and provided habitat for 43% of all age-0 Chinook in the basin (pool use index = 1.60). Few Chinook used glides that lacked woody debris (glide use index = 0.25).

As noted earlier, we assumed that the Chiwawa River was seeded with 1,393,704 Chinook eggs (312 redds times 4,467 eggs/female) in fall, 2016, and that at least 102,106 of those survived to August 2017. This means that the egg-to-parr survival was at least 7.3% (95% confidence bound 6.6-8.0%). During 1992-2017, egg-to-parr survival averaged 7.9% (range 2.7-19.1%) in the Chiwawa River basin (Appendix A). This survival rate comports with those from other streams. For example, Mullan et al. (1992) estimated an egg-to-parr survival rate of 9.8% for spring Chinook salmon in Icicle Creek, a tributary of the Wenatchee River. Using a Beverton and Holt model, Hubble (1993) estimated that egg-to-parr survival of Chinook in the Chewuck River, a tributary to the Methow River, ranged between 13% and 32%, depending on percent seeding level in the basin. Kiefer and Forster (1991) estimated a mean egg-to-parr survival rate of 5.5% (range 5.1-6.7%) for naturally-spawning spring Chinook salmon in the entire upper Salmon River. They also noted that egg-to-parr survival of natural spawners and adult outplants in the headwater streams of the upper Salmon River averaged 24.4% (range 16.1-32.0%). Petrosky (1990) reported an egg-to-parr survival range of 1.2-29.0% for Chinook in the upper Salmon River, Idaho. Konopacky et al. (1986) estimated egg-to-parr survival of Chinook in Bear Valley Creek, Idaho, as 8.1-9.4%. Work by Richards and Cernera (1987) in Bear Valley Creek indicated an egg-to-parr survival of 2.1%.

Mean densities of age-0 Chinook salmon in one reach on the Chiwawa River were not consistently greater than those in a corresponding reference area (Little Wenatchee River) (Figure 5). Mean densities of age-0 Chinook in pools and riffles were greater in the Chiwawa River than in the reference area, while mean densities of age-0 Chinook in glides and multiple channels were greater in the reference area than in the Chiwawa River. Within both the Chiwawa River and its reference area, pools and multiple channels consistently had the highest densities of age-0 Chinook.

We estimated a total of 526 (±32% of the estimated total) age-1+ Chinook salmon in the Chiwawa River basin in August 2017 (Table 3). In August 1992-2017, numbers of age-1+ Chinook ranged from 5 to 967 in the Chiwawa River basin (Figure 3; Appendix B). These fish occurred throughout the Chiwawa River. We found relatively few age-1+ Chinook in tributaries. Age-1+ Chinook were most abundant in multiple channels and pools.

= the number of parr counted in multiple channel habitat, $parr_t$ = the total number of parr counted within all habitat types, $area_{mc}$ = the area of multiple channel habitat within the sampling frame, and $area_t$ = the total area of the sampling frame. A multiple channel use index value of 1 would indicate that parr were uniformly distributed among habitat types and exhibited no preference for multiple habitat types. Values greater than 1 indicate use of multiple channels to a greater extent than the average, while scores between 0 and 1 indicate below-average use of multiple channel habitat.

Juvenile Chinook Salmon Productivity (Fish/Redd)

Freshwater productivity of juvenile Chinook salmon was estimated as the number of parr (age-0 Chinook) per redd in the Chiwawa River basin. Theoretically, the relationship between number of parr and redds can be explained mathematically provided the relationship between the two parameters goes through the origin, increases monotonically at low spawning levels, and shows some level of density dependence at high spawning levels. We identified four alternative hypotheses that may explain the relationship between spawning level (redds) and numbers of age-0 Chinook:

1. The first hypothesis assumed that the number of juveniles increases constantly toward an asymptote as the number of redds increases. After the asymptote is reached, the number of juveniles neither increases nor decreases. The asymptote represents the maximum number of juveniles the system can support (i.e., carrying capacity for the system). This hypothesis was modeled with a Beverton-Holt curve that took the form:

$$\boldsymbol{J = \frac{(\alpha R)}{(\beta + R)}}$$

   where $\boldsymbol{J}$ is the number of juvenile (age-0) Chinook, $\boldsymbol{R}$ is the number or redds, $\boldsymbol{\alpha}$ is the maximum number of juveniles produced, and $\boldsymbol{\beta}$ is the number of redds needed to produce (on average) juveniles equal to one-half the maximum number of juveniles.

2. The second hypothesis, like the first, assumed that the number of juveniles increases toward an asymptote (carrying capacity) as the number of redds increases. After the carrying capacity is reached, the number of juveniles neither increases nor decreases. The carrying capacity represents the maximum number of juveniles the system can support. This hypothesis was modeled with a smooth hockey stick function that took the form:

$$\boldsymbol{J = J_\infty \left(1 - e^{-\left(\frac{\alpha}{J_\infty}\right)R}\right)}$$

   where $\boldsymbol{J}$ and $\boldsymbol{R}$ are as above, $\boldsymbol{\alpha}$ is the slope at the origin of the spawner-recruitment curve, and $\boldsymbol{J_\infty}$ is the carrying capacity of juveniles.

3. The third hypothesis assumed that the number of juveniles increases to a maximum and then declines as the number or redds increases. In this case, mortality rate of juveniles (or eggs) is proportional to the initial number of redds. Higher mortality rate is associated with density-dependent growth coupled with size-dependent predation. This hypothesis was modeled with a Ricker curve that took the form:

$$\boldsymbol{J = \alpha R e^{-\beta R}}$$

   where $\boldsymbol{J}$ and $\boldsymbol{R}$ are as above, $\boldsymbol{\alpha}$ is the number of juveniles per redd at low spawning levels, and $\boldsymbol{\beta}$ describes how quickly the juveniles per redd drop as the number of redds increases.

4. The fourth hypothesis, like the first, assumed that the number of juveniles increases constantly, but unlike the first, the number of juveniles does not reach an asymptote. Rather, the number of juveniles increases indefinitely, but at a slowing rate of increase. This hypothesis was modeled with both a Cushing curve and a Gamma function. The

Cushing curve took the form:

$$\boldsymbol{J = \alpha R^{\gamma}}$$

where $\boldsymbol{J}$ and $\boldsymbol{R}$ are as above, $\boldsymbol{\alpha}$ is the number of juveniles per redd at low spawning levels, and $\boldsymbol{\gamma}$ describes the level of density dependence at high spawning levels. The Gamma function is a three-parameter model that has the form:

$\boldsymbol{J = \alpha R^{\gamma} e^{-\beta R}}$.

This is an un-normalized gamma function that is similar to the Cushing curve when $\beta = 0$.

We used Akaike's Information Criterion for small sample size (AIC_c) to determine which model(s) best explained the productivity of juvenile Chinook in the Chiwawa River basin. AIC_c was estimated as:

$$\boldsymbol{AIC_c = -2log\left(£(\theta|data)\right) + 2K + \left(\frac{2K(K+1)}{n-K-1}\right)}$$

where ***log(£(θ|data))*** is the maximum likelihood estimate, $\boldsymbol{K}$ is the number of estimable parameters (structural parameters plus the residual variance parameter), and $\boldsymbol{n}$ is the sample size (Burnham and Anderson 2002). We used least-squares methods to estimate ***log(£(θ|data))***, which was calculated as $\boldsymbol{log(\sigma^2)}$, where $\boldsymbol{\sigma^2}$ = residual sum of squares divided by the sample size ($\boldsymbol{\sigma^2 = RSS/n}$). AIC_c assesses model fit in relation to model complexity (number of parameters). The model with the smallest AIC_c value represents the "best approximating" model within the model set. Remaining models were ranked relative to the best model using AIC_c difference scores (**ΔAIC_c**), Akaike weights ($\boldsymbol{w_i}$), and evidence ratios. Models with **ΔAIC_c** values less than 2 indicate that there is substantial support for these models as being the best-fitting models within the set (Burnham and Anderson 2002). Models with values greater than 2 have less support. Akaike weights are probabilities estimating the strength of the evidence supporting a particular model as being the best model within the model set. Models with small $\boldsymbol{w_i}$ values are less plausible as competing models (Burnham and Anderson 2002). If no single model could be specified as the best model, a "best subset" of competing models was identified using (1) AIC_c differences to indicate the level of empirical support each model had as being the best model, (2) evidence ratios based on Akaike weights to indicate the relative probability that any model is the best model, and (3) coefficients of determination (R^2) assessing the explanatory power of each model.

The use of AIC_c indicated that the Beverton-Holt model best approximated the information in the juveniles/redd data (Table 4; Figure 6). The estimated structural parameters for this model were:

$$Juveniles = \frac{(153{,}309 \times Redds)}{(192 + Redds)}$$

where the bootstrap estimated standard errors for the two parameters were 17,109 and 56, respectively. The adjusted $R^2 = 0.84$.

The second-best model was the smooth hockey stick model, which was 1.70 AIC_c units from the best model (Table 4; Figure 6). The estimated parameters for this model were:

$$LN(Juveniles) = 11.7 + LN\left(1 - e^{-\left(\frac{716.0}{116,554}\right)Redds}\right)$$

where the bootstrap estimated standard errors of the two parameters were 0.08 and 129, respectively, and the R^2 = 0.83. The AIC_c difference scores, Akaike weights, and evidence ratios indicated that there was substantial support for both the Beverton-Holt and smooth hockey stick models (Table 4). There was less support for the remaining models (Ricker, Gamma[4], and Cushing), which were > 2 AIC_c units from the best models. This was further supported by the fact that, relative to the best models, the remaining models had evidence ratios greater than 20.

Because there was substantial support for both the Beverton-Holt and smooth hockey stick models, we used model averaging to compute a weighted estimate of the predicted values (productivity and population capacity[5]) (Burnham and Anderson 2002). Model averaging estimated a population capacity of 142,283 parr and an intrinsic productivity of 774 parr per spawner.

Although the Beverton-Holt, smooth hockey stick, and Ricker models have different biological assumptions, they all indicated a density-dependent relationship between spawning levels (redds) and juvenile Chinook production in the Chiwawa River basin. This was not only evident in the best approximating models, but there was also a significant negative relationship between juveniles per redd and numbers of redds in the Chiwawa River basin (Figure 7). Although data at high seeding levels are lacking, the Beverton-Holt model estimates the population capacity of juvenile Chinook in the Chiwawa River basin at about 153,309 parr. This equates to about 1,176 Chinook parr per hectare. In contrast, the smooth hockey stick model, which fit the data as well as the Beverton-Holt model, estimates the population carrying capacity for juvenile Chinook at about 116,554 parr. This equates to about 894 Chinook parr per hectare. As noted above, model averaging estimates the population capacity at 142,283, which equates to 1,091 Chinook parr per hectare. As a comparison, Thorson et al. (2013) estimated the carrying capacity for 15 populations of juvenile Chinook in the Snake River metapopulation as 5,000 juveniles per hectare. However, those authors noted that the estimate could be biased because of imperfect detectability and estimates of spawning numbers.

Steelhead/Rainbow Abundance

Based on stream surface area, we estimated a total of 17,296 (±10% of the estimated total) age-0 steelhead/rainbow (<4 in) in reaches of the Chiwawa River basin in August 2017 (Table 5). During the 1992-2017 survey period, numbers of age-0 steelhead/rainbow ranged from 1,410 to 45,727 in the Chiwawa River basin (Figure 8; Appendix B). In 1992-2017, numbers of age-0 steelhead/rainbow varied among reaches, but were typically highest in the lower reaches of the Chiwawa River. In all years they most often used riffle and multiple channel habitats in the Chiwawa River, although we also found them associated with woody debris in pool and glide habitat. In tributaries, they were generally most abundant in small pools. Those that we observed

[4] The γ parameter in the Gamma model was greater than 0, which means that this model is nearly identical to the Ricker model.

[5] In these analyses, we are calculating "population" carrying capacity (*K*), which is defined as the maximum equilibrium population size estimated with population models. This should not be confused with "habitat" carrying capacity (*C*), which is defined as the maximum population of a given species that a particular environment can sustain.

in riffles selected stations in quiet water behind small and large boulders or occupied stations in quiet water along the stream margin. In pool and multiple-channel habitats, we found age-0 steelhead/rainbow using the same kinds of habitat as age-0 Chinook salmon.

We estimated that 6,923 (±7% of the estimated total) age-1+ steelhead/rainbow (4-8 in) lived in reaches of the Chiwawa River basin in August 2017 (Table 6). During the survey period 1992-2017, numbers of age-1+ steelhead/rainbow ranged from 754 to 22,130 (Figure 8; Appendix B). In most years, we found these fish in nearly all reaches, but they were typically most numerous in lower reaches of the Chiwawa River. We observed age-1+ steelhead/rainbow mostly in pool, riffle, and multiple-channel habitats. Those that we observed in pools were usually in deeper water than age-0 steelhead/rainbow and Chinook. Like age-0 steelhead/rainbow, age-1+ steelhead/rainbow selected stations in quiet water behind boulders in riffles, but we generally did not find the two age groups together. Age-1+ steelhead/rainbow appeared to use deeper and faster water than did age-0 steelhead/rainbow.

We estimated that steelhead/rainbow larger than 8 inches numbered 20 (±40% of the estimated total) in the Chiwawa River basin in August 2017 (Table 7). During the period 1992-2017, steelhead/rainbow numbers ranged from 8 to 1,869 (Appendix B). Steelhead/rainbow larger than 8 inches were most abundant in the lower Chiwawa River; however, in 1992 and 1993, they were most abundant near campgrounds in Reaches 8, 9, and 10 (these were mostly hatchery rainbow trout planted near the campgrounds). We found very few in tributaries. Most of the steelhead/rainbow larger than 8 inches used deep pools (>5 feet), and occupied stations near the bottom at the upstream end of pools.

Bull Trout Abundance

We estimated, based on surface area that at least 258 (±26% of the estimated total) juvenile (2-8 in) bull trout lived in reaches of the Chiwawa River basin in August 2017 (Table 8). We found most of these fish in the upper-most reaches of the Chiwawa River and in Rock, Chikamin, and Phelps creeks. During 1992-2017, numbers of juvenile bull trout ranged from 79 to 505 (Figure 9; Appendix B). These estimates and those for adult bull trout are incomplete because we did not sample the entire range of bull trout in all tributaries. That is, we did not extend our surveys into the headwaters of the Chiwawa River because there were no juvenile Chinook there. Areas beyond the distribution of juvenile Chinook salmon are known to support bull trout, steelhead/rainbow, and cutthroat trout (USFS 1993). In addition, our estimates of bull trout abundance were based on daytime snorkel surveys, which may underestimate the actual abundance of bull trout.[6] Several studies (e.g., Goetz 1994; Thurow and Schill 1996; Hillman and Chapman 1996; Bonar et al. 1997) have found bull trout population estimates based on nighttime snorkeling to be in some cases more accurate than daytime snorkeling, especially for juvenile bull trout. Our estimates of adult bull trout numbers may be more accurate than those for juveniles.

In all years, we found most juvenile bull trout in the upstream reaches of the Chiwawa River. In 2017, they occurred primarily in Reaches 8-10 on the Chiwawa River. We found the majority of

[6] Because there are no estimates for probability of detecting bull trout with daytime underwater observation methods in the Chiwawa River basin, we could not adjust bull trout numbers based on detectability. Therefore, the numbers reported in this report likely underestimate the "true" number of bull trout in the survey area.

these fish in multiple channels, pools, and riffles, and few in glides. They consistently occupied stations close to the stream bottom over rubble and small boulder substrate or near woody debris. This is similar to the observation of Pratt (1984) in the upper Flathead River Basin in Montana. She found that juvenile bull trout lay close to instream cover and that they tended to conceal themselves. Consequently, she found it difficult to estimate accurately their numbers. Although this implies that we underestimated numbers of juvenile bull trout in the Chiwawa River, the relative distribution of juvenile bull trout is valid if we assume that we saw the same fraction of juveniles in all reaches (i.e., detection probability was the same across survey sites).

We estimated a total of 1,284 (±11% of the estimated total) adult (>8 in) bull trout in reaches of the Chiwawa River basin in August 2017 (Table 9). This was the second highest number of adult bull trout that we recorded during the more than 20-year survey period. During 1992-2017, numbers of adult bull trout ranged from 76 to 2,286 (Figure 9; Appendix B). As with juvenile bull trout, we found most of the adult bull trout upstream from Reach 6; although they were found in nearly all reaches on the Chiwawa River. We found few adult bull trout in tributaries of the Chiwawa River. Adult bull trout primarily used pools and multiple channel habitat, although most of the smaller adults (<10 in) used riffles.

Abundance of Other Salmonids

In August 2017, we estimated that at least 45 brook trout, an exotic species closely related to the bull trout, occurred in the Chiwawa River, Chikamin Creek, Big Meadow Creek, Minnow Creek, and in the Little Wenatchee River survey areas. In both the Chiwawa and Little Wenatchee rivers, brook trout usually used multiple channels and pools. Few appeared to be bull trout/brook trout hybrids. In Chikamin, Minnow, and Big Meadow creeks, brook trout were most abundant in pools. Brook trout lengths ranged from 2-12 inches.

At least 562 westslope cutthroat trout occurred in the Chiwawa River, Phelps Creek, Rock Creek, and Little Wenatchee River survey areas in August 2017. This was the second highest number of cutthroat trout observed in the study area. These fish most often occurred in pools and multiple channel habitats. They ranged in size from 2-23 inches. Few juvenile coho salmon were observed in the lower Chiwawa River.

We observed both juvenile and adult mountain whitefish in the Chiwawa River, Phelps Creek, Rock Creek, and the Little Wenatchee River survey areas. In sum, at least 9,388 adult and 1,198 juvenile whitefish lived in these streams in August 2017. We found few whitefish in most tributaries to the Chiwawa River.

Conclusion

This was the 25th year of a study to monitor trends in juvenile spring Chinook production in the Chiwawa River basin. As shown in Figure 3, numbers of juvenile Chinook salmon in the Chiwawa River basin have fluctuated widely over the 25-year period. Numbers of juveniles in 2001, 2002, and 2009-2017 were some of the highest recorded, while numbers in the mid-1990s were some of the lowest. Interestingly, the highest spawning escapements (highest redd numbers) resulted in the lowest egg-parr survival rates (Appendix A). This is supported by the fact that the best approximating models clearly demonstrated a density-dependent relationship between seeding levels and juvenile production. Indeed, there was a significant negative relationship between parr per redd and numbers of redds in the Chiwawa River basin. This is an important observation because some of the hypotheses in the revised monitoring and evaluation plan (Hillman et al. 2013) are only valid when the supplemented population is below its carrying capacity.

The best fitting stock-recruitment models indicate that the population capacity of the Chiwawa River basin is between 117,000 to 153,000 spring Chinook parr. This equates to an overall density of about 894-1,176 parr per hectare. These densities can be achieved with about 488 redds. Assuming a female Chinook produces only one redd (Murdoch et al. 2009), a spawning escapement of about 488 females is needed to fill the capacity of the Chiwawa River basin.

The proportion of hatchery-origin spawners (pHOS) within the Chiwawa River basin during the survey period has ranged from 0 to 100%. Thus, some of the variation in juvenile productivity may be related to pHOS. Although there appeared to be a negative relationship between juvenile productivity (parr/redd) and pHOS, the correlation was not significant (Figure 10). In addition, there was no relationship between juvenile productivity and pHOS after the effects of spawning escapement were removed from the analysis (Figure 10). This suggests that spawning escapement has a larger effect on juvenile productivity than does the presence of hatchery spawners.

The presence of density dependence in the early life stages of spring Chinook is not surprising. Rarely does density dependence appear in numbers of adult spring Chinook or on their spawning grounds. The Chiwawa River basin appears to have plenty of spawning habitat, as indicated by the large numbers of spawners and redds widely distributed throughout the basin during high spawning escapements. However, those large spawning escapements did not translate into large numbers of juveniles or smolts. Thus, density-dependent regulation appears to occur sometime during the early life stages of the fish, likely at the fry or early parr stage. It is possible that physical habitat (space) during higher flows when fry are emerging may limit juvenile Chinook production in the basin. Low nutrient levels and its effects on food webs may also be a limiting factor in the basin. If spawning escapements remain relatively high, marine-derived nutrients should increase in the basin, resulting in more food for juvenile Chinook salmon.

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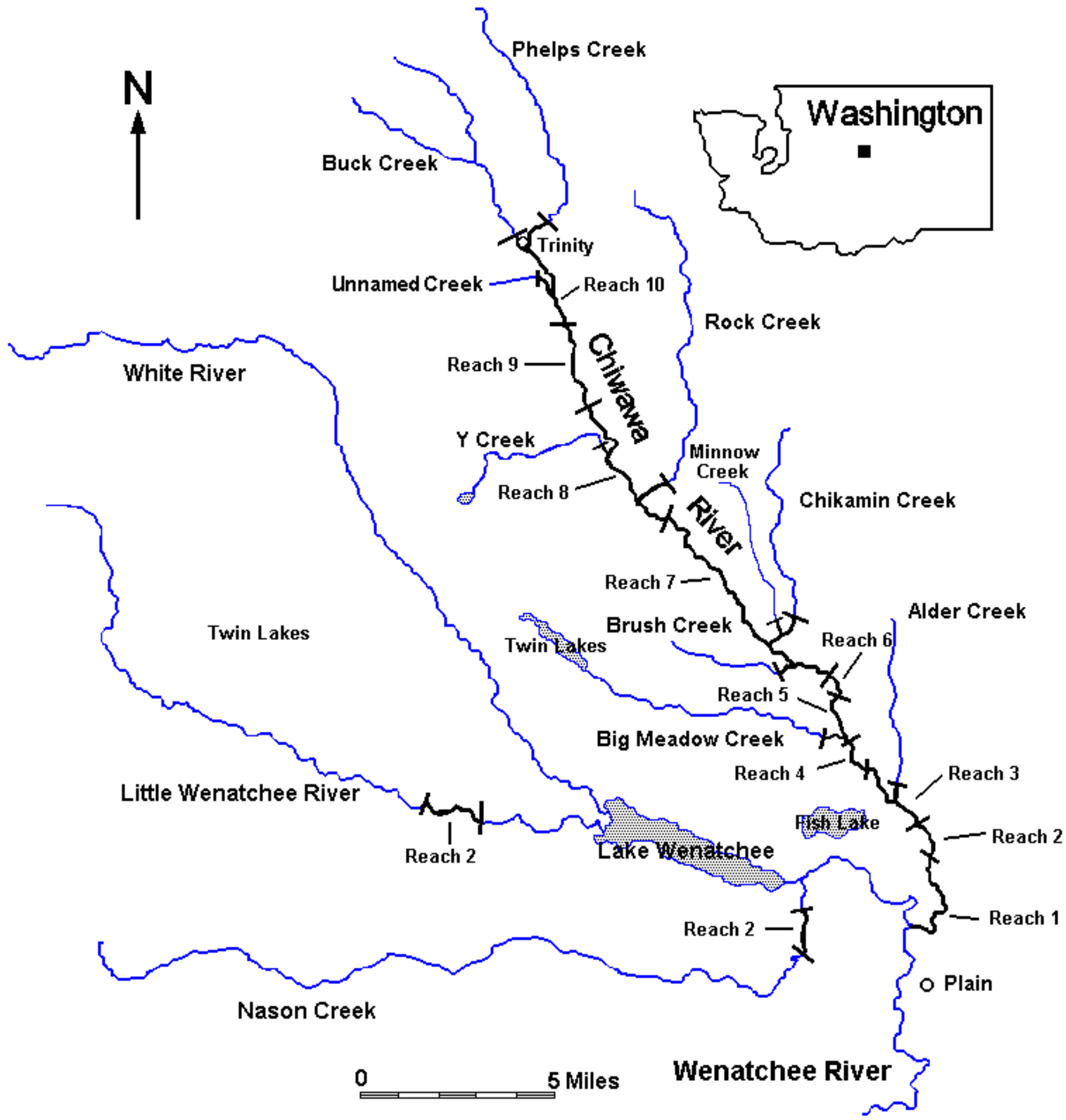

Figure 1. Location of study reaches on the Chiwawa River, and Chikamin, Rock, Big Meadow, Unnamed, Alder, Brush and Phelps creeks, Chelan County, Washington. Reach 2 on Nason Creek and Reach 2 on the Little Wenatchee River were matched with Reaches 3 and 8 on the Chiwawa River, respectively. Nason Creek is no longer used as a reference.

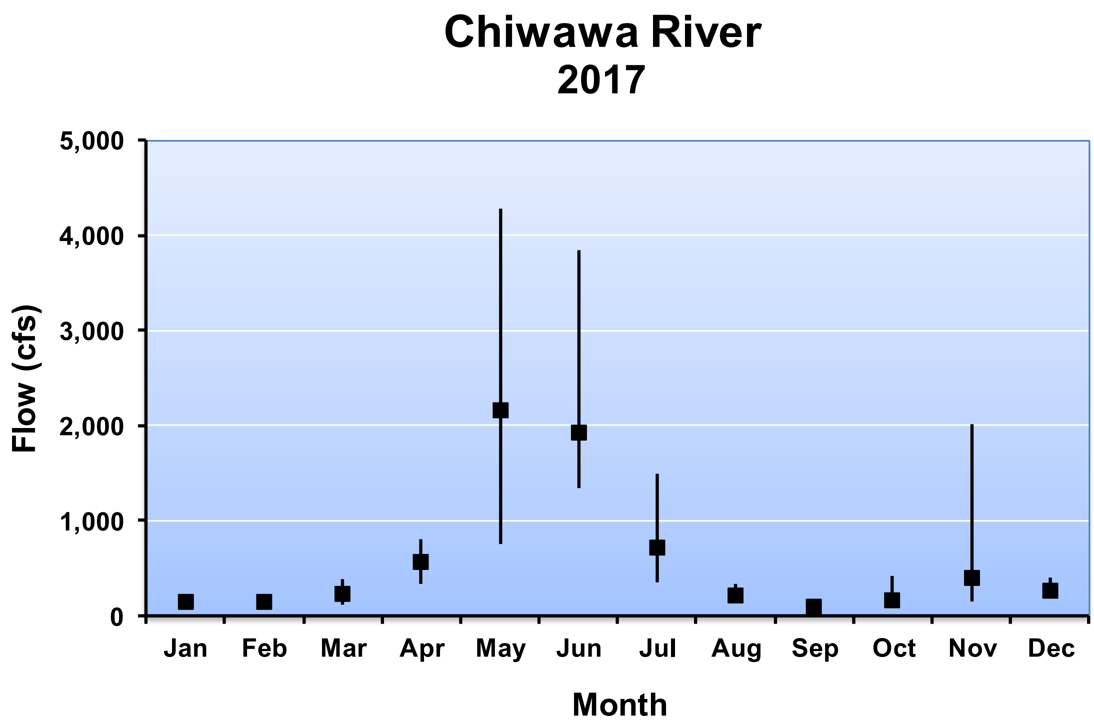

Figure 2. Mean, minimum, and maximum monthly flows in the Chiwawa River for 2017.

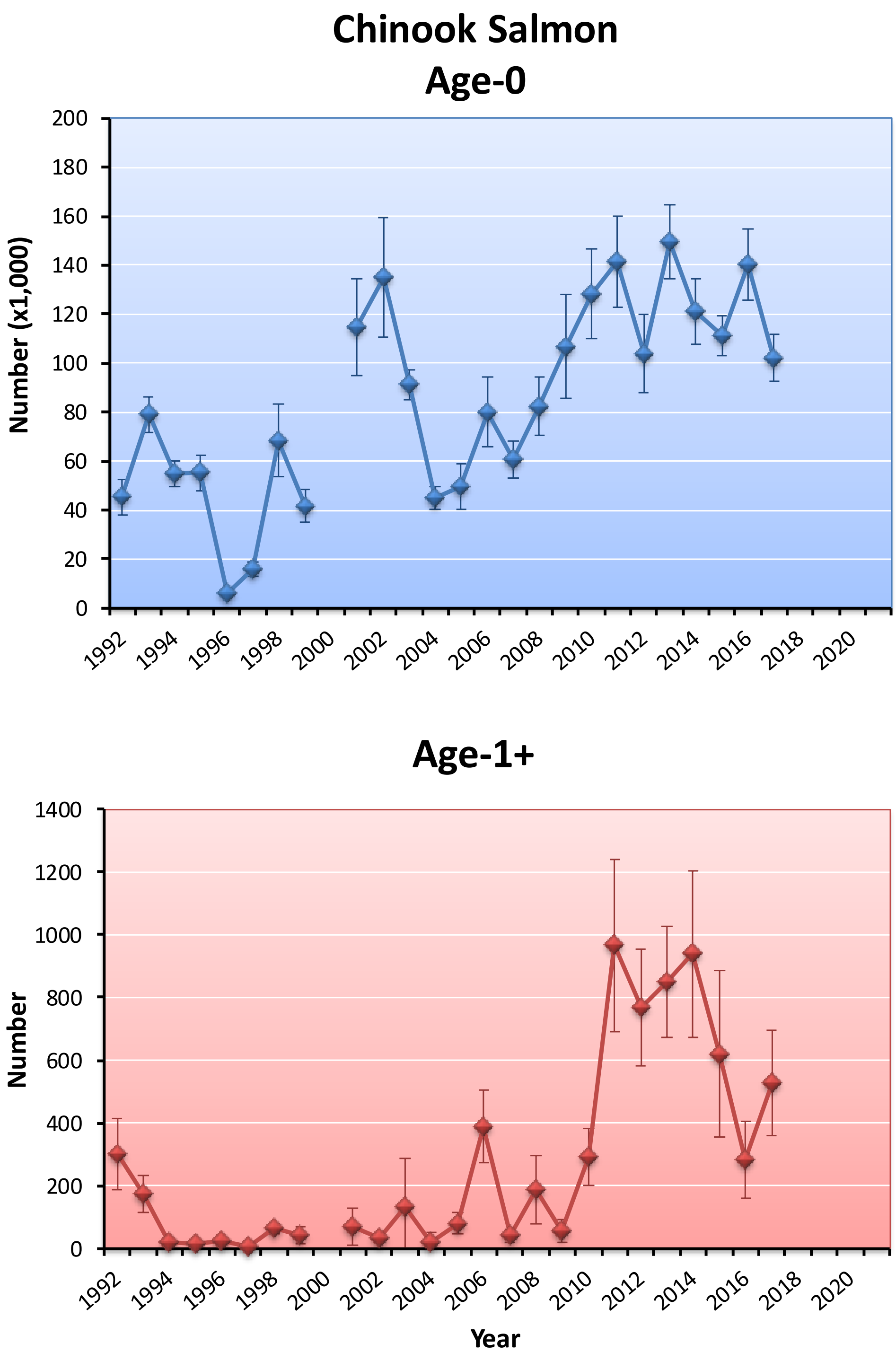

Figure 3. Numbers of age-0 and age-1+ Chinook salmon within the Chiwawa River basin in August 1992-2017; ND = no data. Vertical bars indicate 95% confidence bounds.

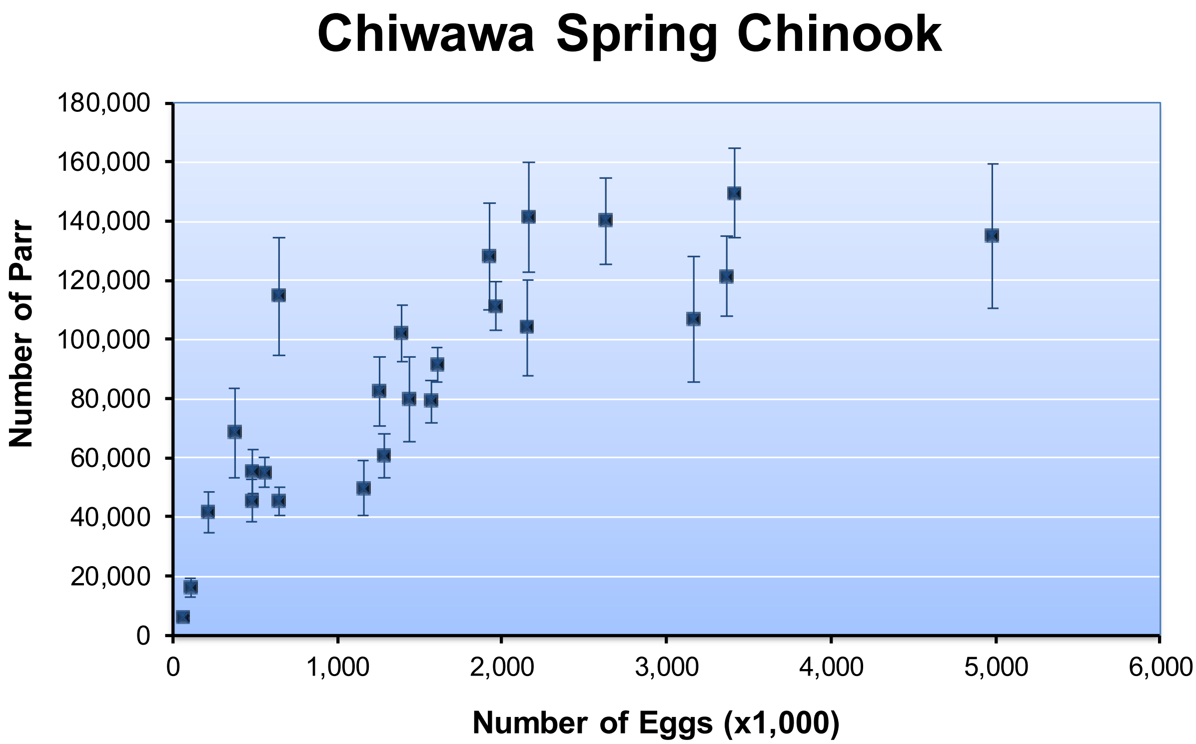

Figure 4. Relationship between total number of Chinook salmon parr counted during the summer (based on fish/ha) and number of eggs deposited in the Chiwawa River basin, 1992-2017. Vertical bars indicate 95% confidence bounds.

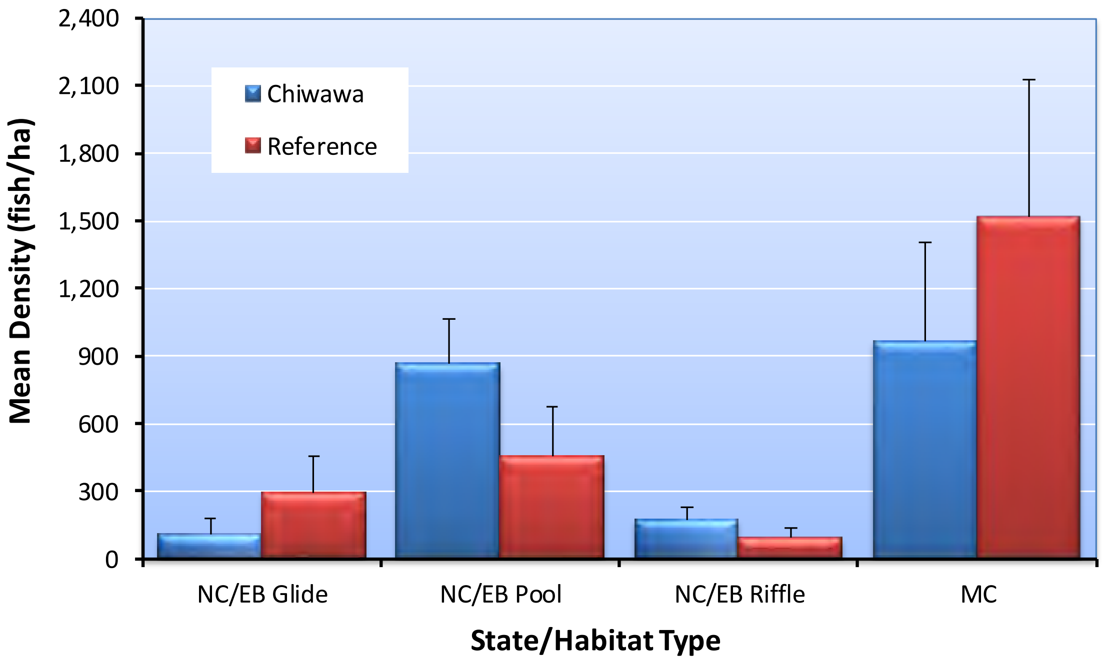

Figure 5. Comparison of the means (95% CI) of age-0 Chinook salmon densities (fish/ha) within state/habitat types in Reach 8 of the Chiwawa River and their matched reference areas on the Little Wenatchee River. There was no sampling in 2000 and no sampling in reference areas in 1992.

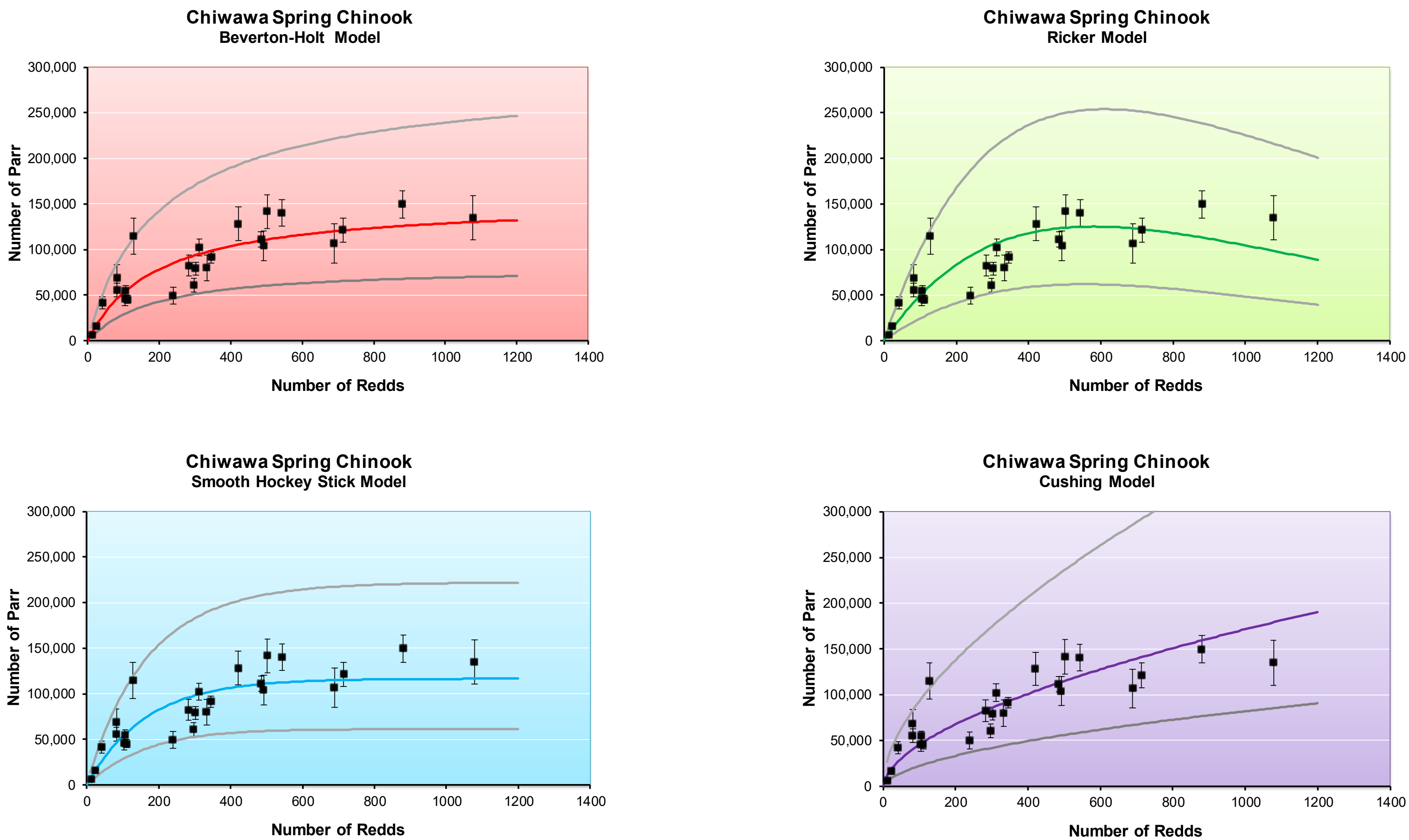

Figure 6. Relationship between numbers of juvenile (age-0) Chinook and redds in the Chiwawa River basin, 1992-2017 (no sampling occurred in 2000). Figures show the fit of the Beverton-Holt model, smooth hockey stick, Ricker model, and the Cushing model to the data. Gray lines indicate the upper and lower 95% C.B.

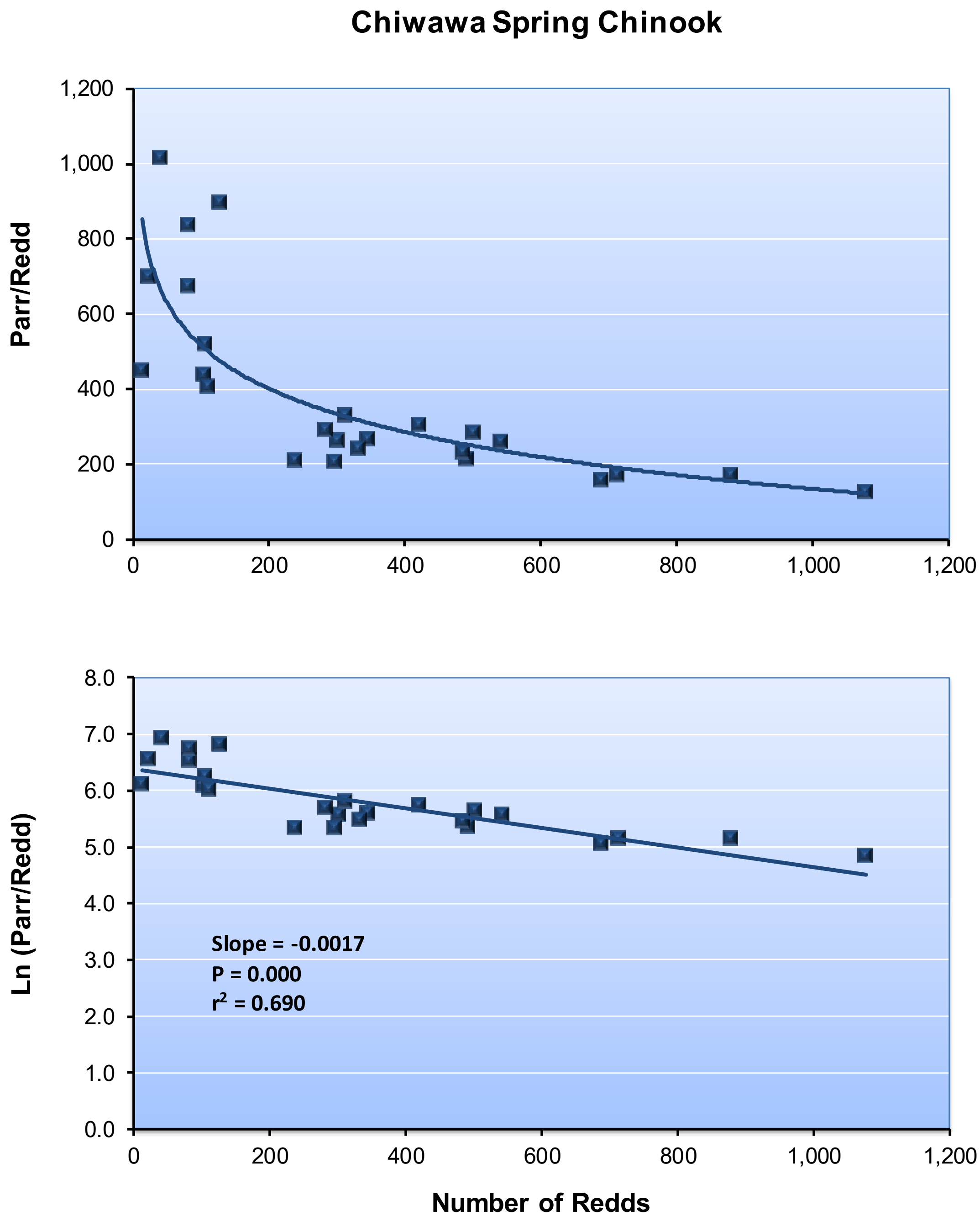

Figure 7. Relationship between parr/redd and numbers of redds (top figure) and natural log parr/redd and numbers of redds (bottom figure) in the Chiwawa River basin, 1992-2017. No sampling was conducted in 2000. Estimates for 1993-2017 included the Chiwawa River and its tributaries; the 1992 estimate included only the Chiwawa River. The linear relationship LN(P/R) = 6.3763 – 0.0017(Redds) was significant with P = 0.000; $r^2 = 0.690$.

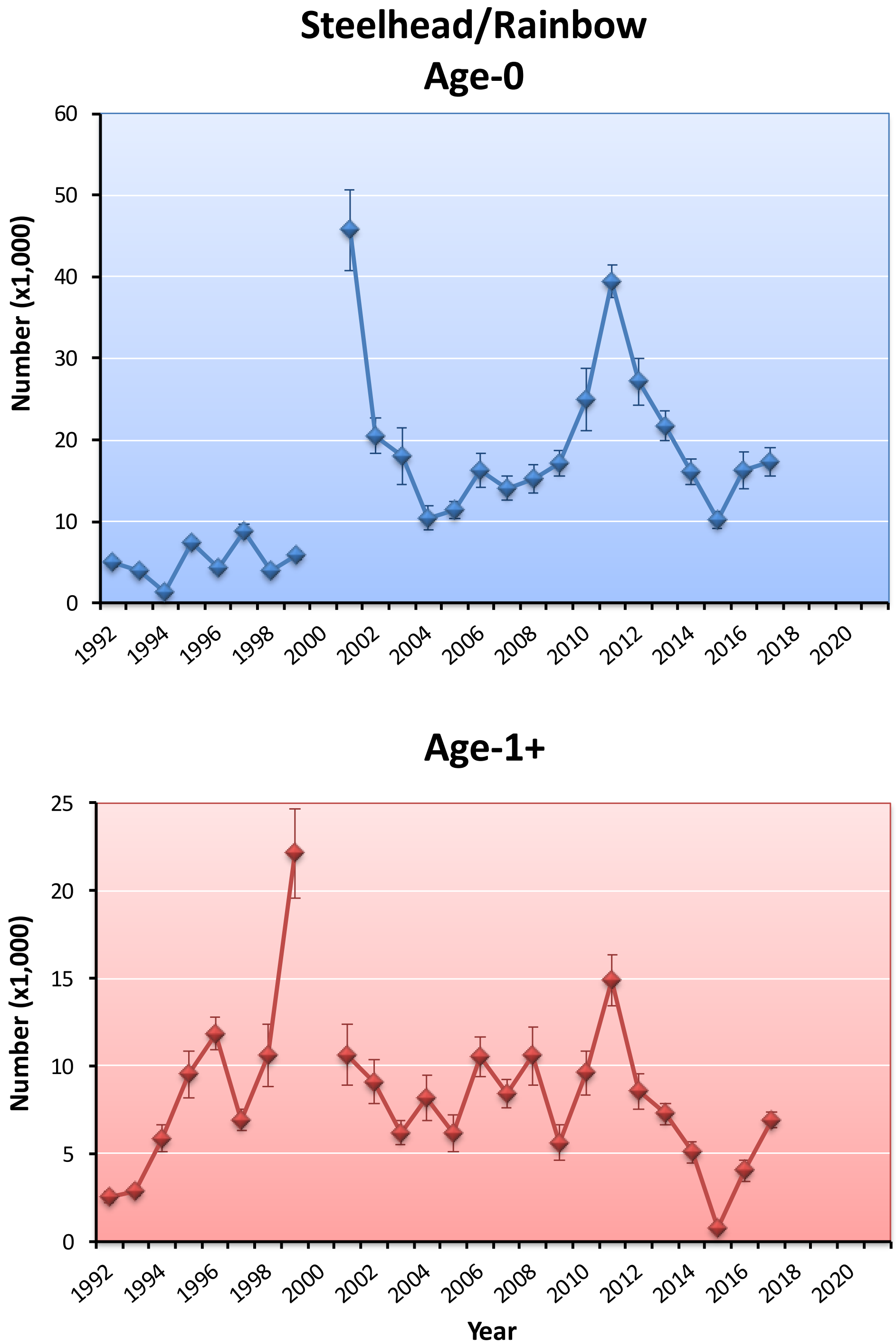

Figure 8. Numbers of age-0 (<4 in) and age-1+ (4-8 in) steelhead/rainbow within the Chiwawa River basin in August 1992-2017; ND = no data. Vertical bars indicate 95% confidence bounds.

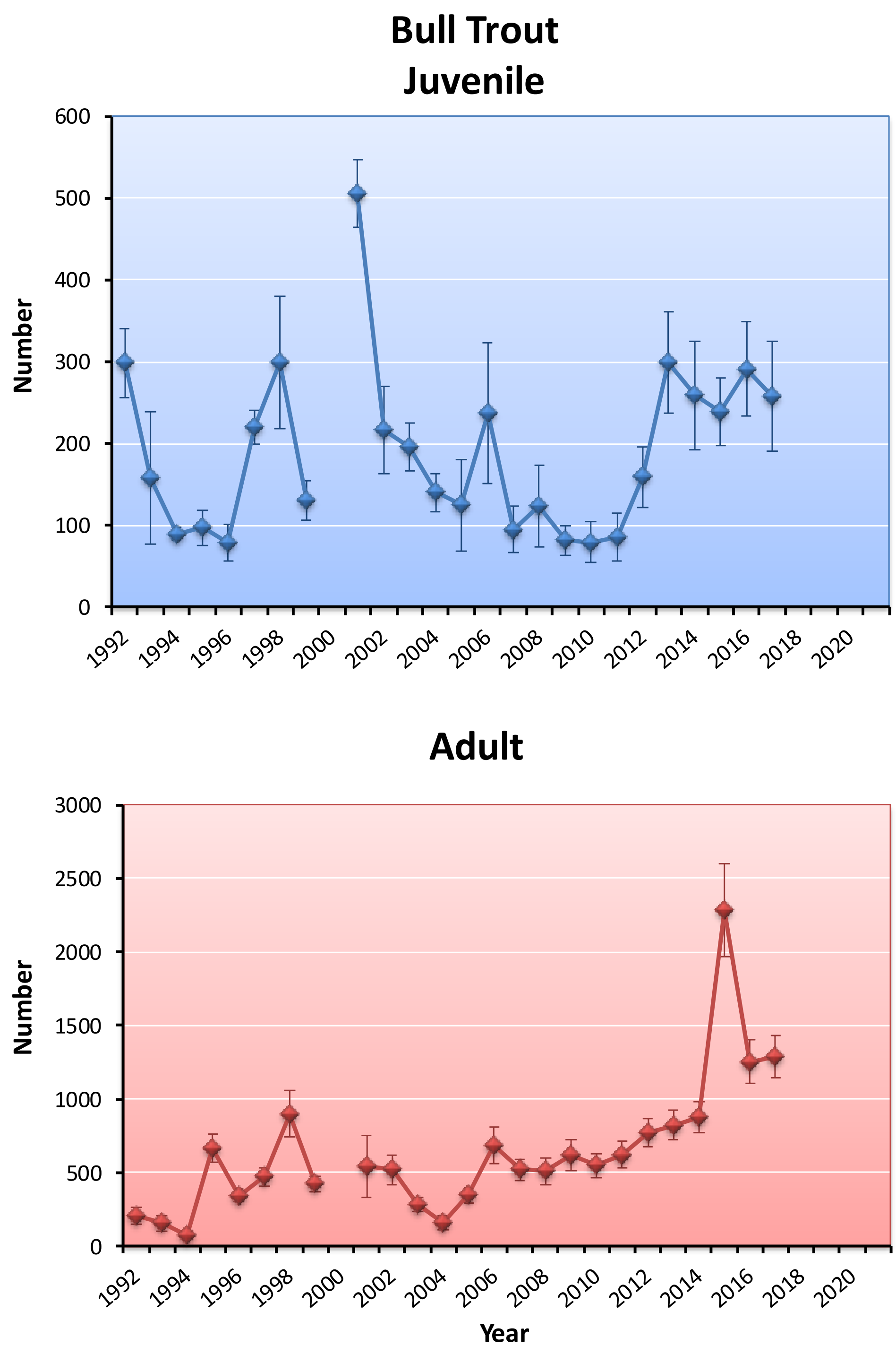

Figure 9. Numbers of juvenile (2-8 inches) and adult (>8 inches) bull trout within the Chiwawa River basin in August 1992-2017; ND = no data. Vertical bars indicate 95% confidence bounds.

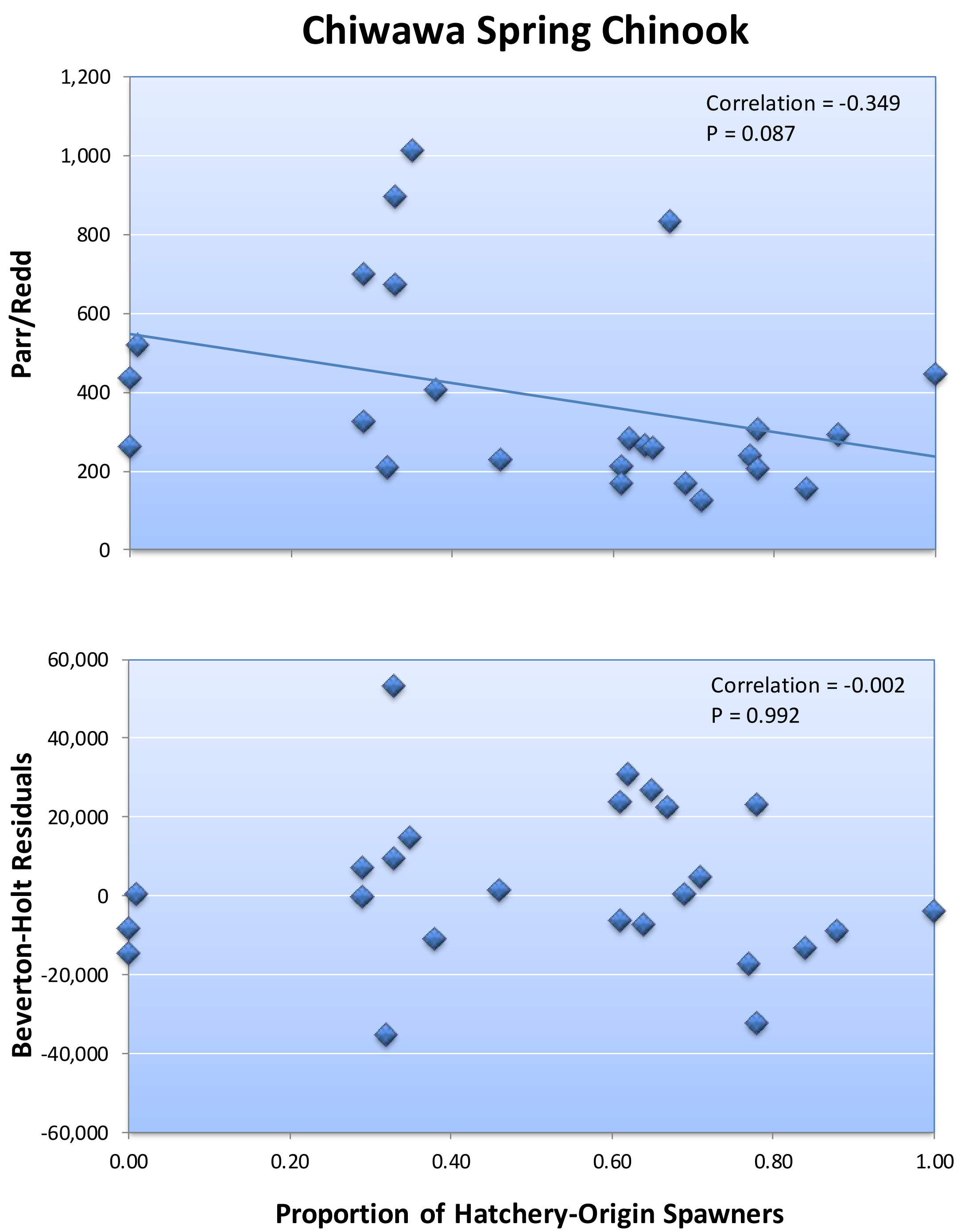

Figure 10. Relationship between juvenile productivity (parr/redd) and the proportion of hatchery-origin spawners (pHOS) (top figure) and the relationship between the residuals from the Beverton-Holt stock/recruitment relationship and pHOS (bottom figure).

Table 1. Description, location (river mile), and area (hectares) of land-class strata (reaches) used by age-0 Chinook salmon in the Chiwawa River basin, 2017. Reaches were classified according to geologic district, landtype association, valley-bottom type, stream state-type, and habitat type within the Cascade Ecoregion; MCV = moderately confined valley, CC = confined canyon, UCV = unconfined valley, NC = natural channel, EB = eroded banks, S = straight, G = glide, P = pool, R = riffle, and MC = multiple channel. See Hillman and Miller (2004) for definitions of stream state codes.

Reach	RM	Gradient	Geologic district	Landtype association	Valley bottom type	Stream state type	Habitat type	Area (ha)	
								Total	Sample
Chiwawa River									
1	0.00-3.77	0.007	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/EB	G	0.57	0.57
						NC/EB	P	1.37	1.00
						NC/EB	R	17.01	1.75
2	3.77-5.51	0.010	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	G	0.31	0.31
						NC/EB	P	0.68	0.23
						NC/EB	R	6.83	0.66
3	5.51-7.88	0.009	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/S	R	5.11	0.78
						NC/EB	G	0.13	0.13
						NC/EB	R	4.70	0.50
						MC	MC	0.36	0.36
4	7.88-8.90	0.007	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	P	0.40	0.30
						NC/EB	R	2.83	0.42
						MC	MC	0.47	0.47
5	8.90-10.83	0.011	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC/EB	P	0.15	0.15
						NC/EB	R	10.54	0.98
6	10.83-11.80	0.008	Glacial Drift over Chumstick Formation	Glacial Canyon	CC Fluvial	NC/EB	P	0.34	0.34
						NC/EB	R	4.62	0.96
						MC	MC	0.36	0.36
7	11.80-20.03	0.001	Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	G	2.85	0.98
						NC	P	6.27	0.59
						NC	R	1.14	0.23
						NC/EB	G	2.62	1.48
						NC/EB	P	6.34	1.87
						NC/EB	R	4.95	0.52
						MC	MC	4.96	2.23
8	20.03-25.42	0.003	Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC/EB	G	2.56	1.07
						NC/EB	P	7.74	1.98
						NC/EB	R	5.51	1.05
						EB	P	0.22	0.22
						EB	R	0.40	0.40
						MC	MC	7.37	2.77
9	25.42-28.81	0.007	Glacial Drift over Swakane Gneiss	Glacial Valley	MCV Alluvial	NC	P	5.21	0.57
						NC	R	2.60	0.62
						MC	MC	2.62	1.03
10	28.81-31.11	0.011	Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.62	0.35
						NC	R	2.45	0.66
						MC	MC	4.63	0.47

Table 1. Concluded.

Reach	RM	Gradient	Geologic district	Landtype association	Valley bottom type	Stream state type	Habitat type	Area (ha)	
								Total	Sampled
Trinity Side Channel									
10b	0.00-0.75	0.011	Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.29	0.07
						NC	R	0.14	0.07
						NC	MC	0.14	0.08
Phelps Creek									
1	0.00-0.35	0.043	Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	R	0.00	0.00
						NC	MC	0.16	0.16
Chikamin Creek[1]									
1	0.00-0.94	0.013	Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	G	0.06	0.06
						NC	P	0.23	0.06
						NC	R	0.40	0.04
						MC	MC	0.18	0.18
Rock Creek									
1	0.00-0.73	0.020	Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC	G	0.01	0.01
						NC	P	0.20	0.06
						NC	R	0.33	0.04
						MC	MC	0.08	0.08
Unnamed Creek									
1	0.00-0.05		Pre-upper Jurassic Gneiss	Glacial Valley	MCV Alluvial	NC	P	0.02	0.02
						NC	R	0.00	0.00
Big Meadow Creek									
1	0.00-0.35	0.025	Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC	G	0.01	0.01
						NC	P	0.12	0.04
						NC	R	0.12	0.03
						NC	MC	0.00	0.00
Alder Creek									
1	0.00-0.01		Glacial Drift over Chumstick Formation	Glacial Valley	MCV Alluvial	NC	P	0.003	0.003
						NC	R	0.005	0.005
Brush Creek									
1	0.00-0.01		Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	P	0.006	0.006
						NC	R	0.005	0.005
Clear Creek									
1	0.00-0.05		Glacial Drift over Chumstick Formation	Glacial Valley	UCV Alluvial	NC	P	0.001	0.001
						NC	R	0.004	0.004
Y Creek									
1	0.00-0.05		Glacial Drift over Swakane Gneiss	Glacial Valley	UCV Alluvial	NC	P	0.000	0.000
						NC	R	0.000	0.000

[1] Includes the lower 0.2 miles of Minnow Creek.

Table 2. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-0 Chinook salmon in reaches in the Chiwawa River basin, Washington, August 2017.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	215.8	0.060	4,090	±392	0.10	4,205	±375	0.09
2	506.4	0.118	3,960	±941	0.24	4,085	±1,262	0.31
3	125.7	0.031	1,295	±94	0.07	1,370	±79	0.06
4	448.1	0.096	1,658	±159	0.10	1,696	±132	0.08
5	133.9	0.030	1,431	±65	0.05	1,309	±75	0.06
6	233.1	0.057	1,240	±146	0.12	1,101	±197	0.18
7	1,068.7	0.150	31,131	±4,369	0.14	30,240	±5,867	0.19
8	706.8	0.114	16,822	±5,142	0.31	16,042	±5,438	0.34
9	1,530.2	0.226	15,960	±5,796	0.36	13,457	±5,553	0.41
10	2,033.1	0.653	16,814	±2,432	0.14	47,589	±3,878	0.08
Phelps Creek								
1	750.0	0.541	120	±0	0.00	120	±0	0.00
Chikamin Creek[1]								
1	3,519.5	1.858	3,069	±880	0.29	3,115	±1,049	0.34
Rock Creek								
1	3,801.0	1.931	2,349	±1,963	0.84	3,054	±1,609	0.53
Unnamed Creek								
1	1,200.0	0.316	18	±0	0.00	18	±0	0.00
Big Meadow Creek								
1	8,104.0	5.021	2,026	±511	0.25	2,050	±513	0.25
Alder Creek								
1	4,333.3	4.063	13	±0	0.00	13	±0	0.00
Brush Creek								
1	16,000.0	7.680	96	±0	0.00	96	±0	0.00
Clear Creek								
1	2,800.0	2.917	14	±0	0.00	14	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**783.4**	**0.183**	**102,106**	**±9,541**	**0.09**	**129,574**	**±10,752**	**0.08**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 3. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-1+ Chinook salmon in reaches in the Chiwawa River basin, Washington, August 2017.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	3.9	0.001	73	±23	0.32	77	±32	0.42
2	4.2	0.001	33	±7	0.21	35	±26	0.74
3	0.0	0.000	0	±0	0.00	0	±0	0.00
4	1.9	0.000	7	±0	0.00	7	±0	0.00
5	0.0	0.000	0	±0	0.00	0	±0	0.00
6	4.3	0.001	23	±11	0.48	19	±14	0.74
7	3.8	0.001	111	±74	0.67	101	±83	0.82
8	3.6	0.001	86	±71	0.83	85	±78	0.92
9	10.6	0.002	111	±108	0.97	89	±122	1.37
10	4.7	0.002	39	±14	0.36	122	±24	0.20
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Rock Creek								
1	69.6	0.037	43	±72	1.67	59	±56	0.95
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**4.0**	**0.001**	**526**	**±168**	**0.32**	**594**	**±183**	**0.31**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 4. Summary of the five productivity models of juvenile (age-0) Chinook salmon in the Chiwawa River basin. Models are shown, including the number of parameters (K), AIC_c values, AIC_c difference scores (Δ_i), the likelihood of the model given the data ($\pounds(g_i|x)$), Akaike weights (w_i), and adjusted R^2 values. The sample size (n) for all models was 25. Models describe the relationship between juvenile Chinook numbers (dependent variable) and redd numbers (independent variable).

Model	K^a	AIC_c	Δ_i	$\pounds(g_i\|x)$	w_i	Adj R^2
Beverton-Holt	3	-138.189	0.000	1.000	0.665	0.843
Smooth Hockey Stick	3	-136.492	1.697	0.428	0.285	0.832
Gamma[b]	4	-131.572	6.617	0.037	0.024	0.809
Ricker	3	-130.846	7.342	0.025	0.017	0.789
Cushing	3	-129.636	8.553	0.014	0.009	0.779

[a] ***K*** is the number of structural parameters in the model plus 1 for σ^2.
[b] The γ parameter in the Gamma model was greater than 0, which means that this model is nearly identical to the Ricker model.

Table 5. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-0 (<4 in) steelhead/rainbow in reaches in the Chiwawa River basin, Washington, August 2017.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	115.6	0.032	2,191	±186	0.08	2,260	±203	0.09
2	148.6	0.035	1,162	±50	0.04	1,207	±127	0.11
3	197.8	0.047	2,037	±459	0.23	2,096	±395	0.19
4	211.1	0.049	781	±168	0.22	863	±150	0.17
5	138.5	0.031	1,481	±70	0.05	1,348	±81	0.06
6	113.7	0.027	605	±81	0.13	521	±77	0.15
7	64.0	0.009	1,863	±1,118	0.60	1,880	±1,186	0.63
8	0.0	0.000	0	±0	0.00	0	±0	0.00
9	0.0	0.000	0	±0	0.00	0	±0	0.00
10	0.0	0.000	0	±0	0.00	0	±0	0.00
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	2,439.2	1.298	2,127	±453	0.21	2,176	±483	0.22
Rock Creek								
1	1,658.6	0.764	1,025	±897	0.88	1,208	±632	0.52
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	15,816.00	9.782	3,954	±509	0.13	3,994	±610	0.15
Alder Creek								
1	12,000.0	11.250	36	±0	0.00	36	±0	0.00
Brush Creek								
1	3,666.7	1.760	22	±0	0.00	22	±0	0.00
Clear Creek								
1	2,400.0	2.500	12	±0	0.00	12	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**132.7**	**0.025**	**17,296**	**±1,675**	**0.10**	**17,623**	**±1,631**	**0.09**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 6. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of age-1+ (4-8 in) steelhead/rainbow in reaches in the Chiwawa River basin, Washington, August 2017.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	94.2	0.026	1,785	±224	0.13	1,847	±222	0.12
2	137.7	0.032	1,077	±223	0.21	1,116	±167	0.15
3	57.5	0.014	592	±33	0.06	618	±33	0.05
4	133.2	0.031	493	±225	0.46	543	±217	0.40
5	118.0	0.027	1,261	±62	0.05	1,149	±78	0.07
6	32.1	0.008	171	±19	0.11	151	±36	0.24
7	5.4	0.001	156	±148	0.95	141	±156	1.11
8	0.0	0.000	0	±0	0.00	0	±0	0.00
9	0.0	0.000	0	±0	0.00	0	±0	0.00
10	0.0	0.000	0	±0	0.00	0	±0	0.00
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	475.9	0.248	415	±63	0.15	416	±68	0.16
Rock Creek								
1	123.0	0.061	76	±55	0.72	96	±40	0.42
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	3,588.0	2.224	897	±160	0.18	908	±94	0.10
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**53.1**	**0.010**	**6,923**	**±459**	**0.07**	**6,985**	**±415**	**0.06**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 7. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of steelhead/rainbow larger than 8 inches in reaches in the Chiwawa River basin, Washington, August 2017.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	0.2	0.000	3	±5	1.67	3	±5	1.67
2	0.8	0.000	6	±5	0.83	7	±8	1.14
3	0.0	0.000	0	±0	0.00	0	±0	0.00
4	0.5	0.000	2	±0	0.00	2	±0	0.00
5	0.1	0.000	1	±0	0.00	1	±0	0.00
6	0.2	0.000	1	±0	0.00	2	±0	0.00
7	0.2	0.000	7	±5	0.71	7	±6	0.86
8	0.0	0.000	0	±0	0.00	0	±0	0.00
9	0.0	0.000	0	±0	0.00	0	±0	0.00
10	0.0	0.000	0	±0	0.00	0	±0	0.00
Phelps Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Chikamin Creek[1]								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Rock Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**0.2**	**0.000**	**20**	**±8**	**0.40**	**22**	**±11**	**0.50**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 8. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of juvenile bull trout (2-8 in) in reaches in the Chiwawa River basin, Washington, August 2017.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
2	0.0	0.000	0	±0	0.00	0	±0	0.00
3	0.0	0.000	0	±0	0.00	0	±0	0.00
4	0.0	0.000	0	±0	0.00	0	±0	0.00
5	0.0	0.000	0	±0	0.00	0	±0	0.00
6	0.0	0.000	0	±0	0.00	0	±0	0.00
7	0.0	0.000	0	±0	0.00	0	±0	0.00
8	0.3	0.000	7	±12	1.71	7	±13	1.86
9	2.5	0.001	26	±18	0.69	24	±21	0.88
10	16.9	0.006	140	±58	0.41	422	±58	0.14
Phelps Creek								
1	150.0	0.108	24	±19	0.79	24	±17	0.71
Chikamin Creek[1]								
1	48.2	0.026	42	±17	0.40	43	±12	0.28
Rock Creek								
1	30.7	0.015	19	±0	0.00	23	±0	0.00
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**2.0**	**0.001**	**258**	**±67**	**0.26**	**543**	**±67**	**0.12**

[1] Includes lower 0.2 miles of Minnow Creek.

Table 9. Estimated mean densities (fish/hectare and fish/m^3), total numbers, 95% confidence bounds on total numbers, and error of the estimated total number of adult bull trout (>8 in) in reaches in the Chiwawa River basin, Washington, August 2017.

Reach	Mean density		Surface area (ha)			Volume (m^3)		
	Fish/ha	Fish/m^3	Total No.	95% C.B.	± Error	Total No.	95% C.B.	± Error
Chiwawa River								
1	1.0	0.000	19	±4	0.21	21	±23	1.10
2	4.6	0.001	36	±4	0.11	38	±23	0.01
3	0.0	0.000	0	±0	0.00	0	±0	0.00
4	3.2	0.001	12	±5	0.42	12	±7	0.58
5	0.8	0.000	8	±0	0.00	9	±0	0.00
6	1.7	0.001	9	±0	0.00	10	±0	0.00
7	11.1	0.002	322	±79	0.25	303	±193	0.64
8	9.4	0.002	224	±72	0.32	226	±148	0.65
9	24.0	0.004	250	±46	0.18	220	±112	0.51
10	48.6	0.014	402	±83	0.21	1,046	±73	0.07
Phelps Creek								
1	12.5	0.009	2	±0	0.00	2	±0	0.00
Chikamin Creek[1]								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Rock Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Unnamed Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Big Meadow Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Alder Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Brush Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Clear Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Y Creek								
1	0.0	0.000	0	±0	0.00	0	±0	0.00
Grand Total	**9.9**	**0.003**	**1,284**	**±143**	**0.11**	**1,887**	**±279**	**0.15**

[1] Includes lower 0.2 miles of Minnow Creek.

APPENDIX A. Numbers of redds, eggs, age-0 Chinook salmon, parr per redd, and percent egg-to-parr survival in the Chiwawa River basin, brood years 1991-2017; NS = not sampled. Numbers of eggs were calculated as the number of redds times the mean fecundity of females collected for broodstock.

Brood Year	Chinook Salmon			Parr/Redd	Egg-to-parr survival (%)
	Redds	Eggs	Age-0 (parr)		
1991	104	478,400	45,483	437	9.5
1992	302	1,570,098	79,113	262	5.0
1993	106	556,394	55,056	519	9.9
1994	82	485,686	55,240	674	11.4
1995	13	66,248	5,815	447	8.8
1996	23	106,835	16,066	699	15.0
1997	82	374,740	68,415	834	18.3
1998	41	218,325	41,629	1,015	19.1
1999	34	166,090	NS	NS	NS
2000	128	642,944	114,617	895	17.8
2001	1,078	4,984,672	134,874	125	2.7
2002	345	1,605,630	91,278	265	5.7
2003	111	648,684	45,177	407	7.0
2004	241	1,156,559	49,631	206	4.3
2005	332	1,436,564	79,902	241	5.6
2006	297	1,284,228	60,752	205	4.7
2007	283	1,256,803	82,351	291	6.6
2008	689	3,163,888	106,705	155	3.4
2009	421	1,925,233	128,220	305	6.7
2010	502	2,165,628	141,510	282	6.5
2011	492	2,157,420	103,940	211	4.8
2012	880	3,716,240	149,563	185	4.4
2013	714	3,367,224	121,240	170	3.6
2014	485	1,961,825	111,224	229	5.7
2015	543	2,631,921	140,172	258	5.3
2016	312	1,393,704	102,106	327	7.3
Average	**332**	**1,519,874**	**85,203**	**385**	**7.9**

APPENDIX B. Estimated numbers of salmonids (based on fish/ha) in the Chiwawa River basin, Washington, 1992-2017; NS = not sampled.

Survey year	Chinook salmon		Steelhead/Rainbow			Bull trout		Cutthroat trout
	Age-0	Age-1+	Age-0	Age-1+	>8 in[1]	2-8 in	>8 in	
1992[2]	45,483	563	4,927	2,533	1,869	299	208	NS
1993	79,113	174	4,004	2,860	768	158	156	NS
1994	55,056	18	1,410	5,856	67	90	76	NS
1995	55,241	13	7,357	9,517	140	97	664	NS
1996	5,815	22	4,245	11,849	78	79	343	NS
1997	16,066	5	8,823	6,905	48	220	472	56
1998	68,415	63	3,921	10,585	78	300	900	93
1999	41,629	41	5,838	22,130	33	130	423	80
2000	NS	NS	NS	NS	NS	NS	NS	NS
2001	114,617	69	45,727	10,623	420	505	542	108
2002	134,874	32	20,521	9,090	181	217	521	111
2003	91,278	134	18,020	6,179	49	196	282	52
2004	45,177	21	10,380	8,190	8	140	157	22
2005	49,631	79	11,463	6,188	48	125	346	23
2006	79,902	388	16,245	10,533	50	238	686	68
2007	60,752	41	14,073	8,448	77	95	520	47
2008	82,351	189	15,230	10,576	144	124	510	109
2009	106,705	54	17,179	5,629	85	82	618	128
2010	128,220	291	25,018	9,616	63	79	547	252
2011	141,510	967	39,446	14,903	65	86	621	240
2012	103,940	767	27,134	8,576	65	159	768	188
2013	149,563	852	21,682	7,253	76	299	820	358
2014	121,240	939	16,083	5,084	87	259	875	761
2015	111,224	620	10,208	754	18	239	2,286	292
2016	140,172	282	16,244	4,031	14	291	1,254	544
2017	102,106	526	17,296	6,923	20	258	1,284	562

[1]During 1992-1993, numbers of steelhead/rainbow greater than 8 inches included both hatchery and wild rainbow trout. Thereafter, only wild trout were observed.
[2]Only the Chiwawa River was sampled in 1992. No tributaries were sampled in that year.

APPENDIX C. Proportion of total habitat available, fraction of all age-0 Chinook within each habitat type, and densities (fish/ha) and numbers of age-0 Chinook within each habitat type in the Chiwawa River basin, survey years 1992-2017; NS = not sampled.

Habitat	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Proportion of total habitat available											
Glide	0.10	0.09	0.10	0.10	0.10	0.09	0.09	0.09	NS	0.07	0.08
Pool	0.19	0.19	0.21	0.18	0.18	0.17	0.16	0.17	NS	0.15	0.16
Riffle	0.61	0.61	0.57	0.59	0.57	0.57	0.58	0.55	NS	0.49	0.48
M. Chan	0.10	0.11	0.12	0.14	0.14	0.17	0.17	0.19	NS	0.29	0.28
Fraction of all age-0 Chinook within habitat types											
Glide	0.07	0.03	0.02	0.01	0.02	0.01	0.01	0.01	NS	0.03	0.01
Pool	0.30	0.28	0.22	0.21	0.30	0.16	0.17	0.14	NS	0.23	0.24
Riffle	0.19	0.16	0.12	0.11	0.43	0.23	0.08	0.11	NS	0.18	0.15
M. Chan	0.45	0.53	0.64	0.67	0.24	0.60	0.74	0.74	NS	0.57	0.60
Densities of age-0 Chinook within habitat types (fish/ha)											
Glide	254	251	93	55	11	12	78	13	NS	351	187
Pool	584	1,049	619	541	82	122	607	257	NS	1,392	1,468
Riffle	116	188	124	91	38	52	79	62	NS	336	300
M. Chan	1,710	3,408	2,985	2,328	84	449	2,620	1,201	NS	1,820	2,069
Number of age-0 Chinook within habitat types											
Glide	2,967	2,458	857	623	137	130	837	157	NS	3,231	1,931
Pool	13,468	21,814	12,131	11,294	1,755	2,553	11,454	5,933	NS	25,890	32,612
Riffle	8,531	12,616	6,698	6,197	2,525	3,699	5,392	4,626	NS	20,629	19,754
M. Chan	20,517	42,225	35,370	36,965	1,396	9,682	50,728	30,912	NS	64,866	80,576

APPENDIX C. Continued.

Habitat	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Proportion of total habitat available											
Glide	0.07	0.07	0.08	0.08	0.07	0.09	0.08	0.08	0.08	0.07	0.07
Pool	0.17	0.16	0.16	0.16	0.17	0.23	0.22	0.23	0.18	0.23	0.23
Riffle	0.49	0.50	0.47	0.47	0.47	0.51	0.54	0.53	0.57	0.53	0.53
M. Chan	0.26	0.27	0.29	0.30	0.29	0.17	0.15	0.16	0.17	0.17	0.17
Fraction of all age-0 Chinook within habitat types											
Glide	0.02	0.01	0.01	0.03	0.02	0.03	0.02	0.02	0.04	0.01	0.02
Pool	0.23	0.07	0.19	0.31	0.46	0.40	0.36	0.34	0.34	0.41	0.37
Riffle	0.15	0.14	0.07	0.12	0.12	0.11	0.11	0.11	0.19	0.15	0.13
M. Chan	0.60	0.77	0.73	0.54	0.40	0.45	0.51	0.53	0.43	0.43	0.48
Densities of age-0 Chinook within habitat types (fish/ha)											
Glide	200	58	49	237	113	238	230	286	526	173	321
Pool	951	155	492	1,240	1,211	1,210	1,453	1,436	1,805	1,360	1,890
Riffle	216	101	60	166	118	156	175	200	330	221	281
M. Chan	1,626	1,008	1,057	1,147	603	1,872	2,993	3,293	2,515	2,061	3,190
Number of age-0 Chinook within habitat types											
Glide	1,884	540	442	2,498	1,120	2,668	2,371	3,164	6,122	1,535	2,822
Pool	21,091	3,183	9,626	26,754	28,851	34,314	39,382	44,765	48,846	42,209	55,651
Riffle	13,783	6,501	3,367	10,753	7,809	9,773	11,558	14,446	27,883	15,418	19,619
M. Chan	54,519	34,952	36,196	46,580	25,409	38,275	55,607	69,609	61,944	44,779	73,057

APPENDIX C. Concluded.

Habitat	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
Proportion of total habitat available											
Glide	0.07	0.07	0.06	0.07							**0.08**
Pool	0.22	0.24	0.24	0.23							**0.19**
Riffle	0.54	0.53	0.54	0.54							**0.53**
M. Chan	0.17	0.16	0.16	0.16							**0.20**
Fraction of all age-0 Chinook within habitat types											
Glide	0.01	0.01	0.01	0.01							**0.02**
Pool	0.37	0.31	0.35	0.43							**0.31**
Riffle	0.11	0.05	0.08	0.12							**0.13**
M. Chan	0.51	0.63	0.56	0.44							**0.54**
Densities of age-0 Chinook within habitat types (fish/ha)											
Glide	133	66	114	146							**169**
Pool	1,569	1,300	1,628	1,446							**1,097**
Riffle	190	98	168	170							**163**
M. Chan	2,957	3,768	3,789	2,121							**1,930**
Number of age-0 Chinook within habitat types											
Glide	1,120	518	931	1,333							**1,696**
Pool	44,321	34,993	49,103	43,697							**26,628**
Riffle	13,085	6,017	11,550	11,840							**10,963**
M. Chan	62,713	69,969	78,589	45,234							**46,827**

Appendix B

Fish Trapping at the Chiwawa and Wenatchee Rotary Smolt Traps during 2017

Monitoring Juvenile Salmonids in the Wenatchee River basin:
Activities in the Chiwawa River and Lower Wenatchee River during 2017

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INTRODUCTION

Background

Monitoring and Evaluation

Productivity indicators in the freshwater environment provide data essential to inform evolving salmon and steelhead hatchery programs. In the Wenatchee River subbasin, the Juvenile Monitoring Component of the Monitoring and Evaluation Plan for PUD Hatchery Programs gather data directed at informing these productivity indicators (see Hillman et al. 2013). More specifically, this data directly addresses Objective 2 of the monitoring and evaluation framework:

"Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks."

Objectives

The Washington Department of Fish and Wildlife monitors juvenile salmonids in the Wenatchee River basin with the primary objective of estimating: natural productivity, migration timing, and age with size at migration. This has occurred at the tributary level (Chiwawa River since 1991) and population level (Wenatchee River since 1997). Target species include spring Chinook Salmon *Oncorhynchus tshawytscha* and summer steelhead *O. mykiss* in the Chiwawa River and is expanded to include sockeye Salmon *O. nerka* and summer Chinook Salmon *O. tshawytscha* in the mainstem Wenatchee River.

Monitoring has primarily been conducted with rotary smolt traps that capture emigrating salmonids from spring through fall. In an effort to reduce biases in emigrant estimates, and to improve understanding of survival and movement during non-trapping periods (December through February), WDFW began remote sampling spring Chinook Salmon in the Chiwawa Basin in 2012.

Study Area

Chiwawa River

The Chiwawa River is a fourth-order river draining a 474-km^2 basin and has a mean annual discharge of 14.4 cubic meters per second (m^3/s); contributing about 15% of the mean annual discharge of the Wenatchee River. The Chiwawa basin is dominated by the snow melt cycle with peak discharge occurring May through July with occasional fall freshets (Figure 1). The Chiwawa River originates in the North Cascades and flows southeast for 60 km before joining the Wenatchee River. This confluence with the Wenatchee River is approximately 9km downstream of Lake Wenatchee and 76 km upstream of the Columbia River (Figure 2). The Chiwawa River basin is relatively natural, with 96% managed as part of the Wenatchee National Forest and the upper 32% designated wilderness.

Precipitation in the basin varies between 76 cm near the confluence and 356 cm at the peaks, while elevations range from 573 to 2,768 m. The river is dynamic with generally shallow pool riffle segments as it meanders through a U-shaped valley formed by ancient glaciers in the region. Gradients remain well under 1% for the majority of the river.

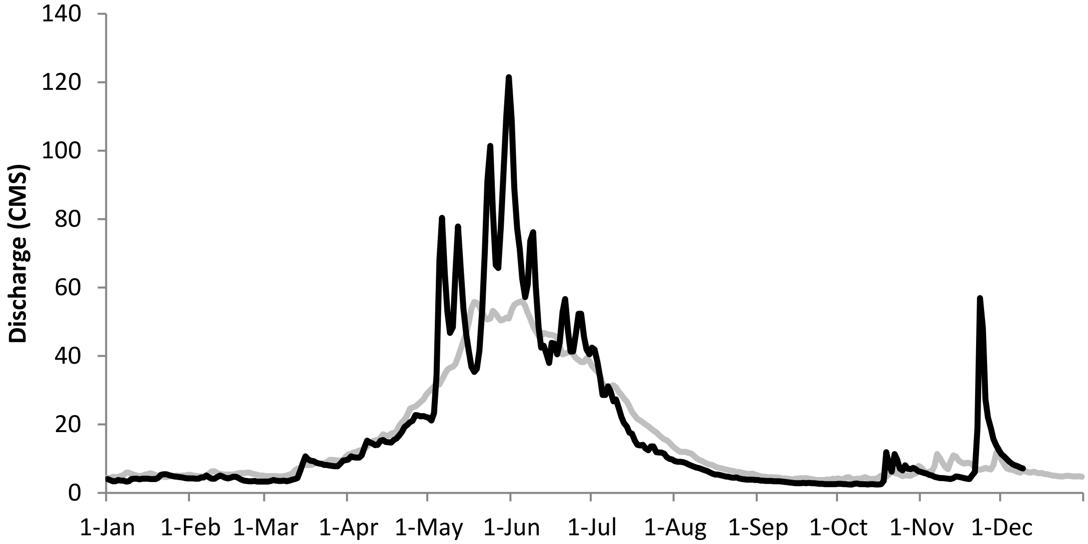

Figure 1. Discharge of the Chiwawa River at Plain, USGS gauge # 12456500. Black line represents 2017 discharge and grey line represents mean discharge from 1990-2016.

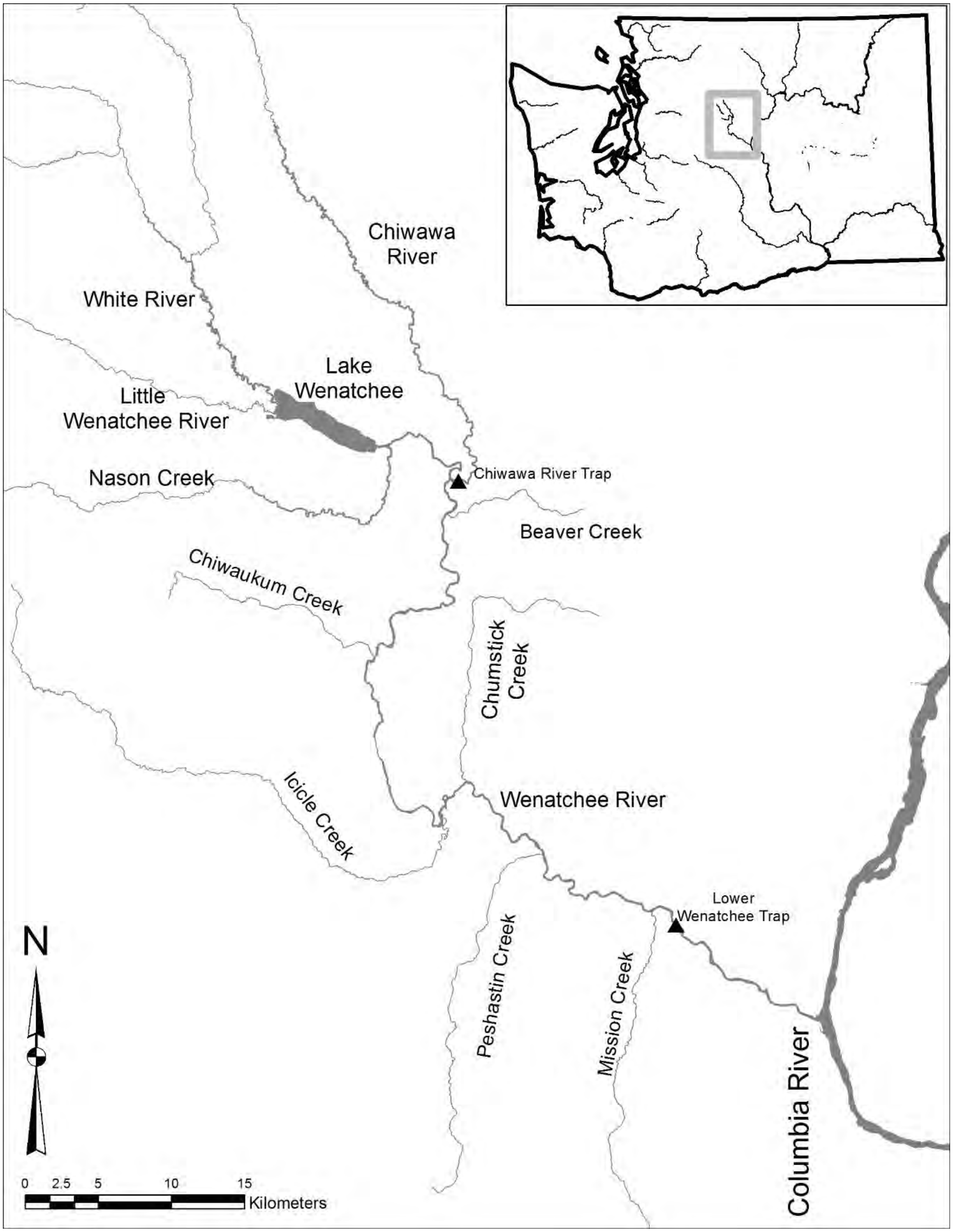

Figure 2. Wenatchee River basin (with rotary smolt trap locations).

Wenatchee River

The Wenatchee River is a fourth-order river draining a 3,437-km^2 basin and has a mean annual discharge of 91.4 m^3/s. The hydrograph is dominated by the snow melt cycle with peak discharge occurring May through July with occasional fall freshets (Figure 3). The mainstem originates at the outlet of Lake Wenatchee and flows southeast 84.5 km before joining the Columbia River, 753 km upstream of the Pacific Ocean (Figure 2). While most of the lowlands (17%) are private, the majority (83%) of basin is public land.

Precipitation in the basin varies from 22 cm near the Columbia River confluence to 381 cm at the crest of the Cascade Mountains with elevations ranging from 237 to 2,768 m. The Wenatchee River has a relatively low gradient except from rkm 40 – 64 where the river flows through a bedrock canyon (Tumwater Canyon) and has a gradient of approximately 9.8 meters per kilometer.

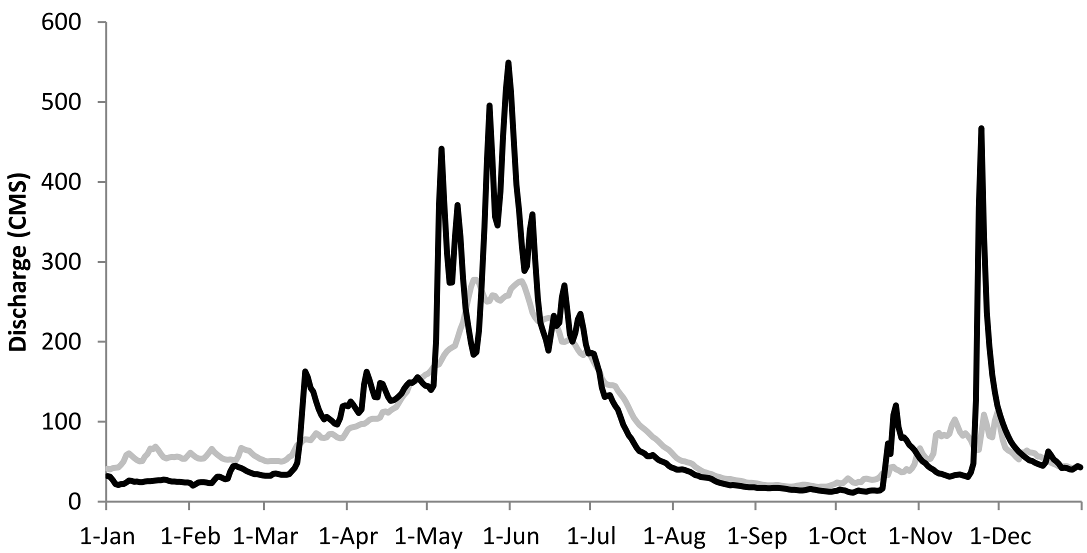

Figure 3. Discharge of the Wenatchee River at Monitor, USGS gauge # 12462500. Black line represents 2017 discharge and grey line represents mean discharge from 1990-2016.

METHODS

Rotary Smolt Traps

Trap Operations

The Chiwawa River trap consists of a single 2.4m cone and has been operating since 1991 at its current location, 0.6 km upstream from the confluence with the Wenatchee River. Trap operations usually begin in late February and continue until ice suspends operations in late fall. The Lower Wenatchee trap consists of two 2.4m cones and has been operating in its current location (rkm 12.5) since 2013. Trap operations usually begin in late January and continue until fall, when river conditions force its removal.

Operational procedures and techniques follow the standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was adapted from Murdoch and Petersen (2000). The traps remain in operation 24 hours a day unless environmental condition (high/low flow, extreme temperature, and high debris), hatchery releases, mechanical failure or human recreational activities halt operations. During periods of high recreational activities in the spring and summer the Lower Wenatchee trap is pulled during daylight hours to minimize human danger.

Fish Sampling

At a minimum of once a day, all fish collected at the traps were identified to genus or species, enumerated, weighed, and fork length (FL) measured. All salmonids were classified as hatchery, wild, or unknown and visually classified as fry, parr, transitional, or smolt. All hatchery salmonids in the basin are marked (adipose fin-clip, coded-wire tags, or Passive Integrated Transponder (PIT) with the exception of coho. Based on length subsamples of known hatchery coho at Leavenworth Fish Hatchery, all coho collected at the Lower Wenatchee rotary smolt trap were considered wild if < 80mm FL or unknown origin if ≥ 80mm FL. Any coho collected in the Chiwawa River are considered wild. Target species (≥ 65 mm FL) were tagged using 12.5 mm FDX PIT tags and all PIT tagging information was uploaded to a regional PIT tag database (PTAGIS) maintained by the Pacific States Marine Fisheries Commission.

A combination of length, time of year, and trap location was used to determine race (spring or summer) of captured juvenile Chinook Salmon. All Chinook Salmon captured in the Chiwawa River trap were considered spring Chinook, regardless of size since summer Chinook Salmon spawning has not been documented upstream of the trap. All yearling (age-1) Chinook captured at the Lower Wenatchee River trap during the spring migration period were considered spring Chinook Salmon because spring Chinook Salmon are yearling migrants and summer Chinook Salmon are typically subyearling migrants. All subyearling fry and parr (age-0) Chinook captured at the Lower Wenatchee River trap during spring were considered summer Chinook Salmon.

Mark–Recapture Trials

Groups of marked juveniles were released during a range of stream discharges in order to determine trapping efficiencies under the varied flow regime. Natural origin fish were marked with a PIT tag if ≥65mm FL or stained with Bismarck Brown dye if <65 mm FL and hatchery origin fish were marked using a caudal fin clip. All marked fish were released evenly upstream on both sides of the river between 1800 hours and 2000 hours. Marked fish from the Lower Wenatchee River trap were transported and released 14.5 km upstream of the trap site while fish from the Chiwawa River trap were released 2.6 km upstream. Each trial was conducted over a four-day (96 hour) period to allow time for passage or capture. Target mark group sizes were based on historical data, location and species, ranging from 100 to over 500 individual fish. See appendix D for mark-recapture trails.

Emigrant Estimates

All emigration estimates were calculated using estimated daily trap efficiency derived from the regression formula using trap efficiency (dependent variable) and discharge (independent variable). Trap efficiency models used a modified Bailey estimator (recaptures + 1) in the calculation of efficiency as a method of bias correction. If a significant relationship ($R^2 > 0.5$ and $P < 0.05$) could not be found a pooled trap efficiency estimate was used. Estimates of emigrating spring Chinook were calculated with and without fry (<50mm FL) due to the uncertainty that these fish were actively migrating to the ocean (UCRTT, 2001). See appendices A and B for detailed equations and information on how the point estimate, variance, and standard error were calculated.

During minor breaks in operation (less than seven days), the number of individual fish collected was estimated. This estimate was calculated using the mean number of fish captured two days prior and two days after the break in operation. For major breaks in operations (greater than seven days), an estimate based on historical run timing was developed. This estimate of daily capture was incorporated into the overall emigration estimate.

Egg-to-emigrant Survival

The estimated total egg deposition (d) was calculated by multiplying the mean fecundity (f) of the brood spawners by the total number of redds (r) found during surveys (Hillman et al. 2015). Egg-to-emigrant survival (s) was calculated by dividing total emigrants (e) by estimated egg deposition (d).

Backpack Electrofishing

Sampling Procedure

From 2012 to present, WDFW has had a goal of PIT tagging 3,000 juvenile spring Chinook Salmon each year. In order to representatively tag the population throughout all reaches, the number of fish tagged in each reach was based on the reach specific abundance encountered during snorkeling surveys in late summer. See Appendix C for further explanation.

Detections and Calculations

Detections occur at PIT tag interrogation sites in and out of the basin as well as rotary smolt traps downstream of the sampling reaches. Calculations of non-trapping emigrant estimates are based on a flow-detection efficiency regression developed using mark-groups previously released to test smolt trap efficiencies. The total number of tagged fish (t) divided by the estimated total parr abundance (p), as based off of standard snorkeling techniques (Hillman et al. 2013), resulted in an overall tag rate (t_i). See Appendix C for further explanation.

RESULTS

Rotary Smolt Traps – Chiwawa

Trap Operation

The Chiwawa Trap operated between 22 March and 29 November 2017. During the trapping period, the trap was inoperable for 36 days due to high or low river discharge, debris, major hatchery releases, and mechanical issues. Throughout the trapping season the trap operated in two positions, the normal position and a new, low flow position.

Fish Sampling

A total of 30,496 individual fish were collected, with wild spring Chinook Salmon and steelhead comprising 62% and 4% of the total catch, respectively. Additionally, 4,518 hatchery spring Chinook and 3,907 hatchery steelhead were collected. Throughout the sampling period 14,861 PIT tag were deployed into wild spring Chinook and steelhead (13,952 and 909 respectively). Spring Chinook mortality for the season totaled 15 yearling, 183 subyearling parr, and 4 fry (0.3%, 1.6%, and 0.4%, respectively). Mortality of steelhead throughout the season totaled 3 (0.3%). The mean fork length (SD) of captured yearling and subyearling spring Chinook Salmon (fry excluded) was 92.6 (7.1) mm and 73.8 (12.0) mm, respectively (Table 1).

Table 1. Mean fork length (mm) and weight (g) of spring Chinook Salmon captured in the Chiwawa rotary smolt trap during 2017.

	Yearling transitional/smolts			Subyearling parr		
	Mean	**SD**	***N***	**Mean**	**SD**	***N***
Fork length	92.6	7.1	5,822	73.8	12.0	11,508
Weight	8.6	2.1	5,790	4.2	2.2	8,237

Yearling Spring Chinook (Brood Year 2015)

Wild yearling spring Chinook Salmon were primarily captured between 23 March and 31 May (Figure. 4). A total of 5,824 yearling Chinook Salmon were captured and an estimated 6,145 would have been captured if the trap had operated without interruption. Seven mark/recapture efficiency trials using PIT tags were conducted producing a mean trap efficiency of 11.9%. In 2017, mark/recapture trials were not conducted at all desired discharge levels and no statistically significant flow-efficiency regression model was obtained ($R^2 = 0.19$, $P > 0.05$).

When the mark/recapture trials were combined with those of 2016, still no significant flow-efficiency model was found (R^2 = 0.46). Therefore, the pooled estimated was used and the estimated number (95% C.I.) of yearling spring Chinook Salmon that emigrated from the Chiwawa River in 2017 was calculated at 53,344 (±15,037). Smolt survival (SE) to McNary of those tagged fish was 42% (4%) using the Cormack-Jolly-Seber estimator.

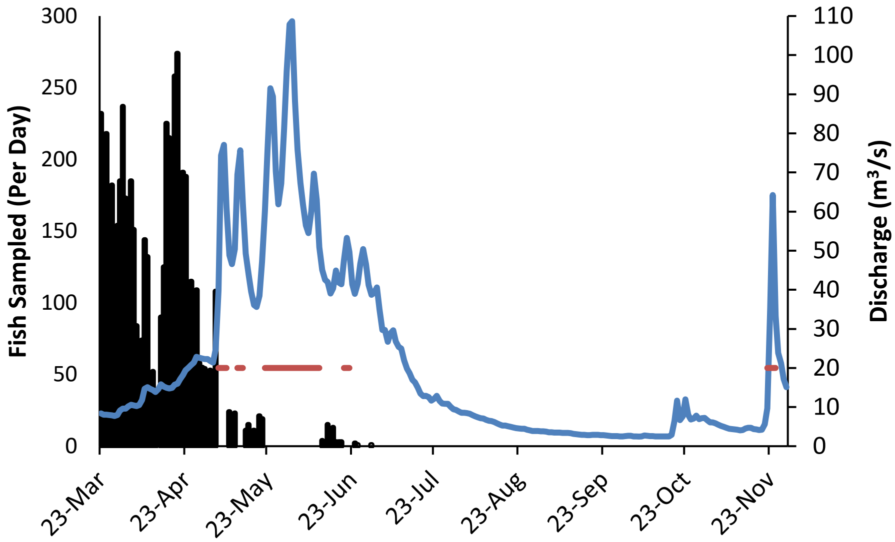

Figure 4. Daily catch of yearling spring Chinook Salmon at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Subyearling Spring Chinook (Brood Year 2016)

Wild subyearling spring Chinook Salmon were captured throughout the sampling period, with peak catches of parr in July, August and October and fry occurring in April and July (Figures 5 and 6, respectively). A total of 11,798 subyearling parr and 1,140 fry were captured with an estimated 12,336 subyearling parr and 1,298 fry had the trap operated without interruption. Twelve mark/recapture efficiency trials were conducted (eight PIT tagged and four Bismarck Brown groups) at the upper cone position with a mean trap efficiency of 19.5%. There were also 6 mark/recapture efficiency trails conducted at the new low flow cone position with a mean trap efficiency of 13%. These trials were used in developing significant regression model for each cone position (R^2 = 0.60, $P < 0.002$ and R^2 = 0.66, $P < 0.05$ for the upper and low flow positions, respectively). In 2017, the estimated number of subyearling spring Chinook Salmon emigrating from the Chiwawa River during the sampling period was 95,063 (± 21,247) if you do not include fry or 111,566 (±22,090) if fry are included.

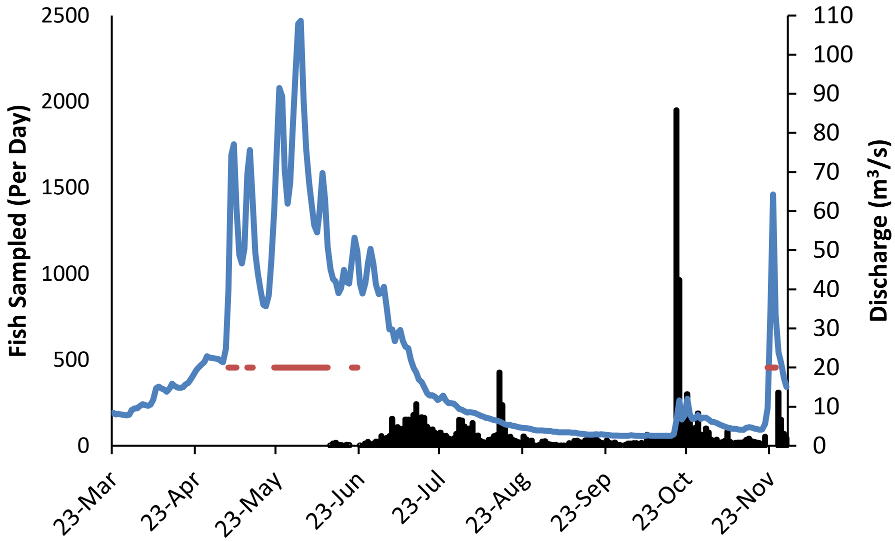

Figure 5. Daily catch of wild spring Chinook subyearling parr at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

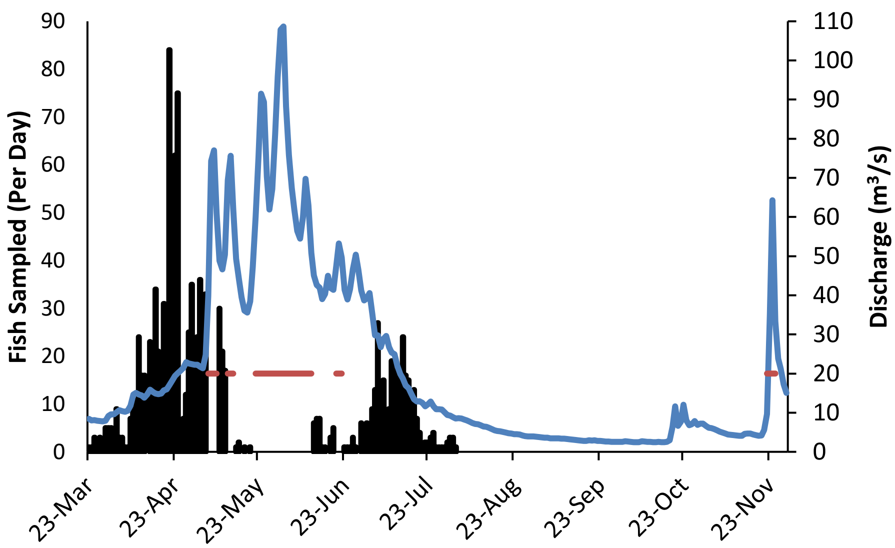

Figure 6. Daily catch of wild spring Chinook fry at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Summer Steelhead

During the trapping period, 244 steelhead transitional/smolts and 812 steelhead/rainbow parr and 25 steelhead/rainbow fry were captured. While collections occurred in moderate numbers throughout the year, peak collections occurred during May, June and October (Figure 7). The mean fork length (SD) of steelhead parr and transitional/smolts captured was 85.4 (23.5) and 156.2 (24.0) mm, respectively (Table 2).

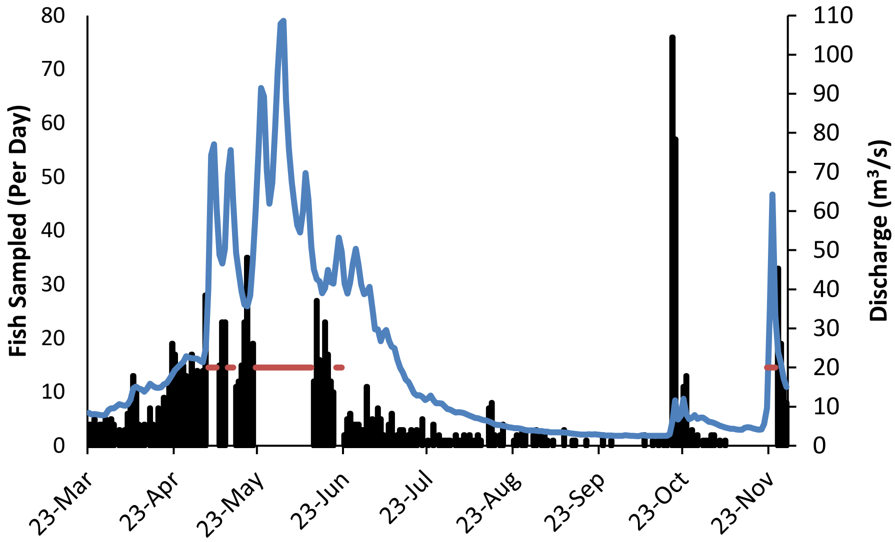

Figure 7. Daily catch of all wild steelhead at the Chiwawa rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 2. Mean fork length (mm) and weight (g) and of steelhead/rainbow captured in the Chiwawa rotary smolt trap during 2017.

	Transitional/smolts			Parr		
	Mean	**SD**	***N***	**Mean**	**SD**	***N***
Fork length	156.2	24.0	244	85.4	23.5	784
Weight	39.4	17.3	236	7.6	7.7	706

Egg-to-emigrant Survival

For BY 2016, 222 redds were counted in the Chiwawa River Basin with an estimated 991,674 eggs being deposited. A total of 139,863 emigrants were estimated resulting in an egg-to-emigrant survival of 14.6% (Table 3). This is up from a five year moving average of 5.28%.

Table 3. Estimated egg deposition and egg-to-emigrant survival rates for Chiwawa River spring Chinook Salmon.

Brood Year	Number of redds	Estimated egg deposition	Estimated number				Egg-to-emigrant survival (%)
			Sub-yearling	**Non-trapping**	**Yearling**	**Total emigrants**	
1992	302	1,570,098	25,818		39,723	65,541	4.2
1993	106	556,394	14,036		8,662	22,698	4.1
1994	82	485,686	8,595		16,472	25,067	5.2
1995	13	66,248	2,121		3,830	5,951	9.0
1996	23	106,835	3,708		15,475	19,183	18.0
1997	82	374,740	16,228		28,334	44,562	11.9

Brood Year	Number of redds	Estimated egg deposition	Estimated number: Sub-yearling	Non-trapping	Yearling	Total emigrants	Egg-to-emigrant survival (%)
1998	41	207,675	2,855		23,068	25,923	11.9
1999	34	166,090	4,988		10,661	15,649	9.4
2000	128	642,944	14,854		40,831	55,685	8.7
2001	1,078	4,836,704	459,784		86,482	546,266	11.0
2002	345	1,605,630	93,331		90,948	184,279	11.5
2003	111	648,684	16,881		16,755	33,637	5.2
2004	241	1,156,559	44,079		72,080	116,158	10.0
2005	333	1,436,564	108,595		69,064	177,659	12.3
2006	297	1,284,228	62,922		45,050	107,972	8.4
2007	283	1,241,521	60,196		25,809	86,006	6.9
2008	689	3,163,199	85,161		35,023	120,184	3.8
2009	421	1,925,233	30,996		30,959	61,955	3.2
2010[a]	502	2,165,628	53,619		47,511	101,130	4.7
2011[a]	492	2,157,420	67,982	3,665	37,185	108,832	5.0
2012[a]	880	3,716,240	49,774	25,305	34,334	109,413	2.9
2013[a]	714	3,367,224	73,695	NA	39,396	113,091	3.4
2014[a]	485	1,961,825	77,510	NA	37,170	114,680	5.8
2015[a]	312	1,512,264	80,543	5,976	53,344	139,863	9.3
2016[a]	222	991,674	95,063	--	49,854	144,917	14.6

[a] Calculated with Bailey model

Non-target Taxa

Bull trout (*Salvelinus confluentus*) also comprised a large proportion of incidental species captured. During the trapping period 337 bull trout (78 ≥ 300 mm FL and 259 <300 mm FL) were captured. Additionally, 61 westslope cutthroat trout (*O. clarki lewisi*), and 1 Eastern brook trout (*S. fontinalis*) were collected. In all, 258 bull trout and 59 westslope cutthroat trout were released with PIT tags. Monthly and annual totals of all fish captured are presented in Appendix E and Appendix F, respectively.

Rotary Smolt Traps – Lower Wenatchee

Trap Operation

The Lower Wenatchee Trap operated between 24 February and 31 July 2017. During that time, the trap was inoperable for 36 days because of high and low river discharge, debris, elevated river temperature, large hatchery releases, and mechanical issues. Extreme river temperatures and low flows resulted in trapping operations being suspended for the season on 31 July. Throughout the season, the trap cones were operated in a single lower position.

Fish Sampling

A total of 68,289 individual fish were collected, with wild summer Chinook Salmon comprising 69% of the total catch. Additionally, 1,332 wild yearling spring Chinook Salmon, 12,132 hatchery yearling Chinook Salmon, 1,046 wild sockeye, 163 wild steelhead, and 337 hatchery steelhead were captured. Throughout the sampling period 1,220, 968, and 106 PIT tag were deployed into wild yearling spring Chinook, sockeye, and steelhead, respectively. Mortality for the season totaled 7 yearling spring Chinook, 360 subyearling summer Chinook, 8 sockeye, and 2 steelhead (0.5%, 0.8%, 0.8%, and 1.2%, respectively).

Wild Yearling Spring Chinook (Brood Year 2015)

Wild yearling spring Chinook Salmon were primarily captured in March and April (Figure 8). Throughout the trapping period 1,332 spring Chinook were collected and an estimated 1,500 would have been collected had the trap operated without interruption. A combination of 2014, 2015 and 2017 trials were used to develop a significant relationship between discharge and trap efficiency ($R^2 = 0.82$, $P < 0.01$). This model was used to calculate an emigrant estimate of 130,426 (±30,679; 95% CI). The mean fork length (SD) of captured yearling Chinook was 97 (8.4) mm (Table 4).

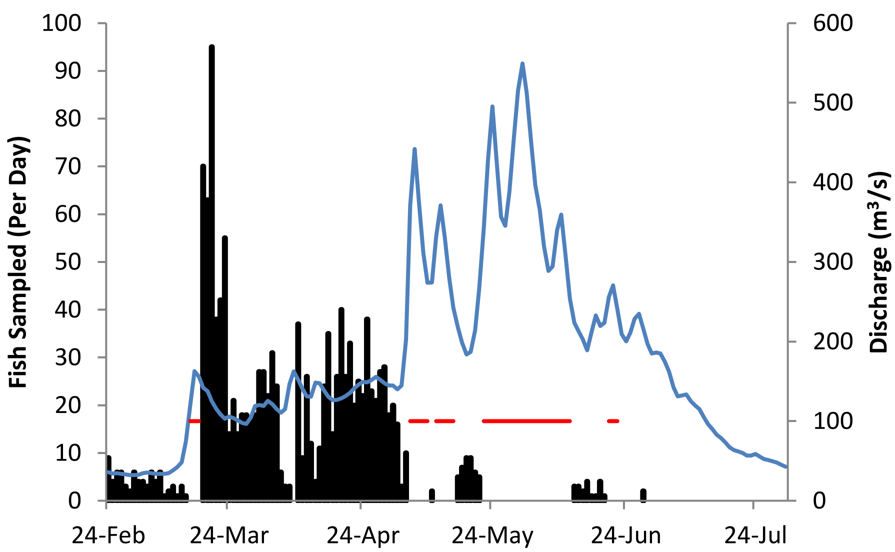

Figure 8. Daily capture of wild yearling Chinook Salmon at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 4. Mean fork length (mm) and weight (g) for wild yearling spring Chinook Salmon sampled at the Lower Wenatchee rotary trap during 2017.

	Mean	**SD**	**N**
Fork length	96.7	8.4	1,319
Weight	9.8	2.6	1,313

Wild Subyearling Summer Chinook (Brood Year 2015)

Wild subyearling summer Chinook dominated the catch (69%) with 46,801 fish being processed. Most were collected in May and June (Figure 9). An estimated 78,944 would have been captured had the trap operated without interruption. Over the season, four mark/recapture efficiency trials were carried out using Bismarck Brown dye. When combined with trials from 2016 and 2015 a significant discharge efficiency relationship was developed ($R^2 = 0.52$, $P < 0.001$) and an emigrant estimate of 7,593,243 (±1,068,936; 95% CI) was calculated. The mean fork length (SD) for captured subyearling parr and fry summer Chinook was 61.6 (8.6) and 42.7 (3.7), respectively (Table 5). No summer Chinook were PIT tagged.

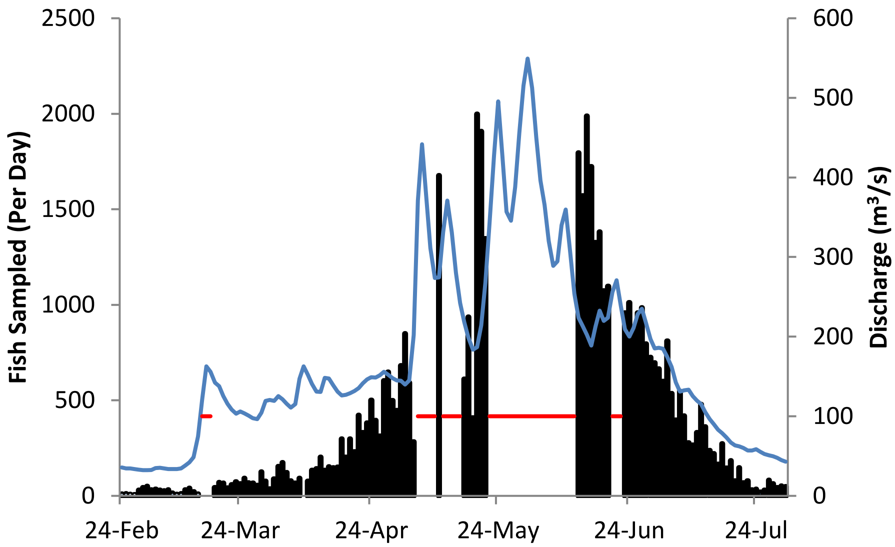

Figure 9. Daily capture of wild summer Chinook Salmon at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 5. Mean fork length (mm) and weight (g) of subyearling summer Chinook Salmon sampled at the Lower Wenatchee rotary smolt trap during 2017.

	Transition / Smolt			**Parr**			**Fry**		
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
Fork length	84.6	5.9	60	61.6	8.6	3,121	42.7	3.7	2,294
Weight	6.7	1.7	50	2.6	1.3	1,819	0.75	0.3	1,548

Wild Sockeye

A total of 1,046 juvenile sockeye were collected in the 2017 season and an estimated 1,105 had the trap operated without interruption. Almost all of these fish (95%) were collected in April (Figure 10). No mark/recapture efficiency trials were carried out due to technical difficulties during the peak of the run. Mark/recapture efficiency trials from the 2013, 2014, and 2015 seasons created a significant discharge efficiency model ($R^2 = 0.52$, $P < 0.043$). This model produced a 2017 emigrant population estimate for juvenile sockeye at 121,926 (±22,908; 95%

CI). Smolt survival (SE) to McNary of those tagged fish was 39% (11%) using the Cormack-Jolly-Seber estimator. In 2017, most were Age 1+ (87%), with the remaining Age 2+ (8%) and Age 0+ (5%) (Table 6). Mean fork length (SD) for captured sockeye was 91 (9.8) mm (Table 7).

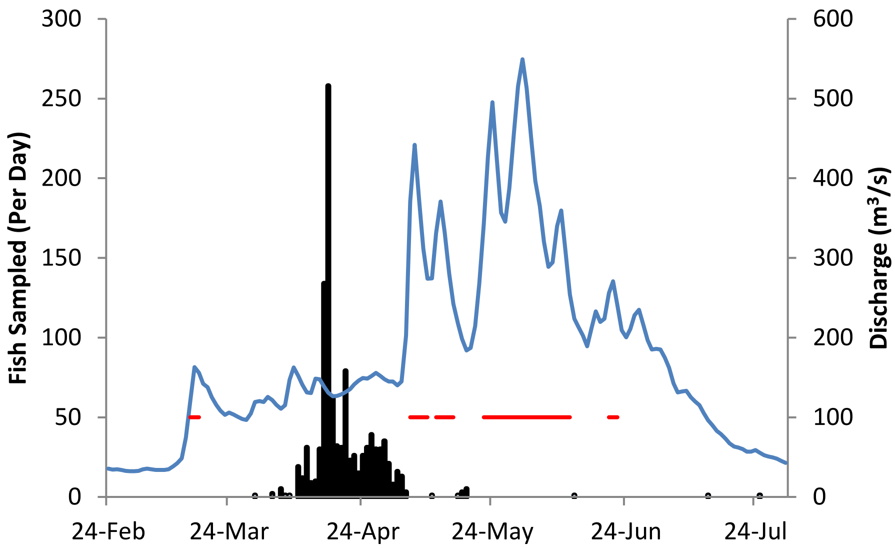

Figure 10. Daily capture of wild sockeye Salmon at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 6. Age structure and estimated number of wild sockeye smolts that emigrated from Lake Wenatchee in 2013-2017.

Run year	Proportion of Wild Smolts				Total Wild Smolts
	Age 0+	Age 1+	Age 2+	Age 3+	
2013	0.008	0.919	0.073	0.00	873,096
2014	0.003	0.948	0.049	0.00	1,275,027
2015	0.003	0.777	0.220	0.00	1,065,614
2016	0.046	0.895	0.059	0.00	208,250
2017	0.053	0.868	0.079	0.00	121,825

Table 7. Mean fork length (mm) and weight (g) of wild sockeye Salmon smolts sampled at the Lower Wenatchee rotary smolt trap during 2017.

	Mean	SD	N
Fork length	91.0	9.8	989
Weight	6.5	2.3	981

Wild Summer Steelhead

Capture of wild steelhead at the Lower Wenatchee site for all life stages was low, totaling 163 fry, parr, and smolts combined and an estimated 210 collected had the trap operated without interruption. Peak catches of steelhead occurred in May and June (Figure 11). Due to the lack of fish no mark/recapture trials were conducted, and no significant relationship could be determined. Thus, a combination of three trials from 2014 and 2016 were used to produce a pooled efficiency of 0.028. This pooled estimated was used to produce an emigrant estimate (no fry) of 5,784 (±58,303) parr and smolt steelhead. If fry are included, the emigrant population was estimated to be 11,845 (± 119,393). Mean length (SE) of transitional/smolts and parr was 149.2 (30.0) and 91.4 (18.5) mm, respectively (Table 8).

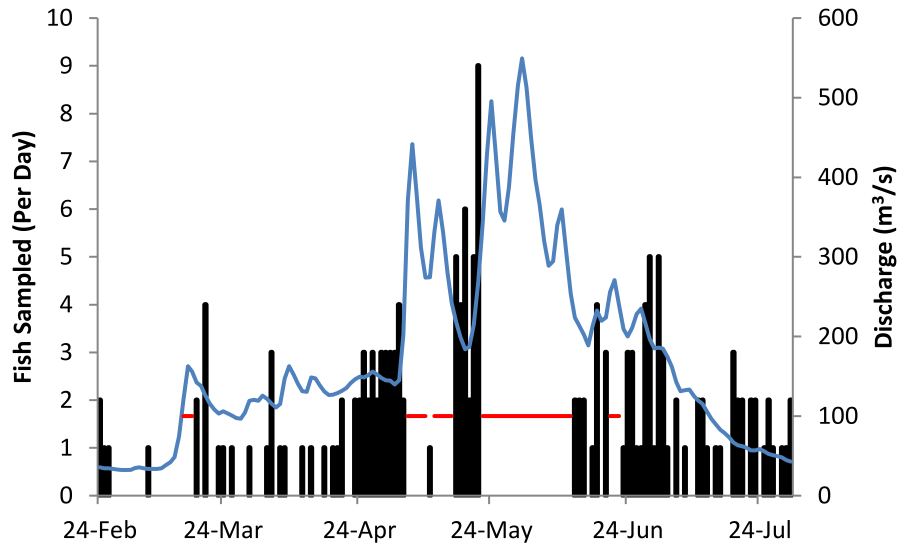

Figure 11. Daily capture of wild steelhead at the Lower Wenatchee rotary smolt trap. Blue line indicates river discharge and red horizontal line indicates non-trapping period.

Table 8. Mean fork length (mm) and weight (g) of wild steelhead sampled at the Lower Wenatchee rotary smolt trap during 2017.

	Transitional/Smolt			Parr			Fry		
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
Fork length	149.2	30.0	52	91.4	18.5	64	31.4	4.1	28
Weight	37.0	21.8	52	8.9	5.7	64	0.3	0.2	23

Survival

For BY 2015, 1,047 spring Chinook Salmon redds were surveyed in the Wenatchee Basin producing an estimated 5,074,809 eggs. An estimate of 130,426 emigrants results in an estimated egg-to-emigrant survival of 2.57%. This is up from the last four-year average of 1.06% (Table 9).

Table 9. Estimated egg deposition and egg-to-smolt survival rates for Wenatchee Basin spring Chinook Salmon.

Brood Year	Number of redds	Estimated egg deposition	Estimated number	
			Total emigrants	Egg-to-emigrant survival (%)
2000	350	1,758,050	76,643	4.36
2001	1,876	8,674,624	243,516	2.81
2002	1,139	5,300,906	165,116	3.11
2003	323	1,887,612	70,738	3.75
2004	555	2,663,445	55,619	2.09
2005	829	3,587,083	302,116	8.42
2006	588	2,542,512	85,558	3.37
2007	466	2,069,506	60,219	2.91
2008	1,411	6,479,312	82,137	1.27
2009	--	--	--	--
2010	--	--	--	--
2011	872	3,823,720	89,917	2.35
2012	1,704	7,195,992	67,973	0.94
2013	1,159	5,465,844	58,595	1.07
2014	969	3,919,605	36,752	0.94
2015	1,047	5,074,809	130,426	2.57

For BY 2016, 2,797 summer Chinook Salmon redds were surveyed in the Wenatchee Basin, 95.8% being upstream of the Lower Wenatchee smolt trap. After extrapolating by the proportion of redds above the trap a total emigrant population of 8,047,997 was estimated resulting in an egg-to-emigrant survival of 67.96%. This is down from the last three year average of 74.34% (Table 10).

Table 10. Estimated egg deposition and egg-to-emigrant survival rates for Wenatchee Basin summer Chinook Salmon.

Brood year	Peak total redd expansion	Estimated egg deposition	Redds above trap / total redds	Estimated number		
				Trap estimate	Total emigrants	Egg-to-emigrant survival (%)
1999	2,738	13,654,406	0.988	9,572,392	9,685,591	70.93
2000	2,540	13,820,140	0.983	1,299,476	1,322,383	9.57
2001	3,550	18,094,350	0.987	8,229,920	8,340,342	46.09
2002	6,836	37,488,624	0.977	13,167,855	13,475,368	35.95
2003	5,268	28,241,748	0.996	20,336,968	20,426,149	72.33
2004	4,874	26,207,498	0.989	14,764,141	14,935,745	56.99

Brood year	Peak total redd expansion	Estimated egg deposition	Redds above trap / total redds	Estimated number		
				Trap estimate	Total emigrants	Egg-to-emigrant survival (%)
2005	3,538	17,877,514	0.993	11,612,939	11,695,581	65.42
2006	8,896	45,663,168	0.979	9,397,044	9,595,512	21.01
2007	1,970	10,076,550	0.983	4,470,672	4,546,838	45.12
2008	2,800	14,302,400	0.978	4,309,496	4,405,473	30.8
2009	3,441	18,206,331	0.983	6,695,977	6,814,805	37.43
2010	3,261	16,184,343	0.957	--	--	--
2011	3,078	15,122,214	0.958	--	--	--
2012	2,504	12,021,704	0.930	9,333,214	10,034,508	83.47
2013	3,241	16,162,867	0.947	11,936,928	12,605,925	77.99
2014	3,458	16,556,904	0.959	14,157,778	14,763,064	89.17
2015	1,804	8,987,528	0.974	4,090,085	4,199,697	46.73
2016	2,797	12,371,131	0.893	7,593,243	8,407,997	67.96

Non-target Taxa

No westslope cutthroat trout or bull trout where sampled at the Lower Wenatchee Trap. No PIT tags were applied to non-target taxa. Monthly and annual totals of all fish captured are presented in Appendix G and Appendix H, respectively.

Backpack Electrofishing

Fish Sampling

Between 6 October and 9 November 2016, WDFW personnel sampled the Chiwawa River. During this sampling, a total of 1,829 subyearling Chinook were collected of which 1,772 received a PIT tag. The greatest concentration of juvenile Chinook occurred between rkm 31 and 45 which had a mean sample rate of one Chinook collected for every 49 seconds of sampling. Over the sample period 5 Chinook died resulting in a mortality rate of 0.3%. Additionally, 267 juvenile bull trout were collected and 89 received a PIT tag. Highest catch rates for bull trout were around rkm 47. A single bull trout mortality was reported (0.4%).

Detections and Calculations

Between the non-trapping season of 23 November 2016 through 22 March 2017, a total of 25 detections of remotely tagged Chinook were recorded at the lower Chiwawa antenna array. During the 2016 fall (6 October through 22 November) and 2017 spring trapping season (23 March and 30 June), the Chiwawa rotary smolt trap collected 38 and 65 remotely tagged Chinook, respectively. We were able to develop a significant relationship between the lower Chiwawa PIT tag antenna array's detection efficiency and flow ($R2 = 0.754$; $P < 0.001$). This allowed us to use the 25 detections and produced a non-trapping estimate of 5,976 (± 2,185; 95% CI). See appendix C for further information.

DISCUSSION

Chiwawa River Rotary Smolt Trap

Over the last five years the Chiwawa River smolt trap has had an average installation date of 1 March. With a relatively heavy snow pack, access to the smolt trap was prevented and installation had to wait until 22 March. Spring runoff resulted in the trap being pulled for 32 days and a major flow event in the fall caused the trap to be pulled for an additional 4 days. The river substrate continues to shift after high flows causing us to continually adapt how we operate the cones position. For this reason, we have started using a new low flow cone position for when flows drop below 4.3 m^3/s. Current operable discharges are believed to be between 2.4 m^3/s and 50 m^3/s.

The total emigrant estimate of spring Chinook Salmon for brood year 2015 was 139,863 (± 58,665). This comprises estimates of subyearling emigrants in 2015, emigrants from the non-trapping period and yearling emigrants in 2016.

The 2017 field season represented the first year we operated the cone in the new low flow position. This meant we needed to develop new models for target species under these flow conditions and cone position. While we conducted enough mark/release trials to develop a significant model, we will continue to improve this new model as we expect the substrate to be ever changing and adjusting trap efficiencies. Particular attention will be paid to our effort in developing a model for steelhead.

Lower Wenatchee River Rotary Smolt Trap

Historically, the smolt trap on the mainstem Wenatchee River has moved location numerous times due to poor trap efficiencies of target species and environmental factors causing abbreviated trapping seasons. At the lower Wenatchee site, the smolt trap has been able to operate into September in 2013 and October in 2014. This marks a relatively large increase in operational length over the old site (located 2.5 km downstream) which had an average trap removal date of 14 August. However, since 2014 river discharge and water temperatures have hampered the trapping season for the Lower Wenatchee trap. At this site, the trap is considered operable between discharges of 36.8 and 283.2 m^3/s. In 2017, high discharge resulted in the trap being pulled for 33 days, mostly in May and June. Complicating things further, river temperatures exceeded 20°C starting 23 July and trapping operations were suspended July 31. River temperatures remained elevated and low flows persisted through the summer, resulting in the decision to remove the smolt trap for the season.

Significant discharge efficiency models were obtained for three of the four target species at the Lower Wenatchee trap during the 2017 trapping season (wild spring and summer Chinook Salmon and sockeye Salmon). Collections of wild steelhead continue to be inadequate for conducting mark–recapture trials. In 2018, we will continue to look for ways to improve our efficiency models for steelhead.

Backpack Electrofishing

Remote sampling in the Chiwawa Basin started in 2012. Some success occurred early with PIT tag targets being met, however permit restrictions and environmental conditions hindered efforts in recent years. While the 2017 sampling effort did not reach our goal of deploying 3,000 pit tags, we were able to tag 1,772 subyearling Chinook. This resulted in 25 detections at the Lower Chiwawa array during the non-trapping period and made it possible for an estimate to be calculated. We will continue to increase and refine our efforts in subsequent years to insure the best estimate will be calculated.

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APPENDICES

Appendix A. Peterson Population and Variance Equations.

Trap efficiency was calculated using the following formula:

Trap efficiency = $E_i = R / Mi,$

Where E_i is the trap efficiency during time period i; M_i is the number of marked fish released during time period i; and R_i is the number of marked fish recaptured during time period i. The number of fish captured was expanded by the estimated daily trap efficiency (e) to estimate the daily number of fish migrating past the trap using the following formula:

Estimated daily migration = $\hat{N}_i = C_i / \hat{e}_i$

where N_i is the estimated number of fish passing the trap during time period i; C_i is the number of unmarked fish captured during time period i; and e_i is the estimated trap efficiency for time period i based on the regression equation.

The variance for the total daily number of fish migrating past the trap was calculated using the following formulas:

Variance of daily migration estimate = $\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{\mathrm{MSE}\left(1 + \dfrac{1}{n} + \dfrac{\left(X_i - \overline{X}\right)^2}{(n-1)s_X^2}\right)}{\hat{e}_i^2}$

where X_i is the discharge for time period i, and n is the sample size. If a relationship between discharge and trap efficiency was not present (i.e., $P < 0.05$; r^2 0.5), a pooled trap efficiency was used to estimate daily emigration:

Pooled trap efficiency = $e_p = \sum R / \sum M$

The daily emigration estimate was calculated using the formula:

Daily emigration estimate = $\hat{N}_i = C_i / e_p$

The variance for daily emigration estimates using the pooled trap efficiency was calculated using the formula:

Variance for daily emigration estimate = $\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{e_p(1-e_p)/\sum M}{e_p^2}$

The total emigration estimate and confidence interval was calculated using the following formulas:

Total emigration estimate = $\sum \hat{N}_i$

95% confidence interval = $1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$

Appendix B. Bailey Population and Variance Equations.

Trap efficiency was calculated using the following formula:

Trap efficiency: *E_i = R+1 / Mi,*

Estimated daily emigration = $\hat{N}_i = \frac{C_i + 1}{\hat{e}_i}$

The variance of the total population abundance was calculated as follows:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i + 1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov\left(\frac{(C_i + 1)}{\hat{e}_i}, \frac{(C_j + 1)}{\hat{e}_j}\right)}_{Part\ B}$$

Part A is the variance of the daily estimates where C_i is the number of fish caught in period *i*, e_i is the estimated trap efficiency for period *i*, and *Cov* is the between day covariance for days that the same linear model is used (part B). For a more details and derivation of Peterson and Bailey estimation methods see Murdoch et al. (2012).

Appendix C. Emigration during non-trapping periods.

A flow-efficiency regression model was developed for the lower Chiwawa River PIT tag interrogation site (CHL) using the same mark/recapture trials used for estimating efficiency at the smolt trap. This CHL model was used to calculate emigration outside of the trapping period by incorporating the tag rate into the Bailey estimator.

$$\text{Estimated daily emigration} = \left(\hat{N}_i = \frac{C_i + 1}{\hat{e}_i} \right) \Big/ t_i$$

Where t_i is equal to the tag rate = $t_i = \frac{t}{p}$

Appendix D: Mark–Recapture groups used to developing emigrant estimates. YCW = Yearling spring Chinook wild, YCH = Yearling spring Chinook hatchery, SKW = Sockeye wild, SUCH = summer Chinook wild, SBC = subyearling Chinook wild.

Species	Date	Position	Released	Recaptured	Efficiency (%)	Discharge (m^3/s)
			Lower Wenatchee River rotary smolt trap			
YCW	13-Mar-14	Low	156	2	1.28	121.8
YCW	21-Mar-14	Low	243	4	1.65	102.8
YCW	31-Mar-14	Low	306	9	2.94	82.9
YCW	14-Apr-14	Low	165	4	2.42	127.6
YCH	17-Apr-15	Low	2,045	82	4.01	63.1
YCW	23-Mar-17	Low	191	3	2.09	106.2
YCW	1-Apr-17	Low	409	3	0.98	115.6
YCW	6-Apr-17	Low	231	1	0.87	141.6
SKW	27-Apr-13	Low	565	6	1.06	141.6
SKW	31-Mar-14	Low	322	1	0.31	83.1
SKW	04-Apr-14	Low	599	2	0.33	81.7
SKW	07-Apr-14	Low	633	2	0.32	99.6
SKW	16-Apr-14	Low	591	3	0.51	126.2
SKW	19-Apr-14	Low	385	4	1.04	130.4
SKW	23-Apr-14	Low	504	2	0.40	125.5
SKW	12-Apr-15	Low	540	2	0.37	73.9
SUCH	03-Apr-15	Low	540	5	0.93	114.7
SUCH	07-Apr-15	Low	1,170	44	3.76	88.1
SUCH	10-Apr-15	Low	755	13	1.72	76.5
SUCH	23-Apr-15	Low	1,035	17	1.64	99.4
SUCH	22-May-15	Low	974	12	1.23	159.5
SUCH	28-May-15	Low	1,109	3	0.27	126.0
SUCH	25-May-16	Low	1,051	10	0.95	171.5
SUCH	02-Jun-16	Low	1,071	22	2.05	164.6
SUCH	11-Jun-16	Low	685	11	1.61	167.6
SUCH	18-Jun-16	Low	1,141	19	1.75	85.1
SUCH	15-Jun-17	Low	1,810	30	1.71	192.6
SUCH	24-Jun-17	Low	881	12	1.48	201.9
			Chiwawa River rotary smolt trap			
YCW	24-Mar-17	Upper	150	20	14.0	8.1
YCW	28-Mar-17	Upper	150	31	21.3	7.8

Species	Date	Position	Released	Recaptured	Efficiency (%)	Discharge (m^3/s)
YCW	30-Mar-17	Upper	149	21	14.8	9.3
YCW	16-Apr-17	Upper	123	8	7.3	15.0
YCW	21-Apr-17	Upper	269	20	7.8	17.6
YCW	26-Apr-17	Upper	212	28	13.7	21.8
YCW	29-Apr-17	Upper	164	22	14.0	22.7
SBC	16-Jun-16	Upper	265	21	7.9	17.6
SBC	26-Jun-16	Upper	241	32	13.3	17.7
SBC	01-Jul-16	Upper	326	34	10.4	24.9
SBC	07-Jul-16	Upper	246	34	13.8	14.5
SBC	11-Jul-16	Upper	80	13	16.3	14.0
SBC	27-Jul-16	Upper	101	22	21.8	12.1
SBC	04-Aug-16	Upper	209	96	45.9	8.2
SBC	10-Aug-16	Upper	162	51	31.5	6.5
SBC	12-Oct-16	Upper	199	73	36.7	5.7
SBC	17-Oct-16	Upper	185	37	20.0	10.9
SBC	28-Oct-16	Upper	200	22	11.0	16.8
SBC	4-Nov-16	Upper	156	17	10.9	11.8
SBC	12-Jul-17	Upper	113	16	15.0	21.5
SBC	1-Aug-17	Upper	138	32	23.9	8.7
SBC	9-Aug-17	Upper	94	14	16.0	7.0
SBC	15-Aug-17	Upper	100	40	41.0	5.8
SBC	25-Aug-17	Low Flow	72	4	6.9	4.3
SBC	14-Sep-17	Low Flow	77	6	9.1	3.0
SBC	20-Sep-17	Low Flow	75	15	21.3	2.9
SBC	24-Sep-17	Low Flow	63	16	27	2.7
SBC	8-Nov-17	Low Flow	102	6	6.9	4.5

Appendix E. Monthly collection information for the Chiwawa River smolt trap.

	2017											
Species/Origin	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Total**
Chinook												
Wild												
Yearling	--	--	1,657	3,727	385	55	0	0	0	0	0	5,824
Subyearling (non fry)	--	--	0	0	0	181	3192	1,964	526	4,778	1,157	11,798
Subyearling fry	--	--	25	620	182	48	261	4	0	0	0	1,140
Hatchery yearling	--	--	0	4,518	0	0	0	0	0	0	0	4,518
Steelhead												
Wild												
Smolt	--	--	1	112	62	9	9	18	10	22	1	244
Parr	--	--	34	111	193	151	60	26	5	156	76	812
Fry	--	--	0	0	0	1	14	7	0	2	1	25
Hatchery	--	--	2	1,550	2,349	4	0	0	2	0	0	3,907
Coho												
Wild												
Smolt	--	--	0	0	0	0	0	0	0	0	0	0
Parr	--	--	0	0	0	0	0	0	0	0	0	0
Fry	--	--	0	0	0	0	0	0	0	0	0	0
Bull trout												
Juvenile	--	--	3	4	8	13	9	2	44	153	23	259
Adult	--	--	0	0	0	0	0	4	47	27	0	78
Westslope cutthroat trout	--	--	0	1	0	4	9	14	26	6	1	61
Eastern brook trout	--	--	0	0	0	0	0	0	0	0	1	1
Rainbow trout	--	--	0	0	0	0	0	0	0	0	0	0
Mountain whitefish	--	--	4	10	2	6	240	346	37	51	49	745
Longnose dace	--	--	6	30	57	86	202	26	119	283	52	861
Sculpin spp.	--	--	0	8	5	12	55	20	5	21	4	130
Dace spp.	--	--	0	2	0	22	0	4	0	0	0	28
Northern pikeminnow	--	--	0	0	0	0	3	34	21	0	0	58
Sucker spp.	--	--	0	0	0	0	0	2	2	3	0	7
Redside shiner	--	--	0	0	0	0	0	0	0	0	0	0
Yellow Perch	--	--	0	0	0	0	0	0	0	0	0	0

Appendix F. Annual collection information from the Chiwawa River smolt trap.

Species origin	2017	2016	2015	2014	2013	2012
Chinook						
Wild						
Yearling	5,824	2,807	6,350	5,419	3,199	7,626
Subyearling	12,938	16,393	31,152	23,755	27,621	14,831
Hatchery	4,518	2,525	7,162	5,293	15,909	30,751
Steelhead						
Wild						
Smolt	244	195	259	49	85	183
Parr and Fry	837	1,522	3,004	1,889	1,949	1,738
Hatchery	3,907	1,518	3,151	290	1,539	1,664
Coho						
Wild						
Smolt	0	0	0	0	1	1
Parr and fry	0	3	38	12	0	0
Hatchery	0	0	0	1	10	3
Bull trout						
Juvenile	259	103	266	260	310	488
Adult	78	15	32	75	51	31
Westslope cutthroat trout	61	43	72	59	86	60
Eastern brook trout	1	3	8	12	13	66
Mountain whitefish	745	883	5,544	2,970	2,108	3,291
Longnose dace	861	979	2,663	2,633	2,257	1,762
Northern pikeminnow	58	69	331	5	71	34
Sculpin spp.	130	94	225	131	91	157
Sucker spp.	7	3	30	4	6	0
Dace spp.	28	16	NA	NA	NA	NA
Redside shiner	0	0	13	0	0	0
Yellow perch	0	1	0	0	0	0

Appendix G. Monthly collection information for the Lower Wenatchee River smolt trap.

2017												
Species/Origin	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Total**
Chinook												
Wild												
Yearling	--	28	556	635	92	21	0	--	--	--	--	1,332
Subyearling (non fry)	--	0	1	13	45	7,642	5817	--	--	--	--	13,518
Subyearling fry	--	64	1,319	7,469	11,242	11,318	1871	--	--	--	--	33,283
Hatchery yearling	--	0	0	11,954	154	23	1	--	--	--	--	12,132
Steelhead												
Wild												
Smolt	--	0	4	20	22	6	0	--	--	--	--	52
Parr	--	4	7	13	22	14	6	--	--	--	--	66
Fry	--	0	0	0	0	13	32	--	--	--	--	45
Hatchery	--	0	0	133	193	10	1	--	--	--	--	337
Sockeye												
Wild												
Smolt	--	0	1	954	33	1	2	--	--	--	--	991
Fry	--	0	0	38	17	0	0	--	--	--	--	55
Coho												
Wild												
Smolt	--	0	0	10	3	0	4	--	--	--	--	17
Parr	--	0	0	0	4	88	236	--	--	--	--	328
Fry	--	0	1	9	256	57	34	--	--	--	--	357
Hatchery	--	0	0	3,186	533	4	1	--	--	--	--	3,724
Unknown	--	0	3	11	0	1	0	--	--	--	--	15
Bull trout												
Juvenile	--	0	0	0	0	0	0	--	--	--	--	0
Adult	--	0	0	0	0	0	0	--	--	--	--	0
Westslope cutthroat trout	--	0	0	0	0	0	0	--	--	--	--	0
Mountain whitefish	--	0	1	1	0	3	3	--	--	--	--	8
Lamprey spp.	--	6	291	135	49	473	353	--	--	--	--	1,307
Northern pikeminnow	--	0	1	4	13	14	51	--	--	--	--	83
Sucker spp.	--	0	10	18	40	19	105	--	--	--	--	192
Dace spp.	--	0	1	3	2	16	18	--	--	--	--	40
Longnose dace	--	1	47	43	18	20	115	--	--	--	--	244
Redside shiner	--	0	0	0	0	21	77	--	--	--	--	98
Sculpin spp.	--	0	6	16	8	5	16	--	--	--	--	51
Fathead minnow	--	0	0	0	0	1	0	--	--	--	--	1
Chiselmouth	--	0	0	0	0	1	6	--	--	--	--	7
3-Spine stickleback	--	0	1	1	0	2	2	--	--	--	--	6
Peamouth	--	0	0	0	0	0	0	--	--	--	--	0

Appendix H. Annual collection information from the Lower Wenatchee River smolt trap.

Species/Origin	2017	2016	2015	2014	2013
Chinook					
Wild					
Yearling	1,332	610	1,559	1,700	1,854
Subyearling	46,801	27,407	252,293	81,445	52,652
Hatchery	12,132	7,701	9,920	31,290	13,979
Steelhead					
Wild					
Smolt	52	88	231	80	173
Parr and fry	111	329	100	102	537
Hatchery	337	259	2,288	494	819
Sockeye					
Wild	1,046	1,346	4,178	7,678	4,520
Hatchery	0	0	0	0	72
Coho					
Wild					
Smolt	17	10	22	220	597
Fry and parr	685	135	4,972	393	923
Hatchery	3,724	219	6,566	16,908	12,960
Unknown	15	2,630	143	NA	NA
Bull trout					
Juvenile	0	0	0	3	6
Adult	0	0	0	0	0
Westslope cutthroat trout	0	0	1	3	0
Mountain whitefish	8	15	9	27	110
Lamprey spp.	1,307	1,497	283	292	762
Longnose dace	244	163	242	541	1,382
Sculpin spp.	51	56	52	128	242
Sucker spp.	192	269	51	134	240
Redside shiner	98	189	19	94	423
3-Spine stickleback	6	2	13	66	196
Dace spp.	40	133	NA	NA	NA
Fathead minnow	1	9	NA	NA	NA
Northern pikeminnow	83	552	12	37	39
Chiselmouth	7	66	6	69	10
Peamouth	0	0	3	9	10

Appendix C

Summary of PIT-Tagging Activities in the Wenatchee Basin, 2017

Appendix C. Numbers of fish captured, recaptured, PIT tagged, trap and handle mortality, shed tags, and total tags released in the Wenatchee River basin during January through November 2017.

Sampling Location	Species and Life Stage	Number collected	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
Chiwawa Trap	Wild Subyearling Chinook	12,938	296	8,241	187	0	8,241	1.45
	Wild Yearling Chinook	5,824	169	5,711	15	0	5,711	0.26
	Wild Steelhead/Rainbow	1,081	2	909	3	0	909	0.28
	Hatchery Steelhead/Rainbow	3,907	0	1	1	0	1	0.03
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**23,750**	**467**	**14,862**	**206**	**0**	**14,862**	**0.87**
Chiwawa Remote (Electrofishing)	Wild Subyearling Chinook	2,740	24	2,703	3	0	2,703	0.11
	Wild Yearling Chinook	0	0	0	0	0	0	0.00
	Wild Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**2,740**	**24**	**2,703**	**3**	**0**	**2,703**	**0.11**
Nason Creek Trap	Wild Subyearling Chinook	2,490	190	1,877	5	0	1,877	0.20
	Wild Yearling Chinook	357	29	346	1	0	346	0.28
	Wild Steelhead/Rainbow	1,562	64	1,353	1	0	1,353	0.07
	Hatchery Steelhead/Rainbow	1,122	138	0	49	0	0	4.37
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**5,531**	**421**	**3,576**	**56**	**0**	**3,576**	**0.98**
Nason Creek Remote (Electrofishing)	Wild Subyearling Chinook	3,401	63	3,242	42	2	3,240	1.23
	Wild Yearling Chinook	0	0	0	0	0	0	0.00
	Wild Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**3,401**	**63**	**3,242**	**42**	**2**	**3,240**	**1.23**
White River Trap	Wild Subyearling Chinook	539	40	507	8	0	507	1.48
	Wild Yearling Chinook	41	0	41	0	0	41	0.00
	Wild Steelhead/Rainbow	6	0	3	0	0	3	0.00
	Hatchery Steelhead/Rainbow	0	0	0	0	0	0	0.00
	Wild Coho	0	0	0	0	0	0	0.00
	Total	**586**	**40**	**551**	**8**	**0**	**551**	**0.30**
Lower Wenatchee Trap	Wild Subyearling Chinook	46,801	36	0	360	0	0	0.77
	Wild Yearling Chinook	1,332	8	1,220	7	0	1,220	0.53
	Wild Steelhead/Rainbow	163	0	106	2	0	106	1.23
	Hatchery Steelhead/Rainbow	337	0	0	1	0	0	0.30
	Wild Coho	702	0	0	3	0	0	0.43
	Unknown Coho	3,739	0	0	3	0	0	0.08
	Wild Sockeye	1,046	1	968	8	0	968	0.76

Sampling Location	Species and Life Stage	Number collected	Number of recaptures	Number tagged	Number died	Shed tags	Total tags released	Percent mortality
	Total	**54,120**	**45**	**2,294**	**384**	**0**	**2,294**	**0.71**
Total:	***Wild Subyearling Chinook***	***68,909***	***649***	***16,570***	***605***	***2***	***16,568***	***0.88***
	Wild Yearling Chinook	***7,554***	***206***	***7,318***	***23***	***0***	***7,318***	***0.30***
	Wild Steelhead/Rainbow	***2,812***	***66***	***2,371***	***6***	***0***	***2,371***	***0.21***
	Hatchery Steelhead/Rainbow	***5,366***	***138***	***1***	***51***	***0***	***1***	***0.95***
	Wild Coho	***702***	***0***	***0***	***3***	***0***	***0***	***0.43***
	Unknown Coho	***3,739***	***0***	***0***	***3***	***0***	***0***	***0.08***
	Wild Sockeye	***1,046***	***1***	***968***	***8***	***0***	***968***	***0.76***
Grand Total:		***90,128***	***1,060***	***27,228***	***699***	***2***	***27,226***	***0.78***

Appendix D

Wenatchee Steelhead Spawning Escapement Estimates, 2017

Estimates of Wenatchee Steelhead Spawners in 2017

Kevin See

January 08, 2018

Introduction

Redd counts are an established method to provide an index of adult spawners (Gallagher et al. 2007). In the Wenatchee and Methow subbasins, index reaches are surveyed weekly during the steelhead spawning season (Mar 06, 2017 - May 18, 2017) and non-index reaches are surveyed once during the peak spawning period. The goal of this work is to:

- Predict observer net error, based on a model developed with data from steelhead redd surveys in the Methow, similar to that described in Murdoch et al. (2014). This model has been updated with some additional data points collected in the Wenatchee.
- Use estimates of observer net error rates and the mean survey interval to estimate the number of redds in each index reach, using a Gaussian area under the curve (GAUC) technique described in Millar et al. (2012).
- Estimate the total number of redds in the non-index reaches by adjusting the observed counts with the estimated net error.
- Convert these estimates of redds in the mainstem areas (surveyed for redds) into estimates of spawners.
- Use PIT-tag based estimates of escapement for all tributaries in the Wenatchee, and combine those estimates with the redd-based estimates of spawners in the mainstem areas to estimate the total number of spawners in the Wenatchee.

Methods

Mainstem areas

The model for observer net error (observed redd counts / true number of redds) is a model averaging of the 5 best models that were fit to 50 data points collected in the Methow and Wenatchee (43 and 7 respectively). All models contained covariates for the log of total redd survey experience and mean thalweg CV as a proxy for channel complexity. Four of them contained observed redd density, while three each contained discharge and mean stream width. Predictions were made using model averaged coefficients (based on AICc model weights) and the 2017 steelhead data. From these survey specific estimates of net error, a mean and standard error of net error was calculated for each reach. The standard deviation was calculated by taking the square root of the sum of the squared standard errors for all predictions within a reach.

Estimates of total redds were made for each index reach using the GAUC model described in Millar et al. (2012). The GAUC model was developed with spawner counts in mind. As it is usually infeasible to mark every individual spawner, only total spawner counts can be used, and an estimate of average stream life must be utilized to translate total spawner days to total unique spawners. However, in adapting this for redd surveys, two modifications could be used. The first would fit GAUC models to data showing all visible redds at each survey and use an estimate of redd life as the equivalent of spawner stream life. However, because conditions can lead to many redds not disappearing before the end of the survey season, the estimates of redd life can be biased low. The second method relies on the fact that individual redds can be marked, and therefore the GAUC model can be fit to new redds only. The equivalent of stream life thus became the mean and standard deviation of the survey interval. We utilized the second method for this analysis.

For non-index reaches, which were surveyed only once during peak spawning, the estimate of total redds was calculated by dividing the observed redds by the estimate of net error associated with that survey. This assumes that no redds were washed out before the non-index survey, and that no new redds appeared after that survey. As the number of redds observed in the non-index reaches ranged from 0 to 2, any violation of this assumption should not affect the overall estimates very much.

To convert estimates of total redds into estimates of natural and hatchery spawners, total redds were multiplied by a fish per redd (FpR) estimate and then by the proportion of hatchery or wild fish. The fish per redd estimate was based on PIT tags from the branching patch-occupancy model (see below) observed to move into the lower or upper Wenatchee (below or above Tumwater dam). FpR was calculated as the ratio of male to female fish, plus 1. This was 1.46 above Tumwater dam, and 2.11 below Tumwater. Reaches W1 - W7 are below Tumwater, while reaches W8 - W10 are above Tumwater. Similarly, the proportion of hatchery and natural origin fish was calculated from the same group of PIT tags for areas above and below Tumwater. The proportion of hatchery origin fish was 0.4 above Tumwater dam, and 0.58 below Tumwater (Table 2).

Tributary areas

Estimates of escapement to various tributaries in the Wenatchee were made using a branching patch-occupancy model (Waterhouse, L. et al., *in prep*) based on PIT tag observations of fish tagged at Priest Rapids dam. All fish that escaped to the various tributaries were assumed to be spawners (i.e. pre-spawn mortality only occurs in the mainstem).

Total spawners

When summing spawner estimates from index reaches to obtain estimates of total spawners in the Wenatchee, an attempt was made to incorporate the fact that the reaches within a stream are not independent. Estimates of correlation between the reaches within a stream were made based on weekly observed redds. Because correlations are often quite high between reaches, this is a better alternative than to naively assume the standard errors between reaches are independent of one another. These estimates of correlation were combined with estimates of standard error for each index reach to calculate a covariance matrix for the Wenatchee index reaches (W2, W6, W8, W9, W10), which was used when summing estimates of spawners to estimate the total standard error. Failure to incorporate the correlations between reaches would result in an underestimate of standard error at the population scale. Non-index reaches were only surveyed once, so it is impossible to estimate a correlation coefficient between non-index reaches and index reaches. Therefore, they were assumed to be independent from the index reaches when summing the estimates of spawners. Because the estimates of tributary spawners were made separately (see above), they were also treated as independent when summing spawner estimates. The uncertainty in each step was carried through the entire analysis via the delta method (Casella and Berger 2002).

Pre-spawn Mortality

After translating estimates of redds to estimates of spawners by origin, we can then compare the spawner estimates to escapement estimates made using PIT tags, and estimate a pre-spawn mortality rate (Table 4). Taking the total PIT-tag based escapement estimate to the Wenatchee (after subtracting the 69 hatchery and 62 wild fish removed at Tumwater, as well as the 13 hatchery fish removed at Dryden, and the 0 and 0 deaths to hatchery and wild fish due to harvest), and subtracting the total estimate of spawners, including the tributaries, then dividing by the total escapement estimate provides an estimate of pre-spawn mortality across the entire Wenatchee population. We can also compare estimates of escapement from the "black box" above LWE (after subtracting 13 hatchery fish removed at Dryden) and the "black box" above Tumwater (after subtracting the 69 hatchery and 62 wild fish removed at Tumwater) to total estimates of spawners in mainstem areas below and above Tumwater dam. This allows us to estimate pre-spawn mortality in the mainstem above and below Tumwater, by origin.

Results

Redd estimates

The estimated net error, observed redds and estimates of redds are shown in Table 1.

Table 1: Estimates of mean net error and total redds for each reach.

Reach	Type	Net.Error	Net.Error.CV	Redds.Counted	Redds.Est	Redds.CV
C1	Index	1	0	0	0	-
N1	Index	1	0	1	1	0
P1	Index	1	0	1	1	0
W1	Non-Index	-	-	0	0	-
W2	Index	0.53	0.14	1	2	0.13
W3	Non-Index	-	-	0	0	-
W4	Non-Index	-	-	0	0	-

W5	Non-Index	-	-	0	0	-
W6	Non-Index	0.61	0.11	0	0	-
W6	Index	0.61	0.1	8	14	0.29
W8	Index	0.57	0.12	2	3	0.14
W9	Non-Index	0.53	0.14	1	2	0.13
W9	Index	0.54	0.14	38	71	0.28
W10	Non-Index	0.43	0.24	2	5	0.23
W10	Index	0.43	0.24	38	92	0.32
Total	**-**	**-**	**-**	**90**	**189**	**0.25**

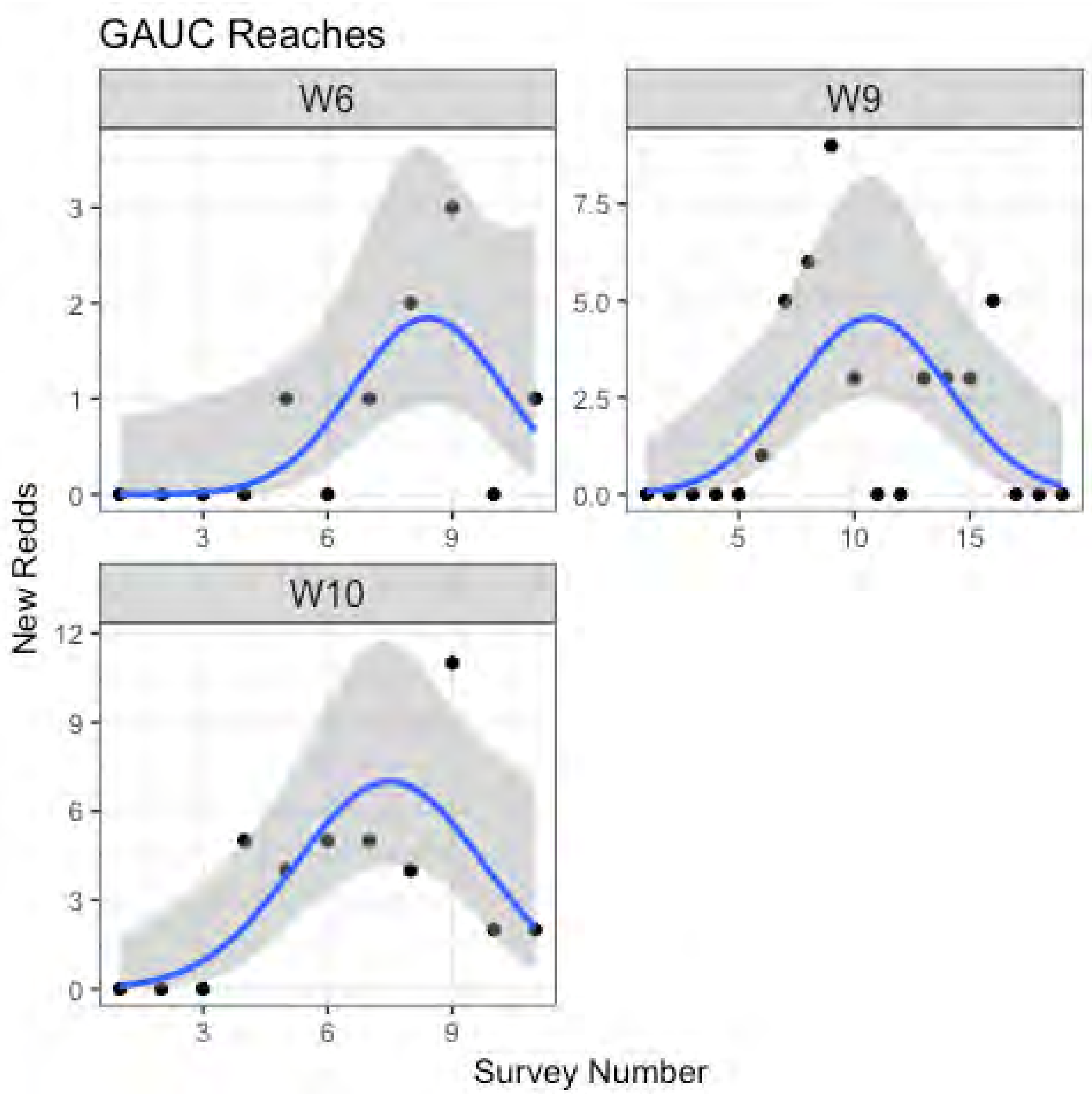

Figure 1: Plots of observed redd counts (black dots) through time for each index reach, and the fitted curve from the GAUC model (blue line) with associated uncertainty (gray).

Spawner estimates

Parameter estimates for fish / redd and proportion hatchery based on PIT tag data are shown in Table 2.

Table 2: Fish per redd and hatchery / natural origin proportion estimates.

Area	Fish / redd	FpR Std. Error	Prop. Hatchery	Prop Std. Error
Below TUM	1.46	0.126	0.4	0.0828
Tribs above TUM	2.11	0.361	0.579	0.113
TUM_bb	1.34	0.0803	0.559	0.0646

Combining PIT tag-based estimates of spawners in the tributaries with adjusted redd-based estimates of spawners in the mainstem areas, Table 3 shows all of them, broken down by area and origin.

Table 3: Estimates (CV) of spawners by area and origin.

Area	Type	Hatchery	Natural
W1	Non-Index	0 (–)	0 (–)
W2	Index	1 (0.26)	2 (0.21)
W3	Non-Index	0 (–)	0 (–)
W4	Non-Index	0 (–)	0 (–)
W5	Non-Index	0 (–)	0 (–)
W6	Index	8 (0.37)	12 (0.33)
W6	Non-Index	0 (–)	0 (–)
W8	Index	2 (0.19)	2 (0.21)
W9	Index	53 (0.31)	42 (0.32)
W9	Non-Index	1 (0.18)	1 (0.2)
W10	Index	69 (0.35)	54 (0.36)
W10	Non-Index	4 (0.26)	3 (0.28)
Icicle	Trib	21 (0.51)	11 (0.65)
Peshastin	Trib	0 (–)	37 (0.35)
Mission	Trib	12 (0.65)	20 (0.47)
Chumstick	Trib	0 (–)	12 (0.68)
Chiwaukum	Trib	0 (–)	0 (–)
Chiwawa	Trib	34 (0.59)	12 (0.71)
Nason	Trib	26 (0.42)	24 (0.42)
Little Wenatchee	Trib	0 (–)	0 (–)
White River	Trib	0 (–)	0 (–)
Total		**232 (0.38)**	**232 (0.38)**

Pre-spawn Mortality

The estimates of overall pre-spawn mortality within the Wenatchee population are shown in Table 4. We found that the estimates of escapement were smaller than the estimates of spawners, leading to negative estimates of pre-spawn mortality for both types of fish. The escapement and spawner estimates had overlapping confidence intervals, so not too much should be made about higher spawner estimates compared to escapement, but it does suggest pre-spawn mortality was very low.

Table 4: Wenatchee pre-spawn mortality estimates. Includes estimates (standard error) of escapement, spawners, pre-spawn mortality, and CV of this rate, separated by origin.

Origin	Escapement	Spawners	Pre-spawn Mortality	CV
Natural	176 (32)	232 (89)	-0.32	-0.009951
Hatchery	191 (35)	232 (88)	-0.21	-0.01242

However, when focused on the mainstem areas above and below Tumwater, there was evidence for pre-spawn mortality below Tumwater. It appeared especially high for hatchery origin fish (Table 5). Estimates of escapement into the mainstem areas above Tumwater were smaller than the estimates of spawners, suggesting very low to no pre-spawn mortality in that area for either origin of fish.

Table 5: Wenatchee pre-spawn mortality estimates. Includes estimates (standard error) of escapement, spawners, pre-spawn mortality, and CV of this rate, separated by origin and mainstem areas above and below Tumwater dam.

Origin	Loc	Escapement	Spawners	Pre-spawn Mortality	CV
Natural	Mainstem above Tumwater	96 (21)	102 (24)	-0.062	0.056
Hatchery	Mainstem above Tumwater	124 (28)	129 (29)	-0.04	0.066
Natural	Mainstem below Tumwater	16 (10)	14 (4)	0.12	0.3
Hatchery	Mainstem below Tumwater	32 (15)	9 (3)	0.72	0.007

Discussion

The estimates of high pre-spawn mortality in the lower mainstem of the Wenatchee could be accurate, but it should be noted that many of the redd surveys failed to observe a single redd in many of the reaches (Table 1). Without any observed redds, any estimate of net error is moot, as the adjusted redd estimate will still be zero. So if all the redds were missed in some of those reaches, the estimate of total spawners in the lower mainstem should be higher, leading to a lower estimate of pre-spawn mortality. It is unclear whether that actually occurred, or if there were actually no redds this year in those reaches.

As for pre-spawn mortality rates estimated above Tumwater, or in the Wenatchee as a whole, the negative estimates of pre-spawn mortality should be interpreted as evidence for very low levels of pre-spawn mortality. Overlapping confidence intervals between estimated escapement and estimated spawners mean that although we estimated more spawners than escapement, not too much should be made of that fact.

Some of our estimates of net error appear fairly low. The primary driver of this appears to be survey experience. Across the whole Methow/Wenatchee dataset, the average number of survey seasons was 27.7. For the 2017 surveys in the Wenatchee, it ranged from 5 to 18.5. Lower than average experience will lead to lower net error estimates. In particular for W10, where 38 redds were observed, the experience was 5. We built the model to use the log of experience, because I didn't want a ton of experience to lead to an estimate of really high net error (suggesting lots of false redds). However, the flip side is that really low experience numbers really shrink the estimates of net error.

In addition, lower observed redd densities lead to lower net error. Given that escapement was pretty low in 2017, all the observed redd densities were below average, also leading to smaller estimates of net error. The mean width of the stream was also lower in 2017 than the average value in the model dataset. But I think the main driver (based on the relative importance of the covariates) is the experience levels.

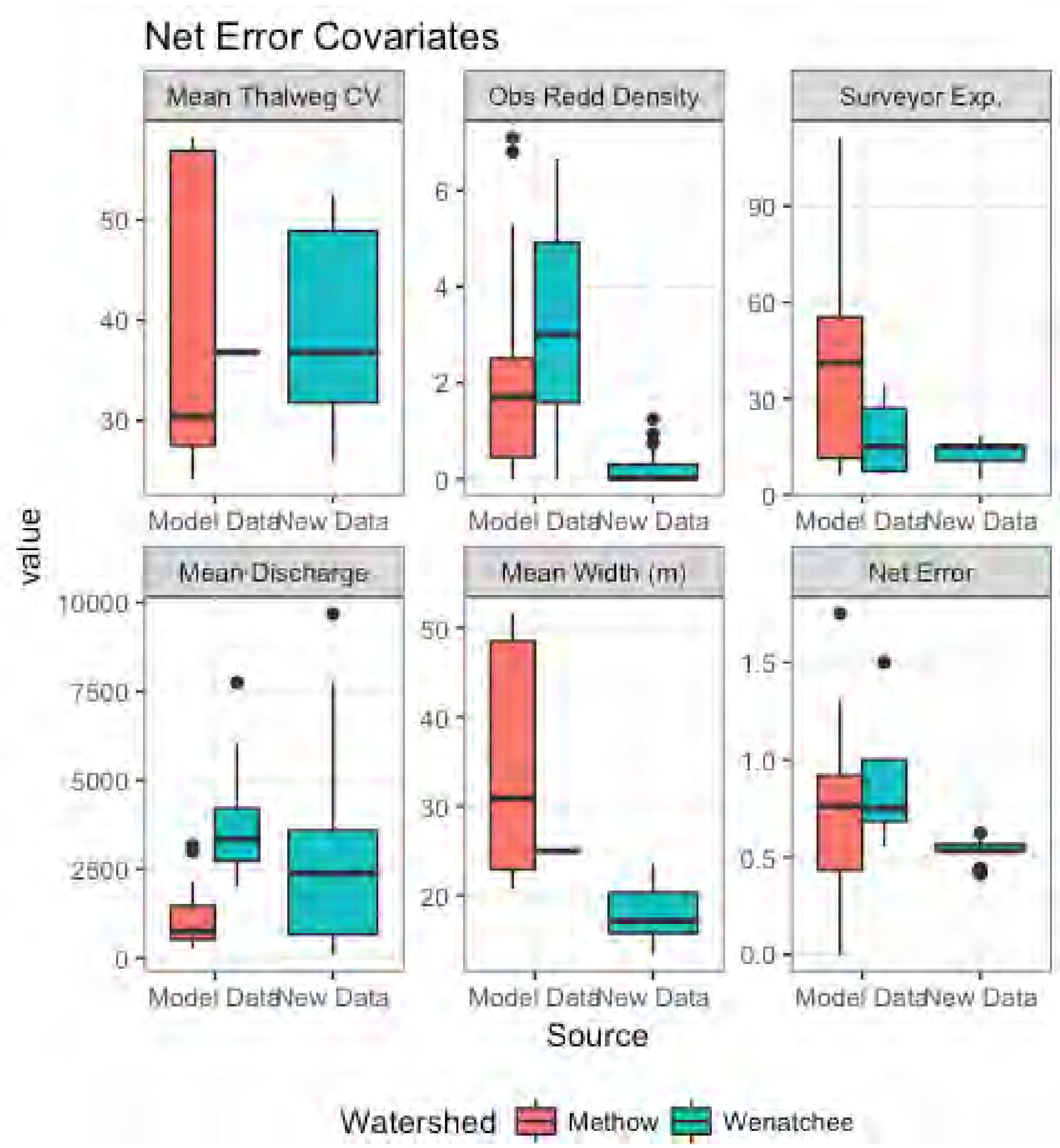

Figure 2: Net error covariate values from the study in the Methow and the predicted reaches in the Wenatchee.

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Appendix E

Genetic Diversity of Wenatchee Summer Steelhead

Examining the Genetic Structure of Wenatchee Basin Steelhead and Evaluating the Effects of the Supplementation Program

Developed for

Chelan County PUD

and the

Rock Island Habitat Conservation Plan Hatchery Committee

Developed by
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17 January 2012

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Executive Summary

In 1997, Wenatchee River summer steelhead, as part of the upper Columbia River evolutionarily significant unit (ESU), were listed as threatened under the Endangered Species Act (ESA). To address concerns about effects of hatchery supplementation, the hatchery program for hatchery produced (HOR) summer steelhead to be planted in the Wenatchee River changed from using mixed ancestry broodstock collected in the Columbia River to using Wenatchee River broodstock collected in the Wenatchee River. Three monitoring and evaluation (M&E) indicators were developed to measure the genetic effects of hatchery production on wild fish populations. To address these indicators, temporal collections of tissue samples from Wenatchee River hatchery-produced (HOR) and natural origin (NOR) adults captured and sampled at Dryden and Tumwater dams and from NOR juveniles from three Wenatchee River tributaries and the Entiat River were surveyed for genetic variation with 132 genetic (SNPs) markers. Peshastin Creek (a Wenatchee River tributary) and the Entiat River served as no-hatchery-outplant controls, meaning they have stopped receiving HOR juvenile outplants. As per the M&E plan, we interrogated these data for the presence or absence of spatial and temporal trends in allele frequencies, genetic distances, and effective population size.

Allele frequencies – Changes to the summer steelhead hatchery supplementation program had no detectable effect on genetic diversity of wild populations. On average, HOR adults had higher minor allele frequencies (MAF) than NOR adults, which may simply reflect the mixed ancestry of HOR adults. Both HOR and NOR adults had MAF similar to juveniles collected in spawning tributaries and in the Entiat River. There was no temporal trend in allele frequencies or observed heterozygosity in adult or juvenile collections and allele frequencies in control populations were no different than those still receiving hatchery outplants. This suggests that the hatchery program has had little effect on allele frequencies since broodstock sources changed in 1998.

Genetic distances – As intended, interbreeding of Wenatchee River HOR and NOR adults reduced the genetic differences between Wells Hatchery HOR adults and Wenatchee River NOR adults observed in the first few years after changing the broodstock collection protocol. Though there were detectable genetic differences between HOR and HOR adults, the magnitude of that

difference declined over time. HOR adults were genetically quite different from NOR adults and juveniles based on pair-wise F_{ST} and principal components analysis (PCA), most likely because of the much smaller effective population size (N_b) in the hatchery population (see below). Pair-wise F_{ST} estimates and genetic distances between HOR and NOR adults collected the same year declined over time suggesting that the interbreeding of HOR and NOR adults in the hatchery (and presumably in the wild) is slowly homogenizing Wenatchee River summer steelhead. Analyses using brood year (the year fish were hatched, determined using scale-based age estimates) were inconclusive because of limitations of the data.

Effective population size (N_b) – Although the effective population size of the Wenatchee River hatchery summer steelhead program was consistently small, it does not appear to have caused a reduction in the effective population size of wild populations. On average, estimates of N_b were much lower and varied less for HOR adults than for NOR adults and juveniles. Estimates of N_b for HOR adults declined from the earliest brood years to a stable new low value after broodstock practices were changed in 1997. There was no indication that this had any effect on N_b in NOR adults and juveniles; N_b estimates for NOR adults and juveniles were, on average, higher and varied considerably over the time period covered by our dataset (1998 – 2010) and showed no temporal trend.

Introduction

The National Marine Fisheries Service (NMFS) recognizes 15 Evolutionary Significant Units (ESU) for west coast steelhead (*Oncorhynchus mykiss*). The Upper Columbia ESU, which contains steelhead in the Wenatchee Basin, was listed as endangered under the Endangered Species Act (ESA) in 1997. Included in this listing were the Wells hatchery steelhead (program initiated in the late 1960s) that originated from a mixed group of native steelhead and are considered to be genetically similar to natural spawning populations above Wells Dam. Juvenile steelhead from Wells Fish Hatchery was the primary stock released into the Wenatchee River (Murdoch et al. 2003). The 1998 steelhead status review identified several areas of concern for this ESU including the risk of genetic homogenization due to hatchery practices and the high proportion (65% for the Wenatchee River) of hatchery fish present on the spawning grounds (Good et al. 2005). The Biological Review Team (BRT) further identified the relationship between the resident and anadromous forms of *O. mykiss* and possible changes in the population structure ('genetic heritage of the naturally spawning fish') in the basin as two areas requiring additional study. Furthermore, the West Coast Steelhead BRT (2003) recommended that stocks in the Wenatchee, Entiat, and Methow rivers, within the Upper Columbia ESU, be managed as separate populations.

A review of the presence of resident *O. mykiss* in the Upper Columbia ESU (Good et al. 2005) shows that rainbow trout are relatively abundant in upper Columbia River tributaries currently accessible to steelhead as well as in upriver tributaries unavailable to anadromous access by Chief Joseph and Grand Coulee dams (Kostow 2003). U.S. Fish and Wildlife Service (USFWS) biologists surveyed the abundance of trout and steelhead juveniles in the Wenatchee, Entiat, and Methow river drainages in the mid-1980s and found adult trout (defined as those with fork length > 20 cm) in all basins (Mullan et al. 1992). The results also supported the hypothesis that resident *O. mykiss* are more abundant in tributary or mainstem areas upstream of the areas used by steelhead for rearing. No samples of rainbow trout from the Wenatchee were available for this study.

In addition to the mixed ancestry Wells Hatchery steelhead, Skamania Hatchery (Washougal River steelhead ancestry) steelhead were also released into the Wenatchee River basin for several years in the late 1980s (L. Brown, Washington Dept. of Fish and Wildlife [WDFW], personal communication). In 1996, broodstock for the Wenatchee River steelhead program were collected from Priest Rapids Dam and Dryden (rkm 24.9) and Tumwater (rkm 52.6) dams on the Wenatchee River. Because of the ESA listing, broodstock collection after 1996 was restricted to the Wenatchee River in an effort to develop a localized broodstock (Murdoch et al. 2003). Thus, starting in 1998, all juvenile steelhead released into the Wenatchee River and Wenatchee River tributaries were offspring of only Wenatchee River captured broodstock.

In response to the need for evaluation of the supplementation program, both a monitoring and evaluation plan (Murdoch and Peven 2005) and the associated analytical framework (Hays et al. 2006) were developed for the Habitat Conservation Plans Hatchery Committee through the joint effort of the fishery co-managers (Confederated Tribes of the Colville Reservation [CCT], NMFS, USFWS, WDFW, and Yakama Nation [YN]) and Chelan County, Douglas County, and Grant County Public Utility Districts (PUD). These reports outline 10 objectives to be applied to various species assessing the impacts of hatchery operations mitigating the operation of Rock Island and Rocky Reach Dams. This report pertains to Wenatchee River basin steelhead (*O. mykiss*) and the steelhead supplementation program as addressed by objective 3, specifically the first three evaluation indicators.

> **Objective 3:** Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

3.1 Allele Frequency

3.2 Genetic Distances Between Populations

3.3 Effective Spawning Population

To address these evaluation indicators the WDFW Molecular Genetics Lab (MGL) obtained pertinent tissue collections and samples, surveyed genetic variation with SNP markers using our standard laboratory protocols, and calculated the relevant genetic metrics and statistics. We used collections from both the Entiat River and Wenatchee River basins. Both have received hatchery plants from non-local stocks [i.e. Entiat was stocked with both Wenatchee and Wells program juveniles averaging 12K and 18K respectively during 1995-2001, and Wenatchee received on average 177K juveniles from the Wells program during 1995-2001; (Good et al. 2005)], and both have all or some part of the basin designated as natural production "reference" drainage – no hatchery outplanting (i.e., the entire Entiat Basin, and Peshastin Creek in the Wenatchee River basin) (Good et al. 2005).

Materials and methods

Sample collections

To address objectives 3.1 through 3.3, we obtained samples from hatchery (HOR, adipose fin clipped) and natural origin (NOR, adipose fin intact) adult summer steelhead captured at Dryden or Tumwater diversion dams in the summer and fall of 1997 through 2009 (excepting 2004 and 2005; Table 1). All or some fraction of these fish was later used as hatchery broodstock the calendar year following the sampling year. In order to keep things simple we have reported years as the spawning year, i.e., the calendar year the fish were spawned, not the calendar year they were captured.

To address objective 3.2, it was necessary to have samples from natural origin fish from each of the spawning populations in the basin. It is difficult to obtain adult samples from known spawning populations due to the life history and behavior of steelhead, without tributary weirs or some other blocking method of collection. The NOR adult samples used as broodstock collected from Dryden and Tumwater Dams were a mixed collection representing all of the spawning populations located upstream. Therefore to determine population substructure within the basin we obtained collections of juvenile fish from smolt traps located within tributaries representing three major populations in the basin and from the Entiat River (Chiwawa River, Nason Creek, and Peshastin Creek; Table 2). We also obtained two collections of juvenile fish caught in a smolt trap in the lower Wenatchee River. These, like the NOR adult collections, were a mixed collection presumably representing all populations located upstream. Fin tissue was taken from each fish and preserved in 95% ethanol.

Sample processing

Fin tissue samples were processed for 1468 HOR and NOR adult steelhead broodstock (Table 1) and for 1542 juvenile *O. mykiss* from the Wenatchee and Entiat Rivers (Table 2). Samples were genotyped at 152 single nucleotide polymorphism loci (SNPs, Tables 3, 4). We originally proposed to use microsatellites, but WDFW MGL and other regional genetic laboratories (Columbia River Inter-Tribal Fish Commission [CRITFC], Idaho Fish and Game [IDFG], USFWS) are moving toward using SNPs and they provide the same kinds of information with faster processing. Twenty SNP loci were developed to discriminate among trout species; 14 distinguish *O. mykiss* from coastal cutthroat trout (*O. clarkii clarkii*) and westslope cutthroat (*O. clarkii lewisi*), and 6 distinguish steelhead and coastal cutthroat from westslope cutthroat (Table 4). The remaining 132 SNP loci were developed to be used for population structure, parentage assignment, or other population genetic studies of *O. mykiss* (Table 3). These markers comprised the current standard set of SNP markers used for genetic studies of *O. mykiss* at WDFW MGL.

We used Qiagen DNEasy ® kits (Qiagen Inc., Valencia, CA), following the recommended protocol for animal tissues, to extract and isolate DNA from fin tissue. SNP genotypes were obtained through PCR and visualization on Fluidigm EP1 integrated fluidic circuits (chips). Protocols followed Fluidigm's recommendations for TaqMan SNP assays as follows: Samples were pre-amplified by Specific Target Amplification (STA) following Fluidigm's recommended protocol with one modification. The 152 assays were pooled to a concentration of 0.2X and mixed with 2X Qiagen Multiplexing Kit (Qiagen, Inc., Valencia CA), instead of TaqMan PreAmp Master Mix (Applied Biosystems), to a volume of 3.75µl, to which 1.25µl of unquantified sample DNA was added for a total reaction volume of 5µl. Pre-amp PCR was conducted on a MJ Research or Applied Biosystems thermal cycler using the following profile: 95°C for 15 min followed by 14 cycles of 95°C for 15 sec and 60°C for 4 minutes. Post-PCR reactions were diluted with 20µl dH_2O to a final volume of 25µl.

Specific SNP locus PCRs were conducted on the Fluidigm chips. Assay loading mixture contained 1X Assay Loading Reagent (Fluidigm), 2.5X ROX Reference Dye (Invetrogen) and 10X custom TaqMan Assay (Applied Biosystems); sample loading mixture contains 1X TaqMan Universal PCR Master Mix (Applied Biosystems), 0.05X AmpliTaq Gold DNA polymerase (Applied Biosystems), 1X GT sampling loading reagent (Fluidigm) and 2.1 µL template DNA. Four µL assay loading mix and 5 µL sample loading mix were pipetted onto the chip and loaded by the IFC loader (Fluidigm). PCR was conducted on a Fluidigm thermal cycler using a two step profile. Initial mix thermal profile was 70°C for 30min, 25°C for 5 min, 52.3° for 10 sec, 50.1°C for 1 min 50sec, 98°C for 5 sec, 96°C for 9 min 55 sec, 96°C for 15 sec, 58.6°C for 8 sec, and 60.1°C for 43 sec. Amplification thermal profile was 40 cycles of 58.6°C for 10 sec, 96°C for 5 sec, 58.6°C for 8 sec and 60.1°C for 43 sec with a final hold at 20°C.

The SNP assays were visualized on the Fluidigm EP1 machine using the BioMark data collection software and analyzed using Fluidigm SNP genotyping analysis software. To ensure all SNP markers were being scored accurately and consistently, all data were scored by two researchers and scores of each researcher were compared. Disputed scores were called missing data (i.e., no genotype).

Evaluation of loci

A two-tailed exact test of Hardy–Weinberg equilibrium (HWE) was performed for each locus in each collection or population using the Markov Chain method implemented in GENEPOP v4.1 (dememorization number 1000, 100 batches, 1000 iterations per batch; Raymond and Rousset 1995; Rousset 2008). Significance of probability values was adjusted for multiple tests using false discovery rate (Verhoeven et al. 2005). F_{IS}, a measure of the fractional reduction in heterozygosity due to inbreeding in individuals within a subpopulation and an additional indicator of scoring issues, was calculated according to Weir and Cockerham (1984) using GENEPOP v4.1. Allele frequencies were calculated using CONVERT v1.0 (Glaubitz 2004). Expected and observed heterozygosities were calculated using GDA v1.1 (Lewis and Zaykin 2001).

Allele frequencies, genetic distances and population differentiation

To evaluate Q1 of Objective 3.1 and 3.2, we evaluated trends and patterns in allele frequencies, genetic distances and population differentiation. To test for temporal patterns in allele frequencies, we compared sample or spawn year to two diversity metrics, allele frequency and observed heterozygosity, from each adult and juvenile collection. Each SNP locus had only one or two alleles, so we used the minor allele frequency (MAF) of each SNP locus for each adult collection and averaged across loci. We also calculated the average observed heterozygosity (Ho) for each SNP locus within each adult and juvenile collection. We examined the presence or absence of a temporal trend in average allele frequency and observed heterozygosity with logistic regression analysis in R (R Development Core Team 2009).

To partition genetic variance into temporal, spatial (juvenile) and origin (adult) fractions, we performed hierarchical analysis of molecular variance (AMOVA) using ARLEQUIN v3.0 (Excoffier et al. 2005) with 1,000 permutations. We performed this analysis separately for juvenile and adult collections. Juveniles were grouped by sampling location (tributary) and adults were grouped by origin (HOR or NOR). To estimate the magnitude of genetic differences among temporal and spatial collections we calculated pairwise F_{ST} estimates among collections using FSTAT (Goudet 1995) with 1000 permutations. Statistical significance was adjusted using false discovery rate (Verhoeven et al. 2005).

To evaluate the temporal changes in genetic relationships, we compared spawn year to within spawn year pairwise F_{ST} estimates between NOR and NOR adults using beta regression (Simas and Rocha 2010). We used beta regression because the dependent variable was bound by zero and one but not binomial. Analysis was performed in R (package "betareg", Cribari-Neto and Zeileis 2010), with a loglog link.

We used principal component analyses (PCA) to explore the relationship between the covariation among the SNP loci within each collection and genetic differentiation between HOR and NOR collections, and to determine if the degree of differentiation has changed with time. Since each SNP is represented by only two alleles, only one allele per SNP is necessary to fully describe the covariation among all SNPs. We used MATLAB® scripts (2007a, The Mathworks, Natlick, MA) to calculate the principal components from SNP allele frequencies using only the major allele (1-MAF) for each SNP. We defined the major allele as the allele with the higher mean frequency across all collections, regardless of its status within any individual collection. We conducted three PCA analyses using: (1) all adult samples, aggregated based on origin (HOR versus NOR) and spawn year (i.e., the year the adult fish were used as broodstock) (N = 1437, 22 collections), (2) same as #1, but with the addition of all juvenile samples (N = 2938, 37 collections), and (3) only those adults samples with available age information (Mike Hughes, WDFW, personal communication) aggregated based on origin, and spawn year or brood year (i.e., the year the fish were hatched) (N = 1313, 20 spawn-year or 25 brood-year collections).

Molecular differentiation between HOR and NOR adults within a year was calculated based on principal component scores using Euclidian distances. We calculated pair-wise Euclidian distances between HOR and NOR fish within a spawn year or brood year using the first three principal components, and standardized each distance by subtracting from it the mean Euclidian distance calculated across all pair-wise distances. We used Mahalanobis distances to calculate the variation among HOR and NOR collections (calculated separately), again using the first three principal components. Here, we calculated Mahalanobis distances as the Euclidian distances between each collection and the centroid of all collections (HOR and NOR combined), but the Euclidian distances are scaled based on the dispersion of collections around the centroid (i.e., the variance). Euclidian and Mahalanobis distances were calculated using MATLAB scripts.

Effective spawning population

To evaluate Q1 of Objective 3.3, we estimated N_e using the single-sample linkage disequilibrium methods implemented in the program LDNE (Waples and Do 2008). This method requires that you input the P_{crit} value, the minimum frequency at which alleles were included in the analysis, since results can be biased depending on this setting (Waples and Do 2010). SNP markers typically have only one or two alleles; if one of two alleles is excluded based on its frequency in the collection it essentially excludes the locus, reducing the overall dataset. Therefore, we used P_{crit} values ranging from 0.1 to 0.001 to evaluate whether trends in N_e changed given which loci were used. Confidence intervals were calculated using a jackknife procedure.

We calculated an estimate of N_e for all adult and juvenile collections individually. However, the intention of an integrated hatchery program such as the Wenatchee River steelhead hatchery program is that HOR and NOR fish are integrated and progress as a single population through intentional interbreeding in the hatchery and presumed natural interbreeding in the wild. Thus, we also combined annual HOR and NOR collections to calculate an overall N_e estimate as has been done in other genetic monitoring and evaluation analyses (e.g., Small et al. 2007, [Chinook salmon, *O. tshawytscha*]).

Estimates of N_e from linkage refer to the generations that produced the sample. To calculate the ratio of effective population size to census size (N_e/N), we obtained the number of fish spawned in the hatchery (1993 through 2006, i.e., those that produced the adipose fin clipped adults that returned to spawn in the Wenatchee River 1998 through 2010) and the estimated escapement of fish spawning naturally (HOR and NOR separately) for the same time period. Estimates of census population size in spawning tributaries was obtained by multiplying the fraction of redds counted within tributaries (Chad Herring ,WDFW, unpublished data) by the total Wenatchee River census population estimate (Andrew Murdoch, WDFW, unpublished data). To calculate N_e/N, we performed two analyses. First, for adults, we assumed a five year generation time for natural origin adults and a four year generation time for hatchery origin adults and divided the N_e estimate by the census population estimate from four or five years earlier. For juveniles, we assumed an age at outmigration of two years and divided the N_e estimates by the estimate of census population size for the appropriate tributary. Second, we used available adult age data to parse individuals into cohorts originating in brood years (rather than spawn years) and then used LDNE to estimate N_e from cohort collections. We performed both analyses to make full use of all available data; age data were not available for many adults, and because of variable survival and sampling not all cohorts had sufficient numbers of HOR and NOR adults. According to Luikart et al. (2010), estimates produced using linkage disequilibrium should be interpreted as something between effective population size (N_e) and the effective number of breeders (N_b). Using cohorts, the estimate produced by LDNE is clearly an estimate of N_b rather than N_e. In order to keep things simple, we have referred to all estimates as N_b.

Results and Discussion

Collections and samples received

From 1468 samples from HOR and NOR adult steelhead broodstock, 1437 produced sufficient genetic data for further analysis (Table 1). From 1542 samples from NOR juvenile steelhead from Wenatchee River tributaries and the Entiat River, 1501 produced sufficient genetic data for further analysis and were genetically identified as *O. mykiss* (Table 2). Samples genetically identified as *O. clarki* (2 samples from the Chiwawa River, 1 from the Entiat River) or *O. clarki*/*O. mykiss* hybrids (4 – lower Wenatchee River, 4 – Nason Creek, 4 – Chiwawa River, and 1 – Entiat River) were omitted from further analysis.

Evaluation of loci

Three loci showed deviations from HWE in 10 or more of 37 Wenatchee steelhead collections before correcting for multiple tests (AOmy016, AOmy051, AOmy252, Table A1) indicating possible scoring issues. These loci were omitted from further analysis. Nine of the remaining loci were monomorphic or nearly monomorphic in all collections (average MAF < 0.1, AOmy023, AOmy028, AOmy123, AOmy129, AOmy132, AOmy209, AOmy229, AOmy270, AOmy271, Table A1) contributing little or nothing to analytical power. These loci were also omitted from further analysis. No genetic data was available for collection 10FD due to poor PCR amplification at locus AOmy213 for the entire collection. AOmy213 had a relatively low MAF in most collections so rather than re-processing this collection at this locus or running different sets of loci for different tests, we omitted this locus from further analysis. Only six tests of deviation from HWE were significant after correcting for 4348 tests using false discovery rate. Two of these tests were in loci already omitted. The remaining four tests were spread among the remaining loci, indicating no more loci needed to be omitted from further analysis.

Objective 3.1, 3.2 – Allele frequencies and Genetic distances

Allele frequencies

Average MAF of SNP loci ranged from 0.00 to 0.60 in HOR adult collections and from 0.00 to 0.61 in NOR adult collections (Table A1). Observed heterozygosity ranged from 0.00 to 0.75 in HOR adult collections and from 0.01 to 0.67 in NOR adult collections. Juvenile collections produced similar ranges of MAF and Ho (Table A1). Average MAF and Ho of HOR adult collections appeared to be greater than those of natural origin collections. However, logistic regression analysis indicated there was no significant temporal trend in either diversity statistic (Figure 1). Similarly, there was no consistent temporal trend in MAF or Ho of juvenile collections (Figure 2). Both the Chiwawa River and Nason Creek, the two tributaries that currently still receive hatchery juvenile outplants, both appeared to have declining allele frequencies, but neither was statistically significant ($P > 0.90$). However, the power to detect significant trends was limited by the small sample sizes ($n = 3$ sample years).

Analysis of Molecular Variance

Analysis of molecular variance (AMOVA) of adult collections (i.e., temporal and origin structure) indicated most of the genetic variance was among individuals or among individuals within populations (99.04%). Most of the remaining variance was temporal variation within hatchery and natural origin groups (0.61%) with the remaining variation from origin (0.35%). AMOVA of juvenile collections (i.e., spatial structure) indicated most of the genetic variance was among individuals (98.44%) or among individuals within populations (0.94%). Most of the remaining variance existed among temporal collections within tributary collections (0.37%) with the smallest fraction as among tributary variance (0.24%). Thus, overall, there was more variability among years than among tributaries or origins, but no trend in the temporal variability.

Pair-wise F_{ST} *estimates*

HOR adults were genetically different that NOR adults as estimated by F_{ST} (full pair-wise table in Table A2, all pair-wise F_{ST} estimates with P-values ≤ 0.05 before correcting for multiple tests were significantly different from zero after correcting for multiple tests using false discovery rate). On average, HOR adult collections were as different from one another (mean F_{ST} = 0.011) as they were from NOR adult collections among years (mean F_{ST} = 0.009) or from NOR adult collections within years (mean F_{ST} = 0.010). Among year comparisons of NOR adult collections were, on average, nearly an order of magnitude lower (mean = 0.002). These patterns held whether spawn year or brood year (data not shown) was used to group individuals. Over time, within spawn year pair-wise F_{ST} estimates between HOR and NOR adults declined over time (β = -0.014, P = 0.0185; Figure 3), suggesting that the integration of hatchery and wild fish is slowly genetically homogenizing the groups. That relationship disappeared when adults were grouped by brood year (i.e., comparing fish produced the same year) and all brood years were used (β = -0.009, P = 0.615, data not shown). However, when the dataset was restricted to just those brood years when all typical (age at maturation frequency among all years > 0.10) age classes were present in the dataset (HOR = age 3, 4; NOR = age 4, 5, 6; brood years 1996-1998, 2004-2005) a non-significant (P = 0.278) negative relationship (β = -0.12) of F_{ST} and brood year was apparent. When the data were further restricted to just the years after the hatchery program changed to only collecting broodstock in the Wenatchee River (brood years 1998, 2004-2005), the slope was also negative (β = -0.09), but the relationship was not statistically significant (P = 0.962).

Within tributary among sample year pair-wise comparisons of juvenile collections were, on average, only very slightly smaller than comparisons among tributaries (0.005 vs. 0.006, respectively, Table 5, all pair-wise F_{ST} estimates with P-values ≤ 0.05 before correcting for multiple tests were significantly different from zero after correcting for multiple tests using false discovery rate). Nason Creek and Peshastin Creek on average showed higher among sample year F_{ST} estimates (0.010 and 0.007, respectively) than the Chiwawa or Entiat Rivers (0.004 and 0.002, respectively). The pair-wise comparison of the two collections of lower Wenatchee River smolts, presumably a mix of Chiwawa, Nason, Peshastin smolts and smolts from other spawning tributaries, was an order of magnitude smaller (F_{ST} = 0.0002), and not significantly different than zero (Table 5). There was no temporal trend in pair-wise comparisons of juvenile collections. However with, at most, four annual collections, detecting any temporal trend was unlikely. We also had no collections from years prior to 1998 (the first year of new hatchery program broodstock collecting protocols) with which to compare contemporary data, nor could we find any reports or papers containing pre-hatchery-program-change genetic comparisons among Wenatchee River tributary populations, making it impossible to determine whether or not changing the hatchery program has had any effect at all on population structure. However, these data will be useful for future studies.

Principal Components

Each principal component analysis (Figures 4, 5) indicated that the genetic structure among HOR collections differed from that among NOR collections, and that this difference has decreased with time. When adult fish were aggregated based on origin and spawn-year, there was a clear differentiation between HOR and NOR adult collections along PC 1, and a separation among HOR collections, differentiating the early spawn-years (1998 – 2003) from the later spawn-years (2004 – 2010) along PC 2 and PC 3, respectively (Figure 4). The pair-wise genetic distances between HOR and NOR collections from the same spawn year (i.e., the HOR and NOR fish used as broodstock within the same year) decreased from the largest distance in 1998 to small distances in 2009 and 2010, although the smallest distance occurred in 2004 (Figure 4, top right). That is, within hatchery broodstock, the genetic difference between HOR and NOR fish decreased, on average, from 1998 to 2010, and the decrease appeared to be a mutual convergence of NOR fish shifting right along PC 1 and HOR fish shifting downward along PC 2 and PC 3. This increasing similarity in adult fish mirrored that seen in within year pair-wise F_{ST} estimates between HOR and NOR adults which also declined over time (Figure 3).

Overall, there was considerably more genetic variation among the HOR collections than there was among the NOR collections with average Mahalanobis distances (distance between each collection and the overall centroid [0,0,0]) among the HOR and NOR collections being 4.2 and 1.5, respectively. Since each NOR collection was generally composed of 3-4 brood-years, while HOR collections rarely were composed of more than two brood-years, we attributed the lower year-to-year genetic variability of the NOR broodstock to the greater homogenizing effect of including four or more brood-years compared with only two brood years for the HOR broodstock.

Including the 15 juvenile collections, along with the 22 adult collections, did not materially alter the principal component structure (Figure 6), although the total genetic variation accounted for by the three principal components decreased from 44% using only the adults to 33% when juveniles were included. For the most-part, the juvenile fish appeared intermediate between HOR and NOR fish, but there was greater overlap in principal component scores (and therefore greater genetic similarity) of the juvenile and NOR collections, than of the juvenile and HOR collections. The average Euclidian distance between the juvenile and HOR collections was 0.49, compared to 0.23 between the juvenile and NOR collections, which was no different than 0.23 and 0.22 for the within juvenile and NOR collections, respectively.

By using the available adult age data, we were able to compare the genetic differentiation among the same set of fish when they are aggregated by origin (hatchery versus natural) and brood-year (year fish were hatched) with aggregates based on origin and spawn-year (year adult fish were spawned). A brood-year analysis compares within a year the genetic diversity generated from hatchery broodstock with that naturally produced in the spawning grounds. A spawn-year analysis compares the HOR and NOR genetic diversity that was mixed among cohorts of the parental generations. The same basic pattern of genetic structure that we have seen in spawn-year analyses (Figure 4, Figure 6, and the right side of Figure 5) also occurred in the brood-year analysis (left side of Figure 5). That is, from Figure 5 we saw (1) that HOR and NOR fish were differentiated from each other; (2) there was considerably more genetic variation (temporal variation) among the hatchery-origin collections than there was among the natural-origin collections (for brood-year, Mahalanobis distances = 5.18 and 0.75, respectively; for spawn-year, Mahalanobis distances = 4.25 and 1.25, respectively), and (3) that the genetic distances between HOR and NOR collections were lower in the more recent brood- and spawn-years, than in the earlier brood- and spawn-years (Figure 7; R^2 = 0.41 or 41%, $P < 0.05$). This indicated that the HOR and NOR fish used as broodstock in 2010 were more similar to each other than they were at the inception of the new hatchery program.

The relationship between genetic distance and brood-year was not the same as the relationship between genetic distance and spawn-year. For brood-year, although the slope was negative (i.e., trending downward or decreased differentiation with time) and the two most-recent brood years (2005-2006) showed relatively small HOR and NOR adult differentiation, the negative slope was not significantly different from zero and the regression accounted for only 7% of the variation. This was likely the result of insufficient sampling of certain age classes from many brood years (especially from NOR adults) due to two un-processed sample years (2005 and 2006).

Objective 3.3 – Effective spawning population

There was no difference in the temporal trends in estimates of N_b with P_{crit} set from 0.1 to 0.001 (Figure 8, data not shown for all collections), so we have reported only results with $P_{crit} = 0.001$, i.e., the full genetic dataset. Using either spawn-year or brood year, estimates of NOR adult N_b were higher and varied more than those of HOR adults (Figures 9, 10), concordant with the PCA analysis. Estimates for HOR adults ranged from 17 to 174 (by spawn year, mean = 65) or from 6 to 130 (by brood year, mean = 39). Estimates for NOR adults ranged from 36 to 982 (by spawn year, mean = 405) or from 59 to 2966 (by brood year, mean = 645). Many N_b estimates for NOR adults had confidence intervals extending to infinity on the upper bound. This reflected the difficulty in obtaining precise estimates of N_b for large populations (Waples and Do 2010).

Estimates of N_b for HOR steelhead dropped by approximately half from 1994, when broodstock were still collected at Wells Hatchery, to 1998, when the program used Wenatchee River trapped adults only, suggesting an effect of changing broodstock collection practices, which began in 1997 (Figures 8, 9). Since 1997, the hatchery population N_b remained at a relatively stable lower level (Figures 8, 9, and 10). There was no obvious change in N_b for NOR steelhead since 1993; the N_b estimate for 1993 was the largest, however the confidence interval overlapped estimates from many other years. The temporal trend in N_b estimates from combined collections mirrored those of the HOR collections alone, though estimates using combined collections were slightly larger (Figure 11).

As with N_b estimates, estimates of the ratio of N_b/N for NOR adults varied more than those of HOR adults (Figures 12, 13). However, using spawn year, i.e., mixtures of cohorts, the average N_b/N ratio for HOR adults was equal to that of NOR adults (mean $N_b/N = 0.26$), whereas when using brood year, the average N_b/N ratio for NOR adults was double that of HOR adults (NOR average =0.40, HOR average = 0.20). This is likely a consequence of the homogenizing effect of mixed cohorts. Estimates of N_b for HOR adults using spawn year were close to those estimated using brood year because of the lower diversity in age at maturation, whereas for NOR, grouping by brood year produces different estimates than when grouping by spawn year because of higher diversity in age at maturation. Regardless of which estimate was used, there was no temporal trend in N_b/N for either NOR or HOR adults.

Summary

On average, HOR adults had higher minor allele frequencies (MAF) than NOR adults, and both had similar MAF as juveniles collected in spawning tributaries and in the Entiat River. There was no temporal trend in allele frequencies or observed heterozygosity in adult or juvenile collections and allele frequencies in control populations were no different than those still receiving hatchery outplants suggesting that the hatchery program has had little effect on allele frequencies since 1998.

HOR adults were genetically quite different from NOR adults and juveniles based on pair-wise F_{ST} and principal components analysis (PCA), most likely because of the much smaller effective population size (N_b) in the hatchery population. Pair-wise F_{ST} estimates and genetic distances between HOR and NOR adults collected the same year declined over time suggesting that the interbreeding of HOR and NOR adults in the hatchery (and presumably in the wild) is slowly homogenizing Wenatchee River summer steelhead. Analyses using brood year (the year fish were hatched, determined using scale-based age estimates) were inconclusive because of limitations of the data.

On average, estimates of N_b were much lower and varied less for HOR adults than for NOR adults and juveniles. Estimates of N_b for HOR adults declined from the earliest brood years to a stable new low value after broodstock practices were changed in 1997. There was no indication that this had any effect on N_b in NOR adults and juveniles; N_b estimates for NOR adults and juveniles were, on average, higher and varied considerably over the time period covered by our dataset (1998 – 2010) and showed no temporal trend. Small N_b sizes increase the risk of loss of genetic diversity due to inbreeding and random effects (genetic drift). The N_b of the hatchery component of the population may be increased by spawning more families, using specific mating designs, and minimizing variance in reproductive success. However, given the apparent lack of effects overall, changes to the hatchery protocol may not be necessary.

Overall, hatchery practices appear to have had little effect on natural origin Wenatchee summer steelhead neutral genetic diversity or N_b. We cannot accurately assess their effects on population structure at this time. However, it is interesting to note that when juvenile collections are analyzed separately from adult collections, Peshastin Creek, which has received fewer hatchery outplants in the past and is currently a refuge from hatchery outplants, is genetically different than other tributaries and the Entiat River (data not shown). On the other hand, the Entiat River, which is also a refuge from hatchery outplants and is not a tributary of the Wenatchee River, is genetically very similar to Nason Creek and the Chiwawa River, both Wenatchee River tributaries. This suggests, though it does not conclude, that within basin population structure may have existed before summer steelhead hatchery production began in the upper Columbia River and that the population structure was eliminated by hatchery influence long before 1998.

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Figures

Figure 1. Observed average minor allele frequencies (MAF) and observed heterozygosities (Ho) of 119 SNP loci from 11 annual collections of hatchery-produced (HOR) and natural origin (NOR) adult steelhead from the Wenatchee River. Trend lines are from a logistic regression. Note the X axis does not cross the Y axis at the origin. Neither the slopes nor the intercepts were statistically significant.

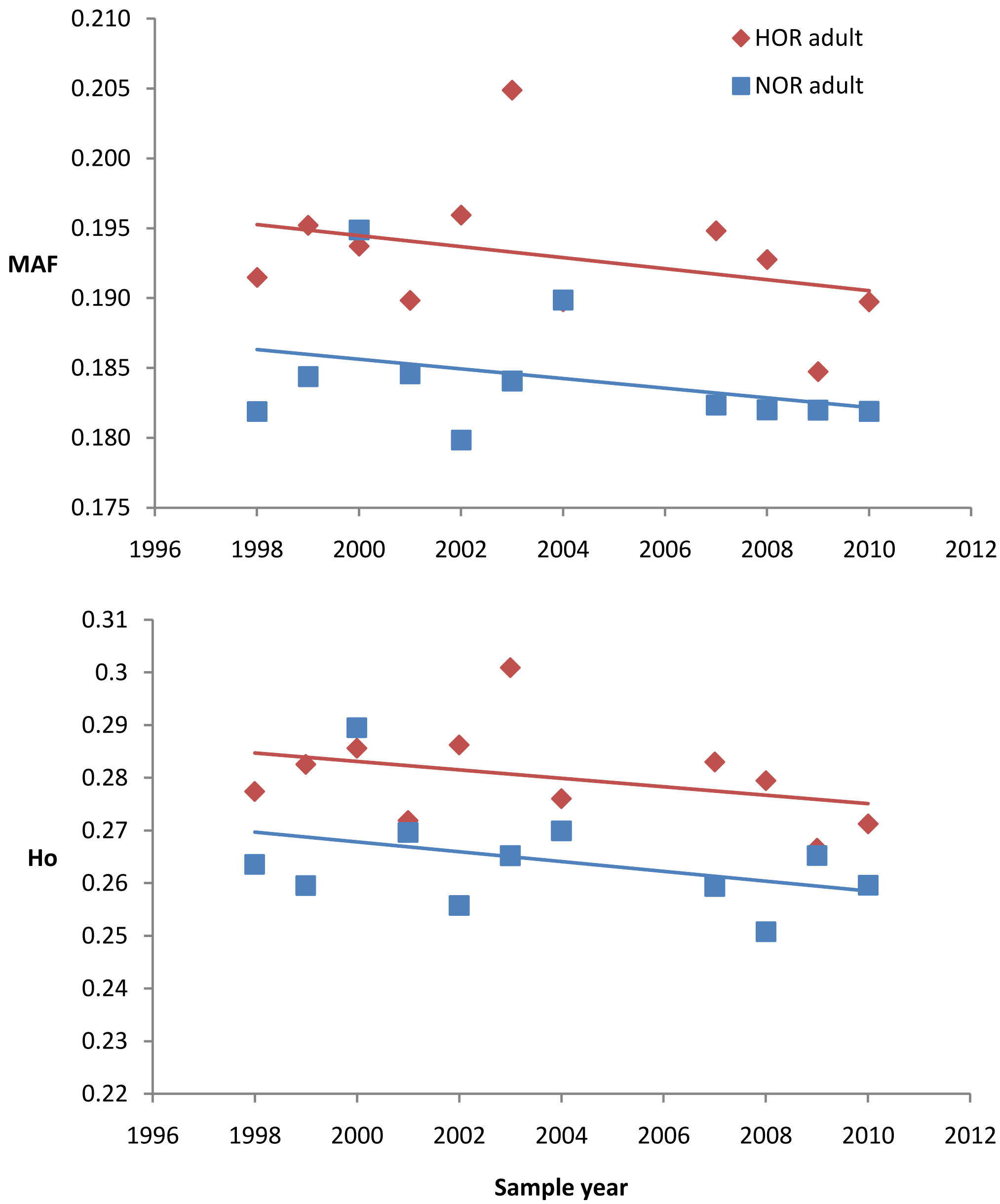


Figure 2. Observed average minor allele frequencies (MAF) and observed heterozygosities (Ho) of 119 SNP loci from 15 collections of natural origin juvenile steelhead from Wenatchee River tributaries, the lower Wenatchee River and the Entiat River. There were no consistent temporal trends in MAF or Ho in these collections.

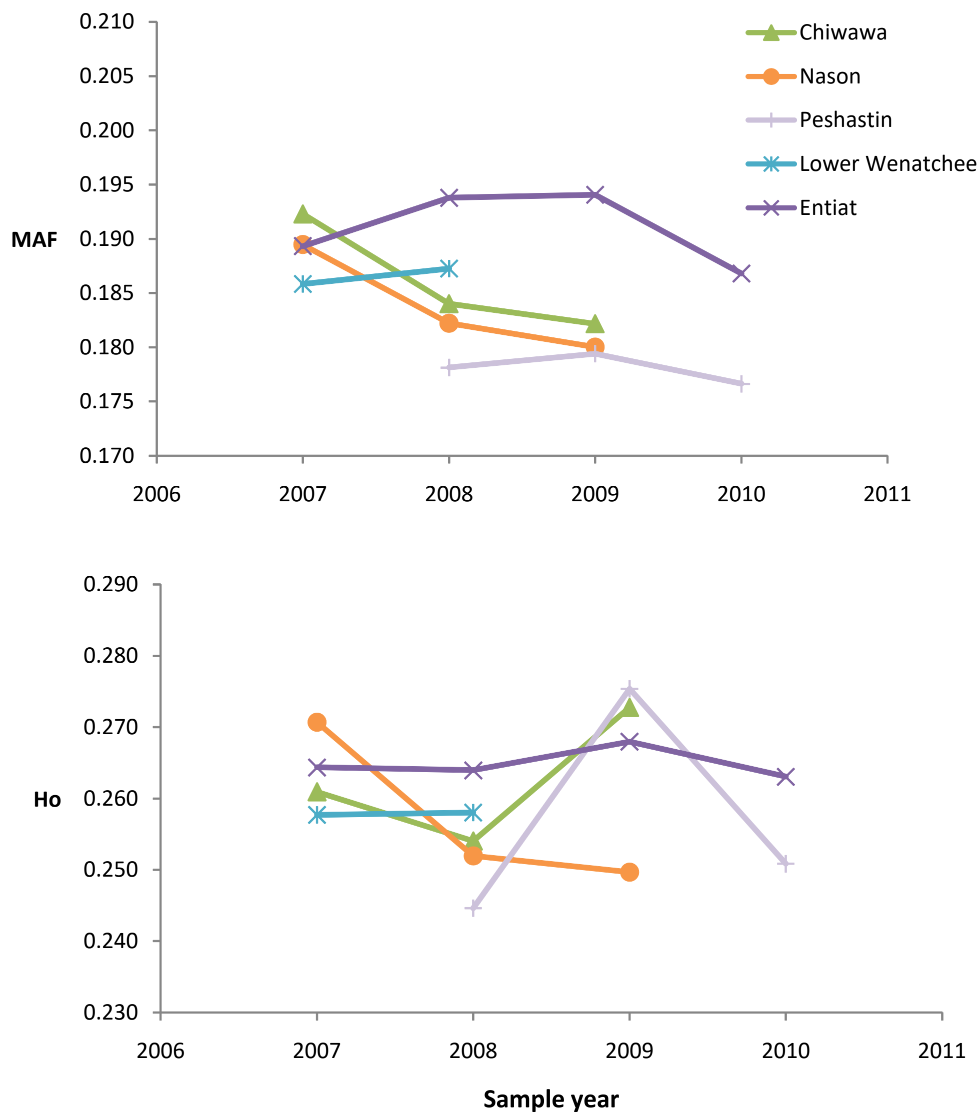


Figure 3. The relationship of time with pairwise F_{ST} estimates between hatchery-produced (adipose fin clipped) and natural origin (unclipped) adults of the same sample year. The line is the prediction based on beta regression.

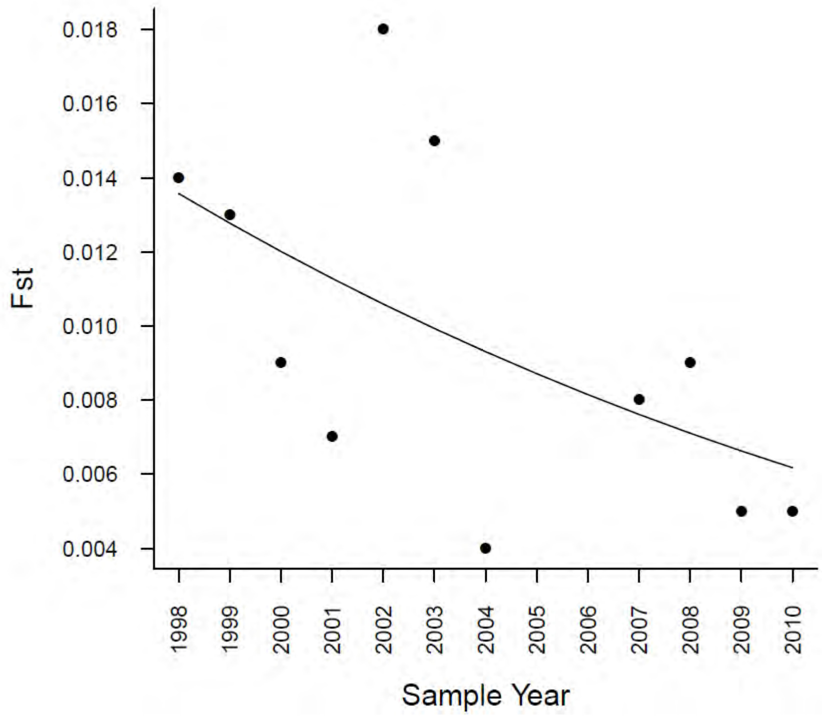


Figure 4. Principal component (PC) 1 versus 2 (top left), PC 1 versus 3 (bottom left), and PC 2 versus 3 (bottom right) based on an analysis using all adults aggregated into origin and spawn-year collections. Natural-origin spawn-years are shown in italicized typeface. The percentage within the label of each axis convey the percent of total genetic variance that is accounted for by that axis. Taken together, the three principal components account for 44% of the total SNP variation. Top right shows pairwise Euclidian distances versus spawn-year, with zero distance equal to average distance across all pairwise distances. Blue line is least-squares fit with $R^2 = 0.45$.

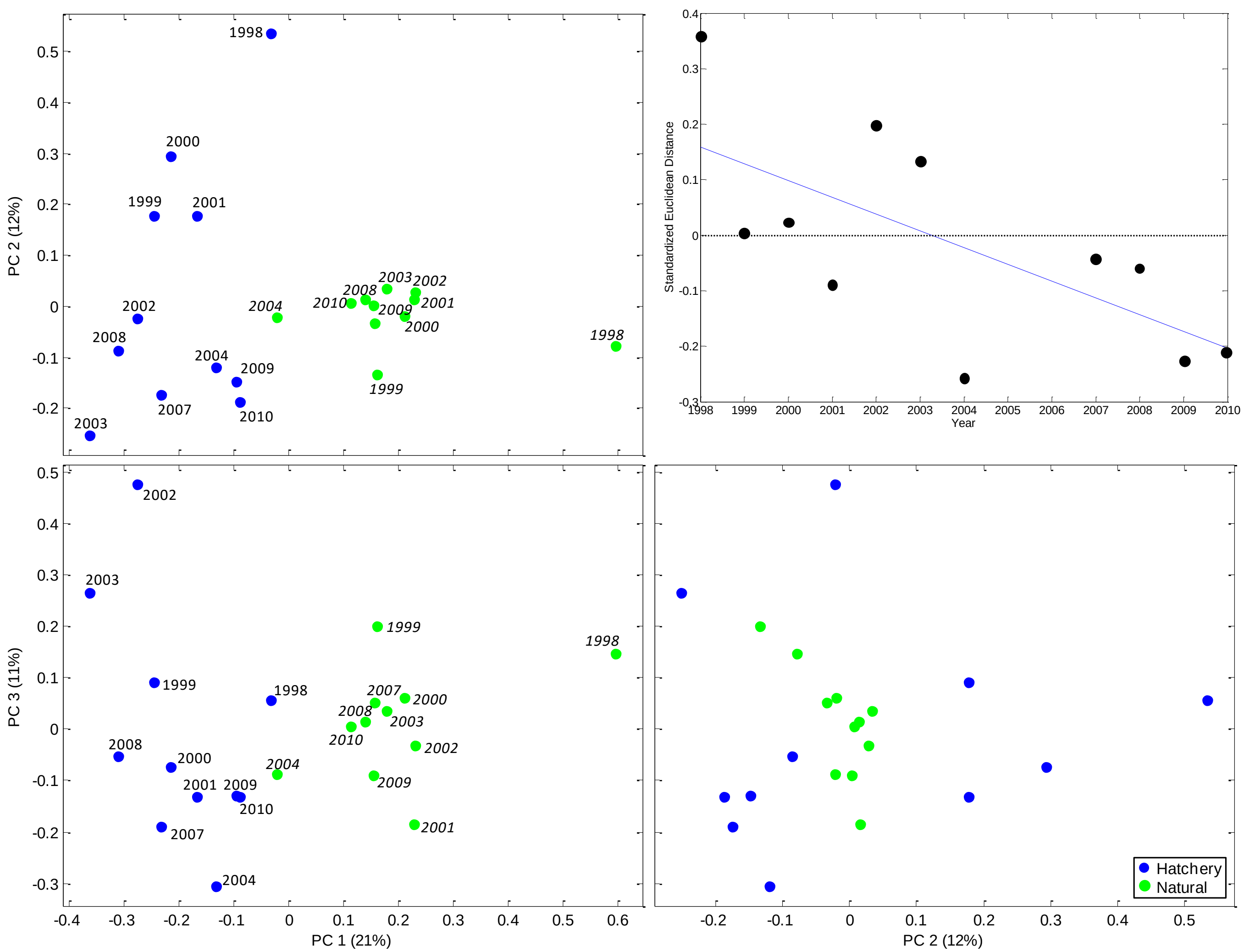


Figure 5. Principal components (PC) 1 versus 2 (top) and 3 (bottom) for adults aggregated into brood-year (BY; left) and spawn-year (SY; right). Spawn-year analysis is the same as in Figure x1, except fewer individuals per collection were included (see methods). Note that for the SY analysis here PC 2 and 3 are similar to PC 3 and 2, respectively, in Figure x1. Only BY1995 (earliest year with paired hatchery-natural data), BY2000 (extreme PC 1 score), and BY2006 (latest year with paired hatchery-natural data) are labeled. Hatchery- and natural-origin individuals from BY1995, BY2000, and BY2006, returned to spawn (spawn-year) in 1999 (hatchery)/1999-2001 (natural), 2003-2004 (hatchery)/2004 and 2007 (natural), and 2009-2010 (hatchery)/2010 (natural), respectively. These years are labeled in the upper right figure. Only 4 year-old BY 2006 natural-origin fish are represented in the SY 2010 collection.

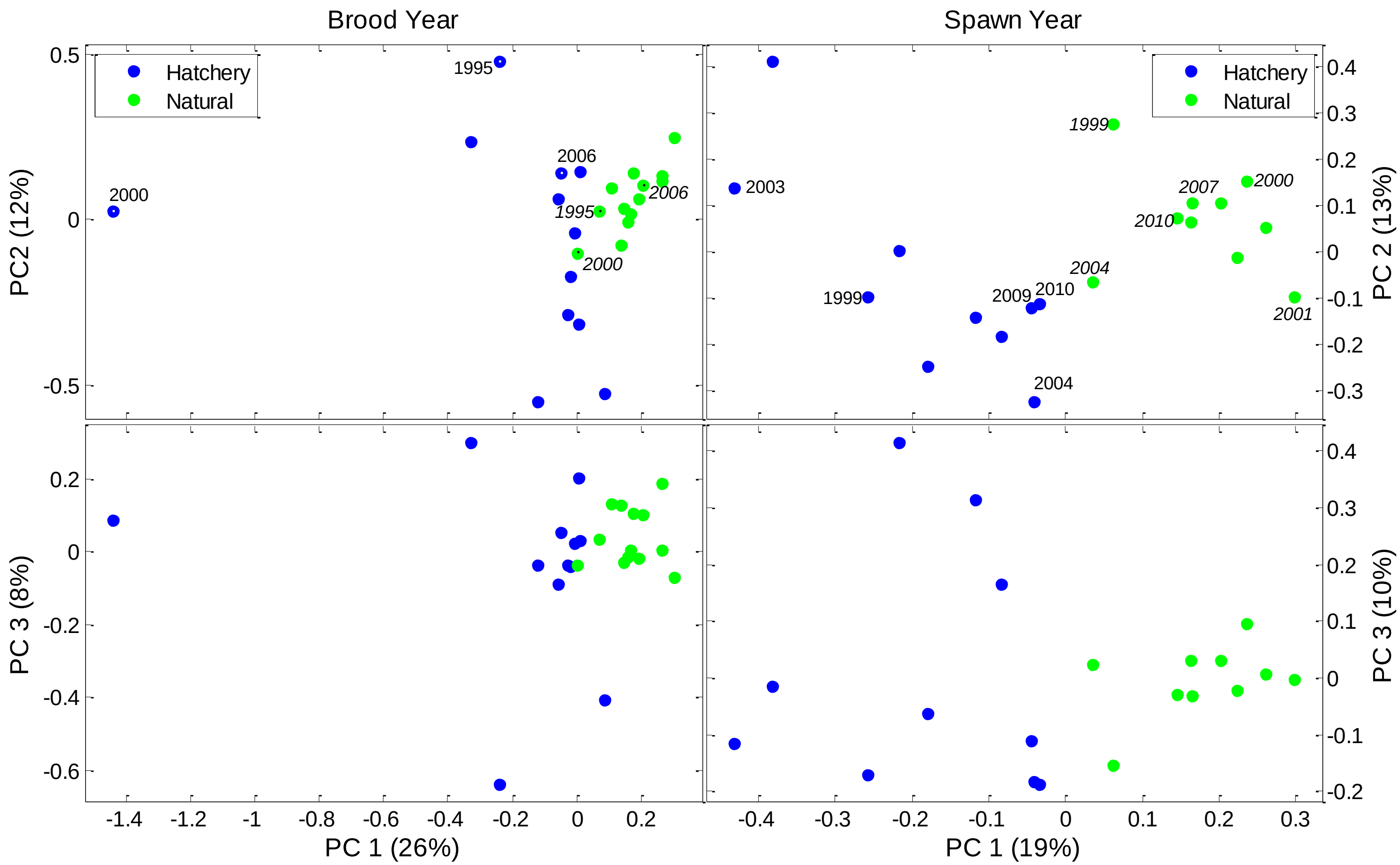


Figure 6. Principal component (PC) 1 versus 2 (top) and PC 1 versus 3 (bottom) based on an analysis using all adult and juvenile fish aggregated into age (juvenile versus adult), origin (hatchery versus adult) and spawn-year collections.

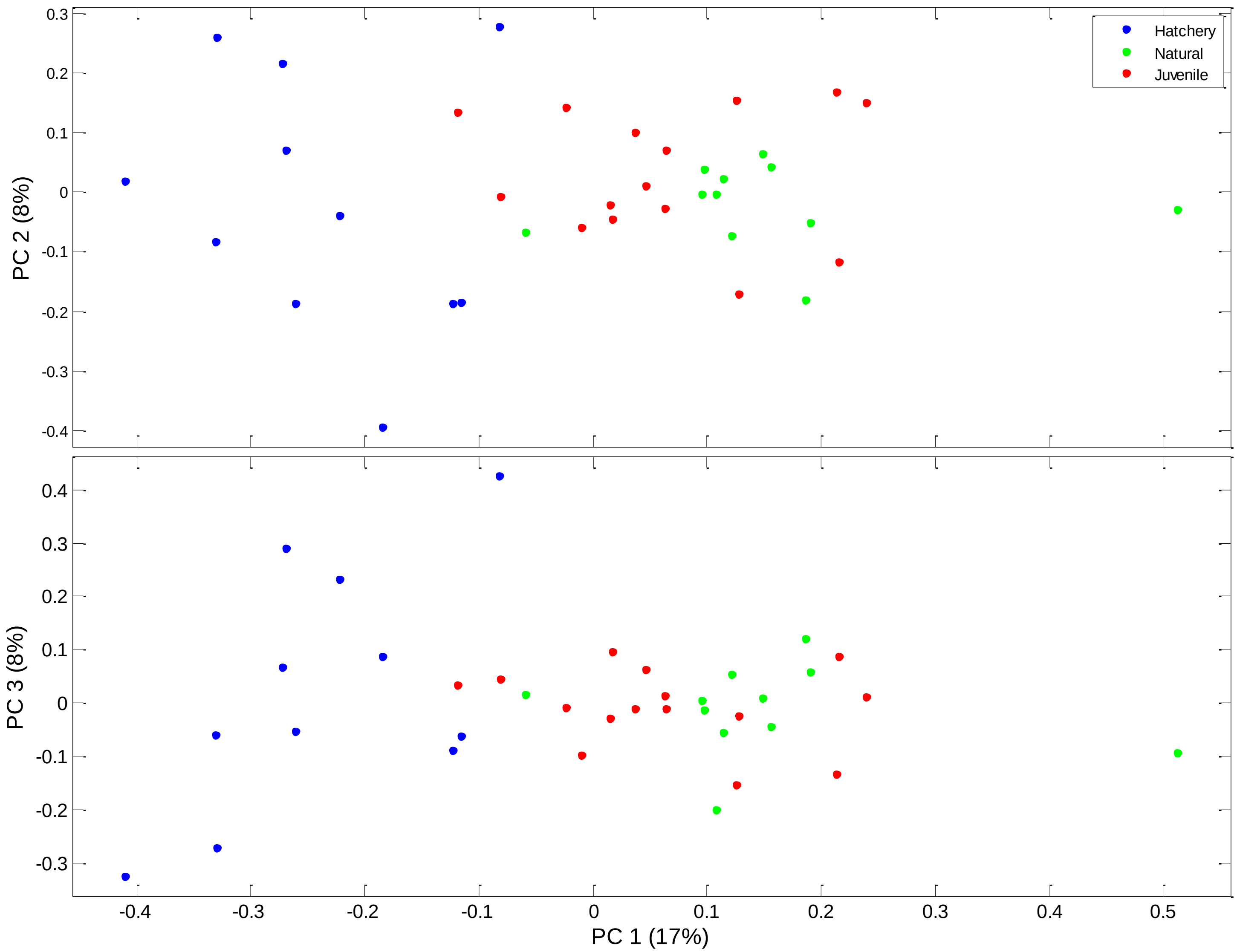


Figure 7. Pairwise Euclidian distances versus brood-year (top) and spawn-year (bottom), with zero distance equal to average distance across all pairwise distances. Blue lines are least-squares fits, which is not significant (slope = 0) for brood-year, but significant (slope > 0) for spawn-year.

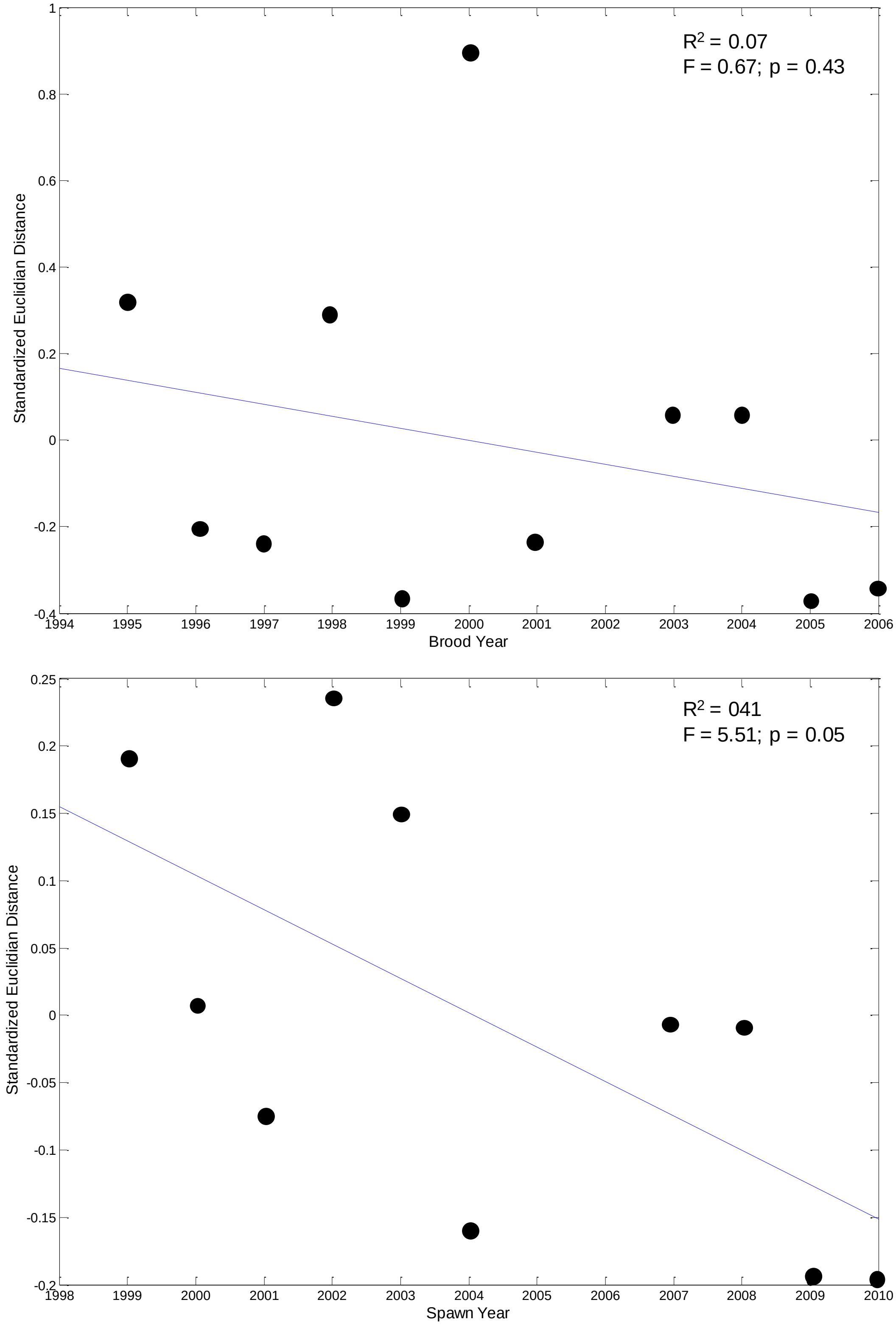


Figure 8. Effective population size estimates (N_b) from Wenatchee River adult hatchery-produced steelhead annual collections calculated using single sample methods implemented in the program LDNE (Waples and Do 2008). Each line connects annual estimates of N_b estimated with a different value of P_{crit}, the smallest allelic proportion allowed during analysis. With SNP data, omitting an allele omits the locus. Estimates of N_b changed very little when P_{crit} varied from 0.1 to 0.001. Setting P_{crit} = 0.001 forced the use of all available loci.

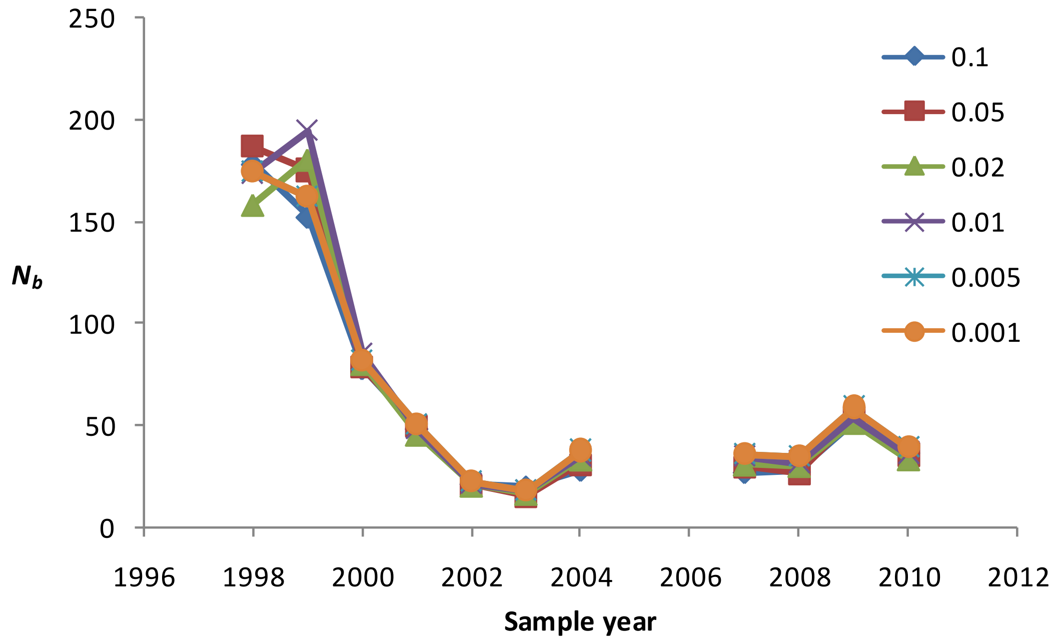


Figure 9. Estimates of Wenatchee River steelhead effective number of breeders (N_b) estimated using the single sample methods incorporated in the program LDNE (Waples and Do 2008). Estimates of N_b refer to parental (and even grantparental) generations. N_b data were plotted against their estimated parental brood year. We assumed a 5 year generation time for natural origin adults (NOR), a 4 year generation time for hatchery-produced adults (HOR) and an age of smolt outmigration of age 2 for smolt collections from Wenatchee River tributaries (Chiwawa River, Nason Creek, Peshastin Creek), the lower Wenatchee River, and the Entiat River. Bars represent the 95% confidence interval estimated by jackknife procedure. Bars that exceed the upper limit of the Y axis are labeled with the upper bound (Inf. = infinity).

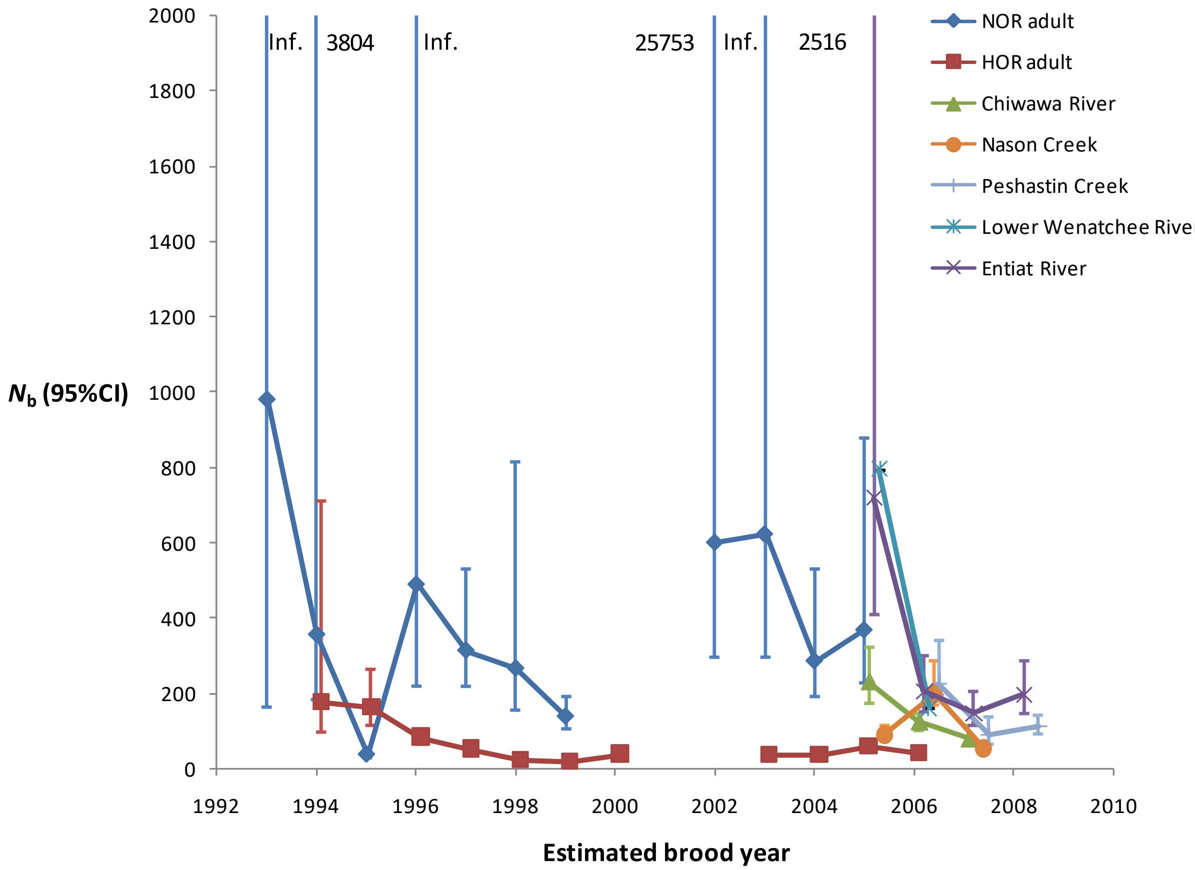


Figure 10. Estimates of N_b for collections of hatchery-produced (HOR) and natural origin (NOR) Wenatchee River summer steelhead grouped by brood year rather than spawn year. Brood year was estimated using scale-based age data. Error bars that extend past the top of the chart are all bounded by infinity.

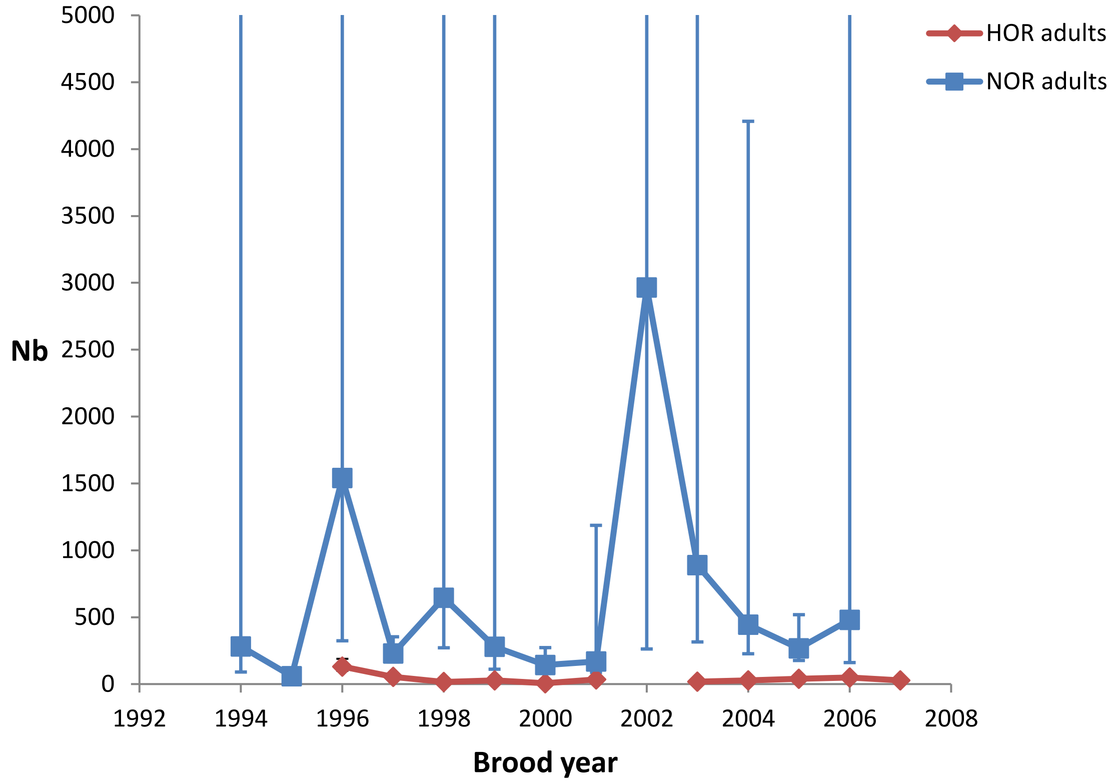


Figure 11. Estimates of N_b for combined annual adult hatchery-produced (HOR) and natural origin (NOR) steelhead and for HOR adults alone. The temporal patterns are similar, though estimates from combined collections are larger than those from HOR collections alone.

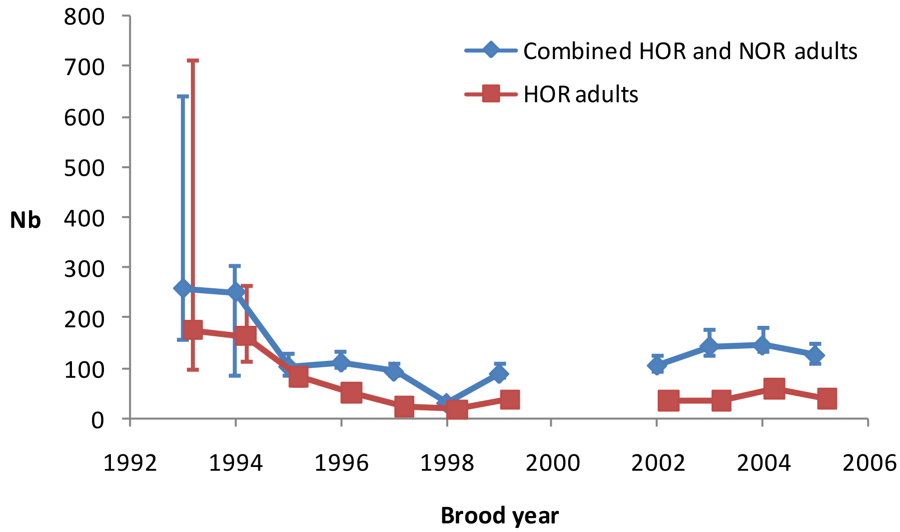


Figure 12. N_b/N ratios for hatchery-produced (HOR) and natural origin (NOR) adult Wenatchee River summer steelhead grouped by spawn year. The average N_b/N ratios are not different, though in later years NOR adults appear to have lower N_b/N ratios.

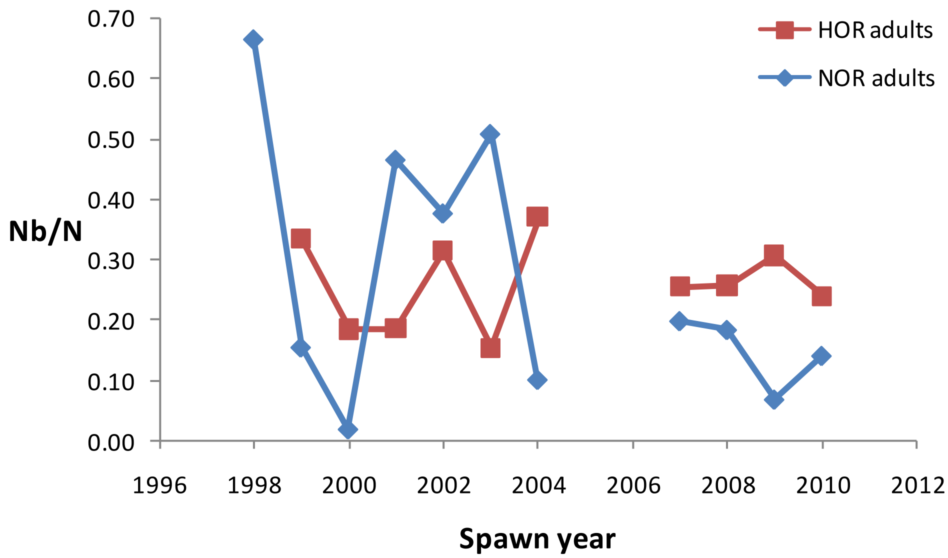
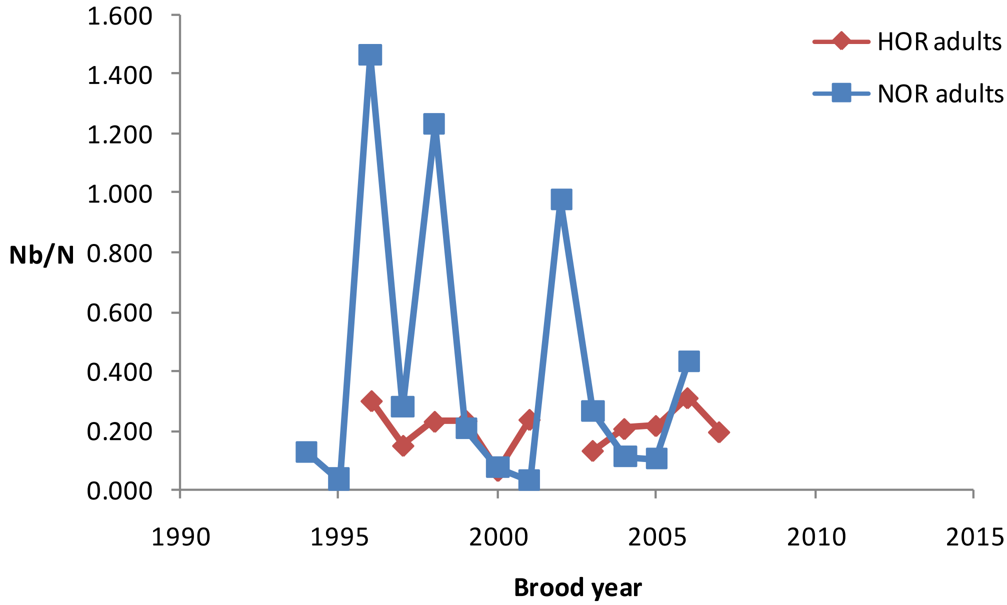


Figure 13. N_b/N ratios for hatchery-produced (HOR) and natural origin (NOR) adult Wenatchee River summer steelhead collections with individuals grouped in brood years rather than spawn years. Individual brood year was estimated using scale-based age data.



Tables

Table 1. Samples of adult steelhead collected for Wenatchee Program broodstock and used for genetic monitoring and evaluation.

Origin	Sampling Location	Year spawned	WDFW Collection code	Samples (N)	Unused Samples[a]
Hatchery	Dryden/Tumwater Dams	1998	98AE	32	4
		1999	98LJ	62	2
		2000	99NE	60	5
		2001	00DQ	99	1
		2002	01MS	64	
		2003	02NP	89	
		2004	03KW	61	
		2007	06CW	64	1
		2008	08AG	56	
		2009	09AV	74	
		2010	10FE	76	1
			Total	737	14
Natural	Dryden/Tumwater Dams	1998	98AF	30	5
		1999	99AA	51	1
		2000	99ND	33	3
		2001	00DP	50	
		2002	01MR	95	
		2003	02NO	50	
		2004	03KV	71	3
		2007	06CX	74	
		2008	08AF	74	1
		2009	09AU	82	2
		2010	10FD	90	2
			Total	700	17

[a]Samples were not used if they had incomplete (≤ 80% or 95 of 119 loci) or duplicate genotypes.

Table 2. Samples of natural origin juvenile steelhead and rainbow trout collected from four Wenatchee basin rivers or creeks and the Entiat River.

Sampling Location	Collection Year	WDFW Collection Code	Samples (N)	Unused samples[a]
Chiwawa River	2007	07AO	127	5
	2008	08CG	143	1
	2009	09NF	35	2
Entiat River	2007	07AL	134	4
	2008	08CI	82	4
	2009	09NC	74	1
	2010	10OX	82	1
Lower Wenatchee River	2007	07AM	139	5
	2008	08CE	98	2
Nason Creek	2007	07AN	81	4
	2008	08CF	133	6
	2009	09NG	103	2
Peshastin Creek	2008	08CH	142	2
	2009	09NE	34	1
	2010	10OY	94	1
		Total	1501	41

[a]Samples were not used if they were genetically identified as cutthroat trout or cutthroat/rainbow trout hybrids, or if they had incomplete (≤ 80% or 95 of 119 loci) or duplicate genotypes.

Table 3. List of 132 general use, diploid single nucleotide polymorphic (SNP) loci genotyped in Wenatchee River basin and Entiat River steelhead.

WDFW Name	Locus Name	Allele 1	Allele 2	Reference
AOmy005	Omy_aspAT-123	T	C	(Campbell et al. 2009)
AOmy014	Omy_e1-147	G	T	(Sprowles et al. 2006)
AOmy015	Omy_gdh-271	C	T	(Campbell et al. 2009)
AOmy016	Omy_GH1P1_2	C	T	(Aguilar and Garza 2008)
AOmy021	Omy_LDHB-2_e5	T	C	(Aguilar and Garza 2008)
AOmy023	Omy_MYC_2	T	C	(Aguilar and Garza 2008)
AOmy027	Omy_nkef-241	C	A	(Campbell et al. 2009)
AOmy028	Omy_nramp-146	G	A	(Campbell et al. 2009)
AOmy047	Omy_u07-79-166	G	T	WDFW - S. Young unpubl.
AOmy051	Omy_121713-115	T	A	(Abadía-Cardoso et al. 2011)
AOmy056	Omy_128693-455	T	C	(Abadía-Cardoso et al. 2011)
AOmy059	Omy_187760-385	A	T	(Abadía-Cardoso et al. 2011)
AOmy061	Omy_96222-125	T	C	(Abadía-Cardoso et al. 2011)
AOmy062	Omy_97077-73	T	A	(Abadía-Cardoso et al. 2011)
AOmy063	Omy_97660-230	C	G	(Abadía-Cardoso et al. 2011)
AOmy065	Omy_97954-618	C	T	(Abadía-Cardoso et al. 2011)
AOmy067	Omy_aromat-280	A	T	WSU - J. DeKoning unpubl.
AOmy068	Omy_arp-630	G	A	(Campbell et al. 2009)
AOmy071	Omy_cd59-206	C	T	WSU - J. DeKoning unpubl.
AOmy073	Omy_colla1-525	C	T	WSU - J. DeKoning unpubl.
AOmy079	Omy_g12-82	T	C	WSU - J. DeKoning unpubl.
AOmy081	Omy_gh-475	C	T	(Campbell et al. 2009)
AOmy082	Omy_gsdf-291	T	C	WSU - J. DeKoning unpubl.
AOmy089	Omy_hsp90BA-193	C	T	(Campbell and Narum 2009)
AOmy094	Omy_inos-97	C	A	WSU - J. DeKoning unpubl.
AOmy095	Omy_mapK3-103	A	T	CRITFC - N. Campbell unpubl.
AOmy096	Omy_mcsf-268	T	C	WSU - J. DeKoning unpubl.
AOmy100	Omy_nach-200	A	T	WSU - J. DeKoning unpubl.

AOmy107	Omy_Ots249-227	C	T	(Campbell et al. 2009)
AOmy108	Omy_oxct-85	A	T	WSU - J. DeKoning unpubl.
AOmy110	Omy_star-206	A	G	WSU - J. DeKoning unpubl.
AOmy111	Omy_stat3-273	G	Deletion	WSU - J. DeKoning unpubl.
AOmy113	Omy_tlr3-377	C	T	WSU - J. DeKoning unpubl.
AOmy117	Omy_u09-52-284	T	G	WDFW - S. Young unpubl.
AOmy118	Omy_u09-53-469	T	C	WDFW - S. Young unpubl.
AOmy120	Omy_u09-54.311	C	T	WDFW - S. Young unpubl.
AOmy123	Omy_u09-55-233	A	G	WDFW - S. Young unpubl.
AOmy125	Omy_u09-56-119	T	C	WDFW - S. Young unpubl.
AOmy129	Omy_BAMBI4.238	T	C	WDFW - S. Young unpubl.
AOmy132	Omy_G3PD_2.246	C	T	WDFW - S. Young unpubl.
AOmy134	Omy_Il-1b-028	T	C	WDFW - S. Young unpubl.
AOmy137	Omy_u09-61.043	A	T	WDFW - S. Young unpubl.
AOmy151	Omy_p53-262	T	A	CRITFC - N. Campbell unpubl.
AOmy173	BH2VHSVip10	C	T	Pascal & Hansen unpubl.
AOmy174	OMS00003	T	G	(Sánchez et al. 2009)
AOmy176	OMS00013	A	G	(Sánchez et al. 2009)
AOmy177	OMS00018	T	G	(Sánchez et al. 2009)
AOmy179	OMS00041	G	C	(Sánchez et al. 2009)
AOmy181	OMS00052	T	G	(Sánchez et al. 2009)
AOmy182	OMS00053	T	C	(Sánchez et al. 2009)
AOmy183	OMS00056	T	C	(Sánchez et al. 2009)
AOmy184	OMS00057	T	G	(Sánchez et al. 2009)
AOmy185	OMS00061	T	C	(Sánchez et al. 2009)
AOmy186	OMS00062	T	C	(Sánchez et al. 2009)
AOmy187	OMS00064	T	G	(Sánchez et al. 2009)
AOmy189	OMS00071	A	G	(Sánchez et al. 2009)
AOmy190	OMS00072	A	G	(Sánchez et al. 2009)
AOmy191	OMS00078	T	C	(Sánchez et al. 2009)
AOmy192	OMS00087	A	G	(Sánchez et al. 2009)

AOmy193	OMS00089	A	G	(Sánchez et al. 2009)
AOmy194	OMS00090	T	C	(Sánchez et al. 2009)
AOmy195	OMS00092	A	C	(Sánchez et al. 2009)
AOmy196	OMS00094	T	G	(Sánchez et al. 2009)
AOmy197	OMS00103	A	T	(Sánchez et al. 2009)
AOmy198	OMS00105	T	G	(Sánchez et al. 2009)
AOmy199	OMS00112	A	T	(Sánchez et al. 2009)
AOmy200	OMS00116	T	A	(Sánchez et al. 2009)
AOmy201	OMS00118	T	G	(Sánchez et al. 2009)
AOmy202	OMS00119	A	T	(Sánchez et al. 2009)
AOmy203	OMS00120	A	G	(Sánchez et al. 2009)
AOmy204	OMS00121	T	C	(Sánchez et al. 2009)
AOmy205	OMS00127	T	G	(Sánchez et al. 2009)
AOmy206	OMS00128	T	G	(Sánchez et al. 2009)
AOmy207	OMS00132	A	T	(Sánchez et al. 2009)
AOmy208	OMS00133	A	G	(Sánchez et al. 2009)
AOmy209	OMS00134	A	G	(Sánchez et al. 2009)
AOmy210	OMS00153	T	G	(Sánchez et al. 2009)
AOmy211	OMS00154	A	T	(Sánchez et al. 2009)
AOmy212	OMS00156	A	T	(Sánchez et al. 2009)
AOmy213	OMS00164	T	G	(Sánchez et al. 2009)
AOmy215	OMS00175	T	C	(Sánchez et al. 2009)
AOmy216	OMS00176	T	G	(Sánchez et al. 2009)
AOmy218	OMS00180	T	G	(Sánchez et al. 2009)
AOmy220	Omy_1004	A	T	(Hansen et al. 2011)
AOmy221	Omy_101554-306	T	C	(Abadía-Cardoso et al. 2011)
AOmy222	Omy_101832-195	A	C	(Abadía-Cardoso et al. 2011)
AOmy223	Omy_101993-189	A	T	(Abadía-Cardoso et al. 2011)
AOmy225	Omy_102505-102	A	G	(Abadía-Cardoso et al. 2011)
AOmy226	Omy_102867-443	T	G	(Abadía-Cardoso et al. 2011)
AOmy227	Omy_103705-558	T	C	(Abadía-Cardoso et al. 2011)

AOmy228	Omy_104519-624	T	C	(Abadía-Cardoso et al. 2011)
AOmy229	Omy_104569-114	A	C	(Abadía-Cardoso et al. 2011)
AOmy230	Omy_105075-162	T	G	(Abadía-Cardoso et al. 2011)
AOmy231	Omy_105385-406	T	C	(Abadía-Cardoso et al. 2011)
AOmy232	Omy_105714-265	C	T	(Abadía-Cardoso et al. 2011)
AOmy233	Omy_107031-704	C	T	(Abadía-Cardoso et al. 2011)
AOmy234	Omy_107285-69	C	G	(Abadía-Cardoso et al. 2011)
AOmy235	Omy_107336-170	C	G	(Abadía-Cardoso et al. 2011)
AOmy238	Omy_108007-193	A	G	(Abadía-Cardoso et al. 2011)
AOmy239	Omy_109243-222	A	C	(Abadía-Cardoso et al. 2011)
AOmy240	Omy_109525-403	A	G	(Abadía-Cardoso et al. 2011)
AOmy241	Omy_110064-419	T	G	(Abadía-Cardoso et al. 2011)
AOmy242	Omy_110078-294	A	G	(Abadía-Cardoso et al. 2011)
AOmy243	Omy_110362-585	G	A	(Abadía-Cardoso et al. 2011)
AOmy244	Omy_110689-148	A	C	(Abadía-Cardoso et al. 2011)
AOmy245	Omy_111005-159	C	T	(Abadía-Cardoso et al. 2011)
AOmy246	Omy_111084-526	A	C	(Abadía-Cardoso et al. 2011)
AOmy247	Omy_111383-51	C	T	(Abadía-Cardoso et al. 2011)
AOmy248	Omy_111666-301	T	A	(Abadía-Cardoso et al. 2011)
AOmy249	Omy_112301-202	T	G	(Abadía-Cardoso et al. 2011)
AOmy250	Omy_112820-82	G	A	(Abadía-Cardoso et al. 2011)
AOmy252	Omy_114976-223	T	G	(Abadía-Cardoso et al. 2011)
AOmy253	Omy_116733-349	C	T	(Abadía-Cardoso et al. 2011)
AOmy254	Omy_116938-264	A	G	(Abadía-Cardoso et al. 2011)
AOmy255	Omy_117259-96	T	C	(Abadía-Cardoso et al. 2011)
AOmy256	Omy_117286-374	A	T	(Abadía-Cardoso et al. 2011)
AOmy257	Omy_117370-400	A	G	(Abadía-Cardoso et al. 2011)
AOmy258	Omy_117540-259	T	G	(Abadía-Cardoso et al. 2011)
AOmy260	Omy_117815-81	C	T	(Abadía-Cardoso et al. 2011)
AOmy261	Omy_118175-396	T	A	(Abadía-Cardoso et al. 2011)
AOmy262	Omy_118205-116	A	G	(Abadía-Cardoso et al. 2011)

AOmy263	Omy_118654-91	A	G	(Abadía-Cardoso et al. 2011)
AOmy265	Omy_120255-332	A	T	(Abadía-Cardoso et al. 2011)
AOmy266	Omy_128996-481	T	G	(Abadía-Cardoso et al. 2011)
AOmy267	Omy_129870-756	C	T	(Abadía-Cardoso et al. 2011)
AOmy268	Omy_131460-646	C	T	(Abadía-Cardoso et al. 2011)
AOmy269	Omy_98683-165	A	C	(Abadía-Cardoso et al. 2011)
AOmy270	Omy_cyp17-153	C	T	WSU - J. DeKoning unpubl.
AOmy271	Omy_ftzf1-217	A	T	WSU - J. DeKoning unpubl.
AOmy272	Omy_GHSR-121	T	C	CRITFC - N. Campbell unpubl.
AOmy273	Omy_metA-161	T	G	CRITFC - N. Campbell unpubl.
AOmy274	Omy_UBA3b	A	T	(Hansen et al. 2011)

Primer and probe sequences for unpublished loci available by request.

Table 4. List of 20 species identification single nucleotide polymorphic (SNP) loci genotyped in Wenatchee River basin and Entiat River steelhead.

WDFW Name	Locus Name	Expected genotype *O. mykiss*	*O. clarkii clarkii*	*O. clarkii lewisi*	Reference
ASpI001	Ocl_Okerca	T	C	C	(McGlauflin et al. 2010)
ASpI002	Ocl_Oku202	A	C	C	(McGlauflin et al. 2010)
ASpI003	Ocl_Oku211	G	T	T	(McGlauflin et al. 2010)
ASpI004	Ocl_Oku216	C	C	A	(McGlauflin et al. 2010)
ASpI005	Ocl_Oku217	C	C	A	(McGlauflin et al. 2010)
ASpI006	Ocl_SsaHM5	A	A	G	(McGlauflin et al. 2010)
ASpI007	Ocl_u800	T	C	C	(McGlauflin et al. 2010)
ASpI008	Ocl_u801	A	T	T	(McGlauflin et al. 2010)
ASpI009	Ocl_u802	C	C	T	(McGlauflin et al. 2010)
ASpI010	Ocl_u803	C	T	T	(McGlauflin et al. 2010)
ASpI011	Ocl_u804	G	G	C	(McGlauflin et al. 2010)
ASpI012	Omy_B9_228	A	A	C	(Finger et al. 2009)
ASpI013	Omy_CTDL1_243	C	A	A	(Finger et al. 2009)
ASpI014	Omy_F5_136	C	G	G	(Finger et al. 2009)
ASpI016	Omy_myclarp404-111	T	G	G	CRITFC - S. Narum - unpubl.
ASpI017	Omy_myclgh1043-156	C	T	T	CRITFC - S. Narum - unpubl.
ASpI018	Omy_Omyclmk436-96	A	C	C	CRITFC - S. Narum - unpubl.
ASpI019	Omy_RAG11_280	T	A	A	(Sprowles et al. 2006)
ASpI020	Omy_URO_302	T	C	C	(Finger et al. 2009)
ASpI021	Omy_BAC-F5.238	C	G	G	WDFW - S. Young unpubl.

Primer and probe sequences for unpublished loci available by request.

Table 5. Pairwise F_{ST} estimates for collections from Wenatchee River tributaries and the Entiat River (below diagonal) and associated bootstrap estimated *P*-values (above diagonal).

		Chiwawa River			Nason Creek			Peshastin Creek			Lower Wenatchee River		Entiat River			
Population	Year	2007	2008	2009	2007	2008	2009	2008	2009	2010	2007	2008	2007	2008	2009	2010
Chiwawa	2007		**0.000**	**0.003**	**0.000**	**0.000**	**0.000**	**0.000**	**0.002**	**0.000**	**0.001**	**0.001**	**0.000**	**0.001**	**0.000**	**0.000**
River	2008	0.004		**0.004**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	2009	0.004	0.003		**0.000**	**0.001**	0.061	**0.000**	**0.001**	**0.000**	0.086	**0.050**	**0.022**	0.108	**0.005**	**0.045**
Nason	2007	0.011	0.010	0.007		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Creek	2008	0.007	0.007	0.005	0.009		**0.003**	**0.000**	**0.002**	**0.000**	0.079	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**
	2009	0.007	0.007	0.003	0.014	0.006		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Peshastin	2008	0.010	0.011	0.008	0.013	0.010	0.013		**0.001**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Creek	2009	0.005	0.005	0.006	0.010	0.007	0.008	0.003		**0.002**	**0.002**	**0.047**	**0.028**	**0.004**	**0.005**	**0.001**
	2010	0.010	0.011	0.008	0.015	0.008	0.011	0.003	0.003		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Lower Wenatchee	2007	0.003	0.003	0.000	0.005	0.008	0.007	0.009	0.010	0.008		0.112	**0.020**	**0.012**	**0.002**	**0.017**
River	2008	0.002	0.005	0.002	0.003	0.004	0.005	0.007	0.009	0.006	0.000		**0.049**	0.459	**0.047**	**0.002**
Entiat	2007	0.005	0.006	0.002	0.005	0.006	0.005	0.005	0.007	0.006	0.001	0.002		0.451	0.173	**0.000**
River	2008	0.004	0.004	0.000	0.007	0.005	0.007	0.008	0.009	0.011	0.002	0.001	0.000		0.644	**0.002**
	2009	0.005	0.006	0.002	0.003	-0.001	0.003	0.002	0.003	0.004	0.003	0.002	0.002	0.000		**0.028**
	2010	0.005	0.006	0.003	0.006	0.004	0.006	0.006	0.008	0.009	0.002	0.003	0.003	0.003	0.002	

P-values in bold were significant at $\alpha = 0.05$ after correcting for multiple tests using false discovery rate.

Appendix F

NPDES Hatchery Effluent Monitoring, 2017

NPDES COMPLIANCE SUMMARY

The WDFW facilities requiring discharge reports include Chelan Hatchery, Chelan Falls Hatchery, Eastbank Hatchery, Wells Hatchery, Chiwawa Ponds, Methow Hatchery, Similkameen Hatchery, Dryden Acclimation Pond, and Priest Rapids Hatchery. The Carlton Acclimation Pond permit became inactive January 2014. An inactive permit is exempt from sampling and submitting discharge reports because production is below the permit requirements for monitoring discharges. National Pollutant Discharge Elimination System (NPDES) permits are not required for the Twisp and Chewuch acclimation facilities, because they are below the levels that require a discharge permit.

The Wells Hatchery Pollution Abatement (PA) pond has no effluent data for July through September. Priest Rapids Hatchery Pollution Abatement (PA) pond has no effluent data for January, February, April, and September through December. The PA ponds for these facilities had no discharge throughout these months.

The Public Utility District (PUD) took over monitoring for Carlton, Methow, and Wells. WDFW is no longer monitoring these hatcheries for the NPDES permit. The PUD took over monitoring for the Methow in December 2017, Carlton in February 2018, and Wells hatchery in October 2017.

There were six violations reported at these NPDES permitted facilities during the period 1 January 2017 through 31 December 2017. All six were due to samples not taken. The violations were of the TSS Avg and TSS Max net. Chiwawa had a TSS Avg and TSS Max net violation in September. Chiwawa-Wenatchee River had a TSS Avg and TSS Max net violation in November. Wells had a TSS Avg and TSS Max net violation in September.

NPDES MONITORING FOR WDFW FACILITIES

All WDFW hatcheries monitor their discharge in accordance with the NPDES permit. This permit is administered in Washington by the Washington Department of Ecology under agreement with the United States Environmental Protection Agency. The previous permit was extended until 31 March 2016. The current permit was renewed effective 1 April 2016 and will expire on 31 March 2021.

Facilities are exempted from sampling during any month that pounds of fish on hand fall below 20,000 lbs and pounds of feed used fall below 5,000 lbs, with the exception of offline settling basin discharges, which are to be monitored once per month when ponds are in use and discharging to receiving waters. Inactive permitted facilities retain a permit but are not required to monitor discharges because the pounds of fish and pounds of feed remain below monitoring guideline set by the permit.

Sampling at permitted facilities includes the following parameters:

<FLOW	Measured in millions of gallons per day (MGD) discharge.
<SS EFF	Average net settleable solids in the hatchery effluent, measured in ml/L.
<TSS COMP	Average net total suspended solids, composite sample (6x/day) of the hatchery effluent, measured in mg/L.

<TSS MAX	Maximum daily net total suspended solids, composite sample (6x/day) of the hatchery effluent, measured in mg/L.
<SS PA	Maximum settleable solids discharge from the pollution abatement pond, measured in ml/L.
<SS %	Removal of settleable solids within the pollution abatement pond from inlet to outlet, measured as a percent. No longer required under permit effective 1 June 2000.
<TSS PA	Maximum total suspended solids effluent grab from the pollution abatement pond discharge, measured in mg/L.
<TSS %	Removal of suspended solids within the pollution abatement pond from inlet to outlet, measured as a percent. No longer required under permit effective 1 June 2000.
<SS DD	Settleable solids discharged during drawdown for fish release. One sample per pond drawdown, measured in ml/L.
<TRC	Total residual chlorine discharge after rearing vessel disinfection and after neutralization with sodium thiosulfate. One sample per disinfection, measured in ug/L.

In addition, at Similkameen Hatchery only, the following sampling was conducted at the request of Washington Department of Ecology, but is not required under NPDES permit:

<SS IW	Settleable solids influent grab taken as wastes are pumped into the pollution abatement pond, measured in mg/L. No longer monitored as of January 2008.
<TSS IW	Total suspended solids influent grab as wastes are pumped into the pollution abatement pond, measured in mg/L. No longer monitored as of January 2008.

Eastbank Hatchery
NPDES Permit Number WAG13-5011

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	Lbs of Fish	Lbs of Feed
2017	JAN	22.62	0	0	0	5000	0		6.6		23523	3033
	FEB	29.09	0	0.1	0.2	5000	0		4.6		33834	5584
	MAR	26.02	0	0.6	0.6	7500	0		29.6		37211	5378
	APR	29.72	0	0	0	5000	0.01		24.4		17254	7017
	MAY	29.72	0	0	0	7000	0.01		17.6		27974	9462
	JUN	29.09	0	0.6	0.6	10000	0		9.6		38467	11831
	JUL	31.03	0	0.2	0.2	9000	0.01		15.2		31906	7380
	AUG	31.03	0	0.2	0.2	10000	0.01		17.4		25522	7885
	SEP	31.03	0	0	0	8000	0		12.4		35034	8729
	OCT	29.72	0	0	0	7000	0		6		44980	9995
	NOV	22.62	0	0	0	7000	0		11.6		34578	4293
	DEC	25.21	0	0	0	5000	0		13.2		19758	4010

Wells Hatchery
NPDES Permit Number WAG13-5009

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	Lbs of Fish	Lbs of Feed
2017	JAN	9.52	0.02	0	0						65532	14292
	FEB	10.97	0.02	1.2	1.2	19505	0.15		6.4		74235	12285
	MAR	17.41	0.04	1.6	1.6	19167	0.05		10		100908	10750
	APR	12.35	0.01	1.6	2.4	*	0.01		12.8		87923	5923
	MAY	9.35	0.01	0.2	0.2	*	0.01		3.6		55162	4600
	JUN	3.66	0.01	-0.8	-0.8	*	0.01		1.6		5009	1695
	JUL	4.8	0	0	0	**	**		**		7169	2320
	AUG	5.16	0	1	1	**	**		**		11095	3277
	SEP	7.15	0	***	***	**	**		**		18706	5840
	OCT	PUD took over monitoring.										
	NOV											
	DEC											

** PA pond - No Flow. ** PA pond - No discharge.
*** Violation. No sampling done.

Chiwawa Ponds - Chiwawa River
NPDES Permit Number WAG13-5015

		FLOW	SS EFF	TSS COMP	TSS MAX	Lbs of Fish	Lbs of Feed	SS DD	TSS DD
2017	JAN	3.11	0	0	0	8283	141		
	FEB	3.21	0	0.2	0.2	11178	89	0.03	61.3
	MAR	3.1	0	-1.4	-1.4	9988	1135		
	APR	1.52	0	-1.4	-1.4	9281	779	0.03	3.4
	MAY	No Monitoring				0	0		
	JUN	No Monitoring				0	0		
	JUL	No Monitoring				0	0		
	AUG	No Monitoring				0	0		
	SEP	4.42	0.03	***	***	6132	88		
	OCT	4.21	0	0.8	0.8	6803	1076		
	NOV	3.32	0	1.3	2.2	7958	634		
	DEC	4.31	0	1.6	1.6	10373	240		

*** Violation. No sampling done.

Chiwawa Ponds - Wenatchee River
NPDES Permit Number WAG13-5015

		FLOW	SS EFF	TSS COMP	TSS MAX	Lbs of Fish	Lbs of Feed	SS DD	TSS DD
2017	JAN	6.68	0	0	0	14392	460		
	FEB	7.1	0	2	2	18420	429	0.03	2.3
	MAR	6.7	0	0.2	0.2	12616	2568		
	APR	2.45	0	0	0	21646	2825	0.03	1.9
	MAY	No Monitoring				0	0		
	JUN	No Monitoring				0	0		
	JUL	No Monitoring				0	0		
	AUG	No Monitoring				0	0		
	SEP	No Monitoring				0	0		
	OCT	No Monitoring				0	0		
	NOV	4.91	0	***	***	8933	840		
	DEC	6.52	0	0.2	0.2	11117	1084		

*** Violation. No sampling done.

Methow Hatchery

NPDES Permit Number WAG13-5000

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	TSS PA	Lbs of Fish	Lbs of Feed	SS DD	TSS DD
2017	JAN	10.8	0	0.2	0.2	14400	0	0	11100	1250		
	FEB	10.8	0	0	0	14400	0.1	0.2	11800	1300		
	MAR	5.62	0	0.6	0.6	14400	0.1	0	5600	650		
	APR	4.6	0	0.2	0.2	14400	0	3	19000	750		
	MAY	1.73	0	0	0	14400	0.1	0.4	3000	840	0	2.4
	JUN	4.03	0	1.4	1.4	14400	0.1	0.4	3500	1070		
	JUL	4.32	0	0	0	14400	0	0.4	4650	430		
	AUG	4.32	0	0	0	14400	0.1	0	5680	1320		
	SEP	4.32	0	0	0	14400	0.1	0.2	6400	620		
	OCT	3.4	0	0	0	14400	0.1	0	5600	2340		
	NOV	3.46	0	0.2	0.2	14400	0.1	0	8000	1000		
	DEC	PUD took over monitoring.										

Similkameen Hatchery

NPDES Permit Number WAG13-5007

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS IW	TSS IW	Lbs of Fish	Lbs of Feed	SS DD	TSS DD
2017	JAN	6.48	0	1.2	1.2				7142	0		
	FEB	6.48	0	0.6	0.6				6413	44		
	MAR	6.48	0	-0.2	1				6439	1804		
	APR	6.62	0	1	1				8859	1308	0	20.6
	MAY	No Monitoring							0	0		
	JUN	No Monitoring							0	0		
	JUL	No Monitoring							0	0		
	AUG	No Monitoring							0	0		
	SEP	No Monitoring							0	0		
	OCT	2.9	0	2.4	2.4				15280	1276		
	NOV	8.1	0	1.2	1.2				13870	880		
	DEC	8.12	-0.14	0	0				13870	0		

Chelan Hatchery

NPDES Permit Number WAG13-5006

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	Lbs of Fish	Lbs of Feed
2017	JAN	6.5	0.05	1.9	2.4	68000	0.05		7.6		21868	5895
	FEB	6.5	0.05	0.6	0.6	68000	0.05		2.2		24063	6538
	MAR	6.5	0.05	0	0	68000	0.05		1.6		34299	1630
	APR	8.9	0.05	0.6	0.6	68000	0.05		1.8		13766	995
	MAY	6.9	0.05	0.8	0.8	68000	0.05		2.4		5140	1214
	JUN	8.9	0.05	0.8	0.8	68000	0.05		0.4		6260	1557
	JUL	9.3	0.04	0	0	68000	0.05		1.8		9551	3380
	AUG	9.3	0.05	0	0	68000	0.05		2		12409	4479
	SEP	9.6	0.05	0.2	0.4	68000	0.05		1.2		17625	6032
	OCT	9.1	0.05	-0.2	-0.2	68000	0.05		0.6		20626	8115
	NOV	4.6	0.05	0.2	0.2	68000	0.05		0.6		12582	6463
	DEC	3.7	0.05	0.2	0.2	68000	0.05		1.8		9468	4664

Chelan Falls Hatchery
NPDES Permit Number WAG13-7019

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	SS %	TSS PA	TSS %	Lbs of Fish	Lbs of Feed
2017	JAN	12.8	0.05	0.2	0.2	857	0.05		0.2		24816	3680
	FEB	12.8	0.05	-0.2	-0.2	857	0.05		0		26448	3671
	MAR	12.8	0.05	0.4	0.4	857	0.05		0.2		31136	5246
	APR	12.8	0.05	-3	-3	857	0.05		1.4		36838	5818
	MAY	No Monitoring									0	0
	JUN	No Monitoring									0	0
	JUL	No Monitoring									0	0
	AUG	No Monitoring									0	0
	SEP	No Monitoring									0	0
	OCT	No Monitoring									0	0
	NOV	6.9	0.04	0	0	3000	0.05		0.4		26640	4013
	DEC	6.9	0.04	-0.6	-0.6	3000	0.05		1.2		30630	8312

Dryden Acclimation Pond

NPDES Permit Number WAG13-5014

		FLOW	SS EFF	TSS COMP	TSS MAX	Lbs of Fish	Lbs of Feed	SS DD	TSS DD
2017	JAN	No Monitoring				0	0		
	FEB	No Monitoring				0	0		
	MAR	10	0	-0.4	-0.4	29075	1056		
	APR	14.08	-0.01	0.4	0.4	31089	2112	0.01	5.6
	MAY	No Monitoring				0	0		
	JUN	No Monitoring				0	0		
	JUL	No Monitoring				0	0		
	AUG	No Monitoring				0	0		
	SEP	No Monitoring				0	0		
	OCT	No Monitoring				0	0		
	NOV	No Monitoring				0	0		
	DEC	No Monitoring				0	0		

Priest Rapids

NPDES Permit Number WAG13-7013

		FLOW	SS EFF	TSS COMP	TSS MAX	FLOW PA	SS PA	TSS PA	Lbs of Fish	Lbs of Feed	SS DD	TSS DD
2017	JAN	21.4	0	2.2	2.2	**	**	**	6363	0		
	FEB	25.49	0	-1.8	-1.8	**	**	**	9009	1054		
	MAR	14.2	0	1.6	1.6		0.01	10.4	16600	8169		
	APR	21.88	0	-1.2	-1.2	**	**	**	34460	16498		
	MAY	45.19	0	1.8	1.8		0	12	84870	43161	0	3.7
	JUN	30.25	0	1.2	1.2		0	41	41569	20397	0	1.2
	JUL	No Monitoring							0	0		
	AUG	No Monitoring							0	0		
	SEP	64.16	0			**	**	**	18546	0		
	OCT	64.53	0			**	**	**	53160	0		
	NOV	64.53	0			**	**	**	20000	0		
	DEC	34.85	0	1	1	**	**	**	7272	0		

**PA pond - No discharge this month

Appendix G

Steelhead Stock Assessment at Priest Rapids Dam, 2015-2016

Priest Rapids Dam 2015-2016 Adult Upper Columbia River Steelhead Run-Cycle Stock Assessment Report

Introduction

Upper Columbia River (UCR) steelhead stock assessment sampling at Priest Rapids Dam (PRD) in 2015 is authorized through the Endangered Species Act (ESA) Section 10 Permit 1395 (NMFS 2003). Permit authorizations include interception and biological sampling of up to 10 percent of the UCR steelhead passing PRD to determine upriver population size, estimate hatchery to wild ratios, determine age-class contribution, and evaluate the need for managing hatchery steelhead consistent with ESA recovery objectives, which include fully seeding spawning habitat with naturally produced UCR steelhead supplemented with artificially propagated enhancement steelhead (NMFS 2003).

Stock Assessment

The 2015 steelhead sampling at Priest Rapids Dam began on 6 July and concluded on 12 November. Sampling consisted of operating the Priest Rapids Off-Ladder Trap (OLAFT), located on the left bank Priest Rapids Dam, 8 hours per day, up to three days per week, for a total of 58 sampling days. Steelhead were trapped, handled, and released in accordance with Section 2.1 and 2.2.1 of the National Marine Fisheries Service (NMFS) Biological Opinion for ESA Permit 1395 (NMFS 2003). The cumulative sample rate attained during 2015 totaled 19.5%.

The Washington Department of Fish and Wildlife (WDFW) sampled 2,778 steelhead from the 2015/2016 run-cycle passing PRD, totaling 14,280 steelhead, for an overall sampling rate of 19.5%. Of the 2,778 steelhead sampled, 1,860 (67.0%) were hatchery origin and 918 (33.0%) were wild origin. The estimated 2015-2016 run-cycle total wild steelhead return was 4,720, representing 159% of the 1986-2014 average and about 89.4% of the most recent 5-year average (Table 1).

Based on external marks and external and internal tags, 1,860 hatchery-origin steelhead were sampled at Priest Rapids Dam during the 2015 return cycle. About 12.0% of these were Wenatchee hatchery-origin steelhead and 72.3% were "above Wells Dam" hatchery-origin steelhead[1] (Table 2). About 7.6% of the hatchery-origin steelhead sampled could not be assigned to a specific hatchery program. Ringold FH origin steelhead represented about 8.1% of the hatchery fish sample (Table 2).

[1] Defined as "above Wells Dam" because hatchery-origin, adipose-clipped steelhead released into the Methow and Okanogan rivers from the Wells FH and Winthrop NFH have the same marks and are indistinguishable from one another.

Table 1. Priest Rapids Dam adult steelhead returns and stock composition, 1974-2014.

Run-cycle[1/]	Hatchery	Wild	Wild percent	Total run
1974				2,950
1975				2,560
1976				9,490
1977				9,630
1978				4,510
1979				8,710
1980				8,290
1981				9,110
1982				10,770
1983				32,000
1984				26,200
1985				34,010
1986	20,022	2,342	10.5	22,364
1987	9,955	4,058	29.0	14,013
1988	7,530	2,670	26.2	10,200
1989	8,033	2,685	25.1	10,718
1990	6,252	1,585	20.2	7,837
1991	11,169	2,799	20.0	13,968
1992	12,102	1,618	11.8	13,720
1993	4,538	890	16.4	5,428
1994	5,880	855	12.7	6,735
1995	3,377	993	22.7	4,370
1996	7,757	843	9.8	8,600
1997	8,157	785	8.8	8,942
1998	4,919	928	15.9	5,847
1999	6,903	1,374	16.6	8,277
2000	9,023	2,341	20.6	11,364
2001	24,362	5,715	19.0	30,077
2002	12,884	2,983	18.8	15,867
2003	14,890	2,837	16.0	17,729
2004	15,670	2,985	16.0	18,655
2005	10,352	3,127	23.2	13,479
2006	8,738	1,677	16.1	10,415
2007	12,160	3,097	20.3	15,257
2008	13,528	3,030	18.3	16,558
2009	32,557	7,439	18.6	39,996
2010	18,784	7,647	28.9	26,431
2011	15,910	4,896	23.5	20,806
2012	13,908	3,284	19.1	17,192
2013	10,415	4,657	30.9	15,072
2014	13,836	5,930	30.0	19,766
1986-2014 average	**11,848**	**2,968**	**19.5**	**14,339**
2010-2014 average	**14,572**	**5,281**	**26.5**	**19,853**

[1/] A return cycle is the combined total of steelhead passing PRD from 1 June – 30 November during year (x), plus steelhead passing PRD between 15 April and 31 May on year (x+1).

Table 2. Origin classification of steelhead sampled at Priest Rapids Dam, 6 July – 12 November 2015.

Steelhead Origin																			
Wild			Hatchery																
			Wenatchee			Above Wells						Ringold		Unk. Hat.					
Criteria			Criteria			Criteria						Criteria		Criteria			Total	Total	Total
NS	NM	Total	CWT	AD+CWT	Total	AD+CWT	CWT	AD	LV	PED	Total	AD+RV	Total	SD	NM	Total	Wild	Hatchery	Total
x	x	918	x		135	x					273	x	151	x	x	142	918	1,860	2,778
				x	88		x				35								
								x			1,026								
									x		8								
										x	2								
Total		**918**			**223**						**1,344**		**151**			**142**	**918**	**1,860**	**2,778**
%Hatchery					**12.0**						**72.3**		**8.1**			**7.6**		**100.0**	
%Total		**33.0**			**8.1**						**48.4**		**5.4**			**5.1**	**33.0**	**67.0**	

Reconciliation of salt-water age of wild and hatchery steelhead sampled at Priest Rapids Dam during 2015 was accomplished through scale sample analysis. Salt-age analysis of the 2015 UCR steelhead run-cycle provides an estimated hatchery-origin return dominated by 1-salt and 2-salt age composition of 62.7% and 37.1%, respectively (Table 3). Natural-origin steelhead salt ages were 48.1% and 51.4% for salt ages 1 and 2, respectively. Three-salt age fish only represented approximately 0.3% of the combined hatchery/wild sample (Table 3).

Table 3. Salt-water age composition of 2015-2016 return-cycle Upper Columbia River steelhead sampled at Priest Rapids Dam, corrected by scale age/origin determination.

Salt-age	Origin					
	Hatchery		Wild		Combined	
	N	%	*N*	%	*N*	%
1-salt	1,134	62.7	456	48.1	1,590	57.7
2-salt	670	37.1	487	51.4	1,157	42
3-salt	3	0.2	5	0.5	8	0.3
4-salt	0	0	0	0	0	0
Total	**1,807**		**948**		**2,755**	

Freshwater residency of naturally produced Upper Columbia River steelhead present in the 2015-2016 run cycle were dominated by age-2 freshwater fish (72.2%), and was only slightly lower than the 1986-2014 average of 75.9% (Table 4).

Table 4. 2015 return-year freshwater age of wild Upper Columbia River steelhead sampled at Priest Rapids Dam during steelhead stock assessment activities, compared to July-November 1986-2014 average.

Freshwater age	2015-2016 run cycle		1986-2014 proportion	
	N	%	*N*	%
1.x	61	7.4	542	7.6
2.x	591	72.2	5,437	75.9
3.x	155	18.9	1,125	15.7
4.x	12	1.5	58	0.8
5.x	0	0	3	>0.1
Total	**819**		**6,040**	

Wild and hatchery-origin steelhead exhibited similar saltwater growth in the 2015 run-cycle. Wild 1- and 2-salt adults were slightly larger than their hatchery cohorts (Table 5). Age 1-salt wild and hatchery steelhead observed in the 2015-2016 adult run-cycle-return past PRD were comparable in size to the 1986-2014 run-cycle average (Table 5). Age 2-salt wild and hatchery steelhead observed in the 2015-2016 adult run-cycle-return past PRD were considerably smaller in size (4.0% and 4.9% for wild and hatchery fish respectively) to the 1986-2014 run-cycle average (Table 5).

Table 5. Average fork length of 1-salt and 2-salt, Upper Columbia River steelhead sampled at Priest Rapids Dam during July-November 2015 and the period between 1986-2014.

Salt age	Average fork length (cm)			
	2015-2016 run cycle		1986-2014 run cycle	
	Wild	Hatchery	Wild	Hatchery
x.1	59.6	58.3	59.5	58.4
x.2	69.3	67.7	72.2	71.2

Appendix H

Wenatchee Sockeye Salmon Spawning Escapement, 2017

PUBLIC UTILITY DISTRICT NUMBER 1 OF CHELAN COUNTY
Natural Resource Division
Fish and Wildlife Department
327 N. Wenatchee Ave., Wenatchee WA 98801 (509) 663-8121

March 30, 2018

To: HCP Hatchery Committee

From: Catherine Willard and Scott Hopkins

Subject: 2017 Wenatchee Sockeye Mark/Recapture-Based Sockeye Escapement Estimates to Tributaries

Introduction

In 2017, the Chelan County Public Utility District (District) estimated sockeye escapement to tributaries based on mark-recapture methodology. The purpose of this document is to report the spawning escapement estimates for the Little Wenatchee and White River subbasins. This information is used to track and/or estimate viable salmonid population parameters (VSP): abundance, productivity, spatial structure, and diversity (McElhaney et al. 2000).

Methods

Mark-Recapture Method:

Detection efficiencies of the in-stream arrays were calculated for the Little Wenatchee River and White River in 2017. The in-stream arrays include a series of upstream and downstream coils (Figure 1). Combined, these coils represented the upstream and downstream detection arrays, respectively. Overall detection efficiency P_{all} of the arrays was calculated based on observed detection probabilities of individual arrays:

$$P_{all} = 1 - \left(1 - P_{array\ 1}\right)\left(1 - P_{array\ 2}\right)$$

where the probability of missing a fish on both the upstream P_{array1} and downstream P_{array2} arrays were combined for an overall efficiency P_{all} (Connolly et al. 2008).

Adult sockeye salmon were tagged at adult fishways within the Columbia River and at Tumwater Dam. Additionally, adult returns that were PIT tagged as juveniles were used in the analyses. Total passage of adult sockeye salmon through Tumwater Dam was obtained from Columbia River Data Access in Real Time (DART 2017). Resulting tag files were queried in PTAGIS (2017), providing detection histories for each study fish.

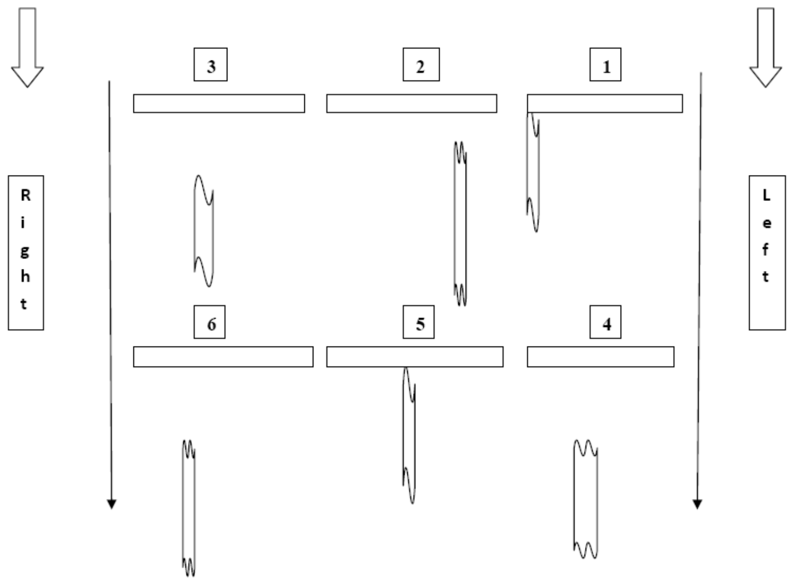


Figure 1. Schematic of a PIT array configuration.

Resulting data from passage at Tumwater Dam, mark and recapture using PIT tags, and detection efficiency estimates can provide estimation of escapement to spawning tributaries. Assumptions include: (1) the study population is “closed,” i.e., no individuals die or emigrate between the initial mark and subsequent recaptures; (2) tags are not lost and detections are correctly identified; (3) all individuals have the same probability of being detected, and (4) the number of recapture events are proportional to the total population. Lastly, it was assumed that PIT-tagging efforts at Tumwater have negligible influence on fish behavior and tagged individuals behave similarly to untagged individuals. The resulting escapement rate, adjusted for detection efficiency, was then applied to the total population as such:

$$Escapement = \left(\frac{\left(\frac{Obs_{LWN}}{Eff_{LWN}} + \frac{Obs_{WTL}}{Eff_{WTL}} \right)}{PITs_{TUM}} \right) \times Counts_{TUM}$$

where the PIT tag detections (*Obs*) at the Little Wenatchee (*LWN*) and White River (WTL) were adjusted for detection efficiency (*Eff*), compared to the number released (*PITs*) at Tumwater Dam (*TUM*), and the resulting proportion was applied to the population observed (*Counts*) passing Tumwater Dam.

Results

Sockeye Salmon Mark-Recapture Method

Fishway enumeration at Tumwater Dam indicated that 23,854 adult sockeye salmon passed the facility during the 2017 migration, which was an insufficient return to open a recreational fishery in Lake Wenatchee for 2017. PIT tags were implanted in 492 fish at Tumwater and 286 fish were PIT-tagged before passing Tumwater; 68 fish were subsequently detected at the Little Wenatchee PIT tag array and 600 fish were subsequently detected at the White River PIT tag array (Table 1). Based on the recapture of PIT-tagged adult sockeye and assigned detection efficiency, total estimated escapement from Tumwater Dam to the Little Wenatchee River was 2,085 adult sockeye and 18,436 adult sockeye to the White River (Table 2).

Table 1. Number of adult sockeye salmon PIT-tagged, released, and detected upstream of Tumwater Dam in 2009 through 2017, and mark/recapture based tributary escapement estimates. Obs. = observed, D.E. = detection efficiency, Est = estimated (Obs./D.E.), and NA = not available.

Year	**Number of PIT-tagged adults detected or tagged at Tumwater[1]**	**White River**			**Little Wenatchee River**			**Chiwawa River Obs.**	**Nason Creek Obs.**
		Obs.	***D.E. (p_{all})***	***Est***	**Obs.**	***D.E. (p_{all})***	***Est***		
2009	1,085	381	0.406	*939*	38	0.971	*39*	37	7
2010	1,164	571	0.900[2]	*635*	67	1.000	*67*	3	1
2011	484	40	NA[3]	*NA*	84	--	*0*	0	0
2012	1,154	410	0.943	*435*	74	0.987	*75*	0	0
2013	719	152	NA[3]	*NA*	55	0.818	*67*	0	0
2014	1,729	848	0.999	*848*	76	1.000	*76*	0	3
2015[4]	950	371	0.999	*371*	50	1.000	*50*	69	4
2016	1,420	743	0.994	*748*	130	1.000	*130*	2	1
2017	778	600	0.998	*601*	68	1.000	*68*	8	0

[1] Also includes fish detected downstream of release point (fallbacks).
[2] Detection efficiency p_{all} = 0.406 in 2009 was assigned from 2010 data.
[3] Technical difficulties with the White River PIT array prevented the calculation of detection efficiency and a mark-recapture based escapement estimate.
[4] In 2015, 45 sockeye salmon were detected in Chiwaukum Creek.

Table 2. Estimated escapement of adult sockeye salmon to Little Wenatchee and White rivers based on mark-recapture events, in-stream detection efficiency, and adult enumeration at Tumwater Dam, 2009-2017.

Year	Tumwater count	Recreational harvest	Little Wenatchee	White River	Combined	Escapement
2009	16,034	2,285	576	13,876	14,452	0.901
2010	35,821	4,129	2,062	19,542	21,604	0.603
2011[1]	18,634	0	2,431	14,582	17,013	0.913
2012	66,520	12,107	4,607	23,866	28,473	0.428
2013[1]	29,015	6,262	2,426	14,294	16,720	0.576
2014	99,898	16,281	4,319	49,021	53,340	0.534
2015	51,435	7,916	2,707	20,097	22,804	0.443
2016	73,697	14,630	6,747	38,802	45,549	0.618
2017	23,854	0	2,085	18,436	20,521	0.860
Average	**46,101**	**7,068**	**3,107**	**23,613**	**26,720**	**0.653**

[1] Escapement was calculated using AUC counts for the Little Wenatchee River and a linear regression relationship to the Little Wenatchee River for the White River.

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Appendix I

Genetic Diversity of Wenatchee Sockeye Salmon

Assessing the Genetic Diversity of Lake Wenatchee Sockeye Salmon And Evaluating The Effectiveness Of Its Supportive Hatchery Supplementation Program

Developed for

Chelan County PUD

and the

Habitat Conservation Plan's Hatchery Committee

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March 2008

Executive Summary

Nine spawning populations of sockeye (*Oncorhynchus nerka*) salmon have been identified in Washington, including stocks in the Lake Wenatchee basin (SaSI 5800) (Washington Department of Fisheries et al. 1993). Lake Wenatchee sockeye are classified as an Evolutionary Significant Unit (ESU), and consists of sockeye salmon that spawn primarily in tributaries above Lake Wenatchee (the White River, Napeequa River, and Little Wenatchee Rivers). Since 1990, the Wenatchee Sockeye Program has released juveniles into Lake Wenatchee to supplement natural production of sockeye salmon in the basin. The program's broodstock are predominantly natural-origin sockeye adults returning to the Wenatchee River captured at Tumwater Dam (Rkm 52.0), where a net-pen system is used to house both maturing adults and juveniles prior to release into Lake Wenatchee to over-winter.

Previous genetic studies have generally found a lack of concordance between population genetic relationships and their geographic distributions. These studies indicate that the nearest geographic neighbors of sockeye salmon populations are not necessarily the most genetically similar. Specifically for the Columbia River Basin, sockeye from Lake Wenatchee, Okanogan River, and Redfish Lake may be more closely related to a population from outside the Columbia River (depending on marker used) then to each other.

In this study we investigated the temporal and spatial genetic structure of Lake Wenatchee sockeye collections, without regard to sockeye populations outside of the Lake Wenatchee area. Our primary objective here was to determine if the Wenatchee Sockeye Program affected the natural Lake Wenatchee sockeye population. More specifically, we were tasked to determine if the genetic composition of Lake Wenatchee sockeye population had been altered by a supplementation program that was based on the artificial propagation of a small subset of that population. Using microsatellite DNA allele frequencies, we investigated population differentiation between temporally replicated collections of natural-origin Lake Wenatchee sockeye and program broodstock. We analyzed thirteen collections of Lake Wenatchee sockeye (Table 1), eight temporally replicated collections of natural-origin Lake Wenatchee sockeye (N=786) and five temporally replicated collections of Wenatchee Sockeye Program broodstock (N=248). Paired natural – broodstock collections were available from years 2000, 2001, 2004, 2006, and 2007.

Conclusions

We observed that allele frequency distributions were consistent over time, irrespective of collection origin, resulting in small and statistically insignificant measures of genetic differentiation among collections. We interpreted these results to indicate no year-to-year differences in allele frequencies among natural-origin or broodstock collections. Furthermore, there were no observed difference between pre- and post-supplementation collections. Therefore, we accepted our null hypothesis that the allele frequencies of the broodstock collections equaled the allele frequencies of the natural collections, which

equaled the allele frequency of the donor population. Given the small differences in genetic composition among collections, the genetic model for estimating N_e produced estimates with extremely large variances, preventing the observation of any trend in N_e.

Introduction

A report titled "Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Hatchery Programs" was prepared July 2005 by Andrew Murdoch and Chuck Peven for the Chelan PUD Habitat Conservation Plan's Hatchery Committee. This report outlined 10 objectives to be applied to various species assessing the impact (positive or negative) of hatchery operations mitigating the operation of Rock Island Dam. This current study pertains only to Lake Wenatchee sockeye and objective 3:

> *Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.*

In order to evaluate cause and effect of hatchery supplementation, WDFW Molecular Genetics Lab surveyed genetic variation of Lake Wenatchee sockeye. The conceptual approach for this project follows that of a parallel study regarding the Wenatchee River spring Chinook supplementation program (Blankenship et al. 2007). We determined the genetic diversity present in the Lake Wenatchee sockeye population by analyzing temporally replicated collections spanning 1989 – 2007, which included collections from before and following the inception of the Wenatchee Sockeye Program. Documenting the genetic composition of the Lake Wenatchee sockeye population is necessary to assess the effect of the hatchery program on the Lake Wenatchee population. In addition, this work provides a genetic baseline for future projects requiring genetic data. See study objectives below for specific details about how this project addresses Murdoch and Peven (2005) objective 3.

Lake Wenatchee Sockeye Salmon

Nine spawning populations of sockeye (*Oncorhynchus nerka*) salmon have been identified in Washington (Washington Department of Fisheries et al. 1993): 1) Baker

River, 2) Ozette Lake, 3) Lake Pleasant, 4) Quinault Lake, and 5) Okanogan River (classified as native stock); 6) Cedar River (classified as non-native stock); 7) Lake Wenatchee, classified as mixed stock); 8) Lake Washington/Lake Sammamish tributaries; and 9) Lake Washington beach spawners (classified as unknown origin). Chapman et al. (1995) listed four additional spawning aggregations of sockeye salmon that appear consistently in Columbia River tributaries: the Methow, Entiat, and Similkameen Rivers; and Icicle Creek in the Wenatchee River drainage.

Located in north central Washington, the Wenatchee River basin drains a portion of the eastern slope of the Cascade Mountains, including high mountainous regions of the Cascade crest. The headwater area of the Wenatchee River is Lake Wenatchee, a typical low productivity oligotrophic or ultra-oligotrophic sockeye salmon nursery lake (Allen and Meekin 1980, Mullan 1986, Chapman et al. 1995). Sockeye salmon bound for Lake Wenatchee enter the Columbia River in April and May and arrive at Lake Wenatchee in late July to early August (Chapman et al. 1995; Washington Department of Fisheries et al. 1993). The run timing of Lake Wenatchee sockeye salmon, classified as an Evolutionary Significant Unit (ESU), appears to have become earlier by 6 - 30 days during the past 70 years (Chapman et al. 1995; Quinn and Adams 1996). Additionally, scale pattern analysis suggests Wenatchee sockeye migrate past Bonneville Dam earlier than the sockeye bound for the Okanogan River (Fryer and Schwartzberg 1994). The Wenatchee population spawns from mid-September through October in the Little Wenatchee, White, and Napeequa Rivers above Lake Wenatchee (Washington Department of Fisheries et al. 1993), peaking in late September (Chapman et al. 1995). Limited beach spawning is believed to occur in Lake Wenatchee (L. Lavoy pers. com.; Mullan 1986), although Gangmark and Fulton (1952) reported two lakeshore seepage areas in Lake Wenatchee that were used by spawning sockeye salmon. Sockeye salmon fry enter Lake Wenatchee between March and May (Dawson et al. 1973), and typically rear in the lake for one year before leaving as smolts (Gustafson et al. 1997; Peven 1987).

Both the physical properties of the habitat and ecological/biological factors of the sockeye populations differ between the Lake Wenatchee ESU and the geographically proximate Okanogan ESU. For example: 1) Different limnology is encountered by sockeye salmon in Lakes Wenatchee and Osoyoos; 2) Lake Wenatchee sockeye predominantly return at ages four and five (a near absence of 3-year-olds), where a large percentage of 3-year-olds return to the Okanogan population; and 3) the apparent one month separation in juvenile outmigration-timing between Okanogan- and Wenatchee-origin fish (Gustafson et al. 1997 and references therein).

Sockeye Artificial Propagation In Lake Wenatchee

The construction of Grand Coulee Dam completely blocked fish passage to the upper Columbia River, and 85% of sockeye salmon passing Rock Island Dam between 1935 and 1936 were estimated to be from natural stocks bound for areas up-river to Grand Coulee Dam (Mullan 1986; Washington Department of Fisheries et al. 1938). To compensate for loss of habitat resulting from Grand Coulee Dam, the federal government initiated the Grand Coulee Fish-Maintenance Project (GCFMP) in 1939 to maintain fish runs in the Columbia River above Rock Island Dam. Between 1939 and 1943, all sockeye salmon entering the mid-Columbia River were trapped at Rock Island Dam, and over 32,000 mixed Lake Wenatchee, Okanogan River, and Arrow Lake adult sockeye salmon were released into Lake Wenatchee (Gustafson et al. 1997 Appendix Table D-2). In addition to adult relocation, between 1941 and 1969 over 52.8 million fry descended from original spawners collected at Rock Island and Bonneville Dams, were released into Lake Wenatchee (Gustafson et al. 1997 Appendix Table D-2).

No releases of artificially-reared sockeye salmon occurred in the Wenatchee watershed during the years 1970 to 1989 (Gustafson et al. 1997 Appendix Table D-2). Since 1990, the Wenatchee Sockeye Program has released juveniles into Lake Wenatchee to supplement natural production of sockeye salmon in the basin. Sockeye adults returning to the Wenatchee River are captured at Tumwater Dam (Rkm 52.0) and transferred to Lake Wenatchee net pens until mature. The Wenatchee Sockeye Program goals are 260 adults with an equal sex ratio, <10% hatchery-origin returns (identified by coded wire tags), and the adults removed for broodstock account for <10% of the run size. Fish are spawned at Lake Wenatchee and their gametes are taken to Rock Island Fish Hatchery

Complex (i.e., Eastbank) for fertilization and incubation. Fry are returned to the Lake Wenatchee net -pens after they are large enough to be coded wire tagged, and are housed in the pens until fall (one year after spawning), when they are liberated into the lake to over-winter. For brood years 1991 – 2004 an average of 218,683 (std. dev. = 71,090) pen-reared Lake Wenatchee-origin juvenile sockeye salmon have been released yearly into Lake Wenatchee.

Previous Genetic Studies

Protein (allozyme) variation – Surveying genetic variation at 12 allozyme loci, Utter et al. (1984) reported moderate population structure among 16 sockeye collections from southeast Alaska through the Columbia River Basin, including Okanogan and Wenatchee stocks, with an apparent genetic association between upper Fraser River and Columbia River sockeye salmon. Winans et al. (1996) surveyed variation at 55 allozyme loci for 25 sockeye salmon and two kokanee collections from 21 sites in Washington, Idaho, and British Columbia, and reported the lowest level of allozyme variability of any species of Pacific salmon and a highest level of inter-population differentiation. Furthermore, these authors reported that there was no clear relationship between geographic and genetic differentiation among the populations within there study. Other studies corroborate the results of Winans et al. (1996), finding a lack of discernible geographic patterning for sockeye salmon populations in British Columbia, Alaska, and Kamchatka (Varnavskaya et al. 1994, Wood et al. 1994, Wood 1995). These studies indicate that the nearest geographic neighbors of sockeye salmon populations are not necessarily the most genetically similar, which contrasts with the other Pacific salmon species that exhibit concordance between geographic and genetic differentiation (Utter et al. 1989, Winans et al. 1994, Shaklee et al. 1991). As part of the comprehensive status review of west coast sockeye salmon (Gustafson et al. 1997), NMFS biologists collected new allozyme genetic information for 17 sockeye salmon populations and one kokanee population in Washington and combined these data for analysis with the existing Pacific Northwest sockeye salmon and kokanee data from Winans et al. (1996). Results of the updated study were consistent with Winans et al. (1996), with no clear concordance between geographic and genetic distances. Sockeye salmon from Lake Wenatchee, Redfish Lake, Ozette Lake, and Lake Pleasant are very distinct from other collections in the study, and Columbia River populations were not necessarily most closely related to each other. Gustafson et al. (1997) also examined between-year variability within a collection location and found low levels of statistical significance among the five Lake Wenatchee collections included in the study (For 10 pair-wise comparisons using sum-G test, five were statistically significant). Lake Wenatchee brood year 1987 accounted for three of the significant comparisons, which were driven by unusually high frequencies of two allozyme alleles (ALAT*95 and ALAT*108) (Winans et al. 1996). Nevertheless, Gustafson et al. (1997) conclude that, in general, temporal variation at a locale was considerably less than between-locale variation.

Nucleic acid variation - Beacham et al. (1995) reported levels of variation in nuclear DNA of *O. nerka* using minisatellite probes. They analyzed 10 collections, including a sample from Lake Wenatchee. Cluster analysis showed the Lake Wenatchee sample was different from all the other collections, including those from the Columbia River. Using a similar molecular technique, Thorgaard et al. (1995) examined the use of multi-locus DNA fingerprinting (i.e., banding patterns) to discriminate among 14 sockeye salmon and kokanee populations. Dendrograms based on analysis of banding patterns produced different genetic affinity groups depending on the probes used. While none of the five DNA probes showed a close relationship between Lake Wenatchee and Okanogan River sockeye salmon, if information from all probes were combined, *O. nerka* from Redfish Lake, Wenatchee, and Okanogan were separate from kokanee of Oregon and Idaho and a sockeye salmon sample from the mid-Fraser River.

Study Objective

We documented temporal variation in genetic diversity (i.e., heterozygosity and allelic diversity), and investigated population differentiation between temporally replicated collections of natural-origin Lake Wenatchee sockeye and program broodstock, using microsatellite DNA allele frequencies. Temporally replicated collections from the same location can also be used to estimate effective population size (N_e). If populations are "ideal", the census size of a population is equal to the "genetic size" of the population.

Yet, numerous factors lower the "genetic size" below census, such as, non-equal sex ratios, changes in population size, and variance in the numbers of offspring produced from parent pairs. N_e is thought to be between 0.10 and 0.33 of the estimated census size (Bartley et al. 1992; RS Waples pers. comm.), although numerous observations differ from this general rule. N_e can be calculated directly from demographic data, or inferred from observed differences in genetic variance over time. Essentially, when calculated from genetic data, N_e is the estimated size of an "ideal" population that accounts for the genetic diversity changes observed, irrespective of abundance.

We will address the hypotheses associated with Objective 3 in Murdock and Peven (2005) using the following four specific tasks:

Task 1 - Document the observed genetic diversity.

Task 2 - Test for population differentiation among Lake Wenatchee collections and the associated supplementation program.

Task 2 was designed to address two hypotheses listed as part of Objective 3 in Murdoch and Peven (2005):

- Ho: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop}}$.
- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Murdoch and Peven (2005) proposed these two hypotheses to help evaluate supplementation programs through a "Conceptual Process" (Figure 5 in Murdoch and Peven 2005). There are two components to the first hypothesis, which must be considered separately for Lake Wenatchee sockeye. The first component involves comparisons between natural-origin populations from Lake Wenatchee to determine if there have been changes in allele frequencies through time starting with the donor population. Documenting a change does not necessarily indicate that the supplementation program has directly affected the natural-origin fish, as additional tests would be necessary to support that hypothesis. The intent of the second component is to determine if the hatchery produced populations have the same genetic composition as the naturally produced populations.

Task 3 - Calculate N_e using the temporal method for multiple samples from the same location to document trend.

Task 4 - Compare N_e estimates with trend in census size for Lake Wenatchee sockeye.

Methods and Materials

Sampling

Thirteen collections of Lake Wenatchee sockeye were analyzed, eight temporally replicated collections of natural Lake Wenatchee sockeye (N=786) and five temporally replicated collections of Wenatchee Sockeye Program broodstock (N=248) (Table 1). Paired natural – broodstock collections were available from years 2000, 2001, 2004, 2006, and 2007 (Table 1). All collections were made at Tumwater Dam on the Wenatchee River. Note that collections classified as broodstock were predominantly natural-origin sockeye. A majority of the genetic samples were from dried scales. The tissue collections from 2006 and 2007 were fin clips stored immediately in ethanol after collection. DNA was extracted from stored tissue using Nucleospin 96 Tissue following the manufacturer's standard protocol (Macherey-Nagel, Easton, PA, U.S.A.).

Laboratory Analysis

Polymerase chain reaction (PCR) amplification was performed using 17 fluorescently end-labeled microsatellite marker loci, *One* 2 (Scribner et al 1996) *One* 100, 101, 102, 105, 108, 110, 114, and 115 (Olsen et al. 2000), *Omm* 1130, 1135, 1139, 1142, 1070, and 1085 (Rexroad et al. 2001), *Ots* 3M (Banks et al. 1999) and *Ots* 103 (Small et al. 1998). PCR reaction volumes were 10 μL, with the reaction variables being 2 μL 5x PCR buffer (Promega), 0.6 μL $MgCl_2$ (1.5 mM) (Promega), 0.2 μL 10 mM dNTP mix (Promega), and 0.1 μL *Go Taq* DNA polymerase (Promega). Loci were amplified as part of multiplexed sets, so primer molarities and annealing temperatures varied. Multiplex one had an annealing temperature of 55°C, and used 0.09 Molar (M) *One* 108, 0.06 M *One* 110, and 0.11 M *One* 100. Multiplex two had an annealing temperature of 53°C, and used 0.08 M *One* 102, 0.1 M *One* 114, and 0.05 M *One* 115. Multiplex three had an annealing temperature of 55°C, and used 0.08 M *One* 105 and 0.07 M *Ots* 103. Multiplex four had an annealing temperature of 53°C, and used 0.09 M *Omm* 1135 and 0.08 M *Omm* 1139. Multiplex five had an annealing temperature of 60°C, and used 0.2 M *Omm* 1085, 0.09 M *Omm* 1070, and 0.05 M *Ots* 3M. Multiplex six had an annealing temperature of 48°C, and used 0.06 M *One* 2, 0.08 M *Omm* 1142, and 0.08 M *Omm* 1130. *One* 101 was run in isolation with a primer molarity of 0.06. Thermal cycling was conducted on either PTC200 (MJ Research) or GeneAmp 9700 thermal cyclers as follows: 94°C (2 min); 30 cycles of 94°C for 15 sec., 30 sec. annealing, and 72°C for 1 min.; a final 72°C extension and then a 10°C hold. PCR products were visualized by denaturing polyacrylamide gel electrophoresis on an ABI 3730 automated capillary analyzer (Applied Biosystems). Fragment analysis was completed using GeneMapper 3.7 (Applied Biosystems).

Genetic data analysis

Assessing within collection genetic diversity - Heterozygosity measurements were reported using Nei's (1987) unbiased gene diversity formula (i.e., expected heterozygosity) and Hedrick's (1983) formula for observed heterozygosity. Both tests were implemented using the microsatellite toolkit (Park 2001). For each locus and collection FSTAT version 2.9.3.2 (Goudet 1995) was used to assess Hardy-Weinberg equilibrium, where deviations from the neutral expectation of random associations among alleles were calculated using a randomization procedure. Alleles were randomized among individuals within collections (4160 randomizations for this dataset) and the F_{IS} (Weir and Cockerham 1984) calculated for the randomized datasets were compared to the observed F_{IS} to obtain an unbiased estimation of the probability that the null hypothesis was true. The 5% nominal level of statistical significance was adjusted for multiple tests (Rice 1989). Genotypic linkage disequilibrium was calculated following Weir (1979) using GENETIX version 4.05 (Belkhir et al. 1996). Statistical significance of linkage disequilibrium results was assessed using a permutation procedure implemented in GENETIX for each locus by locus combination within each collection.

Assessing among collection genetic differentiation - The temporal stability of allele frequencies was assessed by the randomization chi-square test implemented in FSTAT version 2.9.3.2 (Goudet 1995). Multi-locus genotypes were randomized between collections. The G-statistic for observed data was compared to G-statistic distributions from randomized datasets (i.e., null distribution of no differentiation between collections). Population differentiation was also investigated using pairwise estimates of F_{ST}. Multi-locus estimates of pairwise F_{ST}, estimated by a "weighted" analysis of variance (Weir and Cockerham, 1984), were calculated using GENETIX version 4.05 (Belkhir et al.1996). F_{ST} was used to quantify population structure, the deviation from statistical expectations (i.e., excess homozygosity) due to non-random mating between populations. To determine if the observed F_{ST} estimate was consistent with statistically expectations of no population structure, a permutation test was implemented in GENETIX (1000 permutations).

Effective population size (N_e) – Estimates of the effective population size were obtained using a multi-collection temporal method (Waples 1990a). The temporal method assumes that cohorts are used, but we did not decompose the collection year samples into their respective cohorts using age data. Therefore, N_e estimates that pertain to individual year classes of breeders are not valid; however the harmonic mean over all samples will estimate an N_e that pertains to the time period from which the collections are derived. Comparing samples from years *i* and *j*, Waples' (1990a) temporal method estimates the effective number of breeders ($\hat{N}_{b(i,j)}$) according to:

$$\hat{N}_{b(i,j)} = \frac{b}{2(\hat{F} - 1/\tilde{S}_{i,j})}$$

The standardized variance in allele frequency ($\hat{F}$) is calculated according to Pollack (1983). The parameter b is calculated analytically from age structure information and the number of years between samples (Tajima 1992). The age-at-maturity information required to calculate b was obtained from ecological data (Hillman et al. 2007). The harmonic mean of sample sizes from years *i* and *j* is $\tilde{S}_{i,j}$. The harmonic mean over all pairwise estimates of $\hat{N}_{b(i,j)}$ is $\tilde{N}_b$. SALMONNb (Waples et al. 2007) was used to calculate $\tilde{N}_b$.

Results and Discussion

In this section we combine our presentation and interpretations of the genetic analyses. Additionally, this section is organized based on the task list presented in the study plan.

Task 1 - Document the observed genetic diversity.

Substantial genetic diversity was observed over all Lake Wenatchee sockeye collections analyzed (Table 1), with heterozygosity estimates over all loci having a mean of 0.79. Genetic diversity was consistent with expected Hardy-Weinberg random mating genotypic proportions for all collections. The F_{IS} observed for each collection was not statistically significant given the distribution of F_{IS} generated using a randomization procedure. Additionally, there were no statistically significant associations observed between alleles across loci (i.e., linkage equilibrium) (data not shown). We concluded from these results that the genetic data from each collection was consistent with statistical expectations for random association of alleles within and between loci. In other words, each collection represents samples from a single gene pool (i.e., populations), and the genetic diversity observed has no detectable technical artifacts or evidence of natural selection.

Task 2 - Test for differentiation among Lake Wenatchee collections and the associated supplementation program.

We explicitly tested the hypothesis of no significant differentiation within natural-origin or broodstock collections from Lake Wenatchee using a randomization chi-square test. The null hypothesis for these tests was that the allele frequencies from two different populations were drawn from the same underlying distribution. We show the results for the pairwise comparisons among eight temporally replicated natural-origin collections from Lake Wenatchee (28 pairwise tests), and report all tests were non-significant (Table 2A). Similarly, for five temporally replicated broodstock collections, 10 of 10 pairwise tests were non-significant (Table 2B). We also tested if natural-origin and broodstock collections were differentiated from each other over time, and report that 40 of 40 tests were non-significant (Table 2C). The nominal level of statistical significance ($\alpha = 0.05$) was adjusted for multiple comparisons using strict Bonferroni correction (Rice 1989). Yet, there are perhaps slight differences between paired natural-broodstock collections. Note that the p-values for comparisons regarding 2006 and 2007 paired collections are lower than for comparisons regarding 2000, 2001, and 2004. The small sample sizes for broodstock collections in 2006 and 2007 may not have been random samples from the Lake Wenatchee sockeye population.

Given the consistencies observed for allele frequency distributions over time, metrics of population structure were expected to be small. This was the case, as the estimated F_{ST} over all thirteen collections was 0.0003. This observed value fell within the distribution of F_{ST} values expected if there were no population structure present (permutation test p-value 0.12). Analysis of the paired natural-broodstock collections corroborated this result. Pairwise estimates of F_{ST} were 0.000 for years 2000, 2001, 2004, and 2007, and 0.002 for 2006. All five estimates were non-significant. Essentially, all 13 sockeye collections could be considered samples from the same population. Given these results, it is valid to combine all collections for statistical analysis. Therefore, we did not calculate genetic distances among any collections, as it is inappropriate to estimate distances that are effectively zero.

Conclusions

We interpret these data to indicate that there appears to be no significant year-to-year differences in allele frequencies among natural-origin or broodstock collections, nor are there observed differences between collections pre- and post-supplementation. As a result, we accept the null hypothesis that the allele frequencies of the broodstock collections equal the allele frequencies of the natural collections, which equals the allele frequency of the donor population. Furthermore, the observed genetic variance that can be attributed to among collection differences was negligible.

Task 3 - Calculate N_e using the temporal method for multiple samples from the same location to document trend.

The fundamental parameter for inferring N_e using genetic data is the standardized variance in allele frequency ($\hat{F}$) (Pollack 1983). Methods estimate N_e from observed changes in $\hat{F}$ over temporally replicated collections from the same location. Yet, as previously shown, there were no statistically significant differences detected in allele frequencies. The underlying model for estimating N_e produced estimates with extremely large variances, given small temporal differences in $\hat{F}$, which rendered any trend in N_e unobservable. Table 3 shows N_e estimates calculated using temporally replicated natural collections.

Task 4 - Compare N_e estimates with trend in census size for Lake Wenatchee sockeye.

See Task 3

Acknowledgements

We would like to thank Jeff Fryer (CRITFC) for providing critical collections of natural-origin sockeye from Lake Wenatchee. We would like to thank Norm Switzler for collection curation and Ken Warheit and Denise Hawkins for helpful comments regarding this project. This project was funded by Chelan County PUD and the Washington State General Fund.

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Table 1 Lake Wenatchee sockeye collections analyzed. MNA is the mean number of alleles per locus, Hz is unbiased heterozygosity, Obs Hz is observed heterozygosity, and HW is the p-value of the null hypothesis of random association of alleles (i.e., Hardy – Weinberg equilibrium). For reference, the nominal level of statistical significance at $\alpha = 0.05$ is 0.0002 after correction for multiple tests.

Year	Collection Code	Tissue Type	Source	N	MNA	Hz	Obs Hz	HW
1989	89[1]	Scales	Natural	96	14.35	0.792	0.791	0.424
1990	90[1]	Scales	Natural	96	13.19	0.793	0.779	0.131
2000	00AAE	Scales	Broodstock	96	12.31	0.787	0.776	0.213
2000	00[1]	Scales	Natural	96	11.76	0.801	0.826	0.868
2001	01AAS	Scales	Broodstock	53	9.47	0.788	0.793	0.392
2001	01[1]	Scales	Natural	96	14.35	0.786	0.794	0.456
2002	02[1]	Scales	Natural	96	14.53	0.794	0.777	0.780
2004	04[1]	Scales	Natural	96	14.65	0.798	0.803	0.704
2004	04AAV	Scales	Broodstock	43	14.35	0.796	0.795	0.051
2006	06CN	Tissue	Broodstock	38	14.59	0.793	0.785	0.688
2006	06CO	Tissue	Natural	96	14.53	0.806	0.803	0.408
2007	07EE	Tissue	Broodstock	18	14.00	0.790	0.790	0.221
2007	07EF	Tissue	Natural	96	14.35	0.789	0.800	0.347

[1] Samples taken from scale cards provided by Jeff Fryer (CRITFC)

Table 2 Allelic differentiation for Lake Wenatchee sockeye collections. A single analysis tested (pairwise) the allelic differentiation between all thirteen collections; however p-values for G-statistics are partitioned in the table by A) natural-origin, B) broodstock, and C) natural versus broodstock. Underlined values are for paired natural-broodstock collections from the same year. For reference, the nominal level of statistical significance at $\alpha = 0.05$ is 0.0006 after correction for multiple tests. No significant values were observed.

A) Natural-Origin Collections

	89	90	00	01	02	04	06CO	07EF
89		0.257	0.359	0.531	0.331	0.127	0.031	0.263
90			0.953	0.148	0.753	0.903	0.077	0.283
00				0.328	0.527	0.607	0.604	0.400
01					0.209	0.081	0.127	0.093
02						0.085	0.707	0.235
04							0.312	0.577
06CO								0.435
07EF								

B) Broodstock Collections

	00AAE	01AAS	04AAV	06CN	07EE
00AAE		0.189	0.090	0.008	0.058
01AAS			0.122	0.020	0.116
04AAV				0.008	0.031
06CN					0.326
07EE					

C) Natural vs. Broodstock

	89	90	00	01	02	04	06CO	07EF
00AAE	0.027	0.309	<u>0.572</u>	0.018	0.041	0.012	0.093	0.040
01AAS	0.115	0.471	0.160	<u>0.219</u>	0.519	0.049	0.654	0.133
04AAV	0.136	0.219	0.210	0.423	0.208	<u>0.328</u>	0.037	0.153
06CN	0.029	0.004	0.053	0.007	0.022	0.004	<u>0.019</u>	0.001
07EE	0.099	0.229	0.053	0.015	0.093	0.178	0.090	<u>0.037</u>

Table 3 Estimation of N_e for temporally replicated natural-original sockeye collections. Above the diagonal are pairwise estimates of N_e, where negative values mean sampling variance can account for genetic variance observed (i.e., genetic drift unnecessary). Below the diagonal are variances for pairwise estimates of N_e. Absent variance values (denoted by **-**) were too large for SalmonNb to display.

Collection	89	90	00	01	02	04	06CO	07EF
89		-3936.6	-1414	-2636.3	671.4	1871.1	1066.1	1951.2
90	2.59E+09		-1490.3	3649.1	-31144	-6808.4	817.6	93190.2
00	1.40E+09	4.45E+09		-592.2	-6842.2	-667.1	-1736.9	-1350.1
01	1.21E+09	1.47E+09	2.33E+09		977.1	6160.4	387.8	2531.5
02	1.91E+09	1.33E+09	1.16E+09	2.29E+09		1495.6	-848.5	3213.6
04	2.21E+09	3.62E+09	4.08E+09	1.27E+09	1.14E+09		896.6	2155.3
06CO	1.34E+09	1.39E+09	1.73E+09	-	4.51E+09	1.2E+09		3278.6
07EF	2.15E+09	1.51E+09	1.18E+09	1.68E+09	-	1.36E+09	2.65E+09	

Appendix J

Wenatchee Spring Chinook Redd Estimates, 2017

Spring Chinook Redd Estimates - 2017

Upper Wenatchee

Kevin See

January 18, 2018

Goals

Redd counts are an established method to provide an index of adult spawners (Gallagher et al. 2007). In the Wenatchee subbasins, spawning reaches are surveyed weekly during the spring Chinook spawning season (Jul 25, 2017 - Sep 29, 2017). The goals of this work are to:

- Estimate the true number of redds in each spawning reach with uncertainty.
- Summarize the number of redds at the tributary and population scale.

Methods

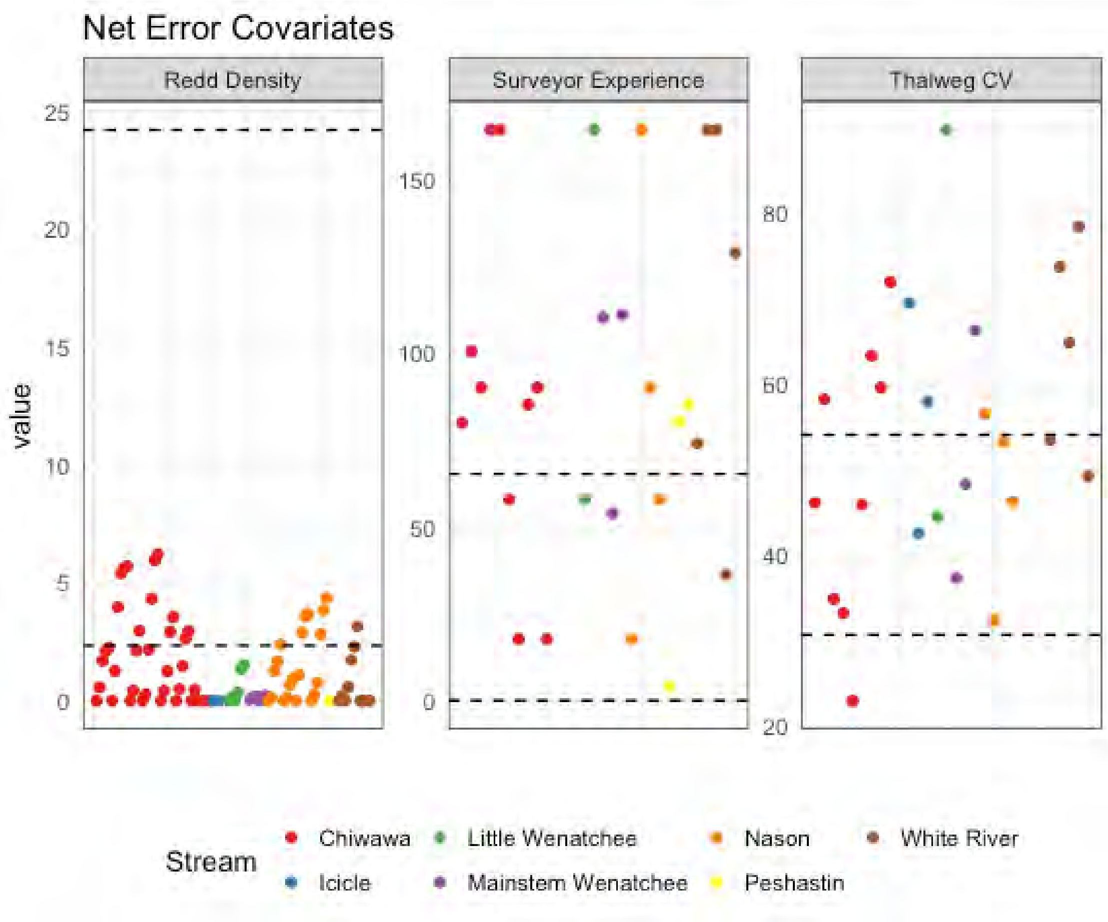
Data

Data were collected on the number of new redds during each survey (usually conducted about every week during the spawning season). Covariates such as surveyor experience, mean thalweg CV and redd density (observed redds / km) were also collected on the reach scale to make predictions of surveyor error.

Surveyor Error

From the results of a previous study on spring Chinook, similar to the one outlined in Murdoch et al. (2014) for steelhead, we had a model that predicted surveyor net error (ratio of identified redds to true redds) based on covariates such as the surveyor's total experience with spawning ground surveys, the mean thalweg CV and the observed redd density (redds/km). This model suggests that increasing experience and observed redd density lead to higher net error, while increasing the stream complexity (mean thalweg CV) leads to lower net error.

Because the net error model is a linear model, and therefore not constrained to be between 0 and 1 (less than 1 implies an underestimate of the number of redds, while net error greater than 1 implies an overestimate due to false identifications), we examined the values of the predictive covariates and compared them to the values used to fit the net error model. Several values were outside the range of the model dataset (See Figure 1). Surveyor experience was often much higher than the model dataset range and observed redd densities were often lower. These lead to opposing effects in the net error model, so the predicted observer errors were in line with the observed error rate in the model dataset, so we proceeded with the analysis.



Values of the covariates for the net surveyor error model, colored by stream. Dashed lines depict the range of values from the data set used to develop the net error model.

Total Redds

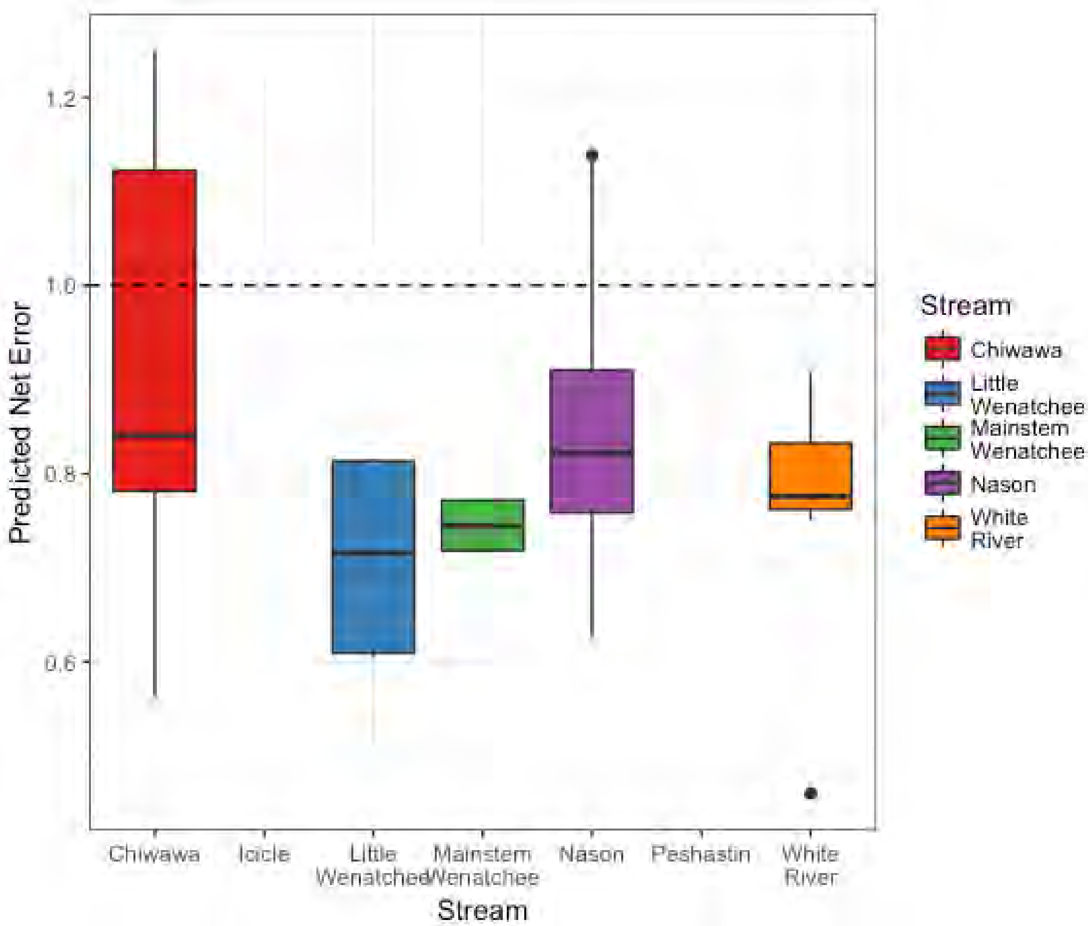
Estimates of total redds were made for each reach using the Gaussian area under the curve (GAUC) model described in Millar et al. (2012). The GAUC model was developed with spawner counts in mind. As it is usually infeasible to mark every individual spawner, only total spawner counts can be used, and an estimate of average stream life must be utilized to translate total spawner days to total unique spawners. However, in adapting this for redd surveys, individual redds can be marked, and therefore we fit the GAUC model to new redds only. The equivalent of stream life thus becomes the interval between surveys. However, this year surveys were unable to be conducted during several weeks coinciding with peak spawning in the Chiwawa. Therefore, to fit the GAUC model, we used survey number instead of Julian day, and set the survey interval to one. We fit these models to reach-scale data, which did pose several challenges for a few reaches. We did not make GAUC estimates for reaches that had fewer than 5 observed redds, or less than 3 weeks with at least one new redd observed.

When summing GAUC estimates at the reach-scale to obtain estimates at the stream scale, an attempt was made to incorporate the fact that the reaches within a stream are not independent. Estimates of correlation between the reaches within a stream were made based on weekly observed redds. This method may not be perfect, since spawners may use certain reaches preferentially at different times in the season, but it may be the best we can do. Because correlations are often quite high between reaches, this is a better alternative than to naively assume the standard errors between reaches are independent of one another. These estimates of correlation were combined with GAUC estimates of standard error for each reach to calculate a covariance matrix for the reaches within each stream, which was used when summing estimates of total redds to estimate the standard error at the stream-scale. Failure to incorporate the correlations between reaches would result in an underestimate of standard error at the stream scales. Different streams (and therefore reaches in different streams) were assumed to be independent.

Results

Surveyor Error

Predictions of net error are shown in Figure 2. Most predictions were less than one, implying some redds may have been missed. A few surveys had predictions of net error greater than one, implying some redds identified by surveyors were false redds.



Boxplots showing predicted net error by stream. Dashed line shows no error.

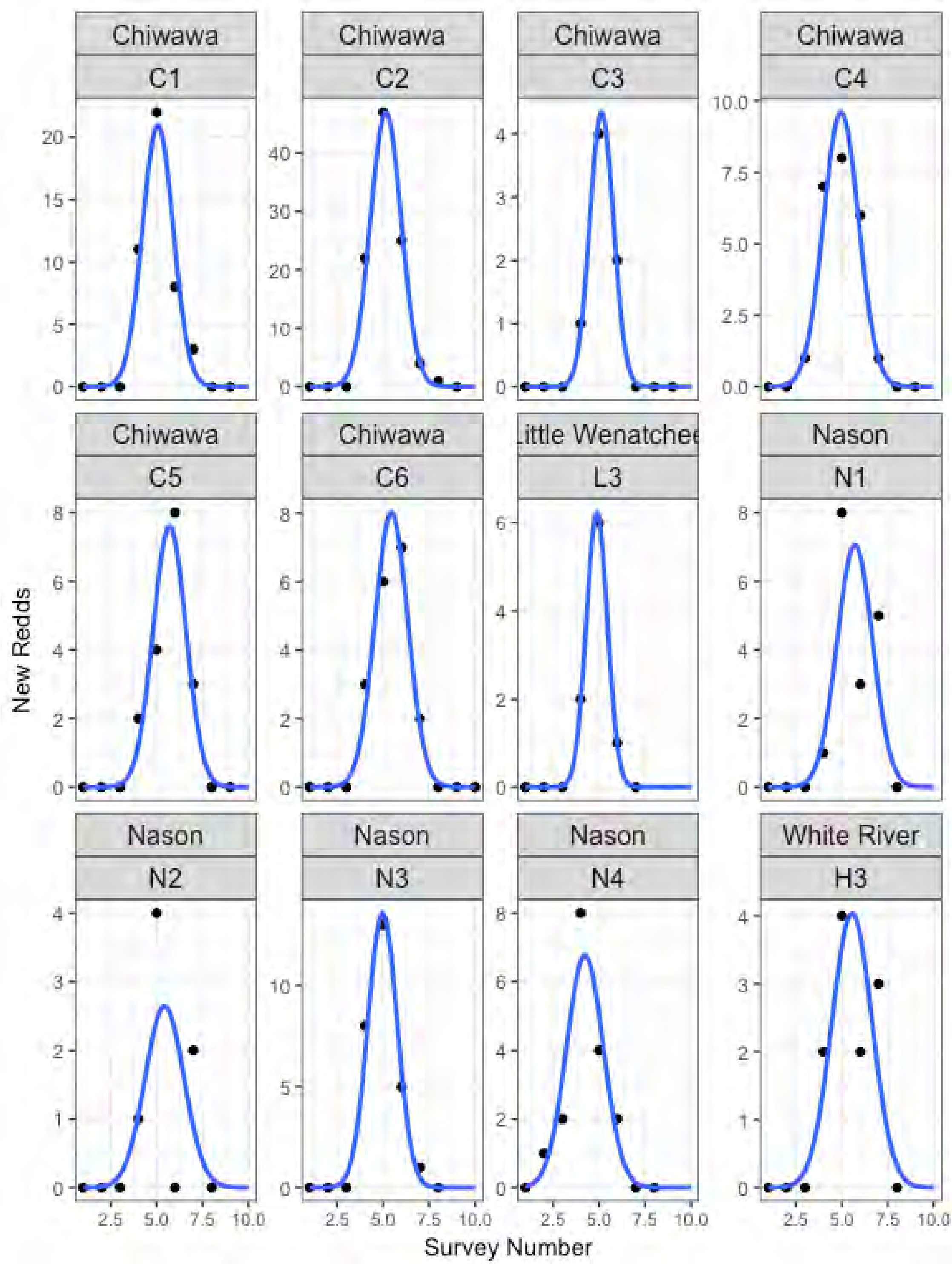
Total Redds

Redds were estimated at the reach scale using the GAUC method whenever possible, and simply dividing the total number of observed redds by the predicted net error when not. For a few small tributary reaches, no estimates of observer error were made and instead the small number of observed redds was assumed to be observed without error. The estimates at the reach scale are displayed in Table 1. The curves that were fit in the GAUC process are shown in Figure 3. The results are summarized at the stream and population scale in Table 2.

Table 1: Estimates of total redds by reach.

Stream	Reach	Type	GAUC	Obs. Redds	Mean Net Error	Est. Redds	SE	CV
Chiwawa	C1	Major	Y	44	0.85	52	7.5	0.14
Chiwawa	C2	Major	Y	99	0.8	124	19.97	0.16
Chiwawa	C3	Major	Y	7	0.98	7	0.69	0.1
Chiwawa	C4	Major	Y	23	1.15	20	2.96	0.15

Chiwawa	C5	Major	Y	17	1.23	14	2.39	0.17
Chiwawa	C6	Major	Y	18	0.82	22	2.23	0.1
Chiwawa	C7	Major	N	1	0.56	2	0.83	0.42
Chiwawa	K1	Minor	N	8	--	8	--	--
Chiwawa	R1	Minor	N	5	--	5	--	--
Chiwawa	S1	Minor	N	0	--	0	--	--
Icicle	I1	Minor	N	2	--	2	--	--
Icicle	I2	Minor	N	30	--	30	--	--
Icicle	I3	Minor	N	8	--	8	--	--
Little Wenatchee	L2	Major	N	1	0.81	1	0.33	0.33
Little Wenatchee	L3	Major	Y	9	0.61	15	4.51	0.3
Mainstem Wenatchee	A1	Minor	N	3	--	3	--	--
Mainstem Wenatchee	W10	Major	N	4	0.77	5	1.49	0.3
Mainstem Wenatchee	W9	Major	N	2	0.72	3	1.3	0.43
Nason	N1	Major	Y	17	0.63	27	7.27	0.27
Nason	N2	Major	Y	7	1.13	6	2.49	0.41
Nason	N3	Major	Y	27	0.81	33	4.85	0.15
Nason	N4	Major	Y	17	0.82	21	3.16	0.15
Peshastin	D1	Minor	N	0	--	0	--	--
Peshastin	P1	Minor	N	2	--	2	--	--
Peshastin	P2	Minor	N	1	--	1	--	--
White River	H2	Major	N	2	0.76	3	0.9	0.3
White River	H3	Major	Y	11	0.76	14	4.44	0.32
White River	H4	Major	N	0	0.83	0	0	--
White River	Q1	Minor	N	2	--	2	--	--
White River	T1	Minor	N	0	--	0	--	--



Observed new redds by survey number and reach. Blue curve depicts the GAUC fitted curve.

Table 2: GAUC results at stream and population scale. Mean net error is the mean of net error estimates, weighted by the number of observed redds in each reach.

Stream	Obs. Redds	Mean Net Error	Est. Redds	Std. Err.	CV

Chiwawa	222	0.89	254	30	0.12
Icicle	40	--	40	0	0
Little Wenatchee	10	0.63	16	4.51	0.28
Mainstem Wenatchee	9	0.75	11	1.98	0.18
Nason	68	0.8	87	15.2	0.17
Peshastin	3	--	3	0	0
White River	15	0.76	19	4.44	0.23
Total	367	--	430	34.28	0.08

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Appendix K

Genetic Diversity of Chiwawa River Spring Chinook Salmon

Assessing the Genetic Diversity of Natural Chiwawa River Spring Chinook Salmon and Evaluating the Effectiveness of its Supportive Hatchery Supplementation Program

Developed for

Chelan County PUD

and the

Habitat Conservation Plan's Hatchery Committee

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March 30, 2007

Table of Contents

Executive Summary

The main objective of this study was to determine the potential impacts of the Chiwawa River Supplementation Program on natural spring Chinook in the upper Wenatchee system. We did this by investigating population differentiation between temporally replicated Chiwawa River natural and hatchery samples from the Wenatchee River watershed using microsatellite DNA allele frequencies and the statistical assignment of individual fish to specific populations. Additionally, to assess the genetic effect of the hatchery program, we investigated the relationship between census and effective population sizes using collections obtained before and after the supplementation program. In this summary, we briefly describe the salient results contained within this report; however, each "Task" within the Results/Discussion section below contains extended coverage for each topic along with an expanded interpretation of each result.

Overall, we observed substantial genetic diversity within collections, with heterozygosities equal to roughly 80%, over thirteen microsatellite markers. Microsatellite allele frequencies among temporally replicated collections from the same population (i.e., location) were variable, resulting in significant genetic differentiation among these collections. However, these difference are likely the result of salmon life history in this area, as four-year-old Chinook comprise a majority of returns each year. That is, the genetic tests are detecting the differences of contributing parents from each cohort, rather than a hatchery effect.

Analysis of Chiwawa River Collections

To assess the multiple competing hypotheses regarding population differentiation within and among Chiwawa River collections, we found it necessary to organized the Chiwawa genetic data into three data sets: (1) fish origin (hatchery versus natural), (2) spawning location (hatchery broodstock versus in-river (natural) spawners), and (3) four "treatment" groups (1. hatchery-origin hatchery broodstock, 2. hatchery-origin natural spawner, 3. natural-origin natural spawner, and 4. natural-origin hatchery broodstock). We conducted separate analyses using each of the three data sets, with each analysis touching on some aspect of the components necessary to move through the Conceptual Process outlined by Murdoch and Peven (2005).

Origin Dataset – We report that allele frequencies within and between natural- and hatchery-origin collections are significantly different, but there does not appear to be a robust signal indicating that the recent natural-origin collections have diverged greatly from the pre- or early post-supplementation collections. Genetic drift will occur in all populations, but does not appear to be a major factor affecting allele frequencies within the Chiwawa collections.

Spawning Location Dataset – There are significant allele frequency differences within and between hatchery broodstock and natural spawner collections. However, in recent years the allele frequency differences between the hatchery broodstock and natural spawner collections have declined. Furthermore, based on linkage disequilibrium, there is a genetic signal that is consistent with increasing homogenization of allele frequencies within hatchery broodstock collections, but a similar homogenization within the natural spawner collection is not apparent. These data suggest that there exists consistent year-to-year variation in allele frequencies among hatchery and natural spawning collections, but there is a trend toward homogenization of the allele frequencies of the natural- and hatchery-origin fish that compose the hatchery broodstock.

Four Treatment dataset – Although there are signals of allelic differentiation among Chiwawa River collections, there are no robust signs that these collections are substantially different from each other. We used two different analyses to measure the degree of genetic variation that exists among individuals and collections within the Chiwawa River. First, we conducted a principal component analysis using all Chiwawa samples with complete genotypes (i.e., no missing alleles from any locus). Although the first two principal component axes account for only 10.5% of the total molecular variance, a substantially greater portion of that variance is among individual fish, regardless of their identity, rather than among hatchery and natural collections. The variances in principal component scores among individuals are 11 and 13 times greater than the variance in scores among collections.

Secondly, using an Analysis of Molecular Variance (AMOVA), we were able to determine how best to group populations, with "best" being defined as that grouping that accounts for the greatest proportion of among group (i.e., population) variance. Furthermore, by partitioning molecular variance into different hierarchical components, we are able to determine what level accounts for the majority of the molecular variance. The AMOVA results clearly show that nearly all molecular variation, no matter how the data are organized, resides within a collection. The percentage of total molecular variance occurring within collections ranged from 99.68% to 99.74%. These results indicate that the significant differences among collections of Chiwawa fish account for less than one percent of the total molecular variance, and these differences cannot be attributed to fish origin or spawning location.

Effective Population Size (N_e)

The contemporary estimate of N_e calculated using genetic data combined for Chiwawa natural-origin spawners (NOS) and hatchery-origin spawners (HOS) Chinook is N_e=386.8, which is slightly larger than the pre-hatchery N_e we estimated using demographic data from 1989 – 1992. Additionally, the N_e /N ratio calculated using 386.8 for N_e and the arithmetic mean yearly census of NOS and HOS Chinook from 1989 – 2005 for N is 0.40. These results suggest the N_e has not declined during the period of Chiwawa Hatchery Supplementation Program operation.

Analysis Of Upper Wenatchee Tributary Collections

We compared genetic data for spring Chinook collected from the major spawning aggregates of the Wenatchee River. We observed significant differences in allele frequencies among temporally replicated collections within populations, and among populations within the upper Wenatchee. However, these differences account for a very small portion of the overall molecular variance, and these populations overall are very similar to each other. Of all the populations within the Wenatchee River, the White River appears to be the most distinct. Yet, this distinction is more a matter of detail than of large significance, as the median F_{ST} between White River collections and all other collections (except the Little Wenatchee collection; see Results/Discussion) is less than 1.5% among population variance. We consider the implications of these results in the Conclusion section that follows the Results/Discussion section. Additionally, there is no evidence that the Chiwawa River Supplementation Program has changed the allele frequencies in the Nason Creek and White River populations, despite the presence of hatchery-origin fish in both these systems.

Introduction

Murdoch and Peven (2005) outlined 10 objectives to assess the impact (positive or negative) of hatchery operations mitigating the operation of Rock Island Dam. Two objectives relate to monitoring the genetic integrity of populations:

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

This study addresses Objective 3 (above), and documents analyses and results WDFW completed for populations of spring Chinook (*Oncorhynchus tshawytscha*) in the Wenatchee River watershed. This study was not intended to specifically address Objective 5 (above); however, genetic data provide results relevant to Objective 5. The critical component of Objective 3 is to determine if hatchery supplementation has effected change. Furthermore, change in this context means altering census size and/or genetic marker allele frequencies; we did not attempt to measure changes in fitness. Perhaps a more meaningful rewording of Objective 3 is, "Did the hatchery supplementation program succeed at increasing the census size of a target population while leaving genetic integrity intact?" In order to evaluate cause and effect of hatchery supplementation, we surveyed and compared genetic variation in samples collected before and after potential effects from the Chiwawa Hatchery Supplementation Program. Samples were acquired from the primary spawning aggregates in the upper Wenatchee River watershed: Nason Creek, Little Wenatchee River, White River, and Chiwawa River. Hatchery samples were acquired from programs that could potentially affect genetic composition of Wenatchee stocks, the integrated Chiwawa River stock (local stock), Leavenworth National Fish Hatchery spring Chinook (Carson Stock – non local), and Entiat NFH (Carson Stock – non local). Additionally, the genetic markers used were the Genetic Analysis of Pacific Salmonids (GAPS) (Seeb et al. in review) standardized microsatellites, so all data from the Wenatchee study will be available for inclusion in the GAPS Chinook coastwide microsatellite baseline.

History of Artificial Propagation

Artificial propagation in the upper Columbia River began in 1899 when hatcheries were constructed on the Wenatchee and Methow rivers (Mullan 1987). These initial operations were small, with the Tumwater Hatchery on the Wenatchee River releasing several hundred thousand fry, and the Methow River hatchery producing few Chinook salmon before it was closed in 1913 (Craig and Suomela 1941, Nelson and Bodle 1990). The Leavenworth State Hatchery operated in the Wenatchee River Basin between 1913 and 1931 using eggs from non-native stocks (Willamette River spring-run and lower Columbia Chinook hatchery fall-run). These early attempts at hatchery production were largely unsuccessful for spring-run Chinook (WDF 1934). Between 1931 and 1939, no Chinook salmon hatcheries were in operation above Rock Island Dam (Rkm 730).

In 1938, the last salmon was allowed to pass upstream through the uncompleted Grand Coulee Dam (Rkm 959). To mitigate the loss of habitat, adult Chinook salmon were trapped, under the auspices of the Grand Coulee Fish Maintenance Project (GCFMP), at Rock Island Dam beginning in May 1939, and relocated into three of the remaining accessible tributaries to the upper Columbia River: the Wenatchee, Entiat, and Methow Rivers. GCFMP transfers continued through the autumn of 1943. Spring- and summer/fall-run fish were differentiated at Rock Island Dam based on a 9 July cutoff date for Chinook arrivals at Rock Island Dam (Fish and Hanavan 1948). Spring-run adults collected at Rock Island Dam (pre 9 July fish) were either transported to Nason Creek on the Wenatchee River to spawn naturally (1939-43), or to the newly constructed Leavenworth NFH (1940) for holding and subsequent spawning (1940-43). Eggs were incubated on site or transferred to the Entiat NFH (1941) and Winthrop NFH (1941). In 1944 spring-run adults were allowed to freely pass Rock Island Dam. The GCFMP did not differentiate among late-run stocks (post 9 July fish) passing Rock Island Dam. Late-run offspring reared at the Leavenworth NFH, Entiat NFH, and Winthrop NFHs were an amalgamation of summer and fall upper Columbia River populations (Fish and Hanavan 1948). Late-run fish were transplanted into the upper and lower Wenatchee, Methow, and Entiat Rivers.

After 1943, the Winthrop NFH continued to use local spring-run Chinook for hatchery production, while the other NFHs largely focused on summer-run Chinook salmon. Renewed emphasis on spring run production in the mid-1970s saw the inclusion of local and non-local eggs (Carson NFH stock, Klickitat River stock, and Cowlitz River stock) to the NFHs. In the early 1980s, imports of non-native eggs were reduced significantly, and thereafter the Leavenworth, Entiat, and Winthrop NFHs have relied on adults returning to their facilities for their egg needs (Chapman et al. 1995). Regarding late-run Chinook, due to the variety of methods employed to collect broodstock at dams, hatcheries, or the result of juvenile introductions into various areas, Chinook populations and runs (i.e., summer and fall) have been mixed considerably in the upper Columbia system over the past five decades (reviewed in Chapman et al. 1994).

Washington Department of Fish and Wildlife (WDFW) operates two facilities producing spring-run Chinook, the Methow Fish Hatchery (MFH) owned by Douglas County PUD that began operation in 1992 and Eastbank Fish Hatchery (EFH) owned by Chelan County PUD that began operation in 1989. Both programs were designed to implement supplementation (supportive breeding) programs for naturally spawning populations on the Methow and Wenatchee Rivers, respectively (Chapman et al. 1995). As part of the Rock Island Mitigation Agreement between Chelan County Public Utility District and the fishery management parties (RISPA 1989), a supplementation (supportive breeding) program was initiated in 1989 on the Chiwawa River to mitigate smolt mortality resulting from the operation of Rock Island Hydroelectric Project. EFH uses broodstock collected at a weir on the Chiwawa River, although in recent years hatchery fish have been collected at Tumwater Dam. Similarly, the MFHC uses returning adults collected at weirs on the Methow River and its tributaries, the Twisp and Chewuch Rivers (Chapman et al. 1995; Bugert 1998). Although low run size and trap efficiency has resulted in most broodstock being collected from the hatchery outfall or in some years Wells Dam, progeny produced from these programs are reared at and released from satellite sites on the tributaries where the adults were collected. Numerous other facilities have reared spring-run Chinook salmon on an intermittent basis.

Previous Genetic Studies – Population differentiation

Waples et al. (1991a) examined 21 polymorphic allozyme loci in samples from 44 populations of Chinook salmon in the Columbia River Basin. These authors reported three major clusters of Columbia River Basin Chinook salmon: 1) Snake River spring- and summer-run Chinook salmon, and mid and upper Columbia River spring-run Chinook salmon, 2) Willamette River spring-run Chinook salmon, 3) mid and upper Columbia River fall- and summer-run Chinook salmon, Snake River fall-run Chinook salmon, and lower Columbia River fall- and spring-run Chinook salmon. Utter et al. (1995) examined allele frequency variability at 36 allozyme loci in samples of 16 upper Columbia River Chinook populations. Utter et al. (1995) indicated that spring-run populations were distinct from summer- and fall-run populations, where the average genetic distance between spring-run and late-run Chinook were about eight times the average of genetic distances between samples within each group. Additionally, allele frequency differences among spring-run populations were considerably greater than that among summer- and fall-run populations in the upper Columbia River. Utter et al. (1995) also reported hatchery populations of spring-run Chinook salmon were genetically distinct from natural spring-run populations, but hatchery populations of fall-run Chinook salmon were not genetically distinct from natural fall-run populations.

As part of an evaluation of the relative reproductive success for the Chiwawa River supplementation program, Murdoch et al. (2006), used eleven microsatellite loci to assess population differentiation among spring Chinook salmon population samples in the upper Wenatchee River. Murdoch et al. (2006) reported a >99% accuracy of correctly identifying spring-run and fall-run Chinook from the Wenatchee River. They also reported slight, but significantly different genetic variation among wild spring populations and between wild and hatchery stocks. Yet, since the spring-run populations are genetically similar, identifying individuals genetically from the upper tributaries of the Wenatchee River was difficult. This result is exemplified in their individual assignment results, where < 8% of spring-run individuals, hatchery or wild, were correctly assigned using their criterion of an LOD (log of odds) score greater than 2. Murdoch et al. (2006) also reported contemporary natural spring Chinook show heterozygote deficit and low linkage disequilibrium (LD), while contemporary hatchery spring Chinook show heterozygote excess and high LD.

Williamson et al. (submitted) have continued the work of Murdoch et al. (2006) by analyzing Chiwawa River demographic data from 1989 – 2005 to estimate the proportions of recruits that were produced by Chinook with hatchery or wild origin. In an "ideal" population, the genetic size (i.e., effective size or N_e) and the census size are equal; however various demographic factors such as unequal sex ratios and variance in reproductive success among individuals reduces the genetic size below the census size. It is generally thought that the genetic size is approximately 10-33% the census size (Bartley et al. 1992; RS Waples pers. comm.), although values have been reported outside this range (Araki et al. 2007; Arden and Kapuscinski 2003; Heath et al. 2002). Despite being difficult to estimate, the effective population size in many respects is a more important parameter to know than census size, because N_e determines how genetic diversity is distributed within populations and how the forces of evolution (i.e., forces that change genetic diversity over time) will affect the genetic variation present.

Williamson et al. (submitted) used demographic data to 1) investigate the effect of unequal sex ratio on genetic diversity, 2) investigate the effect of variation in reproductive success on genetic diversity, 3) investigate the effect of fluctuations in population size on genetic diversity, and 4) estimate the effective population size, using the inbreeding method (Ryman and Laikre 1991). Most importantly, they use demographic data from 1989 – 2000 to assess the impact of the Chiwawa Hatchery Supplementation Program on the effective population size of natural-origin Chiwawa River spring Chinook. They estimate that the N_e of naturally spawning Chiwawa Chinook (i.e., both hatchery- and wild-origin fish on the spawning grounds) from 1989 –

1992 was N_e = 2683 and in 1997 – 2000 was N_e = 989. They compare spawning ground N_e to estimates calculated from combined broodstock and naturally spawning Chinook demographic data. The combined inbreeding N_e estimate from 1989 – 1992 was N_e = 147 and in 1997 – 2000 was N_e = 490. Williamson et al. (submitted) argue that since the combined N_e estimate is lower than the naturally spawning estimate, the supplementation program has had a negative impact on the Chiwawa River N_e.

Williamson et al. (submitted) also present genetic data for Chinook recovered on spawning grounds in upper Wenatchee River tributaries in 2004 and 2005. These genetic data are derived from the Murdoch et al. (2006) study. They compare samples collected from Chiwawa River (i.e., hatchery and wild), White River, Nason Creek, and Leavenworth Hatchery. Additionally, they include a 1994 Chiwawa River wild smolt sample for comparison with the 2004 brood year. Williamson et al. (submitted) report statistically significant genetic differentiation among Chiwawa River, White River and Nason Creek. Additionally, they report that the 1994 and 2004 Chiwawa River wild samples are not statistically different, but the 2004 Chiwawa wild and hatchery collections are statistically different.

Study Objectives

This study investigated within and among population genetic diversity to assess the effect of the Chiwawa Hatchery's supplemental program on the natural Chiwawa River spring Chinook population. Differences among temporal population samples, the census size, heterozygosity, and allelic diversity were documented. We investigated population differentiation between the Chiwawa River natural and hatchery samples, and among all temporally replicated samples from the Wenatchee River watershed using microsatellite DNA allele frequencies and the statistical assignment of individual fish to specific populations. To assess the genetic effect of the hatchery program, correlation between census and effective population sizes were investigated using temporally replicated samples obtained before and after the supplementation program operation. To address the hypotheses associated with Objective 3 in Murdock and Peven (2005) we developed eleven specific "Tasks" (Blankenship and Murdoch 2006), to which we analyzed specific genetic data. We present the results from these analyses specific to each individual Task.

Methods and Materials

Tissue collection and DNA extraction

We analyzed thirty-two population collections of adult spring Chinook salmon (*Oncorhynchus tshawytscha*) obtained from the Wenatchee River between 1989 and 2006 (Table 1). Nine collections of natural Chinook adults from the Chiwawa River (n=501), and nine collections of Chiwawa Hatchery Chinook (n=595) were collected at a weir located in the lower Chiwawa River. The 1993 and 1994 Chiwawa Hatchery samples are smolt samples from the 1991 and 1992 hatchery brood years, respectively. Additional samples were collected from upper Wenatchee River tributaries, White River, Little Wenatchee River, and Nason Creek. Six collections of natural White River Chinook (n=179), one collection from the Little Wenatchee (n=19), and six collections from Nason Creek (n=268) were obtained. Single collections were obtained for Chinook spawning in the mainstem Wenatchee River and Leavenworth National Fish Hatchery. An additional out-of-basin collection from Entiat River was also included in the analysis. Samples collected in 1992 or earlier are scale samples. All other samples were either fin clips or operculum punches, stored immediately in ethanol after collection. DNA was extracted from stored tissue using Nucleospin 96 Tissue following the manufacturer's standard protocol (Macherey-Nagel, Easton, PA, U.S.A.).

Laboratory analysis

We performed polymerase chain reaction (PCR) amplification on each fish sample using the 13 fluorescently end-labeled microsatellite marker loci standardized as part of the GAPS project (Seeb et al. in review). GAPS genetic loci are: *Ogo*2, *Ogo*4 (Olsen et al. 1998); *Oki*100 (unpublished); *Omm*1080 (Rexroad et al. 2001); *Ots*201b (unpublished); *Ots*208b, *Ots*211, *Ots*212, and *Ots*213 (Grieg et al. 2003); *Ots*3M, *Ots*9 (Banks et al.

1999); *Ots*G474 (Williamson et al. 2002); *Ssa*408 (Cairney et al. 2000). PCR reaction volumes were 10 µL, and contained 1 µL 10x PCR buffer (Promega), 1.0 µL MgCl2 (1.5 mM final) (Promega), 0.2 µL 10 mM dNTP mix (Promega), and 0.1 units/mL Taq DNA polymerase (Promega). Loci were amplified as part of multiplexed sets, so primer molarities and annealing temperatures varied. Multiplex one had an annealing temperature of 50°C, and used 0.37 Molar (M) *Oki*100, 0.35 M *Ots*201b, and 0.20 M *Ots*208b, and 0.20 M *Ssa*408. Multiplex two had an annealing temperature of 63°C, and used 0.10 M *Ogo*2, and 0.25 M of a non-GAPS locus (*Ssa* 197). Multiplex three had an annealing temperature of 56°C, and used 0.18 M *Ogo*4, 0.18 M *Ots*213, and 0.16 M *Ots*G474. Multiplex four had an annealing temperature of 53°C, and used 0.26 M *Omm*1080, and 0.12 M *Ots*3M. Multiplex five had an annealing temperature of 60°C, and used 0.30 M *Ots*212, 0.20 M *Ots*211, and 0.10 M *Ots*9. Thermal cycling was conducted on either a PTC200 thermal cycler (MJ Research) or GeneAmp 9700 (Applied Biosystems) as follows: 95°C (2 min); 30 cycles of 95°C for 30 sec., 30 sec. annealing, and 72°C for 30 sec.; a final 72°C extension and then a 10°C hold. PCR products were visualized by electrophoresis on an ABI 3730 automated capillary analyzer (Applied Biosystems). Fragment analysis was completed using GeneMapper 3.7 (Applied Biosystems). Standardization of genetic data to GAPS allele standards was conducted following Seeb et al. (in review).

Genetic data analysis

Assessing within population genetic diversity - Heterozygosity measurements are reported using Nei's (1987) unbiased gene diversity formula (i.e., expected heterozygosity) and Hedrick's (1983) formula for observed heterozygosity. Both tests are implemented using the microsatellite toolkit (Park 2001). We used GENEPOP version 3.4 (Raymond and Rousset 1995) to assess Hardy-Weinberg equilibrium (HWE), where deviations from the neutral expectation of random associations among alleles are calculated using a Markov chain method (5000 iterations in this study) to obtain unbiased estimates of Fisher's exact test. Global estimates of F_{IS} according to Weir and Cockerham (1984) were calculated using GENEPOP version 3.4. Genotypic linkage disequilibrium was calculated following Weir (1979) using GENEPOP version 3.4.

Linkage results for population collections are reported as the proportion of pairwise (locus by locus) tests that are significant (alpha = 0.01). Linkage disequilibrium is considered statistically significant if more than 5% of the pairwise tests based on permutation are significant for a collection.

Within- and among-population genetic differentiation – The temporal stability of allele frequencies within populations, and pairwise differences in allele frequencies among populations were assessed using several different procedures. First, we tested for differences in allele frequencies among populations defined in Table 1 using a randomization chi-square test implemented in GENEPOP version 3.4 (Raymond and Rousset 1995). This procedure tests for differences between pairs of populations where alleles are randomized between the populations (i.e., genic test). The null hypothesis for this test is that the allele frequency distributions between two populations are the same. A low p-value should be interpreted as the allele frequency distributions being compared are unlikely to be samples drawn from the same underlying distribution.

Second, to graphically describe allele frequency differences among populations we conducted a nonmetric multidimensional scaling analysis using allele-sharing distance matrices from two different data sets. Pairwise allele-sharing distances are calculated as 1 – (mean over all loci of the sums of the minima of the relative frequencies of each allele common to a pair of populations). To calculate the allele-sharing distances for each pair of populations we used PowerMarker v3.25 (Liu and Muse 2005). Nonmetric multidimensional scaling is a technique designed to construct an n-dimensional "map" of populations, given a set of pairwise distances between populations (Manly 1986). The output from this analysis is a set of coordinates along n-axes, with the coordinates specific to the number of n-dimensions selected. To simplify our analysis we selected a 2-dimensional analysis to represent the relative positions of each population in a typical bivariate plot. The goodness of fit between the original allele-sharing distances and the pairwise distances between all populations along the 2-dimensional plot is measured by a "stress" statistic. Kruskal (in Rohlf 2002) developed a five-tier guide for evaluating stress levels, ranging from a perfect fit (stress=0) to a poor fit (stress=0.40). We conducted the nonmetric multidimensional scaling analysis for one data set containing Chiwawa natural- and hatchery-origin collections, and another data set containing Chiwawa broodstock and in-river spawner collections. We used the mdscale module in MATLAB R2006b (The Mathworks 2006) to generate the nonmetric multidimensional scaling coordinates.

We examined the geographic and temporal structure of populations in the upper Wenatchee (Chiwawa River, Nason Creek, and White River, only) using a series of analyses of molecular variance (AMOVAs). Here, we defined an AMOVA as an analysis of variance of allele frequencies, as originally designed by Cockerham (1969), but implemented in Arlequin v2.1 (Schneider et al. 2000). These analyses permit populations to be aggregated into groups, and molecular variance is then partitioned into within collections, among collections, but within groups, and among group components. With this approach, we were able to determine how best to group populations, with "best" being defined as that grouping that accounts for the greatest proportion of among group variance. Furthermore, by partitioning molecular variance into three different hierarchical components, we are able to determine what level accounts for the majority of the molecular variance.

Finally, we explored the partitioning of molecular variance between among-individuals and among-populations using a principal component analysis and multi-locus estimates of pairwise F_{ST}, estimated by a "weighted" analysis of variance (Weir and Cockerham, 1984). Principal component analysis is a data-reduction technique whereby the correlation structure among variables can be used to combine variables into a series of multivariate components, with each original variable receiving a weighted value for each component based on its correlation with that component. Here, we used a program written by Warheit in MATLAB R2006b (The Mathworks 2006) that treats each allele for each locus as a single variable (13 loci = 26 alleles or variables), and these 26 "variables" were arranged into 26 components, with each component accounting for a decreasing amount of molecular variance. Estimates of F_{ST} were calculated using GENETIX version 4.05 (Belkhir et al.1996). To determine if the F_{ST} estimates were statistically different from random (i.e., no structure), 1000 permutations were implemented in GENETIX version 4.05 (Belkhir et al.1996).

Effective population size (N_e) – Estimates of the effective population size were obtained using two methods, a multi-collection temporal method (Waples 1990), and a single-collection method (Waples 2006) using linkage disequilibrium data. The temporal method assumes that cohorts are used, but we did not decompose the collection year samples into their respective cohorts using age data. Therefore, N_e estimates that pertain to individual year classes of breeders are not valid; however the harmonic mean over all samples will estimate the contemporary N_e. Comparing samples from years *i* and *j*, Waples' (1990) temporal method estimates the effective number of breeders ($\hat{N}_{b(i,j)}$) according to:

$$\hat{N}_{b(i,j)} = \frac{b}{2(\hat{F} - 1/\hat{S}_{i,j})}$$

The standardized variance in allele frequency ($\hat{F}$) is calculated according to Pollack (1983). The parameter b is calculated analytically from age structure information and the number of years between samples (Tajima 1992). The age-at-maturity information required to calculate b was obtained from Murdoch et al. (2006) for this analysis. They observed for Chiwawa Hatchery Chinook that 8.6% matured at age 2, 4% at age 3, 87% at age 4, and 0.4% at age 5. For Chiwawa natural Chinook, Murdoch et al. (2006) observed that 1.8% matured at age 3, 81.6% at age 4, and 16.7% at age 5. The harmonic mean of sample sizes from years *i* and *j* is $\tilde{S}_{i,j}$. Over all pairwise comparisons the harmonic mean of all $\hat{N}_{b(i,j)}$ is $\tilde{N}_b$, the contemporary estimate of the effective population size (N_e). SALMONNb (Waples et al. 2007) was used to calculate $\tilde{N}_b$. As suggested by authors, alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

The method of Waples (2006) uses linkage disequilibrium (i.e., mean squared correlation of allele frequencies at different gene loci) as a means of estimating effective population size (N_e) from a single sample. While this method is biased in some cases where N_e /N ratio is less the 0.1 and the sample size is less than the true N_e, it has been shown to produce comparable results to the temporal method. Burrows' delta method is used to estimate LD, and a bias corrected estimate of N_e is calculated after eliminating alleles with frequency less than 0.05. This test was implemented using LDN$_e$ (Do and Waples unpublished). In age-structured species, N_e estimates based on LD are best interpreted as the effective number of breeders (N_b) that produced the sample (Waples 2006). N_b should be multiplied by the mean generation length (i.e., 4 in this case) to obtain an overall estimate of N_e based on an N_b estimate. We analyzed collections categorized by spawning location (i.e., hatchery broodstock or in-river) and did not analyze collections categorized by origin (i.e., hatchery or natural). Waples' (2006) method estimates N_e from observed LD, therefore the corresponding N_e estimates for the hatchery collections would be low and the estimates for the natural collections would be high. Yet, since the supplementation program is integrated, and hatchery fish can spawn naturally, we feel it inappropriate to analyze the hatchery and natural samples as if they were separate, which would essentially partition all the LD into the hatchery samples.

Each collection has an N_b estimate and an associated confidence interval. If the confidence interval includes infinity, it means that sampling error accounts for all the LD observed (i.e., empirical LD is less than expected LD). The usual interpretation is that there is no evidence for any disequilibrium caused by genetic drift in a finite number of parents. Since the LD method estimates the number of breeders that contributed to the sample being analyzed, in order to calculate an N_e /N ratio, the appropriate census size must be used. The census size used to derive a ratio was the estimate four years prior to the collection analyzed using LD, which assumed a strict four-year-old lifecycle, although the observed proportion of four-year-olds was approximately 85% each year. The census numbers (Table 2) used to calculate the ratios for Chiwawa broodstock and in-river spawners were combined NOS (natural-origin spawners) and HOS (hatchery-origin spawners) census estimates.

Individual assignment – A population baseline file was constructed containing all 1704 individual Chinook from 34 population collections (Table 1; Chiwawa origin data set plus all samples from other populations). All individuals in the baseline had geneotypes that included nine or more loci. Individual Chinook were assigned to their most likely population of origin based on the partial Bayesian criteria of Rannala and Mountain (1997), using a "jack-knife" procedure, where each individual to be assigned was removed from the baseline prior to the calculation of population likelihoods. This procedure was implemented in a program written by Warheit in MATLAB R2006b (The Mathworks 2006). Two assignment criteria were used, 1) the population with the largest posterior probability for an individual was the "most-likely" population of origin (i.e., all individuals assigned to a collection), and 2) an assignment was consider valid only if the posterior probability was greater than or equal to 0.9. Please note that while the analysis used 34 population collections to assign Rannala and Mountain likelihoods for each individual, these likelihoods were aggregated based on "population" (i.e., Chiwawa, Nason, White, and so on) and posterior probabilities were calculated for population location, rather than individual collections.

Results and Discussion

In this section we combine our presentation and interpretations of the genetic analyses. Additionally, this section will be organized based on the task list presented in the study plan. Overall conclusions are provided following this section.

<u>Task 1:</u> Determine trend in census size for Chiwawa River spring Chinook.

Census data from 1989 – 2005 are provided in Table 2 for the Chiwawa Hatchery broodstock and spring Chinook present in the Chiwawa River. The demographic data for naturally spawning Chinook are based on redd sampling and carcass surveys, while broodstock data are based on Chiwawa hatchery records. As the supplementation program is integrated by design, we also present the proportion of natural-origin broodstock (pNOB) incorporated into the hatchery, in addition to the number of natural-origin (NOS) and hatchery-origin (HOS) spawners present in Chiwawa River. The census size fluctuated yearly, and a general reduction in census size was observed in the mid to late 1990's. This trend was apparent in both the broodstock and in the river. The arithmetic mean census size from 1989 – 2005 for the Chiwawa Hatchery (i.e., broodstock) was N=87.5 per year. The arithmetic mean census size from 1989 – 2005 for the Chiwawa River (i.e., NOS and HOS combined) was N=961.9 per year. For collection years when adult Chiwawa hatchery-origin fish would have been absent in the Chiwawa River (1989 – 1992), the arithmetic mean of natural Chiwawa Chinook census size is N=962.7. We will use this number as the baseline census size to assess if census size has changed. We used two different values for the contemporary census size in the Chiwawa River, NOS only and NOS + HOS. Additionally, we used collection years 2002 – 2005 for the contemporary NOS and HOS estimates, as these are the most recent data and the number of years included for estimation is the same as the pre-hatchery estimate above (i.e., four years). For NOS only, the arithmetic mean census size from 2002 – 2005 was N=536.0. For total census size (i.e., NOS and HOS combined), the arithmetic mean census size from 2002 – 2005 was N=1324.0. For the demographic data presented here, the contemporary census size is larger than the census estimate derived from the years prior to hatchery operation.

<u>Task 2:</u> Document the observed genetic diversity.

Genetic Diversity Categorized By Origin

For Chiwawa River collections categorized by origin (Table 1A), substantial genetic diversity was observed, with heterozygosity estimates over all loci, having a mean of 0.80. Genetic diversity was consistent with expected Hardy-Weinberg random mating genotypic proportions for ten of the eighteen collections. Eight of the nine Chiwawa natural collections were consistent with HWE, and two of nine Chiwawa Hatchery collections were consistent with HWE. F_{IS} is observed to be slight for all Chiwawa population collections, suggesting individuals within collections do not show excessive homozygosity.

The deviations from HWE observed were generally associated with hatchery collections. The two smolt collections (i.e., 1993 and 1994) showed significant deviations from HWE, which may be a function of non-random hatchery practices involving the contributing natural-origin parental broodstocks (i.e., 1991 and 1992 cohort). Deviations from HWE in the remaining hatchery collections may be the result of few individuals being represented in the broodstock (see below).

Additionally, linkage disequilibrium (LD) was also common for Chiwawa hatchery-origin collections and minimal for Chiwawa natural-origin collections. The random association of alleles between loci (i.e., linkage equilibrium) is expected under ideal conditions. LD is observed when particular genotypes are encountered more than expected by chance. Laboratory artifacts (e.g. null alleles) or physical linkage of loci on the same chromosome can cause LD, but the LD we observed was not associated with certain locus combinations, which you would expect if either artifacts or physical linkage were the cause of LD. LD was observed for seven of the nine hatchery-origin collections. As with the deviations from HWE, the high LD in the 1993 and 1994 hatchery-origin collections may be a result of non-random hatchery practices. The substantial LD observed in the hatchery-origin adult collections (collection years 2000, 2001, 2004, and 2006) might be the result of small parental broodstock sizes contributing to those returning adults. During the mid 1990's, the Chiwawa broodstock size was low, with zero individuals collected in 1995 and 1999; so fewer individuals would be contributing to the hatchery adult returns than the natural. This idea is corroborated by the lower LD observed for the 2005 hatchery-origin collection, which had a contributing parental broodstock size in 2001 (i.e., the major contributing parental generation) approximately eight times as large as the previous few collection years (Table 2). LD reappears in the 2006 Chiwawa hatchery-origin collection, which had a contributing parental broodstock size (i.e., for the most-part, the 2002 hatchery brood year) five times lower (Table 2) than that of the 2005 collection.

While seven of nine hatchery-origin collections showed significant LD, only one natural origin collection showed LD, and for this collection, only 10% of the loci-pairs were in disequilibrium (Table 1). The fact that LD predominated in the hatchery samples, suggests that variance in reproductive success (i.e., overrepresentation of particular parents) is higher in the hatchery-origin than in natural-origin collections.

Genetic Diversity Categorized By Spawning Location

For upper Wenatchee River collections categorized by spawning location (Table 1B), substantial genetic diversity was observed, with heterozygosity estimates over all loci, having a mean of 0.79 and ranging from a low of 0.69 (1993 White River) to 0.85 (1993 Little Wenatchee). Genetic diversity was consistent with HWE for nineteen of twenty-nine population collections. For the collections that departed from HWE, seven were from the Chiwawa River, one was from Leavenworth Hatchery, one was the Wenatchee mainstem collection of hatchery-origin – naturally spawning fish, and one was from the White River. F_{IS} is observed to be slight for all population collections except the 1993 White River collection (10% heterozygote deficit) (Table 1B). Collections deviating with HWE generally correlated with collections having high LD. Twelve population collections showed a proportion of pairwise linkage disequilibrium tests (across all loci) greater than 5% (Table 1B), eight of which were Chiwawa collections.

Starting in 1996, spawning location collections are composed of both natural- and hatchery-origin samples. The LD seen in the later spawning location collections may be caused by an admixing effect (i.e., mixing two populations), where random mating has not had the chance to freely associate alleles into genotypes. Interestingly, there appears to be a trend of reducing LD through time within the broodstock collections (Table 1B), which suggests that a "homogenizing" effect is taking place within the Chiwawa River. This observation is discussed more fully in Task 3 below.

Task 3: Test for population differentiation among collections within the Chiwawa River and associated supplementation program.

Introduction

Task 3 was designed to address two hypotheses listed as part of Objective 3 in Murdoch and Peven (2005):

- Ho: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop}}$.
- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Murdoch and Peven (2005) proposed these two hypotheses to help evaluate the Chiwawa supplementation program through the "Conceptual Process" (Figure 5 in Murdoch and Peven 2005; repeated here as Figure 1). There are two components to the first hypothesis, which must be considered separately. The first component involves comparisons between natural-origin populations in the Chiwawa to determine if there have been changes in allele frequencies or genetic distances, through time starting with the donor population. Documenting a change does not necessarily indicate that the supplementation program has directly affected the natural origin fish, as additional tests would be necessary to support that hypothesis. The intent of the second component is to determine if the hatchery produced populations have the same genetic composition as the naturally produced populations.

Although on the surface these two components and their associated comparisons may appear simple, from a hypothesis-testing perspective the analyses are complicated by the fact that natural-origin fish may have had hatchery-origin parents, and hatchery-origin fish may have had natural-origin parents. As such, we organized the Chiwawa genetic data into three data sets: (1) fish origin (hatchery versus natural), (2) spawning location (hatchery broodstock versus in-river (natural) spawners), and (3) four "treatment" groups (1. hatchery-origin hatchery broodstock, 2. hatchery-origin natural spawner, 3. natural-origin natural spawner, and 4. natural-origin hatchery broodstock). We conducted separate analyses using each of the three data sets, with each analysis touching on some aspect of the components necessary to move through the Conceptual Process (Figure 1).

Hatchery- Versus Natural-Origin

We address the following questions with the origin data set:

1. Are there changes in allele frequencies and allele sharing distances in the natural-origin collections from pre-supplementation to today?
2. Are there changes in allele frequencies and allele sharing distances in the hatchery-origin collections from early supplementation to today?
3. Are there significant differences in allele frequencies and large allele sharing distances between hatchery- and natural-origin adults from a collection year, and has this pattern changed through time?

Genic Differentiation Tests – We explicitly tested the hypothesis of no significant differentiation within natural- or hatchery-origin collections from the Chiwawa River using a randomization chi-square test. We show the results for the pairwise comparisons among natural-origin collections from the Chiwawa River populations in the first block of the second page of Table 3. Ten of the 36 (28%) pairwise comparisons have highly significant allele frequency differences, while only 12 of the 36 comparisons (33%) showed no significant differences. Eight of these 12 comparisons involved the 1996 collection, which included only eight samples and therefore provided little power to differentiate allele frequencies. If we exclude the 1996 collection, only 14% of the pairwise comparisons showed no significant differences, and here all but one of these comparisons involved the 1989 collection. The 1989 collection appeared to be the least differentiated collection in the natural-origin data set in that all pairwise comparisons were either not significant, or only mildly significant at the nominal critical value. No comparisons involving the 1989 collection were significant using a Bonferroni-corrected critical value, and 1989 is the only natural-origin collection in our data set that can be classified as "pre-supplementation."

We can interpret these results to indicate that although there appears to be significant year-to-year differences in allele frequencies among post-supplementation collections, the allele frequencies between each post-supplementation collection and the 1989 pre-supplementation collection are not greatly different. However, the level of differentiation does increase from the early post-supplementation years to the more recent years (2001, 2004-2006), although the statistical level of this significance never exceeds the Bonferroni-corrected critical value. Finally, sample sizes were also small for the 1989 collection (n = 36) and we cannot eliminate a reduction in power as a contributing factor for the lack of significance for these tests.

As with the hatchery-origin collections, most pairwise comparisons of allele frequencies between hatchery-origin samples were significant (Table 3, first page, upper block). Out of the 36 pairwise comparisons, all but three are significant at some level, and most comparisons are highly significant. Similar to the natural-origin analysis, the non-significant results were limited to comparisons involving the 1996, which included only eight samples.

As a result of this analysis *we reject the hypothesis that there was no significant differentiation among natural- or hatchery-origin collections from the Chiwawa River*. Furthermore, the allele frequencies of the hatchery-origin collections are significantly different from those of natural-origin collections (Table 3, first page, second block). For those fish collected in the same year, allele frequencies are significantly different between hatchery- and natural-origin collections, although in 2005 the level of significance was below the Bonferroni critical value (Table 3). The next step is to examine the pattern of allelic differentiation to discover first if there is a trend among the data, and second, if this trend suggests that the allele frequency differences among Chiwawa River natural-origin fish collections has been affected by the hatchery-origin fish.

Allele-sharing and Nonmetric Multidimensional Scaling – We constructed a pairwise allele-sharing distance matrix for all hatchery- and natural-origin collections from the Chiwawa River and subjected this matrix to a nonmetric multidimensional scaling analysis, restricting the analysis to two dimensions (Figure 2). The stress statistic for this analysis is 0.09, a value Kruskal (in Rohlf 2002) listed as a good to excellent fit between the actual allele-sharing distances and the Euclidean (straight-line) distances in the plot.

In other words, Figure 2 is a good visual representation of the allele sharing distance matrix; collections with a high percentage of alleles shared will be closer to each other than collections with a lower percentage of alleles shared.

With the exception of the two outlier years (1996 and 1998) the Chiwawa natural-origin collections form a tight cluster indicating an overall common set of shared alleles among these collections. Even if we ignore the 1996 and 1998 hatchery-origin collections, there appears to be a greater variance in shared alleles among the Chiwawa hatchery-origin collections than the natural-origin collections (Figure 2). In fact, the median percentage of alleles shared among the Chiwawa natural-origin collections is 76% compared with 69% alleles shared among the Chiwawa hatchery-origin collections.

Also, there appears to be a convergence in allele sharing distances (i.e., a decrease in allele frequency differences) between the hatchery- and natural-origin fish from the late 1980s/early 1990s to 2006. The series of red arrows in Figure 2 represent the progression of change in hatchery-origin allele sharing distances from 1996 (first adult hatchery origin fish in our analysis) to 2006 and this progression is decidedly in the direction of the natural-origin cluster. However, the most recent natural-origin collections (2001, 2004-2006) appear to have pulled closer to the hatchery-origin collections, compared with the 1989 natural-origin collection (note the close proximity of the 2000 and 1989 natural-origin collections). Nevertheless, the cluster of natural-origin collections adjacent to the hatchery-origin collections in Figure 2 also includes the 1993 natural-origin collection. Qualitatively, it appears that the initial hatchery-origin and natural-origin collections were more different from each other in terms of the percentage of shared alleles than are the most recent hatchery- and natural-origin collections. This may have been a result of a non-random sample of natural-origin fish that was used as broodstock in the initial years of the supplementation program (see discussion in Task 2 concerning deviations from HWE and linkage disequilibrium).

That being said, we do need to emphasize that Figure 2 is dominated by five outlier collections (two each from the 1996 and 1998 collections, and the 1994 smolt collection).

The 1996 and 1998 collections are characterized by small samples sizes, and the 1994 smolt collection has nearly all pairs of loci in linkage disequilibrium (Table 1). If we eliminate these five outlier groups, both the hatchery- and natural-origin collections form a relatively tight cluster. Excluding the five outliers, the median percentage of shared alleles among all pairwise combinations of Chiwawa hatchery versus Chiwawa natural collections is 76%. This compares with a median pairwise percentage of 79% among only Chiwawa natural-origin collections. That is, there are nearly as many alleles shared between the hatchery-origin and natural-origin collections as there are among the natural-origin collections themselves. There is also a narrowing of differences between natural- and hatchery-origin fish from the same collection years from 1993 (76% shared alleles) through 2006 (83% shared alleles).

If allelic differentiation among collections is a function of genetic drift, we would expect a positive correlation between the number of years between two collections and the allele sharing distance. That is, if genetic drift is the primary cause of allele frequency differences between two collections, the greater the number of years between the two collections the larger the allele-sharing distance. For both the natural- and hatchery-origin collections we examined the relationship between the number of years between a pair of collections and the collections' allele-sharing distance (Figure 3). Although the relationship between time interval and allele distance appears to be a positive function in the natural collections, the slope of the regression line is 0.0017, and is not significantly different from zero. Furthermore, the correlation coefficient (r^2) equals 0.1068, which means that the time interval between collections accounts for only 10% of the pairwise differences in allelic distance. The hatchery-origin collections do show a significantly positive slope (0.0037; $p = 0.0254$) and a regression coefficient nearly three times greater than that for the natural-origin collections. However, the correlation coefficient is still relatively small ($r^2 = 0.3290$), indicating that the time interval between collections accounts for one-third of the pairwise differences in allelic distance. The results suggest that if genetic drift is a factor in allelic differentiation between collections, it is only a minor factor, and appears to have affected the hatchery-origin collections more than the natural-origin collections.

If four-year-old fish dominate each collection year, we would expect a closer relationship among collections that are spaced at intervals of four years. The average percentage of alleles shared between two natural-origin collections that are separated by four years or a multiple of four years is 81%, compared with 78% for natural-origin collections separated by years that are not divisible by four. Likewise, for hatchery-origin collections the average percentage of alleles shared is 80% and 75% for collections separated by years divisible and not divisible by four, respectively. Although the percent differences described above are relatively small, they are consistent with the idea that allelic differences between collections are a function of year-to-year variability among different cohorts of four year-old fish.

Summary – The allele frequencies within and between natural- and hatchery-origin collections are significantly different, but there does not appear to be a robust signal indicating that the recent natural-origin collections have diverged greatly from the pre- or early post-supplementation collections. Genetic drift will occur in all populations, but does not appear to be a major factor with the Chiwawa collections. We propose that the differences among collections are a function of differences in allele frequencies among cohorts of the four year-old fish that dominate each collection.

Hatchery Broodstock Versus Natural (In-River) Spawners

We address the following questions with the spawner data set:

1. Are there changes in allele frequencies and allele sharing distances in the natural spawning collections from pre-supplementation to today?
2. Are there changes in allele frequencies and allele sharing distances in the hatchery broodstock collections from early supplementation to today?
3. Are there significant differences in allele frequencies and large allele sharing distances between hatchery and natural spawning adults from a collection year, and has this pattern changed through time?

Genic Differentiation Tests – For the most part there are significant differences in allele frequencies among collections for both the hatchery broodstock and natural spawners (Table 4), and these differences are consistent with the origin data set (Table 3). There are four collection years with paired samples (2001, 2004-2006) where we can compare allele frequency differences between the hatchery broodstock and natural spawners, within the same year. The 2001 hatchery broodstock and natural spawner collections have significantly different allele frequencies, but the level of significance decreased from 2001 to 2004, and become non-significant in 2005 and 2006 (Table 4). This indicates that by 2005, the hatchery broodstock and natural spawners collections were effectively sampling from the same population of fish. Additionally, the percentage of alleles shared between the hatchery broodstock and the natural spawners increased from 76% in 2001 to 86% in 2006 (allele sharing distance matrix, not shown). From this analysis, we conclude that although there are year-to-year differences in allele frequencies within the natural and hatchery spawner collections, *there appears to be a convergence of allele frequencies within collection-year, between the natural and hatchery spawner populations*.

Linkage Disequilibrium – Linkage disequilibrium is the correlation of alleles between two loci, and can occur for several reasons. If two loci are physically linked on the same chromosome, than alleles from each of these loci should be correlated. However, linkage between two loci can occur as a result of population bottlenecks, small population sizes, and natural selection. If any of these conditions had occurred or were occurring within the Chiwawa River system, we would expect to find substantial linkage disequilibrium in many or perhaps all Chiwawa collections. However, many Chiwawa collections, especially the natural-origin collections, do not show linkage disequilibrium (Table 1), and it would appear that the linkage disequilibrium within certain Chiwawa collections is not a function of the processes listed above. Linkage disequilibrium can also result if the collection is composed of an admixture. That is, if two or more reproductively isolated populations are combined into a single collection, the collection will show linkage disequilibrium. Each broodstock and natural spawning collection is composed of natural- and hatchery-origin fish. If these hatchery- and natural-origin fish are drawn from the same population, the spawning collections should not show substantial linkage disequilibrium. However, if the hatchery- and natural-origin fish are from different populations (i.e., full hatchery – natural integration has not been achieved), the spawning collections should show substantial linkage disequilibrium.

There are only three Chiwawa spawning collections that are not composed of both hatchery- and natural-origin samples: 1989 (natural-origin, natural spawner), 1993 (natural-origin, hatchery broodstock), and 2001 (natural-origin, natural spawner). Of the 10 spawning collections with both hatchery- and natural-origin fish, seven show significant linkage disequilibrium. Two of the three collections that did not show linkage disequilibrium are the 1996 and 1998 hatchery broodstock collections, which are composed of only seven natural- and six hatchery-origin fish, and two natural- and 19 hatchery-origin fish, respectively. Within the hatchery broodstock collections with linkage disequilibrium, the percent of loci pairs showing linkage decreased from 32% in 2000 to 13% in 2001 and 2004, to only 1% and 5% in 2005 and 2006, respectively (Table 1). If the homogenization of allele frequencies of natural- and hatchery-origin fish was increasing from 2000 to 2006, we would expect a decrease in linkage disequilibrium among the broodstock collections. This is what occurred within the hatchery broodstock collections, but did not occur within the natural spawner collections, where the percent of loci pairs showing linkage was 18% in 2004, 6% in 2005, and 10% in 2006 (Table 1). Furthermore, the 2001 natural spawner collection, with no hatchery-origin component showed linkage disequilibrium with 9% of loci pairs.

There is no correlation between percent of loci pairs showing linkage disequilibrium and percent of broodstock composed of hatchery-origin fish ($r^2 = 0.0045$). Furthermore, the natural spawner and hatchery broodstock collections were each composed of roughly the same average percentage of hatchery-origin fish (57% and 53%, respectively). If the decrease in linkage disequilibrium among the hatchery broodstock collections from 2000 to 2006 was a result of a homogenization of allele frequencies of natural- and hatchery-origin fish in the broodstock, the same degree of homogenization did not occur within the natural spawner collections. This would occur if natural- and hatchery-origin fish spawning within the river remain segregated, either by habitat or by fish behavior.

Summary – As with the origin data set, there are significant allele frequency differences within and between hatchery broodstock and natural spawner collections. However, in recent years the allele frequency differences between the hatchery broodstock and natural spawner collections has declined. Furthermore, based on linkage disequilibrium, there is a genetic signal that is consistent with increasing homogenization of allele frequencies within hatchery broodstock collections, but a similar homogenization within the natural spawner collection is not apparent. These data suggest that there exists consistent year-to-year variation in allele frequencies among hatchery and natural spawning collections, but there is a trend toward homogenization of the allele frequencies of the natural- and hatchery-origin fish that compose the hatchery broodstock.

Four Treatment Groups

Analyses of genetic differences between hatchery (broodstock) and natural spawner collections is confounded by the fact that each these two groups are composed of fish of natural- and hatchery-origin. To understand the effects of hatchery supplementation on *natural-origin fish that spawn naturally*, we needed to divide the Chiwawa data set into four mutually exclusive groups: (1) hatchery-origin hatchery broodstock, (2) hatchery-origin natural spawner, (3) natural-origin hatchery broodstock, and (4) natural-origin natural spawner, with each group consisting of multiple collection years, for a total of 25 different groups.

Allele-sharing and Nonmetric Multidimensional Scaling –As with previous analyses discussed above, we constructed a pairwise allele-sharing distance matrix for all collections from each of these treatment groups and subjected this matrix to a nonmetric multidimensional scaling analysis, restricting the analysis to two dimensions. Figure 4 shows that five outlier groups dominate the allele-sharing distances within this data set. These outlier groups are also present in Figure 2, as discussed above, and Figure 2 and 4 resemble each other because the same fish are included in each analysis. The difference between Figures 2 and 4 is that in Figure 4 the fish are grouped into collection year and the four treatment groups, rather than collection year and two treatment groups (hatchery- versus natural-origin).

Figure 4 does not provide useful resolution of the groups within the polygon, because the outlier groups dominate the allele sharing distances. We removed the five outlier groups from Figure 4, recalculated the allele sharing distances and subjected this new matrix to a multidimensional scaling analysis (Figure 5). Figure 5 shows separation among the 2001, 2004-2006 collections, but this separation does not necessarily indicate that within-year collections are more similar to each other than any collection is to a collection from another year. For example, the 2006 natural-origin natural spawner and the 2005 natural-origin hatchery broodstock collections share 81% alleles, while the 2006 natural-origin natural spawner and 2006 hatchery-origin hatchery broodstock collections share 75% alleles. There does not appear to be any discernable pattern of change in allele-sharing distance among the collections relevant to pre- or post-supplementation. Although the 1989 pre-supplementation natural-origin collection appears distinct (Figure 5), the 1993 natural-origin hatchery broodstock collection appears quite similar to the 2005 and 2006 natural-origin collections (Figure 5). The 1993 natural-origin hatchery broodstock collection, although not technically pre-supplementation, is composed of fish whose ancestry cannot be traced to any Chiwawa hatchery fish. Therefore, there is no clear pattern of allele sharing change from pre-supplementation to recent collections.

There does appear to be some change in the average percentage of alleles shared within the 2001 to 2006 collections, with an increase from 74% in 2001 and 2004 to 78% and 79% in 2005 and 2006, respectively. The results provided by this analysis are consistent with the results presented in the origin and spawner data sets. That is, there are allele frequency and allele sharing differences among the collections, but analyses do not strongly suggest that these differences are a function of the supplementation program. Furthermore, there is also a weak signal that the hatchery and natural collections within the most recent years are more similar to each other than in the previous years.

Overall Genetic Variance – Although there are signals of allelic differentiation among Chiwawa River collections, there are no robust signs that these collections are substantially different from each other. We used two different analyses to measure the degree of genetic variation that exists among individuals and collections within the Chiwawa River. First, we conducted a principal component analysis using all Chiwawa samples with complete genotypes (i.e., no missing alleles from any locus). Although the first two principal component axes account for only 10.5% of the total molecular variance, a substantially greater portion of that variance is among individual fish, regardless of their identity, rather than among hatchery and natural collections (Figure 6). The variances in principal component scores among individuals are 11 and 13 times greater than the variance in scores among collections, along the first and second axes, respectively.

Second, we conducted a series of analyses of molecular variance (AMOVA) to ascertain the percentage of molecular variance that could be attributed to differences among collections. We organized these analyses to test also for differences in the hierarchical structure of the data. That is, we tested for differences among collections using the following framework:

- No organizational structure – all 25 origin-spawner collections considered separately
- Origin-spawner collections organized into 10 collection year groups
- Origin-spawner collections organized into 2 breeding location groups (hatchery versus natural)
- Origin-spawner collections organized into 2 origin groups (hatchery versus natural)
- Origin-spawner collections organized into the 4 origin-spawner groups

It is clear from this analysis that nearly all molecular variation, no matter how the data are organized, resides within a collection (Table 5). The percentage of total molecular variance occurring within collections ranged from 99.68% to 99.74%. The among group variance component was limited to less than 0.26% and in all organizational structures, except "no structure," the among group percentage was not significantly greater than zero. Furthermore, none of the organizational structures provided better resolution than "no structure" in terms of accounting for molecular variance within the data set. *These results indicate that if there are significant differences among collections of Chiwawa fish, these differences account for less than one percent of the total molecular variance, and these differences cannot be attributed to fish origin or spawning location.*

Summary and Conclusions

We reject the null hypothesis that the allele frequencies of the hatchery collections equal the allele frequencies of the natural collections, which equals the allele frequency of the donor population. Furthermore, because the allele-sharing distances are not consistent within and among collections years, we also reject the second stated hypothesis discussed above. However, there is an extremely small amount of genetic variance that can be attributed to among collection differences. The allelic differentiation that does exist among collections does not appear to be a function of fish origin, spawning location, genetic drift, or collection year. Figure 5 and related statistics does suggest that hatchery and natural collections in 2005 and 2006 are more similar to each other than previous years' collections, and this would be expected in a successful integrated hatchery supplementation program.

Since each of these collection years are generally composed of four-year-old fish, the differentiation among these collections for the most part is differentiation among specific cohorts. The slightly greater percentage of alleles shared among collections that are separated in time by multiples of four years, compared with collections that are not separated in time as such, suggests that cohort differences may be the most important factor accounting for differences in allele frequencies among collections.

<u>Task 4:</u> Develop a model of genetic drift.

See Task 3

Task 5: Analyze spring Chinook population samples from the Chiwawa River and Chiwawa Hatchery from multiple generations.

See Task 3

Task 6: Analyze among population differences for upper Wenatchee spring Chinook.

Supplementation of the Chiwawa River spring Chinook population may affect populations within the Wenatchee River watershed other than the Chiwawa River stock. If the stray rate for Chiwawa hatchery-origin fish is greater than that for natural-origin fish, an increase in gene flow from the Chiwawa population into other populations may result. If this gene flow is high enough, Chiwawa River fish may alter the genetic structure of these other populations. Records from field observations indicate that hatchery-origin fish are present in all major spawning aggregates (A.R Murdoch, unpublished data), and these fish are successfully reproducing (Blankenship et al 2006). The intent of this task is to investigate if there have been changes to the genetic structure of the spring Chinook stocks within upper Wenatchee tributaries during the past 15-20 years, and if changes have occurred, are they a function of the Chiwawa River Supplementation Program? Therefore, we ask the following two questions:

1. Are allele frequencies within populations in the upper Wenatchee stable through time? That is, is there significant allelic differentiation among collections within upper Wenatchee populations?
2. Are the recent collections from the upper Wenatchee populations more similar to the Chiwawa population than earlier collections from the same populations?

For this task we analyzed natural spawning collections from the White River (natural-origin), Little Wenatchee River (natural-origin), Nason Creek (natural-origin), and

Wenatchee mainstem (hatchery-origin), and hatchery collections from Leavenworth NFH and Entiat River NFH (Table 1). We also included in the analysis the natural- and hatchery-origin collections from the Chiwawa River. There are no repeated collections from Leavenworth, Entiat, Little Wenatchee, and Wenatchee mainstem (Table 1), so for many of the analyses we have limited our discussion to the Chiwawa River, White River, and Nason Creek collections. Furthermore, genetic structure of the Little Wenatchee collection, which consisted of only 19 samples, was unexpectedly quite different from the other collections. For example, the F_{ST} statistic measures the percent of total molecular variation that can be attributed to differences between populations. The median F_{ST} for all pairwise combinations of collections from all populations, except Little Wenatchee (33 populations, 528 individual F_{ST} statistics) equals 0.010 (1%), with a range of 0.000 to 0.037 (Table 6). The median F_{ST} for the Little Wenatchee paired with all other collections (33 individual F_{ST} statistics) equals 0.106 (10.6%), with a range of 0.074 to 0.121. The ten-fold increase in the F_{ST} statistic indicates that either the Little Wenatchee spring Chinook is unique among the upper Wenatchee River stocks, or this 1993 collection is somehow aberrant. Therefore, we exclude the Little Wenatchee collection from many other analyses.

Population Differentiation – Table 3 provides the levels of significance for all pairwise genic differentiation tests. Most between-collection comparisons are highly significant, with no pattern of increasing or decreasing differentiation with time, and no differences when comparisons are made with Chiwawa hatchery- versus Chiwawa natural-origin fish. For example, excluding the outlier 1996 and 1998 Chiwawa hatchery- and natural-origin collections, Nason Creek showed highly significant allele frequency differences between the Chiwawa hatchery- and natural-origin collections at 100% and 86% of the comparisons, respectively. The same comparisons with the White River produced 100% and 93% highly significant allele frequency comparisons, respectively. Allele frequencies between Nason Creek and White River were likewise differentiated from each other.

The collection allele frequencies within the upper Wenatchee system are significantly different, and these differences do not appear to change as a function of time (Table 3). Nason Creek shows greater within-population year-to-year variation in allele frequencies than does the White River, with 47% of the pairwise comparisons showing highly significant differences, compared with only 13% for the White River. However, the 2005 and 2006 collections from the White River appear to be somewhat more differentiated from not only each other, but from the earlier collections from the White River.

Despite the high degree of temporal and spatial structure suggested by the genic differentiation tests, as described above for within-Chiwawa analysis (Task 3), most of the genetic variation within this data set occurs within populations, rather than between populations (Table 6). The F_{ST} values for most population comparisons are between 0.01 and 0.02, indicating 1% to 2% among-population variance, with the remaining 98% to 99% variance occurring within populations. The White River shows the highest median F_{ST} among the natural-origin collections, equal to 0.014, compared with 0.009 for both the Nason Creek and Chiwawa natural-origin collections. The median F_{ST} for the Chiwawa hatchery-origin collections (0.012) was higher than that for the Chiwawa natural-origin collections.

Table 7 summarizes the information from the F_{ST} analyses, under five different temporal and spatial scenarios. Under all scenarios, over 99% of the molecular variance is within populations. There is significantly greater spatial structure among populations ("Origin") in 2005 and 2006 than from 1989 to 1996. That is, there appears to be more spatial structure among the Chiwawa hatchery-origin, Chiwawa natural-origin, White River, and Nason Creek now, than in 1989 to 1996, despite the potential homogenizing and cumulative effect of hatchery strays. However, we stress that the amount of molecular variance associated with the among population differences, despite being significantly greater than 0.00%, is limited to only 0.43%.

Allele-sharing and Nonmetric Multidimensional Scaling – As in the Chiwawa River data discussed above, we constructed an allele-sharing distance matrix and then subjected that matrix to a multidimensional scaling analysis (Figure 7). Consistent with all previously discussed multidimensional scaling analyses, the 1996 and 1998 adult, and the 1994 smolt collections are outliers. There is clear separation between the White River collections and all other natural-origin and Chiwawa hatchery-origin collections, indicating that there are more alleles shared among the Nason Creek and Chiwawa collections, than with the White River collections. Furthermore, there is a slight separation between the Chiwawa natural-origin natural spawner collections and Nason Creek collections, suggesting different groups of shared alleles between these populations. There is more variation in the allele-sharing distances among collections involved with the Chiwawa hatchery (origin or broodstock) than any of the natural-origin collections, even if we exclude the 1994, 1996, and 1998 collections. This suggests that there is more year-to-year variation in the composition of hatchery-origin and hatchery broodstock than within natural-origin populations throughout the upper Wenatchee. All Wenatchee mainstem fish are hatchery-origin, and if these fish are from the Chiwawa Supplementation Program (rather than from Leavenworth), it is not unexpected that this collection would be plotted within the Chiwawa polygon (Figure 7).

Assignment of Individual to Populations – Finally, we conducted individual assignment tests whereby we assigned each individual fish to a population, based on a procedure developed by Rannala and Mountain (1997) (Table 8 and 9). Individual fish may be correctly assigned to the population from which they were collected, or incorrectly assigned to a different population. Incorrect assignments may occur if the fish is an actual migrant (i.e., source population different from population where collected), or because the genotype for that fish matches more closely with a population different from its source. If there are many individuals from a population incorrectly assigned to populations other than its source population, that original population is either unreal (i.e., an admixture), or there is considerable gene flow between that population and other populations. Furthermore, in assigning individuals to populations, we can either accept the assignment with the highest probability, regardless of how low that probability may be, or we can establish a more stringent criterion, such as to not accept an assignment unless the posterior probability is equal to or greater than 0.90. This value is roughly equal to having the likelihood of the most-likely population equal to 10 times that of the second most-likely population.

We provide a summary of the assignments in Tables 8 and 9. On average, nearly 50% of the fish are assigned incorrectly if we accept all assignments (Table 8), but the incorrect assignment rate drops to roughly 10% when we accept only those assignments with probabilities greater than 0.90. However, with this more stringent criterion, nearly 64% of the fish go unassigned. These results indicate that the allele frequency distributions for these populations are very similar, and it would be very difficult to assign an individual fish of unknown origin to the correct population. If all fish are assigned, there is a 50% chance, overall, of a correct assignment. If you accept only those assignment with the 0.90 criterion, nearly two-thirds of the fish would be unassigned, but there is a 90% chance of correctly assigning those fish that are indeed assigned.

Of all the populations in the data set, there are fewer errors associated with assigning fish to the White River. If all fish are assigned (Table 8), 72% of those fish assigned to the White River, are actually from the White River (115 fish out of a total of 159 fish assigned to the White River). This compares to a rate of only 52% and 53% for Nason Creek and Chiwawa natural-origin, respectively, and 60% for the Chiwawa hatchery-origin collections. With the 0.90 criterion (Table 9), 89% of the fish assigned to the White River, are actually from the White River, compared with 70% and 65% for Nason Creek and Chiwawa natural origin, respectively, and 81% for the Chiwawa hatchery origin.

When all fish are assigned, most of the incorrectly assigned fish from Nason Creek and White River are assigned to Chiwawa River, at roughly equal frequencies to the hatchery- and natural-origin populations. Incorrectly assigned fish to other populations occur at a slightly higher rate in Nason Creek than in the White River. However, when only those fish meeting the 0.90 criterion are assigned (Table 9), incorrectly assigned fish from Nason Creek are distributed among White and Chiwawa Rivers, as well as Leavenworth NFH, and the Entiat NFH. Mis-assignment to the Chiwawa hatchery-origin was the highest among the Nason Creek collections, equal to nearly 14%. This contrasts with the White River where mis-assignments do not exceed 7% anywhere, and there is a roughly even distribution of mis-assignments among Nason Creek and Chiwawa River collections.

Summary and Conclusions – There is little geographic or temporal structure among populations within the upper Wenatchee systems. Among population molecular variance is limited to 1% or less. The little variance that can be attributed to among populations indicates that the White River is more differentiated from the Chiwawa and Nason populations than these populations are from each other. Furthermore, although we cannot rule out a hatchery effect on the Nason Creek and White River populations, there is no indication there has been any temporal changes in allele frequencies within these populations that can be attributed directly to the Chiwawa River Supplementation Program. In fact, Table 7 weakly suggests that there is more differentiation among these populations now, than there was before or at the early stages of Chiwawa supplementation.

Therefore, returning to our two original questions, there are significant differences in allele frequencies among collections within populations, and among populations within the upper Wenatchee spring Chinook stocks. However, these differences account for a very small portion of the overall molecular variance, and these populations overall are very similar to each other. There is no evidence that the Chiwawa River Supplementation Program has changed the allele frequencies in the Nason Creek and White River populations, despite the presence of hatchery-origin fish in both these systems. Finally, of all the populations within the Wenatchee River, the White River appears to be the most distinct. Yet, this distinction is more a matter of detail than of large significance, as the median F_{ST} between White River collections and all other collections (except the Little Wenatchee) is less than 1.5% among population variance.

Task 7: Calculate the inbreeding effective population size using demographic data for each sample year, and document the ratio of census to effective size.

This analysis was completed by Williamson et al. (submitted).

Task 8: Calculate LD N_b using genetic data for each sample year, and document the ratio of census to effective size.

We report N_e estimated for the Chiwawa River collections based on the bias correction method of Waples (2006) implemented in LDNe (Do and Waples unpublished). N_e estimates based on LD are best interpreted as the effective number of breeders (N_b) that produced the sample (Waples 2006).

For collections categorized by spawning location (i.e., hatchery broodstock or natural), estimates of N_b are shown in Table 10. Considering the hatchery broodstock, N_b estimates range from 30.4 (1996) to 274.3 (2005). To obtain N_e /N ratios, the N_b estimate is multiplied by four (i.e., mean generation length) and divided by the total in river (i.e., NOS [natural-origin spawners] plus HOS [hatchery-origin spawners]) census data from four years prior (i.e., major cohort; see Table 2). The observed N_e /N ratios for the broodstock collections range from 11% to 54% of the census estimate, excluding the 2000 collection which is 106%. A ratio greater than one is possible under special circumstances, and certain artificial mating schemes within hatcheries can inflate N_e above N; yet, it is unknown if this is the case for this collection. While no direct comparisons are possible, the N_b estimates reported by Williamson et al. (submitted) for Chiwawa broodstock collections from 2000 – 2003 are similar in magnitude to our estimates. For Chiwawa natural spawner collections, the N_b estimates range from 5.2 (1989) to 231.5 (2005), with observed N_e /N ratios of 22% - 48% of the census estimate.

Task 9: Calculate N_b using the temporal method for multiple samples from the same location.

Estimates of effective number of breeders (N_b) derived from Waples' (1990) temporal method are shown in Tables 11-13. Eight collection years were used for the Chiwawa broodstock collections (Table 11). The harmonic mean of all pairwise estimates of N_b ($\tilde{N}_b$) was 269.4. This estimate is the contemporary N_e for Chiwawa broodstock collections. For the five collection years of Chiwawa in-river spawners (Table 12), the estimated $\tilde{N}_b = 224.2$. This estimate is the contemporary N_e for Chiwawa River natural spawner collections. Since the Chiwawa Supplementation Program is integrated by design, we also performed another estimation of N_e using composite hatchery and natural samples. There are paired samples from 2004-2006. We combined genetic data for hatchery (HOS) and natural (NOS) origin fish from 2004 – 2006 to create a single Chiwawa River natural spawner sample for each year. The three composite samples from 2004 – 2006 were then analyzed using the temporal method (Table 13), resulting in a $\tilde{N}_b = 386.8$. This estimate is the contemporary N_e for Chiwawa River.

Williamson et al. (submitted) estimated N_e using Waples' (1990) temporal method for Chinook captured in 2004 and 2005, and used age data to decompose brood years into consecutive cohorts from 2000 – 2003. They report for Chiwawa broodstock a $\tilde{N}_b = 50.4$. This estimate is not similar to our Chiwawa broodstock estimate. However, if we analyze the hatchery-origin Chinook only, our estimate is $\tilde{N}_b = 80.1$ for collection years 1989 – 2006 (data not shown). Williamson et al. (submitted) report for Chiwawa naturally spawning Chinook a $\tilde{N}_b = 242.7$, which is slightly higher than our estimate for in-river spawners from 1989 – 2006, but lower than our estimate from combined NOS and HOS Chinook from 2004 – 2006 collection years.

Task 10: Use available data and the Ryman-Laikre and Wang-Ryman models to determine the expected change of N_e for natural spring Chinook salmon in the Wenatchee River due to hatchery operation.

N_e is generally thought to be between 0.10 and 0.33 of the estimated census size (Bartley et al. 1992; RS Waples pers. comm.). We used this range to generate an estimate of N_e for Chiwawa natural spawners prior to hatchery operation. For brood years 1989 – 1992, the arithmetic mean census size was N=962.7 (Table 2), resulting in an estimated N_e ranging from 96.3 – 317.7. The contemporary estimate of N_e calculated using genetic data for the Chiwawa in-river spawners is N_e=224.2 (Table 12), falling in the middle of the pre-hatchery range. The N_e /N ratio calculated using 224.2 and the arithmetic census of NOS Chinook from 1989 – 2005 is 0.42. A more appropriate contemporary N_e to compare with the pre-hatchery estimate (i.e., 96.3 – 317.7) is the combined NOS and HOS estimate from natural spawners, since the supplementation program is integrated. As discussed above, the contemporary estimate of N_e calculated using genetic data for Chiwawa NOS and HOS Chinook is N_e=386.8 (Table 13), which is slightly larger than the pre-hatchery range, suggesting the N_e has not declined during the period of hatchery operation. The N_e /N ratio calculated using 386.8 and the arithmetic census of NOS and HOS Chinook from 1989 – 2005 is 0.40. These results suggest the Chiwawa Hatchery Supplementation Program has not resulted in a smaller N_e for the natural spawners from the Chiwawa River.

Williamson et al. (submitted) argued that since their combined (i.e., broodstock and natural) N_e estimate was lower than the naturally spawning estimate, the supplementation program likely had a negative impact on the Chiwawa River N_e. We disagree with this interpretation of these data. Since the natural spawning component is mixed hatchery and natural ancestry, the N_e estimates from natural spawning data are the results that bear on possible hatchery impacts. The census data show the population declined in the mid 1990's and rebounded by 2000 (Table 2). This trend is reflected in the N_e results, as shown above, and Williamson et al. (submitted) clearly show in their Table 4 the N_e was lower in 2000 (N_e = 989) than it was in 1992 (N_e = 2683). Yet, the important comparison they make in our view was the natural spawning N_e versus the natural only component N_e (i.e., hypothetically excluding hatchery program). Williamson et al. (submitted) report the 1989 – 1992 N_e estimated from naturally spawning Chinook (i.e., NOS and HOS integrated) was essentially the same as the natural only component estimate, 2683 and 2776, respectively. This result is not surprising since no HOS fish were present between 1989 – 1992. They also report that the 1997 – 2000 N_e estimated from naturally spawning Chinook (i.e., NOS and HOS integrated) was N_e =989, while the natural-origin estimate of N_e in 1997 – 2000 was N_e = 629. Since the natural-origin estimate of 629 is lower than 989, the N_e estimate from all in-river spawners, we argue that their analysis of demographic data show the N_e estimated from naturally spawning Chinook (i.e., NOS and HOS integrated) is larger only if the hatchery Chinook in the river are ignored.

Task 11: Use individual assignment methods to determine the power of self-assignment for upper Wenatchee River tributaries.

See "Assignment of Individual to Populations" in Task 6

Conclusions

Has the Chiwawa Hatchery Supplementation Program succeeded at increasing the census size of the target population while leaving genetic integrity intact? This is an important question, as hatcheries can impact natural populations by reducing overall genetic diversity (Ryman and Laikre 1991), reducing the fitness of the natural populations through relaxation of selection or inadvertent positive selection of traits advantageous in the hatchery (Ford 2002; Lynch and O'Hely 2001), and by reducing the reproductive success of natural populations (McLean et al. 2003). The census data presented here show that the current natural spawning census size is similar to the pre-supplementation census size. Despite large numbers of hatchery-origin fish on the Chiwawa River spawning grounds, the genetic diversity of the natural-origin collections appear unaffected by the supplementation program; heterozygosities are high, and contemporary N_e is similar (perhaps slightly higher) than pre-supplementation N_e. We did find significant year-to-year differences in allele frequencies in both the origin and spawner datasets, but these differences do not appear to be related to fish origin, spawning area, or genetic drift. However, we do suggest that cohort differences may be the most important factor accounting for differences in allele frequencies among collections.

The main objective of this study was to determine the potential impacts of the hatchery program on natural spring Chinook in the upper Wenatchee system. We did this by analyzing temporally replicated collections from the Chiwawa River, and by comparing genetic diversity prior to the presumed effect of the Chiwawa Hatchery Supplementation Program, with contemporary collections. We report that the genetic diversity present in the Chiwawa River is unchanged (allowing for differences among cohorts) from 1989 – 2006, and the contemporary estimate of the effective population size (N_e) using genetic data is approximately the same as the N_e estimate extrapolated from 1989 – 1992 census data (i.e., pre-hatchery collection years). We observed substantial genetic diversity, with heterozygosities ~80% over thirteen microsatellite markers. Yet, temporal variation in allele frequencies was the norm among temporal collections from the same populations (i.e., location). The genetic differentiation of replicated collections from the same population is likely the result of salmon life history in this area, as four-year-old Chinook comprise a majority of returns each year. The genetic tests are detecting the differences of contributing parents for each cohort. An important point related to the temporal variation, is that the hatchery broodstock is composed in part of the natural origin Chinook from the Chiwawa River. When we compared the genetic data (within a collection year) for Chinook brought into the hatchery as broodstock with the Chinook that remained in the river (years 2001, 2004 – 2006), there was a trend of decreasing statistical differences in allele frequencies from 2001 to 2004, and no differences were detected for 2005 and 2006. While the replicated collections may have detectable differences in allele frequencies, those differences reflect actual differences in cohorts, not the result of hatchery operations, and the hatchery broodstock collection method captures the differences in returning Chiwawa River spring adults each year. We conclude from these results that the genetic diversity of natural spring Chiwawa Chinook has been maintained during the Chiwawa Hatchery Supplementation Program.

We observe slight, but statistically significant population differentiation between Chiwawa River, White River, and Nason Creek collections. Murdoch et al (2006) and Williamson et al. (submitted) also observed population differentiation between Chiwawa River, White River, and Nason Creek collections. Yet, 99.3% of the genetic variation observed was within samples, very little variance could be attributed to population differences (i.e., population structure). The AMOVA analysis and poor individual assignment results suggest the occurrence of gene flow among Wenatchee River locations or a very recent divergence of these groups. While Murdoch et al. 2006 did not perform an AMOVA analysis, their F_{ST} results provide comparable data to our among-population results. Murdoch et al. 2006 report F_{ST} ranging from 2%-3% for pairwise comparisons between of Chiwawa, White, and Nason River collections. Since F_{ST} is an estimate of among-sample variance, these results also imply a majority of the genetic variance (i.e., 97%-98%) resides within collections. To provide further context for the magnitude of these variance estimates, we present the among-group data from Murdoch et al. 2006 comparing summer-run and spring-run Chinook from the Wenatchee River. They report that approximately 91% of observed genetic variance is within-collection for comparisons between collections of summer- and spring-run Chinook. Ultimately, the information provided by this and other reports will be incorporated into the management process for Wenatchee River Chinook. However, we would like to emphasize that the application of these genetic data to management is more about the goals related to the distribution of genetic diversity in the future than specific data values reported. If Chinook are collected at Tumwater Dam instead of within the upper Wenatchee River tributaries, a vast majority of the genetic variation present in the basin would be captured, although any differences among tributaries would be mixed. Alternatively, management policies could be crafted to promote and maintain the among-group genetic diversity that genetic studies consistently observe to be non-zero within the Wenatchee River.

We agree with Murdoch et al. (2006) that it appears hatchery Chinook are not contributing to reproduction in proportion to their abundance. Additionally, if the total census size (i.e., NOS and HOS combined) within the Chiwawa River does not continue to increase, genetic diversity may decline within this system, given the smaller N_e within the hatchery-origin collections compared with the natural-origin collections.

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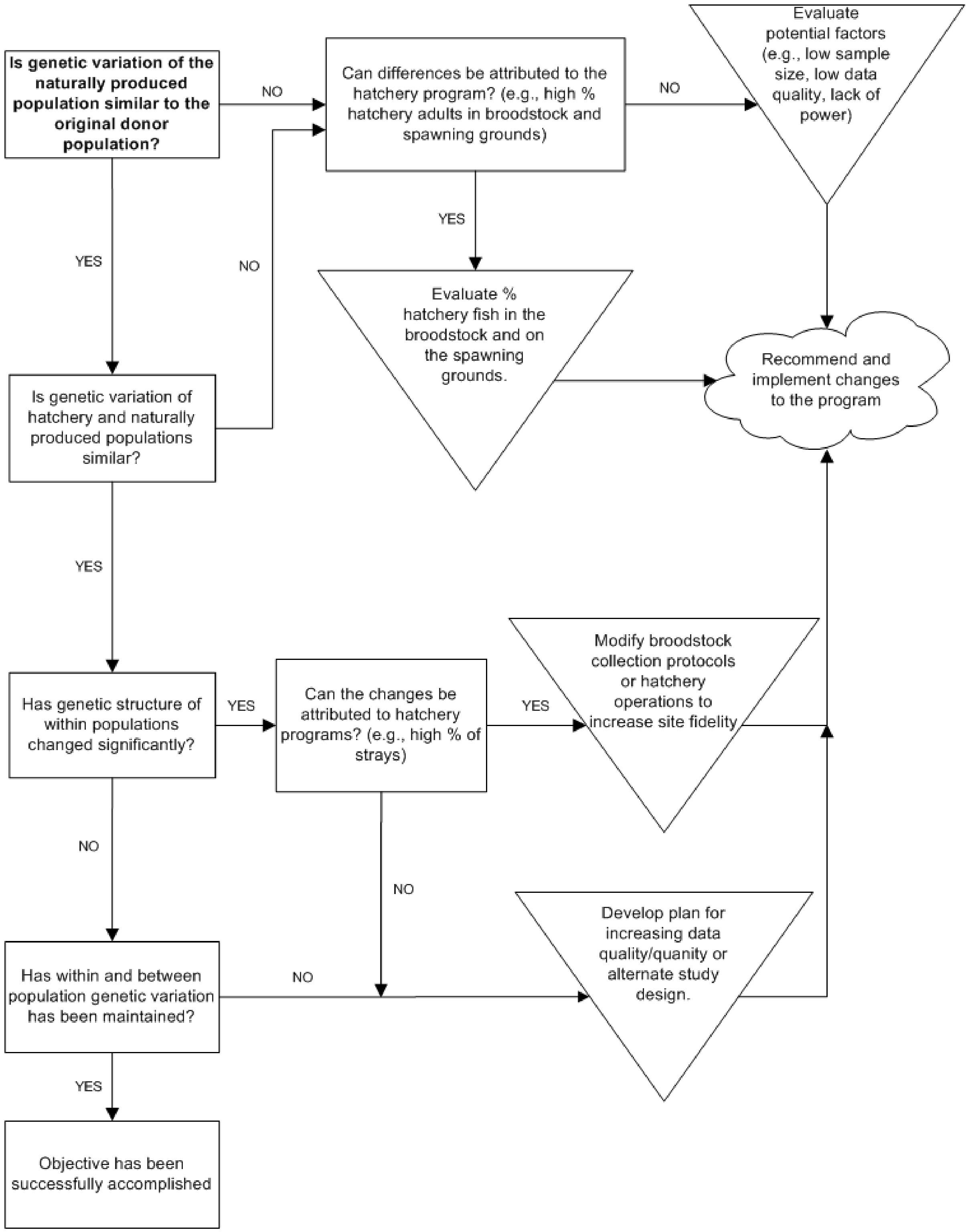

Figure 1. Conceptual process for evaluating potential changes in genetic variation in the Chiwawa naturally produced populations as a result of the supplementation hatchery programs (From Murdoch and Peven 2005).

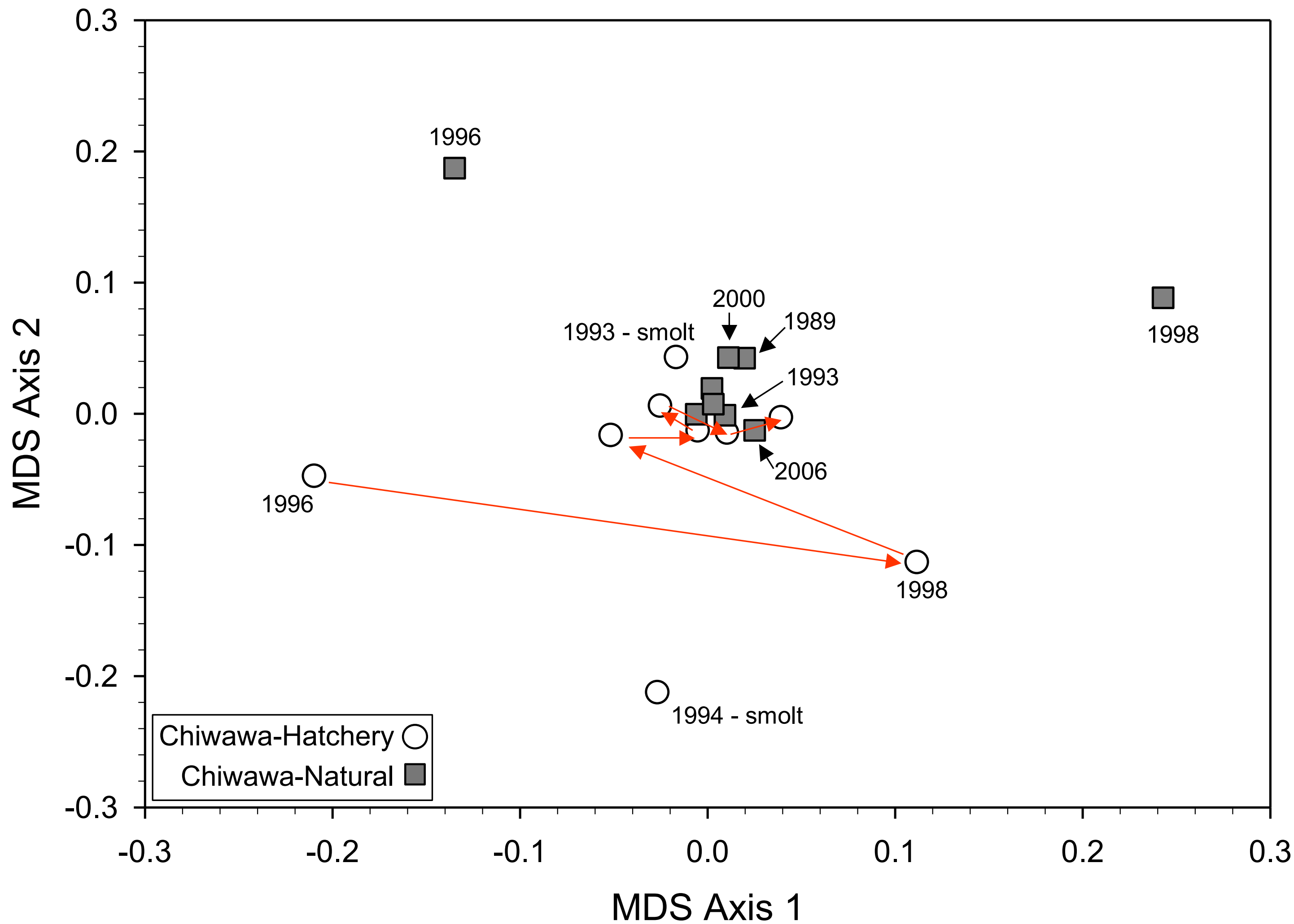

Figure 2. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa data set organized by fish origin (i.e., hatchery versus natural). The red arrows connect consecutive hatchery-origin collections starting with the first adult collection (1996) and ending with the 2006 collection (see Table 1 for collection years).

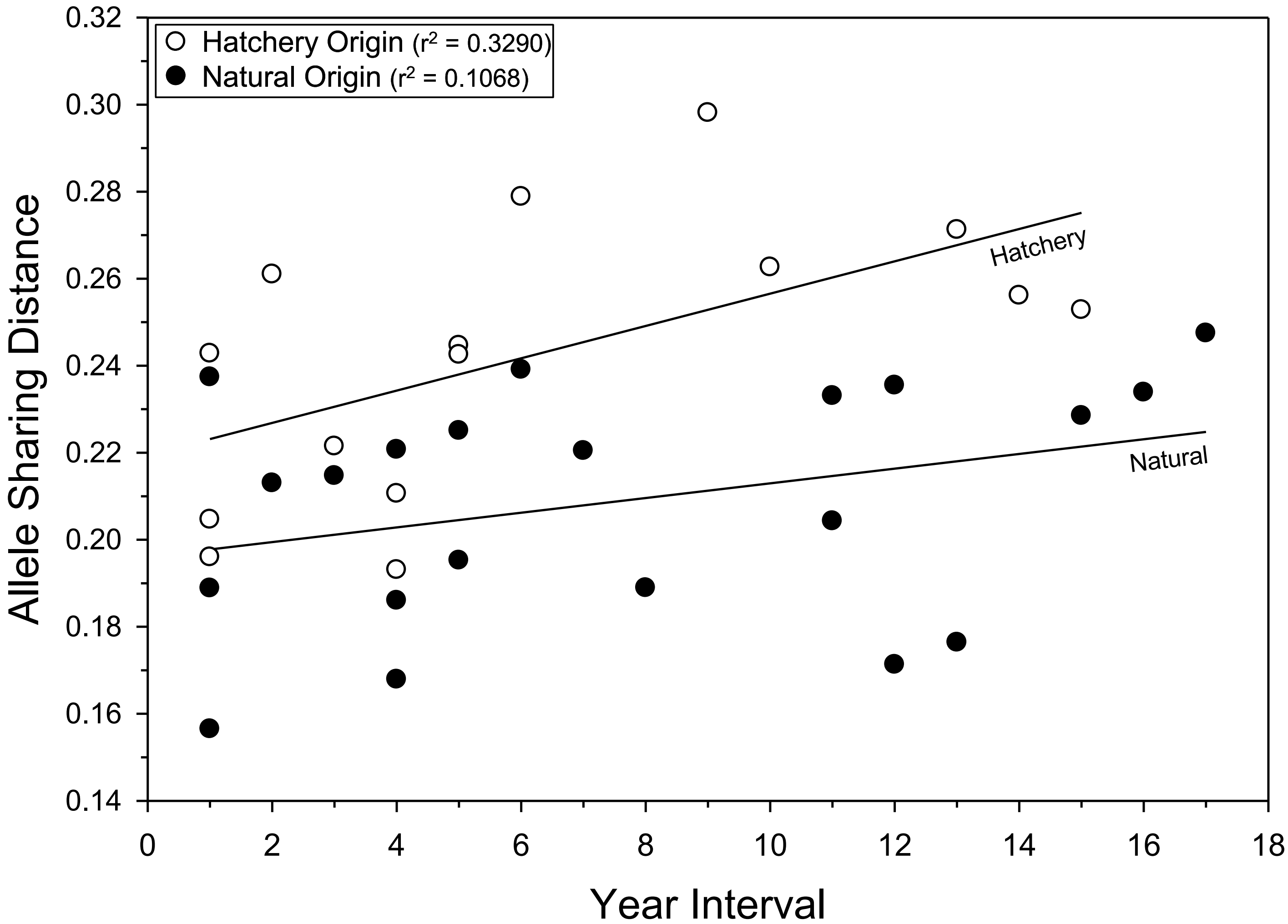

Figure 3. Relationships between the time interval in years and allele sharing distances, with each circle representing the pairwise relationship between two Chiwawa collections. Separate regression lines for the natural- and hatchery-origin collections. The slope for the natural-origin collection is not significantly different from zero (p=0.1483), while the slope for hatchery-origin collection is significantly greater than zero (p=0.0254) indicating a positive relationship between time interval and allele sharing distance.

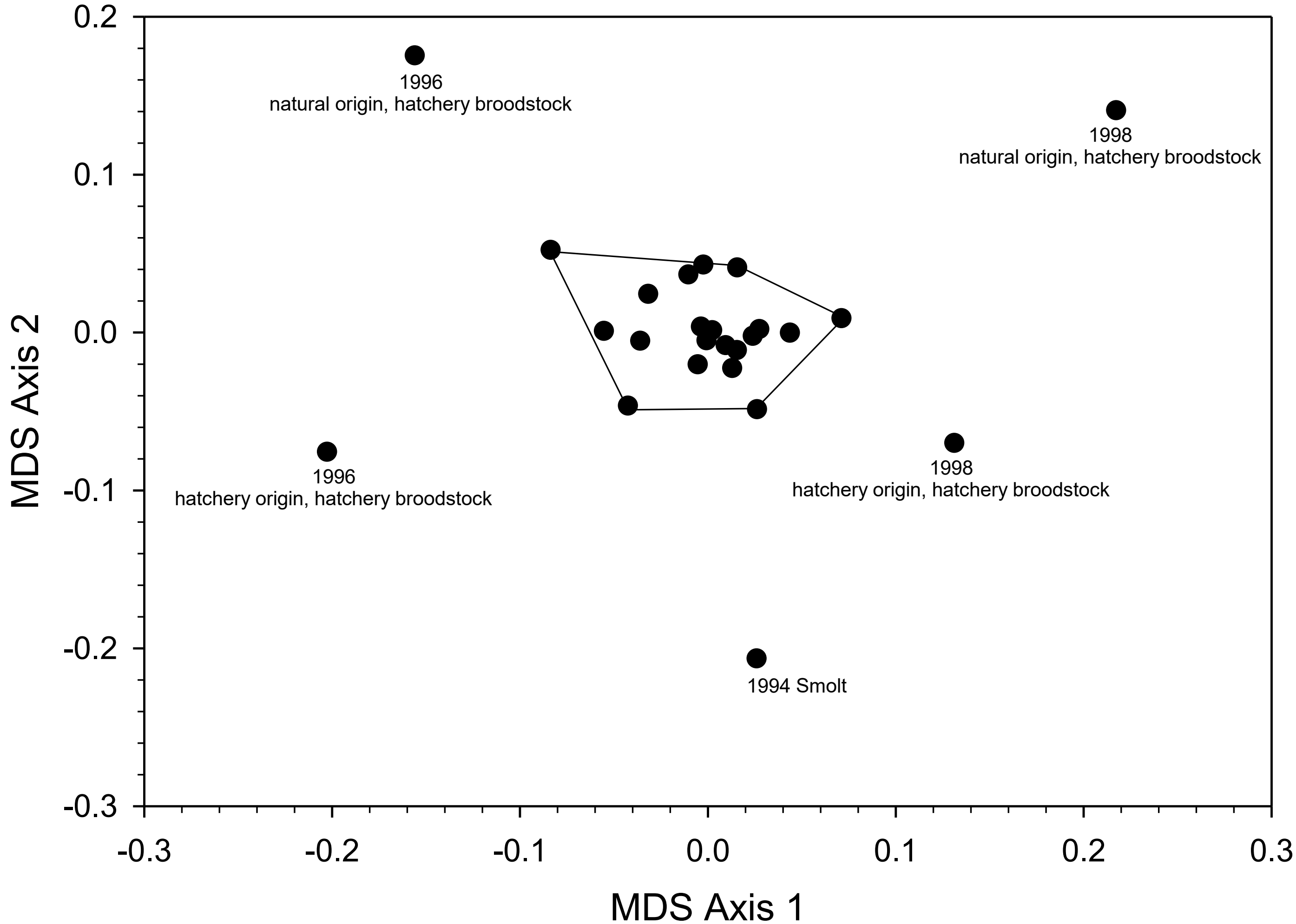

Figure 4. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa data set organized by four treatment groups, as discussed in the text. Each circle represents a single collection within each of the four treatment groups, and the polygon encloses all groups that are not outliers. Each outlier group is specifically labeled.

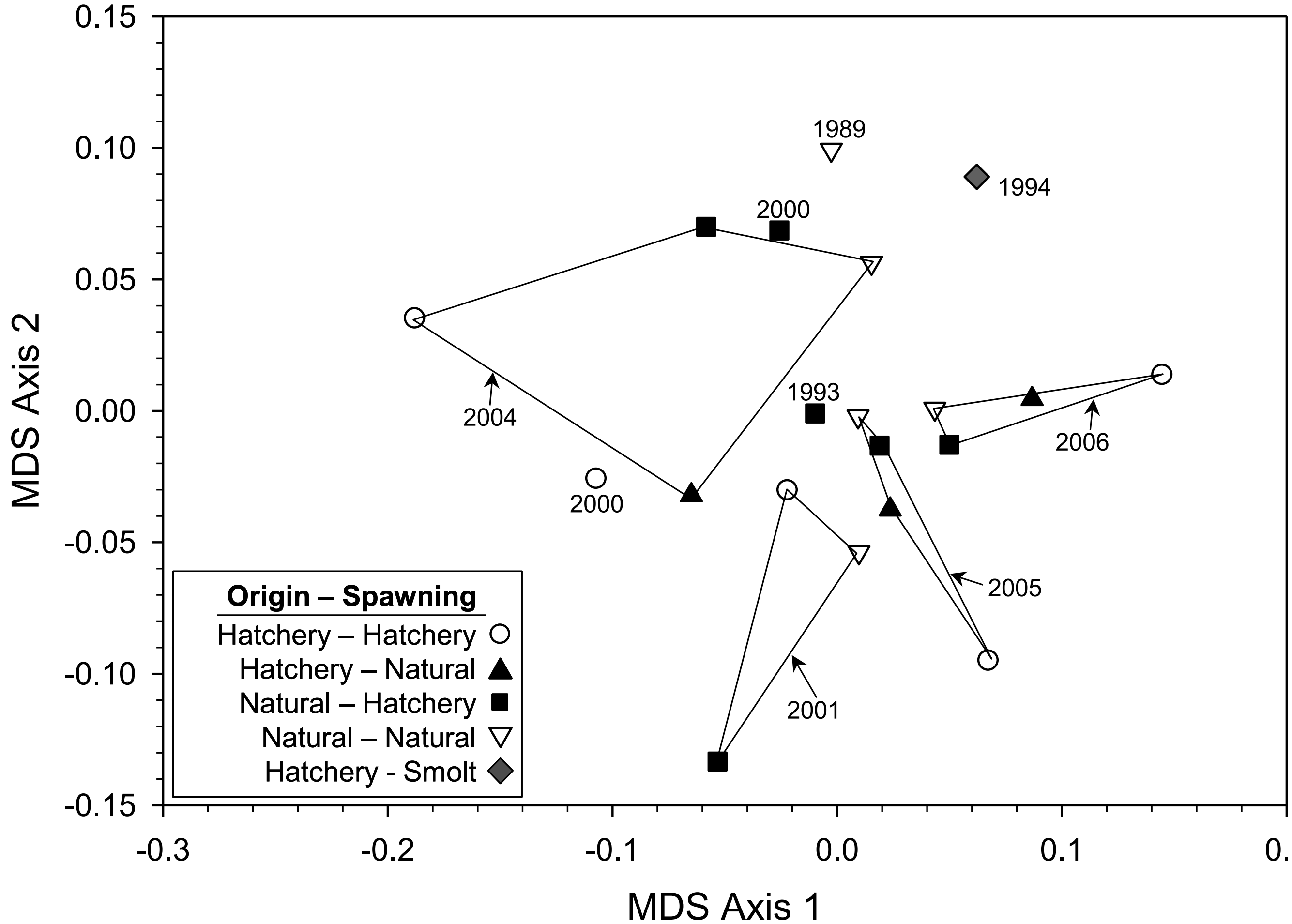

Figure 5. As in Figure 4, but allele-sharing distance matrix recalculated without the five outlier groups shown in Figure 4. Polygons group together treatment groups from the same collection year. Dates associated with symbols also refer to collection year. Collection years 2004-2006 included all four treatment groups, while collection year 2001 did not include a hatchery-origin natural spawner group. Legend is read as follows: Open circles refer to hatchery-origin hatchery spawner group, while filled box refers to natural-origin hatchery spawner group, and so on.

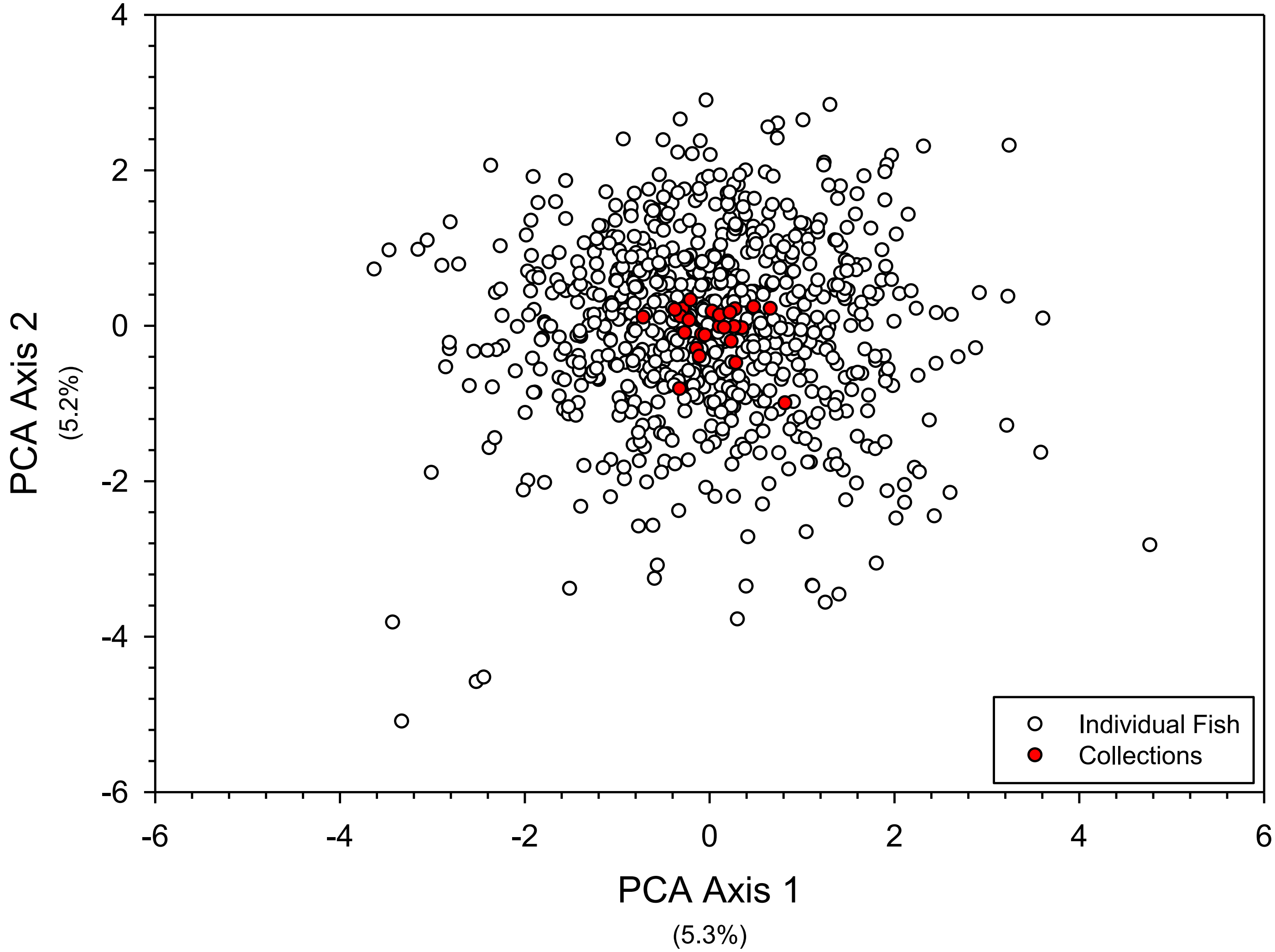

Figure 6. Principal component (PC) analysis of individual fish from the Chiwawa River. Only fish with complete microsatellite genotypes were included in the analysis (n = 757). Open circles are the PC scores for individual fish, and the filled circles are the centroids (bivariate means) for each of the 25 groups discussed in the text. PC axes 1 and 2 account for only 10.5% of the total molecular variance.

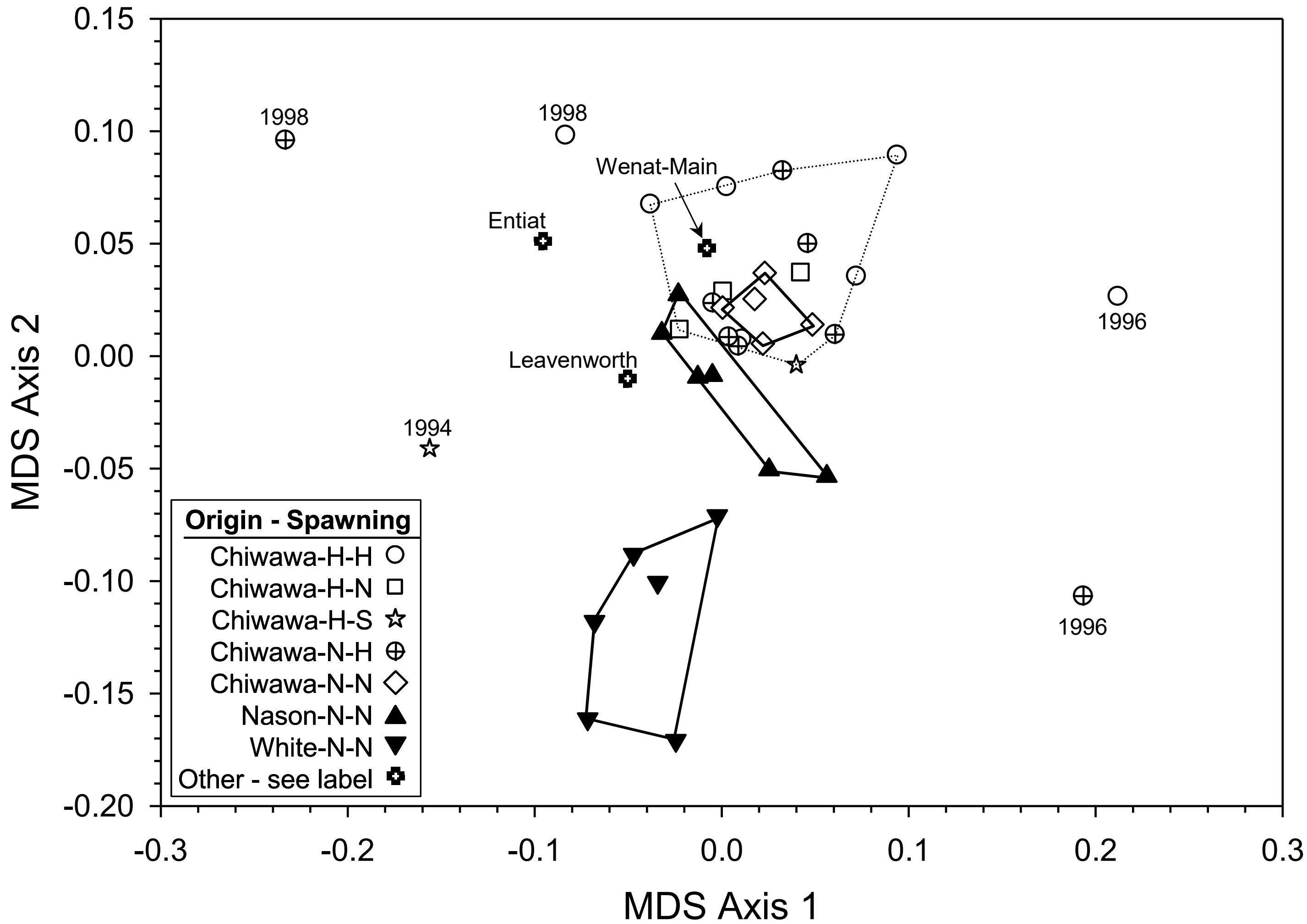

Figure 7. Multidimensional scaling plot from an allele-sharing distance matrix calculated from the Chiwawa origin data set and all other non-Chiwawa collections, except Little Wenatchee River. Legend is read with abbreviations beginning with origin and then spawning location. H=hatchery, N=natural, and S=smolts. Polygons with solid lines enclose the natural-origin natural spawner collections from each population (i.e., river). The polygon with the dotted lines enclose all Chiwawa collections, except for the five outlier collections, as discussed in text.

Table 1 Summary of within population genetic data. Chiwawa collection data are summarized in A) by origin of the sample (i.e., clipped vs. non-clipped). All collection data are summarized in B) by spawning location (i.e., hatchery broodstock or on spawning grounds). Hz is heterozygosity, HWE is the statistical significance of deviations from Hardy-Weinberg expectations (* = 0.05, ** = 0.01, and *** = 0.001), LD is the proportion of pairwise locus tests (across all populations) exhibiting linkage disequilibrium (bolded values are statistically significant), and the last column is mean number of alleles per locus.

Collection	Sample size	Gene Diversity	Observed Hz	HWE	F_{IS}	LD	Mean # Alleles
A) Origin							
1993 Chiwawa Hatchery	95	0.77	0.79	***	-0.02	**0.86**	14.00
1994 Chiwawa Hatchery	95	0.76	0.77	***	-0.01	**0.91**	11.38
1996 Chiwawa Hatchery	8	0.75	0.81	-	-0.01	0.00	8.23
1998 Chiwawa Hatchery	27	0.81	0.82	-	0.00	0.04	12.62
2000 Chiwawa Hatchery	43	0.75	0.78	***	-0.01	**0.19**	12.46
2001 Chiwawa Hatchery	69	0.77	0.80	***	-0.02	**0.14**	15.31
2004 Chiwawa Hatchery	72	0.77	0.77	***	0.01	**0.45**	15.92
2005 Chiwawa Hatchery	91	0.79	0.82	*	-0.03	**0.05**	16.15
2006 Chiwawa Hatchery	95	0.80	0.84	***	-0.05	**0.49**	15.85
1989 Chiwawa Natural	36	0.76	0.78	-	0.01	0.00	12.77
1993 Chiwawa Natural	62	0.78	0.81	-	-0.02	0.04	15.85
1996 Chiwawa Natural	8	0.72	0.78	-	-0.02	0.00	7.54
1998 Chiwawa Natural	10	0.78	0.84	-	0.00	0.00	8.23
2000 Chiwawa Natural	39	0.78	0.79	***	0.00	**0.10**	14.00
2001 Chiwawa Natural	75	0.78	0.80	-	-0.03	0.03	15.31
2004 Chiwawa Natural	85	0.78	0.77	-	0.02	0.01	15.77
2005 Chiwawa Natural	90	0.79	0.79	-	0.01	0.01	16.15
2006 Chiwawa Natural	96	0.80	0.81	-	-0.01	0.01	16.46

Table 1 Within population genetic data analysis summary continued.

Collection	Sample size	Gene Diversity	Observed Hz	HW	F_{IS}	LD	Mean # Alleles
B) Spawning Location							
1993 Chiwawa Broodstock	62	0.78	0.81	-	-0.02	0.00	15.85
1996 Chiwawa Broodstock	16	0.75	0.79	-	-0.02	0.00	10.92
1998 Chiwawa Broodstock	37	0.82	0.83	-	0.00	0.01	14.38
2000 Chiwawa Broodstock	82	0.78	0.78	***	0.00	**0.32**	15.62
2001 Chiwawa Broodstock	89	0.78	0.80	*	-0.02	**0.13**	15.77
2004 Chiwawa Broodstock	61	0.77	0.76	*	0.02	**0.13**	14.92
2005 Chiwawa Broodstock	75	0.79	0.78	*	0.02	0.01	15.85
2006 Chiwawa Broodstock	89	0.80	0.83	-	-0.03	**0.05**	16.46
1989 Chiwawa River	36	0.76	0.78	-	0.01	0.00	12.77
2001 Chiwawa River	55	0.78	0.80	-	-0.02	**0.09**	14.00
2004 Chiwawa River	96	0.78	0.78	*	0.01	**0.18**	17.23
2005 Chiwawa River	106	0.79	0.82	*	-0.02	**0.06**	16.69
2006 Chiwawa River	102	0.80	0.83	***	-0.03	**0.10**	16.77
1989 White River	48	0.75	0.75	-	0.01	0.01	12.85
1991 White River	19	0.76	0.76	-	0.03	0.00	10.92
1992 White River	22	0.75	0.79	-	-0.02	0.01	11.00
1993 White River	21	0.75	0.69	*	0.10	0.00	10.15
2005 White River	29	0.75	0.77	-	-0.01	0.03	12.23
2006 White River	40	0.76	0.76	-	0.01	0.04	13.38

Table 1 Within population genetic data analysis summary continued.

Collection	Sample size	Gene Diversity	Observed Hz	HW	F_{IS}	LD	Mean # Alleles
1993 Little Wenatchee R.	19	0.84	0.85	-	0.02	0.00	11.23
1993 Nason Creek	45	0.78	0.80	-	-0.01	0.01	13.77
2000 Nason Creek	51	0.76	0.78	-	-0.02	**0.13**	13.92
2001 Nason Creek	41	0.79	0.81	-	-0.01	**0.08**	14.23
2004 Nason Creek	38	0.76	0.76	-	0.02	0.03	13.23
2005 Nason Creek	45	0.78	0.82	-	-0.04	0.03	14.92
2006 Nason Creek	48	0.80	0.82	-	-0.01	0.00	15.77
2001 Wenatchee River	32	0.79	0.80	*	0.00	0.04	12.85
2000 Leavenworth NFH	73	0.80	0.82	*	-0.02	**0.15**	16.23
1997 Entiat NFH	37	0.81	0.83	-	-0.01	**0.06**	14.38

Table 2 Demographic data for Chiwawa Hatchery and Chiwawa natural spring Chinook salmon. BS is census size of hatchery broodstock, pNOB is the proportion of hatchery broodstock of natural origin, NOS is the census size of natural-origin spawners present in Chiwawa River, HOS is the census size of hatchery-origin spawners present in Chiwawa River, Total is NOS and HOS combined, and pNOS is the proportion of spawners present in Chiwawa River of natural origin.

	Hatchery		In River			
Brood Year	BS	pNOB	NOS	HOS	Total	pNOS
1989	28	1	1392	0	1392	1.00
1990	18	1	775	0	775	1.00
1991	32	1	585	0	585	1.00
1992	78	1	1099	0	1099	1.00
1993	94	1	677	491	1168	0.58
1994	11	0.64	190	90	280	0.68
1995	0	0	8	50	58	0.14
1996	18	0.44	131	51	182	0.72
1997	111	0.29	210	179	389	0.54
1998	47	0.28	134	45	178	0.75
1999	0	0	119	13	132	0.90
2000	30	0.3	378	310	688	0.55
2001	371	0.3	1280	2850	4130	0.31
2002	71	0.28	694	919	1613	0.43
2003	94	0.44	380	223	603	0.63
2004	215	0.39	820	788	1608	0.51
2005	270	0.33	250	1222	1472	0.17

Table 3 Levels of significance for pairwise tests of genic differentiation among all hatchery- and natural-origin collections used in this analysis. HS = highly significant (P < 0.000095; the Bonferroni corrected p-value for an alpha = 0.05); * = P < 0.05 (nominal critical value for most statistical test); - = P > 0.05 (not significant). A significant result between pairs of populations indicates that the allele frequencies between the pair are significantly different. Results are read by comparing the collections along the rows to collections along columns. The top block for each section is a symmetric matrix, as it compares collections within the same group.

		Chiwawa – Hatchery Origin								
		1993	1994	1996	1998	2000	2001	2004	2005	2006
Chiwawa – Hat. Origin	1993		HS	*	HS	HS	HS	HS	HS	HS
	1994	HS		HS	HS	HS	HS	HS	HS	HS
	1996	*	HS		*	-	*	-	-	*
	1998	HS	HS	*		HS	HS	HS	HS	HS
	2000	HS	HS	-	HS		HS	*	HS	HS
	2001	HS	HS	*	HS	HS		HS	*	HS
	2004	HS	HS	-	HS	*	HS		HS	HS
	2005	HS	HS	-	HS	HS	*	HS		HS
	2006	HS	HS	*	HS	HS	HS	HS	HS	
Chiwawa – Natural Origin	1989	HS	HS	-	HS	HS	*	HS	HS	HS
	1993	HS	HS	-	HS	HS	-	HS	*	HS
	1996	*	HS	-	*	-	-	-	-	-
	1998	HS	HS	-	-	HS	*	*	*	-
	2000	HS	HS	-	HS	HS	HS	*	HS	HS
	2001	HS	HS	-	HS	HS	HS	HS	*	HS
	2004	HS	HS	-	HS	HS	HS	HS	HS	HS
	2005	HS	HS	-	HS	HS	*	HS	*	HS
	2006	HS	HS	-	*	HS	HS	HS	HS	HS
Nason	1996	HS	HS	-	HS	HS	HS	HS	HS	HS
	2000	HS	HS	*	HS	HS	HS	HS	HS	HS
	2001	HS	HS	-	HS	HS	HS	HS	HS	HS
	2004	HS	HS	-	HS	HS	HS	HS	HS	HS
	2005	HS	HS	-	HS	HS	HS	HS	HS	HS
	2006	HS	HS	-	*	HS	HS	HS	HS	HS
White	1989	HS	HS	HS	HS	HS	HS	HS	HS	HS
	1991	HS	HS	-	HS	HS	HS	HS	HS	HS
	1992	HS	HS	*	HS	HS	HS	HS	HS	HS
	1993	HS	HS	*	HS	HS	HS	HS	HS	HS
	2005	HS	HS	-	HS	HS	HS	HS	HS	HS
	2006	HS	HS	HS	HS	HS	HS	HS	HS	HS
Other	Wen-M	HS	HS	*	HS	HS	*	*	-	HS
	Leaven	HS	HS	*	HS	HS	HS	HS	HS	HS
	Entiat	HS	HS	*	HS	HS	HS	HS	HS	HS

Table 3 (con't)

		Chiwawa – Natural Origin								
		1989	**1993**	**1996**	**1998**	**2000**	**2001**	**2004**	**2005**	**2006**
Chiwawa – Natural Origin	**1989**		-	-	-	-	*	*	*	*
	1993	-		-	*	*	*	HS	*	HS
	1996	-	-		-	-	-	-	-	-
	1998	-	*	-		*	*	HS	*	*
	2000	-	*	-	*		HS	-	HS	HS
	2001	*	*	-	*	HS		HS	*	HS
	2004	*	HS	-	HS	-	HS		HS	HS
	2005	*	*	-	*	HS	*	HS		*
	2006	*	HS	-	*	HS	HS	HS	*	
Nason	**1996**	*	*	-	*	*	HS	HS	HS	HS
	2000	HS	HS	HS	HS	HS	HS	HS	HS	HS
	2001	HS	*	-	*	HS	HS	HS	HS	HS
	2004	HS	HS	-	HS	HS	HS	HS	HS	HS
	2005	*	*	-	*	HS	HS	HS	HS	HS
	2006	HS	HS	-	-	HS	HS	HS	HS	HS
White	**1989**	HS	HS	*	HS	HS	HS	HS	HS	HS
	1991	HS	HS	*	-	HS	HS	HS	HS	HS
	1992	HS	HS	-	*	HS	HS	HS	HS	HS
	1993	HS	*	-	*	HS	HS	HS	HS	HS
	2005	HS	*	*	*	HS	HS	HS	*	HS
	2006	HS	HS	*	HS	HS	HS	HS	HS	HS
Other	**Wen-M**	*	-	-	-	*	*	HS	*	*
	Leaven	HS	HS	*	*	HS	HS	HS	HS	HS
	Entiat	HS	HS	*	HS	HS	HS	HS	HS	HS

Table 3 (con't)

		Nason					
		1996	2000	2001	2004	2005	2006
Nason	1996		HS	-	HS	-	*
	2000	HS		HS	HS	HS	HS
	2001	-	HS		*	-	*
	2004	HS	HS	*		*	HS
	2005	-	HS	-	*		-
	2006	*	HS	*	HS	-	
White	1989	HS	HS	HS	HS	HS	HS
	1991	*	HS	HS	HS	*	*
	1992	HS	HS	HS	HS	HS	HS
	1993	*	HS	HS	HS	HS	HS
	2005	*	HS	HS	HS	HS	HS
	2006	HS	HS	HS	HS	HS	HS
Other	Wen-M	HS	HS	HS	HS	*	HS
	Leaven	HS	HS	HS	HS	HS	HS
	Entiat	HS	HS	HS	HS	HS	HS

Table 3 (con't)

		White						Other		
		1989	1991	1992	1993	2005	2006	Wen-M 2001	Leaven 2000	Entiat 1997
White	1989		-	*	-	HS	HS	HS	HS	HS
	1991	-		-	-	*	*	*	HS	HS
	1992	*	-		-	*	*	HS	HS	HS
	1993	-	-	-		*	*	HS	HS	HS
	2005	HS	*	*	*		*	HS	HS	HS
	2006	HS	*	*	*	*		HS	HS	HS
Other	Wen-M	HS	*	HS	HS	HS	HS		HS	HS
	Leaven	HS	HS	HS	HS	HS	HS	HS		HS
	Entiat	HS	HS	HS	HS	HS	HS	HS	HS	

Table 4 Probabilities (above diagonal) and levels of significance (below diagonal) for pairwise tests of genic differentiation among all Chiwawa hatchery broodstock and Chiwawa natural spawner collections used in this analysis. HS = highly significant (P < 0.000476; the Bonferroni corrected p-value for an alpha = 0.05); * = P < 0.05 (nominal critical value for most statistical test); - = P > 0.05 (considered not significant). A significant result between pairs of populations indicates that the allele frequencies between the pair are significantly different. Pairwise comparisons between the hatchery broodstock and natural spawner collections from 2001, 2004, 2005, and 2006, respectively, are highlighted.

		Smolt		Hatchery Broodstock								Natural Spawners				
		1993	1994	1993	1996	1998	2000	2001	2004	2005	2006	1989	2001	2004	2005	2006
Smolt	1993		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1994	HS		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hatchery Broodstock	1993	HS	HS		0.9155	0.0000	0.0073	0.3647	0.0003	0.0694	0.0000	0.2220	0.0039	0.0008	0.0095	0.0000
	1996	HS	HS	-		0.0151	0.8388	0.0452	0.4916	0.3189	0.0716	0.5591	0.0759	0.8101	0.2364	0.0786
	1998	HS	HS	HS	*		0.0000	0.0000	0.0000	0.0000	0.0043	0.0000	0.0000	0.0000	0.0000	0.0005
	2000	HS	HS	*	-	HS		0.0000	0.4720	0.0000	0.0000	0.0036	0.0000	0.0712	0.0000	0.0000
	2001	HS	HS	-	*	HS	HS		0.0000	0.0059	0.0000	0.0003	0.0000	0.0000	0.0126	0.0000
	2004	HS	HS	*	-	HS	-	HS		0.0000	0.0000	0.0001	0.0000	0.0012	0.0000	0.0000
	2005	HS	HS	-	-	HS	HS	*	HS		0.0005	0.0024	0.0137	0.0025	0.7782	0.0018
	2006	HS	HS	HS	-	*	HS	HS	HS	*		0.0000	0.0000	0.0000	0.0000	0.5770
Natural Spawners	1989	HS	HS	-	-	HS	*	*	HS	*	HS		0.0023	0.0317	0.0000	0.0003
	2001	HS	HS	*	-	HS	HS	HS	HS	*	HS	*		0.0000	0.2641	0.0000
	2004	HS	HS	*	-	HS	-	HS	*	*	HS	*	HS		0.0000	0.0000
	2005	HS	HS	*	-	HS	HS	*	HS	-	HS	HS	-	HS		0.0000
	2006	HS	HS	HS	-	*	HS	HS	HS	*	-	*	HS	HS	HS	

Table 5 Analysis of molecular variance (AMOVA) for the Chiwawa collections, showing the partition of molecular variance into (1) within collections, (2) among collections but within group, and (3) among group components. Each column in the table represents a separate analysis testing for differences under a different spatial or temporal hypothesis. The different analyses are grouped together in a single table for comparisons. The values within the table are percentages and the parenthetical values are P-values, or probabilities, associated with that percentage. P-values greater than 0.05 indicate that the percentage is not significantly different from zero. For example, when collections are organized by hatchery- versus natural-origin ("Origin" – fourth column), 0.11% of the molecular variance is attributed to among group (i.e., hatchery- versus natural-origin), which is not significantly different from zero. No collections (first column) indicates no organization or grouping among all collections, and the among-group percentage is equal to the F_{ST} for the entire data set.

	No Structure	Collection Year	Spawning Location	Origin	Origin-Spawning Location
Among Groups	0.26 (0.00)	0.20 (0.43)	0.05 (0.48)	0.11 (0.15)	0.11 (0.06)
Among collections - Within groups	-	0.08 (0.003)	0.24 (0.00)	0.21 (0.00)	0.18 (0.06)
Within collections	99.74 (0.00)	99.72 (0.00)	99.71 (0.00)	99.68 (0.00)	99.71 (0.00)

Table 6 F_{ST} values for all pairwise combinations of populations. Each F_{ST} is the median value for all pairwise combinations of collections within each population (the number of collections within each population is shown parenthetically next to each population name on each row). For example, the F_{ST} for the Chiwawa hatchery versus the White River (0.019) is the median value of 54 pairwise comparisons. The bold values along the center diagonal are the median F_{ST} values within each collection. For those populations with only one collection, the diagonal value was set at 0.000.

	Chiwawa-Hatchery	Chiwawa-Natural	Entiat	Leaven-worth	Nason	Wenatchee-main	White	Little Wenatchee
Chiwawa-Hatchery (9)	**0.013**	0.008	0.016	0.012	0.011	0.005	0.019	0.111
Chiwawa-Natural (9)		**0.003**	0.012	0.011	0.007	0.003	0.014	0.105
Entiat (1)			**0.000**	0.005	0.010	0.008	0.019	0.078
Leavenworth (1)				**0.000**	0.007	0.008	0.014	0.092
Nason (6)					**0.006**	0.008	0.015	0.099
Wenatchee-main (1)						**0.000**	0.012	0.098
White (6)							**0.005**	0.113
Little Wenatchee (1)								**0.000**

Table 7 As in Table 5, except data includes Chiwawa hatchery- and natural-origin, Nason Creek, and White River collections

	All Years	All Years	1989-1996	2005-2006	2005-2006
	No Structure	Origin	Origin	Origin	Collection Year
Among Groups	0.28 (0.00)	0.33 (0.00)	-0.07 (0.67)	0.43 (0.01)	-0.06 (0.57)
Among Collections - Within groups	-	0.04 (0.00)	0.22 (0.00)	0.25 (0.00)	0.64 (0.00)
Within Collections	99.72	99.63	99.85	99.32	99.41

Table 8 Individual assignment results reported are the numbers of individuals assigned to each population using the partial Bayesian criteria of Rannala and Mountain (1997) and a "jack-knife" procedure (see Methods). The population with the highest posterior probability is considered the stock of origin (i.e., no unassigned individuals). Individuals from each population are assigned to specific populations (along rows). Bold values indicate correct assignment back to population of origin. Individuals assigned to a population are read down columns. For example, of the 595 individuals from Chiwawa hatchery origin, 134 individuals were assigned to Chiwawa natural origin (reading across). Of the 511 individuals assigned to Chiwawa natural origin (reading down), 60 were from Nason Creek.

Population	Total	Unassigned	1	2	3	4	5	6	7	8
1) Chiwawa Hatchery	595	0	**371**	134	2	16	0	45	15	12
2) Chiwawa Natural	501	0	156	**269**	4	5	0	42	9	16
3) Entiat	37	0	4	5	**13**	8	0	6	1	0
4) Leavenworth	73	0	9	8	3	**33**	0	17	0	3
5) Little Wenatchee	19	0	0	0	0	0	**19**	0	0	0
6) Nason	268	0	49	60	5	11	0	**131**	1	11
7) Wenatchee Mainstem	32	0	12	9	0	1	0	2	**6**	2
8) White	179	0	22	26	0	2	0	13	1	**115**
TOTAL	1704	0	623	511	27	76	19	256	33	159

Table 9 As in Table 8, except the posterior probability from the partial Bayesian criteria of Rannala and Mountain (1997) must be 0.90 or greater, to be assigned to a population. Those individuals with posterior probabilities less than 0.90 are unassigned.

Aggregate	**Total**	**Unassigned**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1) Chiwawa Hatchery	595	332	**214**	31	1	4	0	10	3	0
2) Chiwawa Natural	501	375	30	**82**	0	1	0	5	2	6
3) Entiat	37	24	1	1	**5**	4	0	2	0	0
4) Leavenworth	73	51	0	1	1	**19**	0	1	0	0
5) Little Wenatchee	19	2	0	0	0	0	**17**	0	0	0
6) Nason	268	188	11	6	2	5	0	**53**	0	3
7) Wenatchee Mainstem	32	23	4	3	0	0	0	0	**2**	0
8) White	179	92	4	3	0	1	0	5	1	**73**
TOTAL	1704	1087	264	127	9	34	17	76	8	82

Table 10 Estimates of N_e based on bias correction method of Waples (2006) implemented in LDNe (Do and Waples unpublished). Collections are categorized by spawning location. Sample size is the harmonic mean of the sample size, 95% CI is the confidence interval calculated using Waples' (2006) equation 12, and Major Cohort assumes that each collection is 100% four-year-olds.

	Sample size	Estimated N_b	95% CI	Major Cohort	Census	N_e/N
1993 Chiwawa Broodstock	58.4	103.1	77.0 - 149.7	1989	1392	0.30
1996 Chiwawa Broodstock	15.5	30.4	19.6 - 58.1	1992	1099	0.11
1998 Chiwawa Broodstock	33.4	37.7	29.8 - 49.7	1994	280	0.54
2000 Chiwawa Broodstock	77.8	48.4	41.4 - 57.2	1996	182	1.06
2001 Chiwawa Broodstock	80.4	49.6	42.2 - 59.2	1997	389	0.51
2004 Chiwawa Broodstock	56.6	48.1	39.0 - 60.9	2000	688	0.28
2005 Chiwawa Broodstock	73	274.3	148.9 - 1131.8	2001	4130	0.27
2006 Chiwawa Broodstock	88.4	198.3	136.1 - 340.5	2002	1613	0.49
1989 Chiwawa River	26.6	5.2	3.9 - 6.3	1985		
2001 Chiwawa River	46.7	38.6	31.0 - 49.3	1997	389	0.40
2004 Chiwawa River	88.5	82.6	67.3 - 104.4	2000	688	0.48
2005 Chiwawa River	104.2	231.5	161.8 - 382.7	2001	4130	0.22
2006 Chiwawa River	101.1	107.3	87.2 - 136	2002	1613	0.27

Table 11 Summary of output from program SALMONNb and data for eight Chiwawa broodstock collections from Wenatchee River. For each pairwise comparison of samples *i* and *j*, $\tilde{S}$ is the harmonic mean sample size, *n* is the number of independent alleles used in the comparison, $\hat{N}_{b(i,j)}$ are the pairwise estimates of N_b, and Var [$\hat{N}_{b(i,j)}$] is the variance of $\hat{N}_{b(i,j)}$. $\tilde{N}_b$ is the harmonic mean of the $\hat{N}_{b(i,j)}$. Alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

Year	1993	1996	1998	2000	2001	2004	2005	2006
Pairwise $\tilde{S}$ (above diagonal) and *n* (below diagonal):								
1993	-	24.5	42.5	66.4	67.2	57.2	64.6	70.3
1996	82	-	21.2	25.8	26.0	24.4	25.6	26.4
1998	80	81	-	46.7	47.2	42.0	45.8	48.4
2000	80	82	84	-	78.6	65.2	75.1	82.7
2001	73	77	81	76	-	66.0	76.2	84.2
2004	77	81	75	76	78	-	63.5	69.0
2005	71	75	82	73	73	69	-	80.0
2006	81	80	84	75	74	75	72	-
Pairwise $\hat{N}_{b(i,j)}$ (above diagonal) and Var [$\hat{N}_{b(i,j)}$] (below diagonal):								
1993	-	-742.7	406.9	1240.8	-5432.0	829.8	808.9	729.0
1996	22491.2	-	110.4	-1786.5	765.9	162.8	824.7	382.7
1998	10910.4	67299.1	-	101.8	237.1	69.6	307.0	140.0
2000	6910.0	742895.8	19122.7	-	490.6	1498.2	706.9	201.6
2001	49318.3	21402.8	9754.2	6126.6	-	307.8	82.0	362.5
2004	8338.4	257267.7	24283.0	145043.4	7095.7	-	269.7	140.1
2005	31511.8	22242.5	10015.8	6596.6	114931.1	8240.4	-	599.6
2006	6223.8	43935.2	73518.7	10152.5	5885.3	12827.0	6370.8	-
$\tilde{N}_b = 269.4$								

Table 12 Summary of output from program SALMONNb and data for five Chiwawa in-river spawner collections from Wenatchee River. For each pairwise comparison of samples *i* and *j*, $\tilde{S}$ is the harmonic mean sample size, *n* is the number of independent alleles used in the comparison, $\hat{N}_{b(i,j)}$ are the pairwise estimates of N_b, and Var [$\hat{N}_{b(i,j)}$] is the variance of $\hat{N}_{b(i,j)}$. $\tilde{N}_b$ is the harmonic mean of the $\hat{N}_{b(i,j)}$. Alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

Year	1989	2001	2004	2005	2006
Pairwise $\tilde{S}$ (above diagonal) and *n* (below diagonal):					
1989	-	33.3	40.2	41.7	42.2
2001	72	-	60.5	63.9	63.3
2004	72	77	-	95.3	94.0
2005	69	72	75	-	102.5
2006	76	76	77	78	-
Pairwise $\hat{N}_{b(i,j)}$ (above diagonal) and Var [$\hat{N}_{b(i,j)}$] (below diagonal):					
1989	-	118.4	299.0	143.3	165.3
2001	40378.8	-	181.7	-1537.3	153.5
2004	10455.2	7265.5	-	387.1	329.4
2005	20923.6	68660.6	5040.7	-	356.8
2006	16227.2	8886.9	3802.0	4522.8	-

$\tilde{N}_b = 224.2$

Table 13 Summary of output from program SALMONNb and data for three brood years that combined Chiwawa natural- and hatchery-origin samples from Wenatchee River. For each pairwise comparison of samples *i* and *j*, $\tilde{S}$ is the harmonic mean sample size, *n* is the number of independent alleles used in the comparison, $\hat{N}_{b(i,j)}$ are the pairwise estimates of N_b, and Var [$\hat{N}_{b(i,j)}$] is the variance of $\hat{N}_{b(i,j)}$. $\tilde{N}_b$ is the harmonic mean of the $\hat{N}_{b(i,j)}$. Alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

Year	2004	2005	2006
Pairwise $\tilde{S}$ (above diagonal) and *n* (below diagonal):			
2004	-	162	164.3
2005	77	-	188.2
2006	76	75	-
Pairwise $\hat{N}_{b(i,j)}$ (above diagonal) and Var [$\hat{N}_{b(i,j)}$] (below diagonal):			
2004	-	611.3	210.8
2005	9351.5	-	727.5
2006	14965.5	8673.9	-

$\tilde{N}_b = 386.8$

Appendix L

Fish Trapping at the Nason Creek Smolt Trap 2017

Population Estimates for Juvenile Salmonids in Nason Creek, WA

2017 Annual Report

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Project No. 1996-040-00

ABSTRACT

In 2017, Yakama Nation Fisheries Resource Management (YNFRM) monitored emigration of Endangered Species Act (ESA) - listed Upper Columbia River (UCR) spring Chinook salmon, UCR summer steelhead, and naturally-spawned coho salmon juveniles in Nason Creek. This report summarizes the resulting juvenile abundance and freshwater survival estimates for each of these species. Fish were captured using a 1.5m rotary smolt trap between March 1 and November 30, 2017. Target catch included 2,487 spring Chinook salmon, 1,562 summer steelhead, and 1 bull trout; all of natural origin and varying age classes. There were no natural-origin coho captured. Daily fish abundances for spring Chinook and steelhead were expanded by stream discharge-to-trap efficiency regressions or pooled estimates. We estimated that 18,182 ± 10,379 brood-year (BY) 2015 wild spring Chinook parr and smolts emigrated from Nason Creek. We subsequently estimated that within Nason Creek, BY2015 spring Chinook had an egg-to-emigrant survival of 4.2%. Additionally, we estimated that 23,728 ± 124,628 BY2014 wild steelhead parr and smolts emigrate from Nason Creek. Corresponding egg-to-emigrant survival for BY2014 steelhead was 2.1%.

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ACKNOWLEDGEMENTS

This project is part of a basin-wide monitoring program requiring close coordination between multiple agencies and contractors. We greatly appreciate the hard work of the Yakama Nation Fisheries Resource Management (YNFRM) crew members including Matthew Clubb, Jamie Hallman, Arlene Heemsah, Tim Jeffris, and Kevin Swager who maintained and operated the trap during all hours including nights/weekends and through challenging weather conditions. We would like to also thank the Wenatchee River Ranger District (U.S. Forest Service), Mr. Duane Bolser for providing use of the trapping site and accommodating the needs of this project, and Peter Graf and Rolland O'Connar (Grant County PUD) for administering contracting and funding. Finally, thank you to Mike Hughes, Mclain Johnson, Andrew Murdoch, Ben Truscott, and Joshua Williams (Washington Department of Fish and Wildlife), and Tracy Hillman (Bio Analysts, Inc.) for shared data and smolt trap methodologies.

1.0 INTRODUCTION

Beginning in the fall of 2004, Yakama Nation Fisheries Resource Management (YNFRM) began operating a rotary smolt trap in Nason Creek for nine months per year. Prior to 2004, the smolt trap was operated on a limited basis solely for hatchery coho predation studies. This project is a cost share between the YNFRM's Mid-Columbia Coho Reintroduction Program (MCCRP) and Grant County PUD's Hatchery Monitoring Plan. Trap operations were conducted in compliance with ESA consultation specifically to address abundance and productivity of spring Chinook, steelhead trout, and coho salmon in Nason Creek.

Within this document we will report:

1) Juvenile abundance and productivity of spring Chinook salmon (tkwínat) *Oncorhynchus tshawytscha*, steelhead trout (shúshaynsh) *Oncorhynchus mykiss* and coho salmon (súnx) *Oncorhynchus kisutch* in Nason Creek.

2) Emigration timing of spring Chinook salmon, steelhead trout and coho salmon emigrating from Nason Creek.

The data presented will be directly used to address Objective 2 in the Monitoring and Evaluation Plan for PUD Hatchery Programs (Hillman et al. 2015) on a 5-year analytic cycle:

Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks (Hillman et al. 2013).

1.1 Watershed Description

The Nason Creek watershed drains 26,547 ha of alpine glaciated landscape where high precipitation and moderate rain on snow recurrence controls the hydrology and aquatic communities. Nason Creek originates near the Cascade crest at Stevens Pass and flows east for approximately 37 river kilometers (rkm) until joining the Wenatchee River at rkm 86.3 just below Lake Wenatchee. There are 26.4 rkm along the mainstem accessible to anadromous fish in Nason Creek. The smolt trap is located downstream from the majority of spring Chinook and steelhead spawning grounds (Figure 1). Private land ownership comprises 21,165 ha (79.7%) of the watershed while 5,180 ha (19.5%) are federal and 194 ha (0.1%) are state owned (USFS et al. 1996).

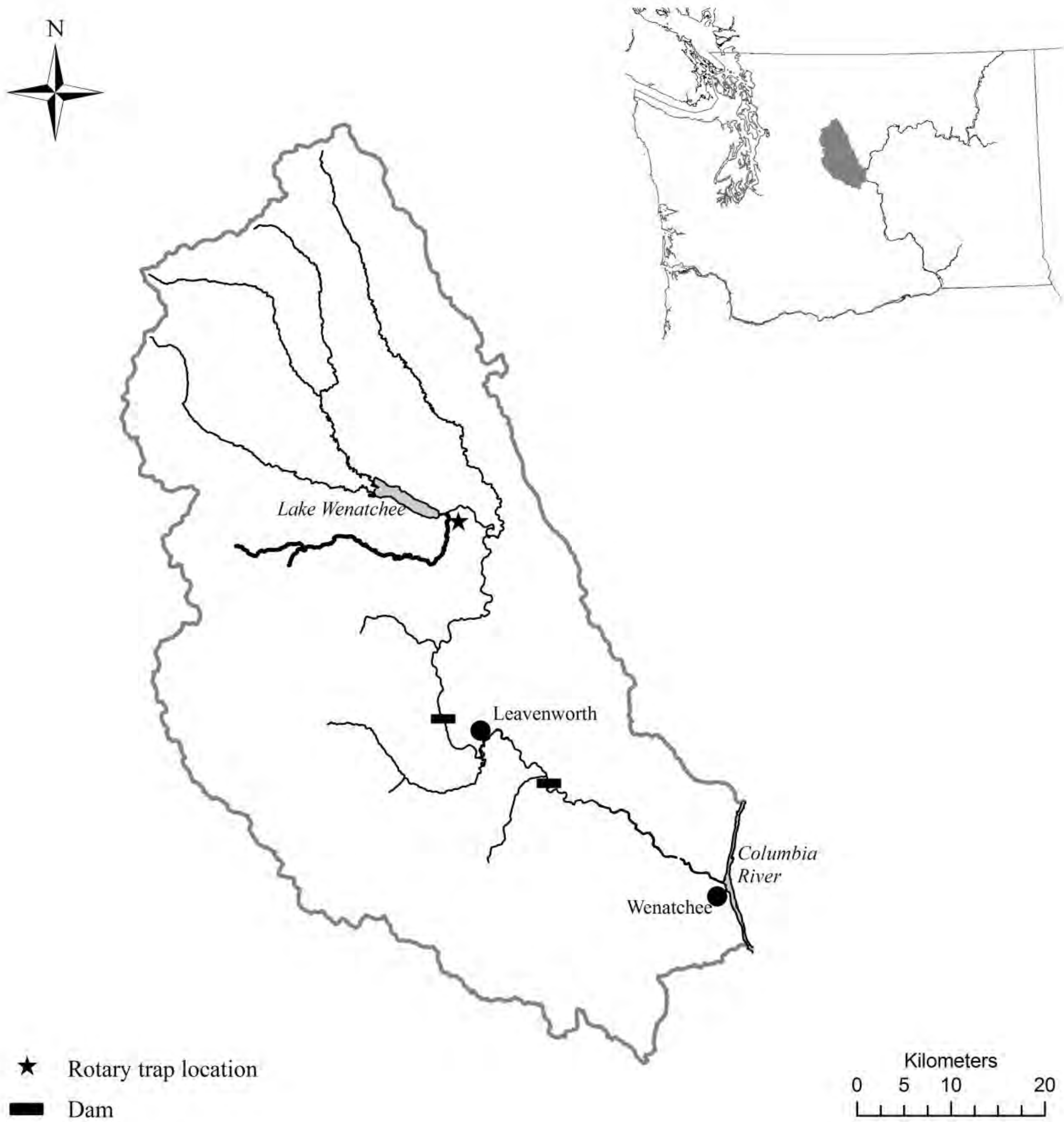


Figure 1. Map of Wenatchee River Subbasin with the Nason Creek rotary trap location.

The channel morphology of the lower 25 rkm of Nason Creek has been impacted by development of highways, railroads, power lines, and residential development resulting in channel confinement and reduced side-channel habitat. The present condition is a low gradient (< 1.1%), low sinuosity (1:2 to 2:0 channel-to-valley length ratio) and depositional channel (USFS et al. 1996). Peak runoff typically occurs in May and June with occasional high water produced by rain on snow events in October and November.

In 2017, mean daily discharge for Nason Creek was 11.1 m^3/s (413 cfs; Figure 2). The timing of spring runoff was typical of the tributary, with the onset ocurring in early March, and a peak in June. The fall saw a large peak in discharge resulting from a rain-on snow event in late

November. The seasonal water temperature regime was also typical in 2017 (Figure 3). Summer temperatures during the low-flow period were below-average.

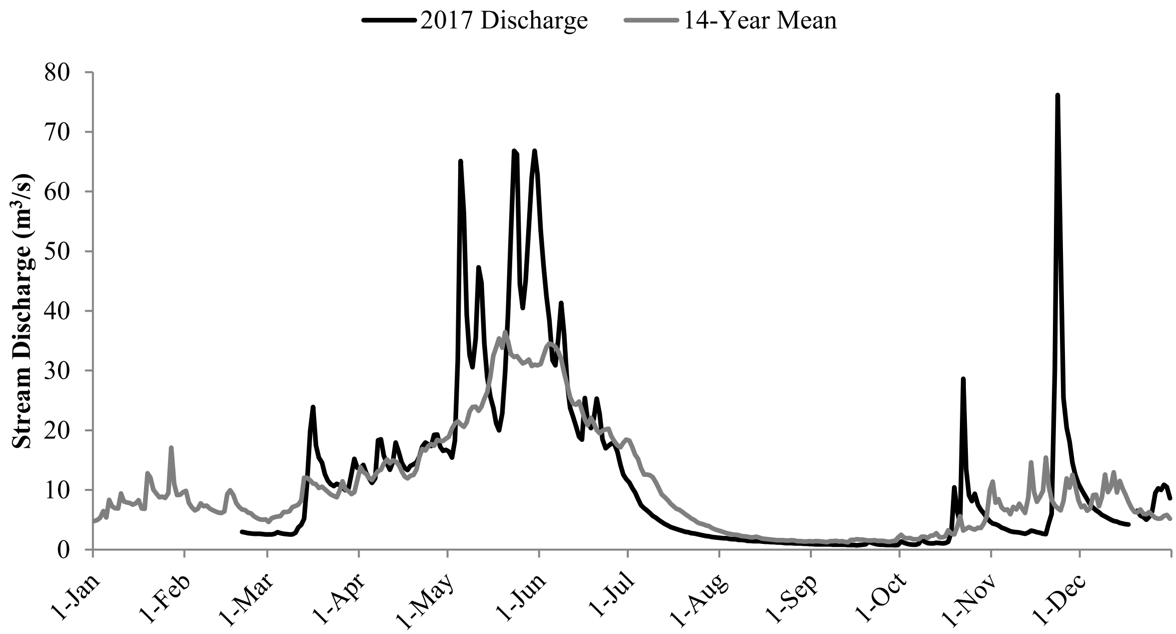


Figure 2. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2017.

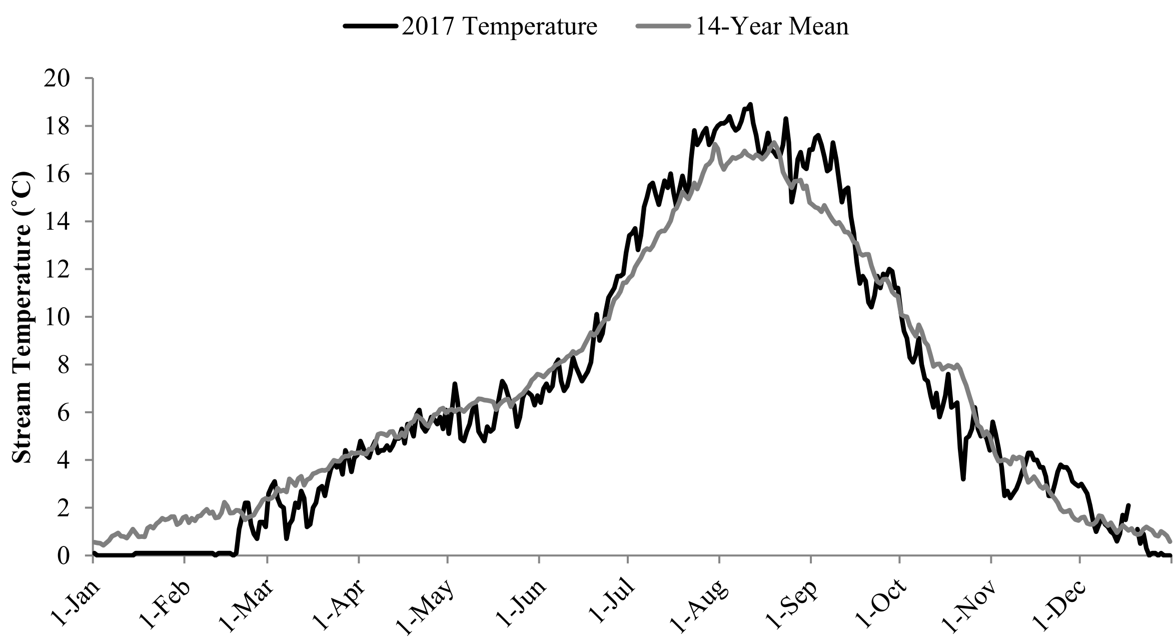


Figure 3. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2017.

2.0 METHODS

2.1 Trapping Equipment and Operation

The smolt trap was operated continually 24 hours per day, 7 days per week when conditions permitted. During spring snowmelt, operations occurred only during hours of darkness in order to minimize trap damage and capture mortality, while retaining the ability to sample during periods of peak fish movement.

On a daily basis, fish were removed from the primary collection box and retained in separate shore-anchored holding boxes until removed for efficiencies trials. A rotating drum-screen constantly removed small debris from the live box to avoid fish injury. All changes/modifications to the trap as well as periods of stoppage were noted.

2.2 Biological Sampling

Trap operating procedures and techniques followed a standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team (RTT) for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was adapted from Murdoch and Petersen (2000).

All fish were enumerated by species and size class. Fish to be sampled were anesthetized in a solution of MS-222, weighed with an electronic scale and measured in a wetted trough-type measuring board. Anesthetized fish received air through aquarium bubblers and were allowed to fully recover before being either released downstream of the trap or used in efficiency trials. Fork length (FL) and weight were recorded for all fish except when large numbers of fry or non-target species were collected; a sub-sample of 25 fish were measured and weighed while the remaining fish were tallied. Weight was measured to the nearest 0.1 gram and FL to the nearest millimeter. We used these data to calculate a Fulton-type condition factor (K-factor) using the formula:

$$K = (W/L^3) \times 100{,}000$$

where K = Fulton-type condition metric;
W = weight in grams;
L = fork length in millimeters;
And 100,000 is a scaling constant.

Scale samples were collected from steelhead measuring ≥ 60 mm FL so that age and brood year could be assigned. Samples were collected according to the needs and protocols set by Washington Department of Fish and Wildlife (WDFW), who conducted the analysis and provided YNFRM with results. Tissue samples were collected from spring Chinook and steelhead for DNA analysis. Samples from spring Chinook and steelhead were retained for reproductive success analyses conducted by WDFW and National Marine Fisheries Service (NMFS). All target salmonids were classified as either natural or hatchery origin by physical appearance, presence/absence of coded wire tags (CWTs), or post-orbital elastomer tags. Developmental stages were visually classified as fry, parr, transitional, or smolt. Fry were defined as newly emerged fish with or without a visible yolk sac and a FL measuring < 50 mm.

Age-0 coho and spring Chinook salmon captured before July 1 were considered ‘fry’ and were excluded from subyearling population estimates because of the uncertainity that these fish were actively migrating (UCRTT, 2001).

2.3 PIT Tagging

All natural origin Chinook, steelhead and coho measuring ≥ 60 mm were PIT tagged. Once anesthetized, each fish was examined for external wounds or descaling, then scanned for the presence of a previously implanted PIT tag. If a tag was not detected, a pre-loaded 12mm Digital Angel 134.2 kHz type TX 1411ST PIT tag was inserted into the body cavity using a Biomark MK-25 Rapid Implant Gun. Each unique tag code was electronically recorded along with date of tag implantation, date of fish release, tagging personnel, FL, weight, and anesthetic bath temperature. Data were entered using P3 software and submitted to the PIT Tag Information System (PTAGIS). PIT tagging methods were consistent with methodologies described in the PIT Tag Marking Procedures Manual (CBFWA 1999) as well as in 2008 ISEMP protocols (Tussing 2008).

After marking and sampling, fish were held for a minimum of 24-hours in holding boxes at the trap to; a) ensure complete recovery, b) assess tagging mortality, and c) determine a PIT tag shed rate. Mark groups were released by hand 0.8 rkm above the trap at nautical twilight. At each release, fish were distributed evenly along river-left, and river-right banks in pools and other protected areas. Fish that were not used in mark-recapture trials were released downstream from the trap.

2.4 Mark-Recapture Trials

Groups of marked juveniles were released during a range of stream discharges in order to determine the trapping efficiency. PIT tags were the only method of marking used in 2017. These releases followed the protocols described in Hillman (2004), in which the author suggests a minimum sample size of 100 fish for each mark-recapture trial. Although 100 fish/trial represented the ideal mark group, low abundance of fish often required mark-recapture trials be completed with smaller sample sizes. To achieve the largest marked group possible, we combined catch over a maximum of 72 hours. Fish being held for mark-recapture trials were kept in auxiliary live boxes attached to the end of each pontoon or floating holding boxed anchored to the stream bank. A pre-season, minimum mark group size for each species/life stage was initially determined based on past regression models. During periods of high abundance, minimum trial sizes could be raised to a more robust mark group with the intention of strengthening existing regression models.

Each mark-recapture trial was conducted over a three-day (72 hour) period to allow time for passage or capture. Completed trials were only considered invalid if an interruption to trapping occurred or proper pre-release procedures were not followed. Trials resulting in zero recaptures were included in the efficiency regression (if determined valid once vetted through release/recapture protocols) as allowed by the new method of observed trap efficiency calculation. The model used (Bailey) employs use of recaptures +1 in the calculation of efficiency as a mode of bias correction. As a result, even trials yeilding no recaptures can be included in regression modeling (See equation 3 in **2.5.1 Estimate of Abundance**).

In the event that low juvenile abundance could not provide any opportunities for efficiency trials, releases were performed to allow for a pooled estimate. These releases did not have a minimum size and were released at equal intervals across the migratory period. Pooled estimates at the Nason Creek trap were utilized as an alternative method of estimation prior to the development of a viable regression model.

2.5 Data Analysis

2.5.1 Estimate of Abundance During Smolt Trapping

Seasonal juvenile migration, N, was estimated as the sum of daily migrations, N_i, i.e., $N = \sum_i N_i$, and daily migration was calculated from catch and efficiency:

$$\hat{N}_i = \frac{C_i}{\hat{e}_i}, \qquad \textbf{(1)}$$

where C_i = number of fish caught in period *I*;

$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2(b_0 + b_1 flow_i)$,

where b_0 is estimated intercept and b_1 is the estimated slope of the regression.

The regression parameters b_0 and b_1 are estimated using linear regression for the model:

$$\arcsin\left(\sqrt{e_k^{obs}}\right) = \beta_0 + \beta_1 flow_k + \varepsilon, \qquad \textbf{(2)}$$

where e_k^{obs} = observed trap efficiency of Eq. 2 for trapping period *k*;

β_0 = intercept of the regression model;

β_1 = slope parameter;

ε = error with mean 0 and variance σ^2.

In Equation 2, the observed trap efficiency, e_k^{obs}, is calculated as follows,

$$e_k^{obs} = \frac{r_k + 1}{m}. \quad \textbf{(3)}$$

The estimated variance of seasonal migration is calculated from daily estimates as:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var(N_i)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov(N_i, N_j)}_{Part\ B}$$

or, **(4)**

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i+1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov\left(\frac{(C_i+1)}{\hat{e}_i}, \frac{(C_j+1)}{\hat{e}_j}\right)}_{Part\ B}$$

Part A of equation 4 is the variance of daily estimates. Part B is the between-day covariance. Note that the between-day covariance exists only for days that use the same trap efficiency model. If, for example, day 1 is estimated with one trap efficiency model, and day 2 estimated from a different model, then there is no covariance between day 1 and day 2. The full expression for the estimated variance:

$$\widehat{Var}\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i \hat{N}_i^2 \left(\frac{N_i \hat{e}_i (1-\hat{e}_i)}{(C^i+1)^2} + \frac{4(1-\hat{e}_i)}{\hat{e}_i} \widehat{Var}(b_0 + b_1 flow_i)\right)}_{Part\ A}$$
$$+ \underbrace{\sum_i \sum_j 4\left(\hat{N}_i(1-\hat{e}_i)\right)\left(\hat{N}_j(1-\hat{e}_j)\right) \cdot \left[\widehat{Var}(b_0) + flow_i flow_j \widehat{Var}(b_1)\right]}_{Part\ B}$$

where $V\hat{a}r(b_0 + b_1 flow_i) = M\hat{S}E\left(1 + \frac{1}{n} + \frac{(flow_i - \overline{flow})^2}{(n-1)s_{flow}^2}\right)$, and $\hat{V}ar(b_0)$ and $\hat{V}ar(b_1)$ are

obtained from regression results. In Excel, the standard error (SE) of the coefficients is provided. The variance is calculated as the square of the standard error, SE^2.

In cases when there was no significant flow-efficiency relationship (i.e., low correlation), then a pooled, or average trap efficiency will suffice for the stratum. The estimator is calculated as follows:

$$\hat{\bar{e}} = \frac{\sum_{j=1}^{k} r_j}{\sum_{j=1}^{k} m_j}$$

where $\hat{\bar{e}}$ = the average or pooled trap efficiency for the stratum;

m_j = the number of smolts marked and released in efficiency trial j for the stratum;

r_j = the number of smolts recaptured out of m_j marked fish in efficiency trial j.

Abundance for a trapping period is estimated as:

$$\hat{N}_i^{pooled} = \frac{C_i}{\hat{\bar{e}}},$$

,and total stratum abundance is:

$$N^{pooled} = \sum_i \hat{N}_i^{pooled}.$$

The variance of seasonal abundance takes into account the variability in catch numbers that are a result of binomial sampling (Part A), the pooled variance of trap efficiency, $\hat{\bar{e}}$ (Part B), and the covariance in daily estimates that arises from using a common estimate of efficiency across all trapping days (Part C):

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i(1-\hat{\bar{e}})}{\hat{\bar{e}}}\right)}_{Part\ A} + \underbrace{\frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\sum_i \hat{N}_i^2}_{Part\ B} + \underbrace{\frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\sum_i\sum_j \hat{N}_i\hat{N}_j}_{Part\ C}$$

The Part B and Part C terms are combined in the calculation as a new Part B:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \left(\sum_i \frac{\hat{N}_i(1-\hat{\bar{e}})}{\hat{\bar{e}}}\right) + \frac{Var(\hat{\bar{e}})}{\hat{\bar{e}}^2}\left[\sum_i \hat{N}_i^2 + \sum_i\sum_j \hat{N}_i\hat{N}_j\right]$$

The variance of $\hat{\bar{e}}$ is calculated as:

$$V\hat{a}r\left(\hat{\bar{e}}\right) = V\hat{a}r\left(\frac{\sum_{k=1}^{n} r_k}{\sum_{k=1}^{n} m_k}\right) = \frac{\sum_{k=1}^{n}\left(r_k - \hat{\bar{e}}_k m_k\right)^2}{\bar{m}^2 n(n-1)}$$

where $\bar{m}$ is the average release size across all efficiency trial, $\frac{\sum_{k=1}^{n} m_k}{n}$.

Confidence intervals were calculated using the following formulas:

95% confidence interval = $1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$

The single M-R estimator of abundance carries a set of well documented assumptions (Everhart and Youngs 1981; Seber 1982),

1. The population is closed to mortality.
2. The probability of capturing a marked or unmarked fish is equal.
3. Marked fish were randomly dispersed in the population prior to recapture.
4. Marking does not affect probabilities of capture.
5. Marks were not lost between the time of release and recapture.
6. All marks are reported upon recapture.
7. The number of fish in the trap, C, is fully enumerated and known without error.

2.5.2 Estimate of Abundace During Trap Stoppages and Suspended Operations

Daily catch during stoppages of seven days or less was estimated by averaging catch three days prior to, and after the discreet non-trapping event and then applying that value to the consecutive days without operation. This method was used for all target species.

For periods of suspended trapping longer than seven days, a methodology developed and currently employed by local WDFW smolt trap operators was used (J. Williams, personal communication, March 8, 2017). This method uses historic run-timing to determine the proportion of the entire emigrant estimate missed during the period of suspended trapping. Once determined, the estimated percentage can be used with in-year data to extrapolate how many fish were missed. This method was used exclusively during the fall migratory period, when low summer flows commonly result in extended stoppages. Because steelhead are considered non-migratory during this period, this type of estimate was only applied to spring Chinook subyearlings.

2.5.3 Estimate of Abundance During The Winter Non-Trapping Period

An estimate of spring Chinook emigration during the non-trapping period (December 1 through February 28) was calculated using remote-tagged spring Chinook parr and the lower Nason Creek PIT tag array (NAL). A flow-detection efficiency regression was developed using mark-groups previously released to test the efficiency of the smolt trap. Daily spring Chinook detections at the NAL array and the developed regression were then applied to the Bailey estimator, as was peformed with daily trap abundance data (See equation **2.5.1 Estimate of Abundance**). Tag rate determined at the Nason Creek smolt trap was used to account for unmarked emmigrants passing the NAL array.

Tag rate, t_i, was calculated as:

$$t_i = \frac{t}{p}$$

where t = total smolt trap recaptures subsequent to the tagging effort;
p = total catch at the smolt trap.

Daily abundace during the non-trapping period is calculated as:

$$\hat{N}_i = \left(\frac{C_i}{\hat{e}_i}\right) \Big/ t_i ,$$

where C_i = number of fish caught in period I;
$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2(b_0 + b_1 flow_i)$;
t_i = tag rate.

2.5.4 Production and Survival

Production estimates by age class were summed to produce a total emigration estimate. For spring Chinook and coho, estimates of fall-migrating parr were added to subsequent spring smolt estimates to generate a single brood year estimate. For steelhead, a single brood year was deemed completely emigrated from Nason Creek after three consecutive years of outmigration. Age 4+ steelhead smolts have been previously identified via scale analysis, but are extremely uncommon. Pending eventual scale analysis, steelhead captured in 2017 were aged via an age-length histogram built upon previously analyzed scale samples. For all three species, egg-to-emigrant estimates were calculated by dividing estimated emigrants by approximated egg deposition during a spawning brood (average fecundity used to determine egg deposition derived from WDFW Chiwawa broodstock spawning). The number of emigrants-per-redd for each brood year was calculated by dividing the total emigrant estimate by the number of redds counted during spawning ground surveys.

3.0 RESULTS

3.1 Dates of Operation

The Nason Creek smolt trap was installed on February 27, and operated in its fixed position for the entirety of the trapping season (March 1 to November 30). Removal of the trap occurred on December 5. We attempted to run the trap continuously 24 hours a day, 7 days per week. In total, the trap was operated for 180 days (Table 1). The primary cause of un-trapped days was a prolonged period (66 days) of intentional pulling due to base flow conditions (~ ≤50 cfs).

Table 1. Summary of Nason Creek rotary trap operation.

Date of Trap Operations	Trap Status	Description	Days
March 1 to June 30	Operating	Continuous data collection	114
	Interrupted	Interrupted by debris	5
	Pulled	Intentionally pulled due to high flow, low flow, or heavy debris load	3
July 1 to November 30	Operating	Continuous data collection	76
	Interrupted	Interrupted by debris	9
	Pulled	Intentionally pulled due to high flow, low flow, or heavy debris load	68

3.2 Daily Captures and Biological Sampling

3.2.1 Spring Chinook Yearlings (BY2015)

Between March 1 and June 30, a total of 357 wild Chinook yearlings were captured (Figure 3). A peak catch of 63 yearling smolts coincided with an early spike in discharge occurring in mid-March. Following this peak, catch dropped substantially with the last yearlings captured on May 20. Mean FL and weight for Chinook yearlings was 96 mm (n = 357; SD = 6.5) and 9.8 g (n = 357; SD = 2.1; Table 2), respectively. Tissue samples were collected from 344 fish for an ongoing, parental-based DNA analysis by WDFW. There was one yearling trapping mortality incurred.

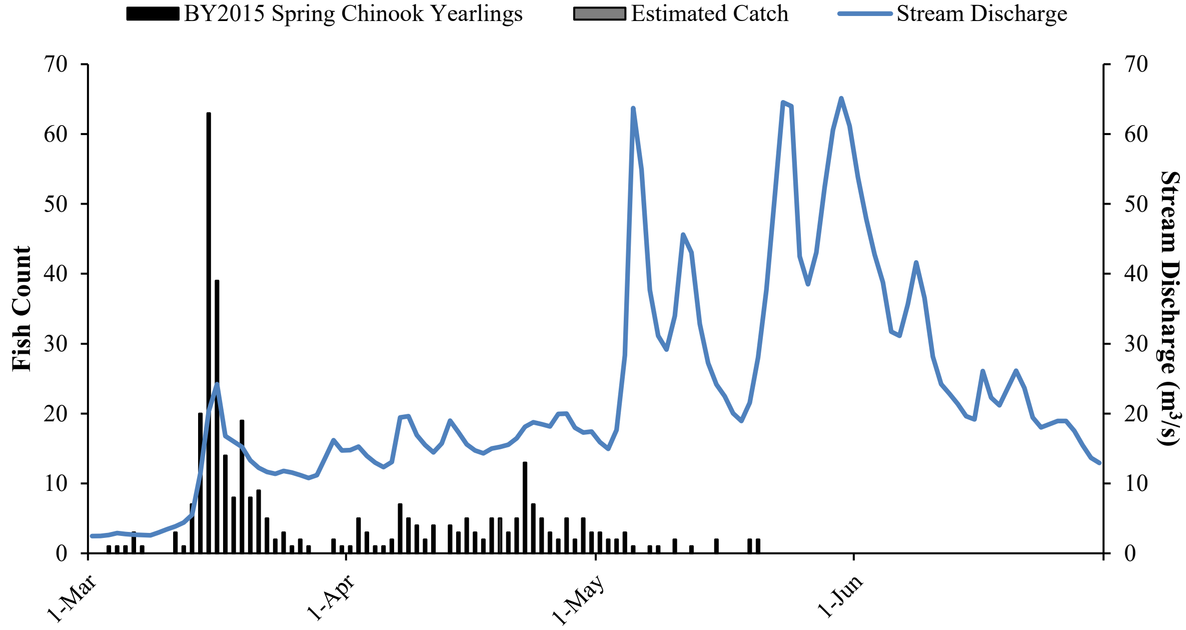


Figure 4. Daily catch of BY2015 spring Chinook yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2017.

Table 2. Summary of length and weight sampling of juvenile spring Chinook captured at the Nason Creek rotary trap in 2017.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2015	Wild Spring Chinook Yearling Smolt	96	357	6.6	9.8	357	2.1	1.09
2016	Wild Spring Chinook Subyearling Fry	39	557	3.9	0.5	557	0.3	0.85
2016	Wild Spring Chinook Subyearling Parr	74	1,864	12.3	4.7	1,863	2.1	1.10
2015	Hatchery Spring Chinook Yearling Smolt	115	143	10.3	18.4	143	5.4	1.20

3.2.2 Spring Chinook Subyearlings (BY2016)

A total of 1,877 wild spring Chinook subyearling parr (FL ≥ 50 mm) and 613 subyearling fry (FL < 50 mm) were captured in 2017 (Figure 4). The majority of parr movement was documented in late October following the first fall freshets. Mean FL and weight among subyearling parr was 74 mm (*n* = 1,864; *SD* = 12.3) and 4.7 g (*n* = 1,863; *SD* = 2.1), respectively. We estimate that an additional 352 Chinook subyearling parr would have been captured during short stoppages (≤7 days) had the trap run without interruption. Daily catch estimates were not made during the two periods of suspended trapping; total emigrant estimates for these two periods will be included in section 3.4.2. Tissue samples were collected from 1,128 fish for an ongoing, parental-based DNA analysis by WDFW. Four subyearling Chinook (two fry and two parr) mortalities occurred in 2017. All deaths were attributed to trapping.

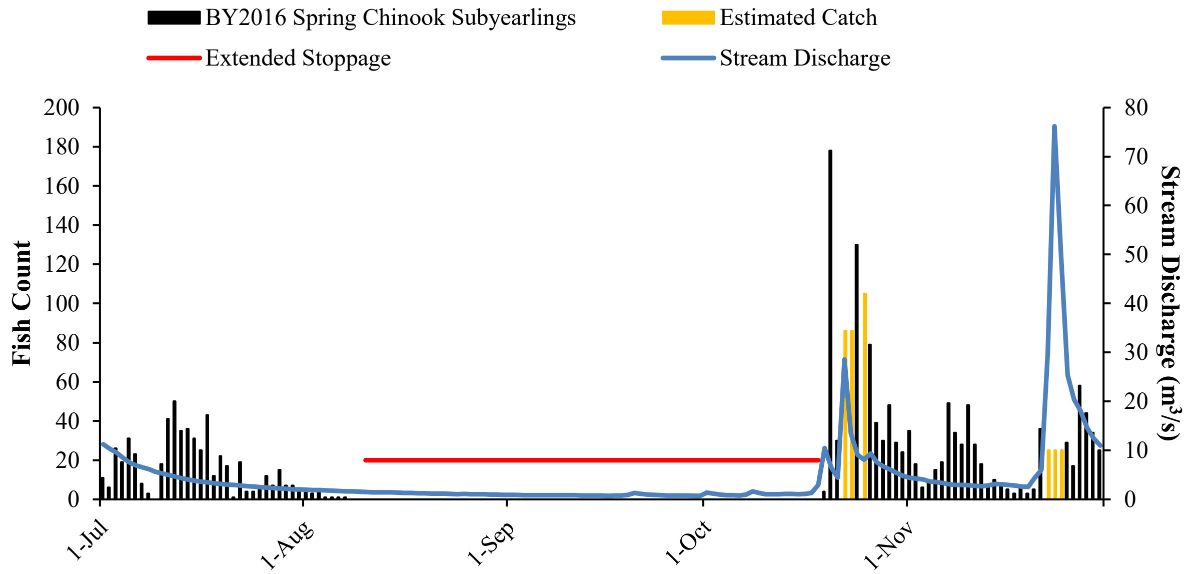


Figure 5. Daily catch of BY2016 spring Chinook subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2017.

3.2.3 Hatchery Spring Chinook Smolts (BY2015)

On April 19, 243,127 hatchery spring Chinook smolts were released directly from the Grant County Public Utility District (GCPUD) Nason Creek Acclimation Facility located at rkm17.3. Subsequently, a total of 1,870 smolts were captured with a mean FL and weight of 114 mm (n =143; SD = 10.3) and 18.4 g (n = 143; SD = 5.4), respectively (Figure 5). Hatchery spring Chinook were not captured at the smolt trap beyond June 14, with majority of catch occurring immediately after initial release. There were no mortalities incurred.

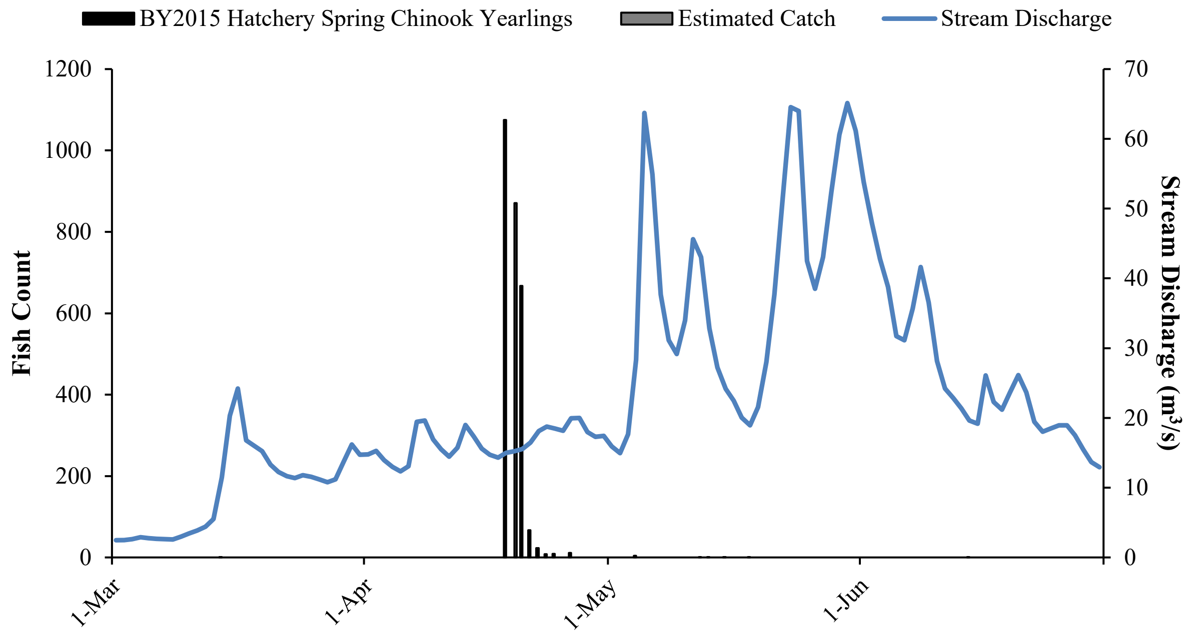


Figure 6. Daily catch of BY2015 hatchery spring Chinook smolts with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2017.

3.2.4 Summer Steelhead

A total of 1,562 wild summer steelhead juveniles were captured throughout the season from March 1 to November 30, with a peak catch of 61 juveniles on May 8 (Figures 6&7). We estimated that nine (eight age-1 and one age-2) juveniles would have been captured had there been no interruptions to trapping during the migratory period (Mar 1 to July 31). Histogram analysis of known steelhead ages sampled from 2005 to 2016 allowed us to estimate ages of fish captured in 2017 using FL. We estimated that of the total steelhead captured, 377 were young-of-the-year (BY2017), 1,111 were age-1 (BY2016), and 74 were age-2 (BY2015). Subyearling steelhead had a mean FL of 54 mm (n = 370; SD = 17.6), and a mean weight of 2.5 g (n = 306; SD = 1.5). The majority of steelhead juveniles captured during the spring emigration were age-1 parr. Mean FL and weight of age-1 fish was 88 mm (n = 1,109; SD = 14.5; Table 3) and 8.1 g (n = 1,108; SD = 4.4), respectively. Age-2 steelhead were caught primarily in the spring, with only three fish being captured after July 31. Mean FL and weight of age-2 fish was 150 mm (n = 74; SD = 15.8) and 35.6 g (n = 74; SD = 11.0), respectively. Scales were taken from a sub-sample (n = 175) of steelhead with FL ≥ 60 mm to be used for future age analyses. One mortality was incurred.

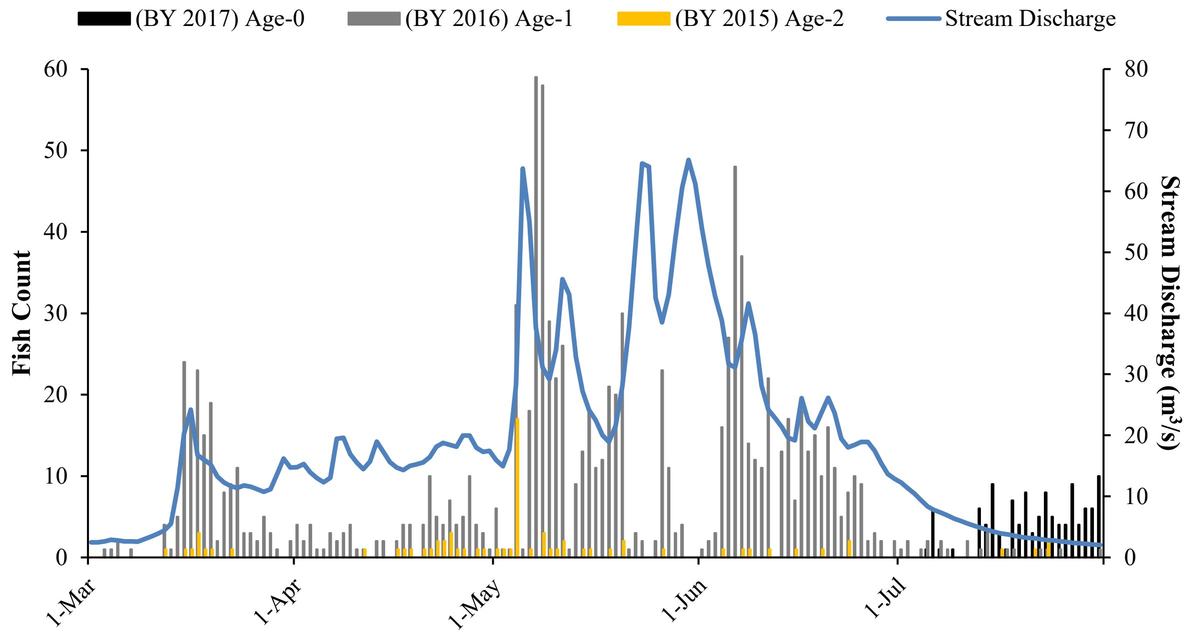


Figure 7. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, March 1 to July 31, 2017. Estimates of fish passage during trap interruptions are not depicted.

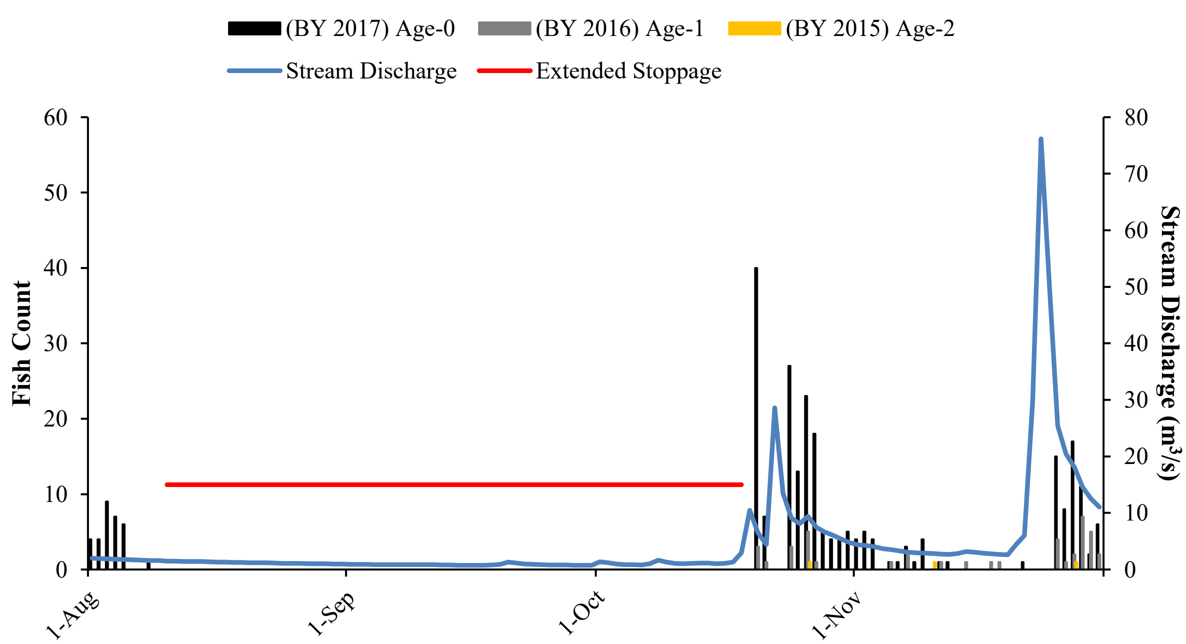


Figure 8. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, August 1 to November 30, 2017. Estimates of fish passage during trap interruptions are not depicted.

Table 3. Summary of length, weight and condition factor by age class of wild summer steelhead emigrants and hatchery steelhead captured at the Nason Creek rotary trap.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2017	Wild Summer Steelhead (Age-0)	54	370	17.6	2.5	306	1.5	1.05
2016	Wild Summer Steelhead (Age-1)	88	1,109	14.5	8.1	1,108	4.4	1.09
2015	Wild Summer Steelhead (Age-2)	150	74	15.8	35.6	74	11.0	1.02
2016	Hatch. Summer Steelhead Smolt	167	497	19.2	43.3	497	17.8	0.99

3.2.5 Hatchery Steelhead Smolts (BY2016)

During April and May, WDFW directly planted a total of 46,588 hatchery summer steelhead smolts into Nason Creek above the smolt trap (M. Babiar, personal communication, February 15, 2018). Subsequently, a total of 1,122 hatchery steelhead were captured at the smolt trap with a mean FL and weight of 167 mm (n =496; SD = 19.2) and 48.3 g (n = 496; SD = 17.9), respectively (Figure 8). Hatchery origin was determined by the presence of coded wire tags (CWT). There were 49 hatchery-origin steelhead trapping mortalities (See section 3.7 ESA Compliance).

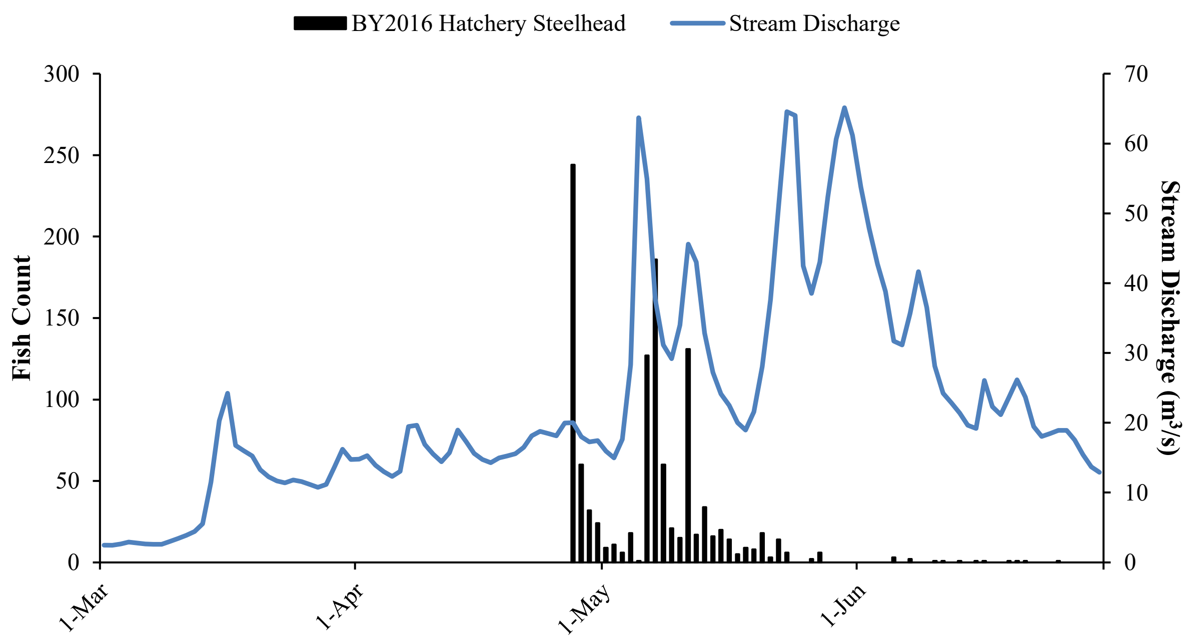


Figure 9. Daily catch of BY2016 hatchery steelhead smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2017.

3.2.6 Bull Trout

Bull trout presence at the trap in 2017 was limited to a single fish with a FL of 215 mm and weight of 92.4 g. The bull trout was released immediately after morphometric measurements were taken. No other sampling/tagging activities were performed.

3.2.7 Coho Yearlings (BY2015)

There were no BY2015 naturally-produced coho smolts captured at the Nason Creek smolt trap in 2017.

3.2.8 Coho Subyearlings (BY2016)

There were no BY2016 naturally-produced coho fry or parr captured at the Nason Creek smolt trap in 2017.

3.2.9 Hatchery Coho Smolts (BY2015)

A total of 127,290 hatchery coho were released into Nason Creek above the trap in spring of 2017. All hatchery coho released were acclimated in natural ponds adjacent to Nason Creek and reared to smolt stage prior to volitional release. Between March 1 and June 30, a total of 1,423 hatchery coho were captured at the trap (Figure 10). Mean FL was 123 mm (n = 548; SD = 8.0) and mean weight was 20.1 g (n = 548; SD = 4.1; Table 2). A peak daily catch of 247 hatchery coho smolts occurred on May 20 following volitional release into Nason Creek. One trapping mortality was incurred. Hatchery coho emigration data at the Nason Creek trap assists the MCCRP by providing size-at-emigration, emigration timing and duration of residence in Nason Creek.

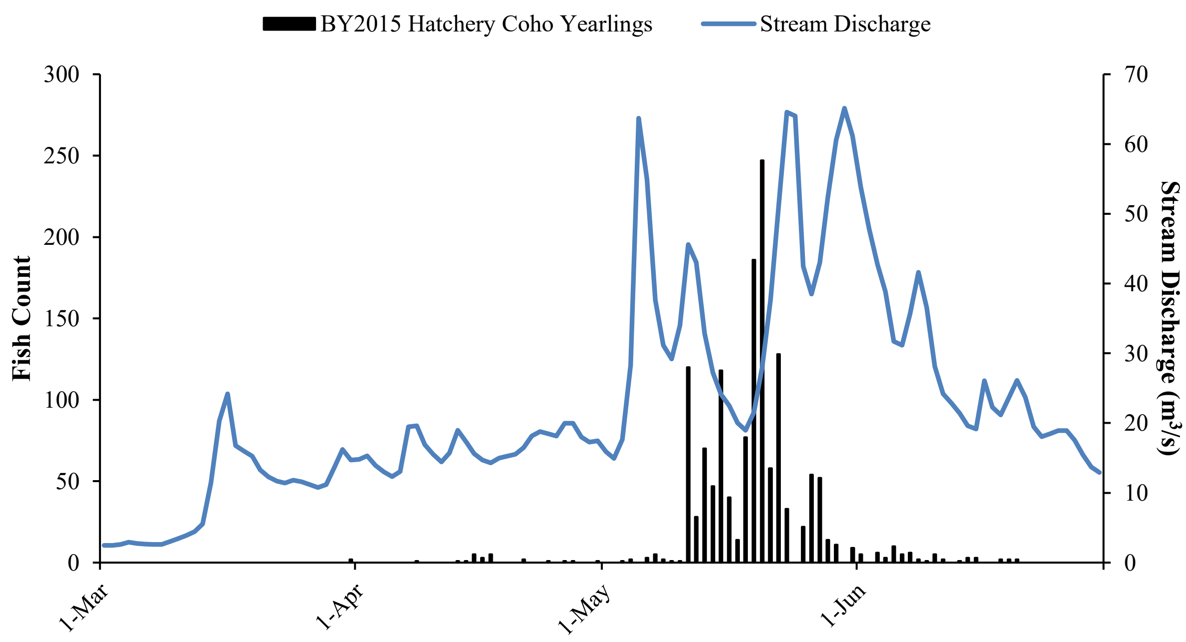


Figure 10. Daily catch of BY2015 hatchery coho smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2017.

3.3 Remote Spring Chinook Tagging and Non-Trapping Estimates

3.3.1 BY2015 Parr

YNFRM and WDFW personnel PIT tagged and released a total of 802 BY2015 spring Chinook parr between September 12 and October 6, 2016 (Table 4). The total surveyed area included Nason Creek from rkm 0.8 to 26.1. All collections were performed via backpack electrofisher. Equal capture effort (measured in electrofisher seconds used) was applied across all reaches.

Table 4. Remote parr tagging results, BY2013 -2016.

Brood Year	Mark Year	Total Marked	Estimated Tag Rate	Detections at NAL		Non-Trapping Estimate
				Total	Non-Trapping Period	
2013	2014	1,821	3.8%	311	13	6,822
2014	2015	1,214	2.0%	100	2	1,442
2015	2016	802	2.8%	60	26	4,407
2016	2017	3,401	—	—	—	—

Between October 1, 2016 and March 31, 2017, a total of 60 re-sights of the remote tagged spring Chinook were documented at the NAL array (Figure 11). Of these detections, 26 were during the winter non-trapping period. Antenna operation during this period was continuous, with no losses in coverage or periods of inactivity. The upstream gauge was inactive during the majority of the non-trapping period, which did not allow concurrent measurement of discharge. Measurement of gauge height was continuous during this period, and acted as a surrogate measurement.

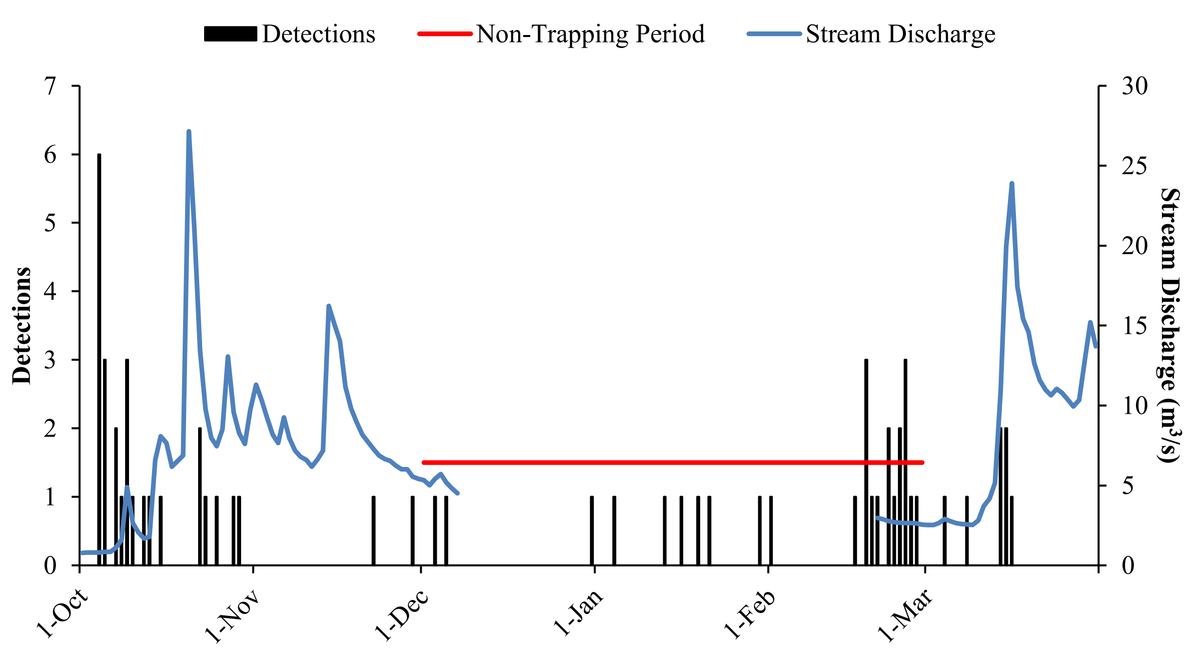


Figure 11. Daily detections of remote-tagged BY2015 spring Chinook at the lower Nason Creek PIT tag antenna array (NAL) between October 2016 and March 2017.

Subsequent to the remote tagging effort, ten remote-tagged BY2015 spring Chinook were recaptured at the Nason Creek smolt trap. Total spring Chinook catch at the smolt trap was 357 emigrants during the same period. The pooled tag rate for remote-tagged spring Chinook captured at the Nason smolt trap was 2.8%. Parr emmigration during the non-trapping period was estimated using a flow-efficiency regression ($r^2 = 0.61$; $p = 0.0002$) based on detections at the NAL pit tag array. We estimated that 4,407 (± 1,004; 95% CI) BY2015 spring Chinook emigrated out of Nason Creek during the non-trapping period (Table 4).

3.3.2 BY2016 Parr

During remote tagging efforts in the fall of 2017, 3,246 spring Chinook were PIT tagged by YNFRM and WDFW personnel (Table 4). Because tag rate cannot be estimated until the completion of the BY2016 emigrant estimate in the spring/summer of 2018, an estimate of emigration during the non-trapping period will not be reported until the following report.

3.4 Trap Efficiency Calibration and Population Estimates

3.4.1 Spring Chinook Yearlings (BY2015)

Infrequent releases, low abundance, and a lack of recaptures did not allow a flow-efficiency model to be used on BY2015 yearling emigrants. In order to produce an estimate, a pooled efficiency (4.9%) composed of spring Chinook yearling releases in 2017 was used (Table 5). We recognize the sub-optimal nature of this estimation methodology, and will recalculate the estimates using linear regression analysis as soon as feasible. We estimated a total of 7,247 (± 10,224; 95% CI) BY2015 spring Chinook yearlings emigrated in spring of 2017 (Table 6). Combined with the non-trapping estimate of 4,407 (± 1,004; 95% CI) emigrants, and a recalculated BY2015 subyearling estimate of 6,528 (± 1,476; 95% CI), we estimated that a total of 18,182 (± 10,397; 95% CI) BY2015 spring Chinook juveniles emigrated from Nason Creek.

Table 5. Trap efficiency trials conducted with BY2015 wild spring Chinook yearlings.

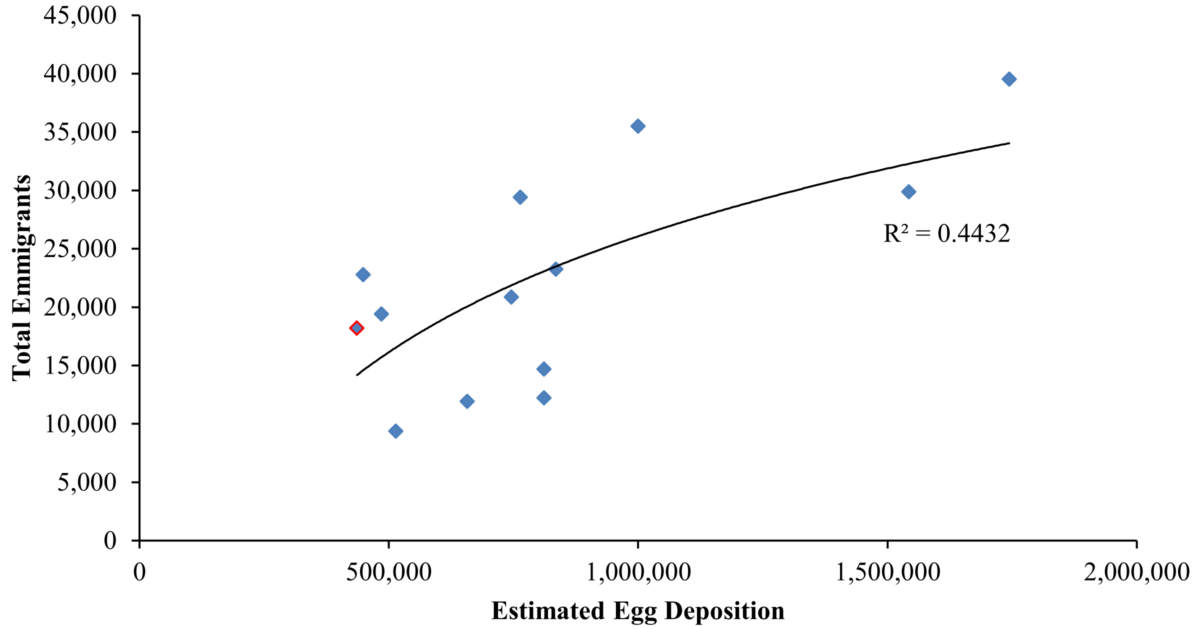
Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (m^3/s)
Wild Chinook Yearlings	1+	3/6/2017	6	0	3
Wild Chinook Yearlings	1+	3/10/2017	1	0	3
Wild Chinook Yearlings	1+	3/14/2017	31	2	11
Wild Chinook Yearlings	1+	3/15/2017	63	3	20
Wild Chinook Yearlings	1+	3/17/2017	68	5	17
Wild Chinook Yearlings	1+	3/22/2017	41	1	11
Wild Chinook Yearlings	1+	3/26/2017	8	0	10
Wild Chinook Yearlings	1+	3/30/2017	2	0	15
Wild Chinook Yearlings	1+	4/3/2017	10	1	13

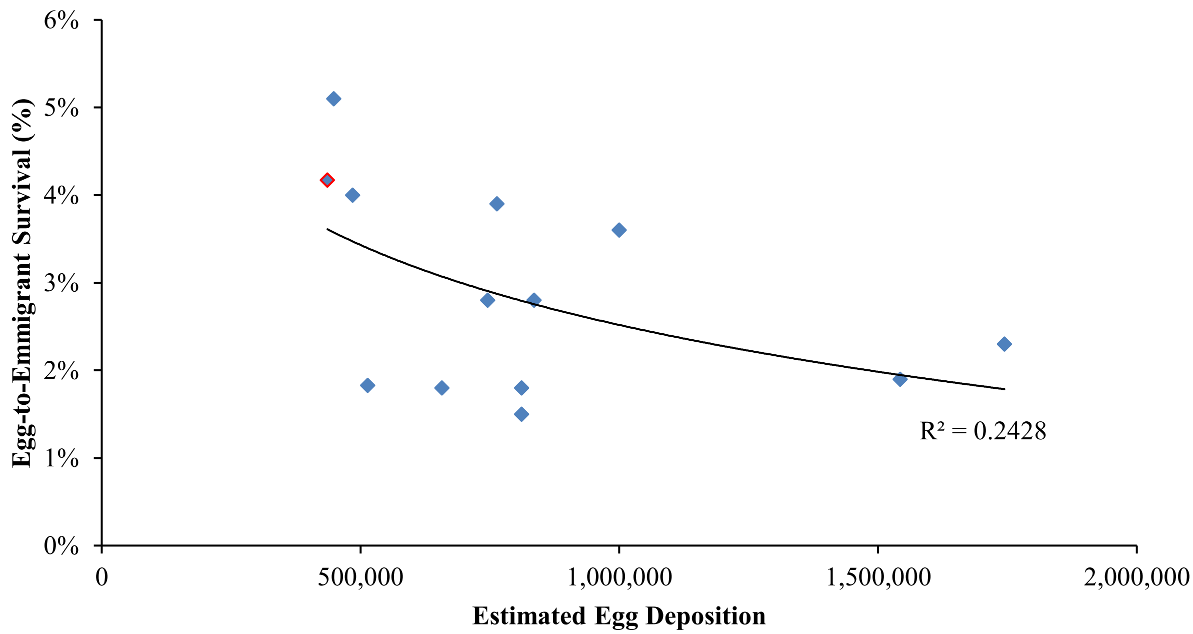
Wild Chinook Yearlings	1+	4/7/2017	11	2	18
Wild Chinook Yearlings	1+	4/11/2017	15	1	13
Wild Chinook Yearlings	1+	4/16/2017	15	0	14
Wild Chinook Yearlings	1+	4/20/2017	10	0	15
Wild Chinook Yearlings	1+	4/24/2017	30	1	18
Wild Chinook Yearlings	1+	4/28/2017	12	1	17
Wild Chinook Yearlings	1+	5/2/2017	13	0	15
Wild Chinook Yearlings	1+	5/6/2017	5	0	56
Wild Chinook Yearlings	1+	5/8/2017	1	0	33
Wild Chinook Yearlings	1+	5/10/2017	2	0	35
Wild Chinook Yearlings	1+	5/18/2017	2	0	20
Wild Chinook Yearlings	1+	5/20/2017	4	0	30
Total			**350**	**17**	

Table 6. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek spring Chinook salmon.

Brood Year	No. Redds	Fecundity[a]	Est. Egg Deposition	No. of Emigrants				Egg-to-Emigrant	Emigrants per Redd
				Age-0[b]	Non Trap[d]	Age-1	Total ± 95% CI		
2002	294	4,654	1,368,276	—	—	4,683	—	—	—
2003	83	5,844	485,052	13,067	—	6,358	19,425 ± 1,993	4.0%	234
2004	169	4,799	811,031	12,111	—	2,597	14,708 ± 2,938	1.8%	87
2005	193	4,327	835,111	14,565	—	8,696	23,261 ± 5,440	2.8%	121
2006	152	4,324	657,248	4,144	—	7,798	11,942 ± 1,744	1.8%	79
2007	101	4,441	448,541	17,097	—	5,679	22,776 ± 2,983	5.1%	226
2008	336	4,592	1,542,912	26,284	—	3,611	29,895 ± 7,244	1.9%	89
2009	167	4,573	763,691	27,720	—	1,705	29,425 ± 12,777	3.9%	176
2010	188	4,314	811,032	8,685	—	3,535	12,220 ± 1,972	1.5%	65
2011	170	4,385	745,450	18,457	—	2,422	20,879 ± 3,887	2.8%	123
2012	413	4,223	1,744,099	34,961	—	4,561	39,522 ± 6,395	2.3%	96
2013	212	4,716	999,792	21,697	6,822	6,992[e]	35,511 ± 34,195	3.6%	168
2014	115	4,467	513,705	7,020	1,442	930[e]	9,393 ± 5,299	1.8%	82
2015	85	5,132	436,220	6,528	4,407	7,247[e]	18,182 ± 10,379	4.2%	214
2016	85	4,674	397,290	26,336	—	—	—	—	—
Avg.[c]	183	4,626	830,299	16,334	—	4,779	22,088	2.8%	135

[a] Data provided by Hillman et al. 2016.
[b] Does not include subyearling fry prior to July 1.
[c] 12-year average of complete brood data, BY2003-2015.
[d] Estimated emigration during the winter non-trapping period (December 1 – February 28).
[e] Pooled estimate


45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Total Emmigrants
R² = 0.4432
0
500,000
1,000,000
1,500,000
2,000,000
Estimated Egg Deposition


6%
5%
4%
3%
2%
1%
0%
Egg-to-Emmigrant Survival (%)
R² = 0.2428
0
500,000
1,000,000
1,500,000
2,000,000
Estimated Egg Deposition

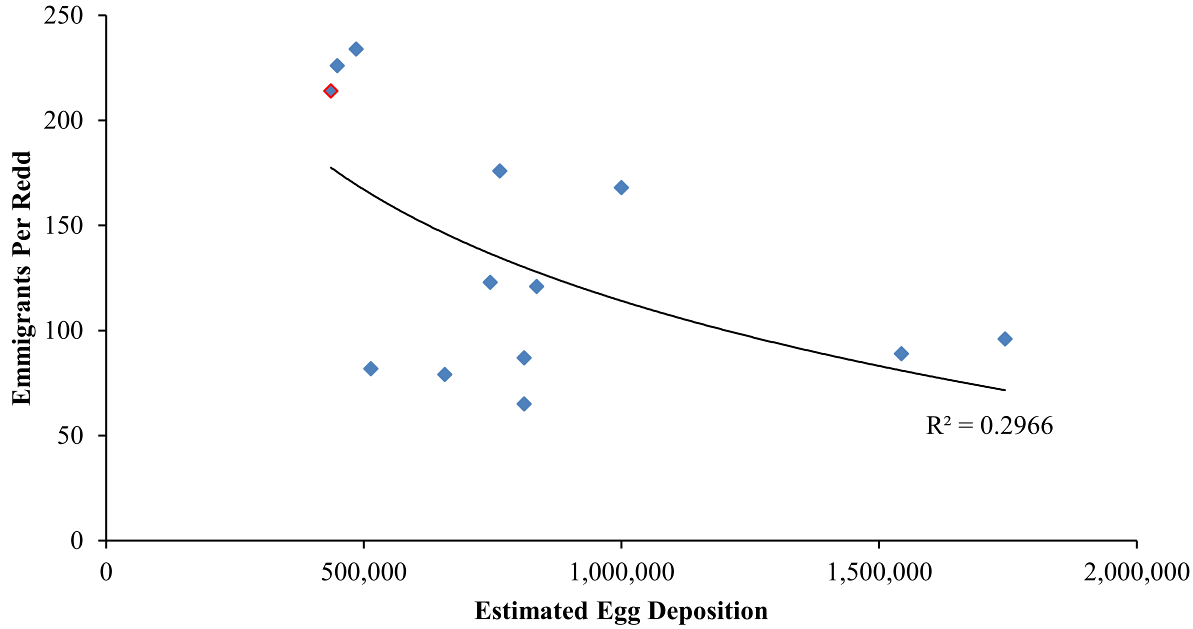


Figure 12. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek spring Chinook, BY 2003 to 2015. *2015 brood (denoted by red border) does not include non-trapping estimate.

3.4.2 Spring Chinook Subyearlings (BY2016)

A linear regression model was developed using subyearling mark groups released in the fall 2014, 2016, and 2017. The resulting regression ($r^2 = 0.11$; $p = 0.12$) was below the desired level of statistical level of significance. However, this was solely attributed to an outlier value resulting from a single efficiency trial on October 31 (Table 7). Without this single outlier, the regression proved significant ($r^2 = 0.60$; $p = 0.0004$). We decided to use the regression (including the outlier) due to the small actual effect of the outlier. Using this model we estimated that a total of 26,336 (± 5,213; 95% CI) BY2016 spring Chinook emigrated past the trap in the fall of 2017.

Table 7. Efficiency trials conducted with BY2016 wild spring Chinook subyearlings.

Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (m^3/s)
Wild Chinook Subyearlings	0	7/4/2017	13	3	8
Wild Chinook Subyearlings	0	7/8/2017	8	0	6
Wild Chinook Subyearlings	0	7/13/2017	68	1	4
Wild Chinook Subyearlings	0	7/17/2017	71	3	3
Wild Chinook Subyearlings	0	7/21/2017	28	2	3
Wild Chinook Subyearlings	0	7/25/2017	26	0	3
Wild Chinook Subyearlings	0	7/29/2017	34	5	2
Wild Chinook Subyearlings	0	8/2/2017	11	0	2

Wild Chinook Subyearlings	0	8/6/2017	5	0	2
Wild Chinook Subyearlings	0	10/23/2017	183	22	13
Wild Chinook Subyearlings	0	10/27/2017	248	24	8
Wild Chinook Subyearlings	0	10/31/2017	114	24	5
Wild Chinook Subyearlings	0	11/4/2017	65	4	4
Wild Chinook Subyearlings	0	11/8/2017	111	16	3
Wild Chinook Subyearlings	0	11/12/2017	115	6	3
Wild Chinook Subyearlings	0	11/27/2017	98	11	18
Total			**1,198**	**121**	

3.4.3 Summer Steelhead

Releases of PIT-tagged steelhead were performed every four days at the established release location (Table 8). Because a viable flow-efficiency regression could not be obtained, a pooled estimate was used. In a total of 39 separate trials, 1,082 wild summer steelhead were released upstream with 56 recaptures (5.2%). Estimates of age-0 fry and parr were not made due to insufficient evidence that active migration is occurring at this young age. Previous attempts at the old location to build a model based on young-of-the-year steelhead parr in the fall have yielded weak flow-efficiency relationships; further suggesting that age-0 parr catch is the result of displacement rather than active migration. We estimated that 20,829 (± 30,791; 95% CI) BY2016 age-1, and 1,391 (± 2,079; 95% CI) BY2015 age-2 steelhead emigrated past the trap in 2017 (Table 9). We estimated that total (age 1-2) BY2014 emigration to be 23,728 (± 124,628; 95% CI). All pooled estimates will be recalculated upon development of a species-specific flow-efficiency model.

Table 8. Efficiency trials conducted with wild summer steelhead juveniles.

Origin/Species/Stage	Date	Marked	Recaptured	Discharge (m^3/s)
Wild Steelhead Parr/Smolt	3/6/2017	4	0	3
Wild Steelhead Parr/Smolt	3/10/2017	1	0	3
Wild Steelhead Parr/Smolt	3/14/2017	11	1	11
Wild Steelhead Parr/Smolt	3/17/2017	54	5	17
Wild Steelhead Parr/Smolt	3/22/2017	40	3	11
Wild Steelhead Parr/Smolt	3/26/2017	17	1	10
Wild Steelhead Parr/Smolt	3/30/2017	8	0	15
Wild Steelhead Parr/Smolt	4/3/2017	10	0	13
Wild Steelhead Parr/Smolt	4/7/2017	6	0	18
Wild Steelhead Parr/Smolt	4/11/2017	10	1	13
Wild Steelhead Parr/Smolt	4/16/2017	7	0	14
Wild Steelhead Parr/Smolt	4/20/2017	15	2	15
Wild Steelhead Parr/Smolt	4/24/2017	34	0	18
Wild Steelhead Parr/Smolt	4/28/2017	26	1	17
Wild Steelhead Parr/Smolt	5/2/2017	14	2	15
Wild Steelhead Parr/Smolt	5/4/2017	50	3	32

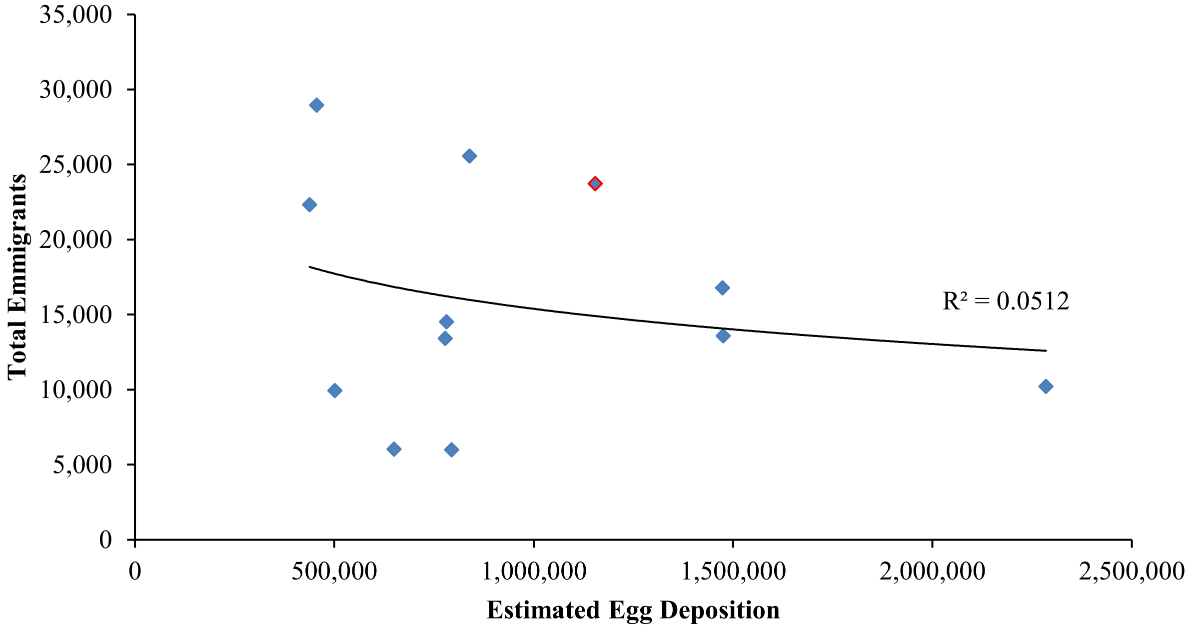
Wild Steelhead Parr/Smolt	5/6/2017	19	0	56
Wild Steelhead Parr/Smolt	5/7/2017	59	5	39
Wild Steelhead Parr/Smolt	5/8/2017	61	5	33
Wild Steelhead Parr/Smolt	5/10/2017	52	1	35
Wild Steelhead Parr/Smolt	5/14/2017	51	7	29
Wild Steelhead Parr/Smolt	5/18/2017	63	4	20
Wild Steelhead Parr/Smolt	5/20/2017	51	1	30
Wild Steelhead Parr/Smolt	5/24/2017	6	0	66
Wild Steelhead Parr/Smolt	5/28/2017	38	0	54
Wild Steelhead Parr/Smolt	6/1/2017	5	0	54
Wild Steelhead Parr/Smolt	6/5/2017	48	2	32
Wild Steelhead Parr/Smolt	6/7/2017	86	4	35
Wild Steelhead Parr/Smolt	6/11/2017	57	0	24
Wild Steelhead Parr/Smolt	6/15/2017	53	2	18
Wild Steelhead Parr/Smolt	6/20/2017	55	4	25
Wild Steelhead Parr/Smolt	6/24/2017	35	2	17
Wild Steelhead Parr/Smolt	6/28/2017	15	0	14
Wild Steelhead Parr/Smolt	7/4/2017	4	0	8
Wild Steelhead Parr/Smolt	7/8/2017	5	0	6
Wild Steelhead Parr/Smolt	7/13/2017	2	0	4
Wild Steelhead Parr/Smolt	7/17/2017	5	0	3
Wild Steelhead Parr/Smolt	7/21/2017	2	0	3
Wild Steelhead Parr/Smolt	7/25/2017	3	0	3
Total		**1,082**	**56**	

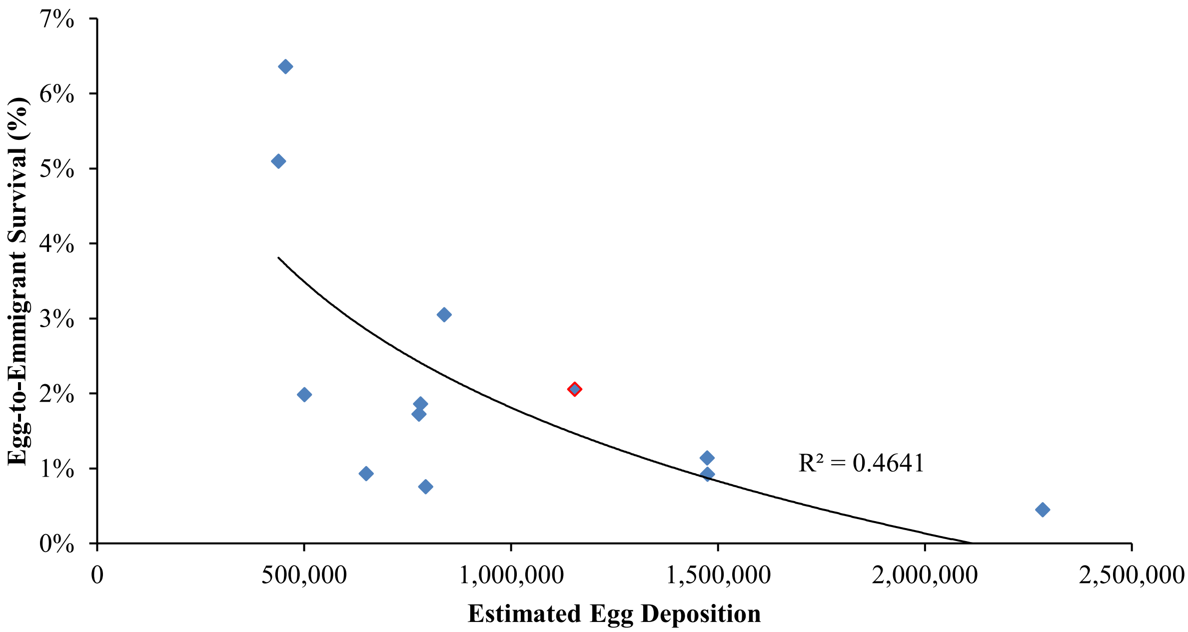
Table 9. Estimated egg-to-emigrant survival and emigrants-per-redd production for Nason Creek summer steelhead.

Brood Year	No. of Redds	Fecundity[a]	Est. Egg Deposition	No. of Emigrants				Egg-to-Emigrant	Emigrants per Redd
				1+	2+	3+	Total ± 95%CI		
2001	27	5,951	160,677	DNOT	DNOT	846	—	—	—
2002	80	5,776	462,080	DNOT	2,475	0	—	—	—
2003	121	6,561	793,881	4,906	1,054	27	5,987 ± 1,193	0.80%	49
2004	127	5,118	649,986	5,107	906	22	6,035 ± 885	0.90%	48
2005	412	5,545	2,284,540	7,416	2,502	298	10,216 ± 2,147	0.40%	25
2006	77	5,688	437,976	19,609	2,673	37	22,319 ± 5,722	5.10%	290
2007	78	5,840	455,520	26,518	2,325	117	28,960 ± 7,739	6.40%	371
2008	88	5,693	500,984	8,782	1,164	0	9,946 ± 2,382	2.00%	113
2009	126	6,199	781,074	13,606	608	312	14,526 ± 2,868	1.90%	115
2010	270	5,458	1,473,660	12,767	3,999	0	16,776 ± 3,885	1.10%	62
2011	235	6,276	1,474,860	13,109	482	0	13,591 ± 3,525	0.90%	58
2012	158	5,309	838,822	24,637	813	116[c]	25,566 ± 6,020	3.00%	162
2013	135	5,749	777,735	11,837	1,508[c]	72[c]	13,417 ± 9,133	1.73%	99
2014	198	5,831	1,154,538	22,504[c]	1,224[c]	0	23,728 ± 124,628	2.10%	120

2015	163	6,220	1,013,860	19,872[c]	1,391[c]	—	—	—	—
2016	92	5,392	496,064	20,829[c]	—	—	—	—	—
Avg[b]	169	5,772	968,631	13,481	1,605	83	15,992	2.2%	126

[a] Data provided by Hillman et al. 2016
[b] 12-year average of complete brood estimates, BY2003-2014
[c] Pooled estimate





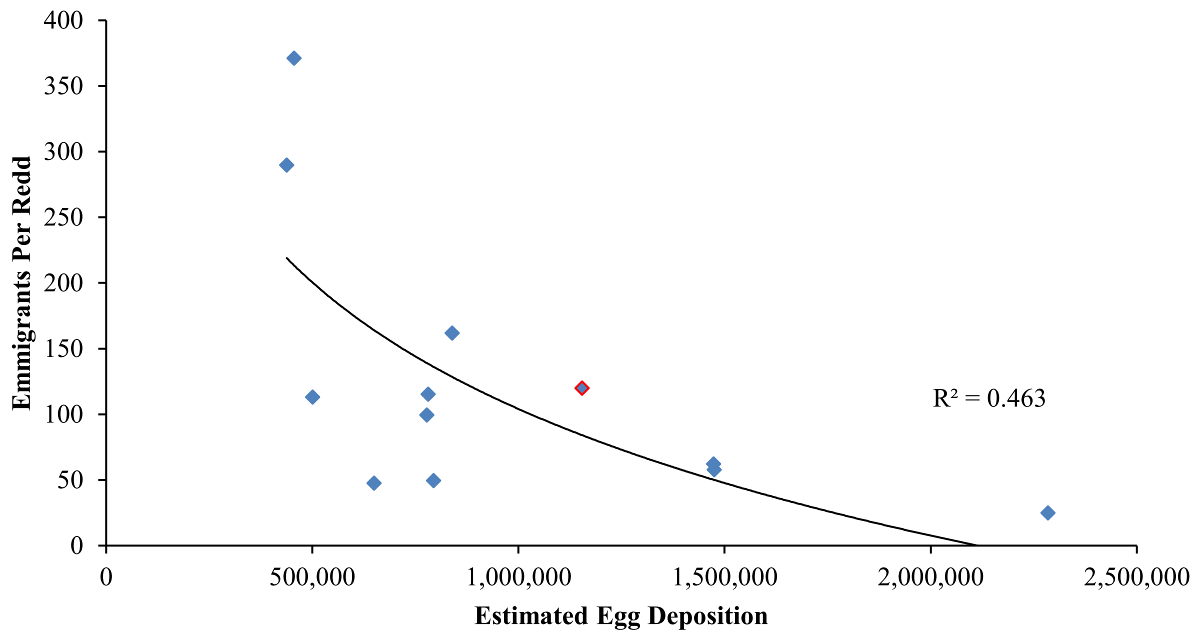


Figure 13. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek summer Steelhead, BY 2003 to 2014. *2014 brood denoted by red border.

3.4.4 Coho Yearlings (BY2015)

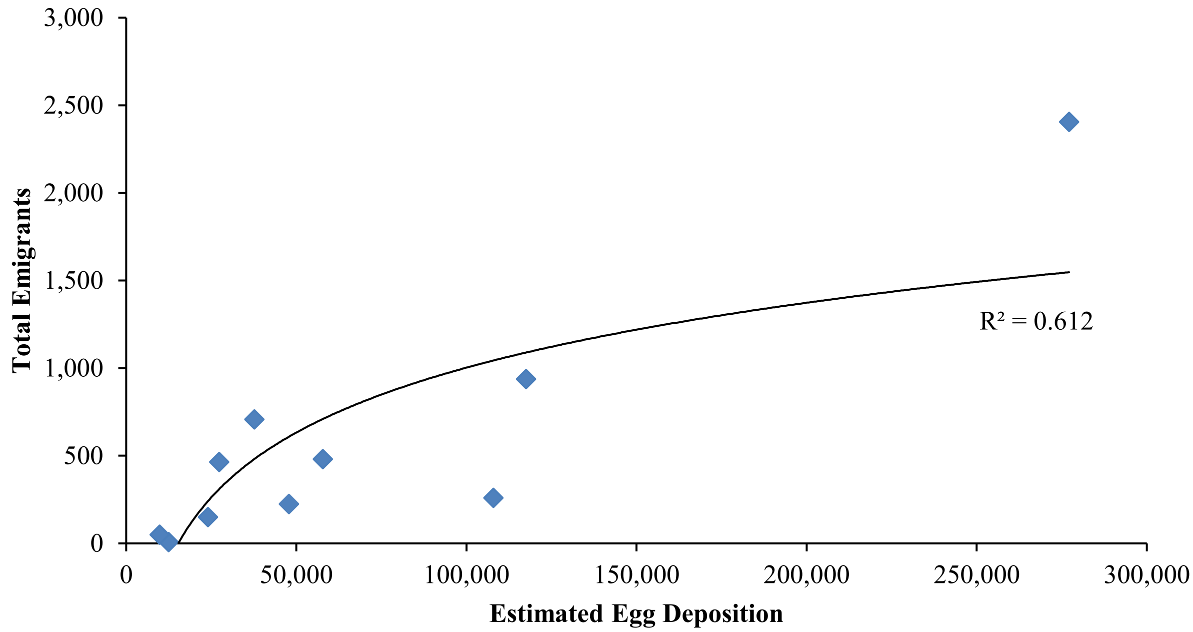
Due to lack of BY2015 naturally-produced coho catch, we concluded that there were no emigrants from Nason in 2017 (Table 10).

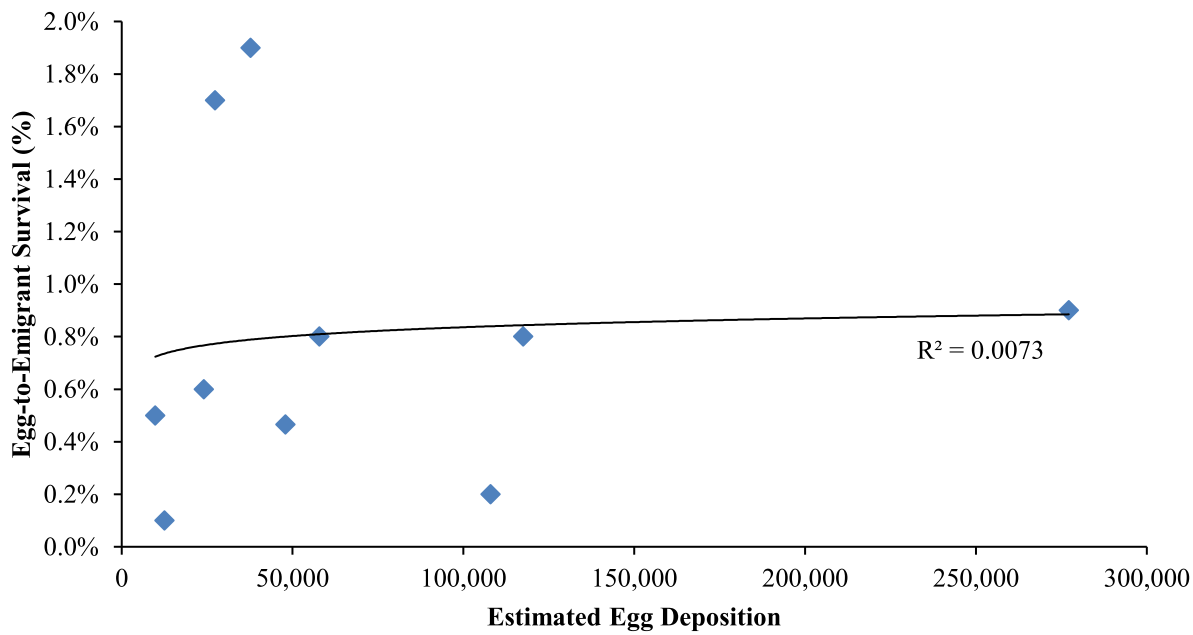
Table 10. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek coho salmon.

Brood Year	No. of Redds	Fecundity	Est. Egg Deposition	No. of Emigrants			Egg-to-Emigrant	Emigrants per Redd
				Age-0[a]	Age-1	Total ± 95% CI		
2003	6	2,458	14,748	DNOT	394	—	—	—
2004	35	3,084	107,940	204	56	260 ± 155	0.20%	7
2005	41	2,866	117,506	27	910	937 ± 347	0.80%	23
2006	4	3,126	12,504	7	0	7 ± 10	0.10%	2
2007	10	2,406	24,060	14	136	150 ± 104	0.60%	15
2008	3	3,275	9,825	50	0	50 ± 57	0.50%	17
2009	14	2,691	37,674	471	237	708 ± 478	1.90%	51
2010	8	3,411	27,288	27	437	464 ± 231	1.70%	58
2011	89	3,114	277,146	1,018	1,387	2,405 ± 612	0.90%	27
2012	21	2,752	57,792	46	434	480 ± 237	0.80%	23
2013	0	—	—	91	91[c]	182 ± 714	—	—
2014	16	2,992	47,872	131[c]	92[c]	223 ± 514	0.47%	14
2015	0	—	—	0	0	0	—	—
2016	0	—	—	0	—	—	—	—

Avg.[b]	20	2,972	71,961	178	360	489	0.80%	24

[a] Does not include subyearling fry prior to July 1.
[b] 12-year average of complete brood data, BY2004-2015.
[c] Pooled estimate





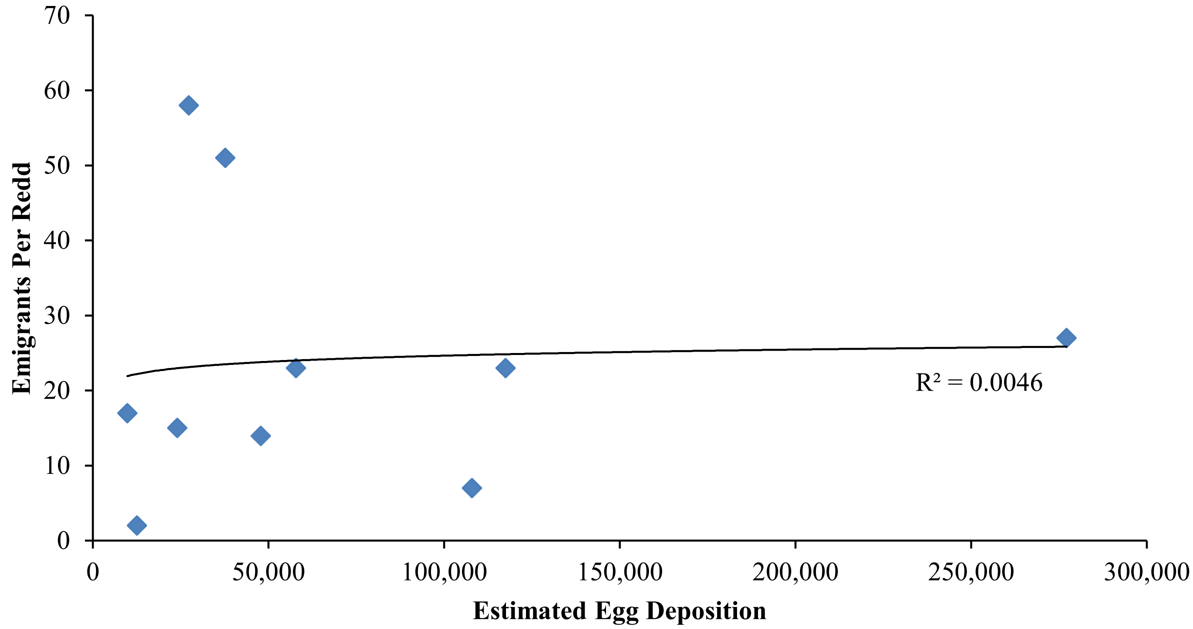


Figure 14. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek natural-produced coho, BY 2003 to 2014.

3.4.5 Coho Subyearlings (BY2016)

Due to lack of BY2016 naturally-produced coho catch, we concluded that there were no emigrants from Nason in 2017.

3.5 PIT Tagging

Total fish PIT tagged included 1,763 wild spring Chinook and 1,353 steelhead (Table 11). All tagging files were submitted to the PTAGIS database. There were no shed tags recovered after the 24-72 hr. post-tagging holding period.

Table 11. Number of PIT tagged Chinook and steelhead with shed rates at the Nason Creek rotary trap in 2017.

Species/Stage	Annual Catch	PIT Tagged	No. of Shed Tags	Percent Shed Tags
Chinook Yearling Smolt	357	346	0	0.0%
Chinook Subyearling Parr (Mar 1 to June 30)	125	22	0	0.0%
Chinook Subyearling Parr (July 1 to Nov 30)	1,752	1,395	0	0.0%
Steelhead Parr	1,379	1,317	0	0.0%
Steelhead Smolt	36	36	0	0.0%

* Counts do not include fish with FL<50mm (fry).

3.6 Incidental Species

Along with wild spring Chinook, wild steelhead/rainbow trout, and naturally produced coho, other resident fish species captured at the Nason Creek rotary trap and included in Table 12 are: bull trout (*Salvelinus confluentus*), cutthroat trout (*Oncorhynchus clarki lewisi*), brook trout (*Salvelinus fontinalis*), flathead minnow (*Pimephales promelas*), longnose dace (*Rhinichthys cataractae*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth (*Mylocheilus caurinus*), redside shiner (*Richardsonius balteatus*), sculpin (*Cottus sp.*), sucker (*Catostomus sp.*), and mountain whitefish (*Prosopium williamsoni*).

Table 12. Summary of length and weight sampling of incidental species captured at the Nason Creek rotary trap in 2017.

Species	Total Count	Length (mm)			Weight (g)		
		Mean	N	SD	Mean	N	SD
Bull Trout	1	215	1	—	92.4	1	—
Cutthroat Trout	2	167	2	111.0	82.0	2	106.1
Brook Trout	1	116	1	—	13.3	1	—
Fathead Minnow	5	46	5	6.2	1.5	5	0.8
Longnose Dace	211	63	211	19.7	3.9	210	4.6
Northern Pikeminnow	14	152	14	72.8	65.7	14	66.4
Peamouth	1	47	1	—	1.5	1	—
Redside Shiner	13	63	13	19.3	3.7	13	2.6
Sculpin	140	79	140	34.3	11.2	135	14.4
Sucker	69	88	69	37.8	14.0	68	37.9
Whitefish	156	53	156	47.6	8.8	122	40.7

3.7 ESA Compliance

The Nason Creek smolt trap was operated under consultation by NMFS and USFWS. Total numbers of UCR spring Chinook and UCR summer steelhead that were captured or handled (indirect take) at the trap were less than the maximum permitted (20%) for each species. The maximum lethal take threshold of 2% was exceeded only in hatchery-origin summer steelhead smolts (Table 13). Exceedance of the limit was due mainly to a single event occurring on May 7, in which 48 hatchery-origin steelhead smolt were killed during a trap stoppage (See Appendix E: Memo to NMFS). The incident was documented and immediately relayed to NMFS on May 8. On May 12, NMFS responded that no further action was necessary (C. Hurst, personal communication, May 12, 2017).

Table 13. Summary of ESA species and coho salmon mortality at the Nason Creek rotary trap.

Species/Stage/Brood Year	Total Collected	Total Mortality	% Mortality
Spring Chinook Yearling (BY2015)	357	1	0.3%
Spring Chinook Subyearling (BY 2016)	2,490	5	0.2%
Total Wild Spring Chinook	**2,847**	**6**	**0.2%**
Total Hatchery Spring Chinook	**1,870**	**0**	**0.0%**
Steelhead Age-0 (BY2017)	377	0	0.0%

Steelhead Age-1 (BY2016)	1,111	1	0.1%
Steelhead Age-2 (BY2015)	74	0	0.0%
Total Wild Summer Steelhead	**1,562**	**1**	**0.1%**
Total Hatchery Summer Steelhead	**1,122**	**49**	**4.4%**
Total Bull Trout	**1**	**0**	**0.0%**

4.0 DISCUSSION

Trap Operation

Operation in 2017 marked the third full year of trapping at the Bolser location. Attempts to characterize a "normal" operational year at the new site are ongoing, and largely inconclusive due to anomalous flow trends during the 2015 through 2017 trapping years. After 2015 and 2016 trap operations were affected by a strong El Niño event, 2017 again saw decreased trap deployment, this time due to precipitation levels markedly below the ten-year mean. In these three years, the trap saw a minimum of 62 days at discharges below 1.4 m^3/s (50 cfs); the approximate lowest discharge required to ensure consistent trap rotation. Though we assume that uninterrupted trap operation is unlikely in a tributary that can fall below 0.6 m^3/s (20 cfs), such long periods of trap stoppage were unexpected. In contrast, 2014 was the only summer sampled in the new location in which temperature, flow, and precipitation trends were near average for the tributary. Days below the 1.4 m^3/s minimum operational flow were limited to 20, and were sporadically distributed instead of a single prolonged period of discontinued trapping. Given the anomalous weather patterns and resulting low-flow conditions in the past three years of operation, 2014 is likely the best indicator of what we can expect given average conditions. In the absence of such anomalous weather patterns, we can expect to see improved trap operation in the coming years.

Spring Chinook

The total BY2015 spring Chinook emigrant estimate was below average; the likely product of low redd deposition. Due to the resulting low rearing density (density dependent effects), egg-to-emigrant survival was conversely above average. Unlike BY2014 emigrants, which we hypothesized were affected by the El Niño conditions concurrent with their in-stream rearing period, BY2015 spring Chinook juveniles appeared to do well, with in-stream survival markedly above average. This is surprising given that 2015 spawning activity was presumably during extremely low-flow conditions. These data suggest that although spawning activity may have been hindered by low-discharge and high temperature, juveniles produced found good rearing conditions thereafter. One caveat is that the BY2015 yearling estimate was made using a pooled efficiency. In Nason Creek, spring Chinook juveniles emigrate out of the system primarily as subyearlings, with up to 95% leaving as age-0 rather than overwintering. A BY2015 yearling emigrant total greater than the subyearling component is suspect, and may be the result of a skewed (overestimating) pooled efficiency. Until the yearling component of the estimate can be recalculated using a viable flow-efficiency relationship, further speculation about the effects of rearing conditions on brood success cannot be made.

The initial BY2016 spring Chinook subyearling estimate suggests that in-stream survival was excellent for the age-0 class. Based on the age-0 emigrant estimate alone, the cohort has an egg-to-emigrant survival rate of 6.6%; a high value unprecedented for Nason Creek spring Chinook. Currently without both the non-trapping (winter) and yearling components, the final BY2016 emigrant estimate will undoubtedly see a higher in-stream survival rate upon completion of the migration in the spring of 2018. Though high survival of BY2016 subyearlings is apparent, we can only speculate as to the cause. We hypothesize that improved survival may be due in-part to natural habitat alterations occurring in the past three years, including a major flood in November 2015 that resulting in significant alterations to channel morphology and LWD throughout the tributary.

Summer Steelhead

The BY2014 steelhead emigrant total was the third largest on record; the likely result of an above-average spawner success rate. The role of density dependence on juvenile summer steelhead in-stream survival continues to be apparent, with egg-to-emigrant survival and emigrants per redd both below-average for the cohort. As in previous years, the overwhelming majority (94.8%) of BY2014 juveniles emigrated from Nason Creek at age-1. Though higher than the mean proportion of age-1 emigrants (87.7%), migratory timing for the 2014 steelhead brood was not out of the ordinary, and from what we can conclude from these data collected, not greatly affected by the El Niño conditions of 2015 and 2016, i.e., no anomalous trends in survival or emigration timing were apparent. Pooled estimates were used to produce all steelhead estimates in 2017. As with Chinook subyearlings, we note the caveat that eventual recalculation using a flow efficiency regression may yield differing result. Further examination of the success of this completed brood migration should performed upon recalculation.

Initial BY2015 and BY2016 emigrant estimates both suggest above-average juvenile abundances based on the age classes collected so far. Though BY2015 juveniles will likely have near-average in-stream survival (age-3 emigrants unlikely to contribute greatly to the final estimate), BY2016 age-1 juveniles alone have nearly twice the normal egg-to-emigrant survival average. While we are unsure of correlation, like the apparent high survival of BY2016 spring Chinook subyearlings, high initial survival rates observed in BY2016 summer steelhead may be due to changing habitat conditions resulting from significant high water events in the past three years.

Coho

The MCCRP is currently in 'Broodstock Develop Phase 2' (BDP2; YNFRM 2018). In an effort to promote the long-range upriver adaptation of the stock, BDPD2 prioritizes adult coho collected at Tumwater Dam. The emphasis placed on Tumwater Dam for adult collections combined with low adult coho returns in both 2015 and 2016 resulted in few coho escaping to spawning habitats upstream of Tumwater Dam (such as Nason Creek). In 2015, adult passage upstream of Tumwater Dam was limited to 25 adults, and 2 adults (unknown sexes) in 2016. Skewed male-to-female sex ratio (13.7M:1F in 2015 and 4.3M:1F in 2016) at Tumwater Dam may have exacerbated the effect of the low passage on redd counts and resulting juvenile production. The lack of juveniles captured at the smolt trap in 2017 were a reflection of this low passage. We expect increased escapement to spawning habitats upstream of Tumwater Dam when biological targets for Broodstock Development Phase 2 have been met and the project transitions to the Natural Production Phases (YNFRM 2018).

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APPENDIX A. Daily Stream Discharge

Date	Stream Discharge (m^3/s)	Water Temperature (˚C)
1/1/2017		0.1
1/2/2017		0.0
1/3/2017		0.0
1/4/2017		0.0
1/5/2017		0.0
1/6/2017		0.0
1/7/2017		0.0
1/8/2017		0.0
1/9/2017		0.0
1/10/2017		0.0
1/11/2017		0.0
1/12/2017		0.0
1/13/2017		0.0
1/14/2017		0.0
1/15/2017		0.1
1/16/2017		0.1
1/17/2017		0.1
1/18/2017		0.1
1/19/2017		0.1
1/20/2017		0.1
1/21/2017		0.1
1/22/2017		0.1
1/23/2017		0.1
1/24/2017		0.1
1/25/2017		0.1
1/26/2017		0.1
1/27/2017		0.1
1/28/2017		0.1
1/29/2017		0.1
1/30/2017		0.1
1/31/2017		0.1
2/1/2017		0.1
2/2/2017		0.1
2/3/2017		0.1
2/4/2017		0.1
2/5/2017		0.1
2/6/2017		0.1
2/7/2017		0.1
2/8/2017		0.1
2/9/2017		0.1
2/10/2017		0.1
2/11/2017		0.0
2/12/2017		0.1
2/13/2017		0.1
2/14/2017		0.1
2/15/2017		0.1
2/16/2017		0.1
2/17/2017		0.0
2/18/2017		0.1
2/19/2017		1.1
2/20/2017	3.0	1.6
2/21/2017	2.9	2.2
2/22/2017	2.8	2.2
2/23/2017	2.7	1.3
2/24/2017	2.7	0.9
2/25/2017	2.6	0.7
2/26/2017	2.7	1.4
2/27/2017	2.6	1.4
2/28/2017	2.6	1.2
3/1/2017	2.5	2.6
3/2/2017	2.5	2.9
3/3/2017	2.7	3.1
3/4/2017	2.9	2.4
3/5/2017	2.8	2.1
3/6/2017	2.6	2.0
3/7/2017	2.6	0.7
3/8/2017	2.6	1.3
3/9/2017	2.5	1.5
3/10/2017	2.8	2.2
3/11/2017	3.7	2.0
3/12/2017	4.2	2.7
3/13/2017	5.2	2.4
3/14/2017	11.0	1.2
3/15/2017	19.9	1.3
3/16/2017	23.9	2.0
3/17/2017	17.4	2.2
3/18/2017	15.4	2.8
3/19/2017	14.6	2.9
3/20/2017	12.6	2.5
3/21/2017	11.6	3.1
3/22/2017	11.0	3.6
3/23/2017	10.6	3.9
3/24/2017	11.0	3.7
3/25/2017	10.8	3.9

3/26/2017	10.4	3.4	5/10/2017	35.4	6.3
3/27/2017	9.9	4.4	5/11/2017	47.3	5.2
3/28/2017	10.3	4.1	5/12/2017	44.7	5.0
3/29/2017	12.7	3.5	5/13/2017	34.5	4.8
3/30/2017	15.2	4.1	5/14/2017	28.9	5.4
3/31/2017	13.7	4.2	5/15/2017	25.5	5.2
4/1/2017	13.7	4.8	5/16/2017	23.8	5.3
4/2/2017	14.2	4.5	5/17/2017	21.2	6.0
4/3/2017	12.9	4.2	5/18/2017	20.0	6.6
4/4/2017	11.9	4.1	5/19/2017	22.8	7.3
4/5/2017	11.2	4.5	5/20/2017	29.7	7.1
4/6/2017	11.9	4.8	5/21/2017	39.6	6.7
4/7/2017	18.3	4.3	5/22/2017	53.0	6.3
4/8/2017	18.5	4.4	5/23/2017	66.8	6.3
4/9/2017	15.8	4.4	5/24/2017	66.3	5.4
4/10/2017	14.4	4.6	5/25/2017	44.5	5.8
4/11/2017	13.4	4.4	5/26/2017	40.5	6.6
4/12/2017	14.6	4.6	5/27/2017	45.0	6.9
4/13/2017	17.9	4.9	5/28/2017	54.1	6.8
4/14/2017	16.3	4.9	5/29/2017	62.3	6.7
4/15/2017	14.6	5.3	5/30/2017	66.8	6.3
4/16/2017	13.7	4.7	5/31/2017	62.9	6.7
4/17/2017	13.3	5.5	6/1/2017	53.5	6.4
4/18/2017	14.0	5.4	6/2/2017	47.6	7.0
4/19/2017	14.3	5.0	6/3/2017	42.5	7.2
4/20/2017	14.6	5.9	6/4/2017	38.5	6.9
4/21/2017	15.6	6.1	6/5/2017	31.7	7.1
4/22/2017	17.2	5.4	6/6/2017	30.9	8.0
4/23/2017	18.0	5.2	6/7/2017	35.4	8.2
4/24/2017	17.6	5.4	6/8/2017	41.3	7.3
4/25/2017	17.4	5.8	6/9/2017	36.2	6.9
4/26/2017	19.2	5.7	6/10/2017	27.8	7.1
4/27/2017	19.3	5.5	6/11/2017	23.8	7.6
4/28/2017	17.2	5.8	6/12/2017	22.3	8.3
4/29/2017	16.5	5.3	6/13/2017	20.8	7.9
4/30/2017	16.7	6.1	6/14/2017	18.9	7.6
5/1/2017	16.4	5.1	6/15/2017	18.4	7.3
5/2/2017	15.4	6.1	6/16/2017	25.4	7.5
5/3/2017	18.3	7.2	6/17/2017	21.5	7.7
5/4/2017	31.7	6.4	6/18/2017	20.4	8.1
5/5/2017	65.1	4.9	6/19/2017	22.0	9.2
5/6/2017	56.4	4.8	6/20/2017	25.3	10.1
5/7/2017	39.4	5.2	6/21/2017	22.8	9.0
5/8/2017	32.6	5.5	6/22/2017	18.5	9.3
5/9/2017	30.6	6.1	6/23/2017	17.0	10.2

6/24/2017	17.4	10.8	8/8/2017	1.6	18.2
6/25/2017	17.8	11.0	8/9/2017	1.6	18.7
6/26/2017	17.8	11.2	8/10/2017	1.5	18.7
6/27/2017	16.3	11.7	8/11/2017	1.5	18.9
6/28/2017	14.3	11.7	8/12/2017	1.4	18.1
6/29/2017	12.6	11.8	8/13/2017	1.4	17.6
6/30/2017	11.8	12.7	8/14/2017	1.4	16.8
7/1/2017	11.2	13.4	8/15/2017	1.4	16.7
7/2/2017	10.3	13.5	8/16/2017	1.3	17.1
7/3/2017	9.6	13.7	8/17/2017	1.3	17.7
7/4/2017	8.5	12.8	8/18/2017	1.3	17.0
7/5/2017	7.5	13.4	8/19/2017	1.2	16.9
7/6/2017	7.0	14.6	8/20/2017	1.2	16.7
7/7/2017	6.6	15.0	8/21/2017	1.2	16.7
7/8/2017	6.1	15.5	8/22/2017	1.2	17.2
7/9/2017	5.6	15.6	8/23/2017	1.1	18.3
7/10/2017	5.3	15.1	8/24/2017	1.1	17.3
7/11/2017	5.0	14.7	8/25/2017	1.1	14.8
7/12/2017	4.6	15.2	8/26/2017	1.1	15.4
7/13/2017	4.3	15.7	8/27/2017	1.0	16.6
7/14/2017	4.1	15.4	8/28/2017	1.0	16.9
7/15/2017	3.8	16.0	8/29/2017	1.0	16.3
7/16/2017	3.6	15.2	8/30/2017	1.0	16.2
7/17/2017	3.5	14.6	8/31/2017	0.9	17.0
7/18/2017	3.3	15.3	9/1/2017	0.9	17.0
7/19/2017	3.1	15.9	9/2/2017	0.9	17.5
7/20/2017	3.0	15.4	9/3/2017	0.9	17.6
7/21/2017	2.9	15.1	9/4/2017	0.9	17.2
7/22/2017	2.8	16.6	9/5/2017	0.9	16.7
7/23/2017	2.7	17.8	9/6/2017	0.9	16.1
7/24/2017	2.6	17.2	9/7/2017	0.9	16.2
7/25/2017	2.5	17.4	9/8/2017	0.8	17.3
7/26/2017	2.4	17.7	9/9/2017	0.8	16.6
7/27/2017	2.3	17.9	9/10/2017	0.8	15.7
7/28/2017	2.2	17.2	9/11/2017	0.8	14.8
7/29/2017	2.1	17.4	9/12/2017	0.8	15.3
7/30/2017	2.1	17.8	9/13/2017	0.8	15.4
7/31/2017	2.0	18.0	9/14/2017	0.8	14.2
8/1/2017	2.0	18.1	9/15/2017	0.8	13.5
8/2/2017	1.9	18.1	9/16/2017	0.8	12.3
8/3/2017	1.9	18.2	9/17/2017	0.8	11.4
8/4/2017	1.8	18.4	9/18/2017	0.8	11.7
8/5/2017	1.8	18.0	9/19/2017	0.9	11.5
8/6/2017	1.7	17.8	9/20/2017	1.3	10.6
8/7/2017	1.7	17.9	9/21/2017	1.1	10.4

9/22/2017	1.0	10.9	11/6/2017	3.3	2.7
9/23/2017	0.9	11.7	11/7/2017	3.1	2.4
9/24/2017	0.8	11.2	11/8/2017	3.0	2.6
9/25/2017	0.8	11.8	11/9/2017	2.9	2.8
9/26/2017	0.8	11.7	11/10/2017	2.9	3.1
9/27/2017	0.8	12.0	11/11/2017	2.7	3.5
9/28/2017	0.8	11.9	11/12/2017	2.7	3.8
9/29/2017	0.7	11.2	11/13/2017	2.9	4.3
9/30/2017	0.8	11.2	11/14/2017	3.2	4.3
10/1/2017	1.3	10.1	11/15/2017	3.1	4.0
10/2/2017	1.2	9.4	11/16/2017	2.9	4.0
10/3/2017	1.0	9.1	11/17/2017	2.8	3.7
10/4/2017	0.9	8.3	11/18/2017	2.6	3.7
10/5/2017	0.8	8.1	11/19/2017	2.6	3.3
10/6/2017	0.8	8.4	11/20/2017	4.4	2.5
10/7/2017	1.0	9.1	11/21/2017	6.0	2.5
10/8/2017	1.7	8.0	11/22/2017	30.0	3.0
10/9/2017	1.3	7.4	11/23/2017	76.2	3.5
10/10/2017	1.1	7.3	11/24/2017	50.4	3.8
10/11/2017	1.0	6.7	11/25/2017	25.4	3.7
10/12/2017	1.1	6.2	11/26/2017	20.4	3.7
10/13/2017	1.1	6.8	11/27/2017	18.1	3.5
10/14/2017	1.1	5.8	11/28/2017	14.6	3.1
10/15/2017	1.1	6.2	11/29/2017	12.5	3.0
10/16/2017	1.1	6.7	11/30/2017	11.0	2.9
10/17/2017	1.3	7.6	12/1/2017	10.1	3.0
10/18/2017	3.0	6.2	12/2/2017	9.2	2.8
10/19/2017	10.4	6.3	12/3/2017	8.4	2.6
10/20/2017	6.5	6.4	12/4/2017	7.6	2.1
10/21/2017	4.4	4.5	12/5/2017	7.0	1.4
10/22/2017	28.6	3.2	12/6/2017	6.6	1.0
10/23/2017	13.5	4.9	12/7/2017	6.2	1.3
10/24/2017	9.1	5.0	12/8/2017	5.8	1.6
10/25/2017	8.1	5.3	12/9/2017	5.6	1.3
10/26/2017	9.4	6.2	12/10/2017	5.3	1.2
10/27/2017	7.5	5.3	12/11/2017	5.0	1.0
10/28/2017	6.7	5.0	12/12/2017	4.8	0.9
10/29/2017	6.1	5.1	12/13/2017	4.7	0.6
10/30/2017	5.4	4.9	12/14/2017	4.5	0.9
10/31/2017	4.8	4.4	12/15/2017	4.4	1.7
11/1/2017	4.4	5.6	12/16/2017	4.2	1.5
11/2/2017	4.3	5.1	12/17/2017	4.2	2.1
11/3/2017	4.0	4.5	12/18/2017		
11/4/2017	3.7	3.7	12/19/2017		
11/5/2017	3.5	2.5	12/20/2017	6.5	1.1

12/21/2017	5.7	0.5
12/22/2017	5.5	0.9
12/23/2017	5.0	0.3
12/24/2017	5.5	0.0
12/25/2017	6.4	0.1
12/26/2017	9.5	0.1
12/27/2017	10.3	0.0
12/28/2017	10.0	0.1
12/29/2017	10.8	0.0
12/30/2017	10.5	0.0
12/31/2017	8.6	0.0

APPENDIX B. Daily Trap Operation

Date	Trap Status	Comments
3/1/2017	Op.	
3/2/2017	Op.	
3/3/2017	Op.	
3/4/2017	Op.	
3/5/2017	Op.	
3/6/2017	Op.	
3/7/2017	Op.	
3/8/2017	Op.	
3/9/2017	Op.	
3/10/2017	Op.	
3/11/2017	Op.	
3/12/2017	Op.	
3/13/2017	Op.	
3/14/2017	Op.	
3/15/2017	Op.	
3/16/2017	Op.	
3/17/2017	Op.	
3/18/2017	Op.	
3/19/2017	Op.	
3/20/2017	Op.	
3/21/2017	Op.	
3/22/2017	Op.	
3/23/2017	Op.	
3/24/2017	Op.	
3/25/2017	Op.	
3/26/2017	Op.	
3/27/2017	Op.	
3/28/2017	Op.	
3/29/2017	Op.	
3/30/2017	Stopped	Debris
3/31/2017	Op.	
4/1/2017	Op.	
4/2/2017	Op.	
4/3/2017	Op.	
4/4/2017	Op.	
4/5/2017	Op.	
4/6/2017	Op.	
4/7/2017	Op.	
4/8/2017	Op.	
4/9/2017	Op.	
4/10/2017	Op.	
4/11/2017	Op.	
4/12/2017	Op.	
4/13/2017	Op.	
4/14/2017	Op.	
4/15/2017	Op.	
4/16/2017	Op.	
4/17/2017	Op.	
4/18/2017	Op.	
4/19/2017	Pulled	
4/20/2017	Op.	
4/21/2017	Op.	
4/22/2017	Op.	
4/23/2017	Op.	
4/24/2017	Op.	
4/25/2017	Op.	
4/26/2017	Op.	
4/27/2017	Op.	
4/28/2017	Op.	
4/29/2017	Op.	
4/30/2017	Op.	
5/1/2017	Op.	
5/2/2017	Op.	
5/3/2017	Op.	
5/4/2017	Op.	
5/5/2017	Stopped	Debris
5/6/2017	Op.	
5/7/2017	Op.	
5/8/2017	Op.	
5/9/2017	Op.	
5/10/2017	Op.	
5/11/2017	Op.	
5/12/2017	Op.	
5/13/2017	Op.	
5/14/2017	Op.	
5/15/2017	Op.	
5/16/2017	Op.	
5/17/2017	Op.	
5/18/2017	Op.	
5/19/2017	Op.	
5/20/2017	Op.	
5/21/2017	Op.	
5/22/2017	Op.	

5/23/2017	Op.		7/7/2017	Op.	
5/24/2017	Pulled	Debris	7/8/2017	Op.	
5/25/2017	Op.		7/9/2017	Op.	
5/26/2017	Op.		7/10/2017	Op.	
5/27/2017	Op.		7/11/2017	Op.	
5/28/2017	Op.		7/12/2017	Op.	
5/29/2017	Op.		7/13/2017	Op.	
5/30/2017	Pulled	Debris	7/14/2017	Op.	
5/31/2017	Op.		7/15/2017	Op.	
6/1/2017	Op.		7/16/2017	Op.	
6/2/2017	Op.		7/17/2017	Op.	
6/3/2017	Op.		7/18/2017	Op.	
6/4/2017	Op.		7/19/2017	Op.	
6/5/2017	Op.		7/20/2017	Op.	
6/6/2017	Op.		7/21/2017	Op.	
6/7/2017	Op.		7/22/2017	Op.	
6/8/2017	Op.		7/23/2017	Op.	
6/9/2017	Stopped	Debris	7/24/2017	Op.	
6/10/2017	Op.		7/25/2017	Op.	
6/11/2017	Op.		7/26/2017	Op.	
6/12/2017	Stopped	Debris	7/27/2017	Op.	
6/13/2017	Op.		7/28/2017	Op.	
6/14/2017	Op.		7/29/2017	Op.	
6/15/2017	Op.		7/30/2017	Op.	
6/16/2017	Op.		7/31/2017	Op.	
6/17/2017	Op.		8/1/2017	Op.	
6/18/2017	Op.		8/2/2017	Op.	
6/19/2017	Op.		8/3/2017	Op.	
6/20/2017	Stopped	Debris	8/4/2017	Op.	
6/21/2017	Op.		8/5/2017	Op.	
6/22/2017	Op.		8/6/2017	Op.	
6/23/2017	Op.		8/7/2017	Op.	
6/24/2017	Op.		8/8/2017	Op.	
6/25/2017	Op.		8/9/2017	Op.	
6/26/2017	Op.		8/10/2017	Stopped	Low flow
6/27/2017	Op.		8/11/2017	Stopped	Low flow
6/28/2017	Op.		8/12/2017	Stopped	Low flow
6/29/2017	Op.		8/13/2017	Stopped	Low flow
6/30/2017	Op.		8/14/2017	Pulled	Low flow
7/1/2017	Op.		8/15/2017	Pulled	Low flow
7/2/2017	Op.		8/16/2017	Pulled	Low flow
7/3/2017	Op.		8/17/2017	Pulled	Low flow
7/4/2017	Op.		8/18/2017	Pulled	Low flow
7/5/2017	Op.		8/19/2017	Pulled	Low flow
7/6/2017	Op.		8/20/2017	Pulled	Low flow

8/21/2017	Pulled	Low flow	10/5/2017	Pulled	Low flow
8/22/2017	Pulled	Low flow	10/6/2017	Pulled	Low flow
8/23/2017	Pulled	Low flow	10/7/2017	Pulled	Low flow
8/24/2017	Pulled	Low flow	10/8/2017	Pulled	Low flow
8/25/2017	Pulled	Low flow	10/9/2017	Pulled	Low flow
8/26/2017	Pulled	Low flow	10/10/2017	Pulled	Low flow
8/27/2017	Pulled	Low flow	10/11/2017	Pulled	Low flow
8/28/2017	Pulled	Low flow	10/12/2017	Pulled	Low flow
8/29/2017	Pulled	Low flow	10/13/2017	Pulled	Low flow
8/30/2017	Pulled	Low flow	10/14/2017	Pulled	Low flow
8/31/2017	Pulled	Low flow	10/15/2017	Pulled	Low flow
9/1/2017	Pulled	Low flow	10/16/2017	Pulled	Low flow
9/2/2017	Pulled	Low flow	10/17/2017	Pulled	Low flow
9/3/2017	Pulled	Low flow	10/18/2017	Pulled	Low flow
9/4/2017	Pulled	Low flow	10/19/2017	Stopped	Low flow
9/5/2017	Pulled	Low flow	10/20/2017	Op.	
9/6/2017	Pulled	Low flow	10/21/2017	Op.	
9/7/2017	Pulled	Low flow	10/22/2017	Pulled	High flow
9/8/2017	Pulled	Low flow	10/23/2017	Pulled	High flow
9/9/2017	Pulled	Low flow	10/24/2017	Op.	
9/10/2017	Pulled	Low flow	10/25/2017	Stopped	Debris
9/11/2017	Pulled	Low flow	10/26/2017	Op.	
9/12/2017	Pulled	Low flow	10/27/2017	Op.	
9/13/2017	Pulled	Low flow	10/28/2017	Op.	
9/14/2017	Pulled	Low flow	10/29/2017	Op.	
9/15/2017	Pulled	Low flow	10/30/2017	Op.	
9/16/2017	Pulled	Low flow	10/31/2017	Op.	
9/17/2017	Pulled	Low flow	11/1/2017	Op.	
9/18/2017	Pulled	Low flow	11/2/2017	Op.	
9/19/2017	Pulled	Low flow	11/3/2017	Op.	
9/20/2017	Pulled	Low flow	11/4/2017	Op.	
9/21/2017	Pulled	Low flow	11/5/2017	Op.	
9/22/2017	Pulled	Low flow	11/6/2017	Op.	
9/23/2017	Pulled	Low flow	11/7/2017	Op.	
9/24/2017	Pulled	Low flow	11/8/2017	Op.	
9/25/2017	Pulled	Low flow	11/9/2017	Op.	
9/26/2017	Pulled	Low flow	11/10/2017	Op.	
9/27/2017	Pulled	Low flow	11/11/2017	Op.	
9/28/2017	Pulled	Low flow	11/12/2017	Op.	
9/29/2017	Pulled	Low flow	11/13/2017	Op.	
9/30/2017	Pulled	Low flow	11/14/2017	Op.	
10/1/2017	Pulled	Low flow	11/15/2017	Op.	
10/2/2017	Pulled	Low flow	11/16/2017	Op.	
10/3/2017	Pulled	Low flow	11/17/2017	Op.	
10/4/2017	Pulled	Low flow	11/18/2017	Op.	

11/19/2017	Op.	
11/20/2017	Op.	
11/21/2017	Op.	
11/22/2017	Stopped	High Flow
11/23/2017	Stopped	High Flow
11/24/2017	Stopped	High Flow
11/25/2017	Op.	
11/26/2017	Op.	
11/27/2017	Op.	
11/28/2017	Op.	
11/29/2017	Op.	
11/30/2017	Op.	

APPENDIX C. Regression Models

Model: Chinook Yearlings (Spring '06-'14) Back Position, (r^2 = 0.15; p = 0.03)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	24.6
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	7.5
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	4.9
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	7.1
Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	18.6
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	12.3
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	27.4
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	20.7
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	10.1
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	12.5
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.16	0.41	5.9
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.03	0.19	39.1
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.07	0.26	10.4
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.14	0.38	24.8
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.13	0.36	26.5
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.05	0.21	9.3
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.19	0.46	7.8
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.14	0.38	5.3
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.15	0.40	34.8
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.17	0.42	8.9
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.16	0.41	7.7
Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.48	9.3
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.08	0.28	27.1
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.15	0.40	16.0

Model: Chinook Subyearling (Fall '06-'13) Back Position, (r^2 = 0.55; p = 0.001)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	10/26/2006	Back	183	50	0.28	0.56	1.4
Wild Chinook Parr	0	10/30/2006	Back	168	52	0.32	0.60	1.8
Wild Chinook Parr	0	11/1/2010	Back	254	42	0.17	0.42	5.6
Wild Chinook Parr	0	11/4/2010	Back	287	49	0.17	0.43	6.1
Wild Chinook Parr	0	11/7/2010	Back	168	32	0.20	0.46	6.8
Wild Chinook Parr	0	11/13/2010	Back	185	35	0.19	0.46	3.7
Wild Chinook Parr	0	11/3/2012	Back	201	25	0.13	0.37	11.4

Wild Chinook Parr	0	11/7/2012	Back	233	27	0.12	0.35	11.2
Wild Chinook Parr	0	11/11/2012	Back	328	87	0.27	0.54	6.1
Wild Chinook Parr	0	11/15/2012	Back	195	34	0.18	0.44	6.0
Wild Chinook Parr	0	9/30/2013	Back	171	12	0.08	0.28	15.3
Wild Chinook Parr	0	10/2/2013	Back	213	43	0.21	0.47	9.3
Wild Chinook Parr	0	10/3/2013	Back	181	41	0.23	0.50	8.4
Wild Chinook Parr	0	10/7/2013	Back	242	31	0.13	0.37	6.6
Wild Chinook Parr	0	10/9/2013	Back	203	40	0.20	0.47	8.6
Wild Chinook Parr	0	11/27/2013	Back	241	55	0.23	0.50	5.2

Model: Chinook Subyearling (Fall ’06-’13) Forward Position, ($r^2 = 0.16$; $p = 0.02$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	7/13/2006	Back	52	8	0.17	0.43	4.8
Wild Chinook Parr	0	7/17/2006	Back	138	15	0.12	0.35	3.7
Wild Chinook Parr	0	7/20/2006	Back	74	5	0.08	0.29	3.2
Wild Chinook Parr	0	7/28/2006	Back	54	5	0.11	0.34	2.6
Wild Chinook Parr	0	7/31/2006	Back	99	7	0.08	0.29	2.2
Wild Chinook Parr	0	9/18/2006	Back	55	10	0.20	0.46	1.3
Wild Chinook Parr	0	7/31/2008	Back	60	15	0.27	0.54	3.4
Wild Chinook Parr	0	8/12/2008	Back	103	2	0.03	0.17	2.4
Wild Chinook Parr	0	8/22/2008	Back	75	11	0.16	0.41	2.7
Wild Chinook Parr	0	8/28/2008	Back	72	7	0.11	0.34	2.3
Wild Chinook Parr	0	10/9/2008	Back	110	22	0.21	0.48	1.8
Wild Chinook Parr	0	10/27/2008	Back	51	12	0.26	0.53	1.6
Wild Chinook Parr	0	10/30/2008	Back	84	15	0.19	0.45	1.5
Wild Chinook Parr	0	11/6/2008	Back	78	8	0.12	0.35	2.2
Wild Chinook Parr	0	11/10/2008	Back	88	0	0.01	0.11	8.7
Wild Chinook Parr	0	7/14/2009	Back	86	2	0.04	0.19	5.5
Wild Chinook Parr	0	7/15/2009	Back	105	4	0.05	0.22	5.1
Wild Chinook Parr	0	7/17/2009	Back	122	8	0.07	0.28	4.4
Wild Chinook Parr	0	7/20/2009	Back	89	2	0.03	0.19	3.8
Wild Chinook Parr	0	8/17/2009	Back	73	1	0.03	0.17	1.6
Wild Chinook Parr	0	9/10/2009	Back	56	7	0.14	0.39	1.7
Wild Chinook Parr	0	8/8/2010	Back	58	1	0.03	0.19	2.4
Wild Chinook Parr	0	8/11/2010	Back	114	8	0.08	0.29	2.2
Wild Chinook Parr	0	9/11/2010	Back	68	9	0.15	0.39	2.1
Wild Chinook Parr	0	10/12/2010	Back	216	42	0.20	0.46	3.6
Wild Chinook Parr	0	10/15/2010	Back	192	37	0.20	0.46	2.7
Wild Chinook Parr	0	10/18/2010	Back	193	36	0.19	0.45	2.3

Wild Chinook Parr	0	10/22/2010	Back	92	18	0.21	0.47	2.0
Wild Chinook Parr	0	10/25/2010	Back	60	7	0.13	0.37	2.2
Wild Chinook Parr	0	10/29/2010	Back	127	0	0.01	0.09	2.7
Wild Chinook Parr	0	8/19/2011	Back	106	5	0.06	0.24	3.5

Model: Chinook Subyearling (Fall '14-'17) Bolser Site ($r^2 = 0.11$; $p = 0.11$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1)/M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	7/14/2014	1	89	7	0.09	0.30	9.3
Wild Chinook Parr	0	7/21/2014	1	74	4	0.07	0.26	5.6
Wild Chinook Parr	0	7/27/2014	1	72	4	0.07	0.27	4.4
Wild Chinook Parr	0	10/24/2014	1	53	4	0.09	0.31	6.3
Wild Chinook Parr	0	10/27/2014	1	71	3	0.06	0.24	6.8
Wild Chinook Parr	0	10/30/2014	1	70	5	0.09	0.30	9.6
Wild Chinook Parr	0	11/1/2014	1	96	6	0.07	0.27	9.6
Wild Chinook Parr	0	10/24/2016	1	59	6	0.12	0.35	8.0
Wild Chinook Parr	0	11/1/2016	1	68	8	0.13	0.37	11.3
Wild Chinook Parr	0	11/15/2016	1	69	11	0.17	0.43	15.1
Wild Chinook Parr	0	7/17/2017	1	71	3	0.05	0.24	3.7
Wild Chinook Parr	0	10/23/2017	1	813	25	0.14	0.39	13.5
Wild Chinook Parr	0	10/27/2017	1	248	24	0.10	0.32	7.5
Wild Chinook Parr	0	10/31/2017	1	114	24	0.22	0.49	4.8
Wild Chinook Parr	0	11/12/2017	1	115	6	0.06	0.25	2.7
Wild Chinook Parr	0	11/27/2017	1	100	11	0.12	0.35	18.4

Model: Summer Steelhead Back Position ('07-'14), ($r^2 = 0.35$; $p = 2.90E-05$)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Steelhead Parr/Smolt	1+	3/20/2007	Back	55	1	0.04	0.19	34.8
Wild Steelhead Parr/Smolt	1+	3/31/2007	Back	56	4	0.09	0.30	24.6
Wild Steelhead Parr/Smolt	1+	4/10/2007	Back	60	8	0.15	0.40	27.4
Wild Steelhead Parr/Smolt	1+	5/1/2007	Back	52	2	0.06	0.24	22.2
Wild Steelhead Parr/Smolt	1+	6/9/2007	Back	71	9	0.14	0.38	23.8
Wild Steelhead Parr/Smolt	1+	6/12/2007	Back	65	8	0.14	0.38	19.9
Wild Steelhead Parr/Smolt	1+	6/14/2007	Back	61	5	0.10	0.32	19.5
Wild Steelhead Parr/Smolt	1+	6/21/2007	Back	67	4	0.07	0.28	21.3
Wild Steelhead Parr/Smolt	1+	4/14/2008	Back	149	46	0.32	0.60	9.3

Wild Steelhead Parr/Smolt	1+	4/17/2008	Back	75	3	0.05	0.23	7.8
Wild Steelhead Parr/Smolt	1+	4/28/2008	Back	74	11	0.16	0.41	7.7
Wild Steelhead Parr/Smolt	1+	5/1/2008	Back	176	29	0.17	0.43	8.9
Wild Steelhead Parr/Smolt	1+	5/12/2008	Back	55	8	0.16	0.42	18.8
Wild Steelhead Parr/Smolt	1+	5/15/2008	Back	57	1	0.04	0.19	39.4
Wild Steelhead Parr/Smolt	1+	6/9/2008	Back	142	20	0.15	0.39	26.6
Wild Steelhead Parr/Smolt	1+	6/12/2008	Back	83	10	0.13	0.37	23.3
Wild Steelhead Parr/Smolt	1+	6/16/2008	Back	81	8	0.11	0.34	32.3
Wild Steelhead Parr/Smolt	1+	4/20/2010	Back	121	11	0.10	0.32	19.1
Wild Steelhead Parr/Smolt	1+	4/22/2010	Back	121	10	0.09	0.31	20.6
Wild Steelhead Parr/Smolt	1+	6/20/2010	Back	128	11	0.09	0.31	26.2
Wild Steelhead Parr/Smolt	1+	4/5/2011	Back	52	1	0.04	0.20	21.5
Wild Steelhead Parr/Smolt	1+	5/22/2011	Back	84	3	0.05	0.22	43.6
Wild Steelhead Parr/Smolt	1+	6/12/2012	Back	69	5	0.09	0.30	33.1
Wild Steelhead Parr/Smolt	1+	7/26/2012	Back	63	4	0.08	0.29	7.9
Wild Steelhead Parr/Smolt	1+	4/22/2013	Back	66	6	0.11	0.33	14.7
Wild Steelhead Parr/Smolt	1+	4/26/2013	Back	50	2	0.06	0.25	18.2
Wild Steelhead Parr/Smolt	1+	4/30/2013	Back	54	2	0.06	0.24	22.0
Wild Steelhead Parr/Smolt	1+	5/8/2013	Back	62	0	0.02	0.13	61.4
Wild Steelhead Parr/Smolt	1+	5/19/2013	Back	122	15	0.13	0.37	32.0
Wild Steelhead Parr/Smolt	1+	5/22/2013	Back	58	4	0.09	0.30	30.6
Wild Steelhead Parr/Smolt	1+	5/26/2013	Back	79	3	0.05	0.23	20.5
Wild Steelhead Parr/Smolt	1+	5/30/2013	Back	92	7	0.09	0.30	24.0
Wild Steelhead Parr/Smolt	1+	6/3/2013	Back	71	6	0.10	0.32	27.2
Wild Steelhead Parr/Smolt	1+	6/7/2013	Back	94	4	0.05	0.23	40.2
Wild Steelhead Parr/Smolt	1+	6/13/2013	Back	64	2	0.05	0.22	21.1
Wild Steelhead Parr/Smolt	1+	6/17/2013	Back	115	5	0.05	0.23	25.0
Wild Steelhead Parr/Smolt	1+	6/29/2013	Back	60	12	0.22	0.48	20.7
Wild Steelhead Parr/Smolt	1+	7/7/2013	Back	75	9	0.13	0.37	9.2
Wild Steelhead Parr/Smolt	1+	5/5/2014	Back	55	3	0.07	0.27	35.7
Wild Steelhead Parr/Smolt	1+	5/20/2014	Back	57	0	0.02	0.13	42.2
Wild Steelhead Parr/Smolt	1+	6/3/2014	Back	75	1	0.03	0.16	45.6

Model: 2013 Summer Steelhead Back Position (In-yr.), (r^2 = 0.15; p = 0.05)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	24.6
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	7.5
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	4.9
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	7.1

Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	18.6
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	12.3
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	27.4
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	20.7
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	10.1
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	12.5
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.16	0.41	5.9
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.03	0.19	39.1
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.07	0.26	10.4
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.14	0.38	24.8
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.13	0.36	26.5
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.05	0.21	9.3
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.19	0.46	7.8
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.14	0.38	5.3
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.15	0.40	34.8
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.17	0.42	8.9
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.16	0.41	7.7
Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.48	9.3
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.08	0.28	27.1
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.15	0.40	16.0

Model: Spring Chinook 2010-2014 Non-Trapping Period Array (NAL) – Full Antenna Function, ($r^2 = 0.61$; $p = 0.0002$)

Origin/Species/Stage	Age	Date	Mark	Detections	Trap Efficiency (R+1) / M	ASIN Transform	Discharge (m^3/s)
Wild Chinook Parr	0	11/4/2010	254	95	0.38	0.66	6.3
Wild Chinook Parr	0	11/7/2010	287	70	0.25	0.52	7.0
Wild Chinook Parr	0	11/10/2010	168	74	0.45	0.73	4.8
Wild Chinook Parr	0	11/13/2010	74	41	0.57	0.85	4.0
Wild Chinook Parr	0	11/18/2010	185	22	0.12	0.36	7.9
Wild Chinook Parr	0	11/3/2012	201	21	0.11	0.34	10.9
Wild Chinook Parr	0	11/7/2012	233	31	0.14	0.38	10.7
Wild Chinook Parr	0	11/11/2012	328	66	0.20	0.47	6.3
Wild Chinook Parr	0	11/15/2012	195	68	0.35	0.64	6.2
Wild Chinook Parr	0	11/4/2013	130	51	0.40	0.68	3.7
Wild Chinook Parr	0	11/8/2013	106	39	0.38	0.66	4.2
Wild Chinook Parr	0	3/9/2014	65	4	0.08	0.28	24.9
Wild Chinook Parr	0	3/13/2014	67	5	0.09	0.30	15.3
Wild Chinook Parr	0	11/4/2014	114	5	0.05	0.23	10.5
Wild Chinook Parr	0	11/1/2014	96	5	0.06	0.25	16.5

Wild Chinook Parr	0	11/10/2014	78	8	0.12	0.35	11.3

Model: Spring Chinook 2010-2014 Non-Trapping Period Array (NAL) – Partial Antenna Function, (r^2 = 0.38; p = 0.007)

Origin/Species/Stage	Age	Date	Mark	Detections	Trap Efficiency (R+1)/M	ASIN Transform	Discharge
Wild Chinook Parr	0	11/4/2010	254	39	0.16	0.41	6.3
Wild Chinook Parr	0	11/7/2010	287	16	0.06	0.25	7.0
Wild Chinook Parr	0	11/10/2010	168	34	0.21	0.47	4.8
Wild Chinook Parr	0	11/13/2010	74	17	0.24	0.52	4.0
Wild Chinook Parr	0	11/18/2010	185	8	0.05	0.22	7.9
Wild Chinook Parr	0	11/3/2012	201	7	0.04	0.20	10.9
Wild Chinook Parr	0	11/7/2012	233	8	0.04	0.20	10.7
Wild Chinook Parr	0	11/11/2012	328	24	0.08	0.28	6.3
Wild Chinook Parr	0	11/15/2012	195	30	0.16	0.41	6.2
Wild Chinook Parr	0	11/4/2013	130	40	0.32	0.60	3.7
Wild Chinook Parr	0	11/8/2013	106	30	0.29	0.57	4.2
Wild Chinook Parr	0	3/9/2014	65	1	0.03	0.18	24.9
Wild Chinook Parr	0	3/13/2014	67	5	0.09	0.30	15.3
Wild Chinook Parr	0	11/1/2014	96	1	0.02	0.15	10.5
Wild Chinook Parr	0	11/4/2014	114	4	0.04	0.21	16.5
Wild Chinook Parr	0	11/10/2014	78	3	0.05	0.23	11.3

APPENDIX D. Historical Morphometric Data

Spring Chinook (2004-2017)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2004	2002	Wild Chinook Yearling Smolt	93.4	336	12.4	9	337	5	1.1
2004	2003	Wild Chinook Subyearling Fry	39.5	82	5.1	0.6	79	0.3	1.0
2004	2003	Wild Chinook Subyearling Parr	82.4	792	7.9	6.1	702	2.7	1.1
2005	2003	Wild Chinook Yearling Smolt	93.6	278	7.9	8.7	276	2.1	1.1
2005	2004	Wild Chinook Subyearling Fry	42.1	107	5.6	0.7	102	0.4	0.9
2005	2004	Wild Chinook Subyearling Parr	75.9	924	9.6	4.9	890	3.8	1.1
2006	2004	Wild Chinook Yearling Smolt	91.2	363	7.1	7.5	362	1.8	1.0
2006	2005	Wild Chinook Subyearling Fry	—	—	—	—	—	—	—
2006	2005	Wild Chinook Subyearling Parr	72.9	1,428	9.6	3.9	1,428	2.3	1.0
2007	2005	Wild Chinook Yearling Smolt	89	676	8.2	8	675	6.1	1.1
2007	2006	Wild Chinook Subyearling Fry	39	24	3.7	0.6	24	0.5	1.0
2007	2006	Wild Chinook Subyearling Parr	79.5	686	13.8	6.1	685	2.6	1.2
2008	2006	Wild Chinook Yearling Smolt	96.1	904	6.6	9.5	904	2.1	1.1
2008	2007	Wild Chinook Subyearling Fry	42.8	127	4.6	0.8	127	0.4	1.0
2008	2007	Wild Chinook Subyearling Parr	75.8	2,049	12.5	5.2	2,049	2.4	1.2
2009	2007	Wild Chinook Yearling Smolt	94.4	198	8.9	9.2	198	2.5	1.1
2009	2008	Wild Chinook Subyearling Fry	44.8	82	4.8	0.9	82	0.6	1.0
2009	2008	Wild Chinook Subyearling Parr	70.1	2,333	12	4.2	2,333	2	1.2
2010	2008	Wild Chinook Yearling Smolt	96.9	366	7.3	10.2	366	2.3	1.1
2010	2009	Wild Chinook Subyearling Fry	41.8	30	5	1.3	8	0.2	1.8
2010	2009	Wild Chinook Subyearling Parr	80.7	3,021	10.7	6.2	3,021	2.3	1.2
2011	2009	Wild Chinook Yearling Smolt	89.1	152	9.9	7.7	152	1.8	1.1
2011	2010	Wild Chinook Subyearling Fry	39.8	217	6.6	0.6	217	0.5	1.0
2011	2010	Wild Chinook Subyearling Parr	73.4	1,046	13.1	4.9	1,046	2.5	1.2
2012	2010	Wild Chinook Yearling Smolt	93.3	368	7	9.2	368	2.2	1.1
2012	2011	Wild Chinook Subyearling Fry	42.7	48	9.1	0.9	48	0.6	1.2
2012	2011	Wild Chinook Subyearling Parr	77.9	2,160	10.7	5.3	2,160	1.9	1.1
2013	2011	Wild Chinook Yearling Smolt	90.6	239	75	7.9	239	2.1	1.1
2013	2012	Wild Chinook Subyearling Fry	45.6	1,824	6.8	1	1,803	0.6	1.1
2013	2012	Wild Chinook Subyearling Parr	70	4,422	11.4	3.8	4,409	1.7	1.1
2014	2012	Wild Chinook Yearling Smolt	89.5	464	6.9	7.5	464	1.8	1.0
2014	2013	Wild Chinook Subyearling Fry	40.1	677	5.2	0.9	221	0.5	1.4
2014	2013	Wild Chinook Subyearling Parr	69.1	1,549	12.3	3.8	1,547	2.3	1.2
2015	2013	Wild Chinook Yearling Smolt	93	152	7	8.4	152	2.2	1.0
2015	2014	Wild Chinook Subyearling Fry	45	338	9.9	1	338	0.9	0.9

2015	2014	Wild Chinook Subyearling Parr	84	210	8	6.5	209	1.7	1.1
2015	2013	Hatchery Chinook Yearling Smolt	136	284	12.3	29.5	284	8.8	1.1
2016	2014	Wild Chinook Yearling Smolt	96	61	5.5	9.0	61	1.7	1.0
2016	2015	Wild Chinook Subyearling Fry	38	285	3.0	0.5	285	0.2	0.8
2016	2015	Wild Chinook Subyearling Parr	85	491	12.7	6.9	490	2.5	1.1
2016	2014	Hatchery Chinook Yearling Smolt	119	87	13.5	19.6	87	7.6	1.1
2017	2015	Wild Chinook Yearling Smolt	96	357	6.6	9.8	357	2.1	1.1
2017	2016	Wild Chinook Subyearling Fry	38	557	3.9	0.5	557	0.3	0.9
2017	2016	Wild Chinook Subyearling Parr	74	1,864	12.3	4.7	1,863	2.1	1.1
2017	2015	Hatchery Chinook Yearling Smolt	115	143	10.3	18.4	143	5.4	1.2

Summer Steelhead (2004-2017)

Trap Year	Brood Year	Age	Origin/Species	Fork Length (mm)			Weight (g)			K-factor
				Mean	n	SD	Mean	n	SD	
2004	2004	0	Wild Summer Steelhead	67	358	10	3.5	279	1.5	1.2
2004	2003	1	Wild Summer Steelhead	101.7	394	23.2	13.2	366	27.3	1.3
2004	2002	2	Wild Summer Steelhead	161.6	146	19.8	43.4	141	15.5	1.0
2004	2001	3	Wild Summer Steelhead	201.6	43	11.2	76	43	21.2	0.9
2004	2003	1	Hat. Summer Steelhead	182.8	523	22.4	62.1	497	21.2	1.0
2005	2005	0	Wild Summer Steelhead	54.1	649	15.7	2.2	616	3.2	1.4
2005	2004	1	Wild Summer Steelhead	93.6	585	25.6	10.8	575	10.1	1.3
2005	2003	2	Wild Summer Steelhead	153.5	103	21.2	38.1	102	16.4	1.1
2005	2002	3	Wild Summer Steelhead	144	1	—	43.2	1	—	1.4
2005	2004	1	Hat. Summer Steelhead	188.2	343	21.2	66	343	24	1.0
2006	2006	0	Wild Summer Steelhead	66.3	180	5.8	2.5	180	1	0.9
2006	2005	1	Wild Summer Steelhead	85.2	877	18.7	6.7	877	6.6	1.1
2006	2004	2	Wild Summer Steelhead	155.9	106	26.8	36.1	105	13.5	1.0
2006	2003	3	Wild Summer Steelhead	197	2	—	73.5	2	—	1.0
2006	2005	1	Hat. Summer Steelhead	—	—	—	—	—	—	—
2007	2007	0	Wild Summer Steelhead	54.2	329	11.7	2	328	1.4	1.3
2007	2006	1	Wild Summer Steelhead	82.7	1,330	16.8	7.2	1,329	6.3	1.3
2007	2005	2	Wild Summer Steelhead	143.8	102	20.6	31.4	102	11.9	1.1
2007	2004	3	Wild Summer Steelhead	143	1	—	26.8	1	—	0.9
2007	2006	1	Hat. Summer Steelhead	149.3	3	47	33.1	3	29.1	1.0
2008	2008	0	Wild Summer Steelhead	52.9	930	11.1	1.7	930	1.2	1.1
2008	2007	1	Wild Summer Steelhead	84.5	1,876	17.1	7.4	1,874	6.6	1.2
2008	2006	2	Wild Summer Steelhead	149.9	122	22.9	36	122	15.5	1.1
2008	2005	3	Wild Summer Steelhead	180.3	13	18.9	57.4	13	16.4	1.0
2008	2007	1	Hat. Summer Steelhead	179.4	389	16.5	55.9	388	14.8	1.0

2009	2009	0	Wild Summer Steelhead	55.6	843	10.5	2.2	688	1.1	1.3
2009	2008	1	Wild Summer Steelhead	82.6	452	18.6	7.1	447	5.5	1.3
2009	2007	2	Wild Summer Steelhead	156.9	72	22	40.9	72	15.5	1.1
2009	2006	3	Wild Summer Steelhead	195	3	5	73	3	6.7	1.0
2009	2008	1	Hat. Summer Steelhead	183.1	280	16.7	60.8	280	18.2	1.0
2010	2010	0	Wild Summer Steelhead	55	1,287	11.1	2.5	917	1.3	1.5
2010	2009	1	Wild Summer Steelhead	89.8	1,079	19.1	9	1,072	7.1	1.2
2010	2008	2	Wild Summer Steelhead	144.9	87	25.1	35	87	17.4	1.2
2010	2007	3	Wild Summer Steelhead	184	8	12.2	61.9	8	10.2	1.0
2010	2009	1	Hat. Summer Steelhead	183.5	531	19.5	61.3	526	19.6	1.0
2011	2011	0	Wild Summer Steelhead	43.5	1,093	10.1	1.1	783	0.9	1.3
2011	2010	1	Wild Summer Steelhead	75.7	818	18.5	5.5	811	5.7	1.3
2011	2009	2	Wild Summer Steelhead	144.8	27	41.3	42.1	27	62.1	1.4
2011	2008	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2011	2010	1	Hat. Summer Steelhead	180.7	464	17	59.1	464	17.6	1.0
2012	2012	0	Wild Summer Steelhead	55.1	589	14.2	2.6	402	1.2	1.6
2012	2011	1	Wild Summer Steelhead	84.7	747	17.4	7.6	741	5.7	1.3
2012	2010	2	Wild Summer Steelhead	127.1	132	27	23.7	132	14.5	1.2
2012	2009	3	Wild Summer Steelhead	161	4	32	40.5	4	15.6	1.0
2012	2011	1	Hat. Summer Steelhead	154.8	318	20.9	37.7	318	14	1.0
2013	2013	0	Wild Summer Steelhead	56.1	878	11.3	2.1	777	1.1	1.2
2013	2012	1	Wild Summer Steelhead	44.5	1,777	14.7	5.4	1,772	4.2	1.2
2013	2011	2	Wild Summer Steelhead	144.7	21	15.7	36.1	21	10.2	1
2013	2010	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2013	2012	1	Hat. Summer Steelhead	166.2	365	21.4	49.2	363	18.2	1.1
2014	2014	0	Wild Summer Steelhead	49.6	490	12.8	1.7	389	1.1	1.4
2014	2013	1	Wild Summer Steelhead	82.2	745	13.6	6.3	745	3.5	1.1
2014	2012	2	Wild Summer Steelhead	145.1	30	16.5	33	30	13.4	1.1
2014	2011	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2014	2013	1	Hat. Summer Steelhead	173.4	632	18.7	52.6	633	15.9	1.0
2015	2015	0	Wild Summer Steelhead	70	182	15.5	4.3	176	2	1.1
2015	2014	1	Wild Summer Steelhead	88	233	20.2	8.3	233	6.7	1.0
2015	2013	2	Wild Summer Steelhead	149	14	13.5	33.7	14	8.2	1.0
2015	2012	3	Wild Summer Steelhead	191	1	—	73.8	1	—	1.1
2015	2014	1	Hat. Summer Steelhead	175	273	15.2	51.3	273	12.5	0.9
2016	2016	0	Wild Summer Steelhead	56	674	16.4	2.4	617	1.8	1.0
2016	2015	1	Wild Summer Steelhead	87	278	21.5	8.3	278	5.9	1.1
2016	2014	2	Wild Summer Steelhead	143	19	17.4	31.1	19	9.6	1.0
2016	2013	3	Wild Summer Steelhead	202	1	—	90.1	1	—	1.1
2016	2015	1	Hat. Summer Steelhead	175	95	15.5	55.1	95	16.2	1.0
2017	2017	0	Wild Summer Steelhead	54	370	17.6	2.5	306	1.5	1.0

2017	2016	1	Wild Summer Steelhead	88	1,109	14.5	8.1	1,108	4.4	1.0
2017	2015	2	Wild Summer Steelhead	150	74	15.8	35.6	74	11.0	1.0
2017	2014	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2017	2016	1	Hat. Summer Steelhead	167	497	19.2	48.3	497	17.8	1.0

Coho (2007-2017)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2004	2002	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2004	2003	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2004	2003	Nat. Or. Coho Subyearling Parr	—	—	—	—	—	—	—
2004	2002	Hatchery Coho Yearling Smolt	136.6	847	12.8	27.4	820	7.5	1.1
2005	2003	Nat. Or. Coho Yearling Smolt	114.4	17	8.8	16.2	17	3.6	1.1
2005	2004	Nat. Or. Coho Subyearling Fry	49.1	9	10.4	1.3	9	0.8	1.1
2005	2004	Nat. Or. Coho Subyearling Parr	76.7	9	12.8	4.9	9	2.7	1.1
2005	2003	Hatchery Coho Yearling Smolt	137.3	689	11.3	28.6	690	7.2	1.1
2006	2004	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2006	2005	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2006	2005	Nat. Or. Coho Subyearling Parr	71	4	13.6	3.8	4	2.9	1.1
2006	2004	Hatchery Coho Yearling Smolt	—	—	—	—	—	—	—
2007	2005	Nat. Or. Coho Yearling Smolt	92.9	36	12.5	8.7	36	4	1.1
2007	2006	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2007	2006	Nat. Or. Coho Subyearling Parr	83	1	—	6.2	1	—	1.1
2007	2005	Hatchery Coho Yearling Smolt	116	2	—	16.8	2	—	1.1
2008	2006	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2008	2007	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2008	2007	Nat. Or. Coho Subyearling Parr	87	1	—	6.4	1	—	1
2008	2006	Hatchery Coho Yearling Smolt	130.2	843	10.4	23.6	843	6.2	1.1
2009	2007	Nat. Or. Coho Yearling Smolt	103	4	9.7	11.7	4	3.4	1.1
2009	2008	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2009	2008	Nat. Or. Coho Subyearling Parr	79.6	5	20.1	6.6	5	4.8	1.3
2009	2007	Hatchery Coho Yearling Smolt	135.3	625	8.9	26.2	579	5.2	1.1
2010	2008	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2010	2009	Nat. Or. Coho Subyearling Fry	48	2	—	1.3	2	—	1.2
2010	2009	Nat. Or. Coho Subyearling Parr	83.6	27	8.6	6.7	27	2.4	1.1
2010	2008	Hatchery Coho Yearling Smolt	130	1,051	10.1	23.8	1,049	5.3	1.1
2011	2009	Nat. Or. Coho Yearling Smolt	100.2	14	12.7	11.3	14	3.9	1.1
2011	2010	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2011	2010	Nat. Or. Coho Subyearling Parr	64.7	3	10.8	3	3	1.5	1.1

2011	2009	Hatchery Coho Yearling Smolt	124.6	969	8.6	21	969	4.8	1.1
2012	2010	Nat. Or. Coho Yearling Smolt	102.1	17	9.1	11.9	17	3	1.1
2012	2011	Nat. Or. Coho Subyearling Fry	36	1	—	—	—	—	—
2012	2011	Nat. Or. Coho Subyearling Parr	78.4	84	9.3	5	84	2.1	1
2012	2010	Hatchery Coho Yearling Smolt	126.2	1,684	7.6	21.5	1,684	5.5	1.1
2013	2011	Nat. Or. Coho Yearling Smolt	97	81	10	10	81	3.1	1.1
2013	2012	Nat. Or. Coho Subyearling Fry	47.3	3	1	1	3	1	0.9
2013	2012	Nat. Or. Coho Subyearling Parr	87.8	4	3.8	6.6	4	1	1
2013	2011	Hatchery Coho Yearling Smolt	130.1	982	8.5	23.3	977	4.9	1.1
2014	2012	Nat. Or. Coho Yearling Smolt	96.3	20	9.8	9.9	20	3	1.1
2014	2013	Nat. Or. Coho Subyearling Fry	36	1	—	—	—	—	—
2014	2013	Nat. Or. Coho Subyearling Parr	73	3	22.5	5.9	3	4.7	1.5
2014	2012	Hatchery Coho Yearling Smolt	127	1,203	9.7	21.7	1,207	5.0	1.1
2015	2013	Nat. Or. Coho Yearling Smolt	109	2	4.9	12.0	2	0.1	0.9
2015	2014	Nat. Or. Coho Subyearling Fry	47	7	13.7	1.4	7	1.5	0.9
2015	2014	Nat. Or. Coho Subyearling Parr	69	3	7	4.0	3	1.3	1.2
2015	2013	Hatchery Coho Yearling Smolt	131	952	9.9	23.3	952	4.8	1.0
2016	2014	Nat. Or. Coho Yearling Smolt	100	6	15.8	11.1	6	5.5	1.0
2016	2015	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2016	2015	Nat. Or. Coho Subyearling Parr	—	—	—	—	—	—	—
2016	2014	Hatchery Coho Yearling Smolt	134	302	8.4	24.8	301	5.0	1.0
2017	2015	Nat. Or. Coho Yearling Smolt	—	—	—	—	—	—	—
2017	2016	Nat. Or. Coho Subyearling Fry	—	—	—	—	—	—	—
2017	2016	Nat. Or. Coho Subyearling Parr	—	—	—	—	—	—	—
2017	2015	Hatchery Coho Yearling Smolt	122	548	8.0	20.1	548	4.1	1.1

APPENDIX E. Memo to NMFS

To: Charlene Hurst

CC: Cory Kamphaus

From: Bryan Ishida

Date: May 8, 2017

RE: Documentation of take exceedance – Nason Creek Smolt Trap

Yakama Nation Fisheries

Columbia River

Honor. Protect. Restore.

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Due to seasonal high river discharge and upstream hatchery releases, the Nason Creek smolt trap is currently being run on a night schedule (8:30 pm – 5:00 am), with Yakama Nation Fisheries (YNF) personnel on-site during all periods of active trapping. Hourly visual checks are made from the adjacent bank using hand-held spotlights to ensure that no debris is lodged in the cone. During periods of high debris flow, checks occur at half-hour intervals. In an attempt to run the smolt trap as continuously as possible, the trap is only pulled into the bank and inspected if an apparent debris blockage must be cleared, or the movement of a large number of hatchery-origin fish (following a direct plant) is anticipated.

At approximately 5:00 am on May 7, 2017, YNF personnel found 48 hatchery-origin summer steelhead dead in the holding box of the Nason Creek smolt trap. Cause of death appeared to be from blunt trauma/crushing. Despite checking the trap at the established one-hour intervals, the on-duty technicians failed to note an approximately 4"x4"x18" piece of wood lodged at the rear of the cone. We suspect that while smaller fish could pass by the blockage unharmed, hatchery steelhead were pushed against it and crushed. With a total of 769 hatchery-origin summer steelhead caught thus far at the Nason Creek smolt trap, we are in exceedance (6.2%) of the 2% lethal take limit as stated in WCR-2015-3778 Section 2.8.1. Hatchery steelhead releases into Nason Creek are ongoing (through May 12), providing a strong likelihood that the current take (%) will be diminished markedly by the conclusion of the outmigration. Take for other ESA-listed species (wild spring Chinook, hatchery-origin spring Chinook, and wild summer steelhead) are all below 2%.

To help prevent further such events, we will instate the mandatory practice of fully drawing in the trap to the bank for full inspection at least once every four hours. More frequent inspections will be performed in the event of high debris load and hatchery release. Additionally, all YNF smolt trap personnel will be briefed on the event, and reminded of the importance of ensuring that even the smallest obstructions are cleared.

Please feel free to contact me with any questions regarding this event.

Sincerely,

Bryan Ishida

Appendix M

Fish Trapping at the White River Smolt Trap during 2017

Population Estimates for Juvenile Spring Chinook Salmon in White River, WA

2017 Annual Report

Prepared by:
Bryan Ishida

YAKAMA NATION
FISHERIES RESOURCE MANAGEMENT
Toppenish, WA 98948

Prepared for:

Public Utility District No. 2 of Grant County
Ephrata, Washington 98823

ABSTRACT

In 2007, Yakama Nation Fisheries Resource Management began monitoring emigration of Endangered Species Act (ESA) - listed Upper Columbia River (UCR) spring Chinook salmon in the White River to provide abundance and freshwater survival estimates. This report summarizes data collected between March 1 and November 30, 2017. We used 1.5 m, and 2.4 m rotary screw traps to collect 657 juvenile spring Chinook; 48 fry, 545 subyearling parr, 41 yearling smolts, and 23 precocial parr. Daily counts at the trap were expanded via regression analysis derived from mark and recapture trials. We estimated that 2,942 (± 2,625; 95% CI) BY2015 wild spring Chinook smolts and 4,851 (± 1,373; 95% CI) BY2016 wild spring Chinook parr emigrated past the White River trap in 2017. Combined with data collected in 2016, this gives us a total estimate of 5,372 (± 2,723; 95% CI) BY2015 emigrants. Using spring Chinook spawning ground data collected by Washington Department of Fish and Wildlife (WDFW) in 2015, we estimated egg-to-emigrant survival of BY2015 spring Chinook to be 2.0% (98 smolts-per-redd).

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ACKNOWLEDGEMENTS

This project is part of a basin-wide monitoring program requiring close coordination between multiple agencies and contractors. We greatly appreciate the hard work of the Yakama Nation FRM crew members including Matthew Clubb, Jamie Hallman, Tim Jeffris, Kevin Swager, and Allyse Thompson who maintained and operated the trap during all hours including nights/weekends and inclement weather conditions. Also thank you to Peter Graf and Rolland O'Connor (Grant County PUD) for administering contracting and funding as well as Mclain Johnson, Andrew Murdoch, and Josh Williams (WDFW) for data sharing and collaboration on smolt trap methodologies.

1.0 INTRODUCTION

White River spring Chinook salmon (tkwínat) *Oncorhynchus tshawytscha* are part of the Upper Columbia River (UCR) spring Chinook salmon Evolutionarily Significant Unit (ESU), which was listed as endangered under the Endangered Species Act (ESA) in 1999. Due to critically low abundance, a captive broodstock program was operated in the White River between 1997 and 2015 as a risk aversion measure. Determining freshwater productivity of spring Chinook salmon in the White River is an essential component of the overall population monitoring, and will help contribute to the body of knowledge needed to evaluate if further supplementation in the White River is warranted.

In the fall of 2005, Washington State Department of Fish and Wildlife (WDFW) began smolt trapping in the lower White River in order to provide an estimate of juvenile spring Chinook salmon production. No trapping was conducted in 2006 as there was a transition between trap operators. In 2007, Public Utility District No. 2 of Grant County (GCPUD) contracted with Yakama Nation Fisheries (YNF) to operate a rotary trap in the White River. This document reports data collected between March 1 and November 30, 2017, and provides emigration estimates for spring Chinook salmon yearlings (BY2015) and subyearlings (BY2016) during that time period. Fish trap operations were conducted in compliance with ESA consultation specifically to address abundance and productivity of spring Chinook salmon in the White River.

Within this document, we will report:

1) Juvenile abundance and productivity of spring Chinook salmon in the White River.

2) Emigration timing of spring Chinook salmon emigrating from the White River.

1.1 Watershed Description

The White River drainage encompasses 40,451 ha originating in alpine glaciers and perennial snow fields (Figure 1; USFS 2004). Elevation within the drainage varies from 569 m at the surface of Lake Wenatchee to 2,614 m at Clark Mountain (Andonaegui 2001). As one of two primary tributaries to Lake Wenatchee, the White River flows in a south-easterly direction for 42.9 rkm before emptying into the lake. Precipitation ranges from 79 cm at the mouth to more than 356 cm in the head waters (Andonaegui 2001). Due to its glacial origins, peak runoff for the White River typically occurs between April and July with occasional high flows caused by rain-on-snow events in the fall and winter months. Water temperatures in this watershed tend to be cooler than other tributaries to the upper Wenatchee River subbasin. As of September 2002, Washington State Department of Ecology (WDOE) began operating a stream monitoring station at rkm 9.9. Operation of this station by WDOE is currently maintained with funding provided by GCPUD. In 2017, daily mean stream discharge ranged from 2.3 m^3/s (81 cfs) to 200.7 m^3/s (7,090 cfs) while mean daily stream temperatures ranged from 0.0°C to 13.7°C (Figs. 2 & 3). Discharge and temperature data provided by WDOE should be considered provisional and are presented in Appendix A.

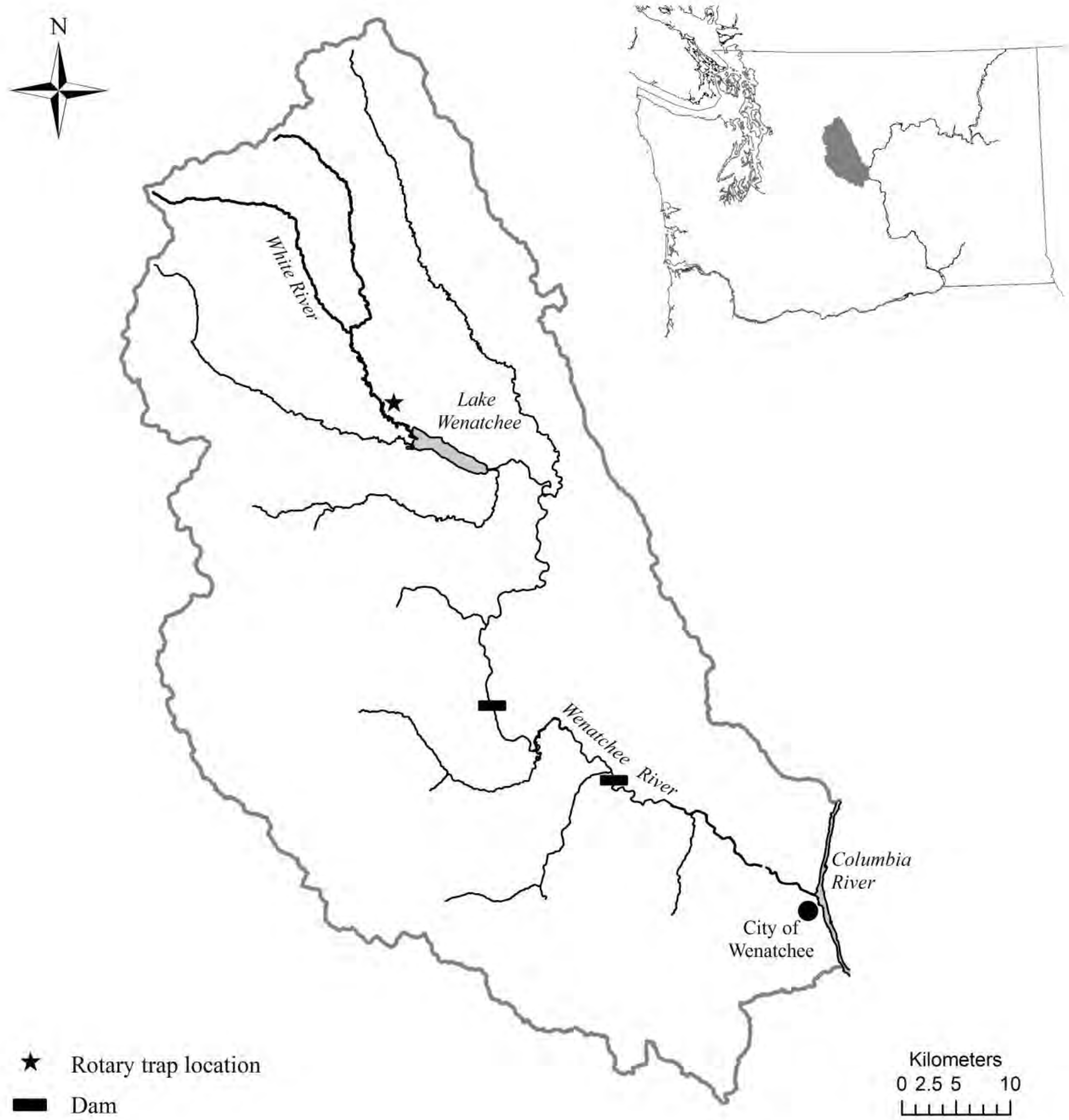


Figure 1. Map of the Wenatchee River subbasin with White River rotary trap location.

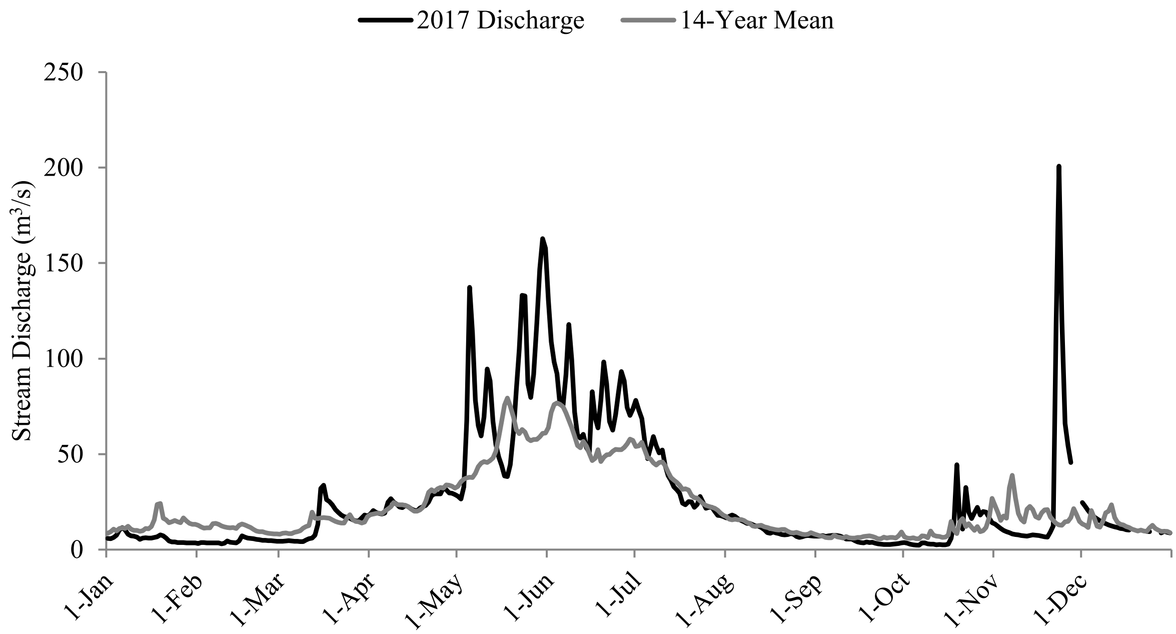


Figure 2. Mean daily stream discharge at the White River DOE stream monitoring station at Sears Creek Bridge, 2017.

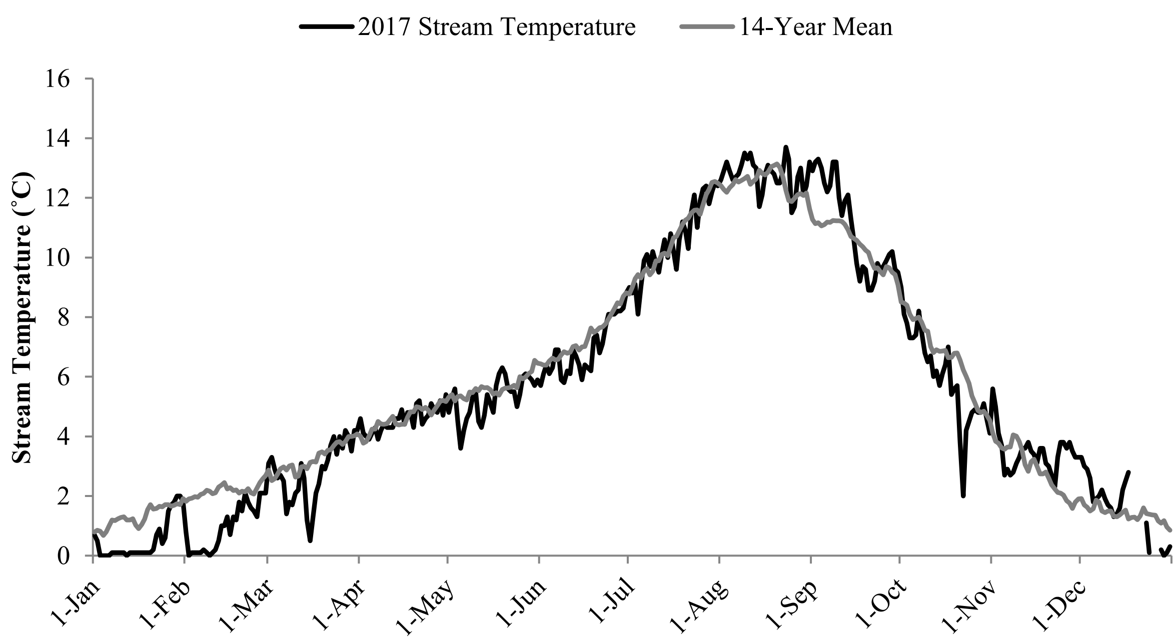


Figure 3. Mean daily water temperatures at the White River DOE stream monitoring station at Sears Creek Bridge, 2017.

The White River drainage has had minimal riparian harvest from the 1950's to the present on federally owned land. Turn of the century settlement and land clearing have impacted the riparian reserve network up to the Napeequa confluence, yet, riparian areas in the mainstem below Panther Creek remain in fair condition (USFS 2004). In the remainder of the watershed, woody debris recruitment, shade, aquatic habitat connectivity, and riparian vegetation appear to be in good condition. Current habitat concerns pertaining to the development of homes and vacation retreats on private lands do exist. Bank armoring (Rip-rap), channel constriction, and stream degradation are considered minor in the watershed. Public ownership comprises 78% of the drainage area; more than half of public land is located within the Glacier Peak Wilderness. The remaining 22% of the drainage is in private ownership (USFS 2004).

Downstream of White River Falls are key spawning grounds for spring Chinook salmon (tkwínat) *Oncorhynchus tshawytscha*, sockeye salmon (kálux) *O. nerka*, and bull trout *Salvelinus confluentus*. Two large tributaries to the White River, Napeequa River and Panther Creek, are also known to support populations of anadromous salmonids (Mullen et al. 1992). For a complete list of known fish species encountered in the White River see Section 3.4 (Incidental Species).

2.0 METHODS

2.1 Trapping Equipment and Operation

Throughout the duration of the trapping season, a 1.5m diameter cone rotary trap (Trap-A) was operated at a fixed position along the river-right bank. This trapping regime employed a single trap position across all flows since 2013. On August 10, a 2.4m diameter rotary trap (Trap B) was installed along the river-left bank to be operated concurrently with Trap-A. Trap-B was installed for the sole purpose of catching additional spring Chinook parr and smolts for tagging and efficiency trials used to build the flow-efficiency model of Trap-A. Both traps were suspended from a single 1/2” 6x37 IWRC galvanized (26,500 lb. breaking strength, 5,300 lb. working-load limit) wire-rope highline anchored to two large western redcedar (*Thuja plicata*) trees on opposing banks. Both traps were affixed to the highline with 13/32” nylon-coated wire rope (9,800 lb. breaking-strength/1,960 lb. working-load limit) and a heavy duty pulley. Each pulley could be moved laterally along the highline with a system of 7/32” nylon-coated wire rope (2,000 lb. breaking-strength/400 lb. working-load limit) positioning cables controlled by hand-powered winches on the river-left bank. For a detailed explanation of the use of Trap B, see the original pilot proposal in Appendix E.

Trap-A acted as the primary trap upon which the flow-efficiency relationship was based i.e., daily catch was integral to producing emigrant estimates. Because of this, we attempted to operate Trap-A 24 hours per day, 7 days per week at all flows. During spring runoff, operations only occurred during hours of darkness to minimize trap damage and fish mortality, while enabling collection during hours of peak migration. Trap-B was operated as channel depth and discharge level permitted. A record of daily trap operations is provided in Appendix B.

During all ranges of river discharge, fish were removed daily. Additional trap checks were necessary during periods of high discharge and/or debris accumulation. Debris in the live-box was removed continually by a rotating drum screen driven by the force of the rotating cone.

2.2 Biological Sampling

Trap operating procedures and techniques followed a standardized, basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team (UCRTT) for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was adapted from Murdoch & Petersen (2000).

Captured fish were transferred from the rotary trap’s live box using covered five-gallon plastic buckets to a stream-side portable sampling station. Fish were anesthetized in a solution of tricaine methanesulfonate (MS-222) to facilitate sampling and reduce handling stress. Fork length (FL) and weight were recorded for all fish, except large numbers of sockeye fry. For these fish, a daily subsample of 25 individuals was measured while the remaining fish were enumerated and released. Weight was measured to the nearest 0.1g with a portable digital scale while FL was recorded to the nearest 1.0 mm using a trough-type measuring board. These data were used to calculate a Fulton-type condition factor (K-factor) for each target species using the formula:

$$K = (W/L^3) \times 100{,}000$$

where K = Fulton-type condition metric;
W = weight in grams;
L = fork length in millimeters;
And 100,000 is a scaling constant.

Portable aerators were used to oxygenate holding water during sampling. All fish were allowed to fully recover from anesthesia before being released. Developmental stages (fry, parr, transitional or smolt) were visually identified and assigned to each individual sampled. Transitional juveniles were identified as having both parr and smolt characteristics; visible parr marks, semi-transparent fin coloration along with silvery coloration throughout body. Smolts were identified by a strong silvery coloration over entire body and faint or absent parr marks. Fry were defined as newly emerged fish with or without a visible yolk sac and a FL measuring < 50 mm. Age-0 spring Chinook salmon captured before July 1 were considered 'fry' and excluded from population estimates due to the inconclusive nature of their movement (i.e. active emigration or local distribution in-stream). Age-0 spring Chinook salmon captured after 1 July were considered subyearling emigrants and included in the population estimate (UCRTT, 2001).

Tissue samples (caudal clip) were taken from spring Chinook salmon and applied to blotter sheets. Samples were provided to WDFW for reproductive success analysis. Scale samples were also collected from all steelhead captured. Scale samples were submitted to WDFW for age analysis. Bull trout tissue or scale samples were not collected in 2017.

During periods when the trap operations were suspended (e.g. - high discharge, high debris and/or mechanical problems), passage estimates were generated to account for emigrants during these time periods. This estimate was calculated using the average number of fish captured three days prior and three days after the break in operation (Hillman et al., 2013; Snow et al., 2013).

2.3 Mark-Recapture Trials

Groups of marked spring Chinook salmon were used for trap efficiency trials. Fish were marked by insertion of a Passive Integrated Transponder (PIT) tag into the abdominal cavity. Ideally, marked groups of fish were released over a broad range of stream discharges in order to determine a trap efficiency-discharge relationship. (See **2.4 Data Analysis**). Mark-recapture (M-R) trials followed the protocol described in Hillman (2004). Although the protocol suggests a minimum sample size of 100 fish for each mark-group, the limited abundance of juvenile emigrants from the White River required that efficiency trials be completed with smaller sample sizes. YN's continued goal is to increase individual mark-group sizes, when possible, to meet the standard described above. Current minimum mark group size is 50 fish.

Number of wild fish included in a marked group was maximized by combining catches from three days of trapping. Fish were held up to 72 hours prior to release in holding boxes located on the river-left bank. Fish to be used in efficiency trials were then transported in five-gallon buckets ~1.0 rkm upstream to the release location at Sears Creek Bridge (rkm 10.3). All mark groups are released by hand at nautical twilight.

Each M-R trial was conducted over a three-day (72 hour) period to allow time for passage or capture. Completed trials were only considered invalid if an interruption to trapping occurred or proper pre-release procedures were not followed. Trials resulting in zero recaptures were included in the efficiency regression as allowed by the new method of observed trap efficiency calculation (See equation 3 in **2.5.1 Estimate of Abundance**).

2.3.1 Marking and PIT tagging

All spring Chinook and summer steelhead juveniles with FL ≥ 60mm were PIT tagged unless the health of a specimen was in question. Once anesthetized, each fish was examined for external wounds or descaling and scanned for the presence of a previously implanted PIT tag. If a tag was not detected, a pre-loaded 12mm Digital Angel 134.2 kHz type TX 1411ST PIT tag was inserted into the body cavity using a Biomark MK-25 Rapid Implant Gun. Each unique tag code was electronically recorded with an appropriate tagging date, release date, tagging personnel and biological data. These data were entered into P_3 and submitted to the PIT Tag Information System (PTAGIS) at the end of each month. Tagging methods were consistent with methodology described in the PIT Tag Marking Procedures Manual (CBFWA 1999) as well as with 2008 ISEMP protocols (Tussing 2008).

Tagged fish were held for a minimum of 24-hours to a) ensure complete recovery, b) assess tagging mortality and c) determine tag-shed rate. Fish that were not to be used in an efficiency trial were released downstream of the smolt trap.

2.4 Data Analysis

2.4.1 Estimate of Abundance

Seasonal juvenile migration, N, was estimated as the sum of daily migrations, N_i, i.e., $N = \sum_i N_i$, and daily migration was calculated from catch and efficiency:

$$\hat{N}_i = \frac{C_i}{\hat{e}_i}, \tag{1}$$

where C_i = number of fish caught in period *I*;

$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2(b_0 + b_1 flow_i)$,

where b_0 is estimated intercept and b_1 is the estimated slope of the regression.

The regression parameters b_0 and b_1 are estimated using linear regression for the model:

$$\arcsin\left(\sqrt{e_k^{obs}}\right) = \beta_0 + \beta_1 flow_k + \varepsilon, \quad \textbf{(2)}$$

where e_k^{obs} = observed trap efficiency of Eq. 2 for trapping period k;

β_0 = intercept of the regression model;

β_1 = slope parameter;

ε = error with mean 0 and variance σ^2.

In Equation 2, the observed trap efficiency, e_k^{obs}, is calculated as follows,

$$e_k^{obs} = \frac{r_k + 1}{m}. \quad \textbf{(3)}$$

The estimated variance of seasonal migration is calculated from daily estimates as:

$$Var\left(\sum_{i=1}^{n} \widehat{N}_i\right) = \underbrace{\sum_i Var(N_i)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov(N_i, N_j)}_{Part\ B}$$

or, **(4)**

$$Var\left(\sum_{i=1}^{n} \widehat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i + 1)}{\hat{e}_i}\right)}_{Part\ A} + \underbrace{\sum_i \sum_j Cov\left(\frac{(C_i + 1)}{\hat{e}_i}, \frac{(C_j + 1)}{\hat{e}_j}\right)}_{Part\ B}$$

Part A of equation 4 is the variance of daily estimates. Part B is the between-day covariance. Note that the between-day covariance exists only for days that use the same trap efficiency model. If, for example, day 1 is estimated with one trap efficiency model, and day 2 estimated from a different model, then there is no covariance between day 1 and day 2. The full expression for the estimated variance:

$$\widehat{Var}\left(\sum_{i=1}^{n}\widehat{N}_i\right) = \underbrace{\sum_i \widehat{N}_i^2\left(\frac{N_i\hat{e}_i(1-\hat{e}_i)}{(C^i+1)^2} + \frac{4(1-\hat{e}_i)}{\hat{e}_i}\widehat{Var}(b_0+b_1 flow_i)\right)}_{Part\ A}$$
$$+\underbrace{\sum_i\sum_j 4\left(\widehat{N}_i(1-\hat{e}_i)\right)\left(\widehat{N}_j(1-\hat{e}_j)\right)\cdot\left[\widehat{Var}(b_0) + flow_i flow_j \widehat{Var}(b_1)\right]}_{Part\ B}$$

where $V\hat{a}r(b_0 + b_1 flow_i) = M\hat{S}E\left(1 + \frac{1}{n} + \frac{(flow_i - \overline{flow})^2}{(n-1)s_{flow}^2}\right)$, and $\hat{V}ar(b_0)$ and $\hat{V}ar(b_1)$ are

obtained from regression results. In Excel, the standard error (SE) of the coefficients is provided. The variance is calculated as the square of the standard error, SE^2.

In cases when there was no significant flow-efficiency relationship (i.e., low correlation), then a pooled, or average trap efficiency will suffice for the stratum. The estimator is calculated as follows:

$$\hat{\hat{e}} = \frac{\sum_{j=1}^{k} r_j}{\sum_{j=1}^{k} m_j}$$

where $\hat{\hat{e}}$ = the average or pooled trap efficiency for the stratum;

m_j = the number of smolts marked and released in efficiency trial j for the stratum;

r_j = the number of smolts recaptured out of m_j marked fish in efficiency trial j.

Abundance for a trapping period is estimated as:

$$\hat{N}_i^{pooled} = \frac{C_i}{\hat{\hat{e}}},$$

,and total stratum abundance is:

$$N^{pooled} = \sum_i \hat{N}_i^{pooled}.$$

The variance of seasonal abundance takes into account the variability in catch numbers that are a result of binomial sampling (Part A), the pooled variance of trap efficiency, $\hat{\hat{e}}$ (Part B), and the covariance in daily estimates that arises from using a common estimate of efficiency across all trapping days (Part C):

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i(1-\hat{\hat{e}})}{\hat{\hat{e}}}\right)}_{Part\ A} + \underbrace{\frac{Var(\hat{\hat{e}})}{\hat{\hat{e}}^2}\sum_i \hat{N}_i^2}_{Part\ B} + \underbrace{\frac{Var(\hat{\hat{e}})}{\hat{\hat{e}}^2}\sum_i\sum_j \hat{N}_i\hat{N}_j}_{Part\ C}$$

The Part B and Part C terms are combined in the calculation as a new Part B:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i^{pooled}\right) = \left(\sum_i \frac{\hat{N}_i(1-\hat{\hat{e}})}{\hat{\hat{e}}}\right) + \frac{Var(\hat{\hat{e}})}{\hat{\hat{e}}^2}\left[\sum_i \hat{N}_i^2 + \sum_i\sum_j \hat{N}_i\hat{N}_j\right]$$

The variance of $\hat{\hat{e}}$ is calculated as:

$$V\hat{a}r\left(\hat{\hat{e}}\right) = V\hat{a}r\left(\frac{\sum_{k=1}^{n} r_k}{\sum_{k=1}^{n} m_k}\right) = \frac{\sum_{k=1}^{n}\left(r_k - \hat{\hat{e}}_k m_k\right)^2}{\overline{m}^2 n(n-1)}$$

where $\overline{m}$ is the average release size across all efficiency trial, $\frac{\sum_{k=1}^{n} m_k}{n}$.

Confidence intervals were calculated using the following formulas:

95% confidence interval = $1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$

The single M-R estimator of abundance carries a set of well documented assumptions (Everhart and Youngs 1981; Seber 1982),

1. The population is closed to mortality.
2. The probability of capturing a marked or unmarked fish is equal.
3. Marked fish were randomly dispersed in the population prior to recapture.

4. Marking does not affect probabilities of capture.
5. Marks were not lost between the time of release and recapture.
6. All marks are reported upon recapture.
7. The number of fish in the trap, C, is fully enumerated and known without error.

3.0 RESULTS

3.1 Dates of Operation

Trap-A was operated between March 1 and November 30. During this period, it was run 24 hours per day, 7 days per week barring inoperable environmental conditions (i.e. heavy debris loads or high discharge). Trap-A was not operated for a total of 19 days (Table 1).

Table 1. Summary of Trap A operation, 2017.

Trap Status	Description	Days
Operating	Continuous data collection	256
Interrupted	Unexpected interruption by debris, etc.	15
Pulled	Intentionally pulled to protect the trap during high flows	4

Trap-B was operated between August 10 and November 30. During this period, it was operated 24 hours per day, 7 days per week barring inoperable environmental conditions (i.e. insufficient channel depth or high discharge). Trap-B was not operated for a total of 44 days (Table 2).

Table 2. Summary of Trap B operation, 2017.

Trap Status	Description	Days
Operating	Continuous data collection	69
Interrupted	Unexpected interruption by debris, etc.	5
Pulled	Intentionally pulled due to grounding, or to protect the trap during high flows	39

3.2 Daily Captures and Biological Sampling

3.2.1 Wild Spring Chinook Yearlings (BY 2015)

Forty-one wild yearling Chinook smolts were collected between March 1 and June 30 (Figure 4). Mean FL was 98 mm (n = 41; SD = 6.6) and mean weight was 10.7 g (n = 35; SD = 2.3; Table 2). All spring Chinook smolts were implanted with PIT tags and had tissue samples taken. Additionally, 23 wild spring Chinook precocial parr were captured following the smolt migration. Mean FL for precocial parr was 140 mm (n = 20; SD = 11.7) and mean weight was 30.1 g (n = 20; SD = 7.2). There were no BY2015 spring Chinook mortalities incurred.

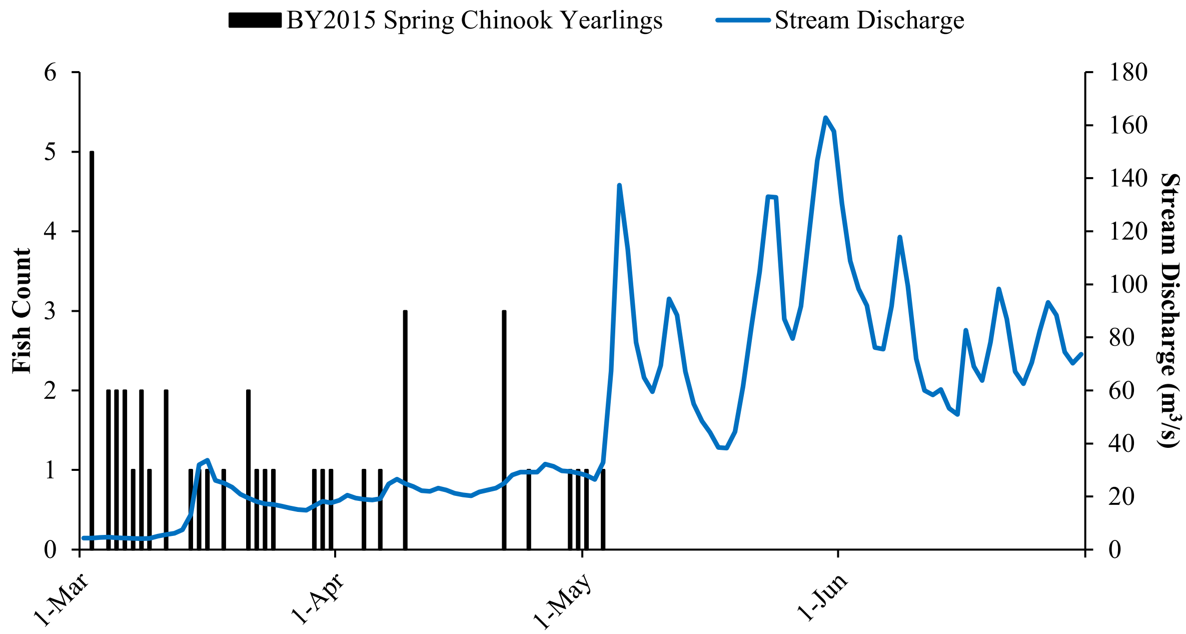


Figure 4. Daily catch of yearling spring Chinook smolt with mean daily stream discharge at the White River rotary trap, March 1 to June 30, 2017.

Table 3. Summary of length and weight sampling of juvenile spring Chinook captured at the White River rotary trap, 2017.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
		Mean	n	SD	Mean	n	SD	
2015	Wild Yearling Smolt	98	41	6.6	10.7	35	2.3	1.10
2015	Wild Precocial Parr	140	20	11.7	30.1	20	7.2	1.09
2016	Wild Subyearling Fry	38	47	3.4	0.4	47	0.2	0.78
2016	Wild Subyearling Parr	85	530	10.1	7.1	516	2.3	1.09

3.2.2 Wild Spring Chinook Subyearlings (BY2016)

Subyearling spring Chinook catch included 48 fry (FL<50 mm) and 545 parr (FL≥50 mm). Chinook fry captured had a mean FL of 38 mm (*n* = 38; *SD* = 3.4) and a mean weight of 0.4 g (*n* = 47; *SD* = 0.2). Parr had a mean FL of 85 mm (*n* = 530; *SD* = 10.1) and a mean weight of 7.1 g (*n* = 516; *SD* = 2.3). Total parr catch was split between Trap A (*n* = 406) and Trap B (*n* = 139). Because Trap A was not installed until August, all fry were captured in Trap A. Annual subyearling trapping mortality included eight parr.

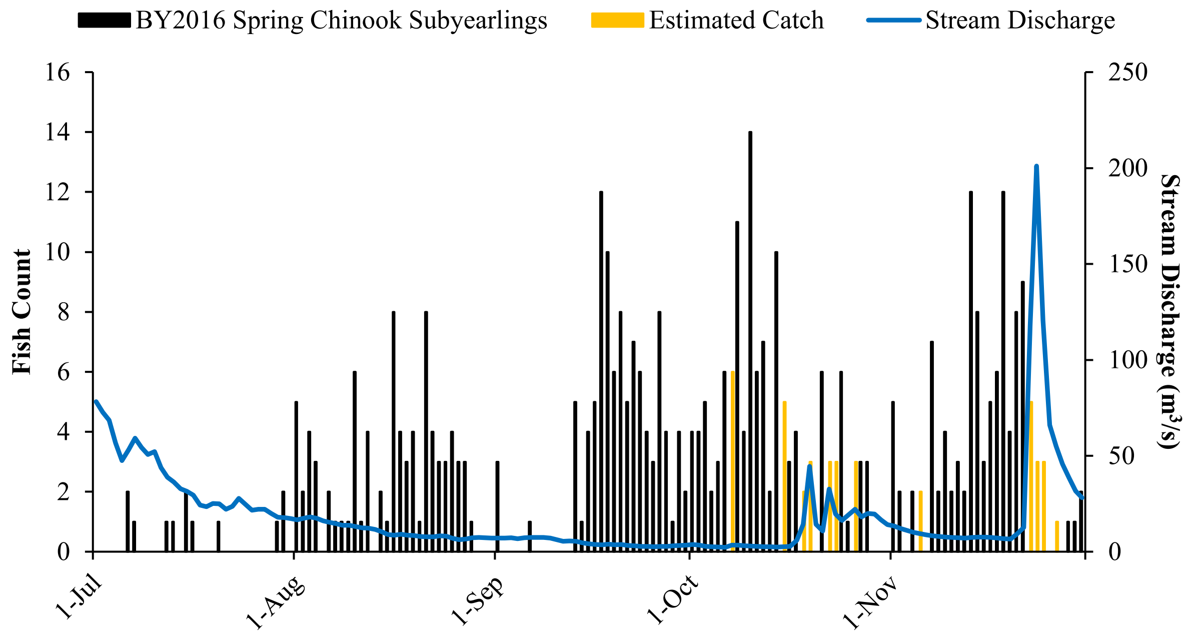


Figure 5. Trap A wild subyearling spring Chinook daily catch with mean daily stream discharge at the White River rotary trap, July 1 to November 30, 2017.

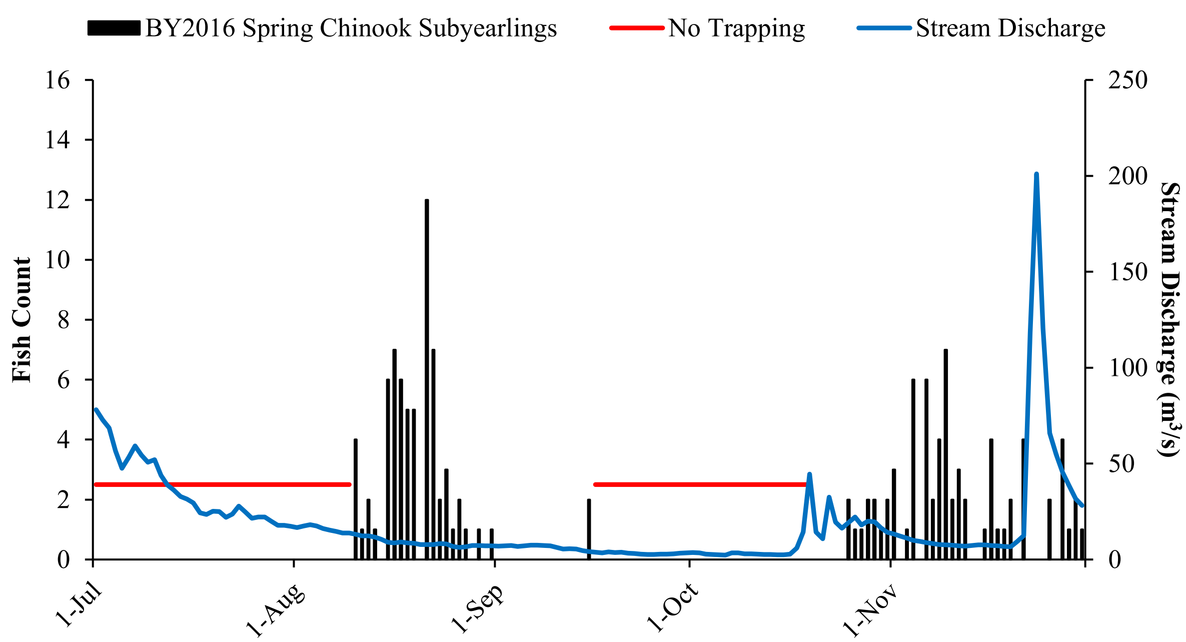


Figure 6. Trap B wild subyearling spring Chinook daily catch with mean daily stream discharge at the White River rotary trap, July 1 to November 30, 2017.

3.3 Trap Efficiency Calibration and Population Estimates

3.3.1 Wild Spring Chinook Yearlings (BY 2015)

Due to low abundance, no BY2015 wild yearling Chinook efficiency trials were performed in 2017. A composite regression model using previous year's (2008-2012) efficiency trials showed statistically significant ($r^2 = 0.57$; $p = 0.001$) flow-efficiency relationship, and was used to calculate yearling abundance. Use of a single spring trapping position allowed this regression to be applied to all yearling Chinook captured in 2017. Weighting of this regression via an R script (provided by WDFW) did not affect calculation parameters greatly and yielded the same r-square and *p*-values. In the fall of 2016, we estimated that 2,430 (± 723; 95% CI) BY2015 subyearlings emigrated past the trap. In the spring of 2017, we estimated that 2,942 (± 2,625; 95% CI) emigrated past the trap. Combining the two estimates, total BY2015 wild spring Chinook emigrants was 5,372 (± 2,723; 95% CI; Table 3).

3.3.2 Wild Spring Chinook Subyearling (BY 2016)

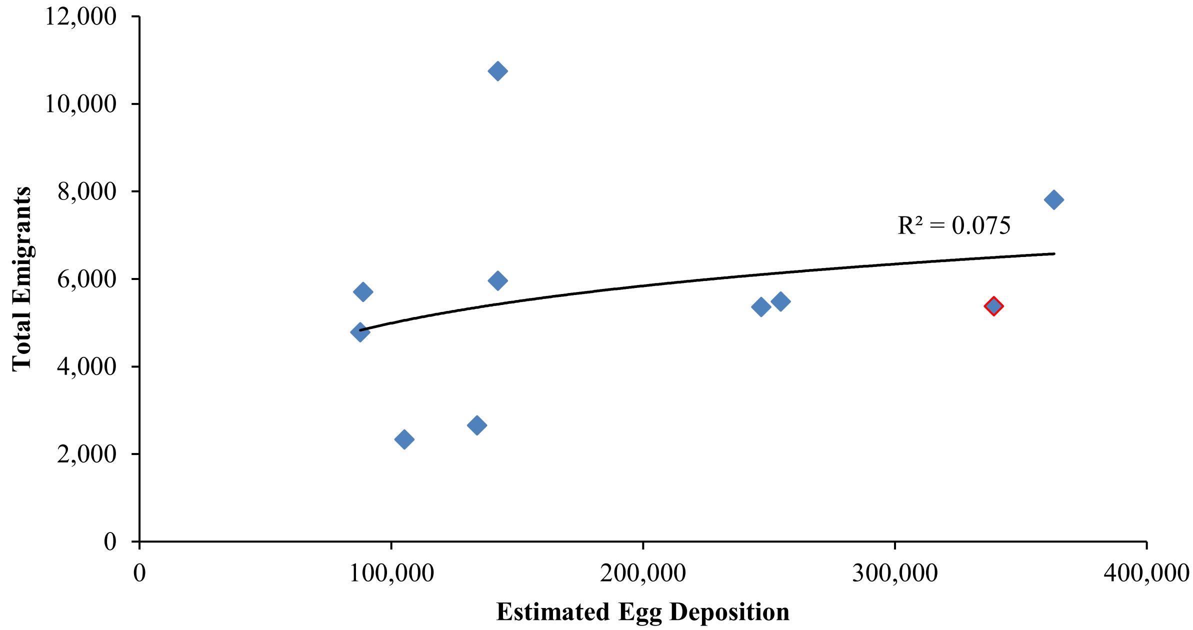
The desired minimum mark group size of ≥ 50 subyearling emigrants could not be fulfilled for any releases in 2017. Test releases used to initially measure the combined efficacy of the two traps in tandem (see section 3.6) did not contribute to the existing flow-efficiency model because of their small sizes, and redundancies in flows tested. The existing composite regression model used data from 2009-2015 to build a flow-efficiency relationship. The weighted regression was not significant ($r^2 = 0.14$; $p = 0.074$) at our accepted limit ($\alpha = 0.05$). However, after comparison with a pooled method and considerations of the pooled estimate limitations, we decided to use the regression model despite its slightly higher *p*-value. This single regression was the only model required to estimate total subyearling migration due to the fact only one fall trapping position was used. We estimated that 4,851 (± 1,373; 95% CI) spring Chinook subyearling parr moved past the trap (Table 3).

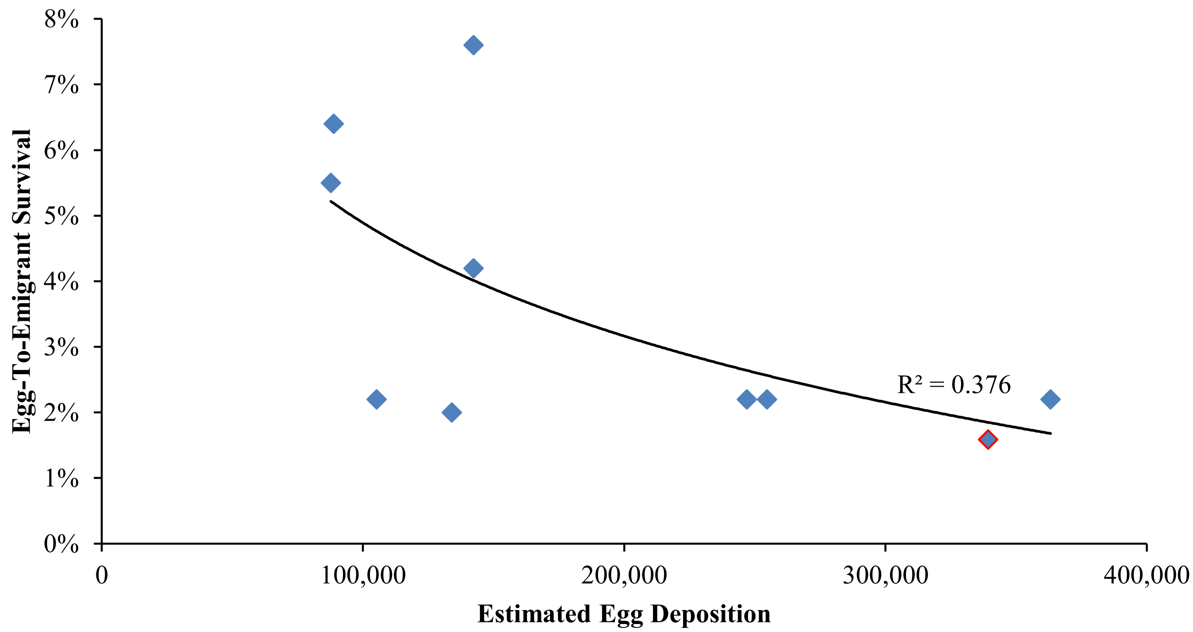
Table 4. Estimated egg-to-emigrant survival and emigrants per redd for White River spring Chinook

Brood Year	No. of Redds[a]	Fecundity[b]	No. of Eggs	No. of Emigrants			Egg-to Emigrant	Emigrants per Redd
				Age-0[c]	Age-1	Total ± 95% CI		
2005	86	4,327	372,122	DNOT[d]	4,856	—	—	—
2006	31	4,324	134,044	652	2,004	2,656 ± 1,597	2.0%	86
2007	20	4,441	88,820	2,309	3,395	5,704 ± 2,201	6.4%	285
2008	31	4,592	142,352	5,560	5,193	10,753 ± 3,783	7.6%	347
2009	54	4,573	246,942	2,428	2,939	5,367 ± 2,497	2.2%	99
2010	33	4,314	142,362	1,859	4,103	5,962 ± 3,448	4.2%	181
2011	20	4,385	87,700	3,128	1,659	4,787 ± 2,022	5.5%	239
2012	86	4,223	363,178	3,816	3,995	7,811 ± 3,847	2.2%	91
2013	54	4,716	254,664	2,461	3,023	5,484 ± 2,836	2.2%	102
2014	26	4,045	105,170	1,950	386	2,336 ± 807	2.2%	90
2015	70	4,847	339,290	2,430	2,942	5,372 ± 2,723	1.6%	77
2016	44	4,467	196,548	4,851	—	—	—	—
Avg	**43**	**4,446**	**190,452**	**2,659**	**2,964**	**5,623**	**3.6%**	**160**

[a] Number of complete redds in White River (Hillman et al. 2017)
[b] Mean annual fecundity of spring Chinook broodstock at Chiwawa River Hatchery

[c] Estimate is based on capture of parr collected during summer/fall and does not include fry captured prior to July1
[d] Did not operate trap; no production estimates were made





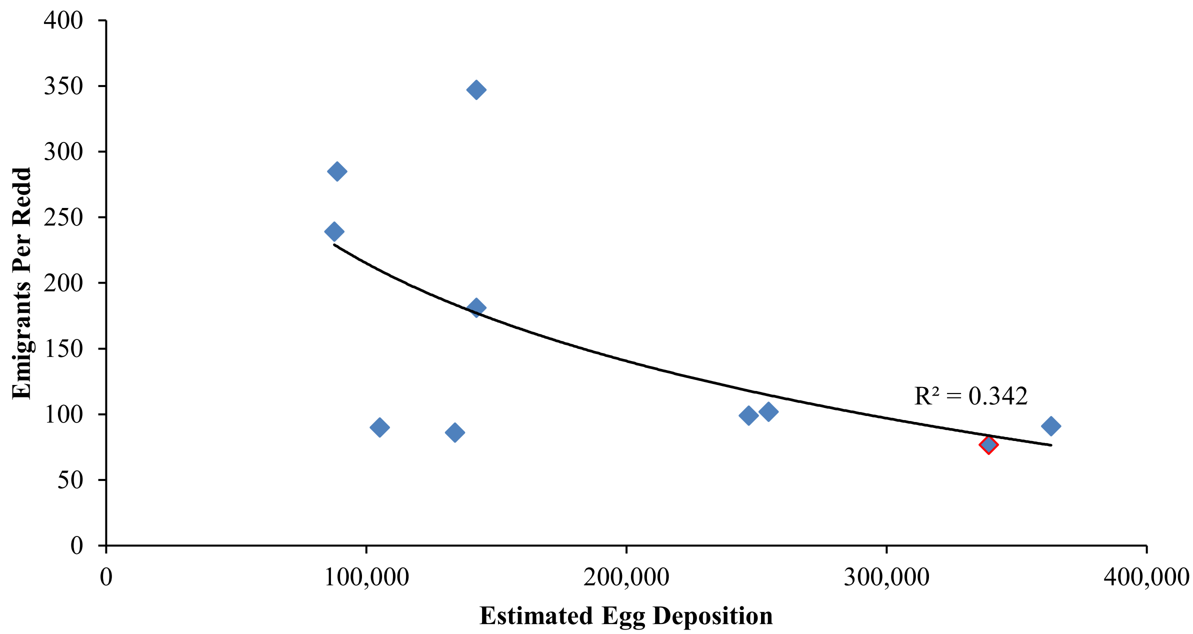


Figure 7. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for White River spring Chinook, BY 2006 to 2015. *BY2015 values denoted by red border.

3.4 PIT Tagging

A total of 548 spring Chinook and 3 steelhead were PIT tagged (Table 4). The post-tagging observational hold time of a minimum of 24 hours yielded no shed tags. There no tagging mortalities (Table 6).

Table 5. Number of PIT tagged spring Chinook and steelhead (FL ≥ 60 mm) with shed rates at the White River rotary trap, 2017.

Brood Year	Species/Stage	Total Catch	Total PIT Tagged	Percent Tagged	Percent Tags Shed
2015	Spring Chinook Yearlings	41	41	100.0%	0.0%
2016	Spring Chinook Subyearlings	539	507	94.1%	0.0%
*	Summer Steelhead	6	3	50.0%	0.0%

* Brood year unknown

3.5 Incidental Species

Incidental species were enumerated and sampled for length and weight (Table 5). Incidental species included: bull trout, longnose dace *Rhinichthys cataractae*, mountain whitefish *Prosopium williamsoni*, northern pikeminnow *Ptychocheilus oregonensis*, steelhead/rainbow trout (shúshaynsh) *Oncorhynchus mykiss*, redside shiner *Richardsonius balteatus*, sculpin *Cottus* *sp*., sockeye salmon, sucker *Catostomus sp*., and westslope cutthroat *Oncorhynchus clarkii lewisi*.

Table 6. Summary of length and weight sampling of incidental species captured at the White River rotary trap, 2017.

Species	Total Count	Fork Length (mm)			Weight (g)		
		Mean	*n*	SD	Mean	*n*	SD
Bull Trout	7	34	3	6.4	0.5	1	—
Longnose Dace	9	58	4	22.3	3.8	3	2.0
Mountain Whitefish	325	82	262	46.8	12.1	257	30.3
Northern Pikeminnow	42	138	31	33.6	28.3	25	19.6
Rainbow Trout/Steelhead Parr	6	143	3	10.2	29.2	2	10.8
Redside Shiner	47	85	41	14.3	8.2	38	4.1
Sculpin	93	65	58	19.2	3.7	56	2.8
Sockeye Fry	2,842	28	1,065	1.5	—	—	—
Sockeye Parr	36	69	30	7.3	3.2	30	1.1
Sockeye (Kokanee)	8	149	1	—	—	—	—
Sucker	40	182	17	81.0	34.5	11	21.5
Westslope Cutthroat	29	234	23	49.7	114.4	20	48.3

3.6 ESA Compliance

ESA-listed species mortalities incurred in 2017 included eight subyearling Chinook parr (Table 6). At no point during the trapping season did the lethal take of wild spring Chinook exceed the maximum allowed 2%. All fish handled were inspected prior to tagging or further sampling with any sign of injury or stress warranting immediate release.

Table 7. Summary of White River ESA listed species catch and mortality, 2017.

Species/Stage	Total Catch	Total Mortality	Total % Mortality
Yearling Chinook Smolt	41	0	0.0%
Chinook Precocial Parr	23	0	0.0%
Subyearling Chinook Parr	545	8	1.5%
Subyearling Chinook Fry	48	0	0.0%
Total Wild Spring Chinook	**657**	**8**	**1.2%**
Bull Trout	7	0	0.0%
Steelhead/Rainbow Trout	6	0	0.0%

Annual maximum allowable take for wild spring Chinook was 20%. To ensure that the addition of Trap B did not push us beyond this limit, multiple test efficiency trails were performed to gauge the combined efficiency of both traps. These efficiency trials did not contribute to the existing flow-efficiency models because they were all below the target mark-group size ($n \geq 50$), and smaller than previous releases in similar flow ranges. In total, the test only yielded one trial resulting in a combined efficiency of over 20% (Table 8). Mean combined efficiency for the six trials was 11.5% at a mean discharge of 8 m^3/s (299 cfs). Though test trials could only be performed at a relatively low range of discharges, based on existing flow-efficiency models we conclude that combined efficiency would also diminish at higher flows.

Table 8. Test combined efficiency trails, 2017

Release Date	Discharge (m^3/s)	Marked	Recaptured			Combined Efficiency
			Trap A	Trap B	Total	
8/18/2017	8.7	36	0	2	2	5.6%
8/22/2017	7.8	33	0	2	2	6.1%
8/26/2017	6.3	21	1	1	2	9.5%
11/9/2017	13.5	32	3	1	4	12.5%
11/13/2017	7.3	24	2	0	2	8.3%
11/17/2017	7.1	26	7	0	7	26.9%

4.0 DISCUSSION

Pilot operation of Trap B in 2017 demonstrated that the proposed tandem smolt trap configuration can reliably increase spring Chinook catch at the White River, while leaving the current budget and estimation methodologies unchanged. Though some flow-based constraints on its use were documented, Trap B proved more effective, and more operationally viable over a wider range of flows than initially predicted.

Trap B was installed for a total of 113 days, 69 of which were operational. Inactivity during this period was caused overwhelmingly by low discharge, which grounded the trap at flows below approximately 4.1 m^3/s (144 cfs). The unseasonably low, and prolonged 2017 base-flow period at the White River saw 32 days below 4.1 m^3/s (144 cfs), contrasting the 14-year average of 18 days. Instances of grounding will likely be fewer in the future. Trap B was operated at a maximum flow of 66.0 m^3/s (2,330 cfs). At discharges higher than this, cone speed diminished as an eddy formed on river-left. Limitations of our initial rigging configuration did not allow us to operate beyond the eddy. We will alter our rigging in 2018 to allow the trap to be pulled to the center of the channel.

Comparison of the two traps during simultaneous operation suggested that they catch emigrants at a relatively similar overall rate at the flows tested. During the 66 days of operational overlap, Trap A captured 190 parr, while Trap B captured 138 parr. Trap B experienced some minor technical difficulties in November resulting in lowered cone speed. We suspect that this likely caused some degree of loss in catch as trap avoidance became easier. We subsequently determined the causes of the lowered cone speed (insufficient lubrication and minor change in positioning), and will prevent them in the future. Though the tandem configuration was only tested for 66 days, results from the pilot operation suggest that the addition of the 2.4m trap may up to double spring Chinook catch. We recommend continued testing of Trap B and plan to continue the tandem trap configuration as flows permit.

Despite a relatively high White River spawner success rate in 2015, the resulting BY2015 emigrant estimate was near average, and egg-to-emigrant survival well-below average. This pattern is typical of the White River and nearby tributaries, where suspected density-dependent effects cause an inverse relationship between in-stream survival and egg deposition (Figure 8). Low in-stream survival as seen in the White River's population was not mirrored in the nearby Chiwawa River and Nason Creek, where redd counts in 2015 were near, or below average. Run timing of BY2015 Chinook was typical, with approximately half of the estimated emigrants leaving as subyearlings, and half as yearlings.

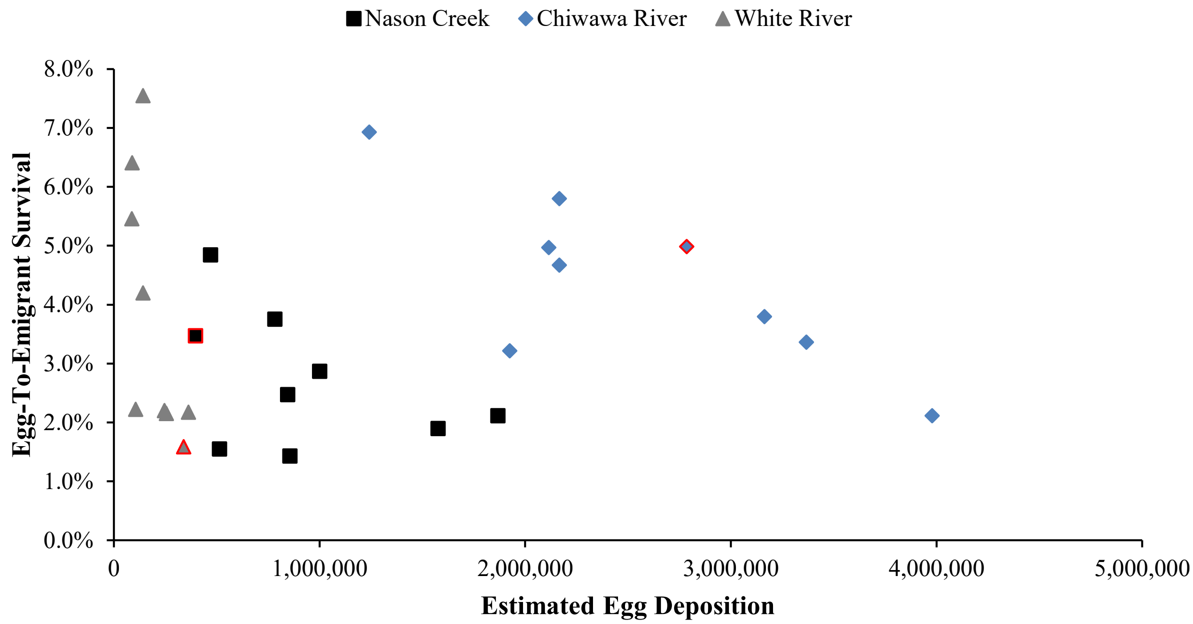


Figure 8. Comparisons of White R., Nason Cr., and Chiwawa River egg-to-emigrant survivals, BY2007-2015. *BY2016 denoted by red border.

The initial BY2016 subyearling estimate suggests that in-stream rearing conditions between the spring and fall of 2017 may have been better than average. Despite a near-mean rate of egg deposition in 2016, our BY2016 subyearling estimate is the second highest on record. If favorable conditions persist through the winter, we may be seeing a yearling estimate of approximately the same number. The major high-water event on November 23 during which discharge reached 224 m^3/s (7,940 cfs) was the largest since the fall of 2007. Due to the magnitude of the flood and heavy debris load observed, early downstream movement (displacement) of BY2016 may have occurred. The potential effects of this flood will be determined upon completion of the BY2016 migratory period in 2018.

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APPENDIX A: White River Temperature and Discharge Data

Date	Stream Discharge (m^3/s)	Water Temperature (˚C)
3/1/2017	4.3	3.1
3/2/2017	4.3	3.3
3/3/2017	4.5	2.9
3/4/2017	4.7	2.6
3/5/2017	4.5	2.7
3/6/2017	4.3	2.5
3/7/2017	4.3	1.4
3/8/2017	4.1	1.8
3/9/2017	4.2	1.7
3/10/2017	5.0	2.1
3/11/2017	5.7	2.2
3/12/2017	6.1	3.1
3/13/2017	7.5	2.6
3/14/2017	13.2	1.2
3/15/2017	32.0	0.5
3/16/2017	33.7	1.3
3/17/2017	26.1	2.1
3/18/2017	25.1	2.4
3/19/2017	23.5	3.0
3/20/2017	20.9	2.9
3/21/2017	19.4	3.2
3/22/2017	18.1	3.7
3/23/2017	17.2	4.0
3/24/2017	17.0	3.4
3/25/2017	16.4	4.0
3/26/2017	15.7	3.6
3/27/2017	15.1	4.2
3/28/2017	14.9	4.0
3/29/2017	16.5	3.5
3/30/2017	18.2	4.2
3/31/2017	17.6	4.2
4/1/2017	18.6	4.6
4/2/2017	20.5	4.1
4/3/2017	19.5	4.0
4/4/2017	19.0	3.9
4/5/2017	18.7	4.1
4/6/2017	19.2	4.3
4/7/2017	24.7	3.9
4/8/2017	26.6	4.2
4/9/2017	24.9	4.4
4/10/2017	23.7	4.3
4/11/2017	22.2	4.3
4/12/2017	22.0	4.3
4/13/2017	23.2	4.6
4/14/2017	22.4	4.6
4/15/2017	21.2	4.9
4/16/2017	20.6	4.4
4/17/2017	20.3	4.8
4/18/2017	21.8	4.8
4/19/2017	22.4	4.3
4/20/2017	23.2	5.1
4/21/2017	25.0	5.2
4/22/2017	28.1	4.4
4/23/2017	29.2	4.6
4/24/2017	29.2	4.7
4/25/2017	29.2	5.1
4/26/2017	32.3	4.9
4/27/2017	31.4	4.8
4/28/2017	29.7	5.2
4/29/2017	29.4	4.7
4/30/2017	28.9	5.4
5/1/2017	28.0	4.8
5/2/2017	26.5	5.3
5/3/2017	32.8	5.6
5/4/2017	67.4	4.5
5/5/2017	137.3	3.6
5/6/2017	113.3	4.2
5/7/2017	78.2	4.6
5/8/2017	64.8	4.8
5/9/2017	59.5	5.3
5/10/2017	69.4	5.5
5/11/2017	94.6	4.5
5/12/2017	88.3	4.3
5/13/2017	67.1	4.7
5/14/2017	54.9	5.4
5/15/2017	48.4	5.1
5/16/2017	44.2	4.8
5/17/2017	38.5	5.7
5/18/2017	38.2	6.1
5/19/2017	44.5	6.3

5/20/2017	61.4	6.1	7/4/2017	56.6	8.1
5/21/2017	83.8	5.6	7/5/2017	47.6	9.0
5/22/2017	104.8	5.5	7/6/2017	53.2	9.9
5/23/2017	133.1	5.5	7/7/2017	59.2	10.1
5/24/2017	132.8	5.0	7/8/2017	54.4	9.7
5/25/2017	86.9	5.4	7/9/2017	50.7	10.2
5/26/2017	79.6	6.0	7/10/2017	52.1	9.8
5/27/2017	91.7	6.1	7/11/2017	43.9	9.5
5/28/2017	118.6	6.0	7/12/2017	38.8	10.1
5/29/2017	146.7	5.9	7/13/2017	36.2	10.6
5/30/2017	162.8	5.7	7/14/2017	32.8	10.0
5/31/2017	157.7	5.9	7/15/2017	31.4	10.8
6/1/2017	130.5	5.7	7/16/2017	29.4	10.2
6/2/2017	108.7	6.1	7/17/2017	24.4	9.6
6/3/2017	98.3	6.4	7/18/2017	23.5	10.6
6/4/2017	92.0	6.1	7/19/2017	25.1	11.2
6/5/2017	76.2	6.3	7/20/2017	24.9	10.9
6/6/2017	75.6	6.9	7/21/2017	22.1	10.3
6/7/2017	91.7	6.9	7/22/2017	23.6	11.5
6/8/2017	117.8	5.9	7/23/2017	27.8	12.1
6/9/2017	99.4	5.8	7/24/2017	24.7	11.0
6/10/2017	71.9	6.2	7/25/2017	21.5	11.9
6/11/2017	60.0	6.1	7/26/2017	22.1	12.3
6/12/2017	58.3	6.9	7/27/2017	22.2	12.4
6/13/2017	60.3	6.7	7/28/2017	20.0	11.8
6/14/2017	53.2	6.4	7/29/2017	17.9	12.2
6/15/2017	51.0	5.9	7/30/2017	17.8	12.5
6/16/2017	82.7	6.4	7/31/2017	17.3	12.4
6/17/2017	69.1	6.3	8/1/2017	16.7	12.6
6/18/2017	63.7	6.2	8/2/2017	17.4	12.9
6/19/2017	78.2	7.3	8/3/2017	18.1	13.2
6/20/2017	98.3	7.4	8/4/2017	17.4	12.9
6/21/2017	86.9	6.8	8/5/2017	16.1	12.6
6/22/2017	67.1	7.1	8/6/2017	15.3	12.7
6/23/2017	62.6	7.7	8/7/2017	14.6	12.8
6/24/2017	70.5	8.1	8/8/2017	13.8	13.1
6/25/2017	82.4	8.1	8/9/2017	13.8	13.5
6/26/2017	93.2	8.1	8/10/2017	13.1	13.3
6/27/2017	88.3	8.2	8/11/2017	12.4	13.5
6/28/2017	74.5	8.2	8/12/2017	12.3	13.1
6/29/2017	70.2	8.3	8/13/2017	11.6	13.0
6/30/2017	73.6	8.8	8/14/2017	10.4	11.7
7/1/2017	78.2	9.0	8/15/2017	8.9	12.1
7/2/2017	72.8	8.8	8/16/2017	8.6	12.8
7/3/2017	68.5	9.1	8/17/2017	9.2	13.1

8/18/2017	8.7	12.9	10/2/2017	3.4	8.1
8/19/2017	8.4	12.8	10/3/2017	2.8	7.8
8/20/2017	7.9	12.5	10/4/2017	2.6	7.3
8/21/2017	7.8	12.5	10/5/2017	2.4	7.3
8/22/2017	7.8	12.9	10/6/2017	2.3	7.4
8/23/2017	8.3	13.7	10/7/2017	3.5	8.2
8/24/2017	8.1	13.3	10/8/2017	3.5	7.5
8/25/2017	6.9	11.5	10/9/2017	3.0	6.8
8/26/2017	6.3	11.7	10/10/2017	2.9	6.5
8/27/2017	6.7	12.7	10/11/2017	2.8	6.7
8/28/2017	7.3	13.0	10/12/2017	2.6	6.0
8/29/2017	7.4	12.1	10/13/2017	2.6	6.2
8/30/2017	7.2	12.4	10/14/2017	2.5	5.7
8/31/2017	7.1	13.2	10/15/2017	2.5	6.1
9/1/2017	7.1	12.9	10/16/2017	2.8	6.4
9/2/2017	7.1	13.2	10/17/2017	5.9	7.0
9/3/2017	7.3	13.3	10/18/2017	14.4	5.4
9/4/2017	6.8	13.0	10/19/2017	44.5	5.6
9/5/2017	7.2	12.5	10/20/2017	14.3	5.7
9/6/2017	7.4	12.2	10/21/2017	10.7	3.8
9/7/2017	7.5	12.4	10/22/2017	32.6	2.0
9/8/2017	7.4	13.2	10/23/2017	19.6	4.2
9/9/2017	7.1	13.2	10/24/2017	16.3	4.5
9/10/2017	6.3	12.0	10/25/2017	19.3	4.8
9/11/2017	5.5	11.4	10/26/2017	22.1	4.9
9/12/2017	5.6	11.9	10/27/2017	18.1	4.8
9/13/2017	5.5	12.1	10/28/2017	20.0	4.8
9/14/2017	4.7	11.3	10/29/2017	19.6	5.1
9/15/2017	4.1	10.6	10/30/2017	16.5	4.6
9/16/2017	3.7	9.8	10/31/2017	14.1	4.1
9/17/2017	3.5	9.2	11/1/2017	13.4	5.6
9/18/2017	4.0	9.7	11/2/2017	12.2	5.0
9/19/2017	3.6	9.6	11/3/2017	11.1	4.1
9/20/2017	3.8	8.9	11/4/2017	10.1	3.7
9/21/2017	3.3	8.9	11/5/2017	9.4	2.7
9/22/2017	3.1	9.2	11/6/2017	8.8	2.9
9/23/2017	2.8	9.8	11/7/2017	8.2	2.7
9/24/2017	2.7	9.6	11/8/2017	7.9	2.8
9/25/2017	2.6	9.7	11/9/2017	7.7	3.1
9/26/2017	2.7	9.9	11/10/2017	7.4	3.3
9/27/2017	2.8	10.1	11/11/2017	7.2	3.6
9/28/2017	3.0	10.2	11/12/2017	7.0	3.6
9/29/2017	3.3	9.6	11/13/2017	7.3	3.8
9/30/2017	3.5	9.5	11/14/2017	7.6	3.5
10/1/2017	3.7	9.0	11/15/2017	7.6	3.4

11/16/2017	7.3	3.1	11/24/2017	120.3	3.8
11/17/2017	7.1	3.6	11/25/2017	66.0	3.8
11/18/2017	6.7	3.6	11/26/2017	54.7	3.6
11/19/2017	6.6	3.1	11/27/2017	45.6	3.8
11/20/2017	9.2	3.0	11/28/2017	–	–
11/21/2017	12.5	2.7	11/29/2017	31.4	3.3
11/22/2017	117.8	2.3	11/30/2017	–	–
11/23/2017	200.8	3.3			

APPENDIX B: Daily Trap Operation Status

Date	Trap A Status	Trap B Status	Comments
3/1/2017	Op.	NA	
3/2/2017	Op.	NA	
3/3/2017	Op.	NA	
3/4/2017	Op.	NA	
3/5/2017	Op.	NA	
3/6/2017	Op.	NA	
3/7/2017	Op.	NA	
3/8/2017	Op.	NA	
3/9/2017	Op.	NA	
3/10/2017	Op.	NA	
3/11/2017	Op.	NA	
3/12/2017	Op.	NA	
3/13/2017	Op.	NA	
3/14/2017	Op.	NA	
3/15/2017	Stopped	NA	Debris
3/16/2017	Op.	NA	
3/17/2017	Op.	NA	
3/18/2017	Op.	NA	
3/19/2017	Op.	NA	
3/20/2017	Op.	NA	
3/21/2017	Op.	NA	
3/22/2017	Op.	NA	
3/23/2017	Op.	NA	
3/24/2017	Op.	NA	
3/25/2017	Op.	NA	
3/26/2017	Op.	NA	
3/27/2017	Op.	NA	
3/28/2017	Op.	NA	
3/29/2017	Op.	NA	
3/30/2017	Op.	NA	
3/31/2017	Op.	NA	
4/1/2017	Op.	NA	
4/2/2017	Op.	NA	
4/3/2017	Op.	NA	
4/4/2017	Op.	NA	
4/5/2017	Op.	NA	
4/6/2017	Op.	NA	
4/7/2017	Op.	NA	
4/8/2017	Op.	NA	
4/9/2017	Op.	NA	
4/10/2017	Op.	NA	
4/11/2017	Op.	NA	
4/12/2017	Op.	NA	
4/13/2017	Op.	NA	
4/14/2017	Op.	NA	
4/15/2017	Op.	NA	
4/16/2017	Stopped	NA	Debris
4/17/2017	Op.	NA	
4/18/2017	Op.	NA	
4/19/2017	Op.	NA	
4/20/2017	Op.	NA	
4/21/2017	Op.	NA	
4/22/2017	Op.	NA	
4/23/2017	Op.	NA	
4/24/2017	Op.	NA	
4/25/2017	Op.	NA	
4/26/2017	Op.	NA	
4/27/2017	Op.	NA	
4/28/2017	Op.	NA	
4/29/2017	Op.	NA	
4/30/2017	Op.	NA	
5/1/2017	Op.	NA	
5/2/2017	Op.	NA	
5/3/2017	Op.	NA	
5/4/2017	Op.	NA	
5/5/2017	Op.	NA	
5/6/2017	Op.	NA	
5/7/2017	Op.	NA	
5/8/2017	Op.	NA	
5/9/2017	Stopped	NA	Debris
5/10/2017	Op.	NA	
5/11/2017	Op.	NA	
5/12/2017	Op.	NA	
5/13/2017	Op.	NA	
5/14/2017	Op.	NA	
5/15/2017	Op.	NA	
5/16/2017	Op.	NA	
5/17/2017	Op.	NA	
5/18/2017	Op.	NA	
5/19/2017	Op.	NA	
5/20/2017	Op.	NA	
5/21/2017	Op.	NA	
5/22/2017	Op.	NA	
5/23/2017	Stopped	NA	Debris

5/24/2017	Stopped	NA	Debris	7/8/3017	Op.	NA
5/25/2017	Op.	NA		7/9/2017	Op.	NA
5/26/2017	Op.	NA		7/10/2017	Op.	NA
5/27/2017	Op.	NA		7/11/2017	Op.	NA
5/28/2017	Op.	NA		7/12/2017	Op.	NA
5/29/2017	Op.	NA		7/13/2017	Op.	NA
5/30/2017	Stopped	NA	Debris	7/14/2017	Op.	NA
5/31/2017	Op.	NA		7/15/2017	Op.	NA
6/1/2017	Op.	NA		7/16/2017	Op.	NA
6/2/2017	Op.	NA		7/17/2017	Op.	NA
6/3/2017	Op.	NA		7/18/2017	Op.	NA
6/4/2017	Op.	NA		7/19/2017	Op.	NA
6/5/2017	Op.	NA		7/20/2017	Op.	NA
6/6/2017	Op.	NA		7/21/2017	Op.	NA
6/7/2017	Op.	NA		7/22/2017	Op.	NA
6/8/2017	Op.	NA		7/23/2017	Op.	NA
6/9/2017	Op.	NA		7/24/2017	Op.	NA
6/10/2017	Op.	NA		7/25/2017	Op.	NA
6/11/2017	Op.	NA		7/26/2017	Op.	NA
6/12/2017	Op.	NA		7/27/2017	Op.	NA
6/13/2017	Op.	NA		7/28/2017	Op.	NA
6/14/2017	Op.	NA		7/29/2017	Op.	NA
6/15/2017	Op.	NA		7/30/2017	Op.	NA
6/16/2017	Op.	NA		7/31/2017	Op.	NA
6/17/2017	Op.	NA		8/1/2017	Op.	NA
6/18/2017	Op.	NA		8/2/2017	Op.	NA
6/19/2017	Op.	NA		8/3/2017	Op.	NA
6/20/2017	Op.	NA		8/4/2017	Op.	NA
6/21/2017	Op.	NA		8/5/2017	Op.	NA
6/22/2017	Op.	NA		8/6/2017	Op.	NA
6/23/2017	Op.	NA		8/7/2017	Op.	NA
6/24/2017	Op.	NA		8/8/2017	Op.	NA
6/25/2017	Op.	NA		8/9/2017	Op.	NA
6/26/2017	Op.	NA		8/10/2017	Op.	Op.
6/27/2017	Op.	NA		8/11/2017	Op.	Op.
6/28/2017	Op.	NA		8/12/2017	Op.	Op.
6/29/2017	Op.	NA		8/13/2017	Op.	Op.
6/30/2017	Op.	NA		8/14/2017	Op.	Op.
7/1/2017	Op.	NA		8/15/2017	Op.	Op.
7/2/2017	Op.	NA		8/16/2017	Op.	Op.
7/3/2017	Op.	NA		8/17/2017	Op.	Op.
7/4/2017	Op.	NA		8/18/2017	Op.	Op.
7/5/2017	Op.	NA		8/19/2017	Op.	Op.
7/6/2017	Op.	NA		8/20/2017	Op.	Op.
7/7/2017	Op.	NA		8/21/2017	Op.	Op.

8/22/2017	Op.	Op.		10/6/2017	Op.	Pulled	Grounded
8/23/2017	Op.	Op.		10/7/2017	Stopped	Pulled	Debris/Grounded
8/24/2017	Op.	Op.		10/8/2017	Op.	Pulled	Grounded
8/25/2017	Op.	Op.		10/9/2017	Op.	Pulled	Grounded
8/26/2017	Op.	Op.		10/10/2017	Op.	Pulled	Grounded
8/27/2017	Op.	Op.		10/11/2017	Op.	Pulled	Grounded
8/28/2017	Op.	Op.		10/12/2017	Op.	Pulled	Grounded
8/29/2017	Op.	Op.		10/13/2017	Op.	Pulled	Grounded
8/30/2017	Op.	Op.		10/14/2017	Op.	Pulled	Grounded
8/31/2017	Op.	Op.		10/15/2017	Stopped	Pulled	Debris/Grounded
9/1/2017	Op.	Op.		10/16/2017	Op.	Pulled	Grounded
9/2/2017	Op.	Op.		10/17/2017	Op.	Pulled	Grounded
9/3/2017	Stopped	Op.	Debris	10/18/2017	Stopped	Pulled	Debris/Grounded
9/4/2017	Op.	Op.		10/19/2017	Stopped	Pulled	Debris/Grounded
9/5/2017	Op.	Op.		10/20/2017	Op.	Op.	
9/6/2017	Op.	Op.		10/21/2017	Op.	Op.	
9/7/2017	Op.	Op.		10/22/2017	Pulled	Pulled	Flood
9/8/2017	Op.	Stopped	Debris	10/23/2017	Pulled	Pulled	Flood
9/9/2017	Op.	Op.		10/24/2017	Op.	Op.	
9/10/2017	Op.	Op.		10/25/2017	Op.	Op.	
9/11/2017	Op.	Op.		10/26/2017	Stopped	Stopped	Debris
9/12/2017	Op.	Stopped	Grounded	10/27/2017	Op.	Op.	
9/13/2017	Op.	Pulled	Grounded	10/28/2017	Op.	Op.	
9/14/2017	Op.	Op.		10/29/2017	Op.	Op.	
9/15/2017	Op.	Stopped	Grounded	10/30/2017	Op.	Op.	
9/16/2017	Op.	Pulled	Grounded	10/31/2017	Op.	Op.	
9/17/2017	Op.	Pulled	Grounded	11/1/2017	Op.	Op.	
9/18/2017	Op.	Pulled	Grounded	11/2/2017	Op.	Op.	
9/19/2017	Op.	Pulled	Grounded	11/3/2017	Op.	Op.	
9/20/2017	Op.	Pulled	Grounded	11/4/2017	Op.	Op.	
9/21/2017	Op.	Pulled	Grounded	11/5/2017	Stopped	Op.	Debris
9/22/2017	Op.	Pulled	Grounded	11/6/2017	Op.	Op.	
9/23/2017	Op.	Pulled	Grounded	11/7/2017	Op.	Op.	
9/24/2017	Op.	Pulled	Grounded	11/8/2017	Op.	Op.	
9/25/2017	Op.	Pulled	Grounded	11/9/2017	Op.	Op.	
9/26/2017	Op.	Pulled	Grounded	11/10/2017	Op.	Op.	
9/27/2017	Op.	Pulled	Grounded	11/11/2017	Op.	Op.	
9/28/2017	Op.	Pulled	Grounded	11/12/2017	Op.	Op.	
9/29/2017	Op.	Pulled	Grounded	11/13/2017	Op.	Op.	
9/30/2017	Op.	Pulled	Grounded	11/14/2017	Op.	Op.	
10/1/2017	Op.	Pulled	Grounded	11/15/2017	Op.	Op.	
10/2/2017	Op.	Pulled	Grounded	11/16/2017	Op.	Op.	
10/3/2017	Op.	Pulled	Grounded	11/17/2017	Op.	Op.	
10/4/2017	Op.	Pulled	Grounded	11/18/2017	Op.	Op.	
10/5/2017	Op.	Pulled	Grounded	11/19/2017	Op.	Op.	

11/20/2017	Op.	Op.	
11/21/2017	Op.	Op.	
11/22/2017	Stopped	Stopped	Debris
11/23/2017	Pulled	Pulled	Flood
11/24/2017	Pulled	Pulled	Flood
11/25/2017	Op.	Op.	
11/26/2017	Stopped	Op.	Debris
11/27/2017	Op.	Op.	
11/28/2017	Op.	Op.	
11/29/2017	Op.	Op.	
11/30/2017	Op.	Op.	

APPENDIX C: Regression Models

Model: Chinook Yearlings (Spring '08-'15) Back Position, (r^2=0.569; p = 0.001)

Origin/Species/Stage	Date	Marked	Recaptured	Trap Efficiency	ASIN Transform	Discharge (m^3/s)
Wild Chinook Yearlings	4/10/2008	25	2	0.12	0.354	6
Wild Chinook Yearlings	3/26/2009	24	5	0.25	0.524	5
Wild Chinook Yearlings	3/30/2009	34	4	0.147	0.394	5
Wild Chinook Yearlings	4/2/2009	37	10	0.297	0.577	6
Wild Chinook Yearlings	4/5/2009	59	15	0.271	0.548	6
Wild Chinook Yearlings	4/10/2009	36	3	0.111	0.34	11
Wild Chinook Yearlings	3/12/2010	25	1	0.08	0.287	8
Wild Chinook Yearlings	3/16/2010	30	5	0.2	0.464	8
Wild Chinook Yearlings	3/20/2010	21	1	0.095	0.314	8
Wild Chinook Yearlings	4/5/2010	37	1	0.054	0.235	10
Wild Chinook Yearlings	4/9/2010	31	4	0.161	0.413	9
Wild Chinook Yearlings	4/12/2010	58	4	0.086	0.298	8
Wild Chinook Yearlings	4/16/2010	73	2	0.041	0.204	11
Wild Chinook Yearlings	4/14/2012	48	1	0.042	0.206	15

Model: Chinook Subyearlings (Fall '09-'15) Back Position, (r^2=0.143; p = 0.074)

Origin/Species/Stage	Date	Marked	Recaptured	Trap Efficiency	ASIN Transform	Discharge (m^3/s)
Wild Chinook Subyearlings	8/20/2009	20	2	15.00%	0.398	9
Wild Chinook Subyearlings	8/29/2009	34	4	14.71%	0.394	7
Wild Chinook Subyearlings	10/7/2009	22	2	13.64%	0.378	3
Wild Chinook Subyearlings	10/16/2009	34	6	20.59%	0.471	4
Wild Chinook Subyearlings	11/17/2009	35	3	11.43%	0.345	11
Wild Chinook Subyearlings	11/23/2009	21	0	4.76%	0.22	9
Wild Chinook Subyearlings	11/21/2011	39	2	7.69%	0.281	5
Wild Chinook Subyearlings	10/4/2012	33	5	18.18%	0.441	4
Wild Chinook Subyearlings	10/24/2012	87	6	8.05%	0.288	8
Wild Chinook Subyearlings	10/28/2012	36	1	5.56%	0.238	21
Wild Chinook Subyearlings	10/31/2013	46	7	17.39%	0.43	8
Wild Chinook Subyearlings	11/6/2013	38	9	26.32%	0.539	7
Wild Chinook Subyearlings	11/9/2013	40	6	17.50%	0.432	7
Wild Chinook Subyearlings	11/13/2013	29	2	10.34%	0.327	12
Wild Chinook Subyearlings	11/23/2013	25	3	16.00%	0.412	12
Wild Chinook Subyearlings	11/27/2013	24	0	4.17%	0.206	10
Wild Chinook Subyearlings	9/17/2015	39	4	12.82%	0.366	3

Appendix D. Historical Morphometric Data

Spring Chinook (2007-2017)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2007	2005	Wild Yearling Smolt	93	173	8.5	8.6	173	2.2	1.1
2007	2005	Wild Yearling Precocial Parr	123	4	7.2	22.2	4	5.8	1.2
2007	2005	Hatchery Yearling Smolt*	76	208	17.9	5.4	203	4.2	1.2
2007	2005	Hatchery Yearling Precocial Parr	98	20	8.7	11.1	19	2.2	1.2
2007	2006	Wild Subyearling Fry	35	7	1.6	—	—	—	—
2007	2006	Wild Subyearling Parr	95	33	12.4	9.8	33	4.1	1.1
2008	2006	Wild Yearling Smolt	100	105	12.3	12.5	105	13.5	1.2
2008	2006	Wild Yearling Precocial Parr	126	9	8.4	22.8	9	4.1	1.1
2008	2006	Hatchery Yearling Smolt	117	229	12.7	18.7	228	9.8	1.2
2008	2006	Hatchery Yearling Precocial Parr	155	2	15.6	47.6	2	12.6	1.3
2008	2007	Wild Subyearling Fry	41	10	4.4	—	—	—	—
2008	2007	Wild Subyearling Parr	95	202	9.1	9.4	202	2.5	1.1
2009	2007	Wild Yearling Smolt	104	275	6.4	12.5	274	2.6	1.1
2009	2007	Wild Yearling Precocial Parr	134	5	7.0	28.5	2	2.7	1.2
2009	2007	Hatchery Yearling Precocial Parr	188	2	17.7	81.9	2	27.1	1.2
2009	2008	Wild Subyearling Fry	38	13	2.1	—	—	—	—
2009	2008	Wild Subyearling Parr	85	507	11.8	7.2	499	2.7	1.2
2010	2008	Wild Yearling Smolt	96	345	7.1	11.2	345	2.4	1.3
2010	2008	Wild Yearling Precocial Parr	130	15	10.3	26.4	15	6.6	1.2
2010	2009	Wild Subyearling Fry	40	31	3.6	—	—	—	—
2010	2009	Wild Subyearling Parr	87	166	12.6	7.7	166	3.0	1.2
2011	2009	Wild Yearling Smolt	99	64	7.7	11.3	64	2.8	1.2
2011	2009	Wild Yearling Precocial Parr	137	1	—	32.3	1	—	1.3
2011	2009	Hatchery Yearling Smolt	127	46	10.6	24.3	46	6.5	1.2
2011	2010	Wild Subyearling Fry	37	26	2.5	—	—	—	—
2011	2010	Wild Subyearling Parr	91	159	13.0	9.2	159	7.1	1.2
2012	2010	Wild Yearling Smolt	98	182	7.9	10.9	179	2.8	1.2
2012	2010	Wild Yearling Precocial Parr	123	13	12.7	22.4	13	6.5	1.2
2012	2011	Hatchery Subyearling Fry	84	29	4.4	6.5	2	2.3	1.1
2012	2011	Hatchery Subyearling Parr	110	25	7.4	14.6	25	3.3	1.1
2012	2011	Wild Subyearling Fry	35	18	2.7	—	—	—	—
2012	2011	Wild Subyearling Parr	91	315	10.1	8.8	288	2.8	1.2
2013	2011	Wild Yearling Smolt	103	20	7.0	12.3	20	3.0	1.1
2013	2011	Wild Yearling Precocial Parr	111	2	0.7	13.5	2	3.0	1.0
2013	2011	Hatchery Yearling Precocial Parr	155	4	17.4	43.4	4	17.8	1.2
2013	2012	Wild Subyearling Fry	40	77	8.1	—	—	—	—
2013	2012	Wild Subyearling Parr	84	445	12.3	6.7	444	4.7	1.1

2014	2012	Wild Yearling Smolt	94	43	7.0	9.4	43	2.2	1.1
2014	2012	Wild Yearling Precocial Parr	127	7	13.0	23.2	7	7.4	1.1
2014	2013	Wild Subyearling Fry	40	22	3.8	—	—	—	—
2014	2013	Wild Subyearling Parr	86	185	14.1	7.5	185	3.3	1.2
2015	2013	Wild Yearling Smolt	103	32	6.8	13.0	31	2.8	1.1
2015	2013	Wild Yearling Precocial Parr	145	2	13.4	35.2	2	11.4	1.1
2015	2014	Wild Subyearling Fry	38	11	3.3	0.5	10	0.2	0.9
2015	2014	Wild Subyearling Parr	96	151	7.5	10.4	148	6.3	1.2
2016	2014	Wild Yearling Smolt	106	3	1.5	12.4	3	0.3	1.1
2016	2015	Wild Subyearling Fry	38	50	3.0	0.46	49	0.3	0.8
2016	2015	Wild Subyearling Parr	89	147	10.7	8.29	147	2.8	1.1
2017	2015	Wild Yearling Smolt	98	41	6.6	10.7	35	2.3	1.1
2017	2015	Wild Yearling Precocial Parr	140	20	11.7	30.1	20	7.2	1.1
2017	2016	Wild Subyearling Fry	38	47	3.4	0.4	47	0.2	0.8
2017	2016	Wild Subyearling Parr	86	530	10.1	7.1	516	7.1	1.1

[a] Includes residualized non-precocial smolts caught after June 30
[b] "Fry" classification based on age despite FL $\geq$ 50mm

Appendix E: White River Smolt Trap Proposal for Pilot 2.4-Meter Trap Addition

White River Smolt Trap

Proposal for Pilot 2.4-Meter Trap Addition

July 2017

Prepared by:

Bryan R. Ishida

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1.0 INTRODUCTION

Established in 2005 to target juvenile Upper Columbia River (UCR) spring Chinook (*Oncorhynchus tshawytscha*), operation of the White River smolt trap has undergone several changes to facilitate development of a flow-efficiency model capable of producing accurate abundance estimates. Early trapping strategies included switching operations between a high-water position at an upstream highline cable, and a low-flow position at a lower highline cable. In the upstream high-water position, 1.5 m (5 ft.) and 2.4 m (8 ft.) traps were separately operated to accommodate a range of flows. However, operation of two trap sizes and two trap positions created the need for multiple flow-efficiency models to produce a single population estimate. Low catch in some trap positions did not allow marked group releases to develop needed flow-efficiency models, making catch expansion impossible. By 2013, the decision was made to abandon the use of multiple trap positions and instead run the smaller 1.5 m trap continuously in a fixed position off of the downstream highline. The use of a single, fixed position provided the ability to simplify abundance estimates to two models (yearling and subyearling) which could be applied across years. Though the single trap and single positon provided a much simpler, and more effective means of producing population estimates, the smaller trap has low efficiency at higher flows. Low catch at the current trap limits our ability to further develop the models needed to produce accurate population estimates. Recently, annual yearling and subyearling abundances have dropped markedly (Table 1). Given the low return of natural-origin adults in 2017 and the discontinuation of GCPUD's hatchery supplementation program in 2015, further development of the flow-efficiency models will be challenging unless catch at the current position can be increased or supplemented.

Table 9. Summary of natural-origin spring Chinook captured at the White River Smolt Trap, 2007-2016.

Capture Year	Yearlings	Sub-Yearlings
2007	172	47
2008	102	229
2009	286	543
2010	372	249
2011	65	251
2012	204	335
2013	22	522
2014	50	212
2015	35	162
2016	3	198
Average	**131**	**275**

Regarding potential changes to trap operation for the purpose of increasing catch, GCPUD has specified the following goals (R. O'Connor, personal communication, June 14, 2017):

1) Preservation of the long term dataset that has been established with the 5' trap

2) Collection of more fish for PIT tagging

3) Preservation of the current budget

The following proposal describes a pilot study in which the feasibility and effectiveness of a tandem-trap configuration at the current location is assessed. Data and results will be reviewed by YN and GCPUD at a later point to determine if the goals can effectively be met and further use of a second trap is warranted.

2.0 PROPOSED ACTION

To supplement the catch of the current 1.5 m trap (Trap-A), we propose the simultaneous operation of a 2.4 m diameter trap (Trap-B). Trap-B will operate with the sole purpose of catching additional spring Chinook parr and smolts for tagging and efficiency trials used to build the flow-efficiency model of Trap-A. Not limited to a single trapping position, Trap-B will be free to be moved in order to optimize channel depth and velocity. Operation of Trap-B can be discontinued during low flow, high flow, and/or heavy debris load conditions without loss of daily emigrant estimates given continued operation of Trap-A.

2.1 Rigging/location

The location of Trap-B will not affect the ability of Trap-A to collect fish in its current position i.e., fish captured in Trap-B will be those which would have otherwise passed Trap-A during outmigration. To ensure this, Trap-B will be suspended off of the same river-spanning cable as Trap-A, with the opening of its cone in line with, or slightly downstream of that of Trap-A (Figure 1). Initial changes to the positioning of Trap-A as a result of the installation of Trap-B will be compensated for via the adjustment of positioning and lead cables.

Figure 9. Current location of Trap-A, and proposed location of Trap-B at rkm 9 of the White River.

Trap-B will be positioned along the river-left bank as shown in Figure 1. The river-left location will provide easy access to the trap for personnel, and an adjacent eddy that can be used as a haven during periods of high flow. The river-left side of the channel is also the deepest section of the river transect, aside from the location of Trap-A and the river-right bank eddy (Figure 2). Because Trap-B will be situated in a shallower location and using a larger cone, we anticipate that it will not be able to operate at the base flows in which Trap-A can run. Based on the latest low-flow transect (2016), it does appear that Trap-B will maintain cone clearance to discharges as low as 154 cfs, although it is unclear if water velocity will be sufficient to turn the cone. However, base, or near-base flow operation is not of major concern given that supplemented catch is needed particularly at mid, to high-water discharges when Trap-A is least efficient.

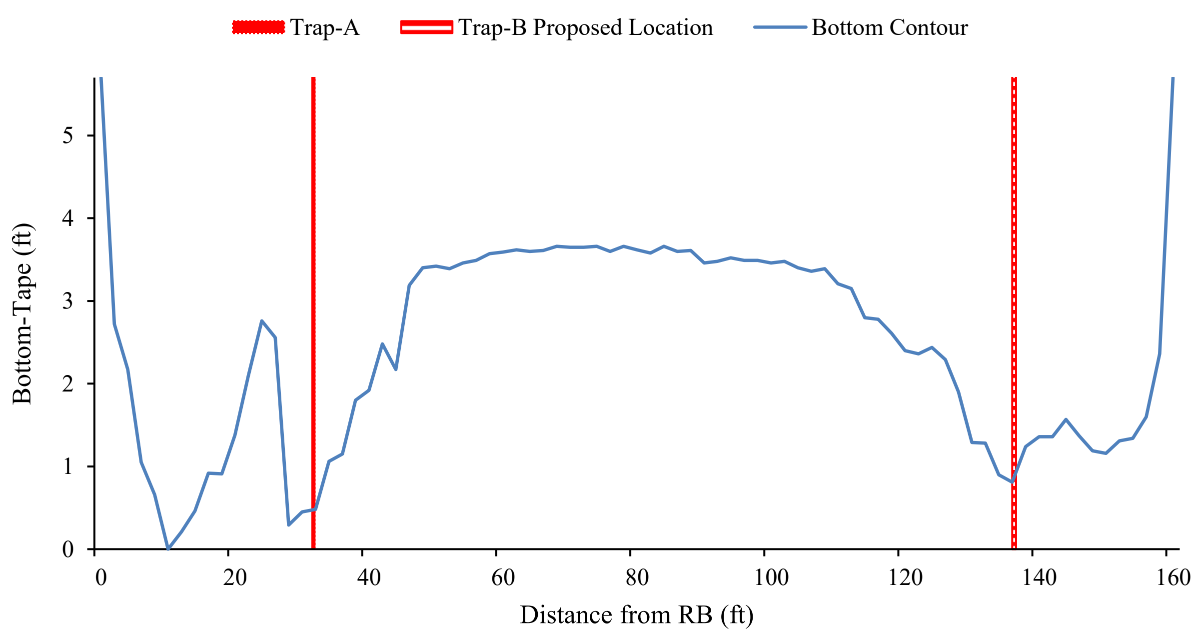

Figure 10. White River transect showing the current position of Trap-A, and the proposed position of Trap-B. Measurement taken on 9/8/2016 at 154 cfs.

Trap-B will be held in place by a rigging configuration similar to that of the Nason Creek smolt trap (Figure 3). This system of rigging will include two side anchors attaching the fore and aft of the starboard pontoon to the river-left bank in addition to the main lead cables attached to the highline. Lateral anchoring points will allow the inclusion of a break-away point located in between the main pulley and the leads. In the unlikely event that the force of debris on Trap-B begins to threaten the integrity of the highline and its anchors, the breakaway point will give way, transferring the load of the trap onto the lateral anchors. With the shift in anchor point(s), the trap will be drawn into an eddy on the river-left bank, alleviating pressure on the trap. A safety cable attached to the aft of the port pontoon will provide a secondary failsafe. In the event that both the highline connection and lateral anchors are pulled, the secondary safety will assume the load, swinging the trap around to a downstream-facing position, clearing the debris blockage and again drawing the trap back to the river-left bank. Lateral movement of the trap within the channel will be made using two positioning cables attached to separate hand winches located below the highline anchor point.

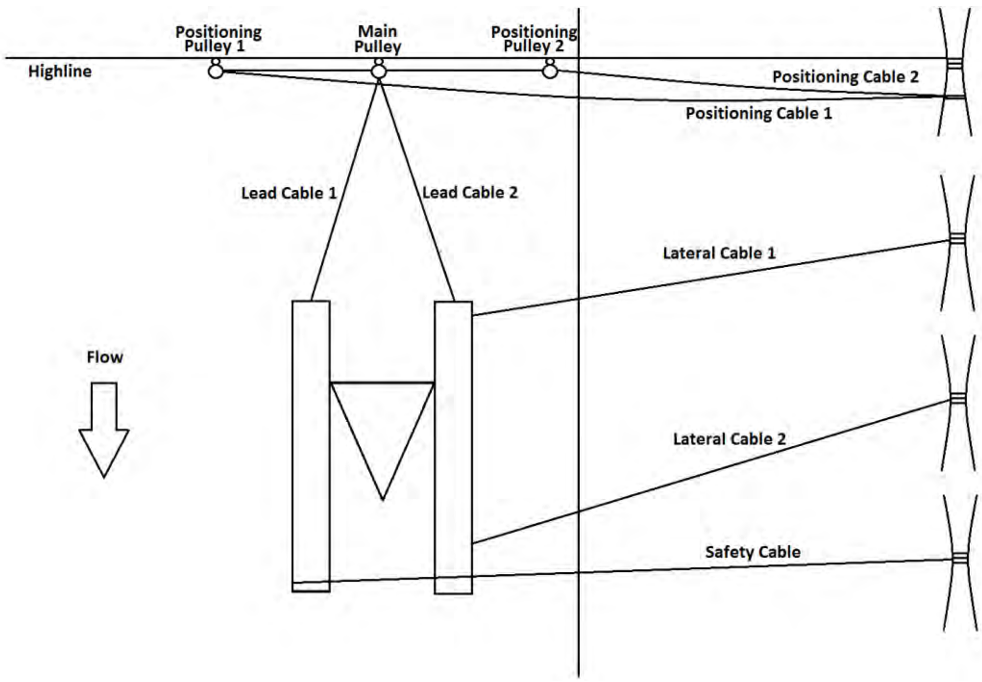

Figure 11. Rigging system to be used to secure Trap-B on the White River.

The current highline cable is made of 1/2" 6x37 IWRC galvanized wire rope (26,500 lb. breaking strength, 5,300 lb. working-load limit). The lateral, safety, and lead cables will all be 13/32" nylon-coated wire rope (9,800 lb. breaking-strength/1,960 lb. working-load limit). Both positioning cables will be made of 7/32" nylon-coated wire rope (2,000 lb. breaking-strength/400 lb. working-load limit). The break-away point will be a single locking shackle (maximum capacity 1,500 – 2,000 lbs.). All live trees used as anchor points will be protected by a layer of untreated 2"x4" wood "tree savers", preventing direct contact between cables and the tree and distributing pressure across a greater surface area. With the exception of the highline cable, all rigging will be removed at the end of the season.

2.2 Target Operational Periods

The secondary trap will be most useful during periods in which active emigrant movement is elevated, yet coinciding with diminishing trap efficiency as a result of increasing discharge (Figure 4). Namely, this includes the initial-onset periods of spring (mid-March to mid-May) and fall freshets (mid-October to late-November). High-flow operations will be limited to avoid undue risk to the trap and fish captured. Trap-B will not be operated if any risk of damage is foreseen, including periods of rapid increase in discharge and/or sustained debris load. When trapping is suspended due to high flow, Trap-B will be pulled into the river-left eddy and secured to the bank with all tension off of the lead cables. We will attempt to run Trap-B at the lowest discharge possible.

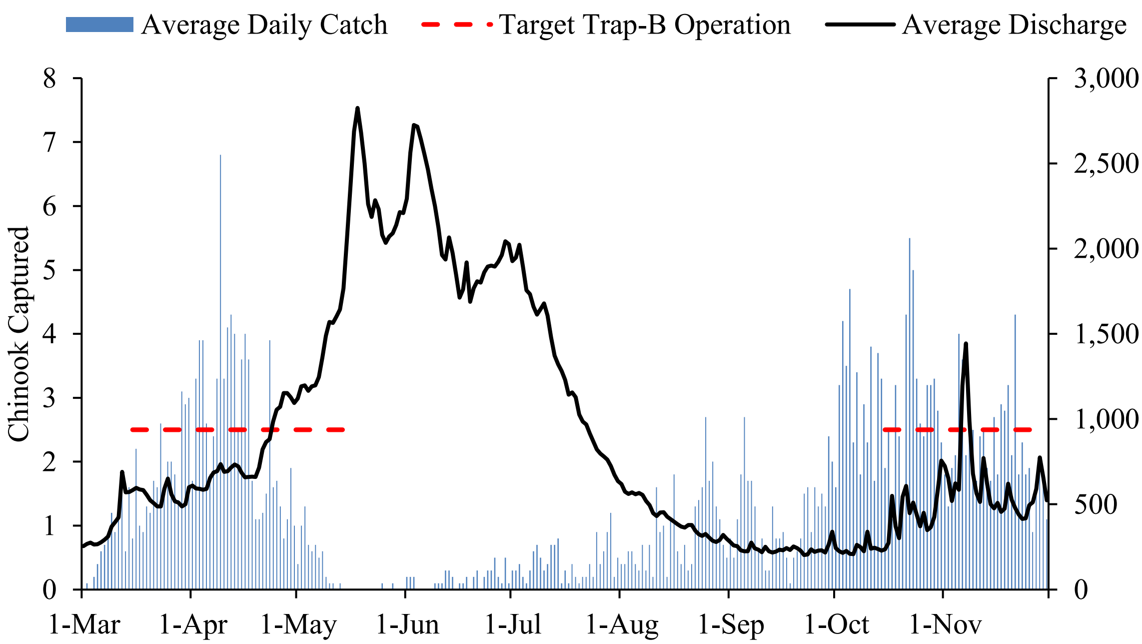

Figure 12. Average daily catch and discharge (2007-2016) with target periods of Trap-B operation.

2.3 Daily Operation and Sampling

YN personnel will sample Trap-B daily when it is running. All non ESA-listed species will be released immediately off of the trap. Non-target ESA-listed species will be quantified, scanned for PIT tags, and released off of the trap without further handling or anesthetization. Spring Chinook juveniles will be the only specimens retained for sampling in aerated five-gallon buckets. Spring Chinook will be sampled using the same protocol as Trap-A, though kept separate in a different P4 tagging file. All spring Chinook with fork lengths ≥ 60mm will be tagged. Tagged fish will be held in holding boxes along the river-left bank until the next mark group release, or release on-site if the minimum mark-group size is not achieved. Efficiency trials will continue to be performed at the Sears Creek Bridge located approximately 2 rkm upstream of the trap location. Trap-B will be operated during the three-day recapture period following each release to determine the combined efficiencies of both traps so that we can ensure we do not exceed the annual handling take for ESA listed spring Chinook (see section 3.3). All trapping, and tagging-caused mortalities of ESA-listed species will be quantified and applied to the take.

3.0 PERMITTING/TAKE LIMITS

3.1 WDFW Land Use Permit #140152A

The current WDFW-issued Land Use Permit (LUP; expiration date February 15, 2020), limits and manages the use of WDFW-owned land adjacent to the smolt trap including impacts on the river bank and trees used as anchor points. It does not regulate how the traps are operated or how many fish are handled. Because both traps will share the same existing access point, no additional impact to the bank and surrounding riparian vegetation will occur. No additional highline or other river-spanning cables/ropes will be needed. The aforementioned break-away system will minimize excessive stress on the highline and its existing tree anchors. Two or three additional tree anchors will be established along the river left bank to secure the lateral and safety cables. The additional anchor points established will not be load-bearing unless a break-away occurs; daily stress on the side anchor points will be minimal. In total, the addition of Trap-B will have a less of an impact than the previously-approved use of two alternating trapping sites, which included two highline cables.

3.2 WDFW Hydraulic Project Approval #2015-2-25+01

The current WDFW Hydraulic Project Approval (HPA; expiration date March 3, 2020) also regards the use of the area around the trap, and does not refer to take limits. Trap-B will not cause any additional disturbance of the bank, riparian vegetation, streambed, or large woody debris within the channel. With the exception of establishing two, to three non-load bearing anchors on the river left bank, impacts on the surrounding environment will remain unchanged after the introduction of Trap-B. All HPA requirements as related to the prohibition of petroleum-based chemicals, motorized tools and equipment, and other substances/practices that may be harmful to the environment will be strictly adhered to in the operation of Trap-B. The operation of a second trap as proposed will be less impactful to the riparian area than the operation of two traps in different positions.

3.3 NMFS Section 7 Biological Opinion #NMFS-WCR-2015-3778

The NMFS Section 7 Biological Opinion (BO) currently specifies the maximum annual total (non-lethal) and lethal take for wild and UCR hatchery-origin spring Chinook and UCR summer steelhead (*Oncorhynchus mykiss*) at the White River Trap. Section 2.8.1.3 of the BO sets an annual total take of "20% of spring-run Chinook salmon and steelhead out-Migrants." Lethal take is specified as: "2% of fish handled," for both species. Because the limitations set on the White River in the BO are based on take percentages and not effort, the operation of the second smolt trap will not violate its terms given continued adherence to the established limits. All take associated by Trap-B will be counted against the single permit, with no extra allowances provided by the change in trapping regime. Non-lethal take will continue to be assessed as a function of mean trap efficiency, with the combined efficiency of both traps representing the total percentage of the out-migrants sampled during tandem-operation.

Because the primary use of Trap-B is to supplement catch during periods in which efficiency of Trap-A is low (>5%), the chance that the 20% threshold is exceeded with the addition of the second trap above approximately 500 cfs is unlikely. Though combined trap efficiency at low flows may approach 20%, annual take will likely be much lower given the bulk of emigration is at higher flows. We have no reason to believe that Trap-B will increase the total lethal take beyond the permitted limit. If anything, lethal take incurred by Trap-B will be less than that of Trap-A considering that it will not be run during periods in which mortalities often occur: extreme low and extreme high flows.

3.4 USFWS Section 10 Permit # TE-022743-6

The White River currently operates under Grant County's USFWS Section 10 permit (expiration date October 27, 2021), which establishes the guidelines associated with the handling of bull trout (*Salvelinus confluentus*). The lethal take maximum as described in the terms and conditions is set as "five individuals, of all life stage, per calendar year." As with the NMFS BO, we do not perceive this as precluding the use of the secondary smolt trap as long as the maximum take is not exceeded in the total catch of both traps. Bull trout captured in Trap-B will be released off the trap with minimal handling and no exposure to anesthetic.

Annual bull trout catch on the white river is relatively low, especially in recent years (Table 2). In the past ten years of operation, we have not had a single bull trout mortality of any kind (trapping or handling). Though possible that Trap-B may capture bull trout, mortalities will be unlikely; especially given the policy of minimal handling.

Table 10. Bull trout catch at the White River smolt trap, 2007-2016.

Capture Year	FL < 50 mm	FL ≥ 50 mm
2007	1	6
2008	24	21
2009	19	27
2010	68	11
2011	46	8
2012	49	16
2013	19	9
2014	11	2
2015	1	8
2016	0	5
Average	**24**	**11**

4.0 BUDGET

We intend to operate Trap-B within the general confines of the current budget (Table 3). All major equipment and rigging are currently on-hand from previous operation at the upper cable. Because the two traps will be in the same vicinity, increase to the daily workload will only be associated with the actual removal, and work-up of fish collected (which would be the same if we were catching target numbers of fish in one trap). Travel times, daily set-up/break-down, data processing, report preparation, and mark-group release procedures will remain virtually the same. We expect that any future increases in the budget will be due to operating costs which are subject to inflation (i.e. wage rates, indirect, GSA vehicle rates, changes in costs of supplies). Such increases would still occur in the absence of Trap-B.

Appendix N

Genetic Diversity of Upper Columbia River Summer Chinook Salmon

Genetic Structure of upper Columbia River Summer Chinook and Evaluation of the Effects of Supplementation Programs

by

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February 2011

Abstract

We investigated genetic relationships among temporally replicated collections of summer Chinook from the Wenatchee River, Methow River, and Okanogan River in the upper Columbia River basin. Samples from the Eastbank Hatchery – Wenatchee stock, Eastbank Hatchery – MEOK stock, and Wells Hatchery were also included in the analysis. Samples of natural- and hatchery-origin summer Chinook were analyzed and compared to determine if the supplementation program has had any impacts to the genetic structure of these populations. We also calculated the effective number of breeders for collection locations of natural- and hatchery-origin summer Chinook from 1993 and 2008. In general, population differentiation was not observed among the temporally replicated collection locations. A single collection from the Okanogan River (1993) was the only collection showing statistically significant differences. The effective number of breeders was not statistically different from the early collection in 1993 in comparison to the late collection in 2008. Overall, these analyses revealed a lack of differentiation among the temporal replicates from the same locations and among the collection from different locations, suggesting the populations have been homogenized or that there has been substantial gene flow among populations. Additional comparisons among summer-run and fall-run Chinook populations in the upper Columbia River were conducted to determine if there was any differentiation between Chinook with different run timing. These analyses revealed pairwise F_{ST} values that were less than 0.01 for the collections of summer Chinook to collections of fall Chinook from Hanford Reach, lower Yakima River, Priest Rapids, and Umatilla. Collections of fall Chinook from Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River had pairwise F_{ST} values that were higher in comparison to the collections of summer Chinook. The consensus clustering analysis did not provide good statistical support to the groupings, but did show relationships among collections based on geographic proximity. Overall the summer and fall run Chinook that have historically been

spawned together were not differentiated while fall Chinook from greater geographic distances were differentiated.

Introduction

The National Marine Fisheries Service (NMFS) recognizes 15 Evolutionary Significant Units (ESU) for Chinook salmon (*Oncorhynchus tshawytscha*) (Myers et al. 1998). The summer Chinook from the upper Columbia River are included in the Upper Columbia River Summer- and Fall-Run ESU, which encompasses all late-run (summer and fall), ocean-type Chinook salmon from the mainstem Columbia River and its tributaries (excluding the Snake River) between Chief Joseph and McNary Dams (Waknitz et al. 1995). Waknitz et al. (1995) concluded that due to high total abundance this ESU was not likely to become at risk from extinction. Yet, a majority of natural spawning activity was in the vicinity of Hanford Reach, and it was unclear whether natural production was self-sustaining given the vast summer Chinook artificial propagation efforts (Waknitz et al. 1995). Additionally, the Biological Review Team expressed concern about potential consequences to genetic and life-history traits from an increasing contribution of hatchery fish to total spawning escapement (Waknitz et al. 1995).

Artificial propagation of ocean-type Chinook from the middle/upper Columbia has been continuous since the implementation of the Grand Coulee Fish Maintenance Project (GCFMP) in 1939 (Myers et al. 1998). The US Fish and Wildlife Service established three hatchery programs for summer/fall Chinook during the GCFMP, Leavenworth NFH, Entiat NFH, and Winthrop NFH. The Washington Department of Fisheries (now Washington Department of Fish and Wildlife) followed with hatchery programs at Rocky Reach (1964), Wells Dam (1967), Priest Rapids (1974), and Eastbank (1990) facilities. Currently, only Leavenworth NFH and Winthrop NFH are not producing summer/fall Chinook. Entiat NFH has resumed production of summer/fall Chinook (Wells FH Stock) in 2009 and released their first yearling summer Chinook smolts in 2010. Since

1941, over 200 million ocean-type Chinook salmon have been released into the middle Columbia River Basin (Myers et al. 1998). Initially, the hatchery programs differentiated between early returning fish (i.e., stream-type) and later returning fish (i.e., ocean-type), but no distinction was made regarding the “summer” and “fall” components of the ocean-type stocks (Waknitz et al. 1995). Therefore, all Chinook salmon now migrating above Rock Island Dam descend from not only a mixture between different stocks from the basin, but also a mixture between the endemic summer and fall life histories. While hatchery protocols have been modified of late to maintain discreet summer and fall Chinook hatchery stocks (Utter et al. 1995; see also HGMP), physical evidence and genetic data suggests that summer and fall Chinook may have become homogenized. During the 1970’s and 80’s, given coded-wire tag recoveries, summer-run Chinook originating from above Rock Island Dam were believed to have spawned extensively with Hanford Reach and Priest Rapids Hatchery fish (Chapman 1994). Stuehrenberg et al. (1995) reported that 10% of their radio tagged summer Chinook were occupying typical fall-run spawning habitat on the mainstem Columbia river, and 25% of fall fish released from Priest Rapids were recovered as summers at (or above) Wells Hatchery. Genetic data reported by Marshall et al. (1995) and Waknitz et al. (1995) corroborate these observations, as genetic distances observed between summer and fall Chinook within the Upper Columbia River Summer- and Fall-Run ESU were essentially zero.

In response to the need for evaluation of the supplementation hatchery programs, both a monitoring and evaluation plan (DCPUD 2005; Murdoch and Peven 2005) and the associated analytical framework (Hays et al. 2006) were developed for the Habitat Conservation Plan’s Hatchery Committee through the joint effort of the fishery co-managers (CCT, NMFS, USFWS, WDFW, and YN) and Chelan County and Douglas County PUDs. These reports outline 10 objectives to be applied to various species assessing the impacts of hatchery operations mitigating the operation of Wells, Rocky Reach, and Rock Island hydroelectric projects. The present monitoring and evaluation study plan differs in scope from previous monitoring and evaluation projects proposed by WDFW Molecular Genetics Lab, in that it does not investigate a single watershed, but instead will encompass all summer Chinook stocks from the upper Columbia River including the three supplementation (Wenatchee, Methow, and Okanogan) and the harvest augmentation program (Wells summer Chinook). The objectives of this study were to determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery programs.

Materials and Methods

Collections

A total of 2,416 summer Chinook were collected from tributaries in the upper Columbia River basin and were analyzed (Table 1). Two collections of natural-origin summer Chinook from 1993 (prior to the supplementation program) were taken from the Wenatchee River Basin and were compared to collections of hatchery and natural-origin from 2006 and 2008 that were post-supplementation. Two pre-supplementation collections from the Methow River (1991 and 1993) were compared to post-supplementation collections from 2006 and 2008. Three pre-supplementation collections from the Okanogan River Basin (1991, 1992, and 1993) were compared with post-supplementation collections from 2006 and 2008. A collection of natural-origin summer Chinook from the Chelan River was also analyzed. Additionally, hatchery collections from Eastbank Hatchery (Wenatchee and MEOK stock) and Wells Hatchery were analyzed and compared to the in-river collections. Summer Chinook data (provided by the USFWS) from the Entiat River was also used for comparison. Lastly, data from eight collections of fall Chinook was compared to the collections of summer Chinook.

Laboratory Analyses

All laboratory analyses were conducted at the WDFW Genetics Laboratory in Olympia, Washington. Genomic DNA was extracted by digesting a small piece of fin tissue using the nucleospin tissue kits obtained from Macherey-Nagel following the recommended conditions in the user manual. Extracted DNA was eluted with a final volume of 100 µL.

Genotype information was generated using thirteen microsatellite markers following standard laboratory protocols and analysis methods. Descriptions of the loci assessed in this study and polymerase chain reaction (PCR) conditions are given in Table 2. PCR reactions were run with a thermal profile consisting of: denaturation at 95°C for 3 min, denaturation at 95°C for 15 sec, anneal for 30 sec at the appropriate temperature for each locus (Table 2), extension at 72°C for 1 min, repeat cycle (steps 2-4), final extension at 72°C for 30 minutes. PCR products were then processed with an ABI-3730 DNA Analyzer. Genotypes were visualized with a known size standard (GS500LIZ 3730) using GENEMAPPER 3.7 software. Alleles were binned in GENEMAPPER using the standardized allele sizes established for the Chinook GAPS dataset (Seeb et al. 2007).

Within-collection Statistical Analyses

Allele frequencies were calculated with CONVERT (version 1.3, Glaubitz 2003). Hardy-Weinberg proportions for all loci within each collection were calculated using GENEPOP (version 3.4, Raymond and Rousset 1995). Heterozygosity (observed and expected) was computed for each collection group using GDA (Lewis and Zaykin 2001).

Allelic richness and F_{IS} (Weir and Cockerham 1984) inbreeding coefficient were calculated using FSTAT (version 2.9.3.2, Goudet 2001). Linkage disequilibrium for each pair of loci in each collection was calculated using GENEPOP v 3.4 (10,000 dememorizations, 100 batches, and 5,000 iterations per batch). Pairwise estimates of genetic differentiation between collection groups were calculated using GENEPOP (version 3.4, Raymond and Rousset 1995). Statistical significance for the tests of Hardy-Weinberg proportions, linkage disequilibrium, and genotypic differentiation was evaluated using a Bonferroni correction of p-values to account for multiple, simultaneous tests (Rice 1989).

Between-collection Statistical Analyses

Pairwise F_{ST} estimates were computed to examine population structure among collections using GENETIX (version 4.03, Belkhir et al. 2001). This estimate uses allelic frequency data and departures from expected heterozygosity to assess differences between pairs of populations.

We used PHYLIP (version 3.5c, Felsenstein 1993) to calculate Cavalli-Sforza and Edwards (1967) pairwise chord distances between collections. Bootstrap calculations were performed using SEQBOOT followed by calculations of genetic distance using GENDIST. The NEIGHBOR-JOINING method of Saitou and Nei (1987) was used to generate the dendrograms and CONSENSE to generate a final consensus tree from the 1,000 replicates. The dendrogram generated in PHYLIP was plotted as an unrooted radial tree using TREEVIEW (version 1.6.6, Page 1996).

Effective Number of Breeders

The effective number of breeders (N_b) was estimated for pre- and post-supplementation program collections (where possible) to investigate whether hatchery programs had affected that genetic metric over the operational period. Wang (2009) derived an equation for effective size (N_e) as a function of the frequency of nested full-sib and half-sib families in a random collection of individuals.

$$\frac{1}{N_e} = \frac{1+3\alpha}{4}\left(Q_1 + Q_2 + 2Q_3\right) - \frac{\alpha}{2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right) \qquad \text{(equation 10)}$$

Where α is a measure of the deviation of genotype frequencies from Hardy-Weinberg expectation (equivalent to Wright's (1969) F_{IS}), Q_i are the probabilities that a pair of offspring are paternal half sibs, maternal half sibs, or full sibs, respectively, and N_1 and N_2 are the number of male and female parents that generation, respectively. Genetic parameters (i.e., sibship distributions) were estimated for summer Chinook collections using algorithms implemented in COLONY (Jones and Wang 2009). To be clear, Wang's (2009) method as implemented here will estimate N_b, given multi-locus genotypes from each collection were partitioned by brood year for this analysis. To obtain an estimate of N_e each N_b value must be multiplied by the mean generation time of that population.

Results

<u>Collections</u>

A total of 2,350 individuals from 32 collections of temporally replicated samples (six locations) were analyzed (Table 1). Temporally replicated collections of hatchery and natural-origin samples were from the Wenatchee, Methow, and Okanogan Rivers. Temporally replicated hatchery-origin summer Chinook were from Wells Hatchery, Eastbank Hatchery - Wenatchee stock, and Eastbank Hatchery - Methow/Okanogan (MEOK) stock. A total of 232 of those individuals were excluded from any analyses because they failed to amplify at nine or more loci. Data for remaining 2,118 individuals were analyzed to assess differences between temporally replicated natural- and hatchery-origin summer Chinook for each location and to compare the differences among the different collection locations. Summer Chinook data from the temporally replicated collection locations were then combined and compared to fall Chinook data from the GAPS v.3.0 dataset.

<u>Statistical Analyses</u>

The population statistics (Hardy-Weinberg equilibrium and F_{IS}) calculated for each of the 32 temporally replicated collection locations were consistent with neutral expectations (i.e., no associations among alleles). Three collections did have a single locus that did not meet expectations (Wenatchee hatchery-origin 2006, Wells hatchery 2006, and Okanogan hatchery-origin 2009). Based on these results we suggest the collections represented randomly breeding groups and were not comprised of mixtures of individuals from different genetic source populations.

Population differentiation was assessed for each of the temporally replicated collections from within each location (Table 3). This analysis revealed the only significant difference observed within a collection location pertained to the collection from 1993 Okanogan River natural-origin samples. Because of the significant difference of this collection to the other temporal replicates it was not included in further analyses.

Given the absence of genetic differentiation observed among the temporally replicated collections, the 32 collections from the Wenatchee, Methow, and Okanogan River were combined to form three location-specific collections for analysis. Population differentiation metrics were compared among the composite Wenatchee, Methow, and Okanogan collections and eight other location-specific collections (11 locations total). Comparing all collections, there were a total of 39 significant genic test comparisons out of a total 496 (Table 4). Thirty-eight of the 39 statistically significant pairwise differences pertained to the Okanogan River and 2006 Wells Hatchery collections (Table 4). F_{ST} results are described further below.

Within-collection genetic metrics were estimated for the 11 location-specific collections of summer Chinook from the upper Columbia River, in addition to eight collections of fall Chinook (Table 1). The population statistics (Hardy-Weinberg equilibrium and F_{IS}) calculated for these collections of summer and fall

Chinook were also consistent with neutral expectations. The collection from Lyons Ferry Hatchery had one locus that did not meet expectations and the collections from Crab Creek and Marion Drain both had three loci that did not meet expectations.

The hatchery collections in general had a higher percentage of significantly linked loci; however the observed genetic diversity were similar for the natural and hatchery-origin collections. Analysis of allelic richness was based on 11 individuals per collection, the minimum number of individuals across all collections with complete multilocus genotypes. The largest number of linked loci occurred in the Crab Creek, Entiat River, and Okanogan natural-origin collections. Allelic richness was on average lower in the collections of summer Chinook (10.7) collections in comparison to the collections of fall Chinook (11.0).

Pairwise F_{ST} (Table 4) estimates revealed low levels of differentiation, where all observed F_{ST} values between the collections of summer Chinook were lower than 0.0096. There were 15 out of 28 comparisons between collections of summer Chinook that were significantly different from zero and occurred primarily from comparisons of the Okanogan River (hatchery and natural-origin) and Wells Hatchery to all other collections. The collection of Eastbank Hatchery – MEOK stock was differentiated from the Wenatchee River natural-origin and Entiat River collections. The collection from the Chelan River had a small sample size of 23 individuals and only differentiated from the Eastbank Hatchery – MEOK stock. F_{ST} estimates regarding pairwise comparisons between each of four fall Chinook collection locations (Crab Creek, Lyons Ferry Hatchery, Marion Drain, and Snake River) to all other collections were significantly different from zero (Table 5). Pairwise comparisons for three other fall Chinook collections (Hanford Reach, lower Yakima River, and Umatilla River) to the collections of summer Chinook were significantly different from zero (Table 6). The only fall Chinook collection that was not significantly differentiated from all of the summer Chinook was Priest Rapids.

The relative genetic relationships among the test groups were assessed using the consensus clustering analysis (Figure 1). Statistical support for the dendrogram topology (i.e., tree shape) was low regarding the branching that separated the collections of summer Chinook from the upper Columbia River. The collections of fall Chinook; however were supported with bootstrap support over 76% with the exception of three collections (lower Yakima River, Crab Creek, and Umatilla River). In other words, 760 of the 1000 bootstrap replicates supported the placement of the node separating summer and fall collections. The collection from the Chelan River had bootstrap support of 68%; however the sample size for that collections was small (N = 23). Even though the bootstrap support was low among the collections of summer Chinook there was concordance between geography and genetic distance.

Where comparisons were possible between pre- and post-supplementation program collections, the effective number of breeders (N_b) estimated to have comprised those collections were slightly lower for contemporary (2008) collections; however in all cases the 95% confidence intervals overlapped between historical and contemporary collections, suggesting statistical equivalency. Regarding Wenatchee River collections, the point estimates of N_b ranged from 134 (08FU) to 190 (93DD), where all collections had overlapping confidence intervals (Table 7). The upper bound of the 1989 brood year for collection 93DD was very large, suggesting the sample size was insufficient for properly inferring the sibship distribution within the collection. Comparing the Okanogan natural collections 93ED and 08GA, the estimated N_b were 142 (CI 102 – 203) and 127 (CI 92 – 180), respectively. For the Eastbank Hatchery MEOK stock comparisons, the N_b estimated for the 93DF collection was 171 (CI 129 – 229), as compared to the 166 (CI 126 – 226) estimated for collection 08MO. In all cases, the estimated N_b can be converted to effective population size (N_e) by multiplying the estimate by the mean generation time.

Discussion

The collections of summer Chinook populations from the upper Columbia River are of interest because census sizes are reduced below historic levels and are the subject of mitigation and supplementation hatchery programs. Concern over the impacts of hatchery supplementation programs on the genetic integrity of natural-origin populations led to our primary objective, which was to evaluate genetic metrics for temporally replicated collections of summer Chinook in the upper Columbia River pre and post hatchery supplementation. A similar analysis by Kassler and Dean (2010) was conducted on spring Chinook in the Tucannon River to evaluate the effects of a supplementation and captive brood program on natural-origin stocks. Additionally, upper Columbia River spring Chinook supplementation programs (Blankenship et al. 2007; Small et al. 2007), spring and fall Chinook populations in the Yakima Basin (Kassler et al. 2008), and a potentially unique population of fall Chinook in Crab Creek (Small et al. 2010) have been evaluated. In the present analysis of summer Chinook populations, collections of pre- and post- supplementation summer Chinook were collected from the Wenatchee River, Methow River, and Okanogan River Basins and analyzed to determine if the genetic profile has changed as a result of the supplementation program. Analysis was then conducted on the collections of summer run to compare the fall run Chinook collections in the upper Columbia River basin.

Allozyme analyses of these three summer run Chinook stocks in the upper Columbia River have identified that each stock was distinct, with a closer relationship detected between the Wenatchee and Methow Rivers (WDF and WDW 1993, Marshall 2002). Wenatchee summer Chinook are thought to be a mixture of native summer Chinook and Chinook from the Grand Coulee Fish Maintenance Project (GCFMP). The goal of the GCFMP project between 1939 and 1943 was to trap migrating Chinook salmon at Rock Island dam (75 miles below Grand Coulee) and homogenize the populations, which reduced the genetic uniqueness of the distinct tributary populations present in the upper Columbia River.

We found allele frequencies for individual temporally replicated hatchery- and natural-origin collection locations of adult summer Chinook were not significantly different from that expected of a single underlying population, except for one collection (1993 Okanogan natural-origin; Table 3). This collection was differentiated to the Okanogan collections in 2006 and 2008; however it was not differentiated from the collection in 1992. The Okanogan collection from 1992 was also not differentiated to any other collection; therefore the difference in the collection from Okanogan 1993 was likely not an indication of genetic change from pre supplementation to post supplementation. The collection was however dropped from further analyses so as to not confuse interpretation of results. The lack of allelic differentiation observed among the temporally replicated collections was interpreted as the genetic metrics from each location in the early 1990's did not differ from the samples collected in 2008. Spanning a few generations, allele frequencies are not expected to change for large populations at genetic equilibrium. In contrast, changes in allele frequencies of small populations may occur due to the stochastic sampling of genes from one generation to the next (i.e., genetic drift).

A second round of analyses was conducted to evaluate the genetic relationships of the summer run collections (temporal collections were combined) with data from the Entiat River, Chelan River, and eight collections of fall Chinook. Assessment of the relationship between the summer run collections in comparison to each other provided very little evidence of genetic differentiation between these collections. While population differentiation did show some significant differences between the Okanogan River and Wells Hatchery collections, all of the pairwise F_{ST} values were below 0.003. Meaning that a very small proportion of the observed genetic variation could be attributed to restrictions in gene flow (i.e., population structure)

The comparison of the hatchery-origin collections revealed a lack of differentiation between the Eastbank Hatchery – Wenatchee stock, Eastbank Hatchery – MEOK stock, and the Wells Hatchery (with exception of the 2006 collection). The genetic similarity or low level of genetic differentiation among these stocks suggests that there has been an integration of natural- and hatchery-origin summer Chinook in the upper Columbia River or a lack of ancestral genetic difference. The difference of the 2006 Wells Hatchery collection to the other collections is most likely a result of sampling effect because of the lack of differentiation among the stocks in the basin. If the 2006 collection had been mixed from different sources of summer Chinook there would not be a detectable level of differentiation as was seen with the 2006 sample.

The analyses to compare summer and fall Chinook collections provided some understanding on the genetic relationships of Chinook with different run timings in the upper Columbia River basin. Historically, the hatchery programs in the upper Columbia River were separated into groups of the early returning fish (i.e., stream-type) and later returning fish (i.e., ocean-type), but the programs did not sort individuals identified as “summer” or “fall” stocks (Waknitz et al. 1995). Now all Chinook salmon that are migrating above Rock Island Dam descend from a mixture of different stocks from the upper Columbia River basin, but also a mixture between the endemic summer and fall life histories.

Small et al. (2010) conducted an analysis on summer run and fall run Chinook in the upper Columbia River and concluded that Crab Creek Chinook in the upper Columbia River were genetically distinct to all other fall and summer run Chinook stocks that were analyzed. They did note a departure from Hardy Weinberg expectation as a result of a null allele at the microsatellite locus *Ogo-4* and a higher linkage disequilibrium value due to the inclusion of family groups in one of their samples. Kassler et al. (2008) found differentiation among spring and fall Chinook populations in the Yakima River.

The tests of pairwise F_{ST} indicated a very low level of genetic differentiation (less than one percent difference) between collections of summer-run Chinook and fall-run Chinook. The range of pairwise F_{ST} values for comparisons between the summer run and fall run collections was 0.0016 – 0.0248. The larger values from the range were associated to the collections from Crab Creek, Lyons Ferry Hatchery, and Marion Drain. Studies by Kassler et al. (2008) and Small et al. (2010) have documented differences among the populations of these collections to others within the upper Columbia River basin. The low pairwise F_{ST} values between Priest Rapids and Hanford Reach collections and the summer run collections were not surprising because summer-run Chinook originating from above Rock Island Dam were believed to have spawned extensively with Hanford Reach and Priest Rapids Hatchery fish during the 1970's and 80's (Chapman 1994). The lack of differentiation among the summer and fall stocks in the Columbia River was also identified by Utter et al. (1995) and the HGMP where they state physical evidence and genetic data suggests that summer and fall Chinook may have become homogenized.

Despite low levels of statistical bootstrap support for dendrogram topology (i.e., tree shape), there was concordance observed between geographic location and the genetic relationships among the summer and fall Chinook populations. The collections from the Okanogan (hatchery and natural-origin) did separate out with collections from Wells Dam Hatchery, Entiat River, and Eastbank Hatchery – MEOK stock, and were next to a group of the Methow and Wenatchee collections. The fall Chinook populations are also separated to the summer collections and the position of all but three of these collections (lower Yakima River, Crab Creek, and Umatilla River) were statistically supported. The geographic proximity of the fall collections seemed to follow the observed pattern in this dendrogram. The relationship of the Snake River and Lyons Ferry Hatchery in proximity to the collection from Marion Drain was not surprising while the relationship between Priest Rapids and Hanford Reach was easily a result of the stocking practices of fall Chinook in the 1970 and 1980’s.

A secondary objective of this study was to determine if the effective population size of upper Columbia River summer Chinook populations had changed over time due to supplementation efforts. We observed that the number of effective breeders in the collections from 1993 and 2008 has not changed thus providing reason to believe that the genetic diversity of summer Chinook in the upper Columbia River has not been altered through the supplementation program.

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Table 1. Samples of adult hatchery- and natural-origin summer and fall Chinook that were analyzed from the upper Columbia River. Total number of individuals that were analyzed / individuals with data for 9 or more loci that were included in the analysis. Collection statistics (allelic richness, linkage disequilibrium (before and after Bonferroni correction), F_{IS}, heterozygosity (H_O and H_E)) and p-values for deviations from Hardy-Weinberg equilibrium (HWE). P-values were defined as significant after implementation of Bonferroni correction for multiple tests (Rice 1989).

WDFW GSI code[a]	Collection location	N =	Allelic Richness[b]	Linkage Disequilibrium[c]	F_{IS} (p-value)[d]	H_O	H_E
93DD	Wenatchee River upstream of Tumwater Dam - natural origin	51 / 45					
93DE	Wenatchee River downstream of Tumwater Dam - natural origin	88 / 88					
06CQ	Wenatchee River upstream of Tumwater Dam - natural origin	95 / 86					
06CR	Wenatchee River downstream of Tumwater Dam - natural origin	95 / 82					
08FV	Wenatchee River upstream of Tumwater Dam - natural origin	95 / 82					
08FW	Wenatchee River downstream of Tumwater Dam - natural origin	95 / 87					
	Wenatchee River - Natural origin combined	**519 / 470**	**10.7**	**17 / 4**	**0.001 (0.403)**	**0.8504**	**0.8513**
06CP	Wenatchee River - hatchery origin	95 / 70					
08FU	Wenatchee River - hatchery origin	95 / 83					
	Wenatchee River - Hatchery origin combined	**190 / 153**	**10.6**	**18 / 6**	**0.018 (0.013)**	**0.8409**	**0.8561**
93EC	Methow River - natural origin	27 / 27					
06CT	Methow River - natural origin	95 / 90					
08FY	Methow River - natural origin	95 / 88					
09CO	Methow River - natural origin	91 / 80					
	Methow River - Natural origin combined	**308 / 285**	**10.7**	**4 / 1**	**0.006 (0.160)**	**0.8506**	**0.8554**
06CS	Methow River - hatchery origin	14 / 8					
08FX	Methow River - hatchery origin	21 / 18					
09CP	Methow River - hatchery origin	19 / 18					
	Methow River - Hatchery origin combined	**54 / 44**	**10.8**	**11 / 2**	**-0.003 (0.593)**	**0.8553**	**0.8523**

Table 1 continued.							
92FM	Okanogan River - natural origin	49 / 46					
93ED*	Okanogan River - natural origin	103 / 87					
06CV	Okanogan River - natural origin	95 / 88					
08GA	Okanogan River - natural origin	95 / 92					
09CN	Okanogan River - natural origin	133 / 126					
	Okanogan River - Natural origin combined	**475 / 439**	**10.8**	**9 / 4**	**0.003 (0.304)**	**0.8563**	**0.8596**
* - not included in the combined dataset							
06CU	Okanogan River - hatchery origin	58 / 49					
08FZ	Okanogan River - hatchery origin	19 / 18					
09CM	Okanogan River - hatchery origin	117 / 107					
	Okanogan River - hatchery origin combined	**194 / 174**	**10.8**	**31 / 10**	**-0.011 (0.920)**	**0.8678**	**0.8586**
91FL	Wells Hatchery	68 / 42					
92FK	Wells Hatchery	25 / 23					
93DG	Wells Hatchery	11 / 9					
06DM	Wells Hatchery	95 / 91					
08HY	Wells Hatchery	95 / 91					
	Wells Hatchery combined	**294 / 256**	**10.7**	**8 / 3**	**-0.001 (0.529)**	**0.8670**	**0.8665**
08MN	**Eastbank Hatchery - Wenatchee River stock**	**95 / 90**	**10.7**	**6 / 1**	**0.020 (0.024)**	**0.8326**	**0.8498**
92FO	Eastbank Hatchery - Methow / Okanogan (MEOK) stock	36 / 33					
93DF	Eastbank Hatchery - Methow / Okanogan (MEOK) stock	90 / 86					
08MO	Eastbank Hatchery - Methow / Okanogan (MEOK) stock	95 / 88					
	Eastbank Hatchery - MEOK stock combined	**221 / 207**	**10.7**	**2 / 0**	**-0.005 (0.782)**	**0.8647**	**0.8604**
		2,350 / 2,118					

Table 1 continued.							
06KN	**Chelan River**	**70 / 23**	**10.3**	**11 / 0**	**0.027 (0.118)**	**0.8334**	**0.8556**
Data provided by USFWS							
	Entiat River - summer Chinook	**190**	**10.9**	**33 / 10**	**0.008 (0.119)**	**0.8553**	**0.8625**
Data from Small et al. (2010)							
08EH	Crab Creek	108					
09AZ	Crab Creek	291					
	Crab Creek	**399**	**10.5**	**35 / 14**	**0.018 (0.000)**	**0.8519**	**0.8676**
GAPS v.3.0 data							
	Priest Rapids Hatchery - fall Chinook	**81**	**11.1**	**3 / 2**	**0.015 (0.079)**	**0.8591**	**0.8723**
	Hanford Reach - fall Chinook	**220**	**11.3**	**4 / 0**	**0.010 (0.068)**	**0.8661**	**0.8746**
	Umatilla - fall Chinook	**96**	**11.2**	**17 / 6**	**-0.003 (0.623)**	**0.8719**	**0.8693**
	lower Yakima River - fall Chinook	**103**	**11.0**	**3 / 1**	**0.000 (0.511)**	**0.8724**	**0.8721**
	Marion Drain - fall Chinook	**190**	**10.8**	**9 / 4**	**0.022 (0.001)**	**0.8586**	**0.8782**
	Lyons Ferry Hatchery - fall Chinook	**186**	**10.6**	**7 / 4**	**0.013 (0.033)**	**0.8527**	**0.8641**
	Snake River - fall Chinook	**521**	**11.1**	**0 / 0**	**-0.001 (0.634)**	**0.8720**	**0.8708**
		NA / 2,009					

[a] - Year that samples were collected is identifed by the two numbers in the WDFW GSI code

[b] - based on a minimum of 11 diploid individuals

[c] - adjusted alpha p-value = 0.0006

[d] - adjusted alpha p-value = 0.0002

Table 2. PCR conditions and microsatellite locus information (number alleles/locus and allele size range) for multiplexed loci used for the analysis of Chinook. Also included are the observed and expected heterozygosity (H_o and H_e) for each locus.

PCR Conditions			Locus statistics		Heterozygosity		
Poolplex	Locus	Dye Label	# Alleles/ Locus	Allele Size Range (bp)	H_o	H_e	References
Ots-M	*Ots-201b*	blue	49	137 - 334	0.9474	0.9544	Unpublished
	Ots-208b	yellow	56	154 - 378	0.9523	0.9672	Greig et al. 2003
	Ssa-408	red	32	184 - 308	0.9177	0.9214	Cairney et al. 2000
Ots-N	*Ogo-2*	red	22	206 - 260	0.8526	0.8673	Olsen et al. 1998
Ots-O	*Ogo-4*	blue	20	128 - 170	0.6694	0.7028	Olsen et al. 1998
	Ots-213	yellow	45	178 - 370	0.9430	0.9525	Greig et al. 2003
	Ots-G474	red	16	152 - 212	0.6816	0.6838	Williamson et al. 2002
Ots-R	*Ots-3M*	blue	15	128 - 158	0.7854	0.7938	Banks et al. 1999
	Omm-1080	green	54	162 - 374	0.9517	0.9670	Rexroad et al. 2001
Ots-S	*Ots-9*	red	9	99 - 115	0.6531	0.6543	Banks et al. 1999
	Ots-212	blue	33	123 - 251	0.9205	0.9360	Greig et al. 2003
Ots-T	*Oki-100*	blue	50	164 - 361	0.9500	0.9567	Unpublished
	Ots-211	red	34	188 - 327	0.9325	0.9414	Greig et al. 2003

Table 3. Tests of population differentiation for temporal collections of summer Chinook from natural and hatchery-origin populations in the upper Columbia River. P-values that are highlighted grey are significantly different after Bonferroni correction (Rice 1989). Adjusted alpha p-value was 0.0001 . The H and W in the collection identifier is for wild or hatchery-origin and the two digit number identifes the year samples were collected.

Wenatchee River

	WenW93U	WenW93D	WenH06	WenW06U	WenW06D	WenH08	WenW08U	WenW08D
WenW93U	****							
WenW93D	0.0162	****						
WenH06	0.0033	0.0102	****					
WenW06U	0.3039	0.1642	0.4795	****				
WenW06D	0.0261	0.0160	0.0678	0.5300	****			
WenH08	0.1126	0.0708	0.0073	0.4359	0.0893	****		
WenW08U	0.2115	0.1148	0.4191	0.7243	0.3830	0.8856	****	
WenW08D	0.1915	0.0014	0.7047	0.4928	0.1671	0.7755	0.7665	****

D - collection was downstream of Tumwater Dam; U - collection was upstream of Tumwater Dam

Methow River

	MetW93	MetH06	MetW06	MetH08	MetW08	MetW09	MetH09
MetW93	****						
MetH06	0.3962	****					
MetW06	0.5481	0.4688	****				
MetH08	0.1408	0.1192	0.2052	****			
MetW08	0.8219	0.8937	0.6156	0.3779	****		
MetW09	0.2564	0.4282	0.2502	0.0328	0.7309	****	
MetH09	0.1543	0.5678	0.0547	0.0017	0.0098	0.0073	****

Okanogan River

	OkanW92	OkanW93	OkanH06	OkanW06	OkanH08	OkanW08	OkanH09	OkanW09
OkanW92	****							
OkanW93	0.0066	****						
OkanH06	0.0193	0.0000	****					
OkanW06	0.2843	0.0082	0.0031	****				
OkanH08	0.1290	0.1106	0.0652	0.7329	****			
OkanW08	0.0106	0.0029	0.0082	0.4075	0.7396	****		
OkanH09	0.0187	0.0001	0.0094	0.0551	0.2214	0.0281	****	
OkanW09	0.0527	0.0000	0.0024	0.7130	0.0262	0.0065	0.0002	****

Table 3 continued.

Wells Dam Hatchery

	Wells91	Wells92	Wells93	Wells06	Wells08
Wells91	****				
Wells92	0.5863	****			
Wells93	0.0490	0.0784	****		
Wells06	0.0089	0.0100	0.0542	****	
Wells08	0.0819	0.1088	0.2552	0.0256	****

Eastbank Hatchery - Wenatchee and MEOK stocks

	EBHWen08	EBHME92	EBHME93	EBHME08
EBHWen08	****			
EBHME92	0.8681	****		
EBHME93	0.0251	0.8661	****	
EBHME08	0.0086	0.9563	0.1895	****

Table 4. F_{ST} pairwise comparisons and genotypic tests of differentiation for hatchery- and natural-origin summer Chinook from the upper Columbia River. Above the diagonol are the F_{ST} values and below are p-values for the test of genotypic differentiation. Non-significant p-values for the result of the genotypic differentiation test are in bold type and F_{ST} values that are not significantly different from zero are in bold type.

	Wenatchee Hatchery	Wenatchee Natural	Methow Hatchery	Methow Natural	Okanogan Hatchery	Okanogan Natural	Wells Hatchery	Eastbank Wenatchee stock	Eastbank MEOK stock	Entiat River	Chelan River
Wenatchee Hatchery	****	**0.0000**	**0.0011**	**0.0000**	**0.0013**	**0.0010**	0.0015	**0.0004**	**0.0007**	**0.0004**	**0.0072**
Wenatchee Natural	**0.4351**	****	**0.0016**	**0.0000**	0.0014	0.0016	0.0024	**0.0006**	0.0012	0.0009	**0.0068**
Methow Hatchery	**0.3800**	**0.0205**	****	**0.0012**	0.0029	**0.0008**	**0.0027**	**0.0014**	**0.0022**	**0.0019**	**0.0078**
Methow Natural	**0.2237**	**0.6566**	**0.1502**	****	**0.0011**	0.0011	0.0013	**0.0007**	**0.0007**	**0.0008**	**0.0053**
Okanogan Hatchery	0.0001	0.0000	**0.0364**	**0.0008**	****	**0.0010**	**0.0014**	0.0029	**0.0000**	**0.0007**	**0.0055**
Okanogan Natural	0.0000	0.0000	**0.1755**	0.0000	**0.0003**	****	0.0016	0.0023	**0.0005**	**0.0008**	**0.0049**
Wells Hatchery	0.0000	0.0000	**0.0129**	0.0000	0.0000	0.0000	****	0.0036	**0.0006**	**0.0008**	**0.0041**
Eastbank Wenatchee	**0.5261**	**0.4102**	**0.1215**	**0.8404**	**0.0015**	0.0000	0.0000	****	**0.0018**	0.0030	0.0096
Eastbank MEOK stock	**0.0485**	0.0000	**0.4246**	**0.0009**	**0.5786**	**0.0051**	0.0000	**0.0065**	****	**0.0005**	**0.0039**
Entiat River	**0.0565**	0.0000	**0.1795**	**0.0044**	**0.0005**	0.0000	**0.0032**	**0.0039**	**0.0042**	****	**0.0052**
Chelan River	**0.0091**	**0.0026**	**0.0182**	**0.0156**	**0.0048**	**0.0030**	**0.0066**	**0.0059**	**0.0493**	**0.0617**	****

Table 5. F_{ST} pairwise comparisons and genotypic tests of differentiation for fall Chinook. Above the diagonol are the F_{ST} values and below are p-values for the test of genotypic differentiation. Non-significant p-values for the result of the genotypic differentiation test are in bold type and F_{ST} values that are not significantly different from zero are in bold type.

	Crab Creek	Hanford Reach Fall	Lyons Ferry Hatchery Fall	lower Yakima River Fall	Marion Drain Fall	Priest Rapids Fall	Umatilla River Fall	Snake River Fall
Crab Creek	****	0.0087	0.0134	0.0079	0.0143	0.0107	0.0073	0.0097
Hanford Reach Fall	0.0000	****	0.0077	**0.0000**	0.0064	**0.0000**	**0.0000**	0.0022
Lyons Ferry Hatchery Fall	0.0000	0.0000	****	0.0063	0.0074	0.0092	0.0062	0.0029
lower Yakima River Fall	0.0000	**0.4140**	0.0000	****	0.0054	**0.0000**	**0.0000**	0.0018
Marion Drain Fall	0.0000	0.0000	0.0000	0.0000	****	0.0067	0.0061	0.0060
Priest Rapids Fall	0.0000	**0.0695**	0.0000	**0.0083**	0.0000	****	**0.0000**	0.0027
Umatilla River Fall	0.0000	**0.4879**	0.0000	**0.4896**	0.0000	**0.2539**	****	0.0011
Snake River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	****

Table 6. F_{ST} pairwise comparisons and genotypic tests of differentiation for hatchery- and natural-origin summer Chinook from the upper Columbia River and fall Chinook. Above the diagonol are the F_{ST} values and below are p-values for the test of genotypic differentiation. Non-significant p-values for the result of the genotypic differentiation test are in bold type and F_{ST} values that are not significantly different from zero are in bold type.

Population Differentiation

	Wenatchee Hatchery	Wenatchee Natural	Methow Hatchery	Methow Natural	Okanogan Hatchery	Okanogan Natural	Wells Hatchery	Eastbank Wenatchee stock	Eastbank MEOK stock	Entiat River	Chelan River
Crab Creek	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hanford Reach Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0349**
Lyons Ferry Hatchery Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
lower Yakima River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0074**
Marion Drain Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Priest Rapids Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0642**
Umatilla River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0579**
Snake River Fall	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 6 continued.

Pairwise F_{ST}

	Crab Creek	Hanford Reach Fall	Ferry Hatchery	Yakima River	Marion Drain Fall	Priest Rapids Fall	Umatilla River Fall	Snake River Fall
Wenatchee Hatchery	0.0158	0.0054	0.0180	0.0056	0.0153	**0.0025**	0.0053	0.0103
Wenatchee Natural	0.0162	0.0059	0.0185	0.0063	0.0157	0.0030	0.0059	0.0102
Methow Hatchery	0.0191	0.0104	0.0248	0.0095	0.0220	0.0069	0.0107	0.0165
Methow Natural	0.0148	0.0057	0.0182	0.0051	0.0148	0.0033	0.0055	0.0101
Okanogan Hatchery	0.0146	0.0041	0.0166	0.0042	0.0151	**0.0016**	0.0041	0.0082
Okanogan Natural	0.0163	0.0064	0.0187	0.0062	0.0170	0.0035	0.0068	0.0113
Wells Hatchery	0.0120	0.0051	0.0135	0.0044	0.0120	0.0028	0.0046	0.0077
Wenatchee stock	0.0184	0.0073	0.0203	0.0074	0.0167	0.0047	0.0084	0.0128
Eastbank MEOK stock	0.0128	0.0036	0.0143	0.0038	0.0135	**0.0019**	0.0038	0.0079
Entiat River	0.0147	0.0059	0.0176	0.0057	0.0156	0.0028	0.0056	0.0100
Chelan River	0.0074	**0.0046**	0.0110	**0.0040**	0.0160	**0.0047**	**0.0035**	0.0072

Table 7. Effective number of breeders per brood year with the largest number of samples of summer Chinook in the upper Columbia River. Brood years with sample size less than 19 individuals (shown in bold type) were not analyzed with exception of the 2008 Wells Hatchery collection. A comparison could not be made between an early and late collection from Wells Hatchery.

WDFW Code	Collection Location	Sample Size	Nb =	CI95(L) =	CI95(U) =
93DD[A]	Wenatchee Natural - upstream	23 / 19	152 / 190	77 / 87	616 / 2,147,483,647
08FV	Wenatchee Natural - upstream	56	162	112	249
93DE[A]	Wenatchee Natural - downstream	39 / 34	145 / 152	94 / 95	256 / 302
08FW	Wenatchee Natural - downstream	67	140	105	199
08FU	Wenatchee Hatchery	60	134	90	213
93EC[A]	Methow Natural	**10 / 15**	---	---	---
08FY	Methow Natural	62	150	106	218
08FX	Methow Hatchery	**9**	---	---	---
93ED	Okanogan Natural	69	142	102	203
08GA	Okanogan Natural	59	127	92	180
08FZ	Okanogan Hatchery	**16**	---	---	---
93DG	Wells Hatchery	**6**	---	---	---
08HY[B]	Wells Hatchery	24 / 39	---	---	---
08MN	Eastbank Hatchery - Wenatchee	88	190	144	263
93DF	Eastbank Hatchery - MEOK	84	171	129	229
08MO	Eastbank Hatchery - MEOK	88	166	126	226

[A] - calculations were made for samples from brood year 1988 / brood year 1989

[B] - samples were collected from brood year 2003 / brood year 2004

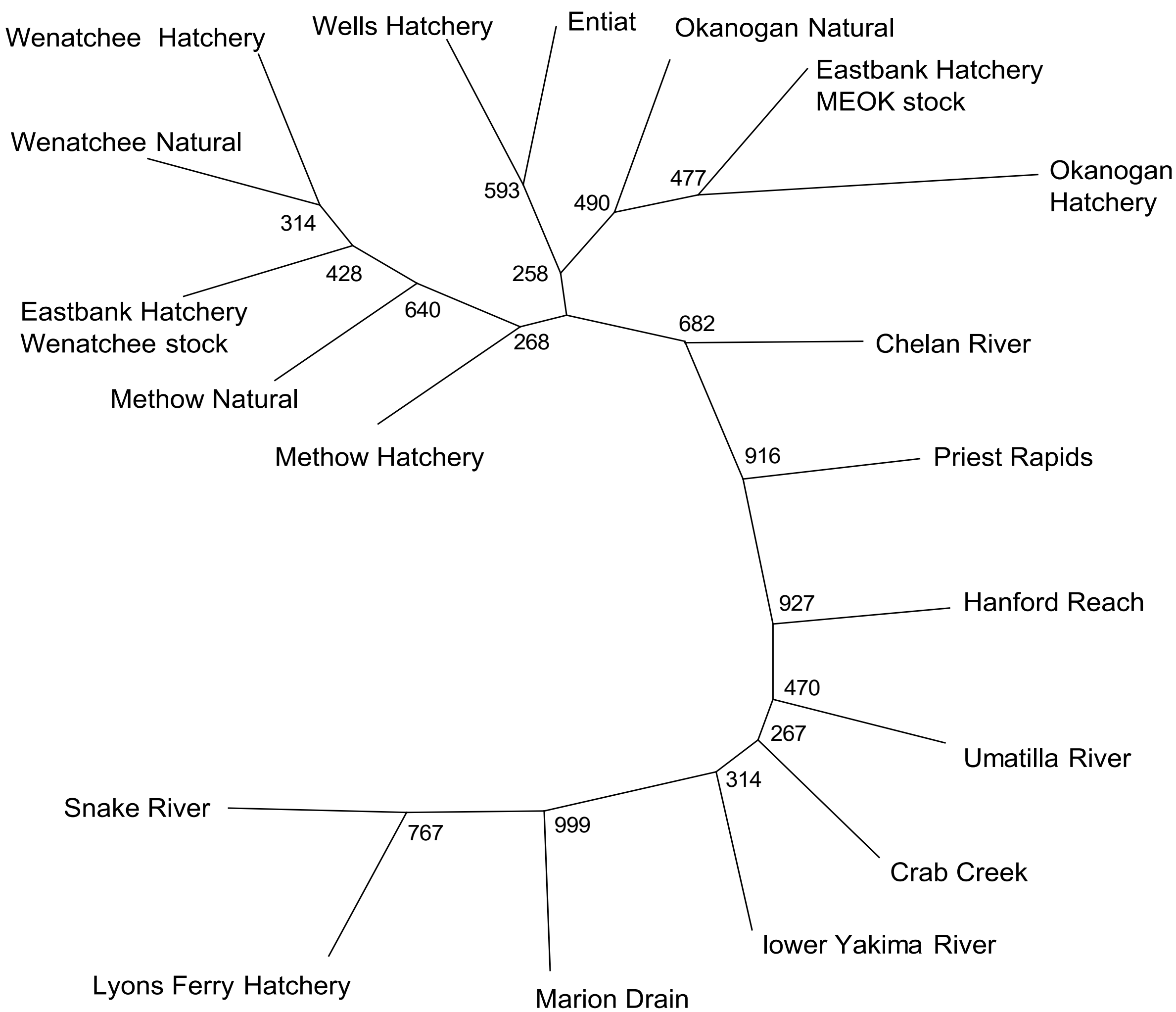

Figure 1. Relationship of natural- and hatchery-origin Chinook collections from the upper Columbia River basin using Cavalli-Sforza and Edwards (1967) chord distance. Bootstrap values are shown at each node.

Appendix O

Summer Chinook Spawning Ground Surveys in the Methow River Basin and Chelan River, 2017

BioAnalysts, Inc.℠
4725 North Cloverdale Road, Ste. 102
Boise ID 83713

April 23, 2018

To: Grant County Public Utility District

From: Denny Snyder and Mark Miller

Re: 2017 Summer Chinook Spawning Ground Surveys in the Methow Basin and Chelan River.

The purpose of this memo is to provide information on the supplemented natural spawning population of summer Chinook in the Methow and Chelan River basins. This work is part of a larger effort focused on monitoring and evaluating Chelan and Grant PUDs' hatchery supplementation programs. The tasks and objectives associated with implementing the Hatchery M&E Plan for 2017 are outlined in Hillman et al. (2017). In 2017, The Okanogan Basin was surveyed by the Colville Confederated Tribes (CCT).

METHODS

Spawning ground surveys were conducted by foot and raft beginning the third week of September and ending late-November. We did not use aerial surveys on the Methow River because past work has demonstrated that ground counts were more accurate than aerial surveys (Miller and Hillman 1997). Ground surveys were used to provide more accurate counts and a complete census of Chinook redds within their spawning distribution. Observers floated or walked through sampling reaches and recorded the location and numbers of redds each week (see Figures 1 and 2). Observers recorded the date, water temperature, river mile, and prepared a drawing of the area where redds were located. A different symbol was used each week to record the number of new and incomplete redds in the survey reach books. In 2017, we tested an iPad Pro and iPad Mini to view and record the location of redds with GIS Pro (by Garafa) mapping software. This method allowed us to observe the position of the boat or surveyor in real time and view redds that had been recorded in previous surveys. The iPad Pro worked well but the iPad Mini, even with external antenna, experienced too much position lag to be effective.

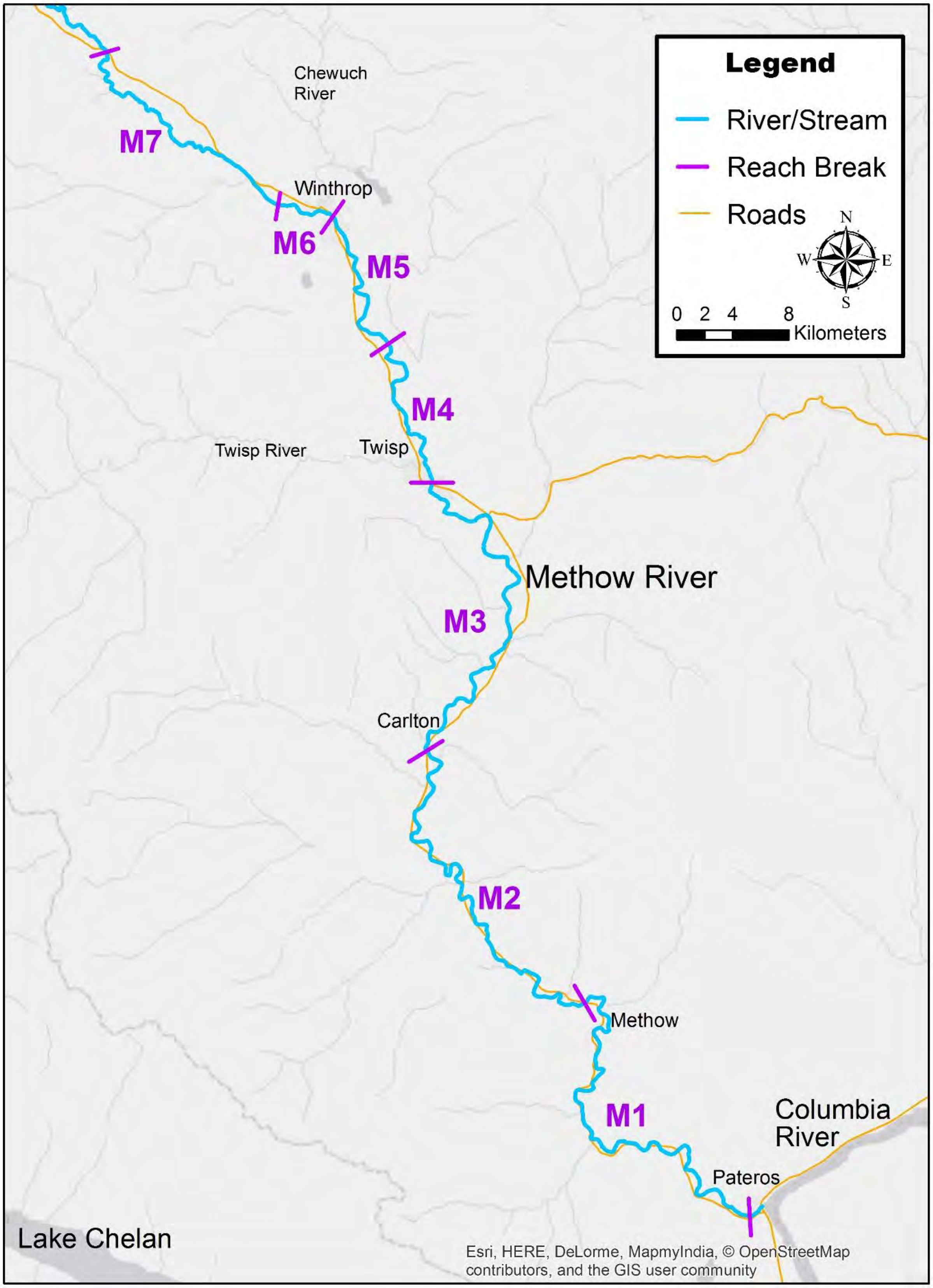

Figure 1. Summer Chinook survey reaches on the Methow River, 2017.

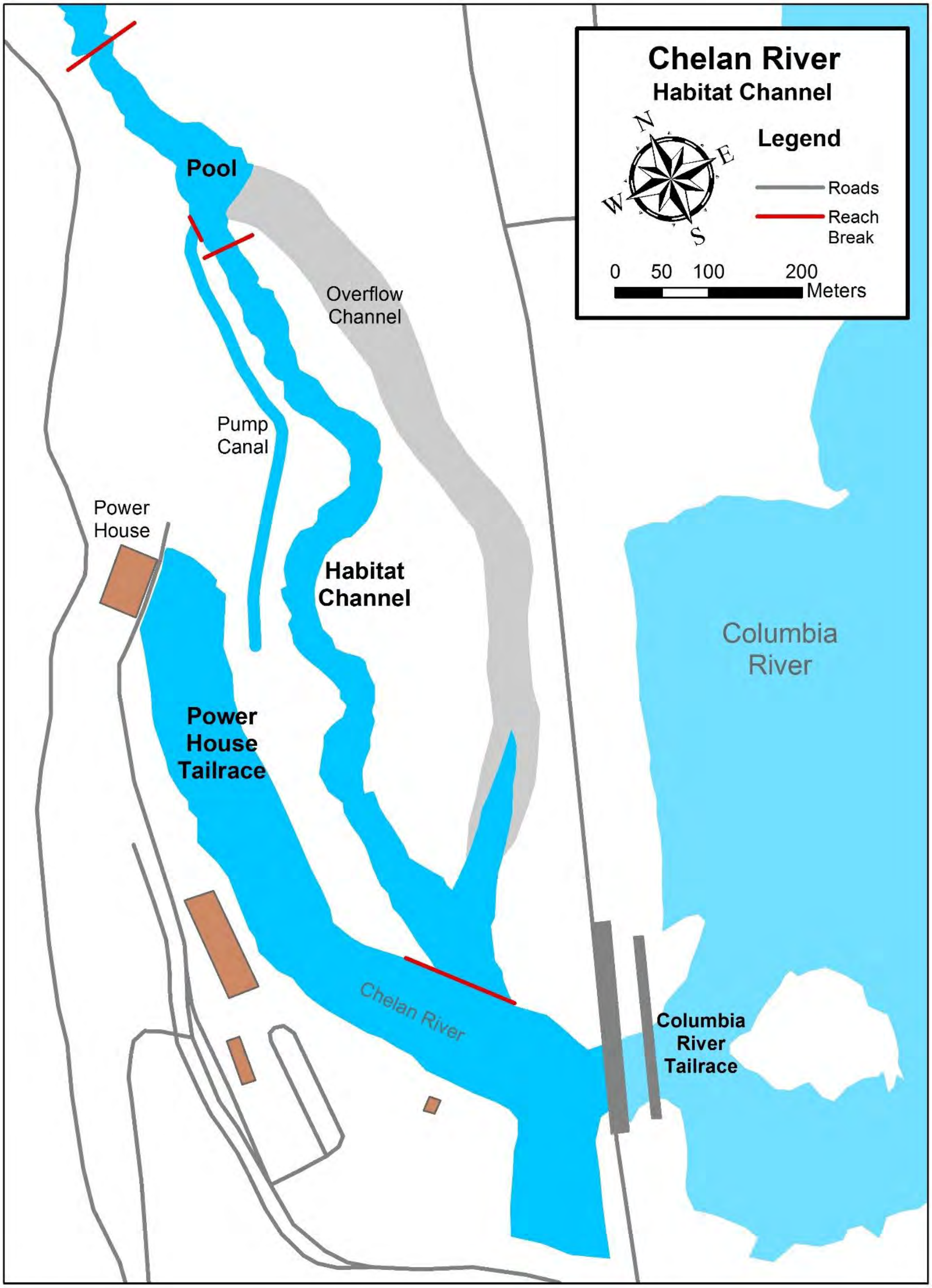

Figure 2. Summer Chinook survey areas on the Chelan River, 2017.

To maintain consistency, at least one observer surveyed the same stream reach on successive dates. In areas where numerous summer Chinook spawn, we constructed detailed maps of the river and used the cell-area-method (Hamilton and Bergersen 1984) to identify the number of redds within each cell. Cells were bound by noticeable landmarks along the banks (e.g., bridges or trees) or at stream habitat boundaries (e.g., transitions between pools and riffles). The number of redds were then recorded in the corresponding grid on the map. When possible, observers estimated the number of redds in a large disturbed area by counting females that defended redds. We assumed that the area or territory defended by a female was one redd.

Spawning escapement was estimated as the number of redds times the sex ratio observed at Wells Dam during broodstock collection. Carcasses of summer Chinook were sampled to describe the spawning population. Biological data collection included: scale samples for age analysis, length measurements (POH and FKL), sex, egg voidance, marks, and presence of PIT tags. These data will be used to assess length-at-age, size-at-age, egg voidance, origin (hatchery or naturally produced), and stray rates. No DNA samples were collected from summer Chinook this year. In this report, we only report the number of redds counted in the Okanogan Basin.

RESULTS

Methow

There were 690 summer Chinook redds counted within seven reaches on the Methow River (Table 1). Most redds (76%) were located in reaches from the mouth to the town of Twisp (M1-M3). Estimated escapement based on expansion of redd counts from the sex-ratio observed at Wells Dam during broodstock collection indicates that 1,408 summer Chinook (690 redds x 2.04 fish/redd) spawned in the Methow River.

Table 1. Number of summer Chinook redds observed each week within the Methow River, 2017. Dashes (--) indicate that no survey occurred.

Reach	Location (Rkm)	Sep	Oct					Nov				Dec	Total	Percent
		24-30	1-7	8-14	15-21	22-28	29-4	5-11	12-18	19-25	26-2	3-9		
		39	40	41	42	43	44	45	46	47	48	49		
M1	0.0-23.8	--	6	32	18	9	36	4	3	0	0	--	108	16
M2	23.8-43.8	5	65	45	35	12	10	0	--	--	--	--	172	25
M3	43.8-63.7	6	130	61	37	10	2	0	--	--	--	--	246	36
M4	63.7-72.3	2	31	8	0	4	1	0	--	--	--	--	46	7
M5	72.3-80.1	4	57	26	12	1	0	0	--	--	--	--	100	14
M6	80.1-83.0	0	0	1	1	1	0	--	--	--	--	--	3	0
M7	83.0-96.1	7	0	8	0	0	0	--	--	--	--	--	15	2
Total:		**24**	**289**	**181**	**103**	**37**	**49**	**4**	**3**	**0**	**0**	**0**	**690**	**100**

Time of spawning was assessed as the number of new redds counted each week in the Methow River. Spawning began the last week of September, peaked in early October, and ended the third week of November (Figure 3). Stream temperatures in the Methow River varied from 7.5-11.5°C in September when spawning began. Spawning peaked the second week of October in Reach M7, while peak spawning occurred in reaches M2-M6 the first week of October. Spawning peaked the first week of November in reach M1 (Table 1). This was the thirteenth highest redd count observed in the last 27 years for the Methow River (Appendix A).

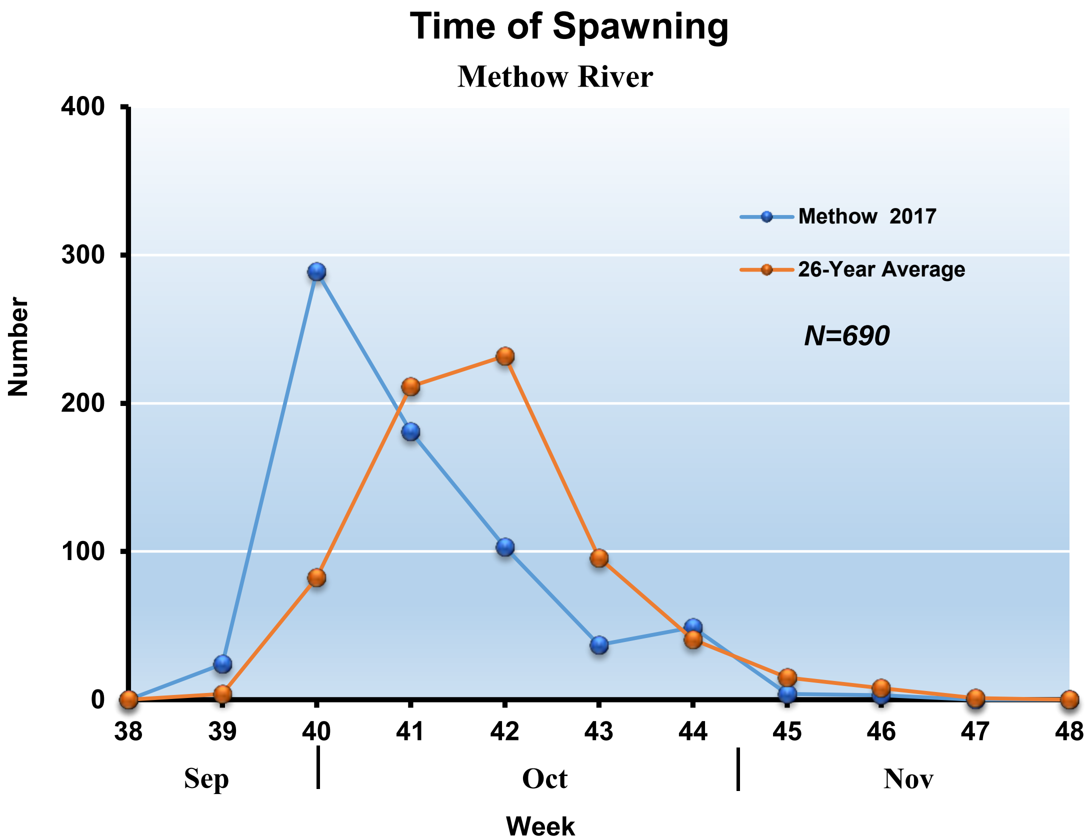

Figure 3. Number of new redds counted each week from late September to late-November in the Methow River, 2017. The figure shows the beginning, peak, and end of spawning for summer Chinook in the Methow River compared to a 26-year average (1991-2016).

There were 420 summer Chinook salmon carcasses sampled within the seven reaches on the Methow River (Table 2). The presence or absence of an adipose fin could not be determined on one fish. Thirty percent of the fish returning to the Methow River were sampled based on the estimated escapement of 1,408 summer Chinook. Ad-clipped hatchery fish made up 25% and naturally produced fish (adipose fin present) made up 75% of the fish sampled (Table 2).

Table 2. Number and percent of hatchery (ad-clipped) and naturally produced (ad-present) summer Chinook sampled in the Methow River, 2017.

Reach	Location (Rkm)	Ad-Clipped Hatchery				Naturally Produced				Reach Total
		Male	Female	Total	Percent	Male	Female	Total	Percent	
M1	0.0-23.8	16	3	19	31	19	23	42	69	**61**
M2	23.8-43.8	28	22	50	34	57	42	99	66	**149**
M3	43.8-63.7	7	19	26	22	29	64	93	78	**120[1]**
M4	63.7-72.3	0	1	1	4	12	9	21	96	**22**
M5	72.3-80.1	3	4	7	14	7	37	44	86	**51**
M6	80.1-83.0	0	0	0	0	3	2	5	100	**5**
M7	83.0-96.1	0	0	0	0	7	5	12	100	**12**
Total		**54**	**49**	**103**	**25**	**134**	**182**	**316**	**75**	**420**

[1] **Origin of one female carcass in Reach 3 could not be determined.**

Most (92%) of the ad-clipped hatchery fish were located in reaches M1-M3, while naturally produced fish were sampled within all survey reaches (Figure 4). Naturally produced fish made up 100% of the fish sampled in upper reaches (M6 and M7). Female summer Chinook accounted for 55% of the fish sampled in 2017 (Table 2). Twenty-one Coho were sampled while conducting Chinook salmon surveys. All Coho salmon data were provided to the Yakama Nation.

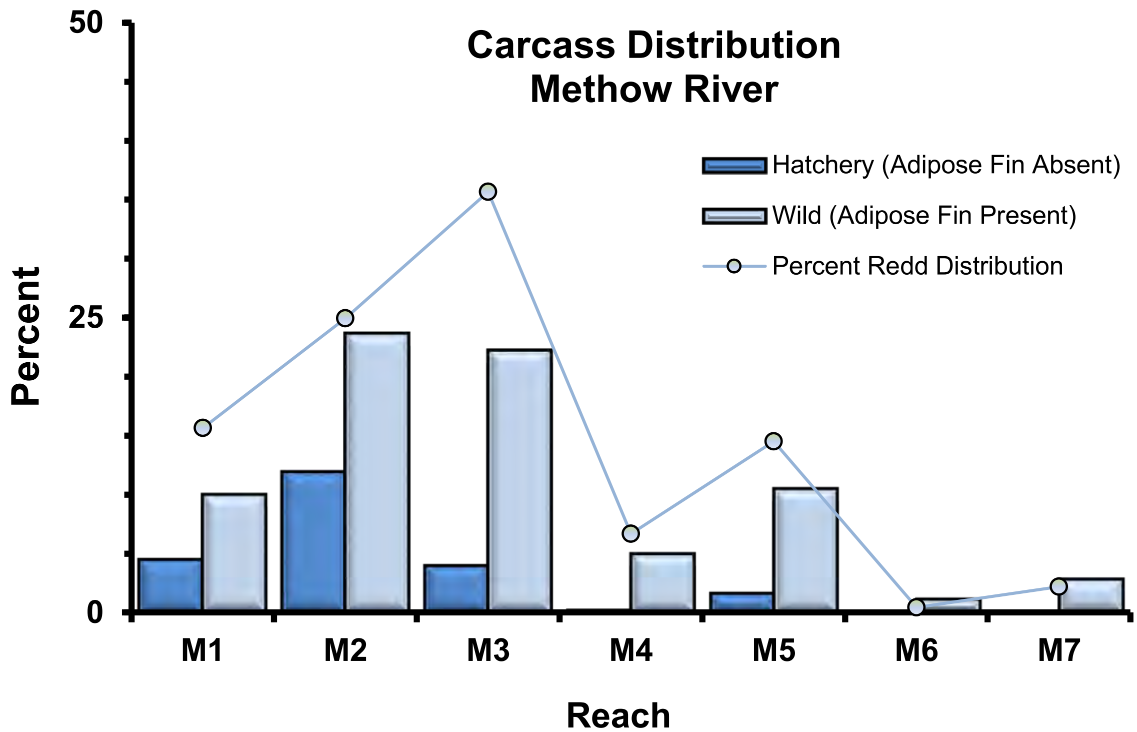

Figure 4. Percent distribution of ad-clipped hatchery and naturally produced fish plotted against the percent distribution of redds observed in reaches on the Methow River, 2017.

Egg voidance was assessed by sampling spawned-out female carcasses. Based on 231 sampled female carcasses, average egg voidance was 99%. Two females died before spawning (i.e., they retained all their eggs).

Chelan River

There were 421 redds counted in the Chelan River. This is the fifth highest redd count observed for summer Chinook in the Chelan River since 2000. The majority of spawning occurred in the powerhouse tailrace (48%), habitat channel (21%), and in the Columbia River tailrace (23%) (Table 3). Estimated escapement based on expansion of counts from the sex-ratio observed at Wells Dam during broodstock collection indicates that 859 summer Chinook salmon (421 redds x 2.04 fish/redd) spawned in the Chelan River.

Table 3. Number of summer Chinook redds observed each week within the Chelan and Columbia rivers, 2017.

Reach	Sep	Oct					Nov				Dec	Total	Percent
	24-30	1-7	8-14	15-21	22-28	29-4	5-11	12-18	19-25	26-2	3-9		
	39	40	41	42	43	44	45	46	47	48	49		
Powerhouse Tailrace	0	1	16	60	55	36	28	6	1	0	0	203	48
Columbia R. Tailrace	0	0	3	54	22	6	9	2	0	0	0	96	23
Pool	0	1	13	9	7	2	2	0	0	0	0	34	8
Habitat Channel	0	0	9	35	26	11	3	2	2	0	0	88	21
Total:	**0**	**2**	**41**	**158**	**110**	**55**	**42**	**10**	**3**	**0**	**0**	**421**	**100**

Time of spawning was assessed as the number of new redds counted each week in the Chelan River. Stream temperatures in the Chelan River varied from 13.5-17.5°C the first week of October when spawning began. Spawning activity began the first week of October and peaked two weeks later (Figure 5). Spawning peaked about one week earlier than what is typically observed. Spawning ended the third week of November.

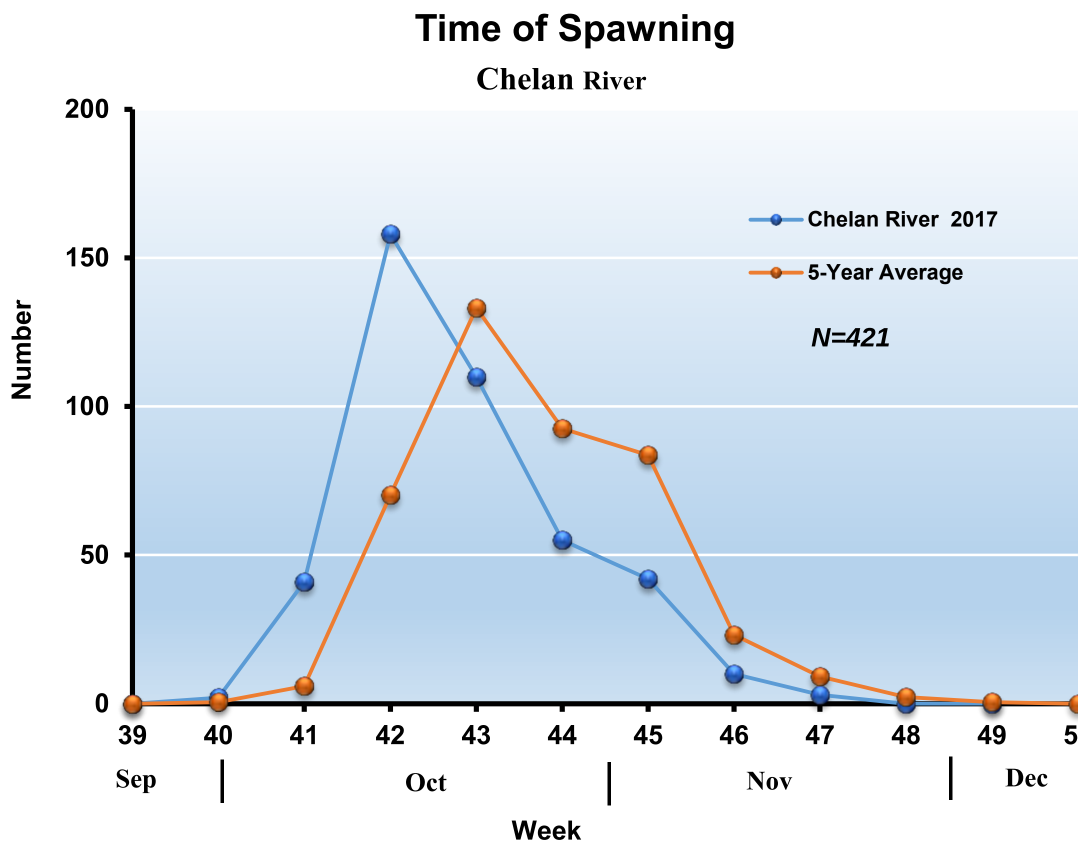

Figure 5. Number of new summer Chinook redds counted each week in the Chelan River from late September to mid-November. The figure displays the beginning, peak, and end of spawning for summer Chinook in the Chelan River in 2017 compared to a 5-year average (2012-2016).

There were 231 summer Chinook carcasses sampled in the Chelan River (Table 4). Twenty-seven percent of the summer Chinook returning to the Chelan River were sampled based on the estimated spawning escapement of 859 fish. Based on the absence of their adipose fin, hatchery fish made up 56% and naturally produced (ad-present) fish made up 44% of the fish examined. Females made up 78% of the carcasses examined (Table 4).

Table 4. Number and percent of hatchery (ad-clipped) and naturally produced (ad-present) summer Chinook collected in the Chelan River, 2017. The origin of one fish sampled could not be determined in the Chelan River.

Reach	Ad-Clipped Hatchery				Naturally Produced				Reach Total
	Male	Female	Total	Percent	Male	Female	Total	Percent	
Powerhouse Tailrace	1	12	13	48	2	12	14	52	**27**
Columbia R. Tailrace	23	43	66	53	12	46	58	47	**124**
Pool	2	13	15	68	2	5	7	32	**22**
Habitat Channel	6	30	36	62	2	20	22	38	**58**
Total	**32**	**98**	**130**	**56**	**18**	**83**	**101**	**44**	**231**

The distribution of ad-clipped hatchery fish and naturally produced fish varied within the Chelan River (Figure 6). A disproportionate number of fish (compared to redds counts) were sampled in the Columbia River tailrace. This likely occurs because carcasses drifted from upstream spawning areas and settle in the Columbia River tailrace. More hatchery fish were sampled in the habitat channel and pool upstream. Conversely, more wild fish were sampled in the powerhouse and Columbia River tailraces than hatchery summer Chinook.

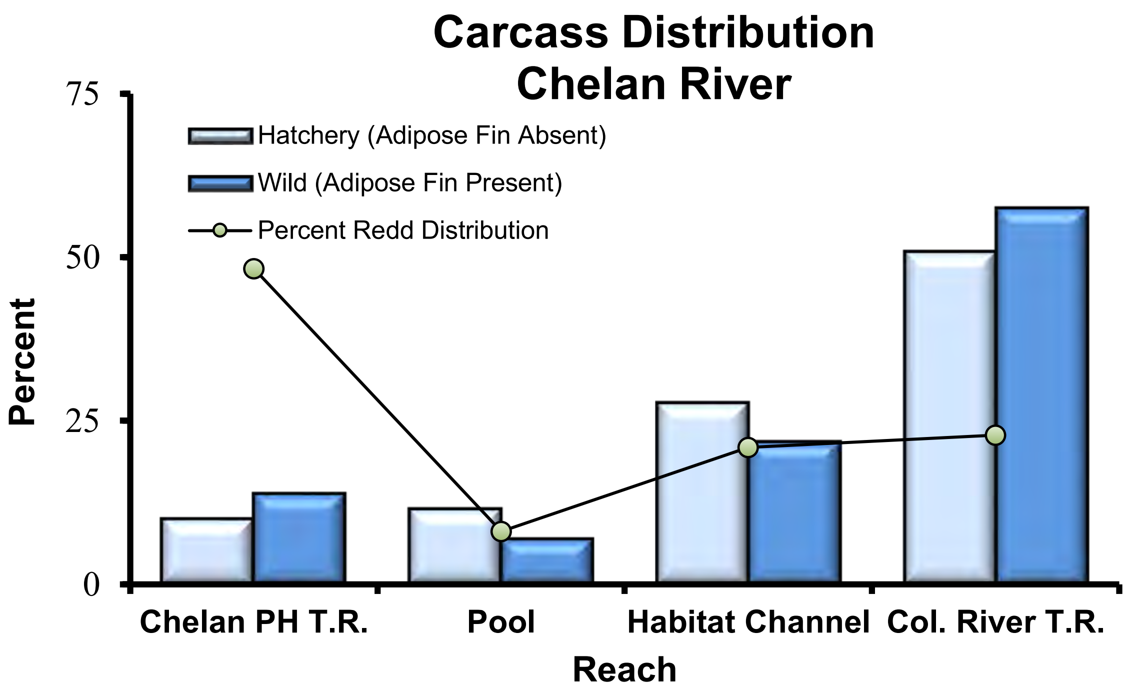

Figure 6. Percent distribution of ad-clipped hatchery and naturally produced fish plotted against the percent distribution of redds observed in reaches on the Chelan River, 2017.

In 2017, approximately 100 summer Chinook were collected as broodstock from the pool area upstream from the habitat channel.

Mean egg voidance assessed from 181 female carcasses was 90%. Egg voidance from one females could not be determined and ten females (5%) died before spawning. One male Coho was sampled (powerhouse tailrace) and three Coho redds were counted in the pool in 2017. Carcass data were provided to the Yakama Nation. Coho surveys were conducted thru December.

Okanogan Basin

In 2017, CCT conducted summer Chinook surveys in the Okanogan River basin. A total of 5,276 redds were counted in the Okanogan River basin (Personal Communication, Andrea Pearl, CCT).

REFERENCES

Hamilton, K. and E. P. Bergersen. 1984. Methods to estimate aquatic habitat variables. Report for Bureau of Reclamation, Division of Planning and Technical Services, Denver, Colorado. Colorado Cooperative Fishery Research Unit, Colorado State University, Fort Collins, CO.

Hillman, T., T. Kahler, G. Mackey, A. Murdoch, K. Murdoch, T. Pearsons, M. Tonseth, and C. Willard. 2017. Monitoring and evaluation plan for PUD hatchery programs: 2017 update. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, WA.

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Appendix A. Historical aerial and ground redd counts of summer Chinook in the Methow, Chelan, Okanogan, and Similkameen rivers, 1956-2017.

Year	Methow		Okanogan		Similkameen		Chelan	
	Aerial	Ground	Aerial	Ground	Aerial	Ground	Aerial	Ground
1956	109	--	37	--	30	--	--	--
1957	451	--	53	--	30	--	--	--
1958	335	--	94	--	31	--	--	--
1959	130	--	50	--	23	--	--	--
1960	194	--	29	--	--	--	--	--
1961	120	--	--	--	--	--	--	--
1962	678	--	--	--	17	--	--	--
1963	298	--	9	--	51	--	--	--
1964	795	--	112	--	67	--	--	--
1965	562	--	109	--	154	--	--	--
1966	1,275	--	389	--	77	--	--	--
1967	733	--	149	--	107	--	--	--
1968	659	--	232	--	83	--	--	--
1969	329	--	103	--	357	--	--	--
1970	705	--	656	--	210	--	--	--
1971	562	--	310	--	55	--	--	--
1972	325	--	182	--	64	--	--	--
1973	366	--	138	--	130	--	--	--
1974	223	--	112	--	201	--	--	--
1975	432	--	273	--	184	--	--	--
1976	191	--	107	--	139	--	--	--
1977	365	--	276	--	268	--	--	--
1978	507	--	195	--	268	--	--	--
1979	622	--	173	--	138	--	--	--
1980	345	--	118	--	172	--	--	--
1981	195	--	55	--	121	--	--	--
1982	142	--	23	--	56	--	--	--
1983	65	--	36	--	57	--	--	--
1984	162	--	235	--	301	--	--	--
1985	164	--	138	--	309	--	--	--
1986	169	--	197	--	300	--	--	--
1987	211	--	201	--	164	--	--	--
1988	123	--	113	--	191	--	--	--
1989	126	--	134	--	221	370	--	--
1990	229	--	88	99	94	147	--	--
1991	--	153	55	64	68	91	--	--
1992	--	107	35	53	48	57	--	--
1993	--	154	144	162	152	288	--	--
1994	--	310	372	375	463	777	--	--
1995	--	357	260	267	337	616	--	--

Year	Methow		Okanogan		Similkameen		Chelan	
	Aerial	Ground	Aerial	Ground	Aerial	Ground	Aerial	Ground
1996	--	181	100	116	252	419	--	--
1997	--	205	149	158	297	486	--	--
1998	--	225	75	88	238	276	--	--
1999	--	448	222	369	903	1,275	--	--
2000	--	500	384	549	549	993	--	196
2001	--	675	883	1,108	865	1,540	--	240
2002	--	2,013	1,958	2,667	2,000	3,358	--	253
2003	--	1,624	1,099	1,035	103	378	--	173
2004	--	973	1,310	1,327	2,127	1,660	--	185
2005	--	874	1,084	1,611	1,111	1,423	--	179
2006	--	1,353	1,857	2,592	1,337	1,666	--	208
2007	--	620	1,265	1,301	523	707	--	86
2008	--	599	1,019	1,146	673	1,000	--	153
2009	--	692	1,109	1,672	907	1,298	--	246
2010	--	887	688	1,011	642	1,107	--	398
2011	--	941	1,203	1,714	1,047	1,409	--	413
2012	--	960	1,170	1,613	762	1,066	--	426
2013	--	1,551	NA	2,267	NA	1,280	--	729
2014	--	591	NA	2,231	NA	2,022	--	400
2015	--	1,231	NA	2,379	NA	1,897	--	448
2016	--	1,115	729	3,486	141	1,790	--	448
2017	--	690	NA	5,276[1]	NA		--	421

[1] The redd count is for the entire Okanogan Basin (Similkameen + Okanogan rivers).

Appendix O
Rocky Reach Hydro Project Habitat Conservation Plan 2018 Annual Financial Report, Plan Species Account



PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
P.O. Box 1231, Wenatchee, WA 98807-1231 • 327 N. Wenatchee Ave., Wenatchee, WA 98801
(509) 663-8121 • Toll free 1-888-663-8121 • www.chelanpud.org

MEMORANDUM

DATE: **January 3, 2019**

TO: **Becky Gallaher**
Alene Underwood

FROM: **Debbie Litchfield**
Treasurer/Director – Treasury

RE: **Rocky Reach Hydro Project Habitat Conservation Plan**
2018 Annual Financial Report, Plan Species Account

In accordance with Section 7.4.3 of the Rocky Reach Habitat Conservation Plan attached is the 2018 year end annual financial report of the Plan Species Account activity completed by Chelan County Public Utility District No. 1.

Chelan County PUD
Rocky Reach Hydroelectric Project
Habitat Conservation Plan
Plan Species Cash Account Activity
Annual Financial Report Per Section 7.4.3
Reporting Year: 2018

Beginning Balance:	**1/1/2018**		**$ 2,657,368.15**
Transfers In:			
Rocky Reach Funding		359,935.00	
Interest Earnings		27,776.84	
Total Transfers In			387,711.84
Transfers Out:			
Payments		(156,869.38)	
Bank Service Fees		(86.00)	
Total Transfers Out			(156,955.38)
Ending Balance:	**12/31/2018**		**$ 2,888,124.61**

The Plan Species Account was established per the Rocky Reach Habitat Conservation Plan, Section 7.4.
Interest earnings shall remain in the Account in accordance with Appendix E, Section 7.4.1.