REPORT

ANNUAL REPORT CALENDAR YEAR 2012 OF ACTIVITIES UNDER THE ANADROMOUS FISH AGREEMENT AND HABITAT CONSERVATION PLAN WELLS HYDROELECTRIC PROJECT FERC LICENSE NO. 2149

Prepared for

Federal Energy Regulatory Commission
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Washington, D.C. 20426

Prepared by

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East Wenatchee, Washington 98802-4497

March 2013

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1 INTRODUCTION

On June 21, 2004, the Federal Energy Regulatory Commission (FERC) approved an Anadromous Fish Agreement and Habitat Conservation Plan (HCP) for the Wells Hydroelectric Project (Wells Dam – FERC License No. 2149) on the Columbia River in Washington State. The Wells Project is owned and operated by Public Utility District No. 1 of Douglas County (Douglas PUD). The HCP provides a comprehensive and long-term adaptive management plan for species covered under the HCP (Plan Species) and their habitats. This document is intended to fulfill Section 6.9 of the HCP, which requires an annual report of progress toward achieving the No Net Impact (NNI) goal, as described in Section 3 of the HCP, and a summary of common understandings based upon completed studies.

Designated representatives of the signatories of the Mid-Columbia HCPs (HCPs for the Wells, Rocky Reach, and Rock Island hydroelectric projects) comprise the Coordinating Committees, Hatchery Committees, and Tributary Committees for each HCP, which meet collectively to expedite the process for overseeing and guiding the implementation of their respective HCPs. Minutes from the monthly meetings are compiled in Appendices A (Coordinating Committees), B (Hatchery Committees), and C (Tributary Committees). In addition, a Policy Committee provides a forum for resolution of disputes that are either elevated to or arise in the Coordinating Committees and remain unresolved. The Policy Committees did not meet in 2012 because there were no disputes. Appendix D lists members of the Wells HCP Committees. The Coordinating Committee for the Wells HCP oversaw the preparation of this ninth Annual Report for calendar year 2012, which covers the period from January 1 to December 31, 2012 (the first through eighth Annual Reports covered January 1 to December 31, 2004 through 2011).

2 PROGRESS TOWARD MEETING OR MAINTAINING NO NET IMPACT

The Wells Project 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 percent combined adult and juvenile project survival achieved by project improvement measures implemented within the geographic area of the project, and 2) 9 percent compensation for unavoidable project mortality, with 7 percent compensation provided through hatchery programs and 2 percent through tributary programs (Section 3.1 of the HCP). In 2012, Douglas PUD continued the maintenance of NNI for the Wells Project by successfully meeting or exceeding all requirements for NNI under the Wells HCP. Section 6.9 of the Wells HCP specifies that by March 2013, Douglas PUD shall prepare for the Coordinating Committee a comprehensive progress report that assesses the status of NNI during the first ten years of the HCP. In December 2012, Douglas PUD distributed their draft Comprehensive 10-Year NNI Progress Report for review by the Coordinating Committee; and they expect to complete the final Comprehensive 10-Year NNI Progress Report in early 2013. The impetus for this report was the March 2013 deadline for achievement of NNI as established in Section 3.1 of the Wells HCP. The purpose of the Comprehensive 10-Year NNI Progress Report is to evaluate whether or not NNI has been achieved by the 2013 deadline, and if it had been achieved, to document that Douglas PUD continues to maintain NNI per all the requirements contained within the Wells Project HCP. The draft Comprehensive 10-Year NNI Progress Report was submitted to the Coordinating Committee in December 2012 and it describes the means by which Douglas PUD achieved NNI for all Plan Species by 2007, and also the measures through which Douglas PUD has maintained NNI to the present.

The remainder of this section of the report summarizes decisions and agreements reached by the Wells Coordinating, Hatchery, and Tributary committees in 2012 in support of maintaining NNI. This section is followed by sections summarizing achievements, actions, and activities specific to the areas of Wells Project survival and dam operations, hatchery compensation, and Tributary Committees funding of habitat protection and restoration.

Throughout 2012, the HCP Coordinating, Hatchery, and Tributary Committees reached agreement on numerous issues during meetings, all of which were documented in the meeting minutes, with many of those decisions described in stand-alone Statements of Agreement (SOAs). All of the agreements approved during calendar year 2013 are summarized in Table 1 and are discussed in the remainder of this section.

Table 1

Summary of 2012 Decisions by the Wells HCP Committees

Meeting Date	Agreement	HCP Committee	Reference
January 12, 2012	Approved revisions to the Policies and Procedures for Funding Projects document	Tributary	Appendix C
February 9, 2012	Agreed to increase the maximum contract allowance for small projects proposals from $75,000 to $100,000 (total project costs)	Tributary	Appendix C
February 9, 2012	Approved the 2012 Wells HCP Action Plan	Tributary	Appendix C
February 15, 2012	Approved the 2012 Wells HCP Action Plan	Hatchery	Appendix B
February 28, 2012	Approved the 2012 Wells HCP Action Plan	Coordinating	Appendix A
March 8, 2012	Approved revisions to Section VII, Full Disclosure, in the Tributary Committees Operating Procedures document	Tributary	Appendix C
March 27, 2012	Approved the 2012 Wells Juvenile Bypass Operating Plan	Coordinating	Appendix A
March 28, 2012	Agreed not to assign the task of developing recommendations for multi-species acclimation to the Hatchery Evaluation Technical Team (HETT) at this time	Hatchery	Appendix B
April 18, 2012	Agreed to defer voting on Columbia River Inter-Tribal Fish Commission's (CRITFC's) steelhead and spring Chinook genetic sampling request	Hatchery	Appendix B
April 18, 2012	Agreed to begin discussions on the update of the Hatchery Program monitoring and evaluation (M&E) Plan and to communicate with National Marine Fisheries Service (NMFS) on the pending Section 10 permits	Hatchery	Appendix B
April 27, 2012	Approved the Douglas PUD 5-Year M&E Report	Hatchery	Appendix R
May 17, 2012	Agreed to continue discussions on the update of the Hatchery Programs M&E Plans at the June 20, 2012 Hatchery Committees meeting	Hatchery	Appendix B
May 22, 2012	Conditionally approved the annual request from CRITFC to collect and tag sockeye at Wells Dam	Coordinating	Appendix A

Meeting Date	Agreement	HCP Committee	Reference
May 22, 2012	Approved Dr. John Skalski's re-analysis of the effects of reduced fishway entrance velocities on the passage of adult salmonids	Coordinating	Appendix A
June 20, 2012	Approved Collection of Entiat National Fish Hatchery summer Chinook broodstock at Wells Hatchery	Hatchery	Appendix B and Appendix F
June 20, 2012	Agreed to release 27 natural-origin Carson lineage adult spring Chinook, collected as broodstock for the Methow Hatchery program, into the Methow River, with the understanding that the broodstock collection target for the Methow Hatchery will likely still be achieved	Hatchery	Appendix B
July 12, 2012	Approved funding from the Wells Plan Species Account of six projects under the 2012 round of the General Salmon Habitat Program	Tributary	Appendix C
July 24, 2012	Approved implementation of a 1.0-foot fishway entrance head differential for lamprey from 17:00 to 00:59 daily during the 2012 lamprey migration period at Wells Dam	Coordinating	Appendix A and Appendix E
August 15, 2012	Agreed to continue the existing Hatchery M&E Programs with minor revisions in 2013, and to implement the updated M&E program for 2014 and beyond	Hatchery	Appendix B
September 19, 2012	Approved the long-term timing of release of Wells Hatchery subyearling summer Chinook	Hatchery	Appendix B and Appendix F
September 19, 2012	Agreed to authorize the Yakama Nation (YN) to release approximately 24,000 excess production coho salmon from Winthrop National Fish Hatchery at the Starr Boat Launch	Hatchery	Appendix B
September 19, 2012	Agreed that the YN proposal to use Douglas PUD's Chewuch Acclimation Facility for the YN Upper Columbia Coho Reintroduction Program, would not affect HCP NNI spring Chinook production.	Hatchery	Appendix B
September 25, 2012	Approved modifications to the fish counting stations to improve lamprey enumeration at Wells Dam	Coordinating	Appendix A
November 8, 2012	Approved funding from the Wells Plan Species Account of the Twisp River Well Conversion project through the Small Projects Program	Tributary	Appendix C
November 30, 2012	Approved Douglas 2011 Annual M&E Report	Hatchery	Appendix Q

Meeting Date	Agreement	HCP Committee	Reference
December 12, 2012	Agreed that Chelan PUD and Douglas PUD will provide their respective annual draft M&E Implementation Plans to the Hatchery Committees for review no later than July 1 of the year preceding the proposed implementation activities	Hatchery	Appendix B
December 14, 2012	Approved the Douglas 2013 M&E Implementation Plan	Hatchery	Appendix P

2.1 Wells Project Survival and Dam Operations

2.1.1 Status of Phase Designations for Current Plan Species

A major feature of the Wells HCP is what is termed a "phased implementation plan" to achieve the survival standards. These phases have been described in previous HCP Annual Reports to FERC. Since February 2005, steelhead, subyearling Chinook, yearling Chinook, and sockeye salmon have been in Phase III (either designated Standard Achieved or Additional Juvenile Studies; see Table 2). In December 2007, coho salmon were designated as in Phase III (Additional Juvenile Studies). In 2008, land and cash with a total value of $600,000 were transferred to the YN pursuant to Douglas PUD's coho mitigation agreement. This transaction completes Douglas PUD's coho mitigation obligation through 2017. No changes in phase designations have occurred in 2011 or 2012.

Table 2
Phase Designations for Wells Dam

Plan Species	Phase Designation	Date
Upper Columbia River (UCR) steelhead	Phase III (Standard Achieved)	February 22, 2005; verified November 16, 2010 [1]
UCR yearling Chinook	Phase III (Standard Achieved)	February 22, 2005; verified November 16, 2010 [1]
UCR subyearling summer/fall Chinook	Phase III (Additional Juvenile Studies)	February 22, 2005
Okanogan River sockeye	Phase III (Additional Juvenile Studies)	February 22, 2005
Methow River Coho	Phase III (Additional Juvenile Studies)	December 12, 2007

Note:
1 Verified in a SOA on November 16, 2010, by the Wells Coordinating Committee. Verification study included Okanogan Basin yearling Chinook per Sections 4.2.1 and 8.4.5.2 of the Wells HCP.

Under Phase III conditions (Standard Achieved), Douglas PUD is required to re-evaluate survival every 10 years, following the initial completion of three years of valid juvenile project survival studies. Douglas PUD conducted valid juvenile survival studies in 1998, 1999, and 2000. In 2010, Douglas PUD completed the first 10-year juvenile survival validation study, verifying the continued achievement of Phase III (Standards Achieved) for yearling Chinook and steelhead migrating through the Wells Project. There were no juvenile project survival studies conducted in 2011 or 2012.

2.1.2 Assessment of Wells Project Survival

As previously reported, Douglas PUD has met the HCP survival standard of 91 percent combined adult and juvenile Wells Project survival, and is in Phase III of the phased implementation plan for all Plan Species. As required by Section 4.2.5.1 of the Wells HCP, Douglas PUD re-evaluated survival in 2010, constituting the first 10-year "verification" survival study. The Wells Coordinating Committee selected yearling summer Chinook as representative of spring migrant salmonids (juvenile spring Chinook and yearling summer Chinook and steelhead) for the 2010 study, and directed Douglas PUD to include both Methow and Okanogan release sites for the study to fulfill Sections 4.2.1 and 8.4.5.2 of the Wells HCP. The results of the 2010 survival study (i.e., there is a 96.38 percent Wells Project rate of survival for yearling Chinook smolts) confirmed the continued achievement of Phase III (Standards Achieved) for yearling Chinook and steelhead migrating through the Wells Project, even during the second lowest flow year in the past 25 years. Douglas PUD is required to re-evaluate juvenile project survival for yearling migrants again in 2020.

In 2012, Douglas PUD conducted its second year of subyearling research aimed at determining whether or not the technology and tools exist to measure the survival of subyearling Chinook migrating through the Wells Project. A third year of study is scheduled prior to the publication of a three year summary subyearling Chinook report.

2.1.2.1 Adult Passage Monitoring

When the HCP was completed in 2002, the signatories acknowledged that no scientific methodology currently existed that would allow the Wells Coordinating Committee to assess adult Wells Project survival for Plan Species (presumed to be 98 percent). This is because available methods are unable to differentiate between mortality caused by the project versus other sources of non-detection. Such sources might include mortality from natural causes or fisheries; delayed mortality from injuries resulting from passage at downstream projects, or from injuries sustained by marine mammals or harvest activities; or fish not detected for other reasons, such as spawning in locations downstream from Wells Dam or loss of body-cavity Passive Integrated Transponder (PIT)-tags due to gonadal maturation during migration. Regardless of tagging method, this limitation remains—technology still does not allow a determination of the fates of tagged fish detected passing a dam but not detected at the next dam upstream—but calculations of total losses of tagged fish between projects provide a means for evaluating compliance with the Wells HCP standards for adult passage. Sequential detections of PIT-tagged adult salmonids through PIT-tag-detection systems in the fishways of each dam provide data for calculating conversion rates through the hydrosystem. Calculated per-project conversion rates furnish sufficient evidence for the achievement of adult survival standards, in that project-related mortality must be less than 2 percent when per-project conversion rates exceed 98 percent (i.e., less than 2 percent of fish missing from all sources including Wells Project-related mortality).

Table 3 details, for all run-years available, PIT-tag detections at Priest Rapids Dam of known-origin adult spring and summer Chinook salmon and steelhead, the number of those adults redetected at the fishway exits at Wells Dam, the estimated conversion rate (Priest Rapids Dam to Wells Dam), and the average per-project (i.e., four dams and four reservoirs) conversion rates. The per-project conversion rate is 99.4 percent for spring Chinook (that is, mortalities from all sources averaged less than 2 percent through each project), is 98.4 percent for steelhead, and 97.5 percent for summer Chinook. All but three of the summer Chinook used in the conversion-rate analyses were raised at either the Wells Fish Hatchery or the Eastbank Fish Hatchery, located downstream of Wells Dam, and were released as smolts upstream from Wells Dam. Similarly, most steelhead also originated from the Wells Hatchery but were released upstream from Wells Dam. Thus, these fish may exhibit homing to their hatchery of origin and may not attempt passage of Wells Dam. Additionally, summer Chinook, steelhead, and sockeye are subjected to popular recreational fisheries downstream of Wells Dam. All spring Chinook used in the conversion-rate calculations originated from hatcheries upstream from Wells Dam and are not subjected to fishery in the mainstem Columbia River upstream of Priest Rapids. Insufficient numbers of sockeye have been PIT-tagged as juveniles to develop a per-project conversion rate of known-origin fish; however, the CRITFC PIT-tags adult sockeye at Bonneville Dam without determining the origins of those fish. Table 3 includes conversion rates of sockeye from Rocky Reach Dam to Wells Dam (98.9 percent). Calculating conversion rates of sockeye from Rocky Reach Dam to Wells Dam minimizes the inclusion of sockeye originating from the Wenatchee Basin that would otherwise substantially decrease conversion rates calculated from Priest Rapids Dam to Wells Dam. The Rocky Reach Dam-to-Wells Dam conversion rate was further refined by subtracting from the Rocky Reach detections those fish that were subsequently detected passing Tumwater Dam in the Wenatchee River (indicating a voluntary fallback event at Rocky Reach Dam).

Table 3
Adult Conversion Rates for All Available Release Groups

Stock Species	Priest Rapids Dam	Wells Dam	Priest Rapids to Wells Total Conversion Rate	Priest Rapids to Wells Average Per Project Conversion Rate[1]
All Releases[2] Summer Steelhead Return Years 2004 to 2012	6,331	5,928	93.6%	98.4%
All Releases[3] Spring Chinook Return Years 2003 to 2012	766	748	97.7%	99.4%
All Releases[4] Summer Chinook Return Years 2003 to 2004; 2011-12	751	678	90.3%	97.5%
Stock Species	**Rocky Reach Dam[5]**	**Wells Dam**	**Rocky Reach-to-Wells Total Conversion Rate[6]**	--
Sockeye[7] RY 2010-2012	1,941	1,920	98.9%	--

Source: Columbia River DART website: http://www.cbr.washington.edu/dart/pit_obs_adult_conrate.html

Notes:

1 Calculated as "Priest Rapids Dam to Wells Dam Total Conversion Rate" to the fourth root (four dams and four pools). Adults detected at Wells Dam that were not also detected at Priest Rapids Dam were excluded from the analysis.

2 Summer steelhead released into the Okanogan and Methow River Systems—PIT-tag release site designations: BEAV2C, CHEWUR, GOLD2C, LIBBYC, METH, METHR, METTRP, OKANR, OMAKC, SGOLDC, SIMILR, STAPAC, TWIS2P, TWISPP, TWISPR, TWISPW, WINT, and WOLFC. Please note that many fish detected at Priest Rapids Dam in 2012 will not pass Wells Dam until the spring of 2013.

3 Spring Chinook salmon released into Methow River System—PIT-tag release site designations: BEAV2C, BIDDLP, CHEWUP, CHEWUR, METH, METHR, METTRP, TWISPP, TWISPR, WINT, WINTBC, and WOLFC. Minijacks were excluded from the calculations.

4 Summer Chinook salmon released into Columbia River System upstream of Wells Dam—PIT-tag release site designations: CARP (Eastbank Hatchery), COLR8, METHR (Wells Hatchery), OKANR (Wells Hatchery), and SIMILR (Eastbank Hatchery). Minijacks were excluded from the calculations. All summer Chinook in these release groups originated from hatcheries downstream of Wells Dam, COLR8 comprises three returning jacks from wild Chinook tagged in Wells Reservoir in 2011.

5 The Rocky Reach count excludes fish that were detected at Tumwater Dam after being detected at Rocky Reach, as a means to exclude Wenatchee-origin fish that ascended and voluntarily fell back over Rocky Reach.

6 Because fish detected at Priest Rapids may be destined for either the Wenatchee or Okanogan rivers, we included only sockeye detections at Rocky Reach and Wells in the calculation to exclude fish destined for Lake Wenatchee. The calculation does not account for fish harvested between Rocky Reach and Wells.

7 PIT-tagged sockeye comprise run-at-large adults tagged by CRITFC at Bonneville Dam and include fish originating primarily from Lake Wenatchee and the Canadian Okanagan Basin but also may include sockeye destined for Redfish Lake in Idaho.

% = percent

Conversion rates of PIT-tagged fish provide a minimum survival estimate between detection sites because they encompass mortalities from all sources and non-detected fish (as described in Table 3) between the two detection sites. They do not include any indirect or delayed mortality that might occur upstream of Wells Dam (the redetection site). As noted in Table 3, conversion rates reflect a combination of mortality attributable to both non-project related causes (e.g., recreational and tribal harvest, predation, and disease) and dam passage, as well as non-detections resulting from straying and spawning downstream of Wells Dam. For this reason, the actual per-project survival rate for adult Plan Species exceeds the 98 percent per-project assumption set forth in the HCP.

Although not addressed in the HCP, passage of adult bull trout was considered in the operation of Wells Dam in 2011 and 2012. In 2004, FERC issued an order incorporating the HCP and the U.S. Fish and Wildlife Service's (USFWS's) *Bull Trout Biological Opinion* into the FERC license for the Wells Dam Project. Article 62 of the original Wells Project license requires Douglas PUD to file an annual report with FERC describing the activities required by Douglas PUD's Bull Trout Monitoring and Management Plan. On December 24, 2008, Douglas PUD filed a report of bull trout monitoring and management activities that were conducted in 2005, and 2006 through late 2008. In March 2010, Douglas PUD filed a *Bull*

Trout Monitoring and Management Plan 2009 Annual Report with FERC that included activities that occurred from late 2008 through 2009. On March 28, 2011, Douglas PUD filed with FERC the Wells *Bull Trout Monitoring and Management Plan 2010 Annual Report* that included activities that took place between January 1, 2010, and December 31, 2010. On March 28, 2012, Douglas PUD filed with FERC the Wells *Bull Trout Monitoring and Management Plan 2011 Annual Report* that included activities that took place between January 1, 2011, and December 31, 2011 (Appendix G).

The new FERC license for the Wells Project required Douglas PUD to implement three bull trout-related plans and programs. Specifically, the license requires Douglas PUD to implement the *Bull Trout Management Plan* contained within the Aquatic Settlement Agreement, the *2012 Bull Trout Biological Opinion,* and Section 18 of the Federal Power Act: Fishway Prescriptions for Bull Trout.

The first license deadline for reporting annual bull trout activities is April 15, 2013, when the Annual Bull Trout Report is due to be filed with USFWS, and the second is May 31, 2013, when the Annual Bull Trout Report is scheduled to be filed with FERC.

2.1.2.2 Completed Studies 2012

Douglas PUD documented the removal of 16,302 northern pikeminnow from the Wells Reservoir and tailrace during annual removal efforts occurring from April 7, 2011, to November 11, 2011. Catch Per Unit Effort (CPUE) levels in 2011 were the lowest to date of any of the annual pikeminnow removal projects. A trend in decreased annual CPUE has been documented over the previous 8 years. This trend suggests that removal efforts are effectively reducing the pikeminnow population within Wells Reservoir and the Wells tailrace area. However, high spring flows in the Columbia River during 2011 prevented pikeminnow capture during the seasonal period when capture has been historically the highest. From 1995 to the present, the pikeminnow removal programs, funded by Douglas PUD, have resulted in the removal of approximately 228,000 pikeminnow from the Wells Project. Annual capture numbers have ranged from approximately 22,000 to 16,000 fish per year over the last 10 years, with a decreasing trend observed over the last 3 years. The 2011

Douglas PUD Pikeminnow Program Annual Report (Appendix H) was finalized in October 2012.

In 2009 and 2010, Douglas PUD conducted studies of fishway entrance efficiencies for lamprey at both 1.0-foot and 1.5-feet head differentials in water surface elevations between the Wells fishway collection gallery and the Wells tailrace, using Dual Frequency Identification Sonar (DIDSON) cameras. A 0.5-foot head differential was tested in 2009, but was later abandoned in 2010 because that differential appeared to offer no additional benefits to lamprey passage in comparison to the 1.0-foot differential. The effect of the different operating conditions on Wells fishway residency times for salmonids was evaluated by species. In 2009, no differences were detected in fishway residency times for any salmonid species evaluated (coho, sockeye, steelhead, and Chinook), although the sample size may have been too low to detect significant differences. In 2010, there was a large sample size of steelhead and Chinook and no differences were detected at either the 1.0-foot or 1.5-feet head differential. Based on the study findings, it was concluded that lamprey appeared to have increased entrance efficiency at the 1.0-foot head differential with no apparent decrease in salmonid passage relative to the 1.5-foot differential. NMFS questioned whether the statistical tests applied were appropriate for the study design, and requested additional statistical analysis of the data on salmonid passage during the lamprey studies. In 2012, Columbia Basin Research and the University of Washington's School of Aquatic and Fishery Sciences completed a report that examined the possible effects of changes in fishway entrance water velocity on the passage counts of Chinook, coho, and sockeye salmon, and steelhead (Skalski, J. R., and R. L. Townsend, 2012; Appendix I). Results of the analysis indicated that there were no statistically detectable effects on salmonids from reduced velocities at the fishway entrances (at the 1.0-foot head differential) during the study hours of operations. NMFS approved the report and the implementation of a 1.0-foot fishway entrance head differential was approved for each night, from 17:00 to 01:00, of the 2012 lamprey migration period at Wells Dam (Appendix F).

In 2010, Douglas PUD and Chelan PUD agreed to monitor PIT-tagged, natural-origin summer/fall Chinook detected at the Rocky Reach Juvenile Fish Bypass (RRJFB) as a means to passively study their life history diversity. A focus of the study was to determine outmigration timing and size-at-migration: information that is necessary for estimating the survival of migratory summer/fall Chinook salmon. However, the initial year of study (2010) revealed limited numbers of PIT-tagged subyearlings in the UCR. In response, Douglas PUD conducted a pilot study in 2011 to investigate spatial and temporal distribution of subyearling Chinook in the Wells Reservoir and to identify opportunities to increase the numbers of PIT-tagged subyearling Chinook for the life history investigation. In 2011, Douglas PUD staff successfully collected more than 18,500 natural-origin subyearling Chinook, and PIT-tagged and released 13,223 subyearling Chinook back to the Wells Reservoir. The collections occurred at several locations in the Wells Reservoir, but CPUE was highest in clear water with cobble bottom, adjacent the confluence of the Okanogan and Columbia rivers. Douglas PUD monitored these PIT-tagged individuals through the Columbia River hydrosystem and will continue tracking their progress through their return migration as adults. The 2011 study results, reported in the *Wells Project Subyearling Chinook Life-History Study 2011 Interim Report* (Appendix J), identified study limitations and logistical obstacles, primarily regarding fish availability, migratory behavior, and fish size, that will be used to inform future research.

Douglas PUD implemented a similar study in 2012, when more than 30,000 subyearling summer/fall Chinook salmon were collected and more than 20,000 were tagged and released. Fish were collected from three locations throughout the reservoir: 1) on the right bank upstream of the Okanogan River near Washburn Island; 2) on the right bank downstream from the mouth of the Okanogan River; and 3) on the left bank approximately one mile upstream of Wells Dam. The data collected during the 2012 study will be compared to the 2011 data and the results will be reported to the HCP Coordinating Committees via a technical memorandum. Additional research into the life history and behavior of subyearling Chinook in the mid-Columbia River will continue in 2013, and a comprehensive three-year report will be developed in 2014.

2.1.2.3 Planned Studies 2013

Section 4.3.2 of the HCP requires Douglas PUD to conduct a 10-year verification of the effectiveness of the timing of bypass operations at Wells Dam in passing 95 percent of the spring and summer migration of HCP Plan Species. Historically, hydroacoustic and fyke netting studies at Wells Dam provided the data on passage timing necessary to determine the timing of annual bypass operations. Douglas PUD discussed the requirement found in Section 4.3.2 of the HCP with the Wells Coordinating Committee in early 2011 to plan for a study in 2012. The Wells Coordinating Committee representatives at first questioned the need for such a study. As an alternative to using the past methods of hydroacoustic monitoring and fyke netting for species verification, Douglas PUD proposed to instead verify run-timing by comparing Rocky Reach Dam juvenile bypass index samples to bypass operations at Wells Dam, using the run-timing of fish passing through the RRJFB as a surrogate for run-timing at Wells Dam.

Results of the analysis of run-timing at the RRJFB confirmed that in most years the Wells bypass was appropriately operated to cover 95 percent of the spring and summer migration at Wells Dam. However, in two of the six years analyzed, an earlier start of the Wells bypass would have provided additional benefits to spring Chinook. Also, the analysis determined that the Wells bypass system could have been shut down earlier in each of the six years analyzed and would still have provided greater than 95 percent protection for summer migrating Chinook. The Wells Coordinating Committee agreed that this data would be used to guide the operations of the Wells Bypass System, beginning in 2012. In 2012, Douglas PUD updated the analysis with data from 2012, following the termination of sampling at the RRJFB, and distributed a report in December 2012 (Appendix K). The updated analysis indicated that the modified bypass timing initiated in 2012 provided bypass passage for more than 99 percent of both spring and summer migrants. As in 2012, Douglas PUD will update the analysis with 2013 bypass data following the bypass season.

Douglas PUD will continue the annual implementation of the pikeminnow removal program in 2013.

Douglas PUD will implement a third year of study on the life-history diversity of subyearling Chinook in the Wells Reservoir, using the same methods as those that were used in 2011 and 2012. In 2013, Douglas PUD intends that the repeated study to allow comparison of year-to-year findings and to evaluate behavior under different environmental conditions.

In conformance with the 2013 Gas Abatement Plan, Douglas PUD will implement monitoring for Gas Bubble Trauma in adult Plan Species at Wells Dam and the Wells Hatchery, and in juvenile Plan Species at the RRJFB sampling facility.

2.1.3 Wells Project Operations and Improvements

This section summarizes project operations toward meeting and maintaining HCP requirements at Wells Dam in 2012. Actions in 2012 were guided by the 2012 Wells HCP Action Plan (Appendix L), as approved by the Coordinating Committees (Appendix E).

2.1.3.1 Operations

In November 2012, FERC issued Douglas PUD their new Wells Hydroelectric Project license. The term of the new license is 40 years. With the Priest Rapids Project and the Rocky Reach Project licenses both expiring in 2052, FERC concluded that it would be practical to put all three projects on a license term that coincides with the expiration of the HCPs and Grant PUD's settlement agreement (i.e., in 2052 or in 40 years)[1]. However, the Wells HCP does not expire until 2054; and thus, the new license does not accomplish the intended synchronization. The new license also stipulates additional review and approval processes that will affect timing and scheduling of project activities.

As in past years, operation of the juvenile bypass system in 2012 was guided by the Juvenile Bypass Operating Plan (BOP; Appendix M) and criteria contained within Section 4.3 of the Wells HCP. The 2012 spring bypass season started on April 9, 2012, at 0000 hours and ran continuously through June 13, 2012, at 2400 hours. The spring bypass operated for a total of 66 days and used a total discharge of 1.31 million acre feet (MAF), or 5.0 percent of total project discharge volume. Summer bypass started on June 14, 2012, at 0000 hours and ran until August 19, 2012, at 2400 hours (67 days) and used 1.33 MAF, or 5.1 percent of the total discharge volume. River flows at Wells Dam during the 2012 juvenile migration of Plan Species (which occurs from April to August) were the third highest on record (less than in 1972 and 1997).

[1] Rock Island Project's term expires in 2028, and thus could not be synchronized with the other projects.

Exceptionally high flows began in mid-May and persisted into August. As a result, some exceptions to normal bypass operations occurred during 2012. To manage total dissolved gas (TDG) levels, in accordance with the 2012 BOP (Appendix M) and provisions of the 2012 Gas Abatement Plan (Appendix N), bypass barriers in Spill Bay 6 were pulled on May 1, 2012. Based on low involuntary spill forecasts, the bypass barriers in Spill Bay 6 were reinstalled on June 6, 2012; however, due to adjusted forecasts in response to heavy precipitation, bypass barriers in Spill Bay 6 were removed once again on June 18, 2012. Following increasing flows and to comply with the FERC-required Emergency Action Plan, on June 21, 2012, additional bypass barriers were removed from Spill Bay 4; and on June 26, 2012, bypass barriers were removed from Spill Bay 8. As flows declined, reinstallation of bypass barriers occurred in the reverse order of their removal, to maintain the bulk of the spill in the center of the project. Thus, bypass barriers were reinstalled in Spill Bays 8, 4, and 6 on July 30, 2012; July 31, 2012; and August 2, 2012, respectively.

In July 2012, the Wells Coordinating Committee approved implementation of a 1.0-foot head differential at Wells Dam fishway entrances (lamprey operations) during the 2012 lamprey migration, to enhance lamprey entrance success. Studies in 2009 and 2010 at Wells Dam indicated that the reduction of the fishway collection gallery-to-tailwater head differential from 1.5 feet to 1.0 foot may enhance lamprey entrance efficiencies into the Wells Dam fishways by reducing velocities at the entrance. Prior to approving the changes, an evaluation of the effects of the change in entrance velocities on salmonid species passage rates was conducted. The evaluation showed no differences in passage rates for Chinook, coho, and sockeye salmon and steelhead, in 2009 and 2010. Timing of the initiation of lamprey operations at Wells Dam fishways, which was based on lamprey passage numbers at Rocky Reach Dam, began at 1700 hours on August 6, 2012. The 1.0-foot differential was implemented from 1700 hours to 0100 hours each night from August 6, 2012, to September 30, 2012. Douglas PUD committed to conducting a full study of the effects of the 1.0-foot head differential on salmonid passage rates prior to considering any permanent change in fishway operations.

2.1.3.2 Improvements

Facility improvements and maintenance at Wells Dam in 2012 that had the potential to affect Plan Species are discussed in the paragraphs that follow.

The fishways at Wells Dam are inspected annually during winter, and each fishway receives, according to an alternating schedule, either a routine annual or more substantial bi-annual maintenance. The west fishway received bi-annual inspection and maintenance in January 2012. Besides annual and bi-annual servicing of the fishways, the hydromechanics at Wells Dam also replaced the drain valves in the collection gallery of the west fishway, with the intention of increasing control over the drainage process and improving drainage rates.

Several improvements were scheduled for the 2012/2013 winter fishway maintenance at Wells Dam. In December, the east fish ladder was dewatered and modifications to simplify fish-salvage operations and improve lamprey enumeration (approved in the fall of 2012), were installed. Modifications included: placing narrower, 0.5-inch-spaced bar screens (0.6875-inch measured on-center) over the existing 1–inch-spaced bar screens of the picketed leads that lead to fishway count stations; and securing an aluminum bar grating (with 0.5-inch-spaced bar screens) on to the existing louvers on both sides of the counting window, along with an 18-inch-wide aluminum plate, or ramp, which was also anchored to the louvers. These same improvements will be installed during the dewatering of the west fish ladder in February 2013. The count window improvements are intended to improve enumeration and simplify salvage operations by eliminating access to an area in the ladder that bypasses the count station and is difficult to recover fish from during maintenance activities.

Other improvements completed during the 2012/2013 winter maintenance period included expanding PIT-tag detection in the east ladder by installing antennae powered by the new 2020 readers—which also read half duplex (HD) PIT-tags—in Pool 19. These improvements are intended to increase the utility of the existing PIT-tag detection system by providing detections between the collection gallery and both the broodstock collection trap and the count station, and they will also enable detection of HD-tagged and full duplex-tagged fish. Identical antennae and readers were installed in the west ladder in February 2012 during the 2011/2012 winter maintenance period.

In preparation for a lamprey radio-telemetry (RT) study in 2013, new RT antennae will be installed in both fishways (or existing RT antennae will be reconnected). The new RT antennae will improve monitoring and will also aid in determining if the count station modifications perform as expected (i.e., if they facilitate improved lamprey passage and enumeration).

Lastly, safety railings were installed along the tops of the walls of the east fishway from Pool 37 down to Pool 6, and will also be installed in the west fishway in February 2013.

2.2 Hatchery Compensation

As required by the HCP, Douglas PUD supported hatchery production in 2012 to compensate for unavoidable project mortality and loss of habitat resulting from original inundation by the project. Section 8 of the Wells HCP outlines a Hatchery Compensation Plan with two hatchery objectives for Douglas PUD: 1) to provide hatchery compensation for spring Chinook, summer/fall Chinook, sockeye, and coho salmon; and for summer steelhead; and 2) to implement specific elements of the hatchery program consistent with the overall objectives of rebuilding natural populations and achieving NNI.

The HCP Hatchery Committees reviewed the draft 2012 Broodstock Collection Protocols in March 2012 and April 2012 (for Chinook and coho salmon, and steelhead). The protocols were finalized in April 2012 and implemented at program hatcheries (Appendix O); in-season revisions were made as needed in coordination with the Wells Hatchery Committee. As recommended by the HCP Hatchery Committees, a prioritized broodstock collection list was added to the 2012 protocols. Coho broodstock collection protocols were provided by the YN and incorporated into the 2012 Broodstock Collection Protocols. The 2012 Broodstock Collection Protocols were intended to guide the collection of salmon and steelhead broodstock in the Methow, Okanogan, Wenatchee, 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 (HCPs, and the Priest Rapids Dam 2008 Biological Opinion), and they comply with Endangered Species Act (ESA) permit provisions. Hatchery compensation for NNI and inundation compensation in 2012 included the release of 859,924 yearling and

492,777 subyearling salmonids from hatcheries associated with the Wells Project (Tables 4 and 5). These totals do not include the increased production of natural-origin sockeye smolts attributed to Douglas PUD's sockeye NNI compensation—the continued implementation of the Fish-Water Management Tool project administered by the Okanagan Nation Alliance and funded by Douglas PUD. The total also does not include NNI compensation paid by Douglas PUD to the YN for the Coho Enhancement Program in the Methow Basin. Lastly, these totals also do not include the Methow Basin spring Chinook raised by Douglas PUD for Chelan and Grant PUDs or the yearling steelhead produced at the Wells Hatchery by Douglas PUD for Grant PUD.

2.2.1 Hatchery Production Summary

Tables 4 and 5 summarize and compare HCP hatchery production objectives and actual 2012 production levels (release numbers) for both the fixed hatchery compensation for the original Inundation and Harvest Enhancement Programs, and the HCP passage loss (NNI) compensation programs.

2.2.1.1 Inundation Compensation Program

The FERC license to operate the Wells Hydroelectric Project requires Douglas PUD to rear and release fish to compensate for original impacts associated with the development of the Wells Dam and Reservoir. All of the fish for this program are raised at the Wells Hatchery. The number of fish to be released each year for the Inundation and Harvest Enhancement Program can be found in Section 8.4.6 of the Wells HCP Agreement.

Table 4
Production Objectives and Release Numbers for the Inundation and Harvest Enhancement Programs in 2012

Inundation and Harvest Compensation Program	Numeric Target	Number Released
Yearling Summer/Fall Chinook (2010 BY)	320,000	350,218
Subyearling Summer/Fall Chinook (2011 BY)	484,000	492,777
Yearling Summer Steelhead (2011 BY)	300,000	297,271

2.2.1.2 NNI Compensation Program

Section 8.4.3 of the Wells HCP contained the initial numbers of juvenile HCP Plan Species to be produced to meet Douglas PUD's NNI production levels for unavoidable juvenile losses at the Wells Project. These initial production targets were decreased in 2011, following the demonstration of higher than expected survival through the Wells Project for spring-migrating yearling Chinook and steelhead (per the 2010 Survival Verification Study). The NNI production goals for 2012 are contained in Table 5 (Numeric Target). Juvenile passage losses are offset through the production of juvenile Plan Species at three facilities (Wells Hatchery, Methow Hatchery, and Eastbank Hatchery) and through the implementation of mitigation options identified in the Sockeye Enhancement Decision Tree.

Table 5
Production Objectives for the
HCP Passage Loss (NNI) Compensation Program in 2012

NNI Compensation Program	Numeric Target	Number Released
Yearling Summer Steelhead (2009 BY)	47,571	41,170[1]
Yearling Summer/Fall Chinook (2008 BY)	105,714	116,006[2]
Yearling Spring Chinook (2008 BY)	59,464	55,259[3]
Yearling Osoyoos Lake Sockeye4	NNI achieved by annually funding the Fish-Water Management Tool	
Methow Coho5	NNI achieved by payment to the YN for the Coho Enhancement Program in the Methow Basin	

Notes:
1 C. Snow (WDFW 2012, personal communication). This is the total wild X wild production released into the Twisp River.
2 Carlton Pond Summer Chinook are released by Chelan PUD for Douglas PUD as part of the Douglas-Chelan Hatchery Sharing Agreement.
3 There were 454,476 spring Chinook smolts released from the Methow Hatchery in 2012 (April 2012 Memorandum from C. Snow), and an additional 55,111 spring Chinook from Methow Hatchery were transferred to the YN and released from Heath Pond. The target release of 548,464 fish is a combination of Wells NNI (59,464) and the sharing agreements with Chelan PUD (288,000) and Grant PUD (201,000). Releases from Heath Pond and Methow Hatchery were combined to determine production objective release targets.
4 Okanogan Sockeye obligation for NNI is covered by Douglas PUD funding of the Fish-Water Management Tool (FWMT) program (Wells HCP: Sections 8.4.4 and 14, and Figure 3) managed through the Okanagan Nation Alliance.
5 NNI for Methow coho is achieved through the funding provided to the YN for the Coho Enhancement Program as approved by the HCP Hatchery Committees at the December 12, 2007 meeting.
BY = brood year

2.2.2 Hatchery Planning

2.2.2.1 Monitoring and Evaluation Plan Implementation and Five-year Update

In 2007, Douglas PUD and Washington Department of Fish and Wildlife (WDFW) updated the 2005 Monitoring and Evaluation (M&E) Plan, entitled *Conceptual Approach to Monitoring and Evaluation for Hatchery Programs Funded by Douglas County Public Utility District*, for the operation of Douglas PUD hatchery programs. The M&E Plan is implemented to assist in determining whether the specific hatchery objectives defined by the HCP are being met. Implementation of this M&E Plan began in 2006 and has continued in 2012 in accordance with two documents: the *Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs*, prepared in 2006 (and updated in 2007), which provides the analysis tools for the M&E Plan; and *Implementation of Comprehensive Monitoring and Evaluation of Hatchery Programs funded by Douglas County PUD*, an M&E Implementation Plan, prepared annually to describe the M&E activities for the next calendar year and anticipate adaptive modification of the plan as necessary in future years. The 2012 M&E Implementation Plan was approved by the HCP Hatchery Committees in December 2011.

Section 8.5.1 requires updates to the M&E Plan every five years. At their April 2012 meeting, the HCP Hatchery Committees began the process of updating the M&E Plan capitalizing on the lessons learned during the first five years of M&E Plan implementation. In August 2012, with the Wells Hatchery Steelhead Hatchery and Genetic Management Plans (HGMP) and M&E permitting still pending resolution, the HCP Hatchery Committees agreed to defer implementation of the fully revised Hatchery M&E Program until 2014, and agreed to implement the existing M&E programs with minor updates in 2013. This revised schedule would align new permit deadlines with the proposed date for the new M&E programs, and also would allow more time for a thorough review of the existing programs and for development of M&E updates. In December 2012, the Douglas PUD 2013 M&E Implementation Plan (Appendix P) was finalized after a 30-day HCP Hatchery Committees review period. Also finalized in December 2012, was the Douglas PUD M&E Report, titled *Monitoring and Evaluation of Wells and Methow Hatchery Programs: 2011 Annual Report,* that documented M&E activities in 2011 (Appendix Q). A similar report will be completed in 2013 for 2012 M&E activities of natural production and hatchery operations.

2.2.2.2 Five-Year M&E Report

During 2011, as required by the HCP (Section 8.5.1), Douglas PUD conducted an analysis of their hatchery programs—including available salmon and steelhead survival and productivity data—to evaluate the performance of those hatchery programs over a period of five years (2006 through 2011). This 5-Year M&E Report was the first 5-year report written under the direction of the HCP. At the November 2011 HCP Hatchery Committees' meeting, Douglas PUD's hatchery M&E contractor (WDFW) presented the preliminary results of the analysis conducted for the 5-Year M&E Report. In April 2012, after a 60-day HCP Hatchery Committees review period, the Douglas PUD Final 5-Year M&E Report was finalized (Appendix R).

2.2.2.3 Hatchery and Genetic Management Plans

In October 2008, NMFS requested that the Wells Hatchery Committee prepare updated HGMPs for Douglas PUD hatchery programs, including the Methow Hatchery Spring Chinook and Wells Hatchery Steelhead programs. NMFS is using the HGMPs to conduct ESA consultations, prepare Biological Opinions (BiOps), and issue new 10-year Incidental Take Permits for those programs. The Methow Hatchery Spring Chinook HGMP was developed and refined throughout 2009 and approved by the Wells Hatchery Committee on February 17, 2010 (Appendix B), and was then submitted to NMFS for ESA consultation on March 12, 2010. NMFS subsequently requested additional analyses to inform the potential to achieve management objectives of interest to NMFS. Douglas PUD performed these analyses for the Methow Hatchery Spring Chinook Program and submitted them to NMFS in November 2012, in the form of a supplemental information package. The Methow Hatchery Spring Chinook HGMP is under review by NMFS with a letter of scientific sufficiency pending.

The Wells Hatchery Steelhead HGMP took longer to develop, requiring most of 2009 and 2010. The extended time required to reach consensus on this HGMP was largely the result of efforts to coordinate federal, state, and tribal interests in the Methow Basin. On March 7, 2011, the Wells Hatchery Committee approved the Wells Hatchery Steelhead HGMP (Appendix B), which was then submitted to NMFS on April 13, 2011, for ESA consultation. In November 2011, NMFS began reviewing the Wells Hatchery Steelhead HGMP and subsequently requested additional analyses to inform the potential to achieve management objectives of interest to NMFS. Douglas PUD performed these analyses for the Wells steelhead program and submitted them to NMFS in October 2012, in the form of a supplemental information package. The Wells Hatchery Steelhead HGMP is under review by NMFS with a letter of scientific sufficiency pending.

2.2.2.4 2013 to 2023 NNI Recalculation

Section 8.4.5 of the Wells HCP requires that hatchery production, except for original inundation mitigation, be adjusted in 2013 and every ten years thereafter to achieve and maintain NNI. In September 2010, the process to recalculate hatchery production was initiated by the HCP Hatchery Committees. Recalculated hatchery production levels are scheduled for release beginning in 2013 (steelhead) and 2014, which requires adjustments to broodstock collection as early as 2012. After first approving a method for recalculating hatchery production on July 20, 2011, the database with the numeric inputs for use in the recalculation efforts was approved as final by the HCP Hatchery Committees on August 17, 2011. The HCP Hatchery Committees then approved the recalculated hatchery production levels for Douglas PUD's NNI supplementation programs for 2013 through 2023 (Table 6) on December 14, 2011.

Table 6
Douglas PUD's 2012 and Recalculated (2013 to 2023) NNI Hatchery Obligations by Species

Species	Facility	Release Location	Recalculated 2013-2023 Obligation	2012 HCP Obligation	Purpose
Spring Chinook	Chief Joseph Hatchery[1]	Okanogan Basin	33,300	--	NNI
	Methow Hatchery	Methow Basin	29,123	59,464	NNI
Summer Chinook[2]	Chief Joseph Hatchery (yearling)	Upper Columbia Mainstem/Okanogan	48,100	105,714	NNI
	Chief Joseph Hatchery (subyearling)	Upper Columbia Mainstem/Okanogan	49,000	--	NNI
Steelhead	Wells Hatchery	Twisp River	8,000	47,571	NNI
Sockeye	NNI met through funding of Fish-Water Management Tool				
Coho	NNI met through a funding Agreement for the YN Coho Reintroduction Program				

Notes:
1 Douglas PUD has agreed to provide funding for spring Chinook salmon at Chief Joseph Hatchery.
2 Douglas PUD has agreed to provide funding for summer Chinook salmon at Chief Joseph Hatchery (54,575 yearlings, or 48,100 yearlings plus 49,000 subyearlings). Prior to recalculation, funding was provided for 105,714 yearling Chinook at the Carlton Acclimation Pond.

2.2.2.5 Hatchery Production Management Plan

In 2011, WDFW, in coordination with the HCP Hatchery Committees, drafted a Hatchery Production Management Plan to document criteria, measures, and actions that contribute to better meeting hatchery production targets, and minimize overproduction. Although not finalized in 2011, WDFW began implementing those actions identified in the draft 2011 Hatchery Production Management Plan for which there was support among the fishery co-managers. In 2012, the Hatchery Production Management Plan was finalized and approved and included as an appendix to the Final 2012 Broodstock Collection Protocols (Appendix O) that was submitted to NMFS in April 2012.

2.2.2.6 Objective 10 of the Hatchery M&E Plan - NTTOC

The HCP Hatchery Committees began addressing the interaction of Plan Species with non-target taxa of concern (NTTOC; Objective 10 of the Hatchery M&E Plan) in early 2008. At the close of 2008, the HCP Hatchery Committees agreed to conduct a review of risks to

NTTOC using an expert-panel and a risk-based model that WDFW had previously developed and applied in the Yakima River basin (Ham and Pearsons, 2001, Fisheries 26: 15-23). The HCP Hatchery Committees agreed on the species to be analyzed and containment objective categories for these species, as well as potential panel members for the exercise, in November 2008. The final documentation for this decision, titled *Summary and Strategy for Monitoring and Evaluation Plan Objective 10 (NTTOC)*, was made available as Attachment B to the January 21, 2009 Hatchery Committees' meeting minutes.

In August 2009, the HCP Hatchery Committees directed the HETT to conduct the NTTOC assessment. For review, input, and approval by the HCP Hatchery Committees, the HETT developed a list of regional and local ecological experts to invite to serve on a panel to estimate the risk of HCP Plan Species hatchery programs to NTTOC, developed a strategy and logistics for conducting the assessment panel workshops (by phone, in person, or a combination of the two), and scheduled the workshops. In 2010, the HETT worked on completing the NTTOC risk assessment template (a dataset structured for modeling and expert panel review) and a draft manuscript describing the risk assessment approach. The template and the manuscript will be provided to potential panel members, along with a cover letter requesting their participation in a Delphi process. In May 2011, the risk assessment manuscript was completed, and in October 2011, the HETT completed the risk assessment template and developed a database to house the risk assessment input data and to use as an analytical tool. In November 2011, the HCP Hatchery Committees directed the HETT to use the recalculated hatchery production numbers in the risk assessment. In 2012, the HETT began working on preliminary runs of the risk assessment model using the recalculated production numbers. Due to the unexpected amount of time needed to complete the NTTOC risk assessment, the HETT decided to limit initial modeling efforts of NTTOC/hatchery program interactions to a subset of all possible interactions, including only hatchery programs representative of certain types of interactions that may occur and that were necessary to model in order for the analysis to remain robust. In August 2012, the HETT agreed to compile the results of model runs completed to date into the database for analysis, which would then also be used to assess Delphi panel results in comparison with the model results. The HETT also agreed that the Delphi panel will initially consist of a smaller group of local scientists and that the HETT will produce a report on the NTTOC modeling and the Delphi results for the HCP Hatchery Committees; later, the HETT will potentially engage a broader Delphi panel and ultimately develop a more robust manuscript.

2.2.2.7 M&E Program Reference/Control Groups

In 2007, the HETT was tasked with making recommendations to the HCP Hatchery Committees on reference/control populations for the Chelan and Douglas PUDs' Hatchery M&E Programs. The HETT develop a three-phased approach for selecting reference populations. Phase I included the identification of non-supplemented populations within the Columbia River and Fraser River basins. Phase II included a coarse screening of all populations identified during Phase I. The coarse screening phase included examination and comparison of life-history characteristics, proportion of hatchery-origin spawners, duration of population time series data, sampling methods, freshwater habitat trends, and out-of-basin effects. Populations that met these criteria were then evaluated in more detail under Phase III, which included examination of correlations, trends, and minimal detectable differences in spawner abundance, natural-origin recruits (NORs), and productivity. The HETT developed density-dependence corrections for analysis of NORs and productivity. In addition, as part of Phase III, the HETT developed an analytical model that scored the relationship between potential reference populations and supplemented populations. The analyses included population performance metrics (spawner abundance, NORs, and productivity) with and without density-dependence corrections. Populations that scored 81 or higher (out of 100 possible points) were considered suitable reference populations.

In 2011, the HETT identified reference populations for the Chiwawa, Methow, Twisp, and Chewuch spring Chinook programs. They also found a suitable reference population for the Wenatchee, Methow, and Okanogan summer Chinook programs. The Methow, Twisp, and Chewuch reference populations were used in analyses for the 5-year M&E report (Section 2.2.2.2). They did not, however, identify suitable reference populations for sockeye or steelhead. Therefore, in 2012, the HETT recommended that prior to the development of the next 5-Year M&E Report (due in 2017), the HCP Hatchery Committees consider how best to evaluate the effects of supplementation when no reference populations are available (as in the case of steelhead and sockeye).

2.2.2.8 Steelhead Reproductive Success Study

Section 8.5.3 of the Wells HCP requires Douglas PUD to fund and implement a steelhead relative reproductive success study (RSS). On February 1, 2010, the Wells Hatchery Committee approved the Twisp Steelhead Reproductive Success Study plan. The study covers a 12-year period beginning in 2010 (and also includes samples collected in 2009). It focuses on an adult-to-adult assessment of the relative reproductive success of hatchery and wild fish, and includes the measurement of covariates of fitness. The study is designed to provide data to distinguish genetic and environmental influences on reproductive success. Study results will be used in management of summer steelhead in the Methow subbasin.

To date, genetic analyses have been completed by the WDFW Molecular Genetics Laboratory on the first three brood years in the study of adult steelhead returns to the Twisp River, with the fourth year (2012) underway. Fish were genotyped using 192 single nucleotide polymorphism (SNP) loci. For brood year 2009, 361 adult steelhead were genotyped, for brood year 2010, 346 adult steelhead were genotyped, and for brood year 2011, 264 adult steelhead were genotyped. Currently, genotyping of approximately 270 samples from 2012 is in process. For all years completed, the SNP loci were assessed for appropriateness for the Twisp River steelhead population and study goals, and several population genetic analyses were conducted. These data will be used to conduct parentage analysis in future years. Field work for this study was conducted under the M&E program (see Section 2.4.2.1, M&E Plan Implementation). In 2011, WDFW issued a draft report for the 2010 samples, followed by a revised report in February 2012. The report for the 2011 samples was issued in August 2012. In future years, the report will be available in September or October.

2.2.2.9 Multi-Species/Expanded Acclimation

In the interest of developing a long-term multi-species/acclimation plan for UUCR salmon mitigation programs, the JFP agreed to develop a draft plan outlining multi-species acclimation options for UCR salmon and steelhead mitigation programs. The HCP Hatchery Committees will consider the plan for adoption in 2013.

2.2.2.10 Fish Water Management Tool

Rather than provide hatchery-reared sockeye smolts as compensation, the HCP Coordinating Committees agreed that Douglas PUD could fund the Fish and Water Management Tool (FWMT; Appendix F). The FWMT, developed through a collaborative effort led by Dr. Kim Hyatt of Fisheries and Oceans Canada, is a water management decision model that guides water management in the Canadian Okanagan River basin for the benefit of Okanagan sockeye and Okanagan Lake kokanee. The FWMT is used by water and fisheries managers to minimize flooding, limit desiccation and scouring of salmon redds, and minimize the spatial extent of low oxygen levels in Osoyoos Lake.

2.2.3 Maintenance and Improvements

Several maintenance and improvement activities were completed in 2012 in support of hatchery production under the Wells HCP. These activities included the Colville Confederated Tribes' continued construction of the new Chief Joseph Hatchery (where Douglas PUD's future NNI production of Okanogan spring Chinook and UCR summer Chinook will be produced). Planning is also underway for modernizing the Wells Hatchery to meet the new requirements of the steelhead and summer Chinook HGMPs as well as to produce sturgeon and resident trout for the Off-License Settlement Agreement.

The modernization of Wells Hatchery is underway. Phase I, completed in September 2012, was an initial assessment of all infrastructure in order to identify needed upgrades. Phase I efforts included useful life facility assessment, surface water and groundwater well field assessments, and bio-programming. Phase II, completed in January 2013, finalized the bio-programming, addressed handling and management of adult returns, refined programmatic needs including potential changes to the programs in the future, and addressed configuration options for the facility in terms of water needs, rearing vessels, biological logistics, and workflow for Wells Hatchery operations. Phase III focuses on creating the Master Plan, which includes all information generated in Phases I and II, and synthesizes that information into a facilities and operation overview. The Master Plan will also guide development of bid drawings in Phase IV. Douglas PUD anticipates completing Phase III by March 2013, and commencing construction by 2014.

2.3 Tributary Committees and Plan Species Accounts

As outlined in the Wells HCP, the signatory parties designated one member each to serve on the Wells Tributary Committee. The Rock Island, Rocky Reach, and Wells Tributary Committees meet on a regularly scheduled basis as a collective group to enhance coordination and minimize meeting dates and scheduling difficulties. Subject items requiring decisions are voted on in accordance with the terms outlined in the specific HCPs. During 2012, the Tributary Committees met on eight different occasions.

An initial task of the Tributary Committees in 2012 was to review and update their operating procedures that provide a mechanism for decision making; these were initially developed in 2005 and included in that year's annual report (Anchor 2005)[2]. The Tributary Committees also developed Policies and Procedures for soliciting, reviewing, and approving project proposals (Anchor 2005); this document was last reviewed and updated in April 2012. 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 Committees established two complementary funding programs, the General Salmon Habitat Program and the Small Projects Program.

In 2012, the Tributary Committees revised language to Section VII, Full Disclosure, in the Operating Procedures. The last sentence in Section VII was changed from, "Committee members should recuse themselves from voting on a particular project if they represent an entity that may benefit from that project" to, "Committee members who represent an entity that submitted a project proposal will not vote on that particular project." Under Section 3.8 in the Policies and Procedures document, the Committees added the following language, "The Tributary Committees reserve the right to require public access on conservation easements or lands acquired with Plan Species Account funds." The addition of this statement does not require public access on all easements or acquisitions. However, if the Committees believe that a given protection project should have public access, they will make it a requirement for that specific project. Thus, the Committees will evaluate public access

[2] Anchor Environmental, L.L.C. 2005. Annual Report, Calendar Year 2005, of Activities Under the Anadromous Fish Agreement and Habitat Conservation Plan. Wells Hydroelectric Project, FERC license no. 2149. Prepared for FERC by Anchor Environmental L.L.C. and Public Utility District No. 1 of Douglas County.

on a case-by-case basis. Finally, after examining the appraisal process used by project sponsors, The Committees decided to hire their own appraisers. The Committees hired Larry Rees as their primary appraiser and Michael Gentry, Peter Shorett, and Fred Strickland as appraisal reviewers. These appraisers will conduct all appraisals and appraisal reviews on conservation easements and acquisitions funded by the Tributary Committees.

2.3.1 Regional Coordination

Similar to the Hatchery Committees and to improve coordination, a representative from Grant PUD and the facilitator of the Priest Rapids Coordinating Committees (PRCC) Habitat Subcommittee were invited to the Tributary Committees monthly meetings. In addition, they received meeting announcements, draft agendas, and meeting minutes. This benefits the Tributary Committees through increased coordination and sharing of expertise. The Grant PUD representative and PRCC Habitat Subcommittee facilitator have no voting authority. The Tributary Committees, through the Coordinating Committees, also invited American Rivers and the Confederated Tribes of the Umatilla Indian Reservation to participate in Committees meetings. Both parties contributed to the development of the HCP, yet elected not to sign the document. Neither of these parties participated in the deliberations of the Tributary Committees in 2012.

The Tributary Committees also coordinate with the Upper Columbia Salmon Recovery Board (UCSRB). Coordination is typically between the chairperson of the Tributary Committees and the Executive Director or Associate Director of the UCSRB. The Tributary Committees also invite representatives from the UCSRB to at least one meeting per year to update the Committees on activities proposed by the Board. In addition, some members of the Committees typically attend the UCSRB meetings to foster coordination in developing and selecting projects for funding. Some members of the Committees are also members of the UCSRB's Regional Technical Team (RTT), which increases coordination in selecting projects for funding. Many of the policies and procedures of the Salmon Recovery Funding Board (SRFB) and Tributary Committees are complementary, and annual funding rounds by these funding entities have been coordinated over the last several years.

The Tributary Committees held a funding coordination meeting with the Bonneville Power Administration (BPA) in July 2012. The purpose of the meeting, according to Section 2 of the Tributary Fund Policies and Procedures for Funding Projects, was to collaborate with regional, local, state, tribal, and national organizations that fund salmon habitat projects. The meeting resulted in identification of cost-shares for suitable habitat restoration projects.

2.3.2 Fiscal Management of Plan Species Accounts

The Tributary Committees set up methods for the long-term management of the Plan Species accounts for each HCP. The Wells Tributary Committee agreed to have Douglas PUD manage the accounting services internally, and to structure the relationship so that it can invoice these administrative costs to the Wells Plan Species account. The beginning balance of the Wells Plan Species Account on January 1, 2012, was $942,708.95; Douglas PUD's annual contribution was $244,533.00; interest accrued during 2012 was $2,123.69; funds disbursed for projects in 2012 totaled $180,442.53; disbursements for administrative costs included $3,033.29 to Chelan PUD for administrative support provided to the Wells Plan Species Account, and $2,176.00 to Douglas PUD for account administration during 2012; resulting in an ending balance of $1,003,713.82 on December 31, 2012. The 2012 Annual Financial Report for this Plan Species Account is provided in Appendix J.

In January 2009, the Wells Tributary Committee recommended to the Fisheries Parties (via the Wells Coordinating Committee) that Douglas PUD make annual payments to the Wells Plan Species Account beginning in 2010, per Section 7.4.1 of the Wells HCP. The annual contribution would be $176,780 (in 1998 dollars). In February 2009, the Wells Coordinating Committee accepted the recommendation that Douglas PUD make annual payments to the Wells Plan Species Account beginning in January 2010. Accordingly, at the end of each January, Douglas PUD will make an annual payment into the Wells Plan Species Account. In 2012, Douglas PUD deposited $244,533.00 into the Wells Plan Species Account.

The Wells Tributary Committee delegated signatory authority to the Tributary Committees Chairperson for processing of payments for invoices approved by the Committee, with the Coordinating Committees Chairperson serving as the alternate. The Tributary Committees

Chairperson works for a limited liability corporation and the Tributary Committees provide funds for liability insurance.

2.3.3 General Salmon Habitat Program

The Tributary Committees established the General Salmon Habitat Program 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 require extensive design, permitting, and public participation to be feasible. Often, a reach-level project involves many authorities and addresses more than one habitat factor. Because of this trend, the General Salmon Habitat Program was designed to fund relatively long-term projects. There is no maximum financial request in the General Salmon Habitat Program; the minimum request is $50,000, although the Tributary Committees may provide lesser amounts during a phased project or as a funding match for projects with multiple funding sources.

In an effort to coordinate with ongoing funding and implementation programs within the region, the 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 2012 General Salmon Habitat Projects

The Tributary Committees announced their 2012 funding cycle in March, with pre-proposal applications due on May 7, 2012 and full proposals due on June 29, 2012. The Tributary Committees received and reviewed 27 pre-proposal applications. The Tributary Committees identified 14 projects that they believed warranted full proposals and dismissed 13 projects because they did not have strong technical merit.

In June, the Tributary Committees received 16 full proposals to the General Salmon Habitat Program. All but one were "cost-shares" with the SRFB or other funding entities. The Tributary Committees approved funding for six projects. 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 Tributary Committees in 2012

Project Name	Sponsor[1]	Total Cost	Request from T.C.	Plan Species Account[2]
Lower Wenatchee Sleepy Hollow Easement	CDLT	$545,000	$136,250	Not funded
Lower White Floodplain Rehabilitation	CCFEG	$125,000	$25,000	Not funded
Nason Creek RM 3.7-4.7 Restoration	CCNRD	$398,233	$60,000	Not funded
Skinney Creek Floodplain Restoration Design	CCNRD	$60,000	$4,000	Not funded
Wenatchee and Entiat Beaver Reintroduction	TU-WWP	$199,000	$70,000	Not funded
Entiat PUD Canal System Conversion	CCD	$240,000	$36,000	Not funded
YN Lower Entiat RM 2.6-3.5 Habitat	YN	$98,000	$98,000	Not funded[3]
Cottonwood Flats Phase 1 Acquisition	CCNRD	$402,000	$60,300	Not funded
Methow Riparian Planting	CCFEG	$95,000	$15,000	Not funded
Twisp River Elbow Coulee Phase II Restoration	MSRF	$77,000	$14,580	W: $14,580[4]
Twisp River-Poorman Wetland Habitat Acq.	MSRF	$423,000	$63,450	W: $63,450
Upper Beaver Creek Habitat Improvement	MSRF	$674,300	$205,225	W/RR: $205,225[4]
Lower Chewuch Beaver Restoration	MC	$231,000	$27,000	W: $27,000
Big Valley Riparian Protection	WDFW	$404,000	$200,000	Not funded
Fish Passage at Shingle Creek Dam	ONA/CCT	$180,950	$118,450	W/RR: $118,450
Lower Foster Creek Habitat Enhancement	FCCD	$85,500	$57,500	W: $57,500

Notes:
1 CCNRD = Chelan County Natural Resource Department; CCD = Cascadia Conservation District; FCCD = Foster Creek Conservation District; MC = Methow Conservancy; ONA/CCT = Okanagan Nation Alliance and Colville Confederated Tribes; MSRF = Methow Salmon Recovery Foundation; WDFW = Washington Department of Fish and Wildlife; CCFEG = Cascade Columbia Fisheries Enhancement Group; TU-WWP = Trout Unlimited – Washington Water Project; YN = Yakama Nation; CDLT = Chelan-Douglas Land Trust.
2 RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.
3 BPA elected to fund this project prior to Tributary Committees project-funding decisions.
4 Subsequent to Tributary Committees project-funding decisions, BPA notified the Tributary Committees of their intent to fund these two projects.

In 2012, the Wells Tributary Committee agreed to fund the following General Salmon Habitat Program projects:

- Twisp River Elbow Coulee Phase II Rt/Lt Bank Restoration Project for the amount of $14,580 (with cost share the total cost of the project was $77,000). The project will improve access, increase rearing habitat, and reduce stranding of fish in two side channels of the Twisp River. This will be accomplished by enlarging a previously constructed levee breach, and breaching an existing levee to reconnect an 800-foot long groundwater-fed channel. Subsequent to the funding decision of the Tributary Committees, BPA informed the Committees of their intent to fund the portion of this project that would have been funded by the Committees. This notice of BPA's funding decision was an anticipated product of the ongoing, regional funding coordination between BPA and the Tributary Committees, and specifically of their meeting in July 2012 (see Section 2.3.1). The Wells Committee will retain the funds intended for this project for use in future funding opportunities.
- Twisp River-Poorman Creek Wetland Habitat Acquisition Project for the amount of $63,450 (with cost share the total cost of the acquisition was $423,000). The project will acquire about 24 acres of riparian habitat adjacent to the Twisp River at RM 4.75 (mouth of Poorman Creek). The acquisition includes about 2,300 feet of Twisp River frontage and 960 feet of Poorman Creek. The project will also decommission two irrigation diversions on Poorman Creek and an irrigation pump station within a wetland.
- Upper Beaver Creek Habitat Improvement Channel Restoration Project for the amount of $102,612.50 (with cost share the total cost of the project was $674,300). This project will increase habitat complexity, which will support rearing, spawning, and migration of steelhead in Beaver Creek. This will be accomplished by reconnecting 600 feet of historic channel and constructing 1,700 feet of new meandering stream to replace a 1,160-foot long straightened channel. In addition, the project will reconnect the stream with the floodplain and add large wood to create complexity. Finally, the Batie diversion will be replaced with a diversion that meets all state and federal criteria. Subsequent to the funding decision of the Tributary Committees, BPA informed the Committees of their intent to fund the portion of the project that would have been funded by the Committees. The Wells Committee will retain the funds intended for this project for use in future funding opportunities.
- Lower Chewuch Beaver Restoration Project for the amount of $27,000 (with cost share the total cost of the project was $231,000). This project will enhance salmon

and steelhead rearing conditions within the lower Chewuch watershed by reintroducing beaver. This action should improve stream habitat complexity, flows, riparian conditions, and sedimentation while helping to ameliorate the effects of climate change.

- Fish Passage at Shingle Creek Irrigation Dam Project for the amount of $59,225 (with cost share the total cost of the project was $180,950). This project will provide fish passage at an irrigation dam, which prevents access to 22 miles of spawning and rearing habitat in Shingle Creek and Shatford Creek. The dam will be modified and/or replaced with a series of riffles that will maintain the stability of the streambed while allowing access to upstream habitat. (The Wells and Rocky Reach Committees elected to share funding for this project, with each contributing $59,225 each.)
- Lower Foster Creek Steelhead Habitat Enhancement Project for the amount of $57,500 (with cost share the total cost of the project was $85,500). This project will increase channel complexity, provide cover, capture sediment, create pools, increase water availability, and increase spawning gravels. This will be accomplished by adding large wood and spawning gravels to lower Foster Creek. In addition, the project will assess the feasibility of relocating the discharge point for Chief Joseph toe-water further upstream.

2.3.3.2 Modifications to General Salmon Habitat Program Contracts

The Wells Tributary Committee received no requests from sponsors in 2012 asking for modifications to General Salmon Habitat Program Projects funded by the Committee.

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 Tributary Committees encourage small-scale projects by community groups, in cooperation with landowners, to support salmon 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. In 2012, the Tributary Committees increased the maximum contract allowed under the Small Projects Program to $100,000.

2.3.4.1 2012 Small Projects

In 2012, the Tributary Committees received seven requests for funding under the Small Projects Program. The Tributary Committees approved funding for three projects. The Committees were unable to make a funding decision on one project because of a lack of information. The Committees have asked the project sponsor to provide additional information. Table 7 identifies the projects, sponsors, total cost of the projects, amount requested from Tributary Funds, and which Plan Species Accounts supported the projects.

Table 7

Projects Reviewed by the Tributary Committees under the Small Projects Program in 2011

Project Name	Sponsor[1]	Total Cost	Request from T.C.	Plan Species Account[2]
Mission Creek Fish Passage	CCD	$50,000	$50,000	RI
Wenatchee Levee Removal and Riparian Restoration	CCNRD	$67,450	$56,700	RI
Wenatchee River RM 20-23 Riparian Restoration	CCD	$95,424	$80,424	Not funded
Peshastin Creek Riparian Restoration	CCD	$76,257	$51,257	Not funded
Entiat 1G/2A Reach Riparian Restoration	CCD	$100,000	$85,000	Not funded
Twisp River Well Conversion	TU-WWP	$87,739	$43,550	W
Beaver Creek Late Season Well Test	TU-WWP	$1,500	$1,500	No Decision[3]

Notes:
1 CCNRD = Chelan County Natural Resource Department; CCD = Cascadia Conservation District; TU-WWP = Trout Unlimited – Washington Water Project.
2 RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.
3 The Tributary Committees were unable to make a funding decision based on the information presented in the proposal. The Tributary Committees asked the sponsor for additional information.

In 2012, the Wells Tributary Committee agreed to fund the following Small Project:

- Twisp River Well Conversion for the amount of $43,550.27 (with cost share the total cost of the project was $87,738.87). This project will improve habitat and remove an irrigation diversion that kills juvenile steelhead and Chinook salmon. The sponsor will replace the existing diversion, located at RM 6.5 on the Twisp River, with a well and efficient irrigation system. The conversion will result in a 4.5 cfs increase in stream flows downstream from the existing diversion.

2.3.4.2 Modifications to Small Project Contracts

The Wells Tributary Committee received no requests from sponsors in 2012 asking for modifications to Small Projects funded by the Committee.

2.3.5 Tributary Assessment Program

In 2008, the Okanagan Nation Alliance responded to the request of the Tributary Committees for a proposal to monitor the Okanagan River Restoration Initiative (ORRI) Project. The Wells Tributary Committees agreed to fund three monitoring tasks of ORRI: 1) Fish Holding and Rearing, 2) Channel Morphometry and Hydraulics, and 3) Substrate Composition. As required in the Wells HCP, Douglas PUD provided funding for the approved monitoring tasks through the Wells Tributary Assessment Program, as per Section 7.5 of the Wells HCP, rather than through the Wells Plan Species Account.

In April 2012, the Okanagan Nation Alliance submitted a report titled, "Aquatic Monitoring of the Okanagan River Restoration Initiative—Post Construction 2011" for review by the Wells Tributary Committee. The Committee reviewed the report and the monitoring proposal/budget and concluded that the fifth and final year of monitoring should continue as planned. Therefore, the Wells Tributary Committee directed Douglas PUD to fund via the Tributary Assessment Program the following components: 1) Fish Holding and Rearing for $3,802, 2) Channel Morphometry and Hydraulics for $9,566, and 3) Substrate Composition for $5,617. Thus, the total amount approved by the Wells Tributary Committee was $18,984. The Wells Tributary Committee directed the sponsor to submit a final report at the end of the five-year study (June 2013).

3 HCP ADMINISTRATION

This chapter lists events of note that occurred in 2012 related to the administration of the HCPs, and provides a list of reports published in 2012 that relate to the HCPs.

3.1 Mid-Columbia HCP Forums

In 2005 and 2006, Mid-Columbia Forums (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 Reservation and American Rivers. As in 2006 through 2011, these parties were invited by letter in 2012 to attend a Forum, 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 Tributary and Hatchery Committees processes. The non-signatory parties again indicated no interest in attending a Forum in 2012, and thus a Forum was not held in 2012.

3.2 HCP Related Reports and Miscellaneous Documents Published in Calendar Year 2012

The following is a list of reports released in 2012 that are related to the implementation of the Wells HCP:

- Anchor QEA, 2012. *Annual Report, Calendar Year 2011, of Activities Under the Anadromous Fish Agreement and Habitat Conservation Plan*. Wells Hydroelectric Project. FERC License No. 2149. Prepared for FERC. March 2012.
- Douglas PUD, 2012. *Bull Trout Monitoring and Management Plan 2011 Annual Report*. Wells Hydroelectric Project, FERC Project No. 2149. Prepared for FERC. March 2012.
- Douglas PUD, 2012. A*nnual Report of Operations, Fish Facilities: 2011*. Wells Hydroelectric Project, FERC No. 2149. Prepared for FERC. March 2012.
- Douglas PUD, 2012. *Analysis of Adult Management of Steelhead in the Methow Basin*. March 2012.

- Douglas PUD, 2012. *Supporting Information Submitted to the National Marine Fisheries Service Regarding the Wells Complex Summer Steelhead HGMP*. October 4, 2012.
- Douglas PUD, 2012. *Supporting Information Submitted to the National Marine Fisheries Service Covering Spawning Composition and Recalculation Pertinent to the Methow Hatchery Spring Chinook HGMP*. November 9, 2012.
- Douglas PUD, 2012. *Wells Project Subyearling Chinook Life-History Study 2011 Interim Report*. Wells Hydroelectric Project. FERC No. 2149. December 2012.
- Jerald, T., 2012. *2011 Public Utility District No. 1 of Douglas County Northern Pikeminnow Removal and Research Program*. Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. January 2012.
- Murdoch, A., C. Snow, C. Frady, A. Repp, M. Small, S. Blankenship, T. Hillman, M. Miller, G. Mackey, and T. Kahler, 2012. *Evaluation of Hatchery Programs Funded by Douglas County PUD, 5-Year Report, 2006-2010.* Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. May 2012.
- Seamons, T. R., C. Bowman, E. Martinez, S. Peterson, and S. Bell, 2012. *Relative Reproductive Success of Twisp River Hatchery and Wild Steelhead (Oncorhynchus mykiss): Summary Report for SNP Genotyping of the First Two Years of Adult Collections (2009-2010).* Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. February 1, 2012.
- Seamons, T. R., C. Bowman, E. Martinez, S. Peterson, and S. Bell, 2012. *Relative Reproductive Success of Twisp River Hatchery and Wild Steelhead (Oncorhynchus mykiss): Summary Report for SNP Genotyping of Adult Collections – Return Year 2011.* Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. August 23, 2012.
- Skalski, J. R., and R. L. Townsend, 2012. *Analysis of Proportion of Outmigration Affected by Bypass Operations at Wells Dam, 2005-2012.* Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. December 1, 2012.
- Skalski, J. R., and R. L. Townsend, 2012. *Assessment of Salmonid Passage Responses to Different Flow Velocities at Wells Dam Fishway Entrance.* Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. April 3, 2012.
- Snow, C., C. Frady, A. Repp, A. Murdoch, M. P. Small, and S. Bell, 2012. *Monitoring and Evaluation of Wells and Methow Hatchery Programs: 2011 Annual Report.*

Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. July 2012.

APPENDICES

APPENDIX A - HABITAT CONSERVATION PLAN COORDINATING COMMITTEES 2012 MEETING MINUTES AND CONFERENCE CALL MINUTES

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	February 29, 2012
From:	Michael Schiewe, Chair		
Cc:	Carmen Andonaegui		
Re:	Final Minutes of the January 20, 2012, HCP Coordinating Committees' Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Friday, January 20, 2012, from 9:30 am to 12:00 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Steve Hemstrom will forward a copy of his email correspondence with Bryan Nordlund reporting steelhead mortalities during dewatering of the Rocky Reach fishway for maintenance on December 8, 2011 (Item II-A).
- Lance Keller will email the Draft 2011 Chelan PUD Predator Control Report to Carmen Andonaegui for distribution to the Coordinating Committees for review (Item II-C).
- Tom Kahler will provide a demonstration of Douglas PUD's Document Management Tool (DMT) for the February 28, 2012, Coordinating Committees' meeting (Item V-B).

DECISION SUMMARY

- There were no decisions made at today's meeting.

REVIEW ITEMS

- The Draft 2011 Rocky Reach Yearling Chinook Survival Study report is out for an extended review period. Comments are now due by January 27, 2012.
- The Draft 2012 Wells HCP Action Plan is out for a 30-day review. Comments are due

to Tom Kahler by February 20, 2012.

- The Draft 2011 Rocky Reach Juvenile Fish Bypass System Report is out for a 60-day review. Comments are due to Lance Keller by March 20, 2012.

REPORTS FINALIZED

- There are no reports to finalize at this time.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees' members and asked for any additions or changes to the agenda. He said that the November 15, 2011, Director Level meeting summary would also be up for approval at today's meeting. The following item was added to the agenda:

- Tom Kahler: Discussion of the draft Wells 2012 HCP Action Plan and an update on the status of Half-Duplex (HD) Passive Integrated Transponder (PIT) tag detector installations in the Wells Dam fishways.

The Committees reviewed the draft November 15, 2011, meeting minutes and the draft November 15, 2011, Director Level meeting summary. The November 15, 2011, meeting minutes and the November 15, 2011, Director Level meeting summary were approved as revised. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Committees.

II. Chelan PUD

A. Rocky Reach Fishway Maintenance (Steve Hemstrom)

Steve Hemstrom gave an update on fishway maintenance activities at Rocky Reach Dam. On December 9, 2011, Hemstrom said that he sent an email to Bryan Nordlund reporting five Endangered Species Act (ESA)-listed steelhead (two adults and three juveniles) mortalities and a number of non-ESA-listed fish mortalities during dewatering of the fish ladder for maintenance on December 8, 2011. He said that this is the first time that fish mortalities have occurred during fishway maintenance at Rocky Reach Dam. Hemstrom reported that Chelan PUD had gone through an extensive review to determine the cause of the mortalities and to identify procedures necessary to prevent future fish mortalities. He said that human error resulted in the total dewatering of the fishway prior to proper safety measures being in place to allow entry by personnel to perform normal, live-fish removal operations; as a result, fish trapped in the fishway died. Hemstrom said that Chelan PUD has prepared documents describing very strict standard procedures that must be followed during future fishway dewatering activities. Hemstrom said that the ESA-listed steelhead mortalities were covered under Chelan PUD's Incidental Take Permit; however, Chelan PUD's goal is to avoid any take during operation of the Rocky Reach Project. Lance Keller said that the recovered steelhead were checked for PIT tags but none were discovered. He said the snout was taken from the one recovered hatchery steelhead and it will be checked for a coded-wire tag.

B. 2011 Rocky Reach and Rock Island Annual Reports Update (Steve Hemstrom)

Steve Hemstrom said that the 2011 updates to the Rocky Reach and Rock Island HCP annual reports have started. He said that Chelan PUD intends to add a section to the reports describing the achievement of all HCP No Net Impact (NNI) standards for Chinook, steelhead, and sockeye. Carmen Andonaegui said that the Rocky Reach and the Rock Island HCP annual reports will be available for a 60-day review by the Coordinating Committees starting February 23, 2012; the Wells HCP annual report will be available February 10, 2012, for a 60-day review. Mike Schiewe said that the HCP annual reports have been produced for the past ten years and provide a summary of all activities accomplished under the HCP by all the HCP committees.

C. Draft 2011 Rocky Reach Juvenile Fish Bypass System Report and Draft 2011 Chelan PUD Predator Control Report (Steve Hemstrom)

Steve Hemstrom said that it was Chelan PUD's intent to have both the draft 2011 Rocky Reach Juvenile Fish Bypass System Report and the draft 2011 Chelan PUD Predator Control Report to the Coordinating Committees for review by today's meeting; however, due to workload constraints, they only just sent the draft 2011 Juvenile Fish Bypass System Report to Carmen Andonaegui January 19, 2012, for distribution to the Committees. He said that Lance Keller will email the draft 2011 Predator Control Report to Andonaegui for distribution to the Committees by the end of day, January 20, 2012. Both of the reports will be available for a 60-day review; comments should be sent to Lance Keller.

D. 2011 Rocky Reach Yearling Chinook Survival Study Results (John Skalski/Columbia Basin Research)

Dr. John Skalski summarized results of the 2011 Rocky Reach Yearling Chinook Survival Study (Attachment B). He reviewed the study purpose, study goals, study design, and assumptions tested. The study design incorporated both a day/night paired-release and a daytime-only triple-release into the bypass system; all releases occurred between April 25 and May 27, 2011. Assumptions tested included: tagger effects, tag lot effects, tag life corrections, and downstream mixing of release groups; no tag lot or tagger effects were detected, and the probability of tag life ending before fish arrived at downstream detection points was less than one percent, and there was good downstream mixing of release groups.

The study design allowed for estimates of project passage survival and route-specific survival (RSS). All study fish were tagged with acoustic tags and 3-D detection was available. Results included an estimate of absolute survival through the surface collector and bypass system, and relative survivals through all other passage routes. Analyses included a comparison of 2011 survival estimates to past years' survival estimates.

Estimated project passage survival was 92.89 percent for daytime releases and 92.99 percent for nighttime releases, with no significant differences between day and night survivals. Pooled project survival was estimated at 92.94 percent. The 2011 water discharge early in the study period was very typical of past years, but very high during the latter part of the study period. To provide a look at the effects of high flows and unintended spill on project survival, early- and late-season survival estimates were calculated (spill was required after May 15, 2011). Estimated early season survival was 91.61 percent with an increase in survival to 95.60 percent during the late-half of the study period. Removal of the 41 detected spillway passage study fish resulted in a decrease in late-season survival (94.74 percent) and a decrease in pooled project survival from 92.94 percent to 92.55 percent, indicating that spilled fish survival was high. Detection at all passage routes was greater than 99 percent.

Analyses of diel project passage data indicated that, regardless of release time, a higher percentage of study fish passed during the daytime compared to nighttime, and that study fish passed at a higher percent than run-of-the-river (ROR) fish during the daytime. ROR fish passed Rocky Reach Dam at a higher percent than study fish, during the night. Passage was highest through units 3 to 11 (47.77 percent) during both day and night. Spillway passage made up a very small proportion of fish passing the dam day or night (4.25 percent and 6.00 percent, respectively). Survival of fish that passed through the surface collector relative to all other passage routes was higher for both daytime and nighttime (1.017 percent and 1.013 percent, respectively); lowest survival was through turbine routes. There were no significant differences between absolute route-specific-survival (RSSs) and no significant differences between day and night absolute survivals for specific routes. The daytime dam passage survival estimate was 97.15 percent and the nighttime survival estimate was 96.14 percent. Overall estimated dam passage survival was 96.21 percent for non-spill routes and 96.42 overall. Estimated pool passage survival was 96.39 percent.

Comparing survival estimates from 2011 with past years' (2004, 2005, and 2010) survival estimates (all using acoustic tagged ROR yearling Chinook and Waterview operations), the lowest estimated survival was 2005 (91.09 percent) and the highest in 2011 (92.94 percent). The four-year average project passage survival was 92.37 percent. A table showing project survival for sockeye, steelhead, and yearling Chinook for all survival study years for each species was provided.

Bill Tweit asked Skalski about river flows during the study years. Skalski said that 2011 was a high-flow year. Steve Hemstrom said that 2004 and 2005 were low-flow years. He said that average flows in 2004 were so low that 2004 did not qualify as a valid study based on HCP minimum flow criteria; however, after evaluating the results, the Coordinating Committees approved the study. Tweit commented on the diel passage route proportions relative to the surface collector and asked for thoughts on why so many fish that did not go through the surface collector would pass through units 3 to 11. The Committees discussed the potential effects of turbine operations on surface collector efficiency, and discussed survivals through the various turbine units. Hemstrom said that the surface collector operated the same during daylight hours in 2011, but that later during the year the powerhouse was fully loaded to handle high flows. He said in 2010, operations were almost the complete opposite. Lance Keller said there are data showing approach tracks in 3-D from the boat restriction zone (BRZ). He said that dam approach tracks of study fish could be viewed under the different flow characteristics. Hemstrom said that data on avoidance versus rejection behavior are available and that these data could be reviewed to see if fish are just not detecting the surface collector attraction flows before being attracted to the powerhouse. Skalski drew Committees' members' attention to the relatively high standard errors (SE) for the absolute survival estimates. Hemstrom asked that anyone with questions please email him and reminded Committees' members that comments were due January 27, 2012, after which time the report will be finalized.

III. Douglas PUD

A. Draft 2012 Wells HCP Action Plan (Tom Kahler)

Tom Kahler reported that the draft 2012 Wells HCP Action Plan (Action Plan) was emailed to Coordinating Committees' members on January 18, 2012. He drew Committees' members' attention to Item 2 of the Coordinating Committees' section, *2013 NNI Progress Report*, in the draft Action Plan. Kahler said that section 6.9 of the Wells HCP describes a 10-Year check-in report describing progress towards achieving NNI by 2013 with a deadline of March 2012 for the report; therefore, the Action Plan includes a date of no later than March 2013 for delivery of a draft 2013 NNI Progress Report (Progress Report) to the Committees. He said that section 6.9 of the HCP also requires the development of an analysis to determine whether each Plan Species is rebuilding. Kahler said that the Action Plan assumes coordination with and participation by the Committees no later than March 2012, in the development of the outline for the Progress Report, then Committees' input on the status update due no later than May 2012. Kahler said that Douglas PUD anticipates relying on the analyses in existing documents for a determination of whether Plan Species are rebuilding. He said Douglas PUD has submitted this draft Action Plan for consideration by each of the HCP Committees and will be asking for approval of the Action Plan at the February 28, 2012, Committees' meeting. Kahler said the draft Action Plan was presented to the Hatchery Committees January 19, 2012, and to the Tributary Committees the week prior for review of their respective sections. Mike Schiewe said that the Coordinating Committees will be asked to approve the items, steps, and timelines in the Action Plan. Kahler said he would like feedback on whether the Committees' members feel all HCP-required tasks for 2012 are reflected in the draft Action Plan and that the actions as presented are accurate according to the HCP.

Bill Tweit asked if there are similar requirements in Chelan PUD's HCPs regarding an analysis of whether Plan Species are rebuilding. Joe Miller said that under section 4.8 in both the Rocky Reach and Rock Island HCPs there is a requirement that Chelan PUD work with the HCP committees to prepare an overall progress report by 2013 describing progress towards achieving NNI; the progress report is to include the status of each Plan Species. Tweit said the question of whether Plan Species are rebuilding is a regional question and should be a requirement for both Chelan and Douglas PUDs' HCPs, as well as in the Grant PUD Priest Rapids Salmon and Steelhead Settlement Agreement. He suggested that the three mid-Columbia PUDs think of this question as a regional issue.

Kahler said that National Marine Fisheries Service (NMFS), as recently as 2011, completed an updated status of ESA-listed Plan Species, and that Douglas PUD planned to rely on these NMFS documents for an analysis of whether ESA-listed species were rebuilding. He also referred to the recently completed draft 5-Year Hatchery Monitoring and Evaluation (M&E) reports for both Douglas and Chelan PUDs' hatchery programs. Kahler said that these analyses provided perhaps the best evaluation of the extent to which Plan Species populations are rebuilding. He said that Douglas PUD was not looking to do a more extensive review of the Plan Species than what is already available. Mike Schiewe said that relying on the NMFS status reviews and the PUDs' 5-year M&E reports does seem reasonable for ESA-listed Plan Species. Schiewe said that Action Plans are provided early in the year by the PUDs and that they are intended to show the Committees all HCP-required actions that can be expect from the PUDs during the coming year.

Tweit reiterated that the HCPs were intended to be similar. He urged Chelan and Douglas PUDs to have joint discussions so that whatever approach is taken regarding analyzing the status of Plan Species that the same approach would be taken by both PUDS. Schiewe said that the draft Action Plan asks only for an NNI progress report outline by March 2012, and then by May 2012 for the Committees to provide Douglas PUD more detailed direction for a status update of Plan Species. The report itself is not due to the Committees for review until 2013 as a draft. Tweit said he wanted to flag Item #2 in the Coordinating Committees section of the draft Action Plan as something that may require more effort and coordination than the other activities in the draft Action Plan. Kahler said that the Action Plans do not create a binding timeline, that timeline dates may be adjusted at the discretion of the Committees as the work progresses.

B. HD PIT tag detection installation Update (Tom Kahler)

Tom Kahler said that at the November 15, 2011, Coordinating Committees' meeting, Douglas PUD said that it planned to install HD PIT tag detection arrays in the Wells Dam west adult fish ladder during annual maintenance in December 2011. He said, however, that the installation of HD PIT tag detectors in the west ladder did not occur due to the contractor's failure to deliver essential components of the system in a timely manner. As a result, Douglas PUD was unable to conduct necessary tests for possible interference between the prototype HD and existing full-duplex (FD) systems. Kahler said that Douglas PUD had now focused on installation of HD PIT tag detector arrays in the east fish ladder at Wells Dam, during the longer, biannual maintenance period in 2012. In early January 2012, Douglas PUD contractors began working on design and installation approaches and in-ladder testing and "noise listening" (identifying electromagnetic-field [EMF] interference) related to ensuring that the installation of the HD detectors in the east ladder would not diminish function of the existing FD detectors and vice versa. Kahler explained that there is a problem with the operation of the HD detectors interfering with FD PIT tag readings and with EMF from the FD system overwhelming the HD system. He said that Douglas PUD and the contractors are still discussing options.

IV. Tributary and Hatchery Committees Update (Mike Schiewe)

Mike Schiewe reported that the Tributary Committees met on December 14, 2011 and on January 17, 2012, and discussed the following items. He said that the majority of items discussed at the last two Tributary Committees' meetings were in the category of house-keeping with requests for amendments to projects or adjustment to funding:

- The Mission Creek Passage Structures project was sent back to the project sponsors for application to the General Salmon Habitat Program after the cost of the project rose from $45,000 to over $90,000. Tom Kahler said that the project concept was for the design and placement of permanent log weir structures to be constructed for three irrigators in place of the annual use of push-up dams. A U.S. Bureau of Reclamation (Reclamation) design brought the project cost to about $90,000, exceeding the Small Projects Program fund grant allowance and was rejected. Subsequently, the Natural Resources Conservation Service (NRCS) provided a design with a total cost of under $50,000, which was approved.
- The maximum contract allowance for projects funded by the Small Projects Program fund was raised from $50,000 to $75,000.
- The 2012 schedule for General Salmon Habitat Program funding proposals came out and will be much the same as in past years with final funding coordinated with other

funding entities for approval in November or December.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the most recent Hatchery Committees' meeting on January 19, 2012, by conference call:

- The Hatchery Committees approved a production swap to move Chelan PUD's 60,000 Methow spring Chinook production to the Wenatchee Basin in 2014. This approval was coupled with a Priest Rapids Coordinating Committee (PRCC) agreement that required Grant PUD picked up the production of 60,000 spring Chinook in Methow Basin.
- The Hatchery Committees discussed an analysis of size-at-release for Wenatchee spring Chinook. There is emerging evidence that a reduced size-at-release reduces the number of minijack returns, increases the age-at-return, and reduces straying. The Hatchery Committees asked Chelan PUD for a proposal for adjusting size-of-release and size-at-transfer targets. Chelan PUD's 5-Year M&E Report, which presents this analysis, will be released by February 3, 2012, for a 60-day review by the Coordinating Committees.
- Allyson Purcell, NMFS, gave an update to the Hatchery Committees on the "Mitchell Act EIS" now referred to as the Federal Hatcheries EIS. NMFS plans to have the draft EIS available early in 2012, but more likely it will be available by the summer. NMFS said that to the extent that Hatchery and Genetic Management Plan (HGMP) Biological Opinions could tier off the Federal Hatcheries EIS, NMFS will use the Federal Hatcheries EIS. Craig Busack, NMFS, said that HGMP Biological Opinions would not be delayed by the timing of the release of the final EIS.
- The Hatchery Committees discussed the Hatchery Committees section of the draft 2012 Wells Action Plan.
- The Hatchery Committees discussed the Washington Department of Fish and Wildlife (WDFW) Parental-Based Tagging (PBT) Pilot Study results which sampled fish at Priest Rapids Dam and re-sampled fish at Tumwater Dam for identification of tributary-of-origin. Preliminary analyses suggested poor parental identification; however, additional analyses have suggested an alternate conclusion. The more definitive analysis and conclusions will be presented by Ken Warheit (WDFW) at the February 15, 2012, Hatchery Committees' meeting.
- The Hatcheries Committees completed and approved the 2013 NNI recalculation for

HCP Plan Species, and SOAs were approved in December 2011 for both Douglas and Chelan PUDs' HCP hatchery programs.

V. HCP Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees' meetings are February 28, 2012, March 27, 2012, and April 24, 2012, all in SeaTac, Washington.

B. Document Management Tools (Tom Kahler/Carmen Andonaegui)

Tom Kahler described Douglas PUD's software for managing documents, the Document Management Tool (DMT). He said that the DMT was developed by a Wells relicensing contractor, and adapted to Douglas PUD's needs, to manage all the Wells Project relicensing documents. Kahler described the DMT as a web-based document-management system and repository that could be accessed from anywhere without the need for the user to have the repository software. He said that the DMT worked not only as a document repository, but also allowed for collaborative editing of documents so that multiple persons could work on the same document at the same time. A document could also be set up so that only one document can be checked out and edited at a time. He said that the DMT worked very well and was being used all over the country. Kahler said that he had experience using SharePoint, but that it could not be used for document collaboration, only for document management. He said that he found the search engine in SharePoint to be cumbersome and of very limited use because of the lack of file structure. He said that SharePoint is not designed to allow browsing through file folders; instead, the user must rely on search results that may not return the desired result or may provide so many results as to render the search fruitless. Kahler said that access to files can be controlled and customized with DMT. He provided an annual cost estimate to maintain a new DMT for all HCP committees (Attachment C). He said there would be initial setup costs associated with DMT which are not reflected in the cost estimate but that the setup costs are likely not much. The DMT can be housed at Douglas PUD on servers or at any preferred location.

Carmen Andonaegui described the SharePoint document management tool. She said that there would be a $400 per month cost, covering up to 3.0 GB of storage, for Anchor QEA to manage a SharePoint site for the combined HCP committees. Andonaegui said the HCP ftp site currently stores 1.9 GB of storage. She said that SharePoint allows for multiple logins, document use restrictions, document management, and document storage, but does not allow for document collaboration. It is a reliable, web-based tool, requiring little maintenance other than managing storage space. SharePoint has a document search function and can be set up to provide user alerts when documents are uploaded or edited. Chelan PUD said it uses SharePoint and had no complaints. Bill Tweit said WDFW uses SharePoint, but his experience using it is very limited. Anchor QEA uses SharePoint. Mike Schiewe said that a decision does not need to be made today and asked Kahler if he would prepare a demonstration of DMT for next meeting. Kahler agreed to provide a DMT demonstration at the February 28, 2012, Committees' meeting.

List of Attachments

Attachment A – List of Attendees
Attachment B – Skalski 2011 Rocky Reach Yearling Chinook Survival Study Presentation
Attachment C – Estimated DMT Server Costs

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Carmen Andonaegui	Anchor QEA, LLC
Steve Hemstrom *	Chelan PUD
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Joe Miller	Chelan PUD
Jerry Marco*	Colville Confederated Tribes
Bill Tweit*	WDFW
John Skalski	Chelan PUD Consultant
Bob Rose*	Yakama Nation
Jim Craig*	USFWS

* Denotes Coordinating Committees member or alternate

SURVIVAL AND MIGRATION DYNAMICS OF YEARLING CHINOOK SALMON SMOLTS AT ROCKY REACH DAM IN 2011

J. R. Skalski
R. L. Townsend
University of Washington

T. W. Steig
P. A. Nealson
Hydroacoustic Technology, Inc.

PURPOSE

- Present 2011 yearling Chinook salmon results at the Rocky Reach Project
- Compare survival results over years

GOALS OF STUDY

- Estimate project passage survival at Rocky Reach for yearling Chinook salmon smolts
- Perform evaluation under “waterview” operating conditions with no voluntary spill
- Partition project passage survival into dam and pool components
- Compare diel passage patterns

RELEASE-RECAPTURE DESIGN

STUDY DESIGN: PAIRED RELEASE

Release dates

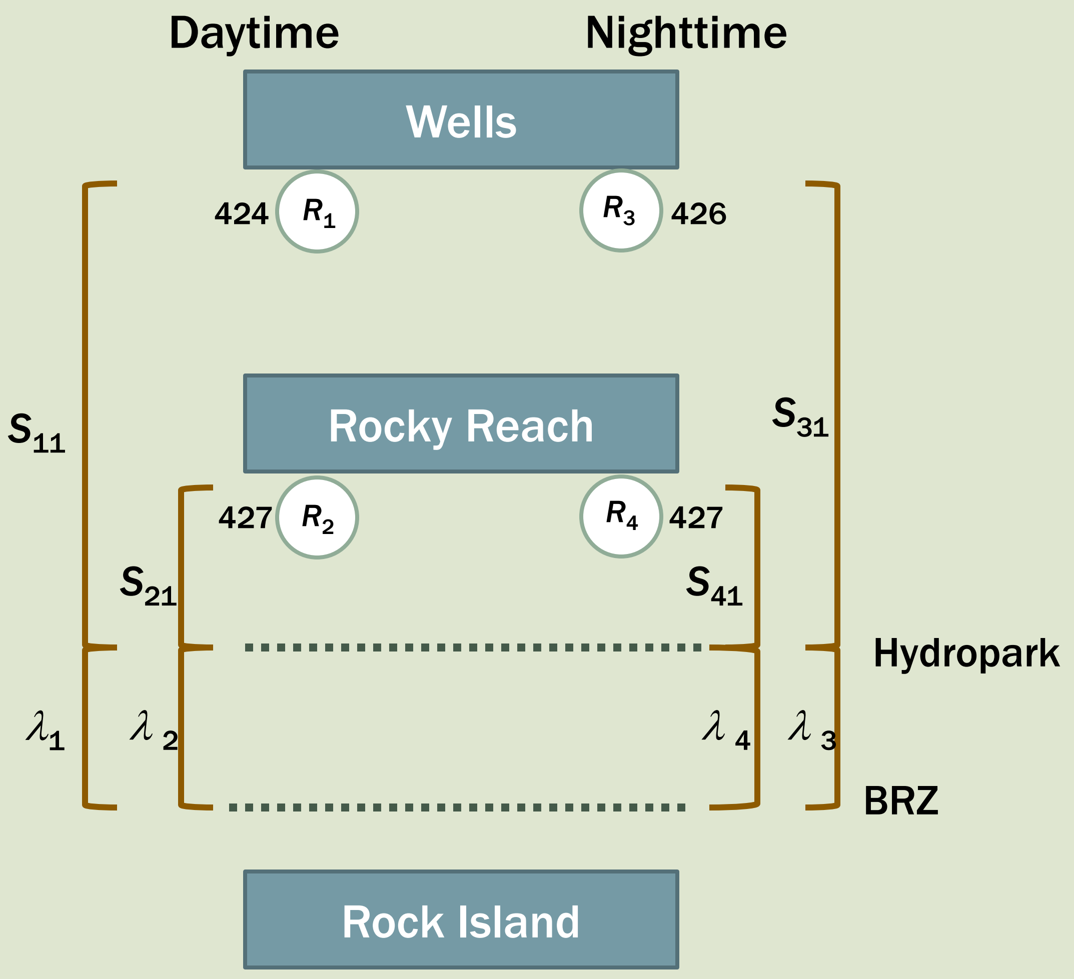
- 25 April - 27 May 2011

Release times

- 1 pm or midnight
- 15 day/15 nighttime

Pool data

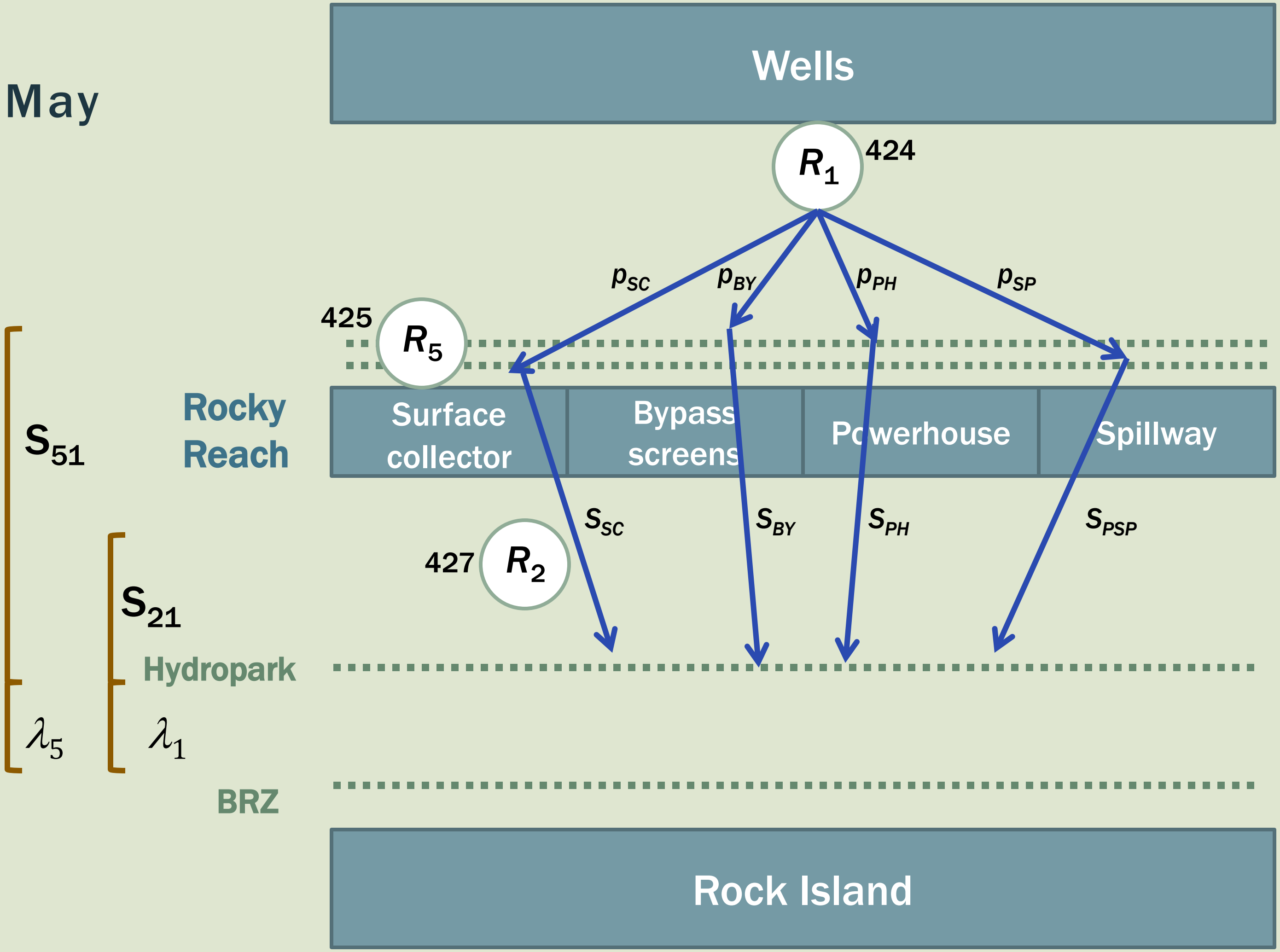
- Day or night
- Season-wide



STUDY DESIGN: TRIPLE RELEASE

Release dates

- 28 April - 26 May 2011
- Daytime only



TRIPLE RELEASE

Triple release used to estimate dam passage survival

- Surface collector survival using releases R_2 and R_5

$$\hat{S}_{SC} = \frac{\left(\frac{r_5}{R_5}\right)}{\left(\frac{r_2}{R_2}\right)}$$

- Relative survival compared to surface collector

$$RS_{BY:SC} = \frac{\left(\frac{n_{BY}}{N_{BY}}\right)}{\left(\frac{n_{SC}}{N_{SC}}\right)};\ RS_{PH:SC} = \frac{\left(\frac{n_{PH}}{N_{PH}}\right)}{\left(\frac{n_{SC}}{N_{SC}}\right)};\ RS_{SP:SC} = \frac{\left(\frac{n_{SP}}{N_{SP}}\right)}{\left(\frac{n_{SC}}{N_{SC}}\right)}$$

ESTIMATES OF SURVIVAL

- Dam passage survival

$$\hat{S}_{\text{Dam}} = \hat{P}_{SC}\hat{S}_{SC} + \hat{P}_{BY}\left(\hat{S}_{SC} \cdot RS_{BY:SC}\right) + \hat{P}_{PH}\left(\hat{S}_{SC} \cdot RS_{PH:SC}\right) + \hat{P}_{SP}\left(\hat{S}_{SC} \cdot RS_{SP:SC}\right)$$

- Pool passage survival

$$\hat{S}_{\text{Pool}} = \frac{\hat{S}_{\text{Project}}}{\hat{S}_{\text{Dam}}}$$

TESTS OF ASSUMPTIONS

TEST FOR TAGGER EFFECTS

- Test for homogeneous survivals
- 0/9 tests of homogeneity significant at $\alpha = 0.10$
- **CONCLUDE:** Use all fish from all taggers

Release site	Release	Tagger	CJS Survival: Release to Beebe Bridge	CJS Survival: Beebe Bridge to RR Boat R. Zone	CJS Survival: RR Boat R. Zone to RI Hydropark
Wells tailrace	Day	#1	0.9825 (0.0123)	0.9643 (0.0175)	0.9630 (0.0182)
		#2	0.9825 (0.0123)	1.0000 (< 0.0001)	0.9732 (0.0153)
		#3	0.9912 (0.0088)	0.9732 (0.0153)	0.9450 (0.0218)
		#4	0.9639 (0.0205)	0.9875 (0.0124)	0.9494 (0.0247)
		P(F-test)	***0.5755***	***0.2327***	***0.7511***
	Night	#1	0.9912 (0.0087)	0.9735 (0.0151)	0.9545 (0.0199)
		#2	1.0000 (< 0.0001)	0.9741 (0.0147)	0.9204 (0.0255)
		#3	0.9911 (0.0089)	0.9820 (0.0126)	0.9541 (0.0200)
		#4	1.0000 (< 0.0001)	0.9881 (0.0118)	0.9639 (0.0205)
		P(F-test)	***0.5677***	***0.8534***	***0.5041***
Rocky Reach SC	Day	#1			1.0000 (< 0.0001)
		#2			1.0000 (< 0.0001)
		#3			0.9821 (0.0125)
		#4			0.9884 (0.0116)
		P(F-test)			***0.3525***
Rocky Reach tailrace	Day	#1			1.0000 (< 0.0001)
		#2			1.0000 (< 0.0001)
		#3			0.9821 (0.0125)
		#4			1.0000 (< 0.0001)
		P(F-test)			***0.1045***
	Night	#1			1.0000 (< 0.0001)
		#2			0.9912 (0.0087)
		#3			1.0000 (< 0.0001)
		#4			0.9884 (0.0116)
		P(F-test)			***0.5613***

TEST FOR TAGGER EFFECTS

- Test for homogeneous tagger effort

Release location	Tagger			
	#1	#2	#3	#4
Wells tailrace (day)	114	114	113	83
RR tailrace (day)	116	115	112	84
			$P\left(\chi_3^2 \geq 0.0216\right) = 0.9992$	
Wells tailrace (night)	114	116	112	84
RR tailrace (night)	115	114	112	86
			$P\left(\chi_3^2 \geq 0.0444\right) = 0.9976$	

TEST FOR TAG-LOT EFFECTS

- Tests for homogeneous survivals

Tag lot	Survival: Release to Rocky Island Hydropark			
	Wells tailrace (day)	Wells tailrace (night)	RR tailrace (day)	RR tailrace (night)
11204	0.9571 (0.0159)	0.9451 (0.0178)	0.9939 (0.0060)	0.9939 (0.0060)
11205	0.8929 (0.0239)	0.9048 (0.0226)	0.9941 (0.0059)	0.9940 (0.0059)
11206	0.9140 (0.0291)	0.9149 (0.0288)	1.0000 (<0.0001)	1.0000 (<0.0001)
11204	0.9571 (0.0159)	0.9451 (0.0178)	0.9939 (0.0060)	0.9939 (0.0060)
P(F-test)	***0.1235***	***0.4958***	***0.6821***	***0.6705***

- 0/4 tests of homogeneity significant at $\alpha = 0.10$
- **CONCLUDE:** Use all tag lots in survival estimation

TEST FOR TAG-LOT EFFECTS

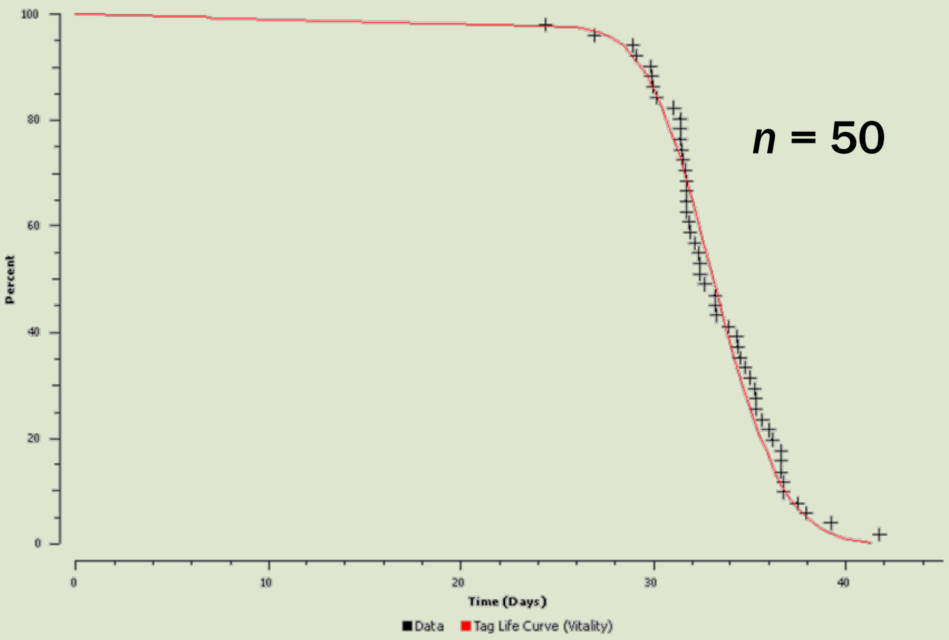
- Test for homogeneous tag-lot usage

Release	Manufacturing lot number		
	11204	11205	11206
Wells tailrace (day)	163	168	93
Wells tailrace (night)	164	168	94
Rocky Reach tailrace (day)	164	170	93
Rocky Reach tailrace (night)	165	168	94
		$P\left(\chi_6^2 \geq 0.0266\right) = 0.9999$	

TAG-LIFE CORRECTIONS

- HTI *Model 795Lm* micro acoustic tags
  - 0.65 g in air
- Vitality curve

  (Li and Anderson 2009)
- $\bar{t}$ = 32.7 days



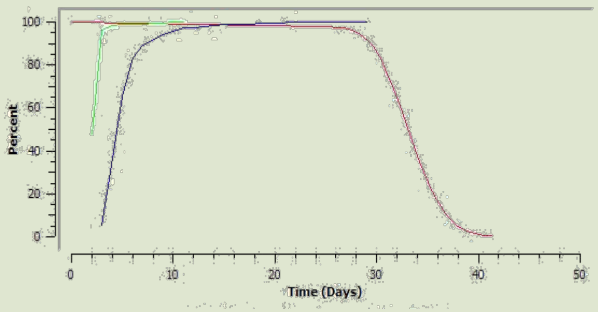
TAG-LIFE CORRECTIONS

- Arrival distributions vs. tag life

Example:

Rock Island BRZ

Daytime releases

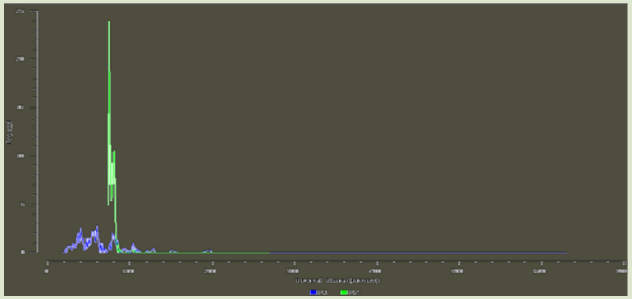


- Probabilities of tags being active

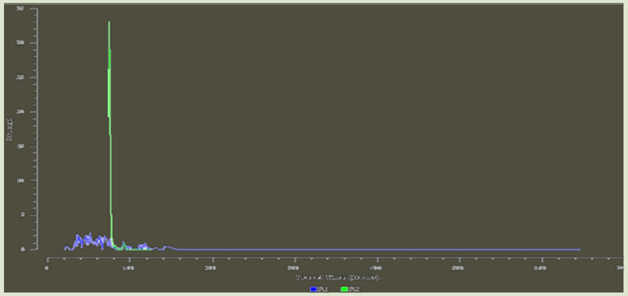
Release time	Release site	Detection site	
		Rock Island Hydropark	Rock Island BRZ
Daytime	Wells tailrace	0.9946 (0.0046)	0.9946 (0.0047)
	Rocky Reach tailrace	0.9972 (0.0024)	0.9970 (0.0027)
Nighttime	Wells tailrace	0.9938 (0.0034)	0.9935 (0.0035)
	Rocky Reach tailrace	0.9970 (0.0018)	0.9965 (0.0021)

DOWNSTREAM MIXING OF RELEASE GROUPS

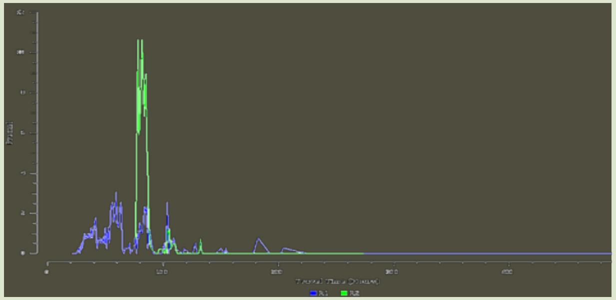
a. Rock Island Hydropark – Daytime releases



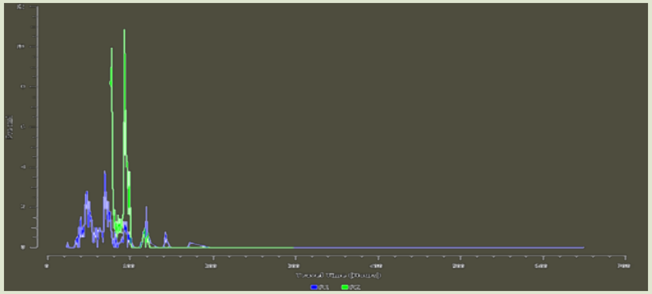
b. Rock Island Hydropark – Nighttime releases



c. Rock Island BRZ – Daytime releases



d. Rock Island BRZ – Nighttime releases



Good mixing achieved

ESTIMATION OF PROJECT PASSAGE SURVIVAL

ESTIMATES OF PROJECT PASSAGE SURVIVAL

- Yearling Chinook Salmon – Study Wide

Daytime releases $\hat{S}_{RR-\text{Day}} = 0.9289 * \left(\widehat{\text{SE}} = 0.0135\right)$

Nighttime releases $\hat{S}_{RR-\text{Night}} = 0.9299 * \left(\widehat{\text{SE}} = 0.0135\right)$

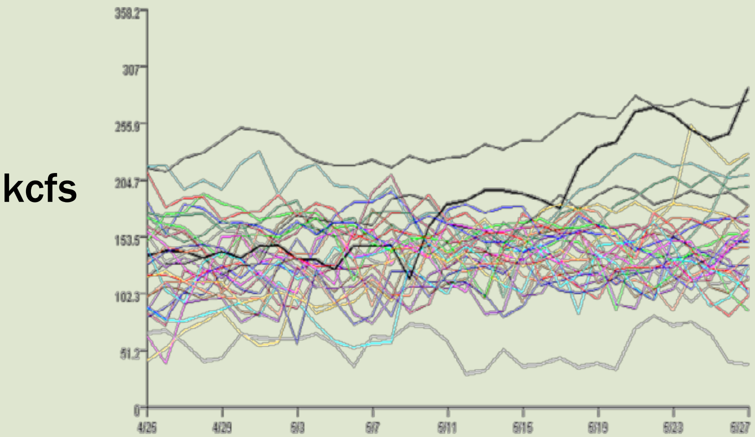
Pooled $\hat{S}_{RR} = 0.9294 \left(\widehat{\text{SE}} = 0.0097\right)$

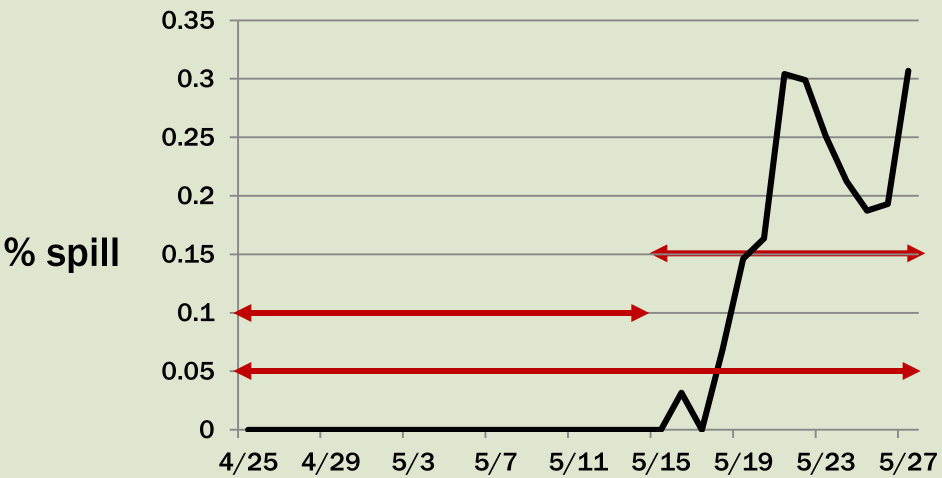
*No significant difference

$$P\left(\left|Z\right| \geq 0.0524\right) = 0.9582$$

FLOW AND SPILL CONDITIONS AT ROCKY REACH DAM – SPRING 2011

Total discharge





SUMMARY OVER DIFFERENT TIME PERIODS

Day and Night Releases Pooled

Period	All fish $(\hat{S})$
Early	0.9161 (0.0125)
Late	0.9560 (0.0143)
Study wide	0.9294 (0.0097)

SUMMARY OVER DIFFERENT TIME PERIODS

Day and Night Releases Pooled

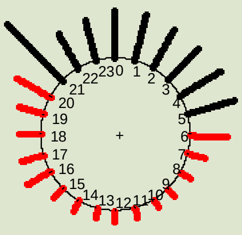
Period	All fish $(\hat{S})$	Spillway detected fish removed	
		#	
Early	0.9161 (0.0125)	0	0.9161 (0.0125)
Late	0.9560 (0.0143)	41	0.9474 (0.0162)
Study wide	0.9294 (0.0097)	41	0.9255 (0.0101)

DIEL PASSAGE

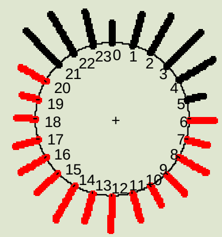
COMPARISON OF 2011 DIEL DISTRIBUTION

Diel Distributions

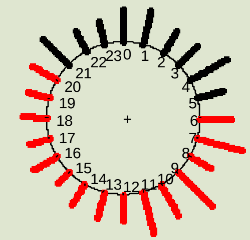
a. Juvenile sampling facility



b. Day releases



c. Night releases

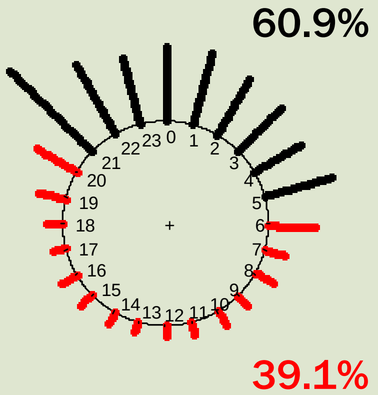


Diel Proportions

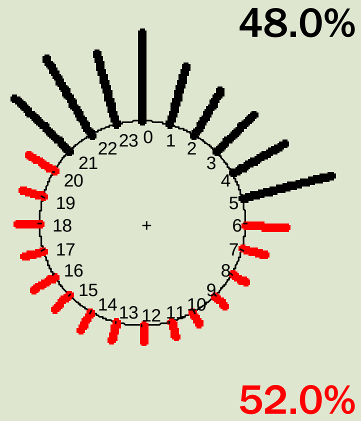
Wells tailrace releases	Proportion of Rocky Reach yearling Chinook salmon passage	
	Day	Night
Day releases	0.5368	0.4632
Night releases	0.6145	0.3855
ROR at Juvenile Sampling Facility	0.4092	0.5908

DIEL PASSAGE DISTRIBUTION AT ROCKY REACH DAM

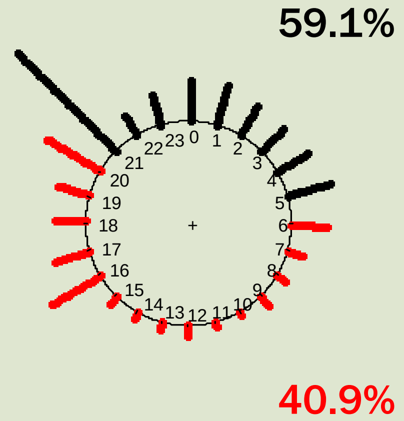
ROR 2009



ROR 2010



ROR 2011



DAM PASSAGE SURVIVAL

DIEL PASSAGE PROPORTIONS AT ROCKY REACH, SPRING 2011

Route	Diel passage proportions		*P*-value (2-tailed)
	Day	Night	
Surface collector	0.3800 (0.0224)	0.2229 (0.0222)	<0.0001
Bypass screens	0.0510 (0.0101)	0.0657 (0.0132)	0.3765
Units 1–2	0.0488 (0.0099)	0.0657 (0.0132)	0.3057
Units 3–11	0.4777 (0.0230)	0.5857 (0.0263)	0.0020
Spillway	0.0425 (0.0093)	0.0600 (0.0127)	0.2662
Total	1.00	1.00	

RELATIVE SURVIVALS (RS)

- Relative survivals (RS) compared to yearling Chinook salmon survival through the surface collector at Rocky Reach Dam

Parameter	Relative survival through the surface collector		*P*-value (2-tailed)
	Day	Night	
$S_{Bypass\ screens}$	1.0170 (0.0099)	1.0130 (0.0131)	0.8075
$S_{Units\ 1\text{-}2}$	0.9286 (0.0604)	0.8809 (0.0720)	0.6118
$S_{Units3\text{-}11}$	0.9492 (0.0193)	0.9487 (0.0211)	0.9860
$S_{Spillway}$	1.0170 (0.0099)	1.0130 (0.0131)	0.8075

ROUTE-SPECIFIC SURVIVAL ESTIMATES

- Route-specific survival estimates during daytime and nighttime passage at Rocky Reach Dam, 2011

Parameter	Absolute survival		*P*-value (2-tailed)
	Day	Night	
$S_{Surface\ collector}$	0.9976 (0.0053)		
$S_{Bypass\ screens}$	1.0146 (0.0113)	1.0106 (0.0141)	0.8248
$S_{Units\ 1\text{-}2}$	0.9264 (0.0605)	0.8788 (0.0720)	0.6128
$S_{Units3\text{-}11}$	0.9469 (0.0199)	0.9464 (0.0216)	0.9864
$S_{Spillway}$	1.0146 (0.0113)	1.0106 (0.0141)	0.8248

DAM PASSAGE SURVIVAL ESTIMATE

Time	$\hat{S}$	$\widehat{SE}$
Daytime	0.9715	0.0103
Nighttime	0.9614	0.0137
Overall (0.4092/0.5908)	0.9642	0.0091
	*0.9621 (0.0097) for non-spill routes	

Pool Passage Survival

$$\hat{S}_{\text{Pool}} = \frac{\hat{S}_{\text{Project}}}{\hat{S}_{\text{Dam}}} = \frac{0.9294}{0.9642} = 0.9639\left(0.0135\right)$$

SUMMARY

CROSS-YEAR SUMMARY

Yearling Chinook Salmon – Rocky Reach Project

Year	Technique	Fish source	Dam operations	$\hat{S}$	$\widehat{SE}$
2004	Acoustic tag	Run-of-river	Waterview	0.9293	0.0196
2005	Acoustic tag	Run-of-river	Waterview	0.9109	0.0179
2010	Acoustic tag	Run-of-river	Waterview	0.9250	0.0142
2011	Acoustic tag	Run-of-river	Waterview	0.9294	0.0097
			Average	0.9237	

THREE-SPECIES SUMMARY ROCKY REACH PROJECT

Species	Year	Technique	Fish source	Dam operations	$\hat{S}$	$\widehat{SE}$
Sockeye	2006	Acoustic tag	Run-of-river	Waterview	0.9331	0.0121
	2008	Acoustic tag	Run-of-river	Waterview	0.9202	0.0212
	2009	Acoustic tag	Run-of-river	Waterview	0.9545	0.0118
				Average	0.9359	
Steelhead	2004	Acoustic tag	Run-of-river	Waterview	0.9833	0.0184
	2005	Acoustic tag	Run-of-river	Waterview	0.9303	0.0134
	2006	Acoustic tag	Run-of-river	Waterview	0.9598	0.0100
				Average	0.9578	
Yearling Chinook	2004	Acoustic tag	Run-of-river	Waterview	0.9293	0.0196
	2005	Acoustic tag	Run-of-river	Waterview	0.9109	0.0179
	2010	Acoustic tag	Run-of-river	Waterview	0.9250	0.0142
	2011	Acoustic tag	Run-of-river	Waterview	0.9294	0.0097
				Average	0.9237	

Estimated Yearly Cost for DMT Server

*** Does not include initial setup costs from Natoma and DCPUD personnel**

Item	Original Cost Per Unit	Num Units Involved	Original Total	Lifespan (yrs)	Original Yearly Cost	Yearly Maint Fee	Total Yearly Cost	Percentage for single server	Yearly Cost For Single Server
Server Hardware	$ 7,500.00	2.00	$ 15,000.00	5.00	$ 3,000.00	$ -	$ 3,000.00	8.50%	$255.00
Storage Hardware	$ 22,700.00	2.00	$ 45,400.00	8.00	$ 5,675.00	$ 1,320.00	$ 8,315.00	1.50%	$124.73
Backup Hardware	$ 41,500.00	2.00	$ 83,000.00	8.00	$ 10,375.00	$ 5,750.00	$ 21,875.00	1.50%	$328.13
Vmware Licenses	$ 4,100.00	2.00	$ 8,200.00	10.00	$ 820.00	$ 1,450.00	$ 3,720.00	8.50%	$316.20
Virtual Center Licenses	$ 3,600.00	1.00	$ 3,600.00	10.00	$ 360.00	$ 1,250.00	$ 1,610.00	1.50%	$24.15
Switches	$ 2,600.00	4.00	$ 10,400.00	10.00	$ 1,040.00	$ 402.00	$ 2,648.00	1.50%	$39.72
Certificate	$ 360.00	1.00	$ 360.00	4.00	$ 90.00	$ -	$ 90.00	100.00%	$90.00
Domain Name	$ 150.00	1.00	$ 150.00	10.00	$ 15.00	$ -	$ 15.00	100.00%	$15.00
RedHat Support	$ -	1.00	$ -	1.00	$ -	$ 675.00	$ 675.00	100.00%	$675.00
In house maintenance	$ 50.00	24.00	$ 1,200.00	1.00	$ 1,200.00	$ -	$ 1,200.00	100.00%	$1,200.00
								Server Costs Per Year	**$720.08**
								Backup Costs Per Year	**$328.13**
								Server Software Costs Per Year	**$780.00**
								Labor Costs Per Year	**$1,200.00**
								Total Costs Per Year	**$3,028.20**

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	April 5, 2012
From:	Michael Schiewe, Chair		
Cc:	Carmen Andonaegui		
Re:	Final Minutes of the February 28, 2012, HCP Coordinating Committees' Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met in SeaTac, Washington, on Tuesday, February 28, 2012, from 9:30 am to 12:30 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Tom Kahler will email the Wells 2011 Gas Bubble Trauma (GBT) Study Report to Carmen Andonaegui for distribution to the Coordinating Committees (Item II-A).
- Tom Kahler will email a photo of the Half-Duplex (HD) Passive Integrated Transponder (PIT) detector installed in the Wells Dam west fish ladder to Jerry Marco (Item II-C).
- Steve Hemstrom will advise the Coordinating Committees whether Chelan PUD supports the use of Douglas PUD's Document Management Tool (DMT) as a document library from where the Committees' members can access HCP documents (Item II-D).
- Lance Keller will email the list of fish recovered during normal maintenance of the Rock Island Dam right fish ladder to Carmen Andonaegui for distribution to the Coordinating Committees (Item III-A).
- Steve Hemstrom will incorporate the 2013 10-Year No Net Impact (NNI) Progress Report into the Rocky Reach and Rock Island HCP Action Plan, including timelines (Item III-D).
- Steve Hemstrom will look into updating Peven et al. 2004 (Item III-E).

DECISION SUMMARY

- The Coordinating Committees approved the 2012 Wells HCP Action Plan (2012 Action Plan) as revised (Item II-B).

REVIEW ITEMS

- The Draft Rock Island and Rocky Reach 2012 HCP Action Plan is out for a 30-day expedited review. Comments are due to Steve Hemstrom by March 1, 2012.
- The Draft 2012 Rocky Reach Fish Bypass Evaluation Study Plan is out for a 30-day expedited review. Comments are due to Lance Keller by March 9, 2012.
- The Draft 2011 Chelan PUD Predator Control Report is out for a 60-day review. Comments are due to Lance Keller by March 24, 2012.
- The Draft 2011 Rocky Reach Juvenile Fish Bypass System Report is out for a 60-day review. Comments are due to Lance Keller by March 26, 2012.
- The Draft 2012 Wells Bypass Operations Plan is out for a 30-day expedited review. Comments are due to Tom Kahler prior to the next Coordinating Committees' meeting on March 27, 2012.

REPORTS FINALIZED

- Tom Kahler will finalize the 2012 Action Plan and email it to Carmen Andonaegui for distribution to the Coordinating Committees (Attachment B).
- The 2011 Rocky Reach Yearling Chinook Survival Study report was finalized on February 17, 2012, and emailed to the Coordinating Committees on February 29, 2012.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees' members and asked for any additions or changes to the agenda. Steve Hemstrom added to the agenda a briefing on the Fish Passage Center's (FPC's) Public Records Request to Chelan PUD, and a discussion of the Draft 2012 Rocky Reach and Rock Island HCP Action Plan.

The Committees reviewed the revised draft January 20, 2012, meeting minutes. Tom Kahler provided editorial comments to item II-A of the meeting minutes, which he will email to Carmen Andonaegui to include in the minutes. The draft January 20, 2012, meeting minutes were approved as revised. Andonaegui will finalize the meeting minutes and distribute them to the Committees.

II. Douglas PUD

A. Draft 2012 Wells Dam Bypass Operations Plan (Tom Kahler)

Tom Kahler said that the Draft 2012 Wells Dam Bypass Operations Plan (Wells Bypass Operations Plan) was similar to the 2011 Wells Bypass Operations Plan with only minor changes. The changes included the adjusted start and end dates for bypass operations previously approved by the Coordinating Committees and changes to the last paragraph of the Wells Bypass Operations Plan to reflect changes in criteria for bypass barriers removal for total dissolved gas (TDG) compliance. Bryan Nordlund noted that the U.S. Army Corps of Engineers (USACE) had indicated that it plans to test spill at Chief Joseph Dam in 2012. Steve Hemstrom said that Chelan PUD was working to schedule a meeting with USACE and other involved parties for the end of March 2012 to discuss the issue. Jerry Marco asked if Douglas PUD used juvenile sampling results from the Rocky Reach Dam juvenile fish bypass to evaluate GBT occurrences for Wells Dam. Steve Hemstrom confirmed that this was the case. Marco referred to the elevated TDG levels coming out of Grand Coulee Dam in 2011 (144 percent). He said that there needs to be a discussion about how to reduce TDG levels in the Wells forebay given the 10-year turbine maintenance schedule at Grand Coulee Dam. Kahler said that he would email a copy of the Wells 2011 GBT Study Report to Carmen Andonaegui for distribution to the Coordinating Committees. He said that the new bypass operation dates will be implemented in 2012 as approved by the Committees on November 15, 2011. Wells Project 2012 bypass operations will commence on April 9, 2012, instead of April 12 as in 2011, and be discontinued August 19, 2012, instead of August 26 as in 2011. Kahler said that he would request approval of the Draft 2012 Wells Bypass Operations Plan at the March 27, 2012, Committees' meeting and said that comments could be provided to him up until the March meeting date.

B. 2012 Wells HCP Action Plan Approval (Tom Kahler)

Tom Kahler said that changes recommended by the Hatchery Committees had been made to the revised draft 2012 Action Plan emailed to the Coordinating Committees on February 10,

2012. He asked for Coordinating Committees' approval of the 2012 Action Plan as revised. The Committees approved the 2012 Action Plan as revised. Kahler will finalize the 2012 Action Plan and email it to Carmen Andonaegui for distribution to the Committees.

C. West Ladder HD-PIT Detection System Installation (Tom Kahler)

Tom Kahler said that Douglas PUD had intended to install the HD detection system in the east fish ladder at the Wells Project during the early December 2011 normal maintenance outage; however, the contractor, Biomark, was moving its manufacturing facility during that period and was not able to build the detection array antennae as required. Kahler said Douglas PUD also was not able to get the 2020 HD detection receiver, which is required to operate the system. In the west fish ladder, an HD detector array was installed in pool 19 during January 2012. Pool 19 is above the maximum tailrace elevation ensuring that migrating adult lamprey will be forced to pass through the detection array (because they are averse to passing via the overflow weirs). Additional detection arrays will be installed in west ladder in December 2012 and HD detection will be installed in the east ladder in January 2013. Kahler will email to Jerry Marco the photograph of the HD detector installed in pool 19 of the west ladder that was provided to Coordinating Committees' members at today's meeting.

D. Document Management Tool Demonstration and Discussion (Tom Kahler)

Tom Kahler said that Douglas PUD intends to use the DMT to create a repository for its HCP-related documents for its internal use. He said that Douglas PUD was willing to make this repository available to the Coordinating Committees for the Committees' use as well. Kahler asked if this would also meet Chelan PUD's needs, making it a single location where all Coordinating Committees members could access all HCP documents. Steve Hemstrom asked whether all files contained in the DMT would be open to a public records request. Kahler replied that he did not know the answer. He gave a brief demonstration of the DMT file structure saying it could function as a library only but that it also allowed for collaborative document revision. Mike Schiewe summarized that the objective for the Committees was to find an alternative to the existing HCP file transfer protocol (ftp) site for storage and management of HCP documents. At the January 20, 2012, Committees' meeting, SharePoint was presented along with the DMT as possible alternatives.

The Committees discussed which documents created within the HCP committees would be available to the public. Schiewe said that only final documents (such as final meeting minutes, study reports, Statements of Agreement [SOAs], and agendas) should be made available to the public and that working versions of documents should be located in a place not accessible to the public. Hemstrom said that Chelan PUD would want a backup of all documents, not just a repository for final documents. Teresa Scott said that she would like a filing system that clearly indicated which documents were subject to discussion for a given meeting. Bryan Nordlund said that he would like a site that provided a consistent filing structure. Kahler said that SharePoint would not meet Douglas PUD's needs and that they will set up a DMT repository for its HCP-related documents. Schiewe asked if Chelan PUD would be supportive of using the DMT as a library for the Committees. The site would be available through the Internet and accessible only by password. Schiewe said that filing structure could allow for some flexibility among HCP committees. Nordlund said that Grant PUD has recently developed a new filing structure for organizing and storing the Priest Rapids Coordinating Committee (PRCC) documents. He suggested that the Committees could hyperlink documents in the HCP library to references in HCP annual reports. The Committees discussed the possibility of including email correspondences in the HCP repository and which categories of emails may or may not be appropriate to archive. Schiewe said that a formal agreement would be necessary in regards to storing emails or email content. Hemstrom said that he would inquire into whether Chelan PUD would be willing to use the DMT as its library for HCP documents. Schiewe said that after a new file storage alternative is selected, the next step would be to discuss document filing structures.

III. Chelan PUD

A. Rocky Reach and Rock Island Fishways Dewatering and Fish Recovery Summary (Lance Keller)

Lance Keller said that at the January 20, 2012, Coordinating Committees' meeting, Steve Hemstrom reported the incidence of fish stranding and mortalities during routine fishway dewatering and maintenance activities at the Rocky Reach Project. He said that the HD PIT-tag detection arrays had been installed as planned in the Rocky Reach fishways along with other scheduled modifications. Keller said that Rocky Reach was being re-watered and would be fully watered by the March 1, 2012, deadline. He reported that Chelan PUD began dewatering the Rock Island left fish ladder on January 5, 2012; two wild steelhead were recovered during dewatering. Staff was able to do required maintenance, and the left fish ladder was re-watered February 3, 2012. Keller said that the center fish ladder at Rock Island was dewatered beginning January 12, 2012, with the right fish ladder remaining open to allow adult fish passage. He said that the center fish ladder was the fishway receiving the major overhaul for 2012. One wild juvenile steelhead was rescued from the center fish ladder. The outage for the center ladder used the entire outage period through February 2012 to ensure that all routine work was performed, and work to procure and replace a unique set of butterfly valves in the Rock Island center ladder auxiliary water supply system. The center fishway will be re-watered February 29, 2012, before the March 1, 2012 deadline. The upper end of the right fish ladder was dewatered on February 8, 2012, and the lower end on February 10, 2012. Keller said that the right fish ladder was the ladder that receives the most use. He provided the list of species recovered during dewatering and maintenance of the right fish ladder and will email a copy of the list to Carmen Andonaegui for distribution to the Committees (Attachment C). Keller said that the right fish ladder would be re-watered by Thursday, February 23, 2012.

B. Draft 2012 Rocky Reach Fish Bypass Evaluation Study Plan (Lance Keller)

Lance Keller said that the draft 2012 Rocky Reach Fish Bypass Evaluation Study Plan included tasks to be accomplished by Chelan PUD in 2012 during the operation of the juvenile bypass. He said that no survival studies were required in 2012, but that routine index sampling of juvenile fish would start April 1, 2012. Keller briefly described the routine indexing procedures. He said that all fish would be interrogated for PIT tags. Bob Rose indicated that the Yakamas might want to take tissue samples for genetic analysis from lamprey captured in the fish bypass. Keller said that there were no changes to the operations of the fish bypass other than that there would be no 24-hour sampling in 2012. Comments on the draft 2012 Rocky Reach Fish Bypass Evaluation Study Plan are due to Keller by March 9, 2012.

C. Pacific Lamprey Fishway Passage Improvements and Half-duplex PIT Antenna Installation (Steve Hemstrom)

Steve Hemstrom said that HD detectors have been installed at Rocky Reach dam as planned. He said that the Rocky Reach Fish Forum toured both dams last week. HD detectors are installed in both the fish ladder exists and in additional locations in Rocky Reach Dam. Hemstrom offered an open invitation to Coordinating Committees' members to tour Rocky

Reach Dam. He reported that the planned improvements to the fish ladders for lamprey were progressing well.

D. Draft 2012 Rock Island and Rocky Reach HCP Action Plan (Steve Hemstrom)

Steve Hemstrom said that the draft 2012 Rock Island and Rocky Reach HCP Action Plan described activities for all the HCP committees. He said that planned activities for 2012 were the same as for 2011, with the exception that no survival studies are planned for 2012. Hemstrom said Coordinating Committees' activities totaled 14. Predator control programs are planned for 2012 with the option for extending long-line fishing later into the year. Lance Keller said that predator control activities will start in February 2012 and extend through October 2012. Mike Schiewe asked if Chelan PUD was required to complete an HCP Plan Species status report similar to that required of Douglas PUD, and if so, he said it should be included in Chelan PUD's 2012 HCP Action Plan. Hemstrom agreed to incorporate the required 2013 10-Year NNI Progress Report into the Rocky Reach and Rock Island HCP Action Plan, including timelines. Tom Kahler said that for the Wells Project, Douglas PUD would be referencing the August 2011 federal agencies' Endangered Species Act (ESA)-listed species status updates, with additional information from the 5-Year Monitoring and Evaluation (M&E) analyses.

Jim Craig asked if Chelan PUD saw an increase in pikeminnow migration in the fall after fish ladder trapping operations are halted in August. Hemstrom said that July is typically the busiest month for adult pikeminnow migration, with the right ladder at Rock Island seeing the heaviest use for both salmon and pikeminnow. Keller said that pikeminnow trapping normally shuts down in September so that staff can turn its attention to spawning ground surveys, but in 2012 trapping did not occur at all due to the large adult sockeye return that overlapped with the pikeminnow migration

Teresa Scott said that she thought the FPC's comprehensive survival study (CSS) intersected with the PUDs' HCP 10-Year Plan Species status check-in. But, she also thought that the CSS was independent from the National Marine Fisheries Service (NMFS) Fish Science Center's species status reviews, which evaluate all viable salmonid population (VSP) parameters and include an evaluation of hatchery survival. Bob Rose said that the FPC wants to evaluate whether survival of juvenile salmonids detected migrating out of the Upper Columbia are "adequate" based on the numbers of returning adults. Scott said that the next

FPC CSS meeting is scheduled for April 12, 2012, for a discussion of study results and conclusions. Rose said that the Committees might want to review the CSS analysis to determine whether it should be incorporated into the HCP 10-Year Plan Species status update. Scott asked how the CSS was similar or different from what was required of the PUDs by their HCPs. Mike Schiewe said that when the CSS began in the late-1990s, the FPC was initially focused on evaluating reach survivals of hatchery releases. Scott said that Michelle DeHart, manager of the FPC, was willing to present a summary of CSS results to the Committees. Scott encouraged Committees' representatives to attend the April 12, 2012, CSS meeting and then to consider inviting DeHart to present the CSS results and answer questions at a future Committees' meeting.

E. Fish Passage Center Public Records Request (Steve Hemstrom)

Steve Hemstrom said that on February 20, 2012, Michelle DeHart requested copies of all Chelan PUD's survival study reports. Hemstrom said he sent DeHart a compact disk containing 31 Adobe Acrobat files of 26 survival study reports conducted from 2003 through 2011. He said that Dehart had said that the FPC was looking at what she called a disparity between the PUDs' survival estimates and survival estimates based on analysis of PIT tag data. She said the focus was mostly on the Rock Island Project since most juvenile spring Chinook, steelhead, and sockeye were PIT-tagged at Rock Island. DeHart said that she was also looking at all PIT-tagged hatchery fish. He said that DeHart was looking into whether there was a positive bias for survival using acoustic-tagged fish. Josh Murauskas and Hemstrom said that they will be attending the FPC's April 12, 2012, CSS meeting.

Bryan Nordlund noted that the FPC tended to favor the use of PIT tags over acoustic tags to estimate survival of run-of-the-river fish. He said that the CSS looked at smolt-to-adult returns (SARs) using PIT tag data; whereas, the PUDs focused on evaluating Project survival and therefore used acoustic tags. Schiewe suggested Committees' members look at the FPC webpage for copies of recent CSS reports. Hemstrom mentioned an unpublished 2007 U.S. Geological Services (USGS) study comparing the performance of acoustic tags versus PIT tags for use in survival studies, which can probably be located on the Internet. The Committees discussed the available literature comparing the use of acoustic- versus PIT-tagged juvenile salmonids for survival studies. Nordlund noted that within the next couple of years, Chelan PUD should think about updating Peven et al. 2004, to include information on the design of acoustic tag survival studies used by the Chelan and Douglas PUDs. Hemstrom agreed and said he would look into what it would take to accomplish the update. Schiewe said that the Committees would be well represented at the CSS April 12, 2012, meeting and that after the meeting they should reconsider if there are outstanding issues to discuss and if they would like to invite DeHart to attend a future Committees' meeting.

IV. Tributary and Hatchery Committees Update (Mike Schiewe)

Mike Schiewe reported that the Tributary Committees met on February 9, 2012, and discussed the following items:

- The 2012 HCP Tributary Account funding levels are $673,000 for Rock Island, almost $319,000 for Rocky Reach, and $244,500 for the Wells Project.
- The Tributary Committees raised the maximum funding limit for Small Projects Programs from $75,000 in 2011 to $100,000 for 2012. The Small Projects Program grants were originally set at a maximum funding level of $25,000, but were increased to $50,000 in 2007 and to $75,000 in 2011.
- The Wells and Rocky Reach Tributary Committees approved $250,000 in funding for a project to protect acreage on the Methow River downstream of Twisp.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the most recent Hatchery Committees' meeting on February 15, 2012, at Chelan PUD's headquarters building:

- Chelan PUD's 5-Year M&E Report is out to the Coordinating Committees for a 60-day review; the Douglas PUD 5-Year M&E Report is almost ready for review. Based on results of the 5-Year M&E Reports, the Hatchery Committees are already considering changes to hatchery programs, such as changing the size-of-release targets for Chiwawa spring Chinook.
- The Wells 2012 HCP Action Plan was approved by the Hatchery Committees at the February meeting. The Hatchery Committees added the modernization of the Wells Hatchery and Hatchery Committees' recommended check-ins to allow for periodic input on the progress of the modernization.
- Ken Warheit, Washington Department of Fish and Wildlife (WDFW), gave a presentation to the Hatchery Committees on parental assignment as a tool for managing spring Chinook in the upper Wenatchee Basin. The results as first presented were not encouraging; however, Warheit's interpretation of the results

showed that parental assignment works, but that the problem may be in getting a large enough sample size collected at Priest Rapids Dam to allow use of the tool. No decisions were made by the Hatchery Committees at this time as to whether to continue with using parental assignment to help with broodstock selection for upper Wenatchee stocks, but it does not look like enough fish can be sampled at Priest Rapids to make this tool effective. The alternative to collecting fish at Priest Rapids Dam is to sample adults at Tumwater Dam (TWD) and hold the sampled adults onsite until the samples can be analyzed and the results returned. The Hatchery Committees will look into the feasibility of using this option. Both Teresa Scott and Bryan Nordlund mentioned the possible negative effect of multiple trapping of returning adults during the migration.

- Maureen Hess, Columbia River Intertribal Fisheries Commission (CRITFC), gave a presentation to the Hatchery Committees on the Snake River parental-based tagging (PBT) program. Hess said CRITFC hoped to expand the collection of genetic samples to the upper Columbia as part of a regional PBT program. She said that the program goal was to collect tissue samples for all Columbia River hatchery steelhead and spring Chinook and asked for the participation of upper Columbia River hatchery operators by collecting and archiving samples. The Hatchery Committees were generally receptive to the program, saying that they were mostly already collecting genetic samples from broodstock and archiving them. Jim Craig said that the U.S. Fish and Wildlife Service (USFWS) did not routinely collect genetic samples at their hatcheries.
- The Yakama Nation introduced the idea of using the Hatchery Evaluation Technical Team (HETT), a subgroup of the Hatchery Committees, to develop a strategy for the use of distributed acclimation for salmon and steelhead hatchery fish in the upper Columbia. The Yakama Nation has pioneered the use of distributed acclimation using coho; since those initial efforts, the Hatchery Committees approved the use of Blackbird Pond for acclimating steelhead and approved co-acclimating coho and steelhead at Rohfling Pond and steelhead and spring Chinook at Twisp Pond. The Yakama Nation would like the Hatchery Committees to develop a long–term approach to distributed acclimation rather than continue with annual approvals. Bob Rose said that he hoped acclimation sites considered would be located in areas with suitable quantities and quality of spawning and rearing habitat. He asked about available information on returns from remote acclimation sites. Schiewe said that the

Yakama Nation was leading the use of remote acclimation and that it is still early for conclusive results. Rose said that a connection should be made to the Tributary Committees funding of habitat restoration and protection projects. Schiewe said that Keely Murdoch had drafted a proposal for the Hatchery Committees to consider assigning to the HETT, requesting their consideration of the role of remote acclimation in improving fish returns. Tom Kahler said that questions to evaluate when considering expanding spawning distribution included targets for ratios of wild-to-hatchery fish on the spawning grounds, and whether it is desirable to extend hatchery fish spawning beyond where they are currently spawning and into strongholds of wild spawners. Hemstrom said that it would be useful to look at other hatchery programs, like in the Clearwater drainage where a goal is to get as many hatchery fish returning to the Lochsa River as possible by planting hatchery fish.

- Craig Busack, National Oceanic and Atmospheric Administration (NOAA), updated the Hatchery Committees on permitting of Hatchery Genetic Management Plans (HGMPs) for Upper Columbia River hatchery programs. NOAA is now reviewing the USFWS and Douglas PUD Methow Basin HGMPs.
- The 2012 Rocky Reach and Rock Island HCP Action Plans are out for a 30-day review with comments to Chelan PUD by March 1, 2012, for approval at the next Hatchery Committees meeting on March 28, 2012.
- The Hatchery Committees discussed Chiwawa spring Chinook size-at-release targets. The draft Chelan PUD 5-Year M&E report suggests that the 12 fish-per-pound (fpp) target was producing more mini-jacks and more straying without increasing the number of returning adults. Hatchery managers will need to look at size-of-transfer to get to a release size of the proposed 18 fpp size-at-release target. The Hatchery Committees are mostly supportive of the proposed change in targets; additional information on feeding rates and other factors related to changing size-at-release will be provided at the next Hatchery Committees' meeting on March 28, 2012.
- The Hatchery Committees discussed the HETT's progress in addressing Objective 10 of the PUD Hatchery M&E programs: Non-target Taxa of Concern (NTTOC), one of three regional M&E program objectives. Objective 10 requires the PUDs to look at interactions between hatchery fish and native fish species. The evaluation has become very involved and the HETT has reported that it will likely be another year before the process is completed. It is expected that the information from the NTTOC evaluation will allow for managing supplementation programs to avoid or minimize

impacts on NTTOC. Schiewe said that the Hatchery Committees will be careful to include timelines in future requests to the HETT to develop a strategy for long-term distributed acclimation of hatchery program fish in the Upper Columbia.

- The HETT has completed the reference stream selection methods analysis assigned to it by the Hatchery Committees. The reference stream selection methods write up has been included as an appendix to both the Chelan and Douglas PUDs' 5-Year M&E reports.
- USFWS announced that all upper Columbia hatchery spring Chinook would be externally marked beginning with the 2012 release. The agreement was reached working through the *U.S. v OR* forum.

V. HCP Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees' meetings are March 27, 2012, April 24, 2012, and May 22, 2012, all in SeaTac, Washington.

List of Attachments

Attachment A – List of Attendees
Attachment B – Final Wells 2012 HCP Action Plan
Attachment C – 2012 Rock Island Adult Fish Ladder Rescue Summary

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Carmen Andonaegui	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Jerry Marco*†	Colville Confederated Tribes
Teresa Scott*	WDFW
Bryan Nordlund*	NMFS
Bob Rose*	Yakama Nation
Jim Craig*	USFWS

*Denotes Coordinating Committees member or alternate
†called in to the meeting

2012 ACTION PLAN
WELLS HCP

WELLS HCP COORDINATING COMMITTEE

1. Bypass Operating Plan

a. Draft to Coordinating Committee (CC): .... February 2012
b. Approval deadline: .... March 2012
c. Period of implementation: .... April 9 to August 19, 2012
d. Report deadline: .... October 2012

2. 2013 NNI Progress Report (per Wells HCP §6.9)

a. Douglas/CC develop report outline .... March 2012
b. CC provides direction on status update for Plan Species .... May 2012
c. Douglas submits Draft NNI Progress Report to the CC .... March 2013

3. Predator Control Programs

a. Pikeminnow removal – Wells Project: .... March – August 2012
b. Draft 2011 pikeminnow report to DCPUD: .... January 2012
c. 2011 pikeminnow report internal review and submission to CC: .... February 2012
d. Avian predator hazing at Wells: .... October 2011 – May 2012

4. Sub-yearling Chinook Life-history Study

a. Draft 2011 report to CC: .... February 2012
b. Final 2011 report: .... April 2012
c. Update study plan: .... January-April 2012
d. Tag and release study fish: .... June-July 2012
e. Monitor study fish: .... through life cycle
f. Draft 2012 report to CC: .... February 2013
g. Final 2012 report: .... April 2013

5. Annual Monitoring of Juvenile Migration Run Timing

a. Skalski analysis of index data from RR: .... September 2012
b. Draft of Skalski's report to DCPUD: .... September 2012
c. Final report presented to CC: .... October 2012

6. Installation of HDX PIT-tag Detection System at Wells Dam

a. Contractor noise testing and site analysis .... January 2012
b. Fabrication and installation of partial system in the west ladder .... January/February 2012
c. Complete installation in the west ladder .... December 2012
d. Complete installation in the east ladder .... January/February 2013

7. Lamprey Entrance Efficiency Study

a. Study plan .... June 2012
b. Conduct velocity test and efficiency study .... July – August 2012
c. Draft report .... November 2012
d. Final report .... February 2013

WELLS HCP HATCHERY COMMITTEE

1. Implement 5-year Hatchery Monitoring and Evaluation (M&E) Plan

a. Ongoing implementation: ....January – December 2012
b. Draft annual report for 2011 to Douglas PUD:.. June 2012
c. Draft annual report to Hatchery Committee (HC): ....July 2012
d. Final annual report to HC: ....October 2012
e. Draft 5-year synthesis/analysis report to HC: .... February 2012
f. Final 5-year synthesis/analysis report:.. April 2012
g. Draft 2013 implementation plan to HC: ....October 2012

2. Review and Update 5-year M&E Plan (per Wells HCP §8.5.1 and 8.8)

a. Draft to HC: ....July 2012
b. Final to HC:...October 2012

3. 2013 Hatchery Program Review (per Wells HCP §8.8)

a. Data and analyses for the Hatchery Program Review are contained within several existing documents or documents scheduled for completion in 2012:
    1. Douglas 5-Year M&E Report (to HC in 2012) addresses all aspects of the Hatchery Program Review for Methow Hatchery spring Chinook and Wells Hatchery steelhead and summer Chinook.
    2. Chelan 5-Year M&E Report (to HC in 2012) addresses all aspects of the Hatchery Program Review for Carlton Pond summer Chinook.
    3. Hatchery M&E annual reports (2003-2011) provide detailed data necessary for the Hatchery Program Review.
    4. Methow Spring Chinook HGMP (2010) included thorough review of the program and redesigned the program based on the review.
    5. Wells Complex Summer Steelhead HGMP (2011) included thorough review of the program and redesigned the program based on the review.
    6. Adjustment of hatchery compensation (2011) conducted review and assessment of SARs, adults returns, hatchery and natural smolt production.
    7. Fish-Water Management Tool (FWMT) Progress Report (Hyatt et al. in prep) provides an analysis of the multi-year data set to determine the contribution of FWMT implementation to average production of Okanagan sockeye.

b. HC directs the development of summary report:..................................June – August 2012
c. HC reviews draft summary report: ....September – October 2012
d. Final summary report to HC: .... December 2012
e. Final summary report from HC to CC: .... January 2013

4. 2012 Broodstock Collection Protocol

a. Draft to HC: .... March 2012
b. Approval deadline:... April 2012
c. Implementation: ....May 2012 to April 2013

5. Annual Implementation Report - Sockeye Fish/Water Management Tools

a. Period covered: ....Water Year 2011-2012 (October – September)
b. Draft to HC: ....*to be determined*

c. Presentation to HC: .... August or September 2012
d. Draft 2013 FWMT progress report to Douglas PUD: .... August 2012
e. Draft 2013 FWMT progress report to HC: .... October 2012
f. Final 2013 FWMT progress report to HC: .... December 2012
g. HC delivers final 2013 FWMT progress report to CC: .... January 2013

6. HGMP – Methow Spring Chinook

a. Draft Spring Chinook HGMP to HC: .... Complete November 2009
b. Final Spring Chinook HGMP to NMFS: .... Completed March 2010
c. NMFS approval of Spring Chinook HGMP: .... *to be determined*

7. HGMP – Wells Steelhead

a. Draft Steelhead HGMP to HC: .... Completed February 2011
b. Final Steelhead HGMP to NMFS: .... Completed March 2011
c. NMFS approval of Steelhead HGMP: .... *to be determined*

8. Methow Steelhead Relative Reproductive Success Study

a. Implementation: .... March 2010 - December 2021
b. Interim reports: .... September 2012
c. Final report: 2021/2022

9. Wells Hatchery Modernization

a. Update on rearing criteria and Master Plan: .... December 2012
b. Provide updates to the HC .... Monthly
c. Provide opportunities for HC input .... Periodically

WELLS HCP TRIBUTARY COMMITTEE

1. **Plan Species Account Annual Contribution**
   a. $176,178 in 1998 dollars..January 2012

2. **Annual Report - Plan Species Account Status**
   a. Draft to Tributary Committee (TC): ....February 2012
   b. Approval Deadline:..March 2012
   c. Period Covered: ....January to December 2011

3. **2012 Funding-round – General Salmon Habitat Program**
   a. Request for project pre-proposals:........................... *To be determined* (typically in March)
   b. Pre-proposals to TC: .... *To be determined* (typically in early May)
   c. Tours of proposed projects: ....*To be determined* (typically in late May)
   d. Project sponsor presentations to TC: .... *To be determined* (typically in early June)
   e. Final project proposals to TC:............................*To be determined* (typically in early July)
   f. RTT project rating decisions:.......................................*To be determined* (typically in July)
   g. Supplemental sponsor presentations..*To be determined*
   h. TC final funding decisions:......................... *To be determined* (typically before December)

4. **Small Project Program**
   a. Project review and funding decision.................................. Applications accepted any time

5. **Tributary Assessment Program**
   a. Proposal to TC for year-5 of 5 for ORRI monitoring ....July 2012
   b. Develop monitoring plan for remaining funds...March 2012
   c. Implement monitoring plan..*To be determined* (2012)
   d. Monitoring plan final product...December 2012
   e. TC delivers final product to CC...January 2013

2012 Rock Island Adult Fish Ladder Rescue Summary:

Left Ladder

Ladder De-Watered: January 5th, 2012
Fish Rescued: 2 wild juvenile steelhead/rainbows
Ladder Back in Operation: February 3rd, 2012

Center Ladder

Ladder De-Watered: January 12th, 2012
Fish Rescued: 1 wild juvenile steelhead/rainbow
Ladder Back in Operation: March 1, 2012

Right Ladder

Ladder De-Watered: February 8th, 2012 (upper portion), February 10th, 2012 (lower portion)
Fish Rescued:

- Clipped Adult Steelhead: 1
- Ad-Present Adult Steelhead: 4
- Ad-Present Steelhead 12-18": 5
- Ad-Present Juvenile Chinook: 2
- Ad-Present Steelhead Parr: 1
- Whitefish: 5
- Burbot: 1
- Sculpin: 1
- Lamprey Macrophthalmia: 5
- Lamprey Macrophthalmia (mortalities): 2

Ladder Back in Operation: February 23rd, 2012

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	April 24, 2012
From:	Michael Schiewe, Chair		
Cc:	Carmen Andonaegui		
Re:	Final Minutes of the March 27, 2012, HCP Coordinating Committees' Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met in SeaTac, Washington, on Tuesday, March 27, 2012, from 9:30 am to 12:00 pm. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Bryan Nordlund will review Peven et al., 2005, and prepare a list of how the juvenile survival study protocols used in the 2011 Chelan PUD survival study differed from the survival study protocols in Peven et al. (2005) (Item I-B).
- Steve Hemstrom will set up a conference call with Douglas PUD to discuss the shared use of Douglas PUD's data management tool (DMT) for use by the Coordinating Committees (Item I-B).
- Tom Kahler will finalize and email to Carmen Andonaegui the 2012 Wells Juvenile Bypass Operating Plan for distribution to the Coordinating Committees (Item II-A).
- Tom Kahler will prepare a detailed outline of the Douglas PUD 2013 No Net Impact (NNI) Progress Report (Progress Report) for distribution to the Coordinating Committees prior to the April 24, 2012, meeting (Item II-B).
- Steve Hemstrom will prepare a detailed outline of the Chelan PUD 2013 NNI Progress Report for distribution to the Coordinating Committees prior to the April 24, 2012, meeting (Item III-A).
- Lance Keller will finalize and email to Carmen Andonaegui the 2012 Rocky Reach Fish Bypass Operations Plan for distribution to the Coordinating Committees (Item III-C).
- Teresa Scott will report to the Coordinating Committees on Washington Department of Fish and Wildlife's (WDFW's) review of the Schaffer Joint-Use Dock and Trail

Proposal (III-E).

- Steve Hemstrom will finalize the Rocky Reach and Rock Island 2012 Fish Spill Plan per comments and as approved at today's Coordinating Committees' meeting and email it to Carmen Andonaegui for distribution to the Coordinating Committees (Item III-B).
- Steve Hemstrom will email Chelan PUD's comment letter regarding the Douglas County Schaffer Joint-Use Dock and Trail Proposal to Carmen Andonaegui for distribution to the Coordinating Committees, (Item III-E).

DECISION SUMMARY

- The Coordinating Committees approved the Wells 2012 Juvenile Bypass Operating Plan (Item II-A).
- The Coordinating Committees approved the 2012 Rocky Reach and Rock Island Fish Spill Plan with revisions (Item III-B).
- The Coordinating Committees approved the 2012 Rocky Reach Fish Bypass Operations Plan with revisions (Item III-C).
- The Coordinating Committees finalized the 2012 Rocky Reach and Rock Island HCP Action Plan (2012 Action Plan) (Item III-D).

REVIEW ITEMS

- Carmen Andonaegui sent an email notification to the Coordinating Committees on March 5, 2012, that the Draft 2011 Rocky Reach HCP Annual Report and the Draft 2011 Rock Island Annual Report were out for a 30-day review with comments due to Andonaegui by April 4, 2012.

REPORTS FINALIZED

- Lance Keller will finalize the 2011 Chelan PUD Predator Control Report and email it to Carmen Andonaegui for distribution to the Coordinating Committees.
- Lance Keller will finalize the 2011 Rocky Reach Juvenile Fish Bypass System Biological Evaluation Report and email it to Carmen Andonaegui for distribution to

the Coordinating Committees.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees' members and asked for any additions or changes to the agenda. The following items were added to the agenda:

- Steve Hemstrom asked if Teresa Scott could provide additional information about the comparative survival study meeting on April 12, 2012.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft February 28, 2012, meeting minutes. Lance Keller raised a variety of editorial corrections, which will be incorporated into the meeting minutes. The draft February 28, 2012 meeting minutes were approved as revised. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Committees.

B. Action Item Review (Mike Schiewe)

Mike Schiewe asked Steve Hemstrom about an Action Item from the February 28, 2012, meeting regarding updating the Chelan PUD Technical Report, *Guidelines and Recommended Protocols for Conducting, Analyzing, and Reporting Juvenile Salmonid Survival Studies in the Columbia River Basin* by Peven et al. (2005). Hemstrom said that although the simplest approach might be to update the existing document that was not realistic, because the document involved multiple authors, some of whom were in different positions. He said that Chelan PUD could potentially draft a new stand-alone protocols document but that he was open to other ideas. Schiewe suggested that writing a stand-alone document might be the best approach. Bryan Nordlund suggested that another approach might be to document changes to the Peven et al. protocols employed in the 2011 survival study as a way to guide the 10-year survival study check-in. As a starting place, Nordlund said that he planned to review the Peven et al. (2005) protocols and prepare a list of how the 2011 juvenile survival study differed from the protocols in Peven et al. (2005). He said he would then submit that list to the Coordinating Committees for review and consideration. The Committees could then discuss the best approach to capture the changes to the 2011 survival study protocols.

With regard to another Chelan PUD Action Item, Schiewe asked Hemstrom whether Chelan PUD staff had further considered using Douglas PUD's DMT as a library for HCP documents. Hemstrom stated that he had discussed this option with Joe Miller, Chelan PUD, and that there were concerns regarding whether the items stored using DMT would be subject to public release. Also, Hemstrom said that Chelan PUD would need to budget funds to cover the cost of using the Douglas PUD DMT and that this was not included in the 2012 budget. Hemstrom said that he and Miller had discussed a number of benefits of using the DMT at Douglas PUD; however, he said that Chelan PUD needed to consider the option further to ensure they understood all the possible implications. Tom Kahler stated that Douglas PUD's new Clean Water Act (CWA) 401 Water Quality Certification (401 Certification) has the requirement that nearly everything associated with implementing the 401 Certification be made available to the public, on a web site, and that Douglas PUD was still sorting out exactly what implementing this requirement will entail. Kahler said that Douglas PUD's funding for using the DMT was in their 2012-2013 budget, which starts in September 2012. He suggested a phone call between Douglas PUD and Chelan PUD staff to talk about some of the issues surrounding shared use of the DMT. Schiewe stated that the FTP site currently used by the group is working for now, but at some point, it will make sense to move the record storage away from an outside consulting company (i.e., Anchor QEA). Schiewe concurred with the need to set up a meeting between Douglas PUD (Kahler and Shane Bickford) and Chelan PUD (Hemstrom and Miller). He said that it would be important to develop rules so that only HCP Committees' member had full access to drafts and working versions of documents. Kahler clarified that the DMT would not be available to the public. He said that there would be logins set up with specific permissions so that access to documents could be managed. Hemstrom said that he will set up a conference call with Douglas PUD to discuss the shared use of Douglas PUD's DMT.

II. Douglas PUD

A. Draft Wells 2012 Juvenile Bypass Operating Plan (Tom Kahler)

Tom Kahler said that Douglas PUD received no comments on this document and asked if there were any comments people wanted to raise today at the meeting. No comments were noted, and the plan was approved. Kahler will finalize the 2012 Wells Juvenile Bypass

Operating Plan and email it to Carmen Andonaegui for distribution to the Coordinating Committees.

B. Douglas PUD 2013 NNI Progress Report Outline (Tom Kahler)

Tom Kahler explained that he has begun working on an outline for the 2013 Progress Report but that it was not ready for review by the Coordinating Committees. He said that the Wells HCP stated that the Hatchery Committees and Tributary Committees would develop an initial progress report for the Coordinating Committees, and then the Coordinating Committees would prepare a "comprehensive" progress report. Kahler said that he envisioned that the Tributary Committees would document the distribution of tributary funds, including the types of projects funded and the amounts distributed, and perhaps some discussion of the implementation of the Tributary Assessment Program. However, Kahler said that because the Tributary Assessment Program is not explicitly tied to NNI this information may not be appropriate to include. He said that the Hatchery Committees' contribution to the Progress Report would probably include a discussion of what has been accomplished during the past 10 years, as compared to what had been identified in the HCPs, including a discussion of additional programs that had been developed since the HCP signing. There would also be a discussion of the 5-Year Monitoring and Evaluation (M&E) Report. The Coordinating Committee's contribution to the Progress Report would be a summary of Wells Project passage survival and a discussion of what has been accomplished and what was planned to continue meeting the HCP survival standards.

Mike Schiewe suggested that the Progress Report be kept as brief as possible. Bryan Nordlund stated that he would like to see the Progress Report include a very general summary of how NNI had been achieved over the past 10 years. He suggested describing habitat improvements, hatchery production, and fish survival rates achieved over the past 10 years. Steve Hemstrom agreed with this approach. Kahler will prepare a more detailed outline for distribution to the Coordinating Committees prior to the next meeting on April 24, 2012.

III. Chelan PUD

A. Chelan PUD 2013 NNI Progress Report (Steve Hemstrom)

Steve Hemstrom said that he had added a line item for the Chelan PUD's 2013 Progress Report to the Chelan PUD 2012 Action Plan. He said that he would provide a detailed draft outline of the Progress Report for distribution to the Coordinating Committees prior to the April 24, 2012 meeting. Bryan Nordlund asked about the target audience for the NNI reports. Tom Kahler responded that the Wells HCP says the Progress Report will be filed "for the Parties," so there is no plan to submit it formally with the Federal Energy Regulatory Commission (FERC). The Committees agreed that, once it is finalized, the report could be distributed to other audiences. Teresa Scott said that the Progress Report should be written with a larger, more general audience in mind. Hemstrom said that Chelan PUD's report will be very straightforward and factual. Mike Schiewe asked that the Committees' members keep in mind that the document is meant to be produced by the HCP Committees for the HCP Signatories (Washington Department of Fish and Wildlife [WDFW], the Yakama Nation, the Colville Confederated Tribes, Douglas and Chelan PUDs, U.S. Fish and Wildlife Service [USFWS], and National Marine Fisheries Service [NMFS]).

B. Rocky Reach and Rock Island 2012 Fish Spill Plan (Steve Hemstrom)

Steve Hemstrom said that the 2012 Fish Spill Plan was sent out for a 30-day review late in February 2012. Hemstrom asked if there were any comments or questions on the document. Jim Craig noted that Table 5 is not included in the text but there is a reference to such a table in the 2012 Fish Spill Plan; Hemstrom agreed to fix this to reference Table 2 or 3, which also includes the same information (on spill levels). Teresa Scott pointed out that 2011 needs to be changed to 2012 in a header on page 7. Hemstrom will make these revisions today (March 27, 2012) and will email the revised 2012 Fish Spill Plan to Carmen Andonaegui for distribution to the Coordinating Committees. The Coordinating Committees approved the document with these revisions.

C. 2012 Rocky Reach Juvenile Bypass Operations Plan (Lance Keller)

Lance Keller provided a summary of the draft 2012 Juvenile Bypass Operating Plan (Bypass Operating Plan). Steve Hemstrom said that this plan had previously been referred to as the, "Annual Bypass Evaluation Plan;" however, Chelan PUD was proposing changing the title to

"Bypass Operating Plan." He said that they believe this would be a more descriptive title because, after 9 years of operation, the plan is about operations and not evaluation. The Committees agreed to the title change. Keller said that comments on the 2012 Bypass Operating Plan were received from Jim Craig and his revisions had been incorporated into the document. Teresa Scott noted that there are some places in the documents (in a heading and in a table title) where the year 2011 needed to be changed to the year 2012. There were no other comments on the document. Keller will incorporate revisions as discussed at today's meeting and email the Final Bypass Operating Plan to Carmen Andonaegui for distribution to the Committees. The Committees approved the Bypass Operating Plan as revised.

D. Draft 2012 Rocky Island and Rocky Reach HCP Action Plan (Lance Keller and Steve Hemstrom)

Steve Hemstrom said that the 2013 Progress Report has been added as an activity to the 2012 HCP Action Plan. Mike Schiewe recommended that, if there were no further concerns or questions, the Coordinating Committees consider approving the 2012 HCP Action Plan today rather than delay until the April 24, 2012, meeting. The Committees approved the 2012 HCP Action Plan.

E. Douglas County Schaffer Joint-Use Dock and Trail Proposal (Steve Hemstrom)

Steve Hemstrom said that Douglas County had asked for comments on a proposed joint use dock and small trail on the Rock Island Reservoir. He said that Chelan PUD sent a comment letter to Douglas County on March 8, 2012. Hemstrom pointed out that Chelan PUD does not own the Shorelines adjacent to the Rock Island Reservoir and so has no authority over land use along the reservoir; they can only provide comments to Douglas County on the proposal. Hemstrom will send Chelan PUD's comment letter to Carmen Andonaegui for distribution to the Coordinating Committees. Hemstrom said that the proposed dock would not be for public access but for use only by several property owners in the vicinity of the dock. Bryan Nordlund and Hemstrom clarified that there are several permits that would still need approval for the proposed project to move forward. Hemstrom said that the proposed project was brought to the Coordinating Committees for their information only and that Chelan PUD was not asking for any action from the Committees at this point. Teresa Scott agreed to report to the Committees on WDFW's considerations after staff reviews of the proposed project.

F. Comparative Survival Study Annual Meeting (Steve Hemstrom)

Steve Hemstrom opened discussion by asking who was planning to attend the Comparative Survival Study (CSS) Annual Meeting. Douglas PUD staff, Hemstrom and Josh Murauskas from Chelan PUD, and Teresa Scott said that they were planning to attend. Mike Schiewe asked if the meeting would be on WebEx; Scott said that she would find out and report back by email. She said that the agenda for the meeting was not available yet, but that the format for the meeting would be a series of very interactive presentations and discussions.

IV. Tributary and Hatchery Committees Update (Mike Schiewe)

Mike Schiewe said that the Hatchery Committees meeting was delayed this month and will be held tomorrow, March 28, 2012, so there would be no Hatchery Committees' update this month. Schiewe reported that the primary item for discussion at the Hatchery Committees' meeting March 28, 2012, would be the 2012 broodstock collection protocols.

Schiewe reported that the Tributary Committees met on March 8, 2012, and discussed the following items:

- Regarding Conflict of Interest in Selection of Projects: The Tributary Committees added to their operating protocols that Tributary Committees' members who represent a project proponent would not be allowed to vote on that proposal.
- Regarding Public Access to Tributary Funded Projects: The Tributary Committees agreed that it is not a requirement for Tributary Program funding, but that it is an option for the Tributary Committees to require public access on a project-by-project or site-by-site basis.
- Regarding Photo Documentation: Photo documentation and monitoring of structures during construction will be included as a requirement on some funded projects.
- Regarding Nutrient Enhancement Design Subcontract Agreement: the Cascade Columbia Fish Enhancement Group (CCFEG) asked the Rock Island Tributary Committee to review and approve their subcontract agreement with Water Quality Engineering. CCFEG asked Water Quality Engineers to assist them with the Nutrient

Enhancement Design Project. The Rock Island Tributary Committee reviewed and approved the subcontract agreement.

- Regarding Evaluation of Appraisals/Values of Conservation Easements: With the escalating value of real estate, the Tributary Committees will be contracting with an economist at a local university, if possible, to research if there are other options for appraising conservation easements. Tom Kahler stated that there appears to be a lot of subjectivity in the appraisals. He said that it seemed prices were being paid to protect property from development that was far in excess of the property's value, especially when it did not appear the property owner intended to develop the property in the first place. Kahler said that Tracy Hillman, BioAnalysts, and Becky Gallaher, Chelan PUD, were directed by the Tributary Committees to begin investigating this issue. Teresa Scott said that the lead at WDFW working on real estate appraisals is Dan Budd; Kahler will pass this information on to Hillman and Gallaher.
- General Salmon Habitat Program Schedule: The Tributary Committees have established their calendar for processing the 2012 Salmon Habitat general fund. It is similar to previous years, although a slightly shorter time frame, and is expected to be finished by the end of August 2012. Pre-proposals are due May 7, 2012; project tours will be May 21 through May 24, 2012; the pre-proposal presentation workshop is scheduled for June 13, 2012; Tributary Committees' review will occur June 14, 2012; final proposals are due June 29, 2012; and final evaluations of proposals will occur by July 12, 2012, with project funding awards announced by August 31, 2012.
- River Safety Signs: The Tributary Committees have been asked whether they would fund the posting of signs at boater-access locations in the Wenatchee and Methow basins, to warn rafters, kayakers, and other boaters of hazards posed by habitat-restoration structures. The Tributary Committees decided against providing funding for the signage, believing that it would be better that the State of Washington provide such signage.

Jim Craig asked whether there was a requirement that projects funded by the Tributary Committees be monitored and then maintained at some functioning level over time following project completion. Kahler stated that this would be a very difficult requirement to include, primarily because it requires funding of presently undefined future actions. He said that the most the Tributary Committees have required of project sponsors to date was that the project be implemented as designed. He said that the program is self-policing at this point, because contractors implementing the projects want to be able to get future projects funded, so it is in their interest to install projects that are designed well and last into the future. Kahler clarified that the Tributary Committees and Regional Technical Team (RTT) have toured completed projects at least once, and annually tour proposed projects, and that in 2012 they are planning to extend the scheduled tours of proposed projects to review some completed projects as well.

V. HCP Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees meeting is April 24, 2012 (conference call only). Subject to arranging for site visits, the May 22 meeting may be moved to the Wenatchee area. The June 26 meeting is planned for SeaTac, Washington.

List of Attachments

Attachment A – List of Attendees

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Virginia See	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Jerry Marco*†	Colville Confederated Tribes
Teresa Scott*†	WDFW
Jim Craig*	USFWS
Bryan Nordlund*	NMFS

*Denotes Coordinating Committees member or alternate
†joined by phone

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	May 24, 2012
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the April 24, 2012, HCP Coordinating Committees' Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Tuesday, April 24, 2012, from 9:30 am to 11:00 am. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Mike Schiewe will coordinate with Steve Hemstrom to confirm a meeting room at Rocky Reach Dam for next month's Coordinating Committees meeting on May 22, 2012, beginning at 10:00 am (Item I-A).
- Teresa Scott will add Jim Craig to her Fish Passage Center Weekly Report distribution list (Item II-B).
- Tom Kahler will send the revised draft 2013 Douglas PUD HCP NNI Progress Report Outline with recent additions tracked to Kristi Geris for distribution to the Coordinating Committees (Item III-B).

DECISION SUMMARY

There were no decisions made at today's meeting.

REVIEW ITEMS

There were no new review items distributed at today's meeting.

REPORTS FINALIZED

There are no reports to finalize at this time.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and introduced Kristi Geris as new Anchor QEA support staff to the Committees. Schiewe reviewed the agenda and asked for any additions or changes to the agenda. No additions or changes were requested.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft March 27, 2012, meeting minutes. Mike Schiewe reported that Carmen Andonaegui incorporated all comments and revisions received by the Coordinating Committees and there were no outstanding items remaining to be discussed. The draft March 27, 2012, meeting minutes were approved as revised. Kristi Geris will finalize the meeting minutes and distribute them to the Committees.

Schiewe suggested holding the May 22, 2012, Coordinating Committees meeting in Eastern Washington or by conference call. The Priest Rapids Coordinating Committee will be meeting in Eastern Washington on May 23, 2012, and hence, this will simplify travel for agency staff serving on both committees. Chelan PUD offered to host the meeting if convened in Eastern Washington. Schiewe suggested the meeting be held at Rocky Reach Dam as a way to familiarize members with the facility. Steve Hemstrom said he will confirm a meeting room at the dam for the meeting. The Coordinating Committees agreed to the new location for the May meeting. Jim Craig indicated he will not attend the May meeting due to other obligations.

II. Chelan PUD

A. 2013 Chelan PUD HCP NNI Progress Report Outline (Steve Hemstrom/Lance Keller)

Steve Hemstrom reported that the draft 2013 Chelan PUD HCP NNI Progress Report Outline was sent to the Committees per an action item from the March 27, 2012, Coordinating Committees meeting. Hemstrom noted the goal of the HCP NNI Progress Report is to produce a report describing what has been accomplished over the past 10 years in such a way that is not "too heavy" on the reader. The HCP NNI Progress Report includes three key pieces: (1) a Passage Survival Plan; (2) a Hatchery Compensation Plan; and (3) a Tributary

Conservation Plan. Hemstrom said the report will document what the HCPs have accomplished in the first 10 years of their implementation.

He added that the report, as required by the HCPs, is due in March 2013, and will be available to the Coordinating Committees and HCP Signatories. Hemstrom stated this will be an ongoing topic with plenty of opportunities for discussion. Mike Schiewe asked the Coordinating Committees to share any initial comments with Hemstrom. Tom Kahler said Douglas PUD and Chelan PUD have met on this topic and both PUDs are striving to use a similar format and include similar content. Jerry Marco said he reviewed both Douglas PUD and Chelan PUD draft outlines and thought both looked good. Marco pointed out, however, that the Chelan PUD outline proposes to address only juvenile survival; whereas, the Douglas PUD outline indicates incorporating information on adult survival as well. Hemstrom confirmed with Marco that Chelan's 2013 Check-in report would address adult passage because the Rocky Reach Project has achieved the HCP Combined Adult and Juvenile Survival Standard for Spring-run Chinook and so it would be important for Chelan to include the relevant adult survival information as well.

Schiewe wrapped up the discussion by reminding the Committees that this is an ongoing effort and both PUDs will provide updates to Coordinating Committees as the draft reports are developed.

B. 2012 Fish Spill and Juvenile Bypass Operations (Steve Hemstrom/Lance Keller)

Steve Hemstrom informed the Coordinating Committees that the fish spill at Rock Island Dam was started on April 17, 2012. Hemstrom also updated the Coordinating Committees about recent spills at Grand Coulee Dam.

Teresa Scott mentioned to the Committees that the Fish Passage Center (FPC) Weekly Reports provide a good summary of water supply and river operations affecting the migration of juvenile and adult salmon and steelhead. These reports include daily average flow and spill reports, reservoir elevations and outflows, and water supply forecast reports. Scott asked the Committees if they would like to be added to her FPC Weekly Report distribution list. Most Committees' members indicated they already received similar information. Jim Craig requested to be added to Scott's list.

Lance Keller updated the Coordinating Committees on recent juvenile bypass operations at Rocky Reach Dam. Keller reported that the bypass system was fully operational on April 1, 2012, with no major problems to report to date; to this, Keller applauded the diligent offseason maintenance of the system. Keller reported there was a recent increase in yearling Chinook passage. The University of Washington RealTime Model currently indicates approximately 14 percent of the yearling Chinook and 2 percent of the steelhead expected this season have passed Rocky Reach Dam. Coho are also showing up in larger numbers. Keller reported that only one injured steelhead had been found in the routine bypass system samples and that there have been no mortalities. Keller concluded that the system is performing as it should.

III. Douglas PUD

A. Re-analysis of Wells Project Salmonid Passage Data During the 2009 and 2010 Lamprey Studies (Tom Kahler)

Tom Kahler reviewed with the Coordinating Committees the final report from Dr. John Skalski evaluating the effects of reduced head differentials at the Wells Dam fishway entrances on salmonid passage. Kahler explained that a study of the reduced entrance velocities had been requested by the Aquatic Settlement Work Group (ASWG) to determine whether a reduction in entrance velocity could potentially enhance lamprey passage. Douglas PUD retained LGL Limited to conduct the study using DIDSON technology to record lamprey passage events at the fishway entrances. The Wells Coordinating Committee conditionally approved the study, provided that the study include an analysis of salmonid-passage data.

During two years of testing (2009 and 2010), three different operating levels were tested: low (0.5-foot), medium (1.0-foot), and high (1.5-foot) head differentials. A 1.5-foot head differential is the standard operating condition. All three levels were tested in 2009; whereas, only the 1.0-and 1.5-foot levels were tested in 2010. Similar to LGL Limited’s findings, results of Skalski’ s analyses indicated no significant differences in passage of Chinook salmon at any of the three head differentials tested; however, significantly fewer steelhead passed at the 0.5-foot level in 2009.

Kahler noted that the lamprey study report that included analysis of salmonid passage was originally distributed about a year ago; however, based on a request from Bryan Nordlund, Douglas PUD asked Skalski to conduct an independent statistical analysis of the salmonid-passage data. The Coordinating Committees decided to continue review of the report and defer approval to next month's meeting when Nordlund returns. Mike Schiewe noted that the ASWG will probably request a similar "lamprey operation" in 2012 to that approved by the Coordinating Committees in 2011. The 2011 lamprey operation included an evening reduction of fishway entrance velocity (a 1.0-foot head differential) from August 19 through September 30, 2011.

B. 2013 Douglas PUD HCP NNI Progress Report Outline (Tom Kahler)

Tom Kahler indicated that a proposed outline of the 2013 Douglas PUD HCP NNI Progress Report had now been internally reviewed, and would be distributed to the Coordinating Committees. Kahler said that Douglas PUD envisioned a very focused document. Changes to the outline that was previously distributed to the Committees included the following:

- Differentiated between juvenile and adult survival (e.g., changed name of plan and moved description).
- Added a summary to the end of the Passage Survival Plan section.
- Added a section on the Tributary Assessment Plan.
- Added an Inundation Compensation Plan section that summarizes the production of inundation compensation fish (this has no NNI implications; just information purposes).

Kahler said he will send the revised draft 2013 Douglas PUD HCP NNI Progress Report Outline with these recent additions tracked to Kristi Geris for distribution to the Coordinating Committees. Kahler welcomed feedback and said if no comments are received, Douglas PUD will move forward as described in the draft outline. Mike Schiewe reminded the Coordinating Committees that the deadline for the final report was March 2013.

Lastly, Kahler added that bypass operation at Wells Dam started April 9, 2012, as expected, and everything was going well. Kahler also reported on involuntary spill at Wells Dam, and the strategy of Mid-Columbia Hourly Coordination to maximize generation at Wells Dam and transferring spill to Priest Rapids Dam as a means of minimizing total dissolved gas (TDG) in the mid-Columbia. Wells involuntary spill over the last week has exceeded bypass spill by 12,000 to 30,000 cubic feet per second (cfs), with an average of 17,000 cfs. Schiewe asked Lance Keller if there is monitoring for Gas Bubble Trauma (GBT) at Rocky Reach, and Keller said monitoring was occurring; however, they have not seen any signs of GBT.

IV. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe reported that the Tributary Committees has not reconvened since March 8, 2012, as already discussed at the March 27, 2012, Coordinating Committees meeting; therefore, there would be no Tributary Committee's update this month.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last two Hatchery Committees' meetings on March 28, 2012, and April 18, 2012, both held at the Douglas PUD's headquarters building:

- *Columbia River Inter-Tribal Fish Commission (CRITFC) Proposal for Participation in the Collection of Hatchery Steelhead and Chinook Genetic Samples*: CRITFC approached the Hatchery Committees two months ago with a proposal asking them to endorse collecting tissue samples from all hatchery broodstock; the samples would be genetically analyzed and these data used to determine parentage of offspring. Hatchery Committees members raised a number of questions about the proposal, including the need for detailed collection and analytical protocols, how the information will be used, who has access to the information, etc. Because of these unresolved issues, the Hatchery Committees deferred consideration of a Statement of Agreement until these issues were satisfactorily addressed by individual agency genetics staff. No schedule was set for revisiting this topic until CRITFC biologists and applicable agencies are satisfied that planning for this endeavor was complete.
- *Facility Modifications Proposed for Dryden and Overwintering Feasibility*: The Hatchery Committees discussed changing/improving the water supply for the Dryden Facility. The current Dryden Facility is served by irrigation canal water, and the Joint Fisheries Parties (JFP) have proposed developing a Wenatchee River surface water supply to open the possibility of overwinter acclimation at Dryden. Currently, only

Chelan PUD summer Chinook are spring acclimated at the Dryden Facility. Beginning in 2013, under a proposed sharing agreement with Chelan PUD, Grant PUD will be also be producing summer Chinook; the JFP, working with the Priest Rapids Coordinating Committee Hatchery Subcommittee are proposing a transition to overwinter acclimation for the Grant PUD program, which would also affect the existing Chelan PUD program. This issue is complicated because planning and decision-making started in the Priest Rapids Coordinating Committee, not with the Hatchery Committees; development of overwintering at Dryden had not yet been fully vetted in the Hatchery Committees, and there are mixed opinions on the topic. One issue for Chelan PUD is compliance with a Washington State Department of Ecology addendum to the Wenatchee total maximum daily load, which establishes a phosphorus discharge limit not to exceed 743 micrograms per liter for the entire Wenatchee River by 2018 (includes the Dryden and Chiwawa facilities, plus waste water discharge facilities). Further, because the goal of transitioning to overwinter acclimation at Dryden is to improve smolt-to-adult returns (SARs) and reduce straying, a necessary step is to consider alternative approaches to achieve these same goals. Accordingly, Chelan PUD agreed to convene a subgroup of the Committees to develop a conceptual approach to investigating Dryden Facility improvement needs for the Committees' review and further development. Joe Miller emphasized that Chelan PUD has not ruled out overwinter acclimation, but wants to make sure that alternatives have been considered and that a final decision is technically supported.

- *Draft 2011 Hatchery M&E Annual Report Out for Review*: Chelan PUD released its annual M&E report available for review by the Committees.
- *Residual Steelhead Associated With Juvenile Hatchery Steelhead Releases*: There was considerable discussion on the management of non-migrating juvenile hatchery steelhead. Currently, there are several programs that employ volitional release, with varying numbers of non-migrants ultimately being forced out. There is concern that this practice could result in a large number of residual steelhead remaining in freshwater near the point of release that (1) prey on juvenile Chinook salmon; and (2) ecologically compete for rearing space. Different approaches to managing non-migrants were discussed, including planting non-migrants in lakes for recreation fisheries. The Washington Department of Fish and Wildlife acknowledged that the National Marine Fisheries Service would need to approve this approach because of the

Endangered Species Act listing of steelhead. The JFP plans to further discuss management of non-migrant steelhead at their next meeting.

- *Fish Water Management Tool (Dr. Kim Hyatt and Margo Stockwell, Fisheries and Oceans, Canada):* Dr. Kim Hyatt gave a presentation on implementation of the Fish and Water Management Tool (FWMT). The FWMT is a water management decision model that guides water management in the Okanogan River basin. The FWMT is used by water managers and fisheries managers to minimize flooding, limit desiccation and scouring of salmon redds, and minimize the spatial extent of low oxygen levels in Osoyoos Lake. Hyatt's team recently received an award for their collaborative efforts to enhance sockeye production in the Canadian Okanagan Basin.

Mike Schiewe suggested that the Coordinating Committees might want to hear the presentation on the FWMT, as it has applications beyond what was accomplished in the Okanogan. Joe Miller suggested that the Coordinating Committees might also benefit from hearing what Chelan PUD is doing to enhance sockeye production in Skaha Lake. The results of the FWMT may support this effort as well.

V. HCP Committees Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees meeting is May 22, 2012, at Rocky Reach Dam at 10:00 am (instead of 9:30 am). The June 26, 2012, and July 24, 2012, meetings are planned for SeaTac, Washington.

List of Attachments

Attachment A – List of Attendees

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Joe Miller	Chelan PUD
Jerry Marco*	Colville Confederated Tribes
Teresa Scott*	WDFW
Jim Craig*	USFWS

* Denotes Coordinating Committees member or alternate

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	June 26, 2012
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the May 22, 2012, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at Rocky Reach Dam in Wenatchee, Washington, on Tuesday, May 22, 2012, from 10:00 am to 2:30 pm. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Teresa Scott will contact Bill Tweit to arrange a presentation for the Committees on the technical modeling being conducted to support decisions relating to CRT re-negotiations (Item II-D).
- Tom Kahler will respond to Columbia River Inter-Tribal Fish Commission's (CRITFC's) request to collect and tag sockeye at Wells Dam indicating conditional approval, with the requirements that tagged adults are released upstream of Wells Dam rather than into the ladders, that Dr. Jeff Fryer (the study's Principal Investigator) provides the Committees with a study plan with future request, and that the Committees receive annual reports of study results prior to receiving future requests and that the submittal of future requests be in time to be included in the March meeting agenda (Item III-A).
- Douglas and Chelan PUDs agreed to have their draft HCP NNI Progress Reports ready for review by the Committees by the October 2012 HCP-CC meeting. It was also agreed that the draft reports should be approximately 15 pages in length (Item III-C).

DECISION SUMMARY

- There were no Statements of Agreement (SOAs) approved at today's meeting.

AGREEMENTS

- The Coordinating Committees approved the annual request from CRITFC to collect and tag sockeye at Wells Dam with the conditions listed in the Action Item Summary (Item III-A).
- The Coordinating Committees approved Dr. John Skalski's re-analysis of the effects of reduced fishway entrance velocities on the passage of adult salmonids (Item III-B).

REVIEW ITEMS

- There were no review items at today's meeting.

REPORTS FINALIZED

- There are no reports to finalize at this time.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and thanked Steve Hemstrom, Lance Keller, and the folks at Rocky Reach Dam for hosting the Coordinating Committees meeting at the dam and providing a tour of the facilities. Schiewe reviewed the agenda and asked for any additions or changes to the agenda. No additions or changes were requested.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft April 24, 2012, meeting minutes. Kristi Geris reported that all comments and revisions received from the Coordinating Committees members were incorporated in the revised minutes and there were no outstanding items remaining to be discussed. The draft April 24, 2012, meeting minutes were approved as revised. Geris will finalize the meeting minutes and distribute them to the Committees.

II. Chelan PUD

A. Follow-up Questions on Rocky Reach Fish Facilities/Operations (Steve Hemstrom/Lance Keller)

Steve Hemstrom invited questions and comments from the Committees regarding Rocky Reach fish operations and facilities, and how these work in the context of the HCP. Hemstrom said to feel free to email him at any time.

B. Update: 2012 River Flow Forecasts/Rock Island Spill (Steve Hemstrom/Lance Keller)

Steve Hemstrom informed the Coordinating Committees that from April 1 to May 20, 2012, flows at Rock Island Dam were at approximately 200,000 cubic feet per second (cfs), and high flows are anticipated to continue in the coming weeks. Hemstrom also reported that fish spill started at Rock Island Dam on April 17, 2012; to date the total dissolved gas (TDG) cap has not been exceeded. The spring target for Rock Island Dam is 10 percent, and Hemstrom said the dam is currently at 16.1 percent. Hemstrom said a peak in flows is expected sometime in June.

Hemstrom also reported "unavoidable spill" at Rocky Reach Dam from May 1 to May 22, 2012. The total spill volume for this period was 20.47 percent of the average river flow; day-average spill for this period was approximately 45,000 cfs. Flow was greater than powerhouse capacity on 19 of the 22 days, with a maximum day-average river flow of 246,000 cfs.

Jerry Marco told the Coordinating Committees that last month the U.S. Army Corps of Engineers shutdown spill at two bays for a couple of days on the right bank at Chief Joseph Dam. This action was taken to facilitate installation of the foundation for the new Chief Joseph Hatchery fish ladder. Marco said that during the shutdown hourly TDG concentrations increased about 2 to 5 percent.

C. Update: Pikeminnow Programs and Catch Rates (Steve Hemstrom/Lance Keller)

Lance Keller said the Pikeminnow Program has already passed the 20,000 fish catch mark this year, averaging approximately 270 to 300 fish per day. The U.S. Department of Agriculture (USDA) has two fishermen on site at Rock Island Dam, three fishermen at Rocky

Reach Dam, and two roaming boats between the two dams. Keller said Columbia Research is also contributing to the removal program. Keller said this year the size distribution of fish caught by both USDA and Columbia Research has been smaller. Last year, both USDA deck crews' combined catch was less than 1,000 fish all year; this year the crews have already caught approximately 600 fish. Keller said the Rotary Club Community Derby will be held this year on Father's Day weekend. Last year, the event attracted approximately 120 to 150 participants, and Keller said the event expects a similar turnout this year. Steve Hemstrom added that pikeminnow passage counts have shown a decreasing trend over the past few years, which is suggestive of lower pikeminnow abundance.

D. *Update: Chelan PUD's General Manager and Commissioners' Recent Trip to Washington D.C. visiting Congressional Representatives, Federal Energy Regulatory Commission Staff, Agency Directors, the U.S. Department of Energy, and the U.S. Department of the Interior (Steve Hemstrom/Lance Keller)*

Keith Truscott presented an overview of Chelan PUD's General Manager and Commissioners' recent trip to Washington D.C. The trip presented an opportunity to inform members of the Northwest Congressional Delegation about the HCP and its accomplishments. Truscott said the HCP and its accomplishments were well-received, and several people were already well-informed about what had been achieved. Truscott shared with the Committees the fact sheets on the HCP that were distributed during the trip (Attachments B and C). Regarding Congressional hydropower bills, Truscott said there was discussion of several non-hydropower projects (approximately 2,000) that have the potential to include hydropower without significant environmental impacts. Wind integration, Truscott said, was another high interest topic, and cyber security was also discussed.

Jerry Marco asked if Truscott thought staff in Washington D.C. were well-versed in the Columbia River Treaty (CRT)? Truscott indicated that they were aware of the issue, but not necessarily well-versed regarding details. Steve Hemstrom said Chelan PUD participates in a CRT evaluation team. Truscott said the primary purpose of the treaty was flood control, and that current discussions are primarily about whether changes are needed in 2024, when changes can first be made. Mike Schiewe asked the Committees if they thought potential changes to the CRT might affect implementation of the HCPs, and whether it may be beneficial to invite someone to speak to the Committees regarding this issue. Hemstrom said a minor re-regulation would not significantly change flows. Teresa Scott volunteered to contact Bill Tweit, who is the lead for the Washington Department of Fish and Wildlife (WDFW) on CRT, to arrange a presentation for the Committees on the technical modeling being conducted to support decisions relating to CRT re-negotiations.

III. Douglas PUD

A. DECISION: Approval of Annual Request from CRITFC to Collect and Tag Sockeye at Wells Dam (Tom Kahler)

Tom Kahler reviewed with the Committees CRITFC's annual request to collect and tag sockeye at Wells Dam (Attachment D). The Committees raised several questions about the ultimate objective of collecting these data, and if there were any annual reports summarizing past data? Josh Murauskas said some of Dr. Jeff Fryer's data are available on the CRITFC website. Kahler added that Fryer has presented his findings to various groups and agencies; however, Kahler remains uncertain of the ultimate objective of the study. Kahler and other members of the Committees expressed concerns regarding the proposed release of tagged fish back into the fish ladder. Kahler said Douglas PUD had recommended to CRITFC that they release tagged fish into the forebay of Wells Dam as in past years, but no changes had been made to the study proposal. Murauskas said he is also interested in Fryer's use of different fish anesthetics and whether he has observed any differences in recovery.

Kahler said Fryer's plan is to begin tagging the last week of June. Mike Schiewe asked whether anyone has reasons to not approve the study this year. Committees members agreed to approve Fryer's request, but conditioned the approval on release of tagged fish upstream of Wells Dam, and receiving a study plan and annual reports of study results prior to receiving future requests to approve collection and tagging of sockeye at Wells Dam. Bryan Nordlund said he would prefer to have the Committees' questions answered this year; however, timing wise, he acknowledged that would not be feasible. Kahler agreed to respond to CRITFC's request to collect and tag sockeye at Wells Dam indicating conditional approval, with the requirements that: (1) tagged adults are released upstream of Wells Dam rather than back to the ladder; (2) that Fryer provides the Committees with a study plan along with future requests for approval of collection and tagging at Wells Dam, and that future requests be submitted to the Committees in time to be included on the March meeting agenda; and (3) the Committees receive annual reports of study results prior to submittal of annual requests for trapping/tagging.

B. Re-analysis of Wells Project Salmonid Passage Data During the 2009 and 2010 Lamprey Studies (Bryan Nordlund blessing; Tom Kahler)

Tom Kahler briefly reviewed for Bryan Nordlund the final report from Dr. John Skalski evaluating the effects of reduced water velocity at the Wells Dam fishway entrances on salmonid passage. The report had been reviewed and discussed by the Committees at the April meeting when Nordlund had been unable to attend. Kahler asked Nordlund if his earlier questions had been answered. Nordlund said they had, and the Committees gave their final approval of the report.

C. Discussion: 2013 Douglas PUD HCP NNI Progress Report Outline (Bryan Nordlund recent comments; Tom Kahler)

Tom Kahler reviewed Bryan Nordlund's recent comments on the revised 2013 Douglas PUD HCP NNI Progress Report outline. The revised outline was emailed to the Committees by Kristi Geris on April 24, 2012, and Nordlund's comments to the revised outline were forwarded to the Committees by Geris on May 3, 2012. Kahler noted the following:

- Comment #3 – Nordlund asked for clarification of how inundation compensation fits within the HCP. Kahler pointed out the new section on Inundation Compensation Production in the revised outline was added to cover this topic.
- Comment #2 – Nordlund asked whether Douglas PUD has data to estimate smolt-to-adult returns (SARs) for the HCP species. Kahler said they do and will.
- Comment #1 – Nordlund asked Douglas PUD to include a discussion of how Wells HCP and achievement of NNI is contributing to recovery of spring Chinook and steelhead, and if adult counts have increased for the non-listed HCP species. Kahler said Douglas PUD had not intended to include that information in the NNI progress report because the purpose of that report was not to demonstrate whether or not HCP implementation had contributed to recovery. The Wells HCP describes a second analysis (in addition to the NNI progress report) for which the Committee was responsible that would determine whether Plan Species were rebuilding. In previous

discussions on this topic the Committee agreed that the PUDs should not make the determination of species status, as that was not their purview. Nordlund explained that including information on species performance could potentially demonstrate that these long-term agreements were beneficial. He said the overarching purpose of the HCPs is to keep listed and non-listed species healthy.

Josh Murauskas said that the focus of the HCP NNI Progress Reports should be on evaluating the three components of the HCP, and describe accomplishments. Steve Hemstrom noted that no net impact (NNI) and recovery are not the same thing. Hemstrom said the PUDs are not accountable for recovery of listed fish in the upper Columbia, but are required to contribute to recovery. Teresa Scott added that there will likely be people who want to make the connection between the HCPs and recovery, so it is important to be as robust as possible. Murauskas said the HCPs are also about harvest opportunities, and Murauskas said there has been great success there. Jerry Marco added that the fisheries managers also need to be included in this discussion because high harvest numbers do not necessarily equal a lot of fish; NNI may be the best way to express successes.

Mike Schiewe reminded the Committees that the HCP NNI Progress Reports are due in March 2013. Hemstrom added that in order to write a useful report with enough detail, and conversely, to avoid too much unnecessary detail, it important to identify the audience. Schiewe clarified that the audience for the HCP NNI Progress Reports is the signatories. Douglas and Chelan PUDs agreed to develop a succinct, draft HCP NNI Progress Report, approximately 15 pages in length, ready for review by the Committees by the October 2012 HCP-CC meeting.

D. Update: Bypass Operations and TDG at Wells Dam (Tom Kahler)

Tom Kahler shared with the Committees that in accordance with Douglas PUD's 2012 Bypass Operating Plan (BOP), the bypass barriers were removed from Bypass Bay #6 at Wells Dam to minimize TDG, as described in an email Kristi Geris distributed to the Coordinating Committees on May 2, 2012.

IV. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe reported that Tracy Hillman had distributed the HCP Tributary Committees Meeting Progress Report, and discussed the following items:

- *General Salmon Habitat Program Pre-Proposals:* The Tributary Committees received 27 General Salmon Habitat Program pre-proposals, and selected nine projects they would like to visit in the field. Schiewe clarified the nine projects selected were ones the Tributary Committees wanted to visit, and not necessarily the only projects considered for funding. The Tributary Committees will conduct their evaluation of pre-proposals on June 14.
- *Okanogan River Restoration Initiative Monitoring:* Continued funding for the Okanogan River was authorized in the amount of approximately $20,000.
- *Methow River River Mile 48.9 (Peters) Conservation Easement:* The Tributary Committees elected not to fund the Methow River Peters Conservation Easement proposal, because they believed the potential benefits of the acquisition did not justify the cost.
- *Evaluation of Appraisals:* The Tributary Committees have been discussing the use of outside appraisals when reviewing proposals that involve purchase of conservation easements or properties. Dan Budd and Shawn Kyes from WDFW's Real Estate group recommended that the Tributary Committees contract directly to have their own appraisals done, use an outside firm to obtain a second evaluation, or both.
- *WDFW Alternate on the Tributary Committees:* WDFW reported that Carmen Andonaegui will serve as alternate representative on the Tributary Committees.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last Hatchery Committees meeting on May 17, 2012, held at the Douglas PUD headquarters:

- *National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) Approval of Tumwater Dam Operations for 2012:* The Rock Island Hatchery Committee, including NMFS and USFWS, approved the Tumwater Dam operations for 2012.
- *Hatchery Monitoring and Evaluation (M&E) Programs (Adaptive Management):* The Hatchery Committees started discussion on the 5-year review and revision of the

Hatchery M&E Programs. It is expected that results from the first Five-Year M&E Reports will inform potential changes. The Committees agreed that Douglas and Chelan PUDs will initiate development of potential paths forward for this effort. The Committees need to finalize changes to the plans by September for the PUDs to have time to award new contracts.

- *Draft SOA Entiat National Fish Hatchery (NFH) Summer Chinook Brood Stock Collection:* The Hatchery Committees discussed approval (and will consider an SOA in June) for collection of summer Chinook at Wells Dam for broodstock for the Entiat NFH program.
- *Coho Restoration:* The Yakama Nation (YN) asked Chelan and Douglas PUDs to consider potential rearing space for coho salmon for their coho salmon reintroduction project. The YN may lose access to their existing space at Willard NFH, which is being considered for reprogramming for John Day mitigation.
- *Dryden Feasibility Study:* Chelan PUD is evaluating a Priest Rapids Coordinating Committee Hatchery Subcommittee proposal to construct a new surface water supply at the Dryden facility; this would open the possibility of implementing over-winter acclimation. Because the potential benefits expected from over-winter acclimation would be improved SARs and reduced straying, Chelan PUD asked whether alternative approaches to achieving these goals were considered. Because they had not, Chelan PUD has asked the Committees to consider investigating other options. A Washington State Department of Ecology Total Maximum Daily Load (TMDL) for phosphorus is anticipated to be in place in 2018 and may limit hatchery activities in the Wenatchee Basin in the future.

V. HCP Committees Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees meeting is June 26, 2012 (conference call only). The July 24, 2012, and August 28, 2012, meetings are planned for SeaTac, Washington.

List of Attachments

Attachment A – List of Attendees
Attachment B – HCP Washington D.C. Update May 2012

Attachment C – Focused on a Sustainable Future

Attachment D – 2012 CRITFC Sockeye Tagging at Wells Dam

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Josh Murauskas	Chelan PUD
Keith Truscott†	Chelan PUD
Tom Kahler*	Douglas PUD
Jerry Marco*	Colville Confederated Tribes
Teresa Scott*	WDFW
Bryan Nordlund*	NMFS

* Denotes Coordinating Committees member or alternate
† Joined for the discussion of Chelan PUD's General Manager and Commissioners' recent trip to Washington D.C.

Chelan County PUD

Habitat Conservation Plans (HCPs) Status Sheet • May 2012

CHELAN COUNTY POWER

Chelan PUD's Habitat Conservation Plans: A success story in the making

Chelan's Habitat Conservation Plans (HCPs) commit us to operate our dams so there is no net impact on Upper-Columbia salmon and steelhead by using a combination of fish bypass and spill to help move at least 93 percent of juveniles safely past the dams plus hatchery programs and habitat restoration in tributaries. By March 2013, Chelan must provide a report assessing the status of achieving no net impact. This report will focus on survival, hatchery programs and tributary program funding.

Young salmon and steelhead survival

Under the HCPs, Chelan PUD must meet minimum targets for either combined juvenile and adult survival (91%), or for juvenile survival only (93%) for fish traveling through our reservoirs and past our dams. Chelan has met or exceeded those levels for all spring migrating salmon and steelhead species at both Rocky Reach and Rock Island hydro projects*.

Spring Species	3-year average project passage survival (targets)	
	Rock Island Dam	Rocky Reach Dam
Sockeye	Target met	Target met
Spring Chinook	Target met	Target met**
Steelhead	Target met	Target met

**Once technology becomes available, Chelan PUD will address survival levels for the smaller subyearling Chinook which migrate in the summer. At this point there is no technology to measure survival for these fish.*

***Combined adult and juvenile measurement.*

Fish Spill* Levels (% of daily river flow)

Moving fish safely through the reservoirs and past the dams is a primary objective of the HCPs. To help move fish past the dams, Chelan PUD uses fish spill at Rock Island Dam and a fish bypass system with supplemental spill at Rocky Reach Dam.

	Spring	Summer
Rocky Reach	0%	9%
Rock Island	10%	20%

**Sending water and fish through spill gates during the juvenile fish migration season.*

Hatchery production - Targets met

Chelan PUD funds hatchery production as part of the no-net-impact requirement of the HCPs. These production targets will be adjusted in 2013 based on project survival and other factors.

Species	Location	Current production targets (fish)
Spring Chinook	Chiwawa River	298,000
	Methow River	288,000
Summer Chinook	Wenatchee River	864,000
	Similkameen River	576,000
	Methow River	400,000
	Chelan Falls	600,000
Sockeye	Lake Wenatchee	280,000
	Skaha Lake, BC	591,000
Steelhead	Wenatchee River	243,000

Tributary projects - Targets met

Chelan PUD funds two accounts for habitat projects as part of compensating for fish that do not survive migration through our reservoirs and past our dams. The funds are used by a committee to award money to projects that members decide will have the best biological outcome. These funds leverage other sources to make up Total Project costs.

HCP Habitat Account	No. of projects since 2005	Funding provided to date*
Rocky Reach	19	$1,291,308
Rock Island	27	$2,774,767
Total	46	$4,066,075
Total project costs		$19,396,064

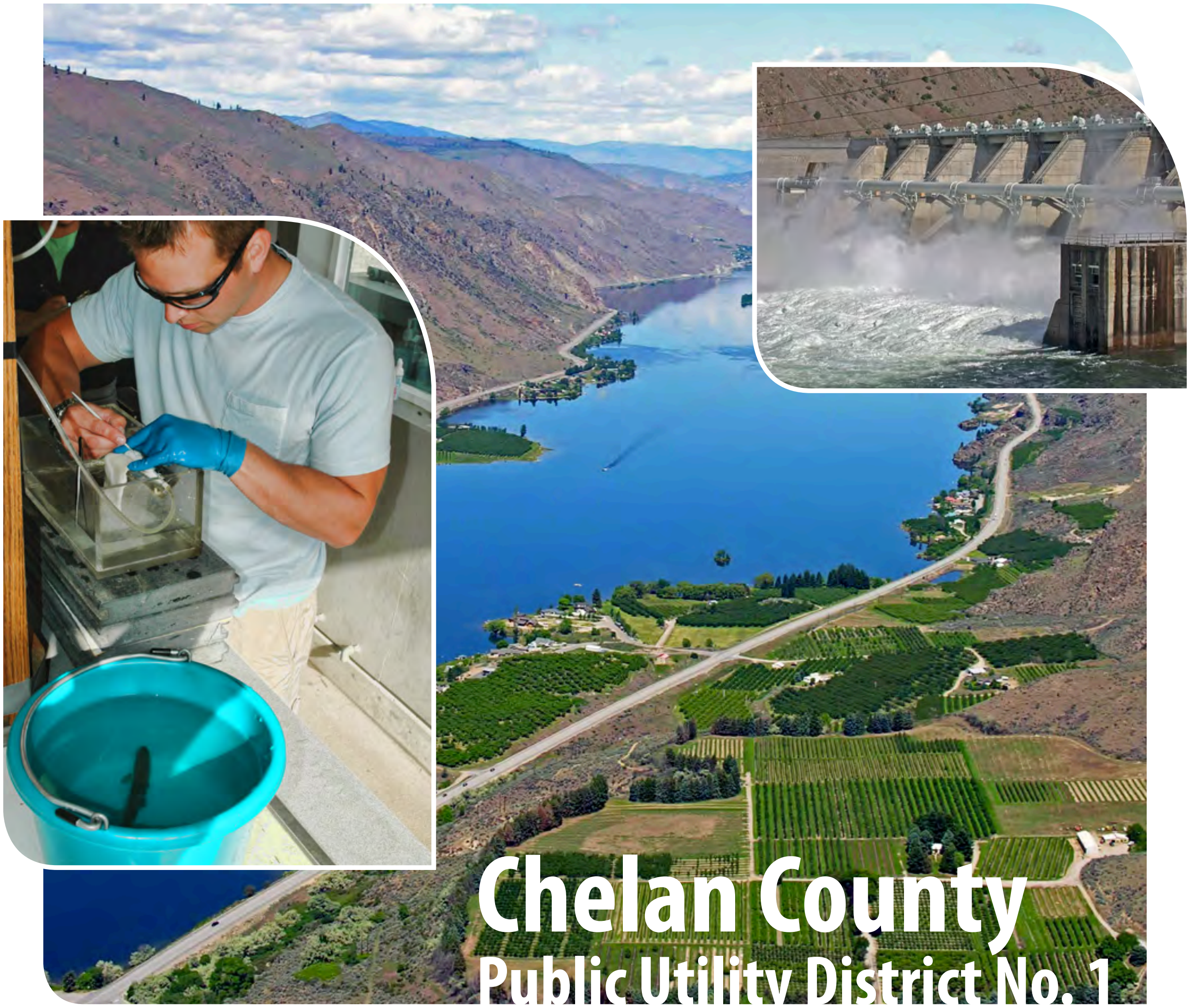
**as of Dec. 1, 2011*

Managing the HCPs toward success

The HCPs are managed by three operating committees: Coordinating, Hatchery and Tributary. Each committee is facilitated by a chair chosen by its members and each committee has a representative from the agencies and tribes that signed the agreements. All decisions are based on unanimous agreement. The signators are:

- Chelan County PUD
- Colville Confederated Tribes
- NOAA Fisheries Service
- US Fish and Wildlife Service
- Washington Department of Fish and Wildlife
- Yakama Nation

Contact: Keith Truscott - Natural Resources Director
(509) 661-4831 • keith.truscott@chelanpud.org



Chelan County Public Utility District No. 1

Focused on a sustainable future

CHELAN COUNTY
www.chelanpud.org

- *About Chelan PUD*
- *Deciding the future of the Columbia River Treaty*
- *Successes of our Habitat Conservation Plans*
- *Integrating wind energy into the regional transmission system*
- *Concerns with proposed tax exempt financing changes*
- *Chelan PUD's view of cyber security for the transmission grid*
- *Congressional hydropower bills show promise*

About Chelan PUD

Chelan County Public Utility District No. 1

May 2012

Chelan County Public Utility District (Chelan PUD) was formed in 1936 by local voters who wanted affordable power for rural as well as urban residents. The PUD delivered its first electricity 11 years later to a small group of customers near Lake Chelan. Today, the PUD operates three hydro projects that deliver clean, renewable, low-cost energy to 48,000 local customers and to other utilities that serve businesses and residents throughout the Pacific Northwest.

The District is directed by a five-member Board of Commissioners elected by the voters of Chelan County. These commissioners oversee a utility system that now includes local water, wastewater and wholesale fiber-optic services in addition to electricity.

Chelan County PUD relies on the mighty Columbia River for much of its hydropower generation. We recognize this great river as a multi-use system and we're proud to take a leadership role in environmental stewardship. Each year the District dedicates millions of dollars and thousands of work hours to protect and enhance fish, wildlife and plant ecosystems. As part of the hydropower operations, the PUD also built 14 parks that serve more than three million visitors each year.

Under the guidance of its elected commissioners, the PUD continues to deliver affordable, dependable utilities to rural and urban areas alike while also emphasizing careful management of our natural habitats. The belief that local people are the best stewards of resources has guided District actions for 75 years. Our ties to the river, local residents and the region are long and strong.

Deciding the future of the Columbia River Treaty

Electric customers should not be required to pay for power benefits that aren't received.

The Columbia River Treaty, which governs river operations between the U.S. and Canada, can be terminated in 2024 if notice is given by either party by 2014. If the Treaty continues without modification post-2024, U.S. power utilities would remain obligated to deliver Canadian Entitlement, a continuous power and energy delivery to the Canadian government paid for by the Northwest electricity customers. Over time, the value of the Canadian Entitlement has remained significant, while the actual benefit realized by U.S. hydro generators has decreased.

Currently, the Bonneville Power Administration (BPA) and the U.S. Army Corps of Engineers (Army Corps) are meeting with states and tribes to review the Treaty. A Columbia River Treaty Power Group has also formed to represent power interests. Members of the Power Group, including Chelan PUD, want to ensure a fair and equitable outcome for the estimated 6.4 million Pacific Northwest electric customers they serve. Further studies are needed to analyze Treaty costs and benefits for Canadian and U.S. operations, and determine impacts of post-2024 flood control on downstream power generation and fish. The Power Group is participating in modeling work with BPA and the Army Corps to consider post-Treaty operational scenarios.

Successes of our Habitat Conservation Plans

We've made a 50-year commitment to ensure our hydro projects have no net impact on mid-Columbia River salmon and steelhead.

Chelan PUD's two Columbia River dams, Rocky Reach and Rock Island, operate under "Habitat Conservation Plans" (HCPs) for migrating salmon and steelhead that commit the utility to a 100% "no net impact" standard, to be met 91% through survival (93% survival standard for juvenile fish); 7% through hatcheries; and 2% through habitat mitigation. Continued success of the HCP is key to Chelan PUD's ability to operate the projects.

Before the HCPs were established, regulatory agencies were contemplating a requirement of 40% river spill for the projects. Under the agreements, Chelan PUD was allowed to test and implement measures which worked better for fish and reduced the need for spill, such as the $107 million juvenile fish bypass system at Rocky Reach and effective predator control in the reservoirs. The HCPs provided for three operating committees through which the signatory parties (fish agencies, tribes and Chelan PUD) have identified issues and made decisions. The process has proved to be collaborative and effective.

At Rock Island, the 93% juvenile fish survival standard has been met, which allows Chelan PUD to reduce spill from 20% to 10% of river flow (with summer spill at 20%) for the next 10 years. At Rocky Reach, fish survival standards have been met for spring species, and the project may be operated with zero spill in the spring and 9% spill in the summer for the next 10 years. Chelan PUD is still verifying the standard for the final species, sub-yearling Chinook, which are difficult to study.

The debate over integrating wind energy into the regional transmission system

We support regional efforts to improve wind integration.

Chelan PUD is less directly affected by BPA's environmental redispatch policy because we do not purchase power from BPA, but we have an interest in a fair and functioning market. Lawmakers should consider reforming incentives that impede voluntary actions to reduce generation during times of oversupply. Chelan PUD understands BPA's need to act consistently with statutory obligations, and the PUD shares concerns about fish protection and elevated total dissolved gas - but also supports reform of BPA's policy to treat all generators fairly.

Chelan PUD sees merit in BPA's recent temporary oversupply cost-allocation proposal as addressing the comparability issues raised by FERC, but the PUD recognizes that longer-term solutions are still needed. Chelan PUD supports regional efforts to improve wind integration through dynamic scheduling and 30-minute intra-hour scheduling. Chelan PUD believes a cost/benefits study of a voluntary energy imbalance market, with both an energy and capacity component, would be appropriate.

Concerns with proposed tax exempt financing changes

Electric ratepayers would pay higher bills if the municipal bond interest exemption is capped.

Tax-exempt financing is an essential tool for financing public power's capital intensive infrastructure. The president's 2013 budget proposal would have capped the municipal bond interest exemption at 28% for high income earners. If this proposal were enacted into law, investors would likely demand higher interest rates for municipal bonds. This approach would be expected to increase financing costs for PUDs and essentially result in a tax increase on ratepayers.

Chelan PUD's view of cyber security for the transmission grid

We urge caution in adopting cyber security legislation for transmission.

Any cyber security legislation should 1) maintain the relationship between the FERC and the North American Electric Reliability Corporation (NERC) and not give FERC new authority over cyber security vulnerabilities or facilities that are not part of the bulk electric system; 2) enhance information sharing between utilities and the federal government; and 3) delineate the framework under which the government responds to an imminent cyber emergency.

Congressional hydropower bills show promise

Hydropower is one of our country's great resources.

Chelan PUD supports hydropower bills sponsored by Representative McMorris Rodgers and Senator Murkowski that facilitate small hydropower and conduit hydropower development and that direct the Federal Energy Regulatory Commission (FERC) to investigate the feasibility of an expedited two-year licensing process for closed-loop pumped storage and hydro installations at non-hydro dams. Chelan PUD also supports several other hydropower bills pending in Congress.

For more information

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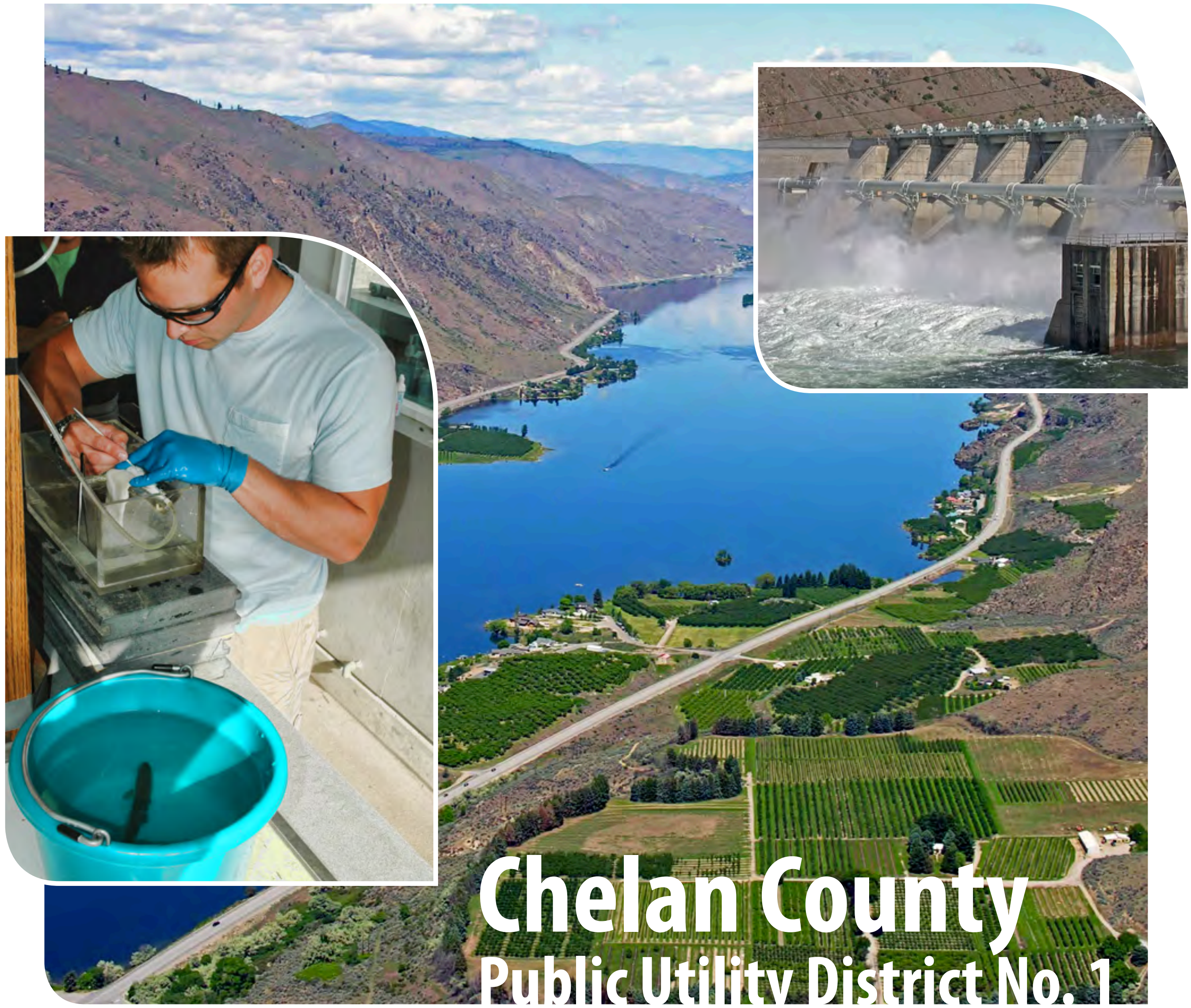

Chelan County
Public Utility District No. 1

Focused on a sustainable future

CHELAN COUNTY
www.chelanpud.org

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
729 NE Oregon, Suite 200, Portland, Oregon 97232 Telephone 503 238 0667
Fax 503 235 4228

April 26, 2012

Shane Bickford
Natural Resources Supervisor
Public Utility District Number 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, Washington 98801

Dear Mr. Bickford:

1200 max

In 2012, CRITFC is planning to once again sample sockeye salmon at Wells Dam. We hope to collect scale samples from up to 600 sockeye, all of which we will PIT tag if they have not already been tagged. In addition, we will acoustic tag up to 70 sockeye salmon and affix temperature tags on up to 200 sockeye salmon. We anticipate sampling from late June through late July. We will coordinate sampling activities with Wells Hatchery brood stock collection programs. Sampling personnel may include Ryan Branstetter and Jeff Fryer of CRITFC, Greg Robison, Kraig Mott, Tim Jeffris, and Barry Hodges of the Yakama Nation, and Jennifer Panther of the Colville Tribe.

One interesting result from last year was that approximately 15% of the Wells tagged fish passed the opposite fish ladder from which they were tagged. We would like to deploy additional acoustic receivers to investigate sockeye behavior after tagging. We hope to deploy some of these receivers in the ladders, as well as immediately upstream and downstream from the ladders. Jennifer Panther will be coordinating with Tom Kahler on possible sites and procedures for this potential deployment.

Please contact me or Dr. Jeff Fryer if you have any questions. Thank you for your cooperation with this study.

Sincerely,

Babtist Paul Lumley
Executive Director

Cc: Jayson Wahls, Wells Hatchery Complex Manager, WDFW
Chris Moran, Fish Management Division, WDFW
Mike Tonseth, Fish Biologist, WDFW
Tom Kahler, Fisheries Biologist, Douglas County PUD

NOTED
APR 30 2012
MEM

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	July 24, 2012
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the June 26, 2012, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Tuesday, June 26, 2012, from 9:30 am to 11:00 am. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Kristi Geris will redistribute to the Coordinating Committees fact sheets on HCP implementation that were presented during Chelan PUD's General Manager and Commissioners' recent trip to Washington D.C., and that were distributed to the Committees by Keith Truscott at the May 22, 2012 Coordinating Committees meeting (Item I-A).
- Mike Schiewe will request that Tom Kahler provide to the Coordinating Committees an overview of Douglas PUD's agenda items from today's meeting (Item II-A).
- Steve Hemstrom will distribute to the Coordinating Committees a study plan and details on the four spill configurations being tested during Chelan PUD's spill gate pattern test at Rocky Reach Dam (Item III-A).
- Steve Hemstrom will contact Chelan County (or the Chelan County Weed Board) to obtain further information on Chelan County's proposal to apply aquatic herbicide to control Eurasian milfoil in the Columbia River at Entiat Park (Item III-B).
- Bryan Nordlund will inquire internally within National Marine Fisheries Service (NMFS) to obtain information on the application of aquatic herbicide to control Eurasian milfoil in the Columbia River (Item III-B).
- Tom Kahler will report back to the Coordinating Committees on how Douglas PUD and Douglas County coordinate on issues of aquatic weed control (Item III-B).

- Kristi Geris will distribute to the Coordinating Committees the HCP Tributary Committees June Progress Report (Item IV).
- Steve Hemstrom will ask Steve Hays to provide a brief overview of the requirements and stipulations (including criteria) for receiving HCP Tributary Funds (Item IV).
- Mike Schiewe will contact Josh Murauskas to be sure he is aware of the Interagency Avian Workgroup, and to suggest that he contact the group regarding his analysis of the putative impact of avian predation on late migrating steelhead smolts (Item IV).

DECISION SUMMARY

- There were no Statements of Agreements (SOAs) approved at today's meeting.

AGREEMENTS

- There were no agreements discussed at today's meeting.

REVIEW ITEMS

- There are currently no items out for review.

REPORTS FINALIZED

- There are no reports that have been recently finalized.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and asked for any additions or changes to the agenda. No additions or changes were requested.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft May 22, 2012 meeting minutes. Kristi Geris reported that all comments and revisions received from the Coordinating Committees members were incorporated in the revised minutes and that there were no outstanding items remaining to be discussed. A request was made that Geris redistribute to the Coordinating Committees the fact sheets on HCP implementation that were presented during Chelan PUD's General Manager and Commissioners' recent trip to Washington D.C., and that were distributed to the Committees by Keith Truscott at the May 22, 2012 Coordinating Committees meeting. The draft May 22, 2012 meeting minutes were approved as revised. Geris will finalize the meeting minutes and distribute them to the Committees.

II. Douglas PUD

A. Update: Projects in Process at Wells Dam (Tom Kahler)

Tom Kahler was unavailable to present Douglas PUD's agenda items at today's conference call. Mike Schiewe requested that Kahler provide to the Coordinating Committees an overview of Douglas PUD's agenda items from today's meeting.

III. Chelan PUD

A. Rocky Reach Spill Gate Pattern Test – Total Dissolved Gas Evaluation (Steve Hemstrom/Lance Keller)

Steve Hemstrom said that on June 18, 2012, Chelan PUD will begin spill gate pattern testing at Rocky Reach Dam to determine if total dissolved gas (TDG) levels can be reduced downstream by using different spill gate patterns at the dam, as described in an email Hemstrom distributed to the Coordinating Committees on June 8, 2012.

Hemstrom said spill gate pattern testing at Rocky Reach Dam was first conducted in 2011. He said this second year of testing is being conducted to collect additional data on how tailrace TDG levels respond to different spill gate patterns. The testing will use the same four spill configurations that were used in 2011: TDG, Shallow Arc, Flattened, and Fish Spill patterns. Hemstrom said 24-hour testing will be conducted each day from June 18, 2012, until July 30, 2012. Data from the 2011 testing will be combined with this year's data to determine if there is a statistical difference in the gate patterns. Hemstrom said he will distribute to the Committees a study plan and additional details on the four spill configurations being tested.

Bryan Nordlund asked Hemstrom what the path forward would be if the gate patterns do not show a statistical difference. Hemstrom said that Chelan PUD hopes that with this second year of testing there will be sufficient data to indicate some differences; whether they are statistically significant or not, Hemstrom believes these differences will be useful. Hemstrom also said that Chelan PUD will likely have Dr. John Skalski analyze the combined data from both years.

Nordlund commented that it is also important to remember that spill patterns are designed to facilitate fish passage at the dams. He said it is important to be sure this testing does not affect, for example, the attraction of adults to the ladders, migration through the ladders, and egress out of the tailrace. Mike Schiewe asked Hemstrom if the spill patterns affect the collection efficiency of the bypass, and Hemstrom replied that the spill patterns are designed to increase both bypass efficiency and spill efficiency. Hemstrom added that during 2011 testing, the migration times for passive integrated transponder (PIT)-tagged adult spring Chinook did not show visible delays, and all adults detected at Rock Island during the various spill gate test scenarios successfully passed upstream of Rocky Reach.

Teresa Scott asked at what discharge level do we start experiencing TDG. Hemstrom said that if a spill gate pattern is identified through this study that reduces incoming and project-related TDG levels downstream, then potentially that spill pattern could be used when river flow and incoming TDG are high. Hemstrom added that the river flow and TDG level at which such a pattern would be implemented has not been decided. Scott said that it is important to manage each project to achieve a regional outcome (e.g., achieve a reduction in TDG through the entire Mid-Columbia system). Hemstrom responded that TDG from all Mid-Columbia projects is managed by the Mid-Columbia Hourly Coordination staff by distributing spill and generation levels among the five Mid-Columbia PUDs. Hemstrom concluded by saying Chelan PUD is only collecting data at this point with the spill gate pattern testing and that there will be substantive discussion with the Committees before any changes are considered at Rocky Reach Dam.

B. Chelan County's (Weed Board) Proposal to Apply Aquatic Herbicide to Control Eurasian Milfoil in the Columbia River at Entiat Park (Steve Hemstrom/Lance Keller)

Steve Hemstrom alerted the Coordinating Committees that Chelan PUD had received notification from the Chelan County Weed Board of their intent to apply aquatic herbicide to control Eurasian milfoil in the Columbia River at Entiat Park. Hemstrom said he currently had little information about this proposal but thought it should be brought to the attention of the Coordinating Committees. Bryan Nordlund said there are mechanical methods for removing milfoil, but Mike Schiewe said mechanical methods have the potential to spread milfoil when the milfoil is cut up. Bob Rose suggested that Chelan County be contacted to provide the Committees with details on this proposal; Hemstrom said he will contact Chelan County to obtain further information. Nordlund agreed to inquire internally within NMFS to obtain information on the application of aquatic herbicide to control Eurasian milfoil in the Columbia River. Schiewe said he will ask Tom Kahler how Douglas PUD and Douglas County coordinate on issues of aquatic weed control and report back to the Coordinating Committees. Hemstrom added that if Chelan County engages in any activity within the Rocky Reach Project boundary, they are required to work with Chelan PUD per their Federal Energy Regulatory Commission (FERC) license.

IV. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe reported that the HCP Tributary Committees last met on June 14, 2012. Kristi Geris said she will distribute to the Coordinating Committees the HCP Tributary Committees June Progress Report. The following items were discussed:

- *General Salmon Habitat Program Pre-proposals*: The Tributary Committees received 27 pre-proposals for the 2012 round of the General Salmon Habitat Program. Thirteen projects were found to be either inconsistent with the intent of the Tributary Fund or did not have strong technical merit; and so the Committees solicited full proposals from the remaining 14 projects, which are due on June 29, 2012. The proposed projects are located in the Okanogan, Foster, Methow, Entiat, and Wenatchee basins. Teresa Scott asked about the criteria that are used to evaluate the proposals. Steve Hemstrom said that the Tributary Committees use both technical and biological criteria that were established by the Upper Columbia Regional Technical Team (RTT). Hemstrom added that HCP Tributary Funds are used to match funds for large projects that also include funds from the Salmon Recovery Funding Board and Bonneville Power Administration. Hemstrom said he will ask Steve Hays to provide a brief overview of the requirements and stipulations (including criteria) for receiving HCP Tributary Funds.

- *Small Projects Program Application*: The Rock Island Tributary Committee approved funding for the Wenatchee Levee Removal and Riparian Restoration Project. The project, located at river mile 13.5 on the Wenatchee River, will remove 300 feet of levee, restore the riparian zone, and eliminate a surface-water irrigation diversion. Approved HCP Tributary Funds will cover $56,700 of the $67,450 total cost of the project.
- *Evaluation of Appraisals*: The Tributary Committees have been discussing how they can better evaluate appraisals. Washington Department of Fish and Wildlife (WDFW) Real Estate Services advised the Tributary Committees to hire a firm to conduct appraisals, or hire a firm to review the appraisals. The Committees decided to do both (i.e., hire both the appraiser and the reviewer).
- *Next Steps*: The next Tributary Committees meeting will be July 12, 2012. The Tributary Committees plan to evaluate General Salmon Habitat Program proposals, discuss a policy for stewardship plans and public access on protected properties, and continue their discussions on appraisals and the appraisal process.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last Hatchery Committees meeting on June 20, 2012, held at the Chelan PUD headquarters:

- *Collection of Entiat National Fish Hatchery (NFH) Summer Chinook Broodstock at Wells Hatchery SOA*: The Wells Hatchery Committee approved the Collection of Entiat NFH Summer Chinook Broodstock at Wells Hatchery SOA. The SOA approves the collection of up to 270 hatchery origin summer Chinook adults to support the Entiat summer Chinook program.
- *5-Year Update of the Monitoring and Evaluation (M&E) Plan*: The Hatchery Committees are reviewing and updating the Chelan PUD and Douglas PUD Hatchery M&E Programs following the completion of the first 5-year summary reports. Josh Murauskas and Greg Mackey presented ideas for initial approaches for reviewing and revising the Hatchery M&E Programs. The Hatchery Committees agreed to convene a smaller workgroup to further discuss recommendations for revisions. A timeline for this process has not yet been developed; however, the goal is to complete the revisions by the end of 2012.

- *Methow Broodstock Collection Update*: WDFW asked the Hatchery Committees for a recommendation for dealing with 27 spring Chinook collected at Wells Dam for Methow broodstock that appear to be of Carson lineage. The Hatchery Committees recommended that the fish not be retained for broodstock, but agreed to their release in the Methow River.
- *Steelhead Residualism and Predation*: Josh Murauskas presented an analysis suggesting a relationship between release data of hatchery steelhead and rates of avian predation. Avian predation was measured by recovering PIT tags from bird colonies on local islands. The analysis shows a significant correlation between later release and a higher likelihood of recovering a PIT tag on one of the islands. Bryan Nordlund said the Priest Rapids Coordinating Committee has also been discussing this issue and suggested that Murauskas consider sharing his findings with that group. Teresa Scott said the U.S. Army Corps of Engineers has convened an Interagency Avian Predation Workgroup (IAPWG) that addresses avian predation. Schiewe said he will contact Murauskas to be sure he is aware of the IAPWG, and will suggest that he contact the group regarding his analysis of the putative impact of avian predation on later migrating steelhead smolts. Scott added that she would like to see broader involvement of all parties in decision-making regarding controlling avian predation. She said that this is a regional issue that is not location specific.
- *Presentation: Dryden Phosphorus Total Maximum Daily Load (TMDL)*: Chelan PUD's Sam Dilly gave a presentation on the Wenatchee River phosphorus TMDL that will be implemented by the Washington State Department of Ecology beginning in 2018. The TMDL may affect rearing at the Dryden Facility. Current background levels of phosphorus are already higher than the TMDL. The Hatchery Committees discussed the potential for using low phosphorus feed and automated feeders, and for rearing summer Chinook to smaller size at release to manage the phosphorus concentration in discharge water. Chelan PUD and Grant PUD agreed to develop a detailed timeline, including milestones, for evaluating options for addressing compliance with the proposed TMDL at the Dryden Rearing Facility.
- *HGMP Update*: Craig Busack reported that NMFS is currently working on the Snake River fall Chinook and Chiwawa spring Chinook Biological Opinions. He said that for the Methow, NMFS is in discussions with WDFW, Douglas PUD, and the affected

tribes regarding reduced production of spring Chinook and steelhead, targeting a proportion hatchery origin spawners (pHOS) of 25 to 30 percent for spring Chinook. Busack also mentioned that NMFS is taking a second look at the White River Project, and is considering alternatives because of local land use permitting issues. Lastly, Busack said it was clear that there are significant differences of opinion regarding the effects of trapping at Tumwater Dam, and NMFS is planning to further investigate the basis for these differences.

V. HCP Committees Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees meetings are July 24, 2012, August 28, 2012, and September 25, 2012, planned for the Radisson Hotel at SeaTac, Washington.

List of Attachments

Attachment A – List of Attendees

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Bob Rose	Yakama Nation
Tom Kahler*	Douglas PUD
Jerry Marco*	Colville Confederated Tribes
Jim Craig*	USFWS
Teresa Scott*	WDFW
Bryan Nordlund*	NMFS

* Denotes Coordinating Committees member or alternate

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	August 29, 2012
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the July 24, 2012, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Gateway Hotel in SeaTac, Washington, on Tuesday, July 24, 2012, from 9:30 am to 12:00 pm. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Steve Hemstrom will update the Coordinating Committees on Chelan PUD's progress on installing a bar system on the outside of the left bank fishway overflow protection gate to prevent fish from entering the space between the fishway and the left bank shore. The bar system will be installed during the Rock Island left bank fishway maintenance period (late winter 2012/2013) (Item III-A).
- Steve Hemstrom will distribute photos of the area between the left bank and left bank fishway at Rock Island Dam where the sockeye and summer Chinook were unintentionally trapped (Item III-A).
- Mike Schiewe will contact Bill Tweit to confirm a presentation for the August 28, 2012 Coordinating Committees meeting covering potential renegotiation of the Columbia River Treaty (Item V-A).

DECISION SUMMARY

- The Coordinating Committees approved the Statement of Agreement (SOA) to implement a 1.0-foot fishway-entrance head-differential for lamprey from 17:00 to 00:59 daily during the 2012 lamprey migration period at Wells Dam (Item II-A).

AGREEMENTS

- There were no agreements discussed at today's meeting.

REVIEW ITEMS

- Kristi Geris sent an email notification to the Coordinating Committees on July 23, 2012, stating that the Draft 2011 Douglas PUD Pikeminnow Program Annual Report is out for a 60-day review period with comments due to Tom Kahler by September 21, 2012.

REPORTS FINALIZED

- There are no reports that have been recently finalized.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and asked for any additions or changes to the agenda. Tom Kahler added an update on the 2011 Douglas PUD Pikeminnow Program Annual Report.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft June 26, 2012 meeting minutes. Kristi Geris said there was one outstanding comment remaining to be discussed regarding something that was said by Steve Hemstrom during the Rocky Reach Spill Gate Pattern Test discussion; Hemstrom clarified what he had said. Teresa Scott also clarified a question she asked during that same discussion. Geris said that all other comments and revisions received from the Coordinating Committees members were incorporated in the revised minutes. The draft June 26, 2012 meeting minutes were approved as revised. Geris will finalize the meeting minutes and distribute them to the Committees.

II. Douglas PUD

A. DECISION: Implementation of Modified Fishway Operations at Wells in 2012 During the Lamprey Migration (Tom Kahler)

Tom Kahler introduced an SOA to implement a 1.0-foot fishway-entrance head-differential for lamprey from 17:00 to 00:59 daily during the 2012 lamprey migration at Wells Dam (Attachment B). The draft SOA was distributed to the Coordinating Committees by Kristi Geris on July 17, 2012. Kahler said this SOA requests the same lamprey operation that was approved by the Committees in 2011. Kahler said that last year the modified fishway operations at Wells began on August 19, 2011; this year, Kahler said, one lamprey had already passed Rocky Reach on July 18, 2012. Kahler said no lamprey have passed at Wells.

Mike Schiewe said that the Aquatic Settlement Workgroup is in the process of developing a Lamprey Study Plan, combining the installation of infrared (IR) cameras in the Wells fishway and the active tagging of translocated adult lamprey, to assess lamprey passage and enumeration at Wells Dam. The study plan is intended to improve the accuracy of fish counts at Wells Dam, and to detect lamprey that may be passing through the picketed lead and bypassing the counting window. Bob Rose added that a more robust lamprey evaluation is anticipated over the next few years, with the tagging of translocated lamprey a component of the plan. The Coordinating Committees approved the SOA to implement a 1.0-foot fishway-entrance head-differential for lamprey from 17:00 to 00:59 daily during the 2012 lamprey migration period at Wells Dam.

B. Update: 2012 Subyearling Life History Studies (Tom Kahler)

Tom Kahler said approximately 20,000-plus subyearling summer/fall Chinook salmon were tagged during the seining efforts from June 25, 2012, to July 12, 2012. Kahler said most fish were collected near the mouth of the Okanogan. However, as the recapture rate increased at that location, seining was moved to an area located approximately one mile above Wells Dam, which Kahler said likely included Methow-origin fish. Kahler said fish were also collected and tagged upstream of the Okanogan near Washburn Island. To date, there has been approximately 700 detections at all locations, including approximately 300 detections at Rocky Reach and others at John Day, McNary, and Bonneville dams. Kahler added that fish bypass system efficiency (and hence tag detection efficiency) at dams will likely be affected by the high flows and involuntary spill this year.

Kahler said that Douglas PUD staff revisited the sampling site above Wells Dam on July 20, 2012, to determine if juvenile Chinook salmon were still present. He said their seining caught a mix of previously tagged and untagged fish ranging in length from 55 millimeters (mm) to 80 mm. Kahler said the 2011 Subyearling Study Report is expected to be released by the end of this summer.

Jerry Marco asked how sampling compared between the 2011 and 2012 studies. Kahler replied that in 2011, their sampling started slowly as they were learning where to fish. Kahler said that as a result of last year's research, this year they were able to go directly to the areas where they knew there were fish, and conversely, skip the areas where there were few fish in 2011. Further, Kahler said that in the areas where many fish were sampled in 2011, even more fish were sampled in 2012. Kahler added that sampling was conducted using a 100-foot-long seine, and on occasion, up to 800 to 1,000 fish were sampled per haul. Kahler said that he has not compared the numbers; however, sampling efforts seemed more productive this year than in 2011.

Jim Craig asked which species were numerically dominant in the bycatch; Kahler said that bycatch was minimal in most seine sets and in some locations rare; but in a few locations there were large numbers of stickleback, juvenile suckers, and shiners. Kahler said they did not routinely examine stomach contents of large predatory species caught; however, in 2011, a bass was caught that had the tail of a subyearling Chinook protruding from its mouth. Bryan Nordlund asked if any hatchery fish were observed, and Kahler replied that no adipose-clipped fish were observed.

C. Update: 2011 Douglas PUD Pikeminnow Program Annual Report (Tom Kahler)

Tom Kahler noted that the Draft 2011 Douglas PUD Pikeminnow Program Annual Report is out for a 60-day review period; Kristi Geris notified the Coordinating Committees of its availability by email on July 23, 2012. Comments are due to Kahler by September 21, 2012.

Kahler noted that the January date on the draft report reflects the date the report was distributed to Douglas PUD staff for internal review.

III. Chelan PUD

A. Chelan County's Rock Island Left-Bank Fish Recovery – Review of Events (Steve Hemstrom)

Steve Hemstrom updated the Coordinating Committees on the status of the fish recovery in the area adjacent to the Rock Island left bank fishway. He said the recovery effort is managed by Lance Keller, and has been described in emails distributed to the Coordinating Committees by Kristi Geris on July 12, 2012; July 13, 2012; and July 22, 2012. Hemstrom said that an area between the riprapped shoreline and the left bank fishway wall, and approximately 45 feet deep, receives overflow water from the left-bank fishway through slots in the fishway wall as a hydraulic/structural protection measure for the fishway itself. Extra water from the fishway flowed into the space, and then exited into the tailrace through a hydraulic relief gate which opened under increased hydraulic pressure. Hemstrom said that when the hydraulic relief gate opened to let the overflow water out of the space, sockeye and summer Chinook salmon entered the space from the tailrace. Hemstrom described the gate as approximately 8 feet by 8 feet and partially submerged, opening and closing automatically to reduce fishway flow. Hemstrom said the gate opened on July 11, 2012, and an estimated 200 to 250 fish entered the space from the fishway; it is unknown how long the gate was open. He said Chelan PUD staff decided to not reopen the gate and run the risk of more fish entering the space than going out. Teresa Scott asked how long this gate system has been in operation at Rock Island; Hemstrom said since the 1960s. Keller added that the gate opened and a similar incident occurred in the 1980s.

Keller said an early visual estimate of the fish trapped in the space was approximately 150 sockeye salmon and 125 summer Chinook salmon. He said Chelan PUD seasonal employees used hook and line on July 13, 2012, to remove 13 sockeye. Hook and line attempts continued on July 16, 2012, and additional fish were caught and released. Keller said a seine net was not as successful due to a natural basalt outcrop in a section of the shoreline where trapped fish were able to avoid the multiple seine attempts. Stainless steel fish traps originally made for capturing pikeminnow, were modified to provide attraction flow through the trap and were submerged in the space. The traps have caught up to 20 fish per day.

Keller said that a Denil and trap with pumped attraction entering a floating box frame and net pen is currently under design for testing. Tangle nets, 15 feet in length with 5-inch mesh, were deployed, and six sockeye were captured, but this method caused two mortalities; therefore, the tangle nets were abandoned. Another method that was rejected involved modifying the panel in the fishway itself; this method posed significant structural concern and ran the risk of more fish entering the space from the fishway itself. Keller said installing a slide gate was also considered; however, this option was determined to be infeasible.

Keller said that 136 sockeye salmon and one summer Chinook salmon have been removed to date, including five sockeye mortalities. Keller said that all other fish have been in good shape when released. Hemstrom and Keller invited the Coordinating Committees to offer suggestions and ideas on how to recover the remaining fish. Keller added that a dedicated crew is working every day on this recovery effort. He also noted that some options are unavailable because BNSF Railway owns a portion of the shoreline adjacent to the space. Hemstrom said that in December 2012, Chelan PUD engineers plan to design and construct a bar system to cover the tailrace side of the relief-gate preventing fish from entering the space again if the relief gate is opened. Hemstrom said he will keep the Coordinating Committees updated on the progress of this Rock Island left-bank fishway maintenance period.

Keller concluded that the current plan is to continue hook and line, and test the steep-pass Denil option. Hemstrom said he will distribute photos to the Committees of the area between the left bank and left bank fishway at Rock Island Dam where the sockeye and summer Chinook salmon are trapped.

B. Update: Pioneer Water District Irrigation Water Withdrawal (Steve Hemstrom)

Steve Hemstrom updated the Coordinating Committees on Pioneer Water District's plans to install a pipeline in the lower Wenatchee River near the confluence with the Columbia River. The pipeline will cross a portion of the Rocky Reach Project Boundary, and will therefore require approval from the Federal Energy Regulatory Commission (FERC). A Hydraulic Project Approval (HPA) permit from the State must also be acquired by the Pioneer Water District before work begins. Hemstrom said the project details are being developed by Pioneer Water District and Trout Unlimited; however, these details are not yet finalized. Hemstrom said the project should be beneficial for fish, and that he will keep the Committees updated as plans progress. Teresa Scott added that most funding for this project is from Washington State Department of Ecology (Ecology).

C. 2012 Adult Passage Counts at Rock Island and Rocky Reach (Steve Hemstrom)

Steve Hemstrom said adult passage fish counts look great. He said that Rock Island is three days behind on posting counts due to so many fish passing on July 19, 2012, and July 20, 2012. The passage count at Rock Island was 354,877, averaging a rate of 10,000 fish per day, which leads to an estimated total count of 394,000 over Rock Island. The passage count at Rocky Reach is 350,000 and Wells is a few behind Rocky Reach.

IV. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe reported that the HCP Tributary Committees last met on July 23, 2012, and that Kristi Geris distributed the HCP Tributary Committees July Progress Report to the Coordinating Committees on July 23, 2012. The following items were discussed:

- *2012 General Salmon Habitat Program Proposals*: The Tributary Committees selected six projects to receive Tributary Funds out of the 16 full proposals received for consideration under the General Salmon Habitat Program. The largest Tributary funds contributions went towards the Upper Beaver Creek Habitat Improvement ($205,225), and to Fish Passage at Shingle Creek Dam ($118,450). Kahler said that Shingle Creek in the Canadian Okanagan is among the best tributary spawning areas on the Okanagan.

  Regarding the summary table of 2012 General Salmon Habitat Program Projects listed in the HCP Tributary Committees July 2012 Meeting Progress Report, Teresa Scott asked for clarification on the footnote for the Twisp River Elbow Coulee Phase II Restoration. Kahler said the footnote was intended to indicate that if BPA elects to fund the entire project, the Wells Committee will not need to contribute any matching funds.

  Scott asked Kahler about the criteria used to evaluate the proposals. Kahler explained that there are no explicit rating criteria to determine fundability of a project. Scott said if there are different purposes for what the Upper Columbia Regional Technical Team (RTT) funds and what the Tributary Committees fund; she said she is interested in any difference. Kahler explained that the RTT does not have funds to distribute, but rates projects according to established criteria for the annual funding rounds of the Salmon Recovery Funding Board (SRFB), which has a set amount of funds to disburse each year that they are required to spend. The Tributary Committees do have dedicated funds to distribute but are not obligated in any given year to fund projects if they do not have consensus.

- *Small Projects Program Applications*: The Tributary Committees received three Small Projects Program Applications, all of which the Tributary Committees elected not to fund because the applications lacked detailed information needed to comprehensively evaluate the potential success of the proposed actions.
- *Acquisitions*: The HCPs include a provision that the PUDs can hold titles to acquired properties; however, the PUDs are uncertain that they want to exercise this option because of the associated liability and other potential implications. Therefore, the PUDs are discussing internally how to address this situation.
- *Methow Conservancy Questions:* The Tributary Committees responded to questions from the Methow Conservancy confirming the requirement for granting public access on conservation easements and acquisitions funded by the Tributary Committees.
- *Next Steps*: There will be no Tributary Committees meeting in August. The next Tributary Committees meeting will be held on September 13, 2012.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last Hatchery Committees meeting on July 18, 2012, held at the Douglas PUD:

- *Summer Chinook Growth Modulation Experiment*: Josh Murauskas has been working with Brian Beckman and Don Larson (National Marine Fisheries Service [NMFS] Northwest Fisheries Science Center) to develop a plan to evaluate fish size at release at summer/fall Chinook acclimation facilities, including the Dryden Facility. Because a reduced size at release would reduce feeding and hence phosphorus in waste water discharge, the results of the study could contribute to meeting the proposed Wenatchee River phosphorus Total Maximum Daily Load (TMDL). Chelan PUD is developing a full proposal to present to the Hatchery Committees. If approved the study would begin in fall 2012.

- *Dryden Acclimation Ponds*: Alene Underwood presented a description of actions developed by Chelan PUD to ensure summer Chinook production and infrastructure complies with the Wenatchee River TMDL for phosphorus. Detailed study plans are still under development. There was also further discussion regarding the Dryden water source issue. The Joint Fisheries Parties (JFP) would like to see Chelan PUD take advantage of Grant PUD's offer to install a dedicated surface water intake at the Dryden Facility. The JFP are anxious for Chelan PUD to complete their due diligence, including reconciling water rights issues and conducting chemical analyses in the irrigation canal (which is scheduled for 2013). Tom Scribner recommended that the fisheries parties collectively meet with Ecology regarding the TMDL issue. Underwood explained that Chelan PUD has multiple interests in the TMDL, particularly because Chelan PUD deals with wastewater. Therefore, Underwood said that Chelan PUD will need to be careful that communication with Ecology is first internally vetted.
- *Douglas PUD and Chelan PUD Hatchery M&E Updates*: Douglas PUD and Chelan PUD laid out schedules for their respective 5-year review and updating of the Hatchery Monitoring and Evaluation (M&E) Programs. Both PUDs said their updated programs may be ready for implementation in 2013. A Hatchery M&E Programs working group has been set up to review and recommend revisions to the Hatchery M&E Plans.
- *Methow Sharing Agreement*: The sharing agreement for Chelan PUD to produce spring Chinook at Methow Hatchery has expired. Chelan PUD is working with Douglas PUD on a new agreement but is uncertain if a new agreement will be worked out. There are several issues and entities affected by these sharing arrangements, including the Colville Confederated Tribes' plans at Chief Joseph.
- *Yakama Nation Coho Restoration Program Update*: The Yakama Nation (YN) has been working with Douglas PUD regarding the potential to rear coho salmon at Wells Hatchery. The YN is also looking for potential coho acclimation sites in the Chewuch River.

- *HETT Update*: The Non Target Taxa of Concern (NTTOC) risk modeling exercise is approaching a point where most model runs are complete. In an effort to evaluate how much further to go, the Hatchery Committees are asking the Hatchery Evaluation Technical Team (HETT) to develop a consensus report based on the modeling results, opposed to moving forward with the Delphi route. Early modeling results suggest there is minimal impact of the supplemented populations on non-target taxa.

V. HCP Committees Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees meetings are August 28, 2012; September 25, 2012; and October 23, 2012, all planned for the Radisson Hotel at SeaTac, Washington.

Dr. Kim Hyatt, Fisheries and Oceans Canada, will attend the August 28, 2012 Coordinating Committees meeting and provide an update on implementation of the Fish and Water Management Tool (FWMT) in the Canadian Okanagan. Mike Schiewe said he will also contact Bill Tweit to confirm a presentation for the August meeting covering potential renegotiation of the Columbia River Treaty.

List of Attachments

Attachment A – List of Attendees
Attachment B – SOA to implement a 1.0-foot fishway-entrance head-differential for lamprey from 17:00 to 00:59 daily during the 2012 lamprey migration period at Wells Dam

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Bob Rose†	Yakama Nation
Tom Kahler*	Douglas PUD
Jerry Marco*†	Colville Confederated Tribes
Jim Craig*	USFWS
Teresa Scott*	WDFW
Bryan Nordlund*†	NMFS

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

Wells HCP Coordinating Committee
Statement of Agreement to implement 1.0' Fishway-entrance Head-differential for Lamprey from 17:00 to 00:59 daily during the 2012 Lamprey Migration at Wells Dam

Date of Approval:

Statement

The Wells HCP Coordinating Committee (CC) approves the request of the Wells Aquatic Settlement Work Group (ASWG) for operating the Wells fishway collection galleries at a 1.0' head differential from 17:00 to 00:59 daily during the 2012 lamprey migration. The requested operations will commence three days after the day on which the cumulative passage of lamprey at Rocky Reach Dam equals five lamprey, and terminate on September 30.

Background

Douglas PUD and the Aquatic Settlement Work Group are evaluating ways to improve the ladder-entrance efficiency for adult lamprey attempting to pass Wells Dam. Radio-telemetry studies and passive monitoring indicate that normal operating conditions may present a velocity impediment to lamprey passage through the fishway entrances. The Wells HCP CC approved studies in 2009 and 2010 at Wells Dam that used Dual Frequency Identification Sonar (DIDSON) technology to observe the behavior of lamprey attempting to pass the fishway entrances under different operating conditions.

At the request of the Wells HCP CC, the studies also included observations of salmonid behavior in response to changes in operating conditions. The results of those studies indicate that lamprey entrance efficiency may be enhanced by reducing the collection-gallery-to-tailwater head differential from 1.5' to 1.0' between 17:00 and 0:59 hours during the peak of the lamprey migration. Post-hoc analyses indicate this is the eight-hour block with the lowest diel salmonid passage activity and highest diel lamprey activity. Analysis of data on the passage of salmonids during the DIDSON studies indicated no significant difference in passage rates of steelhead or sockeye, Chinook, or coho salmon with either a 1'0 or 1.5' head differential.

Conclusions regarding lamprey performance under different flow velocities were drawn from DIDSON observations of only a few lamprey. As a best-management practice and until operational changes can be tested in 2013 with an active-tag study, Douglas PUD and the ASWG propose to operate the Wells Dam fishway entrances with a 1-foot differential at night as a means of enhancing adult lamprey passage.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	September 25, 2012
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the August 28, 2012, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Gateway Hotel in SeaTac, Washington, on Tuesday, August 28, 2012, from 9:30 am to 1:30 pm. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Steve Hemstrom will finalize Chelan PUD's Spill Programs Report, after Rocky Reach and Rock Island bypass operations are complete on August 31, 2012. The final report will include bypass index counts, and corrections to the dates reported in the draft document for Rock Island's 2012 summer spill start and stop dates. Hemstrom will provide the finalized report to Kristi Geris for distribution to the Coordinating Committees (Item IV-A).

DECISION SUMMARY

- There were no decisions at today's meeting.

AGREEMENTS

- There were no agreements at today's meeting.

REVIEW ITEMS

- Kristi Geris sent an email notification to the Coordinating Committees on July 23, 2012, stating that the Draft 2011 Douglas PUD Pikeminnow Program Annual Report is out for a 60-day review period with comments due to Tom Kahler by September 21, 2012.

REPORTS FINALIZED

- There are no reports that have been recently finalized.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and asked for any additions or changes to the agenda. No additions or changes were requested.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft July 24, 2012 meeting minutes. Kristi Geris said all comments and revisions received from Committees' members were incorporated in the revised minutes, and there were no outstanding edits or questions to discuss. The draft July 24, 2012 meeting minutes were approved as revised. Bryan Nordlund approved the July meeting minutes by email as distributed to the Coordinating Committees on August 13, 2012. Geris will finalize the meeting minutes and distribute them to the Committees.

II. Douglas PUD

A. Update: Rebuild of Wells Hatchery (Shane Bickford)

Shane Bickford said that Douglas PUD is currently in Phase I of modernizing Wells Hatchery. He said Phase I includes a facility assessment, a groundwater well field assessment, and bio-programming. Bickford said Phase II will address configurations for the facility in terms of water needs for Wells Hatchery operations. He said that Douglas PUD plans to use only a portion of allotted water for rearing at the Wells Hatchery facility, and it is yet to be determined how or if the remaining allotted water will be used. Bickford said Douglas PUD has discussed potential options with several agencies, including the Yakama Nation's (YN's) Upper Columbia Coho Reintroduction Program and Twisp River Steelhead Kelt Reconditioning Program; Grant PUD's Steelhead Program; and various Colville Confederated Tribes (CCT) programs. Bickford said Phase II of the Wells Hatchery rebuild will also address steelhead and Chinook management, including various rearing strategies. He said Douglas PUD anticipates completing Phase II by November 2012; completing Phase III by January 2013; and commencing construction by 2014. Bickford said there are a lot of stakeholders that are interested in the bio-programming at Wells Hatchery, and that Douglas PUD wants to be sure people are well-informed on the rebuild process. Bickford added that the Hatchery Committees have been informed of the rebuild.

B. Update: 2012 Bypass Operations (Tom Kahler)

Tom Kahler said that in accordance with the Douglas PUD 2012 Bypass Operating Plan (BOP), bypass operations at Wells Dam started April 12, 2012, and ended August 19, 2012. Kahler said that a maximum of three bypass barriers were removed at one time to manage high flows. He said that the three barriers were removed by June 26, 2012, and all barriers were reinstalled by August 2, 2012. Kahler said Wells Dam operated under a regular configuration from August 2, 2012, through August 19, 2012, when bypass operations ended for 2012.

C. Update: Total Dissolved Gas (Shane Bickford)

Shane Bickford said that the 2012 spill season was a challenging flow year, characterized by high total dissolved gas (TDG) levels. He said that last week, TDG levels were in the 122 percent range for four days, and that TDG concentrations exceeded the 120 percent limit for five days. Bickford said that August 26, 2012, was the first day of the current fish passage season that Chief Joseph Dam discharged water in compliance with the TDG standard (below 110 percent).

Bickford said there were 12 instances during the current fish passage season when gas bubble trauma (GBT) monitoring was triggered at Rocky Reach Dam, based on hourly TDG concentrations of 125 percent or greater in the Wells Tailrace. He said that signs of GBT were observed on two of the 12 days; these signs were observed in less than 1 percent of the fish sampled. He said that, from a biological standpoint, TDG concentrations have not posed many problems.

D. Presentation by Dr. Kim Hyatt, Fisheries and Oceans Canada, on implementation of the Fish and Water Management Tool in the Canadian Okanagan (Dr. Kim Hyatt)

Dr. Kim Hyatt, Fisheries and Oceans Canada, introduced the Fish and Water Management Tool (FWMT; Attachment B), and provided an overview of the authors and contributors to FWMT development. Hyatt provided information on the Okanagan Lake/River (OLR) System, including geography, water management control points, and hydrology. He described factors that drive water management decisions in the OLR-System, and issues that affect water management decisions. Hyatt summarized the history of compliance with fishery flows prior to 1997; and he noted that reduced compliance was often the result of competing rules and objectives.

Hyatt said that he was asked to develop a model that could be used to guide a water release strategy quickly enough to inform water managers required to make daily water release decisions. He described the development of the FWMT, starting with the development of a program to model flow versus water needs during critical sockeye salmon life stages. Hyatt explained that available spawning habitat was modeled as a function of flow, and he described how the quantity of habitat could be controlled by flow and how water-release practices affect the survival of sockeye eggs and alevins in that habitat. With the FWMT, water managers can avoid dewatering of redds and flood-scour events, that have historically resulted in substantial density-independent mortality. Hyatt presented the results of an evaluation of risks, by life stage, to the Osoyoos Lake sockeye population as a result of a temperature-oxygen "squeeze," a density-independent rearing limitation in Osoyoos Lake. He said that flows into and out of Okanagan Lake were monitored on a real-time basis, allowing water managers to monitor potential effects on fish in Osoyoos Lake, and to make informed decisions on water use for fish. Hyatt said that this year, in spite of it being a good water year, the upper basin has begun to experience conditions that will result in a temperature-oxygen "squeeze." Hyatt said an option to use pulse discharge to avoid losses to juvenile and adult sockeye is being considered. He said the FWMT will help inform managers of current conditions in terms of thresholds. Hyatt said that in the north basin, sockeye like to hold at 9 to 12 degrees Celsius, 15 to 20 meters below the surface, with at least 5 parts per million (ppm) oxygen.

Hyatt reviewed examples of predicted versus actual flows to demonstrate how the FWMT has been used to inform conditions at several locations. He also reviewed examples of how FWMT predictions for sockeye fry emergence have been used by water managers to manage water storage and release strategies to minimize density-independent mortality associated with scour events. He showed an example of a range of water storage or release options the FWMT produced for three locations in August 2009. He said the FWMT calculated the best options for both domestic and agricultural purposes, and it also calculated what was in the best interest of fish.

Hyatt recapped that the FWMT is a coupled set of biophysical models of key relationships used to predict the consequences of water management decisions for fish and other water users, allowing water managers to avoid or minimize impacts to fish and other users. He said the FWMT may be used to explore the impacts of water management decision in an operational mode employing real-time data, in a prospective mode, or in a retrospective mode. Hyatt said that following the implementation of the FWMT in the OLR System, there has been a five- to ten-fold increase in sockeye smolt production and adult escapement. Furthermore, the FWMT has reduced density-dependent losses.

E. Update: Lamprey Operations at Wells (Tom Kahler)

Tom Kahler said that lamprey operations at Wells Dam for the 2012 lamprey migration commenced August 6, 2012. Kahler said that, to date, no lamprey have passed Wells Dam, and 125 have passed Rocky Reach Dam.

F. Update: 2012 Subyearling Life History Studies (Tom Kahler)

Tom Kahler said Douglas PUD collected more than 30,000 subyearling summer/fall Chinook salmon during their sampling effort. He said that more than 20,000 fish were tagged, and there were approximately 273 mortalities. Kahler said that, to date, there have been nearly 2,700 detections; most of these have been at the Rocky Reach Bypass. Kahler added that three jacks from the 2011 outmigration have also been detected. Kahler said that Andrew Gingerich is developing a detailed report on the 2011 study, and these results will be shared with the Coordinating Committees this fall.

III. WDFW

A. Potential Renegotiation of the Columbia River Treaty (Bill Tweit)

Bill Tweit presented an overview of the Columbia River Treaty (CRT) and modeling results from Iteration 1 (Attachment C), which Kristi Geris distributed to the Coordinating Committees by email on August 27, 2012. Tweit said that all of his presentation materials are public information and can also be found online.

Tweit said that potentially affected parties in the Pacific Northwest have approached review of the CRT using a regional consultation process, called the "Sovereign Process." He said there are two teams: a Columbia River Sovereign Review Team and a Sovereign Technical Team. He noted that the U.S. Department of State will ultimately make all final decisions regarding the U.S. positions in their negotiations with Canada. Tweit said that the Pacific Salmon Treaty also uses a similar approach to seek regional consensus. He said that the purpose of this CRT review process is to determine what to negotiate with Canada in 2014. He said that the United States (U.S.) has three options: 1) keep the status quo of the CRT with no changes; 2) give Canada the required 10-year notice of termination of the treaty; or 3) alert Canada that the U.S. would like to renegotiate the treaty.

Tweit said that Iteration 1 has just been completed, and objectives and details for Iteration 2 are being developed. He said that Iteration 1 modeled two flood control trigger flows: 1) 450,000 cubic feet per second (450 kcfs), which is the status quo; and 2) 600 kcfs, which was primarily advanced by tribal and some state fish and wildlife managers because it allows for decreased fluctuation in water storage reservoirs and higher spring flows. The purpose of the model runs was to investigate costs associated with a change from the status quo to 600 kcfs. Tweit emphasized that assumptions drive model outputs, and that key assumptions in Iteration 1 included assumptions about Canadian Operations post-2024 without the CRT, and assumptions about flood risk management strategies, "effective use," and "called upon."

Tweit discussed that Iteration 1 modeling results indicated almost no difference in the annual hydrograph between the 450 kcfs and 600 kcfs scenarios if the status quo were maintained. However, results suggested a change to a relatively constant outflow across the year without the treaty.

Tweit explained that "effective use" is U.S. use of U.S. flood control. He said that under "effective use," most U.S. reservoirs are drawn down to lower water levels more frequently; the more frequently "effective use" occurs, the more negative impacts there are for the U.S. Tweit said that with 600 kcfs, models indicate "effective use" would only be needed one time in 70 years, peak river flows would increase, and some U.S. reservoirs would on average, have decreased draw down levels and increased refill probabilities. Tweit said that the flood risk management strategy, "called upon," is viewed by Canada as highly disruptive, and that the U.S. has not exercised this option in the history of the treaty. He added that "called upon" has significant financial impacts, and that further modeling of this option is planned for Iteration 2.

Tweit introduced the concept of "ecosystem-based functions," which is a new element being considered in the context of the CRT. "Ecosystem-based functions" address reservoir elevations and river flows, and the potential impacts on anadromous and resident fish, wildlife and the estuary. Other objectives include cultural resources, recreation, and irrigation. He said that, currently, the geographic focus starts in Montana and runs down through the mainstem Columbia River. He added that the Snake River is also being considered, to a lesser degree. Tweit said that the Bonneville Power Administration (BPA) and the U.S. Army Corp of Engineers are assisting in the analysis of the hydropower element of the CRT.

Tweit also presented a summary analysis of ecosystem-based function modeling runs (Attachment D), which Kristi Geris distributed to the Coordinating Committees by email on August 27, 2012. Tweit summarized model runs of five alternatives for these five areas: Kootenai River Basin; Flathead River Basin; Pend Oreille River Basin; Spokane River Basin; the Columbia River border to Grand Coulee Dam; Grand Coulee Dam to the confluence with the Snake River; Snake River Basin; and the Columbia River at the Snake River confluence to its estuary. Tweit said that climate change models will be addressed in Iteration 2.

IV. Chelan PUD

A. Update: Rocky Reach and Rock Island Summer Spill (Steve Hemstrom)

Steve Hemstrom distributed to the Coordinating Committees the Rocky Reach and Rock Island HCPs' 2012 Draft Fish Spill Program Results (Attachment E). Kristi Geris also distributed the draft document to the Coordinating Committees by email on August 27, 2012. Hemstrom said that while spill ended earlier in the month at both Projects, the 2012 Fish bypass operations at both Rocky Reach Dam and Rock Island Dam will end on August 31, 2012. He said that, at that time, Chelan PUD will finalize the draft spill program results and provide a final report to Kristi Geris for distribution to the Coordinating Committees.

Hemstrom reviewed the draft Fish Spill Program results as described in Attachment E and asked the Coordinating Committees to contact him with any questions or comments. Hemstrom received Coordinating Committees representatives' concurrence by email to end spill at Rocky Reach Dam and Rock Island Dam for the 2012 spill season. Hemstrom received concurrence on August 9, 2012, from Scott Carlon on behalf of Bryan Nordlund, and Joe Peone on behalf of Jerry Marco, to end summer spill at Rocky Reach Dam.

B. Final Results of Fish Rescue from Rock Island Left-Bank Overflow Space (Steve Hemstrom/ Lance Keller)

Lance Keller reported that August 17, 2012, was the last day of rescue efforts to recover fish from the area adjacent to the Rock Island left bank fishway. Keller said that as of August 17, 2012, a total of 213 live fish were rescued from the space, including 198 sockeye and 15 summer Chinook salmon. Keller said there were a total of 24 mortalities, including 18 sockeye and 6 summer Chinook salmon. He added that approximately 12 fish have been observed that are remaining in the space. Keller said the design drawing is complete for the bar system that will be installed on the outside of the overflow protection gate for the left bank fishway, in order to prevent fish from entering the space between the fishway and the left bank shore. He said the bar system will be installed during the left bank fishway maintenance period at Rock Island this winter. Steve Hemstrom said the entire rescue effort lasted more than a month; and Keller added that more than $50,000 was billed to this effort.

V. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe reported that the HCP Tributary Committees did not meet in August; therefore, there is no Tributary Committees' update this month.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last Hatchery Committees meeting on August 15, 2012, held at the Chelan PUD:

- *SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook*: Douglas PUD introduced a draft SOA that permanently adjusts the release date for Wells Hatchery subyearling summer/fall Chinook salmon from mid-June to mid-May. The results of a study conducted over a series of years indicated better smolt to adult returns (SARs) in subyearlings released in May rather than June. Josh Murauskas agreed to check with the fish monitoring staff at Rock Island Dam about shifting the start date of subyearling Chinook monitoring to begin in May in future years. Teresa Scott said she will also check with fish monitoring staff at Rock Island Dam about shifting the start date.
- *Hatchery Monitoring and Evaluation (M&E) Update*: Douglas PUD and Chelan PUD have been discussing the review of their Hatchery M&E Plans. The goal is to use results from the first 5-year M&E report to inform changes to the Hatchery M&E programs. The initial plan was to implement a fully revised Hatchery M&E Program in 2013. However, the Hatchery Committees agreed to delay full implementation of a new program to 2014; during 2013, the Hatchery Committees will implement the existing M&E programs with minor changes.
- *Wells Hatchery Modernization Update*: Greg Mackey provided to the Hatchery Committees the same update Shane Bickford provided to the Coordinating Committees on the Wells Hatchery modernization process. Keely Murdoch also provided an update on the YN Kelt Reconditioning Program. Murdoch said the YN is also still investigating options for the YN Upper Columbia Coho Reintroduction Program.
- *CCT's Chief Joseph Hatchery Programs and M&E Plans*: Kirk Truscott provided an overview of Chief Joseph Hatchery Programs and M&E Plans. Truscott promised a more detailed presentation on the CCT's Chief Joseph Hatchery Programs at a future

Hatchery Committees meeting. Truscott said the CCT's Hatchery M&E Program will be complementary to the PUDs' Hatchery M&E Programs although the language will be slightly different to comply with submittal requirements for BPA's PISCES program. Key components of the CCT Hatchery M&E Program include: 1) in-hatchery monitoring by life stage; 2) tagging plans; 3) deployment of two smolt traps to increase monitoring on the Okanogan River; and 4) fall carcass recovery and redd counts. CCT will begin their production this coming year, sourcing fish from Winthrop National Fish Hatchery. CCT is anticipating 60 percent of capacity production in 2012. CCT also plans to operate overwinter acclimation ponds this winter to investigate if groundwater prevents the ponds from freezing.

- *Methow Update*: Chelan PUD is discussing with Douglas PUD options for continuing spring Chinook production at the Methow facility. Chelan PUD terminated the previous sharing agreement.
- *Chelan Falls Brood Collection*: Chelan PUD and Washington Department of Fish and Wildlife (WDFW) are investigating the potential to collect returning Chelan River summer/fall Chinook salmon to use as brood for Chelan Falls Hatchery production. WDFW and Chelan PUD will investigate various methods for capturing returning fish.
- *Summer Chinook Salmon Size Targets*: Chelan PUD presented a proposal for a study to investigate the effect of size-at-release of summer/fall Chinook salmon on fish performance at Chelan Falls and Dryden. This proposal has both performance and Total Maximum Daily Load (TMDL) implications. Chelan PUD, in coordination with National Marine Fisheries Service, plans to refine the proposal and provide the revised study plan to the Hatchery Committees.
- *Dryden Update as it Pertains to the Wenatchee River Phosphorus TMDL*: The Hatchery Committees continued discussing a plan to engage Washington State Department of Ecology in the Hatchery Committees' efforts to meet the Wenatchee River phosphorus TMDL.

VI. HCP Committees Administration (Mike Schiewe)

A. Next Meetings

The next scheduled Coordinating Committees meeting is September 25, 2012 (conference call). The October 23, 2012, and November 27, 2012, meetings are planned for the Radisson Hotel at SeaTac, Washington.

List of Attachments

Attachment A – List of Attendees
Attachment B – FWMT Presentation by Dr. Kim Hyatt, BC Fisheries and Oceans
Attachment C – Columbia River Treaty and modeling results from Iteration 1
Attachment D – Ecosystem-Based Function Presentation
Attachment E – Rocky Reach & Rock Island HCPs 2012 Draft Fish Spill Program Results

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Shane Bickford*	Douglas PUD
Bob Rose*†	Yakama Nation
Jim Craig*	USFWS
Teresa Scott*	WDFW
Bill Tweit*	WDFW
Dr. Kim Hyatt	BC Fisheries and Oceans

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

Okanagan Fish-and-Water Management Tools (Ok-FWMT): A Decision Support System to Balance Water Objectives in Real-time.

HCP Presentation, Aug. 28, 2012, Seattle.

Douglas County Public Utility District

Fisheries and Oceans Canada / Pêches et Océans Canada

Department of Fisheries and Oceans Canada

British Columbia

BC Ministry of Water Land and Air Protection

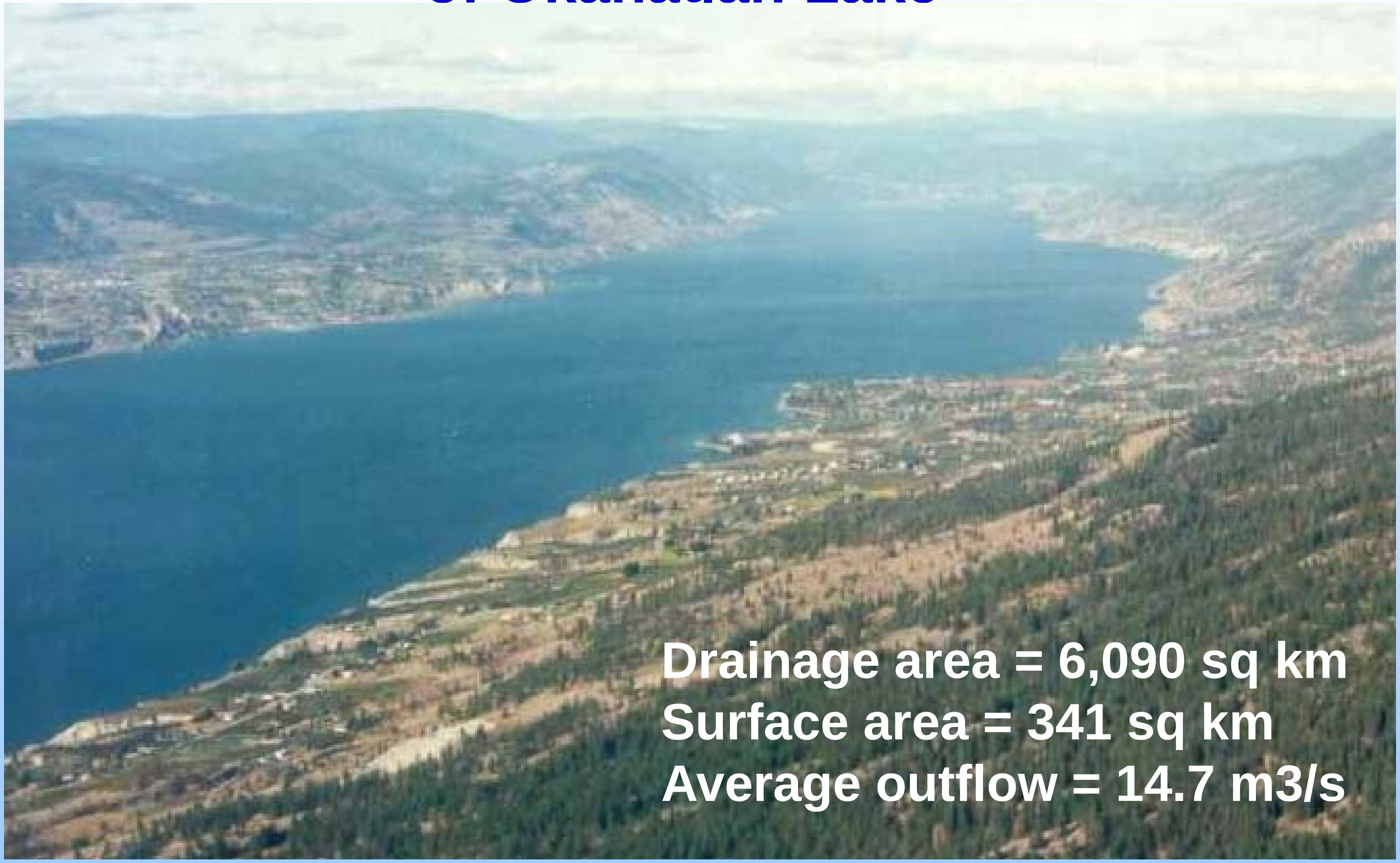
Okanagan Nation Alliance

Kim Hyatt*, Brian Symonds, Clint Alexander, Margot Stockwell, Chris Bull, Steve Matthews, Deana Machin, Andrew Wilson, Paul Rankin, Howie Wright, Colin Daniel, Calvin Peters, Brent Philips, Brian Guy, Harvey Andrusak

Outline for This Talk

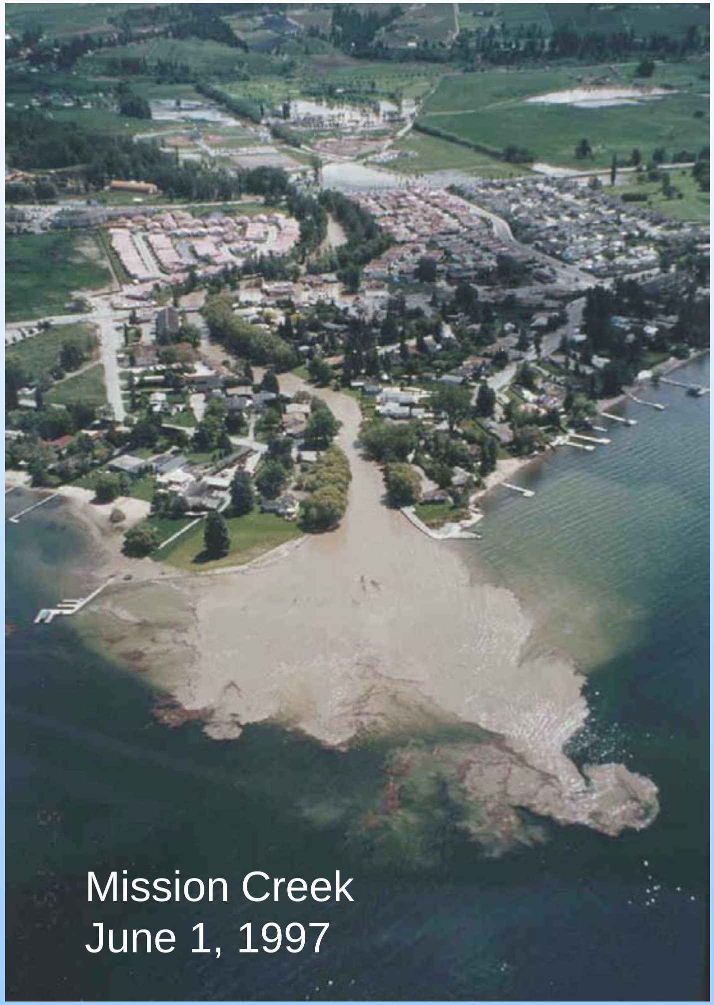
- Identify context, process and objectives for managing water supplies in the OLRS.
- Comment on “audit” for water management compliance with fisheries requirements under the Okanagan Basin Agreement (OBA).
- Describe creation of Fish-and-Water Management Tools (FWMT) system to support “fish friendly” water management.
- Review experience with FWMT as an efficient information exchange, decision support utility.

OLR-System Management Begins in the Headwaters of Okanagan Lake



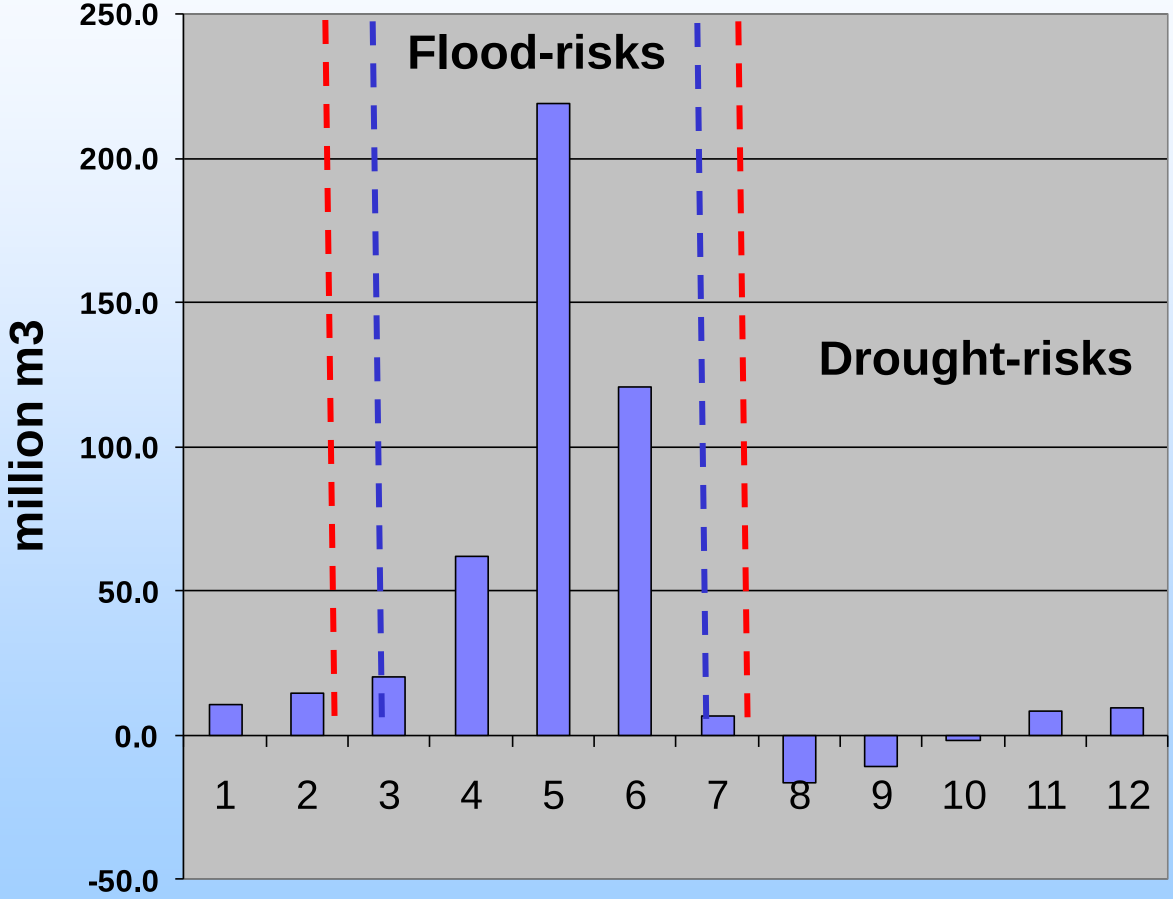
Okanagan Lake Dam at Penticton is the major control point in the system

OKANAGAN LAKE HYDROLOGY



- Annual inflow hydrograph dominated by snowmelt runoff
- Large range of annual inflows:
  - 78 million to 1.4 billion m^3
  - 0.23 m to 4.12 m stage change

Mean monthly inflows to Okanagan L. (85 % of inflow from Apr-Jun)

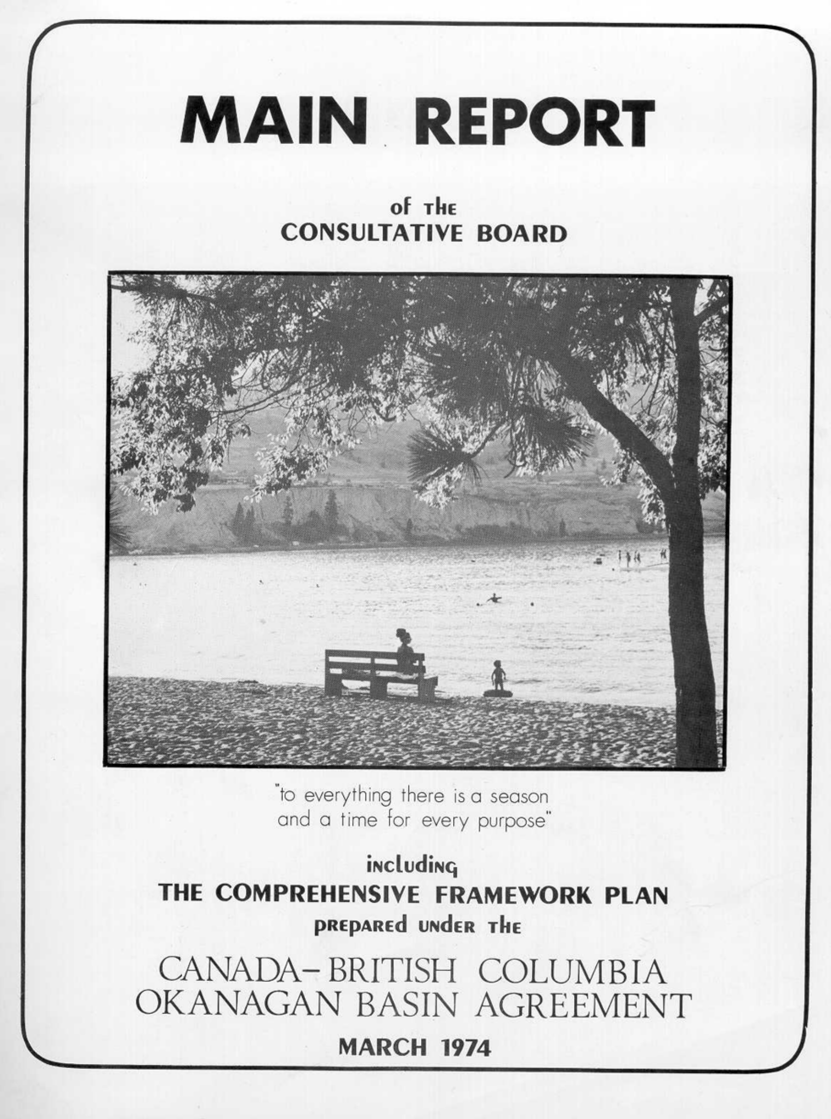


How are Release Patterns Determined?

Okanagan Basin Agreement of 1974

"The Comprehensive Framework Plan"

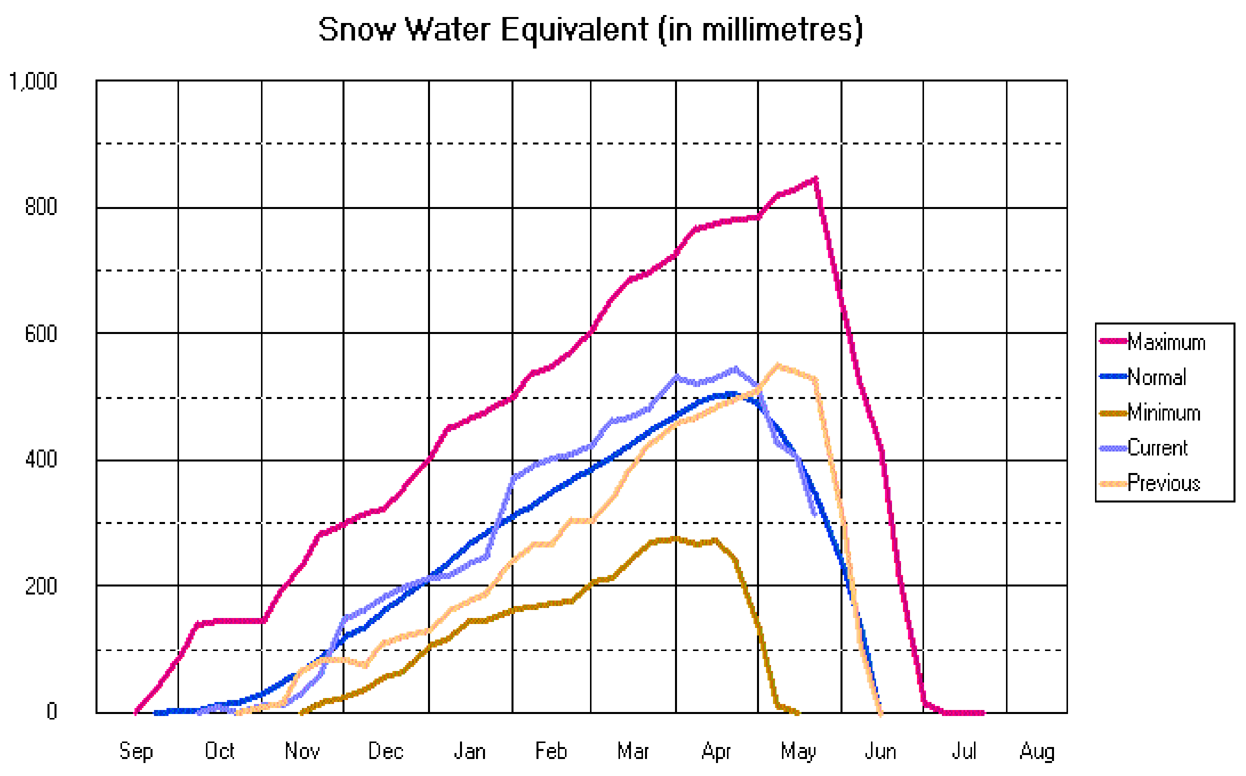
provides general rules for operating the OLRS.



Inflow Forecasts and Discharge Observations Drive Management Decisions

Inflow forecasts based on seasonal precipitation, snow packs & tributary inflow data.

2003-04 Mission Ck. Snow Pillow @2F05P



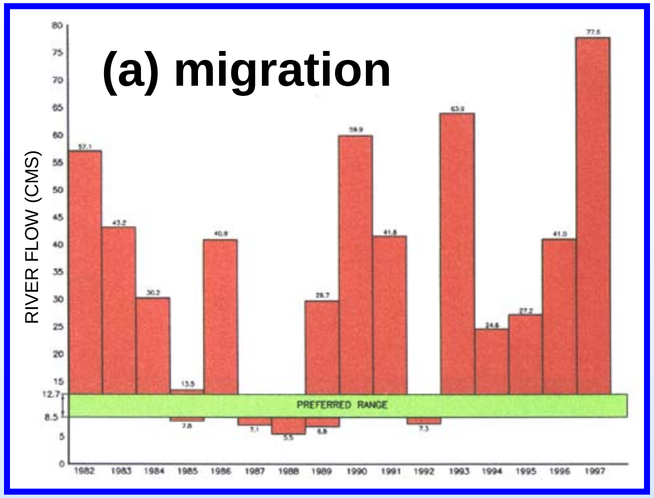
OLRS OPERATIONS

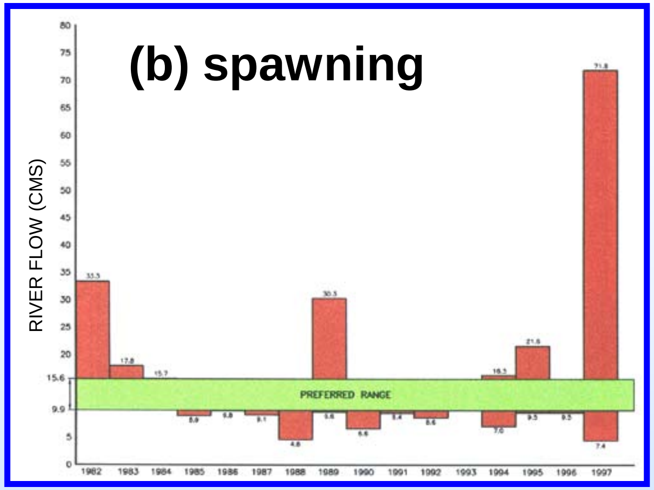
- OBA rules specify seasonal lake levels and flows.
- Operating plans/decisions reflect inflow forecasts.
- Decisions address competing objectives to satisfy: flood control, fisheries values, water storage/extraction, navigation, tourism, international agreements, etc.

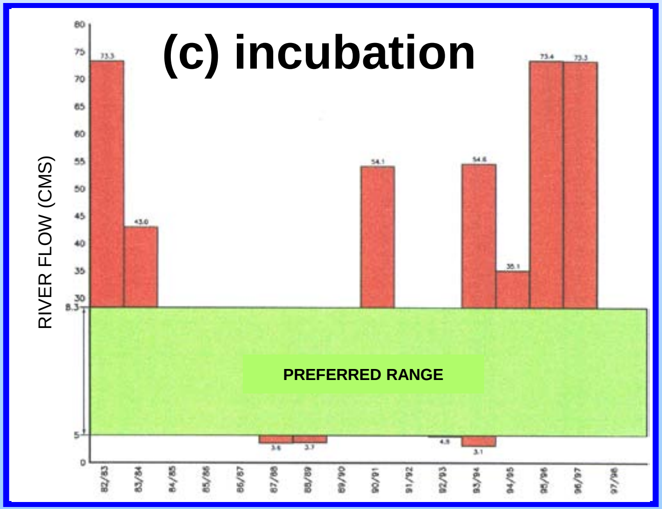
OPERATOR CHALLENGES

- Forecast uncertainty re: freshet inflow volumes and capacity to match lake spill or storage to spring inflows ("bathtub" analogy).
- Effects of environmental variability (water levels, flow, temp.) on risk assessments given competing economic, social & environmental demands of multiple "parties" & authorities.
- **OLRS decisions re: water storage or release based on rules of thumb, past experience & incomplete information.**

Compliance with OBA Fishery Flows was low prior to 1997.







OBA preferred flow range

Observed flow range

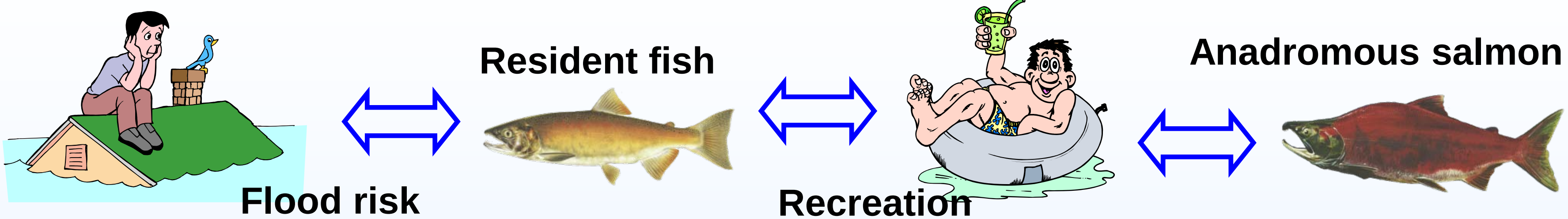
From 1982-1997 river discharge exceeded OBA fishery flows in:

(a) 13 of 16 yrs for adult migration

(b) 7 of 16 yrs for spawning and

(c) 7 of 16 yrs for egg incubation & fry migration

Competing "Rules"& Objectives Reduce Compliance



<u>Rule 1</u>: Don't fill Okanagan Lake above 342.56 meters (i.e. 10 cm rise above 342.56 incurs $5-$10 million in "property" losses !)

<u>Rule 2</u>: Try to avoid drafting to lake levels below 341.50 meters. (i.e. problems with docks, water intakes & vessel navigation become severe).

<u>Rule 3</u>: Minimize draw-down of Okanagan L. between the time of kokanee spawning and 100% fry emergence (i.e. minimize dewatering kokanee eggs & fry <u>but</u> don't risk violatin of "rules" 1 or 6,7,8, & 9)

<u>Rule 4</u>: Minimize the number of buildings flooded at Penticton

<u>Rule 5</u>: Provide summer flows for recreation if possible

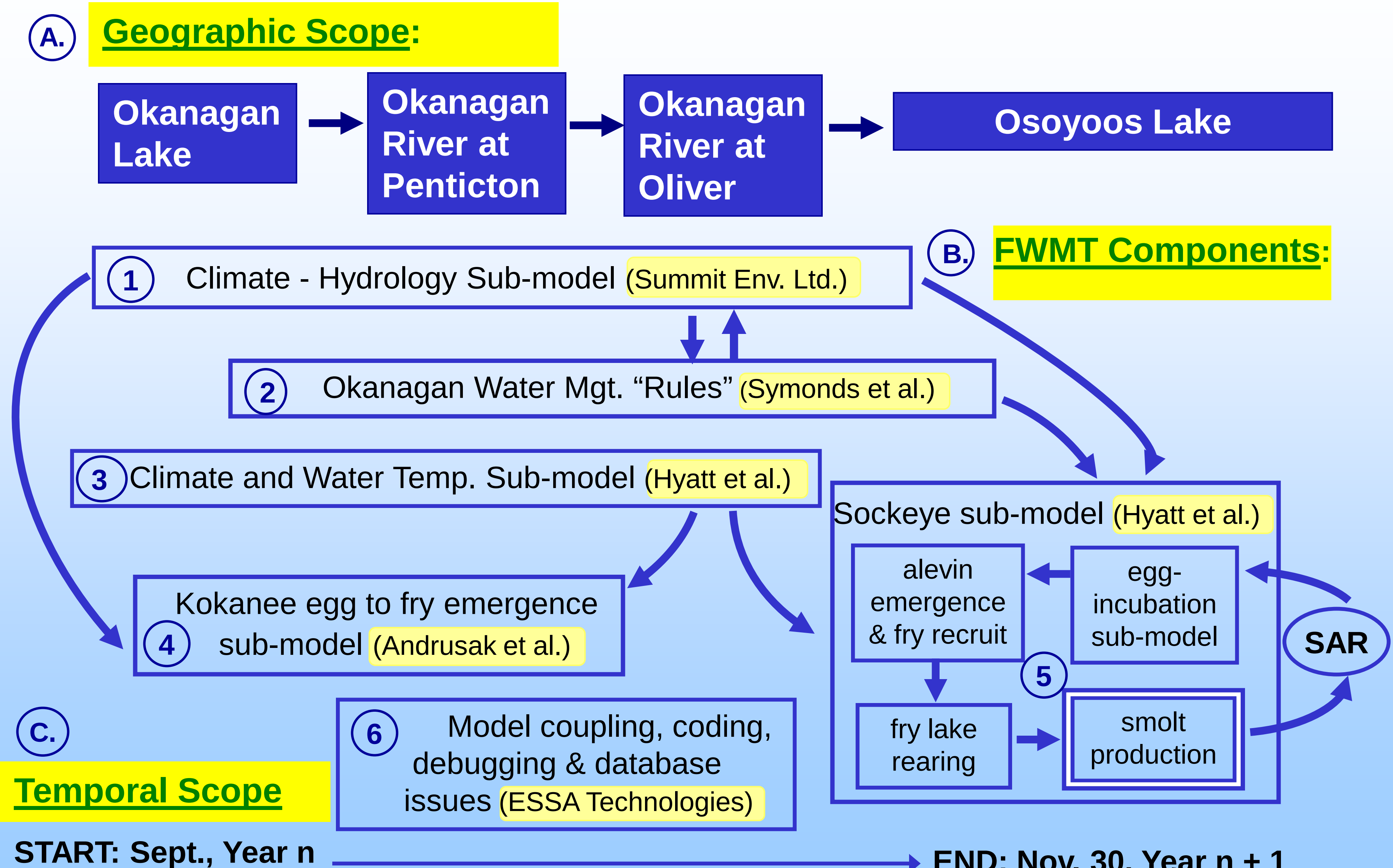
<u>Rule 6</u>: Sox. Migration – maintain flows (@ Oliver) between 8.5 & 12.7 cms during Aug 1 to Sept 15 to allow "easy" passage of VDS.

<u>Rule 7</u>: Sox. Spawning – maintain flows between 9.9- 15.6 cms during Sept 16- Oct 31 to maximize "good" spawning habitat.

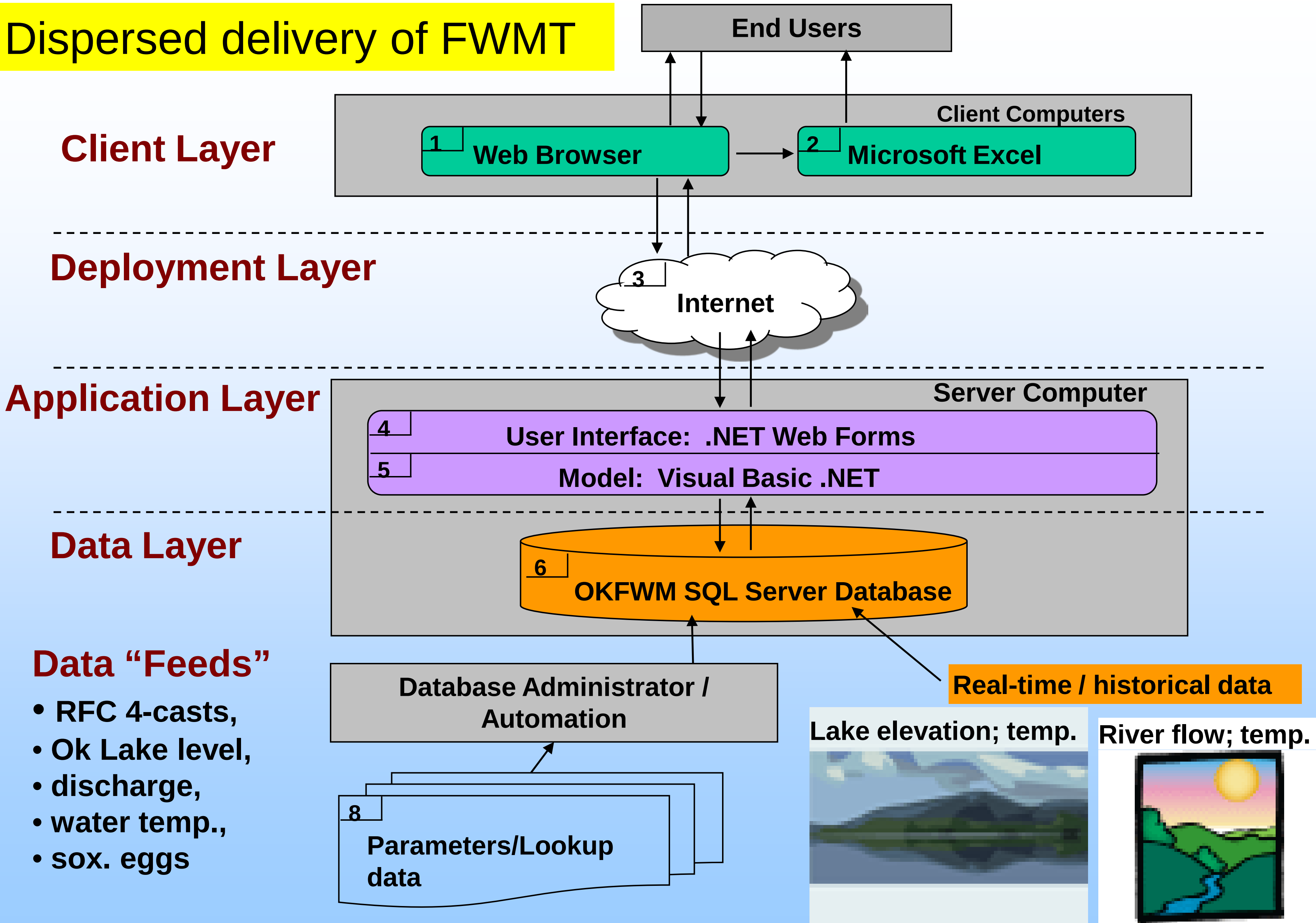
<u>Rule 8</u>: Sox Incubation- flows at 5.0- 28.3 cms during Nov 1- Feb 15 i.e. egg incubation flows greater than or equal to 50 % of spawning flows & must not exceed 28.3 cms to avoid redd desiccation & scouring.

<u>Rule 9</u>: Sox. Fry emergence-migration- flows during Feb16- Apr 30 at 5.0- 28.3 cms.

Structure & Science Foundations of the FWMT Decision Support System



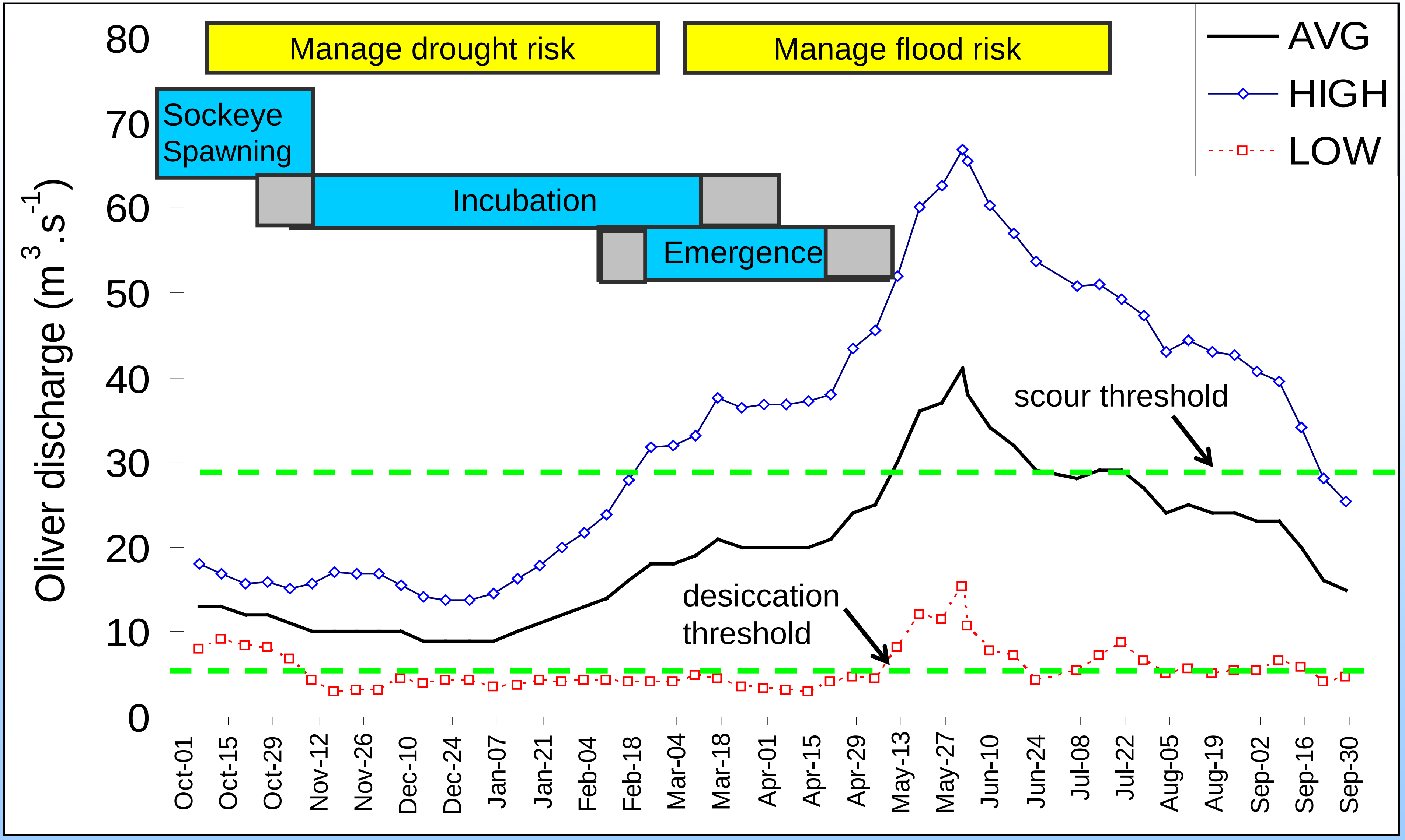
Dispersed delivery of FWMT



Data "Feeds"

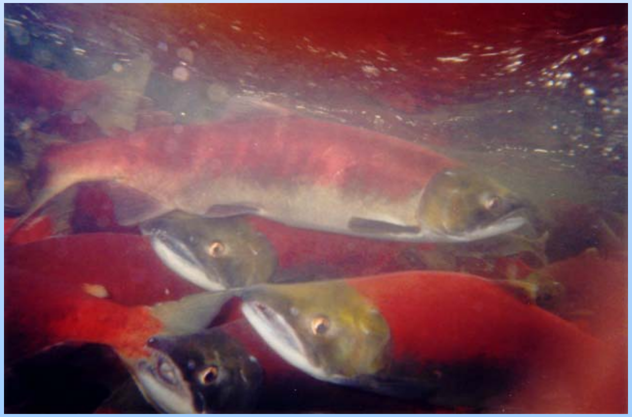
- RFC 4-casts,
- Ok Lake level,
- discharge,
- water temp.,
- sox. eggs

Event timing & natural variations determine whether fish-and-water managers satisfy OBA rules & competing objectives



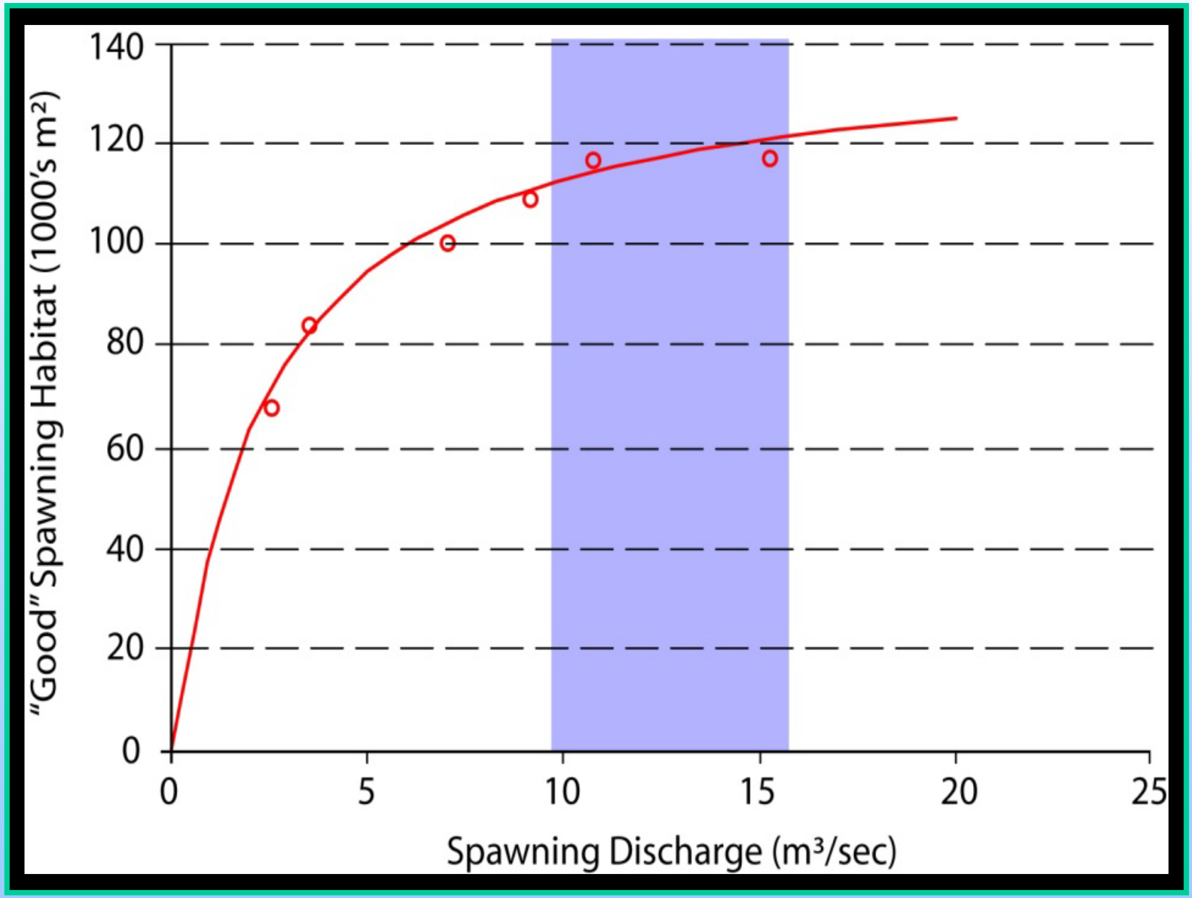
Available Spawning Habitat is Controlled by Flow

Paul Rankin photo



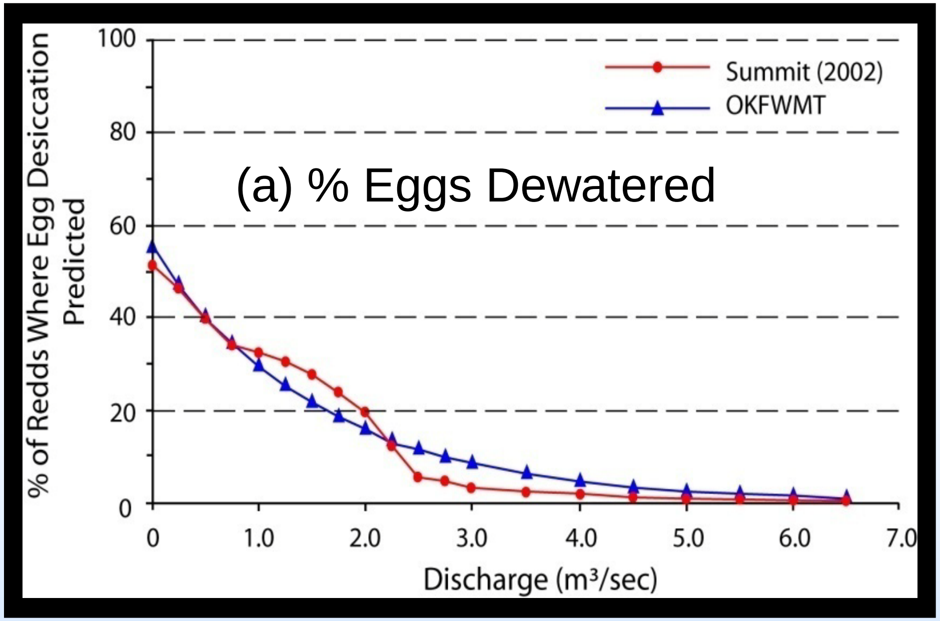
Okanagan Nation Alliance photo

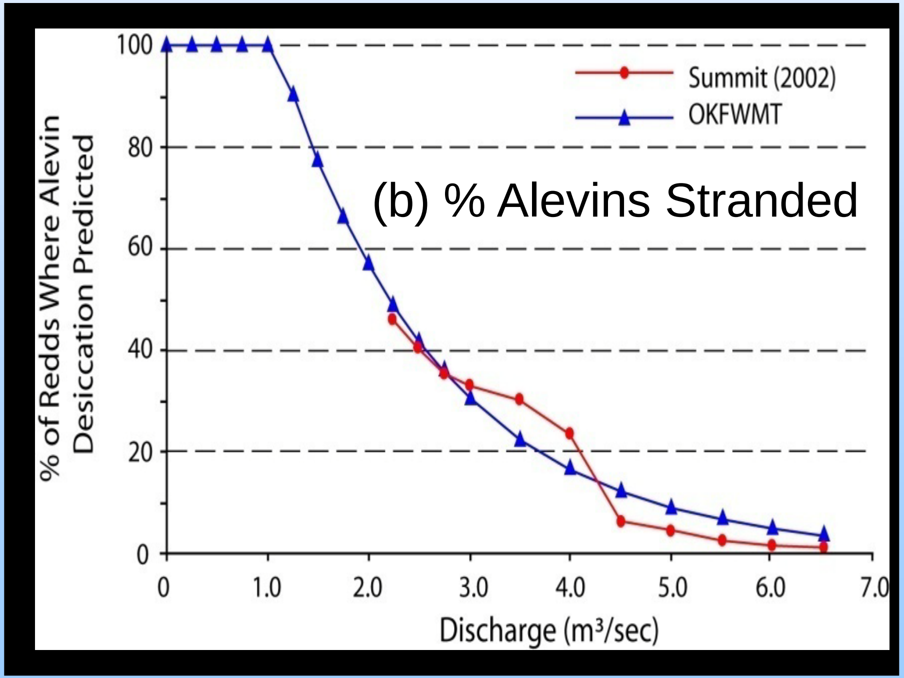
Recommended flows for Okanagan sockeye spawning are: **9.9 m³/sec to 15.6 m³/sec**

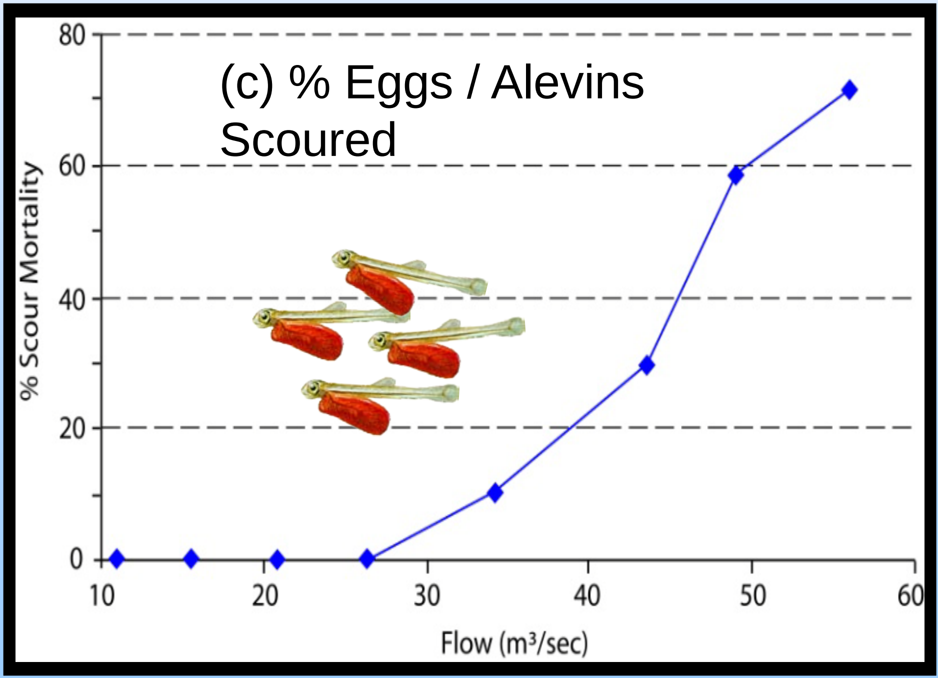


Discharge & Okanagan Sockeye Incubation

Dewatering/desiccation or flood-and-scour processes control incubation and emergence success of sockeye eggs and alevins.

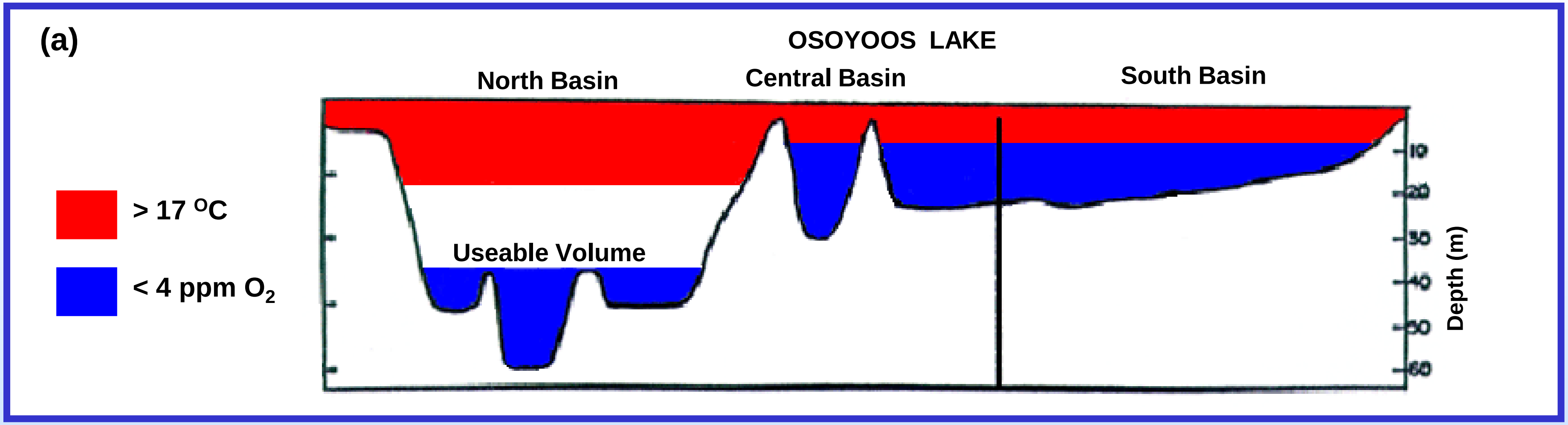




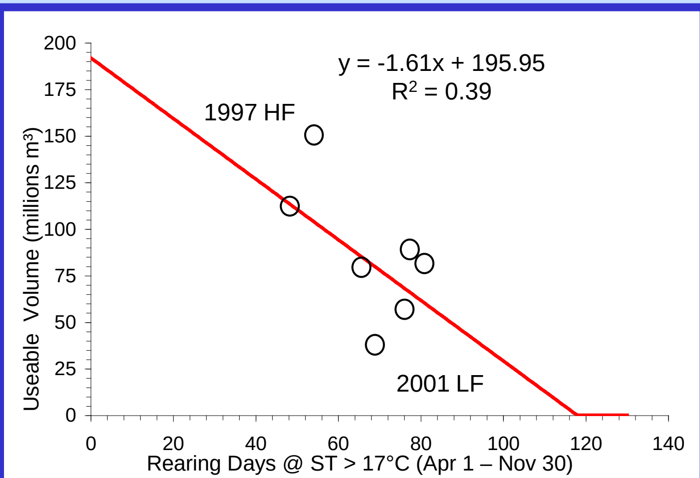


Temperature-Oxygen Effects on Useable Rearing Volume (URV) in Osoyoos L.

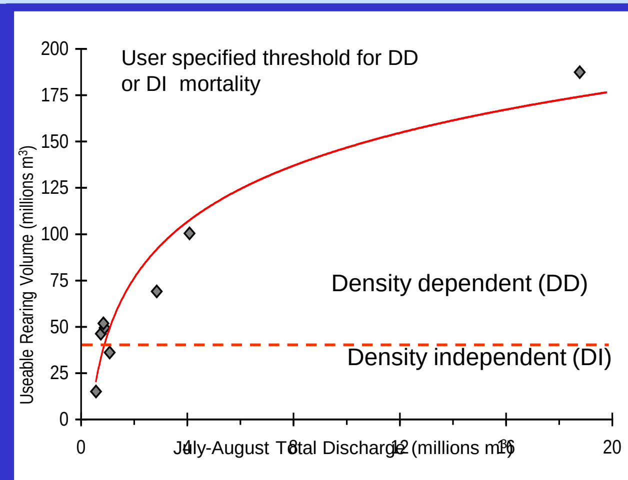
Seasonal temperature and oxygen extremes restrict the useable rearing volume of Osoyoos Lake which can induce density-independent mortality processes.



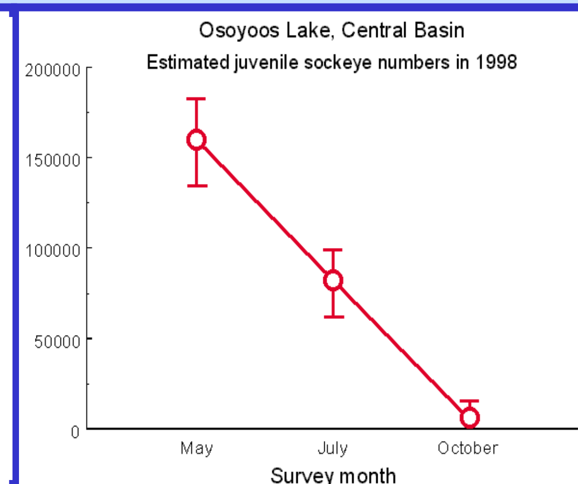
(b) URV vs days > 17oC



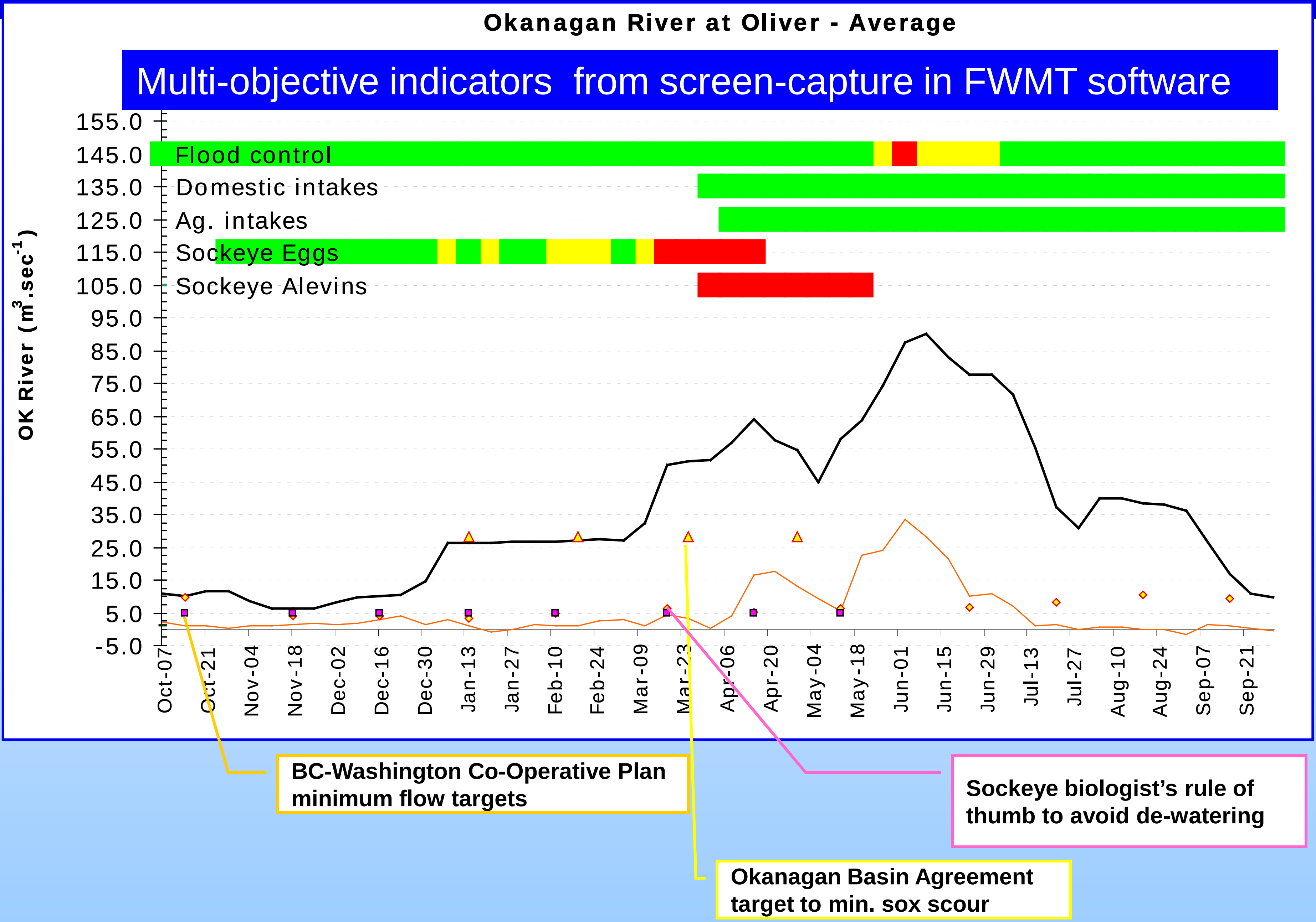
(c) URV vs July-Aug discharge



(d) Fry #s vs URV days at 0

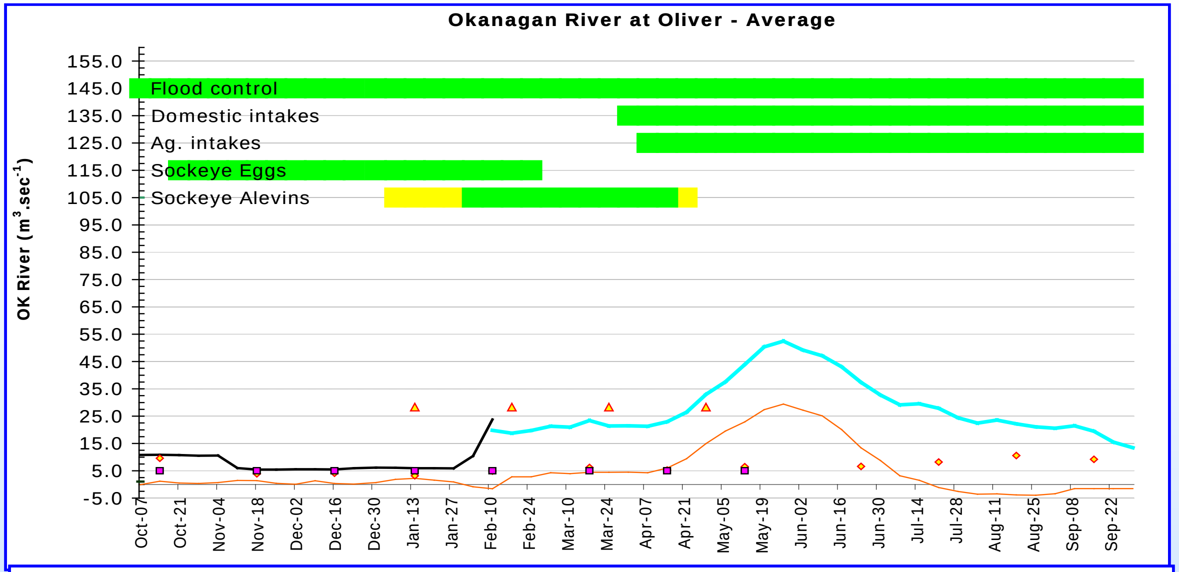


Multi-objective indicators from screen-capture in FWMT software

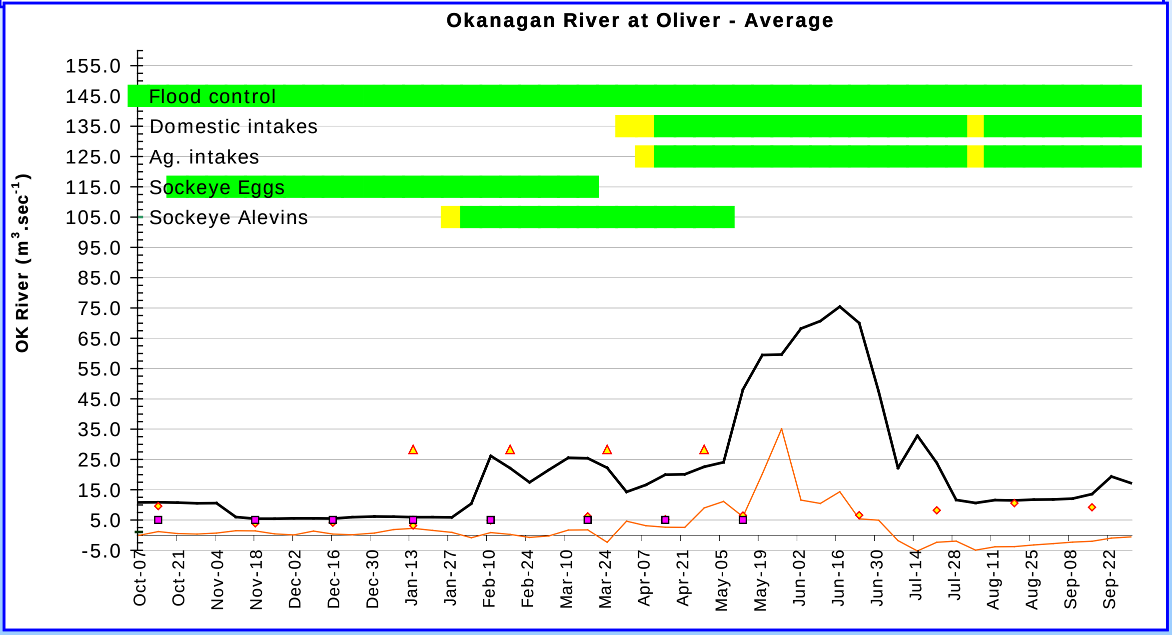


OKANAGAN FWMT 2005-2006 WATER MANAGEMENT YEAR

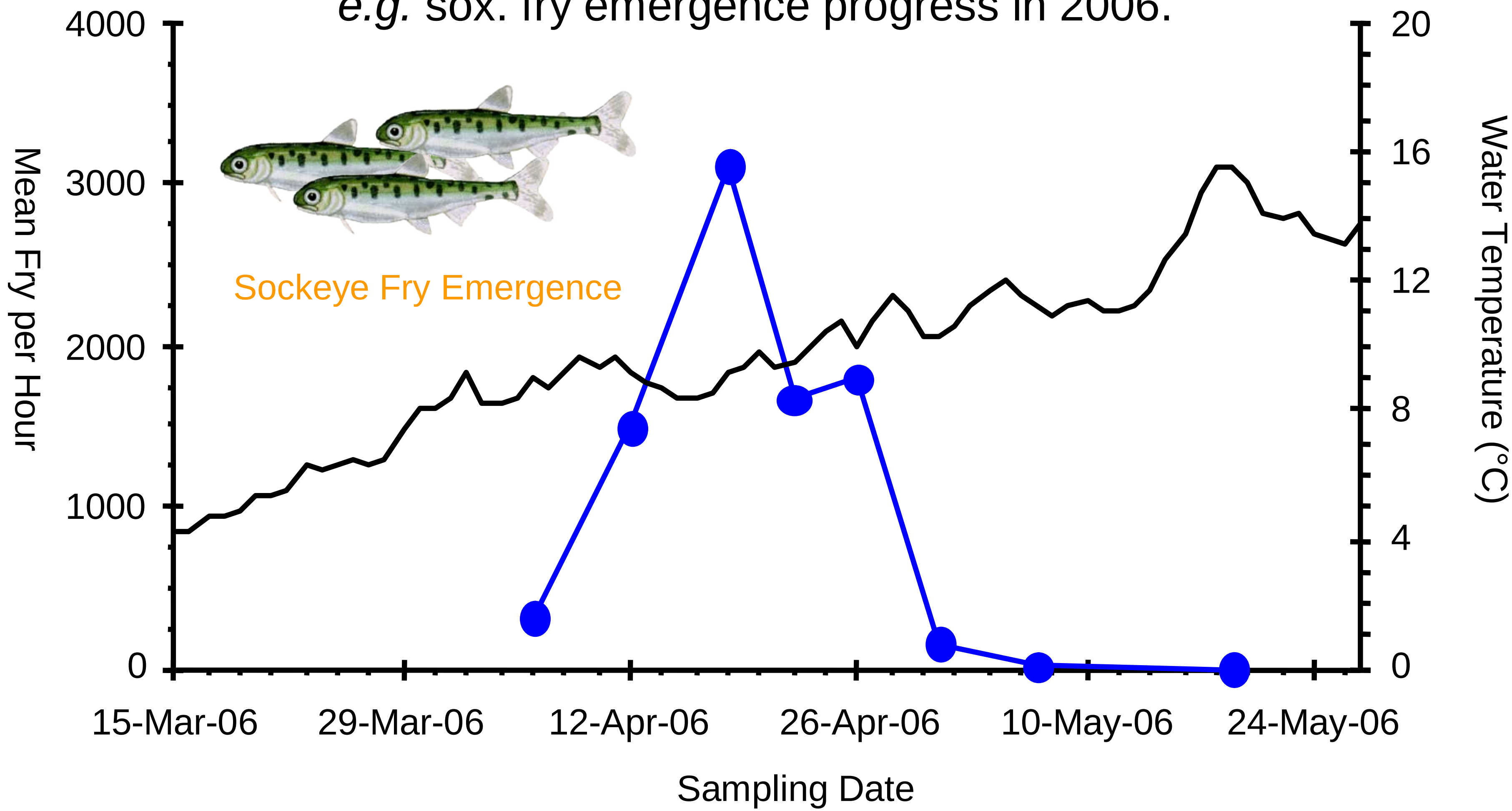
(A) Actual and predicted flows at Oliver (sockeye spawning grounds) 9-Feb-06



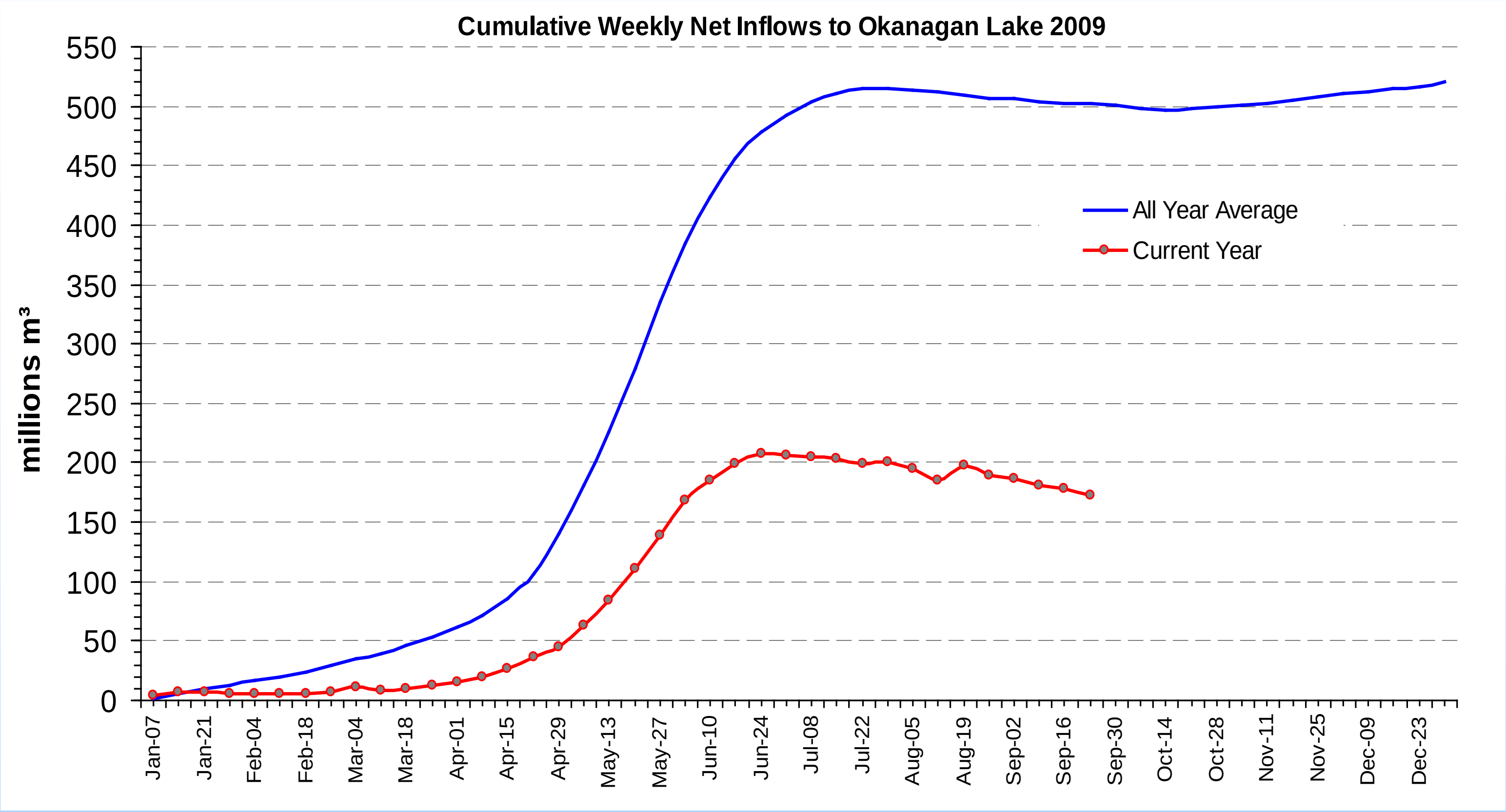
(B) Final outcome at Oliver (sockeye spawning grounds) 30-Sep-06



Field observations verify FWMT predictions
e.g. sox. fry emergence progress in 2006.



FWMT WATER YEAR 2008 - 2009



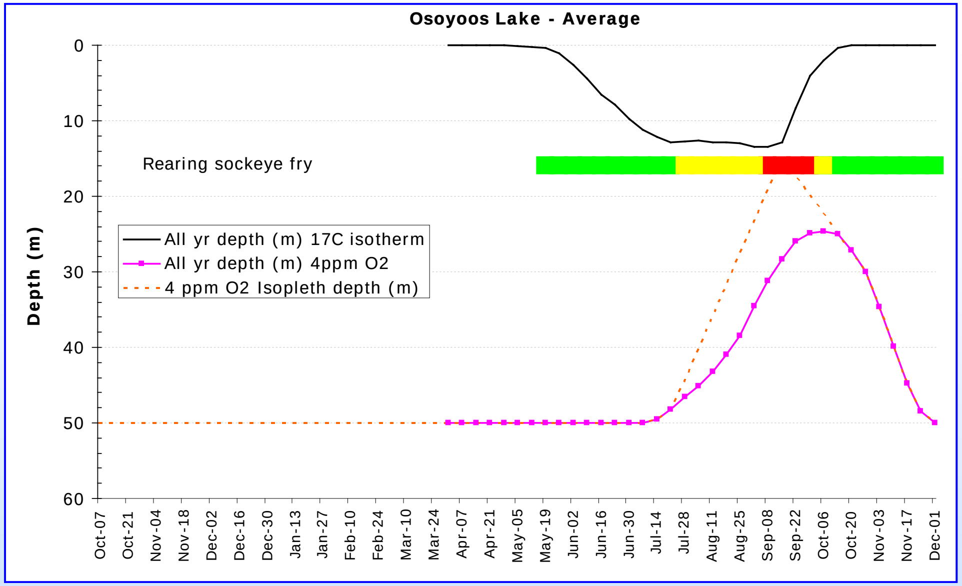
August 2009 FWMT Scenario Options

Table 1. A summary by location & issue of consequences associated with adoption of three alternate flow scenarios (FWMT-569, 561,568) during Aug-Sept, 2009.

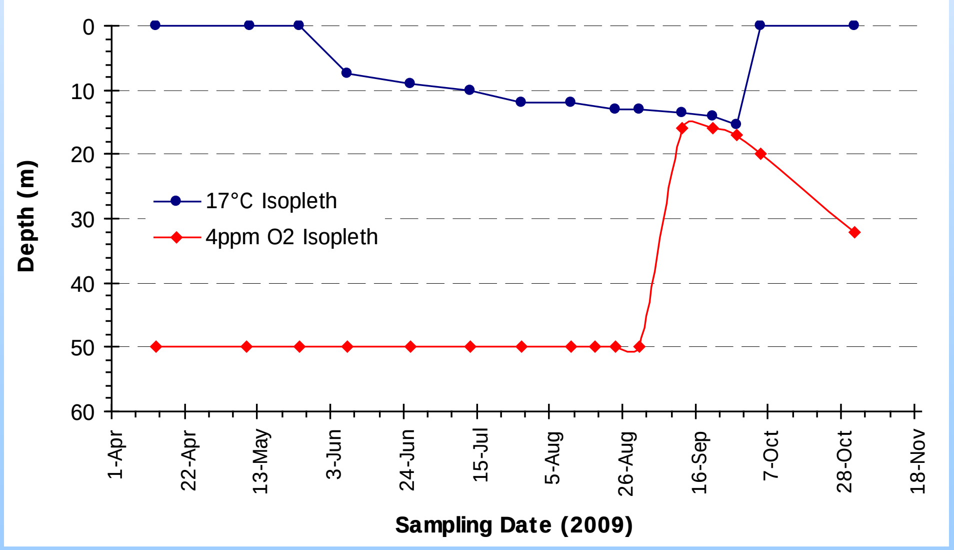
	FWMT-569	FWMT-561	FWMT-568
Location/Issue [1.]	Current (10.7 cms)	OBA max (12.7 cms)	Mitigate squeeze (18.3 cms)
Ok Lk levels predicted (Sept 30, 2009) [2.]	341.76	341.72	341.69
Domestic intakes [3.]			
Agricultural intakes [3.]			
Navigation boats [4.]			
Navigation docks [4.]			
Kokanee spawn/survival [5.]			
Ok Lk levels expected by Oct 14, 2009 [5.]	341.72	341.66	341.64
Okanagan River			
Recreation at Penticton [6.]			
Domestic intakes-Oliver [7.]			
Agricultural intakes-Oliver [8.]			
Osoyoos Lake			
Juvenile sockeye rearing [9.]			
Adult sockeye holding [9.]			
Ok Lk levels expected by April 1, 2010 [10.]	341.48	341.42	341.40

FWMT Fish-and-Water YEAR 2008 - 2009

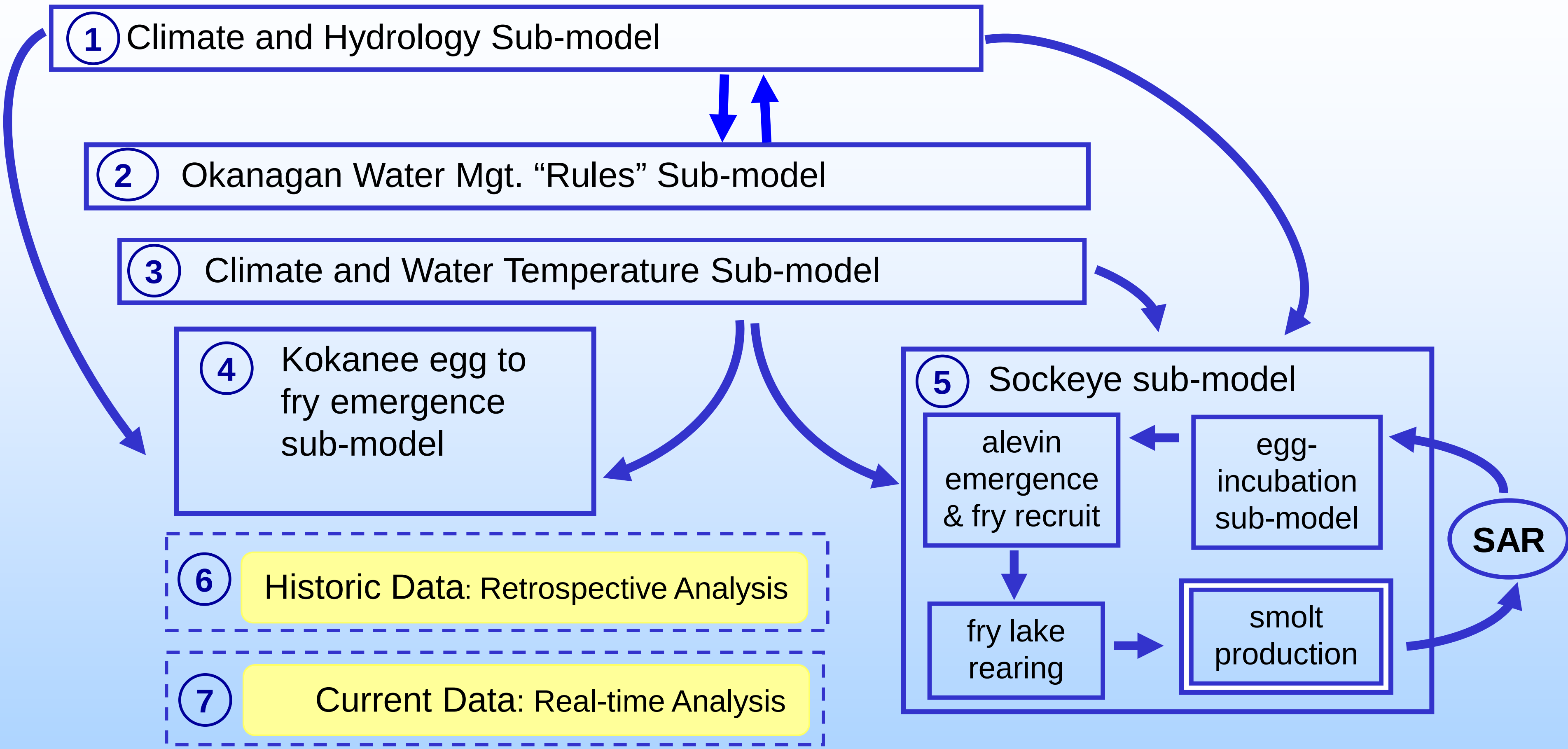
Predicted Temp-O2 "Squeeze"



Observed Temp-O2 "Squeeze"



FWMT Decision Support System



The FWMT System is a coupled set of biophysical models of key relationships (among climate, water, fish & property) used to predict the consequences of water mgt. decisions for fish & other water users.

FWMT may be used to explore water management decision impacts in an operational mode employing real-time data, a prospective-mode going forward or in a retrospective-mode looking back on historic water supply, climate & fish years.

FWMT-DSS vs Jodie's Check List

- X Spatially explicit to represent multiple scales,
- X Species and life stage specific (sockeye and kokanee),
- X Identifies and explores limiting conditions (stage, flow, temperature),
- X Provides predictions & observed events to validate model results,
- X Model uncertainties & sensitivities identified.
- X Models have transparent and flexible structure.
- X FWMT-DSS is effective in communicating with fish-and-water mgrs.

FWMT User Experience to Date

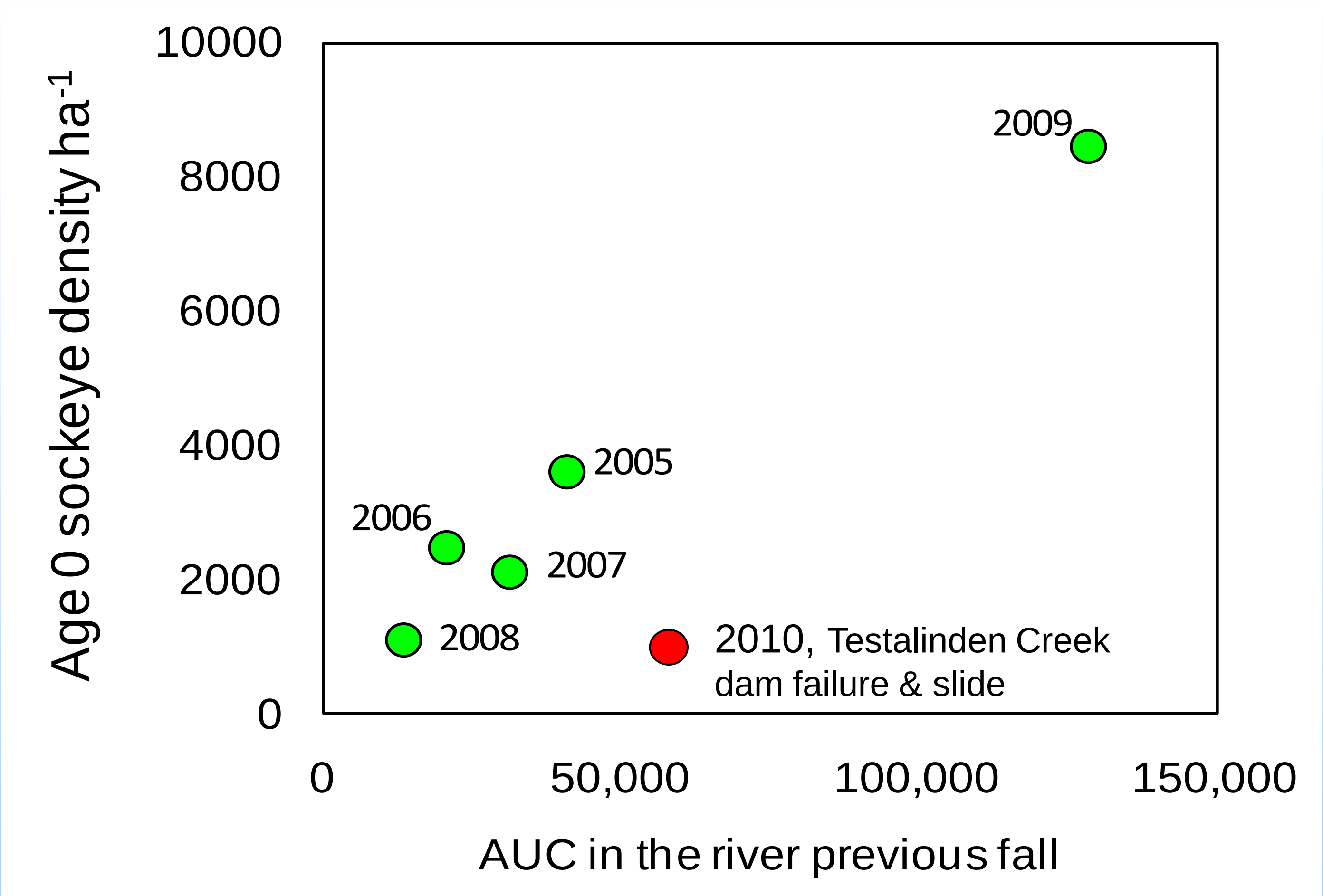
- balances consideration of multiple objectives (*i.e.* social, economic, cultural, ecological)
- recognizes inflow forecast uncertainties,
- uses “rich” information sources refreshed in real-time (*i.e.* annual to daily imports of biophysical data),
- facilitates effective input from limited pool of expertise,
- accelerates training & access to diagnostics,
- provides common, “transparent” framework for “team” collaboration, synthesis & decisions,
- allows managers to “measure twice” & “cut once”,
- provides record of annual strategy & outcomes to assess performance against multiple objectives.

OLRS-Operational Outcomes

Since deployment in fall of 2005, we have avoided (a) major drought and desiccation or flood and scour losses of salmon egg or fry production Okanagan Lake (kokanee) and river (sockeye) and (b) most temp-O2 induced losses of sockeye fry rearing in Osoyoos Lake

In theory, FWMT use should have reduced density-independent losses of fry & smolt production.

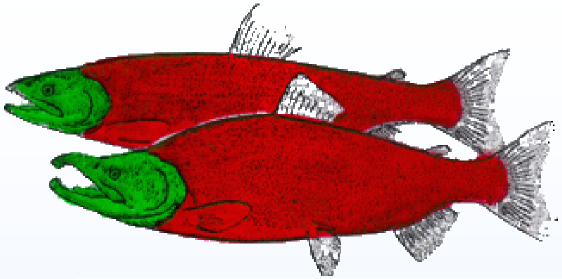
Where do all the sockeye come from ?

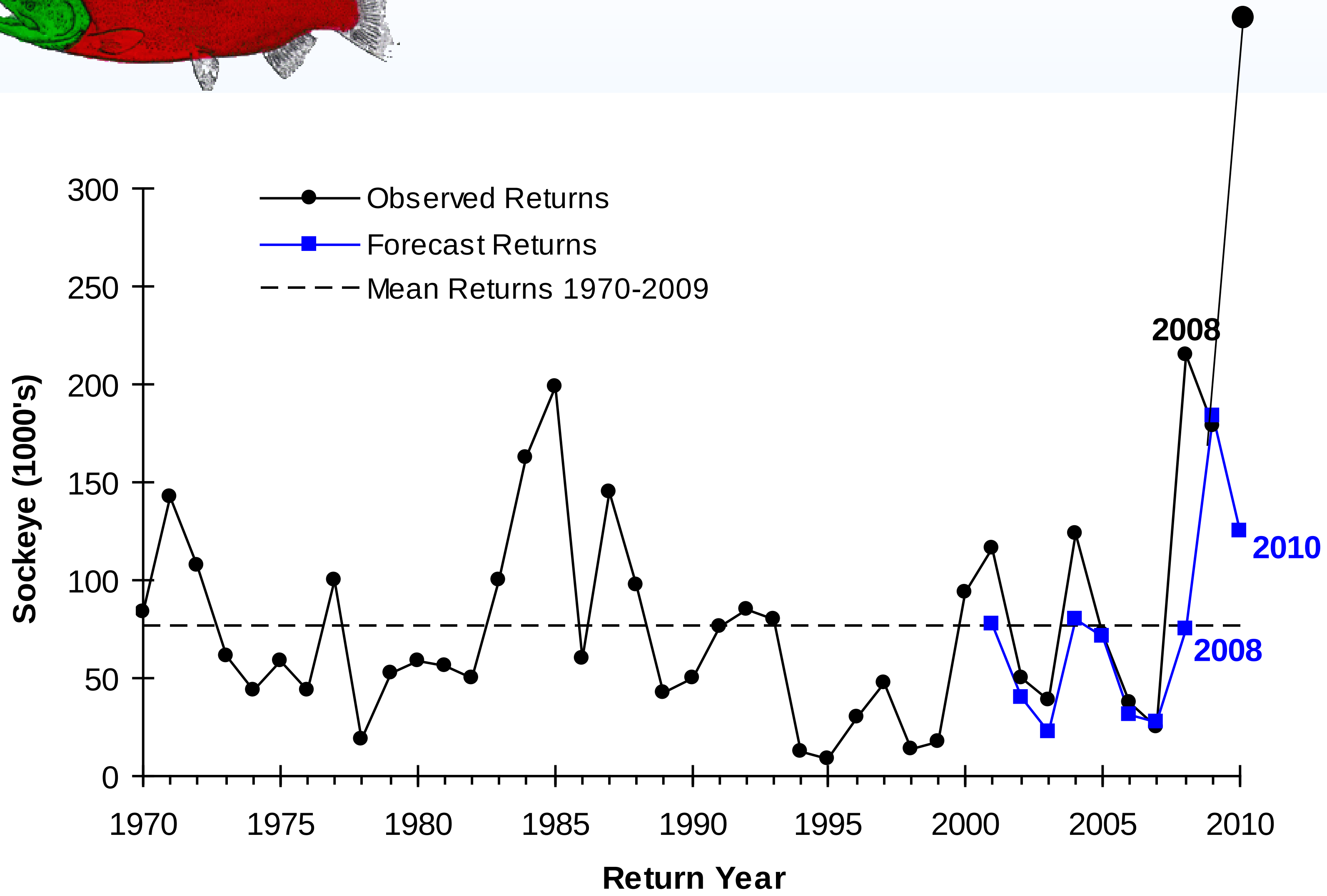


Post FWMT deployment, more adult spawners clearly lead to more smolt production as per Hyatt & Rankin (1996) analysis of carrying capacity of river and lake habitats. However, density independent losses of eggs/fry do still occur e.g. spring 2010.

Columbia R. Sockeye Returns 1970-2010.

Okanagan = 75-80% of all Columbia R. Sockeye after 1980





Questions ?

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

Modeling Results: Iteration One

COLUMBIA RIVER TREATY 2014/2024 REVIEW

CRPAG

July 26, 2012

Overview of Today's Presentation

- Basics of Treaty Review
- Key Terms and Definitions
- Iteration 1 Alternatives
- Iteration 1 Modeling Results
- Next Steps for Treaty Review

Basics of Treaty Review

1. Understand
   - Start by understanding regional needs and priorities.
2. Determine
   - Can the current Treaty meet those needs?
   - Does the Treaty need to be changed?
   - Are the changes so significant that we have to start over with a new Treaty?
3. Arrive at that determination by:
   - Collecting information
   - Evaluating the results
   - Assessing impacts on various river interests

Basics, cont.

1. Evaluation takes place over three "iterations."
2. Each iteration tests a number of scenarios or "alternatives."
3. Information from each iteration used to refine approach and build alternatives for the next iteration.

Basics, cont.

- Iteration One has just been completed.
  - Current Condition (only for comparison)
  - Alternatives post 2024:
    - 450 kcfs – Treaty Continues and Treaty Terminates
      - Uses current storage reservation diagrams
    - 600 kcfs – Treaty Continues and Treaty Terminates
      - Uses relaxed storage reservation diagrams

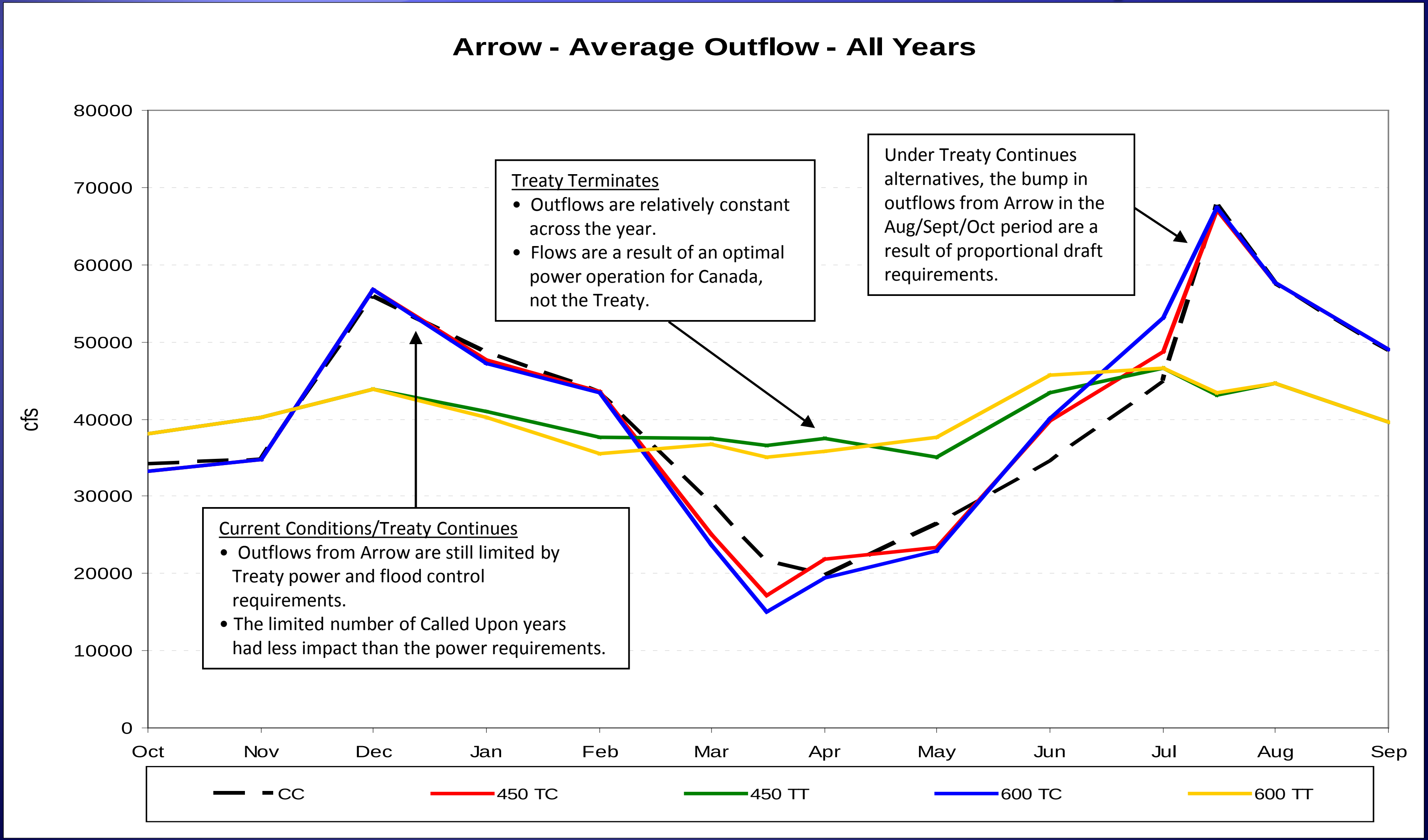
Key Terms and Definitions

- Canadian Entitlement
- Effective Use
- Called Upon Flood Control
- Flood Flow Objective
- Storage Reservation Diagrams
- Peak Flows

Key Assumptions in Iteration 1

- Assumptions about Canadian Operations Post-2024 without the Treaty.
- Flood Risk Management: Effective Use and Called Upon
- Both assumptions affected outcomes across all scenarios.

Canadian Operations:
With (TC) and without (TT) the Treaty



Iteration 1 Results
Flood Risk Management

Effective Use
Called Upon
Peak Flows

Flood Risk Management Effective Use at 450kcfs…

Treaty Continues

- Effective use in 18 out of 70 Years

Treaty Terminates

- Effective use in 23 out of 70 Years

Why is this important?

Under effective use most U.S. reservoirs are drawn down to lower water levels more frequently. This could:

- Limit a reservoir's ability to refill.
- Hinder the ability to meet needs such as irrigation, summer fish flows, recreation and protection of cultural resources.

Flood Risk Management Effective Use at 600 kcfs…

Effective use 1 time in 70 Years, Treaty Continues or Terminates

Increases fish flows during the spring and keeps some U.S. reservoirs fuller.

May increase flood risk. Increases peak river flows

Average: 17-21 kcfs higher
In 10 wettest years: 28-49 kcfs higher
(more analysis in iteration 2)

Flood Risk Management How often do we "Call Upon" Canada for more storage?

At 450 kcfs…

- Treaty Continues – 4 times in 70 Years
- Treaty Terminates – 6 times in 70 Years

At 600 kcfs…

- 0 times in 70 Years

Why is this important?

Called Upon has financial impacts to U.S. – $4-$34 million per request (based on power cost to Canada).

For Iteration 2…
Analysis of the annual average payment required for Called Upon.

Iteration 1 Results
Ecosystem-Based Function

Reservoir Levels

River Flows

Ecosystem-Based Function

Reservoir Elevations

- Effective use resulted in deeper draw downs and less frequent refill for some reservoirs. Could have an impact on resident fish, cultural resources, recreation, and irrigation.
- In several tributary sub-basins, Treaty operations had little or no effect on reservoir elevations and outflows.

Ecosystem-Based Function

River Flows

- In the Lower Columbia Basin, Treaty Terminates alternatives resulted in:
  - Lower winter flows
  - Higher spring flows
  - Lower late summer flows

- 600 kcfs alternatives increased peak river flows in the spring –Treaty or no Treaty.

Why is this important?

- Lower summer flows could affect ability to meet summer fish flow objectives.
- Reduction in winter flows could affect salmon protection flow objectives.
- Higher spring flows could benefit juvenile salmon migration.

For Iteration 2…
We will continue to examine these preliminary results.

Iteration 1 Results Hydropower

Canadian Entitlement

Hydropower Generation

Canadian Entitlement

If the Treaty continues, U. S. payment of Canadian Entitlement also continues:

- Energy -- 442aMW Capacity -- 1331 MW

Estimated value of Canadian Entitlement in 2024:

- Energy -- $113-$219 million
- Capacity -- $115 million
- Combined -- $229-$335 million per year

Hydropower Generation

Net effect of terminating the Treaty on total power and power costs (including the entitlement) for each country:

	Average Annual Hydropower Generation (aaMW)
Canada	410 loss (-$220 to -$320 million)
United States	325 – 350 gain (+$180 to $280 million)

Next Steps for Treaty Review

- End of 2012: Iteration 2 Completed
- Winter 2013: Stakeholder Listening Sessions on Iteration 2
- Website: http://www.crt2014-2024review.gov/

COLUMBIA RIVER TREATY REVIEW

Summary Analysis of Revised Iteration #1

Ecosystem-Based Function

Sovereign Review Team Meeting
June 14, 2012

Locations Analyzed for Ecosystem-Based Functions

KOOTENAI RIVER BASIN

- Lake Koocanusa above Libby Dam
- Kootenai River below Libby Dam

FLATHEAD RIVER BASIN

- Hungry Horse Reservoir
- South Fork Flathead River below Hungry Horse Dam
- Flathead River at Columbia Falls
- Flathead Lake above Kerr Dam
- Flathead River below Kerr Dam

PEND OREILLE RIVER BASIN

- Clark Fork River at Cabinet Gorge Dam (inflow to Lake Pend Oreille)
- Lake Pend Oreille above Albeni Falls Dam
- Pend Oreille River below Albeni Falls Dam

SPOKANE RIVER BASIN

- Lake Coeur d'Alene above Post Falls Dam
- Spokane River below Post Falls Dam

COLUMBIA RIVER BORDER to GRAND COULEE DAM

- Columbia River at Border (flowing into USA)
- Lake Roosevelt above Grand Coulee Dam
- Columbia River below Grand Coulee Dam

Locations Analyzed for Ecosystem-Based Functions

GRAND COULEE DAM to SNAKE RIVER CONFLUENCE

- Columbia River at Priest Rapids Dam
- Columbia River at Vernita Bar

SNAKE RIVER BASIN

- Snake River at Brownlee Dam
- Hells Canyon Complex
- North Fork Clearwater River at Dworshak Dam
- Lower Snake River at Lower Granite Dam

COLUMBIA RIVER at SNAKE RIVER CONFLUENCE to ESTUARY

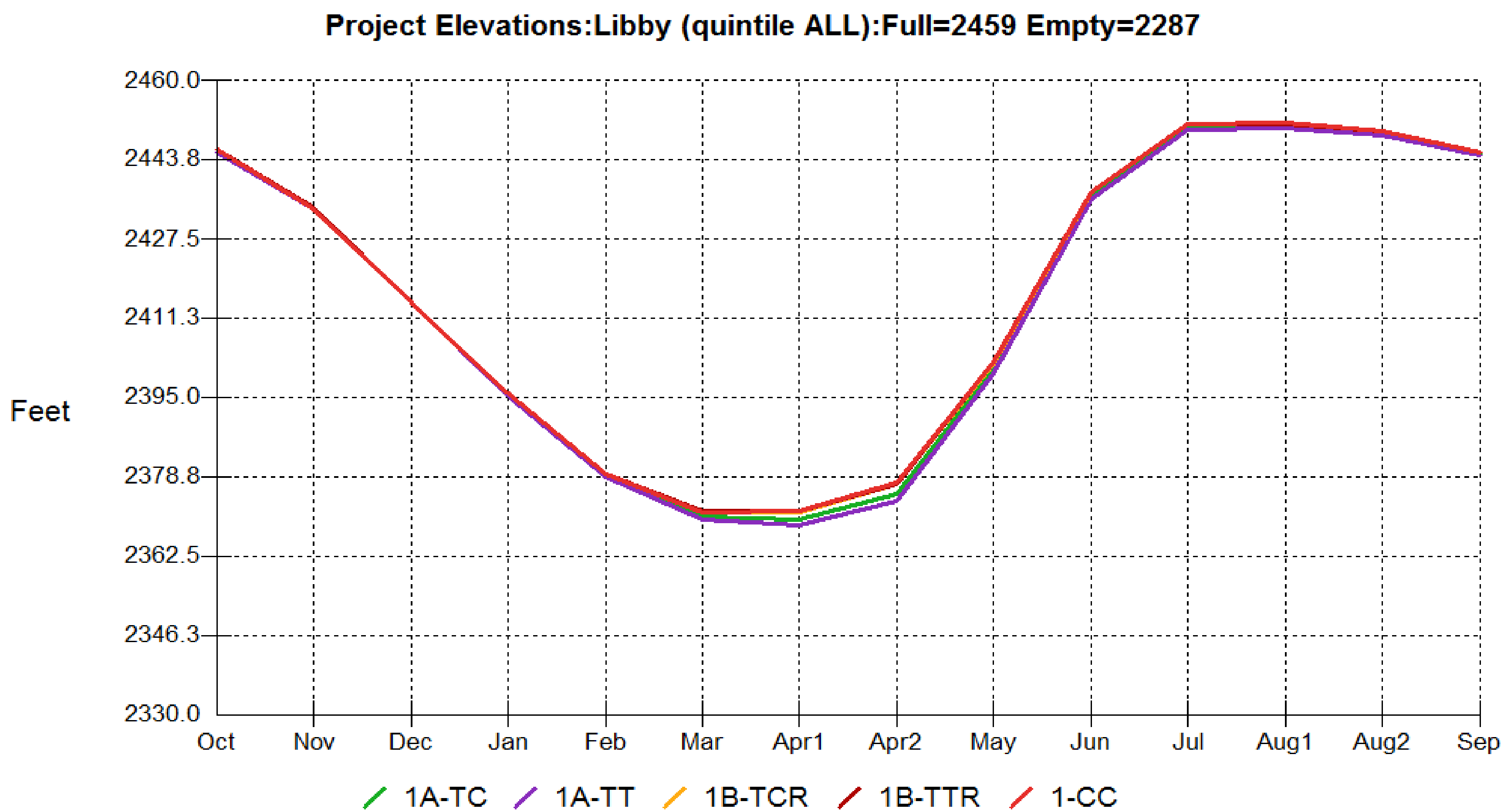
- Columbia River at McNary Dam
- Columbia River at The Dalles Dam
- Columbia River at Bonneville Dam (Estuary)

KOOTENAI RIVER BASIN

- Lake Koocanusa above Libby Dam
- Kootenai River below Libby Dam

LAKE KOOCANUSA – Elevations

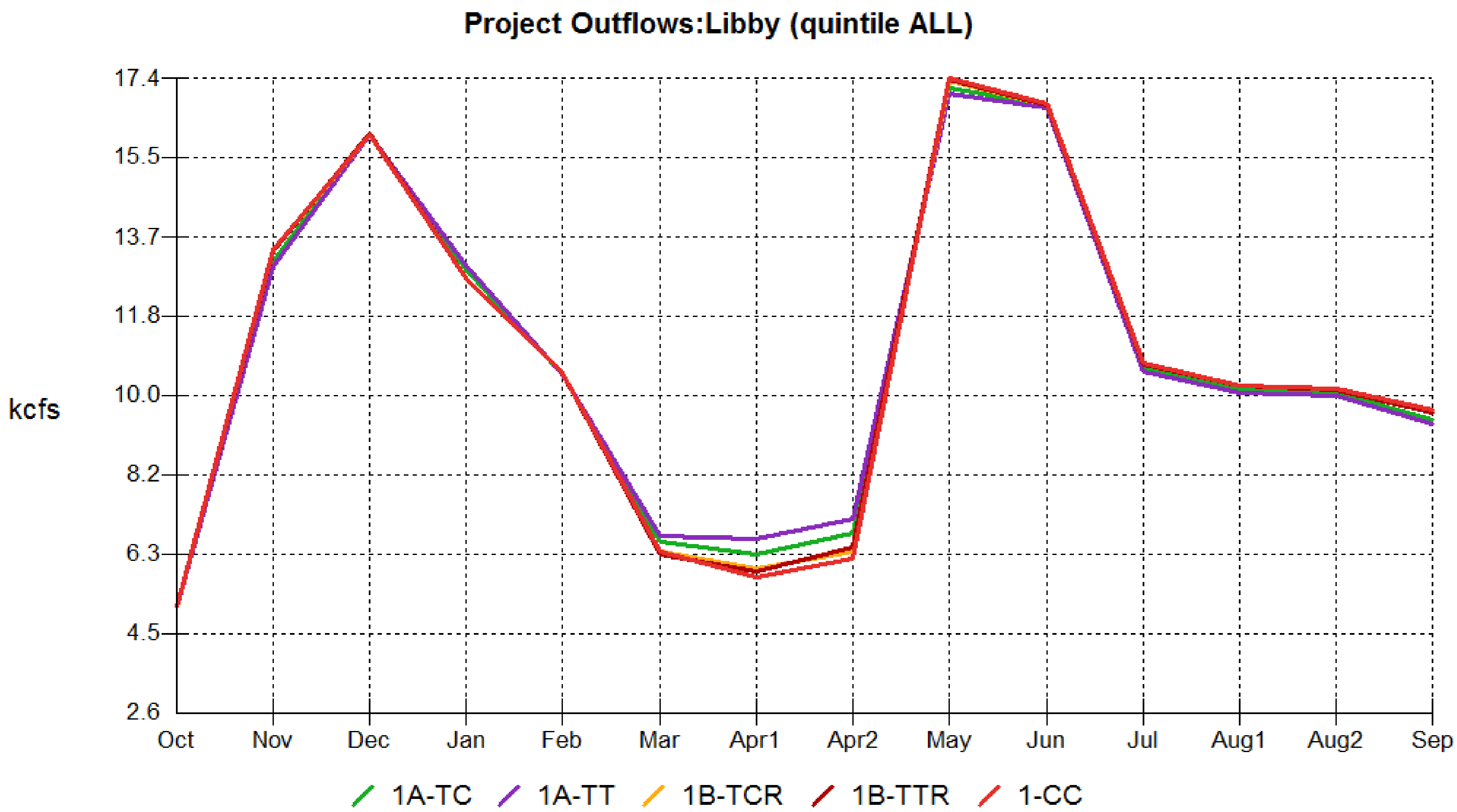
5 Alternatives – 70 Water Years



•With 600 alternatives, Lake is 2'-4' higher in April and 1' higher in summer than 450 alternatives, but 1' lower in April and the same in summer as Current Condition.

•In higher water years, Lake is 5'-12' higher in April and 3'-4' higher in summer with 600 alternatives compared to 450 alternatives ; 600 alternatives draft 2' more than Current Condition, but have same summer elevations.

Kootenai River
5 Alternatives – 70 Water Years

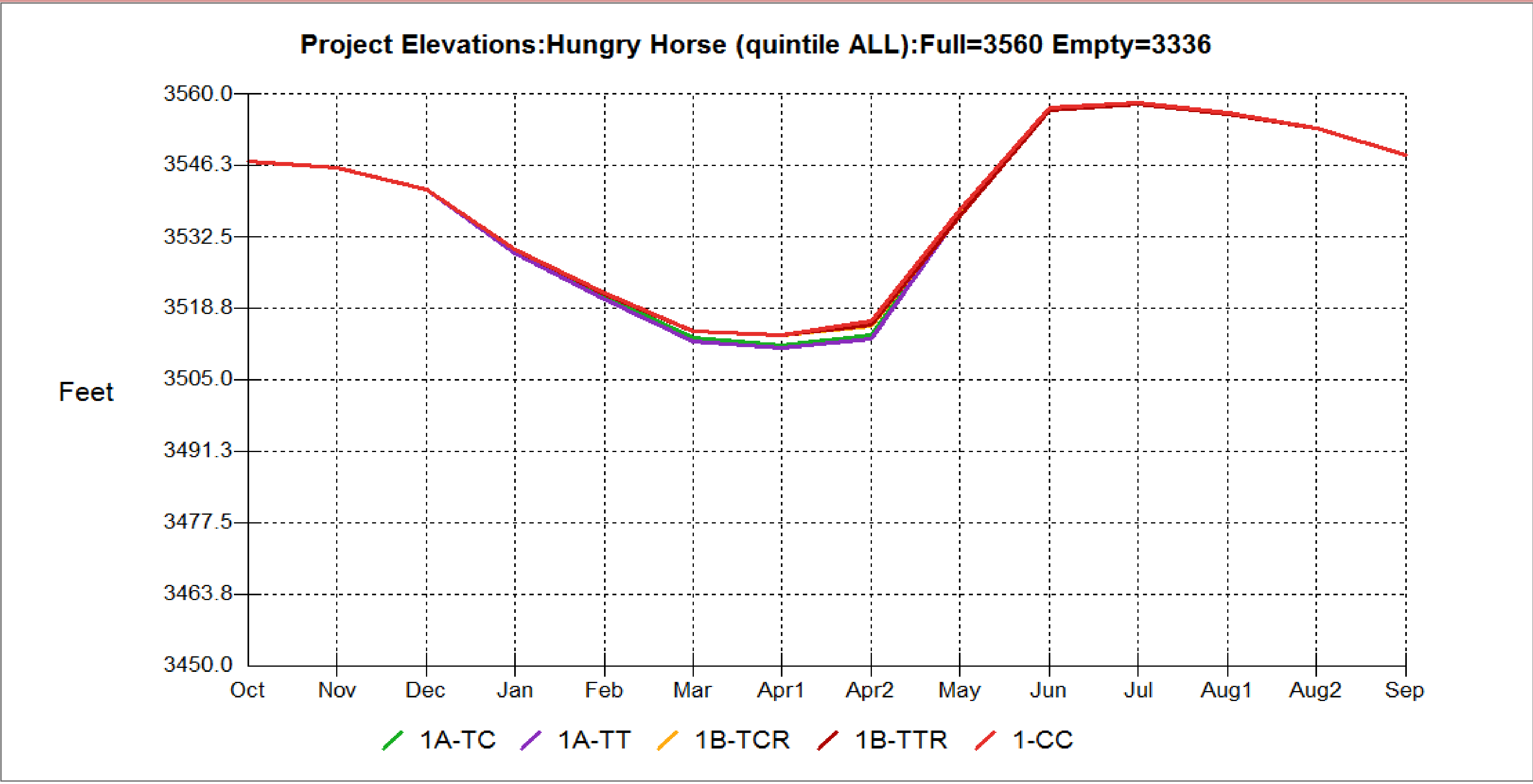


- 450 alternatives have < 1 kcfs greater flows in April compared to 600 alternatives and Current Condition.
- In lower water years, flows are very similar for all alternatives.
- In higher water years, 450 alternatives have flows ~2-3 kcfs more in April; ~ 1 kcfs less in Sept. compared to 600 alternatives and Current Condition.

FLATHEAD RIVER BASIN

- Hungry Horse Reservoir above Dam
- South Fork Flathead River below Hungry Horse Dam
- Flathead River at Columbia Falls
- Flathead Lake above Kerr Dam
- Flathead River below Kerr Dam

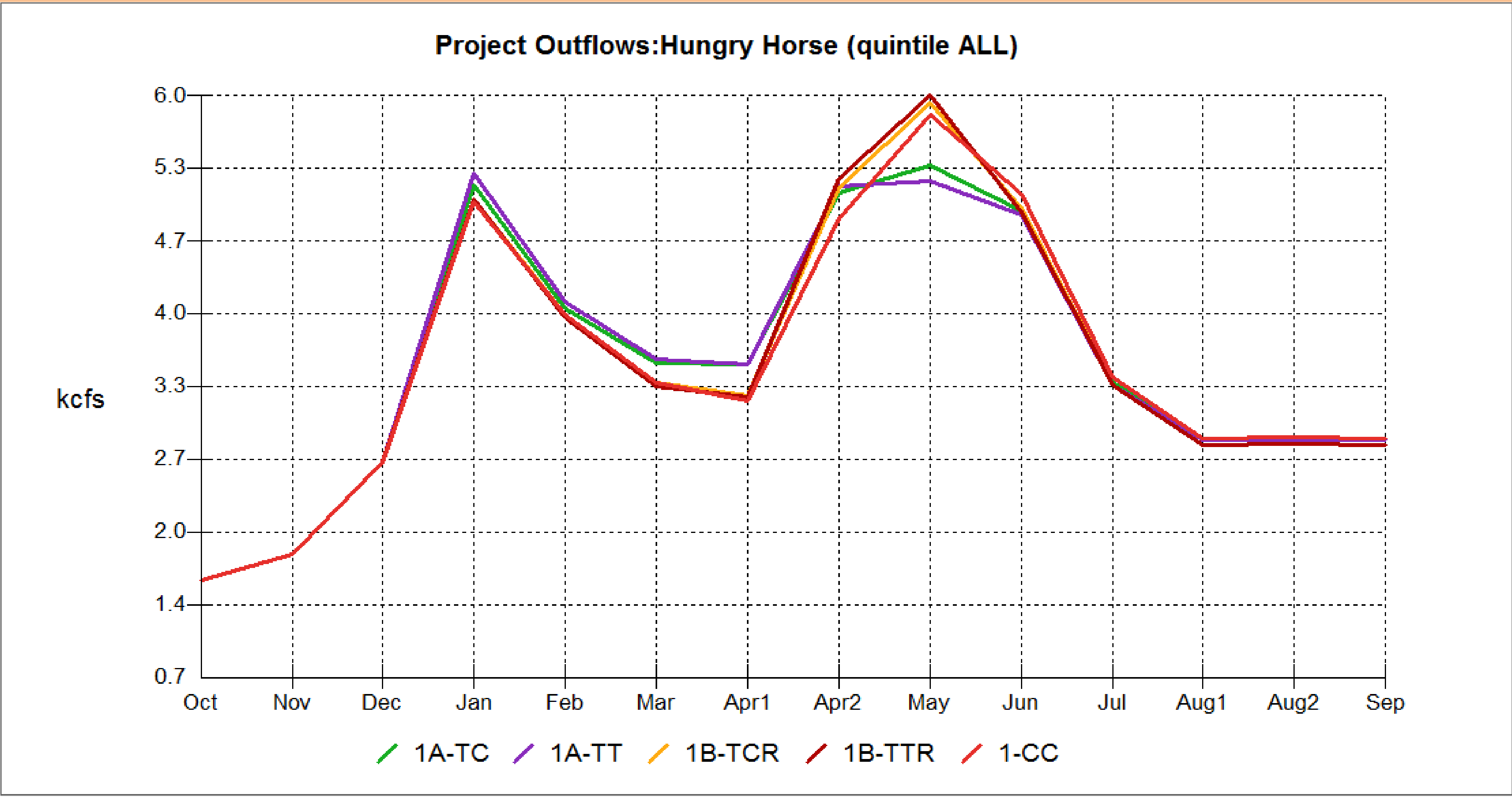
Hungry Horse Reservoir Elevation
5 Alternatives – 70 Water Years



- 600 alternatives draft the reservoir 2'-3' less in the spring compared to 450 alternatives, but 1' more than Current Condition.
- 600 alternatives draft 8'-9' less than 450 alternatives and about 4' more than Current Condition in April.
- Refill is similar for all alternatives.

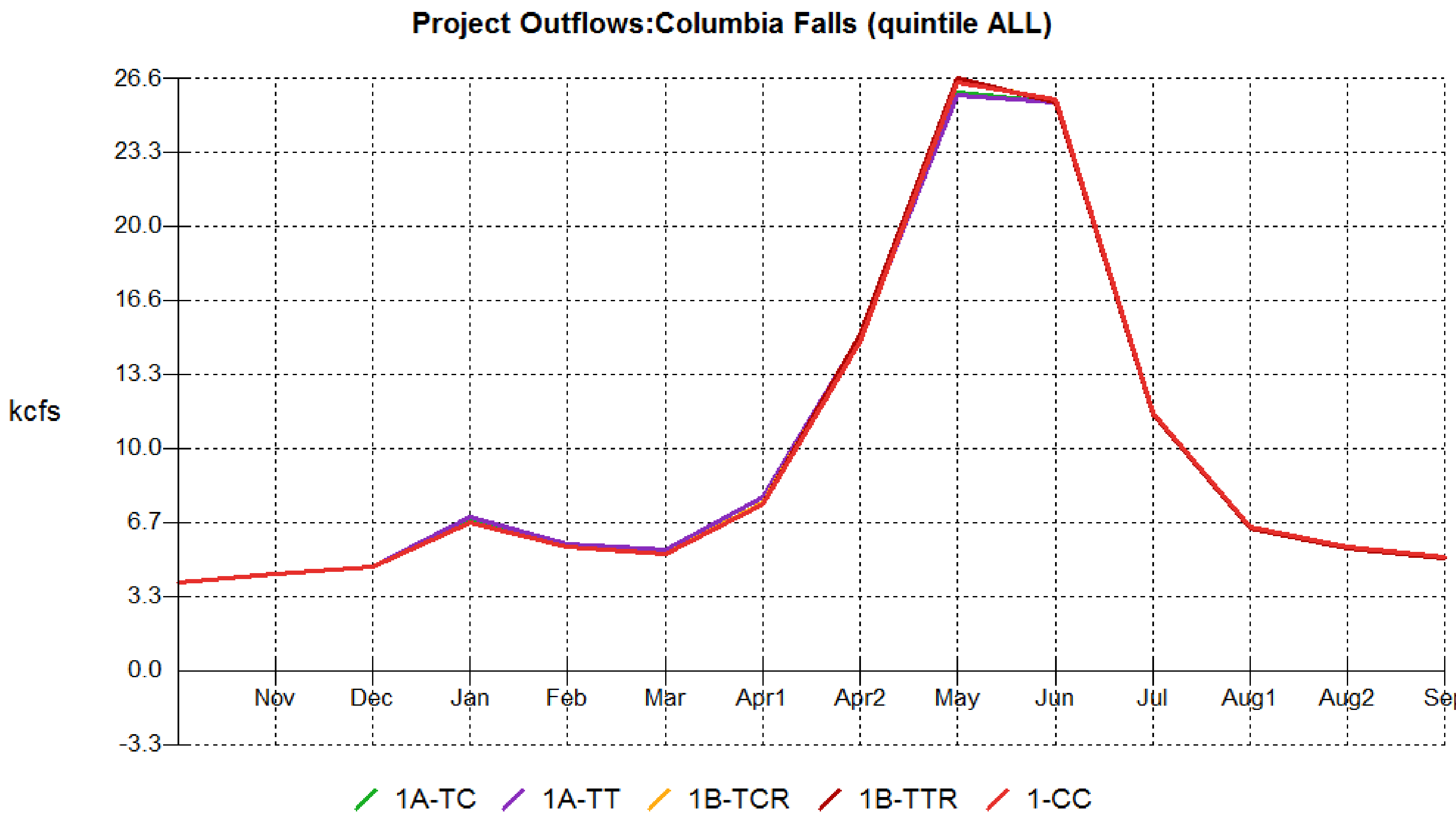
S.F. Flathead below Hungry Horse Dam

5 Alternatives – 70 Water Years



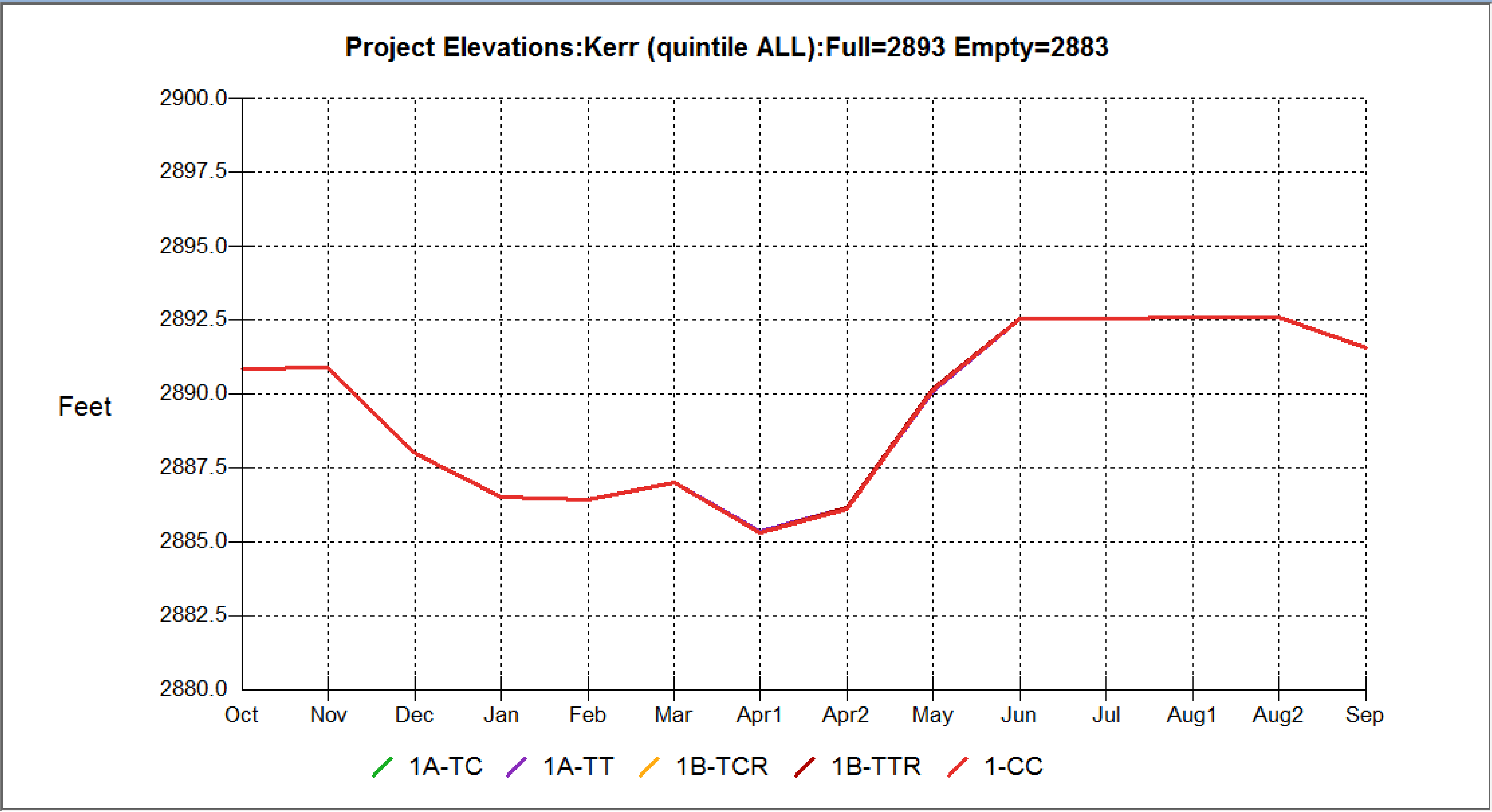
- •450 alternatives show ~ 0.3 kcfs higher flows in early spring and ~ 0.7 kcfs lower flows in May compared to the 600 alternatives and Current Condition.
- •In higher water years, 450 alternatives show ~ 1 kcfs greater flow in the early spring and ~ 2 kcfs less flow in May compared to the 600 alternatives and Current Condition.

Flathead River @ Columbia Falls
5 Alternatives – 70 Water Years



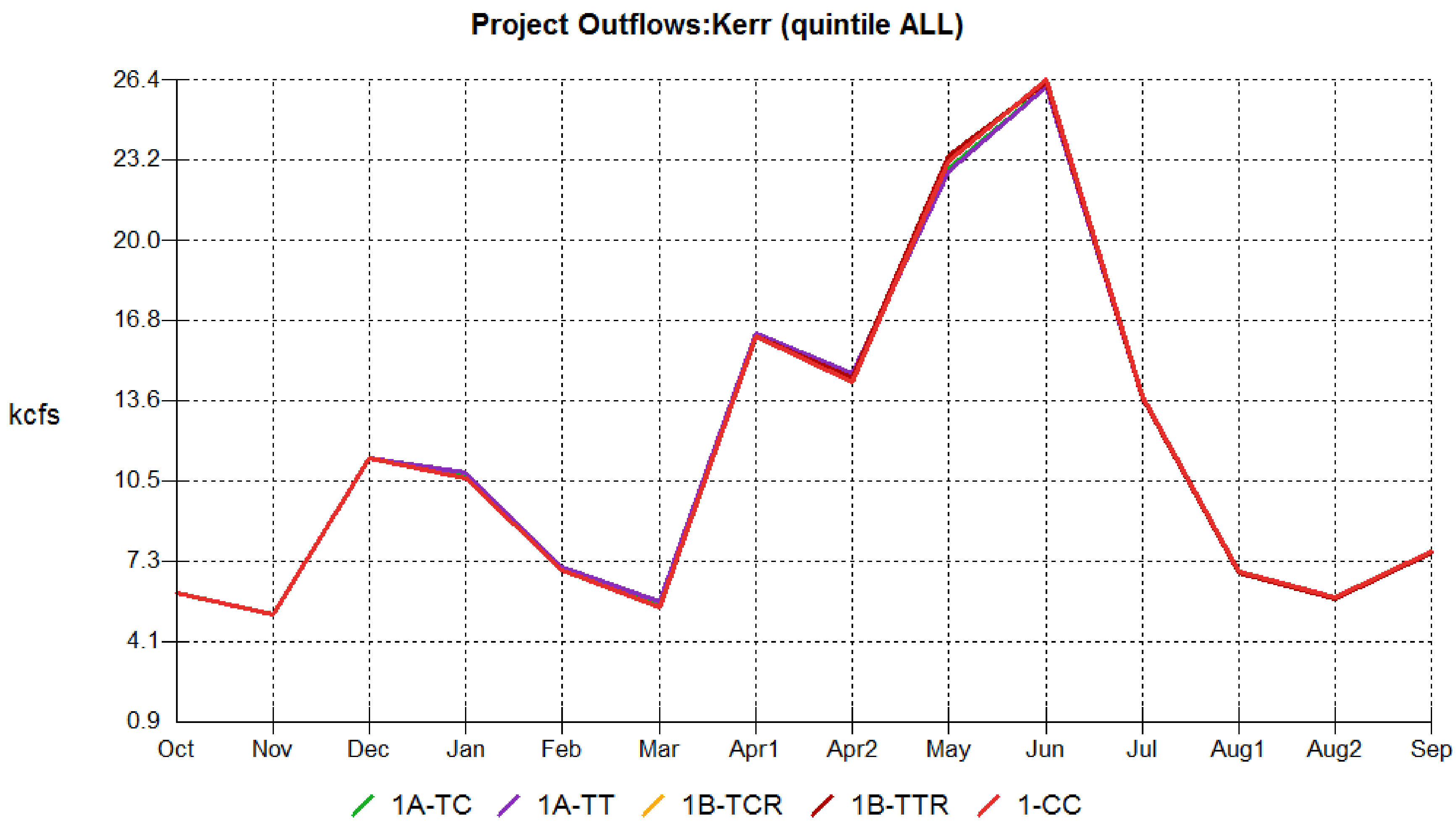
- Little differences in flows between alternatives.
- 450 alternatives' flows are ~1 kcfs higher in early spring and ~ 2 kcfs lower in May compared to the 600 alternatives and Current Condition.

Flathead Lake – Elevations
5 Alternatives – 70 Water Years



•No effects of alternatives on Flathead Lake elevations; same for lowest and highest water years.

Kerr Dam Outflows
5 Alternatives – 70 Water Years



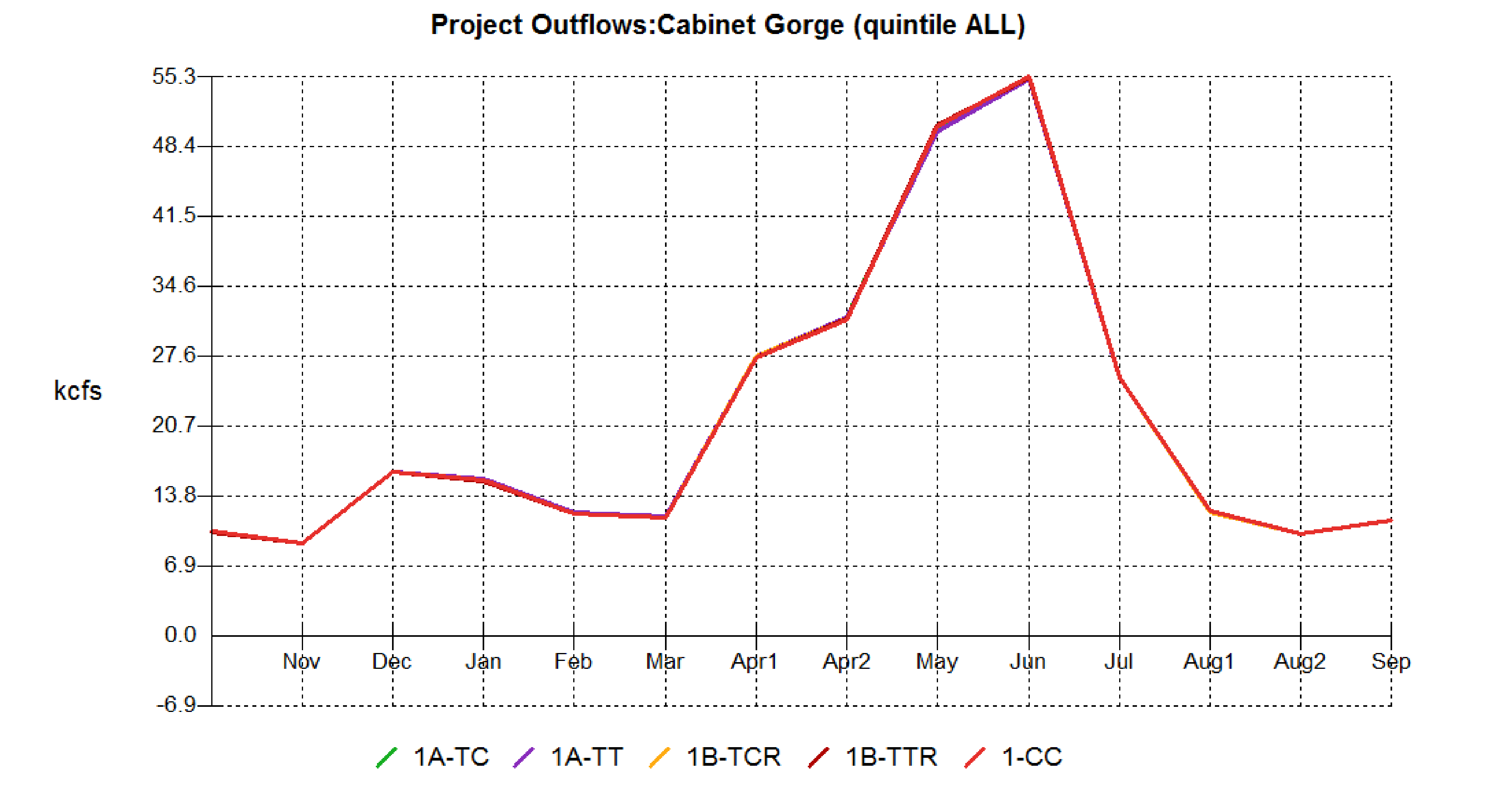
•Little, if any, differences in flows between alternatives; same for lowest and highest water years.

PEND OREILLE RIVER BASIN

- Clark Fork River at Cabinet Gorge Dam
- Lake Pend Oreille above Albeni Falls Dam
- Pend Oreille River below Albeni Falls Dam

Clark Fork River at Cabinet Gorge Dam

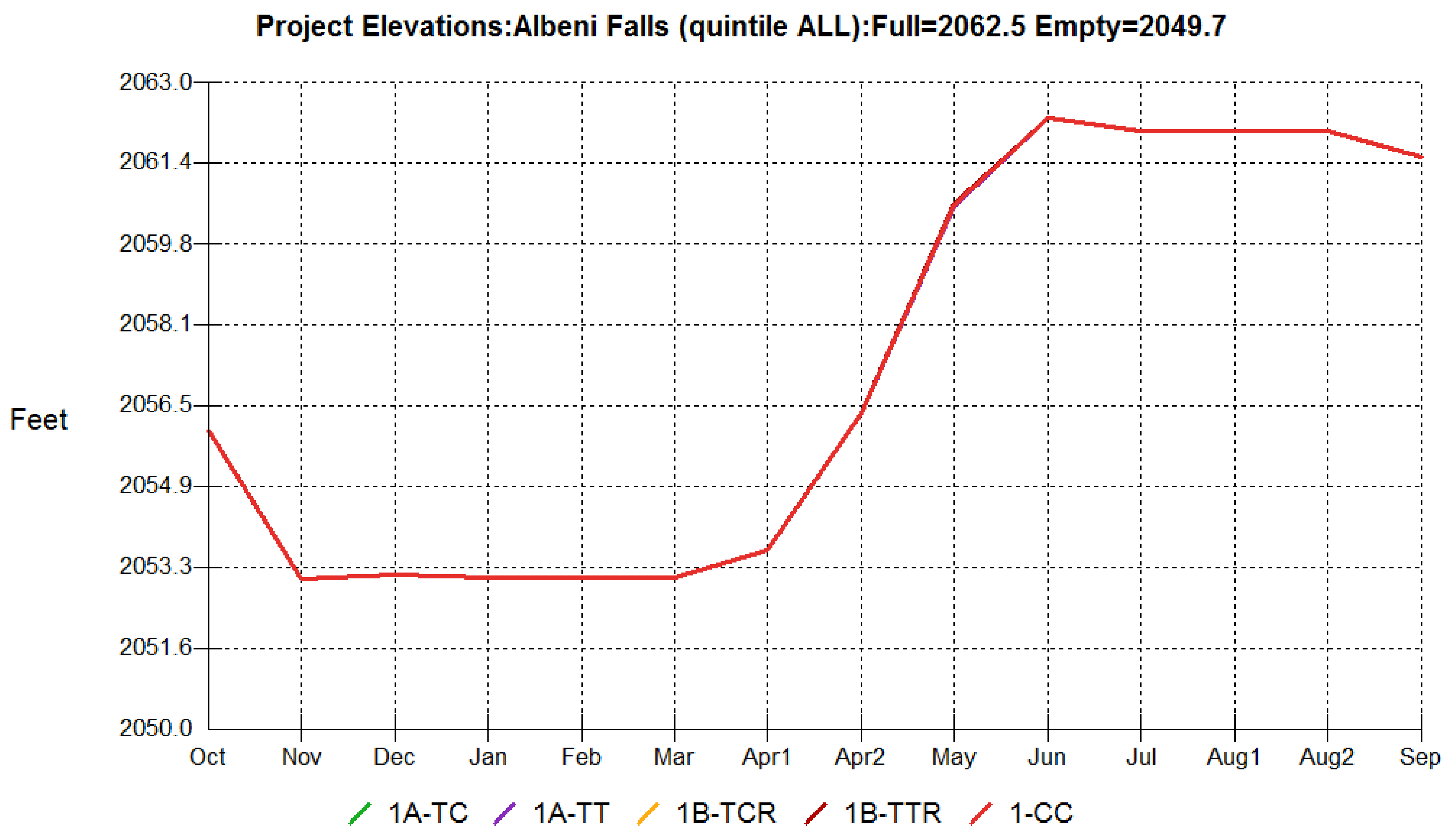
5 Alternatives – 70 Water Years



•Effects of Treaty alternatives is limited to 0 – 0.4 kcfs; similar effects in the lowest and highest water years.

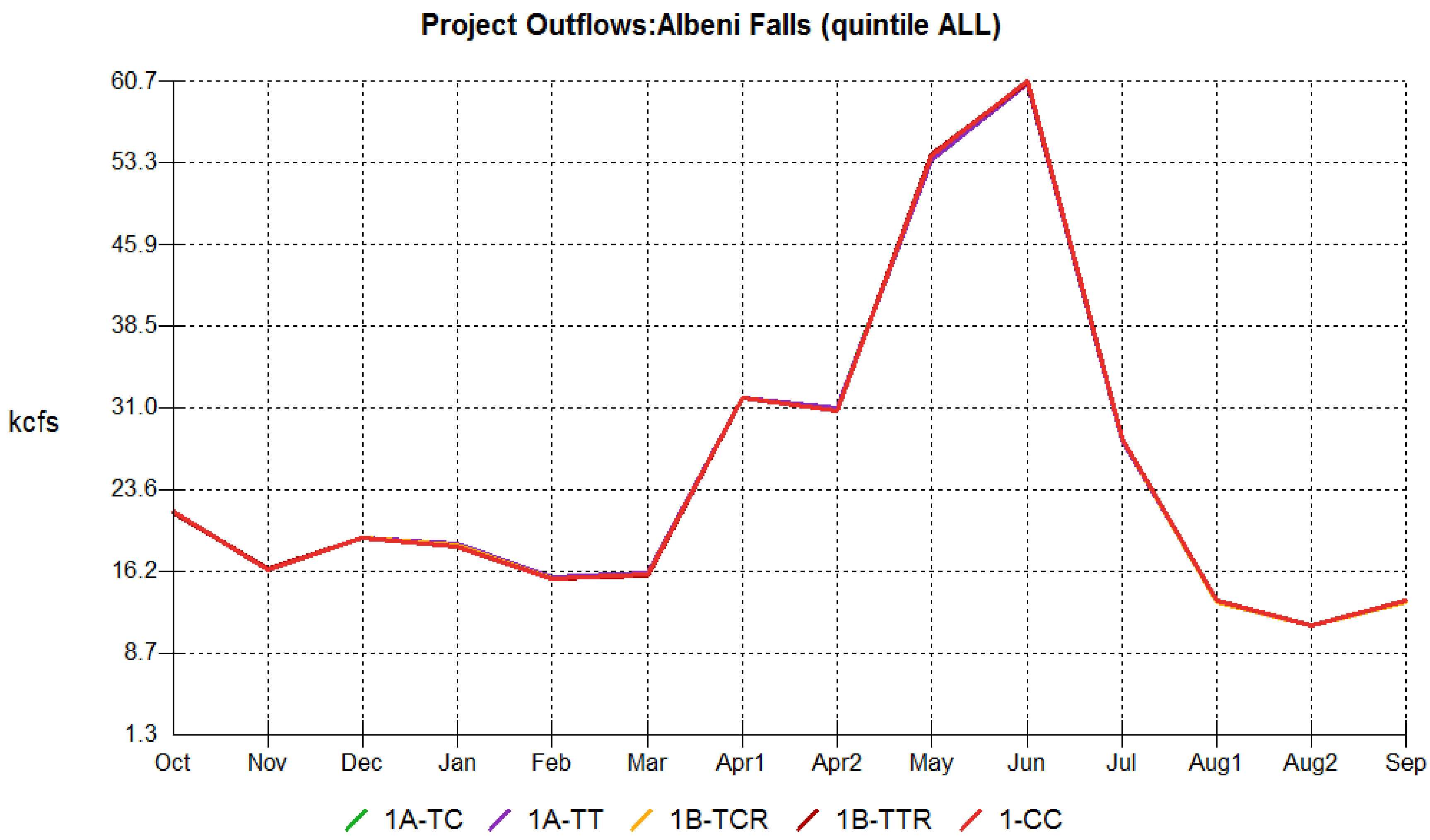
Lake Pend Oreille Elevations

5 Alternatives – 70 Water Years



•No effects of Treaty alternatives on Lake elevations in all water conditions.

Albeni Falls Dam – Outflows
5 Alternatives – 70 Water Years

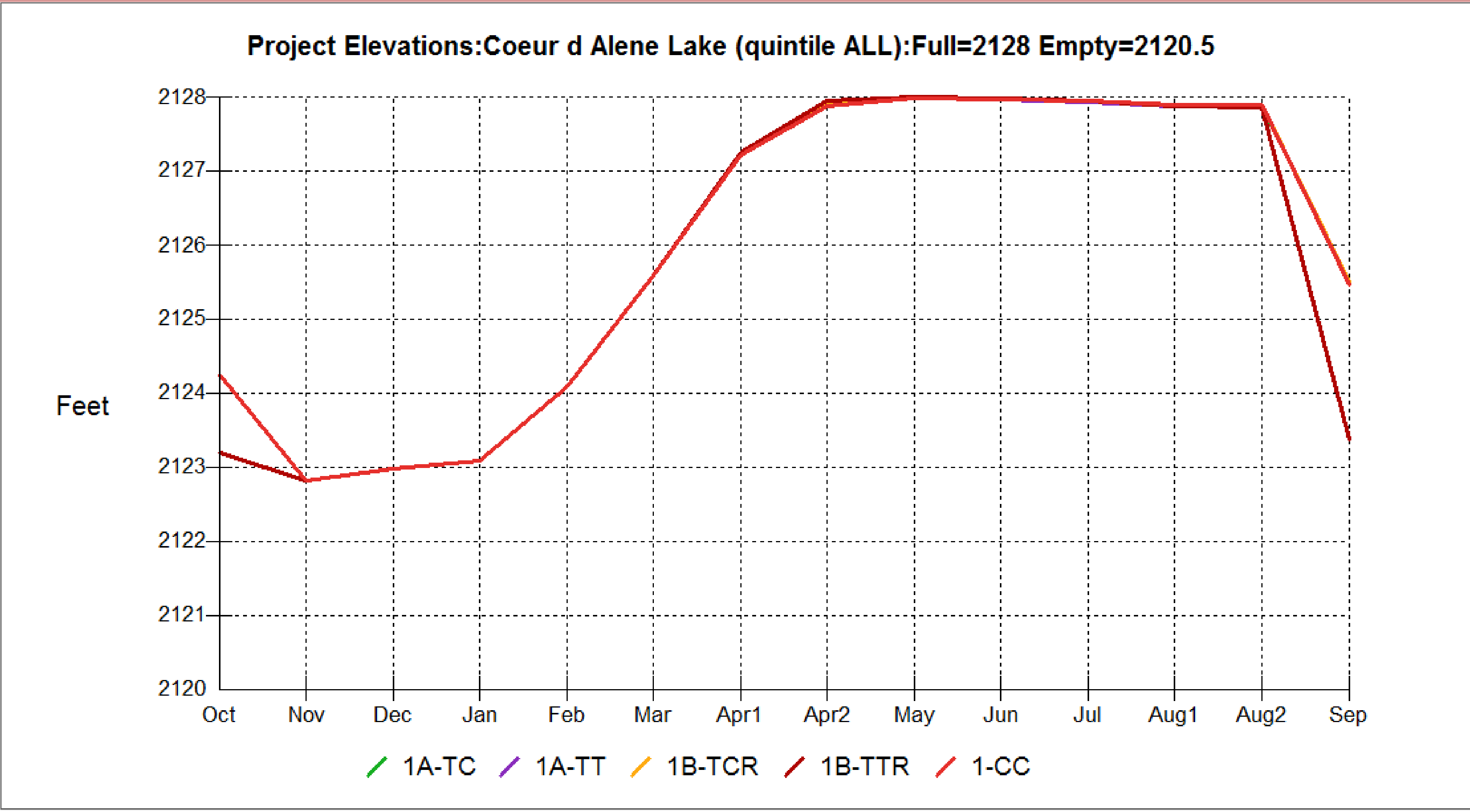


•Flow effects of Treaty alternatives are limited to no more than ~ 0.2 kcfs in all water conditions.

SPOKANE RIVER BASIN

- Lake Coeur d’Alene
- Spokane River below Post Falls Dam

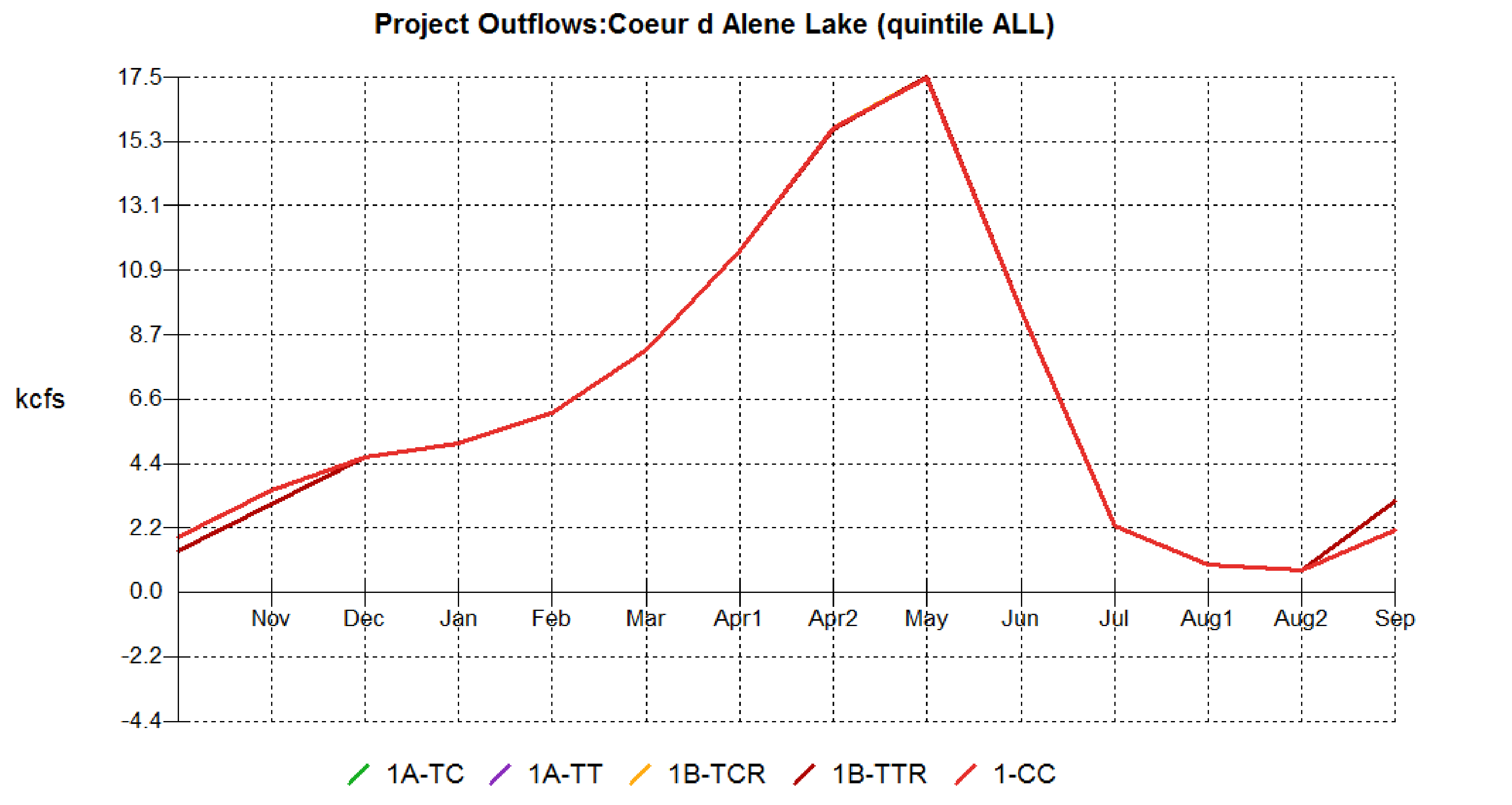
Coeur d' Alene Lake Elevations
5 Alternatives - 70 Water Years



•Modeling of Treaty Terminates alternatives show potential to draft Lake ~ 1' more in the fall (3' in lowest water years), but in actual operations , this is not likely.

Coeur d' Alene Lake Outflows

5 Alternatives - 70 Water Years



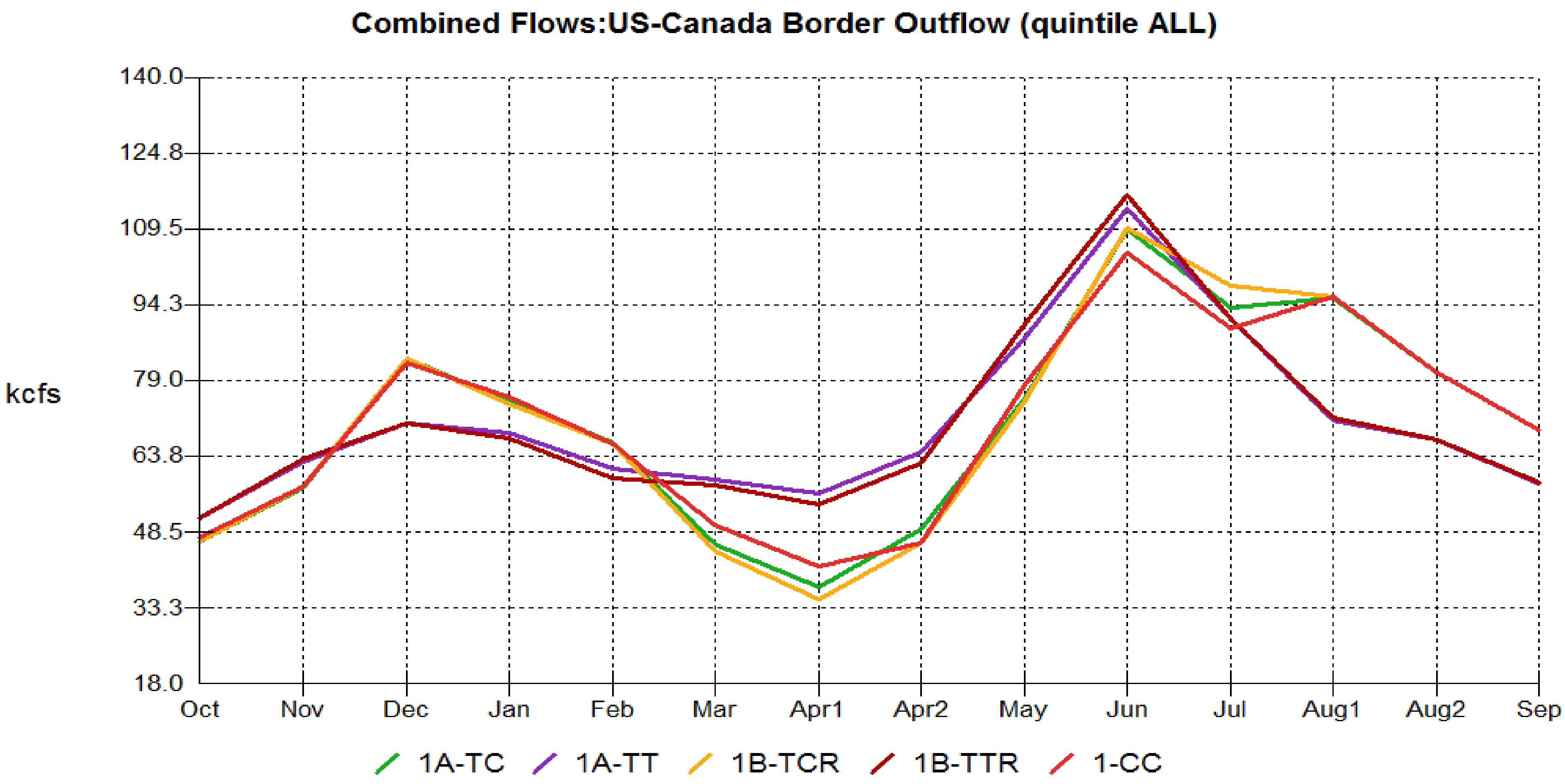
•Modeling of Treaty Terminates alternatives show potential for higher fall flows of ~ 1 kcfs from Post Falls Dam, but in actual operations , this is not likely.

COLUMBIA RIVER BORDER
to
GRAND COULEE DAM

- Columbia River at Border (flowing into USA)
- Lake Roosevelt above Grand Coulee Dam
- Columbia River below Grand Coulee Dam

Columbia River Flows at Border

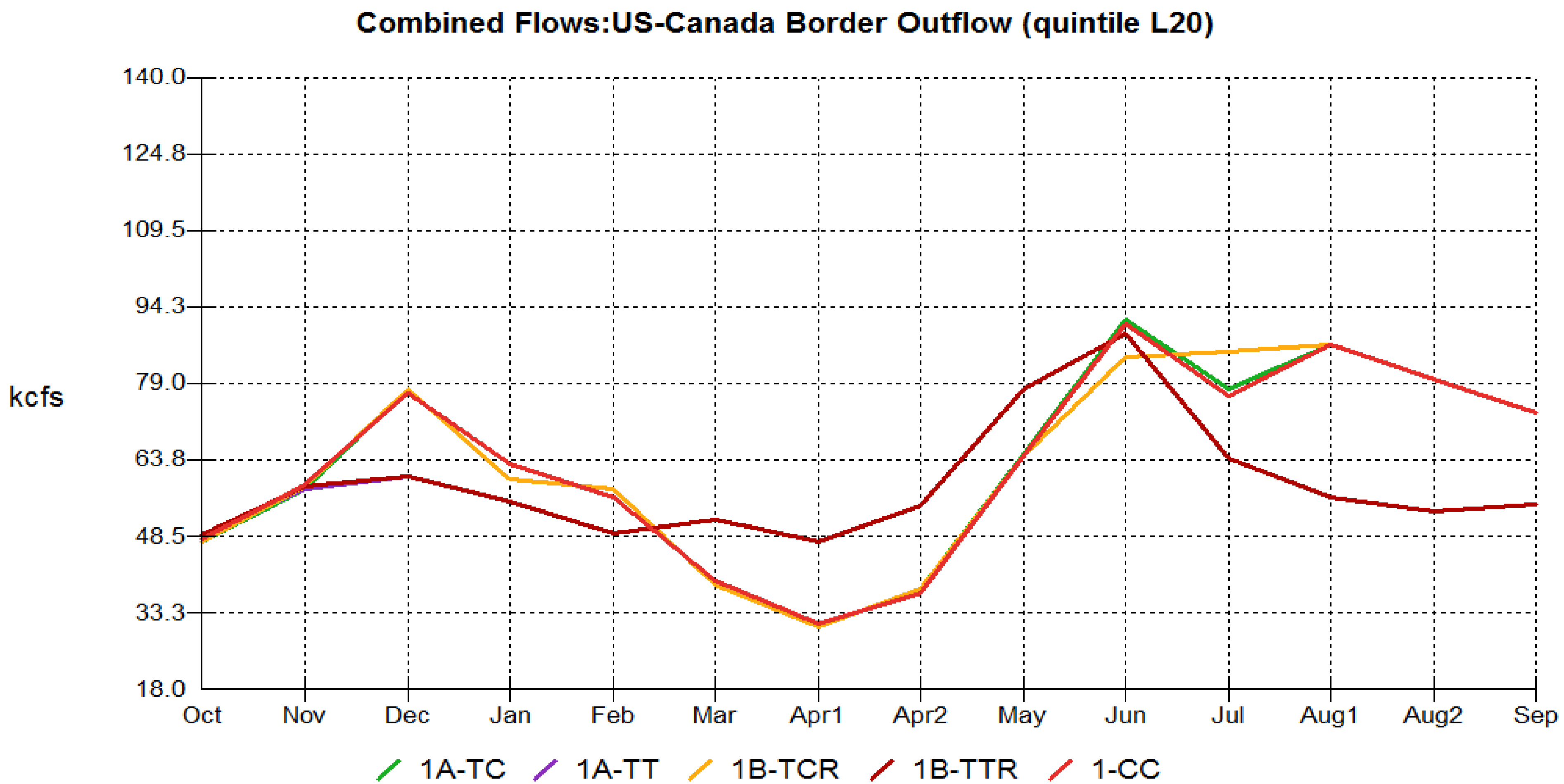
5 Alternatives - 70 Water Years



- Treaty Terminates alternatives show lower winter flows (10-13 kcfs), higher freshet flows (10-20 kcfs) and lower summer flows (10-20 kcfs).

Flows at Border

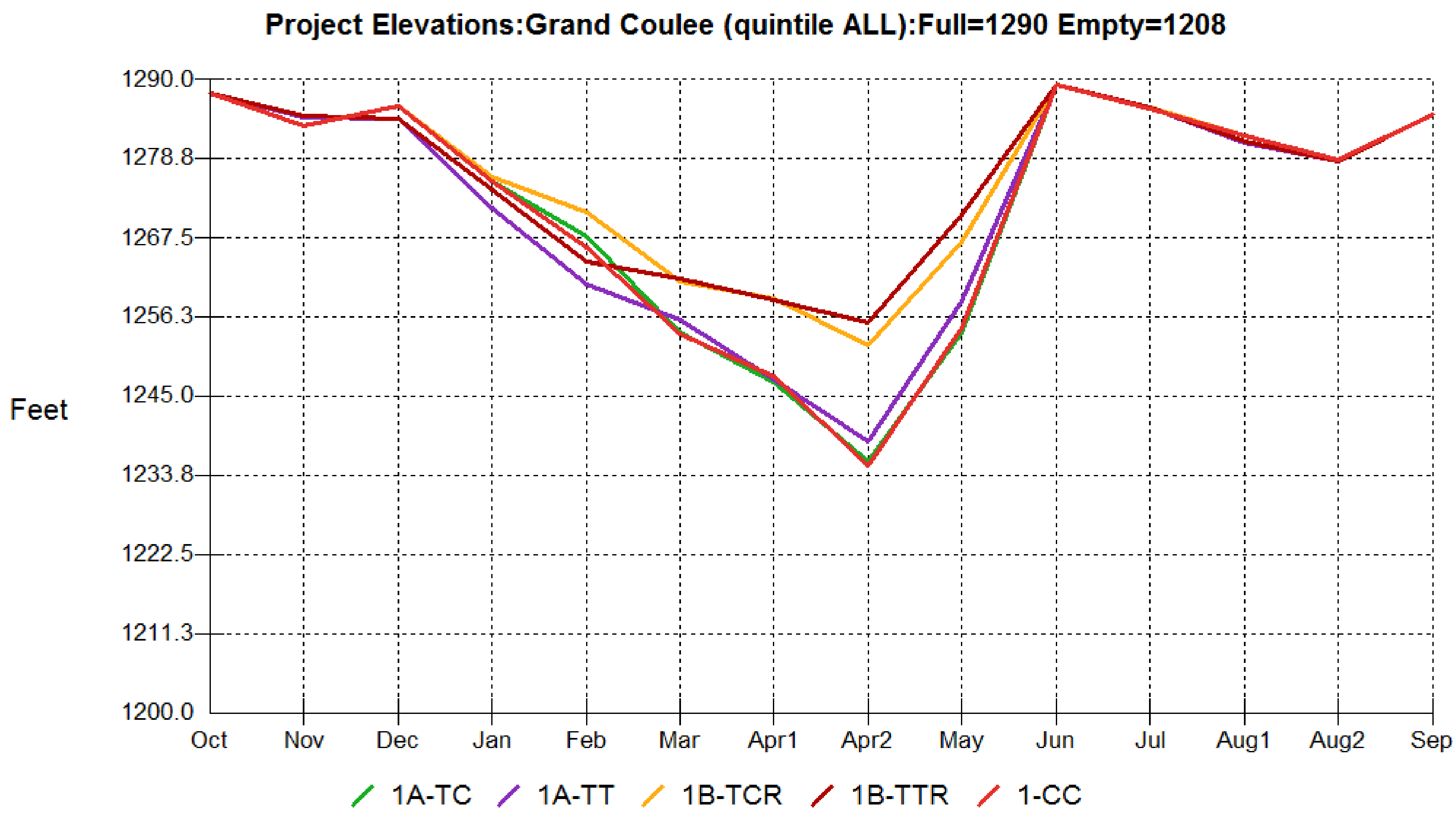
5 Alternatives – 20% Lowest Water Years



- In lower flow years, Treaty Terminates alternatives show similar flow pattern, except even lower summer flows (25-30 kcfs) .
- Flow differences are proportionately greater.

Lake Roosevelt Elevation

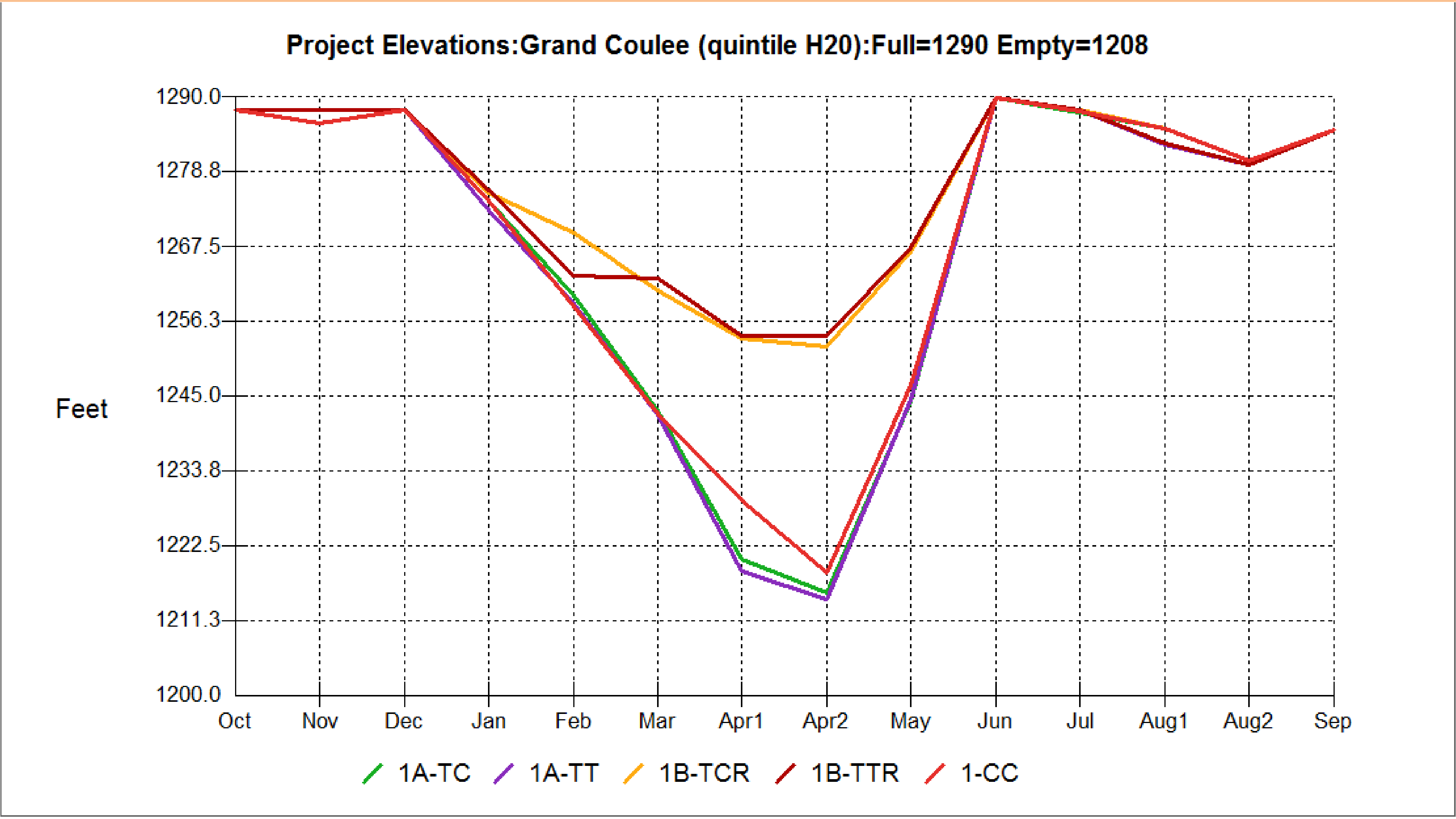
5 Alternatives – 70 Water Years



•600 alternatives draft the Lake 15' – 20' less in April than the 450 alternatives and Current Condition. Lake is also 10' – 15' higher in May.

Lake Roosevelt Elevation

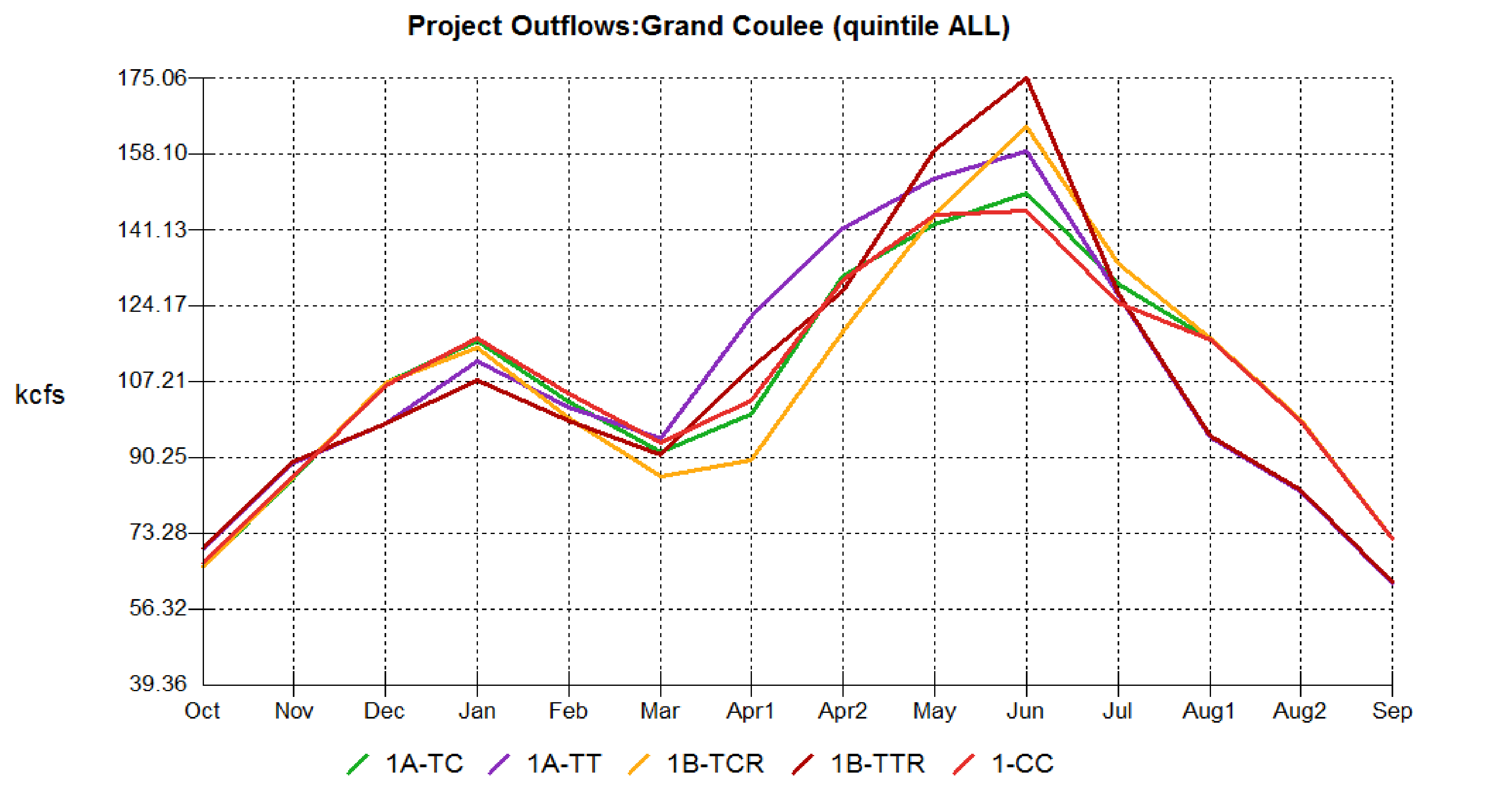
5 Alternatives – 20% Highest Water Years



•600 alternatives draft Lake 35' to 40' less than 450 alternatives and Current Condition.

Grand Coulee – Outflows

5 Alternatives – 70 Water Years



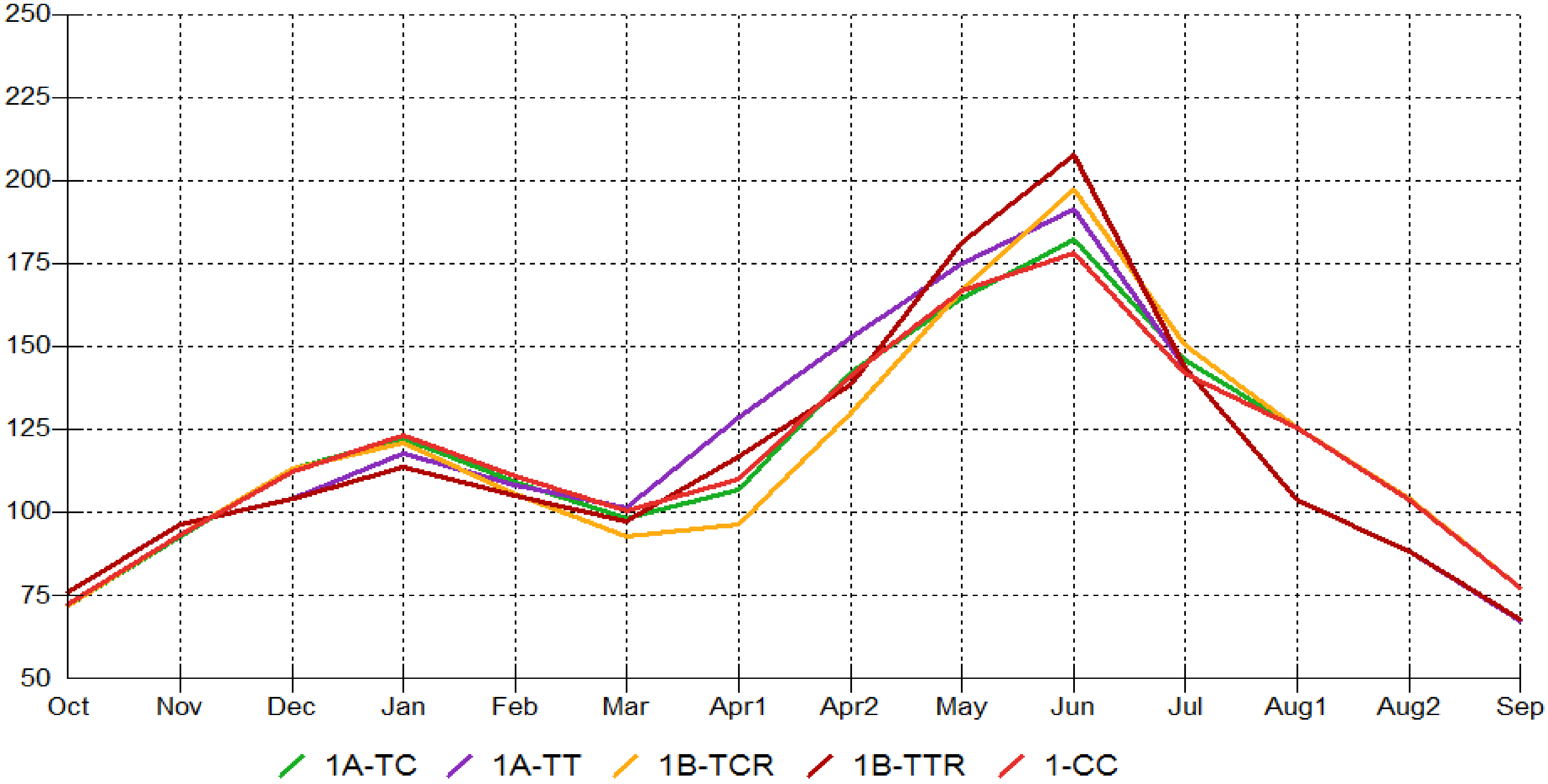
- Treaty Terminates alternatives provide higher spring freshet flows (13-30 kcfs), but lower late summer flows
- 600 alternatives have higher freshet flows (20-30 kcfs) compared to the Current Condition.
- In lower flow years, Treaty Terminates alternatives reduce summer flows by 20-30 kcfs.
- In higher flow years, 600 alternatives restore about 40 kcfs to the spring freshet.

GRAND COULEE DAM to SNAKE RIVER CONFLUENCE

- Columbia River at Priest Rapids Dam
- Columbia River at Vernita Bar – <u>no change</u>

COLUMBIA RIVER – PRIEST RAPIDS (PRD)

70 WATER YEARS AVERAGE FLOWS (KCFS)



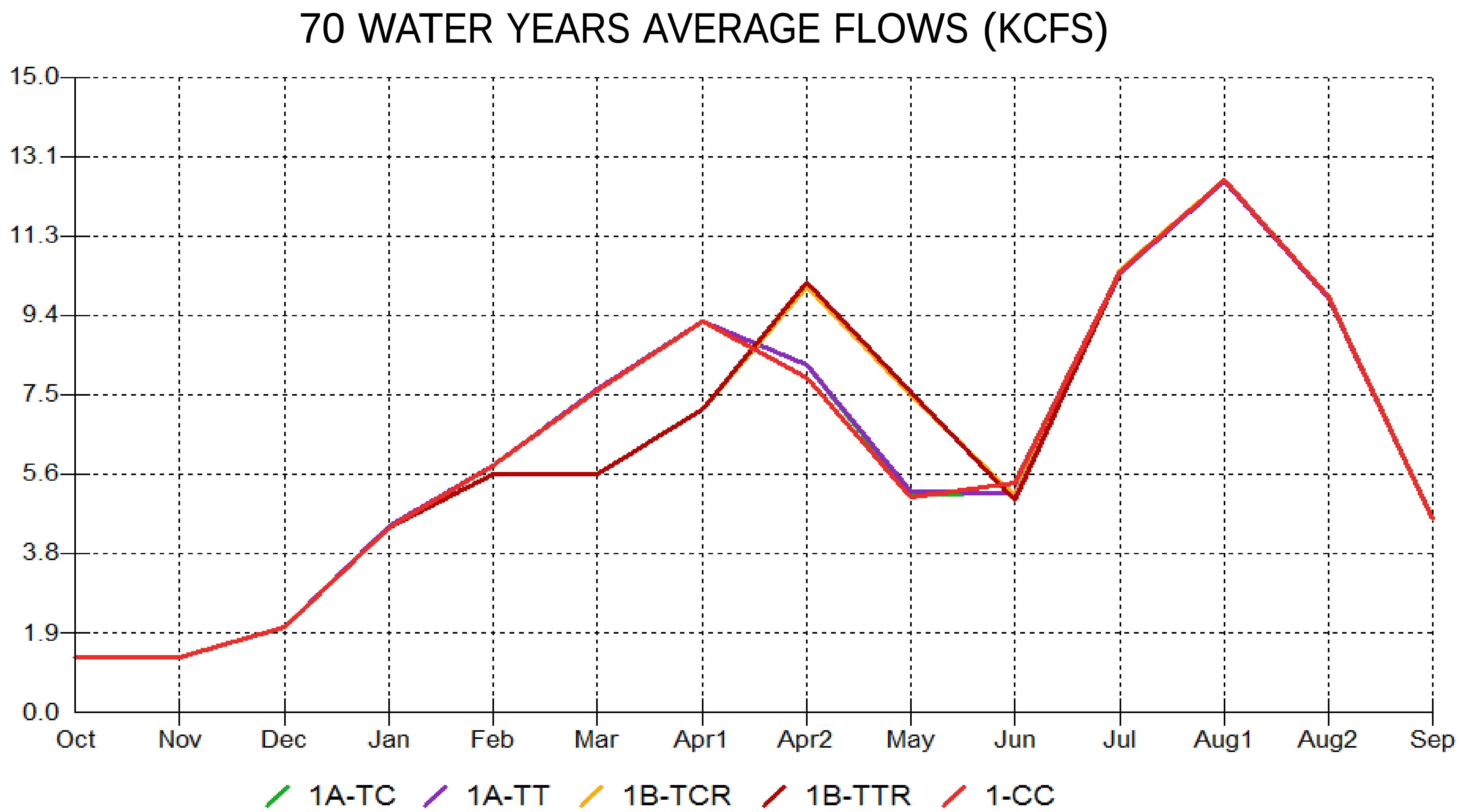
GRAND COULEE DAM to SNAKE RIVER CONFLUENCE - Key Points

- Priest Rapids- all alternatives missed salmon BiOp spring flows of 135 Kcfs in the average of the 20% lowest water years
- All alternatives met BiOp spring flows in all 14 high water years
- For the average of the 70 year period, there was a mix of meeting and missing spring flows for all alternatives
- 600 kcfs alternatives increased June average peak flows over all other alternatives by 5-29 kcfs.
- Vernita Bar- Fall Chinook salmon flows are met for all water years (HYDSIM model methods and assumptions for Vernita Bar flows are under review).

SNAKE RIVER BASIN

- Snake River at Brownlee Dam – no change
- Hells Canyon Complex – no change
- North Fork Clearwater River at Dworshak Dam
- Lower Snake River at Lower Granite Dam – no change

NF CLEARWATER RIVER– DWORSHAK DAM (DWR)



<u>Revised 600 kcfs alternatives results</u>:

- 600 kcfs alternatives shift spring peak flows two weeks later compared to current condition and 450 kcfs alternatives.

Snake River Flows - Key Points

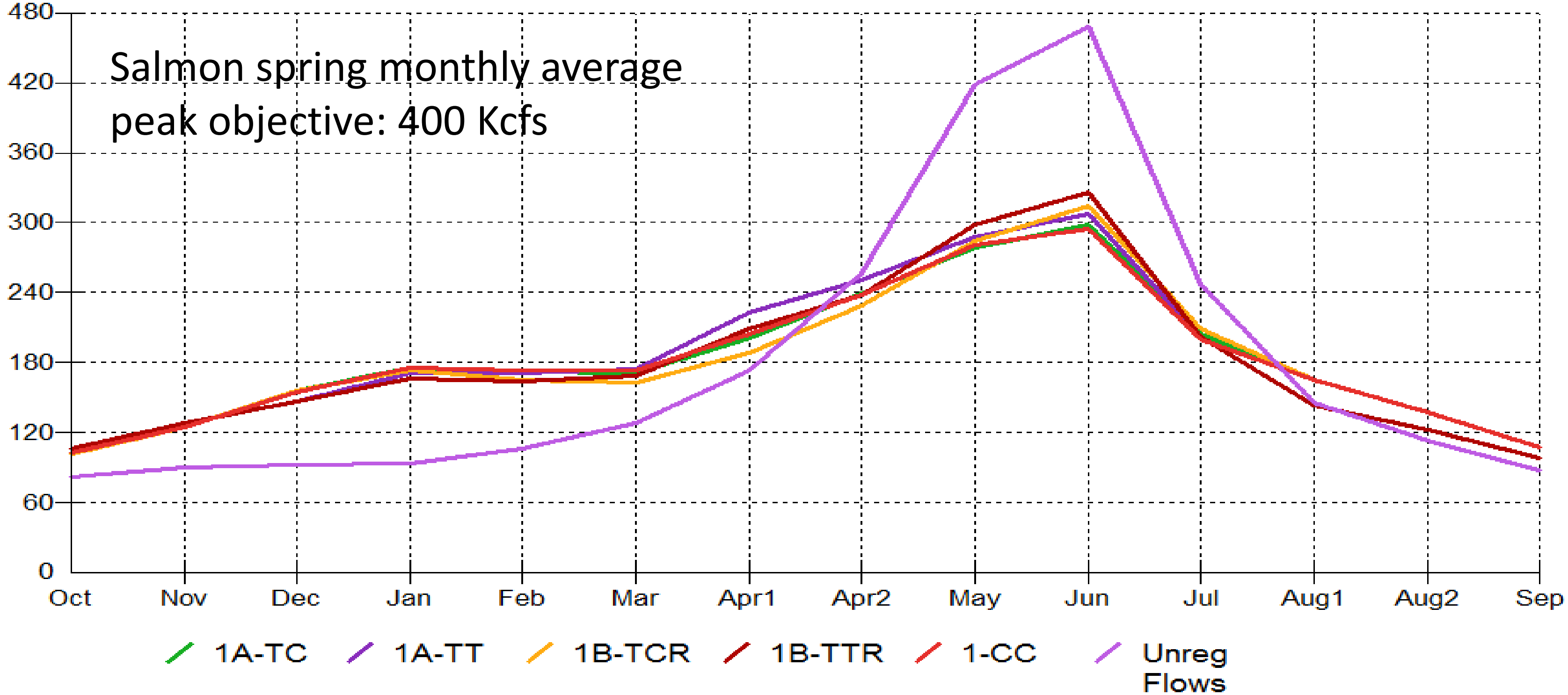
- In general, there were no differences for Snake River flows and other metrics between the iteration #1 alternatives.
- Brownlee, Hells Canyon Complex and Lower Granite - no change in monthly average flows across the alternatives.
- Dworshak - 600 kcfs alternatives have spring peak flows shifted two weeks later than other alternatives.

COLUMBIA RIVER at SNAKE RIVER CONFLUENCE to ESTUARY

- Columbia River at McNary Dam – <u>no change</u>
- The Dalles Dam
- Columbia River at Bonneville Dam (Estuary) – <u>no change</u>

COLUMBIA RIVER – THE DALLES DAM (TDA)

AVERAGE OF 70 WATER YEARS FLOWS and UNREGULATED FLOW (KCFS)



600 kcfs alternatives results:

- June average regulated flows greatest for 600 kcfs treaty terminates alternative, 13 to 31 kcfs higher than all other alternatives.

Lower Columbia River- Key Points

- McNary- all alternatives fail to meet BiOp spring flows all 14 low water years. All alternatives meet BiOp spring flows for the average of the all 70 and 20% high water years
- McNary- 600 kcfs treaty terminates alternatives provide higher spring but lower summer salmon flows than 600 kcfs treaty continues alternatives
- McNary- 600 kcfs treaty terminates alternative results in highest spring flows of all alternatives.
- The Dalles- Treaty terminates alternatives increase spring flows but summer flows are greater for treaty continues alternatives. The 600 kcfs treaty terminates alternative increases the June 70 year average flows by about 31 kcfs over other alternatives.
- The Dalles- 600 kcfs treaty continues alternatives increase 70 year average late summer flows by about 20 kcfs over 600 kcfs treaty terminates alternatives

Lower Columbia River- Key Points Continued

- The Dalles - June 70 year average fish flow objective of 400 kcfs was met for 600 kcfs treaty terminates alternative for 10 of the 14 highest flow years – a gain of 3 years over other alternatives.
- Bonneville – June 70 year average fish flows increased by 10 kcfs for the 600 kcfs treaty terminates alternative over 600 kcfs treaty continues alternatives.
- Bonneville- 70 year average late summer flows were lowest for the 600 kcfs treaty terminates alternatives and highest for the 600 kcfs treaty continues alternative. Average differences were about 16 kcfs.

Chelan County PUD
Draft 2012 Rocky Reach and Rock Island
Fish Spill Program Report
For HCP Coordinating Committee

2012 ROCKY REACH

Rocky Reach Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	May 26, 0001 hrs
Spill stop date:	August 9, 2400 hrs
Percent of run with spill:	**97.50%**
Summer spill percentage:	31.86% (9% plus 22.86% forced spill May 26 – Aug 9)
Average river flow at RR:	233,370 cfs (May 26- Aug 9)
Average spill rate at RR:	74,355 cfs (May 26 – Aug 9)
Cumulative index count:	5,757 subyearling Chinook (Aug 26)
Number of spill days:	76

2012 ROCK ISLAND

Rock Island Spring Spill

Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	April 17, 0001 hrs
Spill stop date:	May 27, 2400 hrs (immediate increase to 20% summer spill)
Percent of run with spill:	**Yrlng Chins 99.80%; Steelhead 99.75%; Sockeye 99.80%**
Cumulative index count:	25,759 Yearling Chins**;** 16,957 Steelhead**;** 46,788 sockeye
Spring spill percentage:	**16.39%** (10% plus 6.39% forced spill, April 17 - May 27)
Ave river flow at RI:	208,770 cfs (April 17- May 27)
Ave spill flow at RI:	34,210 (April 17- May 27)
Total spill days:	41

Rock Island Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	May 28, 0001 hrs
Spill stop date:	August 18, 2400 hrs
Percent of run with spill:	**97.85%**
Cumulative index count:	27,298 subyearling Chins
Summer spill percentage**:**	**27.29%** (June 4 through August 24)
Ave river flow at RI:	212,290 cfs (June 4- August 24)
Ave spill flow at RI:	57,920 cfs (June 4- August 24)
Total spill days:	83

Juvenile Index Counts 2003-2012 from the Rocky Reach Juvenile Fish Bypass sampling facility and the Rock Island Bypass Trap, April 1 – August 31.

Table 1. Rocky Reach Juvenile Bypass index counts, 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sockeye	71,683	30,935	17,575	239,185	169,937	136,206	40,758	724,394	67,879	384,224
Steelhead	10,585	6,433	5,821	4,329	4,532	8,721	6,309	4,931	5,683	4,902
Yrlng Chins	13,918	53,946	27,611	23,461	18,080	38,394	18,946	33,840	24,400	95,207
Subyrlng Chins	172,392	20,062	10,978	19,996	13,496	11,820	11,944	59,751	17,246	5,757

Table 2. Rock Island SMP index counts, 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sockeye	10,312	7,114	1,991	34,604	16,410	38,965	4,926	37,404	18,697	46,788
Steelhead	15,507	10,735	15,974	26,930	18,482	22,780	17,636	17,194	28,408	16,957
Yearling Chins	15,355	12,574	14,797	37,267	23,714	22,562	9,225	11,802	26,407	25,759
Subyrlng Chins	25,916	23,563	18,710	27,106	15,686	15,940	8,189	23,205	27,397	27,298

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	October 23, 2012
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the September 25, 2012, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met by conference call on Tuesday, September 25, 2012, from 9:30 am to 11:00 am. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Kristi Geris will post Chelan PUD's Draft 2013 HCP Comprehensive Progress Report on the Mid-Columbia HCP ftp site, and she will distribute instructions for accessing the site to the Coordinating Committees (Item II-B).
- Douglas PUD will distribute their draft HCP No Net Impact (NNI) Progress Report to the Coordinating Committees at least 10 days prior to the October 23, 2012 Coordinating Committees meeting (Item II-B).
- Steve Hemstrom will provide additional information to the Coordinating Committees on the Rocky Reach Turbine Unit 1 repair/outage scheduled for January 2, 2013, through April 31, 2013. Information will include potential operations for the month of April (Item II-C).
- Lance Keller will compile historical average fish lengths for fish passing Rocky Reach Dam during the month of April, and he will provide these data to Kristi Geris for distribution to the Coordinating Committees (Item II-C).
- Tom Kahler will provide engineering drawings of the Wells Dam fish ladders and count windows to Kristi Geris for distribution to the Coordinating Committees; the design drawings should help Committees' members evaluate proposed modifications to improve Pacific lamprey enumeration at Wells Dam (Item III-A).
- The Coordinating Committees December 2012 meeting date has been rescheduled to be held by conference call on Tuesday, December 11, 2012 at 9:30 am (Item V-A).

DECISION SUMMARY

- No Statements of Agreement (SOAs) were approved at this meeting.

AGREEMENTS

- The Rock Island and Rocky Reach Coordinating Committees representatives present accepted the 2012 Rocky Reach and Rock Island Fish Spill Report as final (Item II–A).
- Modifications to improve Pacific lamprey enumeration at Wells Dam were conditionally approved, subject to National Marine Fisheries Service (NMFS) review of engineering plans, by the Wells Coordinating Committees representatives present (Item III-A).

REVIEW ITEMS

- Kristi Geris sent an email notification to the Coordinating Committees on September 25, 2012, stating that Chelan PUD's HCP Draft 2013 Comprehensive Progress Report is out for a 60-day review period with comments due to Steve Hemstrom by November 30, 2012.

REPORTS FINALIZED

- There are no reports that have been recently finalized.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and asked for any additions or other changes to the agenda. No additions or changes were requested.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft August 28, 2012 meeting minutes. Kristi Geris noted that a second version of the revised draft August meeting minutes had been distributed just prior to the meeting with Bill Tweit's comments incorporated, including clarification of the meaning of the term "effective use," in his presentation on the potential renegotiation of the Columbia River Treaty. Geris said all other comments and revisions received from Committees' members were incorporated in the revised minutes. The draft August 28, 2012 meeting minutes were approved as revised. Geris will finalize the meeting minutes and distribute them to the Committees.

II. Chelan PUD

A. Final Rocky Reach and Rock Island HCP Fish Spill Report (Steve Hemstrom)

Steve Hemstrom said the 2012 Rocky Reach and Rock Island Final Fish Spill Report (Attachment B), which Kristi Geris distributed to the Coordinating Committees by email on September 14, 2012, is the final version of the draft document that was distributed at the Coordinating Committees' August 28, 2012 meeting. He said the changes were *de minimis*, other than the addition of final bypass counts for each species. Hemstrom reviewed key statistics such as percentages of runs covered by spill, seasonal spill averages, and average flows and spill rates.

Teresa Scott noted that the report provides an excellent summary of the Rocky Reach and Rock Island 2012 Fish Spill Programs. Jerry Marco asked about the difference in the cumulative index counts for Rocky Reach and Rock Island. Hemstrom said that Rock Island is a full 24-hour count whereas Rocky Reach conducts and reports 2-hour index counts; therefore, the numbers are not readily comparable. He added that trap efficiency at Rock Island is not as high as at Rocky Reach; and he said that if the same counting methods were possible, the counts would be similar. Marco added that it would be interesting to compare historical average cumulative index counts to current counts at both Rocky Reach and Rock Island to determine how much the recent high flows affected the cumulative counts. The Committees accepted the report as final.

B. Chelan PUD Draft 2013 HCP Comprehensive Progress Report (Steve Hemstrom)

Steve Hemstrom said that the Draft 2013 Comprehensive NNI Progress Report for the Rock Island and Rocky Reach HCPs was distributed today, initiating the 60-day review period. He said that Josh Murauskas, Lance Keller, Joe Miller, and he had put a lot of effort into this draft document that summarizes 10 years of accomplishments under the HCPs. Hemstrom encouraged Coordinating Committees representatives to distribute the draft plan within their respective agencies. He also noted the acknowledgement section at the back of the report, and he asked people to review the section and let him know if there were others who should be acknowledged. Kristi Geris said that she will post Chelan PUD's draft report to Anchor QEA's Mid-Columbia HCP ftp site, and she will distribute instructions for accessing the site to the Coordinating Committees.

Mike Schiewe suggested that the Coordinating Committees discuss both the Chelan PUD and Douglas PUD draft reports at the October 23, 2012 Coordinating Committees meeting. Tom Kahler said Douglas PUD will distribute their draft HCP NNI Progress Report to the Coordinating Committees at least 10 days prior to the October 23, 2012 Coordinating Committees meeting.

C. Rocky Reach Turbine Unit 1 Outage for Rotor Repair, April 2013 (Steve Hemstrom)

Steve Hemstrom notified the Coordinating Committees of a crack in the rotor (blade) of Turbine Unit 1 (C1) at Rocky Reach Dam. He said that the rotor is under warranty from the equipment manufacturer and a repair has been scheduled for January 2, 2013, through April 31, 2013; this equates to a full 4-month outage. Hemstrom said that during this 4-month outage, the month of April is the only month of concern because the Rocky Reach bypass starts operation April 1, 2013, and C1 contributes 60 cubic feet per second (cfs) to the bypass, along with fish diverted via screens from the unit intakes. He said the spring migration of juvenile salmonids has typically started to pass Rocky Reach Dam during the month of April. Hemstrom said that he will provide additional information to the Coordinating Committees on the C1 repair and outage, including potential operations for the month of April.

Bryan Nordlund asked if there was any assurance that the outage would be completed by the end of April, and he added that repairs to turbines can sometimes take longer than complete replacements. Hemstrom replied that Chelan PUD managers at Rocky Reach have assured him that the repair will be complete by April 31, 2012; and it is possible that the outage could end sooner. Lance Keller said the project managers are confident in the April deadline because Rocky Reach crews are familiar with these rotor cracks and have considerable experience repairing them on other units. Nordlund asked if other units are susceptible to these rotor cracks, and Keller said that they are, eventually. Keller added that Turbine Unit

4 (C4) has already been repaired and Turbine Unit 2 (C2) will eventually require a similar repair. Nordlund asked if Chelan PUD could provide average fish lengths for fish passing Rocky Reach Dam during the month of April, and Keller said he will compile these numbers and provide them to Kristi Geris for distribution to the Coordinating Committees.

III. Douglas PUD

A. Fishway Count-Window Modifications to Improve Lamprey Enumeration at Wells Dam (Tom Kahler)

Tom Kahler said that the Aquatic Settlement Workgroup (Aquatic SWG) asked that he present to the Coordinating Committees a memorandum requesting permission to modify the Wells Dam fishway picketed-lead bar screens to improve Pacific lamprey enumeration at Wells Dam (Attachment C). Kristi Geris distributed this memorandum to the Coordinating Committees by email on September 19, 2012.

Kahler explained that fish passing Wells Dam are guided to the counting window by picketed leads that currently are not designed to exclude small fish from passing through the picketed lead and thus bypassing the count window. He said that, based on fishway modifications at other facilities, Douglas PUD has determined that reduced spacing of the bars on the screen would likely minimize the number of lamprey passing through the picketed leads and bypassing the counting windows. Kahler said that Douglas PUD is proposing 0.5-inch-spaced bar screens (11/16-inch measured on-center), which will either replace the existing 1-inch-spaced bar screens or be placed over the existing bar screen.

Bryan Nordlund asked if the design for the new picketed lead had been finalized. Kahler said that it had not and that Douglas PUD had planned to discuss the design with Nordlund prior to finalizing. Nordlund expressed concern that if openings in the picketed leads are reduced, both elevation and velocity through the counting window area could be increased; these increases could result in a tendency for fish to reject passing through the count window area. Kahler said that there are multiple routes for water to move through the counting window area, and also that the water-surface elevation in the area is designed to fluctuate with the forebay elevation. Thus, any increase in water-surface elevation due to reduced open space of the picketed leads would only result in velocity at the count window in excess of design criteria when the forebay is at the maximum of the operating range—a condition that seldom exists. Nordlund said he needed time to consider the effects of the proposal on water velocity at the count windows and how operations influence elevation and velocities. Kahler said he will provide engineering drawings of the Wells Dam fish ladders and count windows to Nordlund for review, and also to Kristi Geris for distribution to the Coordinating Committees.

Teresa Scott asked if other counting mechanisms were considered. Kahler said that infrared (IR) cameras were considered; however, based on the time needed to review the recordings and maintain the IR cameras, they were deemed too costly and impractical for the long term. Mike Schiewe added that the Aquatic SWG also considered running the IR cameras for a specified term and then using these data to estimate a correction factor. Schiewe said that modified picketed leads have already been installed at Rocky Reach Dam, and Bob Rose confirmed that the modifications seem to work fine. Rose noted that IR cameras had been used for enumeration at other projects and were later abandoned because of the time and costs required to review data.

Scott asked about debris collection on the narrower spaced picketed leads. Kahler said there would be regular maintenance as is currently implemented; and monitoring will be conducted to determine if additional maintenance would be required with the new leads. Kahler said that Douglas PUD will be evaluating the new picketed leads as part of an active-tag study monitoring lamprey behavior at Wells Dam planned for 2013. Schiewe said the plan is to translocate and tag adult lamprey collected at Bonneville and Priest Rapids dams and monitor their behavior during fish passage.

The Wells Coordinating Committees representatives present conditionally approved modifications to improve Pacific Lamprey enumeration at Wells Dam, subject to NMFS review of engineering plans.

IV. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe reported that the HCP Tributary Committees did not officially meet in September. He noted that a few members had visited habitat restoration projects on the

Okanagan River in Canada. He added that the Tributary Committees will meet again in October.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last Hatchery Committees meeting on September 19, 2012, held at the Douglas PUD:

- *SOA for Wells Hatchery Sub-Yearling Summer Chinook Release Date*: The Hatchery Committees approved an SOA memorializing the practice of releasing Wells Hatchery subyearling Chinook salmon in mid-May rather than mid-June. This is a practice that was initially agreed to in 2009; this SOA was just a matter of bookkeeping.
- *Rocky Reach Spring Chinook Production*: The Hatchery Committees continued discussion on how to meet above Rocky Reach NNI production of 61,000 spring Chinook salmon. Chelan PUD has exercised the option to terminate the sharing agreement with Douglas PUD for production at the Methow Hatchery, and a new agreement has not been negotiated. Both short-term and long-term options are being considered. Some of the possibilities discussed include (but were not limited to) rearing at Winthrop National Fish Hatchery (NFH); overwinter acclimation at Carlton or other potential Methow basin acclimation sites, and rearing at Chief Joseph Hatchery (CJH). However, CJH is not a likely option due to permitting requirements for rearing Endangered Species Act (ESA)-listed fish. Broodstock collection protocols are required by March 2013.
- *Dryden Update*: The Hatchery Committees continued discussion of efforts to meet phosphorus total maximum daily load (TMDL) limits at the Dryden facility. This issue is causing great concern because preliminary testing shows that incoming water already exceeds the proposed TMDL. Leavenworth NFH is faced with similar issues. The Hatchery Committees are discussing ways to engage Washington State Department of Ecology (Ecology) to demonstrate that the Committees are being proactive and to make clear how difficult the new TMDL limits will be to meet, given the circumstances. Tom Scribner is leading this effort and convening a group to discuss interactions with Ecology.
- *Multi-Species/Expanded Acclimation*: The Yakama Nation (YN) reintroduced their interest in the Hatchery Committees developing a long-term acclimation plan for all

HCP Plan Species. Scribner suggested and the Hatchery Committees agreed that a working group, consisting of the YN, Washington Department of Fish and Wildlife (WDFW), and U.S. Fish and Wildlife Service (USFWS), develop a draft long-term plan to present to the Hatchery Committees. A draft document will be available on December 1, 2012.

- *Authorization for a Thinning Release of Coho to the Columbia River at Starr Boat Launch*: The Hatchery Committees concurred with the YN's request to NMFS for a thinning release of 24,000 coho parr that were excess to production at Winthrop NFH.
- *Chewuch Acclimation Facility*: The Hatchery Committees agreed to the YN proposal to move forward with negotiations with Douglas PUD about acclimating coho salmon, with or without co-acclimation of spring Chinook salmon, at the Chewuch Acclimation Facility. Because a new Hatchery Genetic Management Plan (HGMP) for Methow spring Chinook salmon has not be finalized, it is unknown if Chinook salmon will be acclimated in the Chewuch in the future.

V. HCP Committees Administration (Mike Schiewe)

A. Next Meetings

Mike Schiewe said that the Hatchery Committees' November meeting date will be adjusted to avoid the Thanksgiving holiday. The Coordinating Committees' November meeting is currently scheduled the week after the holiday and will remain as scheduled. The Coordinating Committees agreed to adjust their December meeting from December 25, 2012, to Tuesday, December 11, 2012.

The next scheduled Coordinating Committees meeting is October 23, 2012, planned for the Radisson Hotel at SeaTac, Washington. The November 27, 2012, and December 11, 2012, Coordinating Committees meetings are scheduled to be held by conference call.

List of Attachments

Attachment A – List of Attendees
Attachment B – 2012 Rocky Reach and Rock Island Final Fish Spill Report

Attachment C – Memorandum to Modify the Wells Dam Fishways Picketed-Lead Bar Screens to Improve Pacific Lamprey Enumeration at Wells Dam

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Tom Kahler*	Douglas PUD
Bob Rose*	Yakama Nation
Jerry Marco*	Colville Confederated Tribes
Bryan Nordlund*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Teresa Scott*	Washington Department of Fish and Wildlife

Notes
* Denotes Coordinating Committees member or alternate

Chelan PUD
Rocky Reach and Rock Island HCPs
Final 2012 Fish Spill Program Report

2012 ROCKY REACH

Rocky Reach Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	May 26, 0001 hrs
Spill stop date:	August 9, 2400 hrs
Percent of run with spill:	**97.42%**
Cumulative index count:	5,774 subyearling Chinook (April 1-August 31)
Summer spill percentage:	31.86% (9% plus 22.86% as forced spill May 26 - Aug 9)
Average river flow at RR:	233,370 cfs (May 26- Aug 9)
Average spill rate at RR:	74,355 cfs (May 26 – Aug 9)
Number of spill days:	76

2012 ROCK ISLAND

Rock Island Spring Spill

Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	April 17, 0001 hrs
Spill stop date:	May 27, 2400 hrs (immediate increase to 20% summer spill)
Percent of run with spill:	**Yrlng Chins 99.80%; Steelhead 99.75%; Sockeye 99.80%**
Cumulative index count:	25,759 Yearling Chins**;** 16,957 Steelhead**;** 46,788 sockeye
Spring spill percentage:	**16.39%** (10% plus 6.39% forced spill, April 17 - May 27)
Ave river flow at RI:	208,770 cfs (April 17- May 27)
Ave spill flow at RI:	34,210 cfs (April 17- May 27)
Total spill days:	41

Rock Island Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	May 28, 0001 hrs
Spill stop date:	August 18, 2400 hrs
Percent of run with spill:	**97.84%**
Cumulative index count:	27,464 subyearling Chinook
Summer spill percentage**:**	**24.79%** (May 28 - August 18)
Ave river flow at RI:	212,290 cfs (May 28- August 18)
Ave spill flow at RI:	59,260 cfs (May 28- August 18)
Total spill days:	83

Juvenile Index Counts 2003-2012 from the Rocky Reach Juvenile Fish Bypass and the Rock Island Smolt Monitoring Program (SMP) April 1 – August 31.

Table 1. Rocky Reach Juvenile Bypass index counts, 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sockeye	71,683	30,935	17,575	239,185	169,937	136,206	40,758	724,394	67,879	384,224
Steelhead	10,585	6,433	5,821	4,329	4,532	8,721	6,309	4,931	5,683	4,902
Yearling Chinook	13,918	53,946	27,611	23,461	18,080	38,394	18,946	33,840	24,400	95,207
Subyrlng Chinook	172,392	20,062	10,978	19,996	13,496	11,820	11,944	59,751	17,246	5,774

Table 2. Rock Island Smolt Monitoring Program index counts, 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sockeye	10,312	7,114	1,991	34,604	16,410	38,965	4,926	37,404	18,697	46,788
Steelhead	15,507	10,735	15,974	26,930	18,482	22,780	17,636	17,194	28,408	16,957
Yearling Chinook	15,355	12,574	14,797	37,267	23,714	22,562	9,225	11,802	26,407	25,759
Subyrlng Chinook	25,916	23,563	18,710	27,106	15,686	15,940	8,189	23,205	27,397	27,298

MEMORANDUM

TO: Wells HCP Coordinating Committee

FROM: Chas Kyger, Aquatic Resource Biologist, Douglas PUD

DATE: September 19, 2012

SUBJECT: Modification to Wells Fishways Picketed-lead Bar Screens

Background

The Pacific Lamprey Management Plan (PLMP) is one of the six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement that directs the implementation of Protection, Mitigation, and Enhancement measures (PMEs) for Pacific lamprey (*Lampetra tridentata*) during the term of the new Wells Project operating license. The goal of the PLMP is to implement measures to monitor and address impacts, if any, on Pacific lamprey resulting from the Wells Project during the term of the new license. Objectives of the PLMP include identifying and addressing any adverse Project-related impacts on passage of adult Pacific lamprey and effectively enumerating lamprey passing Wells Dam. Pursuant to this objective, Public Utility District No. 1 of Douglas County (Douglas PUD) is conducting an adult active-tag study to 1) collect additional information on the passage characteristics and behavior of adult lamprey migrating through the Wells Project fishways (section 4.1.6 of the PLMP); and 2) to evaluate enumeration efficiency in the vicinity of the Wells Project fishway count windows (section 4.1.3 of the PLMP) toward identifying alternatives to improve adult lamprey count accuracy.

In an effort to evaluate and improve enumeration of lamprey in the fishway count windows, Douglas PUD proposes to replace the existing 1–inch-spaced bar screens of the picketed leads that lead to fishway count stations with narrower spaced 11/16th-inch bar screen (11/16" measured on-center; actual space between the 3/16"-wide bars is ½ inch). The bar screen with narrower spacing is intended to direct lamprey through the fishway count windows and prevent them from passing through the picketed leads and bypassing the count windows. In recent years, the efficacy of using narrow-spaced bar screen as a way to improve the enumeration of lamprey passing adult fishways has been tested at other public and federal projects on the Columbia River (LGL et al. 2011, ACOE 2011). The use of narrow-spaced leads has resulted in no reduction in travel time and has not increased the fallback rates of lamprey within the fish ladders at those dams tested (Peery et al. 2011).

Proposed Fishway Modification

During the 2012-2013 Wells Dam ladder maintenance period (typically from December through January), Douglas PUD proposes to replace the existing bar screens that form the picketed leads to the count windows with new 11/16th–inch-spaced bar screens within the east and west fishways at Wells Dam. As such, Douglas PUD and the Wells Aquatic Settlement Workgroup seek approval from the Wells HCP Coordinating Committee for this proposed action.

CC:
Wells Aquatic Settlement Workgroup list serve
Shane Bickford, Douglas PUD
Bill Dobbins, Douglas PUD
Mike Bruno, Douglas PUD
Tom Kahler, Douglas PUD
Andrew Gingerich, Douglas PUD

References

Army Corps of Engineers (ACOE). 2011. Pacific Lamprey Passage Improvements Implementation Plan. 2010 Final Progress Report. February 23, 2011.

LGL, Cramer Fish Sciences, Blue Leaf Environmental, and Long View Associates. 2011. Assessment of Pacific Lamprey Behavior and Passage Efficiency at Priest Rapids and Wanapum Dams. Prepared for Public Utility District No. 2 of Grant County.

Peery, C., B. McIlraith, D. Thompson, and F. Loge. 2011. Use of Non-Invasive Methods to Evaluate Pacific Lamprey Counts and Passage Behavior at John Day Dam – 2011. Presentation at the 2011 Anadromous Fish Evaluation Program. Walla Walla, WA.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	December 11, 2012
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the October 23, 2012, HCP Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Hotel in SeaTac, Washington on Tuesday, October 23, 2012, from 9:30 am to 11:30 am. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Douglas PUD will distribute their draft HCP Net No Impact (NNI) Progress Report to the Coordinating Committees at least 10 days prior to the December 11, 2012, Coordinating Committees meeting (Item II-A).
- Steve Hemstrom will provide information to the Coordinating Committees on options being investigated for the Rocky Reach Surface Collector operation scheduled for April 2013 (Item III-B).
- Steve Hemstrom will provide information to the Coordinating Committees on the draft U.S. Army Corp of Engineers (USACE) avian predation proposal, including details about the comment period (Item III-C).
- Lance Keller will provide a summary to the Coordinating Committees on the outages in the middle spillway to the Rocky Reach Fishway due to a mandatory Federal Energy Regulatory Commission (FERC) inspection of the Rocky Reach spillway apron and dragons teeth (Item III-D).
- Coordinating Committees representatives will send comments on the draft statement of agreement (SOA) for a data collection strategy for sub-yearling summer/fall Chinook salmon to Steve Hemstrom no later than Friday, November 9, 2012 (Item IV-A).

- The Coordinating Committees' November 27, 2012, meeting was cancelled. The December 2012 meeting date has been rescheduled to Tuesday, December 11, 2012, to be held at the Radisson Hotel in SeaTac, Washington (Item VI-A).

DECISION SUMMARY

- No SOAs were approved at this meeting.

AGREEMENTS

- Coordinating Committees representatives present agreed to Chelan PUD's proposal to extend the Rocky Reach Dam maintenance work outage two weeks from a beginning date of January 2, 2013, to a beginning date of December 17, 2012, to allow more time to complete needed work (Item III-E).

REVIEW ITEMS

- Kristi Geris sent an email notification to the Coordinating Committees on September 25, 2012, that Chelan PUD's HCP Draft 2013 Comprehensive Progress Report is out for a 60-day review period with comments due to Steve Hemstrom by November 30, 2012.

REPORTS FINALIZED

- The 2011 Douglas PUD Pikeminnow Program Annual Report was finalized and distributed to the Coordinating Committees on October 10, 2012.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and asked for any additions or other changes to the agenda. Chelan PUD added two items: 1) review of recent outages of the middle fishway at the Rocky Reach Dam; and 2) timing of the annual maintenance outage at the Rocky Reach fishway.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft September 25, 2012, meeting minutes. Kristi Geris said that the only outstanding comment was a question regarding the correct location name for what was referred to as Starr Landing in last month's Hatchery Committees Update. Mike Schiewe provided a brief overview of the Yakama Nation's (YN's) request for a thinning release of coho that were excess to production at Winthrop National Fish Hatchery (NFH); the proposed release location was identified as Starr Landing located upstream of Wells Dam on the Columbia River. Tom Kahler noted that the site was usually referred to as Starr Boat Launch, and the use of Starr Landing would be confusing; the Committees agreed to the change. Geris said that all other comments and revisions received from Committees' members were incorporated in the revised minutes. The draft September 25, 2012, meeting minutes were approved as revised. Geris will finalize the meeting minutes and distribute them to the Committees.

II. Douglas PUD

A. Douglas PUD Draft 2013 10-year NNI Comprehensive Check-in Report (Tom Kahler)

Tom Kahler said that Douglas PUD originally discussed having a draft report ready for the October Coordinating Committees meeting; however, Douglas PUD was still waiting for a section on the Fish and Water Management Tool (FWMT) from Dr. Kim Hyatt, Department of Fisheries and Oceans Canada (DFO), that was needed to finalize the report.

Kahler explained that shortly after the implementation of the FWMT, DFO had conducted a retrospective analysis of the potential effectiveness of the FWMT, and concluded that average sockeye smolt production would increase by 55 percent. Kahler said that DFO was now documenting the actual resultant increases in smolt production from 11 years of FWMT deployment in a report to be submitted for publication in a scientific journal, and the report is not expected to be complete until early 2013. He said that Douglas PUD wants to make sure the information in the report is included in their 10-year NNI Comprehensive Check-in Report. Kahler requested one additional month before distributing Douglas PUD's draft report. He said that the report may still be missing the full FWMT component, but will cover the other species and include a draft abstract from DFO's FWMT publication. Kahler said that he will distribute the Douglas PUD draft HCP NNI Progress Report to the

Coordinating Committees at least 10 days prior to the December 11, 2012, Coordinating Committees meeting.

III. Chelan PUD

A. Chelan PUD Draft 2013 10-year NNI Comprehensive Check-in Report (Steve Hemstrom)

Steve Hemstrom said that Chelan PUD has distributed their draft 10-Year Comprehensive Report, and the report is currently in the 60-day comment period. Kristi Geris posted the draft report to the FTP site and distributed the report to the Coordinating Committees by email on September 25, 2012. Comments to the draft report are due to Hemstrom by November 30, 2012. Hemstrom said that Chelan PUD has already received edits and comments from U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). He said that Chelan PUD has nothing new to announce about the draft report, but wanted to provide this opportunity for comments or discussion if needed. No additional comments were provided at this time.

B. Rocky Reach Surface Collector Operation April 2013 (Steve Hemstrom and Lance Keller)

Steve Hemstrom said that as discussed at the September 25, 2012, Coordinating Committees meeting, Turbine Unit 1 (C1) at Rocky Reach Dam will be offline for mandatory rotor crack repair on January 2, 2013, and will be placed back online by May 1, 2013. Hemstrom and Lance Keller discussed options being investigated to provide alternative attraction flow during the Rocky Reach Surface Collector operation including using the pump station, or ramping up Turbine Unit 2 (C2). Hemstrom said that he will provide information to the Coordinating Committees on the options being investigated; and this information is also provided in Attachment B. Hemstrom also added that the bypass and sampling facility will run as usual. Bryan Nordlund asked if the entrance velocities will be affected by C1 being offline, and Keller said that entrance velocities will not be affected.

C. USACE Avian Predation Proposal – Potential Relocation of Caspian Tern Colonies to Banks Lake (Steve Hemstrom)

Steve Hemstrom briefed the Committees that the USACE is reviewing alternatives for reducing impacts of avian predation on salmonid smolts from the Columbia and Snake rivers. This is a required activity under the 2010 Federal Columbia River Power System (FCRPS)

Biological Opinion. Hemstrom said that one option being considered involves relocating a portion of the tern colonies residing in McNary Pool and Goose Island on Potholes Reservoir, to Goose Island on Banks Lake. Hemstrom said that Douglas PUD, Chelan PUD, and Grant PUD are developing a letter to USACE outlining concerns about this alternative. Hemstrom added that several other sites are also under evaluation for the relocation, including a site in Oregon. Jim Craig said that the Priest Rapids Coordinating Committee (PRCC) also discussed this proposal. Jerry Marco noted that the Colville Confederated Tribes (CCT) had already expressed concern that relocation would only move the problem, not address it. Bryan Nordlund agreed with Marco's concerns and added that he is unsure if relocating to Banks Lake would result in a net difference. Mike Schiewe said that this proposal dates back to strategies discussed in the mid-1980s regarding distribution of the avian predation problem. Craig added that planning does not include an option of decreasing the amount of tern colony habitat.

Marco suggested that the U.S. Bureau of Reclamation (Reclamation) may be involved as well, because both locations are Reclamation-owned land, which facilitates an easy move. Marco said that he thinks the Inland Avian Workgroup is involved in this particular relocation proposal, and is developing a draft management plan. He added that the report was delayed and is now not expected until summer 2013, which will allow more time to investigate other sites. Marco also added that the foraging distance is about the same from both locations.

Hemstrom reminded the group that relocation is an alternative under consideration, and not necessarily a recommended action. Hemstrom said that it is unclear how many of the approximately 400 breeding pairs, located at McNary Pool and Goose Island on Potholes Reservoir, would be relocated. Craig said that Banks Lake has the capacity for about 60 breeding pairs.

Hemstrom said that the USACE avian predation proposal is still in draft form, and that he will provide information on the draft proposal to the Coordinating Committees, including information about the comment period. Craig said that the PRCC is developing a letter to USACE; Nordlund added that the letter only outlines data, and it is not a recommendation.

Nordlund added that the letter will hopefully encourage relocating the birds to a location that is not in the upper Columbia River.

D. Recent Outages in the Middle Spillway to the Rocky Reach Fishway (Lance Keller)

Lance Keller said that, as described in an email distributed to the Coordinating Committees on October 15, 2012, FERC requested a mandatory inspection of the Rocky Reach spillway apron and dragons teeth: the inspection required intermittent closure of the middle spillway entrance to the Rocky Reach Fishway from October 15, 2012, to October 18, 2012.

Keller said that outages were required in the middle fishway for three consecutive nights in order to install barriers to inspect the entire spillway apron. Outages included: 1) at 1900 hours on October 15, 2012, restored at 900 hours on October 16, 2012; 2) at 1900 hours on October 16, 2012, restored at 900 hours on October 17, 2012; and 3) at 1900 hours on October 17, 2012, restored at 900 hours on October 18, 2012. Keller apologized for the late notification, and explained that Chelan PUD was unaware a reduction in attraction flow would be required for the inspection. Keller added that he will provide a summary memo to the Coordinating Committees on the outages.

Steve Hemstrom said that because of these outages, Chelan PUD analyzed data on upstream passage of adult salmon, as described in the email distributed to the Coordinating Committees on October 15, 2012. Hemstrom said that the analyses did not indicate any significant statistical differences among passage numbers or rates before, during, or after the outages; therefore, it was concluded that the outages had minimal effects. Bryan Nordlund said that even if Chelan PUD had been able to bring this situation to the Coordinating Committees, the Committees would have recommended Chelan PUD do as they did: perform the inspection at night, and minimize effects. Keller added that Chelan PUD is actively educating new staff on minimizing potential impacts due to project maintenance.

E. Rocky Reach fishway maintenance work outage timing (Lance Keller)

Lance Keller summarized the Rocky Reach fishway maintenance work scheduled for this winter, including fish ladder work, the C1 rotor repair, and antennae array replacement and reinstallation. He said that in order to complete the scheduled fishway maintenance, conduct a full bypass evaluation, and ensure that the C1 repair remains on schedule, Chelan PUD is proposing two additional weeks for outage. This means that fishway maintenance work would start December 17, 2012, as opposed to January 2, 2013, and that the fishway would be back online March 1, 2013.

Mike Schiewe asked if there is a downside to the earlier outage date, and Steve Hemstrom said that biologically, there is minimal passage activity in December according to the past 3 years of monitoring. Keller added that in the past 2 years, Chelan PUD has requested and been approved for even earlier outages. Coordinating Committees representatives present agreed to Chelan PUD's proposal to extend the Rocky Reach Dam maintenance work outage two weeks from a beginning date of January 2, 2013 to a beginning date of December 17, 2012, to allow more time to complete needed work.

IV. HCP Coordination

A. Follow-up on Subyearling Chinook Life History Information (Mike Schiewe and Steve Hemstrom)

Mike Schiewe said that in searching for follow-up information on additional juvenile studies, Bryan Nordlund located a 2008 document summarizing phase designations of plan species under the Rocky Reach and Rock Island Hydroelectric Projects HCPs (Attachment C). The summary document was distributed to the Coordinating Committees by Kristi Geris on October 22, 2012. Schiewe recalled that after Attachment C was finalized in 2008, the Coordinating Committees discussed a path forward that included inviting researchers from other agencies with expertise on subyearling Chinook survival studies to meet with the Coordinating Committees in 2009; they also discussed carrying forward an agreed-upon study information strategy developed by the Coordinating Committees and memorialized by an appropriated SOA. However, a SOA documenting this agreed-upon strategy was not located in reviewed records.

Steve Hemstrom said that based on the 2008 document and the agreed to follow-up, Chelan PUD has now developed a draft SOA summarizing their data collection strategy for sub-yearling summer/fall Chinook salmon (Attachment D). The draft SOA was distributed to the Coordinating Committees by Kristi Geris on October 19, 2012. Hemstrom said that the SOA discusses five items applicable to subyearling Chinook data collection, and satisfies the requirements described in the 2008 summary document that included the Coordinating Committees agreement that Phase III (additional juvenile studies) for Rock Island and Rocky Reach subyearling Chinook. Hemstrom also added that no prior agreements are supplanted by this SOA.

Schiewe noted that Douglas PUD is also at this same phase designation for Wells Project subyearling Chinook and juvenile sockeye salmon, as documented in a February 2005 SOA; and he added that the 2005 SOA is a reaffirmation of what was agreed to in the HCP for Wells. Schiewe recommended revisiting study strategies for sub-yearling Chinook after the first of the year, and before the 2013 field season begins, as more people are available to join discussions.

Bob Rose asked why life history studies on the Snake River were not mentioned in the draft SOA. Hemstrom noted that the migratory diversity of Snake River and Mid-Columbia subyearling Chinook are potentially quite different; however, where appropriate, the behavior of Snake River should be considered. Jim Craig said that the most similarity between the Mid-Columbia and Snake rivers subyearlings would be the technology used to perform the studies. Hemstrom also added that Mid-Columbia fish would likely be smaller due to temperature differences. Schiewe said that Joe Miller and Josh Murauskas have already researched what findings might result from studies on the Snake River; and Miller said that these data are still available if people are interested in reviewing the findings. Miller also added that this SOA is meant to describe a basic commitment, and is not intended to exclude the Snake River.

Tom Kahler said that he hoped to have the Douglas PUD 2011 Subyearling Study Report available for discussion at the Coordinating Committees' December meeting. He said that Douglas PUD also has preliminary results from 2012 tagging, which will contribute data on fish in the upper Columbia River. Coordinating Committees representatives agreed to send comments on the draft SOA for a data collection strategy for sub-yearling summer/fall Chinook salmon to Hemstrom no later than Friday, November 9, 2012.

V. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe reported that the HCP Hatchery Committees did not meet in October due to time conflicts for some participants, and given that Hatchery Committees topics currently under discussion are not time sensitive. Topics under current discussion include: 1) updates to Hatchery Monitoring and Evaluation (M&E) plans; 2) development of 2013 broodstock protocols; and 3) discussions of the future of Rocky Reach spring Chinook production.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last Tributary Committees meeting on October 20, 2012:

- *Nason Creek Upper White Pine Reconnection – Chelan PUD Powerline Relocation Alternative Analysis Project*: The Tributary Committees approved the use of remaining project funds, in the amount of approximately $26,000, to hire a mediator with utility experience to facilitate discussions between the U.S. Forest Service (USFS) and Chelan PUD. Tom Kahler explained that Chelan County is proposing to remove all or a portion of a levee to reconnect floodplain where the power lines are located. This proposed action would threaten Chelan PUD's power poles, and an alternatives analysis was commissioned to identify options for relocating the power line/poles. Several options were discussed and the most practical, efficient alternatives involve obtaining new easements through USFS property. Joe Miller added that this issue is not just a matter of new easements, but of existing easements that predate the USFS; so this issue is about giving up something that is irreplaceable.
- *Mission Creek Fish Passage and Wenatchee Levee Removal and Riparian Restoration Projects*: Contract time extensions for the Mission Creek Fish Passage Project and the Wenatchee Levee Removal and Riparian Restoration Project were requested and approved by the Tributary Committees.
- *Small Projects Program Applications*: The Tributary Committees received a Small Projects Program Application requesting $51,257 from Plan Species Account funds to improve and restore riparian areas along a section of Peshastin Creek. After review of the proposal, the Tributary Committees were unable to make a funding decision, and requested that the sponsor explain why they were seeking funds from the Plan Species Accounts when it appears that the proposed project is better funded through a different source.

- *Acquisitions*: The Tributary Committees had been discussing the possibility of purchasing acquisitions, but it was unclear if the PUDs would be willing to hold the titles to the properties. After further consideration, the PUDs decided this was not something they wanted to do. Kahler said that a key consideration was that if property titles were donated to another entity such as Washington Department of Fish and Wildlife (WDFW), it would result in obvious public benefits (e.g., fishing access); these benefits would not necessarily result if the PUDs held the titles to the properties.

VI. HCP Committees Administration (Mike Schiewe)

A. Next Meetings

The Coordinating Committees agreed to cancel the November 27, 2012, meeting, and to reschedule the December meeting to Tuesday, December 11, 2012, at the Radisson Hotel in SeaTac, Washington. The January 2013 meeting is scheduled for January 22, 2013, and is tentatively planned for the Radisson Hotel in SeaTac, Washington.

List of Attachments

Attachment A – List of Attendees
Attachment B – Summary of options being investigated for the Rocky Reach Surface Collector operation scheduled for April 2013
Attachment C – Summary of phase designations of plan species under the Rocky Reach and Rock Island Hydroelectric Projects HCPs
Attachment D – Draft SOA for a data collection strategy for sub-yearling summer/fall Chinook salmon

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Joe Miller†	Chelan PUD
Tom Kahler*	Douglas PUD
Bob Rose*	Yakama Nation
Jerry Marco*†	Colville Confederated Tribes
Bryan Nordlund*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service

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

Chelan PUD
Rocky Reach and Rock Island HCPs
Final 2012 Fish Spill Program Report

2012 ROCKY REACH

Rocky Reach Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	9% of day average river flow
Spill start date:	May 26, 0001 hrs
Spill stop date:	August 9, 2400 hrs
Percent of run with spill:	**97.42%**
Cumulative index count:	5,774 subyearling Chinook (April 1-August 31)
Summer spill percentage:	31.86% (9% plus 22.86% as forced spill May 26 - Aug 9)
Average river flow at RR:	233,370 cfs (May 26- Aug 9)
Average spill rate at RR:	74,355 cfs (May 26 – Aug 9)
Number of spill days:	76

2012 ROCK ISLAND

Rock Island Spring Spill

Target species:	Yearling Chinook, steelhead, sockeye
Spill target percentage:	10% of day average river flow
Spill start date:	April 17, 0001 hrs
Spill stop date:	May 27, 2400 hrs (immediate increase to 20% summer spill)
Percent of run with spill:	**Yrlng Chins 99.80%; Steelhead 99.75%; Sockeye 99.80%**
Cumulative index count:	25,759 Yearling Chins**;** 16,957 Steelhead**;** 46,788 sockeye
Spring spill percentage:	**16.39%** (10% plus 6.39% forced spill, April 17 - May 27)
Ave river flow at RI:	208,770 cfs (April 17- May 27)
Ave spill flow at RI:	34,210 cfs (April 17- May 27)
Total spill days:	41

Rock Island Summer Spill

Target species:	Subyearling Chinook
Spill target percentage:	20% of day average river flow
Spill start date:	May 28, 0001 hrs
Spill stop date:	August 18, 2400 hrs
Percent of run with spill:	**97.84%**
Cumulative index count:	27,464 subyearling Chinook
Summer spill percentage**:**	**24.79%** (May 28 - August 18)
Ave river flow at RI:	212,290 cfs (May 28- August 18)
Ave spill flow at RI:	59,260 cfs (May 28- August 18)
Total spill days:	83

Juvenile Index Counts 2003-2012 from the Rocky Reach Juvenile Fish Bypass and the Rock Island Smolt Monitoring Program (SMP) April 1 – August 31.

Table 1. Rocky Reach Juvenile Bypass index counts, 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sockeye	71,683	30,935	17,575	239,185	169,937	136,206	40,758	724,394	67,879	384,224
Steelhead	10,585	6,433	5,821	4,329	4,532	8,721	6,309	4,931	5,683	4,902
Yearling Chinook	13,918	53,946	27,611	23,461	18,080	38,394	18,946	33,840	24,400	95,207
Subyrlng Chinook	172,392	20,062	10,978	19,996	13,496	11,820	11,944	59,751	17,246	5,774

Table 2. Rock Island Smolt Monitoring Program index counts, 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sockeye	10,312	7,114	1,991	34,604	16,410	38,965	4,926	37,404	18,697	46,788
Steelhead	15,507	10,735	15,974	26,930	18,482	22,780	17,636	17,194	28,408	16,957
Yearling Chinook	15,355	12,574	14,797	37,267	23,714	22,562	9,225	11,802	26,407	25,759
Subyrlng Chinook	25,916	23,563	18,710	27,106	15,686	15,940	8,189	23,205	27,397	27,298

Summary of Phase Designations of Plan Species under the

Rocky Reach and Rock Island Hydroelectric Projects Habitat Conservation Plans

Final

June 2008

The purpose of this document is to summarize and confirm the phase designations of Plan Species under the Rock Island and Rocky Reach Hydroelectric Projects Habitat Conservation Plans (HCP). Further, it serves to document that the Rock Island and Rocky Reach HCP Coordinating Committees (Committee) have reviewed the limitations associated with the best available technology for measuring survival of subyearling Chinook and has concluded that these limitations currently constrain the ability to make empirically based survival estimates.

Rocky Reach and Rock Island - Shared Status

Three specific areas of shared status currently exist between and the Rocky Reach and Rock Island HCP's when addressing survival standards and phase designations and they are: 1) the role of adult survival as it pertains to the 91% combined juvenile and adult survival standard, 2) the current limitations associated with conducting studies to measure or calculate project or dam survival for subyearling Chinook, and 3) the Coho hatchery compensation and interim juvenile survival value. The following discussions express the shared elements first and then conclude with project specific phase designation summaries.

Adult Survival – Inter-dam Conversion Rates

The HCP combined survival standard of 91% at Rocky Reach and Rock Island includes both juveniles and adults. Because the Committee currently agrees that adult fish survival cannot be conclusively measured for each Plan Species, the Committee reviews inter-dam conversion return rates as a surrogate for adult survival. In all years, since the HCP was signed, it appears based on this analysis that the adult survival standards (i.e., ≤2.0% passage mortality) for all Plan species has been achieved.

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Subyearling Chinook Survival Studies

In 2004, Chelan PUD attempted to measure survival of subyearling Chinook salmon passing Rocky Reach and Rock Island dams using acoustic tag technology. Results suggested that survival was low for Rocky Reach and relatively high for Rock Island. The Committee agreed that since the confidence limits were beyond the precision standards stated in the HCP for the Rocky Reach estimate, that it was not a valid study. On a parallel path, the District conducted a controlled laboratory test of fish tagged with acoustic tags identical to those used in the project survival study. These tests showed that a large percentage of the test fish died in the laboratory after tagging. In the 2004 study, the acoustic tag used weighed 0.75 grams and represented 5.3% of the median study fish's body weight (range: 0.67-8.3%). Current laboratory research indicates survival is negatively effected for fish implanted with an acoustic tag equal to or greater than 7.6% of its body weight (Brown et al. 2007). However, other factors, including temperature, and length and condition of the fish also affect survival.

A Statement of Agreement (SOA) developed by the Committee in January of 2005 addressing appropriate tag methodology for the HCP Plan Species declared that future studies with subyearling Chinook using acoustic tags shall be postponed, citing the 2004 Rocky Reach Project subyearling tag effect study. The SOA also acknowledged that PIT tag studies for subyearlings were currently not possible because of sample size requirements (App. F, 2005 Annual HCP Report).

Work in the Snake River suggests not all tagged subyearling Chinook migrate out of the system in the year that they are tagged, but instead may over-winter in reservoirs before migrating the following year (Williams et al. 2008). If this tendency occurs in the Upper Columbia Basin, the "survival" test and measurement as currently conducted is a joint probability of survival and tendency for migration. New developments in acoustic tag technology may eventually be employed to account for over-wintering of subyearling Chinook.

Calculating Subyearling Chinook Dam Survival

Juvenile dam passage survival (JDPS) is generally based on the percentage of fish passing through a route at the dam multiplied by its associated survival through that specific route. However, performing calculations of this nature at Rocky Reach and Rock Island Dams for subyearling Chinook is problematic due to lack of information pertaining to route-specific and indirect survival.

Currently, no information exists for any route-specific survival rates or route selection at Rocky Reach and Rock Island Dams for subyearlings. At this point in time, if one was to calculate JDPS, surrogate information from other species/races of Chinook would have to be used or dam passage survival information from Snake or lower Columbia River federal projects. Because of differences in life history, migration timing, abiotic factors (flow and temperature), and possibly predation rates, it is not reasonable to assume that using information from yearling fish accurately portrays the experience and hence dam passage survival of subyearling Chinook.

The Committee recognizes the difficulties associated with studying subyearling Chinook survival as previously stated, and have at this time determined that current technological and/or biological limitations preclude the ability to measure project survival. Calculations for dam passage survival are problematic due to current lack of ability to gather route-specific information and lack of good surrogate information. Given the combined current difficulties of conducting tests using subyearling Chinook, the Committee has determined that a responsible action going forward with subyearling Chinook would be to develop a well described step-wise approach to acquiring appropriate information that would enable the Committee to determine when technological advancements are available and subsequently when project or dam passage studies could occur. In doing so, the Committee recognizes that although the survival levels have yet to be determined, the phase designation most closely describing future activities of studying subyearling Chinook is Phase III (additional juvenile studies). This designation will carry with it an agreed upon study information strategy developed in Committee and memorialized by an appropriated SOA (currently in development).

Coho Salmon

In a SOA approved on June 20, 2007, the Rocky Reach and Rock Island HCP Hatchery Committees agreed to provide coho hatchery compensation as detailed in Section 8.4.3a of the HCP. Subsequently, the Rocky Reach and Rock Island Coordinating Committees agreed in a June 26, 2007 SOA that an interim juvenile survival value (HCP section 8.4.3a) of 93% will be assumed.

Project Specific Phase Designations

The current phase designations for the Rocky Reach and Rock Island HCP's are summarized in Table 1 below.

Table 1. Rocky Reach and Rock Island HCP Phase Designation summary, 2008.

Plan Species	*Rock Island	Rocky Reach
Yearling Chinook	Phase III Standard Achieved	Phase III (Provisional Review)
Steelhead	Phase III Standard Achieved	Phase III Standard Achieved
Sockeye	Phase III Standard Achieved	Phase II (Additional Tools)
Subyearling Chinook	Phase III (Additional Juvenile Studies)	Phase III (Additional Juvenile Studies)

***Rock Island operations at 20% spill – Phase I survival tests ongoing for 10% spill**

Rocky Reach Project

Upper Columbia steelhead are designated Phase III (standard achieved) base on the results of three years of testing between 2002 and 2004. A SOA recognizing the Phase III designation was formally adopted by the Committee on October 24, 2006.

Sockeye have been designated Phase II (additional tools) because two years of testing suggested that the juvenile project survival standard was likely not going to be achieved without employing some element of additional measures to increase survival. In the best interest of the long-term goals of the HCP, it was agreed that additional studies should be developed to gain information intended on improving juvenile project survival. Current studies at Rocky Reach are now focused on this effort.

Yearling Chinook salmon are considered to be in Phase III (Provisional Review) because in two years of testing (2004, 2005), the survival results were between 91 and 93% Subsequently, the Committee agreed to postpone the last year of Chinook survival testing until modifications to improve sockeye survival were made that may also benefit Chinook survival. The Committee agreed (with NMFS abstaining) to an additional year of testing modified powerhouse operations at Rocky Reach in 2008 in attempt to improve use of the surface collector by sockeye, which should also potentially benefit Chinook. If 2008 study results show no improvement in providing additional survival, then additional tools that could benefit sockeye (such as additional turbine intake screens, physical structures to improve guidance, spill, a second surface collector entrance and others), will be considered. Phase III (Provisional Review) allows the District up to 5 years (until 2011) after the end of Phase I testing to implement additional measures or conduct further studies to achieve the survival standard. As such, by 2011 the District will be required to complete yearling Chinook survival studies.

Rock Island Project

<u>Yearling Chinook, steelhead, and sockeye</u>

Based on the results of three years of testing under conditions of 20% spill, the Upper Columbia steelhead, yearling Chinook and sockeye are designated in Phase III (Standard Achieved).

The Rock Island HCP Committee reviewed and considered both PIT tag and acoustic tag test results for the 3 years of survival testing for yearling Chinook. The Committee agreed that the 3 year average (2002 – 2004) for either PIT or acoustic tags had exceeded the 93% survival standard required in the HCP. Tests were conducted between 2002 and 2004 for all Plan species. Phase III (Standard Achieved) designation for yearling Chinook was formally adopted through a Statement of Agreement (SOA) by the Committee on March 28, 2005, and sockeye and steelhead were formally adopted as Phase III (Standard Achieved) by Committee SOA on October 24, 2006.

The District, upon successful survival testing and Phase III designation of steelhead, yearling Chinook, and sockeye worked with the Committee to investigate the potential of achieving the 93% project survival standard with a 10% spring spill program in place. The Committee approved a SOA in December, 2006 setting in motion a process to test spring migrant plan species project survival at 10% spill operation. Survival tests at 10% level began in 2007 and are currently on-going for yearling Chinook, steelhead, and sockeye. If survival standards are not met with 10% spill for any of these species, spill levels will return to 20%.

Literature Citation

Brown, R.S., K.M. Carter, K.A. Deters, and C.A. McKinstry. 2007. Determination of a minimum fish size for implantation with a juvenile salmonids acoustic telemetry system (JSATS) tag *in*: Hockersmith, E.E., R. S. Brown, and T.L. Liedtke. 2007. Draft Comparative performance of acoustic-tagged and passive integrated transponder-tagged juvenile salmonids. Prepared for U.S. Army Corps of Engineers, Environmental Resources Branch, Planning and Engineering Division, Portland District, Portland, OR. 138 pp.

J. G. Williams, R. W. Zabel, R. S. Waples, J. A. Hutchings and W. P. Connor. 2008. Potential for anthropogenic disturbances to influence evolutionary change in the life history of a threatened salmonid. Blackwell Publishing 271–285.

Rock Island and Rocky Reach HCP Coordinating Committees

Draft Statement of Agreement

Data collection strategy for sub-yearling summer/fall Chinook salmon

October 23, 2012

Statement

The Rock Island and Rocky Reach Habitat Conservation Plans' (HCP) Coordinating Committees (CC) agree to the data collection strategy for sub-yearling summer/fall Chinook salmon outlined below. These research efforts are intended to compliment the Phase III (Additional Studies) designation assigned to sub-yearling summer/fall Chinook salmon in the briefing paper *Summary of Phase Designations of Plan Species under the Rocky Reach and Rock Island Hydroelectric Projects Habitat Conservation Plans*, reviewed and approved as final by the CC at the June 2008 meeting (Attachment A).

Data Collection Strategy

1. *Technology review* – In November of 2009, the HCP-CC joined with other state, federal, tribal, and PUD biologists in the first sub-yearling Chinook workshop. Presenters included fish biologists with expertise in statistics, active and passive telemetry, veterinary medicine, and sub-yearling life history. Workshops will occur every three to five years to inform the HCP-CC with the latest scientific opinions regarding life history and monitoring of sub-yearling Chinook salmon.

2. *Life history research* – In coordination with Douglas PUD, a passive integrated transponder (PIT) tag detector was installed at the Rocky Reach Juvenile Bypass System (JBS) in 2010. Since installation of the arrays, nearly 50,000 juvenile summer/fall Chinook salmon have been detected at the JBS, including several thousand natural-origin fish. These data will continue to provide insight to the behavior of summer/fall Chinook salmon in the mid-Columbia River.

3. *Resident fish study* – Chelan PUD is funding Washington Department of Fish and Wildlife's Large Lake Research Team to evaluate the distribution, abundance, and composition of near shore piscivorous fishes in the Rocky Reach Reservoir. These data will inform managers on predation risks to sub-yearling Chinook salmon.

4. *Monitoring and evaluation efforts* – Chelan PUD has funded extensive monitoring and evaluation (M&E) efforts on hatchery- and natural-origin summer/fall Chinook in the Wenatchee, Methow, and Okanogan river basins. Efforts include broodstock sampling (origin, age, length, sex, and fecundity), hatchery metrics (rearing, acclimation, quantity, size, condition, and survival), natural juvenile productivity (emigrant estimates), spawning surveys (redd counts and distribution, spawn timing, escapement, carcass surveys), and life history monitoring (run timing, age and size at maturity, straying, contribution to fisheries, genetics, proportion of natural influence, natural- and hatchery-replacement rates, and smolt-to-adult survivals). These data are among the most comprehensive in the Columbia River Basin and will provide valuable insight to population dynamics of summer/fall Chinook salmon.

5. *HCP requirements* – Chelan PUD maintains predator removal, operation of the Rocky Reach JBS, summer spill requirements, funding of the tributary conservation plan, and hatchery compensation requirements, consistent with the HCPs, to benefit sub-yearling summer/fall Chinook salmon in the mid-Columbia River Basin. Returns of summer/fall Chinook salmon averaged over 75,000 adults at Rock Island between 2006 and 2010, including over 40,000 natural-origin fish. Chelan PUD has further invested in aquaculture technology to increase performance of summer/fall Chinook smolts, along with funding arrangements with the new Chief Joseph Hatchery (scheduled to release up to 2.9 M juvenile summer/fall Chinook salmon annually).

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Coordinating Committees	**Date:**	January 23, 2013
From:	Michael Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the December 11, 2012 HCPs Coordinating Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Coordinating Committees met at the Radisson Hotel in SeaTac, Washington on Tuesday, December 11, 2012, from 9:30 am to 1:00 pm. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Washington Department of Fish and Wildlife (WDFW) and Yakama Nation (YN) will submit comments on the Chelan PUD Draft 2013 10-year No Net Impact (NNI) Comprehensive Check-in Report to Chelan PUD no later than January 14, 2013 (Item II-A).
- Chelan PUD will develop a timeline summarizing their path forward for compiling and synthesizing information on subyearling Chinook salmon life history diversity and survival in the upper Columbia River. Chelan PUD will distribute the timeline to the Coordinating Committees prior to the Coordinating Committees meeting on January 22, 2013 (Item II-B).
- Steve Hemstrom will distribute Chelan PUD's recommendation for a Rocky Reach Surface Collector Operation scheduled for April 2013, including information on the cleaning system, to the Coordinating Committees prior to the Coordinating Committees meeting on January 22, 2013 (Item II-C).
- Steve Hemstrom will provide information on Rocky Reach screen velocities to Bryan Nordlund (Item II-C).
- Chelan PUD will incorporate recommended edits to the spring Chinook, sockeye, and steelhead adult conversion rates table and will distribute the revised table to the Coordinating Committees (Item II-E).

- Kristi Geris will send an email to the Coordinating Committees notifying them that the Douglas PUD Sub-yearling Report is out for a 60-day review period, with comments due to Tom Kahler and Andrew Gingerich by Monday, February 11, 2013 (Item III-A).
- Douglas PUD will distribute their draft 2013 10-year NNI Comprehensive Check-in Report to the Coordinating Committees no later than December 21, 2012 (Item III-B).
- Chelan PUD and Douglas PUD will have their respective draft 2013 HCP Action Plans ready for discussion by the time of the Coordinating Committees meeting on January 22, 2013 (Item III-C).
- Mike Schiewe will provide a summary of file sharing options to Chelan PUD and Douglas PUD before the Coordinating Committees meeting on January 22, 2013 (Item V-A).

DECISION SUMMARY

- No Statements of Agreement (SOAs) were approved at this meeting.

AGREEMENTS

- Coordinating Committees representatives present agreed to Chelan PUD's request for a Turbine Unit 2 (C2) outage at Rocky Reach Dam during the last week of August 2013 for mandatory rotor crack repair. It was also agreed to employ the same alternative Rocky Reach Surface Collector Operation as approved for the Turbine Unit 1 (C1) outage in April 2013 (Item II-D).

REVIEW ITEMS

- Kristi Geris sent an email to the Coordinating Committees on December 11, 2012, notifying them that the Douglas PUD Sub-yearling Report is available for a 60-day review period, with comments due to Tom Kahler and Andrew Gingerich by Monday, February 11, 2013.
- Kristi Geris sent an email to the Coordinating Committees on December 26, 2012, notifying them that the Douglas PUD draft 2013 Bypass Plan is available for review.

Tom Kahler indicated that he would like to request approval of this draft plan at the Coordinating Committees meeting on January 22, 2013.

- Kristi Geris sent an email to the Coordinating Committees on December 26, 2012, notifying them that the Douglas PUD draft 2013 HCP Action Plan is available for review. Tom Kahler indicated that he would like to possibly request approval of this draft plan at the Coordinating Committees meeting on January 22, 2013.
- Kristi Geris sent an email to the Coordinating Committees on December 27, 2012, notifying them that the Wells Dam draft 2013 NNI Progress Report is available for review.

REPORTS FINALIZED

- There are no reports that have been recently finalized.

I. Welcome

Mike Schiewe welcomed the Coordinating Committees and asked for any additions or other changes to the agenda. The following revisions were requested:

- Mike Schiewe reserved a moment to congratulate Jerry Marco on his retirement and give thanks for his contributions to the Coordinating Committees over the years.
- Tom Kahler removed Douglas PUD agenda item III-3, item III-4, and item III-5.
- Steve Hemstrom added a discussion regarding a one-week outage for Turbine Unit 2 (C2) at Rocky Reach Dam in August 2013.

A. Meeting Minutes Approval (Mike Schiewe)

The Coordinating Committees reviewed the revised draft October 23, 2012 meeting minutes. Kristi Geris said that all comments and revisions received from members of the Committees were incorporated in the revised minutes, and that there were no outstanding edits or questions to discuss. The draft October 23, 2012 meeting minutes were approved as revised. Geris will finalize the meeting minutes and distribute them to the Committees.

II. Chelan PUD

A. Chelan PUD Draft 2013 10-year NNI Comprehensive Check-in Report (Steve Hemstrom and Joe Miller)

Steve Hemstrom said that the 60-day review period for Chelan PUD's Draft 2013 NNI Report is complete. He said that comments on the draft report were received and incorporated and that the revised 2013 NNI Report, with tracked changes, was distributed to the Coordinating Committees by Kristi Geris on December 3, 2012. Joe Miller said that Chelan PUD would like to extend the review period for members of the Coordinating Committees who have not had the opportunity to review the report and provide comments, keeping in mind that Chelan PUD needs to finalize the report before the March 2013 deadline. He said that a draft SOA memorializing the completion of Chelan PUD's HCP 10-year comprehensive progress report was distributed to the Coordinating Committees by Kristi Geris on November 13, 2012. Teresa Scott asked whether a SOA was needed for this document. Mike Schiewe replied that all Coordinating Committees agreements are always documented in the meeting minutes; however, in general, it has been left to the sponsor of an action, study, or report to decide whether to additionally formalize approval or acceptance by the Committees with an SOA. Schiewe suggested that the 2013 NNI Report is significant enough to warrant an SOA. Scott and Bob Rose said that they have not completed their reviews of the report and requested additional time. Miller reiterated that Chelan PUD wanted every member of the Committees to have ample time for review prior to approval, and said that Chelan PUD would like to pick a date and aim for approval of the SOA at that time. Bryan Nordlund and Jim Craig said that they had already submitted comments on Chelan PUD's draft report and that neither had additional comments at this time. Neither Nordlund nor Craig said that they thought an SOA was necessary, but both were open to the use of one. Hemstrom noted that an SOA would serve to document the Committees' rigorous review and final acceptance of the report; and Schiewe said that an SOA will also make the report easier to search for and locate. Jerry Marco agreed that approving an SOA seemed reasonable.

Miller said that Chelan PUD will request approval of the SOA at the Coordinating Committees meeting on February 26, 2013. Hemstrom said that Chelan PUD had compiled a detailed list of responses to each of the comments received to date and that this list was distributed to the Coordinating Committees by Kristi Geris on December 3, 2012. Scott and

Rose confirmed that they will submit comments on the Chelan PUD Draft 2013 10-year NNI Comprehensive Check-in Report to Chelan PUD no later than January 14, 2013.

B. Subyearling Chinook and Chelan PUD Draft SOA (Steve Hemstrom and Joe Miller)

Steve Hemstrom said that Chelan PUD had revised their path forward for addressing subyearling studies and that the draft SOA distributed to the Coordinating Committees by Kristi Geris on October 19, 2012, is now obsolete and has been retracted by Chelan PUD as a decision item. Joe Miller said that, based on Coordinating Committee feedback from the retracted SOA, it was Chelan's understanding that the new path forward should focus on the following questions: 1) what subyearling Chinook data are currently available and what new data could be collected in the near future (e.g., how has technology changed to facilitate the collection of addition information in the immediate future); and 2) how should passage survival of subyearling Chinook be addressed to ensure HCP obligations are met. To address the first question, Miller said that Chelan PUD would like to gather data/information from the previous subyearling summit and compare those to what is available today. Miller explained the goal of this effort would be to initially identify and summarize how the technology available today has changed, relative to survival study design and assumptions, and then apprise the Coordinating Committee. This summary would, in turn, contribute to a decision by the Coordinating Committee bring in additional expertise (similar to the 2009 summit), collect additional data, or otherwise make specific plans for the future. Miller said that Chelan has also seen other data that were directly and indirectly connected to subyearling life histories/productivity and suggested that they would be informative to the Coordinating Committee for future decisions. Miller described Chelan's recent efforts with hatcheries and an evaluation of predator-prey interactions in Rocky Reach Reservoir. He noted one study by WDFW and BioAnalysts concerning subyearling interactions in particular, and he said that those results will be available in February 2013. Miller said that by March or April 2013, these data combined with life history information can be presented to the Coordinating Committees for evaluation. By summer 2013, he said, the Committees should be in a position to recommend next steps (e.g., outreach to additional fisheries staff with specific expertise in the conduct of survival studies with subyearling Chinook, initiate additional studies, etc.). Hemstrom added that this effort would likely include the development of an interim report by Chelan PUD to help inform a path forward; and he noted that this new proposed effort is based on the fact that project survival studies have not been performed.

Bryan Nordlund said that a better understanding of previous subyearling Chinook studies at other sites should help identify data gaps and determine what new data need to be collected in the Upper Columbia. Nordlund added that limitations need to be defined; for example, why current technology is not suitable for studying subyearling survival in the Upper Columbia River in context of why sub-yearling survival studies have not been done to date. Teresa Scott noted that where the Coordinating Committees want to get with subyearling studies and the path for getting there are two different elements. She said that the Committees should determine if studies would include several reaches or just a single reach. She also noted that the prior SOA specified that workshops be held every 3 to 5 years, and she said that as the learning curve increases, the timing of workshops may need to be more frequent.

Miller said that Chelan PUD will develop a timeline summarizing their path forward for compiling and synthesizing information on subyearling Chinook salmon life history diversity and survival in the upper Columbia River. Chelan PUD will distribute the timeline to the Coordinating Committees prior to the Coordinating Committees meeting on January 22, 2013. Nordlund emphasized that technology is quickly advancing and recommended that the Coordinating Committees keep up on these advances.

C. *Rocky Reach Surface Collector Operation (scheduled for April 2013): Best Alternatives for Operation During Turbine Unit 1 Outage (Steve Hemstrom and Lance Keller)*

Steve Hemstrom reviewed that Turbine Unit 1 (C1) at Rocky Reach Dam will be offline in April 2013 for repairs. He noted that C1 is equipped with screens that divert fish into the bypass system, and that it also provides attraction flow into the cul-de-sac area. Hemstrom said that Chelan PUD is still investigating options for alternative operations during the outage, and he added that choosing an option will come down to an engineering evaluation (an email outlining options being investigated for the Rocky Reach Surface Collector operation was distributed to the Coordinating Committees by Kristi Geris on December 3, 2012).

Hemstrom said that one option being investigated is an increase to the surface collector entrance flow. He said that although Rocky Reach has the infrastructure to allow this increase, the concern is that increased flows may impact smaller fish. He said that another option is to run the other screen unit (Turbine Unit 2 [C2]) above normal level from its minimum set-point flow of 12.1 thousand cubic feet per second (kcfs) to a minimum set-point flow of 15 kcfs; Hemstrom said that this option has been implemented in the past. He said that monitoring at the sampling facility would be conducted daily to monitor any adverse impacts; and added that it could be challenging to evaluate impacts. Lance Keller said that pre-season marked fish releases would ideally be carried out under the modified operations to test for descale, injury, and mortality.

Bryan Nordlund said that he ran calculations for the first option using an increased surface collector entrance flow of 6,800 cfs and concluded that there should not be a problem for salmonids, because screen approach velocities were still low enough to prevent impingement of the size of fish present. He did, however, express concern about whether the Rocky Reach bypass downwell automation could handle that flow. Nordlund asked if this increased flow could result in more turbulent bypass downwell flow, and Hemstrom said that he will ask their engineer about this concern. Nordlund asked Hemstrom to also inquire about the cleaning system, noting that it is important to the overall function of the system. Keller noted that there are extra pumps in the surface collector pump station that can be added and incorporated into existing pump station operations in order to avoid excessive wear due to above-normal use. Hemstrom added that if any undesirable outcomes were to result from the increased flow, the flow could be decreased and the options re-evaluated. He also added that testing the first option would be a good way to inform future operations in the event that pumps go down.

Hemstrom said that he will distribute Chelan PUD's recommendation for a Rocky Reach Surface Collector Operation scheduled for April 2013, including information on the cleaning system, to the Coordinating Committees prior to the Coordinating Committees meeting on January 22, 2013. He also said that he will provide information on Rocky Reach screen velocities to Nordlund.

D. Turbine Unit 2 Outage at Rocky Reach Dam in August 2013 (Steve Hemstrom and Lance Keller)

Steve Hemstrom notified the Coordinating Committees that Turbine Unit 2 (C2) at Rocky Reach Dam will need to be taken offline for the mandatory repair of a cracked rotary unit during the last week in August 2013. He said that the bypass would typically operate through August 31, 2013, so Chelan PUD is proposing an operation similar to the alternative operation approved for the Turbine Unit 1 (C1) outage in April 2013. Lance Keller said that the repair of C2 was originally scheduled for September 2012; however, the date has been moved up to the last week in August due to other unanticipated work and testing. Hemstrom said that he reviewed the past 10 years of data for the proposed time of repair and that there were very few fish using the bypass during the last week of August. Keller said that Chelan PUD needs agreement from the Committees now in order to allow ample time to schedule appropriately. The Coordinating Committees representatives present agreed to Chelan PUD's request for a C2 outage at Rocky Reach Dam during the last week of August 2013 for the mandatory repair of the cracked rotary unit. It was also agreed to employ the same alternative Rocky Reach Surface Collector Operation as approved for the C1 outage in April 2013.

E. Spring Chinook, Sockeye, and Steelhead Adult Conversion Rates Table (Steve Hemstrom and Joe Miller)

Steve Hemstrom said that Josh Murauskas developed draft adult and juvenile combined survival estimates for Rocky Reach and Rock Island dams, using adult passage conversion rate estimates for spring Chinook, sockeye, and steelhead (Attachment B). The draft estimates were distributed to the Coordinating Committees by Kristi Geris on December 7, 2012. Joe Miller said that Murauskas used passive integrated transponder (PIT)-tag data from the past 3 years for the estimates, and that Dr. John Skalski's team reviewed the analyses and provided a document with their independent analysis and findings. Skalski's estimates are described in the adult conversion rate analysis report (Attachment C) that was also distributed to the Coordinating Committees by Kristi Geris on December 7, 2012.

Miller said that these survival estimates were not available when Chelan PUD distributed the first draft of their 2013 NNI Report. He said, however, that Chelan PUD views these results as an important milestone and would like to incorporate them into the final report. He added that, under the HCP, these are very positive results. Miller noted that harvest was only included for sockeye from Rocky Reach in 2010 and 2011. He said that if the harvest component was included, survival estimates would be even higher; however, to be conservative, harvest was not included for steelhead, spring Chinook, or sockeye from Rock Island. Murauskas said that these results are "bare bones" estimates, and noted that there is no way to account for all sources of mortalities; therefore, these estimates represent more than just dam passage and hence are slightly biased in the negative direction.

Teresa Scott asked if harvest in the tributaries was considered as well as in the mainstem; Murauskas responded that only harvest in the mainstem between the projects was used. He said that the harvest component was difficult to document, and that the goal was to limit variability where possible. Bryan Nordlund suggested that calculating survival to the spawning grounds is part of the smolt-to-adult survival for the hatchery recalculation. He acknowledged that this was outside of Chelan PUD's scope of project survival; however, he noted that it would be a useful indicator of overall life cycle survival. Murauskas said that Chelan PUD has started looking at conversion rates to the spawning grounds in the Wenatchee River.

Mike Schiewe noted that juvenile and adult Chinook survivals were estimated from different populations of Chinook, and that this should be explained in a footnote. Whereas juvenile estimates represent spring-migrating yearling Chinook that include a large proportion of yearling summer/fall Chinook, adult survival estimates represent only returning spring Chinook (the latter being Endangered Species Act (ESA)-listed). Schiewe suggested that Chelan PUD more accurately characterize juveniles as "yearlings." Miller said that he believes that this distinction is worth clarifying. Schiewe also noted that juvenile years should be added to the table, and that the year 2012 should be removed from the table title, as these data represent multiple years. Nordlund also noted that not all plan species were included in the table and that the table title should be revised to reflect this omission.

Miller asked the Coordinating Committees if they would like an opportunity for separate review and approval of the table, or whether it should be incorporated in the draft 2012 10-year NNI Report and approved as part of that document. Nordlund said that he would like to review the table separately once all revisions were made. Miller said that Chelan PUD will incorporate recommended edits to the spring Chinook, sockeye, and steelhead adult passage conversion rates table and will distribute the revised table to the Coordinating Committees for approval before its incorporation in Chelan PUD's 10-year NNI Report.

III. Douglas PUD

A. Subyearling Report (Tom Kahler and Andrew Gingerich)

Tom Kahler said that the Douglas PUD 2011 subyearling report and associated presentation (Attachment D) were distributed to the Coordinating Committees by Kristi Geris prior to the Coordinating Committees meeting on December 11, 2012. Kahler introduced Andrew Gingerich to the Coordinating Committees; Kahler said that Gingerich has been working on this subyearling study for the past few years.

Gingerich reviewed the life-history hypotheses, as described in Attachment D, and noted that the hypotheses were separated into two categories: life history and tagging. Bryan Nordlund asked if $H2_{alt}$ in Attachment D implies that there is a percentage of fish that do not migrate through Wells Dam; and Gingerich replied that this hypothesis addresses how the fish are using the system (e.g., passively migrating, rearing, or actively migrating through the system). Gingerich added that one goal of the study is to identify which fish are active migrants versus fish that are rearing or residualizing; so this hypothesis is, in a way, defining the proportion of fish that are actively migrating. Nordlund asked what conclusion about life history is being sought if fish do or do not actively migrate through Wells Dam; and Kahler replied that these data would indicate whether a fish remains in the reservoir for an extended period or is an active migrant. Kahler described how fyke-netting in turbine intakes and spillways and purse-seining in the forebay, conducted in the 1980s and 1990s, captured migrants that generally exceeded the lengths of fish captured and tagged in the current study. Hypothesis 2 sought to determine whether fish of the size captured in those previous studies were actively or passively migrating. Gingerich also noted that some of the hypotheses overlap in both life history and tagging.

Gingerich reviewed capture and detection results, as described in Attachment D, and noted that fish were tagged over a 3-week period and that post-tagging seining was also employed at select locations. Gingerich noted that study methods are outlined in the report. He reviewed graphs of the size distribution of captured fish, by location and by study phase, from late May 2011 into early August 2011. He also reviewed cumulative detection variability and distribution of detections. Gingerich noted that 2011 data indicated that fish were still arriving at McNary Dam 90 days after the termination of bypass operations at Rocky Reach; he said that this was an important factor to consider in terms of tag battery life. Gingerich also noted that PIT-tag detectors operate at downstream dams beginning in April and shut down by November 15 each year, but actual termination of bypass depended on weather and other factors.

Gingerich noted that travel time results indicated that juvenile fish migrate faster as they approach the estuary. Teresa Scott suggested that, in 2011, the water year likely had a significant impact on travel time. Gingerich agreed that the 2011 water year was not an average year in terms of flow and said that after a few more years of data are collected, annual variation and covariates would be better understood.

Gingerich reviewed graphs depicting an apparent size threshold for migration in 2011 and noted that the report includes further statistical analyses, including correlation coefficients and p-values. He said that results indicate substantial variation in migration timing for fish smaller than 87 mm, in contrast with fish 87 mm and longer, but he wants to be careful not to draw any conclusions on size thresholds based on only one year of data. Nordlund asked about the 86-millimeter (mm) threshold, and Gingerich explained that the 86-mm fish length was a size threshold beyond which fish began to leave the littoral habitat. Gingerich added that the results indicate that travel time is five times faster for fish of fork lengths greater than 86 mm when compared to those fish that were smaller than that threshold at tagging. Gingerich reviewed the probability of detection for fish of fork lengths less than 87 mm and for those greater than 86 mm. He said that the results indicated higher rates of detection for larger fish. He also noted that because fish size impacts the probability of mortal injury to tagged fish, there is probably some bias in detection due to fish size even while carrying a 0.1 gram PIT tag. Gingerich explained that smaller fish are more likely to sustain mortal injury due to the smaller fish needing to increase the volume of their swim bladders, relative to larger conspecifics, to make up for the negative buoyancy of carrying a tag. The relative increase in swim bladder size makes smaller fish more susceptible to pressure changes during passage at the dam.

Gingerich said that challenges encountered during the study included the collection of fish that were too small to tag early in the season and the difficulties in locating fish later in the season. Jim Craig asked if any sampling was conducted at night, and Gingerich said that early morning sampling was conducted but that no night sampling was conducted. Jerry Marco asked about temperature differences from May 2012 to August 2012, and Gingerich said that there were differences; however, those differences were only a few degrees Celsius from when tagging began to when tagging stopped. He did note, however, that once the temperature reached about 16 to 17 degrees Celsius, no fish were caught. Gingerich said that fish of all sizes experienced a period of relatively slow growth following tagging and release. Nordlund asked if these fish eventually caught up in size, and Kahler said that some "compensatory growth" would likely occur so that they would catch up with the sizes of their cohort, but that some researchers have noted increased mortality following compensatory growth.

Gingerich reviewed the conclusions. Hemstrom asked if an increase in travel time could be expected based on different flows. Gingerich said that he believes that flows have little effect on migration time; he added that studies conducted in the Snake River also show that flows are only part, if at all, a predictor of travel time for subyearling Chinook. Scott asked how the detection rate may be impacted by flows, and Gingerich said that it is hard to tell with only one year of data. Nordlund also asked if non-migratory fish might be affected by higher flows. Kahler said that the literature reports a decrease in survival with decreasing flow, increasing temperature, and decreasing turbidity; but, he said, the effects of each variable are difficult to isolate because they are interrelated.

Gingerich said that Douglas PUD is just starting to analyze the 2012 data and is discussing how best to present the results; options considered include preparing a stand-alone report, drafting a memorandum comparing the 2011 and 2012 data, or waiting until 2013 to provide a comprehensive 3-year report. Bob Rose suggested that for 2012 it would useful for Douglas PUD to prepare and distribute the same summary graphs and figures as were developed for 2011. Gingerich said that, in 2012, almost 20,000 fish were tagged and released over a 3-week duration, and that, in 2013, they may collect and tag for a longer duration and thus tag more fish. Kahler noted that the Douglas PUD Sub-yearling Report that was just distributed to the Coordinating Committees is now out for a 60-day review period with comments due to Kahler and Gingerich by Monday, February 11, 2013.

B. Douglas PUD Draft 2013 10-year NNI Comprehensive Check-in Report (Tom Kahler)

Tom Kahler said that he will distribute the Douglas PUD draft 2013 10-year NNI Comprehensive Check-in Report to the Coordinating Committees no later than December 21, 2012.

C. Douglas PUD Draft 2013 HCP Action Plan (Tom Kahler)

Tom Kahler indicated that Douglas PUD will have their draft 2013 HCP Action Plans ready for discussion at the Coordinating Committees meeting on January 22, 2013. Chelan PUD indicated that they would have their 2013 HCP Action Plan available as well. Both plans will be on the agenda for approval at the Coordinating Committees meeting on February 26, 2013.

D. Douglas PUD Draft 2013 Bypass Operations Plan (Tom Kahler)

Tom Kahler said that the draft Wells Dam Bypass Operating Plan was distributed to the Coordinating Committees by Kristi Geris on December 7, 2012, and that there were no immediate questions or comments on the plan. The plan will be on the agenda for discussion and potential approval at the Coordinating Committees meeting on January 22, 2013.

E. Fishway Projects Planned and Underway During the 2012/2013 Winter Maintenance Period (Tom Kahler)

Tom Kahler said that several adult fishway projects were scheduled for the winter 2012/2013 fishway maintenance outages at Wells Dam, including: 1) installation of PIT-tag detection antennae in Pool 19 of the east ladder along with the new 2020 readers that record both full-and half-duplex (HD) PIT-tags; 2) installation of improved grating around the count windows in both the East and West Fish Ladders to prevent lamprey bypassing the count windows and fish stranding in the count-window bypass-chamber; 3) installation of new (or reconnection of existing) radio-telemetry (RT) antennas in both fishways, in preparation for a lamprey RT study in 2013; and 4) installation of safety railings along the tops of the walls of both fishways from Pool 37 down to Pool 6.

IV. Hatchery and Tributary Committees Update (Mike Schiewe)

Mike Schiewe said that the Hatchery Committees are meeting on December 12, 2012, and that key discussions will include updates to the Hatchery Monitoring and Evaluation (M&E) Plans, review of options for meeting Chelan PUD's spring Chinook production in the Methow Basin, and development of 2013 broodstock protocols.

Schiewe updated the Coordinating Committees on the following actions and discussions that occurred at the last Tributary Committees meeting on November 19, 2012:

- *Small Projects Program Applications*: The Tributary Committees reviewed three Small Projects Program Applications in November: 1) Twisp River Well Conversion; 2) Beaver Creek Late Season Well Test; and 3) Peshastin Creek Riparian Restoration Project. Funding for the Twisp River Well Conversion was approved; however, the Tributary Committees were unable to make a funding decision for the Beaver Creek Late Season Well Test, and elected not to fund the Peshastin Creek Riparian Restoration Project.
- *Budget Amendment*: The Rocky Reach Tributary Committee approved a budget modification requested by Trout Unlimited. The sponsor said that it took longer than expected to secure permits and that costs to complete those permits were higher than anticipated.
- *Tributary Assessment Program*: The Tributary Committees are discussing how to implement the Tributary Assessment Programs. Tom Kahler explained that the Assessment Program sets aside $200,000 per HCP each year, which is separate from the Plan Species Accounts. He said that the money was originally intended for evaluating projects funded out of the initial contributions to the Plan Species Accounts, but that there has been proliferation of other projects aimed at doing what

some envisioned would be accomplished with this money. Kahler said that the Tributary Committees are now discussing if a parallel process should be initiated, or if the funds should be used for something different. Teresa Scott noted the McNary Fisheries Compensation Committee as a potential partner to contribute to whole reach scale projects.

V. HCP Committees Administration (Mike Schiewe)

A. File Sharing

Mike Schiewe reminded the Coordinating Committees of an ongoing discussion that has yet to be resolved regarding how to manage and archive HCP project files. He introduced Relativity and SharePoint and briefly reviewed the searching capabilities and transferability of each. He said that he will provide a summary of file sharing options to Chelan PUD and Douglas PUD before the Coordinating Committees meeting on January 22, 2013. Tom Kahler reminded the Committees that Douglas PUD had previously suggested the possibility of using their Document Management Tools (DMT) platform; however, further internal discussion resulted in a decision to instead consider using the PUD's existing SharePoint platform for all of the HCP associated documents. He said that Douglas PUD Information Services is working with the Natural Resources Department on an externally available SharePoint site that can be used as a HCP data exchange platform and archive. Schiewe said that one important advantage of Relativity was that it includes a search function allowing searches within a variety of different types of files, including PDFs, whereas SharePoint only allows search within Microsoft Word files (note: Douglas County PUD Information Services confirms that SharePoint does allow searches of PDF documents with OCR capability).

B. Annual Reports

Mike Schiewe noted that the Rocky Reach Dam, Rock Island Dam, and Wells Dam 2012 Annual Reports are being prepared. Kristi Geris said that the comment periods will be from February 8, 2013, to March 6, 2013, for the Wells Dam Annual Report, and from February 21, 2013, to March 19, 2013, for the Rocky Reach Dam and Rock Island Dam Annual Reports.

C. Jerry Marco's Retirement

On this occasion of his last Coordinating Committees meeting, members thanked Jerry Marco for his many years of hard work and numerous contributions to the development and implementation of the Wells, Rocky Reach, and Rock Island HCPs. Marco said that he would notify the Colville Confederated Tribes' (CCT's) interim director that the signatories need a CCT representative for the Coordinating Committees meeting on January 22, 2013. He added that he enjoyed his tenure on the Coordinating Committees, and wished the members continued success.

D. Next Meetings

The next scheduled Coordinating Committees meeting is January 22, 2013, to be held in person in at the Radisson Hotel in SeaTac, Washington. The February 26, 2013 and March 26, 2013 meetings will be held either by conference call or in person at the Radisson Hotel in SeaTac, Washington, but this is yet to be determined.

List of Attachments

Attachment A – List of Attendees
Attachment B – Draft adult and juvenile combined survival estimates for Rocky Reach and Rock Island, with adult passage conversion rate estimates for spring Chinook, sockeye, and steelhead
Attachment C – Adult conversion rate analysis report
Attachment D – Douglas PUD 2011 Subyearling Report presentation

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Steve Hemstrom*	Chelan PUD
Lance Keller*	Chelan PUD
Joe Miller	Chelan PUD
Josh Murauskas†	Chelan PUD
Tom Kahler*	Douglas PUD
Andrew Gingerich	Douglas PUD
Jerry Marco*	Colville Confederated Tribes
Bob Rose*†	Yakama Nation
Bryan Nordlund*	National Marine Fisheries Service
Jim Craig*	U.S. Fish and Wildlife Service
Teresa Scott*	Washington Department of Fish and Wildlife

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

DRAFT

Adult and Juvenile Combined Survival Estimates for Plan Species in the Rock Island and Rocky Reach Hydroelectric Projects, 2012

Table 1. Summary of juvenile, adult, and combined survival rates for Plan Species at Rock Island and Rocky Reach, 2012. Adult conversion rates calculated from adult passage data, years 2010-2012. HCP Combined Adult and Juvenile Project Survival standard is 91%.

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

[1] Estimate does not account for fish losses due to recreational harvest in any years.

[2] No recreational harvest occurred.

[3] Adult conversion rate and Combined Project Survival approved by SOA on August 30, 2011 using 2009-2011 passage data.

[4] Estimate adjusted for fish losses from recreational harvest in 2010 and 2011, but not for harvest losses in 2012.

Estimation of the Adult Salmon and Steelhead Conversion Rates through Rock Island and Rocky Reach Projects, 2010-2012

To:

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5 December 2012

Introduction

This report summarizes our analysis of detections of PIT-tagged adult salmon and steelhead in the mid-Columbia River past Rock Island and Rocky Reach dams in 2010, 2011, and 2012. It extends our previous analysis of the conversion rate of adult spring Chinook salmon through the Rocky Reach Project in 2009 – 2011 to adult spring Chinook salmon through the Rock Island Project in 2010 – 2012, and to both adult sockeye salmon and adult steelhead through the Rock Island and Rocky Reach projects in 2010 – 2012.

The adult conversion rate through a hydroelectric project is a measure of the probability that an adult salmon present at the downstream end of the project (i.e., tailrace of the dam) survives past both of the dam and the reservoir. It is most simply calculated as the ratio of the number of tagged adults detected at the upstream end of the reservoir to the number detected at the downstream end of the project's tailrace. However, the PIT-tag detectors at the mid-Columbia dams are located in the adult fish ladders, and are thus offset from the dam tailraces. For this reason, a conversion rate calculated only by detections at the dam in question and the next dam upstream may assign losses to the incorrect project. Nevertheless, it is possible to make strong inferences about the minimum adult survival experienced through a given project by estimating the conversion rate through the reach that includes both the project in question and one or more of the neighboring projects. For example, a minimum estimate of survival through the Rocky Reach Project may be estimated by the conversion rate from the Rock Island ladder to the Wells ladder. Survival through the Rock Island Project may be minimally estimated by the conversion rate from the Priest Rapids ladder to the Rocky Reach ladder.

The conversion rate provides only a minimum estimate of survival through a project, both because it includes parts of projects other than the one under consideration in an effort to completely cover the given project, and because it reflects losses from factors other than Project-related mortality. In particular, it will reflect losses from straying to tributaries and harvest mortality between dams, non-detection at the upstream dam, and fallback at the downstream dam that is not followed by reascension. The multi-project conversion rate may be scaled to a single-project conversion rate by taking the square root or cubed root, as appropriate. Straying and harvest loss may be partially accounted for by records of recaptures and harvest reports, although without independent estimates of recapture and harvest reporting rates, the adjusted conversion rate will remain a minimum estimate of survival.

Methods

Rock Island Project

Adult survival through Rock Island Project was estimated using a three-project conversion rate from Priest Rapids Dam to Rocky Reach and/or Tumwater dams for adult spring Chinook salmon, steelhead, and sockeye salmon for years 2010, 2011, and 2012. Annual single-project conversion rates representing the Rock Island Project were also estimated by taking the cubed root of the three-project conversion rates. The three-year arithmetic average was reported for both the three-project conversion rate and the single-project conversion rate representing the Rock Island Project. Confidence intervals were reported at the 95% level for annual estimates and three-year average estimates. The confidence intervals and standard errors on the three-year averages were based on the annual standard error estimates, rather than on the sampling variability of the annual point estimates. This is appropriate for making inferences directly to the three years in question (2010, 2011, and 2012).

PIT-tag detections were downloaded from the PTAGIS database on 30 November 2012. For each stock and year, detections were used from the Priest Rapids, Rocky Reach, Wells, and Tumwater adult fish ladders. Spring Chinook salmon detections were limited to those from fish that had been tagged as juveniles in the Methow Basin, upstream of Wells Dam. Steelhead detections were limited to those fish that had been tagged as juveniles in the Methow and Okanogan Basins, upstream of Wells Dam. Sockeye detections came from fish tagged as adults at the Bonneville Adult Fish Facility, and thus represented non-known-source fish. Successful conversion for sockeye through the Rock Island Project was indicated by detection at either Tumwater, Rocky Reach, or Wells dams, whereas successful conversion for spring Chinook salmon and steelhead was indicated by detection at either Rocky Reach or Wells dams.

Rock Island Project: Spring Chinook Salmon

Spring Chinook detections were limited to those that passed through the Priest Rapids-Rocky Reach Dam reach before 1 July of each year, when the Chinook salmon fishery opened. To remove those fish that were migrating after the opening of the fishery, a cutoff arrival date at Priest Rapids was selected to give fish sufficient time to reach Rocky Reach Dam before the fishery opening on 1 July. The cutoff date was determined using the average observed travel time between Priest Rapids and Rocky Reach dam each year (4.5 – 5.2 days). The cutoff date used was 25 June each year. In 2010, one tag was omitted because it arrived at Priest Rapids after this date; it subsequently arrived at Rocky Reach on 1

July. In 2011, seven tags were omitted because they arrived at Priest Rapids after 25 June; each subsequently arrived at Rocky Reach on or before 1 July. No tags were omitted in 2012 because of late passage. Mini-jacks were excluded each year. The annual adult three-project conversion rate for spring Chinook salmon through the Priest Rapids – Rocky Reach Dam reach was estimated as

$$\hat{C} = \frac{n_{RR}}{N_{PR}},$$

where N_{PR} is the number of adult PIT-tagged spring Chinook salmon detected at Priest Rapids by 25 June of the given year, and n_{RR} is the number of the N_{PR} fish that were subsequently detected at Rocky Reach Dam (or Wells Dam) before 1 July. Detections of hatchery and wild fish were combined for this analysis.

Rock Island Project: Sockeye Salmon

Adult sockeye passing Priest Rapids Dam may be headed toward regions upstream of Rocky Reach and Wells dams, or they may be headed toward Tumwater Dam on the Wenatchee River. Thus, detections from Tumwater were included in estimates of the conversion rate through the Rock Island Project, as well as detections from Rocky Reach and Wells.

Sockeye fisheries opened in July of each year downstream of Wanapum Dam. However, the majority of the tagged sockeye passing Priest Rapids were detected there after 1 July each year, so no attempt was made to remove those individuals at risk to the fishery. Furthermore, no harvest data were available from that fishery, so the Rock Island Project conversion rate for sockeye was not adjusted for harvest mortality. Thus, the conversion rate may be considered only a minimum estimate of survival from Priest Rapids to Rocky Reach or Tumwater, and in particular through the Rock Island Project.

The annual adult three-project conversion rate for sockeye salmon from Priest Rapids to Rocky Reach Dam was estimated as

$$\hat{C} = \frac{n_{RR} + n_{TU}}{N_{PR}},$$

where N_{PR} is the number of adult PIT-tagged sockeye salmon detected at Priest Rapids in the given year, n_{RR} is the number of those fish that were subsequently detected at Rocky Reach Dam (or Wells

Dam) that year, and n_{TU} is the number of the Priest Rapids fish that were subsequently detected at Tumwater Dam that year. Because all sockeye were tagged as adults, it was not possible to calculate separate estimates for hatchery and wild fish, so only the combined estimate is reported.

Rock Island Project: Steelhead

Steelhead counts were adjusted to account for overwintering between Priest Rapids Dam and Rocky Reach Dam. One steelhead was detected at Priest Rapids Dam in 2011 and at Rock Island, Rocky Reach, and Wells dams in 2012. This tag contributed to the 2011 conversion rate through the Rock Island Project (and the Rocky Reach Project).

A steelhead fishery opened between Rock Island and Rocky Reach dams on 8 September in 2010 and on 22 September in 2011, and counts of reported harvest were available from the Washington Department of Fish and Wildlife (WDFW). No harvest counts were available from 2012 by the time of analysis. For 2010 and 2012, loss due to harvest was accounted for by estimating the harvest rate in the Rock Island – Rocky Reach Dam reach and adjusting the three-dam project conversion rate accordingly. Because the harvest adjustment was applied equally to all three reaches comprising the reach from Priest Rapids to Rocky Reach Dam, the resulting single-project harvest-adjusted conversion rate is only a minimum estimate of passage survival through the Rock Island Project.

Harvest rate in the reach between Rock Island and Rocky Reach dams was estimated by

$$\hat{h} = \frac{N_{harvest}}{M_{RI(ROR)}},$$

where $N_{harvest}$ is the reported harvest count in the reach between Rock Island and Rocky Reach in the given year, and $M_{RI(ROR)}$ is the total window count of adult hatchery steelhead after the opening of the fishery each year, as reported on the DART at the University of Washington (www.cbr.washington.edu/DART). Because window counts are not available through the late fall and winter, and the harvest count may be under-reported, it is possible that the harvest rate estimate is biased. Using the estimated harvest rate estimate, the harvest-adjusted conversion rate for hatchery fish was estimated as

$$\hat{C}_{h(H)} = \frac{n_{RR(H)}}{N_{PR(H)}(1-\hat{h})},$$

where $N_{PR(H)}$ and $n_{RR(H)}$ are the numbers of adult hatchery steelhead detected at Priest Rapids and again subsequently at Rocky Reach or Wells, respectively. Because harvest targeted only hatchery fish, no harvest adjustment was made for wild fish conversion rates. The combined three-project conversion rate for wild and hatchery fish was estimated as

$$\hat{C}_h = \frac{n_{RR(H)} + n_{RR(W)}}{N_{PR(H)}(1-\hat{h}) + N_{PR(W)}},$$

where $N_{PR(W)}$ and $n_{RR(W)}$ are the number of adult wild steelhead detected at Priest Rapids and again subsequently at Rocky Reach or Wells, respectively. Standard errors were estimated using the delta method.

Rocky Reach Project

Adult survival through the Rocky Reach Project was estimated using a two-project conversion rate from Rock Island Dam to Wells Dam for adult steelhead and sockeye salmon for years 2010 and 2012. Annual single-project conversion rates representing the Rocky Reach Project were calculated by taking the square root of the two-project conversion rates. Both annual estimates and the three-year arithmetic average were reported for both the two-project conversion rate and the single-project conversion rate. Confidence intervals were reported at the 95% level. The confidence intervals and standard errors on the three-year averages were based on the annual standard error estimates, rather than on the sampling variability of the annual point estimates. This is appropriate for making inferences directly to the three years in question (2010, 2011, and 2012).

PIT-tag detections were downloaded from the PTAGIS database on 30 November 2012. For each stock and year, detections were used from the Rock Island and Wells adult fish ladders. Detections of sockeye in the Tumwater adult fish ladder were used, as well. Sockeye detections came from fish tagged as adults at the Bonneville Adult Fish Facility, and thus represented non-known-source fish. Sockeye detections were limited to those that were not eventually detected at Tumwater Dam (see below). Steelhead detections were limited to those fish that had been tagged as juveniles in the Methow and Okanogan Basins, upstream of Wells Dam. For each species, successful conversion through the Rocky Reach Project was indicated by detection at Wells Dam.

Rocky Reach Project: Sockeye Salmon

Sockeye detected at Rock Island Dam may have been headed either toward Rocky Reach and Wells dams, or toward Tumwater Dam on the Wenatchee River. Those fish that remained in the Columbia River past Rocky Reach Dam also experienced a fishery on their way to Wells Dam. The standard conversion ratio is

$$\hat{C} = \frac{n_{WE}}{N_{RI}},$$

where N_{RI} is the number of tagged adults detected at Rock Island Dam, and n_{WE} is the number of the Rock Island adults subsequently detected at Wells Dam. The expected value of this estimator is the joint probability of heading toward Wells Dam (i.e., not entering the Wenatchee River) and surviving from Rock Island to Wells Dam (i.e., ϕ_{WE}). The complement of C (i.e., $1-C$) includes the probability of leaving the Columbia River for the Wenatchee, as well as mortality within the Columbia from either natural factors, harvest, or both. An alternative estimator is

$$\hat{C}_T = \frac{n_{WE}}{N_{RI} - n_{TU}},$$

where n_{TU} is the number of adult sockeye detected both at Rock Island Dam and at Tumwater Dam (possibly after detection at Wells or Rocky Reach). The expected value of this estimator is approximately

$$E(\hat{C}_T) \approx \frac{\phi_{WE}}{1-\phi_{TU}},$$

where ϕ_{TU} is the joint probability of heading toward Tumwater Dam and surviving there from Rock Island Dam. If all fish that were directed toward Tumwater Dam from Rock Island survived to reach Tumwater, then the expected value of $\hat{C}_T$ would equal survival from Rock Island to Wells Dam, assuming no harvest mortality, fallback, or other straying. However, it is not necessarily warranted to assume 100% survival from Rock Island to Tumwater Dam, and without an independent estimate of that survival probability, it is not possible to estimate the probability of survival in the Columbia River from Rock Island to Wells Dam separately from the probability of being directed to Wells Dam. On the other hand, for Rock Island – Tumwater survival less than 100%, the expected value of $\hat{C}_T$ will be less than the true survival from Rock Island to Wells Dam, so C_T may be considered a minimum estimate of that survival.

Another factor that may be accounted for is harvest mortality between Rocky Reach and Wells dams. Harvest counts were available from WDFW, and may be used to estimate a minimum harvest rate in that reach, with the understanding that imperfect harvest reporting rates result in a negatively biased harvest rate. A minimum harvest rate may be estimated by

$$\hat{h} = \frac{N_{harvest}}{M_{RR(ROR)}},$$

where $M_{RR(ROR)}$ is the number of run-of-river sockeye adults estimated to have passed Rocky Reach Dam during the dates when the fishery was open (1 July – 15 October each year), and $N_{harvest}$ is the harvest count. The harvest applies only to hatchery fish, whereas the window counts at Rocky Reach Dam are not separated for wild and hatchery sockeye, so $\hat{h}$ will be negatively biased because wild fish are included in $M_{RR(ROR)}$. Also, $N_{harvest}$ is likely an undercount of the actual sockeye harvested, which also contributes to negative bias in $\hat{h}$. The probable negative bias in $\hat{h}$ results in the harvest-adjusted conversion rate being a conservative (i.e., minimum) estimate of the two-project survival from Rock Island to Wells Dam. The harvest-adjusted conversion rate is estimated as

$$\hat{C}_{hT} = \frac{n_{WE}}{(N_{RI} - n_{TU})(1-\hat{h})}.$$

Under the assumption of 100% survival from Rock Island to Tumwater, 100% harvest reporting rate, and all hatchery fish (and assuming no other straying or fallback over Rock Island), this estimator is unbiased for survival from Rock Island to Wells Dam. With imperfect survival to Tumwater Dam, an imperfect harvest reporting rate, or a sizeable proportion of the sockeye run represented by wild fish, $\hat{C}_{hT}$ is a minimum estimate of survival from Rock Island to Wells. The square root of $\hat{C}_{hT}$ is also a minimum estimate of survival through the Rocky Reach Project. The recommended estimator of the sockeye salmon conversion rate, and that reported in the results, is $\hat{C}_{hT}$.

Rocky Reach Project: Steelhead

Steelhead detection data were adjusted to account for overwintering between Rock Island Dam and Wells Dam. One steelhead was detected at Priest Rapids, Rock Island, and Rocky Reach dams in 2010, and finally detected at Wells Dam in 2011. This was considered a successful 2010 conversion through the Rocky Reach Project. Similarly, one tag was detected at Priest Rapids, Rock Island, and Rocky Reach dams in 2011 and at Wells Dam in 2012; this tag was considered a successful 2011 conversion.

Hatchery steelhead experienced a fishery in both the reach from Rock Island to Rocky Reach, and from Rocky Reach to Wells Dam. The reach-specific harvest rate was estimated by

$$\hat{h}_{RI} = \frac{N_{harvest:RI-RR}}{M_{RI(H)}} \quad \text{and} \quad \hat{h}_{RR} = \frac{N_{harvest:RR-WE}}{M_{RR(H)}},$$

where $M_{RI(H)}$ and $M_{RR(H)}$ are the window counts of hatchery steelhead at Rock Island and Rocky Reach dams, respectively, during the summer and fall portion of the fishery each year, as reported on the DART website. Imperfect harvest reporting rates and window counts again result in possibly biased harvest rate estimates. Using the available harvest data, the harvest-adjusted conversion rate from Rock Island to Wells Dam for hatchery steelhead was defined as

$$\hat{C}_{h(H)} = \frac{n_{WE(H)}}{N_{RI(H)}(1-\hat{h}_{RI})(1-\hat{h}_{RR})},$$

where $N_{RI(H)}$ and $n_{WE(H)}$ are the counts of adult PIT-tagged hatchery steelhead detected at Rock Island and also at Wells, respectively. The combined two-project conversion rate for wild and hatchery steelhead was estimated as

$$\hat{C}_{h} = \frac{n_{WE(H)} + n_{WE(W)}}{N_{RI(H)}(1-\hat{h}_{RI})(1-\hat{h}_{RR}) + N_{RI(W)}},$$

where $N_{RI(W)}$ and $n_{WE(W)}$ are the number of adult wild steelhead detected at Rock Island and again subsequently at Wells, respectively. The single-dam harvest-adjusted conversion rate was estimated as the square root of $\hat{C}_h$, and represented a minimum estimate of survival through the Rocky Reach Project. Standard errors were estimated using the delta method.

Results

Results from the conversion rate analysis are presented by stock below. In each case, the three-project and/or two-project conversion rate estimates are presented, as well as the single-project conversion rate. Because conversion rates include losses from straying, fallback, and unknown (or uncorrected) harvest mortality as well as natural mortality, the multi-project conversion rate is a strong minimum estimate of survival through all projects comprising the reach. Thus, the multi-project conversion rate is also a strong minimum estimate of survival through the reach in question (either Rock Island from the three -project conversion rate, or Rocky Reach from the two -project conversion rate). The single-project conversion rate provides a minimum survival estimate on the scale of a single project, and is a reasonable estimate of survival through the project in question assuming common survival through all projects.

Spring Chinook Salmon: Rock Island Project

The three -project conversion rate from Priest Rapids Dam to Rocky Reach Dam included the Rock Island Project in its entirety. All adult spring Chinook salmon detected at Priest Rapids in 2010 or 2011 were subsequently detected in the Rocky Reach fish ladder, yielding conversion rate estimates of 1.0000 ($\widehat{SE}$ =0) in those years (Table 1). In 2012, all but 1 of the 97 tagged adult spring Chinook salmon detected at Priest Rapids were subsequently detected at Rocky Reach, producing a conversion rate estimate of 0.9897 ($\widehat{SE}$ =0.0103; Table 1). The 3-year arithmetic average of the conversion rate estimates was 0.9966 ($\widehat{SE}$ =0.0034), with an asymptotic 95% confidence interval of (0.9899, 1.0033) (Table 1). The single-project conversion rate estimates were 1.0000 ($\widehat{SE}$ =0) in 2010 and 2011, and 0.9966 ($\widehat{SE}$ =0.0034) in 2012, yielding a 3-year average estimate of 0.9989 ($\widehat{SE}$ =0.0011, 95% CI = (0.9966, 1.0011); Table 1). Because the conversion rate between Priest Rapids and Rocky Reach reflects losses from straying, fallback, and unauthorized harvest as well as natural mortality and also covers a longer river reach than the Rock Island Project, we can conclude that the 3-year average survival of adult spring Chinook salmon through the Rock Island Project was at least as high as 0.9899 (the lower limit of the 95% confidence interval for the three-dam conversion rate estimate), and is more likely as high as

0.9966 (the lower limit of the single-project confidence interval). Our best point estimate for the 3-year average is 0.9989.

Table 1. PIT-tag data and estimates of conversion rate from Priest Rapids to Rocky Reach for adult spring Chinook salmon tagged as juveniles in the Methow River Basin. The single-project conversion rate is estimated as the cubed root of the Priest Rapids – Rocky Reach conversion rate. The average is the 3-year arithmetic average. The 95% confidence intervals are profile likelihood confidence intervals for the year-specific results, and asymptotic confidence intervals for the 3-year average.

	PIT-tag detections		Priest Rapids – Rocky Reach Conversion Rate			Single-Project Conversion Rate		
Year	Priest Rapids	Rocky Reach/ Wells	Estimate	SE	95% CI	Estimate	SE	95% CI
2010	47	47	1.0000	0	(0.9600, 1.0000)	1.0000	0	(0.9865, 1.0000)
2011	232	232	1.0000	0	(0.9918, 1.0000)	1.0000	0	(0.9972, 1.0000)
2012	97	96	0.9897	0.0103	(0.9554, 0.9994)	0.9966	0.0034	(0.9849, 0.9998)
Average			0.9966	0.0034	(0.9899, 1.0033)	0.9989	0.0011	(0.9966, 1.0011)

Sockeye Salmon: Rock Island Project

Passage through the Rocky Reach, Tumwater, and Wells fish ladders was monitored for all PIT-tagged sockeye salmon detected in the Priest Rapids ladder in 2010 through 2012. This three -project conversion rate from Priest Rapids to Rocky Reach and Tumwater dams included the Rock Island Project. Annual estimates of this conversion rate, unadjusted for harvest, ranged from 0.9364 ($\widehat{SE}$ = 0.0105) in 2011 to 0.9782 ($\widehat{SE}$ = 0.0056) in 2010, with a 3-year average of 0.9520 ($\widehat{SE}$ = 0.0095) and a 95% confidence interval of (0.9431, 0.9609) (Table 2). The single-project conversion rate through this reach had estimates from 0.9784 ($\widehat{SE}$ = 0.0037) in 2011 to 0.9927 ($\widehat{SE}$ = 0.0019) in 2010, with a 3-year average estimate of 0.9837 ($\widehat{SE}$ = 0.0016). The 95% confidence interval of the 3-year average single-project conversion rate was (0.9806, 0.9868) (Table 2). Under the assumption of constant survival between Priest Rapids and Rocky Reach or Tumwater dams, the single-project conversion rate is a minimum estimate of survival through the Rock Island Project. The estimate includes an unknown amount of loss to harvest in the fishery between Priest Rapids and Wanapum dams (data unavailable), and so it is likely that survival between Priest Rapids and Wanapum is lower than the single-project conversion rate. Thus, it is likely that survival between Wanapum and Rocky Reach, and in particular through the Rock Island Project, is at least as high as the lower limit of the 95% confidence interval, 0.9806, with our best point estimate at 0.9837.

Sockeye Salmon: Rocky Reach Project

The two-project conversion rate from Rock Island to Wells Dam included the Rocky Reach Project, excluding fish that ended up at Tumwater Dam, and had estimates from 0.9595 ($\widehat{SE}$ =0.0103) in 2011 to 0.9795 ($\widehat{SE}$ =0.0061) in 2010. The 3-year average estimate of the two-project conversion rate was 0.9714 ($\widehat{SE}$ =0.0043), with a 95% confidence interval of (0.9630, 0.9799) (Table 2). We can conclude that 3-year average survival for sockeye from Rock Island to Wells Dam, and in particular through the Rocky Reach Project, was at least as high as 0.9630. The harvest rate of sockeye salmon in the fishery between Rocky Reach Dam and Wells Dam had minimum estimates of 0.0024 ($\widehat{SE}$ =0.0001) in 2010, and 0.0192 ($\widehat{SE}$ =0.0004) in 2011 (Table 3). Because the harvest rate was based on unknown-source sockeye counts at Rocky Reach Dam (including wild fish), it is likely that the harvest rate was higher than these estimates in both years. No harvest data were available in 2012. When adjusted for harvest in the reach between Rocky Reach and Wells, the 3-year average conversion rate from Rock Island to Wells was estimated at 0.9785 ($\widehat{SE}$ =0.0044). Because the actual harvest rates of hatchery fish were likely higher than the estimated rates, the true survival from the reach between Rock Island and Wells (and through the Rocky Reach Project) was likely higher than 0.9795.

The single-project conversion rate estimates for sockeye from Rock Island to Wells ranged from 0.9795 ($\widehat{SE}$ =0.0052) in 2011 to 0.9897 ($\widehat{SE}$ =0.0031) in 2010, unadjusted for harvest (Table 2). When adjusted for harvest, the 2010 estimate of the single-project conversion rate increased to 0.9909 ($\widehat{SE}$ =0.0031), and the 2011 estimate increased to 0.9891 ($\widehat{SE}$ =0.0053). The 3-year average estimate of the single-project conversion rate was 0.9856 ($\widehat{SE}$ =0.0022, 95% CI = (0.9813, 0.9899)) unadjusted for harvest, and 0.9892 ($\widehat{SE}$ =0.0022, 95% CI = (0.9849, 0.9935)) when adjusted for harvest (Table 2). The harvest-adjusted single-project conversion rate estimate is a reasonable estimate of survival in the Rocky Reach Project, although it includes undetected straying and fallback as well as unreported harvest. We can conclude that the 3-year average of survival of adult sockeye through the Rocky Reach Project was at least as high as 0.9630 (lower limit of the unadjusted 3-year average of the two-project conversion rate), and more likely higher than 0.9849 (lower limit of the adjusted 3-year average of the single-project conversion rate), with our best point estimate at 0.9892 (Table 2).

Steelhead: Rock Island Project

Passage through the Rocky Reach and Wells fish ladders was monitored for all adult steelhead tagged as juveniles in the Methow or Okanogan river basins and detected as adults in 2010 – 2012 in the Priest Rapids fish ladder. Estimates of the three -project conversion rate ranged from 0.9722 ($\widehat{SE}$ =0.0194) in 2010 to 0.9842 ($\widehat{SE}$ =0.0064) in 2012, unadjusted for harvest (Table 4). The 3-year average unadjusted conversion rate was estimated at 0.9794 ($\widehat{SE}$ =0.0072), with a 95% confidence interval of (0.9654, 0.9935) (Table 4). The estimated harvest rate of hatchery steelhead in the reach between Rock Island and Rocky Reach dams was 0.0190 ($\widehat{SE}$ =0.0021) in 2010, and 0.0663 ($\widehat{SE}$ =0.0050) in 2011 (Table 3) (data unavailable for 2012). These harvest rates may be inaccurate because of imperfect harvest reporting rates and uncertainty in run counts (i.e., mismatch between run count dates and fishery dates). Nevertheless, using these estimates of harvest, the harvest-adjusted three-project conversion rate from Priest Rapids to Rocky Reach in 2010 increased to 0.9858 ($\widehat{SE}$ =0.0182), and in 2011 increased to 1.0463 ($\widehat{SE}$ =0.0094), with the 3-year average estimate of harvest-adjusted conversion rate from Priest Rapids to Rocky Reach estimated at 1.0054 ($\widehat{SE}$ =0.0072). The harvest-adjusted estimates > 1.0 in 2011 and for the 3-year average are the result of estimating the harvest rate using aggregated harvest counts and, possibly, run counts that omit any late autumn or winter passage. Despite the uncertainty in the harvest-adjusted conversion rate estimates, we can conservatively conclude that average steelhead survival from 2010 to 2012 from Priest Rapids to Rocky Reach (and through the Rock Island Project) was at least as high as 0.9654, the lower limit of the 95% confidence interval for the unadjusted average estimate.

When measured on the scale of a single project, the annual unadjusted conversion rate point estimates were all > 0.99, with the 3-year average estimated at 0.9931 ($\widehat{SE}$ =0.0024, 95% confidence interval = (0.9883, 0.9979); Table 4). When adjusted for harvest between Rock Island and Rocky Reach, the 3-year average of the single-project conversion rate estimates was 1.0017 ($\widehat{SE}$ =0.0024, 95% confidence interval = (0.9970, 1.0064); Table 4). Again, the average estimate > 1.0 is the result of errors in the harvest rate estimate. Nevertheless, we can safely conclude that it is highly likely that the 3-year average survival through the Rock Island Project from 2010 – 2012 for adult steelhead was at least as high as 0.9883, with our best (unadjusted) point estimate at 0.9931.

Table 2. PIT-tag data and estimates of conversion rate from Priest Rapids to Rocky Reach (Project = Rock Island), and from Rock Island to Wells (Project = Rocky Reach) for adult sockeye (wild and hatchery combined) tagged as adults at the Bonneville Adult Fish Facility. Conversion rates are presented both with and without adjustment for harvest. The single-project conversion rate is estimated as the cubed root of the Priest Rapids – Rocky Reach conversion rate for the Rock Island Project, and as the square root of the Rock Island – Wells conversion rate for the Rocky Reach Project. The average is the 3-year arithmetic average. The 95% confidence intervals are profile likelihood confidence intervals for the year-specific results, and asymptotic confidence intervals for the 3-year average.

				Multi-Project Conversion Rate						**Single-Project Conversion Rate**					
		PIT-tag detections		Unadjusted for harvest			Adjusted for harvest[c]			Unadjusted for harvest			Adjusted for harvest[c]		
Project	Year	Upstream Dam[a]	Downstream Dam(s)[b]	Estimate	SE	95% CI	Estimate	SE	95% CI	Estimate	SE	95% CI	Estimate	SE	95% CI
Rock Island	2010	688	673	0.9782	0.0056	(0.9655, 0.9874)				0.9927	0.0019	(0.9884, 0.9958)			
	2011	535	501	0.9364	0.0105	(0.9134, 0.9551)				0.9784	0.0037	(0.9704, 0.9848)			
	2012	1,281	1,206	0.9415	0.0066	(0.9277, 0.9534)				0.9801	0.0023	(0.9753, 0.9842)			
	Average			0.9520	0.0045	(0.9431, 0.9609)				0.9837	0.0016	(0.9806, 0.9868)			
Rocky Reach	2010	536	525	0.9795	0.0061	(0.9651, 0.9893)	0.9818	0.0061	(0.9674, 0.9916)	0.9897	0.0031	(0.9824, 0.9946)	0.9909	0.0031	(0.9836, 0.9958)
	2011	370	355	0.9595	0.0103	(0.9361, 0.9765)	0.9783	0.0105	(0.9545, 0.9956)	0.9795	0.0052	(0.9675, 0.9882)	0.9891	0.0053	(0.9770, 0.9978)
	2012	974	950	0.9754	0.0050	(0.9644, 0.9839)	0.9754	0.0050	(0.9644, 0.9839)	0.9876	0.0025	(0.9820, 0.9919)	0.9876	0.0025	(0.9820, 0.9919)
	Average			0.9714	0.0043	(0.9630, 0.9799)	0.9785	0.0044	(0.9699, 0.9870)	0.9856	0.0022	(0.9813, 0.9899)	0.9892	0.0022	(0.9849, 0.9935)

[a] = Upstream Dam is Priest Rapids Dam for the Rock Island Project, and Rock Island Dam for the Rocky Reach Project. For the Rocky Reach Project, fish detected at Rock Island Dam and then last detected at Tumwater Dam were excluded from analysis and are not included in the Upstream Dam counts. Tumwater Dam counts were: 104 in 2010, 90 in 2011, and 190 in 2010.

[b] = Downstream Dams are Rocky Reach, Tumwater, and Wells dams for the Rock Island Project, and Wells Dam for the Rocky Reach Project.

[c] =Harvest data were unavailable for 2012 at the time of analysis, so the “adjusted” conversion rates for 2012 are not actually adjusted for harvest.

Table 3. Run counts, harvest counts, and estimated minimum harvest rates for sockeye and steelhead in the Rock Island Dam – Rocky Reach Dam and Rocky Reach Dam – Wells Dam reaches in 2010 and 2011. Run counts come from the DART website, and include both wild and hatchery fish for sockeye, and only hatchery fish for steelhead. Run counts are restricted to sockeye passing the dams between 1 July and 15 October each year, and to steelhead passing on or after 8 September in 2010 or 22 September in 2011. Harvest counts come from WDFW.

						Harvest Rate	
		Run Count		Harvest Count		RI – RR	RR - WE
Species	Year	Rock Island	Rocky Reach	Rock Island – Rocky Reach	Rocky Reach - Wells	Estimate (SE)	Estimate (SE)
Sockeye	2010	318,103	285,671		674		0.0024 (0.0001)
	2011	145,041	131,326		2,526		0.0192 (0.0004)
Steelhead	2010	4,097	4,085	78	103	0.0190 (0.0021)	0.0252 (0.0025)
	2011	2,439	2,731	162	203	0.0664 (0.0050)	0.0743 (0.0050)

Steelhead: Rocky Reach Project

In 2010, 67 steelhead were detected at Rock Island, of which 64 were subsequently detected at Wells Dam, yielding a two-project conversion rate estimate of 0.9552 ($\widehat{SE}$ =0.0253; Table 4). Higher numbers were detected in 2011 and 2012, with two-project conversion rate estimates of 0.9915 ($\widehat{SE}$ =0.0049) and 0.9897 ($\widehat{SE}$ =0.0059), respectively (Table 4). The 3-year arithmetic average conversion rate from Rock Island to Wells was estimated at 0.9788 ($\widehat{SE}$ =0.0088), with a 95% confidence interval of (0.9616, 0.9961) unadjusted for harvest. Steelhead experienced harvest pressure both between Rock Island and Rocky Reach, and between Rocky Reach and Wells dams, with estimated harvest rates between Rocky Reach and Wells of 0.0252 ($\widehat{SE}$ =0.0025) in 2010, and 0.0743 ($\widehat{SE}$ =0.0050) in 2011 (Table 3). These harvest rate estimates may be biased because of imperfect harvest reporting rates and window counts; no harvest data were available for 2012. When adjusted for these estimates of harvest, the two-project conversion rate estimates increased to 0.9861 ($\widehat{SE}$ =0.0261) in 2010, and to 1.1343 ($\widehat{SE}$ =0.0094) in 2011 (Table 4). The estimate of 1.1343 in 2011 is the result of inaccurate harvest rate estimates combined with a high estimate of the 2011 conversion rate unadjusted for harvest (0.9915). The harvest-adjusted 3-year average conversion rate estimate from Rock Island to Wells was 1.0367 ($\widehat{SE}$ =0.0094), but depends on the estimated harvest rates. Regardless of the actual harvest rate, we can conservatively conclude that the 3-year average survival through the Rocky Reach Project was at least as high as 0.9616, the lower limit of the 95% confidence interval of the unadjusted three-project conversion rate.

On the scale of a single project, the unadjusted annual conversion rate estimates ranged from 0.9774 ($\widehat{SE}$ =0.0129) in 2010 to 0.9958 ($\widehat{SE}$ =0.0024) in 2011, with a 3-year average of 0.9893 ($\widehat{SE}$ =0.0045, 95% confidence interval = (0.9805, 0.9981); Table 4). Adjusted for the observed harvest, the single-project conversion rate estimates increased to 0.9931 ($\widehat{SE}$ =0.0131) in 2010 and to 1.0650 ($\widehat{SE}$ =0.0044) in 2011, yielding a harvest-adjusted 3-year average minimum survival estimate of 1.0176 ($\widehat{SE}$ =0.0047; Table 4). Again, despite the possibility of error in the estimated harvest rate, it is safe to conclude that the 3-year average survival of steelhead through the Rocky Reach Project is at least 0.9805, with our best point estimate = 0.9893, based on the unadjusted single-project conversion rate estimates from 2010 to 2012.

Summary

- Conversion rates were estimated on both a multiple-project level and a single-project level, and were adjusted for by harvest data when possible.
- The 3-year arithmetic average of survival of adult spring Chinook salmon through the Rock Island Project from 2010 – 2012 was at least as high as 0.9899, with our best point estimate at 0.9989.
- For adult sockeye salmon, the 3-year average survival through the Rock Island Project was at least as high as 0.9431, with our best point estimate at 0.9837. For the Rocky Reach Project, the 3-year average survival from 2010 – 2012 was at least as high as 0.9630, and likely higher than 0.9849 (point estimate = 0.9892).
- For adult steelhead, the 3-year average survival from 2010 – 2012 through the Rock Island Project was at least as high as 0.9654, with our best point estimate at 0.9931. For the Rocky Reach Project, the 3-year average survival from 2010 – 2012 is conservatively at least as high as 0.9616, and more likely as high as at 0.9805 (point estimate = 0.9893).

Table 4. PIT-tag data and estimates of conversion rate from Priest Rapids to Rocky Reach (Project = Rock Island), and from Rock Island to Wells (Project = Rocky Reach) for adult steelhead (wild and hatchery combined) tagged as juveniles in the Methow and Okanogan river basins. Conversion rates are presented both with and without adjustment for harvest. The single-project conversion rate is estimated as the cubed root of the Priest Rapids – Rocky Reach conversion rate for the Rock Island Project, and as the square root of the Rock Island – Wells conversion rate for the Rocky Reach Project. The average is the 3-year arithmetic average. The 95% confidence intervals are profile likelihood confidence intervals for the year-specific results (unadjusted for harvest), and asymptotic confidence intervals for the 3-year average and annual estimates adjusted for harvest.

		Multi-Project Conversion Rate								Single-Project Conversion Rate					
		PIT-tag detections		Unadjusted for harvest			Adjusted for harvest[c]			Unadjusted for harvest			Adjusted for harvest[c]		
Project	Year	Upstream Dam[a]	Downstream Dam(s)[b]	Estimate	SE	95% CI	Estimate	SE	95% CI	Estimate	SE	95% CI	Estimate	SE	95% CI
Rock Island	2010	72	70	0.9722	0.0194	(0.9167, 0.9953)	0.9858	0.0182	(0.9501, 1.0215)	0.9907	0.0066	(0.9714, 0.9984)	0.9952	0.0061	(0.9832, 1.0072)
	2011	386	379	0.9819	0.0068	(0.9652, 0.9922)	1.0463	0.0094	(1.0278, 1.0648)	0.9939	0.0023	(0.9883, 0.9974)	1.0152	0.0031	(1.0092, 1.0212)
	2012	380	374	0.9842	0.0064	(0.9683, 0.9937)	0.9842	0.0064	(0.9683, 0.9937)	0.9947	0.0022	(0.9893, 0.9979)	0.9947	0.0022	(0.9893, 0.9979)
	Average			0.9794	0.0072	(0.9654, 0.9935)	1.0054	0.0072	(0.9914, 1.0195)	0.9931	0.0024	(0.9883, 0.9979)	1.0017	0.0024	(0.9970, 1.0064)
Rocky Reach	2010	67	64	0.9552	0.0253	(0.8880, 0.9887)	0.9861	0.0261	(0.9350, 1.0373)	0.9774	0.0129	(0.9423, 0.9943)	0.9931	0.0131	(0.9673, 1.0188)
	2011	354	351	0.9915	0.0049	(0.9782, 0.9979)	1.1343	0.0094	(1.1158, 1.1527)	0.9958	0.0024	(0.9890, 0.9989)	1.0650	0.0044	(1.0564, 1.0737)
	2012	292	289	0.9897	0.0059	(0.9736, 0.9974)	0.9897	0.0059	(0.9736, 0.9974)	0.9948	0.0030	(0.9867, 0.9987)	0.9948	0.0030	(0.9867, 0.9987)
	Average			0.9788	0.0088	(0.9616, 0.9961)	1.0367	0.0094	(1.0182, 1.0552)	0.9893	0.0045	(0.9805, 0.9981)	1.0176	0.0047	(1.0084, 1.0269)

[a] = Upstream Dam is Priest Rapids Dam for the Rock Island Project, and Rock Island for the Rocky Reach Project.

[b] = Downstream Dams are Rocky Reach and Wells dams for the Rock Island Project, and Wells Dam for the Rocky Reach Project.

[c] =Harvest data were unavailable for 2012 at the time of analysis, so the “adjusted” conversion rates for 2012 are not actually adjusted for harvest.

2011 Subyearling life-history and migration study results

Life-history hypotheses

- $H1_{alt}$: Ocean-type Chinook in Wells Reservoir represent multiple life-history strategies with variable migration timing including spring and summer subyearling, spring yearling, reservoir rearing, and intermediate migration types.
- $H2_{alt}$: Subyearling Chinook tagged into the Wells Reservoir, of the size observed migrating through Wells Dam, do not actively migrate through the Wells Project.
- $H3_{alt}$: Residence time in Wells Reservoir exceeds the battery life of current acoustic tags.
- $H4_{alt}$: A portion of the study-fish population migrates during periods when downstream PIT-tag detection arrays are not operational.
- $H5_{alt}$: Subyearling Chinook released above and below Wells Dam experience different river conditions, and different survival probabilities when migrating through the control reach (Rocky Reach Reservoir).

Tagging hypotheses

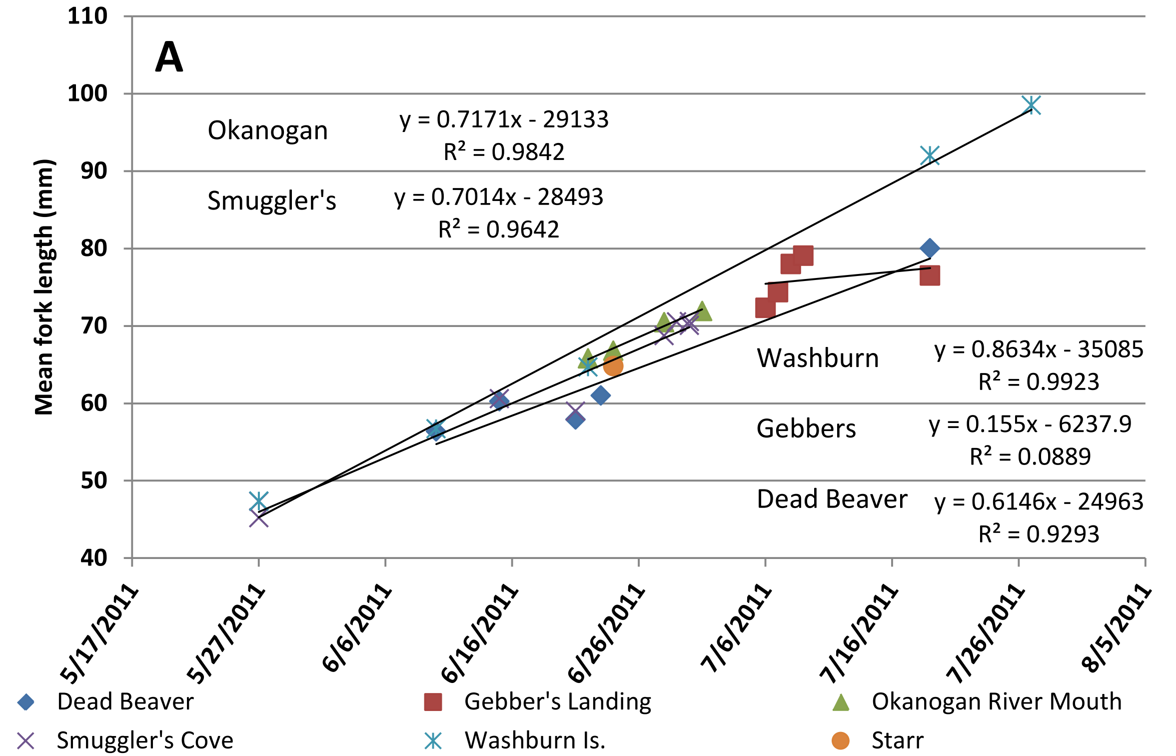
- $H6_{alt}$: The fish available for capture in the Wells Project at time t_1 are not of sufficient size for tagging with 12.5 mm tags.
- $H7_{alt}$: The fish available for capture in the Wells Project are not of sufficient size for tagging with an acoustic transmitter.
- Hypothesis H8 from the 2011 Study Plan would require a lab component to the study, and we did not include a lab component. Following the finalization of the 2011 Study Plan we added the following hypothesis:
- $H9_{alt}$: The process of capture, holding, and tagging incurs a biological cost on subyearling Chinook.

Capture/detection results

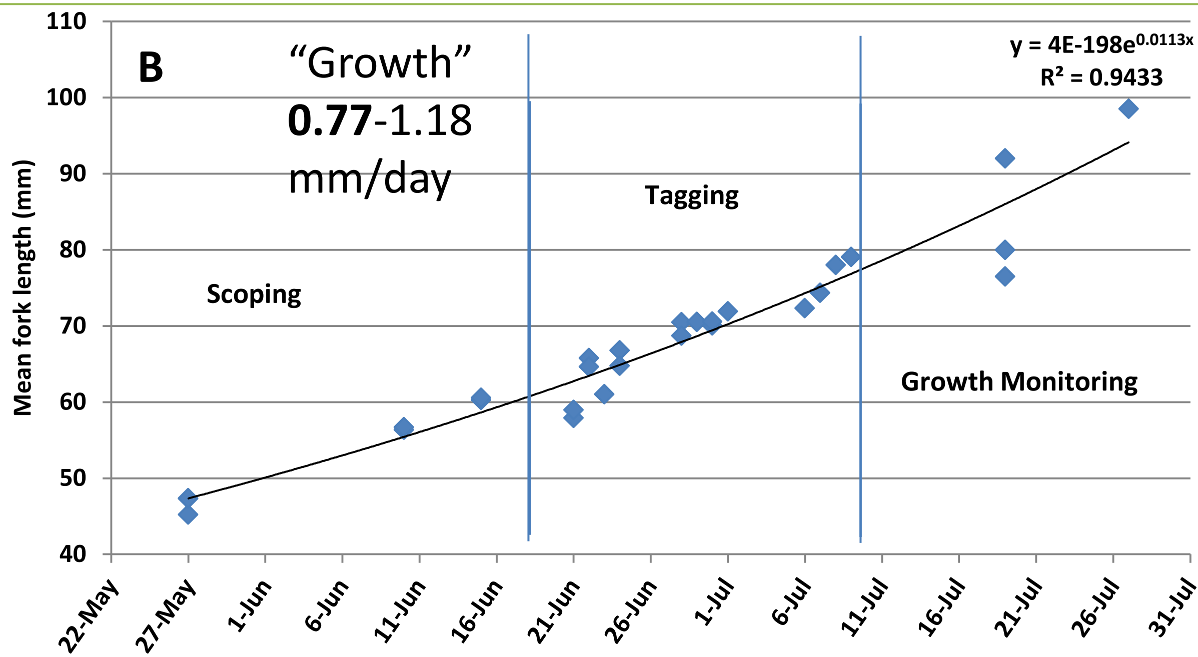
- ~18,500 subs seined→ >13,200 PIT tagged
- Collection was separated into scoping, tagging, and post-tagging/growth monitoring phases
- Fish available in many project locations but a couple ‘honey holes’ located
- >2,300 unique fish detected; 17.5% of tagged fish. Most of which were detected at RRJBS.

Size distribution of captured fish…

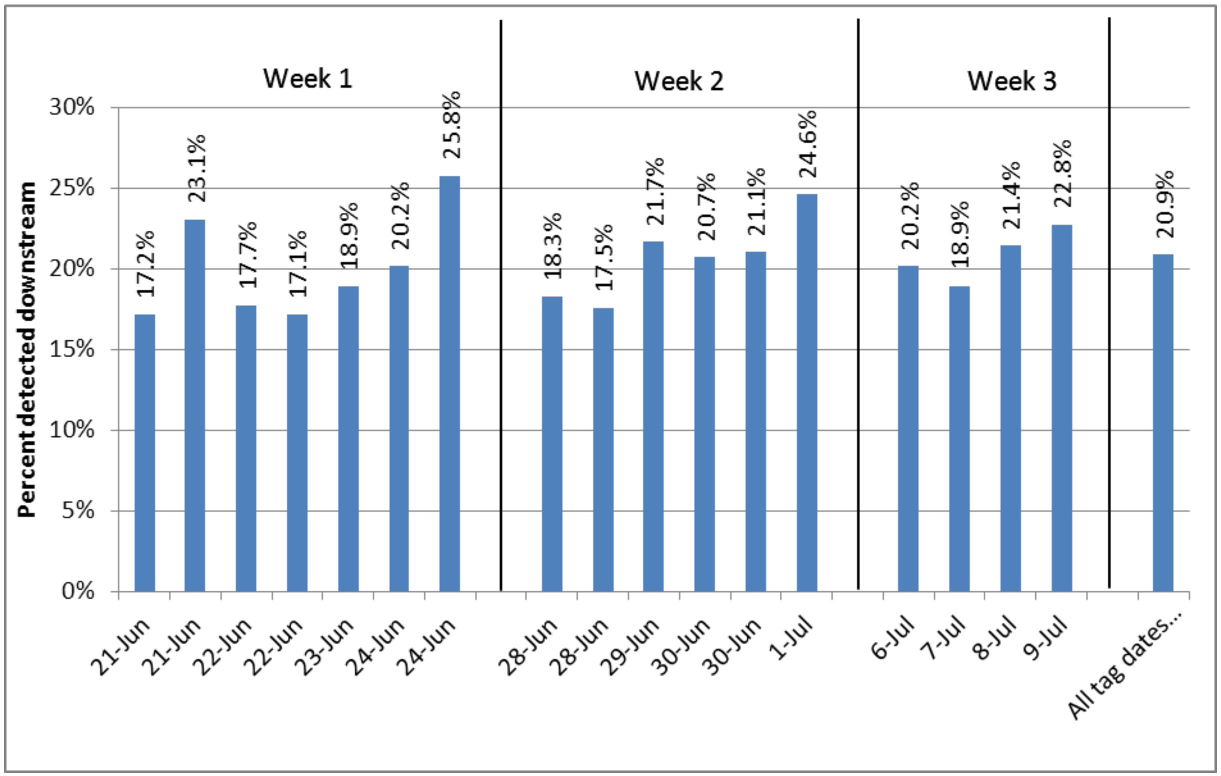
by location



by study phase

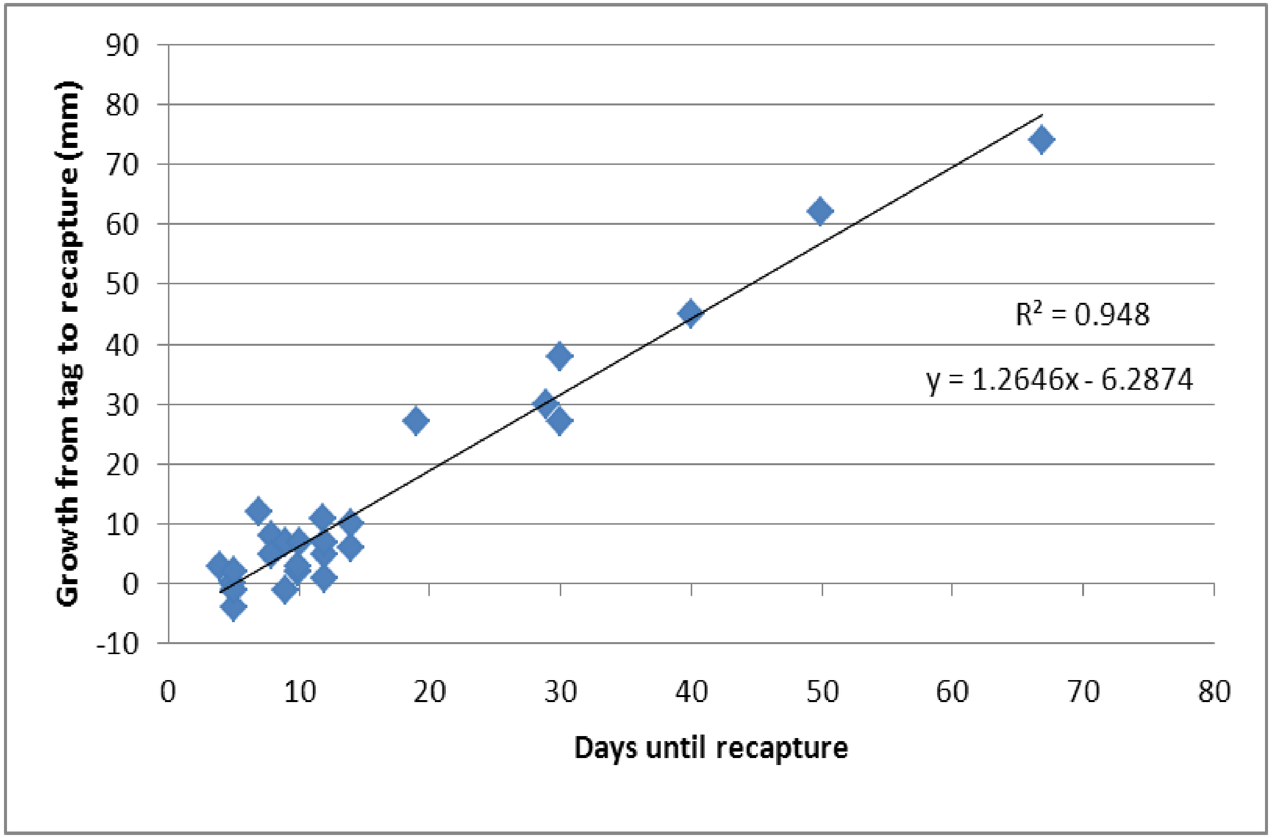


Cumulative detection probability by date (includes all detections- not just unique records)



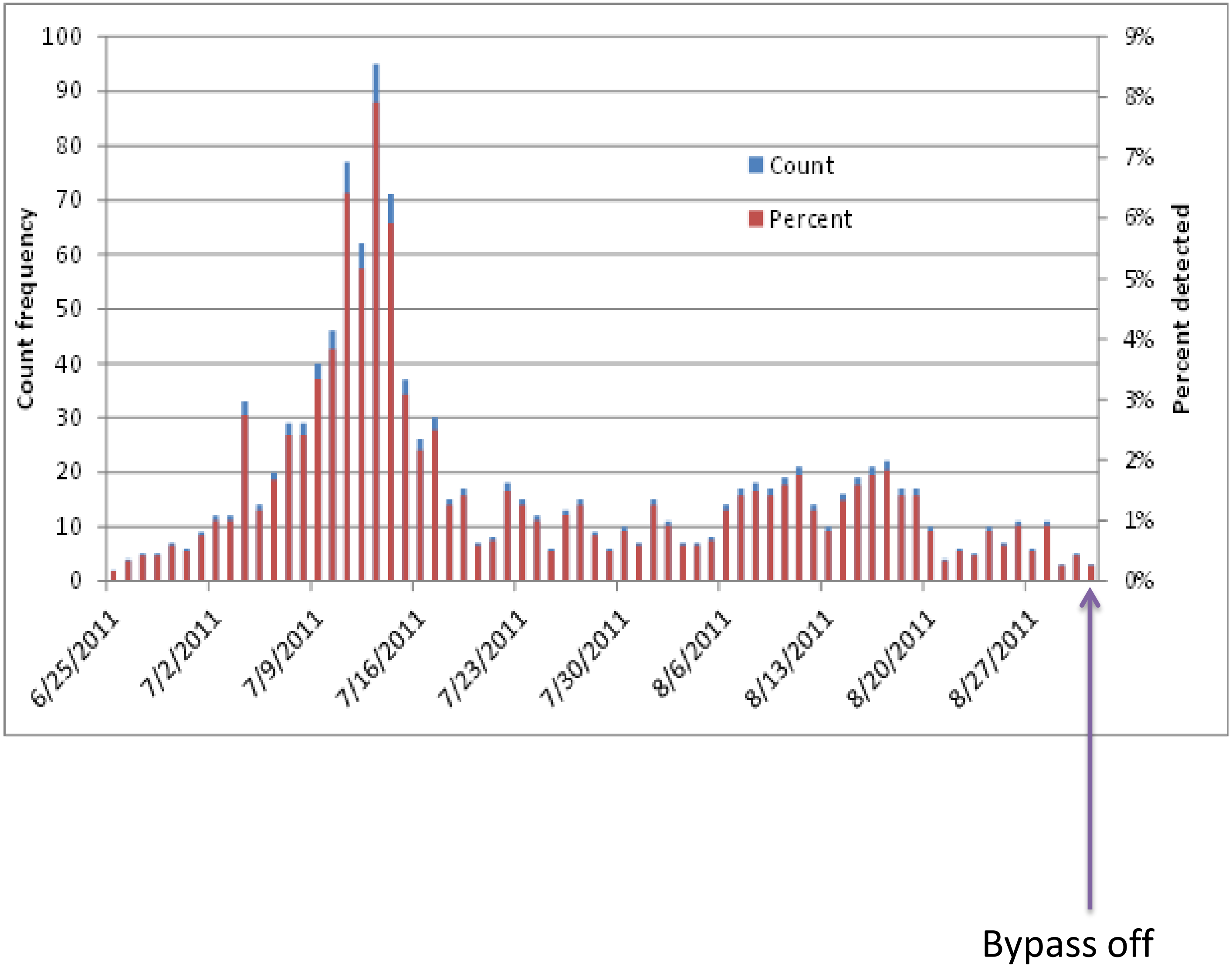
- Duplicate dates are extra tag files on a given day

‘Growth’ of RRJBS recaptures



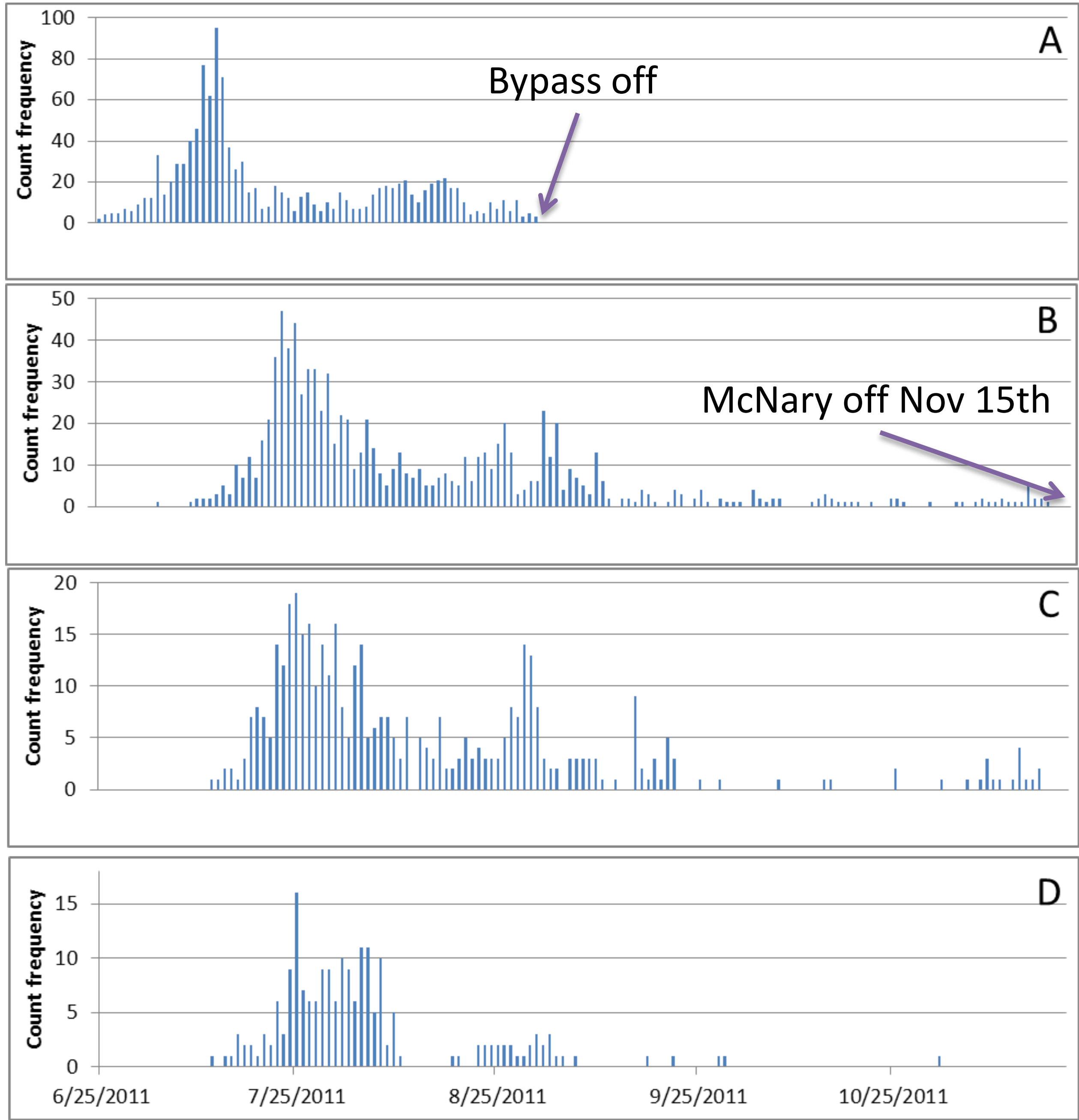
- 1.18 ± 0.08 mm/day.
- Recaps at Rocky Reach N= 26.
- 1,200 PITS detected at Reach; 9% of all tagged fish.

Distribution of detections at Reach



Distribution of detections

- A) Reach
- B) McNary
- C) John Day
- D) Bonneville



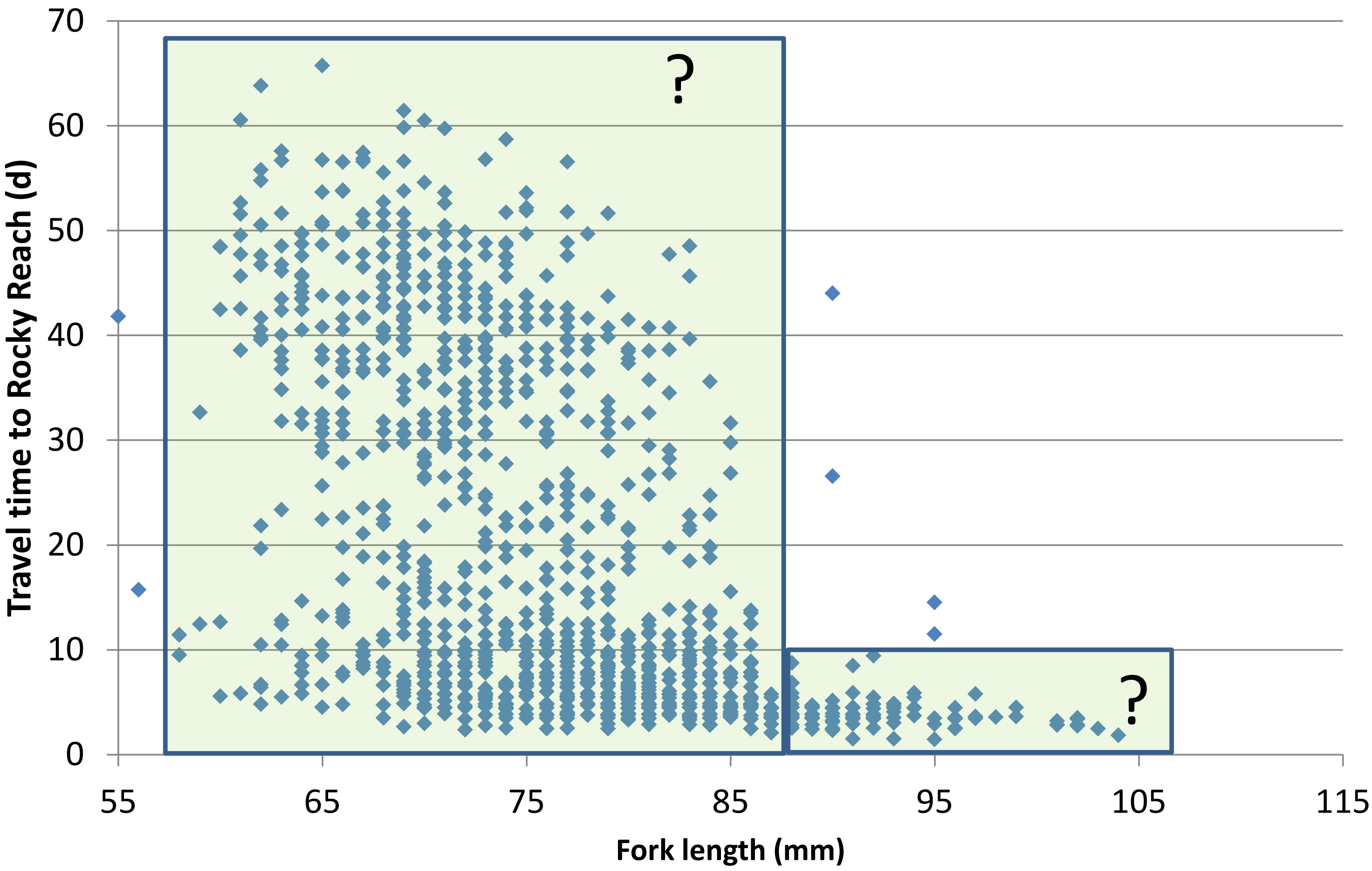
Travel time

	RRH (762)		MCN (470)		JDA (347)		BON (235)	
Location (River KM)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)
Release (856)	19.7 (±0.48; n = 1185)	**4.8**						
RRH (762)			20.1 (±0.98; n = 188)	14.5				
MCN (470)					7.6 (±0.99; n = 99)	16.2		
JDA (347)							2.5 (±0.29; n = 33)	**44.6**

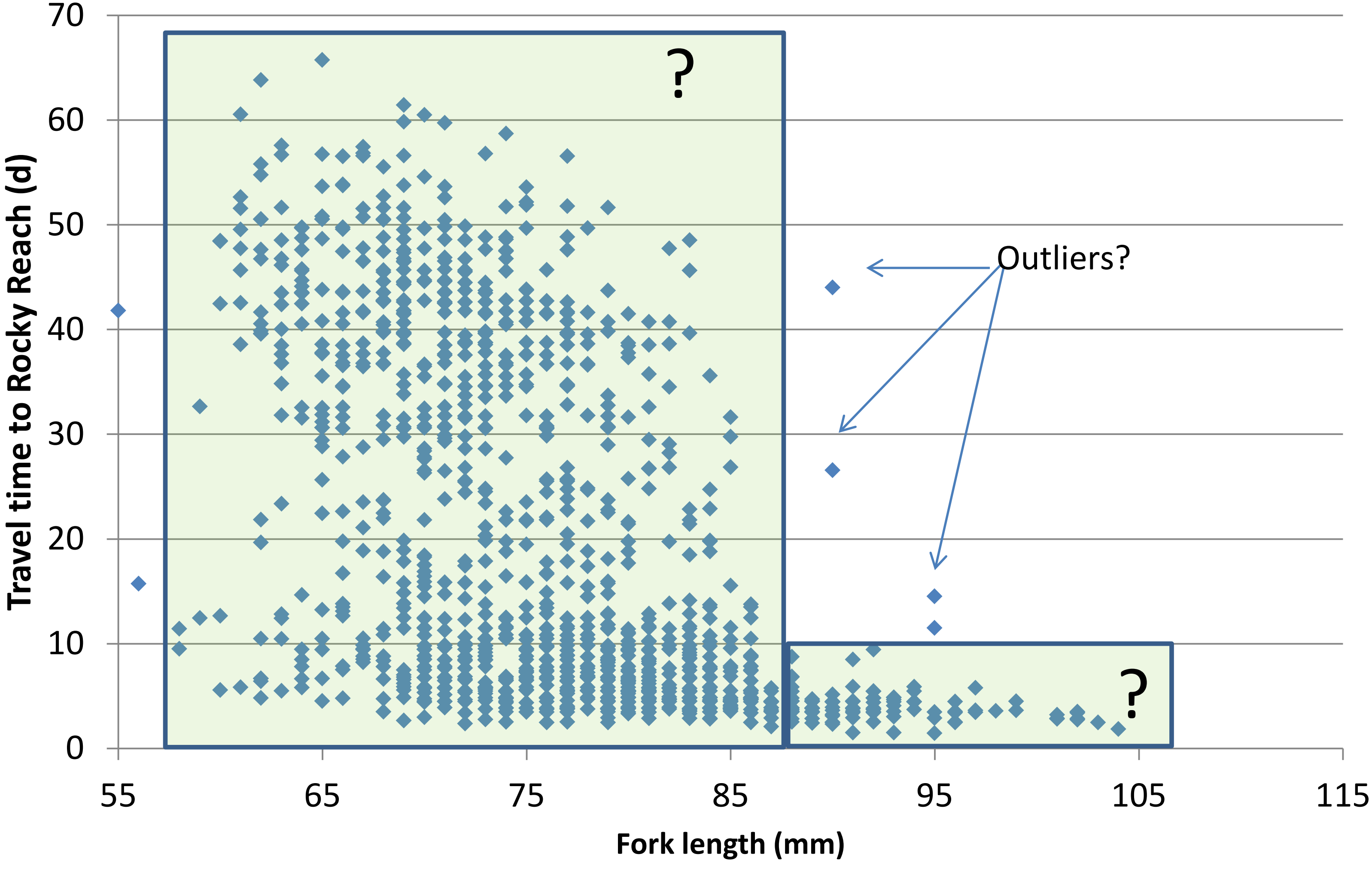
Note. Smolt index recaptures removed.

- Surprise! Fish move faster as they approach the estuary
- 10X faster from John Day to Bonn than from tag to Reach

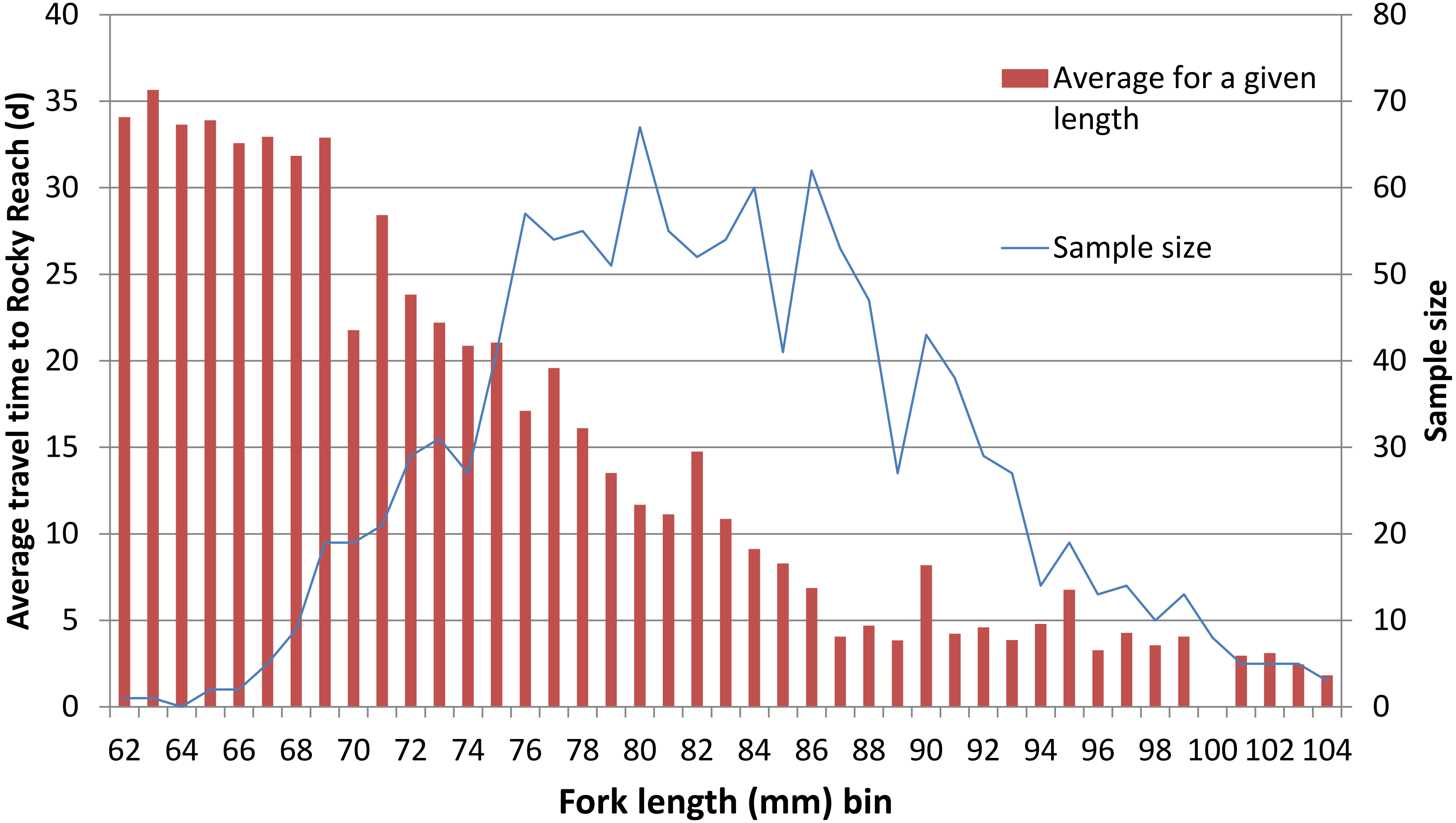
Size threshold for 'migration'?



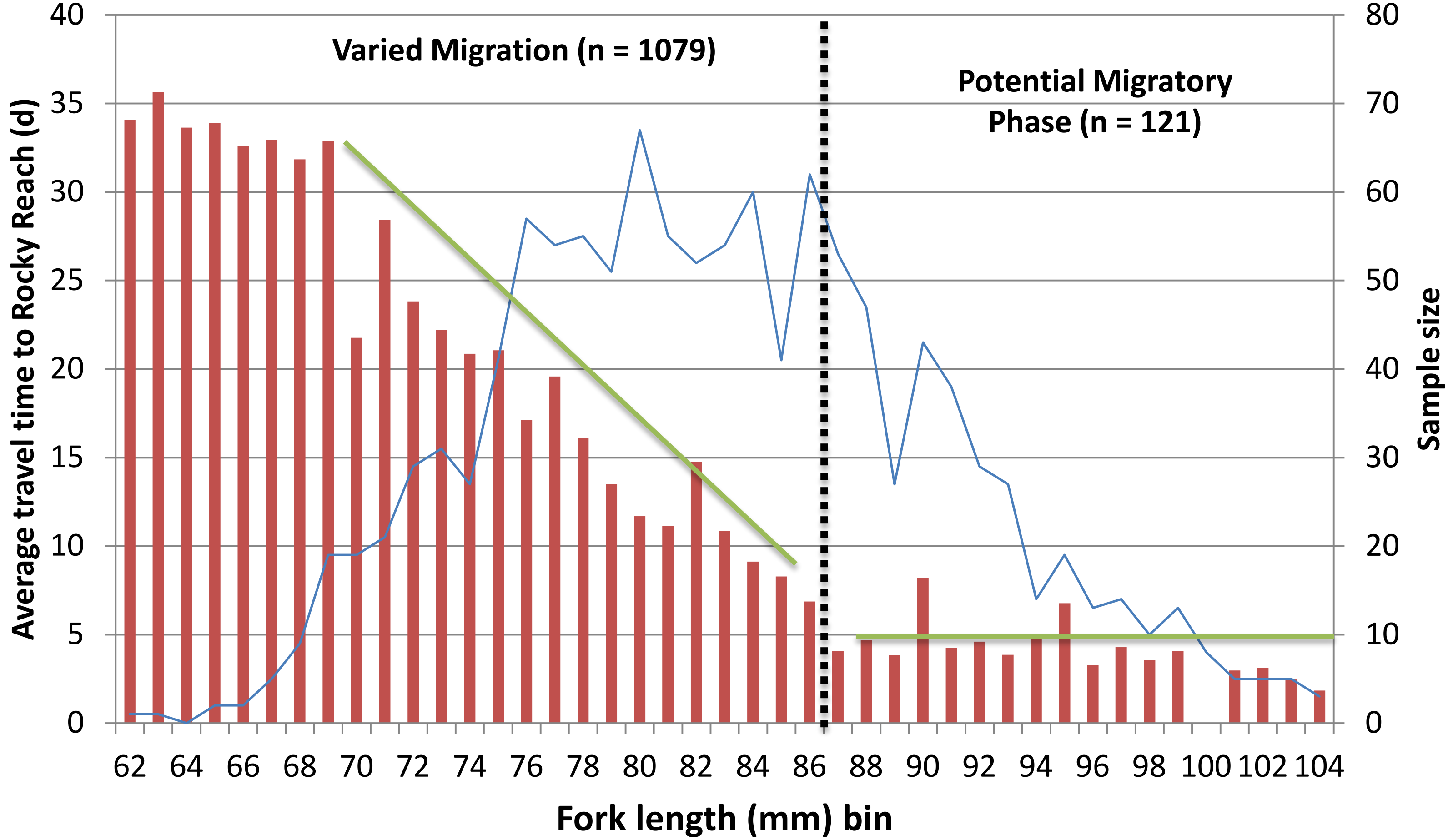
Size threshold for 'migration'?



Size threshold for 'migration'?



Size threshold for 'migration'?



Size threshold for ‘migration’?

>86 mm

5X faster to Rocky Reach

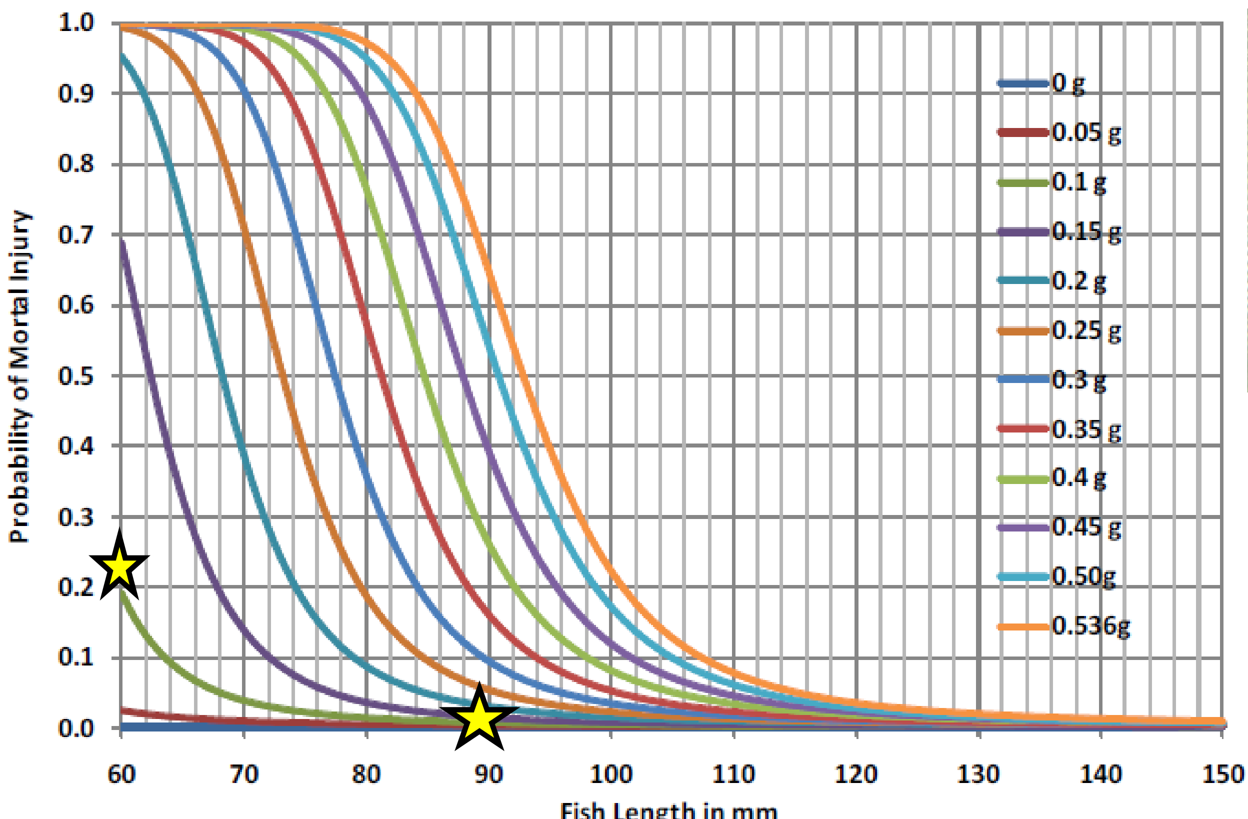
	RRH (762)		MCN (470)		JDA (347)		BON (235)	
Location (River KM)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)
Release (856)	4.7 (±0.41; n = 121)	**20**						
RRH (762)			15.78 (±3.08; n = 17)	18.5				
MCN (470)					3.23 (±0.33; n = 6)	38.1		
JDA (347)							1.92 (±0.17; n = 7)	58.3

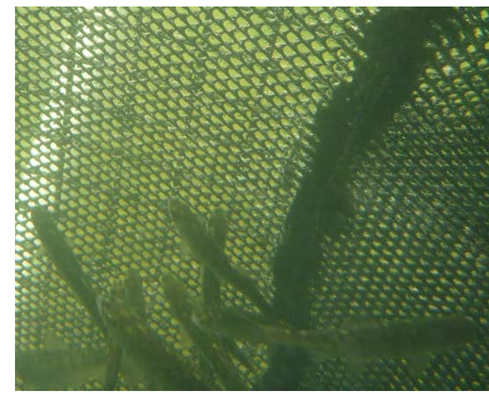
<87 mm

	RRH (762)		MCN (470)		JDA (347)		BON (235)	
Location (River KM)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)
Release (856)	21.17 (±0.5; n = 1080)	**4.4**						
RRH (762)			20.52 (±1.02; n = 173)	14.2				
MCN (470)					7.86 (±1.05; n = 93)	15.6		
JDA (347)							2.67 (±0.37; n = 26)	41.9

Probability of detection for two size classes

Size range (mm)	Number tagged	Number detected	Proportion detected (%)
<87	12192	2448	**20.1**
>86	1028	313	**30.4**



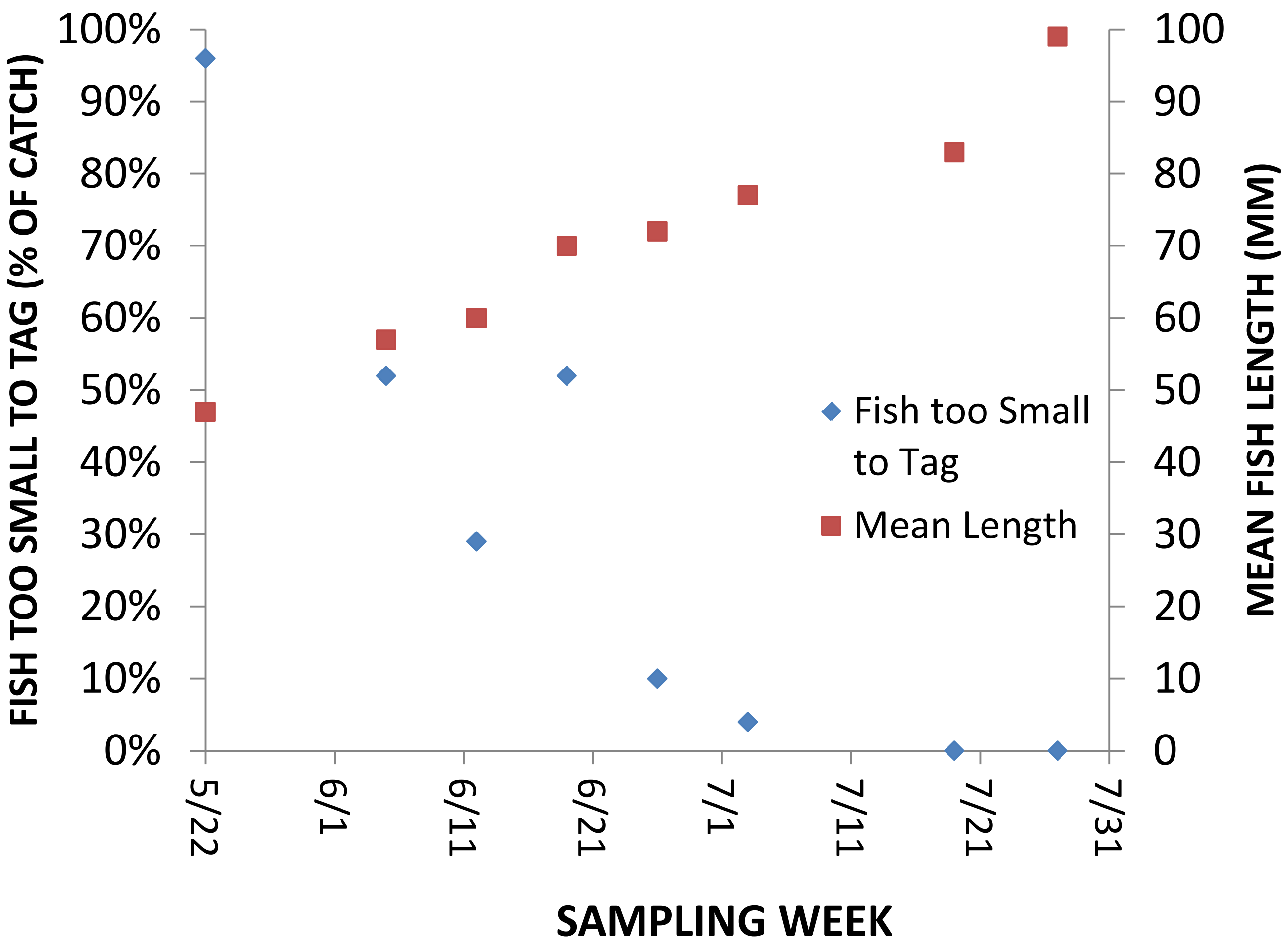


One explanation…**tag burden**: Mortal injury 20% higher on a 60 mm fish vs. a 90 mm fish carrying a 0.1 g PIT tag at the same LRP.

Challenges of tagging/representing the entire 'run'

In May, subyearlings were abundant and easy to catch, but nearly all were too small to tag.

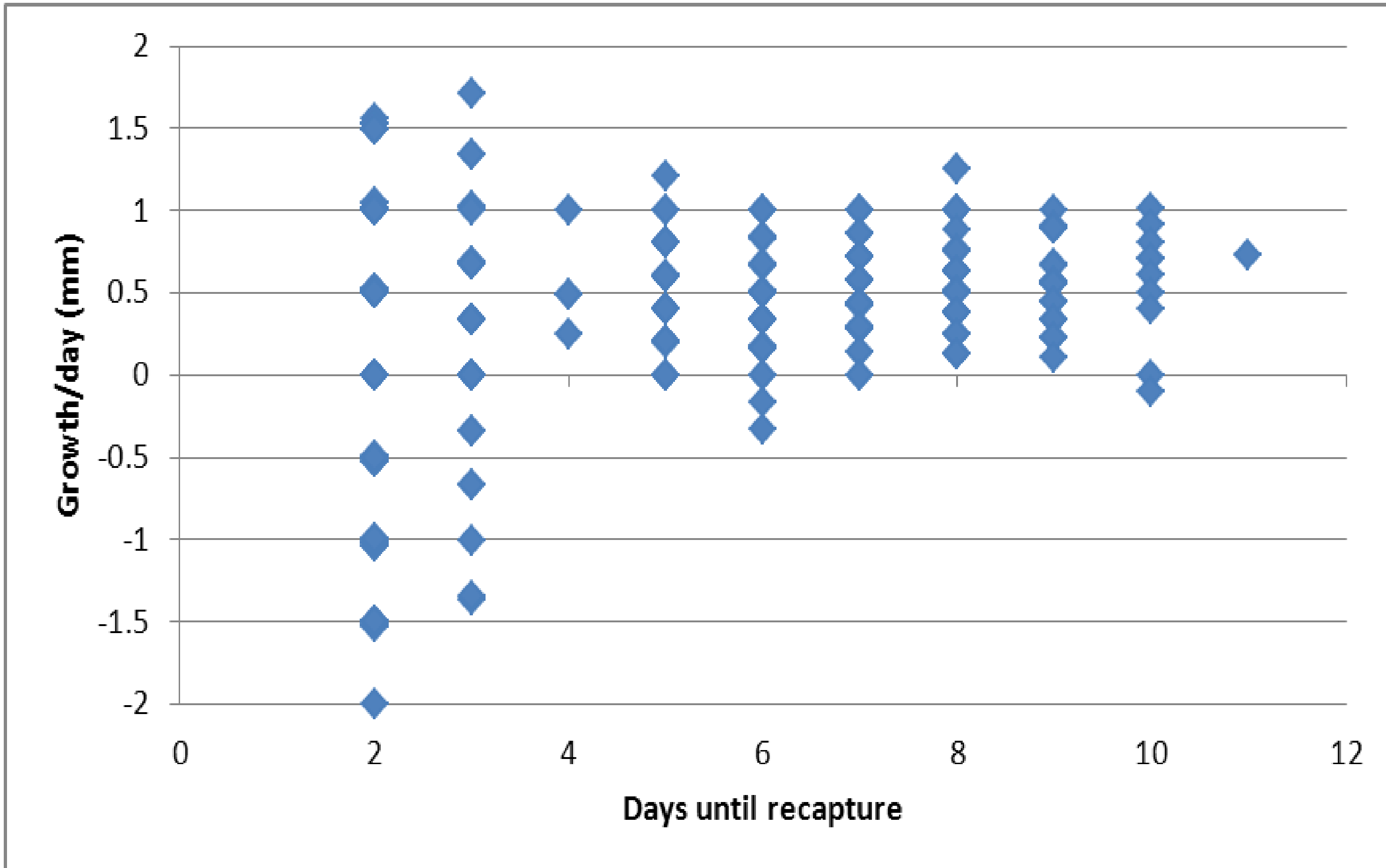
By the end of July, all fish were large enough to tag, but difficult to find.



Cost of capture tagging holding etc.

0.34 mm/d in growth in first 11 days following tag.

0.77-1.18 mm/d growth of run at large

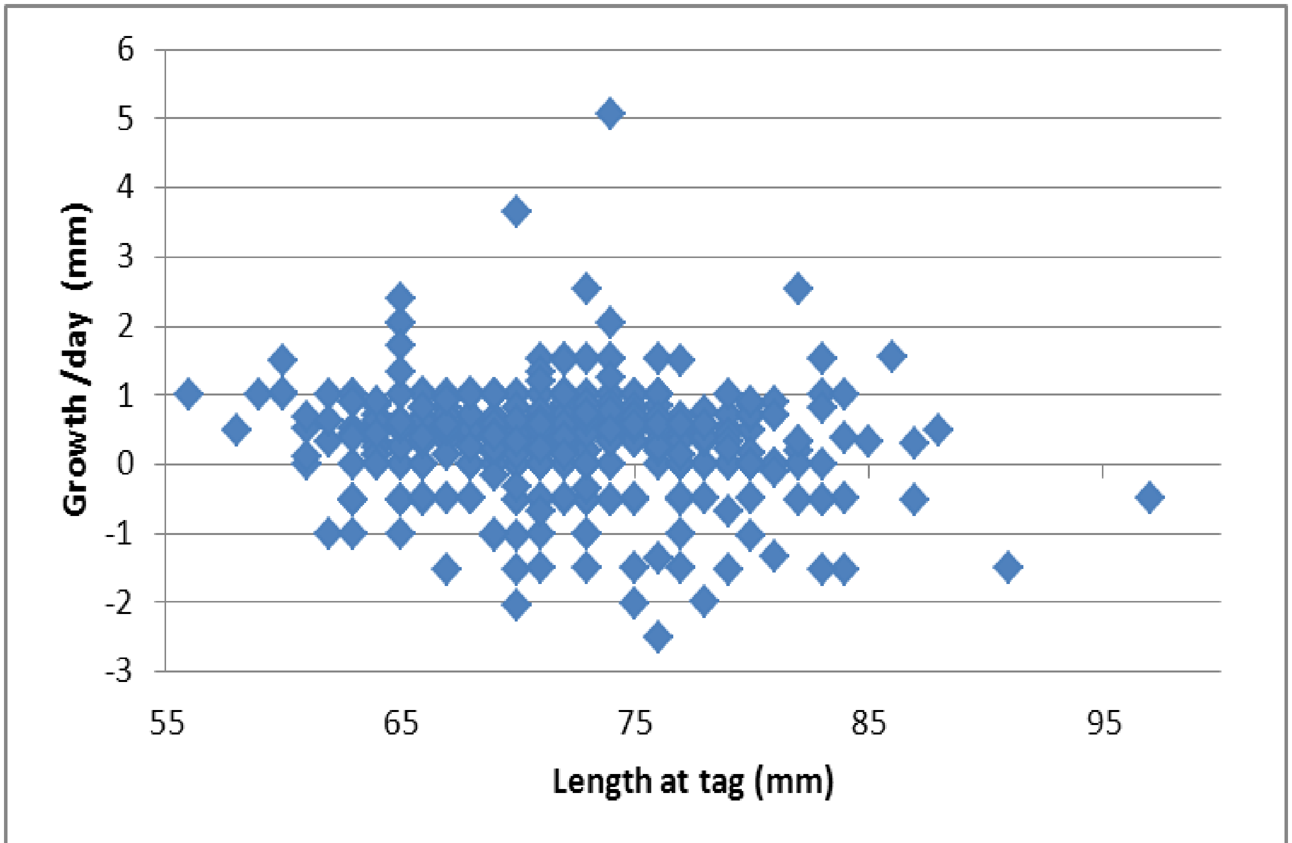


Decrease in growth following tag and release applied equally to all fish sizes

- Therefore, biological cost is associated with tagging procedure/capture/holding not tag burden
- If tag burden smaller fish would have greater cost

0.34 mm/d in growth in first 11 days following tag.

0.77-1.18 mm/d growth of run at large (untagged and tagged fish)



Conclusions

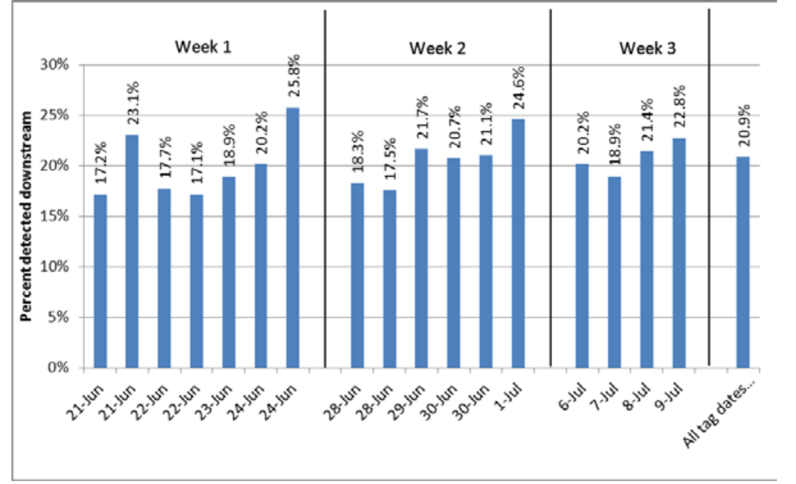
- 1. Fish clearly exhibit a continuum of migration timing: 90+ days.
- 2. The >86 mm fish length was a size threshold in 2011.
- 3. The residence time of fish, at least those less than 87 mm in length, exceeds the battery life of smallest JSATS.
- 4. A portion of the study-fish migrates during periods when all lower river PIT tag detection arrays are not operational.
- 5. Control group violation- variable migration rates trump similar survival rates between controls and treatment.
- 6. By the date when all captured fish were large enough to tag few fish were available for capture by beach seining.
- 7. Nearly all fish available for capture by beach seining are of insufficient size for tagging with the current acoustic transmitter.

From H8 (not tested):

- 9. The process of capturing, holding, and tagging incurs a biological cost.


Questions?
DC PUD

Cumulative detec. Prob.



				JBS								Other		
				Rocky Reach		McNary		John Day		Bonneville		BCC, BO1, MC1, MC2, RIA, RRF, WEA		
Tag Week	Tag Location	Date	Number tagged and released	Detected	Percent Detected	Detected	Percent Detected	Detected	Percent Detected	Detected	Percent Detected	Detected	Percent Detected	Cumulative Percent
1	Dead Beaver	21-Jun	64	8	12.5%	1	1.6%	1	1.6%	0	0.0%	1	1.6%	17.2%
	Smuggler's Cove	21-Jun	65	7	10.8%	3	4.6%	3	4.6%	1	1.5%	1	1.5%	23.1%
	Okanogan	22-Jun	418	33	7.9%	21	5.0%	10	2.4%	1	0.2%	9	2.2%	17.7%
	Washburn	22-Jun	280	19	6.8%	16	5.7%	9	3.2%	1	0.4%	3	1.1%	17.1%
	Dead Beaver	23-Jun	328	26	7.9%	20	6.1%	12	3.7%	0	0.0%	4	1.2%	18.9%
	Okanogan	24-Jun	595	52	8.7%	36	6.1%	22	3.7%	2	0.3%	8	1.3%	20.2%
	Starr	24-Jun	128	17	13.3%	10	7.8%	3	2.3%	2	1.6%	1	0.8%	25.8%
2	Okanogan	28-Jun	235	15	6.4%	14	6.0%	11	4.7%	1	0.4%	2	0.9%	18.3%
	Smuggler's Cove	28-Jun	821	65	7.9%	47	5.7%	21	2.6%	5	0.6%	6	0.7%	17.5%
	Smuggler's Cove	29-Jun	1446	145	10.0%	94	6.5%	54	3.7%	9	0.6%	12	0.8%	21.7%
	Smuggler's Cove	30-Jun	270	21	7.8%	22	8.1%	9	3.3%	1	0.4%	3	1.1%	20.7%
	Smuggler's Cove	30-Jun	1196	112	9.4%	76	6.4%	44	3.7%	9	0.8%	11	0.9%	21.1%
	Okanogan	1-Jul	1163	117	10.1%	102	8.8%	43	3.7%	9	0.8%	15	1.3%	24.6%
3	Gebber's	6-Jul	1463	135	9.2%	100	6.8%	47	3.2%	5	0.3%	8	0.5%	20.2%
	Gebber's	7-Jul	1378	120	8.7%	80	5.8%	37	2.7%	6	0.4%	18	1.3%	18.9%
	Gebber's	8-Jul	1558	144	9.2%	114	7.3%	49	3.1%	12	0.8%	15	1.0%	21.4%
	Gebber's	9-Jul	1815	164	9.0%	164	9.0%	60	3.3%	7	0.4%	18	1.0%	22.8%
Total	All locations	All tag dates dates	13223	1200	9.1%	920	7.0%	435	3.3%	71	0.5%	135	1.0%	20.9%

APPENDIX B - HABITAT CONSERVATION PLAN HATCHERY COMMITTEES 2012 MEETING MINUTES AND CONFERENCE CALL MINUTES

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	February 15, 2012
From:	Mike Schiewe, Chair		
Cc:	Carmen Andonaegui		
Re:	Final Minutes of the January 19, 2012, HCP Hatchery Committees' Conference Call		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees' meeting was held by conference call on Thursday, January 19, 2012, from 9:30 am to 1:00 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Bill Gale will contact Pat Connolly, U.S. Geological Survey (USGS), to request his attendance at the March 21, 2012, Hatchery Committees' meeting to discuss potential collaboration and coordination of Passive Integrated Transponder (PIT)-tagging efforts in the Methow Basin (Item I).
- Josh Murauskas will send Chelan PUD's proposal to adjust spring Chinook hatchery-raised size-at-transfer and size-of-release criteria to Carmen Andonaegui for distribution to the Hatchery Committees; Chelan PUD will ask the Committees to approve the proposal at the February 15, 2012, meeting (Item II-A).
- Josh Murauskas will arrange for Don Larsen and Brian Beckman, National Marine Fisheries Service (NMFS), to participate by phone in the February 15, 2012, Hatchery Committees' meeting to discuss the Chelan PUD proposal to change the Chiwawa spring Chinook size-at-transfer and size-at-release targets (Item II-A).
- Josh Murauskas will provide information to the Hatchery Committees on the ratio of male-to-female returning Chiwawa spring Chinook by age-at-return for the small versus large juvenile size-at-releases (Item II-A).
- Josh Murauskas will email the draft Chelan PUD 5-Year Hatchery Monitoring and Evaluation (M&E) report to Carmen Andonaegui by February 3, 2012, for posting on the ftp site and notification to the Hatchery Committees that the draft report is

available for a 60-day review period (Item II-C).

- Josh Murauskas will finalize the Chelan PUD Spring Chinook Compensation Statement of Agreement (SOA) approved at today's meeting and email it to Carmen Andonaegui for distribution to the Hatchery Committees (Item II-D).
- Greg Mackey will revise the Draft 2012 Wells HCP Action Plan as discussed at today's meeting and email it to Carmen Andonaegui for distribution to the Hatchery Committees for review and approval at the February 15, 2012, Hatchery Committees' meeting (Item III-A).
- Tom Kahler and Joe Miller will coordinate with Kim Hyatt (British Columbia Fisheries and Oceans, Canada) and Howie Wright, Okanagan Nation Alliance (ONA), on a presentation on the Fish Water Management Tool and the Skaha Lake Sockeye Reintroduction Program at the April 18, 2012, Hatchery Committees' meeting (Item III-A).
- Craig Busack will confirm the expected duration of new Endangered Species Act (ESA) hatchery permits (Item IV-B).
- Mike Tonseth will contact Ken Warheit about providing a presentation to the Hatchery Committees on his analysis of the 2010 and 2011 Wenatchee Spring Chinook Parental Based Tagging (PBT) pilot study results at the February 15, 2012, meeting (Item IV-C).
- When cleared for distribution, Mike Tonseth will email a copy of Ken Warheit's genetic analyses of the 2010 and 2011 Wenatchee spring Chinook PBT pilot study to Carmen Andonaegui for distribution to the Hatchery Committees (Item IV-C).
- At the February 15, 2012, meeting, Carmen Andonaegui will provide to the Hatchery Committees a summary of the conclusion of the Hatchery Evaluation Technical Team (HETT) reference stream evaluation and a HETT proposal for next steps (Item V).

DECISION SUMMARY

- The Hatchery Committees approved the Chelan PUD Spring Chinook Compensation SOA – Release Year 2014, as revised (Item III-D).

REVIEW ITEMS

- The Draft 2012 Wells HCP Action Plan is out for a 30-day review for approval at the

February 15, 2012, Hatchery Committees' meeting (Item III-A).

REPORTS FINALIZED

- No reports have been finalized by the Hatchery Committees since the December 14, 2011, meeting.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. Greg Mackey requested time for a discussion of the draft Wells 2012 HCP Action Plan.

Bill Gale said that he would like to postpone, until the February 15, 2012 Committees' meeting, the discussion of items to bring to Pat Connolly's (USGS) attention regarding coordination of salmonid data collection activities in the Methow Basin. Gale will contact Connolly to request his attendance at the March 21, 2012, Committees' meeting for the discussion.

The draft November 30, 2011, conference call minutes and the draft December 14, 2011, meeting minutes were reviewed and approved as revised. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Committees.

II. Chelan PUD

A. Spring Chinook Size-at-Release Target Proposal (Josh Murauskas)

Josh Murauskas introduced a preliminary analysis of the effects of spring Chinook size-at-release on performance of hatchery fish at the December 14, 2011, Hatchery Committees' meeting. On January 18, 2012, he distributed a more complete report, including a recommendation to decrease the size-at-release targets for Chiwawa spring Chinook (Attachment B). Murauskas said that analysis of PIT-tag data showed that there was no performance benefit associated with larger smolts, and that smaller smolts produce fewer jacks and minijacks and a greater proportion of 3-year salt returns. He said that during the past 5 years, Chiwawa spring Chinook releases averaged about 15 fish per pound (fpp), even though the target release size was 12 fpp. Murauskas suggested that if release size targets were decreased even further (i.e., smaller size at release, more fish per pound), the benefits should be fewer jacks and minijacks. Mike Tonseth noted that jacks and minijacks tend to stray at a higher rate than do older returning adults. Further, Tonseth said that the length-to-weight relationship used currently in the hatchery program is not consistent with achieving the desired condition factor. He said that 94 millimeters (mm) is about the average size of wild fish caught in smolt traps. Even with wild fish survival to McNary Dam 5 to 15 percent lower than hatchery fish survival to McNary, adult returns for wild fish are higher than for hatchery fish. Murauskas said that adjusting size-at-release target sizes is an opportunity to capitalize on findings from 5-Year M&E analysis. Bill Gale said that 18 fpp is the size-at-release target for the Leavenworth National Fish Hatchery (NFH) and that there is literature showing that going to smaller release sizes yields higher adult returns. Tonseth said he and John Penny, Washington Department of Fish and Wildlife (WDFW), are supportive of an evaluation to determine a more appropriate, program-specific size-at-release target, and that smaller release sizes could be achieved in the hatchery.

Murauskas said that Chelan PUD was not requesting action by the Committees approving a change in release size today, but was looking for Committees' members questions and suggestions for a path forward. Craig Busack asked for the origin of the current size-at-release targets. Murauskas said that during relicensing settlement agreement discussions during the 1980s and 1990s, release targets were discussed in terms of fish per pound and it was thought that bigger release sizes equated to higher survival. Busack agreed that the Chelan PUD size-at-release targets were large and said that he supported going to smaller size-at-release. Kirk Truscott asked if the sizes presented in the figures were size-at-tagging or size-at-release. Murauskas said they are size-at-release. The Committees discussed the effects of rearing hatchery fish for release at sizes more commensurate with wild smolt sizes, specifically the effect on decreasing minijacks returns and increasing age-at-return. Murauskas said survival of hatchery spring Chinook, from release to McNary Dam, is 20 percent higher than that of natural origin smolts but that hatchery fish return as minijacks at a higher rate while natural origin juveniles return as older salt fish. Overall, he said there is an increase in adult returns of wild over hatchery juveniles if you subtract minijack returns.

Keely Murdoch asked about correlation of length to minijack rate and a correlation of length to survival. Murauskas said the relationship between wild and hatchery fish length and age-at-return is significant (Figure 1 in the Spring Chinook Size Target Proposal). He also said that the hatchery fish were tagged in August and September and the wild fish were tagged as smolts. The Committees discussed the effect of hatchery feeding regimes on fish growth (Attachment C) and the constraints imposed by facility limitations (i.e., availability of space and chillers) and hatchery management considerations (i.e., fish disease issues, size-at-transfer targets).

Tonseth requested that Chelan PUD provide a study proposal to the Committees containing a size-at-transfer target and recommendations on how to manipulate fish growth curves to meet that target. He said that the proposal should consider facility limitations and fish physiological limitations. Busack said that when targeting fish sizes, maintaining variability needs to be considered. Tonseth said that the current brood of spring Chinook will be ponded soon, so there is limited time to reach a decision on size-at-release targets. He asked that the proposal provide size-at-release targets for the 2011 and 2012 broodyear, which may be different due to the narrowing down of what can be done with the 2011 broodyear to manipulate early growth. Murauskas will discuss the implications of decreasing size-at-release targets and setting size-at-transfer targets with Don Larsen and Brian Beckman of NMFS and with hatchery management staff. He said that he would most likely recommend a size-at-release target of 18 fpp, which is not a big change from the past 5 years which averaged a 15 fpp release size. Murauskas will send Chelan PUD's proposal to adjust spring Chinook hatchery-raised size-at-transfer and size-of-release criteria to Carmen Andonaegui for distribution to the Committees; Chelan PUD will ask the Committees to approve the proposal at the February 15, 2012, meeting. Murauskas will invite Larsen and Beckman to participate by phone during the February 15, 2012, Committees' meeting to participate in the discussion.

Truscott asked about the expected effect of a smaller release size on female adult returns. He suggested that if larger overall adult returns were achieved but there was a lower proportion of females in those returns, that might be a net loss for productivity. Murauskas will provide information to the Committees on the ratio of male-to-female returning Chiwawa spring Chinook by age-at-return, for the small versus large juvenile size-at-releases.

B. Feasibility of Overwintering Summer Chinook at Dryden and Carlton (Alene Underwood)

Alene Underwood said that Chelan PUD plans to conduct its feasibility evaluations of the overwintering programs separate from and parallel to those being conducted by Grant PUD. Chelan PUD is evaluating whether to convert either the Dryden or Carlton facility to a permanent overwintering facility. She said that most of the discussions were related to the Dryden facility, and that the feasibility investigation has three components—technical, regulatory, and contractual, summarized below:

- Technical Component: This component of the feasibility investigation considers the physical and biological attributes of the sites. The main technical concern with the Dryden site is related to chronic fish health problems and the concern that longer acclimation at the site could result in higher mortality. There are no technical concerns currently identified for the use of the Carlton site.
- Regulatory Component: Beyond normal permit needs for modifying a facility to accommodate overwintering, a concern with the Dryden site is the ability to meet the phosphorus compliance requirements for the Wenatchee Total Maximum Daily Load (TMDL), which will become effective in 2018. Underwood said that Chelan PUD will start with getting a baseline condition for phosphorus discharges from Dryden Pond when fish are on station. Chelan PUD is also waiting for the U.S. Environmental Protection Agency (EPA) to decide whether they will allow the TMDL to be amended to allow for phosphorus input from the Dryden facility; they believe this decision is imminent, but the process is advancing slowly. Underwood said it could take as long as a year to get resolution on the issue of amending the TMDL. Another concern is obtaining ESA take coverage under Section 10, which will be necessary to accommodate overwintering at Dryden. Chelan PUD will want assurance that ESA take coverage will be available under a new permit or that the current Section 10 permit will be extended. Also, a water rights acquisition will be needed to provide overwintering at Dryden. There are no regulatory concerns, only standard permitting needs, related to providing overwintering at the Carlton site.
- Contracting Component: Underwood said that Chelan PUD will continue to work with Grant PUD on a long-term hatchery sharing agreement, which will need to be executed before any facility modifications are started.

Underwood said that she will provide an update to the Hatchery Committees at the February 15, 2012, meeting.

C. Completed Draft M&E 5-Year Report (Josh Murauskas)

Josh Murauskas said that the draft 5-Year Hatchery M&E Report is almost complete and that he will email a copy to Carmen Andonaegui by February 3, 2012, for distribution to the Hatchery Committees. Mike Schiewe said that the draft report will be available for the standard 60-day review period, during which time the Committees can hold discussion on the content of the report. Murauskas said that Chelan PUD is interested in the Committees' ideas on how the M&E Program could be improved to support achieving program goals.

D. Chelan PUD Spring Chinook Compensation 2014 Release Year SOA (Josh Murauskas)

Josh Murauskas said that the spring Chinook compensation SOA was in response to a Joint Fisheries Party (JFP) request to increase Chiwawa spring Chinook production starting with the 2014 release year, moving Methow Basin production to the Chiwawa Facility.

Kirk Truscott asked if Grant PUD would be backfilling the 60,000 Chelan PUD Methow production in 2014. Todd Pearsons said that the Priest Rapid Coordinating Committee (PRCC) Hatchery Subcommittee (HSC) voted to approve Grant PUD's transfer of production of 60,000 spring Chinook to the Methow Basin and that this approval will go to the PRCC, where an SOA will be up for approval. If approved by the PRCC, Grant PUD will make a request to Douglas PUD to produce the fish necessary to meet the Methow production obligation. Truscott asked that this background information be added to Chelan PUD's SOA. Murauskas said that he will add language to the SOA stating that the Committees' approval of the SOA is contingent on Chelan PUD's Methow 60,000 spring Chinook production being backfilled by Grant PUD. Murauskas emailed a revised SOA to Carmen Andonaegui for distribution to the Committees. The Committees reviewed the revisions and approved the SOA as revised. Murauskas will finalize the SOA and email it to Andonaegui for distribution to the Committees.

III. Douglas PUD

A. Draft 2012 Wells Action Plan (Greg Mackey)

Greg Mackey said that the draft Wells HCP Action Plan (Action Plan) had been sent to members of the HCP Coordinating, Hatchery, and Tributary committees for review. He said that the Action Plan had general due dates for major HCP actions and deliverables for 2012. The second page of the Action Plan contains the 2012 actions that pertain to the Hatchery Committees. Mackey said that all actions captured in the Action Plan were routine except for Item 3, Hatchery Program Review. He said that the 2012 Action Plan included the required HCP 10-Year Hatchery Program review, but that analyses and reports already completed, such as the 5-Year M&E Report, Annual M&E reports, and the analyses performed for hatchery recalculation are essentially redundant with a 10 Year Review, and such a review should be based upon such documents. He said that Douglas PUD would welcome input from the Committees about how all these data and analyses could be used, but that Douglas PUD needs to meet the timeline presented in the Action Plan. Tom Kahler said that the Coordinating Committees do an overall 10-year review of progress towards meeting No Net Impact (NNI) and he described how the Hatchery Committees' report would be a component of the overall report on meeting NNI. Joe Miller said that Chelan PUD had the same requirement in their HCP and that they were working on their draft 2012 HCP Action Plan. Kahler said that he would ask for approval of the Wells 2012 HCP Action Plan at the February 15, 2012, Committees' meeting.

Kahler asked if the Committees would like a presentation on the application of the Okanagan Fish-Water Management Tool and the Skaha Lake Sockeye Reintroduction Program (the HC is typically provided with annual presentations on these programs in August or September, but the 2011 presentations were postponed for various reasons). He said that Kim Hyatt offered to come speak to the Committees at the April 18, 2012, meeting regarding the Okanagan Fish-Water Management Tool. The Committees agreed to a presentation by Hyatt; Kahler will coordinate with him. In addition, Chelan PUD will talk with Howie Wright, ONA, about participating in the same meeting to review ONA progress on the Skaha Lake Sockeye Reintroduction Program.

Kirk Truscott asked about the status of planned modifications to the Wells Hatchery. Mackey said that design planning will start in 2012. He said that it will be a couple years before any construction is started. Truscott asked about including planning, design, and construction related to the Well Hatchery modifications in the Action Plan, given that it has ties to implementation of the HCP hatchery programs. Mike Schiewe said he thought including it would be a good idea. Mackey said that Douglas PUD would evaluate the Wells Hatchery modification project as it relates to the HCP and then add to the appropriate Action Plan items and timelines. Mackey said that in February 2012, Douglas PUD will contact HCP Party signatories independently to ask about their interests related to modernization of the hatchery.

B. Announcements (Greg Mackey)

Greg Mackey said that Douglas PUD is advertising for a senior aquatic scientist and asked Hatchery Committees' members to please pass the advertisement to anyone who might be interested.

IV. NMFS

A. HGMP Update (Craig Busack)

Craig Busack said that NMFS had been discussing ways to speed up review of Upper Columbia hatchery programs; and he said that he would like to schedule regular conference calls with Douglas PUD and the USFWS to talk about their spring Chinook and steelhead hatchery programs in the Methow. Busack said he is aware that the fisheries agencies and tribes and the PUDs have been working on adult management plans. Greg Mackey confirmed that Douglas PUD had been working on this.

Bill Gale updated the Committees on progress toward development of a Winthrop NFH spring Chinook external marking plan, saying that the issue is not completely resolved in *US v OR,* but that it is close to being resolved. He said that the U.S. Fish and Wildlife Service (USFWS) proposal was to adipose-clip (ad-clip) Winthrop NFH spring Chinook based on the following priorities: 1) ensuring that the Methow Fish Hatchery spring Chinook salmon hatchery program is fully supplied so that, in low return years, the priority would be supplying eggs for the Methow spring Chinook program; 2) ensuring that the Winthrop NFH can release up to 400,000 spring Chinook salmon into the Methow Basin; 3) if more than

400,000 Winthrop NFH spring Chinook salmon are produced, ensuring that the extra fish would be transferred to the Okanogan Basin. Any Winthrop NFH production of more than 200,000 would be ad-clipped. If less than 200,000 fish are produced, no hatchery fish would be ad-clipped. All hatchery spring Chinook would be coded-wire-tagged (CWT) regardless of the number of fish produced. Gale said that the USFWS proposal was fairly well received, but that now it has to go to through *US v OR* policy review. He said that there was consensus in support of the proposal within the *US v OR* ad-hoc technical committee. Gale said that he would report to the Committees the outcome of the spring Chinook marking proposal. Busack said that the USFWS would be asked to revise their Winthrop spring Chinook Hatchery Genetic Management Plan (HGMP), if the marking plan was approved. This would allow NMFS to begin consultation on the Winthrop HGMP because it would then be in line with *US v OR* management agreement.

Gale asked if there was any talk by NMFS about finalizing the Entiat biological opinion. Busack said that NMFS was working to get it done. Greg Mackey said that Douglas PUD wanted to meet with NMFS on their HGMPs, and asked if any progress on the Wells steelhead or Methow spring Chinook HGMPs had been made. Busack said that he had started reviewing them and that regularly scheduled conference calls with Douglas PUD and the USFWS would help to move them forward. Gale and Mackey agreed.

Kirk Truscott said that with almost all Upper Columbia hatchery program permits expiring in 2013, it sounded unlikely that Biological Opinions and new ESA Section 10 permits would be ready in time. He asked what plan NMFS had to provide certainty so the hatchery programs could continue. Busack said that once an HGMP has been accepted by NMFS as sufficient for consultation, the sufficiency letters are evidence that the applicant has done all they can to meet permit progress requirements. Busack said that NMFS was not planning to provide any interim permitting. He said that he expected to have all the hatchery programs permitted by the end of 2012. He indicated that his highest priority is the Snake River fall Chinook HGMP; the next priority is the Upper Columbia HGMPs.

B. Federal Hatchery Program EIS Update (Allyson Purcell/NOAA)

Allyson Purcell said that the draft Mitchell Act Environmental Impact Statement (EIS), now referred to as the Federal Hatcheries EIS, was released in August 2011 (Attachment D). NMFS received about 1,000 comments in letters. The scope of the draft EIS was the entire Columbia River Basin, looking at all funding distribution options. The structure of the draft EIS was to provide five very general alternatives and to provide one implementation scenario for each alternative. There was no preferred alternative or preferred implementation scenario identified in the draft EIS. Purcell said that in the final EIS, a preferred alternative would be created using parts of all the implementation scenarios. She said NMFS now had a draft preferred alternative and that it was very general and goal-oriented. Purcell provided a handout of the goals and principle captured by the preferred alternative (Attachment E).

Purcell said that starting in May 2011, working with hatchery managers, NMFS developed an implementation scenario, which they are still modeling. She said that they had not yet decided whether they would release a supplemental draft EIS or a final EIS with the preferred alternative, and in either case, the preferred alternative needs to be completed first. NMFS anticipates completing it and having a final or a supplemental draft EIS ready by late summer 2012. Purcell said that the EIS is not intended to make a determination on whether individual hatchery programs meet ESA requirements, and she said that the HGMP process would not be slowed or delayed by this EIS. She added that the EIS was expected to provide a foundation of information that will be useful for making ESA and National Environmental Policy Act (NEPA) determinations. Purcell said the idea was for the HGMP NEPA processes to be tiered off the Federal Hatcheries EIS once it is final. She said the decision whether to issue a supplemental or final EIS would be based on how many comments were received; there is usually 1 year between producing a draft and releasing a final EIS. If a final EIS is produced, the EIS could potentially be put to use the summer of 2012. She said that HGMPs that are already being processed will not be held up by the EIS process. The Committees asked how the timing of the EIS might influence processing HGMPs that were not yet under review or those HGMPs that have yet to be submitted. Purcell asked for comments or edits to the handout on the goals and principle of the preferred alternative. Bill Gale asked about the duration of HGMP ESA permits, which he thought were 5 years, but which Purcell had indicated were 10 years. Craig Busack said that he would confirm the expected duration of new ESA hatchery permits.

C. 2011 PBT Study Results (Craig Busack)

Craig Busack said that he had discussed the 2010 PBT study report with Ken Warheit of the WDFW genetics laboratory. Warheit said that the probability acceptance threshold for parental assignment had perhaps been set too high, that not a large enough sample was obtained, and that the results were not adequately explained. Keely Murdoch said that she recalled that WDFW had told the Yakama Nation to assume 90 percent assignment of at least one parent for the purposes of collecting broodstock at Tumwater Dam.

Busack said that the message is that PBT works but that a large sample size is important. He suggested Warheit be invited to the next Committees' meeting to give a presentation of his review. Mike Schiewe asked if Warheit's review would affect interpretation of the results for both 2010 and 2011. Busack said that Warheit had re-analyzed the results for both years and that the revised report was undergoing internal review. Schiewe asked about the need for a third year of the pilot study. Busack said that another year of sampling at Priest Rapids Dam would not change the outcome. He said that at issue was whether enough fish can be captured to assign parentage. Joe Miller agreed that a third year of study was not needed, but that a presentation to the Committees from Warheit on his re-analysis would be helpful. Mike Tonseth will contact Warheit about providing a presentation to the Committees on his re-analysis of the 2010 and 2011 PBT study results at the February 15, 2012, meeting. When cleared for distribution, Tonseth will email a copy of Warheit's re-analysis of the 2010 and 2011 PBT study results to Carmen Andonaegui for distribution to the Committees.

V. HETT Update

Carmen Andonaegui reported that the HETT met on January 10, 2012. She reported that the HETT had taken the task of identifying reference streams for the HCP Plan Species supplemented populations as far as they were able. Reference streams have been selected for spring Chinook and for summer Chinook. The HETT determined that reference streams could not be identified for steelhead or sockeye due to limited data. The method developed by the HETT for identifying reference streams is being finalized and will be included as an appendix in the PUD 5-Year M&E Reports.

The HETT previewed a demonstration run of the Predation, Competition, and Disease (PCD) Risk model that will be used for the non-target taxa of concern (NTTOC) risk assessment. Individuals have been identified to conduct model runs for USFWS and Douglas PUD hatchery programs and the Yakama Nation's coho programs. Josh Murauskas said that he would conduct the model runs for the Chelan PUD hatchery programs but could not get to this until February. Kirk Truscott said that he would provide a staff person's name to run the Chief Joseph hatchery program model runs. Over the next couple of months, the HETT will work on completing all the model runs. At the February 15, 2012, meeting, Andonaegui will provide to the Hatchery Committees a summary of the conclusion of the HETT reference stream evaluation and a HETT proposal for any next steps.

VI. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees' meetings are February 15, 2012 (Chelan PUD office), March 21, 2011 (Douglas PUD office), and April 18, 2011 (Chelan PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – Chelan PUD Spring Chinook Size-at-Release Proposal
Attachment C – BY 2007 Chiwawa Spring Chinook Growth Rates
Attachment D – NMFS Federal Hatcheries EIS Update Presentation
Attachment E – Draft NMFS Federal Hatcheries EIS Preferred Alternative handout

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Carmen Andonaegui	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Alene Underwood	Chelan PUD
Joe Miller*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Keely Murdoch*	Yakama Nation
Jayson Wahls	WDFW
Kirk Truscott*	CCT
Mike Tonseth*	WDFW
Craig Busack*	NMFS
Allyson Purcell	NMFS
Bill Gale*	USFWS
Todd Pearsons	Grant PUD

Notes:

* Denotes Hatchery Committees' member or alternate

Use of monitoring and evaluation data to identify appropriate size at release targets for hatchery-origin Chiwawa River spring-run Chinook salmon *Oncorhynchus tshawytscha*

J. G. Murauskas

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Abstract–We examined smolt survival and adult returns of Chiwawa River spring Chinook salmon *Oncorhynchus tshawytscha* using passive integrated transponder tags to determine if juvenile length influenced these results. A logistic regression indicated that increasing juvenile length at tagging significantly increased the probability of both wild- and hatchery-origin smolts returning at younger age classes, including mini-jacks (p = 0.03 and p < 0.01, respectively). Despite significantly smaller size at release and 21.4% lower smolt survival rate on average, wild-origin fish had a 49.2% greater rate of adult returns compared to hatchery-origin fish (p < 0.01). Hatchery-origin smolts were divided into small and large groups by median length at tagging for comparison. The large half of hatchery-origin fish had statistically indifferent juvenile survival compared to the small half, but produced 135% more mini-jacks (p = 0.03), 194% more jacks (p < 0.01) , 6% more 2-salt adults (p = 0.38), and 56% fewer 3-salt adults (3-salt adults from the 2009 releases have not yet returned; p = 0.11). These results indicate that large length targets of hatchery programs do not translate to increased smolt survival or adult returns and further increase the disparity between population demographics of hatchery- and wild-origin populations. We propose that a size target of 126 mm and 25 g (~ 18 fish per pound) in hatchery-reared spring Chinook would provide measurable benefits in terms of adult returns and conservation of an ESA-listed stock.

Introduction–Chiwawa Hatchery (Chiwawa) is located at the confluence of the Chiwawa and Wenatchee rivers approximately 15 miles north of Leavenworth, Washington. Chiwawa was constructed in 1990 as a component of the Eastbank Hatchery Complex designed to rear up to 672,000 spring Chinook smolts to mitigate for losses incurred at hydroelectric projects owned and operated by Chelan County Public Utilities District (PUD). The juvenile fish are transferred from Eastbank Hatchery in the fall prior to migration, over-wintered at Chiwawa, and released directly into the Chiwawa River.

Chelan PUD has funded extensive monitoring and evaluation efforts of Chiwawa spring Chinook since 1989. A comprehensive report on monitoring and evaluation efforts over the past five years is currently being developed. Two recommendations within the report indicate that (1) "more realistic [size] targets should be set based on the length-weight relationship specific to Chiwawa spring Chinook and the size of natural-origin smolts produced in the Chiwawa Basin;" and, (2) "hatchery fish matured at an earlier age than natural-origin fish. This may be related to the size of released hatchery smolts" (Hillman et al. 2011a).

Several researchers have identified relationships between length at release and survival and age at maturity in Chinook and other *Oncorhynchus* spp. (Neilson and Geen 1986; Vøllestad et al. 2004; Scheuerell 2005; Claiborne et al. 2011; Tipping 2011). The current size target for hatchery spring Chinook released in the Chiwawa River is 176 mm FL and 38 g (~ 12 fish per pound), whereas wild-origin fish have averaged 94 mm FL and 9.3 g (~ 50 fish per pound; Hillman et al. 2011b). The purpose of the analyses contained herein is to test the hypotheses that (1) larger spring Chinook smolts lead to a decrease in age at maturity; and, (2) larger spring Chinook smolts do not have a full life cycle survival advantage compared to smaller smolts.

Methods–Data were retrieved from the PIT Tag Information System for the Columbia River Basin (PTAGIS; Pacific States Marine Fisheries Commission 2011). A "tagging detail" query was submitted to obtain records of PIT-tagged spring Chinook that were released from Chiwawa Ponds (CHIP; hatchery-origin smolts only) and Chiwawa Trap (CHIWAT; natural-origin smolts only) during the juvenile migrations of 2006, 2007, 2008, and 2009 (hatchery-origin smolts were not PIT-tagged in 2006). Wild-origin spring Chinook tagged after the month of June are considered sub-yearling juveniles and were excluded from analyses. Descriptive statistics were generated of tagging data for both hatchery- and wild-origin smolts.

An "interrogation summary" query was submitted to obtain observation records of the fish included in the "tagging detail" query described above. The data were filtered to only include observations at the Rock Island adult fishway to identify returning fish. The year of the last observation date at Rock Island was considered the return year, and the difference between the return year and the release year was considered "ocean residence." All juvenile detections in the adult fishway that were last detected the same year as release were considered mini-jacks. Adult returns detected the year following release were considered jacks; two years following release were considered "2 salt" fish, and so forth. Data were tabulated to determine the composition of returns.

A logistic regression was used to model the probability of returning to freshwater after a particular ocean residence (the ordinal variable) as a response to fork length at tagging (the continuous variable). Results were separated by hatchery- and wild-origin smolts. The Whole Model Test was used to determine if the model fits better than constant response probabilities (analogous to the Analysis of Variance table for a continuous response model). *p* values were reported for the Chi-square test used to evaluate how well the categorical model fits the data. Results were considered significant at $p \leq 0.05$ (SAS 2009).

PitPro 4.19 was used to generate Cormack/Jolly-Seber survival estimates and harmonic mean travel time of spring Chinook from release to McNary Dam to examine relative in-river performance of smolts during the outmigration (CBR 2011; Jolly 1965; Seber 1965; Cormack 1964). Fish were initially separated by rear-type (hatchery or wild). Subsequent survival estimates and harmonic mean travel times were generated for hatchery-origin spring Chinook based on a division of fish size each year. Median fork length at tagging was determined for each year and used to divide the "small half" and "large half" subsequently used in comparisons of returns and survival. The small half had larger sample sizes since the median length was included in this group.

Rates of return (RORs) were calculated by dividing the number of PIT-tagged fish detected in the adult fishway at Rock Island Dam (i.e., returns) by the number of fish released. RORs were calculated and compared for specific ages or ocean residence, and also for all adults combined (i.e., 2-salt or greater). A pooled sampling proportion *Pooled* (i.e., for both RORs in comparisons) was calculated by:

$$Pooled = \frac{[(ROR_1 \times n_1) + (ROR_2 \times n_2)]}{(n_1 + n_2)}$$

and SE_{Pooled} was calculated by:

$$SE_{Pooled} = \sqrt{(1 - Pooled)} \times [(1/n_1) + (1/n_2)]$$

The test statistic (two-proportion z-test), *z*, was calculated as:

$$z = \frac{(ROR_1 - ROR_2)}{SE_{Pooled}}$$

The test statistic and resulting *p* value was obtained from a standard normal table. Data manipulation and descriptive and inferential statistics were performed in JMP ® 8.0.2. Results were considered significant at $p \leq 0.05$.

Results–Over 65,000 spring Chinook were PIT-tagged between 2006 and 2009, including 29,906 hatchery- and 14,142 wild-origin yearling smolts. Hatchery fish were tagged between June and August the year prior to the smolt migration; natural-origin fish were tagged between March and June during the smolt migration. Hatchery-origin smolts averaged 93.1 mm (± 0.1 mm SE) and wild-origin smolts averaged 94.0 mm (± 0.1 mm SE) in fork length. Size at tagging was similar, though wild-origin smolts are tagged 8 to 9 months later on average. Nearly 50,000 detections of these fish occurred subsequent to release, including only 346 observations of unique fish within the Rock Island Dam adult fishway.

Two hundred ninety-three (293) returns were observed in the Rock Island Dam adult fishway, including 192 hatchery-origin fish and 101 wild-origin fish. The majority of returns were 2-salt fish for both hatchery- and wild-origin fish, though hatchery-origin fish had a greater number of mini-jacks and jacks and fewer 3-salt returns. RORs, to account for varying release sizes, show that hatchery-origin fish had 24% more mini-jacks (p = 0.30), 893% more jacks ($p < 0.01$), and 33% fewer ≥ 2-salt adults ($p < 0.01$) than wild-origin fish on average (Table 1). The logistic regression indicated that fish length at tagging significantly influenced the probability of returning after a specific period of ocean residence for both hatchery- (n = 192, $P < 0.01$) and wild-origin (n = 101, $P = 0.03$) fish. The probability of returning as a mini-jack or jack

increased significantly with increasing length at tagging for all fish (Figure 1).

Hatchery-origin smolts had an average estimated survival to McNary Dam of 56.6% (range 43.0-65.0%), compared to an average of 44.5% for wild-origin smolts (range 38.5-47.3%). The difference in estimated survival to McNary Dam was 27% greater on average for hatchery-origin fish, ranging from -5% to 69% over comparable years. Hatchery-origin smolts generally traveled to McNary Dam slightly faster during comparable years, though rates were comparable between groups. Estimated survival to McNary Dam was similar between the small half and large half of hatchery fish as was harmonic mean travel time. These results suggest that hatchery-origin smolts have a downstream survival advantage over wild-origin smolts, though a size advantage within hatchery-origin smolts was not observed (Table 2, Figure 2).

RORs from both the small and large half of hatchery smolts show similar rates of ≥ 2-salt fish ($p = 0.48$), with the large half returning 6% more 2-salt adults ($p = 0.38$) and 56% fewer 3-salt adults ($p = 0.11$) compared to the small half. Mini-jack and jack rates were greater in the large half: the large half produced 135% more mini-jacks ($p = 0.03$) and 194% more jacks ($p < 0.01$) compared to the small half (Table 1). The mini-jack rate for the small half was also inflated by the 2007 smolt year where the median hatchery-origin fish were over 20% larger than in 2008 and 2009; outside of 2007, no mini-jacks were observed in the small half of hatchery-origin smolts.

Even greater differences were noticed between the large half of hatchery-origin smolts and wild-origin smolts. The large half hatchery-origin fish produced on average 50% more mini-jacks ($p = 0.09$), 1,186% more jacks ($p < 0.01$), an equal number of 2-salt adults ($p = 0.41$), and 90% fewer 3-salt adults ($p < 0.01$). Generally speaking, all three groups (wild, small half, and large half) produced similar rates of 2-salt fish, whereas large half smolts produced fewer 3-salt fish, more mini-jacks, and more jacks than wild or small half smolts (Table 1). The composition of returns among these three groups demonstrate that most (88%) wild-origin smolts resulted in ≥2-salt adults over the time period observed, compared to 79% in the small half hatchery-origin smolts, and 57% in the large half hatchery-origin smolts (Figure 3).

Discussion–Our first hypothesis – that larger smolts lead to decreased age at maturity in Chiwawa River spring Chinook – is supported by these findings in both wild- and hatchery-origin fish. Neilson and Geen (1986), Scheuerell (2005), Chamberlin et al. (2011), Claiborne et al. (2011), and Tipping (2011) found similar results in Chinook, where the age of maturation decreased with increasing smolt size. Considering the importance of size at age and age at maturity in Chinook salmon (Kinnison et al. 2011), size at release may have considerable implications on the effectiveness of hatchery releases in the Chiwawa River. At a minimum, a disproportionate rate of mini-jacks and precocious males do not contribute favorably to harvest. Likewise, mini-jack and jack Chinook likely have a limited, if not negative, contribution to conservation-based supplementation efforts (Heath et al. 1994, 2002; Asbjørn Vøllestad et al. 2004; Pearsons et al. 2009; Larsen et al. 2010; Williamson et al. 2010). Our results, in combination with the observed size distribution of wild-origin Chinook and the intent to mimic the wild population for supplementation, provide evidence that a reduced target size for hatchery smolts will improve the population demographics of hatchery spring Chinook salmon in the Chiwawa River.

Our second hypothesis – that larger spring Chinook salmon smolts do not have a full life cycle survival advantage over smaller smolts – is also supported by these data. While some researchers have found smolt survival to be greater for larger smolts (e.g., Miyakoshi et al. 2001; Saloniemi et al. 2004), our results are unable to support these findings. Similar results to our study were observed in Imnaha River spring Chinook, where larger hatchery smolts (12-14 fish per pound) did not have a survival advantage over smaller smolts (20-25 fish per pound). Further, while overall smolt-to-adult survival was similar between small and large hatchery smolts, the smaller Imnaha River hatchery smolts had a significantly greater survival to Age 5 (i.e., 3-salt adults; Feldhaus et al. 2011). In either case, the rate and composition of returns – not smolt performance – is a more important metric in evaluating performance. For example, a 10% increase in smolt survival would not be beneficial if it were accompanied by a 50% increase in mini-jack rates. Therefore, supplementation programs intended to promote conservation of wild-origin stocks should focus on RORs, especially absent any evidence of a survival benefit of rearing larger smolts.

The PIT-tagged Chiwawa River spring Chinook provide a unique opportunity to compare wild- and hatchery-origin salmon. The hatchery uses wild-origin brood and resulting progeny are genetically similar to the wild-origin cohorts. In other words, the major difference between the wild- and hatchery-origin smolts is the rearing. Knudsen et al. found hatchery-origin spring Chinook matured at an earlier age just one generation removed from wild-origin cohorts and that minimizing the results of artificial rearing was difficult (2006). Larsen et al. found that changes in feeding rations can reduce mini-jack rates, creating a leaner and smaller hatchery smolt more similar to a wild counterpart (2006). Feldhaus et al. observed smaller hatchery spring Chinook smolts returning at older age classes compared to larger smolts (2011). With our results indicating that the most apparent difference between wild- and hatchery-origin fish is the age structure and associated RORs, and that the size of hatchery smolts is a predictor of these results, we recommend a reduction in the target size of the hatchery program.

While the current hatchery size target is 179 mm FL and 37.8 g (12 fish per pound), the observed lengths and weights have averaged roughly 136 mm and 32 g (~15 fish per pound) over the past five years (brood years 2004-2008; Hillman et al. 2011). Further, a length-weight relationship developed on the data used in our analyses indicate that the current size targets are not achievable (i.e., a 37.8 g smolt would be roughly 140 mm, not 179 mm). Feldhaus et al. (2011) evaluated Imnaha River hatchery spring Chinook smolts in the 18-23 g range (average weight of 21 g, 20-25 fish per pound). The Imnaha River target weights would translate to roughly a 120 mm and 22 fish per pound target in the Chiwawa Program. We recommend beginning with an intermediate size target of 126 mm and 25 g (approximately 18 fpp) and supporting continued PIT-tagging to evaluate the efficacy of this approach.

In conclusion, these results support previous findings highlighting significant differences between wild- and hatchery-origin salmon. While the disparity may be unsolvable, it is apparent that the large size targets and unnatural growth rates decrease age at maturity in Chiwawa River spring Chinook. These results further indicate that smaller hatchery smolts are more similar to wild-origin counterparts and that larger hatchery smolts may even pose a negative impact. A reduced hatchery size target could reduce some of these discrepancies, as well as provide additional benefits, such as lower rearing densities, and reduced adult management obligations.

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Table 1. Observations and rate of return of PIT-tagged Chiwawa River hatchery- and wild-origin spring Chinook in the Rock Island Dam adult fishway, release years 2006-2009.

Origin	Tag year	PIT tags	Ocean residence (years) 0	1	2	3	Rates of return Mini-jacks	Jacks	Age 2	Age 3	Adults
Hatchery	2007	9,981	16	16	29	1	0.160%	0.160%	0.291%	0.010%	0.301%
	2008	9,894	2	14	58	10	0.020%	0.141%	0.586%	0.101%	0.687%
	2009	10,031	3	12	31	0	0.030%	0.120%	0.309%	0.000%	0.309%
	All	**29,906**	**21**	**42**	**118**	**11**	**0.070%**	**0.140%**	**0.395%**	**0.037%**	**0.431%**
Wild	2006	2,355	0	0	12	5	0.000%	0.000%	0.510%	0.212%	0.722%
	2007	2,697	2	0	2	0	0.074%	0.000%	0.074%	0.000%	0.074%
	2008	6,719	5	1	36	26	0.074%	0.015%	0.536%	0.387%	0.923%
	2009	2,374	1	1	10	0	0.042%	0.042%	0.421%	0.000%	0.421%
	All	**14,145**	**8**	**2**	**60**	**31**	**0.057%**	**0.014%**	**0.424%**	**0.219%**	**0.643%**
Hatchery (small)	2007	5,569	7	2	18	1	0.126%	0.036%	0.323%	0.018%	0.341%
	2008	5,394	0	2	30	7	0.000%	0.037%	0.556%	0.130%	0.686%
	2009	5,193	0	8	14		0.000%	0.154%	0.270%	0.000%	0.270%
	All	**16,156**	**7**	**12**	**62**	**8**	**0.043%**	**0.074%**	**0.384%**	**0.050%**	**0.433%**
Hatchery (large)	2007	4,412	9	14	11	0	0.204%	0.317%	0.249%	0.000%	0.249%
	2008	4,500	2	12	28	3	0.044%	0.267%	0.622%	0.067%	0.689%
	2009	4,838	3	4	17		0.062%	0.083%	0.351%	0.000%	0.351%
	All	**13,750**	**14**	**30**	**56**	**3**	**0.102%**	**0.218%**	**0.407%**	**0.022%**	**0.429%**

Table 2. Probability of survival and harmonic mean travel time (days) to McNary Dam of hatchery- and wild-origin spring Chinook smolts, 2006-2009.

Origin	Tag year	PIT tags	Survival to McNary	SE	Travel to McNary (d)
Hatchery	2007	9,981	65.0%	2.0%	28.3
	2008	9,894	61.7%	3.9%	29.0
	2009	10,031	43.0%	2.0%	30.4
	Average		**56.6%**	**2.6%**	**29.2**
Wild	2006	2,355	47.3%	3.0%	20.1
	2007	2,697	38.5%	2.2%	27.9
	2008	6,719	47.0%	2.6%	29.4
	2009	2,374	45.2%	4.6%	36.6
	Average		**44.5%**	**3.1%**	**28.5**
Hatchery (small)	2007	5,569	66.0%	2.6%	28.5
	2008	5,394	68.4%	6.1%	29.7
	2009	5,193	42.7%	2.8%	31.4
	Average		**59.0%**	**3.8%**	**29.9**
Hatchery (large)	2007	4,412	63.6%	3.1%	28.1
	2008	4,500	54.8%	4.8%	28.3
	2009	4,838	43.4%	2.8%	29.4
	Average		**53.9%**	**3.6%**	**28.6**

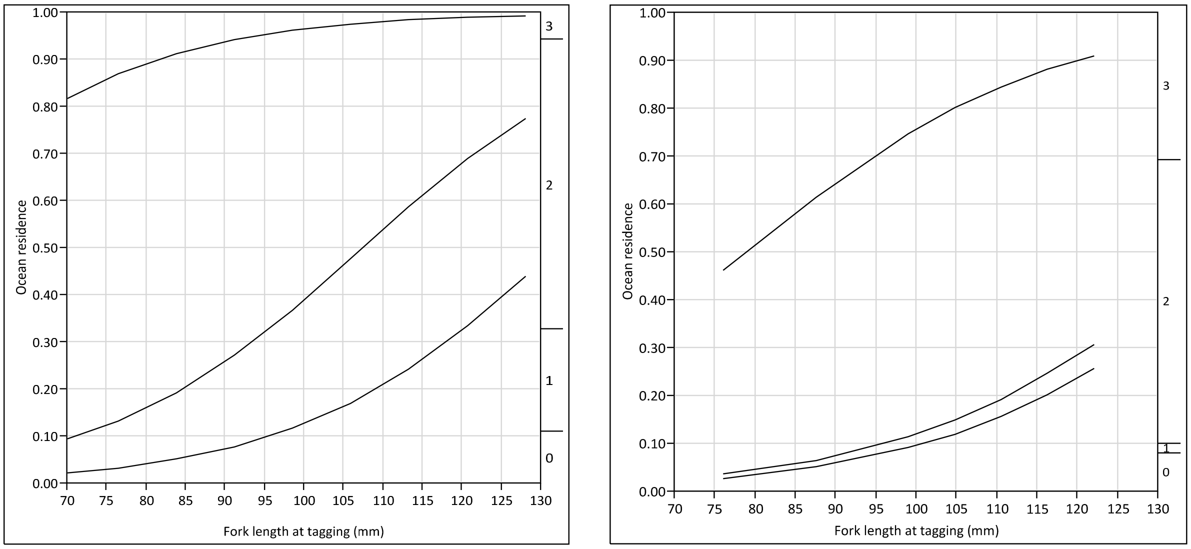


Figure 1. Logistic fit of ocean residence by fork length (mm) at time of tagging for hatchery (left) and wild-origin (right) Chiwawa River yearling spring Chinook. Whole Model Tests indicate a significant relationship for both hatchery ($P < 0.01$) and wild-origin ($P = 0.03$) fish, with an increasing probability of ocean residence = 0 (i.e., mini-jack) with increasing size at tagging.

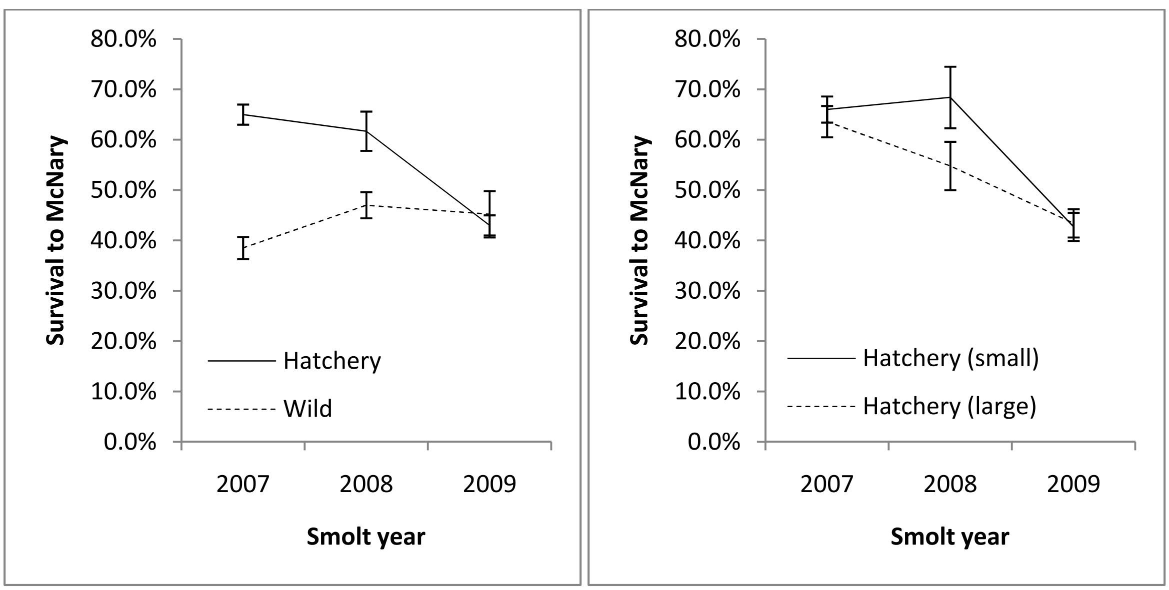


Figure 2. Estimated survival (± SE) to McNary Dam of hatchery and wild spring Chinook smolts (left), and small and larger hatchery-origin smolts (right).

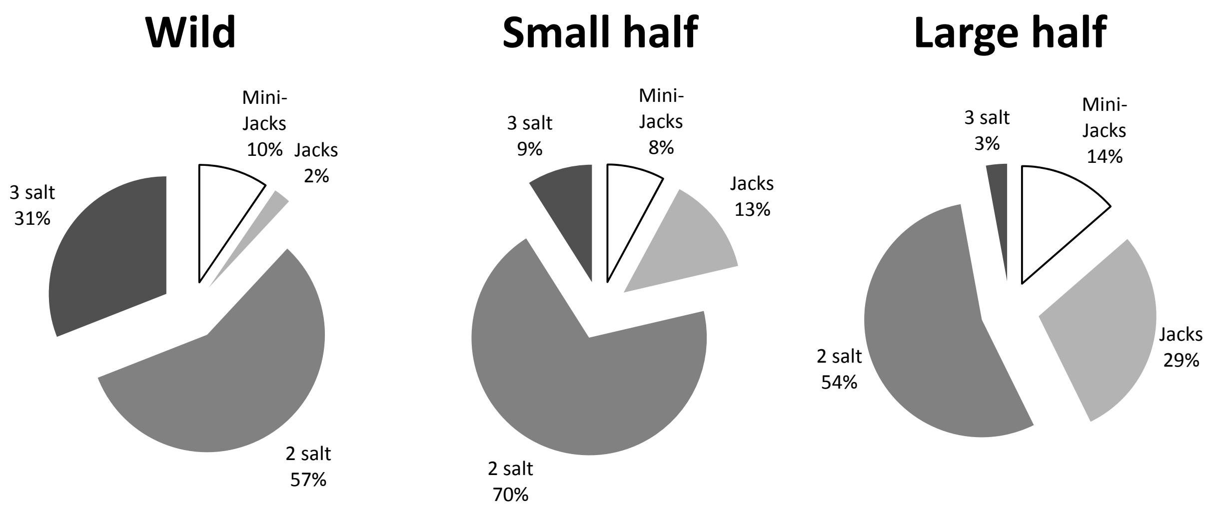
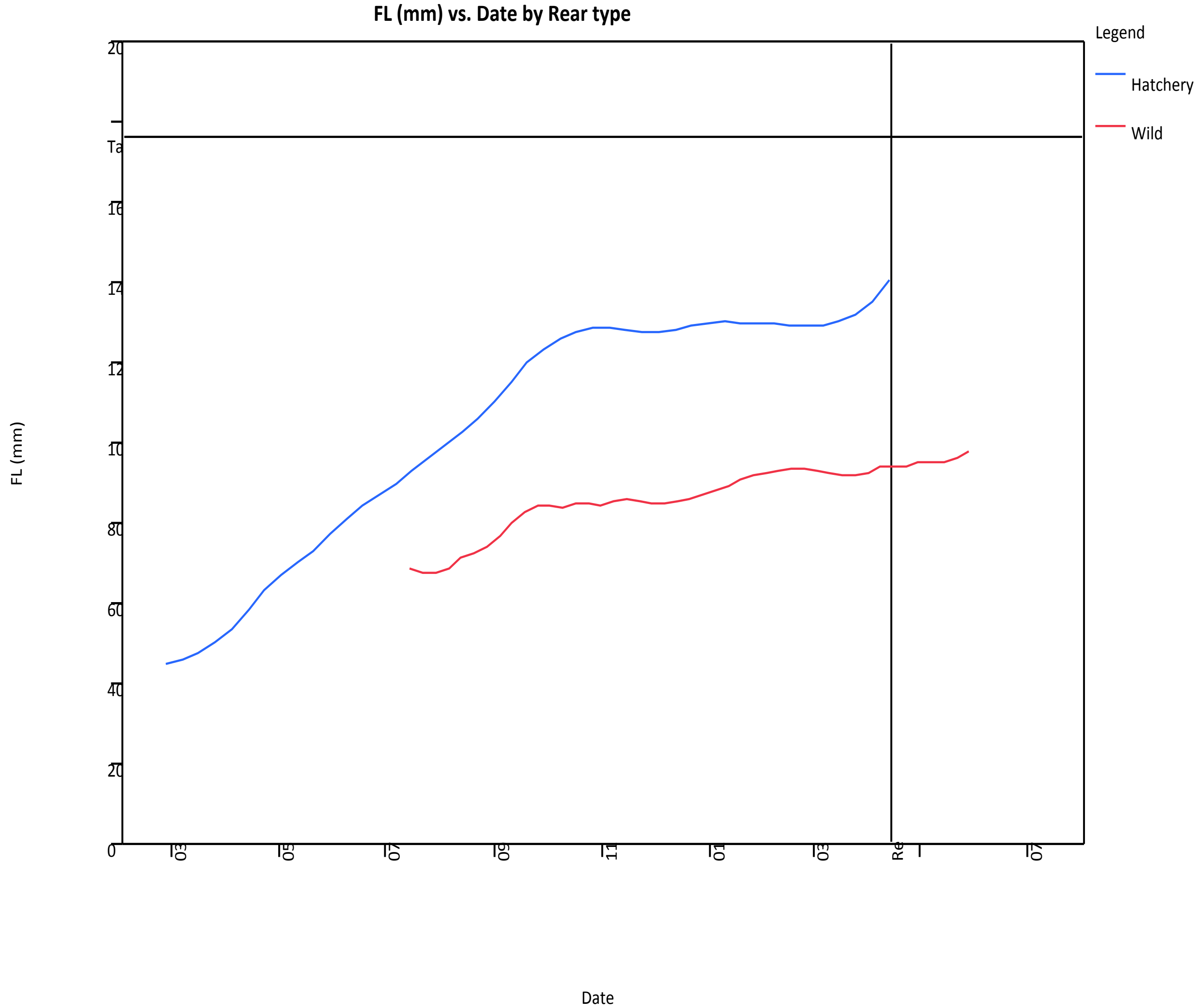


Figure 3. Distribution of returns from wild- and hatchery-origin spring Chinook smolts released in the Chiwawa River, 2007-2009. Hatchery smolts were separated by median fork length at time of tagging and returns from 2009 do not yet include 3-salt fish.

Graph Builder



Science, Service, Stewardship

UPDATE on EIS to Inform Columbia River Basin Hatchery Operations & the Funding of Mitchell Act Hatchery Programs

(AKA: The Mitchell Act EIS)

NOAA FISHERIES SERVICE

Science, Service, Stewardship

Background

- NMFS released a draft EIS on August 6, 2010.
- It was available for a 120-day public comment period.
- A total of 418 letters were received.

Hatcheries and Facilities in the Columbia and Snake River Basins

Prepared by Parametix, Inc. January 19, 2010 (DEIS_Figure_1-3_20100119.mxd).

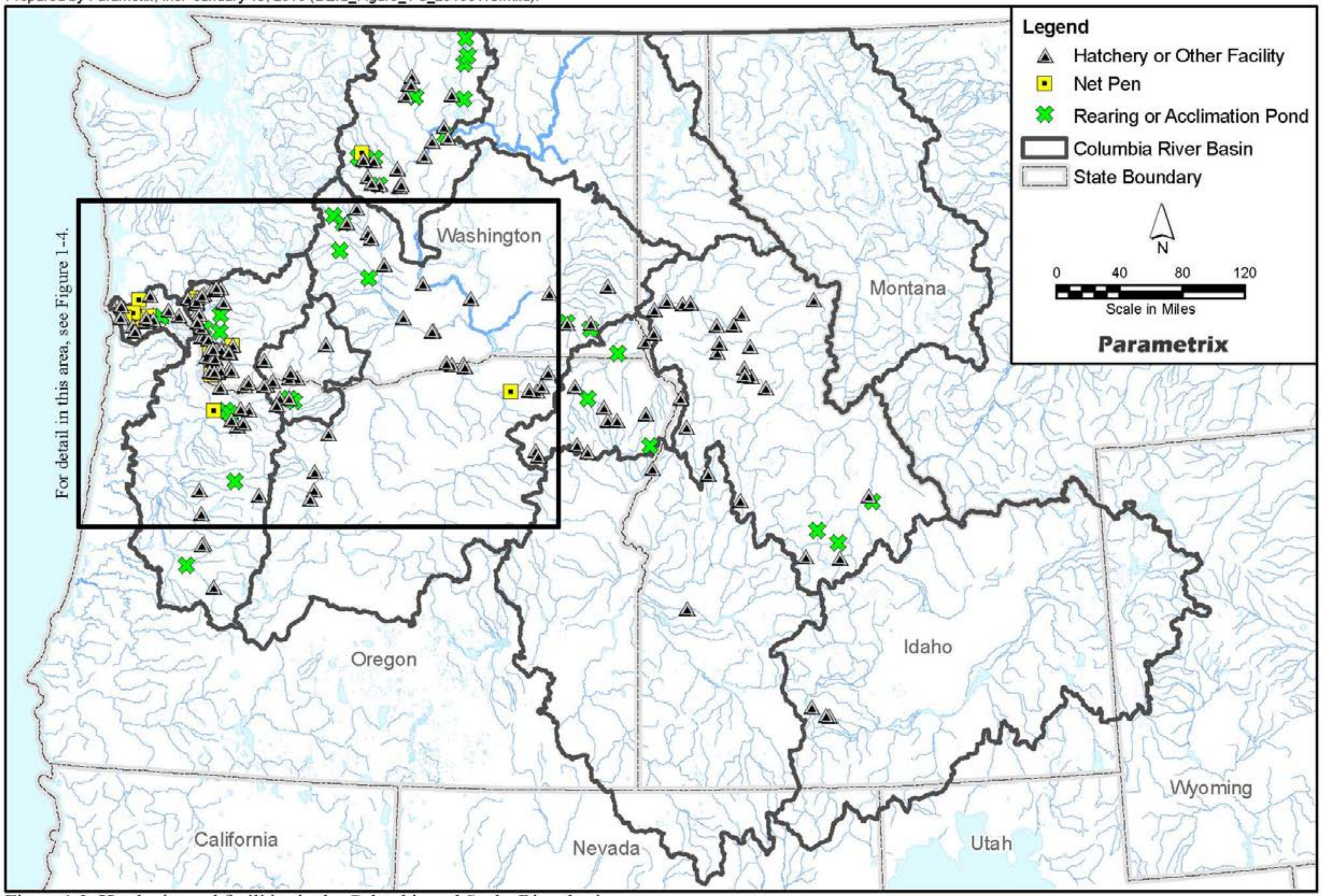


Figure 1-3. Hatcheries and facilities in the Columbia and Snake River basins.

Structure of EIS

- 5 alternatives including status quo
- Each alternative centers around a general policy direction

Science, Service, Stewardship

Structure of EIS

- NMFS developed one example implementation scenario for each alternative for the sake of analysis. Innumerable other scenarios exist.
- No preferred alternative (or implementation scenario) in draft EIS.
- The draft EIS indicated that the Preferred Alternative would likely combine components of more than one of the alternatives.

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Changes to Draft

- Update information to reflect the most recent years of information.
- Update description of Alternative 1 (status quo).
- Add clarifying information (e.g., do a better job describing how EIS relates to other policies and plans).

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Changes to Draft

- Fix errors.
- Identify a Preferred Alternative
- Evaluate potential effects of the Preferred Alternative in an example implementation scenario

Draft Preferred Alternative

- Combines elements of Alternatives 1, 4, and 5.
- Applies stronger performance goals throughout basin.
- Does not limit production or the construction of new hatchery facilities.
- Does not identify pHOS or PNI goals.

Example Implementation Scenario for Preferred Alternative

- Developed with help of hatchery managers.

- Risks of the hatchery programs are minimized in a manner that applies basin-specific strategies after taking into account the status of the natural population, applicable recovery goals, and commitments that have been made in other plans and agreements (e.g., US v OR, Pacific Salmon Treaty, FCRPS Accords).

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Supplemental v. Final

- NMFS has not determined whether the EIS will be released as a supplemental draft or a final EIS.

- NMFS must first finalize the Preferred Alternative and complete the analysis of its potential impacts.

Science, Service, Stewardship

Schedule

- NMFS expects to release a revised EIS in the summer of 2012.

How does this EIS relate to the HGMP process?

- This EIS will not make determination of whether any hatchery program meets the requirements of the ESA.
- HGMP process will not be slowed down by EIS.
- However, the EIS will provide a comprehensive foundation of information that will be useful when NMFS makes future determinations under the ESA and NEPA.

Draft Preferred Alternative

Environmental Impacts Statement (EIS) to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs

November 3, 2011

This is a draft document for the purpose of discussion and coordination.

Alternative 6 (Preferred Alternative)

Alternative 6 is the Preferred Alternative. It is a hybrid of Alternatives 1, 4, and 5 found in the draft EIS. Under Alternative 6, the policy direction would be defined by the following goals and/or principles:

- The stronger performance goal (see below or page 2-13 in the draft EIS) would be applied to all Columbia River basin hatchery programs that affect ESA-listed, primary and contributing, salmon and steelhead populations in the Columbia River basin.
- Conservation hatchery programs would be operated at a level determined by conservation need. Benefits of conservation hatchery programs must outweigh their risks.
- BMPs, tailored to site-specific conditions, would be applied in all hatchery programs.
- New conservation hatchery programs would be initiated throughout the Columbia River basin, where appropriate.
- New harvest hatchery programs would be initiated (i.e., increased hatchery production) and/or existing hatchery programs would be changed to better support harvest opportunities throughout the Columbia River basin and in ocean fisheries.
- Different approaches to hatchery management would be tested and evaluated.[1]
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Development of the Implementation Scenario for Alternative 6 (Preferred Alternative): The implementation scenario for Alternative 6 (Preferred Alternative) will be an implementation scenario that NMFS develops with co-manager input based upon the goals and principles stated in Alternative 6. In the implementation scenario for Alternative 6, risks of the hatchery programs are minimized in a manner that applies basin-specific strategies after taking into account the status of the natural population, applicable recovery goals, and commitments that have been made in other plans and agreements (e.g., US v OR, Pacific Salmon Treaty, FCRPS Accords).

[1] This principle will also be added to Alternatives 1 through 5.

Future Funding Decisions (add to Chapter 1): Funding is not limited within EIS alternatives. However, based on history, funding levels will be limited, so an allocation plan will be put together annually, consistent with the alternative adopted in the ROD, other current agreements and plans in the basin, and after considering other potential sources of funds that may be available for each proposal.

Future ESA Decisions (add to Chapter 1): NMFS will continue to review Columbia River hatchery programs under the ESA. This EIS will inform NMFS of the aggregating effects of proposed hatchery programs in the context of all Columbia River basin hatchery production.

Stronger performance goals = performance goals that promote beneficial effects and that minimize adverse effects of hatchery programs on salmon and steelhead populations.

Intermediate performance goals = performance goals that in most cases reduce adverse effects of hatchery programs on salmon and steelhead populations when compared to status quo conditions.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	March 28, 2012
From:	Mike Schiewe, Chair		
Cc:	Carmen Andonaegui		
Re:	Final Minutes of the February 15, 2012, HCP Hatchery Committees' Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees' meeting was held at the Chelan PUD Headquarters Building in Wenatchee, Washington, on Wednesday, February 15, 2012, from 9:30 am to 3:00 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Greg Mackey will revise the Wells 2012 HCP Action Plan as agreed to and email a copy to Carmen Andonaegui for distribution to the Hatchery Committees (Item II-A).
- Greg Mackey will send notice to Carmen Andonaegui when the Draft 5-Year Monitoring and Evaluation (M&E) Report is ready for review; Andonaegui will email Hatchery Committees' members that the report is ready for download from the HCP ftp site (Item II-B).
- Greg Mackey will email a copy of the revised Steelhead Reproductive Success Study Report to Carmen Andonaegui when Douglas PUD has completed internal review, for distribution to the Hatchery Committees (Item II-B).
- Mike Tonseth will provide to Maureen Hess a list of broodstocks by Upper Columbia hatchery program and facility (Item IV-A).
- Maureen Hess will email Carmen Andonaegui, for distribution to the Hatchery Committees, a proposal for their participation in expanding the Snake River Parental-Based Tagging (PBT) study to Upper Columbia hatcheries (Item IV-A).
- Keely Murdoch will draft a request from the Hatchery Committees to the Hatchery Evaluation Technical Team (HETT), assigning them the task of developing a distributed acclimation plan for the Upper Columbia (Task IV-B).
- Josh Murauskas will revise the Chiwawa Spring Chinook Size-at-Release Target Statement of Agreement (SOA) as agreed to at today's meeting, and email it to

Carmen Andonaegui for distribution to the Hatchery Committees (Item VI-B).
- Josh Murauskas will inform the Hatchery Committees when Chelan PUD will be able to complete the Non-Target Taxa of Concern (NTTOC) Predation, Competition, and Disease (PCD) Risk model runs for Chelan PUD's hatchery programs (Item VI-C).

SOA DECISION SUMMARY

- The Hatchery Committees approved in principal the Spring Chinook Size-at-Release Target SOA, as revised (Item VI-B).

AGREEMENTS

- The Hatchery Committees approved the Wells 2012 HCP Action Plan as revised (Item II-A).

REVIEW ITEMS

- The Chelan PUD Draft 2012 Rocky Reach and Rock Island HCP Action Plan is available for a 30-day review. Comments are due to Steve Hemstrom with a copy to Josh Murauskas by March 1, 2012.
- The Chelan PUD Draft 5-Year M&E Report is available for a 60-day review. Comments are due to Tracy Hillman by April 6, 2012.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. Bill Gale added to the agenda his memo updating the Committees on changes to the spring Chinook hatchery program at the Winthrop National Fish Hatchery (NFH).

The draft January 19, 2012, meeting minutes were reviewed, additional revisions were discussed, and the minutes were approved as revised. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Committees.

II. Douglas PUD

A. Wells 2012 HCP Action Plan (Greg Mackey)

Greg Mackey said that the draft Wells 2012 HCP Action Plan (Action Plan) was distributed to the Hatchery Committees by email on January 18, 2012, and discussed at the January 19, 2012, Committees' meeting. During the January discussion, Kirk Truscott requested that the Wells Hatchery modernization be added to the Action Plan as a 2012 activity. Mackey said that the Wells Hatchery modernization activity had been added to the revised version emailed to the Committees' on February 10, 2012, and under consideration today. The Committees discussed how and when Douglas PUD should involve them in the design process for the hatchery modernization. Mackey will use the Hatchery Committees as the forum for keeping co-managers and appropriate parties advised of the planning and progress related to modernization of the Wells Hatchery. He will add to the Action Plan, under the Wells Hatchery Modernization activity, the following tasks: *1)* monthly updates to the Committees; and *2)* periodic review of modernization designs. Mackey will also make the following correction to the Action Plan: change "2010 Broodstock Collection Protocol" in Number 4 to "2012 Broodstock Collection Protocol." The Action Plan was approved with these revisions. Mackey will revise and finalize the Hatchery Committees' portion of the Action Plan and will email a copy to Carmen Andonaegui for distribution to the Committees once the Coordinating Committees have approved the full plan.

B. Update on Douglas PUD 5-Year M&E Report and the Genetics Analysis Report for the Steelhead Reproductive Success Study (Greg Mackey)

Greg Mackey said that the draft Douglas PUD 5-Year M&E Report was undergoing internal review and was almost ready for distribution to the Hatchery Committees for review. He said that he would notify Carmen Andonaegui when the Draft 5-Year Report is ready; Andonaegui will then notify Hatchery Committees by email when the report is ready for download from the HCP ftp site.

Mackey said that Todd Seamons, Washington Department of Fish and Wildlife (WDFW), had provided Douglas PUD with a 2009/2010 Genetics Analysis Report for the Steelhead Reproductive Success Study and that Douglas PUD was currently reviewing it. WDFW had previously issued the report, but discovered some errors and issued a new version of the report in February 2012. In coming years, the report will typically be available in September or October. Mackey will email a copy of the revised report to Carmen Andonaegui, for distribution to the Committees, when Douglas PUD has completed their internal review.

III. WDFW

A. 2010 and 2011 PBT Study Results Re-analysis (Ken Warheit, WDFW)

Ken Warheit was introduced and gave a presentation to the Hatchery Committees on what he called the Wenatchee Basin parentage analysis, rather than what has been referred to as the Wenatchee Basin PBT study (Attachment C). He provided the Committees with two reports relevant to today's presentation (Attachments D and E). Warheit explained that the genetic sampling and analysis conducted for the Wenatchee experiment was geared towards parental assignment to river of origin for sampled fish, whereas true PBT is an attempt to assign parentage for any offspring of hatchery parents at any life stage. In summary, Warheit concluded that parental analysis could be used to successfully identify Wenatchee-origin spring Chinook, saying that an LOD ≥10 and a two-parent assignment should result in 90 to 100 percent correct assignment; however, parental analysis would require a sampling rate at Priest Rapids Dam that exceeds the average annual return of Wenatchee-origin spring chinook, as well as 100 percent handling of all spring Chinook (both wild- and hatchery-origin fish) at TWD. Warheit reported that the population most limiting the ability to reliably assess parental origin for adult spring Chinook sampled at Tumwater Dam (TWD) was the White River population. There would be permitting difficulties associated with this level of sampling and handling of ESA-listed fish. Warheit said that sampling at TWD rather than at Priest Rapids Dam would work also, and might require a smaller sample size, but that sampled adults would need to be held while the samples were sent to a lab and PBT analysis was completed. Warheit also stressed the importance of maintaining the White River spring Chinook as a separate stock, citing its unique haplotypes relative to the Chiwawa River and Nason Creek.

Warheit said that questions on his analysis can be emailed to him. He will provide a copy of his PowerPoint presentation to Carmen Andonaegui for posting on the ftp site.

IV. Yakama Nation

A. Expanding Snake River Broodstock PBT "Marking" to the Upper Columbia (Maureen Hess, CRITFC)

Maureen Hess, Columbia River Inter-Tribal Fish Commission (CRITFC), said that she had been involved in PBT work in the Snake River Basin where CRITFC has been using single nucleotide polymorphisms (SNPs) to assign parentage to sampled fish (Attachment F). She listed the benefits of the use of genetic tagging of hatchery broodstocks, which allowed for the identification of hatchery-of-origin and age of hatchery-produced offspring. Hess said that the Snake River PBT project was a collaborative effort with Idaho Fish and Game (IDFG), sampling 100 percent of fish used in Snake River Chinook and steelhead hatchery programs in 2008 and continuing in 2012. This is a Bonneville Power Administration (BPA), Fish Accord-funded project.

Hess said that the goal was to extend genetic sampling to 100 percent of Chinook and steelhead hatchery fish upstream of Bonneville Dam starting in 2012. She said that she would like to include Upper Columbia hatchery programs, and requested access to archived tissue samples, as well as newly collected tissue samples, once funding can be arranged through BPA. She said that the genetic data, once analyzed, would be available to all interested parties in a regional database. Mike Tonseth said that he would provide Hess with a list of broodstocks by hatchery program and facility. Hatchery Committees' members expressed willingness to archive genetic samples in the short term, but require a written proposal before making a final commitment. Hess will email Carmen Andonaegui, for distribution to the Hatchery Committees, a proposal for their participation in expanding the Snake River PBT study to the Upper Columbia hatcheries.

B. Multi-Species Acclimation Workgroup Formation (Keely Murdoch)

Keely Murdoch requested the Hatchery Committees' assistance in forming a working group to develop a long-term plan for acclimation in the upper Columbia River. She said that the Yakama Nation would like to be proactive on this issue and was therefore asking the Hatchery Committees to work on a multi-year strategy. Tonseth said that he supported the idea. For the March 23, 2012, meeting, Mike Schiewe asked Murdoch to draft a request from the Committees to the HETT, assigning them the task of developing a distributed acclimation plan for the Upper Columbia. He asked that the request include task objectives and timelines, and identify recommended participants in the HETT effort. Josh Murauskas asked that the location of the acclimation sites be included in the draft request, along with the number and species of fish proposed for acclimation at each site.

V. NMFS

A. HGMP Update (Craig Busack)

Craig Busack reported that he has been directed to focus his work efforts on the upper Columbia River hatchery programs' Hatchery and Genetic Management Plan (HGMP) consultations in the coming months. He said that he will therefore be minimizing his participating in the Hatchery Committees' meetings for the near future. He said that he was meeting with Methow Basin hatchery owners and operators the following week and that, afterwards, he would have a better idea of the status of the Methow HGMPs. Busack said that Rob Jones was working on the Entiat HGMPs, and that an employment recruitment announcement had been advertised for refilling Mark Chilcote's former position with NMFS conducting hatchery consultations.

Craig Busack clarified by email on February 14, 2012, to Carmen Andonaegui, that the duration of the Endangered Species Act (ESA) Section 10 permits for hatchery operations would be 10 years for hatcheries operated under the HCP. Non-HCP hatchery ESA Section 10 permits for hatchery operations would be issued for a period of 5 years unless indicated otherwise.

VI. Chelan PUD

A. Rocky Reach and Rock Island Draft 2012 HCP Action Plan (Josh Murauskas)

Josh Murauskas said that the draft 2012 Rocky Reach and Rock Island HCP Action Plan (Action Plan) was available for a 30-day review. He said that the Action Plan provided a timeline for Rocky Reach and Rock Island projects activities. Comments are due to Steve Hemstrom by March 1, 2012.

B. Spring Chinook Size-at-Release Target SOA (Josh Murauskas)

Josh Murauskas introduced Chelan PUD's SOA for adjusting Chiwawa spring Chinook hatchery program size-at-release targets from 12 fish per pound (fpp) to 18 fpp. He provided a proposal describing the request (Attachment G), reporting that while there was no apparent benefit to larger hatchery smolts, there was an apparent drawback, that smaller hatchery smolts perform more similarly to wild fish, and that there was no effect on female returns from transitioning to a smaller size-at-release. Murauskas presented a summary of his analyses of juvenile spring Chinook, comparing size of wild versus hatchery smolts to performance and age at maturity (Attachment H). His analyses included: 1) comparisons of proportions of age class returns and rate-of-returns between wild fish and small and large size-at-release hatchery fish (<2 salt returns are highest for large half, and 3 salt returns are highest for wild fish); 2) the relationship between stray rates and the proportion of jacks in the return (stray rates increase with the increasing proportion of jacks); 3) the proportion of females in a return year related to size-at-tagging (larger smolts do not contribute to female adult returns); and 4) a comparison of the proportion of jills wild versus hatchery fish (higher in hatchery fish). Murauskas also reported on the feed schedule related to meeting fpp targets.

The Hatchery Committees discussed the analysis and the SOA, agreeing in principle to the SOA, which puts forth the interim change to 18 fpp in the size-at-release target beginning with brood year 2012; the Committees' agreement is contingent on adding to the SOA the following agreed to revisions: 1) more detail in the Background section explaining the request for the decrease in size-at-release targets; 2) a proposed rearing protocol with interim size and feeding targets/goals, in coordination with Chris Moran, Bob Rogers, and John Penny; and 3) a statement that continued M&E will be used to evaluate the effects of the change. Josh Murauskas will revise the Chiwawa Spring Chinook Size-at-Release Target SOA as agreed to at today's meeting, and email it to Carmen Andonaegui for distribution to the Hatchery Committees.

C. HETT Discussion (Josh Murauskas)

Josh Murauskas opened the discussion by saying that Chelan PUD needed objectives and timelines for HETT tasks in order to know how much time would be needed to dedicate to HETT efforts. Mike Schiewe said that the reference stream task had been completed until the next round of M&E reviews opens up. He said that the NTTOC risk assessment was ongoing and that this task was taking an unexpectedly long time to complete. Schiewe asked for input from Hatchery Committees' members who were also HETT members, as to when the task would be completed and how the information would be used.

Keely Murdoch agreed that the NTTOC task was taking a long time to complete, but said that the assessment has turned out to be a lot more complicated than originally thought. She said that she thought the product will be very good given the detailed approach that had been taken and all the data that had gone into the effort. Murdoch said that when the analysis was completed, the Committees would be able to identify where negative interactions are occurring as a result of hatchery supplementation activities. She said that the results of the NTTOC risk assessment would be part of the next 5-Year M&E review. Carmen Andonaegui said that the HETT had discussed a timeline of about 3 to 6 months for completion of the model runs, depending on the level of participation and how quickly modeling glitches are resolved. Greg Mackey said that two management-related outcomes are possible from the risk assessment: obvious negative interactions of an individual program that would draw attention to a particular activity; or a low-level impact across the board resulting in what may be a larger, cumulative impact. The first scenario would be fairly straightforward for managers to address, but the latter would likely be problematic for managers to address. Schiewe said that the objective of the task was to meet the regional M&E objective of analyzing NTTOC impacts, and that whether any management actions are taken was a separate issue.

Murauskas questioned the use of time needed to conduct model runs. Schiewe reviewed how the Committees had not approved modeling as part of the risk assessment, but rather a compilation of data for use in a Dephi process. Todd Pearsons said that, as the HETT worked on the risk assessment, they realized that with the large amounts of information they were compiling, the effects could be modeled. He said that an expert panel would still be used to estimate NTTOC risks based on data provided, but that the modeling process helped to organize and prepare the large amounts of data for use by the expert panelists. In addition, the approach will allow comparison of model and Delphi panel results, which may provide a long-term benefit by increasing confidence in model results. Murdoch and Pearsons spoke about the number of interactions (more than 500) there were to consider, given the number of programs, releases, and geographic area, and the need for a model to handle this degree of complexity. Schiewe asked if the risk assessment could still be meaningful if the Colville Confederated Tribes (CCT) were not able to provide input on their proposed hatchery programs. Mackey said that he thought the assessment would still work for some locations, but that it would leave gaps in areas where CCT hatchery program fish interacted with fish from other hatchery programs. Pearsons said that it would take 3 to 6 months to complete the model runs, but that another year would likely be needed to complete the expert panel assessment. Schiewe asked if there was some way to reduce this time. Mackey said that the HETT could consider the effects on the assessment of only doing model runs on key interactions rather than on all 500+ interactions. Murauskas agreed to inform the Committees when Chelan PUD would be able to complete the model runs for Chelan PUD's hatchery programs.

D. Draft 5-Year M&E Report Review (Josh Murauskas)

Josh Murauskas reported that the draft Chelan PUD 5-Year M&E Report was available for a 60-day review, with comments due to Tracy Hillman by April 6, 2012. He encouraged comments from Hatchery Committees' members.

VII. USFWS

A. Winthrop NFH changes (Bill Gale)

Bill Gale said that he had drafted a memo to the Hatchery Committees informing them of changes to the spring Chinook hatchery program at the Winthrop NFH. He emailed the memo to Carmen Andonaegui today for distribution to the Hatchery Committees. He said the memo reflected agreements reached through the *US v OR* forum that would result in the external marking of all spring Chinook beginning in 2012.

VIII. HETT Update

Carmen Andonaegui reported that the HETT met on February 14, 2012. She said that it had completed the reference stream evaluation and provided a summary of that effort, including the HETT's recommendation for evaluating supplementation effects in the future for steelhead for which no suitable reference streams were found (Attachment I). Schiewe said that as Hatchery Committees' members review the draft PUD 5-Year M&E reports, they could consider how to evaluate steelhead supplementation effects without the benefit of reference streams.

Regarding the HETT NTTOC risk assessment, Andonaegui said that the HETT was working on completing PCDRisk-1 model runs for all Upper Columbia hatchery programs. Once the model runs are completed, the HETT will review the results for anomalies. When the HETT has determined that the data are clean, the data will be ready to send to the expert panel. She said that the HETT anticipated that getting the data ready for the expert panel would take 3 to 6 months, depending on the level of effort and number of issues to resolve to complete the model runs.

IX. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees' meetings are March 21, 2012 (Douglas PUD office); April 18, 2012 (Chelan PUD office); and May 16, 2012 (Douglas PUD office).

Bill Gale said that he had delayed inviting Pat Connolly, U.S. Geological Survey (USGS), to attend the March 21, 2012, Hatchery Committees' meeting to discuss potential collaboration and coordination of PIT-tagging efforts in the Methow Basin. He said that he would extend the invitation to Connolly to attend a later meeting. Tom Kahler said that he is working with Chelan PUD and Grant PUD to schedule Howie Wright, Okanagan Nation Alliance (ONA), and Kim Hyatt, British Columbia Fisheries and Oceans, Canada, for a presentation on the Skaha Lake Sockeye Reintroduction Program and the Fish Water Management Tool, respectively, at the April 18, 2012, Hatchery Committees' meeting.

List of Attachments

Attachment A – List of Attendees
Attachment B – Draft Wells 2012 HCP Action Plan
Attachment C – Warheit PowerPoint presentation on the results of 2002/2010 Wenatchee Spring Chinook parental analysis
Attachment D – Warheit et al. 2012, Wenatchee Spring Chinook PBT Project - Two-Year Summary Analysis
Attachment E – Draft WDFW PBT Feasibility Test Report Memo
Attachment F – CRITFC Snake River PBT Presentation
Attachment G – Chiwawa Spring Chinook Size-at-Release Target Presentation
Attachment H – Chiwawa Spring Chinook Size-at-Release Target Proposal
Attachment I – Summary of the HETT Reference Stream Evaluation

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Carmen Andonaegui	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Alene Underwood	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Keely Murdoch*	Yakama Nation
Kirk Truscott*†	CCT
Craig Busack*†	NMFS
Don Larsen†	NMFS
Jayson Wahls	WDFW
Mike Tonseth*†	WDFW
Ken Warheit†	WDFW
Maureen Hess†	CRITFC
Bill Gale*	USFWS
Russell Langshaw	Grant PUD
Todd Pearsons	Grant PUD

Notes:

* Denotes Hatchery Committees' member or alternate

† Joined by phone

DRAFT 2012 ACTION PLAN
WELLS HCP

WELLS HCP COORDINATING COMMITTEE

1. Bypass Operating Plan
  a. Draft to Coordinating Committee (CC): .... February 2012
  b. Approval deadline: .... March 2012
  c. Period of implementation: .... April 9 to August 19, 2012
  d. Report deadline: .... October 2012

2. 2013 NNI Progress Report (per Wells HCP §6.9)
  a. Douglas/CC develop report outline .... March 2012
  b. CC provides direction on status update for Plan Species .... May 2012
  c. Douglas submits Draft NNI Progress Report to the CC .... March 2013

3. Predator Control Programs
  a. Pikeminnow removal – Wells Project: .... March – August 2012
  b. Draft 2011 pikeminnow report to DCPUD: .... January 2012
  c. 2011 pikeminnow report internal review and submission to CC: .... February 2012
  d. Avian predator hazing at Wells: .... October 2011 – May 2012

4. Sub-yearling Chinook Life-history Study
  a. Draft 2011 report to CC: .... February 2012
  b. Final 2011 report: .... April 2012
  c. Update study plan: .... January-April 2012
  d. Tag and release study fish: .... June-July 2012
  e. Monitor study fish: .... through life cycle
  f. Draft 2012 report to CC: .... February 2013
  g. Final 2012 report: .... April 2013

5. Annual Monitoring of Juvenile Migration Run Timing
  a. Skalski analysis of index data from RR: .... September 2012
  b. Draft of Skalski's report to DCPUD: .... September 2012
  c. Final report presented to CC: .... October 2012

6. Installation of HDX PIT-tag Detection System at Wells Dam
  a. Contractor noise testing and site analysis .... January 2012
  b. Fabrication and installation of partial system in the west ladder ...... January/February 2012
  c. Complete installation in the west ladder .... December 2012
  d. Complete installation in the east ladder .... January/February 2013

7. Lamprey Entrance Efficiency Study
  a. Study plan .... June 2012
  b. Conduct velocity test and efficiency study .... July – August 2012
  c. Draft report .... November 2012
  d. Final report .... February 2013

WELLS HCP HATCHERY COMMITTEE

1. **Implement 5-year Hatchery Monitoring and Evaluation (M&E) Plan**
   a. Ongoing implementation: ....January – December 2012
   b. Draft annual report for 2011 to Douglas PUD:.. June 2012
   c. Draft annual report to Hatchery Committee (HC): ....July 2012
   d. Final annual report to HC: ....October 2012
   e. Draft 5-year synthesis/analysis report to HC: .... February 2012
   f. Final 5-year synthesis/analysis report:.. April 2012
   g. Draft 2013 implementation plan to HC: ....October 2012

2. **Review and Update 5-year M&E Plan (per Wells HCP §8.5.1 and 8.8)**
   a. Draft to HC: ....July 2012
   b. Final to HC:...October 2012

3. **2013 Hatchery Program Review (per Wells HCP §8.8)**
   a. Data and analyses for the Hatchery Program Review are contained within several existing documents or documents scheduled for completion in 2012:
      1. Douglas 5-Year M&E Report (to HC in 2012) addresses all aspects of the Hatchery Program Review for Methow Hatchery spring Chinook and Wells Hatchery steelhead and summer Chinook.
      2. Chelan 5-Year M&E Report (to HC in 2012) addresses all aspects of the Hatchery Program Review for Carlton Pond summer Chinook.
      3. Hatchery M&E annual reports (2003-2011) provide detailed data necessary for the Hatchery Program Review.
      4. Methow Spring Chinook HGMP (2010) included thorough review of the program and redesigned the program based on the review.
      5. Wells Complex Summer Steelhead HGMP (2011) included thorough review of the program and redesigned the program based on the review.
      6. Adjustment of hatchery compensation (2011) conducted review and assessment of SARs, adults returns, hatchery and natural smolt production.
      7. Fish-Water Management Tool (FWMT) Progress Report (Hyatt et al. in prep) provides an analysis of the multi-year data set to determine the contribution of FWMT implementation to average production of Okanagan sockeye.
   b. HC directs the development of summary report: ....June – August 2012
   c. HC reviews draft summary report: ....September – October 2012
   d. Final summary report to HC: .... December 2012
   e. Final summary report from HC to CC: .... January 2013

4. **2012 Broodstock Collection Protocol**
   a. Draft to HC: .... March 2012
   b. Approval deadline:.. April 2012
   c. Implementation: ....May 2012 to April 2013

5. **Annual Implementation Report - Sockeye Fish/Water Management Tools**
   a. Period covered: ....Water Year 2011-2012 (October – September)
   b. Draft to HC: ....*to be determined*

c. Presentation to HC: ....August or September 2012
d. Draft 2013 FWMT progress report to Douglas PUD: ....August 2012
e. Draft 2013 FWMT progress report to HC: ....October 2012
f. Final 2013 FWMT progress report to HC: ....December 2012
g. HC delivers final 2013 FWMT progress report to CC: ....January 2013

6. HGMP – Methow Spring Chinook

a. Draft Spring Chinook HGMP to HC: .... Complete November 2009
b. Final Spring Chinook HGMP to NMFS: ....Completed March 2010
c. NMFS approval of Spring Chinook HGMP: ....*to be determined*

7. HGMP – Wells Steelhead

a. Draft Steelhead HGMP to HC: ....Completed February 2011
b. Final Steelhead HGMP to NMFS: ....Completed March 2011
c. NMFS approval of Steelhead HGMP: ....*to be determined*

8. Methow Steelhead Relative Reproductive Success Study

a. Implementation: .... March 2010 - December 2021
b. Interim reports:.. September 2012
c. Final report:.. 2021/2022

9. Wells Hatchery Modernization

a. Update on rearing criteria and Master Plan: ....December 2012
b. Provide updates to the HC ....Monthly
c. Provide opportunities for HC input.. Periodically

WELLS HCP TRIBUTARY COMMITTEE

1. **Plan Species Account Annual Contribution**
   a. $176,178 in 1998 dollars.. January 2012

2. **Annual Report - Plan Species Account Status**
   a. Draft to Tributary Committee (TC): .... February 2012
   b. Approval Deadline:.. March 2012
   c. Period Covered: ....January to December 2011

3. **2012 Funding-round – General Salmon Habitat Program**
   a. Request for project pre-proposals:........................... *To be determined* (typically in March)
   b. Pre-proposals to TC: .... *To be determined* (typically in early May)
   c. Tours of proposed projects: ....*To be determined* (typically in late May)
   d. Project sponsor presentations to TC: .... *To be determined* (typically in early June)
   e. Final project proposals to TC:............................ *To be determined* (typically in early July)
   f. RTT project rating decisions:....................................... *To be determined* (typically in July)
   g. Supplemental sponsor presentations ....*To be determined*
   h. TC final funding decisions:......................... *To be determined* (typically before December)

4. **Small Project Program**
   a. Project review and funding decision.................................. Applications accepted any time

5. **Tributary Assessment Program**
   a. Proposal to TC for year-5 of 5 for ORRI monitoring ....July 2012
   b. Develop monitoring plan for remaining funds... March 2012
   c. Implement monitoring plan..*To be determined* (2012)
   d. Monitoring plan final product... December 2012
   e. TC delivers final product to CC... January 2013

Priest Rapids Dam – Wenatchee River Spring Chinook salmon Parentage-based Tagging Project: Two-year Summary of Testing Accuracy of Parentage Assignments

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Washington Department of Fish and Wildlife, Molecular Genetics Laboratory, Olympia, WA 98501

January 18, 2012

Introduction:

To evaluate the efficacy of the Wenatchee River spring Chinook salmon parentage-based tagging (PBT) project, the Washington Department of Fish and Wildlife Molecular Genetics Laboratory (WDFW-MGL) was asked to assess the accuracy of genetically assigning parents with known spawning locations within the Wenatchee River Basin to returning adult spring Chinook salmon captured at Priest Rapids Dam. DNA samples from migrating adults captured in 2010 and 2011 at Priest Rapids were genotyped and compared with genotypes from adults within the Wenatchee Basin from spawn years 2005-2008. Here, we provide a summary of the accuracy of the parentage assignments, which should contribute to the overall assessment of the effectiveness of the project.

Methods:

As part of a research program led by Dr. Michael Ford (NOAA), DNA samples were taken from adults (parents) captured on spawning grounds located within the Wenatchee River Basin, including locations in the mainstem Wenatchee River, and tributaries Nason Creek, Chiwawa River, White River, and Little Wenatchee River. Samples from each of these collections were genotyped at a set of 13 microsatellite loci (Table 1) by staff at NOAA and those genotypes were provided to WDFW-MGL staff. This set included eight GAPS microsatellites (Seeb et al. 2007) and five non-GAPS microsatellites. Returning adult Chinook salmon, putative offspring of Wenatchee River Chinook salmon, were captured, DNA sampled, and tagged with PIT tags at Priest Rapids Dam in 2010 and 2011. Tissue samples from these fish were processed and genotyped at WDFW-MGL using a set of 19 microsatellite loci that included the same 13 loci used by NOAA (Table 1). To ensure that alleles of parents and offspring were standardized and that a uniform allele nomenclature was used, we genotyped a subset of 96 samples

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from parents genotyped by NOAA in order to translate all NOAA-generated genotypes to WDFW-MGL and GAPS standard nomenclature. To conduct the PBT analysis, we assumed an age range of 3-5 years for each of the putative offspring and thus, limited the NOAA parental dataset to years 2005 – 2008, which would encompass all potential parents for 3-5 year old fish spawning in 2010 and 2011.

For parentage analysis we used the software FRANz (Riester 2009). We assigned parents separately for the putative offspring migrating in 2010 and 2011. For each group, all parents from 2005-2007 and 2006-2008, respectively, were considered simultaneously, regardless of sampling location or year. Parents with 6 or fewer loci (out of the 13 loci) scored were excluded, as were offspring with eight or fewer loci (out of the 13 loci). In assigning parents to putative offspring we permitted up to 4 mismatches or genotypic incompatibilities between the putative offspring and parent(s). We considered assignments of two (trio) or one (dyad) parent(s) with an offspring, and evaluated the assignments using $\log_e$ of likelihood-odds ratio (LOD) score. Here, LOD is the log of the ratio between the likelihood that the trio or dyad is parent-offspring versus that the trio or dyad are unrelated (see Marshall et al. 1998, Kalinowski et al. 2007, Riester 2009). We assigned individuals as parents if the trio or dyad had the highest LOD score, regardless of the size of the score.

We do not know the true parentage of the putative offspring. Therefore, to evaluate the accuracy of the PBT analysis, we needed to establish criteria to determine which parentage assignments were correct. In principle, a “correct trio” would have both parents spawning in the same year and within the same river, and the offspring’s final PIT detection occurring within the river where the parents spawned. However, not all offspring or potential parents were identified by sex or spawning location. Therefore, we established an attribute table to classify “correctness” at different levels of resolution (Table 2). We then compared this classification to different LOD categories to create PBT criteria that would minimize assignment error.

Results and Discussion:

We received and genotyped samples from 282 putative offspring from the sampling facility at Priest Rapids Dam. Although each of these fish was tagged with a PIT tag, the geographic precision for last detection varied among the fish. We defined three areas as the last detected basins: Wenatchee (for detections within the Wenatchee Basin), Columbia Mainstem (for last detection at Priest Rapids Dam [initial capture location], Rock Island Dam, and Rocky Reach Dam), and Out-of-basin (for last detection within the Entiat or Methow Basins). We differentiated Columbia Mainstem from Out-of-basin because last detection at either Priest Rapids or Rock Island Dam did not preclude the Wenatchee Basin as the "intended" final destination for the fish, and Rocky Reach Dam is the location of Eastbank hatchery, the primary facility for Wenatchee spring Chinook salmon hatchery operations. Fish with last detections within either Entiat or Methow Basin have already passed the Wenatchee River suggesting (more strongly for the Methow) that the fish intended to spawn in systems upriver to the Wenatchee River.

The 282 offspring were divided into 18 attribute categories that defined last detection of offspring and parental spawn years and locations (Table 2). The 18 attributes were divided into eight classes of correctness, depending on the attribute resolution: "Correct-System" (if the highest level of resolution among the parent(s) and offspring was river basin), "Correct-River" or "Correct-System; Incorrect River" (if the highest level of resolution among the parent(s) and offspring was a river within a basin), "Correct – no assigned parents" (if the last detection was out-of-basin and no parents were assigned[2]), "Consistent" (if the last detection was Columbia Mainstem and two parents were assigned with the same spawn year and location), "Indeterminate" (if there was insufficient information on the parental and/or offspring locations), "Incorrect or stray" (if the last detection was out-of-basin and either (1) assigned parents' spawn years and locations are the same, or (2) only one parent was assigned), and "Incorrect" (if two parents were assigned with incompatible spawn year or location) (Table 2). Please note that a "Correct-System; Incorrect River" determination may also be the result of an offspring fish straying from its natal river.

If all parentage assignments were accepted, without regard to the LOD scores, 132 of the 282 fish (47%) were correctly assigned (Attribute # 1-6, 9; Table 2), 129 (46%) were incorrectly assigned (Attribute #7-8, 13-18), and 21 (7%) had indeterminate assignments (Attribute # 10-12). However, we use the LOD scores to determine the strength of the assignments, and low LOD scores may not afford sufficient confidence to maintain the assignment. For LOD scores of base-e or natural logarithms, a zero LOD

[2] Chinook salmon spawn in four major basins above Priest Rapids Dam, the Wenatchee, Entiat, Methow, and Okanogan River basins, so a returning adult (putative offspring) in our sample from Priest Rapids might not have had true parents from the Wenatchee River basin, and therefore would not have had parents in our reference data set of Wenatchee spawner genoytpes.

indicates equivalence between the assigned parents and a random set of genotypes, LOD = 1 indicates that that the assignment is only 2.7 times as likely as a random set of genotypes, while LOD = 10 means that the assignment is 22,000 times as likely as a random set of genotypes, and so on. Clearly, low LOD scores may indicate low confidence for assigning parents to offspring. However, limiting assignments to only those with higher LOD scores will reduce the number of putative offspring with assigned parents.

To best assess the accuracy of the PBT analysis, we limited the evaluation to only those assignments with two parents and all parental and offspring attributes known (Table 3). This reduced the number of offspring with assigned parents to only 29 of the 282 (10%), but depending on the LOD threshold, the percent correctly assigned ranged from a low of 76% to a high of 100%. Limiting assignments to LODs of 10 or greater achieved a correct assignment rate of 91%, while reducing the number of offspring with assigned parents to 23 from 29 (79%) (Table 3). When we allowed for unknown attributes, but still maintained the requirement that two parents needed to be assigned, we increased the number of assigned offspring to 131 (46%) (Table 4). In this group of assignments, the percent correctly assigned for LOD scores of 0-5 ranged 52-55%, not much better than a coin flip. That percent increased to a range 72-94% for LOD scores 10-20. These percentages represent minimum estimates because we assumed that fish do not stray from natal rivers or even natal basins.

Compared to two-parent assignments, one-parent assignments (dyads) had overall lower LOD scores, lower percent correctly assigned and reduced confidence in the parentage assignments (Table 5). For LOD scores 0-5, randomly assigning parents may be more successful than using a statistical approach. For LOD = 10, 100% of the offspring have correctly assigned parents, but the total number of offspring with LOD scores equal to or greater than 10 is only 4 out of the 99 dyads.

Although the purpose of this study was to assess the accuracy of assigning fish to particular rivers based on a PBT analysis, we included not only those fish that returned to the Wenatchee system, but also fish that were never detected in spawning rivers or fish that returned to out-of-basin areas. Neither of the latter sets of fish would be considered for a Wenatchee-based supplementation program. When we limited our analysis to only those fish that returned to the Wenatchee system, and allowed for both two- and one-parent assignments (Attribute # , 1-5, 7-8, and 15-16), our assignment rates are consistently above 85% correct assignment for all LODs. However, most of the correct assignments were to the "Correct-System" (i.e., Wenatchee Basin), an easy achievement given that we limited the analysis to fish returning to the Wenatchee Basin (Table 6). When we removed the Correct-System category from the analysis, the percent correctly assigned reduced to 63-83%, with 72% for LOD = 10, the same percentage as when we allowed for unknown attributes, but still maintained the requirement that two parents needed to be assigned (Table 4).

Conclusions:

This study did not include an ideal set of datasets. Microsatellite loci are known to have different allele calls among different laboratories, and between different instruments within a laboratory. This study required that parental assignments were made using disparate data sets, collected in two different laboratories. This means that this analysis combined standard and expected genotyping errors from two different laboratories, and required an ad-hoc method to translate allele calls from one laboratory to another. We expect that as a result of these non-standard QA/QC procedures, PBT assignment rates were negatively affected. Nevertheless, we showed that with higher LOD scores and two-parent assignments (e.g., Table 3), we can correctly assign a relatively high number of trios. Based on this analysis, we recommend that when using PBT to assign fish to natal rivers, assignments be limited to only those where two parents are assigned (trios) with a minimum LOD score = 10. However, this will reduce the number of fish assigned, thereby limiting the PBT-based program. To compensate, the program would need to increase sampling rates at the Priest Rapids facility to ensure an appropriate number of fish are assigned to parents and are available for supplementation programs. We further recommend minimizing genotyping errors, which can negatively affect parentage assignment rates, by performing genotyping in only one laboratory, using standardized and uniform allele nomenclature.

Literature Cited

Kalinowski, S.T., Taper, M.L., and Marshall, T.C. 2007. Revising how the computer program Cervus accommodates genotyping error increases success in paternity assignment. Mol. Ecol. 16:1099-1106.

Marshall, T.C., Slate, J., Kruuk, L.E.B., and Pemberton, J.M. 1998. Statistical confidence for likelihood-based paternity inference in natural populations. Mol. Ecol. 7:639-655.

Riester, M., Stadler, P.F., and Klemm, K. 2009. FRANz: reconstruction of wild multi-generation pedigrees. Bioinformatics 25:2134–2139.

Seeb, L.W., Antonovich, A., Banks, M.A., and 17 coauthors. 2007. Development of a standardized DNA database for Chinook salmon. Fisheries 32(11): 540 – 552.

Table 1. Standard Chinook salmon microsatellite panels used by WDFW-MGL and by NOAA. To conduct PBT analysis, WDFW established in-house protocols for the NOAA-Only set, and standardized the Ford-NOAA version of the GAPS set.

Microsatellite Locus	Standard Microsatellite Panels		Used in Priest Rapids PBT Analysis
	WDFW Only	Michael Ford (NOAA)	
Ogo-2	GAPS - Standardized	GAPS - Unstandardized	Yes
Ogo-4	GAPS - Standardized	GAPS - Unstandardized	Yes
Ots-201b	GAPS - Standardized	GAPS - Unstandardized	Yes
Ots-208b	GAPS - Standardized	GAPS - Unstandardized	Yes
Ots-211	GAPS - Standardized	GAPS - Unstandardized	Yes
Ots-213	GAPS - Standardized	GAPS - Unstandardized	Yes
Ots-3M	GAPS - Standardized	GAPS - Unstandardized	Yes
Ssa-408	GAPS - Standardized	GAPS - Unstandardized	Yes
Ots-9	GAPS - Standardized	not used	-
Ots-G474	GAPS - Standardized	not used	-
Ots-212	GAPS - Standardized	not used	-
Oki-100	GAPS - Standardized	not used	-
Omm-1080	GAPS - Standardized	not used	-
Ots 10M	not used	NOAA Only	Yes
Ots 2M	not used	NOAA Only	Yes
Oke4	not used	NOAA Only	Yes
Ots 104	not used	NOAA Only	Yes
Ots D9	not used	NOAA Only	Yes
Ssa-197	WDFW Only	not used	-

Table 2. Attribute table for PBT assignments for the 282 spring Chinook salmon sampled and PIT tagged at Priest Rapids Dam in 2010-2011. The assigned parents data were collected by Michael Ford (NOAA) Wenatchee spring Chinook salmon data set for years 2005-2008. All parents captured and sampled in the Wenatchee Basin. The River and Sex designations are generic labels to denote the same or different rivers or sex (e.g., River A versus River A, or River A versus River B, respectively). N = the number of offspring out of the 282 samples that fit into each attribute category. See text for definitions of Last Detected Basin and Determination.

#	Offspring		Parent 1			Parent 2			Determination	Comments	N
	Last Detected Basin	Last Detected River	Spawn Year	Spawn Basin	Spawn River	Spawn Year	Spawn Basin	Spawn River			
1	Wenatchee	River A	Year A	Wenatch.	River A	Year A	Wenatch.	River A	Correct-River		6
2	Wenatchee	River A	Year A	Wenatch.	River A	Year A	Wenatch.	unknown	Correct-River		16
3	Wenatchee	River A	Year A	Wenatch.	River A	----- no assignment -----			Correct-River		1
4	Wenatchee	River A or unknown	Year A	Wenatch.	River A or unknown	Year A	Wenatch.	River A or unknown	Correct - System	Either offspring or parent location is not know but both parents spawned in same year	45
5	Wenatchee	River A or unknown	Year A or unknown	Wenatch.	River A or unknown	----- no assignment -----			Correct - System	One parent, both offspring and parent from Wenatchee system, but either or both river locations not know. Same as #4, but with one parent	22
6	Out-of-basin (Methow or Entiat)	na	----- no assignment -----			----- no assignment -----			Correct - no assigned parents		41
7	Wenatchee	River A	Year A	Wenatch.	River B	Year A	Wenatch.	River B	Correct - System; Incorrect-River	Two parents with matching spawn year and location, but location differs from offspring	2
8	Wenatchee	River A	Year A	Wenatch.	River B	----- no assignment or no locality -----			Correct - System; Incorrect-River	Two or one parents, but only one parental location, and that location does not match offspring	5

Table 2 (con't).

#	Offspring: Last Detected Basin	Offspring: Last Detected River	Parent 1: Spawn Year	Parent 1: Spawn Basin	Parent 1: Spawn River	Parent 2: Spawn Year	Parent 2: Spawn Basin	Parent 2: Spawn River	Determination	Comments	N
9	Columbia mainstem (Priest Rapids, Rocky Island or Rocky Reach Dams)	na	Year A	Wenatch.	River A or unknown	Year A	Wenatch.	River A or unknown	Consistent	Parents match at river and year, but no final location for offspring	1
10	Columbia mainstem (Priest Rapids, Rocky Island or Rocky Reach Dams)	na	Year A or unknown	Wenatch.	River A or unknown	----- no assignment -----			Indeterminate	One parent version of #9	10
11	Columbia mainstem (Priest Rapids, Rocky Island or Rocky Reach Dams)	na	----- no assignment -----			----- no assignment -----			Indeterminate		2
12	Wenatchee	River A or unknown	----- no assignment -----			----- no assignment -----			Indeterminate		9
13	Out-of-basin (Methow or Entiat)	na	Year A	Wenatch.	River A or unknown	Year A	Wenatch.	River A or unknown	Incorrect or stray	Parents identified and spawned same year. No conflict in parental location, but one or both locations may not be know, except from Wenatchee Basin. Offspring found elsewhere	42
14	Out-of-basin (Methow or Entiat)	na	Year A or unknown	Wenatch.	River A or unknown	----- no assignment -----			Incorrect or stray	One parent version of #13	66
15	Wenatchee	River A or unknown	Year A	Wenatch.	River A or unknown	Year B	Wenatch.	River A or unknown	Incorrect	Regardless of match of location, parents did not spawned the same year	5
16	Wenatchee	River A or unknown	Year A	Wenatch.	River A	Year A	Wenatch.	River B	Incorrect	Parents spawned the same year, but not same river; offspring matches one of the parents location	1
17	Out-of-basin (Methow or Entiat)	na	Year A	Wenatch.	River A or unknown	Year B	Wenatch.	River A or unknown	Incorrect		7
18	Columbia mainstem (Priest Rapids, Rocky Island or Rocky Reach Dams)	na	Year A	Wenatch.	River A or unknown	Year B	Wenatch.	River A or unknown	Incorrect		1

Table 3. Parentage assignment results when both parents are assigned, and the complete location (river basin and river) and spawn year information are known for both parents and offspring. In all 29 cases below, parents spawned during the same year. LOD Thresholds are cumulative. That is, a LOD score threshold of 5 would include all assignments with LOD equal to or greater than 5.

Offspring-Parent Attribute #	Determination	Correct Assignment	LOD Threshold				
			5	8	10	15	20
1	Correct-River	Yes	6	6	6	5	2
2	Correct-River	Yes	16	15	15	10	3
7	Correct - System; Incorrect-River	No	2	2	1	1	0
8	Correct - System; Incorrect-River	No	5	1	1	1	0
	Total		29	24	23	17	5
	Correctly Assigned		0.76	0.88	0.91	0.88	1.00

Table 4. Same as Table 3 (both parents assigned), except location and spawn year information may be unknown for some combination of the parents and offspring. Correct assignment is based on the level of information known. For example, Correct – System is considered a correct assignment because we were only able to evaluate the parentage assignment to the level of Wenatchee Basin, and not down to the river within the basin.

Determination	Correct Assignment	LOD Threshold							
		0	1	3	5	8	10	15	20
Consistent	Yes	1	1	1	1	1	1	0	0
Correct - System	Yes	45	45	45	43	38	36	24	11
Correct - System; Incorrect-River	No	7	7	7	7	3	2	2	0
Correct-River	Yes	22	22	22	22	21	21	15	5
Incorrect	No	14	14	13	13	11	9	3	1
Incorrect or stray	No	42	40	39	35	23	12	2	0
Total		131	129	127	121	97	81	46	17
Correctly Assigned		0.52	0.53	0.54	0.55	0.62	0.72	0.85	0.94

Table 5. Same as Table 4, except data are limited to one-parent assignments only. Contrasting this table with Table 4 compares the relative accuracy of one- versus two-parent assignments

Determination	Correct Assignment	LOD Threshold					
		0	1	3	5	8	10
Correct-River	Yes	1	1	1	1	1	0
Correct - System	Yes	22	21	18	9	5	3
Indeterminate	na	10	9	9	4	1	1
Incorrect or stray	No	66	58	43	26	4	0
Total		99	89	71	40	11	4
Correctly Assigned		0.26	0.28	0.31	0.28	0.60	1.00

Table 6. Parentage assignment results when analyses are limited to only those offspring with Wenatchee as the Last Detected Basin. Both one- and two-parent assignments are included and location and spawn year information may be unknown for some combination of the parents and offspring. Correctly Assigned 1 includes all Determination categories. Correctly Assigned 2 excludes Correct – System category, which allows us to compare this analysis to with Table 3 and contrast correct assignment rates between two-parent only (Table 3) and one and two parent (this table).

Determination	Correct Assignment	LOD Threshold							
		0	1	3	5	8	10	15	20
Correct - System	Yes	67	66	63	52	43	39	24	11
Correct - System; Incorrect-River	No	7	7	7	7	3	2	2	0
Correct-River	Yes	23	23	23	23	22	21	15	5
Incorrect	No	6	6	6	6	6	6	3	1
Total		103	102	99	88	74	68	44	17
Correctly Assigned 1		0.87	0.87	0.87	0.85	0.88	0.88	0.89	0.94
Correctly Assigned 2		0.64	0.64	0.64	0.64	0.71	0.72	0.75	0.83

Priest Rapids Dam – Wenatchee River Spring Chinook salmon PBT: Two-year Summary

Wells, Rocky Reach, and Rock Island HCP Hatchery Committees' Meeting

February 15, 2012, Wenatchee, WA

(via WebEx from Olympia, WA)

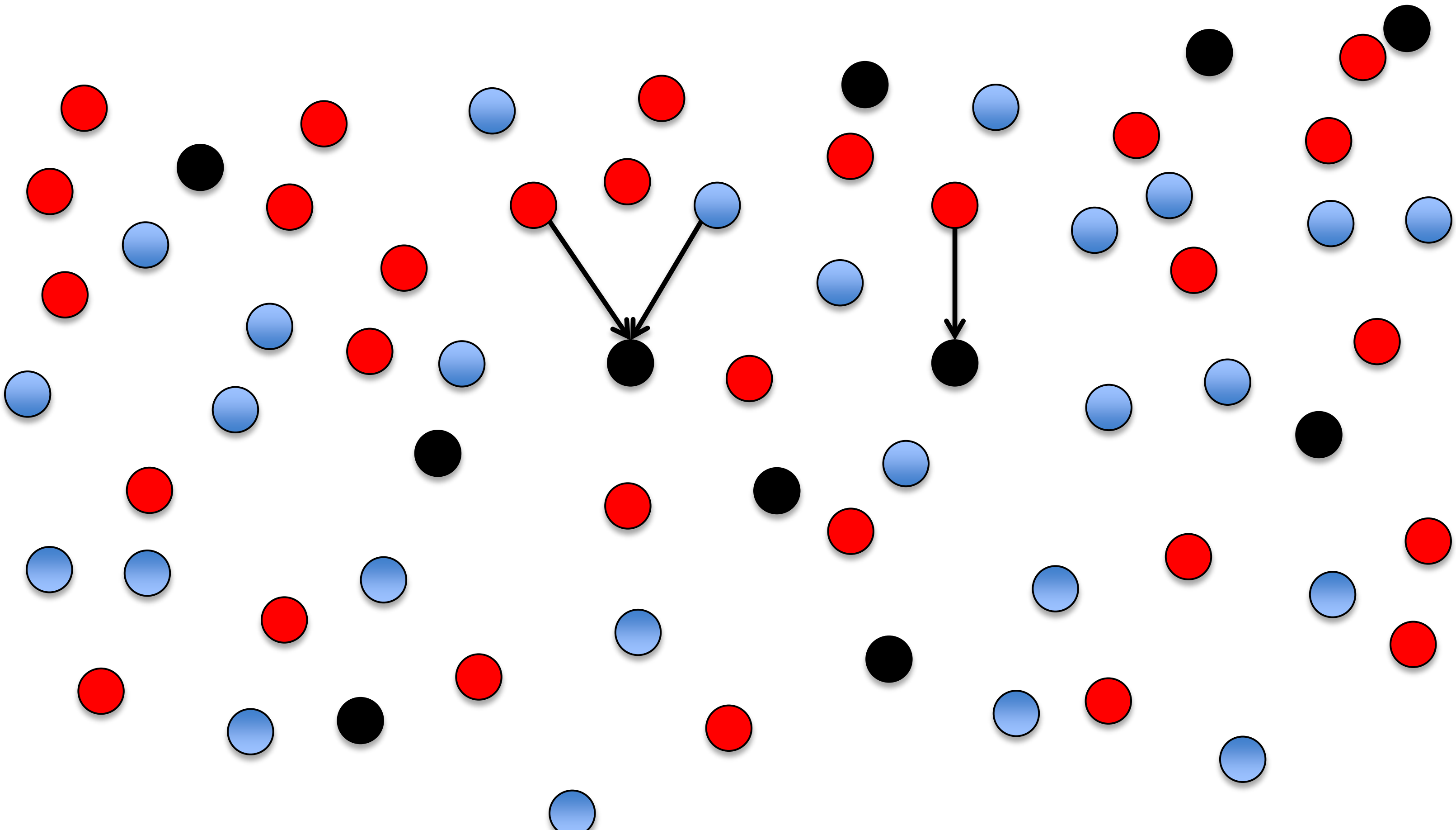
Kenneth I. Warheit

Director, WDFW Molecular Genetics Laboratory

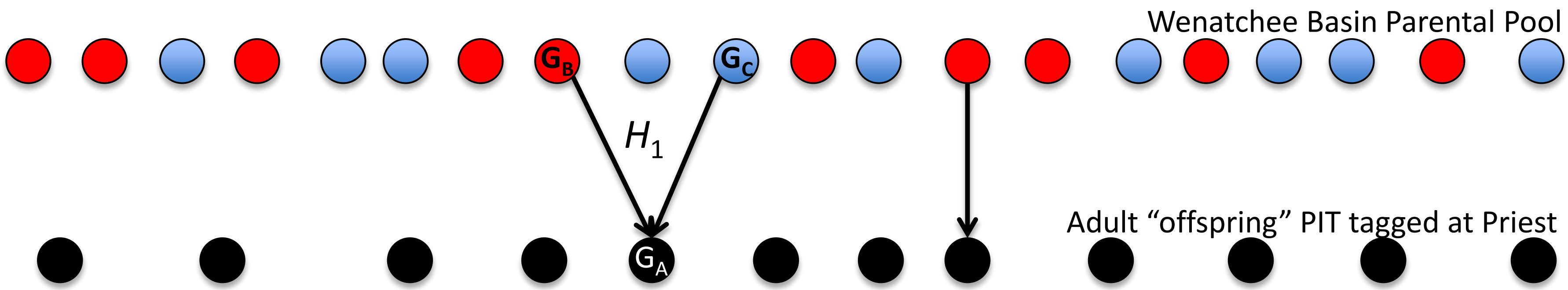
Structure of Discussion

- Parentage Analysis
- Marker types
  - Microsatellite and SNPs
- Summary of Priest Rapids Project (PBT)
  - Limitations
  - Parentage assignment results
  - Sampling issues
- Sampling only at Tumwater Dam
  - Parentage
  - Genetic Stock Identification
  - Power to detect different populations

Parentage Analysis



Parentage Analysis



H_1: Triad = Two parent – offspring relationship
H_2: Triad = Unrelated

$$LOD\ (G_A, G_B, G_C) = \log \frac{Pr(G_A, G_B, G_C \mid H_1)}{Pr(G_A, G_B, G_C \mid H_2)} = \log \frac{T(G_A \mid G_B, G_C)}{Pr(G_A)}$$

1. Calculate LOD scores for all candidate parents
2. Accept triad (or dyad) with highest LOD
3. Evaluate LOD to determine if it is acceptable

From Riester et al. 2009. Bioinformatics 25:2134-2139. FRANz

LOD	Times as Likely
0	1.0
0.1	1.1
0.5	1.6
1	2.7
2	7.4
5	148.4
10	22,026.5
15	3,269,017.4
20	485,165,195.4

Priest Rapids – Wenatchee River Spring Chinook PBT Project

- Goals
  - Test logistics of sampling and PIT tagging at Priest, genotyping in Olympia, and locating at Tumwater
  - Test efficacy of parentage analysis
- Parents (2005 – 2008)
  - Genotyped by NOAA at 13 microsatellite loci.
  - Specific spawning location not known for all samples
- Adult Offspring (2010 – 2011)
  - Genotyped by WDFW at 19 microsatellite loci
  - Final status of individuals not known for all samples
- Last detection of offspring and parents, spawn year, basin, river, sex, and triad or dyad = 18 categories

Microsatellite Locus	Standard Microsatellite Panels		Used in Priest Rapids PBT Analysis
	WDFW Only	Michael Ford (NOAA)	
Ogo-2	GAPS - Standardized	GAPS - Unstandardized	Yes
Ots 104	not used	NOAA Only	Yes
Ots D9	not used	NOAA Only	Yes
Ssa-197	WDFW Only	not used	-

Microsatellites

- Existing parental genotypes from NOAA
- Sufficient power
  - Average # alleles/locus = 27
  - 13 loci
  - Population unique genotypes = 27^{13}
  - 4×10^{18} (4 quintillion)
- Panel of 96 SNPs
  - 8×10^{28} (80 octillion)

Table 3. Parentage assignment results when both parents are assigned, and the complete location (river basin and river) and spawn year information are known for both parents and offspring. In all 29 cases below, parents spawned during the same year. LOD Thresholds are cumulative. That is, a LOD score threshold of 5 would include all assignments with LOD equal to or greater than 5.

Offspring-Parent Attribute #	Determination	Correct Assignment	LOD Threshold				
			5	8	10	15	20
1	Correct-River	Yes	6	6	6	5	2
2	Correct-River	Yes	16	15	15	10	3
7	Correct - System; Incorrect-River	No	2	2	1	1	0
8	Correct - System; Incorrect-River	No	5	1	1	1	0
	Total		29	24	23	17	5
	Correctly Assigned		0.76	0.88	0.91	0.88	1.00

Table 6. Parentage assignment results when analyses are limited to only those offspring with Wenatchee as the Last Detected Basin. Both one- and two-parent assignments are included and location and spawn year information may be unknown for some combination of the parents and offspring. Correctly Assigned 1 includes all Determination categories. Correctly Assigned 2 excludes Correct – System category, which allows us to compare this analysis to with Table 3 and contrast correct assignment rates between two-parent only (Table 3) and one and two parent (this table).

Determination	Correct Assignment	LOD Threshold							
		0	1	3	5	8	10	15	20
Correct - System	Yes	67	66	63	52	43	39	24	11
Correct - System; Incorrect-River	No	7	7	7	7	3	2	2	0
Correct-River	Yes	23	23	23	23	22	21	15	5
Incorrect	No	6	6	6	6	6	6	3	1
Total		103	102	99	88	74	68	44	17
Correctly Assigned 1		0.87	0.87	0.87	0.85	0.88	0.88	0.89	0.94
Correctly Assigned 2		0.64	0.64	0.64	0.64	0.71	0.72	0.75	0.83
Two parent only:					0.76	0.88	0.91	0.88	1.00

Required Sample Sizes

	Escapement		For Egg Take (Females)		Total # Needed @ Tumwater
	Number	Proportion	Number	Proportion	
Chiwawa	2032	0.72	59	0.40	118
Nason	702	0.25	60	0.40	120
White	83	0.03	30	0.20	60
	2817		149		298

From Michael Tonseth & Michael Hughes, WDFW

2,000
(PIT tagged at Priest)

Category	Number	Proportion
Total PIT tagged at Priest Rapids	282	
Returned to Wenatchee River	103	0.37
Minimum LOD = 10	68	0.24
Two-parent assignment	23	0.08

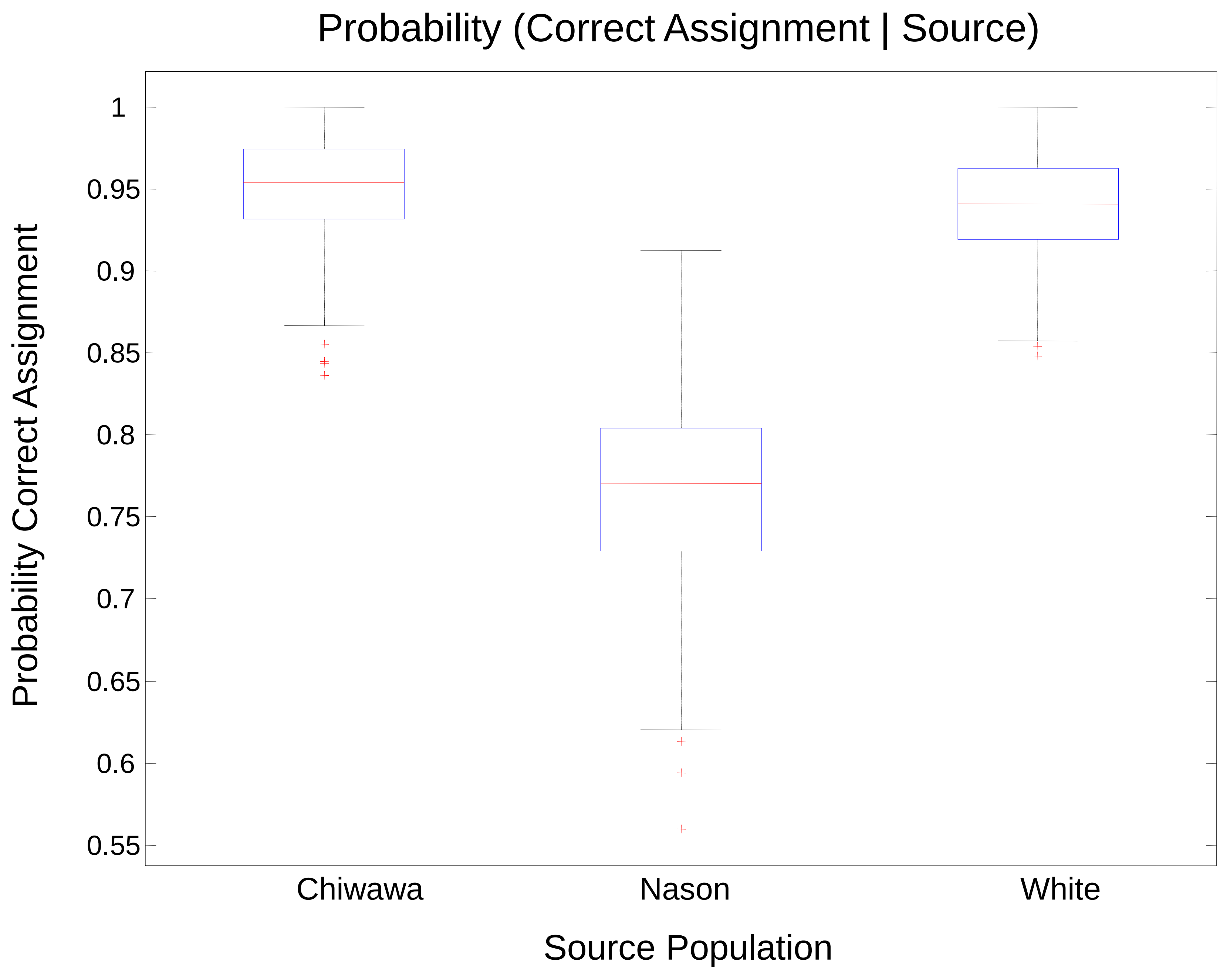
5,405
8,333
25,000
(PIT tagged at Priest

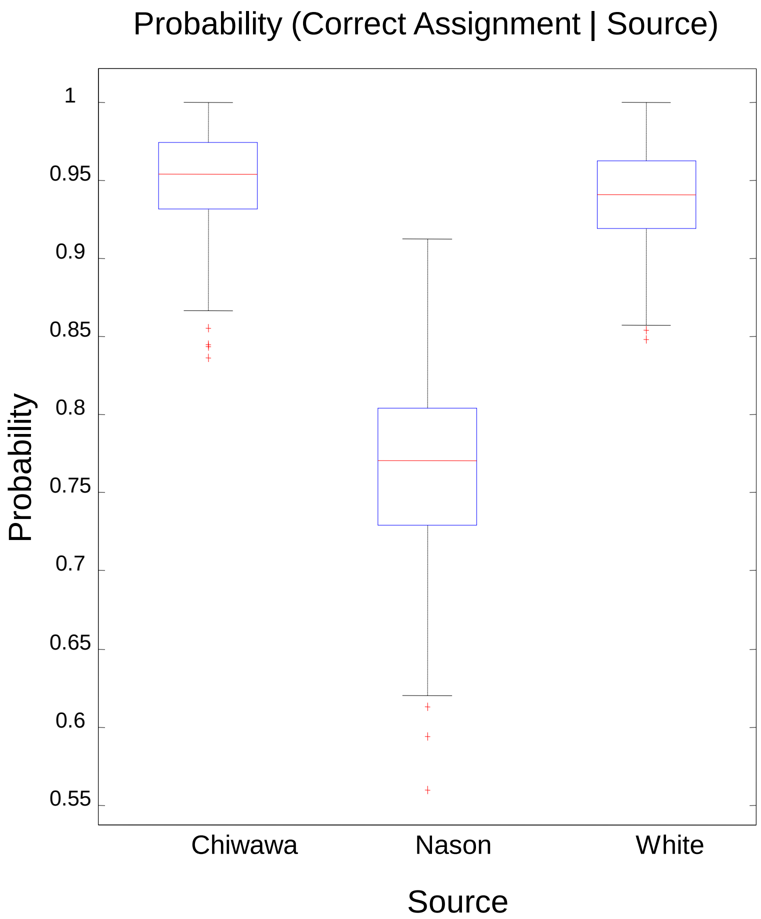
Priest Rapids – Wenatchee River Spring Chinook PBT Project: Summary

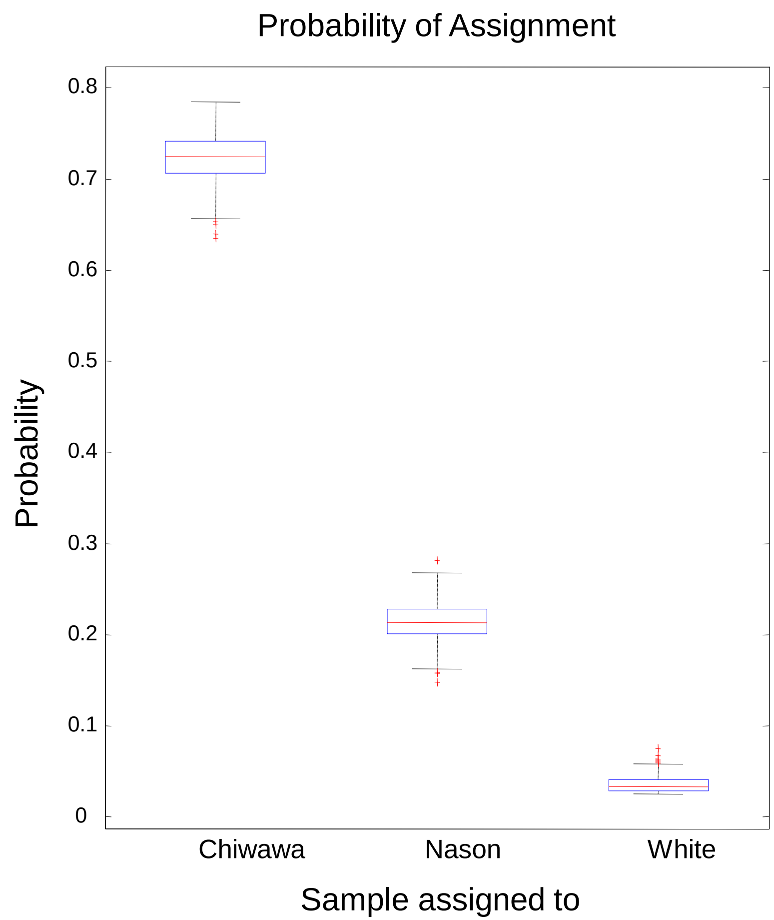
- Logistics: Feasible
- Parentage Analysis:
  - Limited by incomplete adult/offspring information (18 categories)
  - Limited by sample size
  - Possible bias resulting from microsatellite conversions between laboratories
  - LOD ≥ 10, two parent assignment = 90 - 100% correct assignments
  - LOD ≥ 10, one/two parent assignment = 72 – 83% correct assignment
  - More information required (complete parent data) and higher LOD will reduce # of offspring assigned
- Requires high sampling rate at Priest Rapids Dam

Sampling Only at Tumwater

- Parentage Analysis
  - Requires holding fish
  - Rapid turn-around from WDFW-MGL
- Genetic Stock Identification
  - Requires holding fish
  - Rapid turn-around from WDFW-MGL
  - Does not require parental information
  - Does require a good baseline for each population
    - Microsatellite Baseline: exists
    - SNPs Baseline: Not completed
  - Sufficient power?


Probability (Correct Assignment | Source)
Probability Correct Assignment
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
Chiwawa
Nason
White
Source Population

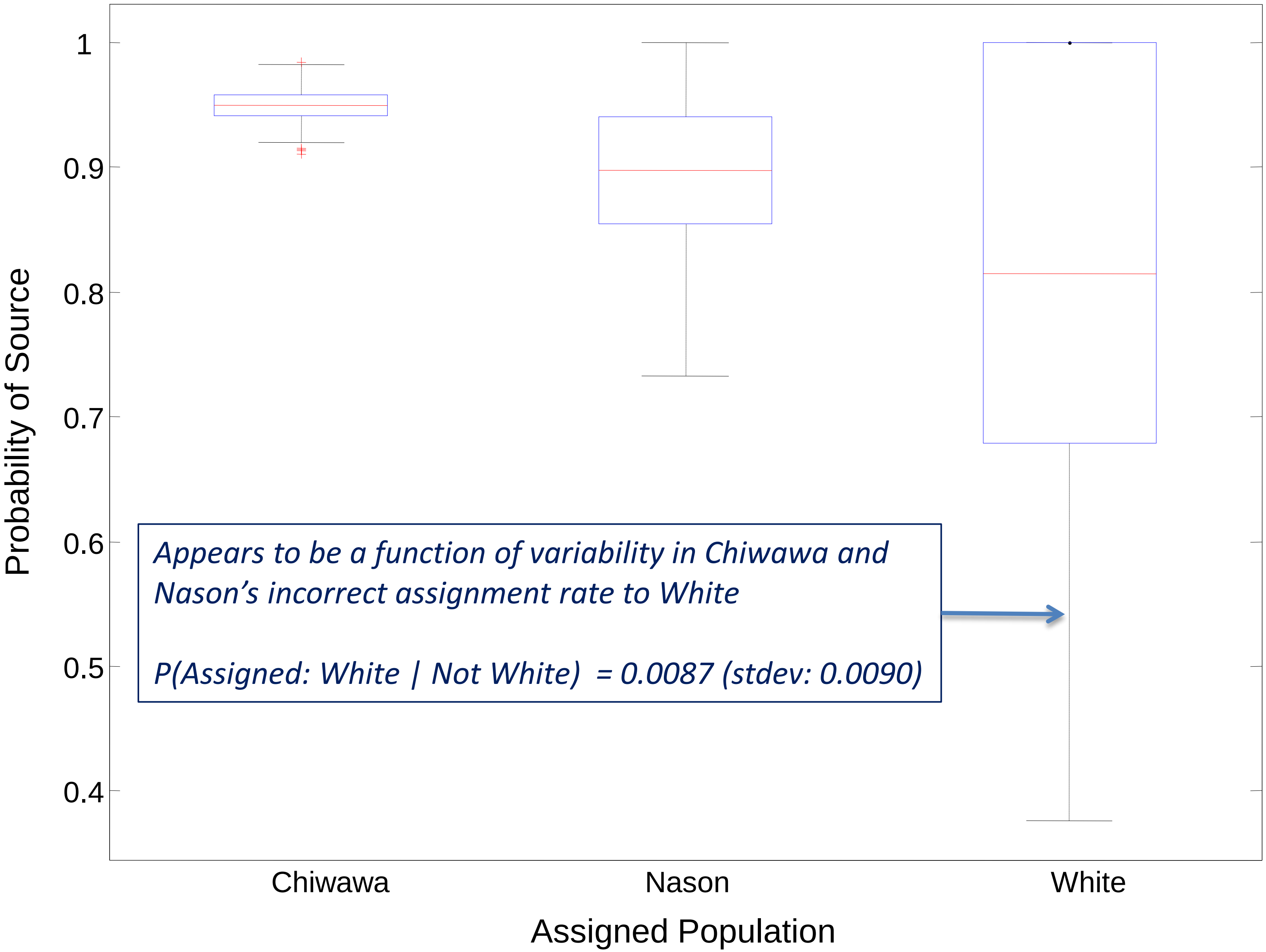


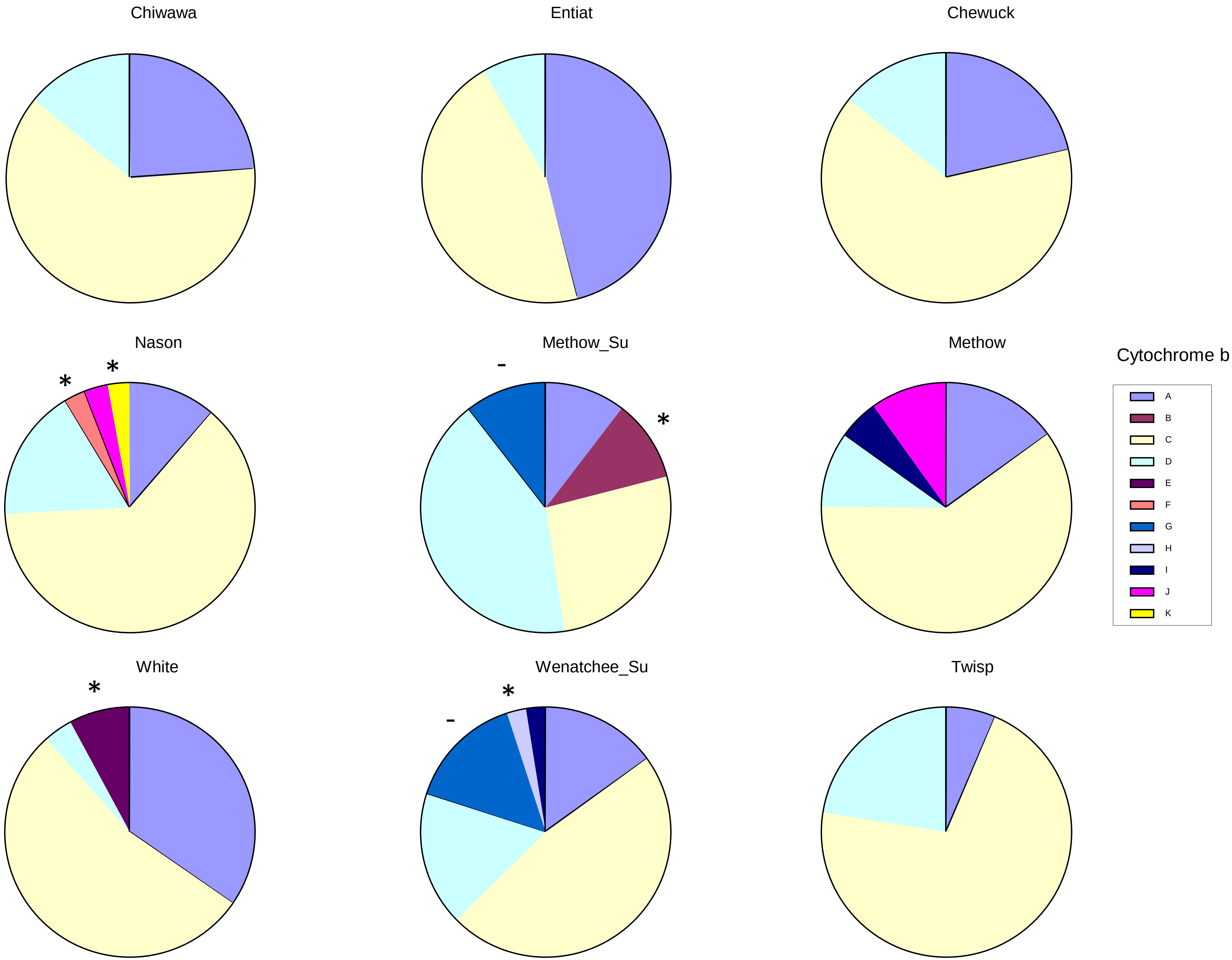


- From same analysis – calculate Pr(Not Correct Assign | Source)
- Probability of Source = escapement proportions (C: 0.72, N: 0.25, W: 0.03)
- Calculate Probability of Assignment

Probability (Source | Assignment)

Probability of making a correct assignment





Chiwawa
Entiat
Chewuck
Nason
Methow_Su
Methow
Cytochrome b
A
B
C
D
E
F
G
H
I
J
K
White
Wenatchee_Su
Twisp

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
FISH PROGRAM -SCIENCE DIVISION
SUPPLEMENTATION RESEARCH TEAM
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January 24, 2012

To: Joe Miller, Chelan County PUD

From: Travis Maitland and Ken Warheit

Subject: 2010 and 2011 Parental-Based Tagging Project at Priest Rapids Dam

In 2010 and 2011 the PBT Feasibility Test was intended to address several objectives necessary for the evaluation of PBT as an alternative brood stock collection method. Specifically, this test was intended to provide an evaluation of (1) trapping and handling effects; (2) logistical feasibility and (3) accuracy of parental based assignments.

Methods

Adult trapping and sampling

Sampling at the Priest Rapids Off Ladder Adult Fish Trap (OLAFT) occurred during two different two week periods in May and June of 2010 and 2011 respectively. In 2010 trapping occurred from May 1st through May 14th. In 2011 trapping occurred from June 1st through June 16th. The shift in sample period from 2010 to 2011 was implemented in an effort to target a higher proportion of Wenatchee River Basin bound spring Chinook as indicated by PIT tag detections during 2008 through 2010. This sampling would consist of (1) trapping spring Chinook at the facility, (2) PIT-tagging up to 200 wild individuals and (3) collecting a tissue sample from each tagged fish. During the two week period in 2010, trapping was conducted for up to five days in a row for a period of up to 16 hours per day to evaluate the potential for trapping effects on adult passage. The target number of natural origin fish sampled was 100 per week. This sampling approach was intended to provide a snap-shot of the effects of operating the OLAFT under conditions simulating full implementation, however, the number of fish sampled (i.e., 200 natural origin Chinook) and duration of the test (i.e., two weeks) would limit the potential for large scale un-anticipated negative effects.

Results from 2010 indicated that there were no significant negative trapping and handling effects. Hence, trapping in 2011 was conducted only up to the point at which the sample goals were met to include all weekdays and weekend days up to 12 hours per day. The target number of natural origin fish sampled was 200 during the sampling period.

After tagging, tissue samples were analyzed by the WDFW genetics lab and assignment probabilities were generated for each fish (with respect to parental genotypes for the Chiwawa River, White River and Nason Creek). Finally, throughout the spring and summer, all Wenatchee bound PIT tagged fish would be detected at Tumwater Dam and interrogated at tributary PIT tag detection arrays to evaluate the conversion from Priest Rapids Dam, and to determine the accuracy of predicted parental based assignments to individual tributaries.

Analysis

Objective 1: Trapping and handling effects- The metrics contributing to this objective would be (a) observed mortality/injury during handling at the OLAFT, (b) relative ratio of fish passage at right and left ladders during the OLAFT operation and periods outside of operation (2010 only), and (c) conversion rates and travel times of PBT PIT-tagged Chinook versus lower River PIT-tagged Chinook (and other sources) from Priest Rapids Dam to Rock Island Dam.

Any observed mortality or injury of fish during sampling was recorded and summarized. In 2010, the proportion of spring Chinook utilizing the left bank ladder when the trap was not operating was compared to the proportion when the trap was operating using a t-test. Proportions were arc-sine square root transformed to meet assumption of normality. Comparisons of travel times of fish sampled and not sampled were also conducted using a t-test. We used previously PIT tagged fish from the Chiwawa River (hatchery and wild) that passed Priest Rapids Dam in May as our control for fish sampled at Priest Rapids Dam. Conversion rates were calculated using the query available on the DART website (http://www.cbr.washington.edu/dart/pit_obs_adult_obs_de.html). However, because relatively large homogenous groups of PIT tagged fish may increase tag collision (i.e., not be detected) at Rock Island Dam, a separate query of fish tagged at Priest Rapids Dam was performed for all possible locations upstream of Rock Island Dam.

Objective 2: Logistical Feasibility- The metrics contributing to this objective would be (a) evaluation by crews operating and maintaining the OLAFT; (b) turn-around time for the WDFW genetics lab; (c) evaluation by crews operating Tumwater Dam (TWD); (d) PIT tag detection rates at Tumwater Dam and tributary arrays; and (e) conversion rates from Priest Rapids Dam to Rock Island Dam and Tumwater Dam are similar to past years -- of those assigned to tributaries above Tumwater Dam, >83% actually arrive at TWD.

Objective 3: Accuracy of parental based assignments – See Appendix A.

Results

Objective 1: Trapping and handling effects

In 2010, the spring Chinook run timing in the Columbia River was later than expected and adequate numbers of fish were not observed until the middle of May. The OLAFT was operated for 43 hours the week of May 9 and 41 hours the week of May 16. A total of 1,984 spring Chinook were passed upstream during trap operation and 196 wild fish were DNA sampled and PIT tagged. Of which, seven fish were PIT tagged as a juvenile at a smolt trap or adult at Bonneville Dam. No mortalities or injuries were reported. No difference was found in the proportion of spring Chinook that used the left ladder on trapping (91.8%) versus non-trapping (87.9%) days (t-test: t= -1.21, P = 0.233; Figure 1). No difference was detected in the travel time from Priest Rapids Dam to Rock Island Dam for fish sampled (3.41 days; N = 175;) and those not sampled (4.07 days; N = 47) during the month of May (t-test: t= 1.71, P = 0.09).

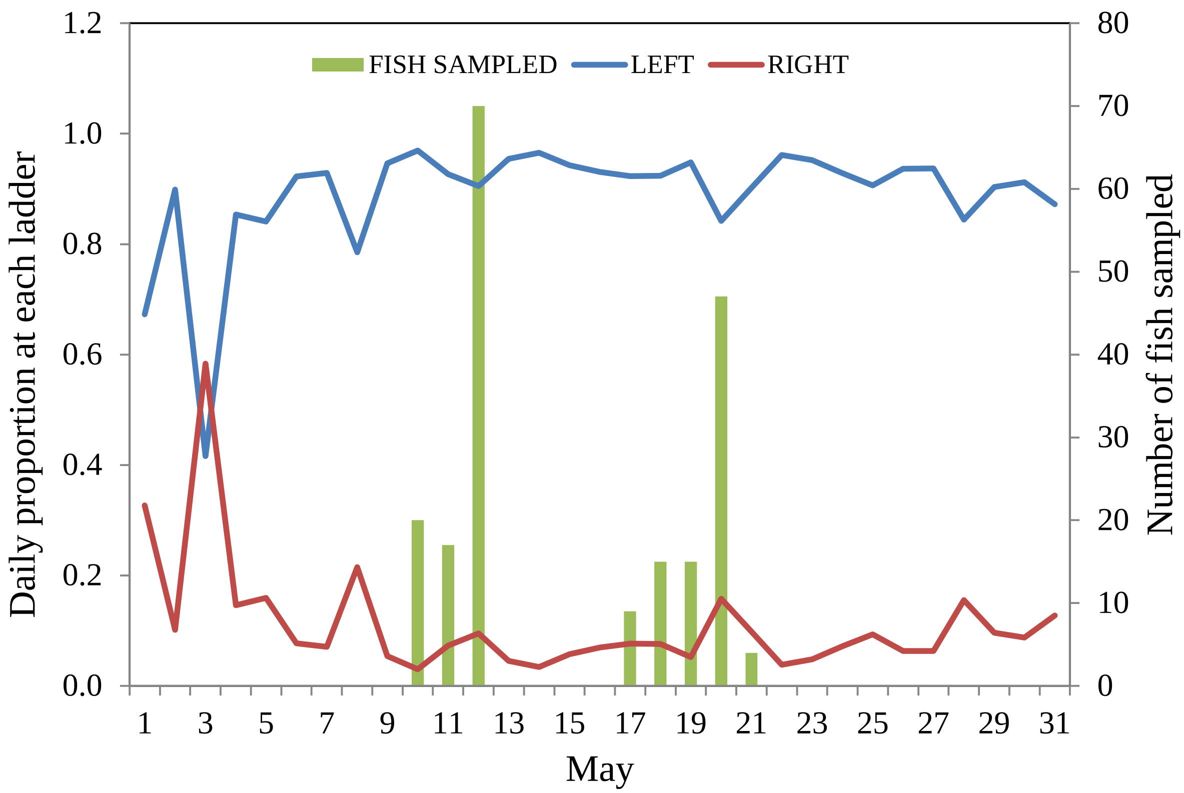


Figure 1. Proportion of spring Chinook using left and right bank ladder trap at Priest Rapids Dam in 2010. Green bars denote number of fish sampled on each day.

In 2011, the spring Chinook run timing in the Columbia River at Priest Rapids Dam was once again later than that of the 10 year average as well as the run timing in 2010. The OLAFT was operated for approximately 170 hours during the sampling period (June 1 through June 18), with June 5 being the only day the trap was not operated due to mechanical issues. A total of 406 spring Chinook (adults and jacks) were passed upstream during trap operation and 86 presumed naturally produced spring Chinook were DNA sampled and PIT tagged. Of which, four fish were determined to be of summer Chinook race and four fish were determined to be of hatchery origin after scale analysis was conducted and three fish were tagged as a juvenile at smolt traps. No mortalities or injuries were reported. No difference was detected in the travel time from Priest Rapids Dam to Rock Island Dam for fish sampled (5.07 days; N = 39) and those not sampled (4.06 days; N = 85) during the month of June (t-test: t= 1.74, P = 0.08).

In 2010, conversion rates of PIT tagged fish from Priest Rapids to Rock Island Dam using the standard DART query resulted in similar rates for those fish that were PIT tagged as juveniles and not sampled (Table 1). In 2011, conversion rates of PIT tagged fish from Priest Rapids to Rock Island Dam using the standard DART query resulted in higher conversion rates than those fish that were PIT tagged as juveniles and not sampled (Table 2). Because fish sampled at PRD were PIT tagged in large groups on a daily basis in 2010, the likelihood of tag collision at Rock Island Dam may be higher when compared to fish return from throughout the run. This was most likely not an issue in 2011 due simply to the fact that there were far fewer fish tagged on a daily basis. A user defined query using PTAGIS of all PBT study fish found that 98% and 95% were detected at or upstream of Rock Island Dam in 2010 and 2011 respectively.

Table 1. Conversion rates of PIT tagged fish at Priest Rapids Dam to Rock Island Dam in 2010.

Tagging location	Number of fish at PRD	Number of fish detected	Conversion rate
Chiwawa smolt trap	54	51	0.944
Chiwawa River	16	15	0.938
Chiwawa Hatchery	98	87	0.888
Entiat River	62	62	1.000
LNFH	127	123	0.969
Methow Trap	3	1	0.333
Methow River	6	6	1.000
Nason Creek	11	11	1.000
Rocky Reach Bypass	1	1	1.000
Twisp River	23	21	0.913
Wenatchee River	2	2	1.000
Wenatchee Trap	7	6	0.857
White River Trap	1	1	1.000
WNFH	19	19	1.000
subtotal	**430**	**406**	**0.944**
Priest Rapids Dam	187	176	0.941
Study Fish	196	192	0.980

Table 2. Conversion rates of PIT tagged fish at Priest Rapids Dam to Rock Island Dam in 2011.

Tagging location	Number of fish at PRD	Number of fish detected	Conversion rate
Chiwawa Smolt Trap	70	60	0.857
Chiwawa River	23	21	0.913
Chiwawa Hatchery	118	91	0.771
Entiat River	49	44	0.898
LNFH	72	68	0.944
Methow Hatchery	75	54	0.720
Methow River	4	3	0.750
Nason Creek	14	11	0.786
Rocky Reach Bypass	1	1	1.000
Twisp River	20	15	0.750
Wenatchee River	1	1	1.000
Upper Wenatchee Trap	4	4	1.000
Lower Wenatchee Trap	2	1	0.500
Wolf Creek	107	73	0.680
WNFH	33	30	0.909
Wells Dam	2	2	1.000
subtotal	**595**	**479**	**0.805**
Priest Rapids Dam	83	79	0.952
Study Fish	86	82	0.953

Objective 2: Logistical Feasibility

During operation of the OLAFT in 2010, no injuries to fish or issues operating the trap were identified. Trapping was conducted as planned without incident. Similarly, the Tumwater fish trapping facility was also operated without incident. Results of pedigree assignments for fish sampled during the two week period were completed on May 21 (7 d) and June 1 (8 d), respectively. In 2010, travel time from Priest Rapids Dam to Tumwater Dam averaged 41.8 d (SD = 7.6) with a median of 42.4 days. The shortest travel time was 27 days.

In 2011, travel time from Priest Rapids Dam to Tumwater Dam averaged 34.4 d (SD = 10.11) with a median of 31.1 days for those fish sampled at the OLAFT. The shortest travel time was 23 days. During operation of the OLAFT in 2011, no injuries to fish were identified. With the exception of one day (June 5), trapping was conducted as planned without incident. Similarly, the Tumwater fish trapping facility was also operated without incident. However, due to the lack of wild spring Chinook that were encountered while trapping at the OLAFT, the sample size goal for Priest Rapids (N = 200) was not achieved. This may have been due in part to adjusting the sampling period to the first two weeks in June rather than the last two weeks in May, as was the case in 2010. A further investigation of PIT tag detections at the antennae array located in the ladder just above the OLAFT revealed that fish may have waited until daily trapping operations were concluded before moving upstream (i.e., trap avoidance). We also experienced a relatively high and extended river discharge which may have contributed to the poor trapping efficiency. We also examined the conversion rate of known Wenatchee River adults to Tumwater Dam (Table 3). Overall, 87% and 84% of the PIT tagged fish detected at PRD were also detected at Tumwater Dam in 2010 and 2011, respectively. Of those fish detected at Tumwater Dam, 55% and 83% were detected at various arrays in the upper Wenatchee Basin in 2010 and 2011, respectively (Table 4).

Table 3. Conversion rates of wild adult spring Chinook tagged in the Wenatchee Basin as juveniles to Tumwater Dam in 2010 and 2011.

Trap site	Number at PRD	Number at Tumwater	Conversion rate
	2010 Conversion Rates		
Chiwawa	72	62	0.86
Nason	11	10	0.91
Wenatchee	7	6	0.86
Total	90	78	0.87
	2011 Conversion Rates		
Chiwawa	70	58	0.83
Nason	14	13	0.93
Wenatchee	4	3	0.75
Total	88	74	0.84

Table 4. Conversion rates of wild adult spring Chinook at Tumwater Dam to PIT tag instream arrays in 2010 and 2011.

Trap site	Number at Tumwater Dam	Number at PIT tag arrays	Conversion rate
	2010 Conversion Rates		
Chiwawa	62	38	0.61
Nason	10	8	0.80
Wenatchee	6	3	0.50
Priest Rapids Dam	34	13	0.38
Total	112	62	0.55
	2011 Conversion Rates		
Chiwawa	58	51	0.88
Nason	13	10	0.77
Wenatchee	3	3	1.00
Priest Rapids Dam	29	21	0.72
Total	103	85	0.83

Objective 3: Accuracy of parental based assignments

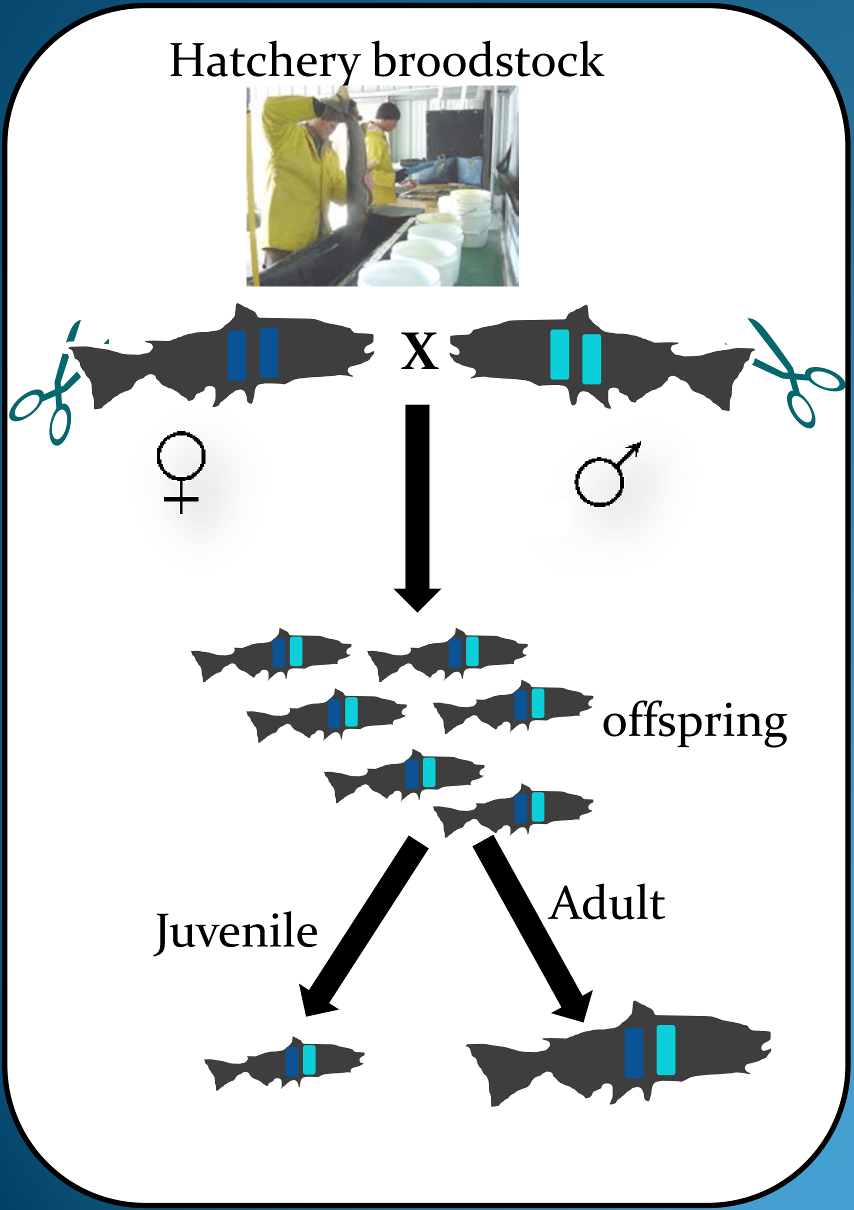
See Appendix A.

Discussion

Trapping and sampling adult spring Chinook at the OLAFT did not appear to have a significant effect on fish passage or survival in either year. A potential trap avoidance problem may have been encountered in 2011 that prevented sample size goals from being met. The proportion of fish assigned to a spawning tributary were much lower than expected and was most likely influenced by the proportion of parents assigned to a spawning tributary between 2005 and 2007. In recent years, the proportion of fish upstream of Tumwater Dam assigned to spawning tributary has greatly increased (~85%). Thereby increasing the probability that a Wenatchee River bound fish sampled at Priest Rapids Dam would be correctly identified to a tributary of origin. Furthermore, to best assess the accuracy of the PBT analysis, we limited the evaluation to only those assignments with two parents and all parental and offspring attributes known. This further reduced the number of offspring that we were able to assign to only 29 of the 282 (10%). Any future program would need to increase sampling rates at the Priest Rapids facility to ensure an appropriate number of fish (i.e., broodstock goal) are assigned to two parents with a minimum LOD score of 10. However, we recognize that without extensive modifications to the OLAFT facilities to increase trapping efficiency, sufficient sample rates in all likelihood cannot be achieved. We further recommend minimizing genotyping errors, which can negatively affect parentage assignment rates, by performing genotyping in only one laboratory, using standardized and uniform allele nomenclature.

What is parentage based tagging (PBT)

Genetic tags (PBT)

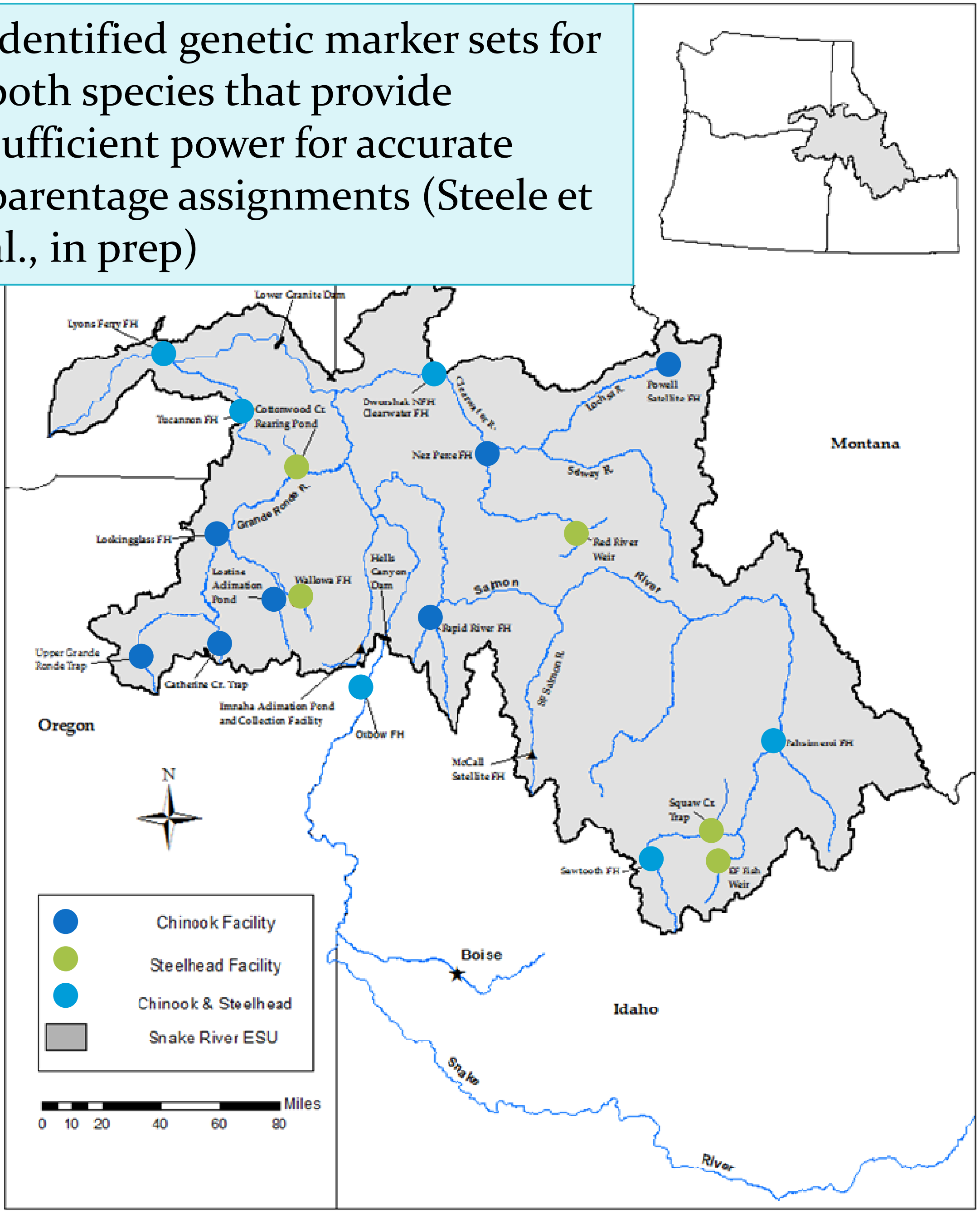


- Genetic tagging of hatchery broodstock = can identify hatchery of origin and age for ANY offspring produced
  - Passive mark (no handling of juveniles)
  - Nearly 100% tagging rate of hatchery fish
  - Eliminates issues with tag loss, tag detection, handling mortality
  - Non-lethal sample to recover tag from offspring

- ➢ Stock contribution to various fisheries
- ➢ Survival trends
- ➢ Escapement estimates
- ➢ Origin of strays and kelts

Snake River basin PBT

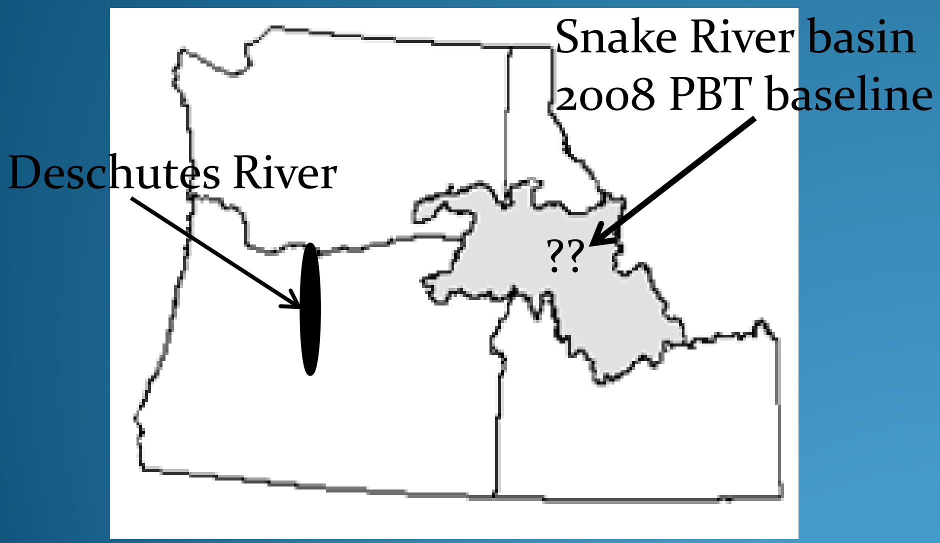
Identified genetic marker sets for both species that provide sufficient power for accurate parentage assignments (Steele et al., in prep)



- Sample all hatchery broodstock:
  ~5,000 steelhead/yr
  ~9,000 Chinook salmon/yr
- Parental sampling complete for 2008 -2011
- All hatcheries record spawn dates and gender (many provide lengths and spawn cross)
- Permanently "tag" ~20 million smolts/yr!

An example application of PBT: Origin of hatchery steelhead strays in the Deschutes River

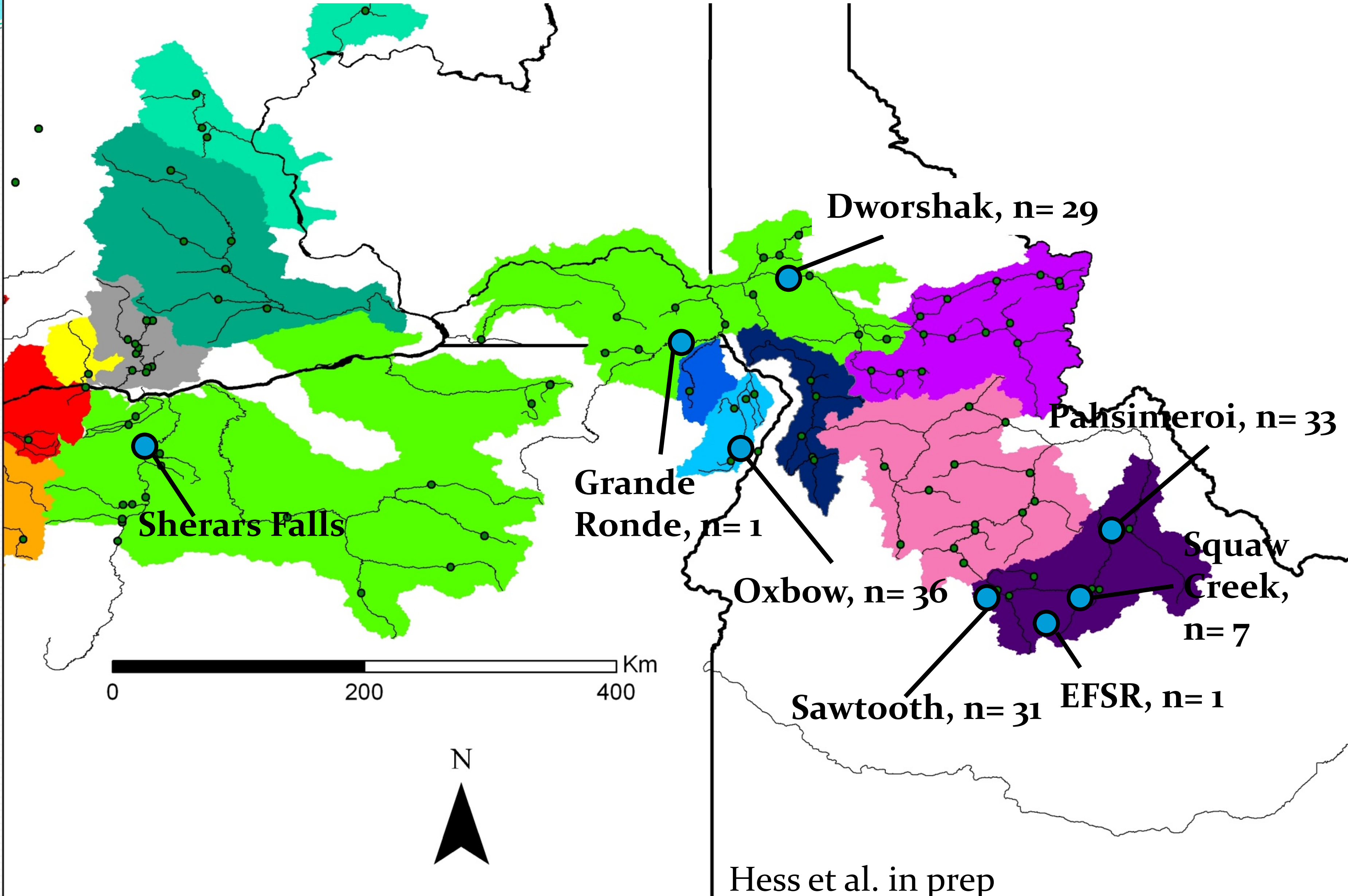
- 462 hatchery steelhead sampled at Sherars Falls, Deschutes River in 2011
  (unknown portion of 3 year old genetically tagged fish)
- Portion of strays from the Snake River basin?



- Steelhead sampled by Rod French ODFW and genotyped by CRITFC
- Sampling continuing in 2012

Hess et al. in prep

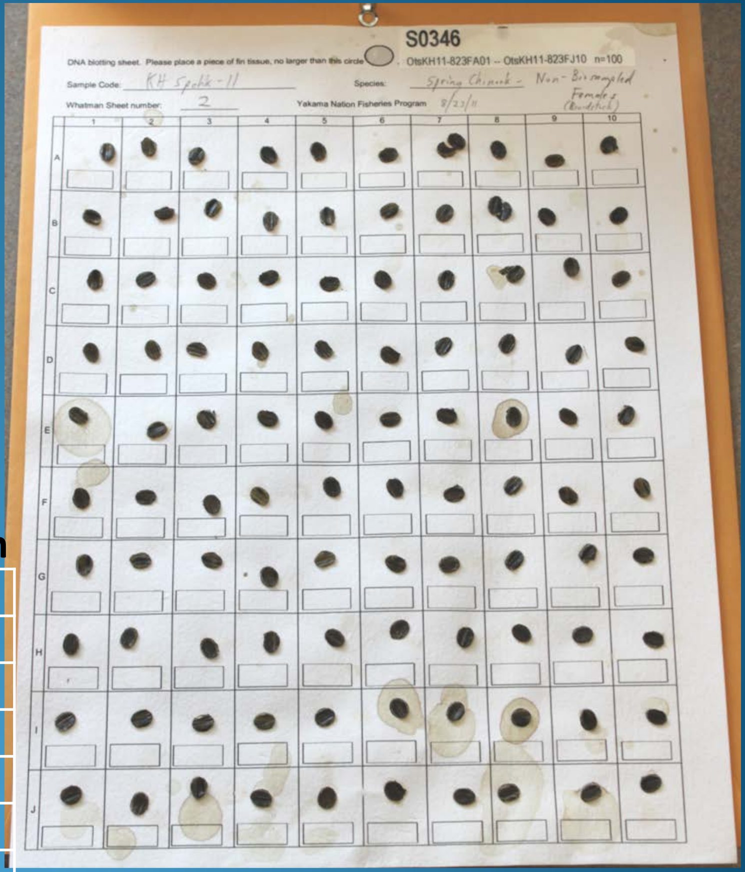
Of the 462 hatchery-origin returns, 138 (~30%) assigned to the 2008 Snake River basin PBT baseline



Goal: Extend PBT sampling to ALL Chinook salmon and Steelhead hatcheries above Bonneville Dam beginning 2012

Large collaborative effort between the tribes, ODFW, WDFW, IDFG, USFWS

Required as fish are spawned:
- Fin tissue
- Spawn date
- Gender



Sample ID	Spawn Date	Gender	Cross 1	Cross 2	Length
PAH12-0001	4/10/2012	M			600
PAH12-0002	4/10/2012	M			730
PAH12-0003	4/10/2012	F	PAH12-0001	PAH12-0007	640
PAH12-0004	4/10/2012	F	PAH12-0009		640
PAH12-0005	4/14/2012	F	PAH12-0002	PAH12-0007	620
PAH12-0006	4/14/2012	F	PAH12-0001		600
PAH12-0007	4/14/2012	M			590
PAH12-0008	4/20/2012	F	PAH12-0007		620
PAH12-0009	4/20/2012	M			620

Hatchery rearing facilities identified in US v OR management production table document (2/7/11)

Steelhead rearing facilities

Chinook salmon rearing facilities

Need assistance with identifying broodstock collection facilities & sample coordination

Steelhead

Prosser
Ringold
Wells
Winthrop NFH

Irrigon
Oak Springs
Skamania for Klickitat

Umatilla
Clearwater
Dworshak NFH
Hagerman NFH
Lyons Ferry
Hagerman NFH
Niagara Springs
Pahsimeroi
Sawtooth

Chinook salmon

Carson NFH
Cle Elum Hatchery
Eastbank
Entiat NFH
Leavenworth NFH
Methow
New Grant PUD facility
Priest Rapids Hatchery
Prosser
Turtle Rock
Wells
Winthrop NFH

Bonneville
Little White Salmon NFH
Round Butte
Spring Creek NFH

Klickitat Hatchery
Umatilla
Warm Springs NFH
Clearwater. FH
Dworshak NFH
Kooskia NFH
Lookingglass
Lyons Ferry
McCall Hatchery
Nez Perce Tribal Hat
Oxbow
Pahsimeroi
Rapid River
Sawtooth

Juvenile Spring Chinook Size, Survival, and Age at Maturity

Josh Murauskas

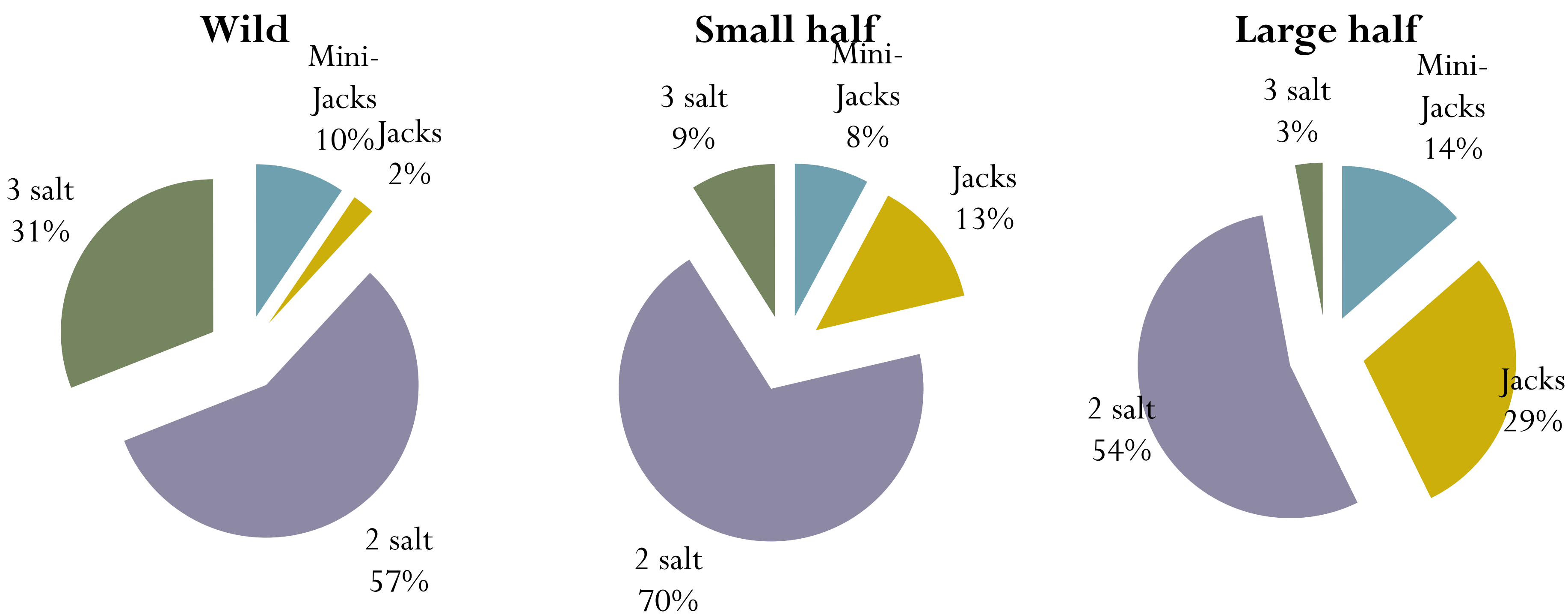
Chelan PUD Natural Resources Department

February15, 2012

Summary of analyses to date

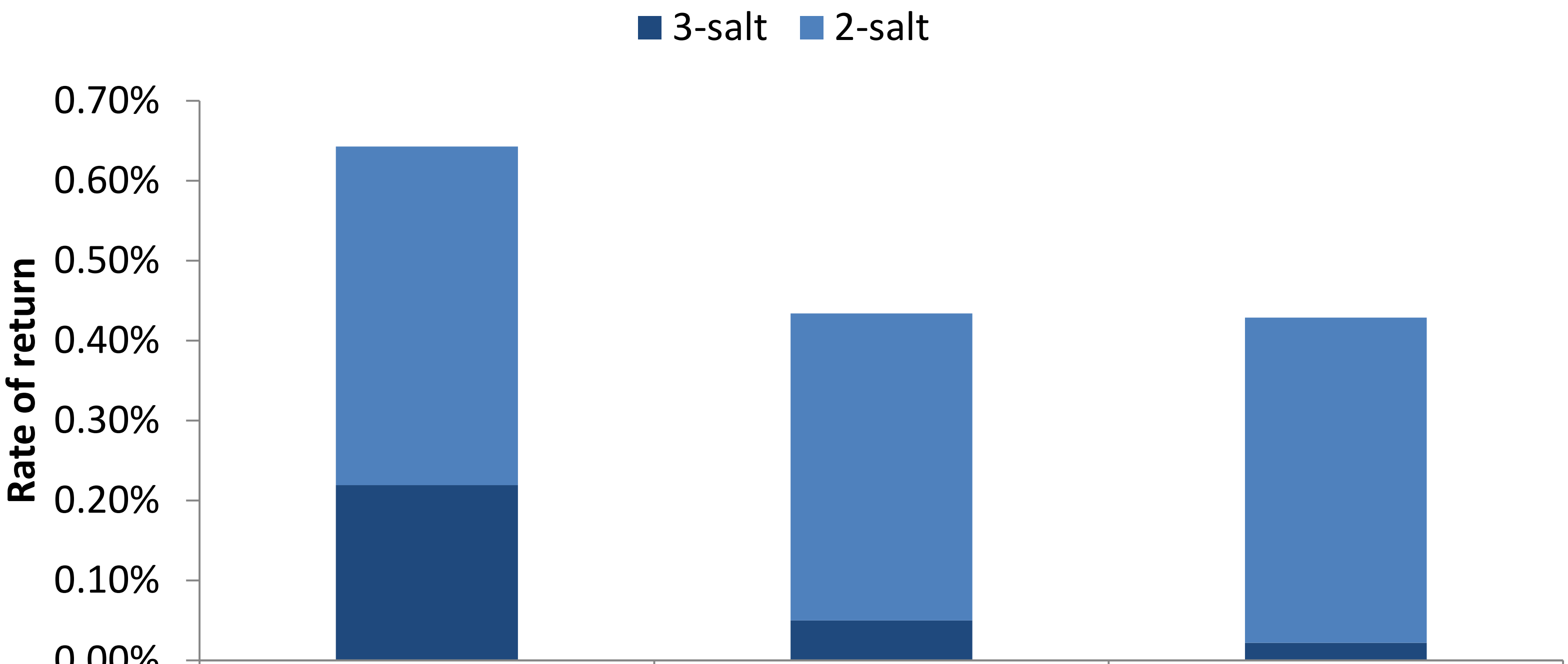
- No apparent benefit in larger hatchery smolts
- Apparent drawback in larger hatchery smolts
- Smaller hatchery smolts perform more similarly to wild fish
  - No effect on female returns

Proportion of age classes by group



12% < 2 salt fish | **21% < 2 salt fish** | **43% < 2 salt fish**

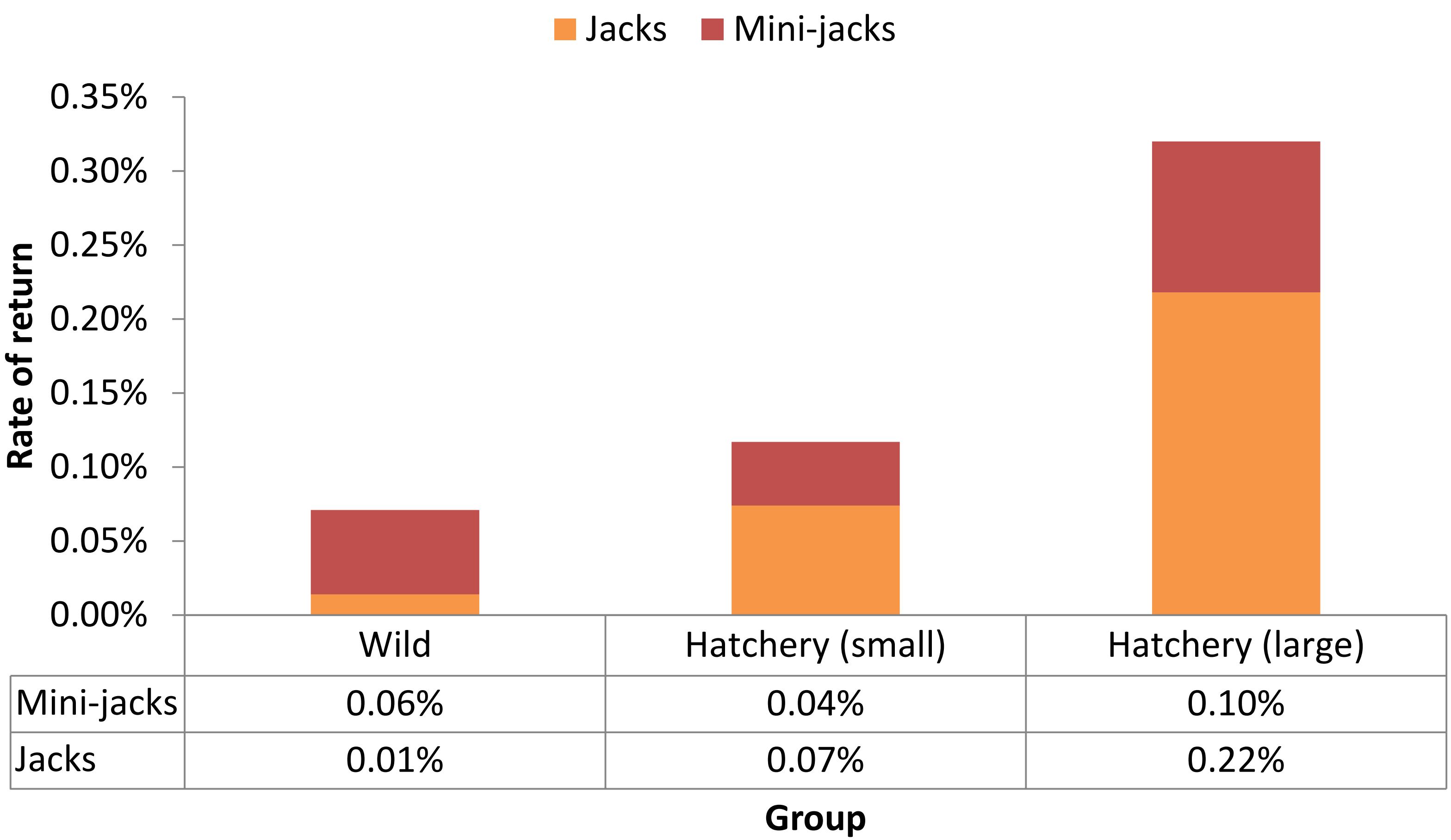
Average returns from Chiwawa R.



	Wild	Hatchery (small)	Hatchery (large)
2-salt	0.42%	0.38%	0.41%
3-salt	0.22%	0.05%	0.02%

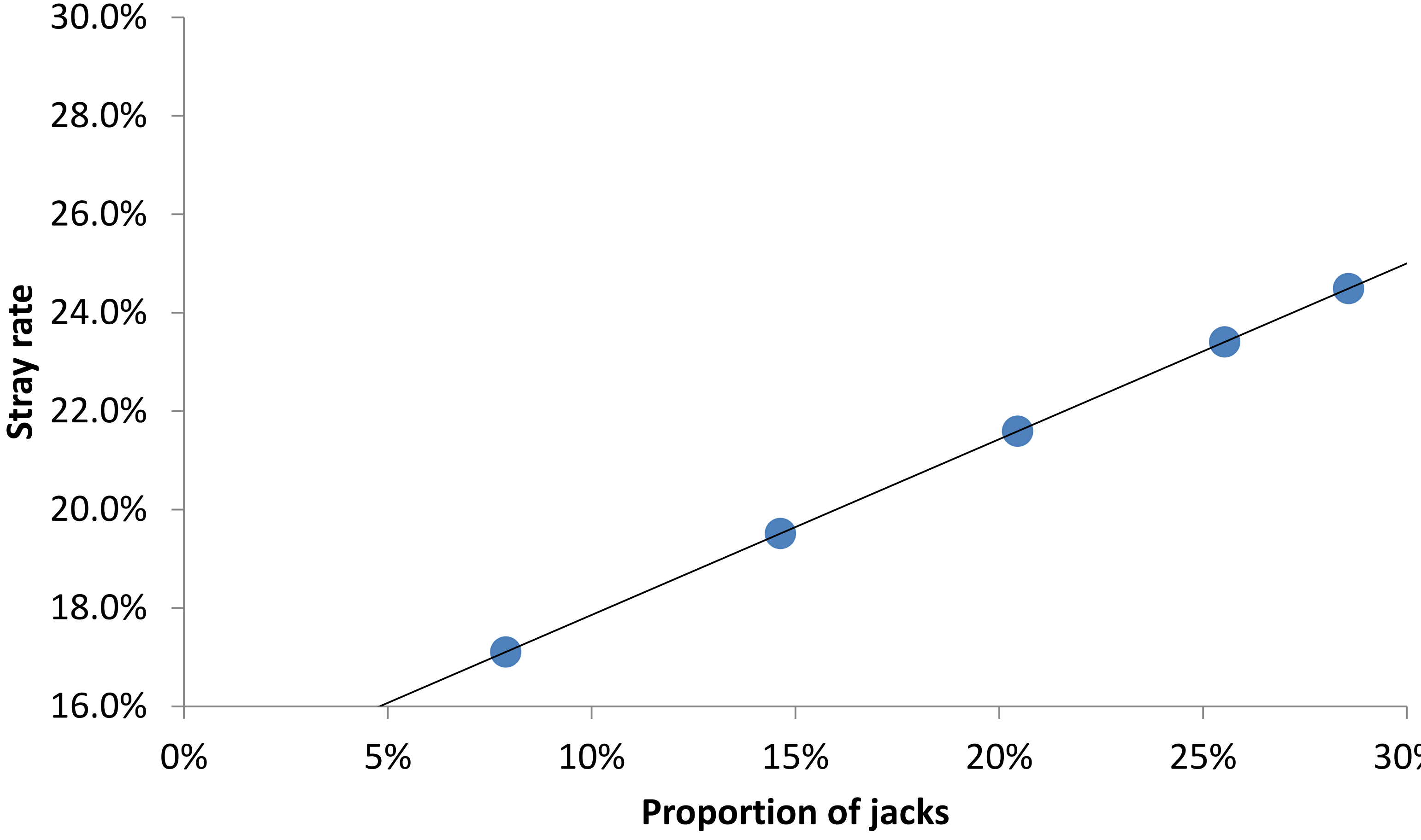
Group

Average returns from Chiwawa R.



	Wild	Hatchery (small)	Hatchery (large)
Mini-jacks	0.06%	0.04%	0.10%
Jacks	0.01%	0.07%	0.22%

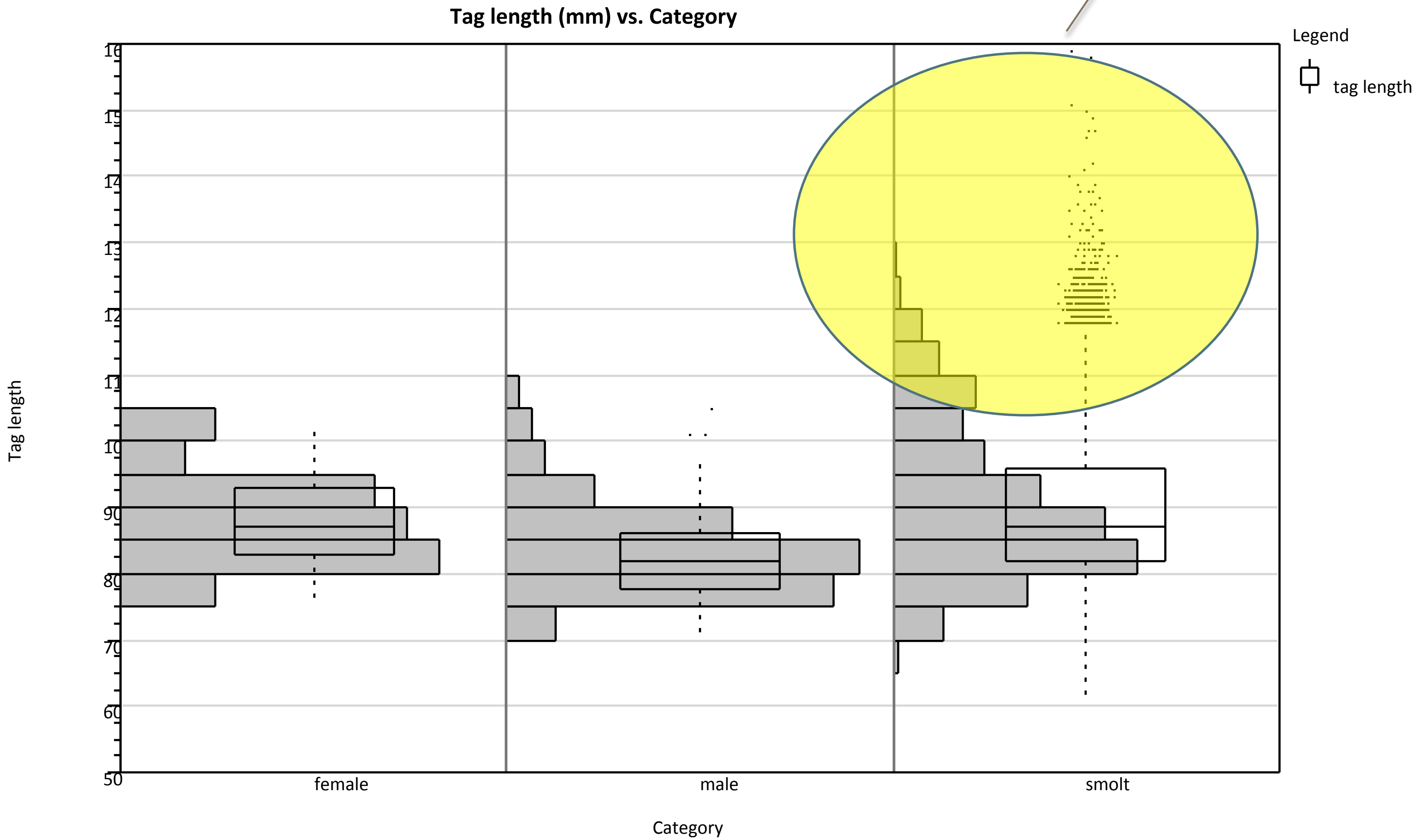
Stray rates



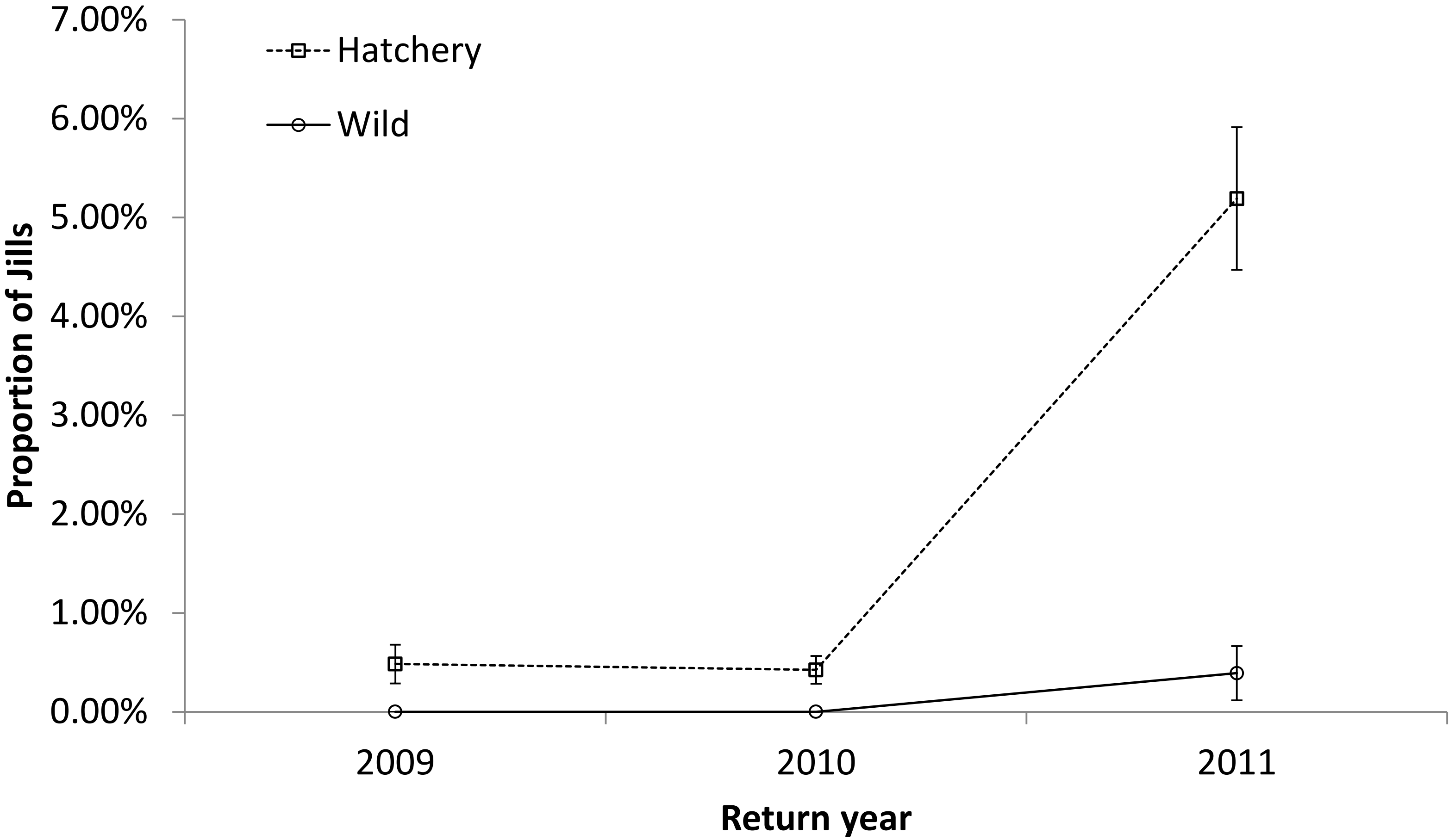
Data from A. Murdoch, WDFW

Female returns

Larger smolts do not contribute to adult returns

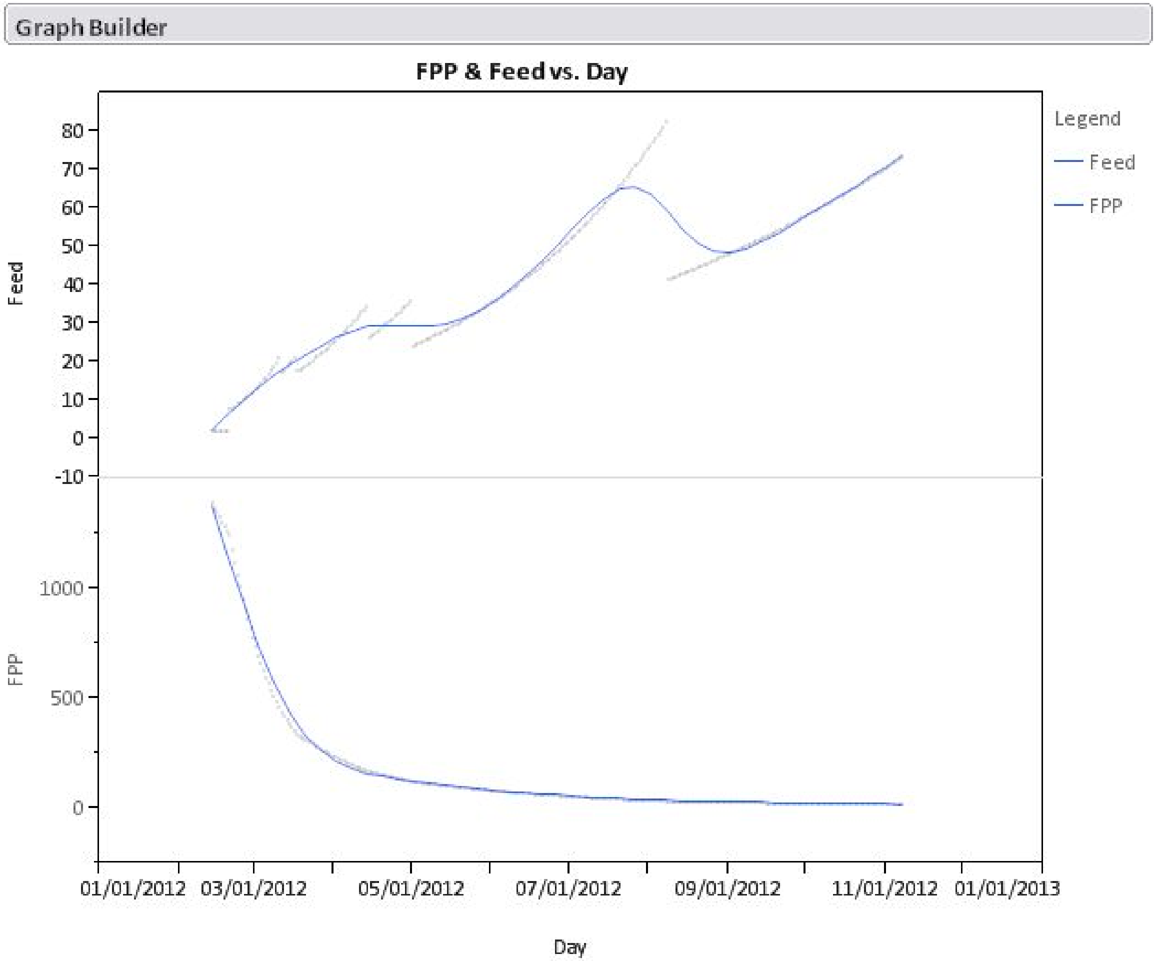


Jill rates



Hatchery
Wild
Proportion of Jills
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
2009
2010
2011
Return year

Feed schedule



Implications

- Mimic wild populations
- Maximize age at return
- Minimize stray rates
- PNI goals for the Wenatchee
- Consistent with M&E results and NOAA recommendations

Questions?

Use of monitoring and evaluation data to identify appropriate size at release targets for hatchery-origin Chiwawa River spring-run Chinook salmon *Oncorhynchus tshawytscha*

J. G. Murauskas

Natural Resources Department, Chelan Public Utilities District, Wenatchee, WA

Abstract–We examined smolt survival and adult returns of Chiwawa River spring Chinook salmon *Oncorhynchus tshawytscha* using passive integrated transponder tags to determine if juvenile length influenced these results. A logistic regression indicated that increasing juvenile length at tagging significantly increased the probability of both wild- and hatchery-origin smolts returning at younger age classes, including mini-jacks (p = 0.03 and p < 0.01, respectively). Despite significantly smaller size at release and 21.4% lower smolt survival rate on average, wild-origin fish had a 49.2% greater rate of adult returns compared to hatchery-origin fish (p < 0.01). Hatchery-origin smolts were divided into small and large groups by median length at tagging for comparison. The large half of hatchery-origin fish had statistically indifferent juvenile survival compared to the small half, but produced 135% more mini-jacks (p = 0.03), 194% more jacks (p < 0.01) , 6% more 2-salt adults (p = 0.38), and 56% fewer 3-salt adults (3-salt adults from the 2009 releases have not yet returned; p = 0.11). These results indicate that large length targets of hatchery programs do not translate to increased smolt survival or adult returns and further increase the disparity between population demographics of hatchery- and wild-origin populations. We propose that a size target of 126 mm and 25 g (~ 18 fish per pound) in hatchery-reared spring Chinook would provide measurable benefits in terms of adult returns and conservation of an ESA-listed stock.

Introduction–Chiwawa Hatchery (Chiwawa) is located at the confluence of the Chiwawa and Wenatchee rivers approximately 15 miles north of Leavenworth, Washington. Chiwawa was constructed in 1990 as a component of the Eastbank Hatchery Complex designed to rear up to 672,000 spring Chinook smolts to mitigate for losses incurred at hydroelectric projects owned and operated by Chelan County Public Utilities District (PUD). The juvenile fish are transferred from Eastbank Hatchery in the fall prior to migration, over-wintered at Chiwawa, and released directly into the Chiwawa River.

Chelan PUD has funded extensive monitoring and evaluation efforts of Chiwawa spring Chinook since 1989. A comprehensive report on monitoring and evaluation efforts over the past five years is currently being developed. Two recommendations within the report indicate that (1) "more realistic [size] targets should be set based on the length-weight relationship specific to Chiwawa spring Chinook and the size of natural-origin smolts produced in the Chiwawa Basin;" and, (2) "hatchery fish matured at an earlier age than natural-origin fish. This may be related to the size of released hatchery smolts" (Hillman et al. 2011a).

Several researchers have identified relationships between length at release and survival and age at maturity in Chinook and other *Oncorhynchus* spp. (Neilson and Geen 1986; Vøllestad et al. 2004; Scheuerell 2005; Claiborne et al. 2011; Tipping 2011). The current size target for hatchery spring Chinook released in the Chiwawa River is 176 mm FL and 38 g (~ 12 fish per pound), whereas wild-origin fish have averaged 94 mm FL and 9.3 g (~ 50 fish per pound; Hillman et al. 2011b). The purpose of the analyses contained herein is to test the hypotheses that (1) larger spring Chinook smolts lead to a decrease in age at maturity; and, (2) larger spring Chinook smolts do not have a full life cycle survival advantage compared to smaller smolts.

Methods–Data were retrieved from the PIT Tag Information System for the Columbia River Basin (PTAGIS; Pacific States Marine Fisheries Commission 2011). A "tagging detail" query was submitted to obtain records of PIT-tagged spring Chinook that were released from Chiwawa Ponds (CHIP; hatchery-origin smolts only) and Chiwawa Trap (CHIWAT; natural-origin smolts only) during the juvenile migrations of 2006, 2007, 2008, and 2009 (hatchery-origin smolts were not PIT-tagged in 2006). Wild-origin spring Chinook tagged after the month of June are considered sub-yearling juveniles and were excluded from analyses. Descriptive statistics were generated of tagging data for both hatchery- and wild-origin smolts.

An "interrogation summary" query was submitted to obtain observation records of the fish included in the "tagging detail" query described above. The data were filtered to only include observations at the Rock Island adult fishway to identify returning fish. The year of the last observation date at Rock Island was considered the return year, and the difference between the return year and the release year was considered "ocean residence." All juvenile detections in the adult fishway that were last detected the same year as release were considered mini-jacks. Adult returns detected the year following release were considered jacks; two years following release were considered "2 salt" fish, and so forth. Data were tabulated to determine the composition of returns.

A logistic regression was used to model the probability of returning to freshwater after a particular ocean residence (the ordinal variable) as a response to fork length at tagging (the continuous variable). Results were separated by hatchery- and wild-origin smolts. The Whole Model Test was used to determine if the model fits better than constant response probabilities (analogous to the Analysis of Variance table for a continuous response model). *p* values were reported for the Chi-square test used to evaluate how well the categorical model fits the data. Results were considered significant at $p \leq 0.05$ (SAS 2009).

PitPro 4.19 was used to generate Cormack/Jolly-Seber survival estimates and harmonic mean travel time of spring Chinook from release to McNary Dam to examine relative in-river performance of smolts during the outmigration (CBR 2011; Jolly 1965; Seber 1965; Cormack 1964). Fish were initially separated by rear-type (hatchery or wild). Subsequent survival estimates and harmonic mean travel times were generated for hatchery-origin spring Chinook based on a division of fish size each year. Median fork length at tagging was determined for each year and used to divide the "small half" and "large half" subsequently used in comparisons of returns and survival. The small half had larger sample sizes since the median length was included in this group.

Rates of return (RORs) were calculated by dividing the number of PIT-tagged fish detected in the adult fishway at Rock Island Dam (i.e., returns) by the number of fish released. RORs were calculated and compared for specific ages or ocean residence, and also for all adults combined (i.e., 2-salt or greater). A pooled sampling proportion *Pooled* (i.e., for both RORs in comparisons) was calculated by:

$$Pooled = \frac{[(ROR_1 \times n_1) + (ROR_2 \times n_2)]}{(n_1 + n_2)}$$

and SE_{Pooled} was calculated by:

$$SE_{Pooled} = \sqrt{(1 - Pooled)} \times [(1/n_1) + (1/n_2)]$$

The test statistic (two-proportion z-test), *z*, was calculated as:

$$z = \frac{(ROR_1 - ROR_2)}{SE_{Pooled}}$$

The test statistic and resulting *p* value was obtained from a standard normal table. Data manipulation and descriptive and inferential statistics were performed in JMP ® 8.0.2. Results were considered significant at $p \leq 0.05$.

Results–Over 65,000 spring Chinook were PIT-tagged between 2006 and 2009, including 29,906 hatchery- and 14,142 wild-origin yearling smolts. Hatchery fish were tagged between June and August the year prior to the smolt migration; natural-origin fish were tagged between March and June during the smolt migration. Hatchery-origin smolts averaged 93.1 mm (± 0.1 mm SE) and wild-origin smolts averaged 94.0 mm (± 0.1 mm SE) in fork length. Size at tagging was similar, though wild-origin smolts are tagged 8 to 9 months later on average. Nearly 50,000 detections of these fish occurred subsequent to release, including only 346 observations of unique fish within the Rock Island Dam adult fishway.

Two hundred ninety-three (293) returns were observed in the Rock Island Dam adult fishway, including 192 hatchery-origin fish and 101 wild-origin fish. The majority of returns were 2-salt fish for both hatchery- and wild-origin fish, though hatchery-origin fish had a greater number of mini-jacks and jacks and fewer 3-salt returns. RORs, to account for varying release sizes, show that hatchery-origin fish had 24% more mini-jacks (p = 0.30), 893% more jacks ($p < 0.01$), and 33% fewer ≥ 2-salt adults ($p < 0.01$) than wild-origin fish on average (Table 1). The logistic regression indicated that fish length at tagging significantly influenced the probability of returning after a specific period of ocean residence for both hatchery- (n = 192, $P < 0.01$) and wild-origin (n = 101, $P = 0.03$) fish. The probability of returning as a mini-jack or jack

increased significantly with increasing length at tagging for all fish (Figure 1).

Hatchery-origin smolts had an average estimated survival to McNary Dam of 56.6% (range 43.0-65.0%), compared to an average of 44.5% for wild-origin smolts (range 38.5-47.3%). The difference in estimated survival to McNary Dam was 27% greater on average for hatchery-origin fish, ranging from -5% to 69% over comparable years. Hatchery-origin smolts generally traveled to McNary Dam slightly faster during comparable years, though rates were comparable between groups. Estimated survival to McNary Dam was similar between the small half and large half of hatchery fish as was harmonic mean travel time. These results suggest that hatchery-origin smolts have a downstream survival advantage over wild-origin smolts, though a size advantage within hatchery-origin smolts was not observed (Table 2, Figure 2).

RORs from both the small and large half of hatchery smolts show similar rates of ≥ 2-salt fish ($p = 0.48$), with the large half returning 6% more 2-salt adults ($p = 0.38$) and 56% fewer 3-salt adults ($p = 0.11$) compared to the small half. Mini-jack and jack rates were greater in the large half: the large half produced 135% more mini-jacks ($p = 0.03$) and 194% more jacks ($p < 0.01$) compared to the small half (Table 1). The mini-jack rate for the small half was also inflated by the 2007 smolt year where the median hatchery-origin fish were over 20% larger than in 2008 and 2009; outside of 2007, no mini-jacks were observed in the small half of hatchery-origin smolts.

Even greater differences were noticed between the large half of hatchery-origin smolts and wild-origin smolts. The large half hatchery-origin fish produced on average 50% more mini-jacks ($p = 0.09$), 1,186% more jacks ($p < 0.01$), an equal number of 2-salt adults ($p = 0.41$), and 90% fewer 3-salt adults ($p < 0.01$). Generally speaking, all three groups (wild, small half, and large half) produced similar rates of 2-salt fish, whereas large half smolts produced fewer 3-salt fish, more mini-jacks, and more jacks than wild or small half smolts (Table 1). The composition of returns among these three groups demonstrate that most (88%) wild-origin smolts resulted in ≥2-salt adults over the time period observed, compared to 79% in the small half hatchery-origin smolts, and 57% in the large half hatchery-origin smolts (Figure 3).

Discussion–Our first hypothesis – that larger smolts lead to decreased age at maturity in Chiwawa River spring Chinook – is supported by these findings in both wild- and hatchery-origin fish. Neilson and Geen (1986), Scheuerell (2005), Chamberlin et al. (2011), Claiborne et al. (2011), and Tipping (2011) found similar results in Chinook, where the age of maturation decreased with increasing smolt size. Considering the importance of size at age and age at maturity in Chinook salmon (Kinnison et al. 2011), size at release may have considerable implications on the effectiveness of hatchery releases in the Chiwawa River. At a minimum, a disproportionate rate of mini-jacks and precocious males do not contribute favorably to harvest. Likewise, mini-jack and jack Chinook likely have a limited, if not negative, contribution to conservation-based supplementation efforts (Heath et al. 1994, 2002; Asbjørn Vøllestad et al. 2004; Pearsons et al. 2009; Larsen et al. 2010; Williamson et al. 2010). Our results, in combination with the observed size distribution of wild-origin Chinook and the intent to mimic the wild population for supplementation, provide evidence that a reduced target size for hatchery smolts will improve the population demographics of hatchery spring Chinook salmon in the Chiwawa River.

Our second hypothesis – that larger spring Chinook salmon smolts do not have a full life cycle survival advantage over smaller smolts – is also supported by these data. While some researchers have found smolt survival to be greater for larger smolts (e.g., Miyakoshi et al. 2001; Saloniemi et al. 2004), our results are unable to support these findings. Similar results to our study were observed in Imnaha River spring Chinook, where larger hatchery smolts (12-14 fish per pound) did not have a survival advantage over smaller smolts (20-25 fish per pound). Further, while overall smolt-to-adult survival was similar between small and large hatchery smolts, the smaller Imnaha River hatchery smolts had a significantly greater survival to Age 5 (i.e., 3-salt adults; Feldhaus et al. 2011). In either case, the rate and composition of returns – not smolt performance – is a more important metric in evaluating performance. For example, a 10% increase in smolt survival would not be beneficial if it were accompanied by a 50% increase in mini-jack rates. Therefore, supplementation programs intended to promote conservation of wild-origin stocks should focus on RORs, especially absent any evidence of a survival benefit of rearing larger smolts.

The PIT-tagged Chiwawa River spring Chinook provide a unique opportunity to compare wild- and hatchery-origin salmon. The hatchery uses wild-origin brood and resulting progeny are genetically similar to the wild-origin cohorts. In other words, the major difference between the wild- and hatchery-origin smolts is the rearing. Knudsen et al. found hatchery-origin spring Chinook matured at an earlier age just one generation removed from wild-origin cohorts and that minimizing the results of artificial rearing was difficult (2006). Larsen et al. found that changes in feeding rations can reduce mini-jack rates, creating a leaner and smaller hatchery smolt more similar to a wild counterpart (2006). Feldhaus et al. observed smaller hatchery spring Chinook smolts returning at older age classes compared to larger smolts (2011). With our results indicating that the most apparent difference between wild- and hatchery-origin fish is the age structure and associated RORs, and that the size of hatchery smolts is a predictor of these results, we recommend a reduction in the target size of the hatchery program.

While the current hatchery size target is 179 mm FL and 37.8 g (12 fish per pound), the observed lengths and weights have averaged roughly 136 mm and 32 g (~15 fish per pound) over the past five years (brood years 2004-2008; Hillman et al. 2011). Further, a length-weight relationship developed on the data used in our analyses indicate that the current size targets are not achievable (i.e., a 37.8 g smolt would be roughly 140 mm, not 179 mm). Feldhaus et al. (2011) evaluated Imnaha River hatchery spring Chinook smolts in the 18-23 g range (average weight of 21 g, 20-25 fish per pound). The Imnaha River target weights would translate to roughly a 120 mm and 22 fish per pound target in the Chiwawa Program. We recommend beginning with an intermediate size target of 126 mm and 25 g (approximately 18 fpp) and supporting continued PIT-tagging to evaluate the efficacy of this approach.

In conclusion, these results support previous findings highlighting significant differences between wild- and hatchery-origin salmon. While the disparity may be unsolvable, it is apparent that the large size targets and unnatural growth rates decrease age at maturity in Chiwawa River spring Chinook. These results further indicate that smaller hatchery smolts are more similar to wild-origin counterparts and that larger hatchery smolts may even pose a negative impact. A reduced hatchery size target could reduce some of these discrepancies, as well as provide additional benefits, such as lower rearing densities, and reduced adult management obligations.

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Table 1. Observations and rate of return of PIT-tagged Chiwawa River hatchery- and wild-origin spring Chinook in the Rock Island Dam adult fishway, release years 2006-2009.

			Ocean residence (years)				Rates of return				
Origin	Tag year	PIT tags	0	1	2	3	Mini-jacks	Jacks	Age 2	Age 3	Adults
Hatchery	2007	9,981	16	16	29	1	0.160%	0.160%	0.291%	0.010%	0.301%
	2008	9,894	2	14	58	10	0.020%	0.141%	0.586%	0.101%	0.687%
	2009	10,031	3	12	31	0	0.030%	0.120%	0.309%	0.000%	0.309%
	All	**29,906**	**21**	**42**	**118**	**11**	**0.070%**	**0.140%**	**0.395%**	**0.037%**	**0.431%**
Wild	2006	2,355	0	0	12	5	0.000%	0.000%	0.510%	0.212%	0.722%
	2007	2,697	2	0	2	0	0.074%	0.000%	0.074%	0.000%	0.074%
	2008	6,719	5	1	36	26	0.074%	0.015%	0.536%	0.387%	0.923%
	2009	2,374	1	1	10	0	0.042%	0.042%	0.421%	0.000%	0.421%
	All	**14,145**	**8**	**2**	**60**	**31**	**0.057%**	**0.014%**	**0.424%**	**0.219%**	**0.643%**
Hatchery (small)	2007	5,569	7	2	18	1	0.126%	0.036%	0.323%	0.018%	0.341%
	2008	5,394	0	2	30	7	0.000%	0.037%	0.556%	0.130%	0.686%
	2009	5,193	0	8	14		0.000%	0.154%	0.270%	0.000%	0.270%
	All	**16,156**	**7**	**12**	**62**	**8**	**0.043%**	**0.074%**	**0.384%**	**0.050%**	**0.433%**
Hatchery (large)	2007	4,412	9	14	11	0	0.204%	0.317%	0.249%	0.000%	0.249%
	2008	4,500	2	12	28	3	0.044%	0.267%	0.622%	0.067%	0.689%
	2009	4,838	3	4	17		0.062%	0.083%	0.351%	0.000%	0.351%
	All	**13,750**	**14**	**30**	**56**	**3**	**0.102%**	**0.218%**	**0.407%**	**0.022%**	**0.429%**

Table 2. Probability of survival and harmonic mean travel time (days) to McNary Dam of hatchery- and wild-origin spring Chinook smolts, 2006-2009.

Origin	Tag year	PIT tags	Survival to McNary	SE	Travel to McNary (d)
Hatchery	2007	9,981	65.0%	2.0%	28.3
	2008	9,894	61.7%	3.9%	29.0
	2009	10,031	43.0%	2.0%	30.4
	Average		**56.6%**	**2.6%**	**29.2**
Wild	2006	2,355	47.3%	3.0%	20.1
	2007	2,697	38.5%	2.2%	27.9
	2008	6,719	47.0%	2.6%	29.4
	2009	2,374	45.2%	4.6%	36.6
	Average		**44.5%**	**3.1%**	**28.5**
Hatchery (small)	2007	5,569	66.0%	2.6%	28.5
	2008	5,394	68.4%	6.1%	29.7
	2009	5,193	42.7%	2.8%	31.4
	Average		**59.0%**	**3.8%**	**29.9**
Hatchery (large)	2007	4,412	63.6%	3.1%	28.1
	2008	4,500	54.8%	4.8%	28.3
	2009	4,838	43.4%	2.8%	29.4
	Average		**53.9%**	**3.6%**	**28.6**

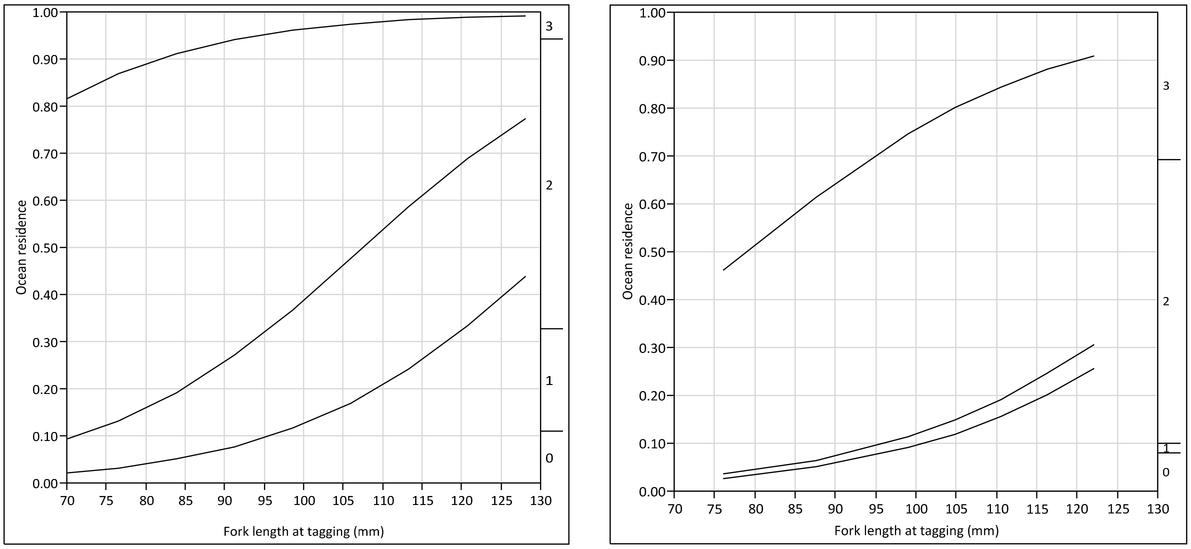

Figure 1. Logistic fit of ocean residence by fork length (mm) at time of tagging for hatchery (left) and wild-origin (right) Chiwawa River yearling spring Chinook. Whole Model Tests indicate a significant relationship for both hatchery (*P* < 0.01) and wild-origin (*P* = 0.03) fish, with an increasing probability of ocean residence = 0 (i.e., mini-jack) with increasing size at tagging.

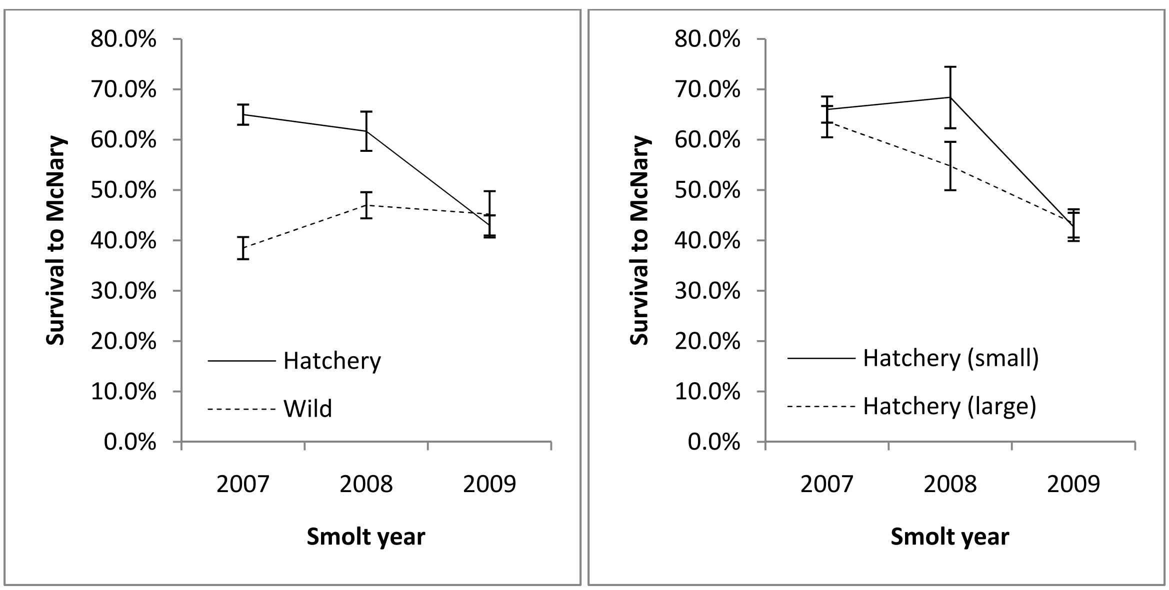

Figure 2. Estimated survival (± SE) to McNary Dam of hatchery and wild spring Chinook smolts (left), and small and larger hatchery-origin smolts (right).

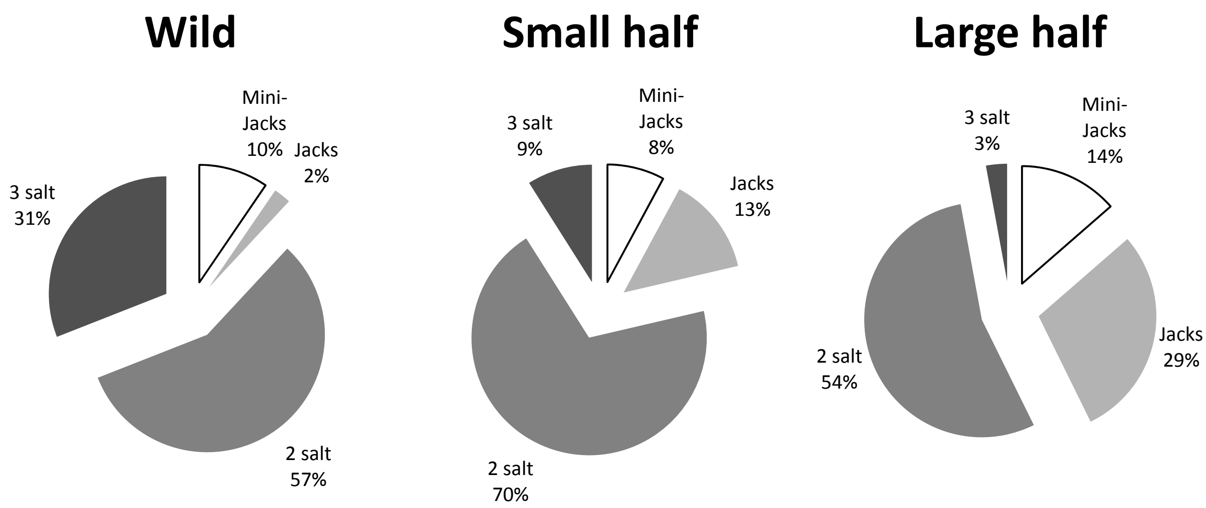

Figure 3. Distribution of returns from wild- and hatchery-origin spring Chinook smolts released in the Chiwawa River, 2007-2009. Hatchery smolts were separated by median fork length at time of tagging and returns from 2009 do not yet include 3-salt fish.

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MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCP Hatchery Committees	**Date:**	February 15, 2012
From:	Carmen Andonaegui, Anchor QEA		
Cc:	Mike Schiewe, Anchor QEA - Chair		
Re:	Summary of the conclusion of the HETT reference stream evaluation and a HETT recommendation for next steps		

In 2007, the HETT was tasked with making recommendations to the Hatchery Committees on reference/control streams for use in the Chelan PUD and Douglas PUD Hatchery Monitoring and Evaluation (M&E) programs. The HETT has developed a three-phased approach for selecting suitable reference populations for use in assessing the effects of supplementation programs on spawner abundance, recruitment, and productivity. The approach is described in a paper titled, *Methods for Identifying Reference Populations and Testing Differences in Abundance and Productivity Between Reference Populations and Supplemented Populations: Chiwawa Spring Chinook Case Study* (Hillman et al. 2011), and is included as Appendix C to Chelan PUD's and Douglas PUD's Five-Year M&E Reports. Suitable reference populations were found for spring Chinook and summer Chinook but no suitable reference populations could be identified for steelhead or sockeye, for which there is a lack of data.

Identification of appropriate references populations was challenging because the candidate populations rarely met all of the characteristics desirable. Hillman et al. 2011 describes the approach developed by the HETT, using the Chiwawa River as an example.

A qualitative sieve approach was used to identify candidate reference populations and then a quantitative approach was used to weight the most favorable reference populations. Qualitative factors included:

- Similar life-history characteristics (e.g., run timing, migration characteristics, etc.);
- No or few hatchery fish in the reference area;
- Accurate abundance estimates;

- Long time series of natural-origin abundance and productivity estimates (ranging from at least 1981 to present);
- Similar trends in freshwater habitat;
- Similar out-of-basin effects (i.e., similar migration and ocean survivals); and
- Harvest estimates for adjusting escapement estimates.

None of the candidate reference populations matched the supplemented population on all the qualitative criteria; however, some of the potential reference populations were *similar* to the supplemented population on several criteria, warranting further investigation. The HETT therefore developed a quantitative scoring method for comparing candidate reference populations to the supplemented populations using five criteria:

- The proportion of natural-origin spawners (pNOS) in the reference population for the period before supplementation (pre-pNOS);
- pNOS in the reference population for the period following supplementation (post-pNOS);
- The correlation between the reference and supplemented populations before supplementation;
- The relative difference in slopes between the reference and supplemented populations before supplementation; and
- The coefficient of variation (CV) of the ratio of supplemented to reference population before the period of supplementation.

Each selection criteria was scored from 0 to 1, with 0 being the worst possible score and 1 being the best, and these criteria were weighted. The total score for a reference population was calculated by multiplying the estimated value, which ranged from 0 to 1, by its weight. The sum of the five weighted values provided a total score, which ranged from 0 to 100. Based on several simulations, the HETT set the cut-off score for candidate reference populations at 81. That is, if the total score for a given reference population equaled or exceeded 81, the population was included as a suitable reference population. If the total score fell below 81, the population was not considered a suitable reference population.

Conclusions of the effects of supplementation on unsupplemented streams without comparison to reference populations often conflicted with conclusions based on comparisons using reference populations. This conflict demonstrated the importance of using appropriate references for evaluation of supplementation programs and demonstrated that results that do not incorporate comparisons to references should be interpreted with caution.

In 2017, the PUDs are required to produce the next 5-Year M&E Report. The HETT recommends that in the lead up to the development of the next 5-Year M&E Report, the Hatchery Committees begin considering how best to evaluate the effects of supplementation when no reference populations are available, as in the case of steelhead and sockeye. For steelhead for example, data that have only started to be collected in the recent past will be available. The HETT believes that these new data will be useful in evaluating the effect of supplementation for developing an existing condition for comparison over time to future conditions.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	April 19, 2012
From:	Mike Schiewe, Chair		
Cc:	Carmen Andonaegui		
Re:	Final Minutes of the March 28, 2012, HCP Hatchery Committees' Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at the Douglas PUD Headquarters' Auditorium in East Wenatchee, Washington, on Wednesday, March 28, 2012, from 9:30 am to 2:00 pm. Attendees are listed in Attachment A of these meeting minutes.

ACTION ITEM SUMMARY

- Josh Murauskas will confirm with Tracy Hillman, BioAnalysts, the delivery date for the Draft 2011 Hatchery Monitoring and Evaluation (M&E) Annual Report (draft M&E Annual Report) to the Hatchery Committees (Item II-B).
- Josh Murauskas will revise and finalize the Spring Chinook Size Target Statement of Agreement (SOA) as approved and email it to Carmen Andonaegui for distribution to the Hatchery Committees (Item III-C).
- Keely Murdoch will provide confirmation to Mike Tonseth that the Yakama Nation will be requesting collection of additional Wells summer Chinook broodstock in 2012 (Item IV-A).
- Comments on the Draft 2012 Broodstock Collection Protocols (Draft Protocols) are due to Mike Tonseth by April 6, 2012 (Item IV-A).
- By April 6, 2012, Keely Murdoch, in coordination with Tonseth, will model selected proportions of conservation versus safety-net Chiwawa spring Chinook program production using the 2012 production levels and evaluate the effects on Proportion Natural Influence (PNI) (Item IV-A).
- Mike Tonseth will confirm with Ken Warheit, Washington Department of Fish and Wildlife (WDFW), WDFW's support of Maureen Hess', Columbia River Inter-tribal Fish Commission (CRITFC), request to collect genetic samples for steelhead and spring Chinook (Item V-B).

STATEMENT OF AGREEMENT DECISION SUMMARY

- The Rocky Reach and Rock Island Hatchery Committees approved the Chiwawa Spring Chinook Size-at-Release Target SOA (Item III-C).

AGREEMENTS

- The Hatchery Committees decided not to assign the task of developing recommendations for multi-species acclimation to the Hatchery Evaluation Technical Team (HETT) at this time (Item V-A).
- The Hatchery Committees agreed that the Yakama Nation could use actively migrating coho and steelhead smolts from Rohlfing Pond to test smolt trap efficiency (Item V-C).

REVIEW ITEMS

- The Chelan PUD Draft 5-Year M&E Report is available for a 60-day review. Comments are due to Tracy Hillman by April 6, 2012.
- The Douglas PUD Draft 5-Year M&E Report is available for a 60-day review. Comments are due to Greg Mackey by April 27, 2012.

FINALIZED REPORTS

- Comments on the Chelan PUD 2012 Rocky Reach and Rock Island HCP Action Plan were due by March 1, 2012. Chelan PUD will finalize the Action Plan and email it to Carmen Andonaegui for distribution to the Hatchery Committees.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. The following agenda items were added:

- Keely Murdoch added an update on Nason Creek steelhead trapping.
- Greg Mackey added a request to change the submittal date of the Douglas PUD draft 2011 M&E Annual Report to the Hatchery Committees from June 1 to September 1, 2012.

The draft February 15, 2012, meeting minutes were reviewed and approved as revised. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Committees.

II. Douglas PUD

A. Methow Steelhead Safety-Net Broodstock Collection for Spring of 2012 (Greg Mackey)

Greg Mackey updated the Hatchery Committees that measures for early implementation of the Wells steelhead HGMP for the Methow safety-net program had been proposed and considered during discussions with WDFW, the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS) and added to the Committees' March 28, 2012, meeting agenda for discussion. The proposed measures would have used hatchery-origin steelhead captured at the Twisp Weir for broodstock in spring 2012. However, fisheries managers later realized that there were already hatchery-by-wild (HxW) steelhead crosses available at the Wells Hatchery for this program, and implementing the Twisp hatchery-origin broodstock collections would have meant surplusing wild progeny or broodstock already on station.Therefore, the proposed action was found to be inappropriate for this brood year.

B. Draft HCP Hatchery M&E Annual Report Submittal Date (Greg Mackey)

Greg Mackey said that Douglas PUD was requesting approval to submit the draft 2011 HCP Hatchery M&E Annual Report for the Hatchery Committees' review no later than September 1, 2012, to accommodate a schedule change requested by Charlie Snow, WDFW. Mackey said that the September 1 submittal date would allow WDFW more time to complete analyses and incorporate the results into the draft M&E Annual Report. Mike Schiewe said that the original June 1 date was initially set to meet the required submittal date to the National Marine Fisheries Service (NMFS). He said that he had confirmed with Craig Busack, NMFS, that permanently changing the draft submission date to the Committees to September 1 would be acceptable. Schiewe asked Mackey if he wanted to permanently change the due date for submitting draft M&E Annual Reports to the Committees for review. Mackey said that he was only asking for a change for 2012, but that the current and future implementation plans would use the July 1 date for submittal of a draft annual Hatchery M&E report to Douglas PUD, with a September 1 delivery to the Committees. The Committees' members approved the change. Josh Murauskas will confirm with Tracy Hillman, BioAnalysts, the delivery date for the Chelan PUD draft HCP Hatchery M&E Annual Report to the Committees.

III. Chelan PUD

A. Updates to PUD Hatchery Programs M&E (Josh Murauskas)

Josh Murauskas suggested that with completion of the 5-Year M&E Report that the Hatchery Committees begin to review Hatchery M&E objectives, methods, and results, and determine whether program changes are needed. He said that Chelan PUD planned to provide recommended changes to the Committees in the near future. Greg Mackey said that a formal adaptive management framework document to guide decisions based on M&E results would be helpful. Murauskas agreed.

B. Dryden Overwintering Site Feasibility (Josh Murauskas)

Josh Murauskas said that at the January Hatchery Committees' meeting, Alene Underwood, Chelan PUD, reported on the initial results of Chelan PUD's facilities evaluation at Dryden in support of overwintering juvenile summer Chinook. Overwintering was proposed by the Joint Fisheries Parties (JFP) as an alternative acclimation method to improve smolt-to-adult returns (SARs) and to reduce straying. Murauskas introduced an alternative approach using the water re-use facilities at East Bank Hatchery for overwinter rearing, with spring acclimation at Dryden to achieve the same goals (Attachment B). He suggested that reducing size-at-release targets would also contribute to improved SARs and reduced stray rates by reducing mini-jack and jack rates. Murauskas said that Chelan PUD is concerned that the JFP have not adequately considered risks to smolt production associated with overwinter acclimation at the Dryden Facility, and Chelan PUD would need assurances from the JFP that facility modifications would indeed improve performance of hatchery smolts, therefore eliminating risks associated with modifying the facility without empirical data.

Keely Murdoch said that the general conclusion of the JFP is that overwintering improves adult returns. She said that if there were to be an opposite result, having modified the Dryden Facility to accommodate overwinter rearing would not preclude using it for spring acclimation. Murauskas asked what data were used in developing the conclusion by the JFP that overwintering improves adult returns. He reminded the HC that the report authored by JFP members indicated that a nearly 3-fold increase in SARs was observed in previous comparisons between over-winter and spring acclimation. Kirk Truscott suggested that an SOA could be drafted to include language that would provide assurances to Chelan PUD and Grant PUD (who would also be using Dryden summer/fall Chinook production to meet requirement in their Settlement Agreement).

Murauskas questioned whether overwintering would adequately reduce straying, saying that stray rates tended to be greater in younger adults, which, in turn are negatively correlated with size-at-release. In his presentation, Murauskas provided the results of his analysis of summer Chinook initially reared using water re-use, followed by spring acclimation at Dryden. Initial results suggested that the jack rate of spring-acclimated Dryden summer Chinook reared using the water re-use facility at Eastbank was up to 37 percent lower than that of to conventional raceway-reared fish. These data suggested that a smaller size-at-release would reduce jack and minijack rates, further reducing the stray rate. Muruaskas said that these results suggested there were alternative approaches to improving SARs and reducting stray rates. Results also indicated that adult returns were up to 74 percent greater and mini-jack rates were nearly half in re-use compared to raceway smolts.

Mike Tonseth said that the primary risk he sees from overwinter acclimation is related to disease. He said that he had long been an advocate of having an independent water supply for the Dryden Facility rather than using irrigation water from the canal. Mike Schiewe suggested that the Committees should first identify the goals for the Wenatchee summer/fall Chinook program (e.g., target SARs and stray rates) and then consider the available evidence supporting which acclimation alternative/rearing protocol would best meet those goals. Murdoch identified the development of a dedicated water source at the Dryden Facility as an important benefit of upgrading the facility for overwintering acclimation and said that developing a dedicated water source at the site would be important no matter which alternative was preferred.

Schiewe asked about the timing of Dryden improvements and hence the urgency of making a decision about rearing and acclimation alternatives. Tonseth said that the Grant PUD Priest Rapids Coordinating Committee (PRCC) Habitat Subcommittee (HSC) was already working on a Basis of Design for modifying the Dryden Facility for overwinter acclimation and that they had scheduled a pre-application meeting with Chelan County for discussing construction activities. Permit submission is scheduled for May 2012. Currently Chelan PUD has a Hatchery Sharing Agreement with Grant PUD to place Grant PUD juveniles at the Dryden Facility if surplus capacity is available. Tonseth said that he sees two pieces to the discussion of feasibility of overwintering at Dryden: 1) operation of the facility for acclimation (reuse, overwintering, etc.); and, 2) whether Chelan PUD can support Grant PUD making facility improvements at Dryden for acclimation whether re-use or overwintering. Each carries a different risk, and he asked that the two discussions be conducted separately. Schiewe recommended that Chelan PUD proceed with development of an analysis and a presentation for their preferred acclimation alternative, both in terms of the biological benefit and in terms of the costs and benefits of implementing a facility upgrade.

Tonseth noted that SARs for current Chelan PUD programs were exceeding the baseline target SARs in the Hatchery and Genetic Management Plans (HGMPs). He suggested that program goals would need to be revised to reflect observed SARs based upon periodic review of M&E data.

C. Status of the Chiwawa Spring Chinook Size-at-Release Target SOA (Josh Murauskas)

Josh Murauskas said that he emailed the revised Chiwawa Spring Chinook Size-at-Release Target SOA on March 26, 2012, to Carmen Andonaegui for distribution to the Hatchery Committees. He summarized the revisions to the SOA as agreed to at the February 15, 2012, meeting and asked if Committees members found the revisions acceptable. There were no objections. The SOA was approved, as revised. Kirk Truscott pointed out an editorial error in the "Statement" section. Murauskas will correct the error and email the revised and approved SOA to Andonaegui for distribution to the Committees.

IV. WDFW

A. Draft 2012 Broodstock Collection Protocols (Mike Tonseth)

Mike Tonseth provided highlights of the Draft Protocols, asking that comments from Hatchery Committees members be provided to him by email in track changes no later than April 6, 2012 (Attachment C). The Final 2012 Broodstock Collection Protocols are due to NMFS by April 15, 2012.

The changes highlighted by Tonseth were captured in the Draft Protocols. Kirk Truscott asked whether there would be a start date for steelhead adult collections at Tumwater Dam (TWD). Tonseth estimated August 2012. Keely Murdoch said that broodstock collection priorities should be identified and listed in the Draft Protocols in case not enough adults are available at the preferred location. For example, Murdoch asked if WDFW would backfill natural-origin steelhead broodstock with hatchery-origin adults if not enough natural-origin adults were available at TWD. Tonseth said that he did not anticipate a lack of natural-origin adults at TWD but agreed that a discussion was needed. He also cautioned that their Endangered Species Act (ESA) Take Permit defined the limits of what could be done regarding activities that have the potential to affect ESA-listed salmonid species. Truscott agreed that it would be good to have a list of broodstock collection priorities in case there was a need to backfill. Tonseth said that he would add a prioritized broodstock collection list to the Draft Protocols. Tonseth said that he would correct the eleventh bullet in the Draft Protocols to say that collection of adult steelhead at the Twisp Weir will occur in spring 2013, not 2012 as indicated. He said that the Committees would need to approve the collection of additional Wells summer Chinook in support of the U.S. Fish and Wildlife Service (USFWS) and Yakama Nation programs, both of which were approved for 2011. Murdoch will confirm whether the Yakama Nation will request additional Wells summer Chinook in 2012.

Murdoch questioned the 50/50 split between conservation and safety-net smolt production in 2012 for the Chiwawa spring Chinook program (Table 8 on page 12 of Draft Protocols). She said that when modeling the effects of varying proportions of conservation versus safety-net smolt production on PNI goals, a total program production level of 300,000 fish was used. Murdoch said that effects on PNI of various splits at the 2012 program production level of 204,452 should to be modeled. Tonseth said that the 50/50 split between conservation and safety-net production is a placeholder only. Murdoch said that there are also marking implications to consider when planning a program with both conservation and safety-net production. Conservation fish would need to be marked differently so that they could be differentiated during potential harvest of safety-net fish. Tonseth said that there needs to be a path forward for resolving Murdoch's concerns consistent with the April 15, 2012, due date to NMFS. Murdoch recommended that the proportion of conservation production be kept at 150,000 as originally modeled, because producing 150,000 smolts for conservation production was the number of smolts that achieved modeled PNI goals. Murdoch said that without revisiting the modeling she was unsure whether the production of only 102,000 conservation smolts would achieve the goals identified in the Wenatchee Spring Chinook Management Plan, which is included as an addendum to the draft Wenatchee Spring Chinook HGMP submitted to NMFS. She said that the order of priority for production in meeting conservation versus safety-net program goals was developed during earlier JFP planning efforts. Tonseth said that adult management needs have to be considered in the context of achieving PNI goals. In coordination with Tonseth, and using the 2012 production levels, Murdoch will re-run the models with varying proportions of conservation versus safety-net program production to evaluate the effects on PNI goals. Murdoch said that she had similar questions about the split for steelhead production.

Murdoch said that she had heard that WDFW and Douglas PUD were considering discontinuing the use of the Chewuch acclimation site. Tonseth said there had been discussions during HGMP meetings with NMFS, WDFW, USFWS and Douglas PUD regarding whether or not to discontinue use of the Chewuch acclimation site but that a change to the management plan had not been developed yet, and that the Draft Protocols do not include or exclude the use of the Chewuch acclimation site for the MetComp production. Murdoch said that the Chewuch acclimation site was identified for acclimation in the *US v OR* forum.

Mike Schiewe said that if there are suggestions for substantive changes to the Draft Protocols, Tonseth could notify him and a Committees' conference call could be convened to review changes.

V. Yakama Nation

A. Multi-species Acclimation Task – Request to the HETT from the Hatchery Committees (Keely Murdoch)

As requested at the February 15, 2012, Hatchery Committees meeting, Keely Murdoch said that she had drafted a memorandum from the Committees to the HETT assigning them the task of developing recommendations regarding the use of temporary natural acclimation sites (Attachment D). She said that the draft memorandum had been distributed to the Committees on March 13, 2012. Murdoch asked for the Committees' approval to forward the request to the HETT. Josh Murauskas asked for discussion on whether the HETT has time to complete the task. Murdoch said that she thought the task would take the HETT a few meetings to complete with the product being an acclimation plan. She said that she would like the task addressed by the HETT or addressed by a different workgroup if the Committees do not want this sent to the HETT.

Mike Tonseth said that he had concerns with developing an acclimation plan in the face of upcoming major reductions in hatchery production following NNI recalculation and uncertainties associated with addressing some of the results of the 5-Year M&E Report. Murdoch said that the development of an acclimation plan would only be for the purpose of determining whether different and/or additional acclimation sites were needed. Tonseth said that he did not think it was appropriate for the HETT to develop an acclimation plan. Mike Schiewe reminded the Committees that HETT would only be developing a recommendation, and that all decision authority was the responsibility of the full Committees. Murdoch reiterated that the Yakama Nation would like to define the role multi-species natural acclimation sites play in the hatchery programs and to identify where acclimation sites are needed. Murdoch explained that the HETT was still working on completing Non-Target Taxa of Concern (NTTOC) risk assessment model runs but that those efforts occurred outside the HETT meetings so it would be a good time for the HETT to take on this task.

Greg Mackey said that the new HGMPs are specific about where fish are raised and released, but that the HGMPs also include options and flexibility based on M&E results. Mackey said that with hatchery programs being reduced 40 to 60 percent starting in 2012, there was a need to wait and allow time to look at outcomes after new production levels have been implemented. He said that when data are available, issues such as spatial distribution of spawners and proportion of effective hatchery-origin spawners (pHOS) could be addressed.

Mackey noted that the draft HGMPs did not use recalculated production levels, because they had been developed prior to completion of recalculation. He said that population dynamics and genetics should be considered as part of an acclimation plan. Tom Kahler said that a lot of information will be needed to evaluate the effects of location of an acclimation site on hatchery program goals and on target and non-target species. Murdoch said that the idea behind tasking the HETT with evaluating available data and making recommendations to the Committees was that each HETT member will pull together data from their respective organizations and bring it to the table and collaboratively develop recommendations. For example, she said that the HETT might identify acclimation needs based on identification of a disproportionate spawning distribution of wild and hatchery fish. Kahler countered that responding to a disproportionate spawning distribution of wild and hatchery fish by extending spawning until both are spatially proportional would only be a "need" if you believed that spawning distribution for wild and hatchery fish should be proportional. Therefore, the decisions on the applicability of dispersed acclimation were of a management nature rather than technical, and thus more appropriately the purview of the Hatchery Committee rather than the HETT. Murdoch noted that if an objective of the hatchery M&E program was to supplement wild spawners, then extending hatchery spawning proportional to wild spawners would be a program need. Mackey said that this type of analysis was included in the 5-Year M&E Reports and should be reviewed. Kirk Truscott agreed with Mackey that the 5-Year M&E evaluation needed to be reviewed to see how the results could help inform to what extent program objectives were being met. If program objectives were not being met, and the effects of not meeting those objectives were biologically significant, then Truscott suggested that the Committees needed to determine if additional scientific information was needed, different M&E protocols were needed, or if program changes were in order. Truscott said that the degree of integration of a given hatchery program needed to be considered when evaluating the success of a hatchery program in that it would have bearing on how many hatchery fish should be integrated into a breeding program and how far up to expand spawning.

Schiewe summarized that there were a couple of issues being considered: 1) Murdoch's request to identify, in a collaborative manner, acclimation site locations and numbers of fish to acclimate at each site; and 2) the extent to which this task is technical or more a management issue. Schiewe said that each year the Committees had agreed to Yakama Nation requests for hatchery fish for their multi-species acclimation sites and asked if the Committees had any problem in the short-term with meeting these Yakama Nation annual requests, or if the Committees felt that the issue needed to be addressed on more than an annual basis. Truscott agreed that it was important for program managers to be able to have certainty that comes with a long-term plan approved by the Committees. Tonseth asked if with the more focused effort in the Upper Columbia Region to use multi-species acclimation, whether NMFS felt that this will affect their ability to conduct consultations on these programs when multi-species acclimation or alternative acclimation sites are only foot notes in the HGMPs or presented as unspecified potential alternatives that may be employed if needed. Craig Busack said that the permits can be written to allow for minor adjustments to the program as long as the rationale for the changes are science based. Tonseth said that much discussion had evolved around the abundance of hatchery fish on spawning grounds and that expanding hatchery spawning into areas where there are no means to control adult returns may be problematic. Busack agreed that NMFS had concerns about too many hatchery fish on spawning grounds and that programs were currently designed to take advantage of an ability to manage adults. He said that where the ability to manage returning adults exists, expanding spawning may be appropriate. Busack asked that NMFS be allowed to complete their consultation on the Methow hatchery programs before being asked to considering expanding spawning. Mackey reiterated that existing data and analysis needed to be considered and reviewed prior to making recommendations on program changes. Busack agreed that a structured review of the 5-Year M&E Reports' results should be part of determining whether spawning needed to be expanded.

Schiewe summarized by saying that he is hearing that Committees' members believe that with the new 5-Year M&E Reports' results available, with new hatchery program sizes, and with pending consultations on the HGMPs, there is a need to move forward more slowly with developing an acclimation plan, allowing time to see how the newly sized programs and possible program adjustments might affect meeting program objectives. Additionally, he said, NMFS was saying that they would design permits with the option for adaptive management. The Committees decided not to assign the task of developing recommendations for multi-species acclimation to the HETT at this time.

B. CRITFC Proposal for Participation in the Collection of Hatchery Steelhead and Chinook Genetic Samples (Keely Murdoch)

Keely Murdoch said that as requested at the February 15, 2012, Hatchery Committees' meeting, Maureen Hess, CRITFC, had prepared a proposal for the Committees requesting their participation in the collection of hatchery steelhead and Chinook genetic samples (Attachment E). Hess is asking that genetic samples be collected (CRITFC will supply

Whatman sheets for the collections where needed) for the spawning year 2012, including at a minimum the spawn date and gender for each tissue sample for the programs listed in the request.

Mike Tonseth said that WDFW was already collecting DNA samples for spring Chinook and steelhead for 100 percent of the broodstock collected for Douglas PUD and Chelan PUD hatchery programs, leaving only summer Chinook unsampled. Tonseth said the genetic samples were placed in alcohol for the Douglas PUD programs and that for the Chelan PUD programs, samples were placed on blotter sheets for spring Chinook and in alcohol for steelhead. Tonseth said that he needed clarification from Ken Warheit, WDFW, before agreeing to the request but that he saw no problem with collecting genetic samples because this was already being done. Greg Mackey agreed for Douglas PUD, but said that he would need to check on the status of summer Chinook sampling. Josh Muruaskas said that if the fisheries co-managers wanted genetic samples collected, Chelan PUD saw no problem with it. Those Committees' members present were generally supportive of Hess' request. Tonseth will speak with Warheit and confirm with Mike Schiewe that WDFW also is supportive of the request.

C. Rohlfing Pond Steelhead Trap (Keely Murdoch)

Keely Murdoch said that more fish were needed for smolt-trap efficiency trails for the Nason Creek steelhead smolt trap than were available instream at this time. She said that the Yakama Nation would like to use actively migrating coho and steelhead from Rohlfing Pond, where coho and steelhead juveniles are being co-mingled for acclimation. The plan would be to net fish that are coming out of Rohlfing Pond each night. Murdoch said that they are trying to target specific flows for the efficiency trails, so timing of the tests would depend on flows. She said that all steelhead would be scanned for passive integrated transponder (PIT) tags and that all fish captured coming out of Rohlfing Pond would be PIT-tagged. Murdoch said that the release site for the efficiency trails was approximately 1 mile upstream from the trap. She said that for the efficiency trials they would be using standard PIT-tagging protocols used both in the Wenatchee and Methow subbasins, with a goal of 100 fish per trail. Murdoch said that the protocol is the same as that used for spring Chinook in the White River. The Hatchery Committees discussed the reliability of efficiency tests given the possible biases introduced by tag shedding, handling and holding effects, and the number of fish for each test. Committees' members agreed to support the proposal.

VI. NMFS

A. HGMP Update (Craig Busack)

Craig Busack reported that NMFS had hired a new biologist to assist with processing HGMPs; however, the staff person, James Dixon, would not likely be on-board until April 23, 2012. Busack said that Dixon would begin by helping to complete consultations which have already been started for the Upper Columbia and Snake River fall Chinook rather than starting new consultations. He said that NMFS continued to have discussions regarding Wenatchee Hatchery programs with a focus on completing the National Environmental Policy Act (NEPA) process. Busack said that NMFS had also been discussing Methow hatchery programs with the hatchery operators and that NMFS had been keeping Steve Parker, Yakama Nation, apprised of these discussions, including following up with Parker on discussions begun at an earlier meeting regarding potential sites for weirs in the Methow basin.

VII. HETT Update

Carmen Andonaegui reported that the HETT had decided to limit modeling of NTTOC/hatchery program interactions to a subset of all possible interactions to reduce the level of effort and time to completion of the NTTOC risk assessment. The subset would include only hatchery programs that are representative of certain types of interactions that may occur and that were necessary to model in order for the analysis to remain robust. She said that the HETT would continue to complete the model runs. Andonaegui said that timing-to-completion of the NTTOC risk assessment was a function of the level of participation and the amount of time HETT members had to commit to HETT tasks.

The Hatchery Committees discussed the level of participation by Committees' members. Kirk Truscott said that he did not anticipate being able to start model runs any time soon.

Josh Murauskas questioned the utility of Chelan PUD's participation in the NTTOC risk assessment. Keely Murdoch said that the NTTOC risk assessment was a Regional Objective (Objective 10) for monitoring and evaluation of PUDs' hatchery programs. Mike Schiewe asked Murauskas for a recommendation for an alternative approach to addressing Objective 10; he asked whether Truscott disagreed that the NTTOC should be a regional objective. Truscott responded that he considered Objective 10 as the lowest priority M&E objective. He said that he had not envisioned each Committees' member having to conduct model runs, but did anticipate having to provide data for use in the assessment, which he had provided. Schiewe said that because the NTTOC risk assessment is an M&E objective, it needs to be addressed by either using the current approach or by an alternative method agreed to by the Committees.

Greg Mackey said that Douglas PUD intended to meet their obligation to assess NTTOC risk from hatchery programs but that what might be done with the results would be a fisheries management issue. However, he said he does not see addressing risks to NTTOC as taking precedence over ESA species management. He said that if Chelan PUD and the Colville Confederated Tribes (CCT) were not able to participate in the assessment there would be missing data for portions of the Wenatchee subbasin not covered by USFWS or Yakama Nation hatchery programs, for the mainstem Columbia River, and for the Okanogan subbasin. Schiewe said that unless there were an alternate proposal agreed to by the Committees, all Parties should plan to participate in the completion of this exercise.

VIII. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees meetings are April 18 (Chelan PUD office), May 16 (Douglas PUD office), and June 20, 2012 (Chelan PUD office).

List of Attachments

Attachment A – List of Attendees

Attachment B – Chelan PUD PowerPoint Presentation on the Feasibility of Overwinter Acclimation at Dryden Ponds

Attachment C – 2012 draft Broodstock Collection Protocols

Attachment D – Multi-species Acclimation HETT Request

Attachment E – CRITFC Proposal to Participate in Collecting Genetic Samples for Hatchery Steelhead and Chinook

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Carmen Andonaegui	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Keely Murdoch*	Yakama Nation
Kirk Truscott*	CCT
Craig Busack*†	NMFS
Mike Tonseth*	WDFW
Todd Pearsons	Grant PUD

Notes:

* Denotes Hatchery Committees member or alternate

†Joined by phone

Feasibility of Overwinter Acclimation at Dryden Ponds

J. Murauskas
Natural Resources Dept.
Chelan County PUD
March 28th, 2012

Introduction

- Construction of a new facility to accommodate overwinter acclimation has been proposed by the JFP at Dryden Ponds

- The construction of the facility is intended to:
  - (1) improve SARs
  - (2) reduce stray rates

Background

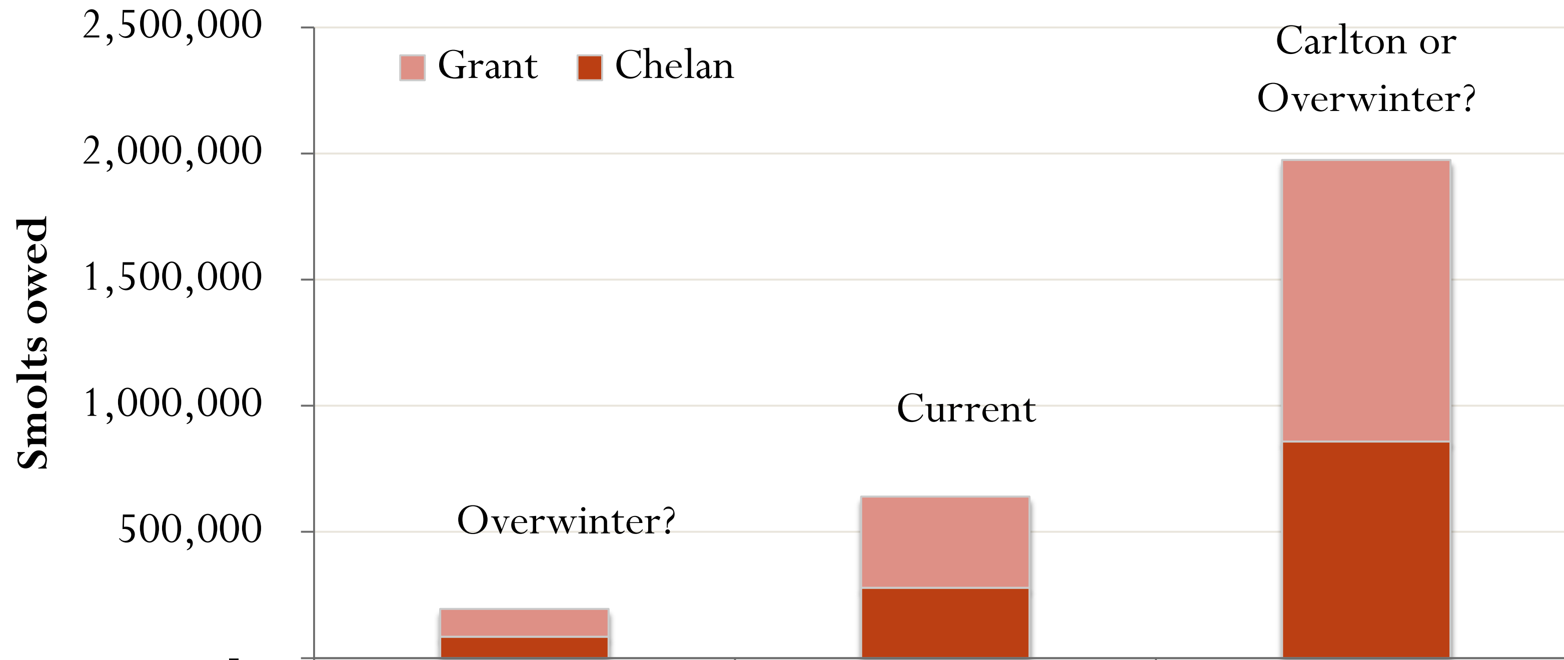
- Analysis conducted by WDFW indicated that overwintered fish had stray rates 47% and SARs 329% of those observed in spring-acclimated fish

- Dryden stray rates (11%) and SARs (0.632%) would change to 5% and 2.081%, respectively, if ratios held true to DFW analysis (with 10.4% less project mortality)

Risks of Overwintering (by DFW)

- Increased exposure to disease
- Weather (e.g., frazzle ice)
- Inability to reach size targets
  - Increased mini-jacks or jacks because of feed schedule
- Increased precocity
  - Competition
  - Predation
  - Disease
  - Lower SARs
- Not meeting goals and increasing obligations

Effect of SARs on Dryden



	2.08%	0.63%	0.21%
Grant	109,994	362,180	1,116,573
Chelan	84,556	278,421	858,351

SAR

* Represents <u>only</u> wild-origin mitigation

Rocky Reach and Rock Island HCPs

- Section 8.6 and facility modifications: "…*the existing facility as modified is compatible with and does not compromise ongoing programs*"
- Chelan PUD must consider risks involved with reconstructing HCP facilities with undefined outcomes
- Use of the scientific approach or receive assurance from JFP before jeopardizing HCP facilities

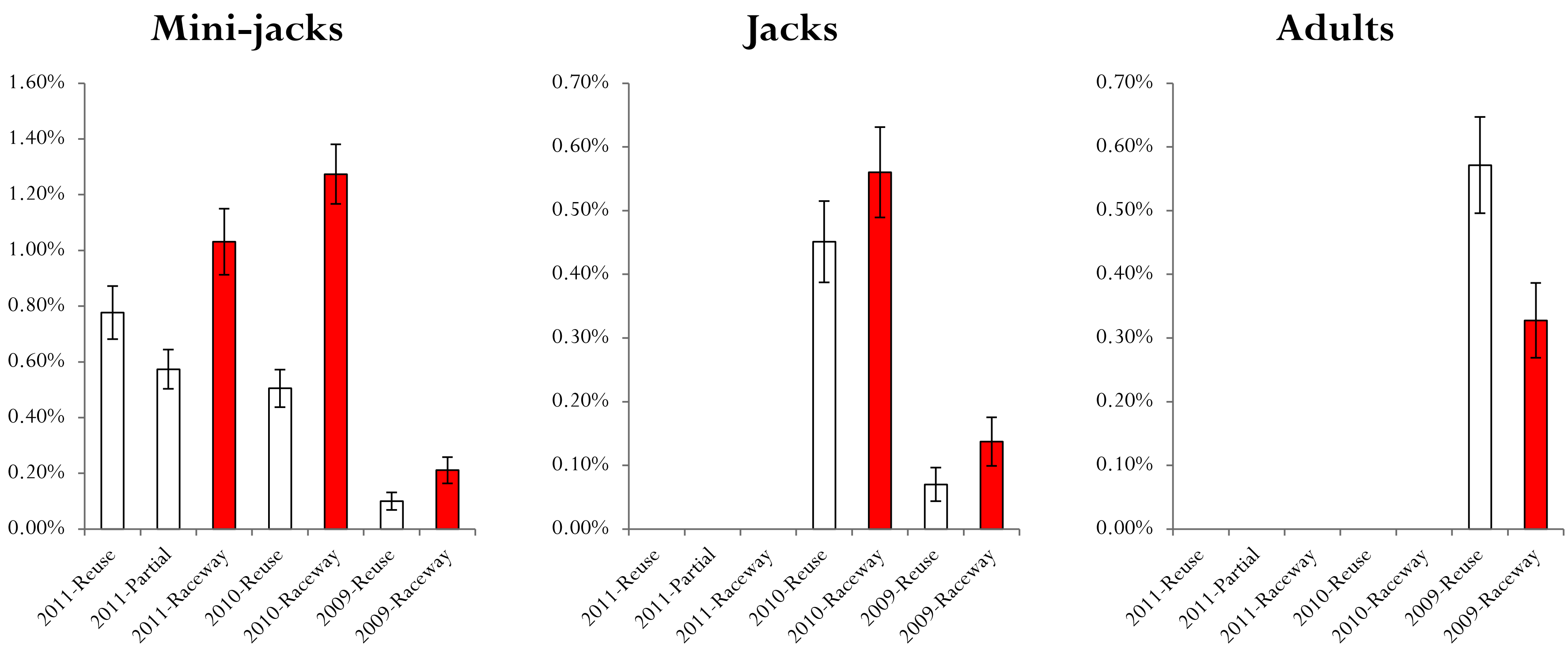
Alternative approaches

- Set program goals (BAMP = 0.3% SAR)

- Re-use technology
  - Greater smolt survival
  - Faster travel time
  - Greater SARs
  - Fewer Age-2 and -3 returns
  - Fewer strays

- Potential test scenarios
  - Control/test at Similkameen
  - Control/test at Dryden

Survival of re-use vs. raceway



Survival of re-use vs. raceway

- **Mini-jacks**
  - 0.46% vs. 0.84% (**182% greater in raceway**)
- **Jacks**
  - 0.17% vs. 0.23% (**134% greater in raceway**)
- **Adults**
  - 0.19% vs. 0.11% (**174% greater in re-use**)
  - Only 2-salt fish available

- Results based on large size-at-release targets
  - Could be further improved

Summer jacks and straying?

- 26.4% of Dryden-origin jacks stray
- Up to 49% reduction in jacks observed with re-use
  - Without adjusting size target
- Up to 37% of summer Chinook over RIS are jacks
- Reduction in jack rate could therefore decrease stray rates
  - Return in 2000 [37% jacks] = 10% stray due to jacks alone;
  - 49% reduction [19% jacks] = 5% stray due to jacks alone;
  - Hatchery production creates majority of jacks

Summary

- Chelan's feasibility of facility modifications at Dryden include:
  - Rigorous scientific analyses for informed decisions
  - Stepwise approaches to improve program performance
  - Assurance that modifications do not jeopardize the program

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
Wenatchee Research Office
3515 Chelan Hwy 97-A Wenatchee, WA 98801 (509) 664-1227 FAX (509) 662-6606

March 23, 2012

To: HCP-HC and PRCC-HSC committee members

From: Mike Tonseth, WDFW

Subject: **DRAFT 2012 UPPER COLUMBIA RIVER SALMON AND STEELHEAD BROODSTOCK OBJECTIVES AND SITE-BASED BROODSTOCK COLLECTION PROTOCOLS**

The attached protocol was developed for hatchery programs rearing spring Chinook salmon, sockeye salmon, summer Chinook salmon and summer steelhead associated with the mid-Columbia HCPs, spring Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project (FERC No. 2114) and fall Chinook 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, and Grant County Public Utility Districts (PUDs) and are operated by the Washington Department of Fish and Wildlife (WDFW). Additionally, the Yakama Nation's (YN) Coho Reintroduction Program broodstock collection protocol, when provided by the YN, will be included in this protocol due to the overlap in trapping dates and locations.

This protocol is intended to be a guide for 2012 collection of salmon and steelhead 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 (HCPs, Priest Rapids Dam 2008 Biological Opinion), changes to programs as approved by the HCP-HC, and to comply with ESA permit provisions.

Notable in this years protocols are:

- No sockeye in 2012.
- No age-3 males will be incorporated into spring or summer Chinook programs
- All NNI programs will have reductions in adult collection requirements due to re-calculation of NNI impacts per HCP's and Settlement Agreements.
- Implementation of the draft Production Management Plan (Appendix B), for all programs where possible, to ensure mitigation production levels are met and that the permitted production ceiling is not exceeded at release.

- Utilization of genetic sampling/assessment to differentiate Twisp River and non-Twisp River natural-origin spring Chinook adults collected at Wells Dam, and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir, Methow FH and Winthrop NFH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components.

- The collection of hatchery-origin spring Chinook for the Methow River Basin program in excess of production requirements, for BKD management.

- A smolt production target for the Chiwawa program in 2012 (2014 release) of 204,452 smolts (144,026 for Wenatchee basin mitigation and a one year agreement to produce CPUD's Methow obligation of 60,516 smolts).

- 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 Wells Hatchery volunteer channel, sufficient to meet a 576K yearling juvenile Chelan Falls program. For 2012 the adults will be transferred to Eastbank FH.

- Collection of 24-natural origin steelhead at the Twisp Weir in spring 2012. Adults will be transferred to Methow Hatchery for spawning and biosecure, isolated incubation through the eyed-egg stage after which they will be moved to Wells FH for the remainder of rearing. The collection of adults will occur in spring of 2013.

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow on-station-released smolts (up to 13 adults). The remainder of the broodstock (37) will be WNFH returns collected at WNFH and surplus to the WNFH program needs. The collection of adults will occur in spring of 2013.

- The collection of natural-origin summer Chinook adults for the 2012 BY Okanogan summer Chinook program in the Wells Reservoir via purse seine (approximately 112 fish). Adults collected for the DC portion of the Okanogan summer Chinook mitigation (26 adults) will be transferred, spawned, incubated, and early reared at Wells FH.

- The collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the USFWS, Entiat NFH summer Chinook programs (requires agreement of the HCP Hatchery Committee [HC]).

- The collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the Yakama Nation (YN) summer Chinook re-introduction program in the Yakima River Basin (requires agreement of the HCP HC). Transfer will occur as gametes.

- Active integration of integrated fall Chinook programs utilizing adults collected at Priest Rapids volunteer channel and/or Priest Rapids Dam OLAFT.

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.

Above Wells Dam

Spring Chinook

Inclusion of natural-origin fish in the broodstock will be a priority, with natural-origin fish specifically being targeted. Collections of natural-origin fish will not exceed 33% of the MetComp and Twisp natural-origin run escapement to maximize natural origin fish on the spawning grounds.

To facilitate BKD management, comply with ESA Section 10 permit take provisions, and to meet programmed production, hatchery-origin spring Chinook will be collected in numbers excess to program production requirements. Based on historical Methow FH spring Chinook ELISA levels above 0.12, the hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 19.4%. For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permit 1196, 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 production at 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by WDFW Fish Health to be a substantial risk to the program. Progeny of natural-origin females, with ELISA levels greater than 0.12, will be differentially tagged for evaluation purposes. Annual monitoring and evaluation of the prevalence and level of BKD and the efficacy of culling in returning hatchery- and natural-origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

Recent 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 that natural origin collections can occur at Wells Dam. Scale samples and non-lethal tissue samples (fin clips) for genetic 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 that analysis. Natural-origin fish retained for broodstock will be PIT tagged (dorsal sinus) for cross-referencing tissue samples/genetic analyses. Tissue samples will be preserved and sent to WDFW genetics lab in Olympia Washington for genetic/stock analysis. The spring Chinook sampled will be retained at Methow FH and will be sorted as Twisp or non-Twisp natural-origin fish prior to spawning. 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. Based on the broodstock-collection schedule (3-day/week, 16 hours/day), extraction of natural-origin spring Chinook is expected to be approximately 33% or less.

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 less than 33%. Twisp and Methow Composite hatchery-origin spring Chinook will be captured at the Twisp Weir, and Methow FH outfall. Trapping at the Winthrop NFH will be included if needed because of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook above Wells Dam during 2012 are estimated at 3,090 spring Chinook, including 2,609 hatchery and 481 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.

The following broodstock collection protocol was developed based on the re-calculated program production levels (223,765 smolts), BKD management strategies, projected return for BY 2012 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and assumptions listed in Table 3.

The 2012 Methow spring Chinook broodstock collection will target up to 166 adult spring Chinook (24 Twisp, 142 Methow). Based on the pre-season run forecast, Twisp fish are expected to represent 6% of the adipose present, CWT tagged hatchery adults and 16% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective of no less than 50% NOR's and to limit extraction to no greater than 33% of the natural-origin spawning escapement to the Twisp, the 2012 Twisp origin broodstock collection will total 24 fish (at least 12 wild and the remainder, maximum = 12, hatchery origin, or 1:1 wild:hatchery if wild broodstock are less than 12), representing 100% of the broodstock necessary to meet Twisp program production of 40,000 smolts. Methow Composite fish are expected to represent 43% of the adipose present CWT tagged hatchery adults and 84% 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 natural-origin recruits, the 2012 Methow broodstock collection will be predominantly natural origin and total 142 spring Chinook (133 wild and 9 Hatchery [alternative if estimated pHOS > 0.5: 71 wild + 71 hatchery]). The broodstock collected for the Methow program represents 100% of the broodstock necessary to meet Methow program production of 183,765 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 1196. The Methow FH releases will include progeny of broodstock identified as wild non-Twisp origin and known Methow Composite hatchery origin fish. Age-3 males ("jacks") will not be collected for broodstock.

Table 1. Brood year 2007-2009 age class-at-return projection for wild spring Chinook above Wells Dam, 2012.

Brood year	Smolt Estimate		Age-at-return: Twisp Basin				Age-at-return: Methow Basin				
	Twisp[1/]	Methow Basin[2/]	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total	SAR[3/]
2007	9,715	99,417	2	35	**17**	54	27	361	**167**	555	0.005581
2008	11,932	56,337	8	**50**	9	67	7	**227**	80	314	0.005581
2009	5,124	31,212	**9**	17	3	29	**11**	142	21	174	0.005581
Estimated 2011 Return			**9**	**50**	**17**	**76**	**11**	**227**	**167**	**405**	

[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/]- Mean Chiwawa NOR spring Chinook SAR to the Wenatchee Basin (BY 1998-2003; WDFW unpublished data).

Table 2. Brood year 2007-2009 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2012.

	Projected Escapement											
	Origin: Hatchery				Origin: Wild				Total: 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	184	898	42	**1,124**	11	227	167	**405**	195	1,125	209	**1,529**
%Total				43%				84%				49%
Twisp	29	123	5	**157**	9	50	17	**76**	38	173	22	**233**
%Total				6%				16%				8%
Winthrop (MetComp)	113	967	248	**1,328**					113	967	248	**1,328**
%Total				51%								43%
Total	326	1,988	295	**2,609**	20	277	184	**481**	346	2,265	479	**3,090**

Table 3. Assumptions and calculations to determine the number of broodstock needed for BY 2012 production of 223,765 smolts.

Program Assumptions	Twisp standard	Twisp program	Methow standard	Methow program	Total program
Smolt Release		40,000		183,765	**223,765**
Fertilization-to-release survival	*88%*		*85%*		
Total egg take target		45,455		216,194	**261,649**
Egg take (production)					
Cull allowance[1/]		45,455	*19.4*	268,231	**313,686**
Fecundity[2/]	*3,952*		*3,851*		
Female Target					
Female to male ratio	*1:1*		*1:1*		
Broodstock target					
Pre-spawn survival	*96%*		*98%*		
Total broodstock collection		**24**		**142**	

[1/]-Hatchery origin MetComp. component only, and is based on the projected natural origin collection and assumption that all Twisp (hatchery and wild) and wild MetComp. fish will be retained for production.
[2/]-Based on historical age-4 fecundities and expected 2012 return age structure (Table 1).

Trapping at Wells Dam will occur at the East and West ladder traps beginning on 01 May, or at such time as the first spring Chinook are observed passing Wells Dam, and continue through 22 June 2012. The trapping schedule will consist of 3-day/week (Monday-Wednesday), up to 16-hours/day. Two of the three trapping days will be concurrent with the stock assessment sampling activities authorized through the 2012 Douglas PUD Hatchery M&E Implementation Plan. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quota). Once the weekly quota target is reached, broodstock collection will cease until the beginning of the next week. If a shortfall occurs in the weekly trapping quota, the shortfall will carry forward to the following week. All natural origin spring Chinook collected at Wells Dam for broodstock will be held at the Methow FH.

To meet Methow FH broodstock collection for hatchery origin Methow Composite and Twisp River stocks, adipose-present coded-wire tagged hatchery fish will be collected at Methow FH, Winthrop NFH and the Twisp Weir beginning 01May or at such time as spring Chinook are observed passing Wells Dam and continuing through 24 August 2012. Natural origin spring Chinook will be retained at the Twisp Weir as necessary to bolster the Twisp program production so long as the aggregate collection at Wells Dam and Twisp River weir does not exceed 33% of the estimated Twisp River natural origin spawners to maximize pNOS in the Twisp. All hatchery and natural origin fish collected at Methow FH, Twisp Weir and Winthrop NFH for broodstock will be held at the Methow FH.

Steelhead

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table xx.

Table XX. Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Number to be Released	Broodstock
Twisp Conservation	Methow Hatchery (incubation); Wells Hatchery (rearing)	Douglas PUD	Twisp Acclimation Pond	48,000	Twisp WxW
Methow Safety-Net	Wells Hatchery	Douglas PUD	Methow Hatchery	100,000	HxH: Twisp Hatchery (25%) + WNFH Hatchery (75%)
Mainstem Columbia Safety-Net	Wells Hatchery	Douglas PUD	Wells Hatchery	160,000	HxH: Methow Hatchery returns (1st option); Wells Stock (2nd option)
WNFH Conservation Program	WNFH	USFWS	WNFH	100,000	Up to 25 collected at Wells Dam/Hatchery; remaining 25 collected by USFWS
Omak Creek	Wells Hatchery	Grant PUD	Omak Creek	Up to 50,000[1]	Omak Creek returns (up to 25 wild or hatchery)
Okanogan	Wells Hatchery	Grant PUD	Okanogan Basin	Up to 100,000[1]	Wells Stock collected at Wells Dam/Hatchery

1/ The Grant PUD programs will total 100,000, with Omak Creek taking precedence, and the Okanogan program = 100,000 – Omak production.

Steelhead mitigation programs above Wells Dam (including the USFWS steelhead program at Winthrop NFH) utilize adult broodstock collections at Wells Dam, Twisp Weir, Methow Hatchery volunteer trap, and WNFH volunteer trap (Table xxx) and incubation/rearing at Wells Fish Hatchery (FH) and incubation at Methow Hatchery (Twisp program). The Wells Steelhead Program has provided eggs for UCR steelhead reared at Ringold FH, not as a mitigation requirement, but rather an opportunity to reduce the prevalence of early spawn hatchery steelhead in the mitigation component above Wells Dam. However, the Methow steelhead program is shifting to locally collected Twisp wild broodstock (Twisp conservation program), and hatchery origin broodstock representative of the Twisp and WNFH conservation programs (Methow safety-net program). Therefore, surplus broodstock will not be collected for the

Methow steelhead programs to address the spawn-timing issue of the Wells stock. The Wells Hatchery Columbia River releases will use returns to the Methow Hatchery volunteer trap to the extent possible, and will be augmented with Wells stock as required to fulfill the program. Therefore, surplus broodstock collection to address spawn timing will not occur. However, the local collections of broodstock in the Methow Basin will occur in the spring, 2013. To ensure the safety-net programs have broodstock, some broodstock will be collected at Wells Dam in the autumn, 2012, and held at Wells Hatchery. These autumn-collected Wells stock fish will be considered surplus to the spring-collected Methow and Okanogan broodstock, and eggs from these surplus broodstock may be transferred to Ringold Hatchery. In addition, Wells Hatchery will be used for adult management and steelhead removed for adult management may be retained for the Ringold program.

The following broodstock collection protocol was developed based on mitigation program production objectives (Table 4), program assumptions (Table 5), and the probability that sufficient adult steelhead will return in 2012/2013 to meet production objectives absent a preseason forecast at the present time.

Table xxx. Broodstock Collection Locations, Number, and Origin by Program

Program	**Wells Dam or Hatchery**		**Twisp Weir**		**WNFH**		**Methow Hatchery**		**Omak Creek**	
	H	W	H	W	H	W	H	W	H	W
Twisp Conservation			0	24						
Methow Safety-Net			Up to 50	0	Up to 50 (backup)	0				
Mainstem Columbia Safety-Net	82 (backup)	0					82	0		
WNFH Conservation Program	8	17								
Omak Creek									Up to 25[1]	
Okanogan	Up to 33	Up to 17								
Ringold[2]	Up to 103	0								
Total	144	34	50	24	0	0	82	0	25	

1/ Wild origin preferred, but hatchery origin broodstock will also be collected to meet target.
2/ Broodstock derived from adult management at Wells Hatchery and surplus brood collected as backup for Methow and Okanogan programs

Trapping at Wells Dam will selectively retain 250 steelhead (east and west ladder collection) and will comprise 21 natural origin fish and 229 hatchery origin fish. Ringold FH production component will comprise 100% hatchery origin returns collected at Wells Dam and Hatchery volunteer channel. In the spring of 2013, 24 wild steelhead will be targeted at the Twisp Weir and transferred to the Methow Hatchery for spawning and incubation to the eyed-egg stage after which they will be moved to Wells Hatchery for the balance of rearing. In addition, 50 surplus hatchery-origin steelhead (to meet the 100K Methow Safety-Net release) will be targeted at the Twisp Weir and moved to Wells Hatchery for spawning. Surplus WNFH hatchery returns will be used to augment the Twisp hatchery-origin collection if needed. Should there be inadequate surplus steelhead from these two sources, steelhead captured at the Methow Hatchery volunteer trap will be used to fulfill the program, and then Wells stock held at the Wells Hatchery will be used as a final option. Approximately, 16 (up to 25) adult steelhead will be targeted in Omak Creek for a 20K (up to 50K) endemic program operated by the CCT and funded by GCPUD as part of their 100K UCR steelhead mitigation obligation. Overall collection for the programs will be 340 fish and limited to no more than 33% of the entire run or 33% of the natural origin return (NOR contribution to the broodstock is estimated at 26%). Hatchery and natural origin collections will be consistent with run-timing of hatchery and natural origin steelhead at Wells Dam. Ladder trapping at Wells Dam will begin on 01 August and terminate by 31 October and will be operated concurrently, three days per week, up to 16 hours per day, if required to meet broodstock objectives. Trapping will be concurrent with summer Chinook broodstocking efforts through 15 September on the west ladder. If insufficient steelhead adults are encountered on the west ladder, the east ladder trap may be considered. 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.

Table 4. Adult steelhead collection objectives for programs supported through 2012 return year adult steelhead broodstock collected at Wells Dam, Twisp Weir, and Omak Creek (CCT endemic program).

Program	# Smolts	# Green eggs	% Wild	# Wild	# Hatchery	Total Adults
DCPUD[1/]	160,000	226,629	0%		82	82
DCPUD[2/]	100,000	141,643	0%		50	50
DCPUD Twisp	48,000	67,989	100%	24		24
GCPUD[3/]	80,000	113,315	33%	13	27	40
GCPUD Omak	20,000	40,000		16		16[4/]
USFWS	50,000	70,821	33%	8	17	25
Sub-total	**458,000**	**660,397**	26%	**61**	**176**	**237**
Ringold	180,000	285,714	0%	0	103	103
Sub-total	**180,000**	**285,714**	**0%**	**0**	**103**	**103**
Grand Total[5/]	**638,000**	**946,111**	**18%**	**61**	**279**	**340**

[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 and/or surplus hatchery adults from the Twisp weir.*

[3/]- *Okanogan Basin releases as part of GCPUD's 100K summer steelhead obligation. Broodstock need is dependent on the Omak collection to achieve 100,000 smolts total.*

[4/]- *Broodstock targeted is 16 total (8 male/8 female) of mixed origin composition based upon what is trapped. Collection could range up to 25 broodstock (50,000 smolt program maximum)*

5/ - *Based on steelhead production consistent with Mid-Columbia HCP's, GCPUD BiOp and Section 10 permit 1395.*

Table 5. Program assumptions used to determine the number of adults required to meet steelhead production objectives for programs above Wells Dam and at Ringold Springs Fish Hatchery.

	Standard	
Program assumptions	**Hatchery**	**Wild**
Pre-spawn survival	95.4%	97.6%
Female : Male ratio	1.0:1.0	1.0:1.0
Fecundity	5,822	5,800
Fertilization-to-yearling release	70.6% 1/	70.6% 1/

1/ -*Not applicable to Ringold Springs Fish hatchery.*

Summer/fall Chinook

Summer/fall Chinook mitigation programs above Wells Dam utilize adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 414,669 summer/fall Chinook smolts for two acclimation/release sites on the Methow and Similkameen rivers (Carlton Pond and Similkameen Pond, respectively).

The TAC 2012 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix A) and BY 2007, 2008 and 2009 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 was developed based on initial run expectations of summer Chinook to the Columbia River, program objectives and program assumptions (Table 6).

For 2012, WDFW will retain up to 107 natural-origin summer/fall Chinook at Wells Dam east and/or west ladders, including 52 females for the Methow summer Chinook program (this total does not include the balance of the Similkameen program that may not be achieved through the CCT purse seine efforts). Collection will be proportional to return timing between 01 July and 15 September. Trapping may occur up to 3-days/week, 16 hours/day. Age-3 males ("jacks") will not be collected for broodstock.

Additionally, in collaboration with the Colville Tribes, in 2012 attempts will be made to collect up to 100% (N=112; 56 females) of the natural origin adults needed to meet the Okanogan summer Chinook obligation through the CCT purse seine efforts. If logistics or capture efficiency become prohibitive to achieving broodstock goals with this collection activity this season, broodstock collection for the balance will revert back to Wells Dam. In addition, if broodstock collection through the CCT's purse seining efforts falls behind by more than 25%, the difference between the fish collected to date and what should have been collected, will be made up at Wells Dam west ladder trap. Fish collected through the CCT trapping effort will be uniquely tagged from fish collected at Wells Dam to evaluate relative differences in disease, mortality, spawn timing, among other metrics.

For the 2012 brood year, 48,540 summer/fall Chinook will be reared at Wells Hatchery from broodstock collected by the CCT through purse seining in the Wells Reservoir. The fish will be reared to a point at which they can be transferred to the Chief Joseph Hatchery, Omak Riverside Acclimation Facility for further grow-out in 2013 and release in 2014.

To better assure achieving the appropriate female equivalents for program production, the collection will utilize ultrasonography to determine the sex of each fish retained for broodstock. 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.

Table 6. Assumptions and calculations to determine the number of broodstock needed for summer/fall Chinook production goals in the Methow and Okanogan river basins.

Program Assumptions	**Standard**	**Carlton Pond**	**Similkameen Pond**	**Wells FH/CCT**	**Total**
Smolt release		**200,000**	**166,569**	**48,540**	**414,669**
Fertilization-to-release survival	81.2				
Eggtake target		**246,305**	**205,134**	**59,236**	**510,675**
Fecundity	4,990				
Female target		**49**	**41**	**12**	**102**
Female:male ratio	1:1				
Broodstock target		**99**	**82**	**24**	**205**
Pre-spawn survival	95.5				
Total collection target		**104**	**86**	**26**	**216**

Coho – Placeholder for YN Methow Coho broodstock plan. This plan will be submitted to NMFS independently by the YN.

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Summer/fall Chinook mitigation programs that release juveniles directly into the Columbia River between Wells and Rocky Reach dams are supported through adult broodstock collections at Wells Dam and the Wells Hatchery volunteer channel. The total production level supported by this collection is 896,000 yearling (320K Wells and 576K Chelan Falls programs) and 484,000 sub-yearling Chinook (Wells Hatchery). Upon agreement in the HCP-HC, the 2012, summer Chinook broodstock collections at Wells FH may also include 345,000 green eggs to support the Yakama Nation (YN) reintroduction of summer Chinook to the Yakima River Basin and up to 266 adults or 509,009 green eggs for the USFWS Entiat program pending agreements between USFWS and DCPUD. If approved by the HCP Hatchery Committee, YN eggs will be the last eggs taken and will be the responsibility of staff associated with the YN program. Adults for the

Entiat program will be transferred to Entiat NFH by either WDFW or USFWS staff (arrangements between USFWS and DCPUD will have been made prior to implementation).

Adults returning from the Wells and Chelan Falls programs are to support harvest opportunities and are not intended to increase natural production and have been termed segregated harvest programs. These programs have contributed to harvest opportunities; however, adults from these programs have been documented contributing to the adult spawning escapement in tributaries upstream and downstream from their release locations. Because of CCT concerns about sufficient natural origin fish reaching spawning grounds, incorporation of natural origin fish for the Wells program 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 (Table 7).

WDFW will collect about 1,287 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall. Overall extraction of natural-origin fish to Wells Dam (Wells program and above Wells Dam summer/fall Chinook programs) will not exceed 33 percent. East and/or West ladder collections will begin 01 July and will be completed by 14 September and will be consistent with run timing past Wells Dam. 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. Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin 11 July and terminate by 31 August. Age-3 males ("jacks") will not be collected for broodstock.

Table 7. Assumptions and calculations to determine the number of broodstock needed for summer/fall Chinook production goals for programs relying on adult collection at Wells Dam or Wells Hatchery in 2012.

Program Assumptions	**Standard**		**Wells FH**		**Chelan Falls FH**	**YN**[1/]	**USFWS**[2/]	
	Sub-yearling	**Yearling**	**Sub-yearling**	**Yearling**	**Yearling**	**Green eggs**	**Green eggs**	**Total**
Smolt release			**484,000**	**320,000**	**576,000**		**400,000**	**NA**
Green egg-to-release survival	76.1%[4/]	83.6%						NA
Eggtake target			**636,005**	**382,775**	**688,995**	**345,000**	**509,009**	**2,561,784**
Fecundity	4,487	4,487						
Female target			**142**	**86**	**154**	**77**	**129**	**588**
Female:Male ratio	1:1	1:1						
Broodstock target			**284**	**242**[3/]	**308**	**154**	**258**	**1,246**
Pre-spawn	96.8%	96.8%						

survival						
Total collection target	**294**	**250**	**318**	**159**	**266**	**1,287**

[1/]-Green eggs for YN reintroduction program in the Yakima River Basin.
[2/]-Adults for USFWS summer Chinook program in the Entiat River Basin.
[3/]- Includes 70 adults collected for the Lake Chelan triploid Chinook program.

Wenatchee River Basin

Spring Chinook

The Eastbank Fish Hatchery (FH) rears spring Chinook salmon for the Chiwawa River acclimation pond located on the Chiwawa River. The HCP HC approved program production level target for 2012 is 204,452 smolts, requiring a total broodstock collection of 120 spring Chinook (54 natural and 66 hatchery origin; Table 8). The production level for 2012 represents agreements made early in 2012 by the Chelan PUD HCP HC to allow CPUD's spring Chinook obligation for the Methow basin (60,516 smolts) to be produced in the Wenatchee basin (CPUD's post 2013 release re-calculated production obligation for the Chiwawa is 144,026 smolts). The gap in production in the Methow is being compensated for by allowing the difference in Grant PUD's Wenatchee spring Chinook at the White River and Nason Creek to be met at Methow Hatchery. This is a one year agreement.

Table 8. Assumptions and calculations to determine the number of broodstock needed in an anticipated 2012 Chiwawa program release of 204,452 smolts.

Program Assumptions	Standard	Conservation	Safety Net	Full program
Smolt Release		**102,226**	**102,226**	**204,452**
Fertilization-to-release survival	*84.5%*			
Total egg take target		120,978	120,978	**241,956**
Egg take (production)			136,826	**257,804**
Cull allowance	*13.1%*			**15,848**
Fecundity	*4,711 W* *4,279 H*			
Female Target		26	32	**58**
Female to male ratio	*1:1*			
Broodstock target		52W	64H	**116**
Pre-spawn survival	*98.0%W/98.5H*			
Total broodstock collection		**54W**	**66H**	**120**

Inclusion of natural origin fish into the broodstock will continue to be a priority, with natural origin fish specifically being targeted. Consistent with ESA Section 10 Permit 1196, natural origin fish collections will not exceed 33 percent of the return to the Chiwawa River and will provide, at a minimum, 33 percent of the total broodstock retained.

In addition to production levels and ESA permit provisions, the 2012 broodstock collection, will target both hatchery and natural origin Chiwawa spring Chinook at the Chiwawa Weir.

Pre-season estimates project 3,819 spring Chinook are destined for the Chiwawa River, of which 481 (12.6%) and 3,338 fish (87.4%) are expected to be natural and hatchery origin spring Chinook, respectively (Tables 9 and 10). These protocols target approximately 120 spring Chinook (54 natural origin and 66 hatchery origin) for broodstock purposes, representing 100% of the program production objectives. 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 Permit 1196.

Table 9. BY 2007-2009 age class return projection for wild spring Chinook above Tumwater Dam during 2012.

Brood year	**Smolt Estimate**[1/]		**Chiwawa Basin**[2/]				**Wenatchee Basin above Tumwater Dam**[2/]				
	Chiwawa	Wen. Basin	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total	SAR[3/]
2007	65,539	103,460	24	271	**71**	366	38	427	**112**	577	0.005581
2008	91,229	168,630	35	**384**	85	504	65	**718**	159	942	0.005581
2009	51,417	88,650	**26**	249	13	287	**8**	387	100	495	0.005581
Estimated 2012 Return			**26**	**384**	**71**	**481**	**8**	**718**	**112**	**838**	

1/-Smolt production estimate for Chiwawa River derived from juvenile smolt data (Hillman et al. 2010); smolt production estimate for Wenatchee Basin is based upon proportional redd disposition between Chiwawa River and Wenatchee River basin and the Chiwawa smolt production estimate.
2/-Based upon average age-at-return (return year 2007-2011), for natural origin spring Chinook above Tumwater Dam (WDFW unpublished data).
3/-Mean Chiwawa spring Chinook SAR to the Wenatchee Basin (BY 1998-2003; WDFW unpublished data).

Table 10. BY 2007-2009 age class return projection for Chiwawa hatchery spring Chinook above Tumwater Dam during 2012.

Brood	**Smolt Estimate**	**Adult Returns**				
Year	Chiwawa[1/]	Age-3[2/]	Age-4[2/]	Age-5[2/]	Total	SAR
2007	305,542	780	1,760	**88**	2,628	0.0086[3/]
2008	609,789	1,229	**2,839**[4/]	139	4,208	0.0069[5/]
2009	438,651	**411**	1,827	88	2,326	0.0053[6/]
Estimated 2012 Return		**411**	**2,839**	**88**	**3,338**	

1/-Chiwawa smolt release (Hillman et. al. 2009).
2/-Based on average age-at-return for hatchery origin spring Chinook above Tumwater Dam, 2005-2009 (WDFW,

unpublished data) and total estimated BY return.
[3/]-Mean Chiwawa hatchery spring Chinook SAR to the Wenatchee Basin (BY 1997-2002).
[4/]-Age-4 returns in 2012 may be significantly underestimated due to age-3 returns in 2011 being in excess of 260% of the 2011 forecast.
[5/]-Mean Chiwawa hatchery spring Chinook SAR to the Wenatchee Basin (BY 1998-2003).
[6/]-Mean Chiwawa hatchery spring Chinook SAR to the Wenatchee Basin (BY 2000-2004).

Collection at the Chiwawa Weir will be based on weekly quotas, consistent with average run timing at Tumwater Dam. If the weekly quota is attained prior to the end of the week, retention of spring Chinook for broodstock will cease. If the weekly quota is not attained, the shortfall will carry forward to the next week. The number of hatchery origin fish retained for broodstock will be adjusted in-season, based on estimated Chiwawa River natural-origin returns provided through extrapolation of returns past Tumwater Dam. If hatchery origin Chinook are retained in excess to that required to maintain a minimum 33% natural origin composition in the broodstock, excess fish will be sampled, killed and either used for nutrient enhancement or disposed of in a landfill depending upon fish health staff recommendations.

Broodstock collection at the Chiwawa Weir will begin 01 June and terminate no later than 11 September. Spring Chinook trapping at the Chiwawa Weir will follow a 4-days up and 3-days down schedule, consistent with weekly broodstock collection quotas that approximate the historical run timing and a maximum 33 percent retention of the projected natural-origin escapement to the Chiwawa River. If the weekly quota is attained prior to the end of the 4-day trapping period, trapping will cease. If the weekly quota cannot be accomplished with a 4-days up and 3-days down schedule, a 7-day per week schedule may be implemented to facilitate reaching the collection objectives. Under the 7-day per week schedule, no more than 33% (1 in 3) of the fish collected will be retained for broodstock. If the weekly quota is not attained within the trapping period, the shortfall will carry forward to the next week.

All spring Chinook in excess of broodstock needs and all bull trout trapped at the Chiwawa weir will be transported by tank truck and released into a resting/recovery pool at least 16.0 km upstream from the Chiwawa River Weir. Age-3 males (“jacks”) will not be collected for broodstock.

Steelhead

The steelhead mitigation program in the Wenatchee Basin use broodstock collected at Dryden and Tumwater dams located on the Wenatchee River. Per ESA section 10 Permit 1395 provisions, broodstock collection will target adults necessary to meet a 50% natural origin – conservation oriented program and a 50% hatchery origin – safety net program, not to exceed 33% of the natural origin steelhead return to the Wenatchee Basin. Based on these limitations and the assumptions listed below (Table 12), the following broodstock collection protocol was developed.

WDFW will retain a total of 130 mixed origin steelhead for broodstock for a smolt release objective of 247,300 smolts (Table 12). The 66 hatchery origin adults will be targeted at Dryden Dam and if necessary Tumwater dam. The 64 natural origin adults will be targeted for collection at Tumwater Dam. Collection will be proportional to return timing between 01 July and 12

November.   Collection may also occur between 13 November and 3 December at both traps, concurrent with the Yakama Nation coho broodstock collection activities. Hatchery x wild and hatchery x hatchery parental cross and unknown hatchery parental cross adults will be excluded from the broodstock collection. Hatchery steelhead parental origins will be determined through evaluation of VIE tags, adipose/cwt presence/absence, and PIT tag interrogation during collection. 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 assure achieving the appropriate females equivalents for program production, the collection will implement the draft Production Management Plan, including ultrasonography to determine the sex of each fish retained for broodstock.

In the event steelhead collections fall substantially behind schedule, WDFW may initiate/coordinated 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.

Table 12. Assumptions and calculations to determine the number and origin of Wenatchee summer steelhead broodstock needed for Wenatchee Basin program release of 247,300 smolts.

Program Assumptions	**Standard**	**Wenatchee program**
Smolt Release		**123,650 Conservation** **123,650 Safety net**
Fertilization-to-release survival	*68.6%*	
Egg take target		**360,496**
Fecundity	*5,749 H* *5,893 W*	
Female Target		**32 H** **31 W**
Female to male ratio	*1:1*	
Broodstock target		**126**
Pre-spawn survival	*96.9%H/97.9%W*	
Total broodstock collection		**130**
Natural:Hatchery ratio	1:1	
Natural origin collection total		**64**

Hatchery origin collection total	66

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 2012 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2012 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix A) and BY 2007, 2008 and 2009 spawn 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 dam 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. Collections will be limited to a 33% extraction of the estimated natural-origin escapement to the Wenatchee Basin. Based on these limitations and the assumptions listed below (Table 13), the following broodstock collection protocol was developed.

WDFW will retain up to 274 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 137 females. To better assure achieving the appropriate females equivalents 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 01 July 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.

Table 13. Assumptions and calculations to determine the number of Wenatchee summer Chinook salmon broodstock needed for Wenatchee Basin program release of 864,000 smolts.

Program Assumptions	Standard	Grant PUD	Chelan PUD	Total Wenatchee Program
Smolt Release		**181,816**	**318,185**	**500,001**
Fertilization-to-release survival	*75.6%*			
Egg take target		**240,497**	**420,880**	**661,377**

Fecundity	*5,135*			
Female Target		**47**	**82**	**129**
Female to male ratio	*1:1*			
Broodstock target		**94**	**164**	**258**
Pre-spawn survival	*94.1%*			
Total broodstock collection		**100**	**174**	**274**

Coho – Placeholder for YN Wenatchee Coho broodstock plan. This plan will be submitted to NMFS independently by the YN.

White River Spring Chinook Captive Brood

Smolt production associated with the White River Captive Broodstock Program (150,000 smolts) will be separate from the smolt production objective associated with the Chiwawa River adult supplementation program. Spawning, incubation, rearing acclimation and release will be consistent with provisions of (expired) ESA Permit 1592.

Nason Creek Spring Chinook

Consistent with agreements made in 2012 in both the HCP-HC and PRCC-HSC, Grant PUDs spring Chinook obligation will be met with primarily production from the White River captive brood program with the balance of the obligation being met with spring Chinook at Methow FH. These agreements allow for Chelan PUD to move their Methow spring Chinook obligation to the Chiwawa to maintain the total Wenatchee Basin spring Chinook production at the recalculated level of 367,696 smolts. Total Methow Basin spring Chinook production will be maintained at the re-calculated level of 223,765 smolts. This agreement is only in place for the 2012 brood.

Priest Rapids Fall Chinook

Collection of fall Chinook broodstock at Priest Rapids Hatchery will generally begin in early September and continue through mid November. Smolt release objectives specific to Grant PUD (5,000,000 sub-yearlings), Federal (1,700,000 sub-yearlings + 3,500,000 eggs – collection of broodstock for the federal programs are conditional upon having contracts in place with the ACOE) and Yakama Nation (500,000 eggs), mitigation commitments. Biological assumptions are detailed in Table 14. Smolt release objectives for Ringold Springs occur as green eggs collected at Priest Rapids FH and incubated at Bonneville prior to eyed-egg transfers to Ringold Springs. The Yakama program would be green egg transfers from Priest Rapids FH. After the new Priest Rapids FH rebuild there will no longer be incubation capacity for programs above GCPUD mitigation obligations.

For 2012 WDFW is proposing to implement active integration of the fall Chinook programs to meet a pNOB of 0.4, an estimated 2,860 females will need to be spawned to meet the 12,298,851 eggs required to meet the current four up-river bright (URB) programs which rely on adults collected at the Priest Rapids Hatchery volunteer channel trap and/or the Priest Rapids Dam off ladder trap (OLAFT). To meet an integrated program with a pNOB = 0.4, an estimated 1,950 natural origin fish will need to be collected (Table 14). Although hatchery returns in 2012 will be comprised of 100% marked fish (otolith, adipose clipped, and/or coded wire tagged), because natural origin fish cannot be differentiated without lethally sampling otolith marked adults, additional adipose present non-wired fish will need to be collected to ensure sufficient natural origin adults are present in the broodstock population to meet, or be significantly closer, to the target pNOB metric of 0.4. As such it is estimated that 2,322 adipose present, non-wired fish collected from the OLAFT under a 6-day/week, 8-hours/day trap operation will yield approximately 1,578 natural origin fish (Table 15). In addition, approximately 4,818 adipose present, non-wired adults collected from the PRH volunteer trap will yield an estimated 267 natural origin fish for a total NOR broodstock component of 1,845 fish (Table 15). Depending upon pre-spawn survival performance of the broodstock, we can reasonably expect to achieve a pNOB of between 0.348 and 0.378 (Table 15).

Implementation Assumptions

1) Consistent with the Priest Rapids Fall Chinook HGMP, SOA 2009-01, SOA 2008-03, HSRG recommendations, and WDFW's Fish and Wildlife Commission policy (POL-C3619), 2012 marks the first year of moving toward meeting the metrics of the program and the overall Hanford Reach fall Chinook population (2012 is the first year for all age classes to return from 100% marked releases – otolith, CWT, adipose clip, or any combination thereof).

2) For 2012, the fall Chinook program will be operated to actively integrate natural origin fish into the program (e.g. determination of origin will be made at spawning). Fish/gametes, from natural origin fish will be prioritized over hatchery fish.

3) For 2012, production will be guaranteed while transitioning the programs to meet a pNOB of 0.4.

4) Broodstock will be collected at both the PRD off ladder trap (OLAFT) and the Priest Rapids Hatchery volunteer channel trap.

5) Assumptions used to determine egg/adult needs is based upon current program performance metrics and is consistent with the draft 2012 Broodstock Collection protocols.

6) For adults collected at the Priest Rapids volunteer channel, the encounter rate is based upon the average of the most recent five year returns to the hatchery volunteer channel (N=15,962).

7) Broodstock retained from the volunteer channel will exclude age-2 and 3 males by age (or otoliths if parties prefer however that will increase the number of broodstock to be retained and otolith sampled by approximately 43%) to address genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity).

8) All adipose present, non-wired fish encountered at the OLAFT will be retained for broodstock.

9) All gametes of fish spawned from natural origin adults (as determined through real-time otolith reading at spawning) will be incorporated into the URB programs.

10) As production obligations are met throughout spawning, hatchery x hatchery eggs in excess of program needs will be culled to maintain incubation capacity and minimize production overages.

Table 14. Juvenile production objectives and associated broodstock needs for fall Chinook programs using upriver bright (URB) adults collected at Priest Rapids Hatchery/Dam in 2012 to meet a pNOB of 0.4 consistent with the Priest Rapids fall Chinook HGMP, SOA's, HSRG recommendations and WDFW FWC policy (#POL-C3619).

Current Programs	Juvenile Release Target		Green eggs	Females spawned	Females collected	Adults required 2:1 F:M	NOR's required @pNOB=0.4 2:1 F:M
	Sub-yearling	Fry					
GCPUD	5,000,000	0	5,747,126	1,337	1,519	2,278	911
John Day (PRH)	1,700,000		1,954,023	454	516	775	310
John Day (Ringold)	3,500,000		4,022,989	936	1,063	1,595	638
John Day (YN)	500,000		574,713	134	152	228	91
Total	**10,700,000**	**0**	**12,298,851**	**2,860**	**3,250**	**4,875**	**1,950**

Table 15. Estimated number adipose present fish encountered and retained for broodstock from the Priest Rapids Dam off ladder trap (OLAFT) and Priest Rapids Hatchery volunteer channel trap in 2012.

Trapping facility/broodstock source	Adipose present, non-wired fish collected	Natural origin fish collected at 69% NOR contribution (2011 data)	Natural origin fish collected at 3% NOR contribution rate	Total number of broodstock retained by site[1]
Operation of OLAFT 6d/week,8hr/day	2,322	1,578		**2,322**
PRH Volunteer Trap – assumes 56.7% ad-present[2]	8,897		267	**4,818**
Total Estimated NOR's	1,845			
Estimated pNOB (%NOR'S)	0.378			
Adjusted pNOB	0.348[3]			
Total Ad-present fish encountered	11,219			**7,140[4]**

[1] Includes both unmarked hatchery and natural origin fish retained for broodstock.
[2] Based upon current adipose clip and/or coded wire tag rates for juvenile fish released.
[3] Adjusted for pre-spawn survival of broodstock from collection to spawning (0.88)
[4] Adjusted for exclusion of age-2 and 3 hatchery origin males (by size) at collection. This represents the cumulative number of broodstock which will need to be retained from both the OLAFT and PRH volunteer trap. All fish will have to be otolith sampled at time of spawning to determine H/W origin.

To achieve the number of broodstock retained, as identified in Table 2, an estimated 18,801 adults will have to be handled at the PRH volunteer trap (15,962) and the OLAFT (2,839; Table 3). This will produce approximately 95% of the natural origin adults required to meet an integrated program.

Table 16. Estimate of total and NOR adult fall Chinook, handled and retained at the Priest Rapids Hatchery volunteer channel trap and Priest Rapids Dam OLAFT, in 2012.

Collection Location	Estimate of fish handled	Estimate of ad present non-wired fish handled	Estimate of ad present non-wired fish retained	Estimate of NOR's by location
OLAFT	2,839	2,322	2,322	1,578
Volunteer trap	15,962	8,897	4,818[1]	267
Total	18,801	11,219	7,140	1,845

[1] Adjusted for exclusion of age-2 and 3 hatchery origin males (by size) at collection.

Alternate Table 16 – if active integration does not occur

Table 14. Assumptions and calculations to determine the number of fall Chinook salmon broodstock needed for non-actively integrated Priest Rapids program release of 6,700,000 sub-yearling fall Chinook in addition to 3,500,000 for Ringold and 500,000 for the Yakama Nation, in 2012.

Program Assumptions	Standard	Program objective
Juvenile Production Level		
Grant PUD Mitigation-PUD Funded		**5,000,000**
John Day Mitigation-Federally Funded		**1,700,000**
John Day Mitigation [1]-Ringold Springs-ACOE funding.		**3,500,000**
John Day Mitigation [2]-Yakama N Request		**500,000**
Total Program Objectives		**10,700,000**
Fertilization-to-release survival	*87%*	
Egg take target		**12,298,851**
Fecundity	*4,300*	
Female Target		**2,860**
Female to male ratio	*2:1*	

Pre-spawn survival	*88%*	
Broodstock target		
Females		**3,250**
Males		**1,625**
Total broodstock collection		**4,875**

[1] As of brood year 2009, Priest Rapids Hatchery is taking 3,500,000 eggs for release at Ringold-Meseberg Hatchery funded by the ACOE – incubation of this program occurs at Bonneville.
[2] The Yakama Nation has requested 500,000 fall Chinook eyed eggs from Priest rapids Hatchery for 2012. This request has been submitted to GCPUD and will be conditional upon agreements between YN and GCPUD.

Appendix A

Columbia River Mouth Fish Returns Actual and Forecasts[a/]			
	2011 Forecast	**2011 Return**	**2012 Forecast**
Spring Chinook Upriver Total	**198,400**	**221,200**	**314,200[b/]**
Upper Columbia (total)	22,400	16,500	32,600
Upper Columbia (wild	2,000	2,200	2,800
Snake River Spring/Summer (total)	91,100	127,500	168,000
Snake River (wild	24,700	31,600	39,000
Summer Chinook	**91,100**	**80,600**	**91,200**
Sockeye	**161,900**	**187,300**	**462,000**
Wenatchee	33,000	41,800	28,800
Okanogan	126,800	143,500	431,300
Snake River	2,100	1,900	1,900

a/ Numbers may not sum due to rounding
b/ TAC used a log-normal sibling regression model to forecast the 2012 4-year old returns from the 2011 Bonneville Dam jack count. Log-normal models appear to work relatively well when jack counts are large, and the 2011 jack count at Bonneville Dam was the second highest on record.

Appendix B

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.

Improved Fecundity Estimates

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). Ultrsonography, 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.

Adult Collection Adjustments

C) Make in-season adjustments to adult collections based upon a fecundity-at-length regression model for each population/program and origin composition needs (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.

Within-Hatchery Program Adjustments

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:

- 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:

- 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
- 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.

To: Hatchery Evaluation Technical Team (HETT)

From: HCP Hatchery Committees

Date: 13 March 2012

RE: Request for HETT to develop recommendations regarding the use of temporary natural acclimation sites.

The YN, through the Columbia River Fish Accords, is developing and evaluating natural acclimation sites in the Wenatchee and Methow sub-basins. Acclimation sites developed through this program could be operated as either singles species sites or multi-species sites. A short-term goal of this program is to evaluate potential sites throughout the Wenatchee and Methow basins, with the longer term goal of integrating their use in existing hatchery programs. The potential benefits of the greater use of distributed acclimation include increased distribution of spawners within the spawning habitat (when compared to a single release location), and increased homing fidelity in situations where limited acclimation is currently available. Ultimately, this may contribute to the understanding of how acclimating and releasing fish in a manner that mimics natural systems can increase the effectiveness of integrated hatchery programs.

Consistent with the discussion at the February 2012 HCP Hatchery Committee meeting, the YN is requesting that the Hatchery Committees approve assigning the HETT the task of developing a long-term plan for expanding the use of distributed acclimation sites in existing Wenatchee and Methow sub basin hatchery programs. Specific task would include:

1) Identify priority locations for developing short-term natural acclimation sites based on biological and geographical consideration., Examples of biological and geographical considerations may include current spawning distribution of hatchery and natural fish and available habitat, and potential to address high stray rates.

2) Identify appropriate numbers of fish for natural acclimation versus traditional hatchery or existing acclimation site release locations based on geographical need.

3) Identify monitoring and evaluation needs beyond those already included in the Douglas PUD and Chelan PUD Hatchery Monitoring Programs, including criteria for successful and continued use of an acclimation site.

It is expected that the recommendations received from HETT will be used by the Committees in planning the future role that natural short-term acclimation sites can play in supporting HCP, PRCC, and USFWS (note: USFWS programs are not under the purview of the Committees or HETT).

It is expected that this is a task that the HETT can complete in within the next four months.

Proposal to collect tissue samples from Chinook salmon and steelhead broodstock annually at facilities under the oversight of the HCP Hatchery Committee and PRCC Hatchery Sub Committee

Submitted to:
HCP Hatchery Committee and PRCC Hatchery Sub Committee

Requesting agency:
Columbia River Inter-Tribal Fish Commission
3059-F National Fish Hatchery Rd.
Hagerman, Idaho 83332

Contact information:
Maureen Hess, CRITFC, hesm@critfc.org, 208-837-9096 x1117
Shawn Narum, CRITFC, nars@critfc.org, 208-837-9096 x1120

Objective

In order to expand parentage based tagging (PBT) throughout the Columbia River basin for Chinook salmon and steelhead, we are requesting that tissue samples be collected from all broodstock as fish are spawned in hatcheries above Bonneville Dam starting in 2012 and continuing for the foreseeable future. We are specifically requesting that the following hatchery programs collect tissue samples from 100% of broodstock, and tissues be sent to the appropriate operating agency's genetics lab for storage until the anticipated funding is in place to genotype samples (herein WDFW, USFWS):

Facility	Species/Program	Operator
Methow Hatchery	Twisp Spring Chinook, MetComp Spring Chinook, Twisp Steelhead, Methow Steelhead	WDFW
Wells Hatchery	Steelhead, Methow Summer Chinook	WDFW
Eastbank	Chiwawa Spring Chinook, Wenatchee Summer Chinook, TurtleRock/Chelan Falls Summer Chinook	WDFW
Willard/LWS	White River Spring Chinook Captive Brood	USFWS
Priest Rapids	Fall Chinook	WDFW

CRITFC can provide sampling supplies in the form of Whatman sheets for spawn year 2012. At a minimum, we ask that a tissue sample be collected upon spawning from every individual fish used as broodstock, and the corresponding spawn date and gender be recorded for each individual. Optional information would include spawn cross records (i.e., which fish were mated together), length, or any other associated data recorded by hatchery staff. It is critical to begin genetically tagging parents in 2012 in order to recover tags from returning adults in subsequent years.

The comprehensive effort of obtaining tissues and implementing the PBT approach will include all salmonid genetics labs (CRITFC, ODFW, WDFW, IDFG, USFWS, NOAA) involved in research in the Columbia River basin, and data is intended to be shared within a centralized database.

Background

Several committees and science review groups have recommended that large-scale evaluations of PBT technology be performed (PFMC 2008; PSC 2008; ISAB/ISRP 2009). Thus far, PBT has been effectively applied to Chinook salmon and steelhead populations in California (Anderson & Garza 2006; Anderson 2010) and throughout the Snake River basin (Steele et al. 2011) for accomplishing a variety of objectives including identification of hatchery parents of harvested fish, strays, returning adults, and outmigrating juveniles.

PBT technology greatly reduces the problem of small sample sizes encountered with CWTs, and thus would provide the statistical power needed to improve escapement estimates and identification of stock contributions to fisheries. By genotyping 100% of parental broodstock, 100% of all offspring are genetically tagged. Implementation of PBT involves annual sampling of hatchery broodstock to create a parental genotype baseline. Offspring produced by these parents must then be sampled (e.g. non-lethal fin clips) either as adults or juveniles, and then genotyped to be assigned back to their parents – thus identifying their age and hatchery of origin. This new PBT approach will provide many opportunities to address additional questions related to fisheries management and strongly complements the existing CWT program in the Columbia Basin.

Literature cited

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Steele CA, Campbell MR, Ackerman M, McCane J, Hess MA, Campbell N, Narum SR. 2011. Parentage Based Tagging of Snake River hatchery steelhead and Chinook salmon. Bonneville Power Administration. Annual Progress Report, Project number 2010-031-00. https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Res11-111Steele2010%20Parentage%20Based%20Tagging%20Snake%20River%20Steelhead%20Salmon.pdf

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	May 21, 2012
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the April 18, 2012, HCP Hatchery Committees' Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees' meeting was held at the Chelan PUD Headquarters Auditorium in East Wenatchee, Washington, on Wednesday, April 18, 2012, from 9:30 am to 3:30 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Chelan PUD will convene a sub-group of the Hatchery Committees to develop a conceptual proposal for evaluating the relative benefits of overwinter acclimation versus alternative rearing strategies (e.g., water re-use in circular tanks) to improve smolt-to-adult survival rates (SARs) and reduce straying in summer Chinook hatchery programs (Item II-A).
- Mike Schiewe will contact Craig Busack to discuss the timing of the National Marine Fisheries Service (NMFS) developing Endangered Species Act (ESA) Section 10 permits for HCP hatchery programs, and the Hatchery Committees planned update of the Hatchery Monitoring and Evaluation (M&E) Plan (Item II-B).
- Greg Mackey will provide an overview of the Principles of Adaptive Management at the May 17, 2012 Hatchery Committees' meeting, as it relates to the Hatchery M&E Plan update (Item II-B).
- Josh Murauskas will email a copy of Dr. Kim Hyatt's, Fisheries and Oceans Canada, presentation to Kristi Geris for distribution to the Hatchery Committees (Item IV-A).
- Bill Gale will email to Kristi Geris, for distribution to the Hatchery Committees, scientific papers regarding the volitional release of hatchery smolts (Item V-A).
- Josh Murauskas will email Chelan PUD's data on the volitional release of Chiwawa hatchery steelhead to Kristi Geris for distribution to the Hatchery Committees (Item

V-A).

STATEMENT OF AGREEMENT DECISION SUMMARY

- The Hatchery Committees agreed to defer voting on Columbia River Inter-Tribal Fish Commission's (CRITFC's) Steelhead and Spring Chinook Genetic Sampling Request Statement of Agreement (SOA) (Item III-A).

AGREEMENTS

- The Hatchery Committees agreed to begin discussions on updating the Hatchery Program M&E Plan and communicating with NMFS on the pending Section 10 permits (Item II-B).

REVIEW ITEMS

- The Douglas PUD Draft 5-Year M&E Report is available for a 60-day review. Comments are due to Greg Mackey by April 27, 2012.
- The Chelan PUD Draft 2011 Hatchery M&E Annual Report is available for a 60-day review. Comments are due to Tracy Hillman by June 4, 2012.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and introduced Kristi Geris as new Anchor QEA support staff to the Committees. Schiewe reviewed the agenda; the following agenda items were added:

- Mike Tonseth added a discussion of disposition of residual juvenile steelhead following spring 2012 releases.
- Josh Murauskas said he would like to include in the same agenda item a discussion of volitional versus forced release of juvenile steelhead from the Chiwawa Facility.

Mike Schiewe said that the Priest Rapids Coordinating Committee (PRCC) had asked if the Hatchery Committees could move their May 2012 meeting from May 16 to May 17 to accommodate PRCC Hatchery Subcommittee attendance at the Chelan County Commissioners' meeting on May 16 to discuss development of Grant PUD's Nason Creek Acclimation Facility. Schiewe asked for Committees members' availability to accommodate the requested meeting date change. All Committees members agreed to changing the May meeting date to May 17, 2012, pending Chelan PUD and Douglas PUD confirmation to Schiewe of their availability. Greg Mackey will confirm the availability of a meeting room at Douglas PUD.

The revised draft March 28, 2012 meeting minutes were reviewed. Carmen Andonaegui said that the draft minutes were initially provided to the Committees by email on April 16, 2012. A revised draft was emailed to the Committees today, April 18, 2012, just prior to the meeting. Committees members discussed the revised draft meeting minutes. The Committees discussed the meeting protocols. Andonaegui will clarify in the March 28, 2012 meeting minutes that informal agreements reached at the meeting were those of the Committees members present. For the record, Gale stated his approval with the decision items at the March 28, 2012, meeting. The Committees approved the March 28, 2012, meeting minutes, as revised.

II. Chelan PUD

A. Dryden Overwintering Feasibility (Josh Murauskas)

Josh Murauskas initiated discussion of potential benefits of overwinter acclimation at Dryden (i.e., reduced stray rates, increased SARs) by reviewing empirical data collected as part of the Hatchery M&E Program (Attachment B and C). He presented a multivariate analysis on roughly 60 variables collected over the past 17 years through the M&E prorgram. The data suggested that there are several operational factors at the Dryden Facility that contribute to stray rates, SARs, and mini-jack rates. For example, the multivariate model significantly ($p < 0.05$) explained a majority of the variation in stray rates through release timing and proportion of natural-origin brood.

The Hatchery Committees discussed the multiple variables associated with the acclimation conditions used in the analysis and how the variation might have affected SARs. In response to a question about the Join Fisheries Parties' (JFP's) preferred alternative of modifying facilities and converting to overwinter acclimation at Dryden, Murauskas said that Chelan PUD wanted the Committees to consider water re-use and circular tank rearing at Eastbank Hatchery, and continued spring acclimation at Dryden Facility for the summer Chinook program. Joe Miller said that the Washington State Department of Ecology's (Ecology) addendum to the Wenatchee Total Maximum Daily Load (TMDL) established a modified phosphorus target not to exceed 743 micrograms per liter for the entire Wenatchee River. Miller said that he hoped the Committees would develop an agreeable, pragmatic approach for acclimation at the Dryden Facility that will meet hatchery program goals and targets using available M&E data. Bill Gale said that it was his impression that overwintered juvenile fish had better SARs, especially for the Okanogan smolts. Mike Tonseth said the Similkameen program was an example of a program showing the benefits of overwintering for SARs. Tom Kahler said that it was not clear whether the improved SARs were the result of overwintering or the result of other hatchery practices affecting those juvenile fish such as growth rates, relative size at age, or water temperature. Keely Murdoch said that there was other literature that documented the benefits of the use of surface water and overwinter acclimation. The Committees discussed the potential to empirically test the effects of overwinter acclimation versus the effects of water re-use and circular tanks and continued spring acclimation. Murauskas reiterated that he was not recommending water re-use and circular tanks as the best acclimation strategy to improve survival and productivity, but that his intent was to approach the question based on the analysis of empirical data, and that re-use acclimation tanks and smaller size-at-release were examples of changes that should be considered.

Gale suggested that it was important to consider changing the water source for the Dryden Facility from irrigation canal water to another water source. The Committees discussed the benefits of having a dedicated water supply other than from the irrigation canal, and the relative risks associated with developing or not developing an alternate water source. Miller suggested first identifying the hatchery operations that might influence straying and improve SARs, and then discussing the facility infrastructure modifications needed to implement those operations. Mike Schiewe asked Chelan PUD if they would be willing to develop for review by the Committees a study proposal to evaluate the benefits of overwintering compared to other alternatives. Kirk Truscott suggested that Chelan PUD develop a conceptual approach to which the Committees could respond, rather than a fully developed study proposal, and that Chelan PUD do so in coordination with the Committees. Gale and Truscott said that they would like to participate in the development of a conceptual proposal. Murdoch reiterated that she still sees the need for a dedicated water intake to provide an alternate source of water for facility operations. Tonseth said he would like to see consideration of fish health at the Dryden Facility included as an objective in the conceptual proposal. Chelan PUD agreed to convene a subgroup of the Committees to develop a conceptual approach to investigating Dryden Facility improvement needs for the Committees' review and further development.

B. Draft 2011 Hatchery M&E Annual Report (Josh Murauskas)

Josh Murauskas said that Tracy Hillman, BioAnalysts, had completed the draft 2011 Hatchery M&E Annual Report and it was available for review, with comments due June 4, 2012. He said that comments on the Chelan PUD draft 5-Year M&E Report were due April 6, 2012; and Hillman is finalizing this report. Mike Schiewe said that, at the next Hatchery Committees meeting, he would like to begin discussion of the conclusions from the 5-Year M&E Report. He said that the Committees should consider whether Hatchery M&E Program objectives need to be revisited, whether the analytical framework needs to be updated, and whether new information needs to be collected. Schiewe asked for the Committees' preference on how to move forward with updating the Hatchery M&E Program in consideration of the conclusions reached in the 5-Year M&E Report.

Murauskas said that the PUDs had been discussing adjustments to their M&E Plans with the goal of improving M&E program efficiency. Greg Mackey said that the M&E Plan update was scheduled by the HCPs to occur in 2012, and that the 5-Year M&E Report should inform the update as well as the consideration of new monitoring technology. Bill Gale inquired about changing the M&E Program prior to completion of the NMFS Hatchery Genetic Management Plan (HGMP) consultations. Mike Schiewe said that he would contact Craig Busack to discuss the linkage between the ESA Section 10 permit in consideration of the Committees' planned update of the M&E Plan. Mike Tonseth said that it is critical that M&E activities not result in take of ESA-listed species that exceeds what is specified in the Incidental Take Statements of the new Section 10 permits because exceeding take automatically triggers reinitiation of ESA consultation. The Committees agreed to begin discussions on updating the M&E Plan and communicating with NMFS on the emerging Section 10 permits. Mackey said that he would make a presentation on the Principals of Adaptive Management at the May 17, 2012 meeting; Kristi Geris will place this item on the May agenda. Chelan PUD and Douglas PUD will begin compiling information for use by the

Committees for the M&E Plan update. Schiewe encouraged other Committees members to bring forward relevant information to the Committees.

III. Yakama Nation

A. CRITFC Steelhead and Spring Chinook Genetic Sampling Request SOA (Keely Murdoch)

Mike Schiewe said that Craig Busack's email on April 9, 2012, stated that he was not ready to approve the SOA without additional details being worked out on the CRITFC sampling proposal. He said that the lack of approval of the SOA did not keep individual parties from providing samples as interested. Keely Murdoch said that she would talk with Busack to find out what his specific concerns were with the proposal. Mike Tonseth said that Washington Department of Fish and Wildlife (WDFW) geneticists had expressed the same concerns as those he had heard expressed by Busack regarding the need for standardization of sampling methods and analyses. He added that WDFW was supportive of the concept but that discussions regarding details were still ongoing among federal and state geneticists. Murdoch agreed that the CRITFC proposal was not ready for a vote today. Schiewe suggested that Murdoch talk with Maureen Hess about further coordination with agency geneticists and then bring the request back to the Committees if CRITFC so chooses.

IV. Douglas PUD

A. Fish Water Management Tool (Kim Hyatt and Margo Stockwell, Fisheries and Oceans Canada)

Mike Schiewe introduced Dr. Kim Hyatt and Margo Stockwell, Fisheries and Oceans Canada, to summarize recent implementation of the Fish and Water Management Tool (FWMT). He said that Rich Bussanich, Okanagan Nation Alliance (ONA), was on the phone. Bussanich coordinates the Skaha Lake Hatchery Program. Hyatt provided an overview of the FWMT (Attachment D). He presented background data on the Columbia River sockeye population, saying that 81 percent of the sockeye return aggregate (1970-2011) was made up of Okanagan wild sockeye, based on counts at Bonneville Dam and harvest data. He presented information on the factors contributing to rebuilding of the Okanagan sockeye salmon run since 2004-2005, when the FWMT was first implemented, and he provided information on the geography of the Okanagan River Basin, its water management control points, and its hydrology. Hyatt described the factors that drive water management decisions in the Okanagan River Basin, the issues that affect water management decisions, and the history of compliance with providing fishery flows prior to 1997. He noted that the lack of compliance was often the result of competing rules and objectives.

Hyatt described the development of the FWMT, starting with the development of a program to model flow versus water needs during key sockeye salmon life stages. He described how available habitat was modeled as a function of flow and how the quantity of habitat could be controlled by flow. Hyatt presented the results of an evaluation of risks, by life stage, to the Osoyoos Lake sockeye population as a result of a temperature-oxygen "squeeze," a density-independent rearing limitation in Osoyoos Lake, during the drought year of 2008-2009. He said that flows into Okanagan Lake were monitored on a real-time basis, allowing water managers to monitor potential effects on fish in Osoyoos Lake, and to make informed decisions on water use for fish. He noted that these decisions were especially important during drought years. Hyatt described in detail conditions and water management during the high snowpack in 2010-2011 when fry emergence was monitored and the FWMT was used to allow for as-early-as-possible water releases for flood control.

Hyatt presented data on potential escapement levels that the Okanagan River Basin could support, given access to habitat and water management, and the lack of density-dependent factors. He said that sockeye natural production has been increased 5-to-10 fold in the Okanagan River Basin through use of the FWMT. Hyatt said that later this year he will prepare a report to the Hatchery Committees providing an overview of the FWMT and the contributions it has made to natural sockeye production. He said that it would be a weight-of-evidence assessment on how changing water use has reduced density-independent losses and that the increase in population abundance is primarily a function of the FWMT, not a function of ocean conditions.

Josh Murauskas asked whether favorable ocean and river conditions could result in exceeding the maximum habitat carrying capacity in the Osoyoos Lake. Hyatt said that the fish were already testing the upper limits of carrying capacity by placing eggs into marginal habitat. However, he said that even with 10 million fry in Osoyoos Lake, there did not appear to be an effect on food supply. Hyatt said that spawning ground capacity would become limiting before lake rearing capacity becomes an issue. He said that he thinks Osoyoos Lake could support an average annual production of 100,000 adults with escapement of 60,000. Hyatt responded to Committees' questions regarding production potential of the entire Okanagan River Basin system. He said that natural fry production limited abundance and discussed the fisheries managers' opposition to restoring anadromy to Okanagan Lake. He discussed how opposition to free passage into Skaha Lake was initially based on perceived competition between kokanee and sockeye, but that if the current experiment proves that both resident fish and anadromous fish could be sustained in Skaha Lake, then free passage may be instated.

Josh Murauskas said he will email a copy of Dr. Kim Hyatt's, Fisheries and Oceans Canada, presentation to Kristi Geris for distribution to the Hatchery Committees.

V. WDFW

A. Residual Steelhead Associated With Juvenile Steelhead Releases (Mike Tonseth)

Mike Tonseth said that there is a need to discuss the management of non-migrating juvenile hatchery steelhead because the ESA Section 10 permit under which the hatcheries operate limits the release of non-migrating fish. He said that currently hatchery managers have been employing volitional release at Wells Hatchery, with varying numbers of non-migrants ultimately being forced out. Volitional release has also been used for Wenatchee steelhead reared in water-re-use circular tanks as well, with non-migrants also ultimately being forced out. Because of the Section 10 limitations, he was looking for recommendations from the Hatchery Committees on the management of non-migrating Wells and Chiwawa steelhead in 2012.

Bill Gale said that at the Winthrop National Fish Hatchery, the U.S. Fish and Wildlife Service (USFWS) will use volitional release this year in its steelhead program, and transfers non-migrant steelhead to ponds for recreational fishing. Gale said that there are two published studies supporting this approach, and indicated that he will email these to Kristi Geris for distribution to the Hatchery Committees. Gale suggested keeping track of the number of non-migrants at the Wells Hatchery and the Chiwawa Facility, so the number of non-migrants produced could be tallied to monitor the extent to which the residualism rate might be reducing smolt production. Non-migrants that did not carry a passive integrated transponder (PIT) tag could be collected and placed in ponds for recreational fishing, and PIT-tagged non-migrants could be forced out of the acclimation ponds and their behavior monitored. The Committees discussed possible alternatives for setting an endpoint for the volitional release period, forcing out or collecting the non-migrants, and transferring all or only non-PIT-tagged non-migrants to ponds for fisheries. Tonseth said that he did not need a decision at today's meeting, but that he would need a decision by mid-May 2012, about what to do with non-migrants from the Wells Hatchery and the Chiwawa Facility. Tonseth said that he will look at the draft Wenatchee steelhead HGMP to see what it says about how non-migrant hatchery steelhead are to be handled. Keely Murdoch said that she wanted to discuss the issue internally with staff. Tonseth said that, because this was an ESA issue, he would also discuss it with NMFS.

Josh Murauskas said that, based on 2010 and 2011 results, which showed no significant difference in survival and travel time to McNary Dam between volitional and non- volitional fish, the Committees may want to consider eliminating volitional release of Wenatchee steelhead reared in the water re-use circular tanks at the Chiwawa Facility, and release them all at once. Kirk Truscott indicated that he favored continuing the volitional release of Chiwawa steelhead as there were less than 20 percent non-migrants. Truscott noted that a letter of approval would be needed from NMFS if non-migrants were used in a fishery, as was required for Blackbird Pond. Greg Mackey said that Douglas PUD would support a proposal to transfer non-migrants to ponds for fisheries, but that Douglas PUD would want credit for the juvenile production. Gale said that a meeting of the JFP was being scheduled, and that they would further discuss management of non-migrant steelhead. Gale said that if the JFP reached a consensus on an approach to managing the non-migrants, he would contact Mike Schiewe for full Hatchery Committees' approval. Truscott said that the JFP also needed to discuss whether the 200,000 Wenatchee steelhead reared in raceways at Chiwawa would be treated the same as the circular tank steelhead (i.e., volitional release and then push out the non-migrants). Murauskas said that the 2010 and 2011 PIT-tagging results showed that a significant proportion of the "non-migrants" that were forced out actually migrated to McNary Dam at a significant rate and he would send to Geris, for distribution to the Committees, these results.

VI. HETT Update

Mike Schiewe said that, with Carmen Andonaegui's departure from Anchor QEA, Anchor QEA would play a lesser role in the Hatchery Evaluation Technical Team (HETT) until the

Non-Target Taxa of Concern (NTTOC) risk analysis group completed the modeling, and should again need administrative support. At that time, Anchor QEA can resume providing administrative support, if requested.

VII. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees' meetings are May 17, 2012 (Douglas PUD office), June 20, 2012 (Chelan PUD office), and July 18, 2012 (Douglas PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – Chelan PUD Dryden Feasibility Discussion Presentation
Attachment C – Chelan PUD Dryden Monitoring and Stray Data
Attachment D – Fish and Water Management Tool Presentation

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Carmen Andonaegui	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Joe Miller	Chelan PUD
Bill Gale	USFWS
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Rick Klinge†	Douglas PUD
Keely Murdoch*	Yakama Nation
Kirk Truscott*	CCT
Kim Hyatt	Fisheries and Oceans Canada
Margo Stockwell	Fisheries and Oceans Canada
Rich Bussanich†	Okanagan Nation Alliance
Mike Tonseth*	WDFW
Todd Pearsons	Grant PUD

Notes:

* Denotes Hatchery Committees member or alternate

†Joined by phone for the presentation on the Fish-Water Management Tool (Item IV-A)

Dryden Feasibility Discussion

J. Murauskas

April 18, 2012

Program improvements

- All parties benefit from:
  - Increased SARs
  - Decreased stray rates
  - Increased age at maturity
  - Decreased environmental footprint
  - Successful program modifications

Empirical evidence at Dryden

- Hatchery Monitoring and Evaluation
- Re-use technology
- Size-at-release and maturity

M&E data (stray rates)

- Over 60 variables – 17 years
- Pair-wise correlations on 15 variables
- Subsequent multiple regression
- Inverse predictions

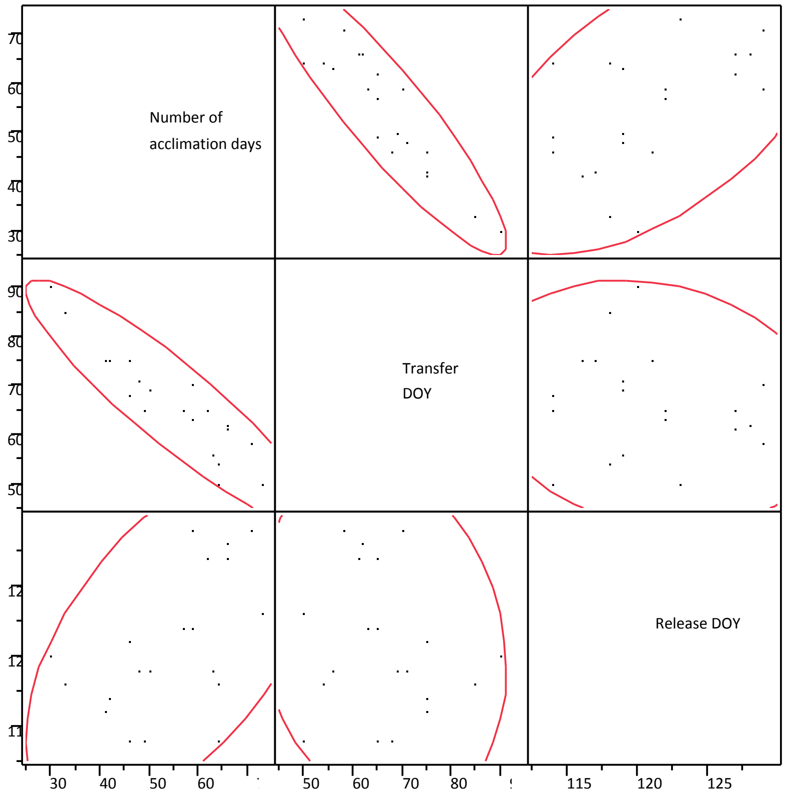
M&E data (stray rates)

- Release DOY (40.5%, $p < 0.01$)
- pNOB (39.6%, $p < 0.01$)
- Smolts released (26.3%, $p = 0.04$)

Significant

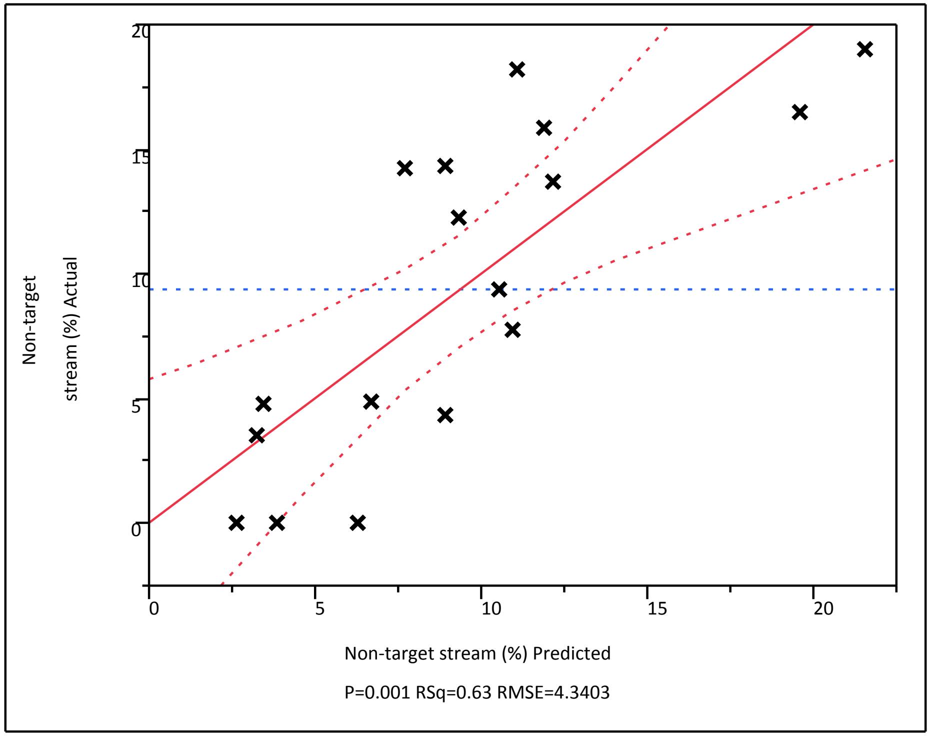
- Days acclimated (18.0%, $p = 0.09$)
- SARs (17.9%, $p = 0.09$)

Release DOY vs. other dates



- Release DOY
  - Significant
  - Not related to transfer
  - Moderate relation to days
- Transfer DOY
  - Not significant
  - Related to total days
- Total days
  - Not significant
  - Related to transfer DOY

Modeling results



- Only two variables
  - Release DOY
  - pNOB
- Model results
  - $R^2 = 63\%$
  - $p = 0.001$
- Other variables
  - Not significant in predicting stray rate

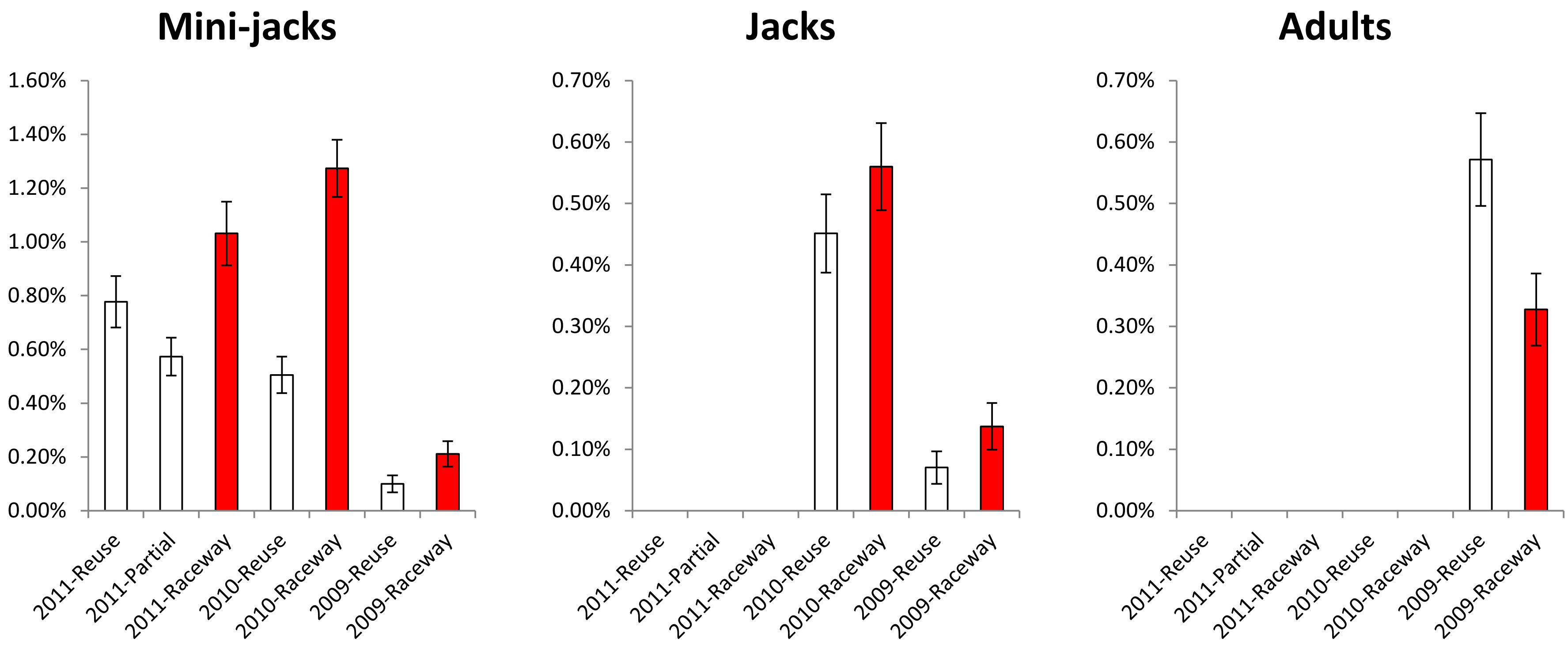
Inverse predictions

Stray Rate Non-target stream (%)	DOY = 130 Predicted pNOB	DOY = 125 Predicted pNOB	pNOB = 100% Predicted Release DOY
5.0	85%	100%	125.1
7.5	73%	88%	121.0
10.0	60%	75%	116.9
12.5	48%	63%	112.8

*DOY 125 = May 4th

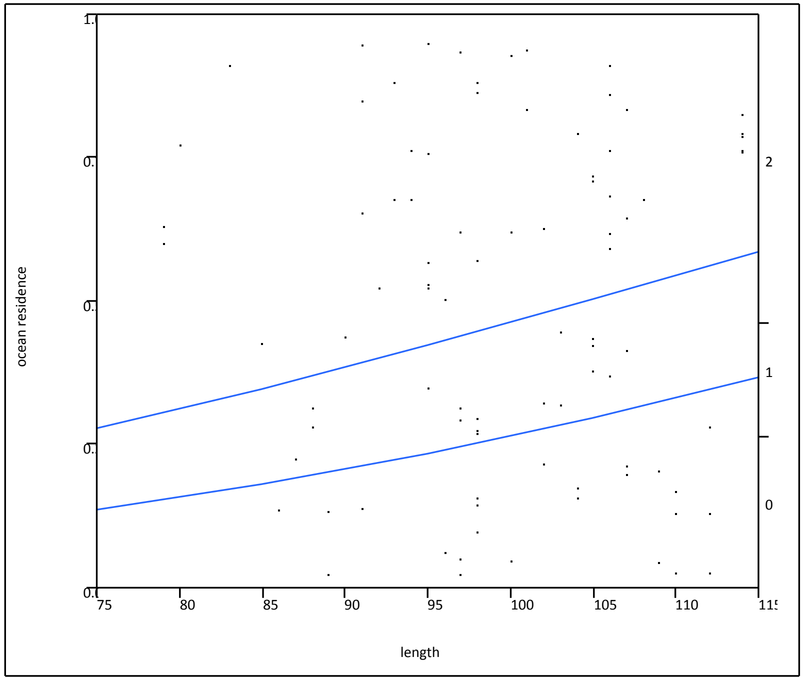
Re-use results (SARs and age)

- Re-use = lower Age 2/3, higher Age 4+

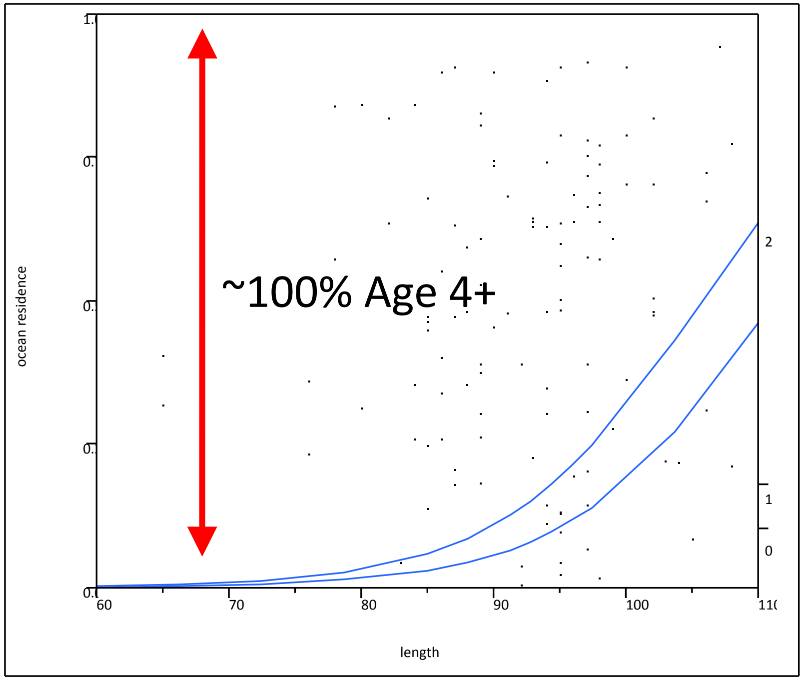


Size-at-release (age)

Raceway (p = 0.194)

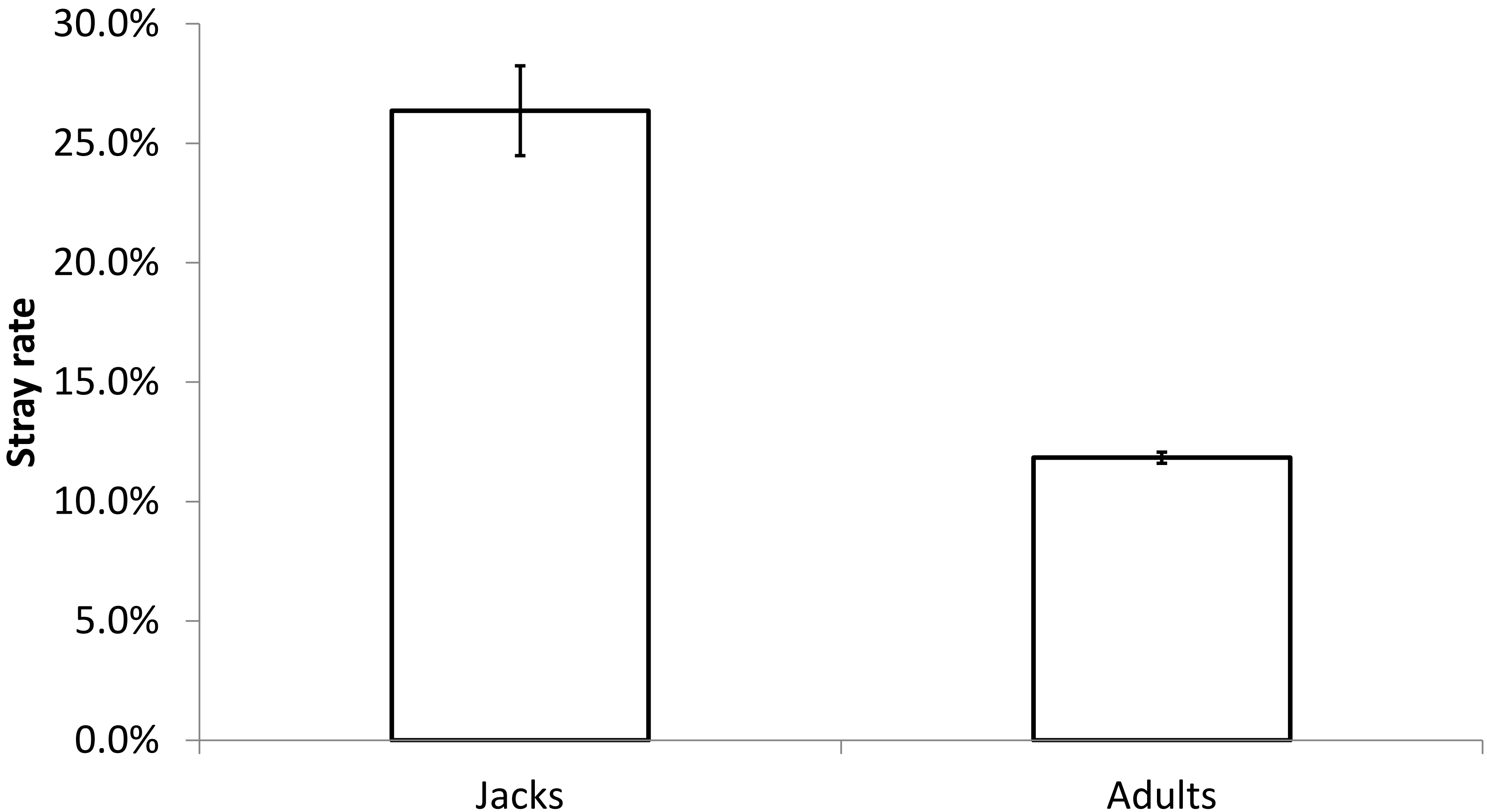


Re-use (p < 0.01)



** Re-use fish benefit from reduced size targets*

CWT data (BY '89-'05)



Conclusions

Decreased stray rates

- Operational changes
  - Delay releases
  - Increased pNOB
  - Decrease program size
  - Improve other programs
- Improved age structure
  - Increase FPP targets
  - Use of circular rearing

Improved survival

- Circular rearing
  - Faster smolt travel times
  - Higher smolt survival
  - ≥ 74% increase in adults
- Decrease mini-jack rates
  - MJs = mortality in SARs
  - Ecological interactions

DRYDEN MONITORING AND STRAY DATA

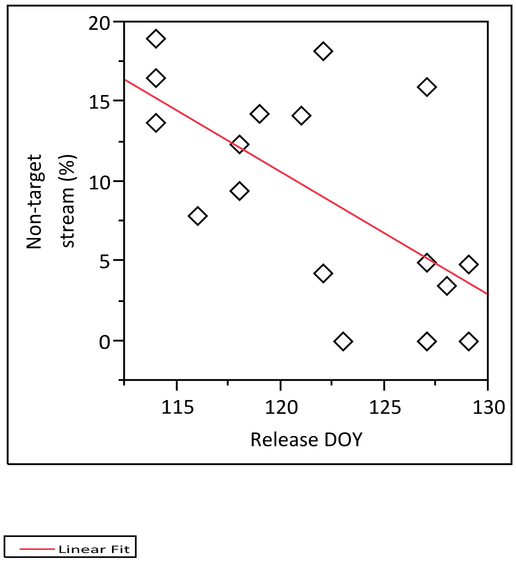
ABSTRACT

Multivariate analyses were conducted on 15 variables measured at Dryden Acclimation Ponds (Dryden) over a 17-year period to determine which variables were strongly related to stray rates. Variables with strongest correlations were subsequently analyzed by linear regression then modeled in a multiple regression using standard least squares with an emphasis on effect leverage (hereafter, model). Findings indicated that release day of year (DOY) was most related to stray rates, explaining 40.5% of the annual variation ($p < 0.01$). Proportion of natural-origin brood (pNOB) was found to be the second-most related factor to stray rates, explaining 39.6% of the annual variation ($p < 0.01$). The number of smolts released was found to be the third-most related factor to stray rates, explaining 26.3% of the annual variation ($p = 0.04$). Number of days in acclimation had a slight negative relationship to stray rates, though the relationship was not significant ($R^2 = 18.0\%$, $p = 0.09$). Likewise, smolt-to-adult returns (SARs) had a positive relationship with stray rates, though the relationship was not significant ($R^2 = 17.9\%$, $p = 0.09$). The model was ran with all five variables and only two factors were found to be significant in predicting stray rates: release DOY and pNOB. The model including only these two variables combined was highly significant ($p = 0.001$) and able to account for 62.6% of the annual variation in stray rates. Inverse predictions indicate that stray rates would be reduced under a static release date in combination with increasing pNOB, or, alternatively, an increasing release date with a 100% pNOB.

CONTENTS

LINEAR REGRESSIONS

BIVARIATE FIT OF NON-TARGET STREAM (%) BY RELEASE DOY



Linear Fit

Non-target stream (%) = 103.43796 - 0.7735229*Release DOY

Summary of Fit

RSquare	0.404995
RSquare Adj	0.365328
Root Mean Square Error	5.292045
Mean of Response	9.341176
Observations (or Sum Wgts)	17

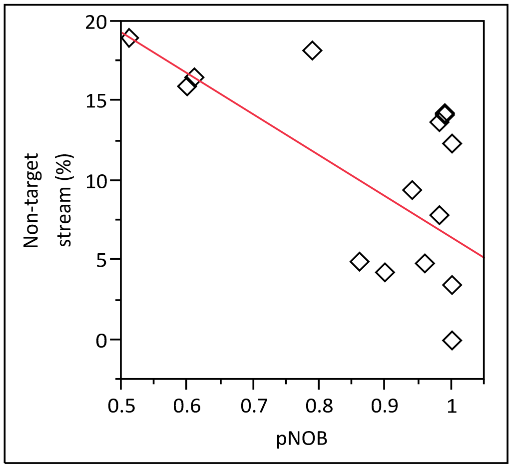
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	285.93501	285.935	10.2099
Error	15	420.08616	28.006	**Prob > F**
C. Total	16	706.02118		0.0060*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	103.43796	29.47656	3.51	0.0032*
Release DOY	-0.773523	0.242082	-3.20	0.0060*

BIVARIATE FIT OF NON-TARGET STREAM (%) BY PNOB



Linear Fit

Non-target stream (%) = 32.214233 - 25.734081*pNOB

Summary of Fit

RSquare	0.395811
RSquare Adj	0.355532
Root Mean Square Error	5.332731
Mean of Response	9.341176
Observations (or Sum Wgts)	17

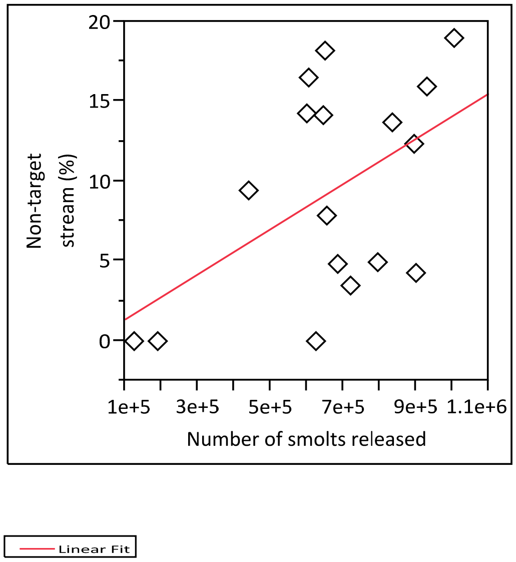
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	279.45092	279.451	9.8267
Error	15	426.57025	28.438	**Prob > F**
C. Total	16	706.02118		0.0068*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	32.214233	7.410353	4.35	0.0006*
pNOB	-25.73408	8.209289	-3.13	0.0068*

BIVARIATE FIT OF NON-TARGET STREAM (%) BY NUMBER OF SMOLTS RELEASED



Linear Fit

Non-target stream (%) = -0.097447 + 0.0000142*Number of smolts released

Summary of Fit

RSquare	0.263111
RSquare Adj	0.213985
Root Mean Square Error	5.889308
Mean of Response	9.341176
Observations (or Sum Wgts)	17

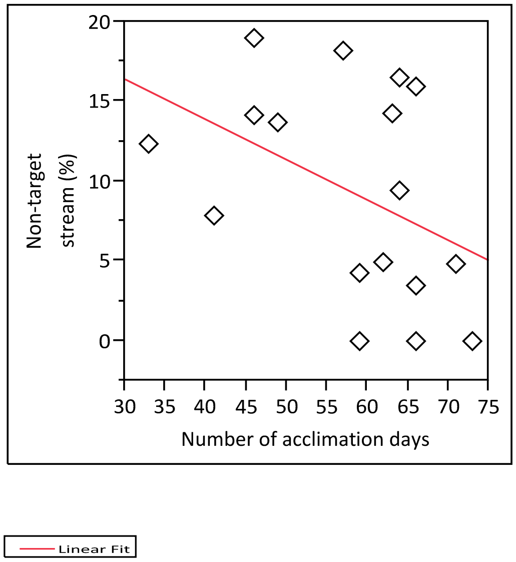
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	185.76186	185.762	5.3558
Error	15	520.25932	34.684	**Prob > F**
C. Total	16	706.02118		0.0352*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-0.097447	4.321337	-0.02	0.9823
Number of smolts released	0.0000142	6.134e-6	2.31	0.0352*

BIVARIATE FIT OF NON-TARGET STREAM (%) BY NUMBER OF ACCLIMATION DAYS



Linear Fit

Non-target stream (%) = 24.0023 - 0.2530346*Number of acclimation days

Summary of Fit

RSquare	0.180007
RSquare Adj	0.125341
Root Mean Square Error	6.212527
Mean of Response	9.341176
Observations (or Sum Wgts)	17

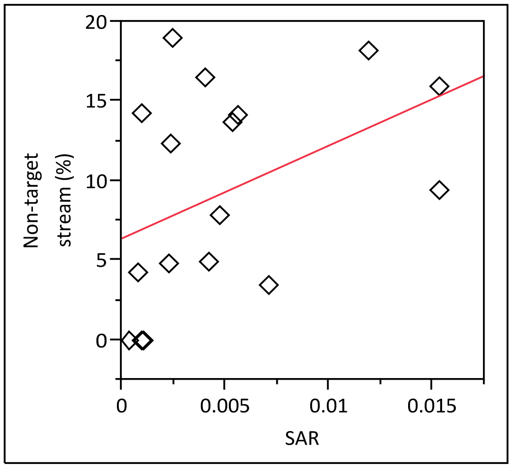
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	127.08887	127.089	3.2928
Error	15	578.93231	38.595	**Prob > F**
C. Total	16	706.02118		0.0896

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	24.0023	8.218748	2.92	0.0105*
Number of acclimation days	-0.253035	0.139442	-1.81	0.0896

BIVARIATE FIT OF NON-TARGET STREAM (%) BY SAR



Linear Fit

Non-target stream (%) = 6.4433522 + 581.75499*SAR

Summary of Fit

RSquare	0.179202
RSquare Adj	0.124483
Root Mean Square Error	6.215574
Mean of Response	9.341176
Observations (or Sum Wgts)	17

Analysis of Variance

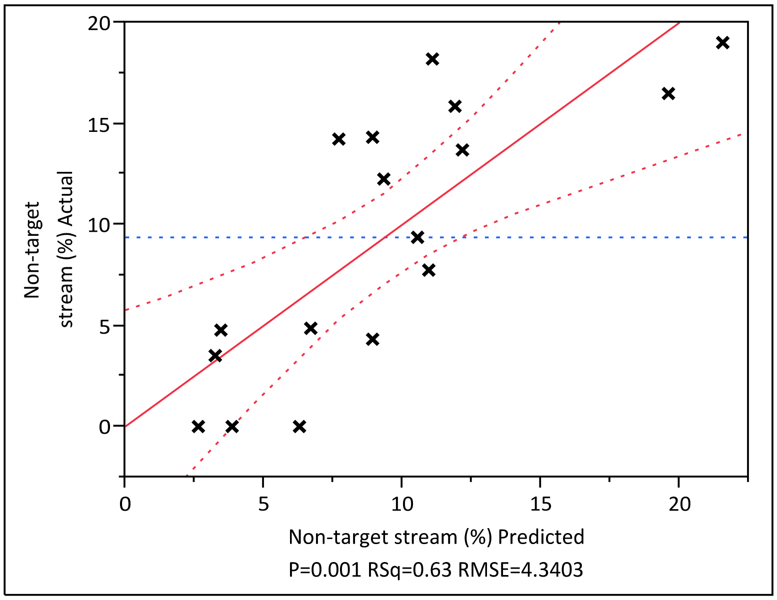
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	126.52076	126.521	3.2749
Error	15	579.50042	38.633	**Prob > F**
C. Total	16	706.02118		0.0904

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	6.4433522	2.199252	2.93	0.0103*
SAR	581.75499	321.47	1.81	0.0904

MULTIPLE REGRESSION MODEL (STANDARD LEAST SQUARES; EFFECT LEVERAGE)

ACTUAL BY PREDICTED PLOT



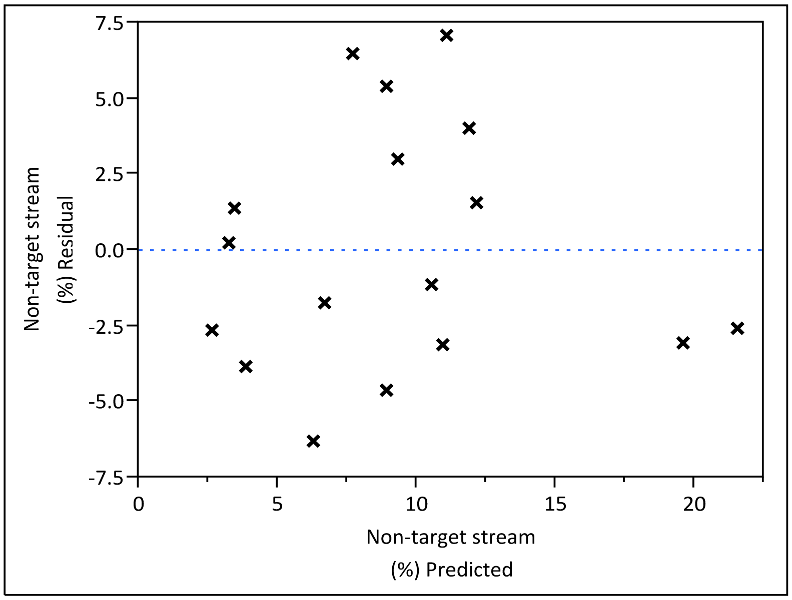
Summary of Fit

RSquare	0.626445
RSquare Adj	0.57308
Root Mean Square Error	4.340322
Mean of Response	9.341176
Observations (or Sum Wgts)	17

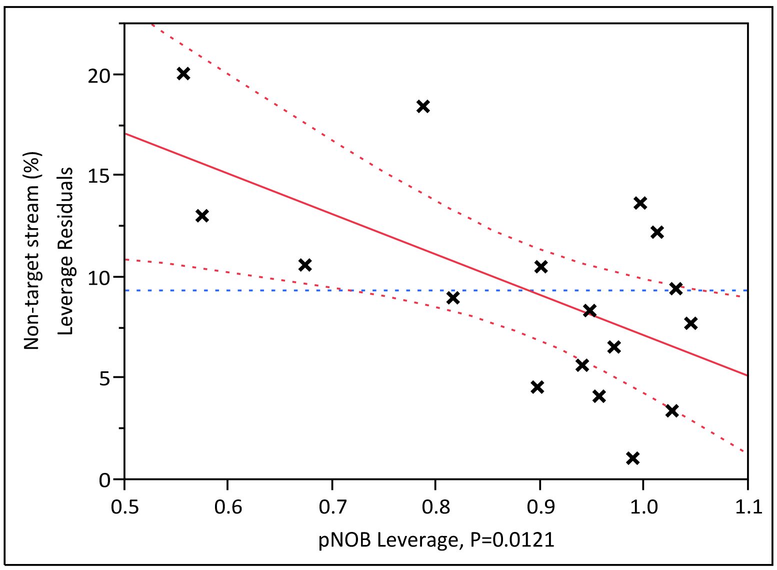
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	442.28367	221.142	11.7389
Error	14	263.73751	18.838	**Prob > F**
C. Total	16	706.02118		0.0010*

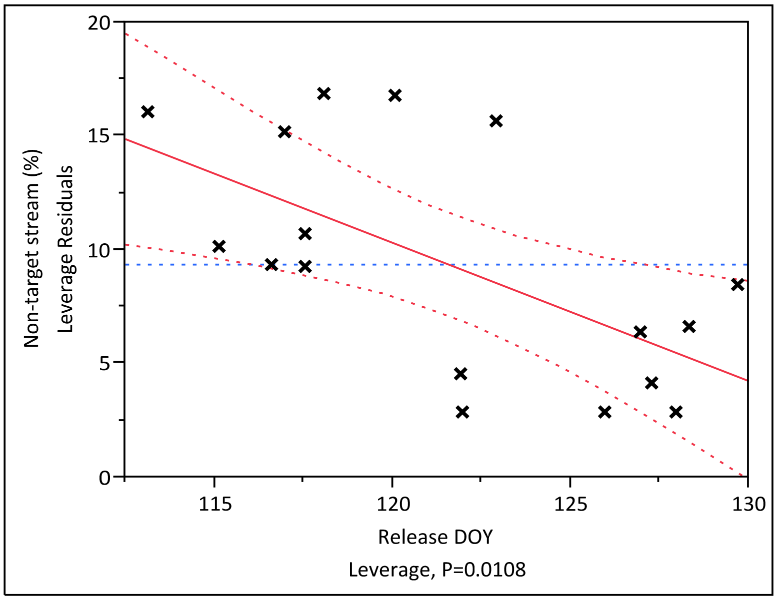
RESIDUAL BY PREDICTED PLOT



PNOB LEVERAGE PLOT



RELEASE DOY LEVERAGE PLOT



INVERSE PREDICTIONS

INVERSE PREDICTION, DOY = 130

Non-target stream (%)	Predicted pNOB	Lower Limit	Upper Limit	1-Alpha
5.000000	0.852132776	0.35952764	1.08165429	0.9500
7.500000	0.727387764	-0.05667284	0.93812679	
10.000000	0.602642753	-0.51090399	0.83262995	
12.500000	0.477897742	-0.98037177	0.74236974	

INVERSE PREDICTION, DOY = 125

Non-target stream (%)	Predicted pNOB	Lower Limit	Upper Limit	1-Alpha
5.000000	1.00376008	0.86505962	1.35932925	0.9500
7.500000	0.87901507	0.62306007	1.04160082	
10.000000	0.75427006	0.21581084	0.88912206	
12.500000	0.62952505	-0.24672821	0.79193313	

INVERSE PREDICTION, PNOB = 100%

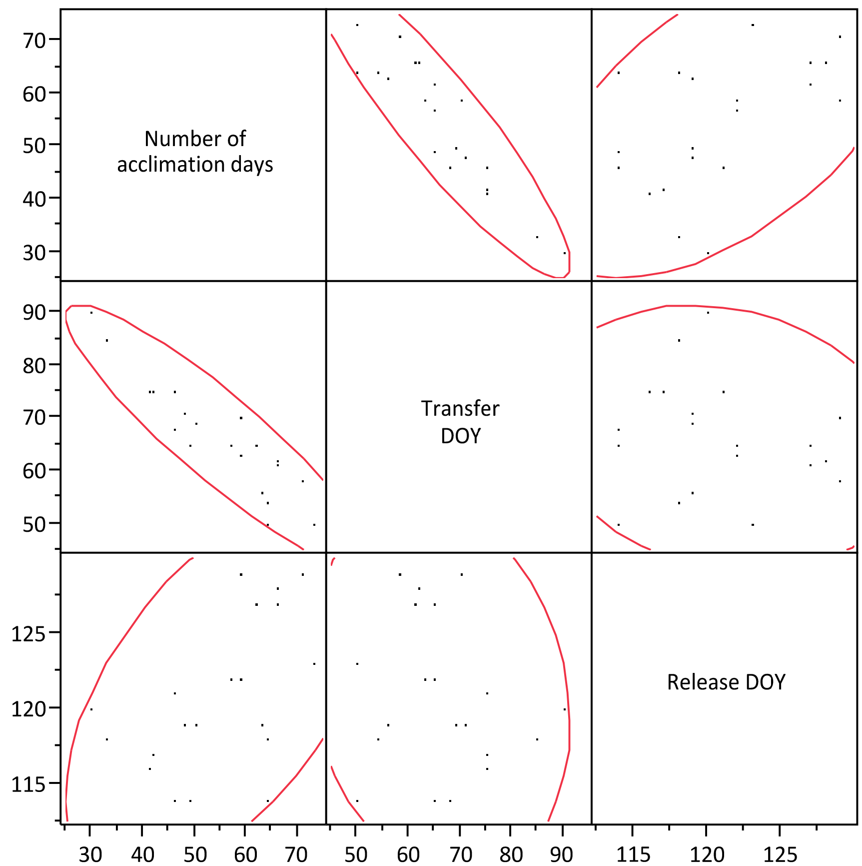
Non-target stream (%)	Predicted Release DOY	Lower Limit	Upper Limit	1-Alpha
5.000000	125.123991	120.238506	135.550844	0.9500
7.500000	121.010451	111.957157	126.245655	
10.000000	116.896910	99.093687	121.522587	
12.500000	112.783370	84.698574	118.331161	

MULTIVARIATE CORRELATIONS (ACCLIMATION PERIOD)

	Number of acclimation days	Transfer DOY	Release DOY
Number of acclimation days	1.0000	-0.9138	0.5571
Transfer DOY	-0.9138	1.0000	-0.1719
Release DOY	0.5571	-0.1719	1.0000

The correlations are estimated by REML method.

SCATTERPLOT MATRIX



PAIRWISE CORRELATIONS

Variable	by Variable	Correlation	Count	Lower 95%	Upper 95%	Signif Prob	Plot Corr
Transfer DOY	Acclimation days	-0.9138	21	-0.9649	-0.7963	<.0001*	
Release DOY	Acclimation days	0.5571	21	0.1652	0.7971	0.0087*	
Release DOY	Transfer DOY	-0.1719	21	-0.5619	0.2806	0.4563	

Okanagan Fish-and-Water Management Tools (Ok-FWMT) Project Contributions to Stock Rebuilding of Okanagan Sockeye Salmon

HCP Briefing, Wenatchee, April 18, 2012.

Douglas County Public Utility District

Fisheries and Oceans Canada / Pêches et Océans Canada
Department of Fisheries and Oceans Canada

British Columbia
BC Ministry of Water Land and Air Protection

Okanagan Nation Alliance

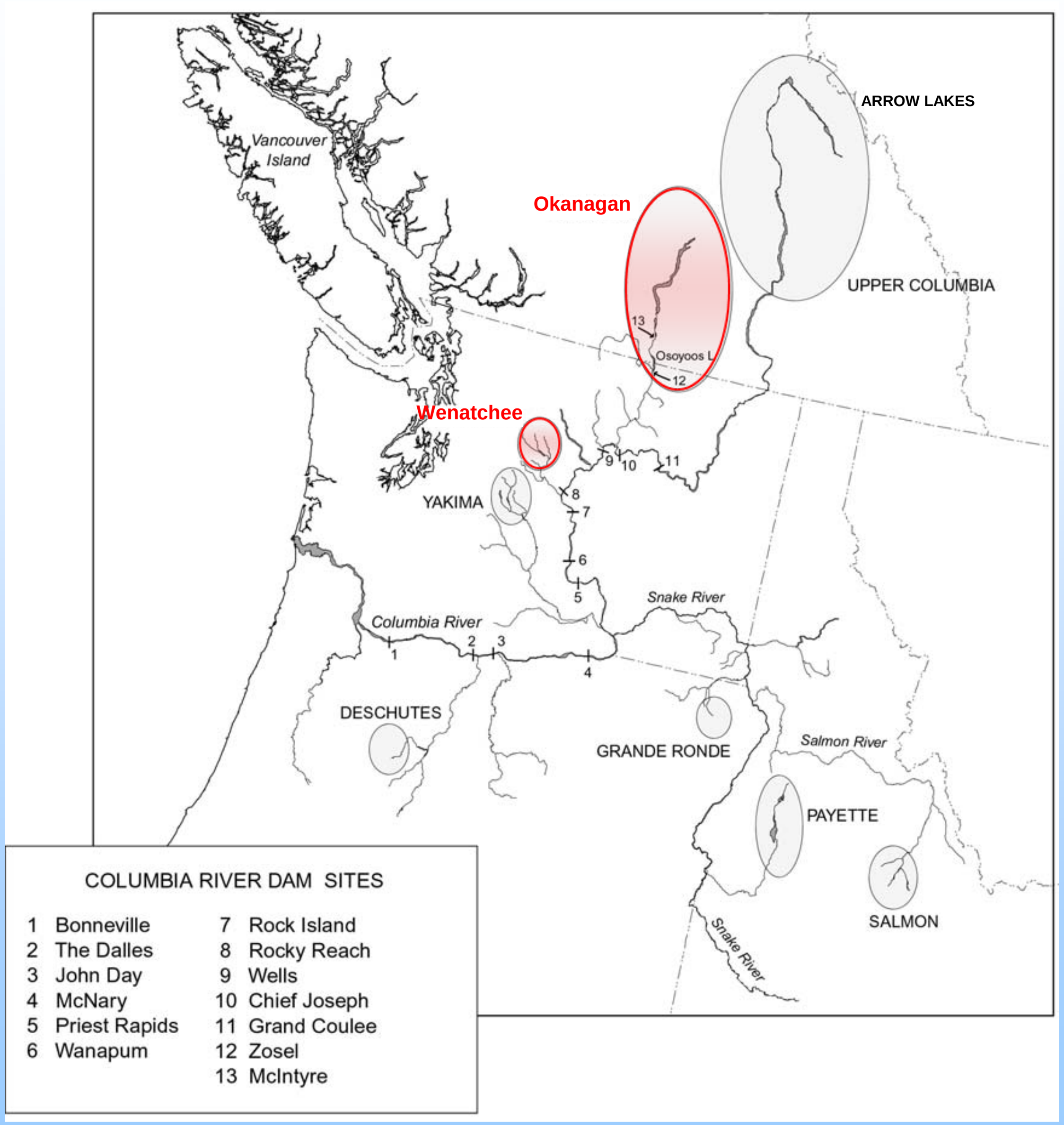
ESSA Technologies

Kim Hyatt and Margot Stockwell
Fisheries and Oceans Canada

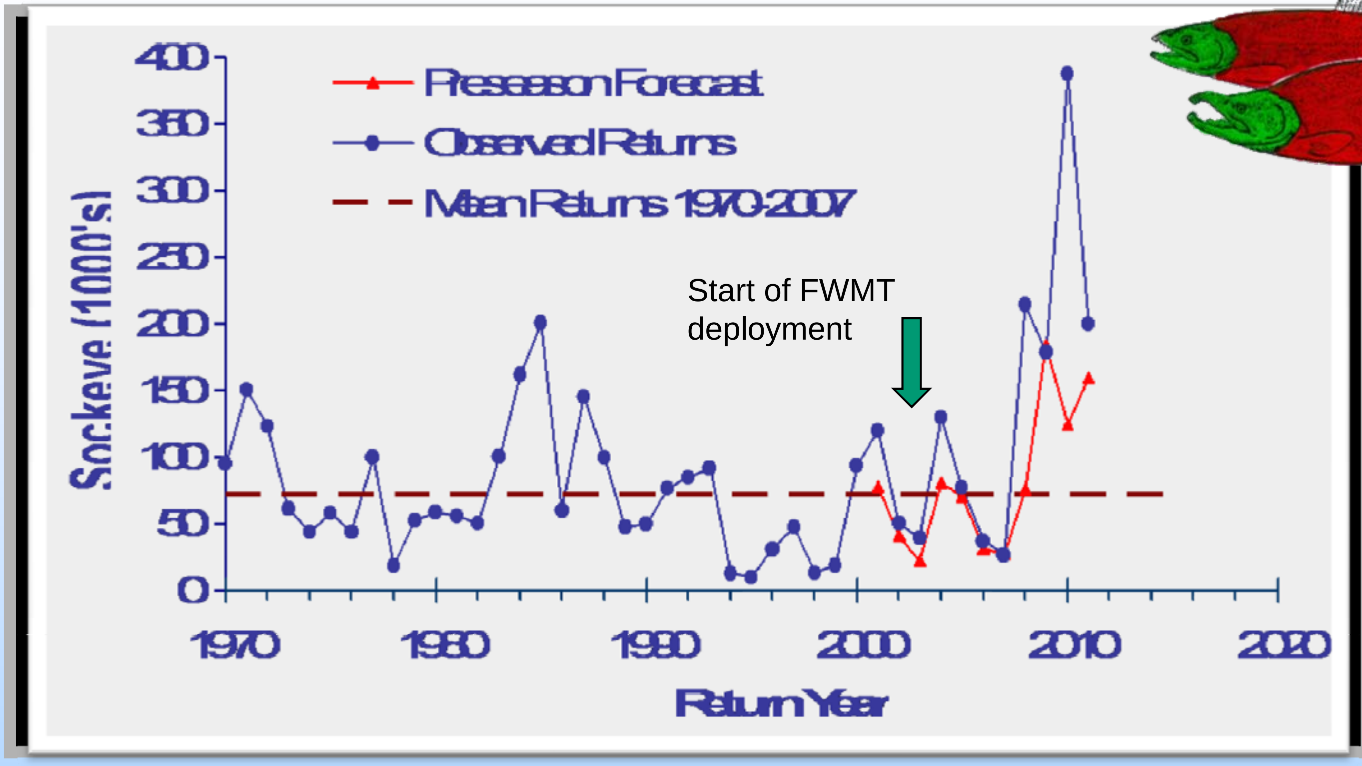
Columbia River Sockeye Salmon Populations

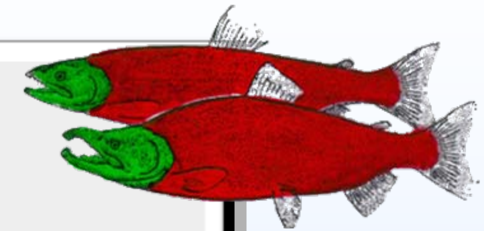
Columbia River sub-basins historically accessible to sockeye

Columbia River sub-basins with present day viable sockeye populations



Columbia R. Adult Sockeye Returns 1970 - 2011





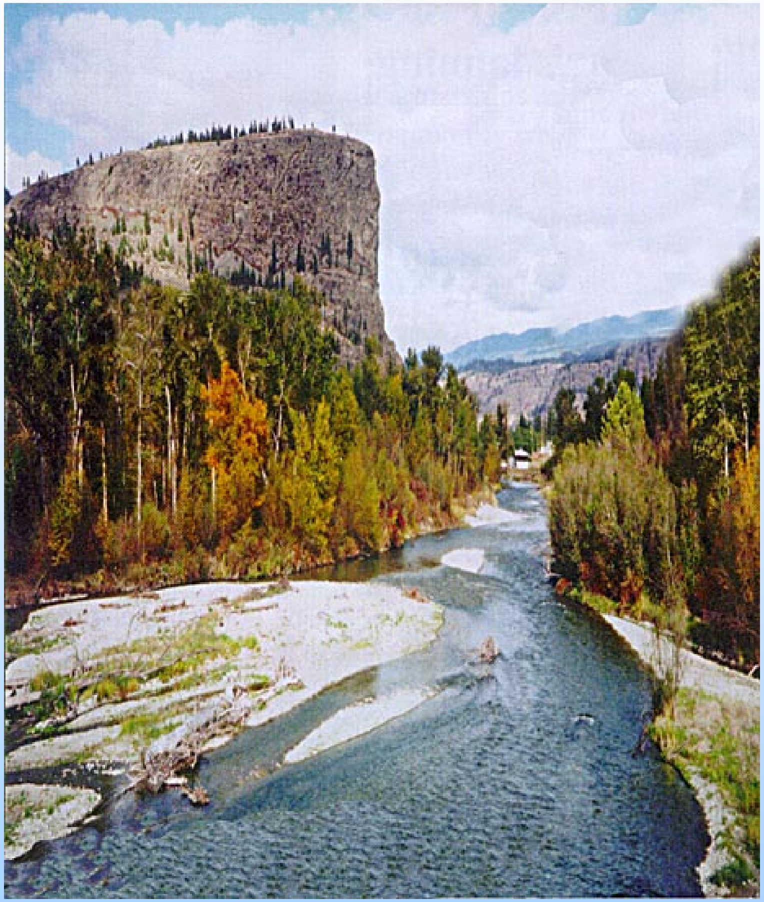
Percent Okanagan Sockeye in Columbia River Returns

	1970 - 2003	**2004 - 2011**
Mean:	54%	81%
Range:	15-85%	63-90%

Factors or Events Contributing to Rebuilding of Okanagan Sockeye Salmon Since Inception of FWMT Deployment in 2003-04

- [x] Revised escapement objectives to utilize full carrying capacity of freshwater spawning and rearing environments,
- [x] Development /deployment of FWMT decision support system to facilitate "fish friendly" flows to reduce losses of eggs & fry to density independent mortality events,
- [x] FWMT mitigation of rearing habitat reductions for juvenile sockeye due to oxygen-temperature "squeeze" conditions in Osoyoos L.
- [x] Supplemental production of hatchery-origin sockeye from Skaha L.
- [ ] Improvements in juvenile fish-passage in the Columbia River,
- [x] Recent survival-favourable conditions for southern sockeye stocks in coastal marine waters.

OLR-System Management Begins in the Okanagan Lake Headwaters of the Okanagan River

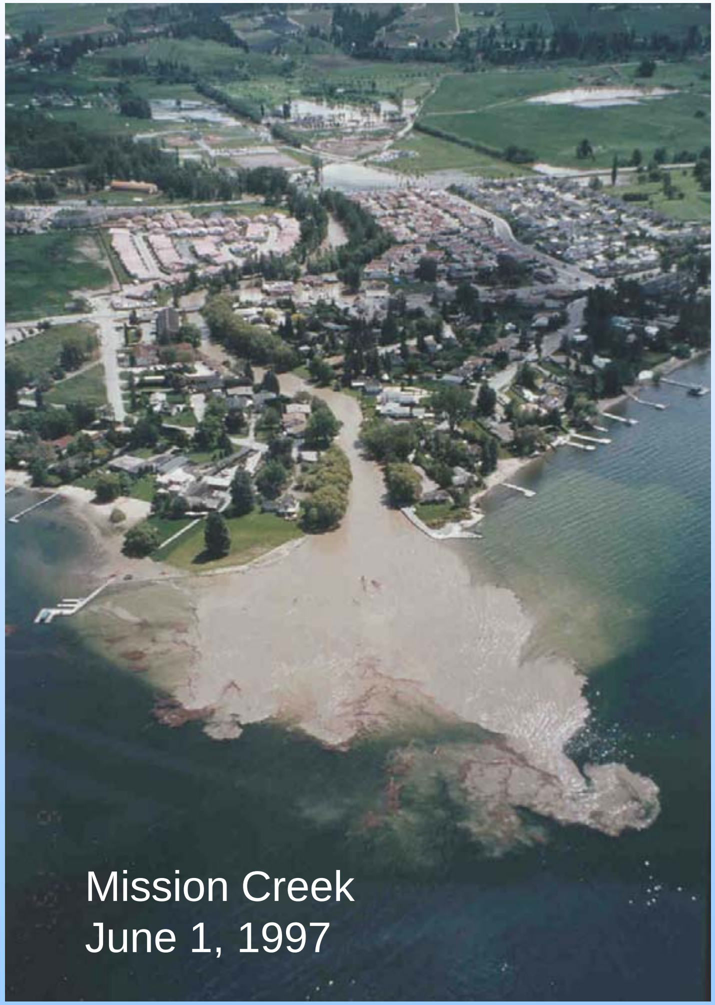


Drainage area = 6,090 sq km
Surface area = 341 sq km
Average outflow = 14.7 m3/s

Okanagan R: Natural = 8.4 km
Channelized= 16.2 km
Average outflow = 14.7 m3/s

Okanagan Lake Dam at Penticton is the major control point in the system

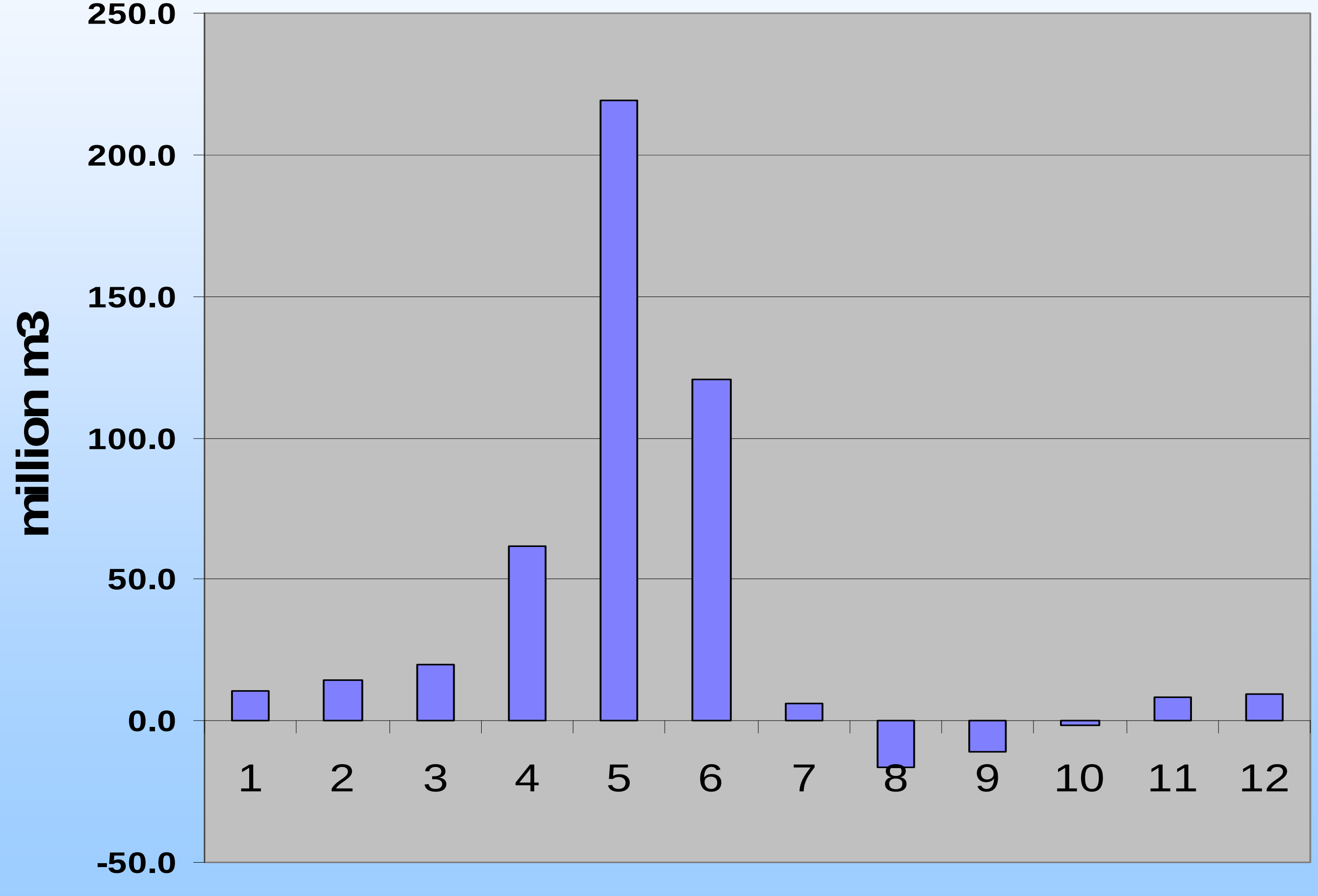
OKANAGAN LAKE HYDROLOGY



- Annual inflow hydrograph dominated by snowmelt runoff
- Large range of annual inflows:

- 78 million to 1.4 billion m^3
- 0.23 m to 4.12 m stage change

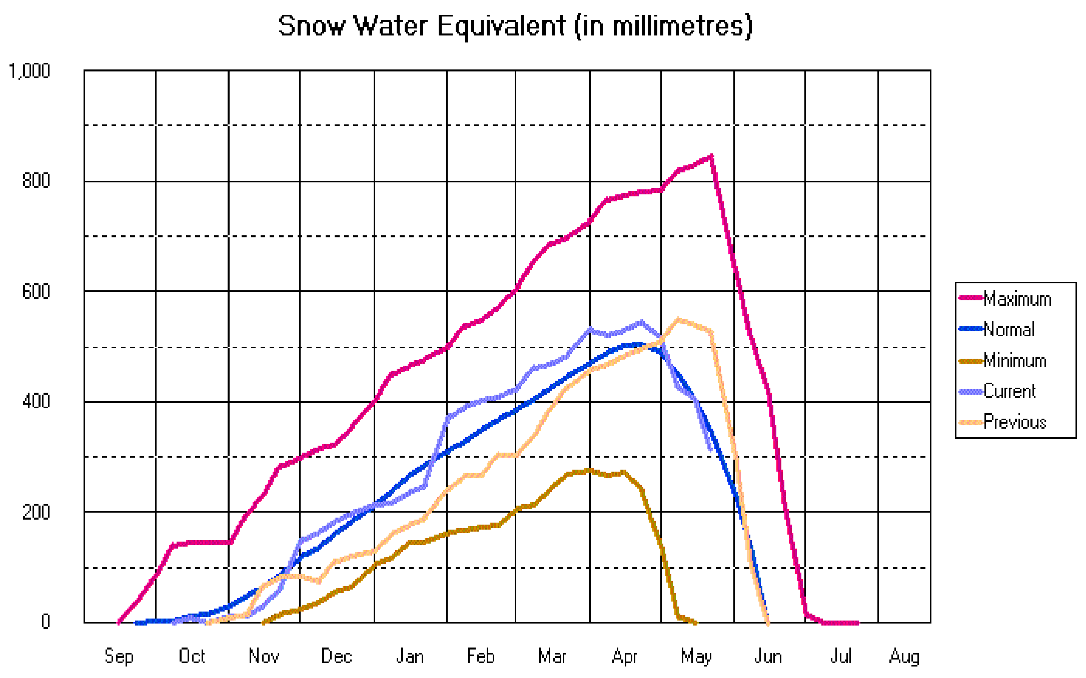
Mean Monthly Inflows to Okanagan L.
(85 % of inflow from Apr-Jun)



Inflow Forecasts and Discharge Observations Drive Management Decisions

Inflow forecasts are based on seasonal precipitation, snow packs & tributary inflow data.

2003-04 Mission Ck. Snow Pillow @2F05P



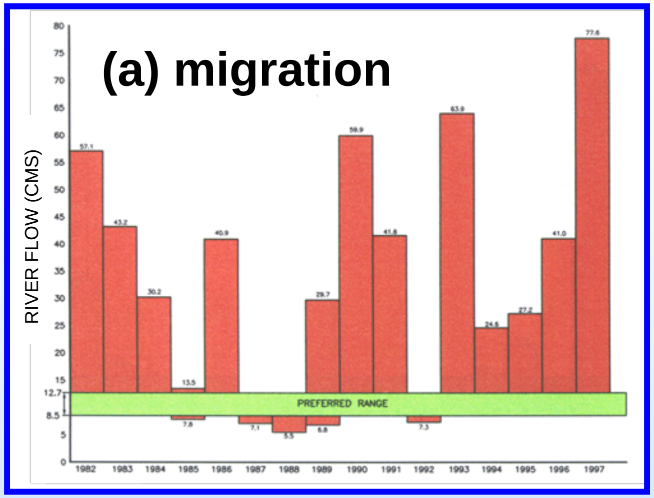
OLRS OPERATIONS

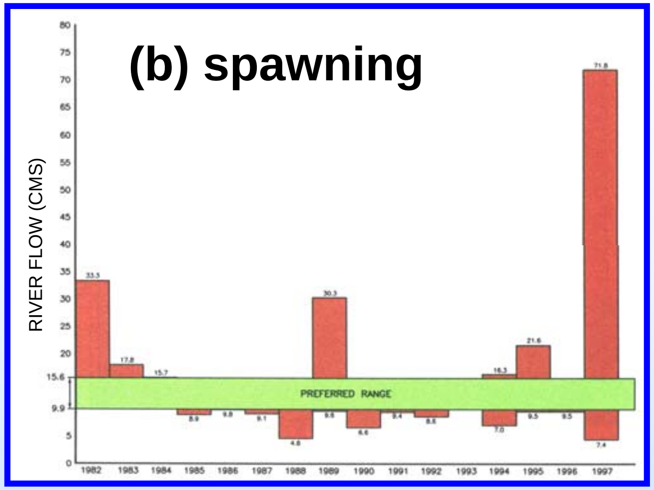
- OBA rules specify seasonal lake levels and flows.
- Operating plans/decisions reflect inflow forecasts.
- Decisions address competing objectives to satisfy: flood control, fisheries values, water storage/extraction, navigation, tourism, international agreements, etc.

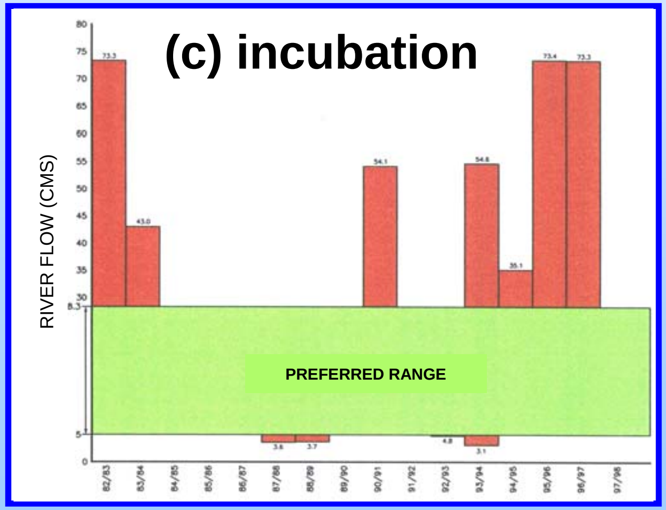
OPERATOR CHALLENGES

- Forecast uncertainty re: freshet inflow volumes and capacity to match lake spill or storage to spring inflows (“bathtub” analogy).
- Effects of environmental variability (water levels, flow, temp.) on risk assessments given competing economic, social & environmental demands of multiple “parties” & authorities.
- **OLRS decisions re: water storage or release based on rules of thumb, past experience & incomplete information.**

Compliance with OBA Fishery Flows was low prior to 1997.







OBA preferred flow range

Observed flow range

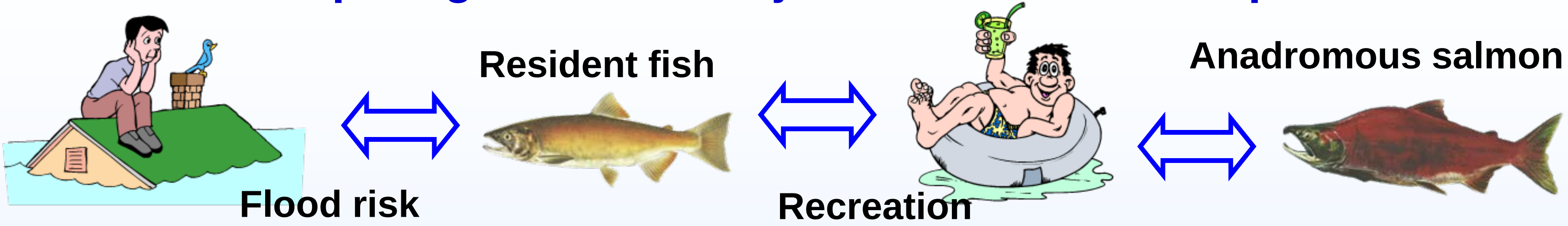
From 1982-1997 river discharge exceeded OBA fishery flows in:

(a) 13 of 16 yrs for adult migration

(b) 7 of 16 yrs for spawning and

(c) 7 of 16 yrs for egg incubation & fry migration

Competing "Rules"& Objectives Reduce Compliance



Rule 1: Don't fill Okanagan Lake above 342.56 meters (i.e. 10 cm rise above 342.56 incurs $5-$10 million in "property" losses !)

Rule 2: Try to avoid drafting to lake levels below 341.50 meters. (i.e. problems with docks, water intakes & vessel navigation become severe).

Rule 3: Minimize draw-down of Okanagan L. between the time of kokanee spawning and 100% fry emergence (i.e. minimize dewatering kokanee eggs & fry but don't risk violatin of "rules" 1 or 6,7,8, & 9)

Rule 4: Minimize the number of buildings flooded at Penticton

Rule 5: Provide summer flows for recreation if possible

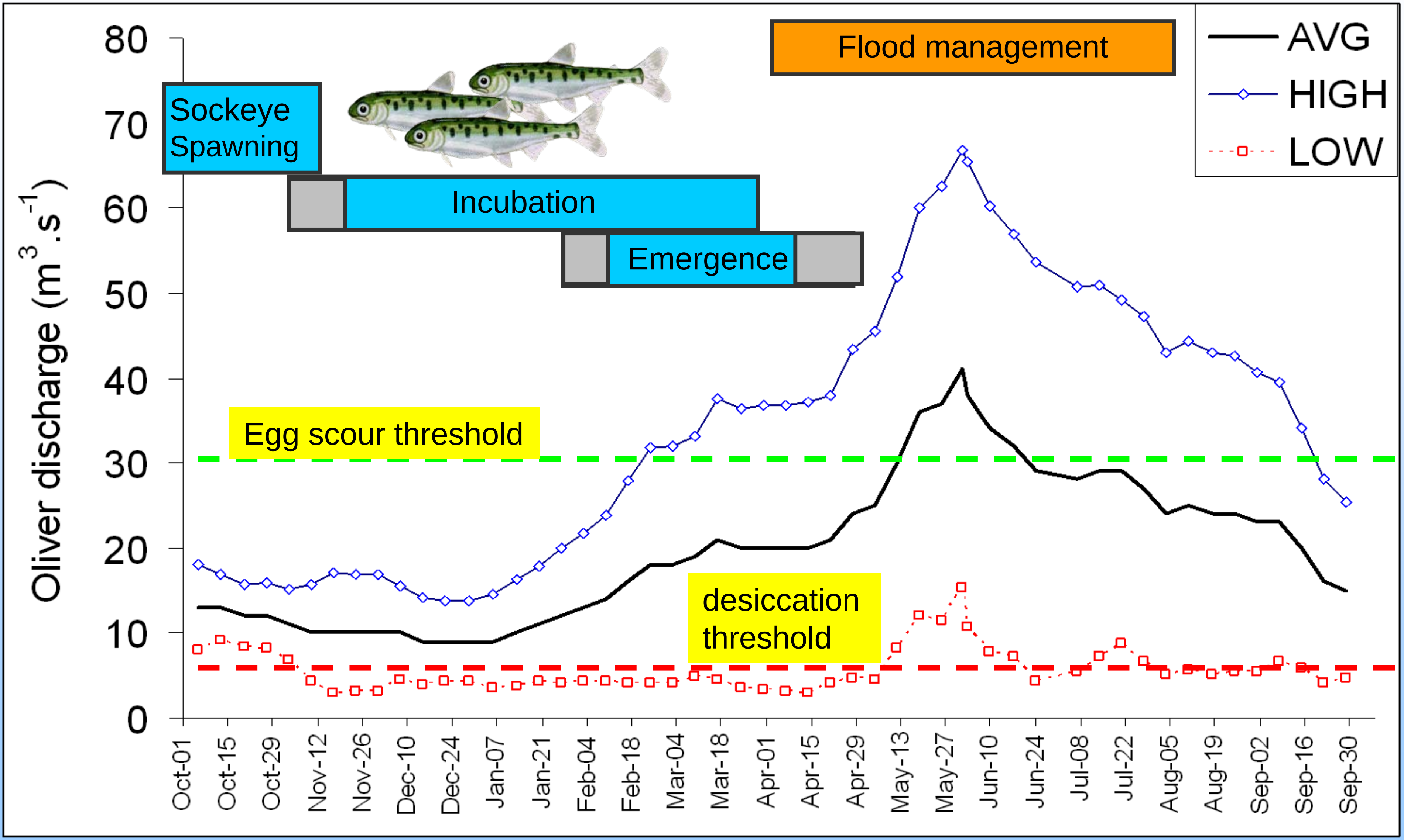
Rule 6: Sox. Migration – maintain flows (@ Oliver) between 8.5 & 12.7 cms during Aug 1 to Sept 15 to allow "easy" passage of VDS.

Rule 7: Sox. Spawning – maintain flows between 9.9- 15.6 cms during Sept 16- Oct 31 to maximize "good" spawning habitat.

Rule 8: Sox Incubation- flows at 5.0- 28.3 cms during Nov 1- Feb 15 i.e. egg incubation flows greater than or equal to 50 % of spawning flows & must not exceed 28.3 cms to avoid redd desiccation & scouring.

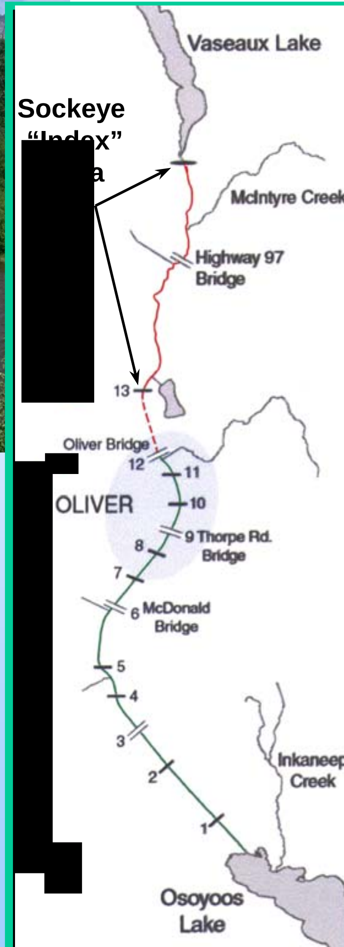
Rule 9: Sox. Fry emergence-migration- flows during Feb16- Apr 30 at 5.0- 28.3 cms.

Event timing & natural variations determine whether fish-and-water managers satisfy OBA rules & competing objectives

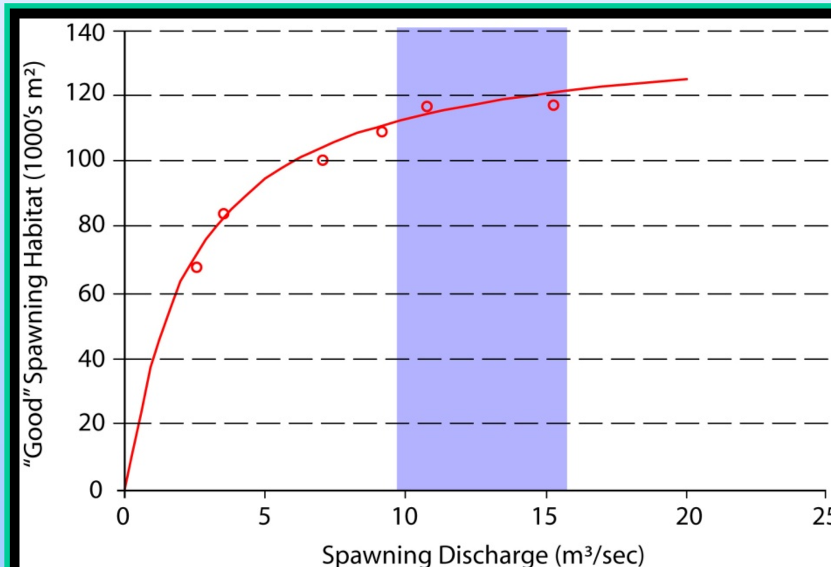


Available Spawning Habitat is Controlled by Flow

Paul Rankin photo



Recommended flows for Okanagan sockeye spawning are: **9.9 m^3/sec to 15.6 m^3/sec**



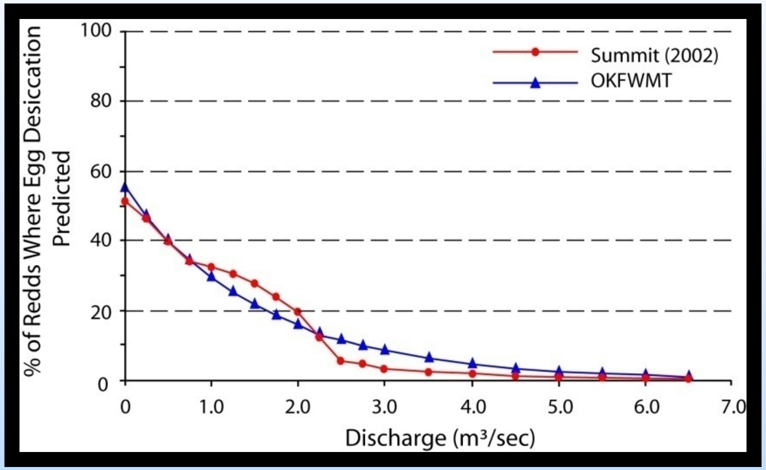
Okanagan Nation Alliance photo

Data Sources: Anon. 1983; Hyatt et al. 2005

Discharge and Okanagan Sockeye Incubation

Dewatering/desiccation or flood-and-scour processes control incubation and emergence success of sockeye eggs and alevins.

(a) % Eggs Dewatered



(b) % Alevins Stranded

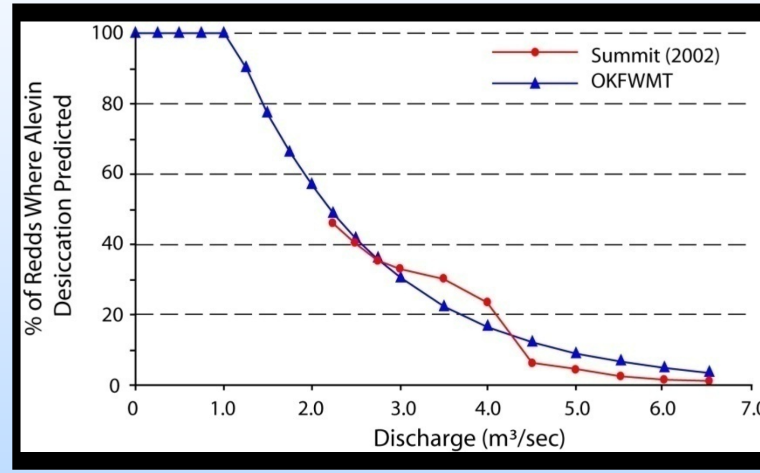
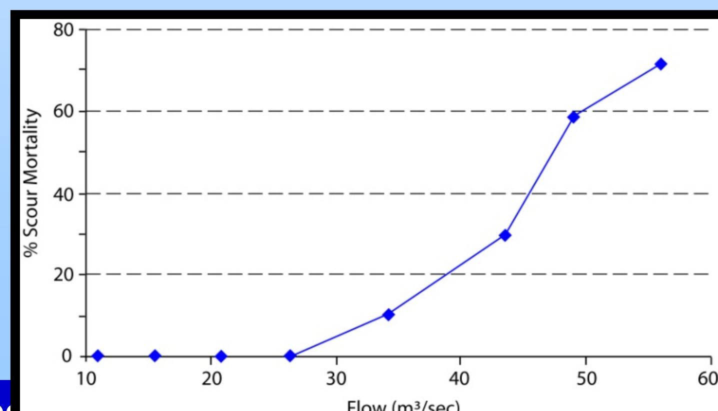
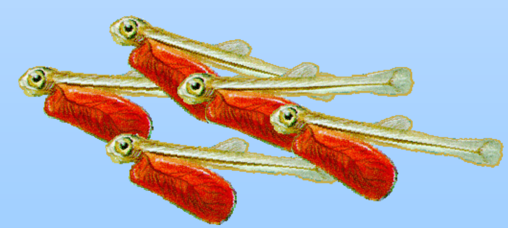


photo: www.nbis.org

(c) % Eggs / Alevins Scoured

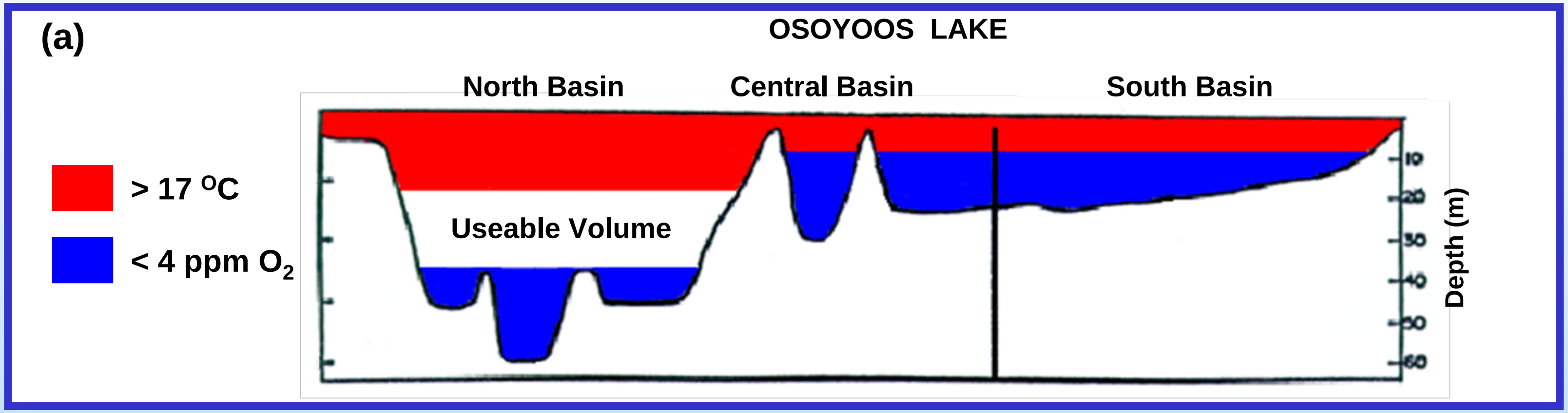




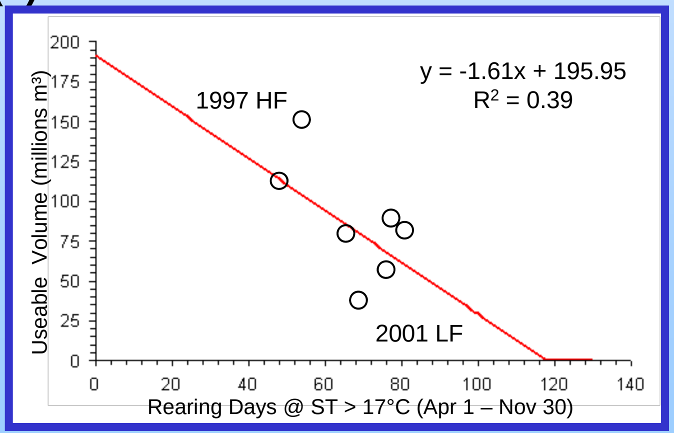
Data Source: Hyatt et al 2005

Temperature-Oxygen “Squeeze” and Density-Independent Rearing Limitations in Osoyoos L.

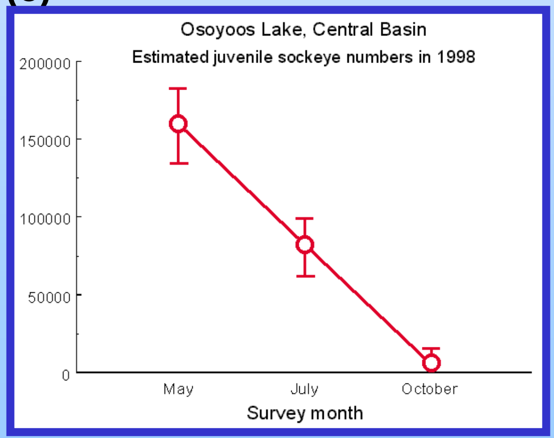
Hyatt et al (2007, in review CJFAS) have established that seasonal temperature and oxygen extremes may operate together to restrict the useable rearing volume of Osoyoos Lake which can induce density-independent mortality processes.



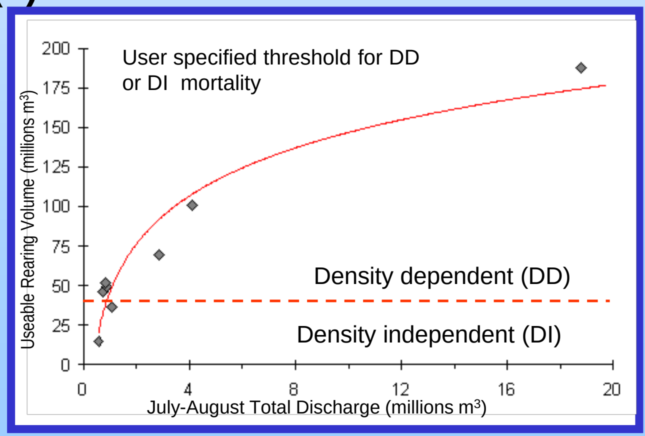
(b)



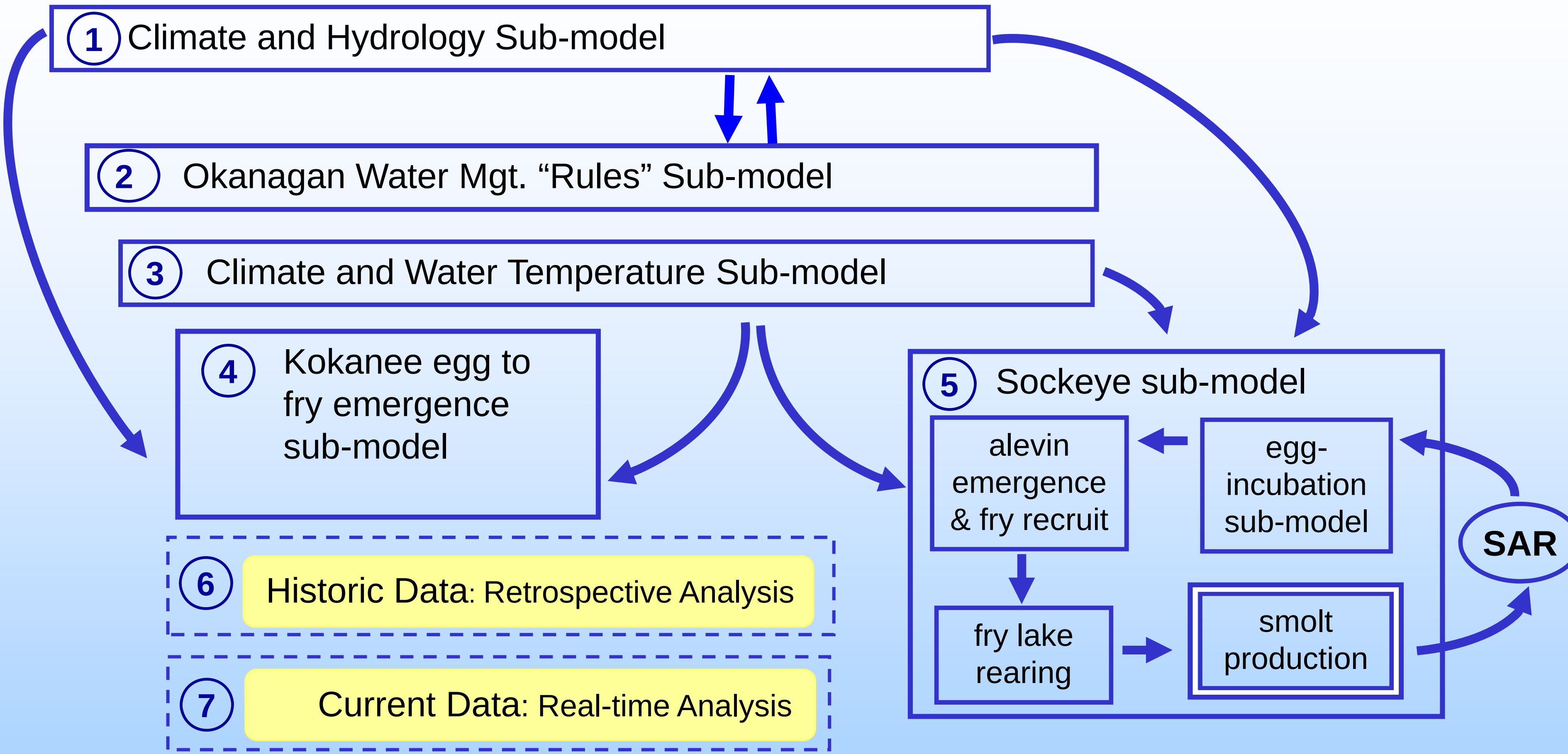
(c)



(d)



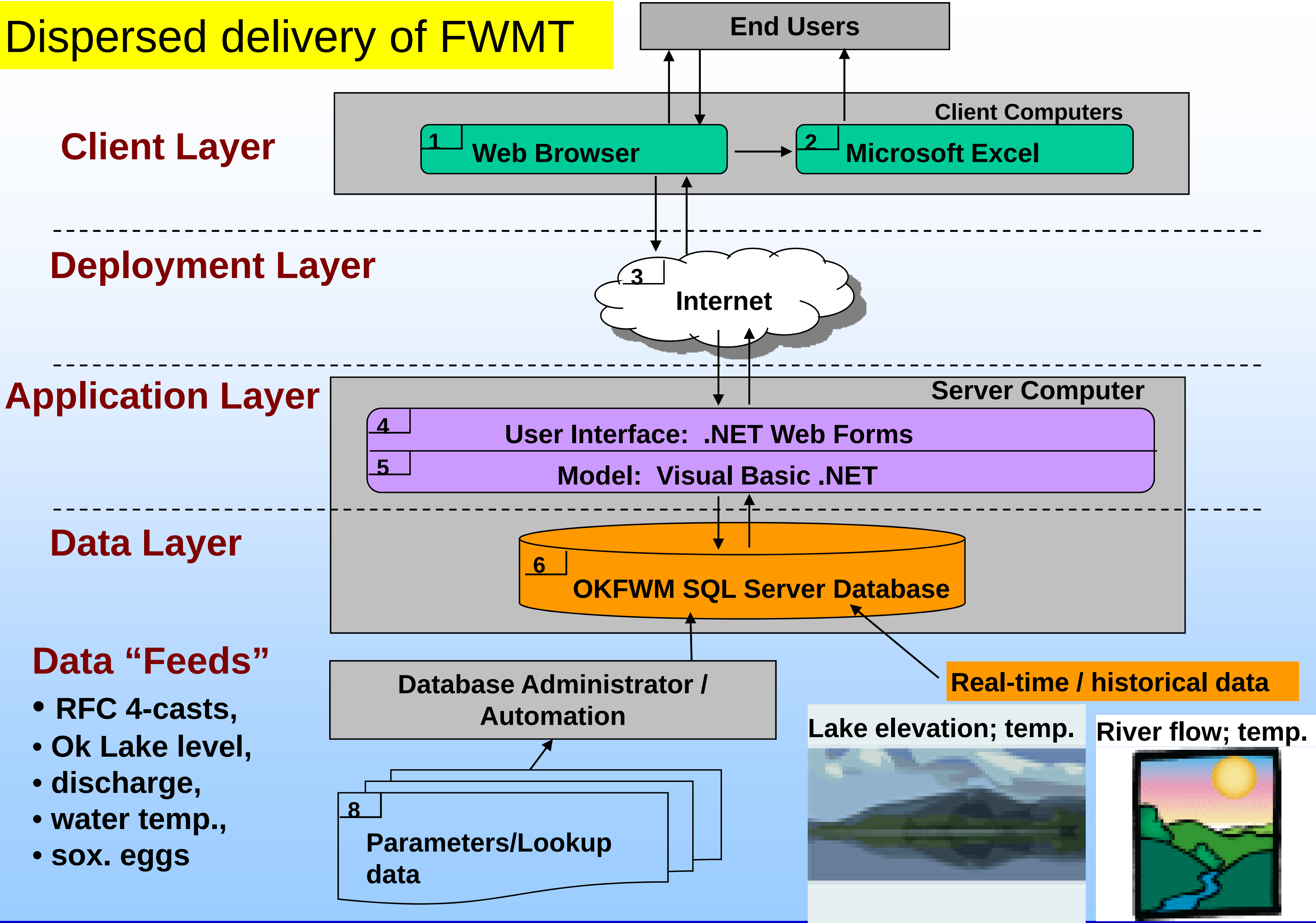
FWMT Decision Support System



The FWMT System is a coupled set of biophysical models of key relationships (among climate, water, fish & property) used to predict the consequences of water mgt. decisions for fish & other water users.

FWMT may be used to explore water management decision impacts in an operational mode employing real-time data, a prospective-mode going forward or in a retrospective-mode looking back on historic water supply, climate & fish years.

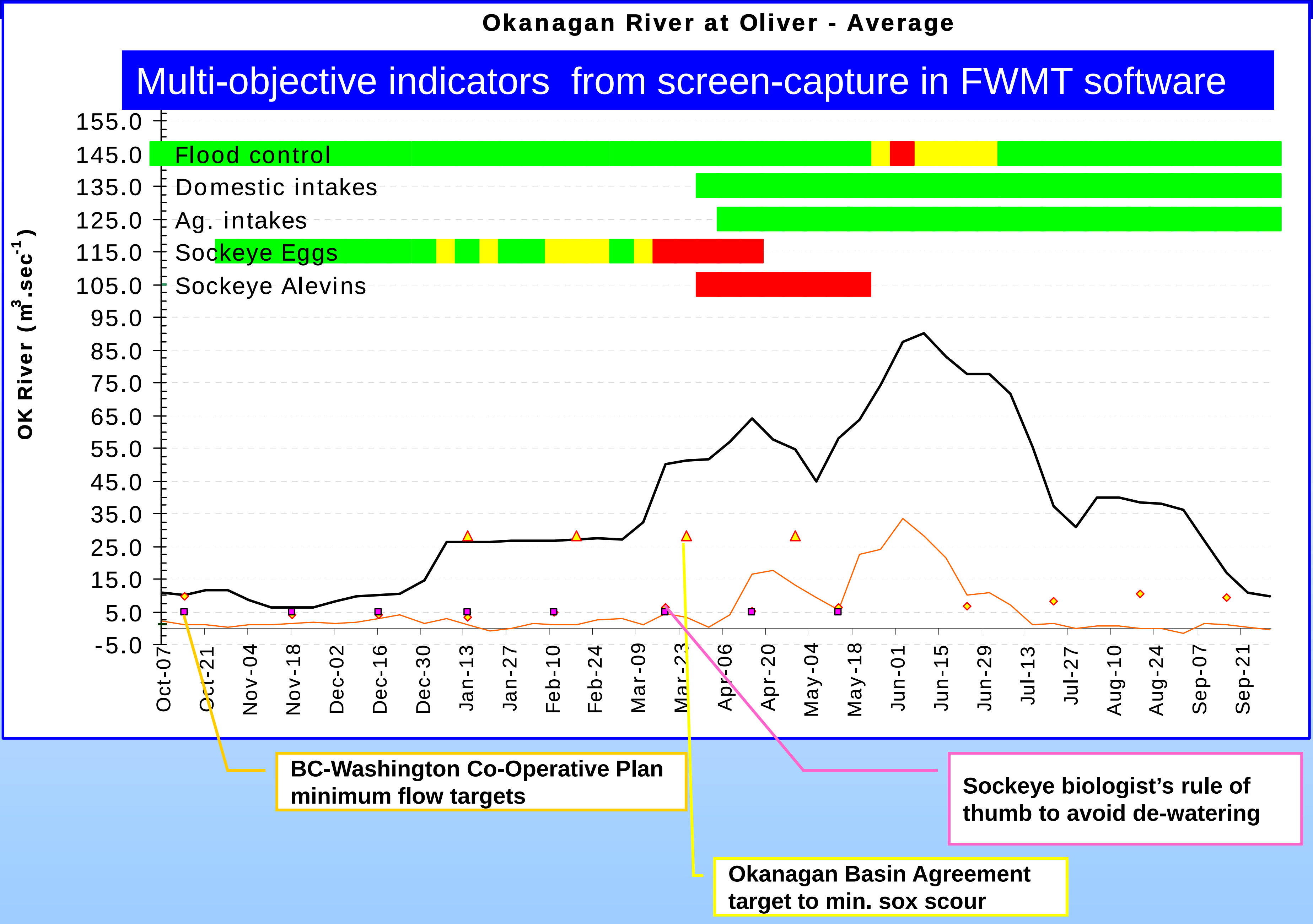
Dispersed delivery of FWMT



Data “Feeds”

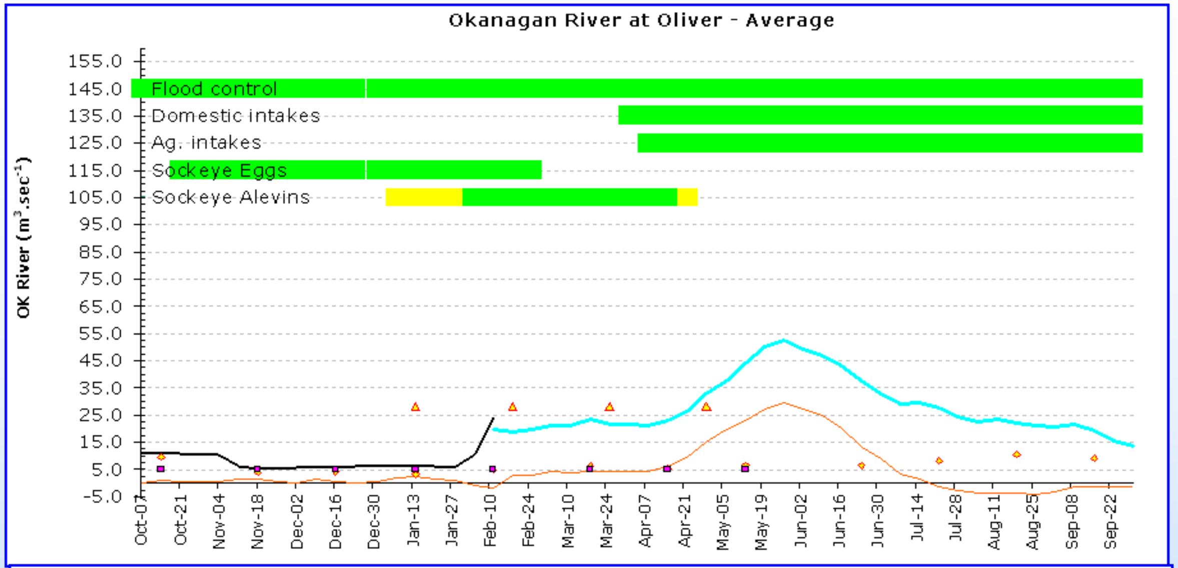
- RFC 4-casts,
- Ok Lake level,
- discharge,
- water temp.,
- sox. eggs

Multi-objective indicators from screen-capture in FWMT software

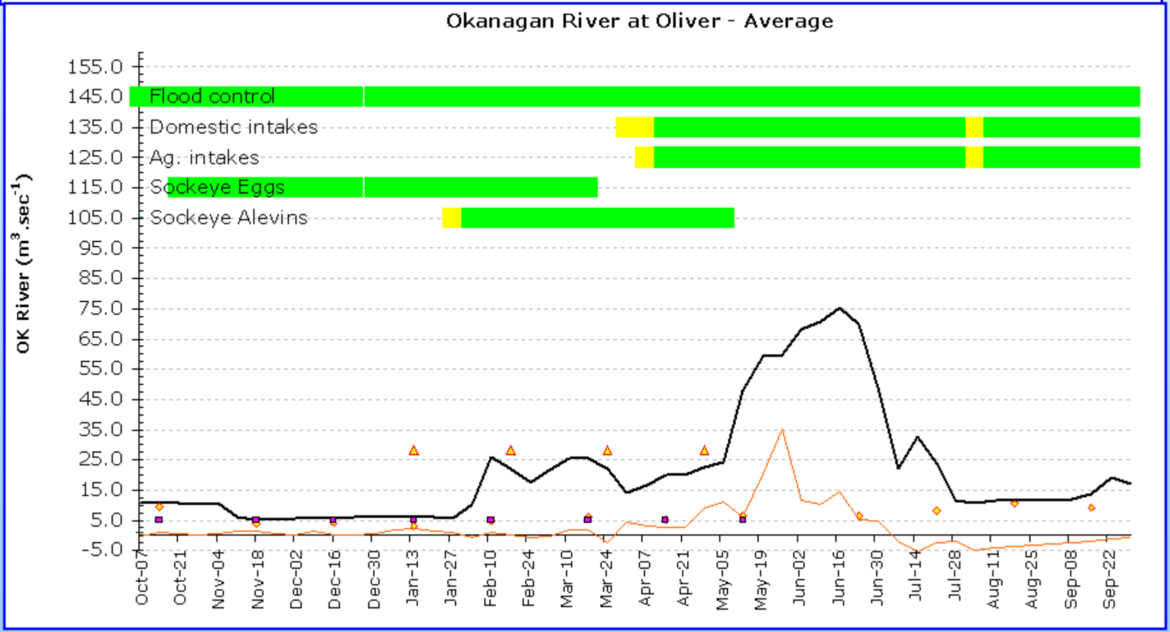


OKANAGAN FWMT 2005-2006 WATER MANAGEMENT YEAR

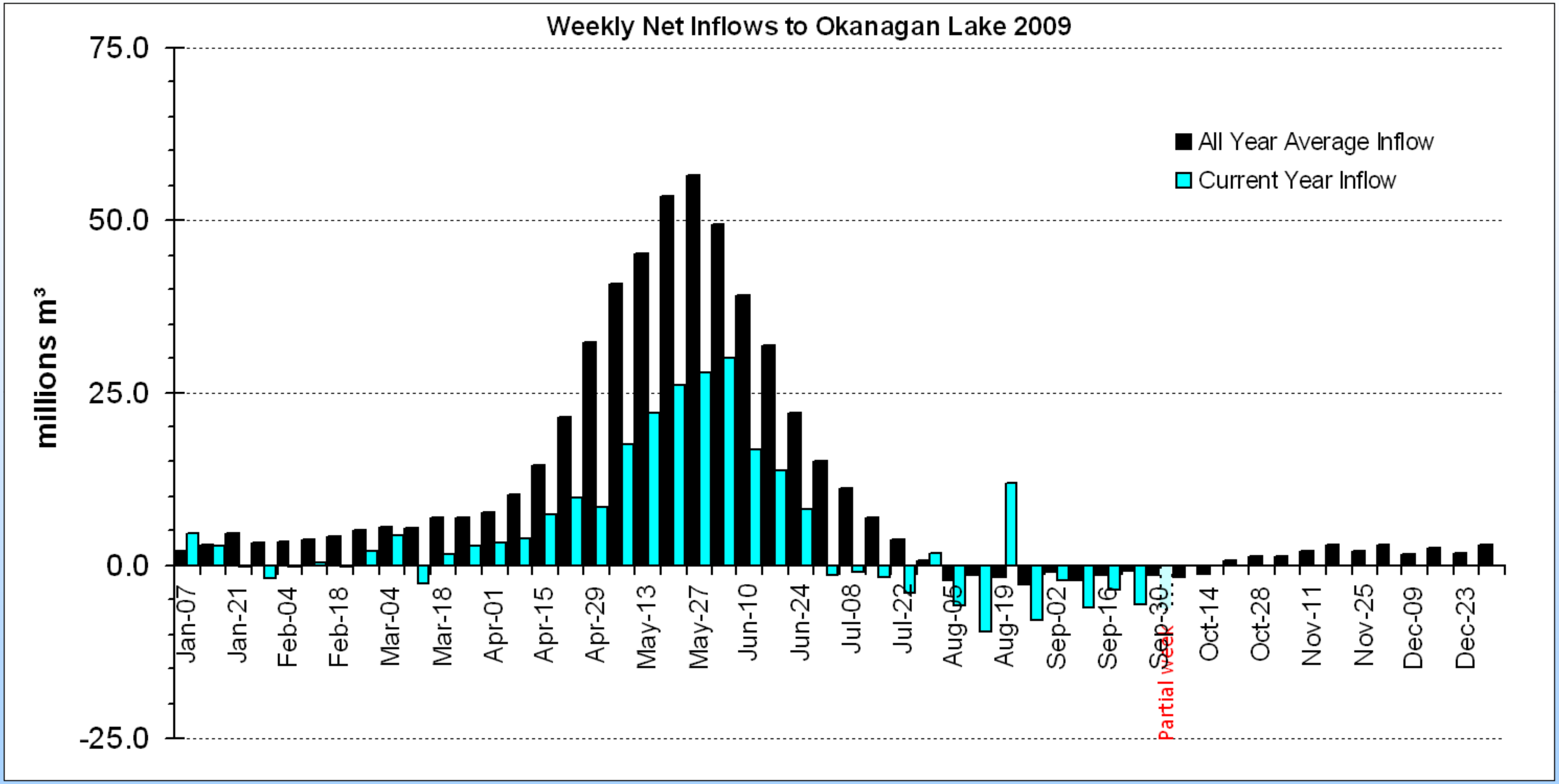
(A) Actual and predicted flows at Oliver (sockeye spawning grounds) 9-Feb-06



(B) Final outcome at Oliver (sockeye spawning grounds) 30-Sep-06

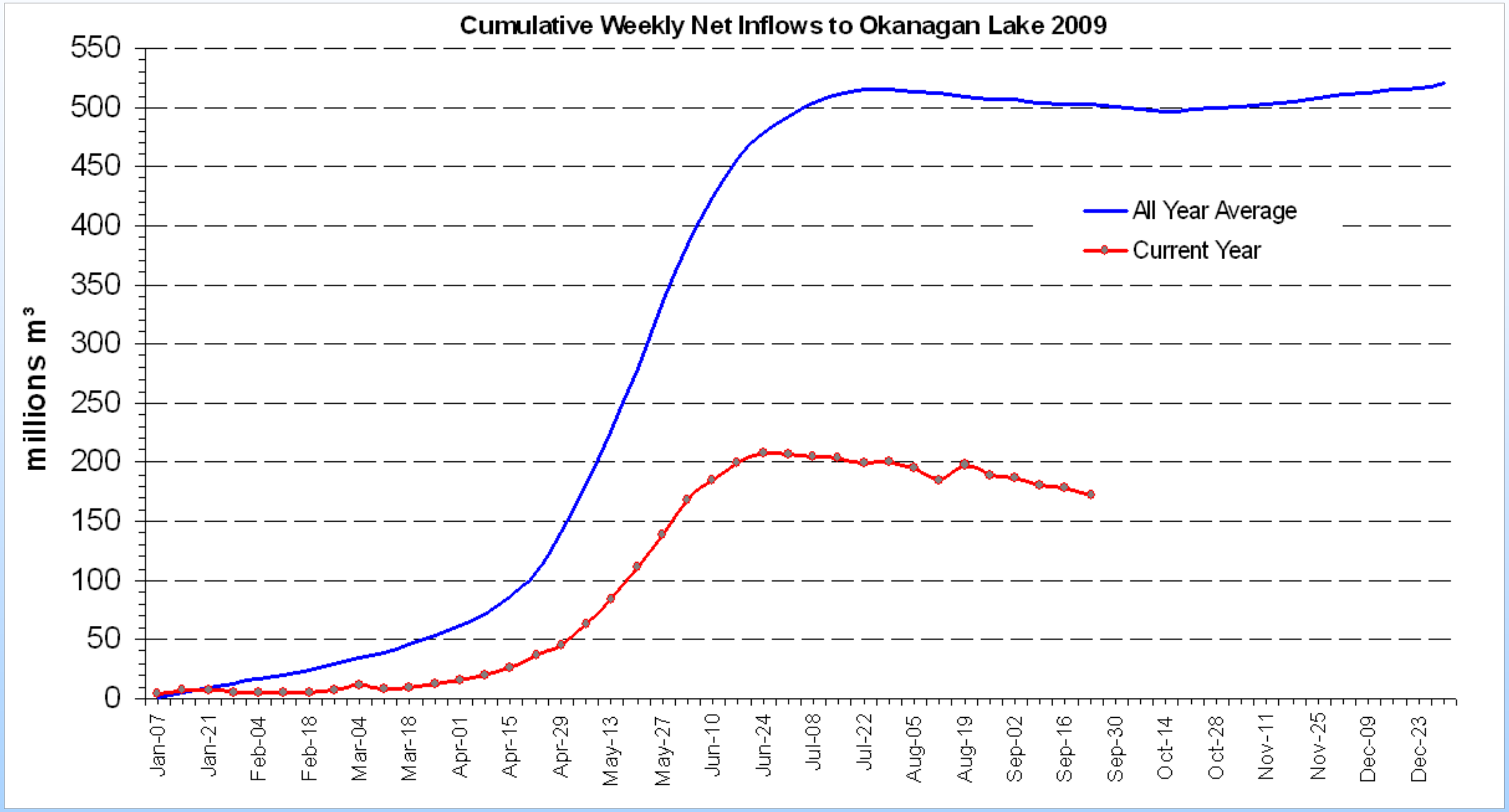


Net Weekly Inflows to Okanagan L. 08-09 Fish-and-Water Year



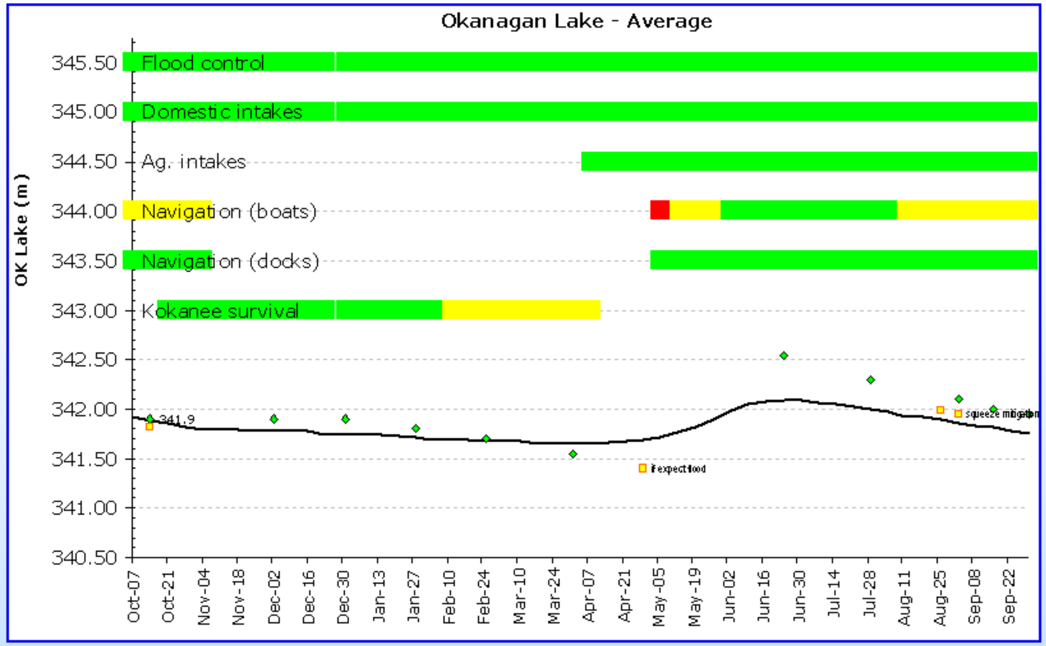
Below average snow-pack (203 vs 525 million m^3), late melt, high peak water yield, early transition to drought.

FWMT WATER YEAR 2008 - 2009

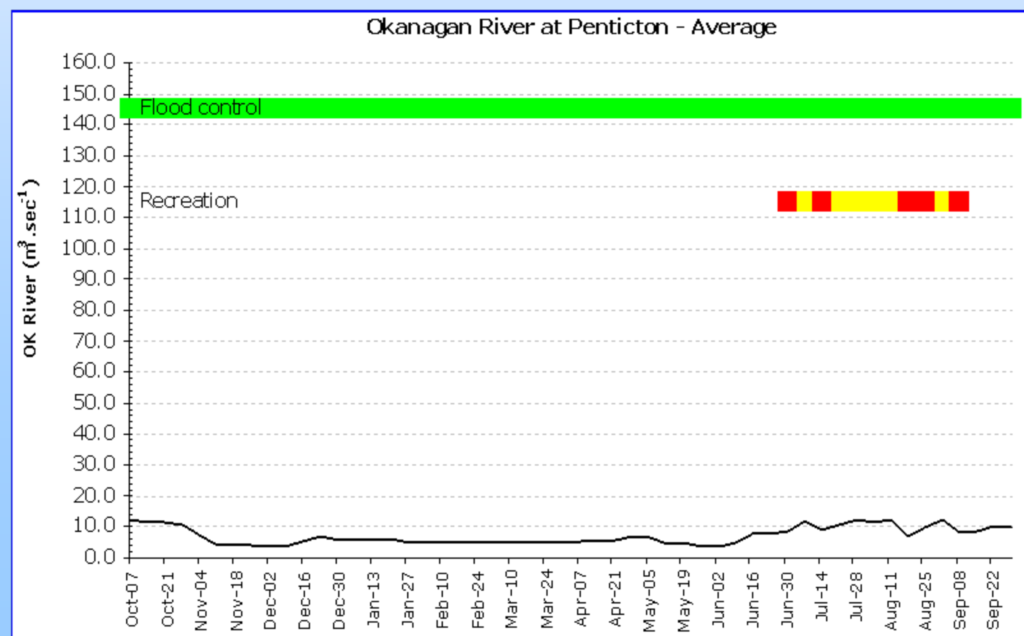


2008 – 2009 Drought

A. Okanagan Lake

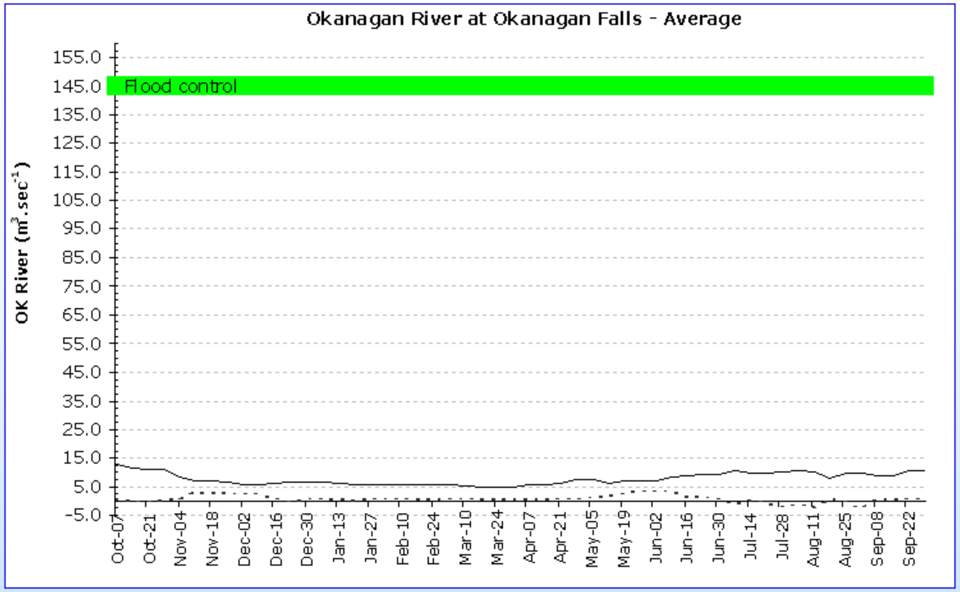


B. Okanagan River at Penticton

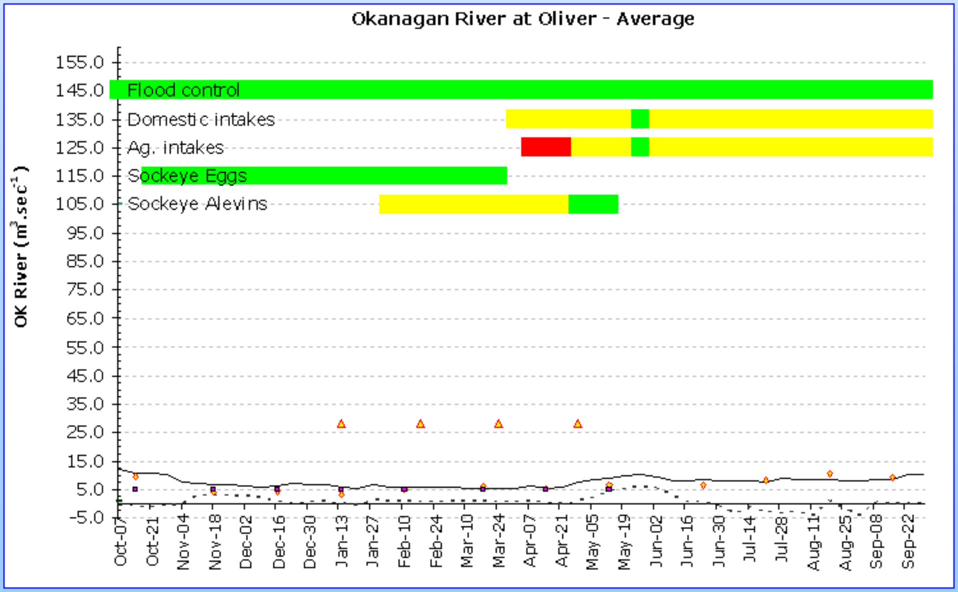


2008 – 2009 Drought

C. Okanagan River
at Ok Falls



D. Okanagan River
at Oliver



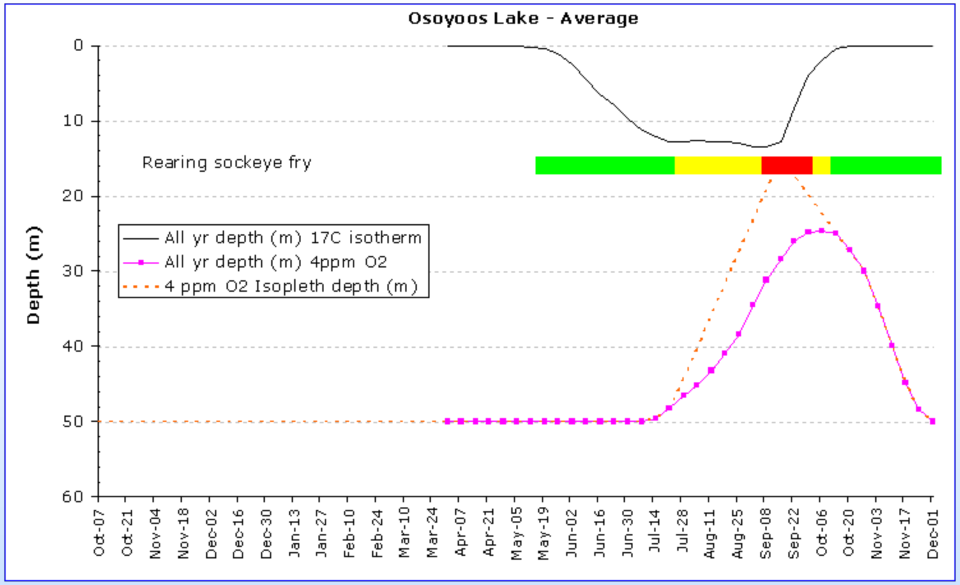
FWMT WATER YEAR 2008 - 2009

Table 1. A summary by location & issue of consequences associated with adoption of three alternate flow scenarios (FWMT-569, 561,568) during Aug-Sept, 2009.

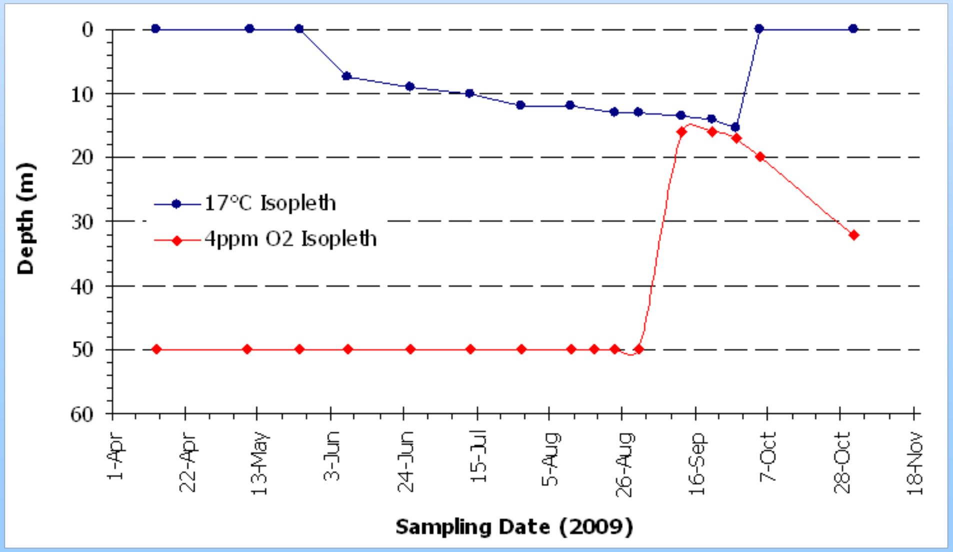
		FWMT-569		FWMT-561		FWMT-568
Location/Issue [1.]		Current (10.7 cms)		OBA max (12.7 cms)		Mitigate squeeze (18.3 cms)
Ok Lk levels predicted (Sept 30, 2009) [2.]		341.76		341.72		341.69
Domestic intakes [3.]						
Agricultural intakes [3.]						
Navigation boats [4.]						
Navigation docks [4.]						
Kokanee spawn/survival [5.]						
Ok Lk levels expected by Oct 14, 2009 [5.]		341.72		341.66		341.64
Okanagan River						
Recreation at Penticton [6.]						
Domestic intakes-Oliver [7.]						
Agricultural intakes-Oliver [8.]						
Osoyoos Lake						
Juvenile sockeye rearing [9.]						
Adult sockeye holding [9.]						
Ok Lk levels expected by April 1, 2010 [10.]		341.48		341.42		341.40

FWMT WATER YEAR 2008 - 2009

Predicted “Squeeze”

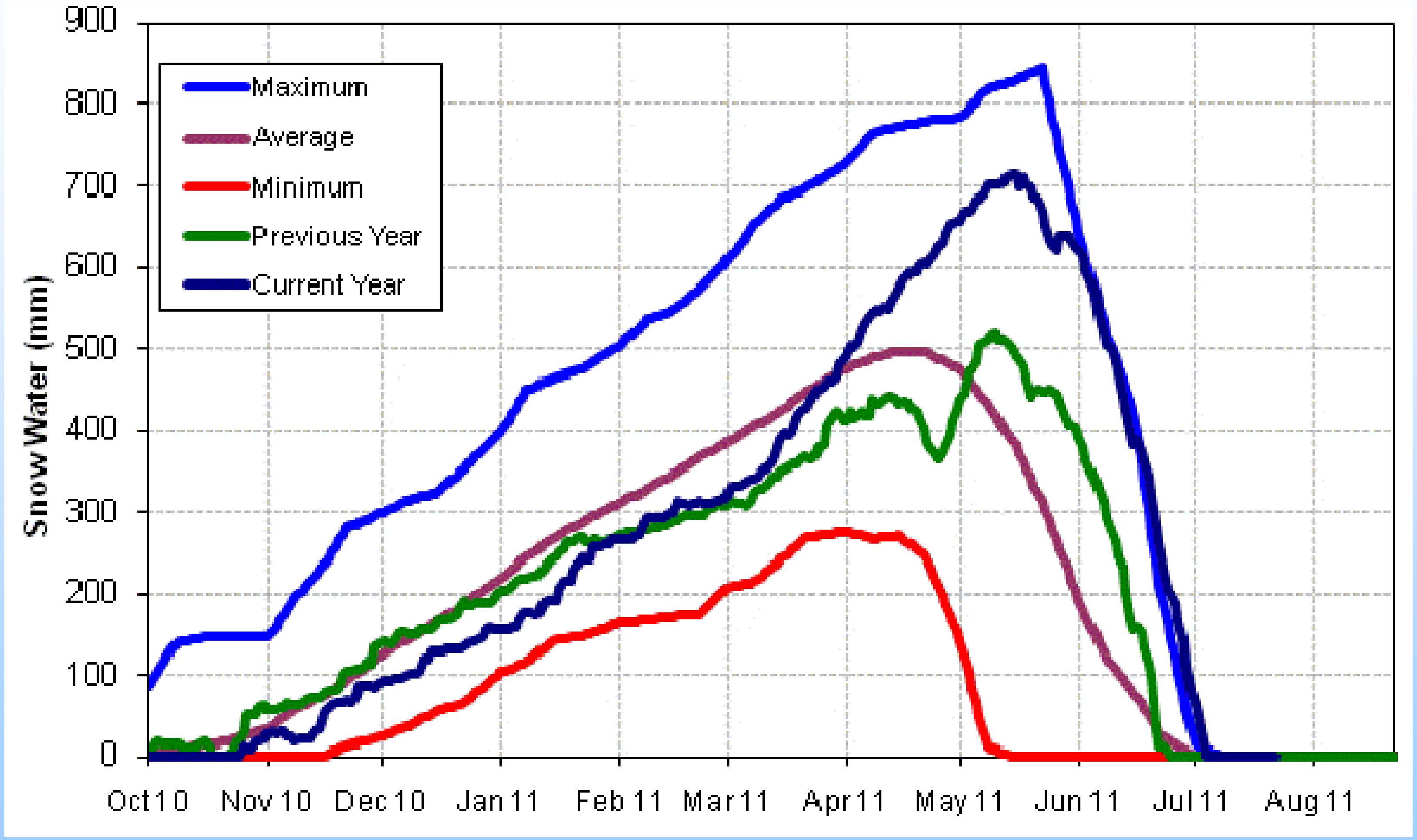


Observed “Squeeze”



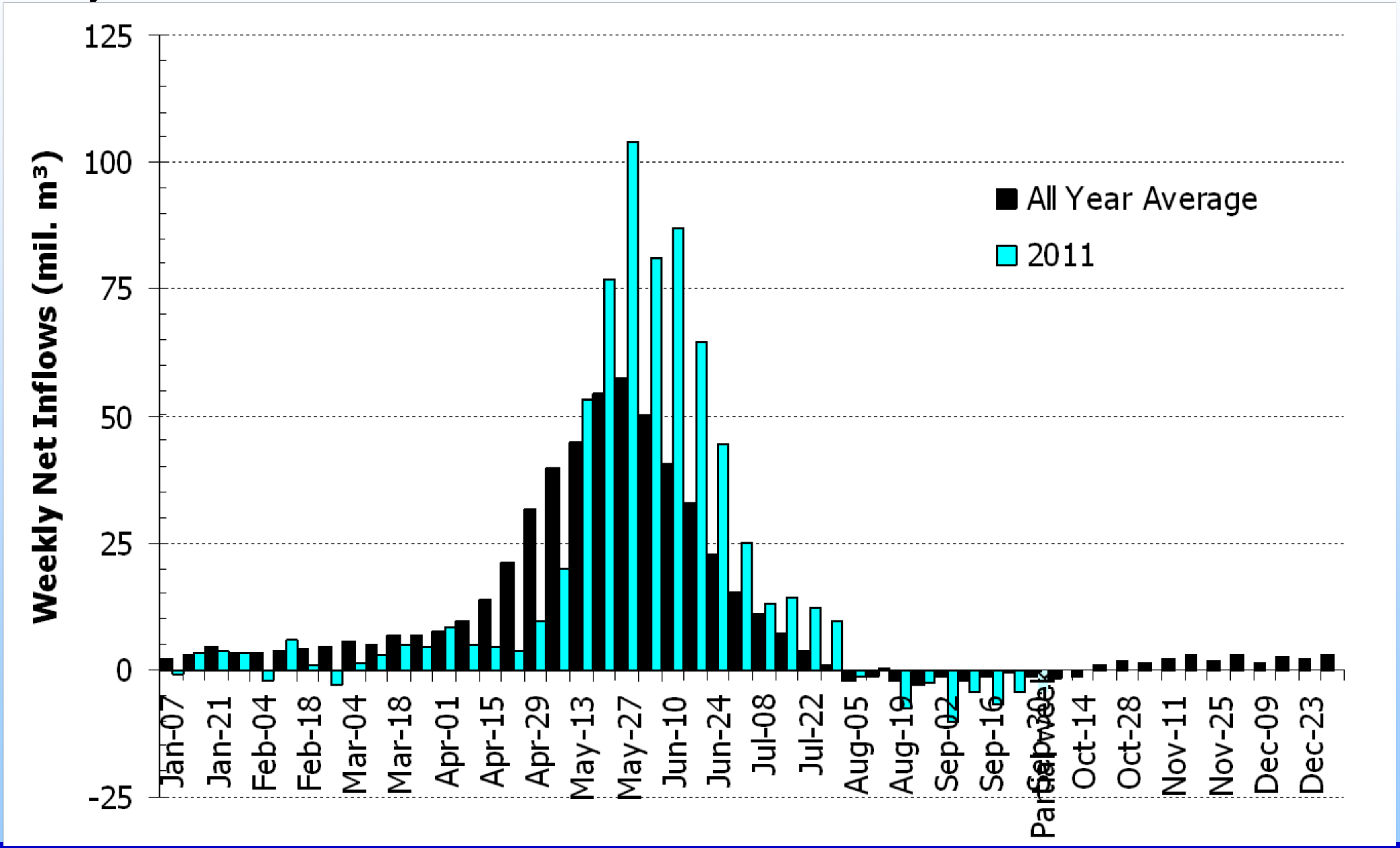
FWMT WATER YEAR 2010 - 2011

A. Mission Creek Automated Snow Pillow 2F05P (Elevation 1794m

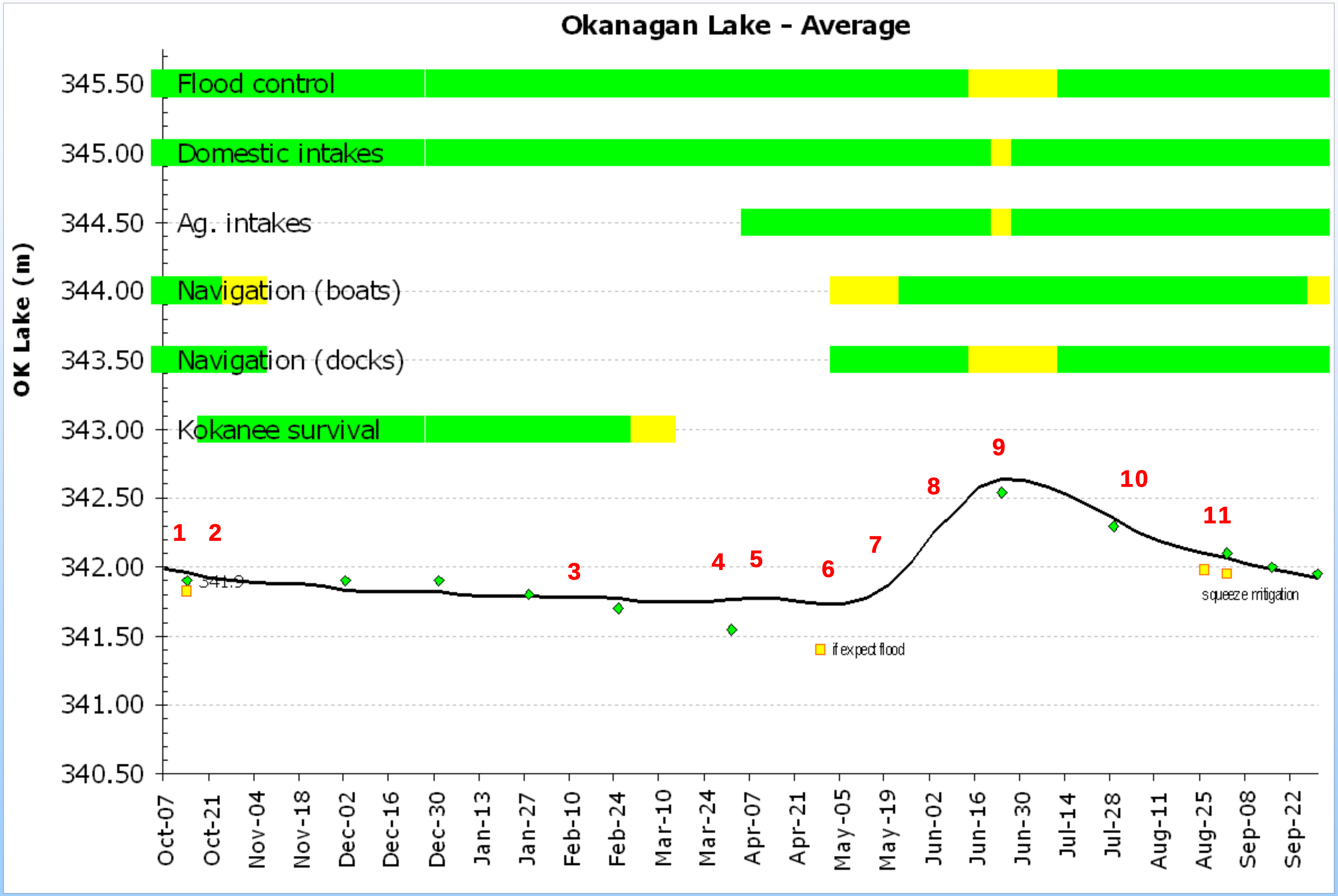


FWMT WATER YEAR 2010 - 2011

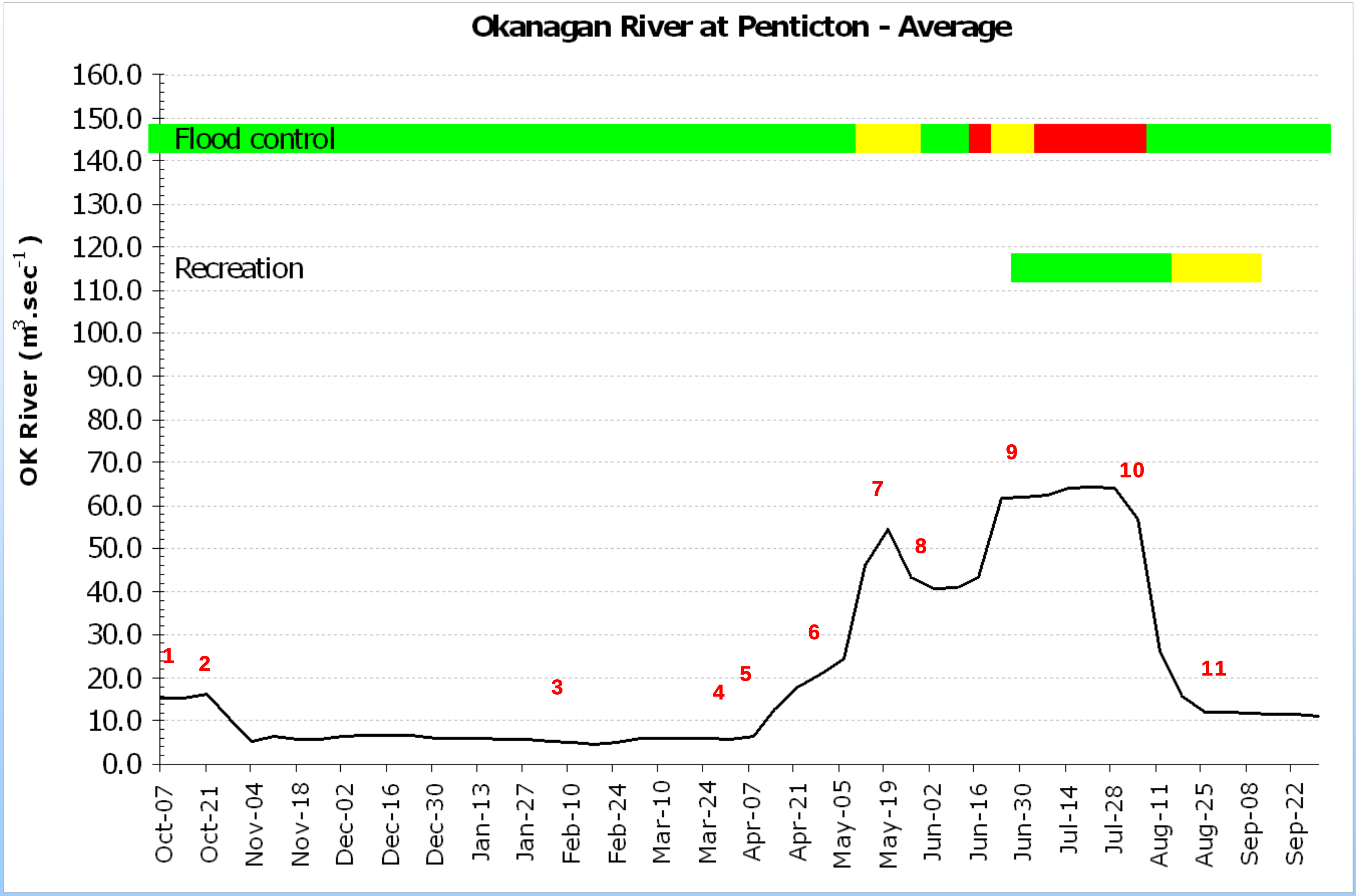
Figure A1. FWMT report of observed weekly net inflows (million m³) into Okanagan Lake January to October 2011.



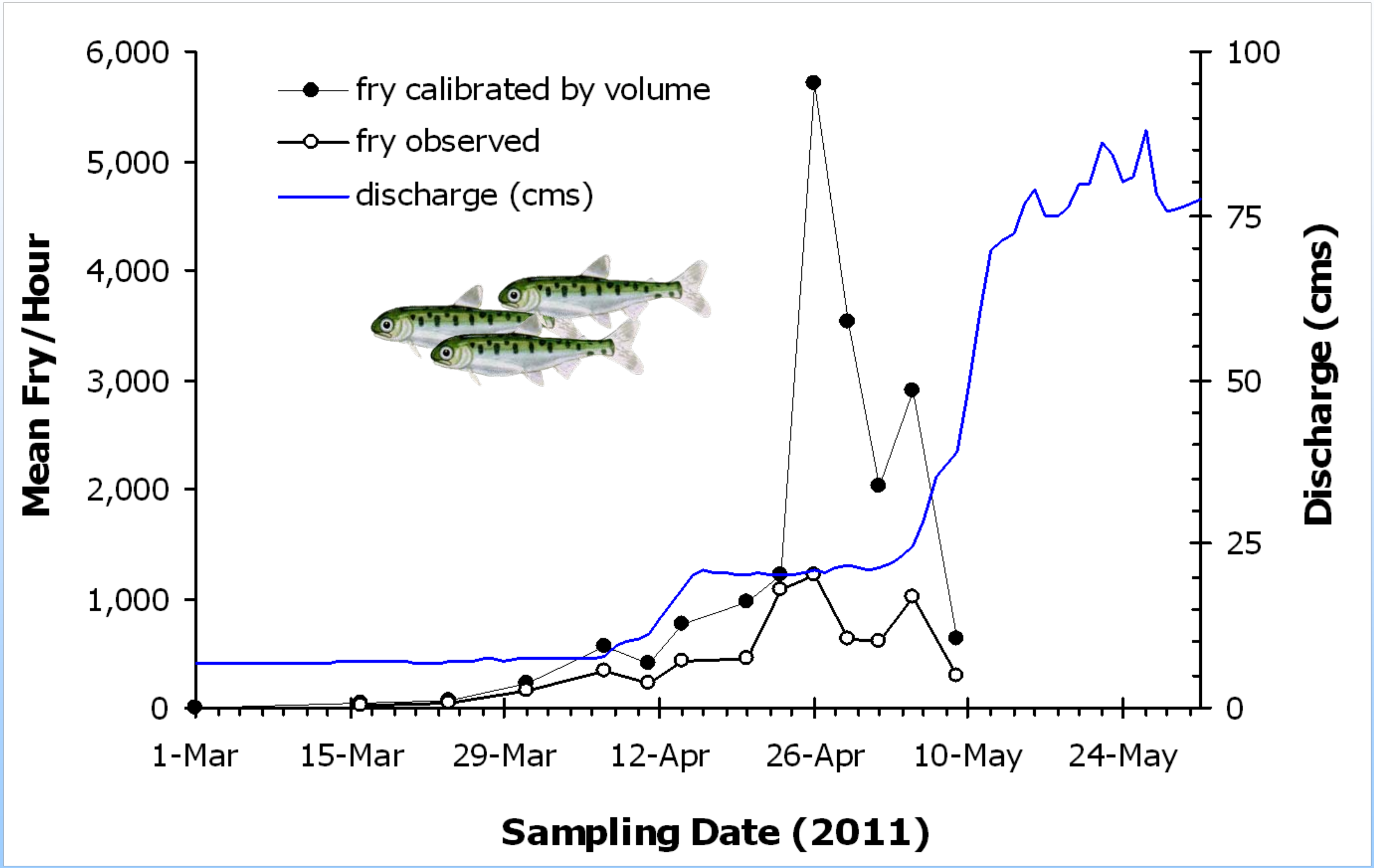
FWMT WATER YEAR 2010 - 2011



FWMT WATER YEAR 2010 - 2011

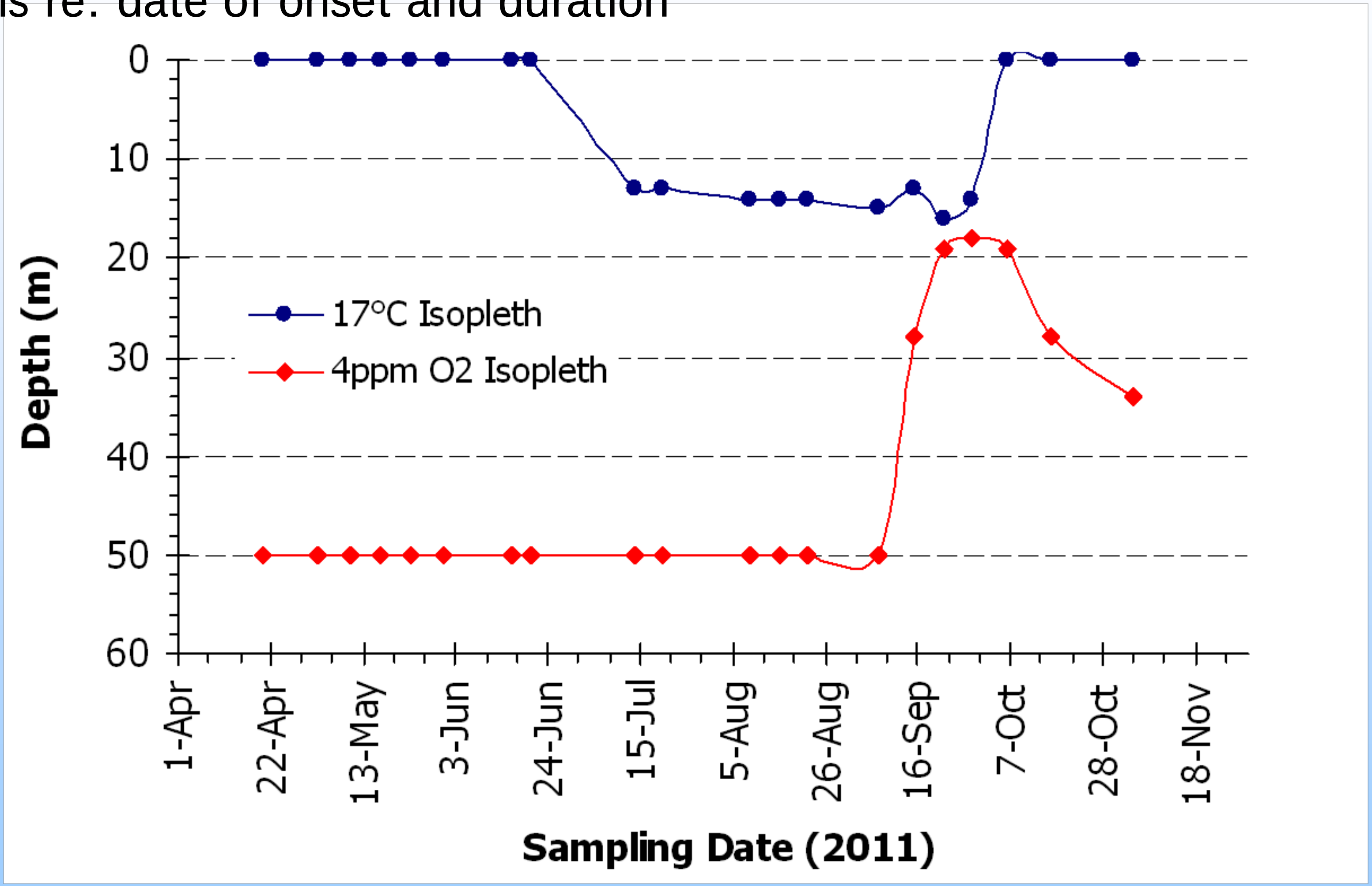


FWMT WATER YEAR 2010 - 2011



FWMT WATER YEAR 2010 - 2011

Minor (<2 weeks) temp-oxygen squeeze event in late Sept. as per “in-season” predictions re: date of onset and duration

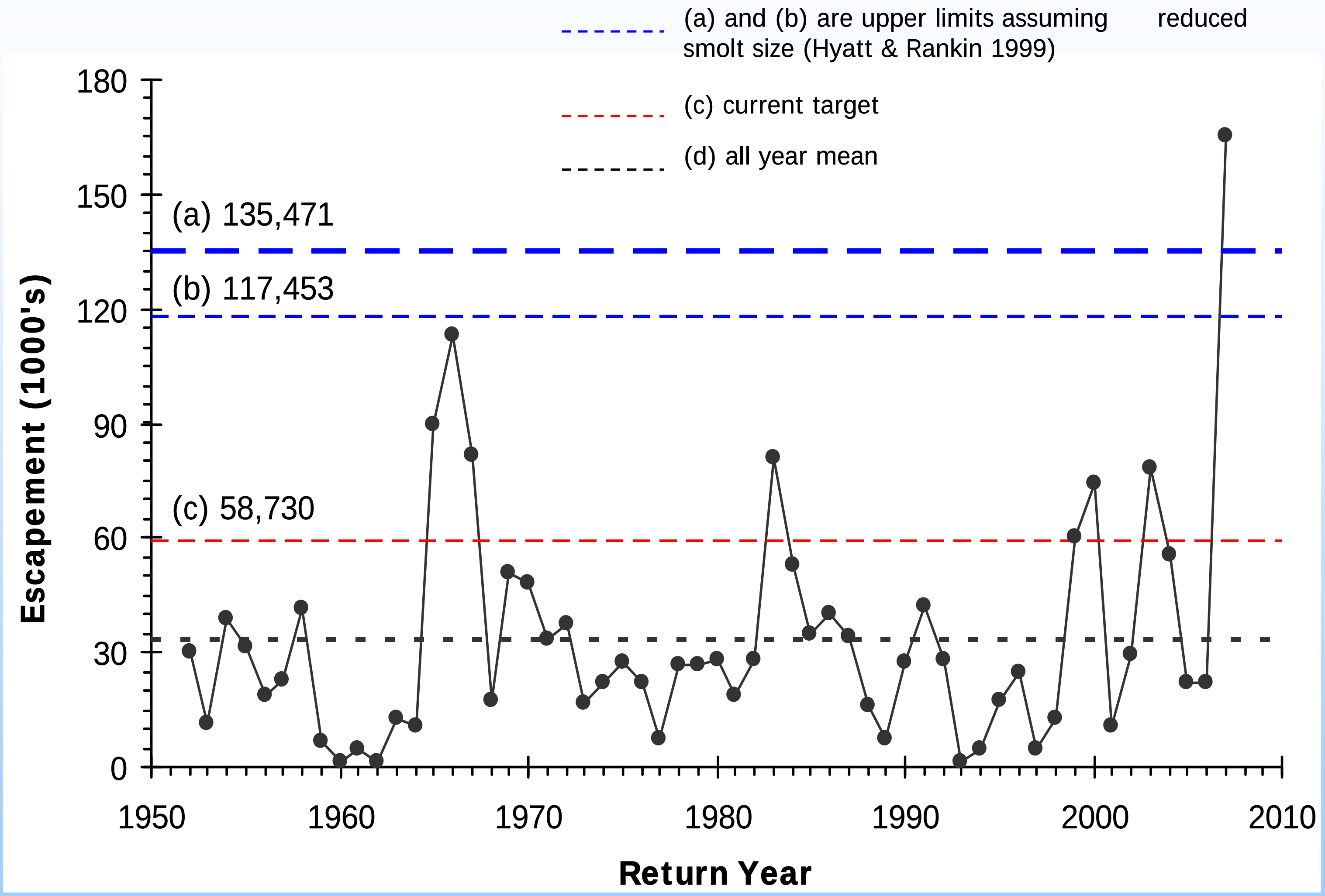


Ok-FWMT Results to Date

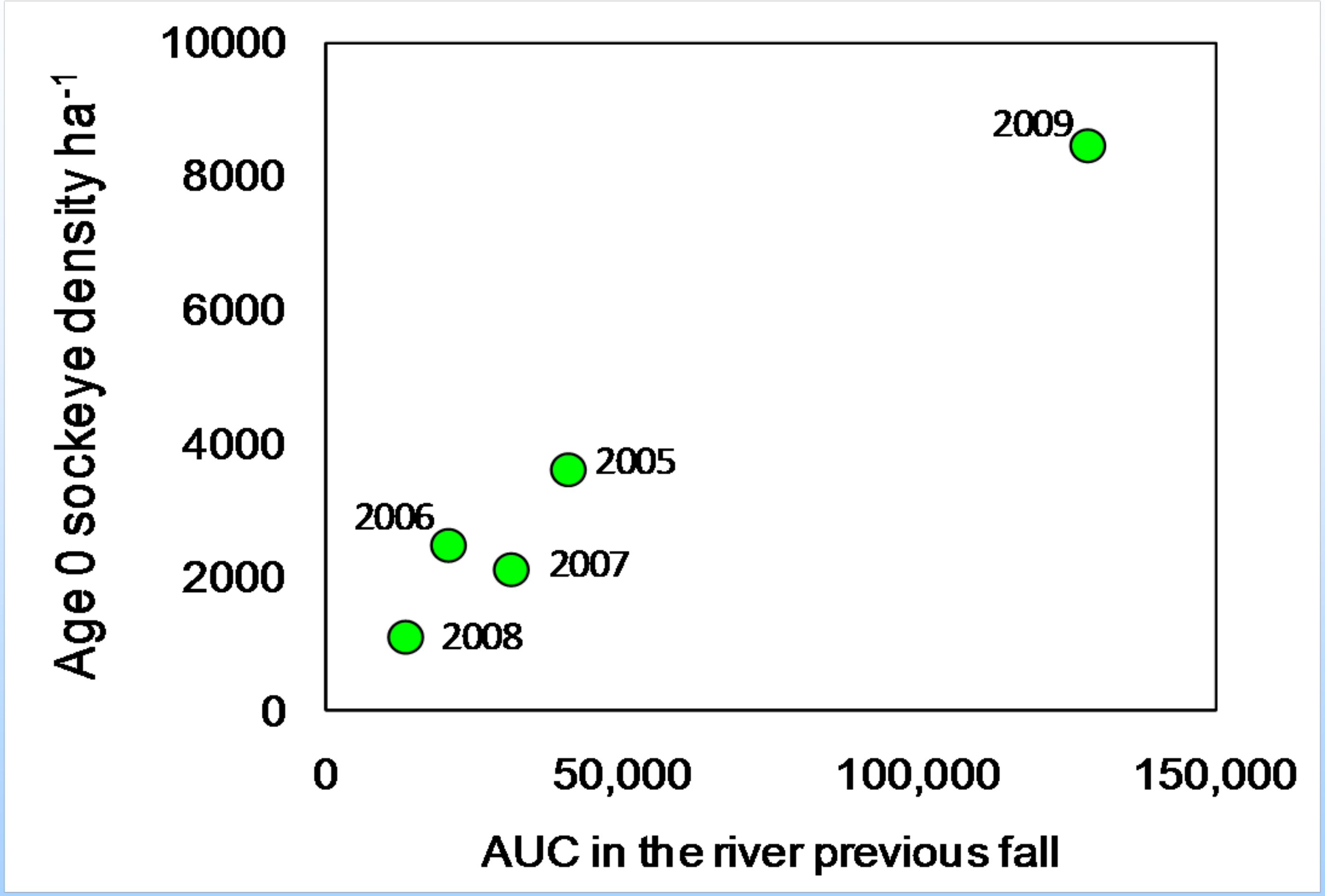
- balances consideration of multiple objectives (*i.e.* social, economic, cultural, ecological)
- recognizes inflow forecast uncertainties,
- uses “rich” information sources refreshed in real-time (*i.e.* annual to daily imports of biophysical data),
- facilitates effective input from limited pool of expertise,
- provides record of annual strategy & outcomes to assess performance against multiple objectives.
- since deployment in fall of 2005 we have avoided (a) major drought and desiccation or flood and scour losses of fry production in-river and (b) most temp-O2 induced losses of lake-rearing fry (i.e. reduced density-independent losses of fry & smolt production).

Influence of FWMT plus other factors on sockeye recovery ?

Escapement Revisions, Hyatt & Rankin 1996



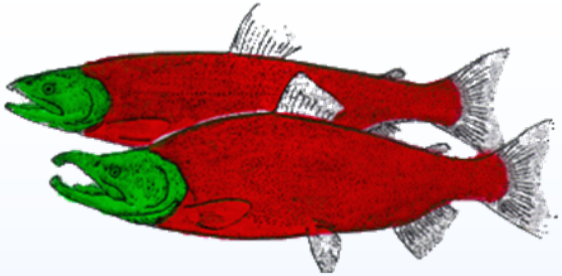
Where do all the sockeye come from ?

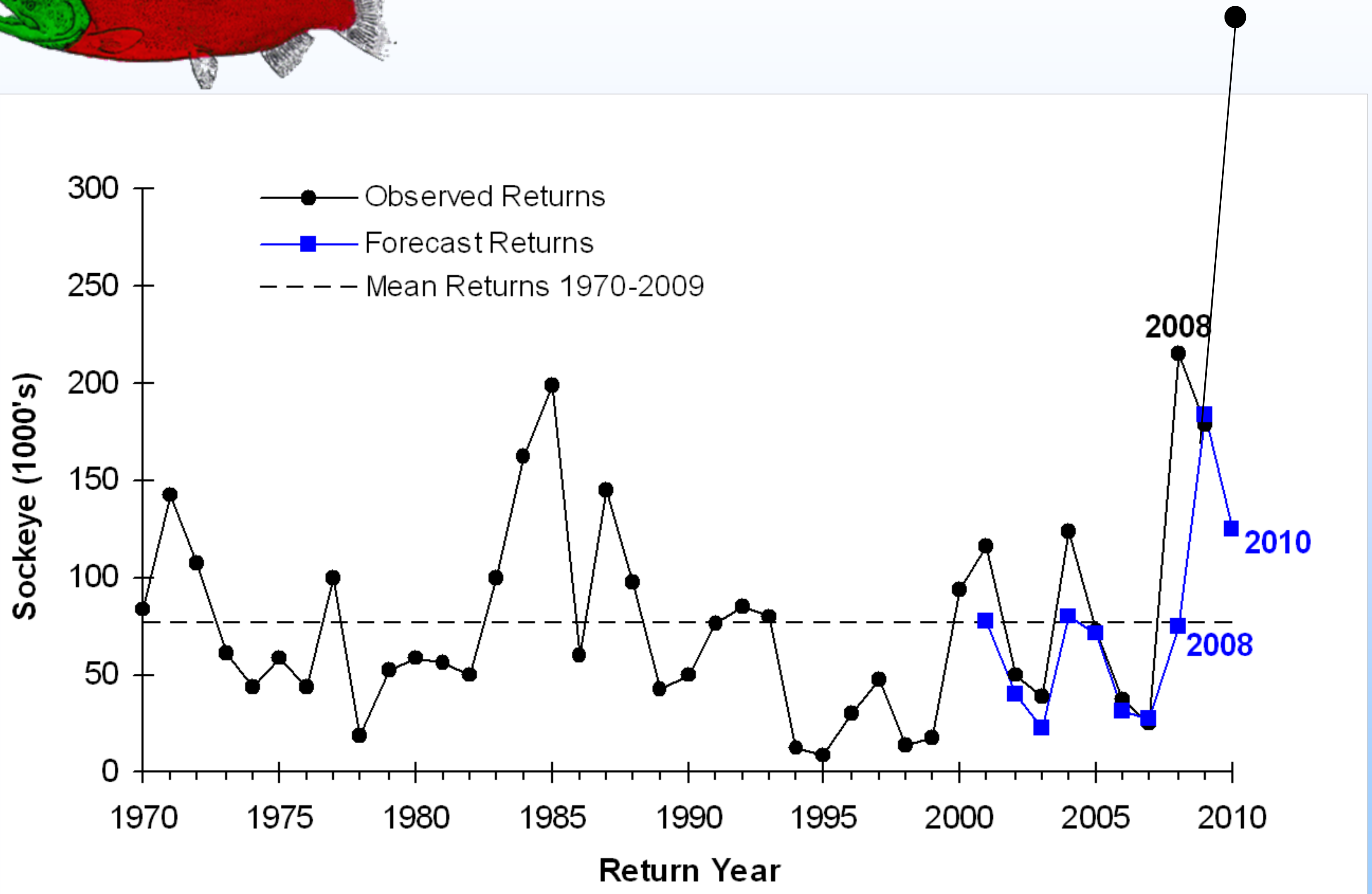


Post FWMT deployment, more adult spawners clearly lead to more smolt production as per Hyatt & Rankin (1996) analysis of carrying capacity of river and lake habitats.

Columbia R. Sockeye Returns 1970-2010.

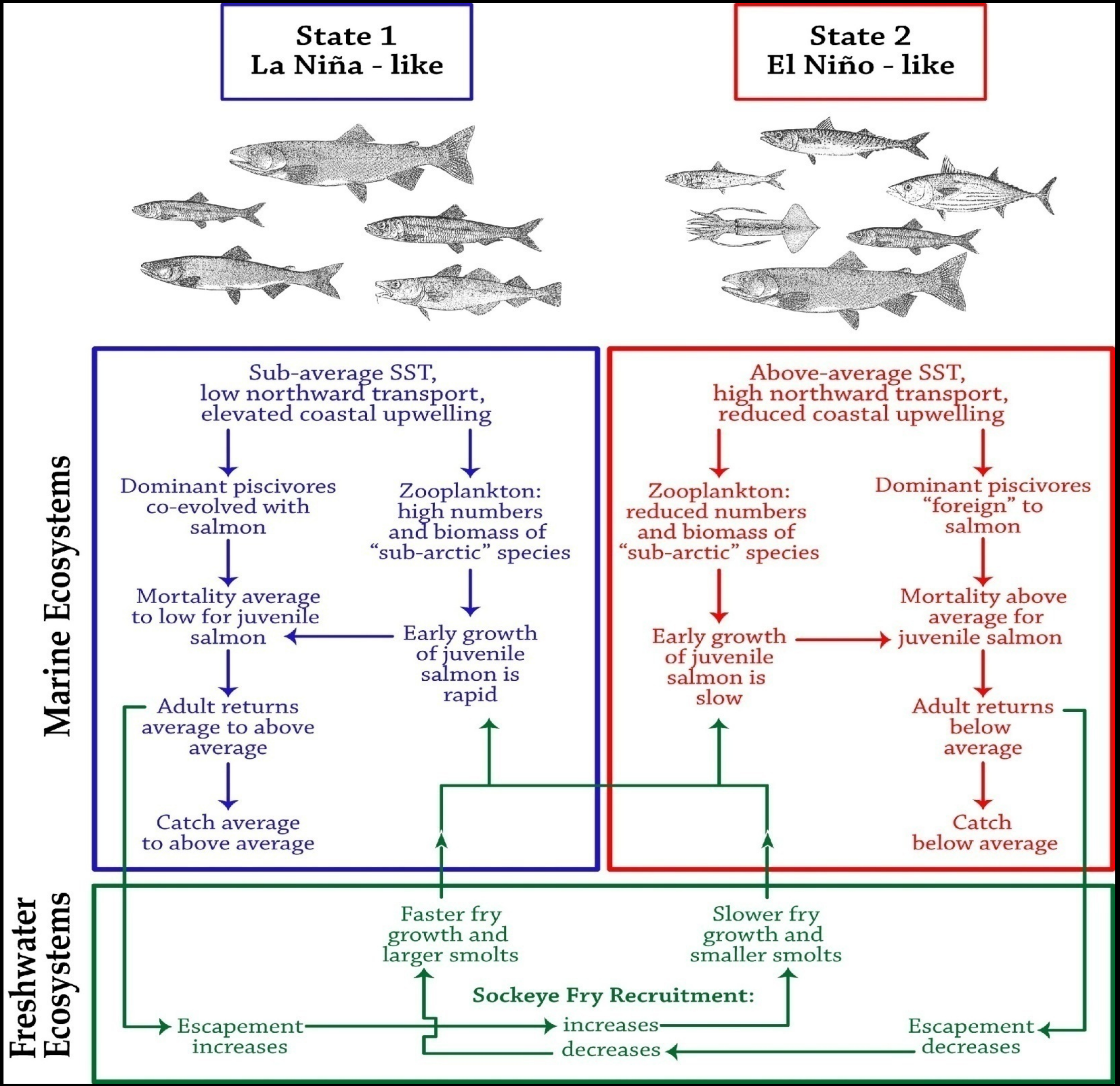
Okanagan = 75-80% of all Columbia R. Sockeye after 1980



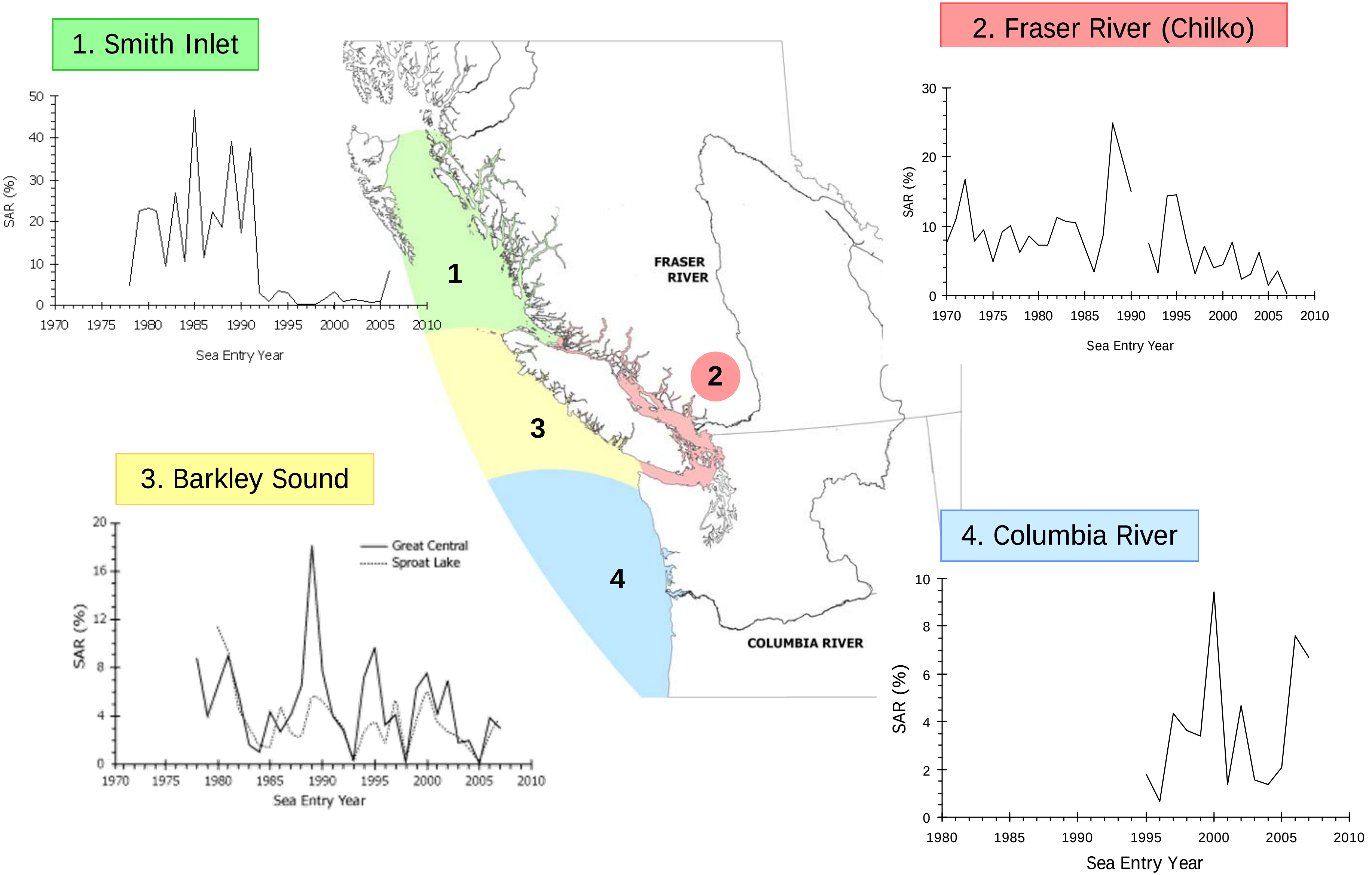


Out of Basin Effects

Two-state model of ocean conditions and salmon survival for Barkley Sd sockeye & the origin of the "HOMS hypothesis"
(Hyatt & Steer 1988)



Sockeye Salmon Index Stocks Marine Survival Trends



Recent among stock comparisons provide compelling evidence supporting the "HOMS hypothesis" (Hyatt et al. 2010, *in prep*) !

Conclusions

- FWMT deployment has stabilized smolt production per spawner by reducing density-independent losses from flood-and-scour or drought-and-desiccation events.
- Higher escapements more fully utilize inherent habitat capacity for spawning, egg incubation and rearing fry with resultant increases in annual smolt production
- Average annual output of smolts from Osoyoos L. increased 5-10 fold in 1998-2010 relative to the 1970-1997 interval.
- Record returns of Columbia R. sockeye principally reflect wild Okanagan sockeye increases in escapement, fry (*from the Okanagan R.*), smolt production (*from Osyoos L.*) and favourable smolt-to-adult survival (*in the Columbia R and Pacific Ocean*).

Questions ?

Fisheries and Oceans Canada   Pêches et Océans Canada

Canada

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	June 20, 2012
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the May 17, 2012, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Douglas PUD Headquarters in East Wenatchee, Washington, on Thursday, May 17, 2012, from 9:30 am to 12:30 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Chelan and Douglas PUDs will present at the June 20, 2012 Hatchery Committees meeting potential paths forward for reviewing and revising the Hatchery Monitoring and Evaluation (M&E) Programs using the results from the Final 5-Year M&E Reports (Item II-A).
- Bill Gale will email to Kristi Geris for distribution to the Hatchery Committees a revised draft Statement of Agreement (SOA) for the Collection of Adult Broodstock at Wells Hatchery for Entiat National Fish Hatchery. Background language in the draft SOA will be revised to indicate that the estimated broodstock required from Wells Hatchery in later years may be adjusted dependent on 2012 returns (Item II-B).
- Joe Miller will email to Kristi Geris for distribution to the Hatchery Committees revisions to the Dryden Conceptual Study Approach, including additional information on issues associated with constructing a dedicated surface water intake at the Dryden facility (Item III-C).
- Steve Lewis will provide to Joe Miller, Mike Tonseth, and Mike Schiewe editorial comments to the 2012 Tumwater Operations request for concurrence; Kristi Geris will distribute these comments to the Hatchery Committees (Item III-E).
- Keely Murdoch will email to Kristi Geris for distribution to the Hatchery Committees additional information on future hatchery space requirements for the Yakama Nation

(YN) Coho Restoration Program, including timelines and details on the split between Methow- and Wenatchee-released fish (Item IV-A).

STATEMENT OF AGREEMENT DECISION SUMMARY

- No SOAs were approved at this meeting.

AGREEMENTS

- The Rocky Reach and Rock Island Hatchery Committees, National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service (USFWS) agreed on Tumwater Dam operations for 2012 (Item III-E).
- The Hatchery Committees agreed to continue discussions on updating the Hatchery Programs M&E Plans at the June 20, 2012 Hatchery Committees meeting.

REVIEW ITEMS

- No reports are currently out for review.

FINALIZED REPORTS

- The Chelan PUD Final 5-Year M&E Report was posted and became available for download from the Anchor QEA FTP site on May 7, 2012.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. The following revisions were made to the agenda items:

- Joe Miller removed Chelan PUD's agenda items III-A, B, and D.
- Kirk Truscott requested that the decision agenda item III-E be discussed at the beginning of the meeting.
- Keely Murdoch added a discussion of the YN Coho Restoration Program.

The revised draft April 18, 2012 meeting minutes were reviewed. Kristi Geris said all comments and revisions received on the draft meeting minutes were incorporated and there are no outstanding items remaining to be discussed. Bill Gale clarified that the USFWS plans to use volitional release for this year's Winthrop National Fish Hatchery (NFH) steelhead program. The Committees approved the April 18, 2012 meeting minutes, as revised.

II. Douglas PUD

A. Principles of Adaptive Management (Greg Mackey)

Greg Mackey presented an overview of adaptive management (Attachment B) to facilitate discussion of possible paths forward for reviewing and revising Chelan and Douglas PUDs' Hatchery M&E Programs. This review is required every 5 years under the HCP. Mackey reminded the Hatchery Committees of the electronic article on adaptive management that Kristi Geris distributed to the Committees via email on May 8, 2012, and pointed out that the article contained insight on all aspects of adaptive management. Mackey's presentation provided an overview of the HCP process, the adaptive management process, and decision analysis, and how the three processes overlap. Mackey discussed the advantages of developing detailed HCP hatchery objectives in an adaptive management framework so that actions feed back into an iterative adaptive management loop. Mackey invited discussion from the Committees.

Keely Murdoch pointed out that the HCP analytical framework does include an outline for an adaptive management process (i.e., review the 5-Year M&E Reports for potential changes, thus making objectives); however, the Committees have yet to adopt a plan to initiate the process. Mackey suggested that when the M&E Plans are updated, they can be updated based upon actions and assessment. For example, if actions aren't helping to inform management actions, they don't need to be included in the plan.

Mike Schiewe said that sometimes management doesn't anticipate tomorrow's questions; developing a knowledge base to be proactive has merit, and that should be on the table as well. Schiewe said that Chelan PUD's 5-Year M&E Plan is final, and Mackey said Douglas PUD is addressing some final questions on the Douglas PUD 5-year M&E Plan, and they should be ready to finalize it prior to the Hatchery Committees' June 20, 2012 meeting.

Bill Gale said that although adaptive management can save resources and improve performance, this concept can collapse without an awareness of what resources exist. Joe Miller added that when the target is not well defined, it is hard to accomplish anything.

Schiewe reminded the Committees that during last month's Hatchery Committees meeting, it was decided that when both M&E 5-Year Reports are finalized, the group should evaluate and discuss how the 5-year findings can inform decisions and management. Mackey said that Douglas, Chelan, and Grant PUDs are already having conversations regarding the 5-year update of the M&E plans. Mackey pointed out that in order to allow enough time for review, approval, and incorporation into next year's M&E implementation plan, the updated M&E plan would need to be finalized by the end of September. Miller added that, within this timeframe, a request for proposals (RFP) needs to be developed as well.

Schiewe acknowledged the need to move quickly, and proposed that Chelan and Douglas PUDs present at the June 20, 2012 Hatchery Committees meeting their potential paths forward in reviewing and revising the Hatchery M&E Programs using the results from the Final 5-Year M&E Reports. The Hatchery Committees agreed to this path forward and timeframe.

B. Broodstock Protocol Update (Greg Mackey)

Greg Mackey asked Mike Tonseth to provide the Hatchery Committees with a brief update on the status of the 2012 Broodstock Protocol. Tonseth said the protocols were completed and submitted to NMFS by April 15, 2012, as required under Section 10 permits 1395, 1347, and 1196. He said that NMFS has tentatively approved them, pending final agreement on the Wenatchee steelhead program.

C. SOA Entiat National Fish Hatchery Summer Chinook Broodstock Collection (Greg Mackey)

Greg Mackey distributed to the Hatchery Committees a draft SOA for the Collection of Adult Broodstock at Wells Hatchery for Entiat National Fish Hatchery. Mackey said that, at this point, the SOA is for discussion purposes only, but he hoped to gain approval on the SOA at the Hatchery Committees' June 20, 2012 meeting. Mike Tonseth requested that the background language in the draft SOA be revised to indicate that the estimated broodstock required from Wells Hatchery in later years may be adjusted dependent on 2012 returns. Gale said he will make the revision and email the revised draft SOA to Kristi Geris for distribution to the Hatchery Committees (Attachment C). Gale indicated his approval of the

SOA during today's meeting because a USFWS representative may not be available to attend the Hatchery Committees' June 20, 2012 meeting.

III. Chelan PUD

A. Discussion: Steelhead Releases from Chiwawa (Joe Miller)

This item was removed from today's agenda.

B. Discussion: Updates to Hatchery M&E (Joe Miller)

This item was removed from today's agenda.

C. Discussion: Dryden Feasibility Study (Joe Miller)

Joe Miller presented to the Hatchery Committees the draft Dryden Conceptual Study Approach (Attachment D). He said that he and Josh Murauskas, Bill Gale, and Kirk Truscott worked together to develop the study strategy. Miller pointed out that a key feature of this study is to identify a target for Dryden, and that target is smolt-to-adult returns (SARs) greater than or equal to those observed at Similkameen Ponds. Miller reviewed the objective, methods, and timeline of the study as outlined in Attachment D. Miller noted that the disease evaluation survey, study, and experiment (collectively, the fish health study; Method 3 in Attachment D) were developed in coordination with Chris Good of Freshwater Institute. Miller said this study will provide important new information to guide future direction.

Kirk Truscott emphasized that, as Table 1 indicates, testing moves forward down parallel paths. Truscott also noted that the Similkameen program was chosen as a reference for success because overwinter acclimation had been successfully implemented there. Truscott said that for comparison to Dryden performance, Similkameen performance would need to be adjusted to account for additional mortalities for dam passage.

Bill Gale said he was concerned that there is no replication possible in the experimental strategy. He said this concern could be eliminated if the experiment was conducted where the 'pond effect' can be controlled. Miller said that if this study produces results with the reuse technology that are consistent with previous results, then the program could be made more efficient.

Keely Murdoch said that she is concerned with the direction the discussion had taken regarding implementation of overwinter acclimation at Dryden. Murdoch said the Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC-HSC) had agreed to overwinter acclimation for Grant PUD production at Dryden, and this has always been the goal for Grant PUD's program. Murdoch indicated that YN may not support future sharing agreements between the PUDs. Miller noted that there is no agreement between Chelan PUD and Grant PUD, presently, to make improvements at Dryden. Further, Murdoch said it is her understanding that the Joint Fisheries Parties (JFP) support construction of a new dedicated surface-water intake at the Dryden facility. The new intake, Murdoch said, will increase flexibility as to how programs are operated, and will provide an alternative to the irrigation canal water source and subsequent fish health issues at Dryden. Murdoch said that she would like to see separate consideration of the benefits of the new intake, and of how the program is operated.

Miller reviewed a document developed by Chelan PUD and distributed by Kristi Geris to the Committees via email on May 16, 2012, which outlined several questions and responses related to Chelan PUD's Dryden Acclimation Facility (Attachment E). After reviewing the document, Miller explained that Chelan PUD needs to fully understand the fish health problem before a new intake is installed.

Mike Tonseth said he understands having a target at Dryden and the need to evaluate how best to achieve that target; however, Tonseth said he also sees the benefit of a dedicated surface-water intake. To be fully dependent on the canal, Tonseth said, risks that the water supply might be unavailable at some time in the future. Miller said Chelan PUD is not backing away from the idea of a new intake, but it will require water quality data to know what the options are. Miller added that if a new intake does not resolve the fish health issue, or is sized to meet a flow rate that precludes necessary future treatment, the program performance will not improve. Tonseth also pointed out the significant difference in water quality between the lower and upper Wenatchee River. Tonseth said the rearing and acclimation experiment element of the conceptual design (Method 4) does not take this into consideration, and he would like to see this issue acknowledged.

Gale said that water chemistry can be evaluated; however, it may not be possible to get reliable information on pathogen concentrations in the water. Tonseth suggested contacting the Freshwater Institute to determine if concentrations of Saprolegnia spores could be measured. Gale suggested that Chelan PUD could use a RFP to determine what type of water quality testing is possible. Mike Schiewe suggested that the signatories could also each reach out within their own organizations for water quality and fish health expertise.

Tonseth asked whether Chelan PUD had decided how to make phosphorus allocations. Miller said that, according to Ecology, there is no transferability. Tonseth pointed out that this will be an issue in trying to achieve the target at Dryden. Miller said that this is one of the reasons water quality and quantity issues need to be determined.

Truscott said that he did not think a new intake at Dryden would affect Total Maximum Daily Load (TMDL). Miller responded that there is an interaction between phosphorus wasteload and flow/discharge (Q), and from a due diligence standpoint, Chelan PUD cannot support installing a new intake without understanding how one parameter will affect the other. Miller said for example, if it turned out that whatever is causing the fish health problems at Dryden required UV treatment, intake size/discharge would need to be reduced (from the current proposal) which would reduce the total daily wasteload allocation. Specifically, the relationship between wasteload allocation and flow is not constant – the daily allocation grams per day decreases as discharge decreases. Miller said that a recirculation system could potentially reduce phosphorus in the effluent and meet the wasteload allocation, at lower discharge levels, but the intake would need to be sized accordingly. Schiewe reminded the Hatchery Committees that the TMDL would not limit production (if it limits it at all) until 2018, and he said that this research strategy would produce data to inform a decision before then.

Murdoch said she would like to see a revision of the study proposal to include more detail on the independent evaluation of a new intake at Dryden. Miller said the current focus of the study design is performance, and to commit to infrastructure at this point would preclude several potential options to achieve the target performance. Murdoch added that she did not approve of a study being drawn out to 2017 in order to use SARs as a performance metric.

Miller agreed to update the Dryden Conceptual Study Approach to incorporate interests concerning the potential installation of a dedicated surface water intake at the Dryden facility. Kristi Geris will distribute the revisions to the Hatchery Committees.

D. Discussion: Spring Chinook Imprinting Study (Joe Miller)

This item was removed from today's agenda.

E. NMFS and USFWS Approval of Tumwater Operations for 2012 (Joe Miller)

Joe Miller introduced the Tumwater Trapping Plan for operations beginning June 1, 2012 (Attachment F). Miller said the plan is the same as last year, and he said that Chelan PUD has asked NMFS and USFWS for approval of the plan. Miller summarized actions included in the plan as described on page 2 (of Attachment F). Mike Tonseth said NMFS had already sent a letter of concurrence, and Steve Lewis joined the meeting by phone for discussion and approval.

Lewis asked Miller about potential effects of the operation on bull trout. Lewis said he had only one editorial comment regarding the underlined language on page 1 of the plan. Lewis said he will provide specific editorial comments to Miller, Mike Tonseth, and Mike Schiewe, and with those edits, Lewis said, USFWS approves the plan. Kristi Geris will distribute the final operation plan to the Hatchery Committees.

IV. Yakama Nation

A. Coho Restoration (Keely Murdoch)

Keely Murdoch said that juvenile coho salmon for the YN Upper Columbia Coho Reintroduction Program are currently being reared at Willard NFH, but this space may be redirected for John Day mitigation in the future. Accordingly, the YN is looking for hatchery space to rear approximately 1.25 million fish (eyed egg to smolt). Murdoch requested information from the PUDs regarding space that might be available at East Bank, Wells, or Methow hatcheries. The Committees had several questions regarding the timeline, the split between Methow- and Wenatchee-released fish, etc., and Murdoch agreed to get answers to these questions to Kristi Geris for distribution to the Hatchery Committees.

V. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees Meetings are on June 20, 2012 (Chelan PUD office), July 18, 2012 (Douglas PUD office), and August 15, 2012 (Chelan PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – Presentation on Adaptive Management and the HCP
Attachment C – Revised Draft SOA Entiat Summer Chinook Broodstock
Attachment D – Dryden Conceptual Study Design
Attachment E – Chelan PUD Dryden Questions
Attachment F – Tumwater Operations Letter

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Joe Miller*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons	Grant PUD
Jayson Wahls	WDFW
Keely Murdoch*	Yakama Nation
Kirk Truscott*	CCT
Bill Gale*	USFWS
Mike Tonseth*	WDFW
Steve Lewis†	WDFW

Notes:

* Denotes Hatchery Committees member or alternate

†Joined by phone for Tumwater Operations discussion

Adaptive Management and the HCP

Gregory Mackey
Douglas PUD

May 17, 2012
HCP Hatchery Committee Meeting

How did the HCP address adaptive management?

HCP

- "…is intended to constitute a comprehensive and long-term adaptive management plan for Plan Species and their habitat as affected by the Project." (Wells HCP, page 1)

HCP Adaptive Management Structure

- Overall Objective: Achieve NNI
  - Combined adult and juvenile survival >= 91%
  - Compensation for Unavoidable Project Mortality
    - 7% Hatchery Programs
    - 2% Tributary Programs

HCP Adaptive Management Structure

- Overall Objective: Achieve NNI
  - Combined adult and juvenile survival >= 91%
  - Compensation for Unavoidable Project Mortality
    - 7% Hatchery Programs
    - 2% Tributary Programs

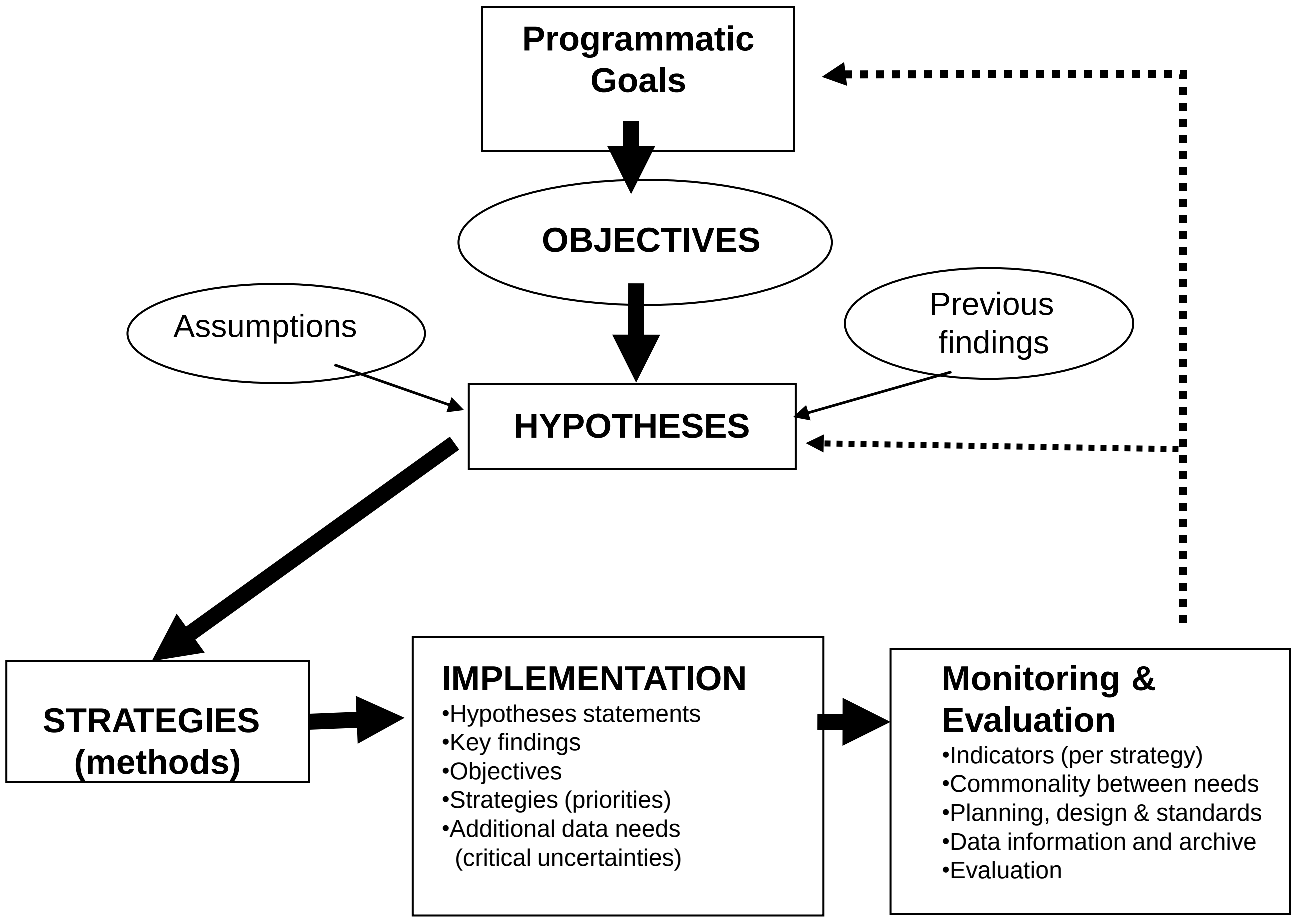
HCP Hatchery Program Objectives

- Overall Objectives: Rebuild natural populations and achieve NNI
  - Contribute to rebuilding and recovery of naturally reproducing populations
  - Maintain genetic diversity
  - Support harvest

Hatchery Program Adaptive Feedback Cycles

- Adjustment of Hatchery Compensation
  - Survival Studies (i.e. adjustment of NNI for project survival)
  - Population Dynamics (i.e. recalculation of NNI)
- Monitoring and Evaluation Program
  - Scheduled updates every 5 years
  - Annual and 5-Year reports (not in HCP)
- Program Modifications as Necessary to Achieve NNI as Determined by the M&E Program
- NMFS under ESA can make changes to the programs
  - Provision for changes that do not effect NNI
  - Provision for changes to do effect NNI
- 10 Year Program Reviews
  - Determine if operating consistent with goals in evaluation plan
  - Adult-to-Smolt survival
  - Smolt-to-Adult survival
  - Hatchery Program Goals and Objectives in Hatchery Plan, Section 10 Permits
  - If Goals and Objectives are not being met, then the Hatchery Committee shall be responsible for establishing alternative plans

M&E Adaptive Management

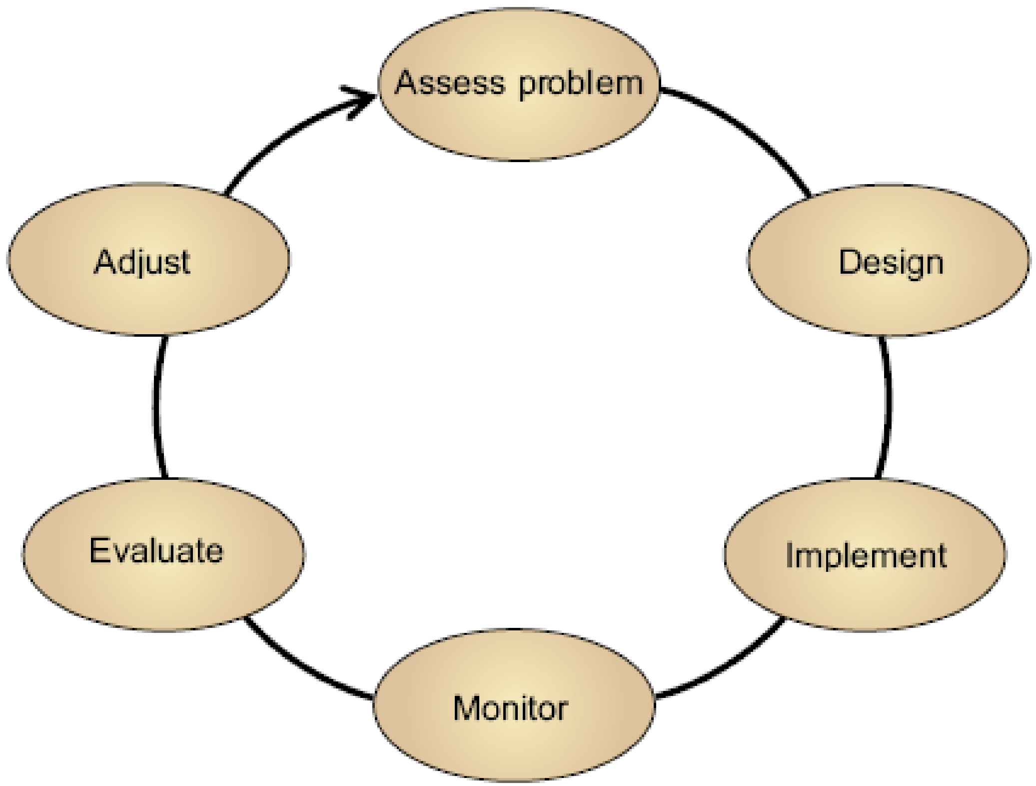


M&E Assessment (Hypotheses)

1. Determine if supplementation has increased naturally spawning and naturally produced adults relative to, and if NRR is similar to non-supplemented population(s)
2. Determine if migration and spawn timing and spatial spawning distribution of hatchery and wild fish are similar.
3. Determine if phenotypes, genetic diversity, population structure, and effective population size have changed in natural spawning populations.
4. Determine if HRR is greater than NRR, and meeting expected HRR.
5. Determine if stray rates are below acceptable levels.
6. Determine if hatchery fish were released at the programmed size and number.
7. Determine if pHOS affects freshwater productivity compared to non-supplemented streams.
8. Determine if harvest opportunities have been provided.

Overview of Adaptive Management

“Adaptive management is not really much more than common sense. But common sense is not always in common use.” (Holling 1978)



Adaptive Management

- Decision process that promotes decision making in the face of uncertainties as outcomes from management actions become better understood.
- Designed to address key uncertainties by iteratively using feedback from the system being managed to reduce those key uncertainties.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Crawford, S., S. Matchett, and K. Reid. 2005. Decision Analysis/Adaptive Management (DAAM) for Great Lakes fisheries: a general review and proposal. Draft discussion paper presented at IAGLR (International Association for Great Lakes Research).

Or…

We can use management structured as an experiment to learn about the system and how to systematically improve management of the system.

Adaptive Management is easy to understand - almost

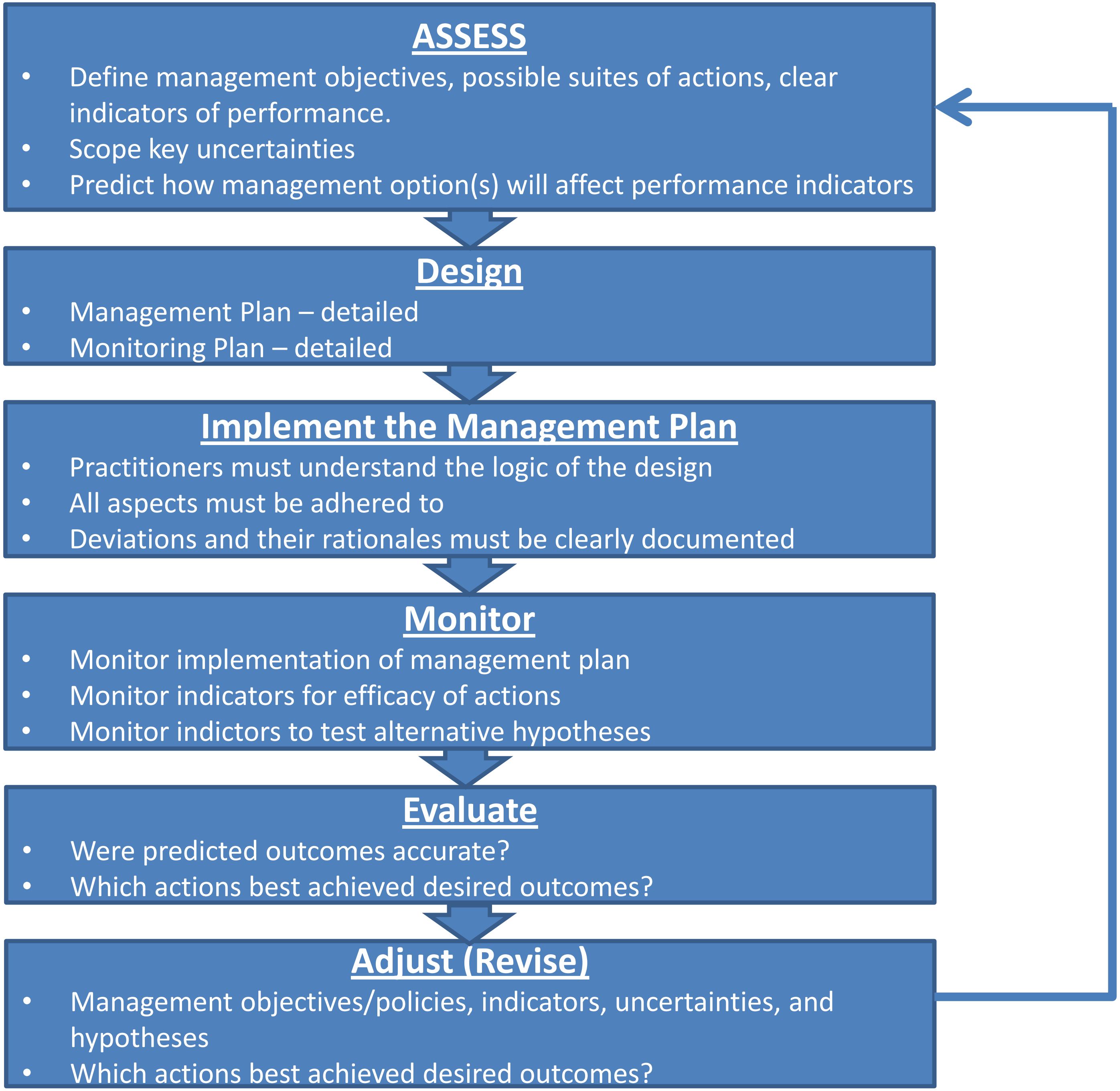
- Adaptive management is not:
  - Trial and error
  - "Flexible" management
  - Consensus from all stakeholders
  - Sophisticated modeling
  - A panacea that can solve all problems

From Crawford et al. 2005.

Walters: Learning by doing

- Integrate existing interdisciplinary experience and scientific information to create dynamic models that make predictions about alternative management actions
  - Clarifies the problem
  - Screens options that are incapable of doing much good
  - Identifies key knowledge gaps

Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology [online]1(2):1. Available from the Internet. URL: http://www.consecol.org/vol1/iss2/art1/


ASSESS
Define management objectives, possible suites of actions, clear indicators of performance.
Scope key uncertainties
Predict how management option(s) will affect performance indicators
Design
Management Plan – detailed
Monitoring Plan – detailed
Implement the Management Plan
Practitioners must understand the logic of the design
All aspects must be adhered to
Deviations and their rationales must be clearly documented
Monitor
Monitor implementation of management plan
Monitor indicators for efficacy of actions
Monitor indictors to test alternative hypotheses
Evaluate
Were predicted outcomes accurate?
Which actions best achieved desired outcomes?
Adjust (Revise)
Management objectives/policies, indicators, uncertainties, and hypotheses
Which actions best achieved desired outcomes?

Decision Analysis

Making hard decisions in the face of uncertainty

Decision Analysis

- Explicitly and quantitatively takes into account key uncertainties as quantitative variables in order to evaluate the effects of various management options.
- Reduces complex problems to more manageable components (can later re-assemble)
- Rank management options
- Determine best management option over a range of hypothesized responses to management actions

State management objectives

Identify management options

Uncertain states of nature: Explicitly state logically possible explanations of cause and effect (hypotheses)

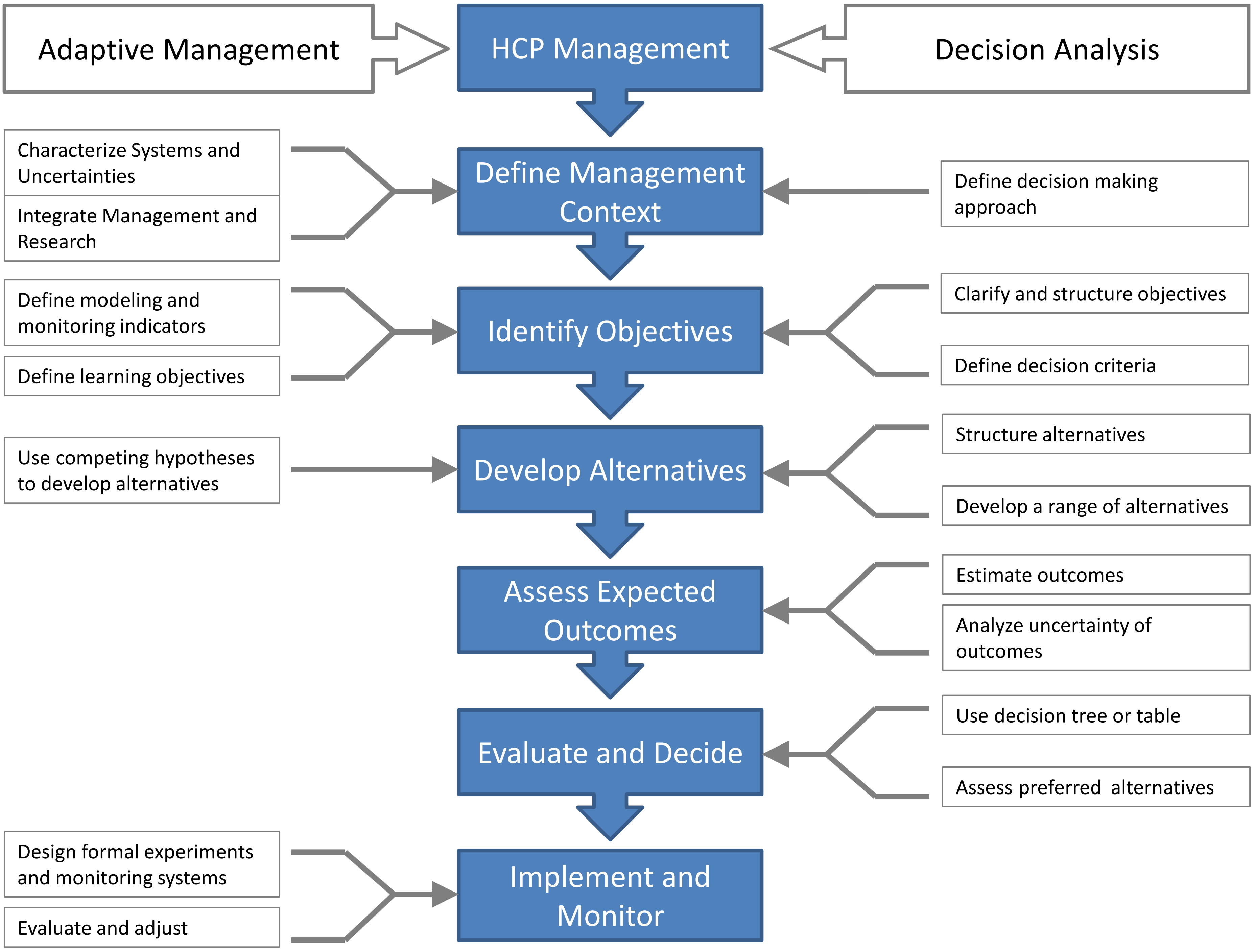
Place probabilities on each hypothesis

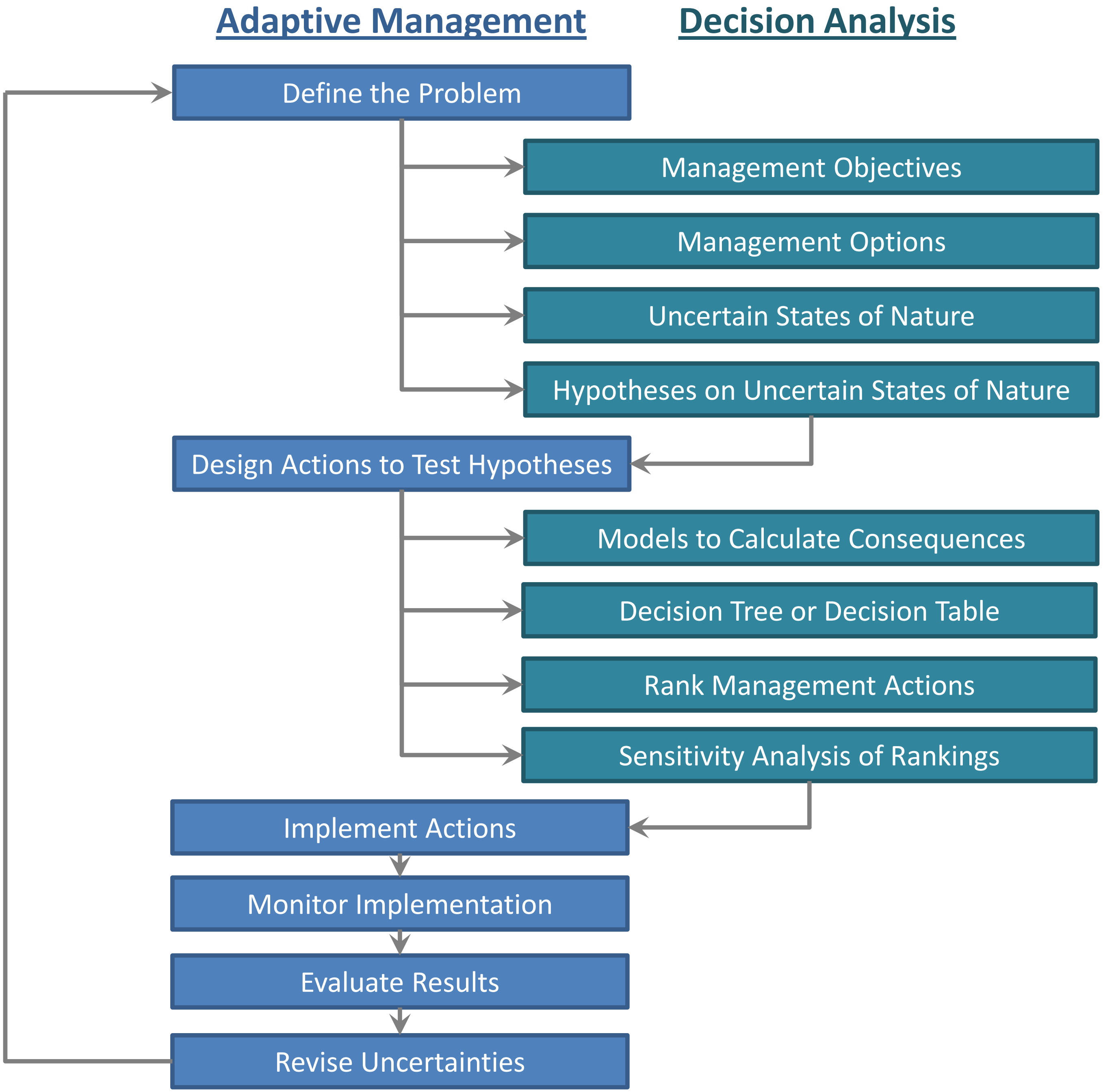
Model outcomes for each management option across possible states of nature

Use decision trees or tables to assess outcomes

Rank management actions (outcome weighted by probability of occurrence)

Sensitivity analysis: Does the rank order of management actions change under different management objectives, hypotheses, or probabilities?


Adaptive Management
HCP Management
Decision Analysis
Characterize Systems and Uncertainties
Integrate Management and Research
Define Management Context
Define decision making approach
Define modeling and monitoring indicators
Define learning objectives
Identify Objectives
Clarify and structure objectives
Define decision criteria
Use competing hypotheses to develop alternatives
Develop Alternatives
Structure alternatives
Develop a range of alternatives
Assess Expected Outcomes
Estimate outcomes
Analyze uncertainty of outcomes
Evaluate and Decide
Use decision tree or table
Assess preferred alternatives
Design formal experiments and monitoring systems
Evaluate and adjust
Implement and Monitor



Adaptive Management
Decision Analysis
Define the Problem
Management Objectives
Management Options
Uncertain States of Nature
Hypotheses on Uncertain States of Nature
Design Actions to Test Hypotheses
Models to Calculate Consequences
Decision Tree or Decision Table
Rank Management Actions
Sensitivity Analysis of Rankings
Implement Actions
Monitor Implementation
Evaluate Results
Revise Uncertainties

Strength and Weaknesses of the HCP Programs

Strength	Weakness
HCP Defines Overarching Goals	Specific goals/objectives are not defined
HCP provides schedule for some adjustment decisions	Specific management actions are not tied to formal adaptive management process or decision analysis
	Management is not set up as an "experiment," greatly limiting assessment of management options
M&E Plan defines hypotheses and analyses	Hypotheses are not tied to management options or decision analysis
	Uncertain states of nature have not been fully scoped and incorporated into management
	Management option outcomes are not predicted
Detailed Monitoring Plan has been developed	Detailed Management Plans not yet developed
Committee of "stakeholders" already in place to make management decisions	Decision Analysis is not used and some aspects of management decisions fall outside the authority of the Committee.

References

- Crawford, S., S. Matchett, and K. Reid. 2005. Decision Analysis/Adaptive Management (DAAM) for Great lakes fisheries: a general review and proposal. Draft discussion paper presented at IAGLR (International Association for Great Lakes Research).

- Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology [online]1(2):1. Available from the Internet. URL: http://www.consecol.org/vol1/iss2/art1/

- Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Wells HCP Hatchery Committee

Statement of Agreement

Collection of Adult Broodstock at Wells Hatchery for Entiat National Fish Hatchery

Approved on XX June 2012

Statement

The Wells HCP Hatchery Committee approves the collection of additional summer Chinook (up to 135 pair) during broodstock collection efforts at the Wells Hatchery volunteer ladder trap for the 2012, 2013, and 2014 brood years. These additional brood will be transferred to the US Fish and Wildlife Service's (USFWS) Entiat NFH to support the Entiat summer Chinook program. Broodstock collection for the Entiat program will take place after Douglas PUD's and Chelan PUD's programs have achieved their broodstock collection goals. Logistical and financial arrangements for these collections will be determined by Douglas County PUD and the USFWS.

Background

The USFWS, in conjunction with other parties (Yakama Nation, the Confederated Tribes of the Colville Reservation NOAA, WDFW, BOR), is implementing a new summer Chinook hatchery production program at Entiat NFH. The long-term goal of this program is to provide fish for tribal, commercial, and sport harvest, and to meet tribal trust responsibilities as mitigation for Grand Coulee Dam. A Hatchery and Genetics Management Plan (HGMP) for this program was submitted to NOAA in July of 2009. This HGMP has also been distributed to all of the relevant co-managers.

The USFWS uses volunteer summer Chinook returns to Wells Hatchery as interim broodstock for the Entiat NFH program, and expects that the Entiat NFH will be self-sufficient starting in 2015 (see Table). Broodstock collection efforts have historically entailed the transfer of eggs in the first year of partial production (BY 2009), and transfer of adults in BYs 2010 and 2011 (and for subsequent years until sufficient numbers of adults return to Entiat NFH). Full production will require the collection of up to 270 hatchery origin summer Chinook adults (enough to provide up to 400K eggs). Funding for this new program is the responsibility of the USFWS and BOR.

Brood Year	Estimated Broodstock Required from Wells Hatchery
2012	270
2013	270
2014	135
2015	0

The above forecasted need for broodstock is based on an assumed SAR of 0.3%. Adults from the Entiat NFH program are expected to begin returning in 2012 but will consist of 2 year old jacks only. As 3 and 4 year old adults return in 2013 and 2014 the need for collection of brood at Wells Hatchery may need to be extended or refined. Any extension of brood collection (past 2014) at Wells Hatchery for the Entiat NFH program would require additional discussion and agreement of the Wells HCP parties.

Broodstock collection for the Entiat program will take place after Douglas PUD's and Chelan PUD's programs have achieved their broodstock collection goals.

Dryden Conceptual Study Approach

Objective

The purpose of this study is to determine the efficacy of program modifications intended to increase SARs at Dryden Acclimation Ponds while keeping stray rates within acceptable limits. SARs greater than or equal to those observed at Similkameen Ponds, adjusted for additional project mortality, would be considered successful. Additional infrastructural improvements would not be required if a suitable method was developed to reach SAR and stray rate objectives. Out-of-basin stray rate targets will remain as specified in the M&E plan (e.g., 5% of the receiving population).

Methods

<u>1) Survey of overwinter acclimation</u>

A review of data and literature on overwinter acclimation of yearling summer Chinook salmon will be conducted to inform discussions.

<u>2) Re-use experiment</u>

Test groups of summer Chinook from Eastbank Hatchery released in 2009, 2010, and 2011 will be evaluated in terms of comparative performance between raceway and re-use reared smolts. Performance will be documented through smolt travel time and survival to McNary Dam, mini-jack rates, adult survival (SARs), and age structure of returning adults. Overall performance will be compared among treatments and to historic and ongoing results from Similkameen.

<u>3) Disease evaluation survey, study, and experiment</u>

Past data on fish health at Dryden will be analyzed to determine the severity of disease and likely causes. Saprolegnia infections will be monitored beginning in 2013, along with occurrences among treatments and rearing densities (the program size will be reduced by 42% beginning with the 2014 releases). Water samples will be collected from the potential intake location on the Wenatchee River and current location on the irrigation canal during current or potential acclimation periods to determine water chemistry and pathogen load (detailed monitoring forthcoming). These tests will continue for three years unless compelling information is obtained at an earlier date. If analyses from water samples suggest that the sources are significantly different, fish health will be tested using a test/control approach.

<u>4) Rearing and Acclimation Experiment</u>

Three PIT-tagged test groups will be evaluated beginning with the 2013 releases: (1) a control group consisting of raceway-rearing at Eastbank and spring acclimation of smolts at Dryden; (2) a test group consisting of re-use rearing at Eastbank and spring acclimation of smolts at Dryden; and (3) a test group consisting of raceway-rearing at Eastbank and winter-acclimation of smolts at Chiwawa with a final spring acclimation at Dryden. The re-use test group will be reared to two different (e.g., 16 fpp and 22 fpp) sizes to determine how size influences the results. These tests will continue for three years unless compelling information is obtained at an earlier date.

Timeline

The survey of overwinter acclimation will begin in 2012 and conclude by 2013. Age ≤ 4 adults from the initial re-use experiment will be available for analysis in 2013. The Dryden water quality and comparative PIT-tagging will begin with the 2013 releases, potentially continuing through 2015 with Age ≤ 4 adult returns continuing through 2017. Decisions could be made in 2013 if re-use and rearing strategies were found to be effective in meeting goals; subsequent decisions on water quality and acclimation strategies could be made as data become available to support decisions. The following table shows a timeline of testing at Dryden.

Table 1. Testing schedule of acclimation strategies at Dryden.

	Year of completion [1]				
Test	2013	2014	2015	2016	2017
1) Survey of overwinter acclimation	X				
2) Re-use experiment	X				
3) Disease evaluation survey, study, and experiment	X	?	?	?	
4) Rearing and Acclimation Experiment	X	X	X	?	?

[1] Potential decision points could occur in 2013 or later depending on availability of compelling information.

For Discussion 5-12-2012
Submitted by Joe Miller, Chelan PUD

Questions Regarding

This document addresses several recurring questions related to Chelan PUD's Dryden Acclimation Facility and potential future modifications.

1. **Do Chelan PUD and Grant PUD have a sharing agreement that precludes options at Dryden or limits consideration of alternative acclimation sites?**
   No

2. **Does the existing contract limit Grant PUD's ability to meet full production using existing capacity at Dryden?**
   No-Grant can produce their full obligation.

3. **Does Chelan PUD have any philosophical problems with overwintering fish?**
   No. However, it is Chelan's understanding that the HC desires the methodology that achieves the highest performance possible.

4. **Why does Chelan PUD have any concerns?…Isn't Grant is paying for everything?**
   The short-term costs may be Grant's responsibility but Chelan will be responsible for the long term performance of the program. More bluntly, if SARs drop we own the consequences and any inefficiency in the commitment of waste load allocation is also borne by Chelan (we have wastewater responsibilities outside of hatcheries). In summary we are financially responsible.

5. **Why is Chelan taking so long?**
   The combined Dryden program was established by the Hatchery Committee in December 2011. We received our phosphorus allocation from Ecology on March 28th, 2012. We are working as fast as possible. Chelan has constructed over $10M worth of upgrades and new facilities to meet HCP requirements in 2011 including capacity for Grant PUD at Eastbank.

6. **Why does Chelan have an issue with Grant immediately building a new intake at Dryden?**

   A new intake may be necessary but it needs to be sized consistent with waste discharge and treatment requirements. An intake would require a discharge commitment that affects our wasteload allocation.

   DOE has provided a discharge allotment of 743 ug/L phosphorus @ Q = 33cfs. The interaction between intake size, phosphorus and Q will have bearing on compliance with the TMDL. It is not possible to build an intake that does not create discharge (i.e., commitment of Q) or a create phosphorus load. We cannot make a short-term commitment (i.e., expedited process without a feasibility assessment) that could jeopardize our long term ability to meet the TMDL requirements. This includes creating a separate, isolated intake/facility within our property boundary.

At present the HC has noted a chronic fish health problem at Dryden and indicated a desire to address the issue. If the problem is endemic to river water in the vicinity of Dryden (i.e., not the existing canal system), then creating a large new intake for single pass water would effectively eliminate treatment options such as UV. At the same time there are no data to indicate that the canal is the source of the fish health problem. Funding and building an intake without attempting to identify the cause of the fish health issue may do nothing to alleviate the problem and create an additional liability.

7. **Why does Chelan insist on considering other options (i.e., different than overwinter).**
   We are held responsible for the performance of the program at Dryden. The PUD has funded extensive monitoring and evaluation programs as well as pilot programs and we suggest that data from this work should be considered prior to modifying the current program. If another method yields higher performance, why wouldn't we advocate for it?

8. **What is Chelan proposing?**
   See Dryden Conceptual Study Approach.

April 25, 2012

Dr. Craig Busack
Salmon Recovery Division
National Marine Fisheries Service
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232

Mr. Steve Lewis
U.S. Fish and Wildlife Service
Central Washington Field Office
215 Melody Lane, suite 119
Wenatchee WA, 98801

Re: Tumwater Trapping Plan for operations beginning June 1, 2012

Dear Dr. Busack and Mr. Lewis:

The Washington Department of Fish and Wildlife (WDFW) and Chelan PUD (District) is proposing continuation of the Tumwater Trapping Plan (Plan) submitted and approved by NMFS and USFWS (Services) in 2011 (initial correspondence dated May 5, 2011). The purpose of this correspondence is to request concurrence from both NMFS and USFWS that (1) the Services support continuation of the Plan during 2012, and (2) the Services are satisfied that the Plan will result in "take" of Endangered Species Act (ESA) –listed salmon, steelhead, and bull trout that is consistent with the manner and extent previously approved by the Services through WDFW's Section 6 cooperative agreement, USFWS's biological opinion on Rocky Reach relicensing, and NMFS's Section 10 permits and associated biological opinions for these activities.

The 2011 spring migration was the first year of implementing modified trapping protocols at Tumwater Dam. PIT tag data indicate that the Plan reduced passage delays. The proportion of fish last detected on the downstream array in the Tumwater fishway was significantly lower for both sockeye ($p < 0.0001$) and Chinook ($p < 0.0001$) compared to previous years. Likewise, the delay of fish in the Tumwater fishway was significantly shorter in duration for both sockeye ($p < 0.0001$) and Chinook ($p < 0.0001$) compared to previous years (Table 1). While environmental conditions and run sizes varied between years, the data suggest that passage under the Plan was improved.

Table 1. Median delays and proportion of adults last detected on the downstream array for previously-tagged sockeye and adult (Age 4+) spring Chinook salmon.

	Median delay		Percent last detected at Weir 15	
	2010	**2011**	**2010**	**2011**
Sockeye	210 hours	6 minutes	38 %	< 1 %
Spring Chinook	190 hours	17 hours	26 %	6 %

For 2012, WDFW and the District are proposing to continue actions identified in the Plan submitted in 2011. Specifically, these actions include (summarized from the initial Plan):

- Real-time monitoring to ensure that median delays are not exceeding 48 hours.
- Relocation of broodstock collection away from the Tumwater trap.
- Improved fish handling efficiency through infrastructure and process improvements;
- Active trapping from June 1 to July 15 to ensure that trapped fish are moved quickly and effectively. The fishway will be opened for volitional passage when staff are not present.
- Limited operations (3 days/week, ≤ 16 hours/day) from July 16 to August 31 to facilitate upstream passage of sockeye.

The WDFW and District recognize the importance of the actions proposed at the Tumwater Trapping Facility and the active support that NMFS and USFWS have provided as both ESA administrators in the Habitat Conservation Plan Hatchery Committees and participants in the proposed trapping activities at Tumwater (i.e., removal of Leavenworth hatchery strays [USFWS]; and co-principal-investigators of the two ongoing relative reproductive success studies [NMFS]). It is our desire to meet the objectives of all parties benefitting from the Tumwater Trapping Facility. However, we are asking for confirmation from NMFS and the USFWS that the operations Plan implemented in 2011 and the proposed continuation of these approaches during the 2012 migration are covered under existing ESA approvals. This letter does not anticipate or request any changes in quantified take levels for any species. Therefore, before allowing trapping to proceed on June 1st pursuant to the Plan, we require written affirmation from both NMFS and USFWS that (1) the Services support continuation of the Plan, and (2) the Services are satisfied that the plan will result in take of ESA-listed salmon, steelhead and bull trout consistent with the manner and extent previously approved by the Services.

Thank you for considering continuation of the Plan. We hope the results from 2011 provide assurance that the Plan is benefiting migratory fishes in the Wenatchee River Basin and should be continued to allow the research and management activities at Tumwater Dam. We also look forward to input from the Services regarding any potential improvements to the plan.

Sincerely,

Josh Murauskas
Senior Fisheries Biologist
Chelan County PUD

Mike Tonseth
UCR Fisheries Biologist
Washington Department of Fish & Wildlife

May 24, 2012

Dr. Craig Busack
Salmon Recovery Division
National Marine Fisheries Service
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232

Mr. Steve Lewis
U.S. Fish and Wildlife Service
Central Washington Field Office
215 Melody Lane, suite 119
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Sincerely,

Josh Murauskas
Senior Fisheries Biologist
Chelan County PUD

Mike Tonseth
UCR Fisheries Biologist
Washington Department of Fish & Wildlife

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	July 18, 2012
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the June 20, 2012, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Chelan PUD Headquarters in Wenatchee, Washington, on Wednesday, June 20, 2012, from 9:30 am to 2:00 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Greg Mackey will provide the final approved Statement of Agreement (SOA) for Collection of Entiat National Fish Hatchery (NFH) Summer Chinook Broodstock at Wells Hatchery to Kristi Geris for distribution to the Hatchery Committees (Item II-A).
- Douglas and Chelan PUDs will coordinate meeting logistics for a Hatchery Monitoring and Evaluation (M&E) Programs Workgroup. This workgroup is open to all Hatchery Committees' members and will review and recommend revisions to the Hatchery M&E Plans (Item III-A).
- Mike Tonseth will provide to the Hatchery Committees an overview of the marking schemes for hatchery programs (Item V-B).
- Chelan and Grant PUDs will develop a detailed timeline, including milestones, for evaluating options to address compliance with the proposed Wenatchee River phosphorus total maximum daily load (TMDL) at the Dryden Rearing Facility (Item VII-A).

STATEMENT OF AGREEMENT DECISION SUMMARY

- The SOA for Collection of Entiat NFH Summer Chinook Broodstock at Wells Hatchery was approved by the Wells Hatchery Committees representatives present.

Kirk Truscott gave his approval by email as distributed to the Hatchery Committees prior to the meeting on June 20, 2012 (Item II-A).

AGREEMENTS

- The Hatchery Committees representatives present agreed to the Request Authorization for Four (4) Additional Hatchery-Origin Wenatchee Spring Chinook for the Continuation of the Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study. Kirk Truscott agreed to the request by email as distributed to the Hatchery Committees prior to the meeting on June 20, 2012 (Item IV-A).
- The Wells HCP Hatchery Committee agreed to release 27 natural-origin Carson lineage adult spring Chinook, collected as broodstock for the Methow Hatchery program, into the Methow River, with the understanding that the broodstock collection target for the Methow Hatchery will likely still be achieved (Item IV-B).

REVIEW ITEMS

- No reports are currently out for review.

FINALIZED REPORTS

- The Douglas PUD Final 5-Year M&E Report was distributed to the Hatchery Committees and was posted and became available for download from the Anchor QEA FTP site on May 21, 2012.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. The following revisions were made to the agenda:

- Mike Tonseth removed Washington Department of Fish and Wildlife's (WDFW's) agenda item IV-B regarding an additional fish request for micro-chemistry evaluation, and added a Methow spring Chinook broodstock collection update.
- Josh Murauskas removed Chelan PUD's agenda item V-B regarding performance of 2012 Passive Integrated Transponder (PIT)-tagged summer Chinook, and added a discussion on marking schemes for hatchery programs.
- Craig Busack added a National Marine Fisheries Service (NMFS) Hatchery Genetic

Management Plan (HGMP) and permitting update.

The revised draft May 17, 2012 meeting minutes were reviewed. Kristi Geris said all comments and revisions received on the draft meeting minutes were incorporated and there are no outstanding items remaining to be discussed. Geris also noted a minor revision received on June 14, 2012, from U.S. Fish and Wildlife Service (USFWS) after the revised May 17, 2012 meeting minutes were distributed on June 12, 2012. Hatchery Committees members present approved the May 17, 2012 meeting minutes, as revised. Kirk Truscott approved the May meeting minutes by email as distributed to the Hatchery Committees prior to the meeting on June 20, 2012

II. Douglas PUD

A. DECISION: Collection of Entiat NFH Summer Chinook Broodstock at Wells Hatchery SOA (Greg Mackey)

Greg Mackey said that Douglas PUD and the USFWS were requesting approval of an SOA for the Collection of Entiat NFH Summer Chinook Broodstock at Wells Hatchery (Attachment B), which was distributed to the Hatchery Committees by Kristi Geris on June 7, 2012. Mackey noted that as requested by the Committees, Bill Gale developed and incorporated additional language to the background section to indicate that the estimated broodstock required in later years may be refined, necessitating an extension of broodstock collection that would require agreement of the Committees. Wells Hatchery Committee representatives present approved the SOA. Kirk Truscott gave his approval by email as distributed to the Hatchery Committees prior to the meeting on June 20, 2012. Mackey agreed to provide a finalized version of the approved SOA to Kristi Geris for distribution to the Hatchery Committees.

III. Douglas PUD and Chelan PUD

A. Discussion: 5-Year Update of the M&E Plan (Greg Mackey & Josh Murauskas)

Josh Murauskas presented Chelan PUD's draft proposal for reviewing and revising the Hatchery M&E goals, objectives, and monitoring activities (Attachment C), which was distributed to the Hatchery Committees by Kristi Geris on June 19, 2012. Murauskas said he divided Chelan PUD's M&E objectives into three categories (see Table 1 of Attachment C): 1) in-hatchery monitoring, which focused on survival in the hatchery; 2) in-river performance;

and 3) long-term monitoring. Each category had an objective and purpose, and proposed action(s) depending on results of the monitoring.

Keely Murdoch questioned whether the categories were different. Murdoch said that Table 1 suggests assessing the outcomes of the categories independently, but Murdoch reminded Murauskas that the M&E Analytical Framework acknowledged that individual objectives would be evaluated in relation to all categories. Murdoch noted that there is a relationship between the productivity indicators and monitoring indicators that was not captured in the handout. Craig Busack added that, conceptually, the first two categories address performance of the hatchery fish, and the third category addresses the effect of the hatchery program on the natural production. Busack suggested framing the categories to reflect that distinction. Todd Pearsons suggested using two categories—an overall hatchery performance category and a natural environment category—and then adding subcategories under those two main categories. Mike Tonseth added that it is important to: 1) make sure the hatchery and natural aspects of monitoring are clearly laid out; 2) review existing objectives and purposes; and 3) determine how many categories are needed to adequately describe the process. Further, Tonseth said, when the current objectives are reviewed, it is important to determine if those objectives are still relevant, or if some of the objectives need to be dropped or revised. Tonseth said it is also important to consider emerging issues such as the effects of residualism, and make sure they are included in the M&E Programs. Murauskas added that there will likely be several changes to the M&E Programs in response to new knowledge, emerging technology, and evolving agency policies.

Greg Mackey presented Douglas PUD's initial approach to reviewing and revising their M&E Program, using a flow chart (Attachment D), which was distributed to the Committees by Geris prior to the meeting this morning on June 20, 2012. Mackey said that each slide of the flow chart relates to an HCP goal, and that the M&E plan was developed to further define objectives within these goals. Mackey mentioned that the 5-year report tends to discuss each objective with equal weight, when in fact some objectives are clearly more important than others, particularly the productivity and monitoring indicators. He said that this presents a challenge in conveying the true hierarchy of objectives.

Mackey identified several areas that Douglas PUD thought needed attention during the review and revision process. Among these areas were the following: 1) genetic monitoring-hypotheses need to be examined for their relationship and applicability to management and the reporting should include a synopsis of findings as they relate to management; 2) patterns of straying (which can fall into multiple categories) and a more precise definition of what constitutes a stray; 3) spatial distribution of spawners and, in particular, a focus on the spatial distribution of natural spawning hatchery and wild fish; 4) the relationship between proportion of hatchery-origin spawners (pHOS) and productivity, and the confounding problem of the correlation of pHOS and spawner abundance; 5) an assessment of whether fish size targets are still valid; and 6) the usefulness of smolt estimates from screw traps versus other PIT-tag-based approaches to estimating juvenile production and survival.

Regarding the question of spatial distribution of spawning, Busack said there are cases of overlap and cases of partial overlap; Busack said his impression of genetic monitoring has been that the goal was to have hatchery-origin fish behave as much as possible like natural-origin fish because such behavior would suggest that there has been minimal genetic impact. Mackey responded that it may be beneficial in some cases for hatchery fish to spawn where natural fish spawn, but it may also be good to leave some areas for wild fish only. Mike Schiewe added that the purpose of a supplementation program is to increase overall production without impacting existing natural production.

Schiewe asked the Hatchery Committees what they would like to see accomplished next as a path forward. Tonseth said the current objectives are responses to questions already asked, and it is important to review the objectives and determine whether these are still the right questions. Tom Kahler suggested determining what the current M&E programs have accomplished that did not result in anything useful, and which efforts have provided the data that we now recognize as essential. Murdoch suggested that a workgroup may be needed to review the objectives. It was agreed that any workgroup should be open to all Hatchery Committees' members, including a Grant PUD representative, and that the workgroup should review and recommend changes to goals and objectives of the Hatchery M&E Plans. Douglas PUD and Chelan PUD will coordinate the meeting logistics for this workgroup.

IV. WDFW

A. Additional Fish Request for Egg-To-Fry Study (Mike Tonseth)

Mike Tonseth reviewed the Request Authorization for Four (4) Additional Hatchery-Origin Wenatchee Spring Chinook for the Continuation of the Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study (Attachment E), and the 2012 Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study Proposal (Attachment F), which were both distributed to the Hatchery Committees by Kristi Geris on June 8, 2012. The Hatchery Committees representatives present agreed to the request, and Kirk Truscott agreed to the request by email as distributed to the Hatchery Committees prior to the meeting on June 20, 2012

B. Methow Broodstock Collection Update (Mike Tonseth)

Mike Tonseth reviewed the status of Methow spring Chinook broodstock collected at Wells Dam. Tonseth said that WDFW is proposing to release a total of 67 fish, of which 21 have been assigned to the Wenatchee/Entiat Basins and will be released below Wells Dam, 27 are natural-origin fish with a high probability of assignment to Winthrop/Carson lineage, 11 are unmarked hatchery fish (as identified by scale pattern analysis) that will be released into the Methow River, and 8 are unassigned wild fish to be released into the Wells pool. Tonseth said all releases are scheduled for Friday, June 23, 2012.

Tonseth said that Methow broodstock collection is on track to meet its target, and WDFW would like Hatchery Committees' guidance on the disposition of the 27 Carson lineage fish. Keely Murdoch asked how long it has been since Carson fish have been released from Winthrop NFH. Tonseth said it was decided in 2006 to eliminate Carson-origin fish in the program. Mackey said that if the 27 fish are kept, there would be 80 broodstock (27 would be Carson lineage fish), but if they are released, that could mean replacing those fish with hatchery-origin Methow Hatchery fish. Therefore, the question before the Committees is if it would be preferable to keep the natural-origin Carson lineage fish in the broodstock, or release them knowing that they may be replaced with hatchery-origin broodstock? The other issue is if releasing the Carson lineage fish will impair the ability of the program to meet the broodstock collection target. The broodstock target should be able to be met, at least with hatchery-origin fish, if the Carson lineage fish are released. Murdoch and Craig

Busack both requested that, in the future, a better understanding of criteria for genetic assignment and a report of methodologies for this analysis be provided. They also requested a post-season report describing this situation and the outcome. Tonseth said the 27 Carson lineage fish can be held a little longer, but he would like to move them as soon as possible to minimize holding. Tonseth indicated that if the 27 fish are of Carson lineage, he would recommend releasing them in the Methow River, where they would still have a chance to contribute to the population, but not perpetuate them in the hatchery program. Of the Hatchery Committees members present, Douglas PUD, WDFW, and USFWS all agreed to the release of the 27 fish, and the Yakama Nation abstained. Tonseth said the fish will be released.

V. Chelan PUD

A. Discussion: Steelhead Residualism and Predation (Josh Murauskas)

Josh Murauskas presented findings on Wenatchee steelhead residuals and predation (Attachment G). Murauskas said the concern was that if steelhead were released late in May or June, then avian predation may increase and affect survival. Avian predation was measured by recovering PIT tags from Island 18, Foundation Island, Badger Island, and Crescent Island. A logistic regression on hatchery releases from April 15 through May 25 showed a significant correlation between later release and a higher likelihood of recovering a PIT tag on one of the islands. Keely Murdoch commented that the correlation does not confirm causation; while an increase in predation may be inferred, this analysis does not conclusively prove it. Mike Tonseth added that there are other variables that could potentially affect interpretation of these data. Tom Kahler also noted that these data could vary from year to year based on, for example, weather, which affects both the migration timing of the fish and the timing of bird reproduction. Fish migrating prior to the hatching of eggs on the bird colonies should be subjected to lower rates of predation by birds. Murauskas acknowledged that his preliminary interpretations were based on correlations, but that these data show that survival and predation are linked, and that hatchery fish are more likely than wild fish to show up on the island; hatchery fish are larger and released later. Mike Schiewe suggested touching base with Dan Roby or Julia Parrish to integrate bird biology into this study. Tonseth said it is important that these types of discussions and analyses are closely tied to monitoring, and they should be incorporated into the revised

M&E Plans. Murauskas said migratory timing is an objective, so there already are direct links. Regarding residualism, Tonseth said that part of the problem is determining what a natural rate of residualism is. Murauskas concluded that these data indicate a significant relationship between date of release of hatchery steelhead and bird predation, with the later May releases suffering greater losses than the early May releases. Murauskas recommended adjusting release strategies to match wild origin run distributions.

B. Marking Schemes for Hatchery programs (Josh Murauskas)

Mike Tonseth suggested moving this agenda item to the July Hatchery Committees meeting. Tonseth agreed to provide an overview of the marking schemes for hatchery programs to distribute to the Hatchery Committees.

VI. NMFS

A. HGMP Update (Craig Busack)

Craig Busack reported that NMFS is currently working on the Snake River fall Chinook and Chiwawa spring Chinook Biological Opinions. He noted that the draft Entiat and Snake River Biological Opinions are currently out for review. In the Methow, he said NMFS is working on fairly radical cutbacks for spring Chinook and steelhead, targeting a pHOS of 25 to 30 percent for spring Chinook and steelhead. NMFS is in discussions with WDFW, Douglas PUD, and the affected tribes regarding the Methow programs. Busack also mentioned that NMFS is taking a second look at the White River Project, and considering alternatives because of local land use permitting issues. Lastly, Busack said it was clear that there are significant differences of opinion regarding the effects of trapping at Tumwater Dam, and that NMFS is planning to further investigate the basis for these differences.

VII. Chelan PUD

A. Presentation: Dryden Phosphorus/TMDL (Sam Dilly)

Josh Murauskas briefly reviewed Chelan PUD's response to a request by the Joint Fisheries Parties (JFP) to clarify their position on the proposed modifications to the Dryden Acclimation Facility (Attachment H). This response was distributed by email to the Hatchery Committees by Kristi Geris on June 15, 2012. Murauskas said the presentation by Sam Dilly should help to further clarify Chelan PUD's concerns about making immediate modifications to the Dryden Facility before the ramifications of the new Wenatchee River phosphorus TMDL were fully understood (Attachment I). Joe Miller introduced Sam Dilly, Chelan PUD engineer, to help describe the situation and clarify some of the engineering concerns.

Dilly's presentation began with a table showing a sliding scale of allowable phosphorus concentrations that decreased with increasing discharge flow. He said Chelan PUD received these proposed discharge limits from the Washington State Department of Ecology (Ecology) earlier this year. Based on preliminary testing, Dilly said that incoming water at Dryden already exceeded the proposed TMDL standard. He said that Chelan PUD had already been discussing the potential for use of low phosphorus feed and automated feeders to minimize the addition of phosphorus to the discharge. Dilly said pilot studies indicate some feeding methods are more efficient and produce better conversion rates. Keely Murdoch asked Todd Pearsons about the results of a low phosphorus feed trial that Grant PUD was conducting, and Pearsons indicated that the results would not be available until later in the year. Pradeep Mugunthan (Anchor QEA) a water quality consultant working with the Yakama Nation, suggested that by the time the TMDL is implemented, the background concentrations of phosphorus in the Wenatchee River would likely be lower than they are now. He thought compliance might be achievable with low-phosphorus feed and automated feeders. Dilly said Chelan PUD was not willing to go forward with a facility plan based on speculated future concentrations unless those future concentrations were agreed to by Ecology. Dilly said that, in fact, Ecology had already told Chelan PUD that the concentration of phosphorus in their water source was Chelan PUD's responsibility to treat. Jim Craig said Ecology often acknowledges that a water source already contains elevated concentrations of a chemical they are regulating, but they still do not allow further exceedences. Dilly suggested that rather than requesting a change in the TMDL and management of phosphorus, the Hatchery Committees should instead work with Ecology to find methods to rear fish and meet phosphorous standards.

Mike Tonseth suggested that the Committees needed to put together contingency plans for continuing to raise the 500,000 summer/fall Chinook being reared at Dryden if the TMDL issue cannot be resolved. Given the technology available, Tonseth said, it seems that a flow of 4 cubic feet per second (cfs) may be the upper limit for a water supply. He questioned whether that would be enough to produce 500,000 smolts. Dilly said that from an engineering feasibility perspective, the Committees might want to start developing design criteria by doing the following: 1) establishing a smolt-to-adult return (SAR)-based goal for the facility; 2) determining how many smolts would need to be produced; 3) identifying the unknown; 4) developing options to meet the criteria; and 5) considering associated risks. Tom Scribner said that additional analyses were needed, and that, collectively, the Committees needed to put together a plan to collect the needed information. Dilly proposed developing an outline of data needs to support developing design criteria; with these data, the Committees could produce three to five alternatives, and pick whichever alternative works best and present it to Ecology. Scribner asked if this was feasible to complete in time to meet the 2018 deadline. Dilly said it was very feasible. Murauskas asked how a reduced size at release target would impact phosphorus. Dilly said it would significantly affect phosphorous because smaller fish size equates to lower phosphorus. Tonseth said that reducing fish size is a possibility; however, WDFW is not ready to take this step yet. Jim Craig said Leavenworth NFH is now looking into water reuse technology to see how well spring Chinook adapt to rearing under this condition. Craig said the U.S. Bureau of Reclamation (the agency that funds Leavenworth NFH) sees the phosphorus TMDL issue as potentially limiting the hatchery's ability to meet its production target. Chelan PUD and Grant PUD agreed to develop a detailed timeline, including milestones, for evaluating options to address compliance with the proposed Wenatchee River phosphorus TMDL at the Dryden Rearing Facility.

VIII. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees Meetings are on July 18, 2012 (Douglas PUD office), August 15, 2012 (Chelan PUD office), and September 19, 2012 (Douglas PUD office).

List of Attachments

Attachment A – List of Attendees

Attachment B – SOA for Collection of Entiat NFH Summer Chinook Broodstock at Wells Hatchery

Attachment C – Chelan PUD 2013 Hatchery M&E Objectives draft document

Attachment D – Douglas PUD M&E Flow Chart

Attachment E – Request Authorization for Four (4) Additional Hatchery-Origin Wenatchee Spring Chinook for the Continuation of the Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study

Attachment F – 2012 Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study Proposal

Attachment G – Wenatchee Steelhead Predation and Residuals Presentation

Attachment H – Response to JFP Memo

Attachment I – Dryden Phosphorus/TMDL Presentation

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Pradeep Mugunthan††	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Joe Miller**	Chelan PUD
Sam Dilly**	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons	Grant PUD
Keely Murdoch*	Yakama Nation
Tom Scribner*††	Yakama Nation
Craig Busack†	NMFS
Jim Craig	USFWS
Mike Tonseth*	WDFW

Notes:

* Denotes Hatchery Committees member or alternate
† Joined by phone
** Joined for Dryden phosphorus/TMDL presentation
†† Joined by phone for Dryden phosphorus/TMDL presentation

Wells HCP Hatchery Committee

Statement of Agreement

Collection of Adult Broodstock at Wells Hatchery for Entiat National Fish Hatchery

Approved on 20 June 2012

Statement

The Wells HCP Hatchery Committee approves the collection of additional summer Chinook (up to 135 pair) during broodstock collection efforts at the Wells Hatchery volunteer ladder trap for the 2012, 2013, and 2014 brood years. These additional brood will be transferred to the US Fish and Wildlife Service's (USFWS) Entiat NFH to support the Entiat summer Chinook program. Broodstock collection for the Entiat program will take place after Douglas PUD's and Chelan PUD's programs have achieved their broodstock collection goals. Logistical and financial arrangements for these collections will be determined by Douglas County PUD and the USFWS.

Background

The USFWS, in conjunction with other parties (Yakama Nation, the Confederated Tribes of the Colville Reservation NOAA, WDFW, BOR), is implementing a new summer Chinook hatchery production program at Entiat NFH. The long-term goal of this program is to provide fish for tribal, commercial, and sport harvest, and to meet tribal trust responsibilities as mitigation for Grand Coulee Dam. A Hatchery and Genetics Management Plan (HGMP) for this program was submitted to NOAA in July of 2009. This HGMP has also been distributed to all of the relevant co-managers.

The USFWS uses volunteer summer Chinook returns to Wells Hatchery as interim broodstock for the Entiat NFH program, and expects that the Entiat NFH will be self-sufficient starting in 2015 (see Table). Broodstock collection efforts have historically entailed the transfer of eggs in the first year of partial production (BY 2009), and transfer of adults in BYs 2010 and 2011 (and for subsequent years until sufficient numbers of adults return to Entiat NFH). Full production will require the collection of up to 270 hatchery origin summer Chinook adults (enough to provide up to 400K eggs). Funding for this new program is the responsibility of the USFWS and BOR.

Brood Year	Estimated Broodstock Required from Wells Hatchery
2012	270
2013	270
2014	135
2015	0

The above forecasted need for broodstock is based on an assumed SAR of 0.3%. Adults from the Entiat NFH program are expected to begin returning in 2012 but will consist of 2 year old jacks only. As 3 and 4 year old adults return in 2013 and 2014 the need for collection of brood at Wells Hatchery may need to be extended or refined. Any extension of brood collection (past 2014) at Wells Hatchery for the Entiat NFH program would require additional discussion and agreement of the Wells HCP parties.

Broodstock collection for the Entiat program will take place after Douglas PUD's and Chelan PUD's programs have achieved their broodstock collection goals.

HATCHERY M&E FIVE-YEAR REVIEW

SUMMARY

Monitoring and evaluation (M&E) of Chelan PUD's hatchery programs is required in the Rock Island and Rocky Reach Anadromous Fish Agreement Habitat and Conservation Plans (HCPs). The M&E strategy as first developed by the Hatchery Committee (HC) will reach the five-year update in 2013 as stipulated in the HCPs. At this time, the HC "shall look back comprehensively at the previous five year plan to help prepare the next five year plan." The review provides the opportunity to incorporate new information and technologies, identify adjustments, and update the M&E program consistent with general objectives for each Plan Species. The HC is responsible for conducting the hatchery program review and developing a summary report. The table is intended to initiate discussion on the overarching goals of the M&E program

TABLE 1. SUMMARY OF HATCHERY MONITORING AND EVALUATION OBJECTIVES, PURPOSE, AND ACTIONS.

Category	Objective	Original objectives	Purpose	Resulting action(s)
In-hatchery monitoring	Are programs releasing target size and number of smolts?	# 1 [a] # 6 [b]	Determine if programs are capable of producing intended number and quality of smolts required by HCP.	No: Utilize data to inform changes that will increase probability of meeting objectives. Maybe: Continue and/or increase monitoring. Yes: Continue and/or decrease monitoring.
In-river performance	What are the migratory timing, distribution, stray rates, and survival of natural- and hatchery-origin fish in supplemented streams?	# 2, 4, 5 [b]	Determine if programs are capable of producing smolts with acceptable post-release performance.	No: Utilize data to inform changes that will increase probability of meeting objectives. Maybe: Continue and/or increase monitoring. Yes: Continue and/or decrease monitoring.
Long-term monitoring	Are programs affecting the abundance, genetic diversity, and population structure of natural-origin spawners, productivity, incidence of disease, and non-target taxa?	# 1, 2 [a] #1, 3, 7, 9, 10 [b]	Determine if programs conserve the long-term fitness of natural populations.	No: Utilize data to inform changes that will increase probability of meeting objectives. Maybe: Continue and/or increase monitoring. Yes: Continue and/or decrease monitoring.

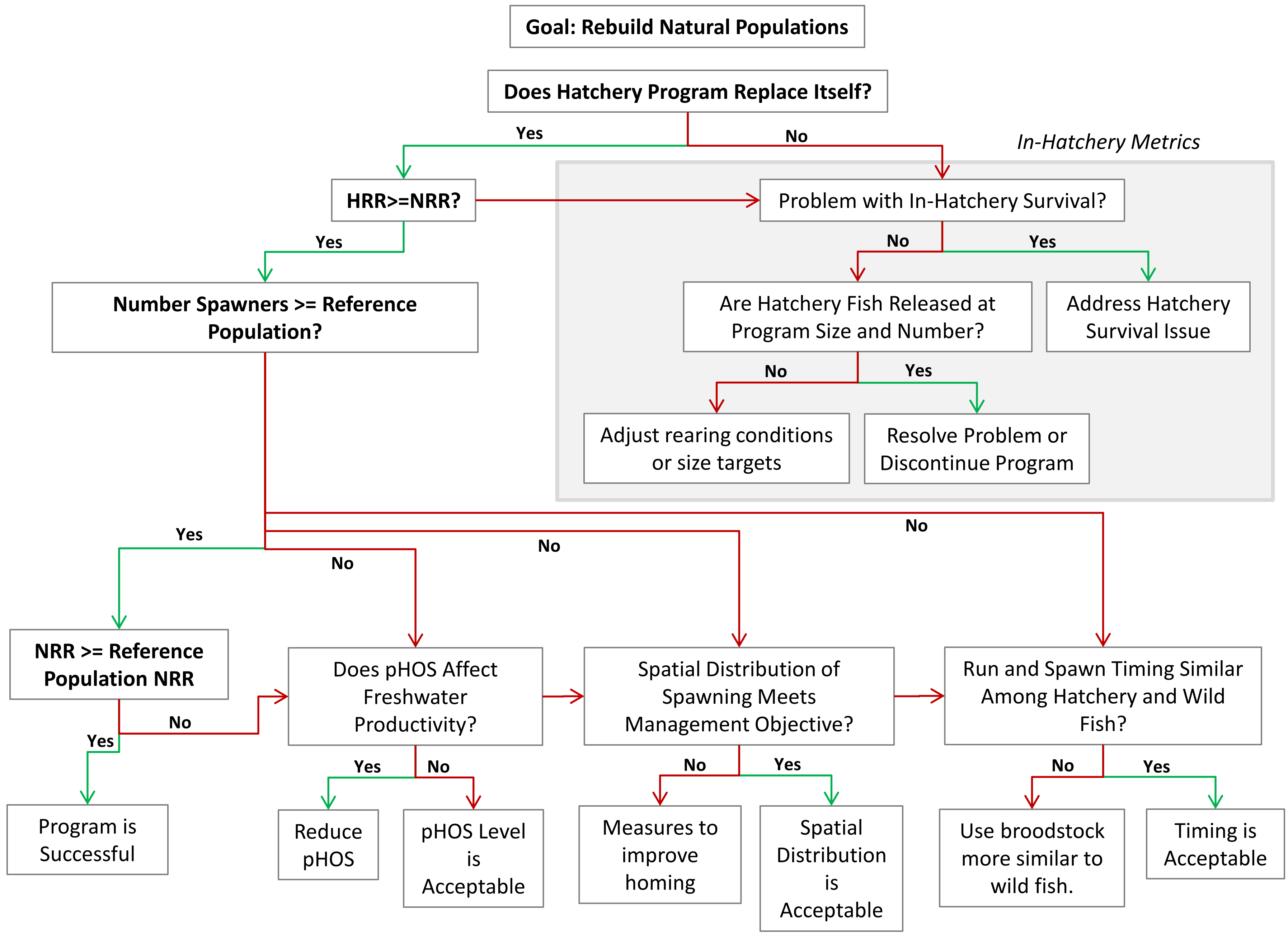
[a] Biological Assessment and Management Plan. Mid Columbia River Program. April, 1998.
[b] Conceptual approach to monitoring and evaluating the Chelan County Public Utility District Hatchery programs. July, 2005.

5-Year M&E Update: Draft Hierarchical Flow of Goals, Objectives and Assessments

Douglas PUD

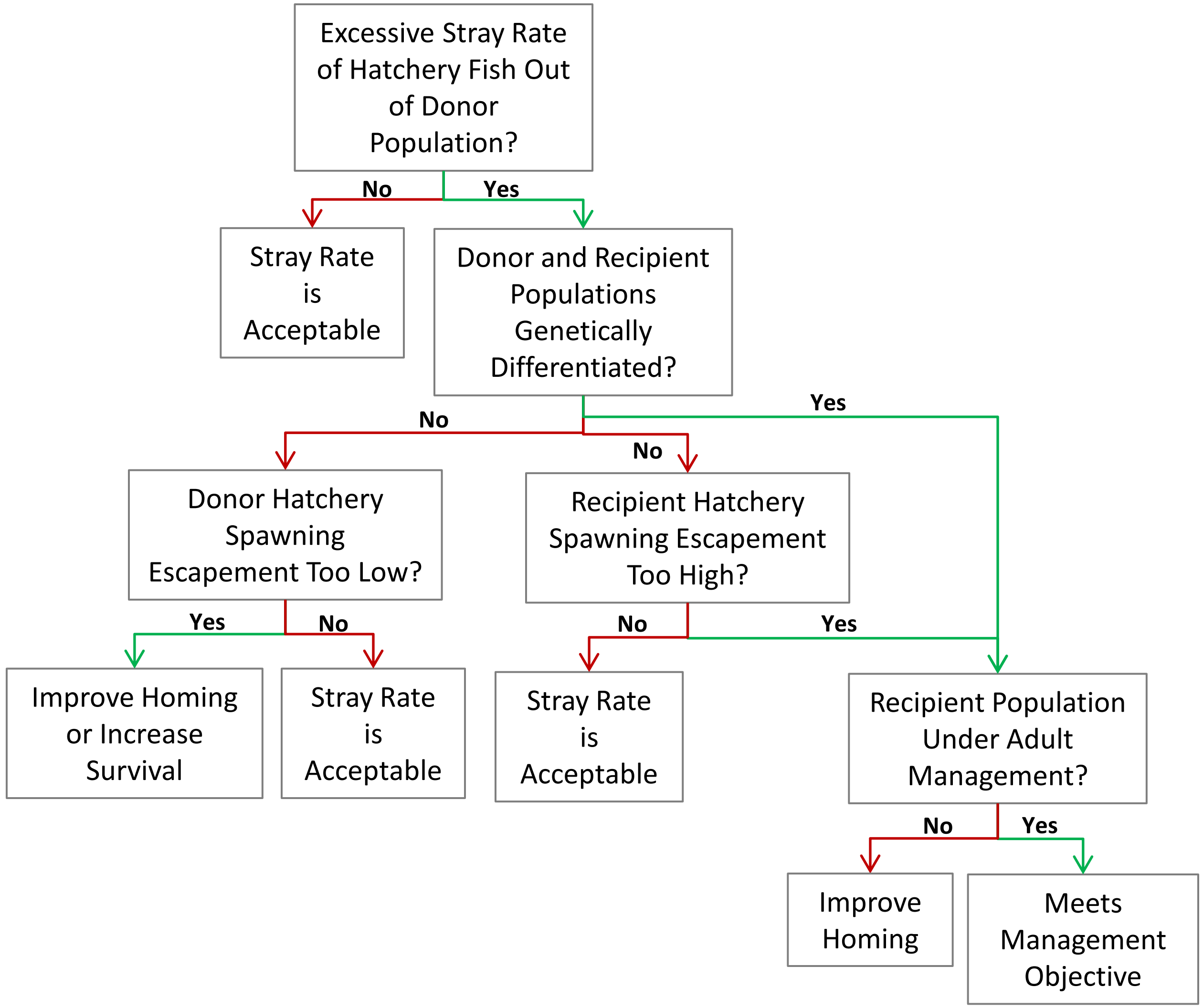
June 20, 2012

HCP Hatchery Committee Meeting



Goal: Rebuild Natural Populations
Does Hatchery Program Replace Itself?
Yes
No
In-Hatchery Metrics
HRR>=NRR?
Problem with In-Hatchery Survival?
Yes
No
Yes
Number Spawners >= Reference Population?
Are Hatchery Fish Released at Program Size and Number?
Address Hatchery Survival Issue
No
Yes
Adjust rearing conditions or size targets
Resolve Problem or Discontinue Program
No
Yes
No
No
NRR >= Reference Population NRR
Does pHOS Affect Freshwater Productivity?
Spatial Distribution of Spawning Meets Management Objective?
Run and Spawn Timing Similar Among Hatchery and Wild Fish?
No
Yes
Yes
No
No
Yes
No
Yes
Program is Successful
Reduce pHOS
pHOS Level is Acceptable
Measures to improve homing
Spatial Distribution is Acceptable
Use broodstock more similar to wild fish.
Timing is Acceptable

Goal: Maintain Genetic Diversity - Straying



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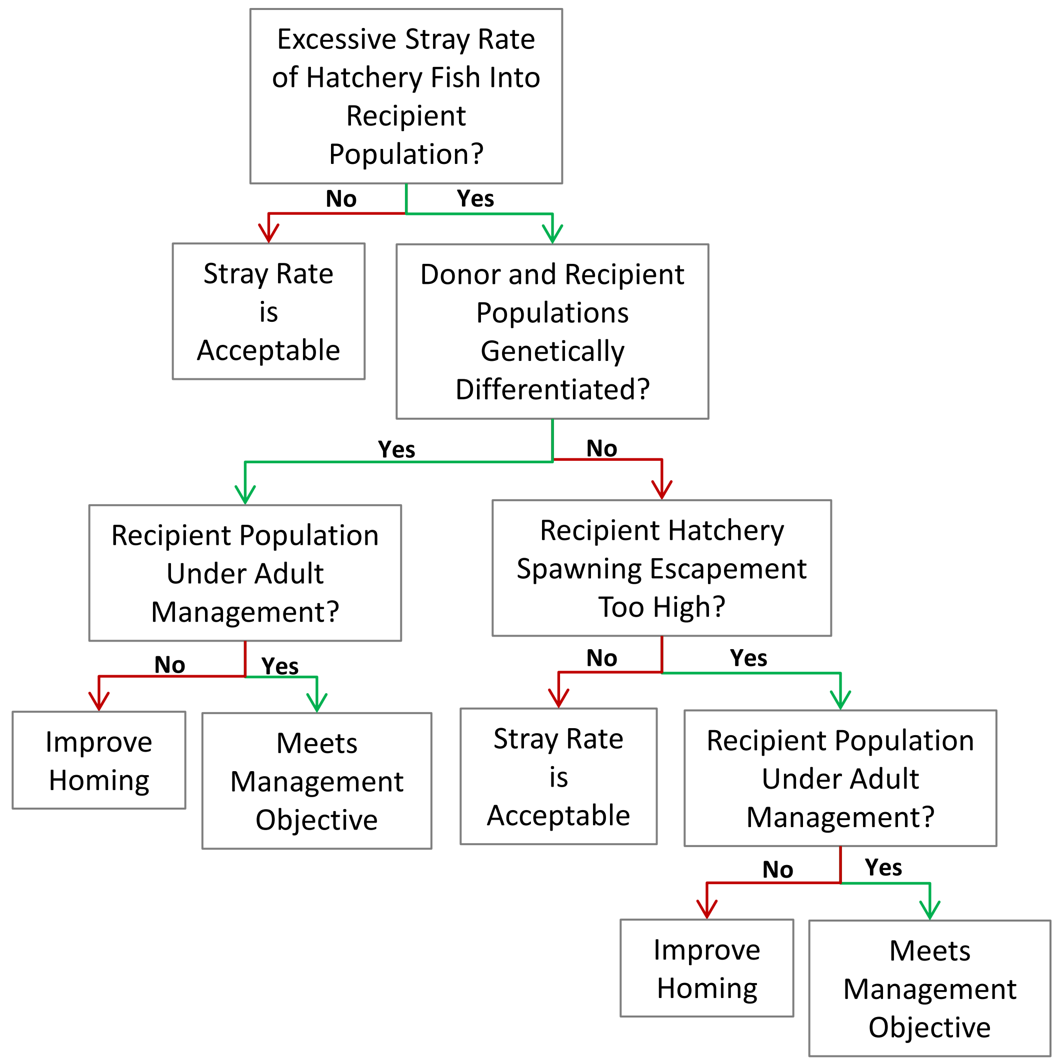
Goal: Maintain Genetic Diversity - Straying



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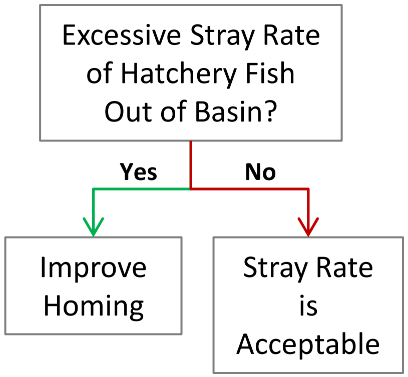
Goal: Maintain Genetic Diversity - Straying



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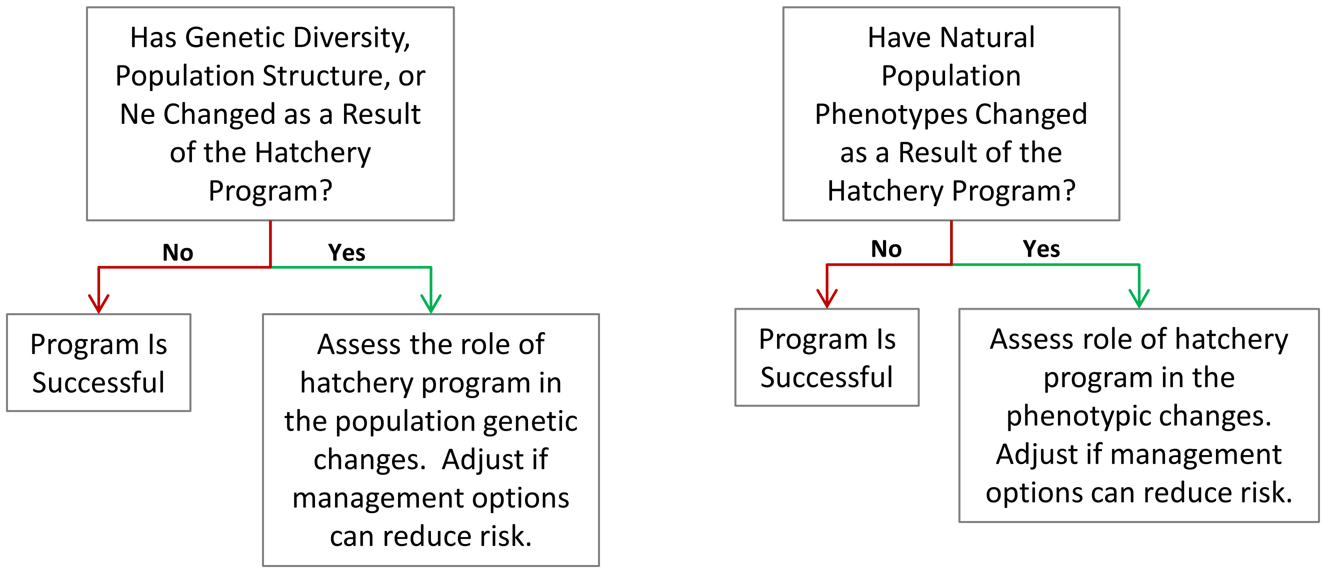
Goal: Maintain Genetic Diversity – Neutral and Selective Traits



State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Wenatchee Field Office

Mailing Address: 3515 State Hwy 97A · Wenatchee, WA 98801 · (509) 664-3148, TTY (800) 833-6388
Main Office Location: Natural Resources Building · 1111 Washington Street SE · Olympia, WA

June 6, 2012

To: Rock Island Habitat Conservation Plan Hatchery Committee

From: Chris Moran, Washington Department of Fish and Wildlife

Re: Request authorization for four (4) additional hatchery-origin Wenatchee Spring Chinook for the continuation of the *Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study*.

The Washington Department of Fish and Wildlife requests authorization to collect two additional adult female, and two additional adult male, hatchery-origin Wenatchee Spring Chinook during 2012 broodstock collection activities. This request is to facilitate the continuation of the *Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study*. To meet the needs of our study design, a total of 5,400 eggs will be collected over three week period during spawning activities (1,800 eggs per week). The collection of four additional adult Chinook are needed in order to supplement agreed to egg take targets for hatchery spawning activities. Please see the attached report to view a detailed description of the study and preliminary results to date.

Your consideration is appreciated.

Sincerely,

Chris Moran
WDFW

Wenatchee Spring Chinook Salmon Egg-To-Fry Survival Study Proposal

Submitted to

Rock Island Habitat Conservation Plan
Hatchery Committee

by

Andrew Murdoch
Chris Johnson
Anthony Fritts
Travis Maitland
Michael Hughes

Washington Department of Fish and Wildlife
Hatchery-Wild Interaction Unit
Science Division, Fish Program
Wenatchee, WA

Short Description of Proposal: Rigorous estimates of egg-to-fry survival across a range of habitat conditions are needed to populate life cycle models to predict the effects of improvements in freshwater habitat on salmon productivity and recovery. In the fourth year of the study WDFW and NOAA seek to obtain gametes from returning hatchery spring Chinook adults at Eastbank FH to place in egg boxes in three reaches in the Chiwawa River during the fall of 2012. It is intended that this study could be expanded to include additional reaches within those two tributaries or other tributaries in the Wenatchee River Basin or upper Columbia Basin (e.g., Methow spring Chinook, Wenatchee summer Chinook). The fourth year of a similar study is ongoing in the Yakima River.

Additional Detail: Funding is available through NOAA and the FCRPS BiOp to generate estimates of egg-to-fry survival, one of the major factors thought to limit freshwater production and recovery of spring Chinook salmon populations, across a range of habitat conditions. Other work on egg to fry survival has generally been focused on a low number of redds, only one or two areas/habitat types within a watershed, and/or used other methods such as egg plates which are known to maximize survival to hatching. The Whitlock-Vibert boxes that we propose to use allow movement of sediment into and out of the box and have been used in sedimentation studies. They have been shown to be a fair representation of the conditions in the redd so we believe that any habitat differences such as sedimentation and intra-gravel flow will result in an observable difference in survival that can be related to habitat.

The eggs we propose to use are from returning marked hatchery origin adults that are taken back to Eastbank Fish Hatchery as part of the Chelan County PUD spring Chinook mitigation in the Chiwawa River basin. Single matings (one female and one male) are fertilized and incubated in individual Heath incubation trays through hatching. This will provide an opportunity for controls and to monitor for variation in fertility of individual fish, as the same parental crosses will be utilized in the artificial redds. In addition, because gametes to be placed in the river sites are held for 24 hrs (due to logistics of collecting gametes and getting them placed in the artificial redds within daylight hours), we propose evaluating potential differences in fertilization rates for day of spawn and the 24 hr hold groups.

Just as the case was in 2010 and 2011, three reaches are proposed in the Chiwawa River (within areas of known spawning). These reaches were chosen because the spring Chinook reproductive success study has determined that spawning success in upper and lower reaches of these rivers is different. This study may provide insight as to the cause of those differences, if the differences are habitat related. Three sites in each reach will be selected that are known spawning areas. Six artificial redds will be constructed in each site, each containing one egg pocket with 100 fertilized eggs, for a total of 5,400 eggs. Additional redds to check development rate may be constructed if time allows. Therefore, we request up to 6,500 hatchery origin eggs if available. Consultation with others such as the redd survey crew must be made to ensure this work does not affect other ongoing projects. See attached draft of the proposed methods for more details regarding the experimental design.

Proposed Action: Use up to 6,500 hatchery origin eggs from 2012 Chiwawa spring Chinook broodstock to perform egg-to-fry survival study.

Long-term Study Objectives:

1) Measure egg to fry (hatch) survival under a range of habitat conditions.
2) Compare egg to fry survival of hatchery and wild fish.
3) Develop efficient techniques for measuring egg to fry survival.
4) Understand mechanisms at site/redd that are influencing differences in survival among redds, sites, and reaches.

2012 Objectives

1) Continue the development of a sampling scheme for measuring egg to fry survival.
2) Measure egg to fry survival at a subset of habitat conditions.
3) Incorporate temperature probes at each redd.
4) Compare sediment intrusion between redd locations.

Field Methods

Study reaches and sites

Study reaches were likely too large and contained too few egg boxes in 2009 to detect differences between reaches. We propose replicating methods used in 2010 and 2011 by using the same three study-reaches in the Chiwawa River for 2012. These reaches represent the upper and lower spring Chinook spawning areas in Chiwawa River. Two reaches are proposed in the lower Chiwawa River because two different channel types are utilized by spring Chinook (pool-riffle and plane-bed). Three sites for egg box placement will be selected within each of the three reaches. These sites will be selected based on both the proximity of spawning females at the time of egg box placement, and historical spawning densities. Six Whitlock-Vibert egg boxes, retrofitted with finer mesh to prevent fry from escaping, each containing 100 bank-fertilized eggs, will be placed in artificial redds at each site. The total number of egg boxes for the study proposed is 54 (3 reaches x 3 sites x 6 egg boxes) and the total number of eggs 5,400 (900 per female, 6 females, two spawning pairs from each of three weekly spawning events; Appendix A). In each of the three reaches there will be two additional egg boxes placed in the lowest site (one on week one and one on week three) as test redds to determine development at the specified pull date (based upon temperature units). In addition, to test for differences in fertilization rates between gametes spawned the day of and those held for 24 hrs, an additional 100 eggs from each cross will be held 24 hrs prior to being fertilized and incubated at Eastbank FH.

Fish collection

Adults will be collected at Tumwater Dam or Chiwawa Weir and transported to the Eastbank Fish Hatchery where eggs will be collected from hatchery origin adults. These collections will correspond with yearly brood stock collection. Eastbank FH staff spawns a proportion of the collected brood once a week over the duration of the spawning period. Because eggs will only be available one day a week and because it is unlikely that we could place all of the egg boxes in one day, box placement will occur at weekly intervals. Timing of the placement of the boxes will be consistent with the peak spawn timing in each of the two tributaries. This will likely require that egg boxes be pulled throughout the late winter and early spring of 2013. One crew will be utilized on each of the three spawning dates, each composed of three to four individuals, in order to maximize consistency in the fertilization of eggs and their placement in each site. One hundred eggs from two adult crosses (900 eggs per cross) will be stocked weekly within each site, one at each of three sites (18 egg boxes per week). Using these methods, all eggs will be placed in three spawning days (i.e., three weeks).

Gamete collection/fertilization:

After spawning at the hatchery, eggs from each hatchery females will be counted into six freezer bags and milt from each hatchery males will also be stored in six freezer bags. Gametes will be stored in freezer bags filled with tanked oxygen overnight and while being transported to the study reaches. During transportation, gametes will be kept cool by transporting on layers of burlap placed over ice in a cooler. Bags will be labeled by desired cross, and numbered for placement sequence in order to avoid confusion when placing eggs in the artificial redds. Eggs will be fertilized on the bank directly prior to their placement within the WV boxes. A bucket filled with fresh river water will hold a submerged egg box, containing substrate collected during construction of the artificial redd. A freezer bag containing one hundred eggs from the appropriate female will then be fertilized with at least two or three drops of milt from the appropriate male in an area shaded from direct sunlight. River water will then be added and the contents gentry swirled to mix the milt throughout, thus activating the eggs. The contents of each will then be placed directly into the prepared Whitlock-Vibert box. The time of gamete collection, time of spawning, water temperature at spawning, and depth of box in relation to surrounding substrate will be recorded at this time. The boxes will then be gently transferred to a pre-constructed artificial redd and carefully backfilled. The time separating gamete collection and egg placement will be as short as possible, and every effort will be made to ensure that gametes are handled in a consistent manner.

Egg box construction and substrate

All egg boxes will be mesh-lined to prevent escapement of fry. Whitlock-Vibert egg boxes will be modified by placing 1/8” mesh across those areas of the box from which fry could escape (middle and top slots). This modification was successful in preventing the escapement of fry under experimental conditions in CESRF spawning channel (WDFW, unpublished data) and showed no increase in accumulated sediment when compared to unscreened boxes. Gravel for use within each egg box will be collected at the time of redd construction and will be consistent with surrounding substrate. Fine sediments will be excluded as these are normally carried away by the current during redd construction. The top trays of the WV boxes will be removed to provide additional room for gravel.

Redd/egg pocket construction

Artificial redds will be created prior to the time of spawning so that all eggs can be deposited as soon as possible after collection. Redds will be constructed using bottomless buckets that will be placed at each redd location and substrate will be removed by shovel or hand and placed into another labeled bucket. As substrate is removed, the bottomless bucket will be pushed into the substrate until the desired depth of 30 cm is reached. Substrate removed from each redd location will be placed into a perforated labeled bucket so the substrate can be placed back into the original redd. The perforated bucket will also facilitate the "washing" of the substrate to remove fine sediment that would have been removed through the natural redd construction process. Egg boxes will be carefully placed in the substrate by hand and substrate carefully placed back in the bottomless bucket, which will then be removed. Additional substrate will be collected by raking substrate particles directly upstream of the redd. Each box will be buried 30cm deep (see DeVries 1997). Each artificial redd will be flagged, and its exact position triangulated using two reference points along the bank. Rebar markers will be used if sufficient natural markers are not present. Point locations, if not rebar, will be marked with green paint. Redd locations will also be recorded using GPS and reference photos. A PIT tag will be affixed to the inside of each WV box to assist in determining the exact location of the egg boxes. The PIT tag will also be used to track data for each respective artificial redd. Lastly, color coded strings will be affixed to each upper corner of the egg boxes so that their location and orientation can be found without disturbing the box itself during excavation.

Habitat and Substrate

Reach scale
Reach morphology and characteristics such as gradient, confinement, and channel type will be obtained from currently existing sources (e.g. GIS, mapping software, Cram et al.).

Site scale
If logistically possible, existing substrate conditions will be categorized by Wolman pebble counts (Wolman 1954) and volumetric substrate samples, using standard methodology, prior to the construction of artificial redds at each site.

Redd scale
Percent of fines will be evaluated by measuring the amount of fines that has accumulated in the WV boxes between placement and removal. Whitlock-Vibert boxes (both standard and modified with additional screening) have been shown to provide conditions of sediment accumulation similar to that of surrounding spawning gravels, and can therefore be used to provide representative results in incubation studies (Garrett and Bennett 1996). Boxes will be carefully extracted by excavating around the box and then carefully placing it into a separate plastic Ziploc bag. This will minimize the loss of fine sediments (Riser, D. Sear, and P. Roni, personal communication). Gravel and fines will then be sifted for a volumetric measure of fine sediment. Scour chains will be placed at each redd site to monitor bed load movements.

Egg to fry survival

Temperature data loggers placed within each reach will be used to measure basin temperatures. Thermal units from those data or other sources will be used to predict the approximate date egg boxes should be removed from the gravel (i.e., calculated fifty percent emergence). To aid in determining the most appropriate date, a small number of additional WV boxes may be placed within the study area and retrieved periodically as the expected target emergence date approaches.

On the determined removal date, boxes will be located via their GPS location, presence of flagging, and their triangulated position relative to bank points and/or PIT tags. A bottomless barrel will be placed over the egg pocket to protect the area from flow while the box is excavated. The gravel and other material will be carefully removed around the box, and the box then placed in a plastic bag while still submerged. The WV boxes will then be opened on site, the contents placed in a fine mesh sieve and the number of dead eggs, live eggs, and live and dead fry counted. All fine sediment accumulated within the box will be saved for subsequent classification.

2009 Results

Two tributaries of the Wenatchee River were selected for the study pilot, Nason Creek, and the Chiwawa River. Two reaches were selected in each tributary, and three study sites within each reach. At each site, hatchery origin spring Chinook eggs were bank fertilized and placed in three artificially constructed redds within modified Whitlock-Vibert egg boxes, using methods defined in Johnson et al. (2009). Egg boxes were removed shortly after reaching a target of 900 accumulated thermal units (degrees C). Pull dates ranged between February 11th and March 30th 2010 in Nason Creek sites and between March 16th and April 12th 2010 in the Chiwawa River.

Survival was similar between reaches, but variable between sites: Nason Creek lower reach: (mean, 57.0; SD, 33.8), Nason Creek upper (mean, 66.6; SD, 30.8), Chiwawa lower (mean, 71.1; SD, 11.5), and Chiwawa upper (mean, 74.7; SD, 11.7). No detectable difference in survival was found between reaches (ANOVA: $F_{2,31} = 0.45$, $P = 0.64$), or between the adult crosses used in the study (ANOVA: $F_{4,31} = 1.2$, $P = 0.34$).

Minimum detectable difference was calculated using the following formula presented by Zar (1999. p.195 eq. 10.36):

$$\delta = \sqrt{\frac{2ks^2\phi^2}{n}}$$

where:
n = group sample size
δ = minimum detectable difference
k = number of groups
s^2 = sample variance
ϕ = among groups variance

Estimated minimum detectable difference in percent survival between reaches in the pilot study was approximately 20.7; or 30.7 percent of the overall mean (67.6 percent).

No difference in the percentage of fine sediment accumulated in the boxes was detected between sites (ANOVA: $F_{3,29} = 1.8$, $P = 0.17$). However, the overall percentage of fines was quite high (mean, 17.7; SD, 9.0). There was no significant correlation between the percentage of fines upon recovery and survival ($R^2 = 0.05$, $P = 0.23$, Figure 1.), although the negative trend was similar to a small but significant trend detected in the Yakima River Basin (Figure 2).

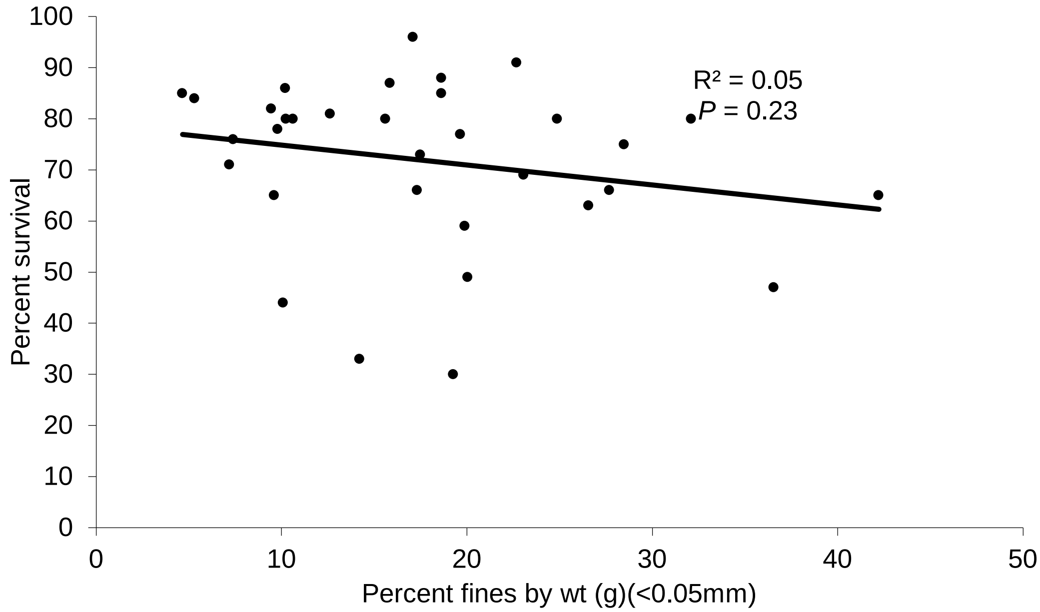


Figure 1. Negative trend in survival with increasing percentage of fine sediment in egg boxes recovered from the Wenatchee River Basin.

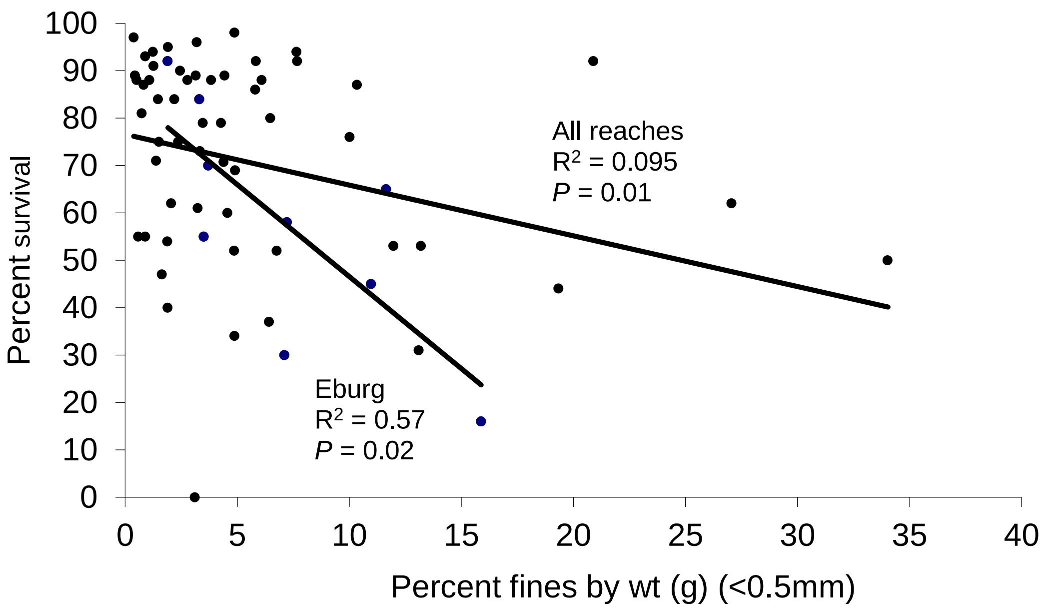


Figure 2 .Significant negative trends in survival with increasing percentage of fine sediment in egg boxes recovered from the Yakima River Basin.

In contrast to findings in the Wenatchee Basin pilot, significant differences in survival were detected in the Yakima River Basin between both reaches and adult cross. Likewise, although there was no detectable decrease in survival with increasing levels of fines in Nason Creek or the Chiwawa River, the trend is similar to that observed in the Yakima Basin where a small but significant relationship between survival and percent fines was detected with a larger sample size

We expect that by decreasing the within-reach variance may allow a more successful analysis of differential egg to fry survival and factors affecting survival in the Wenatchee River Basin. An increase of sample size within each reach, and a decrease in reach length should decrease the level of uncertainty around estimates of survival.

2010 Results

Because 2009 study reaches were likely too large and there were too few egg boxes to detect differences between reaches, we selected three reaches in the Chiwawa River in 2010 and increased the number of egg boxes per site. At each site, hatchery origin spring Chinook eggs were bank fertilized and placed in six artificially constructed redds within modified Whitlock-Vibert egg boxes, using methods defined in Johnson et al. (2009). Egg boxes were removed shortly after reaching a target of 900 accumulated thermal units (degrees C). Removal dates ranged between March 18th and April 18th 2011.

Mean survival was greatest in the upper Pool-Riffle study reach (mean, 60.9; SD, 27.5) and lowest in the Plane-Bed reach (mean, 44.1; SD, 26.7). Survival by adult cross ranged between 69.7 (SD, 11.5), and 33.5 percent (SD, 29.9). Although a positive trend in survival was observed from lower to upper reaches, we found no detectable difference in survival among the three Chiwawa River study reaches (ANOVA: $F_{2, 39} = 2.3$, $P = 0.11$; Figure 3) or among the adult crosses used in the study (ANOVA: $F_{5, 39} = 2.0$, $P = 0.10$; Figure 4).

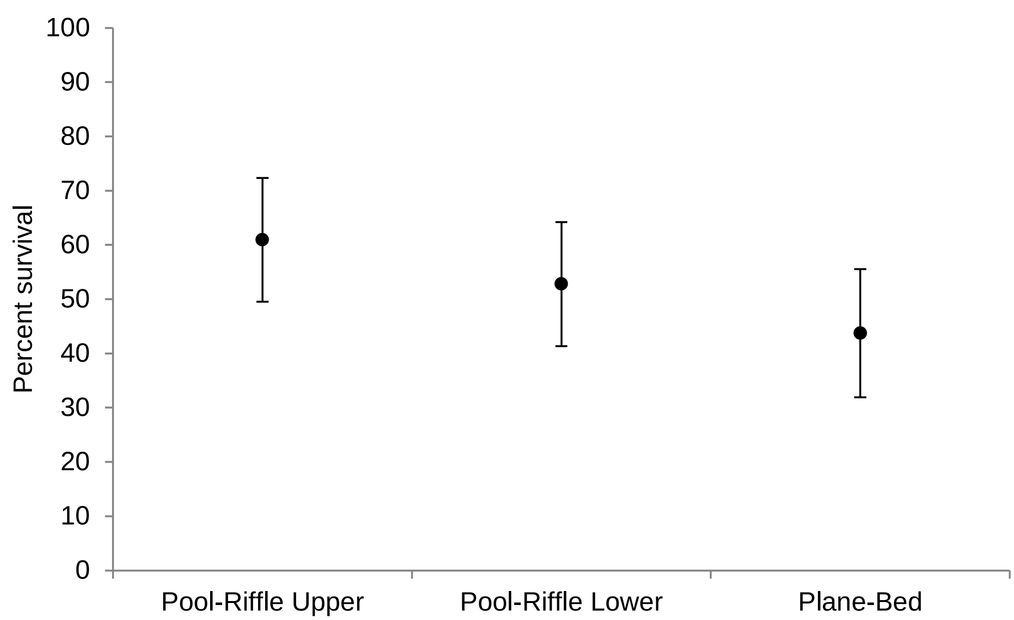


Figure 3. Estimated spring Chinook survival by study reach in the Chiwawa River 2010 (2011 emergent fry). Error bars represent ninety-five percent confidence intervals.

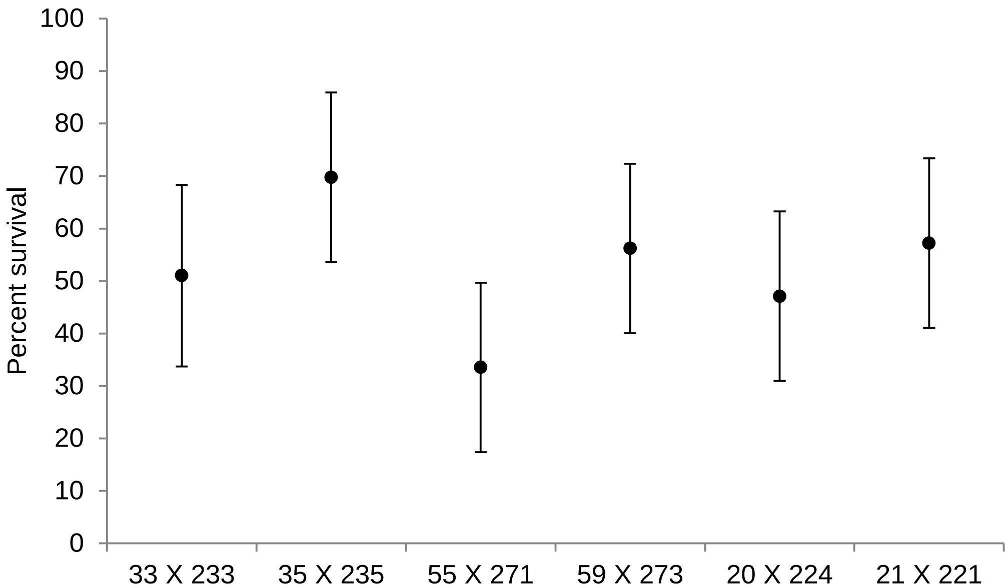


Figure 4. Estimated spring Chinook survival by adult cross in the Chiwawa River 2010 (2011 emergent fry). Error bars represent ninety-five percent confidence intervals.
No difference in the percentage of fine sediment accumulated in the boxes was detected between reaches (ANOVA: $F_{2,48} = 2.2$, $P = 0.12$).

Percent fines in recovered egg boxes averaged 12.9 percent (SD, 8.4). No significant correlation between the percentage of fines upon recovery and survival was detected ($R^2 = 0.02$, $P = 0.13$, Figure 3.), although the negative trend was similar to a small but significant trend detected in the Yakima River Basin (Figure 5).

Although our preliminary results have shown no detectable differences among reaches, we did observe a positive trend in survival from low to high on a reach scale. These observations are consistent with what has been found relative to differences in reproductive success. For this reason, we would like to replicate field methods carried out in 2010.

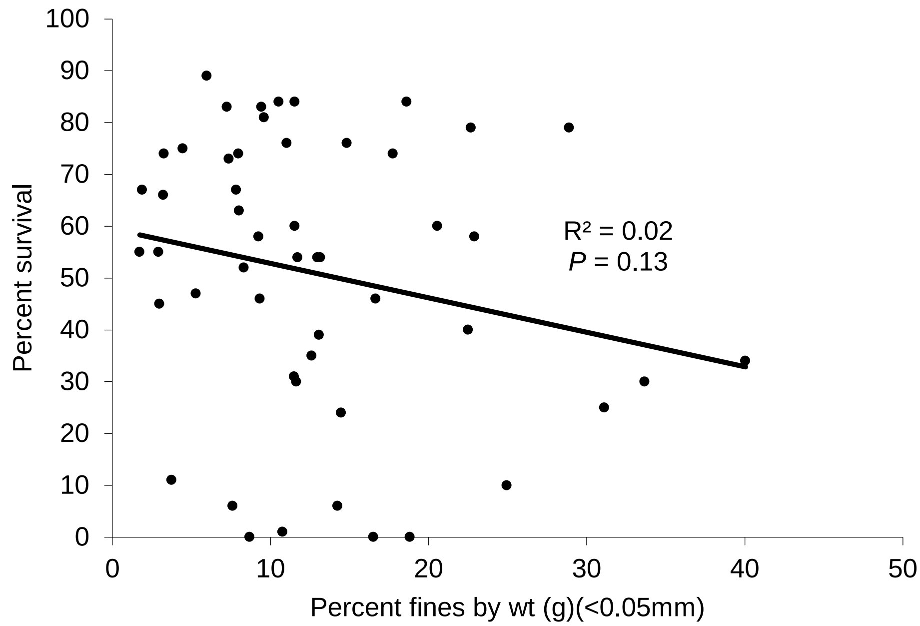


Figure 5. Negative trend in survival with increasing percentage of fine sediment in egg boxes recovered from the Wenatchee River Basin.

2011 Results

The study design and protocols implemented in 2010 were replicated in 2011. At each site, hatchery origin spring Chinook eggs were bank fertilized and placed in six artificially constructed redds within modified Whitlock-Vibert egg boxes, using methods defined in Johnson et al. (2009). Egg boxes were removed shortly after reaching a target of 900 accumulated thermal units (degrees C). Removal dates ranged between March 8th and May 10th 2012. Due to high water, five egg boxes were unable to be recovered.

Adjusted mean survival (i.e., adjusted for differences in female fertilization success) was greatest in the lower pool-riffle reach (mean, 0.60; SD, 0.24) and lowest in the plane-bed reach (mean, 0.43; SD, 0.29; Figure 6). Adjusted mean survival by adult cross ranged between 0.65 (SD, 0.31), and 0.39 percent (SD, 0.29; Figure 7). While the observed mean survival was higher in the two pool-riffle reaches relative to the plane-bed reach, no significant difference were detected among the three study reaches (ANOVA: $F_{2, 46} = 1.65$, $P = 0.20$). Likewise no significant differences were detected among the adult crosses used in the study (ANOVA: $F_{5, 43} = 0.68$, $P = 0.64$). Preliminary substrate composition analyses have not been completed, and therefore, its influence on survival is not presented in this report at this time.

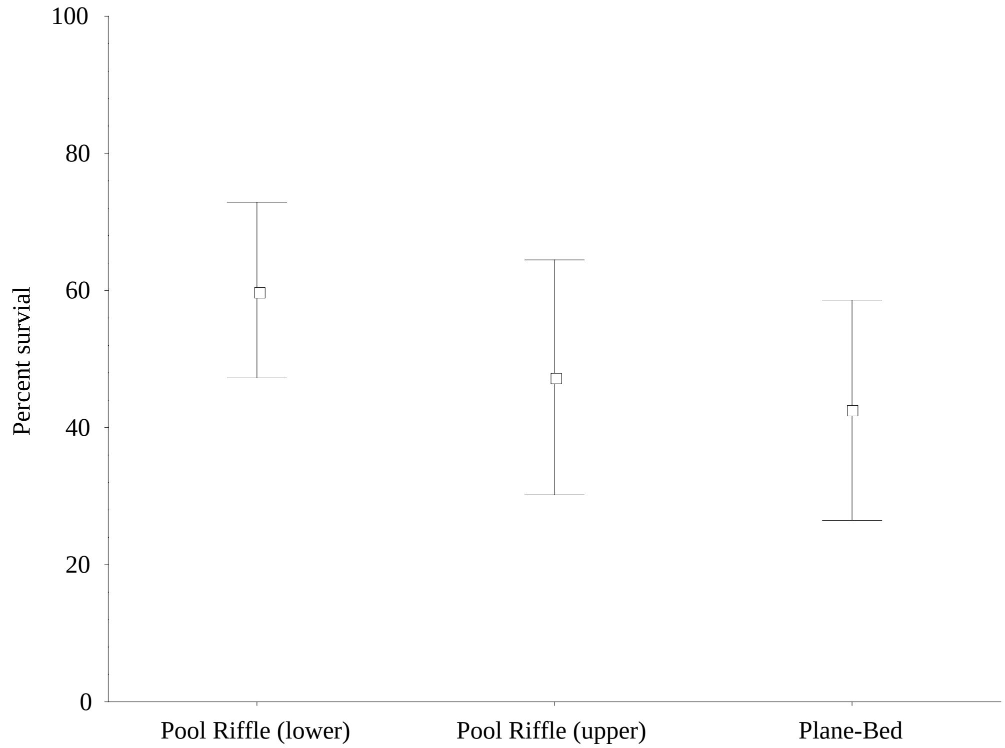


Figure 6. Estimated spring Chinook survival by study reach in the Chiwawa River 2011 (2012 emergent fry). Error bars represent ninety-five percent confidence intervals.

The modified sampling design used in 2010 and 2011 was implemented in an attempt to decrease the within-reach variance and attain a more accurate examination of differential egg-to-fry survival in the Chiwawa River. While our preliminary results have shown no detectable differences among reaches, observed trends are similar with those found relative to differences in reproductive success. However, our inability to retrieve a number of egg boxes, a consequence of high water in 2011, restricted the ability to attain desired sample sizes, especially in the lower and uppermost reaches of the Chiwawa River in 2011. For this reason, we would like to replicate field methods carried out in the previous two field seasons to further attempt to decrease the levels of uncertainty around survival estimates.

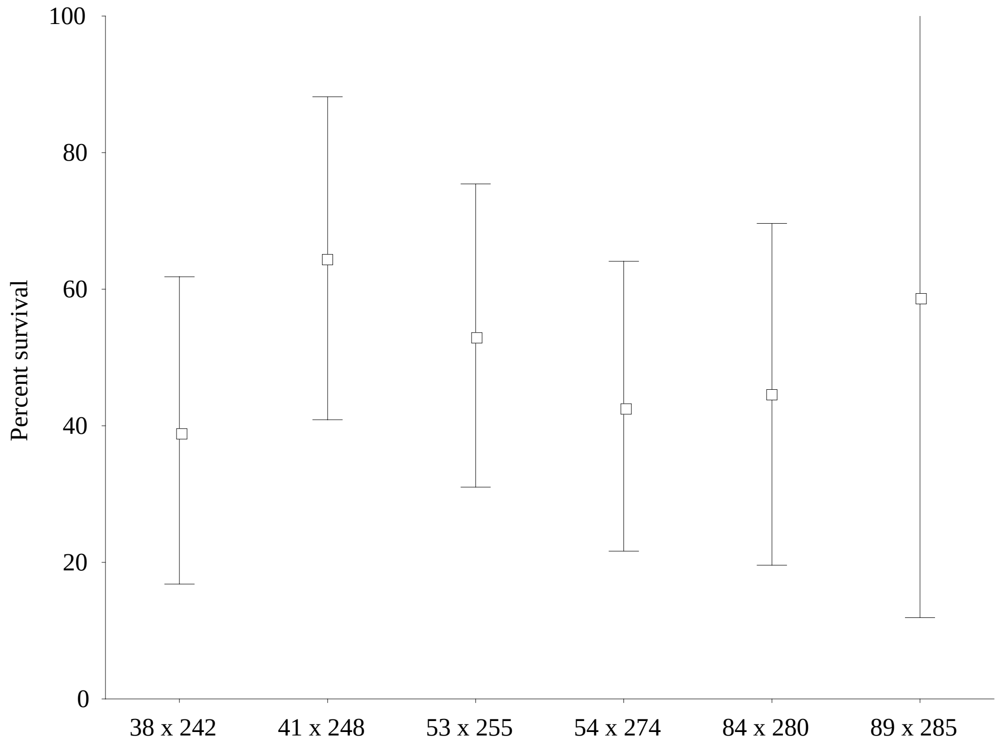


Figure 7. Estimated spring Chinook survival by adult cross in the Chiwawa River 2010 (2011 emergent fry). Error bars represent ninety-five percent confidence intervals.

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Appendix A. Experimental design for egg to fry study.

River	Reach/Channel type	Site	Redd #	Female	Male
Chiwawa	Upper/ pool-riffle	1	A	1	1
			B	2	2
			C	3	3
			D	4	4
			E	5	5
			F	6	6
		2	A	1	1
			B	2	2
			C	3	3
			D	4	4
			E	5	5
			F	6	6
		3	A	1	1
			B	2	2
			C	3	3
			D	4	4
			E	5	5
			F	6	6
	Lower/ plane-bed	1	A	1	1
			B	2	2
			C	3	3
			D	4	4
			E	5	5
			F	6	6
		2	A	1	1
			B	2	2
			C	3	3
			D	4	4
			E	5	5
			F	6	6
		3	A	1	1
			B	2	2
			C	3	3
			D	4	4
			E	5	5
			F	6	6
	Lower/ Pool-riffle	1	A	1	1
			B	2	2
			C	3	3
			D	4	4
			E	5	5
			F	6	6
		2	A	1	1

	B	2	2
	C	3	3
	D	4	4
	E	5	5
	F	6	6
3	A	1	1
	B	2	2
	C	3	3
	D	4	4
	E	5	5
	F	6	6

Wenatchee steelhead predation and residuals

JOSH MURAUSKAS

JUNE 20, 2012

Steelhead predation

- PIT tags recovered from 18, Foundation, Badger, and Crescent Islands
- Releases from the Wenatchee River Basin
  - CHIWAR, NASONC, WENATR (mostly hatchery)
  - CHIWAT, WENATT (mostly wild)

A partnership between Oregon State University, Real Time Research, and the USGS – Oregon Cooperative Fish and Wildlife Research Unit

BIRD RESEARCH NORTHWEST

COLUMBIA BASIN/WESTERN WASHINGTON

SEARCH THIS SITE

STUDY AREAS

Columbia Basin/ Western Washington

Interior Oregon/ NE California

San Francisco Bay

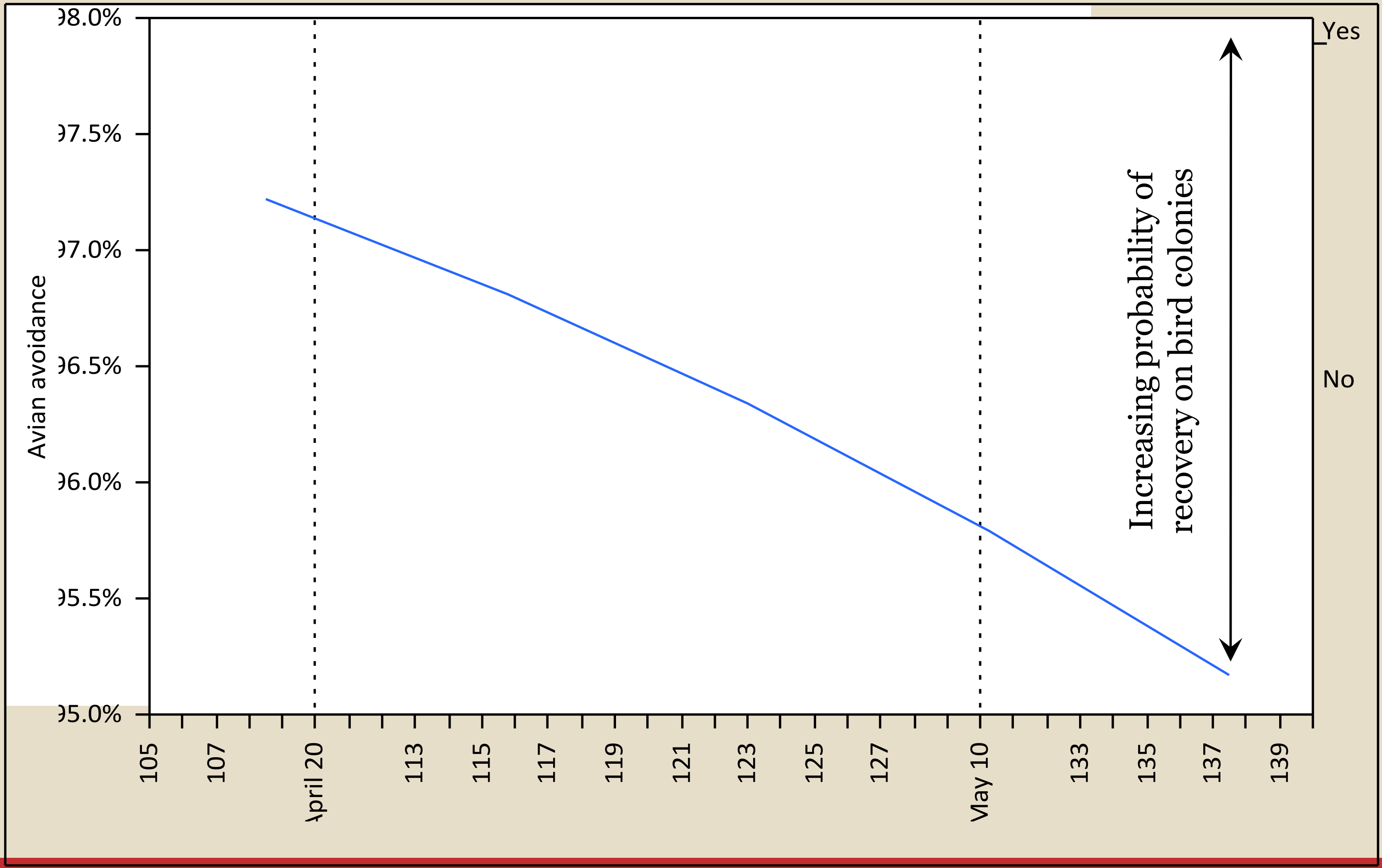
Click on links to get colony descriptions

Steelhead predation

- Hatchery releases 510% more likely to be recovered
  - H = 3.83%, W = 0.75%; $p < 0.0001$
- Release site related to mortality
  - Hatchery-origin ($p = 0.0227$)
    - CHIWAR > WENATR > NASONC
  - Natural-origin ($p < 0.0001$)
    - WENATT > WENATR > CHIWAT > CHIWAR > NASONC

Later releases = greater predation

$P < 0.0001$



Steelhead residuals

- Tags released in the Wenatchee R. Basin, 2006-2010
- Release dates between April 15 and May 31
- Observations anywhere in system over 60 days and less than one year considered a residual

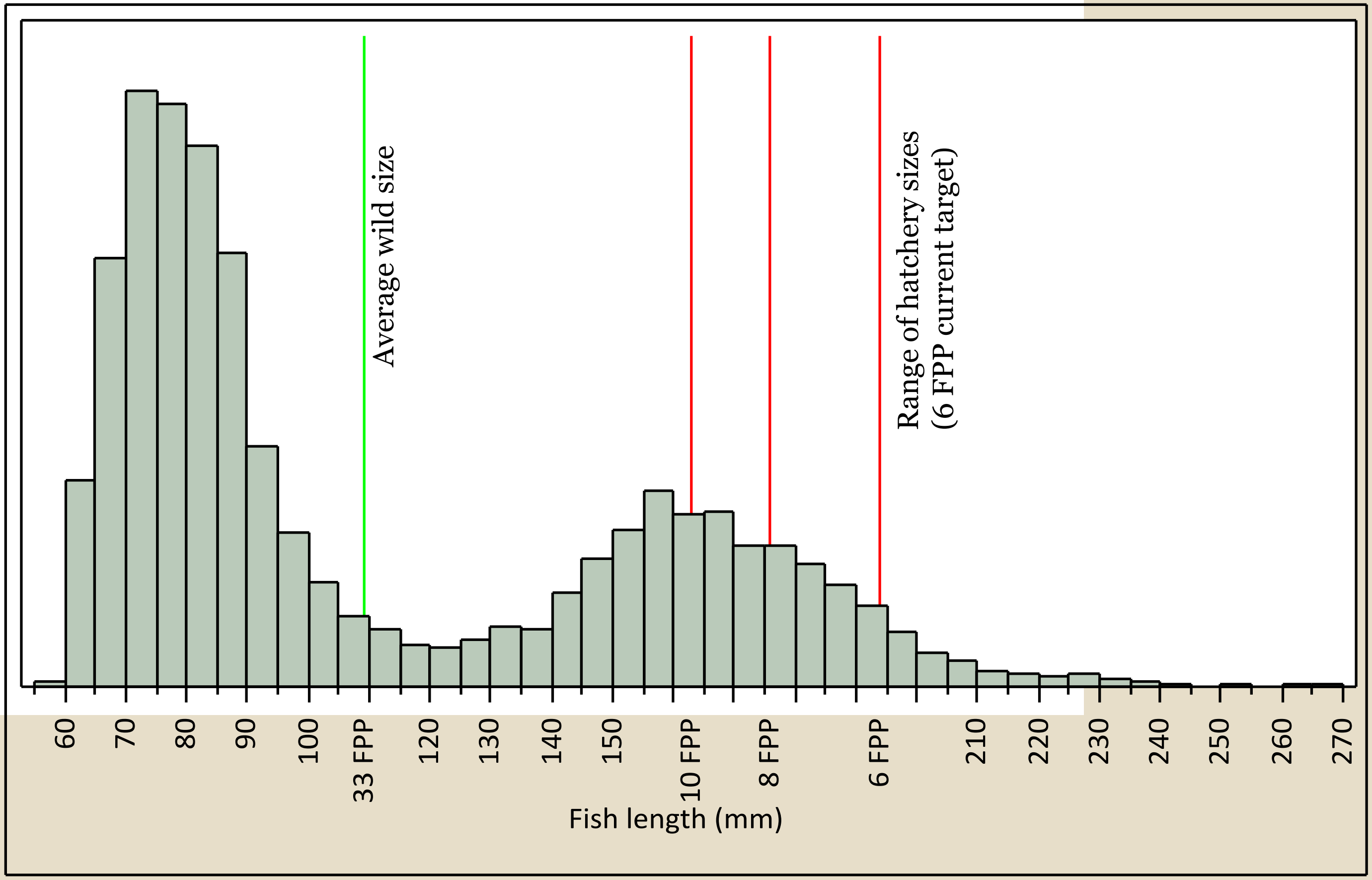
Steelhead residuals

- Wild fish significantly more likely to reside
  - Wild = 1.04%, hatchery = 0.14%; $p < 0.0001$
- Release site related to residualism
  - Hatchery-origin ($p = 0.0458$)
    - CHIWAR > WENATR > NASONC
  - Natural-origin ($p = 0.0080$)
    - NASONC > CHIWAT > WENATT > CHIWAR

Steelhead residuals

- Relationship to release date
  - Hatchery fish ($p = 0.1074$)
  - Wild fish ($p = 0.0362$)
- Relationship to size
  - Varies by year

Steelhead size distribution



Conclusions and recommendations

- Hatchery releases = greater bird predation
- Later releases = greater bird predation
  - Recommend structuring release strategy around wild-origin run distribution
  - Avoid later releases subject to increased predation

Conclusions and recommendations

- No evidence of residual problem in Wenatchee
- May be selecting against a natural trait
  - Consider adjusting size target to mimic wild-origin fish
  - Realistic size targets could reduce avian predation and more closely mimic wild-origin fish

Questions?

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
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June 14, 2012

Craig Busack
Senior Fish Biologist
NOAA Northwest Regional Office

Dear Dr. Busack:

This letter is in response to the request from members of the Rock Island and Rocky Reach Habitat Conservation Plans' Hatchery Committees (HCP-HC) that Chelan County Public Utility District (Chelan) provide a written statement clarifying our position on proposed modifications to the Dryden Acclimation Ponds (Dryden) to accommodate over-winter acclimation. While Chelan agreed to examine the feasibility of overwinter acclimation at Dryden, there has been no commitment to modify the facility in lieu of defined performance targets or in the absence of data identifying risks and benefits of the proposal. Chelan has presented these concerns numerous times over the past few years, including detailed analyses presented at the March and April HCP-HC meetings. It is unexpected that you feel we have not adequately conveyed our position on the matter.

In our preliminary evaluation of the proposed modifications, we have presented the following results collected in the HCP-HC-approved monitoring and evaluation programs (Figure 1 and 2, Table 1):

- SARs for Chinook reared and released at Similkameen and Dryden are not statistically different and exceed the HCP standards.
- There is no significant relationship between observed SARs and acclimation survival rates.
- Acclimation mortality rates are significantly greater in overwinter compared to spring-acclimated programs.
- Acclimation survival in Dryden pond exceeds HCP-defined targets, and increases considerably with decreased densities such as those scheduled for future releases.
- Stray rates have a significant probability to decrease under planned reduced smolt releases.
- WDFW has reported (Murdoch et al. unpublished) that risks of overwinter programs include increased exposure to disease, inability to reach size targets, increased precocity, and inability to reach programmed releases.
- Dryden's phosphorous discharge and Ecology's TMDL criteria could make permits unattainable. In 2012, background concentrations exceeded future pond discharge limits (See Table 2). The observed influent phosphorus level in late April was 42.2ug/L, which exceeds the TMDL wasteload allocation at the proposed intake size of 17 CFS (prior to adding any additional waste). A new intake will not solve this problem and may become obsolete shortly after construction.

- If the baseline phosphorus levels require a higher wasteload concentration, the size of the intake will need to be reduced (see Table 2). Establishing the baseline is a critical first step to designing an intake.

As you are also aware, Chelan has advocated an alternative option to expand the circular vessel and partial water re-use program at Eastbank Hatchery as a means to improve performance at Dryden. This option is based on the following data:

- Travel time to McNary Dam for smolts reared in circular vessels has averaged 12.8% faster compared to traditional rearing strategies.
- Survival to McNary Dam of smolts reared in circular vessels has averaged 12.7% greater compared to traditional rearing strategies.
- Age structure of returning adults reared as smolts in circular vessels show significant improvements, including a 45.8% reduction in Age 2 (mini-jacks), a 34.2% reduction in Age 3 (jacks), and a 74.5% increase in Age 4+ (adults) returns compared to traditional rearing strategies.
- PIT data from the 2009 and 2010 releases in Wenatchee and Okanogan rivers indicate that adult returns from circular vessels have potential to double the next best alternative.

Based on these results, Chelan remains concerned that constructing the proposed intake poses regulatory, financial and performance risks that are not outweighed by a defined benefit. Alternatively, our feasibility analysis indicates that expansion of the partial water re-use program at Eastbank Hatchery is likely to significantly increase performance at Dryden as risks and benefits have been defined over multiple years of research. At this point, Chelan is advocating two options: (1) a scientific approach to identify the risks and benefits of facility modifications; or (2) expansion of the circular vessel and partial water re-use program at Eastbank Hatchery. Regardless of the path forward, Chelan will need to obtain all necessary regulatory approvals and permits (including ESA Section 10) prior to any modifications Dryden.

Chelan is committed to using the best science available to improve our ability to exceed hatchery standards defined in the HCPs. Similarly, we have supported facility modifications at the Carlton Acclimation Ponds by Grant, and will continue to provide hatchery capacity to meet all of Grant's summer Chinook obligations for both the Wenatchee and Methow rivers.

Thank you once again for considering our findings and please do not hesitate to contact our department should you have further questions.

Regards,

Josh Murauskas
Senior Fish Biologist, HC Representative
Chelan County Public Utilities District

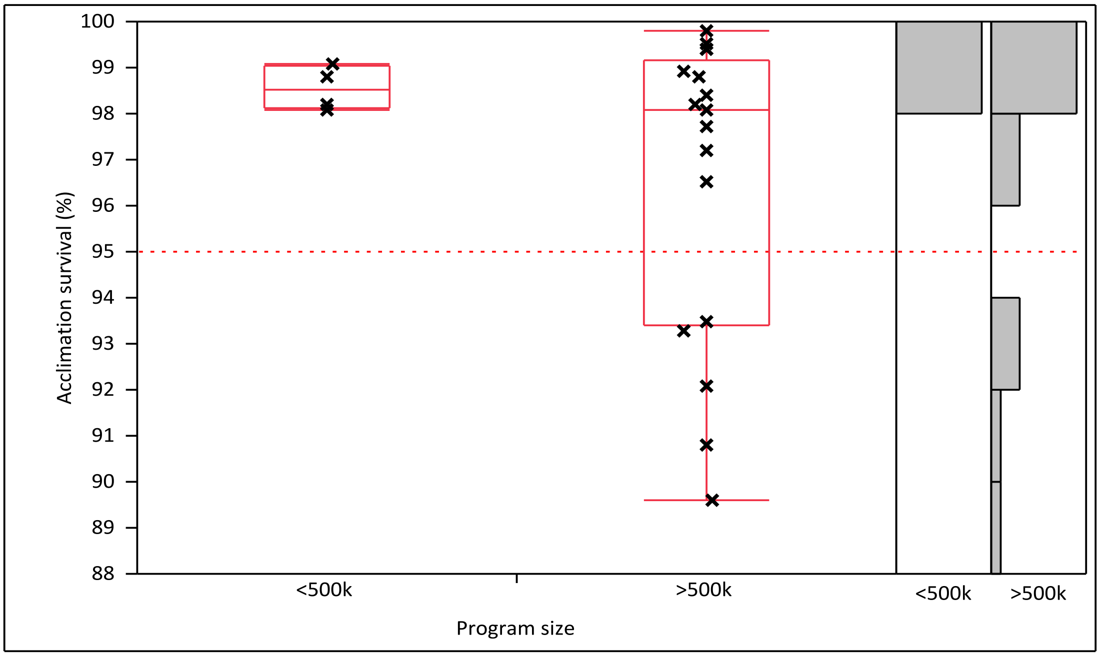


Figure 1. Acclimation survival at Dryden Ponds by program size, brood years 1989-2009.

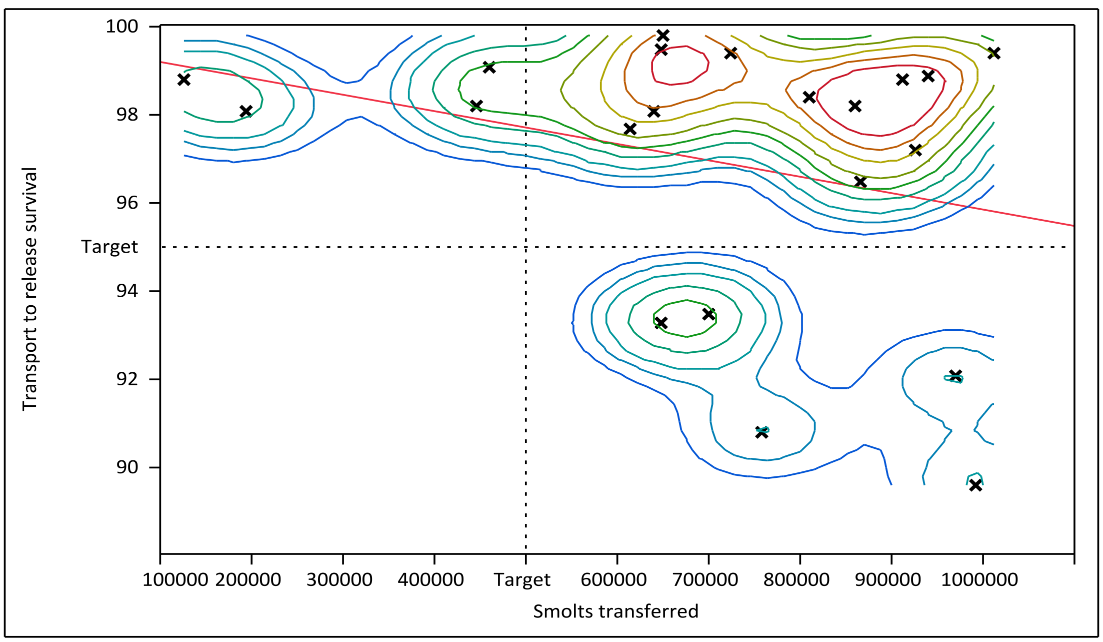


Figure 2. Transport to release survival (%) of summer Chinook smolts transferred to Dryden by program size, brood years 1989-2009.

Table 1. Examples of observed performance metrics from various program configurations possible at Dryden.

Stage	Option A	Option B	Option C
Smolts transferred	500,000	500,000	500,000
Facility survival[1]	96.9%	85.0%	98.6%
Smolts released	484,600	424,850	492,750
Survival to MCN[2]	54.4%	43.5%	72.4%
Mini-jack rate[3]	0.21%	0.26%	0.10%
Estimated smolts downriver	**263,065**	**184,497**	**356,393**

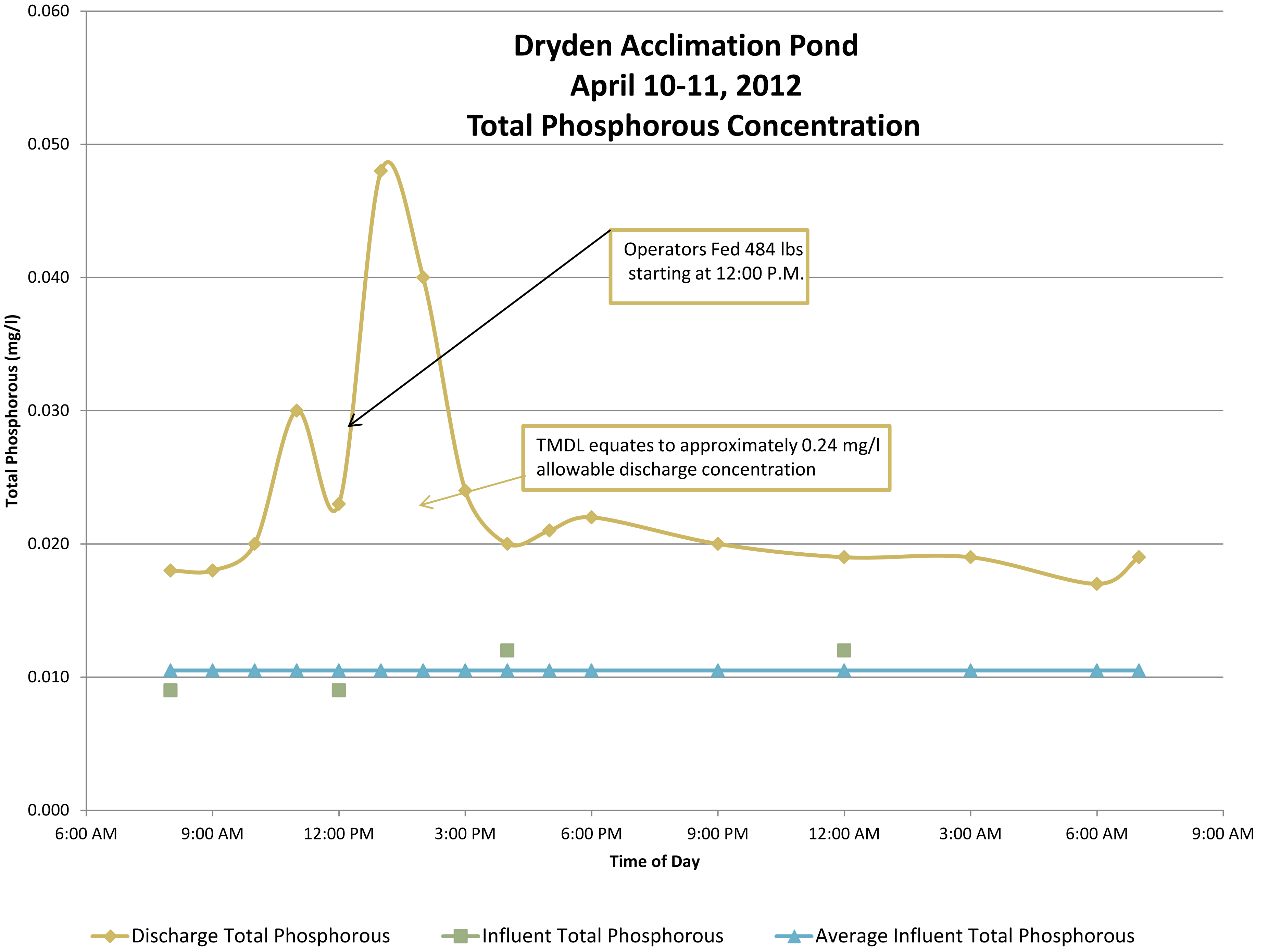
Table 2. Dryden TMDL waste load allocation.

Dryden Q **CFS**	Phosphorus Concentration **ug/L**	Load **g/d**
33	9.2	743
17	16.1	670
8	32.0	626
4	62.3	610
2	122.8	601
1	243.6	596

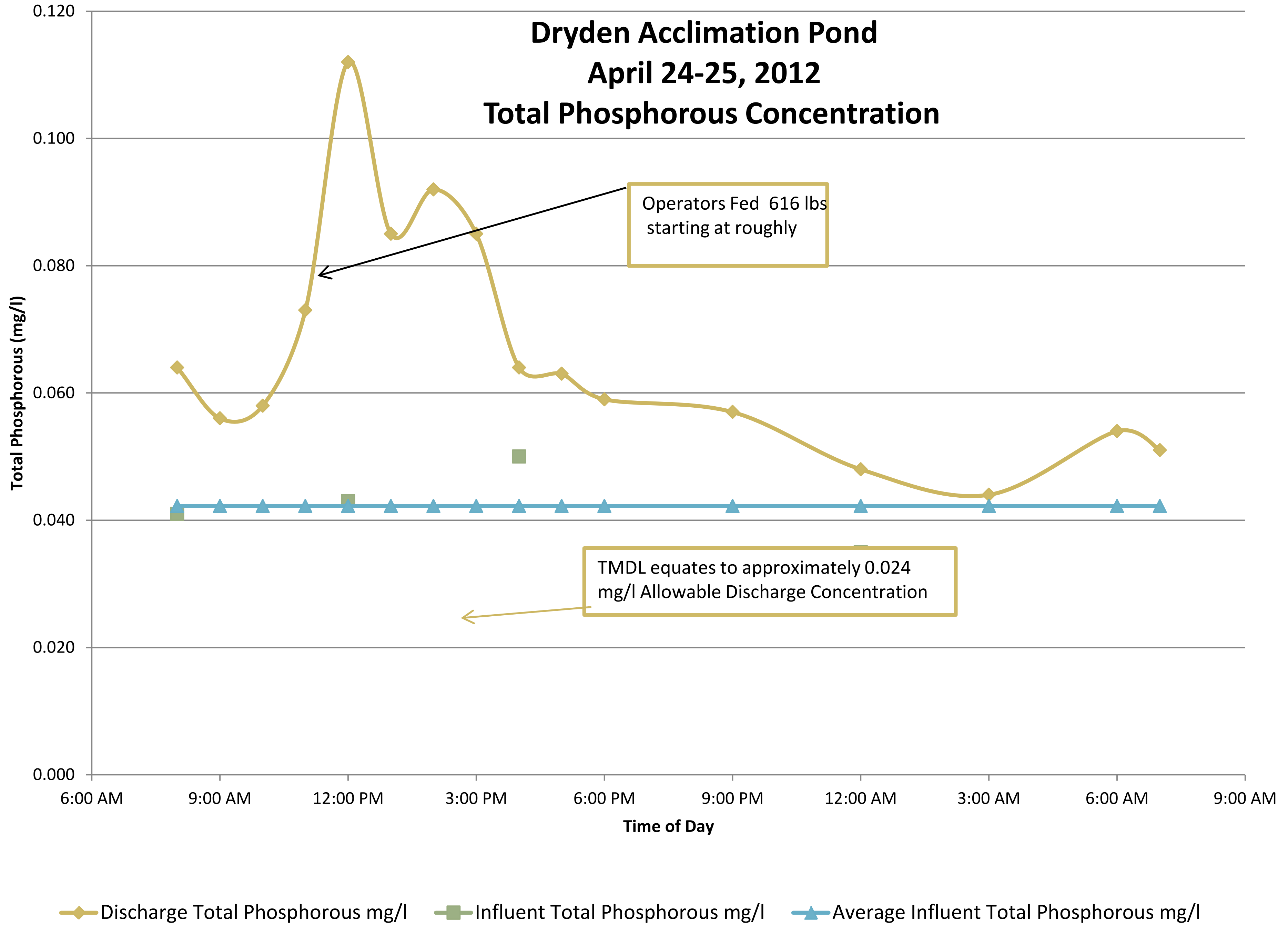
[1] From M&E data collected over program history.
[2] From PIT-based single-release survival estimates in 2009 and 2010.
[3] From PIT-based observations of Age 2 returns from 2009 and 2010 releases.

Load Allocation
Dept. of Ecology 3/12

Dryden Flow	Total Phos. Concentration	Total Phos. Load	Total Phos. Load
CFS	ug/l	grams/day	lbs/day
33	9.2	743	1.64
17	16.1	670	1.48
8	32	626	1.39
4	62.3	610	1.35
2	122.8	601	1.35
1	243.6	596	1.31



Dryden Acclimation Pond
April 10-11, 2012
Total Phosphorous Concentration
Operators Fed 484 lbs starting at 12:00 P.M.
TMDL equates to approximately 0.24 mg/l allowable discharge concentration
Total Phosphorous (mg/l)
0.060
0.050
0.040
0.030
0.020
0.010
0.000
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
3:00 AM
6:00 AM
9:00 AM
Time of Day
Discharge Total Phosphorous
Influent Total Phosphorous
Average Influent Total Phosphorous



Dryden Acclimation Pond
April 24-25, 2012
Total Phosphorous Concentration
Operators Fed 616 lbs starting at roughly
TMDL equates to approximately 0.024 mg/l Allowable Discharge Concentration
Total Phosphorous (mg/l)
0.120
0.100
0.080
0.060
0.040
0.020
0.000
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
3:00 AM
6:00 AM
9:00 AM
Time of Day
Discharge Total Phosphorous mg/l
Influent Total Phosphorous mg/l
Average Influent Total Phosphorous mg/l

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	August 15, 2012
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the July 18, 2012, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Douglas PUD Headquarters in East Wenatchee, Washington, on Wednesday, July 18, 2012, from 9:30 am to 12:30 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Mike Tonseth will provide to the Hatchery Committees an overview of the marking schemes for Mid-Columbia hatchery programs (Item I).
- Chelan PUD will develop a draft study plan for investigating size-at-release of summer/fall Chinook salmon released at selected locations, including the Dryden Rearing Facility (Item II-A).
- Alene Underwood will distribute to the Hatchery Committees for discussion the draft Dryden Total Maximum Daily Load (TMDL) and Fish Health Sampling Plans, as they become available (Item II-B).
- Alene Underwood will ask Sam Dilly to contact Tom Scribner regarding the sizing of a dedicated surface-water intake at the Dryden Rearing Facility (Item II-B).
- Josh Murauskas will finalize meeting logistics for a Hatchery Monitoring and Evaluation (M&E) Program working session, and he will distribute this information to the Hatchery Committees (Item II-C).
- Josh Murauskas will distribute to the Hatchery Committees Chelan PUD's draft timeline for the 5-year review and updating of the Hatchery M&E Program (Item II-C).
- Mike Schiewe will contact Kirk Truscott and request a presentation on the Colville Confederated Tribes' (CCT's) Chief Joseph hatchery programs and their M&E plans

(Item II-D).

- Keely Murdoch will distribute to the Hatchery Committees multi-species acclimation data collected from the back-channel at Winthrop (Item IV-A).
- Greg Mackey will notify the Hatchery Evaluation Technical Team (HETT) that the Hatchery Committees would like HETT to resume meeting and he will set up a meeting to move forward with discussions on the Non Target Taxa Of Concern (NTTOC) risk modeling results (Item V-A).

STATEMENT OF AGREEMENT DECISION SUMMARY

- No Statements of Agreement (SOAs) were approved at this meeting.

AGREEMENTS

- Chelan PUD agreed to meet internally with fisheries and hatcheries staff to discuss the best approach to: 1) engage Washington State Department of Ecology (Ecology) with the Committees' efforts to meet the upcoming Wenatchee River phosphorus TMDL at the Dryden Rearing Facility; and 2) share applicable baseline water quality data. Chelan PUD also agreed to the concept of approaching Ecology pending the outcome of the internal meeting; which the Hatchery Committees discussed should involve preparing a presentation of the proposed 2013 and 2014 study design and collectively presenting these items to Ecology (Item II-B).

REVIEW ITEMS

- No reports are currently out for review.

FINALIZED REPORTS

- No reports have been finalized since the last Hatchery Committees meeting.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees, and Chas Kyger, a new Douglas PUD Aquatic Resource Biologist, was introduced to the Committees. Schiewe reviewed the agenda, and the following revisions were requested:

- Josh Murauskas moved Chelan PUD's agenda item II-A after item II-B to accommodate arrangements with Don Larsen to speak on the summer Chinook growth modulation experiment discussion.
- Josh Murauskas added an update on the Chelan PUD Methow Sharing Agreement.
- Keely Murdoch added an update on the Yakama Nation (YN) Coho Restoration Program.
- Bill Gale requested a HETT update.

The revised draft June 20, 2012 meeting minutes were reviewed. Kristi Geris said there was one outstanding comment remaining to be discussed regarding the action item to develop an overview of the marking schemes for Mid-Columbia hatchery programs. The Hatchery Committees agreed to carry this item forward as a July action item, and agreed that Mike Tonseth was the appropriate individual to address this item. Keely Murdoch also requested a revision to clarify her question about how long it had been since Carson stock spring Chinook had been released in the Methow. Hatchery Committees members present approved the June 20, 2012 meeting minutes, as revised.

II. Chelan PUD

A. Summer Chinook Growth Modulation Experiment (Josh Murauskas)

Josh Murauskas said Chelan PUD has been working with Brian Beckman and Don Larsen (National Marine Fisheries Service [NMFS] Northwest Fisheries Science Center) to develop a conceptual draft Mid-Columbia Chinook Salmon Precocity Studies design (Attachment B). Kristi Geris distributed this draft study design to the Hatchery Committees on July 18, 2012, prior to the meeting. Murauskas said the purpose of this draft is to put forward potential approaches to develop biologically-based growth regimes and size targets (via altering lipid levels and rearing strategies) for Mid-Columbia River hatchery yearling Chinook salmon.

Don Larsen said the focus of this research is the development of biologically-based size targets for yearling summer/fall Chinook salmon, and a plan to integrate them into a comprehensive hatchery strategy that is cost-effective and time-efficient, and builds on existing data. Larsen said monitoring would occur in the fall, beginning in the second year of life, and immediately prior to release. Larsen reviewed the different approaches as outlined in Attachment B, and specifically noted the size versus rearing vessel relationship, proposed primarily at Chelan Falls Acclimation Facility. Larsen said lipid levels in the feed would be manipulated in a two-by-two factorial design, and that ideally, the experiment would be conducted over multiple years to control for environmental variability. Larsen proposed monitoring the fish for smolt quality and early maturation rate, with follow-up monitoring for downstream survival and adult return data. Larsen said the results of this study would further inform questions about the future of the Dryden facility and the ability to meet the proposed Wenatchee River phosphorus TMDL. Murauskas said that identifying a biologically-based size target could allow some flexibility in meeting the TMDL. Murauskas said he wanted to gauge the interest of the Hatchery Committees in pursuing this study before developing a detailed study plan. Murauskas also said that, in order to move forward, Chelan PUD wanted some level of assurance that the results would be used to make changes to the hatchery programs.

Bill Gale said he was concerned with the lack of replication. He said that if an infectious disease occurred in one tank, the entire study could be lost. Murauskas and Larsen agreed that replication was a concern. Larsen said that monitoring over multiple years should compensate for the lack of replication to some degree; he added that robust tagging data may also help. Larsen also said that the tanks proposed for testing at Chelan Falls and Eastbank Hatchery will be less subject to variation in flow, which was a problem with earlier studies conducted in the Chelan Falls net pens. Murauskas noted that not all fish may hit a specific size target; however, tagging a high percentage of the fish will enable collection of more accurate data over a broader size range.

Gale said that he is generally okay with the proposed sample sizes. However, conceptually, he is concerned that the study relies too heavily on passive integrated transponder (PIT) tags. Murauskas said Larsen will focus primarily on the biological indicators, and the data derived from PIT tags are secondary measurements. Gale suggested tagging a large number of fish and conducting one mark-recapture analysis, as is currently being done at Leavenworth. Murauskas reiterated that Chelan PUD would first like to gauge the interest of the Hatchery Committees, and then formulate a study plan with specific details. Gale asked to clarify whether the study will control lipid levels at Chelan Falls. Larsen said lipid levels will be altered in the feed, and size will be altered by ration.

Keely Murdoch said she thinks the study is worth consideration. She added that it is important to consider fish size and associated performance; however, she said this study by itself is not likely to resolve all of the questions associated with meeting the phosphorus TMDL. The Hatchery Committees representatives present agreed to move forward with the size targets aspect of this conceptual design. Murauskas said Chelan PUD will develop a draft study plan for investigating size-at-release of summer/fall Chinook salmon released at selected locations, including the Dryden Rearing Facility.

B. Dryden Acclimation Ponds (Josh Murauskas)

Josh Murauskas said that, as requested at the June 20, 2012 Hatchery Committees meeting, Chelan PUD developed a description of actions to ensure that summer Chinook production and infrastructure complies with the Wenatchee River TMDL for phosphorus (Attachment C). Kristi Geris distributed this document to the Hatchery Committees on July 18, 2012, prior to the meeting.

Alene Underwood reviewed Attachment C with the Hatchery Committees and stated that the document has already been discussed with Grant PUD. Underwood said Action No. 1 sets up a baseline dataset with data collection continuing into 2013 and 2014; she said the feed trial outlined in Action No. 2 will commence next year, pending results of the feed study ongoing this year. Todd Pearsons said the type of phosphorus feed has not yet been fully defined. Bill Gale asked if this trial is linked to the larger project at Leavenworth; Underwood responded that it is. Gale asked about the Joint Fisheries Parties' (JFP's) request for chemical analyses of the two different water sources (i.e., irrigation canal versus the Wenatchee River). Underwood said that issue will be addressed separately from the phosphorus TMDL issue.

Underwood said Action No. 3 is a benchmarking exercise where efficacy of removing phosphorus will be tested at Chelan Falls. Effluent sampling was conducted in 2012 and will continue in 2013 and 2014. Underwood reviewed Actions No. 4 and No. 5, and concluded that Chelan PUD could have all the information to make a decision by 2015 on how to meet the 2019 phosphorus TMDL. Tom Scribner asked if there was a detailed monitoring and sampling plan for each of the actions. Underwood said these plans were under development and that she would distribute them to the Hatchery Committees as they become available.

Scribner suggested that the Hatchery Committees engage Ecology regarding what is being done to meet the TMDL and how the fisheries community has been proactive. Underwood said Chelan PUD has already started discussions with Ecology. Scribner expressed the importance that the Hatchery Committees formally and collectively go to Ecology as a unified group. Underwood said Chelan PUD would need to first coordinate internally to ensure the Hatchery Committees' actions are not counteracting other Chelan PUD interactions that are taking place with Ecology. Chelan PUD agreed to meet internally with fisheries and hatcheries staff to discuss the best approach to: 1) engage Ecology with the Committees' efforts to meet the upcoming Wenatchee River phosphorus TMDL at the Dryden Rearing Facility; and 2) share applicable baseline water quality data. Chelan PUD also agreed to the concept of approaching Ecology pending the outcome of the internal meeting; which the Hatchery Committees discussed should involve preparing a presentation of the proposed 2013 and 2014 study design and collectively presenting these items to Ecology.

Scribner requested that the Hatchery Committees discuss the Dryden water source issue. Underwood said Chelan PUD is currently discussing with a consultant a strategy for best addressing this issue. Gale said that he believes this issue is more time-sensitive than the TMDL issue because pushing this issue back puts Grant PUD on hold for a water source, and a lot of work accomplished by the JFP is now on hold. Gale said that the JFP wants to get this water source issue figured out. The decision to go to overwinter acclimation is secondary; however, the JFP has made it clear that this is important and they would like to see a plan or proposal soon. Underwood said that Chelan PUD is budgeting for chemical analysis to occur in early 2013.

Scribner asked Underwood about what Chelan PUD considered to be the risks associated with developing a new water supply at Dryden. Underwood said that Chelan PUD and Grant PUD's water rights have not been reconciled, and Chelan PUD needs to maintain its priority water right at this location. Second, as Sam Dilly explained during the June Hatchery Committees meeting, discharge volume affects the amount of phosphorous discharge and thus the ability to comply with the TMDL. Underwood added that, at this point, Grant PUD has submitted a water right application, but the status of Chelan PUD's existing water right is still under discussion. Underwood also said that Chelan PUD cannot have that discussion with Grant PUD until more is known about the water source. Underwood said next year's budget starts on January 1, 2013, and the irrigation canal opens in March; when the time is most appropriate, Chelan PUD will conduct sampling in the canal.

Scribner said he did not fully understand the relationship between water volume and the TMDL. Underwood said she will ask Sam Dilly to contact Scribner regarding the sizing of a dedicated surface-water intake at the Dryden Rearing Facility.

C. Hatchery M&E Update (Josh Murauskas)

Josh Murauskas said he will finalize meeting logistics for the Hatchery M&E Program working session, and he will distribute this information to the Hatchery Committees.

Murauskas said Chelan PUD is revisiting the M&E objectives and discussing what metrics are needed to meet those objectives. He said Chelan PUD plans to set up targets by fall 2012 and have them finalized by early 2013. Murauskas said he developed a draft timeline for Chelan PUD's 5-year review and updating of the Hatchery M&E Program, and that he will distribute the timeline to the Hatchery Committees. Regarding Chelan PUD's contracting process, Murauskas said there are a lot of moving pieces that need to be sorted through, particularly with the CCT and Grant PUD.

D. Methow Sharing Agreement (Josh Murauskas)

Josh Murauskas said the Douglas PUD and Chelan PUD Sharing Agreement has expired. The agreement expired this year, and on July 17, 2012, termination of the agreement was authorized by letter from Chelan PUD to Douglas PUD. Murauskas said the last release of Chelan PUD spring Chinook from the Methow under contract will be in 2013. Chelan PUD's spring Chinook will be released at Chiwawa in 2014 per an earlier SOA to accommodate delays in additional spring Chinook production in the Wenatchee River. Murauskas added that Chelan PUD is currently discussing a new sharing agreement with Douglas and will consult with the Hatchery Committees as needed. Greg Mackey said that Douglas PUD had already presented a proposed budget to Chelan PUD to extend the agreement and was prepared to rear fish for Chelan PUD if and when needed. Alene

Underwood said Chelan PUD just recently began budget discussions for 2013. Murauskas said there are several issues and entities affected by these sharing arrangements; Bill Gale suggested that this discussion include a larger group (i.e., Grant PUD, as well as Chelan and Douglas PUDs). Gale and Murauskas both said the proposed Chief Joseph Hatchery programs need to be considered as well. Gale said it would be helpful to have an outline of how all of these hatchery programs link to one another. Mike Schiewe said he will contact Kirk Truscott and request a presentation on the CCT's Chief Joseph hatchery programs and their M&E plans.

III. Douglas PUD

A. Hatchery M&E Update (Greg Mackey)

Greg Mackey said Douglas PUD would like to have an updated Hatchery M&E Plan by fall 2012. Mackey said Douglas PUD operates on an annual contract, and if an implementation plan can be developed in the fall in time for budgeting and contract approval by the end of 2012, it can be implemented in 2013. Mackey said Douglas PUD is not considering significant changes to the objectives, and he reminded the Hatchery Committees of the five items Douglas PUD plans to focus on as reviewed with the Hatchery Committees during the June 20, 2012 meeting; these items are reflected in the meeting minutes.

IV. Yakama Nation

A. YN Coho Restoration Program Update (Keely Murdoch)

Keely Murdoch said the YN is in the early stages of discussions with Douglas PUD to rear juvenile coho salmon for the YN Upper Columbia Coho Reintroduction Program at the Wells Hatchery Facility. Murdoch first discussed that the YN was looking for hatchery space to accommodate expansion of numbers in the YN coho program at the May 17, 2012 Hatchery Committees meeting. Tom Scribner said these discussions are somewhat timely, because Wells Hatchery is in the master-planning stage of a rebuild. Scribner said rearing YN coho at Wells hatchery makes sense geographically and that the YN is very interested and are willing to commit capital funds to it.

Murdoch said that in preparing to move forward with the YN Upper Columbia Coho Reintroduction Program, the YN is also looking for potential acclimation sites. Murdoch said the spring Chinook program is being significantly reduced in the Chewuch River, and so one option may be to co-mingle coho and spring Chinook at Douglas PUD's Chewuch Acclimation Pond. Greg Mackey said Douglas PUD has not yet looked into multispecies acclimation with Chinook and coho, and asked about the YN experience with this. Mackey added that co-acclimating the fish may be possible, but this type of arrangement would require an agreement. Tom Kahler asked about duration of acclimation, and Murdoch replied that most acclimation sites would be short term, spring acclimation only. Murdoch added that the YN would, however, consider overwinter acclimation where possible. Murdoch said acclimation could start as early as 2014; however, this date depends on other acclimation sites because, for a given area, all fish need to be ready for release at the same time. Kahler asked how many coho the YN would consider acclimating in the Chewuch Acclimation Pond, and Murdoch said that as other acclimation locations fall into place, the YN will have a better idea, but it could be approximately 100,000 fish. Mackey asked if the YN had considered truck-planting fish and inquired about stray rates for coho planted by truck versus for those receiving a short spring acclimation. Murdoch said the YN coho plan specifies acclimating fish before release and has not tested truck plants versus acclimated plants; however, the YN has experimented with non-acclimated fish plants and there was significantly lower survival (measured as smolt-to-adult-ratio [SAR] back to the basin).

Scribner said that the YN has experience with co-mingled acclimation of spring Chinook and coho in the back-channel at Winthrop. Murdoch said she will distribute to the Hatchery Committees multi-species acclimation data collected from the back-channel at Winthrop. Scribner added that the YN is just in the beginning stages of exploring what is available and they are considering all options.

V. HETT

A. HETT Update (Greg Mackey)

Greg Mackey said that Douglas PUD has completed their NTTOC Risk Model runs. Keely Murdoch said that the YN has more model runs to complete; however, they can be ready to provide results by next month's meeting. Josh Murauskas said Chelan PUD has not yet had time to run the models. Bill Gale said that as these model runs were discussed in the M&E objectives a couple of years ago, it is time to move forward with discussions on the modeling results. Todd Pearsons pointed out that if a person running the models has already viewed the results, this affects their objectivity as a potential Delphi panelist. Mackey added that people who are running the models, however, are likely the best-suited to be a part of the Delphi Panel, but knowledge of model results would influence their assessment under the Delphi Panel.

Mackey said that HETT did not meet this month. Mike Schiewe said if administrative support is needed, Anchor QEA support can be provided. Mackey said that he will notify HETT that the Hatchery Committees would like HETT to resume meeting and to move forward with discussions on the NTTOC Risk modeling results.

VI. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees meetings are on August 15, 2012 (Chelan PUD office); September 19, 2012 (Douglas PUD office); and October 17, 2012 (Chelan PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – Mid-Columbia Chinook Salmon Precocity Studies Conceptual Draft
Attachment C – Chelan PUD – Dryden TMDL Compliance Timeline

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Alene Underwood*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Chas Kyger	Douglas PUD
Todd Pearsons	Grant PUD
Tom Scribner*†	Yakama Nation
Keely Murdoch*	Yakama Nation
Bill Gale*	USFWS
Jayson Wahls	WDFW
Don Larsen††	NMFS

Notes:

* Denotes Hatchery Committees member or alternate
† Joined by phone
†† Joined by phone for Summer Chinook Growth Modulation Experiment discussion

MID-COLUMBIA CHINOOK SALMON PRECOCITY STUDIES

SUMMARY

Monitoring and evaluation data from mid-Columbia spring- and summer-run Chinook salmon hatcheries indicate that rearing strategies have significant implications in the performance of artificially-produced fish. Growth regimes, influencing size at release, are among the foremost factors affecting survival and population demographics. Rearing approaches therefore provide an opportunity to increase age at maturity, reproductive success, smolt survival, subsequent adult returns, stray rates, impacts to non-target species, and likelihood of reaching genetic management goals. Smolt size further influences the ability to comply with water quality standards (i.e., larger smolts require a greater wasteload allocation). The purpose of this draft study design is put forward conceptual approaches to develop biologically-based growth regimes and size targets for mid-Columbia River hatchery yearling Chinook salmon.

POTENTIAL STUDY CONSTRUCT

The objective of the proposed study would be to assess culture practices to identify techniques that maximize performance of hatchery-origin summer-run yearling Chinook salmon released in the mid-Columbia River. The Dryden and Chelan Falls facilities provide opportunities to evaluate size targets, adiposity, and rearing vessels and their effect on quality and performance of hatchery-origin summer Chinook smolts (Table 1). Smolts reared at Eastbank and spring-acclimated at Dryden can be treated by fish size and rearing vessel (adiposity constant); fish reared at Eastbank and winter-acclimated at Chelan Falls can be treated by fish size and adiposity (rearing vessel constant; Figure 1). Metrics collected will include fish physiological and disease screening, along with smolt and adult in-river behavior (Table 2).

Evaluations will determine if changes in hatchery operations can significantly improve the quality and subsequent performance of hatchery-origin summer Chinook salmon. For example, precocity affects the overall survival of smolts (since precocious males are valued as mortalities in mark-recapture models). With survival held constant between rearing vessels and assumed to increase with size, effective survival decreases at some point with increasing rate of precocity. Optimal strategies can therefore be identified through monitoring physiology, health, and in-river performance of smolts reared under varying circumstances. Results would be used to inform rearing strategies and establish size targets for yearling Chinook salmon programs with the intention of increasing performance. Wasteload allocation toward water quality standards may be subsequently reduced as an ancillary benefit if results warrant a reduced size target.

TABLE 1. POTENTIAL STUDY FACILITIES FOR YEARLING SUMMER CHINOOOK PRECOCITY STUDIES.

Facility	Stock	Potential treatments or replications	Notes
Dryden[1]	Wenatchee	Four	Size [12/20 fpp] × rearing vessel [raceway/circular]. Adiposity held constant.
Chelan Falls	Wells	Four	Size [12/20 fpp] × adiposity [high/low]. Rearing vessel held constant.
Carlton	Wells	Unknown	Potential replication with circular vessels.
Similkameen	Okanogan	Unknown	Potential test with overwinter acclimation.

[1] Dryden is of particular interest given the hatchery limitations presented by wasteload allocation.

TABLE 2. POTENTIAL STUDY METRICS FOR YEARLING SUMMER CHINOOOK PRECOCITY STUDIES.

Metric	Purpose	Hypothesis
Fish screening	Precocity and smolt quality	Feeding regime, size targets, and rearing vessels significantly influence the rate of precocity and quality of yearling summer Chinook.
Disease screening	Smolt quality	
Smolt performance	Travel and survival to McNary	
Adult performance	Age structure, SARs, stray rates	

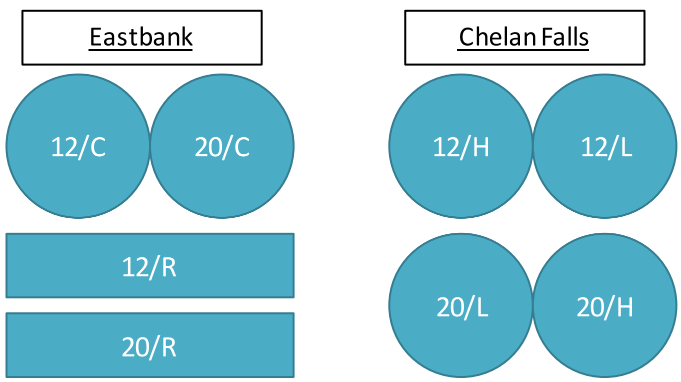

FIGURE 1. POTENTIAL VESSEL AND REARING CONFIGURATION OF SUMMER CHINOOK REARING STRATEGIES EVALUATED AT EASTBANK (DRYDEN) AND CHELAN FALLS, INCLUDING CIRCULAR (C) AND RACEWAY (R) REARING, VARYING SIZES (12/20 FPP), AND ADIPOSITY (HIGH [H] AND LOW [LOW]).

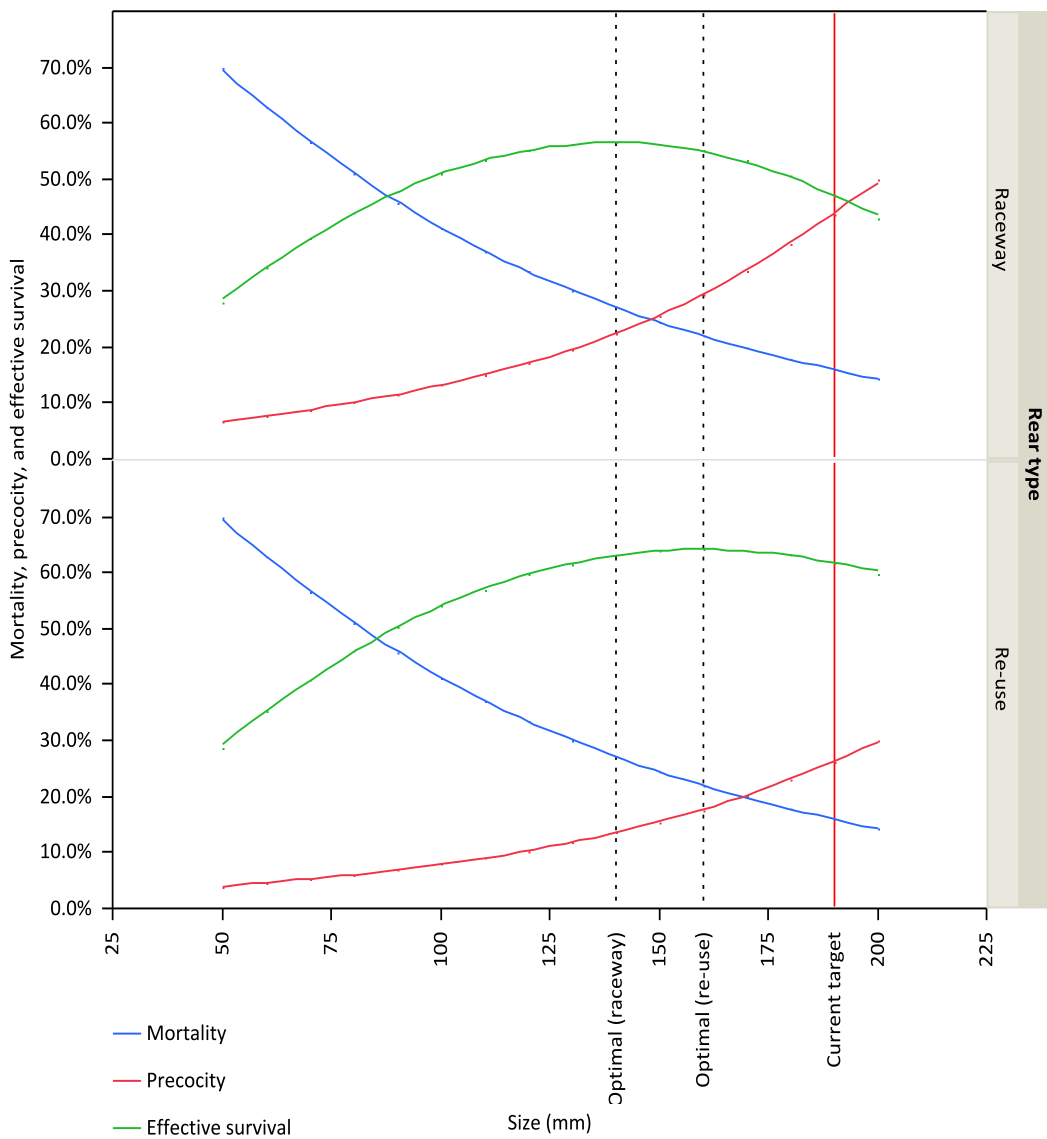

FIGURE 2. CONCEPTUAL MODEL OF MORTALITY, PRECOCITY, AND RESULTING EFFECTIVE JUVENILE SURVIVAL RATE, BY REAR TYPE. CURRENT TARGET (RED), AND OPTIMAL TARGETS (DASHED) FOR RE-USE (~64%) AND RACEWAY (~57%) SHOWN FOR COMPARISON.

Chelan PUD- Dryden TMDL Compliance

At the June HCP HC meeting, Chelan PUD committed to provide the HC with a description of activities required to ensure that we can meet hatchery production levels and TMDL compliance.

The following actions will be used to ensure that summer Chinook production and infrastructure complies with the Wenatchee River TMDL for phosphorus.

Action	Purpose	Timeline	Decision
1. Measure baseline phosphorus levels in Wenatchee River and at Dryden facility (Chelan PUD) before, during, and after fish on station	Use WQ data to establish baseline phosphorous levels and estimate variability. Then, determine the (1) quantity of phosphorous and (2) the flow "Q" that can be discharged	2013 & 2014 acclimation periods	If background concentration levels exceed wasteload allocation, resize Q to appropriate level or consider other treatment options.
2. Conduct low phosphorous feed trial at Dryden (Grant PUD & Chelan PUD)	Use regular and low phosphorous feeds during acclimation to measure WQ response in effluent and to determine efficacy of future use	2013 acclimation period	If low phosphorous feed reduces effluent phosphorous concentration and meets fish health parameters (evaluated separately at FWS lab), then consider use for TMDL compliance
3. Benchmark Chelan Falls and Leavenworth circulars (Chelan PUD & USFWS).	Determine efficacy of circular tanks and radial flow separators for phosphorous removal by looking at effluent WQ	2013 & 2014 (Chelan Falls is currently operational, Leavenworth would be considered if infrastructure is built)	If circular tanks and waste removal effectively remove phosphorous, consider future application for Dryden. Consider reuse if Q is reduced significantly.
4. Evaluate size of smolts released- use physiological data and PIT tag data to empirically test different smolt sizes (NOAA - Beckman and Larsen & Chelan PUD)	Optimize smolt release size to decrease precocity, increase SARs, and reduce phosphorous input (i.e., less food)	Begins in 2012 and would focus on 2014 & 2015 release years	If a smaller smolt can improve return performance, consider application of smaller size for Dryden production group
5. Evaluate the	Examine reduction in	2014 acclimation period	Program changes are

Action	Purpose	Timeline	Decision
number of fish released and effects on phosphorous levels (Chelan PUD)	phosphorous discharge associated with 500k smolt production (reduced from 864k)		likely to reduce phosphorous levels (supports decision in Action 1). This is not a proposal for further reductions.
6. Evaluate Actions 1-5 and select best option(s) for Dryden to meet TMDL standard		2015 summer	

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	September 20, 2012
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the August 15, 2012, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Chelan PUD Headquarters in Wenatchee, Washington, on Wednesday, August 15, 2012, from 9:30 am to 12:30 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Josh Murauskas will check with fish monitoring staff at Rocky Reach Dam about monitoring passage of Wells Hatchery subyearling summer Chinook beginning in May 2013 (Item II-A).
- Kirk Truscott will coordinate with Keith Wolf to arrange a formal presentation on the Colville Confederated Tribes' (CCT's) Chief Joseph Hatchery Programs for the September 19, 2012 Hatchery Committees meeting (Item III-A).
- Kirk Truscott will provide an electronic copy of CCT's proposed brood year (BY) 2013 Chief Joseph Hatchery spring and summer Chinook production to Kristi Geris for distribution to the Hatchery Committees (Item III-A).
- Josh Murauskas will provide to the Hatchery Committees a more detailed study plan for the Mid-Columbia Chinook Salmon Precocity Studies, including: 1) fish size targets and estimated pond timing, and 2) a section on sample sizes and proposed statistical methods for analyzing and interpreting results. Murauskas also agreed to provide to the Committees monthly updates as the study progresses (Item IV-C).
- Alene Underwood will provide the Dryden Facility 2012 effluent sampling results and Chelan PUD's Draft Water Quality Sampling Report to Kristi Geris for distribution to the Hatchery Committees after internal review (Item V-A).
- The Yakama Nation (YN) will develop suggested steps forward for engaging

Washington State Department of Ecology (Ecology) regarding efforts by fisheries interests to meet the Wenatchee River phosphorus Total Maximum Daily Load (TMDL); this topic will be discussed at the September 19, 2012 Hatchery Committees meeting (Item V-A).

STATEMENT OF AGREEMENT DECISION SUMMARY

- No Statements of Agreement (SOAs) were approved at this meeting.

AGREEMENTS

- The Hatchery Committees' representatives present agreed that Chelan PUD and Washington Department of Fish and Wildlife (WDFW) should implement their plan, titled "Chelan River Brood Collection 2012 Pilot Study," to test methods for capturing returning adults to use as broodstock for the Chelan Falls summer/fall Chinook program (Item IV-B).
- The Hatchery Committees representatives present agreed that Chelan PUD could proceed with their proposal, "Mid-Columbia Chinook Salmon Precocity Studies," but requested a more detailed study plan and monthly updates as the study progresses (Item IV-C).
- The Hatchery Committees members present agreed to continue the existing Hatchery Monitoring and Evaluation (M&E) Programs with minor revisions in 2013, and to implement the updated M&E program for 2014 and beyond (Item II-B).

REVIEW ITEMS

- No reports are currently out for review.

FINALIZED REPORTS

- No reports have been finalized since the last Hatchery Committees meeting.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. The following revisions were requested:

- Keely Murdoch asked for an update on the Dryden Rearing Facility studies and efforts to meet the Wenatchee River phosphorus TMDL.
- Kirk Truscott added a presentation on the CCT's Chief Joseph production and M&E plans for fiscal year (FY) 2013.
- Greg Mackey added: 1) a discussion of a draft SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook; and 2) a brief Wells Hatchery modernization update.

The revised draft July 18, 2012 meeting minutes were reviewed. Chelan PUD discussed their revisions already incorporated into the revised minutes. Hatchery Committees' members present approved the July 18, 2012 meeting minutes, as revised. Bill Gale approved the July meeting minutes by email.

II. Douglas PUD

A. SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook (Greg Mackey)

Greg Mackey presented for discussion a draft SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook (Attachment B). The draft SOA was distributed to the Hatchery Committees by Kristi Geris on August 14, 2012. Mackey said that Douglas PUD will be seeking approval of this SOA at the September 19, 2012 Hatchery Committees meeting.

Mackey said that former Wells Hatchery Manager, Jerry Moore, originally expressed concern about the mid-June release time for Wells Hatchery subyearling summer Chinook. He said that, based on Moore's observations and other WDFW staff, a 4-year study beginning in 2004 was conducted to compare smolt to adult returns (SARs) of mid-May versus mid-June release groups of Wells Hatchery subyearlings. The results of this study indicated that the May release group had SARs 2.75 times those of the June release group. Mackey said that, as a result of these findings, in 2008, the HCP Hatchery Committees decided to shift the release time of future Wells Hatchery sub-yearlings to mid-May, starting with the 2009 release group, but did not formalize the decision. Mackey said this SOA is intended to formalize the decision that was made by the HCP Hatchery Committees in 2008. He added that the release time affects water use at Wells Hatchery and needs to be taken into account during ongoing planning for the hatchery's modernization; therefore, Douglas PUD would like to have formal agreement on the release timing.

The Hatchery Committees members expressed continued support for the May release date and draft SOA. Josh Murauskas noted that smolt monitoring at the Rocky Reach Bypass does not begin enumerating subyearling Chinook until June 1. Murauskas agreed to check with the fish monitoring staff at Rocky Reach Dam about shifting the start date of subyearling Chinook monitoring to begin in May in future years.

B. Hatchery M&E Update (Greg Mackey)

Before addressing plans to revise and update the Douglas PUD Hatchery M&E Plan, Greg Mackey updated the Committees on the status of their Hatchery and Genetic Management Plans (HGMP). He said that neither the Wells steelhead nor Methow spring Chinook HGMPs, and associated Endangered Species Act (ESA) permits, have been processed yet by National Marine Fisheries Service (NMFS), and he anticipates that NMFS will incorporate M&E conditions into the new permit. Mackey said Douglas PUD is scheduled to meet with NMFS, WDFW, and U.S. Fish and Wildlife Service (USFWS) staff to discuss HGMP goals. He said these discussions could lead to modifications of the M&E Plan.

With several HGMP and M&E issues still unresolved, Mackey said Douglas PUD is proposing to defer implementation of the fully revised Hatchery M&E Program until 2014; in 2013, they would implement the existing M&E programs with minor updates. Tom Kahler added that in order for Douglas PUD to implement a new M&E program this coming year, the new program would need to be approved by the November 2012 Hatchery Committees meeting; and Douglas PUD will not have their new permits before that time, which will largely shape their M&E programs. Mackey said new permits are due one year from now, which will coincide with the proposed date for the new M&E programs. This revised schedule would allow more time for a thorough review of the existing programs and for development of M&E updates.

Keely Murdoch expressed support for Douglas PUD's proposed timeline to implement a new Hatchery M&E Program in 2014. She added that a lot of thought went into the original M&E Plan, and she does not foresee significant changes in the revised M&E plan. Mackey said Douglas PUD anticipates maintaining most of the original program with only minor revisions.

Josh Murauskas said Chelan PUD plans to complete, in conjunction with the Hatchery Committees, the 5-year review of their Hatchery M&E Program by mid-2013. He said Chelan PUD has discussed their M&E objectives, and plans to review those and verify whether Chelan PUD is meeting the goals of their M&E program.

The Hatchery Committees members present agreed to the new schedule, which includes: 1) continuing to implement the existing Hatchery M&E Programs with minor revisions in 2013; 2) maintaining an aggressive schedule for updating the plan so as to not lose momentum; and 3) implementing the fully revised M&E programs beginning in 2014.

C. Wells Hatchery Modernization Update(Greg Mackey)

Greg Mackey said that Wells Hatchery is currently in Phase I of a modernization process, which largely focuses on the water supply and conveyance system, bio-programming, and the condition of existing facilities. He said Douglas PUD is working with a hydrologist from HDR Engineering, Inc. (HDR), and a report on the well water supply is expected soon. Mackey said HDR is also conducting a facility assessment of the entire Wells Hatchery facility. He said that, in general, the Phase I effort includes an initial assessment of all infrastructure, and identification of needed upgrades.

Mackey said Phase II of the modernization process will continue to focus on bio-programming, which will inform water needs for Wells Hatchery operations. Mackey said rearing vessels needed to accommodate future programs will also be addressed during Phase II.

Mackey said Douglas PUD had met with the YN to discuss the rearing of coho salmon for the YN Upper Columbia Coho Reintroduction Program at Wells Hatchery. However, he said the needed modifications were not within their budget, and the YN has decided to look elsewhere. Mackey did note that Douglas PUD will be able to provide space at Wells Hatchery for the YN Twisp River Steelhead Kelt Reconditioning Program.

Keely Murdoch provided a brief update on the YN Kelt Reconditioning Program. She said they are currently holding kelts at Winthrop National Fish Hatchery (NFH), and will be releasing adults to spawn naturally. She added that, because the kelts have already been spawned once in a hatchery, they do not plan to spawn them in a hatchery again. Murdoch said all fish are passive integrated transponder (PIT)-tagged and tissue sampled for genetic analysis. Mackey suggested that the YN might want to consider a temporary weir to control the migration of reconditioned kelts released into a small stream, such as Little Bridge Creek. This would enable a more controlled assessment of spawning and reproductive success.

III. CCT

A. CCT's Chief Joseph Hatchery Programs and M&E Plans (Kirk Truscott)

Kirk Truscott said that he will coordinate with Keith Wolf to arrange a formal presentation on the CCT's Chief Joseph Hatchery Programs at the September 19, 2012 Hatchery Committees meeting.

Truscott said the CCT submitted a Hatchery M&E Program proposal to the Bonneville Power Administration (BPA) through the PISCES program. He said that the scope of work is based upon work elements that are standardized, and may not correspond to typical M&E program elements. Truscott said that the CCT is developing an additional Hatchery M&E Program that aligns with the HCP and Priest Rapids Coordinating Committee (PRCC) objectives. He added that the CCT will have a contract by October 1, 2012; and an update will be provided at the March 2013 APR workshop.

Truscott said the CCT is no longer operating under multiple-year contracts with BPA; therefore, CCT's Operations and Maintenance (O&M) and M&E plans will be modified annually. Truscott said key components of the CCT Hatchery M&E Program include: 1) in-hatchery monitoring by life stage; 2) tagging plans; 3) deployment of two smolt traps to increase monitoring on the Okanogan River; and 4) fall carcass recovery and redd counts. Truscott said CCT is also developing a pilot weir operation near Monse to facilitate improved accuracy of enumeration of escapement into the Okanogan River.

Truscott said CCT's proposed Hatchery Operations and M&E budgets for FY 2013 are approximately $1.4 million and $960,000, respectively. He said approximately $650,000 of the Hatchery Operations budget is for electricity; and a large amount of the $960,000 for M&E

goes towards database development during the first year, and this figure will decrease in subsequent years.

Truscott said CCT is anticipating a 60 percent of capacity production for BY 2013. He added that spring and summer Chinook production will be adequate to meet the planned PUD Chinook obligations at Chief Joseph Hatchery. Truscott said he will provide an electronic copy of CCT's proposed BY 2013 Chief Joseph Hatchery spring and summer Chinook production to Kristi Geris for distribution to the Hatchery Committees. Truscott said CCT is still expecting to bring BY 2013 spring Chinook on-station by mid-May 2013; he added that the fish will be from broodstock collected at Leavenworth NFH; MetComps will be from Winthrop NFH. Mike Tonseth asked if a plan was in place in case facilities are not ready, and Truscott said that plans are in place. Tonseth also asked about plans for overwinter acclimation. Truscott said that Chief Joseph Hatchery overwinter acclimation preparations are mostly complete, and on track for 2013. He said that CCT plans to operate overwinter acclimation ponds this winter to investigate whether groundwater prevents the ponds from freezing.

IV. Chelan PUD

A. Methow Update (Josh Murauskas)

Josh Murauskas said Chelan PUD sent Douglas PUD a proposal for continuing production at the Methow facility, including associated costs for production of 60,516 Chelan PUD spring Chinook. Mike Tonseth asked when a decision can be expected. Murauskas replied that the sharing agreement would be required for BY 2013, and Greg Mackey said that would require a decision by this winter. Mackey added that Joe Miller and Shane Bickford have been corresponding; however, Mackey said he is unsure of the status as the discussions are ongoing.

B. Chelan Falls Brood Collection (Josh Murauskas)

Josh Murauskas said that Chelan PUD has been coordinating with WDFW on logistics for conducting the Chelan River Brood Collection 2012 Pilot Study (Attachment C). Kristi Geris distributed the study plan to the Hatchery Committees on August 8, 2012. Murauskas said that Chris Moran (WDFW) has been helping with this study plan that is designed to investigate the potential to collect returning Chelan River summer/fall Chinook to use as brood for Chelan Falls Hatchery production. Murauskas said the study includes mark and recapture methods to assess how many fish may be available for production at Chelan Falls Hatchery. Murauskas asked the Hatchery Committees for comments or concerns regarding this study.

Keely Murdoch asked about the rationale for sourcing returning fish for Chelan Falls Hatchery production. She asked why they would not use excess hatchery returns collected at Wells Hatchery. Murauskas said the purpose was to take advantage of the opportunity for local brood collection. Kirk Truscott asked if it was mostly a cost issue, and Murauskas responded that it was, and said if collection at Chelan River turns out to be difficult or expensive, then Chelan PUD will not pursue this option.

Mike Tonseth suggested that there may be the potential for some biological benefit. He said that, unlike at other facilities, there are no rack returns. Truscott added that with Chelan River brood collection, Chelan PUD will not have to rely on Wells production to meet Chelan Falls broodstock. Murdoch added that if Chelan PUD thinks localized brood collection will be more efficient, she is not opposed to the study. She said it will be important to closely observe what fish are collected for the study; it could be a problem if fish are collected that are heading upstream. Tonseth agreed that timing is a major issue. The Hatchery Committees representatives present agreed that Chelan PUD and WDFW should proceed with the Chelan River Brood Collection 2012 Pilot Study for summer Chinook production at Chelan Falls Hatchery.

C. Summer Chinook Size Targets (Don Larsen/Josh Murauskas)

Josh Murauskas said that Chelan PUD, in coordination with Brian Beckman and Don Larsen (NMFS Northwest Fisheries Science Center), recently developed a conceptual draft Mid-Columbia Chinook Salmon Precocity Studies plan (Attachment D). He added that results of this study may contribute information that would help Chelan PUD meet the phosphorus TMDL targets at the Dryden facility. Murauskas said that Chelan and Grant PUDs, the NMFS scientists, and WDFW met with the hatchery staff last week to discuss revisions to the draft study plan. Kristi Geris distributed the revised draft study design to the Hatchery Committees on August 8, 2012.

Larsen said they planned to test a range of fish sizes, and that the study plan was to incorporate replications over years at each site. Larsen said raceway types and fish sizes still need to be determined. He said that the hope was for fish to be sampled next fall to evaluate study progress. Larsen said that results of this study would provide information about differences among rearing vessels, as well as size at release. Murauskas said Chelan PUD was looking for support from the Hatchery Committees to move this study forward.

Mike Schiewe asked about a statistical analysis plan. Murauskas said that PIT tags will be used to analyze smolt survival, performance, and travel time. He added that discussions are still ongoing regarding sample sizes needed for sufficient statistical power. Keely Murdoch asked to clarify what "reduced size" implies as described in Table 1 of Attachment D. Larsen said he is working with fish health staff to determine what size limit would be attainable without impacting fish health. Mike Tonseth asked if they considered increasing the length of chilled incubation to decrease fish size. Alene Underwood said she thinks that option is already being implemented to the extent it can be used without affecting fish health.

Schiewe asked if criteria are being developed to ensure fish health is not being affected. Murauskas said fish will be monitored throughout the study to prevent fish health impacts. He added that fish will also be monitored at the end of spring prior to release. Larsen also said monitoring will include coefficients of variation (CVs) and condition factors of the fish. Brian Beckman said that if monthly monitoring indicates potential issues, culture staff will conduct additional monitoring, and conditions can be adjusted. Beckman said there will be both group and individual monitoring.

Murauskas said that fish will be PIT tagged prior to release in the spring, and fish lengths will be recorded on 100 percent of the fish. Beckman said growth and smolt physiology will also be monitored among the treatments. For adult performance, as described in Table 2 of Attachment D, Kirk Truscott asked if the study plan includes testing for statistical significances in SARs. He suggested that a large number of PIT tags will be needed for this. Murauskas said that for SARs, a large sample size is not needed because of the high probability of detection of returning adults. Murauskas said there can be, however, large variation with tag detection efficiency of smolts.

Truscott asked about the high percentage of overall production that would be involved in the study, and suggested that it was risky to have half of the production manipulated in case something goes wrong. Larsen said they need a large sample size to make a stronger case. He added that considering the potential risk, the reduced ration is planned for the smaller vessels. Beckman added that the general consensus was to use the larger sample size because the overall survival will go up.

Tonseth said that the largest fish size will probably be about 10 fish per pound (fpp), without compromising fish health. Larsen said he agreed with that number and added that it is a good benchmark to aim for. Tonseth said 15 fpp has been targeted, as well; so having half of the program at 10 fpp and the other half at 15 fpp, would not put excessive risk to the program. Larsen clarified that in Table 1 in Attachment D, 10 fpp and 15 fpp should be included as size targets at Chelan Falls to mimic the Dryden control. He said this will be important in identifying issues. Larsen added that both facilities will be adaptively managed.

Schiewe asked if the option had been considered of viewing the 2012 brood as a pilot year, given that there are so many unknowns. Larsen said he originally had in mind a 3-year study. Murauskas noted that, in order for these results to contribute to meeting the Wenatchee phosphorus TMDL, they are needed sooner than 3 years out.

Murauskas added that Table 6.10 in the annual M&E report shows variation with fish size at release up to 22 fpp; so this study appears to be realistic compared to what has happened in the past. Tonseth added that there have been various factors in the past that caused variation.

Tonseth asked if a more detailed study plan will be provided to the Hatchery Committees for review. Murauskas said that the conceptual draft plan (Attachment D) should serve as a good platform; however, if the Committees would like to see something more specific, then Chelan PUD will prepare a more detailed plan. Tonseth said he would like to see a write-up on pond timing and chilled incubation. He said that this information would provide a rough idea of what size at release will be. Murauskas said that within the next month he will provide to the Hatchery Committees a more complete study plan for the Mid-Columbia Chinook Salmon Precocity Studies, including: 1) fish size targets and estimated pond timing, and 2) a section on sample sizes and proposed statistical methods for analyzing and interpreting results. Murauskas also agreed to provide to the Committees monthly updates as the study progresses.

The Hatchery Committees representatives present agreed that Chelan PUD could proceed with the Mid-Columbia Chinook Salmon Precocity Studies, contingent upon receiving a more complete study plan and monthly updates as the study progresses.

V. Yakama Nation

A. Dryden Update as it Pertains to the Wenatchee River Phosphorus TMDL (Keely Murdoch)

Keely Murdoch requested an update on any follow-up to the Hatchery Committees' July meeting discussion on the Dryden facility and plans to comply with Wenatchee River phosphorus TMDL. Murdoch asked if there was a path forward to engage Ecology. She also asked who is working on it, and what the timeline is for the tasks.

Alene Underwood said she thought Tom Scribner was pulling this together, particularly in terms of how and when to engage Ecology. Underwood said Chelan PUD developed a water quality testing plan, which is now being internally reviewed. Underwood said that once that review is complete, she will provide Chelan PUD's Draft Water Quality Sampling Report and the Chelan Falls Hatchery 2012 effluent sampling results to Kristi Geris for distribution to the Hatchery Committees. Murdoch explained that the YN wants to be sure that this issue is not getting dropped, and that someone is taking the lead.

Mike Schiewe explained that Scribner requested that the Hatchery Committees work together on a plan to approach Ecology as a group. Underwood had explained that within Chelan PUD there were multiple units involved in the Wenatchee TMDL issue and that any role of the fisheries staff would have to be reviewed by Chelan PUD management. She added that none of this was an agreement by Chelan PUD to take the lead; in fact, she said Chelan PUD had already been in contact with Ecology on the TMDL issue as summarized by Sam Dilly at the June Hatchery Committees meeting. Murdoch agreed that the YN will develop suggested steps forward on how to engage Ecology regarding what is being done to meet the Wenatchee River phosphorus TMDL, in order to facilitate discussion at the September 19, 2012 Hatchery Committees meeting.

VI. HETT

A. HETT Update (Greg Mackey)

Greg Mackey said that the Hatchery Evaluation Technical Team (HETT) met on August 14, 2012, and discussed the status of the Non-Target Taxa Of Concern (NTTOC) risk modeling. Mackey said that the HETT agreed to send him the model runs completed to date, which Mackey estimated to total approximately 127 runs. Mackey said he will compile the results into a database for analysis, which will then also be used to assess Delphi panel results in comparison the model results. Mackey said the HETT agreed that the Delphi panel will consist, at least initially, of a smaller group of local scientists and that the HETT will produce a report on the NTTOC modeling and Delphi results for the Hatchery Committees, and then potentially engage a broader Delphi panel and ultimately develop a more robust manuscript later. Mackey said the HETT will meet again in one month to discuss data gaps in the modeling. Mackey said a more concrete update will be provided thereafter, once all runs have been received.

VII. HCP Administration

A. Next Meetings

The next scheduled Hatchery Committees meetings are on September 19, 2012 (Douglas PUD office); October 17, 2012 (Chelan PUD office); and November 21, 2012 (Douglas PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – Draft SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook
Attachment C – Chelan River Brood Collection: 2012 Pilot study for summer Chinook production at Chelan Falls Hatchery
Attachment D – Mid-Columbia Chinook salmon precocity studies

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Alene Underwood*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons	Grant PUD
Kirk Truscott	Colville Confederated Tribes
Keely Murdoch*	Yakama Nation
Mike Tonseth*	WDFW
Brian Beckman†	NMFS
Don Larsen†	NMFS

Notes:

* Denotes Hatchery Committees member or alternate

† Joined by phone for the Mid-Columbia Chinook salmon precocity studies discussion

Wells HCP Hatchery Committee

Statement of Agreement

Timing of release of Wells Hatchery Sub-Yearling Summer Chinook

Approved on XX September 2012

Statement

The Wells HCP Hatchery Committee approves the timing of release for the 484,000 subyearling summer Chinook inundation compensation program that takes place annually from the Wells Hatchery. The new release timing for this program will be on or around May 15th of each calendar year.

Background

The Wells HCP requires Douglas PUD to release 484,000 sub-yearling summer Chinook as Fixed Hatchery Compensation – Inundation (Wells HCP; Section 8.4.6). A recent study tested the management strategy of releasing Wells Hatchery subyearling summer Chinook (sub-yearlings) in mid-May (range May 11-18) instead of in mid-June (range June 13-14) , as had been used at Wells Hatchery for many years.

Beginning in 2004, the Wells Hatchery subyearling release was split into May and June release groups and tracked with CWT and PIT tags. The results of this study found that the May release group arrived at McNary Dam approximately 15 days earlier and had 2.75 times the smolt to adult returns (SAR) as the June release group (2004-2007 release years, each year the early release group had a statistically higher SAR). Based on the results of the first three years of the study, in 2008 the HCP Hatchery Committee decided to shift the release timing of all future Wells Hatchery sub-yearlings to the middle of May starting with the 2009 release group.

This SOA is intended to formalize the decision that was made by the HCP HC in 2008. This change in release timing is expected to more than double the number of adult Chinook returning from this component of the summer Chinook inundation compensation program.

Chelan River Brood Collection

2012 Pilot study for summer Chinook production at Chelan Falls Hatchery

Introduction

Fishery managers often desire localized brood collection for genetic and logistic purposes. The Chelan Falls Hatchery was constructed to provide capacity for a 600,000 yearling summer Chinook segregated program intended for harvest augmentation. Brood has typically been collected at the Wells Hatchery, though increasing returns to the Chelan River may provide an opportunity for a localized collection. As a means to test the efficacy of various methods, we are proposing to conduct a pilot study in 2012. The intent is to identify methods to secure brood in the Chelan River for a 576,000 smolt program based on recalculated production values beginning with brood year 2012 (estimated 318 adults including 154 females).

Materials and Methods

Various methods will be used to target adult summer Chinook returning to the Chelan River. Beach seines will be the primary capture technique, though boat seines, fyke nets, Merwin traps, and hook and line fishing will be considered depending on availability of equipment and expertise. Chelan PUD is currently coordinating with Washington Department of Fish and Wildlife to determine which approaches would be viable options to assess during the 2012 return to the Chelan River. All fish handled will be released following capture since the objective is to assess the efficacy of capture methods. Environmental (temperature, flow), date/time, and biological (length, sex) will be determined to the extent possible and results reported to the Hatchery Committee by December 2012. Additional data collected during Chelan River surveys will serve as further context to consider local brood collection.

Timeline

Fish trapping will occur approximately three weeks prior to peak spawning in October. Capture methods, previous years' data, and technician availability will drive the sampling schedule. Reporting will be provided to the Hatcher Committee in December 2012.

MID-COLUMBIA CHINOOK SALMON PRECOCITY STUDIES

SUMMARY

Monitoring and evaluation data from mid-Columbia spring- and summer-run Chinook salmon hatcheries indicate that rearing strategies have significant implications in the performance of artificially-produced fish. Growth regimes, influencing size at release, are among the foremost factors affecting survival and population demographics. The consequences of rearing approaches therefore provide an opportunity to increase age at maturity, reproductive success, smolt survival, subsequent adult returns, and likelihood of reaching genetic management goals. Positive outcomes could further reduce stray rates, precocity, and potential impacts to non-target species in natal streams. The purpose of this study design is to use physiological and behavioral monitoring techniques to develop biologically-based growth regimes and size targets for mid-Columbia River hatchery summer Chinook reared at Dryden and Chelan Falls acclimation ponds. Outcomes would also be considered as a potential means for improving performance of the Wenatchee River summer Chinook hatchery program. Results would be adopted for use in hatchery programs moving forward.

STUDY CONSTRUCT

The goal of the proposed study would be to assess culture practices to identify techniques that maximize performance of hatchery-origin summer-run yearling Chinook salmon released in the mid-Columbia River. The Dryden and Chelan Falls facilities provide opportunities to evaluate size targets and rearing vessels and their effect on quality and performance of hatchery-origin summer Chinook smolts (Table 1). Smolts reared at Eastbank and spring-acclimated at Dryden can be treated by fish size and rearing vessel; fish reared at Eastbank and winter-acclimated at Chelan Falls can be treated by fish size with comparisons to Eastbank. Metrics collected will include fish physiological and smolt and adult in-river performance based on PIT returns (Table 2). Brood years 2012 and 2013 will be evaluated, with juvenile results concluding in 2015 concurrent with additional studies at Dryden Acclimation Ponds.

The goal of the evaluations described here will be to determine if changes in hatchery operations can significantly improve the quality and subsequent performance of hatchery-origin summer Chinook salmon. For example, precocity affects the overall survival of smolts (since precocious males are valued as mortalities in mark-recapture models). With survival held constant between rearing vessels and assumed to increase with size, effective survival decreases at some point with increasing rate of precocity. Optimal strategies can therefore be identified through monitoring physiology, health, and in-river performance of smolts reared under varying circumstances. The funding of this research would be contingent on acceptance from the hatchery committees that results will be used to adopt biologically-derived rearing strategies and further ascertain if operational approaches can be used to increase performance of the Dryden program to meet management objectives.

TABLE 1. POTENTIAL STUDY FACILITIES FOR YEARLING SUMMER CHINOOOK PRECOCITY STUDIES.

Facility	Stock	Treatments or replications
Dryden	Wenatchee	Control (10 FPP) and test (reduced size) fish reared in re-use (2 vessels), super raceways (2 vessels), and standard raceways (2-4 vessels) for a total of ≥3 groups each of control and test fish. The availability of standard raceways 3 and 4 will be determined by the operators. Super raceways will contain ≥ 150k smolts each, 25k smolts in standard raceways, and 50k smolts in circular vessels for a total of 500k smolts destined for Dryden Ponds.
Chelan Falls	Wells	Four groups representing a range of size targets (e.g., 12, 16, 20, and 24 FPP) depending on capacity of operators to manipulate growth among groups.

TABLE 2. POTENTIAL STUDY METRICS FOR YEARLING SUMMER CHINOOOK PRECOCITY STUDIES.

Metric	Purpose	Hypothesis
Fish screening	Precocity and smolt quality	Feeding regime, size targets, and rearing vessels significantly influence the rate of precocity and quality of yearling summer Chinook.
Smolt performance	Travel and survival to McNary	Feeding regime, size targets, and rearing vessels significantly influence the in-river performance of yearling summer Chinook.
Adult performance	Age structure, SARs, stray rates	Feeding regime, size targets, and rearing vessels significantly influence the subsequent in-river performance of adult summer Chinook returns.

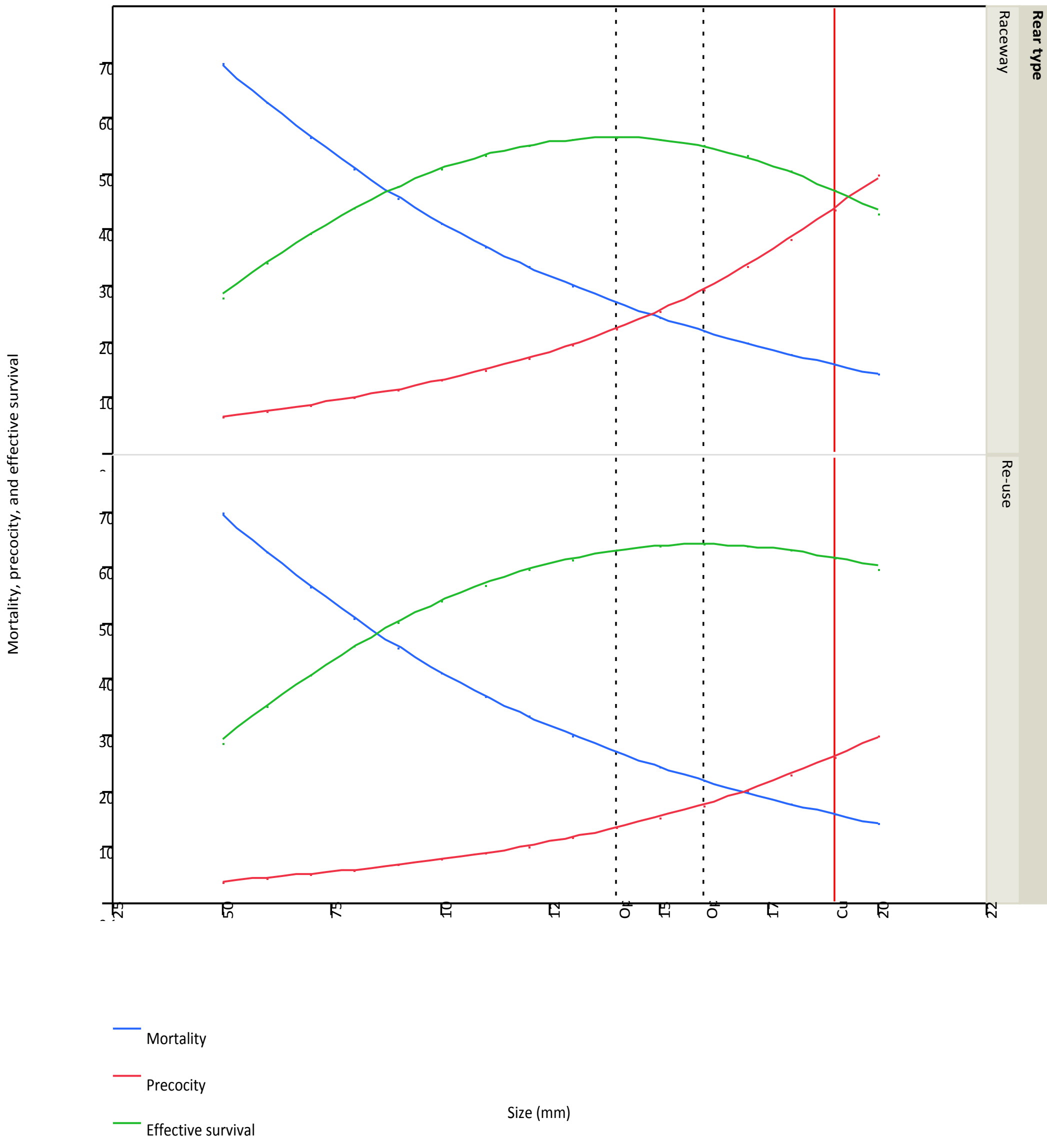

FIGURE 1. CONCEPTUAL MODEL OF MORTALITY, PRECOCITY, AND RESULTING EFFECTIVE JUVENILE SURVIVAL RATE, BY REAR TYPE. CURRENT TARGET (RED), AND OPTIMAL TARGETS (DASHED) FOR RE-USE (~64%) AND RACEWAY (~57%) SHOWN FOR COMPARISON.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	November 15, 2012
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the September 19, 2012, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Douglas PUD headquarters in East Wenatchee, Washington, on Wednesday, September 19, 2012, from 9:30 am to 12:30 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Kirk Truscott will email Colville Confederated Tribes' (CCT's) revisions to the revised draft August 15, 2012 meeting minutes to Kristi Geris to be incorporated into the final Hatchery Committees August 15, 2012 meeting minutes (Item I).
- Chelan PUD and Douglas PUD will present their draft 2013 Hatchery Monitoring and Evaluation (M&E) Work Plans to the Hatchery Committees no later than the November 21, 2012 Hatchery Committees meeting (Item III-A).
- Chelan PUD will contact Douglas PUD to discuss a limited sharing agreement that supports only selected aspects of Chelan PUD's Methow spring Chinook salmon production (Item III-B).
- Bill Gale will discuss with U.S. Fish and Wildlife Service (USFWS) the potential to use Winthrop National Fish Hatchery (NFH) for Chelan PUD above Rocky Reach spring Chinook salmon mitigation (Item III-B).
- Alene Underwood will provide electronic versions of the draft 2012 Wastewater Quality Analysis for Dryden and Chelan Falls, and the draft 2013 Dryden Acclimation Wastewater Sampling Plan to Kristi Geris for distribution to the Hatchery Committees. Comments on the draft documents are due to Chelan PUD prior to the October 17, 2012 Hatchery Committees meeting (Item III-C).
- Alene Underwood will revise the draft 2013 Dryden Acclimation Wastewater

Sampling Plan prior to distribution to the Hatchery Committees (Item III-C).

- Kristi Geris will coordinate with Tom Scribner to set up an initial call convening a workgroup for engaging Washington State Department of Ecology (Ecology) in discussions regarding efforts to meet the Wenatchee River phosphorus total maximum daily load (TMDL). The workgroup will include Tom Scribner representing the Yakama Nation (YN); Bill Gale and Dave Irving representing USFWS; Alene Underwood representing Chelan PUD; Mike Tonseth representing Washington Department of Fish and Wildlife (WDFW); and Todd Pearsons and Ross Hendrick representing Grant PUD (Item III-C).
- Keely Murdoch, Mike Tonseth, and Bill Gale will develop a draft conceptual plan outlining multi-species acclimation options for Upper Columbia salmon and steelhead mitigation programs. The draft plan will be distributed to the Hatchery Committees for review and discussion no later than December 1, 2012 (Item IV-A).

STATEMENT OF AGREEMENT DECISION SUMMARY

- The Statement of Agreement (SOA) for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook was approved by the Wells Hatchery Committees representatives present (Item II-A).

AGREEMENTS

- The Hatchery Committees representatives present agreed to authorize the YN to release approximately 24,000 excess production coho salmon from Winthrop NFH at the Starr Boat Launch (Item IV-B).
- The Hatchery Committees representatives present agreed to the YN proposal to move forward with negotiations with Douglas PUD to use the Chewuch Acclimation Facility for the YN Upper Columbia Coho Reintroduction Program (Item IV-C).

REVIEW ITEMS

- No reports are currently out for review.

FINALIZED REPORTS

- No reports have been finalized since the last Hatchery Committees meeting.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. Tom Scribner added: 1) authorization for a thinning release of coho salmon at Starr Boat Launch; and 2) discussion on using the Chewuch Acclimation Facility for the YN Upper Columbia Coho Reintroduction Program.

The revised draft August 15, 2012 meeting minutes were reviewed. Kristi Geris said all comments and revisions received on the draft meeting minutes were incorporated and there are no outstanding items remaining to be discussed. Kirk Truscott said the CCT has additional revisions to the revised minutes that he will email to Geris to be incorporated into the final meeting minutes; and Keely Murdoch requested a minor text revision to the YN's action item and discussion on engaging Ecology. The Hatchery Committees' members present approved the August 15, 2012 meeting minutes, with CCT's proposed revisions incorporated.

II. Douglas PUD

A. DECISION: SOA for Wells Hatchery Sub-Yearling Summer Chinook Release Date (Tom Kahler)

Tom Kahler said that Douglas PUD is seeking approval from the Hatchery Committees of a draft SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook (Attachment B), which was introduced at the August 2012 Hatchery Committees meeting and then redistributed to the Hatchery Committees by Kristi Geris on September 4, 2012.

Kahler summarized that, historically, the release time for Wells Hatchery subyearling summer Chinook salmon was mid-June; however, releases in June did not produce good numbers of returning adults. A multi-year passive integrated transponder (PIT) tag study to evaluate the relative survival of June versus May subyearling releases indicated that mid-May release groups have smolt-to-adult returns (SARs) 2.75 times those for mid-June release groups. Kahler said that the HCP Hatchery Committees decided in 2009 to shift the release time of future Wells Hatchery sub-yearlings to mid-May; however, this decision was never formalized. He said that Douglas PUD is now developing plans to modernize Wells Hatchery, and because release timing affects water requirements, Douglas PUD needs formal agreement on the release timing. The SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook was approved by the Wells Hatchery Committees representatives present.

III. Chelan PUD

A. Hatchery M&E Update (Josh Murauskas)

Josh Murauskas said the Hatchery M&E Program working group has convened twice, and a third meeting is being scheduled, as distributed to the Hatchery Committees by Kristi Geris on September 5, 2012. Murauskas said the goal is to hold these meeting as often as practical, and he encouraged Hatchery Committees members to participate as time allows. Murauskas recapped that, during the first meeting, the group discussed the strategy for reviewing and revising the Hatchery M&E Plans; and during the second meeting, the group agreed that the starting point would be evaluation of the current analytical framework and existing objectives to determine what modification may be needed. Murauskas noted that adult management has been a key topic, and in particular, how to incorporate it into M&E objectives.

Mike Schiewe reminded the group that the Hatchery Committees agreed to implement the fully revised M&E programs beginning in 2014, and the existing Hatchery M&E Programs, with minor revisions, in 2013. He added that minor revisions to the existing plans will be reflected in the 2013 Hatchery M&E Work Plans. Chelan PUD and Douglas PUD agreed to present their draft 2013 Hatchery M&E Work Plans to the Hatchery Committees no later than the November 21, 2012 Hatchery Committees meeting.

B. Rocky Reach Spring Chinook Salmon Production (Josh Murauskas)

Josh Murauskas presented a handout outlining several potential options for rearing Rocky Reach no net impact (NNI) spring Chinook salmon mitigation in the Upper Columbia (Attachment C), which Kristi Geris distributed to the Hatchery Committees on September 4, 2012. Alternatives to the existing arrangement are necessary because Chelan PUD terminated the existing sharing agreement between Chelan PUD and Douglas PUD, and a new agreement has not been established. Accordingly, he said Chelan PUD wants to begin obtaining feedback on options from the Hatchery Committees. Murauskas said some of the possibilities mentioned so far included rearing at Winthrop NFH, rearing in distributed acclimation ponds, and rearing at the new Chief Joseph Hatchery. Murauskas added that the last possible date for a decision is April 2013, in order to meet the deadline for the Hatchery Committees to review and for WDFW to submit a broodstock collection plan to the National Marine Fisheries Service (NMFS).

Tom Scribner asked if Chelan PUD has a backup plan while options are explored. Murauskas said one possibility was to rear fish at Chiwawa. Scribner asked if Chelan PUD could rear fish at Eastbank Hatchery. Mike Tonseth said that capacity exists at Eastbank for early rearing and holding adults. Bill Gale reminded the Committees that Chelan PUD has an obligation to produce fish for release above Rocky Reach. He said the two options include release in the Okanogan and Methow rivers, both of which require broodstock collection at Wells Dam or above. Gale said that even if Chelan PUD goes elsewhere for rearing, broodstock will still need to be collected at or above Wells Dam, with current options being Wells Dam or a Methow River facility.

Scribner asked if the PUDs had discussed an arrangement where individual steps in production (i.e., broodstock collection, spawning, early rearing, etc.) could be accomplished at the Methow Hatchery. Alene Underwood said that the discussions so far did not include any such options. Tom Kahler added that Douglas PUD has made offers to Chelan PUD and Grant PUD that would require all three PUDs to pay their proportion of overall hatchery capital, M&E, and operation costs; individual components of the program were not split out, and doing so would complicate an otherwise straightforward offer.

Tonseth noted that even if the spring Chinook salmon were reared at Eastbank, adult collection and overwinter acclimation would need to be resolved. Scribner asked if overwinter acclimation could be accomplished at Carlton, and Underwood said that Chelan PUD's portion at Carlton Facility is not currently suitable for overwinter rearing. Gale suggested that if Chelan PUD and Douglas PUD cannot come to agreement about using the Methow Hatchery, then rearing at Carlton would be Chelan PUD's most viable option. Tonseth did not dismiss the possibility of acclimating Carlton-reared fish in the upper basin YN facilities; however, he said that WDFW will find it difficult to support long-term rearing at Carlton because it is too low in the basin, and there is no way to manage proportion of hatchery-origin spawners (pHOS). Gale said he would prefer Carlton over Eastbank.

Scribner asked when Chelan PUD needs a Hatchery Committees recommendation on broodstock collection and spawning. Murauskas said that, at this point, Chelan PUD needs to look into the question of a limited use agreement at Methow Hatchery. He said that Chelan

PUD will contact Douglas PUD to discuss an agreement that supports only selected aspects of Chelan PUD's Methow spring Chinook salmon production.

Responding to a question about the potential for moving the program to Winthrop NFH, Gale said that he did not consider that a good option as the broodstock would have to be held separately, and there was currently not enough rearing space to take 60,000 to full term. He said more rearing space could become available if one of the existing programs was reduced; however, he doubted that USFWS would reduce a U.S. Bureau of Reclamation-funded program to accommodate Chelan PUD production. Gale said another possibility might be to add rearing space, but he was not sure enough water was available. Gale agreed to discuss these options with USFWS hatchery staff. Tonseth noted that the Committees should also consider the differences in SARs at the Methow and Winthrop NFH facilities; the SARs at the two facilities have been 0.234 and 0.134, respectively.

Kirk Truscott said he had discussed options for production at Chief Joseph Hatchery (CJH) with Chelan PUD staff, but the Biological Opinion (BiOp) issued for CJH did not include rearing Endangered Species Act (ESA)-listed salmon and CCT was not willing to reinitiate consultation. Further, Truscott expressed concern that if Methow spring Chinook were reared at CJH until spring acclimation in the Methow Basin, rearing at CJH would consist of water sources above the confluence of the Methow River and unacceptable straying to areas above the Methow would be likely.

Mike Schiewe said that all parties need to continue exploring options, including interim arrangements that maintain production until a permanent solution can be found. Tonseth said that, at a minimum, Chelan PUD needs to figure out where to get broodstock; and he added that both options appear to be at Douglas PUD facilities.

C. Dryden Update (Alene Underwood)

Alene Underwood distributed to the Hatchery Committees the draft 2012 Wastewater Quality Analysis for Dryden and Chelan Falls (Attachment D), and the draft 2013 Dryden Acclimation Wastewater Sampling Plan (Attachment E). She said she will provide electronic versions of the draft documents to Kristi Geris for distribution to the Hatchery Committees.

Underwood provided a quick summary of the two draft documents. Bill Gale noted that Leavenworth NFH would not be operating the pilot program in 2013 as proposed in Attachment E. Underwood said she will revise Attachment E prior to distribution to the Hatchery Committees. She requested comments on the draft documents prior to the October 17, 2012 Hatchery Committees meeting. Underwood added that sampling is not planned to begin until March 2013, so there will be plenty of time to adjust the sampling plan, if needed.

Tom Scribner asked about the spike in Figure 1 of Attachment D. Mike Tonseth suggested including river discharge in Figure 1, which might suggest that a freshet contributed to the pulse (spike). Scribner asked if the recommendations outlined in Section IV of Attachment D have been modeled to determine if phosphorus concentrations would meet the TMDL. Underwood said that Grant PUD's consultant is running the models, and at this point, Chelan PUD is focusing on collecting the empirical data. Todd Pearsons added that key differences in model results depend on what standards are used for incoming phosphorus. He said Grant PUD's consultant discussed this with Ecology, and determined this is still an assumption.

Gale asked about the status of the Hatchery Committees forming a working group to engage Ecology in discussion to ensure they understand the importance to the fisheries parties of the hatchery programs on the Wenatchee River. Keely Murdoch said that the Committees discussed Scribner taking the lead on this effort. Scribner agreed to this role, and said he could contact Ecology with the data collected so far, and let Ecology know there will be more data to come. Mike Schiewe added that the group should also inquire as to whether there is something additional Ecology needs.

Scribner said he would like to convene an initial meeting in the near future. Gale said he is not directly involved in the TMDL, and that Dave Irving is the USFWS lead. Underwood said that Chelan PUD's wastewater staff likely will also want to be kept in the loop. The Hatchery Committees agreed that Geris will coordinate with Scribner to set up an initial call convening a working group for engaging Ecology in a discussion on efforts to meet the Wenatchee River phosphorus TMDL. The workgroup will include Scribner representing the YN; Gale and Irving representing USFWS; Underwood representing Chelan PUD; Tonseth representing WDFW; and Todd Pearsons and Ross Hendrick representing Grant PUD.

D. Brood Collection Feasibility Update (Josh Murauskas)

Josh Murauskas said that Chris Moran (WDFW) recently had collected several summer Chinook salmon from a holding pool at the Eastbank outfall, some of which were of Dryden origin. On August 28, 2012, he collected 56 Chinook salmon, including 53 with coded wire tags. On September 11, 2012, 74 Chinook salmon were collected and snouts taken; coded wire tags were pulled from 21 of these fish. Moran said he also investigated collecting fish in the area around the Chelan Falls powerhouse, but that area was less ideal. Moran suggested, based on his findings so far, moving forward with developing the Eastbank outfall as a broodstock collection site.

Mike Tonseth suggested the option of constructing a trap at the outfall site, indicating that such an option would make it easier to acquire broodstock for the Chelan Falls Hatchery program, rather than seining or hook and line. He also noted that Eastbank Hatchery had not been constructed with a hatchery return rack because it is a central facility; and he added that there may also be a biological benefit to constructing a trap in the outfall. He suggested that if spring Chinook salmon also gather near the outfall, it might be possible to collect broodstock and manage strays.

Mike Schiewe asked what other methods for capturing broodstock were explored. Tonseth said the necessary equipment and permits still need to be obtained before testing other methods. He added that he had already confirmed with National Oceanic and Atmospheric Administration (NOAA) that their current activities at the outfall are consistent with existing ESA permits. Alene Underwood noted that if Chelan PUD decides to install a trap, it would require discussions with their permitting staff, and Chelan PUD would want to first seek the full Hatchery Committees' input. Murauskas said he will update the Committees as broodstock collection efforts continue.

IV. Yakama Nation

A. Multi-Species/Expanded Acclimation (Tom Scribner)

Tom Scribner said that the YN remains interested in developing a long-term multi-species/ acclimation plan for Upper Columbia salmon mitigation programs. He said that the plan would focus mainly on steelhead and Chinook salmon, but also include coho salmon. He added that the YN has data on juvenile rearing and releases to support the planning process. Scribner proposed that the YN develop a draft conceptual plan to present to the Hatchery Committees. Keely Murdoch suggested also involving WDFW in developing the plan; Bill Gale indicated that he would like to participate as well.

Kirk Truscott said that reluctance on the part of the Hatchery Committees to develop such a plan was not a matter of disinterest; rather, there are differences of opinion on some of the technical aspects and information presented to date. Mike Schiewe added that some Committees members were concerned that, because the size of most hatchery programs has just been reduced, waiting for the smaller programs to operate for a few years before developing a plan would be important. Schiewe said that the Hatchery Committees are open to the concept, but the best path forward needs to be established.

Bill Gale said that USFWS is open to discussion of new acclimation opportunities; however, they are currently in the process of ESA consultations, and are somewhat restricted in what decisions can be made until they know the results of the consultation. Mike Tonseth suggested developing a conceptual plan with mechanisms that indicate alternative options in the event that one option is not viable.

Gale asked if the YN would consider focusing on the Wenatchee River first, and then address the Methow River. Scribner said he would like to develop a conceptual plan for the entire Upper Columbia. Tom Kahler said that Douglas PUD has concerns about their ability to obtain the needed broodstock if fish are dispersed. Scribner said the YN does not have significant capital investments at these sites, so there is flexibility to make changes if problems such as collecting broodstock are encountered. He said the YN would like to have plans for steelhead and spring Chinook salmon completed in time for 2014 releases. Tonseth added that, in terms of marking, planning would need to be finalized by March 2013. Tonseth agreed to work with the YN to development a draft plan and identify data gaps. Murdoch said that it will be challenging to incorporate adult management in a conceptual plan without having certain data.

Murdoch, Tonseth, and Gale agreed to work together to develop a draft conceptual plan outlining multi-species acclimation options for Upper Columbia salmon and steelhead mitigation programs. The draft plan will be distributed to the Hatchery Committees for review and discussion no later than December 1, 2012

B. Authorization for a Thinning Release of Coho Salmon at Starr Boat Launch (Tom Scribner)

Tom Scribner said the YN has drafted a letter requesting authorization from NMFS to release approximately 24,000 excess production coho salmon from Winthrop NFH at Starr Boat Launch, located on the Columbia River upstream of Wells Dam. Scribner said that Craig Busack requested that Scribner share the request with the Hatchery Committees to obtain their concurrence. Scribner added that the proposed release of 24,000 is from a total of 250,000 coho salmon that are currently being reared at Winthrop NFH; all fish are coded wire tagged; and the release would be consistent with the current ESA permit. The Hatchery Committees representatives present concurred with the authorization for the release of excess production coho salmon at Starr Boat Launch.

C. Chewuch Acclimation Facility (Tom Scribner)

Tom Scribner said the YN and Douglas PUD have had initial discussions regarding the use of the Chewuch Acclimation Facility for the YN Upper Columbia Coho Reintroduction Program. He added that the YN now has a record of decision (ROD) from the Bonneville Power Administration to implement their long-term plan. Scribner said that, given the recent NNI recalculation, the size of the spring Chinook salmon program has been significantly reduced in the Chewuch River. This change creates an opportunity to co-mingle and acclimate coho and spring Chinook salmon in the existing Chewuch Facility. Scribner said the YN is proposing to acclimate approximately 100,000 coho salmon at the facility; and he added that the YN is also considering acclimating approximately 150,000 coho salmon at Eightmile Creek Acclimation Ponds. Keely Murdoch said that all 250,000 coho salmon are planned for release in the Chewuch River in 2013.

Mike Tonseth said that, as long as spring Chinook salmon acclimation is not adversely affected, then WDFW had no issues with the proposal. Scribner said that the YN has experience with co-mingled acclimation of spring Chinook and coho salmon in the back-channel at Winthrop NFH, and no negative interactions were observed. Tonseth requested further that there be an agreement to suspend co-acclimation if negative interactions are observed, to which Scribner agreed. The Hatchery Committees representatives present agreed to the YN's proposal to move forward with negotiations with Douglas PUD to use the Chewuch Acclimation Facility for the YN Upper Columbia Coho Reintroduction Program.

V. USFWS

A. Biological Opinion Update (Bill Gale)

Bill Gale said that USFWS and NOAA are close to finalizing the Entiat River BiOp. He added that the Leavenworth BiOp is also very close to being finalized. Mike Tonseth said WDFW expects a draft Wenatchee River BiOp from NMFS by the end of this month. He added that terms and conditions will largely be the same as those in the existing BiOp, with a few new terms and conditions incorporated.

VI. HCP Administration

A. Next Meetings

Mike Schiewe said that the "Future of Our Salmon" Conference scheduled for October conflicts with the Hatchery Committees' October 17, 2012 meeting date, and a request has been made to consider rescheduling the Hatchery Committees meeting to accommodate participation at the conference. The Hatchery Committees representatives did not support rescheduling the October meeting; therefore, the next Hatchery Committees meeting will be held as scheduled.

The next scheduled Hatchery Committees meetings are on October 17, 2012 (Chelan PUD office); November 21, 2012 (Douglas PUD office); and December 19, 2012 (Chelan PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – Draft SOA for the Timing of Release of Wells Hatchery Sub-Yearling Summer Chinook
Attachment C – Options for spring Chinook salmon mitigation above Rocky Reach handout
Attachment D – Draft 2012 Wastewater Quality Analysis for Dryden and Chelan Falls
Attachment E – Draft 2013 Dryden Acclimation Wastewater Sampling Plan

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Alene Underwood*	Chelan PUD
Tom Kahler*	Douglas PUD
Todd Pearsons	Grant PUD
Kirk Truscott*	Colville Confederated Tribes
Tom Scribner*	Yakama Nation
Keely Murdoch*	Yakama Nation
Bill Gale*	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Chris Moran†	Washington Department of Fish and Wildlife

Notes:

* Denotes Hatchery Committees member or alternate

† Joined by phone

Wells HCP Hatchery Committee

Statement of Agreement

Timing of release of Wells Hatchery Sub-Yearling Summer Chinook

Approved on XX September 2012

Statement

The Wells HCP Hatchery Committee approves the timing of release for the 484,000 sub-yearling summer Chinook inundation compensation program that takes place annually from the Wells Hatchery. The new release timing for this program will be on or around May 15^{th} of each calendar year.

Background

The Wells HCP requires Douglas PUD to release 484,000 sub-yearling summer Chinook as Fixed Hatchery Compensation – Inundation (Wells HCP; Section 8.4.6). A recent study tested the management strategy of releasing Wells Hatchery subyearling summer Chinook (sub-yearlings) in mid-May (range May 11-18) instead of in mid-June (range June 13-14) , as had been used at Wells Hatchery for many years.

Beginning in 2004, the Wells Hatchery subyearling release was split into May and June release groups and tracked with CWT and PIT tags. The results of this study found that the May release group arrived at McNary Dam approximately 15 days earlier and had 2.75 times the smolt to adult returns (SAR) as the June release group (2004-2007 release years, each year the early release group had a statistically higher SAR). Based on the results of the first three years of the study, in 2008 the HCP Hatchery Committee decided to shift the release timing of all future Wells Hatchery sub-yearlings to the middle of May starting with the 2009 release group.

This SOA is intended to formalize the decision that was made by the HCP HC in 2008. This change in release timing is expected to more than double the number of adult Chinook returning from this component of the summer Chinook inundation compensation program.

Spring Chinook Mitigation above Rocky Reach

Discussion Item for the Rocky Reach Hatchery Committee; September 19th, 2012

The Rocky Reach Hatchery Committee must consider options to fulfill the production requirement of 60,516 smolts beginning with the 2015 release [note that a Statement of Agreement is currently in place to fulfill this obligation at Chiwawa Ponds for the 2014 release]. The following options are submitted for discussion at the September 19th meeting. Hatchery Committee members are encouraged to propose additional options.

Table 1. Potential options for spring Chinook production above Rocky Reach Dam, 2015-2023.

Location	Timeline	Notes
Chief Joseph Hatchery	Immediately	Increase funding to include NNI production
Chiwawa Hatchery	Immediately	Continue 2014 arrangement at Chiwawa
Winthrop Hatchery	Immediately	Provide funding to include NNI production
Carlton Pond	> 2016	Facility modifications, permits, and brood collected needed

Wastewater Quality Analysis for Dryden and Chelan Falls 2012 DRAFT

I. Purpose

The purpose of the 2012 water quality analysis was to document the effect summer Chinook rearing and acclimation has on surface water discharges. Two locations, Dryden Pond and Chelan Falls Rearing Ponds, were tested for influent and effluent water quality. The data create information to guide the District and stakeholders to make decisions about ongoing facility use, future management, and infrastructure development. The data also create an understanding how facility operations (specifically feeding and cleaning) affects effluent water quality.

Background

A. Wenatchee Watershed Water Quality

The Washington Department of Ecology (DOE) issued *Addendum to Wenatchee River Watershed dissolved Oxygen and pH Total Maximum Daily Load, WRIA 45* in March 2012. The addendum communicates a Waste Load Allocation (WLA) according to Table 1.

Table 1
Waste Load Allocation
Total Phosphorous Measurement

Dryden Flow	Total Phosphorous Concentration	Total Phosphorous Load	Total Phosphorous Load
CFS	ug/l	grams/day	lbs/day
33	9.2	743	1.638
17	16.1	670	1.477
8	32.0	626	1.380
4	62.3	610	1.345
2	122.8	601	1.325
1	243.6	596	1.314

The Addendum did not state when the WLA would become effective. It is understood the timeframe to implement the Wenatchee Watershed TMDL is 2018.

B. Production Changes and Overwintering

Recent agreements in the Habitat Conservation Plan Hatchery Committee resulted in a reduction to the Wenatchee River summer Chinook program. Old and new facility acclimation criteria are as shown in Table 2. New criteria will become effective for the 2012 brood year. One future change dependent upon multiple parameters is the time fish are reared in the Dryden Pond. Grant

PUD is considering how to modify the facility to rear Chinook from November to May each season while current methods rear fish from late February until release (generally around May 1). In many years fish transfer is limited by water temperature differences and snow and ice in the Dryden Facility. This was the case with the 2009 and 2010 brood year's acclimation periods. Fish were on station each year for five or six weeks (late March to mid April).

Table 2
Dryden Pond Rearing Conditions

Rearing Criteria	Existing Conditions	Future Conditions
Fish Quantity	864,000	500,000
Fish size	10 fish/lb	10 fish/lb
Flow Index	1.0 gpm/lb-inch	
Density Index	0.125 lb/cf-inch	
Peak Flow Required	31.5 cfs	15.3 cfs[1]
Peak Volume Required	113,000 cf	55,000 cf[1]

1 This assumes 13fish/lb (only implemented under overwintering scenarios); flow and volume calculations are also needed for 10 fish/lb

C. GPUD 2011 Sampling

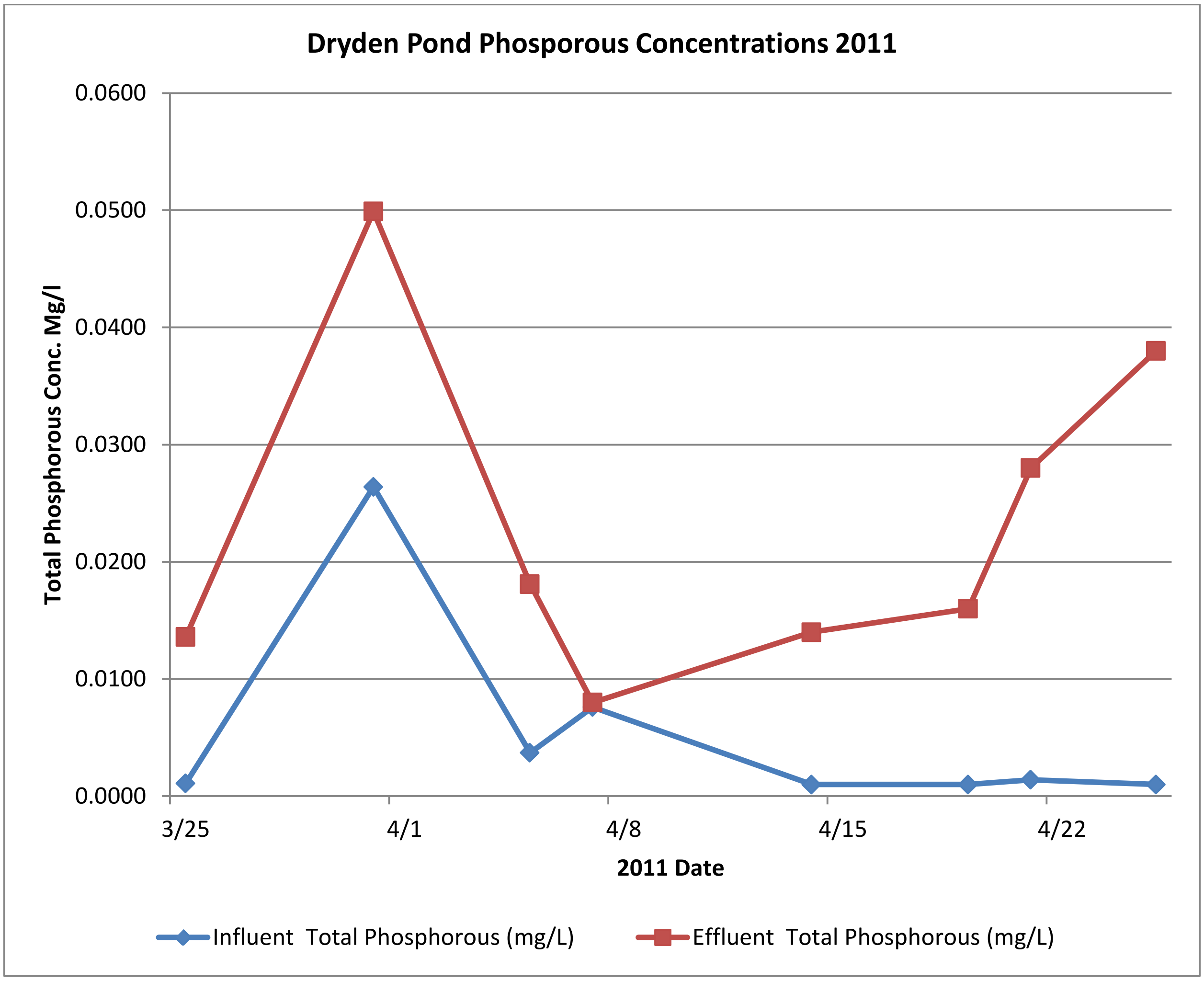
During the 2011 Acclimation Period (2009 brood year) Grant PUD sampled water quality at multiple locations upstream and downstream of the facility. Grant PUD sought to quantify the pond's effect on the river through testing water quality before and after discharge. Also Grant PUD sampled pond influent and effluent to characterize the ponds waste load. Samples were collected once per week during mid day. The sampling included Total and Ortho Phosphorous, inorganic chemicals, and Total Dissolved Solids. Grant PUD data are included in Appendix 2. Influent and effluent Dryden Pond Phosphorous data are summarized in Table 3 and Figure 1.

Table 3
2011 Dryden Influent and Effluent
Phosphorous Concentrations and Discharge Load

Date	Time	Influent		Effluent	
		Total Phosphorous (mg/L)	Ortho Phosphorous (mg/L)	Total Phosphorous (mg/L)	Ortho Phosphorous (mg/L)
3/25/2011	12:00 PM	0.0011	0.002	0.0136	0.003
3/31/2011	3:00 PM	0.0264	0.007	0.0499	0.029
4/5/2011	1:00 PM	0.0037	< 0.001	0.0181	0.015
4/7/2011	10:30 AM	0.0076	0.014	0.0080	0.005
4/14/2011	10:15 AM	0.001[1]	0.006	0.0140	0.006
4/19/2011	12:00 PM	0.001[1]	0.001[1]	0.0160	0.006
4/21/2011	10:00 AM	0.0014	0.001[1]	0.0280	0.013
4/25/2011	1:30 PM	0.0010	0.001	0.0380	0.008

1. Below the 0.001detection limit concentration

Figure 1



II. Water Quality Sampling 2012

A. Dryden

1. Methods

The 2012 (2010 brood year) testing characterized water entering and leaving the pond with correlation to feeding and maintenance operations. Samples were collected once per week while fish were on station. Also, two sets of hourly samples were collected for a 24 hour continuous period. Hourly tests were performed to better understand the effect feeding and maintenance has on effluent water quality.

A number of influences affected Dryden Pond fish rearing during 2012. The acclimation period was again reduced in 2012 due to inclement weather and large water temperature difference between Eastbank and Dryden. Throughout the acclimation period Chinook were at times not fed to allow formalin treatment for Saprolignia. An epidemic evolved among the Chinook causing fish loss. Roughly 793,000 fish were released and 30,000 fish died while in the Dryden pond.

Water samples were tested for TSS, BOD, Total and Dissolved Phosphorous at the pond entrance and exit. The District observed low phosphorous concentrations at times and altered the phosphorous tests to more accurately record dilute concentrations.

2. Sample Data Results

Phosphorous test results and the corresponding daily pounds of phosphorous discharged into the Wenatchee River are recorded in Table 3 and displayed in Figures 2 through 4. Flow into the pond was set by positioning valves and flow control gates. Pond flow the first week was 9,950 gpm. The remaining period flow was set to 15,800 gpm. The lower flow April 3, 3012 may have caused high total phosphorous concentration observed April 3, 2012. Multiple formalin treatments and not feeding fish also may contribute to inconsistent trends among the test results.

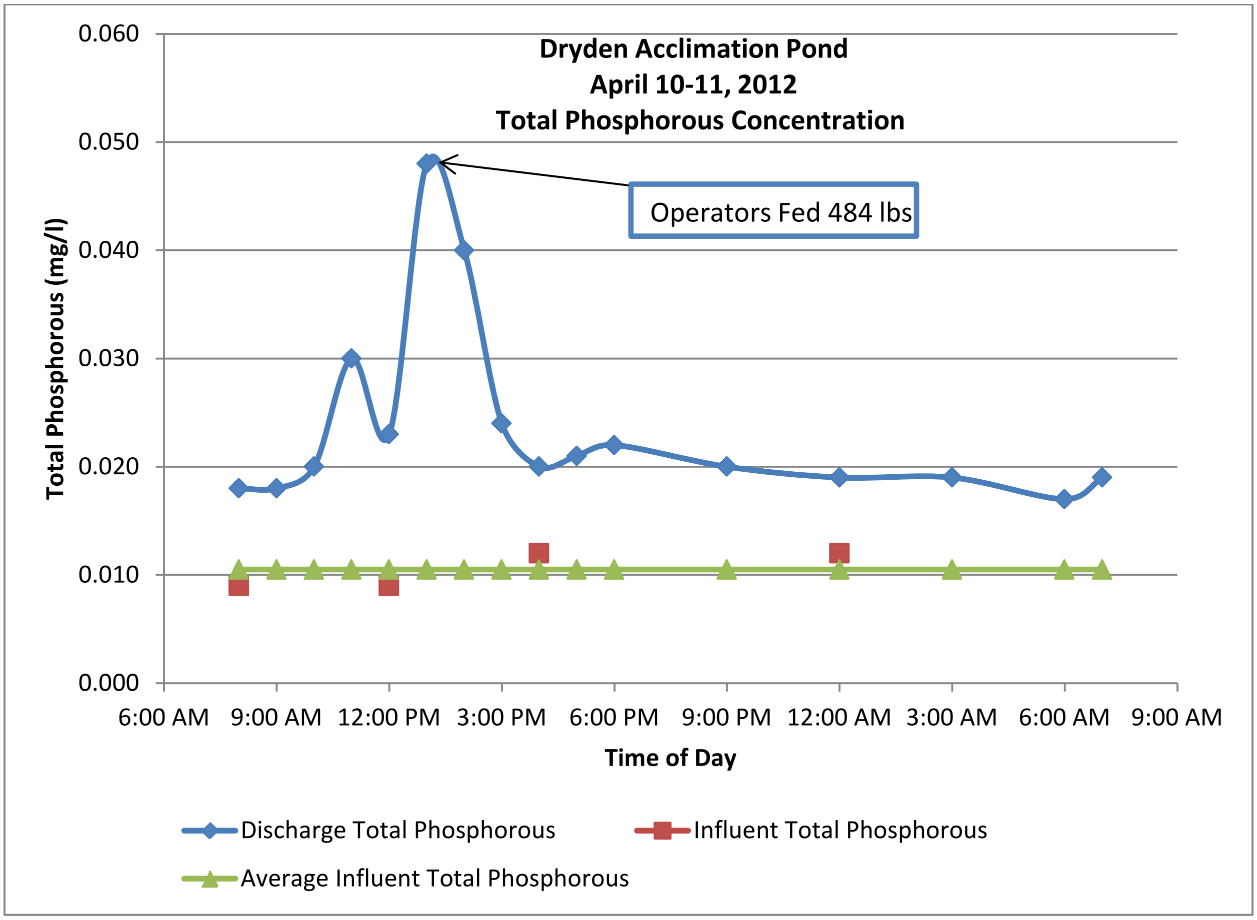
Table 4
2012 Dryden Influent and Effluent
Phosphorous Concentrations and Discharge Load

Date	Time	Influent		Effluent		Difference	Load
		TP (mg/L)	DP (mg/L)	TP (mg/L)	OP (mg/L)	TP (mg/l)	lbs/day
4/3/2012	9:40 AM	0.0120	<0.001	0.0300	0.015	0.0180	3.41
4/10/2012	12:00 PM	0.0090	0.003	0.0230	0.010	0.0140	2.65
4/19/2012	12:40 PM	0.0170	0.004	0.0250	0.019	0.0080	1.51
4/24/2012	8:00 AM	0.0410	< 0.001	0.0640	0.005	0.0230	4.36

Figure 2 data shows effects of feeding fish on total phosphorous discharge. In the late morning April 10, 2012 operators broadcast fed 484 pounds of normal concentration phosphorous feed. Testing detected 20 to 30 Ug/I increase in Total Phosphorous discharge concentrations. Data indicated a slug load event with a typical bell curve concentration distribution over time leading to normal background levels. Concentrations doubled as a result of feed and feces in the pond effluent caused by the feeding event.

Figure 3 data show the effects of pond cleaning on phosphorous discharge. Fish sickness lead to mortality among ponded fish. While sampling April 24, 2012 operators began removing dead fish from the pond floor adjacent to the fluent screens (where they accumulate). The dipping and scraping action stirred depositions from the pond floor and entrained material in the effluent. Total Phosphorous concentrations increased from 0.058 mg/l to 0.112 mg/l as a result of the operator activity. Investigators observed particulate materials in the effluent while sampling. The peak discharge concentration was over ten times greater than the proposed discharge limit.

Figure 2



Dryden Acclimation Pond
April 10-11, 2012
Total Phosphorous Concentration
Operators Fed 484 lbs
Total Phosphorous (mg/l)
0.060
0.050
0.040
0.030
0.020
0.010
0.000
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
3:00 AM
6:00 AM
9:00 AM
Time of Day
Discharge Total Phosphorous
Influent Total Phosphorous
Average Influent Total Phosphorous

Figure 3

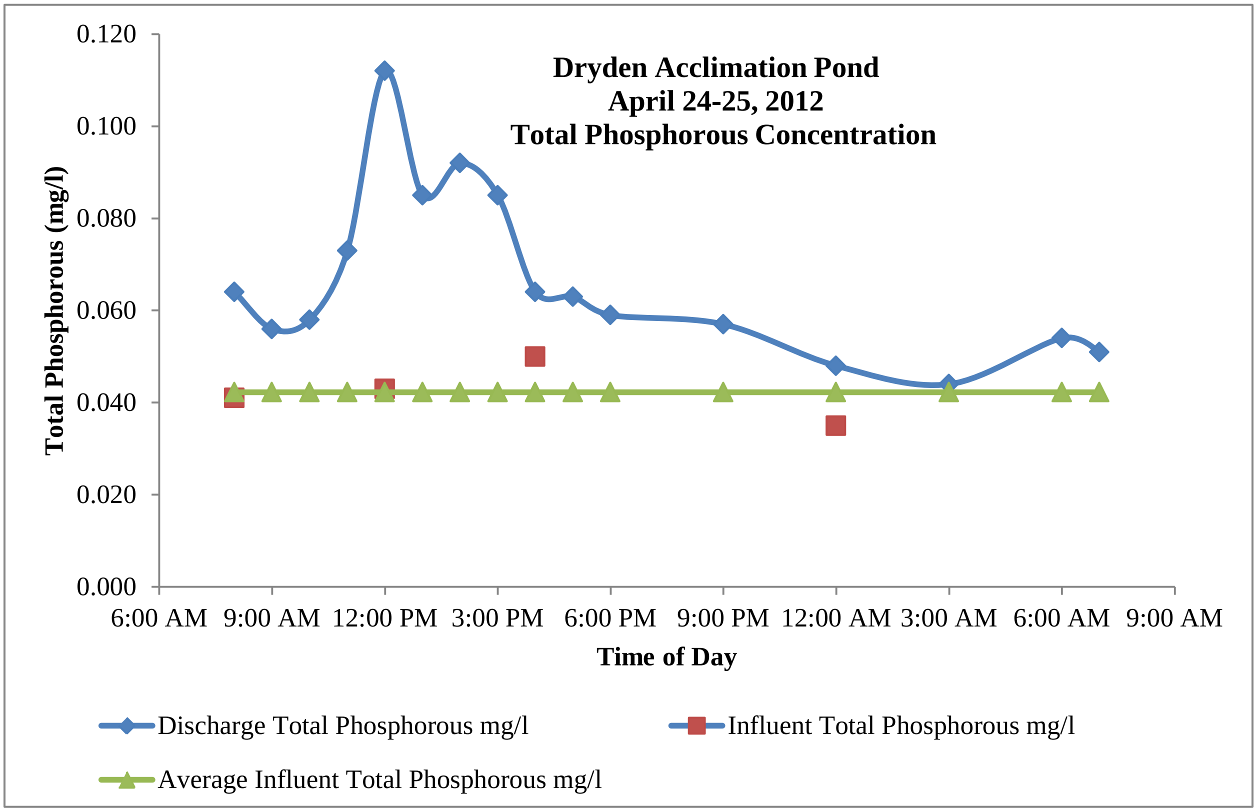
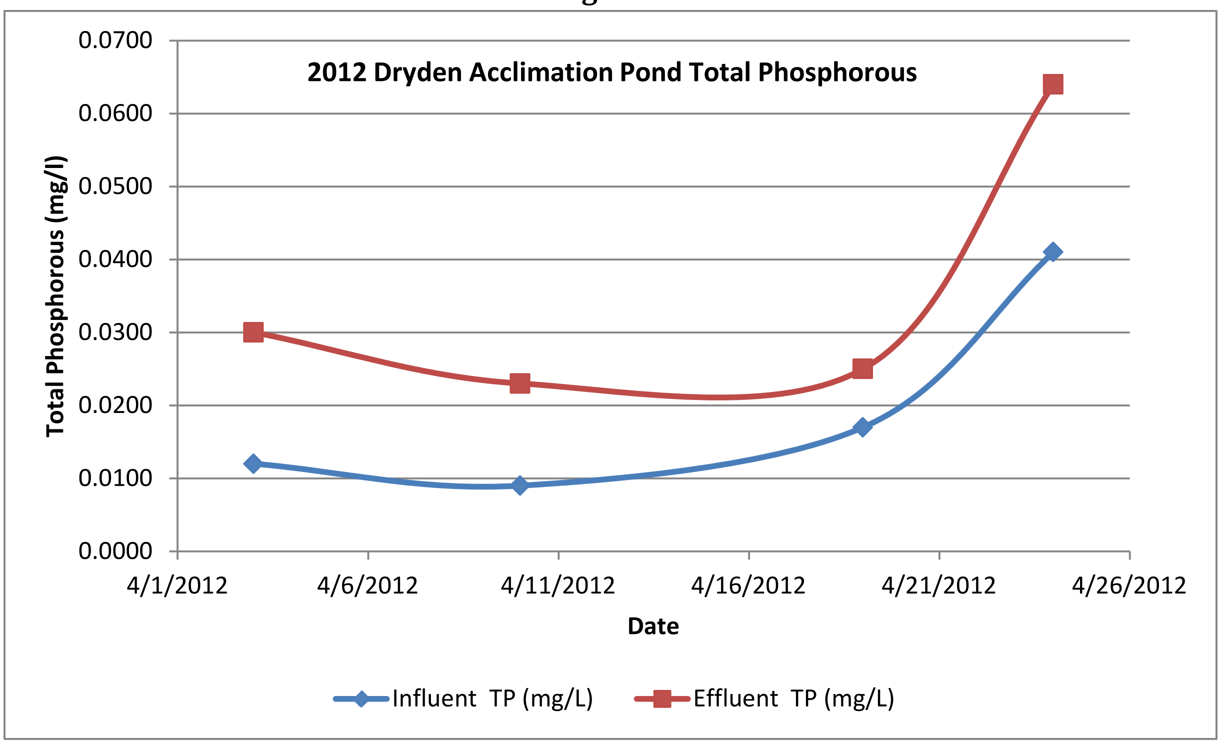


Figure 4



B. Chelan Falls

1. Methods

Chelan Falls Rearing Ponds is a flow through facility that holds summer Chinook from November to late April each year. There are four ponds 45 feet in diameter and 8 feet deep. Tank four held roughly 140,000 summer Chinook during the testing period and received 2,250 gpm of flow. The Cornell dual drain ponds distribute roughly 75 percent of the flow directly to the outfall through a side wall screen. The center drain collects concentrated feces and excess feed into 25 percent of the flow. The center drain flow is routed to a radial flow clarifier (RFC). The clarifier settles solids accumulated at RFC flow are flushed to a waste abatement pond where they are concentrated and hauled off site.

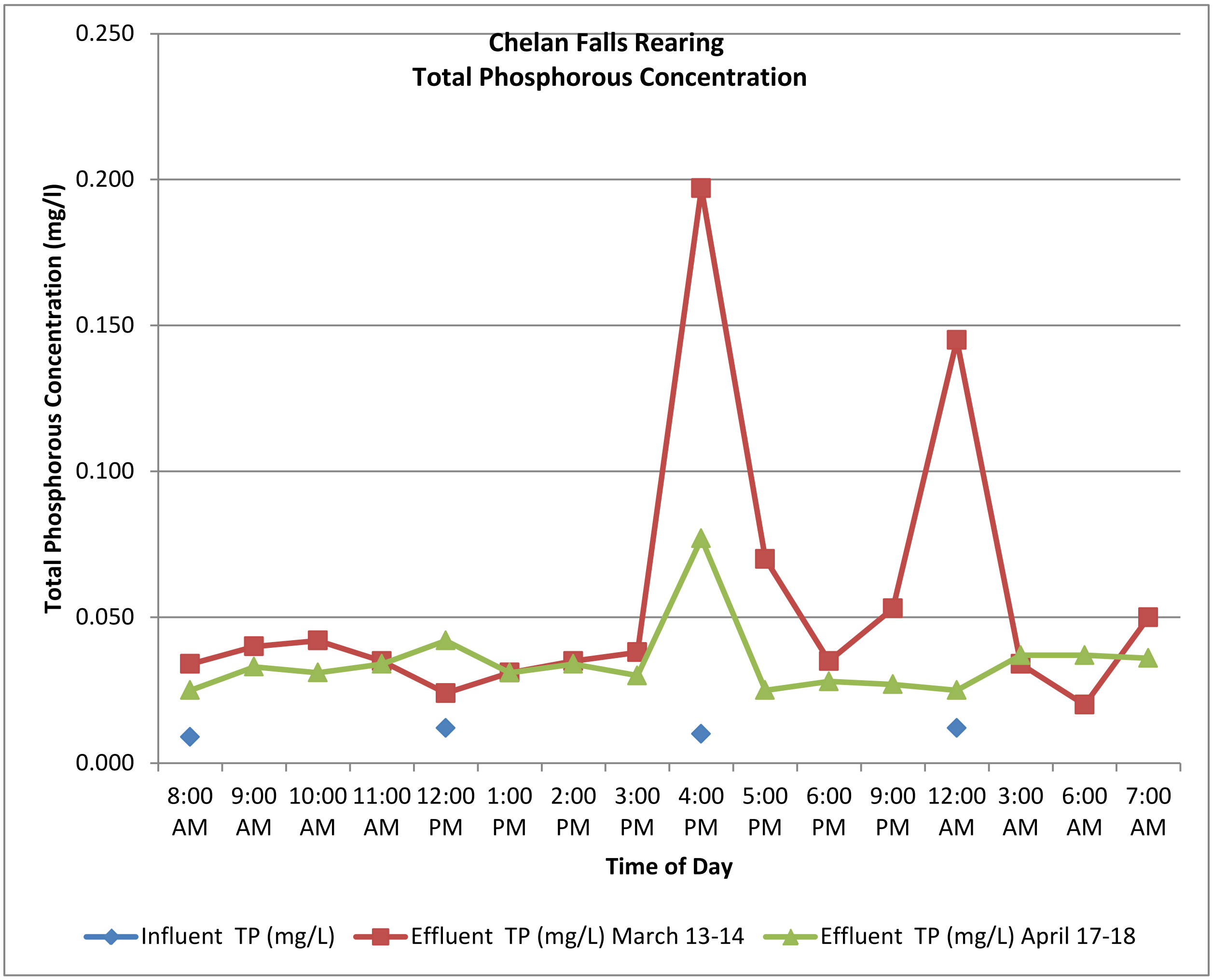
The District sampled water entering pond four and exiting over RFC's weir. The effluent sample is water cleaned by the RFC. The purpose of this sampling is to create data that would help estimate removal capacity of the RFC's.

In designing the Chelan Falls Rearing facility it was estimated that 75 percent of the feces and feed leaves the pond through the center drain and is treated by the FRC. It is estimated 25 percent of the pond waste products leave in the side wall flow.

2. Results

Figure 5 illustrates hourly influent and RFC effluent total phosphorous concentrations in March and April. Data average approximately 20 to 40 ug/l increased phosphorous concentration caused by fish rearing throughout the 24-hour testing with one notable exception. Both sampling events again indicate the effect of fish feed operations. In March fish were fed at 3:45 P.M. and in April fish were fed at 3:20 P.M.

Figure 5



C. Phosphorous Load

Daily load is flow times concentration and as noted above is a DOE TMDL criterion. The influent water contains phosphorous from other anthropogenic sources affecting the watershed. Dryden's influent load was 2 pounds with the exception of the final week when it was 8 pounds. The influent exceeds the 1.6 pound TMDL limit set by DOE for the 33 cfs flow.

Dryden's 779,000 fish rearing activity increases effluent phosphorous load by roughly 2.5 pounds. April 10-11 the effluent load was 4.8 pounds and April 24-25 the load was 12.6 pounds total phosphorous. These loads are three to seven times greater than the TMDL allowable load.

In contrast, roughly 75percent of the waste discharged from Chelan Falls goes through the RFC and amounts to a load ranging from 0.65 to 1.2 pounds total Phosphorous. This load is caused by rearing 560,000 fish. The remaining 25 percent waste load is not treated and was not monitored during 2012. Thus total effluent load cannot be accurately reported or estimated. The 75percent waste capture estimate is based on industry testing of Cornell Dual Drain tanks and is not specific to Chelan Falls.

III. Results

A. Dryden Discharge Compliance with TMDL

Total Phosphorous testing completed in 2011 and 2012 indicate Dryden's load ranges from 2.4 pounds to 12.6 pounds. The future TMDL equates to 1.63 pounds allowable total phosphorous. Dryden fish rearing increases the phosphorous concentration between approximately 0.01 and 0.08 mg/l; considerably greater than the 0.0092 mg/l future TMDL.

Feeding and cleaning affect Dryden's total phosphorous effluent water quality. Large concentrations of phosphorous discharge from the pond after these activities. Similar relationships were observed at Chelan Falls.

IV. Recommendations

A number of alternatives are under consideration to meet future TMDL criteria. It is recommended the most viable of these options be combined and further analyzed. Some alternatives include:

- Rearing fish to a more natural target size
- Feeding fish throughout the week and multiple times per day
- Feeding low phosphorous feed with high settling capabilities
- Continued monitoring of the Dryden Pond water quality to increase the knowledge base
- Compilation of further phosphorous testing data documenting other facility operation using dual drain tanks, automatic feeders, drum filter and abatement pond settling with flow through and water reuse technology

Dryden Acclimation Wastewater Sampling Plan 2013- DRAFT

The goal of 2013 wastewater sampling related to the Dryden Acclimation Facility (Dryden) is twofold. The initial effort is to describe conditions specific to Dryden and are as follows:

1. Create a data set of river water Total Phosphorous at Dryden Acclimation Facility during the period fish may be reared and the TMDL is in effect in the future.
   - Sample upstream of the discharge location weekly from March 1 until fish release
2. Quantify the effects summer Chinook acclimation has on the Wenatchee River Total Phosphorous
   - Sample the canal and pond discharge weekly from March 1 until fish release
3. Quantify the effects feeding and cleaning operations have on Total Phosphorous at Dryden
   - On three occasions, sample each hour for 12 hours followed by samples every 3 hours through the night hour
4. Quantify the effects low phosphorous feed has on discharge Total Phosphorous at Dryden
   - Depending on the biological criteria defined by others, we will sample both weekly and at least one time sample each hour for 12 hours followed by samples every 3 hours through the night hour[1]
5. Quantify the river Total Phosphorous upstream of the acclimation discharge (in the river) and in the canal (current inlet location).
   - This data will be readily available from the above sampling work

The second effort is to refine the District's knowledge of best methods to reduce phosphorous discharge at various rearing facilities/equipment. This work involves testing Chelan Falls Rearing Facility and Eastbank Hatchery. The testing will include the following:

1. Test the effect automatic feeders have on reducing peak total phosphorus discharge from flow-through circular tanks at Chelan Falls. Circular ponds are expected to not result in strong waste discharge caused by cleaning. Automated feeding is thought to lower the amount of uneaten feed left in the tank and to reduce large slug doses of feed and feces in the pond discharge.
   a. Samples will be taken at the influent and radial flow clarifier and sidewall box weekly for the last 12 weeks of rearing at Chelan Falls.
   b. Three times samples will be collected each hour for 12 hours followed by samples every 3 hours through the night hours. These samples will describe the effect automated feeding has on peak discharge concentrations.
2. Test the drum filter at Eastbank Hatchery. The 60 micron drum filter is expected to collect particulate material and dispose it prior to effluent discharge.

[1] This sampling is contingent on low P feed trails at Dryden in 2013.

a. Sampling before and after the drum filter will characterize the drum filters removal capabilities at similar load conditions to the Dryden Acclimation Facility.
b. Samples will be collected before and after the drum filter once per week for 6 weeks.
c. Twice samples will be collected each hour for 12 hours and then every 3 hours through the night to gather information about total removal on a daily basis with intermittent fish feeding operations.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	December 13, 2012
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the November 14, 2012, HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Douglas PUD headquarters in East Wenatchee, Washington, on Wednesday, November 14, 2012, from 9:30 am to 1:00 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- The Joint Fisheries Parties (JFP) will develop a draft strategy to meet Chelan PUD Methow production goals for discussion at the Hatchery Committees' December meeting. The draft will be distributed to the Hatchery Committees at least 1 week prior to the December meeting (Item IV-D).
- Josh Murauskas will distribute to the Hatchery Committees the draft Chelan PUD 2013 Hatchery Monitoring and Evaluation (M&E) Plan, with changes highlighted from the existing 2012 Chelan PUD M&E Plan (Item V-B).
- Mike Schiewe will coordinate with Kirk Truscott to finalize the Hatchery Committee's December meeting date; which will be scheduled for either December 12, 2012, or for December 19, 2012. The Hatchery Committee's December meeting date will be distributed to the Hatchery Committees once it is finalized (Item VI).

STATEMENT OF AGREEMENT DECISION SUMMARY

- No Statements of Agreement (SOA) were approved at this meeting.

AGREEMENTS

- The Hatchery Committees representatives present agreed to a Chelan PUD request for 3,000 summer/fall Chinook salmon eggs from the Eastbank Hatchery for use in an intra-gravel dissolved oxygen (DO) study at Chelan Falls (Item IV-A).

REVIEW ITEMS

- Kristi Geris sent an email notification to the Hatchery Committees on September 29, 2012, stating that the draft Douglas PUD 2011 Monitoring and Evaluation (M&E) Report is out for a 60-day review period with comments due to Greg Mackey by November 30, 2012.
- Geris sent an email notification to the Hatchery Committees on November 13, 2012, stating that the draft Chelan PUD 2013 M&E Plan, distributed to the Hatchery Committees on November 9, 2012, is out for a 30-day review period with comments due to Josh Murauskas by December 10, 2012.
- Geris sent an email notification to the Hatchery Committees on November 13, 2012, stating that the draft Douglas PUD 2013 M&E Implementation Plan is out for a 30-day review period with comments due to Greg Mackey by December 14, 2012.

FINALIZED REPORTS

- No reports have been finalized since the last Hatchery Committees meeting.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed the Hatchery Committees and reviewed the agenda. The following revisions were requested:

- Josh Murauskas added for Chelan PUD a request for approval of 3,000 summer/fall Chinook salmon eyed eggs for research at Chelan Falls, to be presented by Steve Hays.
- Greg Mackey added for Douglas PUD a notification of a new Wells Hydroelectric Project Federal Energy Regulatory Commission (FERC) License; and he added a brief update on the draft Douglas PUD 2013 M&E Plan.
- Bill Gale added for U.S. Fish and Wildlife Service (USFWS) an update on Methow spring Chinook salmon and steelhead Hatchery and Genetic Management Plans (HGMPs).
- Keely Murdoch added for the Yakama Nation (YN) an update on their steelhead kelt reconditioning program, and requested an update from Chelan PUD on their draft 2013 Hatchery M&E Plan.

The revised draft September 19, 2012, meeting minutes were reviewed. Kristi Geris said there were three edits remaining to be discussed regarding Chelan PUD's agenda item III-B on Rocky Reach spring Chinook salmon production: 1) Tom Kahler suggested incorporating a statement pointing out that the possibility of acclimating Carlton-reared fish in the upper basin YN facilities was not dismissed; 2) Mackey requested that Gale clarify his statement regarding his preference for rearing Chelan PUD Methow spring Chinook salmon production at the Carlton facility rather than Eastbank Hatchery; and 3) Geris noted that she received Kirk Truscott's revisions on November 13, 2012, regarding his concerns about rearing Methow spring Chinook salmon at Chief Joseph Hatchery (CJH). Revisions were discussed and incorporated. Geris said that all other comments and revisions received on the draft meeting minutes were incorporated. The Hatchery Committees' members present approved the September 19, 2012, meeting minutes, as revised. Truscott approved the September 19, 2012, meeting minutes by email.

II. Douglas PUD

A. Wells Hydroelectric Project FERC License (Greg Mackey)

Greg Mackey announced that Douglas PUD had received its new Wells Hydroelectric Project license from FERC. Mackey said that the new license includes numerous terms and conditions that Douglas PUD is currently reviewing. Craig Busack asked if the new license is expected to affect the work of the Hatchery Committees. Steve Hays said that FERC typically is not concerned with the details of an action or plan; rather, they are more interested in tracking compliance. Mackey said that he will keep the Hatchery Committees updated as Douglas PUD learns more.

B. Draft Douglas PUD 2013 M&E Implementation Plan (Greg Mackey)

Greg Mackey said that the draft Douglas PUD 2013 M&E Implementation Plan was distributed to the Hatchery Committees by Kristi Geris on November 13, 2012. He said that the draft plan is out for a 30-day review period with comments requested by December 14, 2012. Mackey said that expedited review was requested because the new contract starts on January 1, 2013. Mike Schiewe reminded the Committees that a 60-day review is the default for all plans, proposals, and studies unless a shorter period is approved by the Committees. Mackey said that the draft Douglas PUD 2013 M&E Plan is essentially the same as last year.

Mackey explained that according to the M&E Conceptual Framework, it was time to begin another round of population genetic analyses. However, he explained that the previously adopted time interval of 5 years is far too short for genetic differentiation to occur, particularly when little-to-no differentiation was detected in the first round of studies with the exception of Twisp spring Chinook. Mackey said that a longer time interval between studies should be considered and that in future years Douglas PUD would recommend that the frequency of genetic stock structure monitoring be reduced to every 10 years, rather than the current 5-year interval. He added that tissue samples are collected each year so that analyses can be run for any given interval. Mackey also noted that the past study reports were difficult to interpret and felt that future reports needed to be written with managers and non-geneticists in mind. Craig Busack agreed that every 10 years would be reasonable. Busack also noted that several previous reports on the genetic structure of upper Columbia salmon populations had been largely driven by software outputs. He said that in the future he would like to see a greater emphasis on explaining the biological significance of the findings.

The Hatchery Committees agreed to an expedited 30-day review.

III. USFWS

A. HGMP Update (Greg Mackey and Bill Gale)

Greg Mackey said that HGMPs have previously been submitted by Douglas PUD and USFWS for Methow steelhead and spring Chinook salmon programs. He said that the National Marine Fisheries Service (NMFS) requested supplemental analyses showing that the programs would meet a proportion hatchery-origin spawners (pHOS) target of 0.25. Mackey said he anticipated that the Douglas PUD analyses for their Wells steelhead and Methow spring salmon programs would be submitted to NMFS by the end of this week (November 16, 2012).

Bill Gale said that revisions are being finalized for the Winthrop steelhead HGMP. He said that a supplemental attachment was developed, and that both will be submitted to NMFS by the end of the week. Gale said that revisions to the spring Chinook salmon HGMP are also being completed, and that a supplemental attachment on adult management will accompany this submittal; NMFS should expect the submittal by the end of next week. Mike Schiewe asked if NMFS will be issuing individual permits or biological opinions (BiOps). Craig Busack said that NMFS would issue individual permits, and only one BiOp for each species. Busack acknowledged that the YN had expressed concern over the proposed pHOS target of 0.25, and that NMFS staff has been working with Steve Parker to resolve concerns. Busack noted that the uncertainty regarding Chelan PUD production of spring Chinook salmon in the Methow would likely delay NMFS issuing a permit for that program.

IV. Chelan PUD

A. Request for summer/fall Chinook salmon eyed eggs for research at Chelan Falls (Steve Hays)

Steve Hays said that last year Chelan PUD requested 2,500 summer/fall Chinook salmon eyed-eggs for egg-to-fry survival studies in the Chelan River. Hays said that the Lake Chelan Hydroelectric Project FERC License requires Chelan PUD to evaluate powerhouse flows needed to maintain intra-gravel DO concentrations in the tailrace to support high egg survival. He summarized that in 2012, Chelan PUD had monitored egg survival in tubes placed in the gravel in selected areas of the tailrace. Preliminary results were 100 percent loss in about 50 percent of the tubes, with most of the mortality occurring just prior to hatch. The timing of this mortality coincided with times when the powerhouse was offline. Hays said that this year, Chelan PUD plans to repeat the intra-gravel DO study again with 3,000 eyed-eggs from Eastbank Hatchery to test a more consistent powerhouse operation. The Hatchery Committees representatives present agreed to the Chelan PUD request for 3,000 summer/fall Chinook salmon eyed eggs from the Eastbank Hatchery, for use in an intra-gravel DO study at Chelan Falls. Hays said that a report on the 2012 studies will be available by the end of February 2013, and a final report will be available by April 2013.

B. 2012 steelhead survival (Josh Murauskas)

Josh Murauskas said that his analyses of the post-release survival rates of Wenatchee steelhead (Attachment B) was distributed to the Hatchery Committees by Kristi Geris on November 14, 2012. Murauskas reviewed recent changes to the Wenatchee steelhead program, including: 1) overwinter acclimation at Chiwawa Ponds; 2) a reduction in program size from 400,000 to 250,000; 3) 100 percent wild-by-wild progeny in 2012; and 4) a volitional release strategy with smaller release groups.

Murauskas reviewed the post-release survival rates of steelhead smolts migrating from the Chiwawa River, Nason Creek, and Wenatchee River in 2006 to 2011, based on passive inductive transponder (PIT)-tag detections at McNary Dam. The results were statistically greater than other steelhead programs in the region. He then compared these results to the performance in 2012 for these same release locations, and noted that the values were unprecedentedly low. Mike Schiewe asked where the release location is on the Wenatchee River, and Murauskas said that the release location is near Leavenworth directly in the Wenatchee River. Bill Gale asked if the survival rates represent all fish, or just those volitionally released. Murauskas said that survival rates represent all fish that were planted, but also noted that the "non-migrants" had comparable survival rates to the "volitional migrants."

Murauskas suggested several potential issues that may be the cause of these low survival rates, including: 1) overwinter acclimation; 2) brood origin; 3) size at release; 4) timing; 5) volitional release; and 6) release number, or number of fish in each release group. Murauskas shared a graph depicting brood origin and survival by year. He noted that the lowest survival was that of wild-by-wild crosses. He noted that these results are confounded by release location; however, they can be sorted by brood origin. Mike Tonseth added that there are also differences in size at release. He said that wild fish tend to spawn later; therefore, they are not at the same size.

Murauskas presented differences in 2012 fish sizes at release: 1) 11 fish per pound (fpp) at Blackbird; 2) 8 fpp at Chiwawa re-use; and 3) 12 fpp at Chiwawa Pond 2. He noted that he did not have data on size at McNary, and that he is unsure how size at McNary would impact results. Gale asked how 2012 sizes compared to past years; and Murauskas said that 2011 sizes were about 7 to 8 fpp. Keely Murdoch added that when the YN received fish for the Rolfing Acclimation Pond, the fish were exceptionally small.

Murauskas reviewed a graph depicting the number of fish per release group and said that when numbers of PIT-tags are plotted against survival to McNary, the results indicate that the more fish per release group, the higher the survival rate. Craig Busack asked if these results could also mean that the study is not accounting properly for detectability. Murauskas said that probability of detection is accounted for in the survival model and he believes these results reflect "safety in numbers," and that proportional predation is the explanation. Greg Mackey observed that the variance in survival was positively correlated with release group size, suggesting that smaller release groups are more limited in their potential for survival, while larger groups have a higher range of potential for survival. Gale asked if transport conditions differed among truckloads, and Tonseth said that if anything, transportation time from rearing to release was reduced in 2012. Tom Kahler asked when the smaller release groups were released. Murauskas said he looked at the timing of release; however, survival was so poor for every release that no statistical significance was found among timing of releases.

Murauskas suggested that the Hatchery Committees reconsider volitional release based on results of this analysis. His analyses of the 2012 releases indicated that there was no survival advantage for the volitionally released fish and suggested that releasing all fish at once appeared to improve survival to McNary Dam. Gale noted that there is limited information on the forced release of steelhead at Chiwawa, and Murdoch noted that the study was limited to 1 year. Tonseth recommended being careful how volitional and forced releases are defined. He added that the poor survival numbers could be due to other factors that have nothing to do with release. Murauskas and Tonseth discussed that it would be informative to also consider 2012 survival of Methow steelhead in the context of their historical average.

Murauskas summarized by saying that Chelan PUD was not seeking the Committees' agreement on the cause of the low post-release survival in 2012; however, they wanted to bring this to the Committees' attention before releasing in 2013. Gale said that a mark and recapture analysis is planned for Winthrop National Fish Hatchery (NFH), which may be executed differently than that in Chelan PUD; Gale said he would coordinate with Murauskas. Tonseth cautioned that there is still key information to be determined, both biotic and abiotic, and added that it needs to be determined whether the problem persists. Murauskas reiterated that the new release approaches implemented in 2012 significantly compromised survival of juvenile steelhead and regardless of the exact cause, the Hatchery Committees should consider reverting back to release techniques with proven success before implementing unproven changes.

C. Summer Chinook salmon brood collection options (Chris Moran)

Chris Moran presented an overview of the Chelan Falls summer Chinook salmon pilot broodstock collection study (Attachment C), that Kristi Geris distributed to the Hatchery Committees on November 15, 2012. He said that the purpose of the study was to: 1) determine if adult summer Chinook salmon could be captured in the vicinity of the Chelan River; 2) determine which stocks are returning to the area; and 3) determine the best methods for capture. Collection methods used included tangle nets, hook and line, and sampling the Eastbank Hatchery outfall (EBO). Moran said that other methods were considered such as beach seines and purse seines; however, logistically, these methods were not feasible.

Moran said that on September 24, 2012, WDFW tested a 60-foot tangle net that was attached to the "no trespassing" float line near the Chelan River powerhouse area, which runs parallel to shore. He said that attaching the net parallel to shore was intended to avoid potentially overloading the net with fish. He said that an additional 100-foot tangle net was set diagonally near the attraction waters of the Chelan Falls Acclimation Facility outfall pipe, from the middle portion of the net pens to a small tree on the opposite bank, on October 3, 2012. On September 21, 2012, hook and line fishing was conducted on the Columbia River between the confluence of the Chelan and Columbia rivers to the Highway 97 Bridge; and the EBO was sampled using pond seines on August 28, 2012; September 11, 2012; and October 3, 2012.

Moran reviewed the results for each sampling method and date. The EBO resulted in the highest number of fish captures, while hook and line and the tangle nets resulted in the lowest captures. Moran said that of the 180 fish captured, 174 were collected from the EBO; and of the 174 fish collected from the EBO, 122 heads were sampled, and 114 coded wire tags (CWTs) were recovered. Fish collected from the EBO were predominantly male and the CWTs indicated that most fish were 4-year-olds from Turtle Rock.

Moran said that, based on these results, recommendations include: 1) discontinue testing collection methods in the vicinity of the Chelan River; and 2) utilize the EBO as a trap location for the Chelan Falls program beginning July 2013. He said that incorporating the EBO as a trap location would also provide added benefits such as: 1) establishing a location to manage returning adults; 2) minimizing stray rates of hatchery fish released from Eastbank

Complex facilities; and 3) enhancing the genetic makeup of a domesticated program by incorporating hatchery strays from programs that utilize wild origin fish for hatchery broodstock.

Josh Murauskas said that Chelan PUD is now looking for feedback regarding long-term use of the EBO as source of broodstock for the Chelan Falls program. He noted that Chelan PUD had also been interested in testing purse seine capture this year; however, Chelan PUD was unable to do testing this year. He also noted that Chelan PUD still needs to internally discuss permitting. Mike Tonseth said that eventually it needs to be determined if it is appropriate to use any type of fish collected at the EBO for Chelan Falls broodstock. Tonseth added that from an Endangered Species Act (ESA) perspective, seining in the mainstem presents potential for take of ESA-listed fish. Keely Murdoch said that she is concerned that so few females were collected from the EBO. She agrees with continuing to move forward; however, she also would like some sort of backup plan to ensure production is met. Tonseth suggested that in 2012, what may have led to high male counts is that females tend to arrive early in the return; therefore, toward the end of the season, there are more males. Tonseth recommended that in 2013, sampling activities be conducted earlier to have the opportunity to intercept females, and that the Wells volunteer channel be used as the "backup plan."

D. Update on Chief Joseph Hatchery and Methow sharing agreements (Josh Murauskas and Joe Miller)

Joe Miller indicated that Chelan PUD had recently met with the Colville Confederated Tribes (CCT) to discuss the terms of a hatchery agreement between the two parties' relating to CJH and Similkameen Acclimation Pond. The meeting was successful and both parties have indicated a desire to complete a final contract in the coming months.

Miller said that executing a new sharing agreement with Douglas PUD for rearing Chelan PUD Methow spring Chinook salmon production did not work out. He added that, regarding concerns about ESA coverage that had been raised earlier in the meeting, coverage is currently provided by Permit 1196 until 2014, as described in the Chelan PUD Methow production update (Attachment D) that was distributed to the Hatchery Committees by Kristi Geris on November 6, 2012. Miller said that the current permit provides adequate time to consider alternative rearing strategies and options, and that when the permit expires in 2014, there should be adequate time to obtain ESA coverage. He reminded the Committees that Chelan PUD's Methow program represents about 10 percent of the overall production of hatchery spring Chinook in the Methow Basin. Miller also suggested that implementing a "conservation" program of this small size should be easier from an ESA perspective than the relatively large USFWS safety-net program simply because conservation fish are ostensibly desirable in the spawning grounds (at some level).

Miller said that Chelan PUD is proposing two options for broodstock collection. Option 1 involves trapping at Rocky Reach Dam and holding at Eastbank Hatchery while Genetic Stock Identification (GSI) is used to determine genetic identity. Miller said that this option will not interfere with the migration of Wenatchee-origin fish, and noted that GSI would eliminate Entiat-origin fish. Option 2 is a parental-based tagging (PBT) approach that involves trapping at Priest Rapids, PIT-tagging, running genetics (GSI via micro-satellite or single nucleotide polymorphism) to determine origin, and then recapture at Rocky Reach. Miller noted that PBT was not successful in the Wenatchee but did show promise for Methow fish because: 1) many of the fish tagged during PBT eventually ascended Wells Dam – suggesting Methow-origin; and 2) during the PBT 'pilot,' ample fish were encountered to meet Chelan PUD's reduced broodstock program (i.e., 35 to 40 broodstock). Miller suggested that the genetic markers needed to differentiate Methow fish were already in use (for sorting spring Chinook at Wells Dam) and did not rely on establishment of a parental genotype baseline, which requires years of sampling. Moreover, the segregation of Entiat-origin fish may be relatively easy because previous work has shown the existence of a strong Carson-stock signal in the population, and this signal makes Entiat-origin fish stand out. Miller suggested that, overall, a geographic based GSI approach would be less complicated than the broodstock identification using PBT, which requires a baseline of parental genotypes. He noted that using Option 2 would eliminate the need to hold the fish while the genetic samples are run. Instead they would be sampled and released at Priest Rapids, and the GSI/tributary assignment would be evaluated while fish are in transit between Priest Rapids and Rocky Reach.

Miller said that the adult holding and rearing option being considered is at Eastbank Hatchery. He said the historical issue at Eastbank Hatchery has been temperature; however, rearing only 65,000 juveniles would not be a problem in the long-term because they would be reared in tributary waters that are cooler (identical to the Chiwawa approach). He said for acclimation, two options are being considered. Option 1 involves spring acclimation at Carlton with early imprinting. Option 2 involves Carlton overwintering plus YN upper basin acclimation. Craig Busack said that he does not like the idea of rearing fish outside of the basin. Bill Gale said he has two concerns: 1) details regarding operations of the Rocky Reach trap, such as how many non-target natural origin fish would be encountered; and 2) details regarding acclimation for release at Carlton. Gale said that USFWS and WDFW have been analyzing Methow production using National Oceanic and Atmospheric Administration (NOAA) guidance of a pHOS target of 0.25; and he said that only works if the program returns a high proportion of the adults to a facility where they can be removed. Gale expressed concern that Chelan PUD would be releasing fish that preclude meeting the 0.25 pHOS target. Keely Murdoch asked if fish can be removed from Wells Dam if needed; Gale responded that Wells Dam removal was possible, but that it was complicated by CJH coming online.

Miller said that he is not aware of any overriding risks posed by these options, and added that Chelan PUD can develop a marking scheme if needed. Gale asked if there is a plan to remove excess adults, and noted that the current Methow HGMP analyses are dependent on the ability to remove excess adults. He added that if marked fish are removed at Wells, it would require an agreement between Douglas PUD and Chelan PUD. Greg Mackey said that it is physically possible to trap as many fish as desired at Wells; however, trapping a large portion of the run would entail handling many non-target fish and would cause passage delays for all species. Therefore, Wells Dam is not suitable as a primary adult management facility.

Tonseth said there are a number of issues that would need to be worked out with what Chelan PUD has proposed, and that he has some additional ideas that he would like to discuss with the JFP. He said the JFP can then evaluate and compare options, and identify any issues before presenting a draft strategy to the Hatchery Committees. The JFP agreed to develop a draft strategy to meet Chelan PUD Methow production goals, for discussion at the Hatchery Committees' December meeting. The JFP will distribute the draft to the Hatchery Committees at least 1 week prior to the December meeting. Gale noted that in terms of consultations, Douglas PUD consultations will have to move forward without the Chelan

PUD Methow production goals piece. Miller agreed, and said that Chelan PUD has no intentions of impeding progress on the HGMP.

V. Yakama Nation

A. Steelhead kelt reconditioning program update (Keely Murdoch)

Keely Murdoch said that last year, the YN built a kelt reconditioning facility on the Methow River at Winthrop National Fish Hatchery. She said that the program started with a small number of fish but now is looking to expand. She said that last week, the YN met with Douglas PUD, USFWS, and WDFW to discuss live spawning Twisp natural origin steelhead. She said that the outcome of the meeting was that they agreed that the only way to move forward is to create an isolation facility for these fish during the Wells modernization. Murdoch said that the YN is pursuing construction of an isolation facility for the progeny of 13 females in order to keep the fish separate until testing for disease can be completed. She said that in moving forward with the design, there will likely be some risks to consider; however, there may not be huge issues with such a small program. Murdoch said that the YN will ultimately need a decision by the Hatchery Committees to move forward, and said that the YN will keep the Hatchery Committees informed as discussions progress.

Greg Mackey added that Douglas PUD asked HDR, Inc., to develop a cost to build an isolation area into the Wells facility for the YN kelt reconditioning program. He said that the fish health staff typically take samples for testing at 30 days after swim up, and it takes an additional 30 days to obtain results; this means that the fish need to be held 60 days in isolation. Mackey noted that Infectious Pancreatic Necrosis Virus (IPNV; among other diseases) is of greatest concern to fish health staff as that disease has been detected in steelhead at Wells Hatchery in the past. Murdoch asked the Hatchery Committees to please share ideas for a temporary isolation location until the Wells Hatchery facility is available.

B. Hatchery M&E Plans update (Keely Murdoch)

Keely Murdoch noted that both Chelan PUD and Douglas PUD draft Hatchery M&E Implementation Plans were distributed, and that comments are due prior to the next Hatchery Committees meeting. She recounted that Douglas PUD already said that there were no changes to their plan from 2012; however, she asked Chelan PUD to highlight changes to their plan from 2012. Josh Murauskas said that he will distribute to the Hatchery Committees the draft Chelan PUD 2013 Hatchery M&E Plan, with changes highlighted from the existing 2012 Chelan PUD M&E Plan.

Murdoch noted that the upper Wenatchee River smolt trap is missing from Chelan PUD's draft plan, and she said that she thought the main purpose for the trap was to obtain sockeye estimates. She added that she thought it was agreed during the recalculation exercise that Chelan PUD would continue to collect sockeye data at that location. She also added that although Chelan PUD does not have that program any longer, the data are still needed. Murauskas said that those activities will continue in 2013; however, he said that the new smolt trap downstream would serve the sockeye purpose as well. Murdoch said that in the past, the new smolt trap downstream had lowered efficiency, and that this outcome justified using the other trap. She added that if the new smolt trap downstream works, it is fine, but that data are needed to confirm that it does. Murauskas said that Chelan PUD is also considering possibly using PIT-tags for long-term data collection for sockeye. Murdoch said that if Chelan PUD is still planning to run the trap in 2013, then this should be included in the 2013 plan. Murauskas agreed and said it would be added. Murauskas pointed out that the analytical framework is still in effect but that it will not be appended to the work plan.

Mike Tonseth said that Chelan PUD's draft 2013 plan is similar to the 2012 plan, with some language changes in terms of sockeye on which the Hatchery Committees will need to come to consensus. He added that there are a few items that are flagged for discussion; however, he did not think they needed to be resolved now.

VI. HCP Administration

A. Next Meetings

Mike Schiewe will coordinate with Kirk Truscott to finalize the Hatchery Committee's December meeting date; and that the date will be scheduled for either December 12, 2012, or December 19, 2012. The Hatchery Committee's December meeting date will be distributed to the Hatchery Committees once it is finalized. **Note: Kristi Geris sent an email notification to the Hatchery Committees on November 16, 2012, stating that the Hatchery Committee's December meeting date has been rescheduled to Wednesday, December 12, 2012.*

The next scheduled Hatchery Committees meetings are on December 12, 2012 (Chelan PUD office), January 16, 2013 (Douglas PUD office), and February 20, 2013 (Chelan PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – 2012 Steelhead Survival Presentation
Attachment C – Chelan Falls Summer Chinook Salmon Pilot Study Presentation
Attachment D – Chelan PUD Methow Production Update

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Josh Murauskas*	Chelan PUD
Joe Miller*	Chelan PUD
Steve Hays	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Todd Pearsons	Grant PUD
Keely Murdoch*	Yakama Nation
Craig Busack*†	National Marine Fisheries Service
Bill Gale*	U.S. Fish and Wildlife Service
Mike Tonseth*†	Washington Department of Fish and Wildlife
Chris Moran	Washington Department of Fish and Wildlife
Jayson Wahls	Washington Department of Fish and Wildlife

Notes:

* Denotes Hatchery Committees member or alternate
† Joined by phone

Survival of Wenatchee River Hatchery Steelhead in 2012

Josh Murauskas

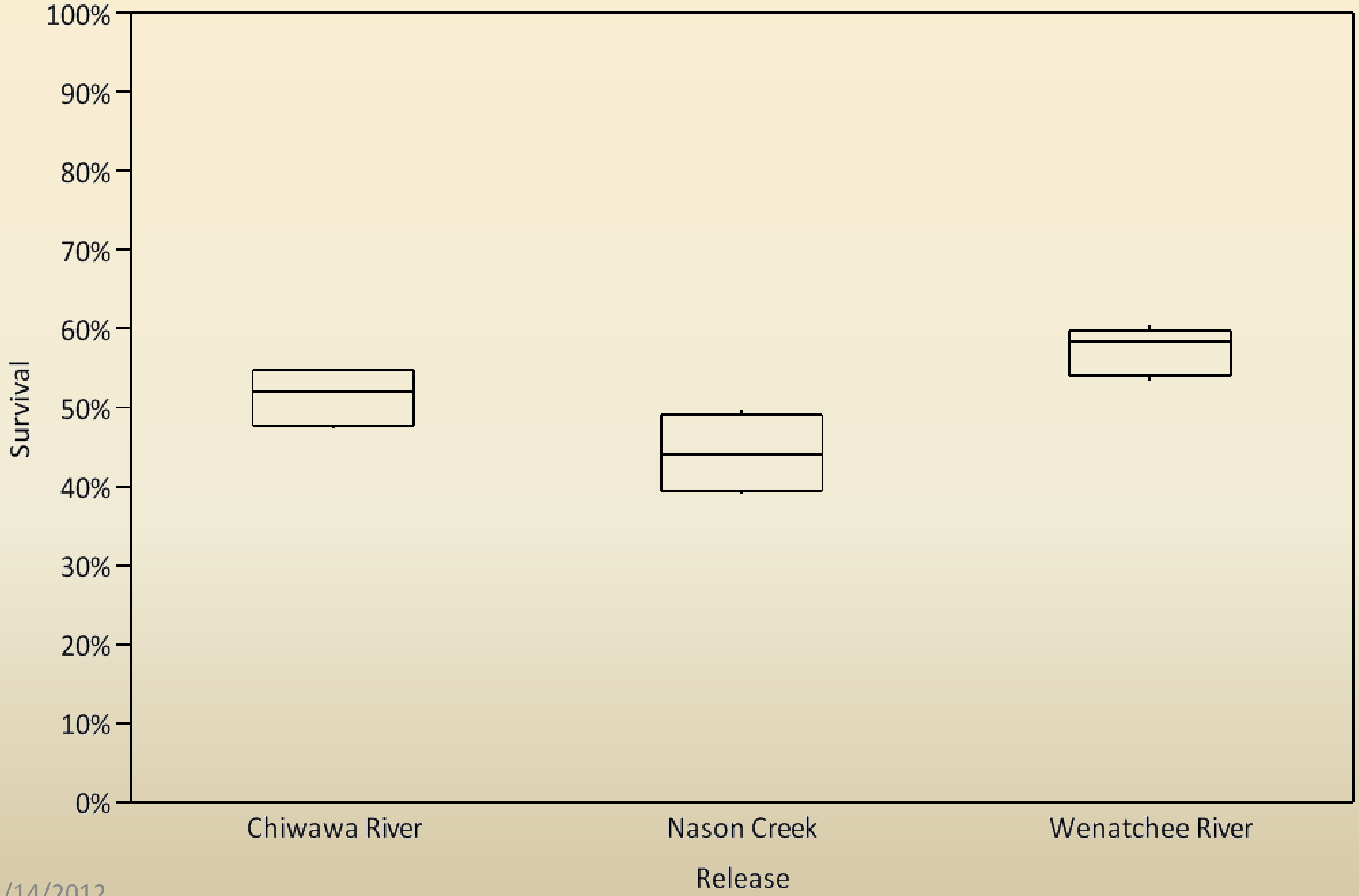
November 14th, 2012

HCP Hatchery Committee

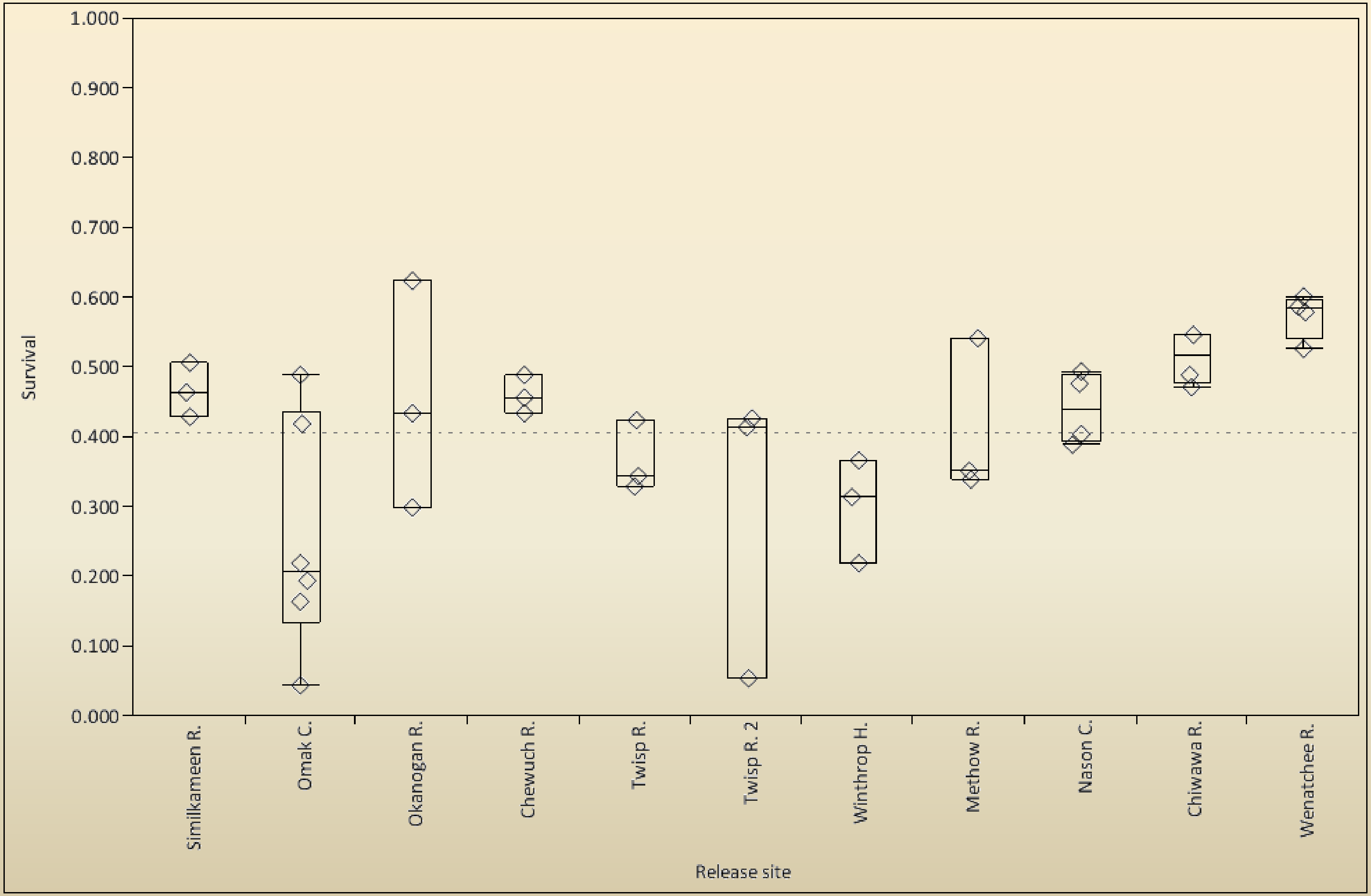
Overview

- Major programmatic changes
  - Overwinter acclimation at Chiwawa Ponds
  - Reduction in program size
  - 100% wild by wild progeny in 2012
  - Volitional release strategy

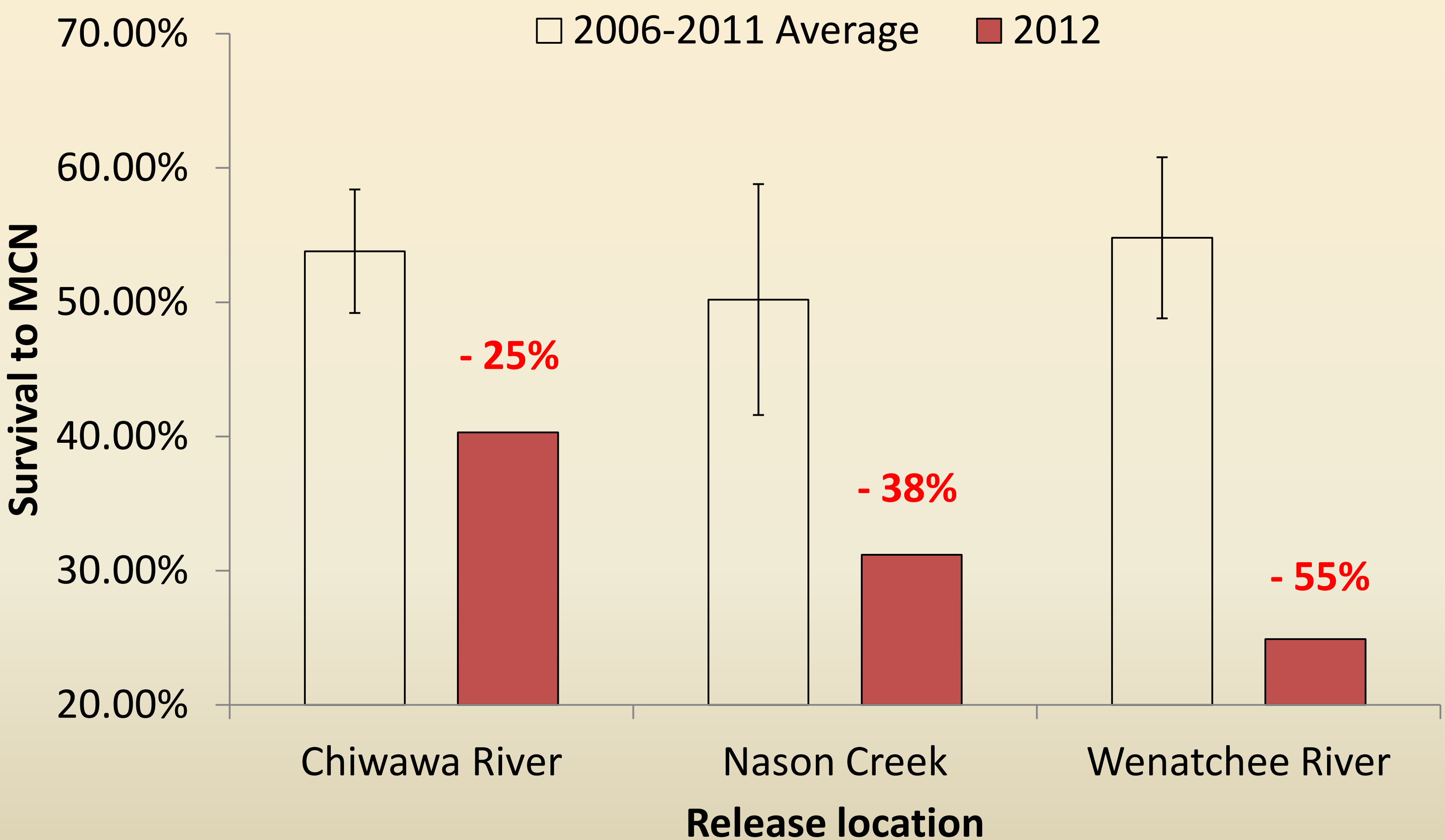
Historical performance



Historical performance



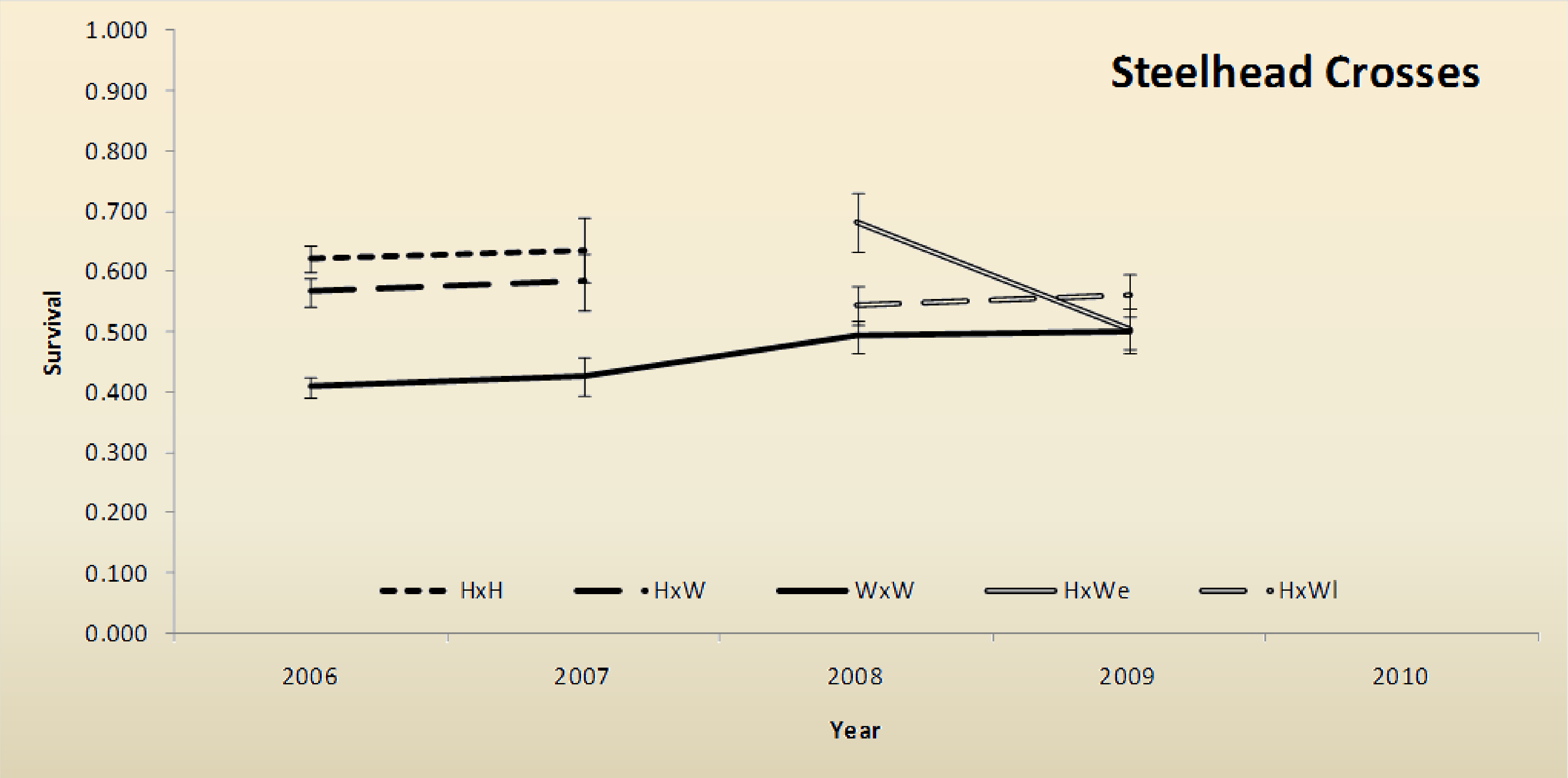
Performance in 2012



Potential issues

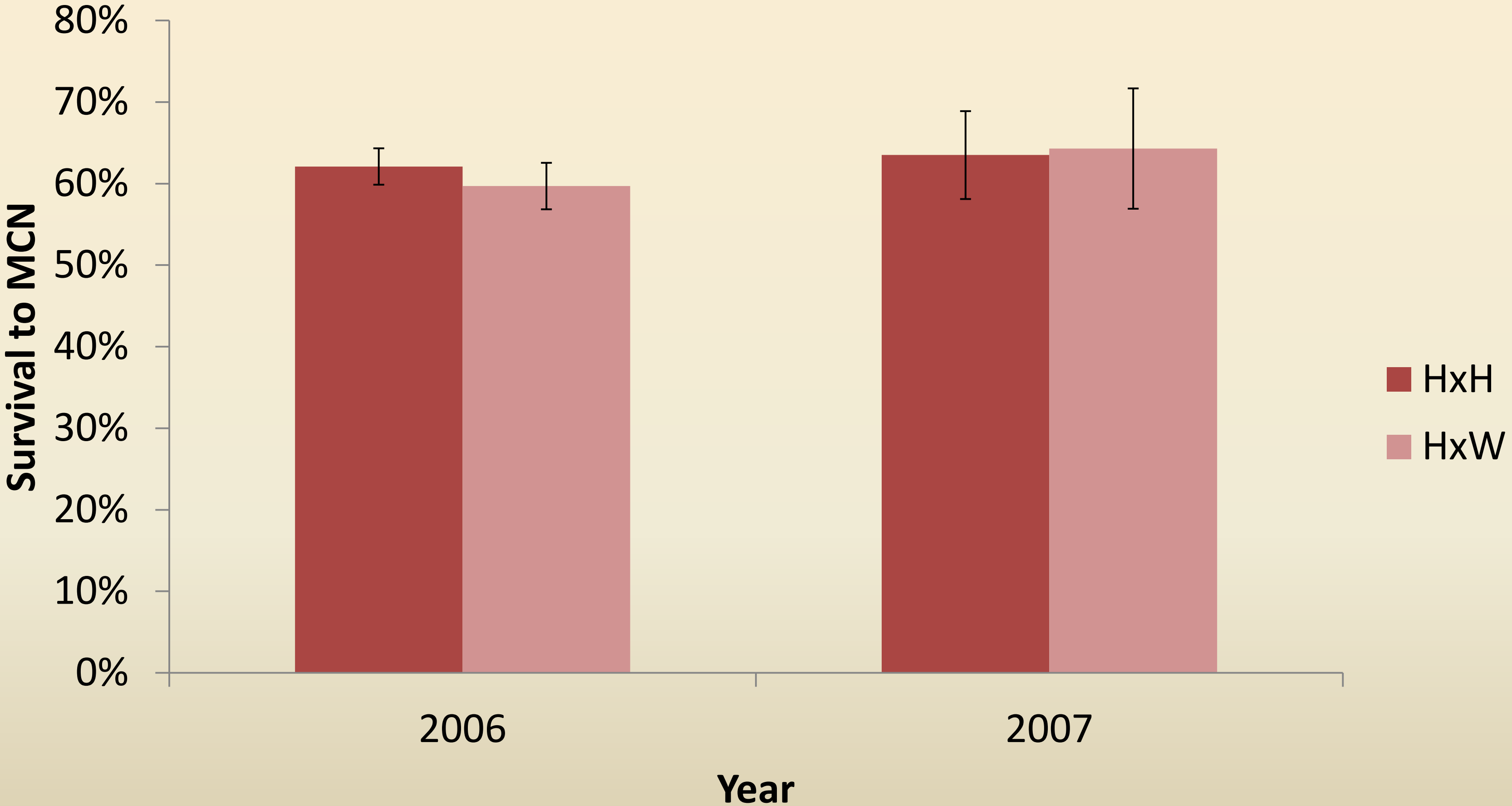
- Overwinter acclimation
- Brood origin
- Size at release
- Timing
- Volitional release
- Release #

Brood origin



** Results confounded by release location*

Brood origin

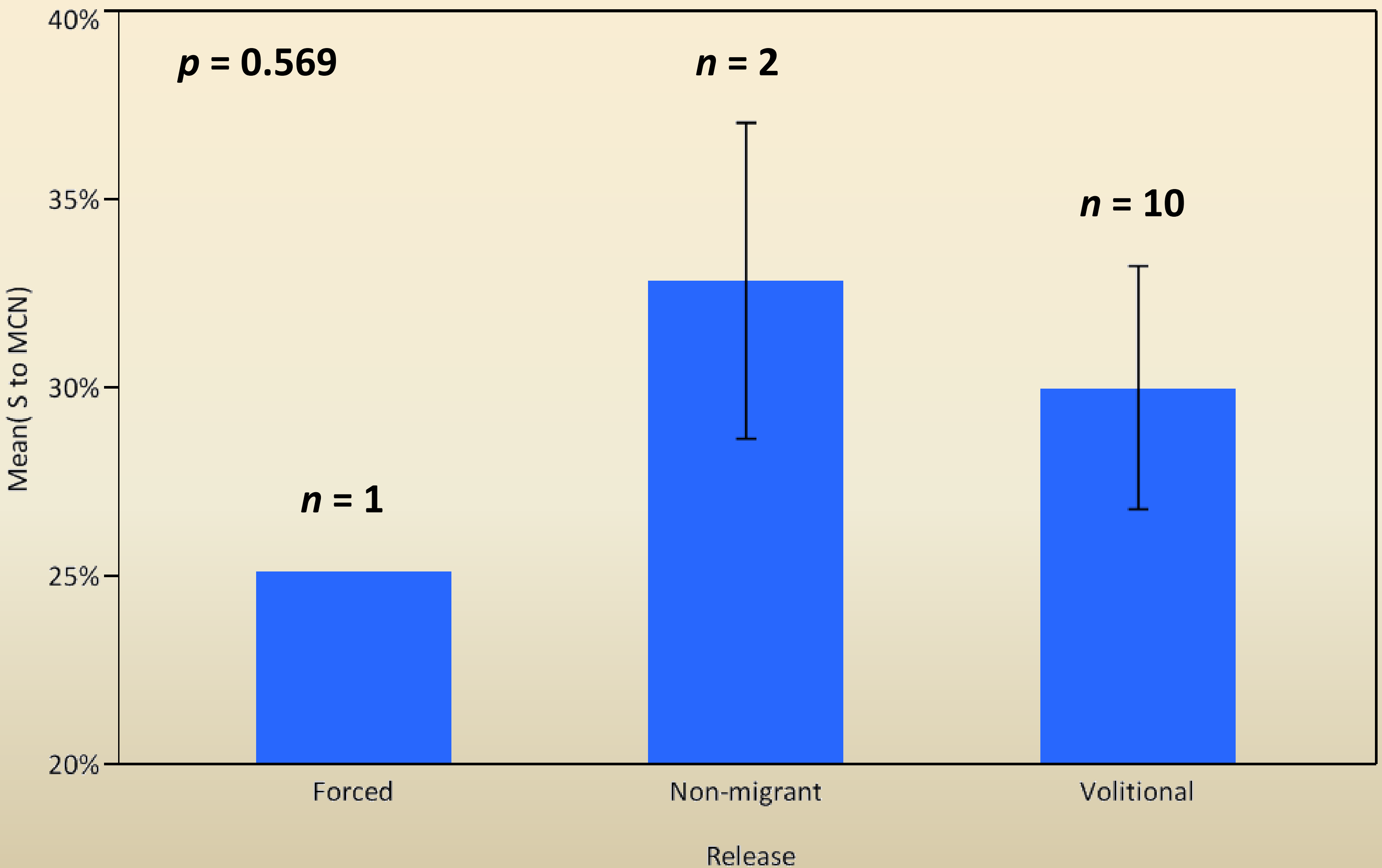


** Wenatchee River Releases only*

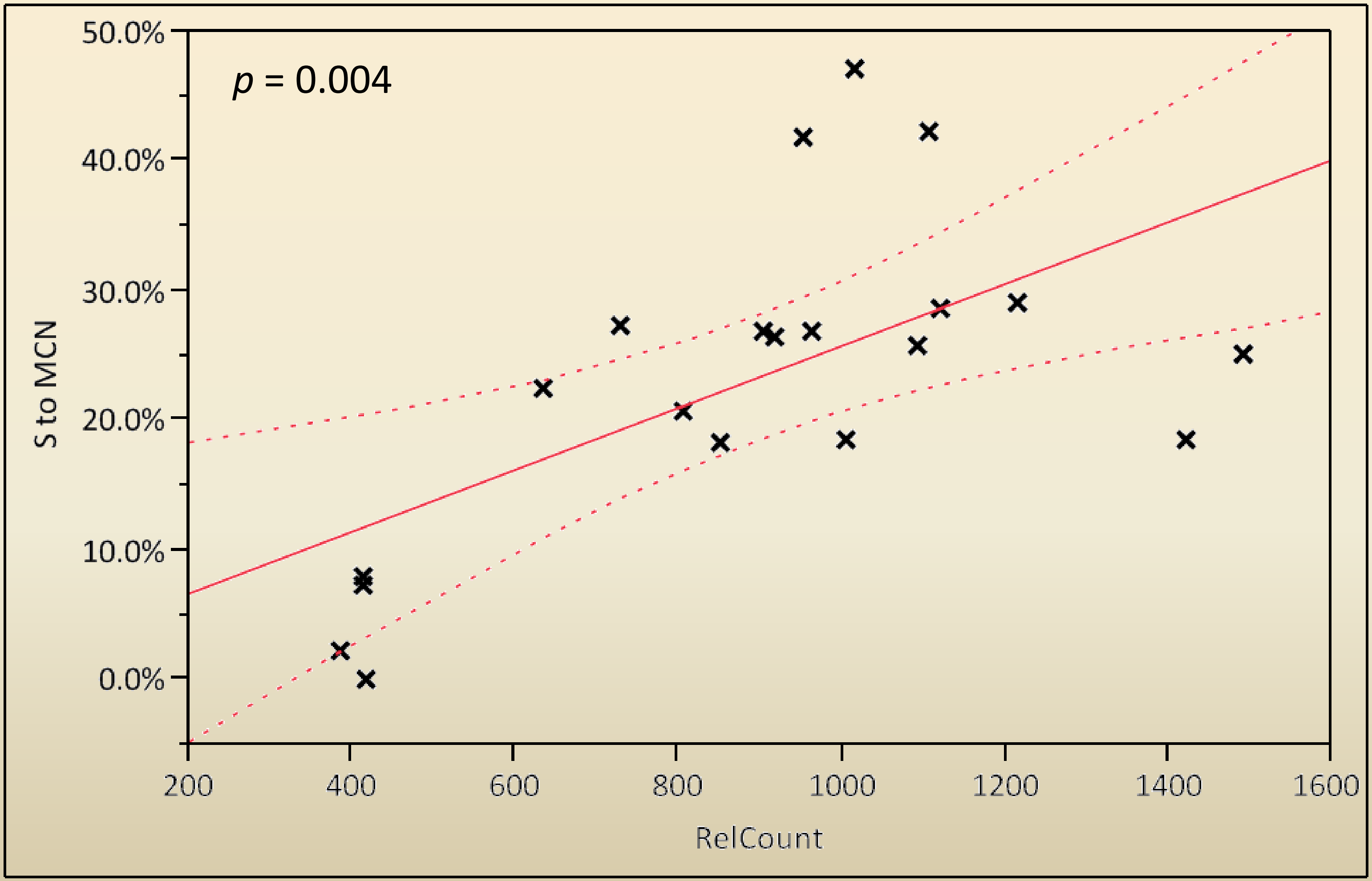
Size at release

- Blackbird = 11 FPP
- Re-use = 8 FPP
- Pond 2 = 12 FPP
- Target = 6 FPP

Volitional release



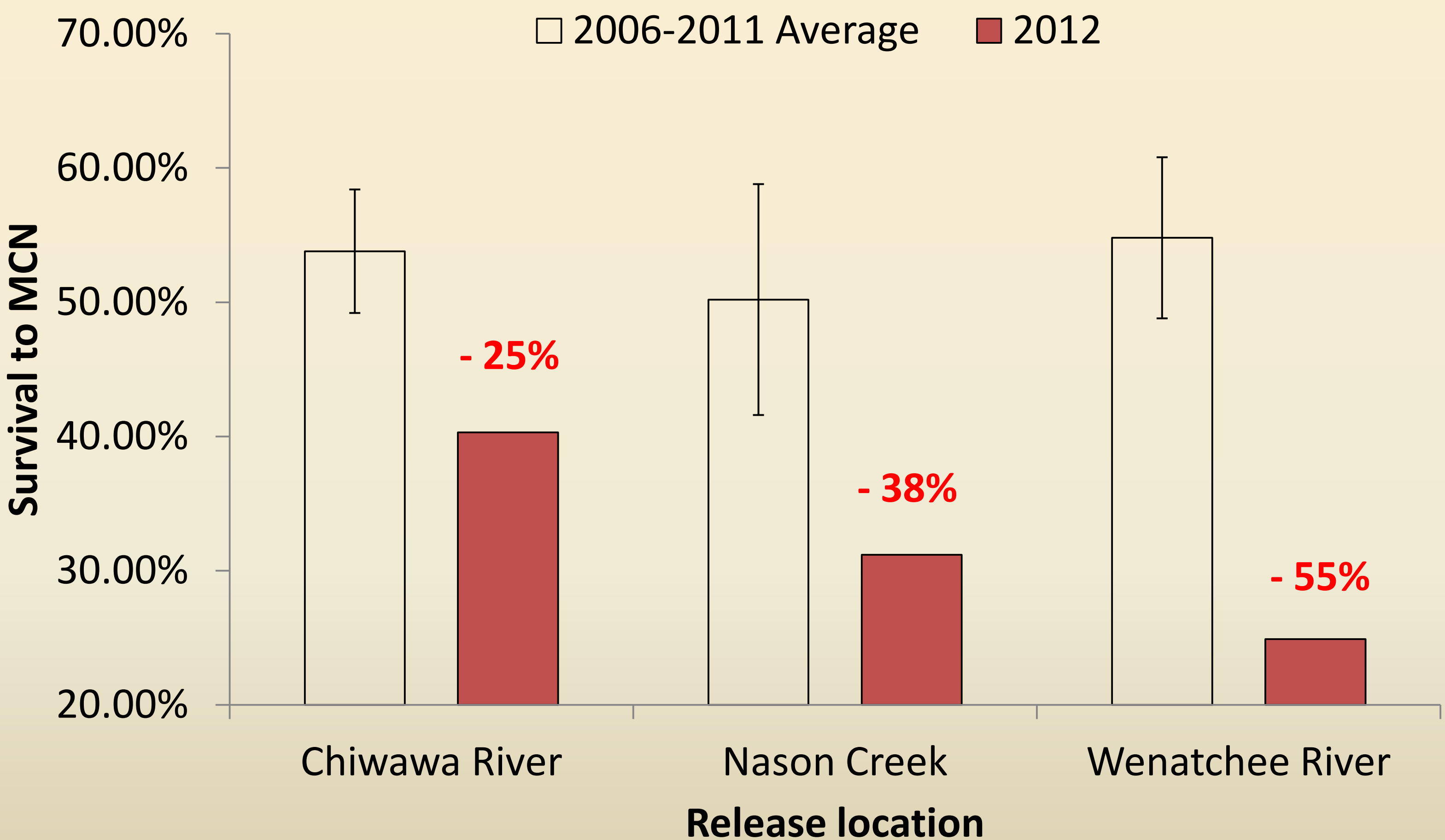
Number in release group



Recommendations

- Revert to original release strategy
  - Force release
  - First week in May
  - Large release groups
- Better investigate residual "problem" before making management decisions

Performance in 2012




Chelan Falls Summer Chinook
Pilot Study

Purpose

- Determine if we could capture adult summer Chinook in the Chelan River area.
- Determine which stocks are returning to the area (hopefully Chelan Falls summers).
- Best methods to utilize.

Methods Used

- Tangle Nets
- Hook and Line
- Eastbank Outfall (EBO)

Methods

Tangle Nets:

- 60’ x 30’ set parallel to shore from the “No Public” line on September 24th.
- 100’ x 30’ set diagonally from net pens to opposite shore on October 3rd.

Methods

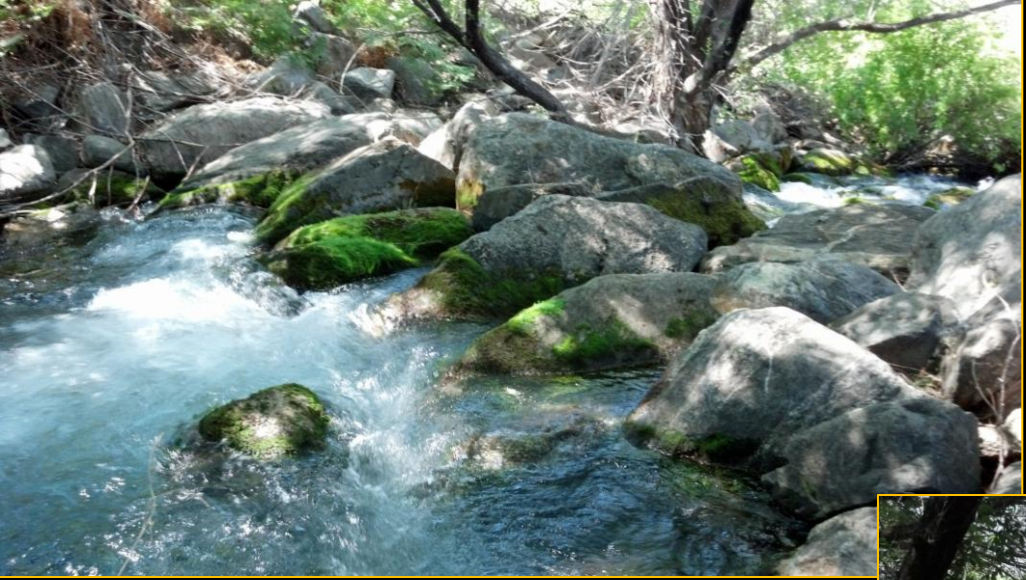
Hook and Line:

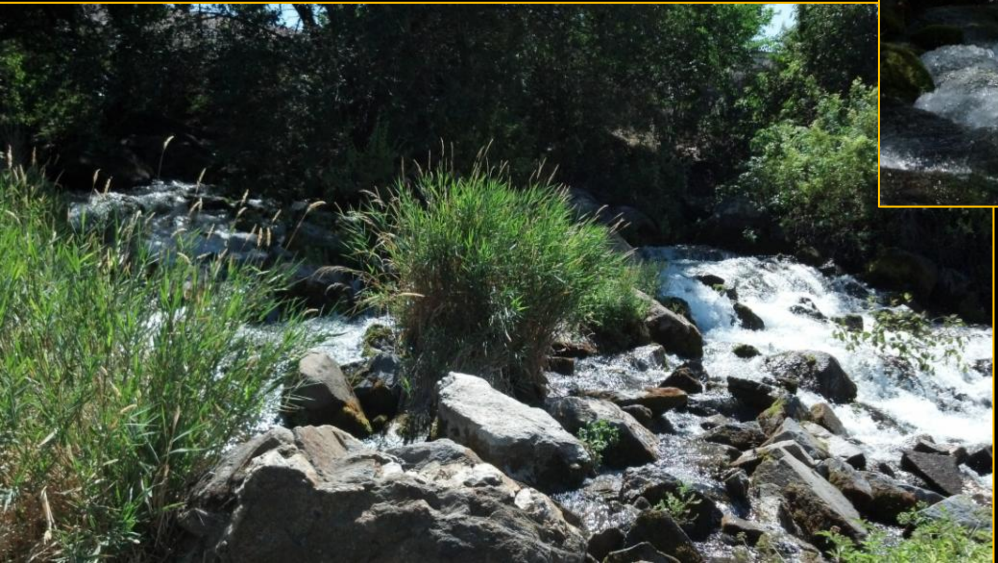
- Columbia River just up river of Chelan River confluence on September 21st.

Methods

Eastbank Outfall:

- Used pond seines on 3 occasions:
  - August 28th
  - September 11th
  - October 3rd



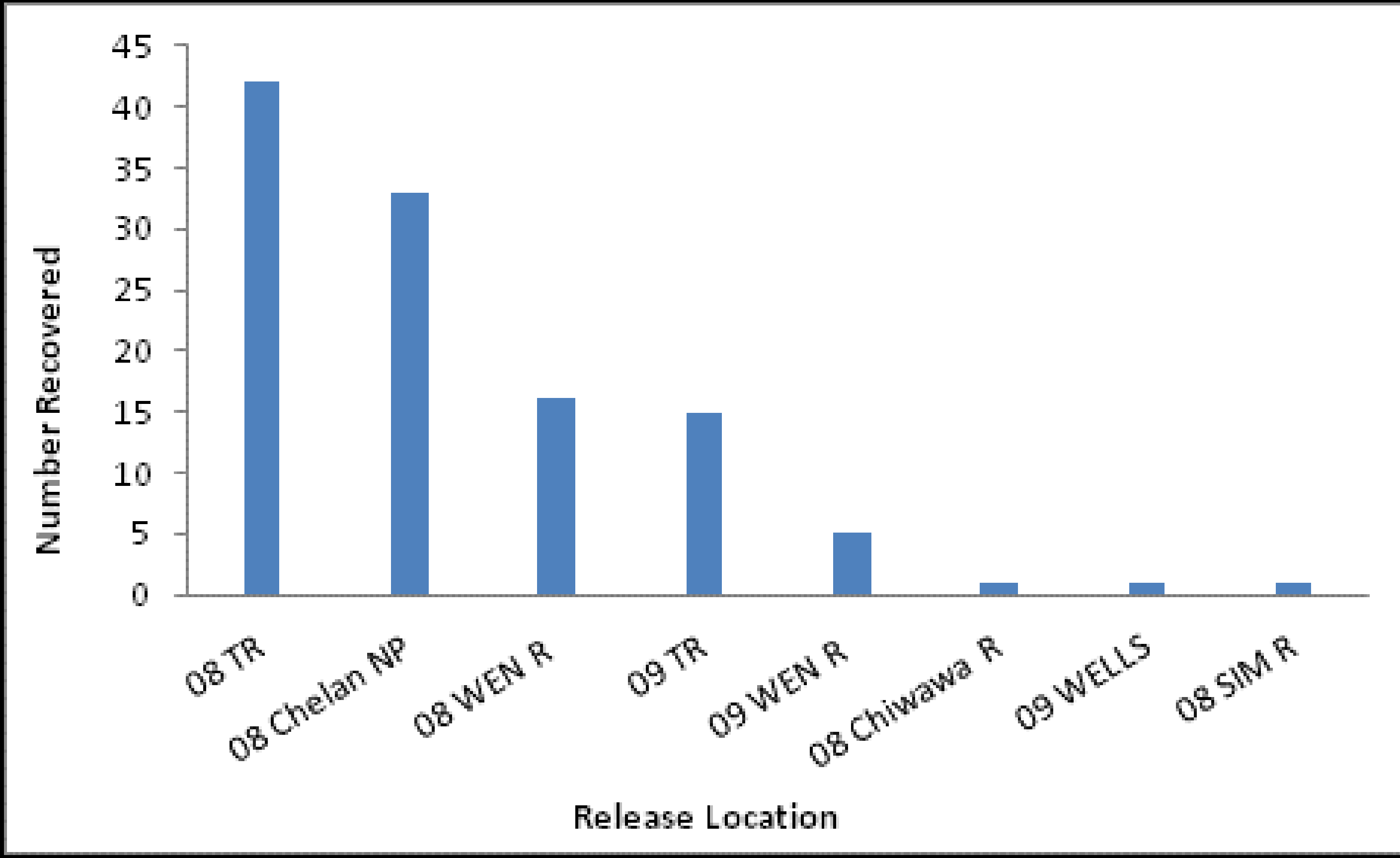


Results

Date	Method	Hours	# Staff	Total Hours	Chinook	Fish/hr
28-Aug	EBO	1.50	8	12.00	56	4.67
11-Sep	EBO	1.00	8	8.00	74	9.25
21-Sep	H+L	3.00	3	9.00	2	0.22
24/25-Sep	Tangle Net	4.00	2	13.00*	0	0.00
03-Oct	EBO	0.75	8	6.00	44	7.33
03/04-Oct	Tangle Net	4.00	3	14.00*	4	0.29

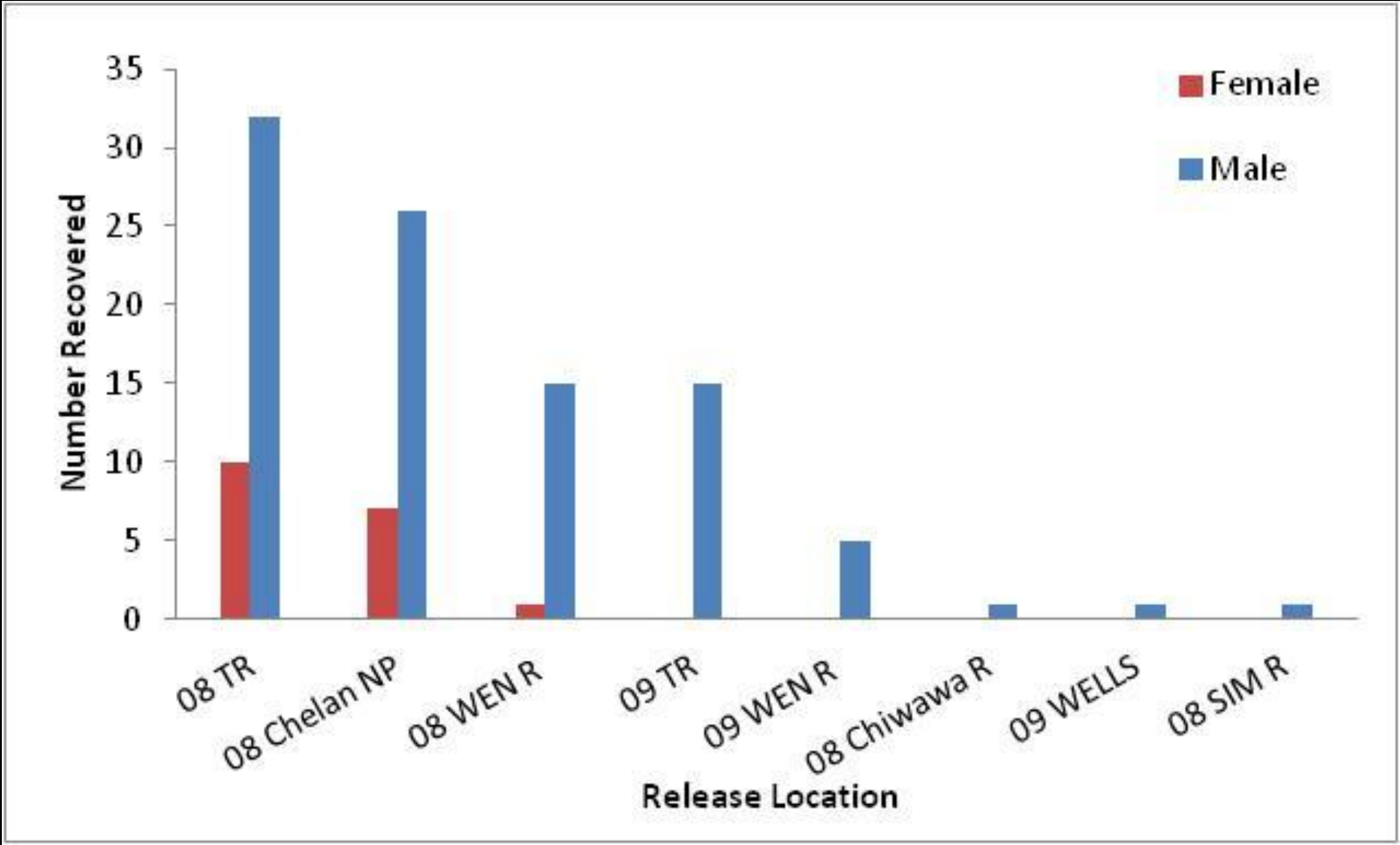
Results

- Release location of fish collected from EBO
  - 122 heads sampled
  - 114 CWT's recovered



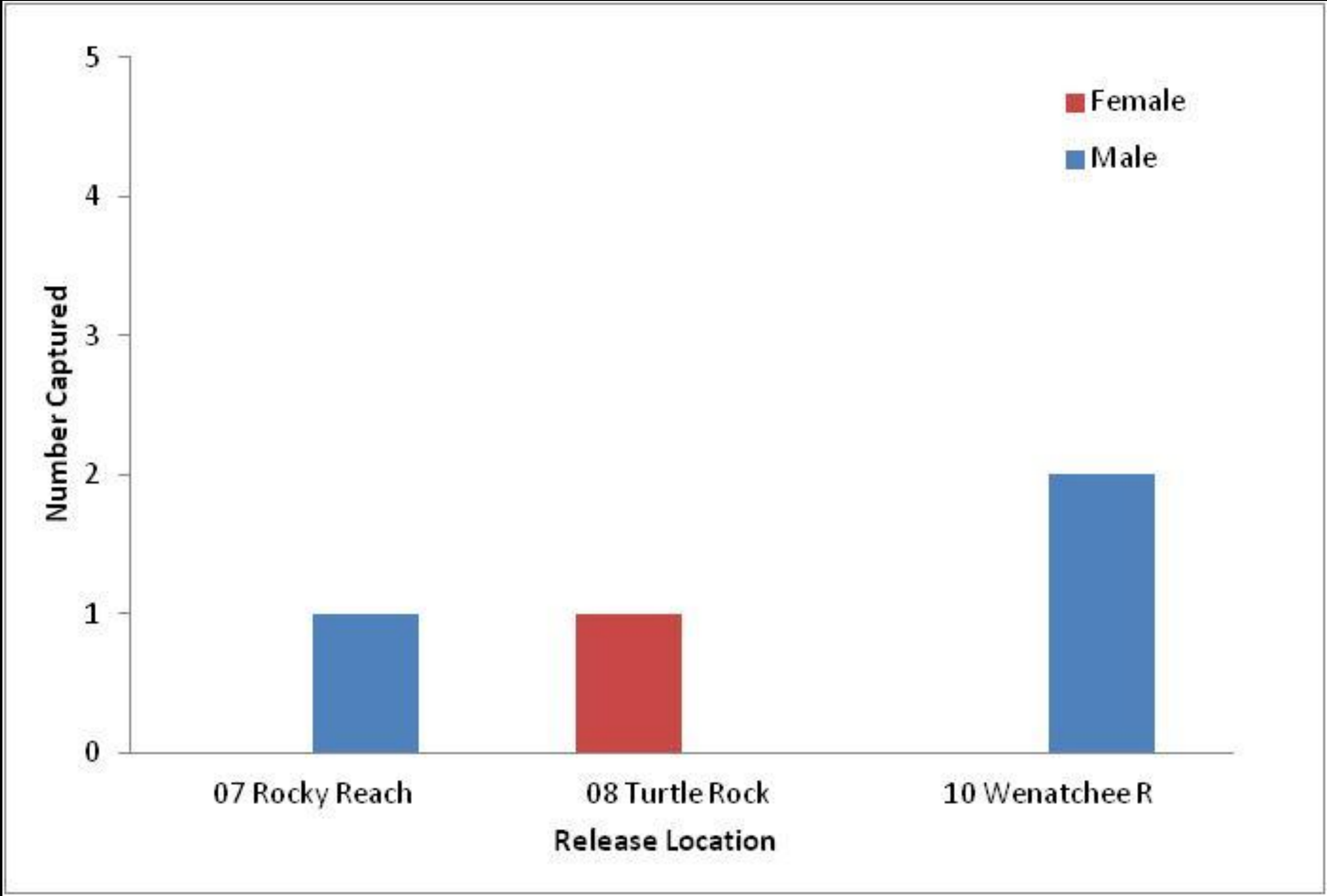
Results

- Female vs. Male collections at EBO.



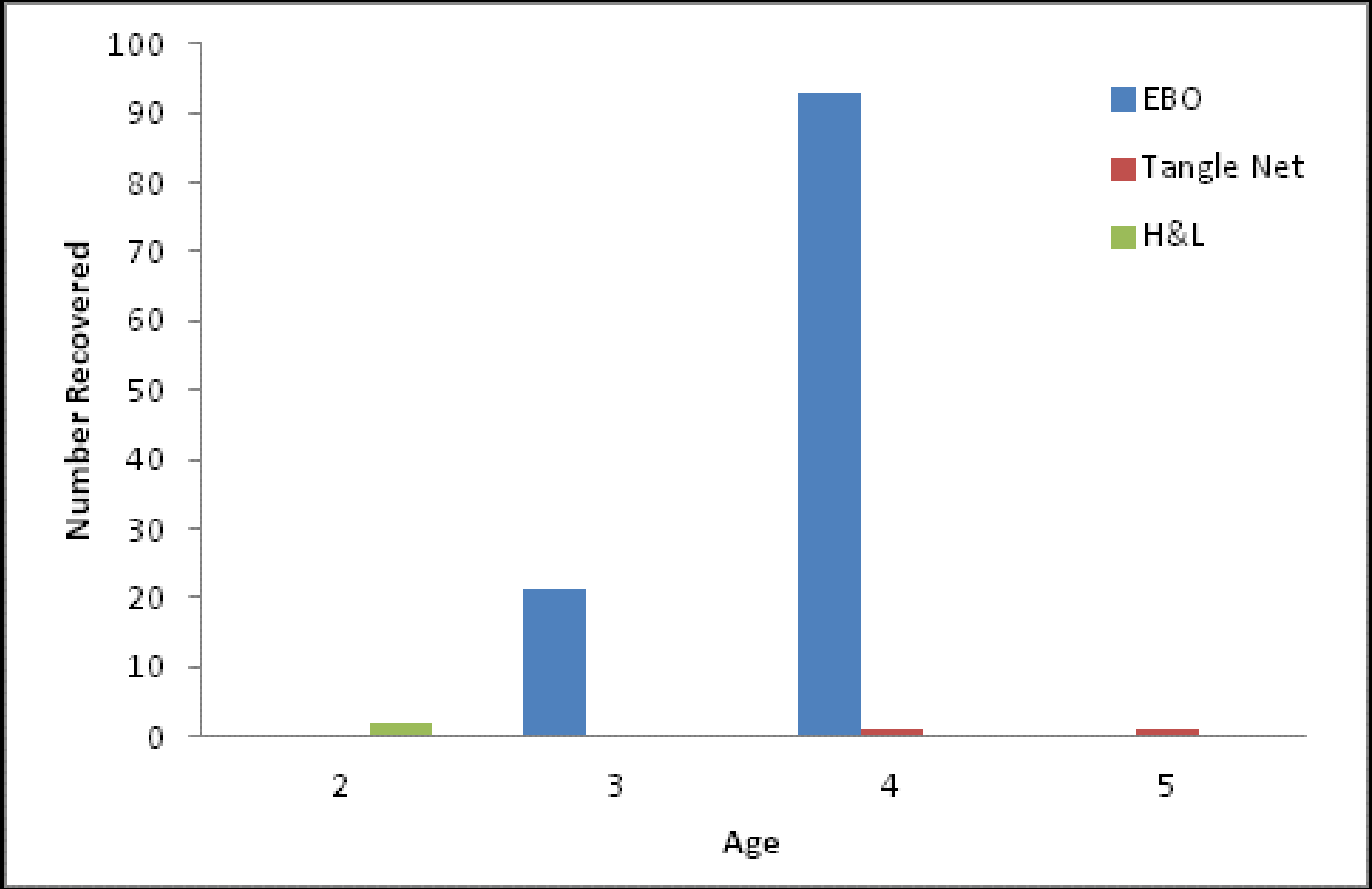
Results

- Origin of Tangle Net and Hook & Line fish.



Results

- Age of collected Chinook based on CWT's



Conclusions/Recommendations

- Not continue testing collection methods in the Chelan River area.
- Incorporate the EBO as a trap location for the Chelan Falls program beginning of July 2013.
- EBO would be:
  - Fish friendly
  - Safe for staff
  - Economical solution
  - Small cost to improve the outfall
    - Potentially capture more females
    - Utilize Volunteer Channel as back up

Conclusions/Recommendations

Added benefits:

- Would establish a location to conduct adult management.
- Can minimize stray rates of hatchery fish released from Eastbank Complex facilities.
- Enhance genetic makeup of this domesticated program by incorporating hatchery strays from programs that utilize wild origin fish for hatchery broodstock (i.e. Wenatchee, Methow, Okanogan, Wells and others?).

Acknowledgements

- Eastbank Hatchery Staff
- Chelan, and Arlington Hatchery staff
- CCPUD
- Wenatchee Food Bank
- Peter Flohr

Chelan PUD Methow Production Update

November 6, 2012

Summary: Over the past several months, Chelan PUD has worked with Douglas PUD to reach an agreement on terms and conditions for future production at Douglas' Methow Hatchery. Despite these efforts, no agreement has been reached. In the interest of moving forward, Chelan is proposing to use alternative hatchery infrastructure to meet our production obligations. We recognize the need for regulatory compliance and Hatchery Committee approval and are therefore initiating the discussions and processes necessary for a new program.

Purpose: This document provides a conceptual draft "proposal" for discussion in the Hatchery Committee. The primary goal of the proposal is to identify one or more pathways to meet production goals within our regulatory requirements. The proposal also provides NMFS with some basic documentation that the production of up to 60,516 smolts is reasonably certain to occur for the purposes of existing or ongoing Section 7 consultations related to the Methow River.

Ensuring ESA Compliance: Currently, ESA coverage is provided by Permit 1196, which expires January 20, 2014. Permit 1196 covers production of up to 550,000 spring Chinook smolts in the Methow River and it is expected that Chelan's 60,516 smolt obligation would result in a level of Take that is within or below that anticipated by Permit 1196 (including the additional production by Grant and Douglas PUD). After the expiration of Permit 1196, new ESA coverage will be required. Chelan will work with NMFS and the HC to ensure that any materials required for an application are prepared and delivered. Broodstock collection for 2012 has already been implemented for a 223,765 smolt program at Methow Hatchery and these fish will be released in 2014, after the expiration of the current permit. Therefore it is expected that NMFS would consider the level of take and effect analysis associated with a 223,765 smolt release, regardless of the timing of individual applications (i.e., there is no need to delay the evaluation of current HGMPs based on the number of fish produced at Methow Hatchery).

Initial Methow Proposal:

Broodstock Collection	*Why?*	Adult Holding and Rearing	*Why?*	Acclimation	*Why?*
Option 1. Rocky Reach Trap + GSI at Eastbank	*Trap was successfully used in the past & small future program of 60,516 smolts = 35 broodstock. Very close to Eastbank for adult holding and sorting. Available GSI markers used to sort out Entiat.*	**Option 1.** Eastbank	*Capacity exists and track record is good: spring Chinook originating from Eastbank perform well (i.e., Chiwawa SAR = .540 vs. Methow SAR = .234)*	**Option 1.** Carlton spring acclimation (short term only)+ early imprinting to improve homing fidelity to desired habitat.	*Allows for imprinting on Methow River water and development of new science that could be applicable on larger scale. Work by Andy Dittman at NMFS shows promise.*
Option 2. Rocky Reach Trap + PBT analog (GSI markers)	*PBT didn't work for Wenatchee, but may be easier for Methow. In 2010, 113 of 196 PBT study fish ascended Wells. These could be collected at Rocky Reach instead. Also PBT relied on availability of parental genotypes, where Methow could use existing GSI markers.*			**Option 2.** Carlton overwinter + Yakama Nation upper basin acclimation (e.g., Heath Ranch or Goat Wall or others)	*Overwintering on lower Methow River water and then acclimating at locations higher in the basin provides options for distributing adult returns and meeting manager goals.*

Note- The options depicted here are conceptual and have not been approved by any party.

Other Options:

1. Chelan is open to any suggestions/options
2. Additional homing fidelity to specific locations within the Methow could be achieved through early life history imprinting (i.e., Andy Dittman, NMFS Science Center). Chelan would support this
3. If there was a short term benefit to moving the 2013 brood year to Chiwawa, Chelan would support the move. This option does not include any commitments from Grant PUD.

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FINAL MEMORANDUM

To:	Wells, Rocky Reach, and Rock Island HCPs Hatchery Committees	**Date:**	January 18, 2013
From:	Mike Schiewe, Chair		
Cc:	Kristi Geris		
Re:	Final Minutes of the December 12, 2012 HCP Hatchery Committees Meeting		

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans (HCPs) Hatchery Committees meeting was held at Chelan PUD headquarters in Wenatchee, Washington, on Wednesday, December 12, 2012, from 9:30 am to 3:00 pm. Attendees are listed in Attachment A to these meeting minutes.

ACTION ITEM SUMMARY

- Mike Tonseth will send the proposal for broodstock collection at Tumwater Dam for Grant PUD's Nason Creek spring Chinook program to Kristi Geris for distribution to the Hatchery Committees after the proposal has been vetted in the Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC; Item I).
- Greg Mackey will distribute to the Hatchery Committees updates to the Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs (Item II-B).
- Joe Miller will contact Grant PUD about the potential to overwinter acclimate Chelan PUD Methow spring Chinook production at Grant PUD's Carlton facility in 2013 (Item III-A).
- Joe Miller will contact Craig Busack regarding drafting concurrence letters to authorize collection of Methow spring Chinook broodstock using a modified parental based tagging (PBT) approach, and out-of-basin rearing facilities—both for brood year (BY) 2013 only (Item III-A).
- Chelan PUD will discuss with the Yakama Nation (YN) the potential use of upper Methow basin acclimation sites for Chelan PUD's BY2013 Methow spring Chinook production, to include installation of temporary adult weirs at the remote acclimation locations (Item III-A).
- Chelan PUD will draft a study plan to test Methow spring Chinook broodstock

collection at the Rocky Reach Trap; the study would potentially involve trapping, tagging, and genetic testing at Priest Rapids Dam, and monitoring at the Rocky Reach Dam Fish Trap (Item III-A).

- Bill Gale will discuss with United States Fish and Wildlife Service (USFWS) staff the potential to collect, spawn, incubate, and early rear Chelan PUD's Methow spring Chinook at Winthrop National Fish Hatchery (NFH) in 2013, and he will also propose a meeting for USFWS, Washington Department of Fish and Wildlife (WDFW), and Chelan PUD staff to review opportunities before the January 16, 2013 Hatchery Committees meeting (Item III-A).
- Bill Gale will distribute to the Hatchery Committees the draft terms and conditions that incorporate non-target taxa of concern (NTTOC) analyses as Monitoring and Evaluation (M&E) measures in the Leavenworth NFH Complex draft Biological Opinions (BiOps; Item IV-A).
- Kirk Truscott will coordinate internally to arrange a presentation on the Colville Confederated Tribes' (CCT's) Chief Joseph Hatchery (CJH) M&E Plan for a future Hatchery Committees meeting (Item VI-A).
- Kristi Geris will re-circulate the Conflict of Interest Policy Agreement amongst the Hatchery Committees members (Item VII-B).

STATEMENT OF AGREEMENT DECISION SUMMARY

- No Statements of Agreement (SOAs) were approved at this meeting.

AGREEMENTS

- The Hatchery Committees representatives present agreed that Chelan PUD and Douglas PUD will provide their respective draft M&E Implementation Plans to the Hatchery Committees for review no later than July 1 of the year preceding the proposed M&E activities (Item V-A).

REVIEW ITEMS

- Kristi Geris sent an email notification to the Hatchery Committees on November 13, 2012, stating that the draft Douglas PUD 2013 M&E Implementation Plan is out for a 30-day review period with comments due to Greg Mackey by December 14, 2012.

FINALIZED REPORTS

- The Douglas PUD 2011 M&E Report was finalized and distributed to the Hatchery Committees on December 3, 2012.

I. Welcome, Agenda Review, Meeting Minutes, and Action Items

Mike Schiewe welcomed Lynn Hatcher to the Hatchery Committees, who will be replacing Craig Busack as the National Marine Fisheries Service (NMFS) primary representative to the committees (Busack will become the NMFS alternate representative to the committees). Hatcher works in the Protected Resources Division of the Northwest Regional Office in their Ellensburg, Washington, office. Schiewe said that during the transition, Busack plans to be in touch frequently and will attend Hatchery Committees meetings by conference call for critical agenda items. Schiewe then reviewed the agenda, and the following revisions were requested:

- Joe Miller added an update on Chelan PUD's requirement to issue a request for proposal (RFP) for implementation of their Hatchery M&E Program.
- Kirk Truscott added an update on CJH.
- Bill Gale added: 1) a review of information compiled by Matt Cooper of the Mid-Columbia River Fishery Resource Office (MCRFRO) on the composition of spring Chinook spawning in the Entiat Basin; and 2) a discussion of the potential to incorporate the results of the NTTOC analyses as a term and condition in the new ESA permit for the operation of Leavenworth NFH.

Miller asked about the status of discussions in the PRCC HSC regarding the use of Tumwater Dam for broodstock collection for Grant PUD's Nason Creek spring Chinook program; Tonseth replied that he will send the proposal to Kristi Geris for distribution to the Hatchery Committees after the proposal has been vetted within the PRCC HSC.

The revised draft November 14, 2012 meeting minutes were reviewed. Geris said that there was one edit remaining to be discussed regarding the discussion on CJH and Methow sharing agreements; however, Greg Mackey said that his comment had already been resolved in subsequent edits. Geris said that all other comments and revisions received on the draft meeting minutes were incorporated. The Hatchery Committees members present approved the November 14, 2012 meeting minutes, as revised.

II. Douglas PUD

A. Draft Douglas PUD 2013 M&E Plan (Greg Mackey)

Greg Mackey reminded the Hatchery Committees that the draft Douglas PUD 2013 M&E Implementation Plan is out for a 30-day review period with comments due to him by December 14, 2012. Mackey encouraged discussion on the draft plan now, if needed. Keely Murdoch said that the YN plans to submit comments to Douglas PUD by December 14, 2012. Mackey said that if no significant comments or revisions are received on the draft plan, it will be finalized on December 14, 2012.

B. Updating the PUD M&E Plans (Greg Mackey)

Greg Mackey said that the Hatchery M&E Programs workgroup recently convened to further discuss updating the Hatchery M&E Plans. Mackey said that the workgroup is evaluating what needs to be addressed; and he added that Douglas PUD has edited the existing Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs. Mackey said that he will provide those edits to Kristi Geris for distribution to the Hatchery Committees.

Mike Schiewe recommended developing a schedule to complete the edits well in advance of the January 2014 implementation date. Bill Gale asked how the Hatchery M&E Plans can be revised when consultations are not complete. Mike Tonseth said that approximately 90 percent of the M&E Plans can be completed now and that once the consultations are complete, any new terms and conditions in the permits can be added. Tonseth added that he did not recommend postponing the update of the Hatchery M&E Plans because this will then impact the timing of the annual Implementation Plans.

Tonseth said that Douglas PUD, Grant PUD, USFWS, and WDFW recently met to discuss projected hatchery M&E programs and activities in the Methow basin, including the associated infrastructure needs and identification of stakeholders. Mackey said that the reasoning behind the discussion was to proactively develop a common understanding of individual agency responsibilities. Keely Murdoch asked why only select agencies attended this meeting, and Mackey explained that this meeting was initially intended to facilitate discussions between USFWS, and Douglas PUD and Grant PUD as funding entities; and then WDFW was brought in because they implement the M&E plan. Tonseth said that a draft spreadsheet template was being developed to capture and organize M&E activities in the Methow Basin, and that once it is refined, it will be distributed to all HCP signatories. Murdoch noted that a similar spreadsheet was developed by the Upper Columbia Salmon Recovery Board that identified agencies and their current data collection efforts. She added that the spreadsheet only focused on field efforts, however, and included no in-hatchery M&E activities. Murdoch also noted that as this effort moves forward, all of the Hatchery Committees representatives should be involved. The Hatchery Committees agreed to this, and Gale added that this first meeting was largely to give Douglas PUD and Grant PUD an idea of USFWS M&E activities. Joe Miller asked if USFWS requirements were fundamentally different from Chelan PUD's, and Gale replied that USFWS does not have a binding M&E framework that requires coordination as occurs under the HCPs; and he also added that USFWS is not bound by the Federal Energy Regulatory Commission (FERC). Miller asked if the completeness of USFWS's program depends on Chelan PUD's program, and Gale replied that most USFWS programs operate independently of other programs. Tonseth reiterated that the purpose of the meeting was to determine who has what requirements for what monitoring activities. He added that the group has a meeting scheduled for December 19, 2012; and Mackey suggested that this meeting should be cancelled and the discussions moved into the Hatchery Committees.

III. Chelan PUD

A. Methow Production (Joe Miller)

Joe Miller recapped that at the last Hatchery Committees meeting, Chelan PUD put forward a proposal for meeting their required Methow spring Chinook production. He noted that an action item that came out of that discussion was for the Joint Fisheries Parties (JFP) to meet, consider the merits of the proposal, and provide feedback, including alternatives if needed. Mike Tonseth said that a memo was distributed on December 11, 2012 summarizing the JFP discussion on the Chelan PUD Methow spring Chinook 2013 production obligation

(Attachment B). He said that the JFP reviewed Chelan PUD's proposal in multiple stages: adult collection, adult holding and spawning, incubation, and juvenile rearing and acclimation.

For adult collection in 2013, Tonseth said that there was a JFP consensus that Chelan PUD must meet its Methow production requirement of 60,516 spring Chinook. He said that the JFP also concluded that using the Rocky Reach trap for broodstock collection posed a risk to populations other than the Methow (i.e., Entiat natural origin recruits [NORs]), and that there was also uncertainty that Chelan PUD could capture enough broodstock to meet its production obligation. Miller told the Hatchery Committees members that neither the Wells Dam nor the Methow Hatchery option was possible without a sharing agreement between Douglas PUD and Chelan PUD, and that such an agreement currently did not exist. Keely Murdoch noted that several other agencies are already trapping broodstock at Wells Dam, and suggested that it would be more efficient if Chelan PUD, Grant PUD, and Douglas PUD all utilized broodstock from the same pool of fish. Miller reiterated that spring Chinook broodstock collection at Wells Dam in 2013 was highly unlikely and that the Committees needed to focus on alternatives.

Miller said that Chelan PUD staff had routinely sampled bull trout using the Rocky Reach trap; and if necessary, Chelan PUD can provide additional information regarding trapping at that location. He added that Chelan PUD is also prepared to work with NMFS and USFWS to obtain the necessary permits. Tonseth said that Chelan PUD needs to demonstrate that the Rocky Reach trap is the only option, and also needs to convince the Hatchery Committees that it is worth the risk. Gale said that his major concern is handling Entiat natural origin spring Chinook. Miller said that during the PBT pilot study, the majority of the fish trapped, sampled, and tagged at Priest Rapids Dam converted over Wells Dam. Murdoch noted that a PBT process had been considered in the past but was dismissed due to the elevated risk involved with over-handling the fish. Tonseth noted that the options available for collecting broodstock in 2013 were limited by what can be initiated in six months.

Kahler asked about the numbers of natural origin fish typically seen in the Winthrop NFH volunteer trap, and Gale replied that there are none, and that very few are in the volunteer channel. Gale added that USFWS needs the Methow Hatchery origin fish trapped in the Winthrop NFH volunteer channel for the Winthrop NFH program. He said that the USFWS might consider collecting Chelan PUD's broodstock at Winthrop NFH as an interim measure for 2013. He added that hatchery program staff would likely be reluctant to hold and spawn at Winthrop NFH. Gale said that he would prefer this broodstock collection option over trapping at Rocky Reach due to the potential impacts to Entiat fish. Miller said that Chelan PUD will consider any option except the Wells Dam option.

Tonseth said that because of the poor returns of spring Chinook forecasted for 2013, it is not likely that there will be enough natural origin fish returning to the Methow for all three PUDs to meet program goals, and that incorporation of hatchery returns to meet production goals will be required. He added that if Wells Dam is truly not an option, in order to get around permitting issues, the Rocky Reach trap may be the most effective short-term solution. Tonseth asked Miller if Chelan PUD could employ a sort-by-code approach to minimize handling; Miller said that, currently, Chelan PUD would need to rely on visual identification. Miller said that Chelan PUD does not have enough time to set up a gate system for sort-by-code. Gale asked if Priest Rapids Dam has a sort-by-code function, and Murdoch said that they do not. Tonseth said that a sort-by-code feature could be installed at the top of the fishway; however, this would entail manually picking out the fish. He suggested that, as proposed by Chelan PUD, an option for implementation in 2013 would be replacing PBT with genetic stock identification (GSI), and then passive integrated transponder (PIT) tagging and externally marking the fish to determine the probability of collecting the fish at the Rocky Reach trap. Tonseth suggested reviewing previous studies and conducting a second pilot study in 2013 to evaluate potential impacts. Miller said that he will contact Craig Busack regarding drafting concurrence letters to authorize collection of Methow spring Chinook broodstock using a modified PBT approach, and out-of-basin rearing facilities—both for BY2013 only.

Tonseth said that the JFP accepted Chelan PUD's proposed option to hold and spawn 2013 broodstock at Eastbank Fish Hatchery (FH); and noted that there are several incubation options possible. He said that the JFP preferred using a portable incubation trailer to initially imprint the fish to groundwater at the Carlton Facility. He said that because of the limited summer water right at Carlton, this option would be implemented during early rearing only. Tonseth asked Miller about the logistical feasibility of this option, and Miller said that he did not think it is impossible, but that implementation in the next 6 months might be difficult. Murdoch said that overwinter acclimation at Carlton was also discussed because the water is too warm at Eastbank FH. She said that the YN's Goat Wall and Heath Pond sites were also considered and that they are both mainstem Methow. Miller said that Chelan PUD will discuss with the YN the potential use of upper Methow basin acclimation sites for Chelan PUD's BY2013 Methow spring Chinook production. Murdoch added that Chewuch would have also been considered but no ponds are developed there yet.

Tonseth said that another option considered involved using surface water acclimation and an ultraviolet (UV) treatment system; however, the feasibility of getting the necessary infrastructure in place by 2013 was questionable. Miller said that from a fish health and bio security perspective, Eastbank FH seems like a good option. He added that the incubation method and location may require further discussion. Truscott noted that another option would be to incubate and early rear at Winthrop NFH if space is available; Gale replied that he will discuss this option with USFWS, but that he was unsure whether there would be space available. Gale asked Miller why Chelan PUD is reluctant about the portable incubation trailer option; and added that he thought that was along the lines of what Chelan PUD wanted. Miller replied that Chelan PUD is interested in that idea for 2014 and beyond but is unsure if the infrastructure will be ready to meet 2013 production.

Schiewe summarized that Chelan PUD is suggesting that it would be less risky to utilize Eastbank FH for incubation and early rearing in 2013. Murdoch said that the YN has routinely transported coho gametes among locations and noted that it can work; however, this option may not be a first choice. Lynn Hatcher added that NMFS would prefer doing as much of the rearing as possible in the Methow. Tonseth said that WDFW's first priority, if approved by USFWS, would be to collect broodstock and incubate eggs and early rear at Winthrop NFH. Schiewe said that if that is not an option, then the next option would be to take fish from Winthrop NFH, and hold and spawn at Eastbank FH. Miller mentioned that Grant PUD is developing a facility at Carlton to accommodate overwinter rearing of their Methow summer Chinook, and that it might be possible to use the existing space proposed by Grant PUD if the densities allow, or adding a single circular tank for Chelan PUD's spring Chinook production. Miller said that he will contact Grant PUD about the potential to overwinter acclimate Chelan PUD Methow spring Chinook production at Grant PUD's Carlton facility in 2013.

Tonseth concluded that for 2013 there seems to be a path forward. Greg Mackey reminded the Committees that it is important to consider measures to meet the percent hatchery origin spawners (pHOS) objectives. Hatcher said that he thought NMFS was comfortable with the pHOS analysis Douglas PUD submitted, and Mackey replied that the submittal did not include Chelan PUD fish. Murdoch noted the small size of Chelan PUD's requirement (approximately 61,000 smolts); she suggested marking fish to address any concerns. She also said that there are many uncertainties associated with the proposed pHOS and escapement targets, and that the YN has not had an opportunity to comment to date.

Schiewe asked what can be accomplished in 2013 that will inform 2014 and beyond. He asked if Chelan PUD can do anything in 2013 to improve understanding of the potential to collect broodstock at Rocky Reach in future years. Tonseth noted that permitting options need to be determined. Miller suggested using a pilot study approach similar to the PBT study to determine if sampling and rapid turnaround GSI at Priest Rapids Dam is feasible. Murdoch noted that a 2-week pilot study at Priest Rapids Dam is a fairly short duration for broodstock collection; and she added that it will not represent the entire run. Tonseth said that sampling could be spread out over the run. Miller said that Chelan PUD will draft a study plan to test Methow spring Chinook broodstock collection at the Rocky Reach Trap, potentially involving trapping, tagging, and genetic testing at Priest Rapids Dam, and monitoring at the Rocky Reach Dam Fish Trap. Gale said that once agreement is reached on Chelan PUD production for 2013 that these decisions need to be discussed with NMFS. Gale added that he will discuss with USFWS staff the potential to collect, spawn, incubate, and early rear Chelan PUD's Methow spring Chinook at Winthrop NFH in 2013, and he will propose a meeting for USFWS, WDFW, and Chelan PUD staff to review opportunities before the January 16, 2013 Hatchery Committees meeting.

B. M&E RFP (Joe Miller)

Joe Miller indicated that the Chelan PUD Commission will require an open competition and RFP for awarding new contracts for implementing the revised Hatchery M&E in 2014. Miller said that this would require completing revisions to the plan by April 2013. Mike Schiewe noted that this means the Hatchery M&E workgroup needs to finalize any proposed changes and that all the Hatchery Committees need to approve the revised Hatchery M&E by April 2013.

IV. USFWS

A. Assessing the Ecological Impact of Leavenworth Releases on NTTOC (Bill Gale and Amilee Wilson [National Oceanic and Atmospheric Administration])

Bill Gale said that as USFWS and NMFS were working through the final drafts of the Leavenworth NFH BiOps (which are now with NMFS for their final quality check [QC]), it was noted that ecological interactions were identified in the BiOps as a potential avenue for incidental take; however, nowhere in the terms and conditions was this incidental take measured or addressed. NMFS is primarily concerned with the effects of residualism. He said that as a result USFWS discussed with NMFS the possibility of incorporating into the BiOps the risk modeling that is being conducted by the Hatchery Evaluation Technical Team (HETT), and using that risk assessment to identify the high-risk areas and interactions that could be subject to intensive monitoring. Gale shared with the Hatchery Committees the draft terms and conditions language that he developed for the Leavenworth NFH BiOps.

Amilee Wilson said that National Oceanic and Atmospheric Administration (NOAA) General Counsel, during their legal reviews of recent BiOps, has asked NMFS to incorporate methods to quantify potential take that could occur through ecological interactions as a result of the hatchery program. She said that NMFS would not only like to address this issue for Leavenworth NFH, but was also interested in developing an approach to apply to all hatchery BiOps. Mike Schiewe asked how take would be determined. Craig Busack noted that calculating take is very difficult and typically involves using surrogate variables. He said that the Predation, Competition, and Disease (PCD) Risk Model could be a useful tool to quantify risk. Gale added that all the HCP parties are already conducting PCD risk modeling as part of the NTTOC analysis. Gale said that he will distribute to the Hatchery Committees the draft terms and conditions incorporating NTTOC analyses as M&E measures in the Leavenworth NFH Complex draft BiOps.

Greg Mackey said that when he was running the PCD risk models for Douglas PUD hatchery programs, he encountered problems when hatchery fish are smaller in size than wild fish, which resulted in the program crashing. Mackey said that he thinks this problem is caused by a programming error. Busack said that an issue with the use of the PCD risk model is that it has not had a lot of use under varying circumstances; and he added that it would be beneficial to hear other users' thoughts on the output. Gale asked the Hatchery Committees if they felt it was reasonable to expect NTTOC risk modeling to be complete by 2015. Keely Murdoch said that 2015 seemed reasonable.

Truscott asked what the difficulty was in performing snorkel surveys to assess residuals. Wilson said that the focus of NMFS' concern is to determine impacts from residual fish. She added that those fish will still be around in the summer, and that terms and conditions can be developed which include snorkel surveys; but for now, NMFS approves using NTTOC analyses as long as the Hatchery Committees are comfortable with those data. Wilson said that this is a good tool to identify programs and populations of high and low risks. She said that for low risk programs, terms and conditions may not be required; however, NMFS will want to require further monitoring of identified high risk programs. Therefore, the PCD-Risk model could be used to identify areas of concern that could require additional field work, such as snorkel surveys, to quantify the level of risk associated with a hatchery program, while in cases of low risk, additional field work would not be required.

Schiewe asked the Hatchery Committees if there were concerns regarding NMFS using PCD modeling as a tool in addressing ecological interactions. Joe Miller said that Chelan PUD was addressing residualism directly and it was not clear how additional NTTOC language would improve the current plan. Chelan PUD would like to first see the recommended language and assess how it aligns with Chelan PUD's planning. Murdoch said that she would also like to internally discuss any recommendation prior to agreement. She added that the YN has discussed the NTTOC process as part of their M&E processes; however, as far as incorporating the process as a term and condition, there is uncertainty about relying fully on a model for these processes. Murdoch also noted that using NTTOC risk modeling as a tool was one thing; however, relying on it in a permit is different. Mackey said that Douglas PUD would consider this idea. Tonseth noted that it seems that agreements still need to happen in regards to NTTOC outputs and what they mean. Gale said that this concern arose late in the process, and USFWS already had existing terms and conditions in place. He said that this was a way to address the concern and move the BiOps forward without requiring additional analyses. Tonseth noted that specific conditions on how to address residualism are outlined in the Hatchery and Genetic Management Plans (HGMPs), and asked if modeling will address those conditions. Mackey said that the model does not quantify residuals, but rather estimates the likelihood and magnitude of ecological interactions. Busack said that there is enough skepticism regarding the use of this model, so the terms and conditions language needs to be carefully crafted; and he added that NMFS will discuss this issue further.

B. Entiat Spring Chinook Salmon (Bill Gale)

Bill Gale introduced a summary of information collected by Matt Cooper and his staff at MCRFRO regarding the genetic composition of spring Chinook spawning in the Entiat Basin (Attachment C), which Kristi Geris distributed to the Hatchery committees on December 11, 2012. Gale said that this review may be useful in evaluating Chiwawa stray rates and the discontinuation of the Entiat program. He explained that these data were obtained through the observation of spring and summer Chinook salmon redd surveys and the recovery of fish carcasses; and he noted that, since 2000, there have been significant Chiwawa Hatchery contributions to the Entiat River spring Chinook spawning population, as shown in Figure 1 of Attachment C. Gale briefly reviewed the data described in Attachment C, and said that this review was not intended as a recommendation about Chiwawa. He said to contact Cooper with any questions.

Joe Miller said that in terms of Chiwawa, several modifications to the program would change the potential stray rates in the future, including: 1) significant reduction in program release numbers; 2) adjustment to smolt release size to reduce precocity; and 3) improved trapping protocols at Tumwater. He also suggested that the Chiwawa program was a victim of its own "success" where high SARs translate to more returns and potential strays, compared to lower performing programs. Mike Tonseth noted that this also involves determining entry timing of known Chiwawa-tagged fish into the Entiat River. Gale suggested installing a trap at the Eastbank FH outfall to capture spring Chinook (and other species) that are reared at Eastbank for part of their lives and may return there as a potential approach to reducing straying to the Entiat. Tonseth said that seining at the Eastbank outfall is planned for July 2013 to determine if installing a trap is worthwhile. Lynn Hatcher asked if the planned seining has been permitted, and Tonseth replied that seining will take place in the hatchery discharge channel; not in the river. Tonseth also added that adult management actions are included in the draft permit currently under consultation.

V. Yakama Nation

A. Protocol and Timeline for Developing, Reviewing, and Approving the Annual M&E Implementation Plans (Keely Murdoch)

Keely Murdoch said that she added this discussion to revisit the purpose and timing of the M&E Implementation Plans. She said that it is her understanding that the purpose of the M&E Implementation Plans is to identify what data are being collected and where they are being collected. She added that the Hatchery Committees need to complete a review of these plans prior to implementation and before contracting begins. Murdoch noted that this review is not taking place. She proposed that Hatchery Committees' approval of annual M&E Implementation Plans needs to occur in the summer preceding implementation and also proposed that a timeline be developed to meet key deadlines.

Mike Schiewe agreed with Murdoch and noted that approval of annual M&E Implementation Plans originally occurred in the summer. He said that this deadline has been steadily slipping primarily due to analytical problems and acknowledgement that the programs might change with the 5-year reviews. Schiewe suggested moving the deadline for approval back to the original summer date, particularly in 2013 when there are potentially significant upcoming changes. Greg Mackey said that he believes July 1 has historically been the deadline for approval; and Schiewe said that as far as a timeline, the PUDs need to work backwards from the date when they present the plans to their commissions. Mackey said that, ideally, the implementation plans should remain largely the same year-to-year because if the methods change too drastically, then the data are invalidated. The Hatchery Committees representatives present agreed that Chelan PUD and Douglas PUD will provide their respective draft M&E Implementation Plans to the Hatchery Committees for review no later than July 1 of the year preceding the proposed M&E activities.

B. 40K Steelhead Converted from Lake Wenatchee Sockeye Program (Keely Murdoch)

Keely Murdoch said that at a recent Production Advisory Committee (PAC) meeting, the idea of converting 40,000 Lake Wenatchee sockeye to spring Chinook, instead of steelhead (as specified in the 2011 SOA on the recalculation of hatchery obligations), was discussed. Mike Tonseth said that WDFW is discussing this proposal and has not yet made a decision. Bill Gale said that he prefers converting to steelhead; and Tonseth noted that if conversion to spring Chinook occurs, these fish would be "safety net fish." Gale asked if there would be sufficient numbers of spring Chinook to justify recreational harvest; and Murdoch replied that there may not be, but that converting these 40,000 fish will improve returns. Gale asked if converting 40,000 fish to spring Chinook will increase numbers enough to result in a hatchery benefit. Tonseth said that converting the sockeye program to steelhead would mean maintaining steelhead production at Chiwawa. He added that also, according to the existing agreement, such a change would not require WDFW approval. Tonseth noted that this is a state economics versus tribal issue because steelhead are an economic benefit to the state. Based on preliminary estimates, he said that the benefits from those fish are negligible—approximately 200 to 230 spring Chinook back, versus 500 steelhead.

VI. CCT

A. Chief Joseph Hatchery Update (Kirk Truscott)

Kirk Truscott said that CJH testing, modifications, and upgrades are still in progress, and that the final completion is expected by July 31, 2013. He said that all facilities and equipment essential for receiving fish will be complete by the end of April. He said that the groundwater system, buildings, and raceways are complete, and that all facility components are now being tested. Truscott said that there have been some unanticipated issues with the original design. He said that, for example, the fish ladders are now anticipated to be complete by the end of February. This change is because of a complete redesign of the fish water intake due to riprap that the U.S. Army Corp of Engineers (USACE) would not allow to be moved. Truscott said that CCT is anticipating 60 percent of capacity production for BY2013. Greg Mackey asked if the interim Douglas PUD summer Chinook spawned from Chief Joseph Hatchery brood collection by the CCT in 2012 and currently reared at Wells Hatchery would be able to be accepted at CJH in 2013, and Truscott noted that CCT was considering holding those fish at Wells Hatchery until October acclimation begins, as opposed to moving the fish multiple times. Truscott said that CCT is working with Chelan PUD on developing a cost share agreement similar to the NNI agreements with Douglas PUD and Grant PUD. He also said that he will coordinate internally to arrange a presentation on CCT's CJH M&E Plan for a future Hatchery Committees meeting. Mackey noted that the Hatchery Committees will want assurance that CJH M&E programs meet the PUDs' program objectives. Truscott said that CCT compared the Bonneville Power Administration (BPA) program format to the PUD format to ensure that PUD objectives would be met. Mike Tonseth asked if CCT planned to conduct the run-composition sampling at Wells Dam for summer Chinook above Wells (which by default includes Methow, Okanogan, and Columbia River mainstem spawning aggregates), and Truscott said that it was not included in their current plan. Tonseth said that all three PUDs have obligations in the Okanogan; and noted that if the PUDs are cost sharing M&E activities with the CCT, those data will need to be collected.

VII. HCP Administration

A. Annual Reports (Mike Schiewe)

Mike Schiewe announced that the Rocky Reach Dam, Rock Island Dam, and Wells Dam 2012 Annual Reports are being prepared. He said that there is a brief chapter on Hatchery Committees highlights summarizing 2012 activities. He said the annual reports also compile published reports, SOAs, and other documentation approved throughout the year. Kristi Geris said that the comment period will be from February 8, 2013, to March 6, 2013, for the Wells Dam Annual Report, and from February 21, 2013, to March 19, 2013, for the Rocky Reach Dam and Rock Island Dam Annual Reports.

B. Conflict of Interest Policy (Mike Schiewe)

Mike Schiewe recommended that the Hatchery Committees extend the Conflict of Interest Policy at the January 16, 2013 Hatchery Committees meeting. He explained that the policy was initially reviewed and approved by the Hatchery Committees in late 2010 for implementation on a 2-year trial basis; however, since then, there have been no opportunities to re-evaluate implementation of the policy. Schiewe said that Kristi Geris will re-circulate the Conflict of Interest Policy Agreement amongst the Hatchery Committees members.

C. Next Meetings

The next scheduled Hatchery Committees meetings are on January 16, 2013 (Douglas PUD office); February 20, 2013 (Chelan PUD office); and March 20, 2013 (Douglas PUD office).

List of Attachments

Attachment A – List of Attendees
Attachment B – JFP discussion on Chelan PUD Methow spring Chinook production obligation
Attachment C – Review of Entiat Basin spring Chinook spawning population, 2000 – 2012

Attachment A
List of Attendees

Name	Organization
Mike Schiewe	Anchor QEA, LLC
Kristi Geris	Anchor QEA, LLC
Joe Miller*	Chelan PUD
Greg Mackey*	Douglas PUD
Tom Kahler*	Douglas PUD
Keely Murdoch*	Yakama Nation
Kirk Truscott*	Colville Confederated Tribes
Lynn Hatcher*	National Marine Fisheries Service
Craig Busack*†	National Marine Fisheries Service
Amilee Wilson†	National Marine Fisheries Service
Bill Gale*	U.S. Fish and Wildlife Service
Mike Tonseth*	Washington Department of Fish and Wildlife
Chris Moran	Washington Department of Fish and Wildlife
Todd Miller†	Washington Department of Fish and Wildlife
Charlie Snow	Washington Department of Fish and Wildlife
Jayson Wahls	Washington Department of Fish and Wildlife

Notes:

* Denotes Hatchery Committees member or alternate

† Joined by phone

December 11 2012

To: HCP-Hatchery Committee

From: Joint Fisheries Parties

Re: JFP Discussion on Chelan PUD Methow Spring Chinook Production Obligation

Introduction

During recalculation of the Upper Columbia PUD's No Net Impact (NNI), Chelan PUD realized a drop in their NNI production obligation for Methow spring Chinook to 60,516 fish. It was assumed by the Joint Fisheries Parties (JFP) that adult collection, spawning, incubation, early, rearing, and release would remain consistent with past practices for the collective conservation program out of Methow Hatchery. Subsequent to recalculation, the JFP were informed of the termination of hatchery sharing agreements between Chelan PUD and Douglas PUD (owners of the facility) and that the two parties have been unable to reach a mutual agreement for continuation of Chelan PUD's production at the Methow FH facilities. At the November HCP-HC meeting, Chelan PUD provided a draft proposal to meeting their Methow spring Chinook production obligation of 60,516 fish beginning with the 2013 brood. This document is a JFP response to that proposal. Under consideration is how to meet the production obligation in the most efficient manner in 2013. Parallel to this is how to best implement this program for the duration of the recalculation period (9 years) without compromising recovery of spring Chinook in the Methow Basin. JFP preferences have been discussed for each of the four major production elements (e.g. adult collection, adult holding/spawning, incubation, and juvenile rearing/acclimation) with other options discussed (no hierarchy provided) following the preferred option.

Adult Collection

Presently the JFP are of the position that adult collection for the Methow spring Chinook conservation program (comprised of GPUD, DPUD, and CPUD production obligations of 134,216, 60,516, and 29,123 respectively) needs to occur at Wells Dam following past prescribed methodology(GSI). Because the Rocky Reach adult collector is relatively unknown, the JFP are in agreement that based upon present knowledge, to use the Rocky Reach trap poses an excessive risk to other populations other than the Methow, and poses risk to not meeting Chelan PUD's production obligation.

Concerns about impacts to the Entiat NOR spring Chinook population combined with the uncertainty of effectiveness to collect the appropriate broodstock (Methow/Chewuch) in the correct proportions (H:W) based upon run size such that extraction of 1/3 of the NOR's is not exceeded, makes any other proposal unsupportable in the near term. Additionally NMFS has expressed concerns about supporting/permitting broodstock collection at locations below Wells Dam.

Adult Holding/Spawning

The JFP agree that adult holding and spawning of broodstock at Eastbank FH for the 61K obligation poses little threat or risk to meeting the production obligation or performance of progeny.

Incubation

For incubation there are a number of possible iterations ranging from traditional incubation practices currently used for the Chiwawa program to less than conventional (or more accurately described as experimental) methods using egg imprinting on natal water sources. The current short term preference is to incubate eggs on ground water at Carlton Ponds using a portable incubation trailer complete with chilled water capacity and using either ISO buckets (as have been used historically at Methow Hatchery) or conventional Heath Trays. At eye-up or more preferably at swim-up, progeny would be transferred to Eastbank FH for early rearing.

Additional incubation alternatives considered:

1.) Eastbank FH using existing well water.
2.) Eastbank FH using experimental egg imprinting on natal surface water
   a.) Requires additional infrastructure to isolate eggs and treat (most probable UV) surface water used for the imprinting/incubation.
3.) Carlton Pond surface water on site
   a.) Requires additional infrastructure including permanent or portable incubation trailer, chiller, and disinfection unit (UV?) to treat surface water.
4.) Carlton Pond using surface water trucked from higher in the Methow Basin for use for experimental egg imprinting/incubation on natal surface water.

Juvenile Rearing/acclimation

As with incubation, there are a number of options available to consider. To address the 2013 brood, acclimating fish at Carlton Pond on surface water from October through March or until fish can be transferred to spring acclimation locations (YN multispecies have been suggested however specific sites and appropriate numbers have not yet outlined), seems the logistically likely action that can be taken. There are significant concerns that acclimation of spring Chinook this low in the Methow Basin poses risk to significantly change the spawner distribution of spring Chinook, and more importantly spawner distribution of hatchery spring Chinook into reaches of the Methow where they haven't been historically observed. Additionally, conducting adult management on returning on excess hatchery adults could be problematic given the absence of structure for fish to return to (such as can occur with Methow Station releases and the Twisp Weir). Strong consideration should be given to implement a robust PIT tagging program such that returning adults can be evaluated to look at spawner distribution of these releases.

Additional juvenile rearing/acclimation alternatives considered:

1.) Eastbank FH on well water until spring transfer to acclimation sites/ponds. This is not an option for serious consideration at this time. Given peak ground water temperatures at Eastbank FH occur in winter. The probability of being able to keep fish within a reasonable size limit would be impossible. In addition, the long term rearing on ground water would likely produce a smolt similar to the WR captive brood program produced at Aquaseed.

2.) Eastbank FH on well water and direct planted into upper reaches of the Methow at the earliest possible time in the spring – assumes no acclimation pond/site is available.

3.) Eastbank FH on well water then direct planted as sub-yearlings (pre-smolt) into upper reaches of the Methow Basin. This option may require adjustment of production level to ensure the smolt equivalents are met. Additionally, release of sub-yearling hatchery fish pose an ecological risk to their natural cohorts due to the length of time they would remain in fresh water in direct competition with wild fish. This type of an approach would be counter to conventional protocol which was previously permitted through the Section 10 permits requiring spring Chinook to be released as actively migrating yearling smolts. Additional information would be needed before this type of approach could be considered. Before the full 61K could be released as sub-yearlings, this approach would need to be piloted to measure/monitor effectiveness and effects. A major benefit of this approach would be overwinter acclimation facilities are not required.

United States Department of the Interior
Fish and Wildlife Service
Mid-Columbia River Fishery Resource Office
7501 Icicle Road
Leavenworth, WA 98826
Phone: (509) 548-7573
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MEMORANDUM December 11, 2012

To: William Gale

From: Matt Cooper

RE: Review of Entiat Basin spring Chinook spawning population, 2000 – 2012.

This review summarizes the spring Chinook spawning population of the Entiat River Basin from 2000 to 2012. It is hoped that this information will provide insight into the ability of fisheries co-managers to achieve program and population specific goals. The following background and methods of hatchery releases and spawning ground surveys were taken as excerpts from the 2011 annual spawning ground report by Hamstreet in 2012.

BACKGROUND

Spring Chinook Salmon

In the initial years after Grand Coulee Dam was built, little effort was made to re-establish wild spring Chinook salmon runs in the Entiat River. From 1942 to 1944, Entiat NFH released a total of 1.3 million sub-yearlings and fewer than 50,000 yearling spring Chinook salmon that were offspring of the upriver stocks collected at Rock Island Dam (Mullan 1987). No spring Chinook salmon were released from Entiat NFH from 1945 to 1975. As early as 1956 and 1957, a wild spring Chinook salmon run was observed spawning in the area above Stormy Creek (rm 18.4) (French and Wahle 1960). Since 1962, spring Chinook salmon redds have been counted in an *index* area between river miles 28.1 and 21.3 where an established spring Chinook salmon run had been documented. MCRFRO has conducted surveys in the upper river (rm 28.1-16.2) and on the Mad River (rm 3.5-1.5) by foot since 1994. Entiat NFH resumed spring Chinook salmon production in 1974. Egg sources have included Cowlitz River (1974), Carson NFH (1975 to 1982), Little White Salmon NFH (1976, 1978, 1979, 1981), Leavenworth NFH (1979-1981, 1994), and Winthrop NFH (1988). Adults that voluntarily returned to the hatchery were the primary brood stock in 1980 and from 1983 to 2006, the last spring Chinook release into the Entiat River was in 2007, after which the program was terminated (Table 1). The last returning age-class of Entiat NFH origin spring Chinook was completed in 2010.

Summer Chinook Salmon

Although summer Chinook salmon are not believed to be endemic to the Entiat River (Craig and Suomela 1941), several efforts were made to establish summer Chinook salmon in the Entiat River following completion of Grand Coulee Dam. In 1939 and 1940, a total of 3,015 adult summer Chinook salmon, collected at Rock Island Dam from the commingled upriver stocks, were placed in upper Entiat River spawning areas. Only an estimated 1,308 of these survived to spawn (Fish and

Hanavan 1948). Entiat NFH reared and released juvenile summer Chinook salmon into the Entiat River from 1941-1964, and 1976 (Mullan 1987). After cessation of spring Chinook program in 2006 a summer Chinook program was reinitiated in 2009 with the first release occurring in 2011. Entiat NFH summer Chinook egg sources have included commingled upriver stocks intercepted at Rock Island Dam (1939-1943), Methow River (1944), Carson NFH (1944), Entiat River (1946-1964), Spring Creek NFH (1964), and Wells Dam (1974, 2009-2010). Historically summer Chinook salmon spawning was monitored by aerial surveys in the lower 10.4 river miles from 1957 to 1991. Positive redd identification from the air is difficult at best; therefore aerial surveys likely underestimated actual redd numbers. Spawning numbers were never high, with a maximum of 55 redds in 1967. For years 1972-1991, aerial redd counts averaged about five per year. MCRFRO has conducted surveys in the upper river (rm 28.1-16.2) by foot since 1994 and on the lower River (rm 6.8-0.3) by raft since 2006.

METHODS

Spring and Summer Chinook Salmon Redd Surveys

Redd surveys consisted of dividing the survey area into several reaches which were surveyed multiple times by walking or rafting downstream. Each encountered redd of both runs were numbered sequentially, number of live fish were recorded and redds were marked with colored flagging hung on nearby vegetation. Hand held Global Positioning System (GPS) units recorded latitude and longitude positions for each redd. Recovered carcasses were measured from snout tip to fork in tail (fork length) and post orbital to hypural plate (POH), gender identified, females were dissected and visually ranked (complete/partial/incomplete or unknown) for egg voidance and scale samples were collected when possible. Scales were viewed using a microfiche reader to determine age and origin (wild or hatchery). Carcasses were examined for external tags or marks and scanned for the presence of coded-wire tags (CWT) and passive integrated transponder (PIT) tags. Snouts were removed from carcasses with detected CWT's. The tags were later retrieved, de-coded and uploaded to the Regional Mark Processing Center with accessory information. The number of CWT potentially available for recovery were estimated by dividing the observed number of CWT's by the estimated carcass recovery rate based on a redd expansion of 2.4 fish/redd. Detected PIT tags were loaded into a portable transceiver and uploaded with accessory information to PTAGIS. Tissue samples were taken for future DNA analysis and the tail was removed to prevent re-counting. The estimated spawning population is determined by expanding the number of redds by 2.4 fish/redd. The subsequent population is then broken by the percentage of carcasses determined to be of hatchery or wild origin using both scales and CWT's. These percentages are then utilized to apportion the estimated spawning escapement by rearing origin. The hatchery population is then further broken by release facility by expanding the estimated number of each CWT group by the percentage of the release that was tagged. The sum total of all expanded CWT's are then utilized to apportion the estimated hatchery spawning escapement by release facility. The FWS currently conducts Chinook salmon redd surveys in the Entiat River Basin from mid-August to November annually. The collection of post-spawn adults (carcasses) and determining their identity/origin is a key component of the surveys.

RESULTS

Data obtained from spring Chinook carcass recoveries for years 2000 to 2011 in the Entiat River Basin shows the following:

- An average of 54% (31% - 75%) natural origin return (NOR) and 46% (25% - 69%) hatchery origin return (HOR) comprised the spawning population (see Figure 1).
- Average number of redds = 138 (73 – 248).
- Average spawning escapement = 340 (175 – 595) for adults expanded by an estimated 2.4 spawners/redd.
- Average estimated carcass recovery rate = 20% (14% - 29%).
- Average NOR spawning escapement = 192 (54 – 367).
- Average HOR spawning escapement = 149 (84 – 276).
- Average NOR age structure = 4% age 3, 68% age 4, and 28% age 5.
- Average HOR age structure = 18% age 3, 74% age 4, and 8% age 5.
- Average within basin (ENFH) contribution rate to spawning population = 23% (0% - 49%).
- Average out of basin contribution rate to spawning population also = 23% (4% - 51%).
- Average Chiwawa Rearing pond contribution rate to spawning population = 12% (0% - 37%).
- Of the hatchery spawning population ENFH = 50% (0% - 92%)
  CRP = 26% (0% - 79%) (see Table 2)
  Other UCR = 14% (0% - 37%)
  Non-UCR = 10% (0% - 47%) (see Figure 2).

Table 1. Entiat NFH spring Chinook releases with marking and tagging rates, 1997-2008.

Brood Year	Release Year	Yearlings	Sub-Yearlings	Total Release	CWT # Tagged	% CWT	% Ad. Clip	# PIT Tagged
1995	1997	200,486		200,486	197,071	98%	98%	1,199
1996	1998	350,784		350,784	124,536	36%	36%	
1997	1998		154,053	154,053	154,053	100%	100%	
1997	1999	354,238		354,238	118,058	33%	33%	
1998	2000	359,667		359,667	109,394	30%	30%	
1999	2000		421,126	421,126	99,963	24%	24%	
1999	2001	397,855		397,855	394,411	99%	99%	
2000	2002	533,720		533,720	159,363	30%	100%	59,401
2001	2003	395,689		395,689	199,248	50%	100%	59,879
2002	2004	386,833		386,833	193,630	50%	100%	58,625
2003	2005	401,240		401,240	199,127	50%	100%	3,732
2004	2006	322,516		322,516	147,991	46%	100%	3,001
2005	2007	362,854		362,854	159,098	44%	100%	999
2006	2008	Entiat spring Chinook program terminated 683,789 transferred off station.						
	AVE	369,626	287,590	357,005	173,534	53%	78%	26,691
	MAX	533,720	421,126	533,720	394,411	100%	100%	59,879
	MIN	200,486	154,053	154,053	99,963	24%	24%	999

Table 2. Age composition for Chiwawa Rearing Pond observed CWT recoveries, 2011-2012.

# Chiwawa Rearing Pond/Year	2011	2012
Age-2	1	0
Age-3	31	4
Age-4	17	23
Age-5	0	1
Totals	**49**	**28**

# Chiwawa Rearing Pond/Year	2011	2012
Age-2	2%	0%
Age-3	63%	14%
Age-4	35%	82%
Age-5	0%	4%
Totals	**100%**	**100%**

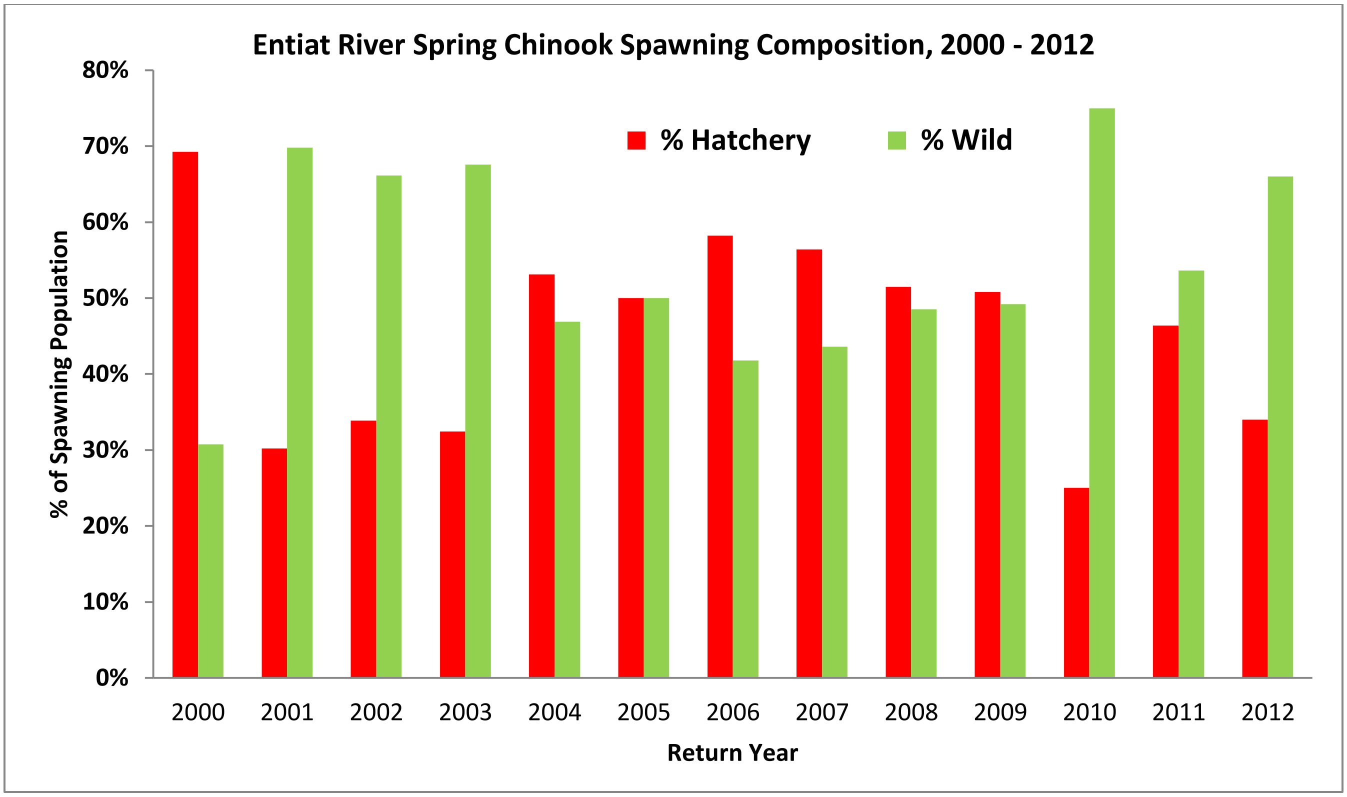

Figure 1. Entiat River spring Chinook spawning composition by rearing origin from 2000 – 2012.

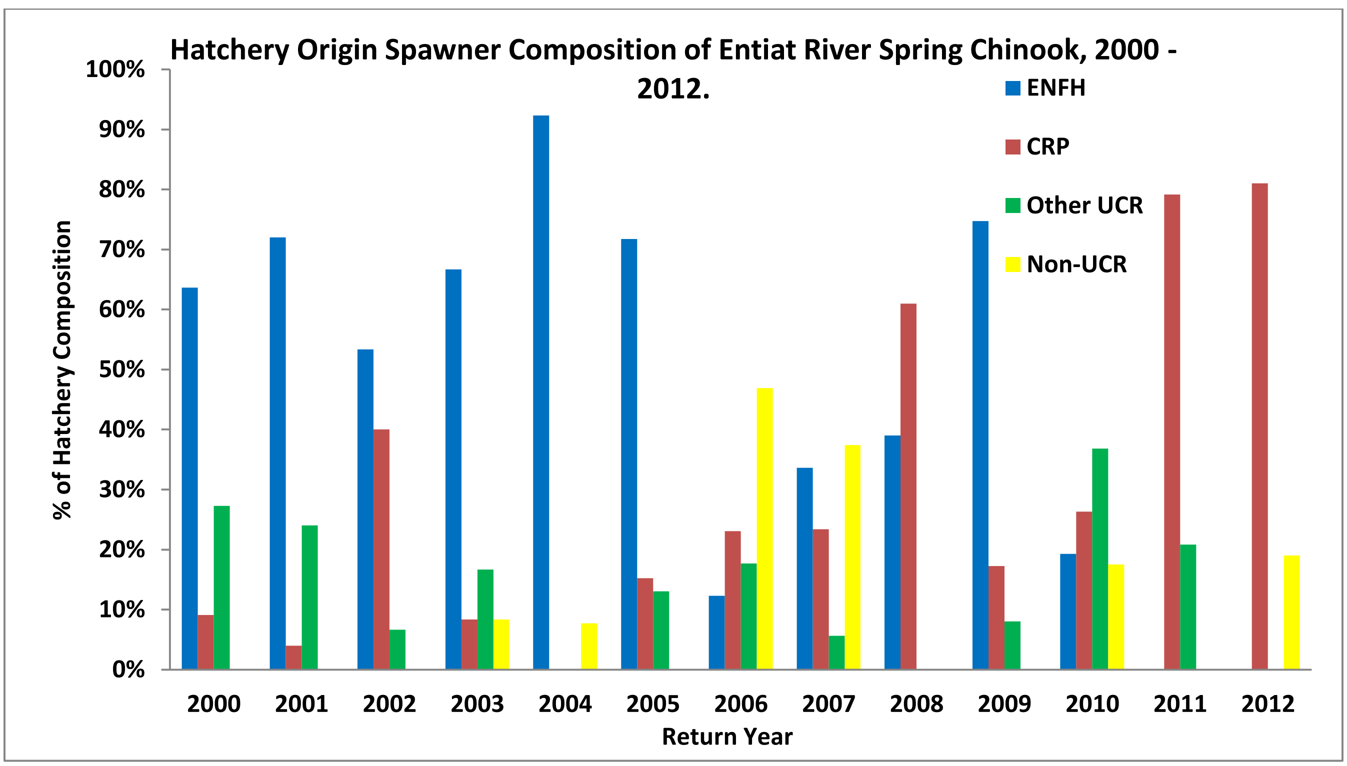

Figure 2. Entiat River hatchery origin spring Chinook spawning composition from 2000 – 2012.

Table 3. Detailed breakdown of the Entiat River spring Chinook spawning population, 2000 – 2012.

Var/Year	1994	1995	1996	1997*	1998	1999	2000	2001	2002	2003	2004**	2005	2006	2007	2008	2009	2010	2011	2012	AVE 00'-11'
Total Counted # Redds	34	13	20	37	24	27	73	202	112	108	126	146	107	102	116	115	204	248	229	138
Index Area # Redds	24	1	8	20	15	6	28	144	72	70	65	81	65	70	77	76	125	180	172	88
Index % of total redds	71%	8%	40%	54%	63%	22%	38%	71%	64%	65%	52%	55%	61%	69%	66%	66%	61%	73%	75%	62%
Spawning Population Exp'd by 3.5	84	4	28	70	53	21	98	504	252	245	228	284	228	357	406	403	714	868	802	382
Spawning Population Exp'd by 2.4	82	31	48	89	58	65	175	485	370	259	302	350	257	245	278	276	490	595	550	340
# Hatchery Spawners	NA	NA	10	NA	0	0	121	146	125	84	161	175	149	138	143	140	122	276	186	149
# Wild Spawners	NA	NA	38	NA	58	65	54	338	245	175	142	175	107	107	135	136	367	319	363	192
ENFH Return	80	121	175	275	216	724	1,919	2,666	1,834	872	759	763	812	627	623	532	15	0	0	952
ENFH Basin Return	80	121	175	275	216	724	1,996	2,771	1,901	928	907	889	830	673	679	597	26	0	0	1,017
#ENFH Strays on the Upriver Pop.	NA	NA	NA	NA	NA	NA	77	105	67	56	148	126	18	46	56	65	11	0	0	65
ENFH Upper River Stray Rate	NA	NA	NA	NA	NA	NA	3.9%	3.8%	3.5%	6.0%	16.3%	14.1%	2.2%	6.9%	8.2%	17.6%	90.9%	0.0%	0.0%	14%
ENFH % Influence on Spawn Pop.	NA	NA	NA	NA	NA	NA	44.1%	21.7%	18.1%	21.6%	49.0%	35.9%	7.2%	19.0%	20.1%	23.6%	4.8%	0.0%	0.0%	22%
# Useable Carcasses	5	0	6	7	7	4	31	128	68	42	43	52	73	40	80	61	84	151	117	71
% of Est. Pop Sampled	6.1%	0.0%	12.5%	7.9%	12.2%	6.2%	17.7%	26.4%	18.4%	16.2%	14.2%	14.8%	28.4%	16.3%	28.7%	22.1%	17.2%	25.4%	21.3%	20%
# Wild	0	0	4	3	7	4	8	74	41	25	15	21	28	17	33	30	63	81	78	36
# Hatchery	0	0	1	0	0	0	18	32	21	12	17	21	39	22	35	31	21	70	40	28
# Unknown	5	0	1	4	0	0	5	22	6	4	11	10	6	1	12	17	9	22	7	10
# Hatchery Age-3	NA	NA	1	0	0	0	3	0	2	2	2	4	1	6	7	6	3	41	7	6
# Hatchery Age -4	NA	NA	0	0	0	0	15	31	18	7	13	16	34	13	26	22	15	26	32	20
# Hatchery Age - 5	NA	NA	0	0	0	0	0	1	1	3	1	1	2	2	2	3	3	2	1	2
# Wild Age-3	NA	NA	0	0	0	0	0	0	0	1	0	1	2	3	1	2	2	6	2	2
# Wild Age -4	NA	NA	4	3	3	4	7	59	18	2	14	17	21	9	28	22	50	45	52	24
# Wild Age - 5	NA	NA	0	0	4	0	1	15	23	22	1	3	5	5	4	6	11	30	23	11
% Hatchery Age-3	NA	NA	100%	0%	0%	0%	17%	0%	10%	17%	13%	19%	3%	29%	20%	19%	14%	59%	18%	18%
% Hatchery Age -4	NA	NA	0%	0%	0%	0%	83%	97%	86%	58%	81%	76%	92%	62%	74%	71%	71%	38%	80%	74%
% Hatchery Age - 5	NA	NA	0%	0%	0%	0%	0%	3%	5%	25%	6%	5%	5%	10%	6%	10%	14%	3%	3%	8%
% Wild Age-3	NA	NA	0%	0%	0%	0%	0%	0%	0%	4%	0%	5%	7%	18%	3%	7%	3%	7%	3%	4%
% Wild Age -4	NA	NA	100%	100%	43%	100%	88%	80%	44%	8%	93%	81%	75%	53%	85%	73%	79%	56%	68%	68%
% Wild Age - 5	NA	NA	0%	0%	57%	0%	13%	20%	56%	88%	7%	14%	18%	29%	12%	20%	17%	37%	30%	28%
			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
% Hatchery	NA	NA	20%	NA	0%	0%	69%	30%	34%	32%	53%	50%	58%	56%	51%	51%	25%	46%	34%	46%
% Wild	NA	NA	80%	NA	100%	100%	31%	70%	66%	68%	47%	50%	42%	44%	49%	49%	75%	54%	66%	54%

Table 3 (con't). Detailed breakdown of the Entiat River spring Chinook spawning population, 2000 – 2012.

Var/Year	1994	1995	1996	1997*	1998	1999	2000	2001	2002	2003	2004**	2005	2006	2007	2008	2009	2010	2011	2012	AVE 00'-11'
ENFH Spawners	NA	NA	NA	NA	NA	NA	77	105	67	56	148	126	18	46	56	105	24	0	0	69
LNFH Spawners	NA	NA	NA	NA	NA	NA	0	0	0	0	0	23	13	0	0	11	0	57	0	9
WNFH Spawners	NA	NA	NA	NA	NA	NA	22	29	0	7	0	0	9	0	0	0	24	0	0	8
MSFH Spawners	NA	NA	NA	NA	NA	NA	11	6	8	7	0	0	5	8	0	0	21	0	0	6
CRP Spawners	NA	NA	NA	NA	NA	NA	11	6	50	7	0	27	34	32	87	24	32	218	151	44
ODFW Spawners	NA	NA	NA	NA	NA	NA	0	0	0	7	12	0	0	0	0	0	0	0	0	2
Sawtooth Spawners	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	5	0	0	0	0	0	6	0
Dworshak/Kooskia NFH Spawners	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	66	52	0	0	11	0	30	11
Nez Perce Spawners	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	11	0	0	1
							121	146	125	84	161	175	149	138	143	140	122	276	186	149
ENFH % of Spawning Population	NA	NA	NA	NA	NA	NA	44%	22%	18%	22%	49%	36%	7%	19%	20%	38%	5%	0%	0%	23%
LNFH % of Spawning Population	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	7%	5%	0%	0%	4%	0%	10%	0%	2%
WNFH % of Spawning Population	NA	NA	NA	NA	NA	NA	13%	6%	0%	3%	0%	0%	4%	0%	0%	0%	5%	0%	0%	2%
MSFH % of Spawning Population	NA	NA	NA	NA	NA	NA	6%	1%	2%	3%	0%	0%	2%	3%	0%	0%	4%	0%	0%	2%
CRP % of Spawning Population	NA	NA	NA	NA	NA	NA	6%	1%	14%	3%	0%	8%	13%	13%	31%	9%	7%	37%	27%	12%
ODFW % of Spawning Population	NA	NA	NA	NA	NA	NA	0%	0%	0%	3%	4%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Sawtooth/Clearwater % of Spawning Population	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	1%	0%
Dworshak/kooskia NFH % of Spawning Population	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	0%	26%	21%	0%	0%	2%	0%	5%	4%
Nez Perce % of Spawning Population	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%
							69%	30%	34%	32%	53%	50%	58%	56%	51%	51%	25%	46%	34%	46%
ENFH % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	64%	72%	53%	67%	92%	72%	12%	34%	39%	75%	19%	0%	0%	50%
LNFH % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	13%	8%	0%	0%	8%	0%	21%	0%	4%
WNFH % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	18%	20%	0%	8%	0%	0%	6%	0%	0%	0%	19%	0%	0%	6%
MSFH % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	9%	4%	7%	8%	0%	0%	3%	6%	0%	0%	18%	0%	0%	5%
CRP % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	9%	4%	40%	8%	0%	15%	23%	23%	61%	17%	26%	79%	81%	26%
ODFW % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	0%	0%	0%	8%	8%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Sawtooth Clearwater % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	3%	0%
Dworshak/kooskia NFH % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	0%	44%	37%	0%	0%	9%	0%	16%	8%
Nez Perce % of Hatchery Origin Spawners	NA	NA	NA	NA	NA	NA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	9%	0%	0%	1%
							100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Estimated CWT's																				
ENFH Exp'd CWT's	NA	NA	NA	NA	NA	NA	7	18	8	8	12	66	16	36	39	65	11	0	0	24
LNFH Exp'd CWT's	NA	NA	NA	NA	NA	NA	0	0	0	0	0	12	11	0	0	7	0	50	0	7
WNFH Exp'd CWT's	NA	NA	NA	NA	NA	NA	2	5	0	1	0	0	8	0	0	0	11	0	0	2
MSFH Exp'd CWT's	NA	NA	NA	NA	NA	NA	1	1	1	1	0	0	4	6	0	0	10	0	0	2
CRP Exp'd CWT's	NA	NA	NA	NA	NA	NA	1	1	6	1	0	14	30	25	61	15	15	190	133	30
ODFW Exp'd CWT's	NA	NA	NA	NA	NA	NA	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Sawtooth SFH/Clearwater Exp'd CWT's	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	4	0	0	0	0	0	5	0
Dworshak/Kooskia NFH Exp'd CWT's	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	57	40	0	0	5	0	26	9
Nez Perce Tribal Hat Exp'd CWT's	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Total Est. CWT's	NA	NA	NA	NA	NA	NA	11	25	15	12	13	92	130	107	100	87	57	240	164	74
Observed CWT's																				
ENFH Obs. CWT's	NA	NA	NA	NA	NA	NA	2	6	4	5	6	5	2	3	5	8	1	0	0	4
LNFH Obs. CWT's	NA	NA	NA	NA	NA	NA	0	0	0	0	0	1	2	0	0	1	0	2	0	1
WNFH Obs. CWT's	NA	NA	NA	NA	NA	NA	2	5	0	1	0	0	2	0	0	0	2	0	0	1
MSFH Obs. CWT's	NA	NA	NA	NA	NA	NA	1	1	1	1	0	0	1	1	0	0	2	0	0	1
CRP Obs. CWT's	NA	NA	NA	NA	NA	NA	1	1	6	1	0	2	8	4	17	4	3	49	28	8
ODFW Obs. CWT's	NA	NA	NA	NA	NA	NA	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Sawtooth SFH/Clearwater	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	1	0	0	0	0	3	1	0
Dworshak/Kooskia NFH	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	2	1	0	0	1	0	1	0
Nez Perce Tribal Hat	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Total Obs. CWT's	NA	NA	NA	NA	NA	NA	6	13	11	9	7	8	18	9	22	13	10	54	30	15

APPENDIX C - HABITAT CONSERVATION PLAN TRIBUTARY COMMITTEES 2012 MEETING MINUTES

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 12 January 2012

Members Present: Dale Bambrick (NOAA Fisheries), Dennis Beich (WDFW), Lee Carlson (Yakama Nation), Tom Kahler (Douglas PUD), Steve Hays (Chelan PUD), Kate Terrell (USFWS), and Tracy Hillman (Committees Chair).

Members Absent: Chris Fisher (Colville Tribes).[1]

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at the Chelan PUD Auditorium in Wenatchee, Washington, on Wednesday, 12 January 2012 from 10:00 am to 12:10 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 8 December 2011 meeting notes with edits from Tom Kahler.

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.

- Washington Rivers Conservancy-Trout Unlimited has continued work with other sponsors on coordinating the Lower Wenatchee Instream Flow Enhancement Project. As part of the coordination, TU, PWUA, and Chelan PUD signed an agreement to allow the project to continue on PUD property. After investigating potential diversion sites, it was determined that the Pioneer Property west of the highway bridge was the best diversion site. The sponsor also worked with the Washington Department of Transportation to identify easement issues associated with the project. Two public meetings were held to inform shareholders of progress and to allow for feedback. The sponsor worked with the Conservation Commission and the local conservation district to garner support for a funding request from the Irrigation Efficiency Program. The JARPA has been modified, based on the selection of the diversion site, and will be submitted in January. A Cultural Resources review has been conducted. Construction is planned for fall 2012.
- The Boat Launch Off-Channel Pond Reconnection project is complete. The sponsor (Chelan County NRD) submitted a final report.
- The Methow River (Bird) Acquisition is expected to close at the end of January.

[1] Chris Fisher voted on decision items following the meeting.

IV. Small Projects Program Application: Mission Creek Fish Passage Project

The Committees reviewed a Small Projects Program application from Cascadia Conservation District titled *Mission Creek Fish Passage Project*.

Mission Creek Fish Passage Project

The purpose of this project is to improve juvenile steelhead and Chinook salmon rearing habitat and passage, stream flows, and riparian habitat and function at four sites (between RM 2.9 and 4.5) on Mission Creek. This will be accomplished by installing four log weirs to provide primary pool habitat that will increase habitat complexity and eliminate season fish passage barriers. In addition, the sponsor will re-vegetate the stream banks to control bank erosion and improve shade in the channelized section of Mission Creek. The total cost of the project is $50,000. The sponsor requested $50,000 from HCP Tributary Funds. After careful consideration of the proposal, ***the Rock Island Committee approved funding for this project***.

The Committee voiced a concern that there is no long-term monitoring of the structures. It is possible that after 90 days a landowner could remove the structure or modify it so that it no longer allows fish passage. Dennis Beich suggested that the Committees address this issue in the future. The Committee also requested that the sponsor demonstrate that the landowners have valid water rights. Finally, the Committee would like to visit these structures sometime in the future.

V. Additional Funding Request for the White River Nason View Acquisition Project

The Chelan-Douglas Land Trust asked the Rock Island Tributary Committee for additional funds for the White River Nason View Acquisition project. Recall that this project will purchase and protect about 117 acres of unconfined floodplain and undisturbed riparian habitat along the White River (between RM 4.3 and 5.4). The property contains about 6,200 feet of riverbank. This land is surrounded by property owned by the Forest Service, WDFW, and the Chelan-Douglas Land Trust. The estimated value of the property in 2009 was $545,000. The Rock Island Tributary Committee agreed to contribute $76,635 to the project. A recent appraisal of the property identified the value of the property at $639,000. Thus, the sponsor is requesting an additional $123,365 from the Rock Island Tributary Committee.

The Rock Island Tributary Committee elected not to contribute additional funds and recommended that the sponsor seek the additional funds from the PRCC Habitat Subcommittee.

VI. SOW Change for the Chewuch Canal Instream Flow Project

The Rocky Reach Tributary Committee received a request from Washington Water Project – Trout Unlimited (WWP-TU) to change the scope-of-work on the Chewuch River Permanent Instream Flow Project. Recall that the purpose of this project is to reduce the Chewuch Canal Company's (CCC) maximum diversion from 34 cfs to 24 cfs when the Chewuch flow levels reach 100 cfs. This will result in a 10% increase in instream flow for the Chewuch River. The basis of the project is a contract between Trout Unlimited and CCC under which CCC agrees to reduce its diversions in exchange for compensation. In part, the request from WWP-TU states:

> *Our original estimate for the saved water quantity for this project was 428 ac/ft annually, 42,372 ac/ft over 99 years. WWP-TU obtained and analyzed additional historic data including hydrographic records and irrigation records to estimate the acre-foot water quantities that will remain instream. Because this agreement is triggered by river flows, the actual amount of water returned for instream flows will change from year to year.* ***Annual diversion reductions during the irrigation season resulting from this***

> ***agreement are on average about 640.8 ac/ft per season based on historical CCC average diversions for the past 20 years and USGS records for flows in the Chewuch River.*** *Climate change modeling specific to the Methow subbasin indicates that climate change will result in an earlier and higher peak flows and earlier and loser base flows in the Methow River. We believe that under this agreement the average annual amount of water returned instream is likely to significantly increase if climate change models are accurate.. This additional water available instream under the terms of this agreement will provide additional protection for aquatic habitat as the Methow River hydrograph shifts, making this project important as a climate change adaption project. In addition, as stated above while working with NOAA Fisheries and others on this project WWP-TU was asked to look at options to help CCC stop filling their reservoir from the Chewuch River in October and November after irrigation ceased annually on October 1. These additional diversions outside the irrigation season under their existing reservoir permit while the river had reached base flows were adversely affecting spring Chinook spawning and rearing and steelhead and bull trout rearing. In the event of climate change and thus increased shareholder demand for water at the same time as the hydrograph shifts unfavorably for irrigation, it is very likely that without this project, CCC would be required to divert 1000 ac/ft annually in October and November.* ***The total saved water on an annual basis is estimated at 1640.8 ac/ft per year. Over the lifetime of the project (99 years) the cost is estimated at around $10.00 per af/ft.***
>
> *When we submitted the proposal to the Trib fund in 2010 we estimated the cost of the project at $1.2 million. Cost estimates based on the current design are estimated at closet to $1.65 million. The increase in cost is largely based on the changes required to the current infrastructure at the Lake Creek location to allow spring fill of the reservoir. This was not anticipated in the original proposal.*
>
> *This project was anticipated to get off the ground late 2010, early 2011 so we would have the water instream in 2012. We are a year behind at this point so we are not entirely clear (depends on the permitting and water right change) how much construction we can get completed in 2012. It is likely some construction will take place in 2013.*

After carefully reviewing the information contained in the request, the Rocky Reach Tributary Committee concluded that they could not determine exactly what the sponsor was requesting. It was not clear if the sponsor was requesting a change in scope-of-work, an increase in funding, a time extension, or some combination of these. Therefore, the Committee directed Tracy Hillman and Becky Gallaher to seek additional information from the sponsor. Specifically, the sponsor needs to identify what was originally proposed, what they are now proposing, and exactly what the sponsor is requesting from the Committee.

VII. Review of Policies and Procedures Documents

Tracy Hillman asked if the Committees had any changes or edits to the Policies and Procedures for Funding Projects and the Tributary Committee Operating Procedures documents. In the Policies and Procedures document under Section 3.6, The Small Projects Program, the Committees agreed to increase the maximum contract allowance from $50,000 to $75,000. Thus, the total cost of a small projects proposal cannot exceed $75,000 (including matches). In the same document under Section 4.3, Ineligible Projects and Elements, the Committees agreed to remove the bullet stating, “Purchase of equipment necessary to implement or monitor a restoration or protection project funded by the Committees.” The Committees will approve the purchase of equipment on a case-by-case basis (e.g., purchase of gloves and pliers may be OK, but the purchase of total stations and excavators would not). ***The Committees directed Tracy to make the edits to the Policies and Procedures document.***

VIII. Tributary Assessment Programs

The Committees discussed how they could implement the Tributary Assessment Programs. According to the HCPs, the purpose of the Tributary Assessment Program is to monitor and evaluate the relative performance of the tributary enhancement projects approved by the Committees. It is not the purpose of the program to measure whether the Plan Species Accounts have provided a 2% increase in survival for Plan Species. Rather, the program will ensure that Plan Species Account dollars are used in an effective and efficient manner. Funding for the Assessment Program is separate from the Plan Species Accounts and shall not exceed $200,000 per account. Currently, some funds from the Wells Tributary Assessment Program are used to help evaluate a large enhancement project in Canada (ORRI project).

The Committees discussed using some of the Tributary Assessment Program funds to evaluate appraisals. About 52% of Plan Species Account funds have been spent on protection projects (acquisitions and conservation easements). The costs of acquisitions and easements have continually increased even though the market has struggled during the last several years. Thus, the Committees see a need to evaluate the appraisals received from project sponsors. In short, funds from the Tributary Assessment Programs could be used to conduct independent appraisals of appraisals. The Committees would like to think about this and discuss it again in the future.

Tracy asked if the Committees would like a spreadsheet that shows the total cost of each acquisition/conservation easement funded through the Plan Species Account. The spreadsheet would include the name of the project, name of the sponsor, total acres of the acquisition/easement, total cost of the acquisition/easement, cost per acre, amount funded by the Committees, and the Plan Species Account. The Committees directed Tracy and Becky to build the spreadsheet.

IX. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in December and January:

   Rock Island Plan Species Account:

   - $29,793.35 to Chelan County Treasurer for work on the Boat Launch Off-Channel Pond Reconnection project. This project is now complete.
   - $16,094.25 to Cascade Columbia Fisheries Enhancement Group for the Assessing Nutrient Enhancement Logistics project. This project is now complete.
   - $679.43 to Chelan County PUD for project coordination during the fourth quarter of 2011.
   - $190.00 to Larson Allen for fourth-quarter financial management and reporting.

   Rocky Reach Plan Species Account:

   - $623.07 to Cascadia Conservation District for administration and riparian plantings for the Below the Bridge project.
   - $329.43 to Chelan County PUD for project coordination during the fourth quarter of 2011.
   - $190.00 to Larson Allen for fourth-quarter financial management and reporting.

   Wells Plan Species Account:

- $108,436.21 to Baines Title Company for the Methow River Acquisition 2010 MR 48.7 (Bird) project.
- $329.47 to Chelan County PUD for project coordination during the fourth quarter of 2011.

2. Becky Gallaher reported that she declined a payment request of $144.00 to Cascadia Conservation District for administration on the Roaring Creek Flow Enhancement project. Recall that this project was pulled in June 2011 because of a significant change in the scope-of-work.
3. Tracy Hillman reported that Chelan and Douglas PUDs will be submitting their Draft 2012 Action Plans to the Coordinating Committees in February. Tom Kahler provided the Committees with the Draft Wells HCP Tributary Committee Action Plan for 2012. The 2012 Draft Action Plan for the Wells Tributary Committee is as follows:

Plan Species Account Annual Contribution

• $176,178 in 1998 dollars:	January 2012

Annual Report – Plan Species Account Status

• Draft to Committee:	February 2012
• Approval Deadline:	March 2012
• Period Covered:	January to December 2012

2012 Funding-Round: General Salmon Habitat Program

• Request for Project Pre-proposals	*To be determined* (March)
• Pre-proposal to TC	*To be determined* (early May)
• Tours of Proposed Projects	*To be determined* (late May)
• Project Sponsor Presentations to TC	*To be determined* (early June)
• Final Project Proposals to TC	*To be determined* (early July)
• RTT Project Rating Decision	*To be determined* (July)
• Supplemental Sponsor Presentations	*To be determined* (September)
• TC Final Funding Decisions	*To be determined* (before Dec.)

Small Projects Program

• Project Review and Funding Decision	Applications accepted anytime

Tributary Assessment Program

• Proposals for year-5 of 5 for ORRI	March 2012
• Develop plan for remaining funds	March 2012
• Implement monitoring plan	*To be determined* (2012)
• Monitoring plan final product	December 2012

The Wells Tributary Committee accepted the Wells Action Plan for 2012. The Committees will review the Rocky Reach and Rock Island 2012 Draft Action Plans in February.

4. Tracy Hillman reported that he and Becky Gallaher have completed Section 2.6 (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. Members of the Committees should soon receive the draft reports for their reviews. The final reports will be submitted to the Federal Energy Regulatory Commission in April. Financial activities in 2011 for each of the Plan Species Accounts are appended as Attachment 1.

5. Tracy Hillman shared with the Committees the draft schedule for proposal development, submission, and review of SRFB/GSHP/BPA projects (see Attachment 2). Currently, pre-proposals would be delivered to the Tributary Committees on 7 May and the Committees would review the pre-proposals during their May and June meetings (10 May and 14 June). Project tours are scheduled for 21-24 May and pre-proposal presentations would occur on 13 June. Final proposals would be delivered to the Tributary Committees on 29 June. The Committees would conduct an initial review of the final proposals during their July meeting (12 July) and determine if supplemental tours of selected projects are necessary. Supplemental tours would occur in September and, if necessary, sponsors would be invited to present their projects to the Committees in October. The Committees would make final funding decisions in November or December.

   The Committees voiced some concern with the proposed dates for the project tours. Because of conflicts with the HCP Coordinating Committees meeting, it would be better to tour Wenatchee/Entiat projects early in the week and Methow/Okanogan projects later in the week. Tracy will share this concern with Derek Van Marter.

6. Tracy Hillman reported that funds will be deposited into each of the Plan Species Accounts at the end of January. The amounts deposited will be about $656,000 into the Rock Island Account, $311,000 into the Rocky Reach Account, and $238,000 into the Wells. Exact amounts deposited into each account will be provided during the February meeting.

X. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 9 February 2012 at Chelan PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
Plan Species Account Financial Statements for 2011

Chelan County PUD
Rock Island Hydroelectric Project
Habitat Conservation Plan
Plan Species Cash Account Activity
Annual Financial Report Per Section 7.4.3
Reporting Period: 1/1/2011 - 12/31/2011

Beginning Balance:	**1/1/2011**		**$ 2,997,035.74**
Transfers In:			
Rock Island Funding		655,882.00	
Interest Earnings		13,834.63	
Total Transfers In			669,716.63
Transfers Out:			
Payments		(236,061.20)	
Bank Service Fees		(95.30)	
Total Transfers Out			(236,156.50)
Ending Balance:	**12/31/2011**		**$ 3,430,595.87**

The Plan Species Account was established per the Rock Island Habitat Conservation Plan, Section 7.4. Interest earnings shall remain in the Account in accordance with Appendix E, Section 7.4.1.

Chelan County PUD
Rocky Reach Hydroelectric Project
Habitat Conservation Plan
Plan Species Cash Account Activity
Annual Financial Report Per Section 7.4.3
Reporting Period: 1/1/2011 - 12/31/2011

Beginning Balance:	**1/1/2011**		**$ 1,761,278.01**
Transfers In:			
Rocky Reach Funding		310,638.00	
Interest Earnings		7,455.55	
Total Transfers In			318,093.55
Transfers Out:			
Payments		(174,224.94)	
Bank Service Fees		(94.80)	
Total Transfers Out			(174,319.74)
Ending Balance:	**12/31/2011**		**$ 1,905,051.82**

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.

Annual Report of Wells Plan Species Account Financial Activity
For the Year Ended December 31, 2011
As required by Section 7.3.7.2 of the Wells Hydroelectric Project HCP

Beginning cash and investment balance 01/01/2011			$ 739,492.33
Sources:			
Annual payment from Douglas PUD per Section 7.4 of HCP		$ 238,153.00	
Interest earnings		3,481.71	
	Total Sources		241,634.71
Uses:			
Project #	Description		
1101	Methow River Acquisition - Bird	2,008.14	
1102	Methow River Acquisition - Hoffman	4,373.02	
1103	Methow River Acquisition - Risley	26,407.24	
	Total for Projects	32,788.40	
0699	Chelan PUD	3,501.69	
0699	Douglas PUD	2,128.00	
	Total for Administration	$ 5,629.69	
	Total Uses		38,418.09
Ending cash and investment balance 12/31/2011			$ 942,708.95

Wyatt W. Scheibner, Treasurer
PUD No. 1 of Douglas County

Attachment 2
Proposed 2012 SRFB/GSHP/BPA Schedule

2012 UPPER COLUMBIA PROCESS SCHEDULE

SRFB/TRIB/BPA

Project Proposal Development, Submittal, and Review

DATE	ACTIVITY/MILESTONE (MEETING/DEADLINE)
FEBRUARY	
9 February	SRFB/TRIB Debrief of 2011 (afternoon)
28 February	IT Funding Coordination Meeting (all day)
MARCH	
March	SRFB/Tributary Fund cycles announced; SRFB Policy Manual available; Regional Process Guide Revisions
APRIL	
5 April	SRFB/TRIB/BPA Kickoff Meeting for the Region; RCO presentation; RTT Technical criteria presentation; CAC criteria presentation
April	Project Sponsors develop projects and pre-proposal (materials available from http://www.ucsrb.com)
MAY	
7 May	**Pre-proposals due to LE Coordinators –** delivered to RTT, TRIB (via TRIB ftp site) and SRFB Panel Members (via PRISM)
14 May	Conference Call to discuss project tour logistics (RTT, LEs, Trib and UCSRB)
21-24 May	SRFB/TRIB/BPA project tours (*subject to change pending final pre-proposals*) • 21st – Okanogan • 22nd – Methow • 23rd – Wenatchee • 24th – Entiat
JUNE	
13 June	Pre-proposal Presentation Workshop: review pre-proposals with RTT, TRIB and CAC's
14 June	TRIB internal review of pre-proposals
June	Proposal refinement based on technical feedback. Two weeks after visiting projects, the State Technical Review Panel will post comments in SharePoint for lead entities and grant applicants. Grant applicants should update their applications to address any Review Panel concerns and attach their responses to Review Panel comments in PRISM with their application. The Review Panel will "flag" projects that it believes would benefit from additional review at the regional area project meeting.

29 June	**Final project proposals due to LE Coordinators –** delivered to RTT, TRIB (via TRIB ftp site) and RCO (via PRISM)
JULY	
6 July	**Grant applicants update applications in PRISM to address Review Panel concerns from initial site visit and review.**
11 July	RTT Meeting: formal project reviews and technical ranking
12 July	Review Panel discusses “flagged” projects and updates the review forms. Panel will meet either in person or via conference call to provide full panel feedback on “flagged” projects.
12 July	TRIB final review of proposals
23 July	Final comments from TRIB will be via e-mail to LE for distribution to project sponsors
AUGUST	
August (TBD)	Okanogan and Chelan CAC project rankings
10 August	**LE submits final project applications and deliverables to RCO/SRFB in PRISM (early optional date)**
22 August	Regional joint CAC approves final combined ranked list
24 August	**LE submits final project applications and deliverables to RCO/SRFB in PRISM (final due date)**
SEPTEMBER	
September	TRIB supplemental tours of selected projects (project sponsors will be notified in advance of visit). TRIB makes initial internal decisions.
14 September	**Regional organizations submit their recommendations for funding and responses to the information questionnaire**
26-29 September	Regional presentations to State Technical Review Panel
OCTOBER	
October	Project Presentations to TRIB (*if needed*)
6 October	Comment forms available from State Technical Review Panel
18 October	Comments due on State Technical Review Panel draft report
NOVEMBER	
16 November	**Final 2011 funding report delivered to SRFB**
DECEMBER	
12-13 December	SRFB makes funding decisions
December (TBA)	TRIB makes supplemental decisions

Acronyms

CAC Citizen's Advisory Committee
BPA Bonneville Power Administration
IT Implementation Team
LE Lead Entity
RCO Recreation and Conservation Office
SRP State Review Panel
SRFB Salmon Recovery Funding Board
TRIB HCP Tributary Committee

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 9 February 2012

Members Present: Dale Bambrick (NOAA Fisheries), Dennis Beich (WDFW), Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Kate Terrell (USFWS), and Tracy Hillman (Committees Chair).

Members Absent: Tom Kahler (Douglas PUD).[1]

Others Present: Becky Gallaher (Tributary Project Coordinator).

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at the Chelan PUD First Floor Conference Room in Wenatchee, Washington, on Wednesday, 9 February 2012 from 10:30 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 January 2012 meeting notes.

III. Monthly Update on Ongoing Projects

Becky Gallaher stated that there are no updates on funded projects.

IV. Review of Policies and Procedures Documents

The Committees revisited the maximum allowance for small projects described under Section 3.6 in the Policies and Procedures for Funding Projects document. Last month the Committees agreed to increase the maximum contract allowance for small projects from $50,000 to $75,000. Chris Fisher suggested that the maximum allowance for small projects should be increased to $100,000. He offered the following reasons: (1) there is less likelihood that a small project proposal will be part of a larger project; (2) funding would be more responsive and timely as opposed to the proponent waiting to submit a General Salmon Habitat Proposal and then waiting for the lengthy review process; and (3) there may be more opportunities to fund small-scale projects. After discussion, the Committees agreed to increase the maximum contract allowance from $75,000 to $100,000. Thus, the total cost of a small projects proposal cannot exceed $100,000 (including matches). ***The Committees directed Tracy to make the appropriate changes in the Policies and Procedures document.***

The Committees also reviewed Section VII, Full Disclosure, in the Operating Procedures document. The last sentence in Section VII states, “Committee members should recuse themselves from voting on a particular project if they represent an entity that may benefit from

[1] Tom Kahler provided his votes on decision items before the meeting.

that project." The Committees recommended that the sentence be changed to, "Committee members who represent an entity that submitted a project proposal will not vote on that particular project." ***The Committees directed Tracy to make the edits in track changes. The Committees will review the edits during the next meeting.***

V. Review of 2012 Draft HCP Action Plans

Tracy Hillman reported that Chelan and Douglas PUDs asked the Tributary Committees to review and approve their 2012 Draft HCP Action Plans. The 2012 Action Plan for both Rocky Reach and Rock Island Tributary Committees is as follows:

- Plan Species Account Deposit: January 2012
- Project solicitation: To be determined
- Project approval deadline: To be determined
- Project implementation: Ongoing

The Rocky Reach and Rock Island Tributary Committees approved the Rocky Reach and Rock Island Action Plan for 2012.

The 2012 Draft Action Plan for the Wells Tributary Committee is as follows:

Plan Species Account Annual Contribution

- $176,178 in 1998 dollars: January 2012

Annual Report – Plan Species Account Status

- Draft to Committee: February 2012
- Approval Deadline: March 2012
- Period Covered: January to December 2012

2012 Funding-Round: General Salmon Habitat Program

- Request for Project Pre-proposals — *To be determined* (March)
- Pre-proposal to TC — *To be determined* (early May)
- Tours of Proposed Projects — *To be determined* (late May)
- Project Sponsor Presentations to TC — *To be determined* (early June)
- Final Project Proposals to TC — *To be determined* (early July)
- RTT Project Rating Decision — *To be determined* (July)
- Supplemental Sponsor Presentations — *To be determined*
- TC Final Funding Decisions — *To be determined* (before Dec.)

Small Projects Program

- Project Review and Funding Decision — Applications accepted anytime

Tributary Assessment Program

- Proposals for year-5 of 5 for ORRI — March 2012
- Develop plan for remaining funds — March 2012

- Implement monitoring plan *To be determined* (2012)
- Monitoring plan final product December 2012
- TC delivers final product to CC January 2013

The Wells Tributary Committee approved the Wells Action Plan for 2012.

VI. Mission Creek Fish Passage Project

Last month the Rock Island Tributary Committee approved funding for the Mission Creek Fish Passage Project. The purpose of the project was to install four log weirs, which should improve stream flows and enhance juvenile steelhead and Chinook salmon rearing habitat and passage in Mission Creek. The total cost of the project was $50,000.

During review of the proposal, the Rock Island Committee noted that there was no long-term requirement to maintain the structures. The Committee also requested that the sponsor verify that the landowners have valid water rights. Finally, the Committee would like to visit these structures sometime in the future. In his letter to the sponsor, Tracy asked the sponsor to respond to these concerns.

In a recent email to Becky Gallaher, Kurt Hosman, Cascadia Conservation District, indicated that he will modify the language in the agreements to include an extended period of maintenance (he will try to extend the period out 10 years). Kurt also provided the Committee with copies of the water rights for each landowner. The Committee reviewed the water rights and determined that they were valid. Finally, Kurt indicated that he will write into the access clause of the agreements that the Committee will be allowed to visit these structures within two years of post-construction.

VII. SOW Change for the Chewuch Canal Instream Flow Project

Last month the Rocky Reach Tributary Committee received a request from Washington Water Project – Trout Unlimited (WWP-TU) asking for a change in the scope-of-work on the Chewuch River Permanent Instream Flow Project. After carefully reviewing the information contained in the request, the Rocky Reach Tributary Committee concluded that they could not determine exactly what the sponsor was requesting. It was not clear if the sponsor was asking for a change in scope-of-work, an increase in funding, a time extension, or some combination of these. Therefore, Becky Gallaher contacted Lisa Pelly, WWP-TU, and asked if she would provide the Committee with a proposal describing exactly what WWP-TU was requesting from the Committee. Lisa indicated that they were simply seeking a change in the schedule. Because the schedule change they were requesting does not require approval from the Committee, the sponsor withdrew their request.

VIII. Silver Protection Project

Last year the Washington Department of Fish and Wildlife (WDFW) submitted a proposal under the General Salmon Habitat Program titled *Silver Protection*. The purpose of the project was to protect about 45 acres along the Methow River downstream from the Town of Twisp. The conservation easement/acquisition would include about 3,500 feet of spring-fed, perennial channel. The total cost of the project was $660,000. The Wells and Rocky Reach Committees elected to contribute $250,000 to the project ($125,000 from each account).

Because the Committees found the proposal lacking in several areas, they made funding contingent on receiving more information. Specifically, the Committees asked for the following information:

1. An example of the management plan for the acquisition and easement.

2. A description of conditions in the easement and of the landowner's intended use of the easement.
3. Indication that the management plan for the property will include language that the property may receive habitat restoration activities if deemed appropriate. Additionally, as a condition of this funding, the Committees must approve any restoration actions on this property.
4. A more detailed and itemized land-management budget (the proposal indicates that only $15,000 is needed for land management, which includes weeds, fencing, etc.). In addition, the sponsor must indicate where and how much fencing is proposed.

The Committees recently received a letter from Ken Bevis, WDFW, responding to the information request from the Committees (see Attachment 1). Ken also provided an example of WDFW's management plan.

After reviewing the letter, the Committees were mostly satisfied with the responses from WDFW. Lee Carlson questioned the major restoration work that WDFW proposes to do on the property. Specifically, Lee was concerned about the possibility that other entities (e.g., the Yakama Nation) would not be allowed to implement restoration actions on the property. Dennis Beich indicated that WDFW has plans to conduct restoration work and would likely work with others intending to do restoration work on the property. ***Each Committee agreed to contribute $125,000 to the project.***

IX. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in January and February:

   Rock Island Plan Species Account:

   - $220.00 to Trout Unlimited for legal services on the Lower Wenatchee Instream Flow Enhancement Project.

   Rocky Reach Plan Species Account:

   - $92.27 to Cascadia Conservation District for project materials on the Entiat National Fish Hatchery Habitat Improvement Project.

   Wells Plan Species Account:

   - $1,531.40 to the Methow Salmon Recovery Foundation for surveying and project administration on the Methow River Acquisition 2010 (Hoffman) Project.

2. Becky Gallaher reported that the PUDs deposited funds into each of the Plan Species Accounts at the end of January. Chelan PUD deposited $673,450 into the Rock Island Account and $318,959 into the Rocky Reach Account. Following the meeting, Tom Kahler reported that Douglas PUD deposited $244,533 into the Wells Account.
3. Tracy Hillman indicated that he will attend the SRFB/TC Debrief Meeting on 22 February in Wenatchee. The purpose of the meeting is to: (1) review what worked well during the 12th round and what needs improvement; and (2) establish plans, expectations, and a timeline for the SRFB 13th round. Tracy will also announce during the debrief meeting that the Tributary Committees have increased the cap on Small Projects from $50,000 to $100,000.

4. Becky Gallaher shared with the Committees a draft spreadsheet that shows project name, sponsor, total acres, total cost, cost/acre, and property information for all acquisitions and conservation easements funded by the Tributary Committees. The Committees reviewed the draft spreadsheet and recommended additional columns showing the closing date for each project and whether the project was a conservation easement or acquisition. Becky and Tracy will update the spreadsheet and share it with the Committees during the next meeting.

X. Next Steps

If necessary, the next meeting of the Tributary Committees will be on Thursday, 8 March 2012 at Chelan PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
Letter from Ken Bevis, WDFW, Regarding Silver Protection

State of Washington

Department of Fish and Wildlife

Winthrop Field Office: 350 Bear Creek Rd, Winthrop WA, 98862

February 1, 2012

To: Wells and Rocky Reach Tributary Committee

From: Ken Bevis, WDFW Watershed Steward

Re: Answers to questions in regard to Silver Protection Project grant

Dear Tributary Committee:

Thank you for supporting WDFW's request for funds on the Silver Protection Project. This note is in response to your request for additional information. I will answer the questions to the best of my ability herein.

First, the lands will be managed as a block of the Methow Wildlife Area, on the west side of the Methow River, adjacent to the Golden Doe Unit. Land management will follow the guidelines and stewardship standards utilized on all of the Methow Wildlife Area. This plan is referenced here.

Specific Questions in letter from Tributary Committee:

1. *Please provide an example of the management plan for the acquisition and easement*.

   Methow Wildlife Area Plan – The WDFW Management Plans for our wildlife areas address many issues associated with long term, holistic land management. First and foremost, our key objectives is to provide habitat for healthy and diverse fish and wildlife populations, through sound stewardship, monitoring and management. The plan can be accessed via WDFW's web site, in the Conservation Tab. The citation is:

Washington Department of Fish and Wildlife. 2006. Methow Creek Wildlife Area Management Plan. Wildlife Management Program, Washington Department of Fish and Wildlife, Olympia. 97 pp.

Easement Example: WDFW's real estate program manages the terms and negotiations for easements held in our name. The specific terms of each easement can be negotiated on a case by case basis, but the attached example contains our general terms.

2. *What are the conditions in the easement? What does the landowner intend to do on the easement?*

Specific terms for any easement can be negotiated. In the specific case of the Silver Protection project, a minority portion of the lands would be placed in a conservation easement, adjacent to the homesites maintained by the landowner, and the waterway. Normal agricultural activities could continue there, particularly continuance of an existing hay field. Specific exclosure distances, likely a minimum of 100 feet, from the edge of the water would be established to protect riparian plantings and vegetation. Fencing would be required to prevent future livestock from being near the water.

3. *Please indicate that the management plan for the property will include language that the property may receive habitat restoration activities if deemed appropriate. Additionally, the Committees must approve any restoration actions on this property.*

The acquisition by WDFW and subsequent management planning will include provisions for the restoration project. The easement will also contain conditions that allow access for a restoration project to occur here. The project itself would largely be on either WDFW lands, or within waters of the state in the channel itself.

The Silver Side Channel has been degraded into a wide shallow channel, likely from many years of intensive grazing, and is in need of restoration. Restoration work will include plantings and instream installation of wood and (possibly) other materials that would narrow and deepen these flows. The ability to do this work has been agreed to with the landowner, and will be formalized in the easement agreement.

The major restoration project anticipated is not funded at this time, and will require significant planning and potentially fund raising. As the project develops we will keep the Tributary Committee fully informed as to the developments. It will also undoubtedly undergo the significant scrutiny of the Upper Columbia Salmon Recovery Board, Regional Technical Team, many members of which are closely associated with the Tributary committee.

4. The proposal indicates that $15,000 will be needed for land management, which includes weeds, fencing, etc. Please provide a more detailed and itemized *land management budget. In addition, indicate where and how much fencing is needed.*

At this time, I do not have detailed information as to the necessary level of weed control intended for the property. Fencing is already present on the adjacent WDFW lands along the west side of the channel in the lower half of the project. We anticipate a need to mirror this fencing on the east side, with approximately 1/2 mile of wire fencing required. Estimated numbers from Methow Wildlife Area staff appear below.

Weed control – equipment, chemicals, staff - $5,000
Fence construction – materials and staff - $10,000

I hope that this memorandum adequately answers the questions posed by the Tributary Committee.

Thank you for accepting our grant application for the Silver Protection Project.

Sincerely,

Kenneth R. Bevis
WDFW Upper Columbia Watershed Steward

Attachment:
Example of WDFW Easement Agreement.

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 8 March 2012

Members Present: Dale Bambrick (NOAA Fisheries), Dennis Beich (WDFW), Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), 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 the Chelan PUD Auditorium in Wenatchee, Washington, on Thursday, 8 March 2012 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 additional discussion items from Dale Bambrick, Kate Terrell, and Tracy Hillman.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 9 February 2012 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.

- Wenatchee River Instream Flow Enhancement – The project is set to begin construction in the fall of 2012. All cultural resource work has been completed, including the new point-of-diversion site, and the sponsor (Trout Unlimited – WWP) expects to have the Department of Archaeology and Historic Preservation concurrence by the end of March. The Army Corps of Engineers permit is being reviewed and approval from the USFWS and NOAA is anticipated. Currently, the outstanding issue is the water right change. The sponsor is working closely with Washington Department of Ecology (WDOE) to identify certainty of expedience on the process.
- Upper White Pine CPUD Power Line Alternatives Analysis - The contractor (HDR Engineering) has completed two drafts of the alternatives analysis memo and has received comments from both the sponsor (CCNRD) and Chelan PUD. The Sponsor will send Becky the draft memo by mid-March.
- Mission Creek Fish Passage Project – The sponsor (Cascadia Conservation District) asked the Rock Island Tributary Committee for an additional $10,000 for the fish passage improvement project on Mission Creek. The additional money would be used for contingencies. The Rock Island Committee rejected the additional funding request.
- White River Van Dusen Conservation Easement – The project is complete and a final report will be submitted to the Rock Island Tributary Committee.

- White River Nason View Acquisition – This project is expected to close at the end of March.
- Chewuch River Instream Flow Project – This project is moving forward quickly on several fronts. The sponsor (Trout Unlimited – WWP) has completed all documents to allow for the change in water right with WDOE. The sponsor has also started significant outreach with local landowners along the ditch. Project engineers are working to finalize the drawings for the Lake Creek part of the project. Final drafting of all of the JARPA documents are close to completion.
- Nutrient Enhancement Assessment – The project contractor (Water Quality Engineers) has started compiling information for the development of a Quality Assurance Project Plan (QAPP) for WDOE. Over the next several months, the sponsor (Cascade Columbia Fisheries Enhancement Group), TU, and Water Quality Engineers will be focusing on data collection protocols and the QAPP.
- Large Wood Atonement Project – To date, the sponsor (Cascade Columbia Fisheries Enhancement Group) has (1) completed cultural resources consultation with the USFWS; (2) conducted initial outreach meetings; (3) coordinated topo and geotech surveys; (4) coordinated with the Sheriff's office to allow motorized use on the White River; and (5) completed and received a temporary use permit from WDFW.

IV. Review of Policies and Procedures Documents

During the last meeting, the Committees reviewed Section VII, Full Disclosure, in the Operating Procedures document. The last sentence in Section VII states, "Committee members should recuse themselves from voting on a particular project if they represent an entity that may benefit from that project." The Committees recommended that the sentence be changed to, "Committee members who represent an entity that submitted a project proposal will not vote on that particular project." ***The Committees approved the change to the Operating Procedures document.***

The Methow Conservancy contacted Tracy Hillman and asked for clarification on the Committees' policy on public access on protection projects. After reviewing Section 3.8 in the Policies and Procedures document, the Committees directed Tracy to add draft language that states, "The Tributary Committees reserve the right to require public access on conservation easements or lands acquired with Plan Species Account funds." Note that this statement does not require public access on all easements or acquisitions. However, if the Committees believe that a given protection project should have public access, they will make it a requirement for that specific project. Thus, the Committees will evaluate public access on a case-by-case basis. If a project sponsor believes that a particular protection project should have no public access, the sponsor will need to demonstrate why this is so in their proposal to the Committees. The Committees will review the draft language during their next meeting.

V. Review of Landowner Agreement for Restoration Projects

Cascadia Conservation District asked the Rock Island Tributary Committee to review their Landowner Agreement for Restoration Projects. This is the agreement that will be signed by the Landowner and Grantee. The Committee reviewed the agreement in detail and requested that the sponsor add the following language to the section titled, The Grantee agrees to:

- ***For the duration of this agreement, the Grantee will annually monitor the structures using photo points to make sure the structures are functioning as designed.***

Tracy Hillman will add this language in track changes to the Landowner Agreement and send it to Cascadia Conservation District.

VI. Nutrient Enhancement Design Subcontract Agreement

The Cascade Columbia Fisheries Enhancement Group (CCFEG) asked the Rock Island Tributary Committee to review their subcontract agreement with Water Quality Engineering, Inc. CCFEG is requesting that Water Quality Engineering assist CCFEG with the Wenatchee Nutrient Enhancement Design Project that was in part funded by the Rock Island Committee. ***The Committee reviewed all sections of the agreement for consulting services, including the scope of work, and approved the subcontract agreement.***

VII. Evaluation of Appraisals

During the January meeting, the Committees discussed how they could implement the Tributary Assessment Programs. According to the HCPs, the purpose of the Tributary Assessment Program is to monitor and evaluate the relative performance of the tributary enhancement projects approved by the Committees. During the January meeting, the Committees discussed using some of the Tributary Assessment Program funds to evaluate appraisals. About 52% of Plan Species Account funds have been spent on protection projects (acquisitions and conservation easements). The costs of acquisitions and easements have continually increased even though the market has struggled during the last several years. Thus, the Committees would like to use some of the funds from the Tributary Assessment Programs to conduct an independent appraisal of appraisals.

The Committees identified two primary questions:

1. Are the appraisals properly capturing the value of the market?
2. Are the costs of acquisitions and conservation easements appropriate?

As a first step in addressing these primary questions, the Committees would like a description of the training that is required to conduct appraisals. Secondly, the Committees would like input from economists at local universities. They directed Tracy and Becky to contact economists at local universities to see what it would cost to conduct an independent evaluation of the appraisals. At the same time, Dale Bambrick will speak with Peter Dykstra about evaluation of appraisals. Finally, the Committees would like a time series plot showing the relationship between costs of protection projects in the Upper Columbia (costs/acre) and indices of property values nationwide, statewide, and countywide.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in February and March:

   Rock Island Plan Species Account:

   - $66,000.00 to North Meridian Title for the White River Nason View Acquisition.
   - $1,354.00 to Chelan-Douglas Land Trust for administration of the White River Nason View Acquisition Project.
   - $6,651.50 to Cascade Columbia Fisheries Enhancement Group for WQE work, QAPP development, and organization of files on nutrient enhancement for the Wenatchee Nutrient Enhancement Design Project.

   Rocky Reach Plan Species Account:

   - $49,000.00 to North Meridian Title for the Entiat Stormy Reach Phase 2 Acquisition.

2. Tracy Hillman reported that he and Kate Terrell attended the SRFB/TC Debrief Meeting on 22 February in Wenatchee. The purpose of the meeting was to: (1) review what worked well during the 12th round and what needs improvement; and (2) establish plans, expectations, and a timeline for the SRFB 13th round. Tracy and Kate provided the following summary from the meeting:

   - The Methow Conservancy requested that the Tributary Committees clearly describe their policy on public access on protection projects (see Section IV above).
   - The SRFB is requiring a pre-proposal from all project sponsors in 2012. Becky Gallaher will work with Jennifer Goodridge on what the Committees require in the pre-proposal.
   - Project sponsors will be allowed more time to present their proposal during the pre-proposal workshop.
   - Pre-proposals are due on 7 May. Project tours will be on 21-24 May and the pre-proposal presentation workshop will be on 13 June. The Tributary Committees will review pre-proposals on 14 June and provide feedback to sponsors on 15 June. Final proposals are due on 29 June. The RTT will review and score final proposals on 11 July and the Tributary Committees will evaluate final proposals on 12 July. The Final Schedule is appended to these notes as Attachment 1.
   - Sponsors would like a final funding decision from the Tributary Committees by the end of July. However, this can create some funding coordination problems for the Committees, who hold funding coordination meetings in August. Therefore, the Committees decided that they will provide final decisions to the sponsors in late August following their funding coordination meetings.
   - The State of Washington Recreation and Conservation Office asked that the Upper Columbia Salmon Recovery Board integrate the Okanogan and Chelan County lead entities into the Upper Columbia Salmon Recovery Board Regional Organization. The reason for the change is to improve efficiencies resulting from reductions in salmon recovery funding sources. The 2012 Federal Pacific Coast Salmon Recovery Fund has been reduced from $80 million to $65 million. Additionally, the state has reduced funding for the lead entity program over the past four years by a total of $615,000. Kate indicated that the Board recently approved the integration of the lead entities into the Upper Columbia Salmon Recovery Board Regional Organization. This means that the Counties will no longer be lead entities.

3. Becky Gallaher said that she was approached by Jason Lundgren (CCFEG) and Ken Bevis (WDFW) about the possibility of the Tributary Committees funding the construction and placement of river safety signs in the Methow and Wenatchee basins. The signs would be placed at put-ins and take-outs along the rivers. The signs would warn about the potential hazards of habitat restoration structures in the rivers. The Committees agreed that the signs are important, but believed that funding should come from statewide sources (e.g., Salmon Recovery Funding Board). The Committees recommended that CCFEG and WDFW talk with Bud Hover, SRFB Chair.

4. On behalf of CCFEG, Kate Terrell asked if the Committees would be interested in covering the costs of transporting large wood collected at the mainstem dams to floodplain habitat in tributaries. The Committees indicated that a wood relocation project would probably not get funding from the Tributary Committees.

5. Tracy Hillman shared with the Committees that he received a Small Projects Application from the Methow Conservancy requesting $96,000 for beaver restoration in the Lower Chewuch. The Conservancy requested an additional $101,000 from the PRCC Habitat Subcommittee. Thus, the total cost of the project exceeded the maximum allowed under the Small Projects Program. Lee Carlson indicated that the Yakama Nation could no longer help fund the project because of BPA and funding issues. Therefore, the US Forest Service and the Methow Conservancy are seeking funds from other sources. The Committees recommended that the sponsor request the funds from the PRCC Habitat Subcommittee.
6. Dale Bambrick provided the following updates.
    - Dale talked about some of the discussions regarding the MVID diversion. He stated that they are currently examining the potential for a pump plant, which would take MVID out of the Twisp River. Converting to a surface pump would cost about $3-4 million.
    - Dale indicated that modifications to the Barkley Irrigation Diversion on the Methow may be a potential project in the future.
    - Finally, Dale said that there are potential breakthroughs regarding diverting water from Icicle Creek. That is, the proposal to divert water out of Icicle Creek may not happen.
7. Finally, Becky Gallaher shared with the Committees a draft spreadsheet that shows project name, type of protection project, sponsor, total acres, total cost, cost/acre, and property information for all acquisitions and conservation easements funded by the Tributary Committees. The Committees reviewed the draft spreadsheet and recommended the addition of cost per feet of shoreline. They would also like a time series plot showing the relationship between costs of protection projects in the Upper Columbia (costs/acre) and indices of property values nationwide, statewide, and countywide (see Section VII above). Becky and Tracy will update the spreadsheet, develop a time series plot, and share them with the Committees during the next meeting.

IX. Next Steps

The Tributary Committees will not meet in April. Their next meeting will be on Thursday, 10 May 2012 at Chelan PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1

2012 UPPER COLUMBIA PROCESS SCHEDULE

SRFB/TRIB/BPA

Project Proposal Development, Submittal, and Review

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13 June	Pre-proposal Presentation Workshop: review pre-proposals with RTT, TRIB and CAC's
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SRFB Salmon Recovery Funding Board
TRIB HCP Tributary Committee

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 10 May 2012

Members Present: Dale Bambrick (NOAA Fisheries), Dennis Beich (WDFW), Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator). Denny Rohr (PRCC Habitat Subcommittee Facilitator), Dave Duvall (Grant PUD), Terrie Preston (WDFW), Dan Budd (WDFW), Shawn Kyes (WDFW), Sheryl Dotson (Grant PUD Lands Department), and Blair Fuglie (Grant PUD Lands Department) joined the meeting at 10:00 am for the Appraisal Presentation and Discussion.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at the Chelan PUD Auditorium in Wenatchee, Washington, on Thursday, 10 May 2012 from 9:00 am to 12:30 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with additional discussion items from Tom Kahler and Tracy Hillman.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 8 March 2012 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.

- Lower Wenatchee River Instream Flow Enhancement – All permits have been submitted and the sponsor (Trout Unlimited – WWP) continues to prepare design documents for the pump station, water intake, fish screen, and site grading. Their consultant has prepared a cross-section design for multiple pipe locations, prepared pipe casing design for multiple right-of-way pipe crossings, and developed the initial structure and obstruction inventory. The sponsor received concurrence from the Washington Department of Ecology (WDOE) to initiate the water right change process with the Chelan County Conservancy Board. The application was submitted and presented to the Board in early April. A decision on the water right will be made in June.
- Upper White Pine CPUD Power Line Alternatives Analysis - The contractor (HDR Engineering) has completed two drafts of the alternatives analysis memo and has received comments from the U.S. Forest Service, Bonneville Power Administration, and Chelan PUD. The Committees provided no comments on the alternatives analysis.

- Mission Creek Fish Passage Project – The project engineer is developing site plans and designs. Becky will request a signed copy of the landowner agreement form from the sponsor (Cascadia Conservation District).
- White River Van Dusen Conservation Easement – The project is complete and a final report will be submitted to the Rock Island Tributary Committee.
- Nason View Acquisition – The project is complete and a final report will be submitted to the Rock Island Tributary Committee.
- Chewuch River Instream Flow Project – The sponsor (Trout Unlimited – WWP) has conducted landowner coordination, permitting, project planning and design, and construction management.
- Nutrient Enhancement Assessment – The sponsor (Cascade Columbia Fisheries Enhancement Group) and their contractor (Water Quality Engineers) has completed a draft Quality Assurance Project Plan, which will serve as the scientific foundation for the project. The sponsor convened a Nutrient Enhancement Technical Group on 2 May. The purpose of the group is to make sure that the QAPP is sound scientifically, that the work takes into account temporal and spatial distribution of salmonids, and that the ultimate goal of understanding the need for nutrient enhancement is met.
- Large Wood Atonement Project – The sponsor (Cascade Columbia Fisheries Enhancement Group) has held two meetings with residents and posted a fact sheet on the Lake Wenatchee Info Website. This process has generated more interest and the sponsor plans to hold another community meeting soon. The sponsor has submitted the JARPA and SEPA Checklist for the geotechnical exploration within the channel of the White River.
- Entiat National Fish Hatchery Habitat Improvement Project – The sponsor (Cascadia Conservation District) planted, weed-matted, and mulched 725 bare-root ponderosa pines at the upstream end of the removed levee and installed temporary irrigation. They also planted, weed-matted, and mulched an additional 209 large potted native trees and shrubs in the relict channel area and seeded the relict channel with native grass. The sponsor installed upgrades to the existing irrigation on the upper floodplain area adjacent to the new abatement/fishing pond. They seeded the upper floodplain area with naturalized turf-blend grasses. Finally, they reconditioned the hatchery access roads, which trucks used during the removal of the levee.

IV. Preliminary Review of General Salmon Habitat Program Pre-Proposals

The Committees received 27 General Salmon Habitat Program pre-proposals. The Committees conducted a preliminary review of the pre-proposals with the intent of identifying which projects the Committees would like to visit in the field. During the July meeting, the Committees will identify which pre-proposals will have no chance or a low likelihood of receiving funding from the Tributary Committees. The following table summarizes which projects the Committees would like to visit.

Project Title	Sponsor	Request Site Visit
Lower Chiwawa Project Development	Cascade Columbia Fisheries Enhancement Group	No
Lower White River Floodplain Rehabilitation	Cascade Columbia Fisheries Enhancement Group	No

Project Title	Sponsor	Request Site Visit
Methow River Riparian Planting	Cascade Columbia Fisheries Enhancement Group	Yes
Entiat PUD Canal system conversion project	Cascadia Conservation District	No
Tyee Ranch Conservation Easement	Cascadia Conservation District	No
Tall Timber Ranch Conservation Easement Phase 2	Chelan-Douglas Land Trust	No
Lower Sleepy Hollow Floodplain Conservation Easements	Chelan-Douglas Land Trust	Yes
Peshastin RM 8.8 Side Channel Reconnection Design	Chelan County Natural Resources Department	Yes
Lower Nason Creek RM 3.5-4.7 Reach Based Restoration	Chelan County Natural Resources Department	No
Cottonwood Flats Bridge Removal	Chelan County Natural Resources Department	Yes
Skinney Creek Restoration Design (USFS)	Chelan County Natural Resources Department	No
Lower Entiat RM 1.9 Channel Design	Chelan County Natural Resources Department	Yes
Upper Peshastin Roads Inventory (USFS)	Chelan County Natural Resources Department	No
Mill Creek/Mountain Home Ranch Road Fish Passage (USFWS)	Chelan County Natural Resources Department	No
Upper Peshastin Tributary Assessment (WFC)	Chelan County Natural Resources Department	No
Providing Fish Passage at Shingle Creek Irrigation Dam (ONA)	Colville Confederated Tribes	No
Lower Foster Creek Steelhead Habitat Enhancement	Foster Creek Conservation District	Yes
Chewuch Campground Bank Restoration (WDFW)	Methow Salmon Recovery Foundation	No
Middle Methow (M2) Wetland Conservation Easement RM 45.75	Methow Salmon Recovery Foundation	No
Twisp River Poorman Creek Wetland Habitat Acquisition RM 4.75	Methow Salmon Recovery Foundation	No
Twisp River Elbow Coulee Phase II Bank Restoration RM 6.5	Methow Salmon Recovery Foundation	Yes
Upper Beaver Habitat Improvement Channel Restoration RM 7	Methow Salmon Recovery Foundation	No
Wenatchee and Entiat Beaver Reintroduction Project	Trout Unlimited	No

Project Title	Sponsor	Request Site Visit
Twisp River Riparian Protection III	Methow Conservancy	Yes
Big Valley Riparian Protection (WDFW)	Methow Conservancy	No
Lower Chewuch Beaver Restoration	Methow Conservancy	No
Lower Entiat RM 26.-3.5 projects (BOR Reach 1B)	Yakama Nation	Yes

Project tours are scheduled for the week of 21 May (see Attachment 1). Becky Gallaher and Tracy Hillman will participate on the conference call on Monday, 14 May, to coordinate the project tours. Sponsors will give presentations to the Tributary Committees and RTT on Wednesday, 13 June. The Committees will then meet on Thursday, 14 June to conduct their final evaluation of pre-proposals.

V. Okanagan River Restoration Initiative Monitoring

Karilyn Alex, Okanagan Nation Alliance (ONA) Project Biologist, submitted a monitoring report titled, "Aquatic Monitoring of the Okanagan River Restoration Initiative—Post Construction 2011" to the Wells Committee. The Committee reviewed the report and the monitoring proposal/budget and concluded that the fifth and final year of monitoring should continue as planned. ***Thus, the Wells Committee directed Douglas PUD to fund via the Tributary Assessment Program (Wells HCP Section 7.5) the following components: (1) Fish Holding and Rearing for $3,802, (2) Channel Morphometry and Hydraulics for $9,566, and (3) Substrate Composition for $5,617. Thus, the total amount approved by the Committee is $18,984.*** At the end of the project, the Committee would like to see a report that summarizes the results of the five-year study. The Committee requested that the final report include a "lessons learned" section.

VI. Methow River RM 48.9 (Peters) Conservation Easement

Last year, the Methow Salmon Recovery Foundation submitted a proposal to the General Salmon Habitat Program titled "Methow River Acquisition 2011 RM 48.9 (Peters) Project." The purpose of the project was to acquire about one acre of riparian and alcove habitat adjacent to the middle Methow River near RM 48.9. The total cost of the project was $37,325. The sponsor requested $6,310 from HCP Tributary Funds. The Committees elected not to fund the project, because they believed the potential benefits of the acquisition did not justify the cost.

Recently, the Methow Salmon Recovery Foundation appraised the property for a conservation easement. Because the cost of the easement is less than half the amount request last year (the sponsor would request about $2,000 from the Committees), the sponsor asked the Committees if they would be interested in reevaluating the proposal and cost estimate. ***The Committees elected not to reevaluate the proposal.***

VII. Appraisal Presentation and Discussion

Since January, the Committees have been discussing how they can use some of the Tributary Assessment Program funds to evaluate appraisals. The costs of acquisitions and easements have continually increased even though the market has struggled during the last several years. Thus, the Committees identified two primary questions that they wanted to explore:

1. Are the appraisals properly capturing the value of the market?
2. Are the costs of acquisitions and conservation easements appropriate?

During the March meeting, the Committees directed Tracy and Becky to begin the process of addressing the two questions. As a first step, the Committees asked for a description of the training that is required to conduct appraisals. Secondly, the Committees wanted input from experts on how to evaluate appraisals. Finally, the Committees asked for time series plots showing the costs of protection projects in the Upper Columbia (costs/acre and cost/river bank) over time.

To this end, Becky and Tracy compiled information on the cost of protection projects funded by the Committees over time. They summarized the information in a table and generated time series plots of the information contained in the table (see Attachment 2). In addition, based on a recommendation from Teresa Scott, WDFW representative to the HCP Coordinating Committees, Becky and Tracy contacted Dan Budd, Manager of Real Estate Services for WDFW, and asked if he would be willing to address the following questions for the Tributary Committees.

- What are the qualifications and training for an appraiser?
- What information does an appraiser need (or use) to appraise property value?
- Why are there large differences in appraised values of a given property among different appraisers?
- How would one evaluate the validity of an appraisal?
- Are there people who appraise appraisals? If so, who?
- What qualifications or criteria should one consider in selecting an appraiser?

Dan indicated that he and Shawn Kyes, WDFW Chief Appraiser, would give a presentation to the Committees and answer any questions the Committees may have. The presentation is appended to these notes as Attachment 3.

Dan Budd provided a brief overview of the WDFW appraisal process. He indicated that because their funding comes from taxpayers and ratepayers, they use very strict criteria in appraising property. He noted that their appraisals are usually contested, and the sellers are very passionate about the outcome, while the buyer is much less passionate. Thus, WDFW must be very thorough in their evaluation of properties. The following notes capture most of the discussion during and after the presentation by Shawn Kyes.

Question (Q): Are there specific assumptions associated with appraisals?
Answer (A): The appraiser must label and be clear on all hypothetical conditions and assumptions (see slide 10 in the presentation).

Q: Should appraisals include the cost of, say, a bridge if access is assumed and there is currently no bridge?
A: The appraisal should identify the bridge as a hypothetical condition and include assumptions.

Q: Does the Yellow Book include a cost/acre threshold value?
A: No. If an appraiser intends to use Yellow Book, the appraiser must have training in Yellow Book.

Q: Is there any reason not to request a Yellow Book appraisal?
A: Yellow Book is not needed unless federal funds are to be used in the purchase of the property. The use of Yellow Book does not give a better appraisal. Yellow Book does require a larger amount of effort, and the appraiser must be trained in Yellow Book.

Q: What do you do if the only comparables are pre-2009?

A: Even though the marked has been slow, there should be comparables available after 2009. If the appraiser does not include recent comparables, he/she must build an argument as to why they did not include recent comparables.

Q: Is there a way to walk away from comparables and start over in the appraisal process?
A: Value is an expectation between the buyer and seller and may be based on sale of related properties. The appraiser must verify the value of the property.

Q: Appraisals are too high and our willingness to fund protection projects may be driving the cost of protection projects. Can you provide advice to a bunch of "ologists," who must decide whether to fund protection projects?
A: The Committees need to take control of the appraisal process. That is, they need to have appraisals conducted by firms hired by the Committees. If this is not possible, at a minimum, they need to have appraisals reviewed, perhaps by PUD evaluators. Keep in mind that appraisals of habitat will be expensive. This is because the seller is in a "take-it-or-leave-it" position. The bottom line is that the Committees need to take control of the appraisal process.

Q: Can the Committees contract with the State to review appraisals?
A: The State is very busy with WDFW evaluations and therefore it is unlikely that they would have time to evaluate Committees' appraisals. The Committees should establish a relationship with appraisers or firms in the area. The Committees could have one firm conduct the appraisal and another evaluate the appraisal. It is important that the appraiser and reviewer know the area.

Q: How would the Committees reconcile differences in appraised values between the Committees' appraiser and the landowner's appraiser?
A: Make sure you select a firm or appraiser you trust. Also, have the appraisals reviewed by trusted firms. Be very skeptical of reviews that cost around $400. Most should cost around $3,500.

Q: Is there a cost rule-of-thumb for conservation easements versus acquisitions?
A: There is no rule-of-thumb. Both conservation easements and acquisitions are negotiations. Make sure you evaluate the terms in a conservation easement.

The Committees found the information provided by Dan and Shawn very useful. They will consider the recommendations by Dan and Shawn and plan their next steps during May and June.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in April and May:

   Rock Island Plan Species Account:

   - $1,151.77 to Chelan PUD for Rock Island project administration/coordination during the first quarter, 2012.
   - $14,253.61 to Trout Unlimited – Washington Water Project for the Lower Wenatchee Instream Flow Project.

   Rocky Reach Plan Species Account:

   - $1,007.41 to Chelan PUD for Rocky Reach project administration/coordination during the first quarter, 2012.

- $42,730.25 to Trout Unlimited – Washington Water Project for the Chewuch Instream Flow Project.
- $15,800.00 to Chelan-Douglas Land Trust for the Entiat Stormy Reach Phase 2 Acquisition Project.

Wells Plan Species Account:

- $863.23 to Chelan PUD for Wells project administration/coordination during the first quarter, 2012.

2. Dennis Beach reported that Carmen Andonaegui would serve as his alternate on the Tributary Committees. Tracy Hillman asked Dennis to provide him and Mike Schiewe with a letter stating that WDFW has identified Carmen as their alternate on the Tributary Committees. Dennis agreed to provide the letter as soon as possible.
3. Tom Kahler indicated that Douglas PUD has requested that the Department of Fisheries and Oceans Canada (DFO) develop a proposal that Douglas PUD will likely submit as a Small Projects Proposal to the Committees for review. Tom explained that they have been very successful in using the Okanogan Fish and Water Management Tool funded by Douglas PUD to reduce density-independent mortality of sockeye salmon eggs and alevins in the Okanogan River, and pre-smolts in Lake Osoyoos. Since its initiation in 2004, the tool has resulted in a 5-10 fold increase in sockeye smolt production from Lake Osoyoos. The Colville Tribes have advocated expanding the model to include summer Chinook downstream from Lake Osoyoos. The purpose would be to use the tool to increase egg-fry survival of summer Chinook spawning within the Okanogan River on the east side of Driscoll Island. The current model could be expanded to include a summer Chinook component with decision rules for Lake Osoyoos. Douglas PUD will likely submit a Small Projects Proposal within two months seeking funding to add a summer Chinook sub-model and a Lake Osoyoos water-level sub-model to the Fish and Water Management Tool.
4. Dennis Beach asked about possible funding options for improving fish passage at Zosel Dam on the Okanogan River. Dennis thought that this would be a good year to evaluate passage issues because of the projected large return of sockeye to the Okanogan Basin. If there is an issue with passage at Zosel Dam, Dennis thought that it may be possible to add another opening with a gate in the dam.

IX. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 14 June 2012 at Chelan PUD in Wenatchee. At that time, the Committees will evaluate General Salmon Habitat Program Pre-Proposals, discuss a Policy for Stewardship Plans, and continue their evaluation of appraisals and the appraisal process.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

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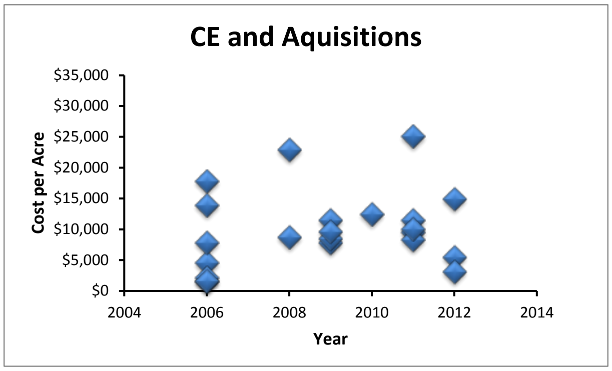
Attachment 2

Land Acquisition/Conservation Easement Cost per Acre

Upper Columbia Basin							
Basin	**CE/Acquisition**	**Year**	**Total Cost**	**Total Acres**	**Linear ft of bank**	**Cost per Acre**	**Cost per ft of bank**
Wenatchee	A	2006	$574,000	127	3802	$4,520	$151
Wenatchee	A	2006	$300,000	38.4	422	$7,813	$710
Wenatchee	A	2008	$190,000	8.3		$22,892	
Wenatchee	A	2006	$30,000	20	2957	$1,500	$10
Wenatchee	A	2006	$112,408	53	3907	$2,121	$29
Wenatchee	A	2006	$96,331	60	2640	$1,606	$36
Wenatchee	A	2012	$639,000	117	6200	$5,462	$103
Wenatchee	CE	2010	$170,000	13.7	1050	$12,409	$162
Wenatchee	CE	2011	$380,000	40	5000	$9,500	$76
Wenatchee	A		$294,700	18	2500	$16,372	$118
Entiat	A	2012	$165,000	53	3380	$3,113	$49
Methow	CE	2006	$1,950,000	140.5	7920	$13,879	$246
Methow	CE	2007	Donation	22.3	1742		
Methow	CE	2008	$600,000	69	3960	$8,696	$152
Methow	CE	2009	$160,000	14	1560	$11,429	$103
Methow	CE	2009	$205,000	26.32		$7,789	
Methow	CE	2009	$90,000	10.6	839	$8,491	$107
Methow	A		$195,048	15	2100	$13,003	$93
Methow	A	2012	$253,000	17		$14,882	
Methow	A	2011	$112,000	13.5	1500	$8,296	$75
Methow	A		$125,000	4.3		$29,070	
Methow	A		$376,000	13.3	1000	$30,150	$401
Methow			$349,988	71	5400	$4,929	$65
Methow	CE	2011	$420,000	36.6	2000	$11,475	$210
Methow	A	2006	$184,000	10.36		$17,761	
Methow	A	2011	$340,000	13.56	723	$25,074	$470
Methow	CE/A		$660,000	45	3500	$14,667	$189
Methow	A	2011	$15,000	1.5		$10,000	
Okanogan	CE	2009	$48,000	5		$9,600	



CE and Aquisitions
Cost per Acre
$35,000
$30,000
$25,000
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2004
2006
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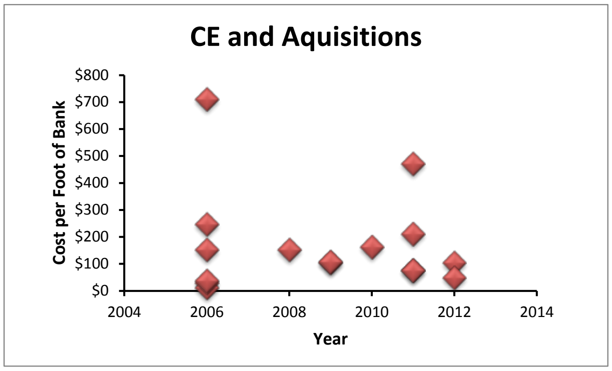

CE and Aquisitions
Cost per Foot of Bank
$800
$700
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2004
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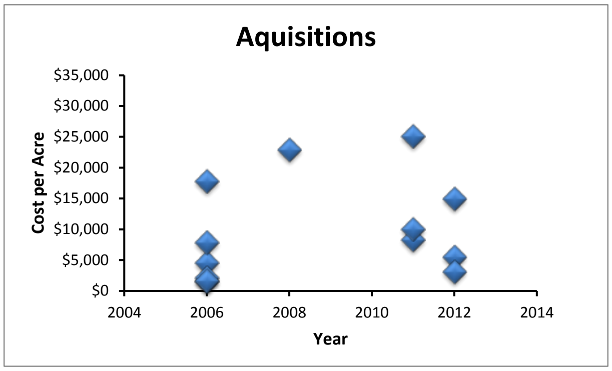

Aquisitions
Cost per Acre
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2004
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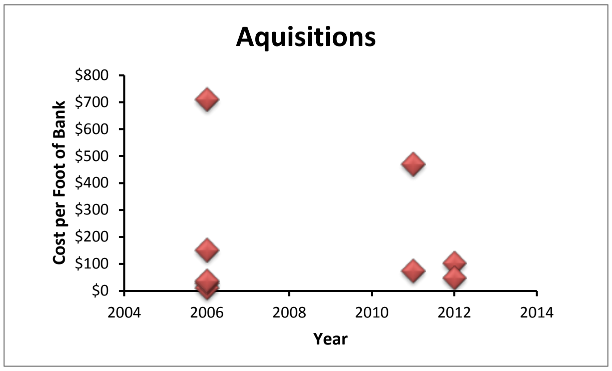

Aquisitions
Cost per Foot of Bank
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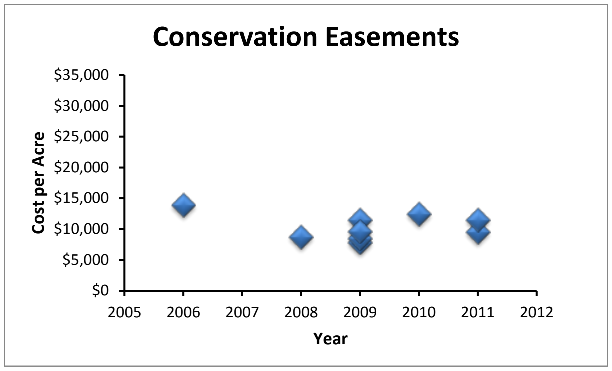

Conservation Easements
Cost per Acre
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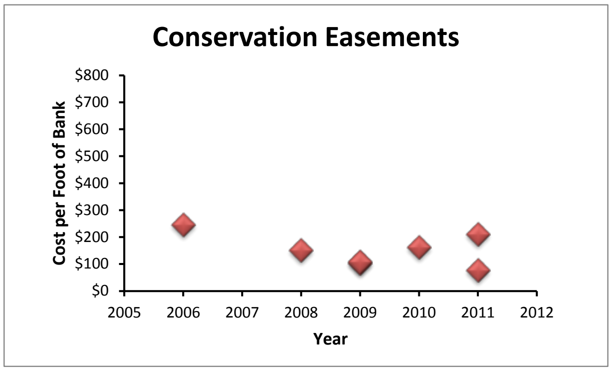

Conservation Easements
Cost per Foot of Bank
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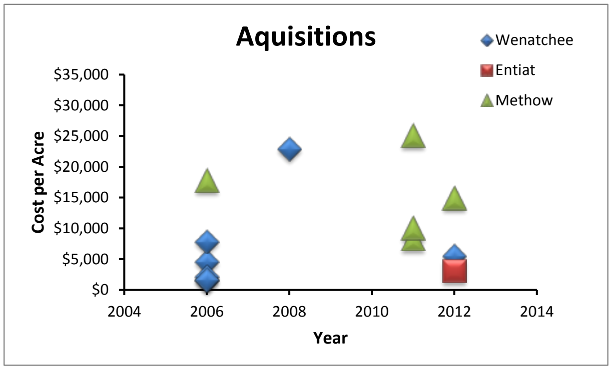
Aquisitions
Wenatchee
Entiat
Methow
Cost per Acre
$35,000
$30,000
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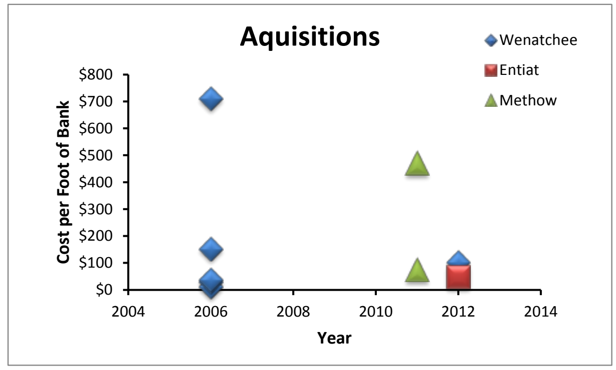
Aquisitions
Wenatchee
Entiat
Methow
Cost per Foot of Bank
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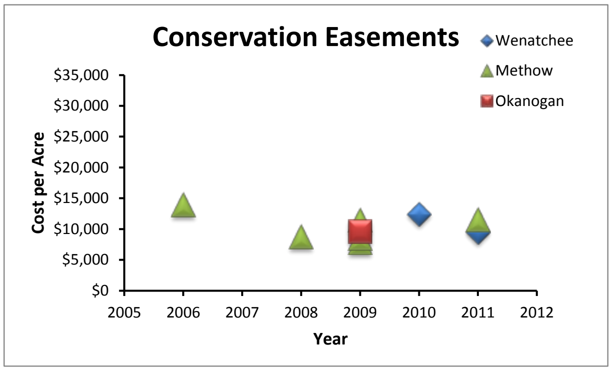
Conservation Easements
Wenatchee
Methow
Okanogan
Cost per Acre
$35,000
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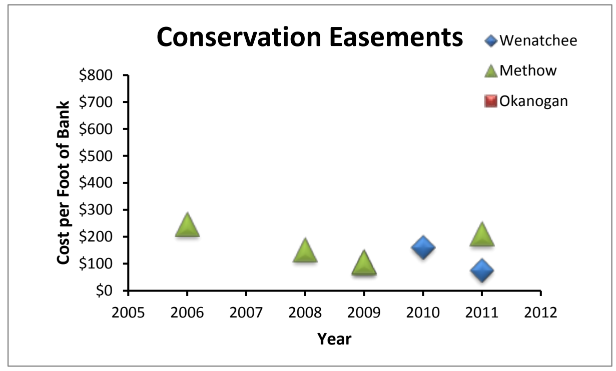
Conservation Easements
Wenatchee
Methow
Okanogan
Cost per Foot of Bank
$800
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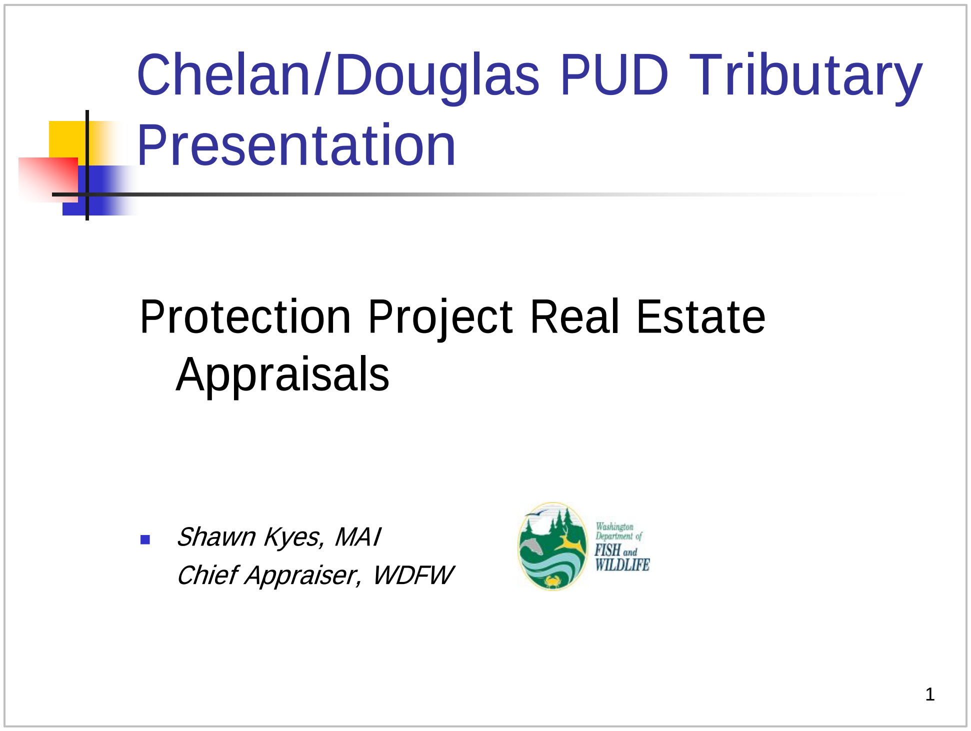
Year

Attachment 3

Presentation by Shawn Kyes (WDFW) on Protection Project Real Estate Appraisals



WDFW Real Estate Services

- Acquisitions/Dispositions/Exchanges
- Property Management
- Environmental Site Assessments
- Conservation Easement Baselines
- *Real Property Appraisals & Reviews*
  - *43 Appraisal Firms Statewide under contract*
  - *Funding sources typically require UASFLA (aka "Yellow Book") compliant appraisals*
  - *Independent contractors solicited for appraisals, with typically internal review*

2

Appraiser Qualifications

- Certified General Appraiser License
  - Bachelors or 30 semester hours in specified
  - 300 hours of RE Appraisal coursework
  - 2.5 years supervised appraisal experience
  - Comprehensive Exam

3

Appraiser Qualifications (continued)

- Experience & Recent Coursework in Uniform Appraisal Standards for Federal Land Acquisitions ("Yellow Book")
- *Valuation of Conservation Easements Course,* jointly presented by Appraisal Institute & American Society of Farm Managers and Rural Appraisers, in conjunction with the Land Trust Alliance.
- Preferably Affiliated or Designation with AI, ASA, ASFMRA, IRWA

4

Scoping the Appraisal Assignment

- Purpose of Appraisal (idea of value, negotiation of sale, secure funding) >> Summary report vs. Self-Contained
- Intended Uses & Users of Appraisal (internal, external also, IRS donation) >> USPAP vs. USPAP & Yellow Book
- Acquisition Scenarios (Total, Partial, Life Estate to be acquired) >> One Fee appraisal vs. "Before & After" Valuation(s).

5

Scoping the Appraisal Assignment
(continued)

- Encumbrances/Conditions
  - Title Report encumbrances
  - Easements, access, water & mineral rights
  - Entitlements/Allowed Uses
  - Landowner Reserved Rights
- History of Ownership & Use
  - Other adjacent lands identified for Larger Parcel analysis
  - Recent Sales/Offerings have to be analyzed by the appraiser
  - Recent Water Usage or Lack of is important for significant Water Right Claims

6

Appraiser Solicitation & Selection

- Cost & Timing
- Geographical Familiarity
- Property Type Familiarity
- Experience
  - Geographic and Property Specific Knowledge
  - Before/After Appraisals
  - Conservation Easements

7

Review Appraiser Consideration & Involvement

- The act or process of developing and communicating an opinion about the quality of another appraiser's work that was performed as part of an appraisal.*
  - Desk Review
  - Field Review

**2012-2013 USPAP*

8

Common Issues/Deficiencies found under Review

- Appraised as if Fee Simple when properties are subject to encumbrances:
  - encumbrances in the Title Report need to be addressed; (easements, access, mineral estates, etc.)
  - Does the Estate appraised equal the Estate to be acquired?

9

Common Issues
(continued)

- The appraiser should not independently create Hypothetical Conditions and Extraordinary Assumptions.
  - Access, water rights, mineral rights, development rights, restrictions of proposed Conservation Easement
  - Must be predominantly stated and be realistic. Client and/or Agency should be consulted prior to their inclusion.

10

Common Issues
(continued)

- Larger parcel ("Yellow Book")
  - No discussion of the three tests, or no larger parcel determination at all.
  - Unity of ownership(title)
  - Unity of Use (Highest and Best Use)
  - Contiguity
- Differences in Larger Parcel Conclusion can have significant effects in conclusions of value from one appraisal to another.

11

Highest and Best Use

- Lack of comprehensive highest and best use analysis using the 4 tests.
  - Legally Permissible
  - Physically Possible
  - Financially Feasible
  - Maximally Profitable (Productive)
- Separate, complete Highest and Best Use analysis is also required in "After" Valuations.

12

Sales Comparables & Analysis

- Dated sales (pre-2009)....are these reflective of post-recession conditions?
- Are the sales truly comparable...."Are the purchasers of the comparables the same people that would be buyers of the subject?"

13

Sales analysis

- All Elements of Comparison examined?
  - Conditions of the sale
  - Market Conditions
  - Location
  - Size/Shape
  - Access
  - Frontage
  - Topography/Views
  - Soils
  - Irrigated Acres/Orchard (Type/Amount)
  - Utilities
  - Zoning/Entitlements

14

Sales analysis

- Are all applicable sales presented or just a select few?
- Are adjustments to sales based on market evidence? Are they reasonable?

15

Common issues with Conservation Easement appraisals

- Appraisals for Conservation Easements will often not include the actual easement language proposed for the projects.
- The analysis is inconsistent with the conditions of the actual easement. (i.e. utility easements, development approach though market conditions don't support)

16

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 14 June 2012

Members Present: Carmen Andonaegui (WDFW), Dale Bambrick (NOAA Fisheries), Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), and Tracy Hillman (Committees Chair).

Others Present: Becky Gallaher (Tributary Project Coordinator). Denny Rohr (PRCC Habitat Subcommittee Facilitator) and Dave Duvall (Grant PUD) joined the meeting during the afternoon.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met at the Chelan PUD Auditorium in Wenatchee, Washington, on Thursday, 14 June 2012 from 9:00 am to 2:00 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with additional discussion items from Dale Bambrick and Tracy Hillman.

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 10 May 2012 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.

- Upper White Pine CPUD Power Line Alternatives Analysis – The contractor (HDR Engineering) has completed a draft report on alternatives analysis. They received comments from the U.S. Forest Service, Bonneville Power Administration, and Chelan PUD.
- Mission Creek Fish Passage Project – The Natural Resources Conservation Service **(**NRCS) has produced 95% design plans for the four sites on Mission Creek. In addition, the sponsor (Cascadia Conservation District) met with the landowners on 5 June. The sponsor will submit revised permit applications to the Corp of Engineers on 11 June. Resubmittal is necessary because the permits expired this spring. Construction is scheduled for late September 2012.
- White River Van Dusen Conservation Easement – The project is complete and the Rock Island Tributary Committee received the final report.
- Nason View Acquisition – The project is complete and the Rock Island Tributary Committee received the final report.

- Entiat Stormy Reach Phase 2 Acquisition – The project is complete and a final report will be submitted to the Rocky Reach Tributary Committee.
- Entiat National Fish Hatchery Project – The project is complete and a final report will be submitted to the Rocky Reach Tributary Committee.
- Chewuch River Instream Flow Project – The sponsor (Trout Unlimited – WWP) has conducted landowner coordination, permitting, project planning and design, and construction management.
- Nutrient Enhancement Assessment – The sponsor (Cascade Columbia Fisheries Enhancement Group) and their contractor (Water Quality Engineers) had a conference call with Washington Department of Ecology on 29 May to discuss the draft Quality Assurance Project Plan (QAPP). The sponsor has incorporated comments into the QAPP and they plan to start sampling for water quality and macroinvertebrates soon.

IV. Small Projects Program Application: Wenatchee Levee Removal and Riparian Restoration Project

The Committees reviewed a Small Projects Program application from Chelan County Natural Resource Department titled *Wenatchee Levee Removal and Riparian Restoration Project*.

Wenatchee Levee Removal and Riparian Restoration Project

The purpose of this project is to restore natural processes to the Wenatchee River by removing a 300-foot long levee, restoring the riparian zone, and eliminating a surface-water irrigation diversion. The project is located at RM 13.5. The sponsor will replace the surface-water diversion with a well, restore a 35 x 265 foot riparian zone, and install a floodplain fence to help capture woody debris. The fence will also protect the adjacent orchard without limiting the river from accessing the floodplain. The total cost of the project is $67,450. The sponsor requested $56,700 from HCP Tributary Funds. After careful consideration of the proposal, ***the Rock Island Tributary Committee approved funding for this project***.

V. Appraisal Discussion

Since January, the Committees have been discussing how they can better evaluate appraisals. The costs of acquisitions and easements have continually increased even though the market has struggled during the last several years. Last month, the Committees listened to a presentation by Dan Budd, Manager of Real Estate Services for WDFW, and Shawn Kyes, WDFW Chief Appraiser. They advised the Committees to take control of the appraisal process. That is, the Committees need to hire a firm to conduct appraisals, or, if that is not possible, the Committees need to hire a firm to review the appraisals. The best approach would be to hire both the appraiser and the reviewer.

Following the May meeting, Dan Budd and Shawn Kyes provided Tracy and Becky with a list of recommended appraisers. Becky shared the list with an appraiser at Chelan PUD. He identified four individuals from the list who he said are well-respected appraisers. They included:

- Michael Gentry with Auble, Jolicoeur and Gentry, Spokane, WA.
- Larry Rees with Cascade Chelan Appraisal, Inc., Chelan, WA.
- Peter Shorett with GVA Kidder Mathews Valuation Advisory SVS, Seattle, WA.
- Fred Strickland with Strickland Heischman and Hoss, Inc., Tacoma, WA.

After reviewing the list of appraisers, the Committees decided that they would use one of the appraisers (e.g., Larry Rees) to do the appraisal and one of the other three to review appraisals. Thus, the Committees will hire both the appraiser and reviewer. The Committees directed Tracy to inform Marc Duboiski (Recreation and Conservation Office) that the Committees will use their own appraisers and reviewers to evaluate the value of future acquisitions and conservation easements.

VI. Review of General Salmon Habitat Program Pre-Proposals

The Committees received 27 General Salmon Habitat Program pre-proposals. The Committees reviewed each pre-proposal and selected those that they believe warranted a full proposal. Projects that the Committees dismissed were either inconsistent with the intent of the Tributary Fund or did not have strong technical merit. The Committees assigned pre-proposals to one of two categories: Fundable and Not Fundable. It is important to note that these are ratings of pre-proposals and do not reflect ratings of full proposals. The Committees directed Tracy to notify sponsors with appropriate projects to submit a full proposal, with a discussion of the questions/comments identified for each pre-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.

Tall Timber Ranch Conservation Easement Phase 2 (Not Fundable)

The Committees recommend that this project, sponsored by the Chelan-Douglas Land Trust, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- It is unlikely that this property will be developed in the future. Thus, the Committees do not see the need for a conservation easement on this property at this time.

Lower Wenatchee Sleepy Hollow Floodplain Conservation Easement (Not Fundable)

The Committees recommend that this project, sponsored by the Chelan-Douglas Land Trust, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- It is unlikely that this property will be developed in the future. Thus, the Committees do not see the need for a conservation easement on this property at this time.

Mill Creek/Mountain Home Ranch Road Fish Passage Project (Not Fundable)

The Committees recommend that this project, sponsored by the Chelan County Natural Resource Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- Although the Committees believe that fish passage is important in Mill Creek, they also believe that there are sufficient funds available to complete the work without having to use Tributary Funds.

Upper Peshastin Creek Tributary Assessment Project (Not Fundable)

The Committees recommend that this project, sponsored by the Chelan County Natural Resource Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- There is no need to conduct an expensive assessment in an area where threats and limiting factors are already known. The Committees would be willing to review proposals that identify specific habitat actions within this area of Peshastin Creek.

Peshastin Creek – Blewett Rock and Gravel Side Channel Reconnection Design Project (Fundable)

The Committees recommend that the sponsor (Chelan County Natural Resource Department) consider the following comments/suggestions as they develop the full proposal:

- Reduce the scope of the final proposal to two alternatives (i.e., alternatives 2 and 3).
- Significantly reduce the cost of the proposal. The Committees believe that ~$200,000 is excessive for design work.

Lower Nason Creek Reach Based Restoration (RM 3.5-4.7) Project (Fundable)

The Committees recommend that the sponsor (Chelan County Natural Resource Department) consider the following comments/suggestions as they develop the full proposal:

- Remove restoration actions 2 (Floodplain Reconnection) and 4 (Oxbow Enhancement). The proposal should focus only on abutment and parking area removal, and engineered logjam structures.
- Significantly reduce the cost of the proposal by combining efforts across the different actions. For example, ~$30,000 for wetland and cultural surveys is excessive for this project, and may not be necessary with the reduced scope of the project as per the above bullet.

Lower Entiat River – RM 1.9 Side Channel Design (Not Fundable)

The Committees recommend that this project, sponsored by the Chelan County Natural Resource Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- This project is too expensive and can be completed without conducting an expensive analysis of different design alternatives.
- The sponsor should simply modifying the upstream openings to the channels to allow high flows to restructure the side channels.

Skinney Creek Restoration Design (originally identified as Not Fundable, but after communicating with the sponsor it was changed to Fundable)

The Committees recommend that the sponsor (Chelan County Natural Resource Department) submit a full proposal.

Upper Peshastin Creek Road Inventory and Analysis Project (Not Fundable)

The Committees recommend that this project, sponsored by the Chelan County Natural Resource Department, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees are not interested in funding an inventory and analysis of forest roads. On the other hand, they would consider funding actions that intend to improve roads that are linked directly to the degradation of fish spawning and rearing habitat.

Wenatchee and Entiat Beaver Reintroduction Project (Fundable)

The Committees recommend that the sponsor (Trout Unlimited-Washington Water Project) consider the following comments/suggestions as they develop the full proposal:

- The sponsor needs to describe how they intend to use the lessons learned from the reintroduction work in the Methow.

- The cost of the project is excessive. The sponsor needs to reduce the cost of the final proposal.

Lower Chiwawa Project Development Project (Not Fundable)

The Committees recommend that this project, sponsored by the Cascade Columbia Fisheries Enhancement Group, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees do not see the need to conduct an expensive assessment in an area where threats and limiting factors are already known. They would be interested in reviewing proposals that identify specific habitat actions within the Chiwawa Basin.

Lower White River Floodplain Rehabilitation Project (Fundable)

The Committees recommend that the sponsor (Cascade Columbia Fisheries Enhancement Group) consider the following comments/suggestions as they develop the full proposal:

- In the final proposal the sponsor needs to focus on project development and identify costs of project implementation.
- Members of the Committees were ambivalent about the utility of various components of the proposal, but several believed that the hydrologic analysis may have the most relevance for the development of future projects.

Methow River Riparian Planting 2012 Project (Not Fundable)

The Committees recommend that this project, sponsored by the Cascade Columbia Fisheries Enhancement Group, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees see a problem with sequencing and recommend that the sponsor plant wider buffers in areas where riparian restoration is appropriate. For example, the Committees believe that the lower terrace on or adjacent to the Silver Property may be a suitable site for the proposed action, but also felt that the sponsor should not proceed with planting that terrace before a plan is developed for the restoration of the combined WDFW holdings in that reach of the Methow. To that end, the Committees would entertain a Small Projects Application that addresses restoration in that area, upon completion of such planning and necessary vetting of the resultant plan. Additionally, the sponsor would need to demonstrate that the rate of erosion along the lower terrace would not remove plantings.

Providing Fish Passage at Shingle Creek Irrigation Dam (Fundable)

The Committees recommend that the sponsor (Okanagan Nation Alliance and the Colville Confederated Tribes) consider the following comments/suggestions as they develop the full proposal:

- Reduce the cost of the proposal. Cost savings may be realized by considering other methods for passing fish.
- Describe the condition of the habitat upstream from the irrigation dam.
- Also, if available, provide information on stream flows and water temperatures.

Lower Foster Creek Steelhead Habitat Enhancement Project (Fundable)

The Committees recommend that the sponsor (Foster Creek Conservation District) consider the following comments/suggestions as they develop the full proposal:

- Consider moving the return water upstream.
- Describe the structural integrity of the dam on Foster Creek.
- Try to secure additional funds from the Army Corps of Engineers.
- Reduce the cost of the project. The sponsor should be able to complete the proposed work with substantially less funding.

Lower Chewuch Beaver Restoration Project (Fundable)

The Committees recommend that the sponsor (Methow Conservancy) consider the following comments/suggestions as they develop the full proposal:

- Reduce the cost of the project. The sponsor should be able to complete the proposed work with less funding.

Big Valley Riparian Protection Project (Fundable)

The Committees recommend that the sponsor (WDFW) consider the following comments/suggestions as they develop the full proposal:

- Remove the 1.5 acre parcel (downstream parcel) from the final proposal. The Committees believe there is no threat of development on this parcel.

Chewuch Campground Bank Restoration Project (Not Fundable)

The Committees recommend that this project, sponsored by WDFW, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- Although the Committees believe that restoring native riparian vegetation is an important component of stream restoration, they do not believe the benefits associated with this project justify the costs. Because the riparian zone is already fenced, they would like the site to restore itself naturally.

Middle Methow (M2) Wetland Conservation Easement 2012 RM 45.75 (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 that there is a low likelihood that this property will be developed in the future. Therefore, they do not see the need for a conservation easement on this property at this time.

Twisp River-Poorman Creek Wetland Habitat Acquisition 2012 RM 4.75 (Fundable)

The Committees recommend that the sponsor (Methow Salmon Recovery Foundation) consider the following comments/suggestions as they develop the full proposal:

- Reduce the cost of the project. The cost of the acquisition appears excessive.

Twisp River Elbow Coulee Phase II Rt/Lt Bank Restoration 2012 RM 6.5 Project (Fundable)

The Committees recommend that the sponsor (Methow Salmon Recovery Foundation) submit a full proposal.

Upper Beaver Habitat Improvement Channel Restoration 2012 RM 7 Project (Fundable)

The Committees recommend that the sponsor (Methow Salmon Recovery Foundation) submit a full proposal.

Twisp River Riparian Protection III 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 reasons:

- The Committees believe that it is unlikely that the floodplain/riparian portion of this property will be developed in the future. Therefore, they do not see the need for a conservation easement on this property at this time.
- The cost per acre is excessive and the public benefit is low relative to that cost.

Entiat PUD Canal System Conversion Project – Phase 2 Project (Not Fundable)

The Committees recommend that this project, sponsored by Cascadia Conservation District, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The project is too expensive and should be funded by Chelan PUD.

Tyee Ranch Conservation Easement (Not Fundable)

The Committees recommend that this project, sponsored by Cascadia Conservation District, should not be submitted as a full proposal to the Tributary Committees for the following reasons:

- The Committees cannot contribute funds beyond the appraised value of the conservation easement.

Cottonwood Flats Phase 1: Bridge Removal Project (Fundable)

The Committees recommend that the sponsor (Chelan County Natural Resource Department) consider the following comments/suggestions as they develop the full proposal:

- Following the presentation, the Committees understand that the sponsor will change the grant application from a restoration proposal to an acquisition proposal. To that end, the Committees are willing to review the final proposal.
- The Committees are not interested in reviewing the final proposal if it includes Phase II (Bridge Removal) or III (Floodplain Restoration) work.

Lower Entiat RM 2.6-3.5 Projects (BOR Reach 1B) Project (Fundable)

The Committees recommend that the sponsor (Yakama Nation) consider the following comments/suggestions as they develop the full proposal:

- The sponsor needs to make sure that the landowners are committed to the project. There is some concern that Mr. Asher may not be committed to the project.

Tracy will share this information with project sponsors on Friday, 15 June. The Committees hope this feedback will help sponsors develop full proposals, which are due on 29 June. The Committees will evaluate final proposals on Thursday, 12 July.

VII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in May and June:

Rock Island Plan Species Account:

- $16,066.90 to Cascade Columbia Fisheries Enhancement Group for the Wenatchee Nutrient Enhancement Project.
- $883.00 to Chelan-Douglas Land Trust for the White River Van Dusen Conservation Easement. This is the final payment for this project.

Rocky Reach Plan Species Account:

- $24,711.82 to Trout Unlimited–Washington Water Project for the Chewuch River Instream Flow Project.

2. Becky Gallaher reported that currently there is $1,437,319.80 in the Rock Island Plan Species Account, $1,057,743.67 in the Rocky Reach Plan Species Account, and $978,751.48 in the Wells Plan Species Account.
3. Tracy Hillman reported that Carmen Andonaegui will serve as the WDFW representative on the Tributary Committees and Dennis Beich will serve as the alternate.
4. Tracy Hillman stated that The Seminar Group will be hosting an Easements Seminar on 10 October at the Washington State Convention Center in Seattle. For more information see the following link: http://theseminargroup.net/seminar.lasso?seminar=12.EASWA
5. Trout Unlimited–Washington Water Project asked the Committees if they would be interested in reviewing a Small Projects Proposal that would fund the drilling and testing of a well, which would remove Greg Port from the Redshirt Ditch on Beaver Creek, a tributary to the Methow River. The cost of the project would not exceed $20,000. The Committees said that they would review the Small Projects Proposal.
6. Dale Bambrick described a Small Projects Proposal that the Committees may receive in the near future. Dale indicated that there are plans to replace the Barkley Irrigation Diversion (push-up dam) on the Methow River with a more fish-friendly project. In the meantime, a short-term fix that does not require a push-up dam is being considered. Dale indicated that the Committees may receive a Small Projects Proposal requesting about $20,000 for poly bags and gravel.
7. Tracy Hillman shared with the Committees an e-mail he received from Julie Grialou with the Methow Conservancy. Julie asked that the Committees address the following questions regarding public access on conservation easements and acquisitions funded by the Tributary Committees:
   - What form of public access will be required/considered (e.g., from river or from road)?
   - On what frequency must public access be allowed (e.g., one day per year vs daylight hours only vs all the time)?
   - Can you describe to us how other project sponsors are meeting this public access requirement in their proposals?
   - Could this access come in the form of organized field trips coordinated by our organization?
   - Is there a standard to which the access must be maintained (surface type/ parking requirements)?
   - Must the access provide access to the river/riparian area?

- Is there any limit to the infrastructure a landowner can provide to accommodate the public use?
- Does the distance of the site from other existing public access points affect the public access that would be required on the easement?
- Must the access be designed in accordance with ADA standards?

The Committees did not have time to address these questions; however, they noted that easements and acquisitions funded by the Committees should have a 10-12 foot wide easement that allows public access to the river, and allows for bird watching and fishing. The Committees will address these questions during the July or August meeting.

VIII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 12 July 2012 at Chelan PUD in Wenatchee. At that time, the Committees will evaluate General Salmon Habitat Program Proposals, discuss a policy for Stewardship Plans and public access on protected properties, and continue their discussions on appraisals and the appraisal process.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 12 July 2012

Members Present: Dale Bambrick (NOAA Fisheries), Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), Kate Terrell (USFWS), and Tracy Hillman (Committees Chair).

Members Absent: Carmen Andonaegui (WDFW)[1].

Others Present: Becky Gallaher (Tributary Project Coordinator). Joe Connor and Peter Lofy (Bonneville Power Administration) joined the meeting for the review of General Salmon Habitat Program Proposals.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met in the Chelan PUD Second Floor Conference Room in Wenatchee, Washington, on Thursday, 12 July 2012 from 9:00 am to 12:20 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 14 June 2012 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.

- Lower Wenatchee Instream Flow Enhancement Project – The sponsor (Washington Rivers Conservancy) has been working through the permitting process. They have completed the NEPA, SEPA, Cultural Resources, Shoreline Exemption, and Wetland Variance reports. The NPDES, Corp of Engineers, and WDFW permits are pending. In addition, the sponsor is working with Chelan PUD on submitting the application for the FERC permit.
- Entiat National Fish Hatchery Project – The project is complete and a final report has been submitted to the Rocky Reach Tributary Committee.
- Mission Creek Fish Passage Project – The sponsor (Cascadia Conservation District) has submitted revised permit applications to the Corp of Engineers. Construction is scheduled for late September 2012.

[1] Carmen provided her votes on decision items before the meeting.

- Chewuch River Instream Flow Project – The sponsor (Trout Unlimited – WWP) has conducted landowner coordination, permitting, project planning and design, and construction management.
- Nutrient Enhancement Assessment – The sponsor (Cascade Columbia Fisheries Enhancement Group) had a conference call with Washington Department of Ecology on 2 July to discuss the draft Quality Assurance Project Plan (QAPP). The QAPP is final and Ecology has been involved and supportive of the project. Ecology sees this project as laying the groundwork for nutrient enhancement work statewide.

  Water Quality Engineers began water quality and macroinvertebrate sampling on 24-25 June. This involved preparation, ordering and calibration of field equipment, reconnaissance of sites, location of riffle zones, photographs, field coordinates, and collection of field samples and field measurements.
- Large Wood Atonement Project – The sponsor (Cascade Columbia Fisheries Enhancement Group) is working with Chelan County and WDFW on permitting the geotechnical phase of the project. The sponsor will collect geotech data in July and continue to conduct landowner outreach.
- Entiat Stormy Reach Phase 2 Acquisition – The project is complete and a final report will be submitted to the Rocky Reach Tributary Committee.

IV. Review of General Salmon Habitat Program Proposals

The Committees received 16 General Salmon Habitat Program proposals. Before reviewing the proposals, Becky Gallaher reported that currently there is $1,437,319.80 in the Rock Island Plan Species Account, $1,057,743.67 in the Rocky Reach Plan Species Account, and $978,751.48 in the Wells Plan Species Account. In addition, and consistent with the Committees' Operating Procedures, members of the Committees identified potential conflicts of interest. Kate Terrell recused herself from voting on the Lower White River Floodplain Rehabilitation project, the Upper Beaver Habitat Improvement Channel Restoration project, and the Lower Foster Creek Steelhead Habitat Enhancement project. Lee Carlson recused himself from voting on the YN Lower Entiat RM 2.6-3.5 Habitat project, Steve Hays recused himself from voting on the Entiat PUD Canal System Conversion project, and Chris Fisher recused himself from voting on the Fish Passage at Shingle Creek Dam project.

Lower Wenatchee Sleepy Hollow Floodplain Conservation Easements

Chelan-Douglas Land Trust is the sponsor of the Lower Wenatchee Sleepy Hollow Floodplain Conservation Easement Project. The purpose of this project is to protect riparian/floodplain habitat along the Wenatchee River between RM 2.5 and 3.1. The easement will protect about 40 acres (all of which is in the 100-year floodplain), including about 3,400 feet of riverbank. The total cost of the project is $545,000. The sponsor requested $136,250 from HCP Tributary Funds. ***The Tributary Committees elected not to fund this project,*** because the risk of development on the properties is low.

Lower White River Floodplain Rehabilitation Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Lower White River Floodplain Rehabilitation Project. The purpose of this project is to assess historic, current, and target riparian and floodplain conditions on a reach scale, and to develop a restoration strategy that improves the health and function of the lower White River area for native salmonids. The total cost of the project is $125,000. The sponsor requested $25,000 from HCP Tributary Funds.

The Committees believe that this project is out of sequence. They believe that the sponsor should first develop alternatives and share those with the landowners to find out which ones the landowners approve. The sponsor should then resubmit the application with the alternatives agreed to by the landowners. The Committees also noted that the proposal did not link the hydraulic assessment with potential actions to improve floodplain connectivity and function. Therefore, ***the Tributary Committees elected not to fund this project***.

Lower Nason Creek RM 3.7-4.7 Restoration Project

Chelan County Natural Resource Department is the sponsor of the Lower Nason Creek RM 3.7-4.7 Restoration Project. The purpose of this project is to restore stream and floodplain function by removing 0.64 acres of floodplain fill and adding large wood structures, brush bundles, and vegetation. The total cost of the project is $398,233. The sponsor requested $60,000 from HCP Tributary Funds.

The Committees recognize that fish would benefit from the placement of large wood and removing the bridge abutment; however, they were unable to recognize a benefit associated with removing the parking area. It was not clear what the intended outcome would be from removing the parking area. Is the removal of fill material intended to create a wetland, side channel, high-flow channel, or simply allow high flows to flood the area? Without knowing the intended outcome of the action, the Committees were unable to assess its biological benefit. Based on these concerns, ***the Tributary Committees elected not to fund this project***.

Skinney Creek Floodplain Restoration Design Project

Chelan County Natural Resource Department is the sponsor of the Skinney Creek Floodplain Restoration Design Project. The purpose of this project is to design a restoration action that will restore natural channel processes such as channel migration and floodplain inundation in lower Skinney Creek and to improve spawning and rearing habitat for spring Chinook and steelhead. This would be accomplished by removing 3,430 feet of levee, increasing floodplain area from 0 to 4-13 acres, increasing juvenile rearing habitat by 50%, and creating 0.1 miles of spawning habitat. The total cost of the design project is $60,000. The sponsor requested $4,000 from HCP Tributary Funds.

The Committees believe that the proposed work is out of sequence and should be reconsidered after the Department of Transportation (DOT) completes their work. It is unclear at this time what specific conditions will result from the actions to be implemented by DOT. This project should be reevaluated after the completion of the DOT work. Therefore, ***the Tributary Committees elected not to fund this project***.

Wenatchee and Entiat Beaver Reintroduction Project

Trout Unlimited – Washington Water Project is the sponsor of the Wenatchee and Entiat Beaver Reintroduction Project. The purpose of this project is to enhance salmon and steelhead rearing conditions within the Peshastin, Mission, Mad, and upper Entiat watersheds by reintroducing beaver. This action should improve stream habitat complexity, flows, riparian conditions, and sedimentation while helping to ameliorate the effects of climate change. The total cost of the project is $199,000. The sponsor requested $70,000 from HCP Tributary Funds.

Although the Committees support the concept of reintroducing beaver into Wenatchee and Entiat watersheds, they believe the project is too expensive. In addition, they believe that before the sponsor seeks funding for the entire project, they should first run the model to identify if suitable introduction sites exist in the watersheds. To that end, the Committees would be willing to review a Small Projects Program Application requesting funds to support model runs. Based on these concerns, ***the Tributary Committees elected not to fund this project***.

Entiat PUD Canal System Conversion Project – Phase 2 Project

Cascadia Conservation District is the sponsor of the Entiat PUD Canal System Conversion Project. The purpose of this project is to complete the conversion of water source from a river-intake canal system to wells on four of seven users of the PUD canal system on the lower Entiat. This project will create water savings (about 4 cfs), enhance off-channel habitat conditions for Chinook and steelhead, and prevent juvenile entrainment. The total cost of the project is $240,000. The sponsor requested $36,000 from HCP Tributary Funds.

Although the Committees support the concept of saving water, they did not believe that the savings of about 4 cfs in the lower Entiat would result in a significant biological benefit. In addition, they believe that the Bureau of Reclamation should address the Milne intake structure. Based on these concerns, ***the Tributary Committees elected not to fund this project***. On the other hand, the Committees would review a Small Projects Program application requesting funding to outfit the test wells so they can be converted to full production.

YN Lower Entiat RM 2.6-3.5 Habitat Projects

The Yakama Nation is the sponsor of the Lower Entiat RM 2.6-3.5 Habitat Project. The purpose of this project is to design a project that will increase habitat diversity and complexity in the lower Entiat. This will be accomplished by adding large wood along the stream margins and boulder clusters within the channel. The total cost of the project is $98,000. The sponsor requested $98,000 from HCP Tributary Funds.

Although the Committees support the proposed project, ***the Tributary Committees elected not to fund this project*** because BPA has agreed to fund the project.

Cottonwood Flats Phase 1: Acquisition

Chelan County Natural Resource Department is the sponsor of the Cottonwood Flats Phase 1: Acquisition Project. The purpose of this project is to acquire about 25.02 acres of riparian and upland habitat (including about 2,475 feet of stream bank) adjacent to the middle Entiat River between RM 17.8-18.1. The total cost of the project is $402,000. The sponsor requested $60,300 from HCP Tributary Funds.

Given that 80% of the acquisition consists of uplands, the Committees found little biological benefit to the proposed project. In addition, the Committees believe that the sponsor should discuss this project with the Chelan-Douglas Land Trust and make sure that the Land Trust agrees with the acquisition and all proposed phases of this project. Based on these concerns, ***the Tributary Committees elected not to fund this project***.

Methow River Riparian Planting Project

Cascade Columbia Fisheries Enhancement Group is the sponsor of the Methow River Riparian Planting Project. The purpose of this project is to restore riparian habitat along the mainstem Methow River between the towns of Carlton and Twisp. Degraded areas will be replanted with native vegetation. The total cost of the project is $95,000. The sponsor requested $15,000 from HCP Tributary Funds.

Although the Committees generally support riparian restoration projects, they see this project as having little biological benefit. In addition, the project seems to be out of sequence with the restoration of the Silver Reach. Riparian restoration should be reevaluated after completion of work in the Silver Reach. Based on these concerns, ***the Tributary Committees elected not to fund this project***.

Twisp River Elbow Coulee Phase II Rt/Lt Bank Restoration 2012 RM 6.5 Project

The Methow Salmon Recovery Foundation is the sponsor of the Twisp River Elbow Coulee Phase II Rt/Lt Bank Restoration Project. The purpose of this project is to improve access, increase rearing habitat, and reduce stranding of fish in two side channels of the Twisp River. This will be accomplished by enlarging a previously constructed levee breach, and breaching an existing levee to reconnect an 800-foot long groundwater-fed channel. The total cost of the project is $77,000. The sponsor requested $14,580 from HCP Tributary Funds. ***The Wells Committee approved funding for this project.***

BPA is currently considering funding the Committee's portion of this project. If they elect to fund this project, funding from the Wells Committee would be unnecessary and the Committee would withdrawal their financial support for this project. If BPA decides not to fund the project, the Wells Committee will contribute up to $14,580 to this project.

Twisp River-Poorman Creek Wetland Habitat Acquisition 2012 RM 4.75

The Methow Salmon Recovery Foundation is the sponsor of the Twisp River-Poorman Creek Wetland Habitat Acquisition Project. The purpose of this project is to acquire about 24 acres of riparian habitat adjacent to the Twisp River at RM 4.75 (mouth of Poorman Creek). The acquisition includes about 2,300 feet of Twisp River frontage and 960 feet of Poorman Creek. The project will also decommission two irrigation diversions on Poorman Creek and an irrigation pump station within a wetland. The total cost of the project is $423,000. The sponsor requested $63,450 from HCP Tributary Funds. ***The Wells Committee approved funding for this project.***

As part of the Wells Committee's contribution to this project, they will use their own appraiser and reviewer to assess the value of the property. This is a new policy of the Committees. All acquisitions and conservation easements funded by the Committees will be evaluated by the Committees' appraiser and reviewer, and the Committees will deduct the costs for the appraisal and appraisal review from the total cost of each project. Finally, the Committee recommended that the management/conservation plan for the property includes language that the property may receive habitat restoration activities if deemed appropriate.

Upper Beaver Habitat Improvement Channel Restoration 2012 RM 7 Project

The Methow Salmon Recovery Foundation is the sponsor of the Upper Beaver Habitat Improvement Channel Restoration Project. The purpose of this project is to increase habitat complexity, which will support rearing, spawning, and migration of steelhead in Beaver Creek. This will be accomplished by reconnecting 600 feet of historic channel and constructing 1,700 feet of new meandering stream to replace a 1,160-foot long straightened channel. In addition, the project will reconnect the stream with the floodplain and add large wood to create complexity. Finally, the Batie diversion will be replaced with a diversion that meets all state and federal criteria. The total cost of the project is $674,300. The sponsor requested $205,225 from HCP Tributary Funds. ***The Wells and Rocky Reach Committees each elected to contribute $102,612.50 to this project.***

Lower Chewuch Beaver Restoration Project

The Methow Conservancy is the sponsor of the Lower Chewuch Beaver Restoration Project. The purpose of this project is to enhance salmon and steelhead rearing conditions within the lower Chewuch watershed by reintroducing beaver. This action should improve stream habitat complexity, flows, riparian conditions, and sedimentation while helping to ameliorate the effects of climate change. The total cost of the project is $231,000. The sponsor requested $27,000 from HCP Tributary Funds. ***The Wells Committee approved funding for this project.***

Big Valley Riparian Protection Project

The Washington Department of Fish and Wildlife is the sponsor of the Big Valley Riparian Protection Project. The purpose of this project is to acquire about 30 acres of riparian and floodplain habitat along the upper Methow River. The total cost of the project is $404,000. The sponsor requested $200,000 from HCP Tributary Funds.

Although the Committees support protecting important habitat, they believe that these parcels have a low probability of being developed. In addition, over half of the proposed acquisition consists of uplands. Finally, the proposal lacked a detailed budget and signed landowner agreement forms. Based on these concerns, ***the Tributary Committees elected not to fund this project***.

Fish Passage at Shingle Creek Irrigation Dam

The Okanagan Nation Alliance and the Colville Confederated Tribes are the sponsors of the Fish Passage at Shingle Creek Irrigation Dam Project. The purpose of this project is to provide fish passage at an irrigation dam, which prevents access to 22 miles of spawning and rearing habitat in Shingle Creek and Shatford Creek. The dam will be modified and/or replaced with a series of riffles that will maintain the stability of the streambed while allowing access to upstream habitat. The total cost of the project is $180,950. The sponsor requested $118,450 from HCP Tributary Funds. ***The Wells and Rocky Reach Committees each elected to contribute $59,225 to this project.***

Lower Foster Creek Steelhead Habitat Enhancement Project

The Foster Creek Conservation District is the sponsor of the Lower Foster Creek Steelhead Habitat Enhancement Project. The purpose of this project is to increase channel complexity, provide cover, capture sediment, create pools, increase water availability, and increase spawning gravels. This will be accomplished by adding large wood and spawning gravels to lower Foster Creek. In addition, the project will assess the feasibility of relocating the discharge point for Chief Joseph toe-water further upstream. The total cost of the project is $85,500. The sponsor requested $57,500 from HCP Tributary Funds. ***The Wells Committee approved funding for this project.***

Funding for this project is contingent on the Committee's review and approval of the restoration design. The Committee questioned the need for 100 cubic yards of spawning gravels. This amount seems excessive for such a small treatment area.

Summary of Review of 2012 General Salmon Habitat Program Projects.

Project Name	Sponsor[1]	Total Cost	Request from T.C.	T.C. Contribution[2]
Lower Wenatchee Sleepy Hollow Easement	CDLT	$545,000	$136,250	$0
Lower White Floodplain Rehabilitation	CCFEG	$125,000	$25,000	$0
Nason Creek RM 3.7-4.7 Restoration	CCNRD	$398,233	$60,000	$0
Skinney Creek Floodplain Restoration Design	CCNRD	$60,000	$4,000	$0
Wenatchee and Entiat Beaver Reintroduction	TU-WWP	$199,000	$70,000	$0
Entiat PUD Canal System Conversion	CCD	$240,000	$36,000	$0
YN Lower Entiat RM 2.6-3.5 Habitat	YN	$98,000	$98,000	$0
Cottonwood Flats Phase 1 Acquisition	CCNRD	$402,000	$60,300	$0
Methow Riparian Planting	CCFEG	$95,000	$15,000	$0
Twisp River Elbow Coulee Phase II Restoration	MSRF	$77,000	$14,580	W: $14,580[3]
Twisp River-Poorman Wetland Habitat Acquisition	MSRF	$423,000	$63,450	W: $63,450

Project Name	Sponsor[1]	Total Cost	Request from T.C.	T.C. Contribution[2]
Upper Beaver Creek Habitat Improvement	MSRF	$674,300	$205,225	W/RR: $205,225
Lower Chewuch Beaver Restoration	MC	$231,000	$27,000	W: $27,000
Big Valley Riparian Protection	WDFW	$404,000	$200,000	$0
Fish Passage at Shingle Creek Dam	ONA/CCT	$180,950	$118,450	W/RR: $118,450
Lower Foster Creek Habitat Enhancement	FCCD	$85,500	$57,500	W: $57,500
Total:		**$4,237,983**	**$1,190,755**	**$486,205**

[1] CCD = Cascadia Conservation District; CCFEG = Cascade Columbia Fisheries Enhancement Group; CCNRD = Chelan County Natural Resource Department; CDLT = Chelan-Douglas Land Trust; FCCD = Foster Creek Conservation District; MC = Methow Conservancy; MSRF = Methow Salmon Recovery Foundation, ONA/CCT = Okanagan Nation Alliance and Colville Confederated Tribes; TU-WWP = Trout Unlimited – Washington Water Project; and WDFW = Washington Department of Fish and Wildlife.

[2] RI = Rock Island Plan Species Account; RR = Rocky Reach Plan Species Account; W = Wells Plan Species Account.

[3] If BPA elects to fund this project, funding by the Wells Committee will be unnecessary.

V. Small Projects Program Applications

The Committees reviewed three Small Projects Program applications from Cascadia Conservation District.

Wenatchee River RM 20-23 Riparian Restoration Project

The purpose of this project is to improve and restore riparian areas along a section of the Wenatchee River between RM 20.0 and 23.0. The total cost of the project is $95,424. The sponsor requested $80,424 from HCP Tributary Funds. After careful consideration of the proposal, ***the Tributary Committees elected not to fund this project***.

Peshastin Creek Riparian Restoration Project

The purpose of this project is to improve and restore riparian areas along a contiguous section of Peshastin Creek from RM 0.6 to 1.4. The total cost of the project is $76,257. The sponsor requested $51,257 from HCP Tributary Funds. After careful consideration of the proposal, ***the Tributary Committees elected not to fund this project***.

Entiat 1G/2A Reach Riparian Restoration Project

The purpose of this project is to improve and restore riparian areas along a nearly contiguous section of the Entiat River from RM 11.5 to 17.0. The total cost of the project is $100,000. The sponsor requested $85,000 from HCP Tributary Funds. After careful consideration of the proposal, ***the Tributary Committees elected not to fund this project***.

Although the Committees believe that riparian restoration is important, they found that the applications lacked enough information to evaluate the success of the proposed actions. For example, there was no information on what species would be planted, nor was there information on the age/size, number, density, and width of plantings. In addition, it was not clear if irrigation would be required to sustain the plantings. Finally, the Committees questioned why the three projects differed in cost per linear foot.

The Committees indicated that they would reevaluate proposals for the Wenatchee River and Peshastin Creek if the sponsor provided more detailed information on the proposed action (Section E in the application). The Committees noted that they were not interested in funding the proposed riparian restoration work in the Entiat. The area proposed for restoration on the Entiat falls within a reference reach for the IMW. In addition, it looks like the vegetation is recovering in that area.

VI. Appraisal Discussion

As noted during the June meeting, the Committees will use Larry Rees as their primary appraiser and Michael Gentry, Peter Shorett, and Fred Strickland as reviewers. The Committees directed Tracy Hillman and Becky Gallaher to contact the appraisers and ask them for rates and qualifications.

The Committees also talked about the possibility of purchasing acquisitions. At this time, it is unclear if the PUDs would be willing to hold the titles to the properties or if they would donate them to another entity such as WDFW, Land Trust, or Methow Conservancy. Because the PUDs do not pay property taxes for land held in fee title, local committees tend to complain about the PUDs acquiring property as a tool to mitigate for their effects on fish and wildlife. Tom Kahler and Steve Hays will check with their respective PUDs to see if the PUDs would be willing to hold the titles or donate them to another entity.

Finally, Tracy informed Marc Duboiski (Recreation and Conservation Office) that the Committees will use their own appraisers and reviewers to evaluate the value of future acquisitions and conservation easements. Marc supported the use of the Committees appraisers.

VII. Methow Conservancy Questions

Last month Tracy Hillman received an e-mail from Julie Grialou with the Methow Conservancy asking the Committees to address several questions regarding public access on conservation easements and acquisitions funded by the Tributary Committees. The Committees provided the following answers to Julie's questions:

- What form of public access will be required/considered (e.g., from river or from road)? Pedestrian access from the road.
- On what frequency must public access be allowed (e.g., one day per year vs daylight hours only vs all the time)? Access will be provided at all times.
- Can you describe to us how other project sponsors are meeting this public access requirement in their proposals? All sponsors awarded funding from the Tributary Committees for protection projects will be required to provide pedestrian access to the river.
- Could this access come in the form of organized field trips coordinated by our organization? No.
- Is there a standard to which the access must be maintained (surface type/ parking requirements)? There will be no impediments to foot access (e.g., fences).
- Must the access provide access to the river/riparian area? Yes.
- Is there any limit to the infrastructure a landowner can provide to accommodate the public use? Infrastructure cannot devalue the habitat being protected.
- Does the distance of the site from other existing public access points affect the public access that would be required on the easement? No. Access must be provided on all protection projects funded by the Committees.
- Must the access be designed in accordance with ADA standards? No.

The Committees directed Tracy to provide these responses to Julie.

VIII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in June and July:

   Rock Island Plan Species Account:

   - $2,066.89 to Chelan PUD for Rock Island project administration/coordination during the second quarter, 2012.
   - $276.50 to Clifton Larson Allen for second-quarter financial management and reporting.
   - $10,830.08 to Cascade Columbia Fisheries Enhancement Group for the Wenatchee Nutrient Enhancement Project.

   Rocky Reach Plan Species Account:

   - $1,816.44 to Chelan PUD for Rock Rocky project administration/coordination during the second quarter, 2012.
   - $276.50 to Clifton Larson Allen for second-quarter financial management and reporting.
   - $15,353.49 to Trout Unlimited–Washington Water Project for the Chewuch River Instream Flow Project.
   - $26,691.92 to Cascadia Conservation District for the Entiat National Fish Hatchery Improvement Project. This is the final bill for this project.

   Wells Plan Species Account:

   - $898.62 to Chelan PUD for Wells project administration/coordination during the second quarter, 2012.

IX. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 13 September 2012 at Chelan PUD in Wenatchee. There will be no meeting in August.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Wells, Rocky Reach, and Rock Island HCP Tributary Committees Notes 11 October 2012

Members Present: Dale Bambrick (NOAA Fisheries), Dennis Beich (WDFW), Lee Carlson (Yakama Nation), Chris Fisher (Colville Tribes), Steve Hays (Chelan PUD), Tom Kahler (Douglas PUD), and Tracy Hillman (Committees Chair).

Members Absent: Kate Terrell (USFWS)[1].

Others Present: Becky Gallaher (Tributary Project Coordinator). Brandon Rogers, Yakama Nation, joined the last 20 minutes of the meeting.

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plans Tributary Committees met in the Chelan PUD Auditorium in Wenatchee, Washington, on Thursday, 11 October 2012 from 10:00 am to 12:20 pm.

I. Review and Adopt Agenda

Tracy Hillman welcomed everyone to the meeting and the Committees adopted the proposed agenda with the following changes:

- Drop the Wenatchee Riparian Restoration Project proposal.
- Add discussion on outreach and coordination.
- Add discussion on Okanogan Fish and Water Management Tool.
- Add discussion on Assessment Funds (The Committees did not have time to discuss this item; therefore, it will be added to the November Agenda).

II. Review and Approval of Meeting Minutes

The Committees reviewed and approved the 12 July 2012 meeting notes with edits from Tom Kahler and Kate Terrell.

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.

- Lower Wenatchee Instream Flow Enhancement Project – The sponsor (Washington Rivers Conservancy) received FERC approval, but recently received notice that the Department of Natural Resources would like to review and comment on the project. The final design was modified slightly and an addendum will be sent to the contractors this week. Becky will check with the sponsor on the modifications to the final design. Installation of the fish screens will begin in late October or early November. The sponsor

[1] Kate provided her votes on decision items following the meeting.

will then begin construction on the pump facility, prep the pipeline transgress, and start laying pipe. The sponsor anticipates completion of the project in early March. They will test the system in early April.

- Twisp River Riparian Protection (Zinn) – The sponsor (Methow Conservancy) is currently drafting the easement and the appraisal is in progress. The Forest Service is behind schedule in completing the land exchange, which is the precursor to the easement. The sponsor and the SRFB have extended the contract to accommodate the Forest Service schedule.
- Nason Creek Upper White Pine Reconnection – Chelan PUD Powerline Reconnection Alternatives Analysis – The alternative analysis was completed in July 2012. The sponsor (Chelan County Natural Resources Department) asked the Rock Island Tributary Committee for a time extension on the project. The contract amendment would extend the current deadline from 31 July 2012 to 31 December 2013. The purpose of the extension is to allow time to select an alternative for relocating the Chelan PUD powerlines. The sponsor also asked if they could use the remaining funds in the project (~$26,000) to hire a mediator with utility experience to facilitate discussions between the Forest Service and Chelan PUD. ***The Rock Island Tributary Committee agreed to extend the period of the project to 31 December 2013. The Committee also approved the use of remaining funds to hire a mediator to facilitate discussions between the Forest Service and Chelan PUD.***
- Mission Creek Fish Passage Project – The sponsor (Cascadia Conservation District) has not yet received the Army Corps of Engineers (ACOE) permit. This is because of internal staffing and workload priorities within the ACOE. If the permit is received this fall, it will be too late to begin construction as planned. In addition, the Bureau of Reclamation and the Natural Resources Conservation Service have expressed concerns that the recent fires may affect flow conditions and sediment dynamics within Mission Creek. The current design may not survive the expected flow conditions and sediment transport. Thus, the sponsor asked the Rock Island Committee for a time extension on the project. The contract amendment would extend the deadline to 31 December 2013. ***The Rock Island Tributary Committee agreed to extend the period of the project to 31 December 2013.***
- Chewuch River Instream Flow Project – Project construction was scheduled to begin this fall; however, the sponsor (Trout Unlimited – WWP) decided to postpone construction until early 2013. This is because (1) the Report of Examination for the change in water right is still in draft form, (2) the bids for the Bear Creek-to-Winthrop portion of the project were all higher than the Bureau of Reclamation’s estimated costs, and (3) project costs. The sponsor will “ground-truth” all costs for the project. If the costs are above the original estimate, the sponsor will seek additional funding.
- Twisp River Acquisition (Hovee) – After the initiation of the acquisition process, the owners of the property separated. This killed the project. The sponsor (Methow Salmon Recovery Foundation) is asking the RCO about substituting the Twisp River Acquisition project for two other adjacent properties. If the RCO approves the substitution, the sponsor will submit a similar request to the Wells Tributary Committee.
- Nutrient Enhancement Assessment – The sponsor (Cascade Columbia Fisheries Enhancement Group) and their contractor have been sampling water quality and macroinvertebrates monthly since June. They are also sampling periphyton and have installed sondes for continuous measurement of pH, dissolved oxygen, temperature, and

conductivity. Preliminary findings will be presented to the CCFEG Board in November. The sponsor is planning to hold another stakeholder meeting in December.

- Large Wood Atonement Project – Gravity Environmental, the U.S. Fish and Wildlife Service, and Tetra Tech have collected topographic and geotechnical information. This information is needed to inform the feasibility and refinement of the design, which the USFWS is currently developing. The sponsor (Cascade Columbia Fisheries Enhancement Group) will schedule a meeting with Chelan County, Chelan-Douglas Land Trust, WDFW, and the Army Corps of Engineers to discuss permitting and logistics.
- Silver Protection Project – The sponsor (WDFW) is still negotiating with the landowner. The sponsor agreement is in the WDFW contracting process.
- Coulter Creek Barrier Replacement Project – Funding for this project is contingent upon the successful implementation of the railroad reconnection project, which has not yet happened.
- Entiat Stormy Reach Phase 2 Acquisition – The project is complete and a final report will be submitted to the Rocky Reach Tributary Committee in November.
- Wenatchee Levee Removal and Riparian Restoration Project – In September, the sponsor (Chelan County Natural Resources Department) asked the Rock Island Tributary Committee for a time extension on the project. This is because there have been some water-right issues that have complicated the process. The sponsor is currently working with the Water Conservancy Board, but it is unlikely the project will be completed by the end of October 2012. Thus, the sponsor asked the Rock Island Tributary Committee for a contract amendment that would extend the deadline to 30 June 2013. ***The Rock Island Tributary Committee agreed to extend the period of the project to 30 June 2013.***

IV. Okanagan Field Trip

Tracy Hillman, with much help from Chris Fisher, Tom Kahler, and Dennis Beich, provided a briefing on their trip to the Okanagan River in Canada (notes from the trip are appended as Attachment A). The Okanagan Nation Alliance (ONA) conducted the site tours. During the first day of the fieldtrip (12 September), members visited the lower portion of Shuttleworth Creek. The lower portion of Shuttleworth Creek was designed to act as a sediment trap. During our visit in October 2010, the lower portion of the stream was wide, shallow, and heavily embedded with fine sediments. The banks were laid-back and there was limited channel structure and riparian vegetation. This year, the Ministry of Environment cleaned the sediment from the channel. This resulted in what looked like a bombing range (see before and after photos below). A rock dam located just upstream from the mouth of the stream maintains the sediment trap. Restoration actions under consideration include removing the barrier, reconfiguring the channel, and restoring riparian vegetation. Reconfiguration would result in a step-pool sequence, which would allow the Ministry of Environment to clean annually the first few pools in the sequence. Restoration would open about 31 km of tributary habitat. This stream is an important spawning and rearing area for steelhead/rainbow.

Before (October 2010)

After (September 2012)

Members then visited the Shuttleworth Creek diversion, which is located at Rkm 3.5. Surface water is diverted through an unscreened intake into a 300-m long open ditch that feeds into Hody Lake. The water is then piped to the Water Users' Community (WUC) properties. The system significantly reduces stream flows and habitat conditions in Shuttleworth Creek, and strands rainbow/steelhead in pools. The goal of the restoration project is to transfer the WUC from surface water to groundwater, and decommission the existing intake and diversion. The PRCC Habitat Subcommittee has approved funding for the conversion to groundwater.

Following the site visit on Shuttleworth Creek, members visited the irrigation dam on Shingle Creek. The dam is located at Rkm 2.3 and blocks access to 35.4 km of spawning and rearing habitat for steelhead and Chinook (once passage is provided at Okanagan Falls Dam). ONA is considering three options: (1) remove the dam, (2) backwater the dam with a series of riffles, and (3) notch the dam and backwater with a series of riffles. The latter is currently the preferred alternative; however, hydraulic analysis and modeling work will determine the best approach.

The ONA discussed restoration options for the Penticton Channel (Okanagan River upstream from Okanagan Falls Dam), which was channelized in the 1950s. About 100 meters of spawning gravels were added to the channel in the mid-1970s. Kokanee spawn extensively in these gravels. The ONA intends to add about four spawning gravel ramps to the Penticton Channel that will be used by sockeye after passage is provided at Okanagan Falls Dam. Because of controlled flows, the gravels should remain stable in the channel.

On the second day (13 September), members visited McIntyre Dam. During the visit in 2009, members noted that fish were temporarily trapped in a cavity along the outer edge of the horizontal lift gates. Engineers have since placed metal plates over the outer edge of the lift gates. ONA continues to test different combinations of passage scenarios (e.g., opening various gates, testing different flows over gates, etc.). As in 2010, it appeared that most fish were attempting to pass along the end wall on the left bank.

Lastly, members visited the Okanagan River Restoration Initiative (ORRI) Project, which is located just upstream from the Town of Oliver. The first phase of implementation, which is complete, was to rebuild the setback dike in the lower portion of the project area. Members observed the completed side channel and instream rock structures, and noted the gravel bar forming in the main channel upstream of the side channels. They also visited the location of the second phase of the project, which will reconnect a 300-m long side channel with the main channel. This will be accomplished by placing bottomless, box culverts at the upstream and downstream ends of the side channel. ONA also intends to modify Vertical Drop Structure (VDS)

13 by removing four V-shaped concrete components within the two middle bays of the structure. This should improve fish passage at the structure and enhance fish habitat (velocities and substrates) upstream from the structure. ONA will monitor the effects of the modification on incubating sockeye eggs.

V. Small Projects Program Application

The Committees reviewed a Small Projects Program application from Cascadia Conservation District.

<u>Peshastin Creek Riparian Restoration Project</u>

The purpose of this project is to improve and restore riparian areas along a contiguous section of Peshastin Creek from RM 0.6 to 1.4. The total cost of the project is $76,257. The sponsor requested $51,257 from HCP Tributary Funds. After careful review of the proposal, ***the Tributary Committees were unable to make a funding decision.*** The Committees questioned why the sponsor was seeking funds from the Plan Species Accounts when it appears that the proposed project fits better with Farm Bill Programs such as the Conservation Reserve Enhancement Program (CREP). The Committees asked that the sponsor please explain why CREP, or other similar funding sources, are not appropriate for this project.

VI. Acquisitions

During the July meeting, the Committees talked about the possibility of purchasing acquisitions. At that time, it was unclear if the PUDs would be willing to hold the titles to the properties or if they would donate them to another entity such as WDFW, Land Trust, or Methow Conservancy. Both Steve Hays and Tom Kahler consulted with their managers and reported that the PUDs have no interest in holding the titles to the properties. Because the PUDs do not pay property taxes for land held in fee title, the local committees would likely complain about the PUDs acquiring property as a tool to mitigate for their effects on fish and wildlife. In addition, the PUDs do not want stewardship responsibilities. Therefore, the Committees decided that they will not pursue purchasing acquisitions.

VII. Information Updates

The following information updates were provided during the meeting.

1. Approved Payment Requests in September and October:

   Rock Island Plan Species Account:

   - $2,108.87 to Chelan PUD for Rock Island project administration/coordination during the third quarter, 2012.
   - $97.50 to Clifton Larson Allen for third-quarter financial management and reporting.
   - $890.21 to Trout Unlimited – Washington Water Project for the Lower Wenatchee Instream Flow Project.
   - $28,703.97 to Chelan County Treasurer for the Nason Creek Upper White Pine Reconnection – Chelan PUD Powerline Alternatives Analysis Project.

   Rocky Reach Plan Species Account:

   - $963.13 to Chelan PUD for Rock Rocky project administration/coordination during the third quarter, 2012.

- $97.50 to Clifton Larson Allen for third-quarter financial management and reporting.

Wells Plan Species Account:

- $941.97 to Chelan PUD for Wells project administration/coordination during the third quarter, 2012.

2. Lee Carlson and Becky Gallaher reported that Cascadia Conservation District, Chelan County, Upper Columbia Salmon Recovery Board (UCSRB), and other entities have identified the need for funding to assist with outreach and coordination in the Upper Columbia. Dale Bambrick indicated that coordination and outreach was supposed to be the job of the UCSRB. He noted, however, that there is a need for messaging. This effort should be an all agency exercise. Dale indicated that he would help with messaging. Becky said that she will see if Derek Van Marter (UCSRB) and Susan Dretke (Cascadia Conservation District) will be able to attend the next meeting to talk briefly about messaging and funding needs.
3. During the May meeting, Tom Kahler indicated that Douglas PUD had asked the Department of Fisheries and Oceans Canada (DFO) to develop a proposal that would expand the Okanogan Fish and Water Management Tool to include summer Chinook downstream from Lake Osoyoos. The purpose would be to use the tool to increase egg-fry survival of summer Chinook spawning within the Okanogan River on the east side of Driscoll Island. During the Okanagan field trip, Tom discussed the expansion of the tool with Chris Fisher and Dennis Beich. Based on advice from Chris and Dennis, Douglas PUD has decided to wait for the new rule curves for Lake Osoyoos before expanding the tool. Thus, Douglas PUD will not be submitting within the next few months a Small Projects Proposal seeking funds to add a summer Chinook sub-model and a Lake Osoyoos water-level sub-model to the Fish and Water Management Tool.

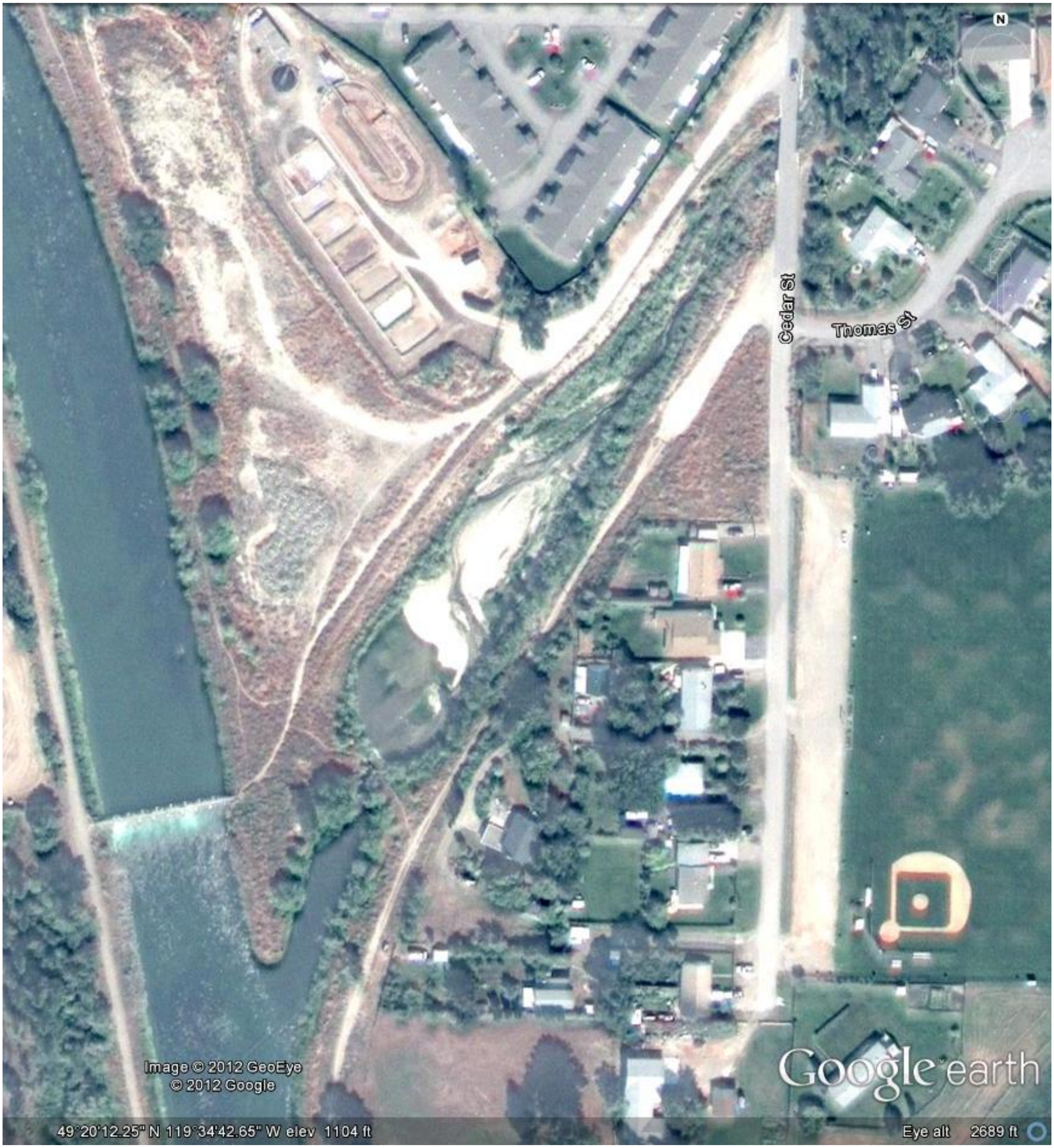
VIII. Next Steps

The next meeting of the Tributary Committees will be on Thursday, 8 November 2012 at Chelan PUD in Wenatchee.

Meeting notes submitted by Tracy Hillman (tracy.hillman@bioanalysts.net).

Attachment 1
Okanagan Field Trip Handouts

Shuttleworth Creek – Sediment basin



Sediment basin - Prior sediment extraction

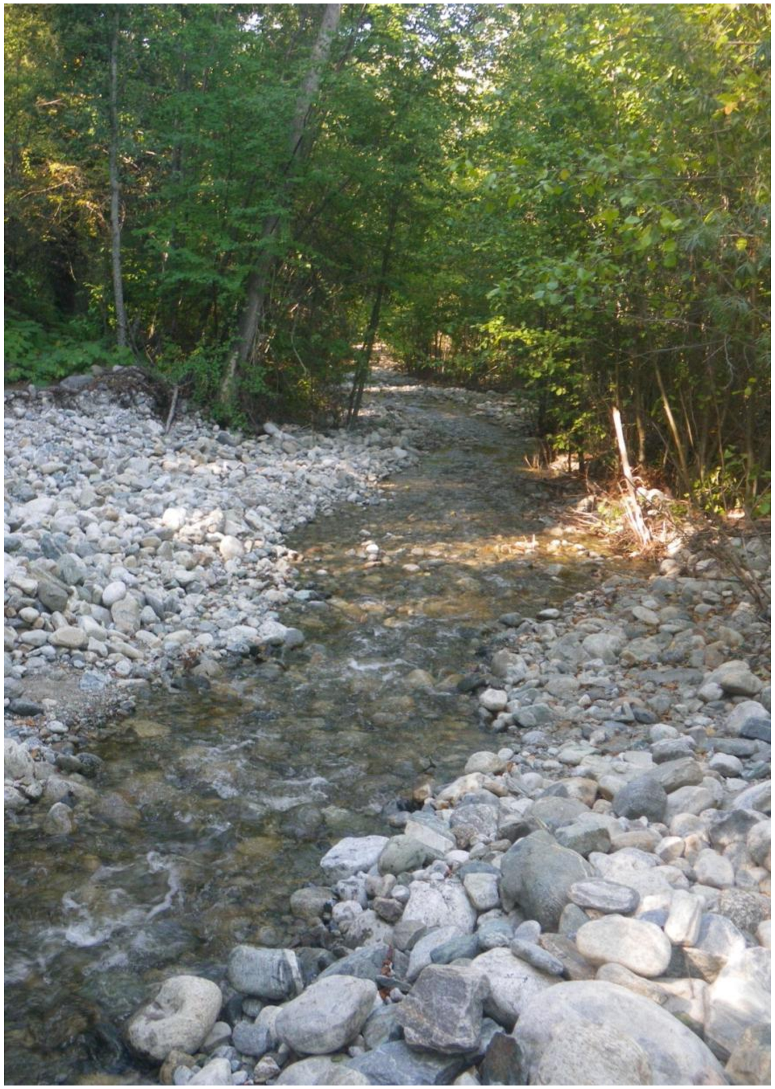
Looking downstream from Cedar Street bridge.

Looking upstream from weir. Note full sediment basin.

Shuttleworth Creek – Habitat upstream of sediment catching basin

Lower Reach (looking upstream)

Middle Braided Reach (looking upstream)



Upper Reach (looking downstream)

Rainbow Trout/Steelhead

Shuttleworth Creek – Sediment basin

Project History:

- The sediment catching basin was constructed by the BC Ministry of Forests, Land and Natural Resource Operations (MoFLNRO) in the 1950's at the mouth of Shuttleworth Creek along with the Okanagan River channelization.
- MoFLNRO has been extracting the accumulated sediment in the basin approximately every 5-10 years since its implementation. The last extraction took place August 2012.
- This sediment basin is a partial fish barrier.
- The upstream section of Shuttleworth Creek contains good quality habitat for Steelhead (listed as endangered in the U.S.).

Project Goal:

- To provide fish passage at the sediment basin while maintaining the BC MoFLNRO criteria for the maintenance of Okanagan River's channel capacity.

Project Location:

- Shuttleworth Creek (mouth)
- Okanagan Falls, BC

Project Progress:

- Currently modeling the basin before and after the sediment extraction in order to provide a foundation for a conceptual design for a re-designed sediment basin.
- Design criteria under discussion through a steering committee involving ONA, MoFLNRO, and Hydraulic Engineers.
- Expect a funding request proposal

Shuttleworth Creek – Intake and Diversion

Legend

Open diversion

Mainline irrigation

Water Users' Community properties

Intake (looking downstream)

Intake (looking upstream)

Just downstream from intake

~2km downstream from intake

Rainbow Trout/Steelhead fry trapped in pool

Shuttleworth Creek – Intake and Diversion

Project History:

- The existing diversion and intake was implemented in the 1930's.
- Intake controls the amount and timing of downstream flow.
- Water is diverted through the unscreened intake into the ~300m long open ditch diversion to Hody Lake. The water is then diverted via pipeline to the Water Users' Community (WUC) properties for irrigation.
- This system greatly reduces fish flows, habitat and passage leaving Rainbow Trout/Steelhead stranded in pools.

Project Goal:

- To transfer the WUC from surface water to groundwater and decommissioning the existing intake and diversion by removing all anthropogenic materials from the creek.
- To restore natural flows within the creek improving fish passage and habitat for Rainbow Trout/Steelhead.

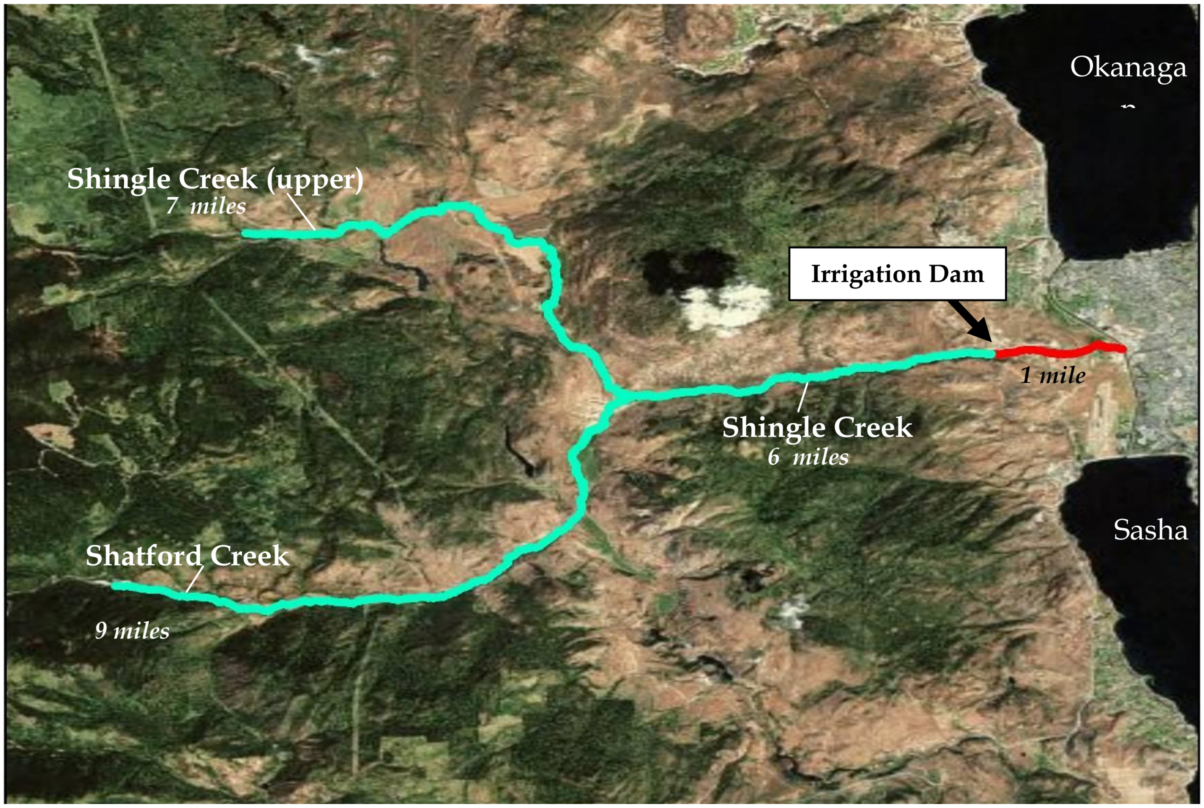
Project Location:

- Shuttleworth Creek (~3.5km upstream from mouth)
- Okanagan Falls, BC

Project Progress:

- Draft design complete from irrigation specialists.
- Awaiting approval from Nature Trust in regards to construction on their land.
- September – discussion with landowners and option to be selected.
- October 1st – start of design implementation.

Fish Passage at Shingle Creek Dam



Ortho Photo of Project Location and Accessible Creeks (22 miles)

Current Shingle Creek Dam

Riffles Concept Diagram

Conceptual Diagram of Projected Project Design Option

Fish Passage at Shingle Creek Dam

Project History:

- Both Shingle and Shatford creeks (tributary of Shingle) are underutilized by anadromous salmonids, due to limited access.
- An irrigation dam located 1.4 miles from the mouth of Shingle Creek prevents upstream fish migration. The dam contains a fish ladder that has not been operational at low flows and even during its operation has been regularly obstructed with debris.
- The irrigation dam was built in 1952 for water withdrawal purposes (irrigation and domestic). Today, water withdrawals are discontinued. The dam and adjacent lands are owned by the Penticton Indian Band (PIB).

Project Goal:

- This project will modify the concrete irrigation dam and install backwatering riffles in order to:
    - Provide access to 22 miles of upstream spawning and rearing habitat for Steelhead and spring Chinook.
    - Increase the creek habitat complexity (pools/riffles).

Projected Fish Passage Design Option:

- The current projected option is backwatering the irrigation dam with a series of riffles. The final project design will be selected depending on the hydraulic analysis and modeling outputs. The number of riffles, the location of the riffles and the size of material will be determined during this process.

Project Location:

- Shingle Creek (1.4 miles from creek mouth)
- Penticton, BC

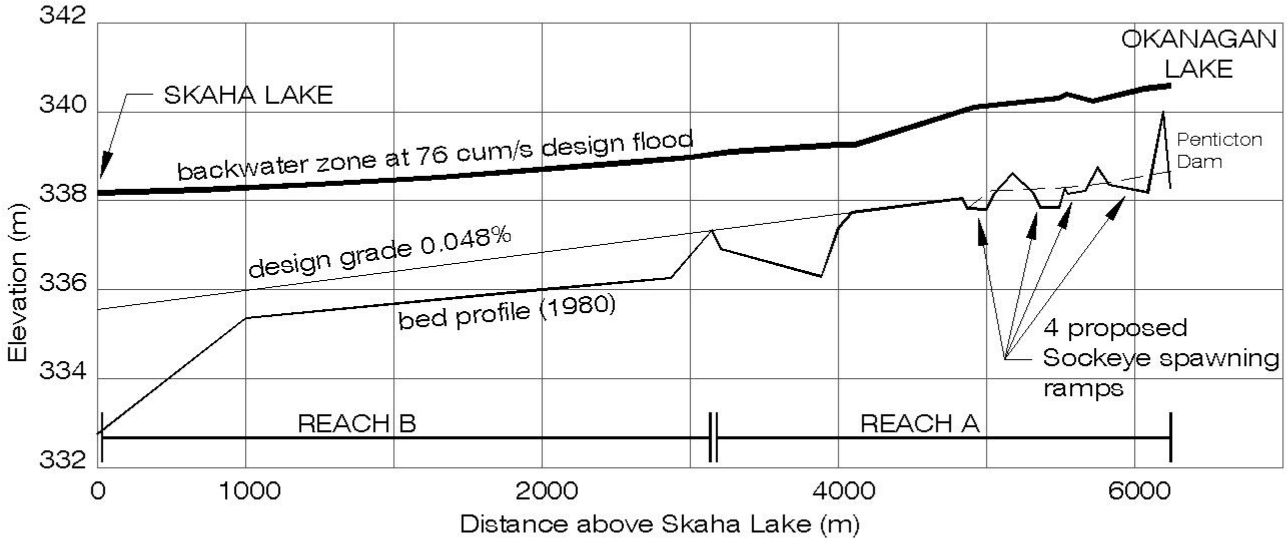
Project Progress:

- Documentation collection and site surveys are completed.
- Funding research is in progress (the majority of funds are secured).
- Hydraulic analysis and modeling of potential design options are in progress (expected for fall 2012).
- Design option selection and design criteria are expected for winter 2012.
- Engineering design and approvals are expected for spring 2013.
- Construction works are expected for summer 2013.
- Post construction site re-vegetation is expected for fall 2013.
- Implementation monitoring (salmon utilization) will be done 2013-2015 within OBMEP monitoring program.

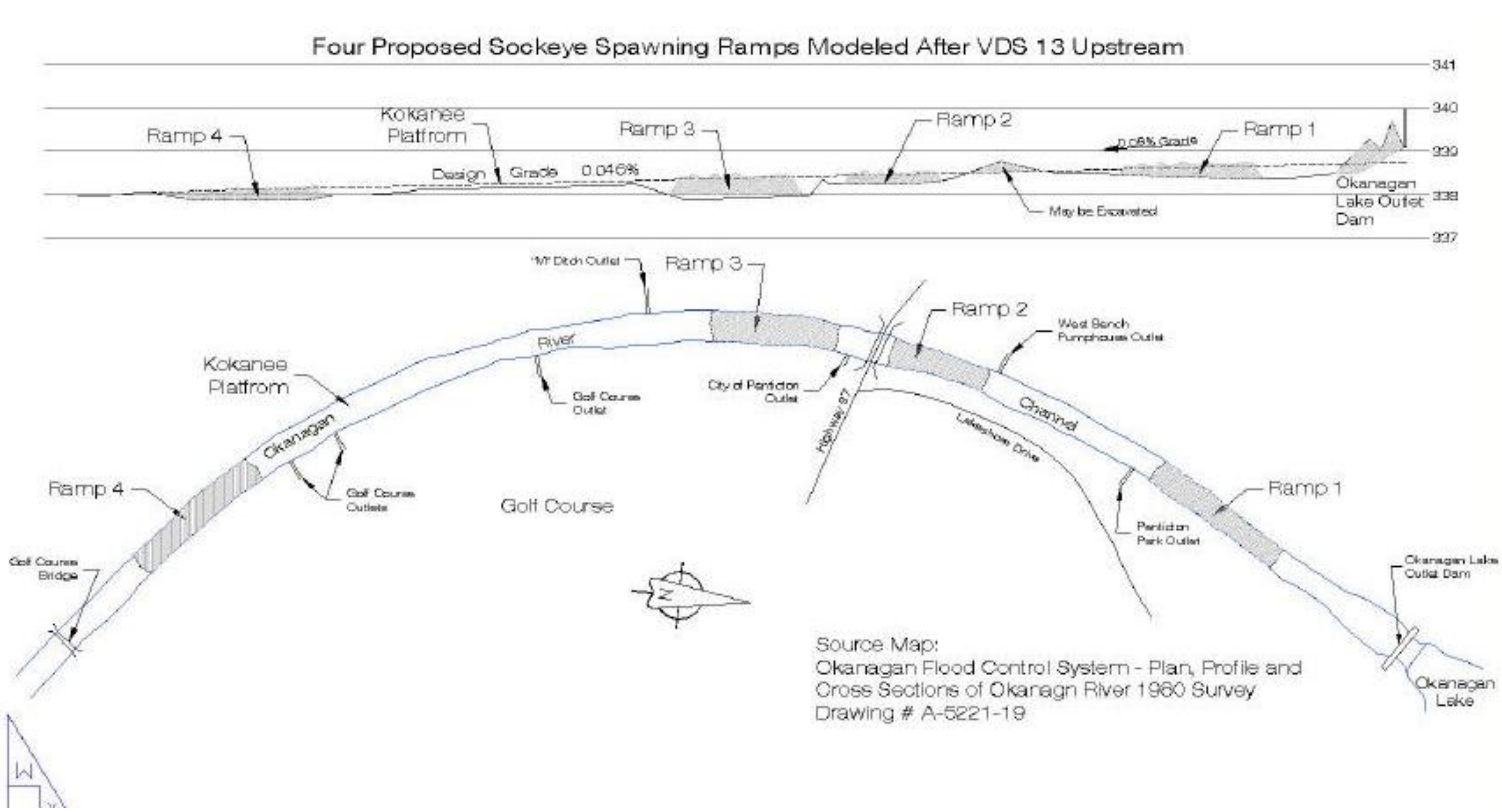
Penticton Channel – River Restoration

Penticton Channel prior channelization, 1930's.

Penticton Channel after channelization, 2012.



Profiles of river bed, design grade and design flood water level.



Profile and plan of proposed spawning ramps.

Penticton Channel – River Restoration

Project History:

- Okanagan River was channelized in the 1950's and few suitable areas remain for salmon to spawn.

Project Goal:

- Restore ecological function where opportunities arise along the entire river reach and its tributaries.
- Create native fish habitat areas where opportunities exist for:
    - Spawning Sockeye (*Oncorhynchus nerka*), Kokanee (*O. nerka)*, Chinook (*O. tshawytscha)*, Steelhead (*O. mykiss)* and Rainbow Trout (*O. mykiss*).
    - Rearing areas for fry and parr of Chinook, Steelhead and Rainbow Trout.
    - Residence areas for adult Rainbow Trout.
- Reduce picivorous exotic fish habitat where opportunities exist.

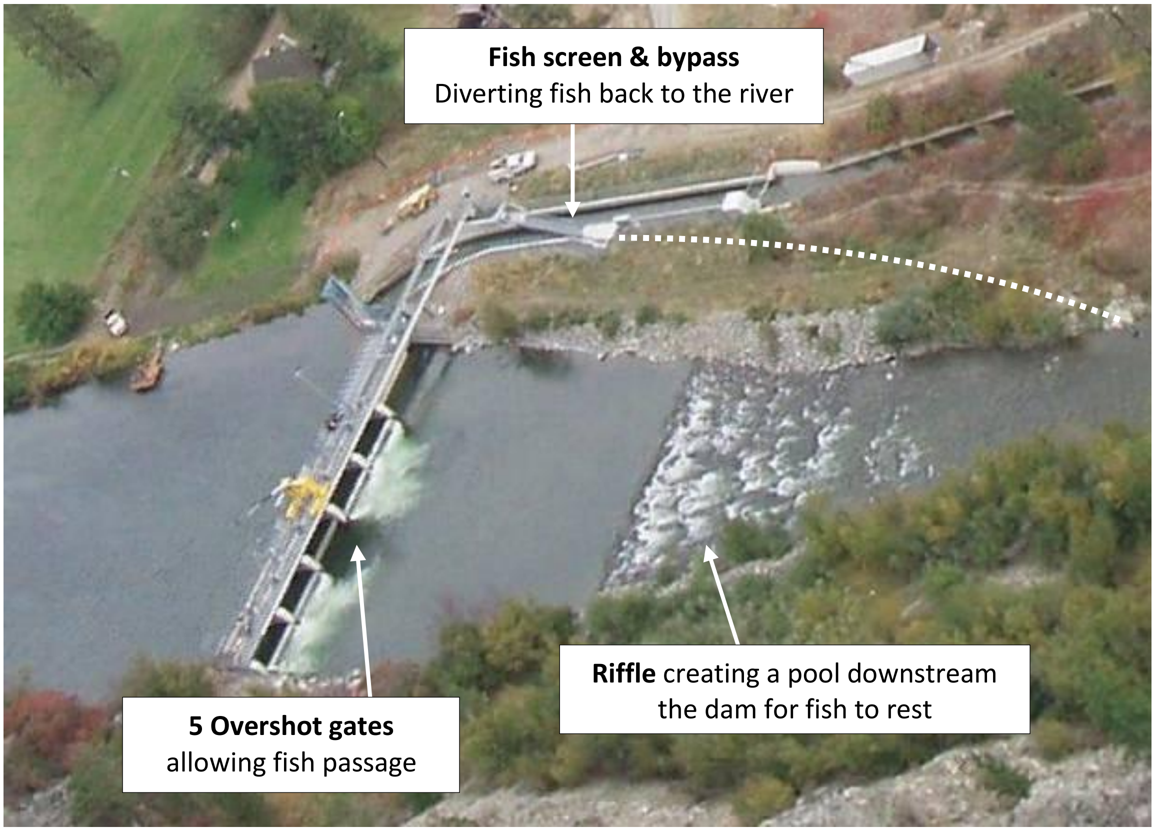
Project Location:

- Penticton Channel (Okanagan River)
- Penticton, BC

Project Progress:

- Scoping of project complete regarding river restoration design options and design criteria.
- Hydraulic analysis for conceptual design options is in progress.

Fish Passage at McIntyre Dam



Conceptual Design of Providing Fish Passage at McIntyre Dam

BEFORE (2008)

AFTER (2011)

McIntyre Dam Before and After the Modifications

Fish Passage at McIntyre Dam

Project History:

- McIntyre Dam was built in 1954 in order to control water levels in the Okanagan River between Vaseux and Osoyoos lakes and in order to provide irrigation water for agriculture and municipality purposes. MoFLNRO operates the dam.
- When this dam was constructed, no upstream fish passage provisions were included. The dam had been the upstream migration barrier for anadromous salmonids in the Okanagan River.

Project Goal:

- The project provided adult salmon passage and improved juvenile salmon downstream migration by:
    1. Replacing the existing 5 undershot gates with 5 overshot gates;
    2. Building a backwater riffle downstream of the dam;
    3. Monitoring the impacts on sockeye salmon migration (juvenile and adults);
    4. Installing a fish screen preventing fish entrainment in irrigation canal (Town of Oliver).
- The completion of this project provided an additional 11 km of spawning and rearing habitat in the Okanagan River and Vaseux Lake, historic habitat which has not been utilized by anadromous fish within the last six decades.

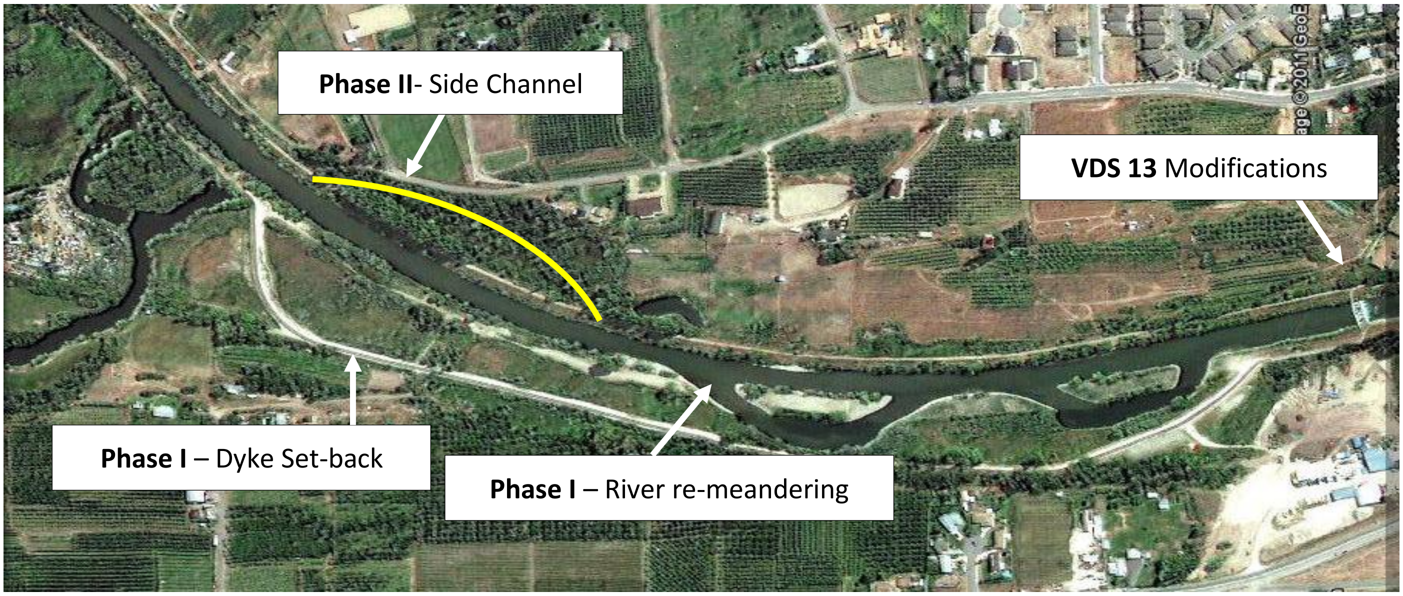
Project Location:

- Okanagan River (1 mile downstream of Vaseux Lake)
- Oliver, BC

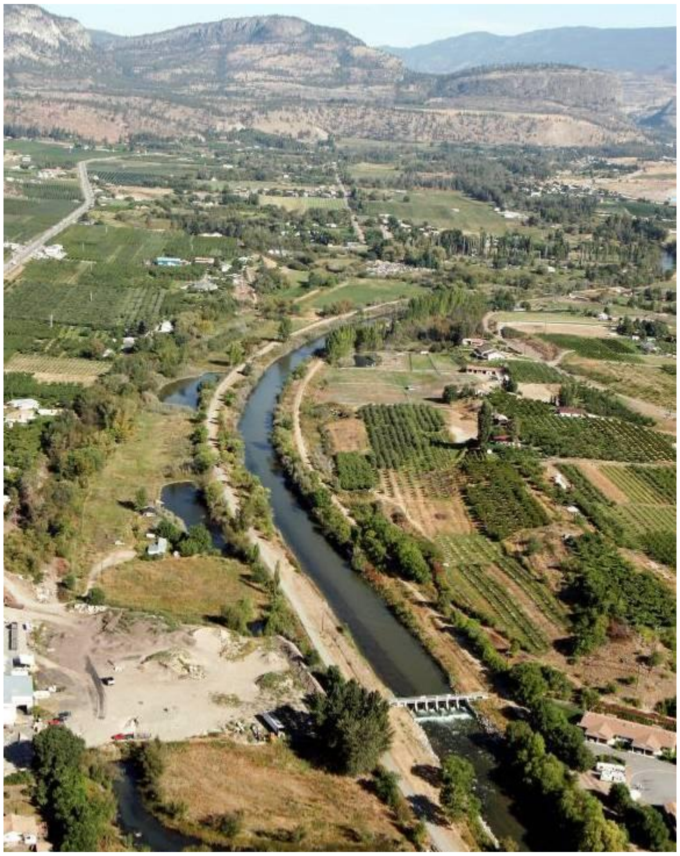
Project Progress:

- McIntyre Dam was refitted for fish passage in 2009.
- In 2010-2012, ONA has been monitoring sockeye utilization of upstream habitat and fish jumping efficiency over the dam.
- The new gates allow passage for sockeye of all sizes, but the fish jumping efficiency is low.
- ONA is working in collaboration with MoFLNRO (the manager of the dam) to find ways to optimize fish passage through the new gates, by producing (expected for winter 2012):
    - Guidelines for gate operation settings.
    - Guidelines for upstream water levels (Vaseux Lake).

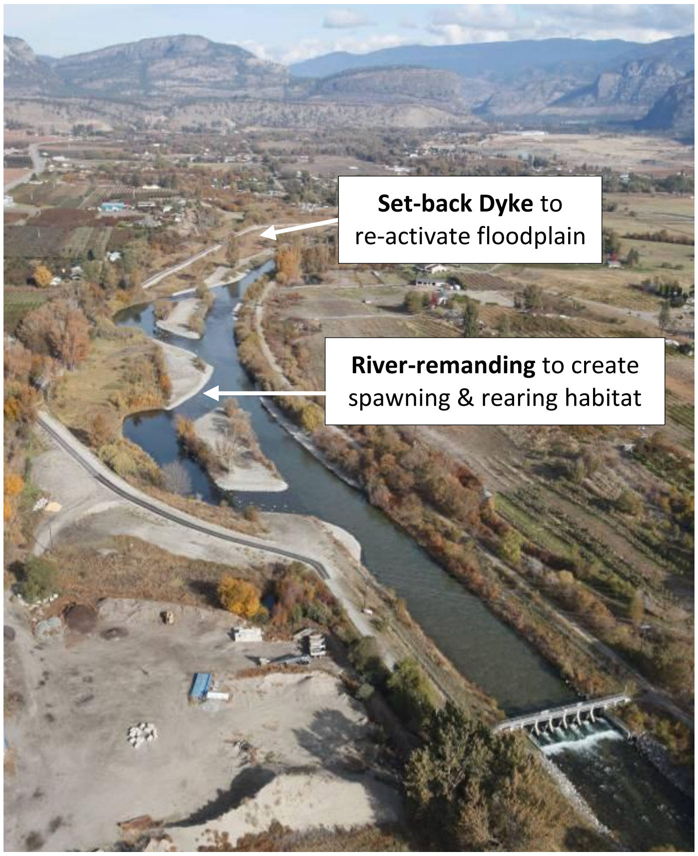
Okanagan River Restoration Initiative - ORRI



ORRI Phases (Phase I, Phase II and VDS 13)

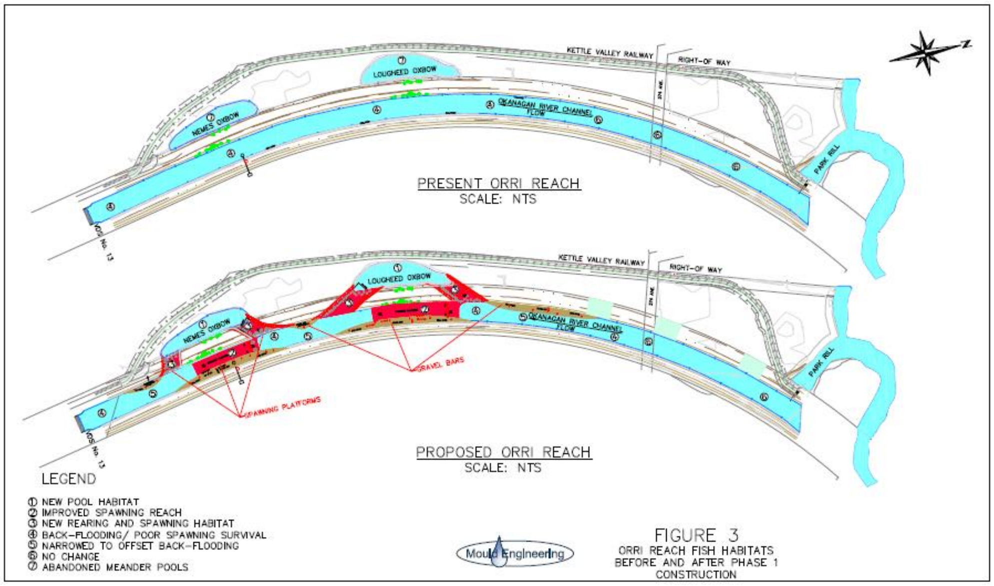


BEFORE (2005)

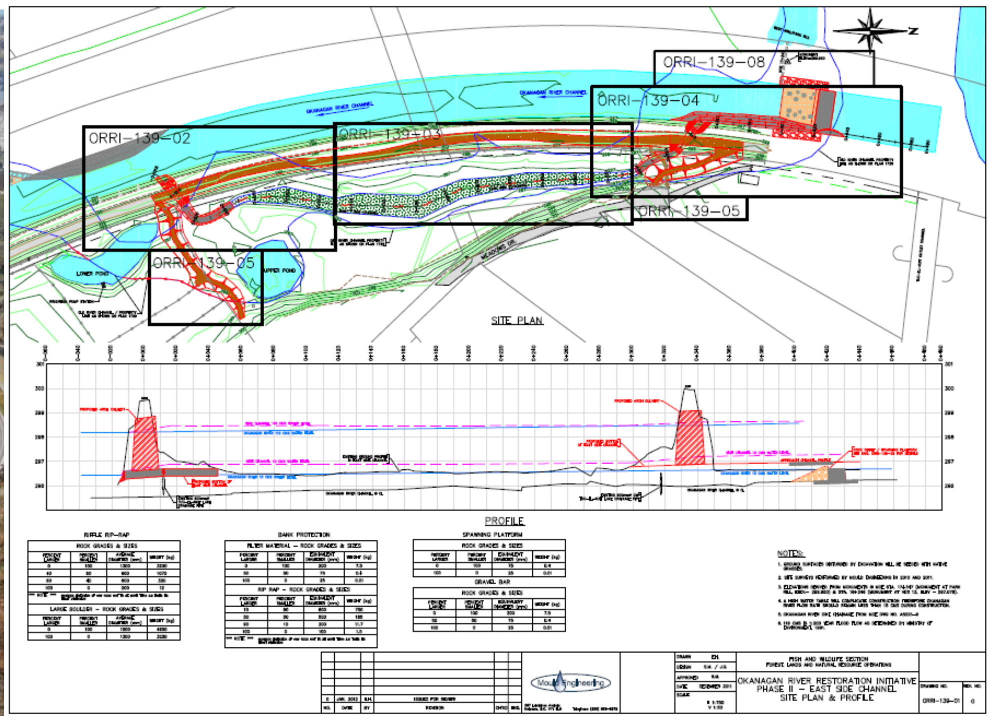


AFTER (2009)

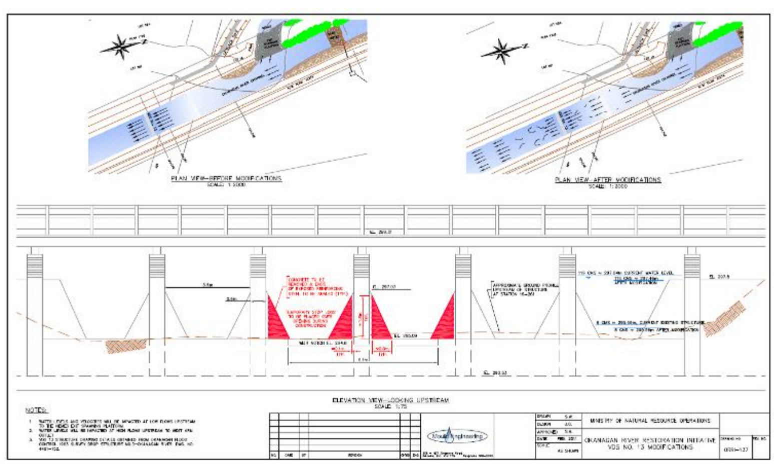
Conceptual Design of Phase I – Reconnection of two old oxbows



Engineering Design of Phase I



Conceptual and Engineering Designs of Phase II



Conceptual and Engineering Designs of VDS 13 Modifications

Okanagan River Restoration Initiative - ORRI

Project History:

- The health of the Okanagan River has been severely impacted by the channelization works that occurred in the mid-1950's. Only 16% (4.9 km) of the river remains in a natural (2.8 km) or semi-natural state (2.1 km). 84% (30.4 km) of the river has been channelized, straightened, narrowed and dyked.
- In an effort to regain the habitat quality and quantity that has been lost, the ORRI concept was conceived in 2000.
- ORRI is an ecosystem based collaborative approach assembling provincial (MoFLNRO), federal (DFO, EC), First Nations (ONA, CCT, OIB) and various local authorities and project funders.
- The ORRI site was specifically chosen based on channel gradient and connection to upstream productive habitats.

Project Goal:

- The goal of the ORRI restoration work is to return portions of the channelized river back to more natural conditions.
- This work involves relocating the dikes, lengthening the river channel, re-establishing meanders and pool/riffle sequences, reconnecting the river to contiguous floodplains, creating side channels, and replanting riparian vegetation.
- The long term purpose of this initiative is to create more complex and diverse habitat for fish and wildlife.

Project Location:

- Okanagan River (10 miles upstream of Osoyoos Lake)
- Oliver, BC

ORRI – Phase I (creation of a dual river channel):

- Phase I Construction works completed in 2009:
  - 1.2 km of dyke was set back reconnecting the river to 15,0000 m^2 of historic floodplain.
  - 0.5 km of river was re-meandered (dual channel) reconnecting 2 oxbows & creating pool/riffle sequences.
  - 5 spawning platforms, 2 riffles and 5 gravel bars were created enhancing fish spawning habitat.
  - 112 boulders clusters and 4 large woody debris were placed creating habitat features for fish & wildlife.
  - Riparian vegetation was re-planted re-establishing the floodplain functions.
- Effectiveness monitoring occurred in 2008-2012. Results to date include:
  - Increased number of Sockeye & Chinook spawners (live + dead) counted in Phase I (relative to total run).
  - Increased density of sockeye redds in the spawning platforms.
  - Increased sockeye egg survival in the spawning platforms.

ORRI – Phase II (creation of a side channel):

- The project involves the creation of a 300m long side channel on the East side of the river immediately upstream ORRI-Phase I. This side channel will provide rearing habitat for Steelhead and Rainbow Trout and spawning habitat for Sockeye salmon.
- Design elements include:
  - A V-shape riffle and an approach channel in the river mainstem diverting flow to the side channel.
  - A culvert crossing the dyke at both the entrance and the exit excavated channels.
  - A 5m wide natural vegetated meandering side channel.
  - Spawning material placed upstream the riffle, at approach channel, at entrance and exit channels.
  - Re-profiled dyke along the side channel and two new small dyke portions.
- Engineering designs, approvals and funding research are near completion. Construction works are expected for summer 2013.

ORRI – VDS 13 (Modifications of VDS 13):

- The project involves the removal of the 4 V-shaped concrete components within the 2 middles bays of the vertical drop structure #13 (VDS 13).
- Engineering designs, approvals and funding research are completed. Construction works are expected for summer 2013 (project delayed by the high flows occurring in summers 2011 and 2012).
- The modifications are expected to improve fish passage through the drop structure and enhance fish habitat (velocities, substrate, Froude numbers) for 0.4 km of river upstream.
- ONA will monitor the effectiveness of the modifications on incubating Sockeye eggs.

APPENDIX D - LIST OF WELLS HCP COMMITTEES MEMBERS

Wells Dam Mid-Columbia HCP Committees, 2012

Coordinating Committee

Name	Organization
Michael Schiewe (Chair)	Anchor QEA, LLC
Jerry Marco	Colville Confederated Tribes
Tom Kahler	Douglas PUD
Bryan Nordlund	NOAA Fisheries
Jim Craig	USFWS
Teresa Scott	WDFW
Bob Rose	Yakama Nation

Hatchery Committee

Name	Organization
Michael Schiewe (Chair)	Anchor QEA, LLC
Kirk Truscott	Colville Confederated Tribes
Greg Mackey	Douglas PUD
Craig Busack (Jan-Dec) Lynn Hatcher (Dec)	NOAA Fisheries
Bill Gale	USFWS
Mike Tonseth	WDFW
Tom Scribner	Yakama Nation

Tributary Committee

Name	Organization
Tracy Hillman (Chair)	BioAnalysts
Chris Fisher	Colville Confederated Tribes
Tom Kahler	Douglas PUD
Steve Hays	Chelan PUD
Dale Bambrick	NOAA Fisheries
Kate Terrell	USFWS
Carmen Andonaegui	WDFW
Lee Carlson	Yakama Nation

Policy Committee

Name	Organization
Michael Schiewe (Facilitator)	Anchor QEA, LLC
Joe Peone (Jan-Dec) Randy Friedlander (Dec)	Colville Confederated Tribes
Shane Bickford	Douglas PUD
Keith Kirkendall	NOAA Fisheries
Jessica Gonzales	USFWS
Bill Tweit	WDFW
Steve Parker	Yakama Nation

APPENDIX E - STATEMENTS OF AGREEMENT FOR COORDINATING COMMITTEES

Wells HCP Coordinating Committee
Statement of Agreement to implement 1.0' Fishway-entrance Head-differential for Lamprey from 17:00 to 00:59 daily during the 2012 Lamprey Migration at Wells Dam

Date of Approval: 24 July 2012

Statement

The Wells HCP Coordinating Committee (CC) approves the request of the Wells Aquatic Settlement Work Group (ASWG) for operating the Wells fishway collection galleries at a 1.0' head differential from 17:00 to 00:59 daily during the 2012 lamprey migration. The requested operations will commence three days after the day on which the cumulative passage of lamprey at Rocky Reach Dam equals five lamprey, and terminate on September 30.

Background

Douglas PUD and the Aquatic Settlement Work Group are evaluating ways to improve the ladder-entrance efficiency for adult lamprey attempting to pass Wells Dam. Radio-telemetry studies and passive monitoring indicate that normal operating conditions may present a velocity impediment to lamprey passage through the fishway entrances. The Wells HCP CC approved studies in 2009 and 2010 at Wells Dam that used Dual Frequency Identification Sonar (DIDSON) technology to observe the behavior of lamprey attempting to pass the fishway entrances under different operating conditions.

At the request of the Wells HCP CC, the studies also included observations of salmonid behavior in response to changes in operating conditions. The results of those studies indicate that lamprey entrance efficiency may be enhanced by reducing the collection-gallery-to-tailwater head differential from 1.5' to 1.0' between 17:00 and 0:59 hours during the peak of the lamprey migration. Post-hoc analyses indicate this is the eight-hour block with the lowest diel salmonid passage activity and highest diel lamprey activity. Analysis of data on the passage of salmonids during the DIDSON studies indicated no significant difference in passage rates of steelhead or sockeye, Chinook, or coho salmon with either a 1'0 or 1.5' head differential.

Conclusions regarding lamprey performance under different flow velocities were drawn from DIDSON observations of only a few lamprey. As a best-management practice and until operational changes can be tested in 2013 with an active-tag study, Douglas PUD and the ASWG propose to operate the Wells Dam fishway entrances with a 1-foot differential at night as a means of enhancing adult lamprey passage.

APPENDIX F - STATEMENTS OF AGREEMENT FOR HATCHERY COMMITTEES

Wells HCP Hatchery Committee

Statement of Agreement

Timing of release of Wells Hatchery Sub-Yearling Summer Chinook

Approved on 19 September 2012

Statement

The Wells HCP Hatchery Committee approves the timing of release for the 484,000 sub-yearling summer Chinook inundation compensation program that takes place annually from the Wells Hatchery. The new release timing for this program will be on or around May 15th of each calendar year.

Background

The Wells HCP requires Douglas PUD to release 484,000 sub-yearling summer Chinook as Fixed Hatchery Compensation – Inundation (Wells HCP; Section 8.4.6). A recent study tested the management strategy of releasing Wells Hatchery subyearling summer Chinook (sub-yearlings) in mid-May (range May 11-18) instead of in mid-June (range June 13-14) , as had been used at Wells Hatchery for many years.

Beginning in 2004, the Wells Hatchery subyearling release was split into May and June release groups and tracked with CWT and PIT tags. The results of this study found that the May release group arrived at McNary Dam approximately 15 days earlier and had 2.75 times the smolt to adult returns (SAR) as the June release group (2004-2007 release years, each year the early release group had a statistically higher SAR). Based on the results of the first three years of the study, in 2008 the HCP Hatchery Committee decided to shift the release timing of all future Wells Hatchery sub-yearlings to the middle of May starting with the 2009 release group.

This SOA is intended to formalize the decision that was made by the HCP HC in 2008. This change in release timing is expected to more than double the number of adult Chinook returning from this component of the summer Chinook inundation compensation program.

Wells HCP Hatchery Committee

Statement of Agreement

Collection of Adult Broodstock at Wells Hatchery for Entiat National Fish Hatchery

Approved on 20 June 2012

Statement

The Wells HCP Hatchery Committee approves the collection of additional summer Chinook (up to 135 pair) during broodstock collection efforts at the Wells Hatchery volunteer ladder trap for the 2012, 2013, and 2014 brood years. These additional brood will be transferred to the US Fish and Wildlife Service's (USFWS) Entiat NFH to support the Entiat summer Chinook program. Broodstock collection for the Entiat program will take place after Douglas PUD's and Chelan PUD's programs have achieved their broodstock collection goals. Logistical and financial arrangements for these collections will be determined by Douglas County PUD and the USFWS.

Background

The USFWS, in conjunction with other parties (Yakama Nation, the Confederated Tribes of the Colville Reservation NOAA, WDFW, BOR), is implementing a new summer Chinook hatchery production program at Entiat NFH. The long-term goal of this program is to provide fish for tribal, commercial, and sport harvest, and to meet tribal trust responsibilities as mitigation for Grand Coulee Dam. A Hatchery and Genetics Management Plan (HGMP) for this program was submitted to NOAA in July of 2009. This HGMP has also been distributed to all of the relevant co-managers.

The USFWS uses volunteer summer Chinook returns to Wells Hatchery as interim broodstock for the Entiat NFH program, and expects that the Entiat NFH will be self-sufficient starting in 2015 (see Table). Broodstock collection efforts have historically entailed the transfer of eggs in the first year of partial production (BY 2009), and transfer of adults in BYs 2010 and 2011 (and for subsequent years until sufficient numbers of adults return to Entiat NFH). Full production will require the collection of up to 270 hatchery origin summer Chinook adults (enough to provide up to 400K eggs). Funding for this new program is the responsibility of the USFWS and BOR.

Brood Year	Estimated Broodstock Required from Wells Hatchery
2012	270
2013	270
2014	135
2015	0

The above forecasted need for broodstock is based on an assumed SAR of 0.3%. Adults from the Entiat NFH program are expected to begin returning in 2012 but will consist of 2 year old jacks only. As 3 and 4 year old adults return in 2013 and 2014 the need for collection of brood at Wells Hatchery may need to be extended or refined. Any extension of brood collection (past 2014) at Wells Hatchery for the Entiat NFH program would require additional discussion and agreement of the Wells HCP parties.

Broodstock collection for the Entiat program will take place after Douglas PUD's and Chelan PUD's programs have achieved their broodstock collection goals.

Rock Island and Rocky Reach HCP Hatchery Committees

Statement of Agreement

Chelan PUD Chiwawa Spring Chinook Size Targets

Approved February 15, 2012

Statement

The Rock Island and Rocky Reach HCP Hatchery Committee agrees to adjusting the size at release target for the Chiwawa Spring Chinook program from 12 fish/pound (~176 mm) to 18 fish/pound (~126 mm) beginning with the 2012 brood year. The intention of the programmatic adjustment is to more closely resemble wild-origin smolt populations and the unique length-weight relationship of Chiwawa spring Chinook, and increase age at maturity for hatchery-origin adults. The size at release targets may be further adjusted based on continued monitoring and evaluation data, consistent with the Rock Island and Rocky Reach HCPs.

Background

Analyses on age structure of spring Chinook returns from the Chiwawa hatchery program (Appendix 1) indicate that large hatchery smolts do not provide an overall survival benefit and further increase the rate of Age 2 and 3 returns (i.e., mini-jack and jack rates). Further analyses suggest that increased age at maturation will reduce stray rates, and are not likely to negatively influence female returns (Appendix 2). Larger smolts have not contributed favorably to female returns, and small smolts have shown to result in a greater proportion of 3-salt (e.g., 11% of females identified at Tumwater were 3-salt fish, compared to 1% of males; Appendix 2). This agreement is consistent with recommendations from monitoring and evaluation results, the program intention of conserving wild-origin populations, and NOAA recommendations. Chelan PUD will continue monitoring and evaluation efforts to ensure that program adjustments are meeting the intended goals.

APPENDIX 1 – ANALYSIS OF SIZE AT RELEASE, JANUARY 9TH, 2012

Use of monitoring and evaluation data to identify appropriate size at release targets for hatchery-origin Chiwawa River spring-run Chinook salmon *Oncorhynchus tshawytscha*

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Abstract–We examined smolt survival and adult returns of Chiwawa River spring Chinook salmon *Oncorhynchus tshawytscha* using passive integrated transponder tags to determine if juvenile length influenced these results. A logistic regression indicated that increasing juvenile length at tagging significantly increased the probability of both wild- and hatchery-origin smolts returning at younger age classes, including mini-jacks (p = 0.03 and p < 0.01, respectively). Despite significantly smaller size at release and 21.4% lower smolt survival rate on average, wild-origin fish had a 49.2% greater rate of adult returns compared to hatchery-origin fish (p < 0.01). Hatchery-origin smolts were divided into small and large groups by median length at tagging for comparison. The large half of hatchery-origin fish had statistically indifferent juvenile survival compared to the small half, but produced 135% more mini-jacks (p = 0.03), 194% more jacks (p < 0.01) , 6% more 2-salt adults (p = 0.38), and 56% fewer 3-salt adults (3-salt adults from the 2009 releases have not yet returned; p = 0.11). These results indicate that large length targets of hatchery programs do not translate to increased smolt survival or adult returns and further increase the disparity between population demographics of hatchery- and wild-origin populations. We propose that a size target of 126 mm and 25 g (~ 18 fish per pound) in hatchery-reared spring Chinook would provide measurable benefits in terms of adult returns and conservation of an ESA-listed stock.

Introduction–Chiwawa Hatchery (Chiwawa) is located at the confluence of the Chiwawa and Wenatchee rivers approximately 15 miles north of Leavenworth, Washington. Chiwawa was constructed in 1990 as a component of the Eastbank Hatchery Complex designed to rear up to 672,000 spring Chinook smolts to mitigate for losses incurred at hydroelectric projects owned and operated by Chelan County Public Utilities District (PUD). The juvenile fish are transferred from Eastbank Hatchery in the fall prior to migration, over-wintered at Chiwawa, and released directly into the Chiwawa River.

Chelan PUD has funded extensive monitoring and evaluation efforts of Chiwawa spring Chinook since 1989. A comprehensive report on monitoring and evaluation efforts over the past five years is currently being developed. Two recommendations within the report indicate that (1) "more realistic [size] targets should be set based on the length-weight relationship specific to Chiwawa spring Chinook and the size of natural-origin smolts produced in the Chiwawa Basin;" and, (2) "hatchery fish matured at an earlier age than natural-origin fish. This may be related to the size of released hatchery smolts" (Hillman et al. 2011a).

Several researchers have identified relationships between length at release and survival and age at maturity in Chinook and other *Oncorhynchus* spp. (Neilson and Geen 1986; Vøllestad et al. 2004; Scheuerell 2005; Claiborne et al. 2011; Tipping 2011). The current size target for hatchery spring Chinook released in the Chiwawa River is 176 mm FL and 38 g (~ 12 fish per pound), whereas wild-origin fish have averaged 94 mm FL and 9.3 g (~ 50 fish per pound; Hillman et al. 2011b). The purpose of the analyses contained herein is to test the hypotheses that (1) larger spring Chinook smolts lead to a decrease in age at maturity; and, (2) larger spring Chinook smolts do not have a full life cycle survival advantage compared to smaller smolts.

Methods–Data were retrieved from the PIT Tag Information System for the Columbia River Basin (PTAGIS; Pacific States Marine Fisheries Commission 2011). A "tagging detail" query was submitted to obtain records of PIT-tagged spring Chinook that were released from Chiwawa Ponds (CHIP; hatchery-origin smolts only) and Chiwawa Trap (CHIWAT; natural-origin smolts only) during the juvenile migrations of 2006, 2007, 2008, and 2009 (hatchery-origin smolts were not PIT-tagged in 2006). Wild-origin spring Chinook tagged after the month of June are considered sub-yearling juveniles and were excluded from analyses. Descriptive statistics were generated of tagging data for both hatchery- and wild-origin smolts.

An "interrogation summary" query was submitted to obtain observation records of the fish included in the "tagging detail" query described above. The data were filtered to only include observations at the Rock Island adult fishway to identify returning fish. The year of the last observation date at Rock Island was considered the return year, and the difference between the return year and the release year was considered "ocean residence." All juvenile detections in the adult fishway that were last detected the same year as release were considered mini-jacks. Adult returns detected the year following release were considered jacks; two years following release were considered "2 salt" fish, and so forth. Data were tabulated to determine the composition of returns.

A logistic regression was used to model the probability of returning to freshwater after a particular ocean residence (the ordinal variable) as a response to fork length at tagging (the continuous variable). Results were separated by hatchery- and wild-origin smolts. The Whole Model Test was used to determine if the model fits better than constant response probabilities (analogous to the Analysis of Variance table for a continuous response model). *p* values were reported for the Chi-square test used to evaluate how well the categorical model fits the data. Results were considered significant at $p \leq 0.05$ (SAS 2009).

PitPro 4.19 was used to generate Cormack/Jolly-Seber survival estimates and harmonic mean travel time of spring Chinook from release to McNary Dam to examine relative in-river performance of smolts during the outmigration (CBR 2011; Jolly 1965; Seber 1965; Cormack 1964). Fish were initially separated by rear-type (hatchery or wild). Subsequent survival estimates and harmonic mean travel times were generated for hatchery-origin spring Chinook based on a division of fish size each year. Median fork length at tagging was determined for each year and used to divide the "small half" and "large half" subsequently used in comparisons of returns and survival. The small half had larger sample sizes since the median length was included in this group.

Rates of return (RORs) were calculated by dividing the number of PIT-tagged fish detected in the adult fishway at Rock Island Dam (i.e., returns) by the number of fish released. RORs were calculated and compared for specific ages or ocean residence, and also for all adults combined (i.e., 2-salt or greater). A pooled sampling proportion *Pooled* (i.e., for both RORs in comparisons) was calculated by:

$$Pooled = \frac{[(ROR_1 \times n_1) + (ROR_2 \times n_2)]}{(n_1 + n_2)}$$

and SE_{Pooled} was calculated by:

$$SE_{Pooled} = \sqrt{(1 - Pooled)} \times [(^1/_{n_1}) + (^1/_{n_2})]$$

The test statistic (two-proportion z-test), *z*, was calculated as:

$$z = \frac{(ROR_1 - ROR_2)}{SE_{Pooled}}$$

The test statistic and resulting *p* value was obtained from a standard normal table. Data manipulation and descriptive and inferential statistics were performed in JMP ® 8.0.2. Results were considered significant at $p \leq 0.05$.

Results–Over 65,000 spring Chinook were PIT-tagged between 2006 and 2009, including 29,906 hatchery- and 14,142 wild-origin yearling smolts. Hatchery fish were tagged between June and August the year prior to the smolt migration; natural-origin fish were tagged between March and June during the smolt migration. Hatchery-origin smolts averaged 93.1 mm (± 0.1 mm SE) and wild-origin smolts averaged 94.0 mm (± 0.1 mm SE) in fork length. Size at tagging was similar, though wild-origin smolts are tagged 8 to 9 months later on average. Nearly 50,000 detections of these fish occurred subsequent to release, including only 346 observations of unique fish within the Rock Island Dam adult fishway.

Two hundred ninety-three (293) returns were observed in the Rock Island Dam adult fishway, including 192 hatchery-origin fish and 101 wild-origin fish. The majority of returns were 2-salt fish for both hatchery- and wild-origin fish, though hatchery-origin fish had a greater number of mini-jacks and jacks and fewer 3-salt returns. RORs, to account for varying release sizes, show that hatchery-origin fish had 24% more mini-jacks (p = 0.30), 893% more jacks ($p < 0.01$), and 33% fewer ≥ 2-salt adults ($p < 0.01$) than wild-origin fish on average (Table 1). The logistic regression indicated that fish length at tagging significantly influenced the probability of returning after a specific period of ocean residence for both hatchery- (n = 192, $P < 0.01$) and wild-origin (n = 101, $P = 0.03$) fish. The probability of returning as a mini-jack or jack

increased significantly with increasing length at tagging for all fish (Figure 1).

Hatchery-origin smolts had an average estimated survival to McNary Dam of 56.6% (range 43.0-65.0%), compared to an average of 44.5% for wild-origin smolts (range 38.5-47.3%). The difference in estimated survival to McNary Dam was 27% greater on average for hatchery-origin fish, ranging from -5% to 69% over comparable years. Hatchery-origin smolts generally traveled to McNary Dam slightly faster during comparable years, though rates were comparable between groups. Estimated survival to McNary Dam was similar between the small half and large half of hatchery fish as was harmonic mean travel time. These results suggest that hatchery-origin smolts have a downstream survival advantage over wild-origin smolts, though a size advantage within hatchery-origin smolts was not observed (Table 2, Figure 2).

RORs from both the small and large half of hatchery smolts show similar rates of ≥ 2-salt fish ($p = 0.48$), with the large half returning 6% more 2-salt adults ($p = 0.38$) and 56% fewer 3-salt adults ($p = 0.11$) compared to the small half. Mini-jack and jack rates were greater in the large half: the large half produced 135% more mini-jacks ($p = 0.03$) and 194% more jacks ($p < 0.01$) compared to the small half (Table 1). The mini-jack rate for the small half was also inflated by the 2007 smolt year where the median hatchery-origin fish were over 20% larger than in 2008 and 2009; outside of 2007, no mini-jacks were observed in the small half of hatchery-origin smolts.

Even greater differences were noticed between the large half of hatchery-origin smolts and wild-origin smolts. The large half hatchery-origin fish produced on average 50% more mini-jacks ($p = 0.09$), 1,186% more jacks ($p < 0.01$), an equal number of 2-salt adults ($p = 0.41$), and 90% fewer 3-salt adults ($p < 0.01$). Generally speaking, all three groups (wild, small half, and large half) produced similar rates of 2-salt fish, whereas large half smolts produced fewer 3-salt fish, more mini-jacks, and more jacks than wild or small half smolts (Table 1). The composition of returns among these three groups demonstrate that most (88%) wild-origin smolts resulted in ≥2-salt adults over the time period observed, compared to 79% in the small half hatchery-origin smolts, and 57% in the large half hatchery-origin smolts (Figure 3).

Discussion–Our first hypothesis – that larger smolts lead to decreased age at maturity in Chiwawa River spring Chinook – is supported by these findings in both wild- and hatchery-origin fish. Neilson and Geen (1986), Scheuerell (2005), Chamberlin et al. (2011), Claiborne et al. (2011), and Tipping (2011) found similar results in Chinook, where the age of maturation decreased with increasing smolt size. Considering the importance of size at age and age at maturity in Chinook salmon (Kinnison et al. 2011), size at release may have considerable implications on the effectiveness of hatchery releases in the Chiwawa River. At a minimum, a disproportionate rate of mini-jacks and precocious males do not contribute favorably to harvest. Likewise, mini-jack and jack Chinook likely have a limited, if not negative, contribution to conservation-based supplementation efforts (Heath et al. 1994, 2002; Asbjørn Vøllestad et al. 2004; Pearsons et al. 2009; Larsen et al. 2010; Williamson et al. 2010). Our results, in combination with the observed size distribution of wild-origin Chinook and the intent to mimic the wild population for supplementation, provide evidence that a reduced target size for hatchery smolts will improve the population demographics of hatchery spring Chinook salmon in the Chiwawa River.

Our second hypothesis – that larger spring Chinook salmon smolts do not have a full life cycle survival advantage over smaller smolts – is also supported by these data. While some researchers have found smolt survival to be greater for larger smolts (e.g., Miyakoshi et al. 2001; Saloniemi et al. 2004), our results are unable to support these findings. Similar results to our study were observed in Imnaha River spring Chinook, where larger hatchery smolts (12-14 fish per pound) did not have a survival advantage over smaller smolts (20-25 fish per pound). Further, while overall smolt-to-adult survival was similar between small and large hatchery smolts, the smaller Imnaha River hatchery smolts had a significantly greater survival to Age 5 (i.e., 3-salt adults; Feldhaus et al. 2011). In either case, the rate and composition of returns – not smolt performance – is a more important metric in evaluating performance. For example, a 10% increase in smolt survival would not be beneficial if it were accompanied by a 50% increase in mini-jack rates. Therefore, supplementation programs intended to promote conservation of wild-origin stocks should focus on RORs, especially absent any evidence of a survival benefit of rearing larger smolts.

The PIT-tagged Chiwawa River spring Chinook provide a unique opportunity to compare wild- and hatchery-origin salmon. The hatchery uses wild-origin brood and resulting progeny are genetically similar to the wild-origin cohorts. In other words, the major difference between the wild- and hatchery-origin smolts is the rearing. Knudsen et al. found hatchery-origin spring Chinook matured at an earlier age just one generation removed from wild-origin cohorts and that minimizing the results of artificial rearing was difficult (2006). Larsen et al. found that changes in feeding rations can reduce mini-jack rates, creating a leaner and smaller hatchery smolt more similar to a wild counterpart (2006). Feldhaus et al. observed smaller hatchery spring Chinook smolts returning at older age classes compared to larger smolts (2011). With our results indicating that the most apparent difference between wild- and hatchery-origin fish is the age structure and associated RORs, and that the size of hatchery smolts is a predictor of these results, we recommend a reduction in the target size of the hatchery program.

While the current hatchery size target is 179 mm FL and 37.8 g (12 fish per pound), the observed lengths and weights have averaged roughly 136 mm and 32 g (~15 fish per pound) over the past five years (brood years 2004-2008; Hillman et al. 2011). Further, a length-weight relationship developed on the data used in our analyses indicate that the current size targets are not achievable (i.e., a 37.8 g smolt would be roughly 140 mm, not 179 mm). Feldhaus et al. (2011) evaluated Imnaha River hatchery spring Chinook smolts in the 18-23 g range (average weight of 21 g, 20-25 fish per pound). The Imnaha River target weights would translate to roughly a 120 mm and 22 fish per pound target in the Chiwawa Program. We recommend beginning with an intermediate size target of 126 mm and 25 g (approximately 18 fpp) and supporting continued PIT-tagging to evaluate the efficacy of this approach.

In conclusion, these results support previous findings highlighting significant differences between wild- and hatchery-origin salmon. While the disparity may be unsolvable, it is apparent that the large size targets and unnatural growth rates decrease age at maturity in Chiwawa River spring Chinook. These results further indicate that smaller hatchery smolts are more similar to wild-origin counterparts and that larger hatchery smolts may even pose a negative impact. A reduced hatchery size target could reduce some of these discrepancies, as well as provide additional benefits, such as lower rearing densities, and reduced adult management obligations.

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Table 1. Observations and rate of return of PIT-tagged Chiwawa River hatchery- and wild-origin spring Chinook in the Rock Island Dam adult fishway, release years 2006-2009.

Origin	Tag year	PIT tags	Ocean residence (years) 0	1	2	3	Rates of return Mini-jacks	Jacks	Age 2	Age 3	Adults
Hatchery	2007	9,981	16	16	29	1	0.160%	0.160%	0.291%	0.010%	0.301%
	2008	9,894	2	14	58	10	0.020%	0.141%	0.586%	0.101%	0.687%
	2009	10,031	3	12	31	0	0.030%	0.120%	0.309%	0.000%	0.309%
	All	**29,906**	**21**	**42**	**118**	**11**	**0.070%**	**0.140%**	**0.395%**	**0.037%**	**0.431%**
Wild	2006	2,355	0	0	12	5	0.000%	0.000%	0.510%	0.212%	0.722%
	2007	2,697	2	0	2	0	0.074%	0.000%	0.074%	0.000%	0.074%
	2008	6,719	5	1	36	26	0.074%	0.015%	0.536%	0.387%	0.923%
	2009	2,374	1	1	10	0	0.042%	0.042%	0.421%	0.000%	0.421%
	All	**14,145**	**8**	**2**	**60**	**31**	**0.057%**	**0.014%**	**0.424%**	**0.219%**	**0.643%**
Hatchery (small)	2007	5,569	7	2	18	1	0.126%	0.036%	0.323%	0.018%	0.341%
	2008	5,394	0	2	30	7	0.000%	0.037%	0.556%	0.130%	0.686%
	2009	5,193	0	8	14		0.000%	0.154%	0.270%	0.000%	0.270%
	All	**16,156**	**7**	**12**	**62**	**8**	**0.043%**	**0.074%**	**0.384%**	**0.050%**	**0.433%**
Hatchery (large)	2007	4,412	9	14	11	0	0.204%	0.317%	0.249%	0.000%	0.249%
	2008	4,500	2	12	28	3	0.044%	0.267%	0.622%	0.067%	0.689%
	2009	4,838	3	4	17		0.062%	0.083%	0.351%	0.000%	0.351%
	All	**13,750**	**14**	**30**	**56**	**3**	**0.102%**	**0.218%**	**0.407%**	**0.022%**	**0.429%**

Table 2. Probability of survival and harmonic mean travel time (days) to McNary Dam of hatchery- and wild-origin spring Chinook smolts, 2006-2009.

Origin	Tag year	PIT tags	Survival to McNary	SE	Travel to McNary (d)
Hatchery	2007	9,981	65.0%	2.0%	28.3
	2008	9,894	61.7%	3.9%	29.0
	2009	10,031	43.0%	2.0%	30.4
	Average		**56.6%**	**2.6%**	**29.2**
Wild	2006	2,355	47.3%	3.0%	20.1
	2007	2,697	38.5%	2.2%	27.9
	2008	6,719	47.0%	2.6%	29.4
	2009	2,374	45.2%	4.6%	36.6
	Average		**44.5%**	**3.1%**	**28.5**
Hatchery (small)	2007	5,569	66.0%	2.6%	28.5
	2008	5,394	68.4%	6.1%	29.7
	2009	5,193	42.7%	2.8%	31.4
	Average		**59.0%**	**3.8%**	**29.9**
Hatchery (large)	2007	4,412	63.6%	3.1%	28.1
	2008	4,500	54.8%	4.8%	28.3
	2009	4,838	43.4%	2.8%	29.4
	Average		**53.9%**	**3.6%**	**28.6**

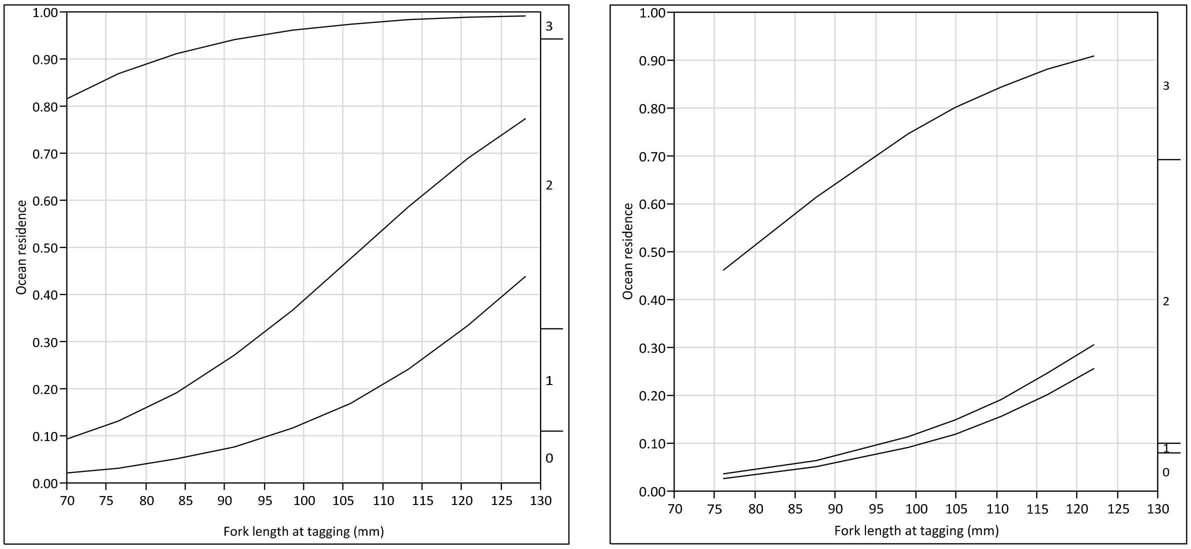


Figure 1. Logistic fit of ocean residence by fork length (mm) at time of tagging for hatchery (left) and wild-origin (right) Chiwawa River yearling spring Chinook. Whole Model Tests indicate a significant relationship for both hatchery ($P < 0.01$) and wild-origin ($P = 0.03$) fish, with an increasing probability of ocean residence = 0 (i.e., mini-jack) with increasing size at tagging.

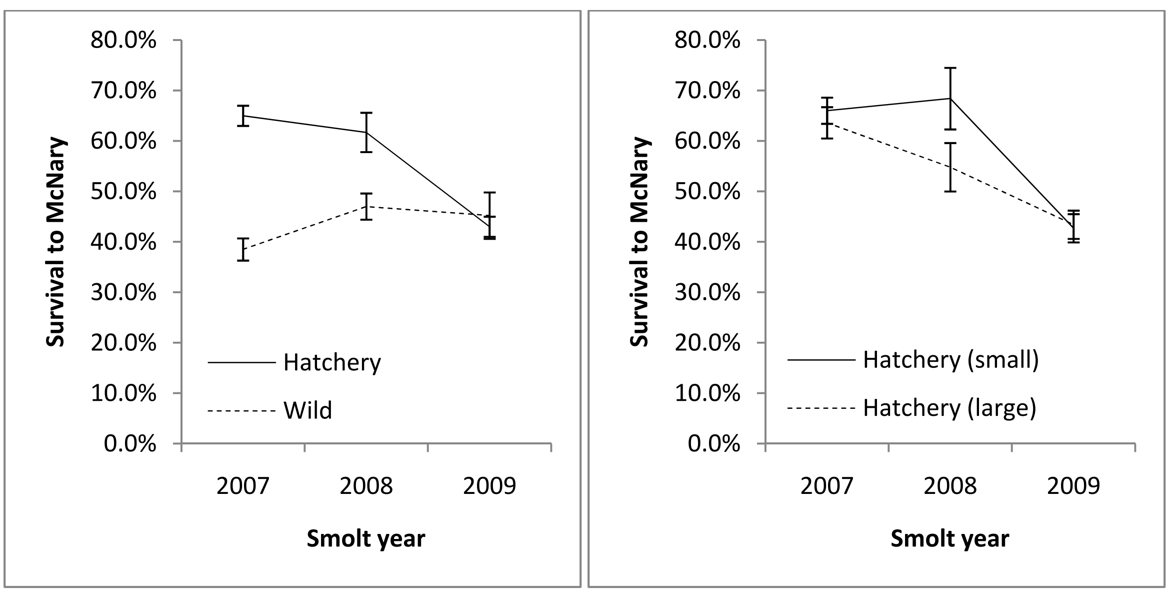


Figure 2. Estimated survival (± SE) to McNary Dam of hatchery and wild spring Chinook smolts (left), and small and larger hatchery-origin smolts (right).

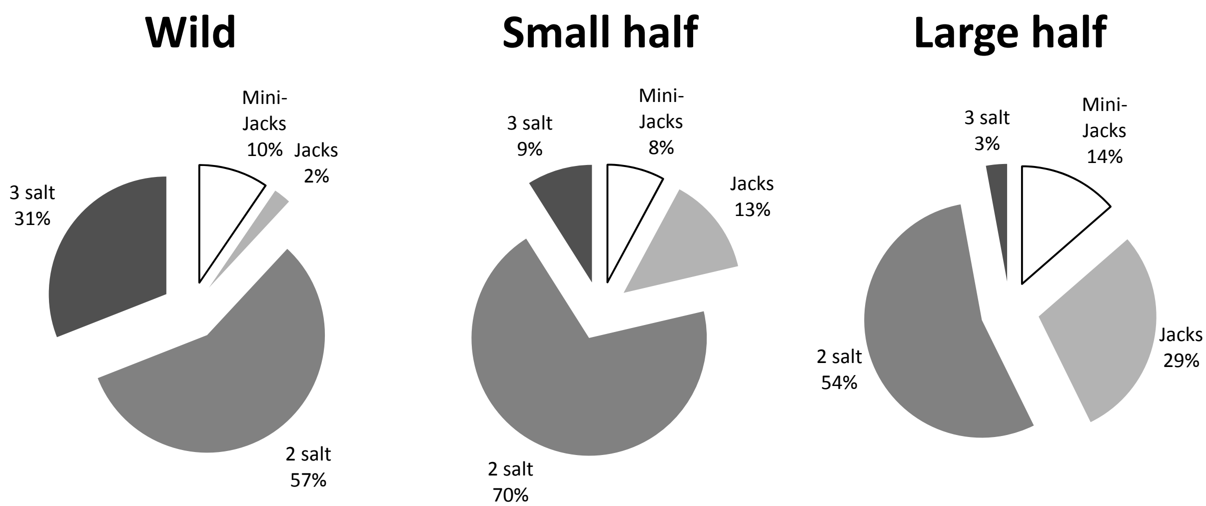


Figure 3. Distribution of returns from wild- and hatchery-origin spring Chinook smolts released in the Chiwawa River, 2007-2009. Hatchery smolts were separated by median fork length at time of tagging and returns from 2009 do not yet include 3-salt fish.

APPENDIX 2 – PRESENTATION TO HCP-HC, FEBRUARY 22ND, 2012

Juvenile Spring Chinook Size, Survival, and Age at Maturity

Josh Murauskas
Chelan PUD Natural Resources Department

February15, 2012

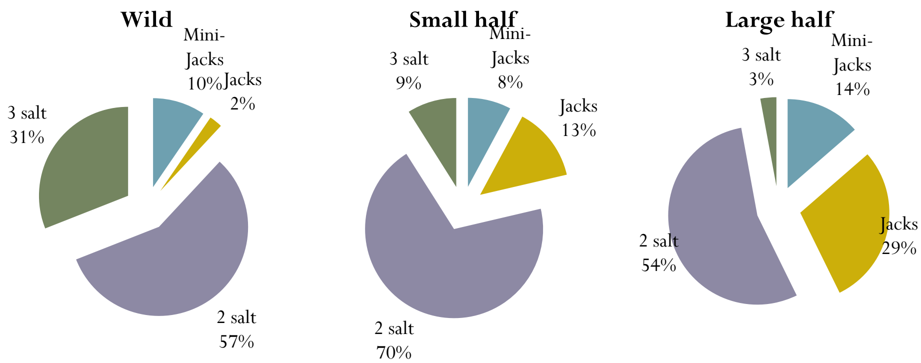
1

Summary of analyses to date

- No apparent benefit in larger hatchery smolts
- Apparent drawback in larger hatchery smolts
- Smaller hatchery smolts perform more similarly to wild fish
  - No effect on female returns

2

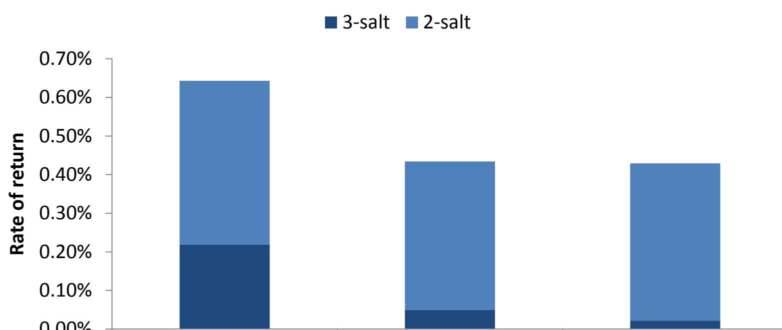
Proportion of age classes by group



12% < 2 salt fish **21% < 2 salt fish** **43% < 2 salt fish**

3

Average returns from Chiwawa R.

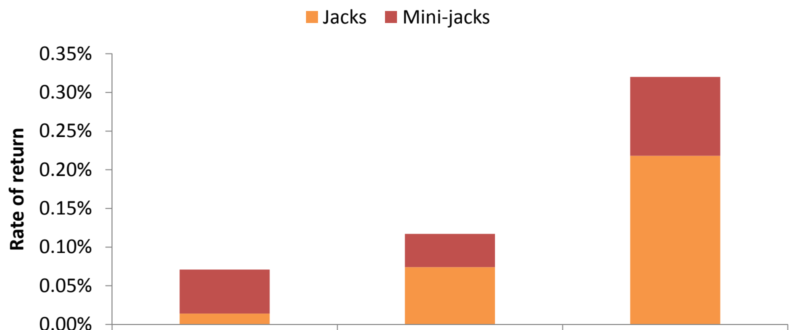


	Wild	Hatchery (small)	Hatchery (large)
2-salt	0.42%	0.38%	0.41%
3-salt	0.22%	0.05%	0.02%

Group

4

Average returns from Chiwawa R.

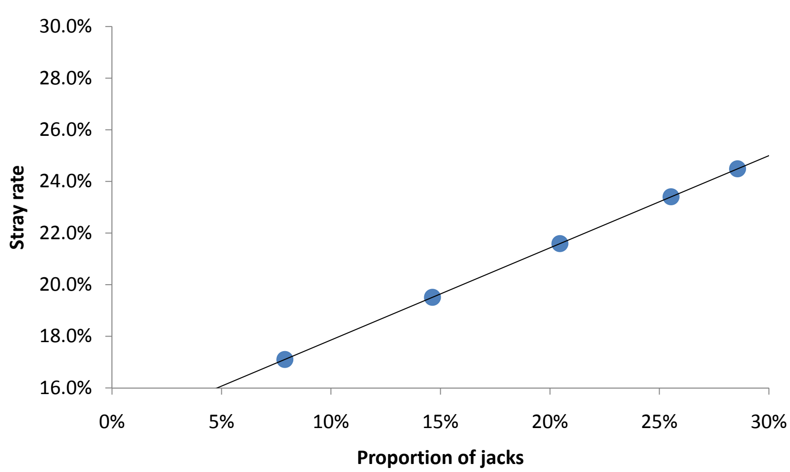


	Wild	Hatchery (small)	Hatchery (large)
Mini-jacks	0.06%	0.04%	0.10%
Jacks	0.01%	0.07%	0.22%

Group

5

Stray rates

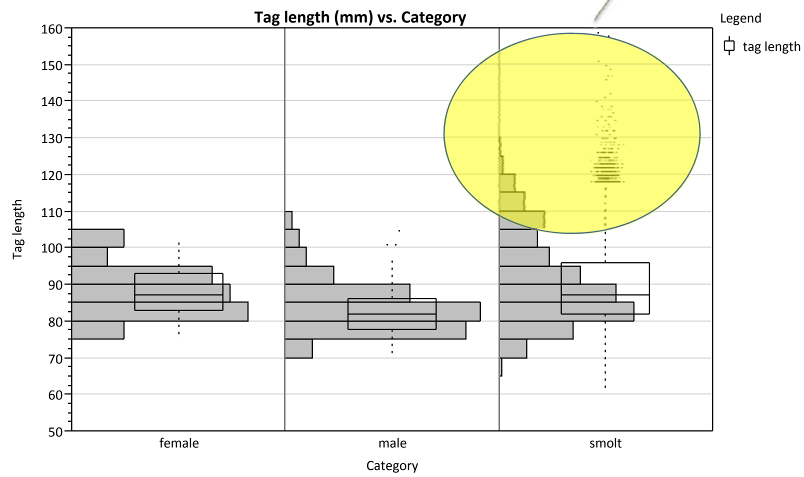


6

Data from A. Murdoch, WDFW

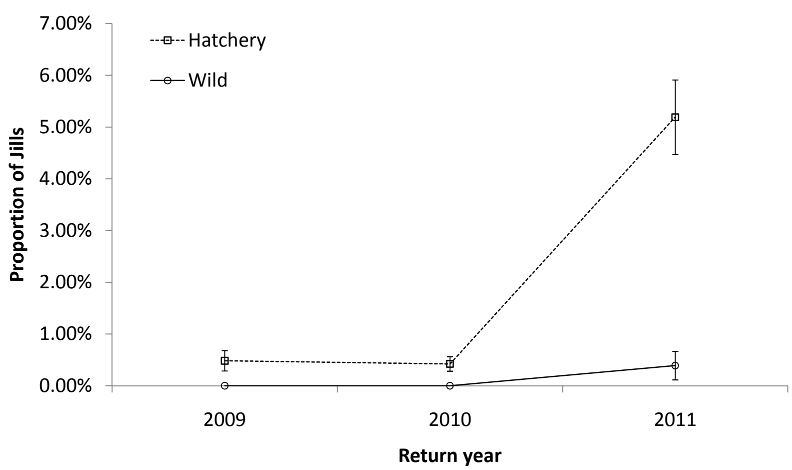
Female returns

Larger smolts do not contribute to adult returns



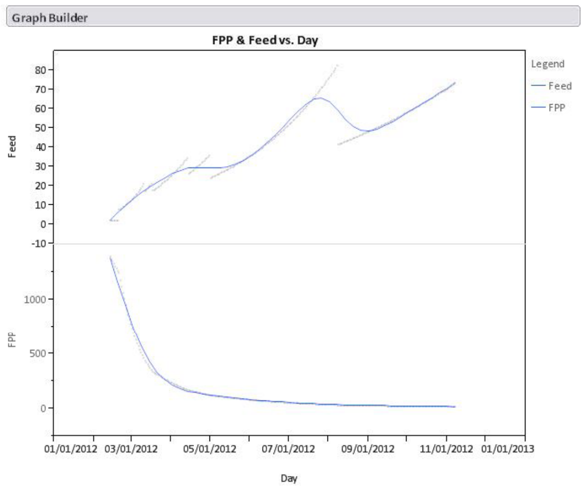
7

Jill rates



8

Feed schedule



9

Implications

- Mimic wild populations
- Maximize age at return
- Minimize stray rates
- PNI goals for the Wenatchee
- Consistent with M&E results and NOAA recommendations

10

Questions?

11

Rock Island and Rocky Reach HCP Hatchery Committees

Statement of Agreement

Chelan PUD Spring Chinook Compensation, Release Year 2014

Approved January 19, 2012

Statement

The Rock Island and Rocky Reach Habitat Conservation Plans' (HCP) Hatchery Committees (HC) approve Chelan PUD meeting its 2014 spring Chinook mitigation obligation through production of 204,542 smolts at the Chiwawa Acclimation Ponds in lieu of production requirements in the Methow River, contingent on the Methow River production (60,516) being produced by another entity (i.e., "backfilled"). This represents No Net Impact obligations for both the Wenatchee (144,026) and Methow (60,516) rivers, per the December 14, 2011 recalculation SOA.

Background

Potential delays to the Grant PUD-funded Nason Creek facility may preclude the full Wenatchee River Basin spring Chinook production scheduled for release in 2014. In order to maintain production targets, Grant PUD has proposed to backfill the Methow Program. This arrangement will allow Chelan PUD to reallocate it's Methow River spring Chinook production requirement to the Chiwawa Hatchery for release year 2014 to maintain the total production target for the Wenatchee River Basin.

APPENDIX G – WELLS BULL TROUT MONITORING AND MANAGEMENT PLAN ANNUAL REPORT

BULL TROUT MONITORING AND MANAGEMENT PLAN
2011 ANNUAL REPORT

WELLS HYDROELECTRIC PROJECT

FERC PROJECT NO. 2149

March 28, 2012

Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

For copies of this Annual Report, contact:

Public Utility District No. 1 of Douglas County
Attention: Natural Resources
1151 Valley Mall Parkway
East Wenatchee, WA 98802-4497
Phone: (509) 884-7191

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EXECUTIVE SUMMARY

The goal of the Wells Hydroelectric Project (Wells Project) Bull Trout Monitoring and Management Plan (Bull Trout Plan) is to identify, develop, and implement measures to monitor and address potential project-related impacts on bull trout (*Salvelinus confluentus*) associated with the operations of the Wells Project and associated facilities (Douglas PUD 2004). The Bull Trout Plan was prepared and is implemented to meet monitoring requirements stipulated in a U.S. Fish and Wildlife Service (USFWS) Biological Opinion (USFWS 2004) regarding implementation of the Wells Project Anadromous Fish Agreement and Habitat Conservation Plan (Wells HCP). The USFWS Biological Opinion monitoring requirements were also incorporated by the Federal Energy Regulatory Commission (FERC) into the existing Wells Project license in 2004. The Bull Trout Plan was developed in collaboration with the USFWS, National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), the Colville Confederated Tribes, and the Yakama Nation, and was approved by the FERC. The Bull Trout Plan has four objectives, addressed by carrying out various field study components from 2004 to 2008 at the Wells Project.

In accordance with Article 62 of the FERC license for the Wells Project, Public Utility District No. 1 of Douglas County (Douglas PUD) is required to prepare and file with the Commission an annual report describing the activities required by the Bull Trout Plan. In December 2008, Douglas PUD filed with the FERC, a final comprehensive report summarizing the results of all activities conducted under the Bull Trout Plan between January 2005 and July 2008.

In a letter to the FERC on December 29, 2008, Douglas PUD requested that the 2008 annual report filing (due March 31, 2009) be eliminated and instead include all remaining 2008 activities (August to December 2008) within the 2009 annual report that was filed with the FERC on March 31, 2010. In a letter dated February 3, 2009 the FERC approved Douglas PUD's request. The 2009 annual report was submitted in March of 2010, and included both the results of those additional activities conducted in 2008 that were not included in the Bull Trout Plan 2005-2008 Final Report (LGL and Douglas PUD, 2008) and the ongoing Bull Trout Plan activities that were conducted in 2009. In March 2011, the 2010 annual was submitted to FERC.

The enclosed annual report is a comprehensive summary of the bull trout research, monitoring and evaluation (M&E) efforts that took place during calendar year 2011.

Four adult bull trout were incidentally captured at Wells Dam during Chinook brood collection activities in the spring of 2011. All of these fish were PIT-tagged and subsequently released back into the fishways to continue their upstream migration. One of these fish was later detected at the Twisp River PIT tag interrogation location on October 12, 2011. Another fish PIT-tagged at Wells was released and detected at the Gold Creek interrogation station on September 28, 2011. The other two adult bull trout tagged at Wells Dam in 2011 have not been detected to date. This outcome is not surprising given the low detection probabilities for the riverine PIT-tag detection arrays, especially during the spring freshet.

One of the five fish PIT-tagged at Wells in 2010, during brood collection activities, was detected in the Twisp River on July 5th and again in the lower Methow River on October 4th of 2010. In

2011, this fish was detected at Rocky Reach and then at Wells Dam in early and mid-July, respectively. Together, this fish appeared to make a spawning migration to the Twisp River in 2010, exited the Methow in the fall of 2010, successfully passed downstream through Wells and Rocky Reach between October 2010 and July 2011, followed by successful accents at both of these projects in July 2011.

Thirty-six adult bull trout (>440 mm) were captured by the PUD's contractor at the Twisp Weir in 2011. Twenty-six of these fish did not have a PIT tag and were given one. Seven of these 36 fish were fish captured and tagged in 2010 and 3 were fish captured twice in 2011. DNA samples were taken from adults captured at the Twisp River Weir in 2010 and 2011. These DNA samples will be passed along to the USFWS for future micro satellite analysis.

Bull trout behavior within the Methow Basin during 2011 remained similar to previous years; however, fewer PIT-tag detections were recorded in the spring of 2011 due to a protracted spring freshet that damaged many of the PIT-tag detection arrays and significantly reduced the detection efficiencies the few remaining interrogation sites. Similarly, bull trout encounters at the Twisp Weir were also down in 2011 when compared to prior years. The historically high flows in 2011 prevented the weir from being operated for almost two months because river flows exceeded the operational tolerance of the weir. As in past years, adult bull trout were detected migrating upstream into the Twisp River in the spring (May and June). After spawning in August and September, a consistent downstream migration was exhibited by adults moving out of the Twisp River and into the lower Methow and Wells reservoir.

Counts of bull trout passing Wells Dam in 2011 remained similar to counts collected during 2008 through 2010, but showed a slight increase in observations. Adult bull trout counts at the Wells Project were 43, 43, 44 and 66 respectively for the years 2008 through 2011. Off-season fishway video monitoring continues to indicate that bull trout are not passing Wells Dam during January to April. In late December 2011 two bull trout were salvaged in the east fish ladder during maintenance activities. During 2011, 97% (64 of 66) of the bull trout passing through Wells Dam fish ladders did so during the months of May through July, with the last observation in early November 2011. This timing is consistent with past years, and indicates bull trout passage at the dam is largely a seasonal migration independent of Project operations.

To date, no sub-adult bull trout have been observed in Wells Dam fishways. After reviewing video of the 66 bull trout that were observed in the fish ladders in 2011, all of these fish were classified as adults. These fish had an average estimated total length of 21 inches and ranged from 15-28 inches (380-710 mm). In August 2011 a Methow Core Area (MCA), PIT tagged (2010) sub-adult bull trout was detected at the Rocky Reach bypass facility and was therefore moving downstream. This fish was 170 mm (7 inches) when tagged in August 2010, suggesting that it may have been a sub-adult at the time it passed Wells Dam (sometime before August 29th 2011). To date, over 100 sub-adult bull trout have been PIT tagged in the MCA by Douglas PUD contractors. The 2011 detection would be the first confirmed MCA sub-adult observed at a mid-Columbia project. This preliminary data suggests that sub-adults in the MCA stay close to their natal habitats relative to adult conspecifics.

Incidental captures of sub-adult bull trout by Douglas PUD's hatchery monitoring and evaluation screw traps were consistent with previous years. Twenty-one sub-adult bull trout were captured in the Twisp River (six year average = 20.1). Two sub-adult bull trout were captured in the Methow River screw trap (six year average = 1.8). DNA samples were taken from all of these fish. Alex Repp (WDFW, Biologist) is the current custodian of these samples. DNA samples from previous years are being held by the WDFW and the USFWS for future analyses. Additional incidental captures of sub-adult bull trout took place by Douglas PUD contractors conducting hook and line, backpack electroshocking and netting for residual steelhead in the Methow Basin. A total of 14 bull trout were incidentally captured with this gear in 2011. All of these fish were subsequently PIT-tagged and released unharmed (Charlie Snow, pers. comm.). Tag codes for all PIT-tagged fish were uploaded to the PTAGIS database.

Douglas PUD biologists conducted a bull trout stranding survey in the Wells project on June 10th 2011, following operations at the project that lowered the reservoir below 773 feet above mean sea level (MSL). No bull trout were observed during this sampling. Past stranding and entrapment surveys have indicated that infrequent Project operations that result in lowering of the reservoir have not impacted adult or sub-adult bull trout in the Wells Project.

In accordance with Article 63 of the Wells Dam operating license, Douglas PUD continued participation in the development of a bull trout recovery plan with regional USFWS authorities. This participation included attending June 29th 2011 and August 29th 2011 recovery planning meetings and data sharing at the request of the USFWS. Douglas PUD will participate in the review of the Bull Trout Recovery Plan following its release in the spring of 2012.

In early 2011 the USFWS initiated an ESA Section 7 consultation on the proposed relicensing of the Wells Project. This consultation was concluded on March 16th 2012 when the USFWS issued a final Biological Opinion and Incidental Take Statement for the relicensing of the Wells Project. Douglas PUD provided the USFWS with biological data and information related to this consultation

1.0 INTRODUCTION

In August 1993, Douglas, Chelan, and Grant Public Utility Districts (collectively, "mid-Columbia PUDs") initiated discussions to develop a long-term, comprehensive program for managing fish and wildlife that inhabit the mid-Columbia River basin (the portion of the Columbia River from the tailrace of Chief Joseph Dam to the confluence of the Yakima and Columbia rivers). After an extensive review, the negotiating parties determined that the best basin-wide approach would be to develop an agreement for anadromous salmonids, specifically: spring and summer/fall Chinook salmon (*Oncorhynchus tshawytscha*); sockeye salmon (*O. nerka*); coho salmon (*O. kisutch*); and steelhead (*O. mykiss*) (collectively, "Plan Species") which are under the jurisdiction of the National Marine Fisheries Service (NMFS).

On July 30, 1998, Public Utility District No. 1 of Douglas County (Douglas PUD) submitted an unexecuted form of an Application for Approval of the Wells Project Anadromous Fish Agreement and Habitat Conservation Plan (Wells HCP) to the Federal Energy Regulatory Commission (FERC) and NMFS. To expedite the FERC's completion of formal consultation, Douglas PUD prepared a biological evaluation of the effects of implementing the Wells HCP on listed species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS).

In a letter to the FERC, the USFWS requested consultation under Section 7 of the Endangered Species Act (ESA) regarding the effects of hydroelectric project operations on bull trout in the Columbia River (letter from M. Miller, USFWS, to M. Robinson, FERC, dated January 10, 2000). The request for consultation was based on observations of bull trout in the study area. In its reply to the USFWS, the FERC noted that there was virtually no information on bull trout in the mainstem Columbia River. To begin to address this information gap, an initial radio-telemetry study of bull trout in the mid-Columbia basin was requested by USFWS in 2000 and implemented from 2001 to 2004 by Douglas, Chelan, and Grant PUDs (BioAnalysts, Inc. 2004).

On November 24, 2003, Douglas PUD filed an application with the FERC for approval of the executed Wells HCP. The 2003 application for approval replaced the 1998 application with the executed form of the Wells HCP. On December 10, 2003, the USFWS received a request from the FERC for formal Section 7 ESA consultation to determine whether the proposed incorporation of the Wells HCP into the FERC license for Wells Hydroelectric Project (Wells Project) operations was likely to jeopardize the continued existence of the Columbia River ESA-listed bull trout, or destroy or adversely modify proposed bull trout critical habitat. In response to the FERC request, the USFWS issued a Biological Opinion (BO) pursuant to Section 7 of the ESA to assess the effects of implementing the HCP on bull trout and other listed species under the jurisdiction of the USFWS. The BO included an Incidental Take Statement outlining reasonable and prudent measures (RPMs) and associated terms and conditions to monitor and limit bull trout take at the Wells Project. On June 21, 2004, the FERC issued orders amending the license for the Wells Project to implement the terms of the Wells HCP. The FERC incorporated the USFWS bull trout RPMs and terms and conditions into the existing Wells Project license, which are detailed in license articles 61, 62, and 63.

Article 61 of the license requires Douglas PUD to file with the FERC a Bull Trout Plan for implementing the USFWS bull trout RPMs and terms and conditions, which were designed to monitor and limit bull trout take associated with Wells Project operations. Article 61 further requires that Douglas PUD prepare the Bull Trout Plan in consultation with the USFWS, NMFS, Washington Department of Fish and Wildlife (WDFW), and interested Indian Tribes (Colville Confederated Tribes and the Yakama Nation). Following consultation with these stakeholders, on February 28, 2005, Douglas PUD filed with the FERC the "*Wells Hydroelectric Project Bull Trout Monitoring and Management Plan, 2004-2008"* (Douglas PUD 2004), which is referred to as the "Bull Trout Plan" in this document. The Bull Trout Plan was approved by the FERC on April 19, 2005.

Article 62 of the license requires Douglas PUD to prepare and file with the FERC an annual report of the status of activities required by the Bull Trout Plan. On March 26, 2008, Douglas PUD with approval from USFWS filed a request for an extension of time to submit the 2007 annual bull trout monitoring report and to consolidate the 2007 annual report with the final bull trout monitoring report, required to be filed with the FERC by December 31, 2008. On April 16, 2008, the FERC issued an order granting this request and per the order, Douglas PUD filed with the FERC a 2005-2008 final monitoring report that summarized all data collected to meet the Bull Trout Plan objectives outlined in the USFWS bull trout RPMs and terms and conditions, and the Wells Project license articles 61 and 62.

The next reporting deadline associated with the Bull Trout Plan was March 31, 2009 (2008 Annual Report). However, because the 2005-2008 final report contained bull trout monitoring activities for most of 2008, Douglas PUD requested and was granted permission, via the FERC's April 16, 2008 letter to Douglas PUD, to eliminate the March 2009 filing of the 2008 Annual Report and instead include all remaining 2008 activities within the 2009 annual report**.** The former document was submitted in March of 2010, which summarized the results of those additional activities conducted in 2008 that were not completed in time for inclusion into the Bull Trout Plan 2005-2008 Final Report (LGL and Douglas PUD 2008) and the ongoing Bull Trout Plan activities that were conducted in 2009. In March of 2011 the 2010 annual report was submitted to the FERC. The following document serves as the 2011 annual report (filed with the FERC in March 2012). As in previous years the 2011 report is a comprehensive summary of all the bull trout research over the last 11 years, but is focused largely on the monitoring and evaluation efforts conducted during 2011.

Article 63 was a reservation of authority by the FERC to require the licensee to carry out specified measures for the purpose of participating in the development and implementation of a bull trout recovery plan. The USFWS continued bull trout recovery planning in 2011. In response to compliance with article 63 of the Wells Project license, Douglas PUD has and will continue to participate in the development of future recovery planning documents for bull trout.

Over the last five years Douglas PUD has worked closely with stakeholders to relicense Well Dam. As part of this process the FERC requested ESA consultation from the USFWS on the Wells Project relicensing application, which included a series of new aquatic, wildlife, avian, botanical, historic property and recreation management plans, in addition to the plans already contained within the Wells HCP. In 2011 the USFWS initiated an ESA Section 7 consultation, requested by the FERC, as part of the relicensing of the Wells Project

2.0 GOALS AND OBJECTIVES

The goal of the Bull Trout Plan is to identify, develop, and implement measures to monitor and address potential project-related impacts on bull trout from Wells Project operations and facilities. The Bull Trout Plan was intended to be an adaptive approach, where strategies for meeting the goals and objectives may be negotiated under a collaborative effort with stakeholders based on new information and ongoing monitoring results. The plan was designed specifically to: (1) address ongoing project-related impacts through the life of the existing operating license; (2) provide consistency with recovery actions as outlined in the USFWS Draft Bull Trout Recovery Plan; and (3) monitor and minimize the extent of any incidental take of bull trout consistent with Section 7 of the ESA.

The Bull Trout Plan has four main objectives: (1) identify potential project-related impacts on upstream and downstream passage of *adult* bull trout through the Wells Dam and reservoir and implement appropriate measures to monitor any incidental take of bull trout; (2) assess project-related impacts on upstream and downstream passage of *sub-adult* bull trout; (3) investigate the potential for bull trout entrapment or stranding in off-channel or backwater areas of Wells Reservoir; and (4) identify the core areas and local populations, as defined in the USFWS Draft Bull Trout Recovery Plan, for the bull trout that utilize the Wells Project Area.

Activities designed to support some objectives in the Bull Trout Plan were only intended to be conducted in the early phases of plan implementation (i.e., radio-tagging of bull trout at Wells Dam between 2005-2008 and comprehensive incidental take calculation for monitoring years 2001-2004 and 2005-2008). The results of these activities can be found in the Bull Trout Plan 2005-2008 Final Monitoring Report (LGL and Douglas PUD 2008) and are considered completed tasks with the filing of that final report. For the purposes of continued annual reporting per Article 62, only ongoing Bull Trout Plan activities are reported herein.

Below is a brief summary of the Bull Trout Plan objectives. A more detailed strategic framework to implement each objective is summarized in the Bull Trout Plan 2005-2008 Final Monitoring Report (LGL and Douglas PUD 2008).

2.1 Objective 1 - Adult Bull Trout Passage Monitoring

Strategy 1-1: Implement an adult bull trout telemetry program to monitor adult upstream and downstream passage in the Wells Project Area and implement appropriate measures to monitor any incidental take of bull trout.

Strategy 1-2: Analyze passage results and operational data to determine if correlations exist between passage times and passage events and project operations.

Strategy 1-3: Determine off-season adult bull trout passage through the adult fishway (numbers and times of year) at Wells for an experimental period 2004-2005. Per request by the USFWS, off-season fishway monitoring for adult bull trout passage has continued to date.

Strategy 1-4: Should upstream or downstream passage problems be identified, pursue the feasibility of options to modify upstream passage facilities or operations that reduce the impact to bull trout passage.

2.2 Objective 2 - Sub-adult Bull Trout Passage Monitoring

Strategy 2-1: The stakeholders agree at this time[1] that because of the inability to collect a sufficient sample size of sub-adult bull trout, it is not feasible to assess sub-adult passage at Wells. However, when encountered at the Wells Project, or in tributary traps, sub-adult bull trout will be PIT-tagged.

Strategy 2-2: Determine off-season sub-adult bull trout passage through the adult fishway (numbers and times of year) at Wells for an experimental period from 2004 to 2005. Per request by the USFWS, off-season fishway monitoring for sub-adult bull trout passage has continued to date.

2.3 Objective 3 - Bull Trout Entrapment and Stranding Evaluation

Strategy 3-1: Evaluate Wells inflow patterns, reservoir elevations, and backwater curves to determine if stranding or entrapment of bull trout may occur.

2.4 Objective 4 - Identification of Core Area and Local Populations of Bull Trout that Utilize the Wells Project Area

Strategy 4-1: Gather genetic samples from radio-tagged and PIT-tagged bull trout for comparison to baseline genetic samples from local populations and core areas.

Strategy 4-2: Work cooperatively with other agencies to obtain locations of radio-tagged fish outside the Project area.

3.0 STUDY AREA

3.1 Wells Bull Trout Plan Study Area

The study area for this report included all waters within the Wells Project, including the lower Okanogan and Methow rivers, the Wells Reservoir, Wells Dam, and Wells Tailrace, downstream to the “Gateway” location set at approximately 3 miles downstream from Wells Dam. Additional monitoring also took place at downstream hydroelectric projects and other accessible reaches of the mid-Columbia Basin including the Methow, Wenatchee, Entiat, and Okanogan rivers. PIT tagging activities also occurred in the Methow and Twisp rivers.

[1] At the time that the Bull Trout Plan was prepared in 2004.

3.2 General Description of the Wells Hydroelectric Project Area

The Wells Project is located at river mile (RM) 515.6 on the Columbia River in the State of Washington. Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Hydroelectric Project, owned and operated by the United States Army Corps of Engineers (COE), and 42 miles upstream from the Rocky Reach Hydroelectric Project owned and operated by Public Utility District No. 1 of Chelan County (Chelan PUD). The nearest town is Pateros, Washington, located approximately 8 miles upstream from the Wells Project at the mouth of the Methow River.

The Wells Project is the chief generating resource for Douglas PUD. It includes 10 generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Fish passage facilities reside on both sides of the hydrocombine, which is 1,130 feet long, 168 feet wide, with a crest elevation of 795 feet mean sea level (msl) in height.

The Wells Reservoir is approximately 30 miles long. The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends approximately 1.5 miles up the Methow River and approximately 15.5 miles up the Okanogan River. The normal maximum surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre-feet at elevation of 781 feet msl. The normal maximum water surface elevation of the reservoir is 781 feet msl (Figure 3.2-1).

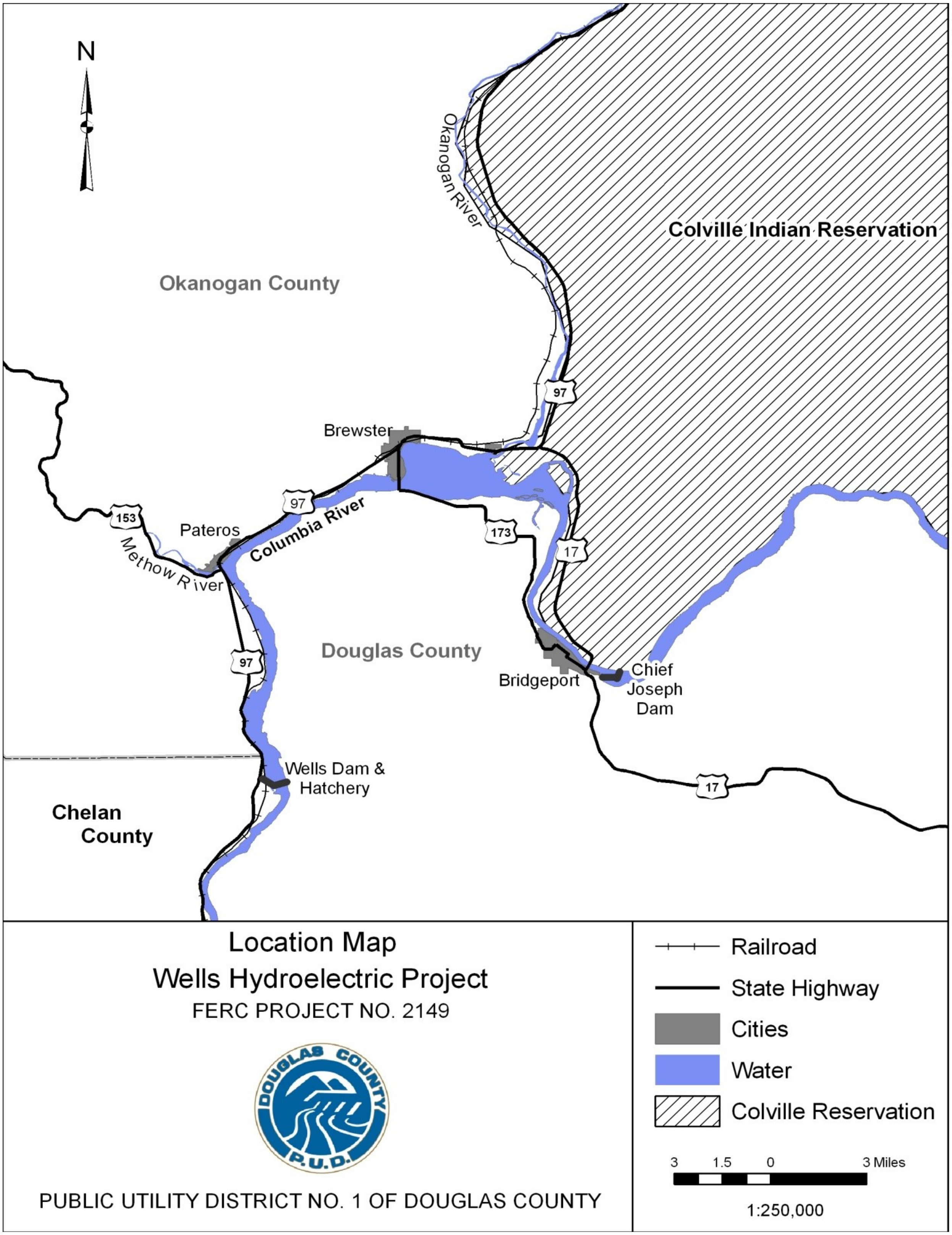

Figure 3.2-1 Location map of the Wells Project.

4.0 BACKGROUND AND EXISTING INFORMATION

4.1 Bull Trout Biology

Bull trout are native to northwestern North America, historically occupying a large geographic range extending from California north into the Yukon and Northwest Territories of Canada, and East to Western Montana and Alberta (Cavender 1978). They are generally found in interior drainages, but also occur on the Pacific Coast in Puget Sound and in the large drainages of British Columbia.

Bull trout currently occur in lakes, rivers and tributaries in Washington, Montana, Idaho, Oregon (including the Klamath River basin), Nevada, two Canadian Provinces (British Columbia and Alberta), and several cross-boundary drainages in extreme southeast Alaska. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta, and the Mackenzie River system in Alberta and British Columbia (Cavender 1978; McPhail and Baxter 1996; Brewin and Brewin 1997). The remaining distribution of bull trout is highly fragmented.

Bull trout are a member of the char group within the family Salmonidae. Bull trout closely resemble Dolly Varden (*Salvelinus malma*), a related species. Genetic analyses indicate, however, that bull trout are more closely related to an Asian char (*Salvelinus leucomaenis*) than to Dolly Varden (Pleyte et al. 1992). Over part of their range, bull trout are sympatric with Dolly Varden; most notably in British Columbia and a small portion of the Coastal-Puget Sound region of Washington State.

Bull trout are believed to have more specific habitat requirements than other salmonids (Rieman and McIntyre 1993). Growth, survival, and long-term persistence are dependent upon habitat characteristics such as clean, cold, connected, and complex instream habitat (USFWS et al. 2000), and stream/population connectivity. Stream temperature and substrate type, in particular, are critical factors for the sustained long-term persistence of bull trout. Spawning is often associated with the coldest, cleanest, and most complex stream reaches within basins. However, bull trout may exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1995), and should not be expected to occupy all available habitats at the same time (Rieman et al. 1997).

Bull trout exhibit four distinct life history types: resident, fluvial, adfluvial, and anadromous. The fluvial, adfluvial, and resident forms exist throughout the range of the bull trout (Rieman and McIntyre 1993), although each form is not present everywhere. The anadromous life history form is currently known only to occur in the Coastal-Puget Sound region within the coterminous United States (Mongillo 1993; Kraemer 1994; McPhail and Baxter 1996; Volk 2000). Multiple life history types may be expressed in the same population, and this diversity of life history types is considered important to the stability and viability of bull trout populations (Rieman and McIntyre 1993).

The majority of growth and maturation for anadromous bull trout occurs in estuarine and marine waters, adfluvial bull trout in lakes or reservoirs, and fluvial bull trout in large river systems.

Resident bull trout populations are generally found in small headwater streams where fish remain their entire lives. Sexually mature resident bull trout are often much smaller at maturation than sexually mature adults of other life histories (McPhail and Baxter 1996).

For migratory life history types, juveniles tend to rear in tributary streams for 1 to 4 years before migrating downstream into a larger river, lake, or estuary and/or nearshore marine area to mature (Rieman and McIntyre 1993). In some lake systems, age 0+ fish (less than 1 year old) may migrate directly to lakes, but it is unknown if this emigration is a result of density dependent effects from limited stream rearing habitat, or if these young-of-the-year actually survive in the lake environment (Riehle et al. 1997). Juvenile bull trout in streams frequently inhabit side channels, stream margins and pools with suitable cover (Sexauer and James 1993) with maximum summer water temperatures generally less than 16ºC (Dunham et al. 2003) and areas with cold hyporheic zones or groundwater upwellings (Baxter and Hauer 2000).

4.2 Status

On June 10, 1998, the USFWS listed bull trout within the Columbia River basin as threatened under the ESA (FR 63(111)). Later (November 1, 1999), the USFWS listed bull trout within the coterminous United States as threatened under the ESA (FR 64(210)). The USFWS identified habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, and grazing; blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species as major factors affecting the distribution and abundance of bull trout. They noted that dams (and natural barriers) have isolated population segments resulting in a loss of genetic exchange among these segments (FR 63(111)). The USFWS believes many populations are now isolated and disjunct. In October 2002, the USFWS completed the first draft of a bull trout recovery plan intended to provide information and guidance that will lead to recovery of the species, including its habitat (USFWS 2002). The USFWS anticipates releasing a recovery planning document in the spring of 2012 (Judy Neibauer, Personal Communication, February 8, 2012). Threatened bull trout population segments are widely distributed over a large area and because population segments were subject to listing at different times, the USFWS adopted a two-tiered approach to develop the draft recovery plan for bull trout (USFWS 2002). In November 2002, the USFWS published in the federal register a proposed rule for the designation of critical habitat for the Klamath River and Columbia River distinct population segments of bull trout (67 FR 71235). In October 2004, the USFWS published a final rule in the Federal Register designating critical habitat for the Klamath River and Columbia River populations of bull trout (69 FR 59995). After legal challenge, the designation was expanded and new critical habitat was proposed throughout the range of bull trout in January 14, 2010 (75 FR 2270), including all of the Wells Project waters except the Okanogan River.

In April 2008, the USFWS completed the 5-year status review for Columbia River bull trout with two recommendations: maintain "threatened" status for the species, and determine if multiple distinct population segments exist within the Columbia River that merit protection under the ESA. The recommendations intend to facilitate analysis of project effects over more specific and biologically appropriate areas, ultimately allowing a greater focus of regulatory protection and recovery resources (USFWS 2008a). The review also identified specific issues that limit the overall ability to accurately and quantitatively evaluate the current status of bull trout. Seven recommendations were made to improve future evaluation and management decisions, all of which are largely based on improvement and standardization of monitoring and evaluation techniques, better delineation and agreement of core areas and Recovery Units, and multi-agency cooperation and management (USFWS 2008b).

The Wells Project is situated within the Upper Columbia River Recovery Unit[2] and the USFWS has identified the Wenatchee, Entiat, and Methow rivers as its core areas. A core area represents the closest approximation of a biologically functioning unit for bull trout. A core area may function as a metapopulation for bull trout. Not all core areas are equal and each has specific functions that are unique. For example, the Entiat Core Area depends heavily on the mainstem Columbia River to provide overwintering, migration, and foraging habitats. The Wenatchee Core Area has populations using lake and riverine habitat (both the Wenatchee and Columbia rivers) for overwintering, migration, and foraging. Within a core area, many local populations may exist. A local population is assumed to be the smallest group of fish that is known to represent a regularly interacting reproductive unit. Sixteen local populations have been identified in the Wenatchee (6), Entiat (2), and Methow (8) core areas (USFWS 2002). However, little genetic information currently existed at the end of 2011, which identifies local populations by genetic means. As part of Douglas PUD's Bull Trout Monitoring and Management Plan, Douglas PUD has provided the USFWS with genetic samples to facilitate this process.

4.3 2001-2004 Mid-Columbia Bull Trout Radio-telemetry Study

Bull trout have been counted at Wells Dam since 1998. In 2000, due to the potential for operations at mid-Columbia dams to affect the movement and survival of bull trout, the USFWS requested that the three mid-Columbia PUDs evaluate the movement and status of bull trout in their respective project areas. At that time, little was known about the behavior, migratory characteristics and habitat use of bull trout in the mid-Columbia River. Therefore, to assess the operational effects of hydroelectric projects on bull trout within the mid-Columbia, a three PUD coordinated radio-telemetry study was implemented beginning in 2001. The goal of the study was to monitor the movements and migration patterns of adult bull trout in the mid-Columbia River using radio-telemetry (Figure 4.3-1) to address the information deficit. The number of bull trout to be collected and tagged at each dam (Rock Island, Rocky Reach, and Wells) was based on the proportion of fish that migrated past those dams in 2000.

From 2001 to 2003, bull trout were collected from the Wells, Rocky Reach, and Rock Island dams, radio-tagged, and monitored through 2004. Multiple-telemetry techniques were used to assess the movement and behavior of tagged bull trout within the study area. At Wells Dam, a combination of aerial and underwater antennas was deployed. The primary purpose for this system was to document the presence of bull trout at the project, identify passage times and

[2] Note that while the USFWS refers to the area encompassing the Wells Project as the Upper Columbia Recovery Unit for bull trout, the section of the Columbia River from Chief Joseph Dam to the confluence of the Yakima and Columbia rivers is often termed the "mid-Columbia" for other purposes, and is the term used in this document when referring to the reach.

determine their direction of travel (i.e., upstream/downstream). In addition to these systems, a number of additional telemetry systems were deployed to address specific questions posed by the USFWS and Douglas PUD. At Wells Dam, several additional systems were installed to identify whether tagged bull trout could enter, ascend, and exit specific gates and fish ladders. All possible access points to the adult fish ladders and the exits were monitored individually during the study period from 2001-2004, allowing the route of passage to be determined as well as the ability to establish the exact time of entrance and exit from the ladder system.

To assess bull trout movements into and out of the Wells Reservoir, fixed-telemetry monitoring sites were established at the mouth of the Methow and Okanogan rivers and periodic aerial telemetry surveys were conducted on the reservoir and throughout both watersheds (English et al. 1998, 2001). English et al. (1998, 2001) provide a detailed description of the telemetry systems at each of the dams and within the tributaries.

Successful bull trout upstream and downstream passage was observed at the Wells Project. In addition, no bull trout injury or mortality was observed associated with the Wells Project. Radio-tagged bull trout that migrated upstream past Wells Dam used the Methow River subbasin during the bull trout spawning period. Key findings of the 2001 to 2004 study are used in this document to assess the 6-year average take analysis as stipulated in the Bull Trout Plan (Objective 1, Strategy 1-1) and are summarized in the results section of this document.

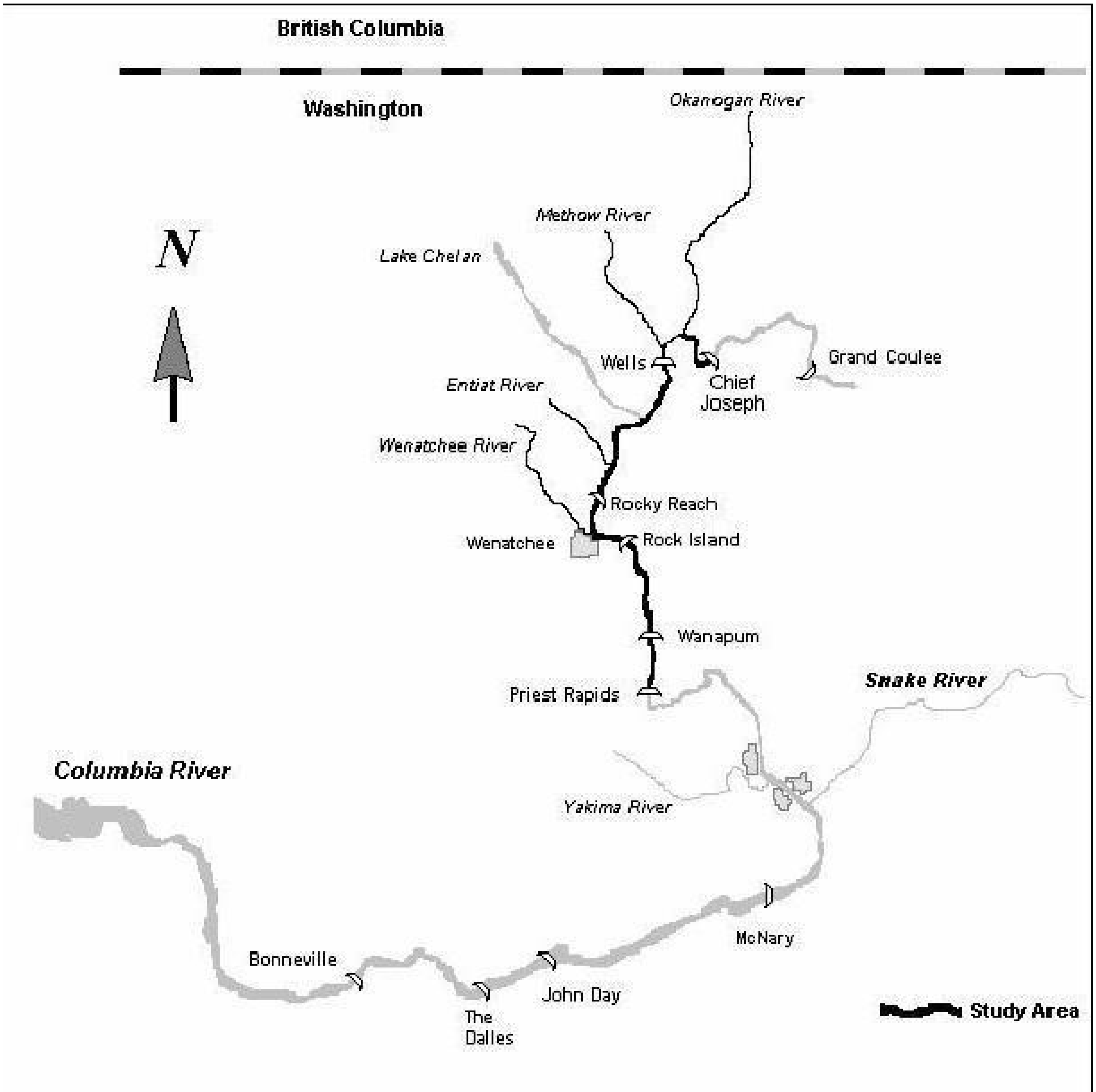

Figure 4.3-1 Study area for assessing migration patterns of bull trout in the mid-Columbia River (2001-2004).

4.4 2005-2008 Bull Trout Monitoring and Management Plan Activities

The goal of the Wells Project Bull Trout Plan is to identify, develop, and implement measures to monitor and address potential project-related impacts on bull trout associated with the operations of the Wells Project and associated facilities (Douglas PUD 2004). The Bull Trout Plan has four objectives, addressed by implementing various field study components from 2004 to 2008 at the Wells Project.

The first objective was to identify potential project-related impacts on upstream and downstream passage of adult bull trout (fish ≥ 400 mm in length) through Wells Dam and reservoir, and implement appropriate measures to monitor any incidental take of adult bull trout. To meet the first objective, radio-telemetry was used to monitor upstream and downstream passage, and off-season video counting was done in the Wells Project fishways during the winter. Between 2005 and 2008, 26 adult bull trout were trapped at Wells Dam and radio-tagged. Concurrent with the implementation of the Bull Trout Plan, the USFWS and Chelan PUD radio-tagged and released 136 adult bull trout at other mid-Columbia River basin locations including the Methow River, and Rock Island and Rocky Reach dams (50 USFWS tags 2006-2008, 86 Chelan PUD tags 2005-2007).

From 2005 to 2008, 25 downstream passage events and 52 upstream passage events by 40 individual bull trout were recorded at Wells Dam. Of these, 17 downstream and 41 upstream passage events occurred within one year of tagging and release. Of all tags released from 2001 to 2004, there were 2 downstream passage events and 41 upstream passage events. Of these, 2 downstream and 38 upstream passage events occurred within one year of release date. The take estimates for the Wells Project were based upon the number of unique upstream and downstream passage events that took place within one year of each bull trout being tagged and released. During the six-year study and eight years of monitoring, 19 downstream and 79 upstream passage events took place at Wells Dam by radio-tagged bull trout within one year of release date. Taking into account all observed passage events a total of 27 downstream and 93 upstream passage events took place at Wells Dam. Radio-tagged bull trout passed downstream through the turbines or spillways as no downstream passage events were recorded via the fishways. Out of the 19 downstream passage events that occurred within one year of tagging, zero bull trout injury or mortality was observed at the Wells Project. Out of the 79 upstream passage events that occurred within one year of tagging, zero bull trout injury or mortality was observed at the Wells Project.

Upstream passage of adult bull trout through the fish ladders at Wells Dam has historically occurred between early May and late October, with peak passage typically occurring in May and June. During the 2005 and 2008 study, 214 adult bull trout were counted passing upstream through Wells Dam. The proportion of the bull trout population at Wells Dam that was radio-tagged was 24% (52/214 = 0.24).

Project operations did not appear to influence the movements of adult bull trout. Instead, adult bull trout passage events appeared to be more closely associated with water temperature, photoperiod and time of year with rather predictable patterns of upstream and downstream movement (LGL and Douglas PUD 2007; 2008). Because no take (injury or mortality) was observed during the study, there was no need to investigate how Project operations affected take at Wells Dam.

During the 2005-2008 monitoring period, no adult bull trout were counted during the 24-hour off-season fishway counting period (November 16 to April 30).

No upstream or downstream passage problems were identified during this study. Passage times upstream through the fishway appeared reasonable relative to the species migration and spawn timing. Because no passage problems were identified during the study, there was no need to develop recommendations to change or modify the fishway operations at Wells Dam.

The second objective was to assess project-related impacts on upstream and downstream passage of sub-adult bull trout (fish <400 mm in length). During the development of the Bull Trout Plan, stakeholders agreed that because of the inability to collect a sufficient sample size of sub-adult bull trout at Wells Dam, it was not feasible to assess sub-adult passage. However, when encountered at Wells Dam fishways, or in tributary traps, sub-adult bull trout would be PIT-tagged. Douglas PUD provided funding, equipment, training, and coordination for the sub-adult bull trout PIT tag program. From 2004 to 2008, 67 sub-adult bull trout were PIT-tagged in the Methow River sub-basin during standard tributary smolt trapping operations. Douglas PUD operated PIT tag detection systems year-round within the Wells Dam fishways during the study period (2005 to 2008) and no PIT-tagged sub-adult bull trout were detected. Additionally, sub-adult bull trout were to be PIT-tagged opportunistically when encountered at the Wells Project; however, no sub-adult bull trout have been encountered at Wells Dam during this period.

The third objective was to investigate the potential for sub-adult entrapment or stranding in off-channel or backwater areas of Wells Reservoir. Field surveys were conducted at potential bull trout stranding sites during periods of low reservoir elevation. High resolution bathymetric information, reservoir elevations, backwater curves, and inflow patterns were used to identify potential stranding sites for the survey. No stranded or entrapped bull trout of any size were found during the field surveys conducted in 2006 and 2008. No surveys were conducted during 2005 or 2007 because river operations were not low enough to warrant a survey.

The fourth objective was to identify the core areas and local populations of bull trout that utilize the Wells Project. Data from radio-tagged bull trout tracked during the 2005 to 2008 study period were analyzed with data from the 2001 to 2004 study. Bull trout that pass Wells Dam (either upstream or downstream) migrated into the Methow, Entiat, and Wenatchee rivers during the spawning period. Observed tributary entrances of bull trout detected at Wells Dam from 2005 to 2008 were 86% Methow River, 10% Entiat River, and 2% Wenatchee River. Genetic samples of all fish tagged at Wells Dam were submitted to the USFWS for analysis. The USFWS is responsible for analyzing the genetic samples and providing those results. To further support this objective (Strategy 4-2: Work cooperatively with other agencies to obtain locations of radio-tagged fish outside the project area), Douglas PUD regularly coordinated bull trout data and monitoring activities with other agencies including the USFWS, WDFW and Chelan PUD.

In summary, no mortality or injury was observed for bull trout (adult and sub-adult) passing through or interacting with the operations of the Wells Project during the take monitoring studies conducted between 2001 and 2008. No incidental take of bull trout was observed at the Wells Project, and the Wells Project is presumed to be within the incidental take levels authorized by the USFWS Biological Opinion Incidental Take Statement (USFWS 2004).

5.0 2011 BULL TROUT MONITORING AND MANAGEMENT PLAN ACTIONS

A more detailed description of the methodologies used to implement each Bull Trout Plan objective-strategy in 2011 can be found in the Bull Trout Plan 2005-2008 Final Monitoring Report (LGL and Douglas PUD 2008). These methodologies were developed from the objectives first outlined in the *Wells Hydroelectric Project Bull Trout Monitoring and Management Plan 2004-2008* (Douglas PUD 2004).

6.0 RESULTS

6.1 Strategy 1-1: Adult bull trout telemetry program

6.1.1 Bull trout tagged by Douglas PUD

As previously reported, an evaluation of station receiver data for the period of August 2008 to December 2009 at Wells Dam, Wells Dam Tailrace, the “Gateway” location (approximately 3 miles downstream from Wells Dam), and at stations located at the Methow and Okanogan river mouths yielded no additional detection data. During the latter half of 2008, bull trout would have already entered the Methow River to access spawning and overwintering habitat located outside of the Wells Project Area. By 2009, most of the tags activated in earlier years expired and were unavailable in providing additional data. A complete description of bull trout radio-telemetry findings can be found in (LGL and Douglas PUD 2008).

No additional radio-telemetry was conducted in 2011. Douglas PUD will implement a radio-telemetry study using adult bull trout captured in the Twisp River Weir in year one of the new FERC license. In 2016 additional radio-telemetry efforts will be carried out at Wells Dam in consultations with the Aquatic Settlement Work Group and the USFWS. These and other bull trout measures are part of the Aquatic Settlement Agreement prepared during the Integrated License Process for Wells Dam.

6.1.2 PIT tagging efforts and interrogations

Thirty-six adult bull trout (>440 mm) were incidentally captured at the Twisp River Weir in 2011. These captures are approximately 60% fewer bull trout that were captured at the weir in 2010 and is a result of high flows in June that made the weir inoperable. Migrating bull trout would have been able to pass the weir without capture during these flows. Twenty-six of the 2011 captures had not been previously PIT tagged. Untagged adults were anesthetized, measured, and given a PIT tag prior to release. Seven of these 36 fish were captured and tagged in 2010 and 3 were captured twice in 2011.

Out of the 26 adult bull trout PIT-tagged at the Twisp Weir in 2011, 14 were subsequently detected on instream PIT-tag arrays within the Methow Basin in 2011. Ninety-three percent of these detections occurred at the TWR (lower Twisp River) location during a time when bull trout have been observed exiting the Twisp River following spawning in the upper reaches of this river (Table 6.1.2-1). These results are consistent with previous years of monitoring.

Ninety one adult bull trout were incidentally captured at the Twisp River Weir in 2010. Eighty seven of these fish were given new PIT tags, while 4 of them were recaptures. These adult bull trout contribute to a novel dataset tagged within the Twisp River or MCA. Sixty nine percent of these adults have since been detected at various locations following release in 2010. Because of the complexity of these in-stream behaviors, movements associated with spawning have been summarized in Table 6.1.2-1. In this summary two assumptions were made: 1) drop back was assumed when a fish was detected at any site downstream of the weir after August of the tagging year and 2) spawning was assumed when a fish was detected post tagging at TWR during the months of September and October, which is associated with downstream movement following spawning. Together, important limitations exist with passive tags, however behaviors appear to be tied to pre- and post-spawning behaviors and bull trout seeking overwintering habitats.

Table 6.1.2-1 Summary of adult bull trout incidentally captures at the Twisp Weir in 2010 and 2011 and their PIT tag detections as of December 31 2011.

Description	2010	2011
Number tagged	87	26
Number detected post release	60	14
Percent detected post release	69%	54%
Spawned in 2010	18	NA
Spawned in 2011	1	13
Spawned in both 2010 and 2011	24	NA
Dropped back after tagging and spawned in 2010 only	0	NA
Dropped back after tagging and spawned in 2011 only	4	0
Dropped back after tagging and spawned in 2010 and 2011	3	NA
Dropped back after tagging (not observed spawning)	8	0
Overwinter detection or upstream movement only	2	1
Percent of bull trout assumed spawned in same tag year*	**75%** (45/60)	**93%** (13/14)

* assumes that an equal number of spawning fish and drop back fish went undetected.
Note. drop back was assumed when a fish was detected at a downstream location after tagging between June and August of tag year.
Note. spawning was assumed when a fish was detected post tagging at TWR during the months of September and October, which is associated with downstream movement following spawning.

During spring Chinook broodstock collection activities, five and four adult bull trout were incidentally captured and tagged at Wells Dam in 2010 and 2011, respectively. One of the 2011 fish was later detected at the Twisp River PIT tag interrogation location on October 12, 2011 and another was detected at the Gold Creek interrogation station on September 28, 2011. The other two adult bull trout tagged at Wells Dam in 2011 have not been detected to date. Of the five fish tagged at Wells in 2010, one was detected in 2011. Following release at Wells Dam in 2010, this fish was detected in the Twisp River on July 5th and, subsequently, in the lower Methow River near the Columbia on October 4th of 2010. In 2011, this fish was detected at Rocky Reach and Wells Dam in early and mid-July respectively, suggesting that this fish made successful downstream passages at Wells and Rocky Reach Dams, followed by successful accents at these projects during a typical upstream passage period. Previous radio-telemetry data is consistent with the behavior, timing, and successful dam passage displayed by this PIT-tagged adult.

Table 6.1.3-1summarizes the number of bull trout tagged in the MCA and at Wells Dam since 2005. These captures and tagging efforts are a result of incidental captures of bull trout during anadromous salmonid M&E and broodstock collection efforts. Together, Douglas PUD has funded the successful capture, tagging and release of 373 sub-adult and adult bull trout since 2005, 137 of which have since been detected passing at least one in-stream PIT tag array (Table 6.1.3-2).

6.1.3 Movement and Behavior within the Methow Basin

Detections within the Methow Basin occurred predominately during the late summer, fall and winter of 2011. Unusually high flows in the spring and early summer reduced detection efficiency and physically destroyed many detection arrays within the MCA. Ninety two unique fish were observed on at least one PIT tag interrogation station in the Methow Basin during 2010, 85 of which were PIT-tagged under Douglas PUD's M&E funding in the MCA. Twenty nine unique fish were observed on an MCA in-stream array in 2011. All but one of these fish were tagged by Douglas PUD's M&E staff (the other was tagged by the Yakama Nation Fisheries staff). Consistent with 2011 it appears that the majority of detections were a result of fish making downstream movements towards and, presumably, into the lower Methow River or Columbia River since approximately 70% of these detections occurred between September and December 2011. Information regarding station outages can be found on the PTAGIS website (http://www.ptagis.org/ptagis/index.jsp).

Table 6.1.3-1 Incidental captures of bull trout during M&E activities from 2005-2011. All fish were given PIT tags and data was uploaded to PTAGIS.

Tag Year	Location: Twisp River Weir	Twisp River Screw Trap	Methow River Screw Trap	Methow hook and line, dipnet, or shock	Twisp hook and line, dipnet, or shock	Chewuch hook and line, dipnet, or shock	Wells Dam	Total	Length (mean; range [mm])
2005	0	16	0	0	0	0	0	16	162; 106-196
2006	0	20	0	0	0	0	0	20	200; 121-287
2007	0	10	4	0	0	0	0	14	188; 146-244
2008	0	27	1	41	1	1	0	71	228; 82-330
2009	0	21	6	1	0	0	0	28	162; 118-227
2010	87	27	0	18	15	0	5	152	473; 118-790
2011	26	21	2	4	10	5	4	72	354; 141-720
Grand total								373	

Note: Presence of adults tagged at the Twisp Weir in 2010 and 2011 highlight the influence of capture method and location on mean fish size.

Table 6.1.3-2 Number of bull trout since detected in the Methow Core Area or Wells Action Area 2005-2011.

Tag year	Numbers tagged	Since detected	Percent detected	Number detected at Wells	Number detected at LMR
2005	16	0	0%	0	0
2006	20	0	0%	0	0
2007	14	2	14%	0	0
2008	71	10	14%	0	2
2009	28	12	43%	1	2
2010	152	84	55%	2	20
2011	72	29	40%	NA	3
Grand total	373	137	37%	3	27

Note. LMR is the lower Methow River interrogation location, approximately a mile upstream of the Methow and Columbia River Confluence. Detections at this location are often associated with upstream movements in the spring and early summer, downstream movements in the fall (September-October), or overwintering from November to May.

Together, three general trends exist for behavior of bull trout in the Methow River Basin:

1) Bull trout enter the Methow Basin in spring and early summer. They move quickly up river, presumably, to foraging and find spawning locations. The lack of upstream migration data, relative to downstream data in the fall is indicative of high flow river conditions, debris damaging PIT tag arrays and lower detection efficiencies during these

seasonal conditions. However, radio-telemetry data confirms that upstream movements do take place in the spring and summer.

2) The most obvious location for spawning occurs in the Twisp River above the Twisp River Weir detection location, since the majority of the fish were detected at the Twisp River Weir in the late summer and early fall.
3) Both adult and sub-adult bull trout appear to make directed downstream movements into the lower Methow and the Wells Project after spawning and prior to the onset of winter. However, adults and sub-adults have been detected in higher reaches of the Methow River during the winter periods, suggesting that over wintering locations are not exclusive to the Columbia and lower Methow Rivers.

6.2 Strategy 1-2: Correlations between passage events and Project operations

Results from the 2005-2008 radio-telemetry effort indicated bull trout movement was determined by seasonal conditions rather than project operations.

Observations of bull trout at Wells Dam in 2011 remained similar to observations from previous years. Adult bull trout fishway counts at the Wells Project were 43, 43, 44, and 66 respectively for the past four years. Over the last ten years, 2001 had the largest count at Wells Dam fishways at 107. The 2011 count is highly comparable to the eleven year average of just under 66 bull trout counted in Wells Dam fishways annually.

Adult bull trout begin seasonal usage of the Wells Dam fishways reliably in early to mid-May, with the >98% of fishway use occurring from May through the end of July. The seasonal end to Wells Dam fishway use by bull trout has been less predictable, occurring sometime between July and November over the last decade. 2011 was the first year that a bull trout was observed in the Wells Dam fish ladder in December. To date, no bull trout have been observed in Wells Dam fish ladders from January to April (Figure 6.2-1).

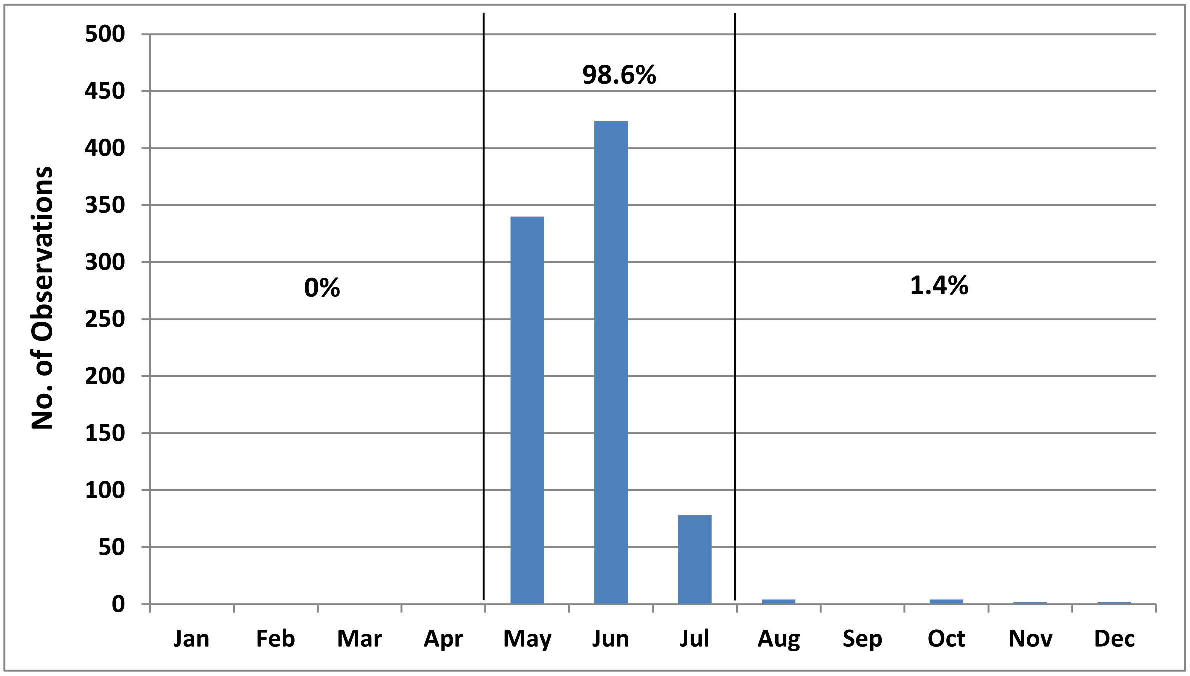

Figure 6.2-1 Seasonal distribution of bull trout observations at Wells Dam for the years 1998-2011.

6.3 Strategy 1-3: Off-season fishway passage of adult bull trout

Off-season video monitoring of both Wells Dam fishways continued for the 2010-2011 winter period (November 16 - April 30). Consistent with prior years of off-season video monitoring, no adult bull trout were observed using the fishways during the winter. However, during annual fish ladder dewatering activities, two bull trout were observed in the east fish ladder in 2011 (December). In 2011, 64 of 66 (97%) counted bull trout at Wells Dam fish ladders passed during the months of May through July. Consistent with observations from several years of year-round fishway counts, adult bull trout passage through Wells Dam primarily occurs in May through July each year (Figure 6.2-1).

6.4 Strategy 1-4: Modifications to passage facilities or operations

There have been no passage issues identified that limit upstream or downstream passage of adult bull trout at Wells Dam. Therefore, there is no need for modifications to current passage facilities or operations.

6.5 Strategy 2-1: Sub-adult PIT tagging program

Douglas PUD passively collected information from all PIT-tagged fish, including bull trout, as they passed through the fishways at Wells Dam. Douglas PUD also scanned all bull trout incidentally captured at rotary screw traps and adult brood collection facilities. The information collected at the dam and in the tributaries was posted on the PTAGIS website, which is operated and maintained by the Pacific States Marine Fisheries Commission.

Consistent with previous years, no sub-adult bull trout were observed or detected at Wells Dam. Douglas PUD continues to provide support to WDFW for PIT tagging bull trout incidentally collected at both on-site and off-site smolt collection facilities (Table 6.5-1). Tag information for all tagged fish was posted on the PTAGIS website (http://www.ptagis.org/ptagis/index.jsp). Despite tagging over 150 sub-adult bull trout in the Methow action area since 2005 only one Methow origin tagged sub-adult bull trout has been detected in the mainstem Columbia. In May of 2011, a sub-adult bull trout that was tagged in August of 2010 at the Twisp River screw trap, was detected at the Rocky Reach juvenile bypass facility. Therefore, this fish successfully passed downstream through Wells Dam. No sub-adults have been detected in Wells Dam fish ladders to date. Together, over 155 sub-adult bull trout have been PIT-tagged in the MCA as a result of Douglas PUD funding, including more than 20 in 2011.

Within the Methow Basin there are 15 separate PIT tag interrogations facilities, making it one of the most extensive PIT tag interrogation networks in the Columbia Basin. Of the bull trout that have been PIT-tagged by WDFW, using Douglas PUD tags, numerous within basin detections have occurred. Within the Methow, tagged sub-adult bull trout have been observed in the lower Methow, middle Methow, Chewuch, Beaver, Gold, Wolf and Eightmile Creek, Twisp River and the lower Methow detection locations. In summary, the majority of bull trout detections in the Methow River Basin occurred between July and November at the MRT and the TWR interrogation locations. Previous Radio-telemetry data suggests that the majority of bull trout tagged at Wells Dam are destined for spawning reaches in the Twisp River. Other spawning locations included the Lost River and Gold Creek (LGL and Douglas PUD 2008).

6.6 Strategy 2-2: Off-season fishway passage of sub-adult bull trout

Similar to off-season video monitoring of adult bull trout (Section 6.3), off-season video monitoring of the Wells Dam fishways for sub-adult bull trout continued for the winter periods (November 16 - April 30). During these monitoring periods, no sub-adult bull trout were observed utilizing the fishways. To date, no sub-adult bull trout have been observed using Wells Dam fishways at any time during the year.

6.7 Strategy 3-1: Inflow patterns, reservoir elevations, and backwater curves

On November 5, 2008, Douglas PUD conducted several stranding surveys intended to document whether or not bull trout are stranded in the Wells Reservoir during lower than normal reservoir surface elevation operations (surface elevation at or below 773 feet MSL). The survey locations were selected based upon an analysis of detailed bathymetric maps produced in 2005 combined with Wells Reservoir hydraulic information. This effort identified several locations where stranding of sub-adult bull trout could potentially occur. Six total potential stranding locations were identified. These locations were the Methow River mouth, the Okanogan River mouth, the Kirk Islands, the shallow water habitat in the Columbia River directly across from the mouth of the Okanogan River, Schluneger Flats and the off-channel areas of the Bridgeport Bar Islands.

Boat and foot surveys were conducted and included a combination of shoreline transects and inspection of isolated sanctuary pools. Similar to previous bull trout stranding surveys, no bull trout were observed during the 2008 survey which suggests that bull trout are able to avoid stranding and entrapment areas in the event of a Wells Reservoir drawdown. During 2009 and 2010, no stranding surveys were conducted as low water events did not take place. On June 10, 2011 Douglas PUD biologists conducted a stranding survey using similar methods as in 2008. This survey was initiated since Wells Project operations reduced reservoir depth to below 773 feet MSL. During this survey no bull trout were encountered and only a few sculpin (*Cottus* sp.) and three-spine stickleback (*Gasterosteus aculeatus*) were observed (less than 10 of each species). Imagines from this survey are included in Figure 6.7-1.

Figure 6.7-1 Low reservoir conditions on June 10, 2011 and Douglas PUD biologists conducting a stranding survey.

6.8 Strategy 4-1: Genetic sampling program

In 2011, 10 and 2 DNA samples were taken from juvenile bull trout in the Twisp River smolt trap and Methow River smolt trap respectively (operated by WDFW). Total DNA samples taken from sub-adults since 2008 are summarized in Table 6.8-1. All samples are currently in the care of WDFW or the USFWS. Genetic analysis results are not yet available, but are anticipated to be provided by USFWS in the future and when available will be included in future reports.

Table 6.8-1 Sub-adult bull trout PIT-tagged in the Methow Basin, 2008-2010 (data from C. Snow, WDFW).

Year	Collection/tag site	# PIT-tagged/ # captured	# DNA sampled
2008*	Methow River trap	0/0*	0*
2008*	Twisp River trap	13/14*	0*
2009	Methow River trap	6/6	5
2009	Twisp River trap	21/21	10
2010	Methow River trap	0/0	0
2010	Twisp River trap	29/29	10
2011	Methow River trap	2/2	2
2011	Twisp River trap	21/21	21

*August to December only: In early 2008 16 sub-adults were captured in the Twisp River trap and 10 DNA samples were taken from these fish. To see 2005-2008 data table similar to above, refer to LGL and Douglas PUD (2008).

6.9 Strategy 4-2: Participation in information exchanges and regional efforts

Douglas PUD continues to coordinate with regional tribal, state, and federal agencies, to promote the exchange of bull trout information and to ensure that local and regional bull trout monitoring efforts are coordinated in the Upper Columbia River. In 2011, Douglas PUD biologists attended June 29th and August 29th meetings to contribute to the recovery planning.

7.0 CONCLUSIONS

Six years of tagging results and eight years of monitoring results, as reported in the Bull Trout Plan 2005-2008 Final Report, demonstrate no project-related impacts to adult or sub-adult bull trout from passage through the Wells Project, nor by stranding/entrapment due to lowering of the reservoir elevation. Using the original eight years of data, Douglas PUD has also determined there are no apparent correlations between project operations and downstream passage events, and that there is no upstream movement of adult or sub-adult bull trout through the Wells Dam fishways during the November 16 through April 30 timeframe. Bull trout captured and tagged at Wells Dam were radio-tracked to the Methow and Entiat Core Areas during spawning periods, and have also demonstrated movement between these systems by successfully passing upstream and downstream through Wells Dam. PIT tag data concurs with radio-telemetry survival estimates (100%), since adult bull trout PIT-tagged in the MCA and at Wells have been detected at Wells in subsequent years following tagging.

Additional tagging and monitoring has taken place since 2008 including tagging and monitoring in 2009, 2010 and 2011. These studies support the conclusions reported for the first eight years of take monitoring at Wells Dam. In particular, the results of the 2011 implementation of the Bull Trout Plan remain consistent with the previous 10 years of monitoring and evaluation. Radio-telemetry and PIT tag data suggest that bull trout passage at Wells Dam is independent of project operations and instead associated with seasonal movement patterns such as spawning migrations during May through July. To date, no sub-adult bull trout have been observed in Wells Dam fishways. Data collected from the Methow River basin smolt collection operations indicate that sub-adult bull trout are present near the confluence of the Methow and Columbia River. However, only one of more than 155 sub-adults PIT-tagged in the MCA has since been detected in the mainstem Columbia below Wells Dam.

In 2011, thirty six adult bull trout were captured at the Twisp River Weir during salmonid broodstock operations. Twenty six of these fish did not have a PIT tag and were subsequently given one prior to release. Seven of the 36 adult bull trout were recaptures from 2010 PIT-tagging at the weir. Newly tagged fish in 2011 add to the unique dataset of already PIT-tagged bull trout in the MCA. Movements of these adult fish appear to be closely related to spawning migration movements (pre and post-spawning) and those related to overwintering.

In 2011, genetic samples were taken from 12 sub-adult bull trout during the implementation of off-site smolt collection activities and provided to the USFWS for future genetic analysis. To date, low-water project operations appear to have no stranding effect on adult or sub-adult bull trout. In addition to coordinating monitoring efforts and information exchanges of project specific bull trout data, Douglas PUD continues to participate in regional activities that support bull trout conservation and recovery.

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APPENDIX H -2011 PUBLIC UTILITY DISTRICT NO. 1 OF DOUGLAS COUNTY NORTHERN PIKEMINNOW REMOVAL AND RESEARCH PROGRAM

2011 PUBLIC UTILITY DISTRICT NO. 1 OF DOUGLAS COUNTY NORTHERN PIKEMINNOW REMOVAL AND RESEARCH PROGRAM

WELLS HYDROELECTRIC PROJECT

FERC NO. 2149

January, 2012

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ABSTRACT

Public Utility District No. 1 of Douglas County's (Douglas PUD) 2011 northern pikeminnow (*Ptychocheilus oregonensis*) removal efforts were conducted from April 7, 2011 to November 11, 2011. The designated capture area was from 1 mile below Wells Dam upstream to the boat-restricted zone (BRZ) of Chief Joseph Dam. All pikeminnow were captured on setline gear.

The setline crew captured 16,302 northern pikeminnow; of those, 14,296 were equal to or greater than 229 mm in total length and 2,006 were less than 229 mm in total length. This cut-off length was established by Bonneville Power Administration as the length at which pikeminnow become predatory on juvenile salmonids (Beaty et al. 1991; Porter 2000) and has been used by Douglas PUD for over ten years of pikeminnow removal. These fish were captured during 5,205 hours of angling effort translating into an overall catch-per-unit-effort (CPUE) of 3.1 pikeminnow per hour. Within the lower Wells Reservoir from the Methow River confluence area to the forebay of Wells Dam, 6,778 fish were captured during 1,680 hours of effort translating into a CPUE of 4.0. Setline efforts in the lower 1-mile section of the Methow River captured 2,349 fish during 660 hours of effort (CPUE = 3.6). Within Wells Reservoir from the mouth of the Methow River to Chief Joseph Dam, 2,164 pikeminnow were captured during 876 hours of effort, a CPUE of 2.5. The remaining fish were captured in the Wells Tailrace (5,011 pikeminnow) during 1,989 hours (CPUE =2.5). The 16,302 pikeminnow were captured over 8,910,000 hook hours, translating into an overall CPUE of 0.0018 fish per hook hour. From 1995 to present, pikeminnow removal programs sponsored by Douglas PUD have resulted in the capture of approximately 228,000 pikeminnow from the Wells Project.

A total of 3,512 non-target fish were captured and released representing 17.7% of the overall catch. Incidental encounters consisted of nine taxa: 1226 peamouth (*Mylocheilus caurinus*), 650 sucker spp. (*Catostomus* spp.), 619 chiselmouth (*Acrocheilus alutaceus*), 579 burbot (*Lota lota*), 223 pikeminnow / chiselmouth hybrids, 73 sculpin spp. (*Cottus* spp.), 71 redside shiner (*Richardsonius balteatus*), 57 white sturgeon (*Acipenser transmontanus*), and 14 brown bullhead catfish (*Ameiurus nebulosus*). All non-target fish were released alive. The presence of white sturgeon by-catch during the 2011 project is attributed to the release of juvenile sturgeon by Chelan PUD within Rocky Reach Reservoir as part of their white sturgeon supplementation program. All incidentally captured white sturgeon were determined to be from this release by PIT tag and scute mark identification. No salmonids were encountered during the project. The setline removal system has consistently produced low levels of by-catch, especially in regards to salmonids, over the previous 10 years.

Gonad analysis indicated that the peak spawning period for pikeminnow occurred during the week of July 16 to 31, during which time 64% of the sub-sampled pikeminnow were classified as ripe. During an average water year, pikeminnow spawn in late June or early July (Jerald 2007, Jerald 2008); therefore the 2011 data represents evidence of delayed egg maturation/spawning events during the current year.

Analysis of digestive tracts was performed on a 5.4% sample of the captured pikeminnow to assess their dietary preferences and predation rates on juvenile salmonids. Forty-six percent of the dissected pikeminnow digestive tracts were empty, 22% contained crayfish, 15% contained

unidentified plant matter, 7% unidentified insect, 6% salmonids, 3% unidentified fish, and 1% sculpin.

The magnitude and duration of the spring freshet hampered CPUE and total catch levels during the 2011 project. River flows at Wells Dam from April to August 2011 were at 122% of the 20-year average, and the third highest on record behind 1996 and 1997. This translated into difficult fishing conditions for the pikeminnow field crews. Given that Wells Dam is a run-of-the-river project with limited storage capacity, and that the turbine-discharge capacity was reduced due to maintenance and rehabilitation projects, high flows were sent through spill bays during the spring and summer freshet. The resultant turbulent conditions in the tailrace made it impossible for crews to capture pikeminnow within this normally productive area in May, June, and July.

The percentage of large (>350 mm) pikeminnow in the annual catch has declined from 23% in 2002 to a low of 14% in 2009, and has remained relatively stable between 14% and 16% since 2006. Thus, the pikeminnow removal program has apparently reduced the abundance of piscivorous pikeminnow >350 mm within the Wells Project area. The size threshold of 350 mm was selected arbitrarily in an effort to monitor any change in annual pikeminnow length in the Wells Project.

1.0 INTRODUCTION

Throughout the Columbia River hydro system, numerous measures have been implemented to improve the survival of salmonids (*Oncorhynchus* spp.) that pass up to nine hydroelectric projects on their migrations to and from the ocean. As one of those measures, Public Utility District No. 1 of Douglas County (Douglas PUD) is required by the Federal Energy Regulatory Commission (FERC) via the Wells Hydroelectric Project Anadromous Fish Agreement and Habitat Conservation Plan (HCP, Section 4.3.3) to implement measures for the control of predacious northern pikeminnow (*Ptychocheilus oregonensis*) at the Wells Hydroelectric Project (Project). Thus, in an effort to understand and control predators of juvenile salmonids within the Project, Douglas PUD has funded research on, and removal of, northern pikeminnow since 1993.

Pikeminnow research and removal, initiated on the lower Columbia River during the summer of 1990, has been recognized as an important part of restoring salmonid stocks within the Columbia River system (Vigg et al. 1990; Matthews et al. 1991). Initial test fisheries utilizing hook-and-line methods in the lower Columbia River captured 17,334 pikeminnow (Vigg et al. 1990). In 1991, 39,817 fish were removed from eight U.S. Army Corps of Engineers hydroelectric projects on the lower main stems of the Columbia and Snake Rivers (Beaty et al. 1991). Shortly thereafter, mid-Columbia Public Utility Districts (PUDs) began to investigate the possibilities of initiating similar pikeminnow research and removal activities.

In 1993, Douglas, Chelan, and Grant PUDs jointly funded a study of predation on juvenile salmonids in the mid-Columbia region (Burley and Poe 1994), to identify areas of northern pikeminnow abundance and areas of high predation on out-migrating juvenile salmonids. Density-index values of pikeminnow in the mid-Columbia reservoirs were as high as many reservoirs of the lower-Columbia. The immediate tailrace of Wells Dam and the outfall of Wells Hatchery were identified as sites where large concentrations of pikeminnow could be found relative to other locations within the Wells Project.

Douglas PUD initiated a northern pikeminnow test fishery in 1995, with the goals of assessing the effectiveness of several gear types for removing pikeminnow, estimating the population size of pikeminnow, and removing pikeminnow from the tailrace of Wells Dam (Bickford and Klinge 1996). During the summer of 1995, crews captured 1,198 pikeminnow, with the majority captured via conventional hook-and-line gear. A similar removal program in 1996 was intended to increase effort and remove as many pikeminnow as possible from the Wells tailrace (Bickford 1997). Unfortunately, removal efforts were hampered by difficult fishing conditions related to high river flows and velocity, and only 313 northern pikeminnow were captured, most on sport-fishing gear. Commercial setline gear was also utilized in 1996, and although the lines did not capture many pikeminnow, catch-per-unit-effort (CPUE) was high relative to other methods tested. Prompted by low catch rates in 1996, biologists at Douglas PUD initiated a behavioral study in 1997, radio-tagging northern pikeminnow throughout the Wells Reservoir and tailrace. Migration patterns, spawning locations, and preferred habitats of northern pikeminnow were identified throughout Wells Reservoir and from the Wells tailrace to eleven miles downstream at Chelan Falls (Bickford and Skillingstad 2000).

In an effort to increase catch levels and conduct studies on northern pikeminnow, Douglas PUD hired Columbia Research in 1998. Columbia Research's removal strategy focused on an incentive-based fishery with a crew of experienced anglers paid on a per-fish basis (anglers hired directly by Douglas PUD in 1995 and 1996 were paid by the hour). Anglers in 1998 captured 7,347 pikeminnow, a significant increase over the numbers of fish captured during previous years. Catch numbers increased during each subsequent year, with 10,382 pikeminnow captured in 1999 and 12,338 in 2000. Catch numbers totaled 14,935, 20,201, and 20,065[1] pikeminnow, in 2002, 2003, and 2004, respectively. From 2005 to 2011 catch per year has ranged from approximately 16,000 to 20,000 fish annually. The success of these annual efforts demonstrates the efficacy of the setline capture technique as implemented by Columbia Research, and the capacity of the program to annually harvest significant numbers of northern pikeminnow from the Project.

To date, pikeminnow removal programs sponsored by Douglas PUD have resulted in the capture and removal of approximately 228,000 pikeminnow. It is believed that these programs have significantly decreased predation on outbound juvenile salmonids within Wells Reservoir and in the immediate Wells tailrace. This report outlines the results of Douglas PUD's 2011 pikeminnow removal project implemented by Columbia Research, and compares the current data with those collected during previous removal efforts from 2002 to 2010.

2.0 MATERIALS AND METHODS

Setline efforts were initiated on April 7, 2011 and were completed on November 11, 2011. Semi-monthly summaries were provided to Douglas PUD during the project, which updated Douglas PUD biologists with project status and catch rates. Setline crews filled out daily data sheets specifying locations fished, number of fish caught per location, setline set times, and incidental catch.

The 2011 pikeminnow removal efforts were conducted throughout the Project from the tailrace area of Wells Dam upstream to the boat restricted zone (BRZ) in the tailrace of Chief Joseph Dam. A scientific collection permit was obtained from the Washington Department of Fish and Wildlife allowing crews to place setlines throughout the study area including the lower 1-mile section of the Methow River, the mouth of the Wells Hatchery outlet channel and the BRZ of Wells Dam. Captured northern pikeminnow were categorized by one of four primary catch locations: Pikeminnow captured downstream from Wells Dam were designated "Wells Tailrace." Fish captured in the reservoir between Wells Dam and a point 1 mile above the Methow River confluence were designated "Lower Wells Reservoir." Fish captured from 1 mile above the Methow River to the tailrace of Chief Joseph Dam were designated "Upper Wells Reservoir." Fish captured from the mouth of the Methow River, to approximately 1 mile upstream were designated "Methow River." CPUE rates were calculated for each location.

From 12 to 18 setlines were retrieved, baited and set each day by a crew of three individuals. Each line contained approximately 150 hooks. Setline gear was fished on the bottom. Each setline consisted of a main line with a buoy and a weight attached to each end. Hooks were

[1] Includes 503 fish captured in 2004 that were not enumerated until 2005, and were not included in the totals reported in the 2004 report.

spaced evenly along the main line between the end weights. The hooks were then attached via leaders of 6-pound-test monofilament approximately 0.6 meters in length. Setline gear was checked once daily, allowing crews to release all non-target fish back into the river unharmed. CPUE was calculated by summing hours spent to retrieve, check, and reset lines as well as travel and preparation time (tying hooks, assembling lines, etc.). Hook-time fished was calculated as the number of hooks fished each day multiplied by total days fished multiplied by 24 hours. Effort calculations methods are consistent from 2002 to 2011 of the pikeminnow program, allowing for easy comparison within and between years.

Biological data were collected randomly from 5.4% of the weekly catch. Biological data consisted of fork length, weight, sex, digestive-tract contents, and gonad maturity. Fork lengths were measured to the nearest millimeter. An Ohaus 5000 electronic scale was used to weigh fish to the nearest 2 grams. Pikeminnow were categorized as male, female, or unidentified, and gonad maturity was identified on a scale of 0 to 4, corresponding to the criteria listed in Table 1. Digestive-tract contents were visually identified. These methods are consistent with previous years of biological data analysis (Jerald 2009, Jerald 2010).

Table 1. Gonad maturity codes.

0	Unidentified	Gonads could not be distinguished between male and female.
1	Immature	Gonads thin and streamlined, sex may be difficult to determine.
2	Developing	Eggs and milt do not flow easily with pressure, but sex is easily determined. Eggs are small and gray in color.
3	Ripe	Females contain orange-colored eggs. Eggs or milt flow freely with gentle pressure.
4	Spent	Gonad size reduced. Some eggs or sperm may still be present.

3.0 RESULTS

One vessel rotated three to five crewmembers during the project. Together, 16,302 northern pikeminnow were captured over 5,205 hours of angling effort, equating to an overall CPUE of 3.1 fish per angling hour. Over the fishing season, angling efforts translated into 8,910,000 hook hours for an overall CPUE of 0.0018 fish per hook hour. Greater than 87% of the captured fish (14,296) were equal to or greater than 229 mm in total length, The balance, 2,006 (~13%), of captured pikeminnow were less than 229 mm.

Within the Lower Wells Reservoir from the Methow River confluence area to the forebay of Wells Dam, 6,778 fish were captured during 1,680 hours of effort translating into a CPUE of 4.0. Setline efforts in the lower 1-mile section of the Methow River captured 2,349 fish during 660 hours of effort (CPUE = 3.6). Within the Upper Wells Reservoir from the mouth of the Methow River to Chief Joseph Dam, 2,164 pikeminnow were captured during 876 hours of effort, a CPUE of 2.5. The remaining fish were captured in the Wells Tailrace (5,011 pikeminnow) during 1,989 hours (CPUE =2.5) (Figure 1).

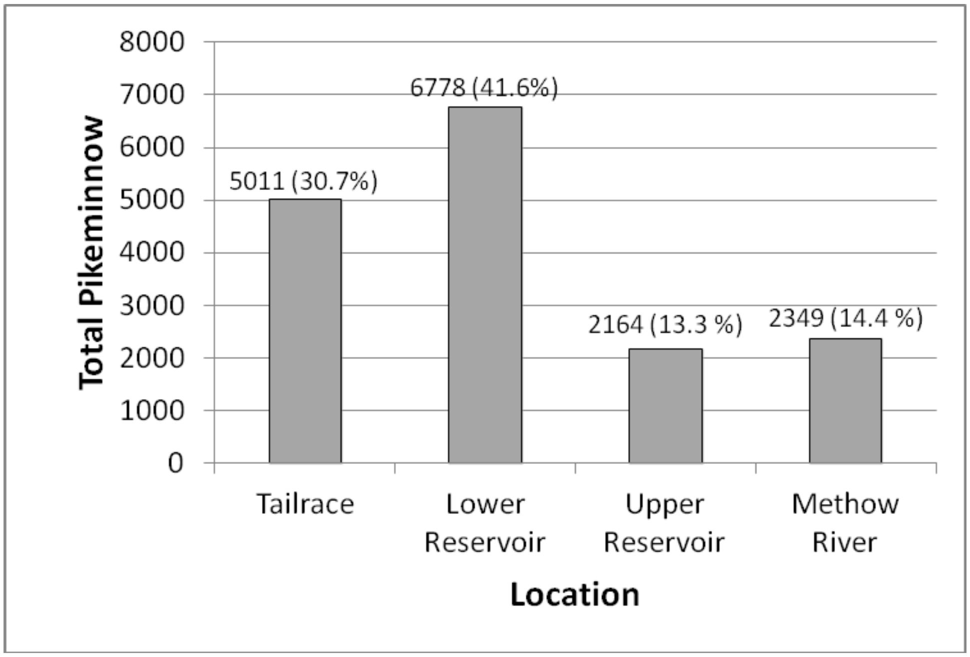

Figure 1. Catch (percentage of total catch) of northern pikeminnow by location.

A majority of effort in 2011 was focused in Wells Reservoir. Initial efforts in April and May were focused within the lower reservoir area from the mouth of the Methow River to Wells forebay. Catch levels were high in April and May with CPUE ranging from 2.9 to 5.3 (Table 2). Project CPUE rates dropped significantly in June, as a result of two factors. First, CPUE dropped significantly within Wells Reservoir which is a phenomenon documented annually during the first week of June (Jerald 2009, Jerald 2010). Second, as crews transferred fishing effort from the reservoir to the normally productive Wells tailrace, they encountered high spill conditions which made it impossible to work the setline gear. At that point, crews were restricted to setting gear within the lower Wells Tailrace approximately 1 mile downstream. This fishing location became quickly fished out, resulting in low CPUE levels through June and July. Even though spill decreased towards the end of July, CPUE levels remained consistently low through August and September. At this time, crews intermittently fished within the Wells Reservoir to determine if catch levels warranted increased effort. However, very low CPUE rates were recorded during these attempts in August and September. During the second half of October a spike in CPUE was observed within the Wells Reservoir around the Methow confluence. At this time, crews transferred all fishing effort back to the Wells Reservoir and high CPUE rates were recorded until the end of the fishing activities in mid-November.

In most years since 2002, the Wells tailrace catch has equaled or outpaced the catch in the Wells Reservoir; however, in 2011 the tailrace catch was approximately half of the catch in the Wells Reservoir. For example, the average of catches for the years 2002-2010 is 8,626 in the Wells Reservoir and 11,311 in the Wells tailrace. In 2011 the catches for these locations were 11,291 and 5,011, respectively. In addition, catch per unit effort in the Wells tailrace declined dramatically compared to the average of the last seven years. The average of CPUEs in the tailrace from 2004-2010 is 5.17; in 2011 CPUE was 2.5.

Table 2. Semi-monthly numbers of pikeminnow caught and CPUEs by fishing location during the 2011 removal program.

Semi-month	Upper Wells Reservoir (CPUE)	Lower Wells Reservoir (CPUE)	Methow River (CPUE)	Wells Tailrace (CPUE)	Total CPUE
4/7 – 4/15	3 (0.8)	744 (4.1)	302 (3.7)		3.9
4/16 – 4/30	14 (0.6)	1945 (5.4)	702 (5.1)		5.3
5/1 – 5/15	388 (2.8)	1187 (3.8)	446 (3.2)		3.4
5/16 – 5/31	1015 (3.3)	485 (2.5)	158(2.6)		2.9
6/1 – 6/15				360 (1.8)	1.8
6/16 – 6/30	402(2.4)	346(2.1	125(1.8)		2.3
7/1 – 7/15	125(2.1)	181(2.2)	28(.9)	330 (2.6)	2.3
7/16 – 7/31	41(1.4)	61(1.6)	30(.6)	506 (2.5)	2.3
8/1 – 8/15				1177 (3.0)	3.0
8/16 – 8/31	176(1.6)			771 (3.2)	2.8
9/1 – 9/17				1058 (2.9)	2.9
9/18 – 9/30				463 (2.1)	2.1
10/1 –10/15				346(1.7)	1.7
10/16-10/27		1135(4.9)	334(4.0)		4.6
10/28-10/11		694(3.5)	224(3.0)		3.2
Total	**2164 (2.5)**	**6778 (4.0)**	**2349 (3.6)**	**5011 (2.5)**	

CPUE for setline gear placed within the lower 1-mile stretch of the Methow River was similar to the CPUE rates recorded in the productive Wells Reservoir locations. We surmise that the Methow confluence area provides increased predator opportunity as prey (juvenile salmonids and lamprey) must travel through this narrow corridor during the annual outmigration.

A total of 885 digestive tracts were sampled. This random sample was collected throughout the entire 2011 effort and on all size classes (pikeminnow over and under 229 mm). Of the 885 pikeminnow digestive tracts sampled, 46% were empty, 22% contained crayfish, 15% contained unidentified plant matter, 7% unidentified insect, 6% salmonids, 3% unidentified fish, and 1% sculpin (Table 3). “Unidentified fish” may include salmonids that were unrecognizable in their digested state, and/or would require laboratory techniques to provide a positive identification. Table 4 provides sampling observations of dietary behavior by week, and also the items consumed as a percentage of the digestive tracts with contents. A relatively high incidence of salmonids were recorded in pikeminnow stomachs sampled during April and May. The presence of salmonids in sampled digestive tracts declined as expected commensurate with the decline in salmonid availability (subyearling Chinook migration typically peaks in mid-May to mid-June). Gonad analysis indicated that the 2011 peak spawn period for northern pikeminnow occurred from July 16 to July 31, at which time 64% of the sub-sampled fish were classified as ripe.

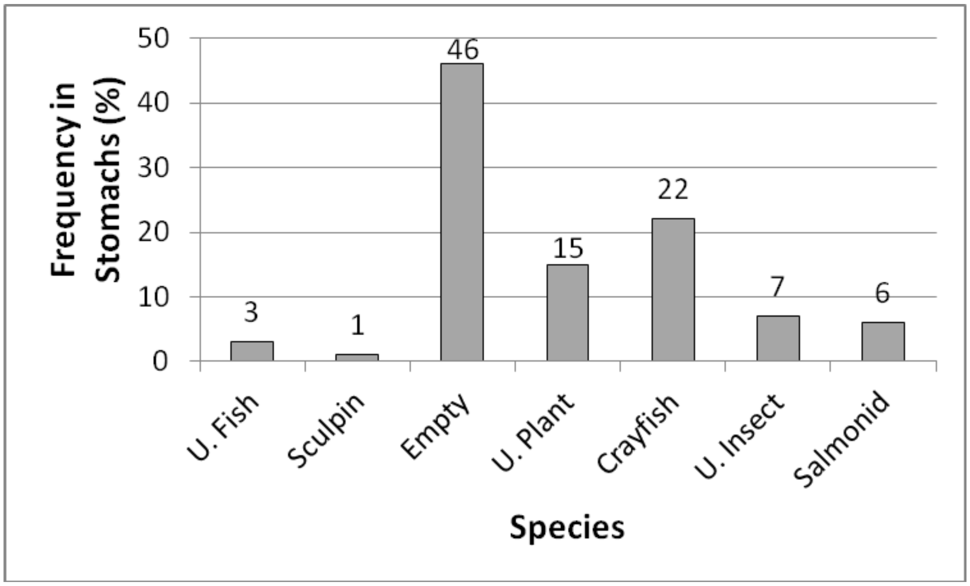

Figure 2. **2011 digestive-tract contents, as determined from analysis of 885 pikeminnow digestive tracts. The abbreviation "U." indicates "unidentified" items within the respective categories. In the case of "U. Fish," this category encompasses all fish other than lampreys, sculpin, or salmonids; "U. Plant" comprises all plant matter and "U. Insect" all arthropods other than crayfish.**

Table 3. **Results of analysis of digestive-tract contents for 2011 by week and number of digestive tracts sampled (*N*). Content categories are listed as the number of digestive tracts sampled that week containing that item. Values in parentheses in the "total" row are the percentages of the number of digestive tracts with contents that were sampled that week. "U." = Unidentified.**

				Content Category (breakdown of "Content Present" only)					
Bi-Week	***N***	**Empty**	**Content Present**	**Salmonid**	**U. Plant**	**U. Fish**	**Crayfish**	**Sculpin**	**U. Insect**
4/7 – 4/15	**60**	53	7	0	0	0	5	2	0
4/16 – 4/30	**120**	81	39	12	6	4	15	0	2
5/1 – 5/15	**120**	76	44	14	10	3	12	1	4
5/16 – 5/31	**120**	63	57	13	6	5	29	0	4
6/1 – 6/15	**20**	18	2	2	0	0	0	0	0
6/16 – 6/30	**45**	13	32	8	6	2	13	1	2
7/1 – 7/15	**35**	12	23	5	7	1	10	0	0
7/16 – 7/31	**35**	20	15	2	6	1	6	0	0
8/1 – 8/15	**60**	2	58	0	18	3	27	1	9
8/16 – 8/31	**50**	5	45	0	16	4	17	0	8
9/1 – 9/17	**50**	11	39	0	14	4	15	0	6
9/18 – 9/30	**25**	6	19	0	8	2	5	0	4
10/1 –10/15	**20**	4	16	0	6	0	7	0	3
10/16-10/27	**75**	24	51	0	21	0	19	0	11
10/28-10/11	**50**	21	29	0	12	1	10	0	6
Total	**885**	**409 (46)**	**476 (54)**	**56(6)**	**136(15)**	**30(3)**	**190(22)**	**5(1)**	**59(7)**

A total of 3,512 non-target fish were captured and released representing 17.7% of the overall catch. Incidental captures consisted of nine separate taxa: 1226 peamouth (*Mylocheilus caurinus),* 650 sucker spp. (*Catostomus spp)*, 619 chiselmouth (*Acrocheilus alutaceus*), 579 burbot (*Lota lota*), 223 pikeminnow/chiselmouth hybrids, 73 sculpin spp. (*Cottus spp*.), 71 redside shiner (*Richardsonius balteatus*), 57 white sturgeon (*Acipenser transmontanus*), and 14 brown bullhead catfish (*Ameiurus nebulosus*) (Figure 3). All non-target fish were released alive. No salmonids were captured during the project.

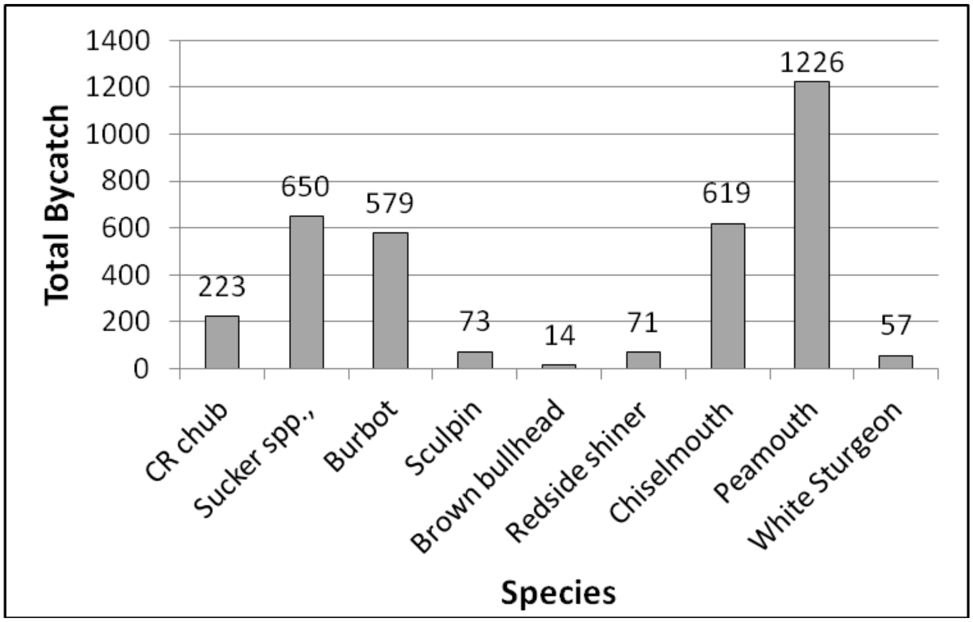

Figure 3. Numbers of non-target (incidental) fish by taxa captured in 2011.

Most incidental species were encountered consistently in all locations during the fishery with the exception of a high incidence of burbot recorded in Wells Reservoir (Table 4). The largest proportion of these fish were encountered in the China Ditch section of the reservoir approximately 1 mile below the Methow confluence. A relatively high incidence of hybrid pikeminnow/chiselmouth were identified in the reservoir area as well. These fish were identified by the presence of a forked caudal fin and lateral line characteristic of a pikeminnow with a sub-terminal mouth characteristic of chiselmouth.

Table 4. Numbers of non-target (incidental) fish captured per semi-month in the 2011 fishery.

Semi-month	Sucker Sp.	Burbot	Sculpin	Peamouth	Bull-head	Redside Shiner	White Sturgeon	Chisel-mouth	Hybrid
4/7 – 4/15	**28**	**34**	**0**	**77**	**0**	**0**	**0**	**7**	**2**
4/16 – 4/30	**81**	**164**	**1**	**180**	**1**	**8**	**0**	**55**	**24**
5/1 – 5/15	**116**	**120**	**9**	**133**	**4**	**2**	**0**	**86**	**29**
5/16 – 5/31	**124**	**78**	**14**	**156**	**3**	**8**	**0**	**78**	**25**
6/1 – 6/15	**32**	**0**	**4**	**24**	**0**	**8**	**0**	**25**	**5**
6/16 – 6/30	**48**	**64**	**9**	**121**	**2**	**6**	**0**	**51**	**20**
7/1 – 7/15	**62**	**28**	**3**	**105**	**0**	**5**	**0**	**46**	**16**
7/16 – 7/31	**42**	**11**	**4**	**88**	**0**	**5**	**1**	**32**	**10**
8/1 – 8/15	**13**	**2**	**3**	**105**	**0**	**7**	**17**	**46**	**21**
8/16 – 8/31	**18**	**3**	**5**	**65**	**0**	**4**	**24**	**58**	**16**
9/1 – 9/17	**22**	**2**	**7**	**72**	**0**	**5**	**10**	**44**	**19**
9/18 – 9/30	**14**	**1**	**5**	**34**	**1**	**2**	**5**	**31**	**10**
10/1 –10/15	**16**	**0**	**2**	**18**	**0**	**3**	**0**	**24**	**8**
10/16-10/27	**22**	**48**	**5**	**32**	**2**	**6**	**0**	**22**	**12**
10/28-10/11	**12**	**24**	**2**	**16**	**1**	**2**	**0**	**14**	**6**
Total	650	579	73	1226	14	71	57	619	223

4.0 DISCUSSION

A relatively low number of pikeminnow were captured in 2011 when compared to pikeminnow captured from 2003 to 2010 (Figure 4). The magnitude and duration of the spring freshet and the resultant spill at Wells Dam hampered CPUE and total catch levels during the 2011 project. 2011 marked one of the highest flow years on record within the Columbia River (http://www.cbr.washington.edu/) and the highest since the setline approach has been used to remove pikeminnow in the Wells Project. This translated into difficult fishing conditions for the pikeminnow field crews. As a result of dramatic drafting at Grand Coulee and Chief Joseph Dam, large quantities of water were spilled at Wells during months in which fishing has historically been productive in the tailrace (May, June, and July). Typically during the annual fishery, approximately 11,000 pikeminnow are captured from the productive Wells tailrace location. In 2011, only 5,011 pikeminnow were caught at that location (see Table 2).

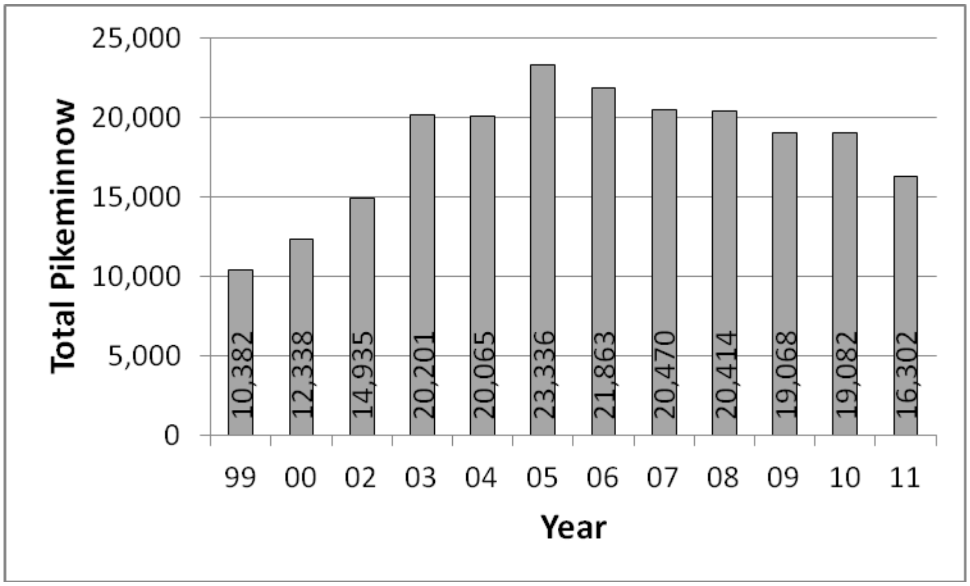

Figure 4. **Douglas County PUD total northern pikeminnow catch by year.**

4.1 Pikeminnow Diet

The timing of the peak migration of salmonid smolts from the Methow and Okanogan rivers corresponds with a dramatic increase in smolts in pikeminnow diets as identified during stomach analysis (data on the timing of smolt migration available from Columbia River DART http://www.cbr.washington.edu/). Temporal changes in prey availability are apparent, such as the presence of salmonids in sampled digestive tracts declining as expected commensurate with the decline in salmonid availability.

4.2 Incidental Catch

During the development stage of the setline removal approach, concerns were raised regarding high incidental catch and mortality. In contrast to those concerns, setline methods have proven to be highly selective for northern pikeminnow, with extremely low rates of encounter with non-target sensitive and game species, including no encounters with salmonids (Jerald 1998; Jerald 1999; Jerald 2000; Magnotti and Jerald 2001; Jerald 2005). Setlines allow for selective harvesting of northern pikeminnow from all depths, currents, substrates, and in all seasons, with minimal by-catch of non-target species, and to date, no by-catch of salmonids other than whitefish. Previous annual reports (Jerald 2005, Jerald 2006) discuss possible explanations for the selectivity of the setline techniques.

4.3 Yearly Comparisons

Catch information has been compiled from the annual Douglas PUD removal programs to provide comparative analysis of the yearly data from multiple years of intensive setline efforts. From 2002 until present, setline gear has been used exclusively for pikeminnow capture (prior to 2002, hook-and-line techniques were also utilized). Thus, the 2002 to 2011 data represent pikeminnow that have been captured on similar sampling gear within the Wells Project area. It should be noted that the catch distribution within the project area was not consistent from 2002 to 2011 (Figure 5). From 2004 to 2011, a much higher proportion of fish were captured in Wells Reservoir than in 2002 and 2003, because productive fishing locations within Wells Reservoir were discovered after 2003. Beginning in the early spring months of March and April 2004, crews were able to place setline gear in locations where pikeminnow overwinter, greatly improving catch rates in the reservoir.

2011 was one of two years in which catch within Wells Reservoir was much higher than Wells tailrace (also 2005). Despite the large proportion of the catch harvested from the reservoir, CPUE decreased dramatically in Wells Reservoir, which might suggest that flow conditions were not the only reason for the decline in total catch in the tailrace. Therefore, besides the reduction of CPUE due to high flows during June and early July in 2011, we also attribute this dramatic depression in catch below Wells Dam to ongoing removal efforts by Chelan and Douglas PUDs in the Rocky Reach Reservoir (below Wells Dam). This interaction is explained further below.

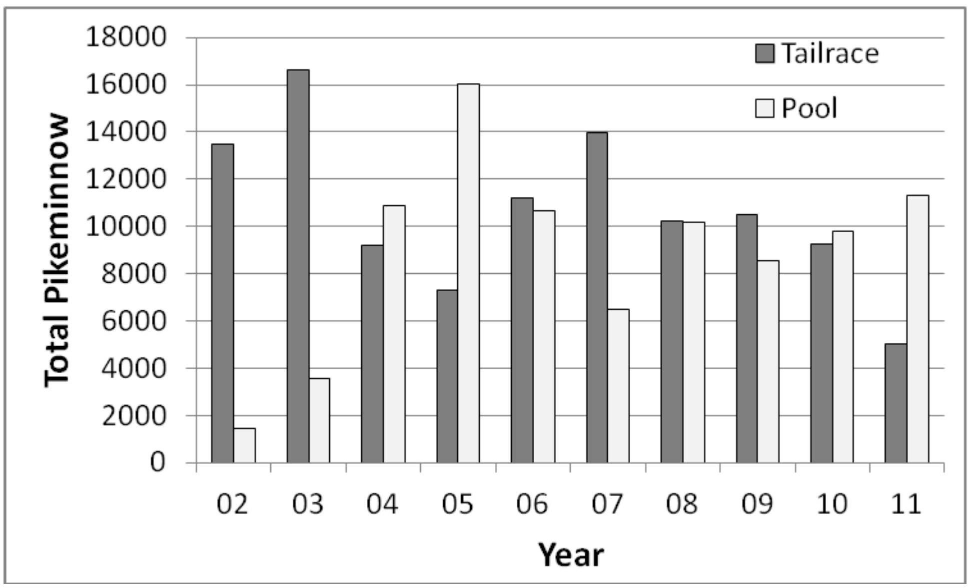

Figure 5. Catch distribution from 2002 to 2011 within Wells Tailrace and Wells Reservoir.

Yearly CPUE rates were noticeably lower in 2011 compared to previous years (Figure 6). We believe that this CPUE decline was due to two primary factors. First, the Project recorded record spill volume and duration during the months of June and July, which are typically the most productive fishing months in the tailrace area with respect to CPUE and total catch. Setline crews could not set gear in the tailrace on a consistent basis, and when they did, the gear frequently moved or disappeared due to turbulent water conditions. Second, the annual salmon fishery commenced below Wells Dam on July 1, with record participation by anglers. There were frequent occurrences of recreational anglers becoming entangled in setline gear as well as tampering with that gear, which resulted in substantial setline gear loss. Combined, these two factors substantially affected total catch and CPUE during the months of June and July. A final consideration is that 127,719 pikeminnow have been removed within the Wells tailrace/Rocky

Reach reservoir over the last five years through Chelan PUD and Douglas PUD sponsored efforts. These programs may have effectively reduced the population of pikeminnow in this location. Bickford and Skillingstad (2000) documented the migration of pikeminnow from middle and lower Rocky Reach reservoir into the Wells tailrace for spawning and/or predation activities. A substantial reduction in the pikeminnow population within Rocky Reach reservoir could result in decreased CPUE rates within Wells tailrace.

Seasonal trends in pikeminnow behavior have been observed during the 1998 to 2011 fisheries. Pikeminnow research has determined that these fish congregate in tailrace areas and hatchery outfalls during times of peak salmonid out-migrations (Bickford and Klinge 1996; Burley and Poe 1994; Li et al. 1987). Typically during May, June, and July, crews have consistently experienced high catch rates within the Wells tailrace location (excluding 2011) and, specifically, the Wells Hatchery outfall area. It has been shown in a radio-tagging study conducted by Douglas PUD that pikeminnow migrate in mid-summer to spawn in gravel beds located in the Wells tailrace, and near Chelan Falls (Bickford and Skillingstad 2000).

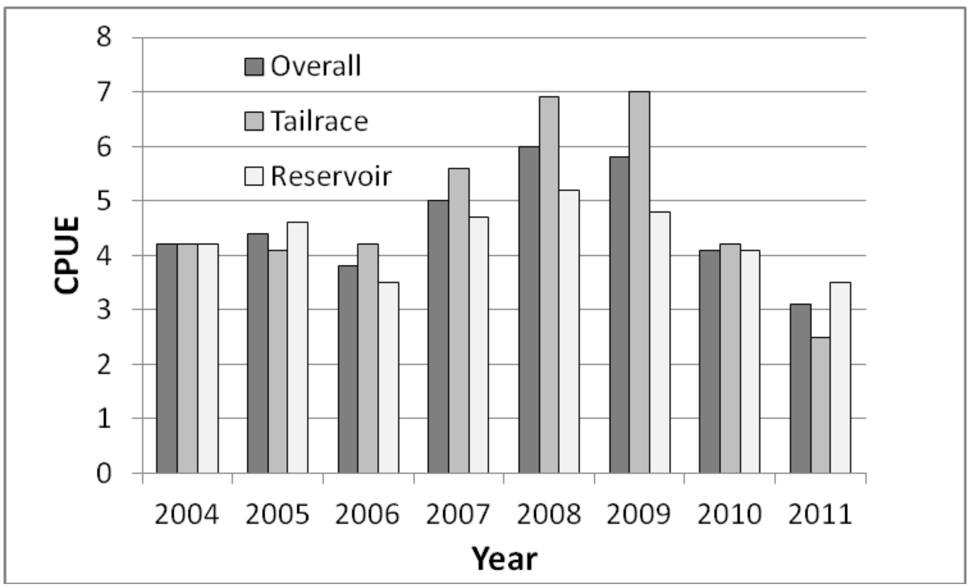

Figure 6. CPUE values by location for Wells Project pikeminnow removal program, 2004 to 2011.

Pikeminnow sex ratios were compared from 2002 to 2011. The highest percentage of males captured in the fishery was documented in 2009, with males comprising 53% of the sampled catch. The highest percentage of females was observed in 2011 when they accounted for 55% of the sampled catch. The 2011 data consists of pikeminnow captured predominantly within Wells Reservoir, where fish have typically been larger than fish from Wells tailrace (Jerald 2009, Jerald 2010). As pikeminnow exhibit sexual dimorphism with females typically larger than males, it stands to reason that a majority of fish recorded during the 2011 project would be female.
A decreasing trend in average lengths is observed from 2002 to 2009 (Figure 7). The lowest average pikeminnow length and weight was recorded during 2009 at 273 mm in length and 243

grams in weight. From 2004 to 2009 (similar fisheries with similar effort within reservoir and tailrace areas) the average pikeminnow length decreased by 29 mm and weight by 53 grams[2].

During 2010 and 2011, a slight increase was recorded in average length and average weight. Although weight and length averages were higher in 2010 and 2011, this data does not exhibit an extensive trend towards increased average lengths and weights. From 2008 to 2011 average fish lengths have only varied within 7 mm (278 mm in 2008, 273 mm in 2009, 277 mm in 2010, and 280 mm in 2011). This may be an indication that yearly pikeminnow removal efforts have reduced the population to an equilibrium level where fishing effort has offset recruitment.

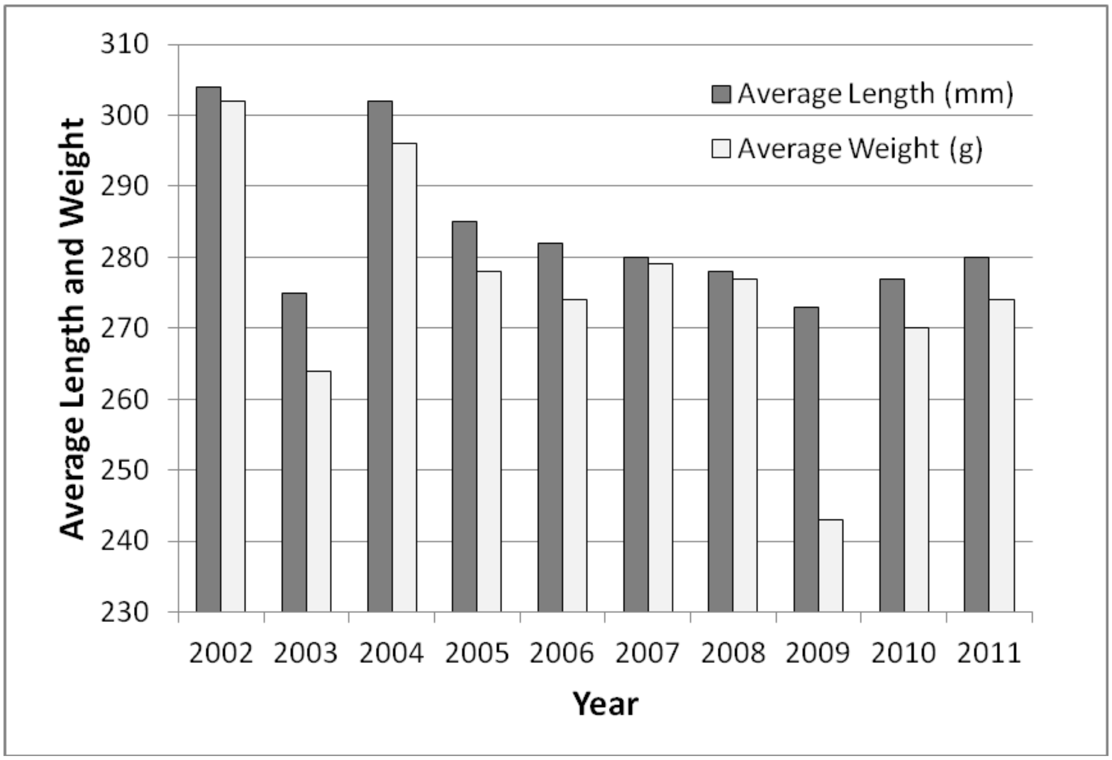

Figure 7. Average pikeminnow length (mm) and weight (g) from sampled pikeminnow in Wells Tailrace and Wells Reservoir 2002 to 2011.

Average fish weight is an unreliable indicator of trends in average fish size in the pikeminnow population over time, as the observed weight per length of pikeminnow varies seasonally (data not shown). Factors affecting fish weight during the fishery likely include fish condition going into the previous winter, winter water temperatures, and the rate of increase in spring water temperature. Additional factors may include the influence of environmental variables on the availability of prey, such as the timing of salmonid fry emergence and smolt migrations or the recruitment rate of larval resident fish from the previous year class. Timing of the commencement of the annual fishery also influences fish weight per length. For example,

[2] The apparent 27-mm increase in average length from 2003 to 2004 is likely because most pikeminnow were captured in the Wells tailrace in 2003, but in 2004 (and each subsequent year), substantially more pikeminnow were captured in Wells Reservoir than during 2003. Fish captured in Wells Reservoir during 2004 were noticeably larger than those captured in the tailrace.

fishing began much later in 2007 (May 6) and 2008 (April 22) than in 2004, 2005, 2006, 2009, and 2010 (March 8, 3, 21, 19, and 16, respectively), and we observed apparently anomalous average pikeminnow weights in 2007 and 2008, despite the annual decline in average length and overall decrease in average weights over the 2004-2009 period. Fish of all lengths in 2007 and 2008 would have experienced several additional weeks of foraging before the commencement of fishing relative to the fish subjected to those fisheries that began in March. Thus, fish captured early in the fishery in 2007 would have exhibited an overall improvement in condition factor relative to those fish of equal length captured early in those fisheries that began in March. Fluctuations in the duration of the pikeminnow removal program may also affect the displayed catch data. In 2009 body masses were ~10% lower than in previous years and are likely attributed to overwinter conditions rather than timing of capture (see Figure 7). In 2010, pikeminnow collection activities took place from March 16 to September 30, a total of 26 weeks. In 2011 fishing activities took place from April 7 to November 11, a total of 31 weeks. These longer fishing periods in 2010 and 2011 inevitably effect size data when comparing on an annual basis. Additionally, when comparing historical data with the current 2011 data, the majority of the 2011 fish were captured in the Wells Reservoir, which typically yields fish larger on average than fish from the Wells tailrace.

No trends have emerged in the percentages of the total annual catch that are either <229 mm or ≥229 mm in length (Figure 8). Therefore, the observed decline in average fish size from 2004 to 2009, and the apparent increase in 2010 and 2011 cannot be explained by a change in the numbers of fish ≥229 mm, but rather by a change in the average size of fish in that category.

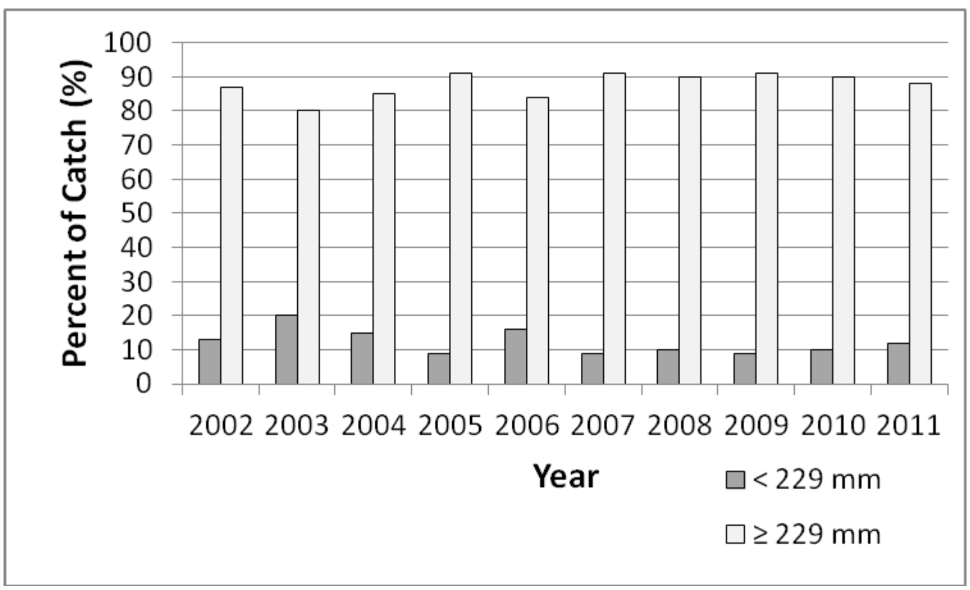

Figure 8. Catch composition by size category reported as the percentage of fish captured annually that were either <229 mm or ≥229 mm.

The size distribution of large pikeminnow over 350 mm was analyzed from 2002 to 2011 in an attempt to quantify any increase or decrease of very large pikeminnow within the population over time. During 2002, fish greater than 350 mm comprised 23% of the total catch (Figure 9).

The occurrence of these larger fish decreased systematically from 2002 to 2009. In 2009 the lowest occurrence of sampled fish >350 mm was observed, comprising only 14% of the total catch. From 2006 to 2011 catch composition of these larger fish only varied from 14% to 16% of total catch, increasing little in 2010 and 2011 despite the greater relative proportion of fish from the reservoir (generally larger fish than in the tailrace) in the total catch in those years. This general stability of the proportion of very large fish in the fishery could provide further indication that the fishery may have reached an equilibrium point with recruitment. While the numbers of very large fish (>350 mm) have declined since 2002, smaller fish within the ≥229 mm category either remain numerous or have increased in numbers to the extent that a corresponding decrease has not occurred in the total numbers of fish within that length category (see Figures 8 and 9).

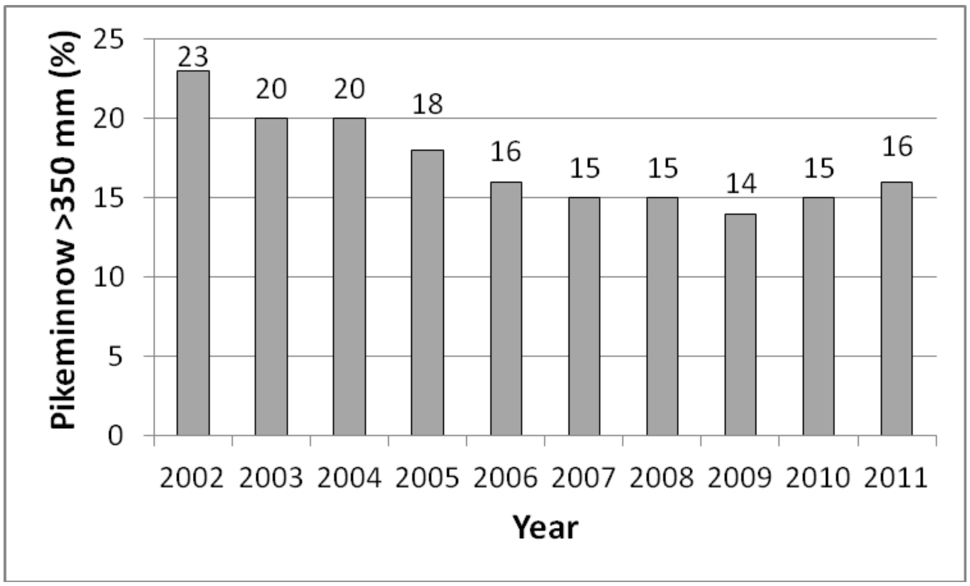

Figure 9. Catch composition as the percentage of fish sampled annually that were >350 mm.

There was no discernable trend in salmonid consumption by northern pikeminnow from 2002 to 2011 (Table 5). The highest occurrences of salmonid consumption were observed in 2004 and 2008, and the lowest incidences were documented in 2006 and 2007. High turbidity levels during 2006 and 2007 may have decreased predator efficiency resulting in fewer salmonids in digestive tracts sampled. Additionally, the relatively late onset of fishing in 2007 (May 1; see discussion above) would have missed the majority of hatchery spring Chinook smolts that migrated in April, possibly explaining the low incidence of smolts in pikeminnow digestive tracts in 2007. Lamprey were first recorded during analysis of digestive tracts in 2009, which likely resulted from training technicians in lamprey identification prior to the onset of the fishing season, and the initiation of fishing effort in the Lower Methow area during the peak of the lamprey emigration. However, no lamprey were observed in the stomachs of the sampled pikeminnow in 2010 or 2011.

Table 5. Digestive-tract contents (%) for pikeminnow captured in Wells Project from 2002 to 2011 (approximately 5% of the catch sampled each year).

Year	Empty	Smolt	Crayfish	Unidentified Fish	Unidentified Plant	Unidentified Insect	Sculpin	Lamprey
2002	69	7	6	7	7	1		
2003	60	8	9	8	7	6		
2004	66	10	4	7	9	3		
2005	61	7	14	6	9	2		
2006	74	5	6	4	6	4		
2007	76	4	4	6	5	4		
2008	64	10	7	8	7	2		
2009	42	7	10	7	21	11		2
2010	55	6	11	6	14	7	1	
2011	46	6	22	3	15	7	1	
Mean (02-11)	61.3	7.0	9.3	6.2	10.0	4.7	0.2	0.2

Peak spawning in 2011, as determined by gonad analysis, occurred during the week of July 16, which is within, but toward the late end of the range of peak spawn dates observed from 2002 to 2010 (June 21 to July 22).

5.0 CONCLUSIONS

Over the last 12 years the northern pikeminnow removal program has consistently removed large numbers of piscivore-sized pikeminnow from the Wells Project area. Since 2002, the percentages of pikeminnow that are ≥ 229 mm in the annual catches have remained steady, while the percentage of large (>350 mm) pikeminnow (which are likely to be females due to sexual dimorphism) has declined from 23% in 2002, to consistently within the 14% to 16% range, reaching a low of 14% in 2009. The 16% value observed in 2011 likely reflects the disproportionate number of fish caught in Wells Reservoir due to exceptional water conditions that precluded the typical efforts in the tailrace in June and July. Had we been able to match historical efforts in the tailrace in 2011, we expect that the percentage of large fish in the catch would likely have been consistent with the percentages observed over the last four years. Regardless, the pikeminnow removal program has reduced the average size of piscivorous and reproductive-sized pikeminnow >350 mm while not discernibly reducing the proportions of fish captured from the ≥ 229 mm and < 229 mm categories.

During 2009 and 2010, CPUE rates in March were the lowest recorded. CPUE rates did not increase to over 4.0 until mid-April. In 2011, crews did not initiate fishing efforts until April, at which time high CPUE levels were recorded. It is suggested that in 2012, crews once again initiate fishing efforts during the first week of April, to avoid low CPUE levels that have previously been recorded in March.

The 2011 CPUE rates were the lowest recorded to date for any of the annual setline fisheries (see Figure 6). High spill and interference by recreational anglers below Wells Dam significantly reduced weekly catch and CPUE levels. However, we cannot ignore the potential that the intensive Douglas PUD-sponsored pikeminnow removal program has appreciably reduced pikeminnow abundance in the study area, as it has been increasingly difficult for crews to capture pikeminnow in recent years.

Analysis of future yearly catch data should reveal whether the pikeminnow population within the study area has reached an equilibrium stage between the fishery and recruitment. Such an effect would be indicated by consistent CPUE levels analyzed on a multi-year rolling-average. Decreasing CPUE levels and total catch levels will be an indication that the pikeminnow population within Wells Reservoir and the Wells tailrace is being substantially affected by the annual removal efforts and has yet to reach a new equilibrium level.

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APPENDIX I - ASSESSMENT OF SALMONID PASSAGE RESPONSES TO DIFFERENT FLOW VELOCITIES AT WELLS DAM FISHWAY ENTRANCE

Assessment of Salmonid Passage Responses to Different Flow Velocities at Wells Dam Fishway Entrance

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1.0 Introduction

In 2009 and 2010, different head differentials were tested at the entrances to the Wells Dam fishways to assess whether there was an effect of the resultant differences in entrance velocities on the passage of Pacific lamprey. Concurrently, passage of salmonids was also monitored to assess whether a reduction in water velocity that might be beneficial to lamprey would have a detrimental effect on salmonid use of the fishway. This report examines the possible effects of changes in fishway entrance water velocity on the passage counts of Chinook salmon, steelhead, coho, and sockeye salmon.

2.0 Methods

Generalized linear models (GLM) (McCullagh and Nelder 1989) were used to analyze the salmonid count data (Appendix A). The fitted model was a two-way classification for a randomized block design. Quasi-likelihood methods were used and the test of treatment effects was based on an *F*-test using the ratio of the treatment mean deviance to that of the error mean deviance. Pairwise treatment comparisons were based on a *t*-test adjusted for the overdispersion (i.e., scale parameter [SP] = error mean deviance).

Treatment means $\bar{x}_i$ were calculated based on the arithmetic average of the replicate values across *n* blocks,

$$\bar{x}_i = \frac{\sum_{j=1}^{n} x_{ij}}{n},$$

with associated variance calculated as

$$\text{Var}\ \bar{x} = \frac{\bar{x}\ \text{SP}}{n}.$$

In 2009, three different treatment levels were considered. Salmonid passage was examined relative to variable head differential treatments: existing high condition (0.46 m), moderate condition (0.31 m) and low condition (0.15 m), which results respectively in relatively high, moderate, and low water velocities at the fishway entrances. The treatments occurred during 4-hour blocks (i.e., 2100 – 0059) each day. However, because of differences in transit time of various salmonids at fishways, observations times were accordingly adjusted (Table 1). In some instances, alternative observation times were used because exact transit times were unknown. It is important when viewing the test results not to consider these alternative observation windows as independent tests. Instead, a significant result among any of the alternative observation windows should be considered as evidence of a treatment effect for a particular species. In 2010, only the moderate condition (0.31 m) and existing high condition (0.46 m) were tested using a randomized block design.

Table 1. Alternative observation time windows used in assessing passage effects on salmonids.

Year	Observation window	Salmonid Species			
		Chinook	Steelhead	Sockeye	Coho
2009	9 PM – 1 AM	X	X	X	X
	10 PM – 2 AM	X			X
	3 AM – 7 AM		X	X	X
2010	6 PM – 2 AM	X			X
	11 PM – 7 AM		X	X	X

In performing the analyses, test blocks with zero counts were excluded from the analyses to avoid artificially underdispersing the data. Typically, this occurred in the later test blocks of sockeye as the run diminished and the early blocks of coho as the run increased (Appendix B) but not once fish were arriving consistently.

A meta-analysis was used to combine the test results across years. Only treatment levels 0.31 m and 0.46 m were tested both years. The meta-analysis was used to test whether salmonid passage was significantly lower at the 0.31 m level compared to the 0.46 m test level. Using the individual *P*-values for the one-tailed test each year (P_i), an overall *P*-value was calculated where

$$P = P\left(\chi_4^2 \geq -2\sum_{i=1}^{2} \ln P_i\right).$$

Separate meta-analyses were performed for each species. Statistical significance in this report refers to *P*-values < 0.05.

3.0 Results

Analyses of deviance were performed on seven combinations of data in 2009 and five species × windows combinations in 2010 (Appendix C). In two instances, count data were inadequate (i.e., all zeros) for analyzing coho responses to the velocity treatments (Table 2). Results are presented by species.

3.1 Chinook Salmon

The two alternative window analyses in 2009 and the one analysis in 2010 were all nonsignificant ($P > 0.05$) (Table 2). Pairwise treatment comparisons in 2009 all were nonsignificant (Table 3). Therefore, no significant evidence exists that suggests Chinook salmon passage was affected by the three different entrance water velocities. Comparison of treatment means shows little relationship between increased entrance velocity and fish passage (Table 4).

3.2 Steelhead

Test results were significant in 2009 for steelhead but not in 2010 (Table 2). Closer examination reveals passage at 0.15 m was lower than at 0.46 m in 2009, and was near significantly different from passage at 0.31 m (Table 3). Pairwise comparisons between 0.31 m and 0.46 m were not significantly different in either year. Comparison of treatment means indicates 0.15 m had a detrimental effect on steelhead passage, while passage at 0.31 m and 0.46 m was comparable (Table 4).

3.3 Sockeye Salmon

No significant effects were found during the 2009 trials for sockeye (Tables 2, 3). A near significant difference was found in 2010 (Table 2), but with the 0.31 m treatment having higher passage than the standard 0.46 m (Table 4).

3.4 Coho Salmon

No significant differences in coho passage were found in either the 2009 or 2010 trials. Data patterns nevertheless suggest the possibility of increased passage as velocities increased (Table 4).

Table 2. *P*-values from analyses of deviance *F*-tests of treatment effects on salmonid passage at Wells Dam, 2009–2010. Results reported by species, window of observation, and year.

	Chinook salmon	Steelhead	Sockeye salmon	Coho salmon
2009				
9 PM – 1 AM	0.3220	0.0258	0.4131	N/A
10 PM – 2 AM	0.8463			N/A
3 AM – 7 AM		0.5202	0.4788	0.4455
2010				
6 PM – 2 AM	0.2304			0.1421
11 PM – 7 AM		0.2760	0.0631	0.4221

Table 3. *P*-values for pairwise comparison of treatment effects on salmonid passage. Results reported by species, window of observation, and year. Two-tailed tests of significance were performed.

Year	Testing period	Treatment level tested		
		0.15 vs. 0.31	0.15 vs. 0.46	0.31 vs. 0.46
			Chinook	
2009	9 PM – 1 AM	0.8630	0.2262	0.1718
2009	10 PM – 2 AM	0.8556	0.5759	0.7041
2010	6 PM – 2 AM			0.2304
			Steelhead	
2009	9 PM – 1 AM	0.0614	0.0101	0.3660
2009	3 AM – 7 AM	0.3428	0.9435	0.3093
2010	11 PM – 7 AM			0.2760
			Sockeye	
2009	9 PM – 1 AM	0.2030	0.5410	0.4720
2009	3 AM – 7 AM	0.7991	0.2683	0.3735
2010	11 PM – 7 AM			0.0631
			Coho	
2009	3 AM – 7 AM	0.6023	0.2836	0.4691
2010	6 PM – 2 AM			0.1421
2010	11 PM – 7 AM			0.4221

Table 4. Mean and standard error of counts of species passage for different treatment levels. Horizontal lines connecting treatments indicate treatments that are not significantly different (α = 0.05) using two-tailed tests. Standard errors in parentheses.

Year	Testing period	Treatment level tested		
		0.15 m	0.31 m	0.46 m
		Chinook		
2009	9 PM – 1 AM	3.6364 (0.7267)	3.8182 (0.7446)	2.4545 (0.5970)
2009	10 PM – 2 AM	3.2727 (0.7074)	3.0909 (0.6874)	2.7273 (0.6457)
2010	6 PM – 2 AM		20.4444 (2.9532)	23.3333 (3.2289)
		Steelhead		
2009	9 PM – 1 AM	7.3636 (1.5245)	12.3636 (1.9754)	15.0909 (2.1824)
2009	3 AM – 7 AM	40.1818 (4.4625)	34.2727 (4.1214)	40.6364 (4.4877)
2010	11 PM – 7 AM		22.3704 (1.6245)	25.0000 (1.7173)
		Sockeye		
2009	9 PM – 1 AM	0.8889 (0.2842)	0.4444 (0.2010)	0.6667 (0.2462)
2009	3 AM – 7 AM	0.7778 (0.3338)	0.6667 (0.3091)	0.3333 (0.2185)
2010	11 PM – 7 AM		3.1111 (0.5806)	1.7222 (0.4320)
		Coho		
2009	3 AM – 7 AM	0.3333 (0.3340)	0.6667 (0.4723)	1.3333 (0.6680)
2010	6 PM – 2 AM		0.5000 (0.2938)	1.5000 (0.5088)
2010	11 PM – 7 AM		1.2500 (0.5480)	2.0000 (0.6932)

4.0 Meta-Analysis Across Years

Only treatment levels 0.31 m and 0.46 m were tested in both 2009 and 2010. A meta-analysis was used to combine the two years of test results and produce an overall *P*-value. The hypotheses tested were

$$\begin{aligned} &H_o: \ \mu_{0.31} \geq \mu_{0.46} \\ &\text{vs.} \\ &H_a: \ \mu_{0.31} < \mu_{0.46}. \end{aligned}$$

The meta-analysis tests whether there was a significant reduction in passage under the 0.31 m test condition compared to the standard operating level of 0.46 m. The meta-analysis was nonsignificant for all species ($P > 0.05$); however, steelhead ($P = 0.1066$) and coho salmon ($P = 0.0780$) were close to being significant with the higher velocity having higher fish passage (Table 5).

5.0 Discussion

Sockeye salmon demonstrated no significant effects of entrance velocity on passage rates. In fact, observed entrance rates were typically higher at the 0.31 m condition than the 0.46 standard condition (Table 4). There was also no evidence that reduced velocities had any effect on Chinook salmon passage rates (Table 4).

Steelhead showed consistent but nonsignificant differences in passage rates between 0.31 m and 0.46 m test conditions, with the higher velocities having the slightly higher passage rate (Table 4). The meta-analysis, combining the 2009 and 2010 results, was nonsignificant at $P = 0.1066$. Coho salmon also showed a consistent but nonsignificant difference in passage rates between the 0.31 m and 0.46 m test conditions (Table 4). The meta-analysis across years was nonsignificant at $P = 0.0780$.

Finally, the analyses were sensitive to the timing of the window of observations. A significant result among any of the alternative observation windows was considered a significant finding in this report. This is based on the assumption that inappropriate windows of observations will be outside the zone of treatment effects and reflect the null hypothesis of no difference by default.

6.0 Literature Cited

McCullagh, P., and Nelder, J. A., (1989), *Generalised Linear Models* (Second ed.), London, United Kingdom: Chapman & Hall.

Table 5. Meta-analysis combining the results of the 2009 and 2010 trials. *P*-values for the one-tailed tests of passage at 0.31 m being less than passage at 0.46 m.

Species	Year	Passage 0.31 m – 0.46 m *P*-value
Chinook salmon	2009	0.9066
	2010	0.1152
	Combined	0.3404
Steelhead	2009	0.1607
	2010	0.1380
	Combined	0.1066
Sockeye salmon	2009	0.8133
	2010	0.9685
	Combined	0.9797
Coho salmon	2009	0.0711
	2010	0.2111
	Combined	0.0780

Appendix A

Salmonid count data used in the subsequent tests of entrance velocity effects in fishway passage

Year: 2009		Chinook		Steelhead		Sockeye		Coho		
Block	Treatment	9PM_to_1AM	10PM_to_2AM	9PM_to_1AM	3AM_to_7AM	9PM_to_1AM	3AM_to_7AM	9PM_to_1AM	10PM_to_2AM	3AM_to_7AM
1	0.31	3	2	3	6	2	0	0	0	0
1	0.46	3	2	2	11	2	2	0	0	0
1	0.15	1	1	0	26	7	3	0	0	0
2	0.31	2	2	1	5	0	2	0	0	0
2	0.46	2	2	4	10	0	0	0	0	0
2	0.15	5	3	7	18	0	0	0	0	0
3	0.46	4	4	2	32	2	0	0	0	0
3	0.31	2	2	5	20	1	1	0	0	0
3	0.15	4	2	7	26	0	0	0	0	0
4	0.15	5	5	6	83	0	2	0	0	0
4	0.46	3	3	20	68	0	1	0	0	0
4	0.31	2	2	3	32	0	1	0	0	0
5	0.15	4	3	10	21	0	1	0	0	0
5	0.31	6	4	20	49	0	0	0	0	0
5	0.46	4	5	11	37	0	0	0	0	0
6	0.15	8	10	13	59	0	0	0	0	0
6	0.31	6	6	32	34	1	1	0	0	0
6	0.46	3	2	29	38	0	0	0	0	0
7	0.31	11	9	27	89	0	0	0	0	0
7	0.46	0	1	44	130	1	0	0	0	0
7	0.15	5	4	3	69	1	1	0	0	0
8	0.31	5	4	14	53	0	0	0	0	0
8	0.46	2	3	9	42	0	0	0	0	0
8	0.15	3	3	3	20	0	0	0	0	0
9	0.15	0	0	13	57	0	0	0	0	0
9	0.31	4	1	15	38	0	1	1	0	0
9	0.46	4	6	20	31	1	0	0	0	2
10	0.15	3	3	10	34	0	0	0	0	1
10	0.46	1	0	10	23	0	0	0	0	1
10	0.31	1	2	11	26	0	0	0	0	1
11	0.46	1	2	15	25	0	0	0	0	1
11	0.15	2	2	9	29	0	0	0	0	0

11	0.31	0	0	5	25	0	0	0	0	1

Year: 2010

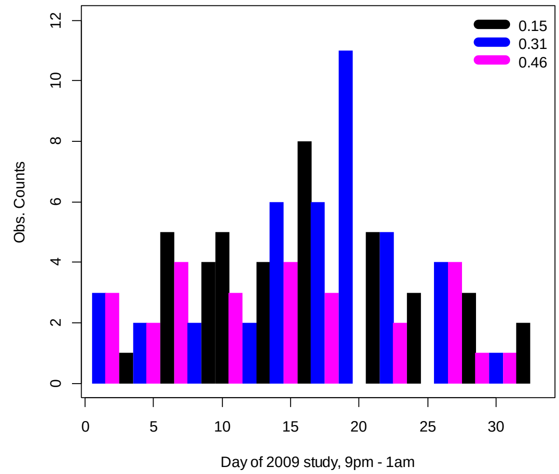
Block	Treatment	Chinook	Steelhead	Sockeye	Coho	
		6PM_to_2AM	11PM_to_7AM	11PM_to_7AM	6PM_to_2AM	11PM_to_7AM
0.31	1	30	4	20	0	0
0.46	1	13	13	8	0	0
0.31	2	33	3	14	0	0
0.46	2	31	13	2	0	0
0.46	3	29	7	7	0	0
0.31	3	21	4	6	0	0
0.31	4	13	3	1	0	0
0.46	4	21	4	3	0	0
0.31	5	6	4	3	0	0
0.46	5	52	28	1	0	0
0.31	6	32	34	5	0	0
0.46	6	32	17	0	0	0
0.46	7	18	10	3	0	0
0.31	7	16	10	0	0	0
0.31	8	12	9	3	0	0
0.46	8	13	19	2	0	0
0.46	9	8	11	1	0	0
0.31	9	13	21	1	0	0
0.31	10	18	14	0	0	0
0.46	10	27	9	1	0	0
0.31	11	33	7	1	0	0
0.46	11	15	3	0	0	0
0.31	12	9	10	1	0	0
0.46	12	95	15	0	0	0
0.31	13	52	33	0	0	0
0.46	13	53	14	0	0	0
0.31	14	19	15	1	0	0
0.46	14	32	23	0	0	0
0.31	15	32	19	0	0	0
0.46	15	16	12	1	1	0
0.31	16	30	22	0	0	0
0.46	16	45	20	0	0	0
0.46	17	102	19	1	0	0
0.31	17	29	26	0	0	0
0.46	18	26	20	1	0	0
0.31	18	55	25	0	0	0
0.31	19	35	46	0	0	0
0.46	19	49	44	0	0	0
0.31	20	43	31	0	0	0
0.46	20	34	43	0	0	1
0.31	21	55	56	0	0	0
0.46	21	32	67	0	0	0
0.46	22	39	40	0	0	0
0.31	22	41	36	0	0	1
0.31	23	20	54	0	0	0
0.46	23	19	57	0	3	5
0.46	24	19	73	0	1	1
0.31	24	29	34	0	0	0
0.31	25	36	22	0	0	1
0.46	25	16	38	0	0	2
0.46	26	31	27	0	3	5
0.31	26	19	38	0	1	2
0.31	27	11	24	0	2	6
0.46	27	20	29	0	1	2

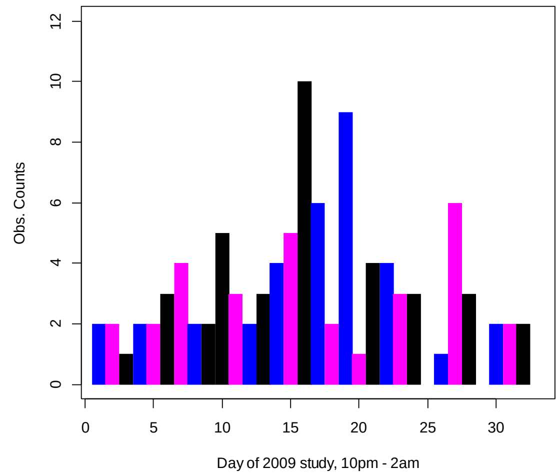
Appendix B

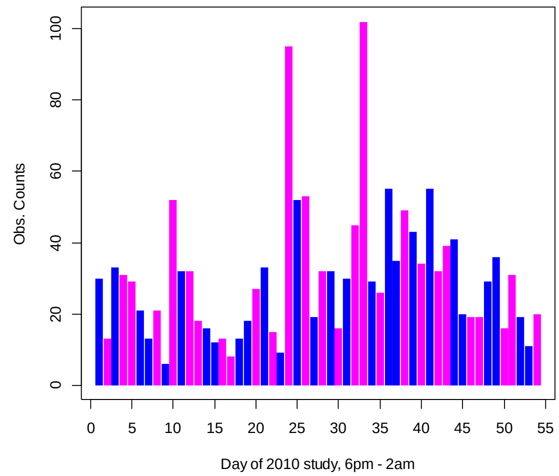
Bar charts of passage counts by test condition over time

Chinook Salmon

Histograms of Chinook salmon counts by trials

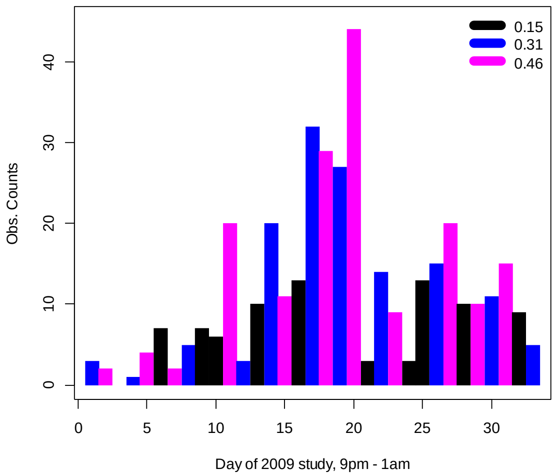


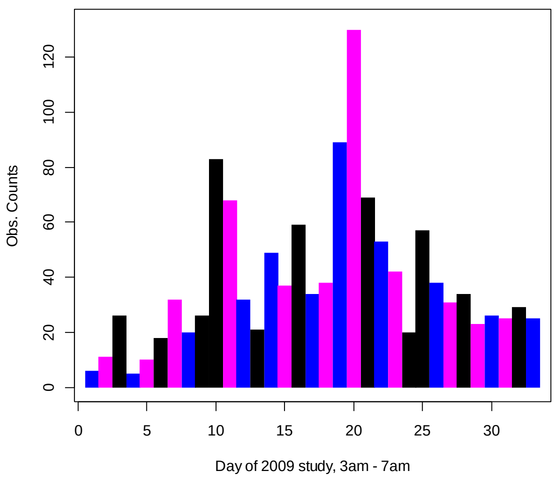


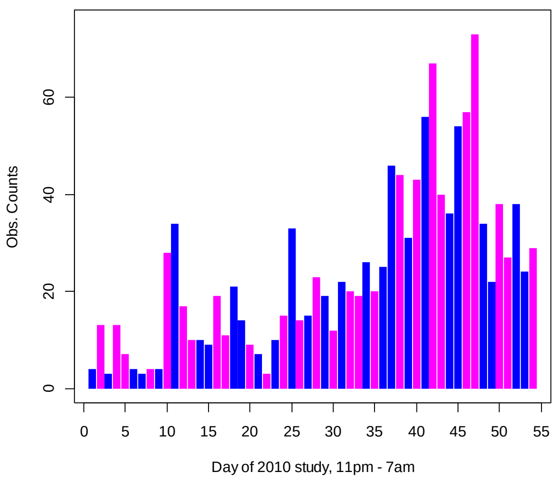


Steelhead

Histograms of steelhead counts by trials

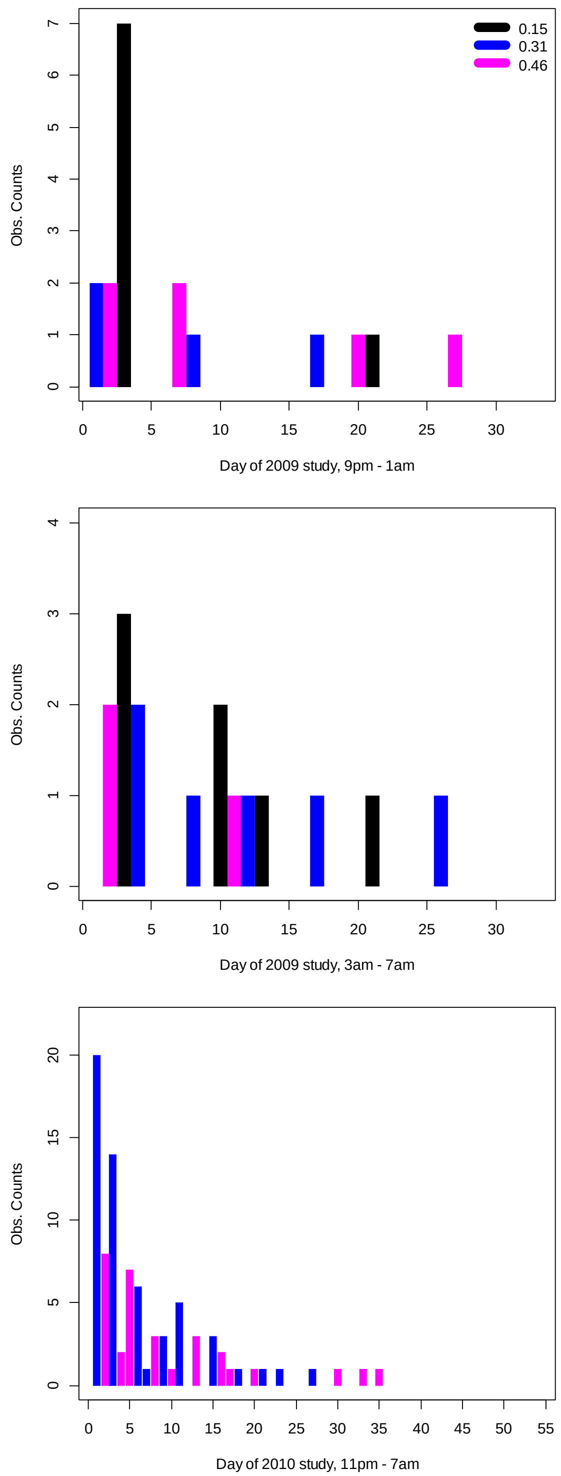






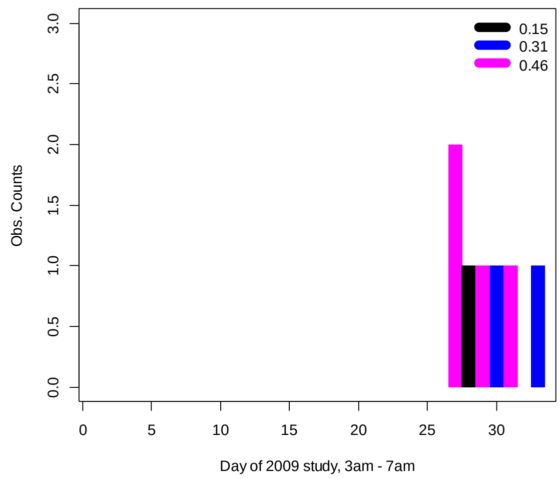
Sockeye Salmon

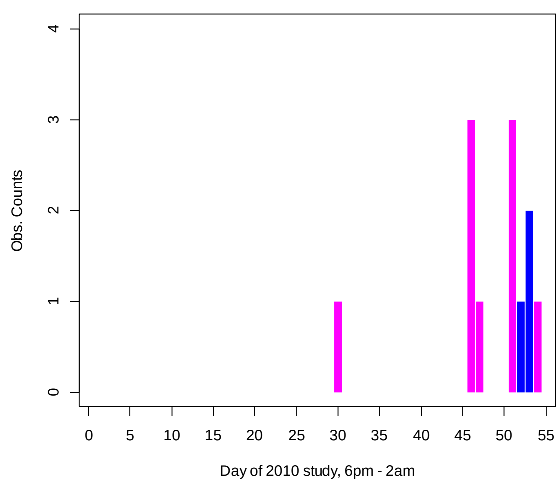
Histograms of sockeye salmon counts by trials

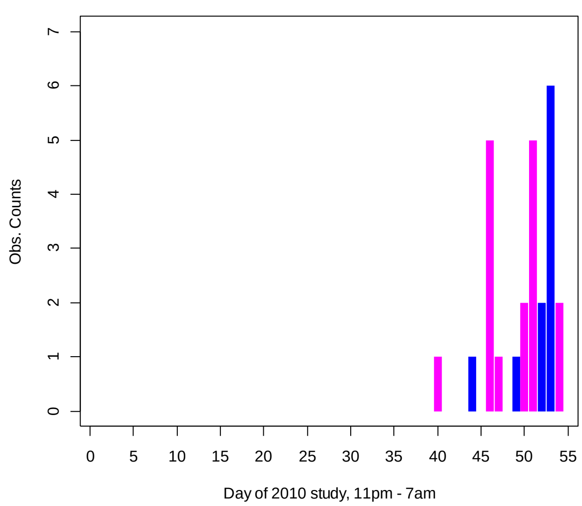


Coho

Histograms of coho salmon counts by trials







Appendix C

Analyses of deviance tables used in testing for differences in salmonid passage under different entrance velocities

Table C1. Analyses of deviance tables for Chinook salmon.

2009: 9 PM – 1 AM

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	32	55.6570			
Block	10	19.8780	1.9878	1.2445	0.3234
Treatment	2	3.8334	1.9167	1.2000	0.3220
Error	20	31.9455	1.5973		

2009: 10 PM – 2 AM

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	32	53.4701			
Block	10	19.2688	1.9269	1.1458	0.3793
Treatment	2	0.5661	0.2831	0.1683	0.8463
Error	20	33.6352	1.6818		

2010: 6 PM – 2 AM

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	53	528.0919			
Block	26	292.3798	11.2454	1.3124	0.2466
Treatment	1	12.9238	12.9238	1.5082	0.2304
Error	26	222.7883	8.5688		

Table C2. Analyses of deviance tables for steelhead.

2009: 9 PM – 1 AM

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	32	253.4061			
Block	10	153.3047	15.3305	4.4157	0.0023
Treatment	2	30.6650	15.3325	4.4163	0.0258
Error	20	69.4364	3.4718		

2009: 3 AM – 7 AM

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	32	513.9085			
Block	10	397.5123	39.7512	7.2917	0.0001
Treatment	2	7.3647	3.6824	0.6755	0.5202
Error	20	109.0315	5.4516		

2010: 11 PM – 7 AM

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	53	625.1908			
Block	26	538.4348	20.7090	6.5018	< 0.0001
Treatment	1	3.9434	3.9434	1.2381	0.2760
Error	26	82.8127	3.1851		

Table C3. Analyses of deviance tables for sockeye salmon.

2009: 9 PM – 1 AM (Blocks 1-9)

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	26	50.1573			
Block	8	37.1647	4.6456	6.3893	0.0008
Treatment	2	1.3592	0.6796	0.9347	0.4131
Error	16	11.6334	0.7271		

2009: 3 AM – 7 AM (Blocks 1-9)

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	26	31.6534			
Block	8	11.5457	1.4432	1.2591	0.3295
Treatment	2	1.7683	0.8841	0.7714	0.4788
Error	16	18.3394	1.1462		

2010: 11 PM – 7 AM (Blocks 1-18)

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	35	170.2084			
Block	17	131.6054	7.7415	4.2024	0.0025
Treatment	1	7.2862	7.2862	3.9552	0.0631
Error	17	31.3168	1.8422		

Table C4. Analyses of deviance tables for coho salmon.

2009: 9 PM – 1 AM Only 1 fish observed (during a 0.31 Treatment period).
2009: 10 PM – 2 AM No fish observed.

2009: 3 AM – 7 AM (Blocks 9, 10, 11 only (starting day 25))

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	8	6.2910			
Block	2	0.2747	0.1373	0.1368	0.8760
Treatment	2	2.0008	1.0004	0.9965	0.4455
Error	4	4.0155	1.0039		

2010: 6 PM – 2 AM (Blocks 15,23-27 only)

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	11	15.9559			
Block	5	7.6382	1.5276	1.4750	0.3401
Treatment	1	3.1395	3.1395	3.0314	0.1421
Error	4	5.1783	1.0357		

2010: 11 PM – 7 AM (Blocks 20-27 only (starting day 39))

	Df	Deviance	Mean Dev.	F	P(> F)
$Total_c$	15	36.7612			
Block	7	21.9098	3.1300	1.6285	0.2678
Treatment	1	1.3972	1.3972	0.7269	0.4221
Error	7	13.4543	1.9220		

APPENDIX J - WELLS PROJECT SUBYEARLING CHINOOK LIFE-HISTORY STUDY 2011 INTERIM REPORT

WELLS PROJECT SUBYEARLING CHINOOK LIFE-HISTORY STUDY 2011 INTERIM REPORT

WELLS HYDROELECTRIC PROJECT

FERC NO. 2149

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ABSTRACT

The Public Utility District No. 1 of Douglas County (Douglas PUD) initiated a study in 2011 to better characterize the behavior and ecology of subyearling Chinook found within the Wells Project. Our goal was to investigate the behavior and life-history strategies of subyearling Chinook in the Wells Reservoir to provide data necessary to determine how best to study their survival through the Wells Hydroelectric Project.

Together nearly 18,500 wild subyearling Chinook salmon were handled during scoping, tagging, and growth monitoring efforts and over 13,200 were Passive Integrated Transponder (PIT)-tagged and released during the 2011 study. Fish were available for capture by beach seine from our first seining efforts in late May to the end of July, with availability declining dramatically by mid-July. Over the course of the study, the proportion of taggable fish captured in seine sets increased from 4% in late May to 100% in late July. During the three-week tagging period the proportion of taggable fish (>57 mm) captured increased from just under 48% to greater than 96%. Estimated growth in the Wells Reservoir was 0.77 mm/day based on the change in mean length of fish captured over the study period, late-May to the end of July. Growth may have been underestimated since larger fish may have moved offshore and newly arrived smaller fish may have replaced them throughout the study. Measured growth rates of tagged fish recaptured at lower-river projects were in excess of 1 mm/d. In contrast, the mean of measured growth rates of 415 tagged fish recaptured in Wells Reservoir within 2 to 11 days of release was only 0.34 mm/d, suggesting a short-term energetic cost to capture, tagging, and handling. Handling and tagging caused an observed mortality of 2.3 %. Delayed mortality from handling was not evaluated.

Prior to mid-November when juvenile bypass systems (JBSs) shut down at McNary, John Day, and Bonneville dams, 2,314 unique fish of 13,223 (17.5%) tagged and released were detected at downstream arrays. The majority of detections occurred at Rocky Reach Dam. Travel rates increased with increasing distance from release location: the mean of travel rates from Wells to Rocky Reach was 4.8 km/d, but was 44.6 km/d from John Day to Bonneville.

In the analysis of our data we compared our results with the set of six “life-history” hypotheses and two “tagging and fish size” hypotheses that we selected to assist us in understanding the degree to which the assumptions of the single- and paired-release experimental models match the behavior of the population of subyearling Chinook in Wells Reservoir. Our results are as follows:

1. Juvenile summer/fall Chinook in the Wells Reservoir clearly exhibit a continuum of migration timing, with passage at downstream projects occurring from spring at least until termination of bypass operations in mid-November.

2. In 2011 the 86-mm fish length was a size threshold beyond which fish began the transition to occupying habitat beyond the reach of our beach-seining efforts, and many of them commenced active migrations.

3. The residence time of for at least 30%of the subyearling Chinook tagged in Wells Reservoir in 2011, and in particular, those less than 87 mm in length, exceeds the battery life of the smallest currently available acoustic tags.

4. A portion of the study-fish population migrates during periods when downstream PIT-tag detection arrays are not operational.

5. Because of differences in migration timing and migration rates of individuals of varying sizes tagged during the same or different time period(s), subyearling Chinook released above and below Wells Dam would experience different river conditions, and different survival probabilities when migrating through the control reach and other downstream reaches.

6. Nearly all fish captured in May in 2011 were too small to PIT-tag, and the proportion of the combined weekly catches that was too small to tag declined in a curvilinear fashion until mid-July when all fish captured were large enough to tag. Unfortunately for study purposes, by the date when all captured fish were large enough to tag few fish were available for capture by beach seining.

7. Nearly all of the subyearling Chinook available for capture by beach seining in the Wells Reservoir were of insufficient size for tagging with an acoustic transmitter.

9. The process of capturing, holding, and tagging incurs a biological cost on subyearling Chinook that affects short-term growth, and may affect both short- and long-term survival.

We conclude that our inability to tag a representative sample of the study population, and the differential probability of detection and survival within the sample population present substantial obstacles to conducting a study of project survival using either active or passive tags. Additional years of study will be required to verify what appears to be a size threshold for a behavioral shift from near-shore rearing to an off-shore migration phase. Further, other environmental variables such as flow and temperature might be important in triggering the transition of fish from a rearing into a migratory phase. Analysis of data from several years of study may reveal the influence of such factors on fish behavior.

1.0 INTRODUCTION

Douglas PUD's Wells Hydroelectric Project (Wells Project or Project) Anadromous Fish Agreement and Habitat Conservation Plan (Wells HCP) establishes requirements for determining the rates of survival through the Wells Project (comprising the reservoir, dam, and tailrace) for all species and races of anadromous salmonids that pass the Project. Studies to measure the passage survival of migrating juvenile salmonids rely on marking or tagging of study subjects and subsequent "recapture" (i.e., tag detection) of those subjects at downstream locations. The "single release" and "paired release" experimental designs rely on conformance of both the study protocols and study subjects to a set of assumptions, the violation of which affects (to varying degrees) the accuracy and/or precision of the resultant survival estimates. Yearling spring migrants (e.g., yearling Chinook and steelhead) and the protocols used to study them adhere neatly to the assumptions of the paired-release study design. In contrast, subyearling Chinook apparently do not conform well to those assumptions (Anchor QEA 2010); and yet, their behavior, both in Wells Reservoir and during their migration, remains poorly understood, as does the degree to which they do not conform to the paired-release survival-study assumptions.

In November 2009 the combined HCP Coordinating Committees (HCP CC) for the Wells, Rocky Reach, and Rock Island hydroelectric projects convened a "Subyearling Workshop" to learn the state of the science regarding juvenile subyearling Chinook and consider means for studying their survival through hydroelectric projects (Anchor QEA 2010). In February 2010, the HCP CC discussed the findings of the Subyearling Workshop and contemplated an appropriate path forward to achieving the HCP requirements regarding determinations of project survival estimates for subyearling Chinook. Douglas and Chelan PUDs (PUDs) agreed to prepare a summary of feasible actions for HCP CC consideration. In June of 2010, the PUDs presented a proposal to monitor detections of Passive Integrated Transponder (PIT)-tagged subyearling Chinook originating upstream of Rocky Reach Dam. The PUD's expected that relatively small numbers of PIT-tagged subyearling Chinook originated above Rocky Reach Dam, but a new PIT-tag detection system installed in the Rocky Reach Juvenile Fish Bypass System would dramatically improve detection probability. By monitoring PIT-tag detections the PUDs hoped to determine the distribution of migration timing of subyearling Chinook.

In December of 2010, Douglas PUD proposed to increase the number of PIT-tagged subyearling Chinook above Rocky Reach Dam by implementing a pilot study to tag up to 20,000 subyearling Chinook in the Wells Reservoir. Besides enhancing the number of PIT-tagged fish available for downstream detection, the pilot study would also more systematically investigate life-history strategies of subyearling Chinook toward an understanding of the population behavior as a foundation for progress toward obtaining a valid passage-survival estimate at the Wells Project. Douglas PUD presented a subyearling pilot-study proposal to the HCP CC in March 2011, and implemented the study in May 2011. This report presents background information on subyearling Chinook in the Columbia River Basin, and the methods, results, discussion, and conclusions from Douglas PUD's 2011 subyearling Chinook life-history study.

2.0 BACKGROUND

2.1 Spring, Summer, and Fall Chinook

The Columbia and Snake r ivers support large populations of spring, summer/fall, and fall Chinook salmon (*Oncorhynchus tshawytscha*) that exhibit a diverse array of downstream passage and life-history strategies (Brannon et al. 2004; Connor et al. 2003; Chapman et al. 1994). Spring Chinook above Wells Dam return to spawning tributaries in the spring, and spawn in August and early September in the upper reaches of major tributaries. Spring Chinook juveniles emigrate as yearlings, following the classic “stream-type” life-history strategy. “Ocean-type” adult Chinook salmon, also referred to as summer/fall Chinook, return to fresh water in the summer and fall (July through November). Spawning occurs in the late fall in the lower reaches of large tributaries and the mainstem Snake and Columbia rivers (Dauble et al. 1999; Groves and Chandler 1999). Above Wells, these fish spawn in the Methow, Okanogan, and Similkameen Rivers, and in the mainstem of the Columbia River within the delta of Foster Creek in the tailrace of Chief Joseph Dam (Mann et al. 2012). Fry rear in fresh water for several weeks to several months, and subsequently move seaward as subyearlings (Lister and Genoe 1970; Healey 1991; Brannon et al. 2004).

The emigration behavior of juvenile summer/fall Chinook above Wells Dam does not fit neatly into the classic “ocean-type” classification, with some emigrants delaying migration or apparently exhibiting a “reservoir-type” life-history strategy (Chapman et al. 1994). “Reservoir-type” summer/fall Chinook salmon juveniles remain in the reservoirs of hydroelectric dams longer than typical ocean-type subyearlings. These fish usually emerge later in the spring and may migrate more slowly to the Pacific Ocean arriving in the late fall. Others may overwinter, or “residualize” (Connor et al. 1996), in reservoirs and migrate seaward as yearlings during the following spring (Connor et al. 2005). The prevalence of ocean-type and reservoir-type life-histories varies dramatically from year to year within the summer/fall Chinook population upstream of Wells Dam (Chapman et al. 1994).

2.2 Subyearlings above Wells

Above Wells Dam, summer/fall Chinook fry are thought to emerge between mid-February and the end of April in the Okanogan and Methow rivers (Chapman et al. 1994; Chapman 2007). Similar emergence dates were recorded in the Wells Hatchery spawning channel from 1968-1971 (Allen 1970; Allen et al. 1971). Following emergence, mid-Columbia subyearlings appear to preferentially select shallow littoral habitats (< 100 cm deep), low velocities (< 1cm/s), and often share small-substrate habitats with small resident fishes (McGee et al. 1983; Chapman et al. 1994; Chapman 2007).

Wells Project subyearlings are suspected to move offshore as they grow and may migrate up- or downstream to seek forage and cover. In addition, subyearlings are reported to return to the nearshore and remain inactive during the night, moving off shore each day to forage (Hillman et al. 1989). This diel movement pattern diminishes with increased growth, since larger subyearlings may participate in nighttime emigration (Chapman 2007). Rondorf and Gray (1987) observed such onshore-offshore movements in the upstream reaches of the McNary

Reservoir (Hanford Reach) from May to mid-July, with 80 mm as a critical fish length that determined the initiation of offshore migration behaviors. Size thresholds for ontogenetic foraging behaviors have not been evaluated above Wells Dam. Our expectations based on available information were that we could capture subyearlings in the Wells Project using seine nets in shallow littoral habitats during spring and early summer. We also considered that it may be easier to capture subyearling Chinook during nighttime hours, when they are docile in shallow-water habitats, up until they reach a critical size and commence offshore movements or emigration behavior.

2.3 Migration Timing and Behavior in the mid-Columbia

Migration-timing disparities between subyearling and yearling Chinook are illustrated in historic PIT tag data. In 2009, 10-90% (run percentile) of out-migrating yearling Chinook passed Rock Island Dam over a 36-day period, highlighting the predictability of yearling migration. However, 10-90% (run percentile) of subyearling Chinook passed Rock Island over a 64 day period (May 30-Aug 2), indicating variable or protracted migration rates relative to yearling Chinook. Comparatively, at Lower Granite Dam, 10-90% (run percentile) of the subyearlings passed the project during a 47 day window (June 5 to July 22; FPC 2009). These results may highlight an increased diversity in run timing in the mid-Columbia compared to the Snake River subyearlings.

In the Snake River, the protracted migration periods exhibited by some subyearling Chinook can be explained by the observation that subyearlings exhibit at least four different migration phases (Connor et al. 2003):

1. Discontinuous downstream dispersal along the shorelines of the free-flowing river,
2. Abrupt and mostly continuous downstream dispersal off shore in the free-flowing river,
3. Passive, discontinuous downstream dispersal offshore in the first reservoir encountered en route to the sea, and
4. Active and mostly continuous seaward migration.

Although scales from returning adults provide evidence of reservoir-type summer/fall Chinook in the mid-Columbia, the expression of the four migration phases described by Conner et al. (2003) has not been empirically identified in the mid-Columbia. That is, we know that reservoir-type fish exist, but the details of their emigration behavior remain undefined. Assuming that subyearling Chinook in the mid-Columbia behave similarly to those in the Snake River, it is unclear which stocks (tributary populations, mainstem spawners) and what proportions of each stock manifest these behaviors. One could reasonably conclude that the percentages of fish exhibiting these behaviors fluctuate with annual variability in flow, water temperature (natal area and migration corridor), and population size; but this information is absent in the mid-Columbia (see Connor et al. 2003; Buchanan et al. 2009).

3.0 STUDY OBJECTIVES, ASSUMPTIONS, AND HYPOTHESES

The goal of the 2011 subyearling Chinook life-history study was to investigate the behavior and life-history strategies of subyearling Chinook in the Wells Reservoir to provide data necessary to determine how best to study their survival through the Wells Project. In particular, Douglas PUD sought to understand the degree to which the assumptions of the single- and paired-release experimental models match the behavior of the population of subyearling Chinook in Wells Reservoir. Those assumptions are as follows:

1. Study fish are representative of the study population and not just a subset of fish that can tolerate the tag
2. The study tag does not affect survival and detection probabilities
3. Mortality does not occur during detection
4. Survival and detection probabilities of individuals are independent of each other
5. All individuals from a release group have the same probability of survival to the end of the reach
6. All individuals alive at detection location have the same probability of detection
7. All tags are correctly identified and status as either alive or dead is accurately assessed
8. Survival below the control release site must be conditionally independent of survival upstream of the control release site
9. Survival in common river segments downstream of the control release site is equal for both the treatment and control release groups

3.1 Objectives

Within the goal stated above, Douglas PUD considered specific assumptions in the design of a pilot study, and, based upon those assumptions, identified primary objectives for the study that considered logistical and practical issues of study implementation within the context of the overall goal. The primary objectives of the 2011 subyearling study were as follows:

1. Using various capture methods (e.g., beach seine, purse seine, screw traps), and gleaning from historical fyke net and bypass data from the Upper Columbia River, and in coordination with annual trapping schedules, begin to identify the size distributions of subyearlings in the Wells Reservoir at given time intervals.
2. Determine the size of fish that are actively migrating past Wells Dam, or begin to identify the critical size at which subyearling fish begin to actively migrate.
3. If appropriate, identify and categorize differences in migration timing between observed variations in subyearling life histories.
4. Determine the presence of taggable fish in the Wells Reservoir, and whether these fish are representative of a migratory subyearling Chinook salmon.
5. Use study results to evaluate the feasibility of/limitations to conducting subyearling survival studies at the Wells Project.

3.2 Life History Assumptions

The assumptions that formed the basis for the objectives stated above and the hypotheses listed below are as follows:

1. Subyearling Chinook present in the Wells Reservoir comprise rearing or passive migrants in addition to active, seaward migrants.
2. Fish migrate past detection points when the tags are still active, detection arrays are operational and active, and detection efficiencies are uniform.
3. Migration occurs during the life of the tag used in the study.
4. Travel times for subyearlings in general are similar for all subyearlings released.
5. Migrating fish are large enough to be tagged and there is no “biological cost” to tagging (biological cost is defined as a decrease in growth or impairment in function, or otherwise increased probability of mortality from any cause).

3.3 Study Hypotheses

Study hypotheses were adapted from Douglas PUD’s 2011 Study Plan reviewed by the Wells HCP CC in March of 2011, and included both life-history hypotheses and tagging and fish-size hypotheses.

3.3.1 Life-history Hypotheses

$H1_{alt}$: Ocean-type Chinook in Wells Reservoir represent multiple life-history strategies with variable migration timing including spring and summer subyearling, spring yearling, reservoir rearing, and intermediate migration types.
$H1_{o}$: Ocean-type Chinook in Wells Reservoir represent a single life-history strategy with discrete and predictable migration timing.

$H2_{alt}$: Subyearling Chinook tagged into the Wells Reservoir, of the size observed migrating through Wells Dam, do not actively migrate through the Wells Project.
$H2_{o}$: Subyearling Chinook tagged into the Wells Reservoir, of the size observed migrating through Wells Dam, are actively migrating through the Wells Project.

$H3_{alt}$: Residence time in Wells Reservoir exceeds the battery life of current acoustic tags.
$H3_{o}$: Residence time in Wells Reservoir does not exceed the battery life of current acoustic tags.

$H4_{alt}$: A portion of the study-fish population migrates during periods when downstream PIT-tag detection arrays are not operational.
$H4_{o}$: The study-fish population migrates only during periods when downstream PIT-tag detection arrays are operational.

$H5_{alt}$: Subyearling Chinook released above and below Wells Dam experience different river conditions, and different survival probabilities when migrating through the control reach (Rocky Reach Reservoir).

$H5_o$: Subyearling Chinook released above and below Wells Dam experience similar river conditions and have similar survival probabilities when migrating through the control reach (Rocky Reach Reservoir).

3.3.2 Tagging and Fish Size Hypotheses

$H6_{alt}$: The fish available for capture in the Wells Project at time t_1 are not of sufficient size for tagging with 12.5 mm tags.
$H6_o$: The fish available for capture in the Wells Project (reservoir, dam and tailrace) at time t_1 are of sufficient size for tagging with a 12.5-mm PIT tag.

$H7_{alt}$: The fish available for capture in the Wells Project are not of sufficient size for tagging with an acoustic transmitter.
$H7_o$: The fish available for capture in the Wells Project are of sufficient size for tagging with an acoustic transmitter.

Hypothesis H8 from the 2011 Study Plan would require a lab component to the study, and we did not include a lab component. Following the finalization of the 2011 Study Plan we added the following hypothesis:

$H9_{alt}$: The process of capture, holding, and tagging incurs a biological cost on subyearling Chinook.
$H9_o$: The process of capture, holding, and tagging does not incur a biological cost to subyearling Chinook.

4.0 METHODOLOGY

4.1 Study Area

The Wells Project is located at river kilometer (RK) 830 on the Columbia River in the State of Washington. Wells Dam is located approximately 50 river kilometers downstream from the Chief Joseph Hydroelectric Project, owned and operated by the United States Army Corps of Engineers (COE), and 70 kilometers upstream from the Rocky Reach Hydroelectric Project owned and operated by Public Utility District No. 1 of Chelan County (Chelan PUD). The nearest town is Pateros, Washington, located approximately 13 kilometers upstream from the Wells Project at the confluence of the Methow River.

The Wells Project is the chief generating resource for Douglas PUD. It includes 10 generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Fish passage facilities reside on both sides of the hydrocombine, which is 1,130 feet long, 168 feet wide, with a crest elevation of 795 feet mean sea level (msl) in height.

The Wells Reservoir is approximately 50 kilometers long. The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends approximately 2.5 kilometers up the Methow River and approximately 26 kilometers up the Okanogan River. The normal maximum surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre-feet at elevation of 781 feet msl. The normal maximum water surface elevation of the reservoir is 781 feet msl.

4.2 Fish Capture Details

Fish were captured with beach-seine nets throughout a two month period of 2011. Capture efforts for tagging began on June 20th, and that date was selected based on mean sizes of fish and growth data collected during scoping activities earlier in the season. Seining dates were as follows: May 27th, June 10th, and June 15th for scoping (captured fish were enumerated, measured, and released without tagging); June 20-23rd, June 27th-30th and July 5th-8th for tagging, and July 19th and 27th for fish-growth monitoring and to determine continued susceptibility of the fish to capture by beach seining.

Scoping efforts prior to the first day of capture allowed Douglas PUD biologists to identify locations for effective beach seining, and to gather location-specific growth information. During the first week of collecting fish for tagging, two crews of 4-5 staff deployed to multiple capture locations. Three beach seines were used to capture fish; one 15.24-m long x 1.83-m deep, another 15.24-m long x 1.22-m deep, and a third 30.49-m long and 3.05-m deep, with a 28.32-cubic-meter “bag” in the center (Figure 1). Seines were made by Memphis Net and Twine (Memphis, Tennessee) and were Delta woven 4.8-mm mesh with “fish-green” treatment. During the second week the two smaller seines were mended together into a single net to increase fishing distance offshore. By the last week of June only the large net was used and one fishing crew was deployed, since a highly productive fishing area was located on the north shore of the Columbia River downstream from the mouth of the Okanogan River.

Figure 1. Operating the large 100-foot seine at Gebber’s Landing in 2011.

To operate the large net, two people would anchor the net on shore, while the other end was affixed to the bow of a tow boat. The boat would back away from the beach perpendicular to the shoreline to deploy the net. Once the net was fully extended, the boat would turn to parallel the shoreline and begin pulling the net upstream. Those on shore would pull the other end of the net up the shoreline, matching the speed of the boat as it slowly reversed parallel to and approximately 50 feet from shore (see Figure 1). The operator on shore holding the lead-line would lead the walk along the shoreline, and attempt to direct fish along the wing of the net towards the center or bag (see Figure 1). Once a suitable distance had been covered (250-2000 feet) the boat would reverse toward the shore where the net could be closed off and the "set" could be completed. From the beach, the lines and net on either side would be pulled in to remove the slack and concentrate fish in the center of the seine. When the bag was the only part of the net remaining in the water, the contents of the bag would be emptied with dip nets. All captured fish were put directly into buckets containing ambient river water. Fish remained in buckets for up to 1 hour (usually much shorter duration), and water was changed out regularly to maintain suitable temperatures and dissolved oxygen. All non-target fish were returned to the water immediately. At regular intervals, subyearlings held in buckets were transported by boat to floating net pens. These net pens were anchored in the river, within one mile of the seining locations. Net pens were approximately 5 square meters and were covered with 4.8-mm mesh; maximizing water exchange, preventing escape, and entrance of predators (Figure 2A). Fish were held in the net pens overnight to recover from capture stress and to evacuate their digestive tracts, prior to tagging on the following day (Figure 2B).

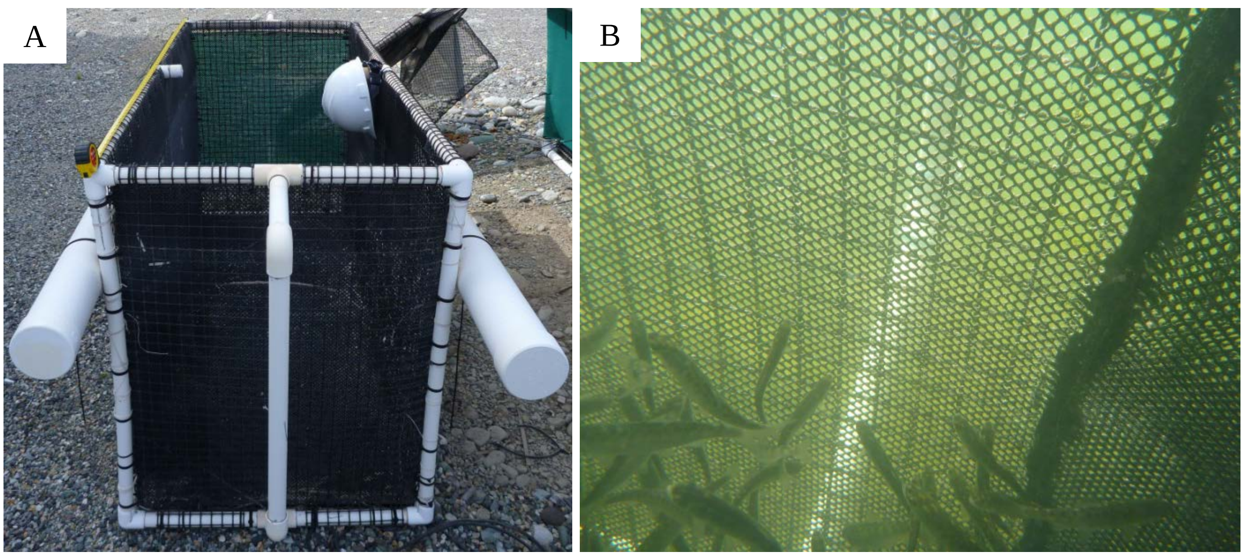

Figure 2.   A) An empty net pen with the lid removed, and B) tagged subyearling fish swim within the in-river net pen.

Fishing effort was focused in areas that contained large numbers of subyearling Chinook that could be fished without snagging the seine net thereby yielding high catch per unit effort. Areas fished in the Wells Projects are provided in Figures 3 and 4, with the bulk of the fish captured coming from seining locations in Figure 3. Capture locations were given the following names for reference purposes: Dead Beaver, Smuggler's Cove, Gebber's Landing, Okanogan Mouth/River, Washburn Island and Starr (Figures 3 and 4).

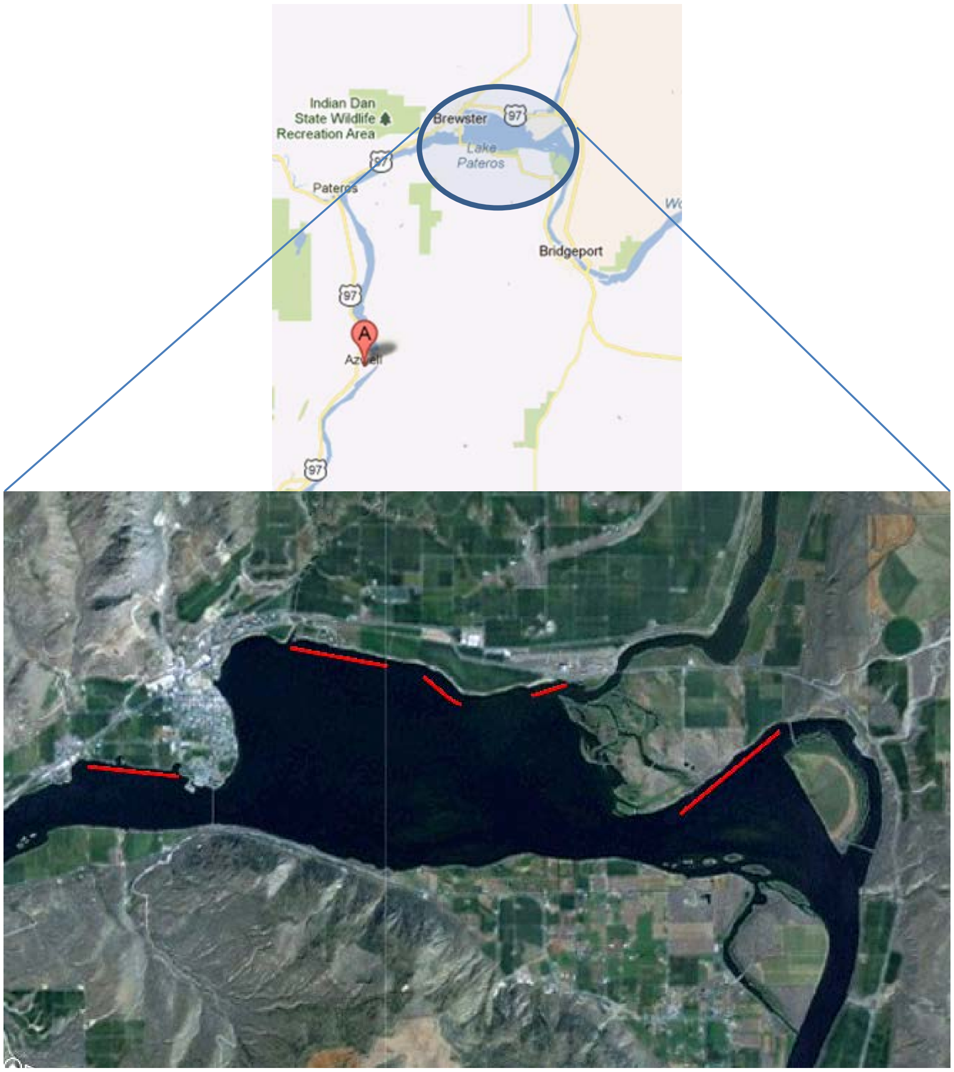

Figure 3. Seining locations in the Wells Project (red lines) in 2011. From left to right: Dead Beaver, Smuggler's Cove, Gebber's Landing, Okanogan Mouth/River, and Washburn Island.

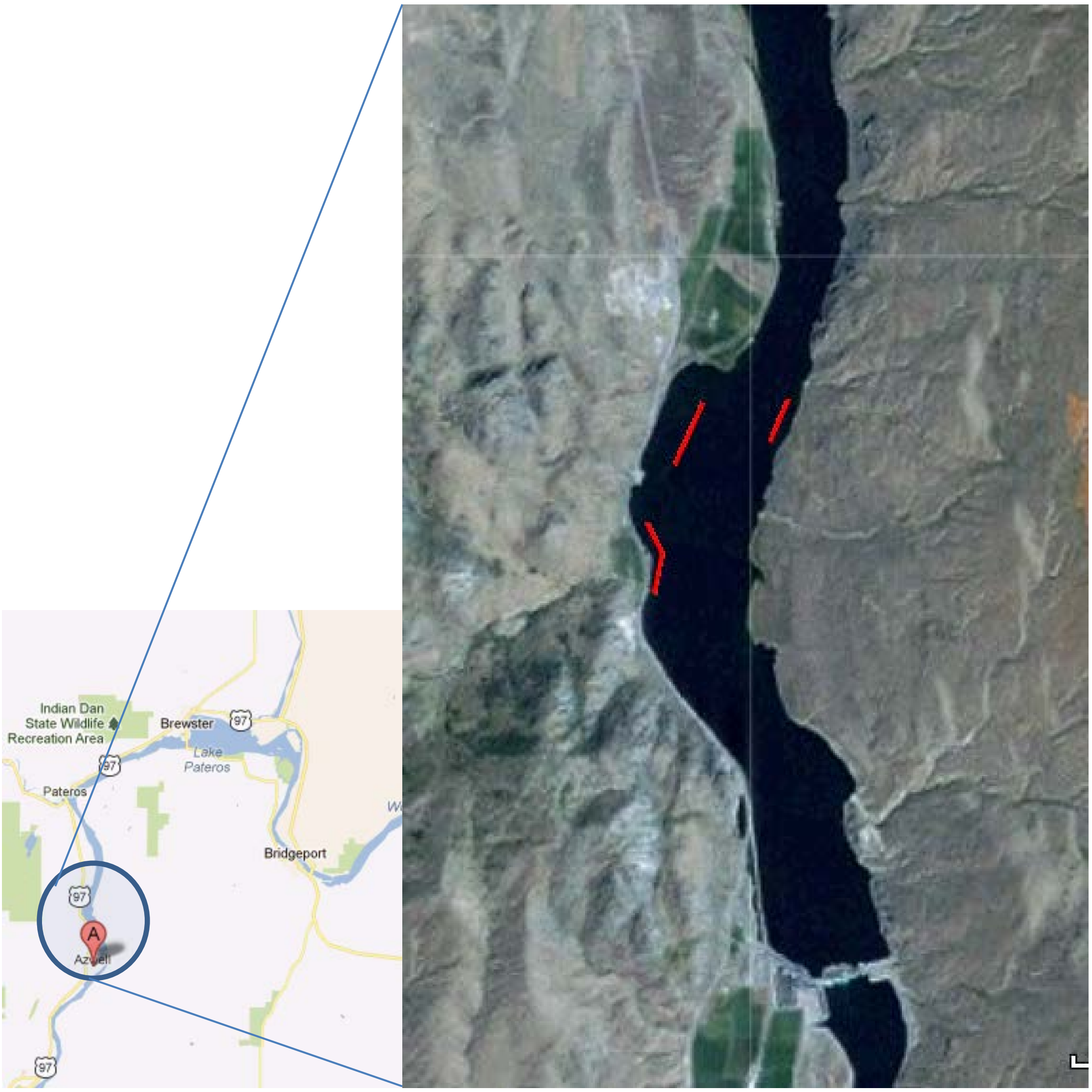

Figure 4. Seining locations in the Starr boat launch area in 2011. Wells Dam extends across the river in the lower portion of the figure.

4.3 Tagging Procedures

4.3.1 General Protocol

All tagging was conducted by Biomark using a Biomark mobile tagging station modified for this project. The tagging station consisted of an approximately one-meter-square aluminum work surface with built in sinks and a trough for holding fish during the tagging process. The station also housed the necessary electronics (computer, digitizer board, tag reader, and antenna) needed for tagging. Water was taken from the Wells Pool via 18.9 liter (5 gallon) buckets to supply the 45 liters needed to fill the sinks and trough of the tagging station. An anesthetic solution consisting of 100 grams tricane methanosulfonate (MS-222) mixed in one liter of water was used to sedate the fish prior to tagging. Approximately 12 milliliters of anesthetic solution was added to the 45 liters of water in the sinks and troughs. Water in the tagging station was changed every 5-10 minutes to maintain the water temperature within 1.0^{o}C of ambient water temperature. The concentration of MS-222 used would bring the fish to the desired level of stage-2 anesthesia in approximately 3 to 4 minutes. All fish were tagged within 10 minutes of the initial exposure. Recovery time was approximately 1 to 2 minutes.

Because of the dispersed nature of the tagging locations (see Figures 3 and 4), the mobile tagging station was set up on a barge that was moved between net pens rather than transporting large numbers of fish to and from a central tagging location. Each day following seining, the barge would move to the net pen containing the fish captured the previous day. Each tagging location had two net pens: one containing the fish to be tagged, and an empty pen for receiving the tagged fish. Fish to be tagged were collected from the respective net pens using a dipnet and placed into an 18.9-liter bucket of water. Up to 40 fish at a time were collected from the bucket using a small dipnet and placed in one of the tagging-station sinks containing anesthetic solution.

Fish were tagged with 12.5 mm 134.2 kHz ISO PIT tags using pre-loaded, single-use, 12-gauge hypodermic needles (BIO12.BPLT) fitted onto injection devices (MK-25). We opted to use the 12.5 mm PIT tags to maximize detection at downstream locations, and, in particular, at Rocky Reach Dam and the Bonneville Dam corner collector. Detection efficiencies at both of these sites would dramatically suffer when using the smaller PIT tags available in June 2011. All fish were tagged with a single-use needle to reduce the chance of disease transmission or injuries caused by dull needles. The two-person Biomark tagging crew consisted of one tagger and one tagger/data collector (data collector interrogates the tag in each tagged fish, records their fork length with an electronic wand on a digitizer board, and notes any anomalies). After the data were collected on a tagged fish, the fish was placed into an 18.9-liter bucket of water, and the fish in the bucket were then placed into the receiving net pen for tagged fish after all the fish in the tag-station sink had been tagged and recorded.

Data collected during tagging were stored using PITTAG3 software (Pacific States Marine Fisheries Commission). After completion of the tagging events, tag files were consolidated, uploaded to PTAGIS, and submitted to Douglas PUD.

4.3.2 Fish Releases

Tagged fish were released the morning after they had been tagged. The net pen was opened and all observed mortalities and moribund fish were removed. Once the mortalities were removed the net pen was tilted to allow the fish to volitionally exit. PIT tags were recovered from mortalities and moribund fish and the associated tag codes were marked as “Mortalities” in the tag files and the tag codes were deleted. No shed tags were recovered since the mesh used on the bottom of the net pens was such that any tags that were shed would fall through the mesh.

4.3.3 Post-tagging Sampling

After the completion of tagging, we sought to monitor growth by attempting to capture, measure, and release fish in locations where they were captured earlier in the season. The same locations were sampled on a semi-weekly basis until fish were no longer available via beach seining. To confirm the absence of subyearling Chinook in these littoral habitats, snorkel surveys were conducted in these locations late into the summer.

4.3.4 Statistical Methods

Comparisons of growth rates, run timing, distribution of passage, and all statistical methods were performed in JMP 7.0 (SAS) or MS excel. Linear regressions were used to assess growth of fish recaptured in the Wells Project; fish captured during scoping, tagging, and growth monitoring; and recaptures at lower-river projects. An analysis of variance (ANOVA) and non-parametric equivalents were used to test for relationships between detection frequency and tagging location. Linear regressions were used to analyze the data for relationships between the observed growth of fish recaptured at Rocky Reach and Rock Island dams and the number of days between release and recapture. Frequency distributions were used to show the distribution of detections at lower-river projects. Travel times of all tagged subyearlings, smaller subyearlings (<87 mm), and large subyearlings (>86 mm) were analyzed using the University of Washington's online travel-time analysis (http://www.cbr.washington.edu/dart/pit_sum_tagfiles.html). A non-parametric Mann-Whitney U test was used to examine differences between travel times to Rocky Reach Dam of smaller and larger fish, in an effort to examine size thresholds that may influence migratory behavior. To examine whether there was a biological cost to capture, handling, tagging, and holding, a linear regression was used to examine growth rates of fish that were recaptured in the Wells Project within 11 days of tagging.

Statistical significance for all tests was assessed to $\alpha = 0.05$. All means were reported with standard errors where appropriate and are indicated in the results. Non-parametric analyses were performed when sample sizes were unequal or when data with unequal variances could not be transformed to meet parametric assumptions.

5.0 RESULTS

5.1 Total Fish Sampled and Fish Size by Location

Fish sampling first occurred on May 27 as a "scoping" effort to locate suitable seining sites with concentrations of subyearling Chinook. During the initial sampling efforts a large number of Chinook fry were observed at several locations including Dead Beaver, Brewster Park, Smuggler's Cove, and lower Washburn Island. Gear deployed in these areas resulted in the capture of hundreds of small Chinook fry (averaging 45.2-47.4 mm in FL). The numbers encountered were too large to easily count and, at many sites, the seine sets were cut short or simply not retrieved because the numbers were too large to safely handle. Bycatch of resident stickleback, chub, and pikeminnow fry were also very high.

River conditions during the second scoping trip on June 10 were very different but the results were similar in terms of the numbers of fish observed. Flows in the Columbia River were above normal, and the Okanogan, and Methow rivers were at or near flood stage. The water-surface elevation of the Wells Reservoir was lowered to prevent damage to shoreline and adjacent properties. Rather than finding juvenile Chinook within the riparian vegetation, as was observed during the prior week of sampling, juvenile Chinook fry were observed in most small bays or backwater areas. Sampling included several sites along the Douglas County shoreline between the Brewster Bridge and Park Islands. The sites closer to the bridge produced large number of Chinook fry (mean 56.4-56.7 mm). Bycatch of resident fish was exceedingly high along this section of river and in particular adjacent to the Wells Wildlife Area. The sites sampled closer to Park Island did not produce any fish even though fishing occurred within the channels between the Park Islands where it was believed that habitat conditions were ideal for juvenile Chinook.

Sampling efforts on the third scoping trip on June 15 captured larger fish than the first two scoping periods. The reservoir remained very low during this period (approximate elevation 773' msl). Fish were collected along Dead Beaver and Smuggler's Cove and the mean fish lengths from the combined seine sets at each location were 60.6 mm and 60.3 mm fork length, respectively. With 65 mm as the target minimum fish length for tagging (this was reduced to 58 mm after the first day of tagging), the decision was made to commence tagging efforts during the following week on June 20.

During the implementation of the study (including scoping efforts) a total of 18,487 subyearling Chinook were handled and greater than 92% of those were measured. Growth regressions were plotted by sampling location and for all sampled fish in the Wells Project combined (Figure 5A and B). P-values were not generated for location-specific regressions since repeated samples at each location were too few. Despite the few location-specific samples, fish size was positively correlated with date except at Gebber's Landing. The mean size of subyearling Chinook at Gebber's Landing reached a maximum of around 80 mm on July 8, but fish captured on July 19 had a smaller mean length and no fish were captured during subsequent sampling. During the growth-monitoring phase of the study (post tagging) fish became increasingly difficult to locate. Only two fish were captured at Washburn Island on July 27th (see figure 5A); no fish were encountered at the two other locations sampled (Dead Beaver and Gebber's Landing).

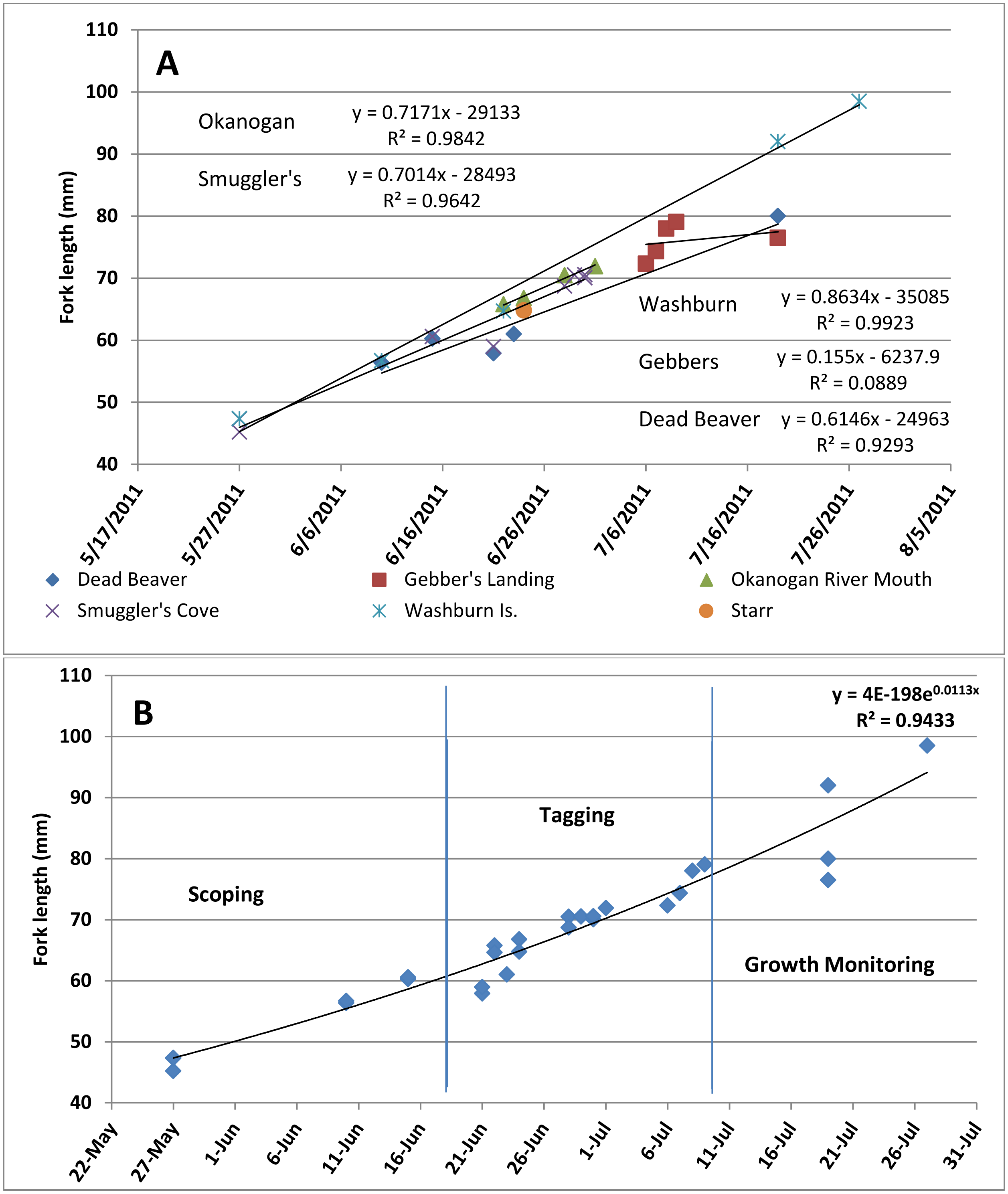

Figure 5. Subyearling Chinook size by A) location, and B) combined sampling from throughout the study ($p<0.0001$). Vertical lines in (B) separate between the three phases of subyearling sampling in 2011: scoping, tagging, and post-tagging growth monitoring.

5.2 Tagging Results

5.2.1 Total Tagged and Handled

Biomark implanted PIT tags into 13,955 wild subyearling Chinook salmon captured in Wells Reservoir between 21 June and 9 July 2011 (Table 1). A total of 3,170 subyearling Chinook were rejected prior to tagging because they were less than the minimum fork length for tagging (n=3,111) or they had obvious signs of disease or injuries (n=59). Together, 17,125 subyearling Chinook were handled during the three-week tagging phase of the study. Fork lengths (mm) were recorded for 13,539 (99.99%) of the fish tagged (Figure 6). Fish were collected, tagged, and released at six different locations in the Wells Reservoir (see Table 1 and Figures 3 and 4). The site with the most fish tagged was Gebber's Landing (river km 856) with 6,272 tagged fish. The site with the fewest fish tagged was Starr Boat Launch (river km 834) with 132 tagged fish.

A total of 415 PIT-tagged fish were recaptured during the project, and most of those were recaptured only once (n = 402). One of the recaptured fish died prior to release the second time. Thirteen of 415 recaptured fish were recaptured twice. More specific recapture information is provided in Appendix C.

Table 1. **Summary of subyearling Chinook salmon PIT tagged in Wells Reservoir in 2011, by week. "Recaps" = recaptured fish; "Rejected Fish" refers to fish handled but not tagged. "Short" indicates fish too small (fork length) to tag.**

Tag File	Tag Date	Tag/Release Site	# Records	# Pre-Release Mortalities	% Mortality	Recaps	% Recaps	# New Tagged Fish Released	Rejected Fish			Total # Fish Handled
									Short	(% Shorts)	Diseased/ Injured	
CSM11172.WP1	6/21/2011	Dead Beaver	68	4	5.9%	0	0.0%	64	418	86.0%	0	486
CSM11172.WP2	6/21/2011	Smuggler's Cove	65	0	0.0%	0	0.0%	65	467	87.8%	1	533
CSM11173.WP1	6/22/2011	Okanogan River	489	71	14.5%	0	0.0%	418	199	28.9%	4	692
CSM11173.WP2	6/22/2011	Near Washburn Is.	334	54	16.2%	0	0.0%	280	177	34.6%	6	517
CSM11174.WP1	6/23/2011	Dead Beaver	340	7	2.1%	5	1.5%	328	605	64.0%	4	949
CSM11175.WP1	6/24/2011	Okanogan River	622	22	3.5%	5	0.8%	595	239	27.8%	8	869
CSM11175.WP2	6/24/2011	Starr Boat Launch	132	4	3.0%	0	0.0%	128	156	54.2%	0	288
		Week 1 Total	***2050***	***162***	***7.9%***	***10***	***0.5%***	***1878***	***2261***	***52.4%***	***23***	***4334***
CSM11179.WP1	6/28/2011	Okanogan River	243	4	1.6%	4	1.6%	235	22	8.3%	3	268
CSM11179.WP2	6/28/2011	Smuggler's Cove	845	20	2.4%	4	0.5%	821	93	9.9%	0	938
CSM11180.WP1	6/29/2011	Smuggler's Cove	1475	27	1.8%	2	0.1%	1446	194	11.6%	8	1677
CSM11181.WP1*	6/30/2011	Smuggler's Cove	271	0	0.0%	1	0.4%	270	40	12.9%	1	312
CSM11181.WP2	6/30/2011	Smuggler's Cove	1244	28	2.3%	20	1.6%	1196	143	10.3%	9	1396
CSM11182.WP1	7/1/2011	Okanogan River	1207	16	1.3%	28	2.3%	1163	106	8.1%	5	1318
		Week 2 Total	***5285***	***95***	***1.8%***	***59***	***1.1%***	***5131***	***598***	***10.2%***	***26***	***5909***
CSM11187.WP1	7/6/2011	Gebber's Landing	1574	17	1.1%	94	6.0%	1463	145	8.4%	5	1724
CSM11188.WP1	7/7/2011	Gebber's Landing	1464	33	2.3%	53	3.6%	1378	62	4.1%	0	1526
CSM11189.WP1	7/8/2011	Gebber's Landing	1659	1	0.1%	100	6.0%	1558	23	1.4%	3	1685
CSM11190.WP1	7/9/2011	Gebber's Landing	1923	10**	0.5%	99**	5.1%	1815**	22	1.1%	2	1947
		Week 3 Total	***6620***	***61******	***0.9%***	***346******	***5.2%***	***6214******	***252***	***3.7%***	***10***	***6882***
		Project Total	**13955**	**318******	**2.3%**	**415******	**3.0%**	**13223**	**3111**	**18.2%**	**59**	**17125**

*Fish in CSM11181.WP1 were remaining fish that were captured on 179 (Julian date) and not tagged on 180 due to high winds during tagging. **One fish in file CSM11190.WP1 was a recaptured fish that died prior to release the second time. This fish is counted in both the mortality and recapture columns, but it is subtracted only once from the "# Records" so that the "# New Tagged Fish Release" remains accurate.

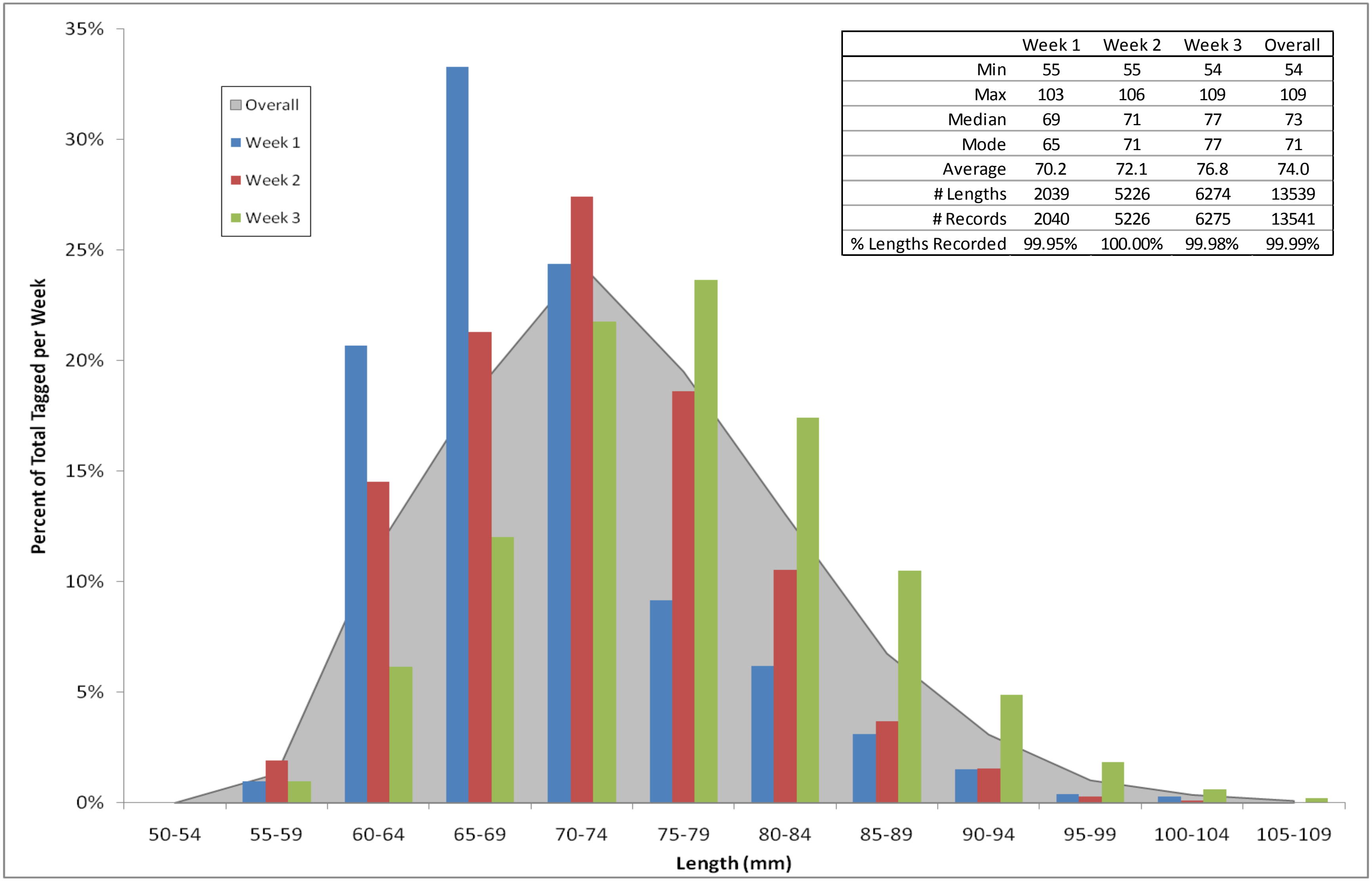

Figure 6. **Length Frequency (by week) of PIT-tagged subyearling Chinook in Wells Reservior in 2011. Week 1 was June 21-24; Week 2 was June 28-July 1; Week 3 was July 6-9.**

5.2.2 Minimum Size Criteria

Tagging began on 21 June at the "Dead Beaver" site (river km 852) and the "Smuggler's Cove" site (river km 855) based upon information collected during the prior weekly sample indicating that subyearling Chinook at those two sites were approaching a minimum fork length of 65mm, which was considered a minimum taggable size. A total of 885 fish in that first group were rejected for having a fork length less than 65mm (86.9% of the 1,019 fish handled the first day of tagging). On subsequent days the target minimum fork length for tagging was reduced to 58 mm. The average fork length of tagged fish increased from about 70.2 mm the first week to 76.8 mm for the third week, which further reduced the rate of fish rejection due to insufficient length. That rejection rate decreased from 52.4% for the first week to 3.7% for the final week, as the size of fish available to our seining gear increased over the three-week tagging period.

5.2.3 Inclement Weather

During tagging on 29 June, high winds resulted in unfavorable tagging conditions. Thus, after tagging 1,475 fish, tagging was suspended for the day (tagging file CSM11180.WP1) with 271 untagged fish left in the net pen. The following day Biomark released the fish from CSM1180.WP1 and recovered 27 mortalities (1.8%) prior to release. Biomark then tagged the remaining 271 fish in the net pen (captured on 28 June) and stored those data in a separate file (CSM11181.WP1). Thus, those 271 fish were held in a net pen for two days prior to tagging and one day post tagging while the rest of the tagged fish in the study were held in net pens for only one day prior to tagging and one day post tagging. No post-tagging mortality was observed in the group held two days.

5.2.4 Fish Releases and Mortalities

Releases occurred between 0800 and 1015 PDT each morning following tagging. A total of 13,223 tagged fish were released during this project, and 318 mortalities and moribund fish were collected prior to releases, for an overall mortality rate of 2.3% (see Table 1). High mortality rates resulting from seining activities on 21 June (tagged on 22 June) pushed the overall mortality rate above 2% (see Table 1). On 21 June, seining crews worked the mouth of the Okanogan River, which had turbid water and a mud substrate that sometimes collected in large mud balls in the bag of the seine. During retrieval of captured fish from the seine when mud balls were present, the fish displayed obvious signs of distress, and the decision was made to avoid those areas where the seine collected mud balls. Nevertheless, 71 (14.5%) of the 489 Chinook tagged at that location did not survive the collection/tagging process. Likewise, at the Washburn Island site, seine sets often enclosed a large amount of filamentous algae, which entangled and distressed the fish, and greatly extended the fish-retrieval time. Fifty-four (16.2%) of the 334 Chinook tagged at that location did not survive the collection/tagging process.

5.3 Post-tagging Sampling

After the completion of tagging, periodic sampling for growth monitoring occurred by attempting to capture, measure and release fish in locations where fish had been captured earlier in the season. On July 19th we captured 144 fish from three locations: Gebber's Landing, Dead Beaver, and Washburn Island. Fish were large in all locations but mean fish length was largest at Washburn Island at 92 mm, followed by 80 mm at Dead Beaver and 76.5 mm at Gebber's Landing. Sample sizes were quite small at Dead Beaver (n = 11) and Washburn (n = 24) compared to Gebber's Landing (n = 109), which may have been a product of larger fish sizes (see discussion below on fish size threshold and behavior).

On July 27 the same three locations were sampled; however, only two subyearling fish were captured, both at Washburn Island. No fish were captured at Gebber's Landing and only non-target taxa were captured at Dead Beaver. The lengths of the two fish captured at Washburn Island were 98 and 99 mm, respectively.

On August 3 the Dead Beaver, Gebber's Landing, and Washburn Island locations were again seined, but no fish were captured during this period. On August 12 Douglas PUD biologists snorkeled Washburn Island, Gebber's Landing, and Starr to locate subyearling Chinook, but found none. Fish observed included resident, non-salmonid taxa and triploid rainbow trout.

5.4 Biological Results

5.4.1 General Detection Results

Together, 2,314 unique fish of 13,223 (17.5%) tagged and released were detected at downstream arrays by mid-November when juvenile bypass systems (JBSs) shut down at McNary, John Day, and Bonneville dams. One percent (n = 135) of these detections occurred at non-JBS facilities (e.g. Wells, Rocky Reach, or Rock Island dams adult fishways, or the corner collector at Bonneville Dam[1]). Total detections at Rocky Reach, McNary, John Day, and Bonneville dams, including fish detected at more than one of these projects, was 1,200, 920,435 and 71 respectively. However, detections at McNary, John Day, and Bonneville dams might be inflated relative to detections at Rocky Reach since the JBSs at lower Columbia River Projects operate into November and thus have two-and-a-half months more time during which to obtain detections. Detections at McNary, John Day and Bonneville dams through August 31st (equivalent to Rocky Reach) were 732, 363 and 59, respectively. Therefore, 20%, 17%, and 17%, respectively, of the total detections at McNary, John Day, and Bonneville dams occurred after August 31st.

The percentage of PIT-tagged fish detected at downstream recapture locations remained consistent between tagging days and release sites (Figure 7A and B respectively). Detection probability for each tag file ranged between 17.2-25.8%. No analysis was performed to confirm trends in detection efficiency. Both an ANOVA and non-parameteric equivalents of mean detection probability by location showed no significant differences in detection probability between fish tagged at Okanogan, and Smuggler's Cove or Gebber's Landing (P = 0.9 and P = 0.8 respectively; other locations were left out of the analysis since the number of times they were sampled was insufficient for analysis). Overall, weighted mean detection probability including detections of fish at multiple projects was 20.9% (weighted by number of fish released per day). Mean detection probability, regardless of daily release numbers was 20.4%.

[1] Although the Bonneville corner collector could be considered part of the JBS system at Bonneville, PTAGIS separates the corner collector and the JBS PIT detection locations and therefore we retained this consistency.

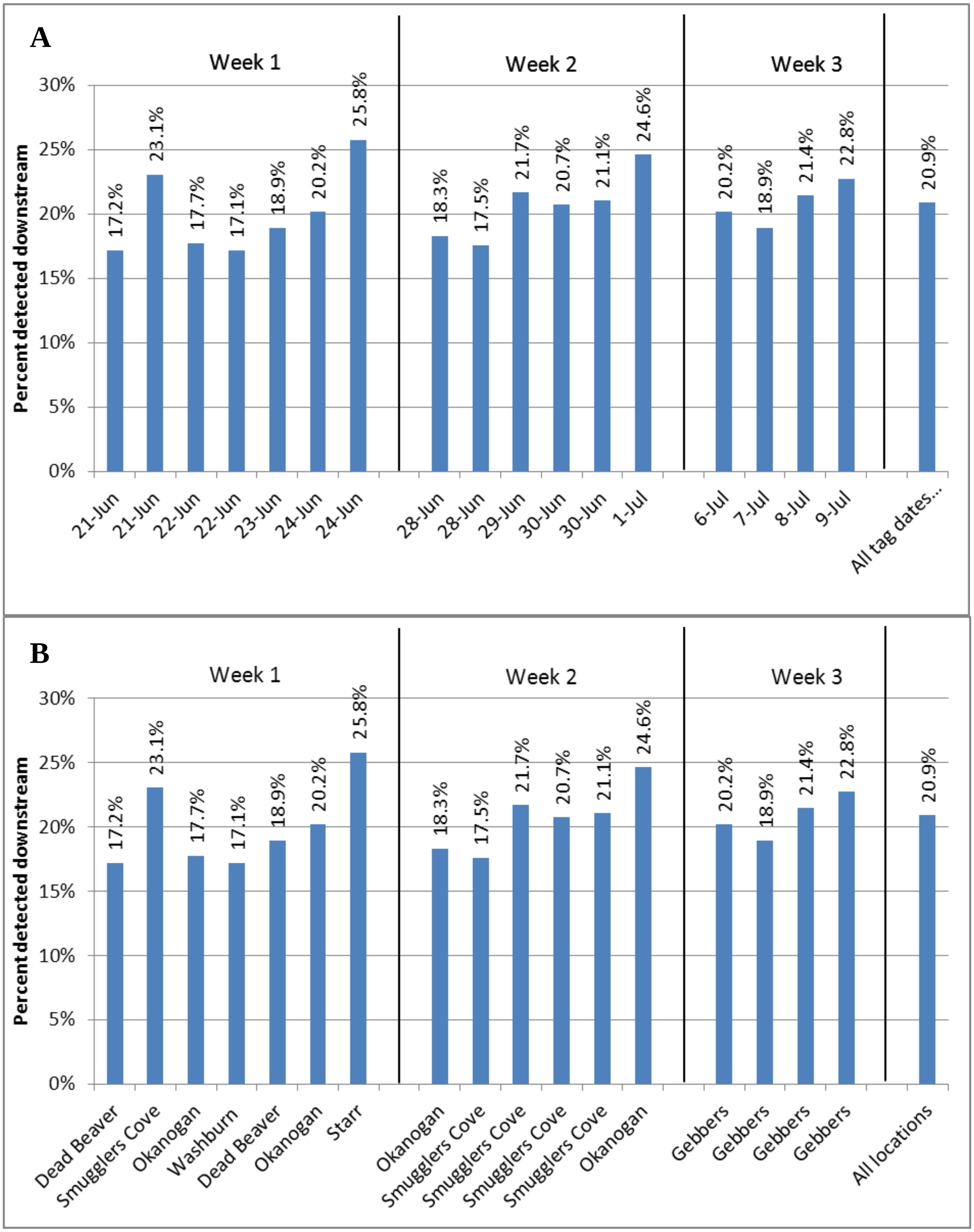

Figure 7. Percent by week of fish tagged A) on a given day, or B) at a location, that were subsequently detected on a PIT-tag detection array at a downstream project in 2011.

Table 2. Detection of released fish by tag file as of November 15th 2011. Note that detections at Rocky Reach Dam are through August 31st only.

				Rocky Reach		McNary		John Day		Bonneville		BCC, BO1, MC1, MC2, RIA, RRF, WEA		
Tag Week	Tag Location	Date	Number tagged and released	Detected	Percent Detected	Detected	Percent Detected	Detected	Percent Detected	Detected	Percent Detected	Detected	Percent Detected	Cumulative Percent
1	Dead Beaver	21-Jun	64	8	12.5%	1	1.6%	1	1.6%	0	0.0%	1	1.6%	17.2%
	Smuggler's Cove	21-Jun	65	7	10.8%	3	4.6%	3	4.6%	1	1.5%	1	1.5%	23.1%
	Okanogan	22-Jun	418	33	7.9%	21	5.0%	10	2.4%	1	0.2%	9	2.2%	17.7%
	Washburn	22-Jun	280	19	6.8%	16	5.7%	9	3.2%	1	0.4%	3	1.1%	17.1%
	Dead Beaver	23-Jun	328	26	7.9%	20	6.1%	12	3.7%	0	0.0%	4	1.2%	18.9%
	Okanogan	24-Jun	595	52	8.7%	36	6.1%	22	3.7%	2	0.3%	8	1.3%	20.2%
	Starr	24-Jun	128	17	13.3%	10	7.8%	3	2.3%	2	1.6%	1	0.8%	25.8%
2	Okanogan	28-Jun	235	15	6.4%	14	6.0%	11	4.7%	1	0.4%	2	0.9%	18.3%
	Smuggler's Cove	28-Jun	821	65	7.9%	47	5.7%	21	2.6%	5	0.6%	6	0.7%	17.5%
	Smuggler's Cove	29-Jun	1446	145	10.0%	94	6.5%	54	3.7%	9	0.6%	12	0.8%	21.7%
	Smuggler's Cove	30-Jun	270	21	7.8%	22	8.1%	9	3.3%	1	0.4%	3	1.1%	20.7%
	Smuggler's Cove	30-Jun	1196	112	9.4%	76	6.4%	44	3.7%	9	0.8%	11	0.9%	21.1%
	Okanogan	1-Jul	1163	117	10.1%	102	8.8%	43	3.7%	9	0.8%	15	1.3%	24.6%
3	Gebber's	6-Jul	1463	135	9.2%	100	6.8%	47	3.2%	5	0.3%	8	0.5%	20.2%
	Gebber's	7-Jul	1378	120	8.7%	80	5.8%	37	2.7%	6	0.4%	18	1.3%	18.9%
	Gebber's	8-Jul	1558	144	9.2%	114	7.3%	49	3.1%	12	0.8%	15	1.0%	21.4%
	Gebber's	9-Jul	1815	164	9.0%	164	9.0%	60	3.3%	7	0.4%	18	1.0%	22.8%
Total	All locations	All tag dates	13223	1200	9.1%	920	7.0%	435	3.3%	71	0.5%	135	1.0%	20.9%

5.4.2 Fish Length and Availability in the Reservoir

During the scoping period from late May to mid-June, the means of fish sizes at each sampling location were between 45.2-60.6 mm fork lengths, irrespective of location (see Figure 5A). During tagging, the mean sizes of fish captured at each location each day ranged between 57.9-79.1 mm. The weekly means of sizes of those fish tagged were 69, 71, and 77 mm for all locations combined, during the three respective weeks (see Figures 5 and 6). Following the conclusion of the tagging phase of the study, we attempted to collect fish on a weekly or biweekly schedule to monitor lengths of captured fish in the reservoir over time, to determine growth of tagged fish through recaptures, and to assess the availability of subyearlings in the Wells Project. During this post-tagging period, fish availability decreased quickly such that, by the end of July, fish availability approached zero. The means of the lengths of subyearlings captured on each collection date increased over time (see Figure 5B). July 27 was the latest date on which we captured subyearlings, and at that time the lengths of the two fish captured at Washburn Island were nearly 100 mm. During the growth-monitoring period (post tagging) some site-specific size differences appeared that were not apparent during the earlier periods of the study. However, these differences were not statistically evaluated since fish were hard to find during the growth-monitoring period and sample sizes were low in most locations. Collectively, fish available during daylight hours in shoreline areas of the Wells Project appeared to follow a curvilinear growth plot throughout the entire study (see Figure 5B; linear regression $p < 0.0001$). Estimated mean increase in the length of captured fish in the Wells Reservoir based on this curve was 0.77 mm/day. This does not represent site-specific growth rates of individuals within the reservoir, but rather the increase over time of the mean sizes of fish available for capture by beach seine at the locations sampled.

5.4.3 Recapture at Downstream Projects and Growth of Recaptured Fish

Twelve hundred of 13,223 tagged fish were detected at Rocky Reach Dam traveling though the JBS before Aug 31st 2011, the last day of Rocky Reach JBS operation. Twenty-six of these fish were captured during smolt-index sampling conducted by Chelan PUD smolt-monitoring staff. The PIT-tag codes and size data for these recaptures were uploaded to PTAGIS by Chelan PUD biologists. Twenty-two of these fish were recaptured at Rocky Reach Dam in June or July, and four in August. Growth data (change in fork length divided by the number days between tagging and recapture) for these recaptures are depicted in Figure 8, which illustrates a positive correlation between growth and days after tagging, especially after 20 or more days following tagging. Fish recaptured in July at Rocky Reach Dam had been 10 mm larger (mean of sampled lengths) at the time of tagging than those recaptured in August (79 ± 5.62 mm vs. 69 ± 8.12 mm when tagged respectively; Kruskal-Wallis $p = 0.03$). However, fish recaptured in June and July had slower and more variable growth rates than those recaptured in August (0.54 ± 0.56 mm/day vs. 1.18 ± 0.08 mm/day; Kruskal-Wallis $p = 0.01$). Means of recapture lengths were 86.77 ± 9.67 mm (n = 22) and 123.75 ± 9.91 mm (n = 4) for fish recaptured at Rocky Reach Dam in June/July and August, respectively and were significantly dissimilar (Kruskal-Wallis $p = 0.001$).

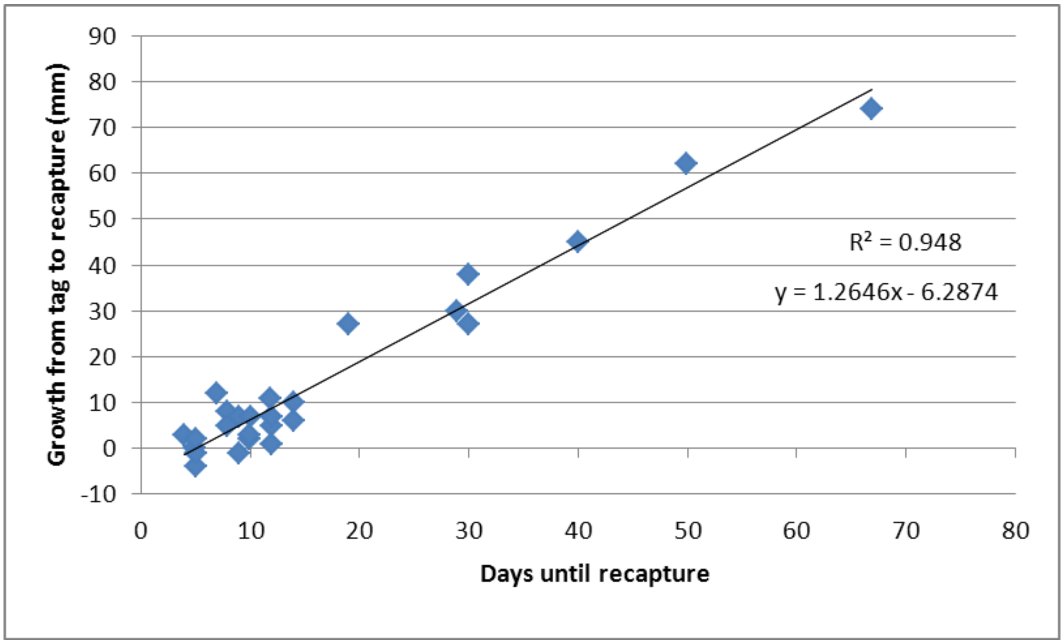

Figure 8. Growth as the increase in fork length (mm) divided by the number of days between tagging and recapture for tagged subyearlings recaptured during index sampling at Rocky Reach Dam (linear regression *p* < 0.0001)

In addition to those fish recaptured at Rocky Reach Dam, 14 tagged fish were recaptured at Rock Island Dam and similarly measured, allowing determination of growth. These data were also uploaded to PTAGIS. Growth of fish recaptured at Rock Island Dam was more variable than for those recaptured at Rocky Reach Dam. Variability coupled with a smaller sample size at Rock Island Dam reduced the fit of the regression equation describing the growth rate of fish recaptured at Rock Island Dam (Figure 9). Average growth was similar to that of fish recaptured at Rocky Reach Dam in June and July at 0.58 ± 0.38 mm/day. Only one of the 14 fish recaptured at Rock Island Dam was captured in August and was 77 mm at tagging, 108 mm at recapture, and had a growth rate of 1.07 mm/day.

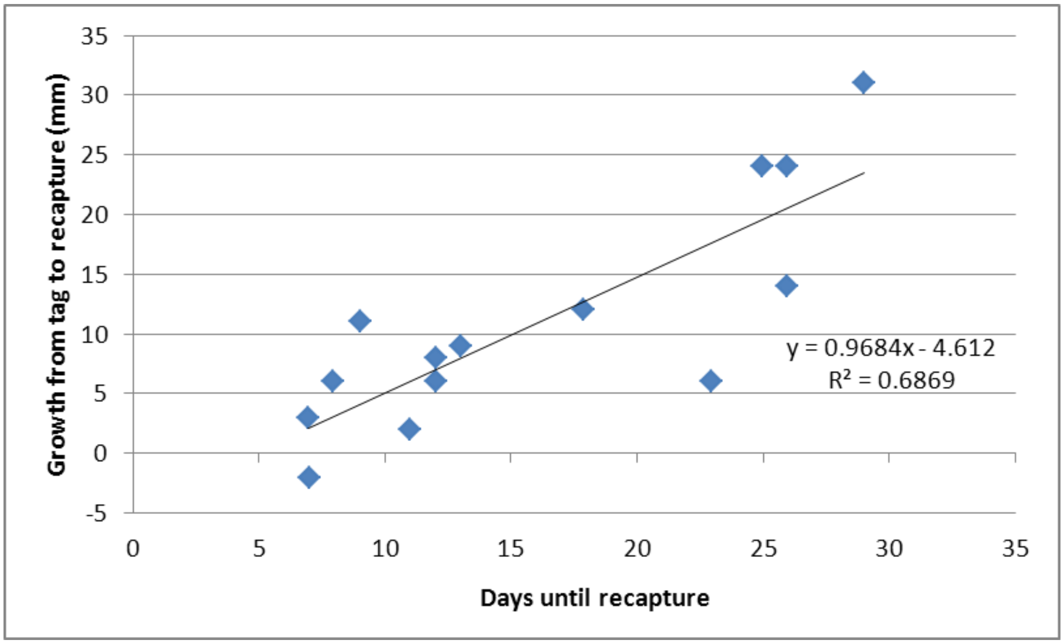

Figure 9. Growth as the increase in fork length (mm) divided by the number of days between tagging and recapture for tagged subyearlings recaptured during index sampling at Rock Island Dam (linear regression $p < 0.0002$)

5.4.4 Run Timing and Travel Time

The majority of the fish detected passing Rocky Reach Dam did so during the month of July (67%) with fewer (30%) passing in August (Figure 10). As the number of PIT-tagged fish released above Wells Dam increased, so did the number of detections at Rocky Reach Dam. The first two detections occurred on June 25th (Figure 11) and were fish released on the 23rd and 24th of June. The last fish detected at Rocky Reach Dam in 2011 had been released in the Wells Reservoir on July 10th, the last release day. The greatest number of detections at Rocky Reach Dam occurred during the first four days following the last release (July 11-14; see Figure 10). Detections decreased dramatically following this peak and subsequently oscillated between 3-22 fish a day through August, with a small peak in detections between August 8th and August 20th (see Figure 11). With the termination of bypass operations at Rocky Reach Dam at midnight on August 31st 2011, we could no longer rely on detections at that location for tracking movements of study fish.

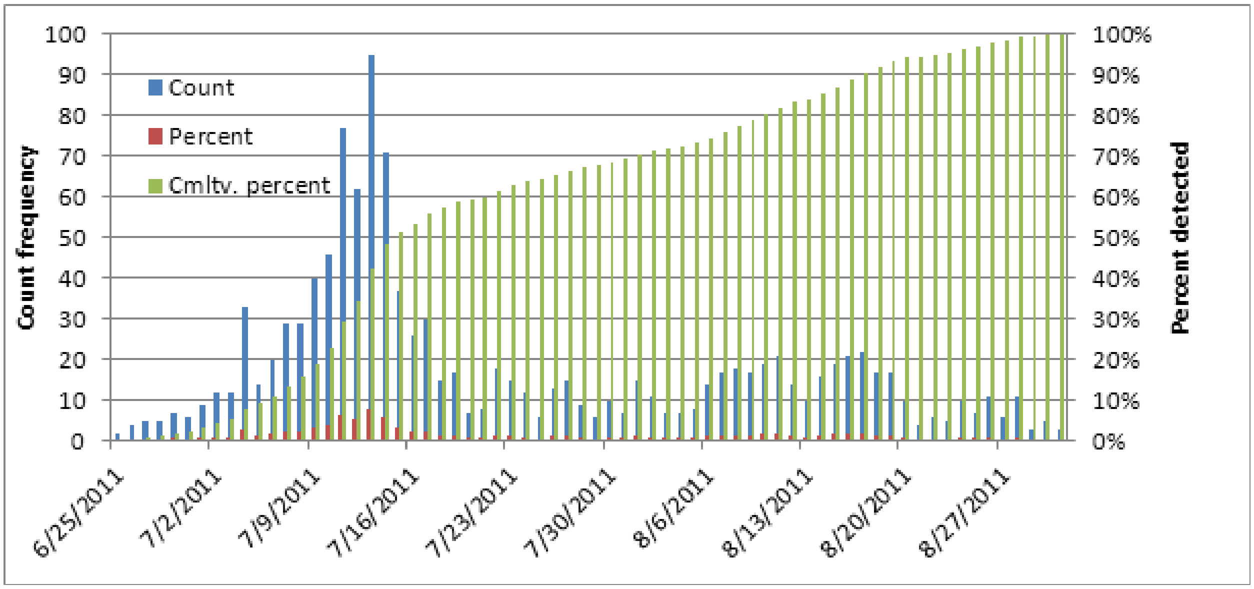

Figure 10. Daily distribution frequency and cumulative percent of PIT-tagged subyearling Chinook passage at Rocky Reach Dam before bypass shutdown on Aug 31st 2011.

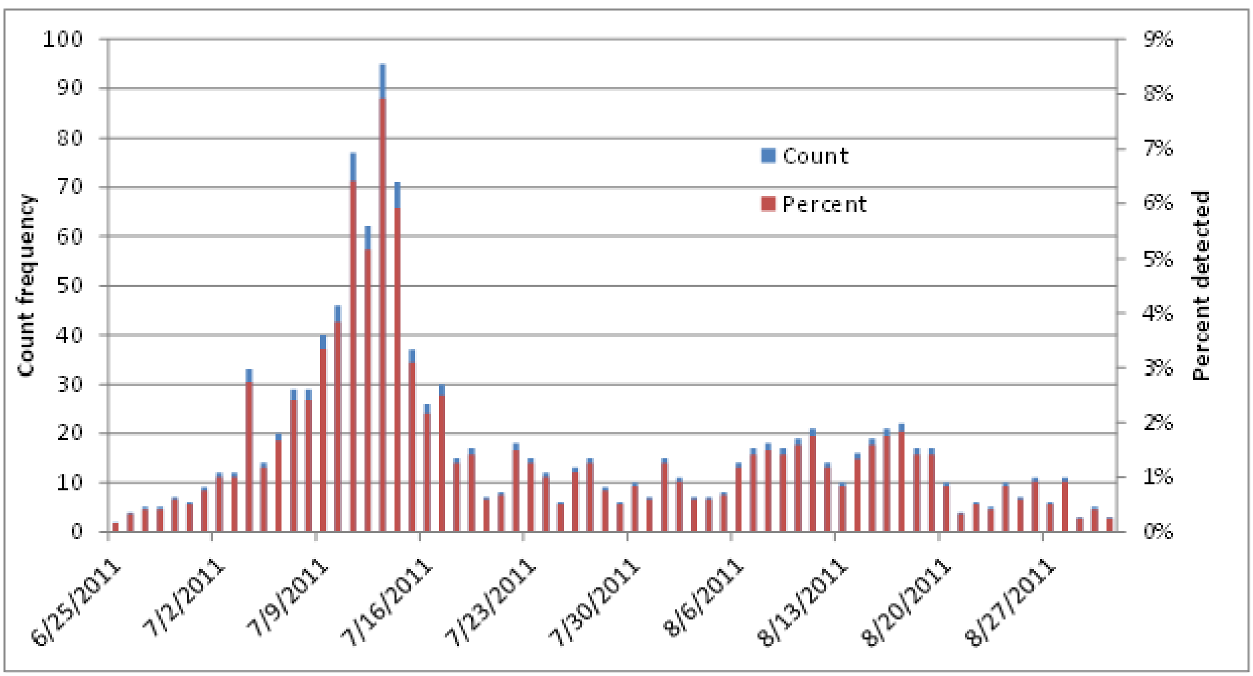

Figure 11. Daily distribution frequency of PIT-tagged subyearling Chinook passage and daily percent passage at Rocky Reach Dam prior to bypass shutdown at midnight on Aug 31st 2011.

At McNary, John Day, and Bonneville dams detections appeared to peak around the same time (Figure 12), with 17-20% of those detections occurring in September through Nov 15th. It is unclear, however, how many tagged fish continued to pass projects after the bypass systems were turned off at the respective projects.

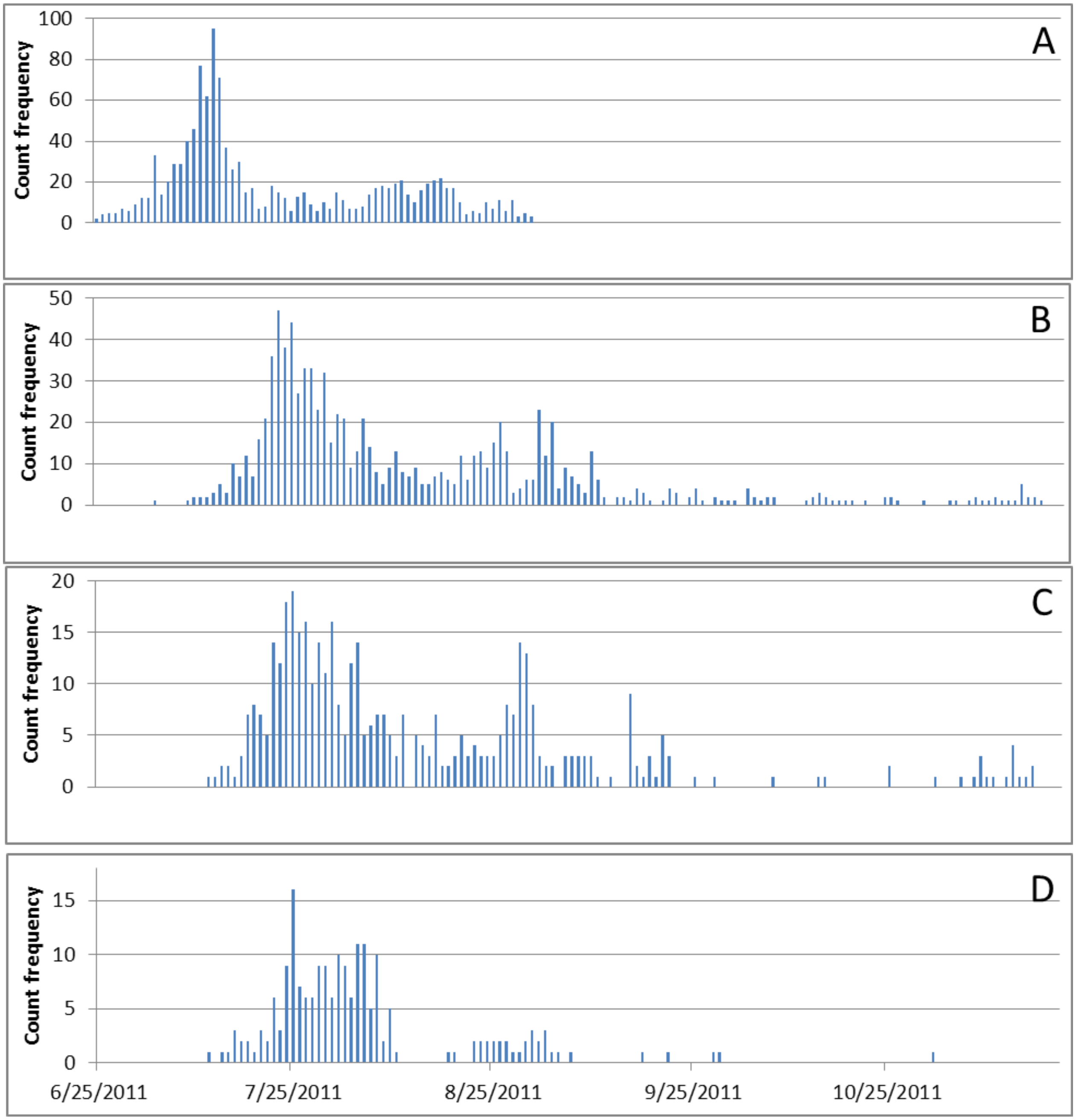

Figure 12. Daily distribution frequency of PIT-tagged subyearling Chinook passage at A) Rocky Reach, B) McNary, C) John Day, and D) Bonneville dams prior to bypass shutdown at each project. Note differences in vertical scales.

5.4.5 Travel Time

Travel time decreased as fish moved down river, and the largest fish at the time of tagging traveled faster than smaller fish. Travel times were protracted through the upper Columbia and decreased as fish moved into the middle and lower Columbia. Migration rates from release to Rocky Reach Dam were the slowest of all reaches (Table 3), with fish moving an average of 4.8 km a day for a mean of 20 days to travel to Rocky Reach Dam. In contrast, the mean of travel times from John Day Dam to Bonneville Dam was only 2.5 days for a rate of 44.6 kilometers per day (km/d).

Table 3. Mean reach-specific travel time (d) and rate (km/d) for all PIT tagged subyearling Chinook released in the Wells Reservoir in 2011 and subsequently detected at downstream hydroprojects. RRH = Rocky Reach Dam, MCN = McNary Dam, JDA = John Day Dam, BON = Bonneville Dam.

	RRH (762)		**MCN (470)**		**JDA (347)**		**BON (235)**	
Location (River KM)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)
Release (856)	**19.7** (±0.48; n = 1185)	**4.8**						
RRH (762)			**20.1** (±0.98; n = 188)	**14.5**				
MCN (470)					**7.6** (±0.99; n = 99)	**16.2**		
JDA (347)							**2.5** (±0.29; n = 33)	**44.6**

Note. Smolt index recaptures removed.

Fish greater than 86 mm at tagging traveled through all reaches faster than fish smaller than 87 mm at tagging (Tables 4 and 5). From release to Rocky Reach Dam fish greater than 86 mm at tagging traveled at rates nearly five times faster than smaller conspecifics. Even in the lower river between McNary and John Day dams, larger fish (at tagging) traveled at nearly double the rate of smaller subyearlings.

Table 4. Mean reach-specific travel time (d) and rate (km/d) for PIT-tagged subyearling Chinook that were greater than 86 mm at the time of tagging in the Wells Reservoir in 2011 and subsequently detected at downstream hydroprojects. RRH = Rocky Reach Dam, MCN = McNary Dam, JDA = John Day Dam, BON = Bonneville Dam.

	RRH (762)		**MCN (470)**		**JDA (347)**		**BON (235)**	
Location (River KM)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)
Release (856)	**4.7** (±0.41; n = 121)	**20**						
RRH (762)			**15.78** (±3.08; n = 17)	**18.5**				
MCN (470)					**3.23** (±0.33; n = 6)	**38.1**		
JDA (347)							**1.92** (±0.17; n = 7)	**58.3**

Note. Smolt index recaptures removed.

Table 5. Mean reach-specific travel time (d) and rate (km/d) for PIT-tagged subyearling Chinook that were less than 87 mm at the time of tagging in the Wells Reservoir in 2011 and subsequently detected at downstream hydroprojects. RRH = Rocky Reach Dam, MCN = McNary Dam, JDA = John Day Dam, BON = Bonneville Dam.

	RRH (762)		**MCN (470)**		**JDA (347)**		**BON (235)**	
Location (River KM)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)	Travel Time (d)	Rate (km/d)
Release (856)	**21.17** (±0.5; n = 1080)	**4.4**						
RRH (762)			**20.52** (±1.02; n = 173)	**14.2**				
MCN (470)					**7.86** (±1.05; n = 93)	**15.6**		
JDA (347)							**2.67** (±0.37; n = 26)	**41.9**

Note. Smolt index recaptures removed.

Comparisons between subyearling Chinook counts at Rocky Reach Dam and river discharge or temperature revealed no biologically meaningful relationships (Figure 13) even though two regressions comparing flow and temperature at Wells Dam with subyearling Chinook counts at Rocky Reach Dam indicated significant positive (Flow: r^2= 0.18; p = 0.003) and negative (Temperature: r^2= 0.07; p = 0.024) relationships, respectively. Notably, the population of subyearling Chinook PIT tagged in Wells Reservoir represented only a portion of the seasonal migration past Rocky Reach and Rock Island dams (Figure 14); counts at Rock Island Dam include fish originating from the Wenatchee and Entiat rivers, and also include fry. The subyearling Chinook migration through Rocky Reach Dam also includes fry from the Entiat, Methow, Okanogan, and mainstem Columbia rivers, and thus, by including only PIT-tagged study fish, Figure 13 depicts a truncated distribution of the total migration through Rocky Reach Dam. Therefore, any apparent relationship between flow or temperature and the counts of tagged subyearlings at Rocky Reach Dam are likely artifacts of incomplete data, as the actual run distribution more likely resembles that observed at Rock Island Dam.

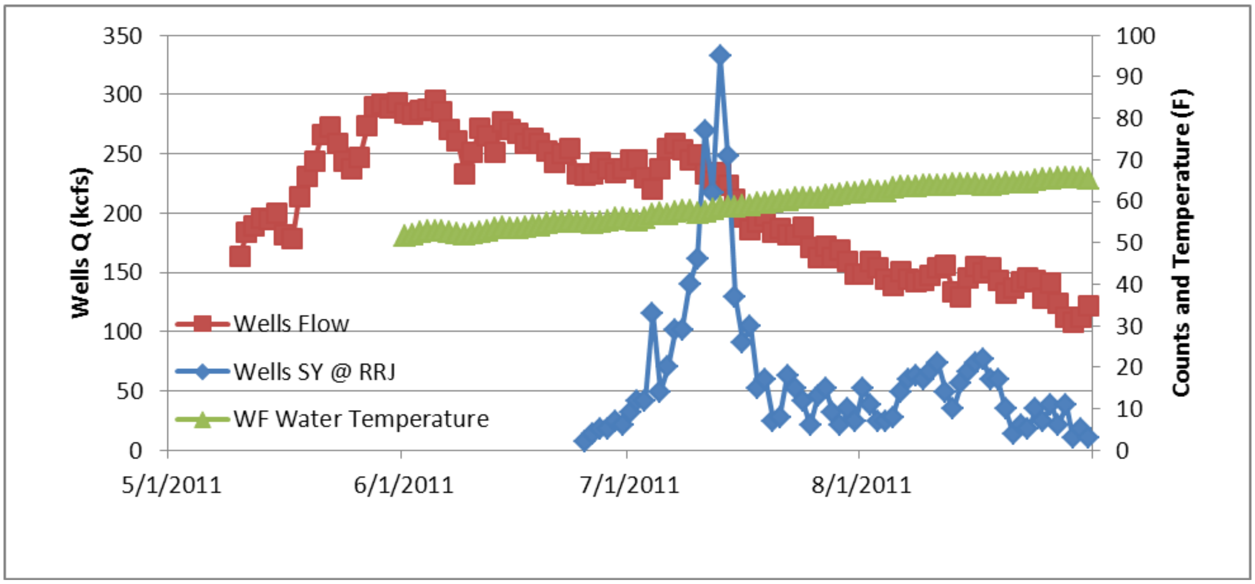

Figure 13. Distribution of PIT tag subyearling Chinook arrival at Rocky Reach Dam and total water flow past Wells Dam in 2011.

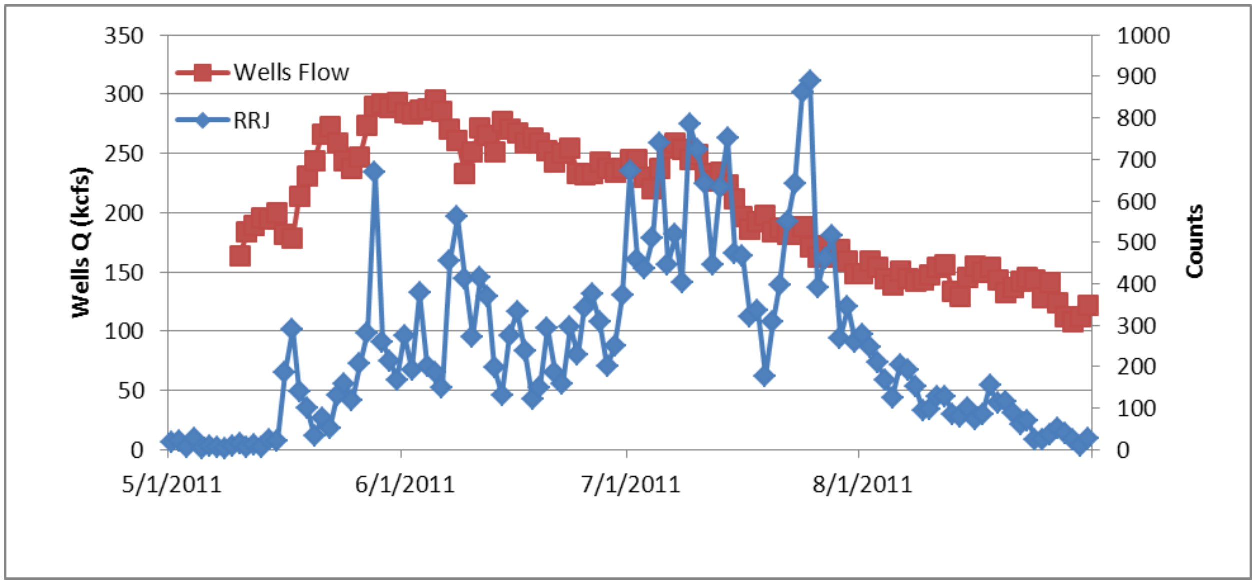

Figure 14. Distribution of subyearling Chinook arrival timing at Rocky Island Dam and total water flow past Wells Dam in 2011.

5.4.6 Size Threshold for Migration

Migration travel time for tagged subyearlings from release to Rocky Reach Dam was highly variable, especially for fish smaller than 87 mm at tagging. As a general rule, larger fish migrated faster (linear regression $P<0.05$; $r^2 = 0.29$; Figures 15 and 16), though fork length was a poor predictor of travel time within any size class, and significance was due more to a large sample size than to a strong relationship. In contrast with the large numbers of fish smaller than 87 mm, sample sizes were small for fish equal to or greater than 87 mm long. Nevertheless, the migration behavior of those larger fish was comparatively active with less variable travel times than their smaller counterparts.

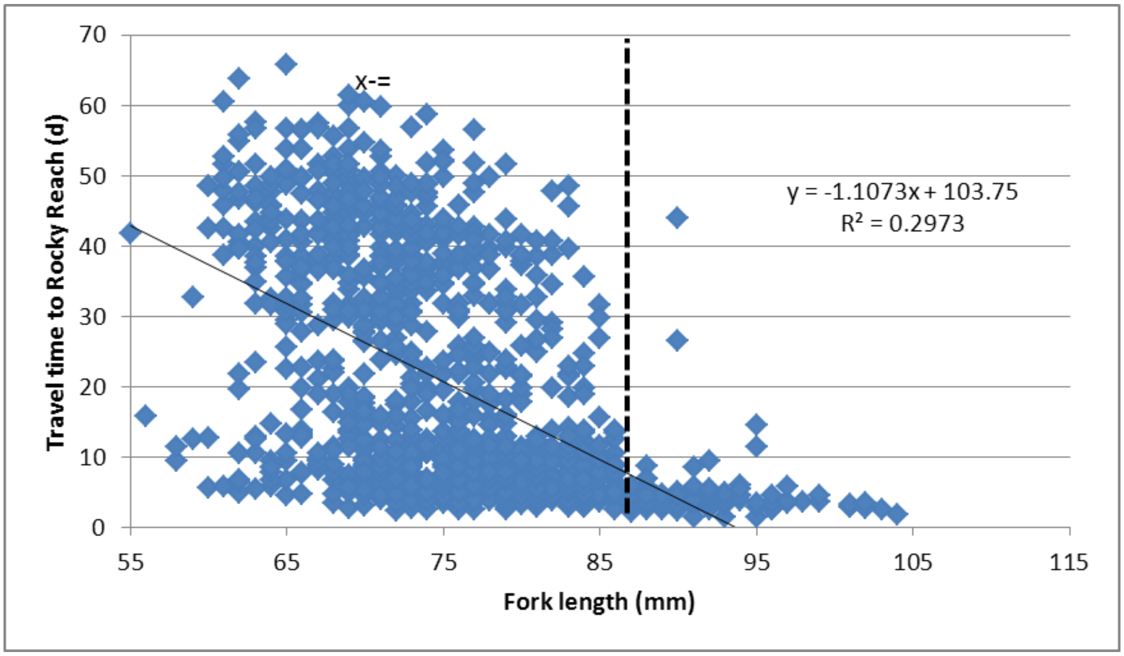

Figure 15. Scatter plot of fish size (fork length) at tagging as a predictor of travel time to Rocky Reach Dam. Although the negative relationship is statistically significant (linear regression P<0.05), it is highly variable below 87 mm. The vertical dashed line represents an apparent shift in migration behavior at 86 mm, with fish ≥ 87 mm exhibiting faster migration rates and less variability in travel time.

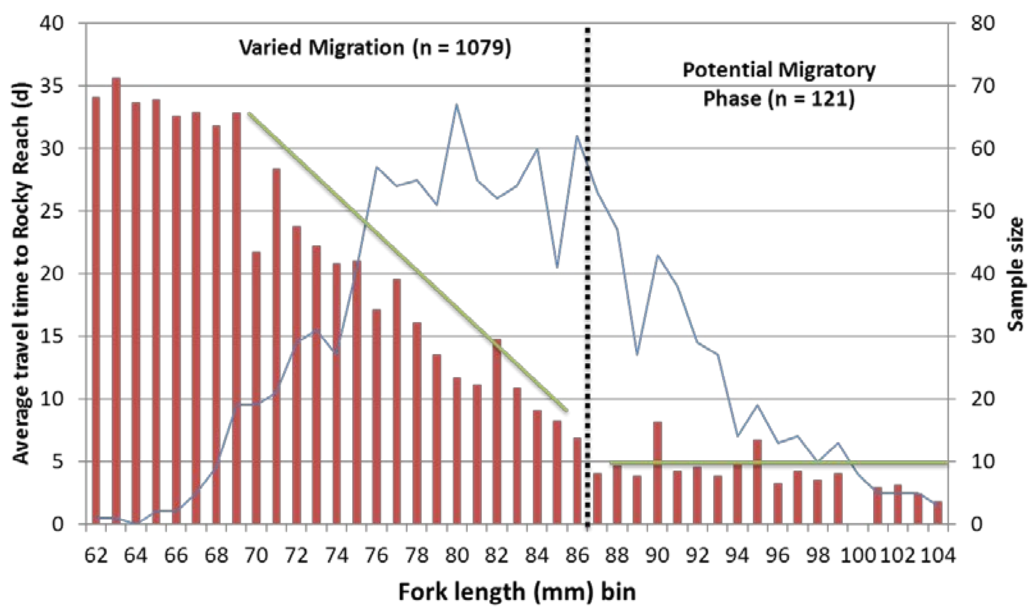

Figure 16. Mean travel time to Rocky Reach Dam for each fork-length size–bin. Travel time increased with decreasing fish length for fish equal to or less than 86 mm, whereas fish 87 mm or greater exhibited no such relationship.

A non-parametric Mann-Whitney U test determined that fish over 86 mm long migrated much faster than fish under this size threshold ($P<0.0001$; see Figure 16), predictably migrating to Rocky Reach Dam within five days of tagging (Table 6). This 86-mm threshold may be important for differentiating the size of actively migrating subyearling Chinook from passively migrating or non-migratory subyearling Chinook. The standard deviations between these groups are quite different, highlighting the increased variability in migration rate to Rocky Reach Dam in those smaller tagged fish. Specifically, the standard deviation in the smaller size class was almost four times greater than that of the larger size class. In addition the median and means for the large size class of subyearlings were almost equal, but for the smaller fish these two metrics were drastically different.

Table 6. Comparison of summary data on travel times from release in the Wells Reservoir to detection at Rocky Reach Dam for two size (fork length) classes of PIT-tagged fish in 2011.

Size range (mm)	*Number tagged*	*Number detected*	***% of size class detected at RRD***	***Mean travel time to RRD***	*Std Dev*
<87	12192	1079	**8.9%**	**21.2**	16.6
>86	1028	121	**11.8%**	**4.7**	4.5

Fish greater than 86 mm represented 10% (121 fish) of the 1,200 PIT-tagged fish that were detected at Rocky Reach Dam. Larger fish were also more likely to be detected at Rocky Reach Dam by the end of August than were smaller conspecifics (see Table 6; 11.8% detected vs. 8.9%). Differences in detectability became even stronger when we used all downstream detection locations. Table 7 illustrates that fish larger than 86 mm had a 30% chance of detection on any downstream array compared to only 20% for their smaller counterparts.

Table 7. Proportion of tagged fish of a give size range detected at any downstream project during 2011 (prior to Nov 15th shutdown of federal JBS systems).

Size range (mm)	*Number tagged*	*Number detected*	***Proportion detected (%)***
<87	12192	2448	**20.1**
>86	1028	313	**30.4**

5.4.7 Biological Cost to Tagging Procedure

Although we did not intend to specifically evaluate the biological cost of the tagging procedure during 2011, evidence from recaptured fish in Wells Reservoir suggests potential costs associated with the capture/handling/tagging experience. The mean of growth rates (0.34 mm/day) was reduced over the first 11 days after tagging (Figure 17) compared to the mean of growth rates of fish recaptured at Rocky Reach Dam (June/July recaps 0.56 mm/day, August recaps 1.18 mm/day). This phenomenon was independent of size at tagging (Figure 18). The apparently negative growth rates in Figures 17 and 18 result from human error in measuring fish on the digitizing board. We did not attempt to quantify the magnitude of nor correct for the measurement error, but assume tagging staff made both positive and negative errors in measurement. Irrespective of measurement errors, the data plots depict a generally flat growth rate during the 11 days post tagging, regardless of fish size at tagging.

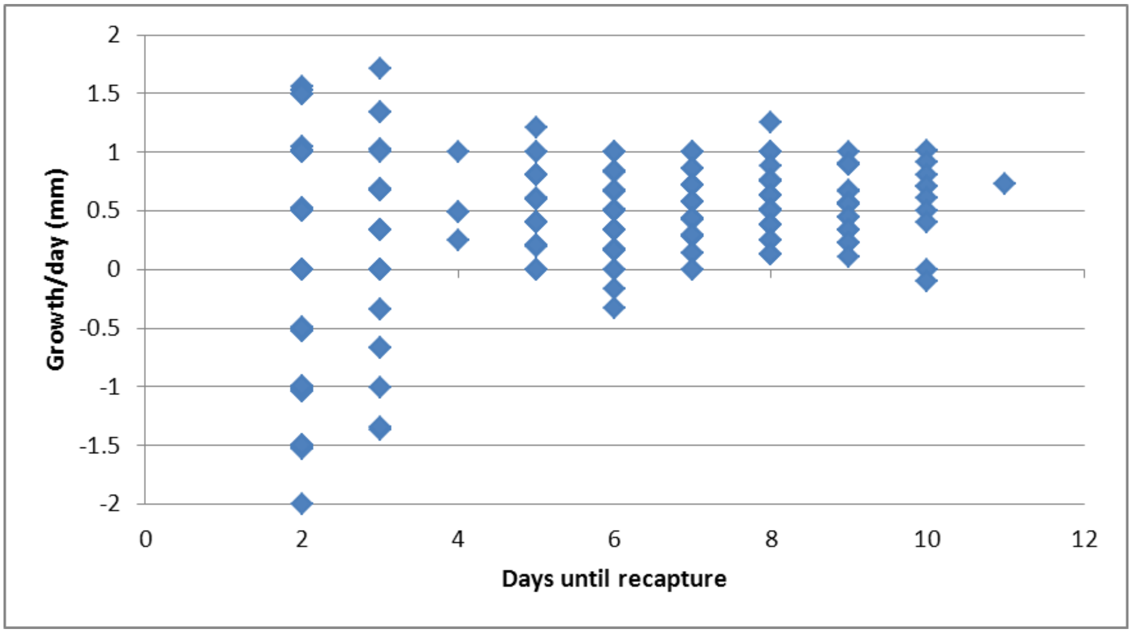

Figure 17. Growth rates (mm/day) by the number of days from tagging to recapture, for fish that were PIT tagged, released and recaptured in the Wells Project during 2011.

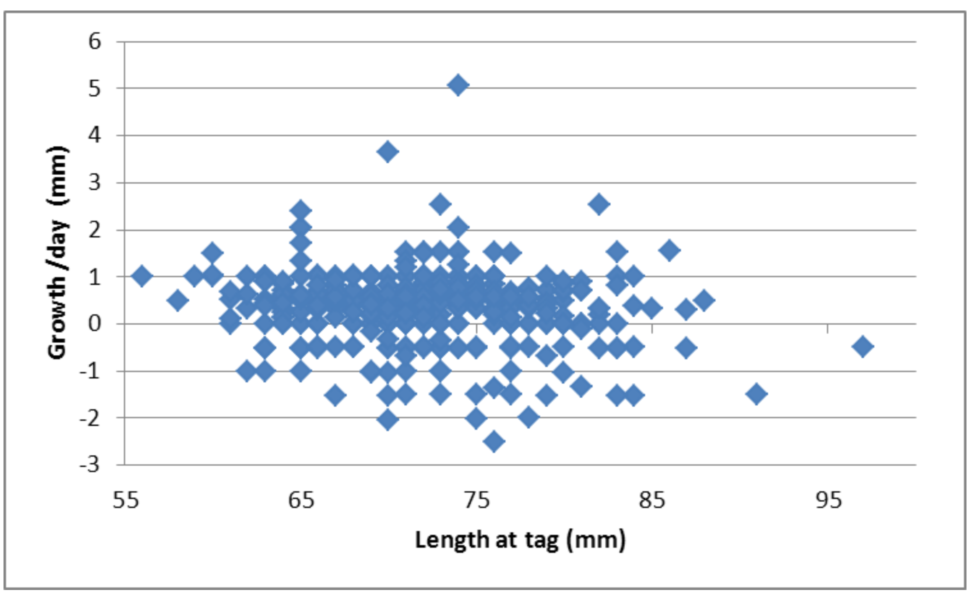

Figure 18. The relationship of fish size at tagging to growth in the subsequent 11 days after tagging.

6.0 DISCUSSION

6.1 Fish Availability and Size

Duing the 2011 pilot study we captured more than 18,500 subyearling Chinook from the Wells Project over a three-month period. Of these fish, we PIT tagged and released 13,223 back to the Wells Reservoir during a three-week period in June and early July. Prior to 2011, limited information existed on the migration behavior, growth and general life-history diversity of subyearling Chinook found within the Wells Project; results from the 2011 study improve our understanding. Subyeraling Chinook were available in May in the Wells Project but most of these fish were too small to tag. Not until the third week in June did weekly test seining yield taggable-sized fish in sufficient numbers to warrant the mobilization of the tagging crew.

Subyearling Chinook were available in most areas that we fished; however, some areas, such as Gebber's Landing, produced consistently more fish than at other sites and minimal bycatch and encounters with debris. The capture of Chinook fry at the Washburn Island site 4.5 kilometers upstream from the mouth of the Okanogan River indicates that subyearling Chinook in the Wells Project originate from not only spawners in the Okanogan and Methow rivers but also from Chinook that spawned in the Columbia River. River flows during May when these fry were captured exceeded 200 kcfs at the Washburn sampling location. The fish sampled in May were too small to swim upstream against the currents observed in this section of the Wells Project. Mann et al. (2012) documented Chinook spawning in the upper reaches of the Wells Reservoir downstream of Chief Joseph Dam, which is the probable spawning location from which the fry we captured originated.

Overall, mortality estimates related to capture, handling and tagging were low (2.3%) and would have been below 2% if areas of high sediment load and debris had been avoided on June 21st. Seining crews learned quickly where to seine to avoid mud balls, debris, and abundant filamentous algae, and how to safely retrieve fish from seine sets with excessive filamentious algae, dramatically reducing mortality rates during the second and third weeks of tagging (see Table 1).

Fish were easier to capture on days when wind pushed debris and waves—and likely food—inshore towards our capture locations. Wave action also caused local turbidity, which may have reduced the ability of the fish to see the net, thus improving capture efficiency. Other authors report this phenomenon, noting postive correations between fish capture abundance and wave action in shoreline surf (Romer 1990; Clark et al. 1996).

Nearly half the number of fish tagged were captured in the third week of fishing. Three factors contributed to a successful third week. First, the relative number of taggable fish was much higher in the third week as the average size of fish in seining locations had increased. For example, only 3% of the captured fish in the third week were too small to tag, compared to 52% and 10% in the first and second weeks, respectively. Secondly, we were able to handle more fish in the third week by focusing seining efforts at Gebber's Landing, which yielded a large number of fish, with limited debris, bycatch, and snagging. Third, the Wells Reservoir was filled to within 2 feet of its maximum operating level 781 msl. This allowed crews to fish over the top of macrophyte beds rather than fishing through the vegetation as was the case during the first two weeks of seining when the water level in the Wells Reservoir was below elevation 776 (msl) for flood control and sediment-flushing purposes on the lower Methow River.

Once released we detected 17.5% of the 13,223 tagged subyearlings before late fall when PIT-tag detectors at downstream hydroprojects were no longer operational. There were no obvious increases in detections related to tagging date or release site, suggesting that the handling of these fish was relatively consistent across the tagging period and tagging sites.

The mean lengths of fish captured within the Wells Project on sequential sampling dates increased in a curvilinear manner. The lengths of fish captured in late May averaged approximately 45 mm, and 43 days later on the last day of tagging, fish length averaged 78 mm. These observed fish-length means are comparable to those reported by McMichael et al. (2003) at Wanapum Dam, where the daily mean sizes of subyearling Chinook were not above 55 mm until after May 26 for the years 2000-2002. In addition, mean length was not above 75 mm until after June 30th for the 2000-2002 sample years (McMichael et al. 2003). Subyearling Chinook in the Wenatchee River had a mean fork length of 48 mm in June and 84 mm in August (Hillman and Chapman 1989), which would be a slightly slower rate of change in fish size over time than we obseved in the Wells Reservoir. We would expect subyearling Chinook rearing in or migrating through the Wenatchee River to grow more slowly than those originating from the Okanogan River (primary source of subyearling Chinook at most of our seining locations) because the Wenatchee River is colder in the spring than the Okanogan River. Our measured and estimated growth rates of subyearlings in the Wells Project were consistent with growth rates observed or estimated in other systems.

6.2 H1: Do Subyearling Chinook in Wells Reservoir Represent Multiple Life-history Strategies?

In our alternate hypothesis H1, we hypothesized that ocean-type Chinook in Wells Reservoir represent multiple life-history strategies with variable migration timing including spring and summer subyearling, spring yearling, reservoir rearing, and intermediate migration types. In 2011 we observed the majority of detected Chinook exhibiting migration behavior that represents the summer-migrating subyearling life-history strategy. Most tagged fish detected during emigration passed Rocky Reach Dam in July, and July and August for downstream projects. Besides the summer migrants, in our scoping sampling in late May and through mid-June we found abundant subyearling Chinook too small to tag and track. The coincidental collection of subyearling Chinook of similar size at the juvenile sampling facility at Rocky Island Dam proves the existence of a spring-migrating component to the subyearling population in the upper Columbia (see Figure 14), but it is debatable whether those fish are true migrants or merely entrained in the flow. Besides those fish that were too small to tag in the spring, we also did not tag beyond July 9, even though we were able to capture fish (albeit at diminished rates) by beach seining through July 27. Of course, we do not know the migration behaviors of those fish that we observed but did not tag during the spring (pre-tagging) or summer (post-tagging).

We did not detect any spring *yearling* migrants among our tagged fish, and must wait for the results of scale analyses to determine whether any migrated as yearlings or as winter parr. Tag detections at lower-river projects demonstrated a small (relative to summer migrants) proportion of tagged subyearlings migrating in the fall right up to the date of bypass shutdown on November 15, and we have no reason to believe that migrants ceased passing those projects on that date. From this body of evidence, we must reject our null hypothesis H1: "Ocean-type Chinook in Wells Reservoir represent a single life-history strategy with discrete and predictable migration timing"; although, from our data so far, we cannot yet fully accept the alternate Hypothesis H1 that includes the yearling spring migrants. Nevertheless, juvenile summer/fall Chinook in the Wells Reservoir clearly exhibit a continuum of migration timing, with passage of downstream projects occurring from spring at least until termination of bypass operations in mid-November. Focusing survival studies on any one segment of that continuum would fail to represent a substantial portion of the entire run.

6.3 H2: Do Subyearling Chinook Tagged in Wells Reservoir Actively Migrate Through the Wells Project?

We hypothesized that subyearling Chinook tagged into the Wells Reservoir, of the size observed migrating through Wells Dam, either actively migrate ($H2_0$) through the Wells Project, or do not actively migrate ($H2_{alt}$) but rather do so passively with the flow through the project. In these hypotheses, the clause "of the size observed migrating through Wells Dam," refers to subyearlings captured in fyke nets at turbine intakes and spill bays at Wells Dam during hydroacoustic studies in the 1980s and 1990s. Mean lengths of fish captured during those studies exceeded 100 mm (Douglas PUD, unpublished data). In contrast, only sixty-two fish captured during the 2011 PIT-tagging effort exceeded 100 mm, and most of those were captured during the last two seining days of the tagging effort. Thus, we cannot directly examine the migration behavior of the size class of fish considered in the drafting of the study hypotheses. Nevertheless, our data from 2011 reveal relationships between fish length and migration behavior that may prove useful for indirectly addressing this hypothesis.

Subyearlings tagged at a size less than 87 mm had highly variable migration rates from release in the Wells Reservoir to detection at Rocky Reach Dam. However, fish that were tagged in the Wells Reservoir when at a length greater than or equal to 87 mm exhibited relatively rapid migration behavior arriving at Rocky Reach Dam in less than 5 days, with a median of less than 4 days (n=121 of 1,200 detected at Rocky Reach Dam), which exceeds travel times for yearling Chinook used in survival studies (Skalski and Townsend 2011; Bickford et al. 2011). Median migration rates between release and Rocky Reach Dam for these fish were 23.8 km/day with some fish migrating at the rate of 47.5 km/day (equating to a travel time of 2 days to Rocky Reach Dam). Emigrating fish could not achieve such rates if passively migrating. Conversely, the mean travel time to Rocky Reach Dam for fish of lengths less than 87 mm was greater than 20 days, or five times longer than larger conspecifics. This travel time would be even longer if we could include fish passing Rocky Reach Dam after August 31st. Thus, 86 mm fork length at tagging appeared to represent a migration threshold above which fish actively migrated and below which fish delayed migration or migrated relatively slowly. This threshold hypothesis is consistent with post-tagging growth-monitoring results conducted on July 27th. The estimated mean size of fish captured in the Wells Project on July 27th should have been above 90 mm according to projections based upon regression analysis (see Figure 7), but no subyearlings were caught in seining attempts in capture locations that yielded large numbers of fish earlier in the season. Again, on subsequent sample days that included shoreline snorkel surveys, no fish were captured or observed. From these observations we might hypothesize that fish were either offshore in deeper habitats or were largely in a migratory phase and had exited the Wells Project.

Although little data exist, large subyearlings have been observed passing Wells later in the year and at larger mean sizes than we observed in our beach-seine sampling. Weekly mean lengths of subyearlings collected in turbine fyke nets were 105, 111, 115, and 121 mm for the consecutive weeks of July 22, July 29, Aug 5th, and Aug 12th, respectively (Douglas PUD unpublished data). Similar subyearling mean lengths were reported by McGee (1984) in purse-seine sampling in the forebay of Wells from mid-June to the end of July (corresponding to our tagging and post-tagging periods). These estimated mean sizes are much larger than fish we were able to capture, indicating that the larger fish are generally not susceptible to our sampling methods because either their swimming capabilities allow them to avoid the net, or their distribution is offshore, beyond the reach of our seines, at least during daylight hours or, they have initiated their seaward migration, thereby vacating the sampling area. Dauble et al. (1989) demonstrated that subyearling Chinook captured in nets positioned off shore in the Columbia River were larger than conspecifics captured along the shoreline. Our mean fish sizes were relatively small compared to those collected by McGee (1984) indicating that McGee captured few fish in the size range of those that we captured in the nearshore, and as described above, we captured few in in the size range of those McGee captured in the forebay. The predominance of large fish and paucity of small fish in catches targeting active migrants, and the scarcity of large fish and predominance of small fish in shoreline-oriented sampling provides evidence of ontogenetic shifts in foraging and migratory behaviors with increasing fish size.

The timing of subyearling Chinook migration past Wells Dam may be a function of fish size at a certain day of the year as recently suggested by Perkins and Jager (2011), who showed that juveniles that become yearling or resident-reared migrants do so soon after emergence if they are too far behind a typical growth schedule given temperature and photoperiod cues. Critical sizes for migration have been identified by other researchers investigating subyearling Chinook. Within an enclosed section of the Wenatchee River, Chinook larger than 80 mm were usually captured in emigrant traps, whereas fish smaller than this size usually remained within the enclosures (Spaulding et al 1989). In addition, few Chinook larger than 80 mm were observed in August in the Methow River by Griffith and Hillman (1986). Similarly, fall Chinook salmon in tributaries of the Columbia River, downstream of Bonneville Dam, migrated when they reached 80-100 mm (Reimers and Loeffel 1967). Onshore-offshore movements have been observed in the Hanford Reach as fish moved into the McNary Reservoir from May to mid-July, where researchers identified 80 mm as a critical size that determined the initiation of offshore migration behaviors (Rondorf and Gray 1987). More recently Connor et al. (2003) noted that mean fork lengths of subyearling Chinook salmon captured in beach seines were 86 and 92 mm in two locations at the end of a given capture season (July) in the Snake River. Beach-seined fish in the Snake River were available from May to July but less than 2%of the total catch was captured in the month of July, suggesting that growing fish move offshore. Finally, Connor et al. (2003) showed increases in travel rates as fish moved down the Snake River comparable to our results in the mid-Columbia.

In summary, a fork length of approximately 87 mm apparently represented a threshold for subyearlings in Wells Reservoir in 2011, with fish 87 mm or larger exhibiting rapid migration rates and declining availability for capture by beach seine relative to their smaller conspecifics. With the data from only one year, we have no estimate of the variability around that apparent threshold. Additionally, without data from multiple years representing a range in environmental variables such as water temperature and the hydrograph, we cannot describe the degree to which those variables influence ontogenetic shifts in foraging or migratory behavior of subyearlings in Wells Reservoir. If size thresholds define a migrant in the Wells Project these findings would be similar to those of other studies that report behavior shifts in subyearling Chinook when they reach a critical size. At the present, we cannot definitively state whether fish of the sizes observed migrating through Wells Dam during fyke netting in the 1980s and 1990s were actively or passively migrating. However, the fact that the lengths of the fyke-netted fish exceeded the lengths of nearly all those available to our sampling gear in 2011 supports the null hypothesis (that they are active migrants), because fish greater than 86 mm in our study displayed consistently faster and less variable migration rates than smaller fish and, in some cases, traveled at rates exceeding those of yearling, active migrants.

6.4 H3: Does Residence time in Wells Reservoir Exceed the Battery Life of Current Acoustic Tags?

The distribution of arrival times of PIT-tagged subyearlings at Rocky Reach Dam in 2011 raises important concerns regarding the use of acoustic tags in studies of the survival of subyearling Chinook through the Wells Project. Currently, the smallest acoustic tag is the JSATS-AMT (Juvenile Salmonid Acoustic Telemetry System) tag from Lotek Wireless (0.3 g in air; New Market, Ontario). These tags typically have a higher detection probability than PIT tags, allowing researchers to use fewer fish to obtain acceptable confidence intervals in survival models. Although the JSATS tag has been used by many researchers for survival studies at federal hydroelectric projects in the Snake and lower Columbia rivers (see McMichael et al. 2010 for examples) tag life remains an important concern for fish tagged above Wells Dam. Currently, the JSATS tag with a 5-second PRI (pulse rate interval) has an expected life of 27 days (Lotek Wireless JSTATS-AMT product sheet 2012). Our results from 2011 show that the travel times from release in Wells Reservoir to detection at Rocky Reach Dam exceeded 27 days for approximately 30% of the detected fish. Furthermore, this percentage may increase if we assume fish continued to pass Rocky Reach after August 31 when the JBS shut down, and once we include any “reservoir-type” fish that migrate as yearlings. Observed counts at projects in the lower river through September to mid-November (17-20% of the detections at McNary, John Day, and Bonneville dams occurred during these months), and the known “reservoir-type” life-history in the Snake River (Connor et al. 2005) support the assumption that fish continued to pass Rocky Reach well outside the expected tag life of the current acoustic tags. Thus, with a minimum 30% of the tagged population passing the nearest downstream detection site after the expiration of the published battery life of the smallest available acoustic tag, the evidence supports the alternate Hypothesis H3: residence time in Wells Reservoir exceeds the battery life of current acoustic tags.

6.5 H4: Do Subyearling Chinook from Wells Reservoir Migrate While PIT-tag Detection Arrays are Operational?

Our null Hypothesis $H4_0$, states that the study-fish population migrates only during periods when downstream PIT-tag detection arrays are operational. Although we were not able to determine passage timing at Wells Dam, detections at Rocky Reach Dam were highly variable with the largest proportion of detected fish migrating through Rocky Reach Dam in July, but fish detections continuing through August 31 when the JBS was turned off. Seventeen to twenty percent of the detections at lower Columbia River projects occurred between September and mid-November, which could indicate that fish migrated past Rocky Reach Dam after the bypass system was turned off. These detections at lower-river projects occurred right up until bypass facilities were turned off in November. Incidences of overwintering fish or residuals will be explored in the spring of 2012 when PIT-tag arrays are once again operational. Based on slow but steady detections at projects immediately prior to JBS shutdowns, it is reasonable to assume that an unknown quantity of subyearlings passed lower river projects at periods when they could not be detected, and thus, tagged fish do not have equal detectability. How many subyearling Chinook pass projects after November 15th and for how long after remains unknown. Proving the assumption that fish pass during a period when JBS systems are shut down will require tracking the fates of tagged fish through to their return as adults.

We have no reason to believe that passage of downstream projects stopped abruptly when the respective bypass systems were shut down. Thus, we have no basis for rejecting the alternate Hypothesis H4: A portion of the study-fish population migrates during periods when downstream PIT tag detection arrays are not operational. This is a concern since fish traveling through projects with non-operational detection arrays violates the assumption of equal detectability. Such fish would be treated as mortalities in current survival models, thereby negatively biasing survival statistics.

6.6 H5: Different River Conditions and Survival Probabilities When Migrating Through the Control Reach.

In Hypothesis H5, we anticipated that subyearling Chinook released to the Wells Reservoir or below Wells Dam would experience different river conditions and survival probabilities while migrating through the control reach (Rocky Reach Reservoir) if they manifested multiple life-history strategies. Thus, Hypothesis H5 is directly related to Hypothesis H1. The differences in river conditions and survival probabilities contemplated in H5 would dramatically exceed the typical variability in River conditions and survival probabilities between release groups that generally occur in a survival study spanning several weeks.

In our 2011 study we observed a range of migration timing among tagged fish that would undoubtedly result in a failure of treatment and control releases from a survival study to mix homogeneously in the control reach or reaches below Rocky Reach Dam. The range of detection dates at Rocky Reach Dam and downstream detection locations spanned more than four months, and we have no reason to believe that passage at detection sites abruptly ceased with the termination of bypass operations at those projects. To an individual fish, the biological importance of that interval between tagging and detection is a function of the span of changes in physical and dependent biological conditions experienced during that interval. Depending upon the length of that time span, temperatures will increase, or may increase and then decease; river discharge will decline, and, if the span is long enough will decline from near the highest to near the lowest extent of the annual hydrograph; photoperiod will decline from near the annual maximum to beyond the autumnal equinox. Wargo-Rub et al. (2011) reported that survival among replicates of both PIT- and acoustic-tagged Chinook in the Snake River changed with discharge and travel time (covariate). Smith et al. (2003) observed for PIT-tagged subyearling Chinook in the Snake River that the probability of survival decreased with increasing (i.e., later) release date. They noted three environmental variables with which survival probability was correlated: survival decreased with declining discharge, increasing temperature, and increasing water clarity, all three of which were highly correlated with each other and predictably tracked with increasing Julian Day. Haeseker et al. (2012) also reported positive correlations between water transit time and both freshwater and marine survival for Snake River yearling Chinook and steelhead. In addition to the variability in environmental parameters over time, predation rates may increase, decrease, or cycle through increasing and decreasing trends over time as the predators respond to the changing environmental parameters and their own reproductive cycles (e.g., Peterson and Ward 1999; Gray and Dauble 2001; Vigg and Burley 1991 Roby et al. 2008).

Combined, all of the changing factors described above influence the survival probabilities of subyearling Chinook in ways both complex and interacting, resulting in inequalities in river conditions and probabilities of survival for study fish exhibiting such variability in both migration behavior and timing of recruitment to taggable size. As an example, we found that larger fish (at tagging) were detected at higher rates than smaller fish. The relationship between fish size at tagging and the probability of subsequent detection at downstream projects likely reflects (among other things such as size-mediated susceptibility to predators) an interaction between migration rate and/or timing, and the physical and biological conditions that individual fish face during their emigration. Thus, the evidence supports the alternate Hypothesis H5, that subyearling Chinook released above and below Wells Dam experience different river conditions, and different survival probabilities when migrating through the control reach (Rocky Reach Reservoir).

6.7 H6: Are the Fish Available for Capture Large Enough to Tag with a 12.5 mm PIT Tag?

As discussed above, we, in consultation with our tagging contractor, Biomark, Inc., decided that we would only tag fish greater than 57 mm fork length. Fish captured on May 27 during the first of three sampling (scoping) efforts prior to tagging were nearly all (96%) too small to PIT tag with the standard 12.5 mm PIT tag, and in the second scoping event on June 10, more than half (52%) of the fish were too small. By the third scoping event on June 15, less than one-third (29%) were too small, and we elected to begin tagging efforts the following week. The size of fish captured in seining efforts varied by sampling site, and several of the sites where we directed much of our efforts during the first week of tagging (week of June 19) yielded catches of relatively small fish (see Table 1). As such, the resultant mean number of undersized fish for that week jumped up to approximately 52%. At the same time, the mean length of the combined catches for the week increased in a linear manner over that of the previous week (Figure 19). During the next two weeks of tagging the proportion of the catch that was too small to tag declined dramatically and the mean lengths of the combined weekly catches continued along the same increasing trajectory as in previous weeks. By the first week of our post-tagging sampling, none of the fish captured were too small to tag. However, by that date catch numbers had declined to the extent that beach seining was no longer a viable method for obtaining sufficient numbers of fish to warrant mobilizing a tagging crew.

From this data we conclude that from the perspective of the logistics of study implementation, during the period when fish were available for capture by beach seining, we conditionally accept the alternate Hypothesis H6: the fish available for capture in the Wells Project at time t_1 are not of sufficient size for tagging with 12.5 mm tags. Assumption 1 of the assumptions from the single- and paired-release survival-study models requires that we tag fish that represent the study population. To fulfill that requirement necessarily forces the rejection of our null Hypothesis H6, that the fish available for capture are of sufficient size for tagging.

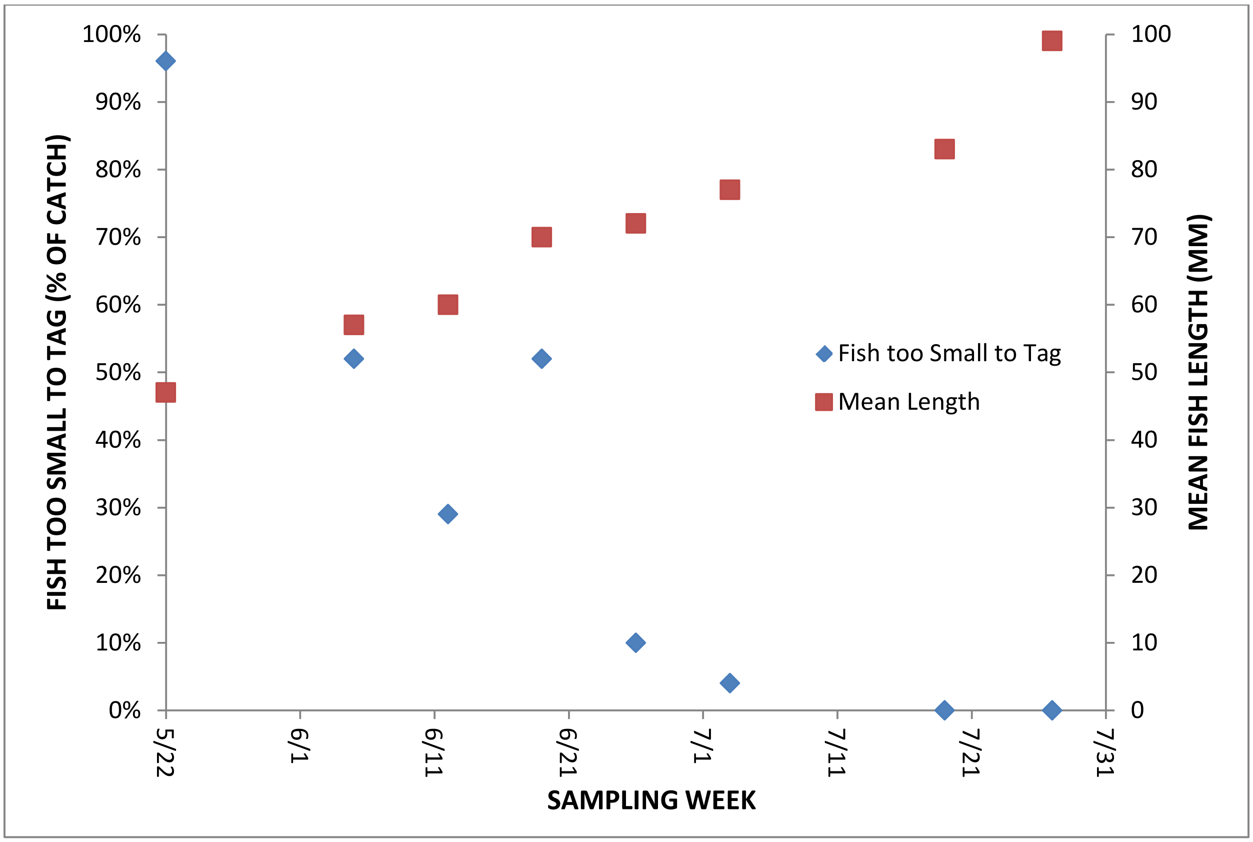

Figure 19. Percentage of fish captured each sampling week that were too small to PIT tag (primary y-axis), and mean length (mm) of combined weekly catch (secondary y-axis), by sampling week. The PIT-tagging size threshold was fork length greater than 57 mm.

6.8 H7: Are the Fish Available for Capture Large Enough to Tag with an Acoustic Transmitter?

$H7_{alt}$: The fish available for capture in the Wells Project are not of sufficient size for tagging with an acoustic transmitter.
$H7_o$: The fish available for capture in the Wells Project (reservoir, dam and tailrace) are of sufficient size for tagging with an acoustic transmitter.

The currently accepted fish-size criterion for acoustic-tag studies in the Columbia hydrosystem limits the use of acoustic tags to study fish 95 mm or greater in length (Carlson and Myjak 2010). This length corresponds with the minimum length at which fish tagged with a surgically implanted acoustic tag and PIT tag did not experience reduced survival in a laboratory study conducted in 2006 by Brown et al. (2007). The fish-length threshold stems from concerns that fish growth, behavior, and ultimately, survival could suffer if the weight of the tag exceeds a threshold ratio relative to fish weight. This ratio, referred to as "tag burden," has been the subject of much study and debate, but all agree with the desirability of minimizing tag burden in biotelemetry studies. Laboratory results do not necessarily translate to field settings, and indeed, in field studies conducted in 2007 to accompany the 2006 laboratory studies, detection probabilities and survival of subyearling Chinook with acoustic tags were so poor that the researchers did not repeat the second year of field trials on subyearling Chinook. Laboratory studies in 2008 demonstrated that even with smaller tags (reduced tag burden; mean 3.3%), acoustic-tagged subyearling Chinook survived at significantly lower rates than PIT-tagged subyearlings (Wargo-Rub et al. 2011). These findings are concerning if studies using tagged fish are assumed to represent the population of untagged conspecifics.

With the 95-mm length limit, only 199 (1.5%) of the 13,223 fish we PIT tagged in 2011 could also have carried an acoustic tag. Improvements in acoustic-tag design have reduced tag burden in study fish, but even the smallest acoustic tags still represent a much greater burden than a standard PIT tag. For example, an 85 mm fish that is approximately 8 g, carrying a 0.3 g JSATS (most current version) acoustic tag would have a tag burden approaching 4%, thus limiting the proportion of the run that could be tagged even further than the approximately 57 mm threshold we used for PIT tags in the 2011 study. Additionally, with our HCP requirement to "consider direct, indirect, and delayed mortality" in our survival studies, we must include a PIT tag (0.1 g) along with any other tag to allow us to monitor delayed mortality via adult returns. This would increase the tag burden to 5%. Brown et al. (2010) reported reduced survival and growth for subyearling Chinook less than 90 mm tagged with both acoustic and PIT tags with a combined weight in air of 0.46 g. Nevertheless, adopting the 90-mm threshold would still have precluded the tagging of nearly 96% of the subyearling Chinook that we PIT tagged in 2011.

Carlson and Myjak (2010) presented curves (Figure 20) to estimate the response of juvenile Chinook to rapid decompression events (such as may occur during turbine passage) in terms of "probability of mortal injury," which is the probability of an injury occurring that laboratory studies show leads to mortality. From these curves one can determine that the estimate of probability of mortal injury for a 60 mm Chinook carrying a PIT tag (weight ~0.1 g) would be just under 20% at given ratio of pressure change, and a fish with a 0.45 g tag burden (~that of the current JSATS tag plus a 12.5 mm PIT tag) would have to be nearly 96 mm in length to experience the same probability of mortal injury as the 60 mm PIT-tagged fish at the same ratio or pressure change.

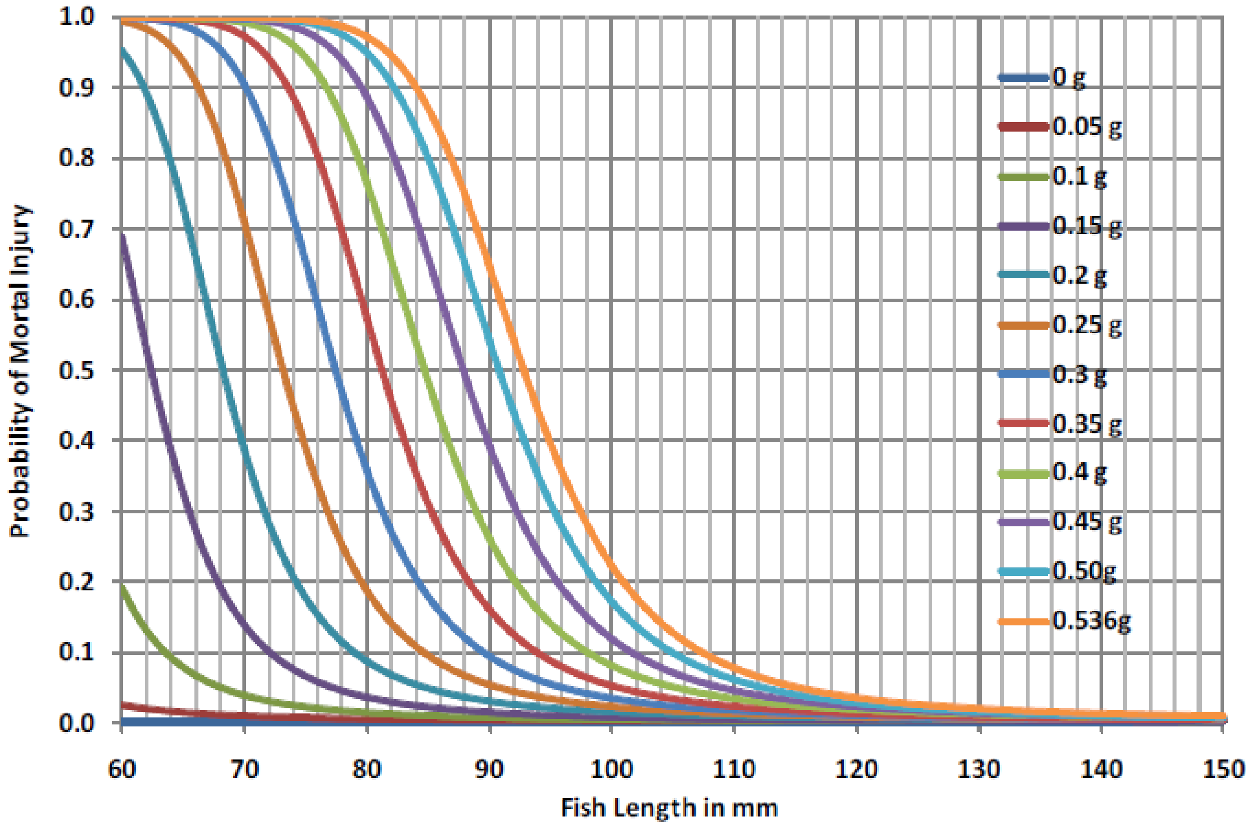

Figure 20. Mortal injury index for transmitter dry weights from 0 g to 0.536 g for fish between 60 mm and 150 mm in length passing a dam via a turbine or otherwise experiencing pressure changes of a similar magnitude as turbine passage (From Carlson and Myjak 2010).

Thus, because greater than 95% to greater than 98% (depending upon threshold accepted) of the subyearlings captured for tagging in the Wells Reservoir in 2011 were too small to tag with the currently available acoustic tags, and from the curves from Carlson and Myjak (2010; see Figure 20) that predict substantial biological consequences to small fish of the tag burden of the current acoustic tags, we accept alternate Hypothesis H7. That is, the fish available for capture in the Wells Project are not of sufficient size for tagging with an acoustic transmitter. A more troubling implication of Figure 20 (above) is that fish smaller than approximately 75 mm will experience a greater probability of mortal injury than larger fish when carrying even a PIT tag weighing approximately 0.1 g and subjected to the same ratio of pressure change. Clearly, for fish within the size range that we tagged in 2011, survival and detection probabilities were affected by the tag, and not all individuals from a release group had the same probability of detection or survival, because of the disproportionate tag burden experienced by the smallest individuals. These probability and detection differences would most specifically apply for those small fish passing a project through a turbine route where pressure changes are more likely, and could possibly explain why fish greater than 86 mm in length had a higher probability of detection than those 86 mm or smaller. Of course, other biases may exist for tagged fish some of which are discussed in H9.

6.9 H9: Are there Biological Costs of the Tagging Process and Carrying a Tag?

We hypothesized ($H9_0$) that the process of capture, holding, and tagging does not incur a biological cost on subyearling Chinook. Tag burden and the effect of a tag or tagging procedures on study fish is the focus of debate and continued research within the fisheries community, and a subject of interest in our study. Although, this topic was not a primary objective of 2011 efforts, we observed growth rates (calculated for recaptured fish) within the Wells Project that suggest some biological cost associated with capture, tagging, and handling. We recaptured 414 fish in the Wells Project 2 to 11 days after release. Although growth rates of these fish from release to recapture varied, in general, fish experienced relatively low growth rates (mean 0.34 mm/day) for up to ten days following release. In contrast, 0.77 mm/day was the growth rate we estimated for run-at-large fish in the Wells Reservoir, and the mean of growth rates calculated from fish recaptured at Rocky Reach Dam greater than 11 days post-release was 1.18 mm/day. Neither of these two measures is a perfect estimate of the rate at which fish grew in the reservoir because the run-at-large growth rate included new fish arriving over time and excluded fish that had moved offshore, thus negatively biasing the actual growth rate that an individual fish experienced in the project. Secondly, the estimated growth rate for fish recaptured at Rocky Reach Dam includes fish sampled later in the year when water temperatures were much warmer and growth might have been faster, thus positively biasing growth. Therefore, we hypothesize that actual growth in the reservoir should have been approximately in between 0.77 and 1.18 mm/d; much higher than the 0.34 mm/d observed in the 414 PIT-tagged recaptures. Importantly, we observed no clear relationship between the size of fish at tagging and growth rates within the 10 days post-tagging. Recaptured fish apparently experienced reduced growth over the first eleven days following tagging, irrespective of fish size at tagging.

We conclude that the reduced growth resulted from the tagging process (capture, holding, and tagging procedure), and not from tag burden, as a cost from tag burden would manifest as a lower growth rate for the smallest fish. Besides any effects from the stress of the capture/tagging process, one aspect of that process should almost certainly reduce the growth rates of tagged individuals—loss of foraging during the process. In our tagging procedure, we held fish overnight prior to tagging to allow them to recover from the capture process and to evacuate their stomachs. Following tagging, we held fish overnight to provide time for them to recover prior to release. Thus, the fish were starved for up to 48 hours post tagging, prior to release. The results of the food deprivation should manifest initially as reduced growth, and could differentially affect larger fish because of their higher metabolic demands (e.g., Clarke and Johnston 1999; Brett and Glass 1973; Wieser 1985), but because of the short duration of the process and the narrow size range of the fish, we do not anticipate a statistically significant difference in response due to fish size (and the occurrences of negative “growth” in our samples reveals the lack of precision in our measurements). Beyond the short-term consequences, the loss of two days of foraging may not result in longer term differences in size between study and run-at-large fish because of the phenomenon of compensatory growth (Nicieza and Metcalfe 1997); although

Johnsson and Bohlin (2006) reported a period of over five months was necessary for brown trout to fully compensate for reduced body length that resulted from temporary restrictions in food consumption. Since all of our study fish experienced the same tagging procedure, we do not expect to observe differential survival or growth in any release group resulting from the tagging process. Nevertheless, long-term fitness consequences may accrue from the tagging process and subsequent compensatory growth. Several researchers have documented such costs, including reduced swimming endurance (Royle at al. 2006) and burst swimming speed (Alvarez and Metcalfe 2007), and delayed mortality (Johnsson and Bohlin 2006). Without a laboratory component to our study we have no means to determine the occurrence or magnitude of such consequences.

From the observed data on reduced growth within the initial days post release, we accept alternate Hypothesis H9: that is, the process of capture, holding, and tagging incurs a biological cost on subyearling Chinook.

7.0 CONCLUSIONS

With data from only the first of a multi-year study available, we have already identified or confirmed challenges to studying the survival of subyearling Chinook originating above Wells Dam. We believe that an accurate and precise study of the survival of subyearling Chinook through the Wells Project is not possible unless we overcome the following logistical obstacles or violations of model assumptions (see Section 4 for the list of model assumptions):

1. Study fish are not representative of the population at large because we can only tag a subset of the population (violation of Model Assumption #1). Current versions of both PIT and acoustic tags are too large to tag the smallest fish (PIT) or most fish (acoustic), and the largest fish are not susceptible to our sampling gear.
2. Survival and detection probabilities are affected by the tags that we could use to study the survival of subyearling Chinook (violation of Model Assumption #2). Currently, tag sizes of both PIT and acoustic tags represent a tag burden that should disproportionately affect the survival and growth of smaller fish. The paired-release model may provide correction of "tag effects" if the other assumptions regarding detectability and survival probabilities were not also violated. However, see below…
3. Not all individuals from a release group have the same probability of survival, nor do they have the same probability of detection (violation of Model Assumptions #5, 6, and 9). We observed variation in migration timing and rates among fish captured and tagged from the same seine set, with passage of downstream projects occurring from within hours after release to at least until termination of bypass operations in mid-November. As described above, survival probability declines with increasing date, and environmental and biological conditions that influence survival probability are not uniform over the migration continuum of subyearling Chinook. Additionally, some fish migrated following shut-down of bypass operations, and long after the batteries of the currently available acoustic tags would have expired. Finally, detection probabilities were higher

for fish that were greater than 86 mm fork length at tagging, than for fish that were less than 87 mm at tagging.

We anticipate that data from additional years of study will refine our characterization of the behavior of subyearling Chinook in the Wells Reservoir, and reveal variations in their manifestation of life-history strategies over time and with changing environmental conditions. We also expect that continued advances in tag technology will enhance our ability to tag a more representative portion of the emigration. Nevertheless, considering the substantial reduction in tag mass necessary to both allow tagging of a broader range of sizes and to eliminate discrepancies in survival and detection probabilities between very large and very small individuals, we are not optimistic that technology will soon overcome these violations of model assumptions.

7.1 Recommendations

We intend the following recommendations to guide continued or future research into the life-history and behavior of subyearling Chinook in the mid-Columbia.

- Repeat the study for several years to allow comparison of year-to-year findings, and to evaluate behavior under different environmental conditions. Increase sample size with specific emphasis on locating fish from the Methow River. In 2011 we focused on fish from the Okanogan River since these fish were highly available and could be captured in a location where target fish were concentrated, by-catch was low, debris and snags were few, and that lacked mud and algae (that clog the net). Connor et al. (2002) reported that subyearling Chinook originating in the Clearwater River have higher propensity to residualize than Snake River Fall Chinook, and attributed this finding to water temperature differences between the two rivers. Since the Methow is colder than the Okanogan in the spring, we might expect Methow subyearlings to have a different proportion of the population manifesting the various life-history alternatives relative to Okanogan subyearlings.
- Refine our study hypotheses in response to the results of our analysis of the 2011 data.
- Sample fish from the mainstem Columbia River upstream of the mouth of the Okanogan River because these fish may have different growth and behavioral profiles than the fish originating from the Okanogan and Methow rivers.
- Continue to track tagged fish from 2011 through adult returns to quantify the incidence of winter emigration.
- Examine tag retention in a subset of tagged subyearlings, and modify net pens to allow collection of shed tags. Ombredane et al. (1998) reported no significant deficit in growth and survival for brown trout tagged when as small as 55 mm using an 11 mm PIT tag. However, these researchers also reported tag shedding greater than 3%, which was not evaluated in our 2011 study.
- Continue to explore the effects of tagging and tag bias.
- Analyze and assess the repeatability of behavioral size thresholds.
- Explore diel movements of subyearling fish in the Wells Project including depth preference of different sizes of fish. For example, in mid-July 1986 night snorkeling in Rock Island Reservoir revealed subyearling Chinook resting on sand and silt less than

one meter in depth and in slow-moving, backwater currents of less than 1cm/s (Chapman et al. 1994).

- Aim to reduce mortalities from capture, tagging, and handling stress to below 2%.

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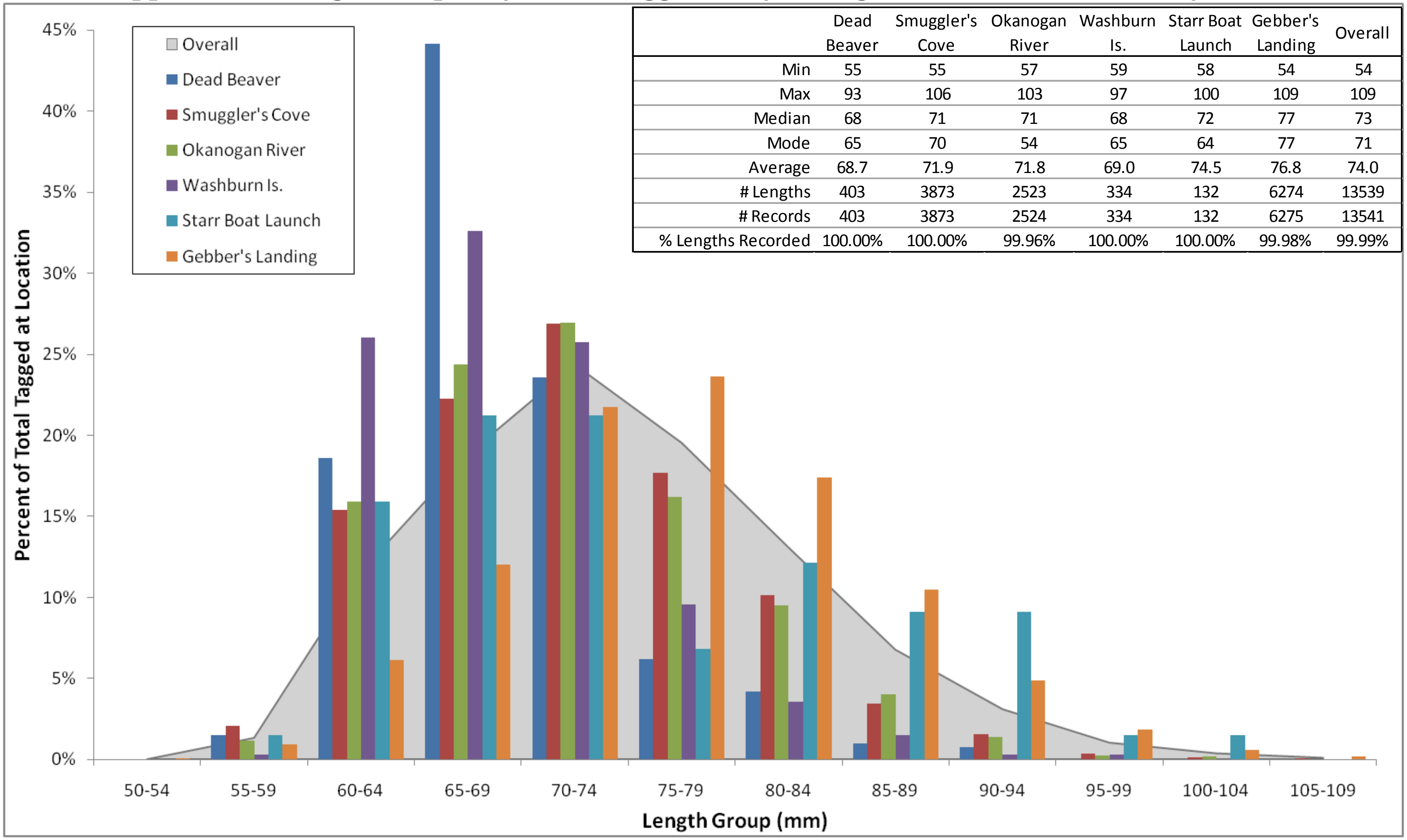
Appendix A. Estimate of bycatch during three weeks of beach seining in the Wells Project. Counts over 15 were estimates. *Greater than 90% of the sockeye were fry <50 mm.

Date	Sockeye*	Stickleback	Triploid Rainbow Trout	Common Carp	Sculpin	Sucker sp	Tench	Pikeminnow	Smallmouth bass	Chiselmouth	Bluegill	Redside Shiners
6/20/2011	100	500										
6/21/2011			2	4								
6/22/2011	250	500	1		20	20						
6/23/2011	100	250		4			2					
6/24/2011	No fishing											
6/25/2011	No fishing											
6/26/2011	No fishing											
6/27/2011								150				
6/28/2011				3		4	1	150	10	25		
6/29/2011				2		2		50	3		4	
6/30/2011			3	3		15	1	100	20			
7/1/2011	No fishing											
7/2/2011	No fishing											
7/3/2011	No fishing											
7/4/2011	No fishing											
7/5/2011								50				3
7/6/2011								25	25			
7/7/2011	No bycatch											
7/8/2011	No bycatch											
Species Total	450	1250	6	16	20	41	4	525	58	25	4	3
Grand Total	2402											
Species Total (%)	18.7%	52.0%	0.2%	0.7%	0.8%	1.7%	0.2%	21.9%	2.4%	1.0%	0.2%	0.1%

Appendix B. Length Frequency of PIT tagged sub yearling Chinook in Wells Pool by Week.



	Dead Beaver	Smuggler's Cove	Okanogan River	Washburn Is.	Starr Boat Launch	Gebber's Landing	Overall
Min	55	55	57	59	58	54	54
Max	93	106	103	97	100	109	109
Median	68	71	71	68	72	77	73
Mode	65	70	54	65	64	77	71
Average	68.7	71.9	71.8	69.0	74.5	76.8	74.0
# Lengths	403	3873	2523	334	132	6274	13539
# Records	403	3873	2524	334	132	6275	13541
% Lengths Recorded	100.00%	100.00%	99.96%	100.00%	100.00%	99.98%	99.99%

Appendix C. Recapture Summary by Location – Single Recaptures

Tag Location	Release Date	Recapture Site	Recap Date	# Recaps	Days After Release
Dead Beaver	22-Jun	Dead Beaver	22-Jun	5	0
	24-Jun	Dead Beaver	27-Jun	1	3
Smuggler's Cove	29-Jun	Smuggler's Cove	29-Jun	17	0
	29-Jun	Okanogan River	30-Jun	18	1
	29-Jun	Gebber's Landing	5-Jul	16	6
	29-Jun	Gebber's Landing	6-Jul	9	7
	29-Jun	Gebber's Landing	7-Jul	6	8
	29-Jun	Gebber's Landing	8-Jul	1	9
	30-Jun	Okanogan River	30-Jun	7	0
	30-Jun	Gebber's Landing	5-Jul	25	5
	30-Jun	Gebber's Landing	6-Jul	14	6
	30-Jun	Gebber's Landing	7-Jul	8	7
	1-Jul	Gebber's Landing	5-Jul	15	4
	1-Jul	Gebber's Landing	6-Jul	8	5
	1-Jul	Gebber's Landing	7-Jul	1	6
	1-Jul	Gebber's Landing	8-Jul	3	7
Gebber's Landing	7-Jul	Gebber's Landing	7-Jul	74	0
	7-Jul	Gebber's Landing	8-Jul	26	1
	8-Jul	Gebber's Landing	8-Jul	59	0
Okanogan River	23-Jun	Okanogan River	23-Jun	5	0
	23-Jun	Okanogan River	27-Jun	3	4
	23-Jun	Smuggler's Cove	28-Jun	1	5
	23-Jun	Smuggler's Cove	29-Jun	2	6
	23-Jun	Okanogan River	30-Jun	3	7
	25-Jun	Smuggler's Cove	27-Jun	3	2
	25-Jun	Okanogan River	27-Jun	1	2
	25-Jun	Smuggler's Cove	28-Jun	1	3
	25-Jun	Smuggler's Cove	29-Jun	2	4
	29-Jun	Gebber's Landing	5-Jul	1	6
	29-Jun	Gebber's Landing	6-Jul	1	7
	2-Jul	Gebber's Landing	5-Jul	36	3
	2-Jul	Gebber's Landing	6-Jul	20	4
	2-Jul	Gebber's Landing	7-Jul	6	5
	2-Jul	Gebber's Landing	8-Jul	4	6

Appendix C. Recapture Summary by Location – Double Recaptures

Tag Location	Release Date	Recapture 1		Recapture 2	
		Location	Date	Location	Date
Smuggler's Cove	6/29	Okanogan River	6/30	Gebber's Landing	7/5
Smuggler's Cove	6/29	Okanogan River	6/30	Gebber's Landing	7/6
Smuggler's Cove	6/29	Gebber's Landing	7/5	Gebber's Landing	7/7
Smuggler's Cove	6/30	Gebber's Landing	7/5	Gebber's Landing	7/7
Smuggler's Cove	6/30	Gebber's Landing	7/5	Gebber's Landing	7/7
Smuggler's Cove	6/30	Gebber's Landing	7/5	Gebber's Landing	7/8
Smuggler's Cove	6/30	Gebber's Landing	7/5	Gebber's Landing	7/8
Smuggler's Cove	6/30	Gebber's Landing	7/6	Gebber's Landing	7/8
Smuggler's Cove	7/1	Gebber's Landing	7/6	Gebber's Landing	7/8
Okanogan River	7/2	Gebber's Landing	7/5	Gebber's Landing	7/7
Okanogan River	7/2	Gebber's Landing	7/5	Gebber's Landing	7/7
Okanogan River	7/2	Gebber's Landing	7/5	Gebber's Landing	7/8
Okanogan River	7/2	Gebber's Landing	7/6	Gebber's Landing	7/8

APPENDIX K – ANALYSIS OF PROPORTION OF OUTMIGRATION AFFECTED BY BYPASS OPERATIONS AT WELLS DAM, 2005-2012

Analysis of Proportion of Outmigration Affected by Bypass Operations at Wells Dam, 2005-2012

Prepared for:

Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, Washington 98802 - 4497

Prepared by:

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Richard L. Townsend

Columbia Basin Research
School of Aquatic and Fishery Sciences
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1 December 2012

Outmigration has been monitored at the juvenile sampling facility at Rocky Reach Dam for four stocks of salmonids (yearling and subyearling Chinook, steelhead, and sockeye) from 2005 onward. The proportion of each stock covered by the bypass operations at Wells Dam can be estimated using the historical daily counts at Rocky Reach, and adding the travel time from Wells to Rocky Reach Dam. Table 1 has the average travel times, based on recent acoustic-tag studies, for yearling Chinook, steelhead and sockeye. Due to a dearth of PIT-tag and acoustic-tag studies performed with subyearling Chinook, travel time was assumed to be 2 days.

Table 1: Average travel times from Wells tailrace to Rocky Reach Dam.

Stock	Travel time
Yearling Chinook	5 days
Subyearling Chinook	2 days
Steelhead	2 days
Sockeye	2 days

Plots of the historical cumulative proportion of the outmigration for spring migrants (yearling Chinook, steelhead, and sockeye—Figure 1), and the subyearling Chinook in the summer (Figure 2) had fairly consistent start and end dates at Rocky Reach. Bypass operations for the spring outmigration at Wells from 2004 through 2011 was from 00:00 12 April – 24:00 13 June of each year for the "spring" spill season, and from 00:00 14 June – 24:00 26 August for the "summer" spill season. For 2012 and beyond, the Wells Habitat Conservation Plan (HCP) Coordinating Committee approved the modification of the timing of bypass operations at Wells Dam as follows: bypass operations commenced at 00:00 on April 9 and continued through 24:00 on August 19. The new timing of bypass operations will continue annually unless modified as a result of future investigations that demonstrate an inadequacy of these dates at providing bypass passage for 95% of both spring- and summer-migrating Plan Species at Wells Dam. Table 2 has the estimated proportion of the annual outmigration covered by the spring, summer, and total bypass operations. Steelhead, sockeye, and subyearling Chinook are estimated to have greater than 98% of their annual outmigration pass through Wells Dam during one or both of the two periods covered by bypass operations for the most recent eight years of record. For yearling Chinook, being the earliest arriving stock, proportion covered ranged from 94.49% to 99.96%. Table 3 compares the migration proportions under historical dates to the new stop/start dates of spill. To assess the actual start date for spring bypass operations, Table 4 has the date that, with hindsight, the spring bypass operations should have started to achieve 95% coverage of the yearling Chinook outmigration for that year. These dates ranged from 9 April to 3 May. For the two years when yearling Chinook coverage was less than 95%, bypass starting dates should have been 9 and 11 April, respectively, instead of 12 April.

Similarly, Table 5 compares the actual date of bypass termination with the date on which bypass operations covered 95% of the subyearling Chinook outmigration. In each year, an earlier termination of bypass operations would have been possible without jeopardizing the achievement of the HCP standard of providing a bypass route for ≥ 95% of outmigrating subyearling Chinook. During the eight years analyzed, the 95% HCP standard was achieved 4 to 32 days prior to the actual date spill was terminated.

Table 2. Total proportion of each stock's migration affected by bypass operations (spring, summer) at Wells Dam, based on travel times from Wells to Rocky Reach Dam, the cumulative proportion of the annual migration of each stock at Rocky Reach, and the start and stop dates of Wells bypass operations.

		Annual migration proportion							
	Proportion passed	2005	2006	2007	2008	2009	2010	2011	2012
Spring Outmigration	**Yearling Chinook**								
	prior to spring Bypass Ops period	0.0528	0.0259	0.0551	0.0025	0.0116	0.0067	0.0085	0.0004
	during spring Bypass Ops period	0.9455	0.9559	0.9154	0.9972	0.9827	0.9917	0.9910	0.9996
	during summer Bypass Ops period	0.0017	0.0.182	0.0296	0.0002	0.0056	0.0016	0.0005	0.0001
	after Bypass Ops period	0	0	0	0	0	0	0	0
	Total Covered by Bypass ops	**0.9472**	**0.9741**	**0.9449**	**0.9975**	**0.9884**	**0.9933**	**0.9915**	**0.9996***
	Steelhead								
	prior to spring Bypass Ops period	0.0015	0.0101	0.0066	0.0009	0.0019	0.0045	0.0190	0.0016
	during spring Bypass Ops period	0.9903	0.9762	0.9887	0.9901	0.9965	0.9763	0.9513	0.9883
	during summer Bypass Ops period	0.0081	0.0137	0.0042	0.0089	0.0016	0.0188	0.0297	0.0101
	after Bypass Ops period	0	0	0.0004	0.0001	0	0.0004	0	0
	Total Covered by Bypass ops	**0.9985**	**0.9899**	**0.9930**	**0.9990**	**0.9981**	**0.9951**	**0.9810**	**0.9984**
	Sockeye								
	prior to spring Bypass Ops period	0	0	0	0	0	0	0	0
	during spring Bypass Ops period	0.9983	0.9984	0.9998	0.9972	0.9957	0.9992	0.9923	0.9995
	during summer Bypass Ops period	0.0017	0.0016	0.0001	0.0028	0.0043	0.0008	0.0077	0.0005
	after Bypass Ops period	0	0	0	0	0	0	0	0
	Total Covered by Bypass ops	**1.0000**	**1.0000**	**0.9999**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**
Summer Outmigration	**Subyearling Chinook**								
	prior to spring Bypass Ops period	0	0	0	0	0	0	0	0
	during spring Bypass Ops period	0.1937	0.1894	0.2136	0.1266	0.1029	0.5212	0.5628	0.5871
	during summer Bypass Ops period	0.8022	0.8077	0.7847	0.8620	0.8882	0.4723	0.4331	0.4115
	after Bypass Ops period	0.0041	0.0029	0.0017	0.0113	0.0089	0.0064	0.0041	0.0014
	Total Covered by Bypass ops	**0.9959**	**0.9971**	**0.9983**	**0.9887**	**0.9911**	**0.9936**	**0.9959**	**0.9986**

***Proportions not summing to 1 are due to round-off error.**

Table 3. Comparison of the new start/stop spill dates (00:00 9 April – 24:00 19 August) versus the historical stop/start dates (00:00 12 April – 24:00 26 August), using the total proportion of each stock's migration affected by bypass operations (spring, summer) at Wells Dam, based on travel times from Wells to Rocky Reach Dam, the cumulative proportion of the annual migration of each stock at Rocky Reach, and the start and stop dates of Wells bypass operations.

		Annual migration proportion 2012	
	Proportion passed	Historical schedule	New Schedule
Spring Outmigration	**Yearling Chinook**		
	prior to spring Bypass Ops period	0.0011	0.0004
	during spring Bypass Ops period	0.9988	0.9996
	during summer Bypass Ops period	0.0001	0.0001
	after Bypass Ops period	0	0
	Total Covered by Bypass ops	**0.9989**	**0.9996***
	Steelhead		
	prior to spring Bypass Ops period	0.0016	0.0014
	during spring Bypass Ops period	0.9883	0.9885
	during summer Bypass Ops period	0.0101	0.0101
	after Bypass Ops period	0	0
	Total Covered by Bypass ops	**0.9984**	**0.9986**
	Sockeye		
	prior to spring Bypass Ops period	0	0
	during spring Bypass Ops period	0.9995	0.9995
	during summer Bypass Ops period	0.0005	0.0005
	after Bypass Ops period	0	0
	Total Covered by Bypass ops	**1.0000**	**1.0000**
Summer Outmigration	**Subyearling Chinook**		
	prior to spring Bypass Ops period	0	0
	during spring Bypass Ops period	0.5871	0.5871
	during summer Bypass Ops period	0.4115	0.4059
	after Bypass Ops period	0.0014	0.0070
	Total Covered by Bypass ops	**0.9986**	**0.9930**

***Proportions not summing to 1 are due to round-off error.**

Table 4. Comparison of the actual start date for spring bypass operations at Wells Dam each year, versus the start date necessary to have covered at least 95% of the yearling Chinook outmigration that year. Operations are assumed to begin at 00:00 for the date listed.

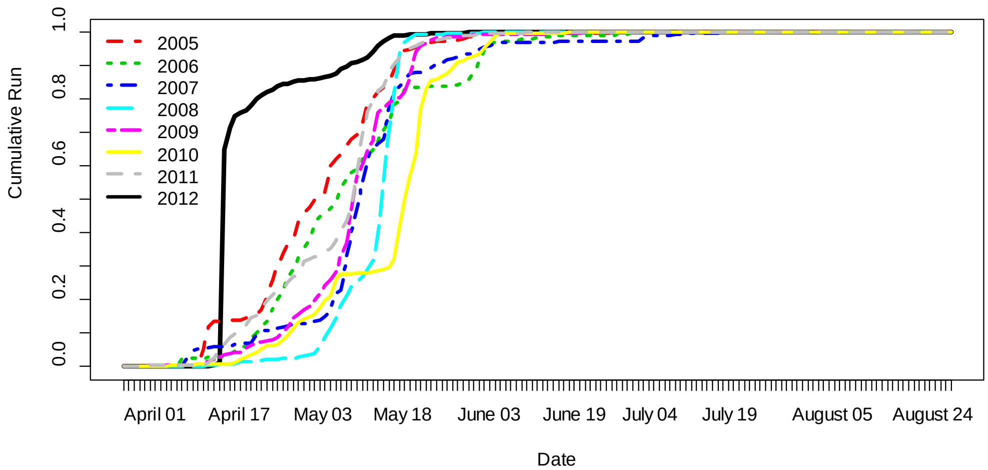
Migration Year	Actual Date	Cumulative proportion passed before 00:00	Proportion Covered by Bypass Ops	Date by which the first 5% passed	Cumulative proportion passed before 00:00	Bypass Ops would have Covered this Proportion	# Days before or after actual date to get 95%
2005	April 12	0.0528	0.9472	April 11	0.0039	0.9961	1 before
2006	April 12	0.0259	0.9741	April 18	0.0468	0.9532	6 after
2007	April 12	0.0551	0.9449	April 9	0.0243	0.9757	3 before
2008	April 12	0.0025	0.9975	May 3	0.0406	0.9594	21 after
2009	April 12	0.0116	0.9884	April 19	0.0436	0.9564	7 after
2010	April 12	0.0067	0.9933	April 22	0.0410	0.9590	10 after
2011	April 12	0.0085	0.9915	April 15	0.0446	0.9554	3 after
2012	April 9	0.0004	0.9996	April 15	0.0115	0.9885	6 after

Table 5. Comparison of the actual stop date for summer bypass operations at Wells Dam each year, versus the stop date necessary to have covered at least 95% of the subyearling Chinook outmigration that year. Operations are assumed to end at 24:00 for the date listed.

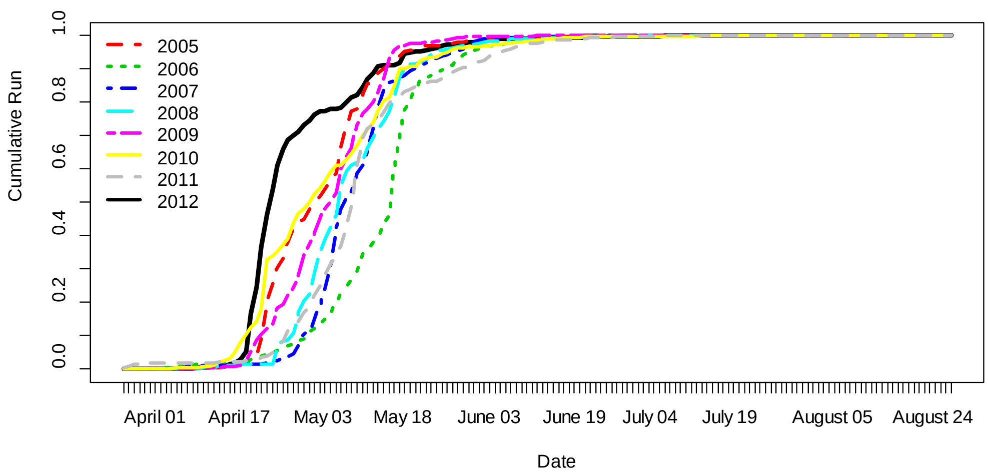
Migration Year	Actual Stop Date	Cumulative proportion passed by 11:59:59 PM	Date on or before the last 5% passed	Cumulative proportion passed by 11:59:59 PM (Bypass Ops would have Covered this Proportion)	# Days before actual date to get 95%
2005	August 26	0.9959	August 3	0.9525	23
2006	August 26	0.9971	August 2	0.9524	24
2007	August 26	0.9983	August 11	0.9538	15
2008	August 26	0.9887	August 19	0.9502	7
2009	August 26	0.9911	August 22	0.9709	4
2010	August 26	0.9936	August 10	0.9537	16
2011	August 26	0.9959	July 25	0.9528	32
2012	August 19	0.9930	July 29	0.9502	22

Figure 1. Passage dates at Rocky Reach Dam for spring migrating stocks, 2005-2012. Cumulative proportions are based on the expanded counts obtained from sampling daily from 1 April – 31 August (or through 4 September in 2008).

a. Yearling Chinook



b. Steelhead



c. Sockeye

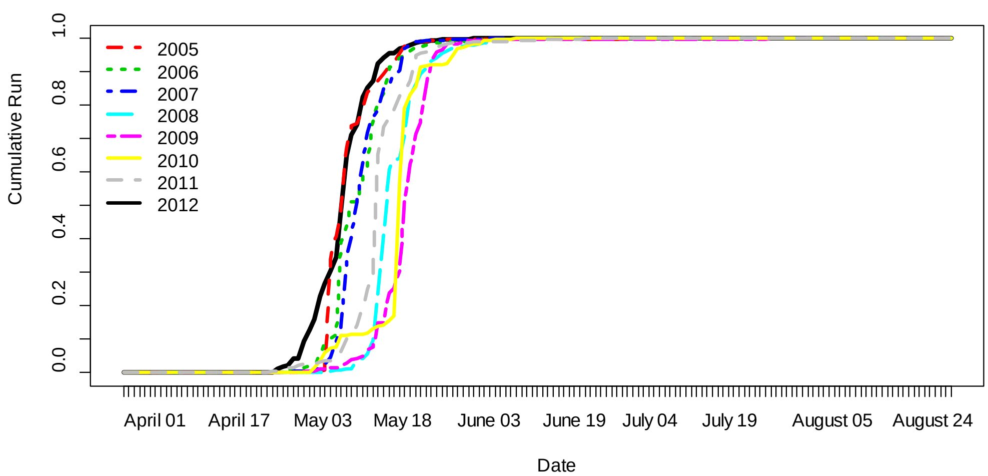
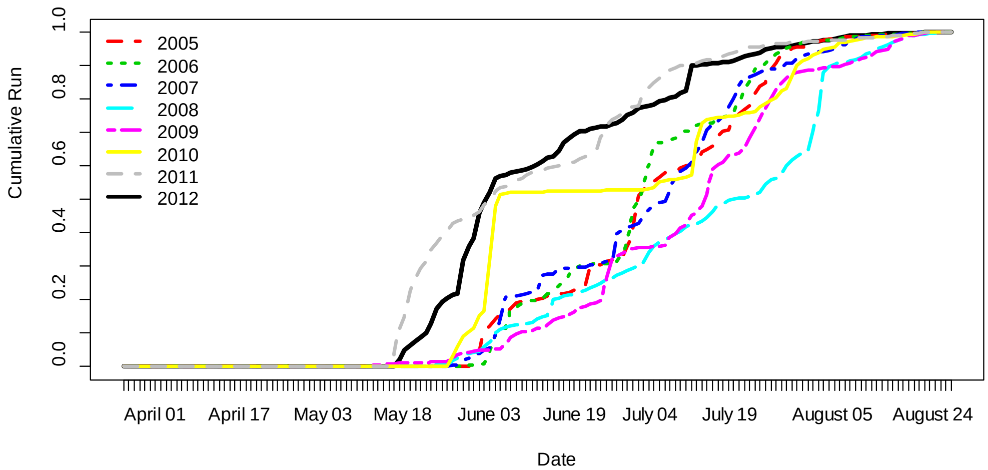


Figure 2. Passage dates at Rocky Reach Dam for summer migrating subyearlings, 2005-2012. Cumulative proportions are based on the expanded counts obtained from sampling daily from 1 April – 31 August (or through 4 September in 2008).

d. Subyearling Chinook



APPENDIX L - 2012 WELLS HCP ACTION PLAN

2012 ACTION PLAN
WELLS HCP

WELLS HCP COORDINATING COMMITTEE

1. Bypass Operating Plan

a. Draft to Coordinating Committee (CC): .... February 2012
b. Approval deadline: .... March 2012
c. Period of implementation: .... April 9 to August 19, 2012
d. Report deadline: .... October 2012

2. 2013 NNI Progress Report (per Wells HCP §6.9)

a. Douglas/CC develop report outline .... March 2012
b. CC provides direction on status update for Plan Species .... May 2012
c. Douglas submits Draft NNI Progress Report to the CC .... March 2013

3. Predator Control Programs

a. Pikeminnow removal – Wells Project: .... March – August 2012
b. Draft 2011 pikeminnow report to DCPUD: .... January 2012
c. 2011 pikeminnow report internal review and submission to CC: .... February 2012
d. Avian predator hazing at Wells: .... October 2011 – May 2012

4. Sub-yearling Chinook Life-history Study

a. Draft 2011 report to CC: .... February 2012
b. Final 2011 report: .... April 2012
c. Update study plan: .... January-April 2012
d. Tag and release study fish: .... June-July 2012
e. Monitor study fish: .... through life cycle
f. Draft 2012 report to CC: .... February 2013
g. Final 2012 report: .... April 2013

5. Annual Monitoring of Juvenile Migration Run Timing

a. Skalski analysis of index data from RR: .... September 2012
b. Draft of Skalski's report to DCPUD: .... September 2012
c. Final report presented to CC: .... October 2012

6. Installation of HDX PIT-tag Detection System at Wells Dam

a. Contractor noise testing and site analysis .... January 2012
b. Fabrication and installation of partial system in the west ladder ...... January/February 2012
c. Complete installation in the west ladder .... December 2012
d. Complete installation in the east ladder .... January/February 2013

7. Lamprey Entrance Efficiency Study

a. Study plan .... June 2012
b. Conduct velocity test and efficiency study .... July – August 2012
c. Draft report .... November 2012
d. Final report .... February 2013

WELLS HCP HATCHERY COMMITTEE

1. Implement 5-year Hatchery Monitoring and Evaluation (M&E) Plan

a. Ongoing implementation: ....January – December 2012
b. Draft annual report for 2011 to Douglas PUD: .... June 2012
c. Draft annual report to Hatchery Committee (HC): ....July 2012
d. Final annual report to HC: ....October 2012
e. Draft 5-year synthesis/analysis report to HC: .... February 2012
f. Final 5-year synthesis/analysis report: .... April 2012
g. Draft 2013 implementation plan to HC: ....October 2012

2. Review and Update 5-year M&E Plan (per Wells HCP §8.5.1 and 8.8)

a. Draft to HC: ....July 2012
b. Final to HC: ....October 2012

3. 2013 Hatchery Program Review (per Wells HCP §8.8)

a. Data and analyses for the Hatchery Program Review are contained within several existing documents or documents scheduled for completion in 2012:
   1. Douglas 5-Year M&E Report (to HC in 2012) addresses all aspects of the Hatchery Program Review for Methow Hatchery spring Chinook and Wells Hatchery steelhead and summer Chinook.
   2. Chelan 5-Year M&E Report (to HC in 2012) addresses all aspects of the Hatchery Program Review for Carlton Pond summer Chinook.
   3. Hatchery M&E annual reports (2003-2011) provide detailed data necessary for the Hatchery Program Review.
   4. Methow Spring Chinook HGMP (2010) included thorough review of the program and redesigned the program based on the review.
   5. Wells Complex Summer Steelhead HGMP (2011) included thorough review of the program and redesigned the program based on the review.
   6. Adjustment of hatchery compensation (2011) conducted review and assessment of SARs, adults returns, hatchery and natural smolt production.
   7. Fish-Water Management Tool (FWMT) Progress Report (Hyatt et al. in prep) provides an analysis of the multi-year data set to determine the contribution of FWMT implementation to average production of Okanagan sockeye.

b. HC directs the development of summary report: ....June – August 2012
c. HC reviews draft summary report: ....September – October 2012
d. Final summary report to HC: ....December 2012
e. Final summary report from HC to CC: .... January 2013

4. 2012 Broodstock Collection Protocol

a. Draft to HC: .... March 2012
b. Approval deadline: .... April 2012
c. Implementation: ....May 2012 to April 2013

5. Annual Implementation Report - Sockeye Fish/Water Management Tools

a. Period covered: .... Water Year 2011-2012 (October – September)
b. Draft to HC: ....*to be determined*

c. Presentation to HC: .... August or September 2012
d. Draft 2013 FWMT progress report to Douglas PUD: .... August 2012
e. Draft 2013 FWMT progress report to HC: .... October 2012
f. Final 2013 FWMT progress report to HC: .... December 2012
g. HC delivers final 2013 FWMT progress report to CC: .... January 2013

6. HGMP – Methow Spring Chinook

a. Draft Spring Chinook HGMP to HC: .... Complete November 2009
b. Final Spring Chinook HGMP to NMFS: .... Completed March 2010
c. NMFS approval of Spring Chinook HGMP: .... *to be determined*

7. HGMP – Wells Steelhead

a. Draft Steelhead HGMP to HC: .... Completed February 2011
b. Final Steelhead HGMP to NMFS: .... Completed March 2011
c. NMFS approval of Steelhead HGMP: .... *to be determined*

8. Methow Steelhead Relative Reproductive Success Study

a. Implementation: .... March 2010 - December 2021
b. Interim reports: .... September 2012
c. Final report: 2021/2022

9. Wells Hatchery Modernization

a. Update on rearing criteria and Master Plan: .... December 2012
b. Provide updates to the HC .... Monthly
c. Provide opportunities for HC input .... Periodically

WELLS HCP TRIBUTARY COMMITTEE

1. **Plan Species Account Annual Contribution**
   a. $176,178 in 1998 dollars..January 2012

2. **Annual Report - Plan Species Account Status**
   a. Draft to Tributary Committee (TC): ....February 2012
   b. Approval Deadline:..March 2012
   c. Period Covered: ....January to December 2011

3. **2012 Funding-round – General Salmon Habitat Program**
   a. Request for project pre-proposals:........................... *To be determined* (typically in March)
   b. Pre-proposals to TC: .... *To be determined* (typically in early May)
   c. Tours of proposed projects: ....*To be determined* (typically in late May)
   d. Project sponsor presentations to TC: .... *To be determined* (typically in early June)
   e. Final project proposals to TC:............................*To be determined* (typically in early July)
   f. RTT project rating decisions:.......................................*To be determined* (typically in July)
   g. Supplemental sponsor presentations..*To be determined*
   h. TC final funding decisions:......................... *To be determined* (typically before December)

4. **Small Project Program**
   a. Project review and funding decision.................................. Applications accepted any time

5. **Tributary Assessment Program**
   a. Proposal to TC for year-5 of 5 for ORRI monitoring ....July 2012
   b. Develop monitoring plan for remaining funds..March 2012
   c. Implement monitoring plan...*To be determined* (2012)
   d. Monitoring plan final product..December 2012
   e. TC delivers final product to CC...January 2013

APPENDIX M - WELLS DAM 2012 JUVENILE BYPASS OPERATING PLAN MEMORANDUM

Commissioners:
T. JAMES DAVIS
LYNN M. HEMINGER
RONALD E. SKAGEN

General Manager:
WILLIAM C. DOBBINS

Public Utility District No. 1 of Douglas County

1151 Valley Mall Parkway • East Wenatchee, Washington 98802-4497 • 509/884-7191 • FAX 509/884-0553 • www.douglaspud.org

Memorandum

TO: Wells HCP Coordinating Committee

FROM: Tom Kahler, Shane Bickford, Douglas PUD

DATE: February 27, 2012

SUBJECT: Wells Dam 2012 Juvenile Bypass Operating Plan

Anticipated Migrants during the 2012 Bypass Period

The 2012 spring and summer outmigration of naturally produced juvenile HCP Plan Species at Wells Dam will consist of offspring of adults that spawned above Wells Dam during brood years (BY) 2010 and 2011 (Table 1). The spring migration will comprise juvenile spring Chinook, coho, sockeye, and steelhead, and summer migrants will be summer/fall Chinook sub-yearlings.

Table 1. Ladder counts at Wells Dam of HCP Plan Species whose progeny are anticipated to migrate through the Wells Project during the 2012 bypass period. Juvenile steelhead migrate predominantly as yearlings from the Okanogan River and as Age-2 fish from the Methow River; thus, both 2009 and 2010 adult counts are included (BY 2010 and 2011, respectively).

Species	Adult Migration Year	Ladder Count	Juvenile Migration
Spring Chinook	2010	8,257	Spring
Summer/Fall Chinook	2011	38,286	Summer
Coho	2010	1,234	Spring
Sockeye	2010	291,766	Spring
Summer Steelhead	2009	25,422	Spring
Summer Steelhead	2010	12,929	Spring

Scheduled hatchery releases above Wells Dam in 2012 include yearling spring Chinook from the Methow Fish Hatchery (510,000) and the Winthrop National Fish Hatchery (WNFH; 550,000). The WNFH also will release approximately 315,000 coho this spring. Summer Chinook yearlings will be released from the Carlton (440,000) and Similkameen (600,000) acclimation ponds. Hatchery steelhead scheduled for release above Wells Dam include approximately 330,000 fish to the Methow Basin and 75,000 to the Okanogan Basin from Wells Hatchery, and 120,000 to the Methow Basin from WNFH. In general, the hatchery yearling Chinook, coho and steelhead are scheduled for release after April 15th with Winthrop coho and Wells steelhead scheduled for release after April 20th. By the first week of May, all of the Chinook and coho will have been released. The steelhead releases have historically continued into late May.

2012 Bypass Operations

Operation of the bypass system throughout the 2012 season will follow the criteria contained within the Wells Dam Juvenile Dam Passage Survival Plan (Wells Juvenile Bypass Plan) found in Section 4.3 of the Wells HCP. One of the main goals of the Wells Juvenile Bypass Plan is to provide bypass operations for at least 95% of both the spring and summer migration of juvenile plan species.

Since 2004, the timing of the implementation of bypass operations has been based upon an analysis of 21 years of hydroacoustic and 14 years of species composition information collected on juvenile run patterns at Wells Dam. From the data available to the Wells HCP Coordinating Committee in February 2004, they agreed that initiation of the Wells bypass system on April 12th and termination on August 26th would conservatively provide bypass operations for more than 95% of both the spring and summer migrations of juvenile Plan Species.

In 2011, Columbia Basin Research performed an analysis of seven years of passage data obtained from the sampling facility of the Rocky Reach Juvenile Fish Bypass System to more accurately estimate the percentage of the migration of both spring and summer migrants that passed during bypass operations at Wells Dam. From that analysis, the Wells Coordinating Committee adjusted the starting and ending dates for bypass operations at Wells Dam, moving the starting date three days earlier to April 9 to cover early-migrating natural origin spring Chinook, and moving the ending date seven days earlier to August 19 to more accurately reflect the end of the sub-yearling Chinook outmigration. Thus, for 2012, bypass operations at Wells Dam will commence at 00:00 on April 9 and end at 24:00 hours on August 19. For accounting purposes, the end of the 2012 spring bypass season will be June 13th at 24:00 hours and the beginning of the summer bypass season will be June 14th at 00:00 hours.

The Federal Energy Regulatory Commission (FERC) requires Douglas PUD to operate Wells Dam with sufficient automatic-gate-opening capacity in the spillway to pass the flow from a load rejection of 200 thousand cubic feet per second (kcfs), in addition to any concurrent inflows. Of the 11 spillways at Wells Dam, only spillways 3 through 9 have automated gate hoists. Thus, the seasonal installation of bypass barriers in the spillway substantially reduces the automatic-gate-opening capacity of Wells Dam by reducing the capacity of each bypass spillbay to 8.6 kcfs. Consequently, Douglas PUD must remove bypass barriers systematically with discharge, as per Table 2, to provide the necessary automatic-gate-opening capacity. Decisions to remove bypass barriers for FERC compliance will be made each Monday during the bypass period and will be based on weekly river-flow forecasts from the National Weather Service Northwest River Forecast Center (NWRFC; http://www.nwrfc.noaa.gov/stp/stp.cgi).

Table 2. Schedule for removal of spillway flow-barriers (bypass barriers) to accommodate flood flows and load rejections.

Inflow Forecast (kcfs)	Bypass Barriers Removed
Up to 210	None
210 – 240	Bypass Bay 6
240 – 275	Bypass Bays 4 and 6
275 – 310	Bypass Bays 4, 6, and 8
310 – 350	Bypass Bays 4, 6, 8, and 10
350 – 390	All Bypass Bays (2, 4, 6, 8, 10)

Bypass Contingency Plan

The failure of a gate-hoist cable in a bypass bay at Wells Dam in late August 2010 provided the impetus for the development of a contingency plan for bypass operations during similar events that could occur in the future. This contingency plan prescribes dam operations during two different scenarios:

Scenario 1: An event that can be quickly repaired,

Scenario 2: An event requiring a relatively long time to repair

As with the 2010 repair of the gate-hoist cable, in the event of a future failure of a bypass gate or other such accident or unanticipated mechanical failure that renders impossible normal bypass operations, Douglas PUD's initial response would follow the Wells Juvenile Bypass Plan: that is, the shutdown of associated turbine units as prescribed in Section 4.3 of the Wells HCP.

Section 4.3 of the Wells HCP directs the District to shut down the turbine units adjacent to the bypass bay that is not being operated due to either a lack of water or an inability to operate the bypass bay. The associated turbine units would remain inactive until personnel at Wells Dam can determine the cause of the bypass failure and the nature of and time required for the necessary repair. If it is determined that Scenario 1 applies, turbine units would remain inactive as long as the affected bypass bay(s) remained inoperable. When it is determined that Scenario 2 applies, associated turbine units would be shut down initially, but Douglas PUD may elect to move the bypass barriers from the inoperable bypass spillway to an adjacent, non-bypass spillway to obtain the use of an additional turbine unit. The gate for that substitute bypass spillway would then be set at the standard 1-foot opening for bypass bays and the adjacent turbine unit could be operated without constraints. This configuration would meet the intent of HCP Section 4.3 by providing bypass spill immediately adjacent to every operating turbine unit.

Bypass Operations and Clean Water Act TDG Compliance

Seasonal bypass operations generally coincide with the spring freshet, an event during which operators of hydroelectric projects must cope with flows that often exceed the hydraulic capacity of their powerhouses. When flows exceed the hydraulic capacity of the generating units, water must be passed via the spillway in what is termed "involuntary spill." Involuntary spill increases the concentration of atmospheric gases in the water below hydroelectric projects, and can result in excessive levels of total dissolved gas (TDG) that may injure fish. To minimize the potential for fish injury, the Washington Department of Ecology (WDOE) imposes TDG standards on operators of hydroelectric projects.

Extensive study of spill operations at Wells Dam and modeling exercises at the University of Iowa provide the basis for the development of annual spill "playbooks" for operations at Wells Dam aimed at achieving the WDOE standards for TDG in the Wells tailrace. From modeling and physical spill studies over the past seven years, Douglas PUD has determined that concentrating spill through the middle of the spillway and supporting that concentrated spill with turbine discharge results in the most effective minimization of TDG in the Wells tailrace. Specifically, the best TDG performance is achieved when concentrating involuntary spill through Spillway 5, and allocating additional spill, beyond the capacity of Spillway 5, to Bypass Bay 6 and then to Spillway 7, up to a maximum of 43 kcfs per spillway.

To accomplish this TDG-minimizing pattern of concentrated spill requires the removal of the bypass barriers from at least one spillway during periods with excessive involuntary spill. The removal of the bypass barriers from one bypass bay takes approximately eight hours and requires the use of a four-man mechanical crew and several gantry cranes. In order to comply with the TDG standards below Wells, the bypass barriers must be removed from at least one spillway whenever involuntary spill exceeds 30 kcfs and one or both of the following conditions applies: 1) prolonged (> 8 hours) involuntary spill in excess of 40 kcfs is predicted (based on tributary inflows and estimates of discharge from Chief Joseph Dam provided by the US Army Corps of Engineers); or 2) total spill is predicted to exceed 53 kcfs, regardless of duration. Once involuntary spill of less than 40 kcfs, for a period of at least four days is predicted, the bypass barriers would be reinstalled. At river flows greater than 240 kcfs, bypass barriers would be removed from additional bypass bays as described above (see Table 2) and reinstalled sequentially as appropriate.

APPENDIX N - WELLS HYDROELECTRIC PROJECT TOTAL DISSOLVED GAS ABATEMENT PLAN

TOTAL DISSOLVED GAS ABATEMENT PLAN

WELLS HYDROELECTRIC PROJECT

(FERC Project No. 2149)

Prepared by:

Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

January 2013

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Executive Summary

Washington State Water Quality Standards (WQS) are defined in Washington Administrative Code (WAC) Chapter 173-201A, and are administered by the Washington Department of Ecology. Compliance with the total dissolved gas (TDG) standard requires that TDG not exceed 110 percent at any point of measurement in any state water body. A dam operator is not held to the TDG standards when the river flow exceeds the seven-day, 10-year frequency flood (7Q-10). In addition to allowances for natural flood flows, the TDG criteria may be adjusted to aid fish passage over hydroelectric dams when consistent with an Ecology-approved gas abatement plan. On a per-application basis, Ecology has approved a TDG adjustment to allow spill for juvenile fish passage past Columbia and Snake River dams (WAC 173-201A-200(1)(f)(ii)).

On the Columbia and Snake rivers there are three separate standards for the fish passage TDG adjustment: 1) TDG shall not exceed 125 percent in the tailrace of a dam, as measured in any one-hour period, 2) TDG shall not exceed 120 percent in the tailrace of a dam and 3) shall not exceed 115 percent in the forebay of the next dam downstream. Compliance with the latter two standards is determined using an average of the 12 highest consecutive hourly readings in any 24-hour period. The increased levels of spill, resulting in elevated TDG levels, are intended to allow increased fish passage with less harm to fish populations than what would be caused by turbine fish passage. This TDG adjustment provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS) (NMFS 2000).

The goal of the Wells Total Dissolved Gas Abatement Plan (GAP) is to implement a long-term strategy to achieve compliance with the Washington State WQS criteria for TDG in the Columbia River at the Wells Hydroelectric Project (Wells Project) while continuing to provide safe passage for downstream migrating juvenile salmonids. Public Utility District No. 1 of Douglas County (Douglas PUD), which owns and operates the Wells Project, is submitting this GAP to Ecology as required for receipt of a TDG adjustment to aid fish passage at Wells Dam.

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1.0 Introduction and Background

The Wells Hydroelectric Project Gas Abatement Plan (GAP) provides details on operational and structural measures to be implemented by Public Utility District No. 1 of Douglas County, Washington (Douglas PUD) at Wells Dam under the Federal Energy Regulatory Commission (FERC) license for Project No. 2149. These measures are intended to result in compliance with the modified Washington State water quality standards (WQS) for total dissolved gas (TDG) allowed under the TDG adjustment, provided incoming water to the Project is in compliance and flows are below the seven-day, 10-year frequency flood levels (7Q-10: 246 kcfs).

The goal of the GAP is to implement a long-term strategy to achieve compliance with the Washington State WQS for TDG in the Columbia River at the Wells Hydroelectric Project (Wells Project or Project), while continuing to provide safe passage for downstream migrating juvenile salmonids via the Juvenile Bypass System (JBS). Douglas PUD is the owner and operator of the Wells Project and is submitting this GAP to the Washington Department of Ecology (Ecology) for approval as required for receipt of a TDG adjustment for fish passage.

Since 2003, Ecology has approved GAPs and issued a TDG adjustment for the Wells Project. The most recent GAP was approved by Ecology in 2012

This GAP contains three sets of information. Section 1.0 summarizes the background information related to regulatory and project-specific TDG information at the Wells Project. Proposed Wells Project operations and activities related to TDG management are contained in Sections 2.0 and 3.0. Section 4.0 provides a summary of compliance and physical monitoring plans, quality assurance and quality control procedures, and reporting.

1.1 Project Description

The Wells Project is located at river mile (RM) 515.6 on the Columbia River in the State of Washington (Figure 1). Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Hydroelectric Project, owned and operated by the United States Army Corps of Engineers (USACE); and 42 miles upstream from the Rocky Reach Hydroelectric Project owned and operated by Public Utility District No. 1 of Chelan County (Chelan PUD). The nearest town is Pateros, Washington, which is located approximately 8 miles upstream from the Wells Dam.

The Wells Project is the chief generating resource for Douglas PUD. It includes ten generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The spillway consists of eleven spill gates that are capable of spilling a total of 1,180 thousand cubic feet per second (kcfs). The crest of the spillway is approximately five and a half feet above normal tailwater elevation and two feet below tailwater elevation when plant discharge is 219 kcfs. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Fish passage facilities reside on both sides of the hydrocombine, which is 1,130 feet long, 168 feet wide, with a dam top elevation of 795 feet above mean sea level (msl). The Juvenile Bypass System (JBS) was developed by Douglas PUD and uses a barrier system to modify the intake velocities on all even numbered spillways (2, 4, 6, 8 and 10). The Wells Project is considered a "run-of-the-river" project due to its relatively limited storage capacity.

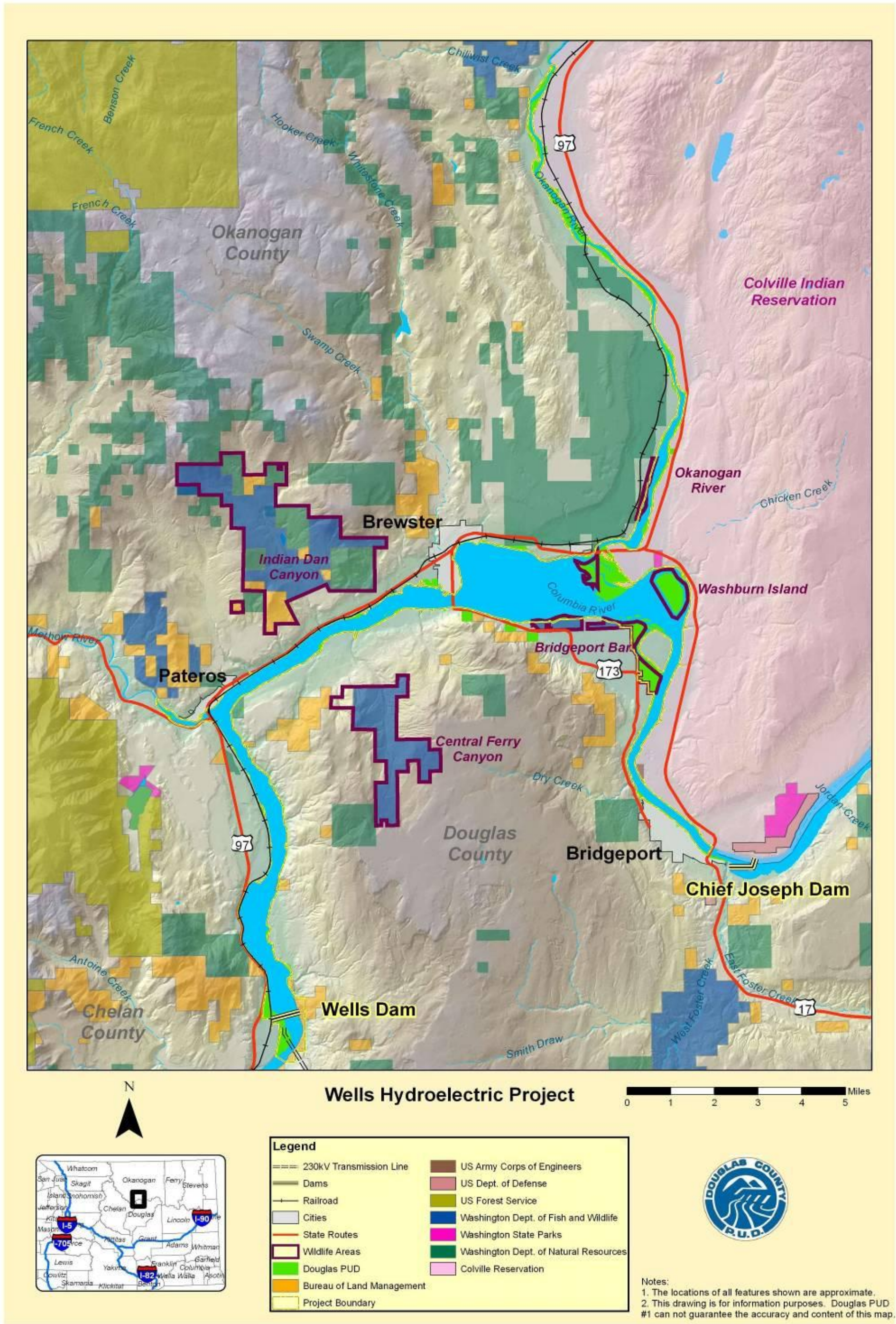

Figure 1. Map of the Wells Hydroelectric Project in Central Washington.

The Wells Reservoir is approximately 30 miles long. The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends approximately 1.5

miles up the Methow River and approximately 15.5 miles up the Okanogan River. The surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre-feet at the normal maximum water surface elevation of 781 feet.

1.2 Regulatory Framework

Article 401(a) of the FERC license for the Wells Project requires that the GAP be developed in consultation with the National Marine Fisheries Service (NMFS), [United States Fish and Wildlife Service (USFWS)], Washington State Department of Fish and Wildlife, [Washington State Department of Ecology (Ecology)], Confederated Tribes of the Colville Reservation, Confederated Tribes and Bands of the Yakama Nation, United States Bureau of Land Management, and United States Bureau of Indian Affairs. The GAP must then be approved by NMFS and Interior before being submitted to Ecology and the Aquatic Settlement Work Group for approval. Once approved by the Aquatic Settlement Work Group and in particular Ecology, then the GAP is to be filed with the FERC for approval.

WAC Chapter 173-201A defines standards for the surface waters of Washington State. Section 200(1)(f) defines the WQS for TDG, and subsection ii defines the TDG criteria adjustment for fish passage.

Under the WQS, TDG shall not exceed 110 percent at any point of measurement in any state water body. However, the standards exempt dam operators from this TDG standard when the river flow exceeds the 7Q-10 flow. The 7Q-10 flow is the highest calculated flow of a running seven consecutive day average, using the daily average flows that may be seen in a 10-year period. The 7Q-10 total river flow for the Wells Project was computed using the hydrologic record from 1974 through 1998, coupled with a statistical analysis to develop the number from 1930 through 1998. These methods follow the United States Geological Survey (USGS) Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" and determined that the 7Q-10 flow at Wells Dam is 246,000 cfs (Ecology et. al. 2004).

In addition to allowances for natural flood flows, the TDG criteria may be adjusted to aid fish passage over hydroelectric dams when consistent with an Ecology-approved gas abatement plan. This plan must be accompanied by fisheries management and physical and biological monitoring plans. Ecology may approve, on a per application basis, an interim adjustment to the TDG standard (110 percent) to allow spill for juvenile fish passage past dams on the Columbia and Snake rivers. Ecology-approved fish-passage adjustments comprise three separate standards to be met by dam operators: 1)TDG shall not exceed 125 percent in any one-hour period in the tailrace of a dam,2) TDG shall not exceed 120 percent in the tailrace of a dam and 3) shall not exceed 115 percent in the forebay of the next dam downstream, with compliance criteria 2 and 3 measured as an average of the 12 highest consecutive hourly readings in any 24-hour period (12C High). The increased levels of spill resulting in elevated TDG levels are authorized by Ecology to allow salmonid smolts a non-turbine downstream passage route that is less harmful to fish populations than turbine fish passage. This TDG adjustment provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS) (NMFS 2000).

A significant portion of the Wells Reservoir occupies lands within the boundaries of the Colville Indian Reservation. Wells Project operations do not affect TDG levels in tribal waters, where the Colville Tribes' TDG standard is a maximum of 110 percent, year-round, at all locations. This TDG standard is also the

U.S. Environmental Protection Agency's (EPA) standard for all tribal waters on the Columbia River, from the Canadian border to the Snake River confluence. TDG levels on the Colville Reservation portion of the mainstem Columbia River within Wells Reservoir result from the operations of upstream federal dams but in particular, the USACE's Chief Joseph Dam (located immediately upstream of Wells Dam) and the US Bureau of Reclamation's Grand Coulee Dam (located immediately upstream of Chief Joseph Dam).

1.2.1 7Q-10 Flood Flows

The 7Q-10 flood flow at the Wells Project is 246.0 kcfs. The Project is not required to comply with state WQS for TDG when project flows exceed this value.

1.2.2 Fish Spill Season

Although not defined in state regulations, the fish spill season at Wells Dam is determined by the Habitat Conservation Plan (HCP) Coordinating Committee and is intended to aid downstream juvenile salmonid fish passage over Wells Dam as an alternative to passage through the Project turbines. The fish spill season is generally April to end of August, but may vary from year to year. During non-fish spill, Douglas PUD will make every effort to remain in compliance with the 110 percent standard. During the fish spill season, Douglas PUD will make every effort not to exceed an average of 120 percent as measured in the tailrace of the dam. TDG at the Wells Project also must not exceed an average of 115 percent as measured in the forebay of the next downstream dam (Rocky Reach). These averages are calculated using the twelve (12) highest consecutive hourly readings in any 24-hour period. In addition, there is a maximum one-hour average of 125 percent, relative to atmospheric pressure, during fish spill season. Nothing in these special conditions allows an impact to existing and characteristic uses.

1.2.3 Incoming TDG Levels

During the fish spill season, TDG concentrations in the Wells Project forebay are primarily determined by the USACE's upstream water management activities at Chief Joseph Dam and the Bureau of Reclamation's activities at Grand Coulee Dam.

Since the completion of spill deflectors at Chief Joseph Dam in 2008, there has been a significant increase in the amount of spill at the Chief Joseph Project resulting from Federal Columbia River Power System (FCRPS)-wide operations. Recent increases in the amount of spill at Chief Joseph Dam have resulted in a dramatic rise in the volume of supersaturated water entering the Wells Project. For example, in 2012 Wells Dam received non-compliant water (>110%) on 125 days of the 133 days fish spill season. This mass influx of supersaturated water has resulted in significantly higher TDG concentrations observed in the forebay of Wells Dam that often exceeds TDG values of 115%.

Despite the absence of fish passage at Chief Joseph Dam, the USACE has operated under the assumption that the fish passage TDG adjustment approved by Ecology applies to all FCRPS dams, rather than the eight dams with fish passage in the lower Snake and Columbia rivers. Chief Joseph and Grand Coulee dams do not currently have upstream or downstream fish passage and subsequently do not have Ecology approved fish passage adjustment for spilling water above the 110% statewide uniform TDG standard. As a result, both the USACE and the Bureau of Reclamation are out of compliance with Washington State WQS, as well as the EPA TDG standard and the Colville Tribe's TDG standard, whenever TDG in the Chief Joseph dam or Grand Coulee dam tailraces exceeds 110 percent.

In 2012 the USACE revamped their proposed spill priority list for the FCRPS in recognition of the 110 percent TDG standard for joint operations of Grand Coulee and Chief Joseph Dams. Douglas PUD strongly supported the USACE's proposed 2012 spill priority as it was expected to reduce the future frequency and duration of non-compliant water entering the Wells Reservoir. Despite the spill priority modification in 2012, Douglas PUD consistently received non-compliant water from the upstream federal hydro-system above 110% on all but 8 days of the 133 day spill season. In addition Wells received water containing TDG over the 115% (12C-High) standard for more than 50% of the spill season days in 2012.

1.2.4 Total Maximum Daily Load

In June 2004, a total maximum daily load (TMDL) for TDG was jointly established for the Mid-Columbia River and Lake Roosevelt by Ecology, the Spokane Tribe of Indians, and EPA (Ecology et al. 2004). EPA's issuance covers all waters above Grand Coulee Dam and all tribal waters; EPA's TMDL covers all tribal waters of the Colville Confederated Tribes, including the right bank of the Columbia River from Chief Joseph Dam downstream to the Okanogan River confluence. Ecology's issuance covers all state waters downstream from Grand Coulee Dam to the Snake River confluence.

A summary implementation strategy prepared by Ecology and the Spokane Tribe of Indians describes proposed measures that could be used to reduce TDG levels in the Columbia River. Short-term actions primarily focus on meeting Endangered Species Act (ESA) requirements, while long-term goals address both ESA and TMDL requirements (Ecology et. al., 2004). Many of the recommended TMDL actions are currently being addressed by Douglas PUD through the implementation of the Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP) for anadromous salmon, the Bull Trout Management Plan resulting from consultation with the U.S. Fish and Wildlife Service, and requirements described in current and past GAPs.

The Wells Project occupies waters both upstream and downstream of the Okanogan River. In waters upstream of the Okanogan River, the TMDL does not provide an exemption for fish passage spills (except as a temporary waiver or special condition as part of the short-term compliance period, as described in the Implementation Plan, Appendix A of the TMDL). Downstream of the Okanogan River, allocations are provided based on both the 110 percent criteria and the criteria established for fish passage in the Washington State WQS. Any adjustment for fish passage downstream of the Okanogan River requires an Ecology-approved Gas Abatement Plan or GAP (Ecology et al. 2004).

1.2.5 Additional 401 Certification Requirements

On May 27, 2010 Douglas PUD filed an application for a new license with the FERC for the Wells Project. On September 30, 2010, Ecology received an application for a 401 Certification from Douglas PUD, requested pursuant to the provisions of 33 USC §1341 (§401 of the Clean Water Act). On September 12, 2011, Douglas PUD withdrew its request and reapplied. On February 27, 2012, Ecology concluded that the Wells Project, as conditioned by its 401 Certification/Order No. 8981, would comply with all applicable provisions of 33 USC 1311, 1312, 1313, 1316, 1317 and appropriate requirements of Washington State law. The 401 Certification general conditions that are relevant to the GAP and the abatement of TDG under the TDG adjustment are as follows:

- Douglas PUD shall consult with Ecology before it undertakes any change to the Project or Project operations that might significantly and adversely affect compliance with any applicable water quality standard (including designated uses) or other appropriate requirement of state law.
- Copies of the Wells Project 401 Certification and associated permits, licenses, approvals and other documents shall be kept on site and made readily available for reference by Douglas PUD, its contractors and consultants, and by Ecology.
- Douglas PUD shall allow Ecology access to inspect the Project and Project records required under the 401 Certification for the purpose of monitoring compliance with conditions of the 401 Certification. Access will occur after reasonable notice, except in emergency circumstances.
- Douglas PUD shall, upon request by Ecology, fully respond to all reasonable requests for materials to assist Ecology in making determinations under the 401 Certification and any resulting rulemaking or other process.
- Douglas PUD shall operate the Wells Project in compliance with a GAP approved by Ecology. By February 28 of each year, Douglas PUD shall submit a GAP to Ecology for approval. Pending Ecology's approval of each subsequent GAP, Douglas PUD shall continue to implement the activities identified within the previously approved plan.
- The GAP will include the Spill Operations Plan and will be accompanied by a fisheries management plan (section 2.2.1) and physical (section 4.1.1) and biological (section 2.2.2) monitoring plans. The GAP shall include information on any new or improved technologies to aid in the reduction in TDG.
- Commencing one year after issuance of a new FERC license, Douglas PUD shall monitor and report spills and TDG during non-fish spill season to determine TDG compliance with the 110 percent standard (see section 4.1.1). The non-fish spill season is defined as the times of the year that are not considered the fish spill season (generally April to end of August).
- If Douglas PUD, at any point, considers modifying any of the measures identified in the spill playbook, they will immediately develop proposed alternative(s) that will produce levels of TDG equal to or less than those estimated to be produced by the measures to be replaced. These measures should be implementable in a similar timeframe and must be submitted to Ecology for review and approval prior to implementation.
- The Project shall be deemed in compliance with the TMDL for TDG as long as it remains in compliance with the terms of the 401 Certification. The certification, including the GAPs and the

Water Quality Attainment Plan (section 2.2.4), is intended to serve as the Project's portion of the Detailed Implementation Plan for the TDG TMDL.

The 401 Certification also contains specific conditions that are relevant to the GAP and the abatement of TDG under the TDG adjustment are as follows:

- Commencing one year after issuance of the new license, Douglas PUD shall monitor and report spills and TDG during non-fish spill season to determine compliance with the 110% standard.
- Douglas PUD shall maintain a TDG monitoring program at its Fixed Monitoring Locations in the forebay and tailrace of Wells Dam and/or at other locations as determined by Ecology, in order to monitor TDG and barometric pressure. Douglas PUD shall monitor TDG hourly throughout the year.
- The TDG monitoring program shall conform to the Ecology Quality Assurance Project Plan (QAPP) requirements per Section 6.7 (f) of the [license] order and the procedures shall be at least as stringent as the quality assurance/quality control calibration and monitoring procedures developed by the USGS for the Columbia River.
- Douglas PUD shall provide an annual TDG report to Ecology for review and approval by February 28th of each year.
- Within one year of issuance of the new license, Douglas PUD shall coordinate the annual HCP Project Fish Bypass/Spill Operations Plan with the GAP, using best available information to minimize the production of TDG. This coordination shall be accomplished in consultation with the Wells HCP Coordinating Committee and the aquatic SWG.
- Within one year of license issuance, Douglas PUD shall submit a Water Quality Attainment Plan for Ecology to review and approve. The plan shall include a compliance schedule to ensure compliance with the water quality criteria with 10 years.
- Douglas PUD shall manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 by minimizing voluntary spill through operations, including scheduling maintenance based upon predicted flows, avoiding spill by coordinating operations with updstream dams to the extent that it reduces TDG, maximize power house discharge, especially during periods of high river flows, and manage voluntary spill in real time in an effort to continue to meet TDG numeric criteria consistent with the GAP.

1.2.6 Additional Requirements of the FERC Operating License

Article 401(a) of the FERC operating license for P-2149 requires that the Gas Abatement Plan be filed with the Commission for approval following the approval of the GAP by NMFS, USFWS and Ecology. Article 401(b) requires the TDG report be submitted to the Commission by February 28th of each year.

Article 401(c) requires Commission authorization of an application to amend the license, prior to the implementation of measures to address non-compliance with numeric water quality criteria.

1.3 History of Operations and Compliance

1.3.1 Historical Flows

Flow from the Columbia River originates in the headwaters of the Canadian Rockies and picks up snow melt from tributary streams as it travels over 1,243 miles before emptying into the Pacific Ocean. There are 85,300 square miles of drainage area above Wells Dam. The natural hydrograph had low flows in November through January with high flows in May through July. Storage dams on the Columbia River and its tributaries upstream of the Wells Project in the U.S. and Canada capture spring and summer high flows to hold for release in the fall and winter months. Table 1 presents information on Columbia River flow, as measured at Wells Dam from 2002 to 2012, and shows that the current hydrograph of the Columbia River is controlled by upstream, federally managed storage and release regimes. Juvenile anadromous salmonid migration occurs within a regime of reduced high flows during the spring migration period.

In general, the hydropower system and reservoir operations in the Columbia River are coordinated through a set of complex agreements and policies that are designed to optimize the benefits and minimize the adverse effects of project operations. The Wells Project operates within the constraints of the Pacific Northwest Coordination Agreement, Canadian Treaty, Canadian Entitlement Agreement, Hourly Coordination Agreement, the Hanford Reach Fall Chinook Protection Program and the FERC regulatory and license requirements.

Table 1. Average monthly flows (kcfs) at Wells Dam, by month (2002-2012).

	Month											
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2002	91	91.9	66.1	116.9	135	205.6	176.5	115.1	73.9	79.4	96.7	93.3
2003	75.7	69.9	82.2	106.7	130.7	137.6	106.2	96.4	64	74.6	87.7	105.5
2004	96.2	80.5	70	87.3	114.2	132.3	101.5	95.7	75.7	79.3	90.9	112
2005	102	104.4	94.9	85.4	122.1	130.8	136.8	107.9	67.6	78.5	90.9	91.8
2006	101.2	104.5	87.3	148.4	165.3	195.1	127.9	103.9	66.3	66.3	77.1	90.8
2007	114.5	85.3	120.3	154.7	159.2	152	133	113.1	60	64.4	80.2	86.8
2008	104	88.6	82.4	90.3	158.7	206.8	135.3	86.5	60.7	63	75.2	94.2
2009	107.8	80.2	71.5	111	122.7	146.6	103.1	74.5	53.5	58.1	80.1	101.8
2010	71.1	72.1	65.2	70.7	112.2	173	119.9	83.6	53.8	67.7	85.8	86.2
2011	114.9	136.6	124.1	145.7	206	259	206.6	139.9	73.8	74.9	89.9	98.2
2012	93.4	83.5	118.4	174.1	217.2	232.9	253.8	158.6	79.5	64	88.4	NA
All	97.4	90.7	89.3	117.4	149.4	179.2	145.5	106.8	66.3	70.0	85.7	96.1

1.3.2 Spill Operations

1.3.2.1 General Operation

The Hourly Coordination Agreement is intended to integrate power operations for the seven dams from Grand Coulee to Priest Rapids. "Coordinated generation" is assigned to meet daily load requirements via Central Control in Ephrata, WA. Automatic control logic is used to maintain pre-set reservoir levels to meet load requirements and minimize involuntary spill. These pre-set reservoir levels are maintained at each project via management of a positive or negative "bias". Positive or negative bias assigns a project more or less generation based on its reservoir elevation at a given time and thus, maximizes system benefits and minimizes involuntary spill.

1.3.2.2 Spill for Fish

Wells Dam is a hydrocombine design where the spillway is situated directly above the generating units. Research at Wells Dam in the mid-1980s showed that a modest amount of spill effectively guided 92.0-96.2% of the spring and summer downstream migrating juvenile salmonids through the JBS (Skalski et al. 1996; Table 2). The operation of the Wells JBS utilizes the five even-numbered spillways. These spillways have been modified with constricting barriers to improve the attraction flow while using modest levels of water. These spillways are used to provide a non-turbine passage route for downstream migrating juvenile salmonids from April through August. Normal operation of the JBS uses 10 kcfs. During periods of extreme high flow, one or more of the JBS barriers will be removed to provide adequate spill capacity to respond to an emergency plant load rejection. Spill barriers may also be removed to minimize TDG production during high spill events, or when flood flows are forecast. Bypass gates are opened when adjacent turbines are operating.

Typically, the JBS will use approximately 6 to 8 percent of the total river flow for fish guidance. Between the years 1997 and 2004, the volume of water dedicated to JBS operations has ranged from 1.5 to 3.2 million acre-feet annually. The operation of the JBS adds a small amount of TDG (up to 2 percent) while meeting a very high level of fish guidance and protection. This high level of fish protection at Wells Dam has met the approval of the fisheries agencies and tribes and is vital to meeting the survival performance standards contained within the FERC-approved HCP. The Wells Project JBS is the most efficient bypass system on the mainstem Columbia River.

Table 2. Wells Hydroelectric Project Juvenile Bypass System Efficiency.

Species	% JBS Passage
Yearling (spring) Chinook	92.0
Steelhead	92.0
Sockeye	92.0
Subyearling (summer/fall) Chinook	96.2

The JBS is used to protect downstream migrating juvenile salmonids. Fish bypass operations at Wells Dam falls into two seasons, Spring Bypass and Summer Bypass. For 21 years, the status of the fish migration for both spring and summer periods was monitored by an array of hydroacoustic sensors placed in the forebay of Wells Dam. The operation period for the juvenile bypass begins in April and ends in August; actual start and stop dates are set by the HCP Coordinating Committee, and are based on long-term monitoring to bracket the run timing of greater than 95 percent of both the spring and summer migrants. Up to thirteen million juvenile salmonids migrate past Wells Dam each year.

1.3.2.3 Flows in Excess of Hydraulic Capacity

The Wells Project is a “run-of-the river” project with a relatively small storage capacity (~98,000 acre ft). By comparison, Grand Coulee Dam, two projects upstream of Wells Dam, has 58 times the storage capacity of the Wells Reservoir. River flows in excess of the ten-turbine hydraulic capacity (219 kcfs) at Wells Dam must be passed over the spillways.

The forebay elevation at Wells Dam is maintained between 781.0 and 771.0 msl. The Wells Project has a hydraulic generating capacity of 219 kcfs (ASL 2007) and a spillway capacity of 1,180 kcfs. In recent years however the Wells project has had less than 200 kcfs plant capacity due to ongoing generator and turbine rebuild and upgrade projects. Data for Columbia River flows for eighty-five years at Priest Rapids yielded a peak daily average discharge of 690 kcfs on June 12, 1948 (USGS web page for historical flows at Priest Rapids on the Columbia River, http://waterdata.usgs.gov/wa/nwis/dv/?site_no=12472800). Therefore, the hydraulic capacity of Wells Dam is well within the range of recorded flow data.

1.3.2.4 Flow in Excess of Power Demand

Spill may occur at flows less than the Wells Project hydraulic capacity when the volume of water is greater than the amount required to meet electric power system loads. This may occur during temperate weather conditions and when power demand is low or when non-power constraints on river control results in water being moved through the Mid-Columbia at a different time of day than the power is required (i.e. off-peak periods). Hourly coordination (Section 3.2) between hydroelectric projects on the river was established to maximize generation by minimizing spill. Spill in excess of power demand provides benefit to migration juvenile salmonids. Fish that pass through the spillway survive at a higher rate relative to passage through a turbine and the turbulence in the tailrace generated by spill in excess of power demand increases tailrace velocity and reduces tailrace egress times. The reductions in tailrace egress time and increases in water turbulence and velocity reduce predation in the Wells tailrace.

1.3.2.5 Gas Abatement Spill

Gas Abatement Spill is used to manage TDG levels throughout the Columbia River Basin. The Technical Management Team (including NMFS, USACE, and Bonneville Power Administration [BPA]) implements and manages this spill. Gas Abatement Spill is requested from dam operators at other projects in the Columbia and Snake Rivers where gas levels are high. A trade of power generation for spill is made between operators, providing power generation in the river with high TDG and trading an equivalent amount of spill from a project where TDG is lower. Historically, the Wells Project has accommodated requests to provide Gas Abatement Spill. However, in an effort to limit TDG generated at the Wells Project, Douglas PUD has adopted a policy of not accepting Gas Abatement Spill at Wells Dam.

1.3.2.6 Other Spill

Other spill includes spill as a result of maintenance or plant load rejection. A load rejection occurs when the generating plant is forced off-line by an electrical fault, which trips breakers and shuts off generation. At a run-of-the-river hydroelectric dam, if water cannot flow through operating turbines, then the river flow that was producing power has to be spilled until turbine operation can be restored. These events are extremely rare, and would account for approximately 10 minutes in every ten years.

Maintenance spill is utilized for any activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include checking gate operation, conducting index and generator load testing and all other maintenance activities that would require spill to pass water. The FERC requires that all spillway gates be operated once per year. To control TDG levels associated with maintenance spill, Douglas PUD limits, to the extent practical, maintenance spill during period of peak flow .

1.3.3 Compliance Activities in Previous Year

1.3.3.1 Operational

Since the Wells Project is a “run-of-the river” project with a relatively small storage capacity, river flows in excess of the ten-turbine hydraulic capacity must be passed over the spillways. Outside of system coordination and gas abatement spill (Douglas PUD has adopted a policy of not accepting the latter), minimization of involuntary spill has primarily focused on minimizing TDG production dynamics of water spilled based upon a reconfiguration of spillway operations. The 2009 Wells Project GAP (Le and Murauskas, 2009) introduced the latest numerical model developed by the University of Iowa’s IIHR-

Hydroscience and Engineering Hydraulic Research Laboratories. The two-phase flow computational fluid dynamics tool was used to predict hydrodynamics of TDG distribution within the Wells Dam tailrace and further identify operational configurations that would minimize TDG production at the Project. In an April 2009 report, the model demonstrated that Wells Dam can be operated to meet the TDG adjustment criteria during the passage season with flows up to 7Q-10 levels provided the forebay TDG levels are below 115 percent. Compliance was achieved through the use of a concentrated spill pattern through Spillbay No. 7 and surplus flow volume through adjacent odd numbered spillbays in a defined pattern and volume. These preferred operating conditions create surface-oriented flows by engaging submerged spillway lips below the ogee, thus increasing degasification at the tailrace surface, decreasing supersaturation at depth, and preventing high-TDG waters from bank attachment. These principles were the basis of the 2009 Wells Project Spill Playbook and were fully implemented for the first time during the 2009 fish passage (spill) season with success. Overall, no exceedances were observed in either the Wells Dam tailrace or the Rocky Reach forebay in 2009.

In 2010, the concepts from the 2009 Spill Playbook were integrated into the 2010 Wells Project Spill Playbook given their effectiveness in maintaining levels below TDG criteria during the previous year. High Columbia River flows in June, which exceeded the preceding 15-year average flow, resulted in several exceedances of the hourly (125 percent maximum) and 12C-High (120 percent) TDG limits in the Wells Dam tailrace, and Rocky Reach forebay (115 percent). In response, Douglas PUD implemented an in-season analysis of the 2010 Spill Playbook and determined that full implementation of the recommendations from IIHR Engineering Laboratory would require the removal of the juvenile fish bypass system flow barriers in one even numbered spillbay. Following the in-season analysis and consultation with the HCP Coordinating Committee, changes were made to the 2010 Spill Playbook that allowed for the removal of the juvenile fish bypass system barriers in spillbay 6. Specifically, the Spill Playbook was modified to state that when spill levels approach the 53 kcfs threshold, the JBS barriers in spillbay 6 would be removed in order to remain in compliance with the TDG criteria in the Wells Dam tailrace and Rocky Reach Dam forebay. When spill exceeded 53 kcfs, excess spill would be directed through spillbays 6 and 7 rather than through spillbays 5 and 7. This operational configuration resulted in a more compact spill pattern that reduced the air-water interface surface area between spillway flows and the subsequent potential for lateral mixing and air entrainment.

In February 2011, Douglas PUD conducted an additional technical analysis of the 2010 Spill Playbook (after in-season changes) and confirmed that continued implementation would be appropriate for 2011 with additional minor modifications. Following approval of the 2011 GAP by Ecology, the 2011 Spill Playbook was implemented. Only minor changes were made to the 2012 spill playbook as a result of high compliance during the 2011 spill season.

In December of 2012 the final GAP report was completed for the 2012 spill season. After analysis it was determined that the 2012 spill season had the 3rd highest average monthly flows since 1969 (April-August). In addition incoming flows were reliably above 115%. Despite these conditions Wells Dam demonstrated high compliance with all standards aside from the Rocky Reach 115% 12C-high forebay standard since incoming flows to Wells were above 115% greater than 50% of the spill season days.

Given these unique conditions, and high compliance performance in 2011 and 2012, no changes are suggested for the 2013 spill playbook.

1.3.3.2 Structural

No structural modifications were implemented (none were scheduled) during the 2012 monitoring season, other than the removal of the JBS barriers, if needed, to accommodate high spill volumes in accordance with the Spill playbook. No structural modifications are planned for the 2013 spill season.

1.3.3.3 Biological Monitoring

NMFS has shown that Gas Bubble Trauma (GBT) is low if the level of TDG can be managed to below 120 percent (NMFS 2000). They recommend that "the biological monitoring components will include smolt monitoring at selected smolt monitoring locations and daily data collection and reporting only when TDG exceeds 125 percent for an extended period of time." The 2012 Wells Project GAP has included the NMFS recommendation to sample for GBT in juvenile salmon when TDG levels exceed 125 percent saturation (NMFS 2000). In 2012, the 125 percent standard was exceeded on numerous occasions, but almost always when flows at Wells Dam were above 7Q-10 flood flows (246.0 kcfs). Regardless of 7Q-10 conditions, Douglas PUD conducted GBT sampling of juvenile salmonids at the Rocky Reach juvenile fish bypass, and in addition, sampled adult salmon at the Wells fish ladder traps. Over 800 adult salmon were collected and sampled from Wells Dam fish ladders, with none showing signs of GBT expression in 2012. Juvenile biological monitoring was initiated on May 3 and continued on days subsequent to 125% exceedences, which require monitoring. Daily monitoring continued until June 29, 2012, after which a three day/week sampling schedule was implemented due to TDG levels being sustained above 125 percent. Douglas PUD continued to monitor TDG conditions and biological responses until July 25, 2012.

Biological sampling indicated that GBT expression in juvenile salmonids examined at Rocky Reach averaged 1.25% for all 24 days of sampling, with a maximum daily occurrence of <6% of the fish examined. In all cases, GBT expression was mild with only a few cases of moderate expression (score of 1 or 2 on the 1-4 expression score scale). GBT expression peaked in late June and early July when the highest TDG values were observed in the Wells and Rocky Reach forebays. GBT expression was confounded by species specific sensitivities to levels of TDG coupled with changes to the species run composition during the spill season. Juvenile salmonids expressed varied amount of GBT by species. Coho expressed the highest incidence of GBT with steelhead and yearling Chinook expressing intermediate GBT and sockeye and subyearling Chinook appearing to be the most resilient to high TDG concentrations. Throughout the season, adult spring Chinook sampled at Wells Dam appeared to have few symptoms of GBT, even when TDG was above 130 percent in the Wells tailrace.

1.3.4 Compliance Success in Previous Year (2012)

TDG river flows in 2012 were much higher than historic flows at the Wells Project (Table 3); 156 percent of the 42-year average for the entire spill season. Flows in 2012 were the third-highest on record since Wells Dam was constructed (1997 and 1972 were slightly higher). The maximum hourly flow observed during the spill season was 314 kcfs on June 25 and flows frequently exceeded the 7Q-10 value of 246.0

kcfs. The average monthly flow from mid-June to the end of July exceeded the 7Q-10 value for the Wells Project in 2012.

Table 3. Average monthly river flow volume (kcfs) during the TDG monitoring season at the Wells Project in 2012 compared to the previous 42-year average (1969-2011), by month.

Month	1969-2011 Mean	2012 Mean	Percent Difference from 42-year Average
April	115.6	174.1	+151%
May	149.4	217.2	+145%
June	164.5	232.9	+142%
July	132.2	253.8	+192%
August	104.6	158.7	+152%
All	133.3	207.34	+156%

High flows and incoming water out of compliance with the TDG standards, resulted in elevated TDG. On June 29 forced spill reached 167.5 kcfs, the maximum hourly value for the 2012 season (total outflow was 312.8 during the same hour). These high spill events were attributed to both flow volumes in excess of the Project's hydraulic capacity, and flows in excess of the power system needs and/or transmission system capacity. Spill volume across the April-August spill season was over 260 percent of the preceding 17-year average (Table 4).

Table 4. Average monthly spill (kcfs) during the TDG monitoring season at the Wells Project in 2012 compared to the 17-year average (1995-2011), by month.

	1995-2011		2012	
Month	**Mean**	**Std Dev**	**Mean**	**Std Dev**
April	10.9	7.0	20.6	13.7
May	21.9	20.7	59.0	18.6
June	36.4	39.6	65.4	41.9
July	15.1	11.2	84.4	28.4
August	7.9	2.1	12.5	9.4
Spill Season	18.4	16.1	48.4	37.0

As a result of these high spill volumes and the reception of non-compliant upstream water from the federal hydro-system, TDG exceeded the fish passage exception levels in early May, through early August. Of the 133 days during the spill season, there were 56 days when one or more hours had flows at Wells Dam above the 7Q-10 value. During the 2012 monitoring season, the TDG criterion for the forebay of Wells Dam was exceeded on all but 8 days (94.0 % of the spill season). If days where the Wells forebay exceedances are not excluded from compliance analysis except when TDG levels in the Wells tailrace are equal to or less than incoming forebay TDG levels, compliance for all three standards range from 49-98%. The 2012 compliance summary is reported in table 5.

Table 5. 2012 compliance summary.

	Compliance	
	Days with 7Q-10 flows removed	**Considering 7Q-10 flows**
Wells Tailrace 125% hourly standard		
Days out of compliance	2	2
Spill/bypass season	77	133
DCPUD Percent compliance	**97%**	**98%**
Wells Tailrace 120% 12C-High standard		
Days out of compliance	14	14
Spill/bypass season	77	133
DCPUD Percent compliance	**82%**	**89%**
Rocky Reach Forebay 115% 12C-High standard		
Days out of compliance	39	39
Spill/bypass season	77	127*
DCPUD Percent compliance	**49%**	**69%**

* Six days where the Rocky Reach forebay sensor failed has been removed from the analysis.

Despite extended periods of high flows, incoming TDG and spill, unit 7 rebuild, the Wells Project attained a high percentage of compliance when periods of flows in excess of 7Q-10, and periods when incoming water to the Project exceeded TDG criteria, are removed from the analysis. These encouraging results support the continued implementation of the 2012 Spill Playbook in 2013 during the fish passage season.

2.0 Proposed Operations and Activities

2.1 Operational Spill

2.1.1 Minimizing Involuntary Spill

Based on the Wells Project'simproved TDG performance as a result of 2012 operations associated with implementation of the Wells Project Spill Playbook, similar operating principles will be implemented for the 2013 fish passage season.

As discussed in Section 1.3.3.1 above, high Columbia River flows in 2012 resulted from high flood flows and subsequent forced spill. Often, incoming water in the forebay was already above tailrace compliance levels. However, operations following the 2012 Spill Playbook, when forebay inflows were below 115 percent TDG adjustment criterion and below 7Q-10 flows, resulted in high rates of compliance. Similarly to 2012, the 2013 Spill Playbook is proposing to shift concentrated spill away from spillway 7 to spillway 5. Spillway 5 was selected because spill through this bay can be more reliably supported by discharge from adjacent turbine units. The turbine discharge from Units 4 and 5 are expected to further enhance the surface jet being spilled through spillway 5. The updated Spill Playbook for 2012 is attached as Appendix 1.

In addition to minimizing involuntary spill through the implementation of the Spill Playbook, Douglas PUD shall manage spill toward meeting water quality criteria for TDG during all flows below 7Q-10 as follows:

- Minimize voluntary spill through operations including to the extent practicable, by scheduling maintenance based on predicted flows;
- Avoid spill by continuing to coordinate operations with upstream dams, to the extent that it reduces TDG;
- Maximize powerhouse discharge, especially during periods of high river flows; and
- During fish passage season, manage voluntary spill levels in real time in an effort to continue to meet TDG numeric criteria.

2.2 Implementation

2.2.1 Fisheries Management Plans

Juvenile salmon and steelhead survival studies conducted at the Wells Project in accordance with the HCP have shown that the operation of the Wells Project, of which the JBS is an integral part, provides an effective means for outmigrating salmon and steelhead to pass through the Wells Project with a high rate of survival (Bickford et al. 2001, Bickford et al. 2011) (Table 6). The Wells JBS is the most efficient juvenile fish bypass system on the mainstem Columbia River (Skalski et al. 1996). The Wells Anadromous Fish Agreement and HCP (Douglas PUD 2002) is the Wells Project's fisheries management plan for anadromous salmonids, and directs operations of the Wells JBS to achieve the No Net Impact (NNI) standard for HCP Plan Species. The Aquatic Resource Management Plans (for white sturgeon, bull trout, Pacific lamprey, resident fish, water quality, and aquatic nuisance species) in the Wells Project's Aquatic Settlement Agreement (developed in support of the pending Wells Project operating license) are the fisheries management plans for all other aquatic life designated uses.

Table 6. 1998 -2000, 2010 Wells Hydroelectric Project Juvenile Survival Study Results.

Species	% Project Survival
Yearling Chinook (2010)	96.4
Yearling Chinook and Steelhead (1998, 1999)	96.2

In spring 2010, Douglas PUD conducted a survival verification study with yearling Chinook salmon, a required 10-year follow-up study to confirm whether the Wells Project continues to achieve survival standards of the Wells Anadromous Fish Agreement and HCP. Approximately 80,000 Passive Integrated Transponder (PIT)-tagged yearling summer Chinook were released over a 30 day period in 15 replicates. The study determined that juvenile Chinook survival from the mouth of the Okanogan and Methow rivers averaged 96.4 percent over the 15 replicate releases of study fish (Table 6). This result confirms conclusions from the three previous years of study and documents that juvenile fish survival through the Wells Project continues to exceed the 93 percent Juvenile Project Survival Standard required by the HCP (Bickford et al. 2011).

The current phase designations (status of salmon and steelhead species reaching final survival determination) for the HCP Plan Species are summarized in Table 7. Specific details regarding survival study design, implementation, analysis, and reporting are available in annual summary reports prepared and approved by the Wells HCP Coordinating Committee.

Table 7. Wells Hydroelectric Project Habitat Conservation Plan Species Phase Designations.

Species	Phase Designation
Yearling (spring) Chinook	Phase III[1] – Standards Achieved (22-Feb-05)
Steelhead	Phase III – Standards Achieved (22-Feb-05)
Sockeye	Phase III – Additional Juvenile Studies (22-Feb-05)
Subyearling (summer/fall) Chinook	Phase III – Additional Juvenile Studies (22-Feb-05)
Coho	Phase III – Additional Juvenile Studies (27-Dec-06)

In 2013, Douglas PUD shall continue to operate Wells Dam adult fishways and the JBS in accordance with HCP operations criteria to protect aquatic life designated uses. Furthermore, all fish collection (hatchery broodstock and/or evaluation activities) or assessment activities that occur at Wells Dam will require approval by Douglas PUD and the HCP Coordinating Committee to ensure that such activities protect aquatic life designated uses.

Douglas PUD shall continue to operate the Wells Project in a coordinated manner toward reducing forebay fluctuations and maintaining relatively stable reservoir conditions that are beneficial to multiple designated uses (aquatic life, recreation, and aesthetics). Coordinated operations reduce spill, thus reducing the potential for exceedances of the TDG numeric criteria and impacts to aquatic life associated with TDG.

2.2.2 Biological Monitoring

As in past years, if hourly TDG levels exceed 125 percent in the tailrace of Wells Dam, Douglas PUD will conduct adult and juvenile salmonid GBT sampling. Douglas PUD will work with the Washington Department of Fish and Wildlife hatchery programs to monitor the occurrence of GBT on adult salmon collected in the Wells Dam and Wells Hatchery fishways. Upon collection of broodstock, hatchery staff will inoculate each fish, place a marking identification tag on them and look for any fin markings or unusual injuries. It is expected that adult broodstock sampled for GBT will consist of spring and summer Chinook and sockeye since they are the species migrating through the Wells Project during fish spill periods where high TDG is a concern, however all encountered salmonids including steelhead and bull trout will be examined.

The JBS at Wells Dam does not have facilities to allow for juvenile fish sampling and observation. To address GBT sampling for juvenile anadromous salmonids if hourly TDG levels exceed 125 percent in the tailrace of Wells Dam, Douglas PUD will request biological sampling of migrating juveniles for symptoms of GBT at the Rocky Reach juvenile bypass sampling facility on the day subsequent to the exceedence. Target species for juvenile GBT sampling will consist of coho, sockeye, and yearling and subyearling Chinook and steelhead. If flood flows above 7Q-10 persist for extended timeframes (more than one

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[1] Phase III = Dam survival >95 percent or project survival >93 percent or combined juvenile and adult survival >91 percent (Standard Achieved).

week), sampling effort will be reduced to 3 days per week. Proposed biological monitoring for 2013 is consistent with 2012 sampling measures.

2.2.3 Water Quality Forums

Douglas PUD is currently involved in the Water Quality Team meetings held in Portland, Oregon. The purpose of the Water Quality Team is to address regional water quality issues. This forum allows regional coordination for monitoring, measuring, and evaluating water quality in the Columbia River Basin. Douglas PUD will continue its involvement in the Water Quality Team meetings for further coordination with other regional members.

Douglas PUD is also currently involved in the Transboundary Gas Group that meets annually to coordinate and discuss cross border dissolved gas issues in Canada and the U.S. Douglas PUD will continue its involvement with the Transboundary Gas Group.

In 2012, Douglas PUD actively participated in regional water quality forums with Ecology, Washington Department of Fish and Wildlife, Tribal Agencies, the U.S. Fish and Wildlife Service, NMFS, the USACE, and other Mid-Columbia PUDs (i.e., Grant and Chelan counties). These meetings, ranging from the Transboundary Gas Group to meetings with the USACE to individual telephone and email information exchange, allow for regional coordination for monitoring, measuring, and evaluating water quality in the Columbia River Basin. Douglas PUD is proposing to continue its involvement in such forums to further improve coordination with other regional water quality managers.

2.2.4 Water Quality Attainment Plan and Quality Assurance Project Plans

In November 2012, Douglas PUD received a new operating license for Wells Dam from the FERC. By October 2013 Douglas PUD is required to submit a Water Quality Attainment Plan (WQAP) and Water Quality Assurance Project plans (QAPP) for temperature and total dissolved gas monitoring to Ecology for review and approval. After Ecology approval, Douglas PUD shall submit the WQAP and QAPP plans to FERC for approval prior to implementation.

The WQAP shall include a compliance schedule to ensure compliance with TDG criteria within 10 years. The WQAP will also allow time for the completion of the necessary studies or for the resolution of the issue of elevated incoming TDG from upstream projects through rule-making or other means. The WQAP shall be prepared in consultation with the Aquatic Settlement Work Group (Aquatic SWG) and the HCP Coordinating Committee and shall meet the requirements of WAC 173-201A-510(5). The WQAP shall:

- Identify all reasonable and feasible improvements that could be used to meet TDG criteria. Data on high TDG levels and flow coming into the Wells forebay and its effects on Project compliance shall be included;
- Contain the analytical methods that will be used to evaluate all reasonable and feasible improvements;

- Provide for any supplemental monitoring that is necessary to track compliance with the numeric WQS; and
- Include benchmarks and reporting sufficient for Ecology to track Douglas PUD's progress toward implementing this plan and achieving compliance within ten years of Ecology's approval of the plan.

If implementing the compliance schedule does not result in compliance with TDG criteria at the time the compliance schedule expires, Douglas PUD may explore other alternative approaches available in the water quality standards, including a second compliance schedule or alternatives provided in WAC 173-201A-510(5)(g).

3.0 Structural Activities

No structural modifications related to spill are scheduled to occur at the Wells Project in 2013. As in 2012, high flow volume and spill may require JBS barrier removal per this GAP (see Appendix 2: 2013 Spill Playbook). The removal of JBS barriers to reduce TDG production at Wells Dam has been integrated into the Juvenile Fish Bypass Operating Plan that is annually approved by the HCP Coordinating Committee.

4.0 Compliance and Physical Monitoring

4.1 Monitoring Locations

4.1.1 TDG

TDG monitoring has been implemented in the Wells Dam forebay since 1984. Douglas PUD began monitoring TDG levels in the Wells Dam tailrace in 1997 by collecting data from a boat and drifting through the tailrace at four points across the width of the river. During the transect monitoring, no TDG "hot spots" were detected; the river appeared completely mixed horizontally. A fixed TDG monitoring station was established in 1998. The placement of the fixed monitoring station was determined based upon the 1997 work and was further verified as collecting data representative of river conditions during a 2006 TDG assessment at Wells Dam (EES et. al. 2007). Results of the 2008-2009 TDG numerical modeling activities conducted by University of Iowa/IIHR also confirmed that the tailrace monitoring station is located at a site representative of the mixed river flow, particularly during higher flows. Furthermore, locations of both forebay and tailrace sensors had to be protected to avoid sensor/data loss and damage and for safe accessibility during extreme high flows. The current locations of both the forebay and tailrace monitors took these criteria into consideration.

TDG monitoring at the Wells Project typically commences on April 1 and continues until September 15 annually. This monitoring period encompasses the operation of the Wells JBS as well as when river flows are at their highest and when a majority of spill occurs. Throughout this period, data from both forebay and tailrace sensors are transmitted by radio transmitters to a master radio at Wells Dam. This system is checked at the beginning of the season for communication between the probes and transmitters by technicians at Wells Dam. TDG data are sent and logged at the Douglas PUD Headquarters' building in 15-minute intervals. Information on barometric pressure, water temperature and river gas pressure is sent to the USACE on the hour over the Internet. The four data points (15 minute) within an hour are used in compiling hourly TDG values, the 24-hour TDG average and the 12C-High readings in a day (24-hour period).

In 2013, Douglas PUD intends to operate a redundant TDG sensor in the tailrace location. Should the primary sensor fail data gaps can be filled from the second sensor. Installation timeframe will be contingent upon regulatory agencies' approvals for in-water work and modification of the shoreline within the ordinary high water mark. Hourly TDG data transmissions to the USACE of Wells forebay and tailrace station data will be expanded to cover the year-round monitoring requirement (starting April 1, 2013.

Starting in 2013, Douglas PUD is planning on installing and operating a new TDG sensor station in the Wells Reservoir located several miles downstream of Chief Joseph Dam. This new TDG sensor station will provide reliable mixed flow TDG readings from Chief Joseph Dam. The current system operated by the USACE below Chief Joseph Dam collects TDG values from the spillways at the dam and does not provide information on TDG passing through the turbines at Chief Joseph Dam originating from Grand Coulee Dam and does not provide an accurate reading of mixed flow TDG being directed at the Wells forebay.

4.2 Quality Assurance

The broad purpose of a well-designed Quality Assurance Project Plan (QAPP) is to attain data of the type and quality needed to make future decisions surrounding the need, or lack thereof, for changes to project operation and construction related to compliance with TDG and temperature standards.

4.2.1 TDG

Douglas PUD will develop a QAPP for TDG in early 2013 in coordination with the Department of Ecology. Briefly, as part of the Douglas PUD's Quality Assurance/Quality Control (QA/QC) program, Douglas PUD's water quality consultant will visit the TDG sensor sites monthly for maintenance and calibration of TDG instruments. Calibration follows criteria established by the USACE, with the exception of monthly rather than bi-weekly calibration of sensors. A spare probe will be available and field-ready in the event that a probe needs to be removed from the field for repairs.

The consultant will inspect instruments during the monthly site visits and TDG data will be monitored weekly by Douglas PUD personnel. If, upon inspection of instruments or data, it is deemed that repairs are needed, they will be promptly made. Occasionally during the monthly sensor calibration, an error may develop with the data communication. These problems are handled immediately by technicians located at Wells Dam. Generally, the radio transmitters at each fixed station will run the entire season without any problems.

Douglas PUD will collect TDG data year round beginning April 1, 2013 but spill season data (April 9 – August 19) will be reported separately in an annual GAP report submitted to the Department of Ecology and FERC. As part of the quality assurance process, data anomalies will be removed. This would include data within a 2-hour window of probe calibration and any recording errors that result from communication problems. Data errors will prompt a technician or water quality specialist or consultant site visit, to inspect the instrument and repair or replace, if necessary. Real time data will be made available to the public by November 2013.

4.3 Reporting

Upon approval of the Wells GAP and issuance of a Wells Project TDG adjustment, Douglas PUD will submit an annual report to Ecology no later than February 28 subsequent to each year that the TDG adjustment is approved. The annual report will summarize all GAP activities conducted for the prior year (i.e., annual report filed February 28, 2013 will be for all GAP activities conducted in 2012) as required by Ecology and the FERC. In addition to reporting on spill season compliance, the annual report will include TDG compliance outside the spill season (110%), per the 401 Certification Section 6.7 2) c) iii).

5.0 Conclusions

Pending approval by Ecology, implementation of the measures identified within the 2013 GAP are intended to serve as a long-term strategy to maintain compliance with the Washington State WQS for TDG in the Columbia River at the Wells Project while continuing to provide safe passage for downstream migrating juvenile salmonids.

6.0 Literature Cited

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Le, B. and J. Murauskas. 2009. Total Dissolved Gas Abatement Plan. Wells Hydroelectric Project. April 2009. Prepared for Washington Department of Ecology, Yakima, Washington, 98902-3452.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.

Skalski, J. R., G. E. Johnson, C. M. Sullivan, E. Kudera and M. W. Erho. 1996. Statistical Evaluation of Turbine Bypass Efficiency at Wells Dam on the Columbia River, Washington. Canadian Journal of Fisheries and Aquatic Science. Volume 53, No. 10, 1996. Pages 2188-2198.

Washington Department of Ecology, Spokane Tribe of Indians and U.S. Environmental Protection Agency. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt: Submittal Report. Accessed online December 7, 2010 at: http://www.ecy.wa.gov/biblio/0403002.html

7.0 Appendices

Appendix 1. Wells Hydroelectric Project Spill Playbook, 2012.

I. No Forced Spill

The Wells Dam JBS should be operated continuously throughout the juvenile salmon outmigration (April 9 to August 19 for 2013). The standard Wells HCP operating criteria, as described in Section 4.3.1 of the Wells HCP, will apply to the 2013 operating season. The operating criteria includes requirements that at least one bypass bay be operated during the entire JBS season, requires that no turbine is operated without an adjacent bypass bay being open and requires that all five bypass bays be operated continuously for 24 hours when the Chief Joseph Dam uncoordinated discharge estimate for that day is 140 kcfs or greater. The Wells JBS is normally operated with 1.7 kcfs passed through S2 and S10, and 2.2 kcfs through S4, S6, and S8. Figure 1 (below) assumes that the Chief Joseph Dam uncoordinated discharge estimate is greater than 140 kcfs or sufficient turbines units are operating that all five bypass bays are open .

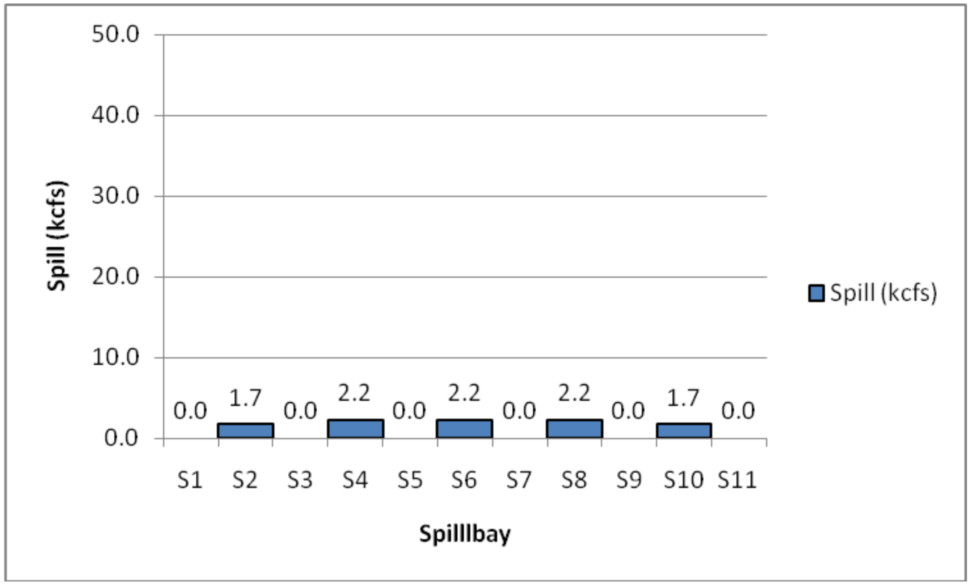

Figure 2. Operational configuration under no forced spill (JBS only).

I. Total Spill ≤ 53.0 kcfs, JBS barriers in place

As forced spill increases, Project Operators should allocate all spill through *S5* until the maximum capacity is reached through that spillbay (~43.0 kcfs). Note that *S5* spill requires support of generation flows from units 4 and 5 to minimize TDG production. This, along with the already established JBS spill (10.0 kcfs) would equal 53.0 kcfs (Figure 3). Over 90% of the spill events over the past decade could have been handled under this configuration.

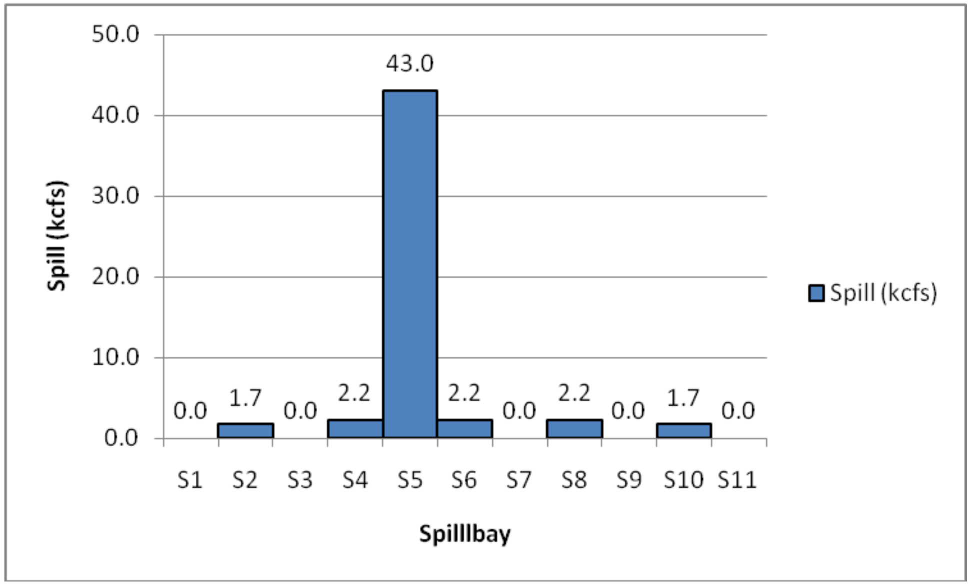

Figure 3. Operational configuration under spill ≤ 53.0 kcfs (including JBS).

II. JBS Barrier Removal Criteria

When either of the following occurs, remove the JBS barrier in *S6*:

Spill in *S5* reaches 30 kcfs and total spill is expected to exceed 40 kcfs for more than 8 hours, *or* total spill is expected to exceed 53 kcfs. After the JBS barrier is removed from *S6* and when flow through S5 is at least 30kcfs, shift 15 kcfs to *S6* (Figure 3). It is best to have generating units 4, 5, and 6 operating to support this spill configuration. Once at least 15 kcfs is being spilled through *S6*, spill can be allocated to *S5* until 43.0 kcfs is reached.

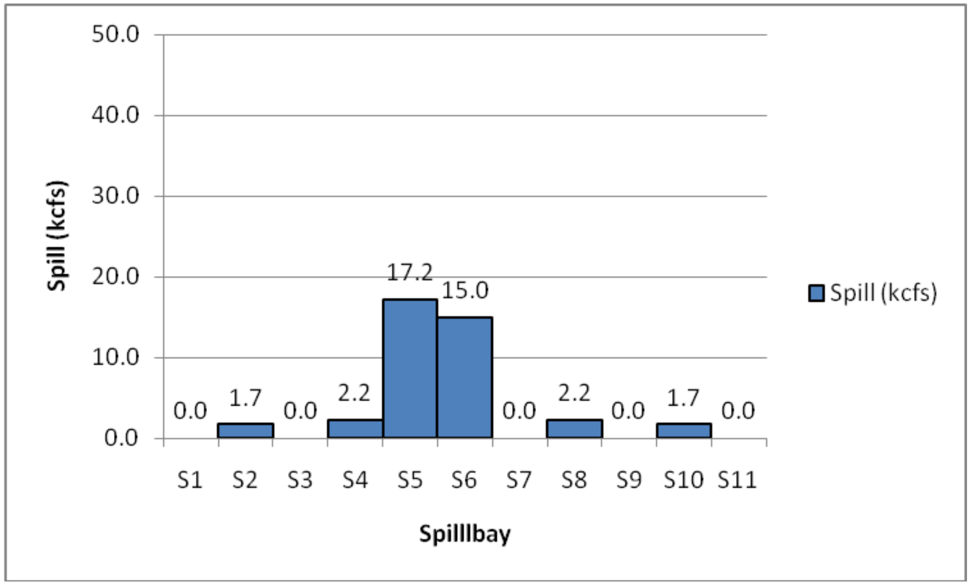

Figure 3. Operational configuration once spill reaches 30 kcfs in S5 and is expected to be above 40 kcfs for more than 8 hours (JBS removed). Shift sufficient spill from S5 to maintain a minimum of 15 kcfs spill at S6. Note that the 15.0 kcfs includes the existing 2.2 kcfs JBS flow.

III. Short duration decreases in Forced Spill (<53.0 kcfs) and JBS Barriers in *S6* Removed

If after removal of JBS barrier in *S6*, total spill drops below 53 kcfs (between 10-53 kcfs), and is expected to stay in this range for only a short period (4 days or less), direct spill through *S6* up to 15 kcfs (total spill < 22.9 kcfs). When total spill exceeds 22.8 kcfs, direct the remainder of spill through *S5*.

IV. Forced Spill (> 53.0 kcfs) and JBS Barriers in *S6* Removed

After *S5* reaches 43.0 kcfs, additional spill should be allocated to *S6* (*S6* is already spilling at least 15.0 kcfs need to fully engage the submerged spillway lip below the ogee). As flow increases, spill should continually increase through *S6* until paired with *S5* (e.g., 43.0 kcfs through *S5* and 26.0 kcfs through *S6*) (Figure 4). Eventually, *S6* will reach 43.0 kcfs (93.8 kcfs, **Figure** 4).

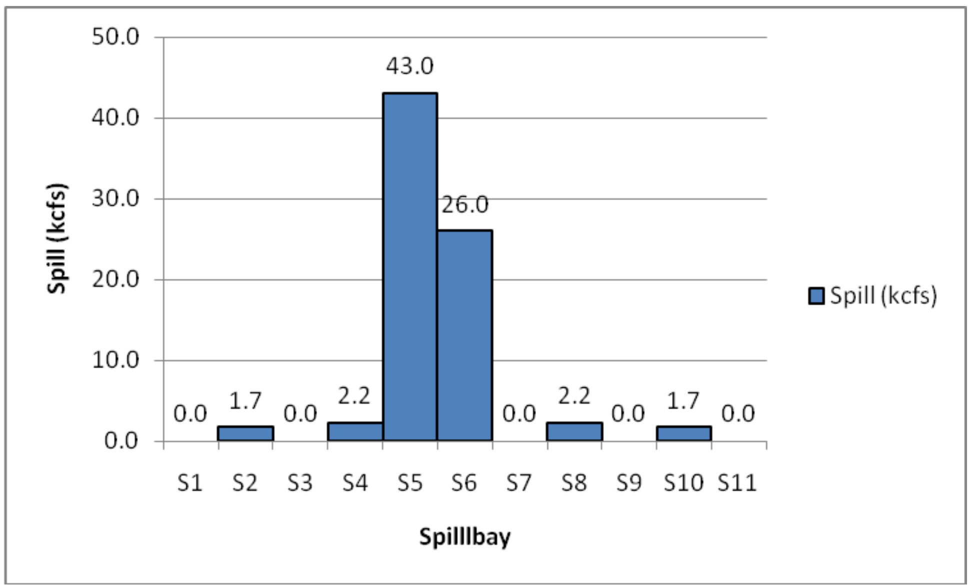

Figure 4. Operational configuration under forced spill > 53.0 kcfs (including JBS flow, with removal of JBS barriers in *S6*). In this instance spill has reached the 43.0 kcfs maximum in S5 and additional spill is being allocated to S6 (26.0 kcfs).

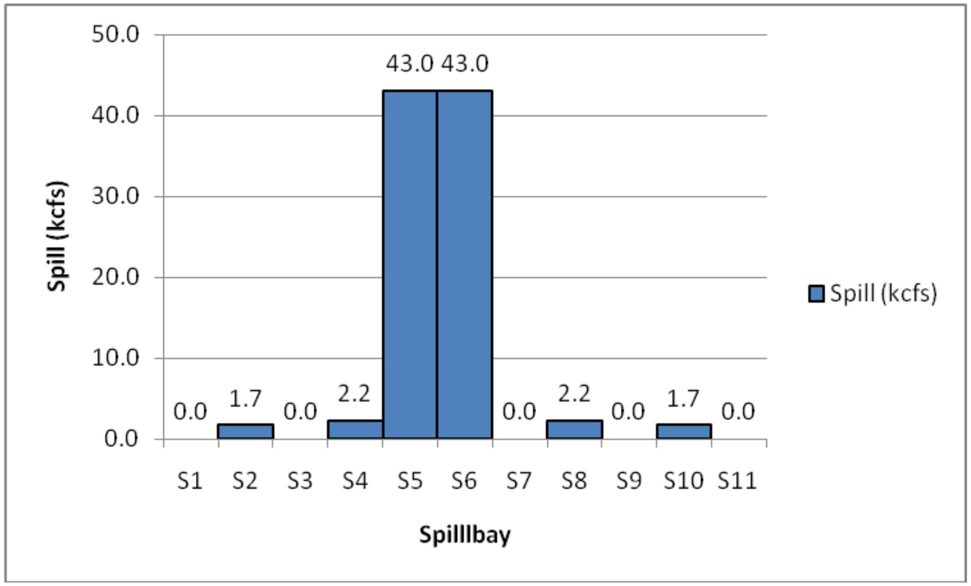

Figure 5. Operational configuration under forced spill > 53.0 kcfs (including JBS). In this instance (93.8 kcfs of spill), S6 has been fully allocated and 43.0 kcfs is now allocated through both *S5* and *S6*.

V. Forced Spill (> 93.8 kcfs) and JBS Barriers in *S6* Removed

After both *S5* and *S6* reach 43.0 kcfs, spill can also be allocated to *S7*. Since a minimum of 15.0 kcfs is needed to fully engage the submerged spillway lip below the ogee, spill through *S6* should be relocated to *S7* (Figure 6). As flow increases, spill can be continually increased through *S7* until paired with *S6* (30.0 kcfs through S6 and S7, while S5 continues at 43.0 kcfs). After this point, both *S6* and *S7* can be increased until all three spillbays have reached 43.0 kcfs (136.8 kcfs of spill, Figure 7).

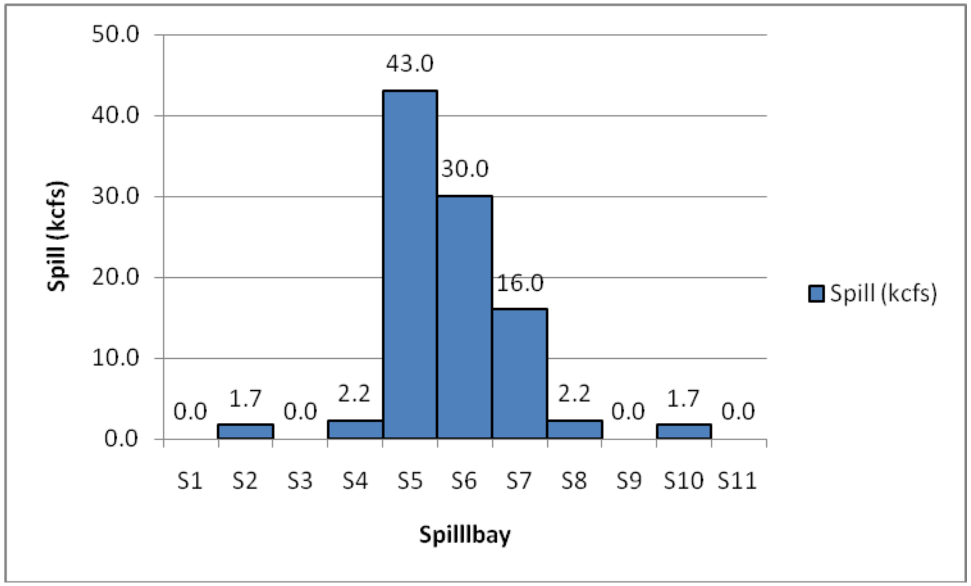

Figure 6. Operational configuration under forced spill > 96.0 kcfs. In this instance (96.8 kcfs of total spill), spill from *S6* is relocated to *S7* to maintain concentrated flow with *S5*. A spill of 16.0 kcfs is maintained in *S7* as to engage the submerged spillway lip.

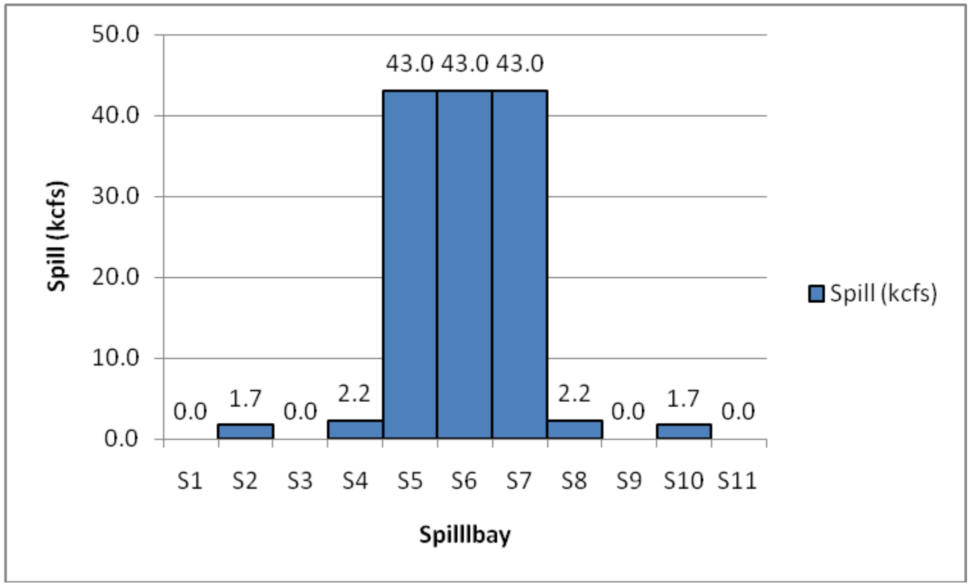

Figure 7. Operational configuration under forced spill > 96.0 kcfs (with removal of JBS barriers in *S6*). In this instance (136.8 kcfs of total spill), 43.0 kcfs is allocated through *S5*, *S6*, and *S7*.

VI. Forced Spill (> 136.8 kcfs)

Forced spill exceeding 136.8 kcfs rarely occurs (less than 0.5%). If these conditions arise and total river flow exceeds 246.0 kcfs, then 7Q-10 conditions are occurring and Wells Dam is exempt from the TDG standards. Under this situation, Project Operators may perform any combination of operations to ensure that flood waters are safely passed. Also, at this point, JBS barriers will likely be removed allowing additional flexibility to spill up to 43 kcfs each through *S2*, *S4*, *S6*, and *S8*. Project Operators may pass spill through *S3* in a similar fashion to operations mentioned above (starting at a minimum of 15.0 kcfs to ensure that spillway lips are engaged).

VII. JBS Re-Installment Criteria

Once spills of less than 40.0 kcfs are predicted for at least four days, JBS barriers should be re-installed in *S6*.

II. Spill Lookup Table

Operation	Total Spill	*S1* -	*S2* *JBS*	***S3***	*S4* *JBS*	***S5***	*S6* *JBS*	***S7***	*S8* *JBS*	***S9***	*S10* *JBS*	*S11* -
		Spillbay Number										
I. No Forced Spill	10.0	0.0	1.7	0.0	2.2	0.0	2.2	0.0	2.2	0.0	1.7	0.0
II. Spill (≤ 53.0 kcfs), min.	11.0	0.0	1.7	0.0	2.2	1.0	2.2	0.0	2.2	0.0	1.7	0.0
II. Spill (≤ 53.0 kcfs), max.	53.0	0.0	1.7	0.0	2.2	43.0	2.2	0.0	2.2	0.0	1.7	0.0
III. Spill (> 53.0 kcfs, *S6* JBS out), min.	54.0	0.0	1.7	0.0	2.2	31.2	15.0	0.0	2.2	0.0	1.7	0.0
III. Spill (> 53.0 kcfs, *S6* JBS out), max.	93.8	0.0	1.7	0.0	2.2	43.0	43.0	0.0	2.2	0.0	1.7	0.0
IV. Spill (> 93.8 kcfs, *S6* JBS out), min.	96.8	0.0	1.7	0.0	2.2	43.0	38.8	15.0	2.2	0.0	1.7	0.0
IV. Spill (> 93.8 kcfs, *S6* JBS out), max.	136.8	0.0	1.7	0.0	2.2	43.0	43.0	43.0	2.2	0.0	1.7	0.0
V. Spill (>137.0 kcfs), min.	137.0	0.0	1.7	15.0	2.2	43.0	43.0	28.2	2.2	0.0	1.7	0.0
V. Total Flow (>246 kcfs), max.	-	*Operators may adjust as needed. TDG exemption in place when total river flows exceed 246.0 kcfs.*										

Notes: (1) No spill through *S1* and *S11* as to minimize interference with fish ladders. (2) Even-numbered spillbays are designated as the Juvenile Bypass System (JBS). (3) Primary spillbays for forced spill are *S5*, *S6*, *S7*, *S3*, and *S9* (in that order).

Appendix 2. Consultation Record: Comments from Washington Department of Ecology on Draft 2013 GAP

Andrew Gingerich

From:	Irle, Pat (ECY) <PIRL461@ECY.WA.GOV>
Sent:	Wednesday, January 16, 2013 3:00 PM
To:	Andrew Gingerich
Cc:	Le, Bao (Bao.Le@hdrinc.com); McKinney, Charlie (ECY)
Subject:	RE: 2013 GAP
Follow Up Flag:	Follow up
Flag Status:	Flagged

Andrew:

Two small fixes, and then it looks good for approval:

In Section 4.2, Quality Assurance, the broad purpose of a well-designed QAPP is to attain data of the type and quality needed to make future decisions; in this case, the data will be used to evaluate the need for changes to project operation and construction related to compliance with TDG and temperature standards.

In Section 4.3, Reporting, the annual report should include TDG levels outside the spill season (as well as during the spill season), per the 401 Certification Section 6.7 2) c) iii), third sentence.

Please give me a call or email if you have any questions.

Sincerely,
Pat Irle
WA Dept of Ecology
Hydropower Projects Manager

From: Andrew Gingerich [mailto:andrewg@dcpud.org]
Sent: Thursday, January 10, 2013 11:36 AM
To: Irle, Pat (ECY)
Subject: RE: 2013 GAP

No apologies necessary. I had this on my to do list for today.

In the future I will try and send this to Ecology first…before sending it to the work group as we discussed yesterday. I know you wanted to see the QAPP too. I am busily working on it for the remainder of this week and likely next week as well.

Thanks Pat.
Andrew

From: Irle, Pat (ECY) [mailto:PIRL461@ECY.WA.GOV]
Sent: Thursday, January 10, 2013 10:49 AM
To: Andrew Gingerich
Subject: 2013 GAP

Hi, Andrew -

I think you said yesterday that you had already sent out a copy of the 2013 GAP? I know I’ve seen a copy of the 2012 GAP report, but I don’t remember this year’s GAP (plan). Could you send it again?

My apologies…

Pat Irle, MA, LG
Hydropower Projects Manager
Department of Ecology
Washington State
(509) 454-7864

Appendix 3. Consultation Record: Aquatic Settlement Work Group Distribution Email

Andrew Gingerich

From: Kristi Geris <kgeris@anchorqea.com>
Sent: Friday, December 28, 2012 5:05 PM
To: Andrew Gingerich; Bao Le; Beau Patterson; Bill Towey (bill.towey@colvilletribes.com); Bob Jateff (jatefrjj@dfw.wa.gov); Bob Rose; 'Brad James'; 'Bret Nine'; 'Chad Jackson'; Charlie McKinney (cmck461@ecy.wa.gov); Chas Kyger; 'Donella Miller'; Jason McLellan; Jeff Korth (korthjwk@dfw.wa.gov); 'Jessi Gonzales'; Joe Peone (joe.peone@colvilletribes.com); kirk.truscott@colvilletribes.com; Mary Mayo; Mike Schiewe; Molly Hallock (hallomh@dfw.wa.gov); Pat Irle (pirl461@ecy.wa.gov); 'Patrick Luke'; Patrick Verhey (Patrick.Verhey@dfw.wa.gov); Paul Ward (ward@yakama.com); Shane Bickford; 'Steve Lewis'; 'Steve Parker (parker@yakama.com)'; Steve Rainey
Subject: FW: 2013 Wells Dam GAP 12-28-2012 clean
Attachments: 2012_12_28 Douglas - 2013 Douglas - Bypass Operating Plan Memo - draft 12-26-12.pdf; 2012_12_28 Douglas - 2013 Wells Dam GAP 12-28-2012 clean.doc

Hi Aquatic SWG: please see the email below from Andrew and the attached proposed 2013 Wells Dam Gas Abatement Plan and 2013 Bypass Operating Plan.

Thanks!
Kristi ☺

Kristi Geris

ANCHOR QEA, LLC
kgeris@anchorqea.com

From: Andrew Gingerich [mailto:andrewg@dcpud.org]
Sent: Friday, December 28, 2012 4:07 PM
To: Kristi Geris
Cc: Mike Schiewe; Shane Bickford; Chas Kyger; Tom Kahler
Subject: 2013 Wells Dam GAP 12-28-2012 clean

Kristi,

Attached is the proposed *2013 Wells Dam Gas Abatement Plan*. For some years now Douglas PUD has worked in collaboration with the Department of Ecology to obtain an adjustment to the 110% TDG water quality criteria during the fish spill season. The adjustment allows for higher TDG values in order to provide fish with higher bypass efficiency via spill routes past virtually all main-stem Columbia and Snake River Projects. In summary, although this may appear to be a new process to some, we go through this process every year in preparation for the upcoming spill season.

This year we will, as always Douglas PUD will work with the WA Dept. of Ecology to obtain the TDG standard adjustment for out-migrating smolts, but also we are sharing it with the ASWG and the HCP Coordinating Committee to provide an opportunity to comment. The *Gas Abatement Plan* fits within the context *Bypass Operating Plan* that is prepared with the HCP-CC every year as well. As such, I have also attached the HCP bypass plan for 2013 to provide additional context related to Wells Dam fish spill and project operations in the spring/summer.

Aquatic SWG members will find that we have put these documents on the agenda for the Jan 9th ASWG meeting, but of course if people have specific questions prior to the meeting I would encourage them to ask away. In the meantime please distribute this message and the document to the ASWG and the HCP CC. As is typical with our vetting process comments are welcome.

Thanks!
Andrew
509-881-2323

Appendix 4. Consultation Record: HCP Coordinating Committee Distribution Email

Andrew Gingerich

From: Kristi Geris <kgeris@anchorqea.com>
Sent: Friday, December 28, 2012 5:09 PM
To: Andrew Gingerich; Bill Tweit (tweitwmt@dfw.wa.gov); Bob Rose (rosb@yakamafish-nsn.gov); 'Bryan Nordlund (bryan.nordlund@noaa.gov)'; Jerry Marco (Jerry.Marco@colvilletribes.com); Jim Craig (jim_l_craig@fws.gov); Mike Schiewe; Rick Klinge; Steve Hemstrom (steven.hemstrom@chelanpud.org); Steve Parker (pars@yakamafish-nsn.gov); 'Teresa Scott (teresa.scott@dfw.wa.gov)'; Tom Kahler
Cc: beichdvb@dfw.wa.gov; Gallaher, Becky; Joe Miller (Joseph.Miller@chelanpud.org); 'Josh Murauskas (josh.murauskas@chelanpud.org)'; Keith Truscott; Lance Keller; Lee Carlson (carl@yakamafish-nsn.gov); Shane Bickford
Subject: FW: 2013 Wells Dam GAP 12-28-2012 clean
Attachments: 2012_12_28 Douglas - 2013 Wells Dam GAP 12-28-2012 clean.doc

Hi HCP-CC: please see the email below from Andrew and the attached proposed 2013 Wells Dam Gas Abatement Plan.

Thanks!
Kristi ☺

Kristi Geris

ANCHOR QEA, LLC
kgeris@anchorqea.com

From: Andrew Gingerich [mailto:andrewg@dcpud.org]
Sent: Friday, December 28, 2012 4:07 PM
To: Kristi Geris
Cc: Mike Schiewe; Shane Bickford; Chas Kyger; Tom Kahler
Subject: 2013 Wells Dam GAP 12-28-2012 clean

Kristi,

Attached is the proposed *2013 Wells Dam Gas Abatement Plan*. For some years now Douglas PUD has worked in collaboration with the Department of Ecology to obtain an adjustment to the 110% TDG water quality criteria during the fish spill season. The adjustment allows for higher TDG values in order to provide fish with higher bypass efficiency via spill routes past virtually all main-stem Columbia and Snake River Projects. In summary, although this may appear to be a new process to some, we go through this process every year in preparation for the upcoming spill season.

This year we will, as always Douglas PUD will work with the WA Dept. of Ecology to obtain the TDG standard adjustment for out-migrating smolts, but also we are sharing it with the ASWG and the HCP Coordinating Committee to provide an opportunity to comment. The *Gas Abatement Plan* fits within the context *Bypass Operating Plan* that is prepared with the HCP-CC every year as well. *Note: the Bypass Operating Plan was distributed to the Coordinating Committees on Wednesday, December 26, 2012 –kristi ☺

Aquatic SWG members will find that we have put these documents on the agenda for the Jan 9th ASWG meeting, but of course if people have specific questions prior to the meeting I would encourage them to ask away. In the meantime please distribute this message and the document to the ASWG and the HCP CC. As is typical with our vetting process comments are welcome.

Thanks!
Andrew
509-881-2323

Appendix 5. Consultation Record: National Marine Fisheries Service Approval Email

Andrew Gingerich

From: Shane Bickford
Sent: Monday, January 28, 2013 11:14 AM
To: Mary Mayo; Andrew Gingerich
Subject: FW: 2013 Wells Dam operations

Follow Up Flag: Follow up
Flag Status: Flagged

Mary and Andrew,

NMFS approval of the BOP and GAP can be found in the e-mail below. Please add this to the agency approval correspondence.

Thanks,

Shane

From: Bryan Nordlund - NOAA Federal [mailto:bryan.nordlund@noaa.gov]
Sent: Monday, January 28, 2013 10:23 AM
To: Shane Bickford
Cc: Tom Kahler
Subject: 2013 Wells Dam operations

Shane - After distribution of draft documents, at the December 2012 meeting of the Wells HCP Coordinating Committee, Douglas PUD presented the Total Dissolved Gas Abatement Plan and the 2013 Juvenile Fish Bypass Operating Plan for Wells Dam, followed by Committee discussion.

I have completed my review of these plans and find them consistent with NMFS expectations for Wells Dam operations in 2013. As such, please consider this email to construe NMFS approval of these plans.

Bryan Nordlund

--
Bryan Nordlund, P.E.
360-534-9338
National Marine Fisheries Service
510 Desmond Drive, Suite 103
Lacey, WA 98503

Appendix 6. Consultation Record: United States Fish and Wildlife Service Approval Letter

United States Department of the Interior
Fish and Wildlife Service
Mid-Columbia River Fishery Resource Office
7501 Icicle Road
Leavenworth, WA 98826
Phone: (509) 548-7573
Fax: (509) 548-5743

January 28, 2013

Shane Bickford
Natural Resources Supervisor
Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, Washington 98802-4497

Dear Mr. Bickford,

In December 2012 Douglas PUD submitted to the HCP Coordinating Committees coordinated plans for juvenile fish bypass operations and total dissolved gas abatement at the Wells Hydroelectric Project in 2013. I, as the U.S. Fish and Wildlife Service representative, reviewed those plans and along with the other agency and tribal Coordinating Committee representatives approved those plans. Specifically, the plans approved were: *Total Dissolved Gas Abatement Plan*, submitted for Coordinating Committee review on 28 December 2012, and the *Wells Dam 2013 Juvenile Fish Bypass Operating Plan* submitted for Coordinating Committee review on 26 December 2012.

I hope this letter assists Douglas PUD with their FERC submission. Feel free to contact me if you need anything further.

Sincerely,

Jim L Craig
Project Leader

Appendix 7. Consultation Record: Washington Department of Ecology Approval of 2013 GAP

APPENDIX O - FINAL 2012 UPPER COLUMBIA RIVER SALMON AND STEELHEAD BROODSTOCK OBJECTIVES AND SITE-BASED BROODSTOCK COLLECTION PROTOCOLS

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
Wenatchee Research Office
3515 Chelan Hwy 97-A Wenatchee, WA 98801 (509) 664-1227 FAX (509) 662-6606

August 13, 2012

To: NMFS and HCP-HC and PRCC-HSC committee members

From: Mike Tonseth, WDFW

Subject: **FINAL 2012 UPPER COLUMBIA RIVER SALMON AND STEELHEAD BROODSTOCK OBJECTIVES AND SITE-BASED BROODSTOCK COLLECTION PROTOCOLS**

The attached protocol was developed for hatchery programs rearing spring Chinook salmon, sockeye salmon, summer Chinook salmon and summer steelhead associated with the mid-Columbia HCPs, spring Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project (FERC No. 2114) and fall Chinook 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, and Grant County Public Utility Districts (PUDs) and are operated by the Washington Department of Fish and Wildlife (WDFW). Additionally, the Yakama Nation's (YN) Coho Reintroduction Program broodstock collection protocol, when provided by the YN, will be included in this protocol due to the overlap in trapping dates and locations.

This protocol is intended to be a guide for 2012 collection of salmon and steelhead 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 (HCPs, Priest Rapids Dam 2008 Biological Opinion), changes to programs as approved by the HCP-HC, and to comply with ESA permit provisions.

Notable in this years protocols are:

- No sockeye in 2012.
- No age-3 males will be incorporated into spring or summer Chinook programs
- All NNI programs will have reductions in adult collection requirements due to re-calculation of NNI impacts per HCP's and Settlement Agreements.
- Implementation of the draft Production Management Plan (Appendix B), for all programs where possible, to ensure mitigation production levels are met and that the permitted production ceiling is not exceeded at release.

- Utilization of genetic sampling/assessment to differentiate Twisp River and non-Twisp River natural-origin spring Chinook adults collected at Wells Dam, and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir, Methow FH and Winthrop NFH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components.

- The collection of hatchery-origin spring Chinook for the Methow River Basin program in excess of production requirements, for BKD management.

- A smolt production target for the Chiwawa program in 2012 (2014 release) of 204,452 smolts (144,026 for Wenatchee basin mitigation and a one year agreement to produce CPUD's Methow obligation of 60,516 smolts).

- 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 Wells Hatchery volunteer channel, sufficient to meet a 576K yearling juvenile Chelan Falls program. For 2012 the adults will be transferred to Eastbank FH.

  Collection of 24-natural origin steelhead at the Twisp Weir in the spring of 2013. Adults will be transferred to Methow Hatchery for spawning and biosecure, isolated incubation through the eyed-egg stage after which they will be moved to Wells FH for the remainder of rearing.

- Collection of surplus hatchery origin steelhead from the Twisp Weir (up to 25% of the required broodstock) to produce the 100K Methow on-station-released smolts (up to 13 adults). The remainder of the broodstock (37) will be WNFH returns collected at WNFH and surplus to the WNFH program needs. The collection of adults will occur in spring of 2013.

- The collection of natural-origin summer Chinook adults for the 2012 BY Okanogan summer Chinook program in the Wells Reservoir via purse seine (approximately 112 fish). Adults collected for the DC portion of the Okanogan summer Chinook mitigation (26 adults) will be transferred, spawned, incubated, and early reared at Wells FH.

- The collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the USFWS, Entiat NFH summer Chinook programs (requires agreement of the HCP Hatchery Committee [HC]).

- The collection from the Wells Hatchery volunteer channel of Wells summer Chinook to support the Yakama Nation (YN) summer Chinook re-introduction program in the Yakima River Basin (requires agreement of the HCP HC). Transfer will occur as gametes.

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.

Above Wells Dam

Spring Chinook

Inclusion of natural-origin fish in the broodstock will be a priority, with natural-origin fish specifically being targeted. Collections of natural-origin fish will not exceed 33% of the MetComp and Twisp natural-origin run escapement to maximize natural origin fish on the spawning grounds.

To facilitate BKD management, comply with ESA Section 10 permit take provisions, and to meet programmed production, hatchery-origin spring Chinook will be collected in numbers excess to program production requirements. Based on historical Methow FH spring Chinook ELISA levels above 0.12, the hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 19.4% (based upon the most recent 5-year mean ELISA results for the program). For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permit 1196, 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 production at 223,765 yearling smolts. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by WDFW Fish Health to be a substantial risk to the program. Progeny of natural-origin females, with ELISA levels greater than 0.12, will be differentially tagged for evaluation purposes. Annual monitoring and evaluation of the prevalence and level of BKD and the efficacy of culling in returning hatchery- and natural-origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

Recent 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 that natural origin collections can occur at Wells Dam. Scale samples and non-lethal tissue samples (fin clips) for genetic 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 that analysis. Natural-origin fish retained for broodstock will be PIT tagged (dorsal sinus) for cross-referencing tissue samples/genetic analyses. Tissue samples will be preserved and sent to WDFW genetics lab in Olympia Washington for genetic/stock analysis. The spring Chinook sampled will be retained at Methow FH and will be sorted as Twisp or non-Twisp natural-origin fish prior to spawning. 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. Based on the broodstock-collection schedule (3-day/week, 16 hours/day), extraction of natural-origin spring Chinook is expected to be approximately 33% or less.

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 less than 33%. Twisp and Methow Composite hatchery-origin spring Chinook will be captured at the Twisp Weir, and Methow FH outfall. Trapping at the Winthrop NFH will be included if needed because of broodstock shortfalls.

Pre-season run-escapement of Methow-origin spring Chinook above Wells Dam during 2012 are estimated at 3,090 spring Chinook, including 2,609 hatchery and 481 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.

The following broodstock collection protocol was developed based on the re-calculated program production levels (223,765 smolts), BKD management strategies, projected return for BY 2012 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and assumptions listed in Table 3.

The 2012 Methow spring Chinook broodstock collection will target up to 166 adult spring Chinook (24 Twisp, 142 Methow). Based on the pre-season run forecast, Twisp fish are expected to represent 6% of the adipose present, CWT tagged hatchery adults and 16% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective of no less than 50% NOR's and to limit extraction to no greater than 33% of the natural-origin spawning escapement to the Twisp, the 2012 Twisp origin broodstock collection will total 24 fish (at least 12 wild and the remainder, maximum = 12, hatchery origin, or 1:1 wild:hatchery if wild broodstock are less than 12), representing 100% of the broodstock necessary to meet Twisp program production of 40,000 smolts. Methow Composite fish are expected to represent 43% of the adipose present CWT tagged hatchery adults and 84% 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 natural-origin recruits, the 2012 Methow broodstock collection will be predominantly natural origin and total 142 spring Chinook (133 wild and 9 Hatchery [alternative if estimated pHOS > 0.5: 71 wild + 71 hatchery]). The broodstock collected for the Methow program represents 100% of the broodstock necessary to meet Methow program production of 183,765 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 1196. The Methow FH releases will include progeny of broodstock identified as wild non-Twisp origin and known Methow Composite hatchery origin fish. Age-3 males ("jacks") will not be collected for broodstock.

Table 1. Brood year 2007-2009 age class-at-return projection for wild spring Chinook above Wells Dam, 2012.

Brood year	**Smolt Estimate**		**Age-at-return**								
			Twisp Basin				**Methow Basin**				
	Twisp[1/]	Methow Basin[2/]	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total	SAR[3/]
2007	9,715	99,417	2	35	**17**	54	27	361	**167**	555	0.005581
2008	11,932	56,337	8	**50**	9	67	7	**227**	80	314	0.005581
2009	5,124	31,212	**9**	17	3	29	**11**	142	21	174	0.005581
Estimated 2011 Return			**9**	**50**	**17**	**76**	**11**	**227**	**167**	**405**	

[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/]- Mean Chiwawa NOR spring Chinook SAR to the Wenatchee Basin (BY 1998-2003; WDFW unpublished data).

Table 2. Brood year 2007-2009 age class and origin run escapement projection for UCR spring Chinook at Wells Dam, 2012.

	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	184	898	42	**1,124**	11	227	167	**405**	195	1,125	209	**1,529**
%Total				43%				84%				49%
Twisp	29	123	5	**157**	9	50	17	**76**	38	173	22	**233**
%Total				6%				16%				8%
Winthrop (MetComp)	113	967	248	**1,328**					113	967	248	**1,328**
%Total				51%								43%
Total	326	1,988	295	**2,609**	20	277	184	**481**	346	2,265	479	**3,090**

Table 3. Assumptions and calculations to determine the number of broodstock needed for BY 2012 production of 223,765 smolts.

Program Assumptions	Twisp standard	Twisp program	Methow standard	Methow program	Total program
Smolt Release		40,000		183,765	**223,765**
Fertilization-to-release survival	*88%*		*85%*		
Total egg take target		45,455		216,194	**261,649**
Egg take (production)					
Cull allowance[1/]		45,455	*19.4*	268,231	**313,686**
Fecundity[2/]	*3,952*		*3,851*		
Female Target					
Female to male ratio	*1:1*		*1:1*		
Broodstock target					
Pre-spawn survival	*96%*		*98%*		
Total broodstock collection		**24**		**142**	

[1/]-Hatchery origin MetComp. component only, and is based on the projected natural origin collection and assumption that all Twisp (hatchery and wild) and wild MetComp. fish will be retained for production.
[2/]-Based on historical age-4 fecundities and expected 2012 return age structure (Table 1).

Trapping at Wells Dam will occur at the East and West ladder traps beginning on 01 May, or at such time as the first spring Chinook are observed passing Wells Dam, and continue through 22 June 2012. The trapping schedule will consist of 3-day/week (Monday-Wednesday), up to 16-hours/day. Two of the three trapping days will be concurrent with the stock assessment sampling activities authorized through the 2012 Douglas PUD Hatchery M&E Implementation Plan. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quota). Once the weekly quota target is reached, broodstock collection will cease until the beginning of the next week. If a shortfall occurs in the weekly trapping quota, the shortfall will carry forward to the following week. All natural origin spring Chinook collected at Wells Dam for broodstock will be held at the Methow FH.

To meet Methow FH broodstock collection for hatchery origin Methow Composite and Twisp River stocks, adipose-present coded-wire tagged hatchery fish will be collected at Methow FH, Winthrop NFH and the Twisp Weir beginning 01May or at such time as spring Chinook are observed passing Wells Dam and continuing through 24 August 2012. Natural origin spring Chinook will be retained at the Twisp Weir as necessary to bolster the Twisp program production so long as the aggregate collection at Wells Dam and Twisp River weir does not exceed 33% of the estimated Twisp River natural origin spawners to maximize pNOS in the Twisp. All hatchery and natural origin fish collected at Methow FH, Twisp Weir and Winthrop NFH for broodstock will be held at the Methow FH.

Steelhead

Steelhead programs located upstream of Wells Dam and at Wells Hatchery are presented in Table 4.

Table 4. 2013 brood year Steelhead Programs at Wells Hatchery and Upstream of Wells Dam

Program	Hatchery	Owner	Release Location	Release Target	Broodstock Collection Location
Twisp Conservation	Methow Hatchery (incubation); Wells Hatchery (rearing)	Douglas PUD	Twisp Acclimation Pond	48,000	Twisp WxW
Methow Safety-Net	Wells Hatchery	Douglas PUD	Methow Hatchery	100,000	HxH: Twisp Hatchery (25%) + WNFH Hatchery (75%)
Mainstem Columbia Safety-Net	Wells Hatchery	Douglas PUD	Wells Hatchery	160,000	HxH: Methow Hatchery returns (1st option); Wells Stock (2nd option)
WNFH Conservation Program	WNFH	USFWS	WNFH	100,000	Up to 25 collected at Wells Dam/Hatchery; remaining 25 collected by USFWS
Omak Creek	Wells Hatchery	Grant PUD	Omak Creek	Up to 50,000[1]	Omak Creek returns (up to 25 wild or hatchery)
Okanogan	Wells Hatchery	Grant PUD	Okanogan Basin	Up to 100,000[1]	Wells Stock collected at Wells Dam/Hatchery

1/ The Grant PUD programs will total 100,000, with Omak Creek taking precedence, and the Okanogan program = 100,000 – Omak production.

Steelhead mitigation programs above Wells Dam (including the USFWS steelhead program at Winthrop NFH) utilize adult broodstock collections at Wells Dam, Twisp Weir, Methow Hatchery volunteer trap, and WNFH volunteer trap (Table xxx) and incubation/rearing at Wells Fish Hatchery (FH) and incubation at Methow Hatchery (Twisp program). The Wells Steelhead Program has provided eggs for UCR steelhead reared at Ringold FH, not as a mitigation requirement, but rather an opportunity to reduce the prevalence of early spawn hatchery steelhead in the mitigation component above Wells Dam. However, the Methow steelhead program is shifting to locally collected Twisp wild broodstock (Twisp conservation program), and hatchery origin broodstock representative of the Twisp and WNFH conservation programs (Methow safety-net program). Therefore, surplus broodstock will not be collected for the Methow steelhead programs to address the spawn-timing issue of the Wells stock. The Wells Hatchery Columbia River releases will use returns to the Methow Hatchery volunteer trap to the extent possible, and will be augmented with Wells stock as required to fulfill the program. Therefore, surplus broodstock collection to address spawn timing will not occur. However, the local collections of broodstock in the Methow Basin will occur in the spring, 2013. To ensure the safety-net programs have broodstock, some broodstock will be collected at Wells Dam in the autumn, 2012, and held at Wells Hatchery. These autumn-collected Wells stock fish will be considered surplus to the spring-collected Methow and Okanogan broodstock, and eggs from these surplus broodstock may be transferred to Ringold Hatchery. In addition, Wells Hatchery may be used for adult management and steelhead removed for adult management may be retained for the Ringold program (Table 5).

Table 5. Broodstock collection locations, number, and origin by program

Program	**Wells Dam or Hatchery**		**Twisp Weir**		**WNFH**		**Methow Hatchery**		**Omak Creek**	
	H	W	H	W	H	W	H	W	H	W
Twisp Conservation			0	24						
Methow Safety-Net			Up to 50	0	Up to 50 (backup)	0				
Mainstem Columbia Safety-Net	82 (backup)	0					82	0		
WNFH Conservation Program	8					17[1]				
Omak Creek									Up to 25[2]	
Okanogan	Up to 33	Up to 17								
Ringold[3]	Up to 103	0								
Total	226	17	50	24	50	17	82	0	25	

1/ Wild origin fish for WNFH program will be collected through USFWS hook and line angling efforts in the Methow in the spring of 2013.
2/ Wild origin preferred, but hatchery origin broodstock will also be collected to meet target.
3/ Broodstock derived from adult management at Wells Hatchery and surplus brood collected as backup for Methow and Okanogan programs

The following broodstock collection protocol was developed based on mitigation program production objectives (Table 6), program assumptions (Table 7), and the probability that sufficient adult steelhead will return in 2012/2013 to meet production objectives absent a preseason forecast at the present time.

Trapping at Wells Dam will selectively retain 243 steelhead (east and west ladder collection) and will comprise up to 17 natural origin fish and 226 hatchery origin fish. Ringold FH production component will comprise 100% hatchery origin returns collected at Wells Dam and Hatchery volunteer channel. In the spring of 2013, 24 wild steelhead will be targeted at the Twisp Weir and transferred to the Methow Hatchery for spawning and incubation to the eyed-egg stage after which they will be moved to Wells Hatchery for the balance of rearing. In addition, up to 50 surplus hatchery-origin steelhead (to meet the 100K Methow Safety-Net release) will be targeted at the Twisp Weir and moved to Wells Hatchery for spawning. Surplus WNFH hatchery returns will be used to augment the Twisp hatchery-origin collection if needed. Should there be inadequate surplus steelhead from these two sources, steelhead captured at the Methow Hatchery volunteer trap will be used to fulfill the program, and then Wells stock held at the Wells Hatchery will be used as a final option. Approximately, 16 (up to 25) adult steelhead will be targeted in Omak Creek for a 20K (up to 50K) endemic program operated by the CCT and funded by GCPUD as part of their 100K UCR steelhead mitigation obligation. Overall collection for the programs will be 340 fish and limited to no more than 33% of the entire run or

33% of the natural origin return (NOR composition in the broodstock, is estimated at 18%). Hatchery and natural origin collections will be consistent with run-timing of hatchery and natural origin steelhead at Wells Dam. Ladder trapping at Wells Dam will begin on 01 August and terminate by 31 October, three days per week, up to 16 hours per day, if required to meet broodstock objectives. Trapping will be concurrent with summer Chinook broodstocking efforts through 15 September on the west ladder. If insufficient steelhead adults are encountered on the west ladder, the east ladder trap may be considered. 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.

Table 6. Adult steelhead collection objectives for programs supported through 2012 return year adult steelhead broodstock collected at Wells Dam, Twisp Weir, and Omak Creek (CCT endemic program).

Program	# Smolts	# Green eggs	% Wild	# Wild	# Hatchery	Total Adults
DCPUD[1/]	160,000	226,629	0%		82	82
DCPUD[2/]	100,000	141,643	0%		50	50
DCPUD Twisp	48,000	67,989	100%	24		24
GCPUD[3/]	80,000	113,315	33%	13	27	40
GCPUD Omak	20,000	40,000		16		16[4/]
USFWS	50,000	70,821	33%	8	17	25
Sub-total	**458,000**	**660,397**	26%	**61**	**176**	**237**
Ringold	180,000	285,714	0%	0	103	103
Sub-total	**180,000**	**285,714**	**0%**	**0**	**103**	**103**
Grand Total[5/]	**638,000**	**946,111**	**18%**	**61**	**279**	**340**

[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 and/or surplus hatchery adults from the Twisp weir.*

[3/]- *Okanogan Basin releases as part of GCPUD's 100K summer steelhead obligation. Broodstock need is dependent on the Omak collection to achieve 100,000 smolts total.*

[4/]- *Broodstock targeted is 16 total (8 male/8 female) of mixed origin composition based upon what is trapped. Collection could range up to 25 broodstock (50,000 smolt program maximum)*

[5/]- *Based on steelhead production consistent with Mid-Columbia HCP's, GCPUD BiOp and Section 10 permit 1395.*

Table 7. Program assumptions used to determine the number of adults required to meet steelhead production objectives for programs above Wells Dam and at Ringold Springs Fish Hatchery.

	Standard	
Program assumptions	**Hatchery**	**Wild**
Pre-spawn survival	95.4%	97.6%
Female : Male ratio	1.0:1.0	1.0:1.0
Fecundity	5,822	5,800
Fertilization-to-yearling release	70.6%[1/]	70.6%[1/]

[1/]*-Not applicable to Ringold Springs Fish hatchery.*

<u>Summer/fall Chinook</u>

Summer/fall Chinook mitigation programs above Wells Dam utilize adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 414,669 summer/fall Chinook smolts for two acclimation/release sites on the Methow and Similkameen rivers (Carlton Pond and Similkameen Pond, respectively).

The TAC 2012 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix A) and BY 2007, 2008 and 2009 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 was developed based on initial run expectations of summer Chinook to the Columbia River, program objectives and program assumptions (Table 8).

For 2012, WDFW will retain up to 107 natural-origin summer/fall Chinook at Wells Dam east and/or west ladders, including 52 females for the Methow summer Chinook program (this total does not include the balance of the Similkameen program that may not be achieved through the CCT purse seine efforts). Collection will be proportional to return timing between 01 July and 15 September. Trapping may occur up to 3-days/week, 16 hours/day. Age-3 males ("jacks") will not be collected for broodstock.

Additionally, in collaboration with the Colville Tribes, in 2012 attempts will be made to collect up to 100% (N=112; 56 females) of the natural origin adults needed to meet the Okanogan summer Chinook obligation through the CCT purse seine efforts. If logistics or capture efficiency become prohibitive to achieving broodstock goals with this collection activity this season, broodstock collection for the balance will revert back to Wells Dam. In addition, if broodstock collection through the CCT's purse seining efforts falls behind by more than 25%, the difference between the fish collected to date and what should have been collected, will be made up at Wells Dam west ladder trap. Fish collected through the CCT trapping effort will be uniquely tagged from fish collected at Wells Dam to evaluate relative differences in disease, mortality, spawn timing, among other metrics.

For the 2012 brood year, 48,540 summer/fall Chinook will be reared at Wells Hatchery from broodstock collected by the CCT through purse seining in the Wells Reservoir. The fish will be reared to a point at which they can be transferred to the Chief Joseph Hatchery, Omak Riverside

Acclimation Facility for further grow-out in 2013 and release in 2014.

To better assure achieving the appropriate females for program production, the collection will utilize ultrasonography to determine the sex of each fish retained for broodstock.
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.

Table 8. Assumptions and calculations to determine the number of broodstock needed for summer/fall Chinook production goals in the Methow and Okanogan river basins.

Program Assumptions	Standard	Carlton Pond	Similkameen Pond	Wells FH/CCT	Total
Smolt release		**200,000**	**166,569**	**48,540**	**414,669**
Fertilization-to-release survival	81.2				
Eggtake target		**246,305**	**205,134**	**59,236**	**510,675**
Fecundity	4,990				
Female target		**49**	**41**	**12**	**102**
Female:male ratio	1:1				
Broodstock target		**99**	**82**	**24**	**205**
Pre-spawn survival	95.5				
Total collection target		**104**	**86**	**26**	**216**

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Summer/fall Chinook mitigation programs that release juveniles directly into the Columbia River between Wells and Rocky Reach dams are supported through adult broodstock collections at the Wells Hatchery volunteer channel. The total production level supported by this collection is 896,000 yearling (320K Wells and 576K Chelan Falls programs) and 484,000 sub-yearling Chinook (Wells Hatchery). Upon agreement in the HCP-HC, the 2012, summer Chinook broodstock collections at Wells FH may also include 345,000 green eggs to support the Yakama Nation (YN) reintroduction of summer Chinook to the Yakima River Basin and up to 266 adults or 509,009 green eggs for the USFWS Entiat program pending agreements between USFWS and DCPUD. If approved by the HCP Hatchery Committee, YN eggs will be the last eggs taken and will be the responsibility of staff associated with the YN program. Adults for the Entiat program will be transferred to Entiat NFH by either WDFW or USFWS staff (arrangements between USFWS and DCPUD will have been made prior to implementation).

Adults returning from the Wells and Chelan Falls programs are to support harvest opportunities and are not intended to increase natural production and have been termed segregated harvest programs. These programs have contributed to harvest opportunities; however, adults from these programs have been documented contributing to the adult spawning escapement in tributaries upstream and downstream from their release locations. Because of CCT concerns about sufficient natural origin fish reaching spawning grounds, incorporation of natural origin fish for the Wells program 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 (Table 9).

WDFW will collect about 1,287 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall. Overall extraction of natural-origin fish to Wells Dam (Wells program and above Wells Dam summer/fall Chinook programs) will not exceed 33 percent. Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin 11 July and terminate by 31 August. Age-3 males ("jacks") will not be collected for broodstock.

Table 9. Assumptions and calculations to determine the number of broodstock needed for summer/fall Chinook production goals for programs relying on adult collection at Wells Dam or Wells Hatchery in 2012.

Program Assumptions	**Standard**		**Wells FH**		**Chelan Falls FH**	**YN**[1/]	**USFWS**[2/]	
	Sub-yearling	**Yearling**	**Sub-yearling**	**Yearling**	**Yearling**	**Green eggs**	**Green eggs**	**Total**
Smolt release			**484,000**	**320,000**	**576,000**		**400,000**	**NA**
Green egg-to-release survival	76.1%[4/]	83.6%						NA
Eggtake target			**636,005**	**382,775**	**688,995**	**345,000**	**509,009**	**2,561,784**
Fecundity	4,487	4,487						
Female target			**142**	**86**	**154**	**77**	**129**	**588**
Female:Male ratio	1:1	1:1						
Broodstock target			**284**	**242**[3/]	**308**	**154**	**258**	**1,246**
Pre-spawn survival	96.8%	96.8%						
Total collection target			**294**	**250**	**318**	**159**	**266**	**1,287**

[1/]-Green eggs for YN reintroduction program in the Yakima River Basin.
[2/]-Adults for USFWS summer Chinook program in the Entiat River Basin.
[3/]- Includes 70 adults collected for the Lake Chelan triploid Chinook program.

Wenatchee River Basin

Spring Chinook

The Eastbank Fish Hatchery (FH) rears spring Chinook salmon for the Chiwawa River acclimation pond located on the Chiwawa River. The HCP HC approved program production level target for 2012 is 204,452 smolts, requiring a total broodstock collection of 114 spring Chinook (78 natural and 36 hatchery origin; Table 10). The production level for 2012 represents agreements made early in 2012 by the Chelan PUD HCP HC to allow CPUD's spring Chinook obligation for the Methow basin (60,516 smolts) to be produced in the Wenatchee basin (CPUD's post 2013 release re-calculated production obligation for the Chiwawa is 144,026 smolts). The gap in production in the Methow is being compensated for by allowing the difference in Grant PUD's Wenatchee spring Chinook at the White River and Nason Creek to be met at Methow Hatchery. This is a one year agreement.

Table 10. Assumptions and calculations to determine the number of broodstock needed in an anticipated 2012 Chiwawa program release of 204,452 smolts.

Program Assumptions	Standard	Conservation	Safety Net	Full program
Smolt Release		**150,000**	**54,452**	**204,452**
Fertilization-to-release survival	*84.5%*			
Total egg take target		177,515	64,440	**241,955**
Egg take (production)			74,154	**251,669**
Cull allowance	*13.1%*			**9,714**
Fecundity	*4,711 W* *4,279 H*			
Female Target		38	17	**55**
Female to male ratio	*1:1*			
Broodstock target		76W	34H	**110**
Pre-spawn survival	*98.0%W/98.5H*			
Total broodstock collection		**78W**	**36H**	**114**

Inclusion of natural origin fish into the broodstock will continue to be a priority, with natural origin fish specifically being targeted. Consistent with ESA Section 10 Permit 1196, natural origin fish collections will not exceed 33 percent of the return to the Chiwawa River and will provide, at a minimum, 33 percent of the total broodstock retained.

In addition to production levels and ESA permit provisions, the 2012 broodstock collection, will target both hatchery and natural origin Chiwawa spring Chinook at the Chiwawa Weir.

Pre-season estimates project 3,819 spring Chinook are destined for the Chiwawa River, of which 481 (12.6%) and 3,338 fish (87.4%) are expected to be natural and hatchery origin spring Chinook, respectively (Tables 11 and 12). These protocols target approximately 114 spring Chinook (78 natural origin and 36 hatchery origin) for broodstock purposes, representing 100% of the program production objectives. 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 Permit 1196.

Table 11. BY 2007-2009 age class return projection for wild spring Chinook above Tumwater Dam during 2012.

Brood year	**Smolt Estimate**[1/]		**Chiwawa Basin**[2/]				**Wenatchee Basin above Tumwater Dam**[2/]				
	Chiwawa	Wen. Basin	Age-3	Age-4	Age-5	Total	Age-3	Age-4	Age-5	Total	SAR[3/]
2007	65,539	103,460	24	271	**71**	366	38	427	**112**	577	0.005581
2008	91,229	168,630	35	**384**	85	504	65	**718**	159	942	0.005581
2009	51,417	88,650	**26**	249	13	287	**8**	387	100	495	0.005581
Estimated 2012 Return			**26**	**384**	**71**	**481**	**8**	**718**	**112**	**838**	

[1/]-Smolt production estimate for Chiwawa River derived from juvenile smolt data (Hillman et al. 2010); smolt production estimate for Wenatchee Basin is based upon proportional redd disposition between Chiwawa River and Wenatchee River basin and the Chiwawa smolt production estimate.
[2/]-Based upon average age-at-return (return year 2007-2011), for natural origin spring Chinook above Tumwater Dam (WDFW unpublished data).
[3/]-Mean Chiwawa spring Chinook SAR to the Wenatchee Basin (BY 1998-2003; WDFW unpublished data).

Table 12. BY 2007-2009 age class return projection for Chiwawa hatchery spring Chinook above Tumwater Dam during 2012.

Brood	**Smolt Estimate**	**Adult Returns**				
Year	Chiwawa[1/]	Age-3[2/]	Age-4[2/]	Age-5[2/]	Total	SAR
2007	305,542	780	1,760	**88**	2,628	0.0086[3/]
2008	609,789	1,229	**2,839**[4/]	139	4,208	0.0069[5/]
2009	438,651	**411**	1,827	88	2,326	0.0053[6/]
Estimated 2012 Return		**411**	**2,839**	**88**	**3,338**	

[1/]-Chiwawa smolt release (Hillman et. al. 2009).
[2/]-Based on average age-at-return for hatchery origin spring Chinook above Tumwater Dam, 2005-2009 (WDFW, unpublished data) and total estimated BY return.
[3/]-Mean Chiwawa hatchery spring Chinook SAR to the Wenatchee Basin (BY 1997-2002).
[4/]-Age-4 returns in 2012 may be significantly underestimated due to age-3 returns in 2011 being in excess of 260% of the 2011 forecast.
[5/]-Mean Chiwawa hatchery spring Chinook SAR to the Wenatchee Basin (BY 1998-2003).
[6/]-Mean Chiwawa hatchery spring Chinook SAR to the Wenatchee Basin (BY 2000-2004).

Collection at the Chiwawa Weir will be based on weekly quotas, consistent with average run timing at Tumwater Dam. If the weekly quota is attained prior to the end of the week, retention of spring Chinook for broodstock will cease. If the weekly quota is not attained, the shortfall will carry forward to the next week. The number of hatchery origin fish retained for broodstock will be adjusted in-season, based on estimated Chiwawa River natural-origin returns provided through extrapolation of returns past Tumwater Dam. If hatchery origin Chinook are retained in excess to that required to maintain a minimum 33% natural origin composition in the broodstock, excess fish will be sampled, killed and either used for nutrient enhancement or disposed of in a landfill depending upon fish health staff recommendations.

Broodstock collection at the Chiwawa Weir will begin 01 June and terminate no later than 11 September. Spring Chinook trapping at the Chiwawa Weir will follow a 4-days up and 3-days down schedule, consistent with weekly broodstock collection quotas that approximate the historical run timing and a maximum 33 percent retention of the projected natural-origin escapement to the Chiwawa River. If the weekly quota is attained prior to the end of the 4-day trapping period, trapping will cease. If the weekly quota cannot be accomplished with a 4-days up and 3-days down schedule, a 7-day per week schedule may be implemented to facilitate reaching the collection objectives. Under the 7-day per week schedule, no more than 33% (1 in 3) of the fish collected will be retained for broodstock. If the weekly quota is not attained within the trapping period, the shortfall will carry forward to the next week.

All spring Chinook in excess of broodstock needs and all bull trout trapped at the Chiwawa weir will be transported by tank truck and released into a resting/recovery pool at least 16.0 km upstream from the Chiwawa River Weir. Age-3 males ("jacks") will not be collected for broodstock.

Steelhead

The steelhead mitigation program in the Wenatchee Basin use broodstock collected at Dryden and Tumwater dams located on the Wenatchee River. Per ESA section 10 Permit 1395 provisions, broodstock collection will target adults necessary to meet a 50% natural origin – conservation oriented program and a 50% hatchery origin – safety net program, not to exceed 33% of the natural origin steelhead return to the Wenatchee Basin. Based on these limitations and the assumptions listed below (Table 13), the following broodstock collection protocol was developed.

WDFW will retain a total of 130 mixed origin steelhead for broodstock for a smolt release objective of 247,300 smolts (Table 12). The 66 hatchery origin adults will be targeted at Dryden Dam and if necessary Tumwater dam. The 64 natural origin adults will be targeted for collection at Tumwater Dam. Collection will be proportional to return timing between 01 July and 12 November. Collection may also occur between 13 November and 3 December at both traps, concurrent with the Yakama Nation coho broodstock collection activities. Hatchery x wild and hatchery x hatchery parental cross and unknown hatchery parental cross adults will be excluded from the broodstock collection. Hatchery steelhead parental origins will be determined through evaluation of VIE tags, adipose/cwt presence/absence, and PIT tag interrogation during collection. 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 assure achieving the appropriate females equivalents for program production, the collection will implement the draft Production Management Plan, including ultrasonography to determine the sex of each fish retained for broodstock.

In the event steelhead collections fall substantially behind schedule, WDFW may initiate/coordinated 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.

Table 13. Assumptions and calculations to determine the number and origin of Wenatchee summer steelhead broodstock needed for Wenatchee Basin program release of 247,300 smolts.

Program Assumptions	**Standard**	**Wenatchee program**
Smolt Release		**123,650 Conservation** **123,650 Safety net**
Fertilization-to-release survival	*68.6%*	
Egg take target		**360,496**
Fecundity	*5,749 H* *5,893 W*	
Female Target		**32 H** **31 W**
Female to male ratio	*1:1*	
Broodstock target		**126**
Pre-spawn survival	*96.9%H/97.9%W*	
Total broodstock collection		**130**
Natural:Hatchery ratio	1:1	
Natural origin collection total		**64**
Hatchery origin collection total		**66**

<u>*Summer/fall Chinook*</u>

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 2012 is 500,001 smolts (181,816 GCPUD mitigation and 318,185 CCPUD mitigation).

The TAC 2012 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix A) and BY 2007, 2008 and 2009 spawn 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 dam 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. Collections will be limited to a 33% extraction of the estimated natural-origin escapement to the Wenatchee Basin. Based on these limitations and the assumptions listed below (Table 14), the following broodstock collection protocol was developed.

WDFW will retain up to 274 natural-origin, summer Chinook at Dryden and/or Tumwater dams, including 137 females. To better assure achieving the appropriate females equivalents 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 01 July 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.

Table 14. Assumptions and calculations to determine the number of Wenatchee summer Chinook salmon broodstock needed for Wenatchee Basin program release of 500,001 smolts.

Program Assumptions	**Standard**	**Grant PUD**	**Chelan PUD**	**Total Wenatchee Program**
Smolt Release		**181,816**	**318,185**	**500,001**
Fertilization-to-release survival	*75.6%*			
Egg take target		**240,497**	**420,880**	**661,377**
Fecundity	*5,135*			
Female Target		**47**	**82**	**129**
Female to male ratio	*1:1*			
Broodstock target		**94**	**164**	**258**
Pre-spawn survival	*94.1%*			
Total broodstock collection		**100**	**174**	**274**

White River Spring Chinook Captive Brood

Smolt production associated with the White River Captive Broodstock Program (150,000 smolts) will be separate from the smolt production objective associated with the Chiwawa River adult supplementation program. Spawning, incubation, rearing acclimation and release will be consistent with provisions of (expired) ESA Permit 1592.

Nason Creek Spring Chinook

Consistent with agreements made in 2012 in both the HCP-HC and PRCC-HSC, Grant PUDs spring Chinook obligation will be met with primarily production from the White River captive brood program with the balance of the obligation being met with spring Chinook at Methow FH. These agreements allow for Chelan PUD to move their Methow spring Chinook obligation to the Chiwawa to maintain the total Wenatchee Basin spring Chinook production at the recalculated level of 367,696 smolts. Total Methow Basin spring Chinook production will be maintained at the re-calculated level of 223,765 smolts. This agreement is only in place for the 2012 brood.

Priest Rapids Fall Chinook

Collection of fall Chinook broodstock at Priest Rapids Hatchery will generally begin in early September and continue through mid November. Smolt release objectives specific to Grant PUD

(5,000,000 sub-yearlings), Federal (1,700,000 sub-yearlings + 3,500,000 eggs – collection of broodstock for the federal programs are conditional upon having contracts in place with the ACOE), mitigation commitments. Biological assumptions are detailed in Table 15. Smolt release objectives for Ringold Springs occur as green eggs collected at Priest Rapids FH and incubated at Bonneville prior to eyed-egg transfers to Ringold Springs. After the new Priest Rapids FH rebuild there will no longer be incubation capacity for programs above GCPUD mitigation obligations.

For 2012, some portion of the broodstock will be collected at the OLAFT as part of the third year of OLAFT studies to determine the composition of natural origin fish that may be attainable in future years to increase the NOR component of the broodstock. Close coordination between broodstock collections at the volunteer channel and the OLAFT will need to occur so over collection is minimized. OLAFT collected and spawned fish will be prioritized for PRH programs (i.e. OLAFT fish will be held in a separate raceway from volunteer collected fish and spawned first each week).

Based upon the biological assumptions in Table 15, an estimated 2,727 females will need to be spawned to meet the 11,724,138 eggs required to meet the current three up-river bright (URB) programs which rely on adults collected at the Priest Rapids Hatchery volunteer channel trap and/or the Priest Rapids Dam off ladder trap (OLAFT).

To increase the probability of incorporating a higher percentage of NOR's from the volunteer channel, only adipose present, non-CWT males and females will be retained.

<u>Implementation Assumptions</u>

1) Broodstock will be collected at both the PRD off ladder trap (OLAFT – two days per week) and the Priest Rapids Hatchery volunteer channel trap.

2) Assumptions used to determine egg/adult needs is based upon current program performance metrics and is consistent with the draft 2012 Broodstock Collection protocols.

3) Broodstock retained from the volunteer channel will exclude age-2 and 3 males (using length at age) to address genetic risks/concerns of younger age-at-maturity males producing offspring which return at a younger age (decreased age-at-maturity).

4) Only adipose present males and females will be retained for broodstock from volunteer channel collected broodstock unless a shortage is expected.

5) Only adipose present, non-wired fish encountered at the OLAFT will be retained for broodstock.

6) All gametes of fish spawned from the OLAFT collections will be incorporated into the URB programs.

Table 15. Assumptions and calculations to determine the number of fall Chinook salmon broodstock needed for non-actively integrated Priest Rapids program release of 6,700,000 sub-yearling fall Chinook in addition to 3,500,000 for Ringold, in 2012.

Program Assumptions	Standard	Program objective
Juvenile Production Level		
Grant PUD Mitigation-PUD Funded		**5,000,000**
John Day Mitigation-Federally Funded		**1,700,000**
John Day Mitigation [1]-Ringold Springs-ACOE funding.		**3,500,000**
Total Program Objectives		**10,200,000**
Fertilization-to-release survival	*87%*	
Egg take target		**11,724,138**
Fecundity	*4,300*	
Female Target		**2,727**
Female to male ratio	*2:1*	
Pre-spawn survival	*88%*	
Broodstock target		
Females		**3,098**
Males		**1,549**
Total broodstock collection		**4,647**

[1] As of brood year 2009, Priest Rapids Hatchery is taking 3,500,000 eggs for release at Ringold-Meseberg Hatchery funded by the ACOE – incubation of this program occurs at Bonneville.

Appendix A

Columbia River Mouth Fish Returns Actual and Forecasts[a/]			
	2011 Forecast	**2011 Return**	**2012 Forecast**
Spring Chinook Upriver Total	**198,400**	**221,200**	**314,200**[b/]
Upper Columbia (total)	22,400	16,500	32,600
Upper Columbia (wild	2,000	2,200	2,800
Snake River Spring/Summer (total)	91,100	127,500	168,000
Snake River (wild	24,700	31,600	39,000
Summer Chinook	**91,100**	**80,600**	**91,200**
Sockeye	**161,900**	**187,300**	**462,000**
Wenatchee	33,000	41,800	28,800
Okanogan	126,800	143,500	431,300
Snake River	2,100	1,900	1,900

a/ Numbers may not sum due to rounding

b/ TAC used a log-normal sibling regression model to forecast the 2012 4-year old returns from the 2011 Bonneville Dam jack count. Log-normal models appear to work relatively well when jack counts are large, and the 2011 jack count at Bonneville Dam was the second highest on record.

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.

<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). Ultrsonography, 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 needs (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.

Within-Hatchery Program Adjustments

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:

- 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:

- 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
- 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 P - IMPLEMENTATION OF COMPREHENSIVE MONITORING AND EVALUATION OF WELLS HATCHERY COMPLEX PROGRAMS IN 2013

Exhibit A

Scope of Work

IMPLEMENTATION OF COMPREHENSIVE MONITORING AND EVALUATION OF WELLS HATCHERY COMPLEX PROGRAMS IN 2013

Submitted to

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Introduction

The Douglas County PUD Monitoring and Evaluation Plan (M&E Plan; Wells HCP Hatchery Committee 2007) describes eight objectives specific to the hatchery programs funded by Douglas County PUD and two regional objectives that are related to artificial propagation. These same objectives have been identified in the M&E Plan for Chelan County PUD (Murdoch and Peven 2005) and are designed to address key questions regarding the use of supplementation as mitigation for mortality associated with the operation of the Wells Hydroelectric Project. All objectives have specified indicators (i.e., primary) that will be measured and compared against target values established in the M&E Plan. Specific tasks and methodologies to be used in accomplishing the objectives are provided in the M&E Plan.

The primary focus of this proposal is the first eight objectives outlined in the M&E Plan, but additional regional objectives are included where warranted. Both disease (Objective 9) and non-target taxa (Objective 10) monitoring have been identified as important components of the M&E Plan. These regional objectives will be addressed once experimental designs have been developed and approved by the Wells HCP Hatchery Committee. Objective 10 is currently being addressed by the Hatchery and Evaluation Technical Team (HETT), a sub-committee under the HCP Hatchery Committee.

Successful implementation of the M&E Plan requires a continuation and potential expansion of existing relationships between the WDFW and other entities conducting similar field work in the Upper Columbia River Basin. Certain objectives require data to be collected from both target and reference populations. Field activities (i.e., data collection) not conducted by the WDFW, that are also required to implement the M&E Plan (i.e., reference populations) are not included in this proposal.

Addressing all the objectives within the M&E Plan will require multiple years of data collection. Several objectives (i.e., Objectives 2, 3, and 8) may be adequately addressed after one year or five years (Table 1), and may require only periodic monitoring (e.g., every five or ten years). However, the data collection necessary to address these objectives may be required for studies outside the scope of the M&E Plan (i.e., Twisp steelhead reproductive success study; Wells HGMPs) or for other Objectives within the M&E Plan (e.g., Objective 5). This proposal and budget encompasses one year of work in which WDFW will furnish all supervision, labor, services, materials, tools, and equipment necessary to implement the Monitoring and Evaluation Plan of hatchery programs funded by Douglas County PUD. All statistical analyses will be conducted consistent with the Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs (Hays et al. 2007), or revised versions of that document, or the 5-yr M&E report (Murdoch et al. 2012) as applicable.

Table 1. A potential long-term implementation schedule of objectives outlined in the Douglas County PUD M&E Plan.

Objective	Year of implementation									
	1-4	5	6-9	10	11-14	15	16-19	20	21-24	25
1	X	X	X	X	X	X	X	X	X	X
2	X	X		X		X		X		X
3	X				X				X	
4	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X
6	X	X	X	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X	X	X	X
8	X	X		X		X		X		X
9	Experimental design not complete									
10	HETT is currently conducting this assessment									

Reference Streams

Reference streams or populations are a critical component of the M&E Plan (Goodman 2004; ISRP & ISAB 2005). The Hatchery Evaluation Technical Team (HETT) has developed a methodology for assessing and choosing reference populations, and WDFW and Douglas PUD have incorporated reference population analyses for Spring Chinook under Objective 1 in the 5-year M&E report (Murdoch et al. 2012). Reference populations for steelhead and summer Chinook have not been identified by the HETT due to lack of populations similar to target populations that have not been substantially supplemented, or because potentially suitable reference populations lack the required data sets. Future analyses of spring Chinook program/populations will be able to build from this initial work. However, it is unclear if suitable reference populations will be available for steelhead due to lack of data. For Wells Hatchery summer Chinook, identifying suitable reference populations is not necessary at this time, since the program is focused on harvest augmentation and not supplementation.

WORK PLAN BY OBJECTIVE

Objective 1: Determine if a) supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and b) the changes in the natural replacement rate (NRR) of the supplemented population are similar to that of the non-supplemented population.

Hypotheses:

- Ho_1: Number of hatchery fish that spawn naturally > number of naturally and hatchery produced fish taken for broodstock.
- Ha_1: Number of hatchery fish that spawn naturally ≤ number of naturally and hatchery produced fish taken for broodstock.
- Ho_2: $\Delta NOR/Max\ recruitment_{\text{Supplemented population}} \geq \Delta NOR/Max\ recruitment_{\text{Non-supplemented population}}$
- Ha_2: $\Delta NOR/Max\ recruitment_{\text{Supplemented population}} < \Delta NOR/Max\ recruitment_{\text{Non-supplemented population}}$
- Ho_3: $\Delta\ NRR_{\text{Supplemented population}} \geq \Delta\ NRR_{\text{Non-supplemented population}}$
- Ha_3: $\Delta\ NRR_{\text{Supplemented population}} < \Delta\ NRR_{\text{Non-supplemented population}}$

General Approach

Spawning ground, broodstock, and harvest data (e.g., selective fisheries) will be the source of all abundance, composition, and productivity information required for this objective. Identification of suitable non-supplemented reference populations will be problematic in the Upper Columbia Basin because some species/races do not have populations that have not been either supplemented or influenced by hatchery fish (e.g., summer Chinook), or do not have adequate data sets for analyses (see discussion, above). For those supplemented populations without a suitable spatial reference population, temporal references may be used (i.e., prior to hatchery intervention). Temporal reference populations may also be initiated if deemed necessary, by discontinuing hatchery releases in a target population for a predetermined period of time (i.e., at least one generation minimum) to allow a before-after comparison.

Methodology

Standard spawning ground survey methodology outlined in Appendix F of the M&E Plan (Spawning ground surveys) and data analysis outlined in Appendix G of the M&E Plan (Relative Abundance) will be used under this objective. WDFW will coordinate with other Agencies (i.e., USFWS, USFS, Tribes) that conduct spawning ground surveys to ensure methodologies and sample rates are consistent with methodologies used in this objective (Table 2). Spawning/carcass surveys will be conducted for Methow Basin spring Chinook (WDFW); Methow Basin steelhead (WDFW); and Okanogan steelhead

(CCT). The use of a composite spring Chinook broodstock in the Methow and Chewuch Rivers suggests that the Methow and Chewuch spawning aggregates be treated as a single group. The combined group (i.e., MetChew) is supported by analysis of genetic data, which concluded that both spawning aggregates are very closely related (Snow et al. 2007). However, differences in spawner abundance, composition, and carrying capacity of the two subbasins may require that each subbasin be treated independently for data analysis purposes.

Table 2. Methodologies used to determine biological information used in Objective 1.

Population	Spawning ground methodology	Spawner composition	Age composition
Methow steelhead	Expanded index	Wells Dam	Wells Dam
Twisp steelhead	Total ground	Twisp weir	Twisp weir
Okanogan steelhead [a]	Total ground	Wells Dam	Wells Dam
Methow sp. Chinook	Total ground	Carcasses	Wells Dam
Chewuch sp. Chinook	Total ground	Carcasses	Wells Dam
Twisp sp. Chinook	Total ground	Carcasses	Wells Dam

[a] Conducted by CCT.

Schedule of Activities

Table 4. Schedule for conducting spawning ground surveys and data analysis (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow/Okanogan steelhead	A	A	D	D	D	D	A	A	A	A	A	A
Methow Basin spring Chinook	A	A	A	A	D	D	D	D	D	A	A	A

Analysis within the 5-year M&E Plan report identified low survival of hatchery- and natural-origin spring Chinook as a factor in the decrease in natural-origin spawner abundance and poor overall productivity of spring Chinook stocks. The recommendation was made to assess the potential to use a PIT-tag based assessment for Methow Basin spring Chinook and steelhead to 1) estimate survival to key life stages, 2) develop population estimates of key life stages, 3) develop estimates of carrying capacity, and 4) understand life-history traits such as juvenile movement, rearing, homing, and straying. To facilitate this approach, we will continue PIT-tagging wild spring Chinook and steelhead in Methow Basin tributaries (Table 3). Fish collection for tagging will be conducted via hook-and-line angling, seine or dip netting, electroshocking, rescuing or trapping from irrigation ditches or naturally de-watering areas using traps, nets, or electroshocking equipment. Tagging during July and August will target age-1 and older wild steelhead, primarily through angling. Tagging during September and October will target age-0 steelhead and Chinook using a variety of capture methods. Additional effort for steelhead tagging conducted in the Twisp River will address sample size requirements for an on-going relative reproductive success study funded under BPA contract # 49080. Tagging methodologies will be consistent with ongoing activities in the Wenatchee and Entiat basins following protocols developed under the ISEMP. Tagging in general will be conducted in approximation of the proportional redd count for each species in an attempt to ensure that tag groups are representational of the density and distribution of the species and brood being evaluated. Survival analysis using the PIT tag based approach will be conducted using a mark/recapture model developed by University of Washington researchers and projected to be available during the spring of 2013.

Table 3. Recommended methodologies and PIT tags required to evaluate life stage survival of M&E Plan species by stock, location, and origin. Survival metrics for most hatchery stocks will be evaluated during within-hatchery monitoring (HM) under other M&E Plan Objectives. Evaluation of smolt-to-smolt survival for wild fish will be accomplished via PIT tagging at WDFW (Twisp and Methow) or USGS (Chewuch) smolt traps, but tags are provided by BPA to meet Comparative Survival Study (CSS) requirements. Some metrics for wild fish will not be evaluated in 2013 (Np).

Stock/origin	Survival metric and PIT tags required			
	Egg-to-fry	Fry-to-parr	Parr-to-smolt	Smolt-to-smolt
Wild spring Chinook				
Methow	Np	Np	1,000	CSS
Twisp	Np	Np	1,000	CSS
Chewuch	Np	Np	1,000	CSS
Hatchery spring Chinook				
Twisp	HM	HM	HM	5,000
Methow	HM	HM	HM	6,000[a]
Chewuch	HM	HM	HM	5,000
Wild summer steelhead				
Methow	Np	Np	1,500	CSS
Twisp	Np	Np	1,500	CSS
Chewuch	Np	Np	1,500	CSS
Hatchery summer steelhead				
Twisp WxW	HM	HM	HM	5,000
Methow Hatchery release	HM	HM	HM	5,000
Columbia River release	HM	HM	HM	5,000

[a] Tagging conducted by Yakima Nation Fisheries.

The recommendation was made within the 5-year report to increase the proportion of locally adapted, naturally produced fish within the broodstock consistent with HSRG recommendations for supplementation programs (i.e., to achieve PNI > 0.67). The Twisp River weir provides an opportunity to collect locally adapted wild steelhead and spring Chinook, but similar facilities do not exist in the Methow and Chewuch rivers. For these programs, naturally produced fish are collected at Wells Dam in lieu of local facilities. This may incorporate out of basin fish (e.g., Entiat), potentially increasing genetic risks to receiving populations through a loss of diversity if locally adapted wild stocks become homogenized. Because options to increase the number of locally adapted wild fish within the broodstock are limited, we may investigate alternative methods of collecting adult natural origin spring Chinook for inclusion in Methow River programs using netting techniques, temporary picket-type weirs, or hook and line angling. These activities would only be implemented after consultation with co-managers through the Wells Hatchery Committee.

Objective 2: Determine if the run-timing, spawn-timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Hypotheses:

- Ho_4: Migration timing $_{\text{Hatchery Age X}}$ = Migration timing $_{\text{Naturally produced Age X}}$
- Ha_4: Migration timing $_{\text{Hatchery Age X}}$ ≠ Migration timing $_{\text{Naturally produced Age X}}$
- Ho_5: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ha_5: Spawn timing $_{\text{Hatchery}}$ ≠ Spawn timing $_{\text{Naturally produced}}$
- Ho_6: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$
- Ha_6: Redd distribution $_{\text{Hatchery}}$ ≠ Redd distribution $_{\text{Naturally produced}}$

General Approach

A properly integrated hatchery program produces fish that have life-history traits similar to naturally produced fish. Differences in any of these behavioral life history traits may affect progeny survival. Migration timing in the Columbia River of both juvenile and adult fish will be assessed using PIT tags when available. Migration timing into spawning tributaries will be assessed at broodstock-collection locations, or using in-stream PIT antenna arrays. In 2009, in-stream antenna arrays were installed in the lower Methow and Twisp rivers to assess the distribution and migration timing of adult hatchery and wild steelhead. These antennas, in conjunction with arrays installed by other researchers (i.e., USGS) will be used to assess steelhead and spring Chinook run timing and distribution throughout the Methow Basin.

Spawn timing and redd distribution data for spring Chinook will be collected during spawning-ground surveys. We propose selecting index reaches to evaluate spawn timing in reaches where similar proportions of hatchery and naturally produced fish are expected to spawn (based on carcass recovery data). The use of index reaches will eliminate any potential bias in spawn timing due to differences in spawning locations. Carcass recovery locations will be used as a surrogate for spawning location.

For summer steelhead, WDFW will conduct an evaluation in the Twisp River using visual observation of spawning fish to evaluate spawn timing and location. All fish sampled at the Twisp River weir in 2013 will be PIT-tagged and steelhead will also be externally Floy-tagged with origin- and sex-specific colors. Surveyors will conduct intensive surveys to quantify redd distribution and collect observational data from Floy-tagged fish. Adult female steelhead will be PIT-tagged in the body cavity to maximize the likelihood that PIT tags will be expelled into redds. Redds will be scanned with portable PIT-tag antennas to confirm the origin of females observed spawning, and to provide spawn-timing information for redds where no visual observations of spawners were made. Further, temporary in-stream PIT antennas will be installed in selected Methow Basin tributaries to assess whether surveys are conducted in all spawning areas, and to estimate spawner abundance in areas where conducting systematic surveys is problematic (e.g., Lost River). Funding for increased spawning ground surveys, PIT tag monitoring, and Floy Tag detections above baseline Douglas PUD M&E activities will be funded by the Bonneville Power Association (BPA) through contracts 49080 and 47950.

Methodology

Migration Timing

As previously stated, when available, PIT tags will be used to evaluate differences in migration timing in the Columbia River. During broodstock collection activities at mainstem dams, tributary traps, and the Twisp River weir, PIT tags will be inserted in all fish captured and released so that data on migration timing to spawning tributaries can be collected (Table 5). Migration timing into spawning tributaries will be assessed using PIT antenna arrays deployed at long-term sites in the lower Methow and Twisp rivers, utilizing antennas installed by other researchers within the Methow and Okanogan Basins (e.g., USGS), and using PIT antennas installed on a temporary basis in selected tributaries.

Table 5. Methods and locations used for evaluating differences in migration timing between hatchery and naturally produced salmon and steelhead.

Target population	Migration timing	
	Columbia River[a]	Spawning tributary
Methow spring Chinook	Wells Dam, PIT tags, CWTs	Twisp Weir, Chewuch PIT array
Methow steelhead	Wells Dam, PIT tags, VIE	Twisp Weir, PIT arrays in select tributaries
Okanogan steelhead	Wells Dam, PIT tags, Ad clip	Omak Cr. Weir/Zosel Dam

[a] PIT tags will be used when available (i.e., in conjunction with other objectives).

Spawn Timing

All spawn-timing information necessary for evaluating differences between hatchery and naturally produced salmon and steelhead will be collected during spawning-ground surveys (M&E Plan Appendix F). Specific spawn-timing information will only be collected within index spawning areas. Index areas identified are likely to have a similar proportion of hatchery and naturally produced fish spawning, based on carcass recoveries between 2003 and 2006 (Table 6). Carcass recovery date of female spring Chinook salmon will be compared to examine relative differences in spawn-timing.

Determining the relative spawn-timing of steelhead in the natural environment is problematic because not all hatchery fish are adipose fin clipped. In 2013, an evaluation of steelhead spawn-timing in the Methow Basin will be conducted utilizing female steelhead Floy-tagged at the Twisp River weir. Floy tag colors will be alternated every other year between hatchery and wild fish to control for any potential color effects on reproductive success. Male and female hatchery fish will be tagged with blue and chartreuse tags, respectively; and male and female wild fish with red and pink tags, respectively. Approximately 85% of the steelhead in the Twisp River spawn upstream of the Twisp River weir (mean 2003-2005). Steelhead will be captured and tagged at the Twisp River weir between 1 March and 30 June. All fish captured will be examined to determine origin (VIE, PIT, CWT, or eroded fins), age, and PIT tags, and colored anchor tags will be applied depending on stock and origin. Surveyors will record the tag color and date of all female steelhead observed during surveys and record GPS locations of all redds. Surveyors will also record the incidence of non Floy-tagged fish upstream of the Twisp River weir to determine weir capture efficiency. Because redd residence time of steelhead can be very low, female steelhead will be PIT-tagged in the body cavity to encourage tag expulsion into the redd. Surveyors will periodically scan completed redds for PIT tags to confirm female origin, or to identify female origin for redds where no visual observations of spawners occurred. Sampling at the Twisp River weir will be accomplished in conjunction with an on-going relative reproductive success study of steelhead in the Twisp River supported through this implementation plan, and BPA contract No. 49080 which partially funds some activities.

Table 6. Potential tributary index areas identified for each respective target population used for evaluating differences in spawn-timing between hatchery and naturally produced salmon and steelhead.

Target population	Historical reach(s)
Twisp spring Chinook	Twisp River (T5 - T6)
Chewuch spring Chinook	Chewuch River (C4 - C6)
Methow spring Chinook	Methow River (M9 - M11)
Twisp steelhead	Twisp River (T4 - T10)

Spawning Distribution

Redd distribution data will also be collected during spawning ground surveys (M&E Plan Appendix F). The origin of spawners will be identified from carcasses (i.e., scales or CWT), and carcass recovery location (i.e., rkm) of female spring Chinook will be used to approximate spawning location and allow analysis by origin or other variables. Overall steelhead redd distribution will be determined from GPS location information for each redd observed. Distribution by origin of spawning adult steelhead cannot be determined without application of an additional mark (e.g., Floy tag) because not all hatchery steelhead were adipose fin-clipped. Steelhead spawning distribution by origin of spawning adults will be assessed at the Twisp River weir in 2013. Surveys will be conducted at least weekly in the Twisp River to assess distribution of Floy-tagged females and to scan for PIT tags as previously described. Resident rainbow, residual hatchery steelhead, and cutthroat trout females will also be PIT-tagged in the body cavity to determine if these species or resident stages contribute to steelhead redd count estimates. Additionally, temporary in-stream PIT tag antenna arrays will be placed in selected tributaries to assist with spawning distribution evaluation. In conjunction with adult salmonid tagging at the Twisp weir and Wells and Priest Rapids Dams, these arrays are expected to provide a reliable, cost-effective means of corroborating current survey methodologies with observed salmonid use, and assessing spawning distribution (if any) in locations where spawning is presumed to not occur, or where surveys are difficult to conduct.

Schedule of Activities

Table 7. Schedule for conducting migration timing, spawn timing, and spawning distribution field activities and data analysis (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow steelhead	A	A	D	D	D	D	D	D	D	D	A	A
Methow spring Chinook	A	A	A	A	D	D	D	D	D			

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 the phenotypic characteristics of natural populations.

Hypotheses related to the genetic diversity, population structure, and effective population size (Ho 7-9) were addressed in the 2008-2010 work plans and will not be addressed in 2013. The following Hypotheses of age and size at maturity will be addressed in 2013:

- Ho_{10}: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$
- Ha_{10}: Age at Maturity $_{\text{Hatchery}}$ ≠ Age at Maturity $_{\text{Naturally produced}}$

- Ho_{11}: Size (length) at Maturity $_{\text{Hatchery Age X and Gender Y}}$ = Size (length) at Maturity $_{\text{Naturally produced Age X and Gender Y}}$
- Ha_{11}: Size (length) at Maturity by age and gender $_{\text{Hatchery}}$ ≠ Size (length) at Maturity by age and gender $_{\text{Naturally produced}}$

General Approach

Genetic Assessment (not performed in 2013): Genotypes of hatchery and naturally produced populations will be sampled and monitored based upon the schedule outlined in Appendix H of the Douglas PUD M&E Plan. Priority of analysis was based upon recovery needs or relative risk a hatchery program may have on the naturally produced population.

Phenotypic Assessment: Differences in phenotypic characteristics that may arise as a result of hatchery programs (i.e., domestication) will be measured using historical (i.e., prior to current hatchery programs) and recent data collected from wild fish and broodstock or carcasses recovered on the spawning grounds. Data related to additional important phenotypic characteristics will be collected and analyzed as part of Objective 2 (e.g., run timing, spawn timing, and spawning location), Objective 4 (e.g., fecundity), and Objective 7 (e.g., size and age at smolt migration).

Methodology

Data for monitoring phenotypic characteristics (i.e., age at maturity and size at maturity) will be collected annually as part of the broodstock collection protocol (M&E Plan Appendix B), run assessment, and carcass recoveries. Broodstock for all programs are not collected randomly from the run at large with respect to sex, origin, or age. However, trapping activities do provide an opportunity to collect data from a random sample of the run-at-large (i.e., those fish collected during broodstock trapping and released upstream). Historically, information related to the spawning population was derived from broodstock, carcasses, or a combination of both. Recent data suggest that these methods are biased and additional sampling at broodstock collection sites is required (Zhou 2002; Murdoch et al. 2005). Broodstock collection sites are located near or below a majority of the spawning locations (Table 8). All fish trapped, or a random sample depending on the stock, will be sampled to determine origin, age, and size. This will provide a sample that more accurately, in a less biased way, represents the population. Additionally, PIT tags may be inserted into adult fish released upstream of Wells Dam and the Twisp River weir to address other M&E Plan objectives (i.e., migration timing and spawning distribution, Objective 2; stray rates, Objective 5).

Table 8. Broodstock collection locations for stock assessment and phenotypic characterization of hatchery and naturally produced fish.

Stock	Primary location	Secondary location
Methow Basin spring Chinook	Wells Dam	Twisp Weir
Methow/Okanogan steelhead	Wells Dam	Twisp Weir / Priest Rapids Dam

Schedule of Activities

Table 9. Schedule for conducting size and age at maturity comparisons (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow/Okanogan steelhead	D	D	D	D	A	A	D	D	D	D	D	D
Methow spring Chinook	A	A	A	A	D	D	D	D	D			

Objective 4: 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 equal to or greater than the program specific expected value (BAMP 1998).

Hypotheses:

- Ho_{12}: $HRR_{\text{Year x}} \geq NRR_{\text{Year x}}$
- Ha_{12}: $HRR_{\text{Year x}} < NRR_{\text{Year x}}$
- Ho_{13}: HRR ≥ BAMP value (preferred)
- Ha_{13}: HRR < BAMP value

General Approach

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome lower post-release survival (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were allowed to spawn naturally. If a hatchery program cannot produce a biologically significant greater number of adults than naturally spawning fish, the program should be modified or discontinued. More simply, the hatchery replacement rate should always be greater than the natural replacement rate.

Hatchery programs in the Upper Columbia River were initially designed based on observed mean survival rates for each stock (BAMP 1998). Performance of the hatchery programs will be assessed using those expected survival rates and the number of broodstock collected on a brood year basis. Harvest augmentation hatchery programs will only be compared to the expected HRR value because a corresponding NRR is not available or applicable (e.g., Wells summer Chinook).

Methodology

Smolt to adult (SAR) and HRR values will be calculated for each stock. SAR values are currently calculated using CWT recoveries from all locations (harvest, hatcheries, and spawning grounds), except for steelhead, for which SAR values are calculated based on sampling that occurs at Priest Rapids Dam or Wells Dam to obtain an estimate of the number of returning adults from the hatchery program. HRR values that fall below the expected values or the corresponding estimate of NRR (M&E Plan Appendix G) will be evaluated to determine whether in-hatchery (M&E Plan Appendix C) or out-of-hatchery (M&E Plan Appendix D) factors contributed to the reduced survival.

The 5-year M&E Plan analysis report noted that survival rates for hatchery and naturally-produced spring Chinook were lower than expected and increased PIT-tagging of both hatchery and wild fish was recommended to help identify survival constraints. For life-stage survival comparisons and to monitor stray rates and migration patterns, rate, and speed within the basin, we propose that hatchery steelhead and spring Chinook be tagged at the Wells and Methow hatcheries prior to release (Table 10) for comparison to naturally produced fish (see Table 3). Comparison groups of hatchery spring Chinook and steelhead were historically tagged at each smolt trap, but tag rates were likely too low to provide meaningful comparisons. Further, PIT-tagging at the Methow smolt trap likely incorporated fish from hatchery programs not covered under the M&E Plan (i.e., WNFH) because release time and hatchery mark were often the same for steelhead and spring Chinook released from WDFW and USFWS hatcheries in the Methow Basin. Since releases of fish from these hatcheries have exhibited different survival rates (Townsend and Skalski 2004), tagging should occur at the hatcheries of origin to ensure that evaluations are conducted with target stocks.

Table 10. PIT-tagging goals for Douglas PUD hatchery fish released in 2014.

Target population	Hatchery fish	
	Steelhead	Spring Chinook
Methow River	5,000	6,000[a]
Twisp River	5,000	5,000
Chewuch River	0	5,000
Wells Hatchery	5,000	NA
Douglas PUD total	15,000	10,000

[a] 6,000 PIT tags proposed for 2013 through Yakama Nation multi-species acclimation project.

Schedule of Activities

Table 11. Schedule of activities for hatchery evaluation activities (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow/Okanogan steelhead	A/D	A/D	D	D	D	D	D	D	D	D	D	D
Wells summer Chinook	A/D	A/D	D	D	D	D	D	D	D	D	D	D
Methow Basin spring Chinook	A/D	A/D	D	D	D	D	D	D	D	D	D	D

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation.

Hypotheses:

- Ho_{14}: Stray rate $_{\text{Hatchery fish}}$ < 5% of total brood return
- Ha_{14}: Stray rate $_{\text{Hatchery fish}}$ ≥ 5% of total brood return
- Ho_{15}: Stray hatchery fish < 5% of spawning escapement (based on run year) within other independent populations
- Ha_{15}: Stray hatchery fish ≥ 5% of spawning escapement (based on run year) within other independent populations
- Ho_{16}: Stray hatchery fish < 10% of spawning escapement (based on run year) of any non-target streams within independent populations
- Ha_{16}: Stray hatchery fish ≥ 10% of spawning escapement (based on run year) of any non-target streams within independent populations

General Approach

Excessive strays from hatchery programs pose significant genetic risk (loss of genetic variation between populations) and must be monitored in order to determine the magnitude of the problem and develop reasonable and appropriate recommendations. Further, straying of steelhead stocks away from release locations may limit the ability to decrease the proportion of hatchery fish (pHOS) on spawning grounds through management activities such as selective fisheries or removing excess adults at hatcheries and weirs. Stray rates will be monitored using CWT recoveries from Chinook spawning ground surveys. The Regional Mark Information System (RMIS) database will provide all necessary CWT information needed when calculating stray rates for each brood year or within and outside basin stray rates based on spawning escapement estimates.

Brood year stray rates will require multiple-year CWT recoveries (i.e., all age classes) from broodstock and carcass recoveries on the spawning grounds. The estimated number of strays for the entire brood year will be calculated by dividing the number of strays by the total number of hatchery fish that returned. Stray rates within, and between independent populations will be calculated in a similar manner as brood year stray rates, except on an annual basis and based on the estimated spawning escapement.

Collecting stray rate information for steelhead poses the greatest challenge because carcasses are not available for examination. When available, radio tag information and/or adult PIT-tag monitoring may provide adequate information for evaluating stray rates. Some data needed for evaluating stray rates for the Methow/Okanogan steelhead will be collected during broodstock trapping activities at Wells Dam (M&E Plan Appendix B), and through operation of the Twisp River weir when assessing spawn-timing (see Objective 2). Stray rates in other tributaries may need to be calculated by other types of sampling (i.e., PIT tags, radio tags, hook and line, electroshocking) if warranted. Antenna arrays installed by WDFW and other researchers should provide tributary stray rate information, provided that adequate numbers of juvenile fish are PIT-tagged prior to release (hatchery fish) or within natal streams (wild fish). Tagging of hatchery steelhead under Objective 4 (see Table 10) should satisfy within-basin and out-of-basin stray rate monitoring goals of fish destined for release in the Methow Basin.

Methodology

Stray rates will be calculated using procedures outlined in the spawning ground survey methodology (M&E Plan Appendix F). As stated previously, information needed to evaluate steelhead stray rates will be obtained during broodstock collection activities at Wells Dam, operation of the Twisp Weir and antenna array, and through other proposals. However, direct observations on the spawning grounds by other Agencies (e.g., USFWS, CCT, or USGS) or via PIT tags may be required in non-target streams (Table 12).

Table 12. Proposed methodologies used to evaluate stray rates for target and non-target streams.

Hatchery program	Target stream	Method
Twisp steelhead NNI	Twisp	PIT/Observation/creel[a]
Methow steelhead safety-net	Methow Hatchery	PIT/Observation/creel[a]
Wells steelhead safety-net	Wells Hatchery	PIT/Observation/creel[a]
Okanogan steelhead	Okanogan, Similkameen	PIT/Observation/creel[a,b]
Twisp spring Chinook NNI	Twisp	CWT
Chewuch spring Chinook NNI	Chewuch	CWT
Methow spring Chinook NNI	Methow	CWT
Wells summer Chinook	Wells Hatchery	CWT

[a] The number of strays will also be estimated during broodstock collection activities or PIT tag detections at Columbia River or tributary dams/detectors, where applicable.
[b] The Okanogan steelhead assessment is performed by the CCT.

Schedule of Activities

Table 13. Schedule for data analysis to determine stray rates of hatchery fish (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow steelhead	A	A	D	D	D	D						
Okanogan steelhead	A	A	D	D	D	D						
Methow Basin spring Chinook	A	A						D	D			
Wells summer Chinook	A	A								D	D	

Objective 6. Determine if hatchery fish were released at the programmed size and number.

Hypotheses:

- Ho_{17}: Hatchery fish $_{\text{Size at release}}$ = Programmed $_{\text{Size at release}}$
- Ha_{17}: Hatchery fish $_{\text{Size at release}}$ ≠ Programmed $_{\text{Size at release}}$
- Ho_{18}: Hatchery fish $_{\text{Number released}}$ = Programmed $_{\text{Number released}}$
- Ha_{18}: Hatchery fish $_{\text{Number released}}$ ≠ Programmed $_{\text{Number released}}$

General Approach

The HCP outlines the number and size at which fish of each program are to be released. However, analyses in the 5-year report revealed that past length-weight targets are not appropriate. The 5-year report offers new targets based on recent data, and a scheduled review of the M&E Plan objectives in 2012/2013 will likely recommend adopting these new targets or suggest revisions. Our assessment of this objective will use the new targets, pending acceptance of the recommendations generated under review of the M&E Plan and accepted by the Hatchery Committee. The programmed size and number of fish for each program will be compared to actual values at release each year. The number of broodstock collected and the population-dynamics assumptions (i.e., sex ratio, fecundity, and survival) in the broodstock collection protocol are important components for consideration. A program's failure to meet the HCP standards (e.g., over or under program goals) will be evaluated taking into account the number of broodstock and associated population-dynamics assumptions. The size of fish will be compared using a representative sample collected immediately prior to release.

Methodology

The number and size of fish released will be calculated according to methodologies outlined in the M&E Plan (Appendix C). An annual review of size and number of fish from each program will be compared to those values defined in the HCP, or adjusted values agreed to by the Wells HCP Hatchery Committee. If release targets were achieved within acceptable levels (i.e., 10% +/- of HCP defined values) then no change would be recommended. If release targets are not achieved then causation will be determined and recommendations made based upon the results of the evaluation. A review of the broodstock protocols will occur every five years (or more frequently if necessary) concurrently with an evaluation of the number of fish released from each program.

Schedule of Activities

Table 14. Schedule of activities to determine the number and size of fish released (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Wells steelhead	D	D	D	D	D	A	D	D	D	D	D	D
Wells summer Chinook	D	D	D	D	D	D	D	A	D	D	D	D
Methow spring Chinook	D	D	D	D	D	A	D	D	D	D	D	D

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Hypotheses:

- Ho_{19}: Slope of Ln(juveniles/redd) vs redds $_{\text{Supplemented population}}$ = Slope of Ln(juveniles/redd) vs redds $_{\text{Non-supplemented population}}$
- Ha_{19}: Slope of Ln(juveniles/redd) vs redds $_{\text{Supplemented population}}$ ≠ Slope of Ln(juveniles/redd) vs redds $_{\text{Non-supplemented population}}$
- Ho_{20}: The relationship between proportion of hatchery spawners and juveniles/redd is ≥ 1.
- Ha_{20}: The relationship between proportion of hatchery spawners and juveniles/redd is < 1.

General Approach

Supplementation should result in an increase in the natural production of the target stock. Given variability in abundance of adult salmonid populations in the Upper Columbia River Basin, monitoring juvenile production (e.g., smolts/redd) should provide a direct assessment of the efficacy of hatchery fish in rebuilding natural populations. Monitoring the freshwater production of both supplemented and non-supplemented populations may provide an early indication of the reproductive success of hatchery fish on the spawning grounds (i.e., no out of basin effects on survival). Conversely, without a smolt monitoring program, changes in smolt production may be masked by out of basin effects. Thus, subsequent recommendations concerning hatchery program modifications may be misdirected.

Smolt monitoring programs are currently ongoing for most treatment streams (Table 15). Coordination with the Agencies operating the various traps is ongoing to ensure similar levels of effort and methodologies are used.

Table 15. Population and location of smolt traps that may be used in examining the influence of hatchery fish on freshwater productivity.

Population	Smolt trap	Size	Agency
Methow Basin spring Chinook	Methow	1 - 8 ft trap; 1 - 5 ft trap	WDFW
Twisp spring Chinook	Twisp	1 - 5 ft trap	WDFW
Methow Basin steelhead	Methow	1 - 8 ft trap; 1 - 5 ft trap	WDFW
Twisp steelhead	Twisp	1 - 5 ft trap	WDFW
Okanogan steelhead	Okanogan	1 - 8 ft trap; 1 – 5 ft trap	CCT

Comparisons between supplemented and unsupplemented populations require extensive data sets, with potentially high annual variability that may require years before the efficacy of the program can be determined. Furthermore, the Wells steelhead program began decades before the HCP was signed and pretreatment data may not be available. Similarly, large releases of spring Chinook occurred in the Methow Basin for decades before the HCP program began.

Methodology

Procedures for this objective are outlined in Appendix E of the M&E Plan. Redd count activities required for this Objective will be accomplished under Objective 2. Juvenile monitoring requires an extensive trapping period (Table 16) over many successive generations due to the diverse life history of spring Chinook (subyearling and yearling emigrants) and summer steelhead (multiple age-class smolts). Random samples of scales must be collected for all stocks with multiple age-class smolts in order to calculate the number of smolts produced from each brood-year. Whenever possible, direct measurements of the proportion of hatchery fish on the spawning grounds (pHOS) will be conducted (i.e., Twisp Weir). Otherwise, the proportion of hatchery-origin fish on the spawning grounds will be estimated where possible, as will the Proportionate Natural Influence (PNI).

Current estimates of egg-to-smolt survival for Methow spring Chinook are much lower than expected. Based on scale analysis of returning Chinook adults, we assumed that all yearling emigrants at the Methow smolt trap were spring Chinook and subyearling emigrants were summer Chinook. Results of DNA sampling at the Methow River trap during the fall of 2006 and 2007 indicated that the majority of subyearling Chinook captured were spring Chinook. Because of this, fall trapping and DNA sampling will be conducted at the Methow smolt trap to estimate total spring Chinook emigrants.

The low abundance of steelhead and yearling Chinook captured at smolt traps in the Methow Basin limits the sample size to conduct migration timing comparisons and life-stage survival estimates (e.g., PIT tag recaptures). The installation of PIT tag antenna arrays in the lower Twisp and Methow rivers will provide additional opportunities to assess migration behavior and survival, and detection rates should increase with additional PIT tagging of hatchery and wild fish conducted under Objective 4 and Objective 1, respectively.

Schedule of Activities

Table 16. Schedule of activities for smolt monitoring programs in the Methow Basin (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow Basin steelhead	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Twisp steelhead	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Methow Basin spring Chinook	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Twisp spring Chinook	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Methow summer Chinook	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate (e.g., Wells Chinook salmon).

Hypotheses:

- Ho_{21}: Harvest rate ≤ Maximum level to meet program goals
- Ha_{21}: Harvest rate > Maximum level to meet program goals
- Ho_{22}: Escapement ≥ Maximum level to meet supplementation goals
- Ha_{22}: Escapement < Maximum level to meet supplementation goals

General Approach

In years when the expected returns of hatchery adults are above the levels required to meet program goals (i.e., broodstock, natural escapement), surplus fish may be available for harvest. Harvest of returning adults is the goal of some programs (e.g., Wells summer Chinook) and an ancillary benefit of other programs (e.g., Methow/Okanogan steelhead). Contribution to fisheries, whether incidental or directed, will be monitored using CWT recoveries on a brood-year basis. Target harvest rates have not been outlined in the M&E Plan. Hence, a qualitative assessment of the contribution rates of hatchery fish to fisheries versus broodstock or spawning grounds is required to determine if the objective has been met.

One approach, based on the goal of the hatchery program, is to compare CWT recoveries by recovery location (i.e., broodstock, fisheries, or spawning grounds). For example, a majority of the CWT recoveries for harvest augmentation programs should occur in fisheries. Conversely, supplementation programs should have a majority of the CWT recoveries occur on the spawning grounds.

Methodology

Robust statistically valid creel survey programs will be conducted for all sport fisheries in the Upper Columbia River to estimate harvest of hatchery fish from hatchery programs funded by Douglas County PUD (M&E Plan Appendix D). Creel survey programs will be designed and implemented by WDFW Fish Management staff. Creel surveys in the Upper Columbia River are also an important component in calculating the HRR (Objective 4) because most CWT recoveries occur within the Upper Columbia River, the exception being summer Chinook. Significant time lags in reporting CWT recovery data to the Regional Mark Information System (RMIS) database requires a continual requerying of recovery data until the number of estimated fish does not change. The number of fish and proportion by brood year for CWT recoveries will be summarized in several categories (Table 17).

Further, steelhead release locations for some stocks have changed recently to reflect a shift in management strategy from supplementation to de-facto harvest augmentation as managers implement fisheries as a means to control the proportion of hatchery fish from selected release groups on spawning grounds. We will evaluate the effectiveness of selective fisheries and adult removal management actions at achieving desired pHOS levels, and quantify—to the extent possible based on release group mark type—the contribution of each steelhead release group to Methow Basin harvest, hatchery removal, broodstock, or spawning escapement. This evaluation will depend on adequate numbers of PIT tagged fish within each release group (see Tables 3 and 10), because current rearing strategies at Wells Hatchery often combine fish of a similar genetic cross (H x H or H x W) for release in multiple locations.

Table 17. Categories for CWT recoveries of hatchery fish released from Douglas County PUD funded programs.

Category	Estimated number of fish (%)		
Broodstock	Total	Target stream	Nontarget streams
Spawning ground	Total	Target stream	Nontarget streams
Fisheries	Total	Commercial	Sport
Commercial	Ocean	Columbia River Treaty	Columbia River non-Treaty
Sport	Ocean	Columbia River	Terminal

Schedule of Activities

Table 18. Schedule of activities to determine harvest rates of hatchery fish (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow/Okanogan steelhead	D	D	D	A	A	A		D	D	D	D	D
Wells summer Chinook	A	A					D	D	D	D		
Methow basin spring Chinook	A	A										

DELIVERABLES

Annual Reports: A draft annual report will be provided to Douglas PUD by 1 July, 2014. A final report will be provided to the HCP HC within 30 days of receiving comments on the draft report. The annual report will summarize all field activities conducted during the contract period. The format of the report will be similar to the 2012 annual report that has been provided to Douglas PUD, with each task reported in a separate chapter. Primary indicators and the data used in calculations during each task will also be presented in each chapter. Secondary and tertiary indicators will be reported if needed to calculate or inform the primary indicator.

Chapter 1. Hatchery Brood Report

a. Broodstock
   - Number collected
   - Age composition
   - Size at maturity
   - Report on Chewuch spring Chinook broodstock collection efforts

b. Juvenile
   - Number released
   - Size at release

c. Hatchery replacement rates

Chapter 2. Harvest

a. Hatchery fish
   - Number
   - Location
   - Stray rates

b. Wild fish
   - Number
   - Location

Chapter 3. Smolt Monitoring

a. Smolt production
   - Number of smolts (captured and total estimate)
   - Smolts/redd
   - Size at emigration
   - Age at emigration

b. Survival
   - Egg to emigrant survival
   - Number of fish PIT-tagged
   - Smolt-to-smolt survival

c. Remote PIT-tagging
   - Number tagged

Chapter 4. Steelhead Spawning Ground Surveys

a. Migration timing
b. Spawn timing
c. Redd distribution
    Number of redds
    Spawning escapement
    Spawner composition
    pHOS and PNI estimates
    Number of NOR
    NRR
    Stray rates

Chapter 5. Chinook Spawning Ground Surveys

a. Migration timing
b. Spawn timing
c. Redd distribution
    Number of redds
    Spawning escapement
    Spawner composition
    pHOS and PNI estimates
    Number of NOR
    NRR
    Stray rates

Recommendations: Recommendations to modify the M&E Plan or reporting will occur on an annual basis and again within the five-year summaries. Initially, changes to protocols or methodologies may be necessary to ensure the data required in the M&E Plan is collected. Changes to the M&E Plans' implementation or hypotheses will be included in the five-year summary report. Recommendations will be consistent with the hatchery program goals and will be included in a separate section of the summary report.

Presentations: A formal presentation (i.e., PowerPoint format) of the M&E Plan results will be provided to Douglas PUD or the HCP HC at their convenience. Presentations will include the status of all hatchery programs in meeting their objectives, potential problems and recommendations. Similar presentations of annual results from field activities can be requested and provided if warranted.

COORDINATION BETWEEN DOUGLAS PUD AND HATCHERY STAFF

The WDFW Supplementation Research Team (a.k.a. Methow Field Office) has been directly involved in the evaluation, development, and implementation of the hatchery programs since 1992. Currently, the WDFW is contracted by Douglas PUD not only to operate its hatcheries, but also to implement the Evaluation Plan developed when the Methow Hatchery program came online.

Coordination with hatchery staff has been a continual process. Hatchery staff conducts routine sampling at the hatcheries and data is provided to us for inclusion in monthly reports. However, special meetings with the hatchery staff are typically conducted prior to significant events (i.e., broodstock collection, spawning, release of juveniles) to ensure proper methodologies are used and critical data is collected. Evaluation staff is present at all significant events and collect data needed for evaluation purposes.

Additional coordination between evaluation staff, hatchery staff, and the WDFW ESA Permitting biologist is often required to ensure that conditions of ESA Section 10 permits are not violated. The ESA permitting biologist is co-located with evaluation staff, which allows for efficient and effective communication on a daily basis in order to ensure compliance with existing permits. Currently, all ESA reporting related to the hatchery programs is the responsibility of the WDFW Permitting Biologist (0.5 FTE). Given the limited resources dedicated to ESA Permit reporting and the extensive workload required to meet reporting requirements, this relationship is critical to ensuring hatchery programs operate within the conditions of the permit.

Monthly reports have served as a primary mode of coordination and are used to keep Douglas PUD as well as HCP Committee members and co-managers informed on all hatchery and evaluation related activities. Unless otherwise requested by Douglas PUD, the role of monthly reports will remain the same. Upon request, additional information can be included in the monthly reports.

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APPENDIX Q - MONITORING AND EVALUATION OF WELLS AND METHOW HATCHERY PROGRAMS: 2011 ANNUAL REPORT

MONITORING AND EVALUATION OF WELLS AND METHOW HATCHERY PROGRAMS: 2011 ANNUAL REPORT

Prepared for

Douglas County Public Utility District

and

Wells Habitat Conservation Plan
Hatchery Committee

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July 2012

Executive Summary

Chapter 1: 2009 Brood Spring and Summer Chinook Salmon and 2010 Brood Summer Steelhead Reared at Methow and Wells Hatchery Facilities:

The Public Utility District No. 1 of Douglas County funds hatchery programs intended by the Joint Fishery Parties (JFP) to supplement natural populations of spring Chinook salmon and summer steelhead, and to produce summer Chinook salmon for harvest augmentation. These hatchery programs collect, rear, and release salmonids under the Wells Habitat Conservation Plan and in accordance with protocols governing the number, origin, and timing of adult salmon and steelhead collected for broodstock, thereby affecting the subsequent number and genetic composition of the juveniles released. For the 2009 brood summer Chinook salmon, adult collection achieved 100% of the overall collection goal of 1,620 fish. The 2009 spring Chinook salmon broodstock collection achieved 89% of the overall collection goal of 359 fish, although too few fish were collected to meet specific production targets for the Twisp River program. The 2010 brood steelhead broodstock collection achieved 98% of the collection goal of 366 fish and pre-spawn survival of broodstock was above the set standards for each program. Wild 1-salt male steelhead had a greater mean fork length than 1-salt hatchery male steelhead, but no other differences were detected between hatchery and wild fish of the same sex and salt age. Age-4 fish were the dominant age class for summer Chinook salmon, with a mean fecundity of 4,403. The majority of spring Chinook collected were age-4 Methow Composite hatchery fish with a mean fecundity of 3,853. No significant differences in fecundity were detected between hatchery and wild spring Chinook of the same stock and age, or between Methow Composite and Twisp fish of the same age regardless of origin. No statistical difference between the mean fecundities of age-4 hatchery and wild summer Chinook was detected. Comparisons between hatchery and wild fish of other ages were not made because sample sizes of wild fish were too low. Evidence of the BKD bacterium in spring and summer Chinook broodstock as assessed by ELISA sampling was generally low for the 2009 brood. The 2009 brood steelhead were comprised primarily of 2-salt hatchery fish with a mean fecundity of 6,502, and no significant difference in fecundity between wild and hatchery steelhead was detected between fish of the same salt-age. Overall juvenile release numbers were within 5% of release goals for the Wells summer Chinook salmon, but were slightly below target levels for spring Chinook salmon and slightly above target release goals for steelhead. The most recent brood years of salmon and steelhead exhibited hatchery replacement rates large enough to replace parent broods (i.e., $\geq$ 1).

Chapter 2: Harvest and Straying of Hatchery Origin Fish Released From Wells Complex Hatchery Facilities:

All stocks of salmon and steelhead covered in this chapter were subject to commercial, sport, or tribal fisheries in ocean and freshwater environments. Based on analysis of coded-wire tag data, most Wells summer Chinook salmon adults were recovered in fisheries, while most Methow spring Chinook salmon stocks were recovered in hatchery broodstocks or on spawning grounds. For the current brood examined (2005), harvest of hatchery and wild Methow Basin spring Chinook totaled 3.6% of the total return of each group. Unlike earlier hatchery releases, recent releases of Methow spring Chinook salmon have not been adipose fin-clipped, which may result in a decrease in harvest rates and an increase in recoveries of coded-wire tagged fish on the spawning grounds. For the most recent broods examined, greater than 5% of the total return of spring Chinook salmon released into the Twisp and Chewuch rivers, and the Wells subyearling summer Chinook strayed to non-target spawning grounds. Less than 5% of the total brood return of Methow spring Chinook and Wells yearling summer Chinook were recovered in non-target spawning grounds. For the 2010 return year, Wells summer Chinook salmon comprised less than 5% of other independent populations. Although not identified as an independent population, 8.8% of the Chelan River spawning population in 2010 was composed of fish originating from Wells Hatchery releases. Local creel census was used to monitored harvest in selective (steelhead), and non-selective (summer Chinook salmon) fisheries occurring in the upper Columbia River ESU. An estimated 4,711 summer Chinook salmon, 4,943 hatchery steelhead, and 89 wild steelhead were directly or indirectly removed through local sport fisheries in 2011. Overall, Wells Complex hatchery fish provided commercial, recreational, and tribal harvest, while meeting escapement requirements with most spring Chinook salmon recovered either in broodstock or on the spawning grounds within target streams, and most summer Chinook salmon recovered in harvest programs.

Chapter 3: Methow River Basin Spring Chinook Salmon and Steelhead Smolt Monitoring in 2011:

The mean number of emigrants produced per redd is a metric used to compare the relative productivity of target species during freshwater rearing. We used salmonid capture data from rotary screw traps and PIT tag interrogation sites to estimate the number of spring Chinook salmon and summer steelhead smolts emigrating from the Twisp River and Methow River basins. During the spring smolt outmigration, we captured 344 wild spring Chinook salmon smolts at the Methow River trap and 317 smolts at the Twisp River trap in 2011. A total of 171 and 329 wild steelhead emigrants were captured at the Methow and Twisp River traps, respectively. The number of fish captured each day was expanded by the estimated trap efficiency based on a regression model using the variables discharge (independent variable) and capture efficiency (dependent variable). Subyearling migrants (parr) from the previous year were combined with yearling migrants (smolt) from the current year to produce a total emigration estimate for each brood year examined. Using this methodology, we estimated that a total of 31,212 (± 8,823, 95% CI) wild spring Chinook salmon from the 2009 brood emigrated from the Methow Basin including 1,602 parr and 29,610 smolts. This estimate includes fish emigrating from the Twisp River where we estimated that 5,124 (± 870, 95% CI) wild spring Chinook from the 2009 brood emigrated past the Twisp River trap including 3,282 parr and 1,842 smolts. Utilizing spring Chinook salmon spawning ground survey data from 2009, we estimated that the number of emigrants produced from each 2009 brood spring Chinook salmon redd in the Twisp River (N = 214) was 3.5 times greater than the number of emigrants produced from redds in the remainder of the Methow River basin (N = 68). During the fall 2011 emigration period, we estimated that 4,874 (± 680, 95% CI) spring Chinook salmon parr emigrated past the Twisp River trap and 8,979 (± 1,832 95% CI) spring Chinook salmon parr emigrated past the Methow River trap. Additionally, we estimated that 514,724 (± 349,514, 95% CI) subyearling summer Chinook emigrated past the Methow River trap in 2011.

Overall we estimated that 15,673 (± 6,512 95% CI) wild steelhead emigrated from the Methow River, including 5,959 (± 1,492, 95% CI) fish from the Twisp River in the spring of 2011. As a comparison to the steelhead smolt production estimate from the Twisp smolt trap, we developed a steelhead smolt emigration estimate using daily PIT tag interrogation data at the in-stream PIT tag interrogation site in the Twisp River. We expanded PIT tags detected between 1 January and 15 May by an estimated tag rate derived from recaptures at the smolt trap and an estimated detection efficiency derived from a discharge/efficiency model developed for the Twisp PIT antenna and estimated that 12,819 (± 17,352, 95% CI) wild steelhead smolts emigrated from the Twisp River. Because steelhead emigrate at multiple ages, we used age data derived from scale samples to assign migrating smolts to their brood year of origin. For the last brood for which a complete emigration estimate is available (2007 brood) we estimated that 33,275 (± 14,890, 95% CI) and 13,512 (± 1,285, 95% CI) juvenile steelhead emigrated from the Methow Basin (excluding Twisp) and Twisp rivers, respectively. Steelhead in the Methow Basin and Twisp River produced an estimated 165, and 45 emigrants from 2007 brood redds, respectively.

Chapter 4: 2011 Brood Summer Steelhead Spawning Ground Surveys Conducted in the Methow River Basin:

Steelhead spawning ground surveys were performed to estimate the relative abundance, distribution, and timing of spawning within the Methow River basin. Based on surveys conducted between 3 March and 1 June, an estimated minimum of 854 steelhead redds were constructed in the Methow Basin in 2011. The greatest number of redds was found in the upper Methow River subbasin (N = 383). The run-at-large above Wells Dam was composed primarily of hatchery origin steelhead (84.9%). Based on biological sampling of steelhead during broodstock collection at Wells Hatchery, 17.4% of total run escapement was composed of out-of-basin stray hatchery fish, primarily from the Wenatchee River. Based on first-day-of-the-week sampling during the broodstock collection period, wild 1-salt and 2-salt fish migrated to Wells Dam earlier than hatchery 1-salt fish. No significant differences in spawn timing of hatchery and wild female steelhead were observed in the hatchery environment (non-hormone-injected females) or during natural spawning in the Twisp River. Based on run-escapement estimates, the mean natural replacement rate for the ten most recent broods of steelhead spawning above Wells Dam (1996-2005) was 0.26 recruits per adult. For all brood years examined (1996-2005), the hatchery replacement rate was significantly greater than the natural replacement rate.

Chapter 5: 2011 Brood Spring Chinook Salmon Spawning Ground Surveys Conducted in the Methow River Basin:

Spawning ground surveys were conducted to evaluate the spawn timing, spatial distribution, genetic composition, and to estimate the tributary-specific spawning escapement of spring Chinook salmon within the Methow River basin. Spawning ground surveys were performed on foot between 2 August and 22 September. A total of 760 spring Chinook salmon redds were constructed in the Methow River basin in 2011. The Methow River subbasin had the greatest number of redds (N = 472). The Chewuch River subbasin had fewer redds (N = 225) than the mainstem Methow River excluding hatchery outfalls and tributaries (N = 316), and the fewest redds were located in the Twisp River (N = 63). After subtracting fish that were double counted at Wells Dam fish ladders (N = 281) and that moved downstream of Wells Dam without reascending (*N* = 734), an estimated 8,219 spring Chinook salmon comprised the population above Wells Dam in 2011. After subtracting fish that were collected for hatchery broodstock (*N* = 808), distributed to local tribes (*N* = 1,515), and those originating from Okanogan River releases (*N* = 106), the estimated run escapement to the Methow River basin was 5,790 adult spring Chinook. There were no significant differences in migration timing between hatchery and wild fish within a given cohort. Redd counts expanded by the male-to-female ratio from sampling at Wells Dam (2.86:1.00) suggest that the Methow River spawning population comprised 2,936 fish, or 50.7% of the estimated run escapement. Peak spawning occurred between 30 August and 12 September in index areas of all three subbasins. Wild female carcasses were found significantly earlier and further upstream than hatchery female carcasses in the Chewuch and Methow subbasins. Hatchery fish comprised 34.8%, 57.4%, and 76.3% of the estimated spawning escapement in the Twisp, Chewuch, and Methow subbasins, respectively. The natural replacement rate (NRR) for the most recent brood year of spring Chinook salmon with complete recovery data (2005 brood) was highest in the Chewuch River subbasin (0.59 recruits per spawner). The geometric mean NRR for brood years 1992 to 2005 was less than 1.0 in each subbasin regardless of whether broodyears 1996 and 1998 were omitted (no spawning ground surveys). Hatchery replacement rate (HRR) values have not consistently met target HRR values for all release groups in broodyears 1992 through 2005. Of the estimated total of coded-wire-tagged hatchery fish recovered on spawning grounds (*N* = 2,171), 28.7% were classified as within-basin strays from Methow Hatchery and 13.2% were stray fish from other basins.

Table of Contents

General Introduction

The Public Utility District No. 1 of Douglas County (DCPUD) funds hatchery programs to compensate for inundation of spawning habitat and lost harvest opportunities related to the construction of the Wells Hydroelectric Project and for mortality associated with operation and passage at the Project as part of the Anadromous Fish Agreement and Habitat Conservation Plan (HCP) for the Wells Hydroelectric Project (Wells HCP 2002). The Joint Fishery Parties (JFP) developed specific goals for these hatchery programs, which are described in the Monitoring and Evaluation Plan (Wells HCP HC 2005).

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 (Methow spring Chinook salmon, Methow summer steelhead, Okanogan summer steelhead).

2. Increase the abundance of the natural adult population of unlisted plan (i.e., HCP) 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 (Methow summer/fall Chinook salmon, Okanogan sockeye).

3. Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural spawning populations (Wells summer/fall Chinook salmon).

These programs occur at either Wells Hatchery, located on the west bank of the Columbia River adjacent to Wells Dam (rkm 830), or Methow Hatchery, located on the Methow River (rkm 83) upstream of the town of Winthrop. At Wells Hatchery, summer steelhead adults are collected from fish ladders at Wells Dam adjacent to the hatchery, spawned, and reared as part of what the JFP has considered a supplementation program. Subsequently, juvenile steelhead are released into the Methow and Okanogan River basins in an effort to increase the abundance of naturally produced populations (Snow 2004). Summer Chinook salmon are collected, spawned, reared, and released directly from Wells Hatchery into the Columbia River as part of a harvest augmentation program (Snow 2005). Methow Hatchery operates as a spring Chinook salmon supplementation facility. Broodstock are collected from the Methow and Twisp rivers, or the fish ladders at Wells Dam. Juvenile spring Chinook salmon are reared on groundwater and Methow River surface water to the pre-smolt stage, and acclimated on surface water in their release basin in acclimation ponds on the Methow, Twisp, and Chewuch rivers prior to release (Humling 2005; Figure 1).

The Wells HCP Hatchery Committee (HC) developed and adopted a conceptual monitoring and evaluation plan (M&E Plan) for the hatchery programs that consists of 10 objectives (Wells HCP HC 2007). This report summarizes activities and presents data collected during 2011 required to address the program-specific objectives of the M&E Plan and is consistent with the implementation plan proposed by the Supplementation Research Team (SRT) of the Washington Department of Fish and Wildlife (WDFW) and approved by the HCP HC (SRT 2010). Hence, annual reports are based on activities conducted during the calendar year or, as necessary, directly related activities from previous years. These activities are reported by subject within each chapter of the report. Analysis of the data and results for each objective in the M&E Plan will be presented in a separate five-year report.

Specific Monitoring and Evaluation Objectives

Objective 1: Determine if: a) supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream), and b) the changes in the natural replacement rate (NRR) of the supplemented population are similar to that of the non-supplemented population.

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

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 the phenotypic characteristics of natural populations.

Objective 4: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HHR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and equal to or greater than the program specific HRR expected value (BAMP 1998).

Objective 5: Determine if the stray rate of hatchery fish is below acceptable levels to maintain genetic variation between stocks.

Objective 6: Determine if hatchery fish were released at the programmed size and number.

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate (e.g., Wells Chinook salmon).

Regional Objectives

Objective 9: Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.

Objective 10: Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

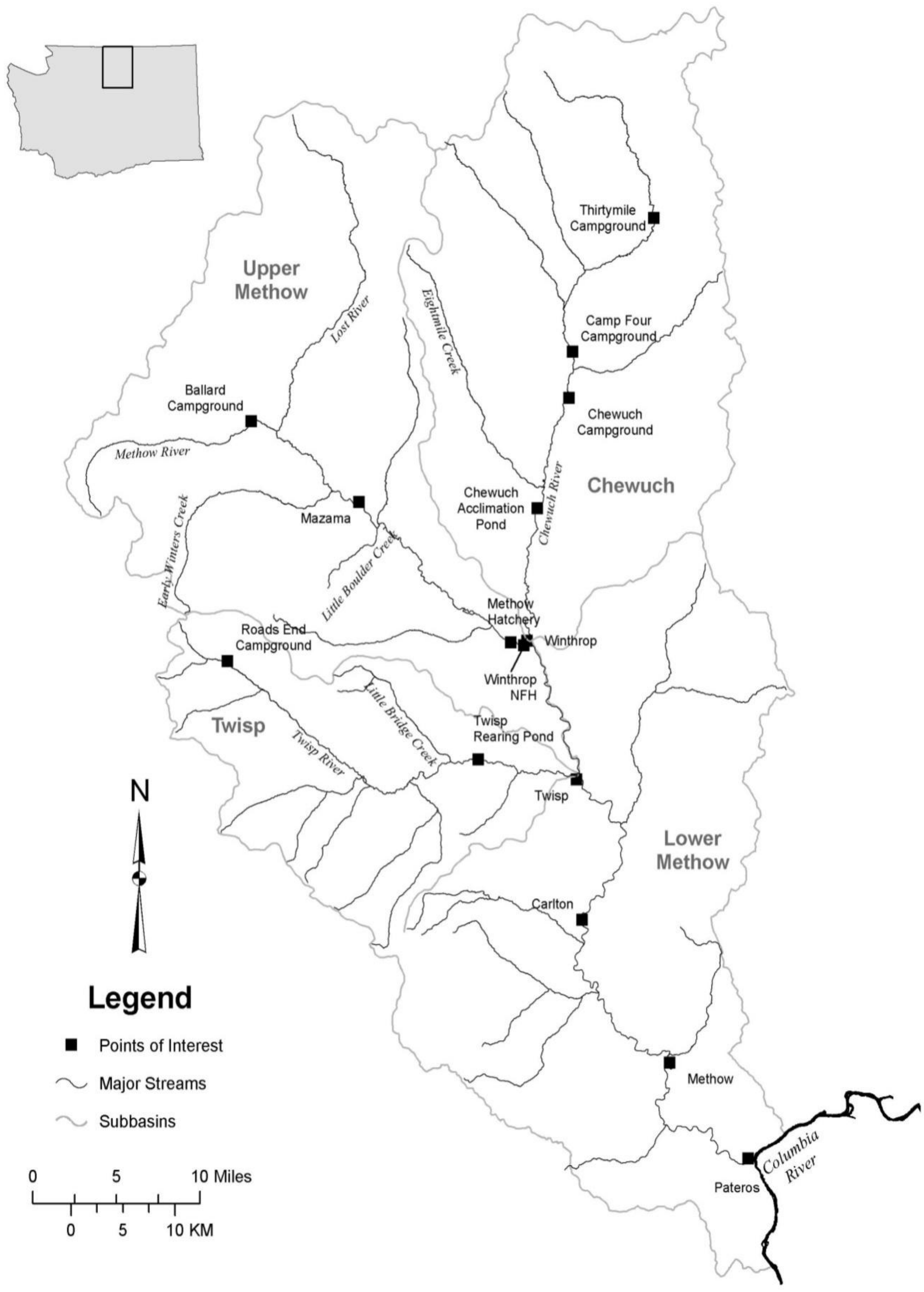

Figure 1. Map of Methow River basin hatchery facilities and rearing ponds.

Chapter 1

2009 Brood Spring and Summer Chinook salmon and 2010 Brood Summer Steelhead Reared at Methow and Wells Hatchery Facilities

Abstract

The Public Utility District No. 1 of Douglas County funds hatchery programs intended by the Joint Fishery Parties (JFP) to supplement natural populations of spring Chinook salmon and summer steelhead, and to produce summer Chinook salmon for harvest augmentation. These hatchery programs collect, rear, and release salmonids under the Wells Habitat Conservation Plan and in accordance with protocols governing the number, origin, and timing of adult salmon and steelhead collected for broodstock, thereby affecting the subsequent number and genetic composition of the juveniles released. For the 2009 brood summer Chinook salmon, adult collection achieved 100% of the overall collection goal of 1,620 fish. The 2009 spring Chinook salmon broodstock collection achieved 89% of the overall collection goal of 359 fish, although too few fish were collected to meet specific production targets for the Twisp River program. The 2010 brood steelhead broodstock collection achieved 98% of the collection goal of 366 fish and pre-spawn survival of broodstock was above the set standards for each program. Wild 1-salt male steelhead had a greater mean fork length than 1-salt hatchery male steelhead, but no other differences were detected between hatchery and wild fish of the same sex and salt age. Age-4 fish were the dominant age class for summer Chinook salmon, with a mean fecundity of 4,403. The majority of spring Chinook collected were age-4 Methow Composite hatchery fish with a mean fecundity of 3,853. No significant differences in fecundity were detected between hatchery and wild spring Chinook of the same stock and age, or between Methow Composite and Twisp fish of the same age regardless of origin. No statistical difference between the mean fecundities of age-4 hatchery and wild summer Chinook was detected. Comparisons between hatchery and wild fish of other ages were not made because sample sizes of wild fish were too low. The 2009 brood steelhead were comprised primarily of 2-salt hatchery fish with a mean fecundity of 6,502, and no significant difference in fecundity between wild and hatchery steelhead was detected between fish of the same salt-age. Evidence of the BKD bacterium in spring and summer Chinook broodstocks as assessed by ELISA sampling was generally low for the 2009 brood. Overall juvenile release numbers were within 5% of release goals for the Wells summer Chinook salmon, but were slightly below target levels for spring Chinook salmon and slightly above target release goals for steelhead. Releases by location or program exceeded target levels for some stocks (i.e., Methow River spring Chinook releases) and were below target levels for other stocks (i.e., Twisp River spring Chinook). The most recent brood years of salmon and steelhead exhibited hatchery replacement rates great enough to replace parent broods (i.e., ≥ 1).

Introduction

To be successful, supplementation programs must achieve a minimum survival rate of fish in the hatchery and after release such that a greater number of fish return as adults than were collected for broodstock. Release goals for Douglas County Public Utility District (DCPUD) funded hatchery programs are based on mitigation for mortality associated with inundation of spawning habitat resulting from the construction of the Wells Hydroelectric Project and mortality resulting from the operation of the Wells Hydroelectric Project (Wells HCP 2002). Hatchery mitigation is a critical component of achieving no net impact (NNI) on anadromous fish populations from the Wells Hydroelectric Project. The number of broodstock required for each hatchery program was derived from biological assumptions related to the sex ratio, broodstock survival, fecundity, and juvenile survival within the hatchery. The ratio of the number of returning hatchery fish from a particular brood year to the number of broodstock collected for that brood is referred to as the hatchery replacement rate (HRR). A minimum expected HRR value for each hatchery program was calculated using this ratio and was listed in the Monitoring and Evaluation Plan (Wells HCP HC 2005). The HRR of hatchery programs must also be greater than the number of naturally produced fish that would have been produced if the broodstock were allowed to spawn naturally. The ratio of the number of naturally produced adults to the number of natural spawners of the parent brood is referred to as the natural replacement rate (NRR) or recruits per spawner. Should the survival of hatchery fish decline such that the actual HRR falls below the expected HRR or the NRR of the target population, an assessment of the hatchery program to determine causation may be necessary.

Harvest augmentation programs were developed to replace lost natural production due to the loss of habitat from inundation and lost harvest opportunities resulting from the construction of the hydroelectric project. While the Wells summer Chinook salmon program remains a harvest augmentation program, the ESA listing of steelhead required a shift from a traditional harvest augmentation to supplementation in order to assist in the recovery of the populations upstream of Wells Dam (Wells HCP HC 2005). The survival standards of hatchery fish in harvest augmentation programs are identical to those in supplementation programs. However, since the returning hatchery adults are not intended to spawn naturally, comparisons between HRR and NRR are not applicable.

The Wells HCP outlines the number and size (fish per pound) of fish that are to be released from each hatchery program. The M&E Plan lists target length and weight goals for each program based on the fish per pound size goals in the HCP (Wells HCP HC 2005, Appendix C Table 5). Modifications to the number of fish released in NNI hatchery compensation or supplementation programs may occur based on the survival studies conducted at each hydroelectric project, or as a result of monitoring and evaluation activities. Monitoring the number and size of fish released is critical in evaluating the hatchery programs and ensuring the conditions of the HCP are being met.

This chapter addresses hatchery activities related to the 2009 brood Wells summer Chinook salmon, 2009 brood Methow spring Chinook salmon, and the 2010 brood Wells summer steelhead. The information presented is applicable to many of the M&E Plan objectives, but will specifically report primary indicators (hatchery replacement rate, number of fish released and size of fish released) for the following objectives and associated hypothesis statements:

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.

- Ho: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$
- Ho: Size (length) at Maturity $_{\text{Hatchery Age X and Gender Y}}$ = Size (length) at Maturity $_{\text{Naturally produced Age X and Gender Y}}$

Objective 4: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific expected value (BAMP 1998).

- Ho: $HRR_{\text{Year X}} \geq NRR_{\text{Year X}}$
- Ho: HRR ≥ BAMP value (expected)

Objective 6: Determine if hatchery fish were released at the programmed size and number.

- Ho: Hatchery fish $_{\text{Size at release}}$ = Programmed $_{\text{Size at release}}$
- Ho: Hatchery fish $_{\text{Number released}}$ = Programmed $_{\text{Number released}}$

Methods

Broodstock Collection and Spawning

Salmon and steelhead broodstock were collected in accordance with protocols designed to ensure enough fish of a desired genetic composition (i.e., hatchery and wild) were collected to satisfy specific program release goals (Appendix A). Although broodstock were collected for Wells HCP hatchery programs and other unrelated programs (i.e., Turtle Rock Summer Chinook Salmon Program [Chelan PUD], Winthrop Summer Steelhead Program [USFWS], and Ringold Hatchery Steelhead Program [WDFW]), this chapter only describes and reports on activities related to hatchery programs funded by Douglas County PUD.

Broodstock were collected as specified in collection protocols (Truscott 2009; Appendix A). Hatchery summer Chinook salmon were collected as volunteers to Wells Hatchery. Wild summer Chinook salmon were collected from the west ladder at Wells Dam, or as volunteers to Wells Hatchery. Summer steelhead were collected from the east and west ladders of Wells Dam. Spring Chinook salmon were collected at Wells Dam, the Twisp River weir, or on the Methow River at the Methow Hatchery and Winthrop National Fish Hatchery outfalls. In addition to specifying the collection location and target numbers, the collection protocols designated a maximum extraction rate for most hatchery broodstocks. Extraction rates are expressed as a proportion of the naturally produced escapement that may be retained for hatchery broodstocks.

Run escapement estimates for Wells Hatchery summer Chinook salmon were calculated as the difference between the number of summer Chinook salmon counted at Wells and Rocky Reach Dams. Although some mainstem spawning occurs and tributaries enter the Columbia River between the two dams (e.g., Entiat and Chelan rivers), natural production of summer Chinook salmon in these tributaries is thought to be limited (Hamstreet 2010, 2011; Miller 2006, Miller 2008). Methow spring Chinook salmon run escapement was estimated from spring Chinook counts at Wells Dam by subtracting summer Chinook salmon passing Wells Dam during the spring Chinook salmon migration period (see Chapter 5). Spawning escapement estimates for spring Chinook salmon in individual tributaries were calculated from a total census of redds multiplied by the number of fish per redd (i.e., sex ratio).

Broodstock were scanned for marks or tags during trapping to assess the number of hatchery and naturally produced fish collected. Spring Chinook salmon were held in separate ponds depending on collection location, or were internally tagged (i.e., Passive Integrated Transponder [PIT] tag) or externally marked (e.g., opercle punch) prior to mixing in order to facilitate mating by collection location at spawning. During spawning, broodstock were crowded to one end of a holding pond and sexually mature fish were sorted to separate holding pens. Spring Chinook salmon, steelhead, and summer Chinook salmon utilized for yearling programs were assigned a unique number at spawning to allow tracking of biological samples (e.g., age, fecundity, ELISA) and to facilitate the implementation of proper mating protocols. Spawning occurred weekly until all broodstock were used or egg collection goals had been satisfied. Spring Chinook salmon adults and gametes were transferred between Methow Hatchery (MH) and Winthrop National Fish Hatchery (WNFH) as necessary to meet program or rearing requirements.

Biological sampling of broodstock occurred after the gametes were collected. Personnel collected length, sex, mark, scale, and origin data in addition to recovering coded wire tags (CWT). Tissue samples were also collected from spring Chinook and steelhead for DNA analysis. The unique sample number assigned to each fish at spawning allowed for the correlation of health sample (i.e., ELISA), fecundity, and egg mortality data provided by hatchery or WDFW fish health personnel. Differences in size and fecundity by age class of hatchery and wild fish were tested with a T-test or with a non-parametric Kruskal-Wallis analysis of variance (KW ANOVA) test when assumptions of normality could not be met with transformed data.

Juvenile Rearing and Release

A description of the rearing facilities at Methow and Wells hatcheries can be found in the Integrated Hatchery Operations Team (1995) manual and described in detail by Snow (2003) and Jateff (2001). The marking scheme for each program varied depending on ESA status or study purpose. All fish released received a CWT and/or an external mark (i.e., adipose fin-clip or elastomer tag). Spring Chinook salmon were initially reared on well water, but were transferred to acclimation ponds (Methow, Chewuch, and Twisp rivers) in the spring and reared on river water prior to release. Rearing anadromous salmonids on ambient-temperature surface water versus relatively warm well water was intended to promote the smoltification process and provide a survival advantage (Bjornn and Ringe 1984). Acclimation ponds located on natal rivers in the vicinity of good spawning habitat were used to decrease stray rates and promote appropriate spatial distribution of spawners. Juvenile fish at Wells Hatchery were reared on Columbia River water prior to release into the Columbia River (summer Chinook salmon) or transfer to tributary streams or acclimation ponds (summer steelhead).

Juvenile Hatchery Survival

The survival of juveniles in the hatchery is a monitoring indicator (an indicator meant to inform or augment primary indicators) in the M&E Plan, but may help explain why program release goals (i.e., number of fish released) were not met despite adequate broodstock. Survival rates were calculated based on the complete inventory of the population at tagging and any mortality that occurred prior to or after tagging was complete, depending on the specific stage of development.

Number of Juvenile Fish Released

A 100% inventory of fish on station is possible during marking because all juvenile fish receive either an internal and/or external tag or mark during rearing. The number of juvenile fish released was calculated based on the number of fish tagged or marked minus mortality that occurred between marking and release.

Size of Juvenile Fish Released

Target release sizes specified in the M&E Plan were derived from weight at release (fish per pound) goals outlined in the Wells HCP. Corresponding length at release targets were derived from 5-years of pre-release length and weight sample data for each stock. The size of juvenile fish released was estimated from fish randomly sampled immediately prior to release. Fork length was measured to the nearest millimeter and weight was measured to the nearest 0.1 gram. Juvenile weight at release was compared to the target release weight using a one-sample t-test.

Hatchery Replacement Rate

Program-specific target hatchery replacement rates (HRR) were derived from the Biological Assessment and Management Plan (BAMP 1998). These rates were calculated by dividing the number of returning adults estimated from CWT recoveries (spring and summer Chinook salmon) or run escapement estimates at Wells Dam (steelhead) by the number of broodstock (including pre-spawn mortality). The HRR of each stock was tested against target HRR rates using a one-sample t-test. For stocks where the HRR data did not meet assumptions of normality, HRR and target values were log transformed prior to analysis.

Results

Adult Collection and Spawning

Broodstock collection is dependent on the run size and migration timing of the target stock. Pre-season estimates of upper Columbia River salmon runs were calculated to assist managers in determining trapping location, duration, and in developing weekly quotas to extract broodstock in proportion to the run-at-large. Pre-season run estimates for spring Chinook salmon were large enough to recommend tributary broodstock collection. However, because of limited on-station smolt releases from Methow Hatchery and the lack of a collection facility in the Chewuch River, Wells Dam and WNFH were included as primary collection sites for the 2009 brood (Appendix A). Broodstock retention from these sites achieved 89% of the overall goal. Summer Chinook salmon were collected from the Wells Hatchery volunteer trap (hatchery and wild fish) and from the west fish ladder at Wells Dam (wild fish only), and retention from these sites achieved 100% of the overall collection goal. Summer steelhead were collected from the east and west fish ladders at Wells Dam and broodstock retention achieved 98% of the overall collection goal.

Summer Chinook salmon collection was skewed later in the run cycle because approximately 25% of the run passed Wells Dam during the first week of the collection period, and weekly collection targets we not similarly skewed. Steelhead broodstock collection was skewed slightly earlier than the run at Wells Dam to account for a slightly earlier run timing of wild fish at the dam. Collection otherwise closely reflected the run-at-large passage during the respective trapping period (Table 1). Spring Chinook salmon collection was skewed towards the earlier part of the run cycle because protocols specified trapping every third day and the majority of fish were collected during a relatively narrow time period when passage was high. Additionally, too few hatchery and wild fish were collected to meet protocol requirements for the Twisp River program (Table 2).

Table 1. Cumulative trapping of selected upper Columbia salmon and steelhead runs at Wells Dam. Wells summer Chinook salmon trapping reflects fish collected from the volunteer channel and the west fish ladder of Wells Dam (MEOK = Methow and Okanogan rivers).

Stock (brood) / Trapping Dates	Cumulative passage date during trapping period and broodstock retained (%)			
	25%	50%	75%	100%
MEOK summer Chinook salmon (2009)	07-Jul	18-Jul	04-Aug	14-Sep
1 Jul - 14 Sept	0.6	20.7	50.4	100.0
MEOK spring Chinook salmon (2009)	25-May	31-May	17-Jun	24-Jun
1-May - 24-Jun	42.1	67.1	100.0	100.0
MEOK summer steelhead (2010)	03-Sep	11-Sep	23-Sep	31-Oct
1-Aug - 31-Oct	41.4	52.9	80.7	100.0

Table 2. Broodstock collection results from Wells Complex hatcheries for steelhead (2010 brood) and Chinook salmon (2009 brood). Estimated escapement and required extraction rates for Wells summer Chinook salmon are based on the difference in Chinook salmon counts between Rocky Reach and Wells Dams, and combine hatchery (H) and wild (W) fish. Broodstock goals for spring Chinook salmon were based on the estimated run escapement and a maximum extraction rate for wild fish of 33% of the total escapement.

	Wells Summer Chinook		Wells Steelhead		Spring Chinook			
					Methow		Twisp	
	H	W	H	W	H	W	H	W
Broodstock goal	1,469	151	280	86	71	221	37	30
Est. run escapement	22,497		10,617	1,717	3,566	663	110	90
Extraction rate required	0.072		0.026	0.050	0.020	0.333	0.333	0.333
Actual extraction rate	0.073		0.026	0.049	0.050	0.146	0.155	0.267
Broodstock collected	1,276	357	277	85	180	97	17	24

Age Composition and Size at Maturity

Biological sampling of adult broodstock occurred at spawning. Mean length, age, origin, and fecundity data were used to estimate egg deposition from naturally spawning fish (Chapters 4 and 5) and were used in part to calculate replacement rates for hatchery and wild stocks. Broodstock were used as a representative sample of the spawning population from which comparisons could be made of demographic and phenotypic traits by origin; however, the broodstock collection is not necessarily a random sample of the population because it only includes retained fish. Sample sizes of wild fish were small or non-existent for some spring and summer Chinook ages and stocks, affecting our ability to make comparisons for all ages of each stock (Table 3; Appendix C). Because of this, comparisons for spring Chinook stocks were also made with carcasses collected during spawning ground surveys (see Chapter 5). Where adequate numbers of hatchery and wild spring Chinook were sampled (age 3-4 Methow Composite males, age 4-5 Methow Composite females, and age-3 male and all age-4 Twisp fish), significant differences in mean fork length were only observed between age-3 male ($P < 0.005$) and age-4 female ($P < 0.05$) fish within the Methow Composite broodstock. For summer Chinook salmon subyearling migrants, age-3 hatchery males had a significantly greater mean fork length than age-3 wild males ($P < 0.005$). However, age-4 wild males had a significantly greater mean fork length than age-4 hatchery males ($P < 0.001$). Similarly, age-5 wild females had a significantly greater mean fork length than age-5 hatchery females ($P < 0.001$). No significant difference was detected when comparing age-4 females ($P = 0.612$) and age-5 males ($P = 0.059$). Wild 1-salt male steelhead had a greater mean fork length than 1-salt hatchery male steelhead ($P < 0.005$), and no other differences were detected between hatchery and wild fish of the same sex and salt age, although sample sizes were not large enough for meaningful statistical comparisons in all cases (i.e., 2-salt male fish; Table 4).

Table 3. Mean fork length (cm; *N*; SD) by age, sex, and origin of 2009 Chinook salmon broodstocks sampled at Wells Hatchery Complex facilities.

	Age-3		Age-4		Age-5		Age-6
Sex	H	W	H	W	H	W	H
			Methow Composite spring Chinook				
M	60.6 (34; 5)	53.1 (16; 3.8)	77.6 (44; 4.6)	77.2 (28; 5.8)	95.0 (1; - -)	94.3 (3; 10.7)	
F	- -	- -	76.8 (98; 3.7)	78.1 (38; 2.9)	86.0 (2; 5.7)	90.5 (10; 4.1)	
			Twisp spring Chinook				
M	51 (4; 5.7)	52.1 (11; 2.7)	72.0 (2; 1.4)	71.3 (6; 5.4)	- -	96.0 (1; - -)	
F	66.0 (1; - -)	- -	77.1 (8; 4.8)	76.0 (6; 8.9)	90.0 (3; 2)	- -	
			Wells summer Chinook subyearling				
M	70.6 (53; 4.8)	67.8 (48; 5)	85.2 (74; 7.9)	89.1 (97; 6.8)	93.0 (3; 3.6)	103.7 (12; 8.5)	- -
F	71.3 (4; 2.2)	67.0 (1; 0)	87.5 (179; 5)	87.2 (106; 5.4)	91.6 (28; 3.3)	95.9 (34; 3.5)	- -
			Wells summer Chinook yearling				
M	63.3 (62; 6.2)	- -	77.0 (191; 6.3)	77.7 (3; 8.4)	90.4 (145; 8.4)	- -	98.7 (6; 9.5)
F	- -	- -	80.0 (46; 5.9)	- -	90.8 (330; 4.6)	- -	93.6 (20; 6.7)

Table 4. Mean fork length (cm; *N*; SD) by saltwater age, sex, and origin of 2010 steelhead broodstock sampled at Wells Hatchery Complex facilities.

Sex	1-Salt		2-Salt	
	H	W	H	W
M	63.4 (75; 3.5)	65.4 (38; 2.4)	76.0 (27; 3.8)	77.3 (6; 5.6)
F	61.2 (51; 3.6)	63.0 (12; 4.0)	72.0 (82; 3.5)	73.4 (14; 3.2)

Fecundity of salmon and steelhead is directly related to fish size (Quinn et al. 2004; Campbell et al. 2006). Most summer Chinook salmon sampled for fecundity were evenly divided between age-4 and age-5 hatchery fish with mean fecundities of 4,403 ($N = 36$) and 4,384 ($N = 36$), respectively. The majority of spring Chinook sampled were age-4 Methow Composite hatchery fish with a mean fecundity of 3,853 (Table 5). No significant difference in fecundity was detected between age-4 hatchery and wild Methow Composite fish, or between age-4 hatchery and wild Twisp fish (T-tests; $P = 0.186 – 0.434$). No significant difference in fecundity was detected between hatchery and wild Methow Composite and Twisp stock fish of the same age, regardless of origin (T-tests; $P = 0.128 – 0.884$). No significant difference between the mean fecundity of age-4 hatchery and wild summer Chinook was detected (*P* = 0.206) and sample sizes for wild fish were too low to conduct tests between fish of other ages. The 2010 brood steelhead were comprised primarily of 2-salt hatchery fish with a mean fecundity of 6,502 (Table 6). No significant difference in fecundity between wild and hatchery steelhead was detected between fish of the same salt-age, although sample sizes of wild fish were low (1-salt fish *P* = 0.094; 2-salt fish *P* = 0.264). Mean fecundity values for previous broods of Chinook salmon and steelhead are reported in Appendix D.

Table 5. Mean fecundity (*N*; SD) by total age and origin of 2009 brood Chinook salmon sampled at Wells Complex hatchery facilities.

Chinook Stock	Origin	Age-3	Age-4	Age-5	Age-6
Wells summer	H	- -	4,403 (36; 875)	4,384 (36; 918)	4,928 (6; 575)
Wells summer	W	- -	4,696 (7; 1,024)	6,692 (1; - -)	- -
Met Comp spring	H	4,411 (1; - -)	3,853 (98; 714)	4,694 (2; 558)	- -
Met Comp spring	W	- -	3,956 (38; 627)	5,218 (10; 627)	- -
Twisp spring	H	- -	3,890 (8; 544)	4,475 (3; 1,079)	- -
Twisp spring	W	- -	4,402 (6; 823)	- -	- -

Table 6. Mean fecundity (*N*; SD) by salt-age and origin of 2010 brood summer steelhead sampled at Wells Complex hatchery facilities.

Origin	1-Salt	2-Salt
H	4,979 (48; 1,214)	6,502 (81; 1,510)
W	4,283 (11; 1,266)	6,046 (14; 883)

Results from ELISA sampling of kidney and spleen tissue collected from female spring and summer Chinook salmon at spawning indicated that the prevalence of the antigen for Bacterial Kidney Disease (BKD) was generally low for the 2009 brood (Table 7). The 2009 brood ELISA results were similar by category to values for recent broods (Appendix E), and were generally improved by ELISA management activities. ELISA values for the 2009 brood Twisp fish were higher in the Low category than that observed in recent years but the number of females sampled was low.

Table 7. Percentage of 2009 brood female Chinook salmon within each ELISA category and associated optical density value. For spring Chinook stocks, parenthetical values reflect the broodstock percentage by category after ELISA management (i.e., culling) and females with 100% mortality were removed.

Program	Below-Low	Low	Med	High	*N*
	<0.099	0.099 - 0.199	0.20 - 0.449	> 0.450	
Wells summer Chinook	99.7	0.3	0	0	272
Methow spring Chinook	84.7 (95.5)	12.7 (4.5)	1.3 (- -)	1.3 (- -)	150 (132)
Twisp spring Chinook	70.6 (70.6)	29.4 (29.4)	0	0	17 (17)

Juvenile Hatchery Survival

Pre-spawn survivals of all broodstocks were above the standards outlined in Appendix C of the M&E Plan (Table 8). Survival of all stocks except steelhead exceeded the unfertilized-egg-to-release standard. The Wells steelhead were below the unfertilized-egg-to-release standard for the current brood primarily because survival in the unfertilized egg-to-eyed egg and ponding-to-release categories were lower than expected. Survival of most recent broods of Wells steelhead has been below survival standards for these categories (Appendix F).

Table 8. Life-stage survival rate standards (%) for Wells and Methow Hatcheries, the 5-year mean (SD) and survival achieved for current brood year.

Life stage	Survival standard	Wells steelhead		Wells-1 summer Chinook		Methow spring Chinook		Twisp spring Chinook	
		5-year mean (SD)	Survival achieved	5-year mean (SD)	Survival achieved	5-year mean (SD)	Survival achieved	5-year mean (SD)	Survival achieved
Collection-to-spawning	90 female	94.9 (3.0)	97.2	97.1 (0.7)	96.0	97.9 (0.9)	100	95.9 (5.9)	100
Collection-to-spawning	85 male	95.7 (2.6)	98.4	97.4 (1.7)	97.2	98.4 (1.9)	99.2	97.6 (5.4)	100
Unfertilized egg-to-eyed	92	84.0 (3.5)	84.6	88.5 (4.4)	95.2	94.9 (1.3)	95.9	93.9 (2.6)	97.3
Eyed egg-to-ponding	98	95.7 (6.1)	99.7	99.0 (1.1)	100	98.4 (2.1)	100	98.3 (1.6)	99.9
30 d after ponding	97	96.9 (2.5)	93.7	99.5 (0.4)	97.6	98.9 (1.0)	99.5	99.5 (0.3)	99.8
100 d after ponding	93	95.0 (3.9)	90.2	99.2 (0.3)	97.5	98.3 (1.0)	99.4	99.1 (0.5)	98.7
Ponding-to-release	90	86.6 (4.6)	84.0	94.3 (2.8)	95.5	90.8 (5.1)	96.8	91.4 (8.1)	97.6
Transport-to-release	95	- -	- -	- -	- -	98.9 (1.5)[a]	99.9[a]	99.7 (0.2)	99.6
Unfertilized egg-to-release	81	69.4 (1.6)	67.9	82.7 (3.9)	90.9	83.7 (3.7)	92.5	84.4 (8.3)	94.9

[a] All data from Chewuch acclimation pond releases.

Number of Juvenile Fish Released

Spring and summer Chinook stocks were within 10% of the release targets overall, but some individual release locations (i.e., Twisp spring Chinook) were not within 10% of the target release goals (Table 9). Spring Chinook salmon releases differed from target values because too few adult fish were collected for the Twisp program, and the shortage was compensated for by increasing the number of Methow Composite broodstock. Thus, overall spring Chinook salmon releases totaling 92% of program goals met the overall management target. Summer steelhead releases were within the 10% release target overall, but some locations (i.e., Methow River) exceeded release targets because fish that did not volitionally migrate from the rearing ponds (i.e., non-migrant fish) were planted in the lower Methow River in an effort to reduce competition between residual hatchery steelhead and wild fish in headwater streams. Annual release numbers for each program are listed in Appendix G.

Table 9. Target and actual release numbers for anadromous fish releases from Wells Complex hatchery facilities in 2010. Release target and number of 2009 brood Wells yearling summer Chinook includes 100,000 fish originally designated for a mainstem Columbia River survival study.

Stock/Program	Target	Number Released (% of target)	18-Year (1992 – 2009 broods)[a]		
			Min.	Max.	Mean
Wells summer Chinook	904,000	917,599 (102)	561,227	923,610	759,603
Yearling	420,000	446,313 (106)	185,200	457,770	337,636
Subyearling	484,000	471,286 (97)	187,382	541,923	421,597
Methow spring Chinook	550,000	504,907 (92)	28,878	611,763	310,922
Methow River	183,334	288,013 (157)	4,477	332,484	156,472
Chewuch River	183,333	149,863 (82)	11,854	284,165	165,399
Twisp River	183,333	67,031 (37)	15,470	116,749	54,077
Wells summer steelhead	429,000	459,111 (107)	328,100	775,272	465,447
Methow River	99,667	154,370 (155)	80,580	392,815	178,906
Chewuch River	99,667	83,861 (84)	78,205	138,300	102,843
Twisp River	99,666	93,297 (94)	74,766	136,680	105,885
Okanogan River	130,000	127,583 (98)	67,500	228,770	123,148

[a] Excludes years of no release: 1995 brood Twisp and 1995 and 1999 broods Chewuch spring Chinook salmon;1994 – 1996 brood steelhead releases in the Twisp and Chewuch rivers.

All juvenile anadromous salmonids released from Wells Complex hatchery facilities were marked or tagged prior to release. Marking allows the identification of stray hatchery fish, and provides the means to calculate survival rates and fishery contribution rates of specific hatchery stocks (Chapter 2). Marks or tags used included elastomer (Wells steelhead), adipose fin-clips (Wells steelhead and summer Chinook salmon), CWT (all stocks), and passive integrated transponder (PIT) tags. These marks are applied independently or in combination with other marks or tags depending on the requirements of individual stocks or studies. Coded-wire tags are inserted into all Chinook salmon prior to release, but subsequent tag loss during rearing typically results in a mark rate less than 100% (Appendix H). A portion of the adipose fin clipped steelhead were also CWT marked prior to release.

Size of Juvenile Fish Released

Target release sizes specified in the M&E Plan were derived from weight at release (fish per pound) goals outlined in the Wells HCP. Corresponding length at release targets were derived from 5-years of pre-release length and weight sample data for each stock (Murdoch et al. 2012). We compared mean fork length at release to these target values and found that mean length at release was significantly different than target lengths for all releases groups except the Okanogan River steelhead (P = 0.43) and the Methow Composite spring Chinook salmon released into the Chewuch River (P = 0.67). The size at release length target for Wells summer Chinook subyearling releases was based on a mitigation-related size at release target of 20 fish per pound (FPP) (Table 10). However, current program objectives focus on releasing fish earlier to increase post-release survival, precluding the ability to achieve the 20 FPP target. Size-at-release values for historic broods are listed in Appendix I.

Table 10. Target size-at-release goals and the actual mean fork length (mm), coefficient of variation (CV), mean weight (g), and fish per pound (FPP) for anadromous fish released from Wells and Methow hatcheries in 2011 (BY = brood year). Na = not applicable.

Stock/Program (BY)	Target			Actual		
		Weight			Weight	
	Fork Length (CV)	Mean (g)	FPP	Fork Length (CV)	Mean (g)	FPP
Wells summer Chinook (2009)						
Yearling	162 (9.0)	45.4	10	168 (7.5)	47.9	9.5
Subyearling	116 (9.0)	22.7	20	84 (12.9)	6.7	67.5
Methow spring Chinook (2009)						
Methow River	137 (9.0)	30.2	15	124 (9.6)	22.9	19.8
Chewuch River	136 (9.0)	30.2	15	135 (14.5)	30.7	14.7
Twisp River	135 (9.0)	30.2	15	144 (11.1)	37.2	12.2
Wells summer steelhead (2010)						
Methow River	191 (9.0)	75.6	6	199 (11.5)	83.5	5.4
Chewuch River	191 (9.0)	75.6	6	199 (11.5)	83.5	5.4
Twisp River	191 (9.0)	75.6	6	199 (11.5)	83.5	5.4
Okanogan River	191 (9.0)	75.6	6	192 (12.3)	76.8	5.9

Hatchery Replacement Rate

For the current broods examined, all Wells FH Complex programs returned enough adults to replace the parent brood (i.e., HRR $\geq$1; Table 11). The mean HRR for the Wells subyearling summer Chinook salmon was significantly less than the target value ($P < 0.05$), and the mean for the yearling summer Chinook salmon was significantly greater than the target value ($P < 0.05$; Table 12). Mean HRR values for all other stocks did not differ statistically from target HRR values ($P = 0.12 – 0.45$). However, the HRR for Wells steelhead includes steelhead released from Winthrop NFH because some fish from both programs were marked similarly (i.e., adipose fin-clip+ CWT) during the years examined and could not be differentiated as returning adults. The HRR values for the current broods of spring Chinook salmon did not meet program-specific target values, but the current broods of steelhead and summer Chinook were above target values. Historic HRR data by stock and brood year is listed in Appendix B.

Table 11. The expected and actual smolt-to-adult (SAR) and HRR or adult-to-adult survival rates for Wells FH Complex programs. Steelhead also include Winthrop NFH releases and returns.

Program	Brood Year	Number of Broodstock	Smolts Released	SAR (%)	Adult Equivalents	# Smolts/ Adult	HRR
Wells summer Chinook							
Yearling program	Expected	182	320,000	0.30	960	333	5.3
Actual	2004	176	312,980	1.16	3,629	86	20.6
Subyearling program	Expected	266	484,000	0.12	581	833	2.2
Actual	2004	293	471,123	0.15	714	660	2.4
Twisp spring Chinook	Expected	121	183,024	0.30	549	333	4.5
Actual	2005	18	27,658	0.17	46	601	2.6
Methow spring Chinook	Expected	121	183,024	0.30	549	333	4.5
Actual	2005	116	156,633	0.21	328	478	2.8
Chewuch spring Chinook	Expected	121	183,024	0.30	549	333	4.5
Actual	2005	160	232,811	0.13	308	756	1.9
Wells steelhead	Expected	260	509,000	1.00	5,090	100	19.6
Actual	2007	218	557,259	3.57	19,919	28	91.3

[a] Does not include 1998 or 2000 broods (mixed MetComp groups).
[b] Does not include 1995, 1998, or 2000 broods (mixed MetComp groups).

Table 12. Summary of expected and achieved HRR values for the 2004 brood Wells Hatchery summer Chinook salmon, 2007 brood summer steelhead, and the 2005 brood Methow Hatchery spring Chinook salmon. Mean and median values include the 1992-2004 broods of yearling and 1993-2004 broods of subyearling summer Chinook salmon, the 1992-2004 broods of Twisp and Chewuch spring Chinook salmon, the 1993-2004 broods of Methow spring Chinook salmon, and the 1996-2006 broods summer steelhead.

Program	HRR			
	Expected	Current Brood	Mean	Median
Wells summer Chinook yearling	5.3	20.6	19.9	10.9
Wells summer Chinook subyearling	2.2	2.4	1.3	0.7
Twisp spring Chinook	4.5	2.6	3.3	2.1
Methow spring Chinook	4.5	2.8	5.5	5.4
Chewuch spring Chinook	4.5	1.9	2.8	1.5
Wells summer steelhead	19.6	91.3	25.3	25.6

Discussion

Spring Chinook

Spring Chinook releases were very close to overall production goals, although releases of Methow Composite fish were much greater than originally proposed in broodstock collection protocols to compensate for a broodstock shortage in the Twisp program. Recent broodstock protocols have included mainstem collection sites (i.e., Wells Dam) in addition to tributary locations to maximize broodstock collection opportunities. However, limitations to trapping duration (i.e., only 3 days per week with a maximum retention of no more than 33% of the natural origin fish collected) and the necessity of using DNA analysis to determine stock origin limits the ability of Wells Dam trapping to achieve numeric objectives, especially where abundance of the target fish is low (i.e., wild Twisp spring Chinook). Genetic analysis of tissue samples currently allows managers to separate collected natural origin fish into Twisp or non-Twisp groups. For the current brood examined, wild spring Chinook salmon identified as non-Twisp origin were incorporated into the Methow Composite stock. Genetic sampling of natural origin fish at Wells Dam in 2012 suggests that this genetic grouping likely resulted in stray fish from other river basins being included in the broodstock, potentially increasing risk to the Methow spring Chinook population. Managers should assess the risk of incorporating out of basin stocks given an estimate of the rate of incorporation into the Methow population. While inadvertently including strays from other basins in the broodstock is generally to be avoided, incorporation of low levels of strays will help maintain genetic diversity that would otherwise be lost through genetic drift and inbreeding. Composition of the broodstock could be managed by incorporating known fish (marked or genetically screened), or incorporating brood collected in-basin with the assumption that these are more likely to be Methow-origin fish, with the goals of maintaining genetic diversity, representing run timing of local stocks, and assisting with meeting numeric collection targets.

Post-release survival of Twisp and Chewuch spring Chinook stocks did not meet the HRR objectives for these programs; however, the mean HRR of releases from the Methow Hatchery has met the objective over the long term. A major difference between these programs is that Twisp and Chewuch fish are transferred to acclimation ponds prior to release, while Methow releases remain on station. While the stress of fish transfer may decrease survival, the ultimate reasons for the survival difference are unclear. These programs are expected to undergo significant changes as the new Hatchery and Genetic Management Plans (HGMPs) are adopted. Further investigation into survival differences between programs will have to reflect the program changes in the HGMPs after they have been fully implemented.

Summer Chinook

Although survival of summer Chinook released as yearlings is considerably greater than for fish released as subyearlings, the subyearling program provides life history diversity with subyearling fish displaying different ocean migration (further north) and age at maturity (older fish) patterns from yearling releases. Such patterns are likely to be genetically based, and maintenance of these life history patterns will help to ensure that this diversity is retained within this segregated hatchery program. Studies initiated with recent broods of subyearling summer Chinook salmon have indicated that earlier release (i.e., mid-May instead of mid-June) improves release-to-adult survival, and Wells Hatchery has adopted mid-May as the release date for all subyearling summer Chinook. Additionally, subyearling fish are currently being reared in a large earthen rearing pond with some surface water influence prior to release instead of being reared in concrete raceways. These changes are not likely to increase survival to that of yearling fish, but they may contribute to increases in survival and greater expression of the subyearling life-history within the hatchery program.

Summer Steelhead

Coded-wire tags are increasingly being used in summer steelhead released above Wells Dam, but recovery effort may not be adequate to provide unbiased survival estimates based solely on CWT data. Locally, creel surveyors routinely sample harvested steelhead for the presence of CWTs and this local effort should provide additional homing and straying information. For the steelhead releases covered in this chapter, calculation of SAR and HRR rates include release and survival information for hatchery programs outside the scope of the DCPUD M&E Plan (i.e., Winthrop National Fish Hatchery releases). This has been necessary because the respective hatchery stocks have historically received the same mark prior to release (i.e., ad-clip). Calculating survival estimates from stock or program-specific mark data (various fin clips and CWT marking schemes) may allow, at least for some broods, the separation of HRR rates of program at Wells Hatchery and Winthrop National Fish Hatchery releases that should better describe the survival of the multiple stocks supplemented by the Wells Fish Hatchery steelhead programs. We suspect that there are hatchery and stock specific differences in survival that warrant further investigation.

Target release lengths specified in the M&E Plan were derived by applying standardized length/ weight relationships by species to weight-at-release (fish per pound) goals outlined in the Wells

HCP. However, the standardized length/weight relationships used may not adequately describe the length/weight relationship of M&E Plan species. Length-based statistical comparisons are better than weight-based comparisons because of inherent variability in fish weight data due to water weight and feeding regime. We developed revised release length targets using linear regressions of pre-release sample data from recent releases of M&E Plan stocks. However, for summer Chinook subyearling program fish, release time has been advanced to improve release to adult survival. Survival of subyearling fish released in May has been about double that of fish released in June, but a corresponding effect of the earlier release is that the mitigation release size of 20 FPP cannot be achieved. Release length and weight targets for these fish should be revised to reflect the new release timing.

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Appendix A

Upper Columbia River salmon and steelhead broodstock collection protocols for hatchery programs funded by Douglas County PUD.

STATE OF WASHINGTON

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April 15, 2009

To: Kristine Petersen, Salmon Recovery Division, NMFS

From: Kirk Truscott, WDFW

Subject: **Final DRAFT 2009 UPPER COLUMBIA RIVER SALMON AND STEELHEAD BROODSTOCK OBJECTIVES AND SITE-BASED BROODSTOCK COLLECTION PROTOCOLS**

The attached protocol was developed in coordination with the mid-Columbia Habitat Conservation Plans (HCPs) for hatchery programs rearing spring Chinook salmon, sockeye salmon, summer Chinook salmon and summer steelhead associated with the mid-Columbia HCPs, spring Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project (FERC No. 2114) and fall Chinook consistent with Grant County Public Utility District and Federal mitigation obligations associated with Priest Rapids and John Day dams, respectively. These programs are funded by Chelan, Douglas, and Grant County Public Utility Districts (PUDs) and are operated by the Washington Department of Fish and Wildlife (WDFW). Additionally, the Yakama Nation's (YN) Coho Reintroduction Program broodstock collection protocol, when provided by the YN, will be included in this protocol because of the overlap in trapping dates and locations.

This protocol is intended to be a guide for 2009 collection of salmon and steelhead broodstocks in the Methow, 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 (HCPs, Priest Rapids Dam 2008 Biological Opinion and to comply with ESA permit provisions.

Notable in this year's protocols are: (1) Wenatchee spring Chinook broodstock collection strategies targeting Chiwawa hatchery origin Chinook at Tumwater Dam, intended to provide improved hatchery origin broodstock collection and to reduce the number of Leavenworth NFH strays into other Wenatchee basin UCR spring Chinook spawning aggregates; (2) Natural origin Chiwawa spring Chinook collection at the Chiwawa Weir, consistent with ESA Section 10 Permit 1196; (3) Methow spring Chinook broodstock protocol targeting natural origin spring Chinook at Wells Dam and at the Twisp River weir; (4) utilization of genetic sampling/assessment to differentiate Twisp River and non Twisp River natural origin adults collected at Wells Dam and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir, Methow FH and Winthrop NFH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components; (5) the collection of hatchery origin spring Chinook for the Methow River Basin program in excess of production requirements for BKD management, (6) the use of ultra-sound technology to determine sex of Wenatchee summer Chinook during collection to aid in achieving the appropriate female equivalents for programmed production, and (7) the potential collection of Wells summer Chinook to support the Yakama Nation (YN) summer Chinook re-introduction program in the Yakima River Basin (requires agreement of the HCP Hatchery Committee). These protocols may be adjusted in-season, based on actual run monitoring at mainstem dams and other sampling locations.

Above Wells Dam

Spring Chinook

Natural origin fish inclusion into the broodstock will be a priority, with natural origin fish specifically being targeted. Natural origin fish collections will not exceed 33 percent of the MetComp and Twisp natural origin run escapement at Wells Dam.

To facilitate BKD management, to comply with ESA Section 10 permit take provisions and to meet programmed production, hatchery origin spring Chinook will be collected in numbers excess to program production requirements. Based on historical Methow FH spring Chinook ELISA levels above 0.12, the hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 18 percent. The parties to the HCP have acknowledged that targeting broodstock collection objectives at levels that provide for culling of eggs from higher ELISA level hatchery origin females and prioritizing natural origin fish for rearing to yearling smolt stage is a viable approach to balance the promotion of fish health while limiting indirect reductions in genetic diversity and reduced program production, particularly for ESA listed supplementation programs. For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permit 1196, 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 production at 550,000 yearling smolts. Culling of eggs from natural origin females will not occur, unless their ELISA levels are determined by WDFW Fish Health to be a substantial risk to the program. Juveniles from natural origin females with ELISA levels greater than 0.12 will be differentially tagged for evaluation purposes. To monitor the efficacy of culling in reducing the prevalence of BKD in Methow Basin spring Chinook, annual monitoring and evaluation of the prevalence and level of BKD in returning hatchery and natural origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

The 2009 Methow spring Chinook broodstock collection will occur at Wells Dam, Twisp River Weir, Methow FH and Winthrop NFH. Limited on-station release of smolts from the Methow FH, absence of a trapping facility on the Chewuch River and poor trapping success at Foghorn

Dam on the mainstem Methow River preclude reasonable certainty of meeting adult collection requirements via tributary and Methow FH outfall collections. The aforementioned limitations are the principle reasons for the inclusion of broodstock collection at Wells Dam and Winthrop NFH during 2009.

Recent WDFW genetic assessment of natural origin Methow spring Chinook (Small et al. 2007) suggest that Twisp natural-origin spring Chinook can be identified with sufficient confidence that natural origin collections can occur at Wells Dam, thereby facilitating natural origin inclusion in the broodstock, while maintaining the ability to manage separately the Twisp origin spring Chinook spawning aggregate. Although Twisp natural origin fish can be assigned to the Twisp population with confidence, some gene flow between the Twisp and Methow Composite spawning aggregates are anticipated as a result of collecting natural origin broodstock at Wells Dam. Based on projected Proportion Natural Origin (pNOB) broodstock composition for Twisp and Methow Composite programs (31% and 30%, respectively) and composite brood year assignment errors for wild Twisp and MetComp spring Chinook provided in Snow et al. (2007), the projected non-source fish contributions to the Twisp and MetComp hatchery programs for 2009 are 1.6% and 1.5%, respectively. In this instance, percent non-source fish contribution may be considered a gene flow estimate between the two program production elements (Twisp and Methow Composite) and is an unavoidable consequence associated with natural origin broodstock collection at Wells Dam during 2009. Although gene flow between the two hatchery production components is likely, it is expected to be relatively low in 2009 and supports a hatchery broodstock collection program objective to infuse natural origin fish into the hatchery program to maintain/improve genetic diversity and reduced domestication. For complete discussion regarding Methow Spring Chinook genetic monitoring and evaluation see Snow et al. (2007).

Non-lethal tissue samples (fin clips) for genetic analysis and scale samples will be obtained from adipose present, non-CWT, non-ventral clipped spring Chinook (suspected natural origin spring Chinook) collected at Wells Dam for origin analysis. Natural origin fish retained for broodstock will be tagged with a PIT tag (dorsal sinus) for tissue sample/genetic analysis cross-reference. Tissue samples will be preserved and sent to WDFW genetics lab in Olympia Washington for genetic/stock analysis. The spring Chinook sampled will be retained at Methow FH and will be sorted as Twisp or non-Twisp natural origin fish prior to spawning. 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 past Wells Dam. Based on the broodstock collection schedule (3-day/week, 16 hours/day), natural origin spring Chinook extraction is expected to be approximately 33% or less.

Weekly estimates of natural-origin spring Chinook passage past Wells Dam will be provided through stock assessment and broodstock collection activities and will provide the opportunity to adjust, in-season, the extraction of natural origin spring Chinook to maintain no greater that 33% extraction of Twisp and Methow Composite natural origin components while maximizing the opportunity for the inclusion of natural origin spring Chinook in the broodstock. Additionally, in-season estimates of Twisp and Methow Composite natural origin escapement past Wells Dam provides the opportunity to utilize both Wells Dam and the Twisp Weir as natural origin collection sites for the Twisp production component, thereby providing additional flexibility to account for differences between projected and actual returns of Twisp and Methow Composite natural origin fish. Twisp and Methow Composite hatchery origin spring Chinook will be captured at the Twisp Weir, Methow FH outfall. Trapping at the Winthrop NFH will be included if needed to address broodstock shortfalls.

The Methow FH rears spring Chinook salmon for three acclimation/release sites in the Methow River Basin, including: (1) Methow River (Methow FH); (2) Twisp River (Twisp Acclimation Pond) and (3) Chewuch River (Chewuch Acclimation Pond). The total production level target is 550,000 smolts divided equally among the three release sites (approximately 183,000 smolts per site).

Pre-season run-escapement of Methow origin spring Chinook past Wells Dam during 2009 are estimated at 2,237 spring Chinook, including 1,943 hatchery and 294 natural origin 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.

Based on current juvenile rearing capacity at Methow FH, programmed production levels (550,000 smolts), BKD management strategies, projected return for BY 2009 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and assumptions listed in Table 3, the following broodstock collection protocol was developed.

The 2009 Methow spring Chinook broodstock collection will target 359 adult spring Chinook. Based on the pre-season run forecast, Twisp fish are expected to represent 3% of the adipose present, CWT tagged hatchery adults and 12% 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%, the 2009 Twisp origin broodstock collection will be predominantly hatchery origin and total 33 fish (11 wild and 22 Hatchery), representing 30% of the broodstock necessary to meet Twisp program production of 183,000 smolts. Methow Composite fish are expected to represent 97% of the adipose present CWT tagged hatchery adults and 88% 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%, the 2009 Methow Composite (combined Methow and Chewuch river spawning aggregates) broodstock collection will be predominantly hatchery origin and total 326 spring Chinook (86 wild and 240 Hatchery). The broodstock collected for the Methow Composite production represents 100% of the broodstock necessary to meet Methow Composite program production of 367,000 smolts (combined Methow and Chewuch production), and sufficient to backfill the expected shortfall of 129,000 Twisp River spring Chinook. 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 1196. The Chewuch Pond and Methow FH releases will include progeny of broodstock identified as wild non-Twisp origin and known Methow Composite hatchery origin fish.

Table 1. Brood Year 2004-2006 age-class return projection for wild spring Chinook above Wells Dam during 2009.

			Age-at-Return								
	Twisp [1/]	Methow Basin [2/]	Twisp				Methow Basin				
BY			**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**SAR** [3/]
2004	5,873	22,941	2	21	**10**	33	6	83	**38**	128	0.005581
2005	5,372	55,381	1	**19**	9	30	15	**201**	93	309	0.005581
2006	18,580	198,400	**5**	67	31	104	**55**	720	332	1107	0.005581
2009 Return Year			**5**	**19**	**10**	**34**	**55**	**201**	**38**	**294**	

[1/]- Smolt estimate based on sub-yearling and yearling emigration (Snow et al. 2008)

[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/]- Mean 1998-2003 Chiwawa River wild SAR as a surrogate wild SAR for Methow spring Chinook

Table 2. BY 2004-2006 age-class and origin run-escapement projection for UCR spring Chinook at Wells Dam, 2009.

	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	164	947	42	1,153	50	182	28	260	214	1,129	70	1,413
% Total				59%				88%				63%
Twisp	14	47	6	67	5	19	10	34	19	66	16	101
% Total				3%				12%				5%
Winthrop (MetComp)				723								723
				37%								
Total				1,943	55	201	38	294				2,237
				87%				13%				100%

Table 3. Assumptions and calculations to determine number of broodstock needed for BY 2009 production of 550,00 smolts.

Smolt release		**550,000**	**Smolts**
Fertilization-to-release survival	90%		
Egg-take (Production)		**611,000**	Eggs
18% cull allowance [2/]		73,000	
Total Egg Take		**684,000**	**Eggs**
Fecundity	4,000 [1/]	171	Females spawned
Female to male ratio	1 to 1	341	Total spawned
Pre-spawn survival	**95%**	**359**	**Broodstock collection target**

1/- Based on historical program age-4 fecundities and expected 2009 return age structure (Table 1).
2/- Hatchery origin MetComp. component only, and is based on projected natural origin collection and assumption that all Twisp (hatchery and wild) and wild MetComp. will be retained for production.

Trapping at Wells Dam will occur at the East and West ladder traps beginning on 04 May, or at such time as the first spring Chinook are observed passing Wells Dam and continue through 24 June 2009. Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Trapping schedule will consists of 3-day/week (Monday-Wednesday), up to 16-hours/day. Two of the three trapping days will be concurrent with the stock assessment sampling activities authorized through the 2009 Douglas PUD Hatchery M&E Implementation Plan. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quotas). Once the weekly quota target is reached, broodstock collection will cease until the beginning of the next week. If a shortfall occurs in the weekly trapping quota, the shortfall will carry forward to the following weeks collection quota. All natural origin spring Chinook collected at Wells Dam for broodstock will be held at the Methow FH.

To meet Methow FH broodstock collection for hatchery origin Methow Composite and Twisp River stocks, adipose-present coded-wire tagged hatchery fish will be collected at Methow FH, Winthrop NFH and the Twisp Weir beginning 01May or at such time as spring Chinook are observed passing Wells Dam and continuing through 21 August 2009. Natural origin spring Chinook will be retained at the Twisp weir as necessary to bolster the Twisp program production so long as the aggregate collection at Wells Dam and Twisp River weir does not exceed 33% of the estimated Twisp River natural origin return past Wells Dam. All hatchery and natural origin fish collected at Methow FH, Twisp Weir and Winthrop NFH for broodstock will be held at the Methow FH.

<u>*Steelhead*</u>

Steelhead mitigation programs above Wells Dam (including the USFWS steelhead program at Winthrop NFH) utilize adult broodstock collections at Wells Dam and incubation/rearing at

Wells Fish Hatchery (FH). The Wells Steelhead Program also provides eggs for UCR steelhead reared at Ringold FH, not as a mitigation requirement, but rather an opportunity to reduce the prevalence of early spawn hatchery steelhead in the mitigation component above Wells Dam. Typically, Wells hatchery origin steelhead held at Wells FH spawn earlier than natural origin steelhead. Early maturation of hatchery fish in the hatchery may indicate a propensity for these fish to spawn early in the natural environment as well and may have a negative effect on hatchery spawner success. In efforts to minimize impacts from early maturation, the Wells Hatchery program has transferred eggs from the earliest spawn hatchery steelhead to Ringold FH. Preliminary evaluations indicate that the mean spawn timing of HxH steelhead at Wells FH has been delayed and may be a function of these actions (Figure 1). Based on these preliminary evaluations, WDFW proposes to continue the transfer eggs from early spawn hatchery origin steelhead to Ringold FH.

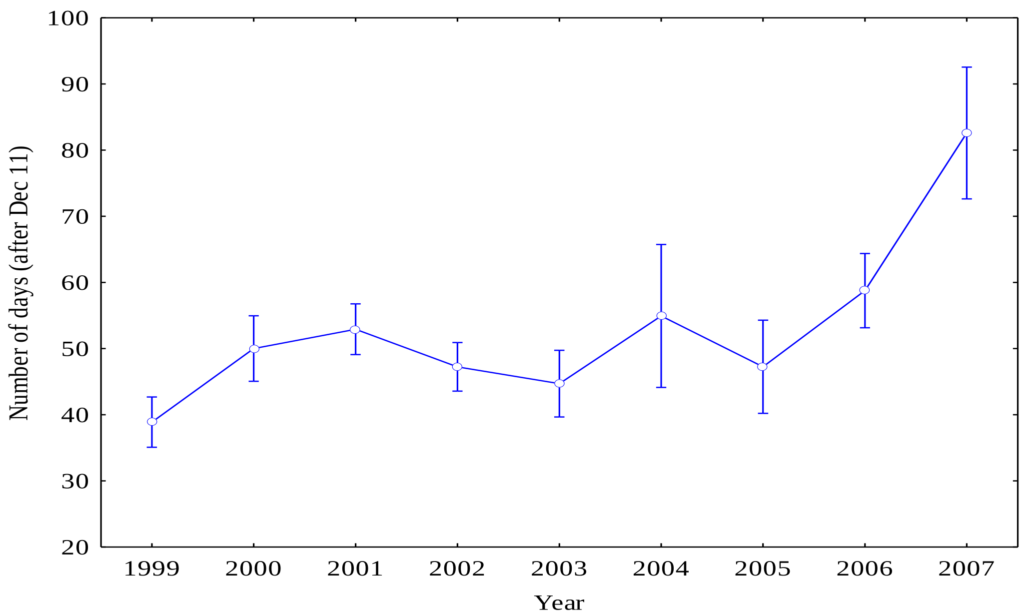

Figure 1. Mean spawn timing of HxH steelhead at Wells FH, BY 1999-2007 (WDFW unpublished Data).

Based on mitigation program production objectives (Table 4) and program assumptions (Table 5), the following broodstock collection protocol was developed.

Trapping at Wells Dam will selectively retain 366 steelhead (east and west ladder collection). Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Hatchery and natural origin collections will be consistent with run-timing of hatchery and natural origin steelhead at Wells Dam. The collection will retain no greater than 33% natural origin broodstock for the mitigation programs and 100% hatchery origin within the Ringold FH production component. Overall collection will be limited to no more than 33% of the entire run or 33% of the natural origin return. The east and west ladder trapping at Wells Dam will begin on 01 August and terminate by 31 October and will be operated concurrently, three days per week, up to 16 hours per day, if required to meet broodstock objectives. Trapping on the east ladder will be concurrent with summer Chinook broodstocking efforts through 14 September and will continue through 31 October, concurrent with west ladder steelhead collections. 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.

Table 4. Adult steelhead collection objectives for programs supported through adult steelhead broodstock collection at Wells Dam.

Program	# Smolts	# eyed eggs	% Wild	# Wild	# Hatchery	Total Adults	
DCPUD [1/]	349,000	401,149	33%	59	119	178	
GCPUD [1/]	80,000	91,954	33%	14	27	41	
USFWS [1/]	80,000	91,954	33%	14	27	41	[3/]
Sub-Total	**509,000**	**585,057**	**33%**	**87**	**174**	**260**	
Ringold	180,000	240,000	0%	0	106	106	[3/]
Sub-Total	**180,000**	**240,000**	**0%**	**0**	**106**	**106**	
Grand Total [2/]	**689,000**	**825,057**	**24%**	**87**	**289**	**366**	

[1/]- Above Wells Dam releases. Target HxW parental adults as the hatchery component
[2/]- Based on steelhead production consistent with Mid Columbia HCP's, GCPUD BiOp and Section 10 Permit 1395.
[3/]- Based on adults required for eyed egg allotment

Table 5. Program assumptions used to determine adult collection required to meet steelhead production objectives for programs above Wells Dam and at Ringold Springs Fish Hatchery.

Program assumption	Standard
Pre-spawn survival	97%
Female to male ratio	1.0 : 1.0
Fecundity	5,400
Propagation survival	
87% fertilization to eyed egg	87%
86% eyed egg to yearling release	86% [1/]
75% fertilization to yearling release	75% [1/]

[1/]- Not applicable to Ringold Springs Fish Hatchery

Summer/fall Chinook

Summer/fall Chinook mitigation programs above Wells Dam utilize adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 976,000 summer/fall Chinook smolts for two acclimation/release sites on the Methow and Similkameen rivers (Carlton Pond and Similkameen Pond, respectively).

The TAC 2009 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix A) and BY 2005, 2006 and 2007 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. Based on initial run expectations of summer Chinook to the Columbia River, program objectives and program assumptions (Table 6); the following broodstock collection protocol was developed.

WDFW will retain 556 natural-origin summer/fall Chinook at Wells Dam east and west ladder, including 278 females. Collection will be proportional to return timing between 01 July and 13 September. Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Trapping will occur 3-days/week, 16 hours/day. The 3-year old component will be limited to 10 percent of the broodstock collection. If the probability of achieving the broodstock goal is reduced based on actual natural-origin escapement levels, broodstock origin composition will be adjusted to meet the broodstock collection objective.

Table 6. Assumptions and calculations to determine number of broodstock needed for summer/fall Chinook production at Carlton and Similkameen ponds.

Program Assumption		Carlton Pond	Similkameen Pond	Total
Smolt release		**400,000**	**576,000**	**976,000**
Fertilization-to-release survival	90%			
Eggtake Target		**512,821**	**738,462**	**1,251,282**
Fecundity	5,000			
Female target		**103**	**148**	**250**
Female to male ratio	1 to 1			
Broodstock target		**205**	**295**	**501**
Pre-spawn survival	95%			
Total collection target		**228**	**328**	**556**

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Summer/fall Chinook mitigation programs that release juveniles directly into the Columbia River between Wells and Rocky Reach dams are supported through adult broodstock collections at Wells Dam. The total production level supported by this collection is 520,000 yearling and 1,562,000 sub-yearling Chinook. Upon agreement in the HCP, the 2009, summer Chinook broodstock collections at Wells FH may also include 250,000 green eggs to support the Yakama Nation (YN) reintroduction of summer Chinook to the Yakima River Basin. If approved by the HCP Hatchery Committee, the YN eggs will be the last eggs taken and will be the responsibility of staff associated with the YN program.

Adults returning from this program are to support harvest opportunities and are not intended to increase natural production and have been termed segregated harvest programs. These programs have contributed to harvest opportunities; however, adults from these programs have been documented contributing to the adult spawning escapement in tributaries upstream and downstream from their release locations. Because adults from these programs contribute to the natural spawn escapement, the broodstock collection will incorporate 10 percent natural-origin fish into the broodstock to reduce the potential genetic risk to the naturalized summer/fall Chinook stocks in the upper Columbia River region. Based on mitigation objectives and program assumptions (Table 7), the following broodstock collection protocol was developed.

WDFW will collect 1,476 run-at-large summer Chinook including 1,339 hatchery fish from the volunteer ladder trap at Wells Fish Hatchery outfall and 137 natural-origin fish from the Wells Hatchery outfall, and/or Wells Dam east and west ladders. Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Overall extraction of natural-origin fish passing Wells Dam (Wells program and above Wells Dam summer/fall Chinook programs) will not exceed 33 percent. West ladder collections will begin 01 July and completed by 14 September and will be consistent with run timing past Wells Dam. Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin 10 July and terminate by 31 August. The 3-year old component will be limited to 10 percent of the broodstock collection.

Table 7. Assumptions and calculations to determine number of broodstock needed for summer/fall Chinook production at Wells and Turtle Rock Island hatcheries.

	Standard		Wells FH		Turtle Rock FH		YN [1/]	
Program Assumption	Sub-yearling	Yearling	Sub-yearling	Yearling	Sub-yearling	Yearling	green-egg	Total
Smolt release			484,000	320,000	1,078,000	200,000	250,000	NA
Fertilization-to-release survival	73% [2/]	78%					NA	NA
Eggtake Target			663,014	410,256	1,476,712	256,410	250,000	3,056,392
Fecundity	4,600	4,600						
Female target			144	89	321	56	54	664
Female to male ratio	1 to 1	1 to 1						
Broodstock target			288	178	642	111	109	1,328
Pre-spawn survival	90%	90%						
Total collection target			**320**	**198**	**713**	**124**	**121**	**1,476**

1/- Green eggs for YN reintroduction program in the Yakima River Basin.

2/- Based on increased monitoring of the green egg-to-marking loss for BY 07 and 08 that indicates a un-fertilized- to- marking loss of 27%.

Coho

Yakama Nation will provide broodstock collection objectives for the coho reintroduction program in the Methow River basin. WDFW will work collaboratively with the Yakama Nation to facilitate coho collections at Wells Dam. Access to the east ladder trap will be coordinating with staff at Wells Dam due to the rotor rewind project.

Reference

Snow et al. 2007. Snow, C., c. Frady, A. Fowler, A. Murdoch, M. Small, K. Warheit, and C. Dean. Monitoring and evaluation of the Wells and Methow programs in 2006. Prepared for Douglas County Public Utility District and Wells Habitat Conservation Plan Hatchery Committee. Washington Dept. of Fish and Wildlife, Supplementation Research Office, Twisp, WA., and Washington Dept. Fish and Wildlife, Conservation Unit, Genetics Lab, Olympia, WA.

Appendix B. Number of broodstock spawned (including pre-spawn mortalities) and smolts released by brood year from Wells Complex hatchery facilities. Wells summer steelhead includes releases from WNFH and Cassimer Bar Hatchery.

Brood year	Number of broodstock	Smolts released	Adult returns	SAR (%)	# Smolts/ adult	HRR
			Wells yearling summer Chinook salmon			
1992	205	331,353	836	0.252	396	4.1
1993	225	388,248	2,011	0.518	193	8.9
1994	185	365,000	141	0.039	2,589	0.8
1995	144	290,000	1,144	0.394	253	7.9
1996	193	356,707	1,652	0.463	216	8.6
1997	189	381,867	10,941	2.865	35	57.9
1998	207	457,770	10,550	2.305	43	51.0
1999	176	312,098	1,544	0.495	202	8.8
2000	175	343,423	8,300	2.417	41	47.4
2001	248	185,200	2,700	1.458	69	10.9
2002	182	306,810	3,677	1.198	83	20.2
2003	144	313,509	1,924	0.614	163	13.4
2004	176	312,980	3,629	1.159	86	20.6
			Wells subyearling summer Chinook salmon			
1993	173	187,382	40	0.021	4,685	173
1994	255	450,935	15	0.003	30,062	255
1995	221	408,000	128	0.031	3,188	221
1996	336	473,000	704	0.149	672	336
1997	274	541,923	240	0.044	2,258	274
1998	179	370,617	376	0.101	986	179
1999	212	363,600	524	0.144	694	212
2000	257	498,500	185	0.037	2,695	257
2001	210	376,027	776	0.206	485	210
2002	265	473,100	126	0.027	3,755	265
2003	224	425,271	152	0.036	2,798	0.7
2004	293	471,123	714	0.152	660	2.4
			Twisp spring Chinook salmon			
1992	18	35,853	21	0.059	1,707	1.2
1993	42	116,749	27	0.023	4,324	0.6
1994	5	19,835	5	0.025	3,967	1.0
1995	-	-	-	-	-	-
1996	43	76,687	278	0.363	276	6.5
1997	15	26,714	67	0.251	399	4.5
1998	10	15,470	23	0.149	673	2.3
1999	32	67,408	61	0.091	1,105	1.9

Appendix B, continued.

Brood year	Number of broodstock	Smolts released	Adult returns	SAR (%)	# Smolts/ adult	HRR
2000	64	74,717	173	0.232	432	2.7
2001	30	51,652	44	0.085	1,174	1.5
2002	9	20,541	120	0.589	170	13.3
2003	33	50,627	49	0.097	1,033	1.5
2004	53	71,617	174	0.243	412	3.3
2005	18	27,658	46	0.166	601	2.6
Methow spring Chinook salmon						
1993	91	210,849	192	0.091	1,098	2.1
1994	2	4,477	1	0.022	4,477	0.5
1995	12	28,878	122	0.422	237	10.2
1996	103	202,947	500	0.246	406	4.9
1997	187	332,484	946	0.284	352	5.1
1998[a]	161	435,670	2,300	0.528	189	14.3
1999	90	180,775	145	0.080	1,247	1.6
2000[a]	147	266,392	852	0.320	313	5.8
2001	69	130,787	508	0.388	257	7.4
2002	81	181,235	599	0.331	303	7.4
2003	30	48,831	57	0.117	857	1.9
2004	53	65,146	316	0.485	206	6.0
2005	116	156,633	328	0.209	478	2.8
Chewuch spring Chinook salmon						
1992	21	40,881	39	0.095	1,048	1.9
1993	103	284,165	116	0.041	2,450	1.1
1994	12	11,854	2	0.017	5,927	0.2
1995	-	-	-	-	-	-
1996	64	91,672	37	0.040	2,478	0.6
1997	64	132,759	360	0.271	369	5.6
2001	85	261,284	738	0.282	354	8.7
2002	123	254,238	699	0.275	364	5.7
2003	60	127,614	61	0.048	2,092	1.0
2004	132	204,906	194	0.095	1,056	1.5
2005	160	232,811	308	0.132	756	1.9

Appendix B, continued.

Brood year	Number of broodstock	Smolts released	Adult returns	SAR (%)	# Smolts/ adult	HRR
			Wells summer steelhead			
1996	207	531,798	2,779	0.523	191	13.4
1997	316	543,028	4,702	0.866	115	14.9
1998	377	888,180	14,076	1.585	63	37.3
1999	310	712,822	14,691	2.061	49	47.4
2000	277	653,874	1,752	0.268	373	6.3
2001	277	541,453	11,218	2.072	48	40.5
2002	288	580,498	4,577	0.788	127	15.9
2003	228	468,538	6,129	1.308	76	26.9
2004	272	467,266	4,878	1.044	96	17.9
2005	273	576,027	7,001	1.215	82	25.6
2006	247	592,468	7,889	1.332	75	31.9
2007	218	557,259	19,919	3.574	28	91.3

[a] Mixed MetComp group.

Appendix C. Mean fork length (cm; *N*; SD) by age, sex, and brood of Wells Hatchery complex broodstocks.

Brood	Sex	Age-3		Age-4		Age-5		Age-6		Age-7
		H	W	H	W	H	W	H	W	H
					Wells summer Chinook-yearling migrants					
2009	M	63.3 (62; 6.2)	- -	77.1 (189; 6.3)	77.6 (3; 8.3)	90.4 (145; 8.4)	- -	96.0 (7; 11.2)	- -	- -
2009	F	- -	- -	79.5 (48; 6.2)	- -	90.8 (330; 4.6)	- -	94.3 (19; 6.1)	- -	- -
2008	M	55.2 (25; 5.2)	- -	81.0 (296; 7.1)	69.0 (1; - -)	93.5 (73; 8.5)	- -	103.3 (23; 6.5)	- -	95.0 (1; - -)
2008	F	- -	- -	83.5 (198; 4.6)	- -	91.0 (227; 5.3)	- -	97.9 (58; 5.8)	- -	- -
2007	M	63.9 (21; 3.5)	- -	76.8 (132; 5.9)	- -	93.1 (255; 7.5)	- -	95.4 (14; 10.3)	- -	79.0 (1; - -)
2007	F	74.0 (1; - -)	- -	80.0 (70; 5.8)	- -	91.4 (408; 4.9)	89.0 (1; - -)	93.3 (37; 5.4)	- -	88.9 (7; 7.7)
2006	M	- -	- -	79.4 (171; 6.1)	- -	91.4 (105; 6.8)	83.5 (4; 8.2)	91.3 (50; 8.4)	- -	92.0 (1; - -)
2006	F	- -	- -	82.7 (62; 5.0)	81.0 (1; - -)	92.0 (178; 5.2)	- -	93.9 (99; 7.0)	- -	- -
2005	M	- -	- -	80.5 (137; 5.9)	80.5 (7; 4.2)	88.9 (295; 6.7)	96.7 (3; 7.1)	91.6 (5; 4.9)	- -	97.0 (1; - -)
2005	F	- -	- -	81.1 (55; 4.5)	88.0 (1; - -)	89.8 (385; 4.9)	95.2 (6; 2.8)	95.5 (23; 5.0)	- -	- -
2004	M	55.0 (1; - -)	- -	79.3 (247; 5.0)	77.2 (5; 5.8)	88.1 (104; 7.1)	94.8 (6; 8.7)	100.0 (36; 10.0)	- -	- -
2004	F	- -	- -	79.7 (90; 4.8)	85.7 (3; 2.1)	89.0 (124; 4.6)	91.9 (14; 3.9)	97.1 (101; 5.5)	- -	76.0 (1; - -)
2003	M	59.1 (9; 5.7)	- -	76.6 (32; 5.8)	74.5 (2; 16.3)	92.4 (343; 7.8)	94.0 (2; 24.0)	97.7 (6; 14.7)	- -	- -
2003	F	- -	- -	80.2 (18; 4.3)	- -	92.4 (488; 4.7)	- -	97.4 (23; 4.2)	- -	- -
2002	M	51.5 (6; 3.3)	- -	80.1 (266; 6.1)	- -	95.4 (278; 7.2)	- -	99.5 (6; 5.9)	- -	- -
2002	F	- -	- -	84.3 (66; 4.5)	- -	94.3 (519; 4.8)	- -	100.0 (10; 2.8)	- -	- -
2001	M	54.9 (12; 3.8)	- -	81.0 (437; 6.4)	84.0 (1; - -)	94.6 (84; 8.0)	97.7 (16; 8.3)	99.5 (2; 7.8)	- -	- -
2001	F	- -	- -	82.7 (302; 4.6)	- -	93.9 (179; 5.3)	98.7 (3; 1.5)	98.5 (12; 6.1)	92.0 (1; - -)	- -
2000	M	53.2 (63; 5.1)	68.0 (1, - -)	75.9 (303; 6.6)	81.9 (13; 8.7)	91.6 (130; 8.0)	97.8 (12; 6.4)	109.0 (1; - -)	- -	- -
2000	F	- -	- -	81.7 (68; 5.3)	85.5 (4; 4.2)	92.1 (208; 5.0)	95.1 (30; 4.5)	98.1 (8; 11.5)	- -	- -
1999	M	51.8 (42; 6.9)	- -	76.8 (172; 7.9)	81.6 (26; 8.7)	93.8 (80; 8.5)	99.6 (8; 6.9)	99.1 (16; 8.7)	- -	- -
1999	F	- -	- -	81.5 (79; 6.1)	84.0 (12; 4.6)	91.4 (169; 5.5)	94.5 (29; 4.6)	98.0 (58; 6.4)	- -	89.5 (2; 2.1)
1998	M	55.7 (30; 5.9)	61.0 (2; 2.8)	74.7 (125; 8.9)	83.0 (19; 6.2)	94.9 (213; 10.1)	100 5 (2; 2.1)	101.0 (19; 9.9)	- -	- -
1998	F	- -	- -	79.4 (30; 5.2)	86.0 (5; 4.2)	95.2 (418; 5.4)	97.6 (8; 5)	97.9 (32; 8.7)	- -	101.0 (1; - -)

Appendix C, continued.

Brood	Sex	Age-3		Age-4		Age-5		Age-6		Age-7
		H	W	H	W	H	W	H	W	H
1997	M	47.0 (2; 0.0)	68.0 (1; - -)	78.7 (46; 6.4)	79.5 (2; 4.9)	91.3 (43; 9.6)	98.0 (18; 5.6)	108.0 (3; 6.8)	109.0 (1; - -)	- -
1997	F	- -	- -	81.2 (26; 5.5)	87.5 (4; 3.7)	92.1 (96; 4.9)	96.2 (9; 5.7)	98.0 (10; 8.5)	- -	- -
1996	M	49.3 (9; 5.4)	57.3 (4; 6.6)	76.4 (87; 7.0)	81.0 (19; 7.5)	90.4 (49; 7.5)	94.9 (24; 6.6)	98.4 (10; 8.1)	102.3 (3; 11.6)	- -
1996	F	- -	- -	80.6 (40; 4.0)	86.9 (10; 3.2)	89.4 (68; 4.5)	94.7 (26; 3.6)	96.3 (39; 7.4)	- -	92.7 (3; 5.9)
1995	M	53.4 (19; 4.4)	62.0 (3; 5.6)	73.1 (71; 8.2)	84.4 (12; 7.3)	90.2 (115; 7.7)	107.0 (1; - -)	98.3 (130; 8.2)	96.0 (1; - -)	- -
1995	F	71.0 (1; - -)	- -	81.9 (22; 6.4)	84.5 (2; 7.8)	90.7 (126; 5.2)	94.7 (65; 4.4)	96.6 (333; 5.8)	- -	- -
1994	M	- -	- -	77.1 (16; 7.9)	- -	89.6 (104; 6.6)	- -	- -	- -	- -
1994	F	- -	- -	71.3 (3; 2.3)	- -	89.7 (137; 5.3)	91.3 (4; 10.2)	- -	- -	- -
Wells summer Chinook-subyearling migrants										
2009	M	70.6 (53; 4.8)	67.8 (48; 5)	85.4 (73; 7.9)	89.1 (97; 6.8)	93.0 (3; 3.6)	102.8 (13; 8.8)	- -	- -	- -
2009	F	71.3 (4; 2.2)	67.0 (1; - -)	87.5 (181; 5.1)	87.2 (105; 5.4)	91.6 (28; 3.3)	96.0 (33; 3.5)	- -	- -	- -
2008	M	74.7 (103; 6.3)	71.9 (33; 4.2)	87.6 (32; 8.1)	86.4 (65; 7.2)	105.0 (1; - -)	102.4 (5; 5.7)	- -	98.0 (1; - -)	- -
2008	F	74.9 (16; 5.6)	71.7 (3; 2.1)	87.8 (64; 5.6)	88.7 (57; 4.5)	94.2 (6; 2.3)	95.5 (10; 3.3)	- -	104.0 (1; - -)	- -
2007	M	73.2 (40; 4.6)	68.2 (18; 5.4)	84.2 (18: 6.8)	86.4 (8; 9.4)	- -	94.3 (6; 6.7)	94.0 (1; - -)	- -	- -
2007	F	74.6 (10; 2.9)	70.3 (3; 2.8)	85.4 (18: 5.3)	78.7 (3; 4.1)	92.1 (7; 4.6)	95.6 (14; 3.9)	91.5 (2; 2.1)	- -	- -
2006	M	81.0 (1; - -)	76.0 (2, 4.2)	83.4 (5; 4.3)	90.4 (15; 5.8)	93.1 (14; 5.3)	95.4 (13; 6.5)	- -	- -	- -
2006	F	- -	- -	85.3 (7; 3.0)	90.0 (8; 6.7)	92.2 (35; 3.9)	96.0 (22; 5.9)	- -	- -	- -
2005	M	78.0 (1; - -)	71.8 (6; 7.2)	85.1 (32; 6.0)	82.6 (23; 6.0)	94.0 (3; 6.9)	98.6 (5; 4.0)	105.0 (1; - -)	- -	- -
2005	F	- -	74.0 (1; - -)	84.2 (55; 4.1)	84.4 (26; 4.4)	88.8 (13; 5.6)	91.8 (4; 2.1)	92.0 (2; 7.1)	100.0 (1; - -)	- -
2004	M	73.4 (9; 4.5)	72.3 (3; 9.9)	84.5 (12; 4.5)	84.0 (11; 1.9)	92.2 (18; 7.0)	98.7 (24; 7.4)	- -	- -	- -
2004	F	68.0 (1; - -)	65.0 (1; - -)	84.0 (11; 6.4)	84.2 (5; 1.1)	90.7 (67; 4.0)	93.9 (61; 5.1)	- -	- -	- -
2003	M	63.0 (5; 4.7)	65.0 (1; - -)	83.0 (29; 6.5)	83.6 (18; 4.2)	- -	98.7 (3; 11.0)	- -	- -	- -
2003	F	- -	- -	84.7 (53; 4.7)	86.4 (11; 4.2)	90.0 (6; 5.5)	95.0 (2; 7.1)	- -	- -	- -
2002	M	67.6 (7; 5.9)	70.5 (2; 4.9)	86.3 (15; 9.3)	73.0 (2; 19.8)	- -	- -	- -	119.0 (1; - -)	- -
2002	F	78.0 (2; 7.1)	- -	88.3 (15; 3.5)	81.0 (1; - -)	90.8 (5; 5.2)	- -	- -	- -	- -

Appendix C, continued.

Brood	Sex	Age-3		Age-4		Age-5		Age-6		Age-7
		H	W	H	W	H	W	H	W	H
2001	M	74.1 (8; 6.3)	- -	85.4 (19; 7.8)	91.7 (10; 8.8)	99.0 (1; - -)	99.6 (10; 8.7)	- -	- -	- -
2001	F	- -	- -	87.6 (14; 5.1)	88.0 (6; 6.5)	97.7 (19; 4.4)	98.0 (1; - -)	- -	- -	- -
2000	M	65.5 (4; 9.6)	72.4 (14; 3.5)	82.8 (60; 6.8)	86.1 (27; 5.9)	109.0 (2; 2.1)	101 0 (11; 8.5)	- -	- -	- -
2000	F	72.0 (1; - -)	- -	87.5 (146; 4.7)	87.8 (32; 5.9)	92.1 (19; 6.1)	94.3 (29; 4.4)	- -	- -	- -
1999	M	68.0 (73; 7.0)	69.6 (18; 6.3)	81.6 (30; 9.6)	85.2 (37; 5.9)	102.0 (6; 5.1)	97.7 (3; 2.1)	84.0 (1; - -)	- -	- -
1999	F	74.1 (20; 6.1)	66.5 (2; 0.7)	85.5 (41; 4.7)	84.7 (52; 5.8)	89.3 (3; 9.5)	96.0 (13; 4.0)	- -	- -	- -
1998	M	67.3 (9; 4.5)	66.1 (9; 3.9)	81.4 (5; 11.9)	89.3 (10; 6.2)	96.0 (3; 7.5)	102 5 (4; 6.0)	- -	- -	- -
1998	F	- -	- -	83.3 (4; 5.6)	85.2 (13; 7.4)	93.8 (6; 5.8)	98.0 (1; - -)	- -	- -	- -
1997	M	- -	- -	90.0 (1; - -)	96.8 (4; 8.4)	- -	101 5 (2; 3.5)	- -	- -	- -
1997	F	- -	- -	85.0 (1; - -)	87.7 (6; 6.0)	- -	100 4 (5; 4.7)	- -	- -	- -
1996	M	59.0 (1; - -)	68.3 (6; 2.7)	80.0 (1; - -)	82.8 (12; 8.5)	- -	103 4 (46; 5.9)	- -	- -	- -
1996	F	- -	- -	- -	87.3 (16; 5.2)	92.0 (1; - -)	94.5 (6; 4.7)	- -	- -	- -
1995	M	- -	69.5 (11; 5.8)	- -	90.1 (8; 8.0)	104.0 (2; 2.1)	99.7 (12; 7.8)	- -	101.5 (2; 2.1)	- -
1995	F	72.0 (1; - -)	63.0 (1; - -)	- -	92.9 (8; 6.3)	97.8 (4; 4.1)	96.2 (102; 4.6)	- -	99.0 (1; - -)	- -
1994	M	- -	- -	75.0 (2; 8.5)	87.3 (7; 8.4)	89.5 (4; 11.3)	- -	- -	- -	- -

Appendix C, continued.

Brood	Male				Female			
	1-salt		2-salt		1-salt		2-salt	
	H	W	H	W	H	W	H	W
	Wells Hatchery summer steelhead							
2009	62.9 (116; 3.2)	64.3 (23; 4.0)	77.8 (12; 4.7)	84.4 (7; 3.2)	60.8 (66; 3.0)	63.2 (22; 3.2)	74.0 (57; 4.0)	74.2 (18; 4.6)
2008	63.2 (131; 2.9)	64.6 (31; 4.3)	77.6 (11; 4.3)	74.0 (3;3.4)	61.1 (67; 2.7)	62.4 (42; 2.8)	71.8 (58; 3.9)	74.4 (13; 3.3)
2007	62.0 (130; 2.9)	63.3 (13; 4.8)	74.6 (10; 4.9)	76.8 (5; 4.6)	60.1 (137; 2.5)	63.3 (10; 3.5)	71.7 (54; 5.4)	73.0 (16; 5.1)
2006	60.3 (98; 3.3)	65.2 (21; 4.5)	75.6 (58; 4)	77.4 (16; 3.5)	59.7 (22; 4.3)	61.4 (8; 4.9)	70.9 (123; 4.2)	72.7 (42; 3.3)
2005	60.4 (93; 3.2)	62.1 (15; 3.2)	74.0 (53; 3.2)	75.6 (9; 2.5)	59.4 (31; 2.4)	62.5 (15; 2.5)	71.8 (138; 3.5)	73.4 (27; 4.1)
2004	60.9 (183; 2.8)	64.2 (53; 3.4)	73.0 (3; 6.6)	- -	60.1 (118; 2.6)	62.2 (55; 3.5)	67.5 (6; 3.4)	73.4 (9; 6.2)
2003	61.9 (30; 3.8)	- -	78.6 (89; 4.9)	81.6 (9; 3.7)	60.4 (17; 3.7)	- -	74.7 (133; 3.9)	75.8 (18; 3.7)
2002	64.3 (106; 3.1)	63.7 (3; 2.9)	78.3 (68; 3.3)	76.0 (1; - -)	62.9 (50; 2.3)	63.8 (5; 5.1)	73.6 (150; 3.5)	74.7 (9; 4.8)
2001	61.2 (120; 3.4)	60.9 (14; 3.7)	76.1 (27; 5.1)	82.5 (2; 4.9)	60.2 (66; 2.5)	59.4 (7; 3.0)	72.9 (106; 3.4)	73.3 (3; 2.5)
2000	63.4 (113; 2.9)	62.9 (13; 3.4)	77.8 (28; 5.0)	76.0 (4; 10.7)	61.4 (87; 2.4)	62.5 (13; 2.4)	73.8 (98; 3.6)	76.8 (11; 7.8)
1999	63.3 (123; 2.9)	64.0 (5; 2.9)	80.0 (41; 2.8)	80.8 (4; 7.4)	62.3 (66; 2.4)	61.8 (5; 2.4)	74.3 (141; 3.6)	73.8 (13; 2.9)
1998	64.8 (122; 3.7)	65.6 (5; 3.0)	79.3 (64; 4.8)	- -	62.1 (78; 3.1)	64.0 (4; 1.4)	75.3 (169; 3.6)	74.3 (3; 0.6)
1997	64.2 (145; 3.1)	63.8 (18; 3.5)	76.6 (20; 3.6)	74.5 (10; 8.0)	62.3 (94; 3.3)	61.6 (14; 2.3)	71.9 (53; 4.5)	74.3 (15; 5.7)
1996	- -	- -	- -	- -	- -	- -	- -	- -
1995	66.0 (1; - -)	64.3 (8; 4.2)	80.0 (1; - -)	77.6 (5; 3.8)	60.3 (9; 2.6)	63.8 (12; 4.4)	74.8 (16; 4.1)	74.2 (11; 5.8)

Appendix C, continued.

Brood	Sex	Age-3		Age-4		Age-5	
		H	W	H	W	H	W
				Methow / Methow Composite spring Chinook salmon			
2009	M	60.6 (34; 5.0)	53.1 (16; 3.8)	77.6 (44; 4.6)	77.2 (28; 5.8)	95.0 (1; - -)	94.3 (3; 10.7)
2009	F	66.0 (1; - -)	- -	76.8 (98; 3.7)	78.1 (38; 2.9)	86.0 (2; 5.7)	90.5 (10; 4.1)
2008	M	57.1 (32; 5.2)	49.5 (2; 3.5)	75.4 (75; 5.9)	74.3 (21; 8.0)	96.0 (1; - -)	102.0 (1; - -)
2008	F	66.0 (1; - -)	- -	76.6 (180; 3.6)	76.2 (16; 3.7)	88.1 (7; 6.0)	90.3 (4; 6.4)
2007	M	51.6 (16; 4.4)	48.0 (1; - -)	70.2 (40; 6.5)	71.6 (6; 6.9)	92.9 (14; 5.2)	96.0 (3; 3.6)
2007	F	- -	- -	74.1 (43; 4.7)	- -	88.0 (21; 3.5)	90.3 (9; 2.2)
2006	M	45.0 (3; 3.6)	50.0 (1; - -)	76.3 (110; 5.0)	75.6 (3; 1.1)	90.5 (2; 7.7)	95.0 (1; - -)
2006	F	- -	- -	74.3 (121; 3.7)	77.2 (4; 2.2)	82.8 (7; 4.9)	92.0 (1; - -)
2005	M	52.1 (28; 3.9)	- -	72.3 (74; 7.0)	- -	- -	- -
2005	F	- -	- -	74.3 (98; 4.4)	71.0 (2; 2.8)	81.0 (1; - -)	- -
2004	M	48.3 (85; 3.3)	- -	72.0 (52; 6.9)	- -	- -	- -
2004	F	- -	- -	73.4 (144; 3.6)	75.0 (1; - -)	76.0 (1; - -)	- -
2003	M	49.0 (36; 3.7)	51.0 (1; - -)	- -	- -	96.7 (9; 2.6)	- -
2003	F	- -	- -	75.3 (17; 3.4)	- -	- -	- -
2002	M	48.3 (7; 6.4)	- -	79.0 (88; 6)	- -	100.0 (1; - -)	- -
2002	F	- -	- -	76.3 (145; 3.5)	- -	87.3 (6; 7.5)	- -
2001	M	60.0 (1; - -)	- -	80.6 (10; 4.7)	- -	- -	- -
2001	F	- -	- -	76.9 (67; 3.7)	- -	- -	- -
2000	M	51.2 (40; 4.2)	- -	73.0 (59; 6.7)	- -	- -	- -
2000	F	- -	- -	74.5 (74; 3.4)	- -	- -	- -
1999	M	- -	- -	- -	- -	- -	- -
1999	F	- -	- -	78.0 (27; 3.1)	77.6 (13; 5.1)	- -	86.5 (4; 6.6)
1998	M	- -	- -	- -	- -	- -	- -
1998	F	- -	- -	76.3 (8; 3.7)	76.1 (27; 3.5)	84.9 (23; 8.7)	88.9 (42; 6.2)
				Twisp spring Chinook salmon			
2009	M	50.0 (3; 6.6)	52.1 (11; 2.7)	72.0 (2; 1.4)	71.3 (6; 5.4)	- -	96.0 (1; - -)
2009	F	- -	- -	77.1 (8; 4.8)	76.0 (6; 8.9)	90.0 (3; 2)	- -
2008	M	53.3 (4; 1.7)	- -	73.4 (9; 4.5)	73.3 (3; 4.5)	- -	- -
2008	F	- -	- -	76.4 (16; 4.6)	75.2 (9; 3.7)	90.0 (1; - -)	- -
2007	M	48.1 (7; 4.3)	48.0 (1; - -)	70.4 (10; 5.4)	- -	- -	- -
2007	F	- -	- -	74.0 (16; 5.3)	73.0 (1; - -)	- -	93.0 (2; 2.8)
2006	M	49.5 (2; 2.1)	- -	66.2 (10; 10.1)	- -	- -	- -
2006	F	- -	- -	72.1 (15; 3.7)	- -	85.0 (1; - -)	- -
2005	M	49.6 (10; 1.8)	- -	- -	82.0 (1; - -)	- -	- -
2005	F	- -	- -	- -	81.0 (4; 8.0)	- -	88.5 (2; 3.5)
2004	M	49.0 (1; - -)	45.7 (3; 2.3)	72.2 (6; 9.0)	71.6 (21; 7.0)	- -	- -
2004	F	- -	- -	73.0 (16; 3.5)	75.8 (20; 5.6)	- -	- -
2003	M	50.7 (3; 3.1)	50.0 (4; 3.2)	- -	67.0 (1; - -)	- -	- -
2003	F	- -	- -	70.7 (3; 7.5)	- -	- -	93.4 (5; 0.9)
2002	M	46.3 (4; 5.3)	- -	- -	- -	- -	- -

Appendix C, continued.

Brood	Sex	Age-3		Age-4		Age-5	
		H	W	H	W	H	W
2002	F	- -	- -	75.0 (5; 2.7)	- -	- -	- -
2001	M	63.0 (2; 2.8)	52.5 (2; 2.1)	79.3 (4; 5.6)	75.3 (22; 4.5)	- -	- -
2001	F	- -	- -	76.9 (7; 2.1)	79.6 (7; 1.5)	92.5 (2; 9.2)	88.0 (1; - -)
2000	M	- -	45.0 (1; - -)	- -	- -	- -	98.0 (2; 1.4)
2000	F	- -	- -	75.1 (38; 3.6)	- -	- -	91.0 (3; 1)
1999	M	- -	- -	- -	- -	- -	- -
1999	F	- -	- -	- -	78.5 (13; 3.1)	- -	89.3 (3; 2.1)
1998	M	- -	- -	- -	- -	- -	- -
1998	F	- -	- -	77.0 (2; 1.4)	- -	76.5 (4; 16.3)	- -
				Chewuch spring Chinook salmon			
1996	F	- -	- -	76.4 (5; 2.9)	- -	- -	- -
1994	M	- -	- -	- -	80.0 (1; - -)	- -	- -
1994	F	- -	- -	- -	74.0 (1; - -)	- -	80.5 (4; 2.6)

Appendix D. Mean fecundity (*N*; SD) of Wells Complex hatchery broodstocks by total age and origin.

Brood	Age-3		Age-4		Age-5		Age-6	Brood total
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	
				Wells summer Chinook salmon				
2009	- -	- -	4,403 (36; 875)	4,696 (7; 1,024)	4,384 (36; 918)	6,692 (1; - -)	4,928 (6; 575)	4,478 (87; 911)
2008	4,106 (4; 1,157)	4,544 (1; - -)	4,443 (43; 964)	4,104 (3; 1,089)	4,918 (37; 940)	4,944 (1; - -)	5,000 (12; 821)	4,666 (101; 963)
2007	3,137 (1; - -)	2,906 (1; - -)	4,016 (10; 900)	- -	4,708 (66; 949)	- -	4,595 (6; 602)	4,616 (87; 963)
2006	- -	- -	3,877 (11; 672)	- -	4,412 (55; 898)	4,154 (4; 641)	4,959 (10; 1,071)	4,420 (87; 967)
2005	- -	- -	3,729 (14; 677)	3,592 (4; 756)	4,264 (63; 694)	4,502 (2; 49)	5,459 (3; 1,029)	4,193 (86; 763)
2003	- -	- -	3,907 (12; 851)	4,427 (3; 1,662)	4,711 (104; 832)	4,190 (1; - -)	4,872 (8; 495)	4,635 (128; 862)
2002	- -	- -	4,742 (13; 648)	- -	5,287 (105; 869)	- -	5,186 (3; 404)	5,226 (121; 853)
2001	- -	- -	4,320 (96; 732)	5,356 (3; 749)	5,011 (91; 896)	5,474 (3; 437)	4,951 (7; 658)	4,689 (200; 878)
2000	2,371 (1; - -)	- -	4,126 (72; 829)	4,582 (10; 998)	4,695 (76; 921)	4,754 (11; 720)	6,598 (1; - -)	4,450 (171; 937)
1999	2,818 (2; 531)	- -	3,848 (30; 925)	3,243 (7; 824)	3,802 (24; 1,197)	4,345 (5; 1,364)	4,736 (15; 946)	3,949 (83; 1,099)
				Twisp spring Chinook salmon				
2009	- -	- -	3,890 (8; 544)	4,402 (6; 823)	4,475 (3; 1,079)	- -	- -	4,174 (17; 751)
2008	- -	- -	3,537 (17; 701)	3,204 (8; 871)	4,499 (1; - -)	- -	- -	3,471 (26; 771)
2007	- -	- -	3,298 (16; 685)	2,860 (1; - -)	- -	5,097 (2; 1,515)	- -	3,464 (19; 927)
2006	- -	- -	3,301 (15; 621)	- -	- -	- -	- -	3,301 (15; 621)
2005	- -	- -	- -	4,216 (4; 641)	- -	4,745 (2; 123)	- -	4,393 (6; 569)
2004	- -	- -	3,496 (16; 633)	3,811 (20; 1,060)	- -	- -	- -	3,671 (36; 898)
2003	- -	- -	3,195 (11; 519)	- -	- -	5,867 (5; 512)	- -	4,012 (17; 1,332)
2002	- -	- -	4,652 (2; 664)	- -	- -	- -	- -	4,652 (2; 664)
2001	- -	- -	3,922 (7; 579)	4,617 (6; 534)	4,941 (1; - -)	4,902 (2; 612)	- -	4,369 (16; 657)
2000	- -	- -	3,820 (38; 698)	- -	- -	5,292 (3; 997)	- -	3,927 (41; 807)
				Methow Composite spring Chinook salmon				
2009	4,411 (1; - -)	- -	3,853 (98; 714)	3,956 (38; 627)	4,694 (2; 558)	5,218 (10; 627)	- -	3,987 (150; 760)
2008	3,211 (1; - -)	- -	3,683 (175; 697)	3,515 (16; 691)	4,866 (7; 857)	3,850 (3; 813)	- -	3,711 (202; 733)
2007	- -	- -	3,341 (43; 792)	- -	4,461 (21; 919)	4,853 (9; 605)	- -	3,850 (73; 1,015)
2006	- -	- -	3,428 (159; 781)	3,894 (3; 661)	4,061 (8; 721)	4,707 (1; - -)	- -	3,481 (173; 789)

Appendix D, continued.

Brood	Age-3		Age-4		Age-5		Age-6	Brood total
	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	
2005	- -	- -	3,475 (98; 809)	3,823 (2; 482)	3,261 (1; - -)	- -	- -	3,480 (101; 800)
2004	- -	- -	3,510 (144; 745)	3,565 (1; - -)	3,510 (1; - -)	- -	- -	3,506 (148; 735)
2003	- -	- -	3,795 (17; 759)	- -	4,839 (31; 1,403)	- -	- -	4,469 (48; 1,306)
2002	- -	- -	3,905 (125; 682)	- -	3,318 (4; 342)	- -	- -	3,887 (129; 681)
2001	- -	- -	3,938 (90; 764)	3,753 (10; 706)	- -	- -	- -	3,920 (100; 758)
2000	- -	- -	3,759 (74; 678)	- -	- -	- -	- -	3,759 (74; 678)

Appendix D, continued.

Brood	1-salt		2-salt		Brood total
	Hatchery	Wild	Hatchery	Wild	
			Wells Hatchery summer steelhead		
2010	4,979 (48; 1,214)	4,283 (11; 1,266)	6,502 (81; 1,510)	6,046 (14; 883)	5,836 (156; 1,566)
2009	5,380 (60; 895)	4,971 (21; 1,247)	7,206 (51; 1,574)	6,718 (17; 1,466)	6,102 (150; 1,562)
2008	5,526 (66; 980)	5,434 (41; 1,099)	6,682 (57; 1,319)	6,171 (13; 1,135)	5,946 (180; 1,264)
2007	4,715 (125; 849)	4,881 (10; 888)	5,868 (46; 1,598)	6,116 (4; 1,748)	5,107 (198; 1,274)
2006	4,652 (13; 815)	4,203 (7; 189)	6,858 (80; 1,538)	6,397 (35; 1,205)	6,387 (135; 1,580)
2005	4,547 (28; 795)	5,370 (13; 1,084)	6,575 (129; 1,317)	6,627 (24; 1,455)	6,208 (194; 1,457)
2004	4,543 (111; 814)	4,517 (54; 1,072)	5,865 (6; 885)	4,832 (9; 1,222)	4,594 (180; 947)
2003	4,241 (17; 600)	- -	6,545 (130; 1,210)	6,954 (18; 1,357)	6,352 (165; 1,382)
2002	4,786 (48; 1,048)	4,721 (5; 1,051)	6,744 (144; 1,221)	6,586 (9; 1,859)	6,232 (206; 1,477)
2001	4,356 (65; 1,093)	3,865 (6; 1,436)	6,624 (94; 1,411)	6,714 (3; 1,155)	5,650 (168; 1,721)
2000	4,837 (26; 1,485)	5,760 (3; 405)	6,049 (31; 1,360)	- -	5,509 (60; 1,495)

Appendix E. Results of ELISA sampling conducted on Wells Complex hatchery Chinook salmon broodstocks by category. The value listed within each category is the percent of the total number of female Chinook salmon that fell within that category for each brood, excluding captive brood and non-viable females. For spring Chinook stocks, the percent of females by category after culling is listed in parenthesis.

Brood	Below-low	Low	Med	High	Total number
	<0.099	0.099 - 0.199	0.20 - 0.449	> 0.450	
			Wells summer Chinook salmon		
2009	99.7	0.3	0.0	0.0	272
2008	99.6	0.4	0.0	0.0	239
2007	98.2	1.8	0.0	0.0	166
2006	100.0	0.0	0.0	0.0	167
2005	98.9	0.5	0.0	0.5	190
2004	95.0	5.0	0.0	0.0	20
2003	94.9	2.0	2.0	1.0	99
2002	93.9	2.4	0.0	3.7	82
2001	99.3	0.0	0.0	0.7	139
2000	87.9	8.8	3.3	0.0	91
1999	99.1	0.9	0.0	0.0	106
1998	91.7	5.5	1.8	0.9	109
1997	88.6	7.6	1.1	2.7	185
1996	99.0	0.5	0.0	0.5	196
1995	78.8	12.9	1.8	6.5	170
1994	97.2	1.7	0.0	1.1	181
1993	100.0	0.0	0.0	0.0	132
			Methow Composite spring Chinook salmon		
2009	84.6 (95.5)	12.7 (4.5)	1.3 (- -)	1.3 (- -)	150 (132)
2008	91.0 (98.6)	8.0 (1.4)	1.0 (- -)	0.0	201 (139)
2007	93.2 (93.2)	4.1 (4.1)	1.4 (1.4)	1.3 (1.3)	73 (73)
2006	73.8 (88.1)	24.0 (11.9)	0.0	2.2 (- -)	179 (143)
2005	89.8 (89.8)	6.3 (6.3)	0.0	3.9 (3.9)	128 (128)
2004	45.6 (67.0)	13.6 (20.0)	10.9 (13.0)	29.9 (- -)	147 (100)
2003	39.5 (34.1)	32.9 (34.0)	6.6 (6.4)	21.0 (25.5)	76 (47)
2002	51.6 (74.8)	37.8 (25.2)	2.4 (- -)	8.2 (- -)	328 (119)
2001	66.7 (76.9)	13.0 (10.5)	2.8 (2.1)	17.5 (10.5)	177 (95)
2000	87.5 (78.3)	9.2 (18.9)	1.1 (1.4)	2.2 (1.4)	185 (74)
1999	78.8 (70.4)	15.3 (20.5)	1.7 (2.3)	4.2 (6.8)	118 (44)
1998	73.6 (73.1)	9.8 (7.7)	3.1 (3.8)	13.5 (15.4)	163 (104)
			Methow spring Chinook salmon		
1997	29.4 (28.7)	51.4 (55.7)	11.3 (15.6)	7.9 (- -)	177 (122)
1996	83.9 (83.6)	10.7 (10.9)	0.0	5.4 (5.5)	56 (55)
1995	14.3 (14.3)	42.8 (42.8)	14.3 (14.3)	28.6 (28.6)	7 (7)
1994	44.5 (100.0)	44.4 (- -)	0.0	11.1 (- -)	9 (1)
1993	38.8 (38.8)	46.9 (46.9)	4.1 (4.1)	10.2 (10.2)	49 (49)

Appendix E, continued.

Brood	Below-low <0.099	Low 0.099 - 0.199	Med 0.20 - 0.449	High > 0.450	Total number
			Twisp spring Chinook salmon		
2009	70.6 (70.6)	29.4 (29.4)	0.0	0.0	17 (17)
2008	96.0 (95.7)	4.0 (4.3)	0.0	0.0	25 (23)
2007	94.1 (94.1)	0.0	5.9 (5.9)	0.0	17 (17)
2006	80.0 (80.0)	13.3 (13.3)	0.0	6.7 (6.7)	15 (15)
2005	83.3 (83.3)	16.7 (16.7)	0.0	0.0	6 (6)
2004	64.9 (64.9)	21.6 (21.6)	10.8 (10.8)	2.7 (2.7)	37 (37)
2003	52.9 (52.9)	29.4 (29.4)	5.9 (5.9)	11.8 (11.8)	17 (17)
2002	80.0 (80.0)	20.0 (20.0)	0.0	0.0	5 (5)
2001	93.3 (93.3)	0.0	0.0	6.7 (6.7)	15 (15)
2000	82.9 (82.9)	17.1 (17.1)	0.0	0.0	41 (41)
1999	81.2 (81.2)	6.3 (6.3)	0.0	12.5 (12.5)	16 (16)
1998	50.0 (50.0)	33.3 (33.3)	0.0	16.7 (16.7)	6 (6)
1997	36.3 (36.3)	36.4 (36.4)	18.2 (18.2)	9.1 (9.1)	11 (11)
1996	68.2 (68.2)	18.2 (18.2)	4.5 (4.5)	9.1 (9.1)	22 (22)
1995	0.0	0.0	0.0	0.0	0.0
1994	25.0 (25.0)	50.0 (50.0)	0.0	25.0 (25.0)	4 (4)
1993	4.3 (4.3)	52.2 (52.2)	26.1 (26.1)	17.4 (17.4)	23 (23)
1992	0.0	77.8 (77.8)	11.1 (11.1)	11.1 (11.1)	9 (9)
			Chewuch spring Chinook salmon		
1997	35.9 (36.0)	28.2 (27.8)	28.2 (30.6)	7.7 (5.6)	39 (36)
1996	71.9 (71.9)	15.6 (15.6)	3.1 (3.1)	9.4 (9.4)	32 (32)
1995	0.0	0.0	0.0	0.0	0.0
1994	33.3 (33.3)	50.0 (50.0)	0.0	16.7 (16.7)	6 (6)
1993	30.5 (31.0)	33.9 (34.5)	6.8 (6.9)	28.8 (27.6)	59 (58)
1992	8.3 (8.3)	83.4 (83.4)	0.0	8.3 (8.3)	12 (12)

Appendix F. Hatchery life stage survival-rate standards and level achieved (%) by stock and broodyear. Pre-spawn survival of adult summer Chinook is listed under the yearling life history stage category.

Brood	Collection to spawning		Unfertilized egg to eyed	Eyed egg to ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg to release
	90.0 female	85.0 male	92.0	98.0	97.0	93.0	90.0	95.0	81.0
				Wells summer Chinook salmon yearling					
2009	96.0	97.2	95.2	100	97.6	97.5	95.5	- -	90.9
2008	97.0	94.6	93.2	97.6	99.8	99.4	92.0	- -	83.8
2007	97.2	98.2	87.9	98.3	99.9	99.7	93.0	- -	80.4
2006	96.4	97.3	82.0	99.3	99.4	99.2	97.8	- -	79.7
2005	96.8	98.9	87.5	100.0	99.2	99.0	92.0	- -	80.5
2004	98.3	98.2	92.0	100.0	99.0	98.9	96.7	- -	89.0
2003	96.8	98.4	86.4	99.8	99.2	99.2	97.7	- -	84.4
2002	94.2	97.0	94.1	100.0	99.6	99.6	92.4	- -	87.0
2001	97.1	93.9	95.3	98.8	99.4	99.4	35.9	- -	33.8
2000	98.3	95.2	93.8	99.9	99.5	99.4	99.0	- -	92.9
1999	97.3	96.3	92.3	97.1	98.0	98.0	97.5	- -	87.4
				Wells summer Chinook salmon subyearling					
2009	- -	- -	94.9	98.6	92.0	86.9	85.9	- -	80.3
2008	- -	- -	95.0	84.2	99.4	94.3	94.1	- -	75.3
2007	- -	- -	91.7	86.5	99.5	99.1	98.3	- -	78.0
2006	- -	- -	90.0	100.0	94.3	80.5	78.6	- -	70.8
2005	- -	- -	87.1	100.0	82.7	82.4	82.2	- -	71.6
2004	- -	- -	93.6	98.4	94.3	94.4	94.3	- -	87.0
2003	- -	- -	85.7	100.0	87.9	87.9	87.8	- -	75.3
2002	- -	- -	93.8	99.9	88.1	87.3	87.1	- -	81.7
2001	- -	- -	94.6	100.0	95.6	94.2	94.1	- -	89.1
2000	- -	- -	94.1	100.0	97.6	97.4	97.1	- -	91.4
1999	- -	- -	90.9	100.0	96.7	96.3	96.2	- -	87.5
				Wells summer steelhead					
2010	97.2	98.4	84.6	99.7	93.7	90.2	84.0	- -	67.9
2009	91.2	93.1	79.8	99.1	97.7	97.2	88.4	- -	69.9
2008	98.9	96.6	85.2	85.2	99.3	99.5	92.9	- -	67.5
2007	92.8	95.8	80.8	99.0	97.8	96.2	85.6	- -	68.4
2006	95.2	93.3	86.6	99.5	92.7	89.8	80.4	- -	69.3
2005	96.4	99.5	87.4	95.9	96.9	92.2	85.7	- -	71.8
2004	98.6	98.4	86.2	94.0	99.4	95.5	94.0	- -	76.1
2003	99.0	99.3	83.5	99.9	93.6	77.6	73.5	- -	61.3
2002	98.0	99.5	82.2	96.2	99.0	98.7	97.8	- -	77.3
2001	98.0	99.0	83.9	98.6	97.0	96.9	95.0	- -	78.6

Appendix F, continued.

Brood	Collection to spawning[a]		Unfertilized egg to eyed	Eyed egg to ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg to release
	90.0 female	85.0 male	92.0	98.0	97.0	93.0	90.0	95.0	81.0
2000	98.0	99.2	85.2	97.4	98.1	98.7	95.3	- -	79.1
1999	99.3	99.8	77.0	98.0	97.1	96.6	92.8	- -	70.0
Methow Composite spring Chinook salmon									
2009	100.0	99.2	95.9	100.0	99.5	99.4	96.8	99.9	92.5
2008	97.6	100.0	95.9	99.7	99.6	97.7	90.2	99.8	84.8
2007	98.6	98.8	92.9	96.0	98.8	98.2	94.5	99.1	84.2
2006	96.8	95.1	94.8	100.0	97.2	97.0	83.0	96.2	77.6
2005	99.0	99.1	96.1	100.0	99.6	99.5	90.4	99.6	87.7
2004	97.7	99.2	94.8	96.2	99.2	99.1	96.1	99.8	84.2
2003	96.3	97.2	90.0	100.0	98.8	98.3	93.0	99.8	77.9
2002	97.7	95.1	93.6	100.0	98.6	98.6	96.5	98.5	92.7
2001	98.9	97.3	96.1	100.0	99.3	99.1	97.0	99.8	90.8
2000	96.2	97.2	96.5	100.0	99.6	99.4	99.0	99.9	92.7
1999	96.0	96.3	97.4	100.0	99.5	99.5	99.2	N/A	92.5
Twisp spring Chinook salmon									
2009	100.0	100.0	97.3	99.9	99.8	98.7	97.6	99.6	94.9
2008	96.3	100.0	90.1	99.5	99.9	99.5	96.3	99.9	86.5
2007	100.0	100.0	92.4	96.0	99.4	98.4	88.6	99.7	78.6
2006	85.7	100.0	95.9	100.0	99.6	99.3	94.2	99.7	90.4
2005	100.0	100.0	95.7	98.2	99.6	99.5	99.2	99.9	93.2
2004	97.4	87.9	95.5	97.8	99.1	98.8	78.7	99.5	73.3
2003	100.0	88.2	91.8	99.8	98.8	98.5	95.9	100.0	86.4
2002	100.0	66.7	97.9	100.0	99.3	99.1	98.5	99.9	96.4
2001	93.8	88.2	91.1	100.0	99.0	95.7	90.1	100.0	81.2
2000	96.4	92.9	97.1	100.0	99.6	99.5	47.3	23.9	46.0
1999	100.0	95.7	94.3	100.0	99.2	99.0	98.0	99.7	92.3

[a] Collection to spawning survival includes all fish trapped for Methow Composite and Twisp programs at WDFW trapping locations (including Wells Dam); does not include captive brood programs.

Appendix G. Annual releases by program from Wells Complex Hatchery facilities. All Wells summer Chinook salmon were released into the Columbia River directly adjacent to Wells Hatchery. Twisp River spring Chinook only include yearling progeny of anadromous adults.

Brood	Release location						Wells summer Chinook salmon		
	Methow	Twisp	Chewuch	Okanogan	Columbia R.	Total	Subyearling	Yearling	Total
	Wells Hatchery steelhead								
2010	154,370	93,297	83,861	127,583	- -	459,111	442,821	- -	442,821
2009	125,801	74,766	92,760	101,090	- -	394,417	471,286	446,313	917,599
2008	103,236	104,903	100,373	146,633	- -	455,145	427,131	336,881	764,012
2007	99,464	100,446	92,670	147,782	- -	440,362	402,527	310,063	712,590
2006	96,219	111,770	107,545	135,547	- -	451,081	396,538	311,880	708,418
2005	99,820	107,245	119,500	146,826	- -	473,391	430,203	333,587	763,790
2004	86,041	96,405	82,280	78,940	- -	343,666	471,123	312,980	784,103
2003	80,580	117,545	78,205	79,605	- -	355,935	425,271	313,509	738,780
2002	96,420	105,323	117,495	141,890	- -	461,128	473,100	306,810	779,910
2001	94,020	84,475	85,615	126,855	- -	390,965	376,027	185,200	561,227
2000	116,830	109,950	99,490	228,770	- -	555,040	498,500	343,423	841,923
1999	139,900	136,680	138,300	144,650	47,782	607,312	363,600	312,098	675,698
1998	320,250	113,583	116,403	160,756	64,280	775,272	370,617	457,770	828,387
1997	127,020	126,000	125,300	100,005	64,703	543,028	541,923	381,687	923,610
1996	310,480	- -	- -	99,720	17,500	427,700	473,000	356,707	829,707
1995	242,400	- -	- -	67,500	18,200	328,100	408,000	290,000	698,000
1994	359,170	- -	- -	91,225	- -	450,395	450,935	365,000	815,935
1993	324,200	- -	- -	95,910	- -	420,110	187,382	388,248	575,630
1992	392,815	- -	- -	118,408	- -	511,223	- -	331,353	331,353
	Methow Hatchery spring Chinook salmon								
2009	347,993	67,031	149,863	- -	- -	564,887			
2008	201,290	78,656	260,344	- -	- -	540,290			
2007	119,407	54,096	126,055	- -	- -	299,558			
2006	249,504	45,892	154,381	- -	- -	449,777			
2005	156,633	27,658	232,811	- -	- -	417,102			
2004	65,146	96,617	204,906	- -	- -	366,669			
2003	48,831	43,734	127,614	- -	- -	220,179			
2002	181,235	20,541	254,238	- -	- -	456,014			
2001	148,128	51,652	244,043	- -	- -	443,823			
2000	66,454	74,717	199,938	- -	- -	341,109			
1999	180,775	67,408	--	- -	- -	248,183			
1998	218,499	15,470	217,171	- -	- -	451,140			
1997	332,484	26,714	132,759	- -	- -	491,957			
1996	202,947	76,687	91,672	- -	- -	371,306			
1995	28,878	--	--	- -	- -	28,878			
1994	4,477	19,835	11,854	- -	- -	36,166			
1993	210,849	116,749	284,165	- -	- -	611,763			
1992	--	35,853	40,881	- -	- -	76,734			

Appendix H. Coded-wire tagged releases from Wells Complex Hatchery facilities. Spring Chinook salmon releases include high ELISA (HE) progeny. Mixed indicates that a single tag code was used for more than one release site and are listed as Chewuch River fish by default.

Brood	Program	Release date	Days acclimated	Mark code		Mark release (*N*)			Total
				Hatchery	CWT	Marked	No mark	Rate	
				Wells summer steelhead					
2009	H x H	14-Apr-10	- -	Ad-clip	635083	55,530	45,560	0.5493	101,090
2007	H x W	21-Apr-08	- -	Ad-clip	633398	117,030	175,550	0.3999	292,580
2005	H x W	01-May-06	- -	Ad-clip	632895	228,355	6,772	0.9712	235,127
				Wells summer Chinook salmon					
2008	Subyearling	11-May-09	21	Ad-clip	634876	415,104	12,027	0.9718	427,131
2007	Subyearling	13-May-08	0	Ad-clip	633872	155,376	3,420	0.9784	158,796
2007	Subyearling	16-Jun-08	0	Ad-clip	633871	242,123	2,360	0.9903	244,483
2006	Subyearling	16-May-07	0	Ad-clip	633385	202,950	1,575	0.9922	204,525
2006	Subyearling	13-Jun-07	0	Ad-clip	633386	190,669	1,344	0.993	192,013
2005	Subyearling	12-May-06	0	Ad-clip	633298	200,461	4,509	0.978	204,970
2005	Subyearling	14-Jun-06	0	Ad-clip	633299	223,048	2,185	0.9903	225,233
2004	Subyearling	13-Jun-05	0	Ad-clip	632285	235,256	5,218	0.9783	240,474
2004	Subyearling	18-May-05	0	Ad-clip	632286	222,069	8,580	0.9628	230,649
2003	Subyearling	14-Jun-04	0	Ad-clip	632370	201,200	9,570	0.9546	210,770
2003	Subyearling	11-May-04	0	Ad-clip	632371	192,558	21,943	0.8977	214,501
2002	Subyearling	16-Jun-03	0	Ad-clip	631368	233,322	1,882	0.992	235,204
2002	Subyearling	16-Jun-03	0	Ad-clip	631370	233,431	4,466	0.9812	237,897
2001	Subyearling	17-Jun-02	0	Ad-clip	631423	368,533	7,494	0.9801	376,027
2000	Subyearling	20-Jun-01	0	Ad-clip	630775	498,500	0	1	498,500
1999	Subyearling	19-Jun-00	0	Ad-clip	630267	350,361	13,239	0.9636	363,600
1998	Subyearling	18-Jun-99	0	Ad-clip	631018	362,362	8,255	0.9777	370,617
1997	Subyearling	04-Jun-98	0	Ad-clip	630602	528,438	13,485	0.9751	541,923
1996	Subyearling	18-Jun-97	0	Ad-clip	636054	232,232	5,214	0.978	237,446
1996	Subyearling	18-Jun-97	0	Ad-clip	636323	230,381	5,173	0.978	235,554
1995	Subyearling	13-Jun-96	0	Ad-clip	635841	229,757	11,110	0.9539	240,867
1995	Subyearling	13-Jun-96	0	Ad-clip	636044	159,424	7,709	0.9539	167,133
1994	Subyearling	15-Jun-95	0	Ad-clip	635546	211,875	6,047	0.9723	217,922
1994	Subyearling	15-Jun-95	0	Ad-clip	635703	226,547	6,466	0.9723	233,013
1993	Subyearling	28-Jun-94	0	Ad-clip	635145	183,199	4,813	0.9777	188,012
2008	Yearling	16-Apr-10	124	Ad-clip	635092	169,091	2,718	0.9841	171,809
2008	Yearling	16-Apr-10	124	Ad-clip	635093	162,461	2,611	0.9841	165,072
2007	Yearling	15-Apr-09	125	Ad-clip	634390	173,218	2,181	0.9875	175,399
2007	Yearling	15-Apr-09	125	Ad-clip	634287	132,990	1,674	0.9875	134,664
2006	Yearling	06-Apr-08	97	Ad-clip	633799	310,106	1,774	0.9943	311,880
2005	Yearling	23-Apr-07	137	Ad-clip	633596	322,445	11,142	0.9666	333,587
2004	Yearling	21-Apr-06	137	Ad-clip	632799	147,802	8,288	0.9469	156,090

Appendix H, continued.

Brood	Program	Release date	Days acclimated	Mark code		Mark release (*N*)			Total
				Hatchery	CWT	Marked	No mark	Rate	
2004	Yearling	22-Apr-06	137	Ad-clip	632864	148,559	8,331	0.9468	156,890
2003	Yearling	11-Apr-05	166	Ad-clip	632580	306,894	6,615	0.9789	313,509
2002	Yearling	19-Apr-04	166	Ad-clip	631890	302,905	3,905	0.9873	306,810
2001	Yearling	21-Apr-03	166	Ad-clip	631549	183,591	1,609	0.9913	185,200
2000	Yearling	15-Apr-02	166	Ad-clip	630995	337,913	7,591	0.978	345,504
1999	Yearling	16-Apr-01	166	Ad-clip	630468	305,947	6,151	0.9803	312,098
1998	Yearling	18-Apr-00	166	Ad-clip	631061	437,235	20,535	0.9551	457,770
1997	Yearling	15-Apr-99	166	Ad-clip	630611	374,268	7,419	0.9806	381,687
1996	Yearling	15-Apr-98	166	Ad-clip	630134	199,585	3,306	0.9837	202,891
1996	Yearling	15-Apr-98	166	Ad-clip	630217	143,295	2,373	0.9837	145,668
1995	Yearling	01-Apr-97	166	Ad-clip	634129	187,847	3,153	0.9835	191,000
1995	Yearling	01-Apr-97	166	Ad-clip	634130	96,720	2,280	0.977	99,000
1994	Yearling	01-Apr-96	166	Ad-clip	635324	109,034	7,966	0.9319	117,000
1994	Yearling	01-Apr-96	166	Ad-clip	635838	242,786	5,214	0.979	248,000
1993	Yearling	15-Apr-95	166	Ad-clip	634610	131,625	3,594	0.9734	135,219
1993	Yearling	15-Apr-95	166	Ad-clip	635702	241,202	11,827	0.9533	253,029
1992	Yearling	27-Apr-94	166	Ad-clip	635005	209,245	122,108	0.6315	331,353
				Chewuch River spring Chinook salmon					
2008	MC Chewuch	15-Apr-10	38	None	635099	258,052	2,292	0.9911	260,344
2007	MC Chewuch	21-Apr-09	29	None	634294	99,242	760	0.992	100,002
2007	MC Chewuch	21-Apr-09	29	None	634471	25,852	201	0.992	26,053
2006	MC Chewuch	17-Apr-08	31	None	633884	151,046	3,335	0.979	154,381
2005	MC Chewuch	16-Apr-07	27	None	633294	230,716	2,095	0.991	232,811
2004	MC Chewuch	18-Apr-06	27	None	632899	202,468	2,438	0.988	204,906
2003	MC Chewuch	18-Apr-05	39	None	632566	54,598	341	0.994	54,939
2003	MC Chewuch	18-Apr-05	39	None	632569	71,432	1,243	0.983	72,675
2002	MC Chewuch	14-Apr-04	22	None	631976	249,763	4,475	0.982	254,238
2001	MC Chew. HE	23-Apr-03	0	None	631494	15,808	1,433	0.917	17,241
2001	MC Chewuch	21-Apr-03	26	None	631384	145,698	2,039	0.986	147,737
2001	MC Chewuch	21-Apr-03	26	None	631440	94,977	1,329	0.986	96,306
2000	MC Mixed	16-Apr-02	18	None	630776	255,124	11,268	0.958	266,392
1998	MC Mixed	17-Apr-00	36	Ad-clip	631024	412,613	23,057	0.947	435,670
1997	Chewuch	19-Apr-99	27	Ad-clip	630614	128,404	4,355	0.967	132,759
1996	Chewuch	15-Apr-98	21	Ad-clip	630233	79,493	12,179	0.867	91,672
1994	Chewuch	21-Apr-96	31	Ad-clip	635132	2,361	21	0.991	2,382
1994	Chewuch	21-Apr-96	31	Ad-clip	635416	3,805	33	0.991	3,838
1994	Chewuch	21-Apr-96	31	Ad-clip	635863	967	9	0.991	976
1994	Chewuch	21-Apr-96	31	Ad-clip	635903	310	3	0.99	313
1994	Chewuch	21-Apr-96	31	Ad-clip	635905	656	5	0.992	661
1994	Chewuch HE	21-Apr-96	31	Ad-clip	635415	3,652	32	0.991	3,684
1993	Chewuch	17-Apr-95	18	Ad-clip	634127	174,761	4,114	0.977	178,875
1993	Chewuch	17-Apr-95	18	Ad-clip	635350	23,236	461	0.981	23,697
1993	Chewuch HE	17-Apr-95	18	Ad-clip	635161	79,804	1,789	0.978	81,593
1992	Chewuch	18-Apr-94	3	Ad-clip	634331	2,577	10	0.996	2,587
1992	Chewuch	18-Apr-94	3	Ad-clip	634332	2,511	25	0.99	2,536

Appendix H, continued.

Brood	Program	Release date	Days acclimated	Mark code		Mark release (*N*)			Total
				Hatchery	CWT	Marked	No mark	Rate	
1992	Chewuch	18-Apr-94	3	Ad-clip	634848	4,148	- -	1	4,148
1992	Chewuch	18-Apr-94	3	Ad-clip	634850	4,432	43	0.99	4,475
1992	Chewuch	18-Apr-94	3	Ad-clip	635121	5,165	31	0.994	5,196
1992	Chewuch	18-Apr-94	3	Ad-clip	635123	4,051	25	0.994	4,076
1992	Chewuch	18-Apr-94	3	Ad-clip	635124	4,417	-	1	4,417
1992	Chewuch	18-Apr-94	3	Ad-clip	635133	3,414	27	0.992	3,441
1992	Chewuch	18-Apr-94	3	Ad-clip	635138	3,580	-	1	3,580
1992	Chewuch	18-Apr-94	3	Ad-clip	635139	3,120	6	0.998	3,126
1992	Chewuch	18-Apr-94	3	Ad-clip	635140	3,228	71	0.978	3,299
Methow River spring Chinook salmon									
2008	MC Methow	15-Apr-10	137	None	634866	174,353	1,346	0.9923	175,699
2007	MC Methow	21-Apr-09	152	None	634293	104,510	960	0.991	105,470
2007	MC Methow HE	21-Apr-09	152	None	634674	13,773	438	0.968	14,211
2006	MC Methow	16-Apr-08	168	None	633866	208,689	3,028	0.986	211,717
2006	MC Methow	23-Dec-06	13	Otolith	None	37,787	0	1	37,787
2005	MC Methow	16-Apr-07	153	None	633395	143,571	1,362	0.991	144,933
2005	MC Methow HE	16-Apr-07	153	None	633281	11,367	333	0.972	11,700
2004	MC Methow	18-Apr-06	169	None	631187	63,270	1,876	0.971	65,146
2004	MC Methow	25-Apr-05	0	None	632694	42,252	0	1	42,252
2003	MC Methow	18-Apr-05	169	None	632568	46,521	2,310	0.953	48,831
2002	MC Methow	02-Apr-04	7	None	631524	35,075	694	0.981	35,769
2002	MC Methow	14-Apr-04	42	None	631891	142,804	2,662	0.982	145,466
2001	MC Methow	21-Apr-03	82	None	630976	49,960	312	0.994	50,272
2001	MC Methow	21-Apr-03	82	None	631179	32,152	4,080	0.887	36,232
2001	MC Methow	21-Apr-03	82	None	631477	43,273	1,110	0.975	44,383
1999	MC Methow	17-Apr-01	171	Ad-clip	630377	161,827	5,454	0.967	167,281
1999	MC HE	17-Apr-01	171	Ad-clip	630380	13,198	296	0.978	13,494
1997	Methow	15-Apr-99	300	Ad-clip	630613	315,441	17,043	0.949	332,484
1996	Methow	15-Apr-98	300	Ad-clip	630130	182,343	3,962	0.979	186,305
1996	Methow	15-Apr-98	300	Ad-clip	630246	2,987	57	0.981	3,044
1996	Met. (Snake R)	15-Apr-98	300	Ad-clip	636315	8,763	167	0.981	8,930
1996	Methow HE	15-Apr-98	300	Ad-clip	630248	4,581	87	0.981	4,668
1995	Methow	15-Apr-97	350	Ad-clip	636037	5,218	4	0.999	5,222
1995	Methow	15-Apr-97	350	Ad-clip	636038	4,747	4	0.999	4,751
1995	Methow	15-Apr-97	350	Ad-clip	636039	4,035	5	0.999	4,040
1995	Methow	15-Apr-97	350	Ad-clip	636041	4,001	5	0.999	4,006
1995	Methow	15-Apr-97	350	Ad-clip	636042	3,536	5	0.999	3,541
1995	Methow HE	15-Apr-97	350	Ad-clip	636040	3,617	29	0.992	3,646
1995	Methow HE	15-Apr-97	350	Ad-clip	636043	3,647	25	0.993	3,672
1994	Methow	22-Apr-96	29	Ad-clip	635417	4,460	17	0.996	4,477
1993	Methow	15-Apr-95	227	Ad-clip	635551	187,496	2,235	0.988	189,731

Appendix H, continued.

Brood	Program	Release date	Days acclimated	Mark code		Mark release (*N*)			Total
				Hatchery	CWT	Marked	No mark	Rate	
1993	Methow HE	15-Apr-95	227	Ad-clip	635410	20,758	360	0.983	21,118
			Twisp River spring Chinook salmon						
2008	Twisp	15-Apr-10	43	None	635085	77,066	1,590	0.9797	78,656
2007	Twisp	25-Apr-09	10	None	634673	52,276	300	0.9943	52,576
2007	Twisp HE	25-Apr-09	10	None	634675	1,498	22	0.9857	1,520
2006	Twisp	21-Apr-08	41	None	633687	39,206	1,183	0.971	40,389
2006	Twisp HE	21-Apr-08	41	None	634068	5,292	211	0.962	5,503
2005	Twisp	16-Apr-07	34	None	633483	26,552	1,106	0.96	27,658
2004	Twisp	02-Apr-05	6	None	631508	3,643	0	1	3,643
2004	Twisp	22-Apr-06	28	None	632878	69,717	1,900	0.976	71,617
2004	Twisp HE	22-Apr-06	28	None	632988	24,380	620	0.975	25,000
2003	Twisp	18-Apr-05	35	None	632567	42,750	984	0.978	43,734
2003	Captive and HE	25-Apr-05	2	None	632499	44,660	2,114	0.955	46,774
2003	Captive and HE	25-Apr-05	2	None	632564	35,390	1,675	0.955	37,065
2003	Captive and HE	25-Apr-05	2	None	632565	8,999	426	0.955	9,425
2002	Twisp	13-Apr-04	27	None	631582	20,377	164	0.992	20,541
2002	Twisp Captive	13-Apr-04	28	None	631076	11,876	517	0.958	12,393
2002	Twisp Captive	13-Apr-04	28	None	631077	10,088	439	0.958	10,527
2002	Twisp Captive	13-Apr-04	28	None	631694	8,504	308	0.965	8,812
2002	Twisp Captive	13-Apr-04	0	None	631695	5,599	202	0.965	5,801
2001	Twisp	21-Apr-03	27	None	631478	50,454	1,198	0.977	51,652
2001	Twisp Captive	21-Apr-03	27	None	631068	5,656	163	0.972	5,819
2000	Twisp Captive	23-Apr-02	0	None	630994	978	9	0.991	987
2000	Twisp	15-Apr-02	20	None	630182	74,045	672	0.991	74,717
1999	Twisp	17-Apr-01	36	Ad-clip	630378	28,808	589	0.98	29,397
1999	Twisp	17-Apr-01	36	Ad-clip	630379	27,743	828	0.971	28,571
1999	Twisp HE	17-Apr-01	36	Ad-clip	630381	9,357	83	0.991	9,440
1998	Twisp	17-Apr-00	36	Ad-clip	631041	14,752	718	0.954	15,470
1997	Twisp	15-Apr-99	30	Ad-clip	630434	25,557	1,157	0.957	26,714
1996	Twisp	15-Apr-98	26	Ad-clip	636114	62,239	2,479	0.962	64,718
1996	Twisp	15-Apr-98	26	Ad-clip	636317	4,394	205	0.955	4,599
1996	Twisp HE	15-Apr-98	26	Ad-clip	636316	7,041	329	0.955	7,370
1994	Twisp	21-Apr-96	36	Ad-clip	634515	6,197	71	0.989	6,268
1994	Twisp	21-Apr-96	36	Ad-clip	635419	4,457	51	0.989	4,508
1994	Twisp	21-Apr-96	36	Ad-clip	635420	4,457	51	0.989	4,508
1994	Twisp HE	21-Apr-96	36	Ad-clip	635418	4,499	52	0.989	4,551
1993	Twisp	17-Apr-95	20	Ad-clip	635329	96,319	3,709	0.963	100,028
1993	Twisp HE	17-Apr-95	20	Ad-clip	635609	16,638	83	0.995	16,721
1992	Twisp	15-Apr-94	3	Ad-clip	634849	4,194	94	0.978	4,288
1992	Twisp	15-Apr-94	3	Ad-clip	634851	4,032	24	0.994	4,056
1992	Twisp	15-Apr-94	3	Ad-clip	635122	5,150	52	0.99	5,202
1992	Twisp	15-Apr-94	3	Ad-clip	635125	4,197	260	0.942	4,457
1992	Twisp	15-Apr-94	3	Ad-clip	635134	3,835	69	0.982	3,904

Appendix H, continued.

Brood	Program	Release date	Days acclimated	Mark code		Mark release (*N*)			Total
				Hatchery	CWT	Marked	No mark	Rate	
1992	Twisp	15-Apr-94	3	Ad-clip	635135	3,169	25	0.992	3,194
1992	Twisp	15-Apr-94	3	Ad-clip	635136	3,316	80	0.976	3,396
1992	Twisp	15-Apr-94	3	Ad-clip	635137	3,821	167	0.958	3,988
1992	Twisp	15-Apr-94	3	Ad-clip	635141	3,355	13	0.996	3,368

Appendix I. Mean fork length (mm), coefficient of variation (CV), weight (g), and fish per pound (FPP) for anadromous fish released from Wells and Methow hatcheries.

Brood	Fork Length			Weight			
	Mean	SD	CV	Mean	SD	CV	FPP
Wells yearling summer Chinook salmon							
2009	168.0	12.6	7.5	47.9	9.7	20.2	9.5
2008	170.0	18.2	10.7	56.0	15.5	27.7	8.1
2007	173.0	9.9	5.7	52.3	9.4	18.0	8.6
2006	153.8	11.1	7.2	41.1	8.6	20.9	11.0
2005	154.9	13.4	8.6	42.1	10.6	25.1	10.7
2004	170.8	11.0	6.4	52.0	10.4	20.0	8.7
2003	157.0	19.8	12.6	45.0	16.4	36.4	10.1
2002	156.0	13.4	8.6	46.7	11.8	25.3	9.7
2001	155.7	12.3	7.9	43.8	10.0	22.8	10.3
2000	161.2	11.6	7.2	47.9	11.1	23.2	9.5
1999	159.5	9.8	6.1	44.5	8.3	18.7	10.2
1998	183.6	13.6	7.4	74.1	16.6	22.4	6.1
1997	202.1	19.5	9.6	75.6	- -	- -	6.0
Wells subyearling summer Chinook salmon							
2009	84.0	10.9	12.9	6.7	- -	- -	67.5
2008	88.5	6.8	7.6	8.6	2.3	26.7	52.9
2007	108.1	7.3	6.7	13.5	- -	- -	33.5
2006	111.0	10.3	9.3	14.9	- -	- -	30.4
2005	108.5	7.4	6.8	14.3	3.6	25.3	31.7
2004	109.5	6.1	5.6	15.0	2.8	18.7	30.2
2003	115.4	7.2	6.2	18.9	4.4	23.5	24.0
2002	108.1	8.0	7.4	14.7	3.6	25.0	30.9
2001	116.9	7.6	6.5	20.6	4.8	23.5	21.9
2000	111.3	8.5	7.6	16.9	4.9	28.9	26.7
1999	122.1	9.2	7.5	24.5	6.6	27.1	18.5
1998	116.5	8.0	6.9	18.3	5.1	27.9	24.7
Wells H x H steelhead							
2010	192.3	23.7	12.3	76.8	27.3	35.5	5.9
2009	172.5	28.6	16.6	63.6	32.5	51.1	7.1
2008	185.7	24.5	13.1	69.0	26.8	38.9	6.5
2007	181.4	15.3	8.4	67.3	16.6	24.7	6.7
2006	180.6	21.9	12.1	65.7	22.3	33.8	6.9
2005	171.4	18.7	10.9	56.8	17.1	30.1	7.9
2004	192.4	21.7	11.3	82.4	28.8	34.9	5.4
2003	189.9	19.4	10.2	79.9	23.4	29.3	5.6
2002	188.5	19.6	10.4	75.9	22.6	29.8	5.9
2001	194.7	15.4	7.9	87.3	20.7	23.7	5.1
2000	172.9	22.4	13.0	60.0	21.3	35.5	7.5
1999	189.4	18.1	9.6	76.8	20.8	27.1	5.9

Appendix I, continued.

Brood	Fork Length			Weight			
	Mean	SD	CV	Mean	SD	CV	FPP
				Wells H x W steelhead			
2010	199.3	22.9	11.5	83.5	27.7	33.2	5.4
2009	183.4	29.2	15.9	74.8	35.7	47.7	6.1
2008	189.7	22.4	11.8	77.0	27.2	35.3	5.8
2007	178.3	16.1	9.0	63.5	17.4	27.4	7.1
2006	181.5	20.4	11.2	68.8	23.1	33.1	6.5
2005	168.4	16.4	9.7	53.3	15.0	28.3	8.5
2004	184.5	24.3	13.1	72.2	29.1	40.2	6.2
2003	163.2	29.7	18.2	62.1	--	--	7.3
2002	187.9	24.1	12.8	73.1	26.7	36.5	6.2
2001	181.8	26.9	14.8	72.9	30.5	41.9	6.2
2000	178.6	20.9	11.7	66.7	21.7	32.5	6.7
1999	195.4	18.2	9.3	83.0	21.3	25.7	5.4
1998	191.8	18.9	9.9	79.4	23.6	29.7	5.7
				Twisp River spring Chinook salmon			
2009	144.6	16.0	11.1	37.2	12.0	32.3	12.2
2008	128.7	11.8	9.1	26.8	7.8	29.1	16.8
2007	127.5	13.6	10.6	24.9	9.3	37.4	18.2
2006	134.0	11.1	8.3	29.6	8.3	28.1	15.3
2005	139.0	10.0	7.2	33.9	7.8	22.9	13.0
2004	130.2	14.6	11.2	27.9	12.0	43.0	16.2
2003	132.8	11.1	8.4	28.2	7.9	28.0	16.1
2002	135.9	9.6	7.1	30.3	7.2	23.8	15.0
2001	122.5	10.0	8.2	21.6	- -	- -	21.0
2000	133.4	6.8	5.1	27.2	- -	- -	16.7
1999	155.9	15.5	9.9	47.7	15.7	32.9	9.5
1998	138.0	10.6	7.7	30.3	7.6	25.1	15.0
1997	133.4	- -	- -	28.2	- -	- -	16.1
1996	137.2	- -	- -	30.7	- -	- -	14.8
1995	na	na	na	na	na	na	Na
1994	138.5	- -	- -	31.4	- -	- -	14.4
1993	132.9	- -	- -	29.8	- -	- -	15.2
1992	135.0	- -	- -	30.0	- -	- -	15.1
				Methow River spring Chinook salmon			
2009	124.2	16.0	9.6	22.9	7.1	31.0	19.8
2008	125.9	12.2	9.7	24.0	7	29.5	18.9
2007	130.8	14.0	10.7	27.0	9.3	34.4	16.8
2006	127.6	15.8	12.4	25.3	12.0	47.6	17.9
2005	130.8	13.9	10.6	27.4	9.3	34.1	17.0
2004	137.3	7.3	5.3	32.1	5.7	17.7	14.1
2003	135.0	10.9	8.1	28.4	6.5	23.0	16.0
2002	132.5	12.5	9.4	28.7	8.1	28.2	15.8

Appendix I, continued.

Brood	Fork Length			Weight			
	Mean	SD	CV	Mean	SD	CV	FPP
2001	132.8	- -	- -	28.4	- -	- -	16.0
2000	131.3	6.8	5.2	26.8	4.8	18.0	16.9
1999	151.0	14.3	9.5	40.9	13.1	100.0	11.0
1998	133.9	6.7	5.0	28.3	5.6	19.8	16.0
1997	126.5	- -	- -	24.7	- -	- -	18.3
1996	128.2	- -	- -	25.0	- -	- -	18.1
1995	134.9	- -	- -	32.2	- -	- -	14.1
1994	132.0	- -	- -	31.2	- -	- -	14.5
1993	134.8	- -	- -	28.5	- -	- -	15.9
1992	na	na	na	na	na	na	Na
Chewuch River spring Chinook salmon							
2009	135.4	19.6	14.5	30.8	14.3	46.4	14.7
2008	133.8	17.1	12.8	30.3	12.2	40.3	15.0
2007	145.5	29.0	20.0	43.3	28.8	66.5	10.4
2006	115.7	10.9	9.4	19.2	6.2	32.3	23.7
2005	126.0	15.3	12.2	24.7	10.2	41.1	18.0
2004	144.1	20.8	14.4	42.4	21.0	49.6	10.7
2003	131.0	11.7	8.9	27.6	7.9	28.6	16.4
2002	142.5	16.1	11.3	35.0	13.2	37.7	12.9
2001	133.8	6.7	5.0	30.2	- -	- -	15.0
2000	131.3	6.8	5.2	26.8	4.8	18.0	16.9
1999	na	na	na	na	na	na	Na
1998	127.9	8.7	6.8	24.6	5.0	20.1	18.4
1997	132.7	- -	- -	27.9	- -	- -	16.2
1996	129.8	- -	- -	22.7	- -	- -	20.0
1995	na	na	na	na	na	na	Na
1994	145.7	- -	- -	35.7	- -	- -	12.7
1993	134.5	- -	- -	27.7	- -	- -	16.4
1992	141.8	- -	- -	30.0	- -	- -	15.1

Chapter 2

Harvest and Straying of Hatchery Origin Fish Released From Wells Complex Hatchery Facilities.

Abstract

All stocks of salmon and steelhead covered in this chapter were subject to commercial, sport, or tribal fisheries in ocean and freshwater environments. Based on analysis of coded-wire tag data, most Wells summer Chinook salmon adults were recovered in fisheries, while most Methow spring Chinook salmon stocks were recovered in hatchery broodstocks or on spawning grounds. For the current brood examined (2005), harvest of hatchery and wild Methow Basin spring Chinook totaled 3.6% of the total return of each group. Unlike earlier hatchery releases, recent releases of Methow spring Chinook salmon have not been adipose fin-clipped, which may result in a decrease in harvest rates and an increase in recoveries of coded-wire tagged fish on the spawning grounds. For the most recent broods examined, greater than 5% of the total return of spring Chinook salmon released into the Twisp and Chewuch rivers strayed to non-target spawning grounds within the Methow Basin. Less than 5% of the total brood return of Methow spring Chinook and Wells yearling summer Chinook were recovered in non-target spawning grounds. Greater than 5% of the Wells subyearling summer Chinook strayed to non-target spawning grounds. For the 2010 return year, Wells summer Chinook salmon comprised less than 5% of other independent populations. The Chelan River does not have an independent population of summer Chinook salmon; however, 8.9% of the summer Chinook spawning in 2010 in the Chelan River was composed of fish originating from Wells Hatchery releases. Local creel census was used to monitor harvest in selective (steelhead), and non-selective (summer Chinook salmon) fisheries occurring in the upper Columbia River ESU. An estimated 4,711 summer Chinook salmon, 4,943 hatchery steelhead (46.5% of hatchery returns), and 89 wild steelhead were directly or indirectly removed through sport fisheries in 2011. Overall, Wells Complex hatchery fish provided commercial, recreational, and limited tribal harvest, while meeting escapement requirements in that most spring Chinook salmon were recovered in broodstocks or on spawning grounds, and most summer Chinook salmon were recovered in fisheries.

Introduction

Wells Complex hatchery facilities funded by Douglas County Public Utility District release juvenile salmonids as compensation for the inundation of mainstem spawning habitat resulting from the construction of the Wells Hydroelectric Project (original inundation compensation) and for mortality associated with passage at the Wells Hydroelectric Project (NNI compensation). Hatchery releases are intended to supplement natural populations (Methow spring Chinook salmon; Methow and Okanogan summer steelhead) or to produce fish for commercial and recreational harvest (Wells summer Chinook salmon, and steelhead released for inundation compensation). However, hatchery fish can stray into other populations, potentially creating genetic and/or ecological risks to recipient populations. Some hatchery fish released from Wells Complex facilities are heavily exploited in marine areas along the Pacific coast from Washington to Alaska by sport, commercial, and tribal harvest. In years of high post-release survival, returning hatchery fish can exceed the level necessary for broodstock and natural spawning purposes, thereby providing excess fish for local harvest. The information presented in this chapter will specifically address the following M&E Plan objectives:

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation.

- Ho: Stray rate hatchery fish < 5% of total brood return
- Ho: Stray hatchery fish < 5% of spawning escapement (based on run year) within other independent populations
- Ho: Stray hatchery fish < 10% of spawning escapement (based on run year) of any non-target streams within independent population

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate (e.g., Wells Chinook salmon).

- Ho: Harvest rate ≤ Maximum level to meet program goals
- Ho: Escapement ≤ Maximum level to meet supplementation goals

Hatchery fish released from Wells Complex facilities were marked prior to release to identify stock, genetic origin, or release location. Hatchery marking differs by stock depending on management requirements of each species, or as mandated by federal permits (ESA section 10). The primary mark used by most agencies to denote hatchery origin is the adipose fin clip. In Chinook salmon stocks, an adipose fin clip also typically identifies the presence of a coded-wire tag (CWT). Because fish released for supplementation purposes are intended to contribute to natural spawning populations and therefore aid in ESA recovery efforts, many of the steelhead and spring Chinook salmon from Wells Complex hatcheries are marked with only a CWT or visual-implant elastomer. Leaving the adipose fin intact on these fish is designed to minimize extraction under mark-selective fisheries. When the return of hatchery fish is greater than that needed to meet broodstock and spawning escapement objectives, mark-selective fisheries may target the adipose fin-clipped portions of an ESA listed population to decrease the number of hatchery origin fish on the spawning grounds (e.g., Wells summer steelhead) or target both hatchery and wild origin fish (i.e., non-selective fishery) of non-ESA listed populations (e.g., summer Chinook salmon).

Local Chinook salmon fisheries target non-listed summer Chinook salmon and are temporally and spatially designed to avoid impacting ESA-listed spring Chinook salmon. Through the use of CWT recovery data, the effectiveness of this segregation can be assessed. Coded-wire tag data from fisheries, spawning grounds, or from hatcheries in the Pacific Region are stored in the Regional Mark Processing Center (RMPC) database. The RMPC is the central repository for all coded-wire tagged and otherwise associated release, catch, sample, and recovery data regarding anadromous salmonids in the greater Pacific Coast Region of the United States of America (RMPC Strategic Plan 2006-2009). The Regional Mark Information System database (RMIS) within the RMPC provides specific recovery data for individual tag codes, along with the sample rate used to derive the total number of recoveries by fishery type. The RMIS database is the primary tool for estimating the survival and extraction rate of adipose fin-clipped and CWT hatchery releases.

In addition to providing harvest estimates, CWT recoveries from spawning ground surveys provide the data necessary to estimate hatchery stray rates (see Chapter 5 for a more in depth assessment of straying). Hatchery fish may stray within their basin of release, or to other river basins, and may contribute to the loss of genetic variation within or between populations. In the upper Columbia River Basin, comprehensive spawning ground surveys are conducted in most river basins for all Chinook salmon stocks. Coded-wire tags extracted from carcasses and the overall carcass sample rates are stored in the RMIS database.

Estimating the impact of fisheries, both direct and indirect (i.e., hooking mortality), on wild fish is challenging. Although wild steelhead and spring Chinook salmon are ESA-listed species, some fish are undoubtedly captured in sport and commercial fisheries either as target species or as unintended by-catch. Estimating the total mortality of fisheries on wild stocks is necessary to make survival comparisons between hatchery and wild fish, and to better understand the risk associated with specific fisheries.

Methods

Hatchery Chinook Salmon

Fishery extraction and escapement rates of hatchery Chinook salmon, whether adipose fin-clipped or not, were calculated from CWT data available within the RMIS database. The RMIS database reports the number of fish observed and estimated for each type of recovery category. The data for each CWT code was sorted by fishery type, year of capture, and reporting agency. In the case of spawning ground and hatchery data, the specific stream or hatchery was also recorded.

Coded-wire tag data reported to RMIS is expanded by a sample rate generated by the agency reporting the data. In some cases, the expanded number of tags reported is less than the number actually observed. This typically occurs when the sample rate is unknown or not reported. In these instances, the observed number was used instead of the estimated number when calculating contribution rates. The sum of the estimated CWT recoveries was then expanded by the marking rate for the population to yield the total number of fish recovered. Mark rates for tagged populations were determined from quality control sampling of juvenile fish prior to release. These data were obtained from the RMIS website or from local quality control sampling documentation. Expanded recovery data was sorted by fishery code and site name, and grouped into four categories:

1. Broodstock
2. Spawning ground
3. Ocean fishery
4. Freshwater fishery

Within the broodstock and spawning ground categories, subcategories were employed to designate target areas (i.e., stream or hatchery of release), and non-target areas (i.e., stray locations). Within the ocean and freshwater categories, subcategories were developed to designate commercial, sport, or tribal harvests. The spawning ground subcategories of target and non-target streams were based on the release location of populations of fish where the entire tagged group was released in the same stream. Releases of 1998 and 2000 brood spring Chinook salmon in the Chewuch River were accomplished with a composite of Methow and Chewuch stocks or Methow Composite stock fish that were not uniquely tagged by release site. Thus, returning adults from these broods could not be identified by release site.

Wells summer Chinook salmon are propagated for harvest augmentation and released into the mainstem Columbia River. Because the purpose of the program is harvest, all spawning ground recoveries of hatchery summer Chinook were considered to be in non-target areas. For hatchery Chinook salmon stocks, observed stray rates were compared to target values using a one-sample t-test at a significance level of 0.05. Because the stray rate for a population may be related to the distance from Wells Hatchery, the proportion of each spawning population comprised of Wells summer Chinook yearling releases based on spawning ground recoveries was transformed (arcsine square root) and compared to the distance from Wells Hatchery.

Wild and Hatchery Spring Chinook Salmon

All of the spring Chinook salmon broods covered in this chapter were subject to sport, commercial, or tribal fisheries. Prior to 2001, these fisheries were able to retain spring Chinook salmon regardless of the presence or absence of an adipose fin (i.e., non-selective). Beginning in 2001, Columbia River sport fisheries have required that sport anglers be allowed to retain only adipose fin-clipped Chinook salmon (i.e., selective fisheries). Since 2002, both non-tribal sport and commercial fisheries in the Columbia River were conducted as selective fisheries. Because non-selective fisheries (i.e., tribal and ocean) retain spring Chinook salmon regardless of origin, the exploitation rate of specific hatchery stocks (e.g., Methow River) should be the same as for naturally produced fish from the same population. The number of wild fish harvested in non-selective fisheries can therefore be estimated from the exploitation rate of hatchery fish, assuming both components of the population are similarly exposed to the open fishery (i.e., same migration timing, spatial distribution, and susceptibility to the gear).

The exploitation rate of a hatchery stock was used to estimate the number of wild fish of a similar stock harvested in selective fisheries. Even though the retention of wild fish is not allowed, selective fisheries impact wild fish through indirect post-release mortality. Estimates of post-release mortality were calculated by multiplying the proportion of hatchery fish harvested in a specific fishery by the indirect mortality rate calculated for each fishery type. Indirect mortality rates have been determined for Columbia River selective fisheries (CRC 2012; Table 1).

Table 1. Indirect mortality rates for selective fisheries in the Columbia River.

Fishery	Indirect Mortality
Sport	10.0 %
Commercial	40.0 %

Summer Chinook Salmon Sport Fishery

A non-selective sport fishery on summer Chinook salmon upstream of Priest Rapids Dam began in 2001, and harvest was monitored through catch record card data. Starting in 2004, creel surveys were conducted for this summer Chinook sport fishery to:

1) Estimate sport harvest of summer Chinook and sockeye salmon.

2) Estimate rates of incidental catch and release of steelhead and Coho salmon.

3) Assist in the evaluation of the summer Chinook salmon hatchery programs.

We used a two-stage non-uniform probability sampling as described in Hahn et al. (1993). This method minimizes some of the problems associated with sampling large rivers containing disproportional angler effort per river section (Table 2).

Table 2. River section descriptions used for summer Chinook salmon creel surveys.

River Section Code	River Section Description
537	Priest Rapids Dam to Wanapum Dam
539	Wanapum Dam to Rock Island Dam
541	Rock Island Dam to Rocky Reach Dam
543	Rocky Reach Dam to Wells Dam
545	Wells Dam to Chief Joseph Dam
627/629	Okanogan and Similkameen rivers

Summer Steelhead Sport Fishery

Since ESA listing in 1997, steelhead returns have had to meet specific requirements for abundance and genetic composition before a local fishery could be considered. Because hatchery steelhead were not coded-wire tagged, no stock-specific fishery harvest estimate could be generated from the RMIS database. Instead, creel census was used to estimate harvest and indirect mortality (i.e., hooking mortality) associated with local fisheries. Creel census was conducted consistent with roving creel census methodologies described by Malvestuto et al. (1978). An estimated hooking mortality rate of 5% was used to estimate mortality of wild and hatchery fish released by sport anglers. Angler interviews produced a catch-per-unit-effort (CPU) statistic where one unit of effort was equal to one angler fishing for one hour. The total number of steelhead captured was determined by multiplying the total angler effort by the overall CPU for each fishery location.

Results

Hatchery Chinook Salmon

Fishery contribution rates for individual broodyears were combined for hatchery spring (1992 – 2005) and summer (1992 – 2004) Chinook salmon. Most hatchery Chinook salmon from these broods, regardless of race, were adipose fin-clipped and received a CWT prior to release (Chapter 1). Starting with the 2000 brood, spring Chinook salmon releases have been coded wire tagged, but have not been marked with an adipose fin-clip. Thus, prior to the 2000 brood, most fish intended for supplementation did not receive any protection from fishery extraction afforded by selective fisheries. Tag rates for the years examined ranged from 88% to 100% for spring Chinook salmon and from 63% to 100% for summer Chinook salmon. Hatchery Chinook salmon stocks were recovered in fishery categories at different rates depending on race. For the most recent completed brood year examined, summer Chinook salmon were primarily recovered in fisheries, while spring Chinook salmon were primarily recovered as broodstock or on spawning grounds (Table 3). Because spring Chinook of the 2005 brood were not adipose fin-clipped, few of these fish were recovered in fisheries. However, harvest and indirect mortality derived using a surrogate stock (2005 brood Chiwawa spring Chinook), indicates Methow spring Chinook salmon were impacted primarily by freshwater selective sport fisheries.

Most spring Chinook salmon hatchery releases covered in this chapter occurred prior to ESA-listing of the species in the upper Columbia ESU and were marked with an adipose-fin clip and tagged with a CWT. This combination did not allow upper Columbia ESU spring Chinook salmon to be exempted from selective fisheries that target hatchery fish based on the absence of an adipose fin. The 2000 brood was the first spring Chinook salmon release covered in this report in which the adipose fin was not clipped. This change in marking strategy resulted in a decrease in the overall proportion of spring Chinook salmon recovered in fisheries from 26.7% (1992 – 1999 broods) to 18.6% (2000 – 2005 broods). For the current brood of hatchery spring Chinook examined (2005), 3.9% were harvested in fisheries.

Stray Rates by Brood Year

For the current brood examined (2005), greater than 5% of the total return of spring Chinook salmon released into the Twisp and Chewuch rivers strayed into non-target spawning grounds (Table 3). Straying of Methow River released spring Chinook was less than 5% of the total return. Mean stray rates to non-target spawning grounds for historic broods were significantly less than the 5% target for Methow releases ($P < 0.05$), and were significantly greater than the 5% target for Twisp ($P < 0.05$) and Chewuch releases ($P < 0.05$).

Table 3. Percent of total hatchery Chinook recoveries by race and recovery location for 2005 brood year spring Chinook salmon and 2004 brood year summer Chinook salmon. Recoveries are expanded by mark rate and sample rate for each category and adjusted for indirect mortality associated with selective fisheries.

Recovery Category	Methow Spring	Twisp Spring	Chewuch Spring	Wells Summer Chinook	
				Yearling	Subyearling
Total recoveries (*N*)	339	47	314	3,627	711
Broodstock target stream	47.8	21.3	11.8	38.6	34.7
Broodstock non-target stream	0.3	2.1	0.0	0.1	0.0
Broodstock from Wells Dam	1.5	0.0	0.3	- -	- -
Spawning ground target stream	43.7	53.2	37.3	NA	NA
Spawning ground non-target stream	2.9	19.1	46.8	4.3	8.9
Ocean fishery-commercial	0.0	0.0	0.0	18.9	20.3
Ocean fishery-sport	0.0	0.0	0.0	6.9	3.2
Ocean fishery-tribal	0.0	0.0	0.0	0.0	0.0
Freshwater fishery-commercial	1.5	2.1	1.6	17.7	16.6
Freshwater fishery-sport	2.4	2.1	2.2	13.2	15.9
Freshwater fishery-tribal	0.0	0.0	0.0	0.4	0.4

NA = Not applicable.

Table 4. Percent of total hatchery Chinook recoveries by race and recovery category. Methow spring Chinook include the 1993 – 1997, 1999, and 2001 – 2005 broods. Twisp spring Chinook include the 1992 – 2005 broods and Chewuch spring Chinook include the 1992 –1997, and 2001 – 2005 broods. Summer Chinook include the 1992 –2004 broods. Recoveries were expanded by mark rate and sample rate for each category and adjusted for indirect mortality associated with selective fisheries.

Recovery Category	Hatchery Release Group				
	Methow Spring	Twisp Spring	Chewuch Spring	Wells Summer Chinook	
				Yearling	Subyearling
Total recoveries (*N*)	3,918	1,269	2,789	49,730	4,042
Broodstock target stream	38.5	6.4	2.9	23.4	30.9
Broodstock non-target stream	0.1	12.2	9.3	1.2	0.8
Broodstock from Wells Dam	9.4	9.9	8.3	- -	- -
Spawning ground target stream	25.8	38.4	25.4	NA	NA
Spawning ground non-target stream	2.8	15.9	32.0	7.3	6.9
Ocean fishery-commercial	0.4	0.3	0.6	44.9	39.0
Ocean fishery-sport	0.0	0.0	0.0	7.5	5.7
Ocean fishery-tribal	0.0	0.0	0.0	1.4	0.8
Freshwater fishery-commercial	9.2	5.2	3.9	6.1	7.9
Freshwater fishery-sport	13.0	10.9	16.9	7.6	7.3
Freshwater fishery-tribal	0.9	0.8	0.6	0.6	0.7

NA = Not applicable.

Adult returns of hatchery summer Chinook salmon were great enough to provide fish for broodstock and harvest. Harvest of summer Chinook salmon occurred primarily in ocean fisheries and yearling releases have provided 92.5% of all recoveries (broodstock and harvest combined) of summer Chinook salmon from the 1992-2004 broods (see Table 4). Because Wells summer Chinook salmon are intended for harvest, no target stream was designated. Consequently, all spawning ground recoveries were considered to be in non-target areas. Stray rates for the current brood examined did not exceed the 5% target for yearling releases (4.3%), but did exceed the 5% target for subyearling releases (8.9%). Overall, mean stray rates to non-target spawning grounds for the 1992-2004 broods were not significantly different from the 5% target value for either the Wells yearling (P = 0.378) or subyearling (P = 0.985) releases (Figure 1; Appendices B, C).

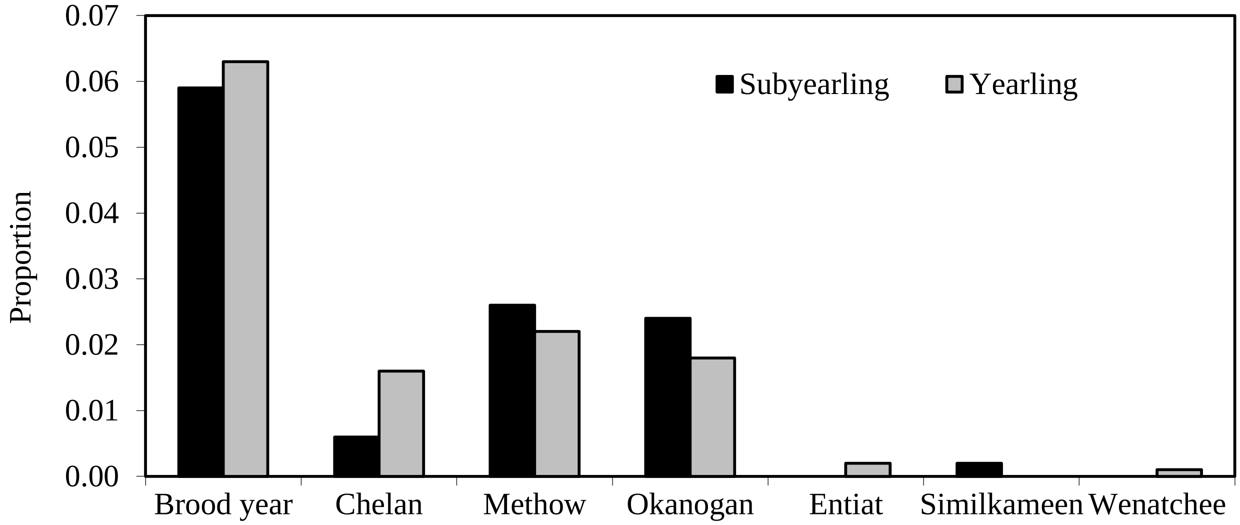

Figure 1. Mean proportion of Wells summer Chinook salmon hatchery adults from yearling (1992-2004 broods) and subyearling (1995-2004 broods) programs that strayed to spawning areas within the Upper Columbia River ESU (1997-2009).

Stray Rates by Return Year

Summer Chinook salmon are known to spawn in the Columbia River downstream of Wells Dam (Miller, T. 2006; Miller, M. 2008), but redds in this area are difficult to quantify and few carcasses have been recovered from this spawning area. Because of this, spawning ground recovery data and smolt-to-adult survival should be considered minimum values. When CWT recoveries were examined by return year, stray rates of Wells summer Chinook salmon were inversely correlated with distance from Wells Hatchery (Figure 2), and were seldom greater than 5% of other independent spawning populations in the Upper Columbia ESU in recent years. The highest proportion of Wells summer Chinook salmon are consistently recovered in the Chelan River, which is currently not identified as a summer Chinook salmon population (Table 5).

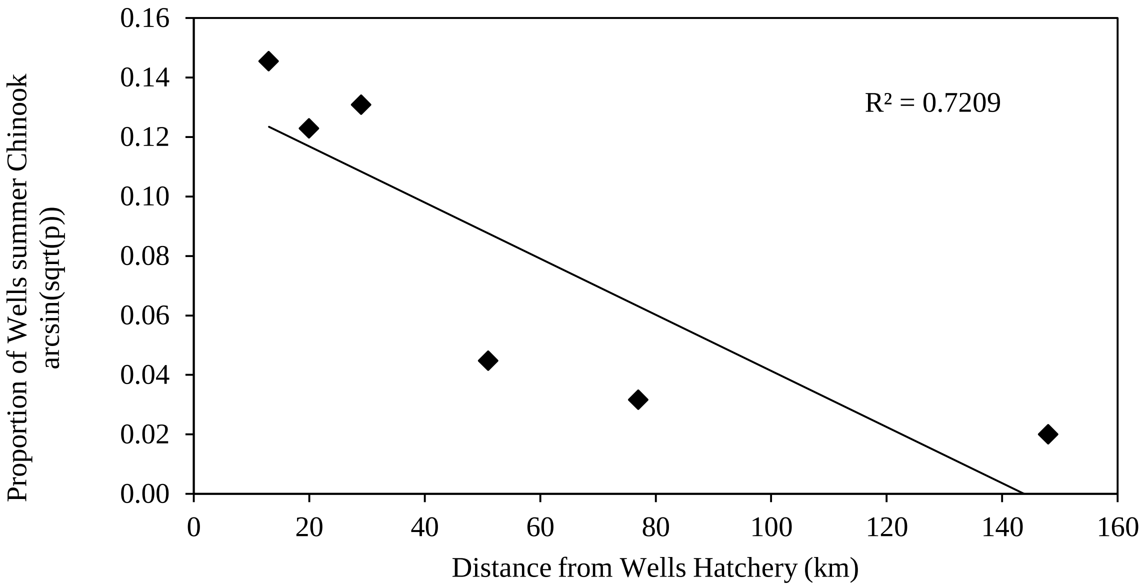

Figure 2. Relationship between the mean proportion of Wells yearling summer Chinook salmon (1997-2010 return years) found on the spawning grounds and the distance from Wells Hatchery.

Table 5. Percent of summer Chinook spawning population by return year comprised of hatchery summer Chinook salmon originating from 1992-2004 brood releases of Wells subyearling and yearling program fish.

Return year	Spawning Location (river)					
	Entiat	Methow	Okanogan	Similkameen	Wenatchee	Chelan
1997	- -	- -	11.2	- -	- -	- -
1998	- -	6.2	4.5	- -	0.1	- -
1999	- -	0.6	0.0	- -	0.0	10.8
2000	- -	3.3	8.2	- -	0.2	26.4
2001	- -	18.4	7.2	0.3	0.0	33.8
2002	8.6	11.6	5.1	0.0	0.1	29.7
2003	9.4	3.7	1.0	0.1	0.1	20.8
2004	0.0	2.1	1.6	0.2	0.1	6.0
2005	3.0	3.2	1.4	0.2	0.2	15.8
2006	0.0	1.8	0.2	0.0	0.0	7.9
2007	1.2	3.4	0.1	0.0	0.0	12.2
2008	3.4	3.4	1.9	0.2	0.1	9.9
2009	1.2	7.2	1.8	0.0	0.0	1.7
2010	2.3	2.8	2.5	0.1	0.1	8.9

Wild Spring Chinook Salmon

Wells Hatchery summer Chinook are a production program with no corresponding wild stock, thus no estimate of wild summer Chinook harvest was appropriate. Harvest of wild spring Chinook salmon was estimated for the Methow River basin using Leavenworth National Fish Hatchery (LNFH) as a surrogate for brood years prior to 1996, and for 2000 – 2002 because hatchery releases from Methow Hatchery (MH) included too few fish, or did not include adipose fin-clipped fish. For the 2003 – 2005 broods, spring Chinook released from the Chiwawa Ponds were used as a surrogate. The percent of wild fish harvested from the 1992 – 2005 broods ranged from 2.63% to 22.07% (Table 6).

Table 6. Summary of spring Chinook salmon selective (S) and non-selective (NS) fisheries by broodyear. Harvest rate is based on harvest of local hatchery stocks determined through CWT analysis (LNFH = Leavenworth NFH; MH = Methow Hatchery; CH = Chiwawa Hatchery).

Brood	Fishery exposure by total age									Harvest Rate	
	Sport			Commercial			Tribal				
	3	4	5	3	4	5	3	4	5	%	Source
1992	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.55	LNFH
1993	NS	NS	NS	NS	NS	NS	NS	NS	NS	3.25	LNFH
1994	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.68	LNFH
1995	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.31	LNFH
1996	NS	NS	S	NS	NS	NS	NS	NS	NS	2.85	MH
1997	NS	S	S	NS	NS	S	NS	NS	NS	22.07	MH
1998	S	S	S	NS	S	S	NS	NS	NS	15.53	MH
1999	S	S	S	S	S	S	NS	NS	NS	2.63	MH
2000	S	S	S	S	S	S	NS	NS	NS	6.13	LNFH
2001	S	S	S	S	S	S	NS	NS	NS	4.14	LNFH
2002	S	S	S	S	S	S	NS	NS	NS	7.13	LNFH
2003	S	S	S	S	S	S	NS	NS	NS	4.65	CH
2004	S	S	S	S	S	S	NS	NS	NS	7.65	CH
2005	S	S	S	S	S	S	NS	NS	NS	3.58	CH

Based on the harvest rates of local hatchery stocks, an estimated 1,127 wild spring Chinook were harvested from the 1992 – 2005 broods (Table 7), with harvest of the current brood (2005) totaling 3.6%. Because the 2005 brood hatchery fish were not adipose fin-clipped, harvest rates of hatchery and wild fish were assumed to be equal. When adipose fin-clipped hatchery fish were used as surrogates (i.e., 2000-2005 broods), recoveries of hatchery fish were expanded by fishery-specific mortality rates, to estimate mortality of wild fish. The 1997 brood provided the majority of wild fish harvested (22.1%). Although escapement of wild spring Chinook in most recent run years has been low, the addition of harvested fish to the run escapement would have been unlikely to result in escapements meeting tributary-specific escapement goals (Chapter 5).

Table 7. Total adult return and number of wild spring Chinook salmon harvested by population and brood year.

Brood	Methow R.		Twisp R.		Chewuch R.		Lost R.		Total	
	Total	Harvest	Total	Harvest	Total	Harvest	Total	Harvest	Return	Harvest
1992	66	4	96	5	41	2	26	1	229	13
1993	115	4	51	2	95	3	5	0	266	9
1994	23	1	23	1	19	0	8	0	72	2
1995	71	4	39	2	34	2	6	0	150	8
1996	125	4	69	2	102	3	143	4	439	13
1997	879	194	1,237	273	1,563	345	33	7	3,712	819
1998	86	13	195	30	89	14	0	0	370	57
1999	5	0	8	0	2	0	0	0	15	0
2000	375	23	522	32	108	7	20	1	1,024	63
2001	257	11	158	7	325	13	26	1	766	32
2002	170	12	135	10	251	18	141	10	697	50
2003	95	4	1	0	54	2	1	0	151	7
2004	201	15	76	6	93	7	50	4	419	32
2005	273	10	40.2	1	322	12	3	0	638	23
Total	2,740	298	2,651	371	3,096	428	462	30	8,949	1,127

Summer Chinook Salmon Sport Fishery

Creel surveys have been conducted during the summer Chinook salmon sport fishery since 2004 and have generally increased in scope over time to ensure all Columbia River sections are surveyed. The greatest number of Chinook salmon harvested has typically been in the upper Columbia River sections, with a total of 4,711 fish harvested during 2011 fisheries (Table 8). Coded-wire tag analysis from the 2011 fishery are currently not available (Appendix A). Harvest of Wells Hatchery summer Chinook has been shifting from ocean fisheries to freshwater fisheries as managers have initiated freshwater fisheries in the Columbia River above Priest Rapids Dam in recent years. Ocean and freshwater sport fisheries accounted for about 52% and 18% of Wells summer Chinook recovered from the 1992-1999 broods, respectively. For the 2000-2004 broods, ocean sport fishery recoveries dropped to 28% of total fishery recoveries and freshwater sport fisheries increased to 50% of the total recoveries.

Table 8. Summary of summer Chinook salmon harvest based on creel surveys conducted during sport fisheries in the upper Columbia River. Harvest data for 2008-2011 was expanded to account for indirect mortality of Chinook salmon released during the fishery.

Year	Area											
	545		543		541		539		537		627/629	
	Harvest	CPU	Harvest	CPU	Harvest	CPU	Harvest	CPU	Harvest	CPU	Harvest	CPU
2004	2,803	0.073	2,139	0.075	907	0.038	NA	NA	NA	NA	NA	NA
2005	1,419	0.068	411	0.054	362	0.024	NA	NA	NA	NA	NA	NA
2006	1,973	0.048	1,444	0.071	446	0.027	1	0.001	NA	NA	145	0.128
2007	1,774	0.055	1,255	0.066	132	0.016	- -	0.000	739	0.060	29	0.042
2008	1,486	0.063	345	0.038	40	0.006	31	0.039	714	0.105	184	0.220
2009	869	0.041	593	0.076	157	0.017	6	0.007	834	0.092	195	0.102
2010	885	0.040	437	0.040	119	0.010	9	0.010	1,315	0.113	142	0.030
2011	339	0.024	1,275	0.043	436	0.029	35	0.016	2,070	0.072	556	0.144

Summer Steelhead

Upper Columbia River summer steelhead return during the summer and fall prior to spawning the following spring (i.e., brood year). Thus, the typical steelhead fishery period occurring between October and March encompasses two calendar years, but targets fish from a single brood year. Steelhead returns met abundance and composition requirements necessary to conduct local sport fisheries on the 2002 – 2011 broods of returning adults. The number of hatchery fish harvested and the indirect mortality rate for both hatchery and wild fish was estimated by creel census. Based on creel surveys, an estimated 4,943 hatchery origin and 89 wild origin steelhead were lethally removed (adipose clipped hatchery fish) or were considered to be unintentional mortalities (unmarked hatchery and wild fish) during sport fisheries targeting the 2011 brood (Table 9). Most steelhead were harvested in the Methow and Columbia River fisheries, and overall harvest of hatchery fish has been increasing in recent years. Harvest of hatchery steelhead was 46.5% of the 2011 brood hatchery fish above Wells Dam (see Chapter 4) which is about 17 % greater than the mean harvest rate experienced by the previous three broods. Increased harvest was due to high returns of adult steelhead over Wells Dam in 2010 (2011 brood), and the adoption of fishery regulations allowing an increased bag limit (4 hatchery fish per day) and the stipulation that retention of hatchery fish was mandatory. Additionally, steelhead fisheries in the upper Columbia and Methow rivers opened earlier than usual (8 September). Steelhead harvest in local fisheries has not impacted broodstock collection because harvest typically occurs after steelhead have escaped the collection location, or after collection has ceased. Because local steelhead fisheries were based on local escapement objectives (i.e., above Priest Rapids Dam), all hatchery fish removed were considered excess fish appropriate for harvest. As in many previous years, retention of hatchery steelhead may have been greater if more juvenile hatchery fish were adipose fin-clipped prior to release.

Table 9. Total number of steelhead removed in upper Columbia River sport fisheries by fishery location and brood. The total CPU was calculated from the total number of fish captured divided by the total number of hours fished in each fishery.

Brood	Methow R.			Okanogan R.			Similkameen R.			Columbia R.			Total		
	H	W	CPU	H	W	CPU	H	W	CPU	H	W	CPU	H	W	CPU
2011[a]	2,913	54	0.141	899	16	0.197	- -	- -	- -	1,131	19	0.133	4,943	89	0.141
2010	4,002	48	0.101	2,269	11	0.191	842	5	0.280	1,068	17	0.049	8,181	81	0.107
2009	635	11	0.077	409	4	0.232	37	1	0.124	921	10	0.060	2,002	26	0.113
2008	470	9	0.095	225	4	0.244	63	3	0.120	872	8	0.177	1,630	24	0.129
2007[b]	- -	- -	- -	- -	- -	- -	- -	- -	- -	523	2	0.093	523	2	0.093
2006	683	8	0.108	229	3	0.332	263	2	0.309	437	4	0.055	1,612	17	0.050
2005	680	9	0.114	243	2	0.087	290	2	0.245	493	4	0.067	1,706	17	0.104
2004	336	10	0.151	328	1	0.149	57	0	0.071	298	4	0.081	1,019	15	0.140
2003	254	13	0.362	57	1	0.074	63	1	0.147	455	9	0.146	829	24	0.189
2002[c]	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	694	73	0.167

[a] Okanogan and Similkameen data combined under the Okanogan River category.
[b] Fishery occurred in Columbia River only.
[c] Fishery occurred in Okanogan and Similkameen Rivers only. Data reflects the total number of fish captured, including those released.

Discussion

Summer Chinook

Wells summer Chinook salmon are an appropriate stock for commercial, tribal, and recreational fisheries to target during years of high abundance. For the years examined, the majority of adult recoveries came from harvest. While most of these fish were harvested outside of the Columbia River Basin, freshwater fisheries in the lower Columbia River and upstream of Priest Rapids Dam have been initiated in recent years. As these fisheries have matured, the proportional allocation of harvest of Wells Hatchery summer Chinook has shifted from ocean fisheries to the Columbia River. For the most recent five broods released where CWT recovery data are complete (2000-2004 broods), the proportional representation of ocean sport fishery harvest has dropped by about 50% while freshwater sport harvest increased by about 270% from previous levels (1992-1999 broods). The freshwater sport harvest category now accounts for about 50% of the total Wells summer Chinook harvested in fisheries. These rates indicate that management strategies have been effective in targeting excess returns of the Wells summer Chinook stock in local fisheries.

Spring Chinook

Hatchery releases intended to supplement natural populations should result in an increased number of adult fish on the spawning grounds of the target (supplemented) stream. Most spring

Chinook salmon broods examined in this chapter were adipose fin-clipped prior to release, thus many of the returning adults from those broods were harvested in fisheries (i.e., primarily Columbia River). To protect these fish from exploitation, recent releases of Methow spring Chinook salmon have not been adipose fin-clipped, which resulted in a dramatic decrease in harvest rates from 28% (1992 – 1999 broods) to 19% (2000 – 2005 broods) and an increase in spawning ground recoveries of these broods from 20% to 54%.

Stray rates for the current brood of hatchery spring Chinook released into the Twisp and Chewuch rivers exceeded the 5% of total brood return threshold but was below the target value for Methow River releases. For these three programs, straying occurred only to within-basin locations. The mean stray rate for all broods released into the Twisp and Chewuch rivers was significantly greater than the target value, and was significantly below the 5% target value for Methow River releases, likely due to the extended acclimation time that these fish receive and the strong attraction of the Methow Hatchery outfall. Although releases in the Twisp and Chewuch basins were accomplished through the use of acclimation ponds, acclimation time is short primarily because environmental conditions (freezing) prevent transfer to the ponds before about 1 March. Although longer acclimation may not be possible due to environmental conditions, experimental early imprinting may reveal pathways to improve homing in circumstances where fish are spring acclimated at a location removed from their natal hatchery. Wells summer Chinook salmon stray rates are generally less than the 5% of the total brood return target, primarily because a high proportion of recoveries of these fish occurs in sport and commercial fisheries, and are collected at the hatchery and donated to local tribes. Wells summer Chinook have exceeded 5% of the spawning population in the Chelan River; however, the Chelan River does not support an independent population of summer Chinook, thus straying to this location poses very low risk.

Summer Steelhead

Steelhead fisheries targeting Wells stock steelhead have occurred locally since 2003. These fisheries are monitored via creel census to determine harvest and mortality of hatchery and wild fish. The accuracy of these estimates has not historically been quantified, and an estimate of accuracy would be a valuable tool for fishery managers in monitoring and evaluating the creel census program. Stray rates for hatchery steelhead have not been estimated primarily because carcasses are seldom recovered during spawning ground surveys. With the increased use of coded-wire and PIT tags in steelhead, local creel census and the increasing prevalence of PIT tag monitoring arrays may begin to address harvest and straying of specific stocks.

Steelhead conservation fisheries conducted on the 2011 brood of returning adults removed a greater proportion (46.5%) of the available hatchery origin fish than had been removed during conservation fisheries in recent years. Fisheries targeting the 2008-2009 broods removed 25.2% of the estimated run of hatchery origin fish, while the 2010 brood fishery removed 37.1% of the hatchery fish returning above Wells Dam. This general increase in removal rates is likely due to the adoption of fishery regulations that increased the daily limit to four hatchery fish per day, and made retention of hatchery fish mandatory. These types of regulation changes may play an ever-increasing role in the management of hatchery stocks where controlling the proportion of hatchery fish on the spawning grounds is of primary concern.

Historically, steelhead fisheries in the Methow Basin have not impacted broodstock collection activities because fisheries occurred after potential broodstock had already passed the collection location (Wells Dam). However, future management plans for Methow Basin steelhead call for spring collection of broodstock at the Twisp Weir, Methow Hatchery and Winthrop National Fish Hatchery volunteer channels, and by hook-and-line angling if necessary to meet program objectives (draft Wells and WNFH steelhead Hatchery and Genetic Management Plans). Conservation fisheries will need to be assessed and conducted to ensure that adequate broodstock are available at these spring collection sites.

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Appendix A

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
Region Two / Fish Management

April 5, 2011

Rob Jones
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Salmon Recovery Division
1201 N.E. Lloyd Blvd., Suite 1100
Portland, OR 97232

Mr. Jones,

The following is a cumulative summary for months September, 2010 through March, 2011 of the upper Columbia River steelhead fishery, which includes estimated run size, law enforcement activities, updated catch information, angler effort, and current natural origin steelhead impacts. **The fishery officially closed for all steelhead areas effective April 1st, 2011.**

Run Estimate and Current Take Status

Current updated steelhead run size estimates at Priest Rapids Dam (Table 1) have allowed WDFW to implement a recreational fishery at a Tier 1 level for the mainstem Columbia River from Priest Rapids Dam to Wells Dam, including the Wenatchee and Entiat Rivers, and at a Tier 2 level for the mainstem Columbia River from Wells Dam to Chief Joseph Dam, including the Methow, Okanogan, and Similkameen Rivers. Also within Table 1, is the allowable take of natural origin steelhead (NOR) for each river system as well as the calculated NOR mortality due to the current fishery.

Table 1. Projected sub-basin escapements, allowable NOR mortality and current NOR take of upper Columbia River steelhead above Priest Rapids Dam updated as of December 31, 2010.

Area	Total Escapement [1]	NOR Escapement [1]	Allowable NOR Take [2]	Current NOR Take [3]
Below RR Dam	4,506	3,477	70	13
Wenatchee	3,294	1,345	27	11
Entiat	5,455	573	11	10
Methow	10,356	1,773	71	70
Okanogan	2,741	474	33	20
Total	**26,352**	**7,642**	**212**	**124**

[1] Priest Rapids in-season stock assessment sampling minus broodstock collection, 2% dam to dam loss, and 5% over wintering mortality
[2] Mortality take for NOR escapement (2% Wenatchee, 2% Below RR, 2% Entiat, 4% Methow, and 7% Okanogan)
[3] Number of NOR released during the fishery times a 5% hook and release mortality (includes one NOR mortality found near the Methow River)

Catch Summary

In the upper Columbia River steelhead fishery from September, 2010 through March, 2011, an estimated 23,907 anglers fished 93,504 hours and caught 11,610 steelhead, of which 5,219 were adipose clipped hatchery origin (5,175 retained and 44 released), 3,938 were adipose present hatchery origin, and 2,453 were natural origin (Table 2).

Table 2. Estimated total fishing effort and catch by area during the upper Columbia River steelhead fishery, September, 2010 through March, 2011.

	Fishing Effort			Steelhead Catch Composition			
Fishery Area	**Anglers**	**Angler Hours**	**Total Steelhead Catch**	**Ad-clipped Hatchery Retained**	**Ad-clipped Hatchery Released**	**Ad-present Hatchery Released**	**NOR Released[1]**
PR to RR	1,602	5,960	539	89	0	187	263
RR to Wells	2,652	10,167	555	171	0	248	136
Wells to CJ	4,350	19,265	2,172	1,096	0	696	380
Wenatchee	2,094	5,758	484	97	0	161	226
Entiat	611	1,840	224	39	0	120	65
Methow	9,124	41,592	5,880	2,813	44	1,953	1,070
Okanogan[2]	3,474	8,922	1,756	870	0	573	313
Total	**23,907**	**93,504**	**11,610**	**5,175**	**44**	**3,938**	**2,453**

[1] Updated percent NOR within the adipose present population (60.0% from Priest Rapids to Rocky Reach and 35.3% above Rocky Reach)
[2] Includes Similkameen River creel data

Natural Origin Impacts

Hook and release mortality on 2,453 natural origin steelhead, plus one NOR mortality found near the Methow River, total 124 NOR and represents 58.5% of the 212 allowable NOR take for the fishery above Priest Rapids Dam (Table 3). Individually, the Wenatchee population NOR impacts are at 31.5%, the Methow at 98.6%, and the Okanogan/Similkameen at 60.6% of the maximum allowable impacts (Table 3).

Table 3. Percent NOR impacts for individual tributary populations during the 2010-2011 upper Columbia River steelhead fishery, September, 2010 through March, 2011.

Tributary Population	Allowable NOR Take	Current NOR Take	% of Allowable NOR Take
Wenatchee [1]	108	34	32.5
Methow [2]	71	70	98.6
Okanogan/Similkameen [3]	33	20	60.6
Total	**212**	**124**	

[1] Wenatchee includes mainstem Columbia from Priest Rapids to Wells Dam plus the Entiat River
[2] Methow includes the 79% of the impacts from the mainstem Columbia from Wells to Chief Joseph Dam
[3] Okanogan/Similkameen includes 21% of the impacts from mainstem Columbia from Wells to Chief Joseph Dam

Adipose Clipped Hatchery Steelhead Removal due to Fishery Activities

Methow/Okanogan/Similkameen

In the steelhead fishery above Wells Dam, which includes the mainstem Columbia, Methow, Okanogan, and Similkameen Rivers, an estimated 4,779 ad-clipped hatchery steelhead have been retained thus precluding them from spawning. This represents a 64.5% reduction of the estimated 7,411 ad-clipped hatchery steelhead, which were observed passing Wells Dam as of November 15th, 2010 (Fish Passage Center).

Wenatchee

In the steelhead fishery from Priest Rapids to Wells Dam, which includes the mainstem Columbia, Wenatchee and Entiat Rivers, an estimated 396 ad-clipped hatchery steelhead have been retained thus precluding them from spawning. This represents a 9.3% reduction of the estimated 4,263 ad-clipped steelhead located between Priest Rapids and Wells Dam, including the Entiat and Wenatchee Rivers (Priest Rapids Data).

Enforcement Activities

During the months of September 2010 through March 2011, there were 1,124 enforcement contacts of anglers fishing the upper Columbia River and tributaries totaling 872 hours of patrol time. A total of 80 arrests were made and 105 warnings were handed out. Violations included fishing in closed waters, no license, fishing with bait and/or barbed hooks in selective gear water, failure to record steelhead on catch record card, missing salmon and steelhead endorsement stamp, drug violation, 2-pole violation, removal of adipose present steelhead from water, and no catch card.

Respectfully,

Robert Jateff (for Jeff Korth)
509-754-4624 ext 224

Cc: Charlie Snow, Andrew Murdoch, Mike Tonseth, Chris Anderson, Bob Leland

Appendix B. Coded wire tag recoveries from the RMIS database by broodyear and stock expanded by sample rate and tag rate.

Brood	Broodstock			Spawning ground		Ocean fishery			Freshwater fishery		
	Target	Non-target	Wells	Target	Non-target	Comm.	Sport	Tribal	Comm.	Sport	Tribal
Wells summer Chinook salmon yearling											
1992	359	9	- -	NA	40	81	37	6	0	4	16
1993	1,141	346	- -	NA	56	645	54	2	14	16	50
1994	89	5	- -	NA	2	30	6	0	0	0	9
1995	392	23	- -	NA	183	332	122	19	22	44	5
1996	501	28	- -	NA	308	593	182	6	2	32	0
1997	1,412	125	- -	NA	1,731	6,088	1,039	308	89	317	63
1998	1,195	43	- -	NA	564	6,863	948	141	219	481	74
1999	164	13	- -	NA	68	826	135	50	100	261	11
2000	2,198	2	- -	NA	345	3,379	490	133	785	988	36
2001	900	0	- -	NA	40	1,033	120	44	269	338	6
2002	1,303	0	- -	NA	79	1,103	311	40	512	480	14
2003	564	0	- -	NA	46	558	137	47	350	212	12
2004	1,399	2	- -	NA	156	684	250	0	642	479	15
Wells summer Chinook salmon subyearling											
1993	19	2	- -	NA	0	15	0	0	3	0	0
1994	9	0	- -	NA	0	3	0	0	0	0	3
1995	62	4	- -	NA	2	42	6	6	3	1	0
1996	267	21	- -	NA	78	266	54	5	2	8	3
1997	44	3	- -	NA	30	117	11	3	7	29	0
1998	44	0	- -	NA	40	236	14	1	7	25	4
1999	94	2	- -	NA	33	297	38	8	32	30	8
2000	63	1	- -	NA	8	78	10	2	23	5	0
2001	295	0	- -	NA	23	310	41	8	81	61	4
2002	37	0	- -	NA	0	35	16	0	23	15	0
2003	66	0	- -	NA	3	33	16	1	20	10	2
2004	247	0	- -	NA	63	144	23	0	118	113	3
Methow spring Chinook salmon											
1993	43	0	134	6	1	0	0	0	0	4	3
1994	0	0	1	0	0	0	0	0	0	0	0
1995	3	0	114	3	0	2	0	0	0	0	0
1996	200	0	58	221	8	0	0	0	2	0	11
1997	297	0	3	16	1	3	0	0	280	209	12
1998	- -	- -	- -	- -	- -	3	0	0	462	428	30
1999	93	0	- -	35	7	1	0	0	3	6	0

NA = Not applicable.

Appendix B, continued.

Brood	Broodstock			Spawning ground		Ocean fishery			Freshwater fishery		
	Target	Non-target	Wells	Target	Non-target	Comm.	Sport	Tribal	Comm.	Sport	Tribal
2000	- -	- -	- -	- -	- -	5	0	0	21	6	0
2001	289	0	5	182	23	3	0	0	0	0	0
2002	245	2	37	287	26	9	0	0	22	28	13
2003	43	0	5	4	0	1	0	0	2	2	0
2004	133	0	5	110	33	0	0	0	11	13	0
2005	162	1	5	148	10	0	0	0	5	8	0
Twisp spring Chinook salmon											
1992	0	0	21	0	0	0	0	0	0	0	0
1993	0	3	18	1	1	0	0	0	0	4	0
1994	0	0	4	0	0	0	0	0	0	0	0
1995	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1996	2	33	65	151	17	0	0	0	1	0	6
1997	10	6	- -	14	0	0	0	0	14	9	1
1998	1	8	- -	0	2	0	0	0	11	0	0
1999	3	25	- -	8	20	1	0	0	4	0	0
2000	22	12	- -	67	40	0	0	0	7	0	0
2001	2	0	1	33	7	0	0	0	0	0	0
2002	7	59	6	70	66	3	0	0	8	10	4
2003	2	2	6	21	13	1	0	0	2	2	0
2004	22	6	5	97	27	0	0	0	7	8	0
2005	10	1	0	25	9	0	0	0	1	1	0
Chewuch spring Chinook salmon											
1992	0	1	38	0	0	0	0	0	0	0	0
1993	0	19	79	8	3	5	0	0	0	0	1
1994	0	0	3	0	0	0	0	0	0	0	0
1995	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1996	- -	15	15	0	4	0	0	0	6	0	1
1997	26	39	22	4	27	2	0	0	24	144	7
2001	15	46	2	323	321	0	0	0	2	0	0
2002	2	92	58	174	299	9	0	0	23	29	13
2003	0	12	10	7	22	2	0	0	2	2	0
2004	0	35	4	76	70	0	0	0	6	7	0
2005	37	0	1	117	147	0	0	0	5	7	0

Appendix C. Proportion by brood year of Wells Hatchery summer Chinook salmon that strayed onto spawning grounds of other Chinook salmon populations. All recoveries are considered to be non-target areas.

Brood year	Summer Chinook salmon spawning population					
	Methow	Okanogan	Similkameen	Chelan	Entiat	Wenatchee
			Wells summer Chinook salmon yearlings			
1992	0.000	0.072	0.000	0.000	0.000	0.000
1993	0.021	0.006	0.000	0.000	0.000	0.002
1994	0.014	0.000	0.000	0.000	0.000	0.000
1995	0.014	0.036	0.000	0.104	0.000	0.004
1996	0.083	0.056	0.000	0.043	0.000	0.000
1997	0.071	0.042	0.001	0.035	0.003	0.000
1998	0.022	0.009	0.000	0.013	0.007	0.001
1999	0.012	0.000	0.001	0.008	0.000	0.009
2000	0.013	0.012	0.001	0.012	0.001	0.001
2001	0.007	0.000	0.000	0.008	0.000	0.000
2002	0.011	0.002	0.000	0.005	0.001	0.000
2003	0.007	0.004	0.000	0.007	0.004	0.000
2004	0.015	0.013	0.000	0.007	0.002	0.002
2005	0.008	0.008	0.000	0.019	0.003	0.000
2006	0.008	0.007	0.000	0.004	0.001	0.000
2007	0.010	0.000	0.000	0.000	0.000	0.000
			Wells summer Chinook salmon subyearlings			
1995	0.016	0.000	0.000	0.000	0.000	0.000
1996	0.026	0.058	0.007	0.015	0.000	0.004
1997	0.068	0.056	0.000	0.000	0.000	0.000
1998	0.040	0.054	0.000	0.011	0.000	0.000
1999	0.015	0.028	0.000	0.018	0.000	0.000
2000	0.042	0.000	0.000	0.000	0.000	0.000
2001	0.016	0.012	0.000	0.000	0.000	0.000
2002	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.022	0.000	0.000	0.000	0.000
2004	0.053	0.023	0.004	0.007	0.000	0.000
2005	0.039	0.032	0.003	0.018	0.000	0.003
2006	0.013	0.025	0.000	0.023	0.000	0.000
2007	0.005	0.000	0.000	0.000	0.000	0.000

Chapter 3

Methow River Basin Spring Chinook Salmon and Steelhead Smolt Monitoring in 2011

Abstract

The mean number of emigrants produced per redd is a metric used to compare the relative productivity of target species during freshwater rearing. We used salmonid capture data from rotary screw traps and PIT tag interrogation sites to estimate the number of spring Chinook salmon and summer steelhead smolts emigrating from the Twisp River and Methow River basins. In 2011, high flows prevented operating the Methow trap from May 15 through July 11 and the Twisp Trap from May 13 through July 26. Missing capture data from this period, and other more brief periods when the traps were not fishing, was estimated based on capture data previous to or post interruptions in operation.

During the spring smolt outmigration, we captured 344 wild spring Chinook salmon smolts at the Methow River trap and 317 smolts at the Twisp River trap in 2011. The number of fish captured each day was expanded by the estimated trap efficiency based on a regression model using the variables discharge (independent variable) and capture efficiency (dependent variable). Subyearling Chinook migrants (parr) from the previous year were combined with yearling migrants (smolt) from the current year to produce a total emigration estimate for each brood examined. Using this methodology, we estimated that a total of 31,212 (± 8,823, 95% CI) wild spring Chinook salmon from the 2009 brood emigrated from the Methow Basin including 1,602 parr and 29,610 smolts. This estimate includes fish emigrating from the Twisp River where we estimated that 5,124 (± 870, 95% CI) wild spring Chinook from the 2009 brood emigrated past the Twisp River trap including 3,282 parr and 1,842 smolts. Utilizing spring Chinook salmon spawning ground survey data from 2009, we estimated that the number of emigrants produced from each 2009 brood spring Chinook salmon redd in the Twisp River (*N* = 214) was 3.5 times greater than the number of emigrants produced from redds in the remainder of the Methow River basin (*N* = 68). During the fall 2011 emigration period, we estimated that 4,874 (± 680, 95% CI) spring Chinook salmon parr emigrated past the Twisp River trap and 8,979 (± 1,832 95% CI) spring Chinook salmon parr emigrated past the Methow River trap. Additionally, we estimated that 514,724 (± 349,514, 95% CI) subyearling summer Chinook emigrated past the Methow River trap in 2011.

Overall we captured a total of 171 and 329 wild steelhead emigrants at the Methow and Twisp River traps, respectively. We estimated that 15,673 (± 6,512 95% CI) wild steelhead emigrated from the Methow River, including 5,959 (± 1,492, 95% CI) fish from the Twisp River in the spring of 2011. As a comparison to the steelhead smolt production estimate from the Twisp smolt trap, we developed a steelhead smolt emigration estimate using daily PIT tag interrogation data at the in-stream PIT tag interrogation site in the Twisp River. We expanded PIT tags detected between 1 January and 15 May by an estimated tag rate derived from recaptures at the smolt trap and an estimated detection efficiency derived from a discharge/efficiency model developed for the Twisp PIT antenna and estimated that 12,819 (± 17,352, 95% CI) wild steelhead smolts emigrated from the Twisp River. Because steelhead emigrate at multiple ages,

we used age data derived from scale samples to assign migrating smolts to their brood year of origin. For the last brood for which a complete emigration estimate is available (2007 brood) we estimated that 33,275 (± 14,890, 95% CI) and 13,512 (± 1,285, 95% CI) juvenile steelhead emigrated from the Methow Basin (excluding Twisp) and Twisp rivers, respectively. Steelhead in the Methow Basin and Twisp River produced an estimated 45, and 165 emigrants from 2007 brood redds, respectively.

Introduction

An important component of both past and present hatchery monitoring and evaluation programs has been estimating the freshwater productivity of spring Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss* in the Methow River basin (MBSCSP 1995; Wells HCP HC 2005). Estimates of natural production by spring Chinook salmon and steelhead coupled with characteristics of the spawning population (i.e., abundance and composition) should provide some of the data necessary to assess the efficacy of hatchery supplementation programs for these species. Although rotary screw traps have proved to be a reliable, cost-effective, and minimally invasive method of producing species-specific production estimates in other river systems (Thedinga et al.1994; Murdoch et al. 2001), limited information exists on smolt production in the Methow Basin because smolt-monitoring efforts were not implemented annually or with consistency of methods or sampling locations. Screw traps were operated sporadically on the upper Methow and Chewuch rivers prior to 2004 (Hubble and Sexauer 1994; Hubble and Harper 1999; Hubble et al. 2003). However, estimates of smolt production for the entire Methow Basin were not calculated because monitoring was intermittent or occurred primarily in tributaries (i.e., Chewuch River). Beginning in 2004, the WDFW Supplementation Research Team implemented a smolt-monitoring program on the Methow River and expanded the program to the Twisp River in 2005. The primary objective was to estimate juvenile production of spring Chinook salmon and steelhead and to estimate stage-specific survival rates. These objectives were incorporated into the development and implementation of the Conceptual Approach to Monitoring and Evaluation for Hatchery Programs funded by Douglas County PUD (M&E Plan; Wells HCP HC 2007), for which this chapter focuses on the following objective:

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

- Ho: Slope of Ln(juveniles/redd) vs. redds $_{\text{Supplemented population}}$ = Slope of Ln(juveniles/redd) vs. redds $_{\text{Non-supplemented population}}$
- Ho: The relationship between proportion of hatchery spawners and juveniles/redd is $\geq$ 1

The M&E Plan requires that smolt production data from supplemented populations be compared to similar data from non-supplemented reference populations (Wells HCP HC 2007). Comparisons using a non-supplemented population or populations (i.e., reference stream) will reduce annual variation associated with these data so only the treatment effect (i.e., supplementation fish) can be tested. Reference populations for Methow spring Chinook salmon have been identified and used in the Evaluation of Hatchery Programs Funded by Douglas

County PUD 5-Year Report 2006-2010 (2012). Reference populations have not been identified for steelhead, to date.

Methods

Methods used in trap operation and in calculating population estimates are provided in more detail in Appendix E of the Monitoring and Evaluation Plan (Wells HCP HC 2007).

Smolt Trap Operation

Rotary smolt traps of different sizes were operated in several configurations depending on the specific requirements of each site. The Twisp River site used a single trap with a 1.5-m cone diameter because of low stream flow and a relatively narrow stream channel. The Methow River site used traps with cone diameters of 2.4 m and 1.5 m to increase trap efficiency at greater ranges of river discharge. Large variation in discharge in the Methow River also required the use of two trapping positions due to the channel configuration and safety of personnel and fish. A 1.5 m trap was deployed in the lower position at the Methow site at discharges below 56.6 m^3/s. At discharges greater than 56.6 m^3/s, an additional 2.4 m trap was installed and operated in tandem with the 1.5 m trap. The tandem traps were operated approximately 30 m upstream of the low position (i.e., upper position).

Trapping occurred mostly after dark. Trap cones were lowered 1-2 hours before sunset and raised 1-2 hours after sunrise. Traps were pulled to the bank during the day to avoid debris as well as to allow easier access for boaters and recreational users as stated in our Okanogan County Conditional Use Permit. During periods of low smolt abundance, fish were removed from the traps each morning. During periods of greater discharge and/or smolt abundance, traps were monitored throughout the night to minimize mortality of captured fish and avoid equipment damage from debris. Discharge and velocity influenced trap position and frequency of sampling, and were the most important factors affecting trap efficiency. Cheng and Gallinat (2004) reported similar conclusions for a rotary screw trap operated on the Tucannon River located in southeastern Washington.

Debris was removed from the catch box by a small rotating drum-screen powered directly by the rotation of the cone (2.4-m trap) or by the cone contacting a rubber tire that caused the drum-screen to rotate (1.5-m traps). Traps were either connected to a main cable spanning the river (Methow River site), or to a single point on the right bank (Twisp River site). A more detailed description of the configuration at each site can be found in Snow and Perry (2005) and Snow and Fowler (2006).

Biological Sampling

Captured fish were retained in a 0.37 m^3 live box and were sorted, counted by species, and classified as hatchery or wild origin at each trap. Fish utilized for mark and recapture trials or tagged with passive integrated transponder (PIT) tags were held in 0.11 m^3 or 1.0 m^3 auxiliary live boxes affixed to the rear section of each trap. Salmonids were anesthetized in a solution of

MS-222 prior to sampling and allowed to recover prior to release. Salmonids were visually classified as fry, parr, transitional, or smolt. Fry were defined as newly emerged fish without a visible yolk sac and largely underdeveloped pigmentation, with a fork length less than 50 mm. Parr had a fork length equal to or greater than 50 mm and distinct parr marks on their sides. Transitional migrants had faded parr marks, bright silver coloration, and some scale loss. Salmonids lacking or having highly faded parr marks, bright silver color, and deciduous scales were classified as smolts.

Most hatchery spring Chinook salmon and some hatchery steelhead were not adipose fin-clipped; therefore, the origin of adipose-present migrating salmonids was determined from the presence of coded-wire tags (e.g., spring Chinook salmon and coho [*O. kisutch*]), or elastomer tags and dorsal fin erosion (e.g., steelhead). Most hatchery summer Chinook salmon released in the Methow River were adipose fin-clipped. Juvenile salmonids lacking any tags, visible marks, or fin erosion were considered wild.

Sampling protocols differed by origin and species, although all fish were scanned for PIT tags prior to release. Hatchery-origin fish were counted by mark type, while most wild-origin fish were counted, measured to the nearest millimeter, and weighed to the nearest 0.1 g. Scale samples were collected from the majority of wild summer steelhead captured throughout the migration period. Scale samples were analyzed by the WDFW Scale Lab to estimate the contribution of different age classes to the migrating population. Most wild spring Chinook salmon, steelhead, and bull trout were PIT tagged prior to release, and all PIT tagging information was uploaded to a regional PIT tag database (PTAGIS) maintained by the Pacific States Marine Fish Commission. Non-salmonids were counted by species or by family if they were too small to identify to species (e.g., *Catostomidae*).

We used age, trap location, and DNA analysis to determine race (spring or summer) of captured juvenile Chinook salmon. All Chinook salmon captured in the Twisp River trap were considered spring Chinook salmon, regardless of size (i.e., summer Chinook salmon have not been documented spawning upstream of the trap). All yearling Chinook salmon captured at the Methow 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 Chinook age-0 fry and parr captured at the Methow River trap during spring were considered summer Chinook salmon. Some spring Chinook salmon juveniles migrate as fry or parr from natal areas and some summer Chinook salmon may migrate as yearlings. Hence, a small yet unknown proportion of spring Chinook salmon may be misclassified as summer Chinook salmon and vice versa. Although the number of misclassified spring Chinook salmon should be relatively small compared with the numerically dominant summer Chinook salmon, production estimates for the less abundant spring Chinook salmon could be profoundly influenced by such misclassifications. In order to determine the proportion of subyearling spring and summer Chinook salmon in the total catch, we collected tissue samples (i.e., fin clips) of emigrating subyearling Chinook salmon captured at the Methow River site for DNA analysis. Tissue samples were transported to the WDFW genetics lab for processing.

During periods when the trap was not operating (e.g., mechanical problems, high debris, or high discharge) the number of spring Chinook salmon, summer Chinook salmon, and summer steelhead captured was estimated. The estimated number of fish captured was calculated using the average number of fish captured two days prior and two days after the break in operation.

Population Estimates

Groups of at least 50 juvenile salmonids were used for trap efficiency trials whenever possible. However, low abundance of target species and low trap efficiency required the use of some groups with fewer than 50 fish. Mark/recapture fish were marked using a top or bottom caudal fin-clip, PIT tag, or were stained with Bismarck brown dye. Fish used in trap efficiency trials were anesthetized prior to marking and then held in an auxiliary live box for up to three days, until the day of the trial. Marked fish were transported upstream of the trap in a 1,211 L two-chamber transport tank, or 18.9 L snap-lid buckets. Fish were divided into two equal groups and released on both stream banks to increase the likelihood that marked fish were uniformly mixed with unmarked fish and therefore representative of the population when recaptured. Releases of marked fish occurred the evening of the next trapping period after the trap was set. Marked groups of fish were released over the greatest range of discharge possible in order to increase the utility of the trap efficiency-flow regression model used to estimate the daily trap efficiency. The mean daily discharge for each trapping period was calculated based on the start and end time of trap operation. Discharge was measured and recorded every 15 min at USGS gauging station No. 12449950 (Methow River near Pateros, Washington) and station No. 12448998 (Twisp River near Twisp, Washington). Marked fish from the Methow River trap were transported and released approximately 5.6 km upstream of the trap (rkm 36). Fish for Twisp River trap mark groups were transported and released approximately 0.81 km upstream of the trap (rkm 3). Recaptured fish were recorded by mark type, measured, and released.

Emigration estimates were calculated using estimated daily trap efficiency, which was derived from a regression formula using trap efficiency (dependent variable) and discharge (independent variable). Trap efficiency was calculated using the following formula:

Trap efficiency = $E_i = R_i / M_i$

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 (N_i) 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 formula:

Variance of daily migration estimate = $\text{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{\text{MSE}\left(1 + \dfrac{1}{n} + \dfrac{(X_i - \bar{X})^2}{(n-1)s_X^2}\right)}{\hat{e}_i^2}$

Where X_i is the discharge for time period i, and n is the sample size (number of mark recapture trials used in model). If a relationship between discharge and trap efficiency was not present (i.e., $P < 0.05$; $r^2 \approx 0.5$), 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 = $\text{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{E_p(1 - E_p) / \sum M}{E_p^2}$

The total emigration estimate and confidence interval were calculated using the following formulas:

Total emigration estimate = $\sum \hat{N}_i$

95% confidence interval = $1.96 \times \sqrt{\sum \text{var}[\hat{N}_i]}$

A valid estimate would require the following assumptions to be true concerning the trap efficiency trials:

1. All marked fish passed the trap or were recaptured during time period *i*.
2. The probability of capturing a marked or unmarked fish is equal.
3. Marked individuals were randomly dispersed in the population before recapture.
4. All marked fish recaptured were identified.
5. Marks were not lost between the time of release and recapture.

Ideally, a species-specific discharge/capture efficiency model (i.e., flow model) was developed at each trap site within each year for each trap position used. When this was not possible, we used the following protocols in order of priority to determine the methodology used to develop production estimates for each trap site and species:

1. Flow model using target species within current year.
2. Flow model using target species over multiple years.
3. Flow model using target and surrogate species within current year.
4. Flow model using target and surrogate species over multiple years.
5. Flow model using surrogate species within current year.
6. Flow model using surrogate species over multiple years.
7. Pooled efficiency estimate using target species within current year.
8. Pooled efficiency estimate from previous year.

The number of wild summer steelhead emigrating from the Twisp River was also estimated using an in-stream PIT tag interrogation site (PTAGIS site code = TWR) located immediately downstream of the Twisp River smolt trap. We developed a discharge/interrogation-efficiency relationship for this site using discrete groups of PIT tagged hatchery steelhead released from Wells Hatchery, or hatchery spring Chinook released for smolt trap efficiency trials. From each group, we used only those PIT tag codes that were recorded at the Rocky Reach Juvenile Bypass interrogation site downstream (PTAGIS site code = RRJ) to determine the number of marked fish released. This ensured that only fish known to have emigrated past the TWR site were used to estimate efficiency. The number of recaptures from each group was thus calculated as the number of PIT tagged fish recorded at RRJ that were also recorded at TWR, and we used the mean discharge during the evening period immediately following release of each group to correlate capture efficiency. To determine the daily emigration of wild steelhead, we expanded the number of unique PIT tags recorded each day at the TWR site by the overall PIT tag mark rate of wild steelhead captured at the Twisp River smolt trap. Only unique PIT tags from remote steelhead parr tagged in previous years were used to estimate smolt emigration (i.e., fish tagged at the smolt trap were excluded). This approach assumed that juvenile steelhead tagged as parr were representative of the population being estimated. The daily emigration estimate was then expanded using the discharge/interrogation-efficiency model as described for smolt traps to develop a total production estimate, variance, and 95% CI. Similar estimates were not conducted for emigrating spring Chinook at the TWR site because too few fish emigrated past the site with existing PIT tags.

Juveniles Per Redd

Production estimates for each age class by trapping location were summed to produce a total brood year emigration estimate. For spring Chinook salmon, the estimate of fall-migrant spring Chinook salmon parr was added to the emigrant estimate from the following spring to produce a total emigrant estimate for each brood year. Because a single brood of steelhead may require four or more years to completely migrate, the annual emigration estimate at each trap location was multiplied by the proportion of migrants from each brood determined through scale pattern analysis. The total number of migrants produced from one brood of spawning adults requires at least four years of emigration estimates. The number of emigrants per redd for each brood year was calculated by dividing the total brood year emigrant production estimate by the total number of redds in that brood year estimated through spawning ground surveys.

For spring Chinook salmon, egg deposition values used to calculate egg-to-emigrant survival were derived from carcass surveys and hatchery broodstock sampling. For each brood examined, the number of redds deposited was estimated by age and origin of the female spawning population within each basin as determined through spawning ground surveys. Each redd was then multiplied by the mean fecundity values by age and origin determined through sampling of Methow Hatchery broodstock, and adjusted by the percent of eggs retained in the body cavity determined through spawning ground (carcass) surveys. For summer steelhead, egg deposition values were derived by multiplying the total number of redds in each basin by mean fecundity values according to age and origin of the female steelhead population as determined through run composition and hatchery broodstock sampling at Wells Hatchery.

Spawning ground surveys identified summer steelhead and spring Chinook salmon redds downstream of the Methow and Twisp River trap sites in some years. We assumed that redds located downstream from each trap site did not contribute to production estimates calculated at upstream smolt traps. To calculate total production and emigration estimates for the populations, we applied the egg-to-smolt survival rates calculated for those redds upstream of trap to the estimated number of eggs deposited downstream of the trap. Confidence intervals (95%) were adjusted in a similar manner. Total brood year emigration estimates were calculated by adding the estimated number of emigrants produced downstream of the trap to the estimate of emigrants produced upstream of the trap location.

Results

Smolt Trap Operation

Trapping in the Methow River basin in 2011 began at the Methow River site on 4 March and at the Twisp River site on 10 March. Trapping at both locations was interrupted on several occasions over the course of the trapping season because of unfavorable environmental conditions (e.g., flooding, low flow, ice). Discharge was above annual mean values for much of the year (Figures 1-2), and exceeded safe trap operation ranges at both sites during spring runoff. River discharge in the fall was near or above mean values at both sites.

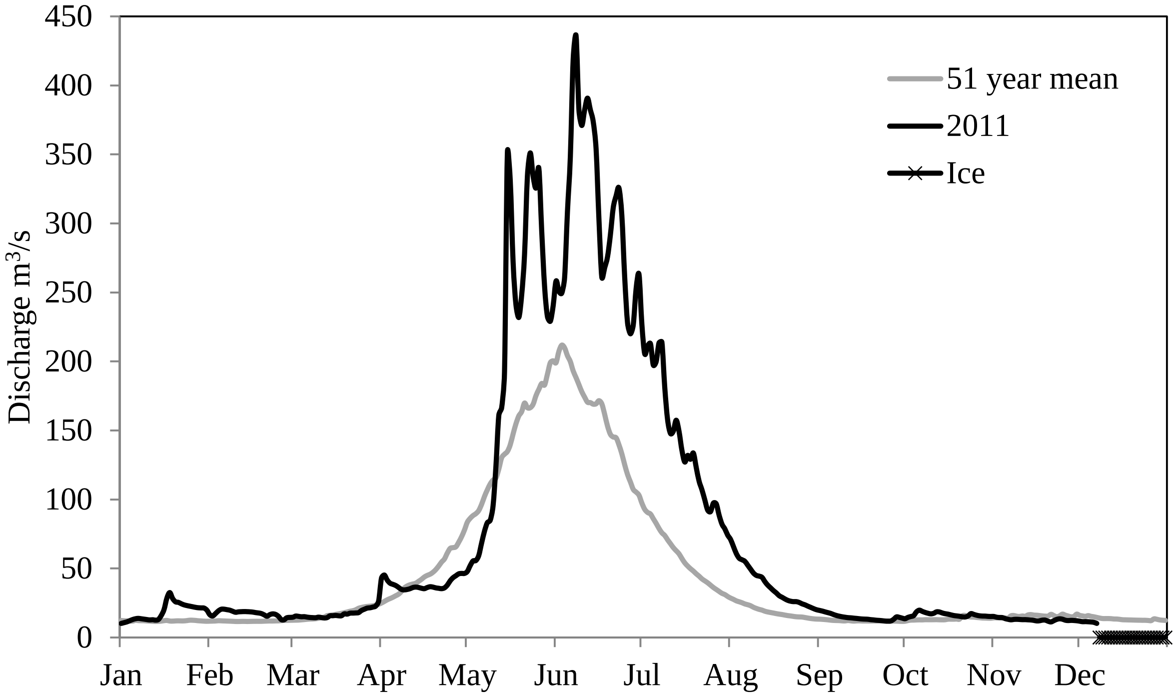

Figure 1. Methow River 2011 daily discharge and 51-year mean as measured at the USGS gauging station No. 12449950 (Methow River near Pateros, Washington).

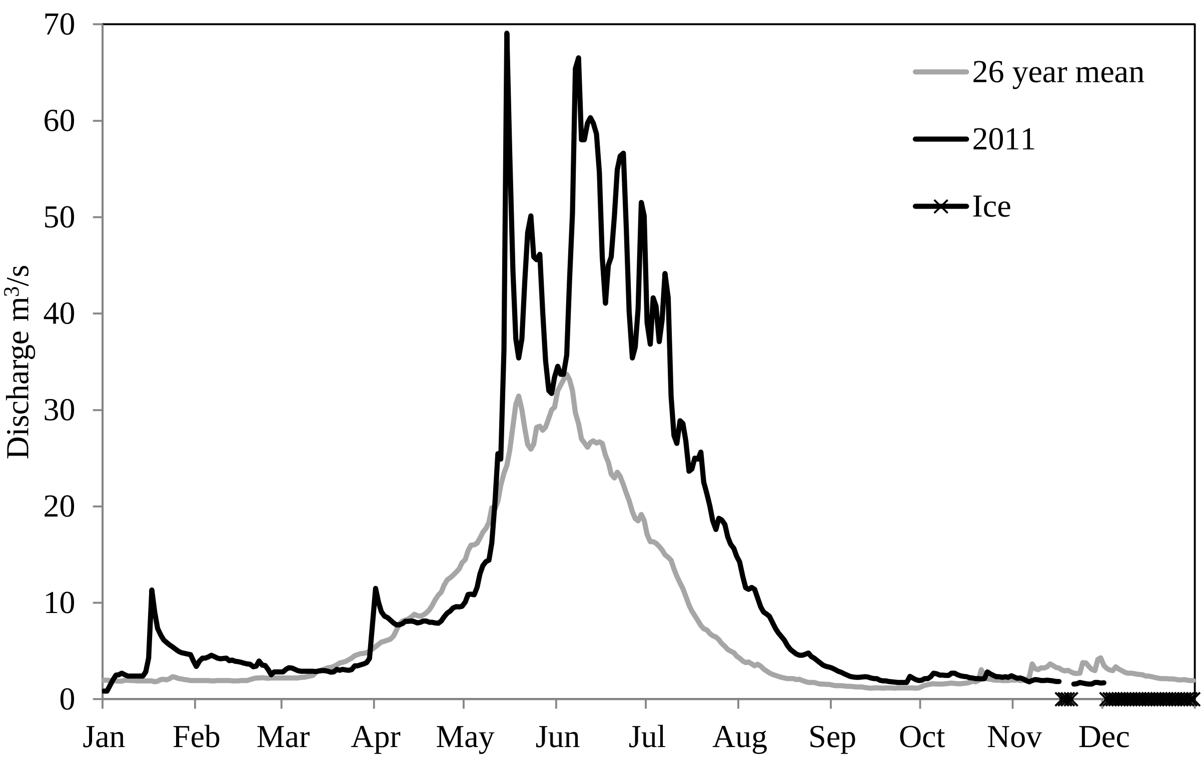

Figure 2. Twisp River 2011 daily discharge and 26-year mean as measured at the USGS gauging station No.12448998 (Twisp River near Twisp, Washington).

Daily Captures and Biological Sampling

Methow River Trap

<u>*2009 Brood Chinook Salmon*</u>

A total of 344 wild yearling Chinook salmon emigrants were captured between 4 March and 30 June (Appendix A1). Peak capture (N = 21) occurred on 2 April (Figure 3). We implanted PIT tags into 325 of the wild smolts captured with no mortalities. We also implanted PIT tags into 1,592 of the 9,910 adipose present and coded-wire tagged hatchery Chinook salmon captured to facilitate trap efficiency mark-recapture trials. These fish were assumed to be spring Chinook salmon, but specific stock or hatchery of origin (i.e., WNFH or MH) could not be determined. Twenty-six mortalities of hatchery Chinook occurred, resulting in 1,566 fish released with PIT tags (Appendix B). Two additional hatchery Chinook mortalities occurred prior to tagging. Mortalities of hatchery Chinook salmon smolts totaled 0.28% (N = 28) of the hatchery smolts captured. Hatchery smolts had a significantly greater mean fork length (135.6 mm) than wild Chinook smolts (98.0 mm) captured at the trap (Mann-Whitney U-test: $P < 0.001$; Table 1).

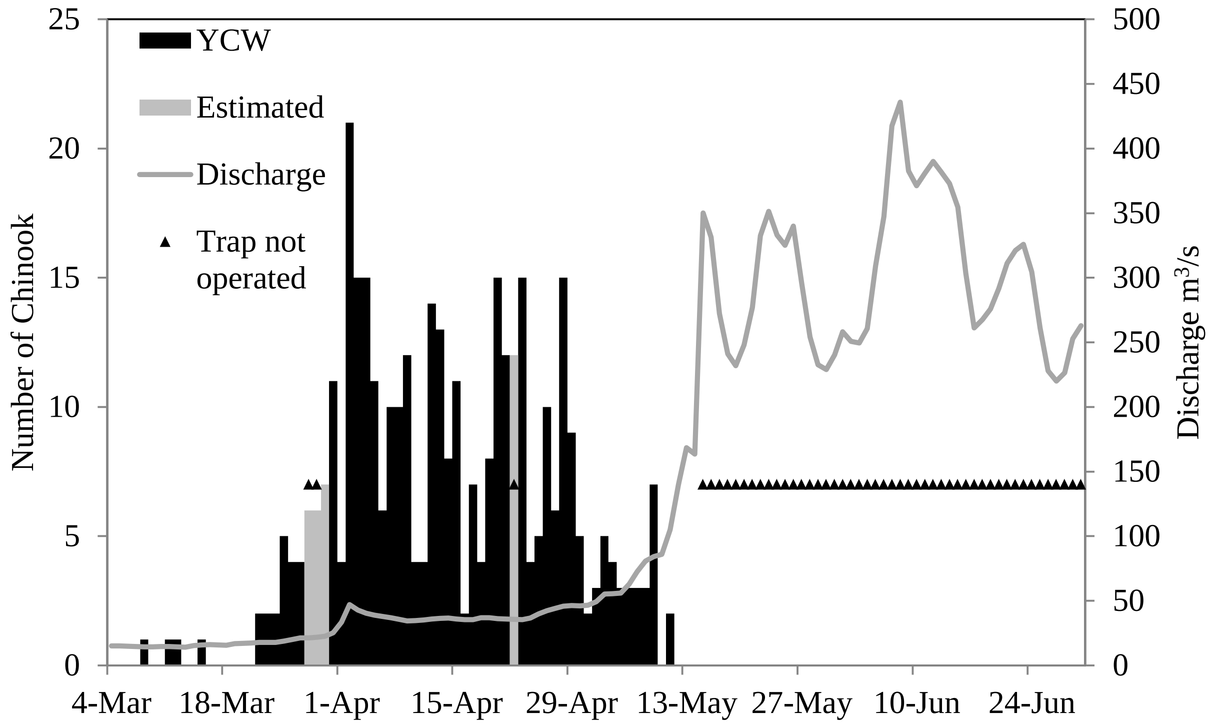

Figure 3. Daily capture of wild Chinook salmon smolts (YCW) at the Methow River smolt trap during 2011.

<u>*2010 Brood Chinook Salmon*</u>

Subyearling Chinook salmon fry (N = 6,536) and parr (N = 779) captured at the Methow trap between 4 March and 30 September had mean fork lengths of 38.6 mm and 70.2 mm, respectively (Table 1). Mortality during this period totaled one fry (0.02%) and six parr (0.86%). Genetic analysis of tissue samples collected from Chinook salmon fry captured during spring trapping (*N* = 209) indicated that 37 (17.7%) were spring Chinook salmon and 172 (82.3%) were summer Chinook salmon (Appendix C; Figure 4). We inserted PIT tags into 508 parr, but eight died prior to release. An additional 177 emigrant Chinook salmon parr were captured during the fall trapping period between 1 October and 5 December. The mean fork length of Chinook salmon parr during this period was 88.1 mm (Table 1), and peak captures occurred on 28 and 29 October (*N* = 8). We inserted PIT tags into 161 of the 177 Chinook salmon parr captured during the fall period and released 170 parr with PIT tags after subtracting a single mortality (Appendix B). Genetic analysis of tissue samples collected from Chinook salmon parr captured during fall trapping indicated that 156 (92.9%) were spring Chinook salmon and 12 (7.1%) were summer Chinook salmon (Appendix C).

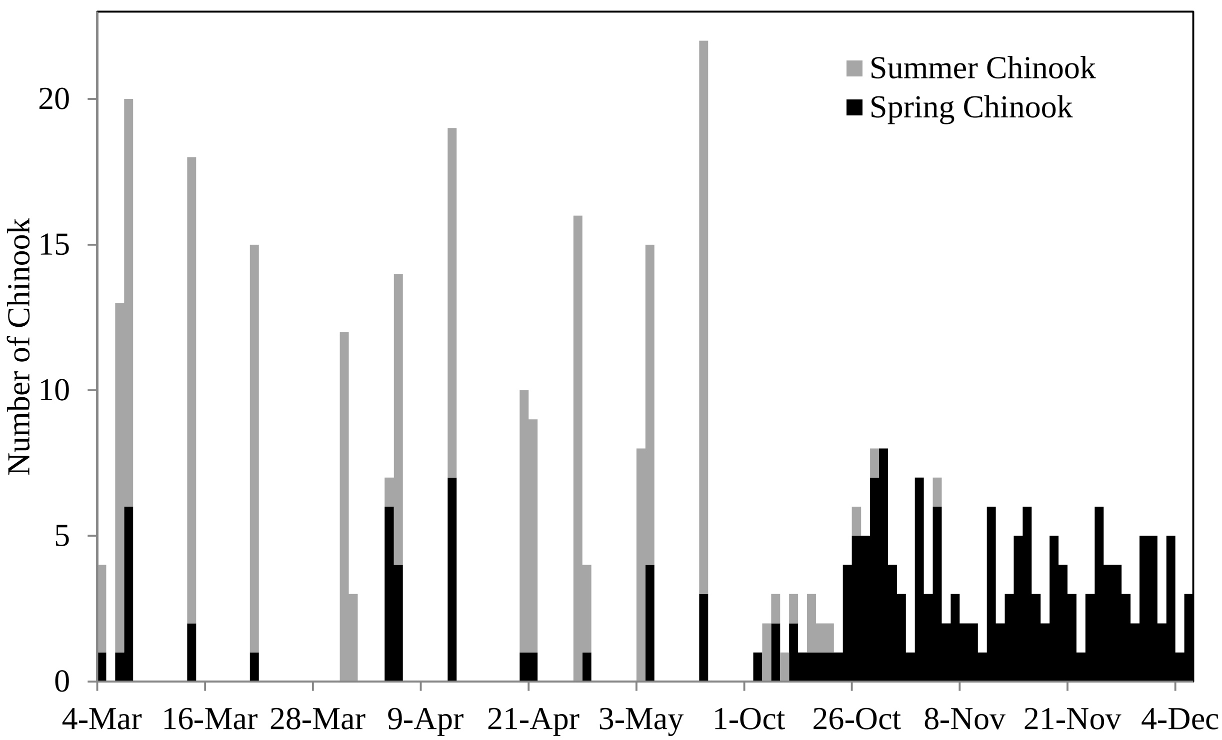

Figure 4. Daily capture of wild subyearling spring and summer Chinook salmon at the Methow River smolt trap in 2011. Periods when the trap was not operated or no genetic analysis was conducted are omitted.

Table 1. Summary of length and weight sampling of Chinook salmon captured at the Methow River smolt trap in 2011.

Brood	Origin/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*N*	SD	Mean	*N*	SD	
2010	Wild fry	38.6	830	3.9	--	--	--	--
2010	Wild parr (Feb-Sep)	70.2	607	13.5	4.9	589	2.8	1.4
2010	Wild parr (Oct-Dec)	88.1	177	8.6	7.8	177	2.3	1.1
2009	Wild smolt	98.0	336	10.0	10.8	336	7.0	1.1
2009	Hatchery smolt	135.6	1,577	32.6	29.8	597	11.9	1.2

Summer Steelhead

We captured 171 wild summer steelhead emigrants (smolt and transitional) between 4 March and 30 June in the Methow River trap, with peak capture on 7 May (*N* = 26; Figure 5). We estimated an additional 51 steelhead would have been captured if the traps had operated during the entire period (Appendix A3). We PIT tagged and released 165 wild steelhead emigrants and no mortality or tag shedding occurred (Appendix B). Most wild summer steelhead migrants were age-2 fish (81.7%) with a mean fork length of 167.4 mm (Table 2).

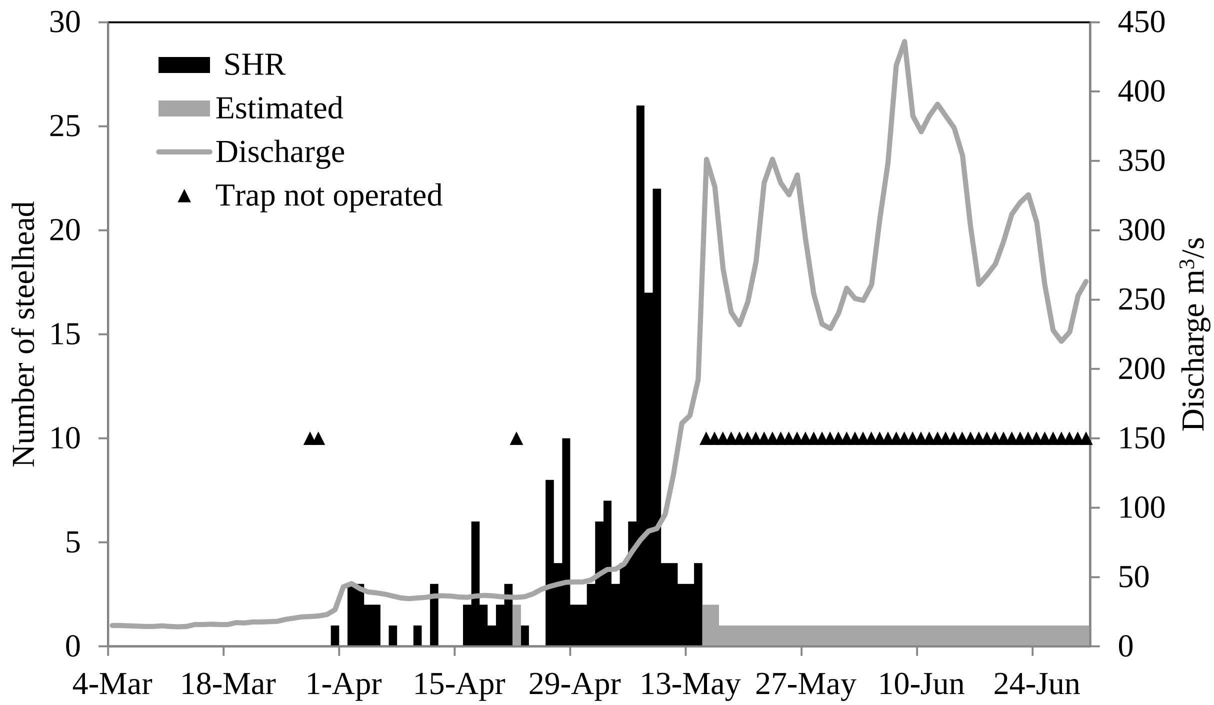

Figure 5. Daily capture of wild steelhead smolt and transitional migrants at the Methow River smolt trap in 2011.

We captured 46 wild fry and 54 wild summer steelhead parr between 3 March and 5 December. Steelhead parr greater than 55 mm and in good physical condition were PIT tagged (*N* = 47) prior to release (Appendix B), and no mortality or tag shedding occurred. Wild steelhead parr had a mean fork length of 95.1 mm.

Table 2. Mean length, weight and condition factor by age class of wild transitional and smolt summer steelhead emigrants captured at the Methow River trap in 2010.

Age	*N* (%)	Fork (mm)			Weight (g)			K-factor
		Mean	*N*	SD	Mean	*N*	SD	
1	9 (6.8)	121.6	9	12.6	20.5	9	5.8	1.1
2	107 (81.7)	167.4	107	15.8	45.5	107	11.6	1.0
3	14 (10.7)	174.4	14	13.2	52.2	14	14.0	1.0
4	1 (0.8)	183.0	1	- -	57.3	1	- -	0.9

Twisp River Trap

<u>*2009 Brood Spring Chinook Salmon*</u>

The Twisp River trap captured 317 wild yearling spring Chinook salmon smolts between 10 March and 30 June. Peak captures occurred on 26 April (*N* = 35; Figure 6). We estimated 11 additional smolts would have been captured had the trap operated without interruption during the entire period (Appendix A4). We inserted PIT tags into 307 of the captured fish, and released 304 tagged smolts after subtracting three mortalities (Appendix B). We also inserted PIT tags into 211 of the 9,649 hatchery spring Chinook salmon captured for use in mark/recapture trials. Hatchery spring Chinook salmon had a significantly greater mean fork length (136.9 mm) than wild Chinook smolts (96.7 mm) captured at the Twisp trap (Mann-Whitney U-test: $P < 0.001$; Table 3).

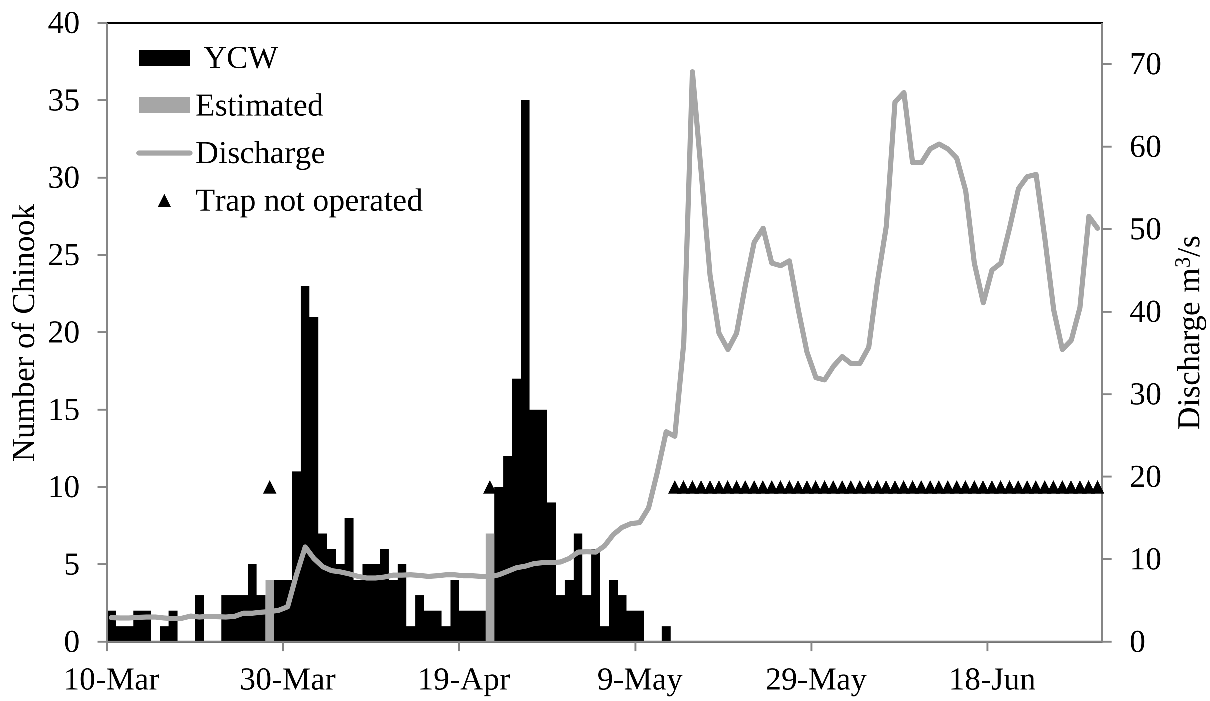

Figure 6. Daily capture of wild spring Chinook salmon smolts at the Twisp River smolt trap in 2011.

Table 3. Summary of length and weight sampling conducted on Chinook salmon captured at the Twisp River smolt trap in 2011.

Brood	Origin/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*N*	SD	Mean	*N*	SD	
2009	Wild smolt	96.7	312	8.2	9.7	312	2.4	1.1
2009	Hatchery smolt	136.9	211	12.9	28.6	208	9.5	1.1
2010	Wild fall parr	85.3	180	7.3	8.4	180	2.3	1.4

2010 Brood Spring Chinook Salmon

We captured 473 subyearling spring Chinook salmon between 10 March and 30 September, of which one (0.2%) fish were recorded as mortalities. An additional 180 migrant parr were captured between 1 October and 17 November, with peak capture occurring on 24 October (*N* = 16; Figure 7). We implanted 315 PIT tags into subyearling parr between 1 July and 31 August, and implanted 170 tags into migrant parr between 1 October and 17 November. No mortality or tag shedding occurred from either group. Fall migrant parr had a mean fork length of 85.3 mm (Table 3).

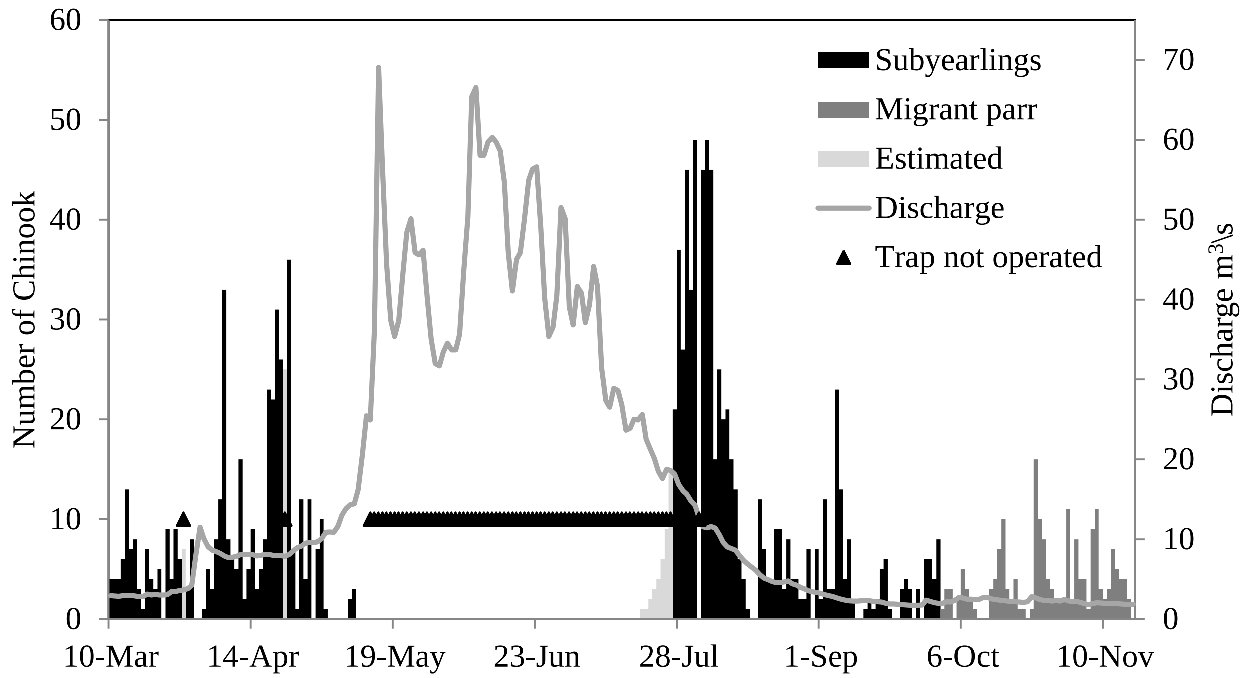

Figure 7. Daily capture of subyearling wild spring Chinook salmon (Mar – Sep) and migrant parr (Oct – Nov) at the Twisp River smolt trap in 2011.

Summer Steelhead

We captured 330 wild summer steelhead emigrants (smolt and transitional) between 4 March and 30 June. Peak capture occurred on 1 April (*N* = 49; Figure 8). We estimated an additional 55 steelhead would have been captured if the trap had operated without interruption (Appendix A6). Wild emigrants (all ages combined) had a mean fork length of 167.3 mm, and were primarily age-2 fish (79.3%; Table 4). Hatchery steelhead captured at the Twisp River trap had a mean fork length of 197.4 mm and were significantly larger than wild summer steelhead captured at the trap (Mann-Whitney U-test: $P < 0.001$). No mortality of wild summer steelhead migrants occurred in 2011 at the Twisp River trap. We inserted PIT tags into 304 wild steelhead emigrants, and released 302 tagged fish after shed tags (*N* = 2) were subtracted (Appendix B). We implanted PIT tags into 770 of 7,005 hatchery origin steelhead captured at the trap to conduct mark recapture trials. We released 752 hatchery steelhead after subtracting 18 mortalities. Hatchery summer steelhead mortalities were 0.25% of all hatchery summer steelhead captured in 2011.

Non-migrant summer steelhead captured at the trap included 44 wild fry and 149 wild parr captured between 10 March and 17 November (Figure 9). We PIT tagged 138 steelhead parr greater than 55 mm and released 136 of these fish with PIT tags after subtracting two shed tags (Appendix B). Wild summer steelhead parr had a mean fork length of 92.0 mm and experienced a single mortality during the trapping season (0.5%).

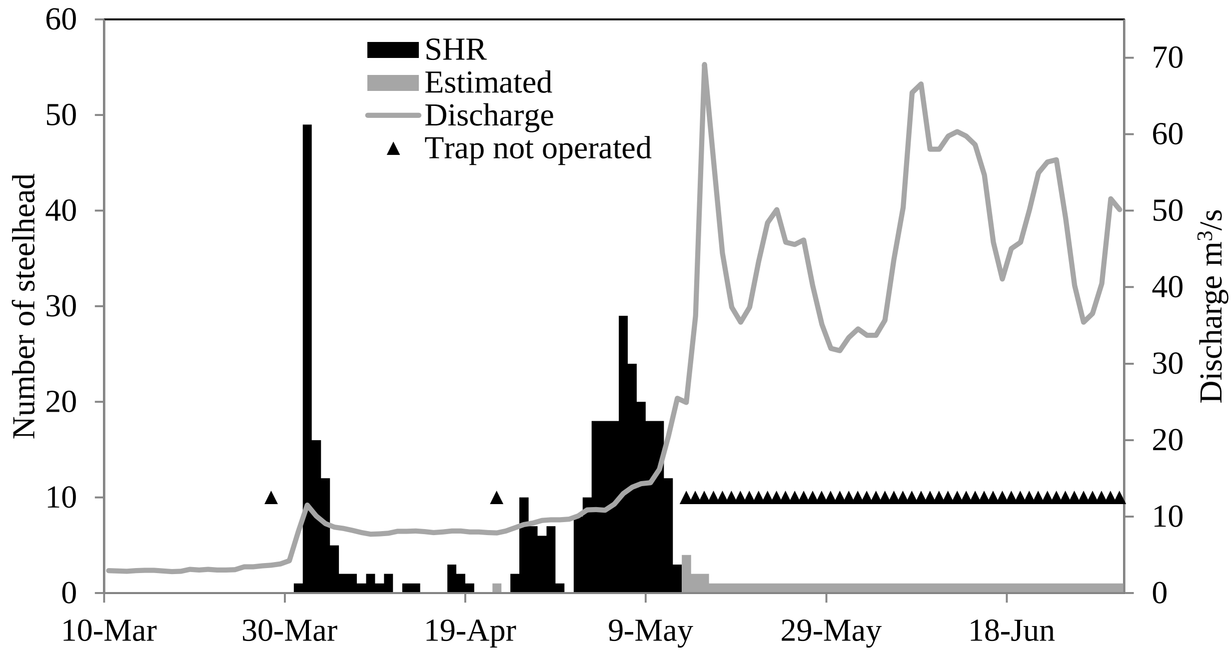

Figure 8. Daily capture of wild steelhead (SHR) smolt and transitional migrants at the Twisp River smolt trap in 2011.

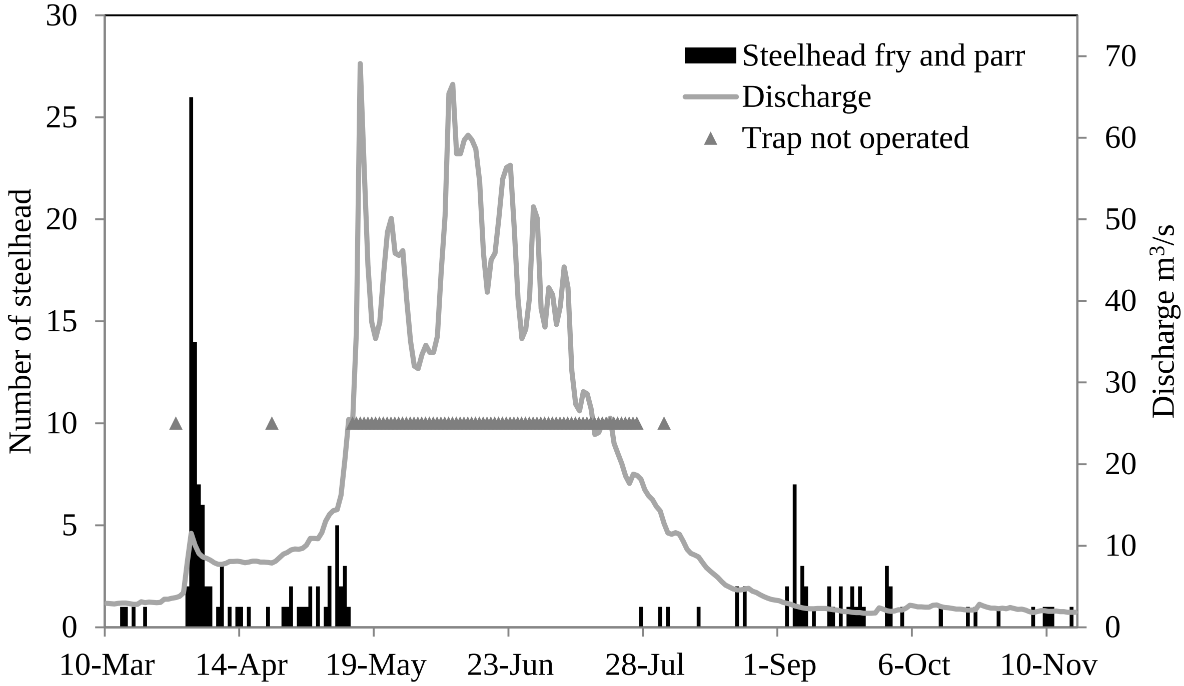

Figure 9. Daily capture of wild steelhead fry and parr at the Twisp River smolt trap in 2011.

Table 4. Mean length at migration age of wild transitional and smolt summer steelhead captured at the Twisp River trap in 2011.

Age	*N* (%)	Fork (mm)			Weight (g)			K-Factor
		Mean	*N*	SD	Mean	*N*	SD	
1	1 (0.4)	135.0	1	--	45.5	1	--	--
2	226 (79.3)	161.7	226	15.8	41.5	226	11.8	1.0
3	37 (12.9)	182.4	37	26.3	60.6	37	25.2	1.0
4	21 (7.4)	181.9	21	26.4	60.8	21	22.9	1.0

Population Estimates

Methow River Basin

<u>*2009 Brood Chinook Salmon*</u>

Mark/recapture efficiency trials for estimating wild spring Chinook salmon smolt production should ideally be conducted with wild Chinook salmon. However, no mark/recapture efficiency trials were conducted with wild spring Chinook smolts because we captured too few wild fish to provide an appropriate sample size. We used hatchery spring Chinook salmon as surrogates for wild spring Chinook but were only able to conduct two mark recapture trials with these fish and no significant regression model could be developed within the 2011 season with these two mark groups. However, when these two mark recapture trials were included with trials from previous years, a significant relationship did exist ($P < 0.001$; $r^2 = 0.59$) and we used this combined model for the low trapping position in 2011. For the upper trapping position, we were unable to conduct any mark recapture trials in 2011 because too few wild fish were captured and high flows did not allow us to operate in this position while hatchery fish were available. Hence, we used the significant model developed in 2010 ($P < 0.03$, $r^2 = 0.59$; Table 5) for this position in 2011. Using both these flow models, the estimated number of yearling spring Chinook salmon emigrants was 29,610 (± 8,255, 95% CI). When combined with the estimate of parr that emigrated past the trap in 2010 (1,602 ± 568, 95% CI; Snow et al. 2011), we estimated that 31,212 (± 8,823, 95% CI) 2009 brood wild spring Chinook salmon migrated from the Methow River basin between 1 October 2010 and 30 June 2011.

Table 5. Mark and recapture efficiency trials used to estimate emigration of 2009 brood spring Chinook salmon (YCH = yearling Chinook salmon hatchery origin, YCW = yearling Chinook salmon wild origin, and COH= yearling Coho salmon hatchery origin).

Species	Date	Position	Released	Recaptured	Efficiency (%)	Discharge (m^3/s)
YCH	20-Apr-08	Low	403	6	1.49	32.3
YCH	22-Apr-08	Low	250	3	1.20	29.7
YCH	03-May-08	Low	281	3	1.06	46.0
YCH	18-Apr-09	Low	221	3	1.36	26.6
YCH	24-Apr-09	Low	423	3	0.71	63.2
YCH	20-Apr-11	Low	521	6	1.15	36.0
YCH	27-Apr-11	Low	493	7	1.42	45.7
	Flow model		2,592	31	1.20	
YCW, COH	06-Apr-07	Upper	109	3	2.75	71.9
YCH	12-Apr-07	Upper	448	9	2.01	119.0
YCH, YCW	14-Apr-07	Upper	224	3	1.34	105.8
YCH	18-Apr-07	Upper	361	10	2.77	95.1
YCH	20-Apr-07	Upper	305	8	2.62	89.9
COH	25-Apr-07	Upper	373	4	1.07	108.2
COH	30-Apr-07	Upper	600	3	0.50	123.0
YCH	22-Apr-10	Upper	525	7	1.30	119.9
	Flow model		2,945	47	1.59	

2010 Brood Chinook Salmon

No mark recapture trials were conducted with subyearling Chinook for the low position in the spring and summer of 2011 and only one mark recapture trial was conducted for the upper position during this time period. Further, we could not obtain sufficient numbers of fish to develop a flow regression model for the low position in the fall of 2011, and used a pooled efficiency from the trials we did conduct to estimate fish passage during this time period (Table 6). Tissue samples were collected from 377 Chinook salmon fry and 173 Chinook salmon parr to determine race composition (i.e., spring or summer) through DNA analysis (Appendix C). Using these data we estimate that 514,724 (± 349,514, 95% CI) subyearling summer Chinook and 8,979 (± 1,832, 95% CI) subyearling spring Chinook migrated past the trap in 2011.

Table 6. Mark and recapture efficiency trials used to estimate emigration of 2010 brood subyearling Chinook salmon (SBC) at the Methow River smolt trap in 2011.

Species	Date	Position	Released	Recaptured	Efficiency (%)	Discharge (m^3/s)
SBC	13-Jul-07	Low	208	1	0.48	47.4
SBC	23-Jul-07	Low	106	3	2.83	32.7
SBC	01-Aug-07	Low	142	3	2.11	20.5
	Pooled		456	7	1.54	
SBC	30-Apr-07	Upper	493	5	1.01	122.9
SBC	26-May-07	Upper	600	5	0.83	171.0
SBC	28-May-07	Upper	600	1	0.17	172.8
SBC	11-Jun-07	Upper	760	7	0.92	132.1
SBC	14-Jun-07	Upper	620	12	1.93	106.8
SBC	18-Jun-07	Upper	1,000	32	3.20	95.2
SBC	25-Jun-07	Upper	1,000	25	2.50	75.7
SBC	28-Jun-07	Upper	833	21	2.50	71.6
SBC	03-Jul-07	Upper	340	12	3.50	64.6
SBC	11-Jun-08	Upper	503	8	1.59	112.9
SBC	23-Jun-08	Upper	170	2	1.18	112.0
SBC	03-Aug-11	Upper	50	2	4.00	59.4
	Flow model		6,969	132	1.89	
SBC	04-Oct-11	Low	2	0	0.0	16.8
SBC	07-Oct-11	Low	5	1	20.0	21.1
SBC	11-Oct-11	Low	3	0	0.0	18.7
SBC	21-Oct-11	Low	3	0	0.0	15.2
SBC	26-Oct-11	Low	10	0	0.0	16.5
SBC	28-Oct-11	Low	11	0	0.0	15.7
SBC	01-Nov-11	Low	15	0	0.0	15.3
SBC	04-Nov-11	Low	17	0	0.0	14.5
SBC	08-Nov-11	Low	7	0	0.0	12.9
SBC	11-Nov-11	Low	3	0	0.0	13.0
SBC	15-Nov-11	Low	14	0	0.0	12.6
SBC	18- Nov-11	Low	12	1	8.3	12.3
SBC	22-Nov-11	Low	12	1	8.3	11.9
SBC	25-Nov-11	Low	10	0	0.0	13.5
SBC	29-Nov-11	Low	13	1	7.7	12.4
SBC	02-Dec-11	Low	13	0	0.0	11.6
SBC	04-Dec-11	Low	7	0	0.0	11.5
	Pooled		157	4	2.55	

Summer Steelhead

One mark/recapture trial was conducted for the upper trap position with wild steelhead in 2011. Because no significant regression model in the upper position exists, and only a single recapture occurred from 2011 mark/recapture trial in the low position, we used the yearling Chinook flow models to estimate steelhead production for each position (see Table 5). Combining estimates from all positions, we calculated that an estimated 15,673(± 6,512, 95% CI) summer steelhead emigrated from the Methow River basin in 2011. Most migrants were age-2 fish from the 2009 brood (Table 7). We estimated the entire 2007 brood migration to be 33,275 (± 14,890, 95% CI) fish, included 135 migrants that were estimated to have been produced from redds (N = 3) located downstream of the trap in 2007.

Table 7. Estimated number of steelhead emigrants from the Methow River basin in 2011 by age and brood.

Age	Brood	Percent of Emigrants	Number
1	2010	6.8	1,066
2	2009	81.7	12,805
3	2008	10.7	1,677
4	2007	0.8	125
Total		100.0	15,673

Twisp River

2009 Brood Spring Chinook Salmon

Capture efficiency in the low position of wild spring Chinook salmon smolts was significantly related to discharge (P < 0.001, r^2 = 0.80) at the Twisp River trapping site in 2011 (Table 8). Using a flow model regression derived from 2010 and 2011 efficiency trials, we estimated that 1,842 (± 123, 95% CI) smolts emigrated from the Twisp River between 10 March and 30 June 2011. No redds were identified downstream of the Twisp trap in 2009, so estimating production downstream of the trap site was unnecessary. Snow et al. (2010) estimated that 3,282 (± 747, 95% CI) 2009 brood spring Chinook salmon parr emigrated from the Twisp River between 1 July and 19 November 2010. Thus the total emigration estimate for this brood was 5,124 (± 870, 95% CI).

Table 8. Mark/recapture efficiency trials used to estimate the 2011 emigration of wild spring Chinook salmon smolts (YCW) from the Twisp River.

Species	Date	Position	Released	Recaptured	Efficiency (%)	Discharge (m^3/s)
YCW	05-Apr-10	Low	63	14	22.2	3.3
YCW	08-Apr-10	Low	61	14	23.0	3.1
YCW	18-Apr-10	Low	157	31	19.7	7.5
YCW	03-Apr-11	Low	57	8	14.0	10.3
YCW	27-Apr-11	Low	59	11	18.6	9.6
	Flow model		397	77		

2010 Brood Spring Chinook Salmon

We were unable to develop a significant flow model for the 2010 brood spring Chinook salmon parr because too few fish were captured to conduct sufficient mark/recapture efficiency trials. However, a flow model incorporating mark/recapture trials from previous years was significantly related to discharge (Table 9; $P < 0.01$, $r^2 = 0.64$), and we used this flow model to estimate that 4,874(± 680, 95% CI) 2010 brood spring Chinook salmon parr emigrated from the Twisp River between 1 July and 17 November 2011. Stream surveyors located no spring Chinook salmon redds downstream of the Twisp smolt trap in 2010, so estimating production downstream of the trap was unnecessary.

Table 9. Mark and recapture efficiency trials used to estimate emigration of 2009 brood wild spring Chinook salmon parr at the Twisp River trap (SBC = subyearling Chinook salmon wild origin).

Species	Date	Position	Released	Recaptured	Efficiency (%)	Discharge (m^3/s)
SBC	14-Nov-06	Low	164	40	24.4	7.6
SBC	18-Nov-06	Low	56	8	14.3	6.3
SBC	21-Nov-06	Low	53	13	24.5	5.8
SBC	22-Oct-07	Low	45	2	4.4	1.5
SBC	31-Oct-07	Low	60	4	6.6	1.8
SBC	10-Nov-08	Low	52	4	7.7	2.3
SBC	17-Nov-08	Low	222	44	19.8	5.5
SBC	25-Nov-08	Low	69	13	18.8	3.7
SBC	02-Nov-09	Low	221	31	14.0	4.0
SBC	05-Nov-09	Low	53	6	11.3	3.2
SBC	08-Nov-09	Low	53	10	18.9	2.8
	Flow model		1,048	175		

Summer Steelhead-Smolt Trap

We were able to develop a flow efficiency relationship for steelhead in 2011 using mark/recapture efficiency trials from previous years. We used this flow model regression ($P < 0.01$, $r^2 = 0.76$) from eight mark groups to estimate the 2011 migration of summer steelhead (Table 10). We estimated that 5,959 (± 1,492, 95% CI) wild summer steelhead migrated from the Twisp River basin between 10 March and 30 June 2011. Most migrants were age-2 fish from the 2009 brood (Table 11). We estimated the entire 2007 brood migration to be 13,512 (± 1,285, 95% CI) fish. No redds were identified downstream of the Twisp trap in 2007.

Table 10. Mark/recapture efficiency trials used to estimate emigration of wild summer steelhead (SHR) migrants from the Twisp River.

Species	Date	Position	Released	Recaptured	Efficiency (%)	Discharge (m^3/s)
SHR	15-Apr-08	Low	92	14	15.2	4.4
SHR	05-May-08	Low	173	10	5.8	10.6
SHR	22-Apr-09	Low	267	15	5.6	13.0
SHR	25-Apr-09	Low	129	11	8.5	10.9
SHR	18-Apr-10	Low	180	17	9.4	7.5
SHR	02-Apr-11	Low	63	7	11.1	10.6
SHR	06-May-11	Low	58	3	5.2	13.5
SHR	09-May-11	Low	56	3	5.4	15.3
	Flow model		1,018	80		

Table 11. Estimated number of wild steelhead emigrants from the Twisp River in 2011 by age and brood.

Age	Brood	% of Total Emigrants	Number
1	2010	0.04	24
2	2009	79.3	4,725
3	2008	12.9	769
4	2007	7.4	441
Total		100.0	5,959

Summer Steelhead-TWR PIT Tag Interrogation Site

We were able to develop a discharge/interrogation-efficiency relationship for steelhead at the Twisp River PIT tag interrogation site (TWR) using five distinct groups of fish released into the Twisp River and detected at the Rocky Reach Dam juvenile bypass (RRJ) interrogation site (Table 12; $P < 0.01$, $r^2 = 0.95$). Additionally, we estimated that the mark rate for wild steelhead emigrating from the Twisp River was 5.76% because 19 of the 329 wild steelhead emigrants we captured at the Twisp River smolt trap had pre-existing PIT tags. We used this tag rate and the discharge/interrogation-efficiency relationship to estimate that 12,819 (± 17,352, 95% CI) wild summer steelhead migrated from the Twisp River basin between 1 January and 15 May (Appendix A7).

Table 12. Mark/recapture efficiency trials used to develop a discharge/antenna efficiency model for the Twisp River instream PIT tag antenna array (TWR). SHH = hatchery origin steelhead.

Species	Date	Released	Recaptured at RRJ	Recaptured at RRJ and at TWR	Efficiency (%)	Discharge (m^3/s)
SHH	04-May-11	498	150	80	53.3	11.2
SHH	09-May-11	429	133	34	25.6	14.4
SHH	10-May-11	660	191	68	35.6	15.3
SHH	11-May-11	564	160	31	19.4	18.6
SHH	16-May-11	599	150	4	2.7	24.7
	Total	2,750	784	217		

Smolts Per Redd

2008 Brood Spring Chinook Salmon

The number of emigrants per redd for the 2009 brood spring Chinook salmon in the Twisp River was greater than that for Methow Basin emigrants (Table 13). When Twisp River production was excluded from the Methow Basin estimate, we calculated that 3.5 times more emigrants were produced per redd in the Twisp River than were produced in the rest of the Methow River basin for the 2009 brood. Yearling emigrants accounted for 35.9% of all 2009 brood emigrants from the Twisp River, and 91.9% of all emigrants from the rest of the Methow River basin.

Table 13. Estimated emigrant-per-redd and egg-to-emigrant survival for Methow Basin spring Chinook salmon. Methow Basin and Twisp River estimates are for redds deposited upstream of the respective trap sites, and do not include redds that dewatered. Age-0 emigrants from the Methow Basin were calculated by incorporating results from DNA analysis of individual broods (2005-2007), or were estimated based on samples collected from the 2005 brood (2003). DNOT = Did Not Operate Trap.

Basin	Brood	Redds	Estimated Egg Deposition	Number of Emigrants			Egg to Emigrant (%)	Emigrants per Redd
				Age-0	Age-1	Total		
Twisp	2010	145	568,266	4,874	--	--	0.9	--
Twisp	2009	24	100,694	3,282	1,842	5,124	5.1	214
Twisp	2008	79	268,711	7,139	4,793	11,932	4.4	151
Twisp	2007	30	128,182	4,168	5,547	9,715	7.6	324
Twisp	2006	84	288,372	5,645	15,660	21,305	7.4	254
Twisp	2005	54	233,874	6,974	3,532	10,506	4.5	195
Twisp	2004	135	496,530	1,323	5,092	6,415	1.3	48
Twisp	2003	18	81,558	DNOT	723	723	0.9	40
Methow	2010	1,218	4,704,698	8,979	--	--	0.2	--
Methow	2009	461	1,823,944	1,602	29,610	31,212	1.7	68
Methow	2008	373	1,365,130	2,948	9,302	12,250	0.9	33
Methow	2007	293	1,182,195	4,083	5,163	9,246	0.8	32
Methow	2006	922	3,362,156	2,913	28,857	31,770	0.9	34
Methow	2005	566	2,069,906	17,490	33,710	51,200	2.5	91
Methow	2004	543	1,933,506	DNOT	15,869	15,869	0.8	29
Methow	2003	462	2,167,026	8,170	15,306	23,476	1.1	51
Methow	2002	1,105	4,235,465	DNOT	26,044	26,044	0.6	24

Summer Steelhead

Since juvenile steelhead may emigrate as age-4 fish, completed emigration estimates have only been calculated for broods prior to 2008 (Table 14). The 2007 brood produced an estimated 45 emigrants from each redd in the Methow River basin (including Twisp River production) and 165 emigrants from each redd in the Twisp River basin. Excluding Twisp River production, Methow Basin steelhead produced an estimated 29 emigrants per redd for 2007 brood steelhead.

Table 14. Estimated emigrant-per-redd and egg-to-emigrant survival of Methow Basin steelhead. Emigrant-per-redd values were not calculated for incomplete brood years. Number of emigrants at age did not incorporate production downstream of each trap site except for the Methow 2003 brood. DNOT = Did Not Operate Trap.

Basin	Brood	Redds	Estimated Egg Deposition	Number of Emigrants					Egg to Emigrant (%)	Emigrants per Redd
				Age-1	Age-2	Age-3	Age-4	Total		
Twisp	2010	332	1,934,564	24	--	--	--	24	0.001	--
Twisp	2009	352	2,147,200	61	4,725	--	--	4,786	0.22	--
Twisp	2008	182	1,078,350	76	2,295	769	--	3,140	0.29	--
Twisp	2007	82	418,774	42	10,217	2,812	441	13,512	3.23	165
Twisp	2006	384	2,452,992	81	4,712	2,223	336	7,352	0.30	19
Twisp	2005	452	2,806,016	292	2,686	2,102	113	5,193	0.19	11
Twisp	2004	254	1,166,876	79	3,192	500	198	3,969	0.34	16
Twisp	2003	606	3,849,312	DNOT	1,787	1,357	58	3,202	0.08	5
Methow	2010	1,720	10,022,440	1,066	--	--	--	1,066	0.01	--
Methow	2009	1,030	6,283,000	3,338	12,805	--	--	16,143	0.26	--
Methow	2008	867	5,136,975	1,238	11,764	1,677	--	14,679	0.29	--
Methow	2007	740	3,779,180	3,194	25,135	4,686	125	33,140	0.88	45
Methow	2006	785	5,013,795	639	6,313	3,819	322	11,093	0.22	14
Methow	2005	1,685	10,460,480	2,030	12,775	868	1,064	16,737	0.16	10
Methow	2004	947	4,350,518	1,883	9,082	1,277	343	12,585	0.29	13
Methow	2003	2,019	12,824,688	1,596	4,872	2,459	106	9,033	0.07	4

Incidental Species

Summer Chinook were the most abundant incidental species captured at the Methow River trap, while longnose dace were the most abundant incidental species captured at the Twisp River trap (Table 14). We captured 29 wild coho smolts from the 2009 brood in 2011. Utilizing the same mark/recapture efficiency trial data used at the Methow and Twisp rivers sites for spring Chinook salmon, we estimate that 2,330 (± 1,239, 95% CI) wild coho emigrated from the Methow River in 2011.

Table 14. Biological sampling conducted on selected incidental species captured at Methow River basin smolt traps in 2011.

Species	Captured	Fork Length (mm)			Weight (g)		
		Mean	*N*	SD	Mean	*N*	SD
Methow River trap							
Pacific lamprey (*Lampetra tridentata*)	2,875	142.2	353	9.5	5.1	352	1.0
Hatchery coho (*O. kisutch*)	1,811	86.5	4	34.8	13.6	3	4.6
Longnose dace (*Rhinichthys cataractae*)	172	64.4	109	33.3	8.9	63	6.1
Sockeye fry (*O. nerka*)	76	27.7	28	4.1	- -	- -	- -
Bridge lip sucker (*Catostomus columbianus*)	57	84.9	40	23.8	9.8	40	12.0
Wild coho parr (*O. kisutch*)	48	66.9	47	15.7	4.6	46	3.2
Wild coho fry (*O. kisutch*)	30	41.7	21	5.4	- -	- -	- -
Whitefish (*Prosopium williamsoni*)	29	73.7	19	38.1	12.0	10	5.1
Sculpin (*Cottus spp.*)	27	69.3	21	39.4	22.5	11	20.0
Wild coho smolt (*O. kisutch*)	24	109.2	23	8.4	14.4	23	3.2
Sucker (*Catostomus spp.*)	19	65.0	4	21.8	5.3	3	3.7
Redside shiner (*Richardsonius balteatus*)	4	94.3	3	35.0	14.4	3	10.8
Cutthroat trout (*O. clarki*)	2	194.0	2	46.7	76.4	2	42.6
Bull trout (*Salvelinus confluentus*)	2	221	2	1.4	100.4	2	1.2
Brown bullhead (*Ictalurus nebulosus*)	1	101.0	1	- -	16.7	1	- -
Twisp River trap							
Longnose dace (*Rhinichthys cataractae*)	309	96.9	192	11.4	11.6	188	4.6
Wild coho parr (*O. kisutch*)	36	61.0	23	9.1	2.9	23	1.6
Sculpin (*Cottus spp.*)	29	77.6	24	29.2	12.7	18	9.5
Whitefish (*Prosopium williamsoni*)	22	46.7	15	16.6	2.9	5	0.5
Bull trout (*Salvelinus confluentus*)	22	213.1	21	84.4	76.5	20	37.3
Sucker (*Catostomus spp.*)	7	115.3	4	19.2	19.3	4	11.9
Cutthroat trout (*O. clarki*)	6	184.8	4	32.1	65.3	4	28.1
Wild coho fry (*O. kisutch*)	4	47.3	4	1.7	- -	- -	- -
Bridge lip sucker (*Catostomus columbianus*)	2	175.0	1	- -	72.5	1	- -
Sockeye fry (*O. nerka*)	2	33.0	1	- -	- -	- -	- -

Discussion

In 2011, high flows prevented operating the Methow trap from May 15 through July 11 and the Twisp Trap from May 13 through July 26. High river discharge, low juvenile abundance and low trap efficiency also limited the ability to conduct trap efficiency trials over a broad range of river conditions in 2011. As a result, inadequate trap efficiency-to-discharge regression models forced the use of pooled trap efficiencies in some cases. Despite moderate observed trap efficiencies for salmon and steelhead at operational discharges (range 2-9%), the relatively low abundance of wild yearling Chinook salmon and steelhead severely limited the number and size of trials that could be conducted using wild fish. Although a common alternative, the use of hatchery fish as surrogates should be carefully examined because of potential behavioral and size differences between wild and hatchery fish. At emigration, hatchery fish are typically greater in size than their wild conspecifics and size- or behavior-related biases related to trap efficiency might reduce the utility of hatchery fish as surrogates for wild trap efficiency trials. Preliminary comparisons between recapture rates of hatchery and wild fish released in paired mark-recapture trials at the Twisp River trap have not indicated that significant differences exist (Chi-square, $P = 0.42$). However, the number of paired trials was low ($N = 4$), and we could not test for capture efficiencies over a wide range of discharges. Missing capture data from this period, and other more brief periods when the traps were not fishing, were estimated based on capture data previous to or post interruptions in operation. Difficult environmental conditions can significantly affect the ability to estimate the numbers of emigrants from the system during these periods using rotary screw traps.

Developing life-stage survival estimates and models for threatened or endangered salmonids is challenging due to their relatively low abundance, complex life history, and the desire to avoid negative impacts to the species on which research is focused. Establishing the relationship between trap efficiency and discharge may be accomplished in a single year provided abundance of the target species is adequate with an appropriate range of flow conditions. However, multiple years of data are required to calculate an estimate of egg-to-emigrant survival for a single brood year (e.g., steelhead). Trap locations in the Methow and Twisp rivers appear appropriate for the target species and expected environmental conditions. Observed trap efficiencies are within the acceptable level of the ESA permit conditions (i.e., < 20%). A retrospective analysis of data from previous years should provide more robust smolt-production estimates once trap efficiency models have been established. Statisticians with WDFW are currently reviewing all methodologies used to more accurately estimate juvenile abundance. From this effort we expect recommendations that address both bias and precision in order to better understand the status and trends of these populations.

In subbasins with spring and summer Chinook salmon populations, smolt traps are intentionally located far downstream of spawning areas for spring Chinook salmon to minimize encounters with subyearling spring Chinook salmon emigrating from spawning tributaries. Hence, all yearling Chinook salmon captured were assumed to be spring Chinook salmon and subyearling Chinook salmon were assumed to be summer Chinook salmon. Based on this assumption, subyearling spring Chinook salmon migrating past the Methow smolt trap may be misclassified as summer Chinook salmon. Conversely, summer Chinook salmon may be misclassified if the yearling life history is more prevalent than adult scale samples suggest or subyearling summer

Chinook salmon are misclassified as yearling spring Chinook salmon. Ongoing studies conducted using DNA analysis should determine to what extent spring Chinook salmon migrate as subyearling fish and summer Chinook salmon as yearlings. Analysis of samples collected during 2007 and 2008 from yearling Chinook salmon at the Methow trap indicated that few of the yearling fish were summer Chinook salmon (0.87% and 1.7%, respectively). Because of this, we assumed that the majority of the yearling Chinook migrants at the Methow River trap in 2011 were spring Chinook.

Tissue samples (i.e., fin clips) were taken from subyearling Chinook captured at the Methow River trap in 2011 to determine the proportion of subyearling fish that were spring Chinook salmon. Spring Chinook salmon accounted for 17.7% of all Chinook sampled during the spring trapping period and 92.9% of the Chinook sampled during the fall trapping period. We produce emigration estimates for spring Chinook salmon during the fall trapping period at the Methow River trap site and remove those fish identified as summer Chinook salmon. However, we do not produce emigration estimates for spring Chinook salmon that may emigrate before the fall period as subyearling fish. Therefore, spring Chinook production estimates for the Methow Basin underestimate production by the portion of spring Chinook salmon emigrating as subyearling fish in the spring, assuming that those fish do not move back upstream of the trap after initial capture in the spring.

We used brood-specific fecundity values, excluded dewatered redds, and included the estimated production from redds downstream from each trap site to calculate egg-to-emigrant and emigrant-per-redd estimates in 2011. The low freshwater production of yearling Chinook salmon and steelhead may suggest severe density dependent mortality, low reproductive success, or another limiting factor contributing to the observed survival rates. Egg deposition estimates for spring Chinook salmon were based on total ground counts of redds throughout the basin. Error associated with spring Chinook salmon redd counts are likely small (i.e., low water levels, high water clarity, large redds). Conversely, steelhead egg deposition estimates may underestimate actual deposition because of environmental factors affecting surveys (i.e., high water discharge, poor water clarity), potentially reducing already low productivity estimates. An observer efficiency study was started during the 2010 spring Chinook spawning survey to try to estimate a variance estimate for redd counts. A similar study for steelhead in the Methow Basin will begin in 2012.

Preliminary comparisons between the Twisp and Methow/Chewuch rivers suggest the Twisp River spring Chinook salmon are more productive per capita than the Methow/Chewuch population, but some of the apparent productivity difference is attributable to the disparity in precision between production estimates from the two trapping sites. The production estimate for yearling spring Chinook in the Twisp River; 1,842 (± 123, 95% CI) was more precise than the estimate for the entire Methow Basin 29,610 (± 8,255, 95% CI). This can be explained in part by differences in the strength of the correlation relationships of the flow models (Twisp $r^2 = 0.80$, Methow upper position $r^2 = 0.59$ and low position $r^2 = 0.59$). Differences in trap efficiencies also help explain differences in precision of the estimates, where lower efficiencies are susceptible to greater error due to random effects on the efficiency estimates. Furthermore, Methow trap efficiencies are much lower than at the Twisp trap resulting in fewer fish available to conduct mark/recapture trials to develop robust trap efficiency models. Trap efficiency models at the Methow River trapping site should improve over time as mark/recapture trials with target species and life stages are conducted.

Summer steelhead productivity may be similar in both the Twisp and Methow/Chewuch, based solely on estimates of smolt production and egg-to-emigrant estimates. Causation of differences in productivity between rivers and the overall low level of juvenile production is unknown. Estimating the proportion of hatchery fish that contribute to the spawning population in each subbasin may also provide important insight in determining why productivity is relatively low. Additional research is necessary to better understand the reproductive success and carrying capacity of spring Chinook salmon and steelhead in the Methow Basin. In 2010, a long-term study of steelhead reproductive success was initiated on the Twisp River. This study should provide insight into the role of reproductive success as it pertains to hatchery and wild fish. The study may also provide insight into carrying capacity in the Twisp River.

The instream PIT tag detection array in the Twisp River provided an additional method of estimating production of emigrating steelhead in 2011. The use of in-stream PIT tag antenna arrays to monitor and evaluate salmonid populations is an emerging technology where methodologies for producing population estimates are still being developed. Using a discharge/interrogation-efficiency model developed with PIT tagged hatchery fish, we estimated that 12,819 (± 17,352, 95% CI) wild steelhead emigrated from the Twisp River, much greater than the estimate derived from the Twisp River smolt trap of 5,959 fish (± 1,492 95% CI). The PIT tag estimate was based on daily observations of PIT tags recorded at the array, and required an estimate of the PIT tag rate of within emigrating wild steelhead obtained using the Twisp rotary screw trap. This rate was relatively low in 2011 (5.8%), but should increase in 2012 and beyond as the result of a greater tagging effort employed to meet the requirements of an on-going relative reproductive success study in the Twisp River. In-stream arrays can provide an estimate of emigration during periods when smolt traps are not deployed, are damaged, or when flows are too great to operate. The PIT tag estimate included fish emigrating about a month earlier (early February) than were observed at the smolt trap because the smolt trap is typically not installed until March due to poor environmental conditions (ice).

The difference between the PIT tag derived estimate and the smolt trap derived estimate this year show further refinement of the methods to derive such estimates is necessary. It also could be an indication of how much we may be underestimating natural production due to the constraints of screw traps. As with smolt trap capture efficiencies, developing a good detection efficiency model is important to generating a precise production estimate at PIT tag interrogation sites. Although the antenna configuration at the Twisp site should be the same each year, the overall detection efficiency model will be unique each year as equipment, such as the six antennas, are repaired or upgraded, the morphology of the stream channel changes, and the flow regimes change within and between years.

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Appendix A1. Daily capture of wild spring Chinook smolts emigrating from the Methow River, 4 March through 14 May 2011. Estimated number of Chinook captured when the trap was not operating (bold) was calculated from the average captures two days preceding and after the break in operation. Estimated trap efficiency and emigration estimate are a rounded values.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
03/04/11	0	0.0142	0	04/05/11	11	0.0120	915
03/05/11	0	0.0142	0	04/06/11	6	0.0122	493
03/06/11	0	0.0142	0	04/07/11	10	0.0124	810
03/07/11	0	0.0142	0	04/08/11	10	0.0126	795
03/08/11	1	0.0142	70	04/09/11	12	0.0128	938
03/09/11	0	0.0142	0	04/10/11	4	0.0128	313
03/10/11	0	0.0142	0	04/11/11	4	0.0127	316
03/11/11	1	0.0142	70	04/12/11	14	0.0125	1,119
03/12/11	1	0.0142	70	04/13/11	13	0.0125	1,044
03/13/11	0	0.0142	0	04/14/11	8	0.0124	644
03/14/11	0	0.0142	0	04/15/11	11	0.0125	879
03/15/11	1	0.0142	70	04/16/11	2	0.0126	159
03/16/11	0	0.0142	0	04/17/11	7	0.0126	556
03/17/11	0	0.0142	0	04/18/11	4	0.0123	324
03/18/11	0	0.0142	0	04/19/11	8	0.0124	647
03/19/11	0	0.0142	0	04/20/11	15	0.0125	1,202
03/20/11	0	0.0142	0	04/21/11	12	0.0125	959
03/21/11	0	0.0142	0	**04/22/11**	**12**	**0.0126**	**953**
03/22/11	2	0.0142	141	04/23/11	15	0.0126	1,189
03/23/11	2	0.0142	141	04/24/11	4	0.0124	323
03/24/11	2	0.0142	141	04/25/11	5	0.0119	422
03/25/11	5	0.0142	352	04/26/11	10	0.0114	875
03/26/11	4	0.0142	282	04/27/11	6	0.0111	538
03/27/11	4	0.0142	282	04/28/11	15	0.0109	1,379
03/28/11	**6**	**0.0142**	**422**	04/29/11	9	0.0108	836
03/29/11	**6**	**0.0142**	**422**	04/30/11	5	0.0108	463
03/30/11	**7**	**0.0142**	**493**	05/01/11	2	0.0108	186
03/31/11	11	0.0142	774	05/02/11	3	0.0103	291
04/01/11	4	0.0130	308	05/03/11	5	0.0094	532
04/02/11	21	0.0107	1,967	05/04/11	4	0.0319	125
04/03/11	15	0.0114	1,321	05/05/11	3	0.0319	94
04/04/11	15	0.0118	1,273	05/06/11	3	0.0319	94

Appendix A1, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
05/07/11	3	0.0316	95	05/11/11	2	0.0165	121
05/08/11	3	0.0274	110	05/12/11	0	0.0102	0
05/09/11	7	0.0257	272	05/13/11	0	0.0102	0
05/10/11	0	0.0248	0	05/14/11	0	0.0102	0

Appendix A2. Daily capture of wild spring Chinook parr emigrating from the Methow River, 1 October through 5 November 2011. Estimated number of Chinook captured when the trap was not operating (bold) were calculated from the average captures two days preceding and after the break in operation. Race of captured Chinook was determined through DNA analysis.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
10/01/11	0	0.0255	0	10/26/11	6	0.0255	235
10/02/11	1	0.0255	39	10/27/11	5	0.0255	196
10/03/11	0	0.0255	0	10/28/11	7	0.0255	275
10/04/11	0	0.0255	0	10/29/11	8	0.0255	314
10/05/11	2	0.0255	78	10/30/11	4	0.0255	157
10/06/11	0	0.0255	0	10/31/11	4	0.0255	157
10/07/11	2	0.0255	78	11/01/11	1	0.0255	39
10/08/11	1	0.0255	39	11/02/11	7	0.0255	275
10/09/11	1	0.0255	39	11/03/11	4	0.0255	157
10/10/11	0	0.0255	0	11/04/11	6	0.0255	235
10/11/11	0	0.0255	0	11/05/11	2	0.0255	78
10/12/11	1	0.0255	39	11/06/11	3	0.0255	118
10/13/11	0	0.0255	0	11/07/11	0	0.0255	0
10/14/11	0	0.0255	0	11/08/11	2	0.0255	78
10/15/11	0	0.0255	0	11/09/11	2	0.0255	78
10/16/11	0	0.0255	0	11/10/11	1	0.0255	39
10/17/11	0	0.0255	0	11/11/11	0	0.0255	0
10/18/11	1	0.0255	39	11/12/11	7	0.0255	275
10/19/11	1	0.0255	39	11/13/11	2	0.0255	78
10/20/11	0	0.0255	0	11/14/11	3	0.0255	118
10/21/11	0	0.0255	0	11/15/11	5	0.0255	196
10/22/11	0	0.0255	0	11/16/11	7	0.0255	275
10/23/11	0	0.0255	0	11/17/11	3	0.0255	118
10/24/11	1	0.0255	39	11/18/11	3	0.0255	118
10/25/11	4	0.0255	157	11/19/11	5	0.0255	196

Appendix A2, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
11/20/11	4	0.0255	157	11/28/11	3	0.0255	118
11/21/11	3	0.0255	118	11/29/11	2	0.0255	78
11/22/11	0	0.0255	0	11/30/11	5	0.0255	196
11/23/11	1	0.0255	39	12/01/11	5	0.0255	196
11/24/11	3	0.0255	118	12/02/11	3	0.0255	118
11/25/11	6	0.0255	235	12/03/11	6	0.0255	235
11/26/11	4	0.0255	157	12/04/11	1	0.0255	39
11/27/11	4	0.0255	157	12/05/11	3	0.0255	118

Appendix A3. Daily capture of wild steelhead smolt and transitional fish emigrating from the Methow River, 4 March to 30 June 2011. Estimated number of steelhead captured when the trap was not operating (bold) was calculated from the average captures two days preceding and after the break in operation. Estimated trap efficiency and daily estimate are rounded values.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
03/04/11	0	0.0142	0	03/24/11	0	0.0142	0
03/05/11	0	0.0142	0	03/25/11	0	0.0142	0
03/06/11	0	0.0142	0	03/26/11	0	0.0142	0
03/07/11	0	0.0142	0	03/27/11	0	0.0142	0
03/08/11	0	0.0142	0	**03/28/11**	**0**	**0.0142**	**0**
03/09/11	0	0.0142	0	**03/29/11**	**0**	**0.0142**	**0**
03/10/11	0	0.0142	0	**03/30/11**	**0**	**0.0142**	**0**
03/11/11	0	0.0142	0	03/31/11	1	0.0142	70
03/12/11	0	0.0142	0	04/01/11	0	0.0130	0
03/13/11	0	0.0142	0	04/02/11	3	0.0107	281
03/14/11	0	0.0142	0	04/03/11	3	0.0114	264
03/15/11	0	0.0142	0	04/04/11	2	0.0118	170
03/16/11	0	0.0142	0	04/05/11	2	0.0120	166
03/17/11	0	0.0142	0	04/06/11	0	0.0122	0
03/18/11	0	0.0142	0	04/07/11	1	0.0124	81
03/19/11	0	0.0142	0	04/08/11	0	0.0126	0
03/20/11	0	0.0142	0	04/09/11	0	0.0128	0
03/21/11	0	0.0142	0	04/10/11	1	0.0128	78
03/22/11	0	0.0142	0	04/11/11	0	0.0127	0
03/23/11	0	0.0142	0	04/12/11	3	0.0125	240

Appendix A3, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
04/13/11	0	0.0125	0	**05/20/11**	**1**	**0.0102**	**98**
04/14/11	0	0.0124	0	**05/21/11**	**1**	**0.0102**	**98**
04/15/11	0	0.0125	0	**05/22/11**	**1**	**0.0102**	**98**
04/16/11	2	0.0126	159	**05/23/11**	**1**	**0.0102**	**98**
04/17/11	6	0.0126	476	**05/24/11**	**1**	**0.0102**	**98**
04/18/11	2	0.0123	162	**05/25/11**	**1**	**0.0102**	**98**
04/19/11	1	0.0124	81	**05/26/11**	**1**	**0.0102**	**98**
04/20/11	2	0.0125	160	**05/27/11**	**1**	**0.0102**	**98**
04/21/11	3	0.0125	240	**05/28/11**	**1**	**0.0102**	**98**
04/22/11	**2**	**0.0126**	**159**	**05/29/11**	**1**	**0.0102**	**98**
04/23/11	1	0.0126	79	**05/30/11**	**1**	**0.0102**	**98**
04/24/11	0	0.0124	0	**05/31/11**	**1**	**0.0102**	**98**
04/25/11	0	0.0119	0	**06/01/11**	**1**	**0.0102**	**98**
04/26/11	8	0.0114	700	**06/02/11**	**1**	**0.0102**	**98**
04/27/11	4	0.0111	359	**06/03/11**	**1**	**0.0102**	**98**
04/28/11	10	0.0109	919	**06/04/11**	**1**	**0.0102**	**98**
04/29/11	2	0.0108	186	**06/05/11**	**1**	**0.0102**	**98**
04/30/11	2	0.0108	185	**06/06/11**	**1**	**0.0102**	**98**
05/01/11	3	0.0108	279	**06/07/11**	**1**	**0.0102**	**98**
05/02/11	6	0.0103	583	**06/08/11**	**1**	**0.0102**	**98**
05/03/11	7	0.0094	745	**06/09/11**	**1**	**0.0102**	**98**
05/04/11	3	0.0319	94	**06/10/11**	**1**	**0.0102**	**98**
05/05/11	4	0.0319	125	**06/11/11**	**1**	**0.0102**	**98**
05/06/11	6	0.0319	188	**06/12/11**	**1**	**0.0102**	**98**
05/07/11	26	0.0316	824	**06/13/11**	**1**	**0.0102**	**98**
05/08/11	17	0.0274	621	**06/14/11**	**1**	**0.0102**	**98**
05/09/11	21	0.0257	817	**06/15/11**	**1**	**0.0102**	**98**
05/10/11	4	0.0248	161	**06/16/11**	**1**	**0.0102**	**98**
05/11/11	4	0.0165	242	**06/17/11**	**1**	**0.0102**	**98**
05/12/11	3	0.0102	293	**06/18/11**	**1**	**0.0102**	**98**
05/13/11	3	0.0102	293	**06/19/11**	**1**	**0.0102**	**98**
05/14/11	4	0.0102	391	**06/20/11**	**1**	**0.0102**	**98**
05/15/11	**2**	**0.0102**	**196**	**06/21/11**	**1**	**0.0102**	**98**
05/16/11	**2**	**0.0102**	**196**	**06/22/11**	**1**	**0.0102**	**98**
05/17/11	**1**	**0.0102**	**98**	**06/23/11**	**1**	**0.0102**	**98**
05/18/11	**1**	**0.0102**	**98**	**06/24/11**	**1**	**0.0102**	**98**
05/19/11	**1**	**0.0102**	**98**	**06/25/11**	**1**	**0.0102**	**98**

Appendix A3, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
06/26/11	**1**	**0.0102**	**98**	**06/29/11**	**1**	**0.0102**	**98**
06/27/11	**1**	**0.0102**	**98**	**06/30/11**	**1**	**0.0102**	**98**
06/28/11	**1**	**0.0102**	**98**				

Appendix A4. Daily capture of wild spring Chinook smolts emigrating from the Twisp River, 10 March to 12 May 2011. Estimated number of Chinook captured when the trap was not operating (bold) was calculated from the average captures two days preceding and after the break in operation.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
03/10/11	2	0.2299	9	04/03/11	7	0.1716	41
03/11/11	1	0.2299	4	04/04/11	6	0.1780	34
03/12/11	1	0.2299	4	04/05/11	5	0.1799	28
03/13/11	2	0.2299	9	04/06/11	8	0.1822	44
03/14/11	2	0.2299	9	04/07/11	4	0.1854	22
03/15/11	0	0.2299	0	04/08/11	5	0.1880	27
03/16/11	1	0.2299	4	04/09/11	5	0.1885	27
03/17/11	2	0.2299	9	04/10/11	6	0.1872	32
03/18/11	0	0.2299	0	04/11/11	4	0.1859	22
03/19/11	0	0.2299	0	04/12/11	5	0.1843	27
03/20/11	3	0.2299	13	04/13/11	1	0.1846	5
03/21/11	0	0.2299	0	04/14/11	3	0.1846	16
03/22/11	0	0.2299	0	04/15/11	2	0.1856	11
03/23/11	3	0.2299	13	04/16/11	2	0.1862	11
03/24/11	3	0.2299	13	04/17/11	1	0.1838	5
03/25/11	3	0.2290	13	04/18/11	4	0.1825	22
03/26/11	5	0.2262	22	04/19/11	2	0.1825	11
03/27/11	3	0.2262	13	04/20/11	2	0.1830	11
03/28/11	**4**	**0.2250**	**18**	04/21/11	2	0.1830	11
03/29/11	4	0.2239	18	**04/22/11**	**7**	**0.1838**	**38**
03/30/11	4	0.2228	18	04/23/11	10	0.1822	55
03/31/11	11	0.1984	55	04/24/11	12	0.1793	67
04/01/11	23	0.1541	149	04/25/11	17	0.1752	97
04/02/11	21	0.1590	132	04/26/11	35	0.1729	202

Appendix A4, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
04/27/11	15	0.1703	88	05/05/11	1	0.1616	6
04/28/11	15	0.1678	89	05/06/11	4	0.1616	25
04/29/11	9	0.1683	53	05/07/11	3	0.1616	19
04/30/11	3	0.1678	18	05/08/11	2	0.1616	12
05/01/11	4	0.1653	24	05/09/11	2	0.1616	12
05/02/11	7	0.1616	43	05/10/11	0	0.1616	0
05/03/11	3	0.1616	19	05/11/11	0	0.1616	0
05/04/11	6	0.1616	37	05/12/11	1	0.1616	6

Appendix A5. Daily capture of wild spring Chinook parr emigrating from the Twisp River, 20 July to 17 November 2011. Estimated numbers of Chinook captured when the trap was not operating (bold) were calculated from the average captures two days preceding and after the break in operation.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
07/20/11	**1**	**0.2599**	**4**	08/10/11	11	0.2599	42
07/21/11	**1**	**0.2599**	**4**	08/11/11	7	0.2599	27
07/22/11	**2**	**0.2599**	**8**	08/12/11	5	0.2599	19
07/23/11	**3**	**0.2599**	**12**	08/13/11	4	0.2599	15
07/24/11	**5**	**0.2599**	**19**	08/14/11	1	0.2599	4
07/25/11	**7**	**0.2599**	**27**	08/15/11	0	0.2579	0
07/26/11	**11**	**0.2599**	**42**	**08/16/11**	**4**	**0.2448**	**16**
07/27/11	18	0.2599	69	08/17/11	9	0.2271	40
07/28/11	24	0.2599	92	08/18/11	7	0.2146	33
07/29/11	21	0.2599	81	08/19/11	4	0.2051	19
07/30/11	45	0.2599	173	08/20/11	3	0.1940	15
07/31/11	33	0.2599	127	08/21/11	6	0.1904	32
08/01/11	33	0.2599	127	08/22/11	8	0.1894	42
08/02/11	**33**	**0.2599**	**127**	08/23/11	2	0.1876	11
08/03/11	32	0.2599	123	08/24/11	8	0.1968	41
08/04/11	33	0.2599	127	08/25/11	4	0.1913	21
08/05/11	33	0.2599	127	08/26/11	4	0.1831	22
08/06/11	13	0.2599	50	08/27/11	2	0.1769	11
08/07/11	19	0.2599	73	08/28/11	2	0.1664	12
08/08/11	13	0.2599	50	08/29/11	6	0.1578	38
08/09/11	15	0.2599	58	**08/30/11**	**4**	**0.1545**	**26**

Appendix A5, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
08/31/11	7	0.1511	46	10/07/11	3	0.0999	30
09/01/11	2	0.1478	14	10/08/11	2	0.1006	20
09/02/11	12	0.1437	83	10/09/11	1	0.1006	10
09/03/11	3	0.1365	22	10/10/11	0	0.0992	0
09/04/11	3	0.1341	22	10/11/11	0	0.1013	0
09/05/11	23	0.1302	177	10/12/11	0	0.1055	0
09/06/11	13	0.1255	104	10/13/11	3	0.1041	29
09/07/11	4	0.1209	33	10/14/11	4	0.1006	40
09/08/11	8	0.1179	68	10/15/11	7	0.0985	71
09/09/11	2	0.1164	17	10/16/11	10	0.0971	103
09/10/11	0	0.1150	0	10/17/11	3	0.0951	32
09/11/11	0	0.1157	0	10/18/11	2	0.0937	21
09/12/11	1	0.1172	9	10/19/11	4	0.0930	43
09/13/11	2	0.1172	17	10/20/11	1	0.0917	11
09/14/11	1	0.1157	9	10/21/11	1	0.0910	11
09/15/11	2	0.1128	18	10/22/11	0	0.0904	0
09/16/11	5	0.1120	45	10/23/11	1	0.0964	10
09/17/11	6	0.1091	55	10/24/11	16	0.1098	146
09/18/11	1	0.1048	10	10/25/11	10	0.1020	98
09/19/11	0	0.1034	0	10/26/11	8	0.0978	82
09/20/11	0	0.1027	0	10/27/11	4	0.0964	41
09/21/11	3	0.1013	30	10/28/11	3	0.0958	31
09/22/11	4	0.0999	40	10/29/11	2	0.0958	21
09/23/11	3	0.0992	30	10/30/11	2	0.0951	21
09/24/11	0	0.0978	0	10/31/11	2	0.0958	21
09/25/11	3	0.0978	31	11/01/11	11	0.0985	112
09/26/11	0	0.0971	0	11/02/11	2	0.0937	21
09/27/11	6	0.1048	57	11/03/11	8	0.0930	86
09/28/11	6	0.1194	50	11/04/11	4	0.0937	43
09/29/11	4	0.1113	36	11/05/11	4	0.0884	45
09/30/11	8	0.0910	88	11/06/11	1	0.0864	12
10/01/11	1	0.0871	11	11/07/11	9	0.0845	107
10/02/11	3	0.0904	33	11/08/11	11	0.0884	124
10/03/11	3	0.0910	33	11/09/11	3	0.0897	33
10/04/11	0	0.0937	0	11/10/11	2	0.0884	23
10/05/11	2	0.0985	20	11/11/11	3	0.0877	34
10/06/11	5	0.1077	46	11/12/11	7	0.0890	79

Appendix A5, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
11/13/11	5	0.0877	57	11/16/11	2	0.0871	23
11/14/11	4	0.0877	46	**11/17/11**	**2**	**0.0838**	**24**
11/15/11	4	0.0871	46				

Appendix A6. Daily capture of wild steelhead smolt and transitional fish emigrating from the Twisp River, 10 March to 30 June 2011. Estimated number of steelhead captured when the trap was not operating (bold) was calculated from the average captures two days preceding and after the break in operation.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
03/10/11	0	0.1409	0	04/05/11	2	0.1018	20
03/11/11	0	0.1409	0	04/06/11	2	0.1042	19
03/12/11	0	0.1409	0	04/07/11	1	0.1075	9
03/13/11	0	0.1409	0	04/08/11	2	0.1102	18
03/14/11	0	0.1409	0	04/09/11	1	0.1108	9
03/15/11	0	0.1409	0	04/10/11	2	0.1094	18
03/16/11	0	0.1409	0	04/11/11	0	0.1080	0
03/17/11	0	0.1409	0	04/12/11	1	0.1064	9
03/18/11	0	0.1409	0	04/13/11	1	0.1067	9
03/19/11	0	0.1409	0	04/14/11	0	0.1067	0
03/20/11	0	0.1409	0	04/15/11	0	0.1078	0
03/21/11	0	0.1409	0	04/16/11	0	0.1083	0
03/22/11	**0**	**0.1409**	**0**	04/17/11	3	0.1059	28
03/23/11	0	0.1409	0	04/18/11	2	0.1045	19
03/24/11	0	0.1409	0	04/19/11	1	0.1045	10
03/25/11	0	0.1409	0	04/20/11	0	0.1051	0
03/26/11	0	0.1409	0	04/21/11	0	0.1051	0
03/27/11	0	0.1409	0	**04/22/11**	**1**	**0.1059**	**9**
03/28/11	0	0.1409	0	04/23/11	0	0.1042	0
03/29/11	0	0.1409	0	04/24/11	2	0.1013	20
03/30/11	0	0.1409	0	04/25/11	10	0.0971	103
03/31/11	1	0.1212	8	04/26/11	7	0.0947	74
04/01/11	49	0.0763	642	04/27/11	6	0.0922	65
04/02/11	16	0.0810	197	04/28/11	7	0.0896	78
04/03/11	12	0.0935	128	04/29/11	0	0.0901	0
04/04/11	5	0.1000	50	04/30/11	0	0.0896	0

Appendix A6, continued.

Date	Captured	Estimated trap efficiency	Daily emigration estimate	Date	Captured	Estimated trap efficiency	Daily emigration estimate
05/01/11	8	0.0871	92	**06/07/11**	**1**	**0.0457**	**22**
05/02/11	10	0.0813	123	**06/08/11**	**1**	**0.0457**	**22**
05/03/11	18	0.0779	231	**06/09/11**	**1**	**0.0457**	**22**
05/04/11	18	0.0758	237	**06/10/11**	**1**	**0.0457**	**22**
05/05/11	18	0.0749	240	**06/11/11**	**1**	**0.0457**	**22**
05/06/11	29	0.0654	443	**06/12/11**	**1**	**0.0457**	**22**
05/07/11	24	0.0582	412	**06/13/11**	**1**	**0.0457**	**22**
05/08/11	20	0.0524	382	**06/14/11**	**1**	**0.0457**	**22**
05/09/11	18	0.0520	346	**06/15/11**	**1**	**0.0457**	**22**
05/10/11	18	0.0457	394	**06/16/11**	**1**	**0.0457**	**22**
05/11/11	12	0.0457	263	**06/17/11**	**1**	**0.0457**	**22**
05/12/11	3	0.0457	66	**06/18/11**	**1**	**0.0457**	**22**
05/13/11	**4**	**0.0457**	**88**	**06/19/11**	**1**	**0.0457**	**22**
05/14/11	**2**	**0.0457**	**44**	**06/20/11**	**1**	**0.0457**	**22**
05/15/11	**2**	**0.0457**	**44**	**06/21/11**	**1**	**0.0457**	**22**
05/16/11	**1**	**0.0457**	**22**	**06/22/11**	**1**	**0.0457**	**22**
05/17/11	**1**	**0.0457**	**22**	**06/23/11**	**1**	**0.0457**	**22**
05/18/11	**1**	**0.0457**	**22**	**06/24/11**	**1**	**0.0457**	**22**
05/19/11	**1**	**0.0457**	**22**	**06/25/11**	**1**	**0.0457**	**22**
05/20/11	**1**	**0.0457**	**22**	**06/26/11**	**1**	**0.0457**	**22**
05/21/11	**1**	**0.0457**	**22**	**06/27/11**	**1**	**0.0457**	**22**
05/22/11	**1**	**0.0457**	**22**	**06/28/11**	**1**	**0.0457**	**22**
05/23/11	**1**	**0.0457**	**22**	**06/29/11**	**1**	**0.0457**	**22**
05/24/11	**1**	**0.0457**	**22**	**06/30/11**	**1**	**0.0457**	**22**
05/25/11	**1**	**0.0457**	**22**				
05/26/11	**1**	**0.0457**	**22**				
05/27/11	**1**	**0.0457**	**22**				
05/28/11	**1**	**0.0457**	**22**				
05/29/11	**1**	**0.0457**	**22**				
05/30/11	**1**	**0.0457**	**22**				
05/31/11	**1**	**0.0457**	**22**				
06/01/11	**1**	**0.0457**	**22**				
06/02/11	**1**	**0.0457**	**22**				
06/03/11	**1**	**0.0457**	**22**				
06/04/11	**1**	**0.0457**	**22**				
06/05/11	**1**	**0.0457**	**22**				
06/06/11	**1**	**0.0457**	**22**				

Appendix A7. Expanded daily detection of wild steelhead emigrants at the Twisp River PIT tag antenna array (TWR) between 1 January and 15 May 2011.

Date	Number of steelhead detected	Number detected by expanded tag rate	Estimated antenna array efficiency	Daily emigration estimate
01/01/11	1	17	0.5506	31
01/18/11	4	69	0.5506	126
01/19/11	2	35	0.5506	63
01/20/11	1	17	0.5506	31
01/21/11	1	17	0.5506	31
01/22/11	1	17	0.5506	31
01/23/11	1	17	0.5506	31
01/26/11	1	17	0.5506	31
02/11/11	1	17	0.5506	31
02/12/11	2	35	0.5506	63
02/16/11	1	17	0.5506	31
03/05/11	1	17	0.5506	31
03/06/11	1	17	0.5506	31
03/14/11	1	17	0.5506	31
03/16/11	1	17	0.5506	31
03/18/11	1	17	0.5506	31
03/19/11	1	17	0.5506	31
03/21/11	2	35	0.5506	63
03/25/11	1	17	0.5506	31
03/30/11	2	35	0.5506	63
03/31/11	31	537	0.5506	975
04/01/11	15	260	0.4689	554
04/02/11	3	52	0.5308	98
04/04/11	1	17	0.5506	31
04/05/11	2	35	0.5506	63
04/06/11	1	17	0.5506	31
04/08/11	1	17	0.5506	31
04/09/11	1	17	0.5506	31
04/10/11	2	35	0.5506	63
04/12/11	1	17	0.5506	31
04/18/11	1	17	0.5506	31
04/19/11	1	17	0.5506	31
04/20/11	1	17	0.5506	31
04/23/11	2	35	0.5506	63
04/24/11	2	35	0.5506	63

Appendix A7, continued.

Date	Number of steelhead detected	Number detected by expanded tag rate	Estimated antenna array efficiency	Daily emigration estimate
04/25/11	2	35	0.5506	63
04/26/11	6	104	0.5506	189
04/27/11	4	69	0.5506	126
04/28/11	5	87	0.5506	157
04/29/11	2	35	0.5506	63
04/30/11	4	69	0.5494	126
05/01/11	4	69	0.5308	130
05/02/11	6	104	0.4961	209
05/03/11	2	35	0.4949	70
05/04/11	6	104	0.4974	209
05/05/11	11	190	0.4639	411
05/06/11	6	104	0.4037	257
05/07/11	3	52	0.3675	141
05/08/11	3	52	0.3485	149
05/09/11	1	17	0.3438	50
05/10/11	17	294	0.2718	1,083
05/11/11	13	225	0.1257	1,791
05/12/11	2	35	0.0300	1,156
05/14/11	1	17	0.0300	578
05/15/11	5	87	0.0300	2,891

Appendix B. Number of fish PIT tagged and released from the Methow and Twisp River smolt traps. YCW = wild yearling spring Chinook; YCH = hatchery yearling Chinook; SBC = wild subyearling Chinook; SHR = wild steelhead; SHH = hatchery steelhead.

Year	Trap site	Number of fish PIT tagged and released					
		YCW smolts	YCH smolts	SBC parr	SHR migrants	SHH migrants	SHR parr
2011	Twisp	304	211	485	302	752	136
2010	Twisp	952	325	291	441	585	450
2009	Twisp	627	201	741	637	205	231
2008	Twisp	2,502	1,081	511	641	1,594	440
2007	Twisp	271	1,096	251	324	1,292	126
2006	Twisp	818	966	562	466	1,410	689
2005	Twisp	110	0	251	0	0	0
2011	Methow	325	1,566	500	165	4	47
2010	Methow	199	1,078	57	303	0	92
2009	Methow	109	645	66	386	3	39
2008	Methow	619	1,619	90	154	1,300	51
2007	Methow	378	1,248	60	162	993	16
2006	Methow	479	1,000	165	318	1,493	57
2005	Methow	301	324	0	0	0	0

Appendix C

2011 Methow Chinook salmon juvenile assignments

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Summary
In spring and fall 2011, emigrating natural-origin sub-yearling Chinook salmon were collected in the Methow River smolt trap (spring: fry < 50mm, collection codes 11CK0001 to 11CK0225; fall: parr, collection codes 11CK0508 to 11CK0681). Because two genetically distinct types of Chinook salmon, a spring-run and summer-run, spawn in the Methow River, the juveniles could be from either or both run types and the different run types may emigrate at different times. Further, the spring Chinook salmon population in the Twisp River, a tributary upstream of the smolt trap in the Methow River, is genetically distinct from Methow/Chewuch spring Chinook salmon population (Small et al. 2007) and juveniles may have originated in the Twisp spring Chinook salmon population. We investigated the genetic identity of the juvenile Chinook salmon through comparisons to adult spring and summer Chinook salmon collections from the Methow River and an adult spring Chinook salmon from the Twisp River. We found that the juveniles were roughly evenly divided between spring and summer type and that nearly 30% of the spring type originated in the Twisp population and less than 0.5% appeared to have mixed spring-summer ancestry. Most fry emigrating in the spring were summer Chinook salmon and most parr emigrating in the fall were spring Chinook salmon.

Methods
We genotyped 385 juvenile Chinook salmon (WDFW collection code 11CK, Table 1) at the 13 standardized GAPS loci as described in Small et al. (2007, 2009, 2010) and compared them to Twisp River spring Chinook, and Methow River spring and summer Chinook salmon genotyped at the same loci. All genetic lab procedures were the same for the 11CK juveniles.

Juvenile identities were examined from three perspectives. In the first examination, individuals were plotted in a factorial correspondence analysis (FCA) plot using the program GENETIX (Belkhir et al. 2004). This analysis constructs composite axes based upon allele frequencies that best describe the variation in the data set and plots individuals within the allelic space based upon their individual genotype. Individuals that are similar genetically plot near each other and individuals that are different genetically plot far from each other. The next analysis examined individual ancestry using a Bayesian analysis implemented in STRUCTURE (Pritchard et al. 2000). In this analysis, we hypothesized that there were two groups in the data set, spring and summer Chinook salmon, and estimated individual ancestry in two groups. Without knowledge of the identity of individuals the program sorts the data set in order to achieve Hardy-Weinberg equilibrium and minimize linkage disequilibrium in each hypothesized group. To further identify juvenile origins, we used assignment tests implemented in GENECLASS (Piry et al. 2004) with the Rannala and Mountain algorithm (Rannala and Mountain 1997) to calculate the likelihood that the juvenile came from the Methow spring or summer Chinook salmon collection or the Twisp summer Chinook salmon collection based on the genotype of the individual and the allele frequencies of the baseline collections.

Results and discussion

Seven juveniles were eliminated from the analysis because the DNA failed to amplify or amplified at fewer than eight loci, preventing definitive assignment, leaving 377 juveniles for the analysis. In the FCA, roughly half the juveniles plotted on the right side of axis 1 in the space occupied by the Methow adult summer Chinook salmon (Figure 1) and roughly half the juveniles plotted on the left side of axis 1 and in the space occupied by the adult spring Chinook salmon. A few juveniles plotted in the space between the spring and summer clusters, suggesting possible hybrid status.

The STRUCTURE analysis divided the adult spring and summer Chinook salmon into two distinct clusters (Figure 2). One hundred and eighty juveniles had 90% or greater ancestry in the summer Chinook salmon cluster (Table 2) and these individuals also plotted in the summer Chinook salmon space in the FCA (data not shown for individuals). Four juveniles had roughly 65 to 85% ancestry in the summer Chinook salmon cluster suggesting that they were backcrossed or a hybrid beyond the first generation (F1). One juvenile had roughly equal ancestry in the summer and spring Chinook salmon clusters suggesting that they were a first generation hybrid (Table 2). One hundred and ninety one juveniles had 90% or greater ancestry in the spring Chinook salmon cluster and these juveniles plotted in the spring Chinook salmon space in the FCA. Note: we included only Methow River spring and summer collections in the STRUCTURE analysis to decrease the complexity of the analysis since genetic variance between Twisp and Methow spring Chinook salmon populations is below the resolving power of STRUCTURE.

Results from GENECLASS paralleled the FCA and STRUCTURE analyses and provided further resolution (Figure 3 and Table 3). We plotted the negative log likelihood assignment values for the juveniles and for the adult spring and summer Chinook salmon collections (Figure 3). The plot shows that the adult spring and summer Chinook salmon assigned well to their respective groups, with overlap among the Methow and Twisp spring Chinook salmon plots. The distinction and overlap indicated high power for distinguishing genetically between run groups and lower power for distinguishing between spring populations because of lower differentiation between spring Chinook salmon collections. The plot also shows that the juvenile assignments were equally divided between the summer and spring collections.

We used a 90% posterior probability of assignment for a positive assignment in GENECLASS. The posterior probability, or relative likelihood, is calculated by dividing the highest likelihood value by the sum of the likelihood values. Ambiguity arises when highest and next highest assignment likelihoods are similar such that the posterior probability is < 90% and the fish is considered unassigned by our criteria. With a >90% threshold criterion, GENECLASS assigned 39 juveniles to the Twisp spring Chinook salmon collection, 119 juveniles to the Methow spring Chinook salmon collection and 184 juveniles to the Methow summer Chinook salmon collection (Table 2). Thirty-five juveniles were unassigned because they had nearly equal likelihoods of assignment to Twisp and Methow spring Chinook salmon collections and were thus spring

Chinook salmon of undetermined origin (Table 2). Summer Chinook salmon predominated in the fry collected outmigrating in the springtime and spring Chinook salmon juveniles predominated in the parr collected outmigrating in the fall. Most spring Chinook salmon juveniles identified by STRUCTURE were unambiguously assigned by GENECLASS to a spring Chinook salmon population, either Twisp or Methow. The 35 spring Chinook salmon juveniles that had ambiguous assignments in the GENECLASS analysis had over 90% ancestry in the spring cluster. These were clearly spring Chinook salmon but the individuals had alleles in their genotypes that were common in both spring Chinook salmon populations in the baseline and GENECLASS calculated similar assignment likelihoods to both collections such that their relative likelihood of assignment was low for a single collection. The Methow and Twisp spring Chinook salmon populations are distinct from each other but they are more similar to each other than to the Methow fall Chinook salmon population so that individuals may assign with similar likelihoods to both spring Chinook salmon collections.

Four out of six fish that STRUCTURE identified with mixed ancestry assigned with >90% relative likelihood to the summer Chinook salmon collection. Their ancestry was primarily summer Chinook salmon, which is very distinct from spring Chinook salmon. Although they had some alleles that STRUCTURE detected as spring Chinook salmon alleles, the majority of their alleles were from summer Chinook salmon such that GENECLASS assigned them with high likelihood to the summer Chinook salmon baseline population. The allele pool for the STRUCTURE analysis was different from the GENECLASS analysis since Twisp spring Chinook salmon were absent from the STRUCTURE analysis. This may have contributed to slight differences between analyses.

One hundred and eighty four smolts assigned to the Methow summer Chinook salmon collection and 193 smolts assigned to Methow or Twisp spring Chinook salmon collections. These assignments were completely congruent with ancestry detected in the STRUCTURE analysis and with FCA plot locations. Smolts collected in 2006 and 2007 in the Methow River smolt trap were mainly spring Chinook salmon (Small and Von Bargen 2009) and smolts collected in 2010 (Small et al. 2011) were mainly summer Chinook salmon. Results support different out-migration times for smolts from the different run groups.

Conclusions

The different genetic perspectives offered congruent results: 51% of the emigrating juvenile Chinook salmon were offspring of spring Chinook salmon and 49% were offspring of summer Chinook salmon.

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Figure 1. Factorial correspondence analysis plot from GENETIX. Each individual in plotted along the first two axes in the analysis, these axes describe a maximum amount of genetic variance in the dataset. Individuals plotting near each other are more similar genetically.

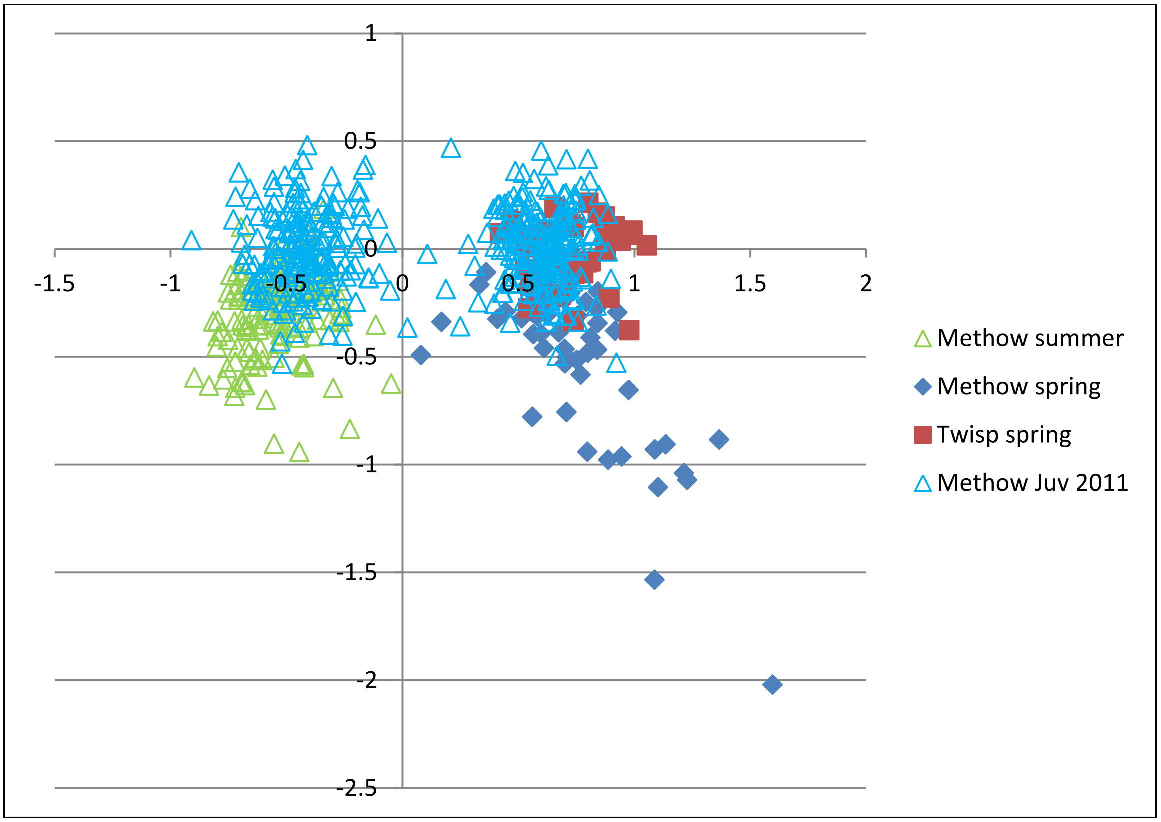

Figure 2. Ancestry values for individual fish calculated in STRUCTURE. Each fish is represented by a bar of color with red corresponding to summer Chinook salmon ancestry and green corresponding to spring Chinook salmon ancestry. Individuals with “pure” ancestry have a single color in their bar and individuals with “mixed” ancestry have two colors in their bar. Individuals are in order of the collection code number so juveniles with spring ancestry can be compared with STRUCTURE ancestry values in Table 2 and GENECLASS assignments in Table 3**.**

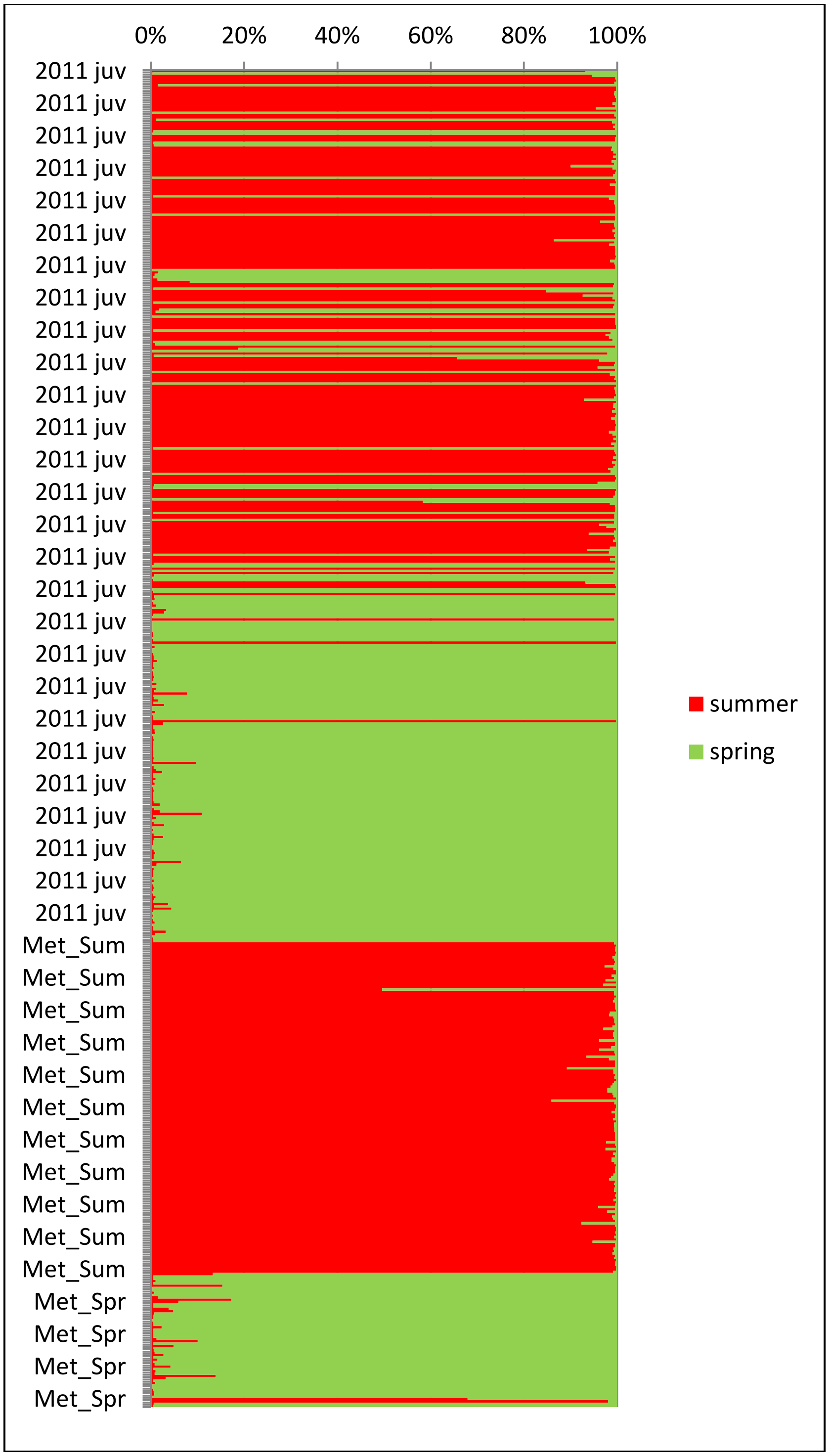

Figure 3. Graph of negative log likelihood assignment scores from GENECLASS. Methow juveniles (blue triangles) are abbreviated Juv. Highest likelihood values assigned 52 to Twisp spring, 141 to Methow spring and 184 to Methow summer. With a >90% threshold likelihood value, 39 assigned to Twisp spring, 119 to Methow spring, 184 to Methow summer and 35 were unassigned because they had roughly equal likelihood of assignment to Twisp and Methow springs.

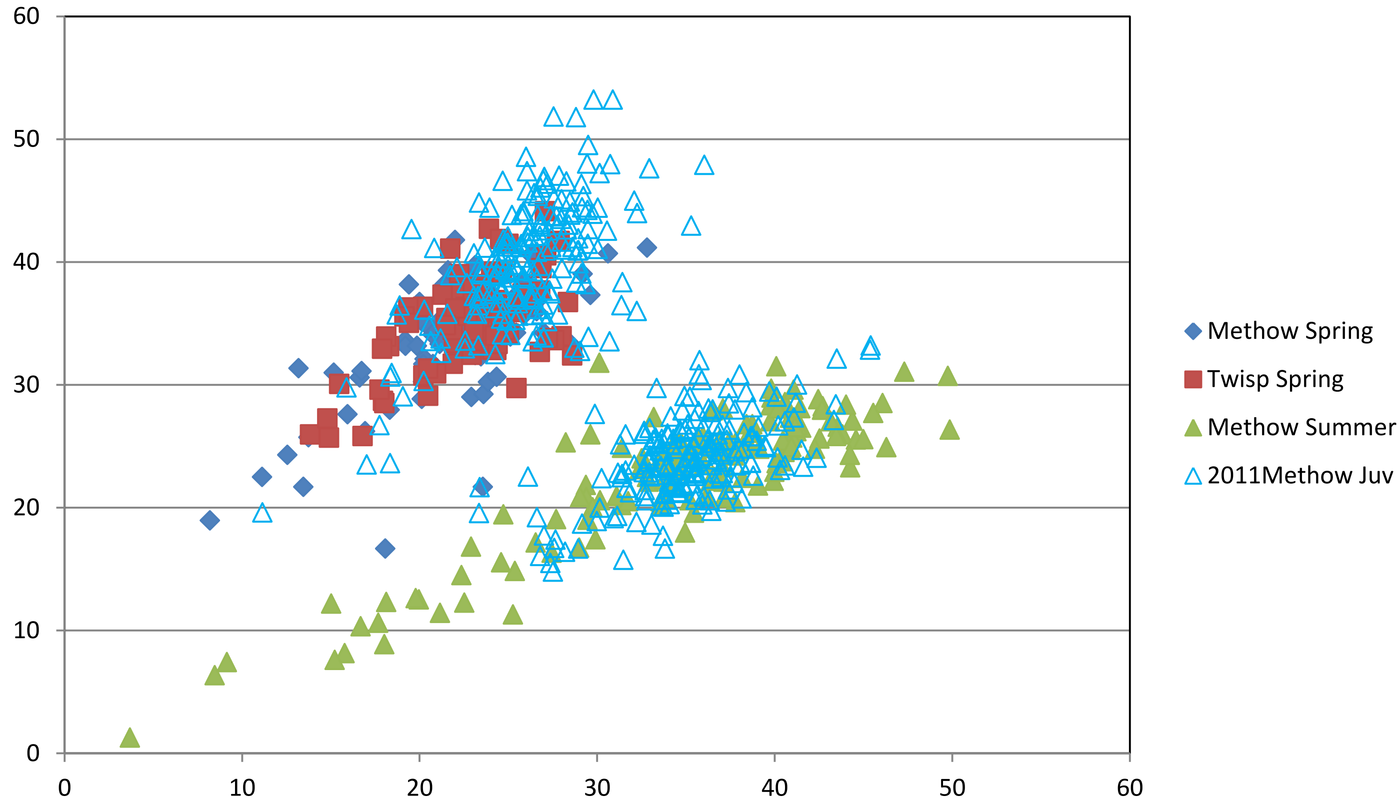

Table 1. List of samples used in the 10Methow Chinook salmon juvenile assignment tests. For the Methow juveniles 385 were processed but only 377 had enough genotypic data (at least eight loci) to include in the study.

Code	Name	N
11CK	Methow juveniles - 2011	377/385
05HW	Methow spring	42
06DA	Methow spring	33
05HX	Twisp spring	42
06DA	Twisp spring	45
93EC	GAPS Methow summer	143

Table 2. Juvenile ancestry values and assignments from STRUCTURE and GENECLASS. See Figure 2 for graphic STRUCTURE data – percentage of ancestry in the two clusters (here spring and summer) is shown as percentage of colors in color bar in Figure 2. Cells in yellow were unassigned with GeneClass.

	Structure clusters		Assignments			Structure clusters		Assignments	
	summer	spring	STRUCTURE	GeneClass		summer	spring	STRUCTURE	GeneClass
11CK001	0.932	0.068	summer	summer	11CK053	0.984	0.016	summer	summer
11CK003	0.003	0.997	spring	unassign	11CK054	0.996	0.004	summer	summer
11CK004	0.946	0.054	summer	summer	11CK055	0.996	0.004	summer	summer
11CK005	0.996	0.004	summer	summer	11CK056	0.996	0.004	summer	summer
11CK006	0.998	0.002	summer	summer	11CK057	0.996	0.004	summer	summer
11CK007	0.994	0.006	summer	summer	11CK058	0.004	0.996	spring	spring
11CK008	0.015	0.985	spring	spring	11CK059	0.982	0.018	summer	summer
11CK009	0.997	0.003	summer	summer	11CK060	0.994	0.006	summer	summer
11CK010	0.997	0.003	summer	summer	11CK061	0.993	0.007	summer	summer
11CK011	0.994	0.006	summer	summer	11CK062	0.995	0.005	summer	summer
11CK012	0.993	0.007	summer	summer	11CK064	0.996	0.004	summer	summer
11CK013	0.995	0.005	summer	summer	11CK065	0.996	0.004	summer	summer
11CK015	0.997	0.003	summer	summer	11CK066	0.996	0.004	summer	summer
11CK016	0.997	0.003	summer	summer	11CK067	0.003	0.997	spring	spring
11CK017	0.990	0.010	summer	summer	11CK068	0.995	0.005	summer	summer
11CK018	0.996	0.004	summer	summer	11CK069	0.995	0.005	summer	summer
11CK019	0.954	0.046	summer	summer	11CK070	0.963	0.037	summer	summer
11CK020	0.997	0.003	summer	summer	11CK071	0.993	0.007	summer	summer
11CK021	0.003	0.997	spring	spring	11CK073	0.994	0.006	summer	summer
11CK022	0.994	0.006	summer	summer	11CK074	0.996	0.004	summer	summer
11CK023	0.997	0.003	summer	summer	11CK076	0.990	0.010	summer	summer
11CK024	0.011	0.989	spring	spring	11CK077	0.996	0.004	summer	summer
11CK025	0.989	0.011	summer	summer	11CK078	0.993	0.007	summer	summer
11CK026	0.996	0.004	summer	summer	11CK079	0.996	0.004	summer	summer
11CK027	0.991	0.009	summer	summer	11CK080	0.864	0.136	summer	summer
11CK028	0.995	0.005	summer	summer	11CK082	0.994	0.006	summer	summer
11CK029	0.004	0.996	spring	spring	11CK083	0.983	0.017	summer	summer
11CK030	0.003	0.997	spring	spring	11CK084	0.995	0.005	summer	summer
11CK031	0.997	0.003	summer	summer	11CK085	0.996	0.004	summer	summer
11CK032	0.995	0.005	summer	summer	11CK086	0.996	0.004	summer	summer
11CK033	0.995	0.005	summer	summer	11CK087	0.995	0.005	summer	summer
11CK034	0.005	0.995	spring	spring	11CK088	0.997	0.003	summer	summer
11CK036	0.006	0.994	spring	spring	11CK089	0.996	0.004	summer	summer
11CK037	0.989	0.011	summer	summer	11CK090	0.985	0.015	summer	summer
11CK038	0.987	0.013	summer	summer	11CK091	0.994	0.006	summer	summer
11CK039	0.992	0.008	summer	summer	11CK092	0.996	0.004	summer	summer
11CK040	0.997	0.003	summer	summer	11CK093	0.996	0.004	summer	summer
11CK041	0.991	0.009	summer	summer	11CK094	0.003	0.997	spring	spring
11CK042	0.997	0.003	summer	summer	11CK096	0.016	0.984	spring	spring
11CK043	0.988	0.012	summer	summer	11CK097	0.008	0.992	spring	spring
11CK044	0.993	0.007	summer	summer	11CK098	0.005	0.995	spring	spring
11CK045	0.900	0.100	summer	summer	11CK099	0.014	0.986	spring	unassign
11CK046	0.990	0.010	summer	summer	11CK100	0.083	0.917	spring	spring
11CK047	0.997	0.003	summer	summer	11CK101	0.993	0.007	summer	summer
11CK048	0.996	0.004	summer	summer	11CK102	0.991	0.009	summer	summer
11CK049	0.991	0.009	summer	summer	11CK103	0.005	0.995	spring	spring
11CK050	0.003	0.997	spring	unassign	11CK104	0.847	0.153	summer	summer
11CK051	0.996	0.004	summer	summer	11CK105	0.992	0.008	summer	summer
11CK052	0.997	0.003	summer	summer	11CK106	0.926	0.074	summer	summer

Table 2, continued

	Structure clusters		Assignments			Structure clusters		Assignments	
	summer	spring	STRUCTURE	GeneClass		summer	spring	STRUCTURE	GeneClass
11CK107	0.990	0.010	summer	summer	11CK164	0.987	0.013	summer	summer
11CK108	0.996	0.004	summer	summer	11CK165	0.995	0.005	summer	summer
11CK109	0.004	0.996	spring	unassign	11CK166	0.996	0.004	summer	summer
11CK110	0.994	0.006	summer	summer	11CK167	0.997	0.003	summer	summer
11CK111	0.991	0.009	summer	summer	11CK169	0.996	0.004	summer	summer
11CK112	0.018	0.982	spring	unassign	11CK170	0.996	0.004	summer	summer
11CK113	0.010	0.990	spring	spring	11CK171	0.982	0.018	summer	summer
11CK114	0.996	0.004	summer	summer	11CK172	0.990	0.010	summer	summer
11CK115	0.003	0.997	spring	spring	11CK174	0.997	0.003	summer	summer
11CK116	0.996	0.004	summer	summer	11CK175	0.992	0.008	summer	summer
11CK118	0.996	0.004	summer	summer	11CK176	0.997	0.003	summer	summer
11CK119	0.996	0.004	summer	summer	11CK177	0.987	0.013	summer	summer
11CK120	0.997	0.003	summer	summer	11CK178	0.994	0.006	summer	summer
11CK121	0.997	0.003	summer	summer	11CK179	0.005	0.995	spring	spring
11CK122	0.004	0.996	spring	spring	11CK180	0.994	0.006	summer	summer
11CK123	0.986	0.014	summer	summer	11CK181	0.995	0.005	summer	summer
11CK124	0.975	0.025	summer	summer	11CK182	0.998	0.002	summer	summer
11CK125	0.982	0.018	summer	summer	11CK183	0.991	0.009	summer	summer
11CK126	0.990	0.010	summer	summer	11CK184	0.998	0.002	summer	summer
11CK127	0.005	0.995	spring	spring	11CK185	0.989	0.011	summer	summer
11CK128	0.009	0.991	spring	unassign	11CK186	0.996	0.004	summer	summer
11CK129	0.996	0.004	summer	summer	11CK187	0.992	0.008	summer	summer
11CK131	0.188	0.812	spring	spring	11CK188	0.980	0.020	summer	summer
11CK132	0.003	0.997	spring	spring	11CK189	0.986	0.014	summer	summer
11CK133	0.979	0.021	summer	summer	11CK190	0.003	0.997	spring	spring
11CK134	0.006	0.994	spring	spring	11CK191	0.995	0.005	summer	summer
11CK135	0.656	0.344	summer	summer	11CK192	0.997	0.003	summer	summer
11CK137	0.961	0.039	summer	summer	11CK193	0.995	0.005	summer	summer
11CK138	0.995	0.005	summer	summer	11CK194	0.958	0.042	summer	summer
11CK139	0.993	0.007	summer	summer	11CK195	0.007	0.993	spring	spring
11CK140	0.958	0.042	summer	summer	11CK196	0.004	0.996	spring	spring
11CK141	0.995	0.005	summer	summer	11CK197	0.997	0.003	summer	summer
11CK142	0.003	0.997	spring	spring	11CK198	0.995	0.005	summer	summer
11CK143	0.984	0.016	summer	summer	11CK199	0.995	0.005	summer	summer
11CK144	0.996	0.004	summer	summer	11CK200	0.992	0.008	summer	summer
11CK145	0.994	0.006	summer	summer	11CK201	0.003	0.997	spring	spring
11CK146	0.997	0.003	summer	summer	11CK202	0.583	0.417	summer	summer
11CK147	0.003	0.997	spring	unassign	11CK203	0.984	0.016	summer	summer
11CK148	0.997	0.003	summer	summer	11CK204	0.995	0.005	summer	summer
11CK150	0.994	0.006	summer	summer	11CK205	0.996	0.004	summer	summer
11CK151	0.995	0.005	summer	summer	11CK206	0.996	0.004	summer	summer
11CK152	0.996	0.004	summer	summer	11CK207	0.005	0.995	spring	spring
11CK153	0.997	0.003	summer	summer	11CK209	0.994	0.006	summer	summer
11CK155	0.993	0.007	summer	summer	11CK210	0.994	0.006	summer	summer
11CK156	0.929	0.071	summer	summer	11CK211	0.003	0.997	spring	spring
11CK157	0.997	0.003	summer	summer	11CK212	0.993	0.007	summer	summer
11CK158	0.992	0.008	summer	summer	11CK213	0.961	0.039	summer	summer
11CK159	0.991	0.009	summer	summer	11CK214	0.977	0.023	summer	summer
11CK160	0.996	0.004	summer	summer	11CK215	0.997	0.003	summer	summer
11CK161	0.989	0.011	summer	summer	11CK216	0.993	0.007	summer	summer
11CK162	0.998	0.002	summer	summer	11CK217	0.939	0.061	summer	summer
11CK163	0.995	0.005	summer	summer	11CK218	0.993	0.007	summer	summer

Table 2, continued.

	Structure clusters		Assignments			Structure clusters		Assignments	
	summer	spring	STRUCTURE	GeneClass		summer	spring	STRUCTURE	GeneClass
11CK219	0.995	0.005	summer	summer	11CK553	0.004	0.996	spring	spring
11CK220	0.991	0.009	summer	summer	11CK554	0.006	0.994	spring	spring
11CK221	0.998	0.002	summer	summer	11CK555	0.006	0.994	spring	unassign
11CK222	0.998	0.002	summer	summer	11CK556	0.013	0.987	spring	spring
11CK223	0.984	0.016	summer	summer	11CK557	0.004	0.996	spring	spring
11CK224	0.935	0.065	summer	summer	11CK558	0.005	0.995	spring	spring
11CK225	0.982	0.018	summer	summer	11CK559	0.006	0.994	spring	unassign
11CK509	0.004	0.996	spring	spring	11CK560	0.003	0.997	spring	spring
11CK510	0.996	0.004	summer	summer	11CK561	0.005	0.995	spring	spring
11CK511	0.985	0.015	summer	summer	11CK562	0.004	0.996	spring	unassign
11CK512	0.996	0.004	summer	summer	11CK563	0.007	0.993	spring	spring
11CK513	0.006	0.994	spring	spring	11CK564	0.004	0.996	spring	spring
11CK514	0.002	0.998	spring	unassign	11CK566	0.003	0.997	spring	spring
11CK515	0.995	0.005	summer	summer	11CK567	0.012	0.988	spring	spring
11CK516	0.002	0.998	spring	spring	11CK568	0.003	0.997	spring	unassign
11CK517	0.992	0.008	summer	summer	11CK569	0.011	0.989	spring	spring
11CK518	0.007	0.993	spring	spring	11CK570	0.007	0.993	spring	spring
11CK519	0.003	0.997	spring	spring	11CK571	0.078	0.922	spring	spring
11CK520	0.005	0.995	spring	spring	11CK572	0.004	0.996	spring	spring
11CK521	0.932	0.068	summer	summer	11CK573	0.006	0.994	spring	unassign
11CK522	0.996	0.004	summer	summer	11CK574	0.015	0.985	spring	spring
11CK523	0.997	0.003	summer	summer	11CK575	0.004	0.996	spring	unassign
11CK524	0.003	0.997	spring	unassign	11CK576	0.028	0.972	spring	spring
11CK525	0.005	0.995	spring	unassign	11CK577	0.003	0.997	spring	spring
11CK526	0.996	0.004	summer	summer	11CK579	0.003	0.997	spring	spring
11CK527	0.007	0.993	spring	spring	11CK580	0.009	0.991	spring	unassign
11CK528	0.008	0.992	spring	spring	11CK581	0.003	0.997	spring	spring
11CK529	0.003	0.997	spring	spring	11CK582	0.004	0.996	spring	spring
11CK530	0.004	0.996	spring	spring	11CK583	0.004	0.996	spring	spring
11CK531	0.011	0.989	spring	spring	11CK584	0.997	0.003	summer	summer
11CK532	0.003	0.997	spring	spring	11CK585	0.026	0.974	spring	spring
11CK533	0.033	0.967	spring	spring	11CK586	0.005	0.995	spring	spring
11CK534	0.028	0.972	spring	spring	11CK587	0.004	0.996	spring	spring
11CK535	0.005	0.995	spring	spring	11CK588	0.008	0.992	spring	spring
11CK537	0.003	0.997	spring	spring	11CK589	0.009	0.991	spring	spring
11CK538	0.994	0.006	summer	summer	11CK590	0.003	0.997	spring	unassign
11CK539	0.003	0.997	spring	spring	11CK591	0.004	0.996	spring	unassign
11CK540	0.003	0.997	spring	unassign	11CK592	0.006	0.994	spring	spring
11CK541	0.003	0.997	spring	spring	11CK593	0.005	0.995	spring	spring
11CK542	0.003	0.997	spring	unassign	11CK594	0.004	0.996	spring	spring
11CK543	0.003	0.997	spring	spring	11CK595	0.005	0.995	spring	spring
11CK544	0.005	0.995	spring	spring	11CK596	0.005	0.995	spring	spring
11CK545	0.004	0.996	spring	spring	11CK597	0.004	0.996	spring	unassign
11CK546	0.003	0.997	spring	spring	11CK598	0.004	0.996	spring	spring
11CK547	0.004	0.996	spring	spring	11CK599	0.005	0.995	spring	spring
11CK548	0.997	0.003	summer	summer	11CK600	0.006	0.994	spring	spring
11CK549	0.003	0.997	spring	spring	11CK601	0.004	0.996	spring	spring
11CK550	0.008	0.992	spring	spring	11CK602	0.097	0.903	spring	spring
11CK551	0.003	0.997	spring	spring	11CK603	0.003	0.997	spring	spring
11CK552	0.003	0.997	spring	spring	11CK604	0.006	0.994	spring	unassign

Table 2, continued.

	Structure clusters		Assignments			Structure clusters		Assignments	
	summer	spring	STRUCTURE	GeneClass		summer	spring	STRUCTURE	GeneClass
11CK605	0.011	0.989	spring	spring	11CK655	0.004	0.996	spring	spring
11CK606	0.024	0.976	spring	spring	11CK656	0.006	0.994	spring	spring
11CK607	0.005	0.995	spring	spring	11CK657	0.004	0.996	spring	spring
11CK608	0.004	0.996	spring	spring	11CK658	0.003	0.997	spring	spring
11CK609	0.010	0.990	spring	spring	11CK659	0.005	0.995	spring	spring
11CK610	0.005	0.995	spring	spring	11CK660	0.010	0.990	spring	spring
11CK611	0.008	0.992	spring	spring	11CK661	0.007	0.993	spring	spring
11CK612	0.003	0.997	spring	spring	11CK662	0.004	0.996	spring	spring
11CK613	0.004	0.996	spring	spring	11CK663	0.037	0.963	spring	spring
11CK614	0.006	0.994	spring	unassign	11CK664	0.007	0.993	spring	spring
11CK615	0.005	0.995	spring	spring	11CK665	0.044	0.956	spring	spring
11CK616	0.005	0.995	spring	spring	11CK666	0.004	0.996	spring	spring
11CK617	0.004	0.996	spring	unassign	11CK667	0.002	0.998	spring	unassign
11CK618	0.005	0.995	spring	spring	11CK668	0.005	0.995	spring	unassign
11CK619	0.006	0.994	spring	spring	11CK669	0.002	0.998	spring	spring
11CK620	0.019	0.981	spring	spring	11CK670	0.005	0.995	spring	spring
11CK621	0.003	0.997	spring	spring	11CK672	0.008	0.992	spring	unassign
11CK622	0.007	0.993	spring	spring	11CK673	0.003	0.997	spring	spring
11CK623	0.019	0.981	spring	spring	11CK675	0.004	0.996	spring	spring
11CK624	0.109	0.891	spring	spring	11CK676	0.005	0.995	spring	spring
11CK625	0.005	0.995	spring	spring	11CK677	0.032	0.968	spring	spring
11CK626	0.011	0.989	spring	spring	11CK678	0.009	0.991	spring	spring
11CK627	0.003	0.997	spring	unassign	11CK679	0.003	0.997	spring	spring
11CK628	0.006	0.994	spring	spring	11CK680	0.005	0.995	spring	spring
11CK629	0.028	0.972	spring	spring	11CK681	0.004	0.996	spring	spring
11CK630	0.003	0.997	spring	spring					
11CK631	0.005	0.995	spring	spring					
11CK632	0.003	0.997	spring	spring					
11CK633	0.006	0.994	spring	spring					
11CK634	0.026	0.974	spring	unassign					
11CK635	0.006	0.994	spring	spring					
11CK636	0.005	0.995	spring	spring					
11CK637	0.005	0.995	spring	spring					
11CK638	0.003	0.997	spring	unassign					
11CK639	0.003	0.997	spring	spring					
11CK640	0.006	0.994	spring	spring					
11CK641	0.009	0.991	spring	spring					
11CK642	0.006	0.994	spring	spring					
11CK643	0.006	0.994	spring	spring					
11CK644	0.003	0.997	spring	unassign					
11CK645	0.064	0.936	spring	spring					
11CK646	0.012	0.988	spring	spring					
11CK647	0.003	0.997	spring	spring					
11CK648	0.006	0.994	spring	unassign					
11CK649	0.004	0.996	spring	spring					
11CK650	0.004	0.996	spring	spring					
11CK651	0.004	0.996	spring	spring					
11CK652	0.002	0.998	spring	unassign					
11CK653	0.006	0.994	spring	spring					
11CK654	0.003	0.997	spring	spring					

Chapter 4

2011 Brood Summer Steelhead Spawning Ground Surveys Conducted in the Methow River Basin

Abstract

Steelhead spawning ground surveys were performed to estimate the relative abundance, distribution, and timing of spawning within the Methow River basin. Based on surveys conducted between 3 March and 1 June, an estimated minimum of 854 steelhead redds were constructed in the Methow Basin in 2011. The greatest number of redds was found in the upper Methow River subbasin (N = 383). Net run escapement upstream of Wells Dam for the 2010 brood was 12,334 fish. The run-at-large above Wells Dam was composed primarily of hatchery origin steelhead (84.9%). Based on biological sampling of steelhead during broodstock collection at Wells Hatchery, 17.4% of total run escapement was composed of out-of-basin stray hatchery fish, primarily from the Wenatchee River. Based on first-day-of-the-week sampling during the broodstock collection period, wild 1-salt and 2-salt fish migrated to Wells Dam earlier than hatchery 1-salt fish. Creel censuses conducted during fisheries above Wells Dam estimated removal of 4,779 adipose fin-clipped steelhead. The total redd count, including all subbasins and tributaries, represents 1,324 fish, or 35.8% of the maximum estimated spawning escapement to the Methow River basin of 3,563 fish. No significant differences in spawn timing of hatchery and wild female steelhead were observed in the hatchery environment (non-hormone-injected females) or during natural spawning in the Twisp River. Based on run-escapement estimates, the mean natural replacement rate for the ten most recent broods of steelhead spawning above Wells Dam (1996-2005) was 0.26 recruits per adult. For all brood years examined (1996-2005), the hatchery replacement rate was significantly greater than the natural replacement rate.

Introduction

Summer steelhead are propagated at Wells Hatchery and used to supplement the natural spawning populations in the Methow and Okanogan rivers. Hatchery adults returning to supplemented streams should have migration timing, spawn timing, and redd distribution similar to those of naturally produced fish. Deviations from these life-history traits may have deleterious effects on the overall reproductive success of the integrated population. The number of spawners, derived from estimates of redd abundance, provides critical information not only for survival and spawner-recruit analyses, but also for assessing freshwater smolt production. Knowledge of both the productivity of the population (i.e., recruits per spawner), as related to the total abundance of spawners, and the proportion of hatchery fish on the spawning grounds should provide valuable insight on the factors limiting the number of naturally produced adults. In addition to spawner abundance, the proportion of stray hatchery fish on the spawning grounds may also assist in understanding the productivity of the population (i.e., stray fish may be maladapted to the Methow Basin).

The implementation of the Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs (Hays et al. 2007) as proposed by Murdoch and Snow (2010) included objectives designed to address key questions regarding supplementation. Steelhead spawning ground surveys and associated activities (i.e., broodstock collection and creel surveys) were used to evaluate spawn timing, distribution, and tributary-specific escapement levels within the Methow River basin. While hatchery steelhead from Wells Hatchery were released in both the Methow and Okanogan populations, this report focuses on the Methow population. Monitoring and evaluation activities are conducted in the Okanogan Basin by the Colville Confederated Tribes and those activities are reported separately (see Miller et. al, 2012) unless specifically relevant to Methow Basin activities. This chapter addresses activities related to steelhead spawning ground surveys in 2011 and specific elements of the M&E Plan for the following objectives:

Objective 1: Determine if a) supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream), and b) changes in the natural replacement rate (NRR) of the supplemented population are similar to that of the non-supplemented population.

- Ho: Number of hatchery fish that spawn naturally ≥ number of naturally and hatchery produced fish taken for broodstock
- Ho: Δ NOR/Max recruitment $_{\text{Supplemented population}}$ > Δ NOR/Max recruitment $_{\text{Non-supplemented population}}$
- Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

- Ho: Migration timing $_{\text{Hatchery age X}}$ = Migration timing $_{\text{Naturally produced age X}}$
- Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

Objective 4: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific expected value (BAMP 1998).

- Ho: HRR $_{\text{Year x}} \geq$ NRR $_{\text{Year x}}$
- Ho: HRR ≥ BAMP value (preferred)

Objective 5: Determine if the stray rate of hatchery fish is below acceptable levels to maintain genetic variation.

- Ho: Stray rate $_{\text{Hatchery fish}} \leq$ 5% of total brood return
- Ho: Stray hatchery fish ≤ 5% of spawning escapement (based on run year) within other independent populations
- Ho: Stray hatchery fish ≤ 10% of spawning escapement (based on run year) of any non-target streams within independent populations

Methods

Migration Timing and Spawner Composition

Broodstock were collected at Wells Dam from a composite of both the Methow and Okanogan populations. Adult fish were trapped a maximum of three days per week and were retained for broodstock as necessary to achieve collection goals for hatchery and wild fish (Tonseth 2010). All trapped steelhead were sampled for hatchery marks, and scale samples were collected from all unmarked fish to determine origin (i.e., hatchery or wild). Additionally, scale samples were collected from fish trapped each Monday to determine origin and age composition of the entire run. Migration timing (first arrival at Wells Dam) of local hatchery (i.e., Wells stock) and wild fish was calculated using all trapped fish for which length and origin could be determined. Migration (arrival) timing in the Twisp River was calculated using PIT tag interrogation data from the Twisp River instream array (rkm 68.7).

Passive integrated transponder (PIT) tag records were reviewed to determine if fish migrated through fish ladders more than once; these events cause overestimation of the total count at Wells Dam. Dam fallback and double counting of fish at Wells Dam were estimated using data from PIT tag detections at Columbia River hydroelectric facilities or within tributaries. The total number of double counted hatchery and wild fish was expanded to the run-at-large hatchery and wild totals. Fish that were detected at dams or within tributaries downstream of Wells Dam after their last detection at Wells Dam were considered fallbacks; fish were not considered fallbacks if downstream detection (e.g., Rocky Reach juvenile bypass) was consistent with likely kelt migration timing. Total fallback was calculated by expanding the estimated fallback proportion of hatchery and wild fish to the run-at-large hatchery and wild totals passing Wells Dam. Steelhead passing Wells Dam were subjected to local selective fisheries, and creel surveys were used to estimate the number of steelhead removed from the Methow, Columbia, Okanogan, and Similkameen River basins (see Chapter 2). Run escapement estimates were calculated for the Methow and Okanogan rivers by applying the proportion of fish that migrated to each basin based on results of local radio-telemetry studies (English et al. 2001, 2003) to the estimated number of hatchery and wild steelhead passing Wells Dam. Basin-specific fishery removal and indirect mortality (5%) estimates, along with local broodstock collections were subtracted from the estimated escapement to each basin to determine the number of steelhead available for natural spawning. No estimates were made of pre-spawn mortality or illegal removal (i.e., poaching).

Spawn Timing and Redd Distribution

Spawn timing within the hatchery environment was assessed during routine spawning operations at Wells Hatchery. Although spawning typically occurs much earlier in the hatchery than in the natural environment, any relative differences observed in the broodstock may also be present in the natural environment. An evaluation of spawn timing and redd distribution in the natural environment was conducted on the Twisp River. Adult steelhead on their upstream spawning migration were trapped at the Twisp weir and sampled for hatchery marks, sex, and origin. All naturally produced fish were sampled, tagged and released upstream from the weir except for 26 fish retained for broodstock. Hatchery fish were also sampled, tagged, and released upstream of the weir consistent with escapement goals and objectives of the Twisp RRS study. These objectives targeted a spawning population upstream of the Twisp River weir comprised of equal populations of naturally produced and hatchery fish. All excess hatchery steelhead were lethally removed from the spawning population. All steelhead released upstream of the weir received uniquely colored anchor tags that represented their origin and sex (green = wild female, pink = hatchery female, blue = wild male, red = hatchery male). The assignment of colored anchor tags will rotate each year to avoid any spawning success bias that could be associated with the presence of anchor tags. Visual observation of these tags was used to assess the spawn timing and location of hatchery and wild fish. Additionally, female steelhead without existing PIT tags from previous sampling events were PIT-tagged in the body cavity to increase the likelihood of tag expulsion into redds during spawning. During surveys, redds were scanned with PIT tag detectors to document tag deposition. While observations of anchor tagged fish on redds were used for spawn timing analyses, both anchor tag observations and PIT tag detections from redds were used to determine redd distribution.

The Methow River basin was divided into four geographic subbasins; the upper Methow, lower Methow, Chewuch, and Twisp. Index areas of annual spawning activity were established within each subbasin based on information from historic surveys (Tables 1 – 4). Index areas were surveyed every four days on foot or by raft throughout the spawning season. Steelhead redds were individually flagged with date, redd number, and location recorded on each flag. Each redd was also recorded with hand-held global positioning system (GPS) devices for subsequent mapping. When spawning was perceived to be near peak, non-index areas were surveyed to obtain a total redd count, and index areas were surveyed by naïve surveyors to determine the proportion of total redds still visible. Redds observed outside of index areas were expanded by the ratio of visible redds to total redds derived from naïve index area counts. Index area surveys continued after peak spawning, and additional expansions were made in non-index areas based on the proportion of additional redds found within index areas after peak spawning. Expanded redd counts from outside the index areas were combined with total redd counts within the index areas (except in the Twisp subbasin) to estimate the total number of redds for each stream as described in Appendix F, task 7-3 of the M&E Plan (Wells HCP HC 2007). Consistent with the objectives of the Twisp River Relative Reproductive Success (RRS) study, nearly all reaches in the Twisp subbasin were surveyed on a four-day rotation, thus we considered redd counts within the Twisp subbasin in 2011 to be complete census counts.

Table 1. Upper Methow River subbasin survey reaches (index reaches in bold).

Stream	Section	Code	Section Length (rkm)		
			Begin	End	Total
Upper Methow	Ballard CG. - Lost River Confluence	M15	120.8	116.8	4.0
	Lost River Confluence - Gate Creek	M14	116.8	112.0	4.8
	Gate Creek - Early Winters Creek	M13	112.0	107.8	4.2
	Early Winters Creek - Mazama Bridge	M12	107.8	104.6	3.2
	Mazama Bridge - Suspension Bridge	**M11**	**104.6**	**100.6**	**4.0**
	Suspension Bridge - Weeman Bridge	**M10**	**100.6**	**95.4**	**5.2**
	Weeman Bridge - Along Hwy 20	M9	95.4	86.4	9.0
	Along Highway 20 - Wolf Creek	M8	86.4	84.2	2.2
	Wolf Creek - Foghorn Dam	M7	84.2	82.4	1.8
	Foghorn Dam - Winthrop Bridge	M6	82.4	79.7	2.7
Lost River	Sunset Creek - Eureka Creek	L3	11.2	6.6	4.6
	Eureka Creek - Lost River Bridge	L2	6.6	0.8	5.8
	Lost River Bridge - Confluence	**L1**	**0.8**	**0.0**	**0.8**
Early Winters Cr.	Klipchuck CG. - Early Winters Bridge	EW5	7.2	5.8	1.4
	Early Winters Bridge - Hwy 20 Bridge	EW4	5.8	3.7	2.1
	Highway 20 Bridge – Diversion dam	EW3	3.7	0.8	2.9
	Diversion dam - Hwy 20 Bridge	**EW2**	**0.8**	**0.5**	**0.3**
	Hwy 20 Bridge - Confluence	**EW1**	**0.5**	**0.0**	**0.5**
Suspension Creek	**100m above fork - Confluence**	Susp1	0.3	0.0	0.3
Little Susp. Creek	**50m above fork - Confluence**	Lsusp1	0.1	0.0	0.1
Hancock Cr.	**Springs - Wolf Creek Road**	HA2	1.1	0.2	0.9
	Wolf Creek Road - Confluence	HA1	0.2	0.0	0.2
Gate Creek	**Culvert - Confluence**	GA1	0.3	0.0	0.3
MH Outfall[1]	**Hatchery to Methow River**	MH1	0.4	0.0	0.4
WNFH Outfall[2]	**Hatchery to Methow River**	WN1	0.4	0.0	0.4

[1]Methow State Fish Hatchery outfall.
[2]Winthrop National Fish Hatchery outfall.

Table 2. Lower Methow River subbasin survey reaches (index reaches in bold).

Stream	Section	Code	Section Length (rkm)		
			Begin	End	Total
Lower Methow	Winthrop Bridge - MVID Dam	M5	80.1	72.1	8.0
	MVID - Twisp Confluence	M4	72.1	64.9	7.2
	Twisp Confluence - Carlton Bridge	M3	64.9	43.8	21.1
	Carlton Bridge - Upper Burma Br.	**M2**	**43.8**	**20.1**	**23.7**
	Upper Burma Bridge - Pateros	M1	20.1	0	20.1
Beaver Creek	Lester Hill Road - Balky Hill Road	BV3	14.2	9.3	4.9
	Balky Hill Road - Hwy 20	BV2	9.3	3.4	5.9
	Hwy 20 - Confluence	**BV1**	**3.4**	**0.0**	**3.4**

Table 3. Twisp River subbasin survey reaches (index reaches in bold).

Stream	Section	Code	Section Length (rkm)		
			Begin	End	Total
Twisp River	Road's End CG. - South Creek Bridge	T10	46.4	41.8	4.6
	South Cr. Bridge - Poplar Flats CG.	T9	41.8	38.6	3.2
	Poplar Flats CG. - Mystery Bridge	T8	38.6	35.4	3.2
	Mystery Bridge - War Creek Bridge	T7	35.4	28.5	6.9
	War Creek Bridge - Buttermilk Bridge	T6	28.5	21.1	7.4
	Buttermilk Br. - Little Bridge Cr.	**T5**	**21.1**	**15.2**	**5.9**
	Little Bridge Creek - Twisp weir	**T4**	**15.2**	**11.4**	**3.8**
	Twisp weir - Upper Poorman Bridge	T3	11.4	7.8	3.6
	Up. Poorman Br. - Low. Poorman Br.	T2	7.8	2.9	4.9
	Lower Poorman Bridge - Confluence	T1	2.9	0.0	2.9
Little Bridge Creek	Road’s End - Vetch Creek	LBC4	9.1	7.8	1.3
	Vetch Creek - Upper Culvert	LBC3	7.8	4.8	3.0
	Upper Culvert - Lower Culvert	LBC2	4.8	2.4	2.4
	Lower Culvert - Confluence	LBC1	2.4	0.0	2.4
Buttermilk Creek	(Fork - Cattle Guard)	BM2	4.1	2.0	2.1
	(Cattle Guard - Confluence)	BM1	2.0	0.0	2.0
Eagle Creek	(FR 4430 Culvert - Confluence)	EA1	0.5	0.0	0.5
War Creek	(FR 4430 Bridge - Confluence)	WR1	1.0	0.0	1.0
South Creek	(Falls - Confluence)	SO1	0.6	0.0	0.6
MSRF pond outfall[1]	Acclimation pond to confluence	MSRF1	0.2	0.0	0.2

[1]Methow Salmon Recovery Foundation pond outfall.

Table 4. Chewuch River subbasin survey reaches (index reaches in bold).

Stream	Section	Code	Section Length (rkm)		
			Begin	End	Total
Chewuch River	Chewuch Falls - 30 Mile Bridge	C13	54.4	50.2	4.2
	30 Mile Bridge - Road Side Camp	C12	50.2	45.6	4.6
	Road Side Camp - Andrews Creek	C11	45.6	41.3	4.3
	Andrews Creek - Lake Creek	C10	41.3	37.3	4.0
	Lake Creek - Buck Creek	C9	37.3	35.0	2.3
	Buck Creek - Camp 4 C.G.	C8	35.0	32.6	2.4
	Camp 4 C.G. - Chewuch CG.	C7	32.6	27.5	5.1
	Chewuch CG. - Falls Creek CG.	C6	27.5	21.8	5.7
	Falls Creek CG. - Eightmile Creek	C5	21.8	18.1	3.7
	Eightmile Creek - Boulder Creek	**C4**	**18.1**	**14.4**	**3.7**
	Boulder Creek - Chewuch Bridge	C3	14.4	12.6	1.8
	Chewuch Bridge - WDFW Land	C2	12.6	5.1	7.5
	WDFW Land - Confluence	C1	5.1	0.0	5.1
Cub Creek	W. Chewuch Road - Confluence	CU1	1.0	0.0	1.0
Eightmile Creek	**300m above diversion - Bridge**	**EM2**	**1.1**	**0.6**	**0.5**
	Bridge - Confluence	**EM1**	**0.6**	**0.0**	**0.6**

The logistical challenges of systematically sampling numerous low-order tributaries in the Methow Basin precluded the use of annual index areas for each tributary. Historically, a rotating panel methodology was used to estimate redd abundance in smaller streams without annual index areas. Streams accessible to spawning steelhead were identified from the Washington State Conservation Commission's Salmon, Steelhead, and Bull Trout Habitat Limiting Factors Report (LFA 2000). Tributaries were initially assigned a survey year to serve as an index stream for each respective subbasin (Table 5). As time permitted, multiple streams within each subbasin have been surveyed to assess the efficacy of these methodologies (Table 5). Select tributaries were surveyed weekly during the spawning season and redd densities (redds/km) of index tributaries were expanded to other subbasin tributaries based on length (km) of available spawning habitat. The length of suitable steelhead spawning was field-verified and adjusted based on data from previous years.

Table 5. Low-order tributaries included in the rotating panel sampling design by subbasin and survey year.

Stream (section)	Survey year	Code	Distance (km)
Upper Methow subbasin			
Little Boulder Creek (Hwy 20 - Confluence)	2004-05, 07-11	LBO1	0.2
Wolf Creek (Rd 5505 access – Footbridge)	2009-11	W2	1.9
Wolf Creek (Footbridge – Confluence)	2002, 05, 07-11	W1	0.5
Goat Creek (FR 52 Bridge - Confluence)	2005-07, 09-11	GT1	2.2
Lower Methow subbasin			
Gold Creek Upper N.F. (10.0 rkm – 6.3 rkm)[a]	2009-10	GDN4	3.7[a]
Gold Creek Middle N.F. (6.3 rkm - N.F. Bridge)	2008-11	GDN3	0.9
Gold Cr. Mid. N.F. (N.F. Br. - Whispering Pines)	2005, 08-11	GDN2	1.5
Gold Cr. Lower N.F. (Whispering Pines - 2nd Br.)	2005, 08-11	GDN1	1.4
Gold Creek S.F. (1st Culvert - 1.7 rkm)	2009-11	GDS3	4.4
Gold Creek S.F. (1.7 rkm - 0.6 rkm)	2005, 08-11	GDS2	1.1
Gold Creek S.F. (0.6 rkm – Confluence)	2009-11	GDS1	0.6
Gold Creek Mainstem (2nd Bridge - Private Land)	2005, 08-11	GDM2	1.2
Gold Creek Mainstem (Private Land - Confluence)	- -	GDM1	1.3
Foggy Dew Creek (FR 200 - Confluence)	2005, 08-11	FD1	4.2
Libby Creek (Rkm 6.2 - Lower Public Land)	2010	LB5	2.8
Libby Creek (Lower Public Land)	2006, 10	LB4	1.0
Libby Creek (Lower Public Land - Realty Land)	2010-11	LB3	1.1
Libby Creek (Realty Land)	2006, 09-11	LB2	0.3
Libby Creek (Realty Land - Confluence)	2009-11	LB1	1.0
Black Canyon Creek (1st Culvert - 0.8 rkm)	2007, 09-11	BC2	1.0
Black Canyon Creek (0.8 rkm - Confluence)	2004, 07, 09-11	BC1	0.8
Twisp subbasin			
Eagle Creek (FR 4430 Culvert - Confluence)	2004-05, 08-11	EA1	0.5
War Creek (FR 4430 - Confluence)	2002-03, 05, 09-11	WR1	1.0
Buttermilk Creek (Fork - Cattle Guard)	2008-11	BM2	2.1
Buttermilk Creek (Cattle Guard - Confluence)	2002-03, 05-06, 08-11	BM1	2.0
South Creek (Falls - Confluence)	2007, 09-11	SO1	0.6
Chewuch subbasin			
Andrews Creek (Little Andrews Creek – 1st Br.)	2009	AN2	0.3
Andrews Creek (1st Bridge - Confluence)	2004, 08-10	AN1	0.2
Boulder Creek (Falls - 1st Bridge)	2004-07, 09-11	BD2	0.8
Boulder Creek (1st Bridge - Confluence)	2002-07, 09-11	BD1	0.8
Lake Creek (Black Lake - 1st Bridge)	2002, 04, 09-11[b]	LK2	11.3
Lake Creek (1st Bridge - Confluence)	2002, 04-05, 09-11	LK1	0.8
Twentymile Creek (Falls – FR 5010)	2007, 09-10	TW2	0.9
Twentymile Creek (FR 5010 - Confluence)	2005, 07, 09-10	TW1	0.1

[a] Distance surveyed since 2009.
[b] Partial surveys each year.

Natural Replacement Rate (NRR) and Stray Rates

To estimate run escapement (parent broods) to the Methow Basin, steelhead returning to Wells Dam were apportioned to the Methow Basin based on radio-telemetry data (English et al. 2001, 2003). The NRR for each brood was calculated by adding the number of recruits (*r*), based on total age determined from scales, from successive return years (*i*) that originated from the same parent brood. The total number of recruits was divided by the number of spawners (*S*) for that brood year:

$$\text{NRR} = (r_{i+1} + r_{i+2} + r_{i+3} + \ldots)/S$$

Estimated run escapement of parent broods (*S*) are apportioned to the Methow and Okanogan basins based on radio telemetry data applied to run-at-large sampling totals at Wells Dam. Fish collected for broodstock and incidental mortality as a result of the local fishery were excluded from escapement totals. Recently, PIT tags have provided the ability to estimate fallback and the total number of double counted fish at Wells Dam fish ladders.

All returning Wenatchee Basin hatchery steelhead were elastomer-tagged prior to release and the contribution of these fish to the stray hatchery steelhead returning to the Methow and Okanogan populations was assessed at Wells Dam. Unmarked hatchery fish (identified through scale analysis) were apportioned to local or stray elastomer-only marked populations based on proportions of elastomer-tagged fish in the weekly collections.

Statistical Analyses

For all comparisons of hatchery and wild fish (excluding Twisp River migration timing), only known, or assumed local hatchery fish were used (hatchery marks: LYE, RYE, Ad-only, Ad+CWT). Data were tested for normality using Shapiro-Wilk's *W*-tests and homogeneity of variances using Levene's tests. Data were transformed using standard statistical procedures to achieve normal distributions when necessary. Nonparametric tests were used when normal distributions could not be achieved and variance was unequal between groups; in the event that normality could not be achieved but variance was equal among groups, ANOVA or ANCOVA were used due to their robustness to non-normality (Zar 1999). All statistical tests were performed at a significance level of 0.05 (i.e., a 5% chance of erroneously rejecting a null hypothesis). Mean passage date at Wells Dam and mean arrival date at the Twisp array were analyzed using Kruskal-Wallis (KW) ANOVA because assumptions regarding equal variance could not be met; first-day-of-the-week sample data at Wells Dam was used to reduce the influence of trap avoidance or unequal sampling effort between ladders. Mean spawn timing in the hatchery was analyzed using KW ANOVA. Mean spawn timing in the Twisp River was analyzed using ANCOVA with elevation as the covariate. Spatial distribution of redds (Rkm) was analyzed using ANOVA. Comparisons of NRR and HRR were analyzed using a Mann-Whitney U-test. Post-hoc multiple comparisons were made for both parametric and non-parametric analyses where applicable. Abundance and productivity comparisons with non-supplemented reference populations (i.e., Objective 1) were not performed because reference populations are currently being investigated and once identified, similar data for those populations will be included in future reports.

Results

Migration Timing and Run Composition

Stock assessment and collection of the 2011 brood Wells Hatchery steelhead broodstock occurred at Wells Dam between 7 July and 25 October 2010. During that time, a total of 12,160 steelhead passed Wells Dam (Table 6). Of those fish, 851 (7.0%) were sampled for hatchery marks or were scale sampled to determine origin. Of the sampled fish, 272 hatchery and 55 wild steelhead were retained for broodstock purposes. An additional three hatchery fish died during trapping. Most of the remaining 447 hatchery and 74 wild steelhead sampled were released into the east or west ladders upstream of the traps, but some fish trapped from the west ladder were released upstream of Wells Dam. Based on first-day-of-week (typically Monday) sampling results, wild 1-salt and 2-salt fish migrated to Wells Dam earlier than hatchery 1-salt fish (Figure 1; KW ANOVA post-hoc multiple comparisons: P = 0.026, 0.003, respectively).

Table 6. Migration of hatchery and wild steelhead to Wells Dam between 7 July and 25 October 2010. Totals include stray hatchery steelhead.

Origin	*N*	Cumulative Migration Date			
		25%	50%	75%	100%
Hatchery	10,322	16-Aug	6-Sept	22-Sept	25-Oct
Wild	1,838	5-Aug	20-Aug	15-Sept	25-Oct

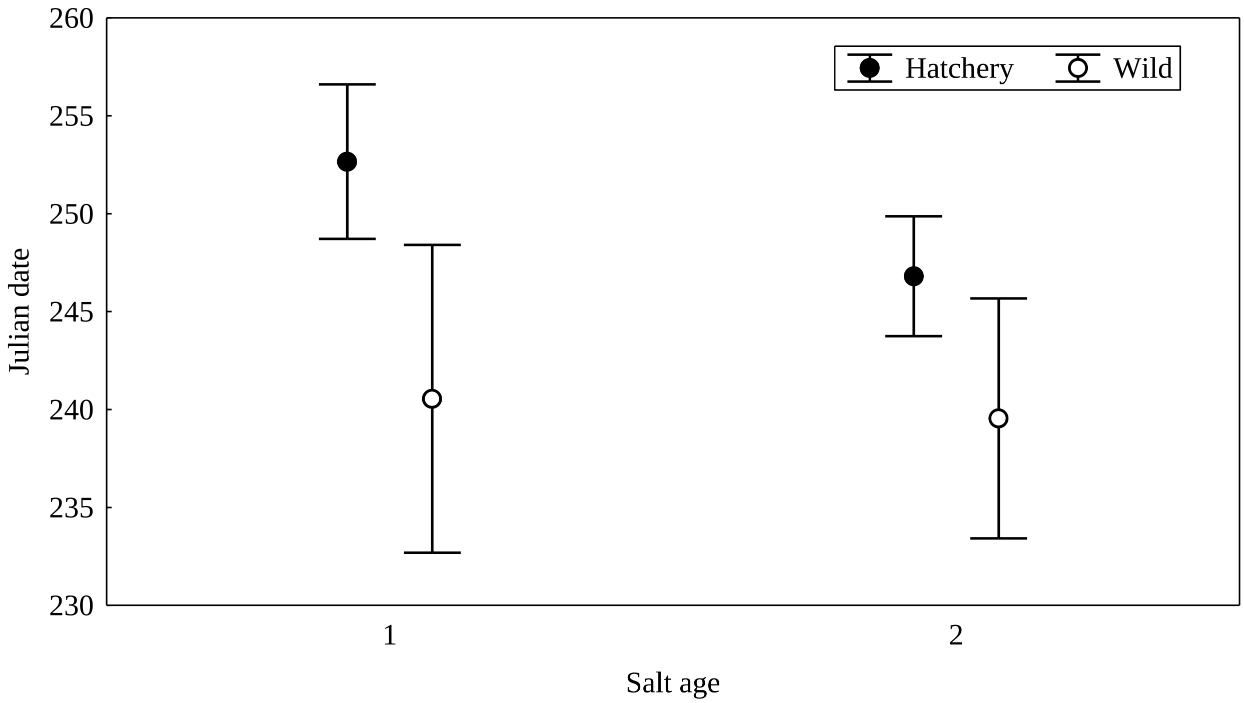

Figure 1. Mean passage date of summer steelhead passing Wells Dam between 7 July and 25 October. Error bars are 95% confidence intervals.

After removing the Wells Hatchery broodstock, the number of fish estimated to have been double-counted at Wells Dam, and the number of fish estimated to have fallen back below Wells Dam and failed to re-ascend, the net run escapement upstream of Wells Dam for the 2010 brood was 12,334 (Table 7). Analysis of scale samples and observations of hatchery marks indicated that wild fish comprised 15.1% of the steelhead run to Wells Dam (84.9% hatchery origin). Based on biological sampling of steelhead during broodstock collection at Wells Hatchery, 17.4% of total escapement was composed of out-of-basin stray hatchery fish, primarily from the Wenatchee River. The abundance and relative proportion of wild steelhead in the 2011 brood return was great enough to allow a selective sport fishery in the Methow, Okanogan, and Similkameen rivers, as well as the mainstem Columbia River (see Chapter 2). Creel censuses conducted during these fisheries estimated 4,779 adipose fin-clipped steelhead were retained (total hatchery fish mortality = 4,943; Table 8; Jateff et al. 2011). Indirect mortality of steelhead captured and released during the fisheries was assumed to be 5% and resulted in estimated mortality of 87 wild steelhead (Table 8). Remaining steelhead were assigned to the Okanogan and Methow Basins based on results of radio-telemetry studies (see Table 7; English et al. 2001, 2003). An estimated 322 and 1,116 wild fish were available for natural spawning in the Okanogan and Methow River basins, respectively (see Table 7). Historic steelhead passage, mortality, and escapement data are presented in Appendix A.

Table 7. Escapement and disposition of the 2011 brood summer steelhead passing Wells Dam. Hatchery (*N* = 272) and wild (*N* = 55) fish removed for broodstock at Wells Dam are not included in the escapement estimate above Wells Dam. Methow and Okanogan River escapements are based on radio-telemetry data (English et al. 2001, 2003), which account for 90.4% and 91.6% of the hatchery and wild escapement, respectively. Dam count includes passage from 16 June 2010 through 15 June 2011.

Area	Description (Variable)		Number
Wells Dam	Wells Dam fish count (DCPUD raw data)	(A)	13,486
	Wells Dam hatchery total (based on trapping)	(A_H)	11,456
	Wells Dam wild total (based on trapping)	(A_W)	2,030
	Estimated double counted fish (H)	(B)	206
	Estimated double counted fish (W)	(C)	40
	Estimated fallback fish (H)	(D)	633
	Estimated fallback fish (W)	(E)	273
	Adjusted Wells Dam hatchery total	($F = A_H - B - D$)	10,617
	Adjusted Wells Dam wild total	($G = A_W - C - E$)	1,717
Above Wells Dam	Local hatchery fish	(H)	8,440
	Stray hatchery fish	(I)	2,177
	Hatchery fish removed in fishery	(J)	1,131
	Above Wells hatchery run estimate	(K = (H+I) - J)	9,486
	Wild fish	(L)	1,717
	Wild fish removed in fishery	(M)	19
	Above Wells wild run estimate	(N = L-M)	1,698
Okanogan Basin	Hatchery run escapement estimate	(O = K * 0.324)	3,073
	Hatchery fish removed in fishery	(P)	899
	Hatchery fish collected for broodstock	(Q)	0
	Wild run escapement estimate	(R = N * 0.208)	353
	Wild fish removed in fishery	(S)	15
	Wild fish collected for broodstock	(T)	16
	Maximum spawning escapement estimate	(O-P-Q+R-S-T)	2,496
Methow Basin	Hatchery run escapement estimate	(U = K * 0.580)	5,502
	Hatchery fish removed in fishery	(V)	2,913
	Hatchery fish collected for broodstock	(W)	31
	Hatchery fish removed as excess	(W^r)	111
	Wild run escapement estimate	(X = N * 0.708)	1,202
	Wild fish removed in fishery	(Y)	53
	Wild fish collected for broodstock	(Z)	33
	Maximum spawning escapement estimate	($U-V-W-W^r+X-Y-Z$)	3,563

Table 8. Estimated number of steelhead caught, retained, released, and mortalities from expanded creel census above Wells Dam during the 2010-2011 fishery.

Origin/Disposition	Columbia	Methow	Okanogan	Similkameen	Total
Est. total steelhead caught	2,172	5,880	1,301	455	9,808
Est. hatchery steelhead retained (ad -)	1,096	2,813	602	268	4,779
Est. hatchery steelhead released (ad -)	0	44	0	0	44
Est. hatchery steelhead released (ad +)	696	1,953	452	121	3,222
Est. wild steelhead released	380	1,070	247	66	1,763
Est. hatchery steelhead hook mortality	35	100	23	6	164
Est. wild steelhead hook mortality	19	53	12	3	87

Based on radio-telemetry data (English et al. 2001, 2003), an estimated 58.0% of the hatchery fish passing Wells Dam were destined for the Methow Basin. After broodstock and fishery removal, an estimated 2,447 hatchery and 1,116 wild steelhead were available for natural spawning in the Methow River basin (see Table 7), resulting in a basin pHOS estimate of 0.69. The maximum estimated spawning escapement to the Okanogan River basin (N = 2,496) was greater than the range of estimated spawning escapement of 1,479 to 1,687 fish calculated from expanded redd counts in 2011 (Miller et al. 2012).

Twisp River Migration Timing

Steelhead migration timing in the Twisp River was evaluated using an in-stream PIT tag antenna array. Tagged steelhead were detected between 15 March and 19 May as they ascended the Twisp River to spawn. There were no differences in arrival timing of steelhead based on origin or salt age (Figure 2; KW ANOVA: P = 0.31).

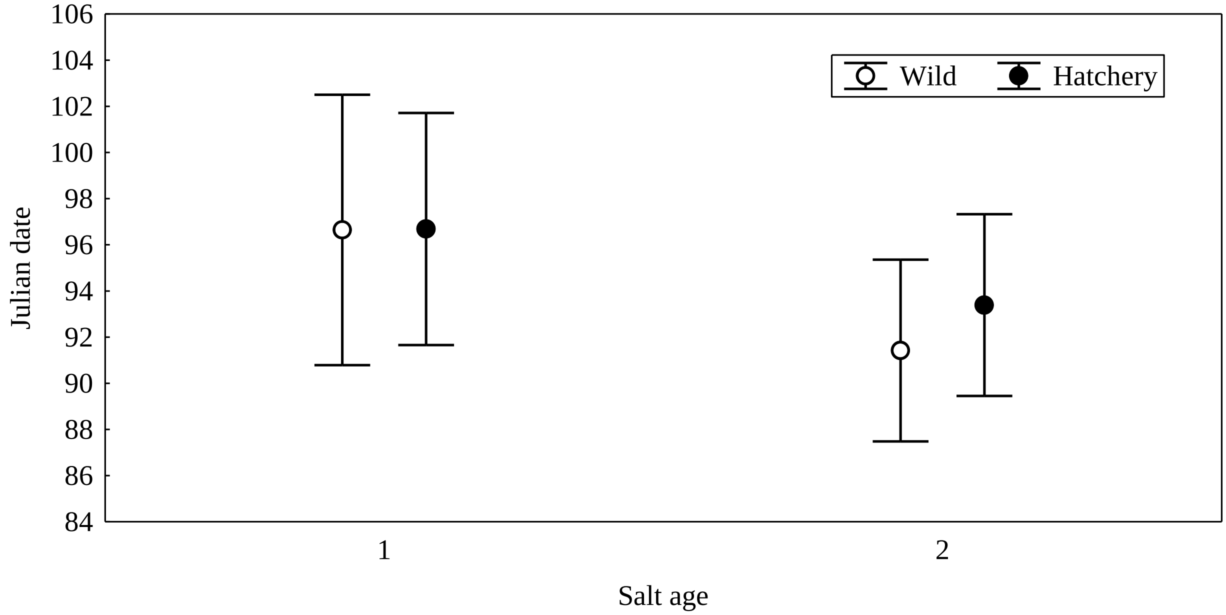

Figure 2. Mean arrival date of summer steelhead at the Twisp River in-stream PIT tag array between 15 March and 19 May. Error bars are 95% confidence intervals.

Spawn Timing and Redd Distribution

In the hatchery, some wild female steelhead (*N* = 7; 21.9% of the wild total) were injected with hormones to accelerate maturation timing and facilitate matings of wild and hatchery fish. There were no differences in female spawn timing between hatchery and wild fish that received no hormone injection (KW ANOVA multiple comparisons: *P* = 0.41). Based on scale analysis, 39.0% (*N* = 145) of the steelhead sampled at the Twisp River weir were wild (Table 9). Twenty six wild steelhead were retained for broodstock. A total of 32 females with anchor tags were observed actively spawning or holding on redds in the Twisp River, seven of which were observed below the weir. Based on unique recapture events of steelhead at the Twisp weir (N_{female} = 37, N_{male} = 38), anchor tag retention was estimated to be 86.5% for females and 97.4% for males. There were no significant differences in female spawn timing based on fish origin (Figure 3; ANCOVA: *P* = 0.12). Observed spawn timing, based on the weekly number of new redds within other index areas in the Methow Basin suggests peak spawn timing occurred mid-to-late April (Table 10). A total of 14 PIT tags were located in steelhead redds above the Twisp weir (Table 11). Recovery rate of PIT tags from female steelhead released above the Twisp weir was 11.2% (125 total females tagged in the body cavity). There were no significant differences in spatial distribution of redds based on female origin (Figure 4; ANOVA: *P* = 0.13).

Table 9. Summary of steelhead sampled at the Twisp weir. A total of 26 wild fish (13 pair) were collected for the Twisp WxW program. All remaining wild fish were released upstream from the weir. Totals exclude three male resident rainbow trout.

Origin	Sex	Mark	Month			Total	Released Upstream
			March	April	May		
Wild	F	None	13	53	20	86	73
	M	None	13	34	12	59	46
	Total		26	87	32	145	119
Hatchery	F	Ad+CWT	0	14	3	17	14
		Ad-only	3	14	9	26	18
		CWTO	0	1	1	2	0
		HFN	5	19	3	27	1
		LYE	1	6	4	11	7
		RYE	6	38	15	59	39
		Total Female	15	92	35	142	79
	M	Ad+CWT	0	3	0	3	1
		Ad-only	2	11	3	16	10
		CWTO	0	0	1	1	0
		HFN	1	16	6	23	0
		LYE	8	10	2	20	13
		RYE	3	19	0	22	14
		Total Male	14	59	12	85	38
	Total		29	151	47	227	117
Total			55	238	79	372	236

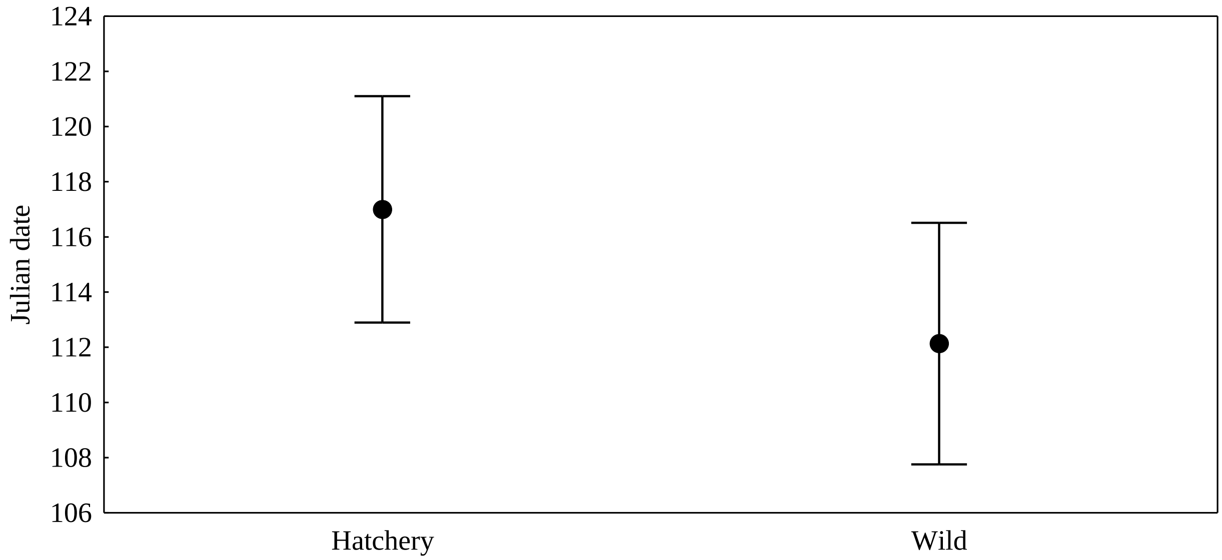

Figure 3. Spawn timing of female steelhead in the Twisp River in 2011. Error bars are 95% confidence intervals.

Table 10. Methow River mainstem index reach and selected stream weekly redd counts by subbasin and week beginning (ns = not surveyed). Few surveys were performed the week of 29 May; counts are included in week 22 May totals. Mainstem index reaches are in bold.

Stream	Survey reach	Code	March			April				May				Total
			13	20	27	3	10	17	24	1	8	15	22	
						Upper Methow subbasin								
Methow	Mazama Br.-Susp. Br.	**M11**	ns	ns	1	5	11	4	11	4	0	ns	ns	36
Methow	Susp. Br.-Weeman Br.	**M10**	ns	ns	1	2	10	9	11	4	0	ns	ns	37
E. Winters	Div. Dam -Hwy 20 Br.	EW2	ns	ns	0	0	0	ns	0	0	ns	ns	ns	0
E. Winters	Hwy 20 Br.-Conf.	EW1	ns	ns	0	0	0	ns	0	0	ns	ns	ns	0
Lost	Lost River Br.-Conf.	L1	ns	0	0	0	1	0	0	2	ns	ns	ns	3
Suspension	Entire length	Susp1	ns	ns	0	2	5	4	7	4	3	ns	1	26
Little Susp.	Entire length	Lsusp1	ns	ns	0	0	1	0	0	0	2	ns	ns	3
Hancock	Spring - Wolf Cr. Rd.	HA2	ns	ns	ns	1	0	ns	1	ns	0	ns	ns	2
Hancock	Wolf Cr. Rd. - Conf.	HA1	ns	ns	ns	0	0	ns	4	ns	0	ns	ns	4
MH outfall	Entire length	MH1	0	0	0	2	4	1	1	0	0	2	2	12
WNFH outfall	Entire length	WN1	0	0	1	4	7	3	2	2	2	3	2	26
	Subbasin subtotal		0	0	3	16	39	21	37	16	7	5	5	149
						Lower Methow subbasin								
Methow	Carlton-Up. Burma Br.	**M2**	0	0	0	2	9	7	2	3	ns	ns	ns	23
Beaver	Hwy 20-Confluence	BV1	0	0	5	1	4	2	0	ns	ns	ns	ns	12
	Subbasin subtotal		0	0	5	3	13	9	2	3	ns	ns	ns	35
						Twisp subbasin								
Twisp	B'milk Br.-Lit. Br. Cr.	**T5**	0	0	0	0	8	6	9	6	3	ns	ns	32
Twisp	Little Br. Cr.-Weir	**T4**	0	0	0	0	0	11	2	0	ns	ns	ns	13
Little Bridge	Lower Br. - Conf.	LBC1	ns	ns	ns	ns	0	0	ns	ns	ns	ns	ns	0
	Subbasin subtotal		0	0	0	0	8	17	11	6	3	ns	ns	45
						Chewuch subbasin								
Chewuch	8 Mile Cr.-Boulder Cr.	**C4**	0	0	1	2	13	4	10	3	ns	ns	ns	33
Eightmile	Bridge - Confluence	EM1	0	0	0	0	0	ns	ns	ns	ns	ns	ns	1
	Subbasin subtotal		0	0	1	2	13	4	10	3	ns	ns	ns	33

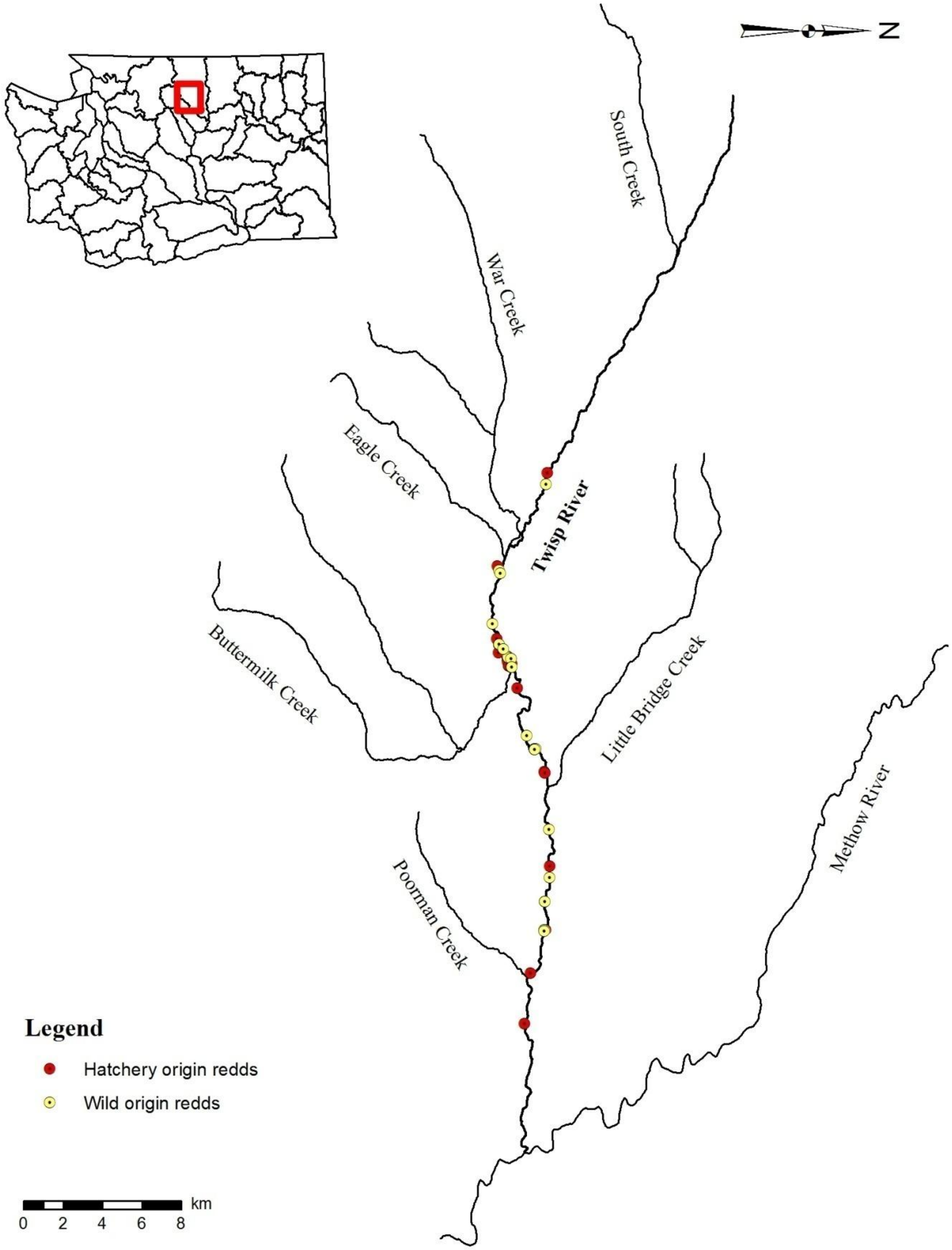

Figure 4. Spatial distribution of steelhead redds in the Twisp River subbasin based on PIT tag detections and anchor tag observations during 2011 surveys.

Table 11. Detection of PIT tags in redds located above the Twisp weir in 2011.

Stream	Reaches	Hatchery mark				Wild	Total	Total redds	Redds scanned	% PITs
		Ad+CWT	Ad-only	LYE	RYE					
Twisp River	T9	0	0	0	0	0	0	0	0	0.0
	T8	0	0	0	0	0	0	0	0	0.0
	T7	0	0	0	0	0	0	8	1	0.0
	T6	0	1	0	6	2	9	47	44	20.5
	T5	0	0	1	2	1	4	32	30	13.3
	T4	0	0	0	0	1	1	13	11	9.1
L. Br. Creek	LBC3-1	0	0	0	0	0	0	0	0	0.0
War Creek	WR1	0	0	0	0	0	0	0	0	0.0
Eagle Creek	EA1	0	0	0	0	0	0	0	0	0.0
B'milk Creek	BM2-1	0	0	0	0	0	0	1	0	0.0
South Creek	SO1	0	0	0	0	0	0	0	0	0.0
Total		0	1	1	8	4	14	101	86	16.3

Based on expanded redd counts, an estimated 854 steelhead redds were created in the Methow River basin in 2011 between 3 March and 1 June (Figures 5-8, Tables 12-15). The greatest number of redds was found in the upper Methow River subbasin (N = 383). Redd density within mainstem index areas (grouped by subbasin) was greatest in the Chewuch and Upper Methow subbasins (8.9 and 7.7 per km, respectively). Based on the male-to-female ratio of hatchery (0.56) and wild (0.50) steelhead calculated during broodstock collection activities and the assumption that a female constructed only one redd, the total redd count, including all subbasins and tributaries, represents 1,324 fish, or 35.8% of the maximum estimated spawning escapement to the Methow River basin of 3,563 fish. Historic redd counts for each of the subbasins surveyed are listed in Appendices B1-B4.

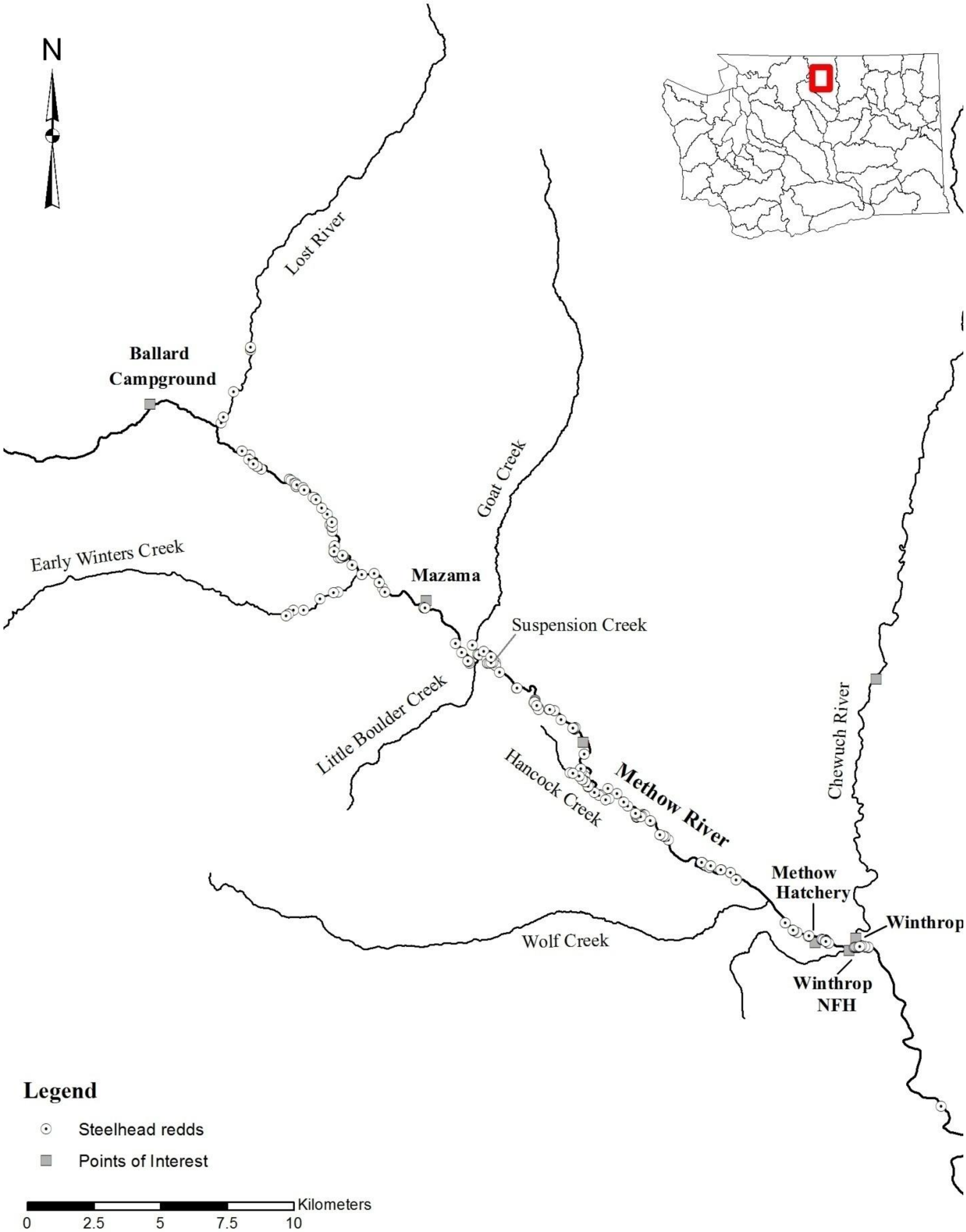

Figure 5. Spatial distribution of observed steelhead redds in the upper Methow River subbasin based on GPS waypoints collected during 2011 surveys. Does not include expanded redds.

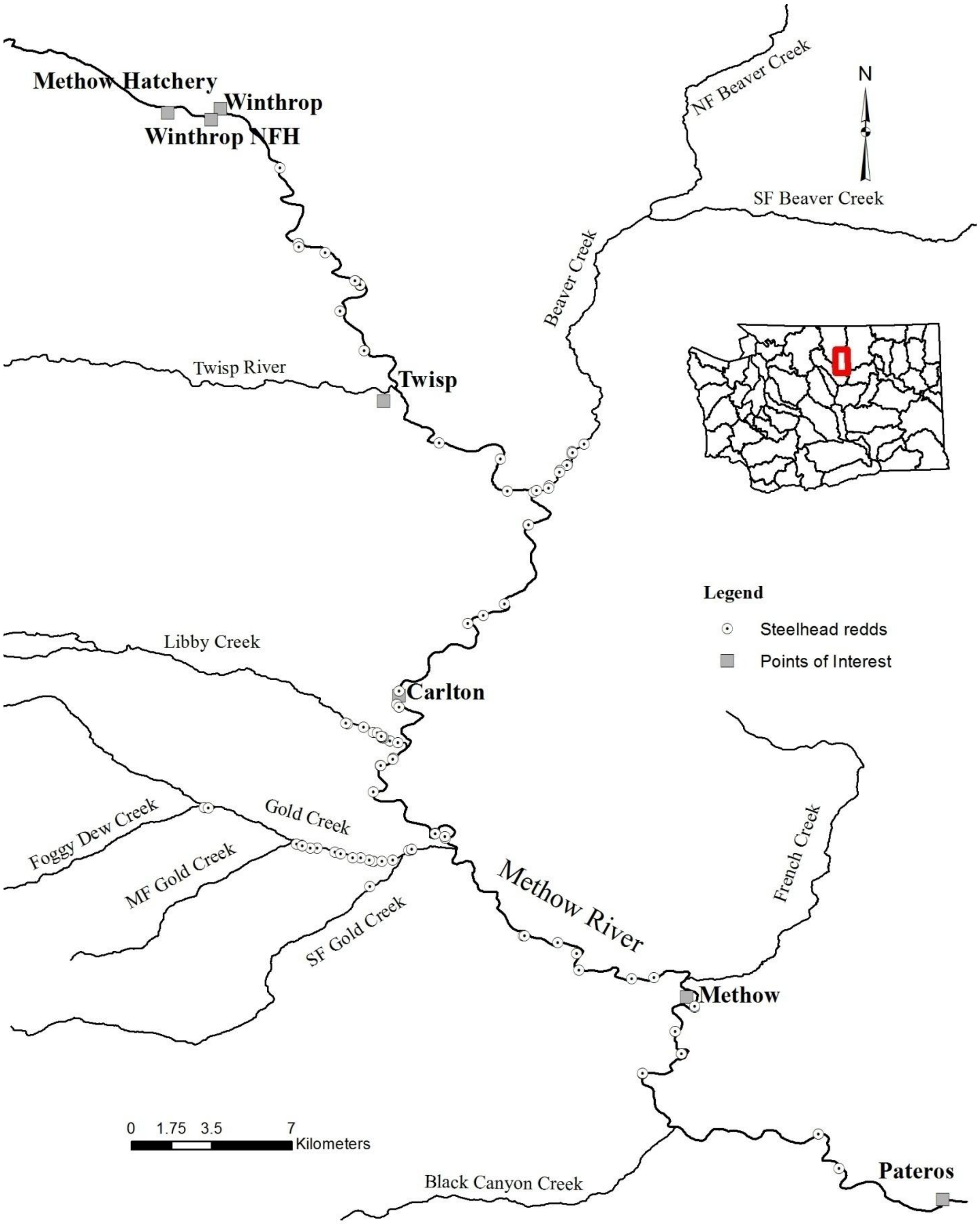

Figure 6. Spatial distribution of observed steelhead redds in the lower Methow River subbasin based on GPS waypoints collected during 2011 surveys. Does not include expanded redds.

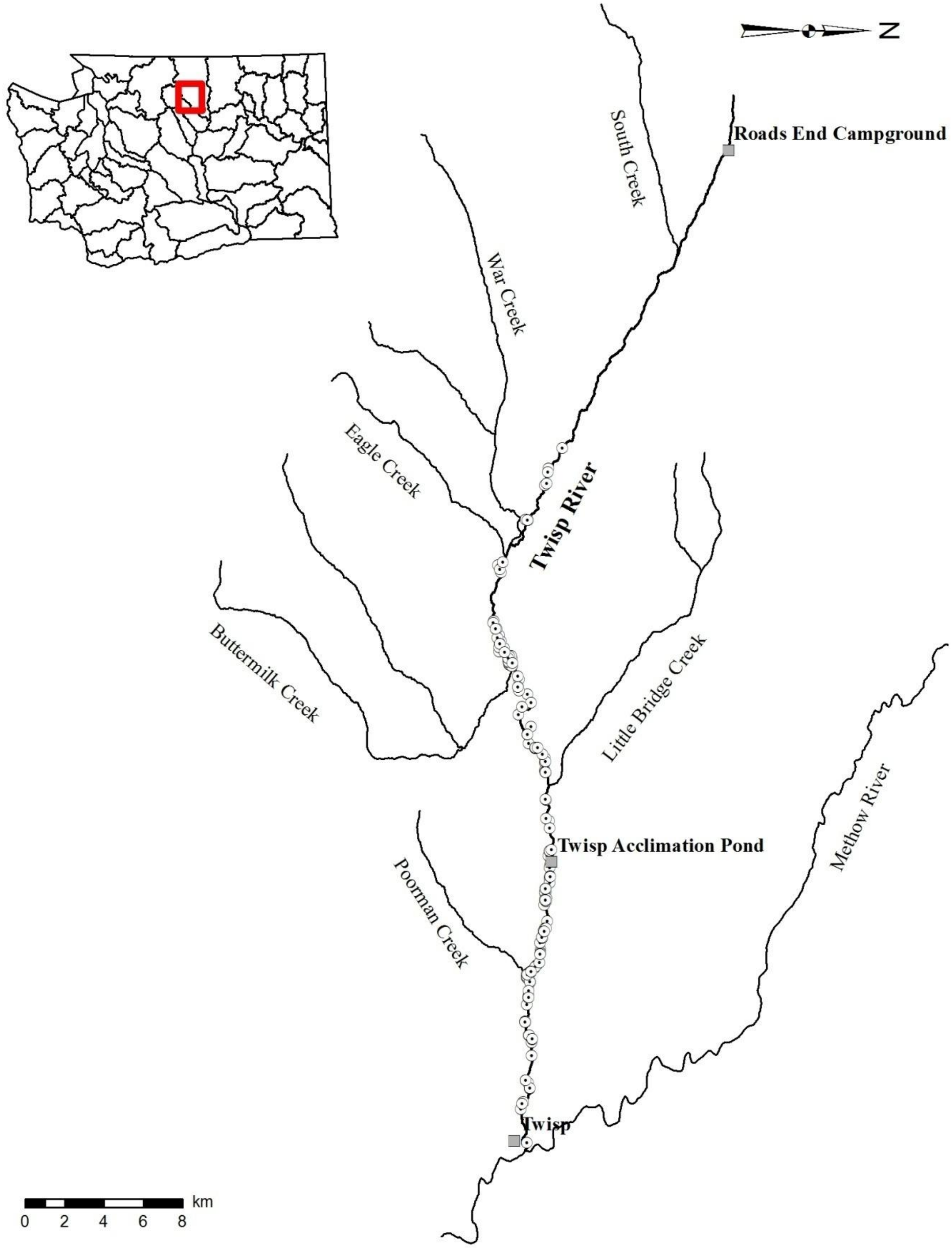

Figure 7. Spatial distribution of observed steelhead redds in the Twisp River subbasin based on GPS waypoints collected during 2011 surveys. Does not include expanded redds.

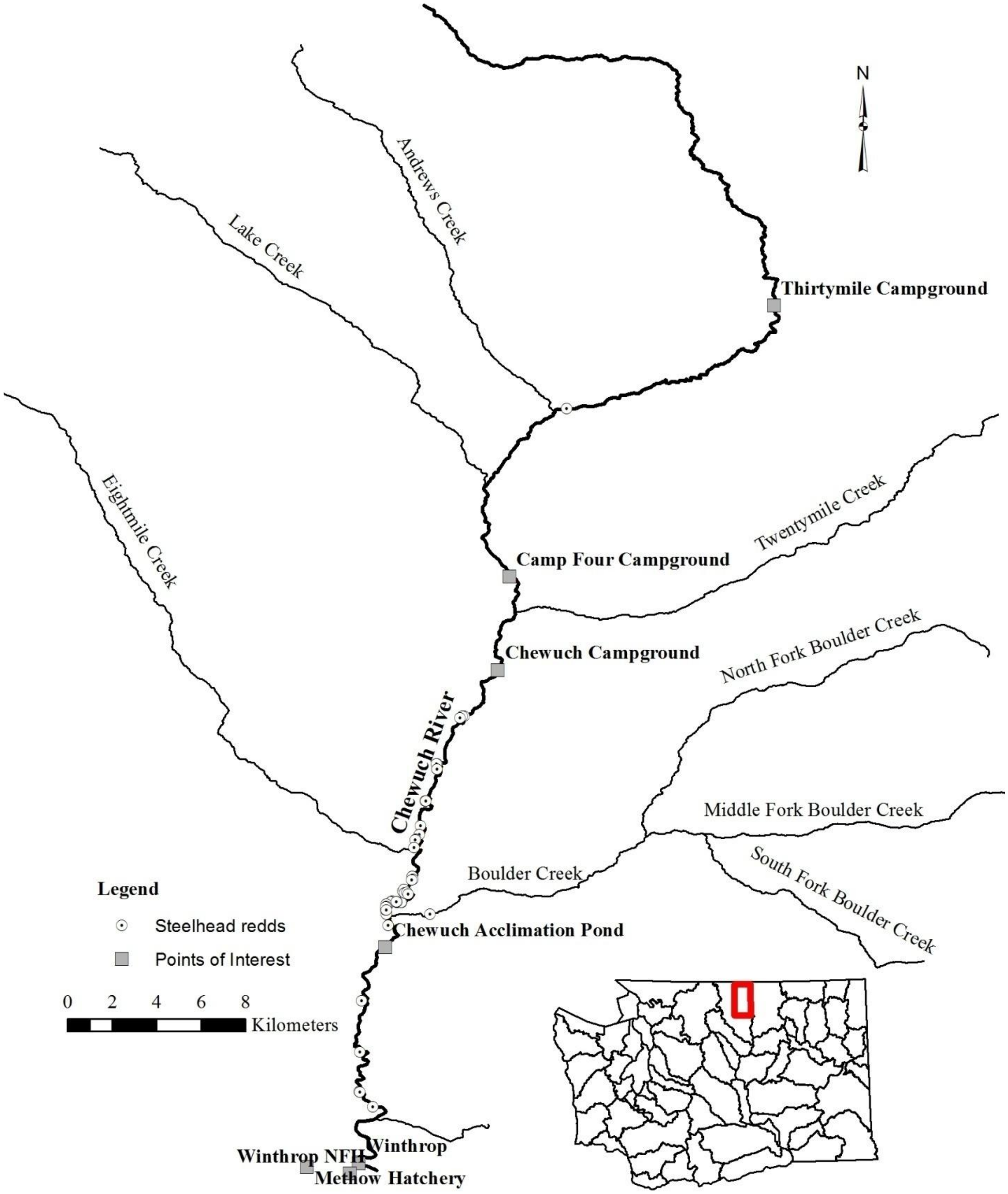

Figure 8. Spatial distribution of observed steelhead redds in the Chewuch River subbasin based on GPS waypoints collected during 2011 surveys. Does not include expanded redds.

Table 12. Upper Methow River mainstem and tributary expanded redd counts by section number and survey year. Rotating panel creeks are designated RP (ns = not surveyed). Expand rates for non-index reaches are based on visible:total redd ratios during peak counts.

Stream reach	Code	Length (km)	2008	2009	2010	2011 Expansion Rate	2011 Redds
Upper Methow River mainstem							
Ballard Campground - Lost River	M15	4.0	6	5	0		0
Lost River - Gate Creek	M14	4.8	25	16	65	0.64	27
Gate Creek - Early Winters Creek	M13	4.2	19	11	65	0.64	69
Early Winters Creek - Mazama Bridge	M12	3.2	25	8	27	0.64	19
Mazama Bridge - Suspension Bridge	M11	4.0	27	5	27	index	36
Suspension Bridge - Weeman Bridge	M10	5.3	21	25	55	index	36
Weeman Bridge - Along Highway 20	M9	9.0	34	94	123	0.58	91
Along Highway 20 - Wolf Creek	M8	2.2	1	0	0	0.58	3
Wolf Creek - Foghorn Dam	M7	1.8	10	10	15	0.58	10
Foghorn Dam - Winthrop Bridge	M6	2.7	10	2	6	0.58	3
Upper Methow River mainstem total		41.2	178	176	383		294
Upper Methow River tributaries							
Lost River (Sunset Creek - Eureka Creek)	L3	4.6	ns	ns	2	- -	ns
Lost River (Eureka Creek - Lost River Bridge)	L2	5.8	ns	11	12		5
Lost River (Lost River Bridge - Confluence)	L1	0.8	3	6	5		3
Early Winters Cr. (Klipchuck C.G. - Bridge)	EW5	1.4	ns	0	0	- -	ns
Early Winters Cr. (Bridge - Hwy 20)	EW4	2.1	ns	2	1	- -	ns
Early Winters Cr. (Highway 20 - Div. Dam)	EW3	2.9	0	0	2		7
Early Winters Cr. (Div. Dam - Hwy 20 Br.)	EW2	0.3	0	2	1		0
Early Winters Cr. (Hwy 20 Br. - Confluence)	EW1	0.5	0	0	0		0
Suspension Creek (Entire length)	Susp1	0.3	37	32	43		26
Little Suspension Creek (Entire length)	Lsusp1	0.3	4	1	11		3
Methow Hatchery Outfall (Entire length)	MH1	0.4	9	12	6		12
Winthrop NFH Outfall (Entire length)	WN1	1.0	27	37	24		26
Hancock Creek (Kumm Rd. - Wolf Cr. Rd.)	HA2	0.9	9	7	12		2
Hancock Creek (Wolf Cr. Rd. - Conf.)	HA1	0.2	4	1	2		4
Gate Creek (Culvert – Confluence)	GA1	0.3	0[a]	0[a]	1		0
RP-Wolf Creek (Rd 5505 access - footbridge)	W2	1.9	ns	0	0		0
RP-Wolf Creek (footbridge - Confluence)	W1	0.5	0	0	0		0
RP-Little Boulder Creek (Hwy 20 – Conf.)	LBO1	0.2	0	0	0		0
RP-Goat Creek (FR 52 Bridge - Confluence)	GT1	2.2	0	0	0		1
Upper Methow River tributary total		26.6	93	111	122		89

[a] Historically surveyed as part of M13.

Table 13. Lower Methow River mainstem and tributary expanded redd counts by section number. Rotating panel creeks are designated RP (ns = not surveyed). Expand rates for non-index reaches are based on visible:total redd ratios during peak counts. Expand rates for rotating panel reaches are based on the number of redds per km in surveyed reaches.

Stream reach	Code	Length (km)	2008	2009	2010	2011	
						Expansion Rate	Redds
Lower Methow River mainstem							
Winthrop Bridge - MVID Dam	M5	8.0	0	23	24	0.57	11
MVID Dam - Twisp Confluence	M4	7.2	0	23	29	0.57	12
Twisp Confluence - Carlton	M3	21.1	5	24	132	0.57	16
Carlton - Upper Burma Bridge	M2	23.7	27	15	39	index	23
Upper Burma Bridge - Mouth	M1	20.1	86	17	180	0.57	21
Lower Methow River mainstem total		80.1	118	102	404		83
Lower Methow River tributaries							
Beaver Creek (Lester Rd. Br. - Balky Hill Rd.)	BV3	5.0	0	0	ns	- -	ns
Beaver Creek (Balky Hill Rd. - Highway 20)	BV2	5.8	15	23	ns	- -	ns
Beaver Creek (Highway 20 - Confluence)	BV1	3.4	38	26	17	index	12
RP-Gold Cr. Upper N.F. (10.0 rkm – 6.3 rkm)[a]	GDN4	3.7[a]	7	0	4	3.3	12
RP-Gold Cr. Mid. N.F. (6.3 rkm - N.F. Br.)	GDN3	0.9	1	7	8		3
RP-Gold Cr. Mid. N.F. (N.F. Br. - W. Pines)	GDN2	1.5	0	6	4		5
RP-Gold Cr. Lower N.F. (W. Pines - 2nd Br.)	GDN1	1.4	1	5	14		6
RP-Gold Cr. S.F. (1st Bridge - 1.7 rkm)	GDS3	0.7	0[b]	5	8		1
RP-Gold Cr. S.F. (1.7 rkm - 0.6 rkm)	GDS2	1.1	9	4	13		0
RP-Gold Cr. S.F. (0.6 rkm - Confluence)	GDS1	0.6	0[b]	1	1		0
RP-Gold Cr. Mainstem (2nd Br. - Private Land)	GDM2	1.2	11	15	14		4
RP-Gold Cr. Mainstem (Private Land - Conf.)	GDM1	1.3	12	16	15	3.3	4
RP-Foggy Dew Creek (FR 200 - Confluence)	FD1	1.8	2	2	6		2
RP-Black Canyon Cr. (1st Culvert - 0.8 rkm)	BC2	1.0	2	2	4	3.0	3
RP-Black Canyon Cr. (0.8 rkm - Confluence)	BC1	0.8	2	0	1	3.0	2
RP-Libby Creek (Hornet Draw - L.P. Land)	LB5	4.6	ns	ns	8	3.0	14
RP-Libby Creek (Lower Public Land)	LB4	1.0	2	ns[c]	8		3
RP-Libby Creek (L.P. Land - Realty Land)	LB3	1.1	2	ns[c]	14		3
RP-Libby Creek (Realty Land)	LB2	0.3	1	0	7		3
RP-Libby Creek (Realty Land - Confluence)	LB1	1.0	2	5	9		10
Lower Methow tributary total		38.2	107	117	155		87

[a] Distance surveyed since 2009.
[b] No expansion due to possible unsuitable habitat.
[c] Beaver dam considered as barrier to upstream migration in 2009.

Table 14. Twisp River mainstem and tributary expanded redd counts by section number and survey year. Rotating panel creeks are designated RP (ns = not surveyed).

Stream reach	Code	Length (km)	2008	2009	2010	2011 Expansion Rate	2011 Redds
Twisp River mainstem							
Road's End C.G. - South Creek Bridge	T10	4.6	ns	0	0	- -	ns
South Creek Bridge - Poplar Flats C.G.	T9	3.2	ns	0	0	index	0
Poplar Flats C.G. - Mystery Bridge	T8	3.2	0	0	0	index	0
Mystery Bridge - War Creek Bridge	T7	6.9	6	22	6	index	8
War Creek Bridge - Buttermilk Bridge	T6	7.4	42	109	79	index	47
Buttermilk Bridge - Little Bridge Creek	T5	5.9	59	71	48	index	32
Little Bridge Creek - Twisp weir	T4	3.8	30	22	27	index	13
Twisp weir - Upper Poorman Bridge	T3	3.5	18	47	78	index	48
Up. Poorman Br. - Lower Poorman Br.	T2	5.0	16	47	54	index	34
Lower Poorman Bridge - Confluence	T1	2.9	6	10	27	index	4
Twisp River mainstem total		46.4	177	328	319		186
Twisp River tributaries							
Little Br. Cr. (Road's End – Vetch Cr.)	LBC4	1.3	ns	ns	0	- -	ns
Little Br. Cr. (Vetch Cr. – 2nd Culvert)	LBC3	3.0	0	0	1		0
Little Br. Cr. (2nd Culvert – 1st Culvert)	LBC2	2.4	2	1	3		0
Little Br. Cr. (1st Culvert - Confluence)	LBC1	2.4	2	17	4		0
MSRF pond outfalls[1]	MSRF1	0.1	0	0	1		3
RP-War Creek (log jam barrier - Conf.)	WR1	0.5	0	2	0		0
RP-Eagle Creek (Rd 4430 - Confluence)	EA1	0.3	0	2	0		0
RP-Buttermilk Cr. (Fork - Cattle Guard)	BM2	2.1	1	0	3		0
RP-Buttermilk Cr. (Cattle Guard - Conf.)	BM1	2.0	0	2	1		1
RP-South Creek (Falls - Confluence)	SO1	0.6	0	0	0		0
Twisp River tributary total		14.7	5	24	13		4

[1] Methow Salmon Recovery Foundation pond outfall.

Table 15. Chewuch River mainstem and tributary expanded redd counts by section number and survey year. Rotating panel creeks are designated RP (ns = not surveyed). Expand rates for non-index reaches are based on visible to non-visible redd ratios during peak counts. Expand rates for rotating panel reaches are based on the number of redds per km in surveyed reaches.

Stream reach	Code	Length (km)	2008	2009	2010	2011 Expansion Rate	2011 Redds
Chewuch River mainstem							
Chewuch Falls - 30 Mile Bridge	C13	4.2	ns	0	0	- -	ns
30 Mile Bridge - Road Side Camp	C12	4.6	ns	4	19		0
Road Side Camp - Andrews Creek	C11	4.3	ns	2	9	0.55	2
Andrews Creek - Lake Creek	C10	4.0	ns	4	13		0
Lake Creek - Buck Creek	C9	2.2	ns	0	ns		0
Buck Creek - Camp 4 C.G.	C8	2.4	ns	34	60		0
Camp 4 C.G. - Chewuch Campground	C7	5.1	13	9	32	0.55	18
Chewuch C.G. - Falls Creek C.G.	C6	5.8	30	30	87	0.39	20
Falls Creek C.G. - Eightmile Creek	C5	3.7	22	11	51	0.39	18
Eightmile Creek - Boulder Creek	C4	3.7	55	28	34	index	33
Boulder Creek - Chewuch Bridge	C3	1.8	4	2	0	0.39	3
Chewuch Bridge - WDFW Land	C2	7.5	37	24	15	0.55	7
WDFW Land - Confluence	C1	5.1	25	7	2	0.55	2
Chewuch River mainstem total		54.4	186	155	322		103
Chewuch River tributaries							
Eightmile Creek (300m abv. div. - Bridge)	EM2	0.3	3	0	0		0
Eightmile Creek (Bridge - Conf.)	EM1	0.5	0	2	1		0
Cub Creek (W. Chewuch Rd. - Conf.)	CU1	1.0	ns	ns	1	- -	ns
RP-Boulder Creek (Falls - 1st Bridge)	BD2	0.8	0	1	0		1
RP-Boulder Creek (1st Bridge - Conf.)	BD1	0.8	0	0	0		0
RP-Lake Creek (Black Lk. - 1st Bridge)	LK2	10.1	0	13	0	0.63	6
RP-Lake Creek (1st Bridge – Conf.)	LK1	0.8	0	1	0		0
RP-Andrews Creek (L. And. Cr. – 1st Br.)	AN2	0.3	ns	0	ns	0.63	0
RP-Andrews Creek (1st Bridge - Conf.)	AN1	0.2	0	0	0	0.63	0
RP-Twentymile Creek (Falls - FR 5010)	TW2	0.9	0	0	0	0.63	1
RP-Twentymile Creek (FR 5010 - Conf.)	TW1	0.1	0	0	0	0.63	0
Chewuch River tributary total		15.8	3	17	2		8

Based on biological sampling of the 2011 broodstock during trapping, the majority of both hatchery and wild-origin steelhead were 2-salt fish (66.5% and 59.0%, respectively). Using expanded redd counts by tributary, and the mean fecundity from Wells Hatchery broodstock by salt age and origin, an estimated 5,339,208 eggs were deposited in the Methow Basin (Table 16; see Chapter 1 for historic fecundities).

Table 16. Expanded 2011 steelhead redds and estimated egg deposition in the Methow Basin based on 2011 Wells Hatchery broodstock mean fecundities and origin-by-age proportions (mean; %): hatchery 1-salt (4,928; 30.9), hatchery 2-salt (6,905; 50.3), wild 1-salt (5,049; 3.6), wild 2-salt (7,073; 15.2).

Area	Exp. Redds	% of Redds	Estimated Egg Deposition				
			2007	2008	2009	2010	2011
Upper Methow	383	44.9%	1,751,701	1,605,675	1,750,700	2,942,635	2,394,516
Chewuch	111	13.0%	704,766	1,119,825	1,049,200	1,887,948	693,972
Twisp	190	22.2%	418,774	1,078,350	2,147,200	1,934,564	1,187,880
Lower Methow	170	19.9%	903,939	1,333,125	1,335,900	3,257,293	1,062,840
Methow Basin	854	100.0%	3,779,180	5,136,975	6,283,000	10,022,440	5,339,208

Natural Replacement Rate (NRR)

A total of 842 steelhead were trapped and sampled at Wells Dam, of which 120 were determined to be wild. The total number of wild fish observed on the first trapping day of the week was expanded to run-at-large weekly ladder counts to estimate the total number of wild fish returning to Wells Dam (N = 2,045). Expanded return at age was based on scale analysis of wild fish sampled during trapping, resulting in an estimated total of 1,448 wild steelhead recruits returning to the Methow Basin prior to broodstock collection, estimated fallback, and Columbia River fishery-related mortality (Table 18). The HRR of hatchery steelhead was significantly greater than the NRR for brood years 1996-2005 (Mann-Whitney U test: $P < 0.001$; see Chapter 1 for HRR values). The NRR of the Methow Basin steelhead population (mean = 0.26 recruits per spawner) was below replacement (i.e., <1.0) in each of the ten brood years examined (see Table 19). A plot of NRR verses spawning escapement suggests that the Methow Basin is consistently over-escaped and with clear density dependent effects (Figure 9).

Table 18. Wild steelhead sampling at Wells Hatchery and expanded age composition by brood year of Methow Basin recruits (70.8% of wild returns to Wells Dam). Brood year totals exclude the estimated number of double counted fish from 2009 through 2011.

Brood Year	Wild Fish (at Wells Dam) Total	Sampled	Sample Rate	Expanded Return at Age (Methow Basin) 1.1	1.2, 2.1	1.3, 3.1, 2.2	2.3, 3.2	Total
2011	2,045	120	0.0587	13	642	717	76	1,448
2010	2,070	115	0.0556	59	762	601	44	1,466
2009	1,217	127	0.1044	72	471	283	36	862
2008	1,283	132	0.1029	15	679	192	22	908
2007	631	52	0.0824	0	214	204	29	447
2006	765	124	0.1621	6	159	332	45	542
2005	861	104	0.1208	10	276	324	0	610
2004	1,161	116	0.0999	14	642	159	7	822
2003	821	27	0.0329	0	0	511	70	581
2002	900	18	0.0200	35	212	319	71	637
2001	553	26	0.0470	15	302	75	0	392
2000	435	41	0.0943	24	166	102	16	308
1999	242	29	0.1198	7	55	109	0	171

Table 19. Run escapement and NRR of Methow Basin steelhead populations calculated from broodstock sampling at Wells Hatchery with corresponding HRR values from Wells Hatchery returns. Escapement values and recruits produced were derived from radio-telemetry data (English et al. 2001, 2003).

Parent Brood	Methow Run Escapement	Brood at Age 1.1	1.2, 2.1	1.3, 3.1, 2.2	2.3, 3.2	Adults Produced	NRR
1996	566	1999	2000	2001	2002	319	0.5636
1997	2,443	2000	2001	2002	2003	715	0.2927
1998	2,378	2001	2002	2003	2004	745	0.3133
1999	1,025	2002	2003	2004	2005	194	0.1893
2000	2,085	2003	2004	2005	2006	1,011	0.4849
2001	3,763	2004	2005	2006	2007	651	0.1730
2002	10,987	2005	2006	2007	2008	395	0.0360
2003	5,064	2006	2007	2008	2009	448	0.0885
2004	5,472	2007	2008	2009	2010	1,006	0.1838
2005	4,698	2008	2009	2010	2011	1,163	0.2476

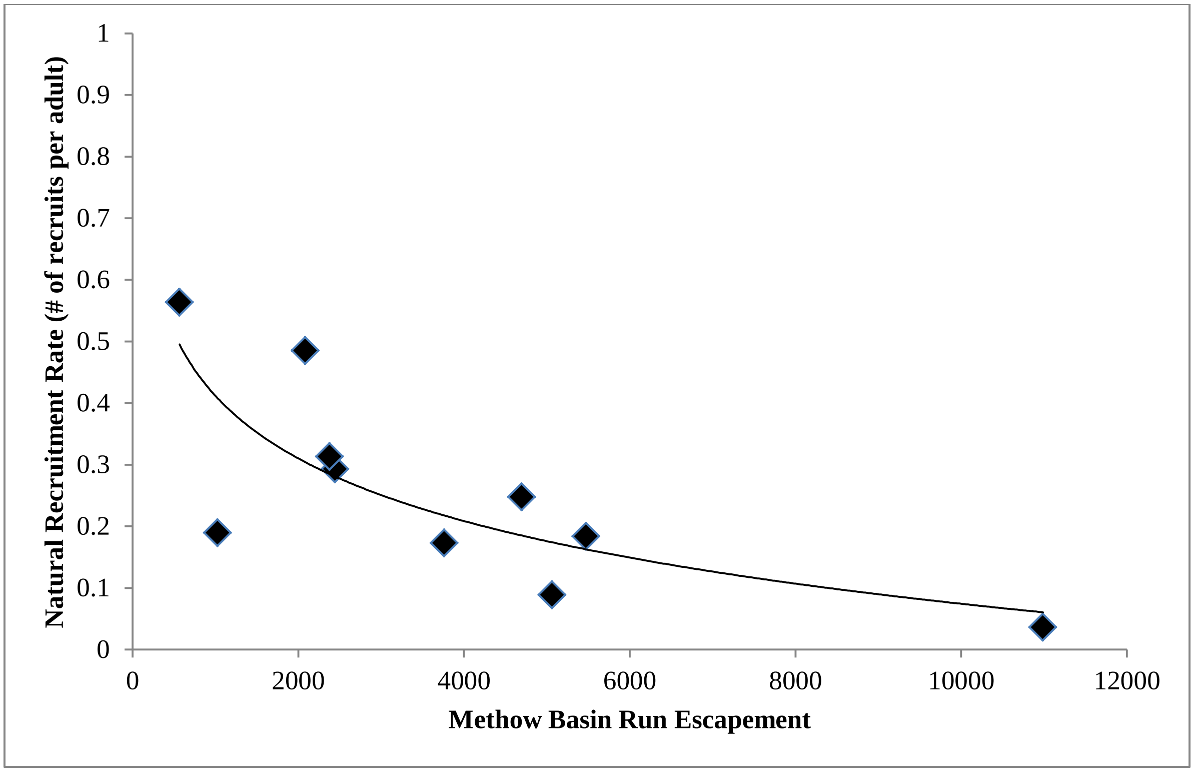

Figure 9. Methow Basin steelhead run escapement verses natural replacement rate (NRR) for parent brood years 1996-2005.

Straying of Out-of-basin Hatchery Steelhead

Straying of Wells Hatchery steelhead could not be determined for recent broods because no release-site specific mark (i.e., PIT tag) was applied that would allow straying to be estimated. Tagging for other studies conducted with Wells Hatchery fish from the 2002-2004 broods indicated that straying to non-target locations was less than 1%, well below the 5% standard (Snow et al., 2011), but no PIT tagging was conducted on the 2005-2008 broods. During the 2011 brood spawning period, the number of PIT-tagged out of-basin hatchery origin steelhead (fish that originated outside of the Methow Basin) detected at instream PIT tag antenna arrays in Methow Basin spawning tributaries was minimal with only two tagged fish detected in Gold Creek. However, after expanding these fish by tag rates, they account for 39.7% of the estimated escapement in the Gold Creek subbasin; a rate similar to that estimated in Gold Creek in 2010 (43.0%). These data should be considered minimum values for the Methow Basin because spawning may occur in the mainstem where few PIT antenna arrays exist or within tributaries that are not monitored or experience poor detection efficiency due to high flow or equipment malfunction during the spawning period.

Discussion

In 2011, spawning ground surveys for steelhead were conducted every four days in all mainstem index reaches as well as all reaches in the Twisp subbasin. Historically, these areas were surveyed weekly. The main impetus for increasing survey frequency was to increase the accuracy and precision of surveys by accounting for all redds created in a rapidly changing environment. Since the detectable life of steelhead redds may be less than a week during spring freshets (WDFW, unpublished data), surveying reaches every four days may increase the total number of unique redds counted. However, data collected in 2011 suggests that surveying index reaches every four days did not increase redd-based spawning escapement as a proportion of estimated run escapement. Spawning escapement as a function of the proportion of run escapement was slightly lower in 2011 (35.8%) than the most recent five-year mean (2006-2010 mean = 39.5%). An evaluation of surveyor efficiency is scheduled to begin in the Methow Basin during the spring of 2012. The results from this study will provide estimates of variance for overall spawning escapement and relate redd count data to environmental covariates.

Retention of ad-clipped hatchery fish during the 2010-2011 upper Columbia River sport fishery was estimated at 4,943 fish. Within the Methow Basin, a total of 2,913 hatchery fish were removed during the fishery, reducing the hatchery component of the estimated population by 47.1%. The conservation fishery is an important tool in managing adult returns comprised primarily of hatchery fish. Return rates of fish propagated from Wells Hatchery averaged ~25 recruits per adult in the last decade. Hatchery fish may exhibit lower reproductive success than wild fish, potentially due to inbreeding depression, domestication selection, or environmental effects (Araki et al. 2008; Berejekian and Ford 2004). Consequently, limiting the number of hatchery fish on spawning grounds, especially during years when adult returns greatly exceed spawning escapement goals, should aid in the recovery of wild steelhead in the Methow Basin. Beginning in 2010 and 2011, escapement of hatchery fish at the Twisp weir was reduced substantially (2010: 60.2%, 2011: 47.6%) to address this concept. Additional excess hatchery fish could be removed from other collection sites in the Upper Columbia (e.g., Wells Hatchery, Wells Dam, Winthrop NFH, and Methow Hatchery).

In 2011, spawn timing and distribution of hatchery and wild spawners in the Twisp River was estimated through a combination of anchor tag observations and PIT tag detections during spawner surveys. Prior to 2009, comparisons of spawn timing in the natural environment was lacking; fish origin could not be determined visually since many hatchery fish were not adipose fin-clipped. Though survey frequency in all Twisp subbasin reaches increased roughly two-fold in 2011, the percent of anchor-tagged female steelhead observed actively spawning or holding on redds (21.2%) was similar to that in 2010 (21.8%). This may indicate that the majority of spawning activity occurred when surveyors were not present (i.e., dawn and dusk), or that survey frequency was not increased enough to account for a very short redd-completion time. Only 14 PIT tags from fish sampled at the Twisp River weir were detected in redds in 2011 (125 females tagged; 86 redds scanned). As a function of both females tagged and redds scanned, recovery rate of PIT tags deposited in redds was lower in 2011 (11.2% and 16.3%, respectively) than in 2010 (21.3% and 18.5%, respectively). Lower tag detection could be a combination of multiple factors including, but not limited to absorption of the tag in the abdominal wall, premature loss of tag, tag collision with tags deposited in the substrate from previous spawners, creation of multiple redds by females, and detection efficiency of both the equipment and personnel.

Current methodology for estimating redd-based spawning escapement relies on the untested assumption that each female steelhead constructs only one redd. A total of 101 redds were found upstream of the Twisp River weir in 2011. The total number of female steelhead sampled and released above the Twisp weir was 151 fish. An estimated 21.9% of the female steelhead with colored-anchor-tags observed on redds were located below the weir. Based on these data, an estimated 33 females sampled at the Twisp weir may have spawned below the weir. Nine additional females sampled at the Twisp weir were detected at the temporary antenna array in Little Bridge Creek and one female was detected at the Twisp River array above South Creek (i.e., out of the survey area). Although surveys were not conducted in these areas during periods of high river discharge, if all ten females detected in Little Bridge Creek and above South Creek spawned in those locations, the total number of redds above the Twisp weir would be 111. We estimate that weir efficiency in 2011 was likely 100%, and after accounting for fallback, an estimated 118 females may have spawned above the weir, resulting in an estimated 1.06 redds per female.

Spawn timing and distribution of resident trout in the Methow Basin remains largely undocumented. Studies have found that westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) spawn at peak discharge or when flows subside (Behnke 1992, Schmetterling 2000). In addition to resident fish already present above the weir, we sampled a total of 20 unique female cutthroat trout and released them above the Twisp weir in 2011. Despite this, surveyors only recorded two cutthroat spawning in 2011, one by visual observation of a fish on a redd, and one via detection of a PIT tag at a temporary PIT antenna on the Twisp River above South Creek. Further, two *Oncorhynchus mykiss* collected 13 July, 2011 in Buttermilk Creek (a tributary to the Twisp River) expelled eggs during sampling. Based on length (184 and 235 mm), these fish would likely have been classified as juvenile steelhead parr. Resident trout or juvenile steelhead are often observed on redds with adult steelhead in small streams throughout the Methow Basin. Although these data are limited, spawning by resident trout in the Twisp River basin appears to occur primarily on the descending limb of the hydrograph after most steelhead have spawned, or in headwater locations where steelhead spawning is limited.

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Appendix A. Summer steelhead run escapement, broodstock collection, fishery-related mortality, and maximum spawning escapement estimates at and above Wells Dam. Methow and Okanogan River escapements are based on radio-telemetry data (English et al. 2001, 2003), which account for 90.4% and 91.6% of the hatchery and wild escapement upstream of Wells Dam, respectively. Total count at Wells Dam includes passage from 15 June (run year) to 14 June (spawn year) for brood years 2003 to present; total Wells Dam count for previous years includes the total reported for the run year (prior to spawn). Ladder counts are based on DCPUD raw data for brood years 2000-2011; data for brood year 1999 was based on data from FPC.org. For brood years 2007-2011, proportion of hatchery and wild fish at Wells Dam was estimated through run-at-large sampling; in previous years, proportions were calculated from broodstock trapping records. Estimated double counts and fallback were based on expanded PIT tag interrogation data. Estimated fishery mortality in the Columbia River, brood year 2004, includes fishery-related mortality in the Wells Dam tailrace; all other fishery mortality in the Columbia River occurred in the section between Wells Dam and Chief Joseph Dam. Estimated fishery mortality for hatchery fish in the Methow Basin includes hatchery fish removed as excess.

Brood year	Total count at Wells Dam based on trapping data and ladder counts from DCPUD		Wells Hatchery broodstock retained		Estimated double counts at Wells Dam		Estimated fallback below Wells Dam		Estimated fishery mortality		Estimated run escapement (using radio-telemetry data)				Estimated fishery mortality				Local broodstock retained				Estimated maximum spawning escapement (using radio-telemetry data)			
									Columbia		Methow		Okanogan		Met.		Okan.		Met.		Okan.		Met.		Okan.	
	H	W	H	W	H	W	H	W	H	W	H	W	H	W	H	W	H	W	H	W	H	W	H	W	H	W
1999	2,943	242	383	29	- -	- -	- -	- -	- -	- -	1,485	151	829	44	- -	- -	- -	- -	- -	- -	- -	- -	1,485	151	829	44
2000	3,448	435	334	41	- -	- -	- -	- -	- -	- -	1,806	279	1,009	82	- -	- -	- -	- -	- -	- -	- -	- -	1,806	279	1,009	82
2001	6,167	553	323	26	- -	- -	- -	- -	- -	- -	3,390	373	1,893	110	- -	- -	- -	- -	- -	- -	- -	- -	3,390	373	1,893	110
2002	18,241	900	374	18	- -	- -	- -	- -	- -	- -	10,363	624	5,789	183	- -	- -	- -	- -	- -	- -	- -	- -	10,363	624	5,789	183
2003	8,962	821	274	27	- -	- -	- -	- -	455	9	4,775	556	2,668	163	254	13	120	2	- -	- -	1	4	4,521	543	2,547	157
2004	9,388	1,161	325	120	- -	- -	- -	- -	298	4	5,084	734	2,840	216	336	10	385	1	- -	- -	11	5	4,748	724	2,444	210
2005	9,098	861	346	69	- -	- -	- -	- -	426	5	4,829	557	2,698	164	679	9	528	3	- -	- -	15	3	4,150	548	2,155	158
2006	6,901	765	324	91	- -	- -	- -	- -	437	4	3,561	474	1,989	139	683	8	486	5	- -	- -	10	3	2,878	466	1,493	131
2007	6,702	631	345	46	- -	- -	- -	- -	523	2	3,384	413	1,890	121	- -	- -	- -	- -	- -	- -	4	7	3,384	413	1,886	114
2008	7,033	1,283	289	90	- -	- -	- -	- -	872	8	3,406	839	1,902	247	470	9	288	7	14	0	5	3	2,922	830	1,609	237
2009	9,148	1,236	300	75	148	19	409	54	444	5	4,551	767	2,542	225	636	11	446	5	8	8	5	11	3,907	748	2,091	209
2010	24,091	2,120	279	88	583	50	1,207	103	1,068	17	12,153	1,318	6,789	387	4,002	48	3,110	16	12	12	4	13	8,139	1,258	3,675	358
2011	11,728	2,085	272	55	206	40	633	273	1,131	19	5,502	1,202	3,073	353	3,024	53	899	15	31	33	0	16	2,447	1,116	2,174	322

Appendix B1. Upper Methow River subbasin steelhead redd counts by section and survey year. Section descriptions in bold indicate rotating panel tributaries. Ns = not surveyed.

River/section	Code	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Upper Methow River											
Ballard C.G. - Lost River	M15	ns	15	27	17	3	2	6	5	0	0
Lost River - Gate Creek	M14	ns		10	51	0	19	25	16	65	27
Gate Creek - Early Winters Creek	M13	ns	215[a]	23	60	15	11	19	11	65	69
Early Winters Creek - Mazama Bridge	M12	ns		0	43	3	5	25	8	27	19
Mazama Bridge - Suspension Bridge	M11	70	44[a]	12	25	9	24	27	5	27	36
Suspension Bridge - Weeman Bridge	M10	156		8	52	26	56	21	25	55	36
Weeman Bridge - Along Highway 20	M9	ns		93	180	30	14	34	94	123	91
Along Highway 20 - Wolf Creek	M8	ns	325[a]	0	9	0	1	1	0	0	3
Wolf Creek - Foghorn Dam	M7	ns		0	9	5	0	10	10	15	10
Foghorn Dam - Winthrop Bridge	M6	ns		0	34	0	0	10	2	6	3
Upper Methow River mainstem total		226	599	173	480	91	132	178	176	383	294
Lost River											
Sunset Creek - Eureka Creek	L3	ns	ns	17	6	ns	ns	ns	ns	2	ns
Eureka Creek - Lost River Bridge	L2	10	25	11	7	ns	ns	ns	11	12	5
Lost River Bridge - Confluence	L1	1	0	3	7	2	10	3	6	5	3
Early Winters Creek											
Klipchuck C,G. - Early Winters Bridge	EW5	ns	ns	0	0	ns	ns	ns	0	0	ns
Early Winters Bridge - Highway 20 Bridge	EW4	ns	ns	0	0	ns	ns	ns	2	1	ns
Highway 20 Bridge - Diversion dam	EW3	ns	ns	23	6	ns	4	0	0	2	7
Diversion dam - Highway 20 Bridge	EW2	ns	ns	0	0	3	2	0	2	1	0
Highway 20 Bridge - Confluence	EW1	ns	ns	1	0	1	0	0	0	0	0
Methow River tributaries											
Suspension Creek (Entire length)	Susp1	ns	ns	43	37	31	49	37	32	43	26
Little Suspension Creek (Entire length)	Lsusp1	ns	ns	ns[b]	ns[b]	ns[b]	29	4	1	11	3
Methow Hatchery Outfall (Entire length)	MH1	15	ns	18	15	14	25	9	12	6	12
Winthrop NFH Outfall (Entire length)	WN1	171	61	113	83	29	68	27	37	24	26
Hancock Cr. (Kumm Rd. to Wolf Cr. Rd.)	HA2	ns	ns	ns	ns	ns	21	9	7	12	2
Hancock Cr. (Wolf Cr. Rd. to Confluence)	HA1	ns	ns	3	0	0	2	4	1	2	4
Gate Creek (Culvert – Confluence)	GA1	ns	0[c]	0[c]	0[c]	0[c]	0[c]	0[c]	0[c]	1	0
Wolf Creek (Rd 5505 access - footbridge)	**W2**	ns	ns	29	0	0	ns	ns	0	0	0
Wolf Creek (footbridge - Confluence)	**W1**	ns	ns	8	0	0	1	0	0	0	0
Little Boulder Creek (Hwy 20 – Conf.)	**LBO1**	ns	ns	3	3	0	0	0	0	0	0
Goat Creek (FR 52 Bridge - Confluence)	**GT1**	ns	ns	33	4	0	0	0	0	0	1
Upper Methow River subbasin total		423	685	478	648	171	343	271	287	505	383

[a] Reaches M12-M14, M10 and M11, and M6-M9 were combined in 2003.
[b] Believed to be unsuitable habitat 2004 and 2006.
[c] Historically surveyed as part of M13.

Appendix B2. Lower Methow River subbasin steelhead redd counts by section and survey year. Sections descriptions in bold indicate rotating panel tributaries. Ns = not surveyed.

River/section	Code	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Lower Methow River											
Winthrop Bridge - MVID Dam	M5	ns	89[a]	14	44	15	0	0	23	24	11
MVID - Twisp Confluence	M4	ns		24	50	0	4	0	23	29	12
Twisp Confluence - Carlton	M3	ns	69	38	123	44	0	5	24	132	16
Carlton - Upper Burma Bridge	M2	ns	99	33	79	28	1	27	15	39	23
Upper Burma Bridge - Mouth	M1	ns	58	42	67	10	2	86	17	180	21
Lower Methow River mainstem total		ns	315	151	363	97	7	118	102	404	83
Beaver Creek											
Beaver Cr. (Lester Rd. Br. - Balky Hill Rd.)	BV3	ns	ns	16[b]	2	ns	9[c]	0	0	0	ns
Beaver Cr. (Balky Hill Rd. - Highway 20)	BV2	ns	ns		14	ns	ns	15	23	0	ns
Beaver Creek (Highway 20 - Confluence)	BV1	70	15	21	39	21	9	38	26	17	12
Lower Methow River tributaries											
Gold Cr. Up. N.F. (10.0 rkm – 6.3 rkm)[d]	**GDN4**	ns	ns	0	22	15	36	7	0	4	12
Gold Cr. Mid. N.F. (6.3 rkm - N.F. Br.)	**GDN3**	ns	ns	0	3	2	5	1	7	8	3
Gold Cr. Mid. N.F. (N.F. Br. - W. Pines)	**GDN2**	ns	ns	0	16	3	6	0	6	4	5
Gold Cr. Lower N.F. (W. Pines - 2nd Br.)	**GDN1**	ns	ns	0	15	2	6	1	5	14	6
Gold Cr. S.F. (1st Bridge - 1.7 rkm)	**GDS3**	ns	ns	0	30	10	25	0[e]	5	8	1
Gold Cr. S.F. (1.7 rkm - 0.6 rkm)	**GDS2**	ns	ns	0	8	3	6	9	4	13	0
Gold Cr. S.F. (0.6 rkm - Confluence)	**GDS1**	ns	ns	0	4	1	3	0[e]	1	1	0
Gold Cr. Mainstem (2nd Br. – Priv. Land)	**GDM2**	ns	ns	0	12	2	5	11	15	14	4
Gold Cr. Mainstem (Priv. Land - Conf.)	**GDM1**	ns	2	0	15	3	6	12	16	15	4
Foggy Dew Creek (FR 200 - Confluence)	**FD1**	ns	ns	0	14	10	24	2	2	6	2
Black Canyon Cr. (1st Culvert - 0.8 rkm)	**BC2**	ns	ns	0	7	2	5	2	2	4	3
Black Canyon Cr. (0.8 rkm - Confluence)	**BC1**	ns	ns	0	6	2	5	2	0	1	2
Libby Creek (Hornet Draw - L.P. Land)	**LB5**	ns	ns	ns	ns	ns	ns	ns	ns	8	14
Libby Creek (Lower Public Land)	**LB4**	ns	ns	0	7	2	6	2	ns[f]	8	3
Libby Creek (L.P. Land - Realty Land)	**LB3**	ns	ns	0	8	2	6	2	ns[f]	14	3
Libby Creek (Realty Land)	**LB2**	ns	ns	0	2	1	2	1	0	7	3
Libby Creek (Realty Land - Confluence)	**LB1**	ns	ns	0	7	3	6	2	5	9	10
Lower Methow River subbasin total		70	332	188	594	181	177	225	219	559	170

[a] Reaches M5 and M4 were combined in 2003.
[b] Reaches BV2 and BV3 were combined in 2004.
[c] Partial survey.
[d] Distance surveyed since 2009.
[e] No expansion due to possible unsuitable habitat.
[f] Beaver dam considered as barrier to upstream migration in 2009.

Appendix B3. Twisp River subbasin steelhead redd counts by section and survey year. Section descriptions in bold indicate rotating panel tributaries. Ns = not surveyed.

River/section	Code	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
							Twisp River					
Road's End C.G. - South Creek Bridge	T10	ns	ns	33	15	9	ns	ns[b]	ns	0	0	ns
South Creek Bridge - Poplar Flats C.G.	T9	ns	ns	5	9	6	4	ns[b]	ns	0	0	0
Poplar Flats C.G. - Mystery Bridge	T8	ns	ns	17	2	17	29	ns[b]	0	0	0	0
Mystery Bridge - War Creek Bridge	T7	2	ns	36	88	112	47	ns[b]	6	22	6	8
War Creek Bridge - Buttermilk Bridge	T6	40	ns	91	9	78	70	ns[b]	42	109	79	47
Buttermilk Bridge - Little Bridge Cr.	T5	47	156	322[a]	22	87	130	60	59	71	48	32
Little Bridge Creek - Twisp weir	T4	100	194		94	25	34	13	30	22	27	13
Twisp weir - Upper Poorman Bridge	T3	48	ns	88	3	32	32	5	18	47	78	48
Up. Poorman Br. - Lower Poorman Br.	T2	46	ns	14	1	29	18	ns[b]	16	47	54	34
Lower Poorman Bridge - Confluence	T1	29	ns	90	0	20	5	ns[b]	6	10	27	4
Twisp River mainstem total		312	350	696	243	415	369	78	177	328	319	186
							Twisp River tributaries					
Little Br. Cr. (Road's End – Vetch Cr.)	LBC4	ns	ns	ns	ns	ns	ns	0	ns	ns	0	ns
Little Br. Cr. (Vetch Cr. – 2nd Culvert)	LBC3	ns	ns	ns	ns	3	0	1	0	0	1	0[c]
Little Br. Cr. (2nd Culvert – 1st Culvert)	LBC2	ns	ns	ns	ns	4	1	0	2	1	3	0[c]
Little Br. Cr. (1st Culvert - Confluence)	LBC1	ns	ns	ns	11	20	3	2	2	17	4	0[c]
MSRF pond outfalls[1]	MSRF1	ns	ns	ns	2	11	0	1	0	0	1	3
War Creek (log jam barrier - Conf.)	**WR1**	ns	0	0	0	2	3	0	0	2	0	0
Eagle Creek (Rd 4430 - Confluence)	**EA1**	ns	ns	ns	0	2	1	0	0	2	0	0
Buttermilk Cr. (Fork - Cattle Guard)	**BM2**	ns	ns	ns	0	13	5	0	1	0	3	0
Buttermilk Cr. (Cattle Guard - Conf.)	**BM1**	ns	4	0	0	13	5	0	0	2	1	1
RP-South Creek (Falls - Confluence)	**SO1**	ns	ns	ns	0	1	2	0	0	0	0	0
Twisp River subbasin total		312	354	696	256	484	389	82	182	352	332	190

[a] Reaches T4 and T5 were combined in 2003.
[b] Not surveyed due to prolonged high flow.
[c] Surveys ended early due to high flow.

Appendix B4. Chewuch River subbasin steelhead redd counts by section and survey year. Sections descriptions in bold indicate rotating panel tributaries. Ns = not surveyed.

River/section	Code	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
					Chewuch River						
Chewuch Falls - 30 Mile Bridge	C13	ns	ns	0	ns	ns	ns	ns	0	0	ns
30 Mile Bridge - Road Side Camp	C12	ns	14	3	ns	ns	ns	ns	4	19	0
Road Side Camp - Andrews Creek	C11	ns	3	8	ns	ns	ns	ns	2	9	2
Andrews Creek - Lake Creek	C10	ns	8	23	ns	ns	ns	ns	4	13	0
Lake Creek - Buck Creek	C9	ns	9	0	ns	ns	ns	ns	0	ns	0
Buck Creek - Camp 4 C.G.	C8	ns	3	3	ns	ns	ns	ns	34	60	0
Camp 4 C.G. - Chewuch Campground	C7	ns	6	10	ns	ns	16	13	9	32	18
Chewuch C.G. - Falls Creek C.G.	C6	ns	26	3	0	ns	21	30	30	87	20
Falls Creek C.G. - Eightmile Creek	C5	ns	44	8	0	ns	7	22	11	51	18
Eightmile Creek - Boulder Creek	C4	105	134	5	20	2	19	55	28	34	33
Boulder Creek - Chewuch Bridge	C3	ns	0	0	ns	ns	0	4	2	0	3
Chewuch Bridge - WDFW Land	C2	ns	35	8	ns	ns	3	37	24	15	7
WDFW Land - Confluence	C1	ns	3	3	ns	ns	0	25	7	2	2
Chewuch River mainstem total		105	285	74	20	2	66	186	155	322	103
					Chewuch River tributaries						
Eightmile Creek (300m abv. div. - Bridge)	EM2	5[a]	20[a]	0	11	0	0	3	0	0	0
Eightmile Creek (Bridge - Conf.)	EM1			1	17	4	1	0	2	1	0
Cub Creek (W. Chewuch Rd. - Conf.)	CU1	ns	ns	ns	ns	ns	ns	ns	ns	1	ns
Boulder Creek (Falls - 1st Bridge)	**BD2**	ns	0	0	5	6	4	0	1	0	1
Boulder Creek (1st Bridge - Conf.)	**BD1**	4	0	0	2	1	4	0	0	0	0
Lake Creek (Black Lk. - 1st Bridge)	**LK2**	ns	ns	0	0	44	51	0	13	0	6
Lake Creek (1st Bridge – Conf.)	**LK1**	1	1	0	0	4	4	0	1	0	0
Andrews Creek (L. And. Cr. – 1st Br.)	**AN2**	ns	ns	0	1	1	2	0	0	0	0
Andrews Creek (1st Bridge - Conf.)	**AN1**	ns	ns	0	1	1	1	0	0	0	0
Twentymile Creek (Falls - FR 5010)	**TW2**	ns	ns	0[b]	1[b]	4[b]	0	0	0	0	1
Twentymile Creek (FR 5010 - Conf.)	**TW1**	ns	ns				5	0	0	0	0
Chewuch River subbasin total		115	306	75	58	67	138	189	172	324	111

[a] Reaches EM2 and EM1 combined 2002 and 2003.
[b] Reaches TW2 and TW1 combined 2004 to 2006.

Chapter 5

2011 Brood Spring Chinook Salmon Spawning Ground Surveys Conducted in the Methow River Basin

Abstract

Spawning ground surveys were conducted to evaluate the spawn timing, spatial distribution, genetic composition, and to estimate the tributary-specific spawning escapement of spring Chinook salmon within the Methow River basin. Spawning ground surveys were performed on foot between 2 August and 22 September. A total of 760 spring Chinook salmon redds were constructed in the Methow River basin in 2011. The Methow River subbasin had the greatest number of redds (*N* = 472). The Chewuch River subbasin had fewer redds (*N* = 225) than the mainstem Methow River excluding hatchery outfalls and tributaries (*N* = 316), and the fewest redds were located in the Twisp River (*N* = 63). After subtracting fish that were double counted at Wells Dam fish ladders (*N* = 281) and that moved downstream of Wells Dam without reascending (*N* = 734), an estimated 8,219 spring Chinook salmon comprised the population above Wells Dam in 2011. After subtracting fish that were collected for hatchery broodstock (*N* = 808), distributed to local tribes (*N* = 1,515), and those originating from Okanogan River releases (*N* = 106), the estimated run escapement to the Methow River basin was 5,790 fish. There were no significant differences in migration timing between hatchery and wild fish within a given cohort. Redd counts expanded by the male-to-female ratio from sampling at Wells Dam (2.86:1.00) suggest that the Methow River spawning population comprised 2,936 fish, or 50.7% of the estimated run escapement. Peak spawning occurred between 30 August and 12 September in index areas of all three subbasins. Wild female carcasses were found significantly earlier and further upstream than hatchery female carcasses in the Chewuch and Methow subbasins. Hatchery fish comprised 34.8%, 57.4%, and 76.3% of the estimated spawning escapement in the Twisp, Chewuch, and Methow subbasins, respectively. The natural replacement rate (NRR) for the most recent brood year of spring Chinook salmon with complete recovery data (2005 brood) was highest in the Chewuch River subbasin (0.59 recruits per spawner). The geometric mean NRR for brood years 1992 to 2005 was less than 1.0 in each subbasin regardless of whether broodyears 1996 and 1998 were omitted (no spawning ground surveys). Hatchery replacement rate (HRR) values have not consistently met target HRR values for all release groups in broodyears 1992 through 2005. Of the estimated total of coded-wire-tagged hatchery fish recovered on spawning grounds (*N* = 2,171), 28.7% were classified as within-basin strays from Methow Hatchery and 13.2% were stray fish from other basins.

Introduction

Spring Chinook salmon spawning ground surveys were used to evaluate spawn timing, spatial distribution, spawner demographics, and to estimate tributary-specific spawning escapement within the Methow River basin. Spring Chinook propagated at Methow Hatchery (MH) are used to supplement natural spawning populations in the Methow, Twisp, and Chewuch rivers. Returning hatchery adults should have migration timing, spawn timing, and redd distributions similar to those of naturally produced fish. Most spring Chinook salmon reared at MH were tagged with unique coded-wire tags (CWT) based on their subbasin of release. In some cases, individual families, progeny from adults with elevated ELISA values, or juveniles released as subyearlings were also tagged with unique CWT codes. Recovery of CWTs from spawning ground surveys provides the data necessary to estimate hatchery stray rates and the composition of spawners in target streams. Hatchery fish may stray within their basin of release, or to other river basins. In the upper Columbia River basin, comprehensive spawning ground surveys are conducted for most spring Chinook salmon stocks and data are directly comparable.

The implementation of the Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs (Hays et al. 2007) as proposed by Murdoch and Snow (2010) included eight objectives designed to examine hypotheses regarding supplementation programs in the Methow Basin. This chapter addresses elements of the M&E Plan related to spring Chinook salmon spawning ground surveys in 2011 and data were collected that specifically address the following objectives:

Objective 1: Determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream), and if the change in the natural replacement rate (NRR) of the supplemented population is similar to that of the non-supplemented population.

- Ho: Number of hatchery fish that spawn naturally ≥ number of naturally and hatchery produced fish taken for broodstock
- Ho: Δ NOR/Max recruitment $_{\text{Supplemented population}} \geq \Delta$ NOR/Max recruitment $_{\text{Non-supplemented population}}$
- Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

Objective 2: Determine if run timing, spawn timing, and spawning distribution of both natural and hatchery components of the target population are similar.

- Ho: Migration timing $_{\text{Hatchery age X}}$ = Migration timing $_{\text{Naturally produced age X}}$
- Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

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 the phenotypic characteristics of natural populations.

- Ho: Size (length) at maturity $_{\text{Hatchery age X and Gender Y}}$ = Size (length) at maturity $_{\text{Naturally produced age X and Gender Y}}$
- Ho: Age at maturity $_{\text{Hatchery}}$ = Age at maturity $_{\text{Naturally produced}}$

Objective 4: Determine if hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific HRR expected value based on survival rates listed in the BAMP (1998).

- Ho: $HRR_{\text{Year x}} \geq NRR_{\text{Year x}}$
- Ho: HRR $\geq$ BAMP value (preferred)

Objective 5: Determine if stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

- Ho: Stray rate $_{\text{Hatchery fish}} \leq 5\%$ of total brood return
- Ho: Stray hatchery fish ≤ 5% of spawning escapement (based on run year) within other independent populations
- Ho: Stray hatchery fish ≤ 10% of spawning escapement (based on run year) of any non-target streams within independent populations

Methods

Migration Timing and Run Composition

Adult spring Chinook salmon were trapped and sampled at Wells Dam to assess migration timing, origin composition, and to collect broodstock for MH (Tonseth 2011). All trapped fish were sampled for hatchery marks (fin-clips) and tags (CWT). Scale samples, sex, and fork length data were collected from all suspected wild fish, and wild fish retained for broodstock were also tissue sampled for DNA analysis to determine genetic origin (i.e., Twisp or non-Twisp). All hatchery fish were sampled for scales, sex, and length, and passive integrated transponder (PIT) tags were inserted in the pelvic girdle of all released fish (hatchery and wild) to assess sex ratio of the 2011 brood. Adipose fin-clipped hatchery spring Chinook salmon were expected to return to both the Methow and the Okanogan river basins. Winthrop National Fish Hatchery (NFH) expected returns of age-3 and age-4 ad-clipped fish from the 2007 and 2008 broods. Colville Confederated Tribes (CCT) expected returns of age-5 ad-clipped fish from the 2006 brood. Scale age was used to estimate escapement of adipose fin-clipped fish to the Methow and Okanogan basins. All fish exposed to anesthetic (MS-222) were marked with an anchor tag near the dorsal fin to allow exclusion from consumptive fisheries if sampled within 21 days of the fishery. Gender was determined using ultrasound. All trapped fish were either transported to MH as broodstock or placed back in the fish ladders upstream of the traps.

Digital video records of fish passage at Wells Dam between 5 June and 2 July for both ladders were reviewed to exclude summer Chinook salmon from the spring Chinook salmon count and vice versa. In general, we reviewed the three busiest hours of passage per ladder per day during these periods. Data collected from summer Chinook trapping data during the month of July were used to estimate the number of spring Chinook after the video review period. Summer Chinook salmon were distinguished from spring Chinook salmon based on body color and shape. The number of fish that were double counted (i.e., fell below and re-ascended) or fell back (i.e., fell below without re-ascending) were estimated based on PIT-tag detections at instream interrogation sites and mainstem Columbia and Snake River dams. Proportions of fish detected at locations downstream of Wells Dam and records of fish migrating through Wells Dam multiple times were expanded to the estimated run-at-large at Wells Dam. No estimates of predation, pre-spawn mortality or illegal removal (i.e., poaching) were made.

Redd Distribution and Spawn Timing

The Methow River basin was divided into three geographic subbasins: Methow River (upstream of Twisp), Chewuch River, and Twisp River. Index areas of annual spawning activity were established within each subbasin based on historic survey information to estimate spawn timing of hatchery and wild fish. Spring Chinook salmon redds were individually marked with flagging tape that included survey date, redd number, and instream location on each flag; as part of a concurrent BPA funded study (BPA project 201003400, Upper Columbia Spring Chinook and Steelhead Juvenile and Adult Abundance, Productivity, and Spatial Structure Monitoring) to estimate surveyor efficiency, redds in select (census) reaches were not flagged. Each location was also recorded with hand-held global positioning system (GPS) devices for subsequent mapping and analyses. Most reaches were surveyed every six to eight days during the spawning season (August and September). Female carcass locations (river kilometers [rkm]) were used as surrogates for spatial redd distribution by origin of fish because most hatchery fish in the Methow Basin lack externally visible marks, greatly limiting the ability to determine the origin of actively spawning fish.

Spawner Composition, Demographics, and Egg Deposition

Spawning population characteristics were derived from biological data collected from carcasses recovered during surveys. Location, origin, sex, fork length, post-orbital-to-hypural-plate (POH) length, egg retention (females), and scale samples were collected from each carcass when possible. Tissue samples were collected from wild fish, and a small number of hatchery fish for genetic analyses; most DNA samples from hatchery fish were collected at Methow Hatchery during spawning activities. Carcass locations, used as a proxy for spawning locations, were recorded using hand-held GPS devices and all carcasses were sampled for CWTs using hand-held electronic detection wands. Most spring Chinook salmon released from Methow Basin hatcheries in recent years have been tagged with a CWT but not been externally marked, thus requiring the use of electronic detectors. Most other hatchery fish released in the Upper Columbia are externally marked with an adipose fin-clip in addition to the CWT to designate hatchery origin. Snouts were sent to the WDFW CWT Lab for tag extraction and decoding. Scales were sent to the WDFW Scale Lab for age determination. Fish age was determined either through CWT or scale analysis. Scale analysis was also used to confirm origin for fish with no detectable hatchery mark or tag (i.e., wild).

Egg retention was determined for female carcasses with an intact abdomen by counting the number of eggs present. The percentage of eggs retained was determined by dividing the number of eggs counted by the mean fecundity for the fish's specific age and origin derived from 2011 MH broodstock (WDFW, unpublished data). Female carcasses with intact abdominal cavities, a large number of eggs, and no external signs of spawning (i.e., eroded caudal fin) were categorized as pre-spawn mortalities. Estimated egg deposition was calculated using mean fecundities from MH broodstock (i.e., MetComp stock for Methow and Chewuch subbasins, Twisp stock for Twisp subbasin) and adjusted for mean egg-retention rates.

Natural Replacement Rate

The natural replacement rate (NRR) for each brood was calculated by adding the number of recruits (r) from successive return years that originated from the same brood year (i), and dividing the sum by the number of spawners (S) for that brood year calculated from expanded spawning ground surveys, as follows:

$$\text{NRR} = (r_{\text{i+1}} + r_{\text{i+2}} + r_{\text{i+3}} + \ldots)/S$$

Estimated spawning escapement was derived from redd counts expanded by fish-per-redd values. Prior to 2006, fish-per-redd values were calculated from Wells Dam counts and adjusted for the proportion of jacks (age-3 fish) in the run (Meekin 1967). Since 2006, fish-per-redd values have been calculated using the male-to-female sex ratio from run-at-large sampling at Wells Dam. In 2011, fish-per-redd values were calculated on the population remaining after broodstock collection and removal of fish from the Winthrop NFH outfall (tribal excess). Recruits were expanded to account for non-selective fishery harvest and indirect mortality attributed to selective fisheries.

Stray Rates

The composition of hatchery-origin fish on spawning grounds, and associated stray rates were determined by expanding all CWT recoveries by the code-specific tag-retention rates and stream-specific sampling rates from spawning ground surveys. Hatchery fish were assigned to one of four categories depending on release and recovery location (local, Winthrop NFH, within-basin stray, or out-of-basin stray). Local fish were composed of Methow Hatchery fish recovered in the stream or subbasin from which they were released. Fish released from Winthrop NFH were expected to return to the Methow River but their within-basin stray rates were not addressed. All MH fish recovered in a stream or subbasin in the Methow River basin from which they were not released were considered within-basin strays. Out-of-basin strays included all fish recovered that originated from hatchery releases outside the Methow River basin.

Statistical Analyses

For all comparisons of hatchery and wild fish (except migration timing), only local hatchery fish were used within specific tributary release locations (i.e., Chewuch River recoveries that were released into the Chewuch River, etc.). Data were tested for normality using Shapiro-Wilk tests and homogeneity of variances using Levene's tests. Data were transformed to achieve normal distributions when necessary. Nonparametric tests were used when normal distributions could not be achieved and variance was unequal between groups. All statistical tests were performed at a significance level of 0.05 (i.e., a 5% chance of erroneously rejecting a null hypothesis). Differences in migration timing among age classes of hatchery and wild fish were tested using Kruskal-Wallis analysis of variance (KW ANOVA). Post-hoc multiple comparisons were made for all run-timing groups. Female carcass locations (river kilometers [rkm]) were used as surrogates for redd distribution because most hatchery fish lack externally visible marks, thus confounding the ability to determine origin of actively spawning fish. Spatial redd distribution of hatchery and wild fish within subbasins was compared using Mann-Whitney U-tests. Differences in spawn timing between hatchery and wild females within each subbasin were tested using analysis of covariance (ANCOVA) with elevation as the covariate except in the Chewuch subbasin where data violated assumptions of ANCOVA and a Mann-Whitney U-test was used instead. Length at maturity was compared using two-sample t-tests. Age at maturity of hatchery and naturally produced fish was compared using Chi-square test. Comparisons of NRR and HRR by subbasin were tested using Mann-Whitney U-tests. HRR values were tested using one-sample t-tests with log-transformed data. Stray rates were tested using one-sample t-tests. Statistical tests for strays by brood year were conducted including fish removed in fisheries (i.e., harvest). Objective 1 of the M&E Plan requires the use of spatial reference populations. Comparisons of supplemented and reference populations will be conducted and reported in a separate report produced every 5 years (see Evaluation of Hatchery Programs Funded By Douglas County PUD 5-Year Report 2006-2010 [Murdoch et al. 2012]).

Results

Migration Timing and Run Composition

The 2011 spring Chinook salmon migration to Wells Dam was monitored between 12 May and 6 July. During this period, the majority (94.8%) of fish migrated between 16 May and 28 June (Julian date 136 and 179, respectively; Figure 1). Hatchery 4-year olds and wild 4 and 5-year olds migrated to Wells Dam earlier than hatchery 3-year olds (KW ANOVA multiple comparisons: $P \leq 0.01$; Figure 2). However, no significant differences in migration timing to Wells Dam were detected between hatchery and wild fish of the same age.

Based on PIT tag detections at Wells Dam fish ladders, an estimated 281 fish were double counted and 734 fish fell below Wells Dam after being counted and did not re-ascend; excluding these totals, the estimated spring Chinook salmon run above Wells Dam (including broodstock) was 8,219 fish (Table 1). The run was composed primarily of hatchery fish (88.3%), the majority of which were not adipose fin-clipped. Wild fish comprised an estimated 11.7% of the run at Wells Dam. Based on spawning ground and broodstock recoveries of PIT-tagged fish, initial gender determination at Wells Dam was 90.3% accurate for adult female fish, 93.7%

accurate for adult male fish, 100.0% accurate for age-3 male fish (i.e., jacks), and 0% accurate for age-3 female fish (i.e., jills; 9 fish sampled, 1 fish recovered). After correcting for sex determination errors and accounting for fish retained for broodstock, the male (including jacks) to female ratio of fish sampled at Wells Dam was 2.86 to 1.00 which equates to a fish-per-redd value of 3.86 assuming females only construct a single redd. After removing fish bound for the Okanogan River (*N* = 106), fish collected for hatchery broodstock (*N* = 808), and fish distributed to local tribes (*N* = 1,515), the estimated run escapement to the Methow River was 5,790 fish.

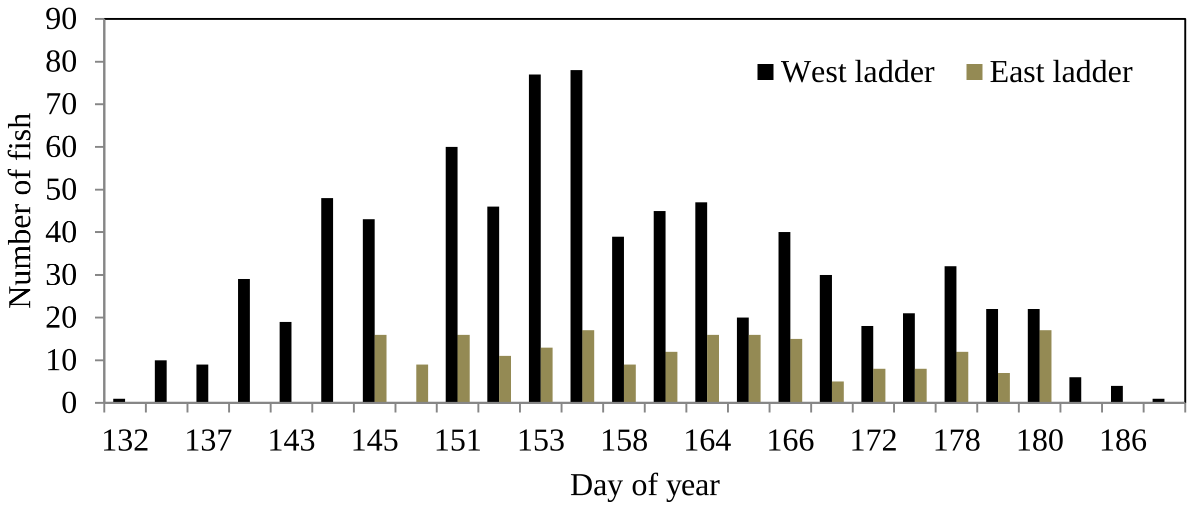

Figure 1. 2011 spring Chinook salmon migration timing to Wells Dam by ladder. All fish sampled during trapping operations are included.

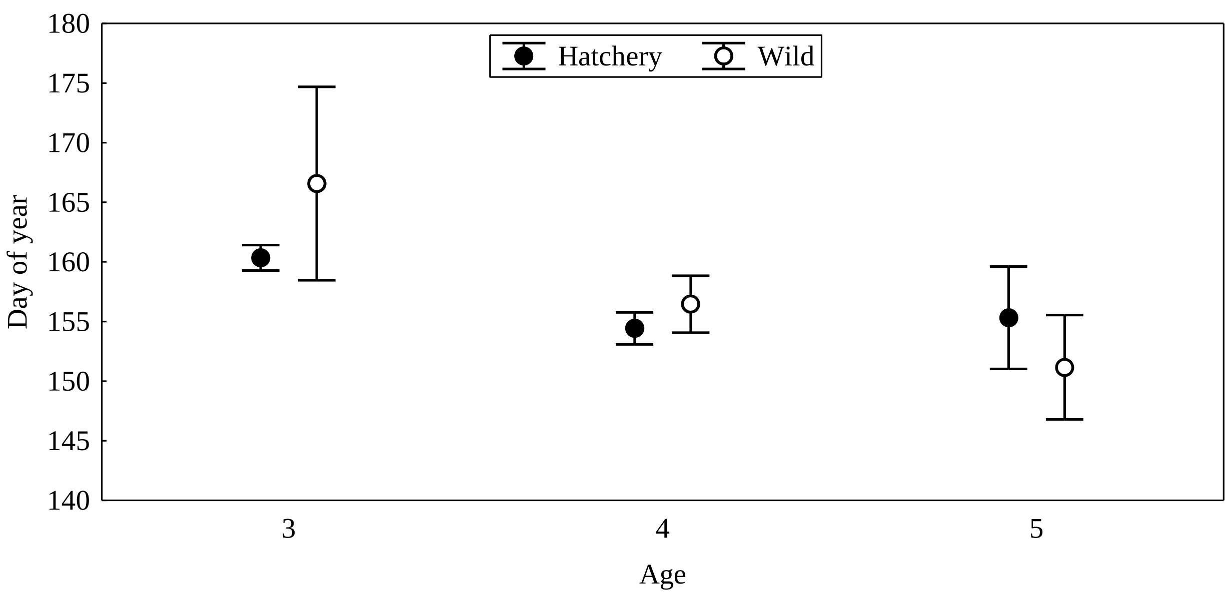

Figure 2. Mean migration timing (Day of year) to Wells Dam by age of hatchery (CWTO) and wild origin spring Chinook salmon in 2011. Error bars represent 95% confidence intervals.

Table 1. Estimated 2011 spring Chinook salmon run composition at (above) Wells Dam based on trapping three consecutive days per week. Okanogan River returns from CCT hatchery releases were based on estimated age of adipose fin-clipped fish (age-5). Estimated run above Wells Dam includes fish collected for broodstock (*N* = 808). The total number of double counted fish and fallbacks are excluded.

Origin	Mark	Adults		Age-3 Fish	
		%	*N*	%	*N*
Hatchery	Coded wire tag only	64.5	2,506	80.8	3,505
	Ad-clip + CWT	7.0	273	8.3	361
	Ad-clip only	2.8	107	3.2	138
	Ad-clip only (CCT)	2.4	94	- -	- -
	None	0.8	30	5.3	229
	Ad-clip + CWT (CCT)	0.3	12	- -	- -
Wild	None	22.2	862	2.4	102
Total		100.0	3,884	100.0	4,335

Redd Distribution and Spawn Timing

Spawning ground surveys were performed on foot between 2 August and 22 September. A total of 760 spring Chinook redds were constructed in the Methow basin in 2011. The majority of redds (62.1%; *N* = 472) were found in the Methow River subbasin (Table 2; Figure 3). The greatest number of redds within that subbasin were found in the 9 km reach downstream of Weeman Bridge (*N* = 156). A total of 124 redds were found in Methow River tributaries (Table 2). The Chewuch River subbasin had 225 redds (Table 3; Figure 4) and 63 redds were found in the Twisp subbasin (Table 4; Figure 5). On average, wild female carcasses were found further upstream than hatchery female carcasses in the Chewuch and Methow subbasins, but not the Twisp (Figure 6; Mann-Whitney U-tests: Chewuch, $P < 0.001$; Methow, $P < 0.001$; and Twisp, $P = 0.42$). However, large numbers of hatchery fish spawning in the vicinity of Methow and WNFH hatcheries had significant influence on the results of the analyses.

Peak spawning occurred between 30 August and 12 September in index areas of all three subbasins. After adjusting for elevation, wild females spawned earlier than hatchery females in the Methow subbasin (Figure 7; ANCOVA: $P < 0.01$). No difference in spawn timing between wild and hatchery fish was detected in the Twisp subbasin (Figure 7; ANCOVA: Twisp $P = 0.15$). Wild females also spawned earlier than hatchery females in the Chewuch subbasin (Figure 7; Mann-Whitney U-test: $P < 0.01$).

Table 2. 2011 spring Chinook salmon redd distribution, estimated spawning escapement, and carcass recoveries in the Methow River subbasin. Ns = not surveyed.

Reach	Redds		Estimated	Carcasses				
				Recoveries			Expanded Count	
	Count	Subbasin Prop. (%)	Spawning Escapement	H	W	Total	H	W
			Methow River mainstem					
M15	3	0.6	12	0	1	1	0	12
M14	23	4.9	89	13	8	22[a]	55	34
M13	9	1.9	35	1	1	2	17	18
M12	15	3.2	58	8	3	11	42	16
M11	22	4.7	85	10	11	21	39	46
M10	26	5.5	100	4	8	12	33	67
M9	156	33.1	602	119	41	160	454	148
M8	0	0.0	0	7	0	7		
M7	37	7.8	143	27	4	32[a]	125	18
M6	54	11.4	208	161	7	168		
M5,4	3	0.6	12	34	1	36[a]	211	9
M3,2	Ns	0.0	0	1	0	1		
Total	348	73.7	1,344	385	85	473[a]	976	368
			Lost River					
L2	11	2.3	42	3	5	8	16	26
L1	4	0.9	15	2	1	3	10	5
Total	15	3.2	57	5	6	11	26	31
			Early Winters Creek					
EW5,4	0	0.0	0	0	0	0	0	0
EW3	3	0.6	12	0	0	0	8[b]	4[b]
EW2,1	0	0.0	0	0	0	0	0	0
Total	3	0.6	12	0	0	0	8[b]	4[b]
			Methow River tributaries					
GDN4	1	0.2	4	1	0	1	4	0
HA2,1	2	0.4	8	1	0	1	8	0
MH1	38	8.1	147	53	1	54	144	3
Lsusp1	5	1.1	19	3	2	5	11	8
Susp1	16	3.4	62	6	1	7	53	9
W3-1	0	0.0	0	0	0	0	0	0
WN1	44	9.3	170	77	4	81	161	9
Total	106	22.5	410	141	8	149	381	29
Grand total	472	100.0	1,823	531	99	633[a]	1,391	432

[a] Includes 3 fish of unknown origin.
[b] Based on the H and W distribution in the adjacent mainstem reaches combined (M13 and M12).

Table 3. 2011 spring Chinook salmon redd distribution, estimated spawning escapement, and carcass recoveries in the Chewuch River subbasin.

Reach	Redds		Estimated	Carcasses				
				Recoveries			Expanded Count	
	Count	Subbasin Prop. (%)	Spawning Escapement	H	W	Total	H	W
			Chewuch River mainstem					
C13	8	3.6	31	0	0	0	28	138
C12	35	15.6	135	3	15	20[a]		
C11	8	3.6	31	2	3	5	12	19
C10	14	6.2	54	7	2	9	42	12
C9	0	0.0	0	0	0	0	0	0
C8	18	8.0	69	4	7	11	25	44
C7	17	7.5	66	7	7	14	33	33
C6	25	11.1	97	19	20	43[a]	47	50
C5	23	10.2	89	11	2	14[a]	75	14
C4	45	20.0	174	49	16	67[a]	131	43
C3	0	0.0	0	0	0	0	0	0
C2	27	12.0	104	25	5	30	87	17
C1	5	2.2	19	11	0	11	19	0
			Chewuch River tributaries					
EM1	0	0.0	0	0	0	0	0	0
Total	225	100.0	869	138	77	224[a]	499	370

[a] Includes 9 fish of unknown origin.

Table 4. 2011 spring Chinook salmon redd distribution, estimated spawning escapement, and carcass recoveries in the Twisp River subbasin.

Reach	Redds		Estimated Spawning Escapement	Carcasses				
				Recoveries			Expanded	
	Count	Subbasin Prop. (%)		H	W	Total	H	W
T10	0	0.0	0	0	0	0	0	0
T9	1	1.7	4	0	1	1	0	4
T8	3	5.0	12	0	2	2	0	12
T7	7	11.7	27	1	1	2	14	13
T6	40	61.6	154	9	22	31	45	109
T5	8	13.3	31	1	2	4[a]	10	21
T4	0	0.0	0	1	0	1	16	0
T3	1	1.7	4	0	0	0		
T2	3	5.0	12	0	0	0		
T1	0	0.0	0	0	0	0		
Total	63	100.0	244	12	28	41[a]	85	159

[a] Includes 1 fish of unknown origin.

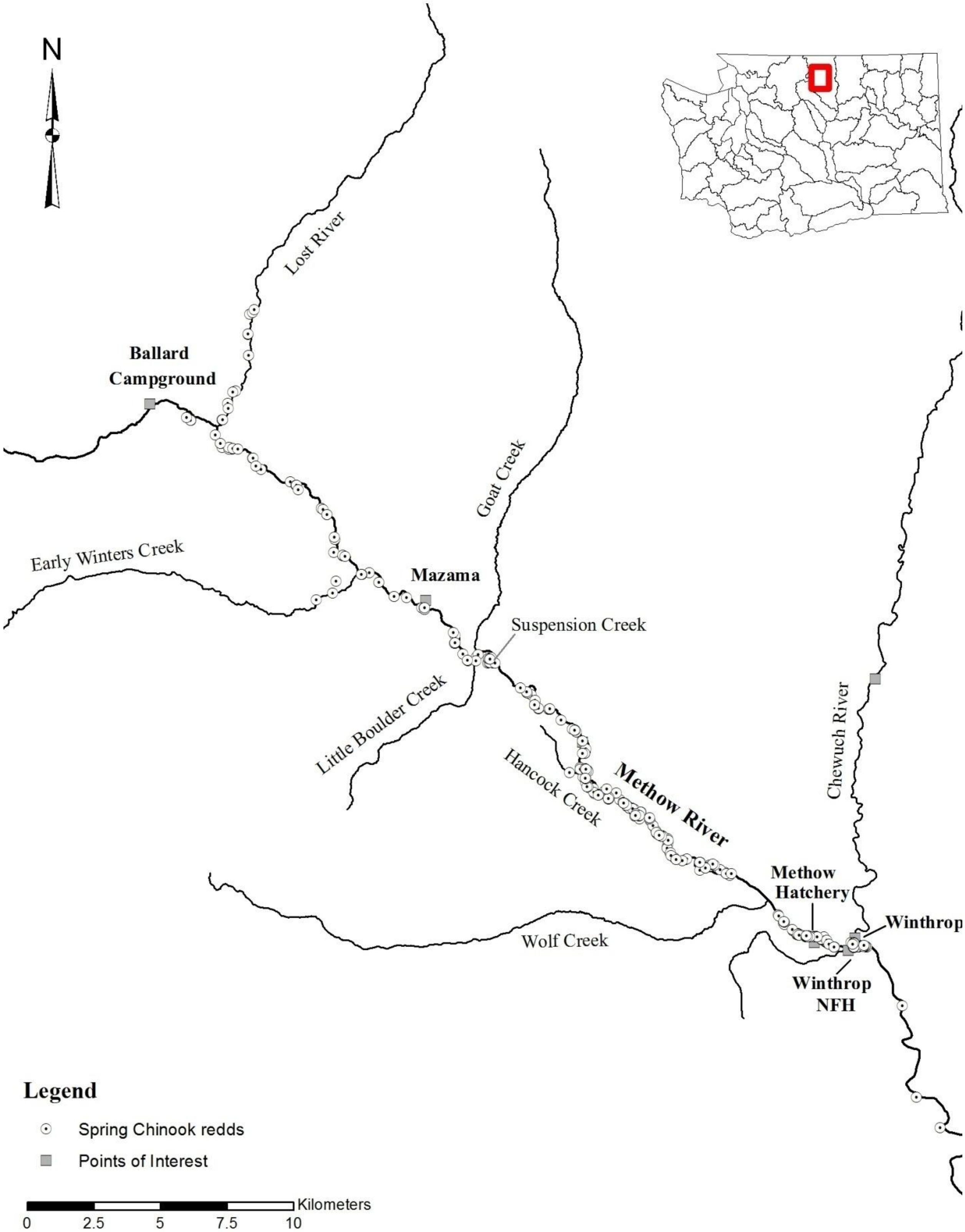

Figure 3. Spatial distribution of spring Chinook salmon redds in the Methow River subbasin based on GPS waypoints collected during 2011 surveys.

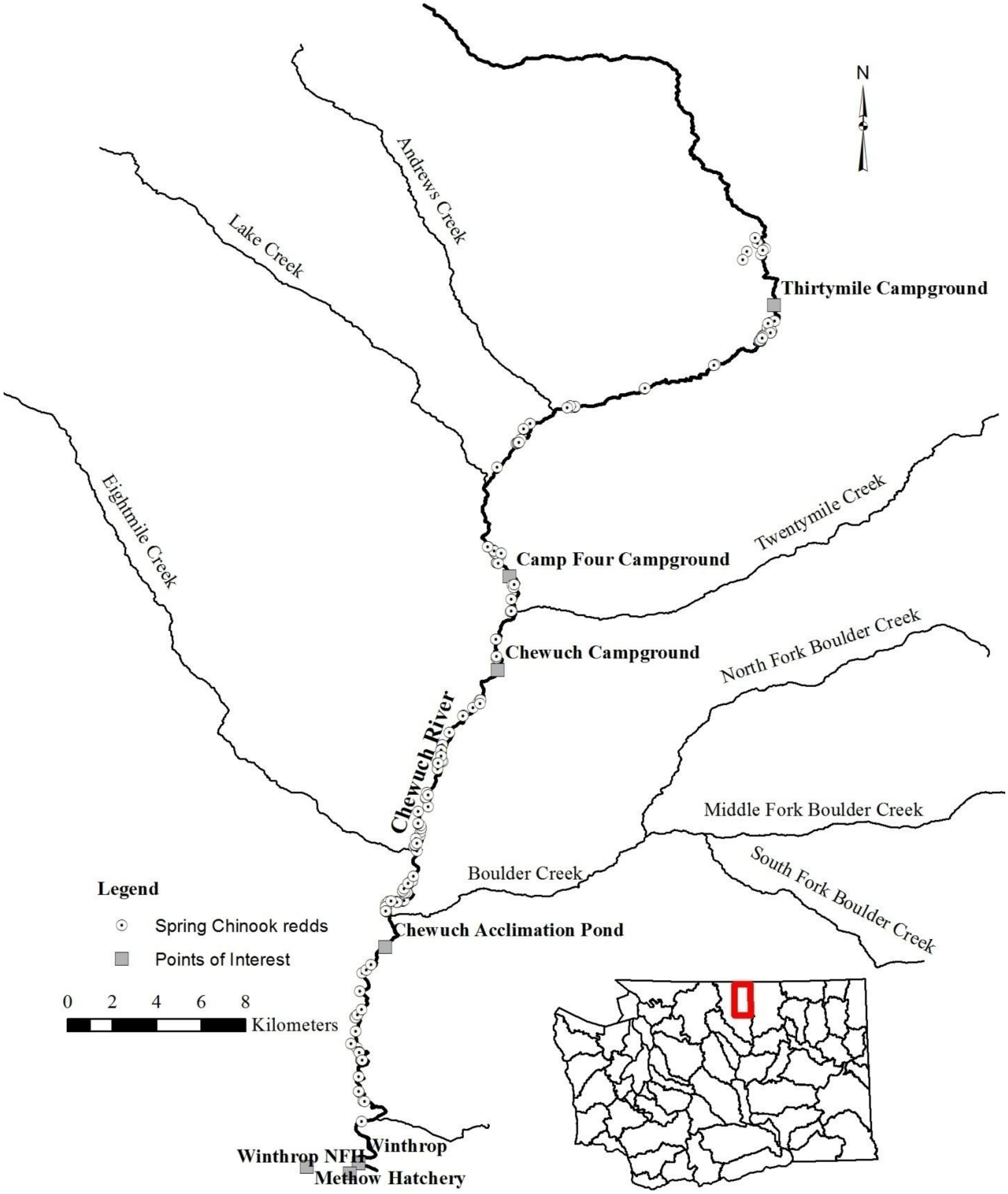

Figure 4. Spatial distribution of spring Chinook salmon redds in the Chewuch River subbasin based on GPS waypoints collected during 2011 surveys.

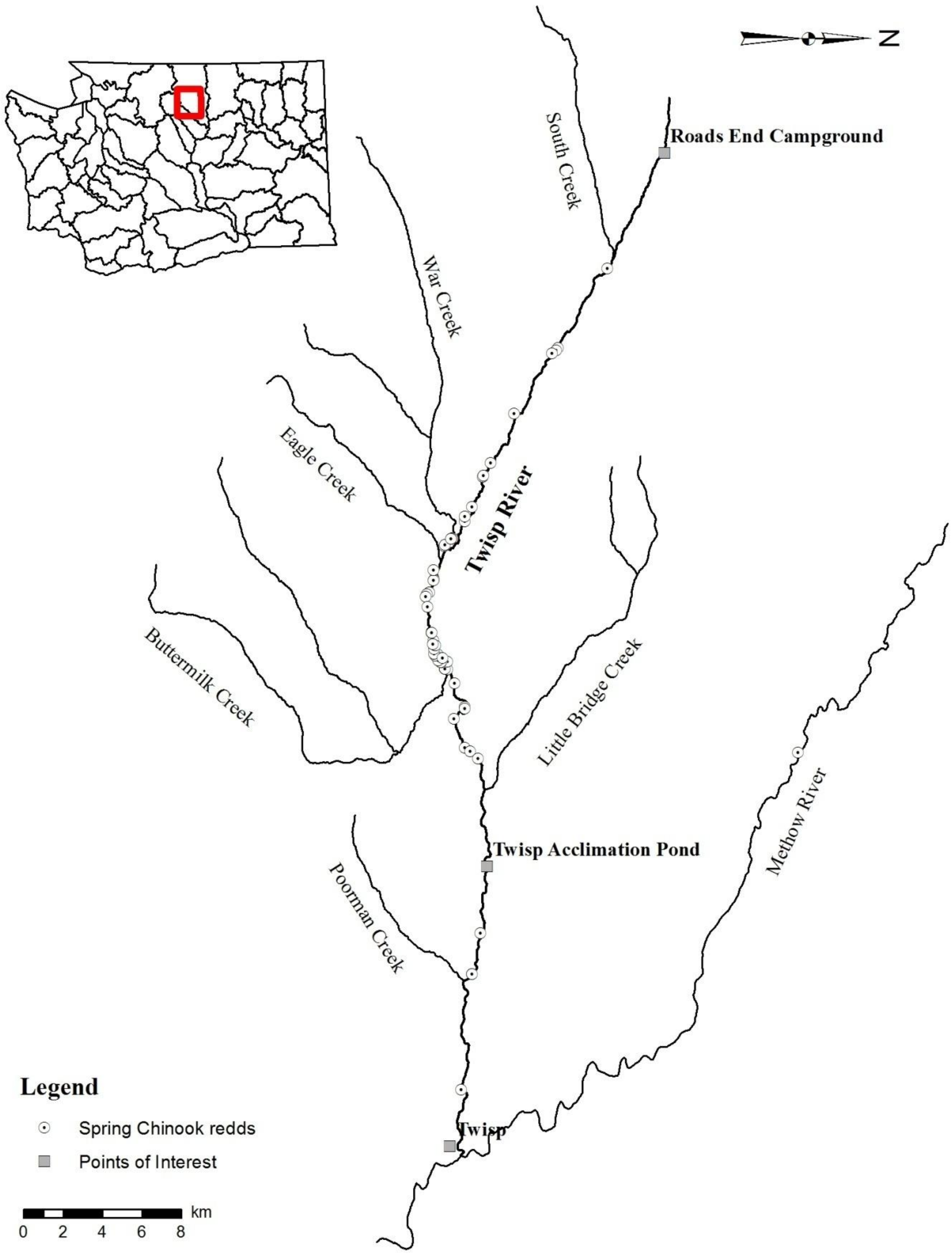

Figure 5. Spatial distribution of spring Chinook salmon redds in the Twisp River subbasin based on GPS waypoints collected during 2011 surveys.

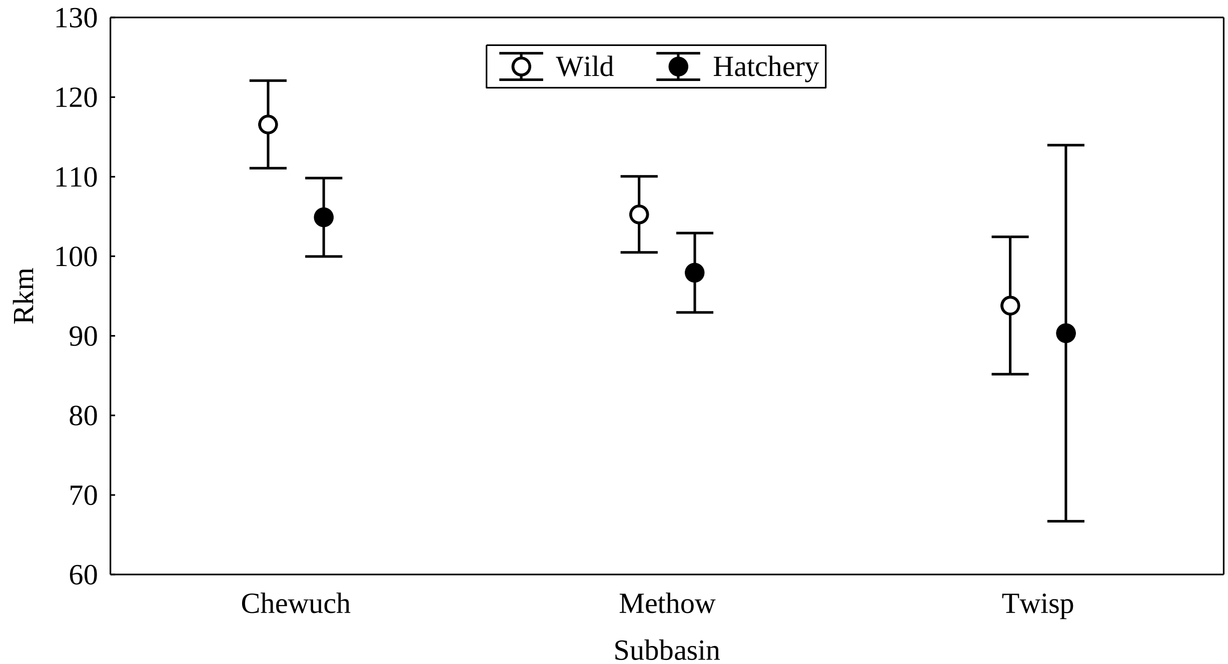

Figure 6. Mean redd distribution (rkm) of hatchery and wild females in the Methow River basin in 2011. Error bars represent 95% confidence intervals.

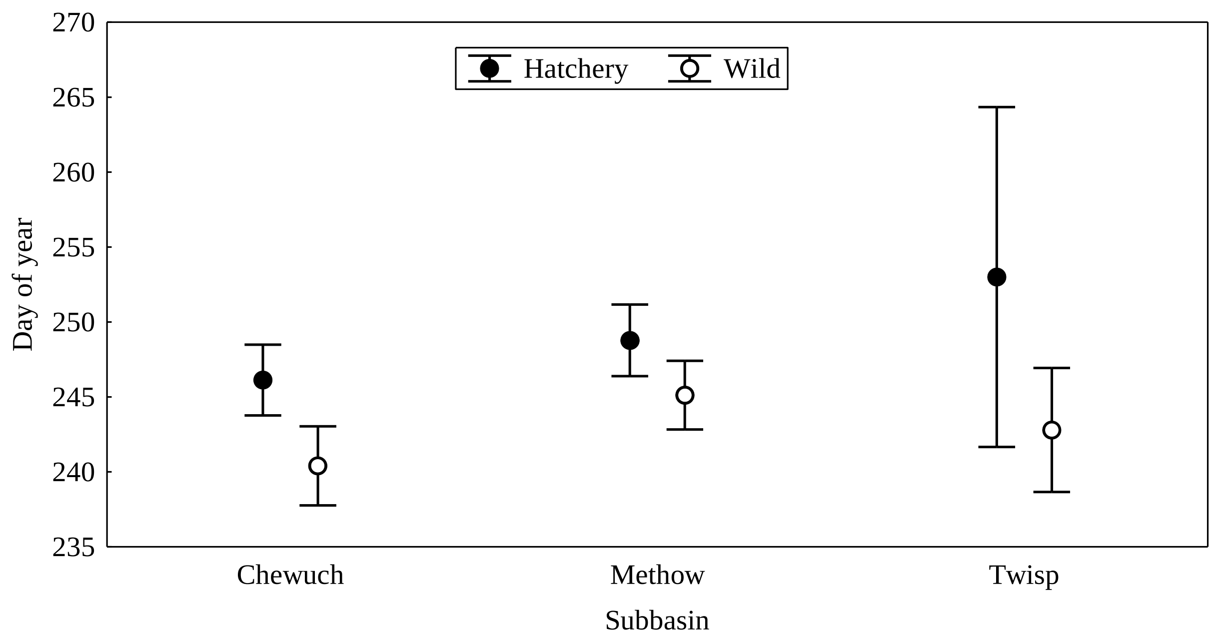

Figure 7. Mean spawn timing (Julian date) of hatchery and wild females in the Methow River basin in 2011. Error bars represent 95% confidence intervals.

Spawner Composition, Demographics, and Egg Deposition

Based on expanded redd counts, there were an estimated 2,936 spawners in the Methow River basin in 2011, of which 971 fish (33.1%) were estimated to be of wild origin (see Tables 2-4). Estimated spawning escapement does not include hatchery or wild fish collected for broodstock. The majority of carcasses (*N* = 629) were recovered in the Methow subbasin, followed by the Chewuch subbasin (*N* = 224), and the Twisp subbasin (*N* = 41; Table 5; Figures 8-10). Wild fish comprised 65.2% (pHOS = 0.348), 44.0% (pHOS = 0.560), and 23.6% (pHOS = 0.764) of the estimated spawning escapement in the Twisp, Chewuch, and Methow subbasins, respectively (see Tables 2-4).

Table 5. 2011 spring Chinook salmon carcass recoveries by origin, stock, and recovery subbasin. Age-3 and age-4 ad-clip-only fish were assumed to be Winthrop NFH releases while age-5 ad-clipped-only fish were assumed to be from Okanogan Basin (CCT) releases. Out-of-basin strays were identified through CWT extraction and identification. Unknown origin fish were those for which no hatchery mark could be identified and scale samples could not determine origin.

Origin	Release Site/Mark	Recovery Subbasin		
		Chewuch	Methow	Twisp
Hatchery	Chewuch	87	174	1
	Methow	9	140	0
	Twisp	0	24	7
	Winthrop NFH	16	146	0
	Ad-clip only - WNFH	4	0	0
	Ad-clip only - CCT	2	14	0
	Out-of-basin strays	12	5	4
	No mark (Unknown hatchery)[a]	8	28	0
Wild	Wild	77	99	28
Unknown	No mark (unknown)	9	3	1
Total		224	633	41

[a] Includes lost tags and hatchery fish missing heads.

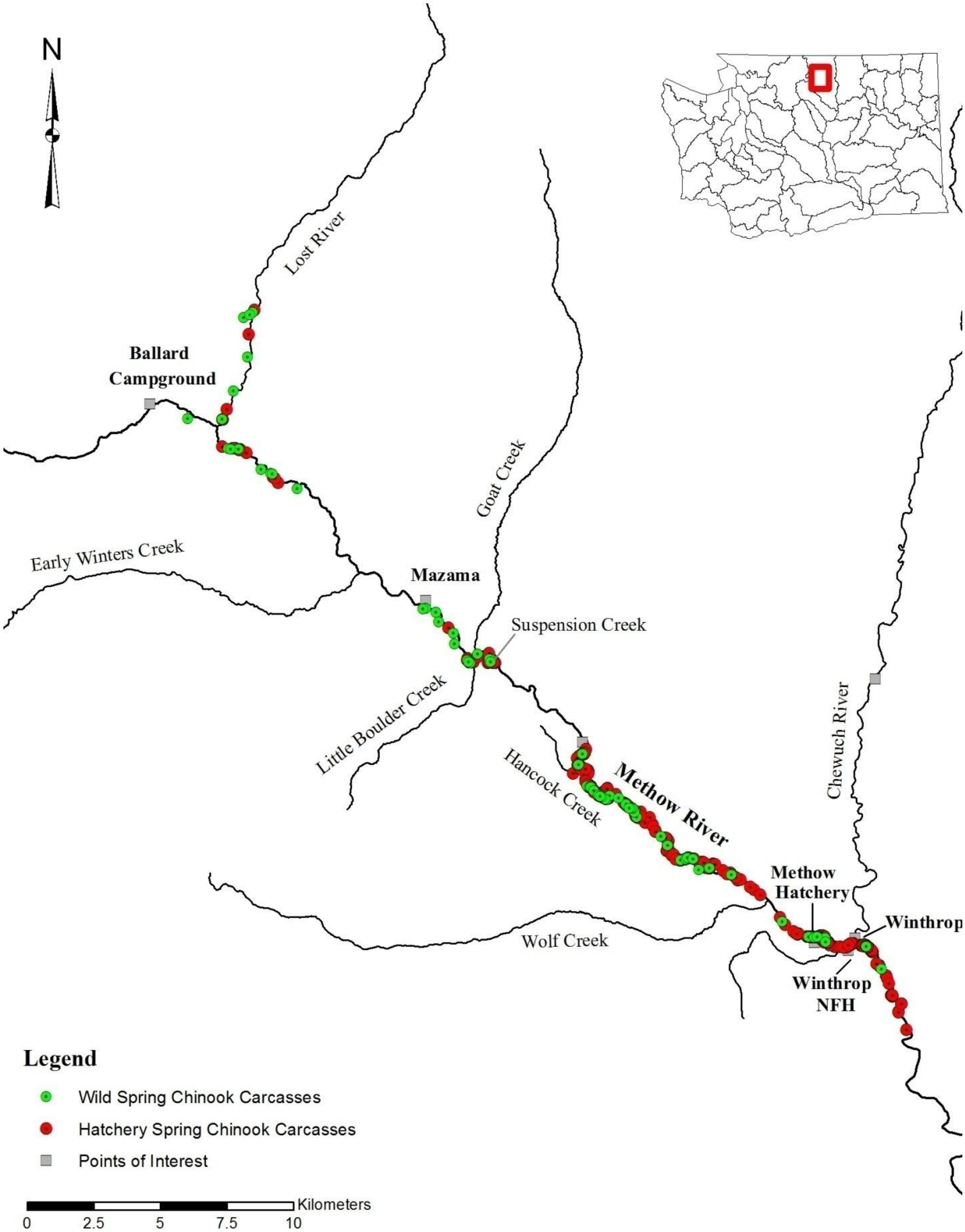

Figure 8. Spatial distribution of spring Chinook salmon carcasses in the upper Methow River subbasin based on GPS waypoints collected during 2011 surveys.

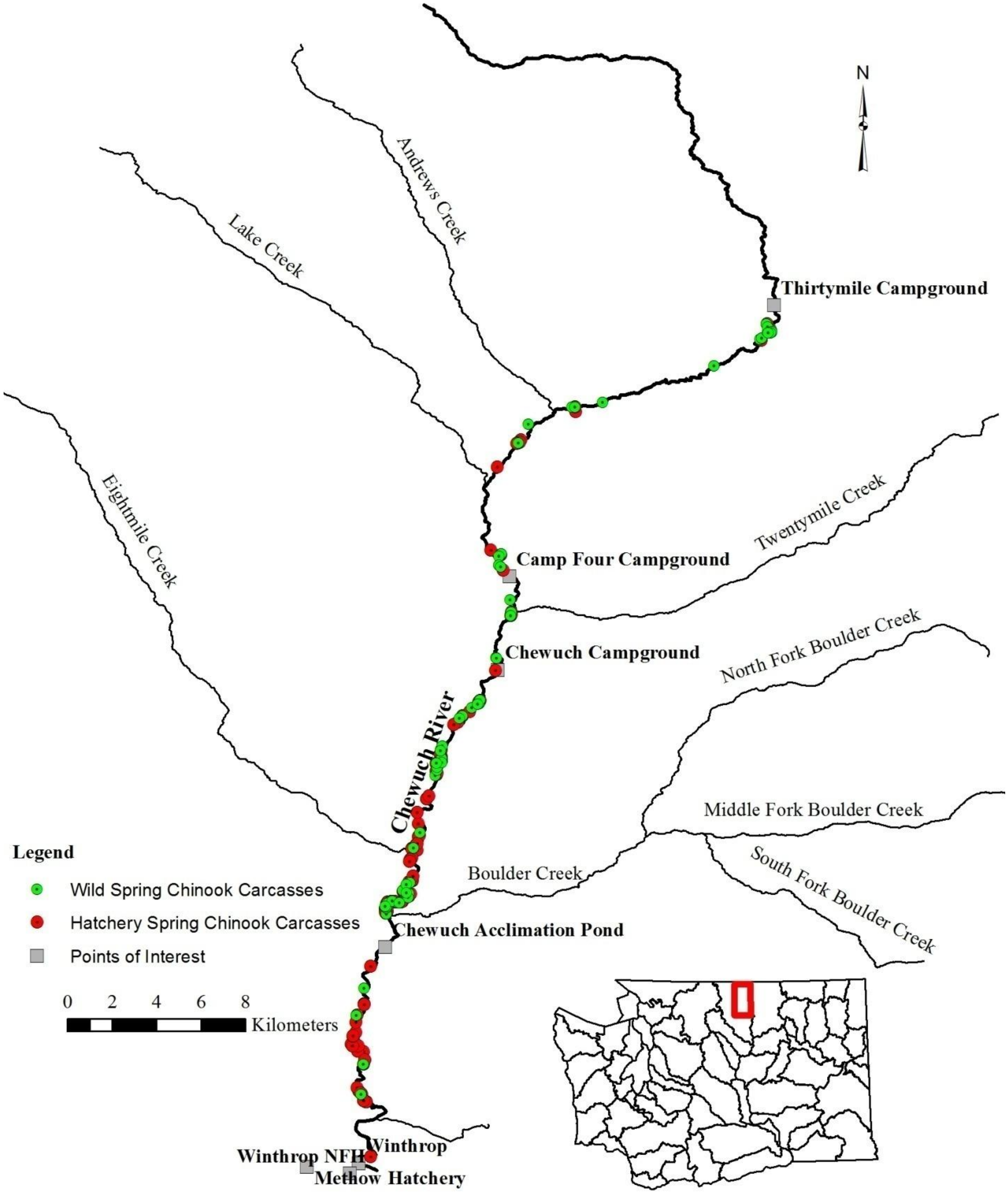

Figure 9. Spatial distribution of spring Chinook salmon carcasses in the Chewuch River subbasin based on GPS waypoints collected during 2011 surveys.

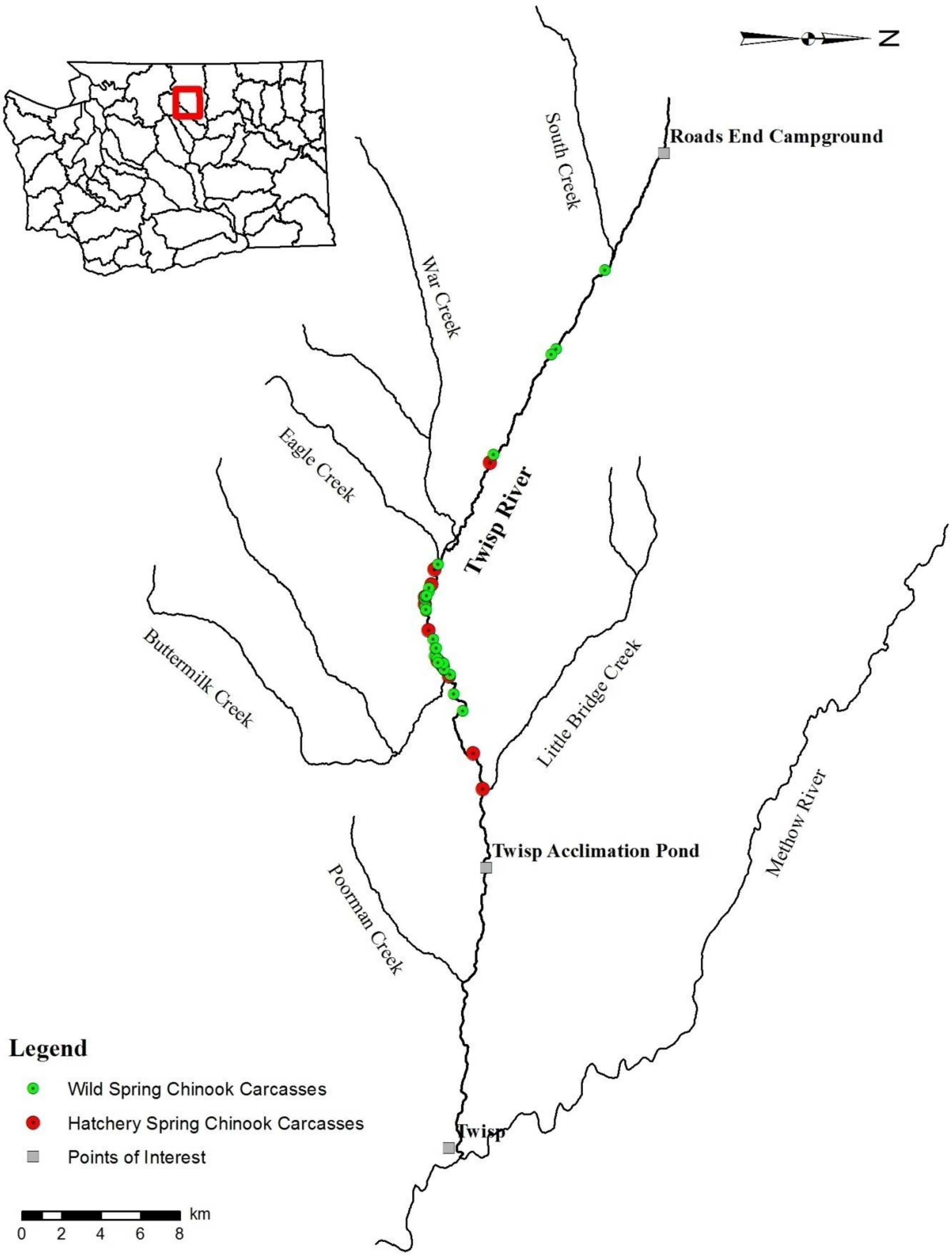

Figure 10. Spatial distribution of spring Chinook salmon carcasses in the Twisp River subbasin based on GPS waypoints collected during 2011 surveys.

Age, origin, gender, and length were determined for 876 of the 898 carcasses recovered (97.6%). Modal age of carcasses was age-4 (*N* = 472), accounting for 53.9% of confirmed hatchery and wild fish. A total of 436 carcasses (48.6%) were wild or local Methow Hatchery fish recovered in their subbasin of release (Table 6); fish from Winthrop NFH comprised a large proportion of overall recoveries. Surveyors recovered 90 of the 624 fish PIT-tagged at Wells Dam estimated to be on spawning grounds (14.4%; Table 7).

Egg retention was estimated for 363 of the 413 female carcasses examined. Using mean fecundities from MH broodstock (MetComp and Twisp), adjusting for mean egg-retention rates, and accounting for the proportion of hatchery and wild females by age class on the spawning grounds, an estimated total of 2,997,650 eggs were deposited in the Methow River basin in 2011 (Table 8). A total of nine redds were considered to be dewatered in 2011 (Upper Methow subbasin). There were no significant differences in length at age for all hatchery verses wild, within gender comparisons. There were also no significant differences in age at maturity between hatchery and wild fish within the MetComp and Twisp stocks (brood years 1993-2005).

Table 6. Mean POH length (*N*; SD) by age and sex of spring Chinook salmon carcasses recovered during Methow Basin spawning ground surveys in 2011. These data only include wild and Methow Hatchery fish recovered in their subbasin of release.

Age	Male		Female	
	Hatchery	Wild	Hatchery	Wild
		Chewuch subbasin		
1.1	38.8 (19; 3.0)	41.8 (4; 6.7)	- -	- -
1.2	56.5 (16; 7.7)	59.7 (17; 5.1)	60.5 (46; 2.3)	61.2 (13; 4.8)
1.3	70.5 (2; 3.5)	74.6 (17; 6.0)	68.8 (4; 5.6)	72.4 (26; 4.2)
		Methow subbasin		
1.1	39.8 (66; 3.1)	39.7 (3; 3.2)	45.0 (1; - -)	- -
1.2	60.2 (21; 5.3)	58.1 (18; 4.7)	61.1 (45; 3.6)	59.8 (33; 3.3)
1.3	74.5 (2; 4.9)	75.2 (19; 6.5)	69.4 (5; 2.5)	72.5 (24; 5.0)
		Twisp subbasin		
1.1	42.0 (5; 3.4)	41.0 (1; - -)	- -	- -
1.2	- -	54.0 (10; 2.8)	59.0 (2; 4.2)	63.0 (7; 4.0)
1.3	- -	77.0 (2; 8.5)	- -	69.0 (8; 3.1)

Table 7. Spawning ground recovery rates of hatchery spring Chinook salmon PIT-tagged at Wells Dam in 2011. Recovery rates are calculated from the fish remaining on spawning grounds after management actions, and accounting for escapement to the Okanogan Basin and fallback.

Recovery Subbasin/Subtotal	Age			Total
	1.1	1.2	1.3	
Total fish sampled at Wells Dam	507	409	64	980
Total collected in broodstock	11	116	25	152
Total excessed to tribes	76	65	2	143
Total identified in the Okanogan Basin	2	2	0	4
Total identified below Wells Dam	41	14	2	57
Potential spawning total	377	212	35	624
Recovered on Chewuch spawning grounds	2	8	1	11
Recovered on Methow spawning grounds	23	47	7	77
Recovered on Twisp spawning grounds	2	0	0	2
Total recovered	27	55	8	90
Recovery rate (%)	7.2	25.9	22.9	14.4

Table 8. Estimated egg deposition for spring Chinook salmon in the Methow Basin in 2011. Mean fecundities were derived from Methow Hatchery broodstock (MetComp or Twisp) and adjusted according to hatchery and wild proportions by age class in each subbasin.

Subbasin	Females with Egg Retention Estimated	Mean Fecundity	Mean Egg Retention (%)	Redds	Subbasin Proportion (%)	Estimated Egg Deposition		
						2009	2010	2011
Chewuch	104	4,089	0.4	225	30.0%	565,294	1,110,677	916,345
Methow	243	3,940	0.7	463[a]	61.6%	1,258,650	3,594,021	1,811,450
Twisp	16	4,292	0.2	63	8.4%	100,694	568,266	269,855
Total	363			751[a]	100.0%	1,924,638	5,272,964	2,997,650

[a] Total after removing nine dewatered redds in the upper Methow River.

Natural Replacement Rate

Natural replacement rates for the latest complete brood (2005) were less than 1.0 in all subbasins (Chewuch = 0.59, Methow = 0.34, Twisp = 0.31; Table 9). Historical NRR values of the spring Chinook salmon stocks in the Methow River basin have not met values necessary to replace the parent population (i.e., NRR ≥ 1.0) in ten of fourteen broodyears. Parent broods from 1995-1998 had high NRR values relative to other years (Appendix A), in part due to the low density of spawners and improved ocean conditions. Comparisons between NRR and HRR only include broodyears in which both metrics were available. Estimated spawning escapement in 1996 and 1998 was not based on redd counts (Murdoch 2007), so analyses were conducted both with and without these years. HRR was significantly greater than NRR in the Chewuch subbasin only when broodyears 1996 and 1998 were omitted (Mann Whitney U-test: $P < 0.01$; Table 10). HRR was significantly greater than NRR in the Methow and Twisp subbasins whether or not broodyears 1996 and 1998 were included (Mann Whitney U-tests: $P < 0.02$ in all cases; Table 10). HRR was not significantly different than the expected BAMP value (4.5; BAMP 1998) in the Chewuch and Methow subbasins (one-sample t-tests; Chewuch: $P = 0.78$, Methow: $P = 0.20$). HRR was significantly less than the expected BAMP value (4.5) in the Twisp subbasin (one-sample t-test: P = 0.04; 1992-2005 mean = 3.22)

Table 9. Estimated spawning escapement and NRR of spring Chinook salmon populations in the Methow River basin. Total expanded recruits were adjusted for harvest and indirect mortality associated with non-selective fisheries. Estimated spawning escapements in 1996 and 1998 were not based on redd counts (Murdoch 2007), and mean values are reported both with and without these brood years.

Broodyear (BY)	Est. Spawning	Adult Returns at Age			Total Expanded	NRR	
	Escapement	1.1	1.2	1.3	Recruits	Arithmetic	Geometric
			Chewuch River				
2005	508	5	282	8	299.6	0.59	- -
1992-2005 mean	386	2	109	28	157.8	2.71	0.65
1992-2005 mean (No BY 96, 98)	449	2	124	24	170.3	1.35	0.41
			Methow River and tributaries				
2005	747	11	239	3	257.4	0.34	- -
1992-2005 mean	1,020	6	111	44	175.0	2.05	0.39
1992-2005 mean (No BY 96, 98)	1,186	5	124	32	176.7	0.68	0.24
			Twisp River				
2005	121	4	28	5	37.5	0.31	- -
1992-2005 mean	203	7	81	25	129.7	2.71	0.61
1992-2005 mean (No BY 96, 98)	235	7	88	22	134.0	1.40	0.38

Table 10. Arithmetic mean NRR and HRR values for Methow basin spring Chinook salmon. All comparisons were analyzed using Mann-Whitney U-tests. Methow and Chewuch HRR values for 1996 and 1998 brood years are based on composite results (one CWT code for both release groups). Values are calculated both with and without brood years 1996 and 1998 because spawning escapements in these years were not based on redd counts.

Subbasin	Arithmetic Mean (± SD) Values for All Years		
	NRR	HRR	*P*-value
Chewuch (92-05)[a]	2.71 (4.19)	3.93 (4.19)	0.07
Chewuch (92-95, 97, 99-05)[a]	1.35 (2.45)	3.23 (2.78)	<0.01
Methow (92-05)[b]	2.05 (4.72)	5.32 (3.87)	<0.01
Methow (92-95, 97, 99-05)[b]	0.68 (1.18)	4.55 (3.03)	<0.01
Twisp (92-05)[c]	2.71 (4.35)	3.22 (3.38)	0.02
Twisp (92-95, 97, 99-05)[c]	1.40 (2.90)	3.02 (3.54)	<0.01
Overall (92-05)	2.33 (4.09)	4.44 (3.78)	0.01
Overall (92-95, 97, 99-05)	1.00 (1.89)	3.73 (2.96)	<0.01

[a] Statistical test excludes 1995 and 1999 brood year (no hatchery program).
[b] Statistical test excludes 1992 brood year (no hatchery program).
[c] Statistical test excludes 1995 brood year (no hatchery program).

Stray Rates by Brood Year

Stray rates were based on CWT recovered during spawning ground surveys. Further, all CWT recoveries of the 1992 and 1994 broods were within broodstock collections, thus stray rates were not calculated for these broods, and no Twisp or Chewuch fish were released from the 1995 brood year. The Methow and Chewuch programs were maintained and released as an aggregate stock (Methow Composite) in the 1998 and 2000 brood years; stray rates could not be determined for the individual release sites.

Based on total expanded CWT recoveries, an estimated 19.1% of the 2005 brood Twisp spring Chinook salmon carcasses were recovered on spawning grounds of non-target areas (Appendix B). Excluding brood years with no spawning ground recoveries (1992, 1994-1995), the recovery rate of Twisp River fish outside of the Twisp subbasin (mean = 15.4%, SD = 10.1) was significantly greater than the 5% target (one-sample t-test: $P < 0.01$). Based on total expanded CWT recoveries, an estimated 46.8% of the 2005 brood Chewuch spring Chinook salmon was recovered on non-target spawning grounds. Excluding brood years with no spawning ground recoveries (1992, 1994-1995, 1998, 2000), the recovery rate of Chewuch River fish outside of the Chewuch subbasin (mean = 26.8%, SD = 16.8) was significantly greater than the 5% target (one-sample t-test: $P < 0.01$). Based on total expanded CWT recoveries, an estimated 2.9% of the 2005 brood Methow spring Chinook salmon was recovered on non-target spawning grounds. Excluding broodyears with no spawning ground recoveries (1992, 1994, 1998, 2000), the recovery rate of Methow River fish outside of the upper Methow subbasin (mean = 2.8%, SD = 3.3) was significantly less than the 5% target (one-sample t-test: $P = 0.02$; arcsine square-root transformed data).

Stray Rates within the Methow Basin

A total of 625 coded wire tags (CWT's) were successfully decoded from spring Chinook salmon collected during spawning ground surveys in the Methow River basin in 2011. These fish were expanded by tag-specific retention rates and stream-specific sample rates to account for 2,171 fish (Table 11, Appendix C). As a proportion of total CWT recoveries, most within-basin strays were recovered in the Methow River. CWT expansions accounted for large numbers of out-of-basin strays in the Chewuch and Twisp Rivers (Table 11). In 2011, CWT recovery data indicated that fish released in the Methow subbasin strayed less (8.2%) within the Methow Basin than fish released in the Chewuch (60.2%) or Twisp (62.8%) subbasins (Table 12).

Table 11. Expanded CWT recoveries by Methow River subbasin 2011.

Subbasin	Local (%)	Winthrop (%)	Within-Basin Strays (%)	Out-of-Basin Strays (%)	Expanded CWT Recoveries
Chewuch	61.3	11.9	6.3	20.5	556
Methow	26.2	28.4	39.1	6.3	1,488
Twisp	33.1	33.4	4.7	62.2	127
Total	35.6	22.5	28.7	13.2	2,171

Table 12. Expanded CWT recoveries (%) by recovery and release stream in the Methow River basin in 2011.

Recovery Stream	Release Stream		
	Chewuch	Methow	Twisp
	Chewuch subbasin		
Chewuch River	39.8	8.2	0.0
	Methow subbasin		
Methow River	44.8	65.0	59.3
Lost River	1.7	0.0	0.0
Suspension Creek	3.1	0.0	0.0
Little Suspension Creek	0.9	0.0	3.5
Hancock Creek	0.0	1.9	0.0
MH outfall	5.4	15.5	0.0
WNFH outfall	3.6	9.4	0.0
Methow subbasin total	59.5	91.8	62.8
	Twisp subbasin		
Twisp River	0.7	0.0	37.2
Total	100.0	100.0	100.0

Table 13 shows the proportion of CWT recoveries comprising the estimated spawning escapements from 2000-2011 by subbasin. For run years 2000 to 2011, Twisp hatchery spring Chinook salmon comprised significantly less than 10% of the estimated spawning escapement in the Methow and Chewuch subbasins (one-sample t-tests: $P < 0.001$). Methow and Chewuch hatchery spring Chinook salmon comprised significantly less than 10% of the estimated spawning escapement in the Twisp subbasin (one sample t-tests: $P < 0.001$). Data for run years 2002 through 2004 in the Chewuch and Methow subbasins were omitted from statistical analyses because release locations for the 1998 and 2000 broods could not be separated (same CWT code). Spring Chinook salmon released in the Methow comprised significantly less than 10% of the estimated spawning population in the Chewuch subbasin (one sample t-test: $P < 0.01$). Chewuch spring Chinook salmon did not comprise significantly less than 10% of the estimated spawning population in the Methow subbasin (one sample t-test: $P = 0.14$).

Table 13. Proportion of CWT recoveries by subbasin comprising estimated spawning escapement in the Methow Basin from 2000-2011. Percent of spawning escapement comprised by wild fish is not calculated.

Run Year	Estimated Spawning Escapement			Hatchery Stock (% of spawning escapement)					
	Hatchery	Wild	Total	Chewuch	Methow	Twisp	Winthrop	MetComp[a]	Out-of Basin
				Chewuch River					
2000[b]	52	31	83	8.4	8.4	0.0	8.7	- -	18.5
2001	1,761	732	2,493	33.8	2.0	0.2	10.4	2.1	0.2
2002	588	78	666	3.6	0.0	0.0	7.9	69.7	0.0
2003	465	25	490	0.0	1.5	0.0	2.6	78.5	0.5
2004	289	46	335	5.1	1.1	0.0	3.0	70.7	0.0
2005	289	219	508	41.9	3.6	0.4	2.1	4.0	3.8
2006	378	135	513	28.8	3.2	0.9	5.5	- -	7.4
2007	203	74	277	20.0	8.4	0.0	8.9	- -	19.4
2008	166	86	252	26.7	4.5	0.0	17.3	- -	10.4
2009	500	271	771	30.8	9.9	1.5	16.0	- -	1.5
2010	341	155	496	39.0	6.7	0.4	14.7	- -	2.5
2011	499	370	869	39.2	4.1	0.0	7.6	- -	13.0
				Methow River					
2000	574	65	639	2.5	38.0	2.9	25.5	- -	0.0
2001	6,994	594	7,588	7.9	27.8	0.4	45.6	1.8	0.4
2002	1,644	86	1,730	0.6	4.6	1.1	28.3	47.1	0.0
2003	597	8	605	0.0	5.1	4.0	26.3	43.3	0.6
2004	622	199	821	3.6	4.5	4.4	16.9	35.6	0.0
2005	526	221	747	32.2	16.2	1.6	11.7	1.2	1.7
2006	942	128	1,070	22.8	25.2	4.6	19.1	- -	7.0
2007	545	152	697	12.3	6.8	7.2	36.6	- -	6.9
2008	468	172	640[c]	11.8	16.2	0.4	38.9	- -	3.1
2009	1,480	261	1,741	10.9	27.2	2.3	36.8	- -	3.4
2010	1,370	251	1,621	10.8	34.9	0.8	29.2	- -	0.4
2011	1,391	432	1,823	28.1	21.4	3.9	23.2	- -	5.1
				Twisp River					
2000	235	21	256	0.0	0.0	72.6	2.2	- -	0.0
2001	384	506	890	1.5	0.8	19.6	0.8	0.0	0.0
2002	60	181	241	0.0	0.0	9.1	12.1	3.1	0.0
2003	18	25	43	0.0	0.0	30.2	0.0	0.0	0.0
2004	98	243	341	0.0	0.0	19.7	1.2	1.3	4.4
2005	34	87	121	2.6	0.0	15.8	0.0	0.0	0.0
2006	100	65	165	0.0	2.5	40.0	2.8	- -	0.0
2007	65	40	105	0.0	0.0	55.2	0.0	- -	0.0
2008	126	40	166	2.7	0.0	60.1	0.0	- -	4.0
2009	97	32	129	0.0	0.0	55.6	3.4	- -	3.4
2010	96	156	252	1.4	0.0	30.1	2.8	- -	1.4
2011	85	159	244	2.5	0.0	17.4	0.0	- -	32.4

[a] Unable to determine release location for 1998 and 2000 MetComp via CWT code.
[b] 2000 run year data not used in statistical analysis of Chewuch subbasin strays.
[c] Greater than estimated spawning escapement from fish-per-redd expanded redd counts; includes actual number of carcasses in reaches where total recoveries exceeded estimated escapement.

Stray Rates outside the Methow Basin

A total of 58 fish from Methow Hatchery were estimated to have strayed to spawning grounds outside the Methow River basin. Of these, 39 fish strayed into other spring Chinook salmon populations (e.g., Chiwawa and Entiat Rivers; Table 14). Stray Methow Hatchery fish have comprised less than 5.0% of the overall estimated spawning escapement to the Entiat River (one-sample t-test: $P < 0.001$; Table 14). The Similkameen River does not have an extant spring Chinook population.

Table 14. Methow Hatchery program strays by run year and recovery location.

Run year	Recovery Location	CWT	Stock	Expanded Recoveries	Estimated Escapement	% of Population
2006	Chiwawa River	631976	MetComp	2	529	0.38
1997	Entiat River	635551	Methow	1[a]	89	- -
2000	Entiat River	630130	Methow	6	175	3.43
2001	Entiat River	630613	Methow	3	485	0.62
2002	Entiat River	631024	MetComp	5	370	1.35
2003	Entiat River	631024	MetComp	6	259	2.32
2006	Entiat River	631976	MetComp	4	257	1.56
2007	Entiat River	632564	Twisp	6	245	2.45
2010	Entiat River	633866	MetComp	6	490	1.22
2000	Similkameen River	630130	Methow	3	- -	- -
2001	Similkameen River	630614	Chewuch	5	- -	- -
2001	Similkameen River	631024	MetComp	5	- -	- -
2002	Similkameen River	631024	MetComp	5	- -	- -
2003	Similkameen River	631024	MetComp	1	- -	- -

[a] Fish was recovered during WDFW genetic study trapping and was not included in spawning escapement estimate.

Discussion

In 2011, fallback accounted for 8.2% (*N* = 734) of the run-at-large at Wells Dam which was lower than estimated fallback in 2010 (1.3%; *N* = 110). The majority of fish falling back below Wells Dam were estimated from the group of un-sampled fish migrating through the East Ladder of Wells Dam (71.3%, *N* = 523). Migration through the East Ladder was proportionately greater in 2011 than the recent 5-year mean (2011 = 58.0%; 2006-2010 mean = 29.7%). Similarly, mean daily discharge at Wells Dam from 1 May through 30 June was 45.9% higher in 2011 than the recent 5-year mean (2011 = 232,000 cfs; 2006-2010 mean = 159,000 cfs). Boggs et al. (2004) found that fallback rates of spring-summer Chinook salmon were positively correlated with mean daily discharge in mainstem Columbia River dams. By combining PIT tag data with radio telemetry data from Columbia and Snake river dams, Boggs et al. (2004) found that less than 2% of spring-summer Chinook salmon stray to non-natal streams; therefore, most of the fallback at Wells Dam was likely comprised of non-Methow Basin fish returning to their natal stream after temporarily overshooting their basin of origin. It appears that increased usage of the Wells Dam East Ladder by spring Chinook salmon may also be related to mean daily discharge.

In 2011, the proportion of redds found in the Methow subbasin (62.1%) was similar to the recent eight-year mean (59.6%). However, the distribution of redds among reaches, and more specifically, tributaries within the Methow subbasin varies substantially among years. Some tributaries with abundant spawning in 2010 had very little, or no spawning detected in 2011 (e.g., Wolf Creek, Early Winters Creek). Spawning in these tributaries has been unpredictable and is unlikely influenced by variations in prevailing environmental conditions and available habitat. Since recent historic run escapement has been primarily fish of hatchery origin, the behavior of the spawning population as a whole is dictated in large part by hatchery fish. Though no redds were found in Wolf Creek in 2011, a total of 98 adults were detected at the Wolf Creek antenna array. However, only a single fish was female, and 91 of these fish were 3-year-old hatchery jacks. Thus, consistent, or lack of use of various tributaries in the Methow Basin may be influenced more by behaviors of hatchery fish and recent management actions than by habitat suitability and availability.

Spawning activity for spring Chinook in the Methow Basin coincides with cooling water temperatures and a decreasing photoperiod. Water temperatures typically cool to preferred spawning range in headwater areas first and cooling progresses downstream through the spawning season. On average, we found that wild females spawned further upstream than hatchery females in the Chewuch and Methow subbasins but these results were likely influenced by large numbers of hatchery fish spawning in close proximity to their release locations. Since most of the suitable spawning habitat in the Twisp subbasin is located upstream of the Twisp acclimation pond between Little Bridge Creek and War Creek, it is plausible to expect that returning Twisp stock hatchery fish will have spawning distributions similar to wild fish. We also detected a statistical difference suggesting that wild females spawned significantly earlier than hatchery females in the Methow and Chewuch subbasins.

Ongoing studies designed to estimate surveyor efficiency will provide fisheries managers greater accuracy in annual redd count estimates which should assist in producing more accurate estimates of escapement. Estimated spawning escapement typically represents only 50% of estimated run escapement, even after accounting for fallback and escapement to the Okanogan River. Other factors affecting escapement estimates (e.g., pre-spawn mortality, predation, poaching) can be difficult to estimate. Surveys are not currently conducted prior to spawning (August and September), but there is no anecdotal evidence suggesting that pre-spawn mortality is high (e.g., carcasses reported during the trout fishery). Ultimately, little is known about the fate of spring Chinook in their natal tributaries prior to spawning. If results of the study evaluating surveyor efficiency conclude that redd counts are effectively enumerating total spawning escapement, then further studies should be developed to determine the limiting factors influencing survival of adult spring Chinook salmon upstream of Wells Dam.

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Appendix A. Natural Replacement Rate (NRR) summary by subbasin for brood years 1992 through 2005 with corresponding hatchery replacement rates (HRR). NOR = natural origin recruits.

Parent brood	Est. spawning escapement	Return age 1.1	Return age 1.2	Return age 1.3	Total expanded recruits (NOR)	NRR	HRR
Chewuch River							
1992	421.75	0	25	14	41.25	0.10	1.86
1993	184.34	2	69	21	95.53	0.52	1.13
1994	62.85	0	15	3	18.95	0.30	0.17
1995	6.09	1	12	19	33.69	5.53	- -
1996	8.00	0	13	86	102.02	12.75	0.58
1997	123.30	1	662	55	921.30	7.47	4.61
1998	7.00	11	23	19	62.69	8.96	14.29
1999	21.08	0	2	0	2.14	0.10	- -
2000	82.84	6	47	13	69.97	0.85	5.80
2001	2,493.22	0	205	49	265.09	0.11	8.68
2002	665.75	2	91	60	164.69	0.25	5.68
2003	489.60	0	15	33	50.25	0.10	1.02
2004	334.62	4	63	11	81.58	0.24	1.47
2005	507.78	5	282	8	299.62	0.59	1.93
Methow River							
1992	924.26	0	44	43	92.38	0.10	- -
1993	759.56	5	79	32	119.66	0.16	2.11
1994	172.27	0	23	7	30.46	0.18	0.50
1995	27.39	1	54	18	77.30	2.82	10.17
1996	15.00	1	30	230	268.34	17.89	4.85
1997	152.45	21	348	50	537.66	3.53	4.39
1998	23.00	16	34	2	60.75	2.64	14.29
1999	70.27	3	2	0	4.32	0.06	1.61
2000	639.39	5	197	39	256.60	0.40	5.80
2001	7,587.84	3	183	36	231.13	0.03	7.36
2002	1,729.65	0	96	93	203.86	0.12	7.40
2003	604.80	0	59	27	90.12	0.15	1.90
2004	820.82	13	163	35	219.75	0.27	5.96
2005	746.76	11	239	3	257.40	0.34	2.83
Twisp River							
1992	316.61	0	54	37	96.00	0.30	1.17
1993	426.42	5	27	17	50.48	0.12	0.64
1994	74.49	0	13	9	22.94	0.31	1.00
1995	12.17	0	26	12	39.30	3.23	- -
1996	8.00	0	11	56	69.10	8.64	6.40
1997	71.74	0	460	109	729.31	10.17	3.60
1998	11.00	24	72	21	138.15	12.56	2.20
1999	24.60	0	7	0	7.36	0.30	1.91
2000	256.27	37	264	17	339.31	1.32	2.70
2001	889.58	27	77	20	129.24	0.15	1.47
2002	241.09	0	47	35	88.65	0.37	13.33
2003	43.20	0	1	0	1.05	0.02	1.48
2004	340.55	8	48	9	67.06	0.20	3.28
2005	121.00	4	28	5	37.52	0.31	2.56

Appendix B. Methow Hatchery expanded CWT recoveries by program and brood year. Stray rate is the percent of spawning ground recoveries collected on non-target spawning grounds. T = target, NT = non-target, W = Wells Dam, Com. = commercial, Sp. = sport, Trbl. = tribal. 1998 and 2000 MetComp broods were not given unique CWT tag codes based on release river and are not included.

Brood	Broodstock			Spawning grounds		Ocean fishery			Freshwater fishery			Total	Stray rate	
	T	NT	W	T	NT	Com.	Sp.	Trbl.	Com.	Sp.	Trbl.		W/ harvest	No harvest
Chewuch spring Chinook salmon														
1992	0	1	38	0	0	0	0	0	0	0	0	39	- -	- -
1993	0	19	79	8	3	5	0	0	0	0	1	115	2.6%	2.8%
1994	0	0	3	0	0	0	0	0	0	0	0	3	- -	- -
1996	- -	15	15	0	4	0	0	0	6	0	1	41	9.8%	11.8%
1997	26	39	22	4	27	2	0	0	24	144	7	295	9.2%	22.9%
2001	15	46	2	323	321	3	0	0	33	114	0	857	37.5%	45.4%
2002	2	92	58	174	299	6	0	0	34	197	8	870	34.4%	47.8%
2003	0	12	10	7	22	2	0	0	2	2	0	57	38.6%	43.1%
2004	0	35	4	76	70	0	0	0	6	7	0	198	35.4%	37.8%
2005	37	0	1	117	147	0	0	0	5	7	0	314	46.8%	48.7%
Methow spring Chinook salmon														
1993	43	0	134	6	1	0	0	0	0	4	3	191	0.5%	0.5%
1994	0	0	1	0	0	0	0	0	0	0	0	1	- -	- -
1995	3	0	114	3	0	2	0	0	0	0	0	122	0.0%	0.0%
1996	200	0	58	221	8	0	0	0	2	0	11	500	1.6%	1.6%
1997	297	0	3	16	1	3	0	0	280	209	12	821	0.1%	0.3%
1998	- -	- -	- -	- -	- -	3	0	0	462	428	30	923	- -	- -
1999	93	0	- -	35	7	1	0	0	3	6	0	145	4.8%	5.2%
2000	- -	- -	- -	- -	- -	5	0	0	69	111	0	185	- -	- -
2001	289	0	5	182	23	2	0	0	24	81	0	606	3.8%	4.6%
2002	245	2	37	287	26	5	0	0	33	188	8	831	3.1%	4.4%
2003	43	0	5	4	0	1	0	0	2	2	0	57	0.0%	0.0%
2004	133	0	5	110	33	0	0	0	11	13	0	305	10.8%	11.7%
2005	162	1	5	148	10	0	0	0	5	8	0	339	2.9%	3.1%
Twisp spring Chinook salmon														
1992	0	0	21	0	0	0	0	0	0	0	0	21	- -	- -
1993	0	3	18	1	1	0	0	0	0	4	0	27	3.7%	4.3%
1994	0	0	4	0	0	0	0	0	0	0	0	4	- -	- -
1996	2	33	65	151	17	0	0	0	1	0	6	275	6.2%	6.3%
1997	10	6	- -	14	0	0	0	0	14	9	1	54	0.0%	0.0%
1998	1	8	- -	0	2	0	0	0	11	0	0	22	9.1%	18.2%
1999	3	25	- -	8	20	1	0	0	4	0	0	61	32.8%	35.7%
2000	22	12	0	67	40	0	0	0	13	41	0	195	20.5%	28.4%
2001	2	0	1	33	7	0	0	0	2	7	0	52	13.5%	16.3%
2002	7	59	6	70	66	2	0	0	11	66	3	290	22.8%	31.7%
2003	2	2	6	21	13	1	0	0	2	2	0	49	26.5%	29.5%
2004	22	6	5	97	27	0	0	0	7	8	0	172	15.7%	17.2%
2005	10	1	0	25	9	0	0	0	1	1	0	47	19.1%	20.0%

Appendix C. Expanded coded wire tag (CWT) recoveries in 2011 by recovery location. Recoveries were expanded by tag-specific mark rates and stream (Methow River, Lost River, etc.) sample rates.

Recovery location	Brood Year	Tag code	Release River	Stray status	Estimated escapement
Chewuch River	2006	053180	Methow	Winthrop	4
Chewuch River	2006	053181	Methow	Winthrop	8
Chewuch River	2006	633884	Chewuch	Local	24
Chewuch River	2007	053573	Clearwater	Out-of-basin	30
Chewuch River	2007	053576	Methow	Winthrop	4
Chewuch River	2007	054299	Methow	Winthrop	8
Chewuch River	2007	054364	Methow	Winthrop	30
Chewuch River	2007	101081	Lochsa	Out-of-basin	8
Chewuch River	2007	102481	Clearwater	Out-of-basin	25
Chewuch River	2007	634290	Chiwawa	Out-of-basin	4
Chewuch River	2007	634291	Chiwawa	Out-of-basin	8
Chewuch River	2007	634293	Methow	Within-basin	8
Chewuch River	2007	634294	Chewuch	Local	192
Chewuch River	2007	634471	Chewuch	Local	51
Chewuch River	2008	054365	Methow	Winthrop	8
Chewuch River	2008	054713	Icicle Creek	Out-of-basin	19
Chewuch River	2008	054965	Methow	Winthrop	4
Chewuch River	2008	612767	Clearwater	Out-of-basin	4
Chewuch River	2008	634866	Methow	Within-basin	27
Chewuch River	2008	634869	Chiwawa	Out-of-basin	12
Chewuch River	2008	635091	Chiwawa	Out-of-basin	4
Chewuch River	2008	635099	Chewuch	Local	74
Hancock Creek	2006	633866	Methow	Local	8
Little Suspension Creek	2007	634471	Chewuch	Within-basin	4
Little Suspension Creek	2008	635085	Twisp	Within-basin	4
Little Suspension Creek	2008	635099	Chewuch	Within-basin	4
Lost River	2006	633884	Chewuch	Within-basin	5
Lost River	2007	054364	Methow	Winthrop	6
Lost River	2007	634291	Chiwawa	Out-of-basin	5
Lost River	2007	634294	Chewuch	Within-basin	10
MH outfall[1]	2006	053181	Methow	Winthrop	3
MH outfall[1]	2006	633866	Methow	Local	6
MH outfall[1]	2007	053576	Methow	Winthrop	8
MH outfall[1]	2007	054299	Methow	Winthrop	9
MH outfall[1]	2007	054364	Methow	Winthrop	3
MH outfall[1]	2007	634293	Methow	Local	41
MH outfall[1]	2007	634294	Chewuch	Within-basin	36
MH outfall[1]	2007	634471	Chewuch	Within-basin	5
MH outfall[1]	2007	634674	Methow	Local	8
MH outfall[1]	2008	054365	Methow	Winthrop	3
MH outfall[1]	2008	054784	Methow	Winthrop	3

Appendix C, continued.

Recovery location	Brood Year	Tag code	Release River	Stray status	Estimated escapement
MH outfall[1]	2008	634866	Methow	Local	11
MH outfall[1]	2008	635099	Chewuch	Within-basin	5
Methow River	2006	052574	Methow	Winthrop	6
Methow River	2006	053179	Methow	Winthrop	3
Methow River	2006	053180	Methow	Winthrop	6
Methow River	2006	053181	Methow	Winthrop	15
Methow River	2006	633687	Twisp	Within-basin	3
Methow River	2006	633866	Methow	Local	9
Methow River	2006	633884	Chewuch	Within-basin	6
Methow River	2007	053576	Methow	Winthrop	20
Methow River	2007	054299	Methow	Winthrop	67
Methow River	2007	054364	Methow	Winthrop	77
Methow River	2007	634291	Chiwawa	Out-of-basin	3
Methow River	2007	634293	Methow	Local	106
Methow River	2007	634294	Chewuch	Within-basin	178
Methow River	2007	634471	Chewuch	Within-basin	17
Methow River	2007	634673	Twisp	Within-basin	6
Methow River	2007	634674	Methow	Local	9
Methow River	2008	052878	Methow	Winthrop	12
Methow River	2008	054365	Methow	Winthrop	29
Methow River	2008	054784	Methow	Winthrop	47
Methow River	2008	054965	Methow	Winthrop	6
Methow River	2008	102683	Clearwater	Out-of-basin	6
Methow River	2008	634866	Methow	Local	152
Methow River	2008	635085	Twisp	Within-basin	58
Methow River	2008	635091	Chiwawa	Out-of-basin	3
Methow River	2008	635099	Chewuch	Within-basin	183
Suspension Creek	2007	054195	Icicle Creek	Out-of-basin	76
Suspension Creek	2007	054364	Methow	Winthrop	19
Suspension Creek	2007	634294	Chewuch	Within-basin	27
Twisp River	2007	634291	Chiwawa	Out-of-basin	6
Twisp River	2007	634673	Twisp	Local	12
Twisp River	2008	107282	Clearwater	Out-of-basin	61
Twisp River	2008	109782	Selway	Out-of-basin	6
Twisp River	2008	635085	Twisp	Local	30
Twisp River	2008	635091	Chiwawa	Out-of-basin	6
Twisp River	2008	635099	Chewuch	Within-basin	6
WNFH outfall[2]	2006	052574	Methow	Winthrop	6
WNFH outfall[2]	2006	053179	Methow	Winthrop	4
WNFH outfall[2]	2006	053180	Methow	Winthrop	6
WNFH outfall[2]	2006	053181	Methow	Winthrop	5
WNFH outfall[2]	2006	633866	Methow	Local	2
WNFH outfall[2]	2007	053576	Methow	Winthrop	4

Appendix C, continued.

Recovery location	Brood Year	Tag code	Release River	Stray status	Estimated escapement
WNFH outfall[2]	2007	054299	Methow	Winthrop	16
WNFH outfall[2]	2007	054364	Methow	Winthrop	21
WNFH outfall[2]	2007	634293	Methow	Local	8
WNFH outfall[2]	2007	634294	Chewuch	Within-basin	25
WNFH outfall[2]	2007	634471	Chewuch	Within-basin	2
WNFH outfall[2]	2007	634674	Methow	Local	9
WNFH outfall[2]	2008	054365	Methow	Winthrop	11
WNFH outfall[2]	2008	054784	Methow	Winthrop	6
WNFH outfall[2]	2008	054965	Methow	Winthrop	2
WNFH outfall[2]	2008	634866	Methow	Local	21
WNFH outfall[2]	2008	635099	Chewuch	Within-basin	4

[1]Methow State Fish Hatchery outfall.
[2]Winthrop National Fish Hatchery outfall.

Appendix D. Methow River subbasin spring Chinook salmon redd counts by section and survey year. Ns = not surveyed.

Section Description	Reach code	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ballard C.G. - Lost River	M15	0	0	0	6	4	1	0	8	3
Lost River - Gate Creek	M14	4	9	7	17	12	17	11	32	23
Gate Creek - Early Winters Creek	M13	0	14	0	5	3	13	1	34	9
Early Winters Creek - Mazama Bridge	M12	6	9	10	20	13	9	10	14	15
Mazama Bridge - Suspension Bridge	M11	7	10	12	24	15	17	14	50	22
Suspension Bridge - Weeman Bridge	M10	34	51	45	36	19	31	44	63	26
Weeman Bridge - Along Highway 20	M9	105	104	136	173	84	94	138	332	156
Along Highway 20 - Wolf Creek	M8	2	3	5	9	2	4	11	8	0
Wolf Creek - Foghorn Dam	M7	20	16	19	59	10	13	11	67	37
Foghorn Dam - Winthrop Bridge	M6	19	17	18	46	12	20	12	71	54
Winthrop Bridge – MVID diversion	M5	5	0	7	0	Ns	2	3	9	3
MVID diversion – Twisp Bridge	M4	Ns	0	0	0	Ns	1	Ns	1[a]	0
Twisp Bridge – Upper Burma Bridge	M3,2	Ns	Ns	Ns	Ns	Ns	Ns	Ns	4[a]	Ns
Eureka Creek - Lost River Bridge	L2	1	10	12	26	11	10	9	12	11
Lost River Bridge - Confluence	L1	0	5	1	2	0	2	4	5	4
Klipchuck C,G. - Early Winters Bridge	EW5	0	0	0	0	0	0	0	0	0
Early Winters Bridge - Highway 20 Bridge	EW4	0	0	0	0	0	0	3	4	0
Highway 20 Bridge - Diversion dam	EW3	3	10	0	9	3	2	7	26	3
Diversion dam - Highway 20 Bridge	EW2	1	0	0	1	0	0	0	1	0
Highway 20 Bridge - Confluence	EW1	0	0	2	4	0	0	0	0	0
Various reaches of Gold Creek + Foggy Dew Creek	GDN4-1,FD1	Ns	Ns	0	0	1	0	0	5	1
Suspension Creek (Entire length)	Susp1	19	12	7	36	0	7	9	31	16
Little Suspension Creek (Entire length)	Lsusp1	Ns	Ns	Ns	Ns	Ns	Ns	Ns	0	5
Methow Hatchery Outfall (Entire length)	MH1	13	9	8	75	7	10	14	50	38
Winthrop NFH Outfall (Entire length)	WN1	11	8	5	21	3	25	17	55	44
Hancock Cr. (Kumm Rd. to Wolf Cr. Rd.)	HA2	Ns	Ns	Ns	Ns	Ns	Ns	Ns	19	2
Hancock Cr. (Wolf Cr. Rd. to Confluence)	HA1	Ns	Ns	Ns	Ns	Ns	Ns	Ns	1	0
Wolf Creek (Rd 5505 access - footbridge)	W3,2	0	Ns	Ns	Ns	Ns	Ns	5	30	0
Wolf Creek (footbridge - Confluence)	W1	2	0	0	0	0	0	0	3	0
Upper Methow River subbasin total		252	287	294	569	199	278	323	935	472

[a] Data provided by BioAnalysts.

Appendix E. Chewuch River subbasin spring Chinook salmon redd counts by section and survey year. Ns = not surveyed.

Section Description	Reach code	2003	2004	2005	2006	2007	2008	2009	2010	2011
Chewuch Falls - 30 Mile Bridge	C13	Ns	Ns	0	Ns	0	2	2	2	8
30 Mile Bridge - Road Side Camp	C12	0	0	3	1	5	4	10	32	35
Road Side Camp - Andrews Creek	C11	0	0	1	1	1	3	4	9	8
Andrews Creek - Lake Creek	C10	0	0	7	9	0	7	4	10	14
Lake Creek - Buck Creek	C9	2	0	0	0	0	1	0	0	0
Buck Creek - Camp 4 C.G.	C8	14	10	5	10	7	7	7	8	18
Camp 4 C.G. - Chewuch Campground	C7	25	2	16	32	9	16	11	24	17
Chewuch C.G. - Falls Creek C.G.	C6	16	19	33	54	23	21	30	37	25
Falls Creek C.G. - Eightmile Creek	C5	18	27	32	22	8	12	14	15	23
Eightmile Creek - Boulder Creek	C4	49	20	44	63	9	19	26	82	45
Boulder Creek - Chewuch Bridge	C3	3	0	10	5	0	0	0	5	0
Chewuch Bridge - WDFW Land	C2	51	29	55	51	13	21	29	52	27
WDFW Land - Confluence	C1	26	10	11	25	4	7	6	9	5
Eightmile Creek Bridge - Confluence	EM1	0	Ns	0	Ns	Ns	0	0	0	0
Black Lake - Confluence	LK2,1	0	0	Ns	Ns	Ns	Ns	Ns	1[a]	Ns
Chewuch River subbasin total		204	117	217	273	79	120	143	286	225

[a] Partial survey in LK2.

Appendix F. Twisp River subbasin spring Chinook salmon redd counts by section and survey year. Ns = not surveyed.

Section Description	Reach code	2003	2004	2005	2006	2007	2008	2009	2010	2011
Road’s End C.G. - South Creek Bridge	T10	0	0	0	0	0	0	0	0	0
South Creek Bridge - Poplar Flats C.G.	T9	0	0	0	0	0	0	0	1	1
Poplar Flats C.G. - Mystery Bridge	T8	0	1	0	3	0	0	0	11	3
Mystery Bridge - War Creek Bridge	T7	1	24	5	19	7	18	5	21	7
War Creek Bridge - Buttermilk Bridge	T6	8	62	24	39	14	24	11	54	40
Buttermilk Bridge - Little Bridge Cr.	T5	7	26	10	15	9	26	3	35	8
Little Bridge Creek - Twisp Weir	T4	1	9	3	3	0	7	3	9	0
Twisp Weir - Upper Poorman Bridge	T3	1	5	8	2	0	2	1	9	1
Up. Poorman Br. - Lower Poorman Br.	T2	0	8	4	2	0	2	1	5	3
Lower Poorman Bridge - Confluence	T1	0	4	1	4	0	0	0	0	0
Twisp River subbasin total		18	139	55	87	30	79	24	145	63

Appendix G. Hatchery and wild spawner composition in the Chewuch subbasin by release group (Methow Hatchery, WNFH Hatchery) and total age. All out-of-basin strays are grouped. Adult spawner PNOB and PNI account for genetic crosses of parent broods; all broods from WNFH and out-of-basin hatcheries are assumed to have PNOB values of zero.

Year	Hatchery spawners (proportion)															H Total	Wild spawners (proportion)			W Total	pHOS	Spawning adult PNOB	PNI
	MC-Che			MC-Met			Twisp			Winthrop NFH			Out-of-basin										
	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5		3	4	5				
2003	0.069	0.000	0.878	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.000	0.007	0.000	465	0.167	0.083	0.750	25	0.949	0.568	0.374
2004	0.063	0.870	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.000	0.000	0.000	0.000	289	0.000	1.000	0.000	46	0.863	0.039	0.043
2005	0.007	0.749	0.071	0.014	0.050	0.000	0.000	0.007	0.000	0.000	0.035	0.000	0.053	0.014	0.000	289	0.010	0.933	0.057	219	0.569	0.339	0.373
2006	0.000	0.510	0.096	0.000	0.067	0.000	0.000	0.025	0.000	0.013	0.088	0.017	0.109	0.071	0.004	378	0.000	0.648	0.352	135	0.737	0.040	0.052
2007	0.063	0.056	0.273	0.091	0.000	0.000	0.000	0.000	0.000	0.098	0.000	0.042	0.091	0.286	0.000	203	0.059	0.176	0.765	74	0.733	0.002	0.003
2008	0.014	0.438	0.014	0.014	0.062	0.000	0.000	0.000	0.000	0.090	0.146	0.042	0.000	0.062	0.118	166	0.051	0.590	0.359	86	0.659	0.003	0.005
2009	0.258	0.247	0.009	0.150	0.015	0.000	0.026	0.000	0.000	0.176	0.075	0.018	0.026	0.000	0.000	500	0.065	0.919	0.016	271	0.649	0.017	0.025
2010	0.006	0.612	0.000	0.006	0.099	0.000	0.000	0.006	0.000	0.000	0.233	0.000	0.000	0.038	0.000	341	0.045	0.910	0.045	155	0.688	0.026	0.036
2011	0.134	0.437	0.042	0.049	0.014	0.000	0.000	0.000	0.000	0.021	0.076	0.023	0.070	0.134	0.000	499	0.052	0.390	0.558	370	0.574	0.102	0.151

Appendix H. Hatchery and wild spawner composition in the Methow subbasin by release group (Methow Hatchery, WNFH Hatchery) and total age. All out-of-basin strays are grouped. Adult spawner PNOB and PNI account for genetic crosses of parent broods; all broods from WNFH and out-of-basin hatcheries are assumed to have PNOB values of zero.

Year	Hatchery spawners (proportion)															H Total	Wild spawners (proportion)			W Total	pHOS	Spawning adult PNOB	PNI
	MC-Che			MC-Met			Twisp			Winthrop NFH			Out-of-basin										
	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5		3	4	5				
2003	0.000	0.000	0.000	0.008	0.060	0.541	0.004	0.042	0.004	0.004	0.010	0.319	0.000	0.008	0.000	597	0.600	0.200	0.200	8	0.987	0.393	0.285
2004	0.056	0.000	0.000	0.059	0.544	0.011	0.000	0.065	0.000	0.056	0.203	0.006	0.000	0.000	0.000	622	0.015	0.985	0.000	199	0.758	0.061	0.074
2005	0.025	0.474	0.000	0.025	0.225	0.019	0.019	0.006	0.000	0.027	0.139	0.012	0.000	0.019	0.010	526	0.000	0.824	0.176	221	0.704	0.296	0.296
2006	0.000	0.290	0.004	0.000	0.321	0.013	0.003	0.058	0.000	0.007	0.274	0.012	0.000	0.013	0.005	942	0.000	0.730	0.270	128	0.880	0.009	0.010
2007	0.067	0.040	0.076	0.040	0.011	0.022	0.058	0.033	0.009	0.200	0.204	0.100	0.000	0.140	0.000	545	0.080	0.360	0.560	152	0.782	0.058	0.069
2008	0.087	0.092	0.009	0.061	0.164	0.000	0.000	0.004	0.000	0.109	0.433	0.000	0.000	0.041	0.000	412	0.060	0.800	0.140	172	0.705	0.006	0.008
2009	0.060	0.073	0.002	0.248	0.086	0.001	0.022	0.006	0.002	0.273	0.160	0.024	0.009	0.034	0.000	1,480	0.097	0.790	0.113	261	0.850	0.017	0.019
2010	0.018	0.120	0.002	0.019	0.439	0.000	0.001	0.010	0.000	0.009	0.374	0.000	0.000	0.006	0.002	1,331	0.024	0.968	0.008	290	0.821	0.024	0.028
2011	0.130	0.204	0.007	0.123	0.122	0.017	0.041	0.004	0.002	0.080	0.170	0.038	0.006	0.056	0.000	1,391	0.030	0.536	0.434	432	0.763	0.112	0.128

Appendix I. Hatchery and wild spawner composition in the Twisp subbasin by release group (Methow Hatchery, WNFH Hatchery) and total age. Adult spawner PNOB and PNI account for genetic crosses of parent broods; all broods from WNFH and out-of-basin hatcheries are assumed to have PNOB values of zero.

Year	Hatchery spawners (proportion)															H Total	Wild spawners (proportion)			W Total	pHOS	Spawning adult PNOB	PNI
	MC-Che			MC-Met			Twisp			Winthrop NFH			Out-of-basin										
	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5		3	4	5				
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	18	0.333	0.167	0.500	25	0.419	0.374	0.472
2004	0.000	0.045	0.000	0.000	0.000	0.000	0.045	0.708	0.000	0.000	0.045	0.000	0.045	0.112	0.000	98	0.098	0.902	0.000	243	0.287	0.112	0.280
2005	0.000	0.136	0.000	0.000	0.000	0.000	0.000	0.864	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34	0.000	0.828	0.172	87	0.281	0.547	0.660
2006	0.000	0.000	0.000	0.000	0.048	0.000	0.000	0.936	0.000	0.000	0.016	0.000	0.000	0.000	0.000	100	0.000	0.692	0.308	65	0.606	0.000	0.000
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.304	0.566	0.130	0.000	0.000	0.000	0.000	0.000	0.000	65	0.167	0.000	0.833	40	0.619	0.509	0.451
2008	0.018	0.018	0.000	0.000	0.000	0.000	0.064	0.827	0.018	0.000	0.000	0.000	0.018	0.037	0.000	126	0.105	0.895	0.000	40	0.759	0.589	0.437
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.619	0.165	0.114	0.051	0.000	0.000	0.051	0.000	0.000	97	0.250	0.500	0.250	32	0.752	0.163	0.178
2010	0.000	0.045	0.000	0.000	0.090	0.000	0.000	0.820	0.045	0.000	0.000	0.000	0.000	0.000	0.000	96	0.024	0.952	0.024	156	0.381	0.029	0.070
2011	0.047	0.000	0.000	0.000	0.000	0.000	0.236	0.095	0.000	0.000	0.000	0.000	0.575	0.047	0.000	85	0.036	0.607	0.357	159	0.348	0.070	0.167

APPENDIX R - 5-YEAR EVALUATION OF DOUGLAS PUD HATCHERY PROGRAMS 2006 TO 2010

EVALUATION OF HATCHERY PROGRAMS FUNDED BY DOUGLAS COUNTY PUD
5-YEAR REPORT
2006-2010

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May 2012

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APPENDICES

PREFACE

This five-year report evaluating the performance of hatchery programs funding by Public Utility District No. 1 of Douglas County (Douglas PUD) 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, Colville Confederated Tribes, Douglas PUD, and BioAnalysts, Inc. An extensive amount of work was conducted in 2006 through 2010 to collect the data needed to monitor the effects of the hatchery programs funded by Douglas PUD. This work was directed and coordinated by the Habitat Conservation Plan (HCP) Hatchery Committee, currently consisting of the following members: Bill Gale, U.S. Fish and Wildlife Service (USFWS); Craig Busack, National Marine Fisheries Service (NMFS); Greg Mackey, Douglas County PUD; Tom Scribner, the Yakama Nation; Mike Tonseth, WDFW; and Kirk Truscott, Colville Confederated Tribes.

The approach to monitoring the hatchery programs was guided by the "*Conceptual Approach to Monitoring and Evaluating the Douglas County Public Utility District Programs*" (Cates et al. 2007). Technical aspects of the monitoring and evaluation program were developed by the Hatchery Evaluation Technical Team (HETT), which consists of the following scientists: Carmen Andonaegui, Anchor Environmental; Matt Cooper, USFWS; Steve Hays, Chelan PUD; Tracy Hillman, BioAnalysts; Tom Kahler, Douglas PUD; Russell Langshaw, Grant PUD; Greg Mackey, Douglas PUD; Joe Miller, Chelan PUD; Andrew Murdoch, WDFW; Keely Murdoch, Yakama Nation; Josh Murauskas, Chelan PUD; and Todd Pearsons, Grant PUD. The HETT developed an "*Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs*" (Hays et al. 2007), which directs the analyses of hypotheses developed under the conceptual approach. The analytical framework provides the foundation for this report.

Most of the work reported in this report was funded by Douglas PUD. This is the first five-year report written under the direction of the Wells HCP.

INTRODUCTION

Douglas PUD operates a number of hatchery programs for spring Chinook, summer steelhead, and summer Chinook as mitigation for unavoidable project mortality or inundation losses under the Wells HCP (2002). The Douglas County PUD Monitoring and Evaluation Plan (M&E Plan) is designed to assess these programs and consists of eight program-specific quantifiable objectives that have been implemented for five years, plus two regional objectives (Cates et al. 2007). Details describing the methodology to collect the data for the eight program-specific objectives are described in Snow et al. (2011). The two regional objectives are either under development (i.e., Objective 9: Impacts of BKD from hatcheries or hatchery fish on natural populations) or data are being currently collected (i.e., Objective 10: Impacts of releasing hatchery fish on non-target taxa of concern; Pearsons et al. 2011). The Wells HCP (2002) requires an update of the M&E Plan every five years. This report documents the initial evaluation of the Douglas PUD hatchery programs based on the M&E plan. Regional objectives will be included in a separate report(s). Due to the natural variability in survival of both hatchery and naturally produced fish, rigorous analysis of specific objectives within the M&E Plan will require many years of data to obtain the desired statistical power. All statistical analyses will be conducted consistent with the Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs (Hays et al. 2007) and using methods for identifying and testing differences between reference and treatment populations (Hillman et al. 2011).

Reference streams or populations are a critical component of the M&E Plan (Goodman 2004; ISRP & ISAB 2005). Data collected from reference populations will be included in the analysis for objectives 1 and 7. Depending on the reference population, data collected may also be included in the analysis for objectives 3, 4, 5, and 8. Suitability of populations as a reference or control for target populations for ongoing hatchery programs funded by Douglas PUD has not yet been determined for steelhead. The HETT is currently evaluating potential spatial reference streams for all supplemented steelhead populations in the Methow and Okanogan rivers. Reference populations for spring Chinook stocks in the Methow population were identified using methods described in Hillman et al. (2011).

We will analyze data collected under the M&E program according to the guidelines, hypotheses, and analytical methods presented in the Conceptual and Analytical frameworks, using recently developed methods for identifying reference populations to enable BACI (Before-After-Control-Impact) style analyses. These analyses will provide results that we will synthesize into broader conclusions based on this first overarching assessment of the hatchery programs. Recommendations for modifying the M&E Plan and the hatchery programs will be based on the results of this evaluation and other pertinent information documented in Hatchery and Genetic Management Plans (HGMPs) or elsewhere in scientific literature.

METHODS

The data used to evaluate each of the eight program-specific objectives are reported in annual reports (see Snow et al. 2011). The reports include information on 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 the annual reports. Those data are presented in this report. The methods used to collect monitoring data are summarized in the annual reports and described in detail by Cates et al. (2007).

In this section we briefly describe the hatchery programs, and the data and methods used to address each objective. Detailed descriptions of methods can be found in Cates et al. (2007), Hays et al. (2007), Hillman et al. (2011), and in appendices to this report. All statistical tests were performed with a significance level of 0.05.

Hatchery Programs

The programs presented in Table 1 are operated by Douglas PUD and subject to the monitoring and evaluation program and analysis under this 5-year report. Spring Chinook hatchery programs began in 1992, the first release of smolts occurred in 1994, and the first year hatchery fish returned to the spawning grounds was 1995. Steelhead and summer Chinook hatchery programs have been operating for decades as harvest-augmentation programs. Steelhead programs were reprogrammed as supplementation programs in 1997, while summer Chinook programs continue to operate as harvest programs. The summer Chinook programs are assessed only under the hatchery survival and characteristics, stray rates, and harvest objectives, while spring Chinook and steelhead are evaluated under all objectives.

Table 1. Douglas PUD hatchery programs and associated objectives from the Analytical Framework (Hays et al. 2007).

Program	Hatchery	Release Target	M&E Objectives
Twisp Spring Chinook	Methow	183,334	1-8
Chewuch Spring Chinook	Methow	183,333	1-8
Methow Spring Chinook	Methow	183,333	1-8
Methow Steelhead	Wells	320,000	1-8
Okanogan Steelhead	Wells	130,000	1-8
Summer Chinook Yearling	Wells	320,000	4-8
Summer Chinook Subyearling	Wells	484,000	4-8

Objective 1: Abundance, Recruitment, and Productivity

One of the most important goals of a supplementation program is to increase the total spawning abundance and natural-origin recruitment (NORs) of the supplemented population, and not reduce the productivity of the supplemented population. Indeed, a successful supplementation program must increase spawning abundance and NORs to levels above those that would have occurred without supplementation. Therefore, the first objective is to *determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference population) and the change in the natural replacement rate (NRR) of the supplemented population is similar to that of the reference population.* This objective requires information on the number of adult spawners (both hatchery and natural-origin adults), NORs, and recruits per spawner (adult productivity or NRR) in both supplemented and reference populations. Here, recruitment is the sum of the number of naturally produced adults harvested and the number of naturally produced adults that spawned.

We derived the metrics analyzed under this objective (total spawning abundance, NORs, and adult productivity) from data collected in the field (e.g., redd counts, scale collections, marks and tags, etc.). The data and methods used to derive these metrics are analogous to those described in detail in Appendices A and B. In addition, the objective calls for comparing the three derived metrics from the supplemented populations with those in reference populations, requiring us to identify suitable reference populations for each supplemented population. Our selection process included identification of reference populations with similar life-history characteristics, few or no hatchery spawners, a long time series of accurate abundance and productivity estimates, and similar freshwater habitat characteristics and out-of-basin effects. We examined those populations that met most of these criteria (no population met all the criteria) for their relationship with the supplemented population during the period prior to supplementation using several methods, including graphic analysis, correlation, trend analysis, and power analysis. These methods are described in detail in Appendix C. We assumed that the supplemented and reference populations that tracked each other before supplementation would continue to track each other in the absence of supplementation. While several methods to calculate difference scores between treatment and reference populations exist (i.e., treatment minus reference, treatment divided by reference, and the annual difference in treatment minus the annual difference in reference), the ratio score (treatment/reference) is more sensitive to changes and is the only difference score reported.

In some cases, we did not find suitable reference populations. Under this scenario, we developed methods for analyzing the objective without reference populations. These included before-after comparisons, correlation analyses, and comparisons to standards. These methods are described in detail in Appendix C.

To address the first objective, we evaluated the following questions and null hypotheses for the spring Chinook and summer steelhead programs (see Appendix C for more details). We modified the first monitoring question and subsequent hypotheses in the Analytical Framework to more directly evaluate changes in spawner abundance, an initial response as a result of the supplementation program.

1.1 Has the supplementation program increased the total number of spawners within the supplemented population?

Ho: Mean ratio scores (treatment/reference) in total spawner abundance before supplementation ≥ Mean ratio (treatment/reference) scores in total spawner abundance during supplementation.

1.2 Has the supplementation program increased NORs within the supplemented population?

Ho: Mean ratio scores in NORs/Maximum Recruitment before supplementation ≥ Mean ratio scores in NORs/Maximum Recruitment during supplementation. [This hypothesis adjusts NORs for the capacity of the habitat; it tests the fraction of the habitat saturated with NORs (see Appendix C for details).]

1.3 Has the supplementation program increased the adult productivity (NRRs) of the supplemented population?[1]

Ho: Mean ratio scores in NRRs (adjusted for density dependence) before supplementation ≤ Mean ratio scores in NRRs (adjusted for density dependence) during supplementation. [This hypothesis adjusts NRRs for density-dependent effects; see Appendix C for details.]

All data were natural-log transformed to better meet the assumption of normality. Density dependence may occur in both treatment and reference populations; thus, both NOR abundance and productivity (NRR) were adjusted based on the smooth hockey stick model estimates of carrying capacity. NORs were adjusted by the fraction of the carrying capacity used (NORs/Kr), while productivity was adjusted by the stock size (K_{SP}) at carrying capacity (Hillman et al. 2011). Analyses were conducted under a BACI design using reference (control) populations. We used graphic analyses, trend analyses, and t-tests to evaluate the statistical hypotheses. Detailed descriptions of the statistical procedures are presented in Appendix C. Because nearly all spring Chinook were trapped at Wells Dam in 1996 and 1998, t-tests were conducted using both all years and excluding 1996 and 1998.

Objective 2: Migration and Spawning Characteristics

Another goal of supplementation is to produce hatchery fish that spawn with natural-origin fish (i.e., hatchery and wild fish should be fully integrated). Thus, hatchery and natural-origin fish should have similar migration and spawn timing, and they should spawn in similar locations. Hatchery adults that migrate at different times than natural-origin fish may be subject to differential survival. In addition, hatchery adults that spawn at different times or locations than natural-origin fish would not be integrated into the naturally produced spawning population. Therefore, the second objective is to

[1] Because adult productivity is affected by the abundance of the population (i.e., productivity decreases with increasing abundance), the goal of supplementation is to increase or maintain productivity, but not decrease it.

determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

The metrics used to analyze this objective are presented in the annual reports (see Snow et al. 2011). For migration timings of hatchery and natural-origin fish, we estimated mean Julian date of passage at the most upstream sampling location (i.e., Wells Dam). Hays et al. (2006) suggest that these comparisons should use hatchery and natural-origin fish of the same age. In this report, we conduct a separate analysis on each age group of adequate sample size. Because most hatchery steelhead smolts are released as age 1 smolts, we used in the analysis the number of years in saltwater instead of total age.

For spawn timing, we used the Julian day when female carcasses were observed in the field. Because steelhead generally do not die after spawning, we were unable to compare the spawn timing of hatchery and natural-origin steelhead using this method, except in the Twisp River where scanning of completed redds for PIT tags during comprehensive spawning ground surveys provided suitable data. For comparing the distribution of redds, we used the locations where hatchery and natural-origin spawners were observed in the field. Again, because there are no steelhead carcass data, we could not compare hatchery and natural-origin steelhead spawning distributions, except in the Twisp River.

To address the second objective, we evaluated the following questions and null hypotheses:

2.1 Is the migration timing of hatchery and natural-origin fish similar?

Ho: The mean migration timing of hatchery-origin fish = the mean migration timing of natural-origin fish.

2.2 Is the spawn timing of hatchery and natural-origin fish similar? Is the timing of spawning (measured as the time female carcasses are observed) similar for hatchery and natural-origin fish?

Ho: The mean spawn timing of hatchery-origin fish = the mean spawn timing of natural-origin fish.

2.3 Is the distribution of redds (measured as the location of female carcasses observed, or steelhead PIT tags detected) similar for hatchery and natural-origin fish?

Ho: The distribution of hatchery-origin redds (hatchery females) = the distribution of natural-origin redds (natural-origin females). [Distribution will be assessed at the reach scale (using historical sampling reaches) and at the 0.01 km scale.]

We used ANOVA or Kruskal-Wallis ANOVA to evaluate the statistical hypotheses.

Objective 3: Genetic and Phenotypic Characteristics

Supplementation programs should not affect the long-term fitness of the supplemented 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. Maintaining the long-term fitness of supplemented populations requires a comprehensive evaluation of genetic and phenotypic characteristics. Thus, the third objective is to *(a) determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program and (b) determine if hatchery programs have caused changes in phenotypic characteristics of natural populations*. Other phenotypic traits such as run timing, spawn timing, spawning location, and stray rates are evaluated under other objectives.

The metrics used to analyze this objective are presented in the annual reports and in appendices to the annual reports (see Snow et al. 2011). Allele frequencies generated from samples of hatchery and natural-origin adults and the donor stocks were used to assess genetic diversity, population structure, and effective population size. Data collected from returning adults were used to estimate age-at-maturity and size-at-maturity. Scales (used to age fish) and lengths (post-orbital to hypural length in cm) were collected from carcasses, broodstock, and fish sampled at stock assessment stations (e.g., Twisp weir, Methow and Winthrop hatcheries and Wells Dam). Ages were reported as total age and saltwater age.

To address the third objective, we evaluated the following questions and null hypotheses:

3.1 Is the allele frequency of hatchery fish similar to the allele frequency of natural-origin and donor fish?

Ho: The allele frequency of hatchery fish = allele frequency of natural-origin fish = allele frequency of donor fish.

3.2 Does the genetic distance among subpopulations within a supplemented population remain the same over time?

Ho: The genetic distance between subpopulations in year x = the genetic distance between subpopulations in year x+1.

3.3 Is the ratio of effective population size (N_e) to spawning population size (N) constant over time?

Ho: The ratio of N_e/N at time x = the ratio of N_e/N at time x+1.

3.4 Is the age-at-maturity of hatchery and natural-origin fish similar?

Ho: The age-at-maturity of hatchery female fish = the age-at-maturity of natural-origin female fish.

Ho: The age-at-maturity of hatchery male fish = the age-at-maturity of natural-origin male fish.

3.5 Is the length-at-age of hatchery and natural-origin fish similar?

Ho: The length-at-age of hatchery female fish = the length-at-age of natural-origin female fish.
Ho: The length-at-age of hatchery male fish = the length-at-age of natural-origin male fish.

We used Fst test, factorial correspondence analysis, ANOVA, regression, and correlation analysis to evaluate the statistical hypotheses.

Objective 4: Hatchery Fish Survival Rates

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome the survival disadvantage after release (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish, then the program should be modified or discontinued. Thus, the fourth objective is to *determine if the hatchery replacement rate (HRR) is greater than the natural replacement rate (NRR) and equal to or greater than the program-specific HRR expected value based on estimated survival rates listed in Appendix D in Cates et al. (2007)*. Production levels were initially developed using historical run sizes and smolt-to-adult survival rates (BAMP 1998). We compared HRRs with stock-specific NRRs and the values listed in the BAMP to determine whether expected levels of survival have been achieved.

Data required to address this objective are presented in the annual reports (see Hillman et al. 2011). HRRs were derived based on the release, recovery, and expansion of coded-wire tagged (CWT) hatchery fish. We calculated two different return estimates; (1) marked hatchery fish that returned to the spawning stream (includes hatchery fish that spawned naturally and those taken for broodstock) and (2) marked hatchery fish that returned to the spawning stream or were collected for broodstock, and those harvested. Methods for estimating HRRs are detailed in Appendix D.

To address the fourth objective, we evaluated the following questions and null hypotheses:

4.1 Does the hatchery replacement rate (HRR) exceed the natural replacement rate?

Ho: The HRR ≥ NRR.

4.2 Does the hatchery replacement rate (HRR) exceed the target value in Cates et al. (2007)?

Ho: The HRR ≥ Target Value.

We used Mann Whitney U-tests and t-tests to evaluate the statistical hypotheses.

Objective 5: Stray Rates

To maintain locally adapted traits, fish populations must exhibit high homing fidelity to the target stream. Hatchery practices (e.g., rearing and acclimation water sources, release methodology, and location) are the main variables thought to affect stray rates. Regardless of the abundance of returning adults, if adult hatchery fish do not contribute to the donor population, the program will not meet the basic condition of a supplementation program. Thus, the fifth objective is to *determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks*. Hatchery fish that stray to non-target, independent populations should not comprise more than 5% of the non-target spawning population. Likewise, hatchery fish that stray to non-target spawning areas within an independent population should not comprise greater than 10% of the spawning aggregate within the non-target spawning area.

Data required to address this objective are presented in the annual reports (see Hillman et al. 2011; Snow et al. 2011). Stray rates were estimated based on the recovery and expansion of coded-wire-tagged hatchery fish captured in different hatcheries, spawning areas, and populations. CWTs recovered in different locations were expanded by sampling rates, and then adjusted for tagging rates. Methods for estimating stray rates are described in Appendix E.

To address this objective, we evaluated the following questions and null hypotheses:

5.1 Is the stray rate of hatchery fish less than 5% for the total brood return?

Ho: The stray rate of hatchery fish ≤ 5% of total brood return.

5.2 Is the stray rate of hatchery fish less than 5% of the spawning escapement within other independent populations?

Ho: The stray rate of hatchery fish ≤ 5% of the spawning escapement within other independent populations.

5.3 Is the stray rate of hatchery fish less than 10% of the spawning aggregate within non-target spawning areas within the target population?

Ho: The stray rate of hatchery fish ≤ 10% of the spawning aggregate within non-target spawning areas within the target population.

We used one sample t-tests to evaluate the statistical hypotheses.

Objective 6: Hatchery Release Characteristics

The Habitat Conservation Plan identifies the number and size of fish that are to be released from each hatchery program to meet NNI compensation levels. Therefore, the sixth objective is to *determine if hatchery fish were released at the programmed size and number*. Although many factors can influence both the size and number of fish released, past hatchery cultural experience with these stocks should assist in meeting program production levels.

Data required to address this objective are presented in the annual reports (see Snow et al. 2011). Numbers, fork lengths (mm), and weights (0.1 g) of fish released from each hatchery program are estimated annually and reported in the annual reports. Target length at release goals in the M & E Plan were based on generic length-weight relationships and did not reflect population specific differences. In this report, population specific length and weight targets were recalculated using stock specific data that better represents the stock being reared.

To address this objective, we evaluated the following questions and null hypotheses:

6.1 Is the fork length (1.0 mm) and weight (0.1 g) of hatchery fish released equal to the program goal?

Ho: The length of hatchery fish released = program length goals.

Ho: The weight of hatchery fish released = program weight goals.

6.2 Is the number of hatchery fish released equal to the program goal?

Ho: The number of hatchery fish released = program number release goals.

We used one sample t-tests to evaluate the statistical hypotheses.

Objective 7: Freshwater Productivity

Out-of-basin effects influence the survival of smolts after they emigrate from the tributaries. These effects introduce substantial variability into NRRs and HRRs and may mask in-basin effects (e.g., habitat quality, density-dependent mortality, and differential reproductive success of hatchery and natural-origin fish). Therefore, the seventh objective is to *determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of juveniles per redd) of supplemented streams when compared to non-supplemented streams*. Data from long-term smolt monitoring programs can be used to estimate egg-to-smolt or egg-to-juvenile survival of target stocks. Smolt production models generated from the information obtained from these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that take into account all effects.

Data required to address this objective are presented in the annual reports (see Snow et al. 2011). Smolt traps, adjusted for capture efficiency, were used to estimate smolt numbers. Adult spawning escapement and pHOS were estimated from data collected during redd and carcass surveys.

The objective calls for comparing freshwater productivity from the supplemented population with those in reference population. Using the same criteria outlined under Objective 1 and described in Appendix C, we were unsuccessful in finding any suitable reference populations for comparing freshwater productivities. This is primarily because un-supplemented populations are not usually monitored for freshwater productivity. In addition, there are no pre-supplementation, freshwater productivity data available for the

Douglas PUD hatchery programs. Therefore, we cannot assess before-after effects of the supplementation programs. Thus, in this report, we use stock-recruitment models and correlation analyses to assess the effects of supplementation on freshwater productivity.

To address this objective, we evaluated the following question and null hypotheses:

7.1 Does the number of juveniles per redd decrease as the proportion of hatchery spawners (pHOS) increases?

Ho: There is no association between pHOS and the number of emigrants per redd produced; rho = 0. [If there is a significant negative association between pHOS and the number of smolts produced, the hatchery fish may be reducing the freshwater productivity of the wild population.]

Ho: There is no association between pHOS and the residuals from the smooth Beverton-Holt stock-recruitment curve; rho = 0. [If there is a significant negative association between pHOS and the residuals, then the hatchery fish may be reducing the productivity of juvenile fish within the population.]

We used stock-recruitment analyses and regression to evaluate the statistical hypotheses.

Objective 8: Harvest

In years when the expected returns of hatchery adults are greater than the numbers required to meet program goals (i.e., supplementation of spawning populations and/or brood stock requirements), surplus hatchery fish may be available for harvest. Thus, the eighth objective is to *determine if harvest opportunities have been provided using hatchery returning adults where appropriate*. It should be noted that if hatchery fish are found to affect the productivity or survival of NORs, harvest or removal of surplus hatchery fish from the spawning grounds could be used to reduce potential adverse effects to naturally produced populations.

Data required to address this objective are presented in the annual reports (see Snow et al. 2011). Methods used to estimate the number of fish captured in ocean and freshwater (includes tribal, commercial, and recreational) fisheries are described in Appendices A and B.

To address this objective, we evaluated the following questions and null hypotheses:

8.1 Is the harvest on hatchery fish produced in the Wells Summer Chinook Program high enough to manage natural spawning [of hatchery fish] but low enough to sustain the hatchery program?

Ho: The harvest on Wells summer Chinook ≤ the maximum level allowable to meet the program goals [broodstock collection and management of naturally spawning hatchery fish].

8.2 Is the escapement of hatchery fish from supplementation programs [sufficiently] in excess of broodstock and natural production needs to provide opportunities for terminal harvest?

Ho: The escapement of hatchery fish from supplementation programs exceeded the level allowable to meet program goals.

We used correlation analysis to evaluate this hypothesis.

RESULTS

Twisp River Spring Chinook

Goal – Support the recovery of Twisp River spring Chinook salmon[2] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

Program **–** Collect sufficient Twisp-origin broodstock (hatchery and naturally produced) from the Twisp weir, Wells Dam and Methow Hatchery in order to release 183,000 yearling smolts from the Twisp Acclimation Pond.

Identification of Reference Streams

Of the possible reference populations identified in Hillman et al. (2011), the Secesh River, Bear Valley Creek, Marsh Creek, and Naches River met most or all criteria and were selected for further analysis as possible reference populations (Table 2). Several other populations in the upper Snake River Basin (Valley Creek, Sulphur Creek, Loon Creek, and Big Creek) also meet most criteria and can be included in the analysis at a later date if required. Spawner abundance, natural-origin recruits (NORs), and productivity (recruits/spawner) data were natural log transformed prior to analysis to better meet the assumptions of normality and equal variances. Analysis of spawner abundance, natural-origin recruits (NORs), and productivity (recruits/spawner) prior to supplementation were conducted to assess the level of appropriateness of each candidate as a reference population. Furthermore, natural-origin recruit (NOR) abundance was adjusted based on the maximum number of recruits produced at carrying capacity (K_R) and productivity was adjusted based on the spawner abundance at carrying capacity (K_{SP}).

Following methods outlined in Hillman et al. (2011) for identifying reference streams, results varied with reference population, metric, and data type. All four populations were correlated ($r > 0.6$) with the Twisp population, except productivity for Marsh Creek (Table 3). Trend analysis revealed no significant difference between the reference populations and the Twisp, except for NORs and productivity in the (Table 3). Graphical analysis suggested that all references streams tracked well with the Twisp, except for

[2] While the HCP is not a recovery plan, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.

some minor differences in NORs and productivity (Figure 1, 2, and 3). The minimum detectable difference varied greatly with response variables with the Naches population consistently having the lowest and Marsh Creek the highest value (Table 4).

Table 2. Populations of stream-type Chinook salmon and their comparison to Twisp River spring Chinook. Populations in bold were selected as reference streams for the Twisp River population.

Population	Similar life-history	No or few hatchery fish	Accurate abundance estimates	Long time series	Similar freshwater habitat	Similar out-of-basin effects
Deschutes River	Yes	Yes	Yes	Yes	No	No
John Day mainstem	Yes	Yes	Yes	Yes	No	No
Middle Fk John Day	Yes	Yes	Yes	Yes	No	No
North Fk John Day	Yes	Yes	Yes	Yes	No	No
Granite Creek	Yes	Yes	Yes	Yes	No	No
Wenaha River	Yes	No	Yes	Yes	Yes	Yes
Minam River	Yes	No	Yes	Yes	Yes	Yes
Slate Creek	Yes	Yes	Yes	No	No	Yes
Secesh River	Yes	Yes	Yes	Yes	Yes	Yes
MF Salmon River	Yes	Yes	Yes	No	No	Yes
Big Creek	Yes	Yes	Yes	Yes	No	Yes
Camas Creek	Yes	Yes	Yes	Yes	No	Yes
Loon Creek	Yes	Yes	Yes	Yes	No	Yes
Sulphur Creek	Yes	Yes	Yes	Yes	No	Yes
Bear Valley Creek	Yes	Yes	Yes	Yes	No	Yes
Marsh Creek	Yes	Yes	Yes	Yes	Yes	Yes
North Fk Salmon River	Yes	Yes	No	No	Yes	Yes
Lemhi River	Yes	Yes	Yes	Yes	No	Yes
EF Salmon River	Yes	No	Yes	Yes	No	Yes
Valley Creek	Yes	Yes	Yes	Yes	No	Yes
Chamberlain Creek	Yes	Yes	Yes	No	Yes	Yes
Naches River	Yes	Yes	Yes	Yes	Yes	No
Little Wenatchee River	Yes	No	Yes	Yes	Yes	No
Entiat River	Yes	No	Yes	Yes	No	No

Table 3. Pearson correlation coefficients and t-test results comparing slopes of trends between potential reference populations and the Twisp spring Chinook population; DF = degrees of freedom and for correlation coefficients, an asterisk (*) indicates significance at $P < 0.05$. Analyses were conducted on natural-log transformed abundance and productivity data.

Reference population	Pearson correlation coefficient	t-test of slopes		
		t-value	DF	P-value
	LN Spawner Abundance			
Naches	0.703	-0.798	12	0.440
Marsh	0.662*	1.225	24	0.233
Secesh	0.626*	1.037	24	0.310
Bear Valley	0.711*	0.525	24	0.600
	LN Adjusted Natural-Origin Recruits			
Naches	0.814*	-1.241	12	0.231
Marsh	0.632*	-2.079	24	0.049
Secesh	0.689*	-3.220	24	0.004
Bear Valley	0.622*	-2.497	24	0.020
	LN Adjusted Productivity (recruits/spawner)			
Naches	0.761*	-0.948	12	0.362
Marsh	0.597*	-1.523	24	0.141
Secesh	0.820*	-3.846	24	0.001
Bear Valley	0.624*	-1.790	24	0.086

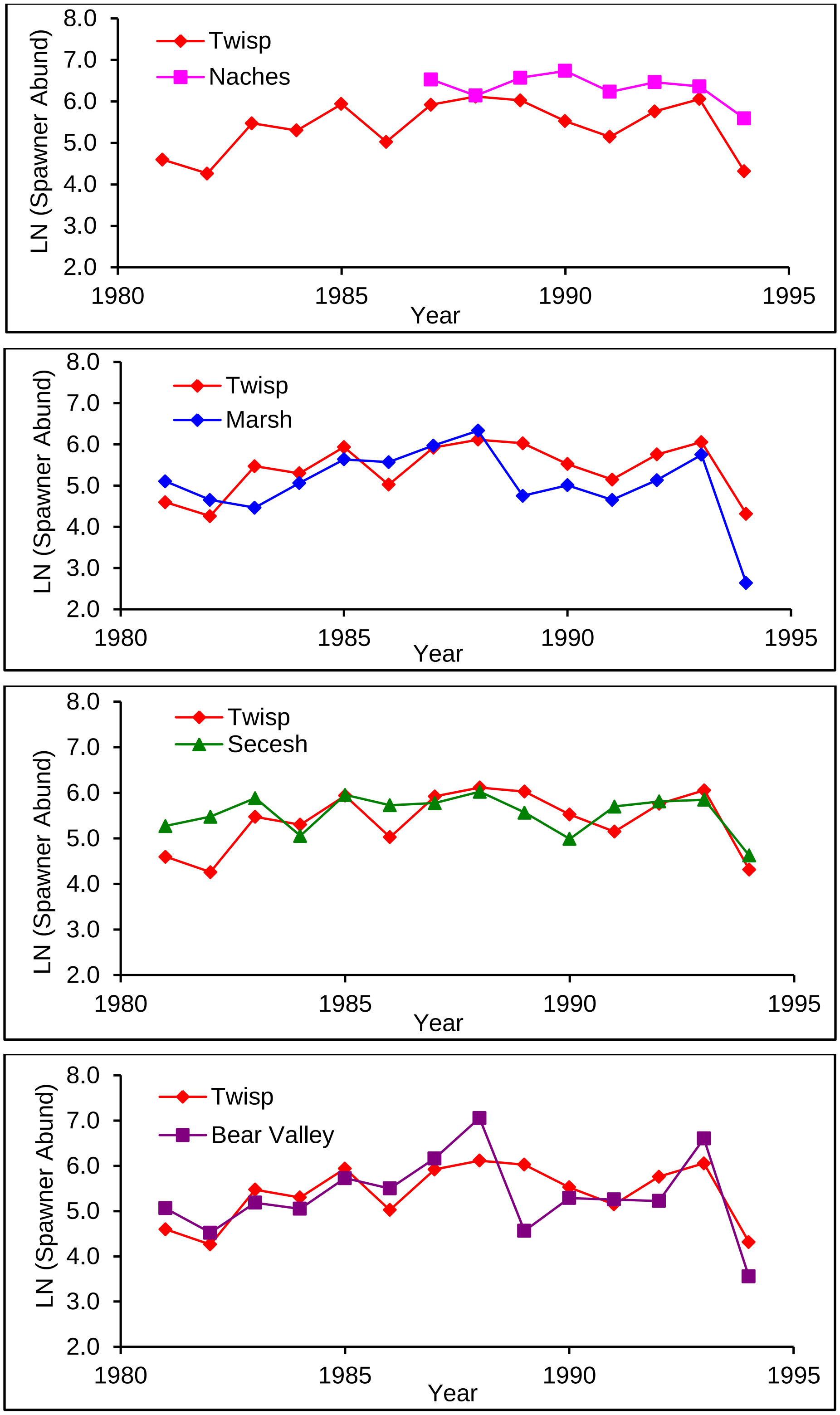


Figure 1. Time series of spawner abundance (natural-log transformed) of potential reference populations and the Twisp spring Chinook population before the Twisp population was supplemented with hatchery fish.

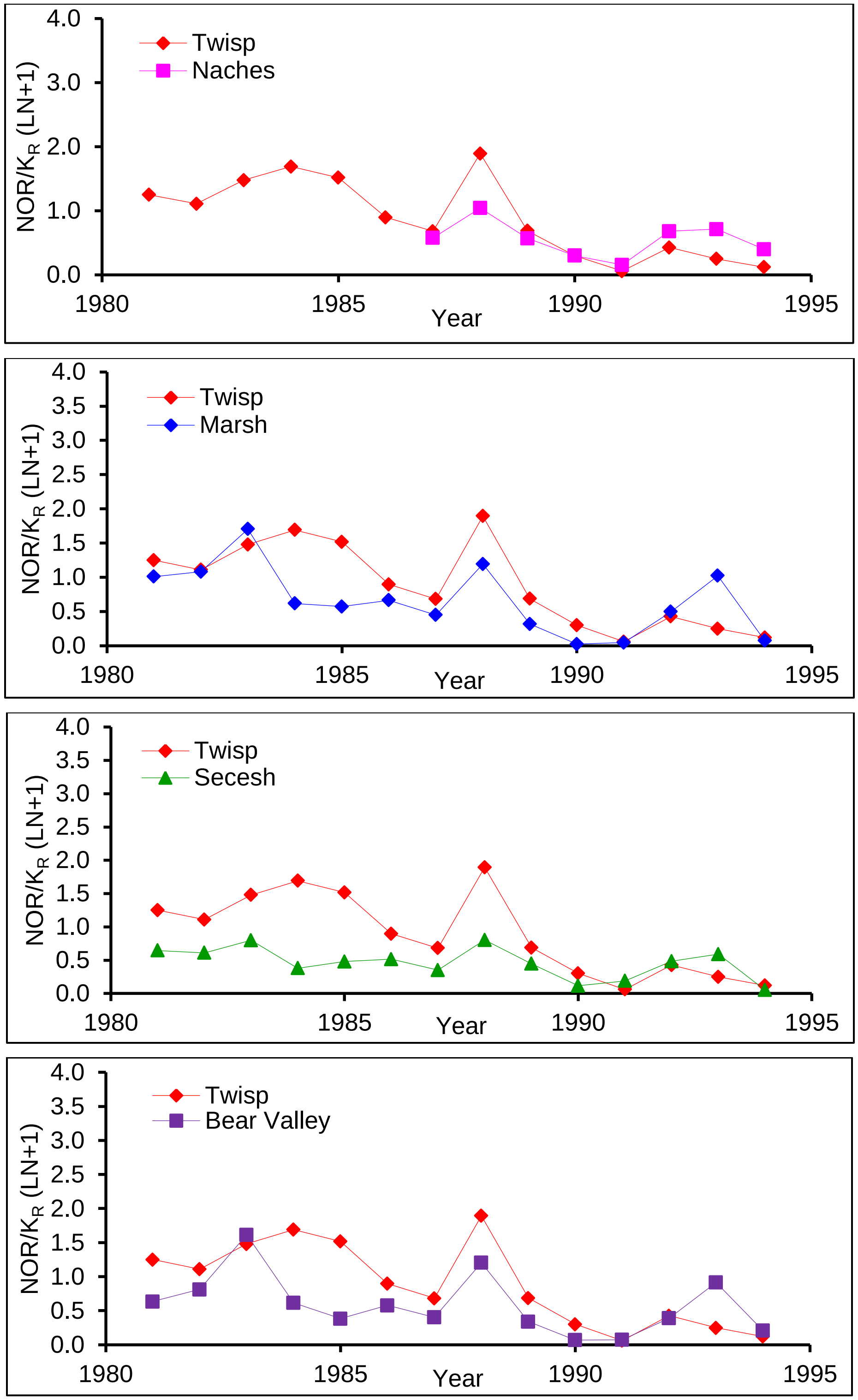


Figure 2. Time series of natural-origin recruits (natural-log transformed) adjusted for fraction of capacity of potential reference populations and the Twisp spring Chinook population before the Twisp population was supplemented with hatchery fish.

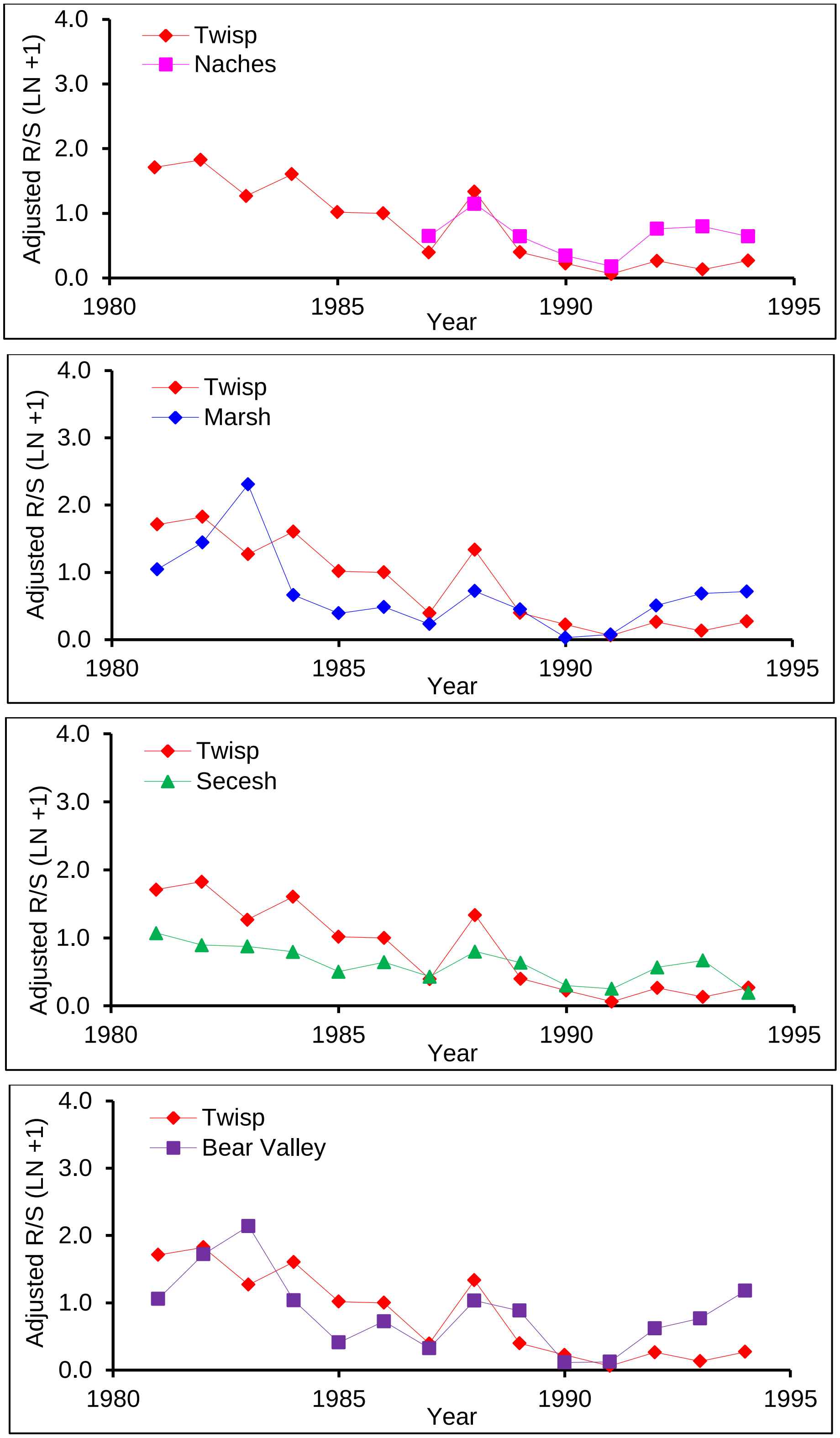


Figure 3. Time series of adult productivity (natural-log transformed) adjusted for spawner capacity of potential reference populations and the Twisp spring Chinook population before the Twisp population was supplemented with hatchery fish.

Table 4. Minimal detectable difference of ratio scores before and during supplementation for both untransformed and natural-log transformed data.

Treatment years	Minimal detectable differences by reference population			
	Naches	Marsh	Secesh	Bear Valley
		Spawner Abundance		
15	0.43	1.92	0.73	1.14
20	0.38	1.75	0.66	1.05
25	0.35	1.61	0.62	0.97
50	0.26	1.22	0.47	0.74
		LN Spawner Abundance		
15	0.32	0.40	0.35	0.37
20	0.30	0.39	0.33	0.36
25	0.29	0.37	0.32	0.34
50	0.24	0.32	0.27	0.29
		Natural-Origin Recruits (adjusted for capacity)		
15	1.08	3.53	2.77	2.38
20	0.97	3.21	2.54	2.18
25	0.89	2.97	2.35	2.02
50	0.69	2.35	1.88	1.62
		LN Natural-Origin Recruits (adjusted for capacity)		
15	0.86	2.80	1.67	1.62
20	0.77	2.56	1.53	1.48
25	0.71	2.37	1.42	1.37
50	0.55	1.90	1.14	1.10
		Productivity (adjusted for spawner capacity)		
15	1.31	2.60	1.67	1.38
20	1.18	2.37	1.53	1.27
25	1.08	2.19	1.42	1.17
50	0.84	1.73	1.13	0.94
		LN Productivity (adjusted for spawner capacity)		
15	0.88	2.11	1.19	1.07
20	0.79	1.92	1.09	0.98
25	0.72	1.77	1.01	0.91
50	0.56	1.40	0.81	0.73

Conclusions

All reference populations are suitable (i.e., weighted score >80) for comparison with the Twisp River spring Chinook population (Table 5). We employed a weighted ranking system (see Appendix C) that included level of correlation, relative difference in slopes of reference verses treatment, CV of ratio scores of reference verses treatment, and proportion of natural-origin spawners in the reference population both before and during supplementation. Populations that had less than 90% natural-origin spawners were removed from consideration. A score of 81.75 was at the upper 97.5th percentile of all possible weighted scores. The Naches River population ranked the highest for all metrics. The Secesh River population also ranked very high for productivity, but had the lowest ranking for spawner abundance and NORs. The Bear Valley Creek population ranked high for both NORs and productivity. Marsh Creek had a high rank for spawner abundance, but the lowest rank for NORs and productivity.

Table 5. Ranking of reference populations (1 = best) for the Twisp River spring Chinook population based on weighted score. Score was based on proportion of natural spawners (before and during supplementation), correlation coefficient, difference in trends, and the coefficient of variation of the ratio scores (treatment/reference).

	Weighted score			Ranking		
Reference populations	Spawner abundance	Natural origin recruits	Productivity	Spawner abundance	Natural origin recruits	Productivity
Naches	92	85	85	1	1	1
Marsh	90	83	81	2	3	3
Secesh	86	83	85	4	3	1
Bear Valley	88	84	83	3	2	2

Objective 1: Abundance, Recruitment, and Productivity

Analysis of mean ratio scores found significant decreases in spawner abundance (hatchery-origin + natural-origin) during supplementation relative to the Naches, Secesh, and Bear Valley, and a non-significant decrease relative to the Marsh population (Table 6; Figure 4). The Marsh population was the least powerful comparison (had the greatest minimum detectable difference), and therefore the nearly significant difference ($P = 0.088$) is strongly suggestive that the Marsh comparison follows the same pattern as the other three reference comparisons. Twisp NOR abundance showed significant decrease in two of four reference population comparisons (Table 6, Figure 5). Productivity (NRR) in the supplemented Twisp population has not significantly changed compared to any of the reference populations (Table 6, Figure 6). High productivity in the early part of the post-supplementation period was presumably due to extremely low spawner abundance. In both 1996 and 1998, nearly all spring Chinook were collected for broodstock at Wells Dam (see Table

6 for a comparison of the reference populations with 1996 and 1998 included and excluded). The few fish that eluded trapping and spawned naturally had extremely high productivity. However, excluding 1996 and 1998 from the analysis did not change the outcome of any of the comparisons.

Table 6. Results of the unequal-variance t-tests on LN spawner abundance, LN adjusted NOR, and LN adjusted productivity data. Tests determined whether the mean ratios during the supplementation period were different than mean ratios during the pre-supplementation period. Results are presented for all years and with 1996 and 1998 excluded (ND = no difference detected).

Response variable	Statistic	Reference populations			
		Naches	Marsh	Secesh	Bear Valley
Spawner abundance	T-test (P-value)	0.001	0.088	0.000	0.001
	Effect size	0.188	0.163	0.235	0.225
	Result	Decrease	ND	Decrease	Decrease
NOR	T-test (P-value)	0.125	0.337	0.001	0.011
	Effect size	0.350	1.009	1.371	1.171
	Result	ND	ND	Decrease	Decrease
Productivity	T-test (P-value)	0.298	0.359	0.317	0.317
	Effect size	0.235	0.678	0.270	0.273
	Result	ND	ND	ND	ND
1996 and 1998 excluded					
Spawner abundance	T-test (P-value)	0.008	0.290	0.000	0.003
	Effect size	0.143	0.090	0.193	0.171
	Result	Decrease	ND	Decrease	Decrease
NOR	T-test (P-value)	0.226	0.504	0.006	0.032
	Effect size	0.303	0.790	1.323	1.096
	Result	ND	ND	Decrease	Decrease
Productivity	T-test (P-value)	0.704	0.370	0.200	0.162
	Effect size	0.089	0.787	0.384	0.419
	Result	ND	ND	ND	ND

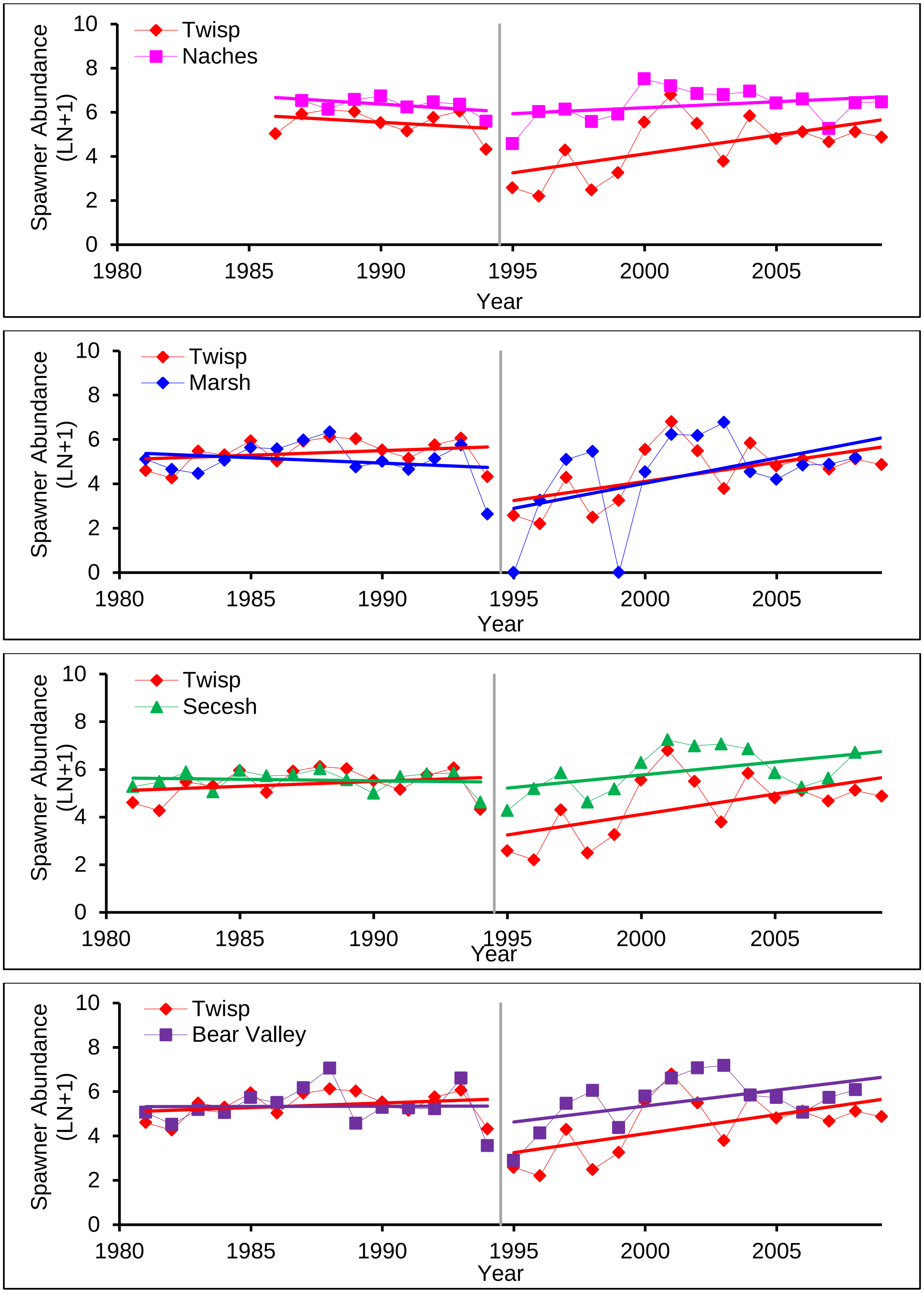


Figure 4. Trends in spring Chinook spawner abundance in the Twisp and reference populations. The vertical lines in the figures separate the pre-supplementation and supplementation periods.

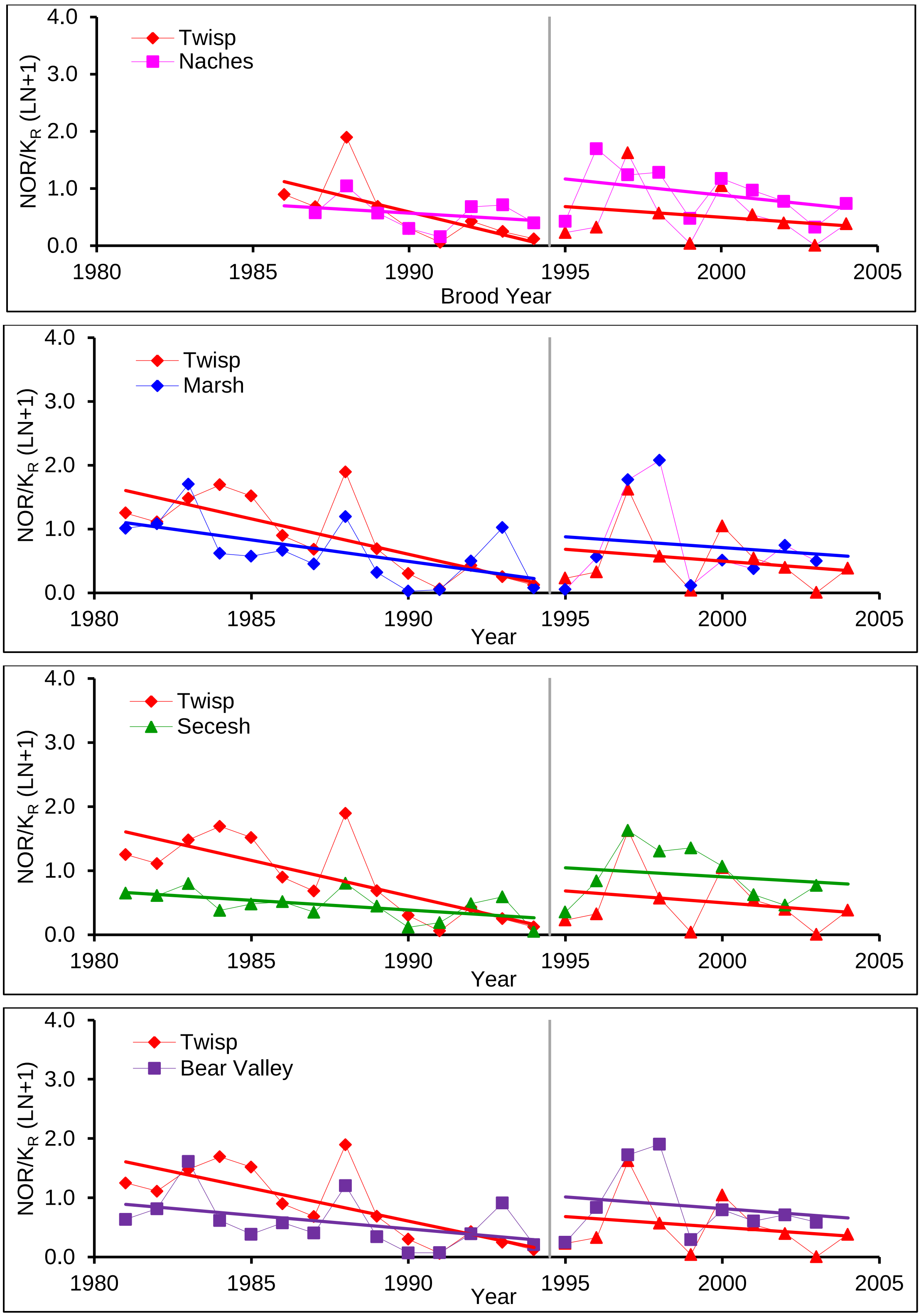


Figure 5. Trends in spring Chinook natural-log NOR abundance adjusted for the fraction of capacity in the Twisp and reference populations. The vertical lines in the figures separate the pre-supplementation and supplementation periods.

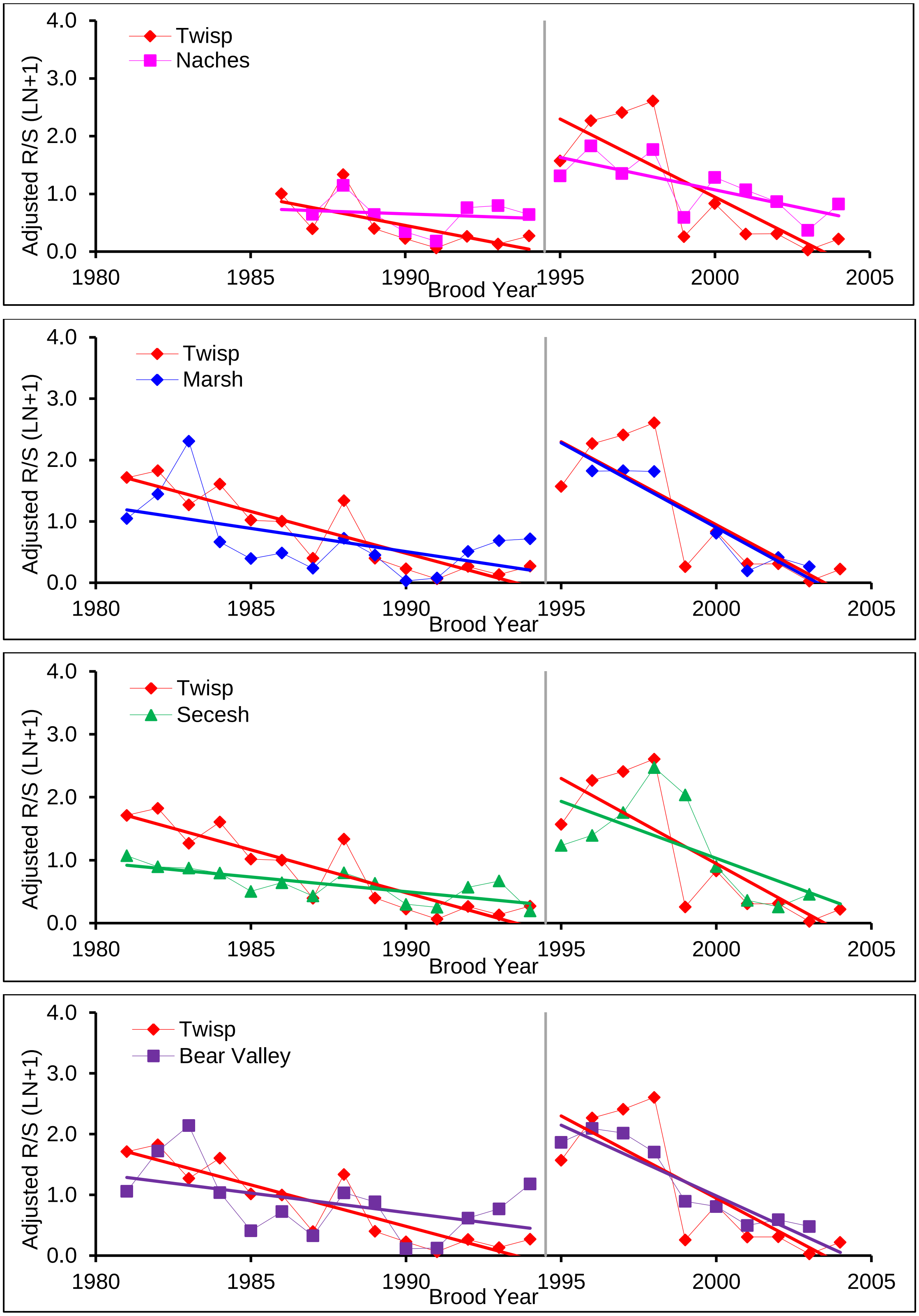


Figure 6. Trends in spring Chinook natural-log productivity adjusted for spawner capacity in the Twisp and reference populations. The vertical lines in the figures separate the pre-supplementation and supplementation periods.

Objective 2: Migration and Spawning Characteristics

Migration Timing

Low sample size for a specific run-years and age-classes prohibited the analysis of migration timing between hatchery and natural-origin adults at Wells Dam, Twisp River weir or Twisp River PIT tag antenna array.

Spawn Timing

No difference in spawn timing, based on female carcass recovery date, was found across years (ANOVA: *P* = 0.10), origin (ANOVA *P* = 0.15) or among origins within years (ANOVA year x origin interaction term: *P* = 0.98; Figure 7).

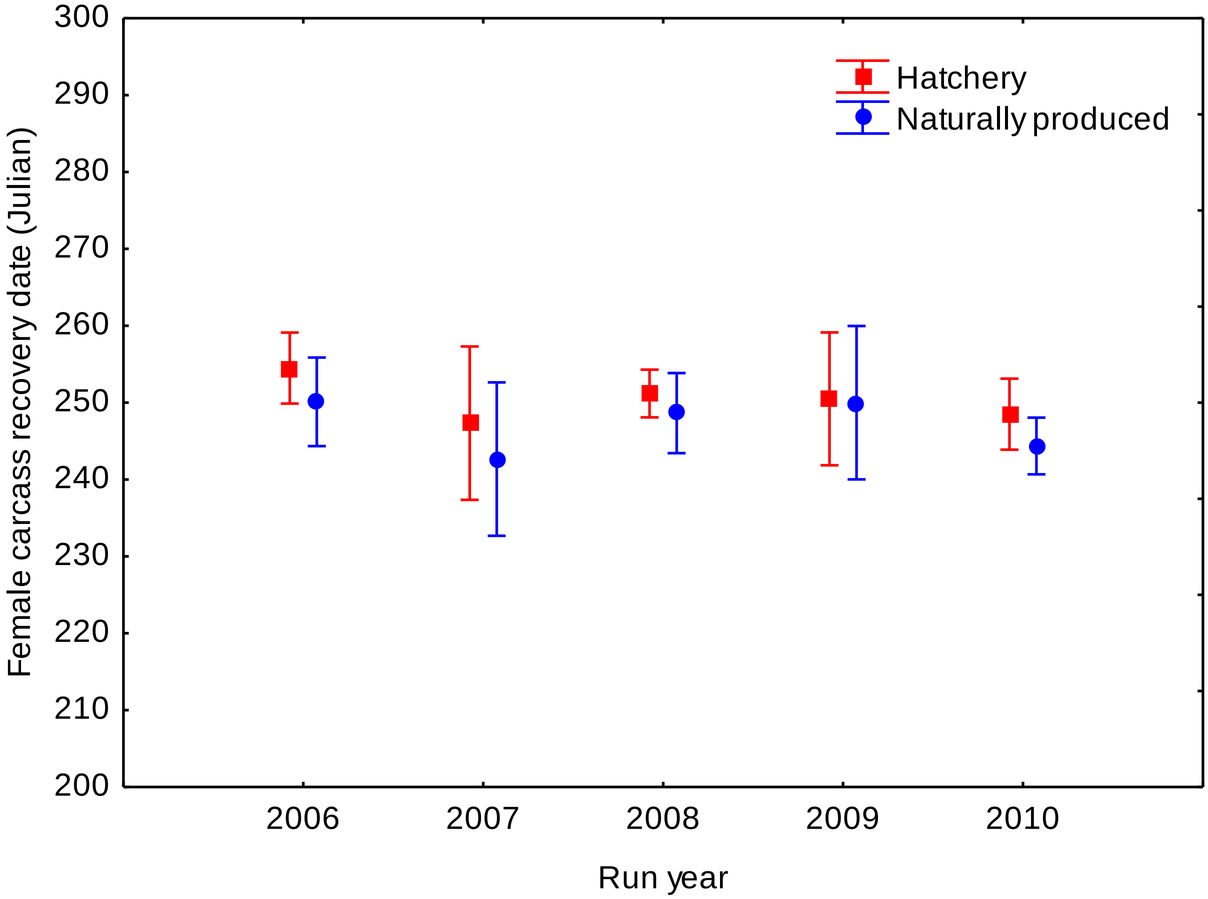


Figure 7. Mean female carcass recovery date of Twisp River spring Chinook.

Redd distribution

The mean location (river kilometer) of recovered carcasses of hatchery and naturally produced females was not significantly different within years (ANOVA year x origin interaction term: *P* = 0.13; Figure 8). Mean female carcass-recovery location, irrespective of origin, were significantly farther upstream in 2008 than in the remaining years analyzed (ANOVA: $P < 0.001$; see Fig. 8).

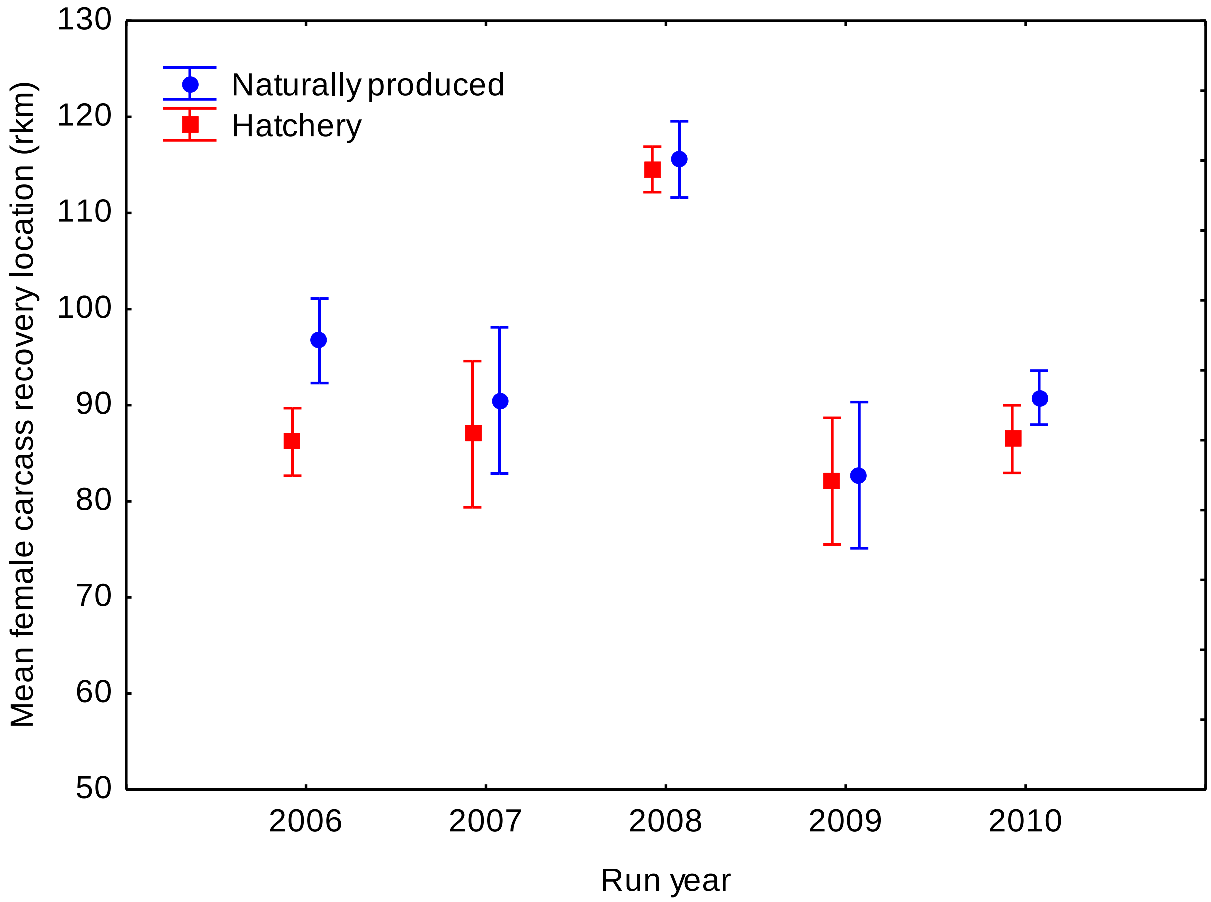


Figure 8. Mean female carcass recovery location of Twisp River spring Chinook.

Objective 3: Genetic and Phenotypic Characteristics

Genetic monitoring

Small et al. (2007) conducted the genotyping and analysis for genotype-based hypotheses and thus is the source for details regarding the methodology and analytical procedures (Appendix D). Results specific to the Twisp spring Chinook were extracted and presented below to specifically address the hypotheses as outlined in the Analytical Framework (Hays et al. 2007).

Twisp spring Chinook had significantly lower mean heterozygosity and allelic richness than the Chewuch ($P < 0.01$) or Methow ($P < 0.005$) stocks. The Twisp hatchery-origin collections were mostly differentiated using Fst from Twisp natural-origin collections (Table 7), although they were more closely related to Twisp natural-origin collections than to collections from other tributaries. The 2006 Twisp natural-origin collection was the smallest collection in the study (N = 13) and was undifferentiated from all other collections after Bonferroni correction. However, the 2005 Twisp natural-origin collection (N = 43) was differentiated from the Methow, Chewuch, and Metcomp collections; therefore, the small sample size of 13 fish may have been inadequate to capture the genetic diversity identified in the 2005 Twisp natural-origin collection. With the exception of 2006 Twisp natural-origin collection, all the Twisp collections were differentiated from the Chewuch and Methow collections. We plotted pairwise F_{ST} values versus time between Twisp collections and found an increase in differentiation over time within Twisp natural-origin collections and within Twisp hatchery-origin collections (Figure 9). Increased differentiation is likely a signal that genetic drift is increasing as N_e decreases.

Table 7. Pairwise F_{ST} values (lower matrix) and *p* values for pairwise genotypic tests (upper matrix) for temporal and spatial collections. Values that were significant before Bonferroni corrections are underlined and values that were significant after Bonferroni corrections are in bold type (corrected alpha = 0.05/253 = 0.00019).

Group	92Twisp W	93Twisp W	01Twisp W	01Twisp H	05Twisp H	05Twisp W	06Twisp H	06Twisp W
92TwispW	*	0.60454	0.00136	**0**	0.00034	0.00969	**0**	0.0476
93TwispW	0.0015	*	0.04706	**0**	**0.00001**	0.00244	**0**	0.013
01TwispW	0.0019	0.0032	*	**0**	**0**	0.0015	**0**	**0.0001**
01TwispH	**0.0179**	**0.0105**	**0.0139**	*	**0**	**0**	**0**	**0.0001**
05TwispH	0.0066	**0.014**	0.0127	**0.0258**	*	**0.00013**	0.02645	0.0027
05TwispW	0.0009	0.0036	0.0018	**0.011**	0.011	*	**0**	0.0347
06TwispH	**0.0168**	**0.0168**	**0.0177**	**0.0271**	0.0112	**0.0122**	*	0.0154
06TwispW	0.0144	-0.0007	-0.0033	0.0151	0.0025	-0.0095	-0.0018	*

We used several analytical approaches to evaluate the relationships between the three Methow Basin stocks and all approaches provided comparable results (Figure 10, Small et al. 2007). Twisp spring Chinook, both natural and hatchery, remain genetically differentiated from the Methow and Chewuch stocks. Early samples from the Twisp River were more tightly clustered than later collections suggesting some differentiation within the stock over time, as discussed above.

Large variance in the estimated effective population size (N_e) may limit the utility of using the spawning population abundance as a predictor of N_e (Small et al 2007). The abundance of natural spawners was positively correlated with N_e (r = 0.55), but the relationship was not significant (Figure 11). The ratio of N_e/N of naturally produced fish did not change for the years examined, but the analysis was limited to only 5 years (Figure 12).

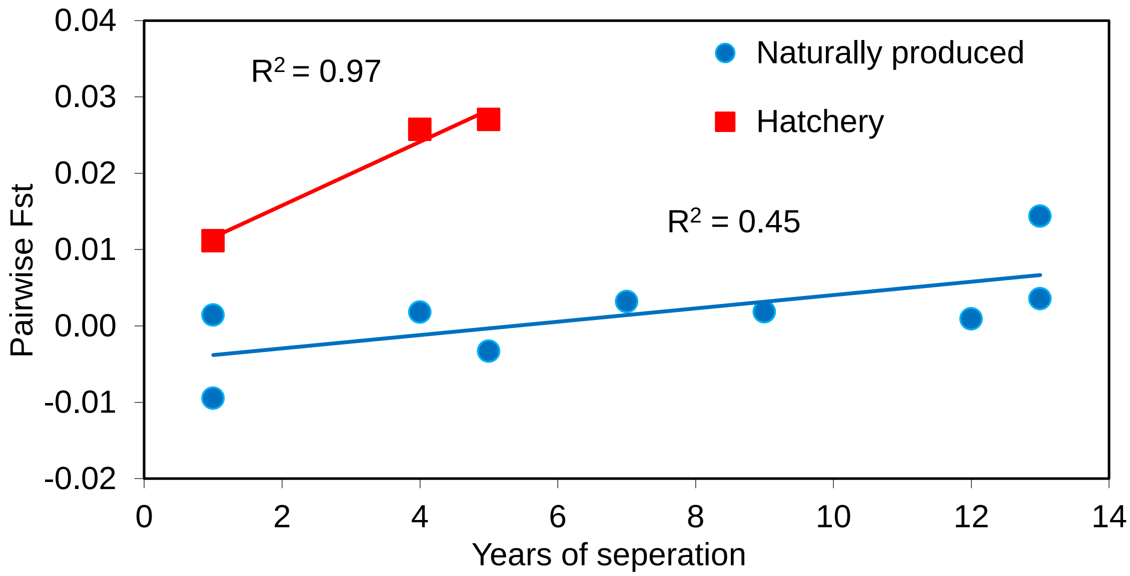


Figure 9. Graph of pairwise F_{ST} values versus time between collections for Twisp spring Chinook.

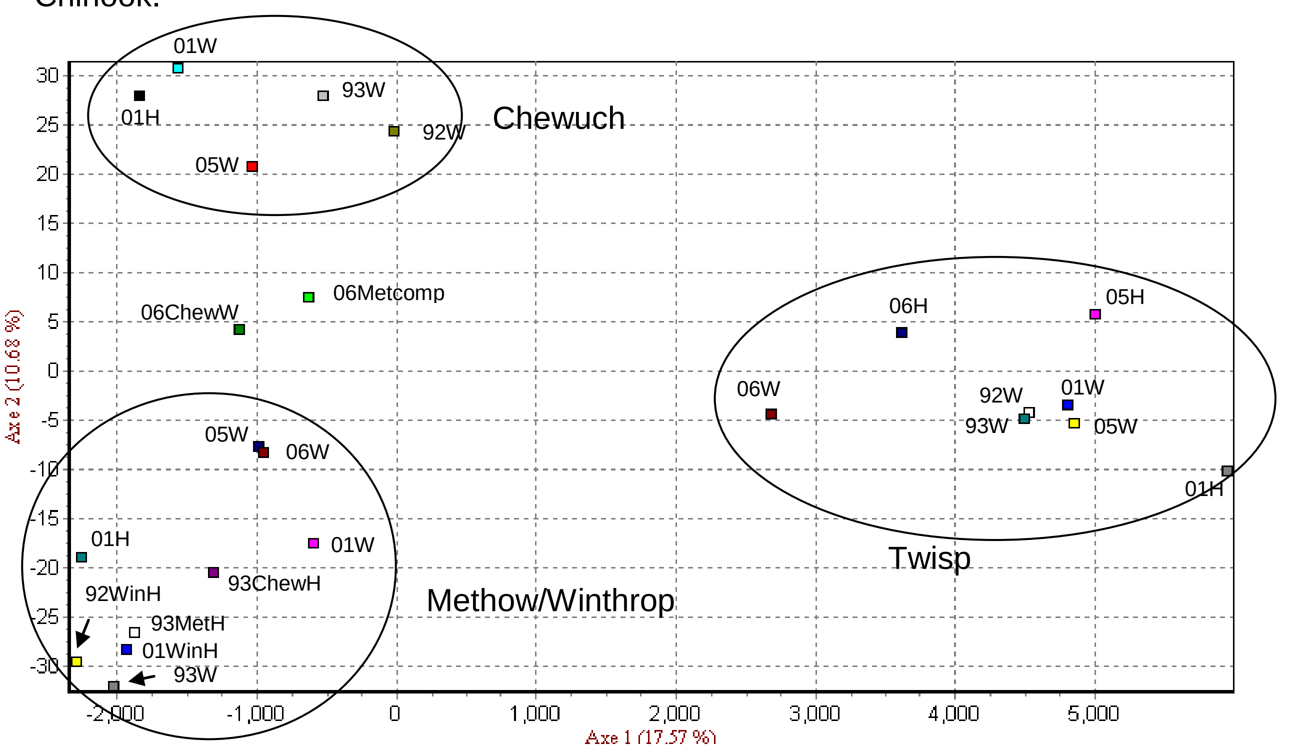


Figure 10. Factorial correspondence analysis plot of hatchery and natural spring Chinook collections from the Methow, Chewuch and Twisp rivers. Hatchery- and natural-origin collections are indicated by "H" and "W", respectively, after the two-digit code for collection year (Small et al. 2007).

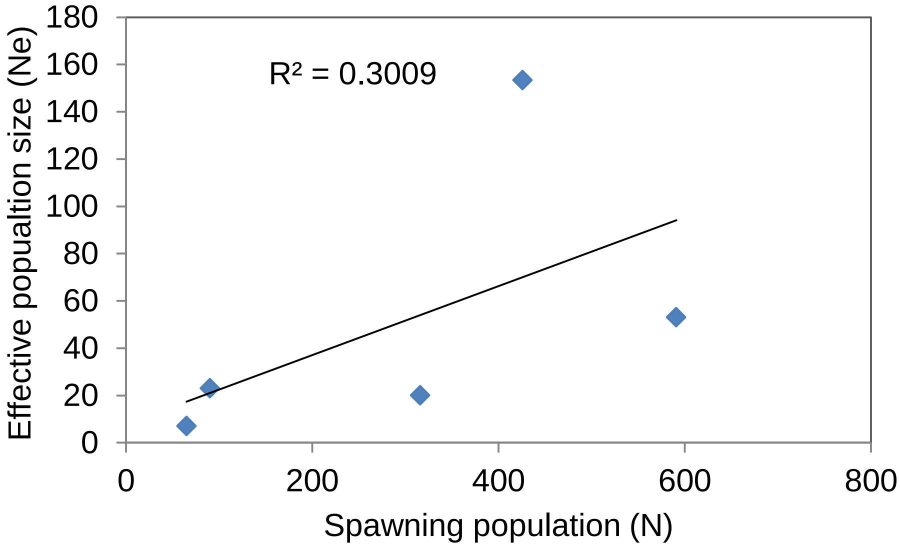


Figure 11. Relationship between the effective population size and the spawning population for naturally produced spring Chinook in the Twisp River.

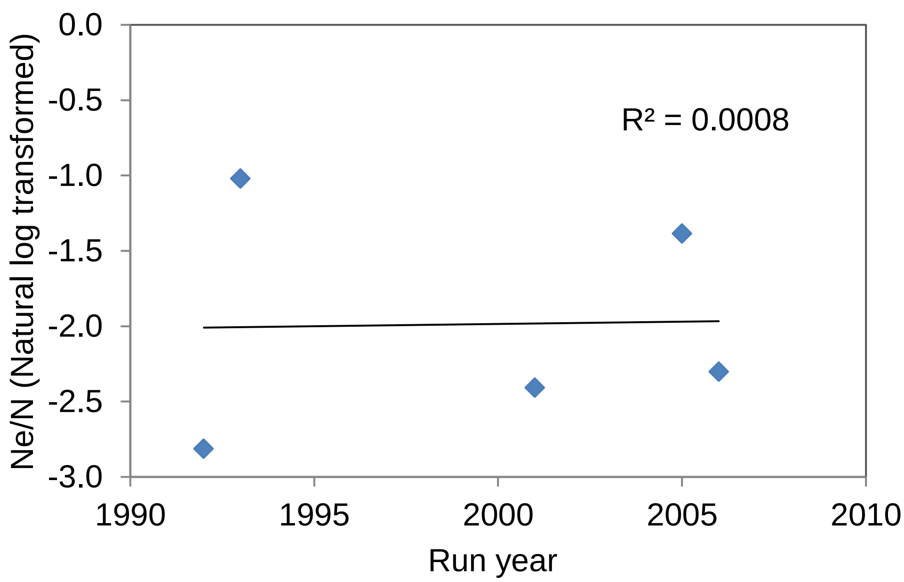


Figure 12. The ratio of N_e/N for naturally produced Twisp spring Chinook.

Age at maturity

Low numbers of adult returns at the beginning of the program limited the analysis of age and size at maturity to broodyears 1997, 2000, and 2004. Furthermore, fish collected as broodstock or as carcasses were pooled by brood year. Mean female and male hatchery and natural-origin age was significantly different when compared by origin across broodyears (Kruskal-Wallis ANOVA: $P < 0.05$), but post-hoc multiple comparisons test found no difference among origins within brood years ($P = 1.0$, Figure 13 and 14). For those years examined, age at maturity was similar among natural origin and hatchery fish, regardless of gender.

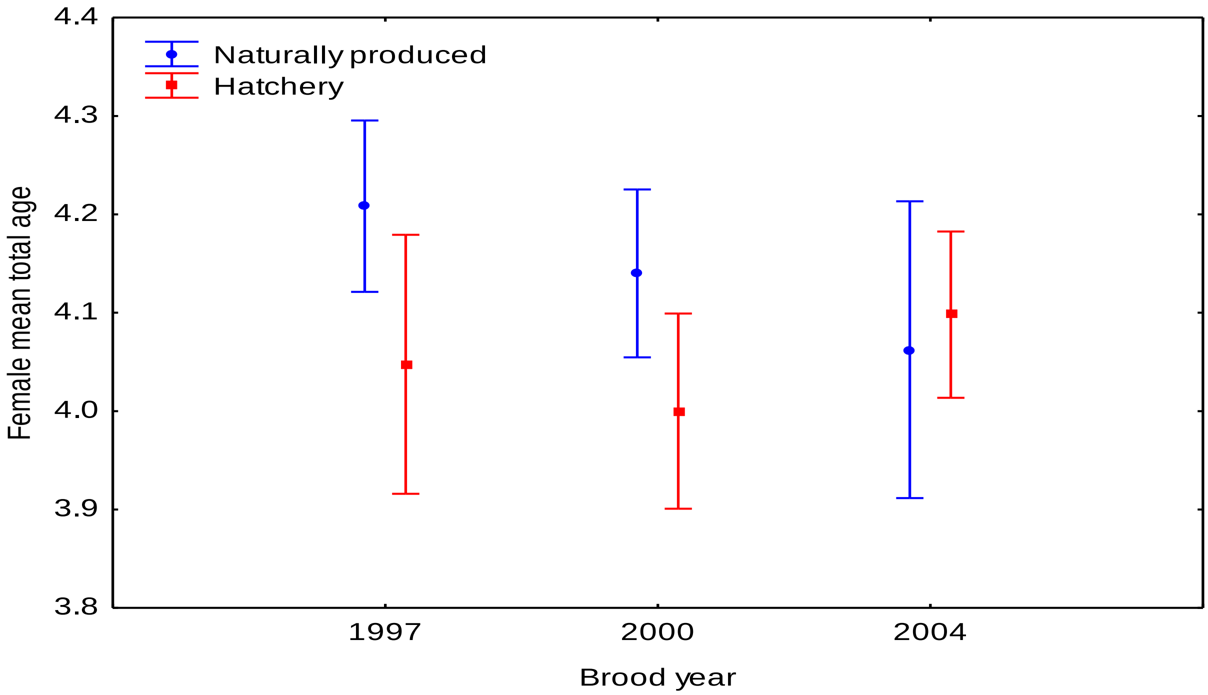


Figure 13. Mean age at maturity of female Twisp River spring Chinook salmon.

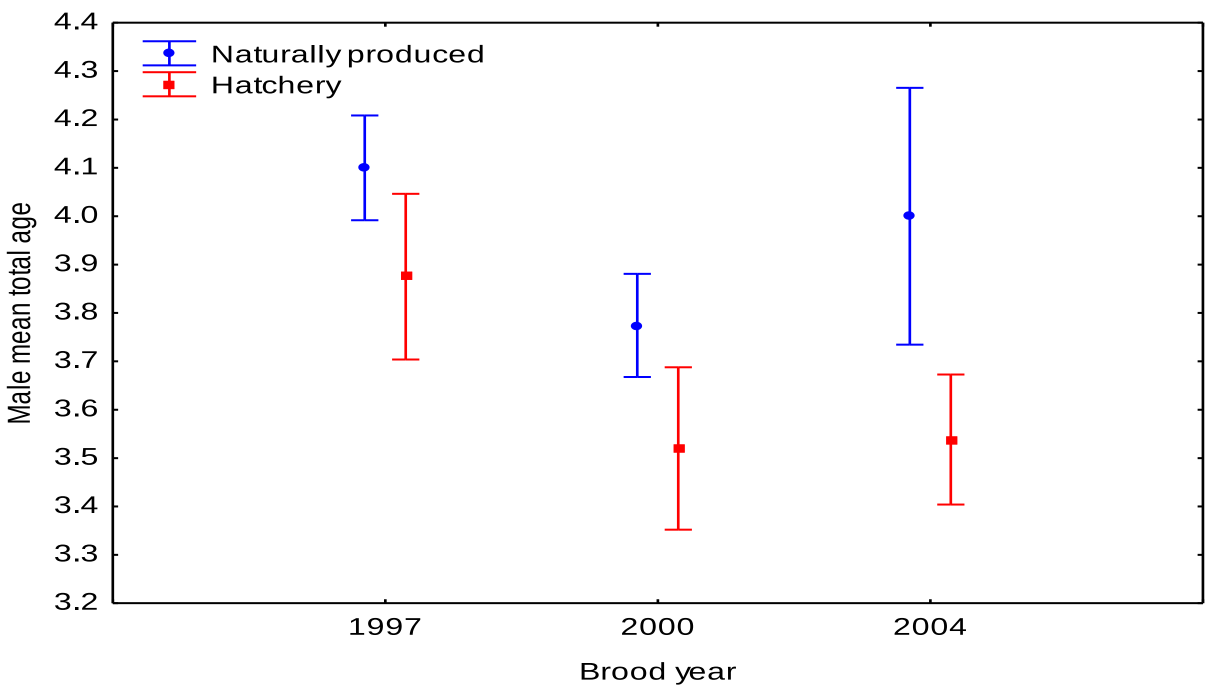


Figure 14. Mean age at maturity of male Twisp River spring Chinook salmon.

Size at maturity

Low adult returns also limited the evaluation of size at maturity to age-four fish. Although differences were detected across brood years for both female and males

(Kruskal-Wallis ANOVA: $P < 0.05$), no difference among origins was detected for females (Figure 15) or males within a broodyear (Figure 16; multiple comparison test: $P > 0.05$).

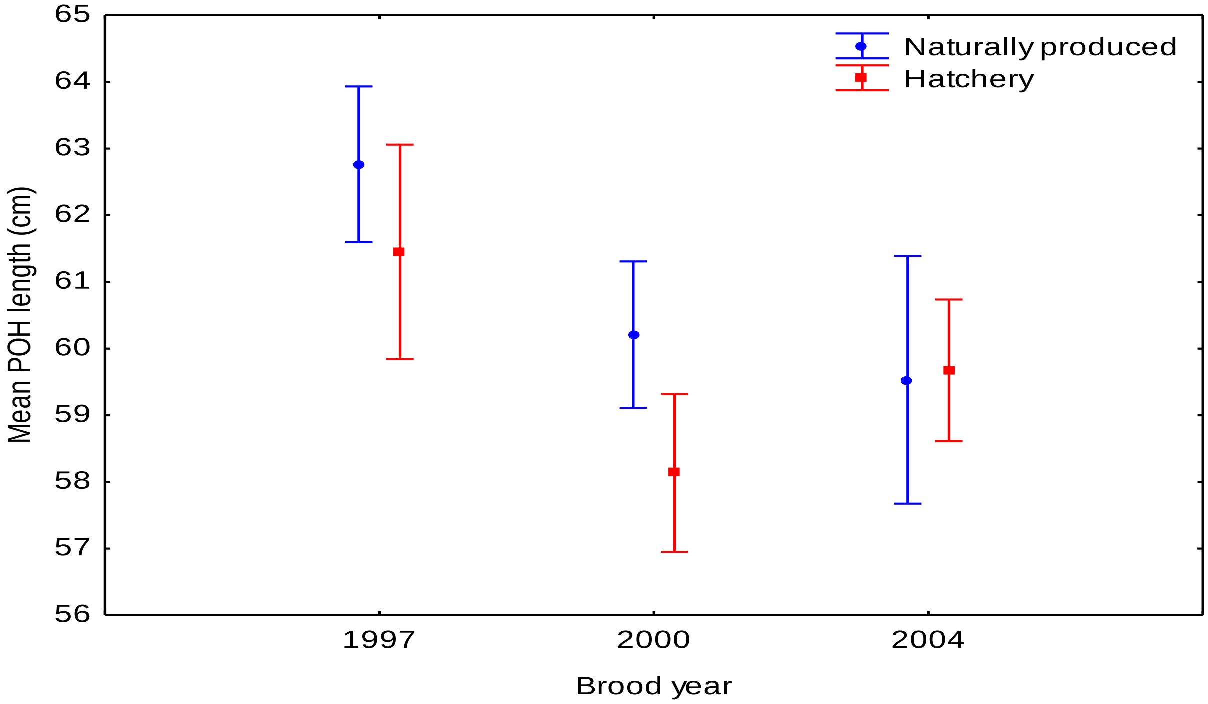


Figure 15. Mean post-orbital to hypural plate (POH) length of age 4 female Twisp River spring Chinook.

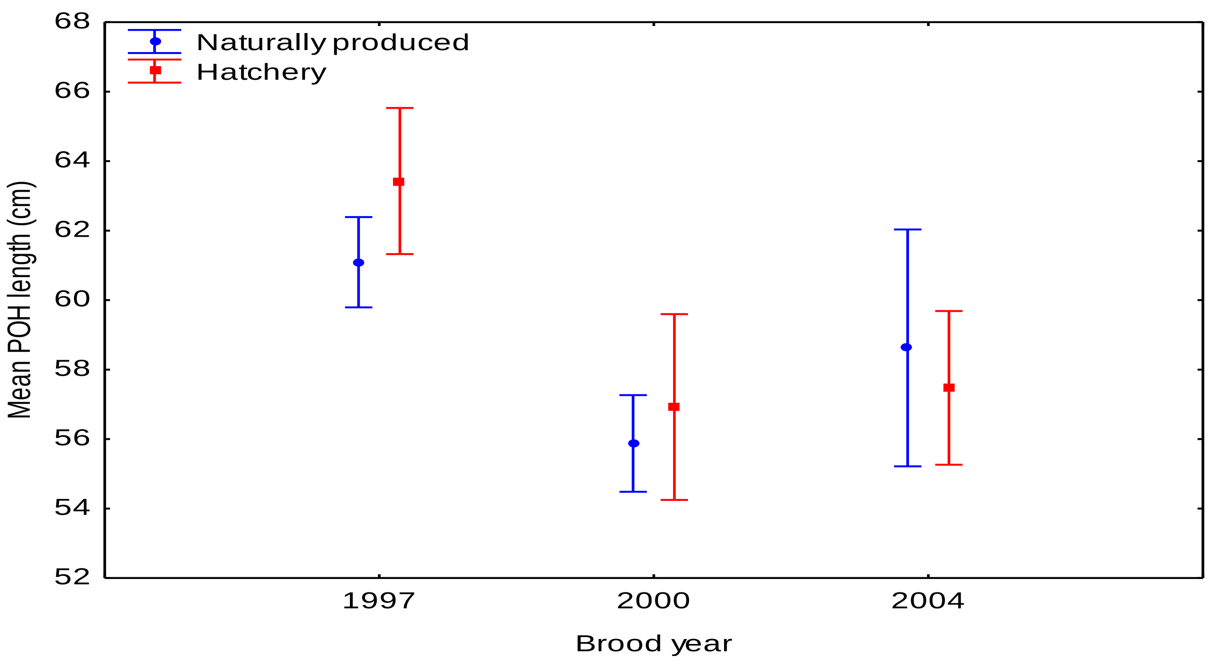


Figure 16. Mean post-orbital to hypural plate (POH) length of age 4 male Twisp River spring Chinook.

Objective 4: Hatchery Fish Survival Rates

The HRR of the Twisp spring Chinook program was significantly less than the expected value (4.5) in the BAMP (Man Whitney U-test: *P* = 0.02, Table 8). The HRR only met or exceeded the BAMP value for 17% of the broodyears. However, the HRR was significantly greater than the NRR (Mann Whitney U-test: *P* = 0.04). Comparison of the geometric means reveals that HRR is 1.9 time higher than NRR. Survival rates of fish in the hatchery have consistently met or exceeded survival standards (Snow et al. 2011). However, Twisp River spring Chinook have experienced significantly lower SARs, based on CWT recoveries that include harvest, than the 0.3% identified in the BAMP (t-test: *P* < 0.01; Table 9).

Table 8. Hatchery replacement rates and natural replacement rates for Twisp spring Chinook salmon adjusted for harvest.

Brood year	HRR	NRR
1992	1.2	0.3
1993	0.6	0.1
1994	1.0	0.3
1996	6.4	8.6
1997	3.6	10.2
1998	2.2	12.6
1999	1.9	0.3
2000	2.7	1.3
2001	1.5	0.1
2002	13.3	0.4
2003	1.5	0.0
2004	3.3	0.2
Mean (SD)	3.3 (3.5)	2.9 (4.7)
Geometric mean	2.3	1.2

Table 9. Smolt to adult return rates for Twisp River spring Chinook.

Brood year	Smolts released	Adult returns	SAR
1992	35,853	21	0.0006
1993	116,749	27	0.0002
1994	19,835	5	0.0003
1996	76,687	275	0.0036
1997	26,714	54	0.0020
1998	15,470	22	0.0014
1999	67,408	61	0.0009
2000	74,717	173	0.0023
2001	51,652	44	0.0009
2002	20,541	120	0.0058
2003	50,627	49	0.0010
2004	71,617	174	0.0024
Mean			0.0018

Objective 5: Stray Rates

Brood stray rates

The mean stray rate of Twisp spring Chinook based on the estimated total number of coded wire tag recoveries by brood year was significantly greater (25%) than the target of 5% (t-test: $P < 0.02$). Stray fish were recovered in similar proportions both in broodstock and on the spawning grounds (Table 10).

Table 10. Stray rates by brood year of Twisp spring Chinook and the number and proportion based on non-target recovery location.

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	0	0.00	0	0.00	0.00
1993	3	0.75	1	0.25	0.15
1994	0	0.00	0	0.00	0.00
1996	33	0.66	17	0.34	0.18
1997	6	1.00	0	0.00	0.11
1998	8	0.80	2	0.20	0.45
1999	25	0.56	20	0.44	0.74
2000	12	0.23	40	0.77	0.27
2001	0	0.00	7	1.00	0.13
2002	59	0.47	66	0.53	0.43
2003	2	0.13	13	0.87	0.31
2004	6	0.18	27	0.82	0.18
Mean		0.40		0.43	0.25
SD		0.34		0.35	0.20

Stray rates within population

Analysis of stray rates within and between independent populations did not begin until 2000 due to lack of spawning ground data in prior years. Twisp spring Chinook have been recovered as carcasses on both the Chewuch and Methow rivers, comprising an average of 0.3% and 2.7% of those respective spawning populations. The proportion of the spawning population within non-target streams of the Methow spring Chinook population was significantly lower than the maximum threshold of 10% (t-test: $P < 0.0001$; Table 11).

Table 11. Proportion of the spawning population comprised of Twisp spring Chinook in non-target streams within the Methow spring Chinook population.

Year	Chewuch River	Methow River
2000	0.000	0.029
2001	0.002	0.004
2002	0.000	0.011
2003	0.000	0.040
2004	0.000	0.044
2005	0.004	0.016
2006	0.009	0.046
2007	0.000	0.072
2008	0.000	0.004
2009	0.015	0.023
2010	0.004	0.008
Mean	0.003	0.027

Stray rates outside of the population

The Entiat River was the only other independent population where Twisp spring Chinook have been recovered on the spawning grounds. Twisp fish comprised 2.5% of the Entiat spawning population in 2007.

Objective 6: Hatchery Release Characteristics

The target length and weight for Twisp spring Chinook was 135 mm and 30.2 g, respectively. The mean length at release was 135 mm and not significantly different from the release target size (t-test: P = 0.86). The mean weight at release was 29.9 g and not significantly different from the release target size (t-test: P = 0.74; Table 12).

Table 12. Mean size at release of Twisp River spring Chinook salmon.

Brood year	Fork length	Weight	Brood year	Fork length	Weight
1992	135	30.0	2002	136	30.3
1993	133	29.8	2003	133	28.2
1994	139	31.4	2004	130	27.9
1996	137	30.7	2005	139	33.9
1997	133	28.2	2006	134	29.6
1998	138	30.3	2007	128	24.9
1999	156	47.7	2008	129	26.8
2000	133	27.2	Mean	135	29.9
2001	123	21.6	Target	135	30.2

The Twisp spring Chinook program released a significantly lower number of fish between 1992 and 2008 (t-test: $P < 0.0001$; Table 13) than the program goal (183,024). Because hatchery life-stage survival rates were at or above survival standards (Snow et al. 2011), failure to meet program release goals were attributed to insufficient broodstock. Broodstock collection goals were not met due to a combination of low fish abundance and lower than expected extraction rates at the Twisp River weir.

Table 13. Number of Twisp River spring Chinook salmon released by brood year. No releases from the 1995 brood occurred.

Brood year	Number	Brood year	Number
1992	35,853	2002	20,541
1993	116,749	2003	43,734
1994	19,835	2004	96,617
1996	76,687	2005	27,658
1997	26,714	2006	45,892
1998	15,470	2007	54,096
1999	67,408	2008	78,656
2000	74,717	Mean	53,267
2001	51,652	Target	183,024

Objective 7: Freshwater Productivity

We successfully fitted both Beverton-Holt and Ricker stock-recruitment models to redd and total emigrant abundance data, but those models only explained between 35-38% of the variation in recruits (Figure 17). To calculate residuals, we natural-log transformed the stock-recruitment data. We did not detect a relationship between the proportion of hatchery fish on the spawning grounds (pHOS; untransformed range: 0.28-0.76) and regression residuals (Figure 18). Nor did we detect a significant relationship between freshwater productivity or emigrants per redd and the proportion of hatchery fish on the spawning grounds (Figure 19).

Smolt monitoring on the Twisp River did not begin until 2005, and more data is necessary to better understand the relationships between spawner abundance and the influence of hatchery spawners in their habitat. Low mean egg-to-emigrant survival in the Twisp River (2004 – 2009 mean = 5%) may be related to biases in abundance estimates, poor reproductive success, or both. Studies are currently underway to assess biases in abundance estimates.

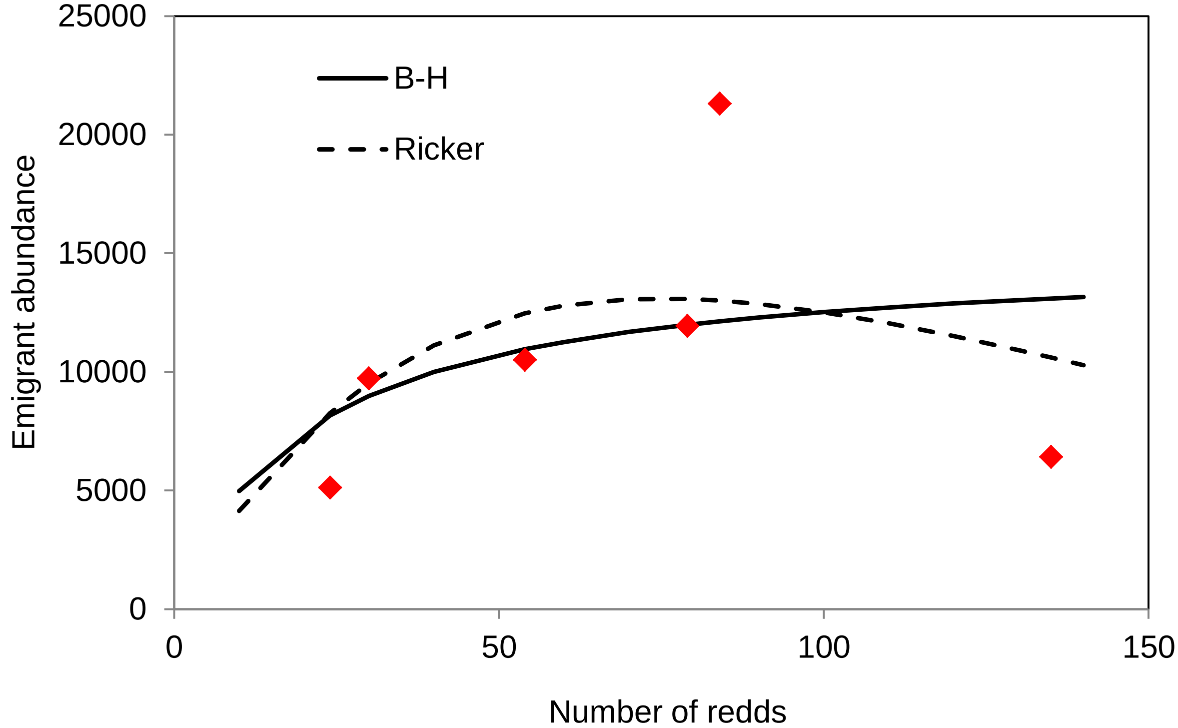


Figure 17. Beverton-Holt and Ricker stock recruitment models for Twisp spring Chinook emigrants.

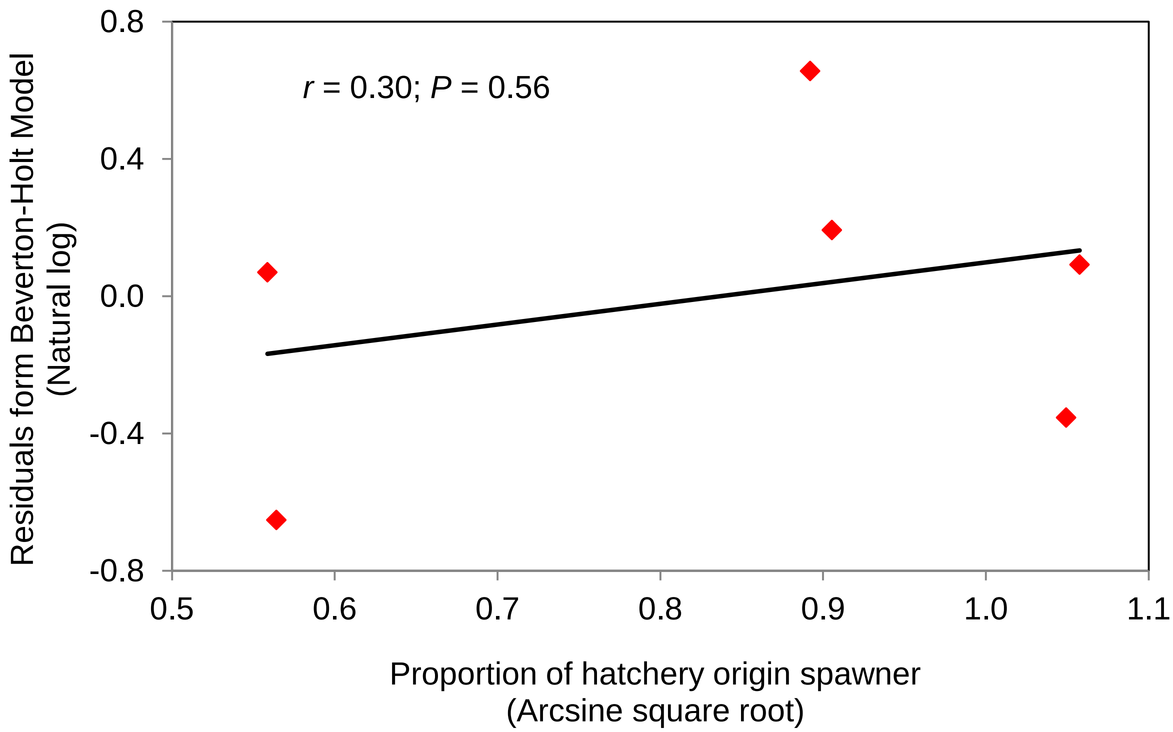


Figure 18. Correlation analysis of residuals from Beverton-Holt model and the proportion of hatchery fish on the spawning grounds.

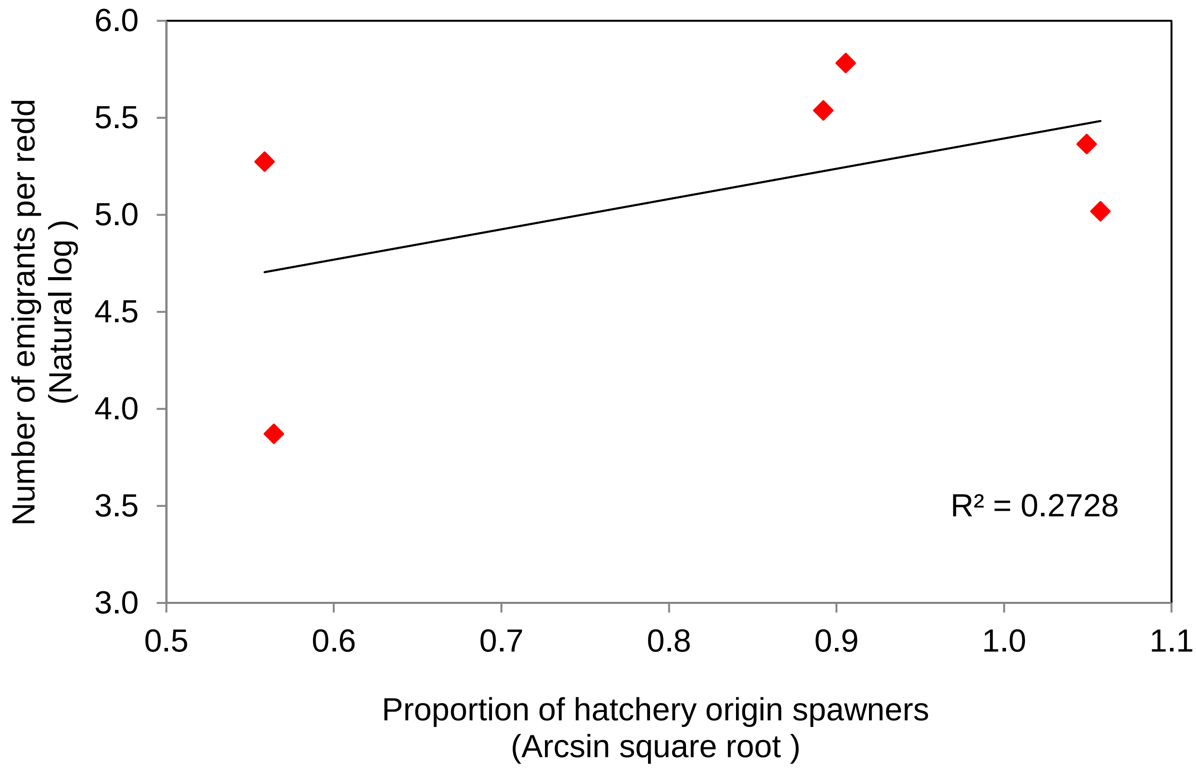


Figure 19. Regression analysis of emigrants per redd and the proportion of hatchery fish on the spawning grounds in the Twisp River.

Objective 8: Harvest

Direct harvest of Twisp spring Chinook salmon has not occurred since fish were listed as endangered in 1999, except for Columbia River tribal fisheries. Furthermore, juvenile fish have not been adipose fin clipped beginning with the 2000 brood (2002 release). Hence, harvest rates in the last 10 years have been minimal and limited to indirect post-release mortality associated with Columbia River commercial and sport fisheries or tribal non-selective fisheries.

Summary

Juvenile Twisp spring Chinook survival was at or above the expected standard within the hatchery. Poor post-release survival, resulting in hatchery replacement rates below the 4.5 target, is responsible for the low observed HRR values. However, the specific life stage(s) responsible for low SARs is unknown. Juvenile hatchery fish have been released at the target length and weight, but the number of fish released has only been on average 29% of the release target due to lack of Twisp-specific broodstock. Adult hatchery Twisp spring Chinook have similar spawn timing and redd distribution as naturally produced adult Twisp spring Chinook in the Twisp River. Hatchery and natural-origin fish did not differ in age at return within brood years, and neither age-four males nor females differed in length by origin. Both spawn timing and spawning distribution of hatchery and naturally produced fish was similar within a given year. The Twisp population has remained genetically differentiated from the Methow and Chewuch populations.

Twisp adults strayed into the Methow and Chewuch rivers at higher than expected rates. Nevertheless, the fact that half of the strays were recovered in Methow Hatchery reveals strong homing back to this natal facility. Salmon are believed to imprint sequentially at various life stages, enabling them to home back to natal waters that they may not inhabit at the parr-smolt transition stage (e.g., Naturally produced Twisp River subyearling Chinook emigrants that rear in Methow River). Thus the lack of earlier life-stage imprinting on Twisp water may cause some fish to home back to the Methow Hatchery and vicinity, rather than to the Twisp. Additionally, the acclimation period in the spring may not be long enough to allow key imprinting during the parr-smolt transformation. Combined or individually, these or other factors may result in the observed level of straying.

Spring Chinook total spawner abundance has decreased and the abundance of NORs has not increased in the Twisp River when compared to reference populations, indicating that the release of hatchery-origin fish has not provided the anticipated demographic boost to the natural-origin population. At the same time, productivity in the Twisp has not significantly diverged from that of reference populations during the time of supplementation, indicating that the presence of hatchery-origin spawners has not significantly decreased productivity compared to reference populations. The decline in abundance of total spawners and lack of increase in NORs are of concern. Low smolt-to-adult survival of hatchery fish, low natural recruitment rate, and straying of hatchery fish outside the Twisp to other parts of the Methow Basin contribute to these troubling population dynamics results. The proportion of hatchery-origin spawners in the Twisp has averaged 0.55, with some years exceeding 0.75. While a delicate balance between demographic benefit and genetic risk of hatchery programs exists, the greatest threat(s) facing the Twisp population is not likely a paucity of hatchery-origin spawners given the lack of response of the population to hatchery supplementation. A brief assessment of all objectives is provided in Table 14.

Table 14. Summary assessment of M & E objectives for the Twisp spring Chinook hatchery program.

Obj.	Primary indicator	Assessment
1	Spawner abundance	Spawner abundance in the Twisp River has declined.
	Natural-origin abundance	Abundance of natural-origin fish in the Twisp population has not increased.
	Adult productivity	Adult productivity has not changed between pre- and during supplementation periods.
2	Migration timing	Insufficient data to assess this objective.
	Spawn timing	Exhibit similar spawn timing as naturally produced fish.
	Redd distribution	Exhibit similar spawning distribution as naturally produced fish.
3	Genetic diversity	Twisp spring Chinook are still distinct from the other stocks in the Methow Basin.
	Effective population size	Ratio of Ne/N is constant as expected.
	Age at maturity	Age at return within brood years did not significantly differ among male and female fish of hatchery and natural-origin.
	Size at maturity	Male and female age 4 hatchery fish were similar in size to naturally produced age 4 fish.
4	Hatchery replacement rate	Post-release survival of hatchery fish was significantly lower than the target of 4.5. Hatchery survival was greater than the natural replacement rate.
5	Stray rates	Brood year stray rates were significantly higher than the target of 5%. However, stray rates into the Methow and Chewuch rivers were within acceptable levels. Twisp spring Chinook did not stray outside of the Methow Basin.
6	Size and number of juveniles released	Target size and number of fish released were met. However, program release goals have not been met due to a low abundance of fish and lack of broodstock.
7	Freshwater productivity	Egg to smolt survival is low, but is not related to the proportion of hatchery fish on the spawning grounds.
8	Harvest	Harvest rates of Twisp spring Chinook have been negligible for both hatchery and naturally produced fish.

Chewuch River Spring Chinook

Goal – Support the recovery of Chewuch spring Chinook salmon[3] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

Program **–** Collect sufficient broodstock from Wells Dam and Methow Hatchery (hatchery and naturally produced) in order to release 183,000 yearling smolts from the Chewuch Acclimation Pond.

Reference Streams

Of the possible reference populations identified in Hillman et al. (2011), the Secesh River, Bear Valley Creek, Marsh Creek, and Naches River met most or all criteria and were selected for further analysis as possible reference populations (Table 15). Big Creek was added as a possible reference stream because initial analysis suggested Marsh and Bear Valley creeks may not be good reference populations for the Chewuch River (i.e., lack of correlation). Analysis of spawner abundance, natural-origin recruits (NORs), and productivity (recruits/spawner) were conducted using natural-log-transformed data.

Following methods outlined in Appendix C, results varied with reference population, metric, and data type. Only the Naches River and Big Creek populations were correlated (r > 0.6) with the Chewuch population for spawner abundance, while Chewuch NORs and productivity were correlated with Naches River, Secesh River, and Big Creek (Table 16). Both Marsh Creek and Bear Valley Creek population were not highly correlated (r > 0.60) with the Chewuch River and were not included in further analysis. Trend analysis revealed no significant difference between the reference populations and the Chewuch for spawner abundance. Significant differences were found in trends of NORs in the Secesh and Bear Valley populations, and the trend of productivity for all populations (Table 16). Differences in trends were likely the result of high productivity values in the beginning of the pre-supplementation period. Graphical analysis results were consistent with correlation analysis for spawner abundance (Figure 20), NORs (Figure 21), and productivity (Figure 22). The minimum detectable difference varied greatly with response variable and metric (Table 17). We chose to use the Naches River, Secesh River, and Big Creek populations as references for these analyses.

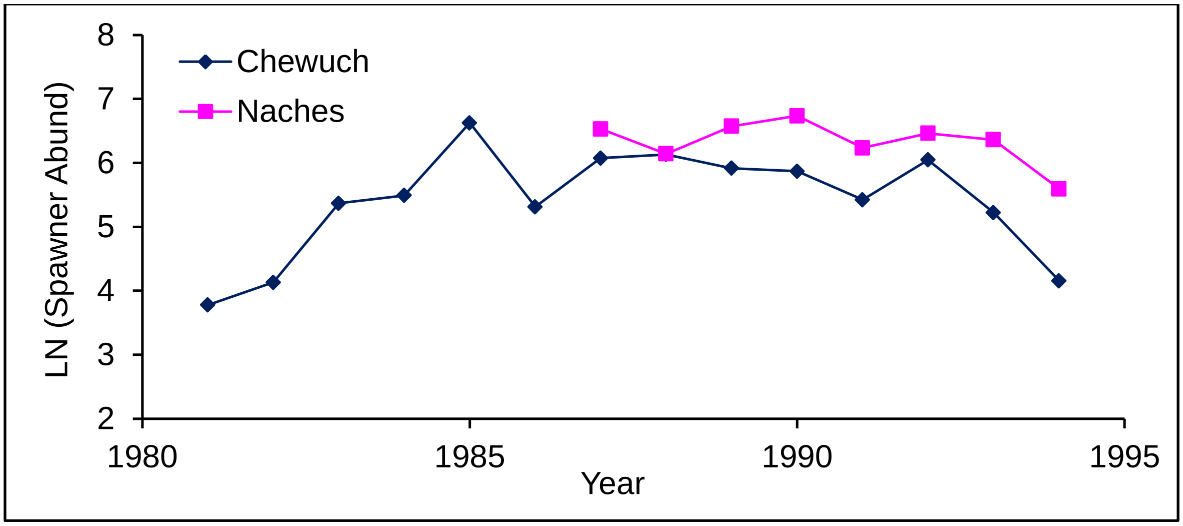
[3] While the HCP is not a recovery plan into itself, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.

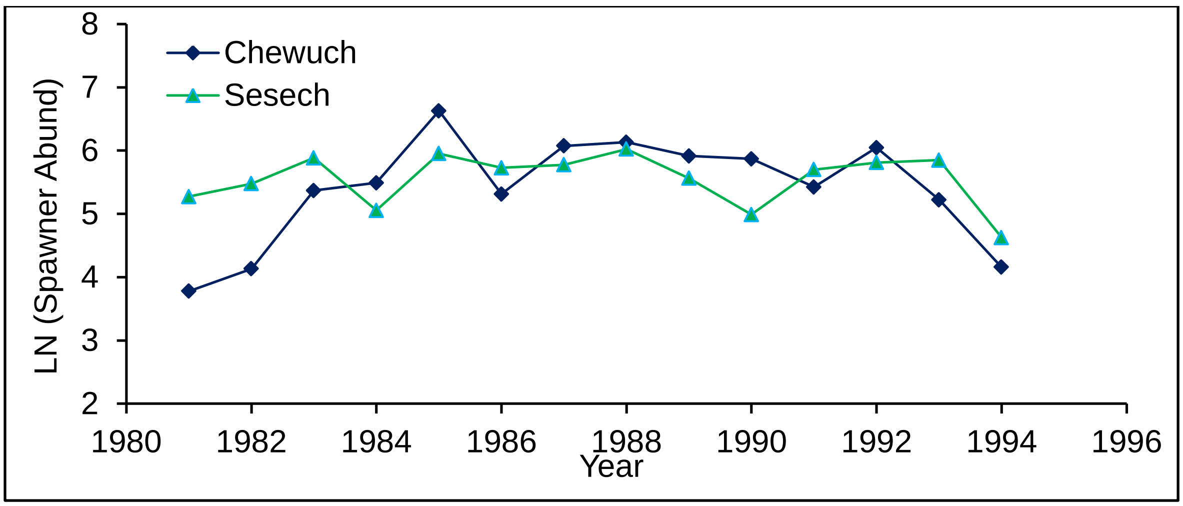
Table 15. Populations of stream-type Chinook salmon and their comparison to Chewuch spring Chinook. Populations in bold were selected as reference streams for the Chewuch population.

Population	Similar life-history	No or few hatchery fish	Accurate abundance estimates	Long time series	Similar freshwater habitat	Similar out-of-basin effects
Deschutes River	Yes	Yes	Yes	Yes	No	No
John Day mainstem	Yes	Yes	Yes	Yes	No	No
Middle Fk John Day	Yes	Yes	Yes	Yes	No	No
North Fk John Day	Yes	Yes	Yes	Yes	No	No
Granite Creek	Yes	Yes	Yes	Yes	No	No
Wenaha River	Yes	No	Yes	Yes	Yes	Yes
Minam River	Yes	No	Yes	Yes	Yes	Yes
Slate Creek	Yes	Yes	Yes	No	No	Yes
Secesh River	Yes	Yes	Yes	Yes	Yes	Yes
MF Salmon River	Yes	Yes	Yes	No	No	Yes
Big Creek	Yes	Yes	Yes	Yes	No	Yes
Camas Creek	Yes	Yes	Yes	Yes	No	Yes
Loon Creek	Yes	Yes	Yes	Yes	No	Yes
Sulphur Creek	Yes	Yes	Yes	Yes	No	Yes
Bear Valley Creek	Yes	Yes	Yes	Yes	No	Yes
Marsh Creek	Yes	Yes	Yes	Yes	Yes	Yes
North Fk Salmon River	Yes	Yes	No	No	Yes	Yes
Lemhi River	Yes	Yes	Yes	Yes	No	Yes
EF Salmon River	Yes	No	Yes	Yes	No	Yes
Valley Creek	Yes	Yes	Yes	Yes	No	Yes
Chamberlain Creek	Yes	Yes	Yes	No	Yes	Yes
Naches River	Yes	Yes	Yes	Yes	Yes	No
Little Wenatchee River	Yes	No	Yes	Yes	Yes	No
Entiat River	Yes	No	Yes	Yes	No	No

Table 16. Pearson correlation coefficients and t-test results comparing slopes of trends between potential reference populations and the Chewuch spring Chinook population; DF = degrees of freedom and for correlation coefficients, an asterisk (*) indicates significance at $P < 0.05$. Analyses were conducted on natural-log transformed abundance and productivity data.

Reference population	Pearson correlation coefficient	t-test of slopes		
		t-value	DF	P-value
		LN Spawner Abundance		
Naches	0.792*	0.991	18	0.335
Marsh	0.559*	1.143	24	0.264
Secesh	0.543*	0.906	24	0.374
Bear Valley	0.543*	0.520	24	0.608
Big	0.645*	1.058	24	0.301
		LN Adjusted Natural-Origin Recruits		
Naches	0.722*	1.881	18	0.077
Marsh	0.589*	-1.902	24	0.070
Secesh	0.605*	-3.969	24	0.001
Bear Valley	0.506	-2.545	24	0.018
Big	0.740*	-1.786	24	0.087
		LN Adjusted Productivity (recruits/spawner)		
Naches	0.682	-2.695	18	0.015
Marsh	0.438	-2.581	24	0.017
Secesh	0.808*	-4.852	24	0.000
Bear Valley	0.430	-2.821	24	0.010
Big	0.687*	-2.476	24	0.021





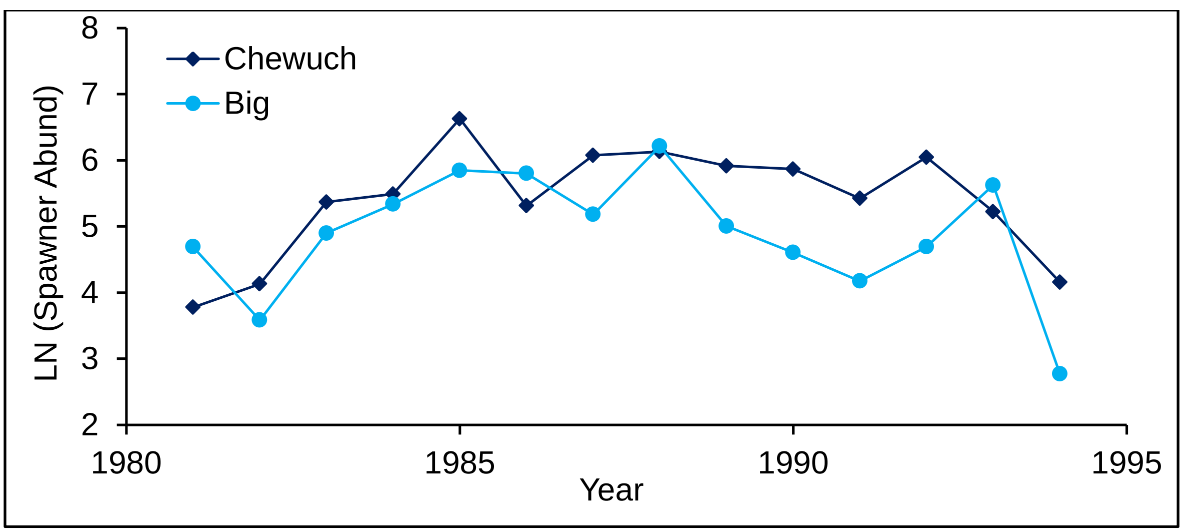


Figure 20. Time series of spawner abundance (natural log transformed) of potential reference populations and the Chewuch spring Chinook population before the Chewuch River was supplemented with hatchery fish.

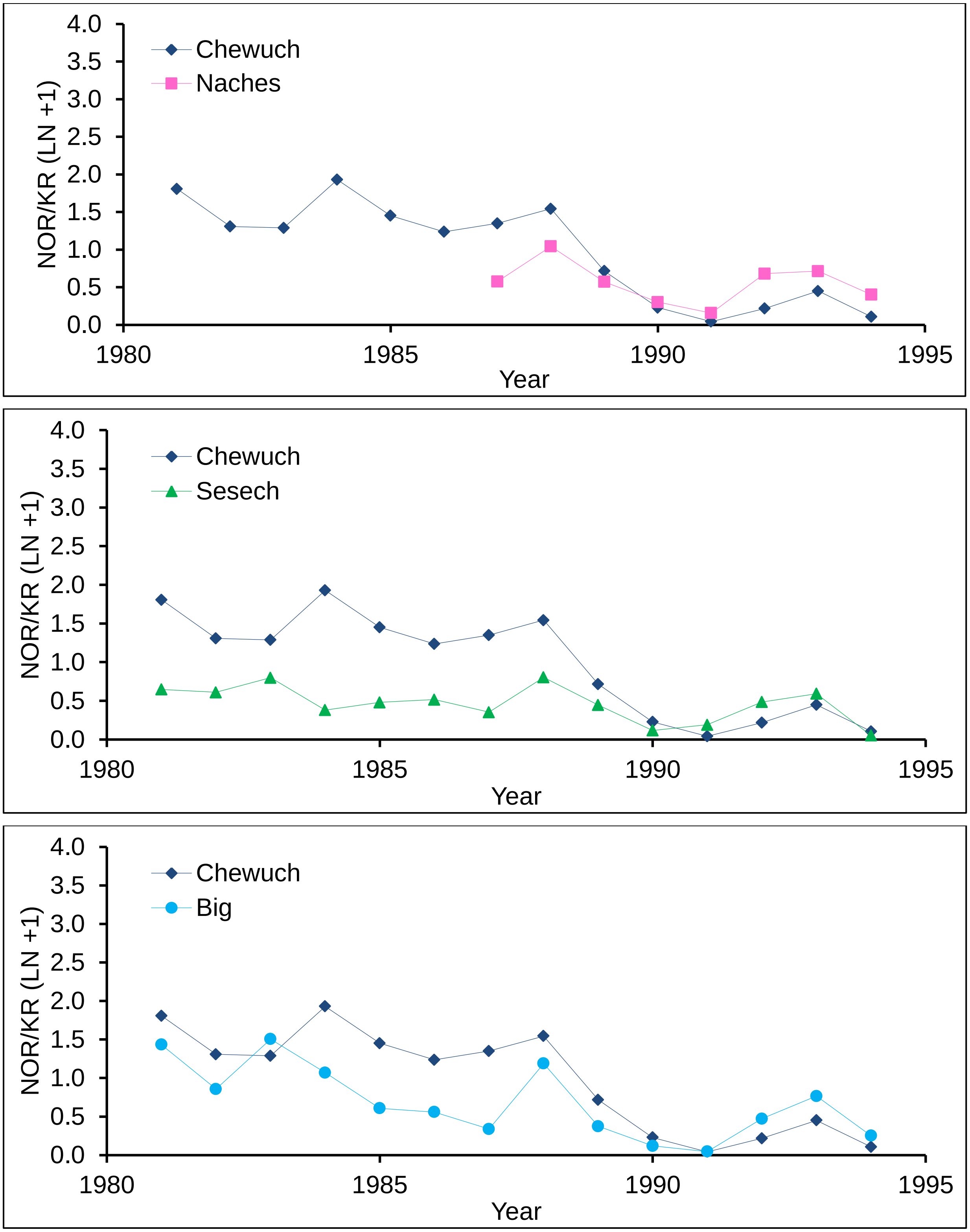


Figure 21. Time series of natural-origin recruits (NORs) of potential reference populations and the Chewuch spring Chinook population before the Chewuch River was supplemented with hatchery fish. NOR was adjusted for carrying capacity and natural log transformed.

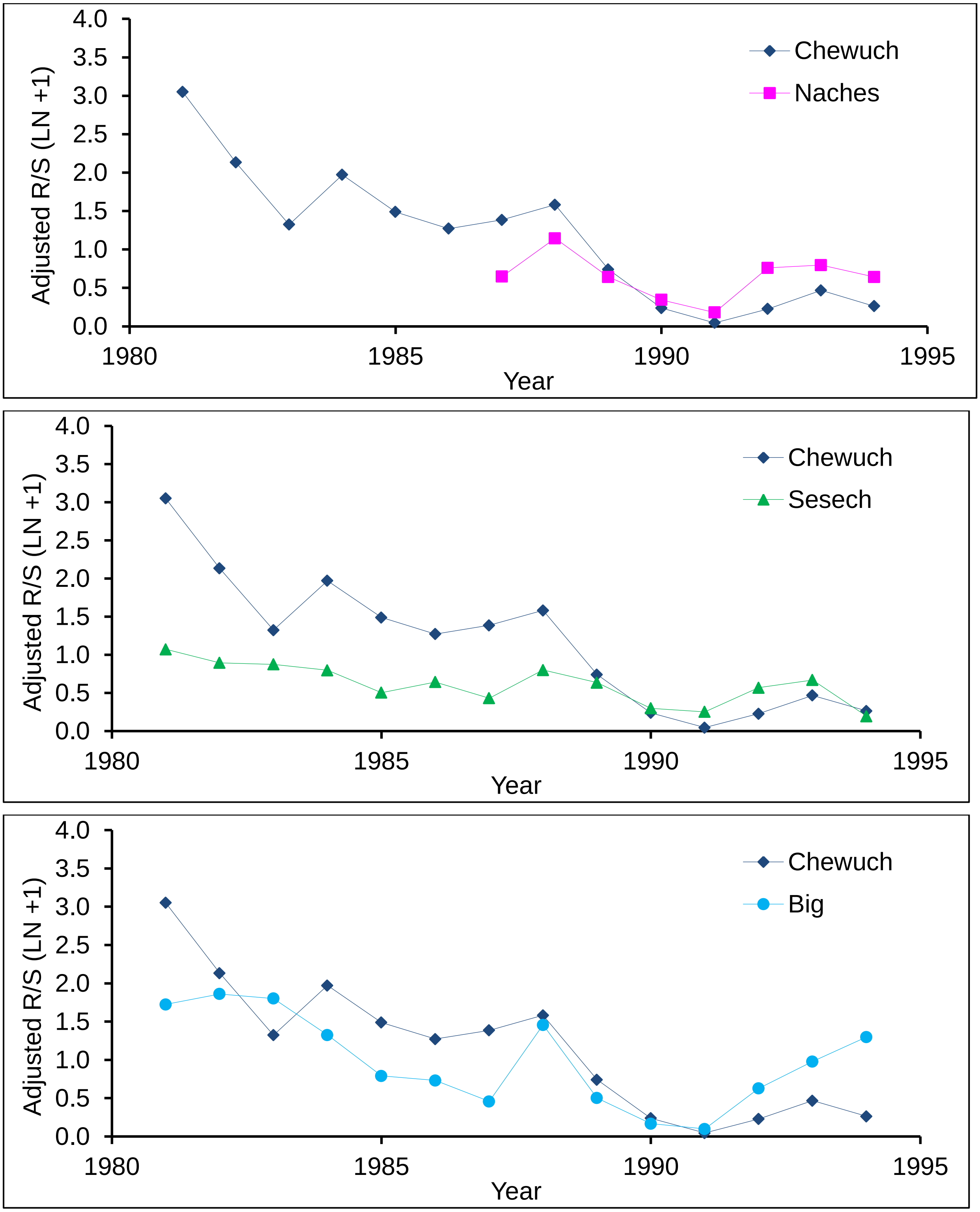


Figure 22. Time series of adult productivity (recruits/spawner) of potential reference populations and the Chewuch spring Chinook population before the Chewuch River was supplemented with hatchery fish. Productivity data were adjusted for spawner capacity and natural log transformed.

Table 17. Minimal detectable difference of ratio scores before and during supplementation for both untransformed and natural-log transformed data.

Treatment years	Minimal detectable differences by reference population		
	Naches	Secesh	Big
	Spawner Abundance		
15	0.76	1.05	3.20
20	0.68	0.96	2.93
25	0.62	0.89	2.71
50	0.46	0.69	2.07
	LN Spawner Abundance		
15	0.34	0.37	0.44
20	0.32	0.35	0.43
25	0.31	0.34	0.41
50	0.26	0.29	0.35
	Natural-Origin Recruits (adjusted for capacity)		
15	1.50	3.91	2.38
20	1.32	3.52	2.14
25	1.18	3.23	1.96
50	0.85	2.40	1.46
	LN Natural-Origin Recruits (adjusted for capacity)		
15	1.13	2.08	1.61
20	0.99	1.87	1.45
25	0.90	1.72	1.33
50	0.64	1.28	0.99
	Productivity (adjusted for spawner capacity)		
15	1.79	3.76	2.05
20	1.57	3.39	1.85
25	1.42	3.11	1.69
50	1.02	2.32	1.26
	LN Productivity (adjusted for spawner capacity)		
15	1.26	1.91	1.35
20	1.11	1.72	1.21
25	1.00	1.58	1.11
50	0.72	1.18	0.83

Conclusions

All reference populations are suitable (i.e., weighted score >80) for comparison with the Chewuch River spring Chinook population (Table 18). We employed a weighted ranking system (see Appendix C) that included level of correlation, relative difference in slopes of reference verses treatment, CV of ratio scores of reference verses treatment, and proportion of natural-origin spawners in the reference population both before and during supplementation. Populations that had less than 90% natural-origin spawners were removed from consideration. A score of 81.75 was at the upper 97.5th percentile of all possible weighted scores. The Big Creek population ranked the highest for all metrics. The Naches River population also ranked high for productivity, but had the lowest ranking for productivity. The Sesech River population had a high rank for productivity, but the lowest rank for spawner abundance and NORs. No analysis of trends in habitat metrics or other “nuisance” factors was conducted.

Table 18. Ranking of reference populations (1 = best) for the Chewuch River spring Chinook population based on weighted score. Score was based on proportion of natural spawners (before and during supplementation), correlation coefficient, difference in trends, and the coefficient of variation of the ratio scores (treatment/reference).

	Weighted score			Ranking		
Reference populations	Spawner abundance	Natural origin recruits	Productivity	Spawner abundance	Natural origin recruits	Productivity
Naches	92	82	82	1	2	3
Secesh	84	81	84	3	3	2
Big	90	87	86	2	1	1

Objective 1: Abundance, Recruitment, and Productivity

No significant increase in mean spawner abundance was detected during supplementation (test of mean ratio scores). Results from comparisons with reference populations were mixed. No difference was detected in comparisons with the Naches River or Big Creek, but a significant decrease in spawner abundance was detected when compared to the Secesh River (Table 19, Figure 23). Excluding those years (1996 and 1998) where a majority of the returning adults were collected at Wells Dam resulted in no significant differences in spawner abundance when compared to any reference streams. However, graphical analysis suggests that spawner abundance for the Chewuch population rapidly increased from very low levels, and beginning in 2001, both reference and Chewuch populations were similar for spawner abundance (Figure 23).

A significant difference in Chewuch NOR abundance was detected during the supplementation period when compared to the Secesh River regardless of whether

1996 and 1998 were included (Table 19). The difference appears to be in 1998-2000, where the Chewuch NORs declined and the Secesh NORs remained stable. The other two reference populations displayed a similar, but less dramatic decline in NORs in those years. All reference populations experienced an increase in NORs during the Chewuch supplementation period (Figure 24).

Productivity (recruits per spawner [R/S]) in the Chewuch population had similar trends in the pre-supplementation and supplementation periods. High productivity in the early part of the pre-supplementation and supplementation periods was presumably due to extremely low spawner abundance. When compared to reference populations, no differences in productivity were detected between pre-supplementation and supplementation periods (Table 19, Figure 25).

Table 19. Results of the unequal-variance t-tests on LN spawner abundance, LN adjusted NOR, and LN adjusted productivity data. Tests determined if the mean ratios during the supplementation period were greater than mean ratios during the pre-supplementation period.

Response variable	Statistic	Reference populations		
		Naches	Secesh	Big
Spawner abundance	T-test (P-value)	0.172	0.038	0.703
	Effect size	0.102	0.167	0.036
	Result	ND	Decrease	ND
NOR	T-test (P-value)	0.300	0.005	0.073
	Effect size	0.298	1.443	0.696
	Result	ND	Decrease	ND
Productivity	T-test (P-value)	0.732	0.425	0.219
	Effect size	0.094	0.335	0.352
	Result	ND	ND	ND
	1996 and 1998 excluded			
Spawner abundance	T-test (P-value)	0.558	0.132	0.938
	Effect size	0.039	0.105	0.007
	Result	ND	ND	ND
NOR	T-test (P-value)	0.503	0.017	0.153
	Effect size	0.210	1.36	0.615
	Result	ND	Decrease	ND
Productivity	T-test (P-value)	0.976	0.467	0.284
	Effect size	0.009	0.344	0.373
		ND	ND	ND

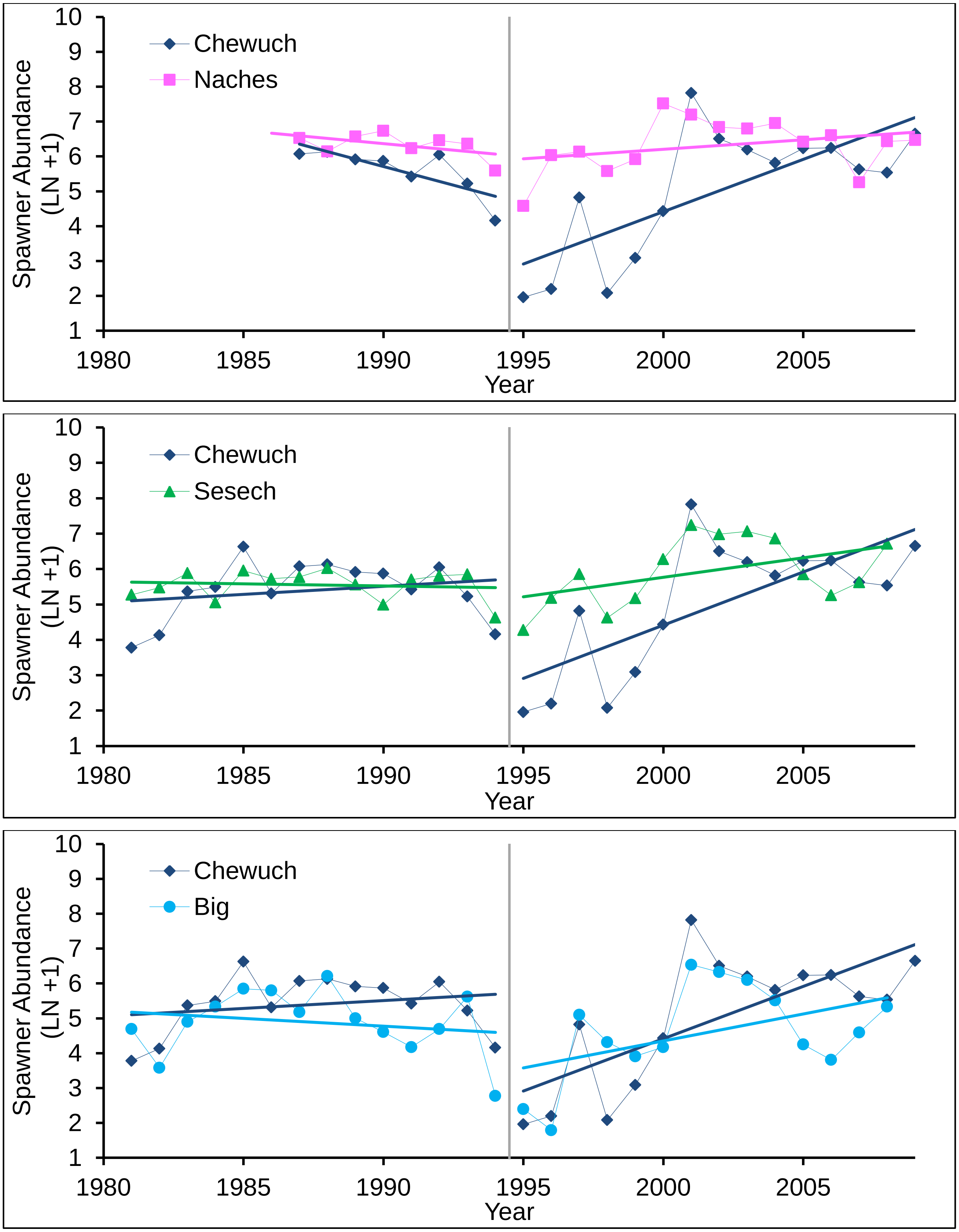


Figure 23. Trends in spring Chinook spawner abundance in the Chewuch and reference populations. The vertical lines in the figures separate the pre-supplementation and supplementation periods.

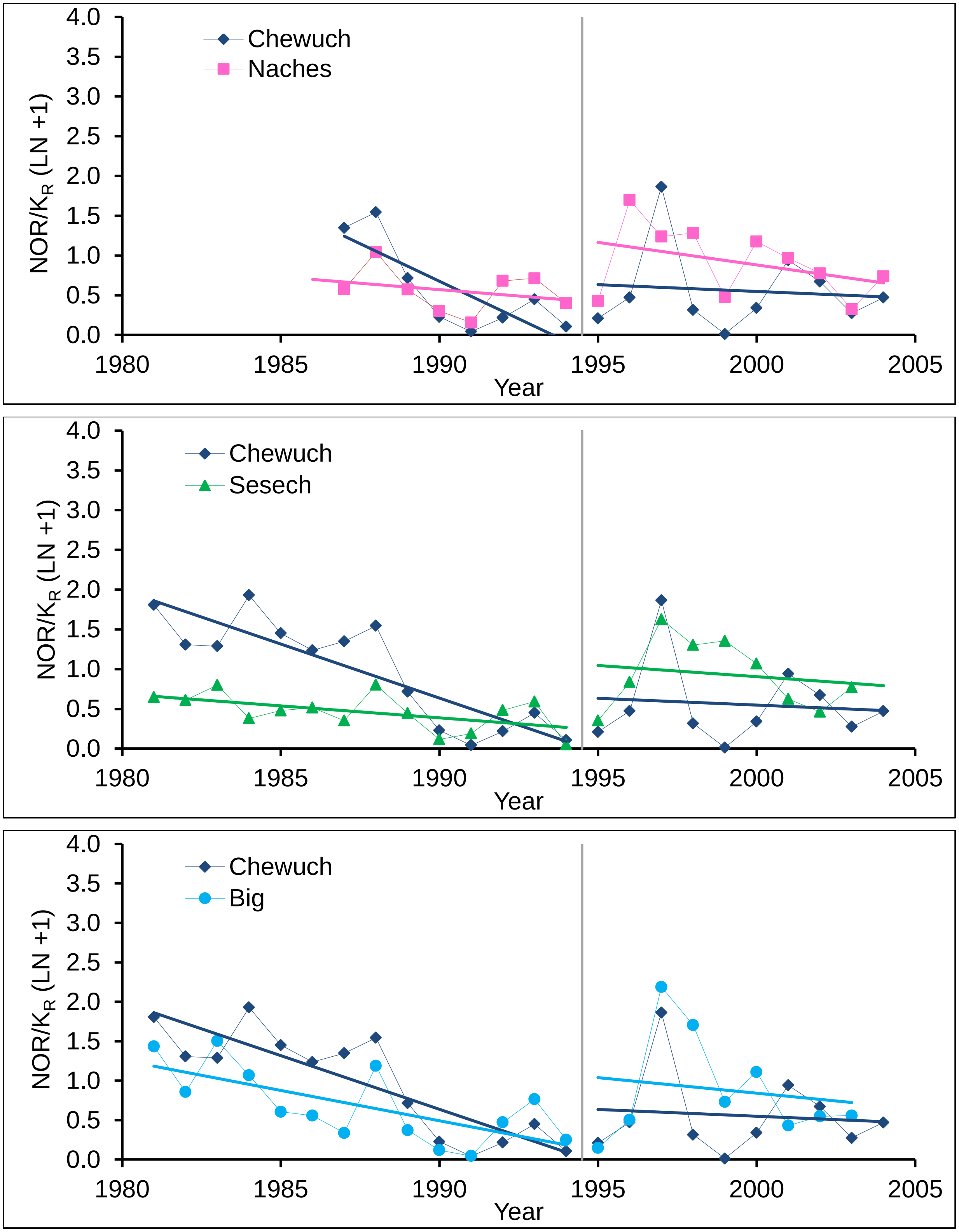


Figure 24. Trends in spring Chinook NOR abundance in the Chewuch and reference populations. The vertical lines in the figures separate the pre-supplementation and supplementation periods.

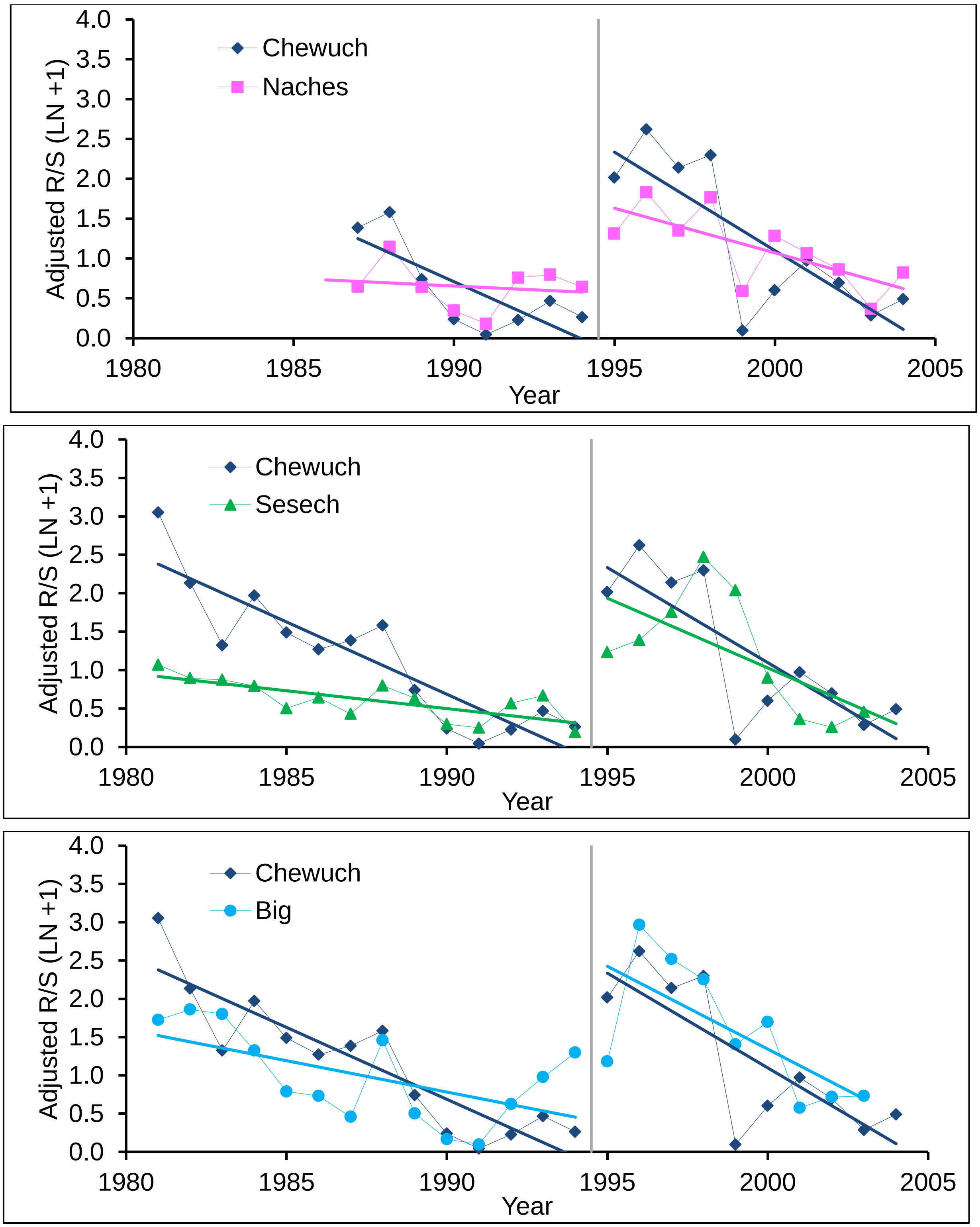


Figure 25. Trends in spring Chinook productivity in the Chewuch River and reference populations. The vertical lines in the figures separate the pre-supplementation and supplementation periods

Objective 2: Migration and Spawning Characteristics

Migration Timing

Migration timing of Chewuch spring Chinook was not analyzed due to lack of stock-specific data. The Chewuch population is not monitored for migration timing.

Spawn Timing

Differences in spawn timing, based on female carcass-recovery date, were found across years (ANOVA: $P = 0.002$). However, no difference was detected between origins (ANOVA $P = 0.74$) or among origins within years (ANOVA year x origin interaction term: $P = 0.57$; Figure 26).

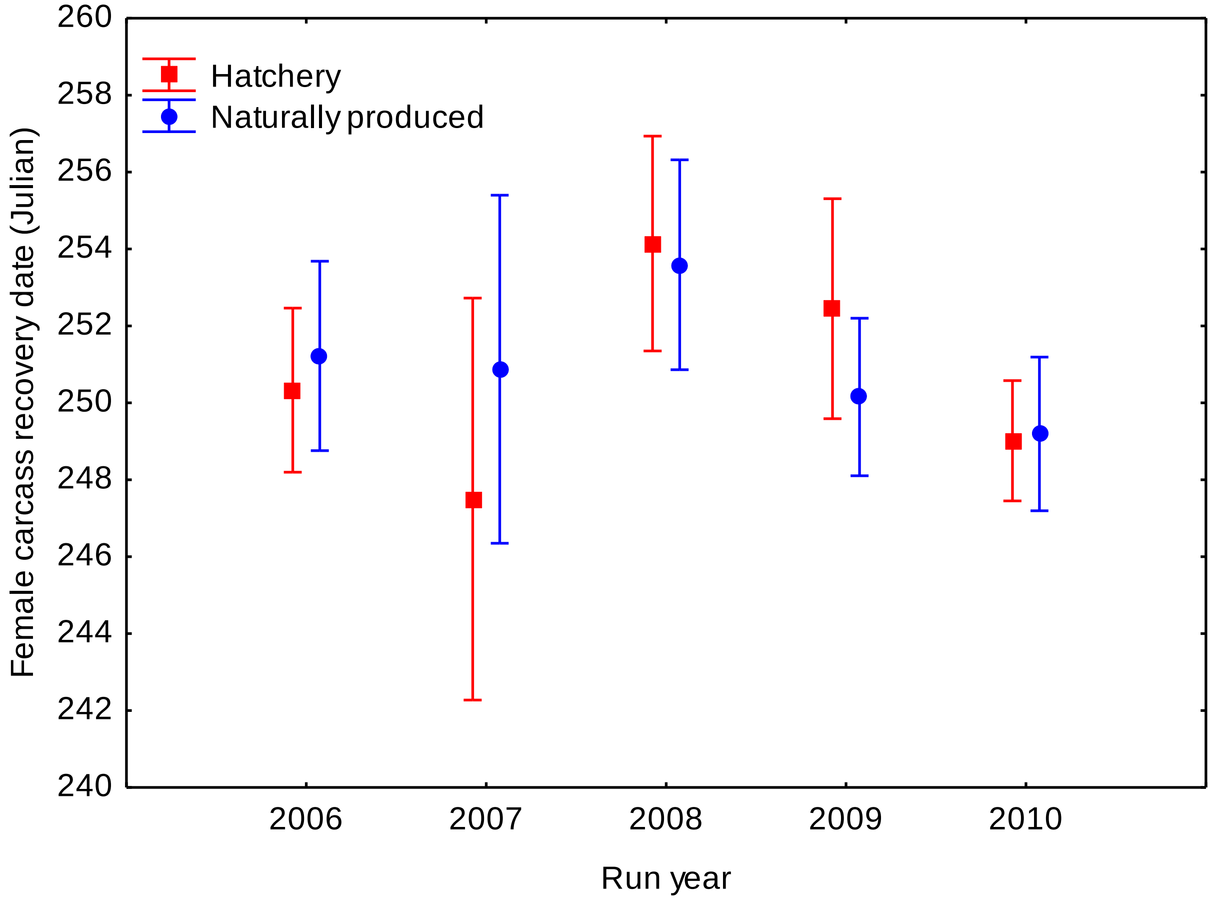


Figure 26. Mean female carcass-recovery date of Chewuch River spring Chinook

Redd distribution

No difference in female carcass-recovery location (natural-log transformed) was detected between years (ANOVA: *P* =0.22). However, differences were detected among (ANOVA: *P* < 0.001) and within origins among years (ANOVA year x origin interaction term: *P* = 0.031; Figure 27). Post hoc analysis using a Tukey Unequal N HSD test detected a difference in female carcass-recovery location between hatchery and naturally produced fish in 2010 (*P* < 0.001).

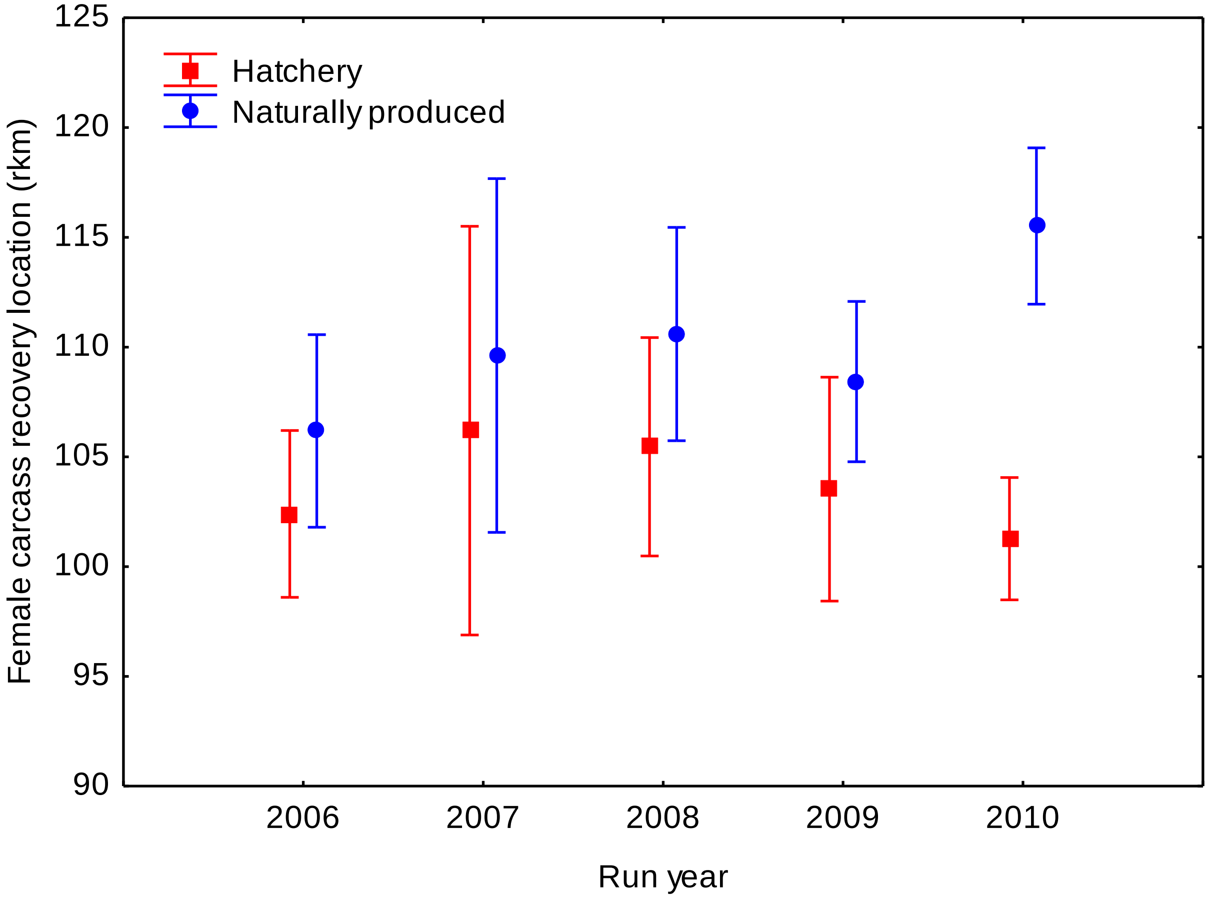


Figure 27. Mean female carcass-recovery location of Chewuch River spring Chinook.

Objective 3: Genetic and Phenotypic Characteristics

Genetic monitoring

Small et al. (2007) conducted the genotyping and analysis for genotype-based hypotheses and thus is the source for details regarding the methodology and analytical procedures (Appendix B). Results specific to Chewuch spring Chinook were extracted and presented below to specifically address the hypotheses as outlined in the Analytical Framework (Hays et al. 2007).

Chewuch spring Chinook had similar mean values for heterozygosity and allelic richness as Methow spring Chinook, but significantly higher values than Twisp spring Chinook (*P* < 0.01). The 2001 Chewuch hatchery-origin collection had low but significant variance in comparisons with other Chewuch collections, and 2006 Chewuch natural-origin was slightly more differentiated from other Chewuch collections (Table 20). Several analytical approaches were used to evaluate the relationships between the three stocks and all approaches provided comparable results (Small et al. 2007, Figure 28). We found low differentiation between Methow and Chewuch collections, some of which was not significantly different from zero after corrections. We plotted pairwise F_{ST} values versus time between collections and found a slight increase in differentiation over time possibly due to drift and introgression from the Methow through the Methow-Composite[4] stock (Figure 29). Increased differentiation is likely a signal that genetic drift is increasing as N_e decreases.

Table 20. Pairwise F_{ST} values (lower matrix) and *p* values for pairwise genotypic tests (upper matrix) for temporal and spatial collections. Values that were significant before Bonferroni corrections are underlined and values that were significant after Bonferroni corrections are in bold type (corrected alpha = 0.05/253 = 0.00019).

Group	Metcomp	92Chew	93ChewW	01ChewW	01ChewH	05ChewW	06ChewW
06Metcomp	*	**0**	**0**	**0**	**0**	**0**	**0**
92Chew	**0.01**	*	0.03835	0.00217	**0**	**0**	**0**
93ChewW	**0.0095**	-0.0021	*	0.03415	**0**	**0.00088**	**0**
01ChewW	**0.009**	0.0018	0.0012	*	**0**	**0.00003**	**0**
01ChewH	**0.0078**	**0.0071**	**0.0049**	**0.0029**	*	0.01551	**0**
05ChewW	-0.001	0.0043	-0.0026	-0.0048	-0.0033	*	**0**
06ChewW	**0.0142**	**0.0186**	**0.0129**	**0.0103**	**0.0116**	**0.0061**	*

Large variance in the estimated effective population size (N_e) may limit the utility of using the spawning population abundance as a predictor of N_e (Small et al 2007). The abundance of natural spawners was not correlated with N_e (r = 0.06). However, the ratio of N_e/N of naturally produced fish did not change for the years examined, but the analysis was limited to only 5 years (Figure 30).

[4] In 1997, due to concerns over diminishing returns of natural-origin spawners, fisheries managers established the Methow-Composite (aka, Met-Comp) stock comprising returns of Methow- and Chewuch-origin (and probably also Twisp-origin) spring Chinook. The Methow-Composite stock was included by the National Marine Fisheries Service in the 1999 ESA listing, while the Carson stock use at the Winthrop NFH was excluded.

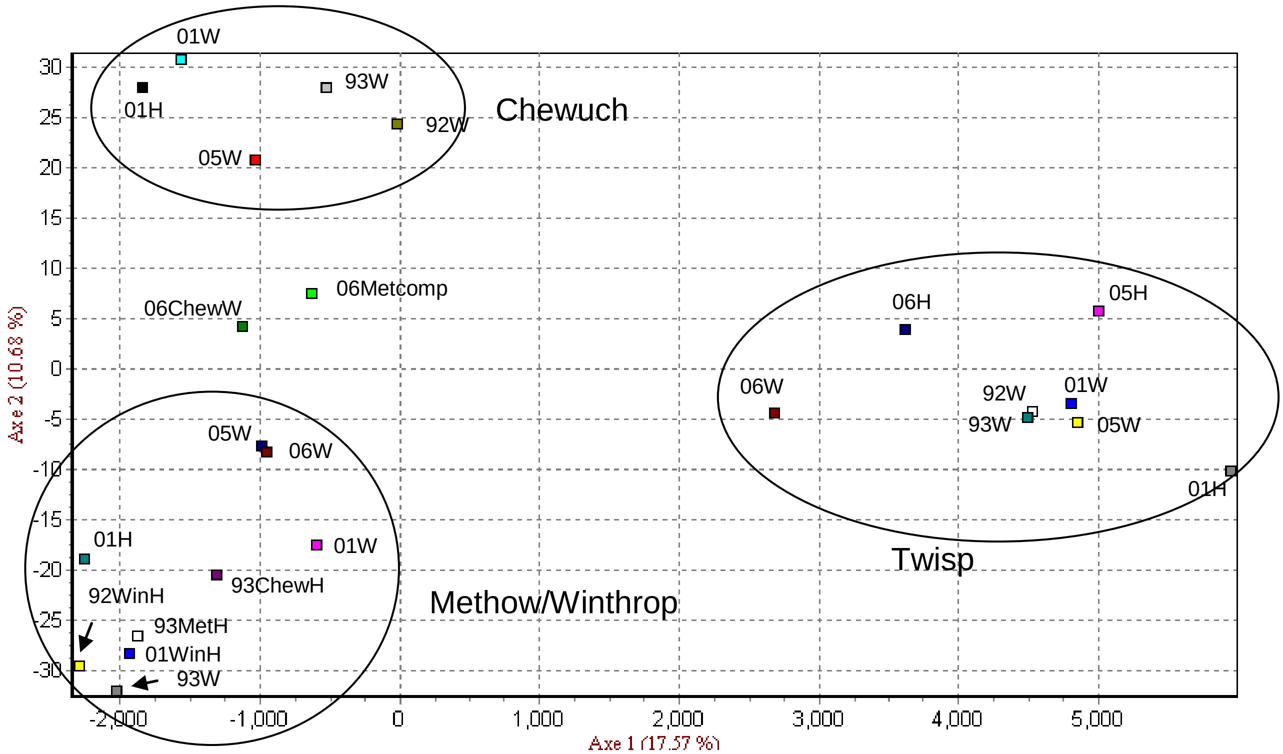


Figure 28. Factorial correspondence analysis plot of hatchery and natural spring Chinook collections from the Methow, Chewuch and Twisp rivers. Hatchery- and natural-origin collections are indicated by “H” and “W”, respectively, after the two-digit code for collection year (Small et al. 2007).

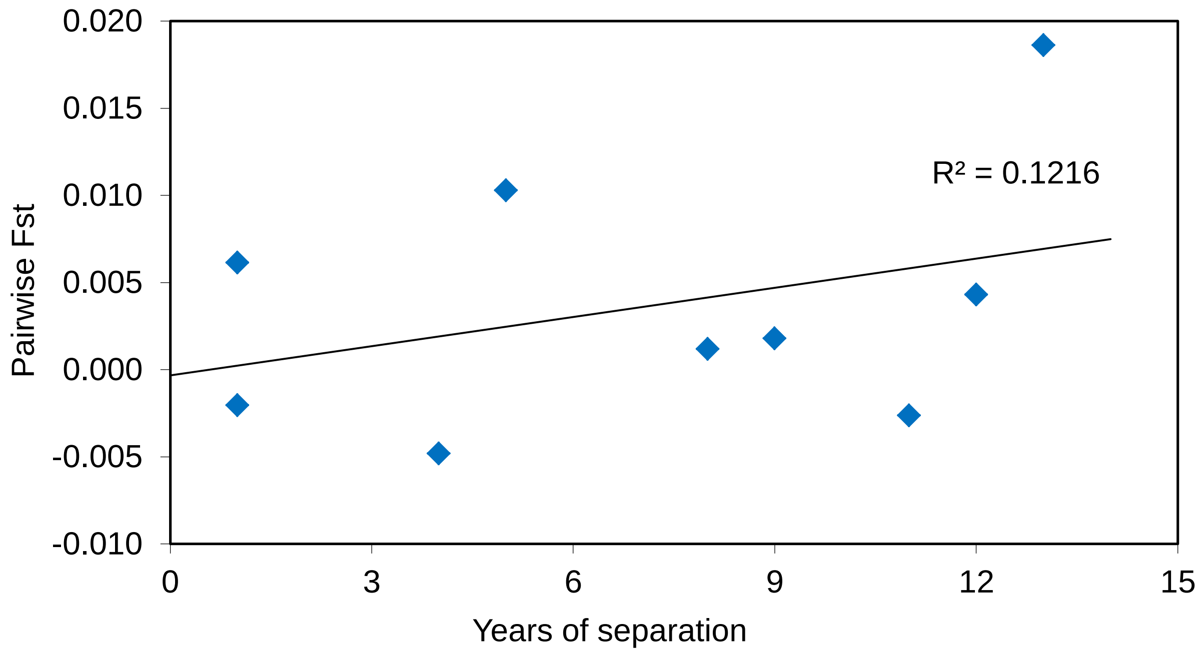


Figure 29. Graph of pairwise F_{ST} values versus time between collections for Chewuch spring Chinook.

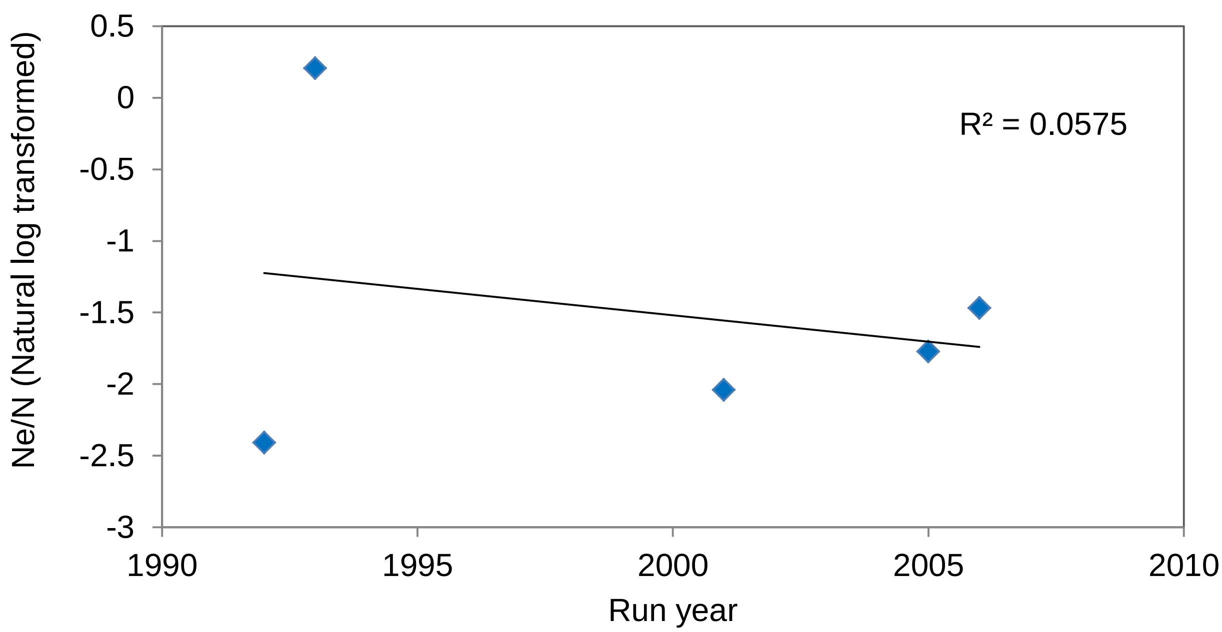


Figure 30. The ratio of N_e/N for naturally produced Chewuch spring Chinook.

Age at maturity

Low numbers of adult returns at the beginning of the program limited the analysis of age and size at maturity to more recent brood years. Furthermore, fish collected as broodstock or as carcasses were pooled by brood year. Female mean age was significantly different based on origin and brood year (Kruskal-Wallis ANOVA: $P <$ 0.001), but post-hoc multiple comparison tests found no difference among origins within a brood year (*P* = 1.0; Figure 31). Conversely, significant differences were found among the mean age of male Chewuch spring Chinook in two of the four brood years examined (*P* < 0.05; Figure 32), when male hatchery fish were composed of a greater proportion of age-3 and lower proportion of age-5 fish compared to naturally produced fish (Figure 33). Interestingly, no difference in age composition was detected in either the 2002 or 2005 brood years. Lack of difference in age composition may suggest a genetic effect, environmental conditions in the hatchery or natural environments, or simply a bias in sampling due to under-sampling of younger, smaller fish.

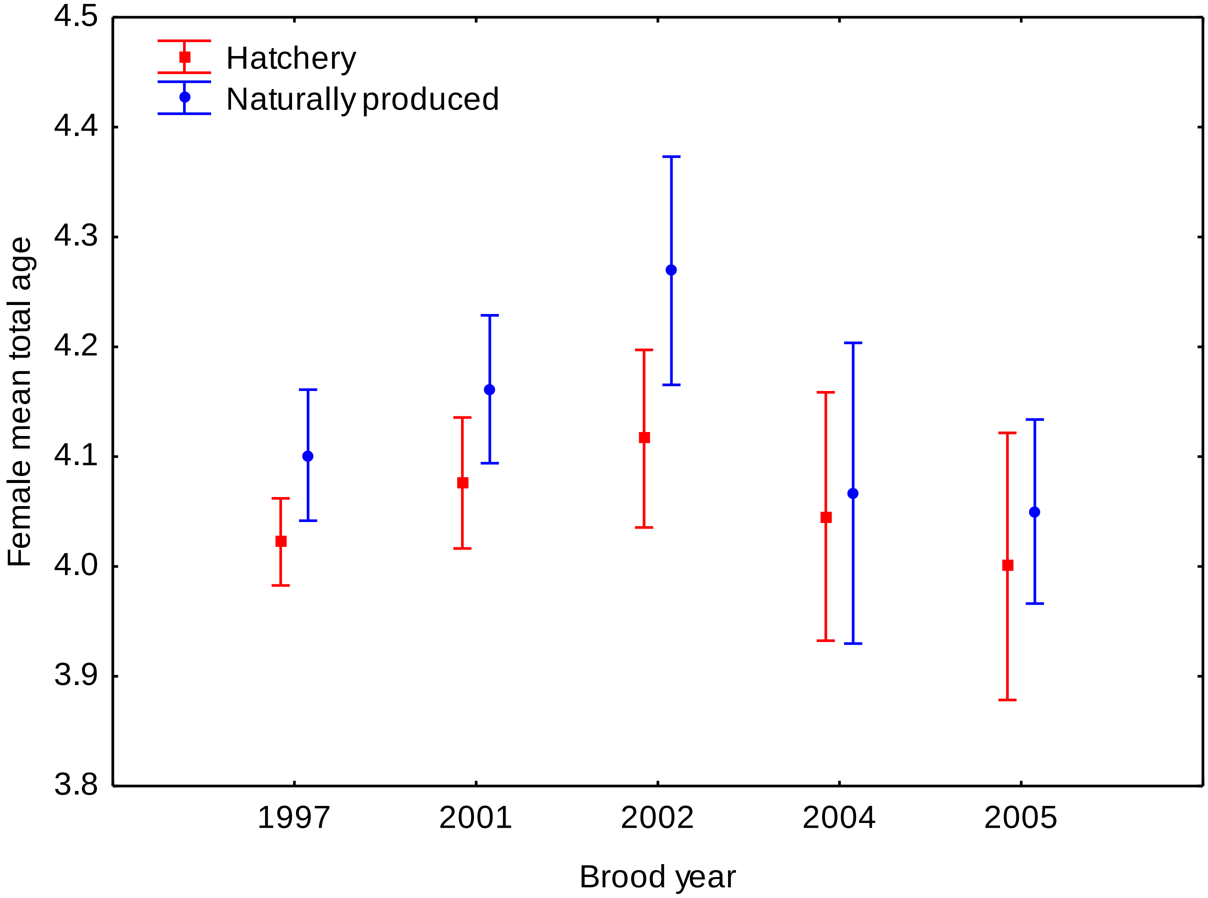


Figure 31. Mean female age at maturity of Chewuch River spring Chinook salmon.

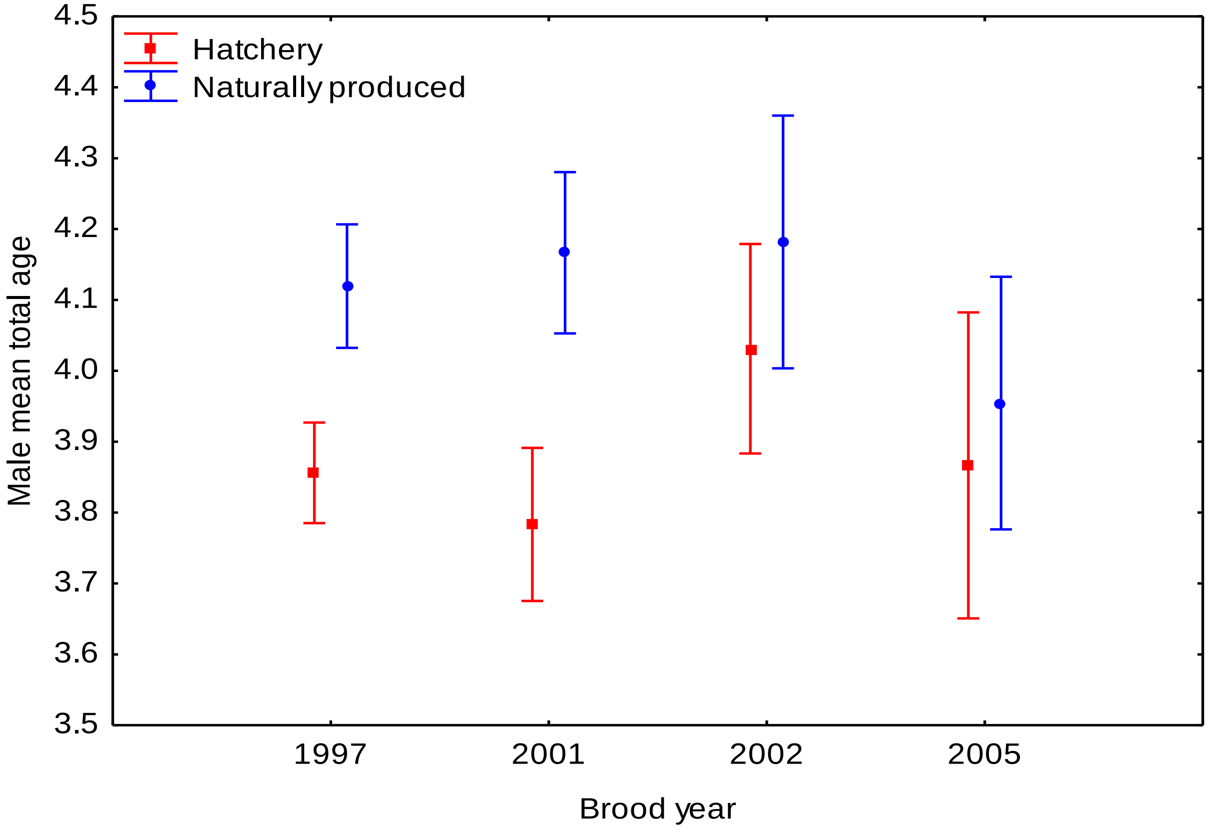


Figure 32. Mean male age at maturity of Chewuch River spring Chinook salmon.

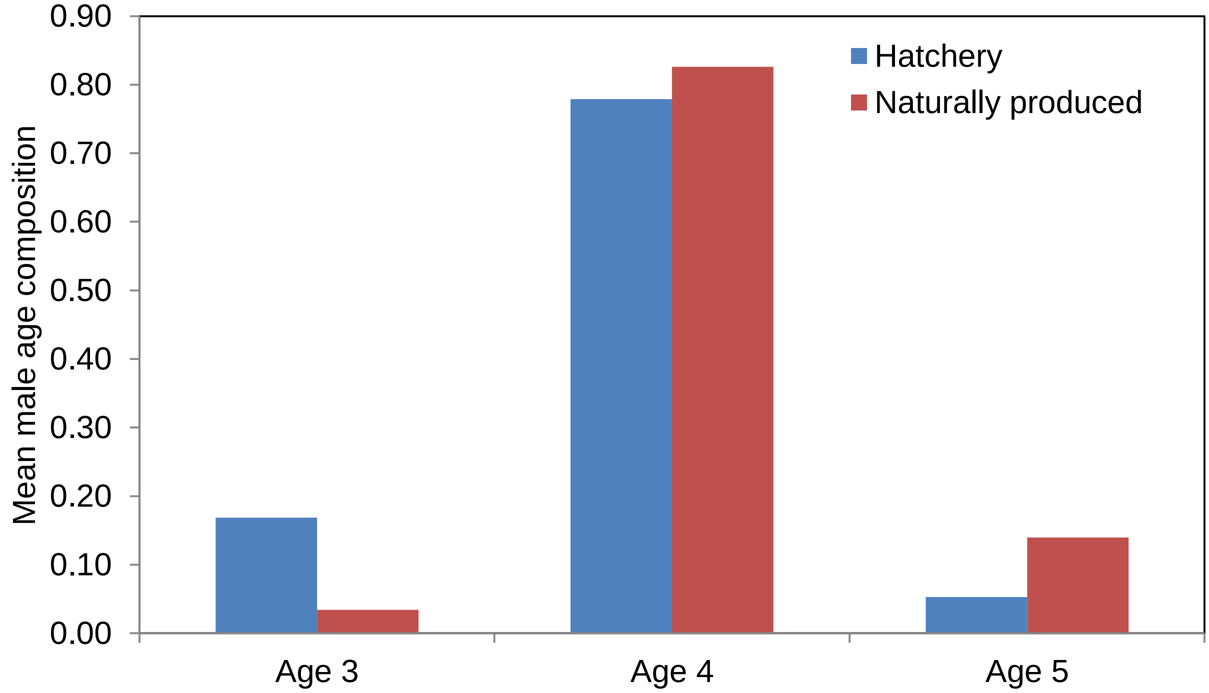


Figure 33. Mean male age composition of hatchery and naturally produced Chewuch River spring Chinook, brood years 1997, 2001, 2002, and 2005.

Size at maturity

Low adult returns limited the evaluation of size at maturity to age-four fish. No difference in size within the age-four fish was detected for females (ANOVA broodyear x origin interaction term: *P* = 0.33, Figure 34). Differences were not detected for male fish across years (ANOVA origin term: *P* = 0.86), but differences were found among origins within years (ANOVA brood year x origin interaction term: *P* = 0.005, Figure 35). Differences within years were attributed to a small sample size (N = 5) of naturally produced males in 1998. When 1998 was excluded from the analysis no difference was detected (ANOVA brood year x origin interaction term: *P* = 0.57).

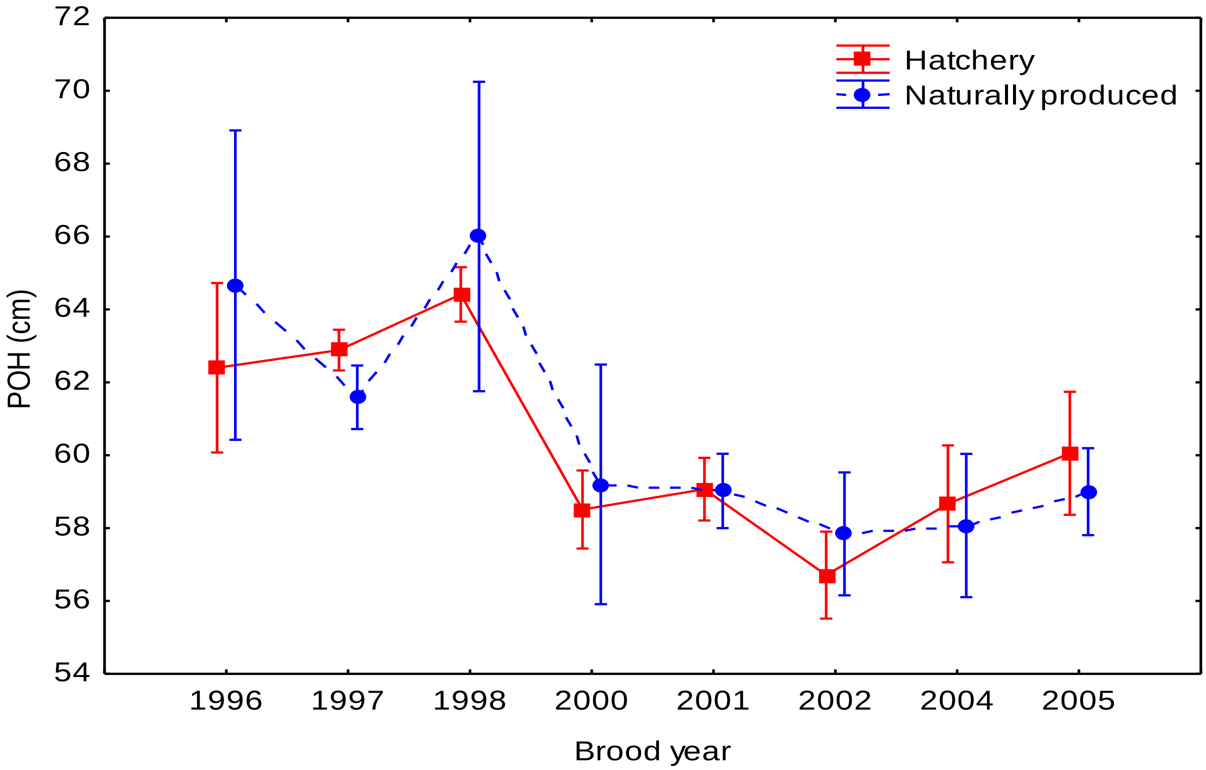


Figure 34. Mean post-orbital to hypural plate (POH) length of age-4 female Chewuch River spring Chinook.

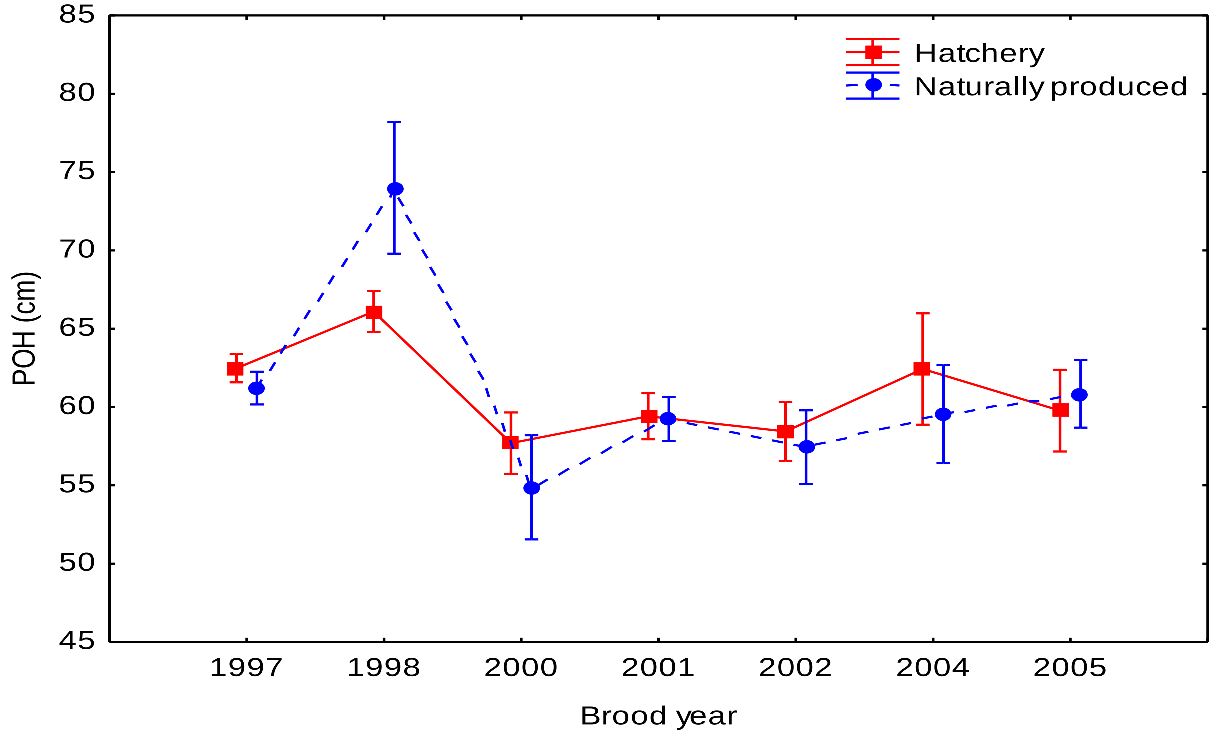


Figure 35. Mean post-orbital to hypural plate (POH) length of age-4 male Chewuch River spring Chinook.

Objective 4: Hatchery Fish Survival Rates

The mean HRR value of the Chewuch spring Chinook program was not significantly different from the expected value (4.5) in the BAMP (Mann Whitney U-test: $P = 0.22$, Table 21). However, the HRR met or exceeded the BAMP value for 33% of the brood years. Similarly, the mean HRR value was not significantly different from the mean NRR (Mann-Whitney U-test: $P = 0.08$). However, examination of the geometric means suggests that HRR is likely approximately 3.2 times higher than NRR (Table 21). Survival rates of fish in the hatchery have consistently met or exceeded survival standards (Snow et al. 2011). However, Chewuch River spring Chinook have experienced significantly lower SARs, based on CWT recoveries that include harvest, than the 0.3% identified in the BAMP (t-test: $P < 0.002$; Table 22). Poor post-release survival is responsible for the low observed HRR values. The specific life stage(s) responsible for low SARs is unknown. Juvenile fish released as part of the 1998 and 2000 brood years were not included in the SAR analysis because fish were not differentially tagged from those fish released into the Methow River (see the Methow River Spring Chinook Section).

Table 21. Hatchery replacement rates and natural replacement rates for Chewuch spring Chinook salmon adjusted for harvest.

Brood year	HRR	NRR
1992	1.9	0.1
1993	1.1	0.5
1994	0.2	0.3
1996	0.6	12.8
1997	4.6	7.5
2001	8.7	0.1
2002	5.7	0.2
2003	1.0	0.1
2004	1.5	0.3
Mean (SD)	2.8 (2.9)	2.4 (4.6)
Geometric Mean	1.6	0.5

Table 22. Smolt to adult return rates for Chewuch River spring Chinook.

Brood year	Smolts released	Adult returns	SAR
1992	40,881	39	0.0010
1993	284,165	116	0.0004
1994	11,854	2	0.0002
1996	91,672	37	0.0004
1997	132,759	295	0.0022
2001	261,284	738	0.0028
2002	254,238	699	0.0027
2003	127,614	61	0.0005
2004	204,906	194	0.0009
Mean	156,597		0.0012

Objective 5: Stray Rates

Brood stray rates

The mean stray rate of Chewuch spring Chinook based on the estimated total number of coded wire tag recoveries by brood year was significantly greater (43%) than the target of 5% (t-test: $P < 0.02$). Stray fish were recovered in similar proportions both in broodstock and on the spawning grounds (Table 23). Stray rates of Chewuch spring Chinook have increased over time (Figure 36) possibly due to the changes in broodstock (i.e., initiation of the "Methow-composite" stock in 1997; see Footnote 4, above). The mean stray rate for the most recent four complete brood years was three times greater than the first five brood years of the program. The positive relationship between stray rate and abundance suggest that recovery of stray fish on the spawning grounds may be related to spawner density or simply a bias in sampling in years of low abundance (Figure 36). Regardless, increases in stray rates have prevented the program from increasing spawner abundance in the Chewuch River.

Table 23. Stray rates by brood year of Chewuch spring Chinook and the number and proportion based on non-target recovery location.

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1992	1	1.00	0	0.00	0.03
1993	19	0.86	3	0.14	0.21
1994	0	0.00	0	0.00	0.00
1996	15	0.79	4	0.21	0.46
1997	44	0.62	27	0.38	0.22
2001	46	0.13	321	0.87	0.88
2002	92	0.24	299	0.76	0.74
2003	3	0.12	22	0.88	0.46
2004	35	0.33	70	0.67	0.86
Mean		0.45		0.43	0.43
SD		0.37		0.37	0.34

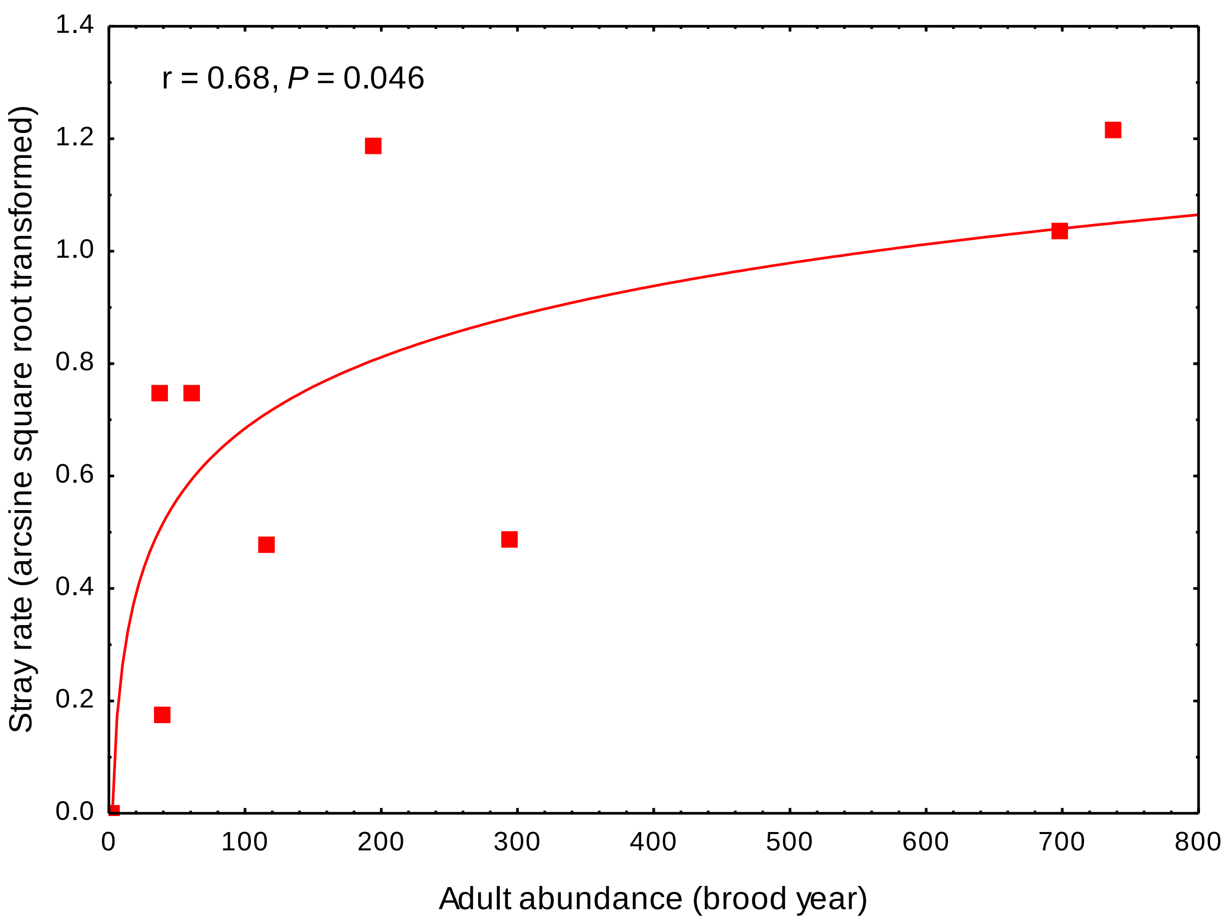


Figure 36. Relationship between the stray rate and brood year abundance of Chewuch spring Chinook.

Stray rates within population

Analysis of stray rates within and between independent populations did not begin until 2000 due to lack of spawning ground data in prior years. Surveyors recovered Chewuch spring Chinook carcasses on both the Methow and Twisp rivers, where Chewuch spring Chinook comprised an average of 10.5% and 0.7% of the spawning population, respectively (Table 24). The proportion of the spawning populations Chewuch spring Chinook comprised in the Twisp River was significantly lower (t-test: $P < 0.0001$) than the maximum target of 10% and no different from that target in the Methow River (t-test: $P = 0.57$).

Table 24. Proportion of the spawning population comprising Chewuch spring Chinook in non-target streams within the Methow spring Chinook population.

Year	Methow River	Twisp River
2000	0.025	0.000
2001	0.079	0.015
2002	0.006	0.000
2003	0.000	0.000
2004	0.036	0.000
2005	0.322	0.026
2006	0.228	0.000
2007	0.123	0.000
2008	0.118	0.027
2009	0.109	0.000
2010	0.108	0.014
Mean	0.105	0.007

Stray rates outside population

The only other independent population from which Chewuch spring Chinook have been recovered on the spawning grounds was the Similkameen River in 2001. An estimated five fish spawned in the Similkameen River. This likely posed little genetic risk to the Similkameen summer Chinook population due to the fact that spring Chinook are unlikely to cross breed with summer Chinook due to difference in spawn timing, and the Similkameen has a very high abundance of summer Chinook spawning.

Objective 6: Hatchery Release Characteristics

The target length and weight for Chewuch spring Chinook was 136 mm and 30.3 g, respectively. The mean length at release was 134 mm (t-test: $P = 0.51$) and the mean weight at release was 29.8 g (t-test: $P = 0.81$; Table 25), both of which were not significantly different from the target value.

Table 25. Mean size at release of Chewuch River spring Chinook salmon.

Brood year	Fork length	Weight	Brood year	Fork length	Weight
1992	141.8	30.0	2002	142.5	35.0
1993	134.5	27.7	2003	131.0	27.6
1994	145.7	35.7	2004	144.1	42.4
1996	129.8	22.7	2005	126.0	24.7
1997	132.7	27.9	2006	115.7	19.2
1998	127.9	24.6	2007	145.5	43.3
2000	131.3	26.8	Mean	134.4	29.8
2001	133.8	30.2	Target	136.0	30.3

The Chewuch spring Chinook program released an average of 172,189 fish and was not significantly different from the program goal (t-test: $P = 0.61$; Table 26). Years when broodstock was not collected (1995 and 1999) due to low run size were not included in the analysis.

Table 26. Number of Chewuch River spring Chinook salmon released by brood year.

Brood year	Number	Brood year	Number
1992	40,881	2002	254,238
1993	284,165	2003	127,614
1994	11,854	2004	204,906
1995	No program	2005	232,811
1996	91,672	2006	154,381
1997	132,759	2007	126,055
1998	217,171	2008	260,344
1999	No program	Mean	172,189
2000	199,938	Target	183,333
2001	244,043		

Objective 7: Freshwater Productivity

Recent estimates of freshwater productivity are not available for the Chewuch River. Smolt monitoring was conducted in the Chewuch River between 1993 and 1996, but those data are incomplete for the entire brood year due to difficulty in trap operation.

Objective 8: Harvest

Direct harvest of Chewuch spring Chinook salmon has not occurred since fish were listed as endangered in 1999, except for Columbia River tribal fisheries. Furthermore, juvenile fish have not been adipose fin clipped beginning with the 2000 brood. Hence, harvest rates in the last 10 years have been minimal and limited to indirect post-release mortality associated with Columbia River commercial and sport fisheries or tribal non-selective fisheries.

Summary

Hatchery-origin Chewuch spring Chinook have experienced hatchery replacement rates (HRR) that were not significantly different from the target value, but met or exceeded this value in only about one-third of the years. The mean HRR was also not significantly different from the natural replacement rate (NRR). However, examination of the harmonic means (used because of a few extremely large values in the data) suggests that the HRR was four times higher than the NRR. The smolt-to-adult survival rate of hatchery fish was significantly lower than the survival target. Juvenile hatchery fish have been released at the target length and weight, and the mean number of fish released has met the program release goal since 2000, but broodstock has been predominately composed of hatchery fish (mean = 84%). Adult hatchery Chewuch spring Chinook have similar spawn timing and redd distribution as naturally produced adult spring Chinook in the Chewuch River. Hatchery-origin females have a similar age structure to natural-origin fish, but hatchery males matured at an earlier age in two of four years examined. The difference was driven by an increase in age-3 and decrease in age-5 males compared to natural-origin males. The Chewuch population has shown a slight increase in genetic differentiation over time from the Methow and Twisp populations, perhaps caused by low effective population size exacerbating genetic drift.

Chewuch hatchery fish strayed at a very high rate, on average only 57% of the Chewuch-program hatchery fish returning to the Methow Basin spawn in the Chewuch River, and this rate apparently increased beginning in 2001. A number of factors may have influenced this increase, including changes in broodstock composition and hatchery rearing techniques, changes in carcass recovery methodologies, and adult abundance.

Releases of hatchery spring Chinook to the Chewuch have not increased the abundance of spawners or NORs in the Chewuch River. Chewuch spring Chinook are increasingly more genetically similar to Methow and Winthrop hatchery fish, presumably as a result of high levels of straying and the Methow-Composite broodstock.

Spawning escapement in the Chewuch River has not increased during supplementation compared to reference populations. Similarly, poor natural-origin fish survival has contributed to a decrease in NORs. However, the spawner-abundance trend for the Chewuch is strongly positive, and since 2001, spawner abundance has been similar to reference streams. The statistical difference detected in spawner abundance was caused by the Chewuch spawning population being much lower than the reference population shortly after supplementation began. While a number of problematic issues exist with Chewuch spring Chinook, the increase in spawner abundance suggests that the hatchery program has succeeded in returning spawners to a level of abundance similar to reference populations. However, the proportionate natural influence (PNI) for the Chewuch from 2001-2010 is 0.14 due to the low NORs and increasing hatchery spawners. Productivity in the Chewuch has remained unchanged during the time of supplementation indicating that the presence of hatchery spawners has not decreased productivity compared to reference populations. Low smolt-to-adult survival of hatchery fish, low natural recruitment rate, and straying of hatchery fish outside of the Chewuch contribute to these population dynamics results. A brief assessment of all objectives is provided in Table 27.

Table 27. Summary assessment of M&E objectives for the Chewuch spring Chinook hatchery program.

Obj.	Primary indicator	Assessment
1	Spawner abundance	Hatchery program has not increased spawner abundance in the Chewuch River.
	Natural-origin abundance	Abundance of natural-origin fish has declined.
	Adult productivity	Adult productivity has not decreased.
2	Migration timing	Insufficient data to assess this objective.
	Spawn timing	Exhibit similar spawn timing as naturally produced fish.
	Redd distribution	Exhibit similar spawning distribution as naturally produced fish.
3	Genetic diversity	Chewuch spring Chinook are more closely related to Methow stock than Twisp stock. Differences among stocks are decreasing over time.
	Effective population size	Ratio of Ne/N is constant as expected.
	Age at maturity	For those years analyzed, female hatchery and naturally produced mean age at maturity was similar. Male hatchery fish have returned at an earlier age for some brood years.
	Size at maturity	Male and female age-4 hatchery fish were similar in size as naturally produced fish.
4	Hatchery replacement rate	Post-release survival of hatchery fish was low but not significantly lower than expected. Hatchery survival was not greater than the natural replacement rate.
5	Stray rates	Stray rates into the Methow River far exceeded the target, but fish did not stray outside of the Methow Basin.
6	Size and number of juveniles released	Target size and number of fish released were met.
7	Freshwater productivity	Insufficient data to assess this objective.
8	Harvest	Harvest rates of Chewuch fish have been negligible for both hatchery and naturally produced fish.

Methow River Spring Chinook

Goal – Support the recovery of Methow spring Chinook salmon[5] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

Program **–** Collect sufficient broodstock from the Foghorn Dam, Wells and Methow hatcheries (hatchery and naturally produced) in order to release 183,333 yearling smolts from the Methow Acclimation Pond.

Reference Streams

Of the possible reference populations identified in Hillman et al. (2011), the Secesh River, Bear Valley Creek, Marsh Creek, and Naches River met most or all criteria and were selected for further analysis as possible reference populations (Table 28). We added Big Creek and Valley Creek as possible reference streams because initial analysis suggested Secesh River and Bear Valley creeks may not be good reference streams for the Methow River (i.e., lack of correlation). We analyzed spawner abundance, natural-origin recruits (NORs), and productivity (recruits/spawner) using natural-log transformed data.

Following methods outlined in Appendix C, results varied with reference population and metric. Only the Naches River population was correlated ($r > 0.6$) with the Methow population for spawner abundance, while Valley and Marsh creeks were significantly correlated but were slightly weaker than desired (0.596 and 0.570, respectively). In addition, we detected no significant differences in trends (Table 29). We could not estimate spawner capacity for Valley Creek with the data available and therefore we could not include it as a possible reference stream for NORs and productivity. Methow NORs were significantly correlated with all reference populations and trend analysis revealed no significant difference between the reference populations and the Methow River (Table 29). Productivity was also significantly correlated with all reference populations, except the Secesh River (Table 29). Graphical analysis results were consistent with correlation analysis for spawner abundance (Figure 37), NORs (Figure 38), and productivity (Figure 39). The minimum detectable difference varied greatly with response variable (Table 30).

[5] While the HCP is not a recovery plan into itself, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.

Table 28. Populations of stream-type Chinook salmon and their comparison to Methow spring Chinook. Populations in bold were selected as reference streams for the Methow population.

Population	Similar life-history	No or few hatchery fish	Accurate abundance estimates	Long time series	Similar freshwater habitat	Similar out-of-basin effects
Deschutes River	Yes	Yes	Yes	Yes	No	No
John Day mainstem	Yes	Yes	Yes	Yes	No	No
Middle Fk John Day	Yes	Yes	Yes	Yes	No	No
North Fk John Day	Yes	Yes	Yes	Yes	No	No
Granite Creek	Yes	Yes	Yes	Yes	No	No
Wenaha River	Yes	No	Yes	Yes	Yes	Yes
Minam River	Yes	No	Yes	Yes	Yes	Yes
Slate Creek	Yes	Yes	Yes	No	No	Yes
Secesh River	Yes	Yes	Yes	Yes	Yes	Yes
MF Salmon River	Yes	Yes	Yes	No	No	Yes
Big Creek	Yes	Yes	Yes	Yes	No	Yes
Camas Creek	Yes	Yes	Yes	Yes	No	Yes
Loon Creek	Yes	Yes	Yes	Yes	No	Yes
Sulphur Creek	Yes	Yes	Yes	Yes	No	Yes
Bear Valley Creek	Yes	Yes	Yes	Yes	No	Yes
Marsh Creek	Yes	Yes	Yes	Yes	Yes	Yes
North Fk Salmon River	Yes	Yes	No	No	Yes	Yes
Lemhi River	Yes	Yes	Yes	Yes	No	Yes
EF Salmon River	Yes	No	Yes	Yes	No	Yes
Valley Creek	Yes	Yes	Yes	Yes	No	Yes
Chamberlain Creek	Yes	Yes	Yes	No	Yes	Yes
Naches River	Yes	Yes	Yes	Yes	Yes	No
Little Wenatchee River	Yes	No	Yes	Yes	Yes	No
Entiat River	Yes	No	Yes	Yes	No	No

Table 29. Pearson correlation coefficients and t-test results comparing slopes of trends between potential reference populations and the Methow spring Chinook population; DF = degrees of freedom and for correlation coefficients, an asterisk (*) indicates significance at $P < 0.05$. Analyses were conducted on natural-log transformed abundance and productivity data.

Reference population	Pearson correlation coefficient	t-test of slopes		
		t-value	DF	P-value
	LN Spawner Abundance			
Naches	0.603	0.572	18	0.572
Valley	0.596*	0.962	24	0.962
Marsh	0.570*	0.757	24	0.757
Secesh	0.328	0.763	24	0.763
Big	0.450	0.812	24	0.812
Bear Valley	0.471	0.691	24	0.691
	LN Adjusted Natural-Origin Recruits			
Naches	0.808*	-0.902	18	0.379
Marsh	0.832*	-0.686	24	0.499
Secesh	0.817*	-1.926	24	0.066
Big	0.734*	-0.490	24	0.629
Bear Valley	0.820*	-1.217	24	0.236
	LN Adjusted Productivity (recruits/spawner)			
Naches	0.744*	-0.811	18	0.428
Marsh	0.626*	0.192	24	0.849
Secesh	0.524	-0.757	24	0.456
Big	0.573*	0.346	24	0.732
Bear Valley	0.544*	-0.069	24	0.946

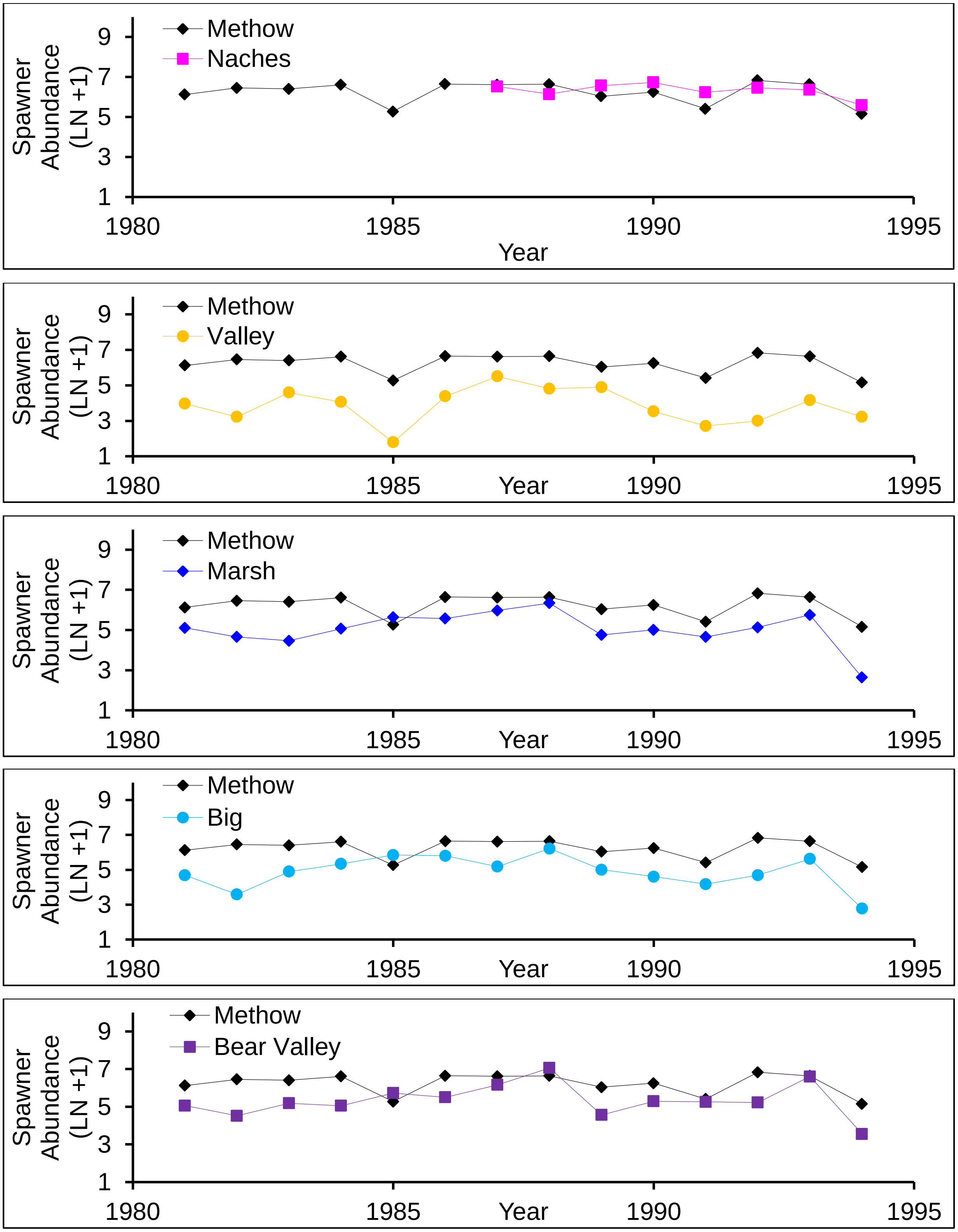


Figure 37. Time series of spawner abundance (natural-log transformed) of potential reference populations and the Methow spring Chinook population before the Methow River was supplemented with hatchery fish.

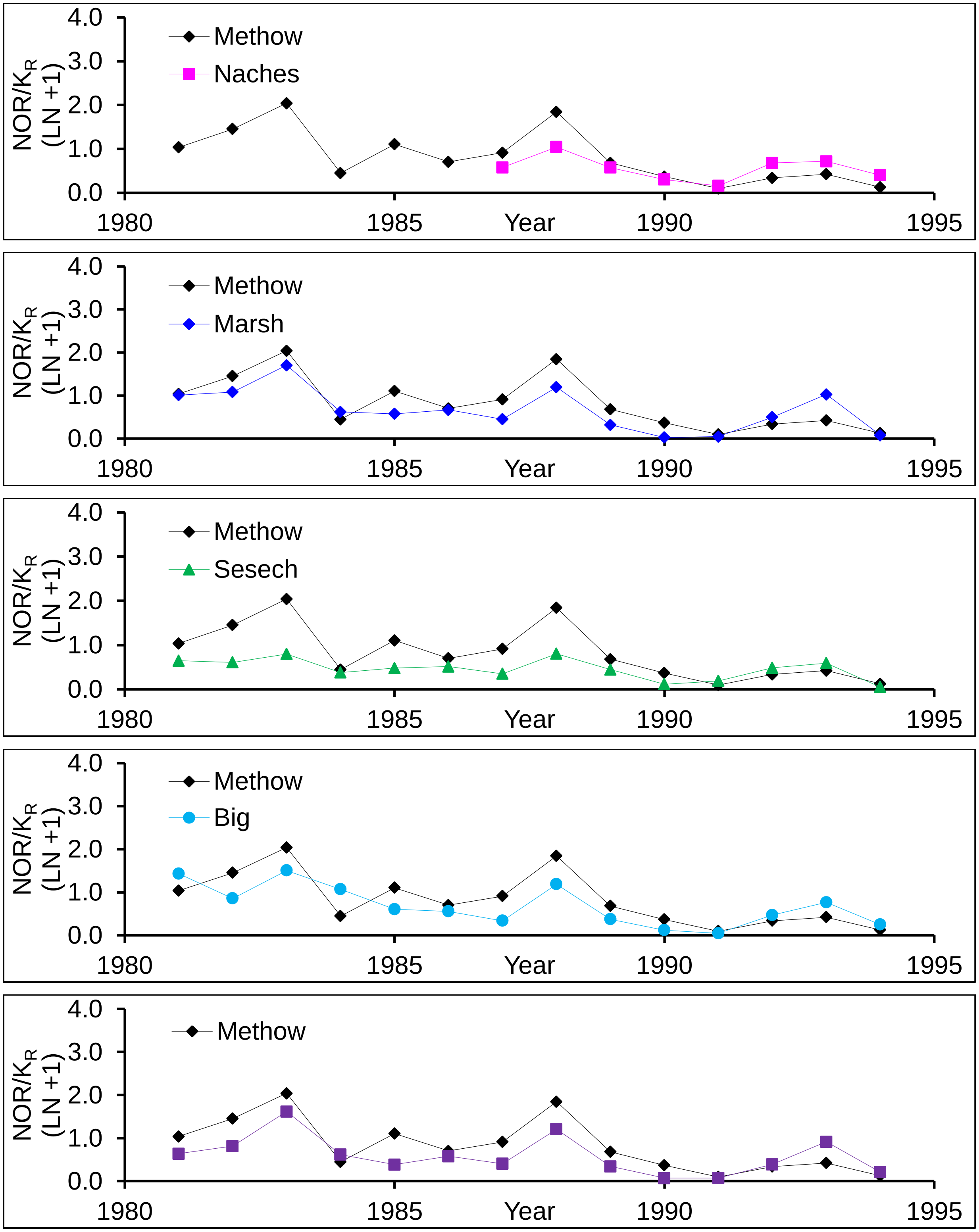


Figure 38. Time series of natural-origin recruits (NORs) of potential reference populations and the Methow spring Chinook population before the Methow River was supplemented with hatchery fish. NOR was adjusted for carrying capacity and natural-log transformed.

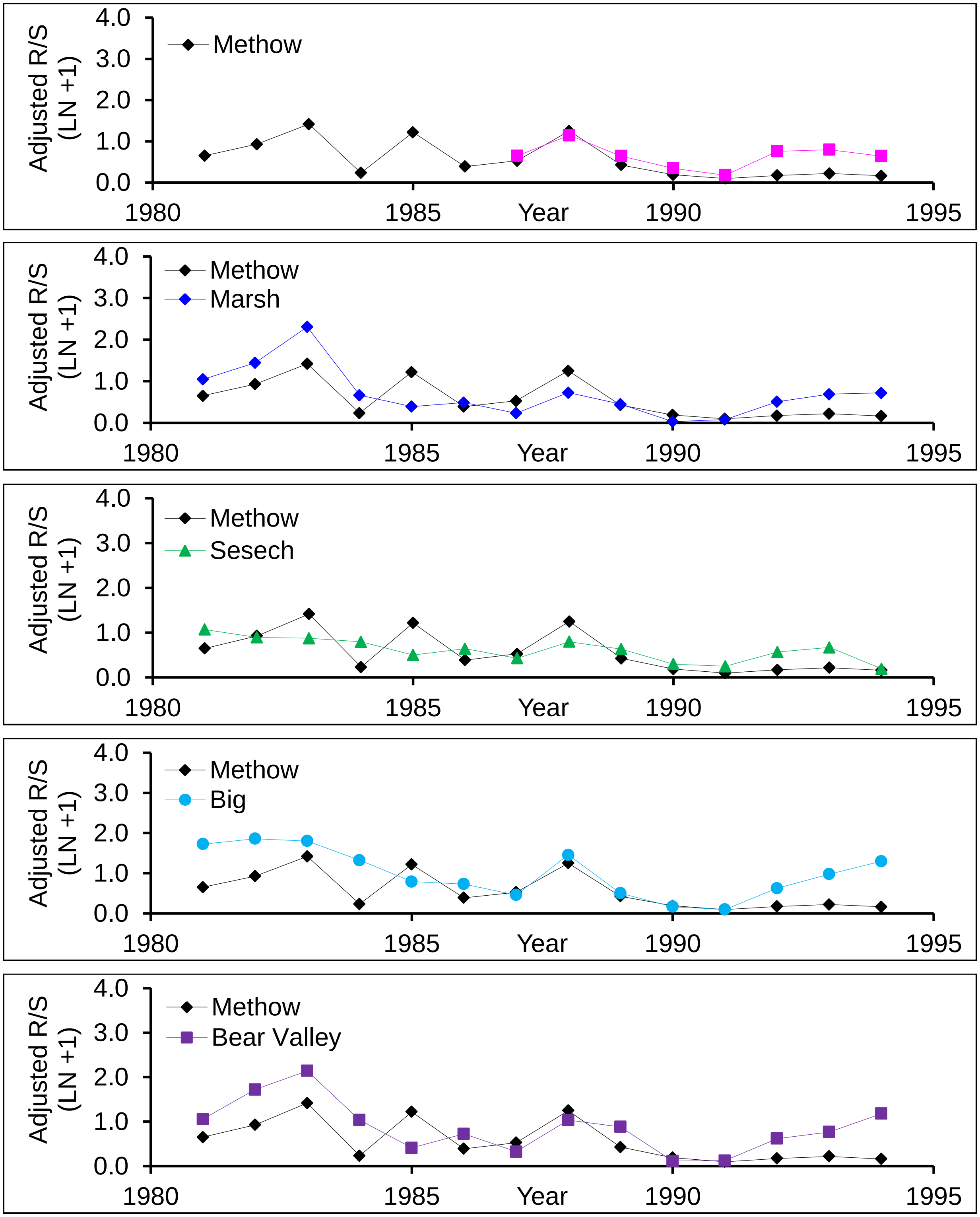


Figure 39. Time series of adult productivity (recruits/spawner) of potential reference populations and the Methow spring Chinook population before the Methow River was supplemented with hatchery fish. Productivity data was adjusted for spawner capacity and natural-log transformed.

Table 30. Minimal detectable differences between mean-ratio scores before and during supplementation.

Treatment years	Minimal detectable differences by reference population					
	Naches	Valley	Marsh	Secesh	Big	Bear Valley
			Spawner Abundance			
15	1.85	18.66	5.96	2.25	7.26	3.37
20	1.66	17.04	5.42	2.06	6.65	3.08
25	1.52	15.77	5.01	1.91	6.17	2.86
50	1.13	12.05	3.80	1.47	4.74	2.20
			LN Spawner Abundance			
15	1.01	1.57	1.23	0.99	1.24	1.06
20	0.91	1.44	1.12	0.91	1.14	0.97
25	0.83	1.33	1.04	0.84	1.06	0.90
50	0.62	1.02	0.79	0.65	0.81	0.69
			Natural-Origin Recruits (adjusted for capacity)			
15	1.29	-	4.38	2.41	1.87	2.20
20	1.14	-	3.95	2.17	1.68	1.98
25	1.02	-	3.62	1.99	1.54	1.81
50	0.29	-	1.06	0.58	0.45	0.53
			LN Natural-Origin Recruits (adjusted for capacity)			
15	1.10	-	3.69	1.69	1.55	1.78
20	0.96	-	3.32	1.52	1.39	1.60
25	0.87	-	3.05	1.39	1.28	1.47
50	0.25	-	0.89	0.41	0.37	0.43
			Productivity (adjusted for spawner capacity)			
15	1.20	-	2.48	1.79	0.80	1.38
20	1.06	-	2.22	1.61	0.72	1.24
25	0.96	-	2.02	1.48	0.66	1.14
50	0.27	-	0.58	0.43	0.19	0.33
			LN Productivity (adjusted for spawner capacity)			
15	0.87	-	2.03	1.11	0.78	1.05
20	0.77	-	1.82	1.00	0.70	0.94
25	0.69	-	1.66	0.92	0.64	0.86
50	0.20	-	0.48	0.27	0.19	0.25

Conclusions

All reference populations are suitable (i.e., weighted score >80) for comparison with the Chewuch River spring Chinook population (Table 18). We employed a weighted ranking system (see Appendix C) that included level of correlation, relative difference in slopes of reference verses treatment, CV of ratio scores of reference verses treatment, and proportion of natural-origin spawners in the reference population both before and during supplementation. Populations that had less than 90% natural-origin spawners were removed from consideration. A score of 81.75 was at the upper 97.5th percentile of all possible weighted scores. The Naches River and Big Creek population ranked the highest for all metrics. The Valley Creek population ranked high for spawner abundance and for reasons previously discussed was not included in the analysis for NORs and productivity. The Marsh Creek and Sesech River populations consistently ranked lower than the other populations for all metrics. No analysis of trends in habitat metrics or other “nuisance” factors was conducted.

Table 18. Ranking of reference populations (1 = best) for the Chewuch River spring Chinook population based on weighted score. Score was based on proportion of natural spawners (before and during supplementation), correlation coefficient, difference in trends, and the coefficient of variation of the ratio scores (treatment/reference).

	Weighted score			Ranking		
Reference populations	Spawner abundance	Natural origin recruits	Productivity	Spawner abundance	Natural origin recruits	Productivity
Naches	92	86	87	1	3	1
Valley	91	-	-	2	-	-
Marsh	89	86	84	3	3	3
Secesh	84	85	82	-	4	4
Big	88	89	87	4	1	1
Bear Valley	85	87	85	5	2	2

Objective 1: Abundance, Recruitment, and Productivity

Analysis of mean-ratio scores found no significant differences in spawner abundance before and during supplementation when compared to any reference stream (Table 30, Figure 40). Analysis of spawner abundance was confounded by the high abundance of hatchery fish on the spawning grounds from the Twisp, Chewuch and programs. In the most recent ten years, hatchery fish from these programs have consistently been recovered as carcasses in the Methow River (Figure 41). On average, hatchery fish released at locations other than the Methow Acclimation Pond have comprised 56% of the spawning population (Figure 42). Unknown hatchery fish were defined as those hatchery fish that could not be assigned to a hatchery program due to lack of a coded wire tag and likely represent known hatchery fish in similar proportions. More fish from the Winthrop NFH spawn in the Methow River than from any other hatchery program, although they are recovered in similar proportions to Methow Hatchery fish (Figure 43).

Winthrop NFH has been releasing large numbers of spring Chinook into the Methow River for decades. It is highly likely these fish were present on the spawning grounds during the pre-supplementation period. Because we were unable to find the data necessary to exclude these fish from the pre-supplementation period, fish from Winthrop NFH were also included in the post-supplementation period. Similarly, fish from the Twisp and Chewuch programs were certainly present on the spawning grounds in the Methow River prior to 2001 and we could not exclude them from the analysis because of insufficient data from the 1995 through 2000 period. Thus, all stray hatchery fish were included in the Methow analysis. Although stray fish on the spawning grounds confound the interpretation of the results for the Methow FH program, the analysis provides a comprehensive assessment of the most recent strategy of artificial propagation at Methow FH and Winthrop NFH for achieving the common goal of increasing the abundance of natural-origin fish in the Methow River.

NOR abundance decreased significantly relative to Secesh River and Bear Valley Creek (Table 30, Figure 44). Differences were still significant in the Secesh after excluding 1996 and 1998 from the analysis. Mean NOR abundance in all reference populations increased during the supplementation period, while decreasing in 2 of 5 and remaining unchanged in 3 of 5 reference population comparisons in the Methow River.

Productivity in the Methow population has not significantly changed compared to any reference population (Table 30, Figure 45). High productivity in the early part of the post-supplementation period was presumably due to extremely low spawner abundance in both 1996 and 1998, when nearly all spring Chinook were collected at Wells Dam for broodstock. The few fish that were not trapped had extremely high productivity. Excluding 1996 and 1998 from the analysis had little effect on the results. The Methow River spring Chinook experienced low productivity or recruit/spawner (R/S) during the pre-supplementation period (mean R/S = 0.77, SD = 0.85) and that, in part, served as impetus for the initiation of a supplementation program at Methow FH. During the supplementation period the proportion of hatchery fish on the spawning grounds averaged 73% (SD = 22%) and the proportion of naturally produced fish in the broodstock, including WNFH, averaged 12% (SD = 14%) resulting in an average PNI of 0.13 (SD = 0.14; Figure 46). During the supplementation period the mean productivity was 2.85 (SD = 5.47), with a geometric mean of 0.55. However, excluding 1996 and 1998, the average R/S decreased to 0.99 (SD = 1.5), with a geometric mean of 0.29. Since 2001, when returns from the Methow-Composite program were present on the spawning grounds, the average R/S was 0.16 (SD = 0.13), with a geometric mean of 0.12.

Table 30. Results of the unequal-variance t-tests on LN spawner abundance, LN adjusted NOR, and LN adjusted productivity data. Tests determined if the mean ratios during the supplementation period were different from mean ratios during the pre-supplementation period. Results are presented for all years and with 1996 and 1998 excluded.

Response variable	Statistic	Reference populations					
		Naches	Valley	Marsh	Secesh	Big	Bear Valley
Spawner abundance	T-test (P-value)	0.428	0.126	0.586	-	0.850	0.065
	Effect size	0.054	0.263	0.059	-	0.020	0.149
	Result	ND	ND	ND	-	ND	ND
NOR	T-test (P-value)	0.179	-	0.568	0.001	0.155	0.038
	Effect size	0.297	-	0.754	1.090	0.500	0.957
	Result	ND	-	ND	Decrease	ND	Decrease
Productivity	T-test (P-value)	0.522	-	0.573	0.961	0.514	0.498
	Effect size	0.125	-	0.374	0.013	0.117	0.192
	Result	ND	-	ND	ND	ND	ND
		1996 and 1998 excluded					
Spawner abundance	T-test (P-value)	0.884	0.304	0.678	-	0.952	0.247
	Effect size	0.010	0.174	0.040	-	0.006	0.075
	Result	ND	ND	ND	-	ND	ND
NOR	T-test (P-value)	0.369	-	0.724	0.001	0.223	0.083
	Effect size	0.209	-	0.528	1.040	0.468	0.893
	Result	ND	-	ND	Decrease	ND	ND
Productivity	T-test (P-value)	0.990	-	0.586	0.616	0.369	0.322
	Effect size	0.002	-	0.428	0.137	0.179	0.311
	Result	ND	-	ND	ND	ND	ND

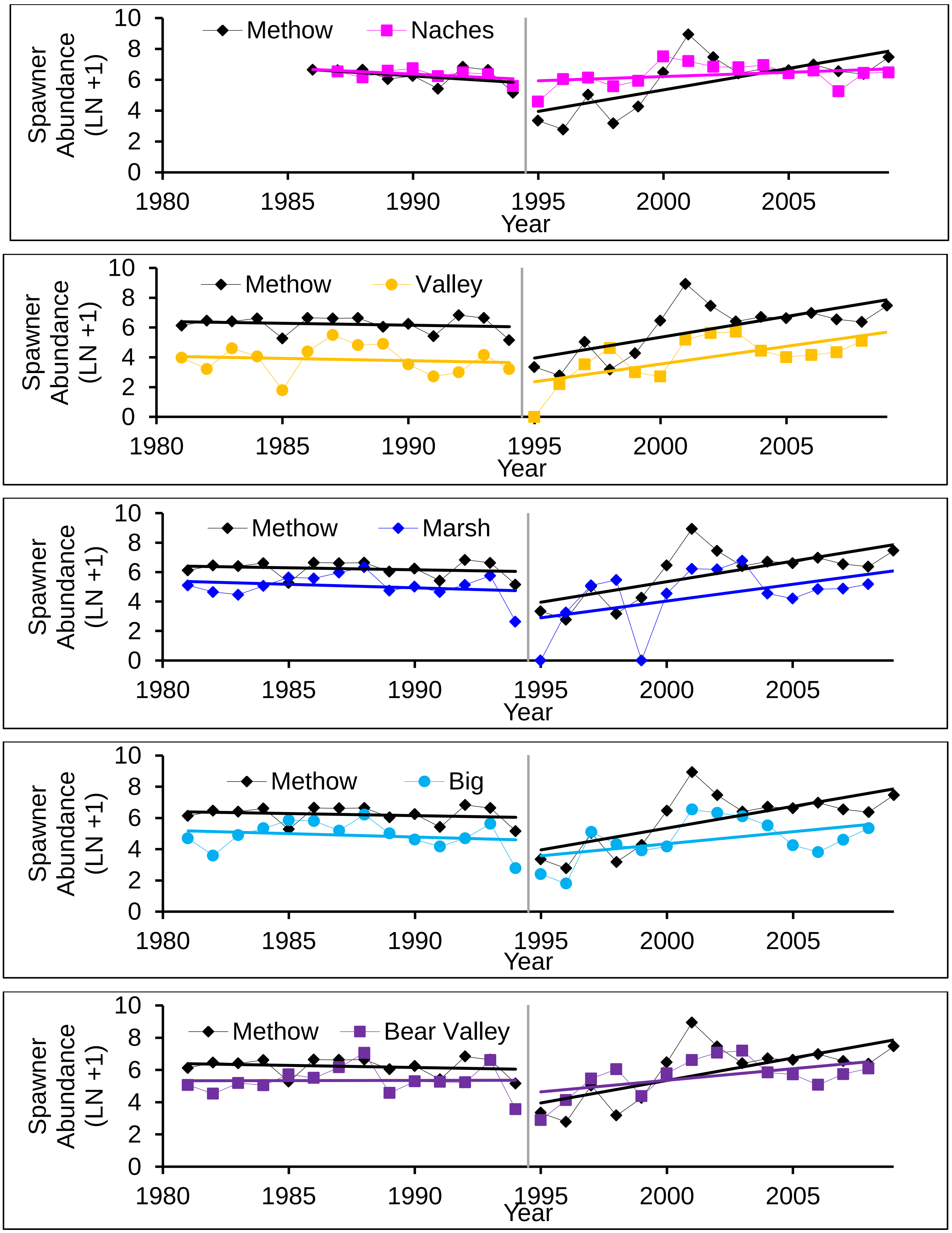


Figure 40. Trends in spring Chinook spawner abundance in the Methow River and reference populations. The vertical lines in the figures separate the pre-supplementation and during supplementation periods.

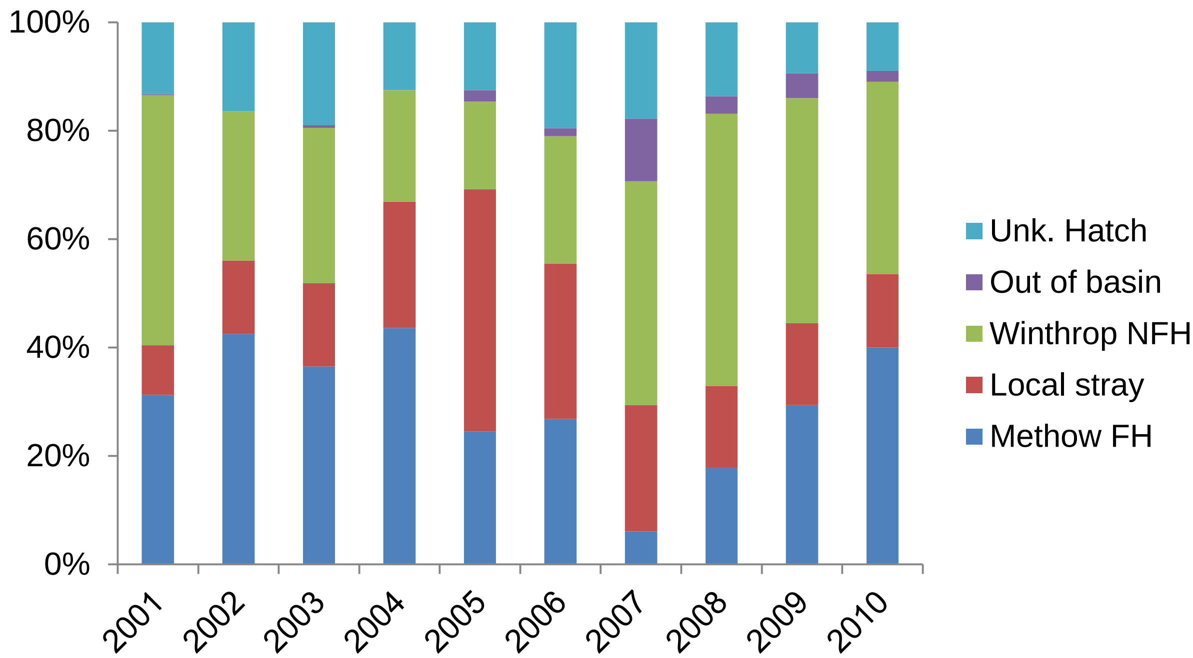


Figure 41. Composition of hatchery fish spawning in the Methow River determined by expansions of coded wire tags from recovered carcasses.

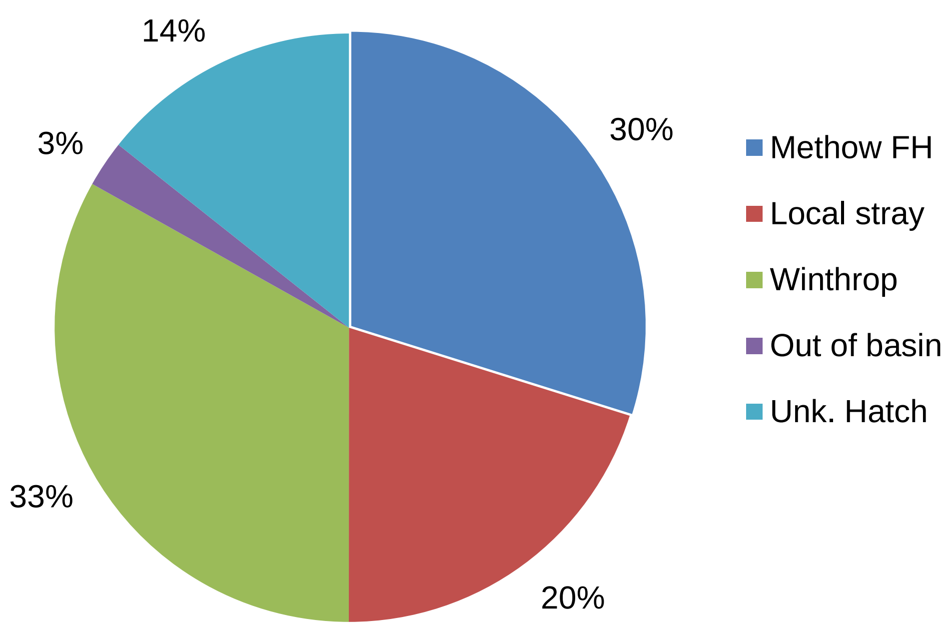


Figure 42. Average relative abundance of hatchery fish recovered as carcasses in the Methow River, based on release location, 2001 – 2010.

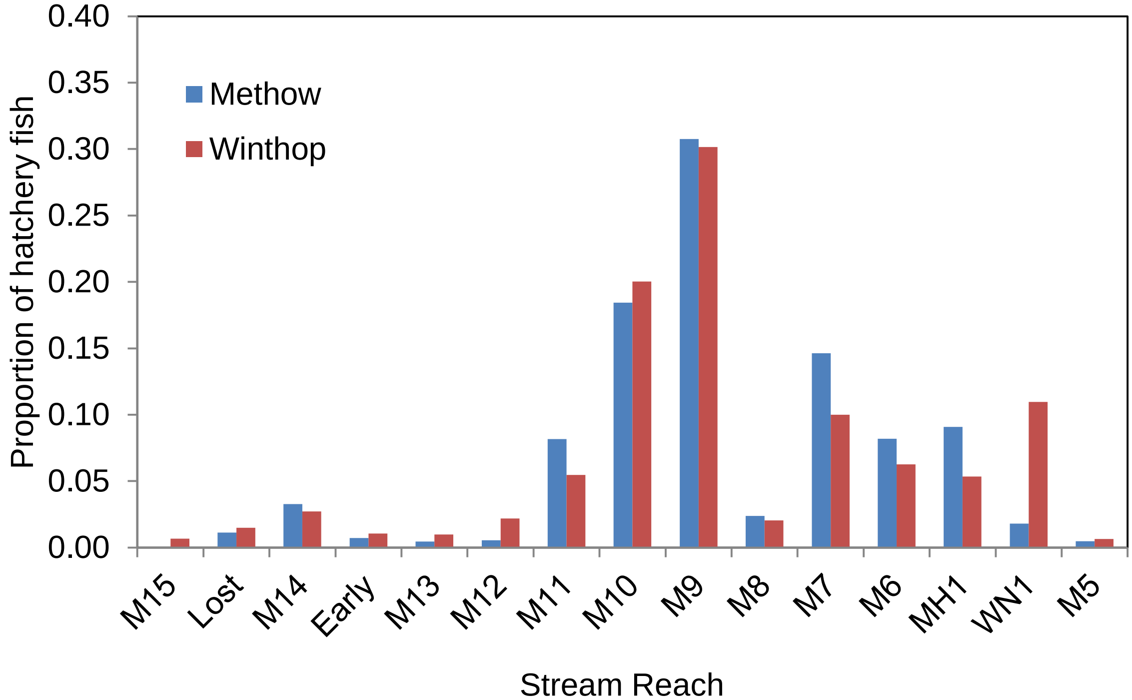


Figure 43. Relative distribution of Methow and Winthrop hatchery spring Chinook on spawning grounds. Stream reaches progress upstream from right to left.

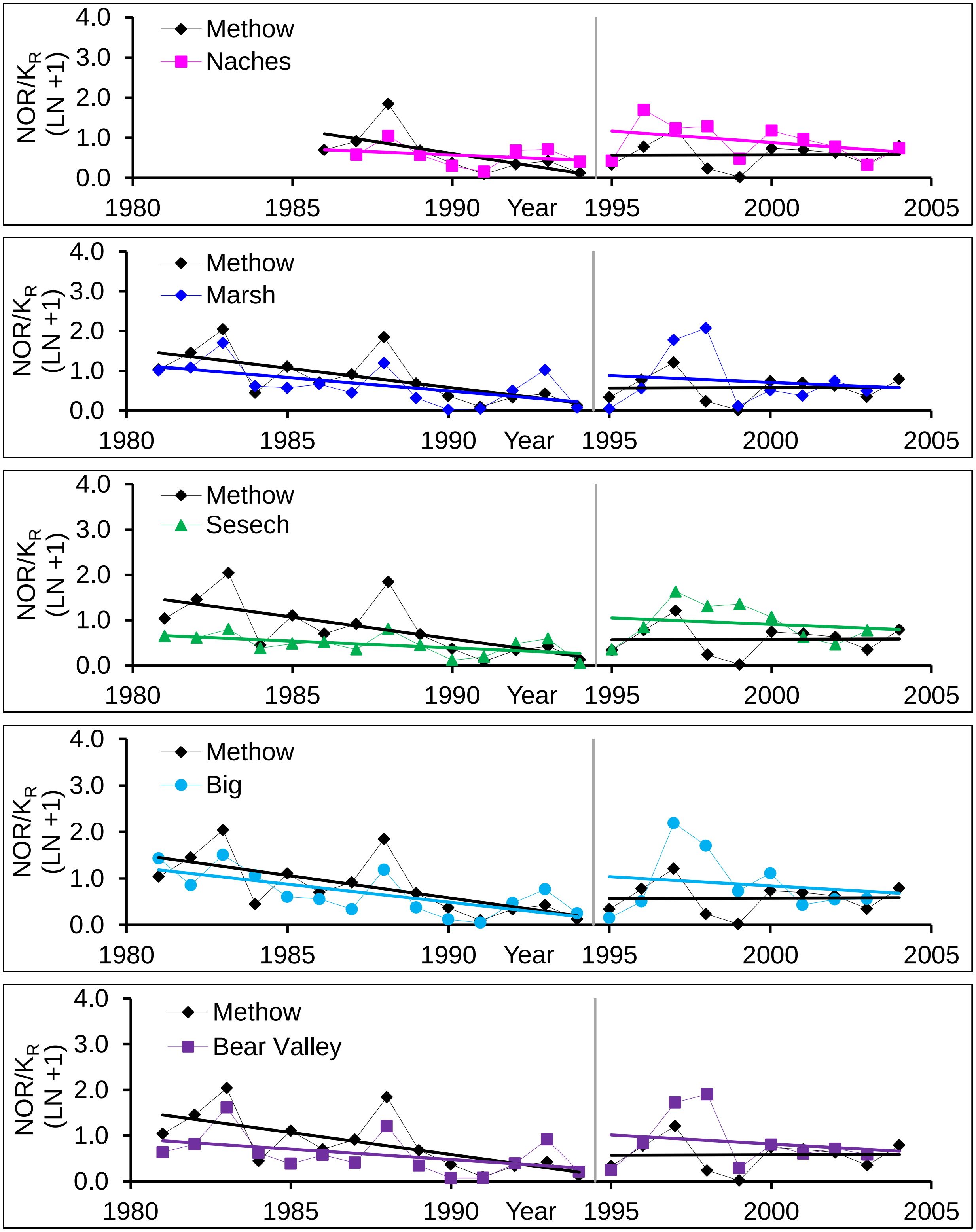


Figure 44. Trends in spring Chinook natural-log NOR abundance adjusted for the fraction of capacity in the Methow River and reference populations. The vertical lines in the figures separate the pre-supplementation and during periods.

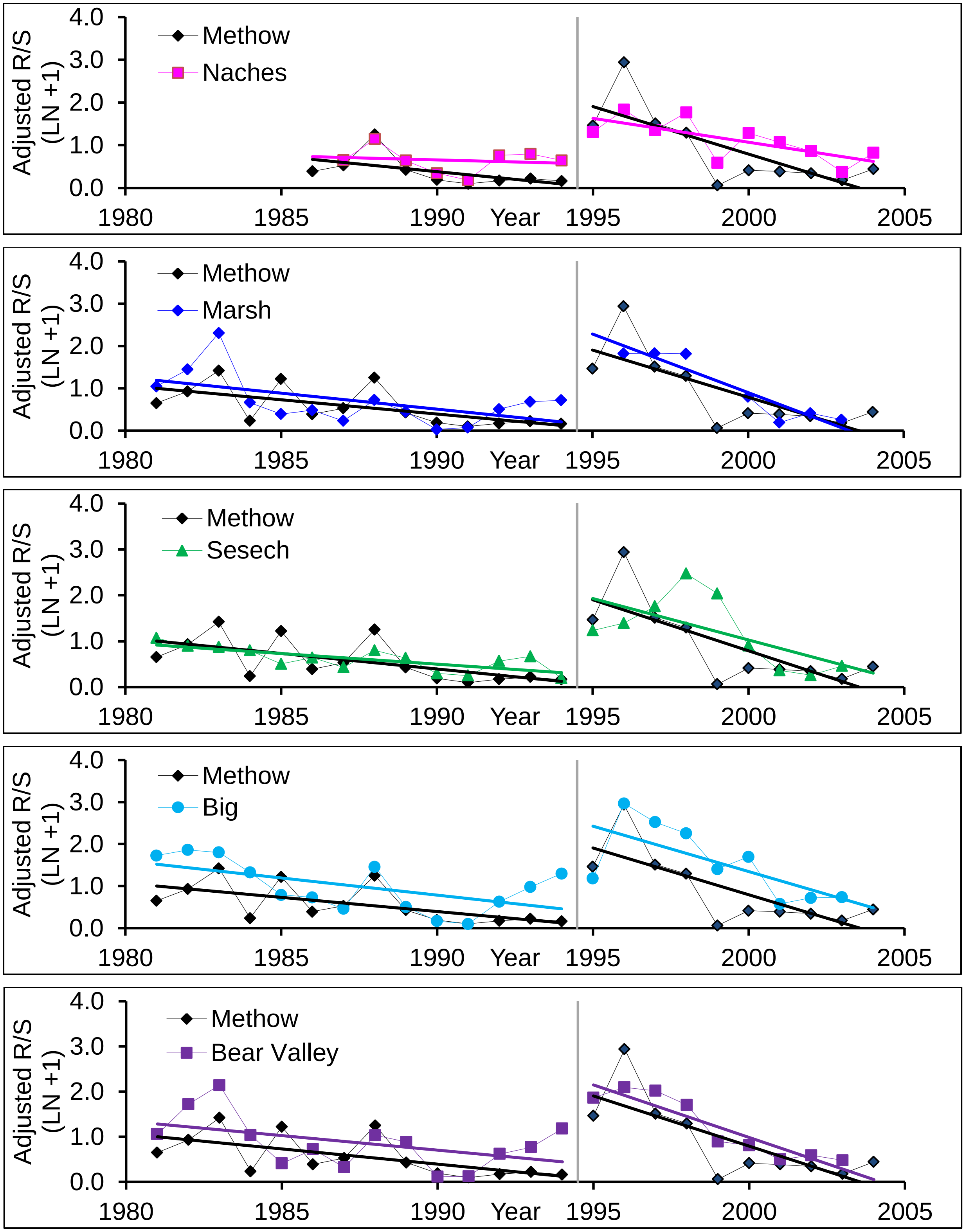


Figure 45. Trends in spring Chinook natural-log productivity adjusted for spawner capacity in the Methow and reference populations. The vertical lines in the figures separate the pre-supplementation and during periods.

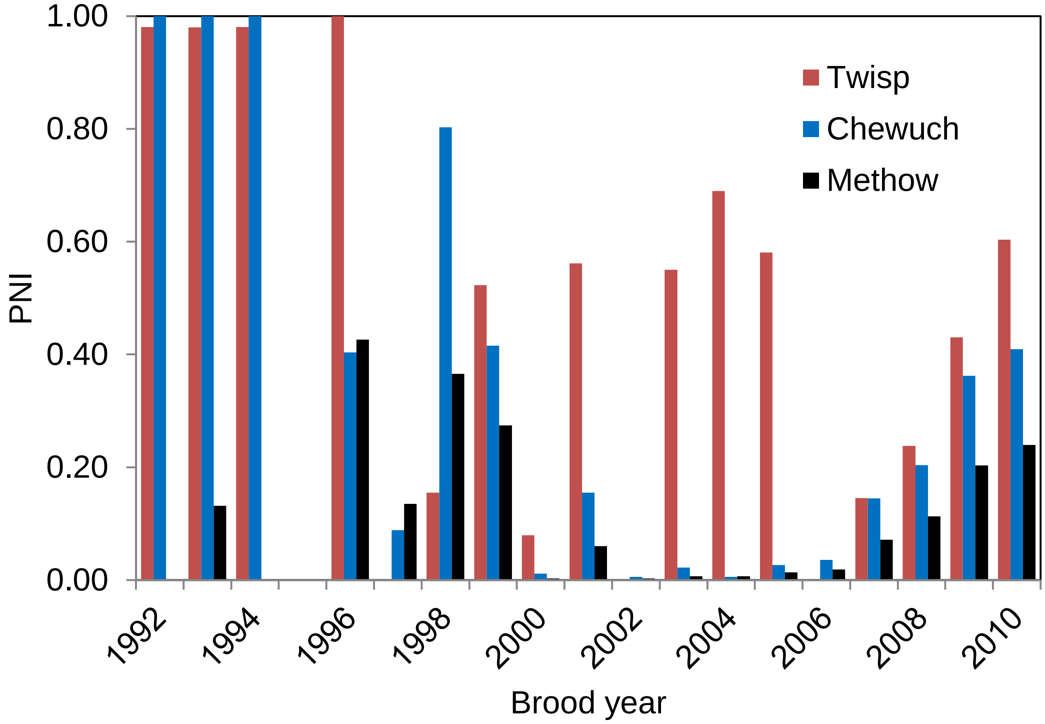


Figure 46. The proportionate natural influence (PNI) of the three spring Chinook supplementation programs in the Methow Basin.

Objective 2: Migration and Spawning Characteristics

Migration Timing

Low sample size for a specific run year and age class prohibited the analysis of migration timing for most years and age classes. The only stock and age class with consistent sample sizes (N = 25 or larger) was age-four fish from the Methow-Composite stock for run years 2008-2010. Julian date was transformed using the natural-log to more closely approximate a normal distribution. Results detected significant differences between years (ANOVA: $P < 0.001$), but not between hatchery and natural-origin (ANOVA: $P = 0.52$). Although significant differences were detected in the interaction term of years and origins (ANOVA year x origin interaction term: $P < 0.05$), a Tukey HSD test for unequal sample sizes found no difference among origins within any year examined ($P > 0.63$; Figure 47).

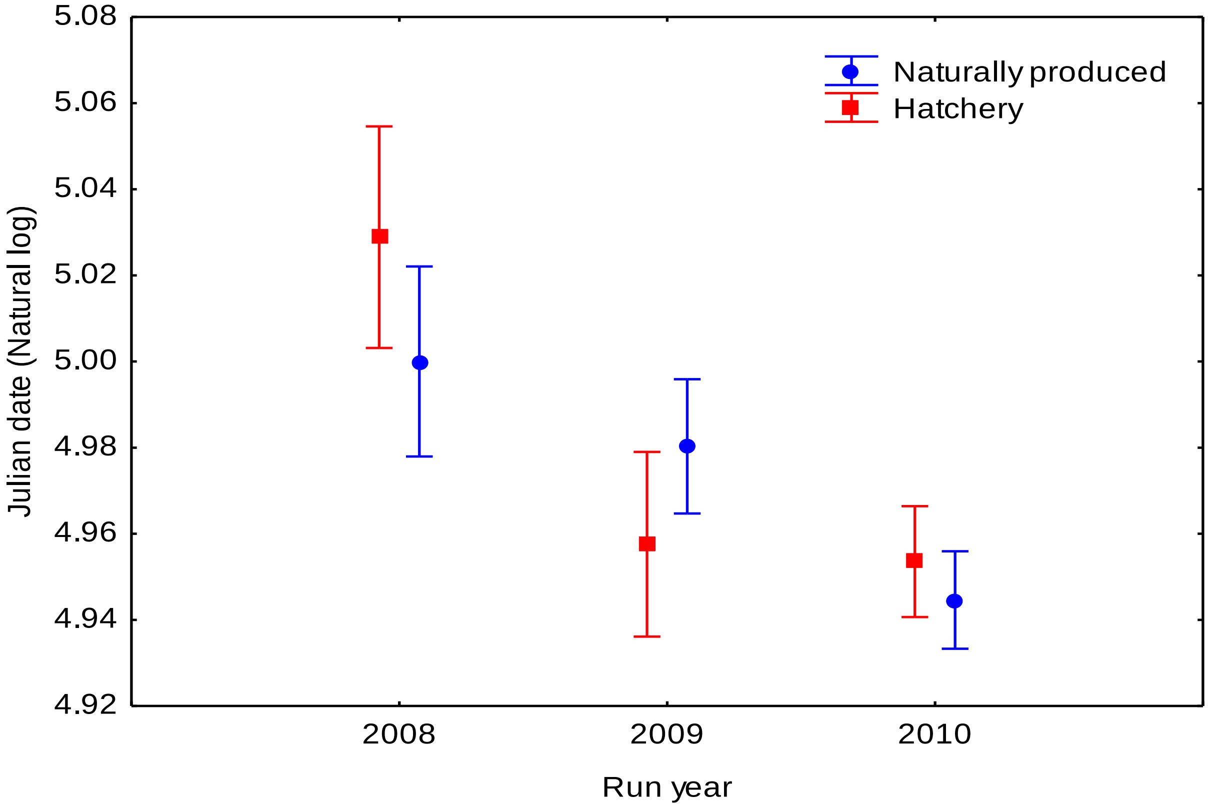


Figure 47. Mean run timing of age-4 Methow spring Chinook at Wells Dam.

Spawn Timing

Significant differences in spawn timing, based on female carcass recovery date, were found across years (ANOVA: $P < 0.001$), but not among hatchery and natural-origin (ANOVA $P = 0.98$) or among origins within years (ANOVA year x origin interaction term: $P = 0.43$). Differences were detected in female carcass recovery date between Methow hatchery fish and hatchery fish released from Winthrop NFH, but only in 2010 ($P < 0.01$; Figure 48).

Redd distribution

Significant differences in female hatchery and natural-origin carcass-recovery location were not detected between years (ANOVA: $P = 0.100$). Differences in spawning location (female carcass recovery location used as a proxy for spawning location) were detected among females of hatchery and natural origins (ANOVA: $P < 0.001$) and between naturally produced and hatchery female carcass recovery location within years (ANOVA year x origin interaction term: $P < 0.001$). No difference was found in carcass recovery location between female hatchery fish from Methow FH and Winthrop NFH (ANOVA year x origin interaction term: $P = 0.22$; Figure 49). Although the mean hatchery female carcass recovery location is significantly different then natural origin (i.e., mean hatchery female spawning location is downstream of mean natural origin females), hatchery and natural produced fish are fully integrated in the Methow River.

Over the last five years hatchery fish, regardless of release location, have comprised nearly 50% or greater of the spawning population in all reaches except the Lost River (Figure 50). Furthermore, spawning habitat in the Methow River is also fully seeded, but does vary depending on habitat quality (Figure 51).

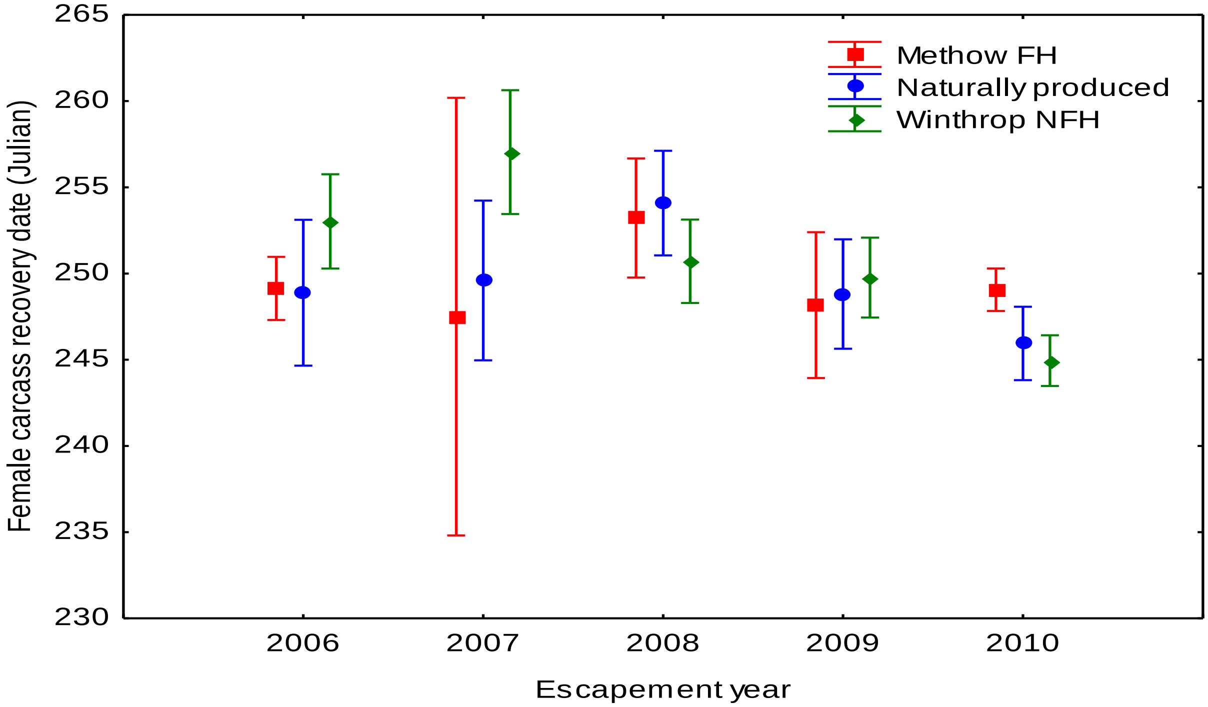


Figure 48. Mean female carcass-recovery date of Methow River spring Chinook.

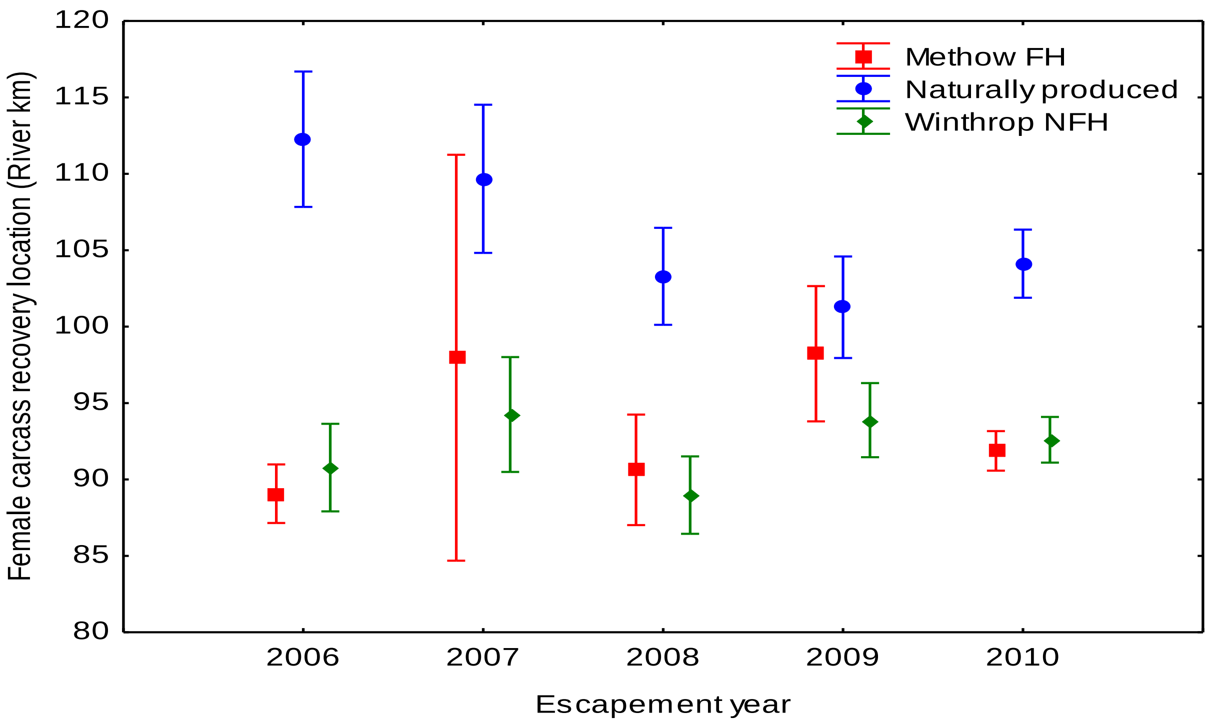


Figure 49. Mean female carcass recovery location of Methow River spring Chinook.

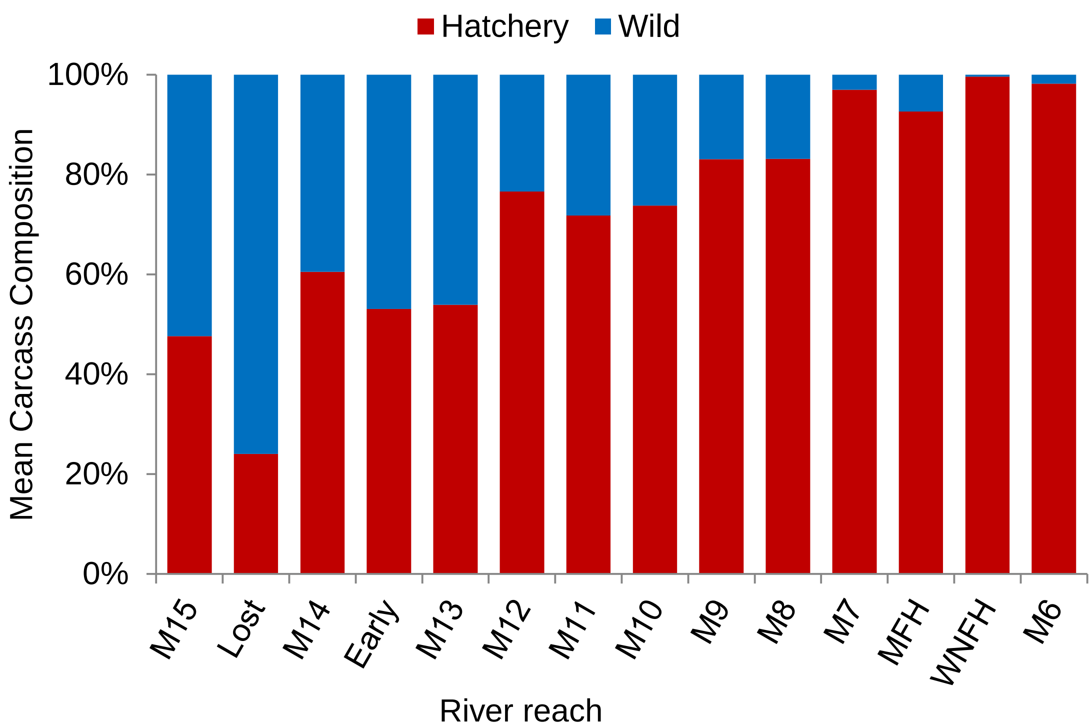


Figure 50. Mean carcass composition of spring Chinook in the Methow River, 2006 – 2010.

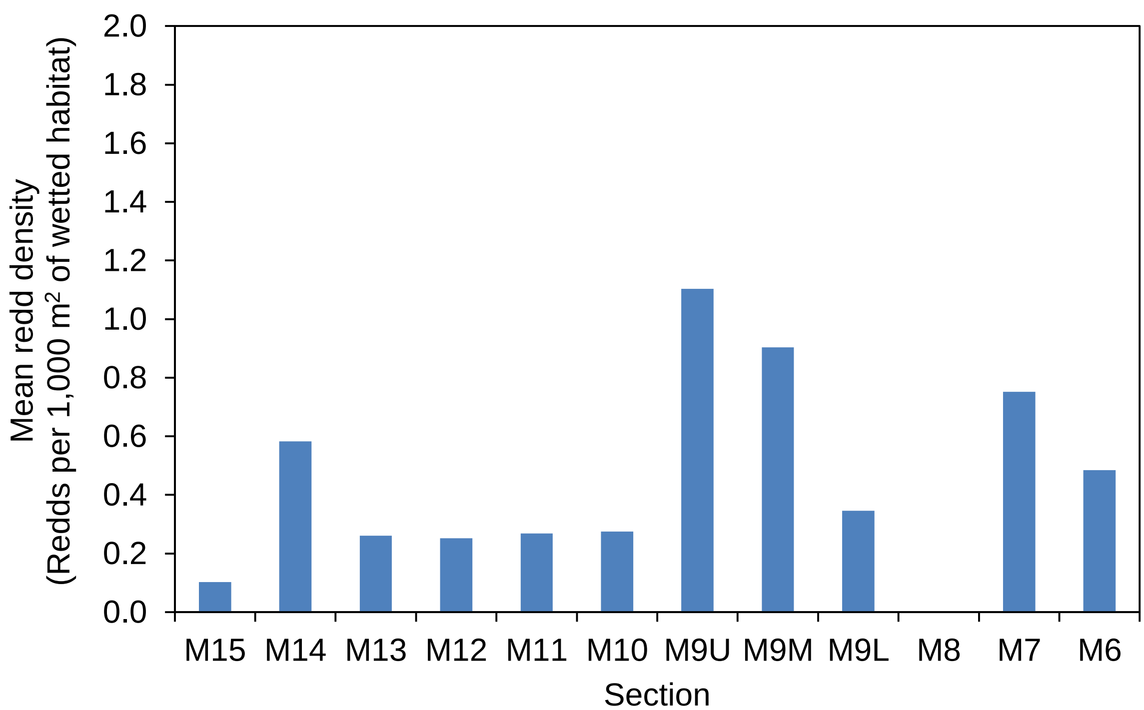


Figure 51. Redd density of spring Chinook in the Methow River in 2011. Reach area was normalized based wetted width and redd locations between 2006 and 2010.

Objective 3: Genetic and Phenotypic Characteristics

Genetic monitoring

Small et al. (2007) conducted the genotyping and analysis for genotype-based hypotheses and thus is the source for details regarding the methodology and analytical procedures (Appendix B). Results specific to the Methow spring Chinook were extracted and presented below to specifically address the hypotheses as outlined in the Analytical Framework (Hays et al. 2007).

Methow spring Chinook had similar mean heterozygosity and allelic richness as Chewuch spring Chinook, but were significantly higher than Twisp spring Chinook ($P < 0.01$). We found low differentiation between Methow and Chewuch natural origin collections, some of which were not significantly different from zero after corrections. Winthrop Hatchery collections were not differentiated from most Methow natural-origin collections, suggesting Winthrop Hatchery introgression into the Methow population (Table 31). Methow spawners contained a substantial proportion of the WNFH genome as early as 1993. Several analytical approaches were used to evaluate the relationships between the three stocks and all approaches provided comparable results (Small et al. 2007, Figure 52). We plotted pairwise F_{ST} values versus time between collections and found a slight increase in differentiation over time possibly due to drift and introgression from the Methow-Composite stock (Figure 53). Increased differentiation is likely a signal that genetic drift is increasing as N_e decreases.

Table 31. Pairwise F_{ST} values (lower matrix) and *p* values for pairwise genotypic tests (upper matrix) for temporal and spatial collections. Values that were significant before Bonferroni corrections are underlined and values that were significant after Bonferroni corrections are in bold type (corrected alpha = 0.05/253 = 0.00019).

Group	92 WinH	01 WinH	93 MetH	93 MetW	01 MetW	01 MetH	05 MetW	06 MetW	06 Metcomp
92WinH	*	0	0.00021	0.05363	**0**	**0**	**0**	**0.00013**	**0**
01WinH	**0.0034**	*	0.00022	0.00048	**0**	**0**	**0**	0.0003	**0**
93MetH	0.0034	0.0044	*	0.19253	**0**	0.53881	0.00815	0.02743	**0**
93MetW	0.0003	0.0052	-0.0004	*	**0.00018**	0.04141	0.00112	0.00065	**0**
01MetW	0.0036	0.0022	-0.0003	0.0041	*	**0**	0.01093	0.03388	**0**
01MetH	**0.0036**	**0.0029**	-0.0002	0.0015	0.0002	*	0.00029	0.06308	**0**
05MetW	**0.0087**	**0.0065**	0.0011	0.0043	0.0048	0.0021	*	0.14475	**0**
06MetW	0.0040	0.0046	-0.0012	0.0022	0.0015	0.0004	0.0002	*	**0**
06Metcomp	**0.0142**	**0.0124**	**0.0109**	**0.0125**	0.0039	**0.0072**	**0.0056**	0.0040	*

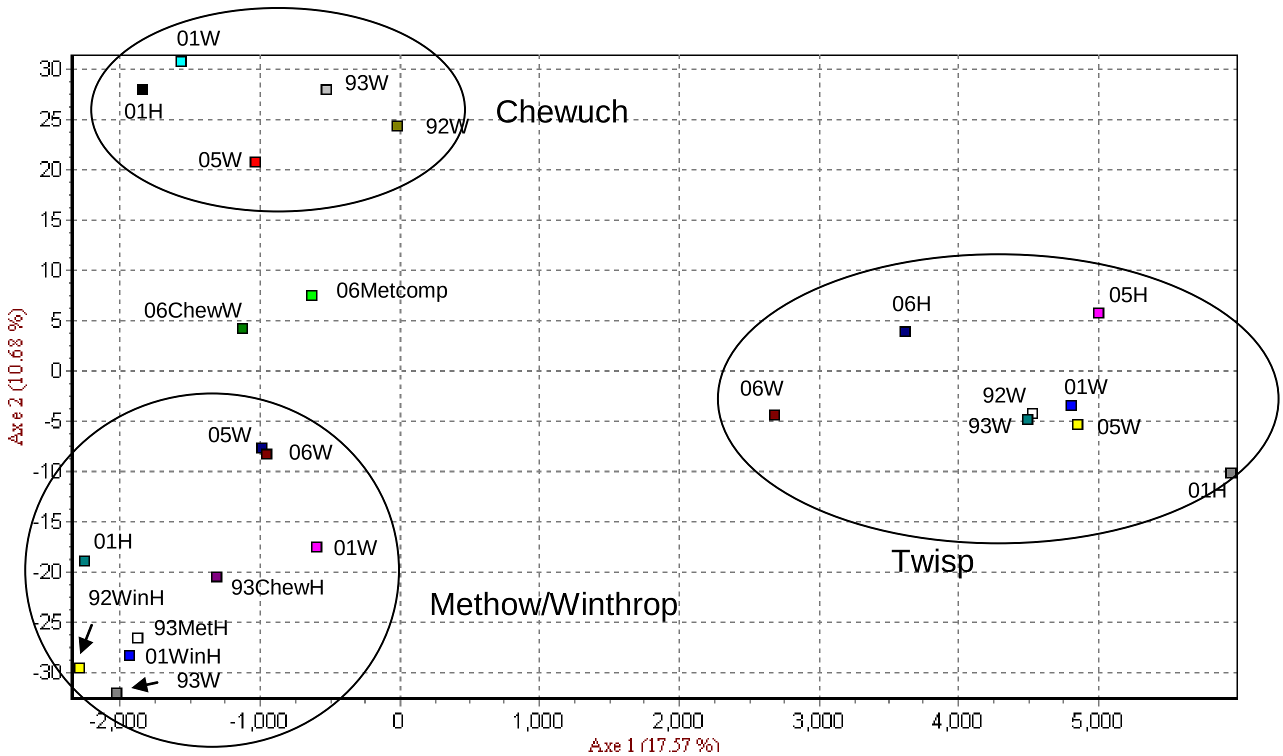


Figure 52. Factorial correspondence analysis plot of hatchery and natural spring Chinook collections from the Methow, Chewuch and Twisp rivers. Hatchery- and natural-origin collections are indicated by “H” and “W”, respectively, after the two-digit code for collection year (Small et al. 2007).

Large variance in the estimated effective population size (N_e) may limit the utility of using the spawning population abundance as a predictor of N_e (Small et al 2007). The abundance of natural spawners was not correlated with N_e ($r = 0.14$). However, the ratio of N_e/N of naturally produced fish has been decreasing over time indicating a decrease in Ne during the supplementation period, but the analysis was limited to only four brood years (Figure 54). Decreases in Ne over time may be the result of inbreeding or large variation in reproductive success, both of which are likely in populations predominately comprising hatchery-origin fish.

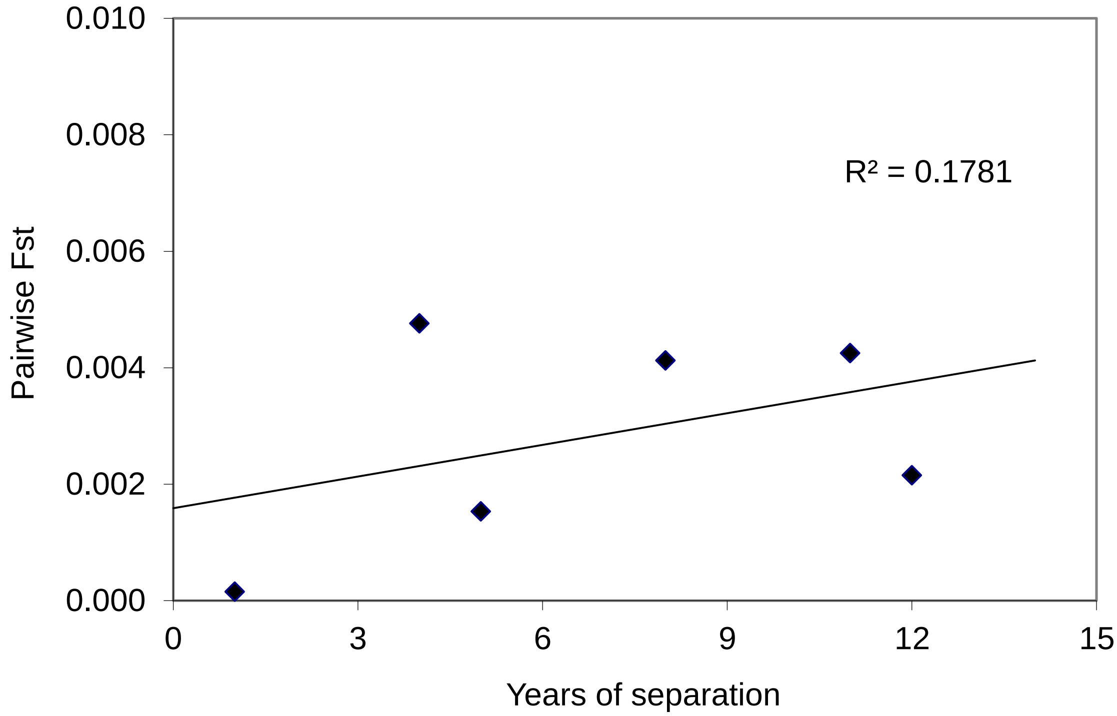


Figure 53. Graph of pairwise F_{ST} values versus time between collections for Methow spring Chinook.

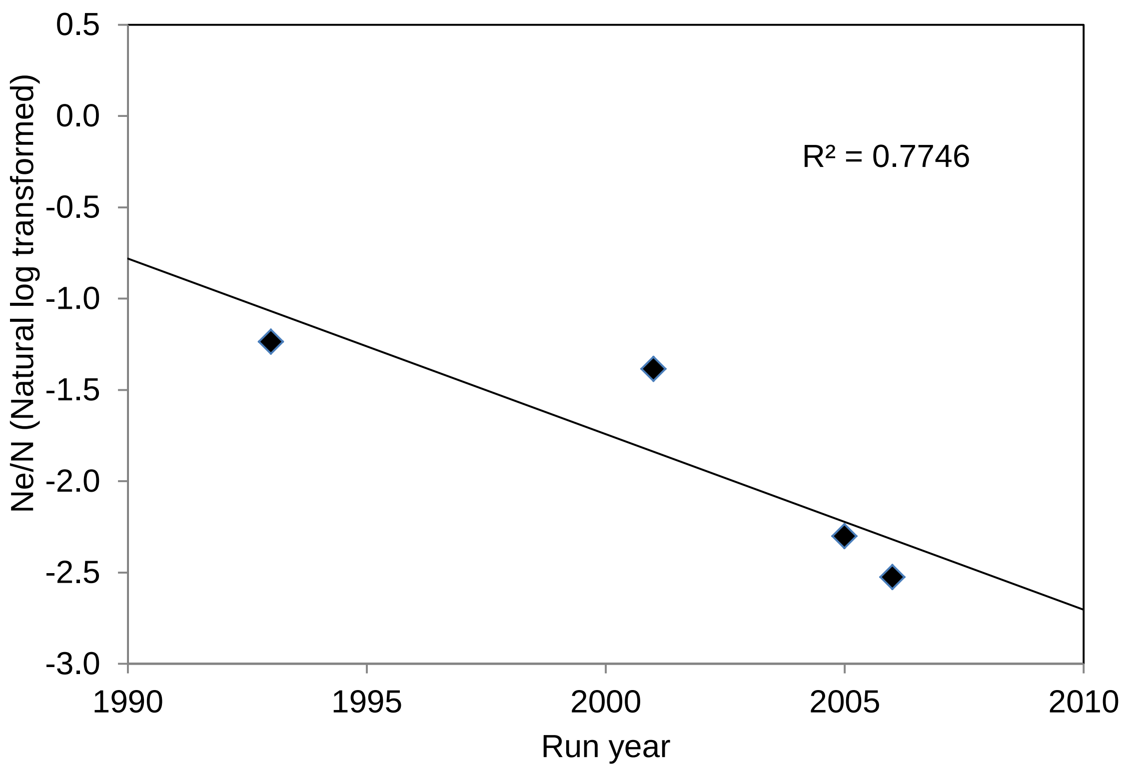


Figure 54. The ratio of N_e/N for naturally produced Methow spring Chinook.

Age at maturity

Low numbers of adult returns at the beginning of the program limited the analysis of age and size at maturity to more recent brood years. Furthermore, fish collected as broodstock or as carcasses were pooled by brood year. Female mean age was significantly different based on origin and brood year (Kruskal-Wallis ANOVA: $P < 0.001$), but post-hoc multiple comparison tests found no difference among origins within any brood year (Kruskal-Wallis ANOVA: $P = 1.0$; Figure 55). Significant differences were also found among the mean age of male Methow spring Chinook across brood years and origins (Kruskal-Wallis ANOVA: $P < 0.001$). In addition, significant differences were detected among origins within brood years in two of the brood years examined (Multiple comparisons tests: $P < 0.01$; Figure 56). Male hatchery fish were composed of a greater proportion of age-3 and lower proportion of age-5 fish compared to naturally produced fish (Figure 57).

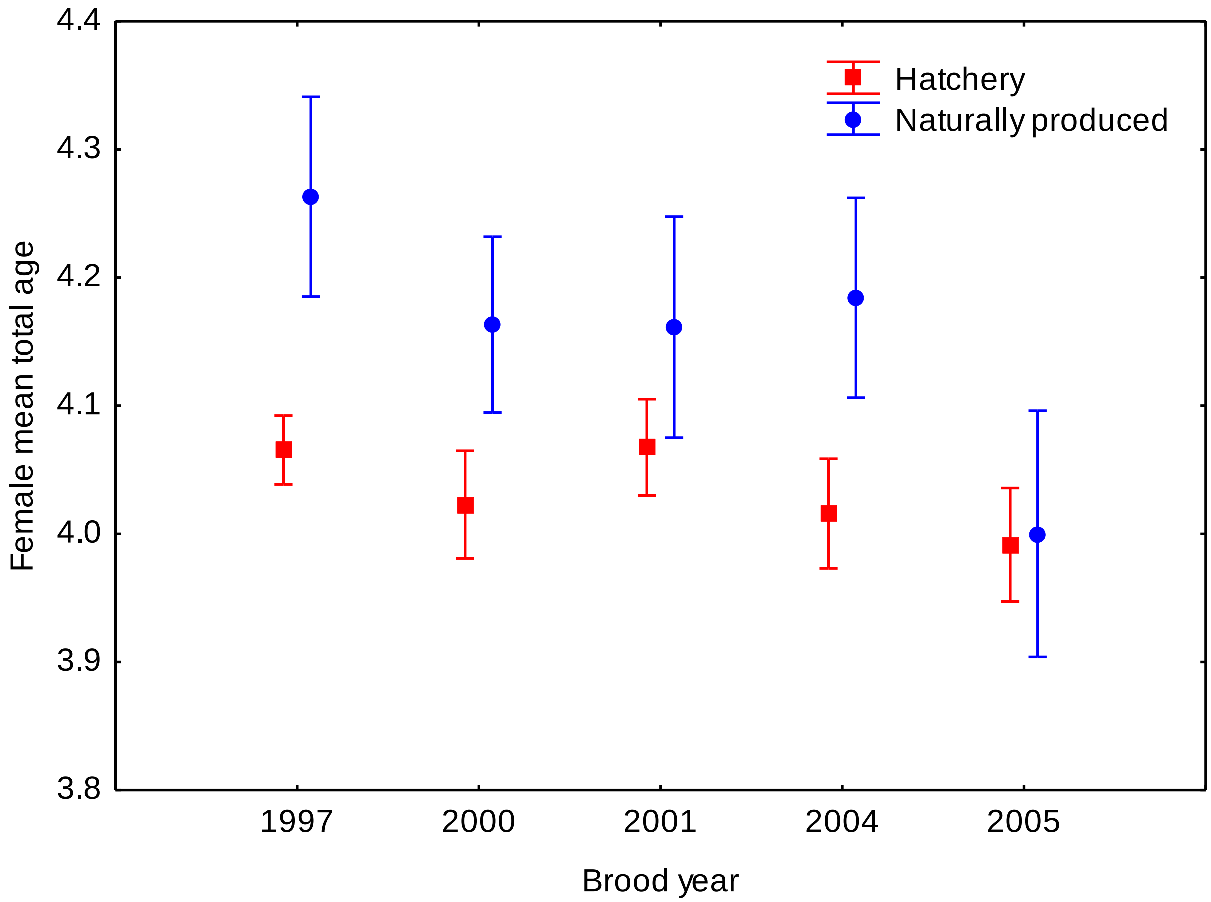


Figure 55. Mean female age at maturity of Methow River spring Chinook salmon.

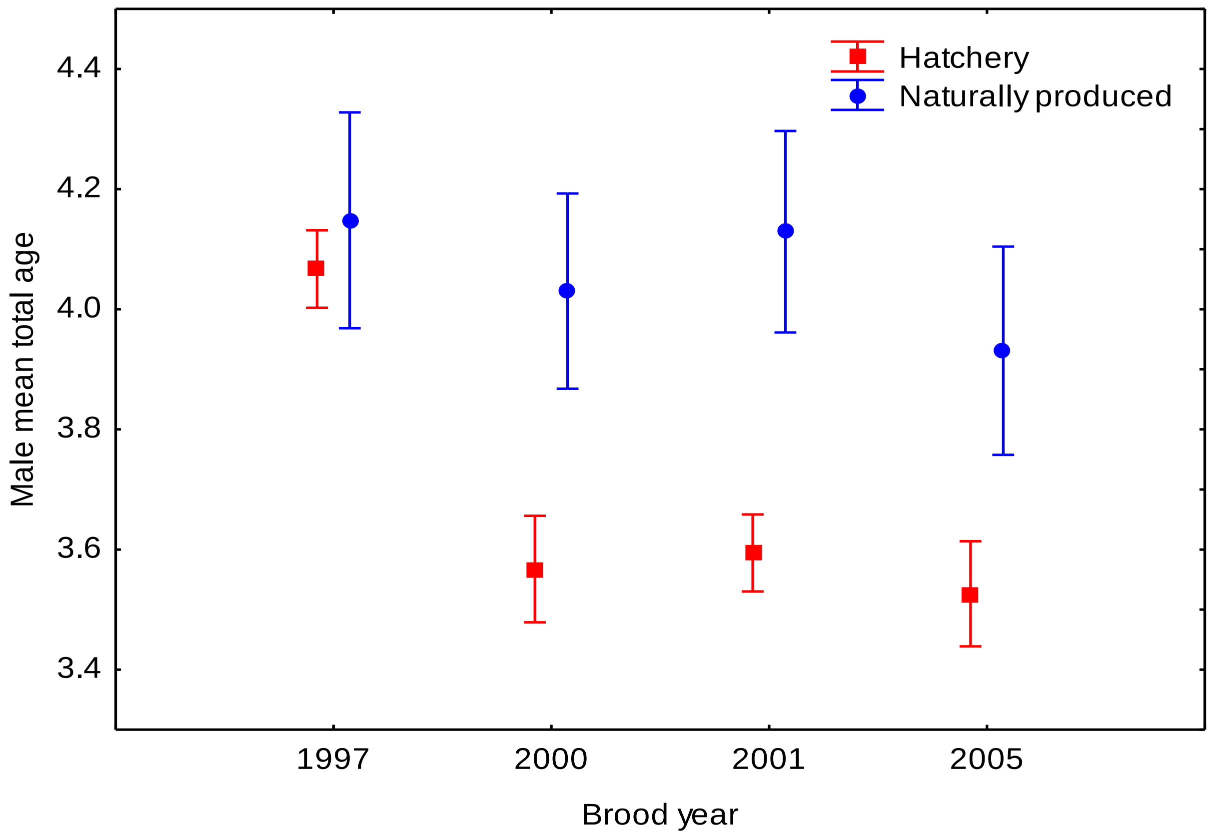


Figure 56. Mean male age at maturity of Methow River spring Chinook salmon.

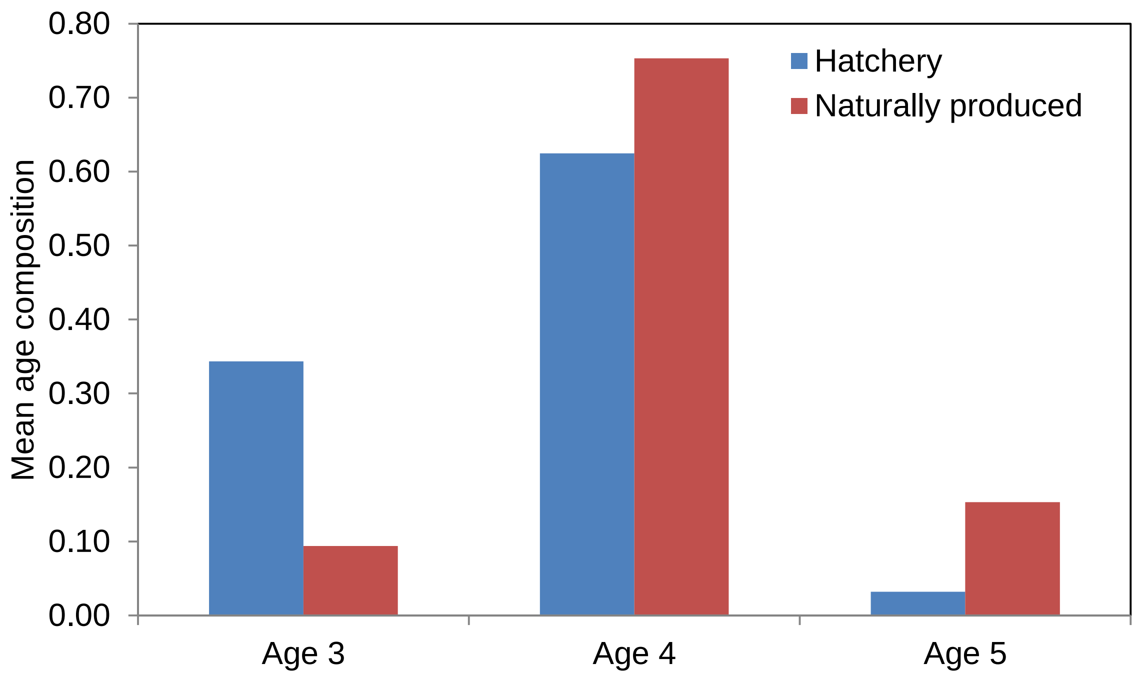


Figure 57. Mean male age composition of hatchery and naturally produced Methow River spring Chinook, brood years 1997, 2000, 2001, and 2005.

Size at maturity

Low adult returns also limited the evaluation of size at maturity to age-four fish. Differences in size within the female age-four fish were detected among brood years and origins (Kruskal-Wallis ANOVA: $P < 0.001$), but no differences were found among origins within years (Multiple comparison test: $P > 0.17$, Figure 58). Similarly, differences in size for male Methow age-four fish were detected across brood years and origins (Kruskal-Wallis ANOVA: $P < 0.001$), but differences were not found among origins within brood years (Multiple comparison test: $P = 1.0$, Figure 59).

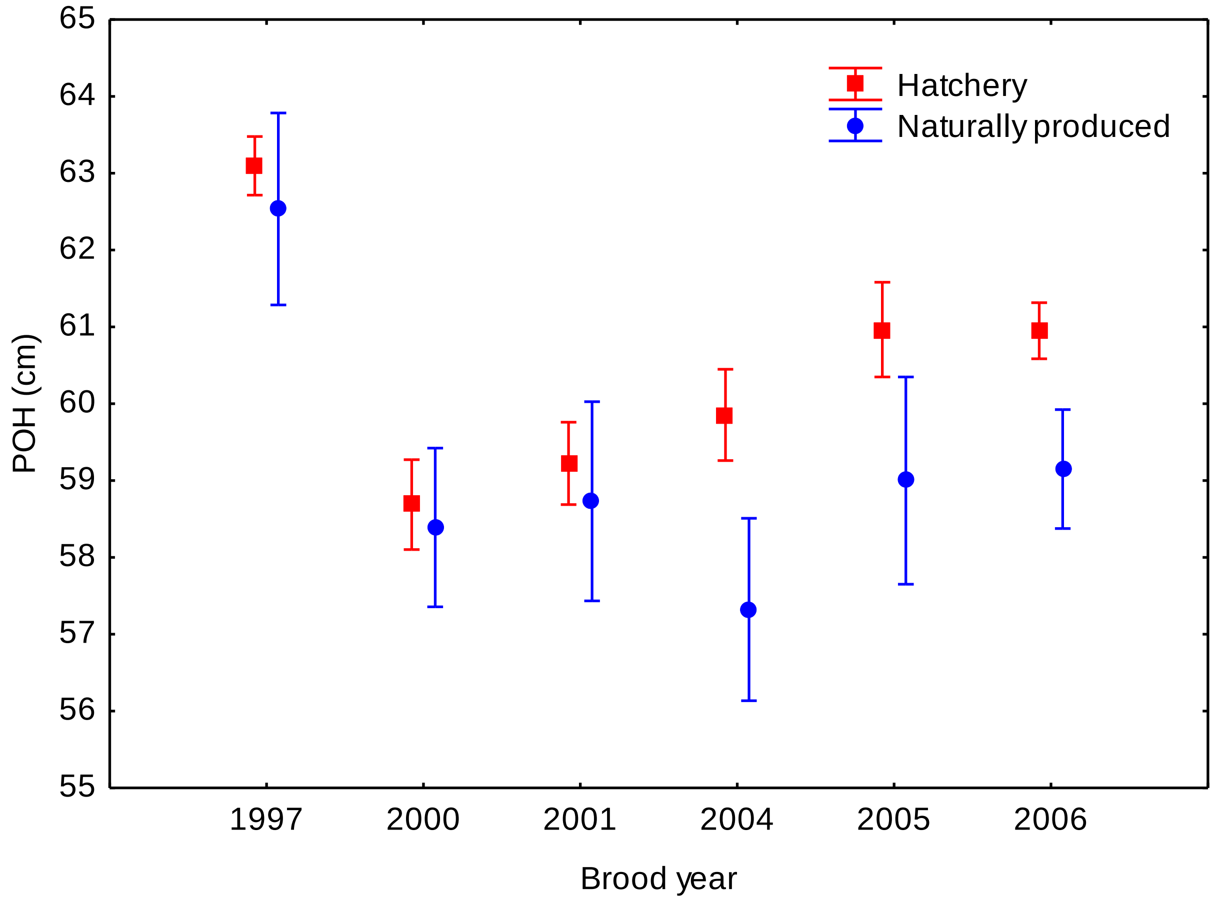


Figure 58. Mean post-orbital to hypural plate (POH) length of age-4 female Methow River spring Chinook.

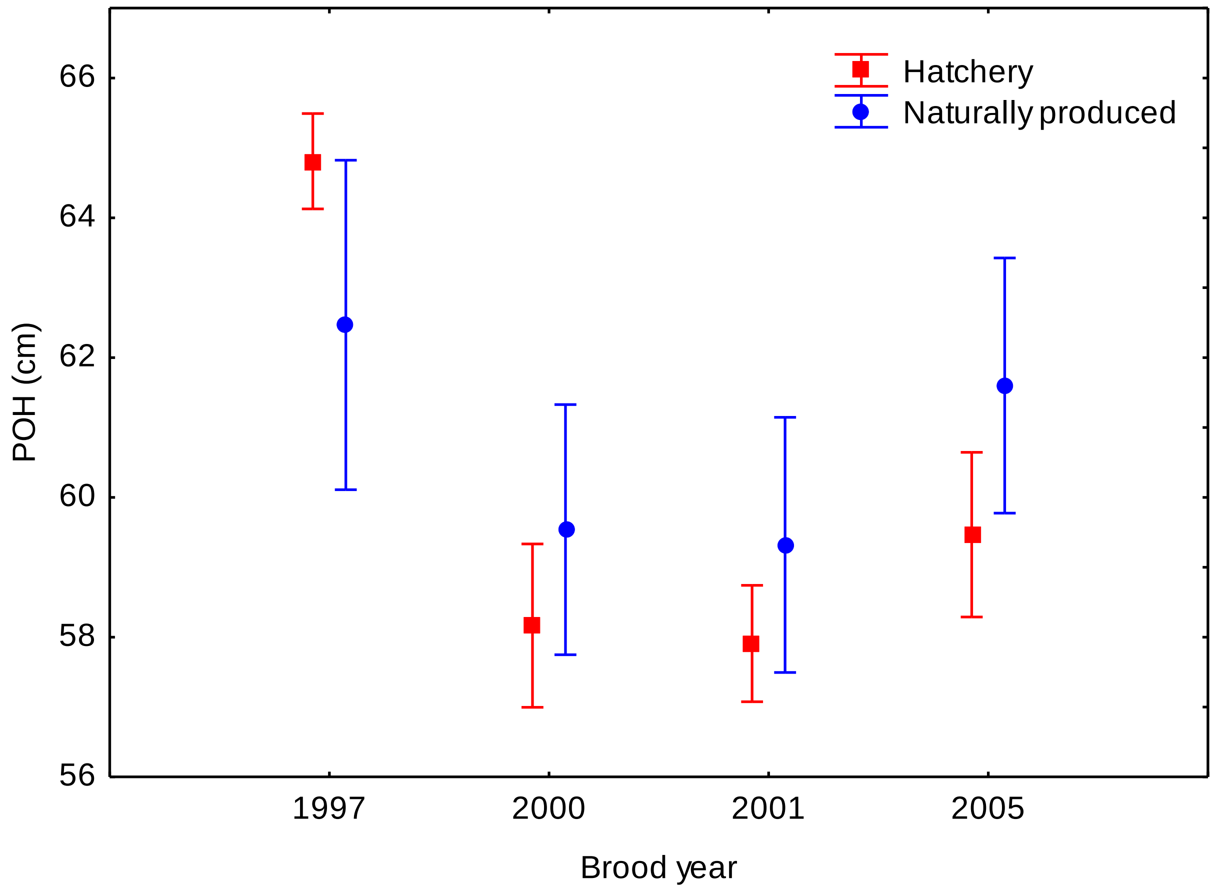


Figure 59. Mean post-orbital to hypural plate (POH) length of age-4 male Methow River spring Chinook.

Objective 4: Hatchery Fish Survival Rates

The mean HRR value of the Methow spring Chinook program was not significantly different from the expected value (4.5) in the BAMP (Mann Whitney U-test: $P = 0.15$, Table 32), and met or exceeded the BAMP value for 75% of the brood years. The mean HRR value was significantly greater than the mean NRR (Mann Whitney U-test: $P < 0.007$). The HRR geometric mean is 4 times greater than the NRR geometric mean. Survival rates of fish in the hatchery have consistently met or exceeded survival standards (Snow et al. 2011). Methow River spring Chinook have also experienced SARs not significantly different than the 0.3% identified in the BAMP (t-test: $P < 0.32$; Table 33).

Table 32. Hatchery replacement rates and natural replacement rates for Methow spring Chinook salmon adjusted for harvest.

Brood year	HRR	NRR
1993	2.1	0.2
1994	0.5	0.2
1995	10.2	2.8
1996	4.9	17.9
1997	4.4	3.5
1998	14.3	2.6
1999	1.6	0.1
2000	5.8	0.4
2001	7.4	0.0
2002	7.4	0.1
2003	1.9	0.1
2004	6.0	0.3
Mean (SD)	5.4(4.0)	2.4(5.1)
Geometric Mean	4.0	1.0

Table 33. Smolt to adult return rates for Methow River spring Chinook.

Brood year	Smolts released	Adult returns	SAR%
1993	210,849	192	0.091
1994	4,477	1	0.022
1995	28,878	122	0.422
1996	202,947	500	0.246
1997	332,484	821	0.247
1998	435,670	2,300	0.528
1999	180,775	145	0.080
2000	266,392	852	0.320
2001	130,787	508	0.388
2002	181,235	599	0.331
2003	48,831	57	0.117
2004	65,146	316	0.485
Mean (SD)			0.273 (0.168)

Objective 5: Stray Rates

Brood stray rates

The mean stray rate of Methow spring Chinook based on the estimated total number of coded wire tag recoveries by brood year was significantly lower (2.5%) than the target of 5% (t-test: $P < 0.02$). Stray fish were recovered predominately on the spawning grounds (Table 34). Stray rates of Methow spring Chinook have been at consistently low levels until the 2004 brood year. It is unknown why a sudden increase in stray fish was observed for that brood year despite a moderate level of returning fish.

Table 34. Stray rates by brood year of Methow spring Chinook and the number and proportion based on non-target recovery location.

Brood year	Broodstock		Spawning grounds		Stray rate
	Number	Proportion	Number	Proportion	
1993	0	0.00	1	1.00	0.005
1994	0	0.00	0	0.00	0.000
1995	0	0.00	0	0.00	0.000
1996	0	0.00	8	1.00	0.016
1997	0	0.00	1	1.00	0.001
1999	0	0.00	7	1.00	0.048
2001	0	0.00	23	1.00	0.038
2002	2	0.07	26	0.93	0.034
2003	0	0.00	0	0.00	0.000
2004	0	0.00	33	1.00	0.108
Mean		0.01		0.69	0.025
SD		0.02		0.48	0.034

Stray rates within population

Analysis of stray rates within and between independent populations did not begin until 2000 due to lack of spawning ground data in prior years. Methow spring Chinook have been recovered as carcasses in both the Chewuch and Twisp rivers, comprising an average of 4.5% and 0.3%, respectively, of the spawning populations (Table 35). The proportion of the spawning populations that Methow spring Chinook comprised in the Chewuch and Twisp rivers was significantly lower (t-tests: $P < 0.001$, and $P < 0.0001$, respectively) than maximum target of 10%.

Table 35. Proportion of the spawning population comprised of Methow spring Chinook in non-target streams within the Methow spring Chinook population.

Year	Chewuch River	Twisp River
2000	0.084	0.000
2001	0.020	0.008
2002	0.000	0.000
2003	0.015	0.000
2004	0.011	0.000
2005	0.036	0.000
2006	0.032	0.025
2007	0.084	0.000
2008	0.045	0.000
2009	0.099	0.000
2010	0.067	0.000
Mean	0.045	0.003

Stray rates outside population

The only independent populations where Methow spring Chinook have been recovered on the spawning grounds were the Similkameen River, Entiat River and Chiwawa River. An estimated 14 fish spawned in the Similkameen River which is a very abundant summer Chinook spawning tributary and thus posed little to no genetic risk. An additional two fish were estimated to have spawned in the Chiwawa River in 2006. Methow spring Chinook routinely are recovered on the Entiat River in 5 of the last 11 years, but at very low levels. When recovered in the Entiat River, Methow spring Chinook have comprised less than 2% of the spawning population, a significantly lower value than the maximum acceptable level of 5% (t-test: $P > 0.007$).

Objective 6: Hatchery Release Characteristics

The target length and weight for Methow spring Chinook was 137 mm and 30.3 g, respectively. The mean length at release was 132.8 mm (t-test: $P < 0.02$), significantly smaller than the target length at release. The mean weight at release was 28.7 g (t-test: $P = 0.07$; Table 36), which was not significantly different from the target weight.

Table 36. Mean size at release of Methow River spring Chinook salmon.

Brood year	Fork length	Weight	Brood year	Fork length	Weight
1993	134.8	28.5	2002	132.5	28.7
1994	132.0	31.2	2003	135.0	28.4
1995	134.9	32.2	2004	137.3	32.1
1996	128.2	25.0	2005	130.8	27.4
1997	126.5	24.7	2006	127.6	25.3
1998	133.9	28.3	2007	130.8	27.0
1999	151.0	40.9	2008	125.9	24.0
2000	131.3	26.8	Mean	132.8	28.7
2001	132.8	28.4	SD	5.8	4.1

The Methow spring Chinook program released an average of 150,971 fish and was not significantly different from the program goal (t-test: $P = 0.17$; Table 37). We did not include brood year 1992 in the analysis because broodstock was not collected that year due to low run size.

Table 37. Number of Methow River spring Chinook salmon released by brood year.

Brood year	Number	Brood year	Number
1992	No program	2002	181,235
1993	210,849	2003	48,831
1994	4,477	2004	65,146
1995	28,878	2005	156,633
1996	202,947	2006	249,504
1997	332,484	2007	119,407
1998	218,499	2008	201,290
1999	180,775	Mean	150,971
2000	66,454	Target	183,333
2001	148,128		

Objective 7: Freshwater Productivity

We successfully fitted both Beverton-Holt and Ricker stock-recruitment models to redd and total-emigrant abundance data, but the models only explained between 16-20% of the variation in recruits (Figure 60). We natural-log transformed stock-recruitment data to calculate the residuals. We detected no relationship between the proportion of hatchery fish on the spawning grounds (pHOS) and regression residuals (Figure 61). We also did not detect a significant relationship between freshwater productivity (emigrants per redd) and the proportion of hatchery fish on the spawning grounds (Figure 62). These analyses suggest that pHOS was not affecting the number of emigrants produced; however, the analyses were limited to only eight brood years.

Smolt monitoring on the Methow River began in 2004 and understanding the relationships between spawner abundance and the influence of hatchery spawners in their habitat will require additional years of data. Extremely low mean egg-to-emigrant survival in the Methow River (2004 – 2009 mean = 1%) may be related to biases in abundance estimates, poor reproductive success, habitat limitations, or some combination. However, spawner abundance (i.e., number of redds) was only responsible for a low proportion of the variance in number of emigrants, unlike what was observed in the Chiwawa River where spawner abundance accounted for as much as 60% of the variation in smolts (T. Hillman, unpublished data, 2011). In summary, analyses of freshwater productivity in the Methow River suggest that both the proportion of hatchery spawners and the total abundance of spawners has little influence on productivity and the number of emigrants, respectively.

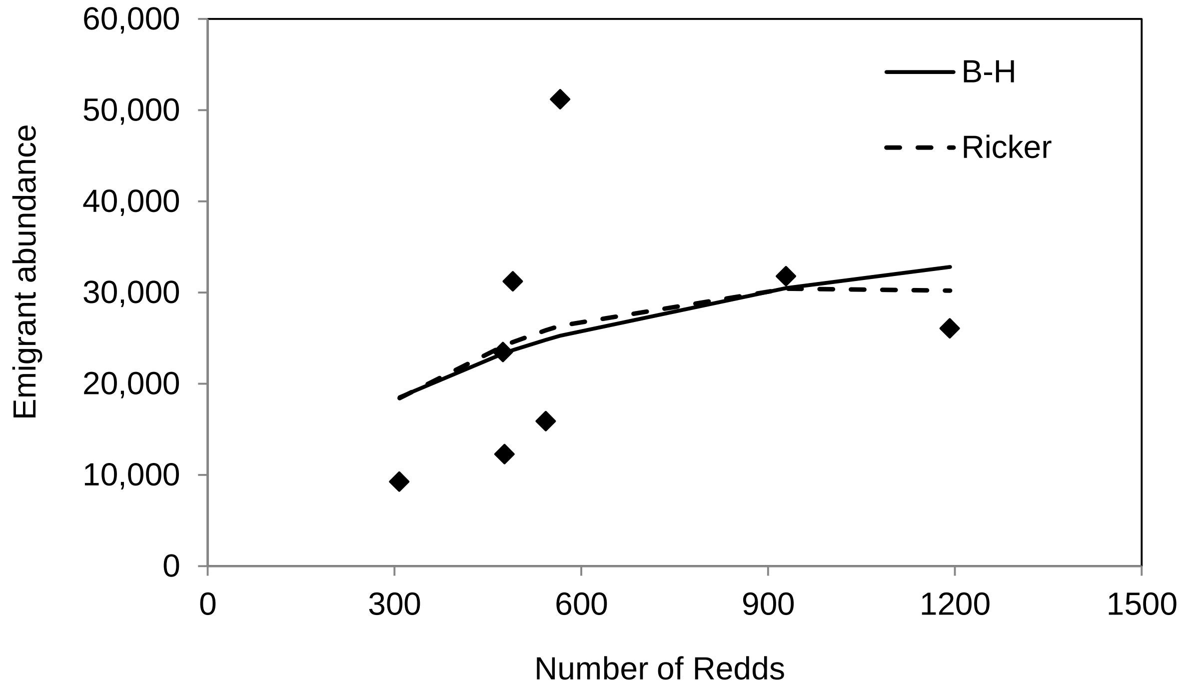


Figure 60. Beverton-Holt and Ricker stock recruitment models for Methow spring Chinook emigrants.

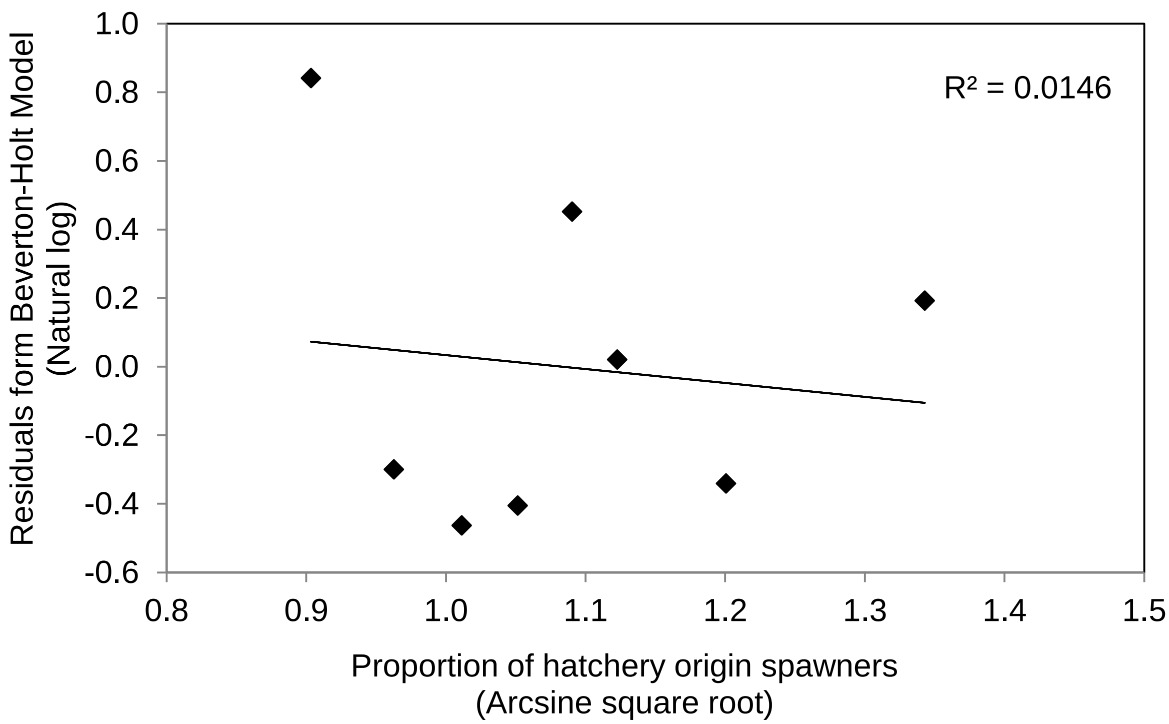


Figure 61. Correlation analysis of residuals from Beverton-Holt model and the proportion of hatchery fish on the spawning grounds.

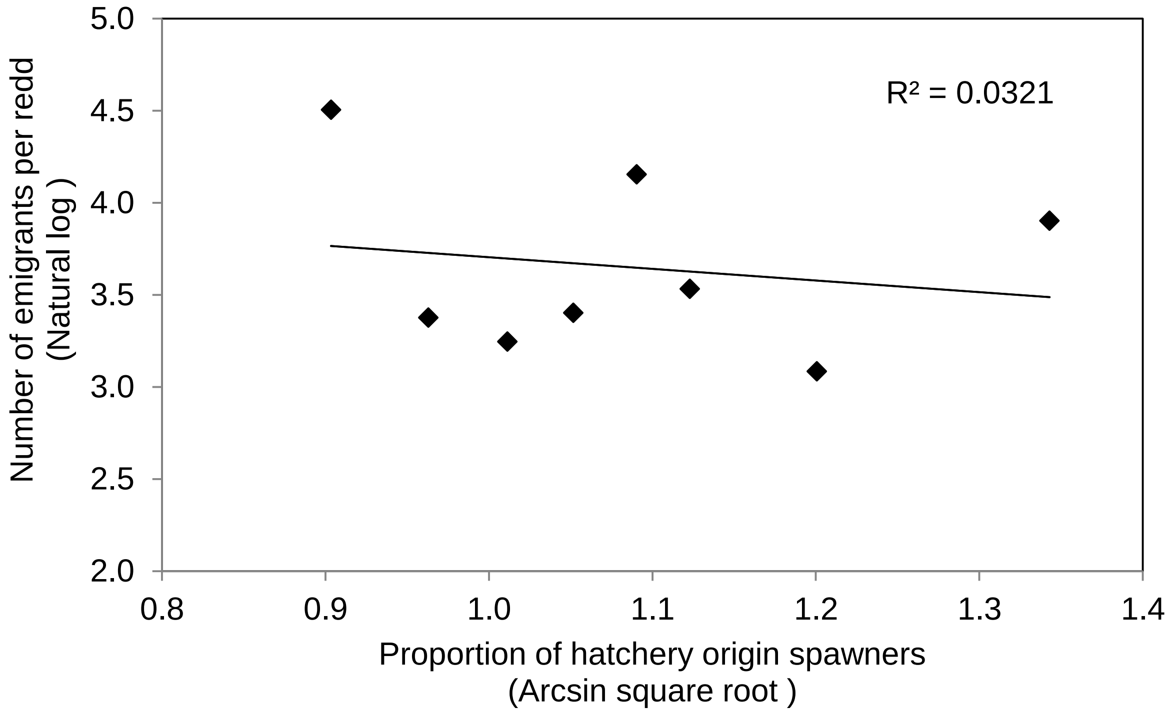


Figure 62. Regression analysis of emigrants per redd and the proportion of hatchery fish on the spawning grounds in the Methow River.

The results of the freshwater productivity analysis in the Methow River conflicts with the generally accepted concepts of density dependence and the influence of hatchery spawners on population productivity. Several hypotheses that may explain the observed results are discussed below.

1. Data used in the analysis are biased, confounding the results.

   Methodologies used to estimate the number of redds have not changed and any bias would be observed in all years and likely have a lesser influence on the results when data are analyzed across years versus comparisons with other populations. Studies are underway to evaluate bias in redd count estimates. While the methodology for estimating emigrants (rotary screw traps) has remained constant over the life of the current monitoring and evaluation contract, substantial variability in annual trapping activity and effort has introduced biases into the data. Statistical approaches currently under development may reduce some of the sources of these biases in both existing and future data, but other sources in existing data cannot be easily corrected. Winter emigration rates remain poorly understood, as does the magnitude of the annual fry migration and the ultimate fates of those fry (mortality, or survive to rear in the lower Methow, in the Columbia, etc.). The location of the Methow smolt trap does not allow the enumeration of those spring Chinook that rear in the lower 17 miles of the Methow. Increasing reliance on PIT tags in estimating emigration rates promises to improve those estimates, and other methodologies under consideration may be implemented during the next five-year evaluation period. At the present time, though, existing estimates of emigrant numbers should be considered conservative, as they exclude an un-quantified portion of the annual emigration. Thus, the reported SAR values for naturally produced fish are almost certainly too large.

2. Data set time series are too short (i.e., number of years) and lack contrast.

   More years of data would benefit the analysis, although we were able to successfully fit stock-recruitment models to existing data. Contrast in the data is lacking. The mean number of redds was 590 with a coefficient of variation (CV) of 47%. The mean proportion of hatchery spawners was 77% with a CV of only 14%. Because the vast majority of spawners are of hatchery-origin, a drastic reduction (> 50%) in hatchery fish would add contrast to the data for both the number of redds and proportion of hatchery fish in the spawning grounds.

3. Smolt monitoring was initiated too late in the history of spring Chinook releases to the Methow River to detect changes in productivity as a result of hatchery operations in the Methow Basin.

   Winthrop NFH has been releasing spring Chinook into the Methow Basin since the 1940's and most recently since 1974. The program shifted its goal from harvest augmentation to supplementation in the 1990's. The number of Winthrop NFH spring Chinook on the spawning grounds prior to 2000 is unknown due to the lack of or low rate of coded wire tagging (100% marking since 1994 brood year) and carcass recoveries. Analysis of limited carcass recovery data from 1992 – 1995 suggest that on average 41% of the spawning population comprised hatchery fish from Winthrop NFH. Since 2000, spring Chinook from Winthrop NFH have comprised on average 33% of the spawning population. Similarly, fish from Methow FH releases have comprised 30% of the spawning population with an additional 20% comprising stray fish from the Chewuch and Twisp programs. Given the long history of spring Chinook artificial propagation in the Methow Basin, including the use of out of basin stocks and the high abundance of hatchery fish on the spawning grounds, it is likely that the productivity of the hatchery fish spawning naturally suffered some negative effects from introgression and domestication prior to the initiation of the current smolt monitoring program in 2004. Interestingly, preliminary estimates of smolt-to-adult returns for those few complete brood returns suggest naturally produced smolts from the Methow Basin survive as well or better than naturally produced Wenatchee Basin smolts (WDFW, unpublished data). If naturally produced Methow spring Chinook SARs are shown to be unbiased, a secondary hypothesis to consider is whether the reproductive success of hatchery-origin fish is negligible and all natural production is from the few naturally produced fish that survive to spawn.

Objective 8: Harvest

Direct harvest of Methow spring Chinook salmon has not occurred since fish were listed as endangered in 1999, except for Columbia River tribal fisheries. Furthermore, juvenile fish have not been adipose fin clipped since the 1999 brood. Hence, harvest rates in the last 10 years have been minimal and limited to indirect post-release mortality associated with Columbia River commercial and sport fisheries or tribal non-selective fisheries.

Summary

Survival of juvenile Methow spring Chinook have consistently met or exceeded the expected standard within the hatchery and met the standard to the adult stage (SAR). Juvenile hatchery fish have been released at the target weight, but lower than the target length. The target number of fish released has been met in most years, but broodstock has been predominately hatchery fish (mean = 84%). Adult hatchery Methow spring Chinook have similar migration and spawn timing as naturally produced fish, but mean spawning location was different in most years examined. However, given the complete spatial overlap of hatchery and naturally produced fish on the spawning grounds and the drastic over escapement of hatchery fish on the spawning grounds (K_{sp} = 490 spawners) any differences in mean spawning distribution are irrelevant. Female Methow hatchery fish mature at similar ages as naturally produced fish, but male Methow hatchery fish mature at an earlier age than naturally produced males. Stray rates of Methow hatchery fish are all below target goals. Methow and Winthrop hatchery fish were genetically similar prior to the use of the Methow-Composite stock. The effective population size was not related to spawner abundance, and relative to the spawner abundance has decreased over time. This suggests that either variance in reproductive success has increased, or inbreeding (fewer successful breeders) has increased.

Methow FH has not increased the abundance of spawners or NORs in the Methow River relative to reference populations. Productivity in the Methow has not changed during supplementation compared to the pre-supplementation period. However, the results presented here are confounded by the presence of hatchery fish from Winthrop NFH previous to commencement of the Methow Hatchery program. Interestingly, the number of hatchery yearling spring Chinook released into the Methow River was significantly lower (t-test: $P < 0.0001$) during supplementation (mean = 563,805; SD = 253,470) than before the supplementation program was initiated (mean = 971,160, SD = 157,918). Therefore, the influence Methow Hatchery program could be difficult to detect analytically, but also the potential effectiveness of the program may have already been compromised by decades of past hatchery practices. PNI has averaged 0.18 during the supplementation period, well below the desired minimum of 0.67. The combination of WNFH and Methow Hatchery returns, combined with inadequate availability of natural-origin broodstock has resulted in this low PNI. Freshwater productivity in the Methow Basin is currently not significantly influenced by spawner abundance or the proportion of hatchery fish on the spawning grounds, but results may also be confounded by a long legacy of artificial propagation in the Basin or simply that smolt monitoring was initiated too late in the program to detect a change. While bias in the estimation of emigrants and redds may introduce error to this analysis these issues are currently being addressed for future data collection efforts, the extent to which past data collection may be affected is not known. A brief assessment of all objectives is provided in Table 38.

Table 38. Summary assessment of M&E objectives for the Methow spring Chinook hatchery program.

Obj.	Primary indicator	Assessment
1	Spawner abundance	Hatchery program has not increased spawner abundance in the Methow River relative to reference populations.
	Natural-origin abundance	Abundance of natural-origin fish has not increased and may have declined.
	Adult productivity	Adult productivity has not decreased.
2	Migration timing	Exhibit similar run timing at Wells Dam as naturally produced fish.
	Spawn timing	Exhibit similar spawn timing as naturally produced fish.
	Redd distribution	In some years, mean spawning location of hatchery fish was farther downstream than naturally produced fish. Mean spawning location of naturally produced fish has also shifted downstream.
3	Genetic diversity	Methow spring Chinook are more closely related to Chewuch stock than Twisp stock. Methow and Winthrop stocks are very closely related.
	Effective population size	Ratio of Ne/N is has declined over time and is not correlated to abundance (N).
	Age at maturity	For those years analyzed, female hatchery and naturally produced mean age at maturity was similar. Male hatchery fish have returned at an earlier age then male natural-origin fish for some brood years.
	Size at maturity	Male and female age-4 hatchery fish were similar in size to naturally produced fish.
4	Hatchery replacement rate	Post-release survival of hatchery fish met the HRR target. Hatchery survival was significantly greater than the natural replacement rate, but the natural replacement was very low.
5	Stray rates	Stray rates into the Chewuch and Twisp rivers were within acceptable levels as were stray rates outside of the Methow Basin.
6	Size and number of juveniles released	Target weight and number of fish released were met.
7	Freshwater productivity	Spawner abundance and the proportion of hatchery fish on the spawning grounds have little influence on productivity, but the analysis may be confounded due to historical hatchery impacts and biases in the data.
8	Harvest	Harvest rates of Methow fish have been negligible for both hatchery and naturally produced fish.

Methow Basin Spring Chinook Discussion and Recommendations

Currently, the Mid-Columbia PUD HCP Hatchery Committees and Grant PUD Hatchery Sub-Committee are conducting adjustment of the hatchery compensation programs. The anticipated result of this adjustment of the combined PUDs' hatchery compensation for the Methow Basin will be the production of approximately 225,000 yearling spring Chinook at the Methow Hatchery. This is a substantial decrease in production and will require adjustment of the management strategies for the Twisp, Chewuch and Methow populations. In addition to the production decrease, future management strategies for Methow Basin spring Chinook must holistically incorporate the genetic consequences of past management practices, current knowledge of homing and straying in the basin, pursuit of PNI goals, and the status of hatchery and natural replacement rates, as presented in this report.

The stray rates of Twisp and Chewuch fish greatly exceeded target thresholds. In the case of the Twisp, the stray rate resulted in approximately 25% of Twisp-origin fish migrating to other parts of the Methow Basin or to the Methow Hatchery. Approximately half of these strays did indeed home to Methow Hatchery suggesting imprinting to this facility at life-stages prior to spring smolting. However, the Twisp already experiences hatchery returns in excess of pHOS targets necessary to meet PNI goals. Therefore, measures to return a greater proportion of Twisp-origin fish to the Twisp River will not result in meaningful conservation gains, except to the extent that the Twisp program could be reduced in size commensurate with an increase in successful homing, and more wild spawners could be allowed to spawn naturally rather than being used for broodstock. Twisp strays to the Methow or Chewuch comprised small proportions of those recipient populations and do not represent a risk to those populations.

The Chewuch fish displayed similar stray patterns to the Twisp fish, but at a higher rate. However, since 1997 both the Methow and Chewuch programs used MetComp stock (Chewuch not entirely MetComp until 2007), and thus Chewuch strays were not necessarily a risk to the Methow population. In contrast, the Winthrop NFH released a large number of Carson-stock fish during the supplementation period, greatly reducing the relative risks to the Methow imposed by Chewuch strays. The HSRG reported, based on modeling results, that their preferred hatchery solution for the Methow Basin would return approximately the same number of natural-origin adults as a no-supplementation option. Indeed, the analyses in this report support the HSRG prediction: natural-origin returns did not increase during the supplementation period relative to reference populations.

In the case of the Chewuch, the hatchery program has apparently not provided a benefit in the form of increased natural-origin spawners or the development of local adaptation, and had a high stray rate. Therefore, our recommendation is to either modify or discontinue the Chewuch program. Possible modifications for consideration include the development of methods to collect local broodstock, sizing the program to release only progeny of Chewuch stock, and managing the proportion of hatchery spawners on the spawning grounds. Alternatively, a discontinuation of the Chewuch program (with production possibly shifted to the Methow) could allow the management of the Chewuch under a no-supplementation strategy that could provide important insight into the response of a population to the discontinuation of a hatchery program (e.g., Entiat spring Chinook). The Chewuch could serve as a reference population for the Twisp and Methow programs, and possibly other programs outside the basin. Recall that natural-origin returns have not increased under the supplementation program; thus a no-hatchery strategy in the Chewuch does not appear to entail increased risk to recovery goals, and may actually reduce risk and increase chances for recovery.

The Methow program experienced low stray rates, but adult returns from Winthrop NFH were still more abundant on the spawning grounds. The Methow program could benefit from the development of a local broodstock, although, such an effort is premature while the river is so heavily influenced by Winthrop NFH spawners. Should the WNFH program successfully address adult management, either through robust adult management practices, or changes to the program such as a reduction in size or releasing fish out of basin, the Methow spring Chinook program could adopt a local broodstock program.

Anticipated hatchery production levels as a result of adjustment of hatchery compensation in 2013/2014 will force changes in the management of spring Chinook. We recommend the implementation of the Twisp program with release size adjusted as necessary to meet PNI goals. Management in the remainder of the basin must balance the number of natural-origin fish available with the potential options for the Chewuch and Methow programs. Perhaps the most realistic option would implement only one of these two programs. Both the Chewuch and Methow programs face significant issues that likely compromise the effectiveness of each program. The Chewuch offers an opportunity to establish a reference stream, or possibly a locally adapted program, while the value of substantially modifying the Methow program remains questionable without first addressing the management of adult returns from the Winthrop NFH program. Nevertheless, the Methow program also offers the opportunity to establish a locally-adapted type of program with minimal risk and low rates of straying. The added benefit of choosing the Methow rather than the Chewuch to establish a locally adapted program is that it also includes the opportunity to manage the Chewuch with a no hatchery strategy and establish it as a reference population (e.g., Entiat spring Chinook).

Recommendations

1. Assess the potential to use a PIT-tag based assessment for 1) estimating survival to key life stages, 2) population estimates of key life stages, 3) developing estimates of carrying capacity, and 4) understanding life-history traits such as juvenile movement and rearing, homing and straying. This approach should allow assessment of both the hatchery and natural populations to detect limiting life stages. It is unclear to what extent such an approach could supersede current methodologies, such as rotary screw trapping. To the extent a PIT-tag approach would improve the ability to address the four questions above, develop field and analytical methods to employ this PIT-tag approach.

2. Improve broodstock collection for the Twisp program to optimize available fish for broodstock. Maximize operation of the Twisp Weir when fish are present and trapping conditions permit operation of the trap. During high water periods, when working the mid-channel trap compromises crew safety, explore the use of the near-shore trap or the concrete left-bank trap. Modify fish-retention rules to optimize trapping opportunities while still allowing the desired spawning escapement.

3. Investigate the potential for incubation in natal streams or using natal stream water to improve homing.

4. The stray rates of Twisp and Chewuch fish exceed the target thresholds. Several possible approaches may ameliorate this issue, including extending the period of acclimation (improbable due to logistical constraints) or exposing the fish to target water (e.g., Twisp or Chewuch) at earlier life-stages. Both approaches attempt to allow fish to imprint on Twisp or Chewuch water at key life-history stages. It is currently unclear at which life-stage(s) imprinting would most effectively increase homing to the Twisp or Chewuch. We recommend an experimental approach to improve homing that may also yield widespread practical improvement for other programs.

5. Implement new hatchery NNI production levels, the anticipated basin release from Methow Hatchery will be approximately 225,000 smolts.

6. Chewuch and Methow broodstock must incorporate an increasingly greater proportion of natural-origin fish to achieve PNI goals. A “stepping stone” broodstock focused on maximizing the mating of natural-origin parents for use in both broodstock and on the spawning grounds could be implemented. These progeny should be tagged, but not marked. The remainder of the production would consist of hatchery x hatchery matings and should be tagged and adipose-fin clipped. This marking scheme would allow the retention of these fish in selective fisheries, removal at dams, weirs, and hatcheries, while maximizing the number of hatchery fish with natural-origin parents on the spawning grounds. The actual production goal would be dependent on the future of both the Chewuch and Winthrop NFH programs.

7. Historically, the Chewuch broodstock suffered from a lack of natural-origin fish; without infrastructure improvements the proportion of natural origin broodstock will not increase and management of the proportion of hatchery fish on the spawning grounds will not be possible. Continuation of the current program (i.e., Met-Comp) would likely result in a further reduction in genetic diversity and, subsequently, productivity of the Chewuch stock without a demographic benefit from the hatchery program. If PNI goals cannot be achieved in the Chewuch, the current hatchery production should be discontinued or moved to a location that

would eliminate any potential negative impacts to the Chewuch spring Chinook population.

8. The goal of the Methow FH is supplementation, while Winthrop NFH will produce a safety-net program, and was originally built for mitigation and harvest augmentation. The current abundance level of naturally produced fish is too low to adequately support the combined smolt release goal of these two programs, and this fact has resulted in an average PNI of 0.13 through the most recent brood year covered by this report. We recommend the implementation of changes to both programs with the specific purpose of increasing the productivity of wild fish and the hatchery fish that are allowed to spawn naturally. We recommend evaluating the efficacy of methods for removing surplus hatchery fish. These may include use of the volunteer channels at Winthrop and Methow hatcheries, and/or other means of removal. Because returning adults from Winthrop NFH are currently not needed for conservation purposes, a minimum of 90% should be removed. In addition, a change in the marking scheme at Winthrop NFH (i.e., 100% adipose fin-clipped) would also contribute to reducing the overall number of fish returning to the Methow Basin.

9. Implement the adult management plan in the draft Methow Spring Chinook HGMP for both Winthrop NFH and Methow Hatchery fish.

10. Following HGMP approval by NOAA, update M & E Plan to ensure objectives and targets are consistent.

Methow Basin Steelhead

Goal – Support the recovery of Methow steelhead[6] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

Program – Collect sufficient broodstock from Wells Dam (hatchery and naturally produced) in order to release 320,000 yearling smolts in the Methow River Basin.

Reference Streams

Data on potential steelhead reference streams are currently not available. Although data collection in some unsupplemented populations that may serve as potential reference populations has begun in the last ten years, we were unable to locate data collected during the pre-supplementation period (1987 – 1997). Accordingly, spawner abundance, NOR abundance, and productivity (including freshwater productivity) were analyzed without using reference populations following methods outlined in Hillman et al. (2011). It is important to note that before-after (BA) comparisons conducted as part of the M&E Plan analyses do not represent periods with and without hatchery fish, but merely a change in the goal of the hatchery program and a shift in broodstock strategy incorporating a greater proportion of naturally produced fish collected from Wells Dam.

Although the goal of the hatchery program changed beginning with the 1998 brood, shifting from a harvest augmentation to a supplementation program, the Methow River has a long history of releases of hatchery steelhead that began in the early part of the 20th Century. Since 1960, hatchery steelhead from several broodstock sources from the upper Columbia River Basin have been released into the Methow River for harvest augmentation. Due to this legacy of hatchery steelhead in the Methow River it is highly unlikely that any data from contemporary reference populations would be appropriate. Furthermore, the before-after analyses presented here compare time periods when the hatchery program shifted intent, but did not change dramatically in fish culture practice or numbers of fish released.

Objective 1: Abundance, Recruitment, and Productivity

Estimating population abundance of adult steelhead upstream of Wells Dam was challenging because empirical population-specific data for the Methow and Okanogan Rivers were not available. Estimates of steelhead spawning abundance are unavailable because steelhead cannot be recovered as carcasses, are difficult to observe on the spawning grounds, and redd counts are frequently compromised by high water. Therefore, abundance of hatchery and naturally produced fish upstream of Wells Dam was estimated based on stock assessment and broodstock collection activities, then apportioned to each population based on radio telemetry results from 1999 and 2001 (English et al. 2001 and 2003). These modeled data do not account for any variation in

[6] While the HCP is not a recovery plan into itself, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.

the number of hatchery steelhead released in the Methow or Okanogan basins or the abundance of stray hatchery fish. However, because hatchery-production goals have not changed during the period examined, modeled data should be relatively accurate. Modeled run escapement data were then adjusted to account for annual harvest estimates of both hatchery and naturally produced fish and represent the closest approximation of the actual spawner abundance, but are likely biased due to unaccounted for pre-spawn mortality.

Steelhead abundance in the Methow River (hatchery + natural-origin) was significantly greater during the supplementation period (t-test: $P < 0.000$; Table 39). Trends in abundance for the pre-supplementation period were not significantly different than during supplementation (t-test: $P = 0.438$; Figure 63). Hatchery steelhead comprised the majority of the steelhead in the Methow River in both the pre-supplementation (mean = 81%) and during supplementation (mean = 87%; Figure 65) periods. The mean proportion of hatchery steelhead in the Methow River was not significantly greater during supplementation (t-test: $P = 0.10$), suggesting the significant increase in abundance may be due, in part, to factors influencing survival outside the basin (e.g., ocean conditions).

Mean NOR abundance also significantly increased during the supplementation period (t-test: $P = 0.012$; see Table 39), but trends in NOR abundance before and during supplementation were not different (t-test: $P = 0.508$; see Figure 63). However, without reference populations we cannot determine whether the change in NOR abundance, like spawner abundance, was caused by factors within or outside the basin.

Between 1988 and 2004, mean productivity in the Methow River averaged 0.26 recruits per adult (SD = 0.28) and the geometric mean was 0.18 recruits per adult. Neither mean productivity (t-test: P=0.532) nor the trend in productivity (t-test: $P = 0.253$) of the Methow steelhead population during supplementation have significantly changed compared to the pre-supplementation period (see Table 39 and Figure 63). Because we used run escapement estimates rather than estimates of spawners, productivity estimates are negatively biased. However, when applying an assumed pre-spawn mortality of up to 50%, modeled results only increase mean productivity to 0.52 recruits per spawner. The long-term stock-recruit relationship (1976-2004; Ogle, 2012; R Development Core Team 2012) is presented in Figure 64. Note that the population is below replacement for all levels of spawner abundance.

During the supplementation period, the proportion of hatchery fish on the spawning grounds averaged 87% (SD = 4%) and the proportion of naturally produced fish in the broodstock averaged 22% (SD = 19%) resulting in an average PNI of 0.15 (SD = 0.11). However, PNI has significantly increased during the supplementation period (mean = 0.24) when compared to the pre-supplementation period (mean = 0.06; t-test: $P < 0.001$, Figure 66), but is still below the desired minimum level of 0.67.

Table 39. Results of the unequal-variance t-tests on LN spawner abundance, LN adjusted NOR, and LN adjusted productivity data for Methow steelhead. Tests determined whether the mean values during the supplementation period were different than mean values during the pre-supplementation period.

Response Variable	Mean		Transformed data					
	Before	During	Before	During	Effect size	t-value	P-value	Result
Spawner abundance	1,407	5,111	7.110	8.433	1.323	-5.690	0.000	Increase
NOR	305	662	0.480	0.874	0.394	-2.874	0.012	Increase
Productivity	0.290	0.185	0.234	0.171	0.063	0.640	0.532	ND

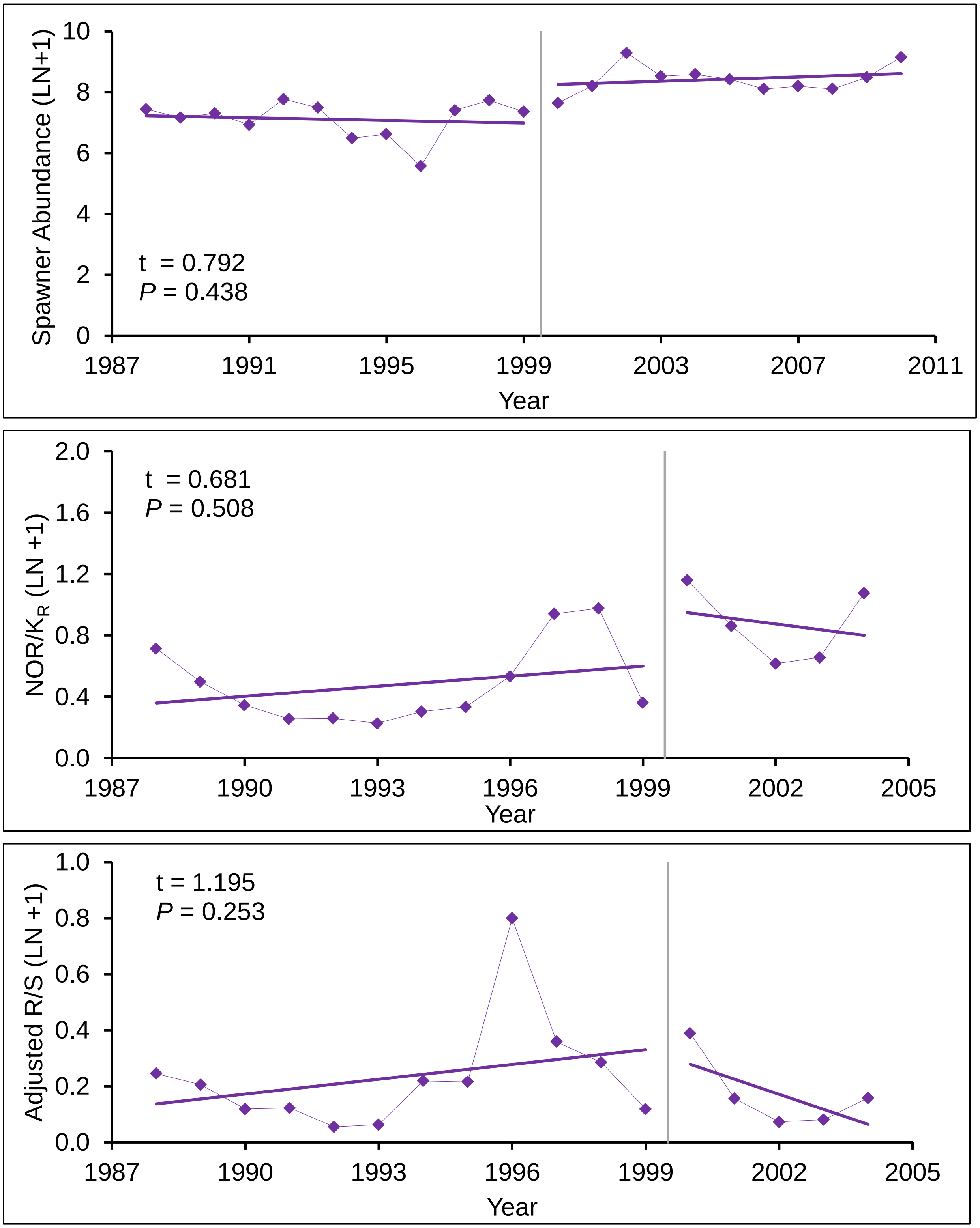


Figure 63. Trends in steelhead spawner abundance, NORs, and productivity in the Methow River. The vertical lines in the figures separate the pre-supplementation and during supplementation periods.

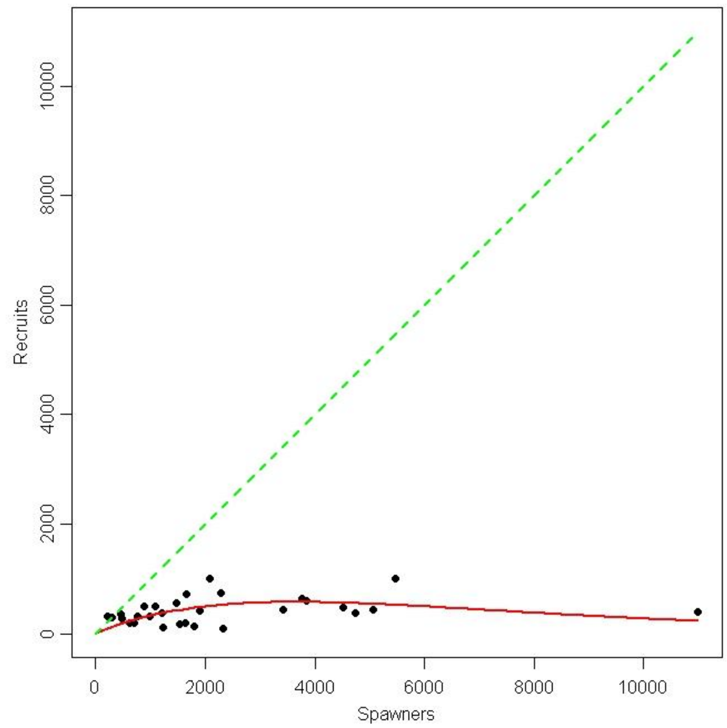


Figure 64. Steelhead stock-recruit relationship between hatchery and wild spawners, combined, and naturally produced adult returns in the Methow River, 1976-2004 (replacement line dashed green).

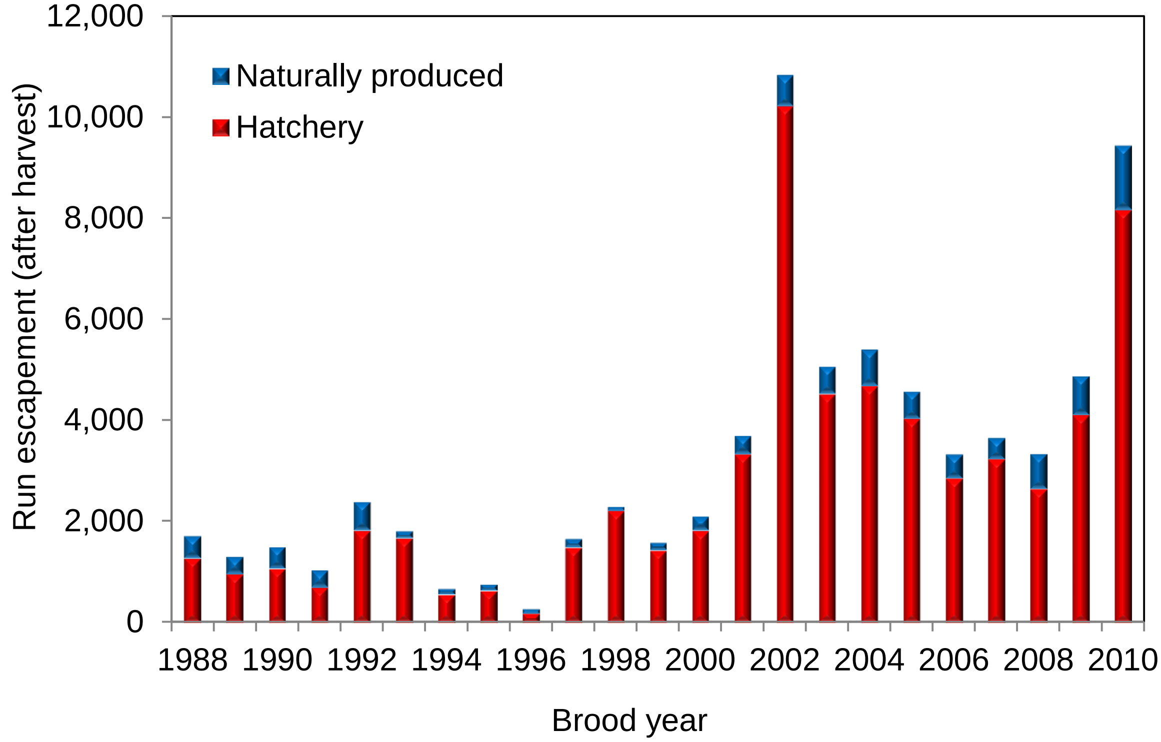


Figure 65. Abundance of hatchery and naturally produced steelhead in the Methow River.

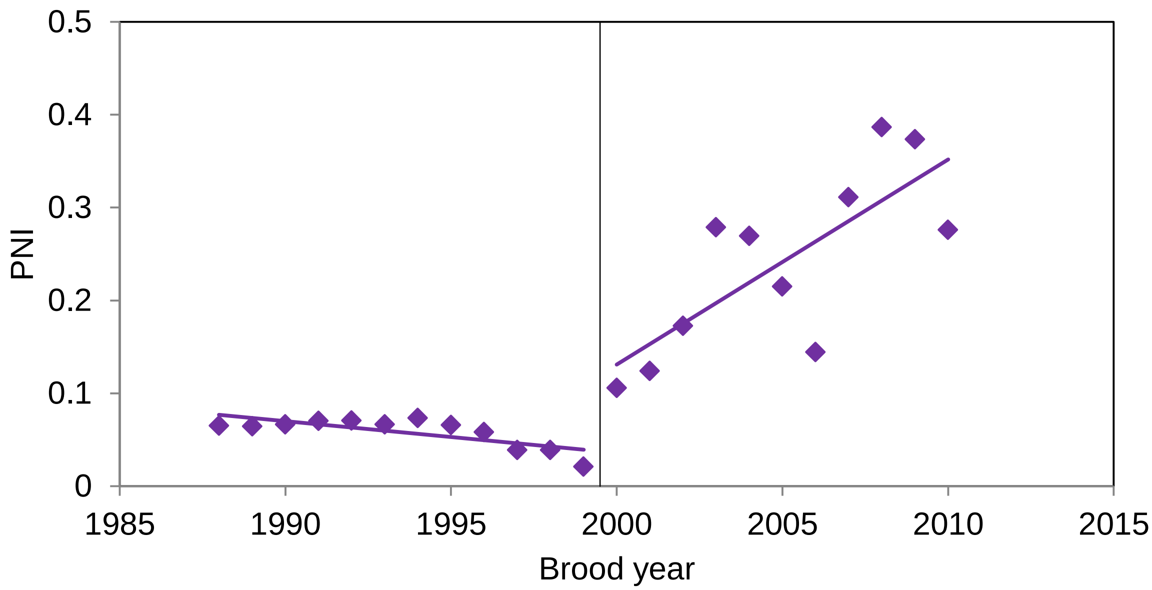


Figure 66. Trends in PNI of the Methow steelhead population. The vertical lines in the figures separate the pre-supplementation and during supplementation periods.

Objective 2: Migration and Spawning Characteristics

Migration Timing

Hatchery steelhead are all released as yearling smolts while the natural-origin smolt age is typically two or more years. This results in obvious differences in total age between hatchery and naturally produced steelhead with similar time spent in the marine environment; therefore, age was confined to the number of winters spent in salt water (freshwater age was excluded). Furthermore, because only a small proportion of naturally produced steelhead and almost no hatchery steelhead return after three or more winters in salt water, the analysis was further confined to 1-salt and 2-salt fish grouped by sex and origin. In all comparisons, migration timing differed across years ($P < 0.001$) and among origins ($P < 0.01$), except for 2-salt male steelhead ($P = 0.272$). However, we found no difference in migration timing in all comparisons of origins within a run year ($P > 0.09$, Figures 67 – 70.

Spawn Timing

Comparisons of spawn timing of hatchery and naturally produced steelhead in the natural environment are problematic due to their spawning behavior (i.e., iteroparous species may not die after spawning making carcass recovery ineffective) and environmental conditions during the spawning period (spawning occurs during seasonally increasing hydrograph). Furthermore, lack of external marks (adipose fin clip) on all hatchery fish may result in the misclassification of some hatchery fish as naturally produced fish. We conducted a limited evaluation (2009 - 2010) of spawn timing was conducted in the Twisp River upstream of the weir. We tagged all fish released upstream of the weir with a colored anchor tag based on origin, and females were also PIT tagged in the body cavity to encourage tag deposition during spawning for subsequent and detection of their PIT tags in redds. For those years examined, we did not detect a significant difference in spawn timing of hatchery and naturally produced fish in the Twisp River (ANOVA Year x origin: $P = 0.59$, Figure 71).

Redd distribution

The spatial distribution of steelhead redds in the Twisp River was assessed. Our analysis of steelhead spawning location was also confounded by the same factors confounding our analysis of spawn timing (i.e., lack of external marks on hatchery fish and of carcass recoveries). Thus, similarly, we relied on redd-location data collected upstream of the Twisp weir to evaluate differences in spawning location between hatchery and naturally produced fish. For those years examined (2009-2010), we detected no significant difference in spawning location of hatchery and naturally produced fish in the Twisp River (Kruskal-Wallis ANOVA: $H = 3.56$, $P = 0.31$, Figure 72-74).

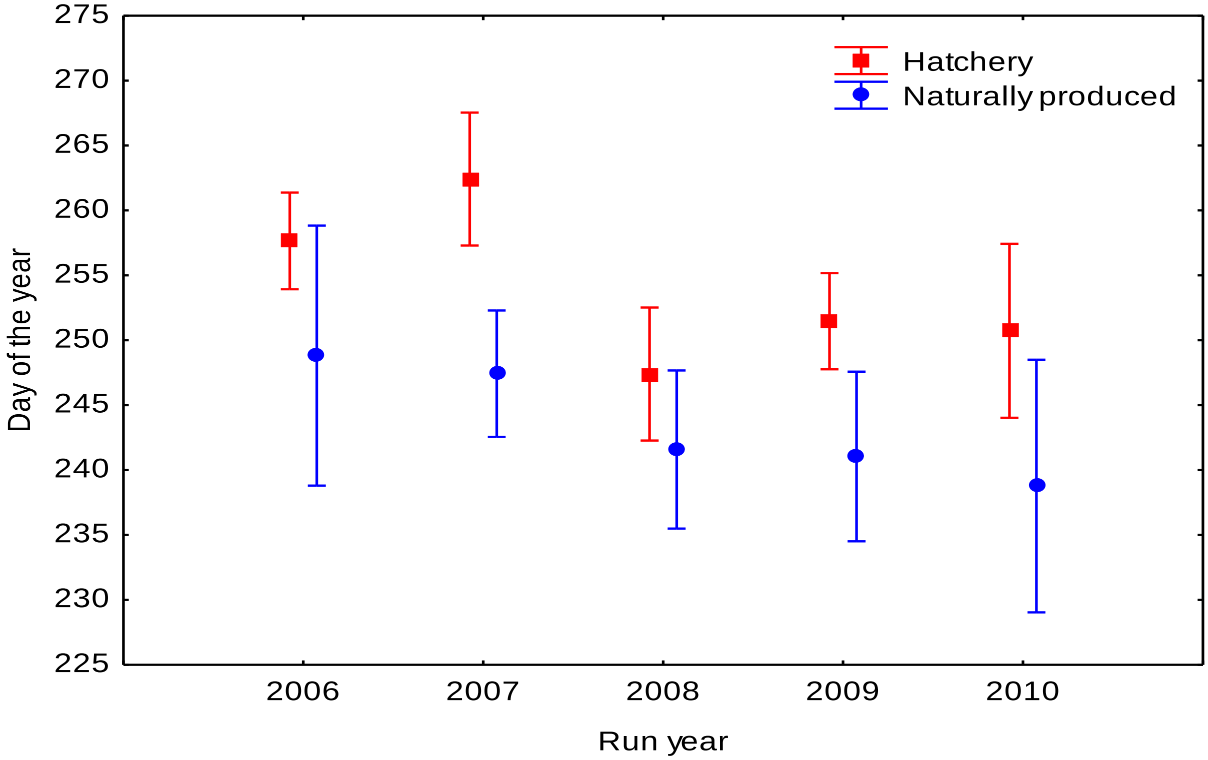


Figure 67. Mean run timing of 1-salt female Methow/Okanogan steelhead at Wells Dam.

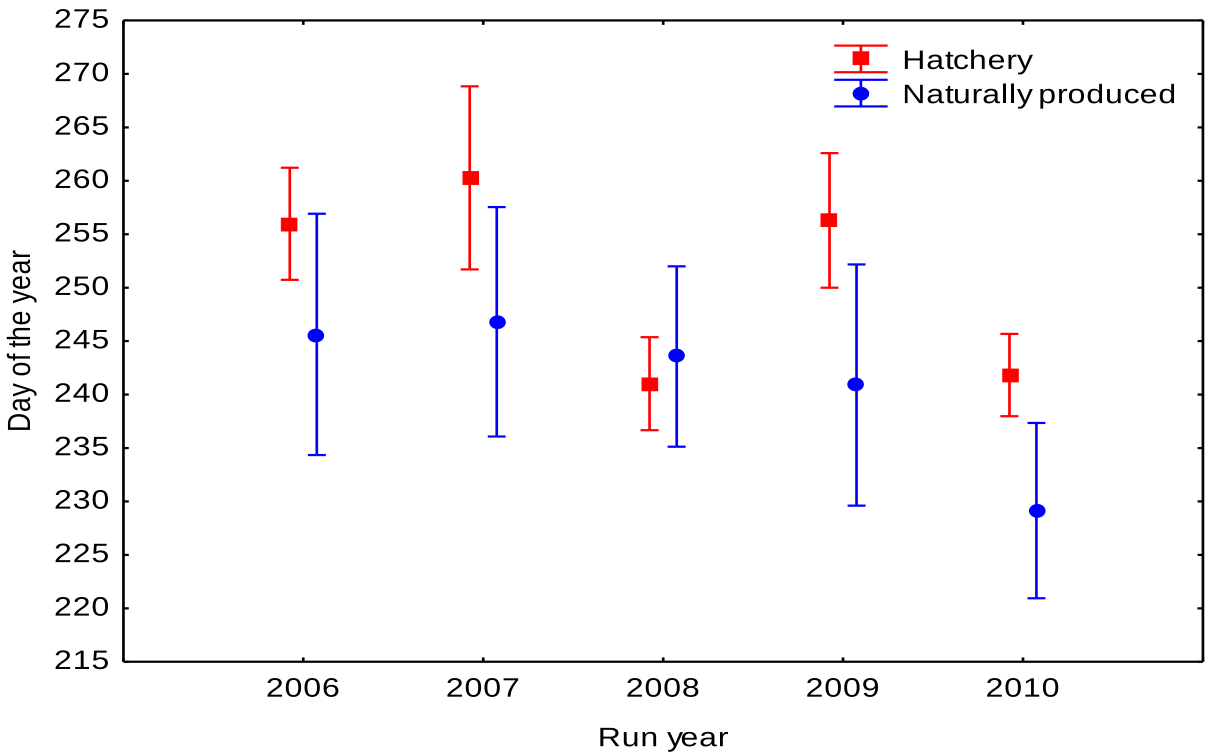


Figure 68. Mean run timing of 2-salt female Methow/Okanogan steelhead at Wells Dam.

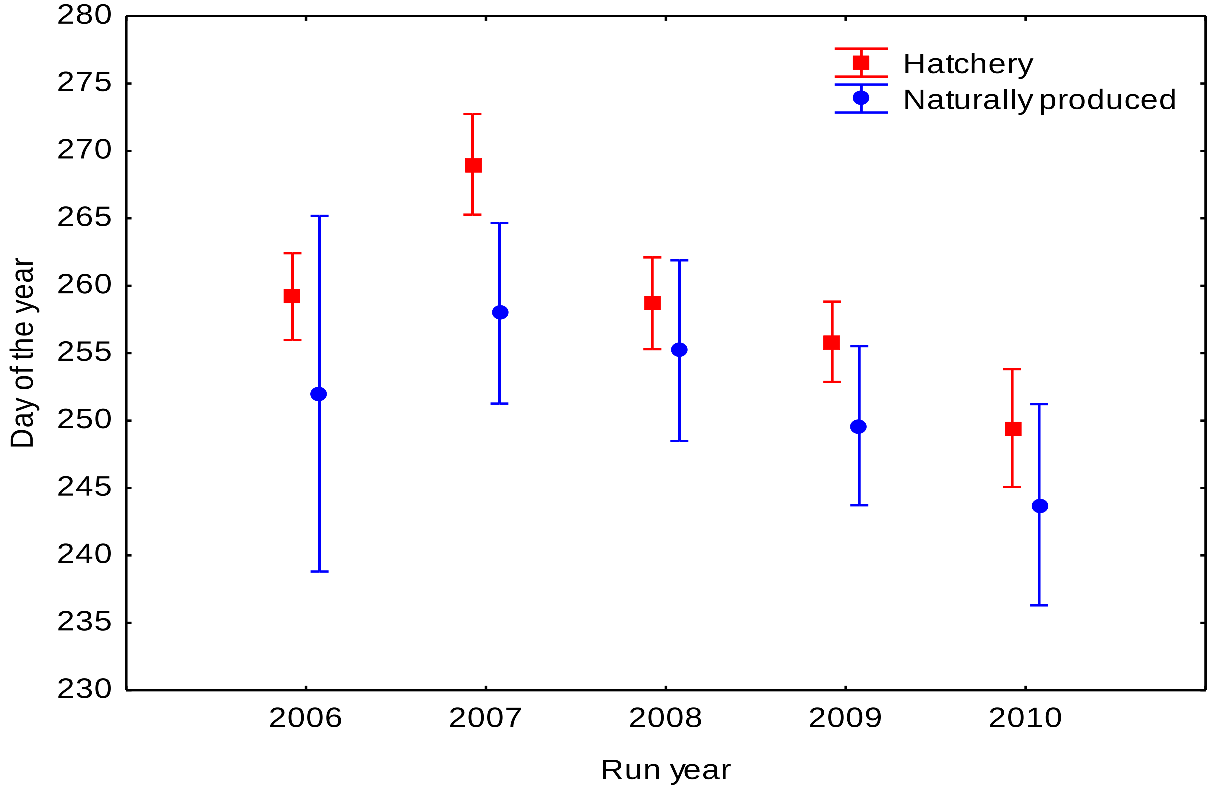


Figure 69. Mean run timing of 1-salt male Methow/Okanogan steelhead at Wells Dam.

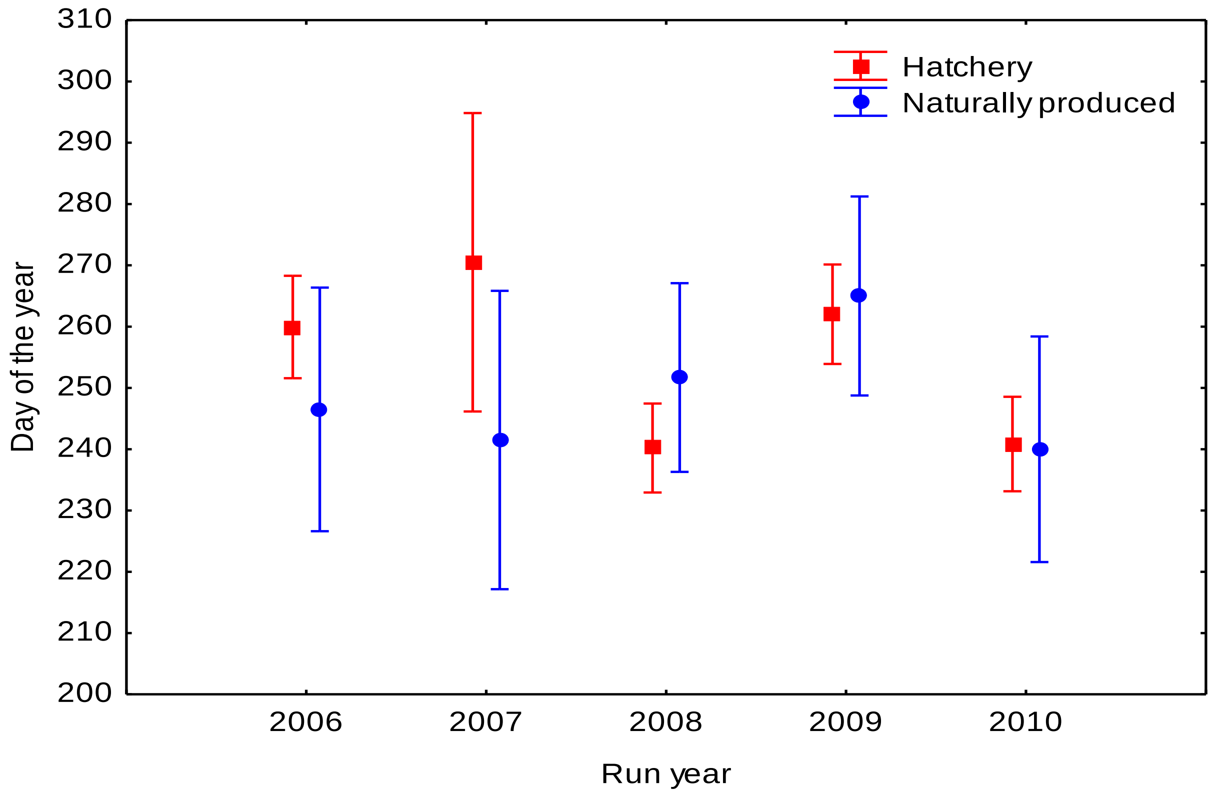


Figure 70. Mean run timing of 2-salt male Methow/Okanogan steelhead at Wells Dam.

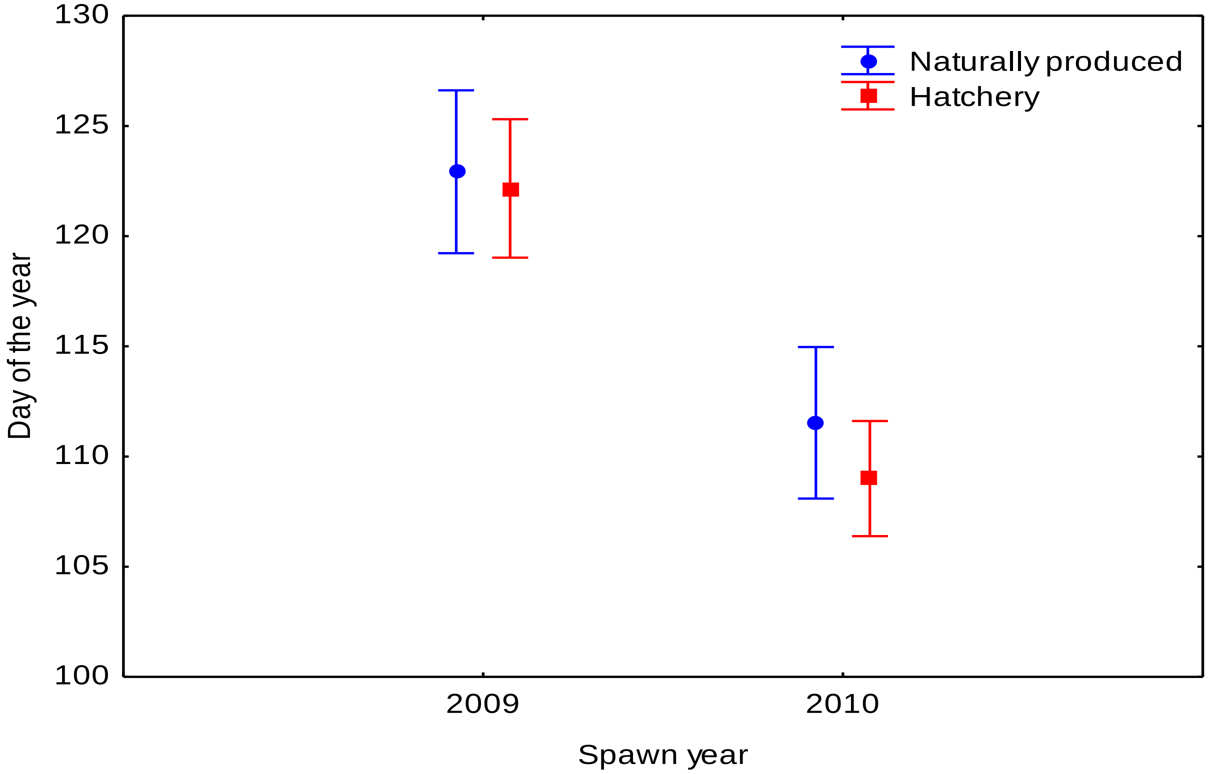


Figure 71. Mean steelhead spawn timing in the Twisp River, 2009 -2010.

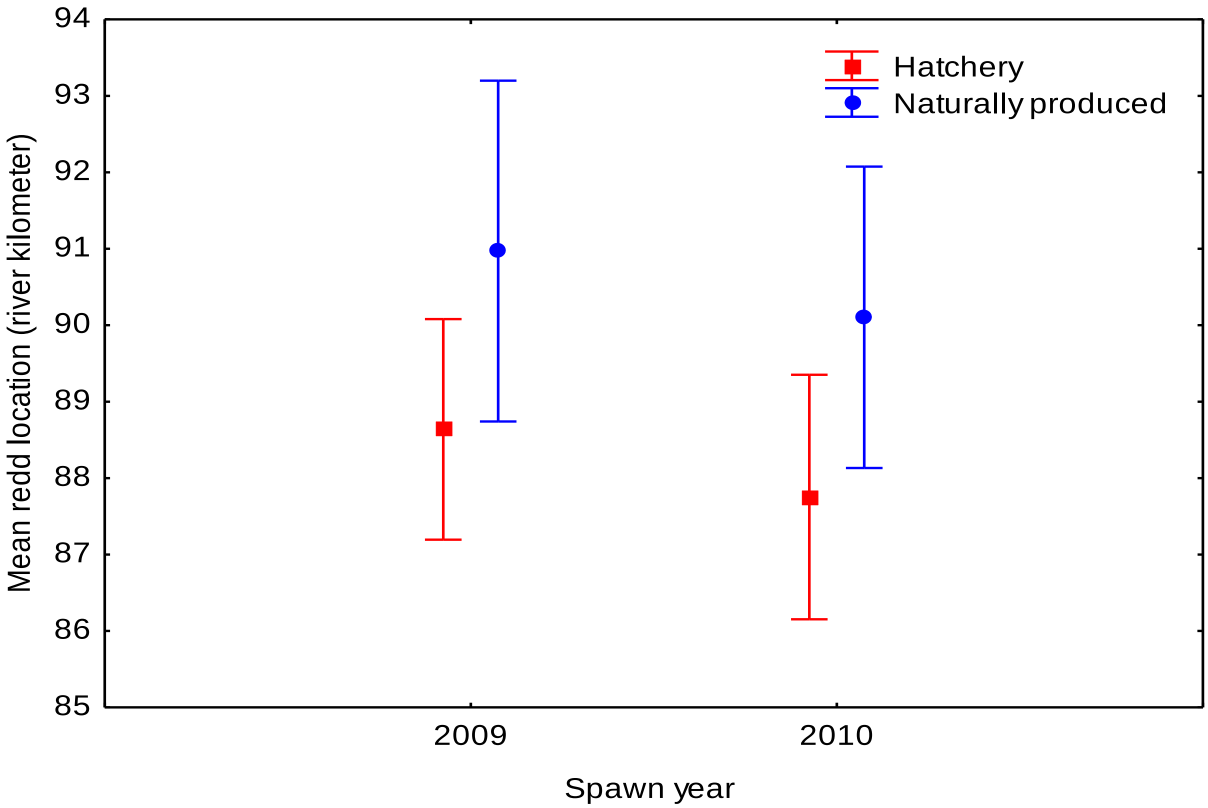


Figure 72. Mean steelhead spawning location in the Twisp River, 2009 -2010.

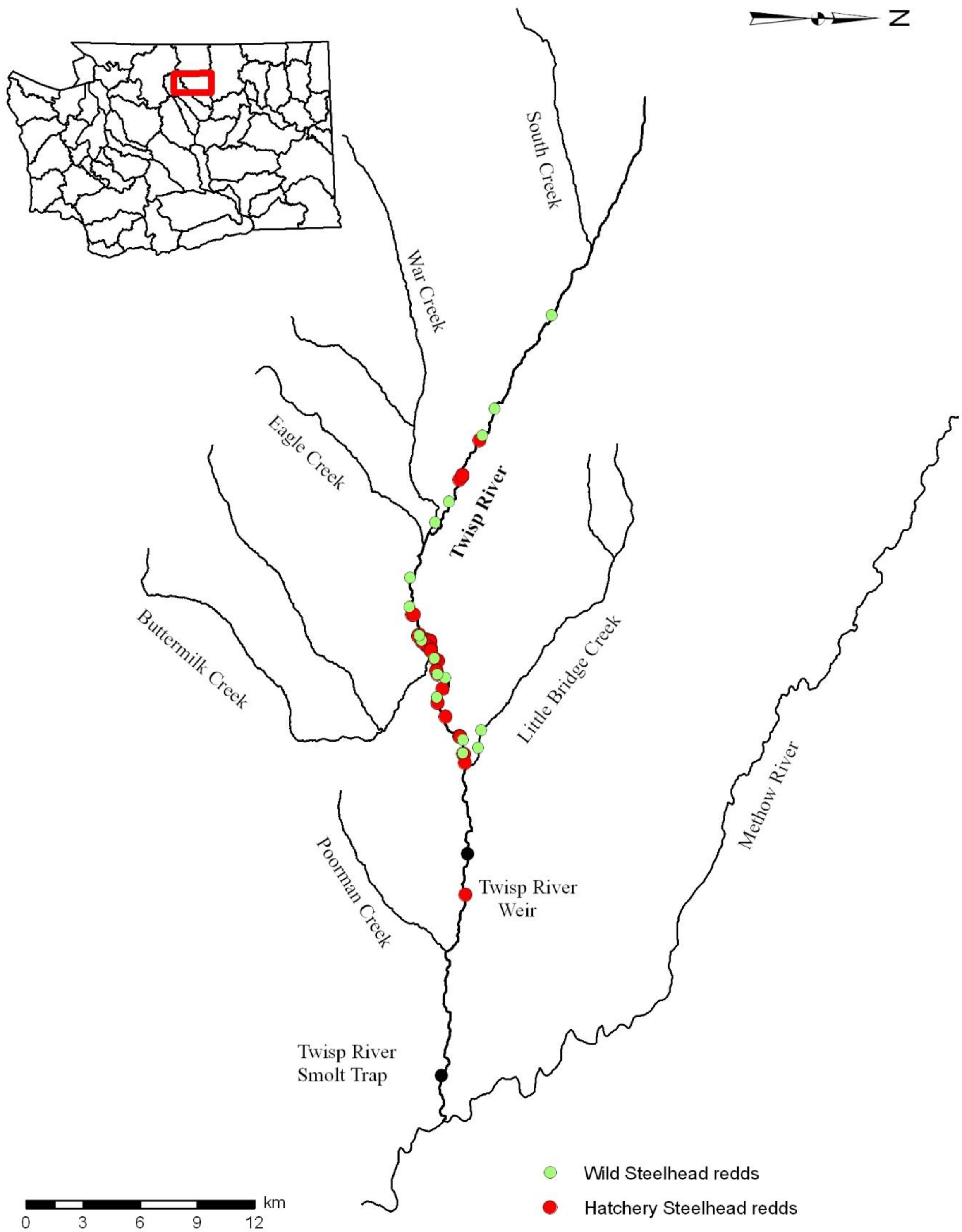


Figure 73. Steelhead redd location in the Twisp River in 2009.

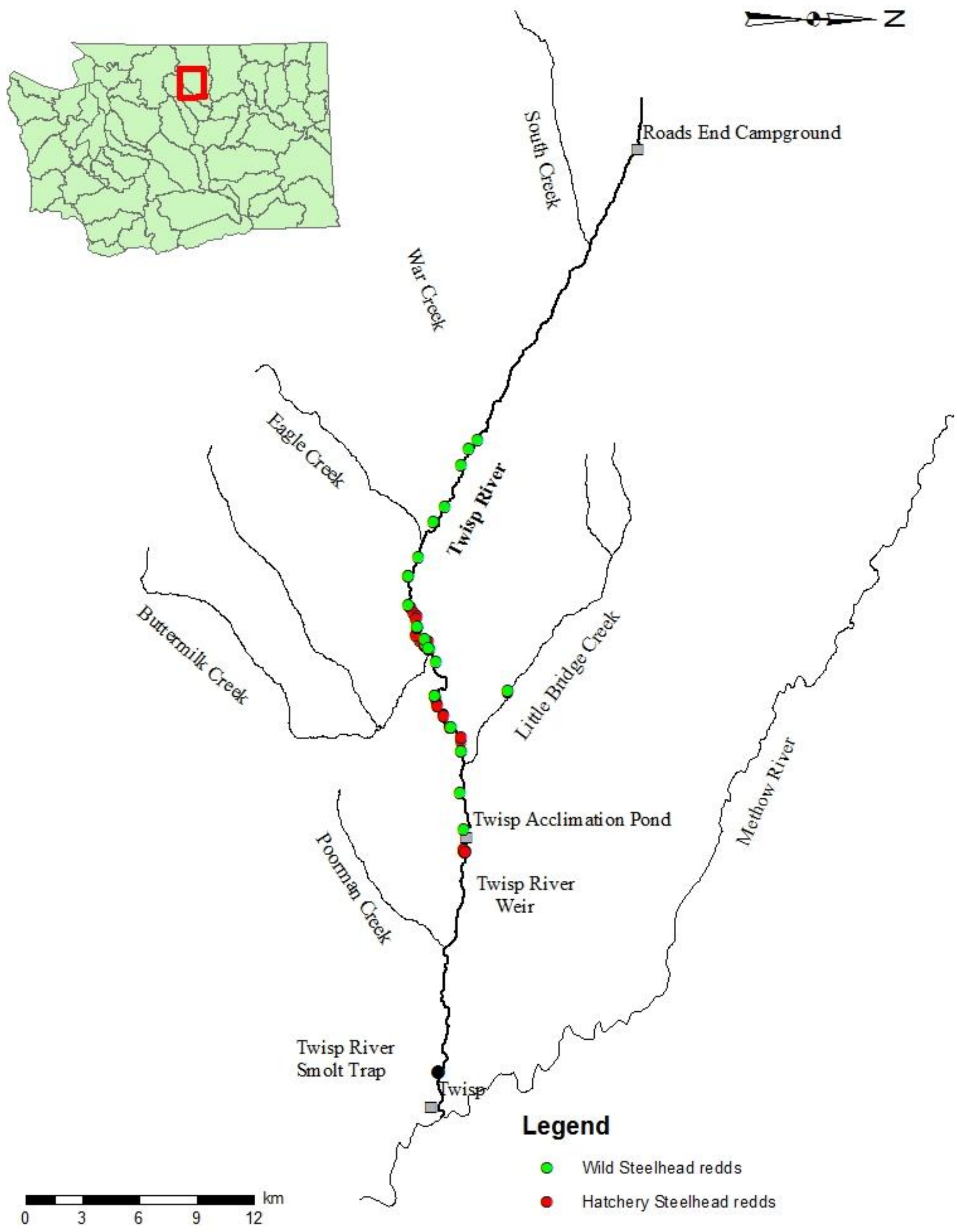


Figure 74. Steelhead redd location in the Twisp River in 2010.

Objective 3: Genetic and Phenotypic Characteristics

Genetic monitoring

Blankenship et al. (2006) conducted the genotyping and analysis of population genetic hypotheses and thus is the source for details regarding the methodology and analytical procedures (Appendix E). Results specific to the Methow steelhead were extracted from the Blankenship et al. (2006) report and presented below that specifically address the hypotheses as outlined in the Analytical Framework (Hays et al. 2007).

Natural-origin steelhead collected for broodstock at Wells Dam had statistically similar allele frequencies across years (collections from 1995 – 2007) and showed no evidence of population structure (i.e., F_{ST} = 0) indicating that natural-origin summer steelhead collections could be combined for any subsequent genetic analysis (Table 40). There was slight genetic differentiation observed between some natural-origin adult and H x H collections, but the differences were quite small (Table 41). In contrast, the two H x W collections had statistically different allele frequencies when compared to each other and the largest F_{ST} estimate observed for any comparison between adult collections was between the two H x W collections (F_{ST} = 0.0168). Additionally, all comparisons between the H x W collections and the natural adult collections showed both statistically different allele frequencies (12 of 12) and estimates of F_{ST} statistically different from zero. The H x W adults were genetically differentiated from other adult collections. We recommend further consultation about the any future potential use of H x W adults to determine potential sources of the observed genetic differences.

Table 40. Pairwise genetic differentiation between natural-origin adult collections. Statistical significance of genetic tests are shown below diagonal, with NS meaning non-significant at α = 0.05. F_{ST} estimates are shown above diagonal.

Year	2003	2005	2007	1995	1997	1999
2003	-	0.0003	-0.0001	-0.0023	0.0019	0.0006
2005	NS	-	-0.0002	-0.0001	0.0005	-0.0016
2007	NS	NS	-	-0.0029	0.0010	0.0004
1995	NS	NS	NS	-	0.0008	-0.0019
1997	NS	NS	NS	NS	-	0.0006
1999	NS	NS	NS	NS	NS	-

Table 41**.** Genetic differentiation between natural-origin adult and the known-origin hatchery collections. Please note that the pairwise tests regarding natural-origin adult collections (underlined codes) are not shown (see Table 40). Statistical significance of genetic tests are shown below diagonal, with NS meaning non-significant and * designating the p-value was below α = 0.05. F_{ST} estimates are shown above diagonal, with bolded values statistically different from panmixia (NP = naturally produced; HW = hatchery (H x NP parents); HH = hatchery (H x H parents).

Group	NP 2003	HH 2003	HW 2003	NP 2005	HH 2005	HW 2005	NP 2007	NP 1995	NP 1997	NP 1999
NP 2003	-	**0.0047**	**0.0141**	-	0.0015	**0.0102**	-	-	-	-
HH 2003	*	-	**0.0044**	**0.0047**	0.0015	**0.0142**	**0.0039**	0.0035	**0.0064**	**0.0042**
HW 2003	*	*	-	**0.0133**	**0.0083**	**0.0168**	**0.0099**	**0.0075**	**0.0110**	**0.0116**
NP 2005	-	NS	*	-	0.0010	**0.0060**	-	-	-	-
HH 2005	NS	NS	*	NS	-	**0.0096**	-0.0001	0.0002	0.0001	0.0023
HW 2005	*	*	*	*	*	-	**0.0069**	**0.0104**	**0.0095**	**0.0126**
NP 2007	-	NS	*	-	NS	*	-	-	-	-
NP 1995	-	NS	*	-	NS	*	-	-	-	-
NP 1997	-	*	*	-	NS	*	-	-	-	-
NP 1999	-	NS	*	-	NS	*	-	-	-	-

Due to the life history and behavior of steelhead, obtaining adult samples from known spawning populations is difficult without tributary weirs or some other population-specific capture method. Natural-origin adult samples were available from Wells Dam; however, those collections were thought to represent more than one upstream population, rendering them unsuitable for population analysis (although see previous section). Therefore, juvenile fish from the major populations upstream of Wells Dam (Methow, Twisp, and Okanogan Rivers) were collected using smolt traps, genotyped, and used to investigate population structure in the basin. Resident *O. mykiss* collected from the Methow, Twisp, and Chewuch Rivers were also analyzed and compared to adult steelhead collections. If genetic distances were stable among populations, then there should not be any trend observed over time regarding differences among collections. These data compare genetic differentiation between in-river juvenile collections (2007, 2008), and the degree to which in-river collections are differentiated from adult collections at Wells Dam (1995 – 2007).

The juveniles collected from the Methow River smolt trap were not substantially different from the natural-origin adult collections. The 2007 Methow smolts showed statistically different allele frequencies from the 1997, 2003, and 2007 natural-origin adult collections, with small but statistically significance F_{ST} estimates of 0.0031, 0.0025, and 0.0015, respectively (Table 42). Regarding the 2008 Methow juveniles, the only statistically significant F_{ST} estimate was the comparison between the 1997 natural-origin adult collection (F_{ST} = 0.0016). The Twisp and Okanogan smolt collections were differentiated from the natural-origin adult steelhead to a greater degree than the Methow juveniles. Note that the Methow juvenile samples include Twisp juveniles to some degree; therefore, the Twisp and Methow comparisons to the adults are not entirely independent. The 2007 Okanogan collection was the most divergent collection in the study (mean F_{ST} = 0.0197).

The juvenile resident collections were genetically differentiated from the natural-origin adults to a similar degree as that observed for smolt collections; however, 2007 resident collections were more divergent from natural-origin adults than the 2008 collections. The 2007 Methow resident collection had statistically different allele frequencies from all natural-origin adult collections except 1995. Statistically significant F_{ST} values were estimated for comparisons between the 2007 Methow resident collection and all the natural-origin adult collections except 1999. In contrast, the 2008 Methow resident collection was only statistically different from the 2003 adult collection. F_{ST} estimates were statistically significant for comparisons between the 2008 Methow resident and the 1997, 2003, 2005, and 2007 adult collections. Regarding the Twisp resident collections, allele frequency distribution comparisons were statistically different between the 2007 Twisp resident and all natural-origin adult collections. In contrast, the 2008 Twisp resident collection allele frequencies differed only from the 2003 adult collection. All F_{ST} values estimated for comparisons between Twisp resident and natural-origin adult collections were statistically significant. Regarding residents collected from the Chewuch River, the 2007 and 2008 collections had statistically different allele frequencies from each other. The 2007 Chewuch collection had statistically different allele frequencies from all adult collections except the 1995 naturally produced (NP 2005) collection. The allele frequency distributions of the 2008 resident collection differed from the 1997 (NP1997) and 2003 (NP 2003) natural adult collections. All F_{ST} values calculated for comparisons between Chewuch resident and natural adult collections were statistically significant (12 of 12).

We used factorial correspondent analysis (FC) on allele-frequency data to investigate if the genetic affinity changed over time among temporally replicated collections of natural-origin adult summer steelhead and juveniles (smolts and residents). In general, the FC results corroborate the genetic diversity analysis described above. Natural-origin adult collections were undifferentiated from each other, except for the 1995 adult collection, although the 1995 adult collection was not statistically different from the 2008 Methow and Chewuch resident collections. We did observe slight differences in genetic characteristics between H x W, natural-origin smolt, and resident *O. mykiss* collections. Despite the observed relative genetic differences among collections, there was no trend in the genetic variance observed over time. All collections are clearly representative of an upper Columbia River summer *O. mykiss*. It is unknown whether the magnitude of genetic differences observed in this study is representative of historic levels of differentiation for Methow River (or upper Columbia River) steelhead. Elucidating whether the observed genetic differences are derived from sampling effects (confounded by relatedness) or subtle, but real population structure would require spatially/temporally explicit sampling data and data from additional years.

Table 42. Genetic differentiation between natural-origin adult and the juvenile steelhead collections. Please note that the pairwise tests regarding natural-origin adults collections (underlined codes) are not shown (see Table 40). Statistical significance of genetic tests are shown below diagonal, with NS meaning non-significant and * designating a p-value below α = 0.05. F_{ST} estimates are shown above diagonal, with bolded values being statistically different from panmixia (NP = naturally produced; A = adult; J = juvenile; W = Wells Dam; MT = Methow smolt trap; TT = Twisp smolt trap; OT = Okanogan smolt trap).

Group	Life stage (location)	NP 2003 A(W)	NP 2005 A(W)	NP 2007 J(MT)	NP 2007 J(TT)	NP 2007 J(OT)	NP 2007 A(W)	NP 2008 J(MT)	NP 2008 J(TT)	NP 2008 J(OT)	NP 1995 A(W)	NP 1997 A(W)	NP 1999 A(W)
NP2003	A (W)	–	-	**0.0025**	**0.0052**	**0.0182**	-	0.0007	**0.0071**	**0.0059**	-	-	-
NP2005	A (W)	-	–	0.0003	**0.0055**	**0.0200**	-	0.0011	**0.0042**	**0.0061**	-	-	-
NP2007	J (MT)	NS	NS	–	**0.0027**	**0.0171**	**0.0015**	0.0008	**0.0043**	**0.0059**	0.0016	**0.0031**	0.0018
NP2007	J (TT)	*	*	NS	–	**0.0196**	**0.0044**	**0.0032**	**0.0047**	**0.0069**	0.0044	**0.0054**	**0.0062**
NP2007	J (OT)	*	*	*	*	–	**0.0180**	**0.0156**	**0.0196**	**0.0186**	**0.0232**	**0.0171**	**0.0221**
NP2007	A (W)	-	-	NS	*	*	–	-0.0001	**0.0042**	**0.0059**	-	-	-
NP2008	J (MT)	NS	NS	NS	*	*	NS	–	**0.0029**	**0.0035**	-0.0005	**0.0016**	0.0001
NP2008	J (TT)	*	*	*	*	*	*	*	–	**0.0082**	**0.0050**	**0.0043**	**0.0066**
NP2008	J (OT)	*	*	*	*	*	*	*	*	–	**0.0064**	**0.0041**	**0.0042**
NP1995	A (W)	-	-	NS	NS	*	-	NS	*	*	–		
NP1997	A (W)	-	-	NS	*	*	-	NS	*	*	-	–	
NP1999	A (W)	-	-	NS	NS	*	-	NS	*	*	-	-	–

We used the multi-sample temporal method (Waples 1990) to estimate the effective population size (N_e) for natural-origin summer steelhead adults. Age data allowed us to partition the collections (i.e., calendar year) into cohorts. Only brood-year collections with at least N = 20 samples were included in the analysis and age-at-maturity information used for parameter estimation was 5%, 43%, 47%, 4.6%, and 0.4% for Ages 3 – 7, respectively (WDFW unpublished). Over the time period analyzed (cohorts 1992 – 2004), we calculated the effective number of breeders (N_b) as $\tilde{N}_b = 371.0$. To estimate of N_e, one must multiply N_b by the mean generation length. Given the age-at-maturity data described above, natural adult steelhead have a mean generation length of 4.5 years. Therefore, N_e = 1,670 (i.e., 4.5 x 371.0) for these particular collections. Please note that the N_e estimate reported was likely an overestimate, because we assumed residents did not contribute to reproductive effort in the anadromous population. Yet, resident and adult steelhead collections were not particularly different, so gene flow between the two life-history forms was likely. Resident *O. mykiss* mature at 2 – 4 years of age, and adults are believed to suffer heavy mortality after first spawning (Behnke 1992). Therefore, if residents contribute to reproduction and are not accounted for, the age composition of the steelhead population may be inaccurate. Waples (1990) did state his model was robust to imperfect knowledge of age composition; however, mean generation length remains an important parameter because it modulates the estimation of N_e (i.e., multiplier to N_b).

Age at maturity

We could not differentiate between Methow or Okanogan hatchery and natural-origin steelhead trapped at Wells Dam for stock assessment and broodstock collection because the fi are derived from a common broodstock source. Furthermore, low abundance of naturally produced fish limited the number of years included in the analysis. Hatchery steelhead are released as yearling smolts and have a younger freshwater age than naturally produced smolts (Snow et al. 2011). Although differences in freshwater age exist, potential differences in the number of winters in salt water (salt-age) have both survival and productivity implications. Therefore, we analyzed only salt age, and did not consider freshwater age. We found significant differences in salt age at maturity of females were found among years and origins (Kruskal-Wallis ANOVA: P < 0.001). However, mean salt-age among origins within brood years was not significantly different except for the 2009 brood year when hatchery females had a greater salt age than natural-origin females (Figure 75, Multiple comparison test: P < 0.05). Male mean salt age was also significantly different across years and origins (Kruskal-Wallis ANOVA: P < 0.001), but no difference was detected among origins within years (Figure 76, Multiple comparison test: P = 1.0).

Size at maturity

Low adult returns limited our evaluation of size at maturity (mean fork-length) to brood years 2004 through 2010. Differences in size within the female 1-salt and 2-salt fish were detected among brood years and origins (ANOVA: P < 0.001), but no differences were found among origins within years (ANOVA: P = 0.51, Figure 77). Differences in size of hatchery- and natural-origin 1-salt male steelhead were detected in 2004 and 2006 (ANOVA: $P < 0.001$), but no differences between 2-salt male steelhead were found among origins within brood years (ANOVA: $P = 0.13$, Figure 78).

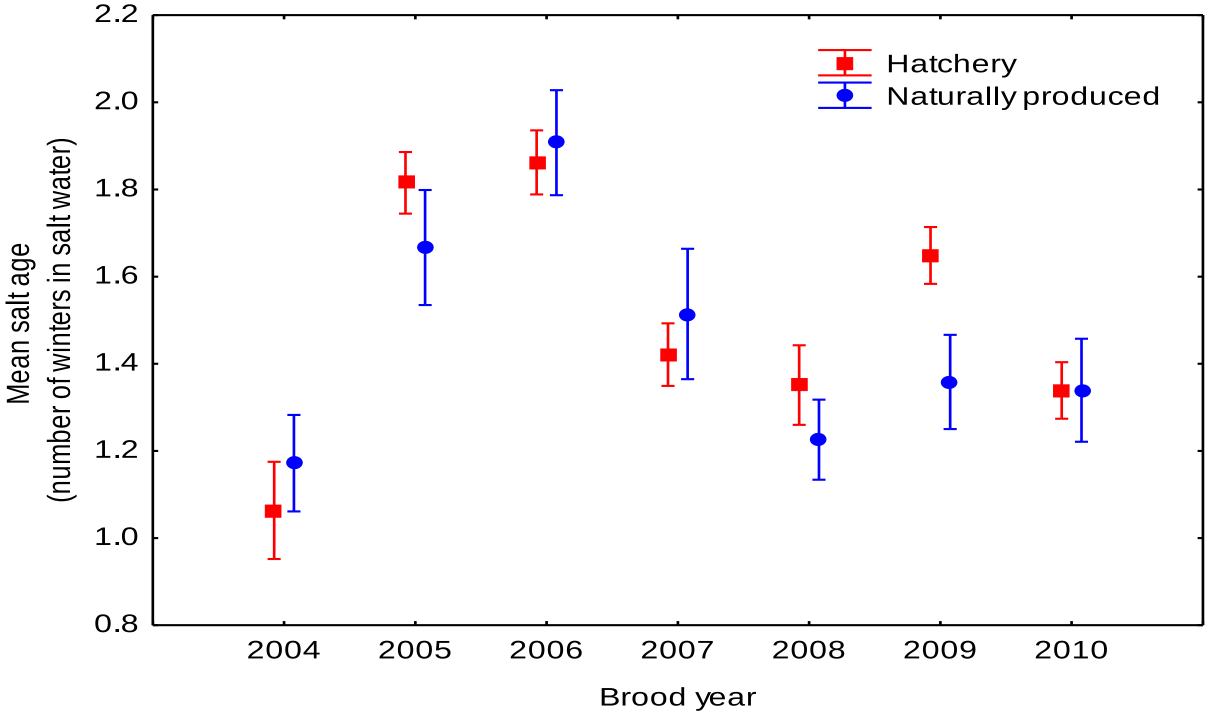


Figure 75. Mean female saltwater age at maturity of Methow/Okanogan River steelhead.

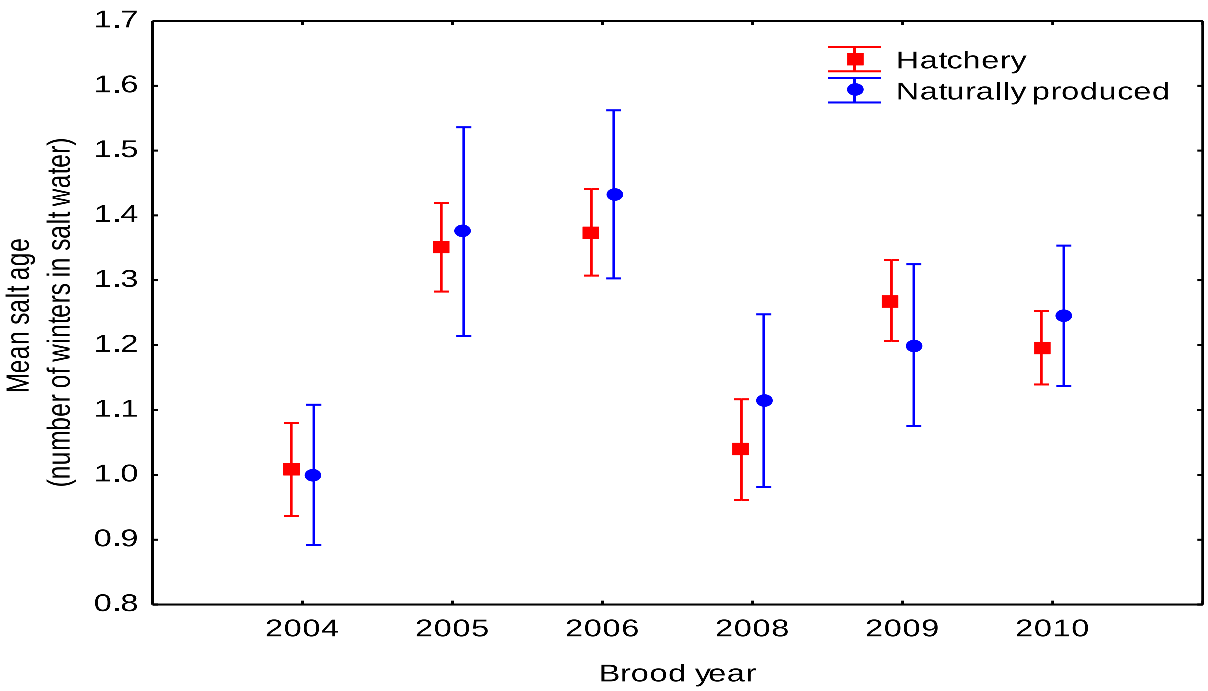


Figure 76. Mean male age at maturity of Methow/Okanogan River steelhead.

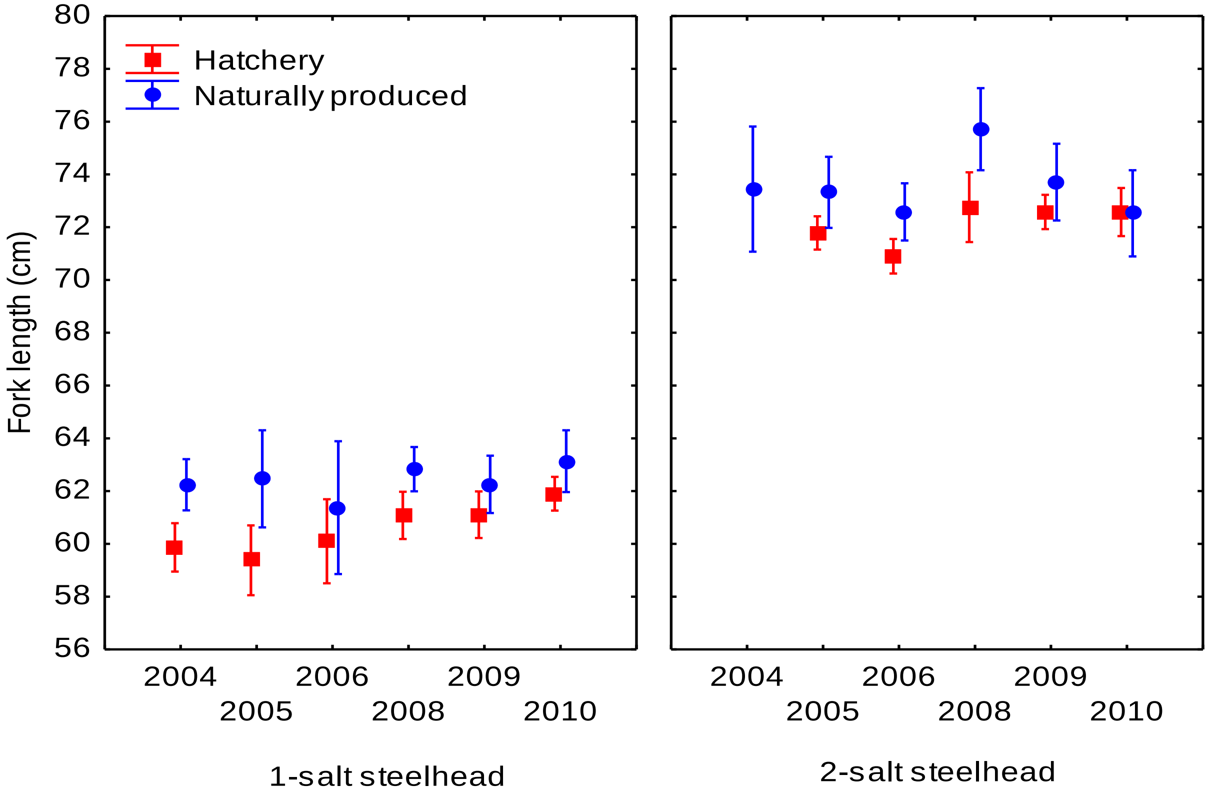


Figure 77. Mean fork length of female Methow/Okanogan River steelhead.

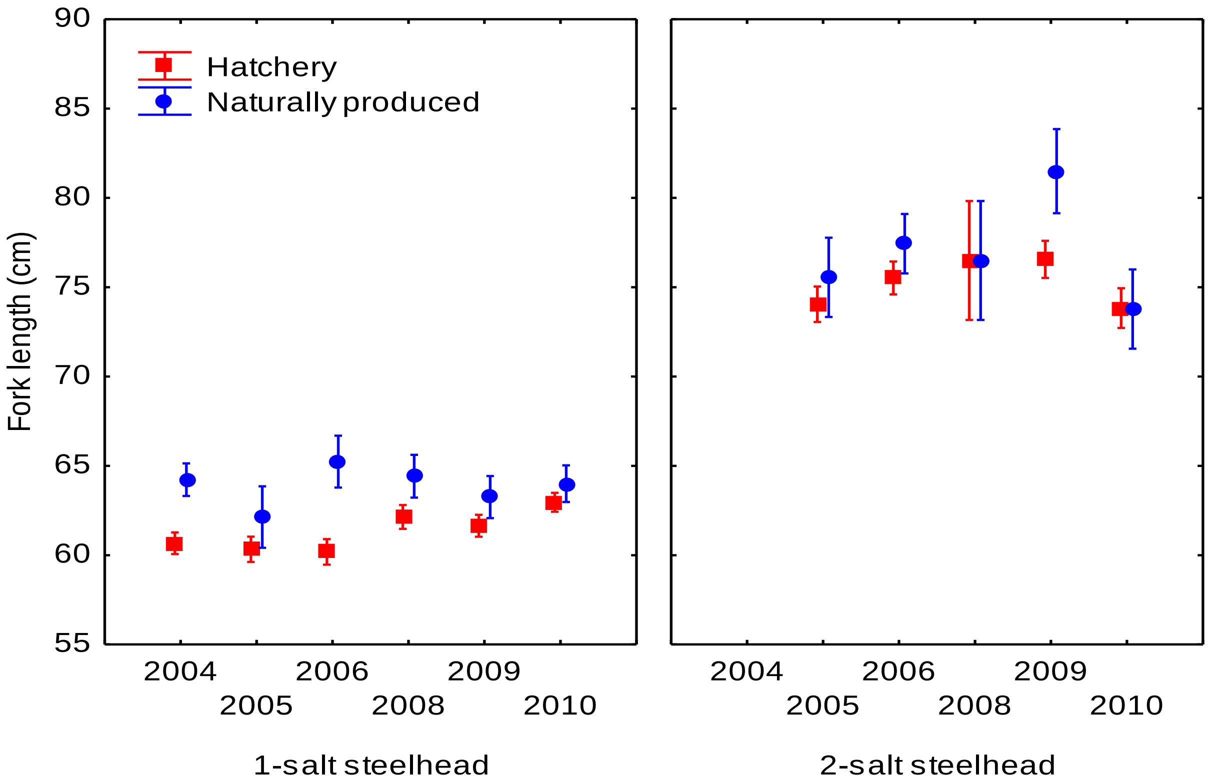


Figure 78. Mean fork length of male Methow/Okanogan River steelhead.

Objective 4: Hatchery Fish Survival Rates

The mean HRR value of the Methow steelhead was not significantly different from the expected value (19.6) in the BAMP (Mann Whitney U-test: $P = 0.22$, Table 43). The HRR met or exceeded the BAMP value for all brood years except 2000. Drought conditions in 2001, the year of the brood year 2000 release, likely negatively affected post-release survival. The mean HRR value was significantly greater than the mean NRR (Mann Whitney U-test: $P < 0.001$). Survival rates of fish in the hatchery and post-release have consistently met or exceeded survival standards (Snow et al. 2011).

Table 43. Hatchery replacement rates and natural replacement rates for Methow River steelhead adjusted for harvest.

Brood year	HRR	NRR
1996	13.4	1.22
1997	14.9	0.43
1998	37.3	0.33
1999	47.4	0.13
2000	6.3	0.48
2001	40.5	0.17
2002	15.9	0.04
2003	26.9	0.08
2004	17.9	0.16
Mean	25.3	0.34
SD	12.9	0.36

Objective 5: Stray Rates

Brood stray rates

Estimating stray rates of steelhead was problematic because fish are not recovered as carcasses and steelhead exhibit complex migration patterns for months prior to spawning. Detection of PIT-tagged steelhead in non-target streams, immediately prior to spawning can provide some insight into potential stray rates. A large proportion of Methow steelhead were PIT tagged at high levels as part of an US Army Corps of Engineers study for brood years 2002- 2004. Based on last known detection location, the average stray rate for the brood years examined was 0.54% (SD = 0.44%; Table 44) and did not exceed the 5% target.

Stray rates within population

Data were inadequate or not available to evaluate the hypothesis for this objective.

Stray rates outside of population

Data were inadequate or not available to evaluate the hypothesis for this objective.

Table 44. Estimated stray rates of Methow River steelhead for brood years 2002-2004.The number of strays* detected in non-target basins was expanded by the tag rate for the respective brood year to estimate the total number of strays for each brood year.

Brood year	Number of strays detected	Estimated total number of strays	Adult returns	Stray rate
2002	19	45	4,577	0.98%
2003	3	6	6,129	0.10%
2004	16	26	4,878	0.53%

*Strays defined as PIT-tagged steelhead detected in a non-target stream immediately prior to spawning.

Objective 6: Hatchery Release Characteristics

The target length and weight for Methow steelhead was 191 mm and 75.6 g, respectively. The mean length at release was 182 mm (t-test: $P < 0.001$), significantly smaller than the target length at release. The mean weight at release was 70.6 g (t-test: $P = 0.06$; Table 45), which was not significantly different from the target weight.

Table 45. Mean size at release of Methow River steelhead.

Brood year	Fork length	Weight	Brood year	Fork length	Weight
1998	191.8	79.4	2005	168.4	53.3
1999	195.4	83.0	2006	181.5	68.8
2000	178.6	66.7	2007	178.3	63.5
2001	181.8	72.9	2008	189.7	77.0
2002	187.9	73.1	2009	183.4	74.8
2003	163.2	62.1	Mean	182.0	70.6
2004	184.5	72.2	SD	9.3	8.2

The Methow steelhead program released an average of 329,359 fish and was not significantly different from the program goal of 320,000 yearling smolts (t-test: $P = 0.69$; Table 46). The Methow steelhead program met or exceeded the release program goal in 33% of the brood years examined, but in 75% of the brood years was within 10% of the release goal.

Table 46. Number of Methow River steelhead released by brood year.

Brood year	Number	Brood year	Number
1998	550,236	2005	326,565
1999	414,880	2006	315,534
2000	326,270	2007	292,580
2001	264,110	2008	308,512
2002	319,238	2009	293,327
2003	276,330	Mean	329,359
2004	264,726	SD	80,195

Objective 7: Freshwater Productivity

Smolt monitoring using rotary screw traps in the Methow Basin was initiated in 2004. Due to the complex freshwater life history (i.e., variable age structure) of steelhead only four complete brood years were used in the analysis of freshwater productivity. Data were not fit to spawner-recruit models due to the low number of years of data available. Although data are limited, estimates of egg-to-emigrant survival have only averaged 0.2% (SD = 0.1%). These data are based on redd counts and smolt-trap population estimates. The estimates of freshwater productivity may be biased either by error in estimating smolt population sizes, or by underestimation of the number of redds in the basin. While it is known that not all spawning habitat was surveyed, resulting in an underestimate of redds to an unknown degree, smolt estimates are compromised by extended periods when traps are inoperable due to extremely low and high water or ice. Therefore, estimates of freshwater productivity are suggestive that productivity is low, but more accurate estimates will require additional years of data and assessment of data collection techniques. Biases in both juvenile and spawner abundance estimate exist and studies are being conducted to evaluate both bias and accuracy. It is very unlikely that the magnitude of bias in either abundance estimate will explain the low productivity estimates of steelhead in the Methow River.

Despite extremely low survival, we found a suggestive but non-significant negative relationship between survival and spawning abundance, suggesting strong density dependence (Figure 79). We also found a suggestive, negative relationship between the number of emigrants per redd and the proportion of hatchery fish on the spawning grounds (pHOS).(Figure 80). However, using data from 1976-1996, the proportion of hatchery spawners is correlated with overall spawner abundance (Figure 81; P = 0.0125, R^2 = 0.29). Thus, density dependent effects of spawner abundance cannot be readily resolved from the effects of increasing proportions of hatchery spawners.

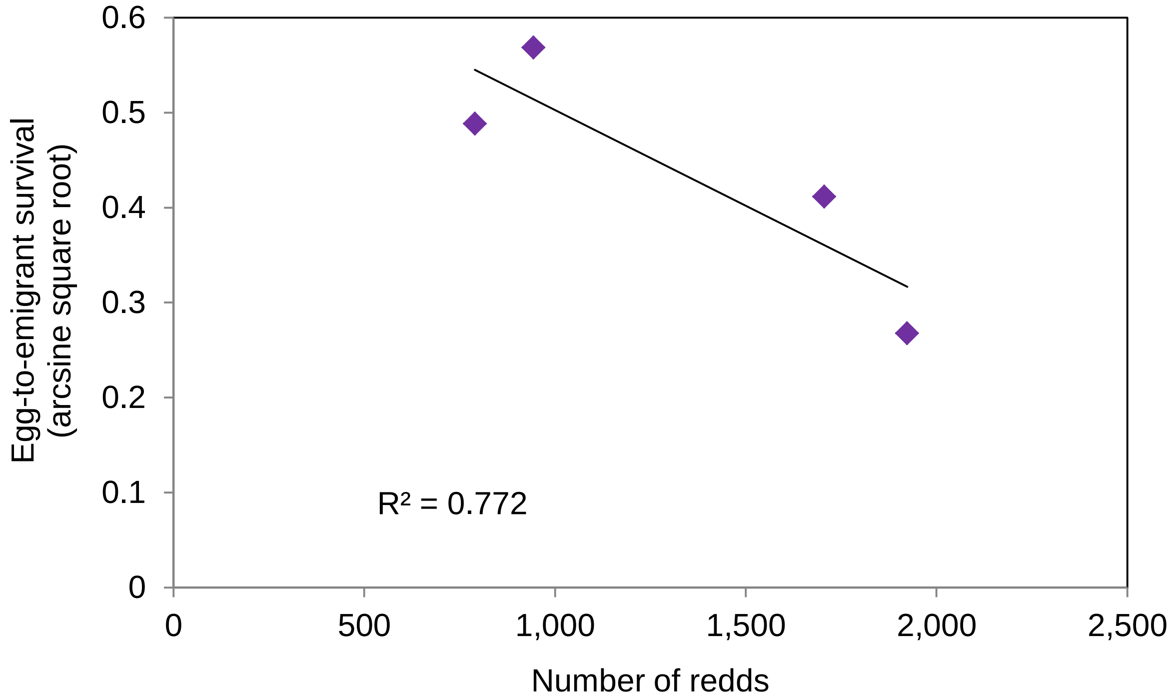


Figure 79. Relationship between freshwater survival (egg-to-emigrant) and spawner abundance for Methow steelhead.

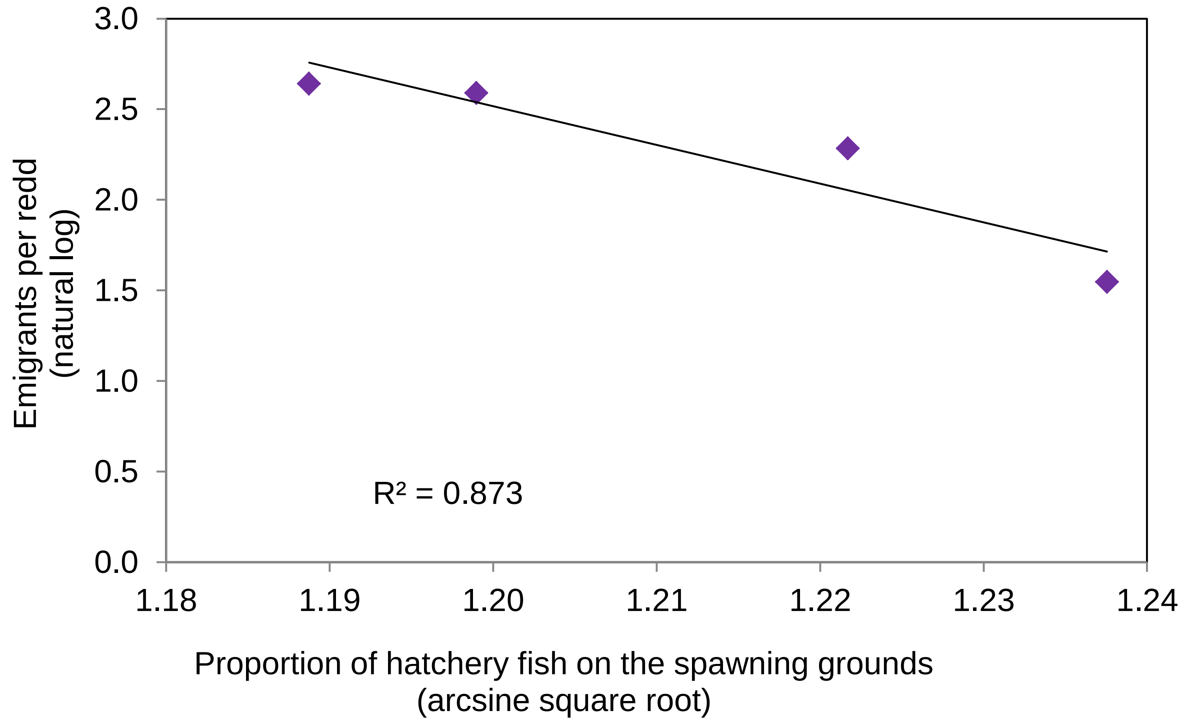


Figure 80. Relationship between freshwater productivity (as emigrants per redd) and the proportion of hatchery fish on the spawning grounds for Methow steelhead.

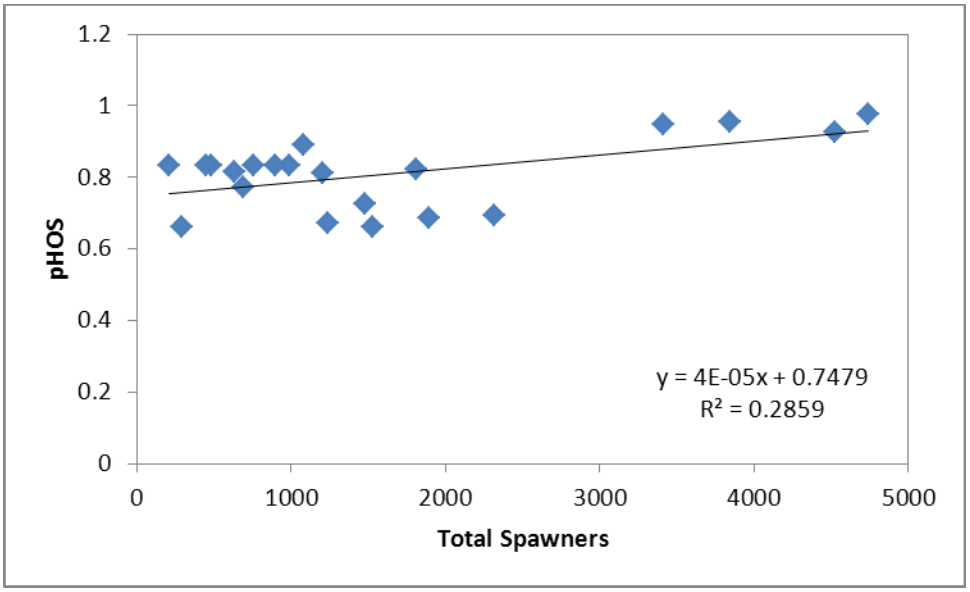


Figure 81. Relationship between total spawner abundance (hatchery + natural origin) and the proportion of hatchery origin spawners in the Methow Basin for years 1979 – 1996).

Objective 8: Harvest

Harvest goals for Methow steelhead do not exist, except to the extent that conservation fisheries are opened to support management objectives to include the removal of hatchery in excess of habitat seeding levels and increase the proportion of natural-origin steelhead on the spawning grounds. Selective sport fisheries in the Columbia and Methow rivers are operated based on annual abundance and are intended to reduce the proportion of hatchery fish on the spawning grounds. Despite these fisheries, the relative abundance of hatchery fish on the spawning grounds has not changed during supplementation and the number of hatchery fish on the spawning grounds has significantly increased (See Objective 1).

Summary

A brief assessment of all objectives is provided in Table 47.

Table 47. Summary assessment of M&E objectives for the Methow steelhead hatchery program.

Obj.	Primary indicator	Assessment
1	Spawner abundance	Spawner abundance increased in the Methow River, but we are uncertain whether this is due to the hatchery program or improved environmental factors.
	Natural-origin abundance	Abundance of natural-origin fish has also increased, but may also be due to improved environmental factors.
	Adult productivity	Adult productivity has not decreased, but remains at a critically low level.
2	Migration timing	Migration timing at Wells Dam was similar to naturally produced fish.
	Spawn timing	Exhibit similar spawn timing as naturally produced fish.
	Redd distribution	Exhibit similar spawning distribution as naturally produced fish.
3	Genetic diversity	When compared to hatchery steelhead, Twisp and Okanogan naturally produced juvenile steelhead are more genetically different than Methow juvenile steelhead.
	Effective population size	For the time period examined N_e was 1,670. N/N_e ratios were not calculated.
	Age at maturity	While freshwater age is different, salt ages were similar to naturally produced fish (both males and females).
	Size at maturity	Female hatchery fish were similar in size as naturally produced fish. Male 1-salt hatchery fish were smaller in some years, but 2-salt fish were similar in size.
4	Hatchery replacement rate	Met or exceeded the target. Hatchery survival was 74 times greater than the natural replacement rate.
5	Stray rates	Based on limited data, brood-year stray rates are very low, but data was inadequate to fully assess this objective.
6	Size and number of juveniles released	Target weight and number of fish released were met, but length at release was significantly lower than the target.
7	Freshwater productivity	Egg to emigrant survival is less than 1% and freshwater productivity may be negatively correlated with abundance of spawners and/or pHOS.
8	Harvest	Harvest rates of hatchery fish have been inadequate to reduce hatchery fish abundance.

Methow Basin Steelhead Discussion and Recommendations

Steelhead programs in the Methow River, similar to spring Chinook, included releases from two facilities: Wells Hatchery and Winthrop NFH. The marking schemes from these programs do not allow for stock discrimination under most stock assessment activities; therefore, hatchery steelhead from Winthrop NFH were, unavoidably, included in the analysis. Currently, the Mid-Columbia PUD HCP Hatchery Committees and Grant PUD Hatchery Sub-Committee are conducting adjustment of the hatchery compensation programs. The anticipated result of this adjustment of the combined PUDs' hatchery compensation for the Methow Basin is unclear at this time, but release numbers will either remain at similar levels or decrease. Conversely, the production of steelhead from Winthrop NFH may increase from 100,000 up to 200,000 smolts. Substantial changes in both production and release location will require adjustment of management strategies. In addition to the changes in production, future management strategies for Methow Basin steelhead must holistically incorporate the genetic consequences of past management practices, current knowledge of homing and straying in the basin, pursuit of PNI goals, and the status of hatchery and natural replacement rates, as presented in this report.

Past management practices likely confound our analyses of Methow Basin steelhead. The analyses presented in this chapter attempt to assess the performance of the Wells Hatchery steelhead program since it was re-classified as a conservation program in 2000. However, the reality is that the program was operated during the supplementation period in a manner very similar to the "pre-supplementation" period. Therefore, it is unlikely that changes detected in spawner abundance, NORs, productivity, and pHOS can be directly related to any substantial changes in steelhead management in the Methow Basin. Rather, results may only reflect a confounded picture of incremental management alterations, such as incorporating a larger proportion of natural-origin fish in the broodstock, and changing environmental factors that combined to effect the population. Thus, the context for interpretation of the findings presented in this chapter is that of an unbroken series of hatchery releases with only modest program changes between the periods compared.

Methow hatchery steelhead survival met or exceeded the expected standards for survival within the hatchery and the hatchery recruitment rate (HRR). Mean HRR was 74 times greater than the mean NRR, indicating that the hatchery program tremendously increases the adult returns above current natural production. The target number of fish released has been met in most years, but broodstock has been predominately hatchery fish with an average of only 5% naturally produced fish during the pre-supplementation period and 25% during supplementation. Methow hatchery steelhead have similar migration timing at Wells Dam as natural-origin fish. Spawn timing and redd distribution of hatchery-origin adult spawners in the Twisp River is similar to naturally produced fish. Age at maturity in terms of sea age is similar for hatchery and natural-origin steelhead at Wells Dam. We excluded freshwater age from our analysis of age at maturity because hatchery-origin fish are reared at an accelerated 1-year smolt age.

We found no population structure in natural-origin adults sampled at Wells Dam. Natural-origin adults had similar allele frequencies across years, indicating a stable genetic population. In contrast, hatchery-origin adults did not have stable allele frequencies across years. The reason for this is unclear. In addition, H x W hatchery-origin adults were genetically differentiated from natural-origin adults and H x H hatchery-origin adults. Again, the reason for this is unclear. Twisp, Okanogan, and resident juveniles were differentiated from the adult samples, while Methow juveniles were not. However, the genetic variance does not appear to be changing over time. Finally, although the genetic analysis paints a complex spatiotemporal picture of population structure in samples collected at and upstream of Wells Dam, all samples are clearly representative of an upper Columbia summer steelhead, with relatively slight genetic differentiation.

Stray rate information was not adequate to fully assess stray rates. However, a PIT tag study of Methow steelhead indicated that stray rates by brood year were very low. Since the hatchery program that is under evaluation began, spawner abundance has increased substantially (mean increase 3,704 spawners) and NORs have also increased (mean increase 357 NORs). However, these analyses are before-after analyses, and without reference streams available for comparison, it is difficult to identify the reason(s) for the increases, or whether the increases are due to the hatchery program or factors outside the hatchery program (e.g. improved ocean survival), or a combination of both. Both adult (stock-recruit) and juvenile (egg-to-emigrant) productivity are extremely low and have not changed during supplementation.

PNI for the Methow steelhead has increased during the supplementation period, but nevertheless has been well below the desired minimum level of 0.67 both before and during supplementation. Freshwater productivity may be negatively correlated with the proportion of hatchery fish on the spawning grounds and/orwith total abundance of spawners, but data were limited to four years and are confounded. Management decisions based on only four years of data may be premature. However, the empirical juvenile data is consistent with modeled adult data (See Objective 1) suggesting the productivity of hatchery steelhead and possibly naturally produced steelhead is extremely low. Intrinsic-productivity estimates used in modeling exercises (i.e., AHA = 1.45) are not consistent with estimates of productivity derived from stock recruitment-models (range 0.3 – 0.66). The stock-recruit relationship reveals that the population is well below replacement, but does not resolve whether this is due to spawner abundance or pHOS. However, given that productivity is low even at low spawner abundance suggests that factors other density dependent effects are involved in the low productivity. Fortunately, a relative-reproductive-success study is currently underway in the Twisp River and will provide empirical estimates of productivity for both hatchery and naturally produced fish. The results from the first year of the study are not yet completed.

While an unknown number of naturally produced steelhead may be harvested in tribal fisheries, harvest rates of hatchery steelhead have been insufficient to reach management objectives. In particular, conservation fisheries directed at reducing the number of hatchery-origin spawners in the Methow River have not succeeded in significantly reducing the proportion of hatchery fish spawning naturally. Recent changes to more aggressive harvest regulations for the conservation fisheries may improve their efficacy; however, these new regulations have been implemented for only the past two seasons. Segregated harvest programs may be the only viable option, other than direct removal at weirs or dams, to reduce the proportion of hatchery fish on the spawning grounds without undue risk to naturally produced fish.

Recommendations:

1. Assess the potential to use a PIT-tag based assessment for 1) estimating survival to key life stages, 2) population estimates of key life stages, 3) developing estimates of carrying capacity, and 4) understanding life history traits such as juvenile movement and rearing, homing and straying. This approach should allow the assessment of both the hatchery and natural populations to detect limiting life stages. It is unclear to what extent such an approach could supersede current methodologies, such as rotary screw trapping. To the extent a PIT-tag approach would improve the ability to address the four questions above, develop field and analytical methods to employ this PIT-tag approach.

2. Develop methodologies to increase the accuracy of both run escapement and spawning escapement for both hatchery and naturally produced steelhead to better assess population viability (productivity) and assist in designing appropriately sized hatchery programs.

3. Implement new hatchery NNI production levels. The anticipated basin release for Douglas PUD programs will be approximately 148,000 smolts. Limit hatchery-origin spawners through a combination of an array of adult-management strategies to reduce pHOS and increase PNI consist with HSRG recommendations.

4. The draft Wells Complex Summer Steelhead HGMP calls for a small program initiated in the Twisp River using locally adapted, naturally produced broodstock, with excess returning hatchery-origin adults removed at the Twisp Weir. We recommend the implementation of the new Twisp steelhead program, which is consistent with HSRG recommendations.

5. Discontinue collection of naturally produced fish (of unknown origin) at Wells Dam. Natural-origin fish should be collected only in their river of origin, or if their origin can be reliably determined, they may be collected at Wells Dam for use in conservation programs.

6. All hatchery production should be adipose fin-clipped. Hatchery steelhead SARs are high enough and lower river harvest rates are low enough that all hatchery fish must be adipose fin-clipped to provide more accurate M&E results and more effective management of excess hatchery-origin adults.

7. Develop and implement a comprehensive hatchery-management plan including both Douglas PUD and USFWS programs. Because all returning hatchery fish may potentially spawn in the natural environment, two hatchery programs operating in the same river with a common goal of recovery should work synergistically to achieve the desired results. Hatchery production levels, hatchery research, and monitoring and evaluation activities and data should be developed and implemented in a comprehensive approach to meet recovery objectives.

8. The draft Wells Complex Steelhead HGMP describes a comprehensive adult management plan for steelhead in the Methow Basin. Adult management components of the plan (removal of hatchery adults through fisheries, at hatcheries and weirs) must be implemented concurrently under the new HGMP, and the effectiveness of the measures will be assessed under the adaptive management framework described in the HGMP.

9. Following HGMP approval by NOAA, update M & E Plan to ensure objectives and targets are consistent.

Okanogan Basin Steelhead

Goal – Support the recovery of Okanogan steelhead[7] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

Program – Collect broodstock from Wells Dam (hatchery and naturally produced) sufficient to release 130,000 yearling smolts in the Okanogan River Basin.

Reference Streams

Data on potential steelhead reference streams are currently not available. Although data collection in some unsupplemented populations commenced within the last 10 years, we could not locate data collected during the pre-supplementation period (1987 – 1997). Although the goal of the hatchery program changed beginning with the 1998 brood (i.e., conversion from harvest augmentation to supplementation), the Okanogan River has a long history of releases of hatchery steelhead beginning in the early part of the 20th Century. Since 1960, hatchery steelhead from several broodstock sources from the upper Columbia River Basin have been released into the Okanogan River for harvest augmentation. Due to this legacy of hatchery steelhead in the Okanogan River it is highly unlikely that any data from contemporary reference populations would be appropriate. Accordingly, spawner abundance, NOR abundance, and productivity (including freshwater productivity) were analyzed following methods outlined in Hillman et al. (2011). It is important to note that before-after (BA) comparisons conducted as part of the M & E Plan analyses do not represent periods with and without hatchery fish, but merely a change in the goal of the hatchery program and a broodstock strategy that targets a greater proportion of naturally produced fish collected from Wells Dam.

Objective 1: Abundance, Recruitment, and Productivity

Estimating population abundance of adult steelhead upstream of Wells Dam was challenging because empirical population-specific data for the Methow and Okanogan rivers were not available. Estimates of steelhead spawning abundance are unavailable because steelhead cannot be recovered as carcasses, are difficult to observe on the spawning grounds, and redd counts are frequently compromised by high water. Therefore, abundance of hatchery and naturally produced fish upstream of Wells Dam was estimated based on stock assessment and broodstock collection activities. We apportioned these estimated numbers of hatchery and naturally produced fish to each population above Wells Dam based radio telemetry results from 1999 and 2001 (English et al. 2001 and 2003). These modeled data do not account for any variation in the number of hatchery steelhead released in the Methow or Okanogan basins or the abundance of stray hatchery fish. However, because hatchery-production goals have not changed during the period examined, modeled data should be relatively accurate.

[7] While the HCP is not a recovery plan into itself, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.

Estimates of steelhead spawning abundance are unavailable; modeled run-escapement data were adjusted based on estimates of annual harvest of both hatchery and naturally produced fish and represent the closest approximation of the actual spawner abundance, but are likely biased due to unaccounted for pre-spawn mortality.

Steelhead spawner abundance (hatchery + natural-origin) in the Okanogan River was significantly greater during the supplementation period (t-test: $P < 0.000$; Table 48). Trends in abundance of the pre-supplementation period were not significantly different than during supplementation (t-test: $P = 0.205$; Figure 77). Hatchery steelhead comprised the majority of the steelhead in the Okanogan River in both the pre-supplementation (mean = 91%) and during supplementation (mean = 93%; Figure 78). The mean proportion of hatchery steelhead in the Okanogan River was not significantly greater during supplementation (t-test: P =0.46), suggesting the significant increase in abundance may be due, in part, to factors influencing survival outside the basin (e.g., ocean conditions).

Mean NOR abundance also significantly increased during the supplementation period (t-test: $P = 0.017$; Table 48), but trends in NOR abundance were not different before and during supplementation (t-test: $P = 0.477$; Figure 77). However, without reference populations we cannot determine if the cause of a change in NOR abundance, like spawner abundance, may be due factors within or outside the basin.

Neither mean productivity (t-test: $P = 0.634$) nor the trend in productivity (t-test: $P = 0.214$) in the Okanogan population during supplementation have significantly changed compared to the pre-supplementation period (Table 48 and Figure 77). Mean productivity in the Okanogan River during the period examined averaged 0.13 recruits per adult (SD = 0.14) and the geometric mean was 0.09 recruits per adult. Because we used run-escapement estimates rather than an estimate of spawners, productivity estimates are negatively biased. However, when applying an assumed pre-spawn mortality as high as 50%, modeled results only increase mean productivity to 0.27 recruits per adult.

During the supplementation period the proportion of hatchery fish on the spawning grounds averaged 93% (SD = 2%) and the proportion of naturally produced fish in the broodstock averaged 9% (SD = 15%) resulting in an average PNI of 0.08 (SD = 0.12). PNI was not significantly greater during the supplementation period (mean = 0.08) when compared to the pre-supplementation period (mean = 0.05; Mann-Whitney U-test: $P = 0.28$, Figure 79), but more recently (2007 - 2010) has increased to an average of 0.22.

Table 48. Results of the unequal-variance t-tests on LN spawner abundance, LN adjusted NOR, and LN adjusted productivity data for Methow steelhead. Tests determined if the mean values during the supplementation period were different than mean values during the pre-supplementation period.

Response variable	Mean		Transformed data					
	Before	During	Before	During	Effect size	t-value	P-Value	Result
Spawner abundance	793	2,510	6.564	7.737	1.173	-5.580	0.000	Increase
NOR	305	662	0.408	0.767	0.359	-2.921	0.017	Increase
Productivity	0.290	0.185	0.129	0.100	0.029	0.487	0.634	ND

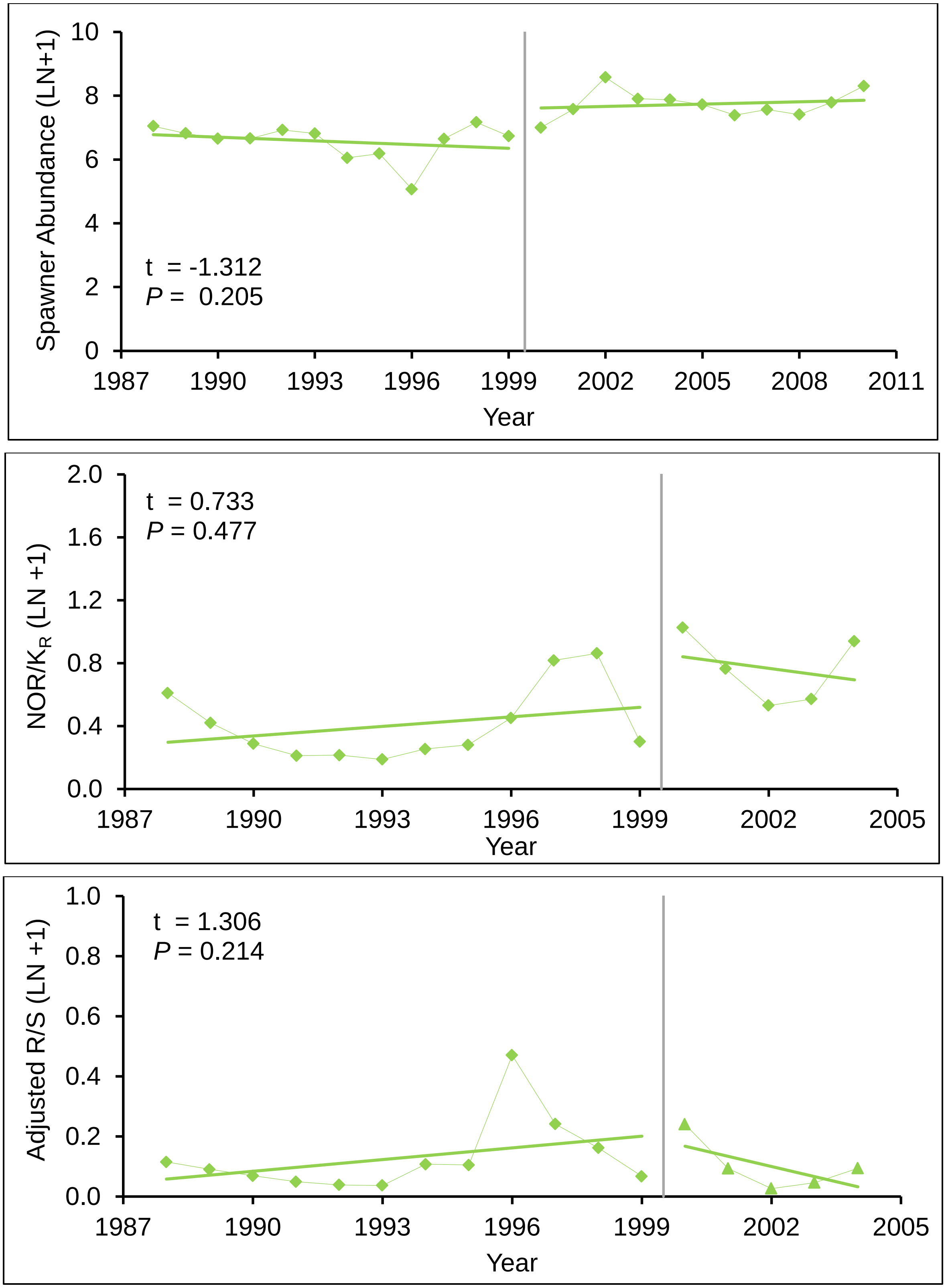


Figure 77. Trends in steelhead spawner abundance, NORs, and productivity in the Okanogan River. The vertical lines in the figures separate the pre-supplementation and during supplementation periods.

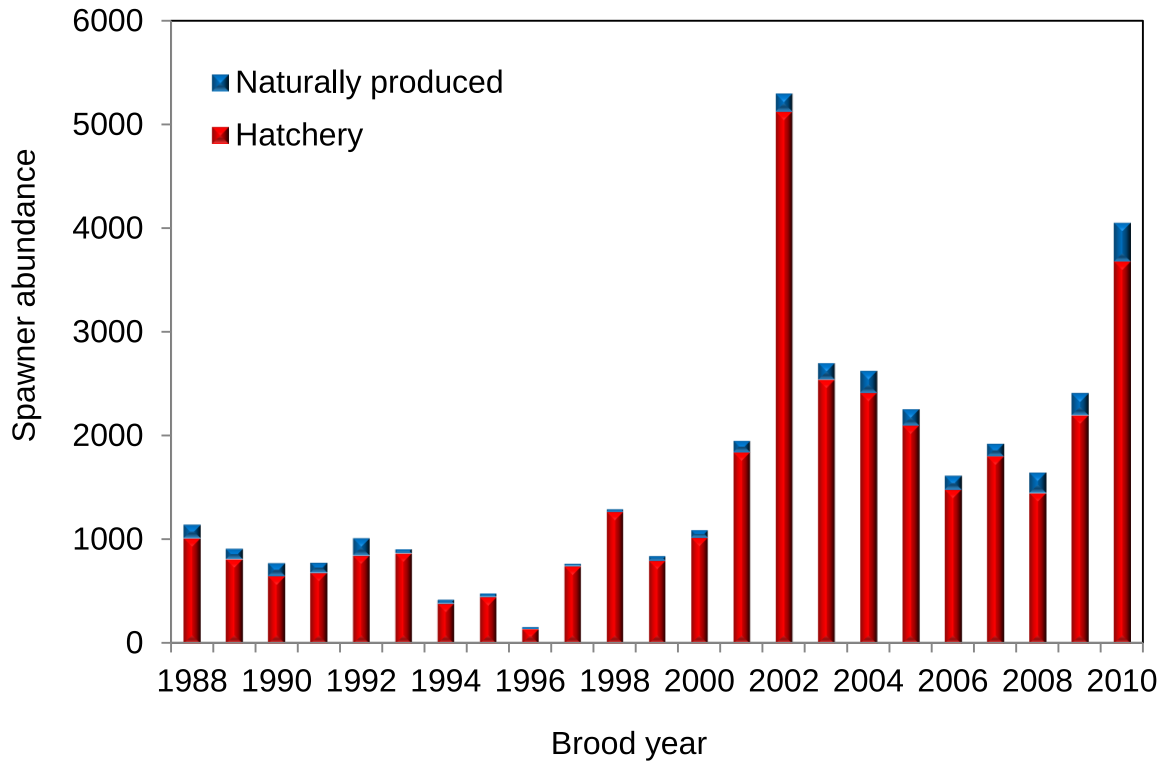


Figure 78. Abundance of hatchery and naturally produced steelhead in the Okanogan River.

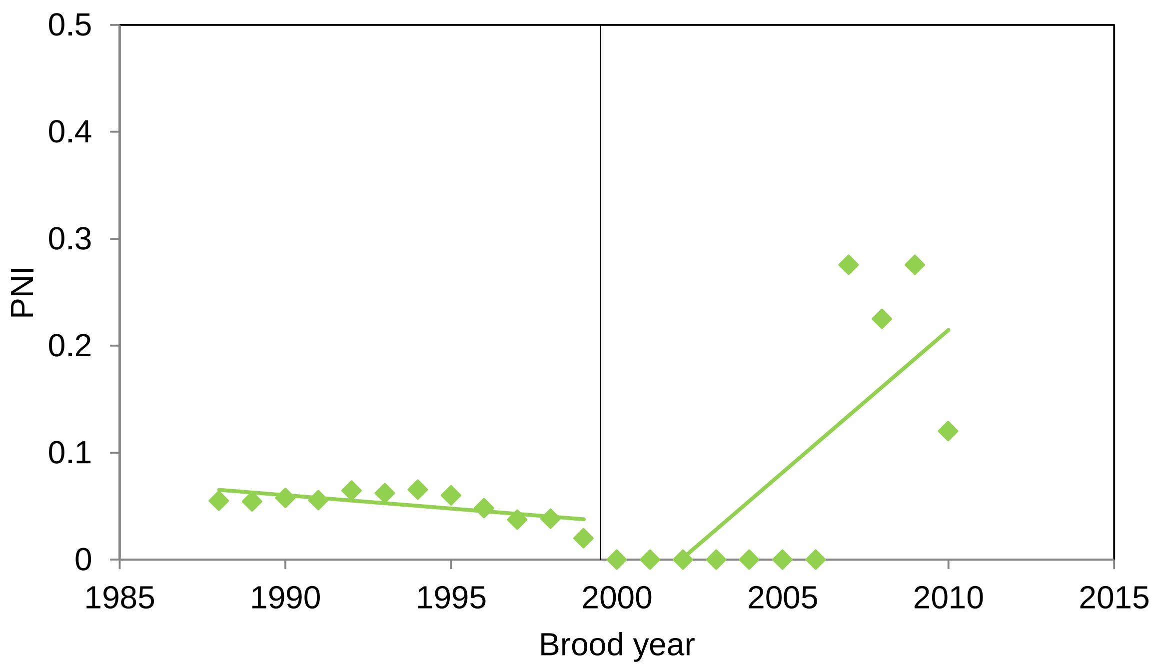


Figure 79. Trends in PNI of the Okanogan steelhead population. The vertical lines in the figure separates the pre-supplementation and during supplementation periods.

Objective 2: Migration and Spawning Characteristics

Migration Timing

Population specific data are not available for Okanogan steelhead. Please refer to the Methow steelhead section of this report for analysis of migration timing of steelhead at Wells Dam.

Spawn Timing

Data were not collected to evaluate the spawn timing of hatchery and naturally produced steelhead in the Okanogan River.

Redd distribution

Data were not collected to evaluate the spawn location of hatchery and naturally produced steelhead in the Okanogan River.

Objective 3: Genetic and Phenotypic Characteristics

Genetic monitoring

Blankenship et al. (2006) conducted the genotyping and analysis of population genetics hypotheses and thus is the source for details regarding the methodology and analytical procedures (Appendix E). Results specific to the Okanogan steelhead were extracted from the Blankenship et al. (2006) report and presented below to specifically address the hypotheses as outlined in the Analytical Framework (Hays et al. 2007).

Natural-origin steelhead collected for broodstock at Wells Dam had statistically similar allele frequencies among collections from 1995 – 2007 and showed no evidence of population structure (i.e., $F_{ST} = 0$) indicating that natural-origin summer steelhead collections could be combined for any subsequent genetic analysis (Table 49). There was slight genetic differentiation observed between some natural-origin adult and H x H collections, but the differences were quite small (Table 50). In contrast, the two H x W collections had statistically different allele frequencies when compared to each other and the largest F_{ST} estimate observed for any comparison between adult collections was between the two H x W collections (F_{ST}=0.0168). Additionally, all comparisons between the H x W collections and the natural-origin adult collections showed both statistically different allele frequencies (12 of 12) and estimates of F_{ST} statistically different from zero. The H x W adults were genetically differentiated from other adult collections. We recommend further consultation about the H x W adults to determine potential sources of the observed genetic differences.

Table 49. Pairwise genetic differentiation between natural adult collections. Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant at α = 0.05. F_{ST} estimates are shown above diagonal.

Year	2003	2005	2007	1995	1997	1999
2003	-	0.0003	-0.0001	-0.0023	0.0019	0.0006
2005	NS	-	-0.0002	-0.0001	0.0005	-0.0016
2007	NS	NS	-	-0.0029	0.0010	0.0004
1995	NS	NS	NS	-	0.0008	-0.0019
1997	NS	NS	NS	NS	-	0.0006
1999	NS	NS	NS	NS	NS	-

Table 50**.** Genetic differentiation between natural-origin adult and the known-origin hatchery collections. Please note that the pairwise tests regarding natural-origin adults collections (underlined codes) are not shown (see Table 40). Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant and * designating the p-value was below α = 0.05. F_{ST} estimates are shown above diagonal, with bolded values being statistically different from panmixia (NP = naturally produced; HW = hatchery (H x NP parents); HH = hatchery (H x H parents).

Group	NP 2003	HH 2003	HW 2003	NP 2005	HH 2005	HW 2005	NP 2007	NP 1995	NP 1997	NP 1999
NP 2003	-	**0.0047**	**0.0141**	-	0.0015	**0.0102**	-	-	-	-
HH 2003	*	-	**0.0044**	**0.0047**	0.0015	**0.0142**	**0.0039**	0.0035	**0.0064**	**0.0042**
HW 2003	*	*	-	**0.0133**	**0.0083**	**0.0168**	**0.0099**	**0.0075**	**0.0110**	**0.0116**
NP 2005	-	NS	*	-	0.0010	**0.0060**	-	-	-	-
HH 2005	NS	NS	*	NS	-	**0.0096**	-0.0001	0.0002	0.0001	0.0023
HW 2005	*	*	*	*	*	-	**0.0069**	**0.0104**	**0.0095**	**0.0126**
NP 2007	-	NS	*	-	NS	*	-	-	-	-
NP 1995	-	NS	*	-	NS	*	-	-	-	-
NP 1997	-	*	*	-	NS	*	-	-	-	-
NP 1999	-	NS	*	-	NS	*	-	-	-	-

Due to the life history and behavior of steelhead, obtaining adult samples from known spawning populations is difficult without tributary weirs or some other population-specific capture method. Natural-origin adult samples were available from Wells Dam; however, those collections were thought to represent more than one upstream population, rendering them unsuitable for population analysis (although see previous section). Therefore, juvenile fish from the major populations upstream of Wells Dam (Methow, Twisp, and Okanogan Rivers) were collected using smolt traps, genotyped, and used to investigate population structure in the basin. The Okanogan collections were differentiated from the natural-origin adult steelhead to a greater degree than the Methow juveniles, with the 2007 Okanogan collection (07AR) appearing the most divergent collection in the study. The two Okanogan collections (07AR, 08CL) were divergent from each other, with statistically different allele frequencies and F_{ST} estimates greater than zero (Table 51). The Okanogan juveniles were also divergent from the natural-origin adult collections, with all allele frequency and F_{ST} comparisons statistically significant. Additionally, the 2007 Okanogan juvenile collection appeared the most dissimilar collection in the study from the natural-origin adults, with a mean F_{ST} of 0.0197.

We used factorial correspondent analysis (FC) on allele frequency data to investigate if the genetic affinity changed over time among temporally replicated collections of natural-origin adult summer steelhead and juveniles (smolts and residents). In general, the FC results corroborate the genetic diversity analysis described above. The Okanogan juvenile collections were statistically different from each other and all other collection centroids. Additionally, the 2007 Okanogan collection contributed greatly to the FC axis 2 (all other collections essentially on the origin), and the 2008 Okanogan collection contributed greatly to FC axis 3. Despite the relative genetic differences among collections, there was no trend in the genetic variance changes observed over time.

Table 51. Genetic differentiation between natural adult and the juvenile steelhead collections. Please note that the pairwise tests regarding natural-origin adults collections (underlined codes) are not shown (see Table 2). Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant and * designating the p-value was below α = 0.05. F_{ST} estimates are shown above diagonal, with bolded values being statistically different from panmixia (NP = naturally produced; A = adult; J = juvenile; W = Wells Dam; MT = Methow smolt trap; TT = Twisp smolt trap; OT = Okanogan smolt trap)..

Group	Life stage (location)	NP 2003 A(W)	NP 2005 A(W)	NP 2007 J(MT)	NP 2007 J(TT)	NP 2007 J(OT)	NP 2007 A(W)	NP 2008 J(MT)	NP 2008 J(TT)	NP 2008 J(OT)	NP 1995 A(W)	NP 1997 A(W)	NP 1999 A(W)
NP2003	A (W)	–	-	**0.0025**	**0.0052**	**0.0182**	-	0.0007	**0.0071**	**0.0059**	-	-	-
NP2005	A (W)	-	–	0.0003	**0.0055**	**0.0200**	-	0.0011	**0.0042**	**0.0061**	-	-	-
NP2007	J (MT)	NS	NS	–	**0.0027**	**0.0171**	**0.0015**	0.0008	**0.0043**	**0.0059**	0.0016	**0.0031**	0.0018
NP2007	J (TT)	*	*	NS	–	**0.0196**	**0.0044**	**0.0032**	**0.0047**	**0.0069**	0.0044	**0.0054**	**0.0062**
NP2007	J (OT)	*	*	*	*	–	**0.0180**	**0.0156**	**0.0196**	**0.0186**	**0.0232**	**0.0171**	**0.0221**
NP2007	A (W)	-	-	NS	*	*	–	-0.0001	**0.0042**	**0.0059**	-	-	-
NP2008	J (MT)	NS	NS	NS	*	*	NS	–	**0.0029**	**0.0035**	-0.0005	**0.0016**	0.0001
NP2008	J (TT)	*	*	*	*	*	*	*	–	**0.0082**	**0.0050**	**0.0043**	**0.0066**
NP2008	J (OT)	*	*	*	*	*	*	*	*	–	**0.0064**	**0.0041**	**0.0042**
NP1995	A (W)	-	-	NS	NS	*	-	NS	*	*	–		
NP1997	A (W)	-	-	NS	*	*	-	NS	*	*	-	–	
NP1999	A (W)	-	-	NS	NS	*	-	NS	*	*	-	-	–

Age at maturity

Population-specific data are not available for Okanogan steelhead. Please refer to the Methow steelhead section of this report for analysis of age structure of steelhead at Wells Dam.

Size at maturity

Population-specific data are not available for Okanogan steelhead. Please refer to the Methow steelhead section of this report for analysis of size structure of steelhead at Wells Dam.

Objective 4: Hatchery Fish Survival Rates

The mean HRR value of the Okanogan steelhead was not significantly different from the expected value (19.6) in the BAMP (Mann Whitney U-test: $P = 0.74$, Table 52). The HRR met or exceeded the BAMP value for all brood years except 2000. Drought conditions in 2001, the year of the brood year 2000 release, likely negatively affected post-release survival. The mean HRR value was significantly greater than the mean NRR (Mann Whitney U-test: $P < 0.0001$). Survival rates of fish in the hatchery and post-release have consistently met or exceeded survival standards (Snow et al. 2011).

Table 52. Hatchery replacement rates and natural replacement rates for Okanogan steelhead adjusted for harvest.

Brood year	HRR	NRR
1996	13.40	0.60
1997	14.90	0.27
1998	37.30	0.18
1999	47.40	0.07
2000	6.30	0.27
2001	40.50	0.10
2002	15.90	0.02
2003	26.90	0.05
2004	17.90	0.10
Mean	25.3	0.17
SD	12.9	0.16

Objective 5: Stray Rates

Population-specific data are not available for Okanogan steelhead. Please refer to the Methow steelhead section of this report for analysis of stray rates.

Objective 6: Hatchery Release Characteristics

The target length and weight for Okanogan steelhead 191 mm and 75.6 g, respectively. The mean length at release was 184 mm (t-test: $P < 0.02$), significantly smaller than the target length at release. The mean weight at release was 71.3 g (t-test: $P = 0.14$; Table 53), which was not significantly different from the target weight.

Table 53. Mean size at release of Okanogan River steelhead.

Brood year	Fork length	Weight	Brood year	Fork length	Weight
1999	189.4	76.8	2006	180.6	65.7
2000	172.9	60.0	2007	181.4	67.3
2001	194.7	87.3	2008	185.7	69.0
2002	188.5	75.9	2009	172.5	63.6
2003	189.9	79.9	Mean	183.6	71.3
2004	192.4	82.4	SD	8.4	9.8
2005	171.4	56.8			

The Okanogan steelhead program released an average of 134,417 fish and was not significantly different from the program goal (t-test: $P = 0.73$; Table 54). The Okanogan steelhead program met or exceeded the release program goal in 73% of the brood years examined, but in 82% of the brood years was within 10% of the release goal.

Table 54. Number of Okanogan River steelhead released by brood year.

Brood year	Number	Brood year	Number
1999	100,005	2006	146,826
2000	160,756	2007	135,547
2001	144,650	2008	147,782
2002	228,770	2009	146,633
2003	126,855	Mean	134,417
2004	141,890	SD	40,983
2005	79,605	Goal	130,000

Objective 7: Freshwater Productivity

Smolt monitoring in the Okanogan Basin was initiated by the Colville Confederated Tribes in 2006. Smolt-production estimates are not available due to the low number of naturally produced steelhead captured.

Objective 8: Harvest

Harvest goals for Okanogan steelhead do not exist, except to the extent that conservation fisheries are enacted to support management objectives to include the removal of hatchery in excess of habitat seeding levels and increase the proportion of natural-origin steelhead on the spawning grounds. Selective sport fisheries in the Columbia and Okanogan rivers are operated based on annual abundance and are intended to reduce the proportion of hatchery fish on the spawning grounds. Despite these fisheries, the relative abundance of hatchery fish on the spawning grounds has not changed during supplementation and the number of hatchery fish on the spawning grounds has significantly increased (See Objective 1).

Summary

A brief assessment of all objectives is provided in Table 55.

Table 55. Summary assessment of M & E objectives for the Okanogan steelhead hatchery program

Obj.	Primary indicator	Assessment
1	Spawner abundance	Adult abundance in the Okanogan River has increased, but may be due to improved out-of-basin factors or the hatchery program.
	Natural-origin abundance	Abundance of natural-origin fish has also increased, but may be due to improved out-of-basin factors.
	Adult productivity	Adult productivity has not decreased, but remains at a critically low level.
2	Migration timing	See Methow steelhead section. Migration timing at Wells Dam was similar to naturally produced fish.
	Spawn timing	Data not available for analysis.
	Redd distribution	Data not available for analysis.
3	Genetic diversity	Okanogan naturally produced juvenile steelhead are genetically different from naturally produced Methow juvenile steelhead.
	Effective population size	See Methow steelhead section. For the time period examined N_e was 1670. N/N_e ratios were not calculated.
	Age at maturity	See Methow steelhead section. While freshwater age is different, salt age of both male and female hatchery fish were similar to naturally produced fish..
	Size at maturity	See Methow steelhead section. Female hatchery fish were similar in size to naturally produced fish. Male 1-salt hatchery fish were smaller than natural-origin males in some years, but similar in size at 2-salt age.
4	Hatchery replacement rate	Post-release survival of hatchery fish was not significantly different than expected. Hatchery survival was greater than the natural replacement rate.
5	Stray rates	Based on limited data, brood-year stray rates below Wells Dam are very low. Stray rates into the Methow River are unknown.
6	Size and number of juveniles released	Target weight and number of fish released were met, but length at release was significantly lower than the target.
7	Freshwater productivity	Data not available for analysis.
8	Harvest	Harvest rates of hatchery fish have been inadequate to reduce hatchery fish abundance.

Okanogan Basin Steelhead Discussion and Recommendations

Past management practices also likely confound our analyses of Okanogan Basin steelhead. The analyses presented in this chapter attempt to assess the performance of the Wells Hatchery steelhead program since it was re-classified as a conservation program in 2000. However, the reality is that the program was operated during the supplementation period in a manner very similar to the “pre-supplementation” period as during supplementation. Therefore, it is unlikely that changes detected in spawner abundance, NORs, productivity, and pHOS can be directly related to any substantial changes in steelhead management in the Okanogan Basin. Rather, these analyses may reflect a confounded picture of incremental management alterations, such as incorporating a larger proportion of natural-origin fish in the broodstock, and changing environmental factors that combined to effect the population. Therefore, the findings presented here should be interpreted with this in mind. Thus, the context for interpretation of the findings presented in this chapter is that an unbroken series of hatchery releases with only modest program changes between the periods compared.

Okanogan hatchery steelhead survival was at or above the expected standard within the hatchery and post-release to returning adults. The target number of fish released has been met in most years, but broodstock has been predominately hatchery fish. Okanogan hatchery steelhead have similar migration timing as naturally produced fish. Although spawning ground surveys are conducted by the Colville Confederate Tribes, comparisons of spawn timing and redd distribution between hatchery and naturally produced fish could not be conducted because the origin of steelhead could not be distinguished on the spawning grounds. Based upon stock-assessment monitoring conducted at Wells Dam, age at maturity in terms of salt age is similar for hatchery and natural-origin steelhead at Wells Dam. Okanogan steelhead are not known to stray below Wells Dam, but likely stray into the Methow at an unknown rate. However, PIT tag studies of Methow steelhead, also reared at Wells Hatchery, revealed low stray rates. Genetic analysis revealed no population structure in natural origin adults sampled at Wells Dam. Based on juvenile samples collected at smolt traps, naturally produced Okanogan steelhead are the most genetically distinct fish upstream of Wells Dam. However, Okanogan steelhead are frequently differentiated among years within the Okanogan, indicating either non-representative sampling, high rates of genetic drift, or possibly large numbers of out-of-basin influence.

The abundance of both total spawners and NORs increased in the Okanogan River during the supplementation period, but without reference populations we cannot determine whether those increases resulted from the hatchery program or from out-of-basin factors. Productivity of the population is extremely low and did not change during supplementation. PNI for the Okanogan steelhead has been well below the desired level both before and during supplementation. Freshwater productivity of steelhead in the Okanogan Basin is unknown.

While an unknown number of naturally produced steelhead may be harvested in tribal fisheries, harvest rates of hatchery steelhead have been insufficient to reach management objectives. Segregated harvest programs may be the only viable option, other than direct removal at weirs or dams, to reduce the proportion of hatchery fish on the spawning grounds without undue risk to naturally produced fish. A proposed weir in the lower Okanogan River may provide a means to remove excess hatchery fish.

Recommendations

1. Little data exist on the abundance and distribution of naturally produced steelhead in the Okanogan. Before new hatchery programs are implemented, incorporating naturally produced broodstock, monitoring needs to be in place to estimate the abundance and distribution of both adult and juvenile steelhead. For example, it is unknown what proportion of naturally produced fish are produced in Washington State. Okanogan steelhead are genetically different from Methow steelhead, suggesting hatchery and naturally produced fish are to some degree reproductively isolated in the Okanogan Basin. Better understanding of the current population status will allow the development of future hatchery programs, either integrated or segregated, based on the biological justification with population-specific objectives.

2. Assess the potential to use a PIT-tag based assessment for 1) estimating survival to key life stages, 2) population estimates of key life stages, 3) developing estimates of carrying capacity, and 4) understanding life history traits such as juvenile movement and rearing, homing and straying. This approach should allow the assessment of both the hatchery and natural populations to detect limiting life stages. It is unclear to what extent such an approach could supersede current methodologies, such as rotary screw trapping. To the extent a PIT-tag approach would improve the ability to address the four questions above, develop field and analytical methods to employ this PIT-tag approach.

3. Develop methodologies to increase the accuracy of both run escapement and spawning escapement for both hatchery and naturally produced steelhead to better assess population viability (productivity) and assist in designing appropriately sized hatchery programs.

4. Based on empirical estimates of run and spawning escapement develop escapement goals and recommend appropriately sized hatchery programs. Hatchery production must be relocated or reduced significantly in order to reduce pHOS and increase PNI. Decades of hatchery production have likely reduced the productivity of hatchery and possibly naturally produced fish in the natural environment. Outplanting of juvenile steelhead of unknown origin from Wells FH (hatchery x hatchery matings) should be discontinued or released in a location that would segregate returning adults from naturally produced fish.

5. Any new production should seek to maximize the number of naturally produced Okanogan fish in the broodstock, but should be limited in size based on the abundance of naturally produced fish. A small program (20,000 smolts) recently

initiated by the Colville Confederated Tribes in Omak Creek uses locally adapted, naturally produced fish.

6. The new Okanogan River weir should be operated to remove all hatchery fish except those produced from local broodstock.

7. All hatchery production should be adipose fin clipped. Hatchery steelhead SARs are high enough and lower river harvest rates are low enough that all hatchery fish must be adipose fin clipped to provide more accurate M & E results and greater management options for excess adults.

8. Implement the draft Wells Complex Sumer Steelhead HGMP in concert with the Grant PUD Artificial Propagation Plan (APP) and the draft Okanogan Summer Steelhead HGMP.

Wells Fish Hatchery Summer Chinook

Goal – Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural spawning populations.

Program – Collect broodstock from the Wells Fish Hatchery volunteer trap and west ladder trap sufficient to release 320,000 yearling smolts and 484,000 subyearling smolts from Wells Fish Hatchery.

Objective 4: Hatchery Fish Survival Rates

The mean HRR value of the Wells FH subyearling Chinook program was significantly less than the expected value (3.0) based on BAMP (Man-Whitney U-test: $P < 0.002$, Table 56). Conversely, the mean HRR value of the Wells FH yearling program was significantly greater than the expected value of (4.9) based on the BAMP (Man-Whitney U-test: $P < 0.004$).

Table 56. Hatchery replacement rates for Wells FH summer Chinook salmon adjusted for harvest.

Brood year	Hatchery Replacement Rate	
	Subyearling program	Yearling program
1992		4.1
1993	0.2	8.9
1994	0.1	0.8
1995	0.6	7.9
1996	2.1	8.6
1997	0.9	57.9
1998	2.1	51.0
1999	2.5	8.8
2000	0.7	47.4
2001	3.7	10.9
2002	0.5	20.2
2003	0.7	13.4
Mean (SD)	1.3(1.1)	20.0 (20.0)
Geometric Mean	0.8	11.8

Rearing strategies have a strong influence on overall survival, but also may affect age at return. Although not required as part of the M & E Plan, comparisons of mean age at maturity based on the number of winters in salt water (salt age) found that the subyearling release strategy consistently produced an older returning adult (ANOVA broodyear x rearing strategy interaction term: $P < 0.001$, Figure 80). Differences in mean salt age do not appear to be influenced by a single age class (e.g., jacks or 1 salt fish), but rather all ages classes (Table 57). The mean difference in salt age between release types across brood years was 0.52 years.

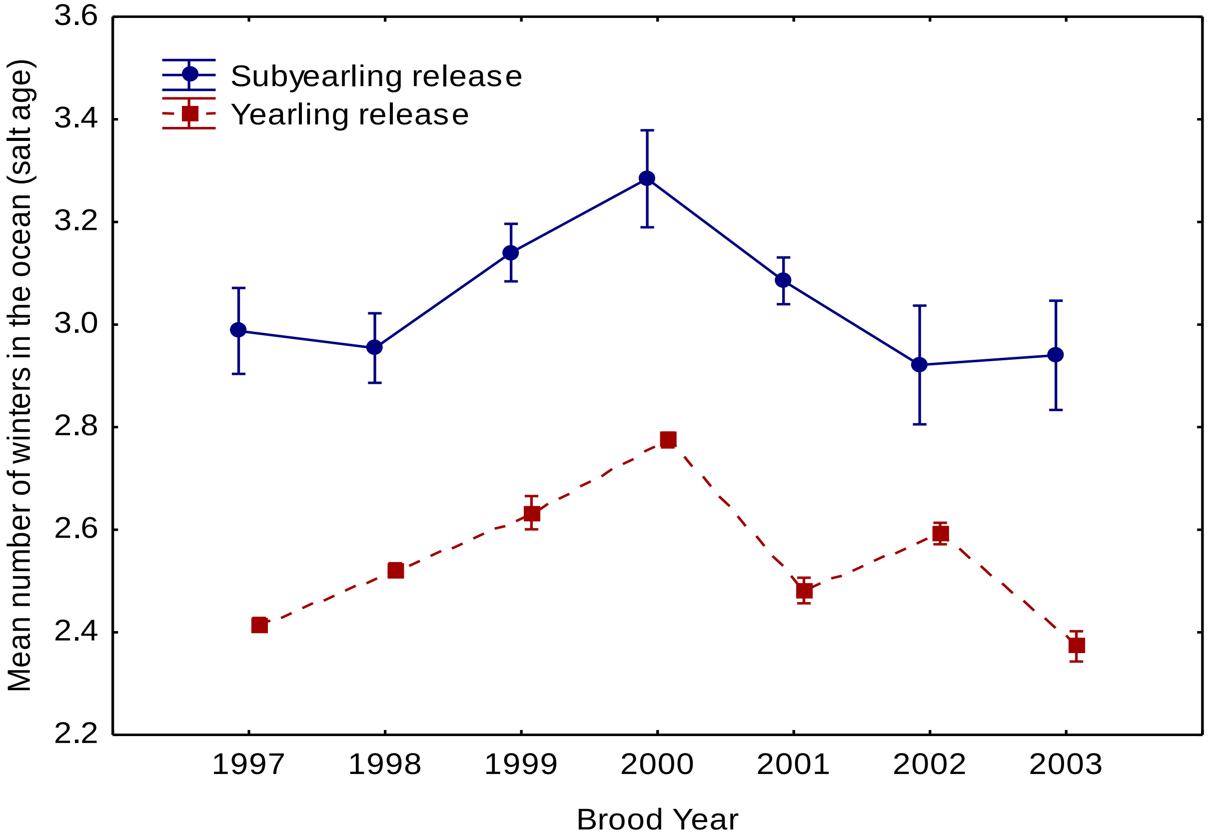


Figure 80. Mean salt age at return of Wells FH summer Chinook released as subyearling and yearling smolts.

Table 57. Mean salt age composition of Wells FH summer Chinook be release life stage, brood years 2000 – 2005.

Salt age	Subyearling		Yearling	
	Mean	SD	Mean	SD
1	0.008	0.009	0.049	0.022
2	0.135	0.027	0.419	0.071
3	0.667	0.114	0.475	0.057
4	0.183	0.120	0.056	0.033
5	0.006	0.008	0.001	0.001

Objective 5: Stray Rates

The mean brood-year stray rate of Wells summer Chinook was not greater than the 5% target (Table 58; t-test, P = 0.173).

Table 58. Stray rates for Wells FH summer Chinook salmon by brood year.

Brood year	Stray rate	Brood year	Stray rate
1992	0.0888	1999	0.0535
1993	0.1710	2000	0.0417
1994	0.0449	2001	0.0176
1995	0.1672	2002	0.0161
1996	0.1846	2003	0.0222
1997	0.1655	Mean	0.0860
1998	0.0594	SD	0.0667

Stray rates outside of populations

Wells summer Chinook have been recovered as carcasses in all major spawning areas upstream of Rock Island Dam (Table 59). The proportion of Wells summer Chinook in the Chelan River was significantly greater than the target of 5%, but was significantly lower than 5% in the Wenatchee and Okanogan populations. Currently, the Chelan River spawning aggregate is not identified as a summer Chinook population, the Chelan River broodstock are collected at Wells Dam and are Wells broodstock, and considering the downstream proximity to Wells Dam, it is not surprising Wells Hatchery fish are recovered there.

Table 59. Percentage of the natural spawning population comprising Wells Hatchery summer Chinook.

Return year	Entiat	Methow	Okanogan	Similkameen	Wenatchee	Chelan
1997		0.0	11.2	0.0	0.0	
1998		6.2	4.5	0.0	0.1	
1999		0.6	0.0	0.0	0.0	10.8
2000		3.3	8.2	0.0	0.2	26.4
2001		18.4	7.2	0.3	0.0	33.8
2002	8.6	11.6	5.1	0.0	0.1	29.7
2003	9.4	3.7	1.0	0.1	0.1	20.8
2004	0.0	2.1	1.6	0.2	0.1	6.0
2005	3.0	3.2	1.4	0.2	0.2	15.8
2006	0.0	1.8	0.2	0.0	0.0	7.9
2007	1.2	3.4	0.1	0.0	0.0	12.2
2008	3.4	3.0	1.7	0.2	0.1	8.8
2009	1.2	7.2	1.8	0.0	0.0	0.4
Mean	3.4	5.0	3.4	0.1	0.1	15.7
t-value	-1.84	-0.84	-2.36	-33.59	-41.56	3.17
DF	7	12	12	12	12	10
P-value	0.11	0.42	0.04	0.00	0.00	0.01

Objective 6: Hatchery Release Characteristics

The target length and weight for the Wells summer Chinook subyearling program was 116 mm and 22.7 g, respectively. The mean length at release was 111 mm and differed significantly from the release target size (t-test: $P = 0.06$). The mean weight at release was 16.4 g and differed significantly from the release target size (t-test: $P < 0.001$; Table 60). Differences in length and weight at release for the subyearling program may be attributable, in part, to time-of-release studies (described below under “Recommendations”) designed to increase survival of the program. Beginning with the 2003 brood, fish were released both in May and June. Those fish released in May lacked an additional month of growth compared to the normal program release in June.

The target length and weight for Wells summer Chinook yearling program was 162 mm and 45.4 g, respectively. The mean length at release was 166 mm and not significantly different from the release target size (t-test: $P = 0.31$). The mean weight at release was 51.8 g and not significantly different from the release target size (t-test: $P = 0.09$; Table 60).

The Wells summer Chinook subyearling program release goal of 484,000 was reduced to 394,000 and 384,000 in 1998 and 1999, respectively, but remained at 484,000 for all other years. Based on the mean release goal (466,727) for the period examined, no difference was detected in the number of subyearling Chinook released (t-test: $P = 0.10$; Table 61). Furthermore, no difference between the mean number of fish released and program goal (320,000) was detected for the Wells summer Chinook yearling program (t-test: $P = 0.22$).

Table 60. Mean size at release of Wells summer Chinook salmon.

Subyearling program			Yearling program		
Brood year	Fork length	Weight	Brood year	Fork length	Weight
1997			1997	202	75.6
1998	117	18.3	1998	184	74.1
1999	122	24.5	1999	160	44.5
2000	111	16.9	2000	161	47.9
2001	117	20.6	2001	156	43.8
2002	108	14.7	2002	156	46.7
2003	115	18.9	2003	157	45.0
2004	110	15.0	2004	171	52.0
2005	108	14.3	2005	155	42.1
2006	111	14.9	2006	154	41.1
2007	108	13.5	2007	173	52.3
2008	89	8.57	2008	170	56.0
Mean	111	16.4	Mean	166	51.8
SD	9	4.2	SD	15	11.7

Table 61. Number of Wells summer Chinook salmon released by brood year.

Subyearling program		Yearling program	
Brood year	Number	Brood year	Number
		1992	331,353
1993	187,382	1993	388,248
1994	450,935	1994	365,000
1995	408,000	1995	290,000
1996	473,000	1996	356,707
1997	541,923	1997	381,867
1998	370,617	1998	457,770
1999	363,600	1999	312,098
2000	498,500	2000	343,423
2001	376,027	2001	185,200
2002	473,100	2002	306,810
2003	425,271	2003	313,509
2004	471,123	2004	312,980
2005	430,203	2005	333,587
2006	396,538	2006	311,880
2007	402,527	2007	310,063
2008	427,131	2008	336,881
2009	471,286	2009	446313
Mean	421,598	Mean	337,983
SD	77,323	SD	602,36

Objective 8: Harvest

Harvest of Wells summer Chinook has averaged 58% (SD = 19) between brood years 1992 and 2003, but in more recent years (1997 to 2003) has averaged 72% (Table 62). Despite high harvest rates, no relationship was detected between harvest rates and the ability to meet the broodstock collection goal (Figure 81), indicating that the high harvest rates did not limit broodstock collection.

Table 62. Harvest rates of Wells Summer Chinook.

Brood year	Broodstock			Harvest rate
	Goal	Collected	% Collected	
1992	179	205	115	0.26
1993	434	398	92	0.34
1994	434	440	101	0.33
1995	434	365	84	0.47
1996	434	529	122	0.49
1997	434	463	107	0.71
1998	445	386	87	0.83
1999	389	388	100	0.83
2000	443	432	98	0.69
2001	443	458	103	0.65
2002	443	447	101	0.66
2003	443	368	83	0.67

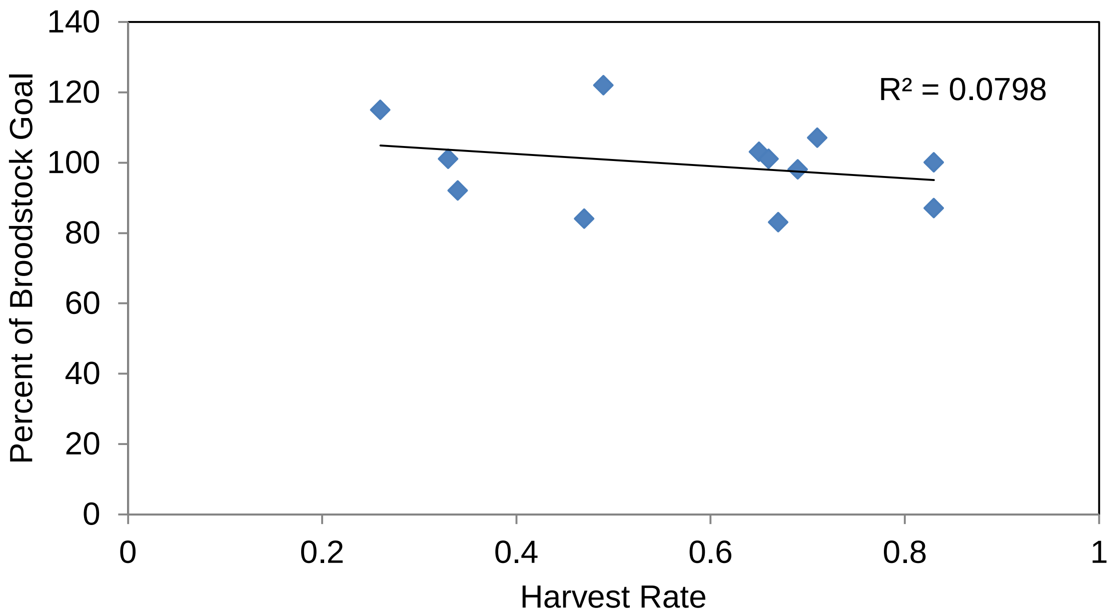


Figure 81. Relationship between harvest rates of Wells Summer Chinook and broodstock collection at Wells Dam.

Summary

A brief assessment of all objectives is provided in Table 63.

Table 63. Summary assessment of M & E objectives for the Wells Hatchery summer Chinook program.

Obj.	Primary indicator	Assessment
4	Hatchery replacement rate	Post-release survival of yearling hatchery fish was not significantly different than expected. Historic survival rates for subyearling were low, but changes in time of release should increase survival to expected levels.
5	Stray rates	Sport fisheries in the upper Columbia and removal of excess hatchery fish at Wells Dam have decreased stray rates to acceptable levels.
6	Size and number of juveniles released	Target length and weight of yearling fish were met. Target weight and length of subyearling fish may need to be modified if survival is increased under the new release schedule. The target numbers of fish released were met.
8	Harvest	Harvest rates of hatchery fish have not limited broodstock.

Wells Summer Chinook Discussion and Recommendations

The Wells summer Chinook program has performed as planned. Survival rates of hatchery fish are adequate. The Wells summer Chinook yearling program releases have been surviving to adults at rates higher than expected and harvest rates are high. Fish stray into non-target populations at acceptable levels, but also require local fisheries and removal of excess hatchery fish at Wells Dam. The Upper Columbia River sport fishery has produced an increase in harvest rates and that, combined with removal of excess fish at Wells FH, is the most likely factor contributing to the observed significant decrease in stray rates of the Wells summer Chinook subyearling program (t-test: $P < 0.01$). Cessation of these activities could increase stray rates above the target level.

Changes in time (an earlier May verses later June release) and size at release of the subyearling Chinook may have provided a survival advantage. We examined differences in SAR and HRR for May-released and June-released (historic) subyearling Chinook from three brood years (2003-2005) using expanded CWT data. Fish released in May had a greater mean SAR (0.18% vs. 0.09%) and HRR (3.0 vs. 1.6) than fish released in June, but neither of these differences were statistically significant due to the low sample size (t-tests: SAR; $P = 0.49$; HRR; $P = 0.62$). Because of the survival benefit provided by May releases, managers shifted the release date for the entire subyearling program to May starting with the 2008 brood. Based on positive preliminary results, the excepted HRR of the subyearling program beginning with the 2008 brood will meet the expected values for the program. In summary, the Wells summer Chinook program is meeting mitigation objectives, while keeping impacts to non-target populations at acceptable levels.

Recommendations:

1. Continue to evaluate time-of-release and size-at-release goals for subyearling Chinook towards increasing opportunity for harvest.

2. Continue or increase sport fisheries targeting Wells summer Chinook and the removal of excess Wells summer Chinook at the volunteer trap in order to ensure that the abundance of stray hatchery fish on the spawning grounds upstream of Wells Dam remains below 5% of the total brood return and below 5% of total spawner abundance in primary populations.

3. A minimum of 10% of the broodstock should be naturally produced fish in order to reduce potential genetic impacts of straying and domestication effects within the broodstock.

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APPENDICES

APPENDIX A

Methods for Estimating Natural Origin Recruits (NORs) and Natural Replacement Rates (NRRs) for Chiwawa Spring Chinook

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This paper describes the methods and data used to estimate natural origin recruits (NORs) and natural replacement rates (NRRs) for spring Chinook in the Chiwawa River. In the annual report (Hillman et al. 2011) we display most of the data used to estimate NORs and NRRs, but have also developed spreadsheets to hold the data and perform the calculations. For the purpose of this paper, we define natural origin recruits as naturally produced (wild)[8] salmon that survive to contribute to harvest (directly or indirectly), to broodstock, or 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). The sum of the natural origin recruits from each brood year are then used to estimate stock-recruit relationships, natural replacement rates, and as a means to compare the survival of wild and hatchery origin fish.

In the Chelan Hatchery Evaluation Program, objectives were identified to evaluate the performance of the program. Specifically, Objectives 1 and 4 assess the adult-to-adult survival of naturally produced and hatchery produced fish (Murdoch and Peven 2005). Under Objective 1, the hypothesis tests if the supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population (supplemented stream) relative to a non-supplemented population (reference stream). Objective 4 compares the natural replacement rate (NRR) to the hatchery replacement rate (HRR). The specific hypotheses tested under each objective are as follows:

Objective 1:

- Ho: The annual change in the number of natural origin recruits for the supplemented population is greater than or equal to the annual change in the number of natural origin recruits of the non-supplemented population.
- Ho: The annual change in natural replacement rates for the supplemented population is greater than or equal to the annual change in natural replacement rates for the non-supplemented population.

[8] In this paper, “natural origin” and “wild” are used interchangeably and refer to the same thing.

Objective 4:

- Ho: The hatchery replacement rate is greater than or equal to the natural replacement rate for the same year.

Two estimates of the number of recruits are identified in the Chelan Hatchery Evaluation Program. First, there is the number of adult wild salmon (NORs) that survive to return to spawn in either the hatchery or spawning grounds. The second is an estimate of the number of recruits that survived to return to spawn plus the number of recruits that were harvested. No pre-spawn mortality, other than harvest, was used to adjust total recruits.

In the following sections we summarize the data used to estimate natural origin recruits and the natural replacement rates for spring Chinook spawning in the Chiwawa River. Data for the period 1981 to 1992 represent population dynamics before initiation of the hatchery program; 1992 to present represent the period of hatchery supplementation. The following sections describe data used to estimate spawning escapement, hatchery-wild fish origin, age structure, and harvest rates. These data are then used to estimate NORs.

Total Spawning Escapement

Redd surveys have been used to estimate the number and distribution of redds of spring Chinook within the Chiwawa River. Redd surveys have evolved over the period 1981 to present. During the period 1981 through 1986, numbers of redds were estimated during “ground peak single surveys” (GPSS), which were conducted once annually during peak spawning (Table 1). From 1987 through 1989, survey effort increased to a “ground peak multiple surveys” (GPMS) during peak spawning. From 1990 through 2003, surveys were conducted once a week throughout the entire spawning period (August-September). Numbers of redds based on this method are referred to as “total ground” (GT) counts. From 2004 to present, survey effort increased to twice a week throughout the spawning period. These different survey methods were used to estimate spawning escapement in the Chiwawa River basin. These escapement estimates include the total number of fish (hatchery and wild) that contribute to natural production in a given return year.

Table 1. Chiwawa River redd counts, expansion factors, and methods used to estimate spawning escapements from 1981 to 2008. GPSS = ground peak single surveys, GPMS = ground peak multiple surveys, GT = total ground count surveys, LJ = Lavoy method, TUM = sampling at Tumwater Dam, and BS = broodstock sampling.

Return Year	Redd Counts		Expansion Factors			Spawning Escapement
	Total	Method	Multiplier	Fish/Redd	Method	
1981	187	GPSS	1.496	2.22	LJ	621
1982	175	GPSS	1.496	2.31	LJ	605
1983	313	GPSS	1.496	2.31	LJ	1,082
1984	348	GPSS	1.496	2.33	LJ	1,213
1985	507	GPSS	1.496	2.27	LJ	1,722
1986	320	GPSS	1.496	2.24	LJ	1,072
1987	444	GPMS		2.24	LJ	995
1988	262	GPMS		2.24	LJ	587
1989	314	GPMS		2.27	LJ	713
1990	255	GT		2.24	LJ	571
1991	104	GT		2.33	LJ	242
1992	302	GT		2.24	LJ	676
1993	106	GT		2.20	LJ	233
1994	82	GT		2.24	LJ	184
1995	13	GT		2.51	LJ	33
1996	23	GT		2.53	LJ	58
1997	82	GT		2.22	LJ	182
1998	41	GT		2.21	LJ	91
1999	34	GT		2.77	LJ	94
2000	128	GT		2.70	TUM	346
2001	1,078	GT		1.60	BS	1,725
2002	345	GT		2.05	BS	707
2003	111	GT		2.43	BS	270
2004	241	GT		3.56	TUM	858
2005	332	GT		1.80	TUM	598
2006	297	GT		1.78	TUM	529
2007	283	GT		4.58	TUM	1,296
2008	689	GT		1.68	TUM	1,158
2009	421	GT		3.20	TUM	1,347
2010	502	GT		2.18	TUM	1,094

Spawning escapements in the Chiwawa River basin are based on expanded redd counts (Table 1). Murdoch et al. (2009) found that on average each female spring Chinook builds and defends one redd (mean = 1.01 redds). Therefore, each redd accounts for one female in the spawning population. By applying an expansion factor (fish/redd), one can account for the number of females and males on the spawning grounds.

Methods for estimating spawning escapements have changed over time based on survey effort and expansion factors used. From 1981 to 1986 when GPSS surveys were conducted, a multiplier of 1.496 was applied to redd counts to make counts based on a single survey comparable to cumulative ground counts (Lavoy 1995). These products were then multiplied by an expansion factor developed by Lavoy (1994; LJ method). The LJ expansion factor was estimated as follows:

$$LJ\ Expansion\ Factor = \left(\frac{Fish}{Redd}\right) \times \left(1 + \left(\frac{Number\ of\ Jacks}{Total\ Escapement}\right)\right)$$

The LJ method used a fish/redd estimate of 2.2, which was calculated as the escapement into the Wenatchee Basin (1,339), divided by the total number or redds (600) counted in the Wenatchee Basin in 1993 (1,339 fish / 600 redds = 2.2 fish/redd). The 2.2 fish/redd estimate was then multiplied by the proportion of jacks in the run (where the number of jacks in the run was estimated as the difference in jack counts at Rocky Reach Dam and Rock Island Dam). For example, if jacks made up 14% of the run, the 2.2 fish/redd was multiplied by 1.14 to estimate an expansion factor of 2.51 fish/redd (2.2 fish/redd x 1.14 = 2.51 fish/redd). This product was then used to convert GPSS and GPMS redd counts into spawning escapements for return years 1987 to 1999.

For return years 2000 to present, the fish/redd expansion estimate was based on the male-to-female ratios observed during sampling at Tumwater Dam (TUM) or during brood stock (BS) sampling at the Chiwawa Weir each return year (Table 1). The gender-based expansion factor was estimated as follows:

$$Gender\ Expansion\ Factor = 1 + \left(\frac{Number\ of\ Males}{Number\ of\ Females}\right)$$

For example, if the sex ratio of a random sample of the run was 1.43 males to 1.00 females, the expansion factor would be 2.43 fish/redd (1.00 + 1.43 = 2.43). This gender-based expansion factor was then multiplied by the total redd count to estimate the spawning escapement. This method assumes that on average males spawn with only one female.

Hatchery and Wild Spawner Escapements

The proportion of hatchery and wild fish within the spawning escapement was estimated from fish collected during broodstock sampling (BS) at Tumwater Dam or at the Chiwawa River weir, and carcass sampling (CS) on the spawning grounds. Prior to initiation of the supplementation program in 1989 and before the return of hatchery fish, returns to the Chiwawa River were assumed to be naturally produced fish. Although it is possible that hatchery fish from the Leavenworth Hatchery strayed into the Chiwawa Basin during this period, the number of strays is assumed to be very low (Pastor 2004). From 1993 to present, the origin of returning fish was determined from analysis of scale growth patterns, presence/absence of adipose fin, and recovery of coded wire tags.

The number of wild and hatchery spawners was estimated by multiplying the total spawning escapement by the proportion of wild and hatchery fish observed in broodstock and carcass sampling. Table 2 presents the proportions of hatchery and wild fish used to estimate the total number of hatchery and wild spring Chinook spawners in the Chiwawa Basin. During return years 1993, 1994, and 1997, when carcass recovery rates were low on the spawning grounds, broodstock and carcass sampling were combined to estimate proportions of hatchery and wild spawners.

From 2004 to 2008, reach-specific wild and hatchery proportions were estimated for each survey reach in the Chiwawa Basin. Reach-specific hatchery-to-wild proportions reduce the possible bias associated with an uneven spawning distribution of hatchery and wild fish within the Chiwawa River.

To estimate the number of wild fish in the spawning escapement, the proportion of wild fish sampled was multiplied to the total spawning escapement to get the escapement of wild fish. For example, in 2001, the proportion of wild fish sampled (0.24) was multiplied by the total spawning escapement (1,725 fish) to get a wild spawning escapement of 598 fish (0.24 x 1,725 = 414). The number of hatchery fish was estimated similarly (0.76 x 1,725 = 1,311). To calculate the total wild return, we added wild fish collected and retained as broodstock to the wild spawning escapement estimate for each year.

Table 2. Total spawning escapements of hatchery and wild spring Chinook calculated from proportions of wild and hatchery spring Chinook sampled in broodstock (BS), from carcass sampling (CS), and reach-specific carcass recovery sampling (CS/reach).

Year	Hatchery and Wild Proportions			Spawning Escapement			Wild Broodstock	Total Wild Return
	Wild	Hatchery	Method	Wild	Hatchery	Total		
1981	1.00	0.00	All wild return	621	0	621	0	621
1982	1.00	0.00		605	0	605	0	605
1983	1.00	0.00		1,082	0	1,082	0	1,082
1984	1.00	0.00		1,213	0	1,213	0	1,213
1985	1.00	0.00		1,722	0	1,722	0	1,722
1986	1.00	0.00		1,072	0	1,072	0	1,072
1987	1.00	0.00		995	0	995	0	995
1988	1.00	0.00		587	0	587	0	587
1989	1.00	0.00		713	0	713	28	741
1990	1.00	0.00		571	0	571	19	590
1991	1.00	0.00		242	0	242	32	274
1992	1.00	0.00		676	0	676	78	754
1993	0.99	0.01	BS+CS	231	2	233	100	331
1994	0.67	0.33	BS+CS	123	61	184	9	132
1995	0.00	1.00	CS	0	33	33	0	0
1996	0.70	0.30	CS	41	17	58	8	49
1997	0.33	0.67	BS+CS	60	122	182	37	97
1998	0.65	0.35	CS	59	32	91	13	72
1999	0.93	0.07	CS	87	7	94	0	87
2000	0.67	0.33	CS	233	113	346	10	243
2001	0.29	0.71	CS	507	1,218	1,725	115	622
2002	0.36	0.64	CS	255	452	707	21	276
2003	0.62	0.38	CS	168	102	270	44	212
2004	0.68	0.32	CS/Reach	580	278	858	100	680
2005	0.23	0.77	CS/Reach	139	459	598	98	237
2006	0.22	0.78	CS/Reach	114	415	529	95	209
2007	0.12	0.88	CS/Reach	156	1,140	1,296	45	201
2008	0.17	0.83	CS/Reach	197	961	1,158	88	285
2009	0.23	0.77	CS/Reach	303	1,044	1,347	113	416

Age Structure (Wild Fish)

In order to estimate the year in which fish were produced (brood year), we organized wild fish by age class (i.e., 1.1, 1.2, and 1.3) within a return year. The age-class structure presented in Table 3 identifies what proportion of the return-year escapement is made up of each age class. The age of returning wild fish was determined from analysis of scales collected on the spawning grounds and/or from fish collected for broodstock. Two year old fish (age-2; 1.0) are not included in the age structure although a few have been recovered (see Hillman et al. 2001; Table 5.29). A few were recovered in 2006 and 2008 but these fish resided within freshwater till their second year. We developed separate age-class structures for fish sampled on spawning grounds and for fish collected for broodstock. For some years the age structure was unknown, so an average age structure was used from data collected during 1986-1993 on the spawning grounds (from Chapman et al. 1995 reported in their Table 9). That age structure was used for 1981-1986 and 1995 on the spawning grounds, and 1989, 1990, and 1992 for wild broodstock.

The age-class proportions in Table 3 were applied to the wild spawning escapement and broodstock to estimate the number of returning fish of a given age (Table 4). The number of wild fish of a given age within a return year was estimated as the spawning escapement or broodstock times the proportion for that return year and age. For example, in 2004 the wild spawning escapement in the Chiwawa Basin was 582 fish (Table 2). The number of wild fish of each age class on the spawning grounds in 2004 was estimated to be 12 age-3 fish (582 x 0.020 = 12 fish), 564 age-4 fish (582 x 0.970 = 564 fish), and 6 age-5 fish (582 x 0.010 = 6 fish). When this exercise is carried out for each return year, the age-specific escapement can be estimated for all wild fish collected for broodstock or returning to spawn in the Chiwawa Basin (Table 4).

This approach does not address the issue of carcass recovery bias. Carcass recovery bias is important for spring Chinook stock reconstruction because a majority of the recruits for any given year are recovered on the spawning grounds. Larger fish may be recovered on the spawning grounds at a greater rate than smaller fish. Furthermore, if hatchery fish return as smaller and younger adults compared to wild fish, they would be underrepresented in the carcass surveys. We intend to address this bias once methodologies have been developed.

Table 3. Proportion of wild Chinook of different ages in broodstock and sampled on the spawning grounds.

Return Year	Wild Spring Chinook Age Class Proportions (Total Age)					
	Spawning			Broodstock		
	Age-3 (1.1)	Age-4 (1.2)	Age-5 (1.3)	Age-3 (1.1)	Age-4 (1.2)	Age-5 (1.3)
1981	0.010	0.564	0.425	-	-	-
1982	0.010	0.564	0.425	-	-	-
1983	0.010	0.564	0.425	-	-	-
1984	0.010	0.564	0.425	-	-	-
1985	0.010	0.564	0.425	-	-	-
1986	0.010	0.564	0.425	-	-	-
1987	0.010	0.564	0.425	-	-	-
1988				-	-	-
1989				0.010	0.564	0.426
1990				0.010	0.564	0.426
1991				0.156	0.594	0.250
1992				0.010	0.564	0.426
1993	0.000	0.286	0.714	0.000	0.220	0.780
1994	0.000	0.250	0.750	0.000	0.286	0.714
1995	0.000	0.100	0.000	No Hatchery Program		
1996	0.294	0.647	0.059	0.286	0.714	0.000
1997	0.000	0.871	0.129	0.000	0.875	0.125
1998	0.000	0.054	0.946	0.000	0.636	0.364
1999	0.050	0.650	0.300	No Hatchery Program		
2000	0.018	0.946	0.036	0.200	0.700	0.100
2001	0.011	0.949	0.040	0.028	0.944	0.028
2002	0.000	0.556	0.444	0.000	0.667	0.333
2003	0.083	0.000	0.917	0.270	0.027	0.703
2004	0.060	0.930	0.010	0.063	0.906	0.031
2005	0.015	0.776	0.209	0.010	0.850	0.140
2006	0.030	0.560	0.400	0.021	0.702	0.277
2007	0.103	0.241	0.655	0.163	0.535	0.302
2008	0.023	0.814	0.163	0.091	0.753	0.156
2009	0.089	0.867	0.044	0.084	0.800	0.116

Table 4. Number of wild fish by age class estimated on the spawning grounds and collected for broodstock.

Return Year	Wild Spring Chinook Age Classes (Total Age)							
	Spawning Grounds				Broodstock			
	Age-3 (1.1)	Age-4 (1.2)	Age-5 (1.3)	Total	Age-3 (1.1)	Age-4 (1.2)	Age-5 (1.3)	Total
1981	6	351	264	621	-	-	-	-
1982	6	342	257	605	-	-	-	-
1983	11	611	460	1,082	-	-	-	-
1984	12	685	516	1,213	-	-	-	-
1985	18	972	732	1,722	-	-	-	-
1986	11	605	456	1,072	-	-	-	-
1987	10	562	423	995	-	-	-	-
1988	6	332	249	587	-	-	-	-
1989	7	403	303	713	0	16	12	28
1990	6	322	243	571	0	11	8	19
1991	2	137	103	242	5	19	8	32
1992	7	382	287	676	1	44	33	78
1993	0	66	165	231	0	22	78	100
1994	0	31	92	123	0	3	6	9
1995	0	0	0	0	0	0	0	0
1996	12	27	2	41	2	6	0	8
1997	0	52	8	60	0	32	5	37
1998	0	3	56	59	0	8	5	13
1999	4	57	26	87	0	0	0	0
2000	4	221	8	233	2	7	1	10
2001	6	481	20	507	3	109	3	115
2002	0	142	113	255	0	14	7	21
2003	14	0	154	168	12	1	31	44
2004	35	539	6	580	6	91	3	100
2005	2	108	29	139	1	83	14	98
2006	3	59	52	114	2	67	26	95
2007	16	38	102	156	7	24	14	45
2008	5	160	32	197	8	66	14	88
2009	27	263	12	303	9	90	13	112

NORs and NRRs (without harvest)

Natural origin recruits (NORs) can be estimated by reorganizing the data in Table 4. First, the number of wild fish in each age class must be backed to brood year (the year the fish were produced). This is calculated by subtracting the total age of the fish from their return year. The number of recruits of each age class for a given brood year are then added together to estimate the total number of wild recruits for a given brood year.

For example, the number of wild fish returning from the 2001 brood year was 310 fish, which is the sum of wild fish returns from 2004-2006:

Return year	Age at Return	Spawning Escapement	Broodstock	Total
2004	3	35	6	41
2005	4	108	83	191
2006	5	52	26	78
			Total	**310**

These 310 fish represent the NORs that returned from natural production in 2001. Table 5 identifies the total number of wild recruits to the Chiwawa Basin organized by age and brood year along with the spawning escapement that produced them. These NORs do not include fish harvested in the ocean, estuary, or Columbia River.

Natural replacement rate (NRR) was estimated as follows:

$$NRR = \frac{NOR}{Spawning\ Escapement}$$

In words, NRR is the total number of wild recruits divided by the spawning escapement (includes both wild and hatchery spawners) that produced them. The NRR for brood year 2001 is 0.18, which was calculated by dividing the total number of wild recruits (310) by the spawning escapement (1,725) to get 0.18 wild recruits per spawner. Table 5 identifies the NRRs for brood years 1981 to 2002.

Table 5. Chiwawa spring Chinook natural origin recruits for brood years 1981 to 2002. The natural replacement rate is total recruits divided by spawning escapement.

Brood Year	Natural Origin Recruits	Spawning Escapement	Natural Replacement Rate
1981	1,440	621	2.32
1982	1,046	605	1.73
1983	822	1,082	0.76
1984	657	1,213	0.54
1985	676	1,722	0.39
1986	451	1,072	0.42
1987	482	995	0.48
1988	676	587	1.15
1989	194	713	0.27
1990	34	571	0.06
1991	2	242	0.01
1992	46	676	0.07
1993	159	233	0.68
1994	37	184	0.20
1995	66	33	2.00
1996	255	58	4.40
1997	716	182	3.93
1998	350	91	3.85
1999	10	94	0.11
2000	699	346	2.02
2001	310	1,725	0.18
2002	245	707	0.35
2003	113	270	0.42
2004	275	858	0.32

NORs and NRRs (with harvest)

So far we have described the wild return as the sum of the wild spawning escapement and wild fish collected for broodstock (Table 2). However, it is also important to add the number of wild fish harvested in various fisheries and the incidental loss of wild fish killed in mark-selective fisheries, which began in 2001, to the wild return. Thus, the total wild escapement is here defined as the number of wild fish harvested, plus the estimated incidental mortalities, plus the number of wild fish in broodstock, plus the number of wild fish spawning in the Chiwawa Basin.

$$Total\ Wild\ Escapement = Spawning\ escapement + Broodstock + Harvest + Incidental\ Loss$$

One way to estimate the number of wild spring Chinook harvested is to apply the return-year harvest rates that are reported in the Joint Staff Reports produced by Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife (ODFW and WDFW 2009). Another way is to use a hatchery indicator stock, such as the Chiwawa Hatchery or Leavenworth National Fish Hatchery (LNFH) to estimate brood-year harvest rates on wild fish. Below we describe both methods as they apply to wild spring Chinook in the Chiwawa Basin. Selection of the most appropriate method, or combination of methods, will be determined by the HETT and Hatchery Committees.

Hatchery Indicator Stock Harvest Rates—The assumption when using a hatchery indicator stock, such as spring Chinook from the LNFH or the Chiwawa River Hatchery, is that hatchery and wild fish have a similar adult migration pattern. That is, hatchery fish and wild fish have similar encounter and capture rates in different fisheries. We used these hatchery indicator stocks to produce brood-year harvest rates that could be applied to brood-year returns of wild spring Chinook. During brood years 1981-1996, when there were no mark-selective fisheries, the harvest rate on hatchery fish that was applied to wild fish was estimated as follows:

$$Hatchery\ Harvest\ Rate = \frac{Total\ Expanded\ Estimate\ of\ CWT\ Fish\ Harvested}{Total\ Expanded\ Estimate\ of\ CWTs\ Collected}$$

The denominator (total expanded estimate of CWTs collected) includes all CWTs estimated in hatchery programs, on spawning grounds, and in fisheries. As an example, the harvest rate on brood year 1993 spring Chinook was 2.6% (16 / 606 = 0.026 or 2.6%). We used the mean harvest rate from several years (1984, and 1986-1989) to describe the harvest rate in missing years (1981-1983, and 1985). Table 6 shows harvest rates on Icicle Creek spring Chinook from the LNFH for brood years 1981 to 1996 and 1999.

These harvest rates were then applied to the wild return (wild spawners plus wild fish in broodstock) to estimate total wild fish escapement, which includes harvest, as follows:

$$Total\ Wild\ Fish\ Escapement = \frac{(Wild\ Fish\ Spawners) + (Wild\ Fish\ in\ Broodstock)}{1 - (Harvest\ Rate)}$$

For example, the total wild escapement (including harvest) for brood year 1989 was estimated at 282 wild spring Chinook. This method of estimating harvest was used for brood years before 1997 (Table 6).

$$Total\ Wild\ Fish\ Escapement = \frac{165 + 29}{1 - 0.313} = \frac{194}{0.687} = 282$$

LNFH harvest rate was also used in 1999 for mark-selective fisheries because there was no broodstock collected for the Chiwawa Hatchery Program that year.

Table 6. Harvest rates on Icicle Creek spring Chinook from the LNFH that were used to estimate harvest on wild Chiwawa River spring Chinook.

Brood Year	Icicle Creek Harvest Rates (LNFH)			Chiwawa River Spring Chinook		
	Total Harvest	Total Collected	Harvest Rate	Total Wild Escapement	Estimated Wild Harvest	Total Wild Escapement + Harvest
1981	---	---	0.348	1,440	769	2,209
1982	---	---	0.348	1,046	558	1,604
1983	---	---	0.348	822	439	1,261
1984	9	20	0.450	657	538	1,195
1985	---	---	0.348	676	361	1,037
1986	144	380	0.379	451	275	726
1987	261	895	0.292	482	199	681
1988	269	884	0.304	676	295	971
1989	112	358	0.313	194	88	282
1990	2	13	0.154	34	6	40
1991	7	93	0.075	2	0	2
1992	8	160	0.050	46	2	48
1993	16	606	0.026	159	4	163
1994	4	158	0.025	37	1	38
1995	16	354	0.045	66	3	69
1996	90	1,054	0.085	255	24	279
1999	40	231	0.048	10	1	11

Mark-selective (adipose fin clipped) harvest was initiated on spring Chinook returns in 2001 for recreational sport fisheries and in 2002 on commercial fisheries in the Columbia River. As a result, total harvest on wild spring Chinook was reduced. However, incidental mortality still occurred on wild spring Chinook as a result of catch-and-release in the mark-selective fisheries. These mark-selective fisheries affected the harvest rate on wild spring Chinook from brood year 1997 to present. We applied the incidental mortality estimates in the Joint Staff Report (2009), which used a 10% incidental mortality rate on wild spring Chinook released from sport-selective fisheries and a 14.7% incidental mortality rate on wild fish released from commercial gillnet fisheries.

Table 7 shows the estimated harvest on hatchery spring Chinook from the Chiwawa Hatchery and LNFH (1999 only) for brood years 1997-2002. The harvest rates were adjusted to estimate the harvest on wild fish based on an incidental mortality rate of 10% in recreational sport fisheries and an incidental mortality rate of 14.7% in commercial gillnet fisheries. Harvest rates (including indirect mortality) on wild fish for brood years 1997-2002 were estimated as follows:

$$HR = \frac{(Sport\ Harvest\ x\ 0.10) + (Commercial\ Harvest\ x\ 0.147) + (Nonselective\ Harvest)}{Total\ Expanded\ CWT\ Estimate}$$

For example, for brood year 1997, the estimated harvest rate on wild fish was 0.0986.

$$HR = \frac{(109\ x\ 0.10) + (27\ x\ 0.147) + (235)}{2{,}549}$$

$$HR = \frac{(11) + (4) + (235)}{2{,}549} = \frac{250}{2{,}549} = 0.09808$$

Thus, the total wild fish escapement (including harvest and incidental mortality) for brood year 1997 was estimated at 794 wild spring Chinook (716/ (1 - 0.09808) = 862).

Table 7. Estimated brood-year harvest rates for wild fish based on adjusted hatchery harvest rates. Hatchery harvest rates were based on CWT recoveries of Chiwawa Hatchery spring Chinook in all years except 1999 when there was no program. In 1999, recoveries of spring Chinook from the LNFH were used to estimate the wild harvest rate.

Brood Year	Fisheries			Total		Hatchery Harvest Rates	Wild Incidental Mortality Rates	Wild Escapement	
	Sport Selective	Comm. Selective	Non-Selective	Harvest	Expanded CWT Estimate			No Harvest	Harvest included
1997	109	27	235	371	2,549	0.1455	0.0980	716	794
1998	119	9	56	184	1,118	0.1646	0.0619	350	373
1999	16	24	0	40	234	0.1709	0.0479	10	11
2000	6	0	17	23	375	0.0613	0.0469	699	733
2001*	11	1	25	37	1,830	0.0143	0.0143	310	314
2002	26	20	25	71	760	0.0934	0.0402	245	255
2003	26	11	47	84	763	0.1101	0.0671	113	121
2004	250	31	190	471	2,973	0.1584	0.0739	275	297

*In brood year 2001 all Chiwawa hatchery fish were released with their adipose fins intact. That is why the hatchery harvest rate and incidental mortality rates are identical.

<u>**Joint Staff Report Harvest Rates**</u>—The Joint Staff Report (2009) estimates total fisheries harvest by return year for upper Columbia wild spring Chinook (Table 8). The Joint Staff also produces a similar table for wild Snake River spring/summer Chinook. The mainstem harvest rate on wild Chiwawa spring Chinook was estimated as follows:

$$Mainstem\ Harvest\ Rate = \left(\frac{(Total\ Fisheries\ Harvest) \times \left(\frac{Priest\ Rapids\ Dam\ Count}{Upper\ Columbia\ Wild\ Run\ Size}\right)}{Priest\ Rapids\ Dam\ Passage} \right)$$

For example the harvest rate on wild spring Chinook in 1989 was estimated at 0.099.

$$Mainstem\ Harvest\ Rate = \frac{653 \times 0.567}{3{,}732} = 0.099$$

The return-year harvest rates were then applied to the total wild returns provided in Table 2. Table 9 shows the estimated harvest on wild spring Chinook from 1981 to 2006 from the Chiwawa River. Because the age structure of harvested wild fish is unknown, we used the combined age structure of fish collected as broodstock and on the spawning ground to estimate the age structure of fish harvested in the mainstem Columbia River. No additional harvest estimates from fisheries in Icicle Creek or on the Wenatchee River were made to adjust the total harvest on wild Chiwawa River spring Chinook.

The return-year age structure for harvested wild fish was converted into brood-year returns using the methods described earlier in this report. Table 10 provides NORs and NRRs estimates with and without harvest. The table also shows for comparison NORs and NRRs adjusted for harvest based on a hatchery indicator stock and return-year harvest rates published in the Joint Staff Report. From 1990 to 2002, both methods provided similar NORs (Table 10 and Figure 1). However, from 1981 to 1989, the hatchery-indicator-stock method consistently estimated larger harvests on wild spring Chinook and therefore higher numbers of NORs (Table 10 and Figure 1).

Table 8. Columbia River fisheries and passage-loss impacts on the Upper Columbia wild spring Chinook run and escapements, 1980-2006 (from Joint Staff Report 2009).

Retur n year	Upper Columbia Wild Run Size	Non-Indian Catch[1]		Treaty Indian Catch[2]		Fisheries Total		Escapement at Priest Rapids[3]	
		No.	% of Run	No.	% of Run	No.	% of Run	No.	% of Run
1980	8,206	17	0.2	266	3.2	283	3.4	3,586	43.7
1981	9,982	141	1.4	506	5.1	647	6.5	6,695	67.1
1982	7,626	135	1.8	526	6.9	661	8.7	3,714	48.7
1983	8,542	413	4.8	346	4.1	759	8.9	5,158	60.4
1984	7,250	252	3.5	483	6.7	735	10.1	5,006	69.0
1985	11,006	402	3.7	376	3.4	778	7.1	9,336	84.8
1986	8,175	170	2.1	476	5.8	646	7.9	5,716	69.9
1987	7,584	120	1.6	462	6.1	582	7.7	5,374	70.9
1988	5,488	354	6.5	365	6.7	719	13.1	3,878	70.7
1989	6,580	158	2.4	495	7.5	653	9.9	3,732	56.7
1990	5,643	287	5.1	372	6.6	659	11.7	4,007	71.0
1991	2,514	100	4.0	152	6.0	252	10.0	1,736	69.1
1992	5,007	83	1.7	302	6.0	385	7.7	3,980	79.5
1993	5,268	45	0.9	322	6.1	367	7.0	4,678	88.8
1994	1,804	71	3.9	88	4.9	159	8.8	1,155	64.0
1995	290	0	0.0	15	5.2	15	5.2	157	54.1
1996	308	0	0.0	16	5.2	16	5.2	173	56.2
1997	1,071	1	0.1	72	6.7	73	6.8	655	61.2
1998	401	0	0.0	21	5.2	21	5.2	284	70.8
1999	642	1	0.2	30	4.7	31	4.8	451	70.2
2000	3,007	6	0.2	183	6.1	189	6.3	2,098	69.8
2001	10,103	156	1.5	1326	13.1	1,482	14.7	8,047	79.6
2002	5,757	112	1.9	625	10.9	737	12.8	4,037	70.1
2003	2,581	40	1.5	204	7.9	244	9.5	1,785	69.2
2004	3,119	65	2.1	271	8.7	336	10.8	2,264	72.6
2005	2,445	40	1.6	153	6.3	193	7.9	1,778	72.7
2006	2,817	38	1.3	185	6.6	223	7.9	1,807	64.1

[1] Includes incidental mortalities in mainstem recreational and commercial fisheries.

[2] Includes winter season commercial sales and spring C&S catches. Since 1982, C&S catch includes gill net, dip net, and hook and line.

[3] Priest Rapids Dam passage.

Table 9. Harvest and age-at-return estimates for wild spring Chinook harvested in the mainstem Columbia River.

Year	Total Wild Return	Return-Year Harvest Rate	Total Wild Return + Harvest	Age at Harvest			Total
				Age-3	Age-4	Age-5	
1981	621	0.065	664	1	24	18	43
1982	605	0.087	663	1	32	25	58
1983	1,082	0.089	1,188	1	60	45	106
1984	1,213	0.101	1,349	1	77	58	136
1985	1,722	0.071	1,854	1	75	56	132
1986	1,072	0.079	1,164	1	52	39	92
1987	995	0.077	1,078	1	47	35	83
1988	587	0.131	675	1	50	37	88
1989	741	0.099	822	1	46	34	81
1990	590	0.117	668	1	44	33	78
1991	274	0.100	304	1	17	12	30
1992	754	0.077	817	1	35	27	63
1993	331	0.070	356	0	6	19	25
1994	132	0.088	145	0	3	10	13
1995	0	0.049	0	0	0	0	0
1996	49	0.055	52	1	2	0	3
1997	97	0.067	104	0	6	1	7
1998	72	0.051	76	0	1	3	4
1999	87	0.047	91	0	3	1	4
2000	243	0.063	259	1	14	1	16
2001	622	0.146	728	2	100	4	106
2002	276	0.127	316	0	23	17	40
2003	212	0.094	234	4	0	18	22
2004	680	0.108	762	5	75	2	82
2005	237	0.081	258	0	17	4	21
2006	209	0.067	224	0	10	5	15

Table 10. Estimates of total spawning escapement, NORs, and NRRs with and without harvest for Chiwawa spring Chinook for brood years 1981-2002. Results from both the hatchery-indicator-stock method and Joint-Staff-Report method are presented for comparison.

Brood Year	Total Spawning Escapement	Harvest Not Included		Harvest Included			
				Indicator Stock		Joint Staff Report	
		NOR	NRR	NOR	NRR	NOR	NRR
1981	621	1,440	2.32	2,209	3.56	1,555	2.50
1982	605	1,046	1.73	1,604	2.65	1,134	1.87
1983	1082	822	0.76	1,261	1.17	907	0.84
1984	1213	657	0.54	1,195	0.99	742	0.61
1985	1722	676	0.39	1,037	0.60	756	0.44
1986	1072	451	0.42	726	0.68	508	0.47
1987	995	482	0.48	681	0.68	527	0.53
1988	587	676	1.15	971	1.65	731	1.25
1989	713	194	0.27	282	0.40	211	0.30
1990	571	34	0.06	40	0.07	37	0.06
1991	242	2	0.01	2	0.01	2	0.01
1992	676	46	0.07	48	0.07	49	0.07
1993	233	159	0.68	163	0.70	169	0.73
1994	184	37	0.20	38	0.21	39	0.21
1995	33	66	2.00	69	2.09	70	2.12
1996	58	255	4.40	279	4.81	273	4.71
1997	182	716	3.93	794	4.36	834	4.58
1998	91	350	3.85	373	4.10	393	4.32
1999	94	10	0.11	11	0.12	12	0.13
2000	312	699	2.02	733	2.12	782	2.26
2001	2490	310	0.18	316	0.18	337	0.20
2002	707	245	0.35	255	0.36	255	0.36

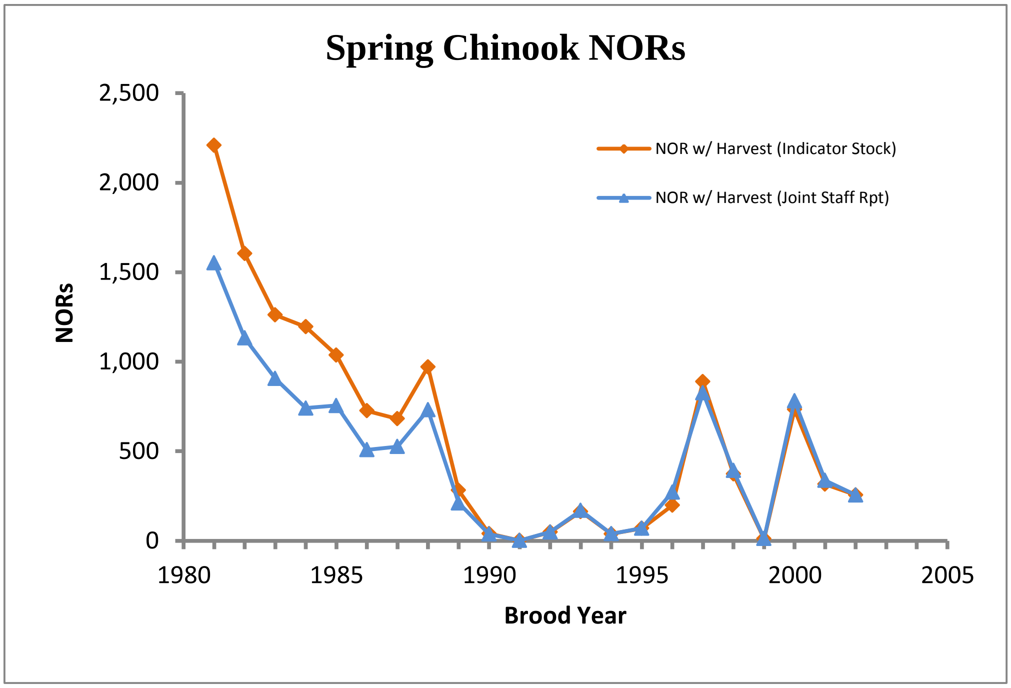

Figure 1. Comparison of the number of harvest-adjusted NORs using the hatchery indicator stock method and the Joint Staff Report method.

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APPENDIX B

Methods for Estimating Stray Rates

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This paper describes the methods and data used to estimate stray rates for coded wire tagged (CWT) Chinook and PIT-tagged steelhead and sockeye salmon. We use Wenatchee Summer Chinook as an example of the methods used that are also applied to Chiwawa Hatchery spring Chinook, Methow and Okanogan summer Chinook, and Turtle Rock Summer Chinook. For steelhead, CWT's have not been routinely used nor are adults recovered on spawning grounds. For steelhead and sockeye, we used the distribution of PIT tag detections to assess brood year stray rates.

In the Chelan Hatchery Evaluation Program, objectives were identified to evaluate the performance of the program. Objective 5 is a comprehensive assessment of returning adult migration behavior. There are three different hypotheses under objective 5 that test if the program is performing within established guidelines:

(1) Stray rates of hatchery fish is less than 5% of the total brood return.

(2) Stray hatchery fish make up less than 5% of the spawning escapement within other independent populations (based on run year).

(3) Stray hatchery fish make up less than 10% of the spawning escapement within non-target spawning areas within the population (based on run year). At this time, this objective applies only to the Chiwawa spring Chinook program.

Chinook stray rates are based on the return, recovery, and expansion of coded wire tagged (CWT) hatchery fish. Coded wire tags can be recovered in ocean and freshwater fisheries (harvest), from volunteer and non-volunteer hatchery locations (broodstock collection), and from spawning ground surveys. For stray rate estimation we focus on CWT returns to hatcheries and spawning grounds. Coded wire tag information was queried from the Regional Mark Process Center's Regional Mark Information System (RMIS).

For PIT-tagged fish, returning adult information can be queried from either the PIT tag information system (PTAGIS) or Columbia River DART. Data can be extracted to develop detection histories and last observation sites for each tagged fish. We used the last detection observation location as the best indication of migratory behavior. That is, if steelhead or sockeye were last detected in the Wenatchee River basin they were assumed to be homing to their natal stream. Last detections within tributaries outside the Wenatchee River basin were considered strays.

The terms "homing" and "straying" are used to describe adult salmonid migratory behavior although, the definition of a "stray" is difficult to resolve when returning fish exhibit exploratory or wandering behavior. This behavior can lead to harvest or broodstock collection before their spawning migration is fully expressed (Pastor 2004). Exploratory behavior or wandering (i.e., temporary use of non-natal tributaries) by salmon and steelhead during migration allows some fish to be intercepted for broodstock at dams or in non-natal streams. Because these intercepted fish may not have completed their spawning migration, they should not be considered "strays." We agree with Heard (1991) that a definite conclusion about "homing" and "straying" cannot be made until the fish has spawned. We suggest that PIT tags and CWT's recovered from harvest should not be considered "strays," and therefore should not be used in the calculation of stray rates. Harvested fish are captured before they spawn, which means that their migration behavior has not been fully expressed. We also recognize that PIT tagged strays rates based on last detection do not document that a fish has spawned but they do offer a reasonable assessment of their migratory behavior.

Hatchery fish can affect hatchery programs and natural production areas when they are used in non-target hatcheries or stray into non-target spawning areas. Therefore, it is important to identify strays that contribute to both natural and hatchery production. As such, we separate the distribution of hatchery returns into two components: (1) hatchery fish that return and contribute to natural production and (2) hatchery fish that return and contribute to hatchery production. The first hypothesis in Objective 5 encompasses both components by examining the performance of returning adult from a specific brood year. For the first hypothesis, we use CWT and PIT tag information to formulate brood year stray rates. The second and third hypotheses consider only the first component by return year into natural production areas. Under the second and third hypotheses, homing and straying is currently only demonstrated by CWT collection of fish on the spawning grounds. With this distinction, homing and straying of hatchery fish can be defined as follows:

1. **Contribution to Natural Production: Hatchery fish that return and spawn in the wild.**

   Natural Homing—Hatchery fish that return and spawn naturally in their natal (target) stream where they were acclimated/released and contribute to the production and gene pool of the local spawning population.

   Natural Straying—Hatchery fish that return and spawn naturally in a non-target stream and contribute to the production and gene pool of that local spawning population.

2. **Contribution to Hatchery Production: Hatchery fish that return and are spawned in a hatchery.**

   Hatchery Homing—Hatchery fish that return to their target stream where they were acclimated/released, but are intercepted <u>and</u> used for broodstock in the hatchery of origin.

Hatchery Straying—Hatchery fish that are collected (actively or volunteered) and spawned by a hatchery other than its origin. These fish contribute to the production and gene pool of that non-target hatchery program[9]**.**

What follows are brief examples that illustrate how stray rates were estimated for each hypothesis in Chelan's Hatchery Evaluation Program (Hillman et al. 2011).

Brood Year Return Stray Rates

***PIT-based Brood Year Stray Rates*-**In hypothesis 1 the stray rates of hatchery fish is compared to the established guideline of less than 5% total brood return strays. We use Wenatchee summer Chinook as an example of calculating stray rates for total brood returns based on CWT returns for Chelan's hatchery Chinook programs. We used recent PIT tagged hatchery fish released from 2006 to 2008 to examine the potential of estimating brood year stray rates for Wenatchee steelhead and sockeye salmon. Development of a fairly comprehensive PIT tag detection system (observation sites) in the Upper Columbia allowed us to track the location of adult hatchery returns to many of the tributaries (Wenatchee, Methow, and Entiat) where sockeye and steelhead spawn. Most of the tributary locations were established after 2006. The Okanogan (Zosel Dam) has only recently been included (Sept. 2010) that will assist with potential detections of PIT tagged sockeye straying from Lake Wenatchee. In the first section, we examine PIT-based stray rates for sockeye salmon and steelhead followed by CWT-based stray rates for Chinook salmon.

Table 1 displays the PIT tag release groups that were used to assess stray rates of Wenatchee steelhead and sockeye salmon. We selected brood year 2005 as the first year of evaluation because most of the tributary PIT tag observation sites were available for sockeye and steelhead adult returns. We used adult PIT tag detection histories from return years 2007 to 2011for steelhead and 2008 to 2010 for sockeye. The 2011 adult sockeye migration was incomplete at the time this evaluation was completed.

[9] Quinn (1997) used the term "functional stray" to refer to fish that swim into, and are spawned at a hatchery different than the releasing hatchery.

Table 1. Juvenile PIT tagged steelhead and sockeye release groups used to assess stray rates as returning adults. Release location designations from PTAGIS appear in parentheses.

Program	Brood Year	Release Year	Release Site	Number Released
Steelhead	2005	2006	Chiwawa River (CHIWAR)	4,215
			Nason Creek (NASONC)	7,383
			Wenatchee River (WENATR)	16,783
	2006	2007	Chiwawa River (CHIWAR)	3,704
			Nason Creek (NASONC)	8,152
			Wenatchee River (WENATR)	18,044
	2007	2008	Chiwawa River (CHIWAR)	3,292
			Nason Creek (NASONC)	8,827
			Wenatchee River (WENATR)	17,282
Sockeye	2005	2006	Lake Wenatchee (WENATL)	14,859
	2006	2007	Lake Wenatchee (WENATL)	14,764
	2007	2008	Lake Wenatchee (WENATL)	14,947

For steelhead we assessed stray rates for brood years 2005 to 2007. We used unique detections of Wenatchee hatchery steelhead at Rock Island, Rocky Reach, and Wells dams combined as a bench mark to assess the number of returning PIT tagged hatchery steelhead and the age at return for each brood year. Detections at these dams showed that most of the PIT tagged hatchery fish returned at two and three years of age (return year-brood year) (Table 2). Two fish were detected within the adult fishways the same year of release and are probably residualized steelhead. These fish were removed from analysis.

Table 2. Number of unique detections for Wenatchee steelhead by brood year and return year at Rock Island (RIS), Rocky Reach (RRH), and Wells (WLS) dams.

Detection Location	Brood Year	Return Year					
		2007	2008	2009	2010	2011	Total
Combined Unique RIS, RRH, WLS dams	2005	169	214	1			384
	2006	1	128	138	3		270
	2007		1	471	302	1	775
	Total:	**169**	**342**	**610**	**305**	**1**	**1,427**

Table 3 displays the number and percent of last detections for three brood years of Wenatchee hatchery steelhead examined in the Upper Columbia River. For the three brood years examined, more than half of the PIT tagged steelhead were last detected at Rock Island, Rocky Reach and Wells dams. Higher tributary detection rates were observed for the 2006 and 2007 brood years as more PIT tag observation sites became established.

Table 3. Distribution of last detections for PIT tagged hatchery Wenatchee steelhead for brood years 2005-2007.

Last Detection Location	Brood Year					
	2005		2006		2007	
	Number	Percent	Number	Percent	Number	Percent
Wenatchee River	80	20.7	72	25.9	171	22.0
Entiat River	11	2.8	13	4.7	23	3.0
Methow River	14	3.6	30	10.8	87	11.2
Okanogan River	1	0.3	0	0.0	0	0.0
Other[1]	0	0.0	0	0.0	1	0.1
Tributary Total:	**106**	**27.4**	**115**	**41.4**	**282**	**36.3**
Rock Island Dam	44	11.4	21	7.6	72	9.3
Rocky Reach Dam	83	21.4	47	16.9	90	11.6
Wells Dam	154	39.8	95	34.2	333	42.9
Project Total:	**281**	**72.6**	**163**	**58.6**	**495**	**63.7**
Combined Total:	**387**		**278**		**777**	

1**.** One fish from BY 2007 was detected in the Tucannon River.

Brood year stray rates for steelhead were developed from the PIT tagged steelhead that were last detected in tributary streams. We assumed that the last detection in a tributary stream was the river basin selected for spawning. The average tributary distribution shows that about 64% of the hatchery steelhead returned to the Wenatchee Basin (successful homing), while 36% strayed to other natural spawning areas (Table 4). There was only one PIT tagged hatchery fish used for broodstock likely because most are probably screened out before broodstock selection occurs.

Table 4. PIT tagged based stray rate estimates for hatchery Wenatchee steelhead based on last tributary detections for brood years 2005 to 2007.

Brood year	Homing				Straying			
	Target stream		Target hatchery		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2005	80	75.5	0	0.0	26	24.5	0	0.0
2006	71	62.3	1	0.9	43	37.7	0	0.0
2007	171	60.6	0	0.0	111	39.4	0	0.0
Total	***322***	***64.1***	***1***	***0.0***	***180***	***35.9***	***0***	***0.0***

For sockeye salmon we assessed stray rates for brood years 2005 and 2006. We used detections at Rock Island Dam as a bench mark to assess the number of returning PIT tagged fish and the age at return for each brood year. Detections at Rock Island Dam showed that most of the PIT tagged hatchery fish returned at four years of age (return year-brood year) with 200 in 2009 and 444 in 2010 (Table 4). We expect that a few five year old fish have returned in 2011, which should complete the 2006 brood year adult return. There were 655 total PIT tagged sockeye detected for brood years 2005 and 2006. About 95 percent of the PIT tagged sockeye detected at Rock Island Dam were last detected at observation sites at Wells Dam and in the Wenatchee, Methow, and Entiat rivers. Wells Dam was used for return years 2008 through 2010 because the Zosel Dam site in the Okanogan River did not come online until September 2010. We used the last detections at these locations to assess brood year stray rates.

Table 5. Adult sockeye salmon PIT tag detections at Rock Island Dam for brood years 2005 and 2006 and last detections at observation sites at Wells Dam and in the Wenatchee, Methow, and Entiat rivers.

Detection Location	Brood Year	Return Year			Total
		2008	2009	2010	
Rock Island Dam	2005	6	200	3	209
	2006	0	2	444	446
	Total:	**6**	**202**	**447**	**655**
Last Detection Locations					
Wenatchee River	2005	6	158	3	167
	2006	0	2	419	421
Methow River	2005	0	0	0	0
	2006	0	0	1	1
Entiat River	2005	0	9	0	9
	2006	0	0	9	9
Wells Dam	2005	0	6	0	6
	2006	0	0	10	10
	Total:	**6**	**175**	**442**	**623**

Brood year stray rates for sockeye salmon were developed from the PIT tagged sockeye that were last detected in tributary streams and Wells Dam. We assumed that last detections in a river basin indicated the area of spawning. We assumed that last detections at Wells Dam without subsequent detection in the Methow River indicate migration into the Okanogan River system.

The average tributary distribution shows that about 94% of the hatchery fish returned to the Wenatchee Basin (successful homing), while 6% strayed to other natural spawning areas (Table 6). No PIT tagged hatchery fish have been used in hatcheries.

Table 6. PIT tagged based stray rate estimates for hatchery Lake Wenatchee sockeye salmon based on last tributary detections for brood years 2005 and 2006.

Brood year	Homing				Straying			
	Target stream		Target hatchery		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
2005	167	91.8	0	0.0	15	8.2	0	0.0
2006	421	95.5	0	0.0	20	4.5	0	0.0
Total	***322***	***94.4***	***0***	***0.0***	***35***	***5.6***	***0***	***0.0***

CWT-based brood year stray rates-Brood year strays based on CWT's were used for all of Chelan's Chinook programs. Stray rates are based on the extrapolation of coded wire tags recovered during spawning ground surveys. Table 7 displays coded wire tag information of returning Wenatchee summer Chinook from brood year 1991. This type of data along with brood year and spawning escapement information were used to estimate brood year stray rates. We used PSC Fishery and site location information on recaptured CWT hatchery fish to assign fish to different fate categories. Fish were assigned to either harvest, straying (natural, hatchery), or homing (natural and hatchery). We assumed that fish collected (snout removed and CWT interrogated) for Chinook hatchery production were spawned and used in the program where they were collected.

In the RMIS database coded wire tags recovered in different locations (observed number) are expanded (estimated number) by sampling rate for each location. The expanded number can then be adjusted by the tag rate to account for the untagged portion of hatchery fish. To accomplish this we divided the estimated number by the tag rate to come up with the tagged and untagged number of hatchery fish. For example, in Table 7 eighteen Wenatchee Hatchery summer Chinook were estimated to have been harvested in a recreational fishery in the Hanford Reach in 1993. The tag rate for that hatchery release was 0.9920. So, the tag rate expansion estimate is 18.15 (18/0.9920). These expansion estimates are rounded to the nearest whole number, which in this case is eighteen fish. Because of the very high tag rates associated with the 1991 brood year releases there was no difference in the estimated values and tag rate expansion values. If multiple CWT identification tags are used for a single broodstock release, then each estimate is expanded separately by the appropriate tag rate. We used the assigned fate categories to sum different components of straying and homing for brood year 1991.

Table 7. Example information collected on CWT Wenatchee hatchery summer Chinook from brood years 1991 used to determine stray rates.

Return Year	PSC Fishery	Site	Fate	Tag Rate	Obs.	Est.	Tag Rate Expansion	Round
1993	Freshwater Sport	Hanford Reach	Harvest	0.9920	1	18	18.15	18
1994	Mixed Net and Seine	JFN 020-000	Harvest	0.9920	1	4	4.03	4
1994	Hatchery	Wells Dam Sp. Chan.	Hatchery Straying	0.9920	1	1	1.01	1
1994	Mixed Net and Seine	NN 003-460	Harvest	0.9997	1	3	3.00	3
1994	Mixed Net and Seine	NN 003-461	Harvest	0.9997	2	5	5.00	5
1995	Hatchery	Wells Dam Sp. Chan.	Hatchery Straying	0.9920	3	3	3.02	3
1995	Hatchery	Wenatchee River	Hatchery Homing	0.9997	1	1	1.00	1
1996	Ocean Troll	AK M 1 NW 113-81	Harvest	0.9920	1	1	1.01	1
1996	Hatchery	Wells Hatchery	Hatchery Straying	0.9920	1	1	1.01	1
1996	Ocean Troll	AK M 1 NW	Harvest	0.9997	1	3	3.00	3
1996	Ocean Troll	AK M 1 NW 113-41	Harvest	0.9997	1	2	2.00	2
1996	Ocean Sport	AK M 1 03 MSNW	Harvest	0.9997	1	10	10.00	10
1996	Hatchery	Wells Hatchery	Hatchery Straying	0.9997	2	2	2.00	2
1996	Fish Trap	Wells E. Ladder Trap	Hatchery Straying	0.9997	1	1	1.00	1
1997	Ocean Troll	Newport Troll 4	Harvest	0.9997	1	2	2.00	2
1997	Spawning Grounds	Wenatchee River	Natural Homing	0.9997	2	14	14.00	14
Total:					**21**	**71**		**71**

Table 8 shows the summarized distribution of homing and straying of Wenatchee hatchery summer Chinook returns for brood years 1989-2004. Overall, the 16-year average distribution shows that about 83% of the hatchery fish returned to the Wenatchee Basin (successful homing), while 17% strayed to other natural spawning areas or other hatchery programs (Table 8). Of those that strayed, about 11% strayed to other spawning grounds and the remaining 5% were collected in other hatchery programs. Based on these data, one would reject the null hypothesis and conclude that on average hatchery fish from the Wenatchee summer Chinook program stray at a rate greater than 5%. It appears that natural straying has increased over time, while hatchery straying has decreased over time (Table 8). These trends are probably related to changes in carcass sampling intensity over time, which is a requirement of the monitoring program and the decreased use of hatchery fish in broodstock collection programs.

Table 8. Stray rate estimates produced for a 16-year period (1989-2004) of total brood year returns of Wenatchee summer Chinook for the hypothesis, stray rates of hatchery fish is less than 5% of the total brood return.

Brood year	Homing				Straying			
	Target stream		Target hatchery		Non-target streams		Non-target hatcheries	
	Number	%	Number	%	Number	%	Number	%
1989	1,352	62.9	60	2.8	75	3.5	662	30.8
1990	74	84.1	1	1.1	0	0.0	13	14.8
1991	14	60.9	1	4.3	0	0.0	8	34.8
1992	375	84.8	7	1.6	0	0.0	60	13.6
1993	67	72.8	9	9.8	4	4.3	12	13.0
1994	890	71.8	205	16.5	56	4.5	88	7.1
1995	748	74.8	139	13.9	42	4.2	71	7.1
1996	261	70.4	42	11.3	53	14.3	15	4.0
1997	3,609	85.6	171	4.1	396	9.4	38	0.9
1998	1,790	78.5	11	0.5	416	18.2	64	2.8
1999	507	79.7	0	0.0	121	19.0	8	1.3
2000	2,745	83.0	0	0.0	526	15.9	37	1.1
2001	521	82.0	0	0.0	105	16.5	9	1.4
2002	1,521	85.3	10	0.6	244	13.7	8	0.4
2003	1,268	89.3	42	3.0	101	7.1	9	0.6
2004	438	83.4	3	0.6	66	12.6	18	3.4
Total	***16,180***	***80.1***	***703***	***3.5***	***2,217***	***11.0***	***1,106***	***5.5***

Stray Rates to Independent Population (based on run year)

For this hypothesis, CWT information was used to determine stray rates to other populations based on run year. No PIT-based estimates for this hypothesis for steelhead and sockeye have been produced. We use Wenatchee summer Chinook as an example of estimating stray rates for this hypothesis. In this hypothesis the goal is to have stray rates based on run year less that five percent of the escapement to other populations. For this example, the goal is then to have less than five percent of the spawning escapement to the Methow or Okanogan include hatchery Wenatchee Summer Chinook.

Similar to the information presented in Table 7, CWT returns are summed across a particular return year for CWT recoveries at a specific location like the Methow or Okanogan rivers. The sum of the recoveries are presented in Table 9 to display the number of fish that strayed from the Wenatchee summer Chinook program into other independent summer Chinook populations (e.g., Okanogan, Methow, Entiat, etc.). To determine the stray rate to other independent populations, we divided the number of strays by the spawning escapement of the population of interest for that return year. For example, in 2003 the spawning escapement of summer Chinook to the Methow River was 3,390 fish. The stray rate of hatchery Wenatchee summer Chinook to the Methow was 0.02 (80/3,390=0.023) or about two percent of the spawning escapement. Since 1994, the percentage of Wenatchee strays in the Methow River has made up 4% of the total escapement from 1994 to 2007 (1,132 strays divided by 26,647 Methow escapement).

Under this hypothesis, stray rate was calculated based solely on hatchery fish that spawned naturally and were recovered on the spawning grounds within other populations. As shown in Table 9, the fourteen-year average distribution of strays (i.e., total number of strays divided by the total spawning escapement) indicates that hatchery fish from the Wenatchee summer Chinook program contributed less than 5% to the spawning escapement of the Methow, Okanogan, and Hanford Reach of the Columbia River. The Chelan and Entiat rivers are on average at or above the established guideline, respectively.

Table 9. Stray rate estimates produced for a 14-year period for Wenatchee hatchery summer Chinook for the hypothesis, stray hatchery fish make up less than 5% of the spawning escapement within other independent populations (based on run year).

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	0.1
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
2003	80	2.0	24	0.7	44	10.5	132	19.1	26	0.0
2004	113	5.2	42	0.6	30	7.1	0	0.0	0	0.0
2005	245	9.6	67	0.8	51	11.5	49	13.4	0	0.0
2006	170	6.2	12	0.1	12	2.9	18	3.1	0	0.0
2007	127	9.3	5	0.1	9	4.8	18	7.3	20	0.1
Total	***1,132***	***4.2***	***351***	***0.5***	***216***	***5.0***	***291***	***8.3***	***59***	***0.0***

Stray Rates within Population (based on run year)

For this hypothesis, CWT information was used to determine stray rates within the Wenatchee spring Chinook population based on run year. Similar to the second hypothesis, we used spawning escapement estimates for each non-target spawning location (stream) within the Wenatchee basin to calculate the stray rate for each stream and return year. In this evaluation, we only used fish recovered on spawning grounds to estimate stray rate. In this hypothesis the goal is to have stray rates based on run year make up less than 10 percent of the escapement to other populations. At this time, this hypothesis refers only to the Chiwawa spring Chinook hatchery program.

Table 10 displays the distribution of stray returns of hatchery fish from the Chiwawa spring Chinook program to non-target spawning areas in the Wenatchee basin from 1992 to 2009. The analysis indicated that Chiwawa hatchery fish, on average, made up more than 10% of the spawning escapement in Nason Creek, Upper Wenatchee River, White River, and Little Wenatchee River (Table 3). In general, annual stray rates tended to increase over the period of record. This may reflect increased sampling effort over the more recent years.

Table 10. Stray rate estimates produced for a 18-year period of Chiwawa spring Chinook returns for the hypothesis, stray hatchery fish make up less than 10% of the spawning escapement within non-target spawning areas within the population (based on run year).

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	27.3
2001	211	35.3	0	0.0	0	0.0	271	77.7	46	39.0	52	31.3
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	29	78.4	259	85.8	30	57.7	52	81.3
2009	289	54.1	8	9.2	0	0.0	16	100.0	73	42.2	56	44.8
Total	***2,097***	***38.8***	***94***	***5.4***	***29***	***3.3***	***1,078***	***60.4***	***298***	***25.5***	***270***	***25.4***

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APPENDIX C

Methods for Identifying Reference Populations and Testing Differences in Abundance and Productivity between Reference Populations and Supplemented Populations: Chiwawa Spring Chinook Case Study

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An important goal of supplementation is to increase spawning abundance and natural-origin recruitment of the supplemented population, and not reduce the productivity of the supplemented population. Indeed, a successful supplementation program must increase spawning abundance and natural-origin recruitment to levels above those that would have occurred without supplementation. There are several methods that can be used to test the effects of supplementation programs on these population metrics. One important method is to compare the performance of population metrics (e.g., spawning abundance, natural-origin recruitment, and productivity) in the supplemented population to those in un-supplemented (reference) populations. By comparing supplemented populations to reference populations, one can determine if the supplementation programs benefit, harm, or have no effect on the supplemented populations. These comparisons, however, are only valid if the performance of the reference populations is similar to the performance of the supplemented population prior to the period of supplementation. If the performance of the two populations differs significantly before any supplementation occurs, then any results from comparing the two populations after supplementation will be suspect. It is therefore important to select reference populations that are as similar as possible to the supplemented populations.

One of the goals of the Conceptual Approach to Monitoring and Evaluating the Chelan County PUD Hatchery Programs (Murdoch and Peven 2005) is to use reference populations to analyze the potential effects of hatchery supplementation programs on natural-origin salmon and steelhead spawner abundance and productivity[10]. Murdoch and Peven (2005) identified specific objectives to evaluate the performance of the program. For example, Objective 1 determines if the supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population (supplemented population) relative to a reference population. Objective 7 determines if the proportion of hatchery fish on the spawning grounds affects the freshwater

[10] Productivity is defined as adult recruits per spawner, where recruits are the number of adults produced from a given brood year (i.e., spawners plus adults harvested).

productivity (e.g., number of juveniles per redd) of supplemented streams when compared to reference streams. The relevant questions tested under each objective are as follows:

Objective 1:

- Is the annual change in the number of natural-origin recruits produced from the supplemented populations greater than or equal to the annual change in natural-origin recruits in an un-supplemented population?
- Is the change in natural replacement rates within the supplemented population greater than or equal to the change in natural replacement rates in an un-supplemented population?

Objective 7:

- Is the change in numbers of juveniles (smolts, parr, or emigrants) per redd in the supplemented population greater than or equal to that in an un-supplemented population?[11]

In this paper, we describe methods used to identify suitable reference streams and statistical techniques that can be used to compare reference populations with supplemented populations. Although we apply the methods described in this paper to Chiwawa spring Chinook salmon (hereafter referred to as Chinook), the methods should also apply to steelhead and other supplemented salmon stocks in the Upper Columbia Basin.

Identification of Reference Populations

Reference populations are an important component of an effectiveness monitoring design because they provide the standard by which treatment conditions are compared (ISRP and ISAB 2005; Murdoch and Peven 2005; Galbreath et al. 2008). Selecting appropriate reference areas and maintaining them over long periods of time is needed to establish the effectiveness of supplementation programs.

We developed a three-step process for identifying suitable reference populations (Figure 1). Each step serves as a filter. That is, potential reference populations are evaluated based on specific criteria under each step. Populations that pass through each step are considered suitable reference populations for a specific supplemented population.

[11] In this paper we only address adult recruits, not juvenile recruits. This is because we were unable to find suitable reference populations for analysis of juveniles. However, the methods described in this paper would also apply to juveniles.

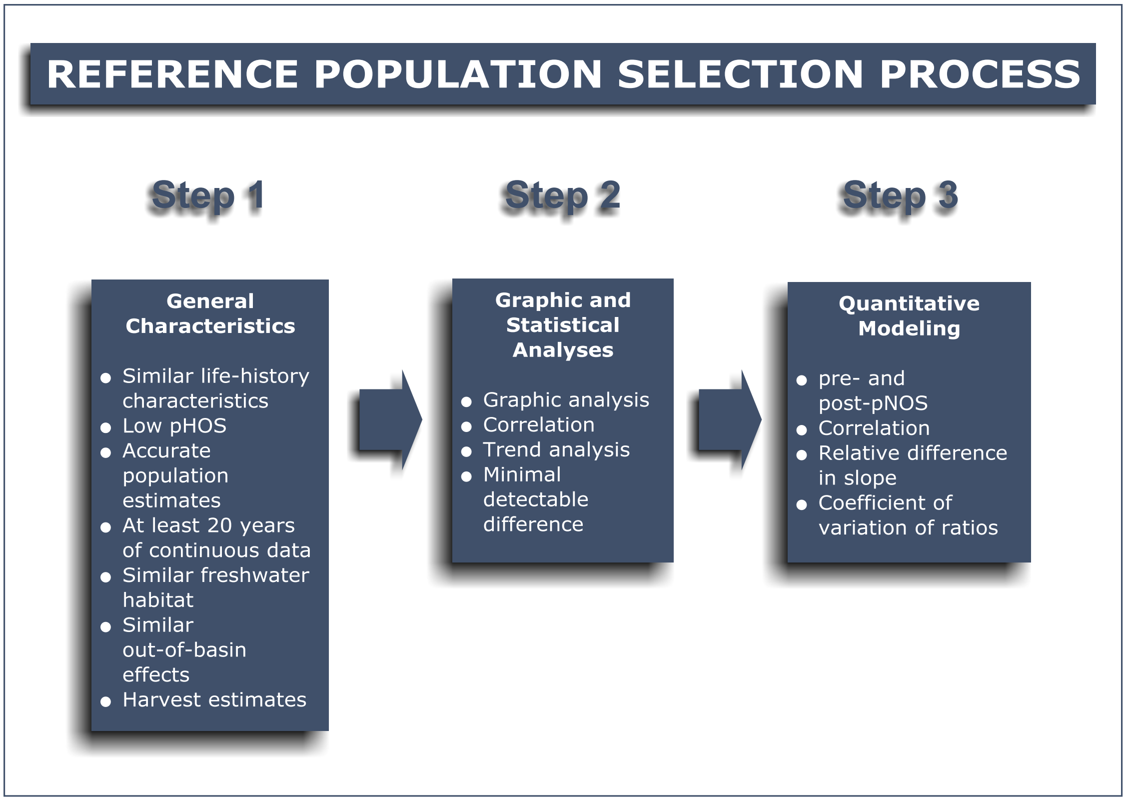

Figure 1. Criteria evaluated during each step in the process of identifying suitable reference populations.

Step 1: General Characteristics

Under step 1, potential reference populations are evaluated based on several general criteria. When compared to the supplemented population, potential reference populations should have:

- Similar life-history characteristics (e.g., run timing, migration characteristics, etc.).
- No or few hatchery fish in the reference area (pHOS < 10%).
- Accurate abundance estimates.
- Long time series of natural-origin abundance and productivity estimates (at least 20 years of continuous data).
- Similar trends in freshwater habitat.
- Similar out-of-basin effects (i.e., similar migration and ocean survivals).
- Harvest estimates for adjusting escapement estimates.

We used these criteria to begin the process of selecting suitable reference populations for the Chiwawa spring Chinook program. We began by identifying stream-type Chinook populations within the Columbia Basin. Galbreath et al. (2008; their Table 1) identified stream-type Chinook populations within the Columbia River Basin that may serve as suitable reference populations for hatchery programs. Supplementing their work with data from the NOAA Fisheries Salmon Population Summary Database, we identified 18 candidate stream-type Chinook populations that may serve as reference populations for the Chiwawa supplementation program (Table 1).

Table 1. Populations of stream-type Chinook salmon and their comparison to Chiwawa spring Chinook.

Population	Similar life-history	No or few hatchery fish	Accurate abundance estimates	Long time series (at least 20 years)	Similar freshwater habitat impairments	Similar out-of-basin effects	Comments
Deschutes River	Yes	Yes	Yes	Yes	No	No	
John Day mainstem	Yes	Yes	Yes	Yes	No	No	
Middle Fk John Day	Yes	Yes	Yes	Yes	No	No	
North Fk John Day	Yes	Yes	Yes	Yes	No	No	
Granite Creek	Yes	Yes	Yes	Yes	No	No	
Wenaha River	Yes	No	Yes	Yes	Yes	No	Hatchery strays (>10%)
Minam River	Yes	No	Yes	Yes	Yes	No	Hatchery strays (>10%)
Slate Creek	Yes	Yes	Yes	No	No	No	
Secesh River	Yes	Yes	Yes	Yes	Yes	No	
Middle Fk Salmon River	Yes	Yes	Yes	No	No	No	Fair productivity est.
Big Creek	Yes	Yes	Yes	Yes	No	No	
Camas Creek	Yes	Yes	Yes	Yes	No	No	Fair productivity est.
Loon Creek	Yes	Yes	Yes	Yes	No	No	Fair productivity est.
Sulphur Creek	Yes	Yes	Yes	Yes	No	No	
Bear Valley Creek	Yes	Yes	Yes	Yes	No	No	
Marsh Creek	Yes	Yes	Yes	Yes	Yes	No	
North Fk Salmon River	Yes	Yes	No	No	Yes	No	
Lemhi River	Yes	Yes	Yes	Yes	No	No	
East Fk Salmon River	Yes	No	Yes	Yes	No	No	Hatchery strays (>10%)
Valley Creek	Yes	No	Yes	Yes	No	No	Hatchery strays (>10%)
Chamberlain Creek	Yes	Yes	Yes	No	Yes	No	
Naches River	Yes	Yes	Yes	Yes	Yes	No	
Little Wenatchee River	Yes	No	Yes	Yes	Yes	Yes	Hatchery strays (>10%)
Entiat River	Yes	No	Yes	Yes	No	No	Hatchery release ending

We then assessed the accuracy and length of the series of abundance estimates. We assumed that abundance estimates generated from expanded redd counts or adjusted weir counts would compare well with estimates in the Chiwawa Basin, which were based on expanded redd counts. In addition, we looked for populations that had an abundance data series that extended from at least 1981 to present. Based on this analysis, we identified 18 populations with abundance estimates that could be compared to those from the Chiwawa Basin (Table 1).

Next, we determined if the potential reference populations came from watersheds with habitat conditions similar to those in the Chiwawa Basin. For this exercise, we searched recovery plans and draft recovery plans to identify tributary factors that limit Chinook abundance, productivity, and survival within the reference populations. We compared these factors with those limiting Chinook salmon in the Chiwawa Basin. Based on this analysis, we identified eight populations with habitat impairments similar to those in the Chiwawa Basin (Table 1).

Finally, we examined the potential reference populations to see if they experienced out-of-basin effects similar to spring Chinook from the Chiwawa Basin. In this case, we compared the number of mainstem dams that each potential reference population passes during migration. Six of the potential reference populations pass less than six mainstem dams; the other populations pass eight mainstem dams (Table 1). Only the Little Wenatchee population passes seven dams, similar to the Chiwawa population.

In sum, there were no reference populations that matched the Chiwawa spring Chinook population on all the criteria identified above. Differential out-of-basin effects and freshwater habitat conditions prevented most reference populations from matching with Chiwawa spring Chinook. However, some of the potential reference populations were similar to the Chiwawa population on several criteria and warranted further investigation. We selected the following populations for further investigation: Sesech River, Marsh Creek, Naches River, Little Wenatchee, and Entiat River.

We included the Little Wenatchee because it is within the Wenatchee River basin and experiences similar out-of-basin effects and has the same climatic and environmental conditions as the Chiwawa. A confounding effect with the Little Wenatchee is that Chiwawa hatchery fish have strayed into the Little Wenatchee. However, straying of Chiwawa hatchery fish should decrease with the change in source water to the Chiwawa acclimation ponds in 2006. We also included the Entiat River because it is an adjacent basin to the Chiwawa and experiences similar climatic and environmental conditions. The spring Chinook hatchery program that has operated in the Entiat since 1975 has been discontinued. Therefore, this population offers a unique opportunity to compare the Chiwawa population to a population in which the hatchery program has been discontinued.

Step 2: Graphic and Statistical Analysis

Graphic Analysis

Although we were unable to find potential reference populations that matched with the Chiwawa population on all criteria considered under Step 1, spawner abundance, natural-origin recruits (NORs), and productivity of some of the potential reference populations may nevertheless track closely with the Chiwawa population. If the time series of abundance, NORs, and productivity of a potential reference population tracks closely with the abundance, NORs, and productivity of the Chiwawa population, the reference population may provide a reasonable reference condition for testing the effects of supplementation on the Chiwawa population.

Under Step 2, we used graphing techniques to examine the relationship of abundance, NORs, and productivity between the Chiwawa population and the five reference populations (Sesech River, Marsh Creek, Naches River, Little Wenatchee, and Entiat River). We compiled spawner abundance, NORs, and productivity data from local biologists and the NOAA Fisheries Salmon Population Summary Database. We then compared time series plots of spawner abundance, NORs, and productivity data of potential reference populations with the Chiwawa population (Figures 2, 3, and 4; plots on the left side of figures). The time series only included the period 1981 to 1992, which represented the period before supplementation of the Chiwawa population (pre-treatment period). We also plotted the relationship between the abundance, NORs, and productivity of each potential reference population to the Chiwawa population (Figures 2, 3, and 4; plots on right side of figures). These plots show whether the reference populations closely tracked the Chiwawa population. As a point of reference, data points that fall along the dashed line would represent a perfect relationship between the two populations (i.e., both populations have identical abundance, NORs, and productivity estimates). While a perfect relationship between two independent populations is unrealistic, a strong linear relationship between the two populations indicates populations with similar trends.

Based on analysis of spawner abundance, the Naches River time series tracked more closely with the abundance of Chiwawa spring Chinook than did the other potential reference populations. The poor relationship with the other potential reference streams was largely because of the relatively high abundance of Chiwawa spring Chinook during the mid-1980s. As with spawner abundance, analyses of NORs indicated a close relationship between the Naches and Chiwawa populations. The other potential reference populations tracked poorly with the Chiwawa. The analyses of productivity indicated close relationships between potential reference populations and the Chiwawa population. The Naches, Sesech, and Little Wenatchee populations tracked the closest with the Chiwawa population.

When analyzing the potential effects of a supplementation program on fish performance, it is common to transform the data to meet various assumptions of statistical analysis. The most common transformation used to adjust abundance, NORs, and productivity data is the natural logarithm (LN or $\log_e$). We therefore transformed the spawner abundance, NORs, and productivity data using LN and re-plotted the relationships between the potential reference populations and the Chiwawa population (Figures 5, 6, and 7). We added 1 to each observation before taking its logarithm to avoid taking the logarithm of 0, which is undefined (note that the LN of 1 is 0).

By transforming spawner abundance, NORs, and productivity data, most of the potential reference populations tracked more closely with the Chiwawa population. The Naches, Entiat, and Little Wenatchee abundance data tracked the closest with the Chiwawa abundance data (Figure 5). For NORs, Marsh Creek and the Little Wenatchee populations tracked the closest with the Chiwawa (Figure 6). For productivity, the Naches, Sesech, and Little Wenatchee tracked the closest with the Chiwawa (Figure 7).

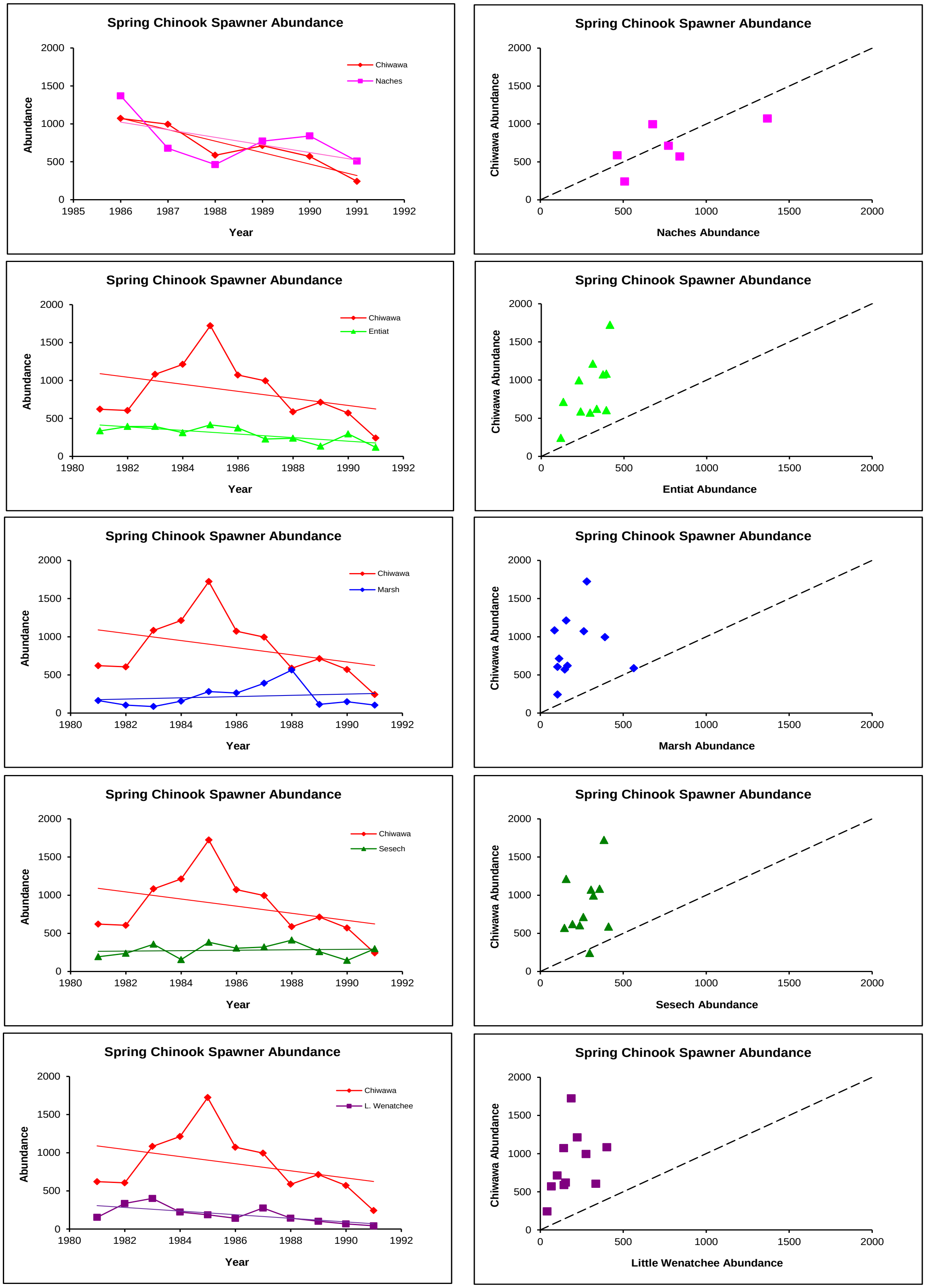

Figure 2. Time series of spawner abundance of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

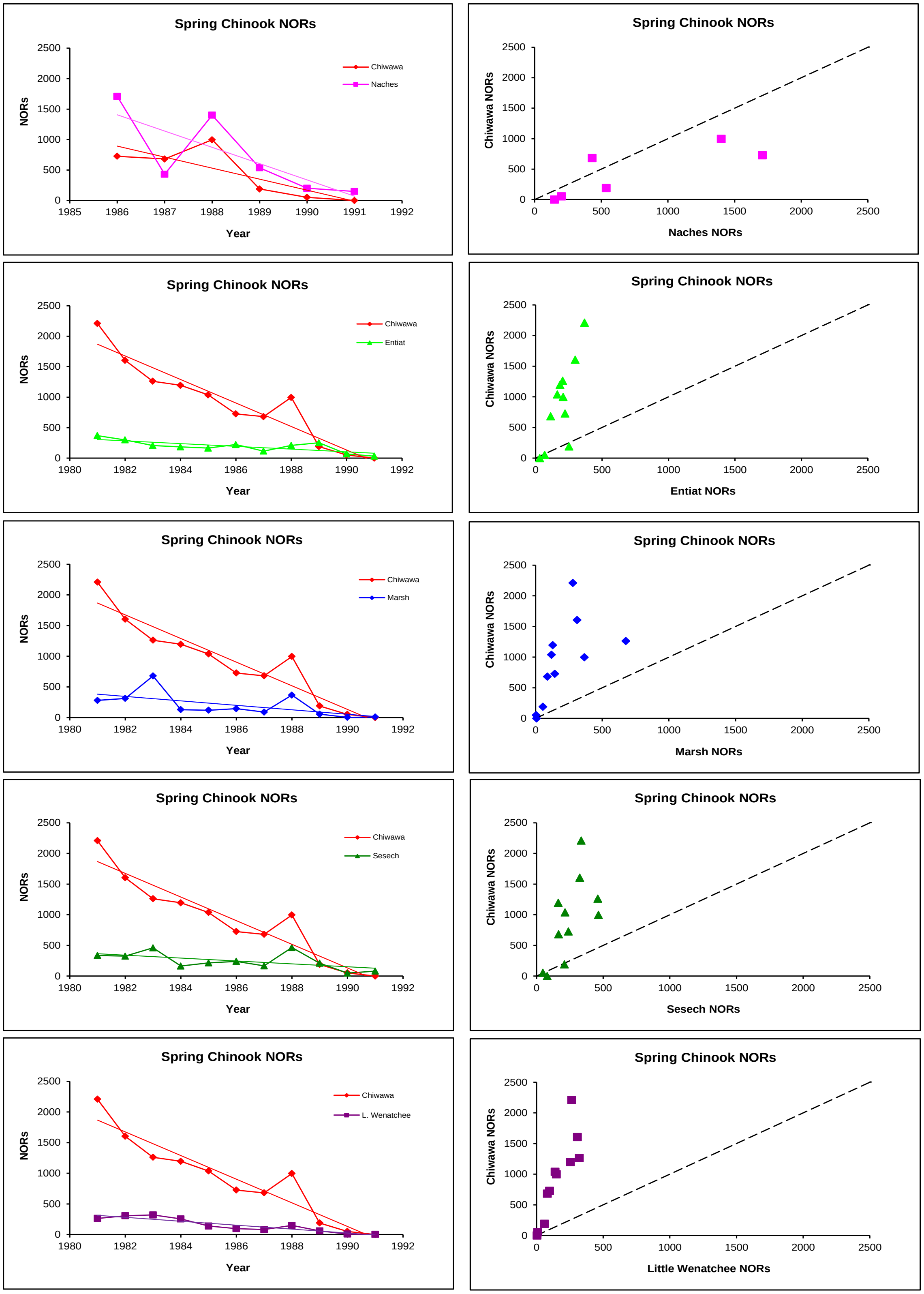

Figure 3. Time series of natural-origin recruits (NORs) of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

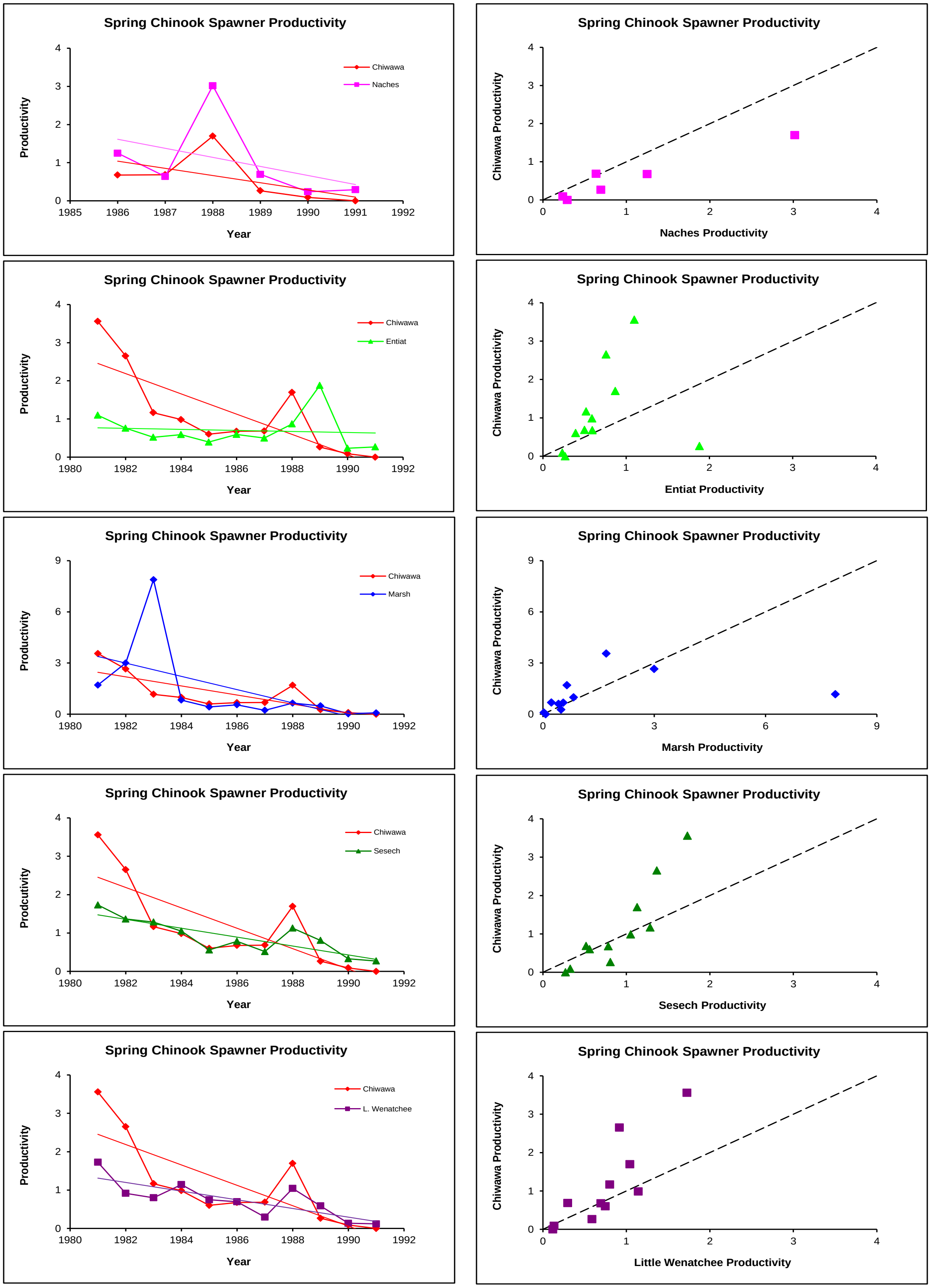

Figure 4. Time series of adult productivity of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

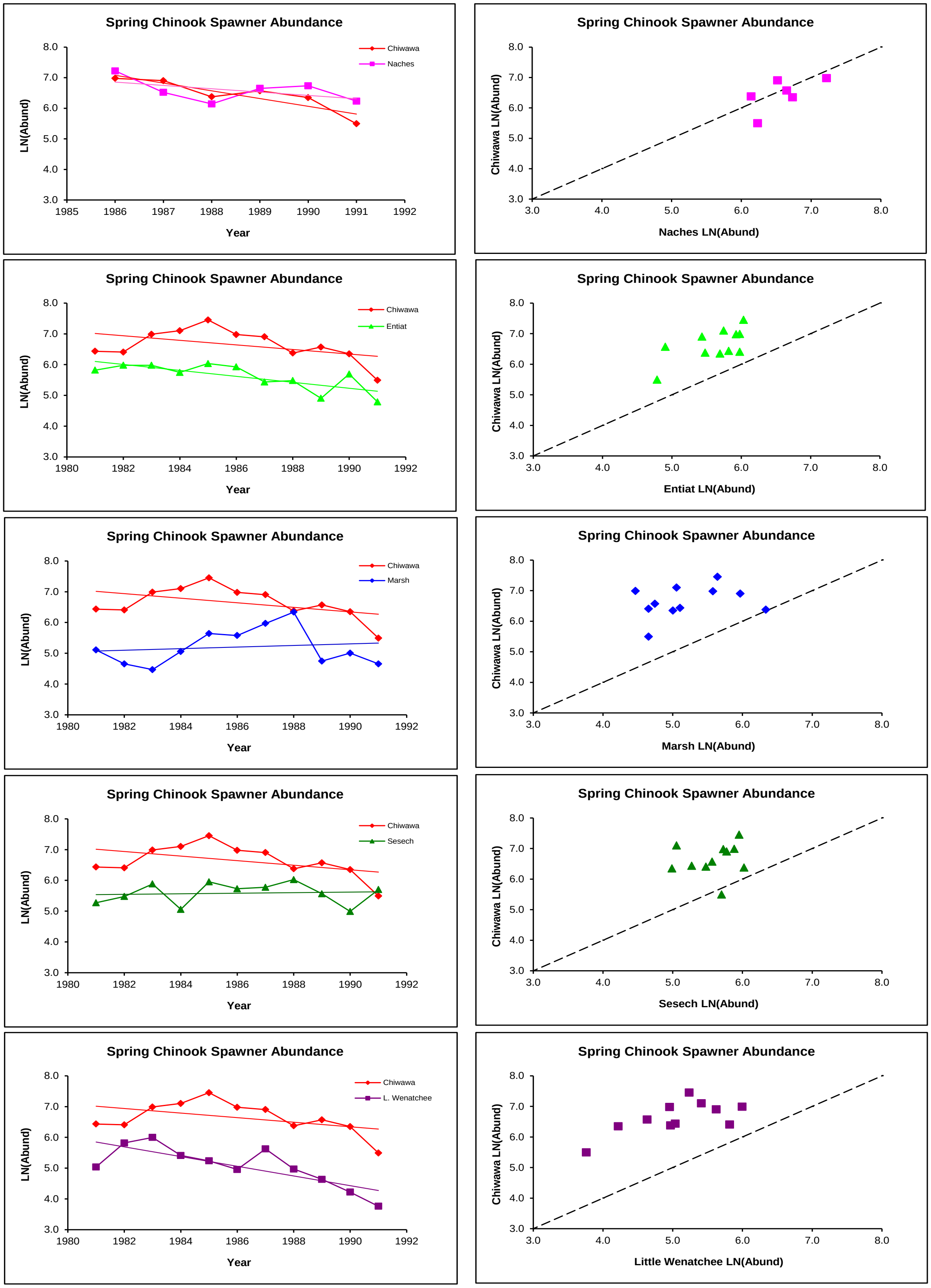

Figure 5. Time series of natural log spawner abundance of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

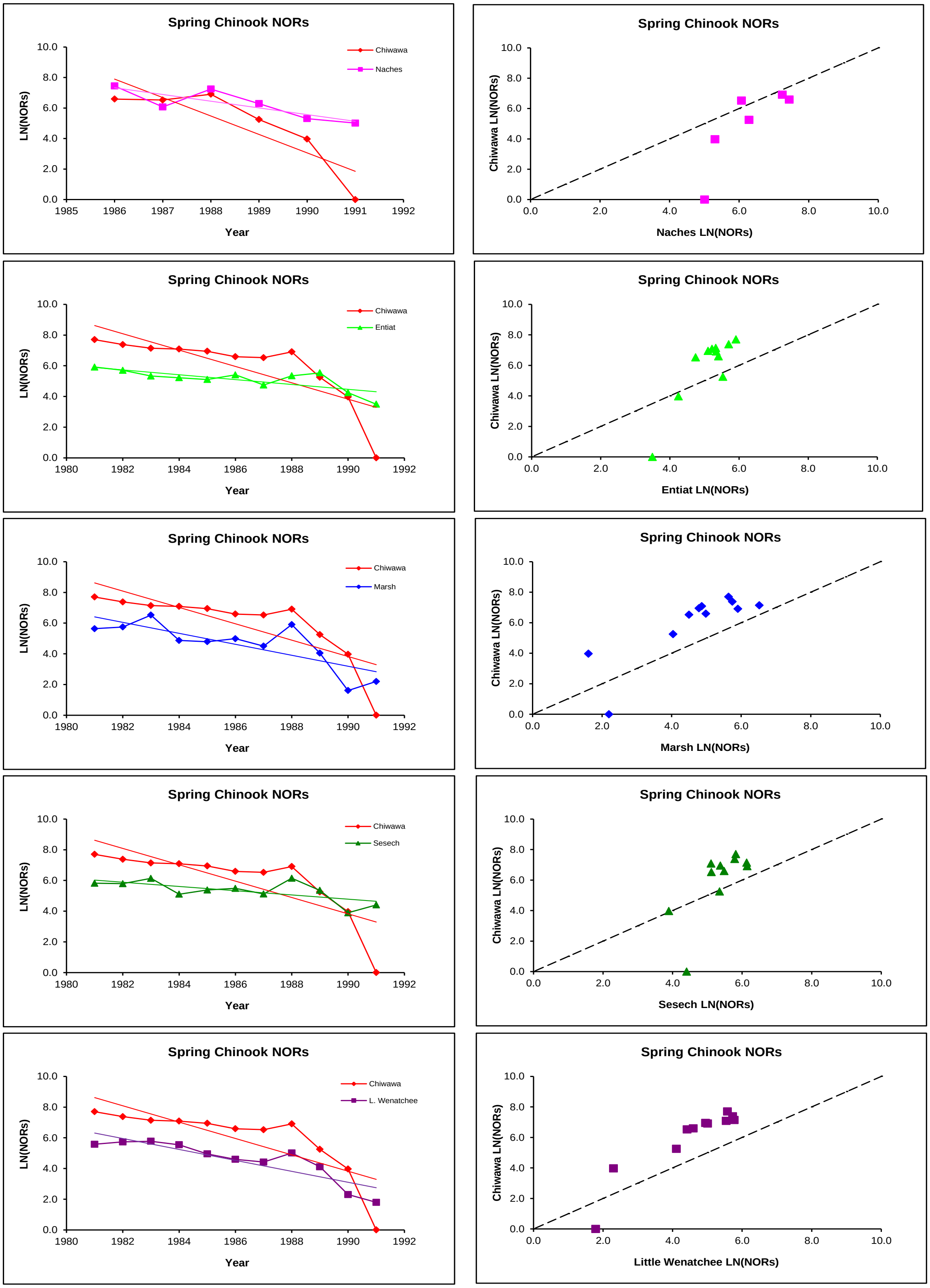

Figure 6. Time series of natural log natural-origin recruits (NORs) of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

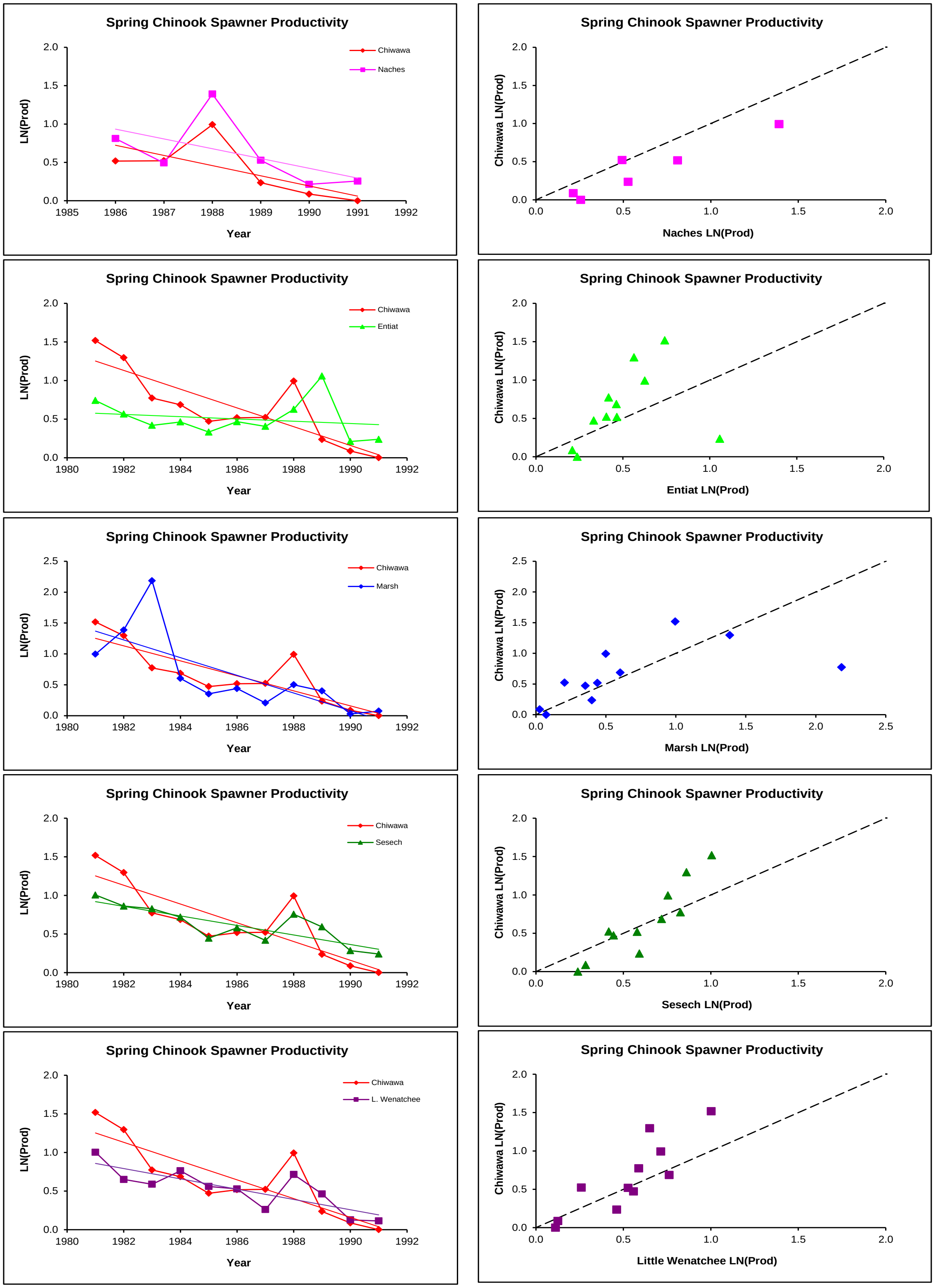

Figure 7. Time series of natural log adult productivity of potential reference populations and the Chiwawa spring Chinook population before the Chiwawa population was supplemented with hatchery fish.

Correlations and Trends

Other methods for evaluating the suitability of potential reference populations under Step 2 include correlation and trend analyses. For correlation analysis, we simply calculated the Pearson correlation coefficient, which is an index of the strength of the association between the potential reference populations and the Chiwawa population. The coefficient ranges from -1 to 1, where a value near 1 or -1 represents that strongest association between the populations. A value of 0 means no association. We used only spawner abundance, NORs, and productivity data during the pre-treatment period (1981-1992). We assumed that populations with coefficients greater than 0.6 represented reasonable reference conditions.

For trend analyses, we used least squares techniques to compute a straight-line trend through the spawner abundance and productivity data for the potential reference populations and the Chiwawa population. Trends were fit to the pre-treatment time series data (1981-1992). We then used t-tests to determine if the slopes of the trends between potential reference populations and the Chiwawa population differed significantly.

It is important to note that time-series trend analyses are susceptible to temporal correlations in the data. Autoregressive integrated moving average (ARIMA) models can be used to describe the correlation structure in temporal data (Gotelli and Ellison 2004). However, these models require a long time series (N > 40) and therefore we could not use them to model the spring Chinook data. As such, we were unable to correct for any temporal correlation that may exist within the time series.

Tests of correlation with spawner abundance data indicated that the Naches River closely correlated with the Chiwawa population (Table 2). There was no difference in abundance trends between the potential reference populations and the Chiwawa population (Table 2; Figure 2). For NORs, all potential reference populations correlated with the Chiwawa population (Table 2). However, trends in NORs of all reference populations, except Naches, differed significantly from the Chiwawa population (Table 2; Figure 3). For productivity, the Naches, Sesech, and Little Wenatchee correlated with the Chiwawa population (Table 2). Only the Entiat productivity trend differed significantly from the Chiwawa population trend (Table 2; Figure 4).

Table 2. Pearson correlation coefficients and t-test results comparing slopes of trends between potential reference populations and the Chiwawa spring Chinook population; d.f. = degrees of freedom and for correlation coefficients, an asterisk (*) indicates significance at $P < 0.05$.

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	d.f.	P-value
Spawner Abundance Data				
Naches	0.684*	-0.659	8	0.528
Entiat	0.598*	-0.596	18	0.559
Marsh	0.147	-1.341	18	0.197
Sesech	0.274	-1.265	18	0.222
Little Wenatchee	0.399	-0.591	18	0.562
Natural-Origin Recruits				

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	**d.f.**	**P-value**
Naches	0.803*	0.666	8	0.524
Entiat	0.795*	-7.495	18	0.000
Marsh	0.605*	-5.786	18	0.000
Sesech	0.648*	-6.874	18	0.000
Little Wenatchee	0.880*	-7.206	18	0.000
Productivity Data				
Naches	0.960*	0.169	8	0.870
Entiat	0.272	-3.057	18	0.007
Marsh	0.320	0.605	18	0.553
Sesech	0.903*	-2.059	18	0.054
Little Wenatchee	0.848*	-2.065	18	0.054

We also ran correlation and trend analyses on natural-log transformed spawner abundance, NORs, and productivity data. These analyses indicated that the Naches, Entiat, and Little Wenatchee abundance data correlated with the Chiwawa population data (Table 3). None of the abundance trends of the potential reference populations differed significantly from the Chiwawa population trend (Table 3; Figure 5). For NORs, all potential reference populations correlated with the Chiwawa population (Table 3). Only trends in NORs of the Entiat and Sesech differed significantly from the Chiwawa population (Table 2; Figure 6). For productivity, the Naches, Marsh, Sesech, and Little Wenatchee correlated with the Chiwawa population data (Table 3). Only the Entiat productivity trend differed significantly from the Chiwawa population trend (Table 3; Figure 7).

Table 3. Pearson correlation coefficients and t-test results comparing slopes of trends between potential reference populations and the Chiwawa spring Chinook population; d.f. = degrees of freedom and for correlation coefficients, an asterisk (*) indicates significance at P < 0.05. Analyses were conducted on natural-log transformed abundance and productivity data.

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	**d.f.**	**P-value**
LN Spawner Abundance Data				
Naches	0.642*	-1.323	8	0.222
Entiat	0.652*	0.412	18	0.685
Marsh	0.294	-1.324	18	0.202
Sesech	0.149	-1.431	18	0.170
Little Wenatchee	0.670*	1.325	18	0.202
LN Natural-Origin Recruits				
Naches	0.824*	-1.985	8	0.082
Entiat	0.886*	-2.563	18	0.019

Reference populations	Pearson correlation coefficient	t-test on slopes		
		t-value	d.f.	P-value
Marsh	0.830*	-1.038	18	0.313
Sesech	0.730*	-2.664	18	0.016
Little Wenatchee	0.927*	-1.150	18	0.265
LN Productivity Data				
Naches	0.944*	-0.042	8	0.968
Entiat	0.373	-3.043	18	0.007
Marsh	0.610*	0.428	18	0.674
Sesech	0.913*	-2.050	18	0.055
Little Wenatchee	0.862*	-1.811	18	0.087

In summary, based on correlation, trend, and graphic analyses, the Naches, Entiat, and Little Wenatchee populations appear to be reasonable reference populations for comparing spawner abundance data with Chiwawa data. For NORs, the Naches, Marsh, and Little Wenatchee appear to be reasonable reference populations. For productivity, the Naches, Marsh, Sesech, and Little Wenatchee populations appear to be reasonable reference populations for the Chiwawa population.

Minimal Detectable Differences (MDD)

Given a suite of potential reference populations, it is important to conduct power analyses to determine the minimum differences that can be detected when comparing the reference populations to the supplemented population. As a final exercise under Step 2, we examined potential reference populations for the smallest minimal detectable differences. Before conducting power analyses, several decisions needed to be made, including what statistical procedures will be used to analyze the data, the desired level of statistical power (probability of rejecting a false null hypothesis), the size of the type-I error (the probability of rejecting a true null hypothesis of no difference), and the number of samples (i.e., years) included in the analysis. In this case, the number of samples represents the number of treatment (supplementation) years. The number of pre-treatment years (1981-1992) was based on the number of years of quality data available for Chiwawa spring Chinook and potential reference populations.

We designed the study as a modified BACI (Before-After, Control-Impact) design, which includes replication before and after supplementation in both the treated (T) population and the reference (R) populations. A common approach used to analyze data from BACI designs includes analysis of difference scores (Stewart-Oaten et al. 1992; Smith et al. 1993). Differences are calculated between paired treatment and reference population scores (i.e., T-R). Another approach is to calculate ratios (treatment/reference; T/R) for paired treatment and reference population scores (Skalski and Robson 1992). Finally, differences in annual changes in paired treatment and reference population scores can be calculated (i.e., ΔT-ΔR) (Murdoch and Peven 2005; Hays et al. 2006).[12] These derived difference and ratio scores are then analyzed for a before-after treatment effect with a two-sample t-test, Aspin-Welch modification of the t-test, or a randomization test. For power analyses, we calculated minimal detectable differences assuming the use of an independent two-sample t-test with a type-I error rate of 0.05, power of 0.80 (beta or type-II error rate of 0.20), and sample sizes (treatment years) of 5, 10, 15, 20, 25, and 50 years.

The power analysis calculated the minimal detectable difference between mean difference or ratio scores before and during supplementation. We used existing data to calculate variances for the pre-supplementation and supplementation periods. Thus, variances were known and unequal. For both spawner abundance and NORs, the null hypothesis tested was that the mean difference or ratio before supplementation equaled the mean difference or ratio during supplementation. The alternative hypothesis was that the mean difference or ratio before supplementation was less than the mean difference during supplementation (one-tail test; Difference < 0). For productivity, the null hypothesis tested was that the mean difference or ratio before supplementation equaled the mean difference or ratio during supplementation. The alternative hypothesis was that the mean difference or ratio before supplementation was greater than the mean difference during supplementation (one-tail test; Difference > 0).

Based on spawner abundance data, power analysis indicated that the Sesech-Chiwawa pairing consistently produced the smallest detectable differences (Table 4). However, when the abundance data were transformed using natural logs, the Entiat-Chiwawa pairing produced the smallest detectable difference (Table 5). Minimal detectable differences, based on mean difference scores on untransformed data and a treatment period of 20 years, ranged from 334 to 394 adult spawners; transformed data ranged from 0.479 to 1.010. These analyses indicate that the Naches, Entiat, Sesech, and Little Wenatchee populations appear to be reasonable reference populations for comparing spawner abundance data with Chiwawa data. The Marsh Creek population produced some of the largest detectable differences and based on these analyses may not be a reasonable reference population.

Table 4. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on spawner abundance data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	638	604	560	396	652
	10	464	448	444	354	481
	15	405	395	406	341	424
	20	376	368	387	334	394

[12] The difference of annual difference scores was estimated by first subtracting the population parameter (e.g., spawner abundance) in year 2 from year 1. This continues for all years in the data series for both treatment ($T_{t+1} – T_t$) and reference populations ($R_{t+1} – R_t$). We then calculated differences between paired treatment and reference annual difference scores [$(T_{t+1} – T_t) - (R_{t+1} – R_t) = ΔT-ΔR$].

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
	25	358	352	376	331	376
	50	322	319	354	323	340
T/R	5	0.600	2.084	39.251	1.569	5.498
	10	0.506	1.548	24.729	1.508	3.828
	15	0.478	1.367	19.646	1.490	3.256
	20	0.465	1.275	16.828	1.481	2.954
	25	0.458	1.219	14.974	1.475	2.765
	50	0.447	1.105	10.573	1.465	2.366
ΔT-ΔR	5	1,049	761	717	518	766
	10	750	542	539	411	547
	15	650	467	480	376	473
	20	598	429	450	359	434
	25	567	405	431	348	410
	50	506	355	395	329	361

Table 5. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-log transformed spawner abundance data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	0.975	0.871	2.061	0.828	1.013
	10	0.721	0.613	1.375	0.648	0.722
	15	0.637	0.525	1.138	0.588	0.623
	20	0.595	0.479	1.010	0.559	0.571
	25	0.569	0.450	0.928	0.541	0.539
	50	0.521	0.390	0.749	0.505	0.473
T/R	5	0.157	0.162	2.343	0.160	0.368
	10	0.116	0.115	1.474	0.125	0.247
	15	0.102	0.099	1.170	0.114	0.206
	20	0.095	0.090	1.001	0.108	0.183
	25	0.091	0.085	0.890	0.104	0.169
	50	0.082	0.075	0.625	0.098	0.138
ΔT-ΔR	5	1.261	1.288	3.076	1.160	1.467
	10	0.898	0.900	2.020	0.887	1.001
	15	0.776	0.768	1.653	0.797	0.840
	20	0.713	0.698	1.463	0.751	0.755

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
	25	0.675	0.655	1.325	0.724	0.701
	50	0.600	0.564	1.038	0.670	0.585

Based on NORs, power analysis indicated that the Entiat-Chiwawa, Marsh-Chiwawa, and Little Wenatchee-Chiwawa pairings produced the smallest detectable differences (Table 6). When NORs were transformed using natural logs, the Little Wenatchee-Chiwawa pairing produced the smallest detectable difference (Table 7). Minimal detectable differences, based on mean difference scores on untransformed data and a treatment period of 20 years, ranged from 483 to 640 NORs; transformed data ranged from 0.958 to 2.262. These analyses indicate that the Entiat, Marsh, and Little Wenatchee populations appear to be reasonable reference populations for comparing NORs with Chiwawa data.

Table 6. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-origin recruits.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	1,139	541	573	630	546
	10	809	511	515	550	503
	15	698	502	498	526	489
	20	640	497	489	514	483
	25	604	494	484	507	479
	50	534	489	474	493	472
T/R	5	0.469	2.538	5.196	1.976	6.973
	10	0.451	2.183	4.183	1.894	5.118
	15	0.446	2.072	3.854	1.869	4.492
	20	0.445	2.017	3.691	1.857	4.170
	25	0.444	1.986	3.594	1.850	3.973
	50	0.443	1.924	3.405	1.836	3.572
ΔT-ΔR	5	1,639	500	519	609	531
	10	1,239	386	409	433	396
	15	1,109	348	374	372	351
	20	1,046	329	356	341	328
	25	1,009	318	346	321	314
	50	943	295	325	281	285

Table 7. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-log transformed natural-origin recruits.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	2.380	1.646	1.967	2.247	1.174
	10	2.291	1.479	1.505	1.835	1.026
	15	2.270	1.428	1.351	1.702	0.980
	20	2.262	1.403	1.273	1.636	0.958
	25	2.258	1.389	1.227	1.597	0.945
	50	2.253	1.361	1.133	1.522	0.920
T/R	5	0.322	0.332	0.739	0.398	0.356
	10	0.301	0.289	0.581	0.334	0.322
	15	0.296	0.275	0.530	0.314	0.312
	20	0.294	0.269	0.504	0.305	0.307
	25	0.293	0.265	0.488	0.299	0.304
	50	0.291	0.258	0.458	0.288	0.298
ΔT-ΔR	5	2.858	2.400	2.355	3.283	2.109
	10	2.560	1.714	1.881	2.311	1.552
	15	2.485	1.481	1.728	1.979	1.365
	20	2.456	1.360	1.652	1.805	1.269
	25	2.443	1.285	1.607	1.697	1.210
	50	2.430	1.130	1.519	1.471	1.092

Using untransformed productivity data, power analysis indicated that the Little Wenatchee-Chiwawa pairing consistently produced the smallest detectable differences (Table 8). The Marsh-Chiwawa pairings produced the largest detectable differences. When we analyzed natural-log transformed productivity data, the Naches-Chiwawa and Little Wenatchee-Chiwawa pairings produced the smallest detectable differences (Table 9). Minimal detectable differences, based on mean difference scores on untransformed data and a treatment period of 20 years, ranged from 0.754 to 1.839; transformed data ranged from 0.277 to 0.477. These analyses indicate that the Naches, Entiat, Sesech, and Little Wenatchee populations appear to be reasonable reference populations for comparing productivity data with Chiwawa data. The Marsh Creek population produced some of the largest detectable differences and based on these analyses may not be a reasonable reference population.

Table 8. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on productivity data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	2.181	1.382	2.033	3.517	1.192
	10	1.442	1.119	1.900	2.265	0.901

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
	15	1.186	1.033	1.859	1.828	0.804
	20	1.047	0.991	1.839	1.588	0.754
	25	0.959	0.966	1.828	1.432	0.724
	50	0.764	0.917	1.806	1.074	0.664
T/R	5	1.364	1.773	0.863	0.876	2.167
	10	1.095	1.359	0.831	0.687	1.587
	15	1.011	1.221	0.822	0.625	1.391
	20	0.971	1.152	0.817	0.594	1.290
	25	0.949	1.110	0.814	0.575	1.228
	50	0.910	1.027	0.908	0.538	1.102
ΔT-ΔR	5	3.298	1.864	3.211	4.420	1.942
	10	2.263	1.382	2.968	2.811	1.291
	15	1.909	1.220	2.894	2.248	1.066
	20	1.723	1.137	2.859	1.938	0.944
	25	1.606	1.087	2.839	1.735	0.866
	50	1.365	0.986	2.800	1.259	0.695

Table 9. Minimal detectable differences between mean difference and ratio scores before and during supplementation. Analyses were conducted on natural-log transformed productivity data.

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
T-R	5	0.540	0.551	0.674	0.890	0.585
	10	0.367	0.452	0.542	0.590	0.413
	15	0.308	0.421	0.499	0.486	0.355
	20	0.277	0.405	0.477	0.430	0.324
	25	0.257	0.396	0.465	0.393	0.305
	50	0.215	0.378	0.440	0.314	0.265
T/R	5	0.915	1.286	0.743	0.697	1.685
	10	0.744	0.973	0.704	0.541	1.227
	15	0.691	0.868	0.692	0.489	1.072
	20	0.666	0.815	0.687	0.463	0.993
	25	0.652	0.783	0.683	0.447	0.943
	50	0.628	0.719	0.677	0.416	0.843
ΔT-ΔR	5	0.885	0.810	1.028	1.252	0.971
	10	0.631	0.609	0.822	0.809	0.640
	15	0.546	0.542	0.755	0.655	0.525

Response variable	Treatment years	Minimal detectable differences by reference population				
		Naches	Entiat	Marsh	Sesech	Little Wenatchee
	20	0.502	0.508	0.722	0.570	0.463
	25	0.475	0.487	0.702	0.516	0.423
	50	0.423	0.446	0.664	0.391	0.333

Step 3: Quantitative Method for Ranking Selection Criteria

Not surprisingly, different selection criteria produced different results (Table 10). Determining whether a given population is or is not a suitable reference population based on selection criteria such as graphic analysis can be subjective. In addition, treating each selection criterion as equally important may not be appropriate. For example, using the information in Table 10, is it appropriate to select a reference population that has two or three "Yes" entries, or should only populations with four "Yes" entries be selected as suitable reference populations? This approach does not allow certain selection criteria to carry more weight in the overall selection process. That is, correlation may be more important than graphic analysis in the overall selection process. In order to reduce subjectivity, we developed a method of scoring and weighting each selection criterion. This method allows a more quantitative process for selecting suitable reference populations.

Table 10. Summary of results from graphic analysis, correlations, trend analysis, and power analysis (minimal detectable differences). "Yes" indicates that the population is a suitable reference population for the Chiwawa population; "No" indicates that it may not be a suitable reference population.

Potential reference populations	Graphic analysis	Correlation	Trends	Minimal detectable differences
Spawner Abundance				
Naches	Yes	Yes	Yes	Yes
Entiat	Yes	Yes	Yes	Yes
Marsh	No	No	Yes	No
Sesech	No	No	Yes	Yes
Little Wenatchee	Yes	Yes	Yes	Yes
Natural-Origin Recruits				
Naches	Yes	Yes	Yes	No
Entiat	No	Yes	No	Yes
Marsh	Yes	Yes	Yes	Yes
Sesech	No	Yes	No	No
Little Wenatchee	Yes	Yes	Yes	Yes
Productivity				
Naches	Yes	Yes	Yes	Yes
Entiat	No	No	No	Yes

Potential reference populations	Graphic analysis	Correlation	Trends	Minimal detectable differences
Marsh	No	Yes	Yes	No
Sesech	Yes	Yes	Yes	Yes
Little Wenatchee	Yes	Yes	Yes	Yes

We developed scoring methods for each of the following five selection criteria:

(1) The proportion of natural-origin spawners (pNOS) in the reference population for the period before supplementation (pre-pNOS);

(2) pNOS in the reference population for the period following supplementation (post-pNOS);

(3) The correlation between the reference and supplemented populations before supplementation;

(4) The relative difference in slopes between the reference and supplemented populations before supplementation; and

(5) The coefficient of variation (CV) of the ratio of supplemented to reference populations before the period of supplementation.

Each selection criteria was scored from 0 to 1, with 0 being the worst possible score and 1 being the best.

The pre- and post-pNOS values were calculated as the average pNOS values before and after supplementation, respectively. Because pNOS values range from 0-1, we did not need to rescale these values. When using reference populations to evaluate the effects of supplementation programs, it is important that the reference populations maintain high values of pNOS throughout the life of the monitoring program. Therefore, we heavily weighted the mean pNOS scores. We assigned weights of 30 and 40 to the mean pre- and post-pNOS scores, respectively. The relatively larger weight for the post-supplementation period is to reduce the likelihood of retaining a reference population that becomes influenced by hatchery fish during the supplementation period.

We assessed the association between the reference and supplemented populations during the pre-supplementation period by calculating the Pearson correlation coefficient, which ranges from -1 to 1. To scale the coefficient between 0 and 1, we took the absolute value of the coefficient. Thus, a coefficient of -0.92 would be reported as 0.92. For our analyses, we were not concerned with the direction of the relationship, only the strength of the relationship. The correlation coefficient was given a weight of 12.5.

As noted earlier, we used least squares to fit a linear trend to each of the reference populations and the supplemented population during the pre-supplementation period. Using the slope estimates for each trend line, we calculated the relative difference in slopes as the slope of the supplemented population minus the slope of the reference population, divided by the slope of the reference population. To scale this value between 0 and 1, we used absolute values, and depending on the direction of the slopes, we subtracted the relative difference from 1. The latter was needed to make sure a larger relative difference value indicated a small difference in slopes between the supplemented and reference populations. The relative difference score was given a weight of 7.5.

Finally, as a means to score effect size, we calculated the CV of the ratio of supplemented to reference population parameters (i.e., T/R). The CV was calculated as the standard deviation of the ratios divided by the absolute value of the mean ratios. The CV was subtracted from 1. This scaled the value from 0 to 1 with larger values representing the best condition. The CV was given a weight of 10, which is greater than the weight for trend, but less than the weight for correlation.

The total score for a reference population was calculated by multiplying the estimated value, which ranged from 0 to 1, by its weight. The sum of the five weighted values provided a total score, which ranged from 0 to 100. Based on several simulations, we set the cut-off score at 81. That is, if the total score for a given reference population equaled or exceeded 81, the population was included as a suitable reference population. If the total score fell below 81, the population was not considered a suitable reference. Based on the distribution of all scores possible, a score of 81 or greater represented only 3% of the total distribution. Thus, a cut-off of 81 is quite conservative.

Under Step 3, we used this method to select the final suite of suitable reference populations. Table 11 shows results from scoring each of the reference populations using the quantitative method. Using the cut-off criterion of 81, only the Naches, Marsh, and Sesech populations would be considered suitable reference populations for the Chiwawa supplementation program. Both the Entiat and Little Wenatchee populations failed to meet the minimum score, largely because of the influence of hatchery fish within those populations (i.e., relatively low pNOS values).

Table 11. Results from scoring potential reference populations using the selection criteria (pNOS, correlation, trend, and effect size). Populations with scores less than 81 were considered unsuitable as reference populations. Populations with scores equal to or greater than 81 were considered suitable references. These results were based on natural-log transformed data.

Potential reference populations	Population metric		
	Abundance	NORs	Productivity
Naches	85	88	91
Entiat	23	21	16
Marsh	79	91	87
Sesech	84	85	88
Little Wenatchee	51	53	49

An important benefit from scoring the different selection criteria is that the total scores can be used to weight the outcome of differing statistical results. For example, analyses may show that when three suitable reference populations are compared to the supplemented population, two of the reference populations may indicate a significant treatment effect, while the third indicates no effect. Under this scenario it is not clear if the supplementation program has or has not affected the abundance or productivity of the supplemented population. If, however, the two reference populations that produced a significant result had higher total scores than the reference population that did not indicate a significant result, one can place more weight on the results from populations with higher total scores.

Conclusions

The purpose of this exercise was to develop a method for selecting suitable reference populations that could be used to assess the effects of supplementation programs on spawner abundance, NORs, and productivity. The selection process included a three-step process (Figure 8). Step 1 identified populations with similar life-history characteristics, few or no hatchery spawners, a long time series of accurate abundance and productivity estimates, and similar freshwater habitat impairments and out-of-basin effects. Populations that met these criteria were then examined for their graphical and statistical relationship with the supplemented population (Step 2). The statistical analysis under Step 2 were converted to a quantitative model (Step 3) that was used to generate a weighted score for pNOS, correlation, trends, and effect sizes for each potential reference population. Reference populations with total scores of 81 or greater were selected as suitable reference populations.

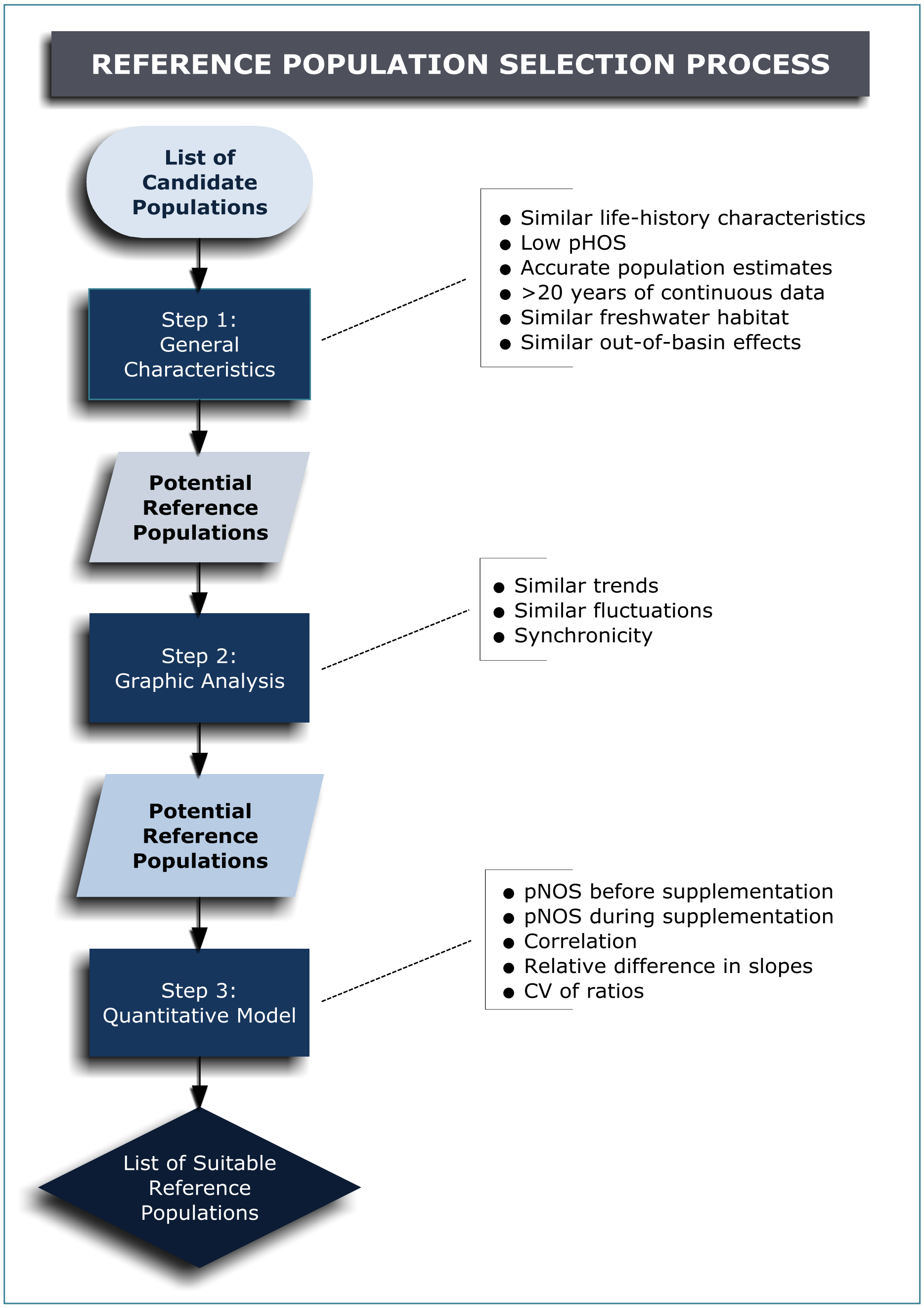

Figure 8. Three-step process for selecting suitable reference populations for supplemented populations.

We used this approach to select suitable reference populations for analyzing the effects of the Chiwawa spring Chinook supplementation program on fish abundance and productivity. The method indicated that the Naches, Marsh, and Sesech populations would serve as suitable reference populations for the Chiwawa spring Chinook supplementation program. Both the Entiat and Little Wenatchee populations failed to meet the minimum score, largely because of the influence of hatchery fish within those populations (i.e., relatively low pNOS values). However, because the presence of hatchery spring Chinook within those populations should decrease, they may serve as unique reference populations in which the comparisons change from all populations receiving hatchery fish to only the Chiwawa population receiving hatchery fish. Therefore, we will continue to include both the Little Wenatchee and Entiat populations in future analyses.

An important assumption in the use of reference populations is that the supplemented and reference populations that tracked each other before supplementation would continue to track each other in the absence of supplementation. Given that the reference populations did not match the Chiwawa population on all criteria examined (Table 1) and some reference populations tracked the Chiwawa population more poorly than others (Figures 2-7; Tables 2-4), there may be some uncertainty as to whether differences observed between the Chiwawa and reference populations during the supplementation period are associated with the hatchery program, "nuisance" factors[13], or a combination of both. In addition, we have no ability to regulate or control activities in reference areas. Any large-scale change (man-made or natural) in reference areas could affect our ability to assess the effectiveness of the supplementation program.

Because we have no ability to maintain reference areas for long periods of time and may not be able to control all activities even within the supplemented populations, we propose the use of a "causal-comparative" approach to strengthen the certainty of our inferences (Pearsons and Temple 2010). The causal-comparative approach relies on correlative data to try and make a case for causal inference.[14] Correlation is used to rule out alternative hypotheses (note that we make our case as much if not more by disproving plausible alternatives as we do by showing that the data are consistent with a hypothesis). For example, large scale land-use activities or natural events can affect stream flows, fine sediment recruitment, and water temperatures. Changes in these factors can affect the freshwater survival and productivity of fish independently of supplementation programs. If changes in habitat, migratory, and ocean conditions do not affect reference and treatment populations similarly, inferences associated with supplementation programs may be confounded. By measuring and tracking these extraneous factors within reference and treatment areas, we can assess the effects of these state variables on population conditions independent of the supplementation programs. This allows us to more effectively assess the influence of supplementation programs on populations.

To that end, we recommend that the following state variables be measured and tracked within the Chiwawa Basin and each of the reference areas: mean annual precipitation, total and riparian forest cover, road density, impervious surface, and alluvium. These variables can be used to describe differences in water temperatures at different life stages (pre-spawning, egg incubation, and summer rearing) and substrate characteristics, including fine sediments and embeddedness (Jorgensen et al. 2009). They can be used to

[13] A "nuisance" factor is any factor that is outside the control of the experimenter and can affect the response variable (spawner abundance or productivity). In this case, nuisance factors may include differences in freshwater habitat trends and conditions, out-of-basin effects (e.g., migration and ocean survival), and hatchery strays that affect the Chiwawa and reference populations differently.

[14] It is important to point out that correlation does not demonstrate cause-and-effect. It only suggests a relationship between variables. Thus, inferences based on correlation lack the certainty that is associated with a design-based approach.

assess possible changes in spawner abundance, NORs, and productivity that are independent of supplementation.

Analyses with Reference Populations

Once suitable reference populations are selected, methods for analyzing the supplemented and reference populations need to be identified. What follows is a description of different analyses that can be used to assess the effects of supplementation programs on spawner abundance, NORs, and productivity using reference populations. Later in this report we describe methods for assessing supplementation effects when reference populations are not available.

We used some of the reference populations selected for the Chiwawa program to illustrate the different methods for evaluating the effects of the supplementation program on spawner abundance, NORs, and productivity. For abundance, we selected the Naches, Entiat, Little Wenatchee, and Sesech populations as suitable references for the Chiwawa population. For NORs, we selected the Naches, Entiat, Marsh, and Little Wenatchee populations as suitable references. For productivity, we selected the Naches, Sesech, Little Wenatchee, and Marsh Creek as suitable references for the Chiwawa. As noted earlier, we included the Little Wenatchee and Entiat populations, even though they did not meet all the criteria for suitable reference populations.

Analysis of Trends

As a first step, we used trend analyses to assess the effects of the Chiwawa supplementation program on spring Chinook spawner abundance, NORs, and productivity. Here, we compared the slopes of the trends between each treatment/reference pair before and during supplementation using t-tests. If the hatchery program is successfully supplementing the natural spring Chinook population, trends in spawner abundance and NORs should deviate significantly (i.e., the slope of the supplemented population should be greater than the slopes of the reference populations during the supplementation period). For productivity, the slope of the supplemented population, relative to the reference population, should increase or remain the same.

Trend analysis indicated that the relationship of slopes of spawner abundance between the Chiwawa and reference populations did not change significantly after the initiation of supplementation (Figure 9; Table 12). This was true for both transformed and untransformed abundance data. Before supplementation, spawner abundances trended down in both the Chiwawa and reference populations (Figure 9). During the period of supplementation, abundances in both the Chiwawa and reference populations trended upward. Interestingly, in nearly all treatment/reference comparisons, the Pearson correlation coefficient was greater in the supplementation period than in the pre-supplementation period (Table 12). This was most evident in the transformed abundance data (Figure 9).

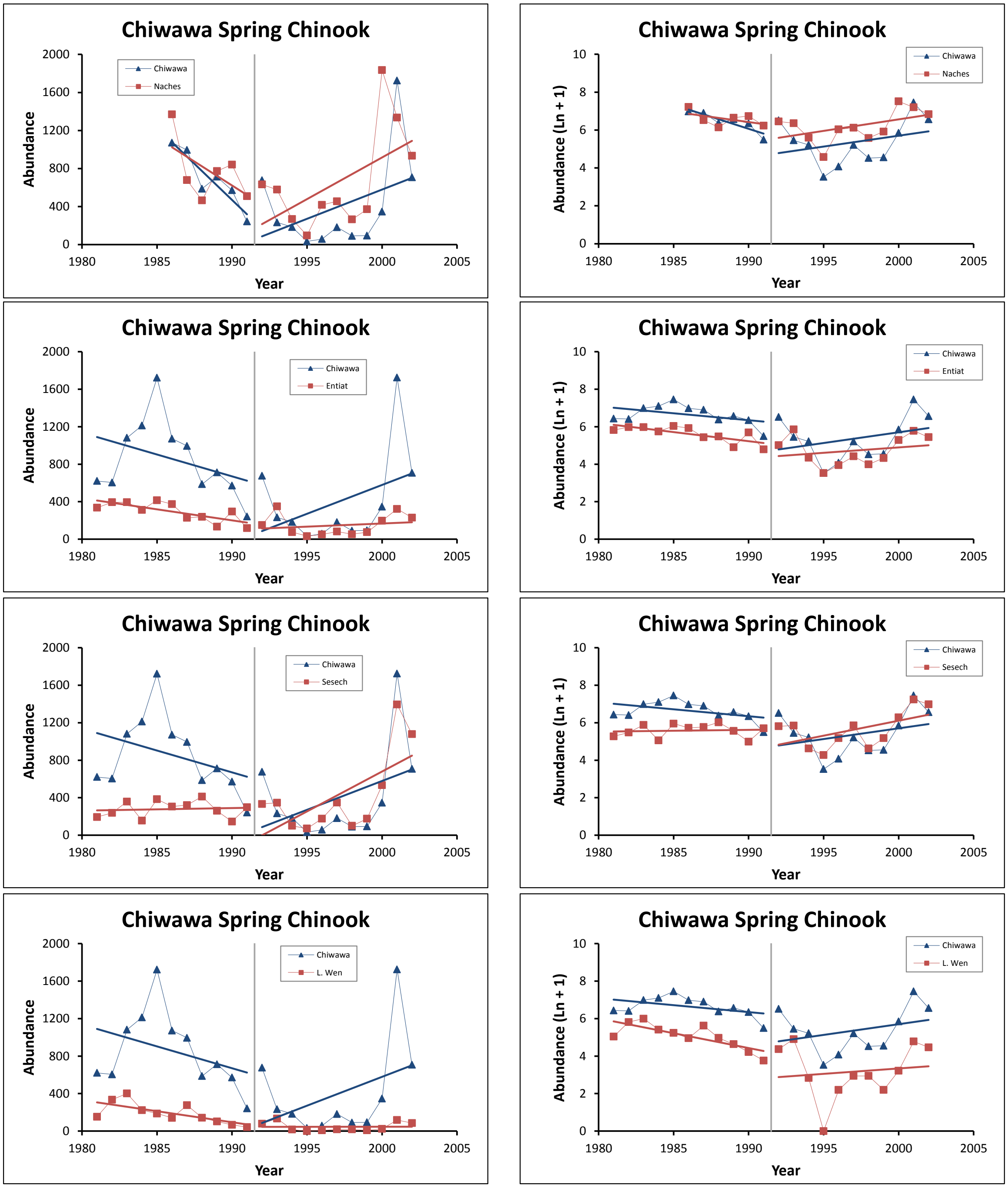

Figure 9. Trends in spring Chinook spawner abundance in the Chiwawa and reference populations. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left include untransformed spawner abundance data; those on the right include natural-log transformed data.

Table 12. Pearson correlation coefficients and t-test results comparing slopes of spawner abundance trends between reference populations and the Chiwawa spring Chinook population before and during the supplementation periods; for correlation coefficients, an asterisk (*) indicates significance at P < 0.05. Analyses include both untransformed and natural-log transformed spawner abundance data.

Reference population	Pearson correlation coefficient		Test on slopes			
			t-value		P-value	
	Before	During	Before	During	Before	During
Spawner Abundance						
Naches	0.684*	0.595	-0.659	-0.414	0.528	0.684
Entiat	0.598*	0.672*	-0.596	1.162	0.559	0.260
Sesech	0.274	0.904*	-1.265	-0.418	0.222	0.681
Little Wenatchee	0.399	0.685*	-0.591	1.330	0.562	0.200
LN Spawner Abundance						
Naches	0.642*	0.813*	-1.323	-0.047	0.222	0.963
Entiat	0.652*	0.860*	0.412	0.422	0.685	0.678
Sesech	0.149	0.878*	-1.431	-0.333	0.170	0.743
Little Wenatchee	0.670*	0.861*	1.325	0.316	0.202	0.756

Trend analysis indicated that the relationship of slopes of NORs between the Chiwawa and reference populations did not change significantly after the initiation of supplementation (Figure 10; Table 13). Before supplementation, Chiwawa NORs trended downward more strongly than the reference populations (Figure 10). However, during the supplementation period, both the Chiwawa and reference population NORs trended upward in parallel. In nearly all treatment/reference comparisons, the Pearson correlation coefficient was greater in the pre-supplementation period than in the supplementation period (Table 13).

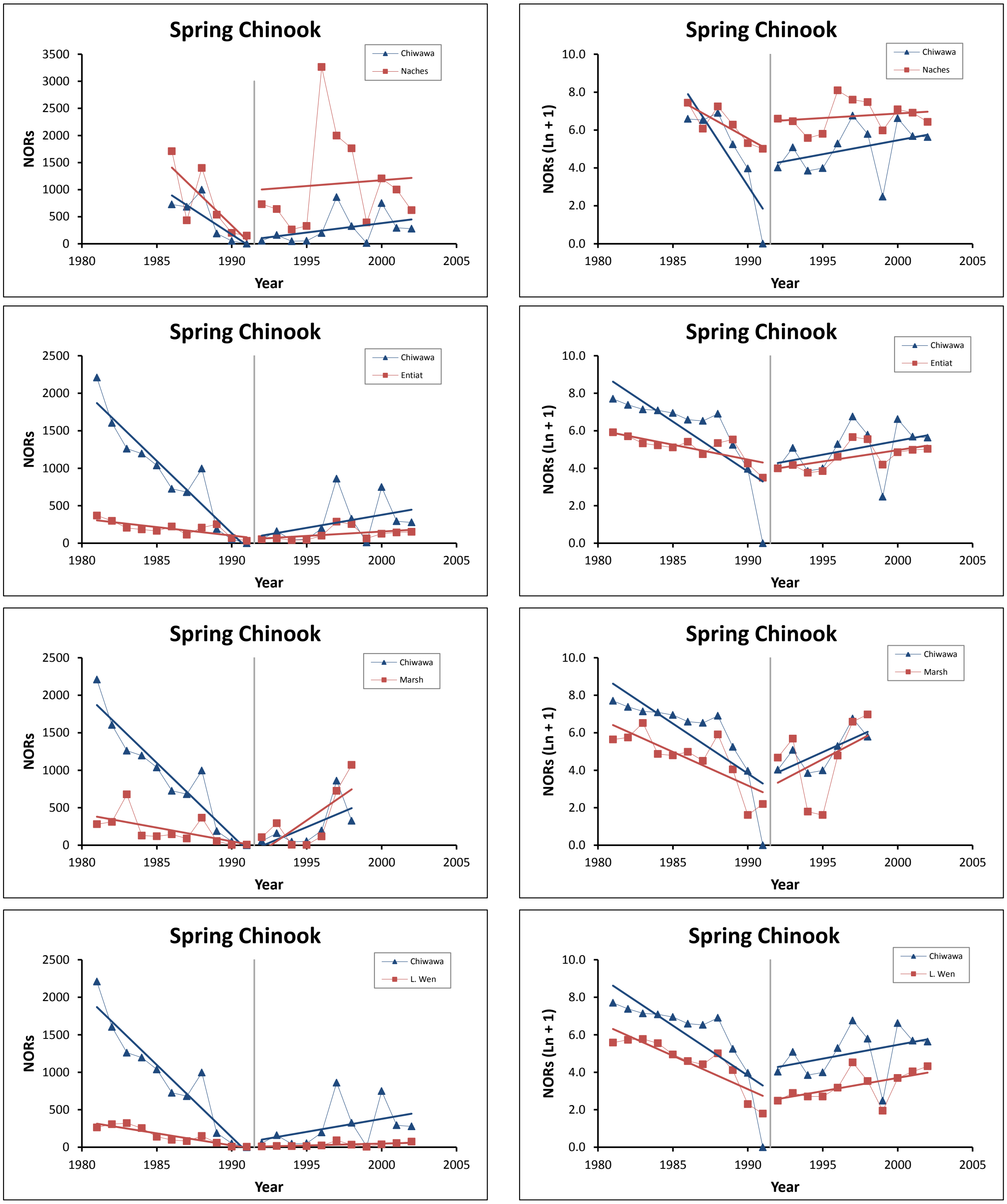

Figure 10. Trends in spring Chinook natural-origin recruits (NORs) in the Chiwawa and reference populations. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left include untransformed NORs; those on the right include natural-log transformed data.

Table 13. Pearson correlation coefficients and t-test results comparing slopes of natural-origin recruits trends between reference populations and the Chiwawa spring Chinook population before and during the supplementation periods; for correlation coefficients, an asterisk (*) indicates significance at P < 0.05. Analyses include both untransformed and natural-log transformed natural-origin recruits.

Reference population	Pearson correlation coefficient		Test on slopes			
			t-value		P-value	
	Before	During	Before	During	Before	During
Natural-Origin Recruits						
Naches	0.803*	0.432	0.666	0.140	0.524	0.890
Entiat	0.795*	0.754*	-7.495	0.847	0.000	0.408
Marsh	0.605*	0.677*	-5.786	-0.718	0.000	0.489
Little Wenatchee	0.880*	0.758*	-7.206	1.128	0.000	0.274
LN Natural-Origin Recruits						
Naches	0.824*	0.710*	-1.985	0.693	0.082	0.497
Entiat	0.886*	0.796*	-2.563	0.202	0.019	0.842
Marsh	0.830*	0.835*	-1.038	-0.134	0.313	0.896
Little Wenatchee	0.927*	0.898*	-1.150	0.046	0.265	0.964

As with NORs and spawner abundance data, trend analysis indicated that the relationship of slopes of productivity (recruits/spawner) between the Chiwawa and reference populations did not change significantly after the initiation of supplementation (Figure 11; Table 14). This was true for both transformed and untransformed productivity data. Before supplementation, productivities trended down in both the Chiwawa and reference populations (Figure 11). During the period of supplementation, productivities fluctuated widely in both the Chiwawa and reference populations. Nevertheless, during the supplementation period, productivities generally increased in both the reference and Chiwawa populations. Unlike with spawner abundance, the Pearson correlation coefficients resulting from analysis of productivity data were generally higher in the pre-supplementation period than during the supplementation period (Table 14).

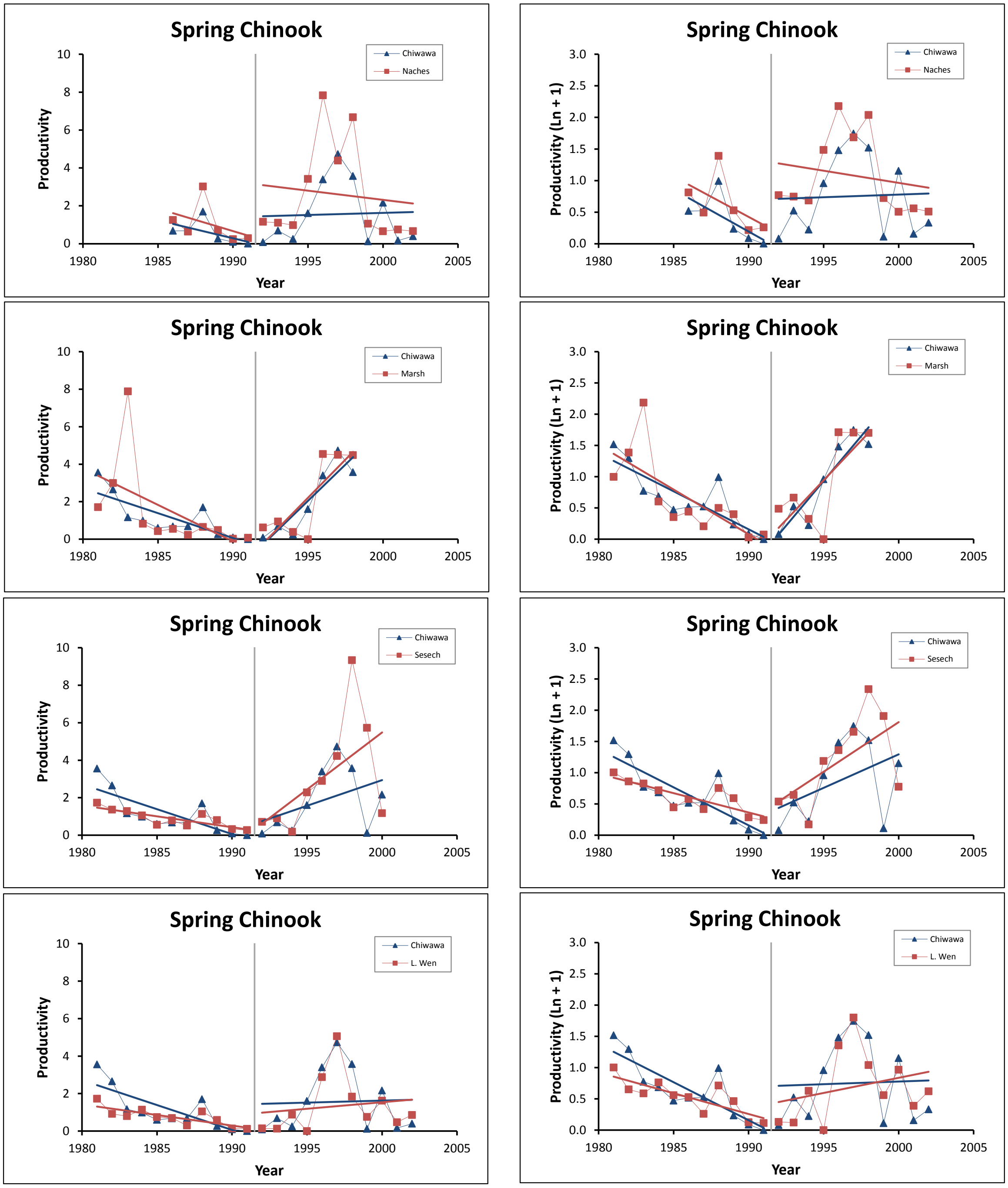

Figure 11. Trends in spring Chinook productivity (recruits/spawner) in the Chiwawa (supplemented) and reference populations. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left include untransformed productivity data; those on the right include natural-log transformed data.

Table 14. Pearson correlation coefficients and t-test results comparing slopes of productivity (recruits/spawner) trends between reference populations and the Chiwawa spring Chinook population before and during the supplementation periods; for correlation coefficients, an asterisk (*) indicates significance at P < 0.05. Analyses include both untransformed and natural-log transformed productivity data.

Reference population	Pearson correlation coefficient		Test on slopes			
			t-value		P-value	
	Before	During	Before	During	Before	During
Productivity						
Naches	0.960*	0.802*	0.169	0.387	0.870	0.703
Marsh	0.320	0.910*	0.605	-0.132	0.553	0.898
Sesech	0.903*	0.491	-2.059	-0.837	0.054	0.417
Little Wenatchee	0.848*	0.864*	-2.065	-0.213	0.054	0.834
LN Productivity						
Naches	0.944*	0.805*	-0.042	0.526	0.968	0.605
Marsh	0.610*	0.804*	0.428	0.281	0.674	0.784
Sesech	0.913*	0.531	-2.050	-0.463	0.055	0.651
Little Wenatchee	0.862*	0.751*	-1.811	-0.480	0.087	0.637

Using trend analysis, we found no evidence that the supplementation program has significantly increased the spawner abundance and NORs of spring Chinook in the Chiwawa Basin. Even though we documented an increasing trend in spawner abundance and NORs during the supplementation period, a similar increase in spawner abundance and NORs was observed in the reference populations. In addition, we found no evidence that the supplementation program has increased the productivity of spring Chinook in the Chiwawa Basin. Importantly, the productivity of spring Chinook in the Chiwawa Basin did not trend downward during the supplementation period. Thus, based on trend analysis, it appears that the supplementation program has not increased or decreased the abundance and productivity of spring Chinook in the Chiwawa Basin.

We note that this exercise only tests the slopes of the trend lines. It does not test for differences in elevations of the trend lines. A supplementation program could increase spawner abundance, NORs, and productivity of the target population without changing the slopes of the trend lines. That is, supplementation could cause the elevation of the trend line to be greater during the supplementation period than during the pre-supplementation period. In the next section we evaluate elevation differences by testing mean differences before and after supplementation.

Analysis of Mean Differences, Ratios, and Rates

For assessing mean differences between supplemented and reference populations, we derived three different response variables using transformed and untransformed spawner abundance, NORs, and productivity data. The first included difference scores, which were calculated as the difference between paired treatment and reference data (T-R). The second included ratios, which were calculated as the ratio of paired treatment and reference data (T/R). Finally, we calculated the differences in annual changes in paired treatment and reference population data (ΔT-ΔR; see footnote #2).

If the hatchery program is successfully supplementing the natural spring Chinook population, the mean difference or ratio score of paired spawner abundance data and NORs during the supplementation period should be greater than the pre-supplementation period. For productivity, the mean difference or ratio score during the supplementation period should be equal to or higher than the pre-supplementation period. We tested the following statistical hypotheses.

Spawner Abundance and NORs:

Ho: Mean Difference (or Ratio) before supplementation ≥ Mean Difference (or Ratio) during supplementation.

Ha: Mean Difference (or Ratio) before supplementation < Mean Difference (or Ratio) during supplementation (i.e., $\mu_{pre} - \mu_{post} < 0$).

Productivity (Recruits/Spawner):

Ho: Mean Difference (or Ratio) before supplementation ≤ Mean Difference (or Ratio) during supplementation.

Ha: Mean Difference (or Ratio) before supplementation > Mean Difference (or Ratio) during supplementation (i.e., $\mu_{pre} - \mu_{post} > 0$).[15]

For each set of response variables, we tested before/after supplementation effects using a one-tailed Aspin-Welch unequal-variance test. We used the Aspin-Welch unequal-variance test instead of Student's t-test, because in nearly every case, the variances of response variables in the pre-treatment and supplementation periods were unequal.[16] This was true even for natural-log transformed variables. We used the modified Levene equal-variance test to assess the equality of variance. In some cases, the distributions of response variables were not normal (based on the Omnibus Normality test and examination of histograms, normal probability plots, and box plots). Therefore, we also used a randomization test, based on 10,000 Monte Carlo simulations, to assess differences in response variables before and during supplementation. The randomization procedure only allowed the testing of two-tailed hypotheses. Therefore, we generated 95% confidence intervals on the mean difference ($\mu_{pre} - \mu_{post}$) using bootstrapping methods to determine the direction of the difference. We generated 5,000 bootstrap samples to calculate confidence intervals.

All these statistical methods assume that the samples of derived difference or ratio scores from the pre-supplementation and supplementation periods were independent. However, BACI designs, like time-series trend analysis, are repeated-measures designs and

[15] Because of the logic of null hypothesis testing, the rejection of the null hypothesis of no difference in productivity would mean that the supplementation program has reduced the productivity of the target population (here rejection of the null indicates "harm"). Notice that the rejection of the null hypothesis of no difference in spawner abundance means that the supplementation program has improved the spawner abundance in the target population (here rejection of the null indicates "benefit").

[16] In cases in which the variances were equal, both the Aspin-Welch test and Student's t-test gave the same result.

therefore are susceptible to temporal correlations in the data. This means that the two samples of difference or ratio scores may not be independent. Under this scenario, ARIMA models can be used to describe the correlation structure in temporal data (Gotelli and Ellison 2004). ARIMA models can be fit individually to the reference and supplemented time series data, or to a derived data series created by taking the ratio or difference of the supplemented/reference data at each time step. ARIMA models, however, require a long time series (N > 40) and therefore we could not use them to model the spring Chinook data. Thus, we acknowledge that our analyses may be confounded if the samples are not independent.

Difference Scores (T-R)

Analysis of supplementation effects on spawner abundance using difference scores indicated that supplementation did not significantly increase spawning abundance in the Chiwawa Basin (Table 15; Figure 12). Only the Little Wenatchee-Chiwawa pairing using transformed abundance data indicated a significant increase in spawning abundance following supplementation. The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction (i.e., CIs > 0). That is, compared to the reference populations, spawner abundance decreased in the Chiwawa Basin during the supplementation period (Figure 12).

Table 15. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed spawner abundance data. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Spawner Abundance					
Naches	1.066	0.848	184	0.322	-162 – 472
Entiat	1.872	0.962	316	0.078	17 – 633
Sesech	4.502	0.999	607	0.000	349 – 851
Little Wenatchee	1.773	0.954	321	0.093	0 – 690
LN Spawner Abundance					
Naches	2.603	0.990	0.701	0.026	0.210 – 1.214
Entiat	1.701	0.946	0.388	0.108	-0.033 – 0.811
Sesech	5.394	0.999	1.327	0.000	0.891 – 1.805
Little Wenatchee	-2.259	0.018	0.609	0.034	-1.125 – -0.097

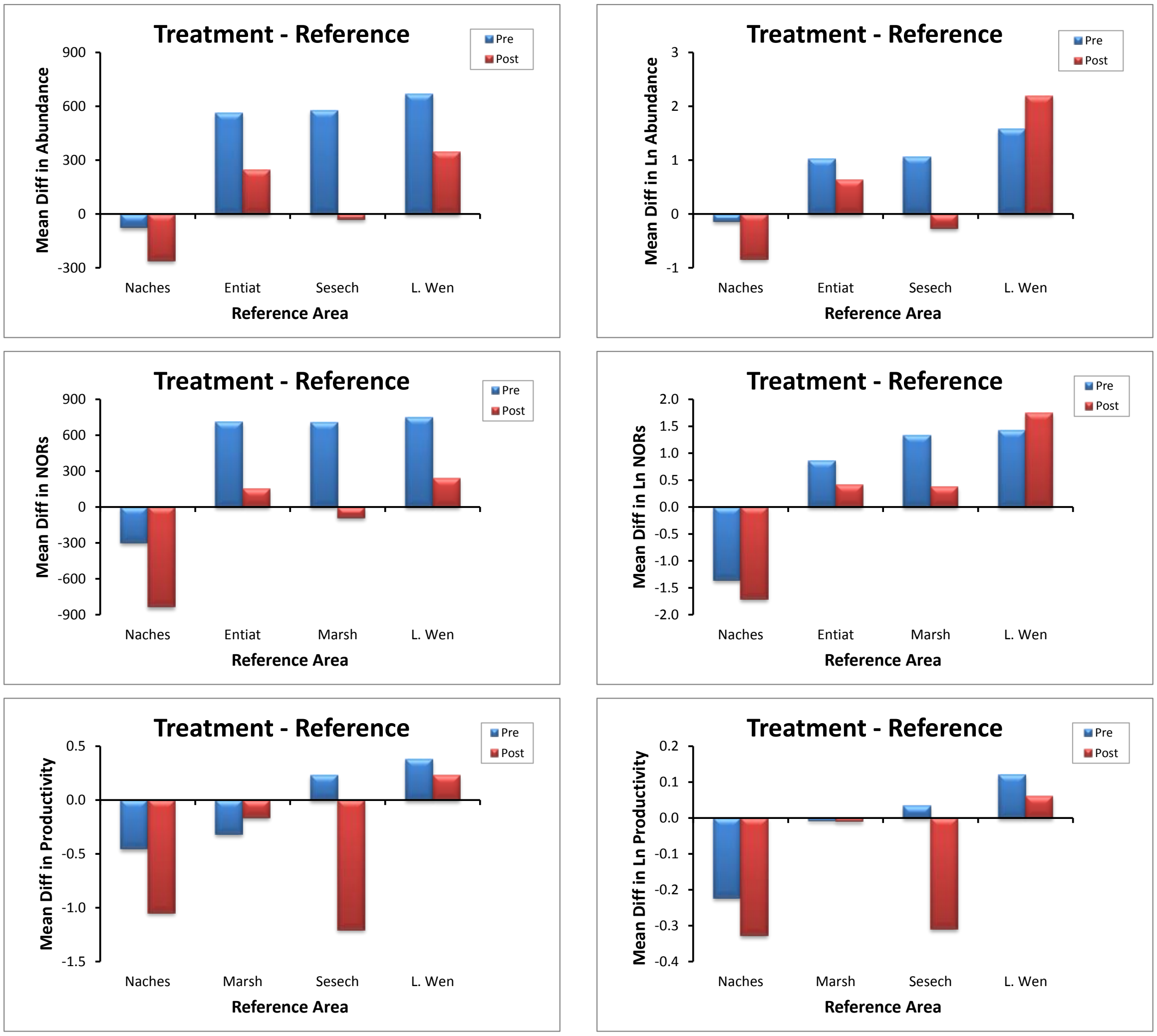

Figure 12. Mean difference (Treatment – Reference) scores of untransformed (figures on the left) and transformed (figures on the right) spawner abundance, natural-origin recruits (NORs), and productivity data before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin. Positive effects of supplementation on spawner abundance and NORs are indicated when the post-supplementation (red) bars are greater than their corresponding pre-supplementation (blue) bars. Negative effects of supplementation on productivity are indicated when the pre-supplementation (blue) bars are greater than their corresponding post-supplementation (red) bars.

Analysis of supplementation effects on NORs using difference scores indicated that supplementation did not significantly increase NORs in the Chiwawa Basin (Table 16; Figure 12). The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction. That is, compared to the reference populations, NORs decreased in the Chiwawa Basin during the supplementation period (Figure 12).

Table 16. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed natural-origin recruits. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Natural-Origin Recruits					
Naches	1.787	0.953	537	0.081	-60 – 1039
Entiat	2.879	0.993	558	0.007	201 – 916
Marsh	3.817	0.999	795	0.001	381 – 1153
Little Wenatchee	2.668	0.991	510	0.013	145 – 863
LN Natural-Origin Recruits					
Naches	0.430	0.659	0.354	0.686	-0.948 – 1.975
Entiat	0.788	0.779	0.445	0.465	-0.504 – 1.583
Marsh	1.45	0.916	0.953	0.168	-0.169 – 2.243
Little Wenatchee	-0.813	0.214	-0.319	0.506	-0.948 – 0.484

Analysis of supplementation effects on productivity (adult recruits/spawner) using difference scores indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 17; Figure 12). All tests, regardless of treatment-reference pairs, indicated that productivity did not change significantly during the supplementation period. These tests indicate that supplementation has not negatively affected the productivity of spring Chinook salmon in the Chiwawa Basin.

Table 17. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data. Tests determined if the mean difference scores during the supplementation period were less than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	1.134	0.139	0.594	0.296	-0.427 – 1.540
Marsh	-0.203	0.579	0.152	0.932	-0.304 – 1.381
Sesech	1.607	0.071	1.435	0.151	-0.403 – 2.917
Little Wenatchee	0.431	0.335	0.147	0.665	-0.498 – 0.762
LN Productivity					
Naches	0.770	0.227	0.104	0.480	-0.125 – 0.378
Marsh	0.012	0.495	0.003	0.992	-0.375 – 0.493
Sesech	1.463	0.087	0.343	0.161	-0.135 – 0.732

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Little Wenatchee	0.390	0.351	0.060	0.701	-0.229 – 0.347

Ratio Scores (T/R)

As with difference scores, analysis of supplementation effects on spawner abundance using ratios indicated that supplementation did not significantly increase spawning abundance in the Chiwawa Basin (Table 18; Figure 13). Only the Little Wenatchee-Chiwawa pairing indicated a significant increase in spawning abundance following supplementation. Analysis with both transformed and untransformed Little Wenatchee-Chiwawa data indicated a significant effect. In contrast, only difference scores derived from transformed data indicated a significant effect. The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction. That is, compared to the reference populations, spawner abundance decreased in the Chiwawa Basin during the supplementation period (Figure 13).

Table 18. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed spawner abundance data. Tests determined if the mean ratios during the supplementation period were greater than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Spawner Abundance					
Naches	2.110	0.970	0.398	0.065	0.056 – 0.737
Entiat	1.254	0.888	0.731	0.223	-0.365 – 1.834
Sesech	4.251	0.999	2.428	0.000	1.278 – 3.435
Little Wenatchee	-2.649	0.009	3.897	0.018	-6.579 – -1.202
LN Spawner Abundance					
Naches	2.783	0.993	0.120	0.021	0.045 – 0.199
Entiat	1.273	0.890	0.055	0.220	-0.026 – 0.135
Sesech	5.143	0.999	0.244	0.000	0.160 – 0.335
Little Wenatchee	-3.462	0.002	0.327	0.003	-0.516 – -0.154

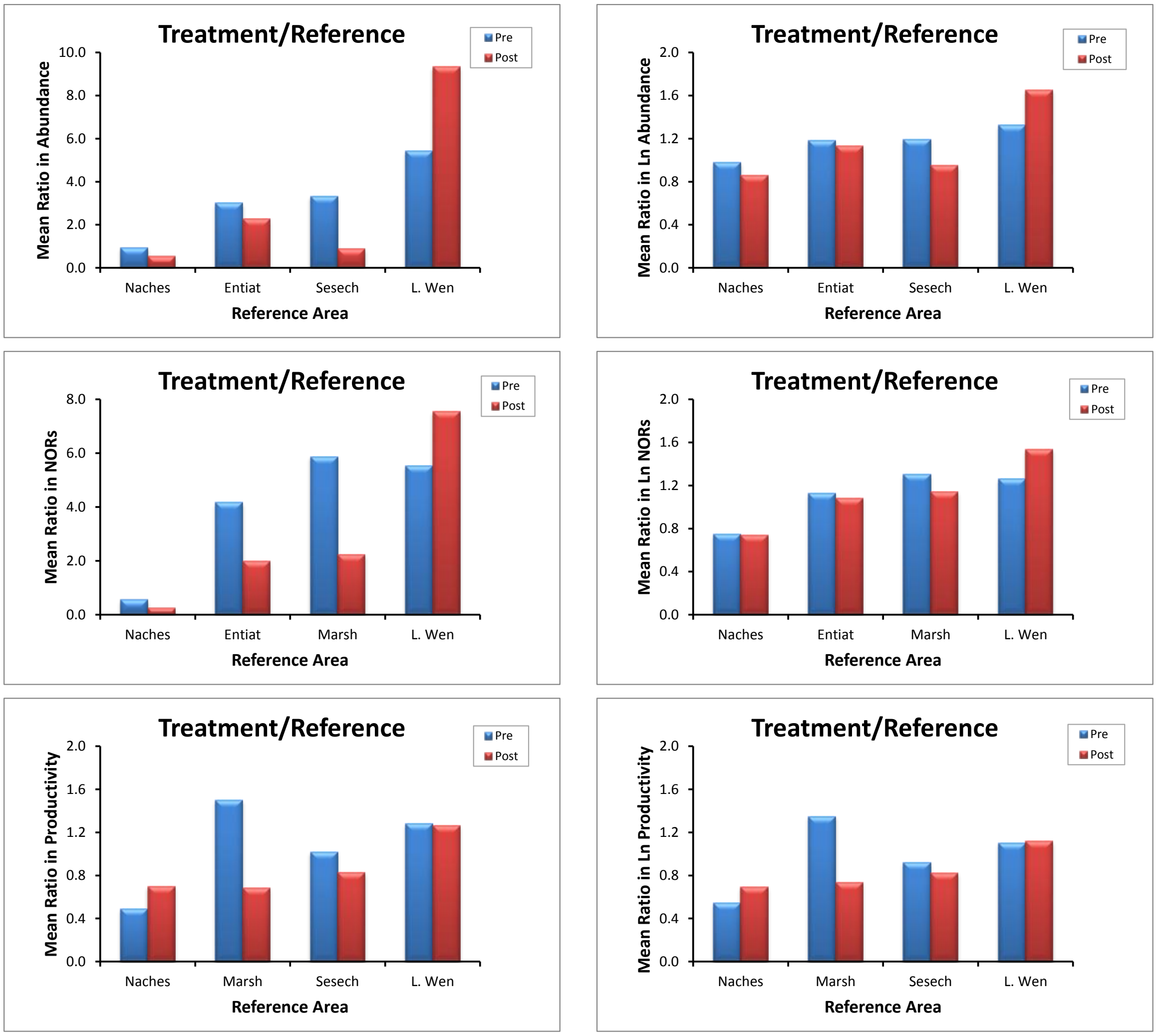

Figure 13. Mean ratios (Treatment/Reference) scores of untransformed (figures on the left) and transformed (figures on the right) spawner abundance, natural-origin recruits (NORs), and productivity data before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin. Positive effects of supplementation on spawner abundance and NORs are indicated when the post-supplementation (red) bars are greater than their corresponding pre-supplementation (blue) bars. Negative effects of supplementation on productivity are indicated when the pre-supplementation (blue) bars are greater than their corresponding post-supplementation (red) bars.

Analysis of supplementation effects on NORs using ratios indicated that supplementation did not significantly increase NORs in the Chiwawa Basin (Table 19; Figure 13). Only the Little Wenatchee-Chiwawa pairing indicated a significant increase in transformed NORs following supplementation. The randomization test indicated significant differences in several of the treatment-reference pairs; however, the bootstrap CIs indicated that those differences were in the wrong direction. That is, compared to the reference populations, NORs decreased in the Chiwawa Basin during the supplementation period (Figure 13).

Table 19. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed natural-origin recruits. Tests determined if the mean ratios during the supplementation period were greater than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Natural-Origin Recruits					
Naches	1.318	0.881	0.306	0.219	-0.157 – 0.670
Entiat	2.447	0.987	2.172	0.028	0.593 – 3.871
Marsh	2.001	0.965	3.638	0.075	0.532 – 7.201
Little Wenatchee	-1.148	0.136	2.020	0.284	-5.055 – 1.516
LN Natural-Origin Recruits					
Naches	0.057	0.522	0.009	0.967	-0.230 – 0.351
Entiat	0.359	0.638	0.049	0.759	-0.173 – 0.336
Marsh	0.603	0.721	0.161	0.579	-0.272 – 0.681
Little Wenatchee	-1.914	0.038	0.277	0.027	-0.504 – 0.031

Analysis of supplementation effects on productivity (adult recruits/spawner) using ratios indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 20; Figure 13). Although the Aspin-Welch test indicated a significant effect when comparing the Chiwawa to the Marsh Creek population, both the randomization test and the bootstrap CI did not indicate a significant effect. These tests indicate that supplementation has probably not negatively affected the productivity of spring Chinook salmon in the Chiwawa Basin.

Table 20. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data. Tests determined if the mean ratios during the supplementation period were less than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	-0.677	0.745	0.209	0.688	-0.700 – 0.425
Marsh	2.236	0.022	0.814	0.054	0.112 – 1.459
Sesech	0.677	0.253	0.191	0.515	-0.356 – 0.718
Little Wenatchee	0.033	0.487	0.018	0.979	-0.879 – 1.162
LN Productivity					
Naches	-0.639	0.734	0.148	0.616	-0.548 – 0.316
Marsh	1.952	0.036	0.613	0.081	-0.003 – 1.170
Sesech	0.447	0.330	0.098	0.663	-0.301 – 0.515
Little Wenatchee	-0.034	0.513	0.015	0.982	-0.692 – 0.861

Difference of Annual Difference Scores (ΔT-ΔR)

Analysis of supplementation effects on spawner abundance using difference scores of annual changes indicated that supplementation did not significantly increase spawning abundance in the Chiwawa Basin (Table 21; Figure 14). None of the statistical analyses detected a significant increase in annual change in the Chiwawa Basin relative to the reference populations.

Table 21. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed spawner abundance data. Tests determined if mean difference scores of annual change during the supplementation period were greater than mean difference scores of annual change during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Spawner Abundance					
Naches	0.009	0.503	2	0.995	-502 – 539
Entiat	-0.239	0.407	48	0.826	-414 – 327
Sesech	-0.126	0.451	20	0.902	-311 – 266
Little Wenatchee	-0.318	0.377	65	0.761	-452 – 311
LN Spawner Abundance					
Naches	-0.425	0.339	0.142	0.698	-0.744 – 0.466
Entiat	-0.084	0.467	0.028	0.933	-0.681 – 0.593
Sesech	-0.349	0.366	0.117	0.740	-0.741 – 0.515
Little Wenatchee	0.001	0.500	0.000	0.999	-0.663 – 0.687

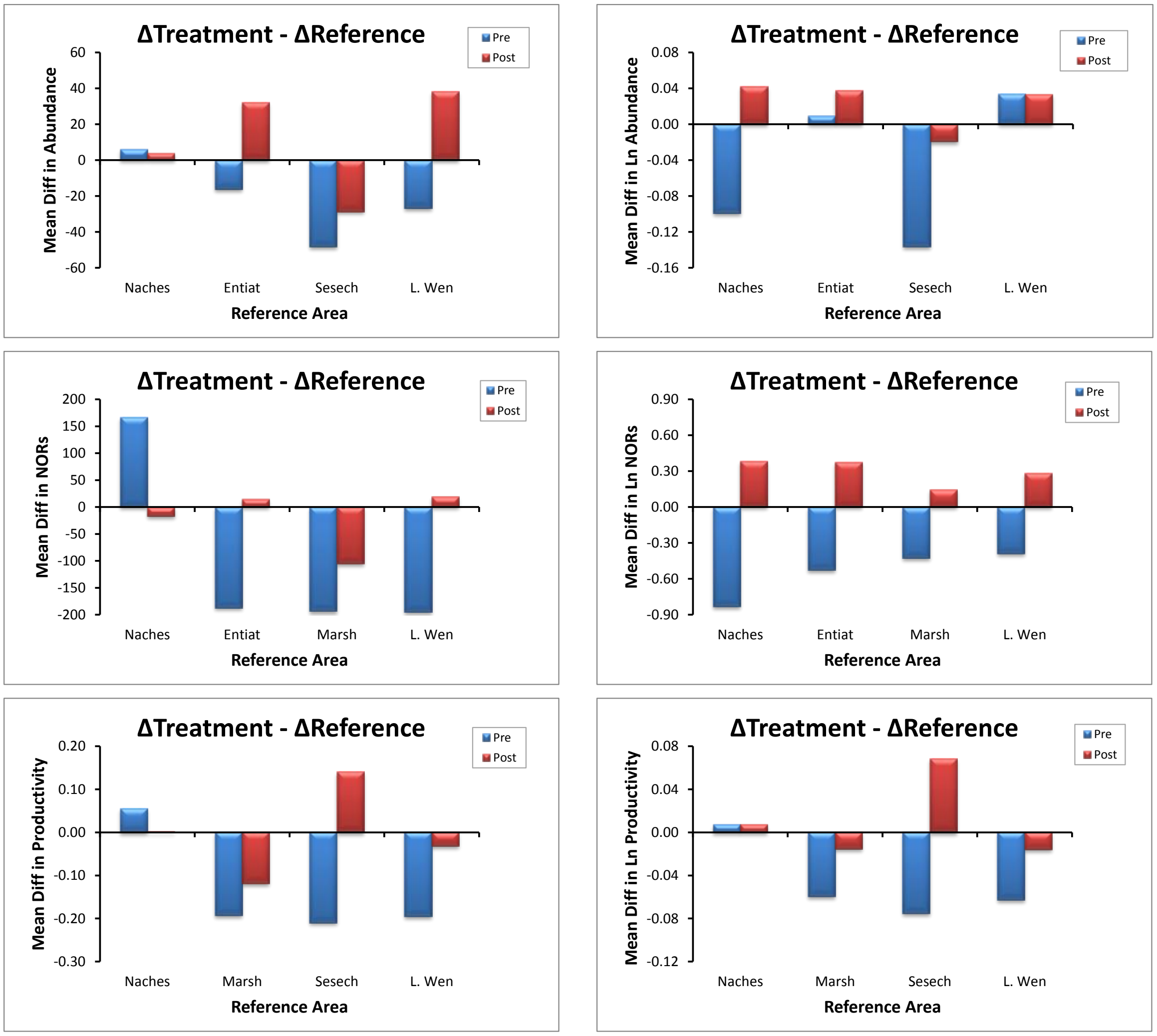

Figure 14. Mean difference scores of annual changes (ΔTreatment – ΔReference) of untransformed (figures on the left) and transformed (figures on the right) spawner abundance and productivity data before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin.

Analysis of supplementation effects on NORs using difference scores of annual changes indicated that supplementation did not significantly increase NORs in the Chiwawa Basin (Table 22; Figure 14). None of the statistical analyses detected a significant increase in annual change in the Chiwawa Basin relative to the reference populations.

Table 22. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed natural-origin recruits. Tests determined if mean difference scores of annual change during the supplementation period were greater than mean difference scores of annual change during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Natural-Origin Recruits					
Naches	0.399	0.652	184	0.741	-699 – 989
Entiat	-1.381	0.092	202	0.194	-471 – 86
Marsh	-0.505	0.311	88	0.624	-425 – 206
Little Wenatchee	-1.437	0.084	214	0.179	-481 – 64
LN Natural-Origin Recruits					
Naches	-1.301	0.118	1.214	0.224	-2.783 – 0.531
Entiat	-1.408	0.088	0.901	0.188	-1.977 – 0.387
Marsh	-0.712	0.244	0.570	0.517	-1.952 – 0.975
Little Wenatchee	-1.154	0.132	0.674	0.274	-1.706 – 0.497

Analysis of supplementation effects on productivity (adult recruits/spawner) using difference scores of annual changes indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 23; Figure 14). All tests, regardless of treatment-reference pairs, indicated that productivity did not change significantly during the supplementation period.

Table 23. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data. Tests determined if the mean difference scores of annual change during the supplementation period were less than mean difference scores of annual change during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	0.002	0.475	0.054	0.952	-1.464 – 1.583
Marsh	-0.063	0.525	0.074	0.948	-2.395 – 2.031
Sesech	-0.317	0.621	0.350	0.628	-2.387 – 1.695
Little Wenatchee	-0.347	0.633	0.163	0.728	-1.023 – 0.725
LN Productivity					
Naches	0.000	0.500	0.000	0.999	-0.408 – 0.445
Marsh	-0.126	0.549	0.044	0.904	-0.715 – 0.595
Sesech	-0.449	0.668	0.144	0.727	-0.685 – 0.509
Little Wenatchee	-0.200	0.578	0.047	0.842	-0.466 – 0.391

We believe results from analysis of mean differences of annual change (ΔT-ΔR) in spawning abundance, NORs, and productivity are difficult to interpret and may be insensitive to treatment effects. A simpler analysis, which is also easier to interpret, is the use of trend analysis. Therefore, we recommend that analyses using differences of annual change be replaced with trend analysis.

Corrections for Density Dependence and Carrying Capacity

The analyses described above assume that the density of spawners or recruits does not affect the survival and productivity of fish. However, it is well known that the density of fish can affect the number of recruits as well as the productivity of the population. This occurs through the relationship between density and mortality. Mortality of fish can be generally classified as density independent and density dependent. In general, when densities are low, the mortality is density independent, but as densities increase, the amount of density-dependent mortality increases. Monitoring programs can make use of this information to derive density-corrected estimates of productivity. In this section, we describe two different methods for deriving density-corrected estimates of productivity.

The first method controlled the effects of density on productivity (adult recruits/spawner; R/S) by partitioning observed productivities into density-independent and density-dependent productivity. When abundance is below the minimum number of spawners (S) needed to produce the maximum number of recruits (K_{sp}), the observed productivity is used in statistical tests. However, when the abundance is equal to or above K_{sp}, the modeled value of productivity (R/K_{sp}) is used in statistical tests.

$$\boldsymbol{Adj\ R/S =} \begin{matrix} \boldsymbol{R/S,} & \boldsymbol{if\ S < K_{sp}} \\ \boldsymbol{R/K_{sp},} & \boldsymbol{if\ S \geq K_{sp}} \end{matrix}$$

The density-independent and density-dependent productivities were then combined in a single test.

The second method was based on one of the goals of supplementation, which is to fill the capacity of the environment with fish. This method corrects for differences in carrying capacities between the supplemented and reference populations. We did this by calculating the percent saturation of NORs. That is, we calculated the fraction of the habitat (τ) that was filled with NORs by dividing the observed NOR by the modeled maximum number of NORs (K_R) that the habitat could support.

$$\boldsymbol{\tau = \frac{NOR_{obs}}{K_R}}$$

Note that 1-τ represents the unused portion of the carrying capacity and is the term that is multiplied by the exponential growth equation to derive the logistic growth equation. We included τ in the statistical analyses.

These two methods require the estimation of carrying capacity (K_R) and the spawning abundance that produces the maximum number of recruits (K_{sp}). We estimated these parameters for both reference populations and the supplemented population using Ricker, Beverton-Holt, and smooth hockey stick stock-recruitment models. We used only spawner abundance as a predictor of subsequent brood recruitment. We made the following assumptions in proceeding with the analysis:

- *Density-dependent mortality*—For some time period before recruitment, the brood instantaneous mortality rate is proportional to the number of parent spawners (Ricker 1954).
- *Lognormal variation*—At any particular spawning stock size, the variation in recruitment is log-normally distributed about its average, and acts multiplicatively (Quinn and Deriso 1999).
- *Measurement error*—Error in spawning stock size estimates (measurement error) is small relative to the range of spawning stock sizes observed (Hilborn and Walters 1992). Variation in realized recruitment at any particular spawning stock size (process error) dominates recruitment measurement error.
- *Stationarity*—The average stock-recruitment relationship is constant over time (Hilborn and Walters 1992). That is, environmental conditions randomly affect survival independent of stock size or time.

In general, the methods we used to fit the models to the data followed those outlined in Hilborn and Walters (1992) and Froese (2008). The Ricker model, which assumes that the number of recruits increases to a maximum and then declines as the number of spawners increases, takes the form:

$$\boldsymbol{E(R) = \alpha S e^{-\beta S}}$$

where E(R) is the expected recruitment, S is spawner abundance, α is the number of recruits per spawner at low spawning levels, and β describes how quickly the recruits per spawner drop as the number of spawners increases. We estimated K_R as:

$$\boldsymbol{K_R = \frac{\alpha}{\beta}\ e^{-1}}$$

and K_{sp} as:

$$\boldsymbol{K_{sp} = \frac{1}{\beta}}$$

The Beverton-Holt model assumes that the number of recruits increases constantly toward an asymptote as the number of spawners increases. After the asymptote is reached, the number of recruits neither increases nor decreases. The asymptote represents the maximum number of recruits the system can support (i.e., carrying capacity for the system; K_R). The Beverton-Holt curve takes the form:

$$\boldsymbol{E(R) = \frac{(\alpha S)}{(\beta + S)}}$$

where E(R) and S are as above, α is the maximum number of recruits produced (K_R), and β is the number of spawners needed to produce (on average) recruits equal to one-half the maximum number of recruits. Because $K_{sp} = \infty$ in the Beverton-Holt model, we estimated K_{sp} as the number of spawners needed to produce 0.99(K_R).

Like the Beverton-Holt model, the smooth hockey stick model assumes that the number of recruits increases toward an asymptote (carrying capacity; K_R) as the number of spawners increases. After the carrying capacity is reached, the number of recruits neither increases nor decreases. The carrying capacity represents the maximum number of recruits the system can support. This curve takes the form (Froese 2008):

$$\boldsymbol{E(R) = R_\infty \left(1 - e^{-\left(\frac{\alpha}{R\infty}\right)S}\right)}$$

where E(R) and S are as above, α is the slope at the origin of the spawner-recruitment curve, and R_∞ is the carrying capacity of recruits (note that $R_\infty = K_R$). As with the Beverton-Holt model, we estimated K_{sp} as the number of spawners needed to produce 0.99(K_R).

We used non-linear regression to fit the three models to spawner-recruitment data. Before fitting the models, we transformed recruitment data using natural logs. We estimated bias and uncertainty measures (95% CI) for the model parameters using bootstrap procedures, which assumed that the {R, S} sample represented or approximated the population. The number of bootstrap samples was 3,000. We computed and stored the non-linear regression results for each bootstrap sample. We then calculated the bootstrap 95% CI by arranging the 3,000 bootstrap parameter values in sorted order and selected the 2.5 and 97.5 percentiles from the list.

We used Akaike's Information Criterion for small sample size (AIC_c) to determine which model(s) best explained the relationship between spawners and recruitment in the supplemented and reference populations. AIC_c was estimated as:

$$\boldsymbol{AIC_c = -2log\left(£\left(\theta \mid data\right)\right) + 2K + \left(\frac{2K(K+1)}{n-K-1}\right)}$$

where *log(£(θ|data))* is the maximum likelihood estimate, *K* is the number of estimable parameters (structural parameters plus the residual variance parameter), and *n* is the sample size (Burnham and Anderson 2002). We used least-squares methods to estimate *log(£(θ|data))*, which was calculated as $log(\sigma^2)$, where σ^2 = residual sum of squares divided by the sample size ($\sigma^2 = RSS/n$). AIC_c assessed model fit in relation to model complexity (number of parameters). The model with the smallest AIC_c value represented 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 (w_i), and evidence ratios. Models with ΔAIC_c values less than 2 indicated 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 had 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 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.

Stock-Recruitment Analysis

We successfully fit stock-recruitment models to the Chiwawa and reference population data. The span of spawner data for the Chiwawa and reference populations was greater than 14 times the minimum observed spawners, which should provide sufficient contrast for estimation of model parameters. In addition, the span of recruitment data was greater than 12 times the minimum observed recruitment, again providing sufficient contrast for estimation of parameters. The relationship between natural log R/S and spawners indicated that some of the highest productivities occurred at the lower spawner levels and the lowest productivities generally occurred at the highest spawner levels (Figure 15). This is consistent with the assumption of density-dependent mortality.

Although model fits were generally poor, explaining less than 40% of the residual variation in natural-log recruitment data, we were able to estimate average maximum recruitment levels (K_R) and the spawning levels needed to produce maximum recruitment (K_{sp}) (Table 24; Figure 15). For all populations examined, Akaike information criterion was unable to identify a best approximating model (i.e., ΔAIC_c values were less than 2, indicating support for all three models). However, evaluation of 95% CIs and the asymptotic correlation coefficients indicated that the smooth hockey stick model may be the best approximating model for each population. Therefore, we used estimates of K_R and K_{sp} derived from the smooth hockey stick model to correct for density dependence and different carrying capacities in treatment-reference comparisons.

As part of the regression diagnostics, we examined the dependence of the model residuals on time and found a significant ($P < 0.05$), positive, one-year-lag autocorrelation for the Entiat (0.562), Marsh (0.551), Sesech (0.564), and Little Wenatchee (0.629) populations. For the purposes of our work here, we did not attempt to correct for this one-year-lag correlation in the residuals. Future analyses will explore the use of autoregressive models (e.g., AR1; Noakes et al. 1987) to correct for autocorrelation.

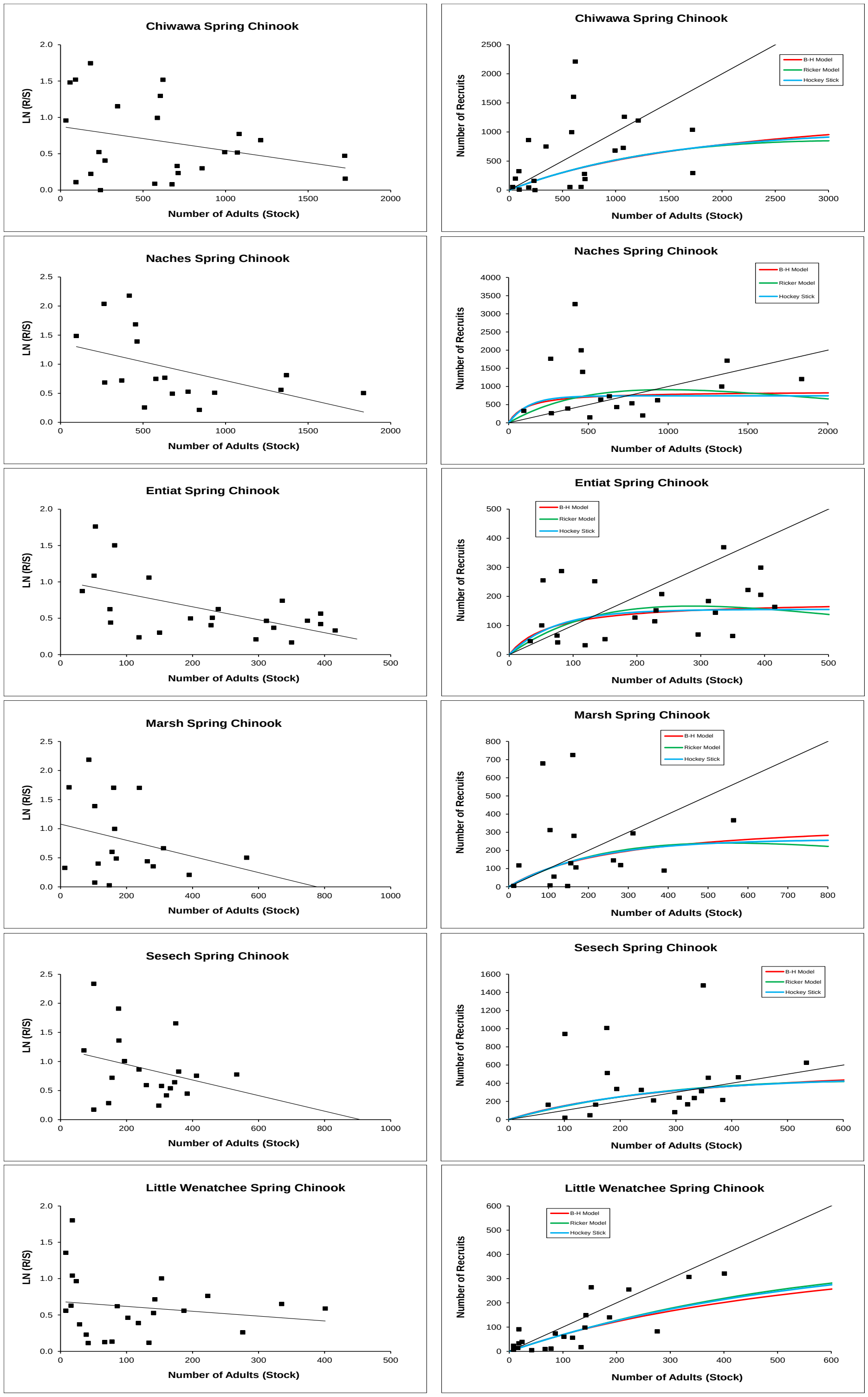

Figure 15. Relationships between natural log recruits/spawner (LN R/S) and spawners (Stock) in the Chiwawa and reference populations (figures on the left) and relationships between numbers of untransformed recruits and spawners in the Chiwawa and reference populations (figures on the right). Figures on the right also show the fit of the Ricker, Beverton-Holt, and the smooth hockey stick models to the data (black straight line represents R=S).

Table 24. Results from fitting Ricker, Beverton-Holt, and smooth hockey stick models to stock-recruitment data from the Chiwawa and reference populations. 95% CI on parameter estimates are based on 3,000 bootstrap trials; Corr coef = asymptotic correlation of the parameter estimates; K_R = maximum natural origin recruits (recruits at carrying capacity); K_{sp} = number of spawners needed to produce K_R; AICc = Akaike's Information Criterion for small sample size; Adj R^2 = coefficient of determination that is adjusted for the number of parameters in the model.

Model	Parameter	Parameter value	Bootstrap 95% CI	Corr coef	K_R	K_{sp}	AICc	Adj R^2
Chiwawa Population								
Ricker	α	0.7048	-0.6197 1.1055	0.791	852	3,285	-47.949	0.125
	β	0.000304	-0.000668 0.000609					
Beverton-Holt	α	1687.4	-65654539 3062.1	0.989	1,687	43,760	-47.962	0.125
	β	2308.5	-99999538 4526.1					
Smooth hockey stick	α	6.956	-41.313 8.2270	-0.708	1,049	6,847	-47.949	0.125
	β	0.7118	-2.397 1.122					
Naches Population								
Ricker	α	2.5223	-2.0003 3.9672	0.844	912	983	-45.063	-0.143
	β	0.001018	-0.000752 0.001717					
Beverton-Holt	α	869.4	97.4 1641.4	0.858	869	11,455	-46.801	-0.097
	β	111.8	-346.2 569.8					
Smooth hockey stick	α	6.612	5.9223 7.006	-0.399	744	565	-46.831	-0.095
	β	6.013	-89.071 12.026					
Entiat Population								
Ricker	α	1.5843	0.1609 2.4178	0.867	167	286	-68.365	-0.049
	β	0.003496	0.001141 0.005906					
Beverton-Holt	α	186.1	67.9 304.3	0.880	186	1,277	-69.895	0.029
	β	65.0	-59.1 189.2					
Smooth hockey stick	α	5.045	4.381 5.378	-0.450	155	344	-69.379	0.003
	β	2.180	-89.369					

Model	Parameter	Parameter value	Bootstrap 95% CI	Corr coef	K_R	K_{sp}	AICc	Adj R^2
			3.704					
Marsh Creek Population								
Ricker	α	1.1852	-1.8268 1.9269	0.823	241	552	-32.237	0.218
	β	0.001810	-0.003063 0.003625					
Beverton-Holt	α	383.3	-85109314 665.4	0.970	383	5,310	-32.291	0.234
	β	282.4	-99999944 564.9					
Smooth hockey stick	α	5.565	-22.631 6.584	-0.694	261	984	-32.264	0.227
	β	1.265	-108.574 2.531					
Sesech Population								
Ricker	α	1.6835	-2.9253 2.5951	0.912	421	680	-54.589	-0.005
	β	0.001470	-0.002951 0.002941					
Beverton-Holt	α	689.9	-986.8 2366.7	0.981	690	6,591	-54.678	0.000
	β	351.7	-1059.0 1762.5					
Smooth hockey stick	α	6.1528	-22.851 6.815	-0.821	470	1,185	-54.633	-0.002
	β	0.8000	-119.370 2.909					
Little Wenatchee Population								
Ricker	α	0.7447	0.0828 1.0280	0.735	356	1,298	-66.978	0.357
	β	0.000770	-0.003052 0.001541					
Beverton-Holt	α	564.7	-74423355 1067.6	0.994	565	13,400	-67.055	0.358
	β	719.7	-99999856 1413.4					
Smooth hockey stick	α	6.0181	-49.5620 8.1122	-0.683	411	2,544	-67.000	0.357
	β	0.7550	-0.9539 1.0452					

Method 1: Productivity Data Adjusted for Density Dependence

Analysis of supplementation effects on productivity (adult recruits/spawner adjusted for density-dependent effects based on the smooth hockey stick model) using difference scores indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 25; Figure 16). All tests, regardless of treatment-reference pairs, indicated that productivity did not change significantly during the supplementation period, even though productivity did decrease during the supplementation period (Figure 16). These results are consistent with those based on unadjusted productivity data (Table 17). This is because most abundance estimates were below the level of assumed density dependence.

Table 25. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data corrected for density dependence. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Productivity					
Naches	0.904	0.190	0.496	0.412	-0.511 – 1.497
Marsh	-0.203	0.579	0.152	0.927	-1.298 – 1.372
Sesech	1.607	0.071	1.435	0.146	-0.359 – 2.911
Little Wenatchee	0.431	0.335	0.147	0.668	-0.487 – 0.781
LN Productivity					
Naches	0.570	0.290	0.083	0.568	-0.168 – 0.362
Marsh	0.012	0.495	0.003	0.991	-0.373 – 0.480
Sesech	1.463	0.087	0.343	0.171	-0.125 – 0.732
Little Wenatchee	0.390	0.351	0.060	0.709	-0.218 – 0.365

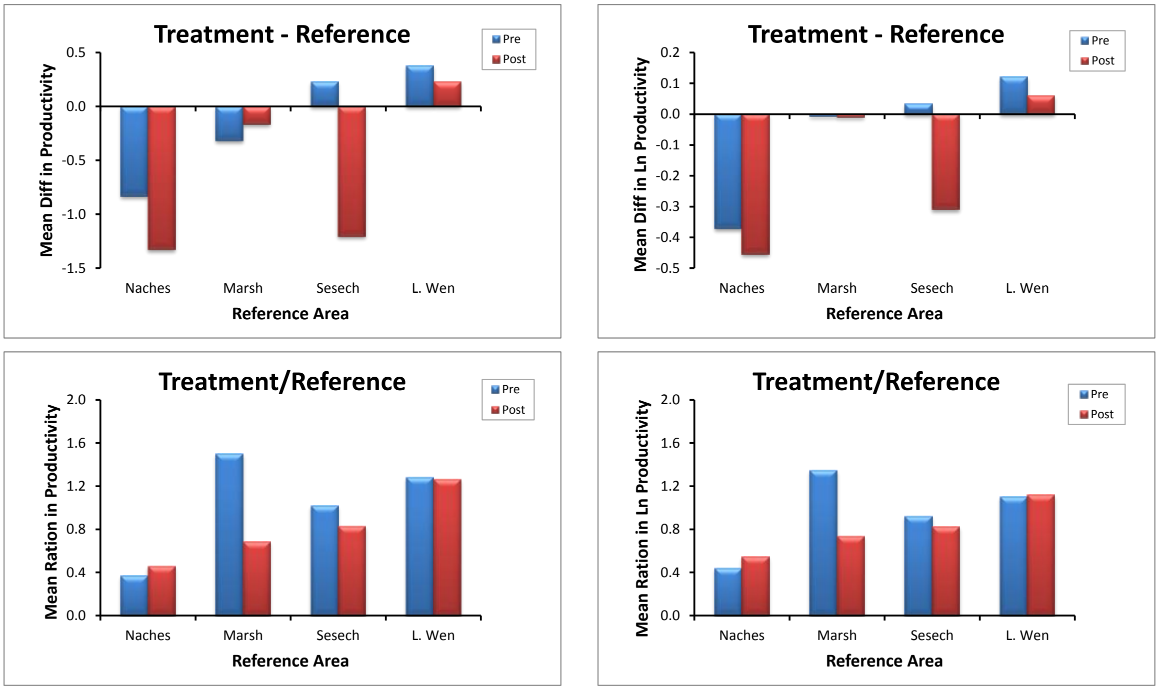

Figure 16. Mean differences (Treatment – Reference; figures on the top) and mean ratios (Treatment/Reference; figures on the bottom) of transformed and untransformed productivity data (adjusted for density dependence) before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin. Negative effects of supplementation on productivity are indicated when the pre-supplementation (blue) bars are greater than their corresponding post-supplementation (red) bars.

Analysis of supplementation effects on productivity (adult recruits/spawner adjusted for density-dependent effects) using ratios indicated that supplementation did not significantly decrease productivity in the Chiwawa Basin (Table 26; Figure 16). The Aspin-Welch test and the 95% CIs did indicate a significant effect when comparing the Chiwawa to the Marsh Creek population. These results are consistent with those using unadjusted productivity data (Table 20). Again, this is because most abundance estimates were below the level of assumed density dependence.

Table 26. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on transformed and untransformed productivity data corrected for density dependence. Tests determined if the mean ratios during the supplementation period were less than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
		Productivity			
Naches	-0.529	0.696	0.087	0.597	-0.394 – 0.214
Marsh	2.236	0.022	0.814	0.056	0.140 – 1.470
Sesech	0.677	0.253	0.191	0.496	-0.343 – 0.727
Little Wenatchee	0.033	0.487	0.018	0.978	-0.902 – 1.181

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
LN Productivity					
Naches	-0.621	0.726	0.104	0.536	-0.406 – 0.191
Marsh	1.952	0.036	0.613	0.076	0.005 – 1.163
Sesech	0.447	0.330	0.098	0.649	-0.312 – 0.498
Little Wenatchee	-0.034	0.513	0.015	0.980	-0.697 – 0.852

Our analyses assume that there is a spawner abundance (K_{sp}) at which density-independent effects end and density-dependent effects begin. In reality, density-dependent effects occur at low spawning abundance and intensify as spawning abundance increases (evident in the changing slope of the three stock-recruitment curves used in our analyses). We did not account for these increasing density-dependent effects at spawner abundances less than K_{sp}. If we accounted for the increasing effects of density dependence at spawning abundances less than K_{sp}, the analysis with and without productivity adjustments may give different results.

Method 2: Fraction of Carrying Capacity Filled with NORs

We analyzed the effects of supplementation on filling the capacity of the habitat with natural-origin recruits. The smooth hockey stick model derived the carrying capacity (K_R) estimates for the Chiwawa and reference populations. The fraction of the carrying capacity filled with Chinook recruits before and during supplementation for the Chiwawa and reference populations is provided in Table 27. These data indicate that for the Chiwawa population, the mean fraction of the K_R filled with fish decreased significantly from the pre-supplementation period through the supplementation period (Table 27). Likewise, the Entiat and Little Wenatchee populations showed a significant decline in the mean fraction of K_R filled with adult recruits. In contrast, the mean fraction of K_R in the Naches and Marsh Creek populations increased during the same period (Table 27).[17] Interestingly, the fraction of K_R filled with adult recruits for all populations trended downward during the pre-supplementation period (Figure 17). During the supplementation period, however, the fraction of K_R filled with adult recruits trended upward for all populations. These results suggest that agents of mortality outside the Chiwawa and reference populations were reducing recruitment to the populations.

[17] Although we do not show the results here, statistical analysis of the mean fraction of carrying capacity filled by adult recruits using natural-log transformed data produced the same result as using untransformed data. This was true for all populations.

Table 27. Fraction of the carrying capacity that was filled with Chinook salmon adult recruits in the Chiwawa and reference populations before (pre) and during (post) supplementation in Chiwawa Basin. The smooth hockey stick model estimated carrying capacity for each population. Statistical results from comparing the pre and post mean scores using the Aspin-Welch unequal-variance test are provided at the bottom of the table.

Supplementation period	Chiwawa	Reference populations			
		Naches	Entiat	Marsh	L. Wenatchee
Pre-supplementation period (1981-1992)	2.11		2.38	1.07	0.64
	1.53		1.93	1.20	0.75
	1.20		1.32	2.60	0.78
	1.14		1.19	0.49	0.62
	0.99		1.06	0.46	0.34
	0.70	2.30	1.43	0.56	0.24
	0.65	0.58	0.74	0.34	0.20
	0.95	1.88	1.34	1.40	0.36
	0.18	0.72	1.63	0.22	0.15
	0.05	0.27	0.45	0.02	0.02
	0.00	0.20	0.21	0.03	0.01
Pre-Mean:	0.86	0.99	1.24	0.76	0.37
Pre-Range:	0.00 – 2.11	0.20 – 2.30	0.21 – 2.38	0.02 – 2.60	0.01 – 0.78
Post-supplementation period (1992-2002)	0.05	0.98	0.34	0.41	0.03
	0.15	0.86	0.41	1.13	0.04
	0.04	0.35	0.27	0.02	0.03
	0.05	0.44	0.30	0.02	0.03
	0.19	4.39	0.65	0.45	0.06
	0.82	2.68	1.85	2.78	0.22
	0.31	2.37	1.65	4.10	0.08
	0.01	0.53	0.42		0.02
	0.71	1.62	0.82		0.10
	0.28	1.35	0.93		0.14
	0.27	0.83	0.98		0.18
Post-Mean:	0.26	1.49	0.78	1.27	0.08
Post-Range:	0.04 – 0.82	0.35 – 4.39	0.30 – 1.85	0.02 – 4.10	0.02 – 0.22
One-sided Aspin-Welch t-test of pre and post means	t = 2.846; P = 0.007	t = -0.967; P = 0.825	t = 1.833; P = 0.041	t = -0.799; P = 0.776	t = 3.321; P = 0.003

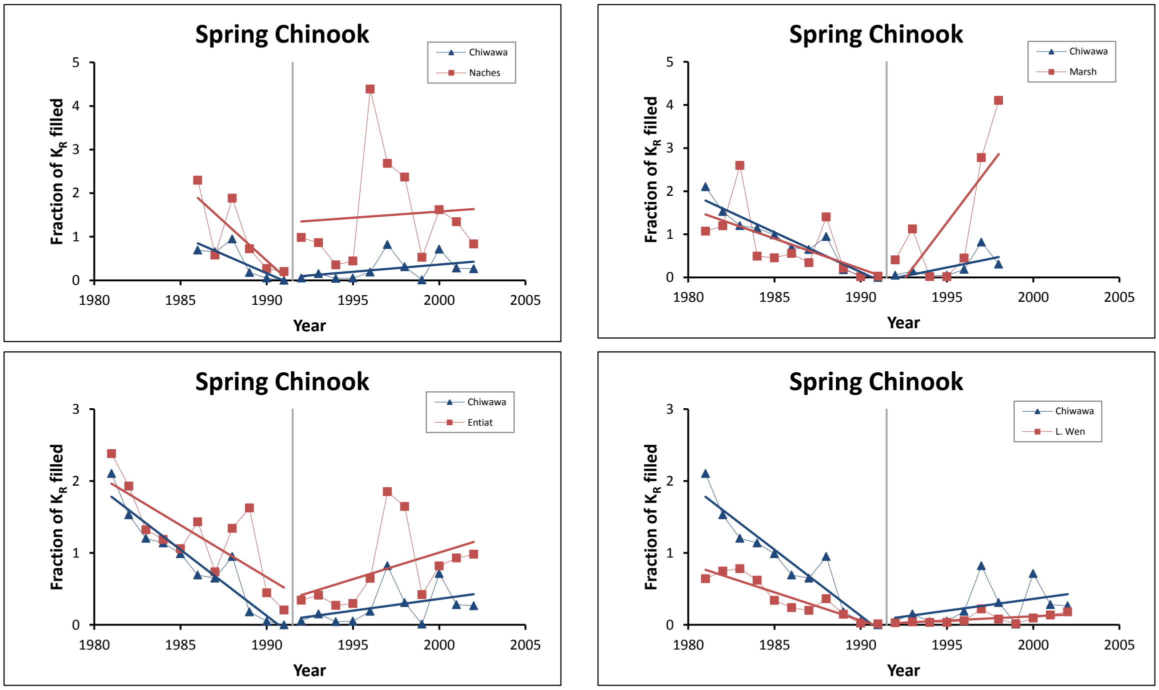

Figure 17. Trends in the fraction of the carrying capacity that was filled with Chinook salmon adult recruits in the Chiwawa and reference populations before (pre) and during (post) supplementation in Chiwawa Basin. The vertical lines in the figures separate the pre- and post-supplementation periods. The smooth hockey stick model estimated carrying capacity for each population.

We then compared the mean difference scores and ratios between the Chiwawa and reference populations before and during supplementation using data representing the fraction of K_R filled with adult recruits. In most of the Chiwawa-reference population comparisons, the absolute value of the mean difference between the fraction of K_R filled with recruits was greater in the supplementation period than during the pre-supplementation period; two of the four pairings were significant (Table 28; Figure 18). Analysis of difference scores using natural-log transformed data indicated that three of the four pairings were significant (Table 28).

Results from analyses using ratios were similar to results using difference scores. Mean ratio scores were generally smaller during the supplementation period than during the pre-supplementation period (Figure 18). This indicated that the mean fraction of K_R filled by adult recruits in most reference populations was greater during the supplementation period than during the pre-supplementation period (i.e., the denominator in the ratio increased between the pre- and post-supplementation periods). In contrast, the fraction of K_R filled by adult recruits in the Chiwawa decreased from the pre- to post-supplementation period (i.e., the numerator in the ratio decreased between the pre- and post-supplementation periods). Thus, unlike the Chiwawa population, the capacity of most reference populations was becoming more saturated during the period when the Chiwawa was being supplemented. Statistical analysis with mean ratios indicated that two of the four pairings were significant (Table 29).

Analyses comparing the Little Wenatchee with the Chiwawa indicate that adult recruits to the Little Wenatchee have been well below its carrying capacity. During the pre-supplementation period, the capacity of the Little Wenatchee was on average 37% saturated with adult recruits. During the supplementation period, the capacity of the Little Wenatchee declined to 8% saturation with adult recruits (a 22% decline). The Chiwawa, during the pre-supplementation period, was on average 86% saturated. During the supplementation period, percent saturation in the Chiwawa decreased to 26% (a 30% decrease). During the same time periods, the capacity of the Entiat population, which until recently has been supplemented, declined from 124% to 78% saturation (a 63% decline).

Table 28. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on the fraction of the habitat capacity (K_R) that is filled with natural origin recruits. Analyses include both transformed and untransformed data. Tests determined if the mean difference scores during the supplementation period were greater than mean difference scores during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
Fraction of Capacity Filled					
Naches	1.550	0.071	0.657	0.145	-0.173 – 1.378
Entiat	0.835	0.207	0.141	0.422	-0.167 – 0.475
Marsh	2.026	0.040	1.141	0.055	0.064 – 2.054
Little Wenatchee	2.166	0.023	0.310	0.031	0.035 – 0.569
LN Fraction of Capacity Filled					
Naches	2.123	0.026	0.311	0.039	0.031 – 0.575
Entiat	1.405	0.087	0.122	0.176	-0.034 – 0.289
Marsh	2.547	0.017	0.519	0.017	0.125 – 0.864
Little Wenatchee	1.744	0.049	0.130	0.100	-0.004 – 0.273

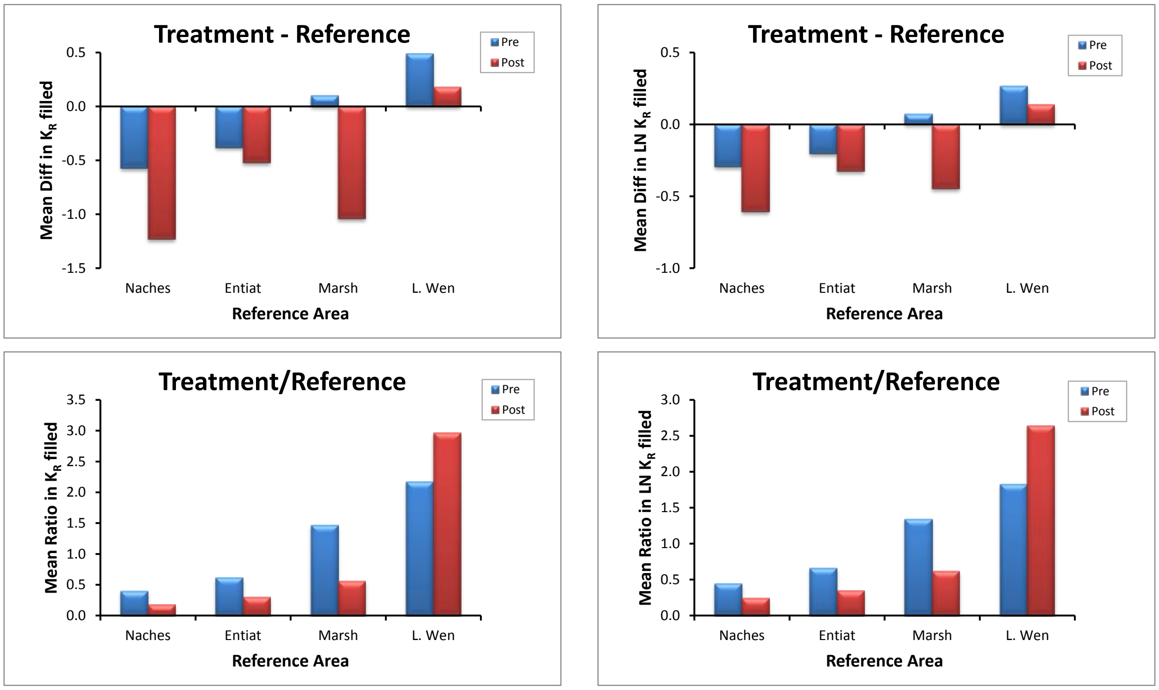

Figure 18. Mean differences (Treatment – Reference; figures on the top) and mean ratios (Treatment/Reference; figures on the bottom) of transformed and untransformed fractions of carrying capacity filled with adult recruits before (pre) and after (post) spring Chinook supplementation in the Chiwawa Basin.

Table 29. Results of the Aspin-Welch unequal-variance test, randomization test (based on 10,000 Monte Carlo samples), and 95% CI (based on 5,000 bootstrap samples) on the fraction of the habitat capacity (K_R) that is filled with natural origin recruits. Analyses include both transformed and untransformed data. Tests determined if the mean ratios during the supplementation period were less than mean ratios during the pre-supplementation period.

Reference population	Aspin-Welch unequal-variance test			Randomization test P-value	Bootstrap 95% CI
	t-value	P-value	Effect size		
		Fraction of Capacity Filled			
Naches	1.317	0.119	0.217	0.219	-0.103 – 0.482
Entiat	2.449	0.013	0.321	0.028	0.085 – 0.577
Marsh	2.001	0.035	0.905	0.070	0.138 – 1.788
Little Wenatchee	-1.148	0.864	0.791	0.278	-1.979 – 0.578
		LN Fraction of Capacity Filled			
Naches	1.257	0.127	0.207	0.249	-0.099 – 0.484
Entiat	2.346	0.016	0.313	0.031	0.072 – 0.583
Marsh	1.737	0.056	0.729	0.111	0.028 – 1.531
Little Wenatchee	-1.525	0.924	0.815	0.142	-1.751 – 0.195

Comparing Stock-Recruitment Curves

As a final set of treatment and reference population comparisons, we compared the stock-recruitment curves of the Chiwawa population (using {R, S} data only from the supplementation period) to the reference populations (using all available {R, S} data). Specifically, we tested whether the regression parameters were equal between the Chiwawa population and the reference populations, and whether the fitted curves coincided between populations. Earlier in this report we described the data, methods, and results of fitting the Ricker, Beverton-Holt, and smooth hockey stick curves to the data. Because AIC_c was unable to identify a best approximating model, here we included all three models in our analyses. We tested the following hypotheses.

Parameter equivalence:

Ho: Stock-recruitment parameters (α and β) of the Chiwawa population = Stock-recruitment parameters of the reference populations.

Ha: Stock-recruitment parameters (α and β) of the Chiwawa population ≠ Stock-recruitment parameters of the reference populations.

Curve equivalence:

Ho: Modeled stock-recruitment curves of the Chiwawa population = Modeled stock-recruitment curves of the reference populations.

Ha: Modeled stock-recruitment curves of the Chiwawa population ≠ Modeled stock-recruitment curves of the reference populations.

We used two-sided randomization tests to test the null hypotheses of equal model parameters and that fitted curves coincided. Because the total number of permutations was in the millions, we used a Monte Carlo approach to randomly select 10,000 permutations. The test statistic for comparing the model parameters was formed by summing the difference between the population parameter estimates for each pair of populations. The test statistic for comparing the whole curve was formed by summing the difference between the estimated predicted values for each pair of populations at 500 equally spaced points along the curve.

Ricker Relationships

Ricker curves differed significantly between the Chiwawa and reference populations (Figure 19; Table 30). Interestingly, however, the parameters in the Ricker model did not differ significantly among most populations (Table 30). Only the β parameter differed significantly between the Chiwawa and Entiat populations.

In the Ricker model, the α parameter represents intrinsic productivity (i.e., recruits per spawner at low spawner densities). In this analysis, there was not enough evidence in the stock-recruitment data to reject the hypothesis of inequality in intrinsic productivity. Thus, this test was unable to demonstrate that supplementation, based on the Ricker curve, affected productivity in the Chiwawa population.

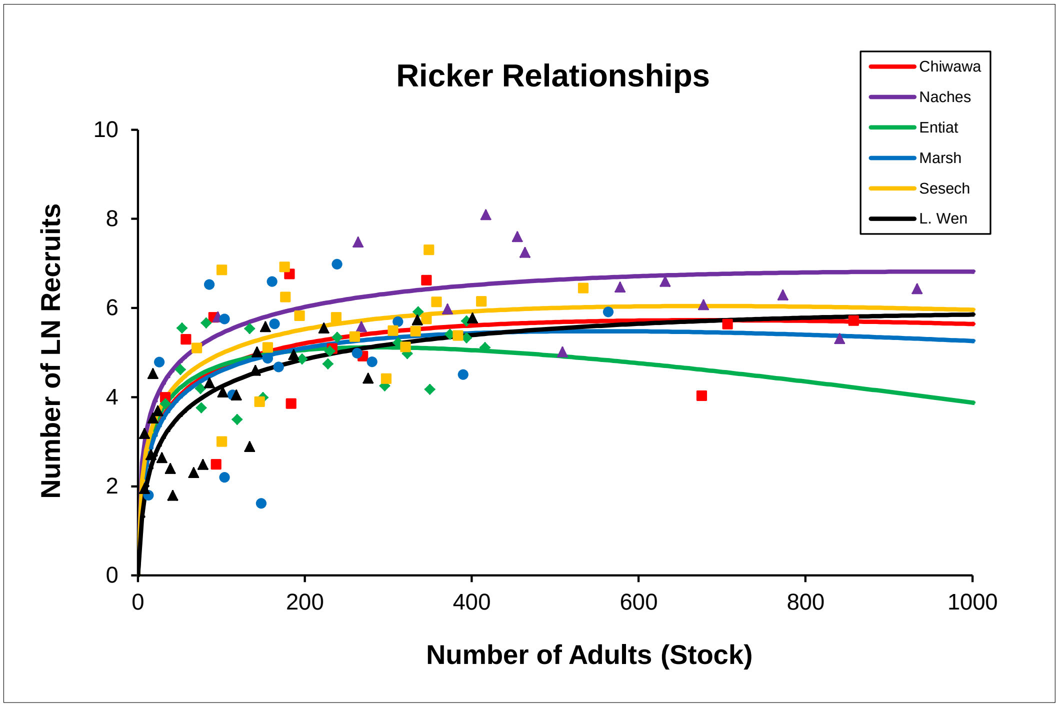

Figure 19. Scatter plot of the number of spawners and natural log adult recruits and fitted Ricker curves to the Chiwawa (supplemented population) and reference (un-supplemented) populations.

Table 30. Randomization test results comparing the equality of Ricker curves and equality of parameter values (α and β). Randomization tests were based on 10,000 Monte Carlo samples. Equality or curves was based on 500 points along the x-axis (spawner abundance axis).

Curves tested	Curve inequality randomization P-value	Parameter inequality		
		Model Parameter		Randomization P-value
		Chiwawa	Reference	
Chiwawa v. Naches	0.008	α = 1.2247	α = 2.5267	0.236
		β = 0.0015	β = 0.0010	0.600
Chiwawa v. Entiat	0.004	α = 1.2247	α = 1.5836	0.978
		β = 0.0015	β = 0.0035	0.025
Chiwawa v. Marsh	0.034	α = 1.2247	α = 1.1855	0.997
		β = 0.0015	β = 0.0018	0.688
Chiwawa v. Sesech	0.036	α = 1.2247	α = 1.6818	0.972
		β = 0.0015	β = 0.0015	0.997
Chiwawa v. L. Wenatchee	0.034	α = 1.2247	α = 0.7439	0.969
		β = 0.0015	β = 0.0008	0.203

Beverton-Holt Relationships

Beverton-Holt curves differed significantly only between the Chiwawa and Naches populations (Figure 20; Table 31). There was no significant difference in curves between the Chiwawa and the other reference populations. The parameters in the Beverton-Holt model did not differ significantly among any of the populations (Table 31). This was true even for the Chiwawa and Naches populations.

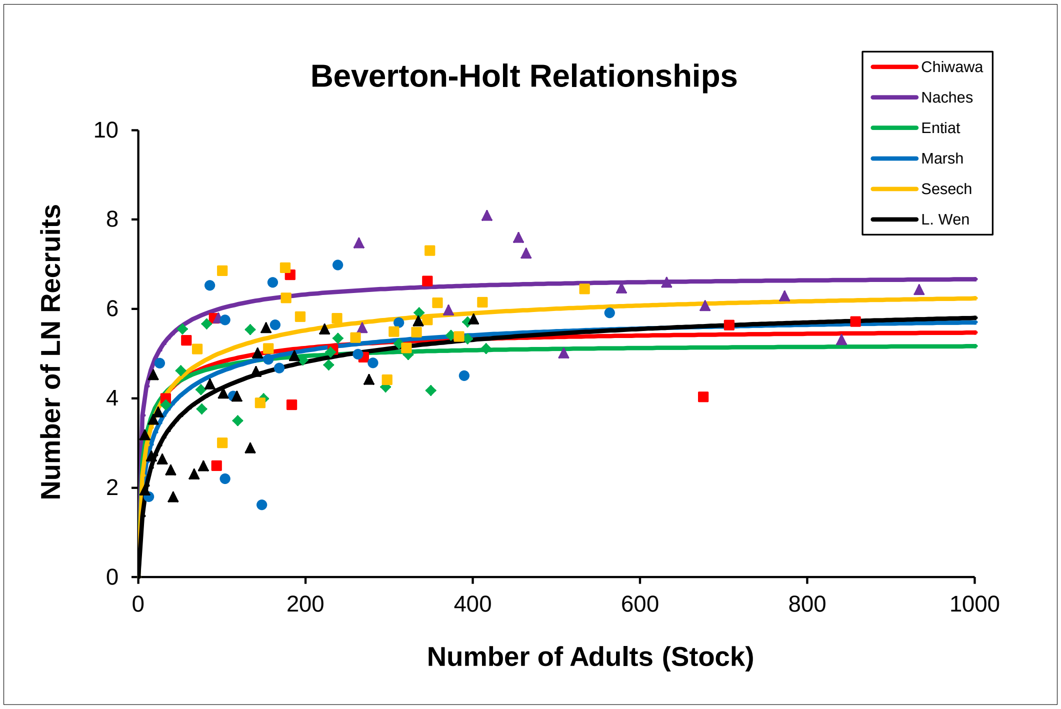

Figure 20. Scatter plot of the number of spawners and natural log adult recruits and fitted Beverton-Holt curves to the Chiwawa (supplemented population) and reference (un-supplemented) populations.

Table 31. Randomization test results comparing the equality of Beverton-Holt curves and equality of parameter values (α and β). Randomization tests were based on 10,000 Monte Carlo samples. Equality or curves was based on 500 points along the x-axis (spawner abundance axis).

Curves tested	Curve inequality randomization P-value	Parameter inequality		
		Model Parameter		Randomization P-value
		Chiwawa	Reference	
Chiwawa v. Naches	0.036	α = 264.25	α = 870.62	0.777
		β = 113.79	β = 112.24	0.963
Chiwawa v. Entiat	0.746	α = 264.25	α = 186.34	0.960
		β = 113.79	β = 65.33	0.954
Chiwawa v. Marsh	0.850	α = 264.25	α = 381.79	0.944

Curves tested	Curve inequality randomization P-value	Parameter inequality		
		Model Parameter		Randomization P-value
		Chiwawa	Reference	
		β = 113.79	β = 281.04	0.891
Chiwawa v. Sesech	0.272	α = 264.25	α = 689.31	0.821
		β = 113.79	β = 351.59	0.869
Chiwawa v. L. Wenatchee	0.654	α = 264.25	α = 568.69	0.864
		β = 113.79	β = 725.87	0.751

Smooth Hockey Stick Relationships

Smooth hockey stick curves differed significantly between the Chiwawa and Naches populations and the Chiwawa and Sesech populations (Figure 21; Table 32). There was no significant difference in curves between the Chiwawa and the other reference populations. Most of the parameters in the smooth hockey stick model did not differ significantly among the populations (Table 32). However, the productivity parameter β did differ significantly between the Chiwawa and the Naches and the Chiwawa and Little Wenatchee populations. The β parameter for the Naches was significantly greater than the Chiwawa, while the β parameter for the Little Wenatchee was significantly less than the Chiwawa.

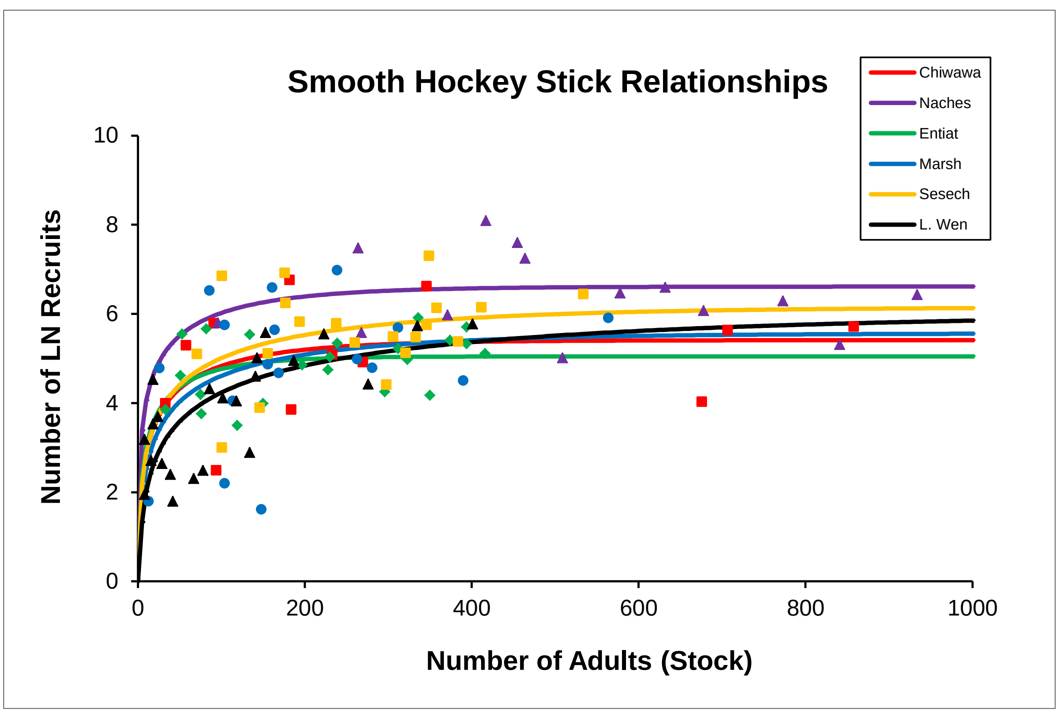

Figure 21. Scatter plot of the number of spawners and natural log adult recruits and fitted smooth hockey stick curves to the Chiwawa (supplemented population) and reference (un-supplemented) populations.

Table 32. Randomization test results comparing the equality of smooth hockey stick curves and equality of parameter values (α and β). Randomization tests were based on 10,000 Monte Carlo samples. Equality or curves was based on 500 points along the x-axis (spawner abundance axis).

Curves tested	**Curve inequality randomization P-value**	**Parameter inequality**		
		Model Parameter		**Randomization P-value**
		Chiwawa	**Reference**	
Chiwawa v. Naches	0.000	$\alpha = 5.41$	$\alpha = 6.61$	0.000
		$\beta = 1.84$	$\beta = 5.99$	0.000
Chiwawa v. Entiat	0.999	$\alpha = 5.41$	$\alpha = 5.05$	0.999
		$\beta = 1.84$	$\beta = 2.17$	0.999
Chiwawa v. Marsh	0.999	$\alpha = 5.41$	$\alpha = 5.56$	0.999
		$\beta = 1.84$	$\beta = 1.27$	0.999
Chiwawa v. Sesech	0.000	$\alpha = 5.41$	$\alpha = 6.15$	0.000
		$\beta = 1.84$	$\beta = 1.80$	0.999
Chiwawa v. L. Wenatchee	0.990	$\alpha = 5.41$	$\alpha = 6.02$	0.999
		$\beta = 1.84$	$\beta = 0.75$	0.000

Comparing different stock-recruitment curves and their parameters did not provide strong evidence that the supplementation program has negatively affected the productivity of the Chiwawa population.

Analysis without Reference Populations

In some cases, suitable reference populations may not exist to compare with supplemented populations. It is therefore important to have alternative analyses to assess supplementation effects. In this section, we describe methods that can be used to assess supplementation effects when suitable reference populations are not available. We discuss before-after comparisons, correlation analysis, and comparisons to standards as alternatives when reference populations are unavailable.

Before-After Comparisons

Before-after analyses compare population metrics (spawner abundance, NORs, and productivity) before supplementation to those during supplementation. In this case, data collected before supplementation represent the reference condition. The assumption is that population trajectories measured during the pre-supplementation period would continue in the absence of supplementation. We compared trends in abundance and productivity, mean abundance and productivity, and stock-recruitment relationships before and after supplementation.

Trend Analysis

Comparing trends before and after supplementation can be used to assess the effects of supplementation. Here, we compared the slopes of trends of spawner abundance, NORs, and productivity before and during supplementation using t-tests. If the hatchery program is successfully supplementing the natural spring Chinook population, the trend for spawner abundance and NORs during supplementation should be greater than the slope during the pre-supplementation period. For productivity, the slope during the supplementation period should increase or remain the same as that during the pre-supplementation period.

Visual examination of trends of Chiwawa data indicates that spawner abundance, NORs, and productivity decreased during the pre-supplementation period, but increased during the supplementation period (Figure 22). Only the changes in NOR trends were significant (Figure 22). This was true for both transformed and untransformed data.

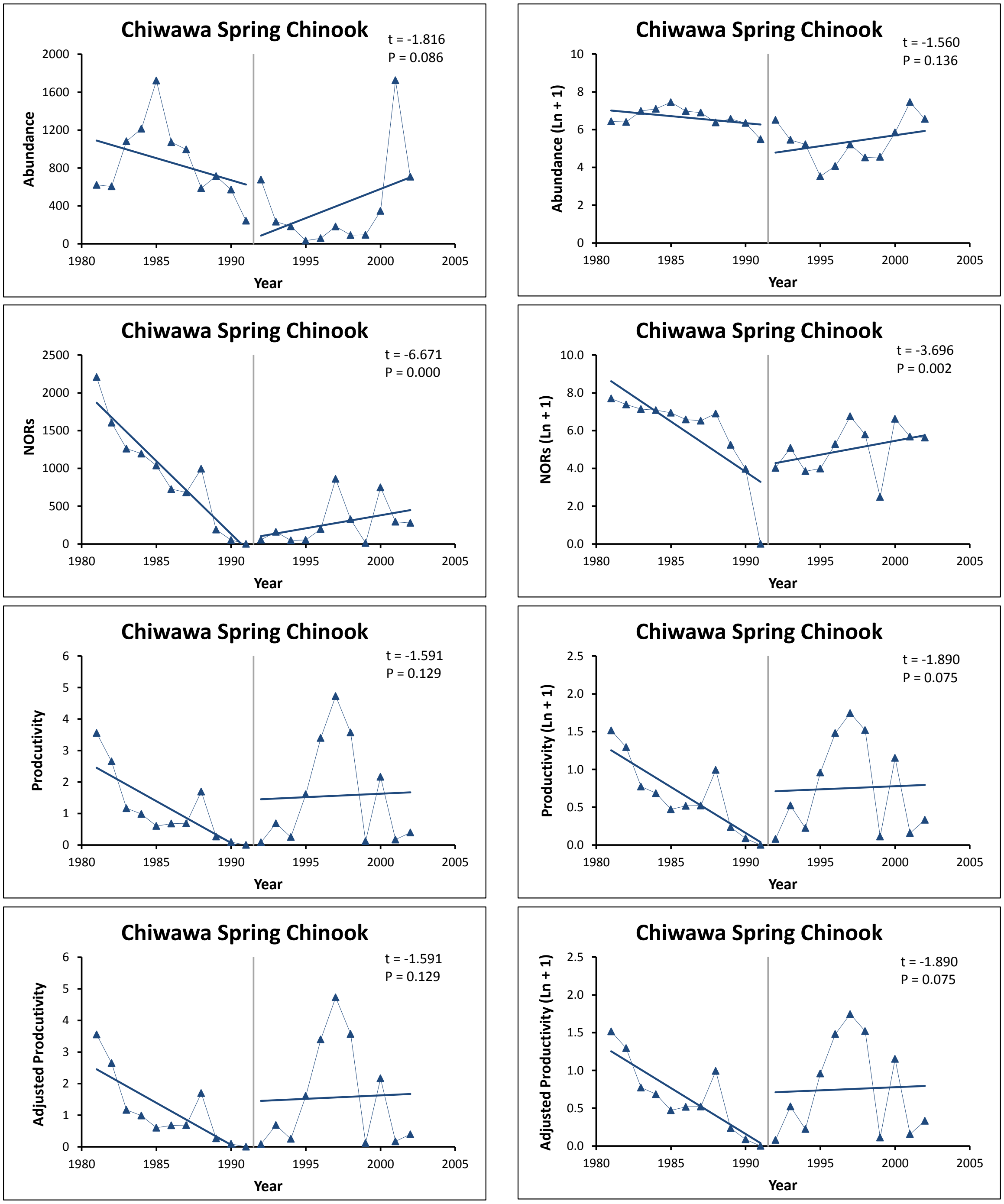

Figure 22. Trends in Chiwawa spring Chinook spawner abundance, natural-origin recruits (NORs), productivity (adults recruits per spawner), and adjusted productivity (adjusted for density dependence) before and during supplementation. The vertical lines in the figures separate the pre- and post-supplementation periods. Figures on the left show untransformed data; figures on the right include natural-log transformed data. Figures include results of t-tests comparing slope of trends before and during supplementation.

Analysis of Mean Scores

We also compared mean spawner abundance, NORs, and productivity data before and after supplementation. If the hatchery program is successfully supplementing the natural spring Chinook population, mean spawner abundance and NORs during the supplementation period should be greater than the pre-supplementation period. For productivity, the mean productivity during the supplementation period should be equal to or higher than the pre-supplementation period. We tested the following statistical hypotheses.

Spawner Abundance and NORs:

Ho: Mean spawner abundance and NORs before supplementation ≥ Mean spawner abundance and NORs during supplementation.

Ha: Mean spawner abundance and NORs before supplementation < Mean spawner abundance and NORs during supplementation.

Productivity (Recruits/Spawner):

Ho: Mean productivity before supplementation ≤ Mean productivity during supplementation.

Ha: Mean productivity before supplementation > Mean productivity during supplementation.

We tested before-after supplementation effects using a one-tailed Aspin-Welch unequal-variance test. We also used a randomization test, based on 10,000 Monte Carlo simulations, to assess differences in spawner abundance and productivity before and during supplementation. The randomization procedure only allowed the testing of two-tailed hypotheses. Therefore, we generated 95% confidence intervals on the mean difference (μ_{pre} - μ_{post}) using bootstrapping methods to determine if the significant result from the randomization test was in the right direction. We generated 5,000 bootstrap samples to calculate confidence intervals.

Mean spawner abundance during the supplementation period was significantly less than the pre-supplementation spawner abundance (Table 33). Mean spawner abundance decreased 46% between the pre- and post-supplementation periods. Likewise, mean NORs decreased significantly between the two periods (Table 33). On the other hand, productivity increased slightly, but not significantly, between the pre- and post-supplementation periods (Table 33). This was true for both adjusted and transformed productivity data.

Table 33. Statistical results comparing mean scores of spawner abundance, natural-origin recruits (NORs), and productivity (using both untransformed and natural-log transformed) before and during supplementation of Chiwawa spring Chinook. Randomization tests were based on 10,000 Monte Carlo samples and 95% CI were based on 5,000 bootstrap samples.

Population metric	Mean scores		Test on means			
			Aspin-Welch test		Random test P-value	Bootstrap 95% CI
	Before	During	t-value	P-value		
Abundance	856	393	2.383	0.986	0.028	112 - 843
LN Abundance	6.6	5.4	3.304	0.997	0.004	0.56 – 1.99
NORs	905	275	2.846	0.993	0.009	214 – 1034
LN NORs	6.0	5.0	1.197	0.876	0.250	-0.40 – 2.54
Productivity	1.13	1.56	-0.721	0.759	0.479	-1.55 – 0.73
LN Productivity	0.64	0.75	-0.450	0.671	0.649	-0.55 – 0.35
Adj Productivity	1.12	1.56	-0.721	0.759	0.477	-1.54 – 0.71
LN Adj Productivity	0.64	0.75	-0.450	0.671	0.652	-0.57 – 0.34

Analysis of Stock-Recruitment Curves

The third method compared stock-recruitment curves of the Chiwawa population during supplementation with those generated before supplementation. Specifically, we tested whether the regression parameters were equal between the pre- and post-supplementation periods, and whether the fitted curves coincided between the two time periods. We used the methods described earlier to fit the Ricker, Beverton-Holt, and smooth hockey stick curves to the two data sets. We tested the following hypotheses.

Parameter equivalence:

Ho: Stock-recruitment parameters (α and β) of the pre-supplementation period = Stock-recruitment parameters of the supplementation period.

Ha: Stock-recruitment parameters (α and β) of the pre-supplementation period ≠ Stock-recruitment parameters of the supplementation period.

Curve equivalence:

Ho: Modeled stock-recruitment curves from the pre-supplementation period = Modeled stock-recruitment curves from the pre-supplementation period.

Ha: Modeled stock-recruitment curves from the pre-supplementation period ≠ Modeled stock-recruitment curves from the pre-supplementation period.

We were only able to fit stock-recruitment curves to the post-supplementation data. Non-linear regression was unable to converge on a solution using only pre-supplementation data. Therefore, we were unable to use this method to test supplementation effects on the Chiwawa spring Chinook population. If we could have fit curves to both the pre- and post-supplementation periods, we would have used two-sided randomization tests to evaluate the null hypotheses of equal model parameters and that fitted curves coincided.

Before describing correlation approaches, it is important to note that comparing before-after data can sometimes be misleading. For example, the spawner abundance, NORs, and productivity data presented in Figure 22 suggest that supplementation is increasing the abundance and productivity of spring Chinook in the Chiwawa Basin. However, when we compared these trends to those from reference populations during the same time periods (Figures 9-11), it becomes clear that supplementation was not responsible for increasing the trends in spawner abundance, NORs, and productivity of the Chiwawa population. Thus, whenever possible, it is wise to compare before-after data with a reference population.

Correlation Analyses

A simple way to see if the supplementation program is increasing or decreasing productivity is to assess the association between the proportion of adult spawners that are made up of hatchery adults (pHOS) and productivity (recruits/spawner). If the supplementation program is working as planned, the increase in hatchery fish spawning naturally should increase the productivity of the population. It should not decrease the productivity of the population.

We tested the association between pHOS and adult productivity[18] using Pearson correlation. During the pre-supplementation period, productivity averaged 1.13 recruits/spawner; during the supplementation period, productivity averaged 1.39 recruits/spawner. This increase in productivity did not appear to be strongly correlated to pHOS (Figure 23). Correlation analysis showed that there was no significant association between pHOS and productivity, even though productivity increased with increasing pHOS.

[18] Note that the analysis could also include juvenile productivity (e.g., smolts/spawner).

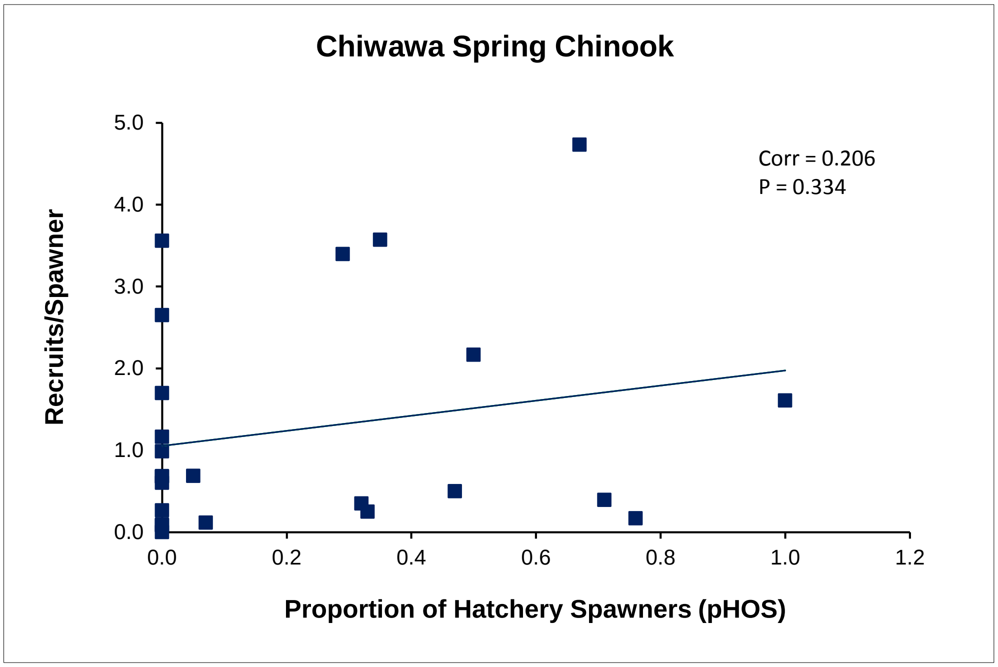

Figure 23. Association between the proportion of spawners that are made up of hatchery adults (pHOS) and the number of natural-origin recruits. The Pearson correlation coefficient (Corr) and its P-value (P) are shown in the figure.

The association between pHOS and productivity can also be assessed by testing the correlation between pHOS and the residuals from stock-recruitment curves fitted to the Chiwawa spawner and natural-origin recruitment data. This approach removes the effects of density dependence on the relationship between pHOS and productivity. A significant negative association provides evidence that hatchery-origin spawners may not be as productive as natural-origin spawners.

The Ricker, Beverton-Holt, and smooth hockey stick models were fit to the Chiwawa stock and recruitment data (including {S, R} data from both the pre- and post-supplementation period, 1981-2004) using methods described earlier. Residuals were calculated by subtracting the predicted recruitment values from the observed (modeled) values. Pearson correlation then tested the association between pHOS and the residuals from each model.

Although there was a negative trend in residuals with increasing pHOS, suggesting that hatchery-origin spawners may not be as productive as natural-origin spawners, the association was not significant (Figure 24). Thus, based on these analyses, there is no strong evidence that the supplementation program has significantly benefited or harmed the natural spring Chinook population.

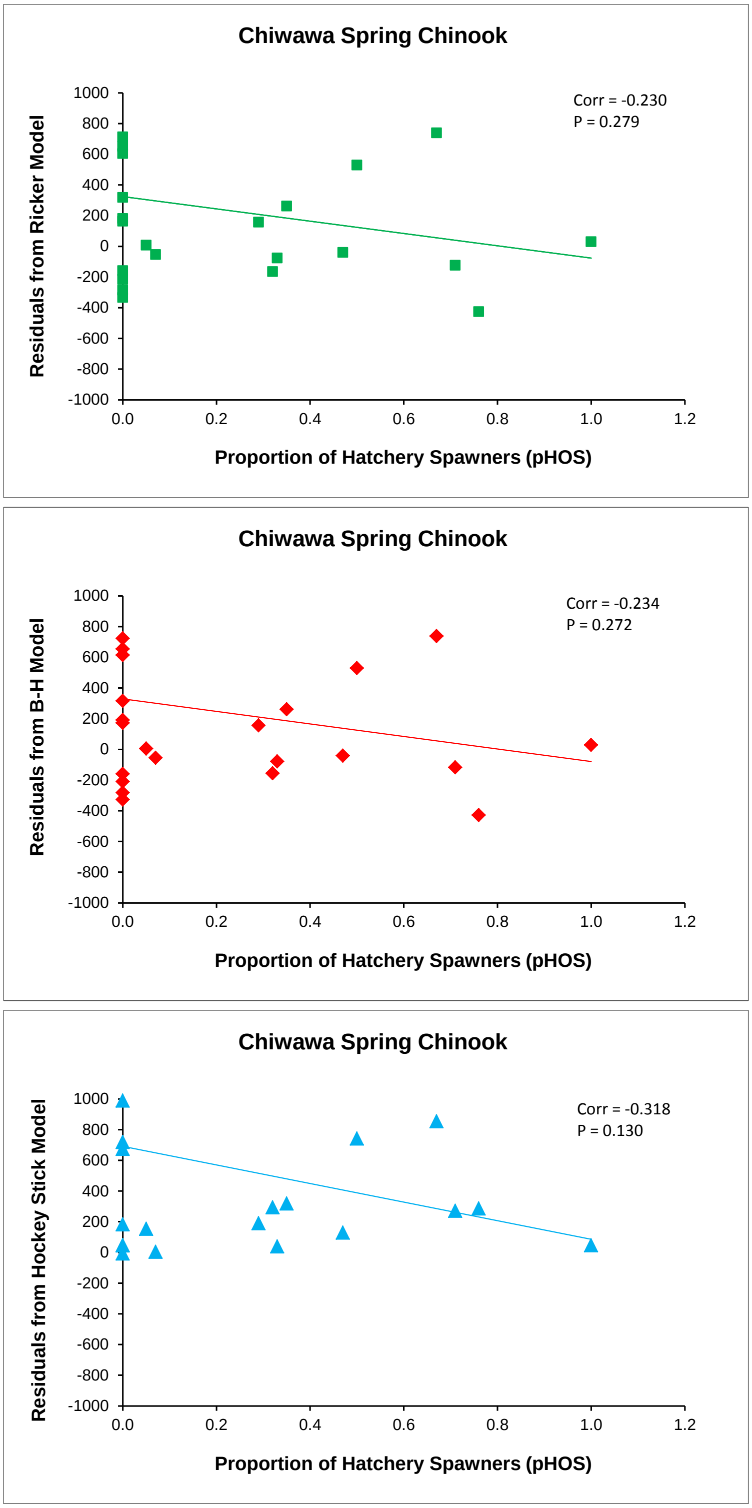

Figure 24. Association between the proportion of spawners that are made up of hatchery adults (pHOS) and the residuals from Ricker, Beverton-Holt (B-H), and smooth hockey stick stock-recruitment models. The Pearson correlation coefficient (Corr) and its P-value (P) are shown in the figures.

Comparison to Standards

In those cases in which suitable reference populations are not available and there are no pre-supplementation data, the investigator is left with comparing population parameters to relevant standards. Standards can include performance of natural-origin fish in similar environments (a type of reference condition), mitigation requirements, quantitative objectives of the program, Biological Assessment and Management Plan (BAMP) values, or other appropriate standards. An example of a statistical hypothesis would be:

Ho: Productivity (Recruits/Spawner) of the supplemented population ≥ standard productivity.

Ha: Productivity (Recruits/Spawner) of the supplemented population < standard productivity.

For these analyses to be useful, the standards must be based on biological reality.

Conclusions and Recommendations

Hatcheries are an important component of fish production within the Upper Columbia Basin. The goal of some of these programs is to supplement natural production in declining populations. The supplementation programs generally use both hatchery and natural (spawned and reared in nature from either wild or hatchery parents) adults for hatchery broodstock. These programs are designed to supplement natural populations by increasing natural reproduction while preventing the establishment of a domesticated hatchery stock. Thus, the programs should increase total spawning escapement and NORs, and not reduce the productivity of the natural population. Measuring the success of these programs is challenging and expensive.

In this paper, we described methods that can be used to determine if supplementation programs are achieving some of their goals. This paper focused on the use of reference populations to determine if the supplementation programs increase total spawning escapement, NORs, and maintain or increase productivities. In some cases, suitable reference populations may not be available (e.g., we found no suitable reference populations for Upper Columbia steelhead and sockeye). In these cases, alternative methods are needed to assess supplementation effects. We also described these alternative methods in this paper.

Identification of Reference Populations

Finding suitable reference populations that match well with supplemented populations is a difficult and time-consuming process. Our three-step selection process included identification of populations with similar life-history characteristics, few or no hatchery spawners, a long time series of accurate abundance and productivity estimates, and similar freshwater habitat impairments and out-of-basin effects. Those populations that met these criteria were then examined for their relationship with the supplemented population (in this case, the Chiwawa spring Chinook population). Several criteria were scored, including pNOS, correlation, trend, and effect size. Reference populations with total weighed scores of 81 or greater were selected as suitable reference populations.

This selection process provided a valuable framework for selecting suitable reference populations for supplemented populations. Interestingly, we found that a given reference population may match well with one parameter of the supplemented population (e.g., spawning escapement), but not for all parameters (e.g., not NORs or productivity). The reason for this may be related to errors in the estimation of population parameters and/or differential factors limiting population parameters of supplemented and reference populations. Therefore, depending on the parameter analyzed, a different suite of reference populations may be needed.

An important assumption in the use of reference populations is that the supplemented and reference populations that tracked each other before supplementation would continue to track each other in the absence of supplementation. Given that the reference populations did not match the Chiwawa population on all criteria examined, and some reference populations tracked the Chiwawa population more poorly than others, there may be some uncertainty as to whether differences observed between the supplemented and reference populations during the supplementation period are associated with the hatchery program, or other unaccounted factors. For example, any large-scale change (man-made or natural) within the reference or supplemented population could affect our ability to assess the effectiveness of the supplementation program.

To account for some of these uncontrollable factors, we recommend the use of a "causal-comparative" approach to strengthen the certainty of our inferences. This approach relies on correlative data to try and make a case for causal inference. We recommend that the following state variables be measured and tracked within the supplemented and reference populations: mean annual precipitation, total and riparian forest cover, road density, impervious surface, and alluvium. These variables can be used to describe differences in water temperatures at different life stages (pre-spawning, egg incubation, and summer rearing) and substrate characteristics, including fine sediments and embeddedness. These state variables can be used to help explain possible changes in spawner abundance, NORs, and productivity that are independent of supplementation. In addition, the use of multiple reference streams reduces the possibility that man-made changes to a single reference stream will influence the interpretation of the results.

Analyses with Reference Populations

Using reference populations, we evaluated the effects of supplementation on natural-log transformed and untransformed total spawning escapement, NORs, and productivity by comparing trends, analyzing mean differences, ratios, and rates, and comparing stock-recruitment curves and their parameters. For trend analysis, we compared the slopes of the trends between each supplemented/reference pair before and during supplementation. If the hatchery program is successfully supplementing the natural population, trends in spawner abundance and NORs should deviate significantly during the supplementation period (i.e., the slope of the supplemented population should be greater than the slopes of the reference populations during the supplementation period), but not during the pre-supplementation period. For productivity, the slope of the supplemented population, relative to the reference population, should increase or remain the same.

Because trend analysis only tests the slopes of the trend lines, it does not test for differences in elevations of the trend lines, additional analyses were needed to determine if supplementation increased spawner abundance, NORs, and productivity of the target population without changing the slopes of the trend lines. To do this, we derived three different response variables using natural-log transformed and untransformed spawner abundance, NORs, and productivity data. The first derived variable included difference scores, which were calculated as the difference between paired treatment and reference data (T-R). The second included ratios, which were calculated as the ratio of paired treatment and reference data (T/R). Finally, we calculated the differences in annual changes in paired treatment and reference population data (ΔT-ΔR). If the hatchery program is successfully supplementing the natural population, the mean difference or ratio score of paired spawner abundance data and NORs during the supplementation period should be greater than the pre-supplementation period. For productivity, the mean difference or ratio score during the supplementation period should be equal to or higher than the pre-supplementation period.

As a final set of analyses, we compared the stock-recruitment curves of the supplemented population (using stock and recruitment data only from the supplementation period) to the reference populations (using all available stock and recruitment data). Specifically, we tested whether the regression parameters were equal between the supplemented population and the reference populations, and whether the fitted curves coincided between populations. Here, we were most interested in comparing the productivity parameters in the models.

Surprisingly, these different analyses yielded similar results when they were applied to the Chiwawa spring Chinook and reference population data. Trend analysis was unable to detect a significant difference in trends between the supplemented and reference populations during the supplementation period. Even though we measured an increasing trend in spawner abundance, NORs, and productivity in the supplemented population during the supplementation period, these same parameters trended upward in the reference populations. Likewise, we were unable to detect a significant supplementation effect using difference scores, ratios, and differences in annual changes. However, we found the results from analysis of mean differences of annual change difficult to interpret and they may be insensitive to treatment effects. A simpler analysis, which is also easier to interpret, is to use trend analysis. Finally, comparing stock-recruitment curves and their parameters did not provide strong evidence that supplementation has affected the productivity of the natural population.

Based on these results, we do not recommend using difference scores of annual change (ΔT-ΔR), nor do we recommend comparing stock-recruitment curves and their parameters. As noted above, difference scores of annual change are difficult to interpret and may be redundant with trend analysis. Testing stock-recruitment curves and their parameters appears redundant with testing differences in productivity using difference scores or ratios. In addition, the analyses are computer intensive and do not appear to be very sensitive to changes.

There was little difference in results using difference scores and ratios. It appears that ratios may be more sensitive to change than difference scores (e.g., we found significant differences in some comparisons using ratios but not with difference scores), but ratios can be more difficult to interpret than difference scores. Nevertheless, we recommend the use of ratios in future analyses.

Correcting for Density Dependence and Carrying Capacity

The analyses described so far assumed that the density of spawners or recruits did not affect the survival and productivity of fish. However, without controlling for density effects, productivity of the population would continue to decline with increasing abundance. This scenario could occur in supplementation programs that increase the number of spawners, and could result in lower productivities relative to reference populations. In addition, lower productivities may be caused by differential environmental carrying capacities rather than the capacity of the supplemented fish to produce offspring. Therefore, we described two different methods for deriving density-corrected estimates of productivity. The first controlled the effects of density on productivity by partitioning observed productivities into density-independent and density-dependent productivity. These productivities were then combined in a single test. The second method corrected for differences in carrying capacities between the supplemented and reference populations. This was accomplished by calculating the percent saturation of NORs, which was estimated as the ratio of observed NORs to the maximum number of NORs that the habitat could support.

We fit Ricker, Beverton-Holt, and smooth hockey stick models to stock and recruitment data to estimate the maximum number of NORs (NORs at carrying capacity) and the maximum number of spawners needed to produce maximum NORs. We fit models to the supplemented and reference populations. Using information-theoretic criterion and evaluating the precision of estimated parameters, we found that the smooth hockey stick model provided the best estimates of maximum NORs and spawners. We used these modeled values to estimate density-independent and density-dependent productivities, and saturation of NORs.

Statistical analyses, using difference scores and ratios of adjusted Chiwawa spring Chinook productivity data, found no significant effects of supplementation on the productivity of the supplemented population. Indeed, the results from correcting for density dependence were similar to those without correcting for density dependence. This is in part because the abundance of the supplemented and reference populations has been below their respective carrying capacities in most years. This was clearly demonstrated in the analyses of NORs corrected for carrying capacity. In the supplemented population, the mean fraction of the carrying capacity filled with NORs decreased significantly during the supplementation period. In other words, the carrying capacity was filled with more NORs during the pre-supplementation period than during the supplementation period, which is contrary to the goal of supplementation. By comparison, two of the reference populations showed a similar decrease in saturation, while the other two reference populations actually increased in saturation. Analyzing the saturation scores using BACI-design analyses indicated that two of the four pairings differed significantly. That is, the percent saturation of the supplemented population decreased significantly relative to two reference populations.

Because productivity can be affected by the abundance of spawners and recruits, we recommend that future analyses comparing supplemented and reference populations adjust for density-dependent effects and differential carrying capacities. Although we detected only slight differences between adjusted and unadjusted results, as supplemented stocks recover, it will become more important to adjust productivities to account for density dependence. Importantly, the analyses using percent saturation placed NORs in the context of the carrying capacity of the environment. This will help managers determine if supplementation programs are filling or over-filling the capacity of the habitat with NORs.

As we noted earlier, analyses using productivities adjusted for density dependence assume that there is a spawner abundance at which density-independent effects end and density-dependent effects begin. In reality, density-dependent effects occur at low spawning abundance and intensify as spawning abundance increases. We did not account for these increasing density-dependent effects at lower spawner abundances. This is an area that needs additional attention.

Analyses without Reference Populations

Because of the rigorous criteria we used to select reference populations, it is likely that reference populations may not exist for making comparisons with supplemented populations. For example, we used the criteria described in this paper to identify reference populations for supplemented steelhead and sockeye populations in the Upper Columbia Basin. We were unsuccessful in identifying any suitable reference populations. Therefore, in the absence of suitable reference populations, it is important to have alternative methods for assessing supplementation effects. We described three different types of analyses one can use to assess supplementation effects in the absence of reference populations. They include before-after comparisons, correlation analysis, and comparisons to standards.

Before-after analyses compare population metrics before supplementation with those during supplementation. In this case, data collected before supplementation represent the reference condition. The assumption is that population trajectories measured during the pre-supplementation period would continue in the absence of supplementation. We compared trends in spawner abundance, NORs, and productivity before and after supplementation. In addition, we compared mean scores in these three parameters before and after supplementation. Finally, we attempted to compare stock-recruitment parameters before and after supplementation. The hypotheses examined were that the spawner abundance and NORs would be greater during the supplementation period, and that productivities would not decline during the supplementation period.

Trend analysis indicated that the all three Chiwawa spring Chinook population parameters trended downward during the pre-supplementation period, but trended upward during supplementation. On the other hand, mean spawner abundance and NORs were lower during the supplementation period than during the pre-supplementation period. Mean productivities increased, but not significantly, during the supplementation period. We were unable to compare pre- and post-supplementation stock-recruitment curves because we were unable to fit stock-recruitment models to the pre-supplementation data.

We used correlation analyses to determine if the proportion of hatchery-origin fish that spawn naturally on the spawning grounds (pHOS) increased productivity. In addition, we used correlation to assess the association between pHOS and the residuals from stock-recruitment relationships. A significant negative association provides evidence that hatchery-origin spawners may not be as productive as natural-origin spawners. The analysis indicated that the productivity of Chiwawa spring Chinook increased with increasing pHOS, but the association was not significant. In contrast, there was a negative association between pHOS and the stock-recruitment residuals, but again the association was not significant. The latter analysis accounts for density-dependent effects.

In concert, the before-after comparisons and correlation analyses do not provide conclusive evidence that the supplementation program has increased spawner abundance and NORs, or that it has significantly reduced the productivity of the supplemented population. Although increasing the number of hatchery fish on the spawning grounds appears to reduce NORs and productivity, mean productivity actually increased during the supplementation period compared to the pre-supplementation period.

It is important to note that relying on only one set of analysis could result in drawing a wrong conclusion. For example, if we had only conducted trend analysis, we may have concluded wrongly that the Chiwawa spring Chinook supplementation program significantly increased spawner abundance, NORs, and productivity in the supplemented population. The analysis of mean scores and correlations indicates that the supplementation program has not increased spawner abundance or NORs in the supplemented population. Therefore, in the absence of suitable reference populations, we recommend that analyses include the evaluation of trends, means scores, and correlations. By conducting more than one set of analyses, one can use weight-of-evidence to assess the effects of supplementation programs.

Under the scenario that there are no reference populations or pre-supplementation data, one is left with comparing population parameters to relevant standards. These standards could come from mitigation requirements, quantitative objectives, or published or unpublished standards. One could also use correlation to evaluate the association between productivity and pHOS, but this requires a wide range in pHOS values to be most effective. A more extreme approach, which probably would not gain much traction with managers, is to shutoff the supplementation program for some time and then evaluate the effects of the program in a before-after design. The Entiat spring Chinook hatchery program provides a unique opportunity to evaluate this type of management decision.

Some Concerns and Limitations

No matter how hard we try to explain different sources of variation in population data, we are limited by the quality of the data. Teasing out the effects of supplementation requires long time series of population data. Because funding levels and methods change over time, the quality (i.e., accuracy and precision) of the data also changes over time. Importantly, the population parameters examined in this paper (spawner abundance, NORs, and productivity) are rarely measured directly in the field. That is, other population metrics, such as numbers of redds, number of fish counted at weirs or dams, scales, tags, etc., are sampled in the field. These metrics are then used to calculate spawner abundance[19], NORs, and productivity, often based on assumptions about fish/redd, pre-spawning loss, marking rates, and sampling rates. This has a tendency to increase the variability in the data independent of supplementation programs. In our studies, we can only control sampling within the supplemented populations, and even that

[19] The smooth hockey stick model, which we used to estimate density-dependent correction factors for productivity and NORs, is sensitive to errors in spawner escapement estimates. Therefore, it is important to use accurate and precise estimates of spawner escapement.

is limited by available funding. We have no control over the sampling within reference populations. Thus, we have to assume that sampling within the reference populations will continue and that sampling effort will remain comparable to that in the supplemented populations.

In our analyses, we included both the Entiat and Little Wenatchee populations as references for the Chiwawa population. In the analyses, we treated them as equivalent to the other reference populations. That is, the statistical procedures used to compare the supplemented population to each reference population were identical. This is appropriate. However, the interpretation of the results must be different when comparing the Entiat and Little Wenatchee to the supplemented population, because they are populations that were influenced by hatchery fish. As noted earlier, the Entiat spring Chinook hatchery program has been discontinued. Therefore, it provides a unique type of reference where the comparison changes from both populations being supplemented to only one population being supplemented. For the Little Wenatchee, nearly all the strays came from the Chiwawa program. Straying should stop or be greatly reduced with the change in water supply to the Chiwawa Rearing Ponds. In sum, one must be careful in how they interpret these test-reference results.

Finally, it is important to point out that for this paper, we conducted 463 statistical tests. Because we set our Type I error rate at 0.05, by random chance alone, we may have incorrectly rejected about 23 null hypotheses. Inasmuch as this work was designed to evaluate different ways to analyze test-reference data, the number of future analyses will be greatly reduced based on the results from this work. However, if the Type I error rate is a concern to managers, researchers can use a lower error rate, such as $\alpha = 0.01$. Another option is to analyze test-reference data graphically. Although this is subjective, there are no statistical analyses and therefore no concerns with violating assumptions of statistical tests, including temporal correlation. We believe researchers should use the statistical procedures recommended in this report to support graphic analysis.

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APPENDIX D

Genetic monitoring of Methow Spring Chinook

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Final report, April 13, 2007

Executive summary

Temporal samples from 1992 through 2006 of fish from the Winthrop National Fish Hatchery (WNFH), and hatchery- and natural-origin fish from the Methow, Twisp, and Chewuch rivers were genetically characterized. Twisp hatchery- and natural-origin collections formed a discrete group distinct from a Methow-Chewuch-WNFH group. Methow collections were genetically very similar to the WNFH collections and differentiated from 1992 and 1993 Chewuch collections. The Methow and Chewuch became more similar after implementing the hatchery broodstock developed from a combination of Methow and Chewuch spawners. Collections were examined for signals indicating negative effects from hatchery supplementation, which was started in 1992 and a genetic bottleneck experienced by all fish in 1996-1997. Genetic diversity measures, heterozygosity and allelic richness, and genetic differences between Twisp and other collections were unchanged following hatchery supplementation and the bottleneck. Effective population sizes were difficult to compare pre- and post-supplementation and bottleneck since values differed significantly between 1992 and 1993 collections. If only collections from 2001 and beyond are compared, effective population sizes remained stable in Methow and Chewuch and declined in the Twisp, although supplementation has slowed the decline in Twisp fish. Assignment tests indicated that if natural-origin fish were collected at Wells Dam for broodstocks and assigned with a moderate probability threshold (10 times more likely to have come from one collection as from another), there is low risk of incorrectly identifying a Methow-Chewuch fish as a Twisp fish and even lower risk of incorrectly identifying a Twisp fish as a Methow-Chewuch fish.

Introduction

Supplementation programs were implemented in 1992 on the Twisp, Chewuch, and Methow rivers to mitigate for smolt mortality associated with the operation of Wells Hydroelectric project. Initially these programs used in-river natural broodstock collected from each respective subbasin. Beginning in 2001, an alternative strategy was developed for the Chewuch and Methow rivers, which used a common broodstock developed from the Chewuch and Methow rivers spawning aggregates. This broodstock (Methow-Composite, hereafter referred to as Met-Comp) employed natural- and hatchery-origin fish collected from both rivers as well as hatchery adults returning to either Methow or Winthrop Hatchery. Progeny of this broodstock have been released annually into both the Chewuch and Methow rivers. In the Twisp River, located roughly 20 miles downstream from the confluence of the Chewuch and Methow rivers, natural- and hatchery-origin fish have also been collected for hatchery broodstock each year, but their progeny have been released back into the Twisp River only.

Hatchery-origin fish were identified on spawning grounds by wanding for coded-wire tags (CWT) and in hatcheries by decoding CWTs. In some fish, especially fish from the earlier collections (e.g., 1992 and 1993), hatchery fish without CWTs were identified by diagnosic scale patterns. Hatchery fish have demonstrated a tendency to stray into rivers upstream of the release locations (A. Murdoch, unpublished data), so some Twisp hatchery-origin fish have strayed into the Chewuch and Methow rivers. But reciprocal straying is rarely detected on the spawning grounds (A. Murdoch, unpublished data). Previous to the Methow Fish Hatchery Program, a federal hatchery program was implemented in the 1940's at the Winthrop National Fish Hatchery (WNFH), located on the Methow River one mile upstream of the confluence of the Chewuch and the Methow rivers. WNFH originally used broodstock derived from out-of-basin fish (Carson stock), but transitioned in 2001 to the Metcomp broodstock. Based upon CWT recoveries, relatively few spring Chinook from WNFH of Carson stock origin have strayed into the Twisp River compared to the Methow or Chewuch rivers (A. Murdoch, unpublished data). The proportion of WNFH origin spawning adults (range 2.2 – 71.4%) that have spawned annually in the Methow and Chewuch rivers has increased since the late 1990's(Cooper 2006). Since 2001, WNFH collected only the number of fish required to meet the broodstock goal and all returning hatchery fish in excess of the broodstock goal spawned naturally in either the Methow or Chewuch rivers.

Based on the Douglas County PUD Monitoring and Evaluation Plan (Wells HCP HC, 2005), we developed nine specific genetic-related tasks (Small and Murdoch 2006) to be completed in a multi-year study. However, funding allowed us to complete the study in a single year, rendering some tasks unnecessary (e.g., task 3 – modeling effects of bottleneck in 1996-97 to assess if bottleneck effects could be distinguished from hatchery impact). Since we have data for samples collected before and after bottlenecks and hatchery impacts, we can estimate these effects from the samples rather than through a model. In the tasks (described in the discussion section below) we outlined the development of genetic profiles of natural-origin collections from the Methow, Chewuch, and Twisp rivers from three time periods: before in-river hatchery supplementation (1992-1993), after the bottleneck and early in the interactions between natural-origin and hatchery-origin fish on spawning grounds (2001), and after several years of interactions between natural-origin and hatchery supplementation fish on spawning grounds (2005-2006). We estimate measures of genetic diversity and compare these among collections from the three time periods to document changes. We also profile changes in genetic variance among collections from different time periods and estimate if temporal differences among collections from the same river are greater than spatial differences among rivers within a single year. We calculate the effective number of spawners (N_e) for each collection and look for changes over time in hatchery- and natural-origin fish and calculate the relationship of N_e to census size. The effective population size is the theoretical number of individuals that would display similar diversity and be subject to similar genetic drift (random changes in allele frequencies). Since reproductive success is unequal among individuals within a population, N_e is usually smaller than the population's census size. In our final task we estimate the probability of correctly assigning naturally produced spring Chinook collected at Wells Dam to the Twisp, Chewuch, or Methow spawning aggregates through assignment tests with collections separated into temporal and spatial collections and grouped into spatial (tributary) collections.

Methods

Sample processing

Scale and tissue samples were processed for 1681 fish from Methow, Chewuch, and Twisp rivers (Figure 1) and the Metcomp hatchery broodstock (Table 1). Fish were genotyped at the 13 standardized Chinook Technical Committee (CTC) or GAPS loci. We added an additional ten loci to increase the power to distinguish between closely related samples, making a total of 23 loci for a complete genotype (Table 2). Genomic DNA was extracted from tissue and scale samples using silica membrane kits (Macherey-Nagel). Microsatellite alleles at 23 loci were PCR-amplified using fluorescently labeled primers (see Table 2 for detailed PCR information). PCRs were conducted in 96 well plates in 10 μl volumes employing 1 μl template with final concentrations of 1.5 mM $MgCl_2$, 200μM of each dNTP, and 1X Promega PCR buffer. After initial three minute denature at 94°, 40 cycles consisting of 94° for 15 seconds, annealing (temperature in Table 1) for 30 seconds, extension at 72° for 60 seconds were followed by a 10-minute extension at 72°. Microsatellites were detected using an ABI 3730 automated DNA Analyzer, and alleles were sized (to base pairs) and binned using an internal lane size standard (GS500Liz from Applied Biosystems) and GeneMapper software (Applied Biosystems). Scale samples and some tissue samples were degraded and required rerunning to attempt complete genotypes. Since many samples were of poor quality, fish included in the analysis (N = 1576) were genotyped at a minimum of ten total loci (Table 1). There were several hatchery-origin fish in samples from 1992 and 1993 (pre-hatchery supplementation, see Table 1). In the 1993 Methow and Chewuch collections, 62 out of 93 fish and 10 out of 104 fish, respectively, were identified by scale analysis to be of hatchery-origin. To determine the source of these hatchery fish, we analyzed samples as separate groups and dropped hatchery-origin samples under 10 fish from 1992 Chewuch and 1993 Twisp natural-origin collections (Table 1).

Within-population genetic diversity and equilibrium

We used FSTAT 2.9.3 (Goudet 2001) to assess conformation to Hardy-Weinberg equilibrium expectations as expressed by F_{IS} and tested its significance for each locus and over all loci in each collection with 350,000 randomizations. Departures from Hardy-Weinberg equilibrium within a population can result from a variety of causes, including, nonrandom relationship among individuals within the collections resulting from the presence of family groups or inbreeding, or when a collection is composed of two or more populations. Linkage disequilibrium in each locus pair in each collection group was assessed using

GENEPOP (Raymond and Rousset 1995) with 5000 burn-ins and 5000 iterations. If a collection has several pairs of linked loci, the collection may contain family groups or be an admixture of more than one population. Other causes of linkage disequilibrium within a population include natural selection, bottlenecks, and genetic drift (Nielsen et al. 1999). We examined collections for family groups by measuring pairwise relatedness among individuals with IDENTIX (Belkhir *et al*. 2002), using Queller and Goodnight's (1989) "Q" value (Q = 0.25 for half-siblings and 0.5 for full-siblings). We also calculated the mean and variance of the Q value for each collection and their significance compared to a null model of no relatedness using 1000 permutations (if samples contain family groups individuals will either be highly related or unrelated such that the variance of relatedness is high). Allelic richness was calculated using a randomization implemented in FSTAT and based upon permutation of 8 diploid individuals, the smallest sample size at a single locus. Allelic richness is a measure of diversity. In general, populations that are isolated and have smaller effective population sizes have fewer alleles. Gene diversity (expected heterozygosity corrected for sample size, Nei 1987) was calculated using FSTAT. Heterozygosity is another diversity measure – isolated populations with small effective population sizes tend towards lower heterozygosity, or the same, rather than two different alleles at each locus. Effective population size was estimated using a linkage disequilibrium method (Waples 2006) and the program LDN_e (Do and Waples unpublished).

Population differentiation

Genetic variance among temporal and spatial collections was estimated by a hierarchical analysis of molecular variance (AMOVA) using ARLEQUIN3.0 (Schneider et al. 2000) with 10,000 permutations. If genetic variance is unequally distributed among collections, there is genetic structure in the data set and we explore this structure for temporal and spatial patterns. We examined the magnitude of genetic differences among temporal and spatial collections in pairwise F_{ST} tests with 10,000 permutations using ARLEQUIN. We conducted explicit tests of differences in genotypic distributions among temporal and spatial collections in pairwise genotypic tests with 200,000 permutations using FSTAT. Statistical significance in all analyses was evaluated using a Bonferroni correction of *p*-values (Rice 1989).

We used GENETIX (Belkhir et al. 2004) to visualize relative similarities among spring Chinook populations based on genotypic data. GENETIX performs a factorial correspondence analysis in which composite factorial axes are generated that describe the most variance in a "cloud" of observations, here a plot of individuals according to their allele types. Individuals are plotted in three dimensions along these axes according to their genotype (Lu et al. 2001). The analysis was conducted "over populations" in which the program condenses the cluster of individuals into a single point representing the mean allele frequencies in the collection (Belkhir et al. 2004). We viewed genetic distance relationships among collections in a dendrogram. We generated allele frequencies for each collection using CONVERT 1.3 (Glaubitz 2004) and calculated pairwise chord distances (Cavalli-Sforza and Edwards, 1967) among collections from allele frequencies using GENDIST in PHYLIP 3.5c (Felsenstein 1993). Chord distances were plotted in a neighbor-joining (NJ) tree using PHYLIP and visualized with TREEVIEW 1.6.6 (Page 2001). To test the repeatability of branching in the NJ tree, the allele frequency file was bootstrapped 1,000 times across loci using SEQBOOT. Tree topologies were created for replicates with NEIGHBOR, and a consensus tree was generated using CONSENSE. Node values from the consensus tree were added to the chord distance tree described above.

We used a third method to view population differences and similarities in a nonmetric multidimensional scaling analysis (MDS) using allele-sharing distance matrices. 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, 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 n-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 using the mdscale module in MATLAB R2006b (The Mathworks 2006).

Individual assignment tests

We completed a series of individual assignment tests, using a variety of baseline collections. Fish 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. We implemented this procedure using 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 considered valid only if the posterior probability was greater than or equal to 0.9. A posterior probability of 0.9 is roughly equivalent to a likelihood ratio of 10, whereby the assigned population is 10 times (or more) likely than the second-most likely population. Please note that while we used temporal collections as populations for each analysis (e.g., 1993 natural-origin fish from Twisp River [93TwispW]), likelihoods for each of these collections were summed based on more inclusive population grouping (e.g., Chewuch, Twisp, Methow) and posterior probabilities were calculated for that grouping or population, rather than individual temporal collections.

Results

Hardy-Weinberg equilibrium

We tested for departures from Hardy-Weinberg equilibrium (HWE) expectations at individual loci and over all loci. There were 125 (out of 506) departures from HWE for excess homozygotes at individual loci before corrections for multiple simultaneous tests (data not shown), and 20 departures after corrections (corrected alpha = 0.00009). Seven of these departures were at the locus *Omm*-1080. This locus also appeared unstable in genotypes for scale samples since several genotypes in reruns differed from original runs. Therefore, we dropped *Omm*-1080 from all tests and analysis, except for the individual assignments tests and the MDS analysis (see below). There were also 23 departures from HWE for excess heterozygosity, before corrections and 2 departures after corrections. In tests over all loci, 10 collections departed from HWE with excess homozygosity (after corrections) and 2005 Twisp natural departed from HWE with excess heterozygosity (Table 2). Excess homozygosity may indicate inbreeding due to small population size, or the collection may have contained genetically differentiated groups, such as families or spawners from other populations. Excess heterozygosity could indicate that a population recently decreased in size or that some parents were from genetically differentiated groups.

Linkage disequilibrium

Pairwise linkage disequilibrium was moderate to numerous in collections (Table 1). All collections had some linkage disequilibrium before Bonferroni corrections, and after corrections several hatchery-origin collections as well as the 1992 and 2006 Twisp collections had significant (>5%) linkage. The GAPS loci have been screened for evidence of physical linkage (loci on the same chromosome) and the loci to increase discrimination power have not been reported as physically linked to other loci in this study. Significant linkage suggests that some hatchery-origin and Twisp natural-origin collections may contain family groups or be composed of recently merged genetically differentiated groups now interbreeding. Our analysis on the pairwise relatedness of individuals within the population supports the family groups hypothesis (see below).

Family analyses

Since linkage indicated that hatchery collections might contain family groups we examined pairs of hatchery- and natural-origin collections for indications of family groups by measuring pairwise relatedness among individuals within collections using the program IDENTIX (Table 3). The highest percentage of full sibling relationships was 2.6% in 2006 Twisp hatchery collection and the highest percentage of half sibling relationships was 6.8% in 2001 Twisp hatchery collection. We found positive relationships between the percentage of loci in linkage disequilibrium and the percentage of half or full sibling relationships (Figure 2a, b). The 2005 Twisp natural-origin collection was anomalous in that it had high linkage but relatively low sibling relationships (Table 3). The r^2 value for the half-sibling regression line for linkage before Bonferroni corrections changed from 0.0067 to 0.2385 when 2005 Twisp natural-origin values were removed from the regression (plot shown without 2005 Twisp natural-origin) and the regression for linkage after corrections changed from a negative to positive slope with an r^2 value of 0.4671. The 2005 Twisp natural-origin collection also had a significant excess of heterozygotes (Table 1), suggesting that that the high linkage was at least partially the result of mating among genetically differentiated groups in the parental generation. We found significantly high variance ($p < 0.001$) in pairwise relatedness within all hatchery and natural-origin collections and variance was higher in collections with high linkage).

Diversity

Mean heterozygosity and mean allelic richness were the same in Chewuch and Methow natural-origin collections (Table 1, $p = 0.07$ and 0.09 respectively for one-tailed Student's t-tests). Mean heterozygosity and allelic richness were significantly lower in Twisp natural-origin collections than in Chewuch ($p = 0.01$ and 0.00047, respectively for one-tailed Student's t-tests) and Methow natural-origin collections ($p = 0.0046$ and 0.00026, respectively for one-tailed Student's t-tests). There were no significant differences in heterozygosity or allelic richness in collections from before and after the bottleneck ($p > 0.05$ for comparisons of collections within each river using group test in FSTAT).

Effective population size (N_e)

We calculated N_e and its 95% confidence interval (1000 bootstraps) for each temporal collection (Table 1) using a linkage disequilibrium method (Waples 2006) with the lowest frequency allele set at 5% to avoid bias introduced by small samples. N_e values changed dramatically between 1992 and 1993 for Chewuch and Twisp natural-origin collections (we had no 1992 Methow collection), suggesting differences in survivorship between years (Figure 3). Differences could also be influenced by non-biological phenomena such as sampling error or poor genotyping for scale tissue collected in 1992 (in Chewuch failure rate was 6.6% for scales from 1992 and 1.7% for tissues from 1993, respectively, and in Twisp 10.24% for 1992 and 4.5% for 1993, respectively). If we compare only 1993 collections to later collections, N_e was universally smaller after the 1996-1997 bottleneck (Figure 3). Post-1997, N_e in Chewuch and Methow collections remained stable while N_e in Twisp collections declined.

Since the programs employed a supplementation hatchery protocol, we also calculated N_e for combined hatchery- and natural-origin collections (Table 1) and plot these values for Twisp in Figure 3. With the exception of 2001 Twisp, hatchery supplementation increased N_e in the combined population. In 2001 Twisp, N_e of the hatchery was roughly one-third the N_e of the natural-origin collection and when the hatchery and natural-origin collections were combined, the N_e was lower than the N_e for the natural-origin collection alone. The ratio of N_e to census size was highly variable (Table 1), but we found a positive relationship between census size and N_e (Figure 4).

Analysis of Molecular Variance (AMOVA)

The analysis of molecular variance (AMOVA) indicated little variance among collections (1.11%). There was virtually no temporal variance among collections and modest spatial variance. When averaged over all loci, only 0.005% variance was among temporal collections and 1.18% variance was between Twisp collections and a combination of the Methow, Chewuch and Winthrop hatchery-origin collections. Most of the variance (98.89%) was among individuals within collections.

Pairwise F_{ST} and genotypic differentiation

Pairwise F_{ST} values and genotypic tests indicated that spawning aggregates in the Twisp River (and Twisp hatchery-origin collections) are genetically differentiated from spawning aggregates in the Methow and Chewuch rivers (Table 4). Several genotypic tests differed from F_{ST} tests. Genotypic tests are sensitive to low levels of genetic structure (Waples and Gaggiotti 2006), but so sensitive that they may yield significant values that are biologically meaningless. Pairwise F_{ST} values inform about the magnitude of differentiation, providing a complement to genotypic tests. Wherever the test results differed, the pairwise F_{ST} value was very low, suggesting that differences at one or two loci led to a significant genotypic test. Temporal comparisons within tributaries (boxed values in Table 4) support low temporal variation found in the AMOVA. The 2001 Chewuch hatchery-origin collection had low but significant variance in comparisons with other Chewuch collections, and 2006 Chewuch natural-origin was slightly more differentiated from other Chewuch collections. The Twisp hatchery-origin collections were mostly differentiated from Twisp natural-origin collections, although closer to Twisp natural-origin collections than to collections from other tributaries. The 2006 Twisp natural-origin collection was the smallest collection in the study (N = 13) and was basically undifferentiated from all other collections. Since the 2005 Twisp natural-origin collection (N = 43) was differentiated from the Methow, Chewuch, and Metcomp collections, 13 fish may have been inadequate to capture the genetic diversity identified in the 2006 Twisp natural-origin collection. We found low differentiation between Methow and Chewuch collections, some of which was not significantly different from zero after corrections. With the exception of 2006 Twisp natural-origin collection, all the Twisp collections were differentiated from the Chewuch and Methow collections. Winthrop hatchery collections were not differentiated from most Methow natural-origin collections, suggesting Winthrop hatchery introgression into the Methow population. We plotted pairwise F_{ST} values versus time between collections and found an increase in differentiation over time within Twisp natural-origin collections and within Twisp hatchery-origin collections (Figure 5). Increased differentiation is likely a signal that genetic drift is increasing as N_e decreases. Differentiation also increased among Chewuch collections, possibly due to drift and introgression from the Methow through the Metcomp hatchery program.

Graphical representation of population differentiation

In the factorial correspondence analysis (FCA) the Twisp collections formed a group on the right side of the first axis with the Twisp hatchery-origin collections (and 2006 Twisp natural-origin) around the periphery of the cluster of natural-origin collections (Figure 6). The Chewuch and Methow collections plotted on the left side of the first axis with the two groups spread along the second axis. Earlier collections plotted at the far ends of the second axis and later collections plotted near the center of the second axis. The Winthrop hatchery collections and the 1993 Methow natural-origin collection formed a tight cluster with the hatchery fish from the 1993 Chewuch and Methow collections plotting nearby, suggesting that these were Winthrop hatchery fish that had strayed into spawning areas. The genetic distance tree shows essentially the same relationships as the FCA plot (Figure 7). The Twisp hatchery- and natural-origin collections form a cluster with 73% bootstrap support. The earlier Twisp collections form a terminal group with 82% bootstrap support. Except for the 2006 natural-origin collection, the Twisp hatchery-origin collections show longer branch lengths indicating some differentiation of hatchery groups, possibly reflecting variance in family size as suggested by higher percentage of sibling relationships and lower N_e. Earlier (pre-2006) Chewuch collections form a cluster with 78% bootstrap support. Methow and Winthrop (and 1993 Chewuch hatchery-origin) collections form a weakly supported cluster. The Metcomp collection inserts between the Chewuch and Methow/Winthrop clusters.

The FCA and dendrogram had many similarities to the nonmetric multidimensional scaling (MDS) analysis. The stress statistic for the MDS was 0.11, a value Kruskal (in Rohlf 2002) considered to be a good fit between the actual allele-sharing distances and the Euclidean (straight-line) distances in the plot indicating that Figure 8 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.

The natural- and hatchery-origin collections from the Twisp River form a loose cluster distinct from the aggregate formed by the Methow, Chewuch, Winthrop, and Metcomp collections (Figure 8). The hatchery-origin collections from 1993 Chewuch and 2006 Twisp appear as outliers, suggesting that their allele distributions were non-representative or that distances were distorted due to small sample sizes. The median percentage of alleles shared among the natural-origin Twisp collections is 77%, compared with a median percentage of 68% shared between Twisp natural-origin collections and the aggregate of Chewuch, Methow, Metcomp, and Winthrop collections. The median percentage alleles shared between the Methow and Chewuch collections is 74%, nearly as high as the alleles shared among the Twisp collections.

The two Winthrop Hatchery collections are adjacent in the MDS plot and are within the Methow minimum convex polygon (Figure 8). These two collections share approximately 81% of their alleles. The 1993 hatchery-origin collection from the Methow River shares an average of 80% of its alleles with these two Winthrop Hatchery collections, compared with 77% of its alleles with the 1993 Methow natural-origin collection. Furthermore, this 1993 hatchery-origin collection is adjacent to the Winthrop collections in the MDS plot. This suggests that the fish from 1993 Methow hatchery-origin collection were strays from the Winthrop Hatchery. Although the Winthrop Hatchery collections are within the Methow natural-origin polygon the percentage of alleles shared between these two collections and each of the natural-origin Methow collections remained relatively unchanged at 75-76% from 1993 through 2006.

In summary, there is spatial structure among the populations of fish within the Methow system, and this can seen clearly in both the FCA (Figure 6) and the MDS (Figure 8) plots. There is greater allele sharing among the collections from the Chewuch and Methow Rivers, and the Metcomp and Winthrop Hatcheries, than between any of these collections and the Twisp collections. The Twisp collections form a distinct group; however, the allele sharing among the Twisp collections is variable, and the 2006 natural-origin collection from Twisp River (N=13) appears quite divergent.

Assignment tests

Assigning individuals of unknown origin to populations. Individual assignment tests can be used for at least two purposes. First these tests can be used as a measure of discreteness of a population: individuals are tested for assignment probabilities back to their collection of origin (self-assignment). If individuals assign with high probability to their collection of origin, this is an indication that there has been little straying into the population over time and the population is genetically discrete. Second, these tests can be used to assign a fish of unknown origin to a specific population based on baseline data from a series of populations. Here, we assume that all individuals from a baseline population (i.e., all individuals collected from a specific locality, such as Twisp River) are native to that population and allele frequencies for the baseline population represent the “true” population. We calculate the probabilities that an individual of unknown origin originated from each of the baseline populations based on the alleles in the individual and allele frequencies in the baseline populations. If the allele frequencies for baseline populations are similar to each other, the assignment probabilities associated with these populations will also be similar, and the individual of unknown origin may be incorrectly assigned to a population from which it did not originate. A baseline-specific error rate for this type of assignment test can be quantified using the jack-knife procedure described in the Methods section, and implemented in Task 9, including the preliminary Task 9 analysis in Small et al. (2007).

We expand the Small et al. (2007) analysis to include collections from all years; however, we are restricting the analysis to natural-origin fish only. Since hatchery-origin fish are uniquely tagged, their origins (Twisp, Metcomp, or Winthrop Hatcheries) are known presumably without error. Therefore, only natural-origin fish require genetic analyses to determine their source populations, and they are from rivers and not hatcheries.

For Task 9, we conducted two different individual assignment tests. First, in self-assignments we included all natural-origin temporal collections in the baseline and conducted a jack-knife analysis of all individuals from each collection to calculate posterior probabilities of assignment for the Methow/Chewuch and Twisp populations (Table 5). For each temporal collection, we summed the number of individuals assigned to either the Methow/Chewuch or Twisp population, and calculated the assignment error rate for each group using two different threshold criteria (Table 5). Second, instead of including all natural-origin collections as a baseline, we removed from the baseline the three 2006 natural-origin collections from the Twisp, Chewuch, and Methow rivers, and used the remaining collections as the baseline. Instead of a jack-knife analysis, we assigned as unknown fish each of the 2006 natural-origin fish to either the Methow/Chewuch or Twisp populations, and calculated the assignment error rate for collections from each river (Table 6).

For the jack-knife analysis (self-assignment), the error rate for the Twisp and Methow/Chewuch ranged 7.32 - 9.83% and 5.48 - 6.57%, respectively (Table 5). Our use of the stringent 0.90 criterion produced an error rate for the Twisp that was 34% lower than that using the highest posterior probability criterion and 20% lower in the Methow/Chewuch. The 7.32% error rate for the Twisp is over three times greater than the 2.25% error rate calculated by Small et al. (2007), who combined the hatchery- and natural-origin fish from the 2005 and 2006 Methow/Chewuch and Twisp collections. This comparison clearly indicates that assessing assignment errors depends on the baseline used to calculate population allele frequencies.

The error rates associated with assigning collection year 2006 fish to the Twisp River are much larger than those associated with either the jack-knife procedure described above or in Small et al. (2007) (Table 6). However, we note that a total of only five fish were assigned to the Twisp River (posterior probability ≥ 0.90) and the origin for four of these fish was indeed the Twisp River (Table 6). Furthermore, seven of the 13 natural-origin Twisp fish were unassigned and in many regards the 2006 natural-origin Twisp collection was unusual compared with the other Twisp collections (see Figures 6, 7, 8).

Assignment tests for measuring immigration rates. Individual assignment tests can also be used to estimate whether an individual in a population is an immigrant to that population (i.e., the fish originated elsewhere and strayed to the population from which it was captured). Algorithmically, the test is identical to the jack-knife procedure used for assessing error with individual assignment tests described above. However, the results are interpreted differently and are based on a different suite of assumptions. Here, if an individual from a baseline population is assigned to a population other than the population from which it was captured, that individual represents a potential immigrant to the population, rather than a potential error to the assignment process. As with any individual assignment procedure, if two baseline populations are similar it would be difficult to differentiate between immigration and assignment error; however, to accept that an individual is an immigrant the two baseline populations (i.e., the source and capture populations) should have significantly different allele frequencies, and the posterior probability to the assigned population must meet a stringent criterion.

We used individual assignment tests to quantify the degree of straying among rivers within the Methow system, and to determine if fish from the Winthrop Hatchery occur more readily in the Methow River rather than the Chewuch or Twisp Rivers. Table 7 provides the results from a jack-knife-based individual assignment test for each temporal collection. As discussed above, we use the more stringent criterion when assuming “incorrect” assignments are a product of immigration, rather than assignment error associated with two similar baseline populations. Because these analyses are directly relevant to Task 5, we provide an expanded analysis and discussion on introgression in the Task 5 Discussion section, below.

Discussion

The main objectives for this study were to identify genetic structure among spring Chinook populations in the Methow, Chewuch, and Twisp rivers and to determine if hatchery supplementation was negatively impacting populations. Here we restate the tasks outlined in the study plan and discuss our results in light of these tasks.

Task 1: Develop genetic profiles of spring Chinook salmon populations in the Twisp, Chewuch and Methow rivers from samples gathered in 1992 and 1993 (one to two collection years per stock) using 20-25 loci. This will be our pre-supplementation baseline with which we establish the basin population structure. We will also assess whether effective population sizes (N_e) can be calculated using a linkage disequilibrium method.

Task 2: Develop a genetic profile for the WNFH spring Chinook salmon (Carson stock) from 1992 and compare to the pre-supplementation populations in the Twisp, Chewuch and Methow rivers. This will be our baseline for this hatchery.

Methow spawners contained a substantial proportion of the WNFH genome. This was indicated in the close grouping of the 1993 Methow natural-origin collection with 1992 and 2001 Winthrop hatchery-origin collections (Figure 6, Figure 7, and Figure 8), and non-significant pairwise F_{ST} values and genotypic tests (Table 4). The 1992 and 1993 Chewuch and Twisp collections were significantly differentiated from the Winthrop hatchery-origin collection, the Twisp more so than the Chewuch (Table 4). The average of pairwise F_{ST} values indicated a gradient of Winthrop hatchery influence in natural-origin spawners from the different tributaries: 0.0043 Methow, 0.0010 Chewuch, and 0.0168 Twisp (the higher the value, the greater the genetic difference).

Task 3: Using the pre-supplementation baseline, model the effects of the genetic bottleneck (enhanced genetic drift) experienced by the Methow basin spring Chinook salmon in 1996-1997.

We did not model the effects of genetic drift since this project was accomplished in a single year and we could look directly at post-1997 collections to estimate effects of drift. The bottleneck appeared to have little effect on genetic diversity since heterozygosity and allelic richness were essentially unchanged between earlier and later collections (Table 1). Branch lengths for natural-origin collections were similar in earlier and later collections (Figure 7, except 2006 Twisp), indicating little impact by genetic drift on genetic distances. The 2006 Twisp natural-origin collection had a long branch length and was anomalous in all analyses. Because the collection contained only 13 fish, these results are just as likely to have been sampling error as a signal indicating genetic drift. If 1992 collections are ignored, N_e was significantly lower in all post-1997 collections (Figure 3), compared with the 1993 collections. Compared to 1992 collections, N_e was significantly higher in 2001 Chewuch and Twisp collections. Since the 1992 collections were scales and many had incomplete genotypes (50% missing at least one locus in Chewuch and 63% missing at least one locus in Twisp versus 18% and 35%, respectively, missing at least one locus in 1993 collections), the 1992 collections may not have represented the Chewuch and Twisp populations as well as the 1993 collections. There may also have been sampling error, such as family groups, in 1992 collections that contributed to low N_e, as suggested by higher linkage in 1992 collections. Alternatively, the 1993 collections may have been anomalous. For instance, in the 1993 Chewuch collection the N_e was 1.2 times the census size (Table 1) and N_e was high in relation to census size in 1993 Methow and 1993 Twisp (N_e is generally between 0.1 and 0.3 times the census size, Bartley et al.1992).

Task 4. Genetically profile the spring Chinook salmon populations from 2001 in the Twisp, Chewuch and Methow rivers after the supplementation program fish have returned and have had a chance to interbreed with the wild fish. Compare these to 1992-93 samples to determine if genetic drift and the bottlenecks caused significant divergence between samples within rivers. Determine whether N_e for individual populations could be calculated using a temporal method.

The decrease in N_e in 2001 collections relative to 1993 collections could indicate that in-river supplementation programs were negatively impacting natural spawner groups. Decreased N_e in natural spawners is one danger from integrated hatchery programs due to unequal representation of hatchery families on the natural spawning grounds (Ryman and Laikre 1991). Sibling relationships were higher in hatchery-origin collections than in natural-origin collections (Table 3) and high variance in Q values supported family groups in hatchery- as well as natural-origin collections. However, we found no significant divergence among natural-origin collections from before and after the bottleneck. We did not calculate N_e using a temporal method since we were interested in changes of point estimates of N_e over time.

Task 5. Compare the 2001 naturally produced spawners with the 1992 WNFH fish to identify possible introgression by Carson stock into wild populations.

As discussed above, the Methow population appears closely related to the Carson stock maintained at the WNFH. The pairwise F_{ST} values between WNFH and the 2001 collection from Chewuch were lower than pairwise values with 2001 Twisp natural spawners (Table 4), suggesting a closer relationship between WNFH and Chewuch fish. We plotted pairwise F_{ST} values versus time of separation between WNFH collections and Chewuch and Twisp hatchery- and natural-origin collections and found a slightly negative slope and much variance in the values (Twisp -0.0005, r^2 = 0.0501; Chewuch -0.0003, r^2 = 0.1109). If the 2006 Twisp natural-origin collection was removed, the slope became flat and r^2 = 0.0096. Since Methow fish were genetically very similar to the WNFH fish, introgression into Chewuch and Twisp populations could have been mediated by either Methow or WNFH fish.

The assignment tests provide further information regarding possible introgression. The number of natural-origin fish “incorrectly” assigned to the Winthrop Hatchery is variable among temporal collections from the Chewuch, Methow, and Twisp Rivers (Table 7, Figure 9). There were considerably more Methow fish than Chewuch fish “incorrectly” assigned to the Winthrop Hatchery.

These mis-assigned fish are not hatchery-origin fish[20] and therefore, they are not strays from the Winthrop Hatchery. However, since these fish have been robustly identified as being from the Winthrop Hatchery (i.e., their posterior probabilities were > 0.90), we interpret these results to indicate that these individuals are very recent descendants from at least one parent that strayed from the Winthrop Hatchery into these tributaries. These results suggest that Winthrop Hatchery introgression was greater into the Methow than the Chewuch River, and that there has been no introgression into the Twisp population (Figure 9). Because the Winthrop Hatchery started producing Metcomp fish in 2001, we will lose our ability to statistically differentiate Winthrop Hatchery introgression from natural production from the Methow and Chewuch rivers.

We also examined the source of the hatchery-origin fish (identified by scale patterns) from the 1993 Twisp, Chewuch, and Methow collections, by assigning these fish to either the 1992 Winthrop Hatchery, or the 1992 and 1993 natural-origin collections (Table 8). Considerably more than 50% of the Methow and Chewuch samples assigned to the Winthrop Hatchery, while only one individual from the Twisp assigned to the Winthrop Hatchery. These Winthrop Hatchery-assigned individuals are strays from the Winthrop Hatchery. Those individuals that were not assigned to the Winthrop Hatchery are either natural-origin fish misidentified as hatchery-origin fish, or are Winthrop Hatchery-origin fish with at least one natural-origin parent from one of the respective rivers. If the latter, these fish are also strays from the Winthrop Hatchery.

To estimate straying of natural-origin fish among rivers, we conducted an additional four individual assignment tests each using only the natural-origin collections from a single year. For example, for the first test we included only the 1993 natural-origin collections from the Twisp, Methow, and Chewuch Rivers. In each of these tests, we calculated the proportion of fish in the combined Methow/Chewuch population that assigned to the Twisp River from the same year. Similarly, we also calculated the proportion of fish in the Twisp River that assigned to the combined Methow/Chewuch population from the same year. Because the Methow/Chewuch population is dissimilar to the Twisp population (Figure 8), and because we limited our assignments to individuals with posterior probabilities ≥ 0.90, we identified these "incorrectly" assigned fish as actual strays (Figure 10). This suggested that more Methow/Chewuch fish stray into the Twisp River than do Twisp fish into either the Methow or Chewuch Rivers. Furthermore, except for 2001, when the stray rate into the Twisp was 8%, no less than 18% of the individuals from each Twisp collection were identified as Methow/Chewuch fish. In 2006 Twisp collection, nine of the 11 fish with posterior probabilities ≥ 0.90 assigned to the Methow/Chewuch (Figure 10). The two fish from the 2006 Twisp collection that did not meet the 0.90 threshold were assigned to the Twisp, with posterior probabilities equal to 0.83 and 0.87. If we

[20] These fish possess no CWTs, clipped adapose fins, scale hatchery check marks, or any other explicit mark indicating hatchery origin.

accept the assignments for these two fish, the 2006 Twisp collection was composed of 69% Methow/Chewuch fish and 31% Twisp fish (Figure 10). The somewhat intermediate position in the FCA of the 2006 Twisp natural-origin collection between the rest of the Twisp collections and the Methow/Chewuch group (Figure 6) also suggests that the 2006 Twisp natural-origin is an admixture. Clearly, if these proportions represent the actual proportions of fish breeding in the Twisp River, the 2006 spring Chinook cohort emerging from the Twisp River will resemble more the Methow/Chewuch population than the Twisp population from previous years.

Task 6: Genetically profile hatchery fish returning to spawning grounds in 2001 to determine if hatchery fish are genetically distinguishable from wild spawners. If hatchery fish are different, and 2001 fish are not significantly different from the 1992-1993 fish (or temporal variance is smaller than spatial variance), we will estimate genetic impacts of hatchery fish on wild fish. Estimate numbers of families represented in hatchery fish to explore Ryman-Laikre effects.

We found significant differentiation between hatchery- and natural-origin collections from the same year and between hatchery-origin fish from different collection years in the Chewuch and Twisp (Table 4). However, temporal variance was much smaller than spatial variance (Figure 6, Figure 7, Figure 8, Table 4) and collections from the same tributary clustered together regardless of origin. Although linkage values (Table 1) and sibling analyses (Table 3) suggested that both sampling groups contained family members, there appeared to be more family structure within hatchery-origin collections than in natural-origin collections (Table 3). In paired t-tests, hatchery-origin collections had significantly more full sibling pairs than natural-origin collections (p = 0.028), and although hatchery-origin collections averaged twice as many half-sibling pairs as natural-origin collections, the difference was insignificant (p = 0.055). Genetic differences between hatchery- and natural-origin fish could thus be a combination of genetic drift from small N_e in both groups, sampling errors associated with limited numbers in hatchery broodstocks, and differential representation of family groups from hatcheries.

Task 7. Genetically profile naturally produced fish from the Twisp, Chewuch, and Methow from 2005 and compare with baseline and hatchery-origin collections to determine if changes have occurred within and between stocks. If the 2001 samples are different from the earlier samples, we will be unable to distinguish between hatchery and bottleneck effects in the 2005 samples, so differences in this later year would be due to unknown causes. We would just document that they are different.

With the exception of 2006 Chewuch, natural-origin collections from the same tributary were not significantly different from each other in pairwise F_{ST} tests (Table 4) and clustered together in the dendrogram (Figure 7), FCA (Figure 6), and MDS plot (Figure 8). Hatchery-origin collections also clustered near natural-origin collections but Twisp hatchery-origin collections had longer branch lengths (Figure 7) and plotted on the periphery of the natural-origin cluster (Figure 8). Most pairwise tests indicated significant differences between hatchery and natural-origin collections (Table 4). Further, there is a trend towards increased differentiation between natural-origin collections from the same river over time (Figure 5). These differences between hatchery and natural-origin collections and among natural-origin collections in the same river suggest that genetic drift is impacting gene pools. Genetic drift is the random fluctuation of allele frequencies that occur by chance because individuals have unequal reproductive success, and fluctuations in allele frequencies increase with smaller N_e. Only considering collections from 2001 and beyond, N_e is basically stable in the Methow and Chewuch collections (Figure 3), but N_e is small and decreasing in the Twisp natural and hatchery-origin collections (Figure 3). Comparing the N_e of the integrated hatchery-natural group (TwispComb in Figure 3) to the N_e of the natural-origin spawners, hatchery supplementation has been effective in slowing the decrease in N_e, but N_e is still precipitously low.

Task 8. If N_e can be estimated, determine if changes in spawning population size are correlated with changes in N_e.

N_e is positively correlated with census size (Figure 4), but there is enormous variance in the ratios of N_e to census size (Table 1). In general, a larger census size indicates a larger N_e, but there is so much variance that census size is a poor predictor of N_e. Because of this variance, using census size to approximate N_e would be risky since a large census size could mask a low N_e.

Task 9: If baseline populations are genetically differentiated and remain differentiated in 2005 samples, estimate the probability of correctly assigning naturally produced spring Chinook collected at Wells Dam to the Twisp, Chewuch, or Methow spawning aggregates using a mixed stock fishery simulation and assignment tests.

Using the error rates discussed in the Result section (Tables 5 and 6, and Small et al. (2007)), and an estimate of the percentage of the Twisp and Metcomp hatchery broodstock composed of natural-origin fish (Table 9a), we can calculate the percentage of natural-origin Twisp fish that would be included in the Metcomp broodstock, and the percentage of natural-origin Methow/Chewuch fish that would be included in the Twisp hatchery broodstock if fish are sorted at Well Dam (Table 9b). We emphasize that these calculations are a function of the following two assumptions:

1. error rates are true errors in that they represent the incorrect identification of a fish being from a population that is not its source; and
2. the percent natural-origin fish being used as hatchery broodstock (pNOR) is as calculated in Table 9a.

We calculated the percentage of the Metcomp hatchery broodstock that would be composed of natural-origin Twisp fish by multiplying an estimate of the Metcomp pNORs (either the median or maximum values from Table 9a) by three sets of Methow/Chewuch error rates: the one in Small et al. (2007), the composite errors from Table 5, and the 2006 collection error rates from Table 6. Likewise, we calculated the percentage of the Twisp hatchery broodstock that would be composed of natural-origin Methow/Chewuch fish with the same procedure using Twisp pNORs and appropriate error rates from the same set of tables. We present these results in Table 9b.

The efficacy of collecting appropriate hatchery broodstock at Wells Dam will depend on the percentage of non-source fish used in the respective hatchery broodstocks. We have calculated a wide range of percentages, each depending on a specific error rate and pNOR. If we consider only the composite error rates and limit the assignment of fish to those with posterior probabilities equal to or greater than 0.90 (see Table 5), maximum percentage of non-source fish would be 5.14% in Twisp and 1.55% in Metcomp (Table 9b). These percentages decrease to 2.82% and 0.05%, respectively, as the pNOR is reduced from the maximum to the median values for Twisp and Metcomp in Table 9a. In other words, since the source of hatchery-origin fish is presumably known without error, if the pNORs are limited to 20% or less[21], given the composite error rates, percentage of non-source fish included in either the Twisp or Metcomp hatchery broodstocks can be limited to no more than 1.5% of the total broodstock. Since we are using the more stringent assignment criterion, there will be fish that are not assigned and therefore cannot be used in either hatchery program.

In summary, the ability to sort spring Chinook at Wells Dam, and to use these sorted fish in programs that successfully segregate the Twisp from the Methow/Chewuch broodstock will depend on two factors: assignment error rates and the percentage of natural-origin fish included in the broodstock. If either of these factors increases from some standard level our ability to maintain an independent Twisp stock will be compromised. Establishing a “standard level” would require a mathematical model or simulation that includes as variables assignment error rates and pNORs. For now, assignment errors comparable to those presented in Table 5 and pNORs less than or equal to 20% would result in less than 2% gene flow within both the Twisp and Metcomp programs.

[21] We are not necessarily recommending that you reduce the pNORs in the Twisp and Metcomp hatchery programs to 20% or less. There is a tradeoff between lower pNORs and having lower percentage of forced geneflow between the Twisp and Methow/Chewuch populations, and higher pNORs and reducing the likelihood of selecting for the negative effects of domestication within your hatchery programs.

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Figure 1. Map of the Methow region obtained from the following source http://wa.water.usgs.gov/projects/methow/maps.htm. Towns are indicated by a box and a name in bold type.

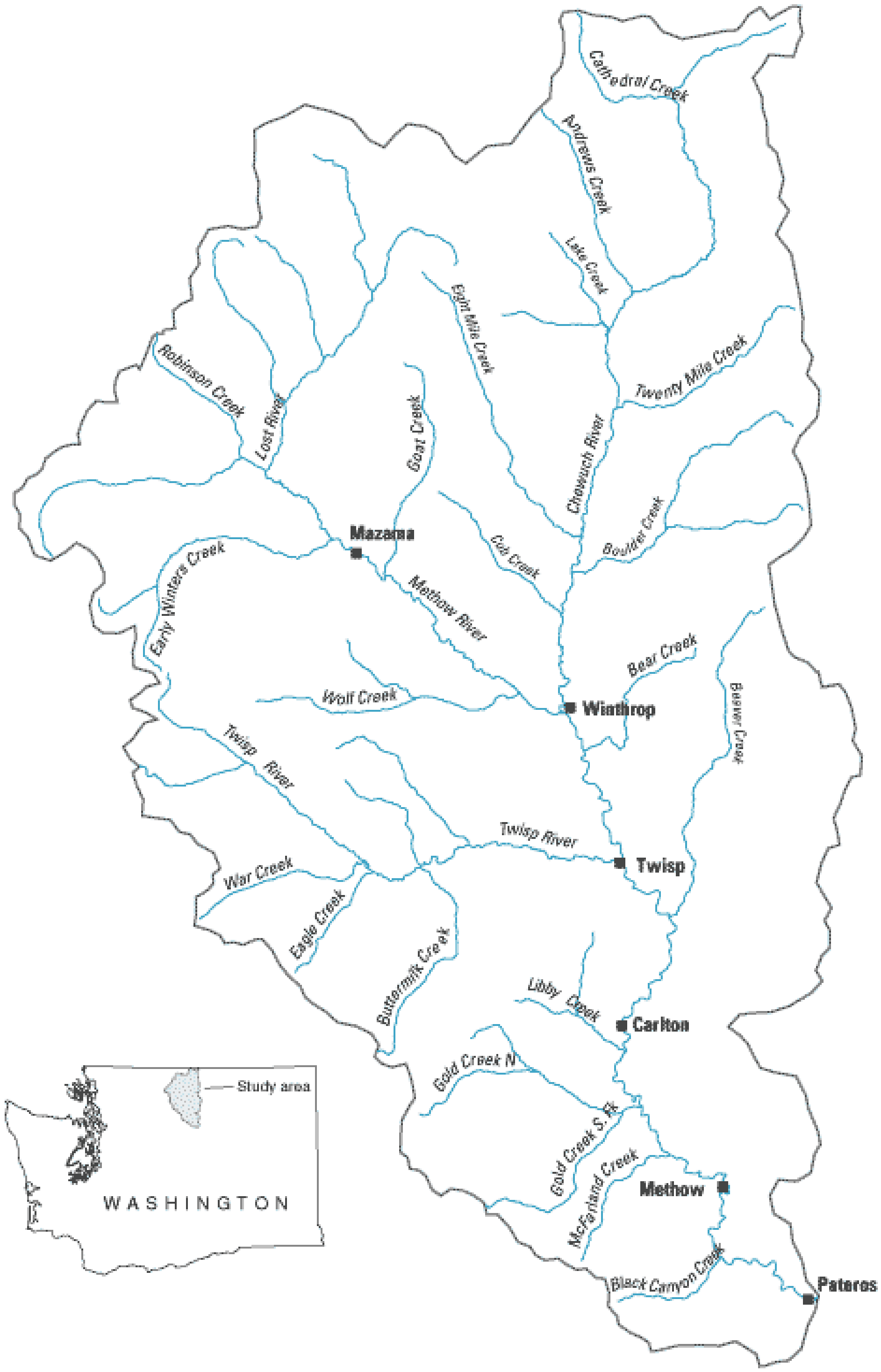
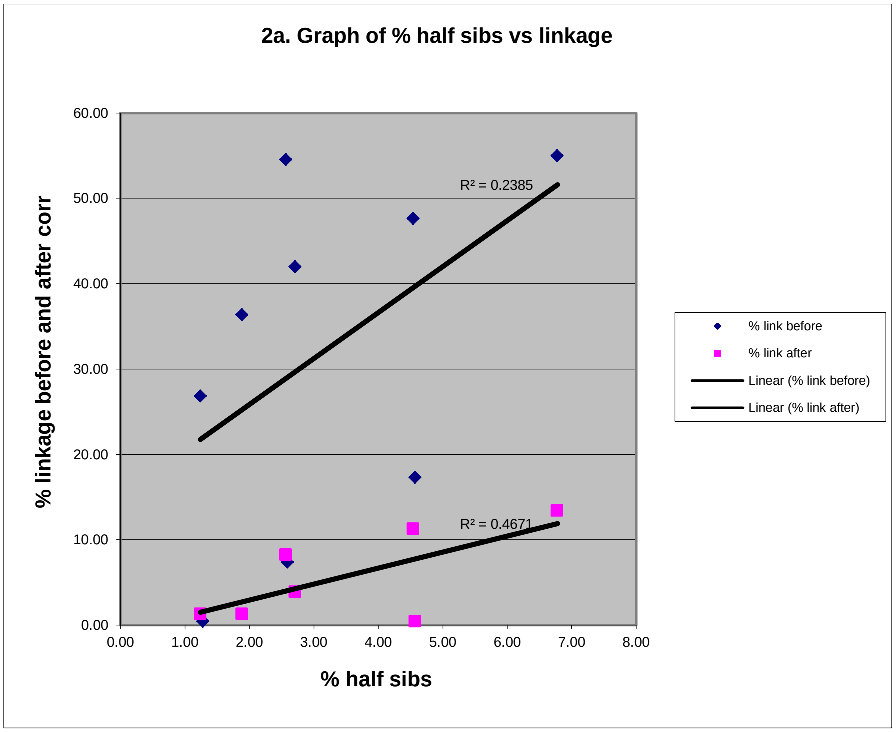


Figure 2a, b. Graph of the percentage of full and half sibling relationships in 2001 – 2006 hatchery- and natural-origin collections versus the percentage of loci in linkage disequilibrium before and after Bonferroni corrections.



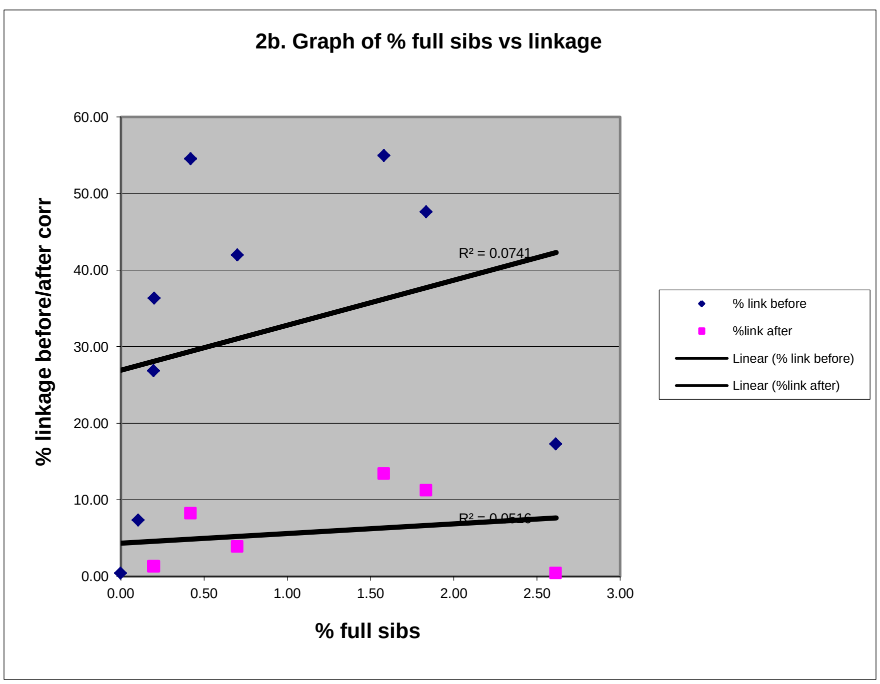


Figure 3. Graph of N_e and 95% confidence interval in temporal collections including natural-origin collections (W) from Methow, Chewuch, Twisp, and hatchery-origin (H) collections from Twisp. N_e for the combined hatchery and natural-origin collections from the Twisp were plotted as “TwispComb”.

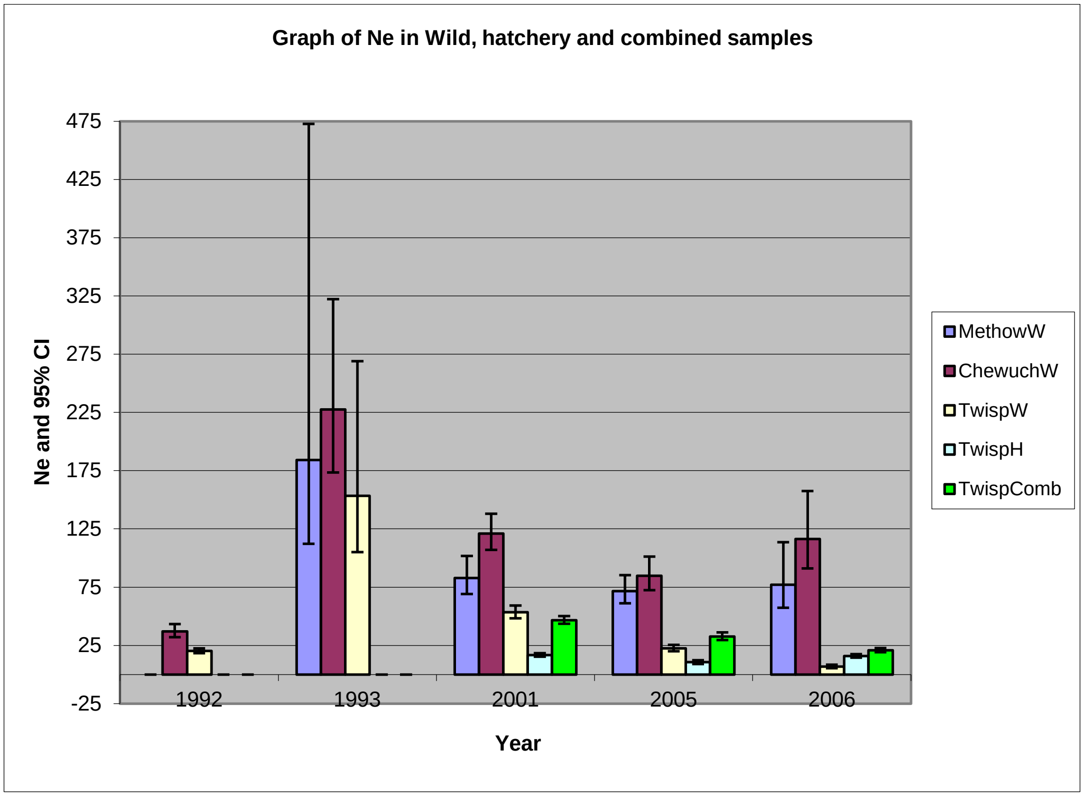


Figure 4. Graph of N_e in hatchery- and natural-origin collections versus census size.

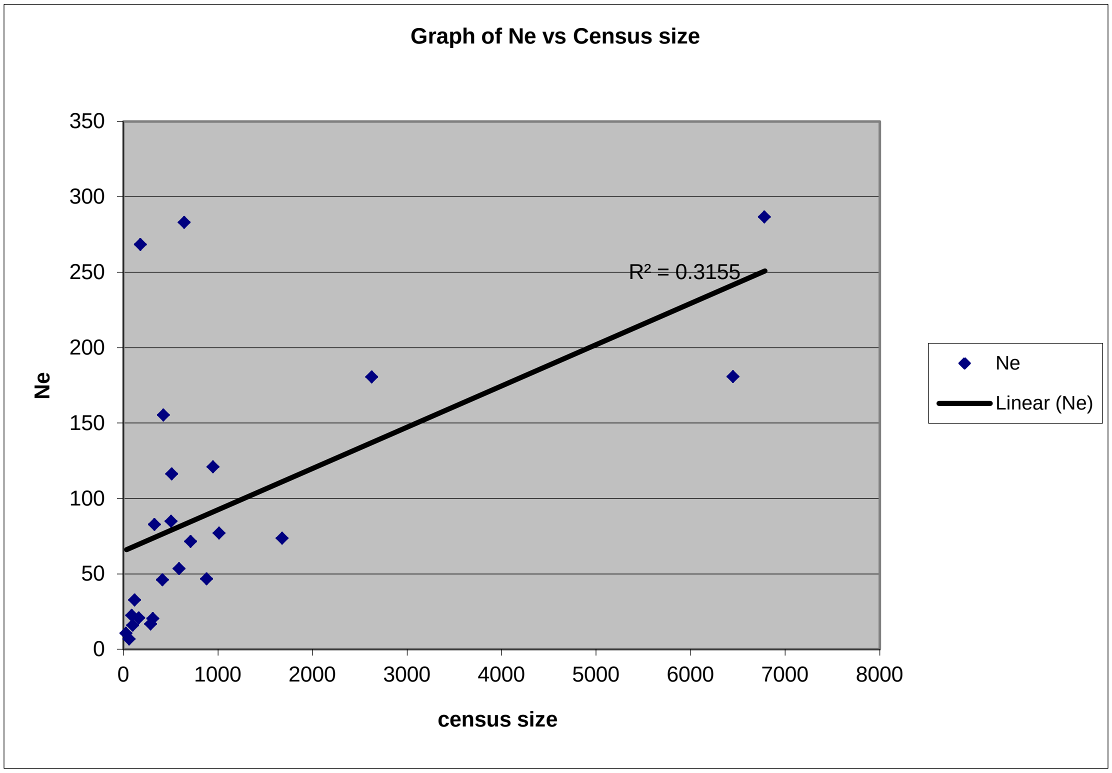


Figure 5. Graph of pairwise F_{ST} values versus time between collections from within the same river (or hatchery). The trendline for linear regressions are plotted for Twisp hatchery, and Twisp natural (wild) collections. The r^2 values for regression lines were 0.9716 for Twisp hatchery, 0.4471 for Twisp natural, 0.1216 for Chewuch natural, and 0.1781 for Methow natural.

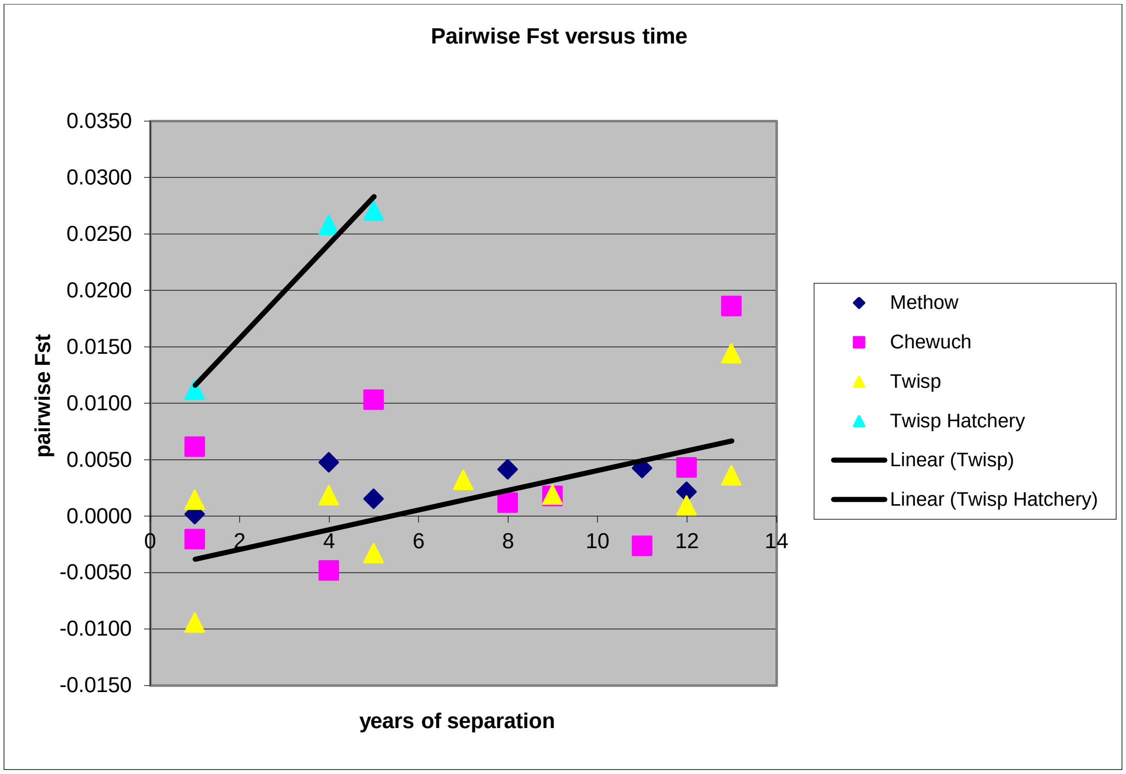


Figure 6. Factorial correspondence analysis plot of hatchery and natural spring Chinook collections from the Methow, Chewuch and Twisp rivers. Hatchery- and natural-origin collections are indicated by “H” and “W”, respectively, after the two-digit code for collection year.

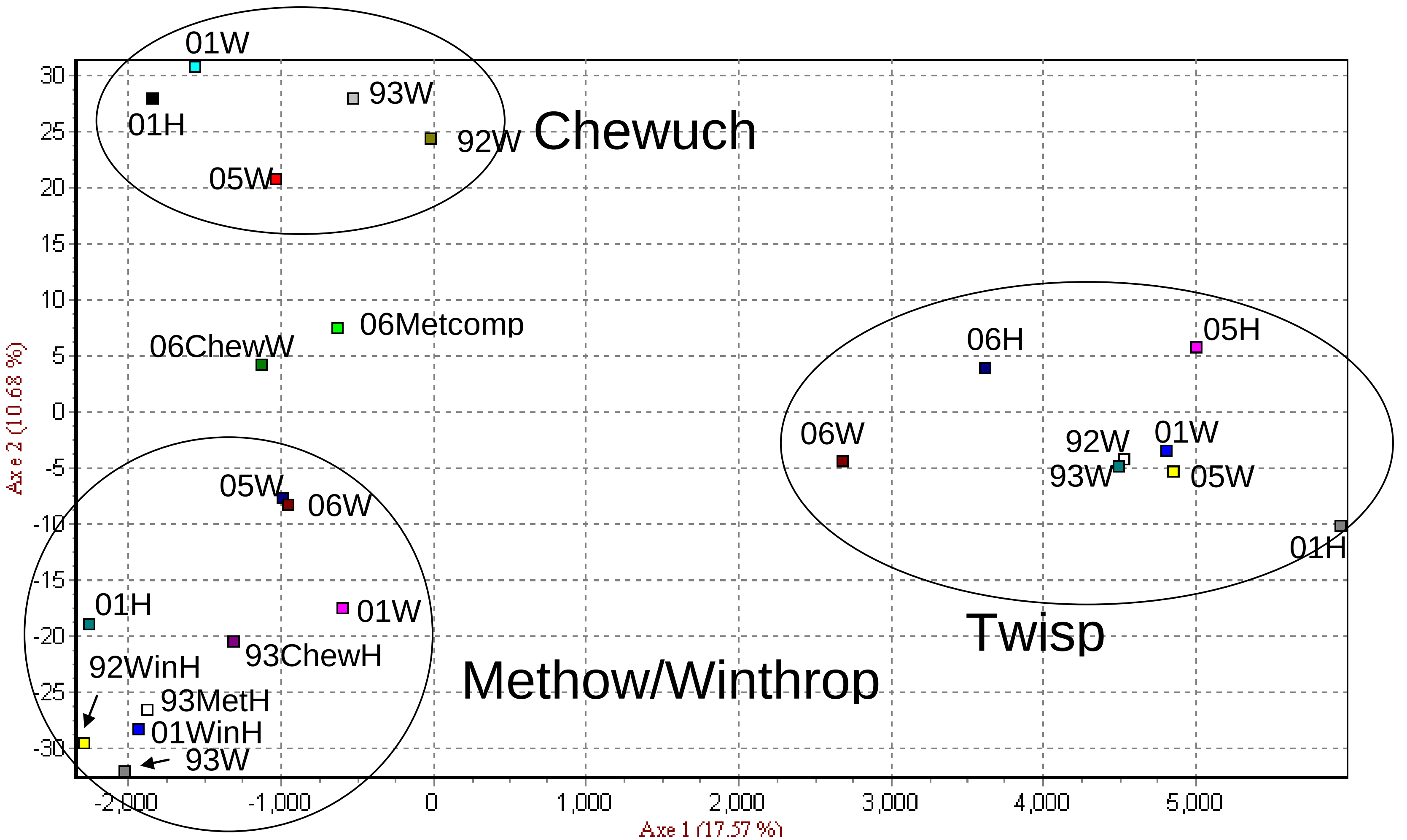


Figure 7. Neighbor-joining tree of Cavalli-Sforza and Edwards chord distances among spring Chinook collections from the Chewuch, Methow and Twisp rivers. Numbers at the nodes are the percentage of trees out of 1,000 trees in which the collections beyond the node grouped together in the consensus tree.

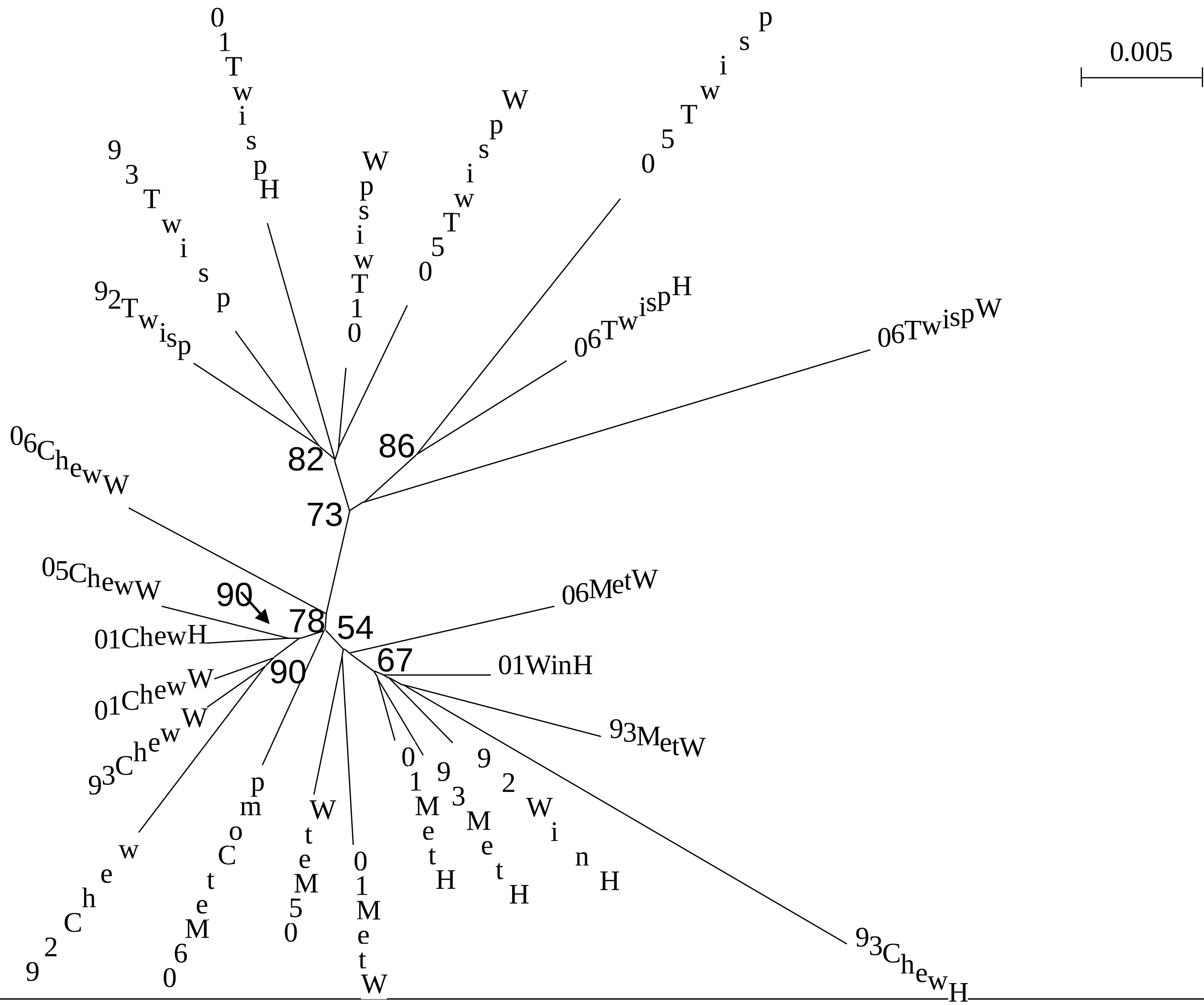


Figure 8. Nonmetric multidimensional scaling plot from an allele-sharing distance matrix calculated using all 24 temporal populations. Polygons enclose the natural-origin collections from the Methow, Chewuch, and Twisp Rivers, respectively (moving left to right). All Twisp, Methow, and Chewuch temporal collections are labeled except 2005 collections (i.e., the unlabeled symbols are from the 2005 collections). The two Winthrop Hatchery collections are from 1992 (below) and 2001 (above), and the Methcomp Hatchery collection is from 2006.

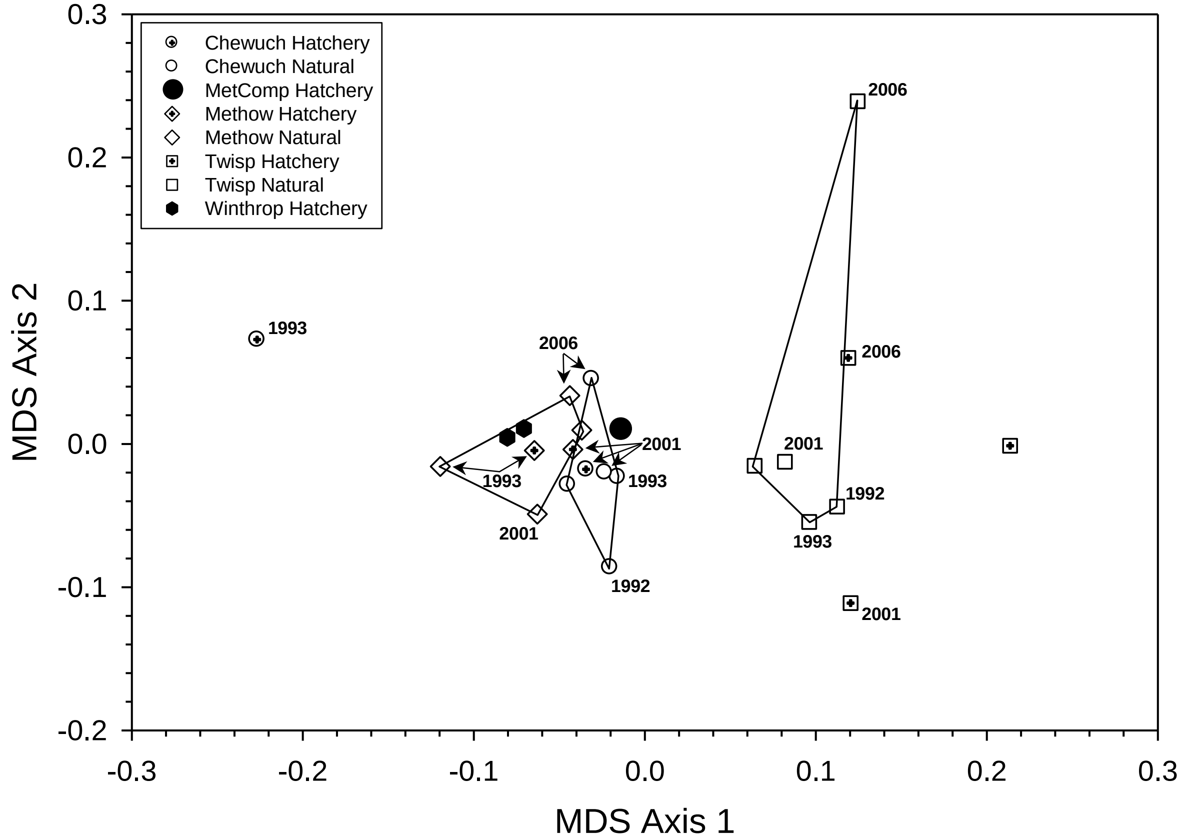


Figure 9. Proportion of natural-origin fish from the Chewuch, Methow, and Twisp rivers that are assigned to the Winthrop Hatchery. These results can be interpreted as the proportion of fish in each river that descended from Winthrop Hatchery strays. Upper and lower plots are based on Highest Posterior Probability and Posterior Probability ≥ 0.90, respectively. Data are from Winthrop columns in Table 8.

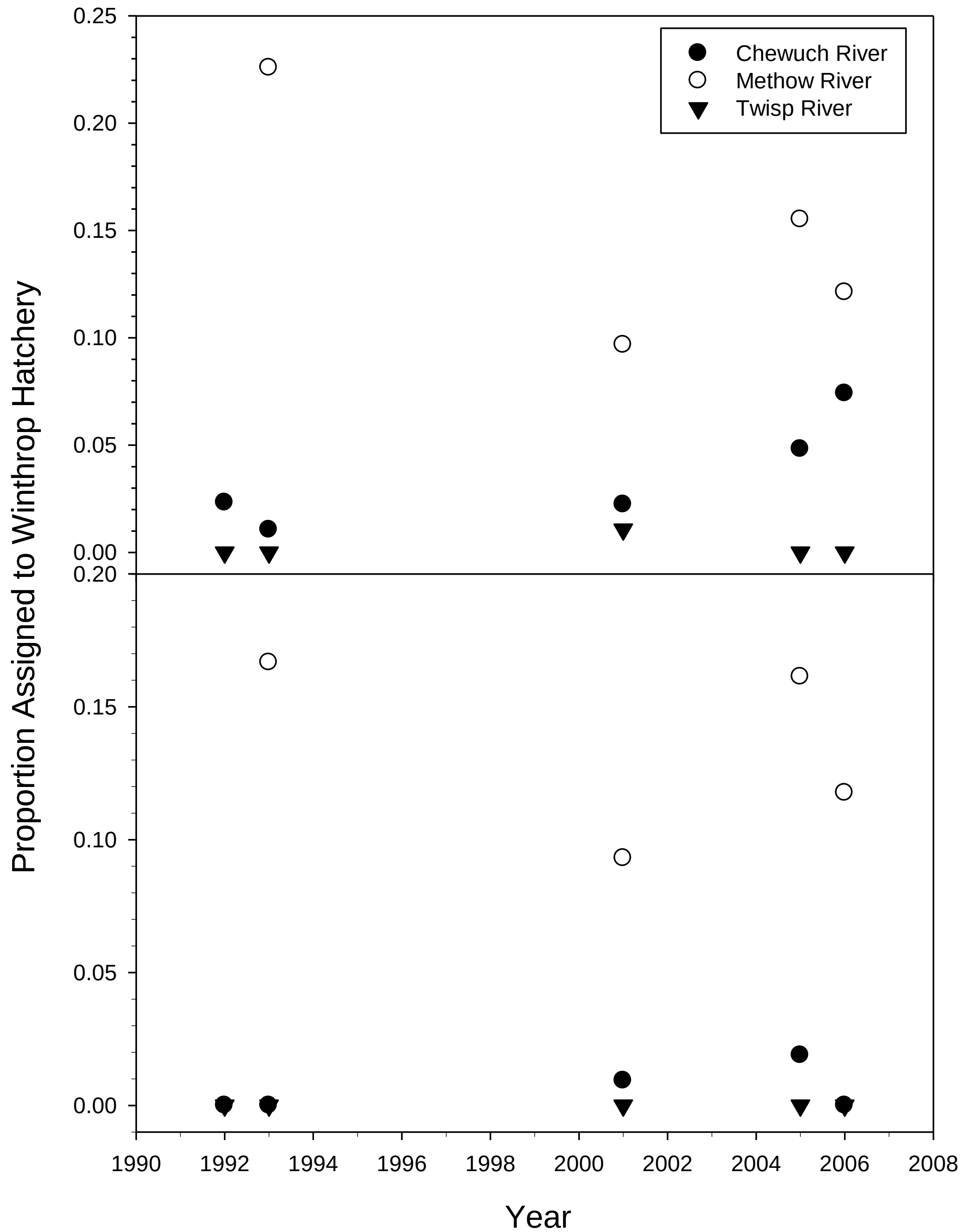


Figure 10. Assignment errors associated with four independent individual assignment tests, one each for the collection years 1993, 2001, 2005, and 2006. These results can be interpreted as the proportion of fish in each river group that are strays from the other river group. For example, in 1993 roughly 28% of the fish captured in the Twisp were assigned to Methow/Chewuch; these fish may represent Chewuch or Methow fish that have strayed into the Twisp River.

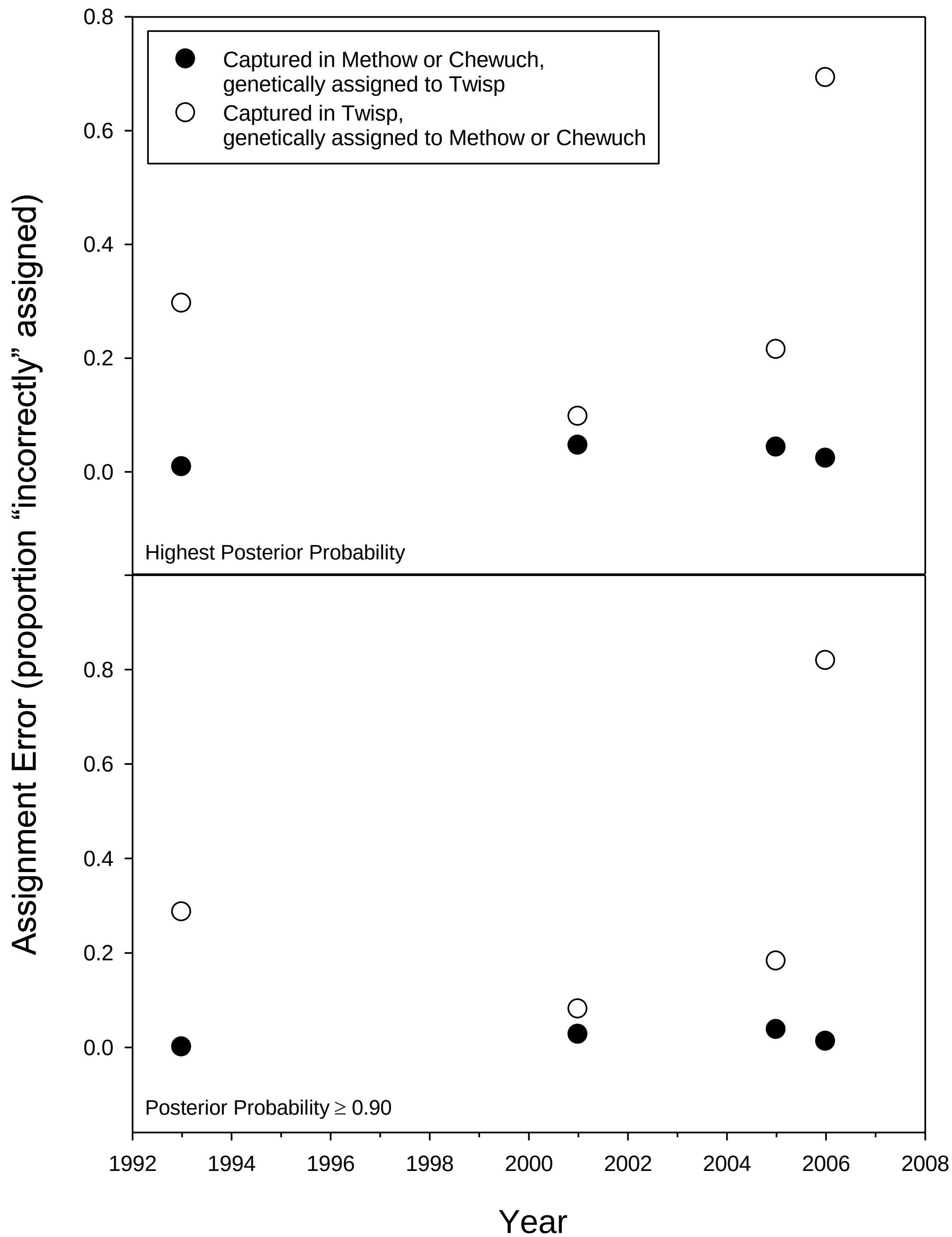


Table 1. Statistics for samples processed and analyzed for the 2007 Methow spring Chinook. The data include the WDFW sample codes ("Code"), the number of samples processed, and the number of samples with genotypic data at ten or more loci (N >= 10), Hardy-Weinberg equilibrium as expressed by F_{IS} (bold values had significant homozygote excess and boxed values had significant heterozygote excess), and their significance (*p*val), the percentage of loci in linkage disequilibrium (% link) before and after Bonferroni corrections. Combined hatchery and natural samples are below individual samples and indicated by the prefix "All". Diversity statistics include expected heterozygosity (H_e, Nei 1987) and allelic richness. Effective population size (N_e) was calculated from linkage disequilibrium, (see Figure 3 for 95% confidence interval). Census size (from A. Murdoch, WDFW) and ratio of N_e to census size are in the last two columns.

						% link					95% CI			
Tributary/Hatchery	Code	N	N >= 10	F_{IS}	*p*val	before	after	He	Richness	N_e	low	high	Census	Ne/Cen
92Winthrop Hatchery	92DR	100	100	-0.012	0.9149	10.82	0.43	0.7897	7.51	128	108	156		
01Winthrop Hatchery	01EL	95	93	0.007	0.2221	40.26	5.19	0.7829	7.41	63	57	71		
06MetComp Hatchery	06EP	127	127	-0.005	0.7542	50.65	25.97	0.7704	7.28	43	40	46		
93Methow Natural	93EA	93	31*	0.044	0.0026	3.29		0.7913	7.53	184.2	112.1	472.6	646	0.29
93Methow Hatchery?	93EA		62[@]	0.025	0.0083	5.634		0.7882	7.65	481.9	264.8	2161		
01Methow Natural	01AAJ	62	62	**0.127**	0.0000	7.36		0.7970	7.86	83	69	102	333	0.25
01Methow Hatchery	01AAK	142	139	**0.021**	0.0015	26.84	1.30	0.7904	7.67	181	155	215	6453	0.03
01AllMet			201	**0.054**	0.0000	31.92	2.82	0.7939	7.79	287	241	350	6786	0.04
05Methow Natural	05HW,05HZ	62	62	**0.062**	0.0000	25.54		0.7867	7.67	72	61	85	714	0.10
06Methow Natural	06DA	33	33	0.020	0.0891	4.76	0.43	0.7735	7.59	77	57	114	1017	0.08
92Chewuch Natural	92DO	47	43*	0.042	0.0019	27.70	0.94	0.7697	7.05	37	32	43.2	415	0.09
93Chewuch Natural	93DZ	104	94*	0.021	0.0109	13.62		0.7643	7.29	227.5	173.5	322.1	184	1.23
01Chewuch Natural	01EL, 01AAN	142	134	**0.039**	0.0000	36.36	1.30	0.7795	7.46	121	107	138	950	0.13
01Chewuch Hatchery	01EL, 01AAO	144	140	**0.089**	0.0000	54.55	8.23	0.7833	7.52	74	67	81	1681	0.04
01AllChew			274	**0.066**	0.0000	67.61	6.57	0.7830	7.57	181	163	202	2630	0.07
05Chewuch Natural	05HY	88	83	**0.059**	0.0000	5.63		0.7928	7.64	85	72	101	508	0.17
06Chewuch Natural	06DC	54	54	**0.052**	0.0000	3.03		0.7707	7.42	116	91	157	513	0.23
92Twisp Natural	92DQ	61	59	-0.004	0.6311	63.38	10.33	0.7686	6.78	20	18	22	316	0.06
93Twisp Natural	93EB	48	44*	0.033	0.0089	2.82		0.7612	6.98	153.4	105.2	269	426	0.36
01Twisp Natural	01EL, 01AAL	95	93	0.017	0.0403	41.99	3.90	0.7530	6.69	53	48	59	591	0.09
01Twisp Hatchery	01EL, 01AAM	61	60	0.037	0.0018	54.98	13.42	0.7515	6.49	17	15	18	292	0.06
01AllTwisp			153	**0.031**	0.0000	72.30	18.31	0.7577	6.79	47	44	50	883	0.05
05Twisp Natural	05HX, 05HZ, 05IA	43	42	-0.061	0.9977	90.48	47.62	0.7576	6.59	23	20	26	90	0.25
05Twisp Hatchery	05HX, 05HZ, 05IA	21	21	0.006	0.3244	17.32	0.43	0.7625	6.78	11	9	12	31	0.34
05AllTwisp			63	-0.009	0.7648	88.26	46.48	0.7652	6.87	33	30	36	121	0.27
06Twisp Natural	06DB	13	13	0.016	0.1278	0.433		0.7561	6.83	7	5	8	65	0.10
06Twisp Hatchery	06DA, 06DB, 06DC, 06EQ	46	46	0.042	0.0721	47.62	11.26	0.7712	6.96	16	15	18	100	0.16
06AllTwisp			59	0.024	0.0243	48.83	11.74	0.7618	6.96	21	19	23	165	0.13

[@] These fish were collected as natural-origin spawners in the Methow but scales indicated hatchery origin.
*Fish collected as natural-origin were eliminated from this collection when scale analysis indicated hatchery origin.

Table 2. Information for multiplexes and loci including annealing temperature (°C) primer concentration, number of alleles observed, size range (in basepairs). References for primer sequences are under Citation.

		CTC standardized loci				
Multiplex	Locus	Anneal temp	conc [uM]	Alleles Observed	Size Range	Citation
Ots-M	*Oki100*	50	0.37	24	164-353	Miller, DFO, unpublished
	Ots201b		0.35	29	133-342	Banks, OSU, unpublished
	Ots208b		0.2	29	142-378	Grieg et al. 2003
	Ssa408		0.2	20	180-320	Cairney et al. 2000
Ots-N	*Ogo2*	60	0.15	16	200-258	Olsen et al. 1998
	Ssa197[a]		0.25	28	171-318	O'Reilly et al. 1996
Ots-O	*Ogo4*	56	0.18	14	132-170	Olsen et al. 1998
	Ots213		0.18	29	178-378	Grieg et al. 2003
	OtsG474		0.16	8	144-220	Williamson et al. 2002
Ots-R	*Omm1080**	53	0.26	46	162-458	Rexroad et al. 2001
	Ots3M		0.12	10	122-170	Banks et al. 1999
Ots-S	*Ots211*	60	0.2	29	196-337	Grieg et al. 2003
	Ots212		0.3	21	123-263	Grieg et al. 2003
	Ots9		0.1	5	99-115	Banks et al. 1999
		Loci we developed to increase discrimination power				
Ots-T pool	*Ots104*	50	0.07	41	185-325	Nelson and Beacham, 1999
	Ots107	50	0.1	33	187-329	Nelson and Beacham, 1999
	Ots515	50	0.23	13	209-261	Naish and Park, 2002
	One8	58	0.06	17	155-192	Scribner et al. 1998
Ots-U pool	*Ocl1*	53	0.08	9	158-176	Condrey and Bentzen, 1998
	Oke4	53	0.15	8	238-255	Bucholz et al. 1999
	Ots108	53	0.1	48	99- 343	Nelson and Beacham, 1999
Ots-V	*Omm1020*	56	0.08	6	153-167	Rexroad et al. 2002
	Ots100	56	0.2	58	246-422	Nelson and Beacham, 1999

[a] We collect data for this locus, along with Ogo2, in multiplex Ots-N, but Ssa197 is not a CTC-GAPS locus.

* We collected data for *Omm*1080 but excluded the locus from analyses due to instability with scale-origin DNA.

Table 3. Estimated percentage of full (Q > 0.45), and half (0.22 < Q < 0.45) sibling relationships in paired hatchery- and natural-origin collections, total number of pairwise relationships in the collection (total) and the percentage of loci in linkage disequilibrium in each collection before and after Bonferroni corrections. The following abbreviations were employed: Methow = "Met", Chewuch = "Chew", Natural = W and Hatchery = H.

	total	% full	% half	% link	% link after
01MetH	9591	0.20	1.24	26.84	1.30
01MetW	1891	0.11	2.59	7.36	
01ChewH	9730	0.42	2.57	54.55	8.23
01ChewW	8911	0.20	1.89	36.36	1.30
01TwispH	1770	1.58	6.78	54.98	13.42
01TwispW	4278	0.70	2.71	41.99	3.90
05TwispH	153	2.61	4.58	17.32	0.43
05TwispW	861	1.28	0.93	90.48	47.62
06TwispH	1035	1.84	4.54	47.62	11.26
06TwispW	78	0.00	1.28	0.43	

Table 4. Pairwise F_{ST} values (lower matrix) and *p* values for pairwise genotypic tests (upper matrix) for temporal and spatial collections. Values that were significant before Bonferroni corrections are underlined and values that were significant after Bonferroni corrections are in bold type (corrected alpha = 0.05/253 = 0.00019). Abbreviations follow Table 3. Temporal comparisons within tributary are boxed (Metcomp was included with both Methow and Chewuch comparisons).

	92WinH	01WinH	93MetH	93MetW	01MetW	01MetH	05MetW	06MetW	Metcomp	92Chew	93ChewW	01ChewW	01ChewH	05ChewW	06ChewW	92Twisp	93Twisp	01TwispW	01TwispH	05TwispH	05TwispW	06TwispH	06TwispW
92WinH	*	0	0.00021	0.05363	**0**	**0**	**0**	**0.00013**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0000**
01WinH	**0.0034**	*	0.00022	0.00048	**0**	**0**	**0**	0.0003	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0000**
93MetH	0.0034	0.0044	*	0.19253	**0**	0.53881	0.00815	0.02743	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0001**
93MetW	0.0003	0.0052	-0.0004	*	**0.00018**	0.04141	0.00112	0.00065	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0000**
01MetW	0.0036	0.0022	-0.0003	0.0041	*	**0**	0.01093	0.03388	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0.0011
01MetH	**0.0036**	**0.0029**	-0.0002	0.0015	0.0002	*	0.00029	0.06308	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0.0008
05MetW	**0.0087**	**0.0065**	0.0011	0.0043	0.0048	0.0021	*	0.14475	**0**	**0**	**0**	**0**	**0**	0.00613	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0001**
06MetW	0.0040	0.0046	-0.0012	0.0022	0.0015	0.0004	0.0002	*	**0**	**0.00001**	**0.00002**	**0.00009**	**0.00001**	**0.00002**	**0.00003**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0.0031
06Metcomp	**0.0142**	**0.0124**	**0.0109**	**0.0125**	0.0039	**0.0072**	**0.0056**	0.0040	*	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0.0008
92Chew	**0.0126**	**0.0141**	**0.0099**	**0.0123**	**0.0096**	**0.0107**	**0.0131**	0.0027	**0.0100**	*	0.03835	0.00217	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0000**
93ChewW	**0.0141**	**0.0132**	**0.0104**	**0.0105**	0.0035	**0.0094**	**0.0082**	0.0013	**0.0095**	-0.0021	*	0.03415	**0**	**0.00088**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0000**
01ChewW	**0.0091**	**0.0099**	**0.0062**	**0.0067**	0.0026	**0.0059**	**0.0049**	0.0006	**0.0090**	0.0018	0.0012	*	**0**	**0.00003**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0000**
01ChewH	**0.0098**	**0.0090**	**0.0078**	**0.0104**	0.0043	**0.0064**	**0.0054**	0.0060	**0.0078**	**0.0071**	**0.0049**	**0.0029**	*	0.01551	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0001**
05ChewW	0.0013	0.0024	-0.0026	0.0003	0.0045	-0.0014	-0.0039	0.0046	-0.0010	0.0043	-0.0026	-0.0048	-0.0033	*	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0000**

06ChewW	0.0106	0.0126	0.0102	0.0117	0.0174	0.0114	0.0098	0.0103	0.0142	0.0186	0.0129	0.0103	0.0116	0.0061	*	0	0	0	0	0	0	0	0.0087
92Twisp	0.0205	0.0180	0.0118	0.0192	0.0186	0.0156	0.0215	0.0141	0.0160	0.0179	0.0122	0.0142	0.0198	0.0221	0.0279	*	0.60454	0.00136	0	0.00034	0.00969	0	0.0476
93Twisp	0.0256	0.0240	0.0152	0.0215	0.0174	0.0177	0.0211	0.0161	0.0194	0.0187	0.0177	0.0173	0.0195	0.0213	0.0294	0.0015	*	0.04706	0	0.00001	0.00244	0	0.0130
01TwispW	0.0222	0.0210	0.0162	0.0198	0.0133	0.0152	0.0165	0.0089	0.0172	0.0133	0.0143	0.0159	0.0184	0.0143	0.0262	0.0019	0.0032	*	0	0	0.0015	0	0.0001
01TwispH	0.0347	0.0314	0.0239	0.0294	0.0288	0.0252	0.0316	0.0261	0.0300	0.0329	0.0293	0.0263	0.0321	0.0329	0.0388	0.0179	0.0105	0.0139	*	0	0	0	0.0001
05TwispH	0.0320	0.0292	0.0251	0.0265	0.0198	0.0240	0.0206	0.0183	0.0245	0.0167	0.0239	0.0224	0.0238	0.0181	0.0317	0.0066	0.0140	0.0127	0.0258	*	0.00013	0.02645	0.0027
05TwispW	0.0223	0.0191	0.0151	0.0185	0.0125	0.0129	0.0134	0.0147	0.0170	0.0159	0.0166	0.0156	0.0176	0.0129	0.0261	0.0009	0.0036	0.0018	0.0110	0.0110	*	0	0.0347
06TwispH	0.0247	0.0227	0.0194	0.0242	0.0258	0.0200	0.0213	0.0193	0.0221	0.0231	0.0221	0.0209	0.0233	0.0194	0.0185	0.0168	0.0168	0.0177	0.0271	0.0112	0.0122	*	0.0154
06TwispW	0.0029	-0.0035	-0.0094	0.0001	0.0164	-0.0054	-0.0066	0.0062	-0.0102	0.0116	-0.0043	-0.0027	0.0009	0.0121	0.0004	0.0144	-0.0007	-0.0033	0.0151	0.0025	-0.0095	-0.0018	*

Table 5. Summary of the jack-knife-based individual assignment tests for each of the natural-origin collections from the Methow, Chewuch, and Twisp rivers. Each temporal collection was used as baseline collections, and individual fish were assigned to either an aggregate Methow/Chewuch or Twisp group using two different criteria, as explained in the Methods Section. All fish are assigned when using the Highest Posterior Probability criterion, but only those fish with a posterior probability greater than or equal to 0.90 were assigned using the more stringent criterion. The table lists numbers of fish from each temporal collection assigned to the respective group. Percent correct refers to the aggregate number of samples correctly assigned from each group. For example, 92.68% of all the fish assigned to Twisp were from one of the Twisp temporal collections (190/205 = 0.9268). Error rate is equal to 1- % correct. Abbreviations follow Table 3.

Year	Population	N	Highest Posterior Probability		Posterior Probability >= 0.90		
			Methow/Chewuch	Twisp	Methow/Chewuch	Twisp	unassigned
1992	ChewW	43	39	4	35	3	5
1993	ChewW	94	92	2	91	0	3
2001	ChewW	134	130	4	125	3	6
2005	ChewW	83	80	3	79	2	2
2006	ChewW	54	52	2	52	1	1
1993	MetW	31	30	1	30	1	0
2001	MetW	62	59	3	55	2	5
2005	MetW	58	55	3	53	2	3
2006	MetW	33	32	1	32	1	0
1992	TwispW	59	8	51	4	46	9
1993	TwispW	44	11	33	10	32	2
2001	TwispW	93	9	84	7	75	11
2005	TwispW	42	7	35	6	31	5
2006	TwispW	13	5	8	5	6	2
	TOTAL	843	609	234	584	205	54
	% Correct		93.43%	90.17%	94.52%	92.68%	
	Error Rate		6.57%	9.83%	5.48%	7.32%	

Table 6. As in Table 5, except that the 2006 temporal collections were removed from the baseline and assigned to either the Methow/Chewuch or Twisp group, based on the new baseline populations. The table lists numbers of fish from each 2006 collection assigned to the respective groups, using the two different assignment criteria.

			Highest Posterior Probability		Posterior Probability ≥ 0.90		
Year	Population	N	Methow/Chewuch	Twisp	Methow/Chewuch	Twisp	unassigned
2006	ChewW	54	53	1	26	1	27
2006	MetW	33	32	1	14	0	14
2006	TwispW	13	8	5	2	4	7
	TOTAL	100	93	7	42	5	47
	% Correct		91.40%	71.43%	95.24%	80.00%	
	Error		8.60%	28.57%	4.76%	20.00%	

Table 7. Summary of the jack-knife-based individual assignment test for each temporal collection from the Methow, Chewuch, and Twisp rivers, the 2006 MetComp hatchery, and the Winthrop Hatchery. Each individual fish was assigned to either Chewuch, Methow, Metcomp, Twisp, or Winthrop hatchery groups using two different criteria, as explained in the Methods Section. The table lists the percentage of fish from each temporal collection assigned to the respective group. These results provide the relative proportion of fish from each of the Chewuch, Methow, Metcomp, Twisp, or Winthrop populations captured within each temporal collection. The percentages from non-source populations can represent the proportion of individuals that have immigrated into that temporal collection. For the results associated with the Posterior Probability ≥ 0.90 criterion, the percentages are based on the total number of assigned individuals.

Year	Population	N	Highest Posterior Probability					Posterior Probability ≥ 0.90					
			Chewuch	Methow	Metcomp	Twisp	Winthrop	Chewuch	Methow	Metcomp	Twisp	Winthrop	unassigned
1992	ChewH	4	0.50	0.25	0.00	0.00	0.25	0.33	0.33	0.00	0.00	0.33	0.25
1993	ChewH	10	0.20	0.30	0.00	0.00	0.50	0.20	0.20	0.00	0.00	0.60	0.50
2001	ChewH	14	0.71	0.18	0.02	0.03	0.06	0.79	0.13	0.02	0.01	0.05	0.27
1992	ChewW	43	0.74	0.14	0.02	0.07	0.02	0.83	0.06	0.03	0.08	0.00	0.16
1993	ChewW	94	0.82	0.13	0.02	0.02	0.01	0.94	0.06	0.00	0.00	0.00	0.23
2001	ChewW	13	0.83	0.09	0.02	0.04	0.02	0.88	0.06	0.03	0.03	0.01	0.20
2005	ChewW	83	0.64	0.24	0.00	0.07	0.05	0.79	0.13	0.00	0.06	0.02	0.36
2006	ChewW	54	0.63	0.22	0.04	0.04	0.07	0.79	0.21	0.00	0.00	0.00	0.46
1993	MetH	62	0.11	0.58	0.02	0.03	0.26	0.00	0.71	0.02	0.05	0.21	0.32
2001	MetH	13	0.14	0.58	0.01	0.02	0.25	0.13	0.60	0.01	0.02	0.25	0.27
1993	MetW	31	0.13	0.61	0.00	0.03	0.23	0.11	0.67	0.00	0.06	0.17	0.42
2001	MetW	62	0.23	0.60	0.03	0.05	0.10	0.14	0.70	0.02	0.05	0.09	0.31
2005	MetW	58	0.31	0.47	0.02	0.05	0.16	0.32	0.45	0.03	0.03	0.16	0.47
2006	MetW	33	0.30	0.48	0.06	0.03	0.12	0.35	0.47	0.06	0.00	0.12	0.48
2006	MetComp	12	0.15	0.09	0.69	0.03	0.04	0.14	0.07	0.73	0.04	0.02	0.28
1993	TwispH	4	0.00	0.25	0.00	0.50	0.25	0.00	0.00	0.00	0.67	0.33	0.25
2001	TwispH	60	0.02	0.07	0.02	0.88	0.02	0.02	0.04	0.02	0.91	0.02	0.07
2005	TwispH	18	0.00	0.06	0.00	0.94	0.00	0.00	0.06	0.00	0.94	0.00	0.00
2006	TwispH	46	0.11	0.02	0.02	0.78	0.07	0.10	0.03	0.03	0.82	0.03	0.15
1992	TwispW	59	0.08	0.05	0.02	0.85	0.00	0.06	0.02	0.00	0.92	0.00	0.14
1993	TwispW	44	0.11	0.16	0.02	0.70	0.00	0.11	0.08	0.03	0.79	0.00	0.14
2001	TwispW	93	0.02	0.05	0.04	0.87	0.01	0.03	0.04	0.01	0.93	0.00	0.14
2005	TwispW	42	0.07	0.07	0.00	0.86	0.00	0.06	0.03	0.00	0.91	0.00	0.17
2006	TwispW	13	0.15	0.15	0.08	0.62	0.00	0.13	0.00	0.00	0.88	0.00	0.38
1992	WinH	10	0.06	0.36	0.00	0.01	0.57	0.04	0.32	0.00	0.00	0.65	0.43
2001	WinH	93	0.08	0.34	0.01	0.00	0.57	0.07	0.33	0.00	0.00	0.61	0.34

Table 8. Proportion of samples from each hatchery collection assigned to the 1992 and 1993 natural-origin collections and the 1992 Winthrop Hatchery collection. All samples are assigned using the Highest Posterior Probability criterion (upper table), while only those individuals satisfying the Posterior Probability ≥ 0.90 criterion are assigned in the lower table.

Hatchery Population	N	Highest Posterior Probability					
		92ChewW	92TwispW	93ChewW	93MetW	93TwispW	92WinH
93ChewH	10	0.00	0.00	0.00	0.20	0.00	0.80
93MetH	62	0.02	0.02	0.11	0.24	0.02	0.60
93TwispH	4	0.00	0.00	0.25	0.25	0.25	0.25

Hatchery Population	N	Posterior Probability ≥ 0.90					
		92ChewW	92TwispW	93ChewW	93MetW	93TwispW	92WinH
93ChewH	7	0.00	0.00	0.00	0.14	0.00	0.86
93MetH	54	0.00	0.00	0.13	0.20	0.02	0.65
93TwispH	3	0.00	0.00	0.00	0.33	0.33	0.33

Table 9a. Composition of the Methow-Chewuch (Metcomp) and Twisp hatchery broodstocks from 2000 through 2006. H = number of hatchery-origin fish; N = number of natural-origin fish contributing to each hatchery broodstock. For both the Twisp and Metcomp programs, the median and maximum percent natural-origin part (pNOR) are highlighted in bold typeface. These pNORs were used to calculate the non-source component of each broodstock, as explain in the text and shown in Table 9b. Data from Kirk Truscott.

Brood Year	Metcomp					Twisp				
	H	%	N	%	Total	H	%	N	%	Total
2000	173	100.0%	0	0.0%	173	63	91.3%	6	8.7%	69
2001	104	71.7%	41	**28.3%**	145	14	29.8%	33	**70.2%**	47
2002	248	100.0%	0	0.0%	248	9	100.0%	0	0.0%	9
2003	93	98.9%	1	1.1%	94	16	61.5%	10	38.5%	26
2004	284	99.6%	1	0.4%	285	23	34.3%	44	65.7%	67
2005	202	99.0%	2	1.0%	204	11	61.1%	7	38.9%	18
2006	315	96.3%	9	2.8%	327	26	100.0%	0	0.0%	26
Mean	202.714	95.1%	7.714	4.8%	210.857	23.143	68.3%	14.286	31.7%	37.429
Median	202.000	99.0%	1.000	**1.0%**	204.000	16.000	61.5%	7.000	**38.5%**	26.000

Table 9b. The percentage of non-source fish contributing to each hatchery program based on specific assignment error rates, and the percent natural-origin fish (pNOR) being used as hatchery broodstock. The pNORs are represented as median and maximum estimates from Table 9a. The percentage of non-source fish contributing to each hatchery program is calculated by multiplying the error assignment rates from Small et al. (2007), Table 5, and Table 6, by the median and maximum pNORs from Table 9a. See text for details.

		Small et al. (2007)		Composite Errors		2006 Errors	
		Median	Max	Median	Max	Median	Max
Highest Posterior Probability	% MetComp Hatchery composed of Natural Origin Twisp	0.10%	2.83%	0.07%	1.86%	0.09%	2.43%
	% Twisp Hatchery composed of Natural Origin Methow & Chewuch	4.53%	8.26%	3.78%	6.90%	11.00%	20.06%
Posterior Probability ≥ 0.90	% MetComp Hatchery composed of Natural Origin Twisp	0.05%	1.29%	0.05%	1.55%	0.05%	1.35%
	% Twisp Hatchery composed of Natural Origin Methow & Chewuch	0.87%	1.58%	2.82%	5.14%	7.70%	14.04%

APPENDIX E

Methow Basin Steelhead – Evaluating the Effects Of The Supplementation Program

Developed for

Douglas County PUD
and
Wells Habitat Conservation Plan Hatchery Committee

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Executive Summary

In response to the need for evaluation of the supplementation program, both a monitoring and evaluation plan (DCPUD 2005) and the associated analytical framework (Hays et al. 2007) were developed for the Habitat Conservation Plans Hatchery Committee through the joint effort of the fishery co-managers (CCT, NMFS, USFWS, WDFW, and YN) and Chelan County and Douglas County PUDs. This study pertains to Methow basin steelhead *Oncorhynchus mykiss* and the steelhead supplementation program at Wells Dam. The primary objective of this study focus Objective 3 of the monitoring and evaluation plan, specifically, the first three evaluation indicators: 1) Evaluation Indicator 3.1 - Compare allele frequencies of hatchery fish to naturally produced and donor fish; 2) Evaluation Indicator 3.2 – Determine the temporal stability of genetic distances among subpopulations within a supplemented population; and 3) Evaluation Indicator 3.3 – Evaluate the effective Spawning Population. *Oncorhynchus mykiss* from the upper Columbia River collected between 1995 and 2008 (N=1894) were analyzed for this study. Thirteen collections of adults were obtained at Wells Hatchery (N=865), six of natural origin (i.e., unmarked), three collections with unspecified origin, two collections of adults that were descendants of two hatchery-origin parents (H x H), and two collections of adults that were descendants with one hatchery-origin parent (H x W). In 2007 and 2008, juvenile *O. mykiss* were collected from smolt traps (N=772) in the Methow, Twisp, and Okanogan Rivers. Additionally, in 2007 and 2008, juveniles classified as residents were collected (N=257) from the Methow, Twisp, and Chewuch Rivers. All individuals were genotyped using 16 fluorescently end-labeled microsatellite marker loci, and data were collected following standardized nomenclature.

Substantial genetic diversity was observed, with observed heterozygosities ranging from 0.764 (2003 H x W adults) to 0.831 (1997 natural adults). While no collections deviated from Hardy-Weinberg expectations, statistical associations among alleles across loci (linkage disequilibrium [LD]) were observed for five collections. Hidden population structure within collections (i.e., inadvertent mixture of slightly differentiated populations) could result in LD. Another potential cause of LD in these collections might be the presence of related individuals, as we observed statistical evidence of relatedness in 18 of 25 study collections.

Evaluation Indicator 3.1 - Allele Frequency: Over a small number of generations, allele frequencies are not expected to change over time for large populations at genetic equilibrium. In contrast, if a population is quite small, changes in allele frequencies may occur due to the stochastic sampling of genes from one generation to the next (i.e., genetic drift). Other processes may also alter allele frequencies over time, such as substantial variance in reproductive success or particular types of hatchery practices. In regard to the current study, the *O. mykiss* populations under consideration have census sizes reduced below historic levels and are the subject of a hatchery supplementation program. Therefore, monitoring whether allele frequencies are temporally stable is a worthy endeavor. To complete this objective, we genotyped replicated *O. mykiss* collections (natural- and hatchery-origin) and analyzed their genetic characteristics to determine whether the frequency of alleles present changed from 1995 to 2007. If allele

frequencies are temporally stable, then there should be no observed statistical difference between allelic distributions sampled multiple times from the same population during 1995 – 2007.

Natural-origin adult collections (spanning 1995 – 2007) did not have statistically different allele frequencies when compared to each other, and showed no evidence of population structure (i.e., $F_{ST} = 0$). There were no temporal changes in genetic characteristics observed. These results suggest all natural adult collections were drawn from a single underlying population, and can be combined for subsequent genetic analysis. In other words, there was no evidence the hatchery supplementation program affected the genetic characteristics of the natural-origin steelhead from 1995 to 2007. Additionally, there was no evidence the natural-origin collections represented mixtures of multiple populations above Wells Hatchery. The natural-origin adults did not differ genetically from the unspecified-origin adult collections. There was slight genetic differentiation observed between some natural adult and H x H collections, but the differences were quite small. In contrast, the two H x W collections had statistically different allele frequencies when compared to each other and the largest F_{ST} estimate observed for any comparison between adult collections was between the two H x W collections (F_{ST}=0.0168). Additionally, all comparisons between the H x W collections and the natural adult collections showed both statistically different allele frequencies (12 of 12) and estimates of F_{ST} statistically different from zero. The H x W adults were genetically differentiated from other adult collections. We recommend further consultation about the H x W adults to determine potential sources of the observed genetic differences.

Evaluation Indicator 3.2 - Genetic Distances Between Populations: Due to the life history and behavior of steelhead, obtaining adult samples from known spawning populations is difficult without tributary weirs or some other blocking method. Natural-origin adult samples were available from Wells Dam; however, those collections were thought to represent more than one upstream population, rendering them unsuitable for population analysis (although see previous section). Therefore, juvenile fish from the major populations in the basin (Methow, Twisp, and Okanogan Rivers) were collected using smolt traps, genotyped, and used to investigate differentiation in the basin. Resident *O. mykiss* collected from the Methow, Twisp, and Chewuch Rivers were also analyzed and compared to adult steelhead collections. If genetic distances are stable among populations, then there should not be any trend observed over time regarding differences among collections. These data compare genetic differentiation between in-river collections (2007, 2008), and the degree to which in-river collections are differentiated from adult collections (1995 – 2007).

The juveniles collected from the Methow River smolt trap were not substantially different from the natural adult collections. The 2007 Methow smolts showed statistically different allele frequencies from the 1997, 2003, and 2007 natural adult collections, with small but statistically significance F_{ST} estimates of 0.0031, 0.0025, and 0.0015, respectively. Regarding the 2008 Methow juveniles, the only statistically significant F_{ST} estimate was the comparison between the 1997 natural adult collection (F_{ST} = 0.0016). The Twisp and Okanogan smolt collections were differentiated from the natural adult steelhead to a greater degree than the Methow juveniles, with the 2007 Okanogan collection the most divergent collection in the study (mean F_{ST} = 0.0197).

The juvenile resident collections were genetically differentiated to a similar degree from the natural adults as that observed for smolt collections; however 2007 collections were more divergent from natural adults than the 2008 collections. The 2007 Methow resident collection had statistically different allele frequencies from all natural adult collections (except 1995). Statistically significant F_{ST} were estimated for comparisons between the 2007 Methow resident collection and all the natural adult collections (except 1999). In contrast, the 2008 Methow resident collection was only statistically different from the 2003 adult collection at allele frequencies. F_{ST} estimated were statistically significant for comparisons between the 2008 Methow resident and the 1997, 2003, 2005, and 2007 adult collections. Regarding the Twisp resident collections, allele frequency distribution comparisons were statistically different between the 2007 Twisp resident and all natural adult collections. In contrast, the 2008 Twisp resident collection allele frequencies differed only from the 2003 adult collection. All F_{ST} estimated for comparisons between Twisp resident and natural adult collections were statistically significant. Regarding residents collected from the Chewuch River, the 2007 and 2008 collections had statistically different allele frequencies from each other. The 2007 Chewuch collection had statistically different allele frequencies from all adult collections except 1995 (95AA) collection. The allele frequency distributions of the 2008 resident collection differed from the 1997 (97AC) and 2003 (03KS) natural adult collections. All F_{ST} calculated for comparisons between Chewuch resident and natural adult collections were statistically significant (12 of 12).

We used factorial correspondent analysis (FC) on allele frequency data to investigate if the genetic affinity changed over time among temporally replicated collections of natural adult summer steelhead and juveniles (smolts and residents). In general, the FC results corroborate the genetic diversity analysis described above. Natural adult collections were undifferentiated for each other, except for the 1995 adult collection, although the 1995 adult collection was not statistically different from the 2008 Methow and Chewuch resident collections. We did observe slight differences in genetic characteristics between H x W, smolt, and resident collections. Despite the observed relative genetic differences among collections, there was no trend in the genetic variance observed over time. All collections are clearly representative of an upper Columbia River summer *O. mykiss*. It is unknown whether the magnitude of genetic differences observed is this study is representative of historic levels of differentiation for Methow River (or upper Columbia River) steelhead. To elucidate whether the observed genetic differences are derived from sampling effects (confounded by relatedness) or subtle, but real population structure, spatially/temporally explicit sampling data will be required, in addition to length. A survey of otolith chemistry from parr collected in the Methow River would be informative as well.

Evaluation Indicator 3.3 Effective Spawning Population: We used the multi-sample temporal method (Waples 1990) to estimate the effective population size (N_e) for natural summer steelhead adults. Age data allowed the collections (i.e., calendar year) to be partitioned into cohorts. Only brood year collections with at least N=20 samples were included in the analysis and age-at-maturity information used for parameter estimation was 5%, 43%, 47%, 4.6%, and 0.4% for Age3 – 7, respectively (WDFW unpublished). Over the time period analyzed (cohorts 1992 – 2004), the effective number of breeders (N_b) was calculated to be $\tilde{N}_b$ = 371.0. In order to obtain an estimate of N_e, N_b must be multiplied by the mean generation length (g). Given the age-at-maturity data described above, natural adult steelhead have a g = 4.5. Therefore, N_e = 1669.5 (i.e., 4.5 x 371.0) for these particular collections. Please note that the N_e estimate reported was likely an overestimate, because we assumed residents did not contribute to reproductive effort. Yet, resident and adult steelhead collections were not particularly different, so gene flow between the two life-history forms was likely. Resident *O. mykiss* mature at 2 – 4 years of age, and adults are believed to suffer heavy mortality after first spawning (Behnke 1992). Therefore, if residents contribute to reproduction and are not accounted for, the age composition of the steelhead population would be inaccurate. Waples (1990) did state his model was robust to imperfect knowledge of age composition; however, g remains an important parameter because it modulates the estimation of N_e (i.e., multiplier to N_b).

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 Methow Basin, was listed as endangered under the Endangered Species Act (ESA) in 1997 (Busby et al 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 (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 (81% for the Methow River) of hatchery fish present on the spawning grounds (Good et al. 2005). The 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. Within the Upper Columbia ESU, the West Coast Steelhead BRT (2003) recommended that stocks in the Wenatchee, Entiat, and Methow rivers be considered 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 tributaries currently accessible to steelhead as well as in upriver tributaries blocked off to anadromous access by Chief Joseph and Grand Coulee dams (Kostow 2003). USFWS biologists surveyed the abundance of trout and steelhead juveniles in the Wenatchee, Entiat, and Methow river drainages in the mid-1980s (Mullan et al. 1992) and found adult trout (defined as trout >20 cm) in all basins. The results also supported the hypothesis that resident *O. mykiss* are more abundant in tributary or mainstem areas above the general areas used by steelhead for rearing.

As indicated above, hatchery production of steelhead began at Wells Fish Hatchery in the 1960s using a mix of native populations collected at Priests Rapids and Wells Dams. After 1982, broodstock for the supplementation program were collected at Wells Dam and current mitigation efforts are focused on using local broodstock with progeny outplanted in the Methow and Okanogan Rivers (Murdoch et al. 2003, Snow 2004, Good et al. 2005). As described in Good et al. (2005) estimates of the annual returns of upper Columbia River steelhead populations are based on dam counts with counts over Wells Dam assumed to be returns originating from natural production and hatchery outplants from the Wells program. The annual estimated return levels above Wells Dam are broken down into hatchery and wild components by applying the ratios observed in the Wells sampling program for run years since 1982. Harvest rates have been substantially reduced from historic levels with no commercial harvest allowed and recreational take limited to hatchery fish. Although hatchery returns continue to dominate the counts over Wells Dam (91%), both hatchery and natural origin returns have increased in recent years (Good et al. 2005).

In response to the need for evaluation of the supplementation program, both a monitoring and evaluation plan (DCPUD 2005) and the associated analytical framework

(Hays et al. 2007) were developed for the Habitat Conservation Plans 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 for the construction and operation of Wells Dam. This study pertains to Methow basin steelhead (*O. mykiss*) and the steelhead supplementation program at Wells Dam, and our primary objectives focus on the monitoring and evaluation plan 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.
>
> > **Evaluation Indicator 3.1 - Allele Frequency**: Is the allele frequency of hatchery fish similar to the allele frequency of naturally produced and donor fish?
> >
> > **Evaluation Indicator 3.2 - Genetic Distances Between Populations:** Does the genetic distance among subpopulations within a supplemented population remain the same over time?
> >
> > **Evaluation Indicator 3.3 Effective Spawning Population:** Is the change in spawning population equal to the change in effective population?

Methods and Materials

Samples

Oncorhynchus mykiss from the upper Columbia River collected 1995 – 2008 (N=1894) were analyzed for this study (Figure 1). Thirteen collections of adult *O. mykiss* were obtained at Wells Hatchery (N=865), six of natural origin (i.e., unmarked), three collections with unspecified origin, two collections of adults that were descendants of two hatchery-origin parents (H x H), and two collections of adults that were descendants with one hatchery-origin parent (H x W) (Table 1). In 2007 and 2008, juvenile *O. mykiss* were collected from smolt traps (N=772) in the Methow, Twisp, and Okanogan Rivers (Table 1). Additionally, in 2007 and 2008 juveniles classified as residents were collected (N=257) from the Methow, Twisp, and Chewuch Rivers (Table 1). Trapped *O. mykiss* smolts were classified as fry, parr, transitional, or smolts, and only fish classified as transitional or smolt were sampled. Resident samples were collected via hook and line angling in the Methow, Twisp, and Chewuch Rivers. Sampling for residents typically occurred during the month of July within the sample year, with "larger" fish (< 180 mm in length) exhibiting signs of maturity or recent spawning activity (e.g. dark fish, expressing milt, beat up) targeted. Fin clips were taken from all sampled individuals (except 1995 unspecified-origin adults) and stored directly in ethanol. The 1995 unspecified-origin adults were liver samples collected in ethanol. DNA was extracted from stored tissue using Nucleospin 96 Tissue following the manufacturer's standard protocol (Macherey-Nagel, Easton, PA, U.S.A.).

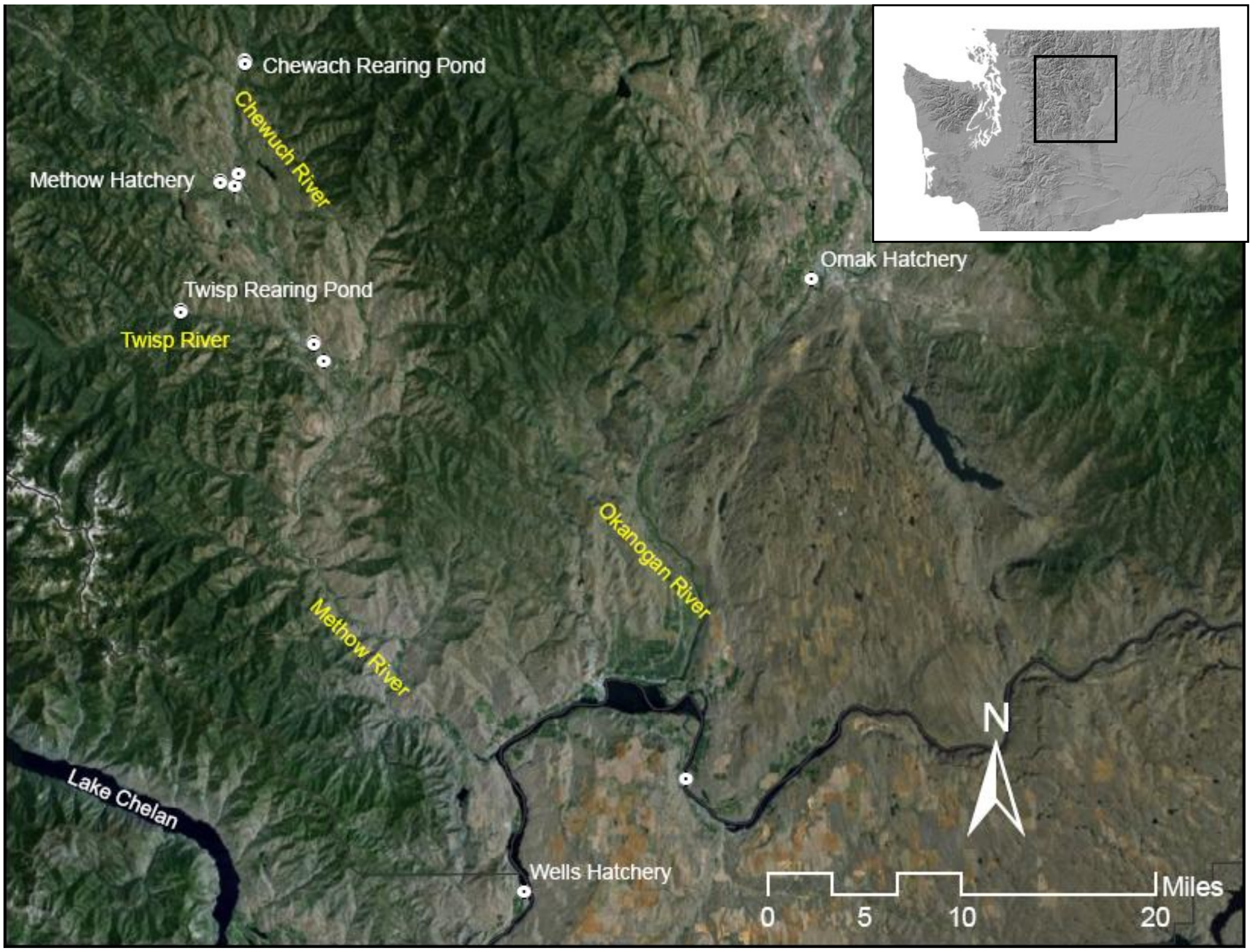

Figure 1. Map of study area.

Laboratory analysis

Polymerase chain reaction (PCR) amplification was performed using 16 fluorescently end-labeled microsatellite marker loci, *Ogo*-4 (Olsen et al. 1998), *Oke*-4 (Buchholz et al. 2001), *Oki*-10 and 23 (Smith et al. 1998), *Omm*-1070 (Rexroad et al. 2001), *Omy*-7 (K. Gharbi, pers. comm.), *Omy*-1001 and 1011 (Spies et al. 2005), *One*-14 (Scribner et al. 1996), *One*-102 (Olsen et al. 2000), *Ots*-3M and 4 (Banks et al. 1999), *Ots*-100 (Nelson and Beacham 1999), *Ssa*-289 (McConnell et al. 1995), *Ssa*-407 and 408 (Cairney et al. 2000). Microsatellite loci are the SPAN standardized suite except *Omm*-1070. 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), 1.0 µL 10 mM dNTP mix (0.02 mM) (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 47°C, and used 0.26 Molar (M) One-102, 0.14 M Oke-4, and 0.14 M Ots-100. Multiplex two had an annealing temperature of 55°C, and used 0.20 M Oki-23, 0.20 M Omy-7, and 0.28 M Ssa-408. Multiplex three had an annealing temperature of 59°C, and used 0.12 M Ots-4, 0.14 M Omm-1070, and 0.20 M Omy-1011. Multiplex four had an annealing temperature of 49°C, and used 0.14 M Omy-1001 and 0.07 M Ots-3M. Multiplex five had an annealing temperature of 59°C, and used 0.14 M Ssa-407, 0.16 M Ogo-4, and 0.24 M One-14. Multiplex six had an annealing temperature of 50°C, and used 0.20 M Ssa-289 and 0.22 M Oki-10. 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 electrophoresis using POP7 polymer 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. For each locus and collection GENEPOP 4.3 (Raymond and Rousset 1995) was used to assess Hardy-Weinberg equilibrium, where deviations from the neutral expectation of random associations among alleles (F_{IS}) were calculated using an exact test. A Markov chain method was employed, with the rejection zone generated for the null hypothesis (Raymond and Rousset 1995). If the exact test null hypothesis (i.e., random association) was rejected, a second test was performed to explicitly test the alternative hypothesis (i.e., heterozygote excess or deficit) (Raymond and Rousset 1995). Genotypic linkage disequilibrium was calculated following Weir (1979) using GENETIX version 4.05 (Belkhir et al. 1996). Statistical significance of linkage disequilibrium (LD) was assessed using a permutation procedure implemented in GENETIX for each locus by locus combination within each collection, where results are reported as the proportion of pairwise combinations significant at $\alpha = 0.05$ (p-values were adjusted for multiple comparisons). The presence of families within the collections was evaluated using Queller & Goodnight's (1989) estimator of pairwise relatedness, with statistical significance determined using a permutation procedure implemented in IDENTIX (Belkhir et al. unpublished). A null distribution (i.e., collection of independent multilocus genotypes from a panmictic population) was generated by resampling N genotypes independently for each locus (without replacement), assigning them at random to the N individuals, and then recalculating the relatedness statistic (100 replicates). The mean observed relatedness estimates were compared to the null expectations of no relatedness from simulated datasets for each population.

Assessing among collection genetic differentiation - Differentiation 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 (6000 permutations). The G-statistic for observed data was compared to G-statistic distributions from randomized datasets (i.e., the null distribution of no allelic differentiation between collections). P-values were adjusted for multiple comparisons at $\alpha = 0.05$. 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 statistical expectations of no population structure, a permutation test was implemented in GENETIX (1000 permutations). Population differentiation was assessed further using factorial correspondence analysis (FC) on allele frequencies. In brief, genetic data are transformed into a contingency table, where each individual is described by its multi-locus genotype (i.e., contingency table is individual's X alleles). The relationship between any two individuals in n-dimensional space (n = number of alleles) is represented by their χ^2 distance. Specifically, the plot represents the ordination of individuals along three orthogonal vectors that represent the three largest eigenvalues derived from the weighted contingency table. Additionally, each individual was not shown, but rather the collection centroids, which are the "centers of mass" for each collection. Mahalanobis distances were calculated (over all individuals) to determine if the relative genetic distances between collection centroids were statistical significant.

Effective population size (N_e) – Estimates of the effective population size were obtained using a multi-sample temporal method (Waples 1990) on consecutive cohorts of steelhead. We used age from scale analysis to sort populations into cohort samples. Only cohort samples with greater than 20 individuals were used in the temporal method analysis. Comparing samples from years *i* and *j*, Waples' (1990) temporal method estimates the effective number of breeders ($\hat{N}_{b(i,j)}$) according to:

$$\hat{N}_{b(i,j)} = \frac{b}{2(\hat{F} - 1/\tilde{S}_{i,j})}$$

The standardized variance in allele frequency ($\hat{F}$) was 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 the cohort data. 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 $\tilde{N}_b$. As suggested by the authors, alleles with a frequency below 0.05 were excluded from the analysis to reduce potential bias.

Table 1. Description of *O. mykiss* collections used for genetic analysis and summary of within-collection genetic diversity results. N is the number of samples analyzed from collection, GD is unbiased gene diversity, Hz is observed heterozygosity, F_{IS} is quantified deviation from random association of alleles within loci, LD is the proportion of pairwise locus combinations showing significant (α=0.05) correlation of alleles across loci, and IDENTIX results are the p-values for the observed mean and variance in relatedness under a null hypothesis of no relatedness. Bolded values are statistically significant.

Collection		WDFW							IDENTIX	
Location	Description	Code	N	Lifestage	GD	Hz	F_{IS}	LD	Mean	var
Wells Hatchery	natural origin	95AA	28	Adult	0.818	0.808	0.013	0.000	0.34	0.16
Wells Hatchery	natural origin	97AC	56	Adult	0.812	0.831	-0.023	0.000	0.18	0.60
Wells Hatchery	natural origin	99NC	37	Adult	0.816	0.810	0.007	0.000	0.21	0.26
Wells Hatchery	natural origin	03KS	92	Adult	0.809	0.822	-0.016	0.000	0.23	**0.00**
Wells Hatchery	natural origin	05LQ	85	Adult	0.809	0.789	0.025	0.000	0.78	0.14
Wells Hatchery	natural origin	07AV	88	Adult	0.810	0.788	0.027	0.000	0.05	0.05
Wells Hatchery	unspecified	95AB	45	Adult	0.811	0.815	-0.005	0.000	0.23	**0.03**
Wells Hatchery	unspecified	99NB	95	Adult	0.806	0.807	-0.001	0.000	0.95	**0.01**
Wells Hatchery	unspecified	07AW	97	Adult	0.809	0.819	-0.012	0.000	0.90	**0.00**
Wells Hatchery	HxH origin	03KT	48	Adult	0.811	0.789	0.027	**0.057**	0.65	**0.00**
Wells Hatchery	HxH origin	05LR	49	Adult	0.807	0.785	0.028	0.000	0.27	**0.00**
Wells Hatchery	HxW origin	03KU	95	Adult	0.798	0.764	0.043	**0.257**	0.95	**0.00**
Wells Hatchery	HxW origin	05LS	50	Adult	0.791	0.797	-0.007	**0.152**	**0.01**	**0.00**
Methow trap	natural origin	07AP	113	Juvenile	0.806	0.794	0.015	0.010	0.46	**0.02**
Methow trap	natural origin	08CJ	156	Juvenile	0.816	0.803	0.015	0.048	0.49	**0.00**
Twisp trap	natural origin	07AQ	113	Juvenile	0.804	0.794	0.012	0.000	0.86	**0.00**
Twisp trap	natural origin	08CK	185	Juvenile	0.801	0.804	-0.004	0.048	0.05	**0.00**
Okanogan trap	natural origin	07AR	86	Juvenile	0.775	0.772	0.004	**0.276**	**0.00**	**0.00**
Okanogan trap	natural origin	08CL	119	Juvenile	0.817	0.779	0.047	**0.105**	**0.03**	**0.00**
Methow River	resident	07AS	36	Juvenile	0.802	0.771	0.039	0.010	0.53	0.18
Methow River	resident	08CM	30	Juvenile	0.805	0.784	0.027	0.000	0.31	**0.00**
Twisp River	resident	07AU	32	Juvenile	0.800	0.729	0.090	0.000	0.65	**0.00**
Twisp River	resident	08CN	19	Juvenile	0.804	0.800	0.005	0.000	0.32	0.09
Chewuch River	resident	07ER	80	Juvenile	0.809	0.787	0.027	0.029	0.08	**0.00**
Chewuch River	resident	08CO	60	Juvenile	0.805	0.778	0.033	0.010	0.62	**0.00**

Results and Discussion

Evaluation Indicator 3.1 - Allele Frequency

Natural summer steelhead adults – Substantial genetic diversity was observed for natural summer steelhead adult collections sampled from Wells Hatchery. Observed heterozygosity was in the low 80% range for the four earliest collections and was 79% for the 2005 and 2007 collections (Table 1). While a larger F_{IS} was observed for the 2005 and 2007 collections (i.e., fewer heterozygotes observed than expected) no collections showed statistically significant deficits in heterozygotes (Table 1). A classic signal of a collection being a mixture is the non-random associations of alleles among loci. This statistical correlation among alleles is termed linkage disequilibrium, which was not observed in any natural adult collection (Table 1). The 2003 natural adult collection showed a statistically significant variance in relatedness values (i.e., observed variance unlikely given a panmictic population), which is statistical evidence for related individuals being present within the collection.
We compared the allele frequency distributions of the natural summer steelhead collections in a pairwise fashion using a randomization chi-square test. No comparison was statistically significant, suggesting all collections were drawn from a single underlying population. Additionally, all estimates of F_{ST}, the measure of heterozygosity loss due population subdivision, were not statistically different from zero (Table 2). In other words, the allele frequencies are equivalent for collections from 1995 – 2007 and the natural summer steelhead collections could be combined for any subsequent genetic analysis.

Table 2. Pairwise genetic differentiation between natural adult collections. Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant at $\alpha = 0.05$. F_{ST} estimates are shown above diagonal.

Collection	03KS	05LQ	07AV	95AA	97AC	99NC
03KS	–	0.0003	-0.0001	-0.0023	0.0019	0.0006
05LQ	NS	–	-0.0002	-0.0001	0.0005	-0.0016
07AV	NS	NS	–	-0.0029	0.0010	0.0004
95AA	NS	NS	NS	–	0.0008	-0.0019
97AC	NS	NS	NS	NS	–	0.0006
99NC	NS	NS	NS	NS	NS	–

Hatchery origin adults – Seven adult summer steelhead collections from Wells Hatchery were genetically characterized and compared with the natural origin collections described in the previous section. Three collections were not classified to origin, two collections were composed of individuals that were the product of two hatchery parents (i.e., H x H), and two collections were returning adults from H x W crosses (Table 1). Substantial genetic diversity was observed, with heterozygosities ranging from 0.764 (03KU) to 0.819 (07AW). No statistically significant deviations from Hardy-Weinberg equilibrium were observed for hatchery origin collections (Table 1). Statistically significant associations of alleles among loci were observed for three collections, H x H 03KT (LD=0.057), H x W 03KU (LD=0.257), and H x W 05LS (0.152).

To clarify further, an LD=0.057 result for collection 03KT means that 5.7% of the locus by locus comparisons showed larger correlation among alleles than expected. While some statistical correlations are expected given the large number of simultaneous tests (i.e., each allele across 105 pairwise tests replicated 100 times), 5.7% is higher than expected by chance. A classical cause of LD is a collection being composed of multiple populations, but other factors could cause associations among alleles, such as the presence of related individuals (or families). We tested for the presence of related individuals, and all the hatchery-origin collections showed statistically significant variance in relatedness, which suggests the presence of multiple families within the collections (Table 1). Additionally, the H x W 05LS collection showed a statistically significant mean relatedness estimate, suggesting the collection was generally composed of related individuals, as compared to multiple (yet unrelated) family groups. We compared the allele frequency distributions of the summer steelhead collections in a pairwise fashion using a randomization chi-square test. Table 3 shows results comparing natural summer steelhead collections to the origin-unspecified adult collections. Please note that the values comparing natural collections to each other have been removed, as these are redundant to Table 2. No statistically significant differences in allele frequencies were observed. There were statistically significant estimates of F_{ST} observed (Table 3); however the largest F_{ST} value observed was 0.004, signifying minimal population differentiation among these collections.

Table 3. Genetic differentiation between natural adult and the unspecified hatchery collections. Please note that the pairwise tests regarding natural adults collections (underlined codes) are not shown (see Table 2). Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant and * designating the p-value was below α = 0.05. F_{ST} estimates are shown above diagonal, with bolded values being statistically different from panmixia.

Group	<u>03KS</u>	<u>05LQ</u>	<u>07AV</u>	07AW	<u>95AA</u>	95AB	<u>97AC</u>	99NB	<u>99NC</u>
<u>03KS</u>	–	-	-	0.0007	-	**0.0037**	-	**0.0021**	-
<u>05LQ</u>	-	–	-	**0.0019**	-	0.0023	-	0.0012	-
<u>07AV</u>	-	-	–	**0.0018**	-	0.0001	-	0.0000	-
07AW	NS	NS	NS	–	0.0016	**0.0028**	**0.0028**	**0.0022**	0.0022
<u>95AA</u>	-	-	-	NS	–	-0.0012	-	0.0005	-
95AB	NS	NS	NS	NS	NS	–	0.0007	0.0009	0.0028
<u>97AC</u>	-	-	-	NS	-	NS	–	**0.0040**	-
99NB	NS	NS	NS	NS	NS	NS	NS	–	**0.0027**
<u>99NC</u>	-	-	-	NS	-	NS	-	NS	–

Allele frequency distributions for natural adults and known-origin hatchery adults (i.e., H x H and H x W) were compared in a pairwise fashion using a randomization chi-square test (Table 4). Please note that the values comparing natural collections to each other have been removed, as these are redundant to Table 2. When compared to each other, the two H x H collections (03KT, 05LR) had neither statistically different allele frequencies nor an F_{ST} estimate different from zero (0.0015) (Table 4). When compared to natural origin adults, the H x H 03KT had statistically different allele frequencies from the 2003 (03KS) and 1997 (97AC) collections. Additionally, the H x H 03KT collection had a statistically significant F_{ST} estimate for all comparisons with natural collections except the 1995 collection (95AA), although the calculated F_{ST} values were quite small. The two H x W collections (03KU, 05LS) had statistically different allele frequencies when compared to each other. Additionally, the largest F_{ST} estimate observed for any comparison between adult collections was between 03KU and 05LS (0.0168) (Table 4). All comparisons between the H x W collections and the natural adult collections showed both statistically different allele frequencies (12 of 12) and estimates of F_{ST} statistically different from zero. The H x W collections are more differentiated from the natural collections than the H x H collections.

Table 4. Genetic differentiation between natural adult and the known-origin hatchery collections. Please note that the pairwise tests regarding natural adults collections (underlined codes) are not shown (see Table 2). Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant and * designating the p-value was below α = 0.05. F_{ST} estimates are shown above diagonal, with bolded values being statistically different from panmixia.

Collection	03KS	03KT	03KU	05LQ	05LR	05LS	07AV	95AA	97AC	99NC
03KS	–	**0.0047**	**0.0141**	-	0.0015	**0.0102**	-	-	-	-
03KT	*	–	**0.0044**	**0.0047**	0.0015	**0.0142**	**0.0039**	0.0035	**0.0064**	**0.0042**
03KU	*	*	–	**0.0133**	**0.0083**	**0.0168**	**0.0099**	**0.0075**	**0.0110**	**0.0116**
05LQ	-	NS	*	–	0.0010	**0.0060**	-	-	-	-
05LR	NS	NS	*	NS	–	**0.0096**	-0.0001	0.0002	0.0001	0.0023
05LS	*	*	*	*	*	–	**0.0069**	**0.0104**	**0.0095**	**0.0126**
07AV	-	NS	*	-	NS	*	–	-	-	-
95AA	-	NS	*	-	NS	*	-	–	-	-
97AC	-	*	*	-	NS	*	-	-	–	-
99NC	-	NS	*	-	NS	*	-	-	-	–

Steelhead juvenile collections – Juvenile steelhead were collected in 2007 and 2008 from smolt traps in the Methow, Twisp, and Okanogan Rivers (Table 1). Analysis of genetic diversity showed none of the juvenile steelhead collections had statistically significant deviations from Hardy-Weinberg equilibrium; however the 2008 collections from the Methow and Twisp showed statistically significant LD, as well as both collections from the Okanogan. Additionally, the 2007 Okanogan juvenile steelhead collection showed the highest LD observed in the study (LD=0.276). The observed LD could be the result of relatedness, as all juvenile collections showed evidence for family structure, with statistically significant variances in relatedness (Table 1). Additionally, both Okanogan collections had statistically significant mean relatedness values.
We compared the allele frequency distributions of the natural adults and steelhead juvenile collections in a pairwise fashion using a randomization chi-square test. No statistical differences in allele frequency distribution were observed when the Methow juvenile collections were compared to each other or the natural adults (Table 5). Comparing the 2007 and 2008 Methow juvenile steelhead collections to each other, the F_{ST} estimate was not statistically different than zero (0.0008) (Table 5). Comparing the

Methow juveniles to natural adult collections, the 2007 juveniles were statistically different from the 1997 (97AC), 2003 (03KS), and 2007 (07AV) natural adult collections, with F_{ST} estimates of 0.0031, 0.0025, and 0.0015, respectively. Regarding the 2008 Methow juveniles, the only statistically significant F_{ST} estimate was the comparison between the 1997 (97AC) natural adult collection (F_{ST} = 0.0016) (Table 5). Overall, the Methow steelhead juveniles were not substantially different from the natural adult collections.

The Twisp and Okanogan collections were differentiated from the natural adult steelhead to a greater degree than the Methow juveniles, with the 2007 Okanogan collection (07AR) appearing the most divergent collection in the study. The two Twisp collections (07AQ, 08CK) showed statistically different allele frequencies when compared to each other, and had a slight, but statistically significant F_{ST} estimate (0.0047) (Table 5). When allele frequency distributions were compared to the natural adults, 10 of 12 comparisons were statistically different. Regarding the F_{ST} estimates, 11 of 12 comparisons were statistically significant. The single non-significant result was the comparison between the 2007 Twisp juvenile collection (07AQ) and the 1995 natural collection (95AA) (F_{ST}=0.0044). The two Okanogan collections (07AR, 08CL) were divergent from each other, with statistically different allele frequencies and F_{ST} estimates greater than zero (Table 5). The Okanogan juveniles were also divergent from the natural adult collections, with all allele frequency and F_{ST} comparisons being statistically significant. Additionally, the 2007 Okanogan juvenile collection appeared the most dissimilar collection in the study from the natural adults, with a mean F_{ST} of 0.0197.

Table 5. Genetic differentiation between natural adult and the juvenile steelhead collections. Please note that the pairwise tests regarding natural adults collections (underlined codes) are not shown (see Table 2). Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant and * designating the p-value was below α = 0.05. F_{ST} estimates are shown above diagonal, with bolded values being statistically different from panmixia.

Collection	03KS	05LQ	07AP	07AQ	07AR	07AV	08CJ	08CK	08CL	95AA	97AC	99NC
03KS	–	-	**0.0025**	**0.0052**	**0.0182**	-	0.0007	**0.0071**	**0.0059**	-	-	-
05LQ	-	–	0.0003	**0.0055**	**0.0200**	-	0.0011	**0.0042**	**0.0061**	-	-	-
07AP	NS	NS	–	**0.0027**	**0.0171**	**0.0015**	0.0008	**0.0043**	**0.0059**	0.0016	**0.0031**	0.0018
07AQ	*	*	NS	–	**0.0196**	**0.0044**	**0.0032**	**0.0047**	**0.0069**	0.0044	**0.0054**	**0.0062**
07AR	*	*	*	*	–	**0.0180**	**0.0156**	**0.0196**	**0.0186**	**0.0232**	**0.0171**	**0.0221**
07AV	-	-	NS	*	*	–	-0.0001	**0.0042**	**0.0059**	-	-	-
08CJ	NS	NS	NS	*	*	NS	–	**0.0029**	**0.0035**	-0.0005	**0.0016**	0.0001
08CK	*	*	*	*	*	*	*	–	**0.0082**	**0.0050**	**0.0043**	**0.0066**
08CL	*	*	*	*	*	*	*	*	–	**0.0064**	**0.0041**	**0.0042**
95AA	-	-	NS	NS	*	-	NS	*	*	–		
97AC	-	-	NS	*	*	-	NS	*	*	-	–	
99NC	-	-	NS	NS	*	-	NS	*	*	-	-	–

Table 6 Genetic differentiation between natural adult and the juvenile resident collections. Please note that the pairwise tests regarding natural adults collections (underlined codes) are not shown (see Table 2). Statistical significance of genic tests are shown below diagonal, with NS meaning non-significant and * designating the p-value was below $\alpha = 0.05$. F_{ST} estimates are shown above diagonal, with bolded values being statistically different from panmixia.

Collection	03KS	05LQ	07AS	07AU	07AV	07ER	08CM	08CN	08CO	95AA	97AC	99NC
03KS	–	-	**0.0083**	**0.0109**	-	**0.0118**	**0.0088**	**0.0108**	**0.0061**	-	-	-
05LQ	-	–	**0.0074**	**0.0124**	-	**0.0120**	**0.0056**	**0.0059**	**0.0046**	-	-	-
07AS	*	*	–	**0.0193**	**0.0073**	**0.0091**	-0.0022	**0.0167**	**0.0091**	**0.0059**	**0.0100**	0.0042
07AU	*	*	*	–	**0.0091**	**0.0176**	**0.0184**	**0.0185**	**0.0093**	**0.0138**	**0.0105**	**0.0123**
07AV	-	NS	*	*	–	**0.0087**	**0.0063**	**0.0085**	**0.0037**	-	-	-
07ER	*	*	*	*	*	–	**0.0133**	**0.0169**	**0.0095**	**0.0052**	**0.0107**	**0.0074**
08CM	*	NS	NS	*	NS	*	–	**0.0195**	**0.0085**	0.0047	**0.0089**	0.0040
08CN	*	NS	*	NS	NS	*	*	–	**0.0164**	**0.0081**	**0.0069**	**0.0101**
08CO	*	NS	*	*	NS	*	*	*	–	**0.0057**	**0.0098**	**0.0046**
95AA	-	-	NS	*	-	NS	NS	NS	NS	–	-	-
97AC	-	-	*	*	-	*	NS	NS	*	-	–	-
99NC	-	-	*	*	-	*	NS	NS	NS	-	-	–

Resident juvenile collections – Resident juveniles were collected in 2007 and 2008 from the Methow, Twisp, and Chewuch Rivers. No statistically significant deviations from Hardy-Weinberg equilibrium were observed for the resident collections (Table 1). None of the resident collections showed evidence of LD. Four resident collections showed statistical evidence for the presence of related individuals, 2008 Methow (08CM), 2007 Twisp (07AU), and both Chewuch collections (Table 1).
We compared the allele frequency distributions of the natural adults and resident juvenile collections in a pairwise fashion using a randomization chi-square test. The allele frequency distributions of the Methow resident collections (07AS, 08CM) were not statistically different from each other, and the F_{ST} estimate comparing the collections was not statistically difference from zero (-0.0022) (Table 6). Six of the 12 pairwise allele frequency comparisons made between Methow residents and natural adults were statistically different. The 2007 resident collection was statistically different from all natural adult collections except from 1995 (95AA). In contrast, the 2008 Methow resident collection was only statistically different from the 2003 adult collection (03KS). Statistically significant F_{ST} were estimated for comparisons between the 2007 resident collection and all the natural adult collections except 1999 (99NC). For the 2008 Methow resident collection, statistically significant F_{ST} were estimated for comparisons with the 1997 (97AC), 2003 (03KS), 2005 (05LQ), and 2007 (07AV) adult collections. Regarding the Twisp resident collections (07AU, 08CN), the allele frequency distributions were not statistically different from each other (Table 6). Yet, all allele frequency distribution comparisons were statistically different between the 2007 Twisp resident collection and natural adults. In contrast, the 2008 resident collection allele frequencies differed only from the 2003 (03KS) adult collection. For all comparisons between Twisp resident and natural adult collections the F_{ST} estimated were statistically significant (12 of 12).

Regarding residents collected from the Chewuch River (07ER, 08CO), the 2007 and 2008 collections had statistically different allele frequencies from each other. The 2007 Chewuch collection had statistically different allele frequencies from all adult collections except 1995 (95AA) collection. The allele frequency distributions of the 2008 resident collection differed from the 1997 (97AC) and 2003 (03KS) natural adult collections. All F_{ST} calculated for comparisons between Chewuch resident and natural adult collections were statistically significant (12 of 12).

Evaluation Indicator 3.2 - Genetic Distances Between Populations
We used factorial correspondent analysis (FC) on allele frequency data to investigate if the genetic affinity changed over time among temporally replicated collections of natural adult summer steelhead and juveniles (smolts and residents). Shown in Figures 2 and 3 are the *O. mykiss* collection centroids (the “centers of mass” for each collection) plotted relative to each other on the three axes that represent the largest vectors of genetic variance. The natural summer adult collections (circles; points 1 – 6) joined by a horizontal black line were not statistically different from each other based on mahalanobis distances (Figure 2). The 1995 adult collection centroid was statistically different from all other centroids. Regarding the Methow juveniles (Squares; points 7 and 8), no horizontal lines were draw for visual reasons. The 2007 Methow collection

(point 7) was statistically different from 1995 adults (point 1), but not statistically different from adult centroids 2 – 6. The 2008 Methow collection was statistically different from adult centroids 1 and 4 – 6. The 2007 and 2008 Twisp juvenile steelhead collections (Diamonds; points 9 and 0) were not statistically different from each other (connected by horizontal line), but were differentiated from all other collection centroids. The Okanogan juvenile collections (Triangles) were statistically different from each other and all other collection centroids. Additionally, the 2007 Okanogan collection contributed greatly to the FC axis 2 (all other collections essentially on the origin), and the 2008 Okanogan collection contributed greatly to FC axis 3. Despite the relative genetic differences among collections, there was no trend in the genetic variance changes observed over time.

The relative genetic differences of natural summer adult and resident collections are shown in Figure 3. All natural adult collection centroids except 1995 adults (point 1) were undifferentiated, as described above. The Methow resident centroids (Squares; points 7 and 8) were statistically different from each other, but the 2008 collection (point 8) was not statistically different from the 1995 adult centroid (point 1) (joined by horizontal line). The 2007 and 2008 Twisp resident collection centroids (Diamonds; points 9 and 0) were not statistically different from each other (joined by horizontal line), but were differentiated from all other collection centroids. The Chewuch resident centroids (Triangles; points A and B) were statistically different from each other, but the 2008 Chewuch collection (point B) was not statistically different from the 2008 Methow centroid (point 8) (joined by horizontal line).

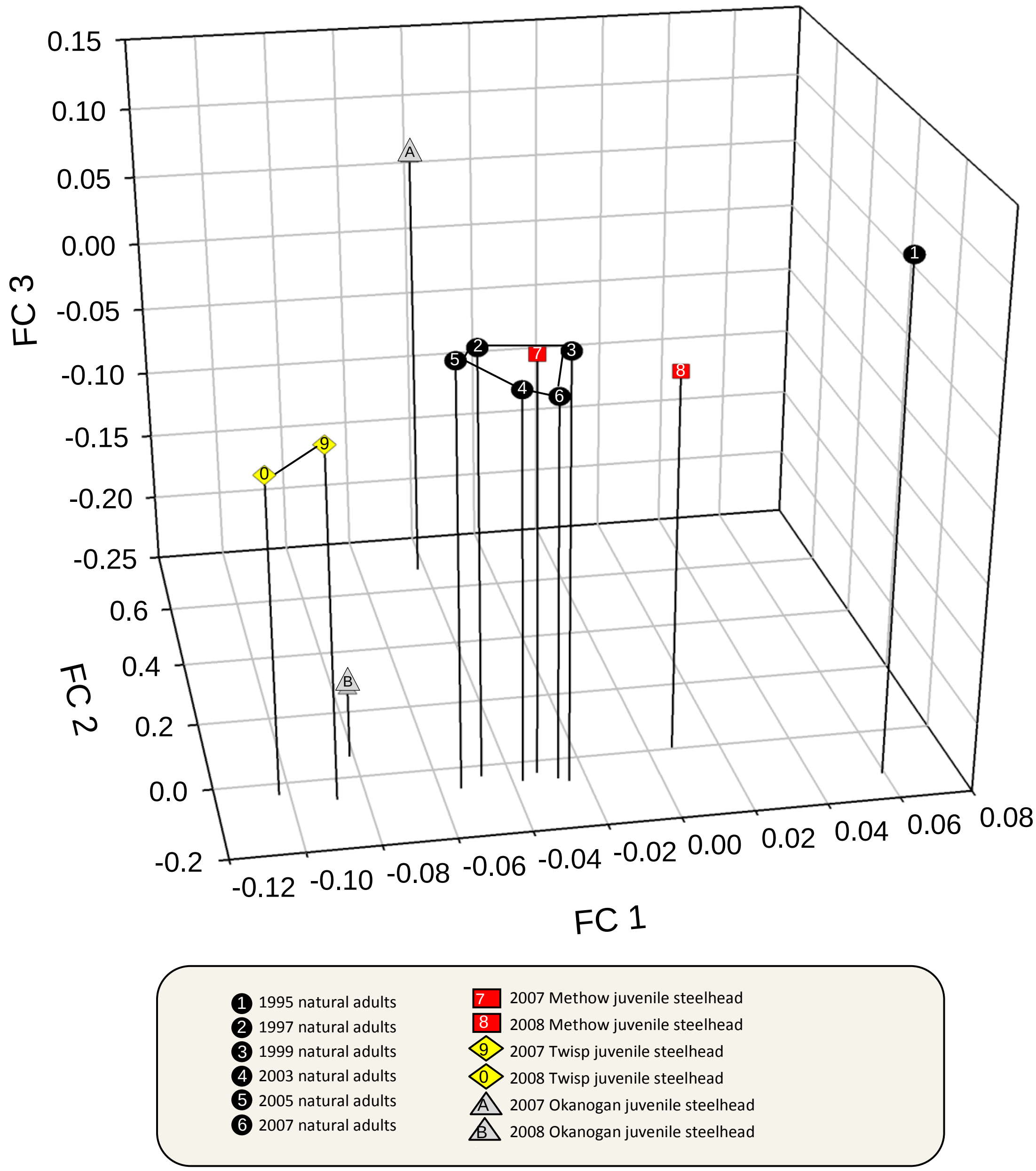

Figure 2. Factorial correspondence plot of collection centroids for natural adult and juvenile steelhead collections. Collections that are not statistically different, as measured by Mahalanobis distances, are joined by horizontal lines (or a minimum convex polygon).

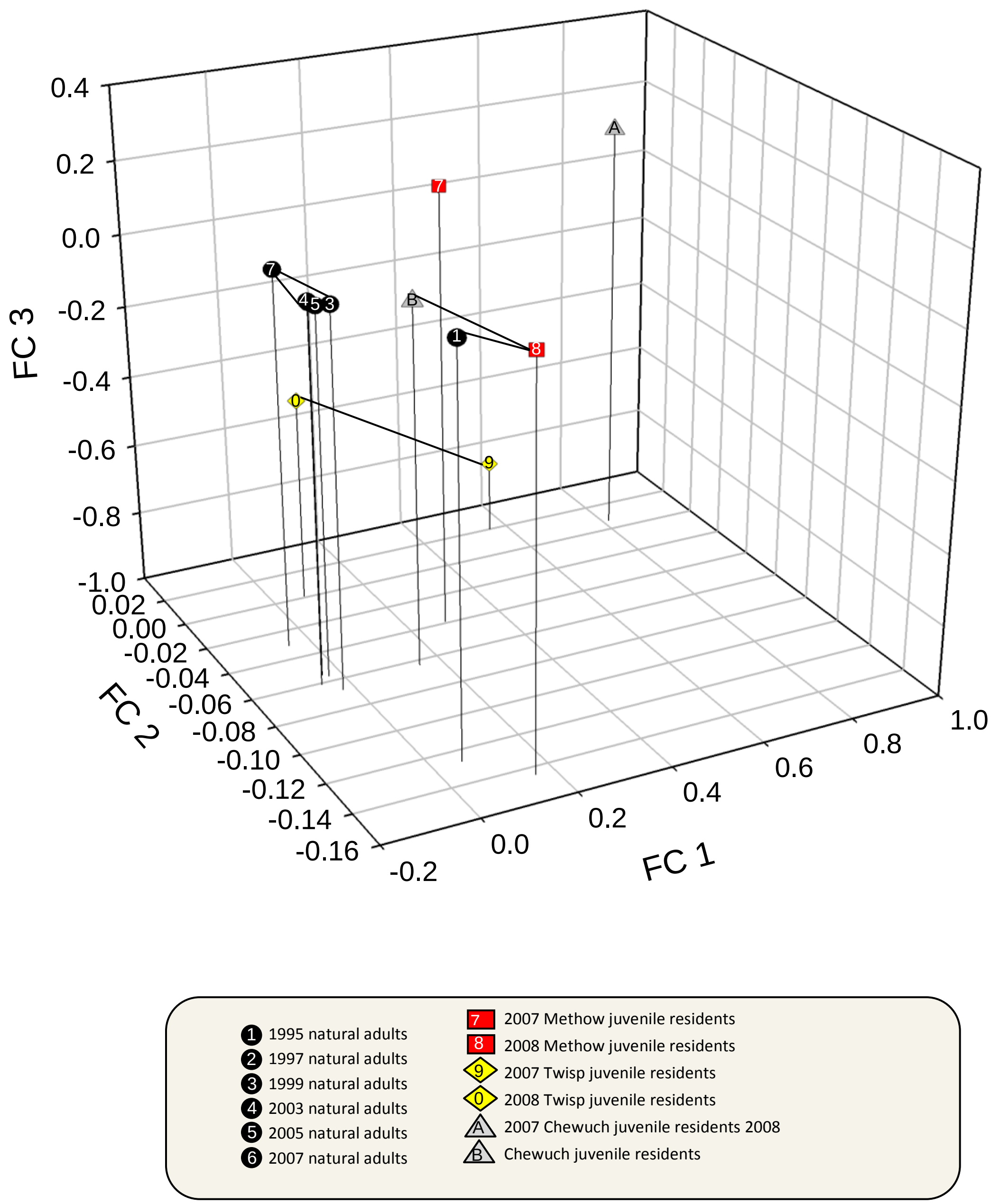

Figure 3. Factorial correspondence plot of collection centroids for natural adult and juvenile resident collections. Please note that point 2 is not visible. Collections that are not statistically different, as measured by Mahalanobis distances, are joined by horizontal lines (or a minimum convex polygon).

Evaluation Indicator 3.3 Effective Spawning Population

We used the multi-sample temporal method (Waples 1990) to estimate the effective population size (N_e) for natural summer steelhead adults. We used scales to age individual fish and thereby partition collections (i.e., calendar year) into cohorts (i.e., brood year). For example, an Age-4 steelhead collected in 2008 would be assigned to a 2004 brood year collection. Only brood year collections with at least N=20 samples were included in the analysis. The average cohort age composition used for parameter estimation (i.e., b) was 5%, 43%, 47%, 4.6%, and 0.4% for Age 3 – 7, respectively (WDFW unpublished). As described by Waples et al. (2007), the pairwise brood year comparisons (i.e., $\hat{N}_{b(i,j)}$) may fluctuate greatly, and negative values are possible if the standardized variance between two collections can be explained by sampling effects. Negative values should be interpreted as incalculable estimates (i.e., infinity). The harmonic mean over all $\hat{N}_{b(i,j)}$ is a more reliable estimate of N_b (Waples et al. 2007), and was calculated to be $\tilde{N}_b$ = 371.0. This is the estimate of the effective number of breeders contributing to the collections analyzed. In order to obtain an estimate of N_e, N_b must be multiplied by the mean generation length. Given the age composition data provided above, the mean generation length = 4.5 for natural adult steelhead. Therefore, N_e = 1669.5 (i.e., 4.5 x 371.0) for these particular collections.

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