YAKIMA/KLICKITAT FISHERIES PROJECT MONITORING AND EVALUATION

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THE CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION

FINAL REPORT
For the Performance Period
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Executive Summary

The Yakima-Klickitat Fisheries Project (YKFP) is a joint project of the Yakama Nation (lead entity) and the Washington State Department of Fish and Wildlife (WDFW) and is sponsored in large part by the Bonneville Power Administration (BPA) with oversight and guidance from the Northwest Power and Conservation Council (NPCC). It is among the largest and most complex fisheries management projects in the Columbia Basin in terms of data collection and management, physical facilities, habitat enhancement and management, and experimental design and research on fisheries resources. Using principles of adaptive management, the YKFP is attempting to evaluate all stocks historically present in the Yakima subbasin and apply a combination of habitat restoration and hatchery supplementation or reintroduction, to restore the Yakima Subbasin ecosystem with sustainable and harvestable populations of salmon, steelhead and other at-risk species.

The original impetus for the YKFP resulted from the landmark fishing disputes of the 1970s, the ensuing legal decisions in *United States versus Washington* and *United States versus Oregon*, and the region's realization that lost natural production needed to be mitigated in upriver areas where these losses primarily occurred. The YKFP was first identified in the NPCC's 1982 Fish and Wildlife Program (FWP) and supported in the *U.S. v Oregon* 1988 Columbia River Fish Management Plan (CRFMP). A draft Master Plan was presented to the NPCC in 1987 and the Preliminary Design Report was presented in 1990. In both circumstances, the NPCC instructed the Yakama Nation, WDFW and BPA to carry out planning functions that addressed uncertainties in regard to the adequacy of hatchery supplementation for meeting production objectives and limiting adverse ecological and genetic impacts. At the same time, the NPCC underscored the importance of using adaptive management principles to manage the direction of the Project. The 1994 FWP reiterated the importance of proceeding with the YKFP because of the added production and learning potential the project would provide. The YKFP is unique in having been designed to rigorously test the efficacy of hatchery supplementation. Given the current dire situation of many salmon and steelhead stocks, and the heavy reliance on artificial propagation as a recovery tool, YKFP monitoring results will have great region-wide significance.

Supplementation is envisioned as a means to enhance and sustain the abundance of wild and naturally-spawning populations at levels exceeding the cumulative mortality burden imposed on those populations by habitat degradation and by natural cycles in environmental conditions. A supplementation hatchery is properly operated as an adjunct to the natural production system in a watershed. By fully integrating the hatchery with a naturally-producing population, high survival rates for the component of the population in the hatchery can raise the average abundance of the total population (hatchery component + naturally-producing component) to a level that compensates for the high mortalities imposed by human development activities and fully seeds the natural environment.

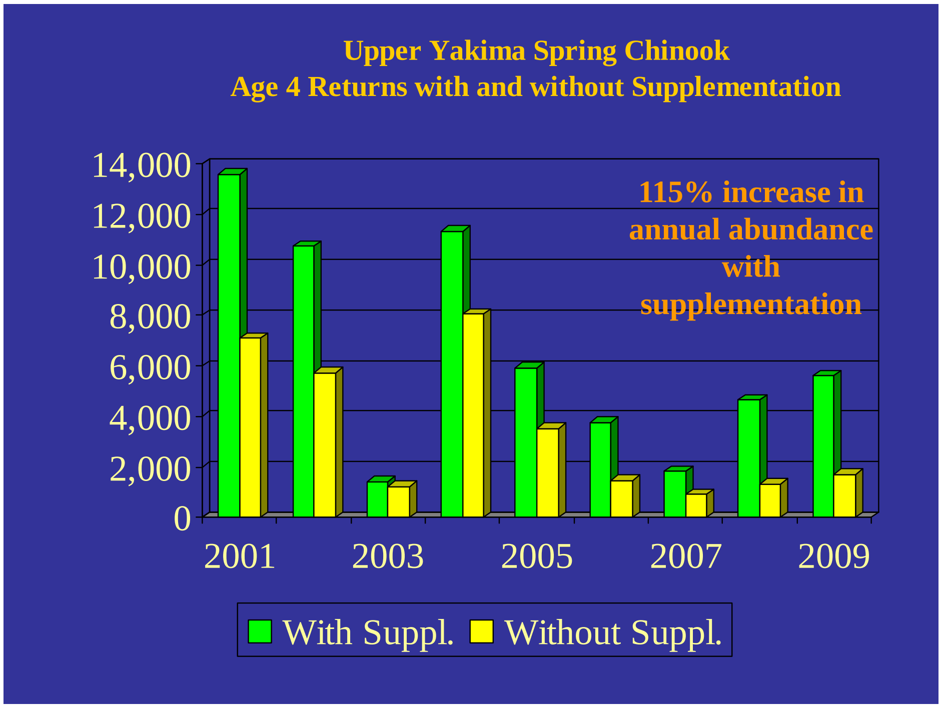
The objectives of the YKFP are to: use Ecosystem Diagnosis and Treatment (EDT) and other modeling tools to facilitate planning for project activities, enhance existing stocks, re-introduce extirpated stocks, protect and restore habitat in the Yakima Subbasin, and operate using a scientifically rigorous process that will foster application of the knowledge gained about hatchery supplementation and habitat restoration throughout the Columbia River Basin. The YKFP is still in the early stages of evaluation, and as such the data and findings presented in this report should be considered preliminary until results are published in the peer-reviewed literature. The following is a brief summary of current YKFP activities by species.

Spring Chinook

The Cle Elum Supplementation and Research Facility (CESRF) collected its first spring Chinook brood stock in 1997, released its first fish in 1999, and age-4 adults have been returning since 2001, with the first F2 generation (offspring of CESRF and wild fish spawning in the wild) returning as adults in 2005. In these initial years of CESRF operation, recruitment of hatchery origin fish has exceeded that of fish spawning in the natural environment (BPA annual reports). Preliminary results indicate that significant differences have been detected among hatchery and natural origin fish in about half of the traits measured in our monitoring plan and that these differences can be attributed to both environmental and genetic causes. For example, we have detected differences in hatchery and natural origin fish after only one generation of hatchery exposure for the following variables measured on adults: age composition, size-at-age, sex ratio, spawning timing, fecundity, egg weight, and adult morphology at spawning (Busack et al. 2007; Knudsen et al. 2006, 2008). With respect to spawning success, no differences were detected in the egg deposition rates of wild and hatchery origin females, but pedigree assignments based on microsatellite DNA showed that the eggs deposited by wild females survived to the fry stage at a 5.6% higher rate than those spawned by hatchery-origin females (Schroder et al. 2008); behavior and breeding success of wild and hatchery-origin males were found to be comparable (Schroder et al. 2010). Significant differences in juvenile traits have also been detected: emergence timing and size of progeny, food conversion efficiency, length-weight relationships, agonistic competitive behavior, predator avoidance, and incidence of precocious maturation (Beckman et al. 2008; BPA annual reports; Larsen et al. 2004, 2006). Most of the differences have been 10% or less.

Redd counts in the 2001-2009 period have increased significantly in both the supplemented Upper Yakima and Naches control systems relative to the pre-supplementation period (1981-2000), but the average increase in redd counts in the upper Yakima (236%) was substantially greater than that observed in the Naches system (163%; BPA annual reports). Spatial distribution of spawners has also increased as a result of acclimation site location, salmon homing fidelity and more fully seeding preferred spawning habitats (Dittman et al. 2010). Semi-natural rearing and predator avoidance training have not resulted in significant increases in survival of hatchery fish (Fast et al. 2008; BPA annual reports). Growth manipulations in the hatchery appear to be reducing the number of precocious males produced by the YKFP and consequently increasing the number of migrants, however post-release survival of treated fish appears to be significantly lower than conventionally reared fish (Larsen et al. 2006; Pearsons et al. 2009; BPA annual reports). Genetic impacts to non-target populations appear to be low because of the low stray rates of YKFP fish (BPA annual reports). Ecological impacts to valued non-target taxa were generally within containment objectives, or impacts that were outside of containment objectives were not caused by supplementation activities (Pearsons and Temple 2007; BPA annual reports). Changes to rainbow trout abundance and biomass were observed in a tributary watershed where hatchery-origin fish were released, but the trout may have been simply displaced to other areas (Pearsons and Temple 2010). Fish and bird piscivores consume large numbers of salmonids in the Yakima Basin (Fritts and Pearsons 2006; BPA annual reports). Natural production of Chinook salmon in the upper Yakima Basin appears to be density dependent under current conditions and may constrain the benefits of supplementation (BPA annual reports). However, such constraints could be countered by YKFP habitat actions (see summary below). Additional habitat improvements implemented by other entities, including the Conservation Districts, counties and private interests are also continuing in the basin. Harvest opportunities for tribal and non-tribal fishers have also been enhanced, but are variable among years (BPA annual reports).

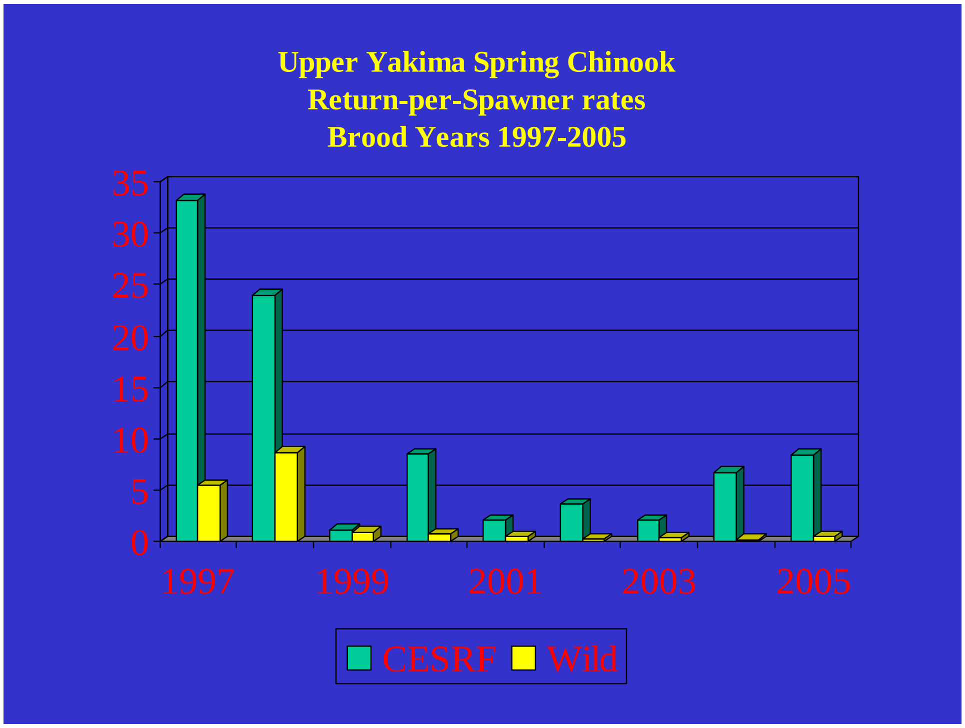
Figure 1. Actual returns (green bar) of age-4 Upper Yakima spring Chinook to the Yakima River mouth compared to estimated returns (yellow bar) if the Cle Elum Supplementation and Research Facility (CESRF) had not been constructed. Data are for age-4 return years 2001-2009.



Methods and Discussion: For all years, actual returns with supplementation (green bars) are derived from actual counts of marked (CESRF) and unmarked (wild/natural) fish at Roza Dam backed through harvest to the Yakima River mouth. For F1 returns (returns from wild fish spawned in the hatchery) in 2001-2004, the yellow bars (estimated returns without supplementation) are calculated as the actual returns of unmarked (wild) fish at Roza backed to the river mouth plus estimated returns from fish taken for CESRF broodstock had these fish been allowed to spawn in the wild and returned at observed wild/natural return per spawner rates. For F2 and later generation returns from 2005 forward (where wild/natural returns are comprised of crosses of wild/natural and CESRF fish spawning together in the wild), estimated returns without supplementation are calculated as if the estimated "without supplementation" return four years earlier had been the total escapement, spawned in the wild, and their progeny returned at observed wild/natural return per spawner rates. Using this method the estimated benefit (increase in abundance of natural spawners) from supplementation ranged from 15% in return year 2003 to 250% in return year 2008 and averaged 115% from 2001-2009.

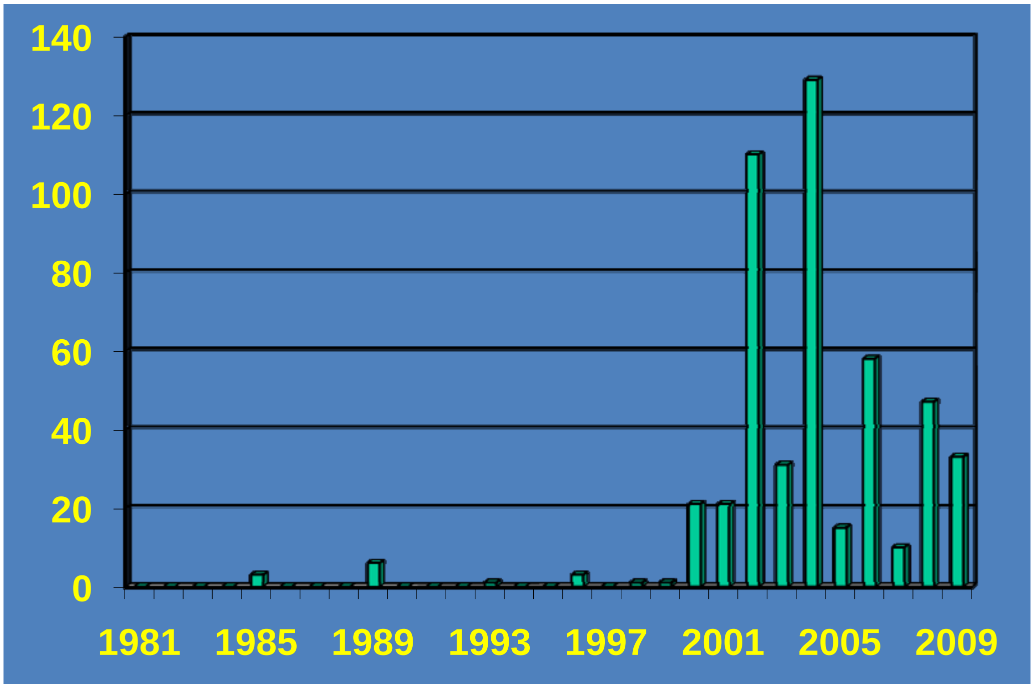
Figure 2. Yakima River mouth return per spawner (adult-to-adult productivity) rates of Cle Elum Supplementation and Research Facility (CESRF) and wild/natural upper Yakima

spring Chinook for brood years 1997-2005. Note: Age-5 returns are not yet included for brood year 2005.



Methods and Discussion: Return per spawner rates for both CESRF and wild/natural upper Yakima spring Chinook are calculated using standard run reconstruction and brood/cohort methods from counts of marked (CESRF) and unmarked (wild/natural) fish at Roza Dam, age data from scale samples taken at Roza Dam, and in-basin harvest data. The CESRF is resulting in increased abundance of spring Chinook on the natural spawning grounds even in years when wild/natural productivity rates are less than 1.

Figure 3. Teanaway River Spring Chinook Redd Counts, 1981 – 2009.



Methods and Discussion: Redd surveys in the Teanaway River have been conducted annually by Yakama Nation staff since 1981. The Jack Creek acclimation site began releasing CESRF spring chinook in 2000, with the first age-4 females returning from these releases in 2002. Redd counts in this tributary have increased from a pre-supplementation average of 3 redds per year to a post supplementation average of 54 redds per year. In addition, the number of natural origin spawners has increased in the targeted Teanaway River indicating this approach may be successful for reintroduction of salmonids into underutilized habitat.

For detailed data and supporting information, see Appendix A of this report and the references to WDFW reports shown under tasks 1.b, 1.k, 1.l, 3.a-3.b, and 4.c-4.d of this report.

Fall Chinook

The YKFP is presently studying the release of over 2.0 million Upriver Bright fall Chinook smolts annually from the Prosser and Marion Drain Hatcheries. These fish are a combination of in-basin production from brood stock collected in the vicinity of Prosser Dam plus out-of-basin Priest Rapids stock fish reared at Little White National Fish Hatchery and moved to Prosser Hatchery for final rearing and release. Marion Drain broodstock are collected from adult returns to a fishwheel in the drain. These fish contributed to the improved returns of fall Chinook to the Columbia River in recent years. The YKFP is investigating ways to improve the productivity of fish released from Prosser Hatchery and to improve in-basin natural production of fall Chinook. For example, rearing conditions designed to accelerate smoltification of Yakima Basin fall Chinook have resulted in smolt-to-smolt survival indices that exceeded those of conventionally reared fall Chinook in five of the six years for which results are available.

A Master Plan is being developed that proposes to: 1) transition out-of-basin brood source releases from the Little White Salmon National Fish Hatchery to Priest Rapids Hatchery and release these fish from acclimation sites in the lower Yakima River below Horn Rapids Dam, 2) continue development of an integrated production program above Prosser Dam using locally collected brood stock, 3) re-establish a summer-run component using an appropriate founder stock, and 4) upgrade existing brood collection, production and acclimation facilities to accommodate changes in production strategies. The total number of fish released would remain similar to existing levels.

Coho

The YKFP is presently studying the release of over 1.0 million coho smolts annually from acclimation sites in the Naches and Upper Yakima subbasins. These fish are a combination of in-basin production from brood stock collected in the vicinity of Prosser Dam plus out-of-basin stock generally reared at Willard or Eagle Creek National Fish Hatcheries and moved to the Yakima Subbasin for final rearing and release. YKFP monitoring of these efforts to re-introduce a sustainable, naturally spawning coho population in the Yakima Basin have indicated that adult coho returns averaged over 3,600 fish from 1997-2009 (an order of magnitude greater than the average for years prior to the project) including estimated returns of wild/natural coho averaging nearly 1,400 fish since 2001. Coho re-introduction research has demonstrated that hatchery-origin coho, with a legacy of as many as 10 to 30 generations of hatchery-influence, can reestablish a naturalized population after as few as 3 to 5 generations of outplanting in the wild (Bosch et al. 2007). The project is working to further develop a locally adapted broodstock and to establish specific release sites and strategies that optimize natural reproduction and survival.

Habitat

The project objectives include habitat protection and restoration in the most productive reaches of the Yakima Subbasin. The YKFP's Ecosystem Diagnosis Treatment (EDT) analysis will provide additional information related to habitat projects that will improve salmonid production in the Yakima Subbasin. Major accomplishments to date include protection of 1,300 acres of prime floodplain habitat, reconnection and screening of over 20 miles of tributary habitat, substantial water savings through irrigation improvements, and restoration of over 80 acres of floodplain and side channels. Restoration designs are now complete for the middle reaches of Taneum and Swauk Creeks. Restoration designs for lower Swauk Creek are being finalized. A road alternatives analysis has been developed, including preliminary cost estimates for relocating a portion of a USFS road in the little Naches watershed. Appraisals have also been completed on important habitat properties, and we are trying to get some of these purchased.

Research

One of the YKFP's primary objectives is to provide knowledge about hatchery supplementation to resource managers and scientists throughout the Columbia River Basin, to determine if it may be used to mitigate effects of hydroelectric operations on anadromous fisheries. To facilitate this objective, the Project created a Data and Information Center (Center) in 1999. The Center's purpose is to gather, synthesize, catalogue, and disseminate data and information related to project research and production activities. Dissemination of accumulated project information occurs through the Project Annual Review (PAR) conference, the project web site (ykfp.org), other regional websites (e.g., DART, RMPC, PTAGIS, and Streamnet), numerous technical reports (such as BPA annual reports), publications, and other means (e.g., electronic mail). Data and results are published in the peer-reviewed literature as they become ripe. Since its inception, the YKFP has generated a number of technical manuscripts that are either in final internal review, in peer review, are in press, or are published. Please refer to the project web site for a complete list of project technical reports and publications. Project publications for this performance period relevant to this specific contract include:

Knudsen, C. M., M. V. Johnston, S. L. Schroder, W. J. Bosch, D. E. Fast, and C. R. Strom. 2009. Effects of passive integrated transponder tags on smolt-to-adult recruit survival, growth, and behavior of hatchery spring

Chinook salmon. North American Journal of Fisheries Management 29:658-669.

Introduction

While the statement of work for this contract period was provided in work element format, we believe that annual progress is best organized and communicated by task as presented in our FY2007-2009 proposal. The monitoring and evaluation program for the YKFP was organized into four categories- Natural Production (tasks 1.a - 1.p), Harvest (tasks 2.a and 2.b), Genetics (tasks 3.a and 3.b) and Ecological Interactions (tasks 4.a – 4.d). This annual report specifically discusses tasks directly conducted by the Yakama Nation during fiscal year 2009. Those tasks that are conducted directly by the Washington State Department of Fish and Wildlife cite the written report where a complete discussion of that task can be found. International Statistical Training and Technical Services (IntStats) provides the biometrical support for the YKFP and IntStats' written reports for tasks 1.c, 1.d, 1.e, 1.f, and 1.g are included in full as appendices to this report. Some tasks have been completed or have been discontinued; information regarding these tasks was published in prior annual reports.

Contributing authors from the Yakama Nation YKFP in alphabetical order are: Bill Bosch, Melinda Davis, Chris Frederiksen, David Lind, Jim Matthews, Todd Newsome, Michael Porter and Sara Sohappy. Doug Neeley of Intstats Consulting also provided material used in this report, some or all of which are included as appendices.

Special acknowledgement and recognition is owed to all of the dedicated YKFP personnel who are working on various tasks. The referenced accomplishments and achievements are a direct result of their dedication and desire to seek positive results for the betterment of the resource. The readers of this report are requested to pay special attention to the Personnel Acknowledgements. Also, these achievements are attainable because of the efficient and essential administrative support received from all of the office and administrative support personnel for the YKFP.

We also wish to thank the Bonneville Power Administration for their continued support of these projects which we consider vital to salmon restoration efforts in the Yakima River Basin.

NATURAL PRODUCTION

Overall Objective: Determine if supplementation and habitat actions increase natural production. Evaluate changes in natural production with specified statistical power.

Task 1.a Modeling

Rationale: To design complementary supplementation/habitat enhancement programs for targeted stocks with computer models incorporating empirical estimates of life-stage-specific survival and habitat quality and quantity.

Methods: To diagnose the fundamental environmental factors limiting natural production, and to estimate the relative improvements in production that would result from a combination of habitat enhancement and supplementation using models such as "Ecosystem Diagnosis and Treatment" (EDT) and All-H analyzer (AHA). Additional information about these models can be obtained through ICF, Jones, and Stokes.

Progress: For the contract year covered in this report, efforts under this task were conducted in support of the following:

- **Yakima *O. mykiss* Life-History Response Modeling** (with WDFW and Cramer Fish Sciences)

  Sympatric population dynamics between anadromous and resident forms of *O. mykiss* have been identified as a critical uncertainty by the U.S. National Marine Fisheries Service in their evaluations of threatened and endangered steelhead populations (71 FR 839). More specifically, the ability of one ecotype to produce the other and its influence on population viability have not been integrated into current population viability analyses used for status and trend assessments. Genetics studies confirm that anadromous and resident individuals commonly interbreed, and otolith microchemistry and controlled breeding experiments have found that both life-history types produce offspring of the alternate ecotype. A pilot version of the sympatric life-cycle model has recently been completed using empirical data that includes demographic and abundance data specific for steelhead, resident trout, and juvenile *O. mykiss*. The model incorporates interactions between anadromous and resident *O. mykiss* at the spawning and rearing life-stages. The primary application of the model is to generate hypotheses and increase our understanding of sympatric population dynamics that can assist in future population viability analyses. The model will also be capable of predicting changes in steelhead abundance based on newly opened habitat, habitat restoration, and improvements in smolt-to-adult return rates. A version of the model can be downloaded under Yakima *O. mykiss* Life-History Response Modeling found at Cramer Fish Sciences' website. Additional model development and data collection needs specific to model parameters will be conducted as NPCC "fast track" proposal 201003000 is implemented.

- **Summer/Fall Chinook Salmon Summits** (with WDFW, USFWS, NMFS, and Colville Tribes)

  The goal of the summit was to develop and refine options for management actions as appropriate to ensure conservation objectives, artificial production objectives and harvest management objectives are well linked to protect and perpetuate this valuable natural resource. The joint meetings, referred to as 'Summer Chinook Summits' have covered a broad range of information, including the recent assessments by the HSRG, observations of adult returns, spawning levels and productivity estimates, harvest and exploitation rates, modeling of population response to increased hatchery production from the upcoming Chief Joseph Hatchery and other mitigation programs, population structure, and conservation objectives

  The Summit participants' summer/fall Chinook model was built to estimate harvest rates (HR) and exploitation rates (ER) for Columbia River fisheries; for current conditions, near-term conditions, where hatchery production increased by 122%, and long-term conditions where there was a 122% increase in hatchery production and a corresponding 44% increase in wild production. The three populations that HR and ER were estimated for were the Wenatchee, Methow and Okanogan. For each population, there were three scenarios modeled with three run sizes for each scenario. Proceedings and findings from the Summer/Fall Chinook Salmon Summits provide a detailed status report.

Task 1.b Percent habitat saturation and limiting factors

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/searchpublications/. This year's report is expected to be available soon. The most recent report is:

Pearsons, T. N., C. L. Johnson, and G. M.Temple. 2008. Spring Chinook Salmon Interactions Indices and Residual/Precocious Male Monitoring in the Upper Yakima Basin; Yakima/Klickitat Fisheries Project Monitoring and Evaluation. Annual Report 2008. DOE/BP-00034450.

Task 1.c Yakima River Juvenile Spring Chinook Marking

Rationale: Estimate hatchery spring Chinook smolt-to-smolt survival at CJMF and Columbia River projects, and smolt-to-adult survival at Bonneville (PIT tags) and Roza (PIT and CWT) dams.

Method: Brood year 2001 marked the last brood year of the OCT/SNT treatment cycle. The last five-year old adults from this experiment returned in 2006 (see Fast et al 2008 for results). For brood years 2002-2004, the YKFP tested two different feeding regimes to determine whether a slowed-growth regime can reduce the incidence of precocialism (Larsen et al 2004 and 2006) without a reduction in post-release survival. The two growth regimes tested were a normal (HI) growth regime resulting in fish which were about 30/pound at release and a slowed growth regime (LO) resulting in fish which were about 45/pound at release. For brood years 2005 and 2007, the YKFP is testing a saltwater transition feed during the acclimation rearing phase to see if it improves survival to returning adult relative to standard nutritional feeds. For brood year 2006, we are testing a moist feed (EWOS, Canada) against a standard feed (BioVita, BioOregon, Inc., Oregon). However, because of high mortality rates associated with the EWOS feed, all fish were put on the same BioVita diet on May 3, 2007 after approximately two months of experimental and control diets. In addition to these treatments, the YKFP initiated a hatchery-control line in 2002 to test differences in fish that have only one generation of exposure to the hatchery environment (supplementation line whose parents are always natural-origin fish) to fish that have multiple generations of hatchery exposure (hatchery control line whose parents are always hatchery-origin fish).

To estimate smolt-to-smolt survival by rearing treatment, acclimation location and raceway, we PIT tagged and adipose clipped the minimum number to determine statistically meaningful differences detected at CJMF and lower Columbia River projects. The remaining fish are adipose fin clipped and tagged with visual implant elastomer (VIE) tags in the adipose eyelid tissue and also with coded wire tags in either the snout or the posterior dorsal area. This allows unique marking for rearing treatment, acclimation location, and raceway. Returning adults that are adipose clipped at Roza Dam Broodstock Collection Facility (RDBCF) are interrogated using a hand-held CWT detector to determine the presence/absence of body tags. We recover coded-wire tags during spawning ground surveys. We will use ANOVA to determine significant differences between treatment groups for both smolt-to-smolt and smolt-to-adult survival and report on these data annually.

Progress: Tagging of brood year 2008 fish began at the Cle Elum hatchery on October 19, 2009 and was completed on December 14, 2009. Marking results are summarized in Table 1. Appendix A contains mark summary data for brood years since 2002 (see previous annual reports for earlier brood years). As in prior years, all fish were adipose fin-clipped. Between 2,000 and 4,000 fish (4.0% to 8.2% of the fish) in each of 18 raceways were CWT tagged in the either the snout or the posterior dorsal area and then PIT tagged. The remaining progeny of natural brood parents (~754,000 fish) had a CWT placed in their snout, while the remaining progeny of hatchery brood parents (hatchery control line; ~97,600 fish) had a CWT placed near their posterior dorsal fin. Previously CWTs were placed in one of six body locations to designate acclimation site raceways at release. However, beginning with brood year 2004, it was determined that placing CWTs in the snout would provide more information about harvest of CESRF fish in out-of-basin fisheries. All fish which were not PIT-tagged had a colored elastomer dye placed into the adipose eyelid. The three colors of elastomer dye in the adipose eyelid corresponded to the three acclimation sites (red = Clark Flat, orange = Easton, and green = Jack Creek). A final quality control check by YN staff took place on December 29, 2009 (ponds 1-14) and December 30, 2009 (ponds 15-18). Estimated tag retention was generally good, ranging from 80-100% for CWT and 86-100% for elastomer tags.

Smolt-to-smolt and smolt-to-adult survival data and analyses for brood years 1997-2001 OCT/SNT treatments were published (see Fast et al 2008).

Appendix B contains an analysis of various smolt measures including smolt-to-smolt survival for supplementation (natural-by-natural crosses) and hatchery-control (hatchery-by-hatchery crosses) fish for release years 2004-2009 (brood years 2002-2007). Additional survival data across years are given in Appendix A.

Table 1. Summary of 2008 brood year marking activities at the Cle Elum Supplementation and Research Facility.

CE RW ID	Treat-ment	Accl ID	Cross Type	Elastomer Eye Site	Elastomer Eye Color	CWT Body site	Number Tagged CWT	Number Tagged PIT	Number Tagged Total	Start Date	Finish Date
CLE01	BIO	ESJ01	WW	Right	Orange	Snout	44917	2000	46917	19-Oct-09	22-Oct-09
CLE02	BIO	ESJ02	WW	Left	Orange	Snout	45576	2000	47576	22-Oct-09	27-Oct-09
CLE03	BIO	CFJ03	WW	Right	Red	Snout	44099	2000	46099	27-Oct-09	30-Oct-09
CLE04	BIO	CFJ04	WW	Left	Red	Snout	42464	2000	44464	30-Oct-09	04-Nov-09
CLE05	BIO	JCJ05	WW	Right	Green	Snout	46118	2000	48118	05-Nov-09	09-Nov-09
CLE06	BIO	JCJ06	WW	Left	Green	Snout	43708	2000	45708	09-Nov-09	11-Nov-09
CLE07	BIO	ESJ05	WW	Right	Orange	Snout	48468	2000	50468	12-Nov-09	17-Nov-09
CLE08	BIO	ESJ06	WW	Left	Orange	Snout	47611	2000	49611	18-Nov-09	23-Nov-09
CLE09	BIO	CFJ05	HH	Right	Red	Posterior Dorsal	45169	4000	49169	23-Nov-09	30-Nov-09
CLE10	BIO	CFJ06	HH	Left	Red	Posterior Dorsal	44493	4000	48493	01-Dec-09	07-Dec-09
CLE11	BIO	JCJ01	WW	Right	Green	Snout	44583	2000	46583	09-Dec-09	14-Dec-09
CLE12	BIO	JCJ02	WW	Left	Green	Snout	45086	2000	47086	03-Dec-09	10-Dec-09
CLE13	BIO	ESJ03	WW	Right	Orange	Snout	45518	2000	47518	25-Nov-09	03-Dec-09
CLE14	BIO	ESJ04	WW	Left	Orange	Snout	44879	2000	46879	20-Nov-09	25-Nov-09
CLE15	BIO	CFJ01	WW	Right	Red	Snout	45169	2000	47169	16-Nov-09	19-Nov-09
CLE16	BIO	CFJ02	WW	Left	Red	Snout	44149	2000	46149	10-Nov-09	16-Nov-09
CLE17	BIO	JCJ03	WW	Right	Green	Snout	45807	2000	47807	05-Nov-09	09-Nov-09
CLE18	BIO	JCJ04	WW	Left	Green	Snout	45157	2000	47157	29-Oct-09	04-Nov-09

Task 1.d Roza Juvenile Wild/Hatchery Spring Chinook Smolt PIT Tagging

Rationale: To capture and PIT tag wild and hatchery spring Chinook to estimate: 1) wild and hatchery smolt-to-smolt survival to CJMF and the lower Columbia River projects, and 2) to estimate differential smolt-to-adult survival between winter and spring migrant fish.

Methods: The Roza Dam juvenile fish bypass trap was used to capture wild and hatchery spring Chinook pre-smolts. The trap was operated from February 4, 2009 through May 13, 2009. The trap was fished five days per week, 24 hours per day. Fish were removed from the trap each morning, PIT tagged on site, and released the following day after recovery. Fish tagged on Friday mornings were released on Friday afternoons.

Progress: A total of 6,055 (2,049 wild and 4,006 hatchery) juvenile spring Chinook were PIT tagged from fish collected at the Roza juvenile fish bypass trap. Wild fish were tagged from February 4, 2009 through May 13, 2009; and hatchery fish March 19 through May 13, 2009.

Appendix C contains a detailed analysis of wild/natural and CESRF (hatchery) smolt-to-smolt survival for Roza-tagged releases for brood year 2007 (migration year 2009) and summarizes these data for prior brood years 1997-

2007 (migration years 1999-2009). Additional data on this task are provided in Appendix A.

Task 1.e Yakima River Wild/Hatchery Salmonid Survival and Enumeration (CJMF)

Rationale: As referenced in the YKFP Monitoring Plan (Busack et al. 1997), CJMF is a vital aspect of the overall M&E for YKFP. The baseline data collected at CJMF includes: stock composition of smolts, outmigration timing, egg-to-smolt and/or smolt-to-smolt survival rates, hatchery versus wild (mark) enumeration, and differences in fish survival rates between rearing treatments for CESRF spring Chinook. Monitoring of these parameters is essential to determine whether post-supplementation changes are consistent with increased natural production. This data can be gathered for all anadromous salmonids within the basin.

In addition, the ongoing fish entrainment study is used to refine smolt count estimates, both present and historic, as adjustments are made to the CJMF fish entrainment to river discharge logistical relationship.

The facility also collects steelhead kelts for the kelt reconditioning project, and conducts trap and haul operations when conditions in the lower Yakima are not favorable to smolt survival.

Methods: The CJMF is operated on an annual basis, with smolt enumeration efforts conducted from late winter through early summer corresponding with salmonid smolt out-migrations. A sub-sample of salmonid outmigrants is bio-sampled on a daily basis and all PIT tagged fish are interrogated.

Replicate releases of PIT tagged smolts were made in order to estimate the fish entrainment and canal survival rates in relation to river conditions. The entrainment rate estimates were used in concert with a suite of independent environmental variables to generate a multi-variate smolt passage relationship and subsequently to derive passage estimates with confidence intervals (see Appendix D for details).

PIT tag detections were expanded to calculate passage of hatchery fish, although hand-held CWT detectors were also used to scan for body-tags on hatchery spring Chinook smolts. This monitoring and evaluation protocol is built in as a backup in the event that the corresponding PIT tagged fish from each CESRF treatment group failed to be accurately detected by the PIT detectors stationed at the CJMF. Fortunately there was good correspondence between the detection rates between the two mark groups.

Progress: The 2009 smolt passage estimates were as follows: natural-origin spring Chinook – 107,263; hatchery-origin spring Chinook– 176,489; unmarked fall Chinook– 77,312; natural-origin coho– 50,635; hatchery-origin coho– 44,239; and wild steelhead– 28,754. These estimates are provisional and subject to change as better entrainment estimates are developed. Appendix D contains an updated analysis of data obtained from these studies. These data are being reviewed and may be updated in the future. Additional data on this task are also provided in Appendix A.

Personnel Acknowledgements: Biologist Mark Johnston and Fisheries Technician Leroy Senator are, respectively, the project supervisors and on-site supervisor of CJMF operations. Other Technicians that assisted are Sy Billy, Wayne Smartlowit, Morales Ganuelas, Pharamond Johnson, Steve Salinas, Shiela Decoteau, Jimmy Joe Olney and Tammy Swan. Biologist David Lind uploads and queries PIT tag information, and performs daily passage calculations based on entrainment and canal survival estimates developed by consultant Doug Neeley.

Task 1.f.1 Yakima River Fall Run Chinook Survival Monitoring & Evaluation

Rationale: To determine optimal rearing treatments and acclimation site location(s) to increase overall smolt passage and smolt-to-adult survival.

Method: In BY2007, we implemented two new experiments: 1) Using our in-basin stock, we compared a group of the accelerated subyearlings versus a group of yearling releases (BY2006). This experiment is on-going. Both groups were 100% adipose clipped and PIT tagged for monitoring. 2) Using our out-of-basin Little White Salmon (LWS) stock, we compared survival to in-basin stock. All experimental groups were monitored using PIT tags.

Progress: Using the BY2007 in-basin stock (subyearlings), we entered into the second year release comparison of the subyearling vs. yearling rearing treatments. The subyearlings were reared using an accelerated strategy already determined to have better survival than the traditional conventional method. Survival of smolts to McNary Dam was monitored via PIT tags. For the initial releases in 2008 (BY2006), we marked 100% of the fish either with a PIT tag or an Adipose (AD) fin clip. We released 1,811 yearlings and 10,007 subyearlings. Both Tagging-to-McNary and Release-to-McNary Survivals were substantially and significantly greater for yearling compared to sub-yearling releases (respectively 61.6% and 37.4% for Tagging-to-McNary Survival, $P < 0.020$; and 65.2% and 49.9% for Release-to-McNary Survival, $P = 0.039$); whereas Pre-Release survivals from time of tagging were nearly the same (respectively 94.6% and 92.3%, $P = 0.81$; D. Neeley, Appendix E in Sampson et al. 2009). As was the case for other comparisons, the higher survival to McNary was associated with an earlier detection date (04/22 for Yearling and 05/31 for Sub-Yearling, $P < 0.0001$; D. Neeley, Appendix E in Sampson et al. 2009).

For the 2009 (BY2007) releases, we PIT tagged approximately 7,516 yearlings and 7,567 (BY2008) subyearlings. For the combined 2008 and 2009 migration years, release-to-McNary survival was significantly higher for the yearling releases (71.8%) compared to subyearling releases (39.9%, $p < 0.0001$; D. Neeley, Appendix E). The yearling-subyearling difference was substantially greater for 2009 migrants (74.3% to 28.4% respectively) than for 2008 migrants (65.2% to 49.9% respectively). The 2010 release data are pending; however, using "raw" detections at McNary, the yearlings have out-numbered the subyearling releases in detections.

We also compared juvenile survival differences for Little White stock and Yakima brood source releases. In spite of a higher Yakima-stock release-to-McNary survival compared to the Little White stock for migration year 2007 (D. Neeley, Appendix E in Sampson et al. 2009), the Yakima-stock release-to-McNary survival was not significantly higher than that for the Little-White stock over the three migration years 2007-2009 ($p = 0.31$; D. Neeley, Appendix E).

The Yakima Subbasin Summer and Fall Run Chinook Master Plan (in development) proposes to transition the existing hatchery program. Fall Chinook from Little White Salmon would be replaced with an egg transfer from Priest Rapids Hatchery (PRH) or an adult brood collection program at Priest Rapids Dam. This stock transition was recommended by both the USFWS hatchery review and the HSRG. The Prosser Hatchery would be expanded as necessary to accommodate the program, including changes necessary for fish health and disease considerations. Fish would be released from acclimation site(s) in the lower Yakima River below Horn Rapids Dam. In addition, an integrated program using local fall Chinook brood stock to augment harvest and natural spawning escapement would continue to be developed. This program will use local brood stock collected at or near Prosser

Dam and will mark releases so that natural-origin returns can be distinguished. These fish would be released from Prosser Hatchery. Pursuant to the Little White to Priest Rapids stock transition we plan to import 500,000 eyed eggs from Priest Rapids Hatchery for BY2010 as a pilot study. The 1.7 million John Day Mitigation fish from LWS hatchery will continue until details for the transition to Priest Rapids stock are finalized.

Historically, we have released fall run Chinook from Prosser Hatchery, Marion Drain, Stiles pond (lower Naches River), Billy's pond (Union Gap) and a one-time release from Skov pond (Selah, WA). Fish released in 2008 (BY2007) were the last fall run Chinook to be released above Prosser Hatchery. Beginning with BY2008, fall run Chinook have been released at or below Prosser Hatchery. We are currently investigating possible acclimation sites below Prosser Dam near the Tri-Cities.

Brood year 2008 marked the beginning of a Yakama Nation initiative to restore summer run Chinook (NOAA Fisheries grouped summer and fall run Chinook together as part of the Upper Columbia River ESU) to the Yakima Basin (Task 1.f.2). Summer run Chinook (BY2008) were imported from Wells Hatchery as green eggs, incubated and reared at Prosser Hatchery with final acclimation rearing and release at Stiles pond in 2009. Summer run Chinook will be the only fish acclimated and released above Prosser Hatchery in the future.

BY2009 was the last brood year that adults were taken using the adult fish wheel trap in the Marion Drain. Marion Drain adults will be DNA-sampled again in 2014 for the purpose of monitoring the population. The Marion Drain Hatchery will now be used primarily for summer run Chinook. The combined annual release goal for the fall-run and summer-run program is approximately 2.0 to 2.7 million Chinook.

Task 1.f.2 Yakima River Summer Run Chinook Monitoring & Evaluation

Rationale: Investigate the feasibility of re-establishing a summer run Chinook population in the Yakima River.

Method: In brood year 2008, the Yakama Nation imported approximately 200,000 green eggs and milt from an equal number of individual females and males from the Washington State Department of Fisheries Wells Hatchery in Pateros, WA. This egg take was repeated with BY2009 and will continue for future years until a more suitable broodstock is available, or sufficient numbers of summer Chinook adults return to the Yakima River for collection in the Yakima basin. The YN in cooperation with Wells Hatchery staff spawned the fish at Wells Hatchery and transferred the eggs and milt to the Yakama Nation Prosser Hatchery in Prosser, WA (BY2008) and Marion Drain Hatchery in Toppenish, WA (BY2009). All of the individual females were tested for virus and BKD at Wells Hatchery. Pathology was conducted by the US Fish and Wildlife Service. Eggs from the individual females were fertilized using the imported milt from Wells Hatchery males. The individual lots of eggs were quarantined until fish health sampling results were confirmed negative. Incubation and rearing to the sub-yearling stage for BY2009 remained entirely at the Marion Drain Hatchery. Final acclimation of all fish was located at Stiles Pond, ~RM 3.4 of the Naches River.

Progress: For BY2008 fish, pathology results for 100% of the females were clean and cleared for release. Incubation temperatures were kept below 49·F to limit mortality resulting from coagulated yolk, a problem associated with this stock of fish at Wells Hatchery. These cooler temperatures resulted in low mortality. However, growth was slow which delayed our ability to mark these fish early enough to allow for a minimum acclimation period at Stiles pond and a release period with flows and temperatures conducive to good survival. Survival from release to McNary for the 2009 release year was estimated to be only 1.8% (D. Neeley, Appendix E). Low survival was attributed to minimal acclimation and late release time (June 12th, 2009). A blockage in the fish bypass of the Wapato Dam also contributed to the low survival to both Prosser and McNary Dams (see Task 4.b).

For the BY2009 collection, eggs were incubated at a warmer ~52·F using a mixture of both well and river water. The slightly warmer temperature allowed for earlier application of CWTs and transfer of fish to Stiles Pond for acclimation. Approximately 200,747 fish were transferred to Stiles with 29,997 PIT tagged and 170,750 CWT only. Fish were released on May 14th, 2010, about a month earlier than the previous year and an effort was made to improve fish passage at Wapato Dam. PIT tags were monitored at both Prosser and McNary Dams and survival for these 2010 summer run releases will be reported in next year's annual report.

Task 1.g Yakima River Coho Optimal Stock, Temporal, and Geographic Study

Objective: The ultimate goal of the Yakima coho reintroduction project is to determine whether adaptation and recolonization success is feasible and to reestablish sustainable populations in the wild.

Rationale: Determine the optimal locations, life stage, release timing, and brood source that will maximize opportunities to achieve the long-term objective. Monitor trends in returning adults (e.g., abundance of natural- and hatchery-origin returns, spawning distribution, return timing, age and size at return, etc.) to evaluate progress towards achieving objectives. Continue to investigate the coho life history in the Yakima Basin. Assess ecological interactions (see tasks under Objective 4). Develop and test use of additional culturing, acclimation, and monitoring sites.

By the middle 1980s, coho were extirpated from the Yakima Basin and large portions of the middle and upper Columbia River Basins. This project is attempting to restore some of this loss pursuant to mitigation and treaty trust obligations embodied in the NPCC FWP and *U.S. v Oregon* agreements. Questions regarding rates of naturalization for hatchery-origin fish allowed to spawn in the wild and integration of hatchery and natural populations have been identified as high priority research needs by the NPCC. Restoration of coho salmon to the Yakima Basin and other middle and upper Columbia River Basins is also consistent with stated ecosystem restoration goals in the FWP and subbasin plans. Monitoring and evaluation results will facilitate decision making regarding long-term facility needs for coho.

Method: ***Phase I (1999-2003)*** Phase I of the coho study was designed to collect some preliminary information relative to the project's long-term objective and to test for survival differences between: out-of-basin and local (Prosser Hatchery) brood sources; release location (acclimation sites in the upper Yakima and Naches sub basins); and early versus late release date (May 7 and May 31). Phase I has been completed and results are published:

> Bosch, W. J., T. H. Newsome, J. L. Dunnigan, J. D. Hubble, D. Neeley, D. T. Lind, D. E. Fast, L. L. Lamebull, and J. W. Blodgett. 2007. Evaluating the Feasibility of Reestablishing a Coho Salmon Population in the Yakima River, Washington. North American Journal of Fisheries Management 27:198-214.

Phase II (2004-2011) Implementation plans and guidance for phase II of the coho feasibility study are documented in the current coho master plan (Hubble et al. 2004). We are continuing to test survival from specific acclimation sites: Holmes and Boone ponds in the Upper Yakima and Lost Creek and Stiles ponds in the Naches subbasins. Each acclimation site releases fish from both local and out-of-basin brood sources and approximately 2,500 PIT tags represent each group at each acclimation site during the normal acclimation period of February through May. Acclimation sites have PIT tag detectors to evaluate fish movement during the late winter and early spring. Fish are released volitionally, beginning the first Monday of April. However, in an extreme drought emergency, project guidelines allow coho to be moved to acclimation sites earlier and forced out of acclimation sites in March. Up to 3,000 PIT-tagged coho (parr stage) are also planted into select tributaries during late summer to assess and monitor over winter survival and adults are also planted in select tributaries to assess spawning and rearing success.

Progress:

The program completed an interim phase (2004-2006) including necessary planning and environmental assessment work and moved to Phase II implementation activities in 2007. The 4 progressive goals of Phase I continue to be monitored in Phase II:

1. Increase juvenile survival out of the Yakima sub-basin (metric: smolt passage estimates at Chandler and estimated smolt survival from tagging and release to McNary Dam using PIT-tagged fish)
2. Increase natural production (metrics: dam counts and sampling, redd counts)
3. Continue to develop a local (Yakima Basin) coho brood stock
4. Increase smolt to adult return rates for both natural- and hatchery-origin coho (metric: Chandler juvenile and Prosser adult counts and sampling).

Estimated hatchery-origin coho smolt passage to McNary Dam increased dramatically in 2009 to approximately 306,500. Redd counts also increased dramatically with coho returns to the Yakima Basin highest in recent record. Development of the local coho brood source continues and smolt-to-adult return rates are encouraging, especially for natural-origin coho. Redd surveys are showing nearly all the spawning in areas above Wapato Dam. Radio telemetry has provided evidence of more adults using tributaries and venturing into new, unseeded areas and some adult coho are returning to the furthest upriver acclimation sites (e.g., Lost Creek and Easton Acclimation Sites). Additionally, radio tagged adults returning from the summer parr releases showed excellent homing fidelity.

Phase II Goals

1. Monitor and evaluate juvenile coho survival in tributaries.
2. Monitor and assess overall spawning success in select tributaries.
3. Test and monitor possible new acclimation techniques.
4. Continue to advance to a 100% in basin (local brood source) coho program.

2009 Methods

The 2009 juvenile coho releases again tested in-basin vs. out-of-basin stocks within acclimation sites. Approximately, 2,500 PIT tags (two 1,250 replicates) for each stock were put in each acclimation site, totaling 5,000 PIT tags per site (except Easton). Each acclimation site was fitted with multiple outlet PIT tag detectors. The fish were released volitionally on the first Monday in April. Smolts reared in the Mobile Acclimation unit were also PIT-tagged to assess migration success. Adult returns were monitored at the Prosser Right Bank Alaskan Steep Pass Denil, Roza Dam and by radio tracking. Redd surveys were conducted from October through December in the maintsem Yakima and Naches Rivers as well as select tributaries.

2009 Results

Juvenile Survival

In 2009, dual PIT tag detectors were used at Prosser, Holmes, Lost Creek and Stiles to evaluate survival of PIT tagged coho from acclimation sites to McNary Dam. Using two detectors enabled significant gains in detection efficiency. Lost Creek and Stiles had tag detection efficiencies between 95% and 100%. The Holmes acclimation site had only one detector and very few detections because of flooding and mechanical trouble. The Prosser Hatchery outfall also had very good detection efficiency.

Survival estimates were calculated for the number of juvenile smolts that were PIT-tagged and released from the acclimation sites to passage at McNary Dam. Survival was greater for Naches subbasin releases than for upper Yakima River releases (Table 2). This was true for both out-of-basin (Eagle Creek NFH) and local brood source fish. Within the Naches subbasin, the Stiles Pond survival index was higher than Lost Creek. Tagging-to-McNary Dam survival of smolts migrating in 2009 was greater for local brood source coho released in the Naches system but approximately 3% less than Eagle Creek brood source for coho released in the Upper Yakima. The mean estimated survival from tagging to McNary Dam passage over all 3 upriver release sites was about 30% for the Yakima (local) brood source compared to about 31% for Eagle Creek brood source smolts. There was no significant difference in release-year 2006 through 2009 tagging-to-McNary smolt-to-smolt survivals between the Eagle Creek and the Yakima (local) brood sources ($P = 0.30$; D. Neeley, Appendix F).

The pre-release survival (tagging to release) of the Eagle Creek brood-stock was significantly greater than that of the Yakima (local) brood-stock ($P < 0.0002$; D. Neeley, Appendix F), but the survival from detection at time of volitional release from acclimation sites to McNary passage was significantly less for Eagle Creek brood source than for the Yakima (local) brood source ($P < 0.0001$; D. Neeley, Appendix F). The combined effects of the significantly higher pre-release survival and the significantly lower release-to-McNary survival of the Eagle Creek brood-stock probably contributed to the failure to detect a significant difference between the two brood sources' tagging-to-McNary survival which is a combination of pre-release and release-to-McNary survivals. These data may indicate differential tagging-induced mortality effects between the two brood sources. We investigated the causes of this and decided to tag both stocks within the same month. See Appendix F for a detailed report and analysis of coho juvenile survival indices for 2009 and prior year releases.

Table 2. Estimated percentage of 2009 smolts that were PIT-tagged and released from acclimation sites and survived to McNary Dam (tagging-to-McNary juvenile survival indices) by brood source and acclimation site (D. Neeley, Appendix F).

	Acclimation Site[1]			Pooled
Brood Source	Stiles	Lost Cr.	Holmes	Mean
Yakima (local)	47.3	33.7	9.2	30.1
Eagle Creek	40.8	27.8	12.0	31.3

[1] Boone pond was not used in the analysis for 2009 due to ice.

Parr Releases

Summer Parr were released into tributaries throughout both the Upper Yakima and Naches basins. Up to 3,000 PIT-tagged parr were released in North Fork Little Naches, Little Naches, Cowiche Creek, Nile Creek, Wilson Creek, Ahtanum Creek, Reecer Creek, Little Rattlesnake Creek and Big Creek. The summer coho parr were approximately 70-85mm in length and were in excellent shape. The fish were scatter planted throughout each system. The coho were distributed using buckets with aerators.

Appendix F gives estimated tagging to McNary survivals for parr releases from 2005 through 2009. Coho parr survival (tagging-to-McNary) has generally been good, with survival estimates close to or exceeding smolt survival estimates for some sites in some years. The highest tagging-to-McNary survival estimate at any site in any year was 32% in 2009 for parr released in July of 2008 into the lowest elevation tributary, Reecer Creek. South Fork Cowiche Creek also had excellent survival for July 2008 parr plants (2009 outmigrants) at nearly 24% estimated tagging-to-McNary smolt survival. Most other tributaries also had good survival (1.9-19 percent tagging-to-McNary smolt survival). A preliminary trend in the data is showing that higher elevation tributaries are subject to lower survival (Figure 4). Even tributaries with excellent habitat (North Fork Little Naches) showed lower survival compared to the lowest elevation tributaries. There are some anomalies. Ahtanum Creek is the third lowest in elevation and had only average survival. Some further investigations will need to be done to understand these differences. We intend to use these data over the next 3 years to better target our tributary recovery efforts.

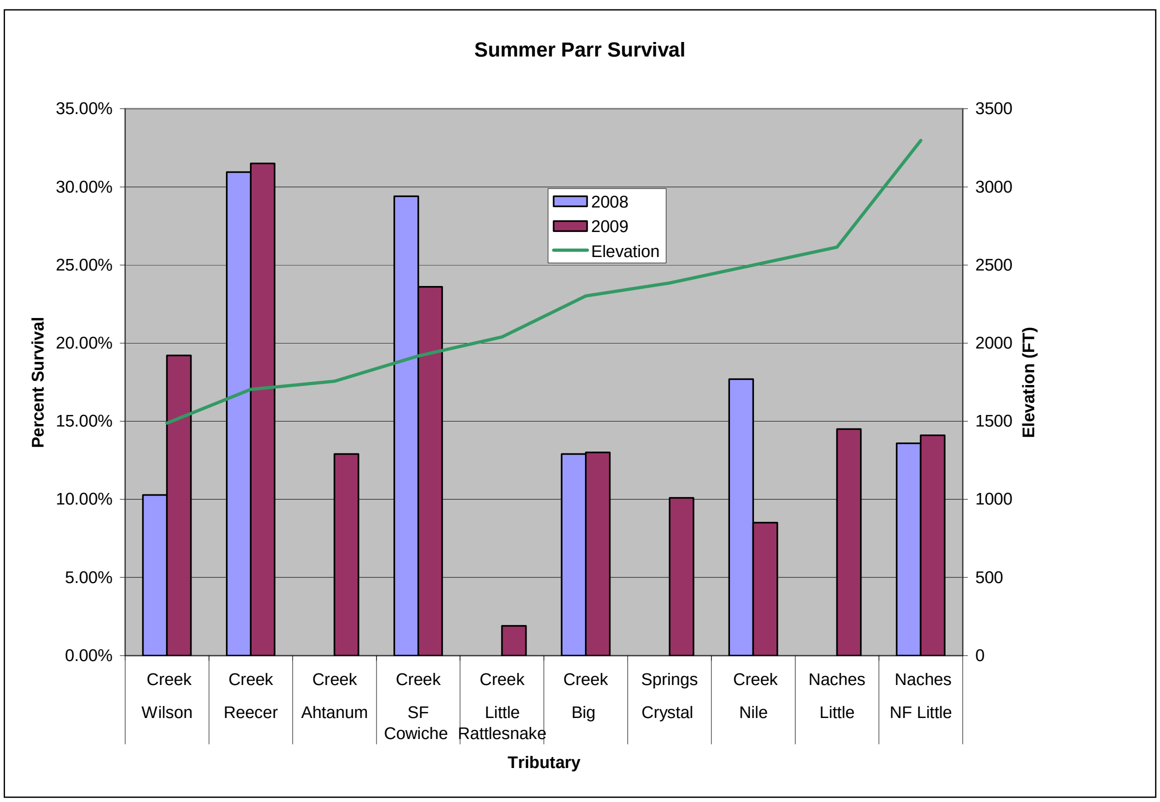


Figure 4. Summer parr survival from tagging to smolt passage at McNary Dam for coho plants by tributary for outmigration years 2008 and 2009. Tributaries are shown from lowest elevation on left of chart to highest elevation on right.

Adult Outplants

Adult Coho were out planted in Nile Creek, Ahtanum Creek and Taneum Creek. Twenty pairs of coho were put into Nile and Ahtanum Creeks in early November. Approximately 300 adults were planted into 3 separate sections of Taneum Creek. Each section contained 50 males and 50 females. All adults were of unknown hatchery origin and collected off the right bank Steep Pass Denil at Prosser Dam. The fish for Taneum Creek were held until 300 adults were captured. Large 2,000 gallon fish hauling trucks were used to haul up to 50 adults per trip for release into Taneum Creek. Spawning coho were observed within days of release, but spawning lasted nearly a month in all three tributaries. Redd characteristics were measured in December.

The adults experienced very low mortality in transportation and movement into the stream, however, adults did experience some limited mortality from animals such as bear, bobcat and otter. Water conditions in 2009 were excellent with decent flows and there was no flooding. A total of 17 redds were located in Nile Creek, 8 in Ahtanum Creek and 130 in Taneum Creek. The data for 2009 was the highest redd counts for Taneum Creek that we have observed. Only 20 fish were unaccounted for. Nile Creek also had incredible success with only 3 fish unaccounted for. Ahtanum Creek was somewhat below 50% success with only 8 redds found. These data are much higher than 2007 observations when 6 redds were observed in Nile Creek, 4 in Cowiche Creek, and 75 in Taneum Creek. In 2008, Taneum Creek and other identified tributaries experienced very high flows, washing many fish out of designated reaches, affecting spawning activity, and our ability to locate redds.

The progeny of the 2007 Taneum Creek adult outplants were monitored in conjunction with the WDFW Ecological Interactions Team. Beginning in mid-summer (2008), sections of the Taneum system were electrofished to PIT-tag the natural-origin juvenile progeny of adult coho outplanted in 2007. Approximately 1,300 wild juvenile coho salmon were PIT-tagged. Condition of these juvenile coho fry was excellent. Juvenile out migration survival estimates were found to be approximately 16%. Adults from this group of smolts will be returning back to Taneum Creek in the fall of 2010 providing us actual instream smolt to adult returns for wild rearing Taneum Creek coho. In mid-summer (2009) over 1800 juvenile progeny of adults spawned in 2008 were PIT-tagged. These fish will migrate out in the spring of 2010.

Aggregate smolt passage and smolt-to-adult survival rates (SAR)

Overall smolt passage at Prosser in 2009 was estimated at about 306,490 hatchery coho (adjusted from Chandler counts using PIT tag survival to McNary Dam). This compared to a range of 14,000 to 285,000 coho smolts for the 2002-2008 migration years. In 2009, the estimated smolt-to-adult survival rate for 31,000 wild/natural origin coho smolts (counted at CJMF in 2008) was 7.9%. The estimated smolt-to-adult survival rate for 215,000 hatchery coho smolts (counted at CJMF in 2008) from releases in the Upper Yakima and Naches Rivers was 3.7%. The hatchery SAR was a dramatic increase over the prior 5-year average of approximately 1%.

The upward trends in overall smolt passage have ultimately increased the returns of hatchery-origin adults since 2006. Beginning in 2007, the adults that were PIT-tagged and unmarked escaped back to the upper Columbia River at much higher Smolt to Adult (SAR) return rates than the remaining marked fish. This difference was observed again in 2008 and we expect it will continue for at least 2 more years. The ocean and river fisheries target adipose clipped fish, therefore our PIT-tagged, unmarked adults are not representing the general release groups that are 100% adipose clipped. Therefore, beginning in 2009 all coho releases from Yakima (local) brood source will be coded wire tagged and not adipose-clipped to minimize their harvest in selective fisheries. This strategy should work to accelerate the local brood source production program.

The 2009 adult coho run was comprised of 1855 wild/natural (14%) and 6662 (86%) hatchery-origin adult coho the Prosser Dam and an estimated 1300 adults and jacks into the Prosser Hatchery swim-in trap. This was the ninth and final year this break down has been possible. The entire hatchery release group (except for pit tagged smolts) was 100% adipose fin clipped. The 2009 out-migration included smolts that were unmarked from hatchery out plants in Lake Cle Elum. Therefore, wild hatchery breakdowns will have to be extrapolated at the Prosser Denil using scales and CWT's beginning in 2011. The natural-origin broodstock will have to be taken off the Prosser Right Bank Denil and determined from the absence of a CWT.

The SAR's for summer parr releases surviving to McNary Dam as smolts were excellent. All juveniles migrating from the individual tributaries were PIT tagged. Smolt-to-adult return rates for the summer parr releases were estimated using PIT detections of juveniles and adults at McNary Dam. Wilson Creek had the highest at 10.3% followed by Cowiche and Reecer Creeks at 4.3% (Table 3). SARs for the summer parr releases were generally higher than the SARs for hatchery-origin smolt releases which averaged approximately 2% over the past 10 years.

Table 3. McNary Dam smolt-to-adult return rate estimates for 2007 summer parr releases in Yakima tributaries which returned in 2009.

Tributary	PITs Released	McNary juvenile detections	McNary Adult Detections	McNary smolt-to-adult return rate
Cowiche Cr.	3001	900	39	4.3%
Nile Cr.	3000	540	15	2.8%
N.F. Little Naches	3001	420	8	1.9%
Wilson Cr.	3000	300	31	10.3%
Reecer Cr.	3001	930	40	4.3%
Big Cr.	3001	390	8	2.1%

Results of 2009 Radio Telemetry Studies and adult PIT tag returns for Yakima Basin

During the 2009 adult migration we again only radio tagged adult coho that had a PIT tag present during capture. This gives managers much more information on homing fidelity than randomly tagging large groups of coho. For the Upper Yakima River the summer parr releases had an average of 76% homing fidelity versus the smolts for the Upper Yakima River which had 73% homing fidelity (percentages were from Prosser Dam to Roza Dam). Of the 7 Wilson Creek Coho that were radio tagged 5 were detected in Wilson Creek. There were 19 radio tagged Reecer Creek Adult Coho and 4 of them were detected in Reecer Creek. There were 9 Holmes returning adults tagged, two of these fish were detected in the Holmes acclimation area.

In the Naches River a PIT tag detector was located at the mouth of Cowiche Creek. The in stream adult PIT tag detections came from returning adults to Cowiche Creek. These adults came from 2007 summer parr plants. A mobile PIT tag detector was set up at the mouth of the creek and operated from October 5 through November 10. A total of 21 Cowiche Creek adults returned over Prosser Dam, and 17 were detected swimming into Cowiche Creek from 10/28 through 11/06 including 2 of the 6 radio tagged adults. For smolt acclimation and returning adults 2 of 5 radio tagged adult coho from Stiles were detected at or near Stiles. There were no Lost Creek Adults detected in the Naches River, however, redds were observed in and below the Lost Creek Acclimation site outfall.

Snorkel Surveys

Snorkel surveys to look for residualized juvenile coho were also conducted again in 2009. Surveys were conducted on the Upper Yakima River (Cle Elum Reach) from the Cle Elum Hatchery (Rkm 299) to the confluence of the Teanaway River (Rkm 283). In the Naches River (Lost Creek reach), surveys were done from the Lost Creek acclimation site (Rkm 61.8) to the confluence with Rock Creek (Rkm 53.9). A total of 1,500 meters of river was snorkeled in these surveys in 2005 and we found no incidence of age-0 precocials. There were significant numbers of sub yearling coho observed in the lower Naches River in 2009 surveys, indicating good natural production is occurring.

Personnel Acknowledgements: Special thanks to all the people involved in the coho monitoring and evaluation activities which also include redd surveys. These people include but are not limited to Joe Jay Pinkham III, Conan Northwind, Quincy Wallahee, Andrew Lewis, Denny Nagle, Nate Pinkham, and Germaine Hart. Also, thanks to the staff at the Prosser Fish Hatchery for their excellent fish culturing skills and year round cooperation. Ida Sohappy is the YKFP book keeper, Rachel Rounds is the NEPA representative for BPA, and Patricia Smith is the contracting officer and technical representative for BPA for this project. Gabriel Temple and crews from WDFW assist with adult plants and snorkel surveys.

Task 1.h Adult Salmonid Enumeration at Prosser Dam

Rationale: To estimate the total number of adult salmonids returning to the Yakima Basin by species (spring and fall chinook, coho and steelhead), including the estimated return of externally marked fish (i.e., adipose clipped fish). In addition, biotic and abiotic data are recorded for each fish run.

Methods: In the past, monitoring was accomplished through use of time-lapse video recorders (VHS) and a video camera located at each of the three fishways. The use of digital video recorders (DVR) and progressive scan cameras (to replace the VHS systems) was tested at each of the three Prosser fishways in 2007 and became fully functional in February of 2008. The new system functions very similarly to the VHS system but allows video data to be downloaded directly from the equipment at Prosser to the viewing stations in Toppenish. This new system also allows technicians in Toppenish to scan directly to images of fish giving a quicker and more accurate fish count. The technicians review the images and record various types of data for each fish that migrates upstream via the ladders. These images and information are entered into a Microsoft Access database, and daily dam count reports are regularly posted to the ykfp.org web site. Post-season, counts are reviewed and adjusted for data gaps and knowledge about adult and jack lengths from sampling activities. Historical final counts are posted to the ykfp.org and Data Access in Real-Time (DART) web sites.

Progress:

Spring Chinook (2009)
Using video data, an estimated 9,394 spring Chinook passed upstream of Prosser Dam in 2009. The total adult count was 6,538 (70%) fish, while the jack count was 2,856 (30%) fish. Of the adult count, 2,946 were identified as hatchery origin. Returning hatchery adults this year comprised 4 and 5 year olds (brood years 2004 and 2005). The ratios of wild to hatchery fish were 55:45 and 24:76, for adults and jacks respectively. The 25%, 50% and 75% dates of cumulative passage were May 18, May 26 and June 7, respectively.

Post-season evaluation using Roza dam count and Yakima Basin harvest data resulted in adjusted final Prosser counts of 3,039 hatchery-origin adults, 3,590 natural-origin adults, 3,183 hatchery-origin jacks, and 791 natural-origin jacks.

Fall Run (coho and fall chinook)

Coho (2009)
Using video data, the estimated coho return upstream of Prosser Dam was 9,090 fish. Adults comprised 94% and jacks 6% of the run. Of the estimated run, 34.9% were processed at the Denil and mark sampling there indicated the run was comprised of approximately 18.2% wild/natural and 81.8% hatchery-origin coho. The 25%, 50% and 75% dates of cumulative passage were October 17, October 21, and October 25, respectively.

Note that some coho return to the Yakima River but are not reflected in the Prosser counts. Some fish may have been harvested or spawned below Prosser Dam while others may have been falsely attracted into tributaries such as Spring Creek.

Fall Chinook (2009)
Estimated fall chinook passage at Prosser Dam was 2,972 fish. Adults comprised 80.1% of the run, and jacks 19.9%. Of the total number of fish, 627 were adipose clipped or otherwise identified as of definite hatchery-origin (315

adults and 312 jacks). The median passage date was September 25, while the 25% and 75% dates of cumulative passage were September 13 and October 18, respectively. Of the total fish estimate, 337 (11.3%) were counted at the Denil.

Steelhead (2008-09 run)
The estimated steelhead run was 3,469 fish. Of the total, 25 (0.7%) were adipose clipped fish, which were all out-of-basin strays (hatchery-origin steelhead have not been released in the Yakima River since the early 1990s). The median passage date was November 18th, 2008, while the 25% and 75% cumulative dates of passage were October 20th, 2008 and February 6th, 2009 respectively.

Personnel Acknowledgements: Biologist Jeff Trammel, Data Manager Bill Bosch, and Fisheries Technicians Winna Switzler, Florence Wallahee and Sara Sohappy.

Task 1.i Adult Salmonid Enumeration and Broodstock Collection at Roza and Cowiche Dams.

Rationale: The purpose is to estimate the total number of adult salmonids returning to the upper Yakima Basin for spring and fall Chinook, coho and steelhead at Roza Dam, and for coho only into the Naches Basin at Cowiche Dam. This includes the count of externally marked fish (i.e., adipose clipped). In addition, biotic and abiotic data are recorded for each fish run.

Methods: Monitoring was accomplished through use of time-lapse video recorders (VHS) and a video camera located at each fishway. The videotapes are played back and various types of data are recorded for each fish that passes. Spring Chinook passing Roza Dam are virtually entirely enumerated through the Cle Elum Supplementation and Research Facility trap operation activity. Roza Dam in-season counts and historical final counts are posted to the ykfp.org and Data Access in Real-Time (DART) web sites.

Progress:
Roza Dam
Steelhead
A total of 206 steelhead were counted past Roza Dam for the 2008-09 run. As shown in Figure 5, most steelhead migrated past Roza Dam from late February through early May of 2009.

Spring Chinook

At Roza Dam 8,633 (60% adults and 40% jacks) spring Chinook were counted at the adult facility between May 12 and September 10, 2009. The adult return was comprised of natural- (45%) and CESRF-origin (55%) fish. The jack return was comprised of natural- (21%) and CESRF-origin (79%) fish. Figure 6 shows spring Chinook passage timing at Roza in 2009.

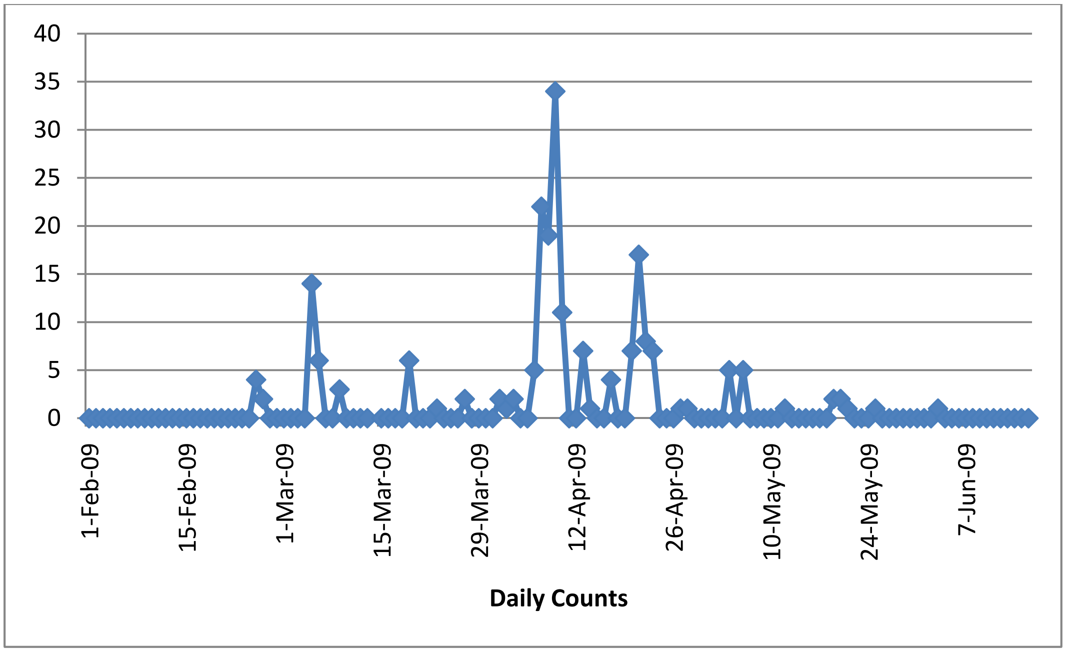


Figure 5. Daily steelhead passage at Roza Dam, 2008-09.

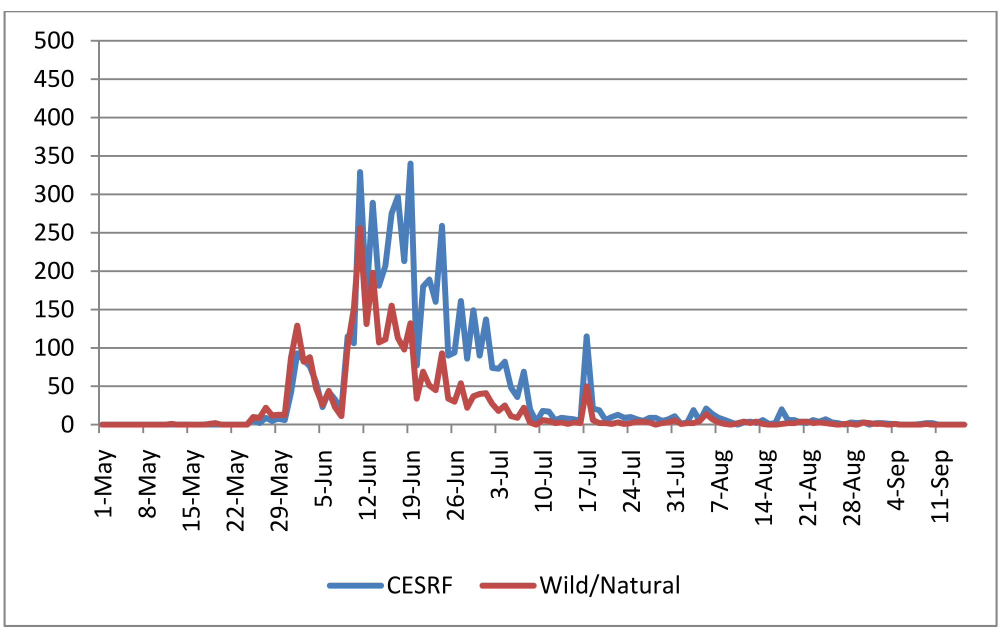


Figure 6. Daily passage counts for natural- and CESRF-origin spring Chinook at Roza Dam, 2009.

Coho

Video observations and trap sampling (14Sep – 10Nov) were conducted at Roza Dam during the fall and winter months of 2009-2010. A total of 1,164 adult and 16 jack coho were counted and/or sampled.

Cowiche Dam

Coho

Video observations were not conducted at Cowiche Dam in 2009.

Task 1.j Spawning Ground Surveys (Redd Counts)

Rationale: Spawning ground surveys (redd counts): Monitor spatial and temporal redd distribution in the Yakima Subbasin (spring chinook, Marion Drain fall chinook, coho, Satus/Toppenish steelhead), and collect carcass data.

Methods: Regular foot and/or boat surveys were conducted within the established geographic range for each species (this is increasing for coho as acclimation sites are located upriver and as the run increases in size). Redds were individually marked during each survey and carcasses were sampled to collect-egg retention, scale sample, sex, body length and to check for possible experimental marks.

Progress: A summary of the spawning ground surveys by species are as follows.

Steelhead: The Yakama Nation conducted steelhead spawner surveys in Satus and Toppenish basins and Ahtanum Creek in the spring of 2010. Total redd counts by subbasin were as follows: Satus basin- 465 (3 passes; good conditions for all passes), and Toppenish basin- 105 (one pass of the upper 18 miles of Toppenish and 3 passes each of the Simcoe watershed and lower Toppenish reaches; snow pack prevented us from accessing the upper 18 miles of Toppenish Creek until late May). Ahtanum creek was not surveyed in 2010 because of consistent high flows. In addition, 13 redds were identified in Marion and Harrah Drains before irrigation returns made the drains too turbid to survey in mid-April.

Data for steelhead redd surveys in the Naches River system in the spring of 2010 were unavailable at the time this report was produced. Historical steelhead redd count and Prosser and Roza escapement data can be obtained at http://www.ykfp.org/.

Spring Chinook: Redd counts began in late July 2009 in the American River and ended in early October 2009 in the upper Yakima River. Total counts for the American, Bumping, Little Naches, and Naches rivers were respectively: 91, 163, 65, and 159 redds. Redd counts in the upper Yakima, Teanaway and the Cle Elum rivers were: 1301, 33, and 197, respectively. The entire Yakima basin had a total of 2,009 redds (Naches- 478 redds, upper Yakima- 1,531). Historical spring Chinook redd count data are provided in Appendix A.

Fall Chinook: Redd counts in the Yakima River Basin above Prosser Dam began in mid-September and ended in late November. The river was divided into sections and surveyed every 7-10 days via raft or foot. Redd distribution for the Yakima, Naches, and Marion Drain was as follows:

Yakima R.: 218 redds. All redds were located between RM 70 and RM 104. The majority of redds (89.4%) were observed between RM 83 and 91. However, visibility was poor between RM 70 and 83 where redd counts normally almost equal those found between RM 83 and 91.

Naches R.: 0 redds. Surveys were conducted from Wapatox Dam to the mouth of the river.

Marion Drain: 70 redds. 34.3% of the redds were located above Hwy 97 up to Old Goldendale Road. The remaining 65.7% were located below Hwy 97 down to the Hwy 22 bridge.

Historical fall Chinook redd count data can be obtained at http://www.ykfp.org/.

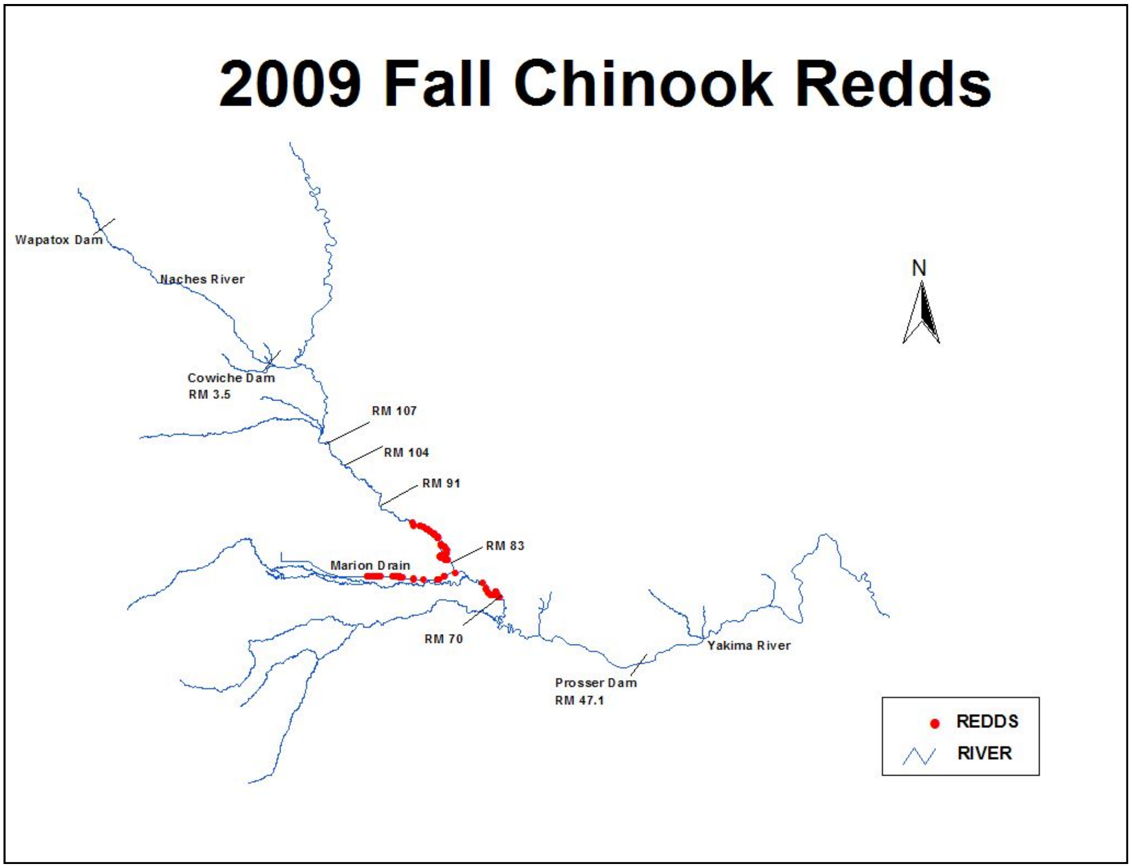


Figure 7. Distribution of fall Chinook redds in the Yakima River Basin in 2009.

Coho: Surveys began the third week of October and ended in late December. Redd surveys were conducted daily in conjunction with fall Chinook surveys. The Yakima and Naches Rivers are broken into sections that are checked by boat or ground surveys. The 2009 coho redd count was the highest the YN has recorded. Conditions were excellent for surveys throughout the spawning season. Tributaries were checked methodically by foot in conjunction with the Washington Dept of Fish and Wildlife. Main river sections of the Yakima and Naches were floated by raft once a week. The 2009 spawning ground surveys showed large increases in redds in both the Upper Yakima River and Naches River. Over 160 redds were found in the Upper Yakima River and nearly 300 in the Naches River. Tanuem Creek had 130 redds from the 150 females that were planted. Redds were found in high densities around the Stiles Acclimation site and the Holmes Acclimation site. Over 400 redds were found in tributaries throughout the Yakima Basin (Table 4).

Table 4. Yakima Basin Coho Redd Counts, 1998-2009.

River	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Yakima River	53	104	142	27	4	32	33	57	44	63	49	229
Naches River	6	NA	137	95	23	56	87	72	76	87	60	281
Tributaries	193	62	67	29	16	55	150	153	187	195	242	485
Total	252	166	346	151	43	143	270	282	307	345	351	995

One of the overall goals of Phase II is to evaluate the transition of redds from the maintsem river into historic tributaries. With the beginning of Phase II of the Coho Program we have observed large increases in tributary spawning. Tributary spawning has averaged over 200 redds annually since 2004, a marked increase over the prior five years (Table 4). Coho are volunteering into many tributaries, and the fidelity of adults from the summer parr plants is showing good results. Overall redd counts and distribution has increased substantially. Many redds in the maintsem, were located intermixed with fall chinook redds, tucked under cut banks or were found in side channels. Tributary redd enumeration and identification continues to be accurate due to the fall low water levels, improving interagency cooperation, and relatively good weather. Figure 8 shows the distribution of coho redds throughout the Yakima Basin in 2008 and 2009.

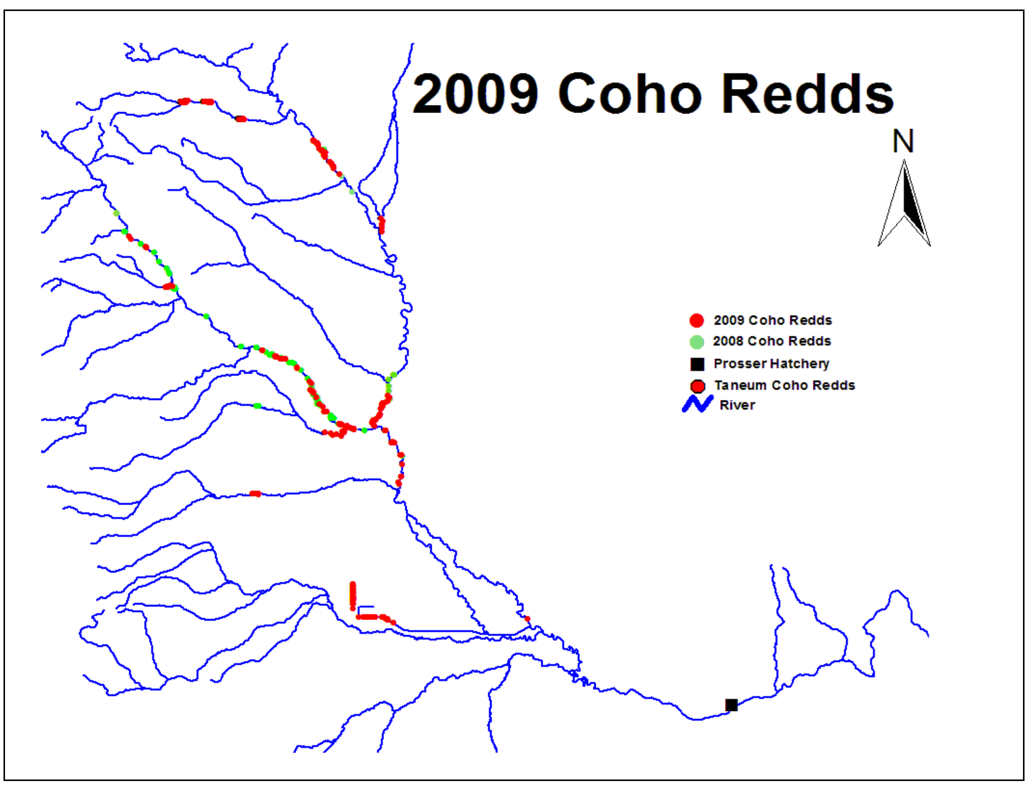


Figure 8. Distribution of coho redds in the Yakima River Basin, 2008-09.

Task 1.k Yakima Spring Chinook Residual/Precocial Studies

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/searchpublications/ . This year's report is expected to be available soon. The most recent report is:

Johnson, C.L., T.N. Pearsons, and G. M. Temple. 2009. Spring Chinook Salmon Interactions Indices and Residual/Precocious Male Monitoring in the Upper Yakima Basin; Yakima/Klickitat Fisheries Project Monitoring and Evaluation. Annual Report 2008.

Task 1.1 Yakima River Relative Hatchery/Wild Spring Chinook Reproductive Success

The latest information on these studies are available on the BPA website: http://www.efw.bpa.gov/searchpublications/ and in:

Schroder, S. L., C.M. Knudsen, T. N. Pearsons, T. W. Kassler, S. F. Young, E. P. Beall, and D. E. Fast. 2009. Breeding success of four male life history types in spring Chinook salmon spawning under quasi-natural conditions. Yakima/Klickitat Fisheries Project Monitoring and Evaluation. Annual Report, June 2009.

Knudsen, C.M. 2009. Reproductive Ecology of Yakima River Hatchery and Wild Spring Chinook. Yakima/Klickitat Fisheries Project Monitoring and Evaluation, Annual Report 2008.

Knudsen, C.M., S.L. Schroder, C. Busack, M.V. Johnston, T.N. Pearsons, and C.R. Strom. 2008. Comparison of Female Reproductive Traits and Progeny of First-Generation Hatchery and Wild Upper Yakima River Spring Chinook Salmon. Transactions of the American Fisheries Society 137:1433-1445.

Schroder, S. L., C. M. Knudsen, T. N. Pearsons, T. W. Kassler, S. F. Young, C. A. Busack, and D. E. Fast. 2008. Breeding Success of Wild and First-Generation Hatchery Female Spring Chinook Salmon Spawning in an Artificial Stream. Transactions of the American Fisheries Society, 137:1475-1489.

Task 1.m Scale Analysis

Rationale: Determine age and stock composition of juvenile and adult salmonid stocks in the Yakima basin.

Methods: Random scale samples are collected at broodstock collection sites (Prosser and Roza dams and Chandler Canal) and from spawner surveys. Acetate impressions are made from scale samples and then are read for age and stock type using a microfiche reader. Data are entered into the YKFP database maintained by the Data Management staff.

Progress: Juvenile scale sample results for 2009 were not available at the time this report was produced. Available adult scale sample results for 2009 are summarized in Table 5 by species and sampling method. Historical data from age and length sampling activities of adult spring Chinook in the Yakima Basin are presented in Appendix A.

Table 5. Age composition of salmonid adults sampled in the Yakima Basin in 2009.

	Age 2		Age 3		Age 4		Age 5	
	Count	Length	Count	Length	Count	Length	Count	Length
Yakima R. Spring Chinook								
Roza Dam Samples								
Upper Yakima Supplementation	12	15.1	255	43.6	290	62.1	11	67.5
Upper Yakima Wild/Natural			39	45.8	422	62.4	12	70.4
Spawner Survey Samples								
Upper Yakima Supplementation			3	47.7	2	45.8		
Upper Yakima Wild/Natural			54	46.9	101	58.7	1	68.0
American River Wild/Natural			4	44.0	21	65.0	4	69.8
Naches River Wild/Natural			1	43.0	30	65.2	10	74.9
Yakima R. Fall Chinook								
Hatchery	No data were available at the time this report was produced.							
Wild/Natural								
Yakima R. Coho								
Hatchery								
Wild/Natural								

Note: Yak. SpCh Lengths are average post-eye to hypural plate length.
Yak. FaCh/Coho lengths are average mid-eye to hypural plate lengths from denil trap sampling.

Task 1.n Habitat inventory, aerial videos and ground truthing

Rationale: Measure critical environmental variables by analyzing data extracted from aerial videos and verified by ground observations. These data are critical to validating EDT and AHA model outputs which are used to guide Project decisions.

Methods: Aerial videos of the Yakima Subbasin will be conducted and analyzed. The habitat conditions (e.g. area of "watered" side channels, LWD, pool/riffle ratio, etc.) from the videos will be checked by dispatching technicians to specific areas to verify that conditions are in fact as they appear on video.

Progress: No ground survey work was conducted in fiscal year 2009.

Task 1.o Sediment Impacts on Habitat

Rationale: To monitor stream sediment loads associated with the operation of dams and other anthropogenic factors (e.g. logging, agriculture and road building) which can affect survival of salmonids in the Yakima Basin.

Methods: Representative gravel samples were collected from various reaches in the Little Naches, South Fork Tieton, and Upper Yakima Rivers in the fall of 2009. Each sample was analyzed to estimate the percentage of fine or small particles present (<0.85 mm). The Washington State TFW program guidelines on sediments were used to specify the impacts that estimated sedimentation levels have had on salmonid egg-to-smolt survival. These impacts will be incorporated in analyses of impacts of "extrinsic" factors on natural production.

Progress:

Little Naches

A total of 120 samples were collected and processed from the Little Naches drainage this past year (10 reaches, 120 samples). All of the regular sites in the Little Naches were sampled. With this year's monitoring work, the data set for the Little Naches drainage now covers a time period of 25 years for the two historical reaches, and 18 years for the expanded sampling area that includes several tributary streams.

The average percent fine sediment less than 0.85mm for the entire Little Naches drainage was reduced (cumulative average of 9.3%) compared to the prior five years when overall fine sediment conditions in the Little Naches drainage were stable and ranged from about 10.5% to 12% fines (Figure 9). The relatively low level of fine sediment found in spawning substrate is encouraging and should minimize mortality on incubating eggs and alevins. With the improving conditions, fine sediment levels in the Little Naches have now approached those observed in the American River, a relatively undisturbed and reference watershed.

The factors affecting spawning gravel conditions in the Little Naches are not completely understood, but some activities probably have had an effect. In the late 1980's and early 1990's, considerable road building and timber harvest activity was taking place in the upper portions of the watershed. The ground disturbance and erosion from this work probably contributed to the high fine sediment conditions observed at that time. Logging and road building moderated after the middle 1990's. During that time period, greater stream and riparian protection measures were also initiated under the Northwest Forest Plan (1994) and the Plum Creek Habitat Conservation Plan (1996). In addition, considerable road improvement, abandonment and drainage work has been accomplished by landowners, especially in the middle 1990's. In the last few years very little timber harvest activity has been taking place in the watershed. The USFS has also improved and relocated some of the motorized trails near streams to deter sediment delivery. All of these factors have helped reduce fine sediment delivery to the stream system and spawning substrate.

At the reach scale, several of the sampling reaches had lower fine sediment rates than those found in 2008. Seven of the sampling reaches had greater than a 1.0% point decrease in average fines compared to the previous year (Little Naches Reach I, Little Naches Reach 2, South Fork Reach I, Little Naches Reach 3, Bear Creek Reach 2, North Fork Reach I and Pyramid Creek Reach 1). Two sampling reaches had little change (less than 1.0% point) in average sediment rates compared to 2008 (Bear Creek Reach I slightly higher, North Fork Reach 2 slightly lower). Only the Little Naches Reach 4 showed a marked increase in average fine sediment levels. This particular sampling reach has been undergoing major change in the last couple years. The river channel has now rerouted around the right bank of the large logjam at this site. The river channel is actively down cutting and transporting out bedload accumulated upstream of the log jam. Variability within sampling reaches was slightly greater in 2009 compared to 2008. Five of the reaches had a higher standard deviation, one reach had a similar standard deviation, and four reaches had a lower standard deviation than in 2008.

A review of the data from the two historical reaches (Little Naches Reach 1 and North Fork Reach 1) provides a greater time period of record for assessing sediment trends in the drainage. Sampling began on these two reaches in 1985. For these particular reaches the sediment levels follow a slightly different pattern than the overall watershed trend. Generally average fine sediment levels on these reaches ramped up in the late 1980's and stayed elevated through the 1990's, before decreasing in the last few years. In the early years of 1985-1986 average fine sediment levels were fairly low (8-10%). From 1987 until 1993, reach average fine sediment increased dramatically up to about

19-20%. Considerable road building and timber harvest activity was taking place in this time frame. The Falls Creek Fire also occurred during this period (1988) and burned substantial portions of the North Fork, Pyramid, and Blowout Creek sub-watersheds. After 1993, the fine sediment levels receded for two or three years at these historical sampling reaches, before moving back up. From 1998 through 2001 the rate of fine sediment in these two reaches remained relatively constant between 16 and 18 percent for reach average fines. The last several years the average percentage of fine sediment declined to a range of 11-13%. This year the average fine sediment levels in these two long-term monitoring reaches declined further (8.9% at Little Naches Reach 1 and 9.84% at North Fork Reach 1).

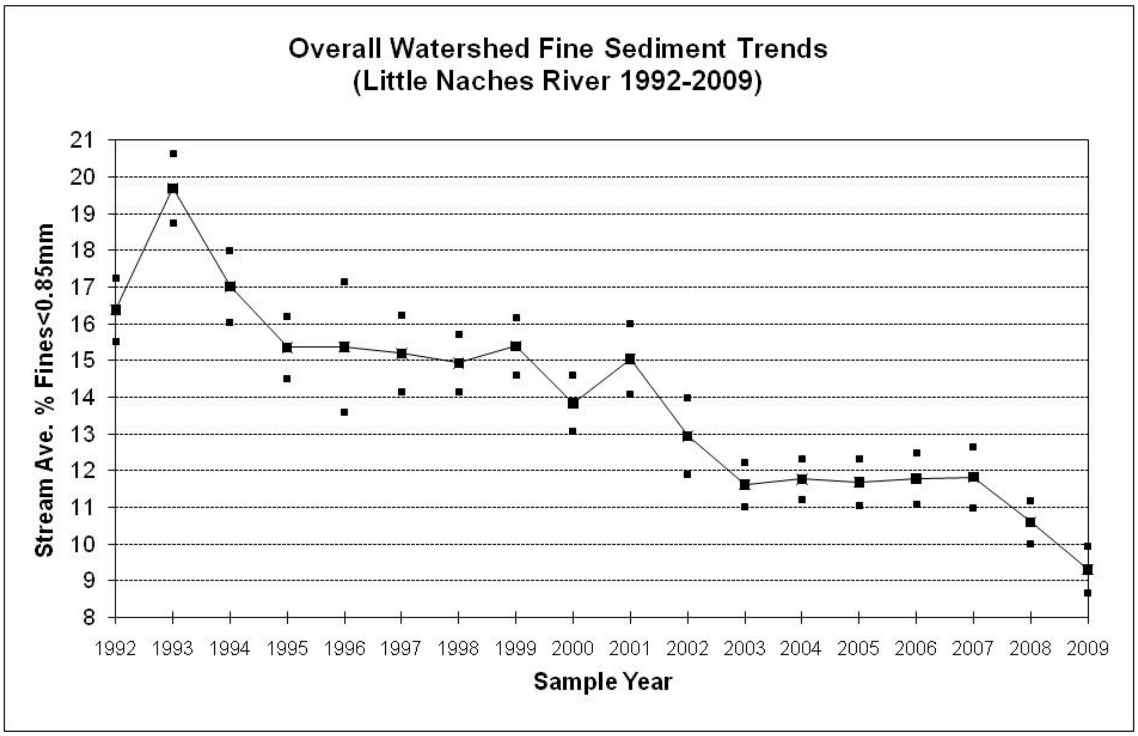


Figure 9. Overall Fine Sediment (<0.85mm) Trends with 95% confidence bounds in the Little Naches River Drainage, 1992-2009.

South Fork Tieton

One reach on the South Fork Tieton River (in the vicinity of Minnie Meadows) was sampled again this past season by the U.S. Forest Service. This marks 11 years that the USFS has been sampling this area. This stream reach typically receives considerable bull trout spawning activity and the sampling provides additional information on their spawning conditions. Average fine sediment levels in this reach slightly increased to 11.9% in 2009 (Figure 10).

Upper Yakima

A total of 60 samples were collected and processed from the Upper Yakima River drainage this past year (5 reaches, 12 samples from each reach). The same reaches (Stampede Pass, Easton, Camelot to Ensign Ranch, Elk Meadows, and Cle Elum) have been sampled annually for the past 13 years. Average percent fine sediment less than 0.85mm by reach and for the combined Upper Yakima drainage was lower than the average observed over the thirteen years of sampling (Figure 11).

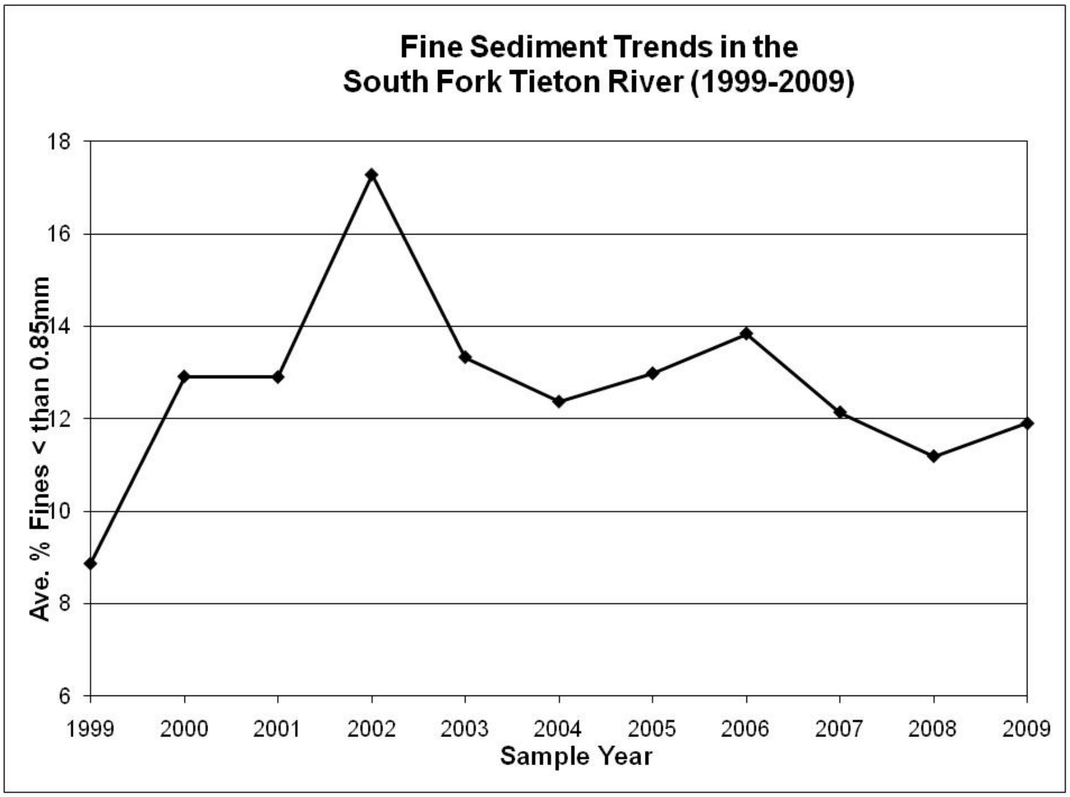


Figure 10. Fine Sediment Trends in the South Fork Tieton River, 1999-2009. Note: 2007 Year Data only contains data collected from 1 Riffle.

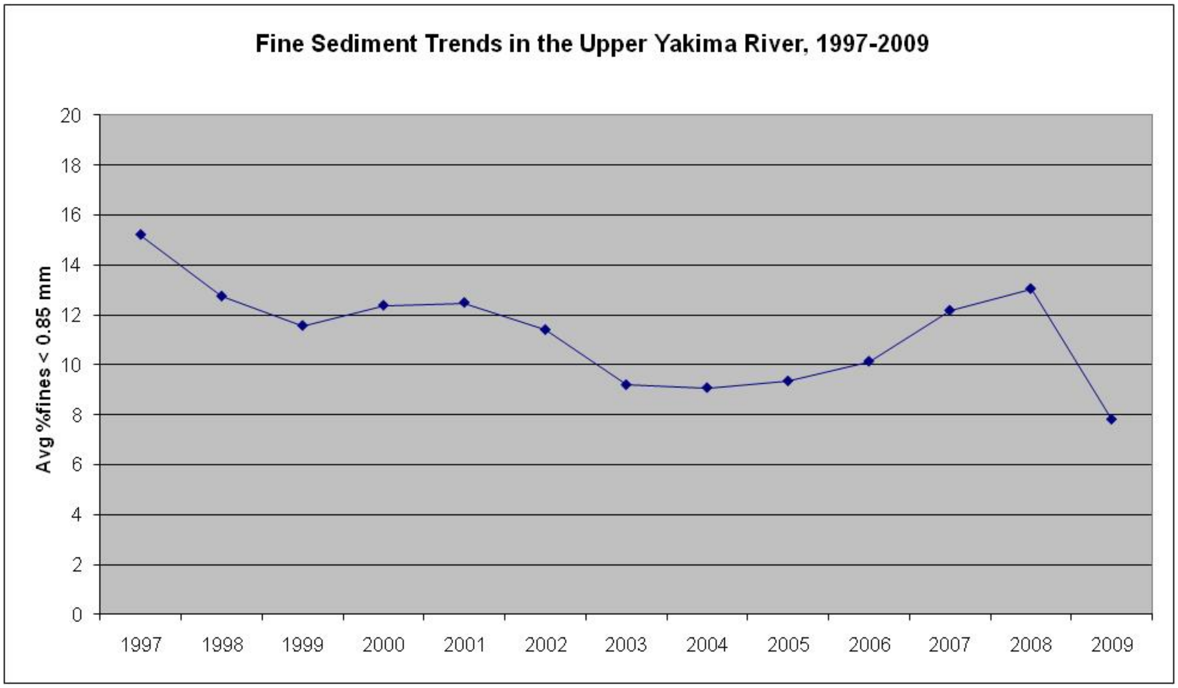


Figure 11. Overall average percent fine sediment (< 0.85 mm) in spawning gravels of the Upper Yakima River, 1997-2009.

<u>Summary</u>

The overall average fine sediment level in the Little Naches this past season was lower than in previous years. Overall average fine sediment in 2009 for all the samples in the Little Naches was 9.3%. This marks the lowest overall fine sediment in the watershed since sampling was expanded in 1992. Data were similar for the Upper Yakima system, where overall average fine sediment in 2009 was 7.8%, the lowest in this watershed since sampling began in 1997. These conditions should favor salmonid spawning success.

The results of the USFS sampling in the South Fork Tieton River were similar to the previous year, but slightly higher. Reach average fines in the South Fork increased slightly to 11.9% in 2009. These conditions should support bull trout spawning success, but are still higher than found in 1999.

Two new reaches in Nile Creek were sampled by the USFS this past year. Average fine sediment for the two sample reaches was 13.66% less than 0.85mm. This level of fine sediment suggests moderate impacts on spawning conditions. Efforts should be made to further identify and address sediment delivery sources.

Detailed field data including additional tables and graphs for samples collected in the upper Yakima and Naches basins can be obtained from Jim Mathews, fisheries biologist for the Yakama Nation (jmatthews@yakama.com).

Personnel Acknowledgements: Credit needs to go to all parties involved with this last year's sampling effort. The U.S. Forest Service staff collected samples from tributary streams to the Naches and Tieton Rivers. The USFS staff again took samples from the upper South Fork Tieton River, and expanded their monitoring efforts by sampling two reaches in Nile Creek. Fisheries technicians from the Yakama Nation did another great job coring the samples from the Little Naches and processing all the samples this winter.

Task 1.p Biometrical Support

Doug Neeley of International Statistical Training and Technical Services (IntSTATS) was contracted by the YKFP to conduct the following statistical analyses:

- Annual Report: Comparisons between Smolt Measures of Hatchery x Hatchery- and Natural x Natural-Brood Stock from Upper Yakima Spring Chinook for Brood-Years 2002-2007 (Appendix B)

- Annual Report: Smolt Survival to McNary Dam of Year-2008 Spring Chinook Releases at Roza Dam (Appendix C)

- 2009 Annual Report: Chandler Certification for Yearling Outmigrating Spring Chinook Smolt (Appendix D)

- 2009 Annual Report: Smolt-to-smolt Survival to McNary Dam of Yakima Fall and Summer Chinook (Appendix E)

- Annual Report: 2006-2009 Coho Smolt-to-smolt Survival of Eagle Creek and Yakima Brood Releases into the Yakima Basin (Appendix F)

All of these reports are attached to this YKFP M&E annual report as appendices as noted above, and summaries of results have been incorporated within the appropriate M&E task.

HARVEST

Task 2.a Out-of-basin Harvest Monitoring

Rationale: Estimate harvest of hatchery- and natural-origin anadromous salmonids outside of the Yakima Subbasin.

Method: Monitor recoveries of CWTs and PIT tags in out-of-basin fisheries using queries of regional RMIS and PTAGIS databases. Coordinate with agencies responsible for harvest management (WDFW, ODFW, USFWS, CRITFC, etc.) to estimate the harvest of target stocks.

Progress: Additional detail about methods used to evaluate harvest of Yakima Basin spring Chinook in Columbia Basin and marine fisheries is given in Appendix A. Historical results of this evaluation including results for the present year are given in Tables 46 and 47 of Appendix A.

Task 2.b Yakima Subbasin Harvest Monitoring

Rationale: Estimate harvest of hatchery- and natural-origin anadromous salmonids within the Yakima Subbasin. Harvest monitoring is a critical element of project evaluation. Harvest data are also important for deriving overall smolt-to-adult survival estimates of hatchery- and natural-origin fish.

Method: The two co-managers, Yakama Nation and WDFW, are responsible for monitoring their respective fisheries in the Yakima River. Each agency employs fish monitors dedicated to creel surveys and/or fisher interviews at the most utilized fishing locations and/or boat ramps. From these surveys, standard techniques are employed to expand fishery sample data for total effort and open areas and times to derive total harvest estimates. Fish are interrogated for various marks. This information is used along with other adult contribution data (i.e. broodstock, dam counts, spawner ground surveys) to determine overall project success.

Progress: Yakima River in-basin Tribal harvest for salmon and steelhead are presented in Table 6. For additional data see Table 45 in Appendix A.

Personnel Acknowledgements: Data Manager Bill Bosch, biologists Mark Johnston and Roger Dick Jr., and Fisheries Technicians Steve Blodgett and Arnold Barney.

Table 6. A summary of Yakama Nation tributary estimated harvest in the Yakima Subbasin, 2009.

River	Dates	Weekly Schedule	Notes	Chinook	Jacks	Steelhead	Coho
Yakima River	4/14-6/27	Noon Tues to 6 PM Saturday		1,038	765	0	0
Yakima River	9/15-11/21	Noon Tues to 6 PM Saturday		0	0	0	0

GENETICS

Overall Objective: Monitor and evaluate genetic change due to domestication and potential genetic change due to in-basin and out-of-basin stray rates.

Progress: All Tasks within this Section are assigned to WDFW and are reported in written progress reports submitted to BPA. These tasks are the following:

- Task 3.a Yakima spring Chinook domestication.
- Task 3.b Stray recovery on Naches and American river spawning grounds.

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/searchpublications/. This year's report is expected to be available soon. The most recent report is:

Blankenship, S., C. Bowman, C. Busack, A. Fritts, G. Temple, T. Kassler, T. Pearsons, S. Schroder, J. Von Bargen, K. Warheit, C. Knudsen, W. Bosch, D. Fast, M. Johnston, and D. Lind. 2009. Yakima/Klickitat Fisheries Project Genetic Studies, Yakima/Klickitat Fisheries Project Monitoring and Evaluation, Annual Report 2008.

ECOLOGICAL INTERACTIONS

Overall Objective: Monitor and evaluate ecological impacts of supplementation on non-target taxa, and impacts of strong interactor taxa on productivity of targeted stocks.

Task 4.a Avian Predation Index

Rationale: Monitor, evaluate, and index the impact of avian predation on annual salmon and steelhead smolt production in the Yakima Subbasin. Avian predators are capable of significantly depressing smolt production and accurate methods of indexing avian predation across years have been developed. The loss of wild spring Chinook salmon juveniles to various types of avian predators has long been suspected as a significant constraint on production and could limit the success of supplementation. The index consists of two main components: 1) an index of bird abundance along sample reaches of the Yakima River and 2) an index of consumption along both sample reaches and at key dam and bypass locations (called hotspots). Due to a major shift in the major avian predator, first observed in 2003, from Ring-Billed and California Gulls (*Larus delawarensis* and *L. californicus*) to American White Pelican (*Pelecanus erythrorhynchos*) in the lower Yakima River, changes in piscivorous predation have occurred and warrant further study to quantify consumption rates of salmonids and other preferred prey species.

Methods: The methods used to monitor avian predation on the Yakima River in 2009 were consistent with the techniques used in 2001-2008. Consumption by gulls at hotspots was based on direct observations of gull foraging success and modeled abundance. Consumption by pelicans and all other piscivorous birds on river reaches and hotspots were estimated using published dietary requirements and modeled abundance. Seasonal patterns of avian piscivore abundance were identified, diurnal patterns of gull and pelican abundance at hotspots were identified, and predation indices were calculated for hotspots and river reaches for the spring and summer. In addition three aerial surveys for pelicans were conducted on the lower Yakima River from Union Gap to the mouth of the Columbia River.

A new method was also instituted in 2006 and continued in 2007-09: Pelican, Double-crested Cormorant, Great Blue Heron and Common Merganser roosting and nesting sites were examined for the presence of salmon PIT tags in August and September. Sites surveyed included the Roza recreation site gravel bar, cormorant and heron rookeries along the Yakima River near Selah, areas near the Selah gravel ponds (both pond islands and a gravel bar in the Yakima River itself), and the Chandler pipe outfall. In 2006 and 2008-09, cormorant and heron rookeries at Satus Wildlife Management Area on the Yakama Reservation were also surveyed.

Details of survey, analytical methods and results can be found in Appendix G of this annual report.

Progress (Executive Summary, see Appendix G for additional detail, tables and figures):

Gull numbers remain low in the Yakima River Basin and the focus of future studies has shifted towards: Pelican numbers and diet, management of extreme numbers of piscivorous birds in given areas, and surveys of PIT tags where mortality can be linked to predation.

Mergansers on their breeding grounds in the upper and middle Yakima River have not shown a numeric response to hatchery supplementation of spring Chinook and Coho salmon smolts yet remain a concern as they are known to congregate in large numbers below Roza Dam.

Pelican numbers remain a concern as in previous years. Pelican numbers at Chandler and Wanawish Dam have become a noteworthy concern as new findings of predation by Pelicans comes to light. PIT tag data from Badger Island and Chandler Juvenile bypass shows American White Pelicans are targeting YINN juvenile salmonids.

The Double Crested Cormorant presence of 2008 at the Sunnyside Wildlife Area Great Blue Heron Rookery has developed into a breeding colony. PIT tag surveys of the Double Crested Cormorant Colony produced high numbers of PIT tags, and when compared to similar nests numbers of nearby Great Blue Herons, Cormorants produced significantly higher numbers of PIT tags.

The Chandler Bypass outfall pipe makes fish of all species vulnerable to predation at low water, as the fish are disoriented and upwelling at right angles to the current. The presence of large dead and disabled fish exiting from the bypass pipe may attract avian predators to the site. PIT tag detection at Chandler outlet pipe did show high mortality for both juvenile and adult salmonids.

PIT tag surveys in 2009 proved very productive as over 14,352 tags have been discovered in the Yakima Basin. PIT tag numbers are significantly larger than the previous 4100 from 2008 surveys. Tags detected were linked to sources of release and 4022 of these tags were from Yakima River juvenile salmonids. Predation by Herons showed correlation with river flow. High flow eliminates opportunity for wading bird foraging in many parts of the river. Conversely low flow creates foraging opportunities for Herons.

PIT tag analysis was developed by determining detection efficiencies in 2 diverse rookeries to assess a number of undetected PIT tags.

Plans for the 2010 field season include continued monitoring of river reaches and at hotspots with a focus on Pelican foraging. Heron rookeries and cormorant nesting colonies will continue to be surveyed. PIT tags found at pelican, heron nesting and roosting sites will be used to assign smolt predation estimates to specific bird species.

Personnel Acknowledgements: Michael Porter served as the project biologist for this task. Sara Sohappy and Jamie Bill collected the majority of the field data for this project. Dave Lind, Bill Bosch and Chris Fredrickson contributed to the analysis. Some photographs were taken by Ann Stephenson. Paul Huffman helped with the maps. Bird surveys at smolt acclimation ponds were conducted by Farrell Aleck, Marlin Colfax, Nate Pinkham, William Manuel, Terrance Compo and Levi Piel.

Task 4.b Fish Predation Index

Rationale: Monitor, evaluate, and index impact of piscivorous fish on annual smolt production of Yakima Subbasin salmon and steelhead. Fish predators are capable of significantly depressing smolt production. By indexing the mortality rate of upper Yakima spring chinook attributable to piscivorous fish in the lower Yakima River, the contribution of in-basin predation to fluctuations in hatchery and wild smolt-to-adult survival rate can be deduced.

Methods: PIT Tag Surveys

Predation within irrigation diversion fish screening facilities may cause significant mortality to juvenile salmonids. WDFW permits for Scientific investigation of the removal of piscivorous Northern pikeminnow (NPM, *Ptychocheilus oregonensis*) and Smallmouth bass (*Micropterus dolomieu*) were obtained by YKFP for Sunnyside dam, Wapato Dam, Roza Dam, and Prosser Dam to determine concentration of presence during smolt outmigration. In 2009 with these concerns and study questions in mind, the YKFP began PIT tag surveys at four Bureau of Reclamation and one City of Yakima-operated fish screening facilities.

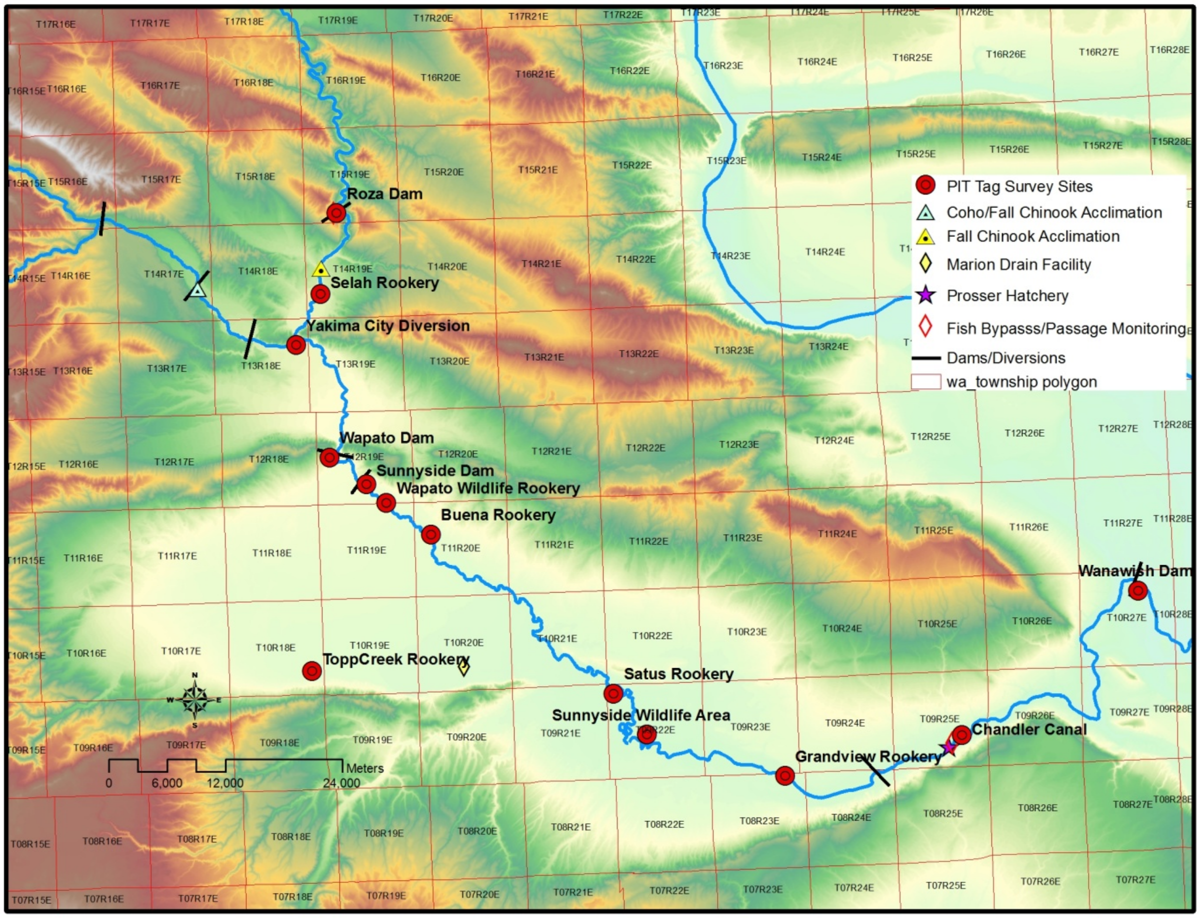


Figure 12. PIT tag survey sites for 2009 (Includes Great Blue Heron Rookeries)

Survey times of irrigation diversion fish screening facilities coincide with Bureau of Reclamation annual services of the facilities at each site. Annual servicing occurs in the late fall and winter while irrigation diversion from the Yakima River is halted.

SURVEY SITE	SURVEY DATES								
Chandler Forebay	12/11/2008								
Chandlet Outlet									
Roza Gravel Bar	2/11/2010								
Sunnyside Forebay	3/6/2009								
Wapato Forebay	2/25/2009	2/26/2009	3/2/2009	3/3/2009	3/4/2009	1/25/2010	1/26/2010	1/28/2010	2/9/2010
Wapato Canal	3/5/2009	3/6/2009	1/21/2010	1/22/2010					
Wanawish Right	2/12/2009	2/18/2010							
Wanawish Left	2/12/2009	2/18/2010							
Naches Forebay	2/11/2010								

Table 7. Survey dates of Irrigation Diversion Fish Screening Facilities.

Irrigation Diversion PIT tags were related to fish predation given these key elements:

- Surveys conducted in front of fish screens and behind screens
- Numerous tags behind trash screens
- Underwater cameras behind trash screens have shown fish predation
- PIT tags at diversions are linked to fish predation due to saturation of salmonids at sites

Progress:

The combined number of PIT tags discovered at all irrigation diversions surveyed was 6548 total PIT tags. The total number of PIT tags scanned was 6741, which leaves approximately 200 PIT tags surveyed in the diversions without a tagging detail record in PTAGIS. These 200 PIT tags with lack of tagging detail may be explained by either human error at tagging or possible tags inserted into adults for purposes of tracking their upstream locations after spawning (leaving them in an enclosed system of the Yakima River Basin).

Migration year	Species	Run	PIT Tag Totals	Migration year	Species	Run	PIT Tag Totals
2009	Chinook	Spring	395	2008	Chinook	Spring	696
2009	Chinook	Summer	1274	2008	Chinook	Fall	581
2009	Chinook	Fall	45	2008	Coho	Unknown	279
2009	Coho	Unknown	201	2008	Steelhead	Summer	5
2009	Steelhead	Summer	3	Total			1561
Total			1918				
Migration year	Species	Run	PIT Tag Totals	Migration year	Species	Run	PIT Tag Totals
2007	Chinook	Spring	383	2006	Chinook	Spring	209
2007	Chinook	Fall	500	2006	Chinook	Fall	354
2007	Coho	Unknown	216	2006	Coho	Unknown	102
2007	Steelhead	Summer	1	2006	Steelhead	Summer	1
2007	Steelhead	R	1	Total			666
Total			1101				
Migration year	Species	Run	PIT Tag Totals	Migration year	Species	Run	PIT Tag Totals
2005	Chinook	Spring	386	2004	Chinook	Spring	107
2005	Chinook	Fall	132	2004	Chinook	Fall	77
2005	Coho	Unknown	110	2004	Coho	Unknown	15
2005	Steelhead	Summer	3	Total			199
Total			631				
Migration year	Species	Run	PIT Tag Totals	Migration year	Species	Run	PIT Tag Totals
2003	Chinook	Spring	99	2002	Chinook	Spring	53
2003	Chinook	Fall	18	2002	Chinook	Fall	1
2003	Coho	Fall	44	2002	Coho	Fall	20
2003	Steelhead	Summer	1	2002	Steelhead	Summer	1
Total			162	Total			75
Migration year	Species	Run	PIT Tag Totals	Migration year	Species	Run	PIT Tag Totals
2001	Chinook	Spring	108	2000	Chinook	Spring	58
2001	Chinook	Fall	6	2000	Chinook	Fall	6
2001	Coho	Fall	18	2000	Coho	Fall	14
Total			132	Total			78

Figure 13. Surveyed PIT tags of all diversions shown by migration year and species

Wapato Dam and Fish Screening Facility

Fish Diversions uses rolling screens with a sweeping velocity to direct fish to three bypass pipes. PIT tag surveys in 2009 and early 2010 led to the discovery of less than optimum operation and maintenance at the Wapato Diversion. In the Wapato Screening Facility two of the fish bypass pipes were discovered to be clogged and one was operating at less than 15% efficiency.

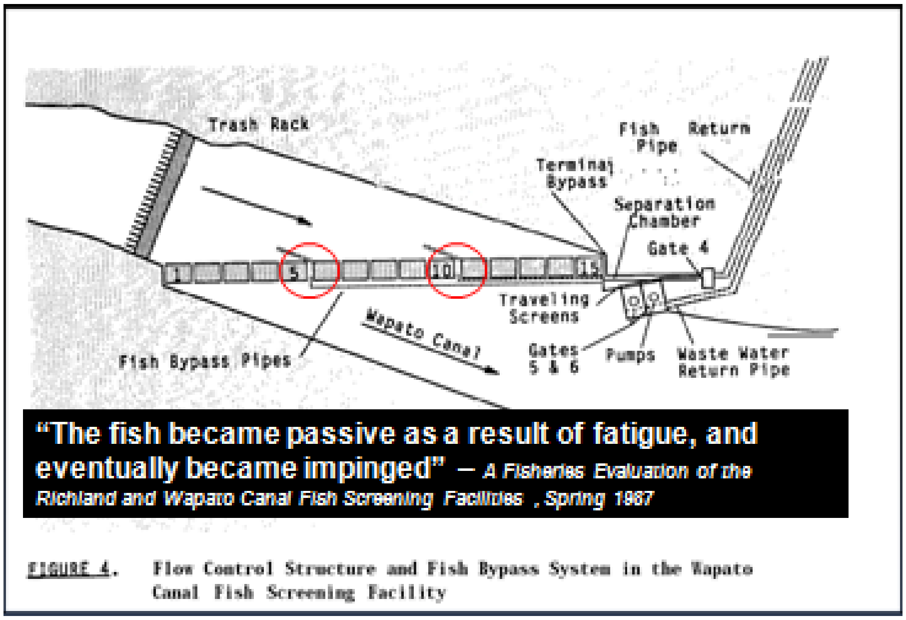


Figure 14. Wapato Dam Fish Screening Facility. Bypass pipes circled were not functioning

A total of 1604 PIT tags surveyed at the Wapato Diversion site returned a tagging detail. The species with the most mortality for the 2009 migration year was YINN Summer Chinook with 422 PIT tags. The remaining tags were Coho with 77 and Spring Chinook with 88. High numbers of Summer Chinook detections may be explained by their late release time. Entrainment into a fish screening facility is related to flow. Irrigation diversion water stays constant at the given amount of water diverted from the river, so as flow in the river decreases, juvenile salmonids are entrained at higher rates as a greater percentage of river flow is directed into the diversions. "Assuming uniform fish distribution above Sunnyside Dam, about 75% of the fish in the Yakima River may be diverted through the Sunnyside Canal Fish Screening Facilities" (A Fisheries Evaluation of the Sunnyside Canal Fish Screening Facility, Spring 1985).

Wapato Irrigation Diversion : PIT tags shown by Migration Year

	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook			112	76	104	45							337
Spring Chinook		88	170	31	21	161	19	9	6	33	5		543
Summer Chinook		422											422
Steelhead			2			1							3
Coho	1	77	76	38	27	56	4	14	1	4	1		299
Unknown Chinook													0
Total	1	587	360	145	152	263	23	23	7	37	6	0	1604

Table 8. Wapato Diversion PIT tag numbers shown by species and Migration Year.

In response to the inoperable condition which resulted in over a 90 percent mortality of Yakama Nation juvenile salmonids entering the Wapato diversion a letter to the BOR was transcribed and sent, it included key points:

- BOR has not been maintaining the fish passage facilities at Wapato Dam
- The Bureau of Reclamation (BOR) has had the responsibility and funding to maintain and operate these fish passage facilities.
- An examination of the facilities showed the juvenile by-pass facilities maintained by Reclamation at Wapato Dam was blocked due to lack of maintenance by Reclamation.
- Yakama Nation may wish to seek restitution and/or other compensation for our losses

YKFP plans to continue the monitoring of the Wapato Dam fish screening facility and expects to see a lower juvenile salmonid mortality as the site is managed properly in future years.

PIT tag numbers were also high at the Sunnyside irrigation diversion with 2266 total PIT tags and the Chandler Irrigation diversion with 2577 PIT tags (PIT tags with tagging detail).

Sunnyside Irrigation Diversion: PIT Tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Summer Chinook	445											445
Spring Chinook	140	154	140	105	183	60	61	39	63	36	1	982
Fall Chinook		105	106	143	33	2						389
Coho	69	110	89	63	42	10	27	17	8	12		447
Steelhead			1		2							3
Unknown Chinook												0
Total	654	369	336	311	260	72	88	56	71	48	1	2266

Table 9. Sunnyside Irrigation Diversion PIT tag numbers shown by species and migration year.

Chandler Irrigation Diversion: PIT Tag Numbers

	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook		43	357	314	100	50	74	16	1	6	6		967
Summer Chinook		404											404
Spring Chinook		127	372	210	80	41	28	28	8	12	17		923
Coho		51	92	85	12	11	1	3	2	6	1		264
Steelhead		3	4	1	1	6	1	1	1				18
Unknown Chinook								1					1
Total	0	628	825	610	193	108	104	49	12	24	24	0	2577

Table 10. Chandler Irrigation Diversion PIT tag numbers shown by species and migration year.

Wanawish Irrigation Diversion: PIT Tag Numbers

	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook		2	6	4	7	4	1	2					26
Summer Chinook		2			1	1		1					5
Spring Chinook													0
Coho				2									2
Steelhead													0
Unknown Chinook													0
Total	0	4	6	6	8	5	1	3	0	0	0	0	33

Table 11. Wanawish Irrigation Diversion PIT tag numbers shown by species and migration year.

Roza Irrigation Diversion: PIT Tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook												0
Spring Chinook	21		4	2								27
Summer Chinook												0
Coho	4	1	2									7
Steelhead												0
Unknown Chinook												0
Total	25	1	6	2	0	0	0	0	0	0	0	34

Table 12. Roza Irrigation Diversion PIT tag numbers shown by species and migration year.

Yakima City Irrigation Diversion : PIT Tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook		1										1
Spring Chinook												0
Summer Chinook	1											1
Coho												0
Steelhead												0
Unknown Chinook												0
Total	1	0	0	0	0	0	0	0	0	0	0	1

Table 13. Yakima City Irrigation Diversion PIT tag numbers shown by species and migration year.

Piscivorous Fish Populations and Management:

Based on YKFP and WDFW studies of piscivorous fish in the Yakima River Basin it was determined that management of the piscivorous fish populations in the area is necessary for survival of juvenile salmonids. In early 2010, the YKFP began initial study checks to determine management and study goals for piscivorous fish. Presence and absence of piscivorous fish was determined through electro-fishing various sections of the Yakima River to determine temporal and spatial trends of each species of piscivorous fish. Based on these surveys and continuing summer and fall surveys YKFP will target piscivorous fish in key areas of the Yakima River in 2011. Population estimates will be made as management objectives are met and yearly impacts to piscivorous fish populations will be submitted on a yearly basis to monitor effectiveness of population controls. Table 14 shows current investigative results for temporal and spatial distribution of piscivorous fish.

Month	Survey Date	Location	Species	Adult Numbers	Juvenile Numbers	Stomach Contents
January	1/26/2010	Yakima	NPM	2	0	Empty
Feburary	2/5/2010	Benton to Horn	SMB	0	2	Empty
	2/18/2010	Zillah to Granger	NPM	0	68	crayfish, sculpin, stickleback, insects, fish
March	3/23/2010	Benton to Horn	SMB	1	1	Empty
	3/23/2010	Benton to Horn	NPM	0	1	Empty
	3/24/2010	Benton to Horn	SMB	1	1	Empty
	3/24/2010	Benton to Horn	NPM	0	1	Empty
May	5/7/2010	Kennewick	SMB	1	26	Crawdad, carp, catfish, empty
	5/7/2010	Kennewick	NPM	0	1	Empty

Table 14. Survey results for Temporal and Spatial trends of Piscivorous Fish Yakima River.

Task 4.c Upper Yakima Spring Chinook NTTOC Monitoring

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/searchpublications. This year's report is expected to be available soon. The most recent report is:

Temple, G.M., T.N. Pearsons, A.L. Fritts, C.L. Johnson, T.D. Webster, Z. Mays, and G. Stotz. 2009. Ecological Interactions between Non-target Taxa of Concern and Hatchery Supplemented Salmon. Yakima/Klickitat Fisheries Project Monitoring and Evaluation Report. Annual Report 2008.

Task 4.d Pathogen Sampling

This project was discontinued. The latest WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/searchpublications

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Fisheries Project, Toppenish, WA. See www.ykfp.org Technical Reports and Publications to obtain an electronic copy of this report.

Knudsen, C. M., S. L. Schroder, C. A. Busack, M. V. Johnston, T. N. Pearsons, W. J. Bosch, and D. E. Fast. 2006. Comparison of Life History Traits between First-Generation Hatchery and Wild Upper Yakima River Spring Chinook Salmon. Transactions of the American Fisheries Society 135:1130–1144.

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Schroder, S. L., C. M. Knudsen, T. N. Pearsons, T. W. Kassler, S. F. Young, C. A. Busack, and D. E. Fast. 2008. Breeding Success of Wild and First-Generation Hatchery Female Spring Chinook Salmon Spawning in an Artificial Stream. Transactions of the American Fisheries Society, 137:1475-1489.

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APPENDICES A through G

	Task	
A.		Yakima River / CESRF Spring Chinook Salmon – Yakama Nation Data Summary
B.	1.c.	IntStats, Inc. Annual Report: Comparisons between Smolt Measures of Hatchery x Hatchery and Natural x Natural Brood Stock from Upper Yakima Spring Chinook for Brood-Years 2002-2007
C.	1.d.	IntStats, Inc. Smolt Survival to McNary Dam of Year-2009 Spring Chinook Releases PIT-tagged and/or released at Roza Dam
D.	1.e.	IntStats, Inc. Chandler Certification for Yearling Outmigrating Spring Chinook Smolt
E.	1.f.	IntStats, Inc. Smolt-to-Smolt Survival to McNary Dam of Yakima Fall and Summer Chinook
F.	1.g.	Intstats, Inc. 2006-2009 Coho Smolt-to-Smolt Survival of Eagle Creek and Yakima Brood Releases into the Yakima Basin
G.	4.a.	Avian Predation Annual Report

Appendix A

Summary of Data Collected by the Yakama Nation relative to Yakima River Spring Chinook Salmon and the Cle Elum Spring Chinook Supplementation and Research Facility

2009 Annual Report

July, 2010

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Project Numbers: 1995-063-25
Contract Numbers: 00042445

Acknowledgments

Monitoring and evaluation efforts for the Cle Elum Supplementation and Research Facility (CESRF) and Yakima River spring Chinook salmon are the result of a cooperative effort by many individuals from a variety of agencies including the Yakama Nation Fisheries Program (YN), the Washington Department of Fish and Wildlife (WDFW), the United States Fish and Wildlife Service (USFWS), the National Oceanic and Atmospheric Administration Fisheries department (NOAA Fisheries) as well as some consultants and contractors.

The core project team includes the following individuals: Dave Fast, Mark Johnston, Bill Bosch, David Lind, Paul Huffman, Joe Hoptowit, and a number of technicians from the YN; Charles Strom and a number of assistants from the CESRF; Andrew Murdoch, Steve Schroder, Anthony Fritts, Gabe Temple, Christopher Johnson, and a number of assistants from the WDFW; Curt Knudsen from Oncorh Consulting and Doug Neeley from IntSTATS Consulting; Ray Brunson and assistants from the USFWS; and Don Larsen, Andy Dittman, and assistants from NOAA Fisheries. The technicians and assistants are too numerous and varied to mention each by name (and risk leaving some out). However, their hard work in the field is the source of much of the raw data needed to complete this report. We sincerely appreciate their hard work and dedication to this project.

We would especially like to thank former members of the Yakima/Klickitat Fisheries Project, Bruce Watson, Joel Hubble, Bill Hopley, Todd Pearsons, and Craig Busack. These individuals put in countless hours of hard work during the planning, design, and implementation of this project. Their contributions helped to lay a solid foundation for this project and our monitoring and evaluation efforts. Dan Barrett (retired) served as the manager of the CESRF from 1997-2002. He helped to lay a solid foundation for the critical work done day in and day out at the Cle Elum facility.

We also need to recognize and thank the Yakama Nation and WDFW for their continued support, and the Columbia River Inter-Tribal Fish Commission, the University of Idaho, the Pacific States Marine Fisheries Commission, Mobrand, Jones, and Stokes, and Central Washington University for their many contributions to this project including both recommendations and data services.

This work is funded by the Bonneville Power Administration (BPA) through the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program. Patricia Smith is BPA's contracting officer and technical representative (COTR) for this project. David Byrnes preceded Patricia in this position and contributed substantially to the project over the years.

Abstract

Historically, the return of spring Chinook salmon (*Oncorhynchus tshawytscha)* to the Yakima River numbered about 200,000 fish annually (BPA, 1990). Spring Chinook returns to the Yakima River averaged fewer than 3,500 fish per year through most of the 1980s and 1990s (less than 2% of the historical run size).

In an attempt to reverse this trend the Northwest Power and Conservation Council (formerly the Northwest Power Planning Council, NPPC) in 1982 first encouraged Bonneville Power Administration (BPA) to “fund the design, construction, operation, and maintenance of a hatchery to enhance the fishery for the Yakima Indian Nation as well as all other harvesters” (NPPC 1982). After years of planning and design, an Environmental Impact Statement (EIS) was completed in 1996 and the CESRF was authorized under the NPCC’s Fish and Wildlife Program with the stated purpose being “to test the assumption that new artificial production can be used to increase harvest and natural production while maintaining the long-term genetic fitness of the fish population being supplemented and keeping adverse genetic and ecological interactions with non-target species or stocks within acceptable limits”. The CESRF became operational in 1997. This project is co-managed by the Yakama Nation and the Washington Department of Fish and Wildlife (WDFW) with the Yakama Nation as the lead entity.

This report documents data collected from Yakama Nation tasks related to monitoring and evaluation of the CESRF and its effect on natural populations of spring Chinook in the Yakima Basin through 2009. This report is not intended to be a scientific evaluation of spring Chinook supplementation efforts in the Yakima Basin. Rather, it is a summary of methods and data (additional information about methods used to collect these data may be found in the main section of this annual report) relating to Yakima River spring Chinook collected by Yakama Nation biologists and technicians from 1982 (when the Yakama Nation fisheries program was implemented) to present. Data summarized in this report include:

- Adult-to-adult returns
- Annual run size and escapement
- Adult traits (e.g., age composition, size-at-age, sex ratios, migration timing, etc.)
- CESRF reproductive statistics (including fecundity and fish health profiles)
- CESRF juvenile survival (egg-to-fry, fry-to-smolt, smolt-to-smolt, and smolt-to-adult)
- CESRF juvenile traits (e.g., length-weight relationships, migration timing, etc.)
- Harvest impacts

The data presented here are, for the most part, “raw” data and should not be used without paying attention to caveats associated with these data and/or consultation with project biologists. No attempt is made to explain the significance of these data in this report as this is left to more comprehensive reports and publications produced by the project. Data in this report should be considered preliminary until published in the peer reviewed literature.

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Introduction

Program Objectives

The CESRF was authorized in 1996 under the NPCC's Fish and Wildlife Program with the stated purpose being "to test the assumption that new artificial production can be used to increase harvest and natural production while maintaining the long-term genetic fitness of the fish population being supplemented and keeping adverse genetic and ecological interactions with non-target species or stocks within acceptable limits". The CESRF became operational in 1997. The experimental design calls for a total release of 810,000 smolts annually from each of three acclimation sites associated with the facility (see facility descriptions). The first program cycle (brood years 1997 through 2001) also included testing new Semi-Natural rearing Treatments (SNT) against the Optimum Conventional Treatments (OCT) of existing successful hatcheries in the Pacific Northwest. The second program cycle (brood years 2002-2004) tested whether a slower, more natural growth regime could be used to reduce the incidence of precocialism that may occur in hatchery releases without adversely impacting overall survival to adult returns. Brood years 2005-2006 tested survival using different types of feed treatment. Subsequent broods have used a standard treatment in all raceways. With guidance and input from the NPCC and the Independent Scientific Review Panel (ISRP) in 2001, the Naches subbasin population of spring Chinook was established as a wild/natural control. A hatchery control line at the CESRF was also established with the first brood production for this line collected in 2002. Please refer to the project's "Supplementation Monitoring Plan" (Chapter 7 in 2005 annual report on project genetic studies) for additional information regarding these control lines.

Facility Descriptions

Returning adult spring Chinook are monitored at the Roza adult trapping facility located on the Yakima River (Rkm 205.8). This facility provides the means to monitor every fish returning to the upper Yakima Basin and to collect adults for the CESRF program. All returning CESRF fish (adipose-clipped fish) are sampled for biological characteristics and marks and returned to the river with the exception of fish collected for broodstock, experimental sampling, and all hatchery control line fish. Through 2006, all wild/natural fish passing through the Roza trap were returned directly to the river with the exception of fish collected for broodstock or fish with metal tag detections which were sampled for marks and biological characteristics. Beginning in 2007, all wild/natural fish were sampled (as described above) and tissue samples were collected for a "Whole Population" Pedigree Study of Upper Yakima Spring Chinook.

The CESRF is located on the Yakima River just south of the town of Cle Elum (rkm 295.5). It is used for adult broodstock holding and spawning, and early life incubation and rearing. Fish are spawned in September and October of a given brood year (BY). Fish are typically ponded in March or April of BY+1. The juveniles are reared at Cle Elum, marked in October through December of BY+1, and moved to one of three acclimation sites for final rearing in January to February of BY+2. Acclimation sites are located at Easton (ESJ, rkm 317.8), Clark Flats near the town of Thorp (CFJ, rkm 266.6), and Jack Creek (JCJ, approximately 32.5 km north of Cle Elum) on the North Fork Teanaway River (rkm 10.2). Fish are volitionally released from the acclimation sites beginning on March 15 of BY+2, with any remaining fish "flushed out" of the acclimation sites by May 15 of BY+2. The annual production goal for the CESRF program is 810,000 fish for release as yearlings at 30 g/fish or 15 fish per pound (fpp) although size-at-release may vary depending on experimental protocols (see Program Objectives).

Yakima River Basin Overview

The Yakima River Basin is located in south central Washington. From its headwaters near the crest of the Cascade Range, the Yakima River flows 344 km (214 miles) southeastward to its confluence with the Columbia River (Rkm 539.5; Figure 1).

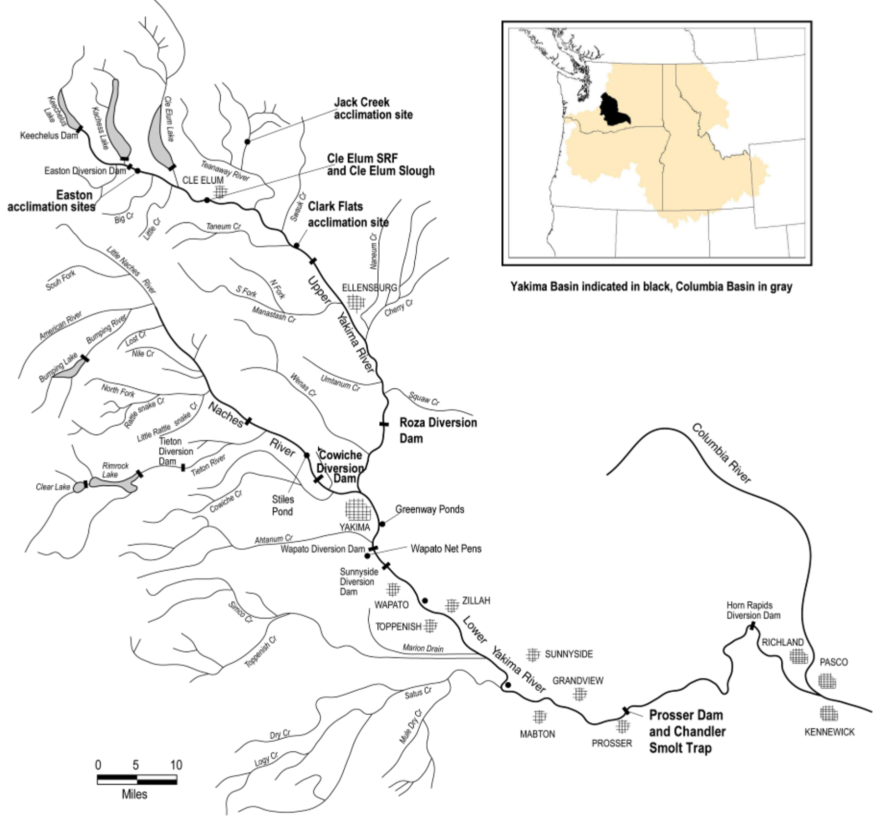

Figure 1. Yakima River Basin.

Three genetically distinguishable populations of spring Chinook salmon exist in the Yakima basin: the American River, the Naches, and the Upper Yakima Stocks (Figure 1). The upper Yakima was selected as the population best suited for supplementation and associated evaluation and research efforts.

Local habitat problems related to irrigation, logging, road building, recreation, agriculture, and livestock grazing have limited the production potential of spring Chinook in the Yakima River basin. It is hoped that recent initiatives to improve habitat within the Yakima Basin, such as those being funded through the NPCC's fish and wildlife program, the Pacific Coastal Salmon Recovery Fund, and the Washington State salmon recovery fund, will: 1) restore and maintain natural stream stability; 2) reduce water temperatures; 3) reduce upland erosion and sediment delivery rates; 4) improve and re-establish riparian vegetation; and 5) re-connect critical habitats throughout the basin. These habitat restoration efforts should permit increased utilization of habitat by spring Chinook salmon in the Yakima basin thereby increasing fish survival and productivity.

Adult Salmon Evaluation

Broodstock Collection and Representation

One of the program's goals is to collect broodstock from a representative portion of the population throughout the run. If the total run size could be known in advance, collecting brood stock on a daily basis in exact proportion to total brood need as a proportion of total run size would result in ideal run representation. Since it is not possible to know the run size in advance, the CESRF program uses a brood collection schedule that is based on average run timing once the first fish arrive at Roza Dam. We have found that, while river conditions dictate run timing (i.e., fish may arriver earlier or later depending on flow and temperature), once fish begin to move at Roza, the pattern in terms of relative run strength over time is very similar from year to year. Thus a brood collection schedule matching normal run timing patterns was developed to assure that fish are collected from all portions of the run (Figure 2).

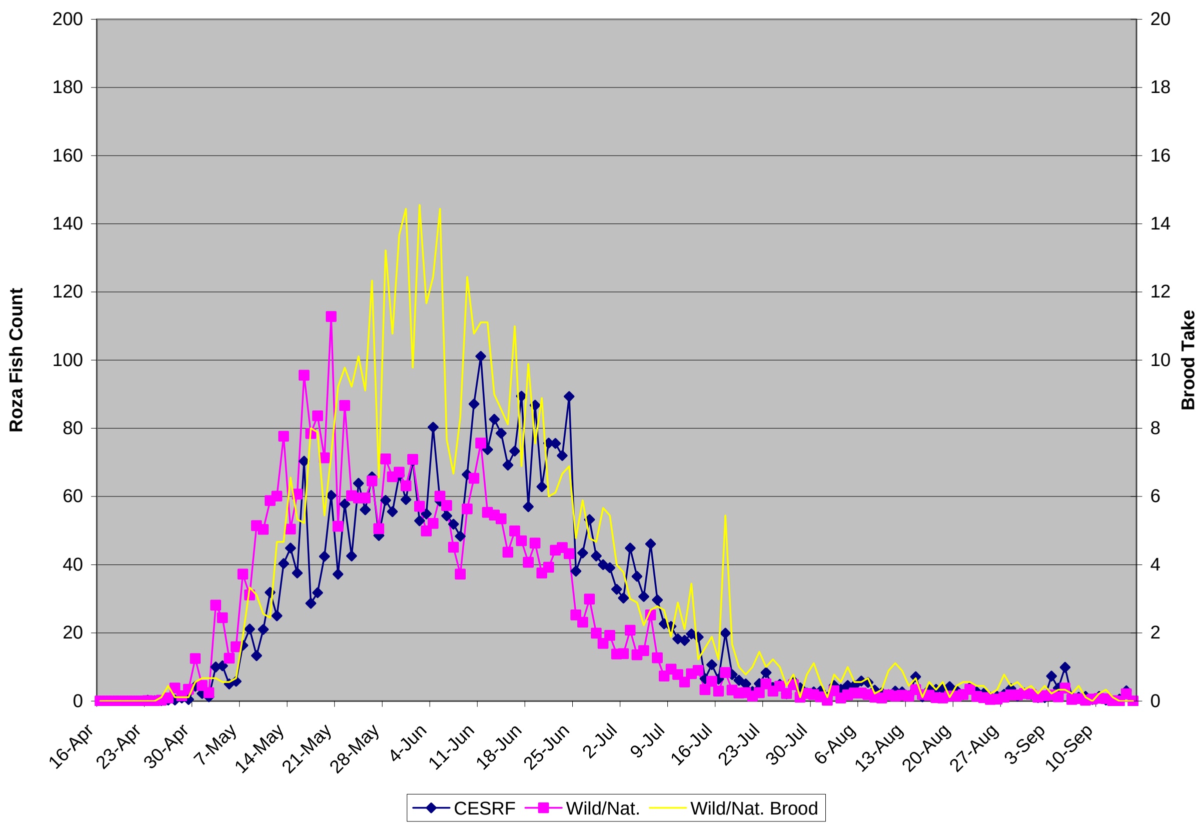

Figure 2. Mean spring Chinook run timing and broodstock collection at Roza Dam, 2001-2009.

Another program goal is to take no more than 50% of the wild/natural adult return to Roza Dam for broodstock. Given this goal and with a set brood collection schedule at Roza Dam, the project imposed a rule that no more than 50% of the fish arriving on any given day be taken for broodstock. Under-collection relative to the schedule is "carried over" to subsequent days and weeks. This allows brood collection to adjust relative to actual run timing and run strength. Performance across years with respect to these brood collection goals is given in Table 1.

Table 1. Counts of wild/natural spring Chinook (including jacks), brood collection, and brood representation of wild/natural run at Roza Dam, 1997 – present.

Year	Trap Count	Brood Take	Brood %	Portion of run collected:[1] Early[3]	Middle[3]	Late[3]	Portion of collection from:[2] Early[3]	Middle[3]	Late[3]
1997	1,445	261	18.1%	26.4%	17.6%	17.7%	7.3%	83.1%	9.6%
1998	795	408	51.3%	51.1%	51.3%	51.9%	5.6%	84.3%	10.0%
1999	1,704	738	43.3%	44.6%	44.1%	35.9%	5.6%	86.3%	8.1%
2000	11,639	567	4.9%	10.7%	4.5%	4.4%	12.5%	77.8%	9.7%
2001	5,346	595	11.1%	6.9%	11.4%	10.7%	3.0%	87.7%	9.2%
2002	2,538	629	24.8%	15.7%	25.2%	26.1%	3.2%	86.3%	10.5%
2003	1,558	441	28.3%	52.5%	25.9%	36.4%	9.5%	77.8%	12.7%
2004	7,804	597	7.6%	2.6%	7.4%	12.8%	2.0%	81.6%	16.4%
2005	5,086	510	10.0%	2.2%	9.5%	21.9%	1.3%	77.0%	21.7%
2006	2,050	419	20.4%	48.5%	22.2%	41.0%	9.1%	75.1%	15.8%
2007	1,293	449	34.7%	25.0%	34.4%	60.6%	3.2%	80.0%	16.9%
2008	1,677	457	27.3%	57.7%	26.7%	32.4%	9.3%	79.0%	11.6%
2009	3,030	486	16.0%	10.0%	14.1%	35.9%	3.5%	73.9%	22.6%

1. This is the proportion of the earliest, middle, and latest running components of the entire wild/natural run which were taken for broodstock. Ideally, this collection percentage would be equal throughout the run and would match the "Brood %".
2. This is the proportion of the total broodstock collection taken from the earliest, middle, and latest components of the entire wild/natural run. Ideally, these proportions would match the definitions for early, middle, and late given in 3.
3. Early is defined as the first 5% of the run, middle is defined as the middle 85%, and late as the final 10% of the run.

Natural- and Hatchery-Origin Escapement

While the project does not actively manage for a specific spawning escapement proportion (natural- to hatchery-origin adults), we are monitoring the proportion of natural influence (PNI; Table 2). The project will adaptively manage this parameter considering factors such as: policy input regarding surplusing of fish, meeting overall production goals of the project, guidance from the literature relative to percentage of hatchery fish on the spawning grounds with fitness loss, considerations about what risk is acceptable in a project designed to evaluate impacts from that risk, and the numerous risk containment measures already in place in the project. The State of Washington is using mark-selective fisheries in the lower Columbia River and, when possible, in the lower Yakima River in part as a tool to manage escapement proportions. Natural- and hatchery-origin escapement to the upper Yakima Basin is given in Table 2. Wild/natural escapement to the Naches subbasin is given in Table 3.

Table 2. Escapement (Roza Dam counts less brood stock collection and harvest above Roza) of natural- (NoR) and hatchery-origin (HoR) spring Chinook to the upper Yakima subbasin, 1982 – present.

	Wild/Natural (NoR)			CESRF (HoR)			Total				
Year	Adults	Jacks	Total	Adults	Jacks	Total	Adults	Jacks	Total	PHOS[1]	PNI[1]
1982			1,146								
1983			1,007								
1984			1,535								
1985			2,331								
1986			3,251								
1987			1,734								
1988			1,340								
1989			2,331								
1990			2,016								
1991			*1,583*[2]								
1992			3,009								
1993			1,869								
1994			563								
1995			355								
1996			1,631								
1997	1,141	43	1,184								
1998	369	18	387								
1999	498	468	966								
2000	10,491	481	10,972		688	688	10,491	1,169	11,660	5.9%	
2001	4,454	297	4,751	6,065	982	7,047	10,519	1,279	11,798	59.7%	62.6%
2002	1,820	89	1,909	6,064	71	6,135	7,884	160	8,044	76.3%	56.7%
2003	394	723	1,117	1,036	1,105	2,141	1,430	1,828	3,258	65.7%	60.3%
2004	6,536	671	7,207	2,876	204	3,080	9,412	875	10,287	29.9%	77.0%
2005	4,401	175	4,576	627	482	1,109	5,028	657	5,685	19.5%	83.7%
2006	1,510	121	1,631	1,622	111	1,733	3,132	232	3,364	51.5%	66.0%
2007	683	161	844	734	731	1,465	1,417	892	2,309	63.4%	61.2%
2008	988	232	1,220	2,157	957	3,114	3,145	1,189	4,334	71.9%	58.2%
2009	1,843	701	2,544	2,234	2,260	4,494	4,077	2,961	7,038	63.9%	61.0%
Mean[3]	2,702	322	3,024	2,602	767	3,369	5,116	1,119	6,235	55.8%	65.2%

1. Proportion Natural Influence equals Proportion Natural-Origin Broodstock (PNOB; 1.0 as only NoR fish are used for supplementation line brood stock) divided by PNOB plus Proportion Hatchery-Origin Spawners (PHOS).
2. This is a rough estimate since Roza counts are not available for 1991.
3. For NoR columns, mean of 1997-present values. For all other columns, mean of 2001-present values.

Adult-to-adult Returns

The overall status of Yakima Basin spring Chinook is summarized in Table 3. Adult-to-adult return and productivity data for the various populations are given in Tables 4-8 (Means are for 1988 to present).

Table 3. Yakima River spring Chinook run (CESRF and wild, adults and jacks combined) reconstruction, 1983-present.

	River Mouth Run Size[1]			Harvest Below Prosser	Prosser Count	Harvest Above Prosser	Spawners Below Roza[2]	Roza Count	Roza Removals[3]	Est. Escapement		Redd Counts	
Year	Adults	Jacks	Total							Upper Y.R.[4]	Naches[5]	Upper Y.R.	Naches
1983	1,231	210	1,441	72	867	12	118	1,007	0	1,007	*232*	360	83
1984	2,251	407	2,658	119	2,539	170	180	1,619	84	1,535	570	634	220
1985	4,109	451	4,560	321	4,239	544	247	2,428	97	2,331	1,020	860	427
1986	8,841	598	9,439	530	8,909	810	709	3,267	16	3,251	4,123	1,472	1,313
1987	4,187	256	4,443	359	4,084	158	269	1,928	194	1,734	1,729	903	677
1988	3,919	327	4,246	333	3,913	111	60	1,575	235	1,340	2,167	424	490
1989	4,640	274	4,914	560	4,354	187	135	2,515	184	2,331	1,517	915	541
1990	4,280	92	4,372	131	*2,255*	532	282	2,047	31	2,016	*1,380*	678	464
1991	2,802	104	2,906	27	2,879	5	131		40	*1,583*	*1,121*	582	460
1992	4,492	107	4,599	184	4,415	161	39	3,027	18	3,009	1,188	1,230	425
1993	3,800	119	3,919	44	3,875	85	56	1,869	0	1,869	1,865	637	554
1994	1,282	20	1,302	0	1,302	25	10	563	0	563	704	285	272
1995	526	140	666	0	666	79	9	355	0	355	223	114	104
1996	3,060	119	3,179	100	3,079	375	26	1,631	0	1,631	1,047	801	184
1997	3,092	81	3,173	0	3,173	575	20	1,445	261	1,184	1,133	413	339
1998	1,771	132	1,903	0	1,903	188	3	795	408	387	917	147	330
1999	1,513	1,268	2,781	8	2,773	596	55	1,704	738	966	418	212	186
2000	17,519	1,582	19,101	90	19,011	2,368	204	12,327	667	11,660	4,112	3,770	887
2001	21,225	2,040	23,265	1,793	21,472	2,838	286	12,516	718	11,798	5,832	3,260	1,192
2002	14,616	483	15,099	328	14,771	2,780	29	8,922	878	8,044	3,041	2,816	943
2003	4,868	2,089	6,957	59	6,898	381	83	3,842	584	3,258	2,592	868	935
2004	13,974	1,315	15,289	135	15,154	1,544	90	11,005	718	10,287	2,515	3,414	719
2005	8,059	699	8,758	34	8,724	440	28	6,352	667	5,685	1,904	2,009	576
2006	5,951	363	6,314	0	6,314	600	14	4,028	664	3,364	1,672	1,245	444
2007	2,968	1,335	4,303	10	4,293	269	13	3,025	716	2,309	986	722	314
2008	6,615	1,983	8,598	539	8,059	993	9	5,478	1,144	4,334	1,578	1,372	495
2009	7,472	4,648	12,120	1,517	10,603	758	18	8,633	1,595	7,038	1,194	1,527	478
Mean[6]	10,326	1,654	11,980	450	11,530	1,297	77	7,613	835	6,778	2,543	2,100	698

1. River Mouth run size is the greater of the Prosser count plus lower river harvest or estimated escapement plus all known harvest and removals.
2. Estimated as the average number of fish per redd in the upper Yakima times the number of redds between the Naches confluence and Roza Dam.
3. Roza removals include harvest above Roza, hatchery removals, and/or wild broodstock removals.
4. Estimated escapement into the upper Yakima River is the Roza count less harvest or broodstock removals above Roza Dam except in 1991 when Upper Yakima River escapement is estimated as the (Prosser count - harvest above Prosser - Roza subtractions) times the proportion of redds counted in the upper Yakima.
5. Naches River escapement is estimated as the Prosser count less harvest above Prosser and the Roza counts, except in 1982, 1983 and 1990 when it is estimated as the upper Yakima fish/redd times the Naches redd count.
6. Recent 10-year average (2000-2009).

Estimated spawners for the Upper Yakima River are calculated as the estimated escapement to the Upper Yakima plus the estimated number of spawners in the Upper Yakima between the confluence with the Naches River and Roza Dam (Table 3). Total returns are based on the information compiled in Table 3. Age composition for Upper Yakima returns is estimated from spawning ground carcass scale samples for the years 1982-1996 (Table 11) and from Roza Dam brood stock collection samples for the years 1997 to present (Table 13). Since age-3 fish (jacks) are not collected for brood stock in proportion to the jack run size, the proportion of age-3 fish in the upper Yakima for 1997 to present is estimated using the proportion of jacks (based on visual observation) counted at Roza Dam relative to the total run size.

Table 4. Adult-to-adult productivity for upper Yakima wild/natural stock.

Brood Year	Estimated Spawners	Estimated Yakima R. Mouth Returns				Returns/ Spawner
		Age-3	Age-4	Age-5	Total	
1982	1,280	324	4,016	411	4,751	3.71
1983	1,125	408	1,882	204	2,494	2.22
1984	1,715	92	1,348	139	1,578	0.92
1985	2,578	114	2,746	105	2,965	1.15
1986	3,960	171	2,574	149	2,893	0.73
1987	2,003	53	1,571	109	1,733	0.87
1988	1,400	53	3,138	132	3,323	2.37
1989	2,466	68	1,779	9	1,856	0.75
1990	2,298	79	566	0	645	0.28
1991	1,713	9	326	22	358	0.21
1992	3,048	87	1,861	95	2,043	0.67
1993	1,925	66	1,606	57	1,729	0.90
1994	573	60	737	92	890	1.55
1995	364	59	1,036	129	1,224	3.36
1996	1,657	1,059	12,882	630	14,571	8.79
1997	1,204	621	5,837	155	6,613	5.49
1998	390	434	2,803	145	3,381	8.68
1999	1,021[1]	164	722	45	930	0.91
2000	11,864	856	7,689	127	8,672	0.73
2001	12,084	775	5,074	222	6,071	0.50
2002	8,073	224	1,875	148	2,247	0.28
2003	3,341[1]	158	1,036	63	1,257	0.38
2004	10,377	207	1,547	75	1,828	0.18
2005	5,713	293	2,623		2,916	0.51
2006	3,378	866				
2007	2,322					
2008	4,343[1]					
2009	7,056[1]					
Mean	3,937	323	2,952	126	3,364	0.85

1. Jack proportions for 1999, 2003, 2008 and 2009 respectively were: 0.48, 0.56, 0.27, and 0.43.

Estimated spawners for the Naches/American aggregate population (Table 7) are calculated as the estimated escapement to the Naches Basin (Table 3). Estimated spawners for the individual Naches and American populations are calculated using the proportion of redds counted in the Naches Basin (excluding the American River) and the American River, respectively (see Table 31). Total returns are based on the information compiled in Table 3. Age composition for Naches Basin age-4 and age-5 returns are estimated from spawning ground carcass scale samples (see Tables 9-12). The proportion of age-3 fish is estimated after reviewing jack count (based on visual observations) data at Prosser and Roza dams. Since sample sizes for carcass surveys in the American and Naches Rivers can be very low in some years (Tables 9 and 10), it is recommended that the data in Tables 5 and 6 be used as indices only. Table 7 likely provides the most accurate view of overall productivity rates in the Naches River Subbasin.

Table 5. Adult-to-adult productivity for Naches River wild/natural stock.

Brood Year	Estimated Spawners	Estimated Yakima R. Mouth Returns					Returns/ Spawner
		Age-3	Age-4	Age-5	Age-6	Total	
1982	86	85	1,275	324	0	1,683	19.57
1983	131	123	928	757	10	1,818	13.83
1984	383	110	706	564	0	1,381	3.60
1985	683	132	574	396	0	1,102	1.61
1986	2,666	68	712	499	15	1,294	0.49
1987	1,162	27	183	197	0	407	0.35
1988	1,340	32	682	828	0	1,542	1.15
1989	992	28	331	306	0	665	0.67
1990	954	24	170	74	0	269	0.28
1991	706	7	37	121	57	222	0.31
1992	852	29	877	285	0	1,191	1.40
1993	1,145	45	593	372	0	1,010	0.88
1994	474	14	164	164	0	343	0.72
1995	124	40	164	251	0	455	3.66
1996	887	179	3,983	1,620	0	5,782	6.52
1997	762	207	3,081	708	0	3,996	5.24
1998	503	245	1,460	1,128	0	2,833	5.63
1999	358[1]	113	322	190	0	626	1.75
2000	3,862	71	2,060	215	0	2,345	0.61
2001	3,914	126	1,250	474	0	1,849	0.47
2002	1,861	59	758	153	0	970	0.52
2003	1,400	52	238	175		465	0.33
2004	2,197	107	875	232		1,214	0.55
2005	1,434	167	697			865	0.60
2006	1,171	205					
2007	465						
2008	1,074						
2009	967						
Mean	1,247	92	986	429	4	1,480	1.19

1. Approximately 48% of these fish were jacks.

Table 6. Adult-to-adult productivity for American River wild/natural stock.

Brood Year	Estimated Spawners	Estimated Yakima R. Mouth Returns Age-3	Age-4	Age-5	Age-6	Total	Returns/ Spawner
1982	22	42	223	248	0	513	23.32
1983	101	67	359	602	0	1,028	10.21
1984	187	54	301	458	0	813	4.36
1985	337	81	149	360	0	590	1.75
1986	1,457	36	134	329	11	509	0.35
1987	567	12	71	134	0	216	0.38
1988	827	19	208	661	5	892	1.08
1989	524	11	69	113	0	193	0.37
1990	425	15	113	84	0	213	0.50
1991	414	3	5	22	0	30	0.07
1992	335	23	157	237	0	417	1.24
1993	721	8	218	405	8	639	0.89
1994	230	7	36	16	0	59	0.26
1995	98	33	32	98	0	163	1.65
1996	159	30	176	760	0	967	6.07
1997	371	13	1,544	610	0	2,167	5.84
1998	414	120	766	1,136	0	2,022	4.88
1999	61	72	99	163	0	334	5.50
2000	250	60	163	111	0	335	1.34
2001	1,918	18	368	253	0	638	0.33
2002	1,180	19	274	256	0	550	0.47
2003	1,192	22	182	440		644	0.54
2004	318	120	52	35		207	0.65
2005	469	79	184			262	0.56
2006	501	48					
2007	521						
2008	504						
2009	227						
Mean	530	38	258	318	1	596	1.12

Table 7. Adult-to-adult productivity for Naches/American aggregate (wild/natural) population.

Brood Year	Estimated Spawners	Estimated Yakima R. Mouth Returns Age-3	Age-4	Age-5	Age-6	Total	Returns/ Spawner
1982	108	127	1,274	601	0	2,002	18.54
1983	232	190	1,257	1,257	8	2,713	11.68
1984	570	164	1,109	1,080	0	2,354	4.13
1985	1,020	213	667	931	0	1,811	1.77
1986	4,123	103	670	852	31	1,657	0.40
1987	1,729	39	231	400	0	669	0.39
1988	2,167	51	815	1,557	11	2,434	1.12
1989	1,517	39	332	371	0	741	0.49
1990	1,380	40	326	168	0	533	0.39
1991	1,121	10	32	144	127	314	0.28
1992	1,188	52	1,034	661	0	1,747	1.47
1993	1,865	53	603	817	17	1,489	0.80
1994	704	21	160	167	0	348	0.49
1995	223	73	201	498	0	771	3.46
1996	1,047	209	4,010	2,360	0	6,580	6.29
1997	1,133	220	4,645	1,377	0	6,242	5.51
1998	917	364	2,167	2,316	12	4,859	5.30
1999	418[1]	185	369	279	0	833	1.99
2000	4,112	131	2,286	346	0	2,762	0.67
2001	5,832	144	1,598	785	0	2,526	0.43
2002	3,041	78	975	443	0	1,496	0.49
2003	2,592	75	387	1,028	0	1,489	0.57
2004	2,515	227	514	247		989	0.39
2005	1,904	246	901			1,147	0.60
2006	1,672	253					
2007	986						
2008	1,578						
2009	1,194						
Mean	1,778	130	1,187	798	10	2,072	1.17

1. Approximately 48% of these fish were jacks.

Estimated spawners at the CESRF are the total number of wild/natural fish collected at Roza Dam and taken to the CESRF for production brood stock. Total returns are based on the information compiled in Table 3 and at Roza dam sampling operations. Age composition for CESRF fish is estimated using scales and PIT tag detections from CESRF fish sampled passing upstream through the Roza Dam adult monitoring facility.

Table 8. Adult-to-adult productivity for Cle Elum SRF spring Chinook.

Brood	Estimated	Estimated Yakima R. Mouth Returns				Returns/
Year	Spawners	Age-3	Age-4	Age-5	Total	Spawner
1997	261	741	7,753	176	8,670	33.22
1998	408	1,242	7,939	602	9,782	23.98
1999	738[1]	134	714	16	864	1.17
2000	567	1,103	3,647	70	4,819	8.50
2001	595	396	845	9	1,251	2.10
2002	629	345	1,886	69	2,300	3.66
2003	441	121	800	12	932	2.11
2004	597	805	3,101	115	4,021	6.73
2005	510	1,305	3,019		4,324	8.48
2006	419	3,005				
2007	449					
2008	457					
2009	486					
Mean	504	920	3,300	134	4,107	8.14

1. 357 or 48% of these fish were jacks.

Age Composition

Comparisons of the age composition in the Roza adult monitoring facility (RAMF) samples and spawning ground carcass recovery samples show that older, larger fish are recovered as carcasses on the spawning grounds at significantly higher rates than younger, smaller fish (Knudsen et al. 2003 and Knudsen et al. 2004). Based on historical scale-sampled carcass recoveries between 1986 and 2009, age composition of American River spring Chinook has averaged 1, 40, 57, and 2 percent age-3, -4, –5, and -6, respectively (Table 9). Naches system spring Chinook averaged 2, 58, 40 and 1 percent age-3, -4, –5 and -6, respectively (Table 10). The upper Yakima River natural origin fish averaged 8, 87, and 5 percent age-3, -4, and –5, respectively (Table 11). While these ages are biased toward the older age classes, we believe the bias is approximately equal across populations and is a good relative indicator of differences in age composition between populations. The data show distinct differences with the American River population having the oldest age of maturation, followed closely by the Naches system and then the upper Yakima River which has significantly more age-3's, fewer age-5's and no age-6 fish.

Table 9. Percentage by sex and age of American River wild/natural spring Chinook carcasses sampled on the spawning grounds and sample size (n), 1986-present.

Return	Males					Females					Total			
Year	3	4	5	6	n	3	4	5	6	n	3	4	5	6
1986		23.8	76.2		21		8.9	86.7	4.4	45		13.6	83.3	3.0
1987		70.8	25.0	4.2	24		42.9	57.1		21		57.8	40.0	2.2
1988			100.0		1		100.0			1		33.3	66.7	
1989		39.6	60.4		48		10.0	90.0		50		24.5	75.5	
1990	2.5	25.0	72.5		40		28.3	71.7		46	1.2	26.7	72.1	
1991		23.8	76.2		42		13.3	86.7		60		17.6	82.4	
1992		71.2	23.1	5.8	52		45.8	54.2		48		59.0	38.0	3.0
1993	4.8	14.3	81.0		21		8.0	92.0		75	1.0	9.4	89.6	
1994		44.4	55.6		18		50.0	46.7	3.3	30		49.0	49.0	2.0
1995	14.3	14.3	71.4		7			100.0		13	5.0	5.0	90.0	
1996		100.0			2		83.3	16.7		6		87.5	12.5	
1997		40.0	60.0		5		22.2	64.4	13.3	45		24.0	64.0	12.0
1998		12.1	87.9		33		6.6	93.4		76		8.3	91.7	
1999		100.0			2		40.0	40.0	20.0	5		57.1	28.6	14.3
2000		66.7	33.3		15		61.5	38.5		13		64.3	35.7	
2001		65.6	34.4		90		67.9	32.1		106		67.0	33.0	
2002	1.7	53.4	44.8		58		56.4	43.6		110	0.6	55.4	44.0	
2003		8.1	91.9		74		7.9	92.1		151		8.0	92.0	
2004		100.0			3		20.0	80.0		5		50.0	50.0	
2005		64.7	35.3		17		84.0	16.0		25		76.7	23.3	
2006		61.5	38.5		13		48.6	51.4		35		52.1	47.9	
2007	10.5	31.6	57.9		19		43.8	56.3		48	3.0	40.3	56.7	
2008		8.7	91.3		23		11.9	88.1		42		10.6	89.4	
2009	30.8	69.2			13		75.0	25.0		16	13.8	72.4	13.8	
Mean	2.7	46.2	50.7	0.4			39.0	59.3	1.7		1.0	40.4	57.0	1.5

Table 10. Percentage by sex and age of Naches River wild/natural spring Chinook carcasses sampled on the spawning grounds and sample size (n), 1986-present.

Return Year	Males 3	Males 4	Males 5	Males 6	Males n	Females 3	Females 4	Females 5	Females 6	Females n	Total 3	Total 4	Total 5	Total 6
1986	5.0	60.0	30.0	5.0	20		33.3	64.3	2.4	42	1.6	41.9	53.2	3.2
1987	5.9	76.5	11.8	5.9	17		69.0	31.0		42	1.7	71.7	25.0	1.7
1988		50.0	50.0		8	5.6	38.9	55.6		18	3.3	46.7	50.0	
1989		70.2	29.8		47		34.9	63.5	1.6	63		50.0	49.1	0.9
1990	9.1	60.6	30.3		33	10.7	57.1	32.1		28	11.1	57.1	31.7	
1991	4.3	52.2	43.5		23		13.3	86.7		45	1.5	26.5	72.1	
1992	4.0	80.0	12.0	4.0	25		70.6	29.4		34	1.7	75.0	21.7	1.7
1993		42.3	57.7		26		18.6	81.4		43		28.6	71.4	
1994		50.0	50.0		4		30.0	70.0		10		35.7	64.3	
1995		25.0	75.0		4		28.6	71.4		7		33.3	66.7	
1996		100.0			17		75.0	25.0		16		87.9	12.1	
1997	2.9	70.6	20.6	5.9	34		57.1	36.7	6.1	49	1.2	62.7	30.1	6.0
1998		29.4	70.6		17		27.9	72.1		43		30.6	69.4	
1999	12.5	62.5	25.0		8		33.3	66.7		9	5.9	47.1	47.1	
2000	1.7	94.9	3.4		59		92.2	7.8		77	0.7	93.4	5.9	
2001	1.7	72.9	25.4		59		61.0	39.0		118	0.6	65.2	34.3	
2002	2.1	78.7	19.1		47		63.3	36.7		98	0.7	66.9	32.4	
2003	7.8	25.0	67.2		64	1.1	18.9	80.0		95	3.8	21.4	74.8	
2004	7.5	87.5	5.0		40		91.3	8.7		92	2.3	89.5	8.3	
2005		81.8	18.2		11		83.8	16.2		37		83.7	16.3	
2006		61.5	38.5		13		61.5	38.5		13		61.5	38.5	
2007		75.0	25.0		4		57.9	42.1		19		60.9	39.1	
2008	36.4	45.5	18.2		11		87.0	13.0		23	11.8	73.5	14.7	
2009	7.1	71.4	21.4		14		76.9	23.1		26	2.4	73.2	24.4	
Mean	4.5	63.5	31.2	0.9		0.7	53.4	45.5	0.4		2.1	57.7	39.7	0.6

Table 11. Percentage by sex and age of upper Yakima River wild/natural spring Chinook carcasses sampled on the spawning grounds and sample size (n), 1986-present.

Return	Males				Females				Total		
Year	3	4	5	n	3	4	5	n	3	4	5
1986		100.0		12		94.1	5.9	51		95.2	4.8
1987	10.8	81.5	7.7	65		77.8	22.2	126	3.7	79.1	17.3
1988	22.5	70.0	7.5	40	10.4	75.0	14.6	48	15.6	73.3	11.1
1989	0.8	93.1	6.2	130	0.4	95.5	4.1	246	0.5	94.7	4.8
1990	6.3	88.4	5.3	95	2.1	94.8	3.1	194	3.4	92.8	3.8
1991	9.1	87.3	3.6	55		89.2	10.8	111	3.0	88.6	8.4
1992	2.4	91.6	6.0	167		98.1	1.9	315	0.8	95.9	3.3
1993	4.0	90.0	6.0	50	0.9	92.0	7.1	112	1.9	91.4	6.8
1994		100.0		16		98.0	2.0	50		98.5	1.5
1995	20.0	80.0		5		100.0		12	5.6	94.4	
1996	9.1	89.6	1.3	154	0.7	98.2	1.1	282	3.7	95.2	1.1
1997		96.7	3.3	61		96.3	3.7	136		96.4	3.6
1998	14.3	85.7		21	5.3	86.8	7.9	38	8.5	86.4	5.1
1999	61.8	38.2		34		94.4	5.6	36	31.0	66.2	2.8
2000	2.8	97.2		72		100.0		219	1.0	99.0	
2001	2.7	89.2	8.1	37		83.6	16.4	122	0.6	85.0	14.4
2002	2.4	58.5	39.0	41	3.6	87.5	8.9	56	5.1	73.7	21.2
2003	60.5	39.5		38	4.3	82.6	13.0	23	39.3	55.7	4.9
2004	6.5	93.5		108	0.0	99.5	0.5	198	2.3	97.4	0.3
2005	9.2	90.0		120	1.4	97.2	1.4	214	4.2	94.7	1.2
2006	23.7	74.6		59	2.3	96.5	1.2	86	11.0	87.6	1.4
2007	17.1	82.9		76	0.9	93.8	5.4	112	7.4	89.4	3.2
2008	11.8	88.2		34	0.0	95.8	4.2	24	6.9	91.4	1.7
2009	47.7	52.3		111	2.2	95.6	2.2	45	34.6	64.7	0.6
Mean	14.4	81.6	3.9		1.4	92.6	6.0		7.9	86.9	5.1

Carcasses from upper Yakima River CESRF origin fish allowed to spawn naturally have also been sampled since age-4 adults began returning in 2001. These fish averaged 19, 79, and 2 percent age-3, -4, and –5, respectively (Table 12) from 2001-2009 compared to 12, 82, and 5 percent respectively for their wild/natural counterparts in the upper Yakima for the same years (Table 11). The observed difference in age distribution between wild/natural and CESRF sampled on the spawning grounds may be due in part to the carcass recovery bias described above. A better comparison of age distribution between upper Yakima wild/natural and CESRF fish is from samples collected at Roza Dam which are displayed in Tables 13 and 14. However, it must be noted that jacks (age-3 males) were collected at Roza in proportion to run size from 1997 to 1999, but from 2000-present we have attempted to collect them at their mean brood representation rate (approximately 7% of the spawning population). Age-3 females do occur rarely in the Upper Yakima population, but it is likely that the data in Table 13 slightly over-represent the proportion of age-3 females due to human error associated with scale collection, handling, processing, and management and entry of these data.

Table 12. Percentage by sex and age of upper Yakima River CESRF spring Chinook carcasses sampled on the spawning grounds and sample size (n), 2001-present.

Return	Males				Females				Total		
Year	3	4	5	n	3	4	5	n	3	4	5
2001	23.5	76.5		34	0.9	99.1		108	6.3	93.7	
2002	8.0	81.3	10.7	75		88.6	11.4	140	2.8	86.2	11.1
2003	100.0			1		100.0		1	50.0	50.0	
2004	9.5	90.5		21		98.0	2.0	51	2.8	95.8	1.4
2005	42.9	57.1		21		90.9	4.5	22	23.3	74.4	2.3
2006	26.7	73.3		15		100.0		43	6.9	93.1	
2007	66.7	33.3		6		100.0		11	23.5	76.5	
2008				0		100.0		1		100.0	
2009	60.0	40.0		5					60.0	40.0	
Mean	42.2	56.5	1.3		0.1	97.1	2.2		19.5	78.9	1.6

Table 13. Percentage by sex and age of upper Yakima River wild/natural spring Chinook collected for brood stock at Roza Dam and sample size (n), 1997-present.

Return	Males				Females				Total		
Year	3	4	5	n	3	4	5	n	3	4	5
1997	4.5	92.0	3.4	88		94.6	5.4	111	2.0	93.5	4.5
1998	22.4	73.1	4.5	134		91.6	8.4	179	9.6	83.7	6.7
1999	71.1	26.1	2.8	425		92.6	7.4	215	48.8	47.0	4.2
2000	17.8	81.7	0.4	230		98.7	1.3	313	7.5	91.5	0.9
2001	12.4	77.4	10.3	234	0.9	90.5	8.5	328	5.7	85.2	9.2
2002	16.4	78.3	5.3	226	0.6	94.8	4.7	343	6.9	88.2	4.9
2003	27.4	60.2	12.4	201		83.3	16.7	228	12.8	72.6	14.7
2004	15.1	84.5	0.4	239	0.3	99.0	0.7	305	6.8	92.6	0.6
2005	15.5	82.3	2.2	181	0.4	97.1	2.5	276	6.3	91.2	2.4
2006	11.1	77.4	11.5	226		89.4	10.6	255	5.2	83.8	11.0
2007	13.6	74.7	11.7	162		87.8	12.2	255	5.3	82.7	12.0
2008	20.0	77.4	2.6	190		95.6	4.4	252	8.6	87.8	3.6
2009	17.4	81.2	1.4	207	0.8	96.1	3.1	258	8.2	89.5	2.4
Mean	20.3	74.3	5.3		0.2	93.2	6.6		10.3	83.8	5.9

Table 14. Percentage by sex and age of upper Yakima River CESRF spring Chinook collected for research or brood stock at Roza Dam and sample size (n), 2001-present.

Return	Males				Females				Total		
Year	3	4	5	n	3	4	5	n	3	4	5
2001	12.5	87.5		40		100.0		75	5.1	94.9	
2002	14.7	83.8	1.5	68		98.3	1.7	115	5.5	92.9	1.6
2003	36.1	34.7	29.2	72		61.2	38.8	67	18.7	47.5	33.8
2004	19.6	80.4		46		100.0		60	8.5	91.5	
2005	17.8	75.6	6.7	45		88.1	11.9	59	7.7	82.7	9.6
2006	18.3	80.0	1.7	60		100.0		65	8.8	90.4	0.8
2007	33.3	60.8	5.9	51		87.5	12.5	56	15.9	74.8	9.3
2008	50.0	50.0		40		100.0		56	20.8	79.2	
2009	25.4	71.2	3.4	59	1.2	97.6	1.2	84	11.2	86.7	2.1
Mean	25.3	69.3	5.4			92.5	7.3		11.4	82.3	6.4

Sex Composition

In the American River, the mean proportion of males to females in wild/natural carcasses sampled on the spawning grounds from 1986-2009 was 45:55 for age-4 and 32:68 for age-5 spring Chinook (Table 15). In the Naches River, the mean proportion of males to females was 42:58 for age-4 and 27:73 for age-5 fish (Table 16). In the upper Yakima River, the mean proportion of males to females was 35:65 for age-4 and 23:77 for age-5 fish (Table 17).

For upper Yakima fish collected at Roza Dam for brood stock or research purposes from 1997-2009, the mean proportion of males to females was 38:62 and 36:64 for age-4 fish from the wild/natural and CESRF populations, respectively (Tables 19 and 20). For these same samples, the mean proportion of males to females was 36:64 and 41:59 for age-5 fish from the wild/natural and CESRF populations (excluding years with very small age-5 sample sizes), respectively (Tables 19 and 20). For adult fish, the mean proportion of males to females in spawning ground carcass recoveries was substantially lower than the ratio found at RAMF (Tables 17 and 19), indicating that sex ratios estimated from hatchery origin carcass recoveries were biased due to female carcasses being recovered at higher rates than male carcasses (Knudsen et al, 2003 and 2004). Again, despite these biases, we believe these data are good relative indicators of differences in sex composition between populations and between years.

Sample sizes for Tables 15-20 were given in Tables 9-14. As noted earlier, few age-6 fish are found in carcass surveys and those that have been found were located in the American and Naches systems. The data indicate that age-3 females may occasionally occur in the upper Yakima and, to a lesser extent, the Naches systems.

Table 15. Percent of American River wild/natural spring Chinook carcasses sampled on the spawning grounds by age and sex, 1986-present.

Return	Age-3		Age-4		Age-5		Age-6	
Year	M	F	M	F	M	F	M	F
1986			55.6	44.4	29.1	70.9		100.0
1987			65.4	34.6	33.3	66.7	100.0	
1988			0.0	100.0	100.0	0.0		
1989			79.2	20.8	39.2	60.8		
1990	100.0		43.5	56.5	46.8	53.2		
1991			55.6	44.4	38.1	61.9		
1992			62.7	37.3	31.6	68.4	100.0	
1993	100.0		33.3	66.7	19.8	80.2		
1994			34.8	65.2	41.7	58.3		100.0
1995	100.0		100.0	0.0	27.8	72.2		
1996			28.6	71.4	0.0	100.0		
1997			16.7	83.3	9.4	90.6		100.0
1998			44.4	55.6	29.0	71.0		
1999			50.0	50.0	0.0	100.0		100.0
2000			55.6	44.4	50.0	50.0		
2001			45.0	55.0	47.7	52.3		
2002	100.0		33.3	66.7	35.1	64.9		
2003			33.3	66.7	32.9	67.1		
2004			75.0	25.0	0.0	100.0		
2005			34.4	65.6	60.0	40.0		
2006			32.0	68.0	21.7	78.3		
2007	100.0		22.2	77.8	28.9	71.1		
2008			28.6	71.4	36.2	63.8		
2009			42.9	57.1	0.0	100.0		
mean			44.7	55.3	31.6	68.4		

Table 16. Percent of Naches River wild/natural spring Chinook carcasses sampled on the spawning grounds by age and sex, 1986-present.

Return	Age-3		Age-4		Age-5		Age-6	
Year	M	F	M	F	M	F	M	F
1986	100.0		46.2	53.8	18.2	81.8	50.0	50.0
1987	100.0		31.0	69.0	13.3	86.7	100.0	
1988		100.0	36.4	63.6	28.6	71.4		
1989			60.0	40.0	25.9	74.1		100.0
1990	50.0	50.0	55.6	44.4	52.6	47.4		
1991	100.0		66.7	33.3	20.4	79.6		
1992	100.0		45.5	54.5	23.1	76.9	100.0	
1993			57.9	42.1	30.0	70.0		
1994			40.0	60.0	22.2	77.8		
1995			33.3	66.7	37.5	62.5		
1996			58.6	41.4		100.0		
1997	100.0		46.2	53.8	28.0	72.0	40.0	60.0
1998			29.4	70.6	27.9	72.1		
1999	100.0		62.5	37.5	25.0	75.0		
2000	100.0		44.1	55.9	25.0	75.0		
2001	100.0		37.4	62.6	24.6	75.4		
2002	100.0		37.4	62.6	20.0	80.0		
2003	83.3	16.7	47.1	52.9	36.1	63.9		
2004	100.0		29.4	70.6	20.0	80.0		
2005			22.5	77.5	25.0	75.0		
2006			50.0	50.0	50.0	50.0		
2007			21.4	78.6	11.1	88.9		
2008	100.0		20.0	80.0	40.0	60.0		
2009	100.0		33.3	66.7	33.3	66.7		
mean			42.2	57.8	26.6	73.4		

Table 17. Percent of Upper Yakima River wild/natural spring Chinook carcasses sampled on the spawning grounds by age and sex, 1986-present.

Return	Age-3		Age-4		Age-5	
Year	M	F	M	F	M	F
1986			20.0	80.0		100.0
1987	100.0		35.1	64.9	15.2	84.8
1988	64.3	35.7	43.8	56.3	30.0	70.0
1989	50.0	50.0	34.0	66.0	44.4	55.6
1990	60.0	40.0	31.3	68.7	45.5	54.5
1991	100.0		32.7	67.3	14.3	85.7
1992	100.0		33.1	66.9	62.5	37.5
1993	66.7	33.3	30.4	69.6	27.3	72.7
1994			24.6	75.4		100.0
1995	100.0		25.0	75.0		
1996	87.5	12.5	33.3	66.7	40.0	60.0
1997			31.1	68.9	28.6	71.4
1998	60.0	40.0	35.3	64.7		100.0
1999	100.0		27.7	72.3		100.0
2000	100.0		24.2	75.8		
2001	100.0		24.4	75.6	13.0	87.0
2002	33.3	66.7	32.9	67.1	76.2	23.8
2003	95.8	4.2	44.1	55.9		100.0
2004	100.0		33.9	66.1		100.0
2005	78.6	21.4	34.2	65.8	25.0	75.0
2006	87.5	12.5	34.6	65.4	50.0	50.0
2007	92.9	7.1	37.5	62.5		100.0
2008	100.0		56.6	43.4		100.0
2009	98.1	1.9	57.4	42.6		100.0
mean	84.5	15.5	34.7	65.3	22.5	77.5

Table 18. Percent of upper Yakima River CESRF spring Chinook carcasses sampled on the spawning grounds by age and sex, 2001-present.

Return	Age-3		Age-4		Age-5	
Year	M	F	M	F	M	F
2001	88.9	11.1	19.5	80.5		
2002	100.0		33.0	67.0	33.3	66.7
2003	100.0			100.0		
2004	100.0		27.5	72.5		100.0
2005	90.0	10.0	37.5	62.5		100.0
2006	100.0		20.4	79.6		
2007	100.0		15.4	84.6		
2008				100.0		
2009	100.0		100.0			
mean	97.4	2.6	28.1	71.9		

Table 19. Percent of upper Yakima River wild/natural spring Chinook collected for brood stock at Roza Dam by age and sex, 1997-present.

Return	Age-3		Age-4		Age-5	
Year	M	F	M	F	M	F
1997	100.0		43.5	56.5	33.3	66.7
1998	100.0		37.4	62.6	28.6	71.4
1999	100.0		35.8	64.2	42.9	57.1
2000	100.0		37.8	62.2	20.0	80.0
2001	90.6	9.4	37.9	62.1	46.2	53.8
2002	94.9	5.1	35.3	64.7	42.9	57.1
2003	100.0		38.9	61.1	39.7	60.3
2004	97.3	2.7	40.1	59.9	33.3	66.7
2005	96.6	3.4	35.7	64.3	36.4	63.6
2006	100.0		43.4	56.6	49.1	50.9
2007	100.0		35.1	64.9	38.0	62.0
2008	100.0		37.9	62.1	31.3	68.8
2009	94.7	5.3	40.4	59.6	27.3	72.7
mean	98.0	2.0	38.4	61.6	36.1	63.9

Table 20. Percent of Upper Yakima River CESRF spring Chinook collected for research or brood stock at Roza Dam by age and sex, 2001-present.

Return	Age-3		Age-4		Age-5	
Year	M	F	M	F	M	F
2001	100.0	0.0	31.8	68.2		
2002	100.0	0.0	33.5	66.5	33.3	66.7
2003	100.0	0.0	37.9	62.1	44.7	55.3
2004	100.0	0.0	38.1	61.9		
2005	100.0	0.0	39.5	60.5	30.0	70.0
2006	100.0	0.0	42.5	57.5	100.0	
2007	100.0	0.0	38.8	61.3	30.0	70.0
2008	100.0	0.0	26.3	73.7		
2009	93.8	6.3	33.9	66.1	66.7	33.3
mean	99.3	0.7	35.8	64.2	40.9	59.1

Size at Age

Prior to 1996, samplers were instructed to collect mid-eye to hypural plate (MEHP) lengths from carcasses surveyed on the spawning grounds. From 1996 to present the method was changed and post-eye to hypural plate (POHP) lengths have been recorded. Mean POHP lengths averaged 40, 61, and 77 cm for age-3, -4, and -5 males, and averaged 62 and 73 cm for age-4 and -5 females, respectively, from carcasses sampled on the spawning grounds in the American River from 1996-2009 (Table 21). In the Naches River, mean POHP lengths averaged 41, 61, and 76 cm for age-3, -4, and -5 males, and averaged 61 and 73 cm for age-4 and -5 females, respectively (Table 22). For wild/natural spring Chinook sampled on the spawning grounds in the upper Yakima River, mean POHP lengths averaged 44, 60, and 72 cm for age-3, -4, and -5 males, and averaged 60 and 69 cm for age-4 and -5 females, respectively (Table 23). From 2001-2009, CESRF fish returning to the upper Yakima have been generally smaller in size-at-age than their wild/natural counterparts (Tables 23-28).

Table 21. Counts and mean mid-eye (MEHP) or post-orbital (POHP) to hypural plate lengths (cm) of American River wild/natural spring Chinook from carcasses sampled on the spawning grounds by sex and age, 1986-present.

	Males								Females					
Return	Age 3		Age 4		Age 5		Age 6		Age 4		Age 5		Age 6	
Year	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP
1986			5	57.1	16	80.9			4	65.8	39	75.2	2	74.0
1987			17	58.0	6	80.8	1.0	86.0	9	64.5	12	76.9		
1988					1	79.0			1	63.0				
1989			19	61.1	29	77.4			5	63.0	45	73.5		
1990	1	41.0	10	63.6	29	77.3			13	62.5	33	73.6		
1991			10	59.5	32	77.1			8	65.1	52	73.4		
1992			37	60.6	12	76.2	3.0	86.7	22	64.1	26	76.4		
1993	1	47.0	3	64.0	17	80.2			6	63.7	69	75.5		
1994			8	67.3	10	83.0			15	70.8	14	76.4	1	85.0
1995	1	44.4	1	70.0	4	83.5					12	76.4		
		POHP		POHP		POHP		POHP		POHP		POHP		POHP
1996			2	56.3					5	59.0	1	67.0		
1997[1]			2	62.0	1	63.0			4	62.8	14	64.4	5	71.0
1998			4	58.3	29	79.1			5	64.0	71	73.4		
1999			2	50.5					2	61.0	2	73.0	1	77.0
2000			10	57.9	5	83.2			8	63.9	5	76.2		
2001			59	65.9	31	77.6			72	63.6	34	73.0		
2002	1	40.0	31	63.0	26	77.3			62	64.4	48	74.7		
2003			6	63.0	68	79.4			12	64.3	139	76.7		
2004			3	56.0					1	58.0	4	77.5		
2005			11	60.6	6	80.2			21	62.6	4	74.8		
2006			8	60.8	5	75.4			17	61.8	18	71.7		
2007	2	37.0	6	62.8	11	76.5			21	60.0	27	73.3		
2008			2	67.5	21	83.1			5	67.4	37	78.9		
2009	4	44.0	9	68.3					12	62.6	4	69.8		
Mean[2]		40.3		60.9		77.5				62.5		73.2		74.0

[1] Carcasses sampled in 1997 had a mix of MEHP and POHP lengths taken. Only POHP samples are given here.
[2] Mean of mean values for 1996-2009 post-eye to hypural plate lengths.

Table 22. Counts and mean mid-eye (MEHP) or post-orbital (POHP) to hypural plate lengths (cm) of Naches River wild/natural spring Chinook from carcasses sampled on the spawning grounds by sex and age, 1986-present.

	Males								Females							
Return	Age 3		Age 4		Age 5		Age 6		Age 3		Age 4		Age 5		Age 6	
Year	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP
1986	1	45.0	12	62.7	6	74.3	1.0	80.0			14	64.5	27	73.6	1	83.5
1987	1	37.0	12	64.2	2	80.5	1.0	94.0			29	67.9	13	75.7		
1988			4	62.0	4	74.6			1	45.0	7	69.1	10	73.6		
1989			33	58.4	14	77.5					22	61.7	40	73.2	1	75.0
1990	3	53.0	20	59.4	10	75.9			3	51.7	16	60.9	9	73.7		
1991	1	31.0	12	56.3	10	72.8					6	62.5	39	71.1		
1992	1	42.0	20	58.8	3	72.3	1.0	83.0			24	62.4	10	71.7		
1993			11	60.0	15	77.7					8	63.3	35	72.5		
1994			2	62.5	2	77.0					3	63.7	7	73.1		
1995			1	59.0	3	73.0					2	64.0	5	73.8		
		POHP		POHP		POHP		POHP		POHP		POHP		POHP		POHP
1996			17	58.1							12	60.3	4	69.6		
1997[1]	1	39.0	24	59.8	4	71.5	2.0	78.0			28	60.0	15	68.6	1	75.0
1998			5	57.8	12	75.0					12	61.1	31	71.6		
1999	1	40.0	5	61.2	2	73.0					3	58.7	6	75.0		
2000	1	35.0	56	58.2	2	84.0					71	59.5	6	72.8		
2001	1	45.0	43	61.4	15	73.4					72	62.2	46	74.5		
2002	1	40.0	37	63.6	9	77.3					62	62.4	36	71.8		
2003	5	41.4	16	62.2	43	79.4			1	41.0	18	62.8	76	75.6		
2004	3	46.0	35	59.8	2	74.5					84	61.5	8	75.8		
2005			9	60.1	2	78.0					31	61.7	6	71.7		
2006			8	56.9	5	76.0					8	63.8	5	71.2		
2007			3	61.3	1	67.0					11	56.9	8	72.1		
2008	4	42.0	5	59.6	2	81.5					20	62.0	3	78.7		
2009	1	43.0	10	67.9	3	76.3					20	63.9	6	73.2		
Mean[2]		41.3		60.6		75.9		78.0		41.0		61.2		73.0		75.0

[1] Carcasses sampled in 1997 had a mix of MEHP and POHP lengths taken. Only POHP samples are given here.
[2] Mean of mean values for 1996-2009 post-eye to hypural plate lengths.

Table 23. Counts and mean mid-eye (MEHP) or post-orbital (POHP) to hypural plate lengths (cm) of upper Yakima River wild / natural spring Chinook from carcasses sampled on the spawning grounds by sex and age, 1986-present.

	Males						Females					
Return	Age 3		Age 4		Age 5		Age 3		Age 4		Age 5	
Year	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP	Count	MEHP
1986			12	60.8					48	58.7	3	70.3
1987	7	45.3	53	58.5	5	73.0			96	59.3	28	70.6
1988	9	40.0	28	59.0	3	79.0	5	52.6	36	59.2	7	70.3
1989	1	50.0	121	59.7	8	70.6	1	40.0	235	58.6	10	67.2
1990	6	47.0	84	58.0	5	77.0	4	51.5	184	59.3	6	72.5
1991	5	39.6	48	56.2	2	67.5			99	57.6	12	68.8
1992	4	43.0	153	58.4	10	71.2			309	58.2	6	69.5
1993	2	44.0	45	60.7	3	75.0	1	56.0	101	59.5	8	70.3
1994			15	62.9					49	61.3	1	72.0
1995	1	43.0	4	62.0					12	61.4	0	
		POHP		POHP		POHP		POHP		POHP		POHP
1996	14	40.9	138	59.1	2	66.5	2	41.0	277	58.6	3	68.0
1997			59	59.3	2	74.0			131	58.6	5	69.4
1998	3	38.7	18	56.4			2	47.0	33	57.5	3	66.7
1999	21	38.8	13	57.4					34	58.9	2	69.8
2000	2	41.0	70	60.3					219	58.3	0	
2001	1	43.0	33	60.7	3	74.7			102	60.6	20	69.8
2002	1	44.0	24	64.9	16	69.3	2	46.0	49	62.5	5	70.2
2003	23	44.4	15	59.8					19	62.4	3	67.8
2004	7	47.3	101	59.9					197	58.7	1	67.0
2005	11	49.2	108	60.6	1	75.0	3	48.7	207	59.5	3	67.3
2006	14	41.8	44	59.4	1	72.0	2	39.5	82	58.3	1	71.0
2007	13	44.2	61	61.7					101	60.6	6	66.0
2008	3	48.3	29	60.5					22	59.7	1	77.0
2009	53	46.8	58	57.6			1	51.0	43	60.2	1	68.0
Mean[1]		43.7		59.8		71.9		45.5		59.6		69.1

[1] Mean of mean values for 1996-2009 post-eye to hypural plate lengths.

Table 24. Counts and mean post-orbital to hypural plate (POHP) lengths (cm) of upper Yakima River CESRF spring Chinook from carcasses sampled on the spawning grounds by sex and age, 2001-present.

	Males						Females					
Return	Age 3		Age 4		Age 5		Age 3		Age 4		Age 5	
Year	Count	POHP	Count	POHP	Count	POHP	Count	POHP	Count	POHP	Count	POHP
2001	8	40.5	25	59.0	1	69.5	1	41.0	107	59.0		
2002	6	47.7	61	61.2	8	68.9			124	60.6	16	71.2
2003	1	42.0							1	69.0		
2004	2	52.0	19	60.8					50	57.9	1	68.0
2005	8	41.8	12	59.9			1	46.0	20	59.6	1	72.0
2006	4	42.3	11	54.0					43	57.0		
2007	4	44.3	2	58.5					11	60.1		
2008	0		0						1	58.0		
2009	3	47.7	2	---								
Mean		44.8		58.9		69.2				60.1		70.4

Table 25. Counts and mean post-orbital to hypural plate (POHP) lengths (cm) of upper Yakima River wild/natural spring Chinook from carcasses sampled at the CESRF prior to spawning by sex and age, 1997-present.

	Males						Females					
Return	Age 3		Age 4		Age 5		Age 3		Age 4		Age 5	
Year	Count	POHP	Count	POHP	Count	POHP	Count	POHP	Count	POHP	Count	POHP
1997	4	39.7	81	59.7	3	73.3			105	60.5	6	68.9
1998	28	43.0	95	57.3	6	67.0			161	59.2	15	65.6
1999	124	41.4	75	59.5	10	64.6			199	60.4	16	67.4
2000	19	42.0	145	59.0	1	77.0			263	59.4	3	69.4
2001	17	42.9	115	59.6	14	74.1			196	60.5	19	69.8
2002	23	42.1	113	60.6	5	72.9	1	36.6	233	61.2	9	70.9
2003	37	42.7	92	60.4	19	73.7			164	61.4	31	69.4
2004	18	42.4	108	58.9	1	67.8			225	58.3	2	66.5
2005	19	42.1	113	60.0	2	67.3	1	42.6	223	59.8	5	67.8
2006	17	41.0	82	56.7	20	70.4			197	57.8	24	68.1
2007	20	44.6	108	58.8	17	67.6			181	59.4	24	67.2
2008	17	45.5	121	59.6	4	71.1			209	59.7	11	68.4
2009	16	44.4	122	61.5	3	69.3	1	50.4	206	60.3	6	68.0
Mean		42.6		59.4		70.5				59.8		68.3

Table 26. Counts and mean post-orbital to hypural plate (POHP) lengths (cm) of upper Yakima River CESRF spring Chinook from carcasses sampled at the CESRF prior to spawning by sex and age, 2001-present.

	Males						Females					
Return	Age 3		Age 4		Age 5		Age 3		Age 4		Age 5	
Year	Count	POHP	Count	POHP	Count	POHP	Count	POHP	Count	POHP	Count	POHP
2001			4	61.3					33	60.4		
2002	2	40.2	25	59.6					63	59.4	2	66.1
2003	17	42.6	16	57.8	15	74.0			31	59.7	19	70.4
2004	6	39.4	9	57.1					42	59.3		
2005	6	37.9	21	58.4	2	68.7			38	58.6	5	68.0
2006[1]			3	57.2					3	56.3		
2007	8	40.4	18	59.3	1	71.4			35	58.2	5	67.6
2008	17	43.8	9	59.1					28	59.4		
2009	5	43.8	11	61.1					32	60.1	1	67.5
Mean		41.2		59.0		71.4				59.0		67.9

[1] Few length samples were collected since these fish were not spawned in 2006.

Table 27. Counts and mean post-orbital to hypural plate (POHP) lengths (cm) of upper Yakima River wild/natural spring Chinook from fish sampled at Roza Dam by age, 1997-present.

Return	Age 2		Age 3		Age 4		Age 5	
Year	Count	POHP	Count	POHP	Count	POHP	Count	POHP
1997			4	39.6	202	60.5	12	71.0
1998			37	42.8	309	59.1	24	67.3
1999			352	40.7	336	60.0	30	68.0
2000			41	41.4	499	60.3	5	73.1
2001			32	42.9	482	61.4	52	72.4
2002			45	42.1	525	60.8	29	71.1
2003			55	43.5	314	62.3	63	72.4
2004	2	15.5	41	43.4	515	59.8	3	69.3
2005			35	43.2	441	60.9	11	71.0
2006			28	41.5	413	58.9	49	70.9
2007	2	14.5	32	43.2	363	60.6	52	69.8
2008			38	45.8	394	61.0	16	70.8
2009			39	45.8	422	62.4	12	70.4
Mean				42.8		60.6		70.6

Table 28. Counts and mean post-orbital to hypural plate (POHP) lengths (cm) of upper Yakima River CESRF spring Chinook from fish sampled at Roza Dam by age, 2000-present.

Return	Age 2		Age 3		Age 4		Age 5	
Year	Count	POHP	Count	POHP	Count	POHP	Count	POHP
2000	66	15.9	633	38.3				
2001	893	15.2	474	40.0	2343	59.3		
2002	475	15.2	26	38.7	1535	59.2	34	67.0
2003	137	15.7	394	41.8	255	60.6	215	71.4
2004	83	15.5	49	40.4	451	59.5	2	71.0
2005	137	15.6	98	40.4	218	59.3	18	70.1
2006	26	14.5	26	40.4	407	57.6	2	70.5
2007	54	15.5	175	41.4	231	59.4	19	70.4
2008	11	15.4	95	45.0	251	60.3	1	67.0
2009	12	15.1	255	43.6	290	62.1	11	67.5
Mean		15.4		41.0		59.7		69.4

Migration Timing

Wild/natural spring Chinook adults returning to the upper Yakima River have generally shown earlier passage timing at Roza Dam than CESRF spring Chinook (Figures 2 and 3).

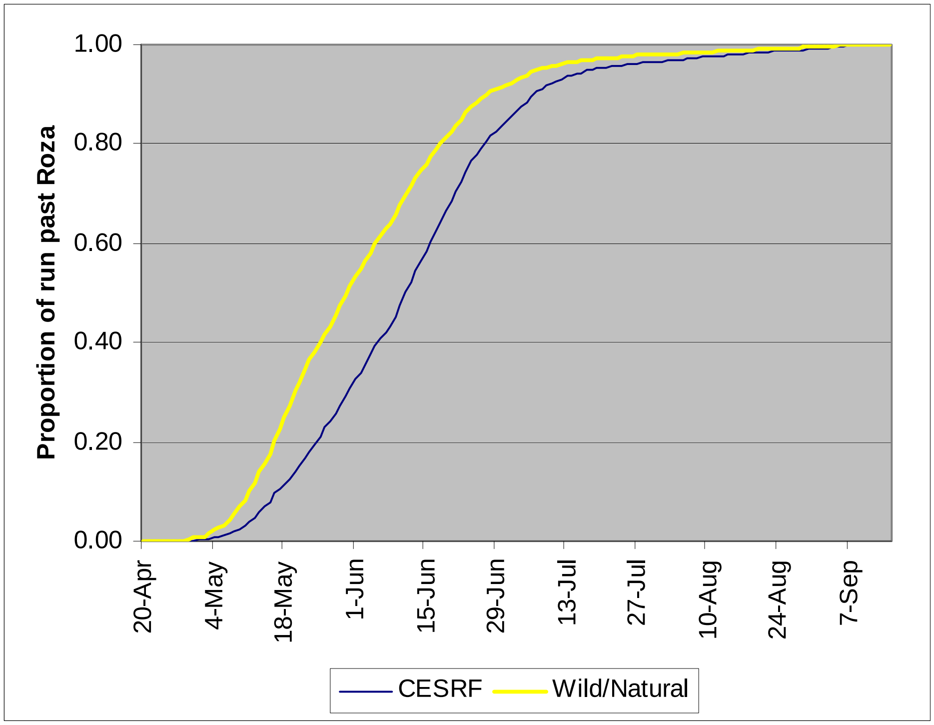

Figure 3. Proportionate passage timing at Roza Dam of wild/natural and CESRF adult spring Chinook (including jacks), 2001-2009.

Table 29. Comparison of 5%, median (50%), and 95% passage dates of wild/natural and CESRF adult spring Chinook (including jacks) at Roza Dam, 1997-Present.

	Wild/Natural Passage			CESRF Passage		
Year	5%	Median	95%	5%	Median	95%
1997	10-Jun	17-Jun	21-Jul			
1998	22-May	10-Jun	10-Jul			
1999	31-May	24-Jun	4-Aug			
2000	12-May	24-May	12-Jul	21-May[1]	15-Jun[1]	27-Jul[1]
2001	4-May	23-May	11-Jul	8-May	28-May	15-Jul
2002	16-May	10-Jun	6-Aug	20-May	13-Jun	12-Aug
2003	13-May	11-Jun	19-Aug	13-May	10-Jun	24-Aug
2004	4-May	20-May	24-Jun	5-May	22-May	26-Jun
2005	9-May	22-May	23-Jun	15-May	31-May	2-Jul
2006	1-Jun	14-Jun	18-Jul	3-Jun	18-Jun	19-Jul
2007	16-May	5-Jun	9-Jul	24-May	14-Jun	19-Jul
2008	27-May	9-Jun	9-Jul	31-May	17-Jun	14-Jul
2009	31-May	14-Jun	17-Jul	2-Jun	19-Jun	17-Jul

1. In 2000 all returning CESRF fish were age-3 (jacks).

Spawning Timing

Median spawn timing for CESRF spring Chinook is earlier than that observed for wild/natural fish in the Upper Yakima River. These differences are due in part to environmental conditions and spawning procedures at the hatchery. It must also be noted that spawning dates in the wild are only a coarse approximation, derived from weekly redd counts not actual dates of redd deposition. A clear delineation of wild/natural spawn timing between subbasins is apparent, with American River fish spawning about 1 month earlier than Naches Basin fish which spawn about 2 weeks earlier than Upper Yakima fish.

Table 30. Median spawn[1] dates for spring Chinook in the Yakima Basin.

Year	American	Naches	Upper Yakima	CESRF
1988	14-Aug	7-Sep	3-Oct	
1989	14-Aug	7-Sep	19-Sep	
1990	14-Aug	12-Sep	25-Sep	
1991	12-Aug	12-Sep	24-Sep	
1992	11-Aug	10-Sep	22-Sep	
1993	9-Aug	8-Sep	27-Sep	
1994	16-Aug	14-Sep	26-Sep	
1995	14-Aug	7-Sep	1-Oct	
1996	20-Aug	18-Sep	23-Sep	
1997	12-Aug	11-Sep	23-Sep	23-Sep
1998	11-Aug	15-Sep	30-Sep	22-Sep
1999	24-Aug	8-Sep	27-Sep	21-Sep
2000	7-Aug	20-Sep	19-Sep	19-Sep
2001	14-Aug	13-Sep	25-Sep	18-Sep
2002	12-Aug	11-Sep	23-Sep	24-Sep
2003	11-Aug	14-Sep	28-Sep	23-Sep
2004	17-Aug	12-Sep	27-Sep	21-Sep
2005	15-Aug	15-Sep	27-Sep	20-Sep
2006	15-Aug	14-Sep	26-Sep	19-Sep
2007	14-Aug	12-Sep	25-Sep	25-Sep
2008	11-Aug	12-Sep	23-Sep	23-Sep
2009	17-Aug	10-Sep	23-Sep	28-Sep
Mean	13-Aug	11-Sep	25-Sep	22-Sep

1. Approximately one-half of the redds in the system were counted by this date and one-half were counted after this date. For the CESRF, approximately one-half of the total broodstock were spawned by this date and one-half were spawned after this date.

Redd Counts and Distribution

Table 31. Yakima Basin spring Chinook redd count summary, 1981 – present.

	Upper Yakima River System				Naches River System				
Year	Mainstem[1]	Cle Elum	Teanaway	Total	American	Naches[1]	Bumping	Little Naches	Total
1981	237	57	0	294	72	64	20	16	172
1982	610	30	0	640	11	25	6	12	54
1983	387	15	0	402	36	27	11	9	83
1984	677	31	0	708	72	81	26	41	220
1985	795	153	3	951	141	168	74	44	427
1986	1,716	77	0	1,793	464	543	196	110	1,313
1987	968	75	0	1,043	222	281	133	41	677
1988	369	74	0	443	187	145	111	47	490
1989	770	192	6	968	187	200	101	53	541
1990	727	46	0	773	143	159	111	51	464
1991	568	62	0	630	170	161	84	45	460
1992	1,082	164	0	1,246	120	155	99	51	425
1993	550	105	1	656	214	189	88	63	554
1994	226	64	0	290	89	93	70	20	272
1995	105	12	0	117	46	25	27	6	104
1996	711	100	3	814	28	102	29	25	184
1997	364	56	0	420	111	108	72	48	339
1998	123	24	1	148	149	104	54	23	330
1999	199	24	1	224	27	95	39	25	186
2000	3,349	466	21	3,836	53	483	278	73	887
2001	2,932	386	21	3,339	392	436	257	107	1,192
2002	2,441	275	110	2,826	366	226	262	89	943
2003	772	87	31	890	430	228	216	61	935
2004	2,985	330	129	3,444	91	348	205	75	719
2005	1,717	287	15	2,019	142	203	163	68	576
2006	1,077	100	58	1,235	133	163	115	33	444
2007	665	51	10	726	166	60	60	28	314
2008	1,191	137	47	1,375	158	165	102	70	495
2009	1,301	197	33	1,531	91	159	163	65	478
Mean	1,022	127	17	1,165	156	179	109	48	492

[1] Including minor tributaries.

Homing

A team from NOAA fisheries has conducted studies to determine the spatial and temporal patterns of homing and spawning by wild and hatchery-reared salmon released from CESRF facilities from 2001 to present. These studies collected GPS information on each redd and carcass recovered within a survey reach. Carcass surveys were conducted annually in late-September to early October by NOAA personnel in cooperation with Yakama Nation survey crews over five different reaches of the upper Yakima River and recorded the location of each redd flagged and carcass recovered. For each carcass sex, hatchery/wild, male status (full adult, jack, mini-jack), and CWT location was recorded. Data collected on the body location of CWTs allowed the identification of the release site of some fish. While these studies were not designed to comprehensively map carcasses and redds in all spawning reaches in the upper watershed, preliminary data indicate that fish from the Easton, Jack Creek, and Clark Flat acclimation facilities had distinct spawner distributions. A more complete description of this project including preliminary results is available from NOAA fisheries.

Dittman, A. H., D. May, D. A. Larsen, M. L. Moser, M. Johnston, and D. Fast. 2010. Homing and spawning site selection by supplemented hatchery- and natural-origin Yakima River spring Chinook salmon. Transactions of the American Fisheries Society 139:1014-1028.

Straying

The regional PTAGIS (PIT tag) and RMIS (CWT) databases were queried in February 2010 to determine the number of CESRF releases not returning to the Yakima River Basin. For adult (age-3, -4, or -5) PIT tagged fish, a stray is defined as detection at an out-of-basin facility in the Snake (Ice Harbor or Lower Granite) or Upper Columbia (Priest Rapids, Rock Island, or Wells) without a subsequent detection at Prosser or Roza Dam. For coded-wire tagged fish, a stray is generally defined as a tag recovery in tributaries of the Columbia River upstream (and including the Snake River Basin) of its' confluence with the Yakima River. Marked (adipose fin clipped) fish are occasionally found during carcass surveys in the Naches River system. All marked fish observed in spawning ground carcass surveys in the Naches Basin are assumed to be CESRF fish and are used to estimate in-basin stray rates.

Table 32. Estimated number of PIT- and CWT-tagged CESRF fish not returning to the Yakima River Basin (strays), and marked fish sampled during spawner surveys in the Naches Basin, per number of returning fish, brood years 1997-present.

	CESRF PIT-Tagged Fish			All CESRF Fish			CESRF Age-4 Fish		
Brood Year	Roza Adult Returns	Adult Strays	Stray Rate	Yakima River Mth Return	CWT Strays	Stray Rate	Yak R. MthRtn	In-Basin Strays	Stray Rate
1997	598	2	0.33%	8,670	1	0.01%	7,753		
1998	398	0	0.00%	9,782			7,939	1	0.01%
1999	23	0	0.00%	864			714		
2000	150	4	2.67%	4,819	2	0.04%	3,647	4	0.11%
2001	80	3	3.75%	1,251			845	2	0.24%
2002	97	5	5.15%	2,300			1,886	1	0.05%
2003	31	0	0.00%	932			800		
2004	125			4,021			3,101		
2005	138			4,324			3,019		

CESRF Spawning and Survival

As described earlier, a portion of natural- and hatchery-origin (NoR and HoR, respectively) returning adults are captured at Roza Dam during the adult migration and taken to the CESRF for broodstock and/or research purposes. Fish are held in adult holding ponds at the CESRF from capture in the spring and summer until spawning in September through early October. All mortalities during the holding period are documented by sex and origin. During the spawning period data are kept on the number of males and females of each origin used for spawning or other purposes. All females have samples taken that are later evaluated for presence of BKD-causative agents. Eggs from females with high BKD-presence indicators are generally excluded (see Female BKD Profiles). Once fertilized, eggs are placed in holding troughs until shock time. Dead eggs are then sorted and hand-counted. All live eggs are machine counted, sorted into two lots per female (treatment and control) and placed into incubation (heath) trays. Using hand counts of egg samples from a subsample of female egg lots, WDFW staff determined that machine counts are biased and that the best approximation of live egg counts is given by the following equation:

$$\left(\left(\frac{\text{no. eggs in subsample}}{\text{wt. of subsample}} * \text{total egg mass wt}\right) * 0.945\right) - \text{dead eggs}$$

where
the first 3 parameters are from egg samples taken from females at spawn time,
dead eggs are the number of dead or unfertilized eggs counted at shock time, and
the 0.945 value is a correction factor from 1997 and 2000 WDFW studies.

Total egg take is calculated as the total number of live eggs, dead eggs, and all documented egg loss (e.g. spilled at spawn time, etc.). Heath trays are periodically sampled during incubation and dead fry are culled and counted. The number of live eggs less documented fry loss is the estimate of the number of fry ponded. Once fry are ponded, mortalities are counted and recorded daily during the rearing period. Fish are hand counted in the fall prior to their release as they are 100-percent marked. This hand-count less documented mortalities from marking through release is the estimate of smolts released. Survival statistics by origin and life-stage are given in Tables 33 and 34.

Table 33. Cle Elum Supplementation and Research Facility spawning and survival statistics (NoR brood only), 1997 - present.

Brood Year	Total Collected	Total Morts.	PreSpawn Survival	No. Fish Spawned[1] Males[2]	Females	% BKD Loss	Total Egg Take	Live Eggs	% Egg Loss[3]	Fry Ponded[4]	Live-Egg-Fry Survival	Smolts Released	Fry-Smolt Survival	Live-Egg-Smolt Survival
1997	261	23	91.2%	106	132	2.6%	500,750	463,948	7.3%	413,211	98.5%	386,048	93.4%	91.9%
1998	408	70	82.8%	140	198	1.4%	739,802	664,125	10.2%	627,481	98.7%	589,648	94.0%	92.7%
1999	738[5]	24	96.7%	213	222	2.7%	818,816	777,984	5.0%	781,872	97.3%	758,789	97.0%	94.5%
2000	567	61	89.2%	170	278	9.2%	916,292	851,128	7.1%	870,328	97.3%	834,285	95.9%	93.4%
2001	595	171	71.3%	145	223	53.2%	341,648	316,254	7.4%	380,880	98.6%	370,236	97.2%	96.1%
2002	629	89	85.9%	125	261	10.0%	919,776	817,841	11.1%	783,343	98.0%	749,067	95.6%	93.6%
2003	441	54	87.8%	115	200	0.0%	856,574	787,933	8.0%	761,968	98.4%	735,959	96.6%	95.1%
2004	597	70	88.3%	125	245	0.4%	873,815	806,375	7.7%	776,941	97.8%	691,109[6]	89.0%	87.0%
2005	526	57	89.2%	136	241	0.0%	907,199	835,890	7.9%	796,559	98.1%	769,484	96.6%	94.7%
2006	519	45	91.3%	122	239	1.7%	772,357	703,657	8.9%	631,691	97.3%	574,361[7]	90.9%	88.3%
2007	473	49	89.6%	149	216	0.9%	798,729	760,189	4.8%	713,814	98.9%	676,602	94.8%	93.7%
2008	480	38	92.1%	151	253	2.0%	915,563	832,938	9.0%	809,862	99.0%	752,109[8]	97.3%	96.3%
2009	486	57	88.3%	142	219	1.4%	850,404	848,339	0.2%	832,702	98.2%			
Mean	517	62	88.0%	141	225	6.6%	785,517	728,200	7.3%	706,204	98.2%	657,308	94.9%	93.1%

1. Total collected minus total mortalities does not equal total spawned. This is because some fish are used in the spawning channel, some have been released back to the river, and some have not been used.
2. Includes jacks.
3. All documented egg loss at spawn time plus dead eggs counted at shock divided by the estimated total egg take.
4. Based on physical counts at mark time less all documented rearing mortality from ponding to release, except for BY2009 it is live eggs (est.) minus fry loss.
5. Approximately one-half of these were jacks, many of which were not used in spawning.
6. Approximately 45,000 smolts lost at Jack Creek due to frozen equipment in February, 2006.
7. EWOS feed treatment had high mortality and was discontinued in May 2007; resulted in lower survival to release.
8. Approximately 36,000 NoR (Table 33) and 12,000 HoR (Table 34) fish were culled in July 2009 to reduce pond densities; these fish were added back in to fry-smolt and live-egg-smolt survival calculations.
9. Table 34 -- From 2002 to present this is the estimated total egg take from all HxH crosses. Due to the large surplus of eggs over the approximately 100K needed for the HxH line, many surplus fry were planted in nearby land-locked lakes and some surplus eggs were destroyed.
10. Table 34 -- For only those HxH fish which were actually ponded.

Table 34. Cle Elum Supplementation and Research Facility spawning and survival statistics (HoR brood only), 2002 - present.

Brood Year	Total Collected	Total Morts.	PreSpawn Survival	No. Fish Spawned[1] Males[2]	Females	% BKD Loss	Total Egg Take[9]	Live Eggs[10]	% Egg Loss[3]	Fry Ponded[4]	Live-Egg-Fry Survival	Smolts Released	Fry-Smolt Survival	Live-Egg-Smolt Survival
2002	201	22	89.1%	26	72	4.2%	258,226	100,011	7.8%	91,300	98.2%	87,837	96.2%	94.4%
2003	143	12	91.6%	30	51	0.0%	219,901	83,128	7.3%	91,203	98.8%	88,733	97.3%	96.1%
2004	126	19	84.9%	22	49	0.0%	187,406	94,659	5.9%	100,567	98.3%	94,339	93.8%	92.2%
2005	109	6	94.5%	26	45	0.0%	168,160	89,066	12.2%	92,903	98.1%	90,518	97.4%	95.6%
2006	136	21	84.6%	28	41	2.4%	112,576	80,121	8.6%	74,735	97.6%	68,434[7]	91.6%	89.4%
2007	110	15	86.4%	26	35	0.0%	125,755	90,162	3.2%	96,912	99.2%	94,663	97.7%	96.9%
2008	194	10	94.8%	51	67	1.5%	247,503	106,122	5.1%	111,797	98.9%	97,196[8]	97.4%	96.4%
2009	164	24	85.4%	30	38	0.0%	148,593	91,994	0.8%	90,395	98.3%			
Mean	148	16	88.9%	30	50	1.0%	183,515	91,908	6.4%	93,727	98.4%	88,817	95.9%	94.4%

See footnotes for Table 33 above.

Female BKD Profiles

Adults used for spawning and their progeny are tested for a variety of pathogens accepted as important in salmonid culture (USFWS Inspection Manual, 2003), on a population or "lot" basis. At the CESRF, and in the Columbia Basin it has been accepted that the most significant fish pathogen for spring Chinook is *Renibacterium salmoninarum*, the causative agent of Bacterial Kidney Disease (BKD). All adult females and 60 juveniles from each acclimation pond are individually tested for levels of *Renibacterium salmoninarum* using ELISA (Enzyme linked Immuno-sorbant Assay). ELISA data are reported annually to CESRF and YKFP staff for management purposes, eventual data entry and comparisons of ponds and rearing parameters. To date, no significant occurrences of other pathogens have been observed. Periodic field exams for external parasites and any signs of disease are performed on an "as needed" basis. Facility staff have been trained to recognize early signs of behavior changes or diseases and would report any abnormalities to the USFWS, Olympia Fish Health Center for further diagnostic work.

Adult females are ranked from 0 to 13 based on the relative amounts of BKD in the tissue samples of the tested fish. All BKD ranks below 5 are considered low risk for transferring significant BKD organisms through the egg to cause significant disease in progeny receiving proper care. The progeny of adults with BKD rank 6 are considered to be moderate risk and those with BKD rank 7 or greater are considered to be high risk. Given these data, the CESRF chose to rear only the progeny of females with a BKD rank of 6 or less through brood year 2001. Beginning with brood year 2002, the progeny of fish with BKD rank 6 (moderate risk) or greater (high risk) have not been used for production purposes at the CESRF.

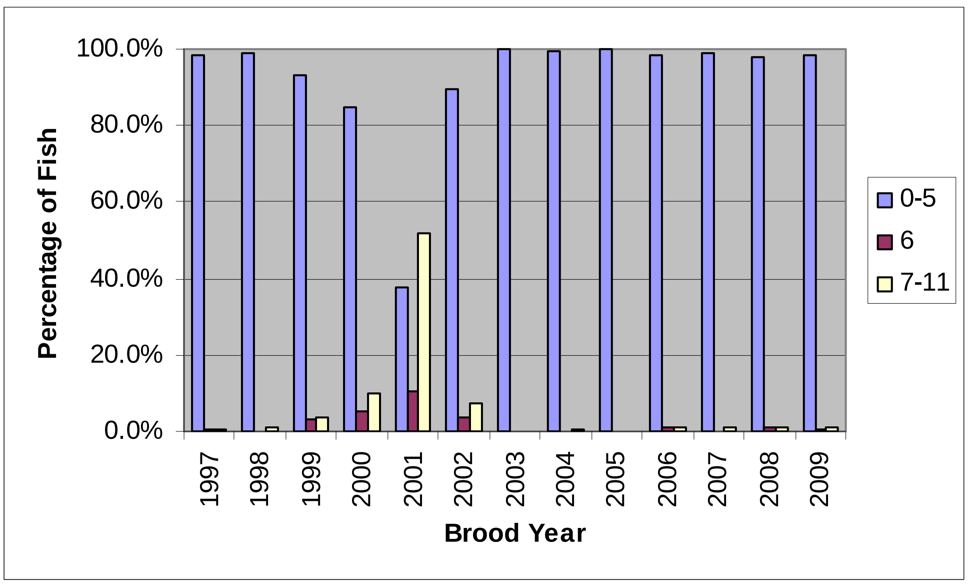

Figure 4. Proportion of wild/natural females spawned at CESRF by BKD rank, 1997 – present.

Fecundity

Fish collected at Roza Dam are taken to the CESRF for spawning and/or research purposes. Egg loss due to spill or other reasons at spawn time is documented. When eggs are shocked, unfertilized (dead) eggs are hand-counted and remaining eggs are machine counted. Due to error associated with machine counts, average fecundity is calculated using spawn-time egg sample data (see discussion above under CESRF Spawning and Survival) and adding in documented egg loss for all females divided by the number of females (N) in the sample.

Table 35. Mean fecundity by age of adult females (BKD rank < 6) spawned at CESRF, 1997-present.

	Wild/Natural (SN)						CESRF (HC)					
Brood	Age-3		Age-4		Age-5		Age-3		Age-4		Age-5	
Year	N	Fecundity	N	Fecundity	N	Fecundity	N	Fecundity	N	Fecundity	N	Fecundity
1997			105	3,842.0	4	4,069.9						
1998			161	3,730.3	15	4,322.5						
1999			183	3,968.1	14	4,448.6						
2000			224	3,876.5	2	5,737.9						
2001			72	3,966.9	9	4,991.2			18	4,178.9		
2002	1	1,038.0	205	3,934.7	7	4,329.4			60	3,820.0	1	4,449.0
2003			163	4,160.2	31	5,092.8			30	3,584.1	19	5,459.9
2004			224	3,555.4	2	4,508.3			42	3,827.2		
2005	1	1,769.0	218	3,815.5	5	4,675.1			38	3,723.9	5	4,014.7
2006			196	3,396.4	24	4,338.9			36	3,087.3		
2007			178	3,658.3	24	4,403.3			33	3,545.2	2	4,381.9
2008			207	3,814.0	10	4,139.9			58	3,898.0		
2009	1	2,498.2	195	4,018.9	6	4,897.1			34	3,920.3		
Mean				3,825.9		4,611.9				3,731.7		4,576.4

Juvenile Salmon Evaluation

Food Conversion Efficiency

At the end of each month that fish are in the rearing ponds at the CESRF or the acclimation sites, a sample of fish are weighed and measured to estimate growth. These data, in addition to monthly mortality and pond feed data are entered into the juvenile growth and survival tracking database. Hatchery managers monitor food conversion (total pounds fed during a month divided by the total pounds gained by the fish) to track how well fish are converting feed into body mass and to evaluate the amount of feed that needs to be provided on a monthly basis. Average monthly food conversion and growth statistics for the CESRF facilities by brood year are provided in the following tables and figures.

Table 36. Mean food conversion (lbs fed/lbs gained) of CESRF juveniles by brood year and growth month, 1997 – present.

Brood Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1997	2.2		1.1	0.8	1.2	0.8	1.5	1.5		1.9		5.3	0.7
1998		1.0	0.9	1.0	0.9	0.8	2.4	1.4	2.1	-0.3	1.0	1.2	0.8
1999		1.0	1.1	1.1	1.2	1.5	1.8	1.0		-0.5	0.3	1.7	0.7
2000	0.8	0.8	1.0	1.5	1.2	1.4	2.2	2.0	1.6	2.1	2.5	2.4	
2001	1.1	1.1	2.6	1.1	1.3	1.2	1.6	2.0	2.3	2.5	2.8	0.9	
2002	0.9	1.0	1.4	1.2	1.4	1.1	1.5	2.2	4.0	-1.4	2.9	1.0	
2003	0.6	1.0	0.9	1.4	1.2	1.2	4.6	0.7	0.9	-0.2	1.8	1.0	
2004	0.9	1.0	1.2	1.6	2.4	1.2	1.7	2.0	2.8	0.9	-2.6	1.1	
2005	0.8	0.7	1.3	1.0	1.3	1.2	1.5	-0.8	0.4	-0.4	2.2		
2006	0.8	0.7	0.6	0.9	0.8	1.0	1.6	-1.0		-2.6	0.6	0.6	
2007	0.7	0.7	0.9	0.9	1.0	0.8	2.2	-1.6	1.9	2.0	0.7	0.9	0.4
2008	0.5	0.6	0.9	0.9	1.0		0.8	1.7	-1.1	0.9	0.9	0.6	
Mean	0.9	0.9	1.1	1.1	1.2	1.1	1.9	0.9	1.7	0.7	1.2	1.1	0.6

Length and Weight Growth Profiles

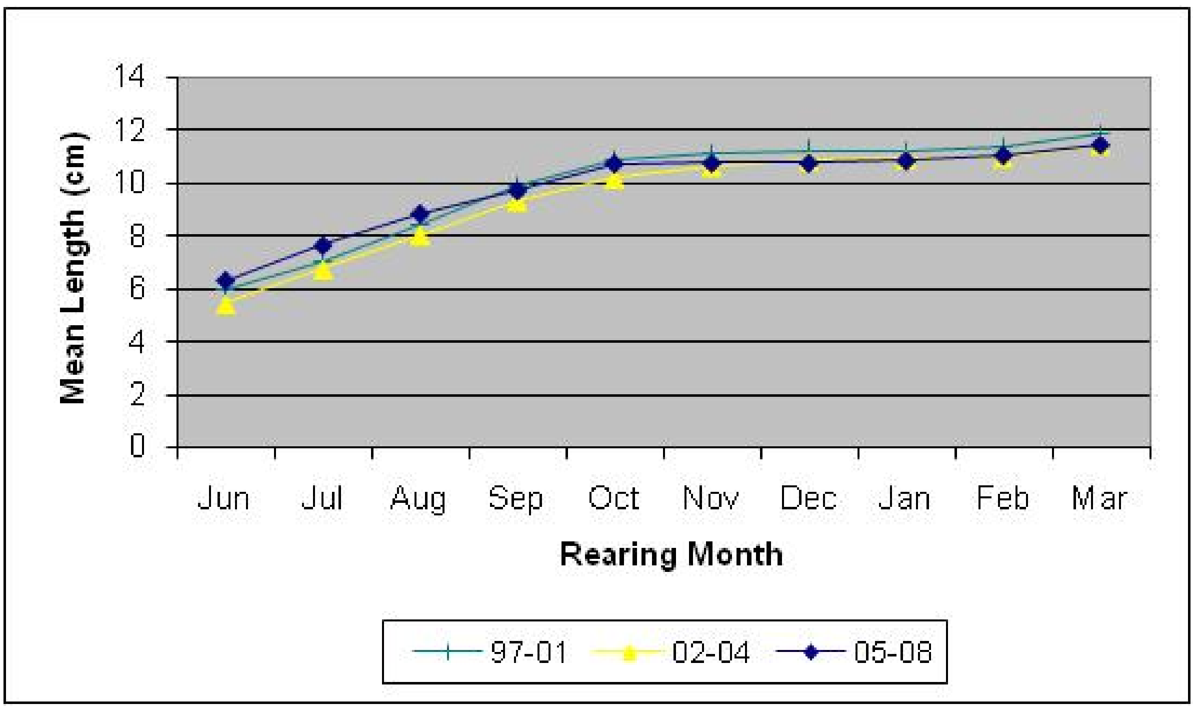

Figure 5. Mean length (cm) of "standard growth treatment (Hi)" CESRF juveniles by brood year and growth month, 1997 - present.

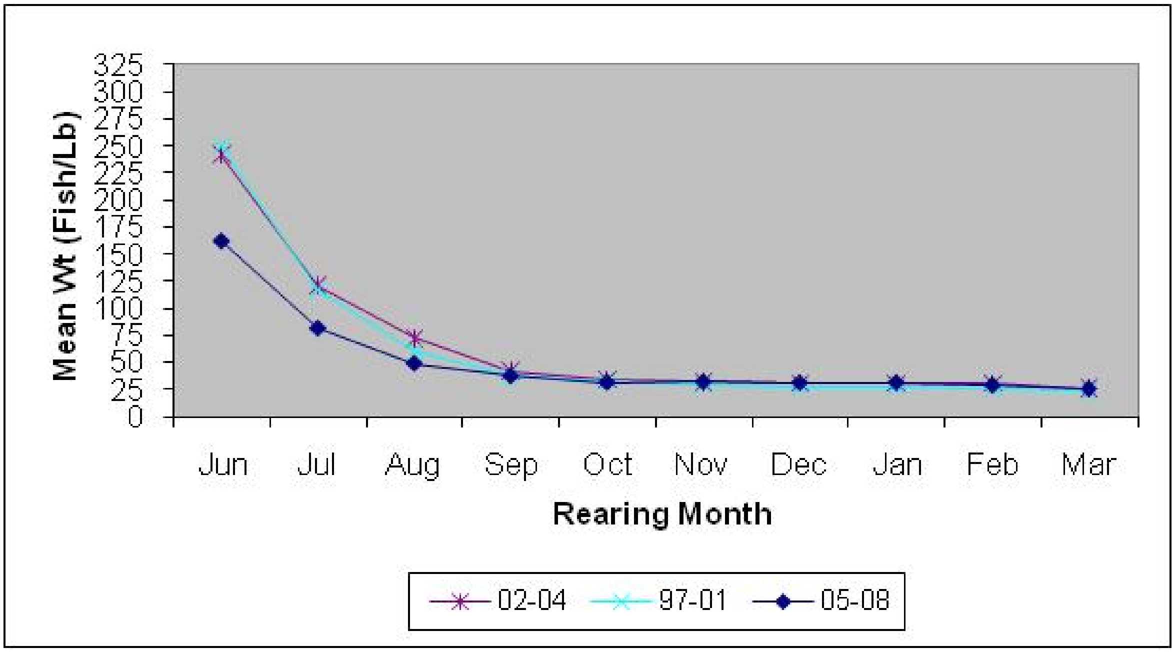

Figure 6. Mean Weight (fish/lb) of "standard growth treatment (Hi)" CESRF juveniles by brood year and growth month, 1997 - present.

Juvenile Fish Health Profile

Approximately 30-60 fish from each acclimation site pond are sacrificed for juvenile fish health samples in the spring (usually in March) of their release year. Tissue samples from these fish are processed at USFWS laboratories in Olympia, Washington for presence of bacterial kidney disease (BKD) using enzyme-linked immunosorbent assay (ELISA) tests (see Female BKD Profiles for additional discussion). Fish are ranked from 0 to 13 based on the relative amounts of BKD in the tissue samples of the tested fish. Based on empirical evidence, fish with BKD ranks of 0-5 are considered to be low risk for incidence of BKD in the presence of a good fish culture and rearing environment (i.e., water temperature and flows, nutrition, densities, etc. all must be conducive to good fish health).

Table 37. Mean BKD rank of juvenile fish sampled at CESRF acclimation sites by brood year and raceway, 1997-present.

	Brood Year[1]									
Raceway	1997	1998	2000	2001[2]	2002	2003	2006	2007	2008	Mean
CFJ01	0.80	0.53	2.17	1.90	0.28	0.28	2.10	1.57	1.93	1.28
CFJ02	1.08	1.88	1.33	1.10	0.18	0.25	1.87	1.50	1.73	1.21
CFJ03	2.38	0.82	1.50		0.22	0.28	1.79	1.70	1.97	1.33
CFJ04	1.15	0.58	1.18		0.16	0.14	1.96	1.87	2.57	1.20
CFJ05	0.85	0.78	1.20		0.06	0.75	2.34	1.50	2.10	1.20
CFJ06	1.05	0.70	1.02		0.21	0.02	1.71	1.73	1.97	1.05
ESJ01	2.03	0.50	1.97	1.19	0.10	0.55	1.73	1.10	1.47	1.18
ESJ02	1.68	0.53	1.17	1.50	0.05	0.43	1.63	0.97	0.97	0.99
ESJ03	2.23	1.37	2.47	0.86	0.07	0.33	1.97	1.13	1.57	1.33
ESJ04	1.33	0.55	1.35	0.79	0.15	0.60	1.41	1.87	1.47	1.06
ESJ05		1.15	3.12	0.73	0.04	0.68	2.07	1.30	1.63	1.34
ESJ06		0.67	1.30	0.80	0.05	0.23	2.05	1.40	1.93	1.06
JCJ01		0.67	1.93	1.47	0.04	0.10	1.43	2.03	1.90	1.20
JCJ02		0.48	1.30	1.52	0.19	0.08	2.00	1.73	2.37	1.21
JCJ03		0.33	1.45	1.62	0.06	0.20	1.66	1.87	2.03	1.15
JCJ04		0.62	1.50	1.56	0.05	0.13	1.40	1.67	2.10	1.13
JCJ05			1.55	1.67	0.00	1.35	1.83	1.77	2.17	1.48
JCJ06			1.25	1.46	0.03	0.10	1.31	1.97	1.93	1.15
Clark Flat	1.22	0.88	1.40	1.50	0.18	0.29	1.96	1.64	2.04	1.24
Easton	1.81	0.80	1.89	0.98	0.08	0.47	1.81	1.29	1.51	1.18
Jack Creek		0.53	1.50	1.55	0.06	0.33	1.61	1.84	2.08	1.19
All Ponds	1.46	0.76	1.60	1.30	0.11	0.36	1.79	1.59	1.88	1.20

1. For the 1999, 2004 and 2005 broods, antibody problems were encountered and the USFWS was unable to process the samples.
2. High BKD incidence in adult broodstock reduced production to just 9 ponds (Clark Flat 1-2, Jack Creek, and Easton). Easton samples were for predator avoidance trained (PAT) fish and were the cumulative equivalent of one Cle Elum pond (i.e., ~6,500 fish per pond).

Incidence of Precocialism

For brood years 2002-2004, the YKFP tested two different feeding regimes to determine whether a slowed-growth regime reduces the incidence of precocialism without a reduction in post-release survival. The two growth regimes tested were a normal (High) growth regime resulting in fish which were about 30/pound at release and a slowed growth regime (Low) resulting in fish which were about 45/pound at release. As a critical part of this study, a team from NOAA Fisheries conducted research to characterize the physiology and development of wild and hatchery-reared spring Chinook salmon in the Yakima River

Basin. While precocious male maturation is a normal life-history strategy, the hatchery environment may be potentiating this developmental pathway beyond natural levels resulting in potential loss of anadromous adults, skewing of sex ratios, and negative genetic and ecological impacts on wild populations. Previous studies have indicated that age of maturation is significantly influenced by endogenous energy stores and growth rate at specific times of the year. These studies will help direct rearing strategies at the CESRF to allow production of hatchery fish with physiological and life-history attributes that are more similar to their wild cohorts.

Relevant Publications:

Larsen, D. A., B. R. Beckman, K. A. Cooper, D. Barrett, M. Johnston, P. Swanson, and W. W. Dickhoff. 2004. Assessment of High Rates of Precocious Male Maturation in a Spring Chinook Salmon Supplementation Hatchery Program. Transactions of the American Fisheries Society 133:98-120.

Beckman, B.R. and Larsen D.A. 2005. Upstream Migration of Minijack (Age-2) Chinook Salmon in the Columbia River: Behavior, Abundance, Distribution, and Origin. Transactions of the American Fisheries Society 134:1520–1541.

Larsen, D.A., B.R. Beckman, C.R. Strom, P.J. Parkins, K.A. Cooper, D.E. Fast, W.W. Dickhoff. 2006. Growth Modulation Alters the Incidence of Early Male Maturation and Physiological Development of Hatchery-reared Spring Chinook Salmon: a Comparison with Wild Fish. Transactions of the American Fisheries Society 135:1017-1032.

Larsen, D.A., B.R. Beckman, and K.A. Cooper. 2010. Examining the Conflict between Smolting and Precocious Male Maturation in Spring (Stream-Type) Chinook Salmon. Transactions of the American Fisheries Society 139: 564-578.

CESRF Smolt Releases

The number of release groups and total number of fish released diverged from facility goals in some years. In brood year 1997, the Jack Creek acclimation facility was not yet complete and project policy and technical teams purposely decided to under-collect brood stock to allow a methodical testing of the new facility's operations with less risk to live fish, which resulted in the stocking of only 10 of the 18 raceways. In brood year 1998, the project did not meet facility release goals due to a biological specification that no more than 50% of returning wild fish be taken for brood stock. As a result only 16 raceways were stocked with progeny of the 1998 brood. In the same year, raceway 4 at the Jack Creek acclimation site suffered mechanical failures causing loss of flow and reduced oxygen levels and resulted in the loss of approximately one-half the fish in this raceway prior to release. In the drought year of 2001, a large number of returning adults presented with high enzyme-linked immunosorbent assay (ELISA) levels of *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (BKD). The progeny of these females were purposely destroyed. As a result, only nine raceways were stocked with fish. The project decided to use the fish from an odd raceway for a predator avoidance training sub-experiment (these fish were subsequently acclimated and released from the Easton acclimation site).

Table 38. CESRF total releases by brood year, treatment, and acclimation site.

Brood Year	Control[1]	Treatment[2]	Acclimation Site CFJ	ESJ	JCJ	Total
1997	207,437	178,611	229,290	156,758		386,048
1998[3]	284,673	305,010	221,460	230,860	137,363	589,683
1999	384,563	374,226	232,563	269,502	256,724	758,789
2000	424,554	409,731	285,954	263,061	285,270	834,285
2001[4]	183,963	186,273	80,782	39,106	250,348	370,236
2002	420,764	416,140	266,563	290,552	279,789	836,904
2003	414,175	410,517	273,377	267,711	283,604	824,692
2004[5]	378,740	406,708	280,598	273,440	231,410	785,448
2005	431,536	428,466	287,127	281,150	291,725	860,002
2006	351,063	291,732	209,575	217,932	215,288	642,795
2007	387,055	384,210	265,907	254,540	250,818	771,265
2008	421,290	428,015	280,253	287,857	281,195	849,305
Mean	357,484	351,637	242,787	236,039	251,230	709,121

Table 39. CESRF average pond densities at release by brood year, treatment, and acclimation site.

Brood Year	Treatment Control[1]	Treatment[2]	Acclimation Site CFJ	ESJ	JCJ
1997	41,487	35,722	38,215	39,190	
1998[3]	35,584	38,126	36,910	38,477	34,341
1999	42,729	41,581	38,761	44,917	42,787
2000	47,173	45,526	47,659	43,844	47,545
2001[4]	41,116	41,667	40,391	6,518	41,725
2002	46,752	46,238	44,427	48,425	46,632
2003	46,019	45,613	45,563	44,619	47,267
2004[5]	42,082	45,190	46,766	45,573	38,568
2005	47,948	47,607	47,855	46,858	48,621
2006	39,007	32,415	34,929	36,322	35,881
2007	43,006	42,690	44,318	42,423	41,803
2008	46,810	47,557	46,709	47,976	46,866
Mean	43,309	42,494	42,709	43,511	42,912

1. Brood years 1997-2001: Optimum Conventional Treatment (OCT). Brood Years 2002-2004: Normal (High) growth. Brood Years 2005-2008: Normal feed at Cle Elum or accl. sites.
2. Brood years 1997-2001: Semi-natural Treatment (SNT). Brood Years 2002-2004: Slowed (Low) growth. Brood Year 2005, 2007-2008: saltwater transition feed at accl. sites. Brood Year 2006: EWS diet at CESRF through May 3, 2007.
3. At the Jack Creek acclimation site only 4 of 6 raceways were stocked, and raceway 4 suffered mechanical failures resulting in the loss of about 20,000 OCT (control) fish.
4. High BKD incidence in adult broodstock reduced production to just 9 ponds (Clark Flat 1-2, Jack Creek, and Easton). Easton ponds were used for predator avoidance trained (PAT) fish and a single Cle Elum pond was spread between 6 ponds at Easton with crowders used to simulate pond densities for fish at other acclimation sites. These releases were excluded from mean pond density calculations by treatment.
5. At the Jack Creek acclimation site raceway 3 suffered mechanical failures resulting in the loss of about 45,000 high-growth (control) fish.

Mean length and weight at release by brood year are shown in Figures 5 and 6 under Juvenile Salmon Evaluation, length and weight growth profiles. Mark information and volitional release dates are given in Appendix A.

Smolt Outmigration Timing

The Chandler Juvenile Monitoring Facility (CJMF) located on the fish bypass facility of Chandler Canal at Prosser Dam (Rkm 75.6; Figure 1) serves as the cornerstone facility for estimating smolt production in the Yakima Basin for several species and stocks of salmonids. Daily species counts in the livebox at the CJMF are expanded by the canal entrainment, canal survival, and sub-sampling rates in order to estimate daily passage at Prosser Dam (Neeley 2000). Expansion techniques for deriving Chandler smolt passage estimates are continually being reviewed and revised to incorporate new information. A subset of fish passing through the CJMF is sampled for presence of internal (CWT or PIT) or external (fin-clip) marks. All fish with marks are assumed to be of hatchery origin; otherwise, fish are presumed to be of natural origin.

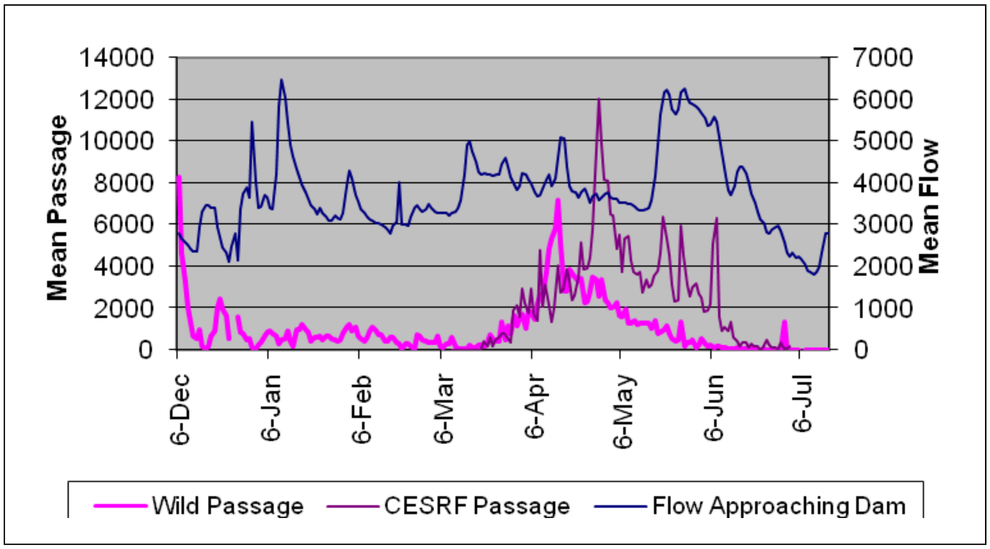

Figure 7. Mean flow approaching Prosser Dam versus mean estimated smolt passage at Prosser of aggregate wild/natural and CESRF spring Chinook for outmigration years 1999-2009.

Smolt-to-Smolt Survival

OCT-SNT Treatment (Brood Years 1997-2001, Migration Years 1999-2003)

Results of this experiment have been published:

Fast, D. E., D. Neeley, D.T. Lind, M. V. Johnston, C.R. Strom, W. J. Bosch, C. M. Knudsen, S. L. Schroder, and B.D. Watson. 2008. Survival Comparison of Spring Chinook Salmon Reared in a Production Hatchery under Optimum Conventional and Seminatural Conditions. Transactions of the American Fisheries Society 137:1507–1518.

Abstract — We found insufficient evidence to conclude that seminatural treatment (SNT; i.e., rearing in camouflage-painted raceways with surface and underwater structures and underwater feeders) of juvenile Chinook salmon *Oncorhynchus tshawytscha* resulted in higher survival indices than did optimum conventional treatment (OCT; i.e., rearing in concrete raceways with surface feeding) for the specific treatments and environmental conditions tested. We reared spring Chinook salmon from fry to smolt in paired raceways under the SNT and OCT rearing treatments for five consecutive years. For four to nine SNT and OCT raceway pairs annually, we used passive integrated transponder, coded wire, and visual implant elastomer tags to compare survival indices for juvenile fish from release at three different

acclimation sites 340–400 km downstream to passage at McNary Dam on the Columbia River, and for adults from release to adult return to Roza Dam in the upper Yakima basin. The observed differences in juvenile and adult survival between the SNT and OCT fish were either statistically insignificant, conflicting in their statistical significance, or explained by significant differences in the presence of the causative agents of bacterial kidney disease in juvenile fish at release.

High-Low Growth Treatment (Brood Years 2002-04, Migration Years 2004-2006)

Two early-rearing nutritional regimes were tested using hatchery-reared Yakima Upper spring Chinook for brood years 2002 through 2004. A low nutrition-feeding rate (low treatment or low) was administered at the Cle Elum Hatchery through early rearing to determine whether that treatment would reduce the proportion of precocials produced compared to a conventional feeding rate during early rearing. The conventional feeding rate, which served as a control treatment, is referred to here as a high nutrition-feeding rate (high treatment or high). Feed was administered at a rate of 10 grams/fish for the low treatment and 15 grams/fish for the high treatment through mid-October, after which sufficient feed was administered to both sets of treated fish to meet their feeding demands. The treatments were allocated within pairs of raceways (blocks), there being a total of nine pairs. The Low nutritional feed (Low) had a significantly lower release-to-McNary survival than did the High nutritional feed (High), respective survivals being 18.1% and 21.2% ($P < 0.0001$; D. Neeley, Appendix B of 2008 annual report). The Low survival to McNary was consistently lower than the High at all sites in all years. Low-treated fish were smaller fish at the time of release and had somewhat later McNary passage times than high-treated fish.

Control versus Saltwater Transfer Treatment (Brood Year 2005, Migration Year 2007)

An STF feed (intended to facilitate smolt fresh-water to salt-water transition) was tested at the Cle Elum facility and compared to the control feed. These two treatments were assigned to different raceways within adjacent raceway pairs, there being up to nine raceway pairs. Each raceway pair was assigned to juvenile progeny from the same diallele crosses, the different raceway pairs being from different diallele crosses. Juveniles were transported to three acclimation sites (Clark Flat, Easton, and Jack Creek), up to three pairs of adjacent Cle Elum raceways assigned to corresponding adjacent raceways at a given site, different Cle Elum raceway pairs to different sites. There were no significant or substantial differences between the two feeding treatments (Appendix B of 2008 annual report).

Control (Bio-Oregon) versus EWOS Feed Comparison (Brood Year 2006, Migration Year 2008)

This experimental design was similar to that described above for the Control versus saltwater transfer treatment study, with the standard Bio-Oregon pellets fed to half of the rearing ponds and an EWOS (www.ewos.com) diet fed to the other ponds. The different feed treatments only lasted about 6 weeks from the time of initial ponding as we found substantially higher mortalities for fish receiving the EWOS feed. From May 7, 2007 until these fish were released in 2008 all fish in this study received the Bio-Oregon diet. For the parameters of interest, we found no significant or substantial differences between the two feeding treatments (Appendix B of 2008 annual report).

Smolt-to-Adult Survival

Calculation of smolt-to-adult survival rates for Yakima River spring Chinook is complicated by the following factors:

1) Downstream of the confluence of the Yakima and Naches rivers the three populations of spring Chinook (Upper Yakima, Naches, and American) are aggregated. A subsample of the aggregate wild/natural populations is PIT-tagged as part of the Chandler juvenile sampling operation but their origin is not known at the time of tagging. Through 2003, the primary purpose of this subsampling effort was to derive entrainment and canal survival estimates (see 2 below). Due to issues such as tag retention and population representation, adult detections of smolts PIT-tagged at Chandler can not be used in any valid smolt-to-adult survival analyses.

2) Smolt accounting at Prosser is based on statistical expansion of Chandler smolt trap sampling data using available flow data and estimated Chandler entrainment rates. Chandler smolt passage estimates are prepared primarily for the purpose of comparing relative wild versus CESRF passage estimates and not for making survival comparisons. While these Chandler smolt passage estimates represent the best available data, there may be a relatively high degree of error associated with these estimates due to inherent complexities, assumptions, and uncertainties in the statistical expansion process. Therefore, these estimates are subject to revision. We are in the process of developing methods to subdivide the wild/natural outmigration into Upper Yakima, Naches, and American components based on DNA samples of juveniles taken at Chandler since 1998.

3) Installation of adult PIT detection equipment at all three ladders at Prosser Dam was not completed until the fall of 2005. Therefore, detection of upstream-migrating PIT-tagged adult spring Chinook at Prosser Dam was not possible for all returning fish until the spring of 2006. Periods of high flow may preclude use of automated detection gear so 100% detection of upstream migrants is not possible in all years.

4) Through 2006, detection of upstream-migrating PIT-tagged adult spring Chinook at Roza Dam occurred at an approximate 100% rate only for marked CESRF fish and wild/natural fish taken for broodstock. The majority of wild/natural fish were passed directly back to the river without PIT interrogation.

5) For the 1997 brood (1999 out-migration), 400 Khz PIT-tags were used. Mainstem detection facilities were not configured to detect these tags at nearly the efficiency that they can detect the newer 134.2 kHz ISO tags. Although all marked adult fish are trapped and hand-wanded for PIT detections of adults at Roza Dam, the reliability of the 400kHz detection gear and problems with hand-sampling in general likely precluded a complete accounting of all 1997 brood PIT returns.

6) All CESRF fish are adipose-fin clipped and subjected to higher harvest rates than unmarked wild/natural fish in marine and Columbia River mark-selective fisheries. No adjustments have yet been made in the following tables to account for differential harvest rates in these mark-selective fisheries.

7) PIT tag retention is a factor in estimating survival rates (Knudsen et al. 2009). No attempt has been made to correct the data in the following tables for estimates of tag retention.

8) The ISAB has indicated that "more attention should be given to the apparent documentation that PIT-tagged fish do not survive as well as untagged fish. This point has major implications for all uses of PIT-tagged fish as surrogates for untagged fish." Our data appear to corroborate this point (Tables

43-44). However, these data are not corrected for tag loss. If a fish loses its PIT tag after detection upon leaving the acclimation site, but before it returns as an adult to Roza Dam, it would be included only as a release in Table 43 and only as an adult return in Table 44. Knudsen et al. (2009) found that smolt-to-adult return rates (SARS) based on observed PIT tag recoveries were significantly underestimated by an average of 25% and that after correcting for tag loss, SARS of PIT-tagged fish were still 10% lower than SARS of non-PIT-tagged fish. Thus, the data in Table 43 under-represent "true" SARS for PIT-tagged fish and SARS for PIT-tagged and non-PIT-tagged fish are likely closer than those reported in Tables 43 and 44.

9) Due to issues relating to water permitting and size required for tagging, CESRF juveniles are not allowed to migrate until at least March 15 of their smolt year. However, juvenile sampling observations at Roza and Chandler indicate that a substantial number of wild/natural juveniles migrate downstream during the summer, fall, and winter months prior to their smolt year. Analysis of adult returns of wild/natural spring chinook that were PIT-tagged as juveniles at either Roza or Chandler indicate that 35-40% (or more-cumulative across several brood years) of adult return PIT detections at Bonneville for these fish were from fish that migrated in the fall or winter as juveniles (before CESRF fish would have the opportunity). Comparison of SAR data for non-contemporaneously migrating juveniles may be invalid.

Given these complicating factors, Tables 40-44 present available smolt-to-adult survival data for Yakima River CESRF and wild/natural spring Chinook. Unfortunately, true "apples-to-apples" comparisons of CESRF and wild/natural smolt-to-adult survival rates are not possible from these tables due to complexities noted above. The reader is cautioned to correct these data for factors noted above prior to any use of these data.

Table 40. Estimated smolt passage at Chandler and smolt-to-adult survival rates (Chandler smolt to Yakima R. mouth adult).

			Estimated Smolt Passage at Chandler				CESRF smolt-	Yakima R. Mouth Adult Returns[6]		Smolt-to-Adult Survival[6]	
Brood Year	Migr. Year	Mean Flow[1]	Wild/ Natural[2]	Control[3]	Treatment[4]	CESRF Total	to-smolt survival[5]	Wild/ Natural[2]	CESRF Total	Wild/ Natural[2]	CESRF Total
1982	1984	4134	381,857					6,753		1.8%	
1983	1985	3421	146,952					5,198		3.5%	
1984	1986	3887	227,932					3,932		1.7%	
1985	1987	3050	261,819					4,776		1.8%	
1986	1988	2454	271,316					4,518		1.7%	
1987	1989	4265	76,362					2,402		3.1%	
1988	1990	4141	140,218					5,746		4.1%	
1989	1991		109,002					2,597		2.4%	
1990	1992	1960	128,457					1,178		0.9%	
1991	1993	3397	92,912					544		0.6%	
1992	1994	1926	167,477					3,790		2.3%	
1993	1995	4882	172,375					3,202		1.9%	
1994	1996	6231	218,578					1,238		0.6%	
1995	1997	12608	52,028					1,995		3.8%	
1996	1998	5466	291,557					21,151		7.3%	
1997	1999	5925	277,087	42,668	55,176	97,844	25.3%	12,855	8,670	4.6%	8.9%
1998	2000	4946	77,009	109,087	116,020	225,107	38.2%	8,228	9,782	10.7%	4.3%
1999	2001	1321	105,422	233,921	216,649	450,570	59.4%	1,765	864	1.7%	0.2%
2000	2002	5015	481,414	193,515	132,228	325,743	39.0%	11,445	4,819	2.4%	1.5%
2001	2003	3504	261,707	49,845	62,232	112,077	30.3%	8,597	1,251	3.3%	1.1%
2002	2004	2439	137,343	155,031	145,056	300,087	35.9%	3,743	2,300	2.7%	0.8%
2003	2005	1285	157,057	124,412	106,253	230,665	28.0%	2,746	932	1.7%	0.4%
2004	2006	5652	92,175	86,308	73,044	159,352	20.3%	2,817	4,021	3.1%	2.5%
2005	2007	4551	130,263	163,151	162,197	325,348	37.8%	4,063[7]	4,324[7]	3.1%[7]	1.3%[7]
2006	2008	4298	76,859	92,914	71,623	164,537	25.6%				
2007	2009	5784	107,263			176,489	22.9%				

1. Mean flow (cfs) approaching Prosser Dam March 29-July 4. No data available for migration year 1991. In high flow years (flows at or > 5000 cfs) operation of the Chandler smolt sampling facility may be precluded during portions of the outmigration.
2. Aggregate of Upper Yakima, Naches, and American wild/natural populations.
3. Brood years 1997-2001: Optimum Conventional Treatment (OCT). Brood Years 2002-2006 : Normal (High) growth.
4. Brood years 1997-2001: Semi-natural Treatment (SNT). Brood Years 2002-2004 : Slowed (Low) growth. BY05: transfer diet at accl. Sites. BY06: EWS diet at CESRF through May 3. BY07 to present: no treatment.
5. Estimated smolt-to-smolt (release from upper Yakima River acclimation sites to Chandler) survival for CESRF juveniles.
6. Includes combined age-3 through age-5 returns. CESRF adult returns and smolt-to-adult survival values are understated relative to wild/natural values since these figures are not adjusted for differential harvest rates in mark selective fisheries in marine and lower Columbia River fisheries.
7. Preliminary; data do not include age-5 adult returns.

Table 41. Estimated wild/natural smolt-to-adult return rates (SAR) based on adult detections of PIT tagged fish. Roza tagged smolts to Bonneville Dam adult returns.

		Wild/Natural smolts tagged at Roza				
Brood	Number	Adult Returns at Age[1]				
Year	Tagged	Age 3	Age 4	Age 5	Total	SAR[1]
1997	310	0	1	0	1	0.32%[2]
1998	6,209	15	171	14	200	3.22%
1999	2,179	2	8	0	10	0.46%
2000	8,718	1	51	1	53	0.61%
2001	7,804	9	52	3	64	0.82%
2002	3,931	2	41	4	47	1.20%
2003	1,733	0	6	1	7	0.40%
2004	2,333	1	8	1	10	0.43%
2005	1,200	0	7		7	0.58%
2006	1,675	12				
2007	3,795					

Table 42. Estimated CESRF smolt-to-adult return rates (SAR) based on adult detections of PIT tagged fish. Roza tagged smolts to Bonneville Dam adult returns.

		CESRF smolts tagged at Roza				
Brood	Number	Adult Returns at Age[1]				
Year	Tagged	Age 3	Age 4	Age 5	Total	SAR[1]
1997	407	0	2	0	2	0.49%[2]
1998	2,999	5	42	2	49	1.63%
1999	1,744	1	0	0	1	0.06%
2000	1,503	0	1	0	1	0.07%
2001	2,146	0	4	0	4	0.19%
2002	2,201	4	5	0	9	0.41%
2003	1,418	0	3	1	4	0.28%
2004	4,194	3	13	0	16	0.38%
2005	2,358	0	3		3	0.13%
2006	4,130	32				
2007	3,736					

1. CESRF adult returns and smolt-to-adult survival values are understated relative to wild/natural values since these figures are not adjusted for differential harvest rates in mark selective fisheries in marine and lower Columbia River fisheries.
2. The reliability of the 400kHz detection gear precluded an accurate accounting of all 1997 brood PIT returns. Therefore, this is not a true SAR. It is presented for relative within-year comparison only and should NOT be compared to SARs for other years.

Table 43. Estimated release-to-adult survival of PIT-tagged CESRF fish (CESRF tagged smolts to Bonneville and Roza Dam adult returns).

Brood Year	Number Tagged[1]	Adult Detections at Bonn. Dam					Adult Detections at Roza Dam				
		Age3	Age4	Age5	Total	SAR	Age3	Age4	Age5	Total	SAR
1997[2]	39,892	18	182	4	204	0.51%	65	517	16	598	1.50%
1998	37,388	49	478	48	575	1.54%	54	310	34	398	1.06%
1999	38,793	1	25	1	27	0.07%	1	22	0	23	0.06%
2000	37,582	42	159	2	203	0.54%	37	112	1	150	0.40%
2001	36,523	32	71	0	103	0.28%	22	58	0	80	0.22%
2002[3]	39,003	25	119	4	148	0.38%	15	80	2	97	0.25%
2003	38,916	7	37	1	45	0.12%	3	27	1	31	0.08%
2004	36,426	37	123	4	164	0.45%	24	98	3	125	0.34%
2005	39,119	63	126		189	0.48%	44	94		138	0.35%
2006	38,595	221					178				

1. When tag detection data are available, this is the number of unique PIT tags physically detected leaving the acclimation sites. Otherwise, this is the number of fish PIT tagged less documented mortalities of PIT-tagged fish from tagging to release.
2. BY1997 used 400 kHz tags and Bonneville Dam was not fully configured for adult detection of this type of tag; therefore we saw more detections at Roza Dam where fish were manually wanded for adult PIT detections.
3. Includes HxH fish beginning with this brood year.

Table 44. Estimated release-to-adult survival of non-PIT-tagged CESRF fish (CESRF tagged smolts to Roza Dam adult returns).

Brood Year	Number Tagged[1]	Adult Detections at Roza Dam				
		Age3	Age4	Age5	Total	SAR
1997[2]	346,156	623	5,663	120	6,406	1.85%
1998	552,295	936	5,834	534	7,304	1.32%
1999	719,996	103	652	13	768	0.11%
2000	796,703	1,005	2,764	69	3,837	0.48%
2001	333,713	290	791	9	1,091	0.33%
2002[3]	797,901	332	1,771	135	2,238	0.28%
2003	785,776	115	1,568	14	1,696	0.22%
2004	749,022	683	3,688	202	4,574	0.61%
2005	820,883	1,012	5,304		6,316	0.77%
2006	604,200	2,392				

1. These fish were adipose fin-clipped, coded-wire tagged, and (beginning with 4 of 16 ponds in 1998) elastomer eye tagged. This is the number of fish physically counted at tagging.
2. BY1997 used 400 kHz tags and Bonneville Dam was not fully configured for adult detection of this type of tag; therefore we saw more detections at Roza Dam where fish were manually wanded for adult PIT detections.
3. Includes HxH fish beginning with this brood year.

Harvest Monitoring

Yakima Basin Fisheries

For spring fisheries in the Yakima River Basin, both the WDFW and the Yakama Nation employ two technicians and one biologist to monitor and evaluate in-basin harvest in the respective sport and tribal fisheries. Harvest monitoring consists of on-the-water surveys to collect catch data and to record tag information (e.g., elastomer, CWT, etc.) where possible for adipose-clipped fish. Survey data are expanded for time, area, and effort using standard methods to derive estimates of total in-basin harvest by fishery type (sport and tribal) and catch type (CESRF or wild denoted by adipose presence/absence).

Table 45. Spring Chinook harvest in the Yakima River Basin, 1982-present.

	Tribal		Non-Tribal		River Totals			Harvest
Year	CESRF	Wild	CESRF	Wild	CESRF	Wild	Total	Rate[1]
1982	0	434	0	0	0	434	434	23.8%
1983	0	84	0	0	0	84	84	5.8%
1984	0	289	0	0	0	289	289	10.9%
1985	0	865	0	0	0	865	865	19.0%
1986	0	1,340	0	0	0	1,340	1,340	14.2%
1987	0	517	0	0	0	517	517	11.6%
1988	0	444	0	0	0	444	444	10.5%
1989	0	747	0	0	0	747	747	15.2%
1990	0	663	0	0	0	663	663	15.2%
1991	0	32	0	0	0	32	32	1.1%
1992	0	345	0	0	0	345	345	7.5%
1993	0	129	0	0	0	129	129	3.3%
1994	0	25	0	0	0	25	25	1.9%
1995	0	79	0	0	0	79	79	11.9%
1996	0	475	0	0	0	475	475	14.9%
1997	0	575	0	0	0	575	575	18.1%
1998	0	188	0	0	0	188	188	9.9%
1999	0	604	0	0	0	604	604	21.7%
2000	53	2,305	0	100	53	2,405	2,458	12.9%
2001	572	2,034	1,252	772	1,825	2,806	4,630	19.9%
2002	1,373	1,207	492	36[2]	1,865	1,243	3,108	20.6%
2003	134	306	0	0	134	306	440	6.3%
2004	289	712	569	109[2]	858	820	1,679	11.0%
2005	46	428	0	0	46	428	474	5.4%
2006	246	354	0	0	246	354	600	9.5%
2007	123	156	0	0	123	156	279	6.5%
2008	521	414	586	11[2]	1,107	426	1,532	17.8%
2009	1,089	715	463	8[2]	1,552	722	2,275	18.8%
Mean	488	588	374	104	862	625	904	12.3%

1. Harvest rate is the total Yakima Basin harvest as a percentage of the Yakima River mouth run size.
2. Includes estimate of post-release mortality of unmarked fish.

Columbia Basin Fisheries

Standard run reconstruction techniques are employed to derive estimates of harvest from the Columbia River mouth to the Yakima River mouth for spring Chinook. Data from databases maintained by the *United States versus Oregon* Technical Advisory Committee (TAC) are used to obtain harvest rate estimates downstream of the Yakima River for the aggregate Yakima River spring Chinook population and to estimate passage losses from Bonneville through McNary reservoirs. These data, combined with the Prosser Dam counts and estimated harvest below Prosser, are used to derive a Columbia River mouth run size estimate and Columbia River mainstem harvest estimate for Yakima spring Chinook.

Table 46. Estimated run size, harvest, and harvest rates of Yakima Basin spring Chinook in Columbia River mainstem and terminal area fisheries, 1982-present.

						Columbia Basin Harvest Summary			Col. Basin Harvest Rate	
Year	Columbia R. Mouth Run Size	Col. R. Mouth to BON Harvest	BON to McNary Harvest	Yakima R. Mouth Run Size	Yakima River Harvest	Total	Wild	CESRF	Total	Wild
1982	3,916	69	269	1,822	434	772	772	0	19.7%	
1983	2,493	120	100	1,441	84	304	304	0	12.2%	
1984	3,955	137	262	2,658	289	688	688	0	17.4%	
1985	5,275	193	180	4,560	865	1,238	1,238	0	23.5%	
1986	13,680	283	793	9,439	1,340	2,416	2,416	0	17.7%	
1987	6,348	99	383	4,443	517	1,000	1,000	0	15.7%	
1988	5,762	369	381	4,246	444	1,194	1,194	0	20.7%	
1989	9,031	217	679	4,914	747	1,642	1,642	0	18.2%	
1990	7,330	373	483	4,372	663	1,518	1,518	0	20.7%	
1991	4,686	186	283	2,906	32	501	501	0	10.7%	
1992	6,365	105	383	4,599	345	833	833	0	13.1%	
1993	5,261	45	320	3,919	129	494	494	0	9.4%	
1994	2,416	94	116	1,302	25	235	235	0	9.7%	
1995	1,392	1	69	666	79	149	149	0	10.7%	
1996	5,767	6	302	3,179	475	783	783	0	13.6%	
1997	5,179	3	348	3,173	575	926	926	0	17.9%	
1998	2,777	3	142	1,903	188	333	333	0	12.0%	
1999	3,992	4	184	2,781	604	792	792	0	19.8%	
2000	28,864	58	1,755	19,100	2,458	4,271	4,148	123	14.8%	
2001	30,661	976	3,818	23,265	4,630	9,424	5,417	4,008	30.7%	29.4%
2002	23,686	1,318	2,369	15,099	3,108	6,795	2,511	4,284	28.7%	24.4%
2003	9,652	307	728	6,957	440	1,475	873	601	15.3%	14.1%
2004	21,481	1,016	1,695	15,289	1,679	4,390	2,386	2,004	20.4%	15.6%
2005	11,998	337	692	8,758	474	1,503	1,175	328	12.5%	11.7%
2006	11,707	349	742	6,314	600	1,691	935	755	14.4%	12.6%
2007	5,103	217	333	4,303	279	829	380	449	16.3%	13.5%
2008	11,242	1,159	1,346	8,598	1,532	4,038	1,094	2,944	35.9%	25.1%
2009[1]	13,372	1,069	1,035	12,120	2,275	4,378	1,234	3,144	32.7%	24.2%
Mean	9,407	325	721	6,505	904	1,950	1,285	2,058	18.0%	16.7%

1. Preliminary.

Marine Fisheries

Based on available CWT information, harvest managers have long assumed that Columbia River spring Chinook are not harvested in any abundance in marine fisheries as the timing of their ocean migration does not generally overlap either spatially or temporally with the occurrence of marine fisheries (TAC 1997). The Regional Mark Information System (RMIS) will be queried regularly for any CWT recoveries of CESRF releases in ocean or Columbia River mainstem fisheries. Table 47 gives the results of a query of the RMIS database run on Feb. 12, 2010 for CESRF spring Chinook CWTs released in brood years 1997-2006. Based on the information reported to RMIS to date, it is believed that marine harvest accounts for about 0-2% of the total harvest of Yakima Basin spring Chinook.

Table 47. Marine and freshwater recoveries of CWTs from brood year 1997-2006 releases of spring Chinook from the CESRF as reported to the Regional Mark Information System (RMIS) 12 Feb, 2010.

Brood	Observed CWT Recoveries			Expanded CWT Recoveries		
Year	Marine	Fresh	Marine %	Marine	Fresh	Marine %
1997	5	56	8.2%	8	321	2.4%
1998	2	53	3.6%	2	228	0.9%
1999		2	0.0%		9	0.0%
2000		14	0.0%		35	0.0%
2001		1	0.0%		1	0.0%
2002		7	0.0%		36	0.0%
2003		4	0.0%		10	0.0%
2004	1	139	0.7%	6	400	1.5%
2005[1]		94	0.0%		94	0.0%
2006[1]		9	0.0%		9	0.0%

1. Reporting of CWT recoveries to the RMIS database typically lags actual fisheries by one to two years. Therefore, CWT recovery data for brood years 2005-2006 are considered incomplete.

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Appendix A. Tag and Release Information by Cle Elum Pond Id, Brood Years 2002-2008.

Brood Year	C.E. Pond	Accl. Pond	Treatment[1] /Avg BKD			Tag Information			First Release	Last Release	CWT Code	No. PIT	No. CWT	Est. Tot. Release[2]
2002	CLE01	JCJ06	HI	WW	2.0	Right	Green	Anal Fin	3/15/2004	5/14/2004	613400	2,222	45,007	46,875
2002	CLE02	JCJ05	LO	WW	2.0	Left	Green	Adipose Fin	3/15/2004	5/14/2004	613401	2,222	46,273	46,588
2002	CLE03	ESJ03	HI	WW	1.6	Right	Orange	Anterior Dorsal	3/15/2004	5/14/2004	613402	2,222	49,027	50,924
2002	CLE04	ESJ04	LO	WW	1.6	Left	Orange	Posterior Dorsal	3/15/2004	5/14/2004	613403	2,222	50,347	52,115
2002	CLE05	CFJ05	LO	WW	2.2	Left	Red	Adipose Fin	3/15/2004	5/14/2004	613404	2,222	45,816	46,584
2002	CLE06	CFJ06	HI	WW	2.2	Right	Red	Anal Fin	3/15/2004	5/14/2004	613405	2,222	46,468	48,496
2002	CLE07	ESJ05	LO	WW	1.9	Left	Orange	Adipose Fin	3/15/2004	5/14/2004	613406	2,222	45,047	45,491
2002	CLE08	ESJ06	HI	WW	1.9	Right	Orange	Anal Fin	3/15/2004	5/14/2004	613407	2,222	48,293	50,316
2002	CLE09	JCJ03	LO	WW	1.8	Left	Green	Anterior Dorsal	3/15/2004	5/14/2004	613408	2,222	41,622	43,512
2002	CLE10	JCJ04	HI	WW	4.9	Right	Green	Posterior Dorsal	3/15/2004	5/14/2004	613409	2,222	46,346	48,279
2002	CLE11	ESJ02	LO	WW	1.9	Left	Orange	Right Cheek	3/15/2004	5/14/2004	613410	2,222	43,619	45,594
2002	CLE12	ESJ01	HI	WW	1.9	Right	Orange	Left Cheek	3/15/2004	5/14/2004	613411	2,222	44,091	46,112
2002	CLE13	JCJ01	HI	WW	1.8	Right	Green	Right Cheek	3/15/2004	5/14/2004	613412	2,222	44,379	46,327
2002	CLE14	JCJ02	LO	WW	1.8	Left	Green	Left Cheek	3/15/2004	5/14/2004	613413	2,222	46,241	48,208
2002	CLE15	CFJ01	LO	HH	1.3	Left	Red	Snout	3/15/2004	5/14/2004	613414	2,222	42,192	44,184
2002	CLE16	CFJ02	HI	HH	1.3	Right	Red	Snout	3/15/2004	5/14/2004	613415	2,222	41,702	43,653
2002	CLE17	CFJ03	HI	WW	1.6	Right	Red	Anterior Dorsal	3/15/2004	5/14/2004	613416	2,222	37,769	39,782
2002	CLE18	CFJ04	LO	WW	1.6	Left	Red	Posterior Dorsal	3/15/2004	5/14/2004	613417	2,222	42,066	43,864

[1] HI = normal growth or LO = slowed growth for brood years 2002 – 2004. All fish are progeny of wild/natural parents unless denoted as HH which designates the hatchery control line beginning with brood year 2002. “Avg BKD” denotes the average BKD ELISA ranking of the female parents whose progeny were in these ponds.

[2] The number of fish released is estimated as the total number of fish counted at marking less mortalities documented from mark to release.

Appendix A. Tag and Release Information by Cle Elum Pond Id, Brood Years 2002-2008.

Brood Year	C.E. Pond	Accl. Pond	Treatment[1] /Avg BKD			Tag Information			First Release	Last Release	CWT Code	No. PIT	No. CWT	Est. Tot. Release[2]
2003	CLE01	CFJ02	HI	WW	0.2	Left	Red	Anal Fin	3/9/2005	4/27/2005	610126	2,222	43,712	45,785
2003	CLE02	CFJ01	LO	WW	0.2	Right	Red	Adipose Fin	3/9/2005	4/27/2005	610127	2,222	42,730	44,551
2003	CLE03	ESJ04	LO	WW	0.1	Right	Green	Left Cheek	3/9/2005	4/27/2005	610128	2,222	41,555	43,544
2003	CLE04	ESJ03	HI	WW	0.1	Left	Green	Right Cheek	3/9/2005	4/27/2005	610129	2,222	43,159	45,215
2003	CLE05	JCJ02	LO	WW	0.2	Right	Orange	Anal Fin	3/9/2005	4/27/2005	610130	2,222	45,401	47,443
2003	CLE06	JCJ01	HI	WW	0.2	Left	Orange	Adipose Fin	3/9/2005	4/27/2005	610131	2,222	46,079	48,095
2003	CLE07	ESJ02	LO	WW	0.3	Right	Green	Anal Fin	3/9/2005	4/27/2005	610132	2,222	43,418	45,464
2003	CLE08	ESJ01	HI	WW	0.3	Left	Green	Adipose Fin	3/9/2005	4/27/2005	610133	2,222	43,261	45,310
2003	CLE09	ESJ06	LO	WW	0.2	Right	Green	Posterior Dorsal	3/9/2005	4/27/2005	610134	2,222	43,410	45,402
2003	CLE10	ESJ05	HI	WW	0.2	Left	Green	Anterior Dorsal	3/9/2005	4/27/2005	610135	2,222	44,255	42,776
2003	CLE11	CFJ04	LO	HH	0.1	Right	Red	Snout	3/9/2005	4/27/2005	610136	2,222	41,017	43,021
2003	CLE12	CFJ03	HI	HH	0.1	Left	Red	Snout	3/9/2005	4/27/2005	610137	2,222	43,680	45,712
2003	CLE13	JCJ04	LO	WW	0.2	Right	Orange	Left Cheek	3/9/2005	4/27/2005	610138	2,222	44,569	46,413
2003	CLE14	JCJ03	HI	WW	0.2	Left	Orange	Right Cheek	3/9/2005	4/27/2005	610139	2,222	45,218	47,079
2003	CLE15	CFJ06	LO	WW	0.1	Right	Red	Posterior Dorsal	3/9/2005	4/27/2005	610140	2,222	45,697	47,468
2003	CLE16	CFJ05	HI	WW	0.1	Left	Red	Anterior Dorsal	3/9/2005	4/27/2005	610141	2,222	44,815	46,840
2003	CLE17	JCJ06	LO	WW	0.1	Right	Orange	Posterior Dorsal	3/9/2005	4/27/2005	610142	2,222	45,375	47,211
2003	CLE18	JCJ05	HI	WW	0.1	Left	Orange	Anterior Dorsal	3/9/2005	4/27/2005	610143	2,222	45,420	47,363

[1] HI = normal growth or LO = slowed growth for brood years 2002 – 2004. All fish are progeny of wild/natural parents unless denoted as HH which designates the hatchery control line beginning with brood year 2002. “Avg BKD” denotes the average BKD ELISA ranking of the female parents whose progeny were in these ponds.

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Brood Year	C.E. Pond	Accl. Pond	Treatment[1] /Avg BKD			Tag Information			First Release	Last Release	CWT Code	No. PIT	No. CWT	Est. Tot. Release[2]
2004	CLE01	CFJ03	HI	WW	0.3	Right	Red	Snout	3/15/2006	5/15/2006	610156	2,222	44,771	46,906
2004	CLE02	CFJ04	LO	WW	0.3	Left	Red	Snout	3/15/2006	5/15/2006	610157	2,222	43,957	46,030
2004	CLE03	ESJ03	HI	WW	0.4	Right	Orange	Snout	3/15/2006	5/15/2006	610158	2,222	43,991	46,083
2004	CLE04	ESJ04	LO	WW	0.4	Left	Orange	Snout	3/15/2006	5/15/2006	610159	2,222	43,045	45,155
2004	CLE05	JCJ03	HI	WW	0.3	Right	Green	Snout	3/15/2006	4/28/2006	610160	2,222	45,803	2,248
2004	CLE06	JCJ04	LO	WW	0.3	Left	Green	Snout	3/15/2006	4/28/2006	610161	2,222	43,843	45,920
2004	CLE07	ESJ05	HI	WW	0.3	Right	Orange	Snout	3/15/2006	5/15/2006	610162	2,222	43,913	46,035
2004	CLE08	ESJ06	LO	WW	0.3	Left	Orange	Snout	3/15/2006	5/15/2006	610163	2,222	42,560	44,668
2004	CLE09	JCJ05	LO	WW	0.4	Left	Green	Snout	3/15/2006	4/28/2006	610164	2,222	42,416	44,485
2004	CLE10	JCJ06	HI	WW	0.4	Right	Green	Snout	3/15/2006	4/28/2006	610165	2,222	43,842	45,942
2004	CLE11	JCJ01	HI	WW	0.3	Right	Green	Snout	3/15/2006	4/28/2006	610166	2,222	45,892	47,993
2004	CLE12	JCJ02	LO	WW	0.3	Left	Green	Snout	3/15/2006	4/28/2006	610167	2,222	42,749	44,822
2004	CLE13	ESJ01	HI	WW	0.3	Right	Orange	Snout	3/15/2006	5/15/2006	610168	2,222	44,887	46,981
2004	CLE14	ESJ02	LO	WW	0.3	Left	Orange	Snout	3/15/2006	5/15/2006	610169	2,222	42,451	44,518
2004	CLE15	CFJ01	HI	HH	0.3	Right	Red	Posterior Dorsal	3/15/2006	5/15/2006	610170	2,222	45,790	47,920
2004	CLE16	CFJ02	LO	HH	0.3	Left	Red	Posterior Dorsal	3/15/2006	5/15/2006	610171	2,222	44,364	46,419
2004	CLE17	CFJ05	HI	WW	0.4	Right	Red	Snout	3/15/2006	5/15/2006	610172	2,222	46,512	48,632
2004	CLE18	CFJ06	LO	WW	0.4	Left	Red	Snout	3/15/2006	5/15/2006	610173	2,222	42,578	44,691

[1] HI = normal growth or LO = slowed growth for brood years 2002 – 2004. All fish are progeny of wild/natural parents unless denoted as HH which designates the hatchery control line beginning with brood year 2002. “Avg BKD” denotes the average BKD ELISA ranking of the female parents whose progeny were in these ponds.

[2] The number of fish released is estimated as the total number of fish counted at marking less mortalities documented from mark to release.

Appendix A. Tag and Release Information by Cle Elum Pond Id, Brood Years 2002-2008.

Brood Year	C.E. Pond	Accl. Pond	Treatment[1] /Avg BKD			Tag Information			First Release	Last Release	CWT Code	No. PIT	No. CWT	Est. Tot. Release[2]
2005	CLE01	JCJ06	STF	WW	2.4	Left	Orange	Snout	3/15/2007	5/15/2007	613418	2,222	45,991	47,913
2005	CLE02	JCJ05	CON	WW	2.4	Right	Orange	Snout	3/15/2007	5/15/2007	613419	2,222	46,172	48,189
2005	CLE03	JCJ04	STF	WW	2.6	Right	Orange	Snout	3/15/2007	5/15/2007	613420	2,222	47,604	49,605
2005	CLE04	JCJ03	CON	WW	2.6	Left	Orange	Snout	3/15/2007	5/15/2007	613421	2,222	47,852	49,865
2005	CLE05	CFJ06	CON	WW	2.5	Right	Red	Snout	3/15/2007	5/15/2007	613422	2,222	46,258	48,282
2005	CLE06	CFJ05	STF	WW	2.5	Left	Red	Snout	3/15/2007	5/15/2007	613423	2,222	47,129	49,155
2005	CLE07	ESJ06	CON	WW	2.5	Right	Green	Snout	3/15/2007	5/15/2007	613424	2,222	41,808	43,871
2005	CLE08	ESJ05	STF	WW	2.5	Left	Green	Snout	3/15/2007	5/15/2007	613425	2,222	42,094	44,193
2005	CLE09	CFJ02	CON	HH	2.3	Right	Red	Posterior Dorsal	3/15/2007	5/15/2007	613431	2,222	43,580	45,616
2005	CLE10	CFJ01	STF	HH	2.3	Left	Red	Posterior Dorsal	3/15/2007	5/15/2007	613427	2,222	42,971	44,902
2005	CLE11	ESJ02	CON	WW	2.5	Right	Green	Snout	3/15/2007	5/15/2007	613428	2,222	50,108	52,186
2005	CLE12	ESJ01	STF	WW	2.5	Left	Green	Snout	3/15/2007	5/15/2007	613429	2,222	44,487	46,550
2005	CLE13	ESJ04	CON	WW	2.5	Right	Green	Snout	3/15/2007	5/15/2007	613430	2,222	45,040	47,132
2005	CLE14	ESJ03	STF	WW	2.5	Left	Green	Snout	3/15/2007	5/15/2007	613426	2,222	45,132	47,218
2005	CLE15	JCJ02	STF	WW	2.5	Right	Orange	Snout	3/15/2007	5/15/2007	613432	2,222	46,178	48,266
2005	CLE16	JCJ01	CON	WW	2.5	Left	Orange	Snout	3/15/2007	5/15/2007	613433	2,222	45,804	47,887
2005	CLE17	CFJ04	CON	WW	2.5	Right	Red	Snout	3/15/2007	5/15/2007	613434	2,222	46,476	48,508
2005	CLE18	CFJ03	STF	WW	2.4	Left	Red	Snout	3/15/2007	5/15/2007	613435	2,222	48,638	50,664

[1] CON = normal feed or STF = salt-water transition diet at acclimation sites. All fish are progeny of wild/natural parents unless denoted as HH which designates the hatchery control line beginning with brood year 2002. "Avg BKD" denotes the average BKD ELISA ranking of the female parents whose progeny were in these ponds.

[2] The number of fish released is estimated as the total number of fish counted at marking less mortalities documented from mark to release.

Appendix A. Tag and Release Information by Cle Elum Pond Id, Brood Years 2002-2008.

Brood Year	C.E. Pond	Accl. Pond	Treatment[1] /Avg BKD			Tag Information			First Release	Last Release	CWT Code	No. PIT	No. CWT	Est. Tot. Release[2]
2006	CLE01	CFJ04	BIO	WW	3.5	Right	Red	Snout	3/15/2008	5/14/2008	190101	2,000	36,945	38,607
2006	CLE02	CFJ03	EWS	WW	3.5	Left	Red	Snout	3/15/2008	5/14/2008	190102	2,000	31,027	32,790
2006	CLE03	ESJ02	BIO	WW	3.2	Right	Green	Snout	3/15/2008	5/14/2008	190103	2,000	36,931	38,762
2006	CLE04	ESJ01	EWS	WW	3.2	Left	Green	Snout	3/15/2008	5/14/2008	190104	2,000	29,635	31,400
2006	CLE05	JCJ02	BIO	WW	3.3	Right	Orange	Snout	3/15/2008	5/14/2008	190105	2,000	36,735	38,383
2006	CLE06	JCJ01	EWS	WW	3.3	Left	Orange	Snout	3/15/2008	5/14/2008	190106	2,000	28,984	30,680
2006	CLE07	ESJ04	BIO	WW	3.4	Right	Green	Snout	3/15/2008	5/14/2008	190107	2,000	38,212	40,006
2006	CLE08	ESJ03	EWS	WW	3.4	Left	Green	Snout	3/15/2008	5/14/2008	190108	2,000	32,726	34,519
2006	CLE09	CFJ02	BIO	WW	3.4	Right	Red	Snout	3/15/2008	5/14/2008	190109	2,000	36,485	38,097
2006	CLE10	CFJ01	EWS	WW	3.4	Left	Red	Snout	3/15/2008	5/14/2008	190110	2,000	29,907	31,647
2006	CLE11	JCJ04	BIO	WW	3.3	Right	Orange	Snout	3/15/2008	5/14/2008	190111	2,000	39,491	40,703
2006	CLE12	JCJ03	EWS	WW	3.3	Left	Orange	Snout	3/15/2008	5/14/2008	190112	2,000	33,418	35,273
2006	CLE13	ESJ06	BIO	WW	3.4	Right	Green	Snout	3/15/2008	5/14/2008	190113	2,000	38,609	39,841
2006	CLE14	ESJ05	EWS	WW	3.4	Left	Green	Snout	3/15/2008	5/14/2008	190114	2,000	31,573	33,404
2006	CLE15	JCJ06	BIO	WW	3.4	Right	Orange	Snout	3/15/2008	5/14/2008	190115	2,000	36,844	38,619
2006	CLE16	JCJ05	EWS	WW	3.4	Left	Orange	Snout	3/15/2008	5/14/2008	190116	2,000	29,857	31,630
2006	CLE17	CFJ06	BIO	HH	3.2	Right	Red	Posterior Dorsal	3/15/2008	5/14/2008	190117	4,000	34,299	38,045
2006	CLE18	CFJ05	EWS	HH	3.2	Left	Red	Posterior Dorsal	3/15/2008	5/14/2008	190118	4,000	26,643	30,389

[1] BIO = BioVita (BioOregon Protein Inc.) or control diet; EWS = EWOS (EWOS Canada Ltd.). All fish were switched to BioVita diet beginning May 3, 2007. All fish are progeny of wild/natural parents unless denoted as HH which designates the hatchery control line. "Avg BKD" denotes the average BKD ELISA ranking of the female parents whose progeny were in these ponds.

[2] The number of fish released is estimated as the total number of fish counted at marking less mortalities documented from mark to release.

Appendix A. Tag and Release Information by Cle Elum Pond Id, Brood Years 2002-2008.

Brood Year	C.E. Pond	Accl. Pond	Treatment[1] /Avg BKD			Tag Information			First Release	Last Release	CWT Code	No. PIT	No. CWT	Est. Tot. Release[2]
2007	CLE01	JCJ06	BIO	WW	2.8	Right	Orange	Snout	3/15/2009	5/15/2009	190151	2,000	38,044	39,840
2007	CLE02	JCJ05	STF	WW	2.8	Left	Orange	Snout	3/15/2009	5/15/2009	190152	2,000	40,066	41,843
2007	CLE03	JCJ04	BIO	WW	2.7	Right	Orange	Snout	3/15/2009	5/15/2009	190153	2,000	40,843	42,647
2007	CLE04	JCJ03	STF	WW	2.7	Left	Orange	Snout	3/15/2009	5/15/2009	190154	2,000	40,196	41,979
2007	CLE05	CFJ06	BIO	WW	2.8	Right	Red	Snout	3/15/2009	5/15/2009	190155	2,000	40,855	42,717
2007	CLE06	CFJ05	STF	WW	2.8	Left	Red	Snout	3/15/2009	5/15/2009	190156	2,000	40,475	42,345
2007	CLE07	ESJ06	BIO	WW	2.6	Right	Green	Snout	3/15/2009	5/15/2009	190157	2,000	42,549	44,387
2007	CLE08	ESJ05	STF	WW	2.6	Left	Green	Snout	3/15/2009	5/15/2009	190158	2,000	43,243	45,080
2007	CLE09	CFJ02	BIO	HH	2.7	Right	Red	Posterior Dorsal	3/15/2009	5/15/2009	190159	4,000	43,803	47,625
2007	CLE10	CFJ01	STF	HH	2.7	Left	Red	Posterior Dorsal	3/15/2009	5/15/2009	190160	4,000	43,256	47,038
2007	CLE11	ESJ02	BIO	WW	2.8	Right	Green	Snout	3/15/2009	5/15/2009	190161	2,000	41,098	42,945
2007	CLE12	ESJ01	STF	WW	2.8	Left	Green	Snout	3/15/2009	5/15/2009	190162	2,001	40,535	42,405
2007	CLE13	ESJ04	BIO	WW	2.7	Right	Green	Snout	3/15/2009	5/15/2009	190163	2,009	39,308	41,190
2007	CLE14	ESJ03	STF	WW	2.7	Left	Green	Snout	3/15/2009	5/15/2009	190164	2,000	36,663	38,533
2007	CLE15	JCJ02	BIO	WW	2.9	Right	Orange	Snout	3/15/2009	5/15/2009	190165	2,000	40,312	42,083
2007	CLE16	JCJ01	STF	WW	2.9	Left	Orange	Snout	3/15/2009	5/15/2009	190166	2,000	40,594	42,426
2007	CLE17	CFJ03	STF	WW	2.8	Right	Red	Snout	3/15/2009	5/15/2009	190167	2,000	40,687	42,561
2007	CLE18	CFJ04	BIO	WW	2.8	Left	Red	Snout	3/15/2009	5/15/2009	190168	2,000	41,704	43,621

[1] BIO = BioVita (BioOregon Protein Inc.) or control diet; STF = salt-water transition diet at acclimation sites. All fish are progeny of wild/natural parents unless denoted as HH which designates the hatchery control line beginning with brood year 2002. “Avg BKD” denotes the average BKD ELISA ranking of the female parents whose progeny were in these ponds.

[2] The number of fish released is estimated as the total number of fish counted at marking less mortalities documented from mark to release.

Appendix A. Tag and Release Information by Cle Elum Pond Id, Brood Years 2002-2008.

Brood Year	C.E. Pond	Accl. Pond	Treatment[1] /Avg BKD			Tag Information			First Release	Last Release	CWT Code	No. PIT	No. CWT	Est. Tot. Release[2]
2008	CLE01	ESJ01	STF	WW	3.3	Right	Orange	Snout	3/15/2010	5/11/2010	190191	2,000	44,917	46,704
2008	CLE02	ESJ02	BIO	WW	3.3	Left	Orange	Snout	3/15/2010	5/11/2010	190192	2,000	45,576	47,414
2008	CLE03	CFJ03	STF	WW	3.2	Right	Red	Snout	3/15/2010	5/11/2010	190193	2,000	44,099	45,931
2008	CLE04	CFJ04	BIO	WW	3.2	Left	Red	Snout	3/15/2010	5/11/2010	190194	2,000	42,464	44,271
2008	CLE05	JCJ05	STF	WW	3.0	Right	Green	Snout	3/15/2010	5/11/2010	190195	2,000	46,118	47,936
2008	CLE06	JCJ06	BIO	WW	3.0	Left	Green	Snout	3/15/2010	5/11/2010	190196	2,000	43,708	45,466
2008	CLE07	ESJ05	STF	WW	3.2	Right	Orange	Snout	3/15/2010	5/11/2010	190197	2,000	48,468	50,299
2008	CLE08	ESJ06	BIO	WW	3.2	Left	Orange	Snout	3/15/2010	5/11/2010	190198	2,000	47,611	49,419
2008	CLE09	CFJ05	STF	HH	2.9	Right	Red	Posterior Dorsal	3/15/2010	5/11/2010	190199	4,000	45,169	48,942
2008	CLE10	CFJ06	BIO	HH	2.9	Left	Red	Posterior Dorsal	3/15/2010	5/11/2010	190201	4,000	44,493	48,254
2008	CLE11	JCJ01	STF	WW	3.3	Right	Green	Snout	3/15/2010	5/11/2010	190202	2,000	44,583	46,413
2008	CLE12	JCJ02	BIO	WW	3.3	Left	Green	Snout	3/15/2010	5/11/2010	190203	2,000	45,086	46,856
2008	CLE13	ESJ03	STF	WW	3.1	Right	Orange	Snout	3/15/2010	5/11/2010	190204	2,000	45,518	47,317
2008	CLE14	ESJ04	BIO	WW	3.1	Left	Orange	Snout	3/15/2010	5/11/2010	190205	2,000	44,879	46,704
2008	CLE15	CFJ01	STF	WW	3.2	Right	Red	Snout	3/15/2010	5/11/2010	190206	2,000	45,169	46,893
2008	CLE16	CFJ02	BIO	WW	3.2	Left	Red	Snout	3/15/2010	5/11/2010	190207	2,000	44,149	45,962
2008	CLE17	JCJ03	STF	WW	3.2	Right	Green	Snout	3/15/2010	5/11/2010	190208	2,000	45,807	47,580
2008	CLE18	JCJ04	BIO	WW	3.2	Left	Green	Snout	3/15/2010	5/11/2010	190209	2,000	45,157	46,944

[1] BIO = BioVita (BioOregon Protein Inc.) or control diet; STF = salt-water transition diet at acclimation sites. All fish are progeny of wild/natural parents unless denoted as HH which designates the hatchery control line beginning with brood year 2002. “Avg BKD” denotes the average BKD ELISA ranking of the female parents whose progeny were in these ponds.

[2] The number of fish released is estimated as the total number of fish counted at marking less mortalities documented from mark to release.

Appendix B

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Annual Report: Comparisons between Smolt Measures of Hatchery x Hatchery- and Natural x Natural-Brood Stock from Upper Yakima Spring Chinook for Brood-Years 2002-2007

Doug Neeley, Consultant to the Yakama Nation

Summary

Hatchery x Hatchery (HxH) and Natural x Natural (NxN) Stock[1] were allocated to Clark Flat acclimation-site raceway pairs, within which different pairs of nutrition treatments had been assigned. This report primarily focuses on the Stock comparisons, not main-effect nutrition-treatment comparisons[2]; however, comparisons between Stocks were made within nutrition levels whenever there was evidence of Stock x Treatment Interaction.

For several analyzed measures, there were significant[3] and substantial interactions between stock- and year-effects. These significant interactions appeared to be largely associated with a significantly and much higher proportion of mini-jacks among the males for the NxN stock than the HxH stock for brood-year Grouping 2002, 2003, 2004 and 2007 (BY-Group 1) but little overall difference among the stocks' mini-jack proportions for brood-year Grouping 2005 and 2006 (BY-Group 2). Therefore, the two brood-year Groupings were analyzed separately, the results being summarized briefly below:

Pre-Release Weights did not significantly differ between stocks within either of the brood-year BY-Groups.

1 HxH and NxN Stock are part of domestication selection study. The original progenitors of both Stocks were wild Upper-Yakima Stock. Both Stocks are reared in the hatchery, but HxH are progeny of hatchery-spawned parents, and NxN are progeny of naturally spawned parents. HxH progeny are never permitted to spawn outside of the hatchery, and NxN progeny are never spawned in the Hatchery.

2 Nutrition treatments were also allocated to raceways at two other acclimation sites (Easton and Jack Creek) wherein the raceways were only stocked with NxN stock. The Clark Flat acclimation site is the only subject site of this report since it is the only one at which both NxN and HxH stock are acclimatized.

3 Significance is defined here as less that a 5% chance of concluding that there is a true population difference in the trait being measured when, in fact, there is not.

Pre-Release Survival Index was consistently lower for the HxH Stock than for the NxN stock within each year and was significantly lower when combined over years within each BY-Group.

Pre-Release Male Proportion did not significantly differ between stock within BY-Group-1 or BY-Group-2 brood years.

Pre-Release Mini-Jack Proportion of Males was significantly lower for the HxH Stock than for the NxN Stock within BY-Group-1 brood years but was not significantly different within BY-Group-2 Years. Within the Group-2 brood years, the HxH stock had a lower, but not significantly lower, mini-jack proportion in BY 2005 but had a significantly higher Mini-jack proportion in BY 2006 (the reverse of the BY-Group-1 year relation).

Release-to-McNary-Dam Survival was significantly higher for the HxH stock than for NxN Stock within BY-Group-1 brood years but was significantly lower within BY-Group-2 brood years. When the number of fish released from each raceway was adjusted for the raceway's estimate of mini-jack proportion, significant within-BY-Group stock main-effect differences disappeared.

Volitional Release Date did not significantly differ between the two stocks within the BY-Group-1 brood years, but the mean Passage Date was significantly later for the HxH Stock than for the NxN Stock within Group-2 brood years.

McNary-Dam Passage Date, like Volitional Release Date, did not significantly differ between the two stocks within the BY-Group-1 brood years, but the mean Passage Date was significantly later for the HxH Stock than for the NxN Stock within Group-2 brood years.

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Design of Experiment

The HxH assignment was superimposed at only the Clark Flat Acclimation Site at which there were three pairs of raceways[4], with the feed treatments[5] allocated to the different raceways within each pair[6], the HxH Stock being allocated to one of the three pairs of raceways and the NxN

4 Raceways within each pair were similar in that they were physically adjacent to each other and in that they both received progeny from the same set of diallele crosses, there being different male and female parental sources in the different diallele sets. This could result in smolt within raceway pairs being more similar than smolt from different raceway pairs due to genetic and/or parental-effect similarities within pairs.

5 In every year, two treatments were evaluated. In BY 2002- BY 2004, they were Low and High Nutrition levels, the High level being the standard feed or control. The Low Nutrition was tested to determine whether it would reduce the proportion of male smolts that were sexually mature (mini-jacks). In BY 2005, two feeds (Control and STF) were tested as to whether there was a relative difference between their effects on the rate of smoltification. In BY, a different two feeds (Bio as a control and EWOS) were evaluated with the same objective. In Brood Year 2007 the two feeds evaluated were Transfer and Vita.

6 The feed treatments (low and high nutrition levels, the high being standard) allocated to the raceways within the one HxH and two NxN raceway pairs in BY 2002-2004 were intended to evaluate the effect the nutritional level on the precocial proportion of male fish. While the lower nutritional level of feed did lower the precocial level, the survival was seriously reduced and the treatment was abandoned. Feed

Stock to the other two pairs[7]. Thus there were twice as many raceways at Clark Flat assigned to the NxN Stock than to the HxH Stock. The design was effectively a Spilt-Plot design at Clark Flat with the Stock assigned to the raceway pairs (main plot), and the feed levels assigned to raceways within raceway pairs (subplot).

A portion of the fish in each raceway was PIT-tagged for the primary purpose of estimating pre-release survival and smolt survival from release to McNary Dam (McNary). Beginning with the 2006 brood, there were twice as many HxH fish PIT-tagged per raceway than there were NxN fish to give approximately an equal total number of PIT-tagged fish for both Stocks at Clark Flat. In previous brood years, there were approximately half as many HxH fish tagged as NxN fish at that acclimation site. For the purpose of assessing Mini-Jack Proportions, approximately twice as many fish were sampled from HxH raceways in all but Brood Year 2002.

Analysis of Individual Traits

As will be seen in subsequent tables, there were significant differences between the Stock main effects and significant interactions between the effects of Stock and treatment and between the effects of Stock and year.

Six variable sets were analyzed:

1. Mean Pre-Release Weights,
2. Mean Pre-Release-Survival,
3. Mean Pre-Release Male Proportion,
4. Mean Pre-Release Mini-Jack Proportion of Males,
5. Mean Release-to-McNary Smolt-to-Smolt Survival,
6. Mean Dates of Juvenile Release, and Mean McNary-Dam Juvenile Passage

Of these variables, Pre-Release Proportion of Mini-Jacks, Release-to-McNary Smolt-to-Smolt Survival, and Mean McNary Juvenile-Passage Date significantly interacted with years[8]. The years were grouped, BY-Group 1: BY 2002-BY 2004 and BY 2007; BY-Group 2: BY 2005–BY 2006. For those three variables, the partitioned Stock x Year interactions resulted in a higher degree of significance for the Stock x BY-Group interaction and a reduced level of significance of Stock x Year interaction within each BY-Group of years. This suggests that the Stock x Year interactions were largely attributed to different Stock responses within the two BY-Groups of years. The next sections present means and mean comparisons for the above six variables followed by a discussion of interactions for various feed treatments. The analyses of variation on which the statistical significance of the comparison were made are presented in Appendix A. Detailed survival-estimation procedures were presented in the 2007 annual report along with

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treatments allocated to BY 2005-2007 in other years were intended to increase the rate of smoltification, not the rate of precocialism. The specific feeds were changed from one year to another, in part due to availability of the feeds.

7 NxN stock was the only stock used at the other two acclimation sites (all three pairs of raceways at both Easton and Jack Creek).

8 Significant at 5% significance level. Stock x Year interaction for pre-release weight and for McNary detection date was significant at the 10% level.

individual release survival estimates for releases made prior to 2008. Individual release survival estimates for releases made in 2008 and 2009 are presented in Appendix B.

1. Mean Pre-Release Smolt Weight

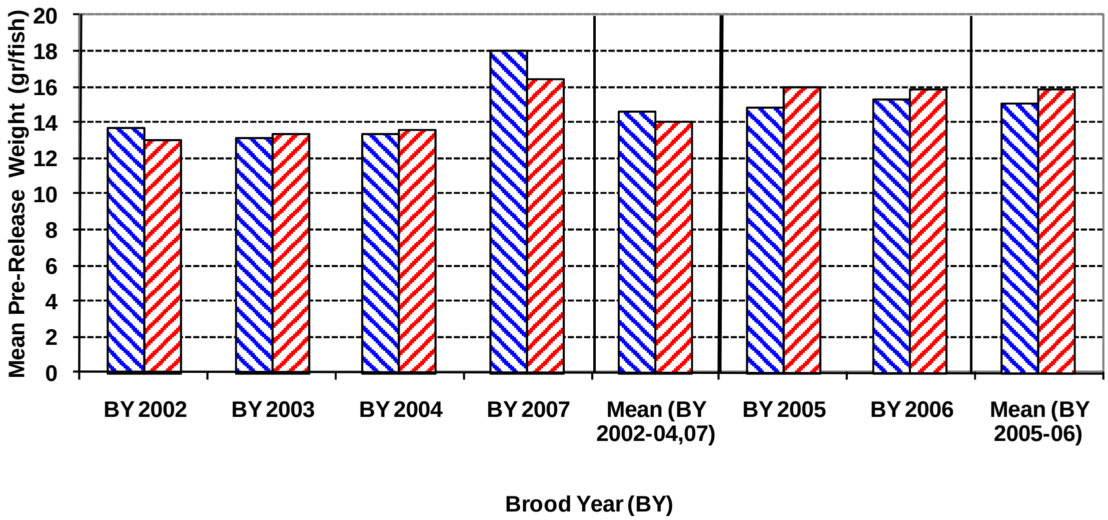
Table 1 and Figure 1 present the individual year and BY-Group HxH and NxN mean pre-release fish-weight estimates. There is no significant difference between stock within BY-Group 1 (P = 0.12), but within BY-Group2 the weight of the HxH stock is nearly one gram higher than that of the NxN stock (not quite significant at the 5% level, P = 0.055).

Table 1. Mean Pre-Release Weight (grams) of Natural x Natural and Hatchery x Hatchery Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)[9]

		Group 1					Group 2		
	Brood Year (BY)	**2002**	**2003**	**2004**	**2007**	**Mean (BY**	**2005**	**2006**	**Mean (BY**
Source	**Outmigration Year**	**2004**	**2005**	**2006**	**2009**	**2002-2004)**	**2007**	**2008**	**2005-2006)**
NxN	**Mean Weight**	13.7	13.2	13.3	18.0	**14.6**	14.8	15.3	**15.0**
	Number Sampled	240	240	240	240		240	240	
HxH	**Mean Weight**	13.0	13.3	13.5	16.4	**14.1**	16.0	15.8	**15.9**
	Number Sampled	120	120	239	240		240	240	
NxN - HxH		0.7	-0.2	-0.2	1.6	**0.5**	-1.2	-0.5	**-0.9**
Estimated Significance Level in Difference (p)		Group 1 Year x (HxH vs NN) Interaction (P = 0.1599)				(P = 0.1238)	Group 2 Year x (HxH vs NN) Interaction (P = 0.4413)		(P = 0.055)

9 Appendix A.1 presents the associated analysis of variance with the significance levels.

Figure 1. Mean <u>Pre-Release Weight</u> (grams) of Natural x Natural (downward slant) and Hatchery x Hatchery (upward slant) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007))



2. Mean Pre-Release Survival

The pre-release survival index is simply the number of fish detected leaving the raceway divided by the total number of tagged fish in the raceway. This measure is the proportion of tagged fish that survived from the time of tagging, did not shed their tags, and were detected leaving the pond[10].

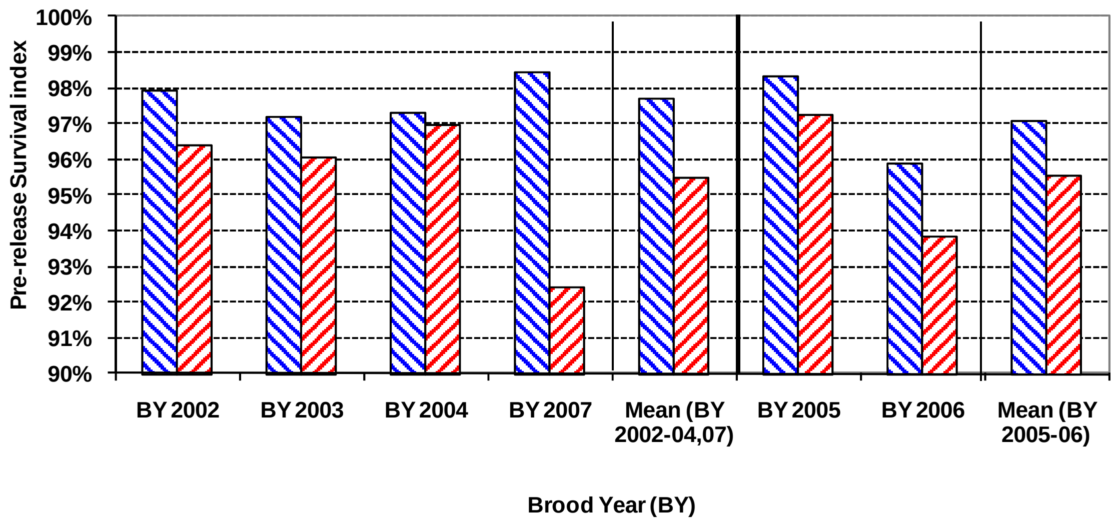
Table 2 and Figure 2 present the individual year and BY-Group HxH and NxN mean Pre-Survival Index estimates. There were significant HxH versus NxN Stock main-effect differences within both BY-Groups ($P < 0.0001$ within BY-Group-1 Years and $P = 0.0006$ within BY-Group-2 Years), and the nature of the differences are the same, HxH having a lower Pre-Release Survival in all years.

10 In the 2008 Annual Report, it was erroneously stated that this measure was adjusted for PIT-tag efficiency as a measure of pre-release survival. The adjusted pre-release survival would be the proportion detected leaving the pond divided by the detection efficiency, which was estimated for each raceway by dividing the number of PIT-tagged fish detected at McNary Dam that were previously detected at the acclimation site by the total number detected at McNary Dam. The detection efficiency is always nearly 100%, but dividing by the near 100% value frequently left a pre-release survival estimate of greater than 100%. Because of the fear of over-estimating survival, it is now the proportion-released estimate that is presented and not pre-release survival. Even if the adjustment were made, it would not have been a true estimate of pre-release survival but rather would have estimated the product of pre-release survival and the proportion of fish retaining their tags.

Table 2. **<u>Pre-Release survival Index</u> of Tagged Natural x Natural and Hatchery x Hatchery Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)[11]**

		Group 1				Group 2			
	Brood Year (BY)	2002	2003	2004	2007	Mean (BY	2005	2006	Mean (BY
Source	Outmigration Year	2004	2005	2006	2009	2002-2004)	2007	2008	2005-2006)
NxN	Pre-Release Survival	97.9%	97.2%	97.3%	98.4%	**97.7%**	98.3%	95.9%	**97.1%**
	Number Tagged	8,892	8,889	8,889	8,000		8,894	8,000	
HxH	Pre-Release Survival	96.4%	96.1%	97.0%	92.4%	**95.5%**	97.2%	93.9%	**95.5%**
	Number Tagged	4,446	4,444	4,446	8,000		4,445	8,000	
HxH		1.5%	1.1%	0.4%	6.0%	**2.2%**	1.1%	2.0%	**1.5%**
Estimated Significance		**Group 1 Year x (HxH vs NN) Interaction (P < 0.0001)**				**(P < 0.0001)**	Group 2 Year x (HxH vs NN) Interaction (P = 0.711)		**(P = 0.0006)**

Figure 2. **<u>Pre-Release survival Index</u> of Tagged Natural x Natural (downward slant) and Hatchery x Hatchery (upward slant) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)**



There was a significant interaction between the stock and BY-Group 1 years (P < 0.0001); however, this was driven by the much higher BY 2007 NxN-stock pre-release survival over the HxH stock (Figure 2) compared to BY 2002-2004 and not by a difference in the direction of the difference.

11 Appendix A.2 presents the associated analysis of variance with the significance levels.

3. Pre-Release Male Proportion

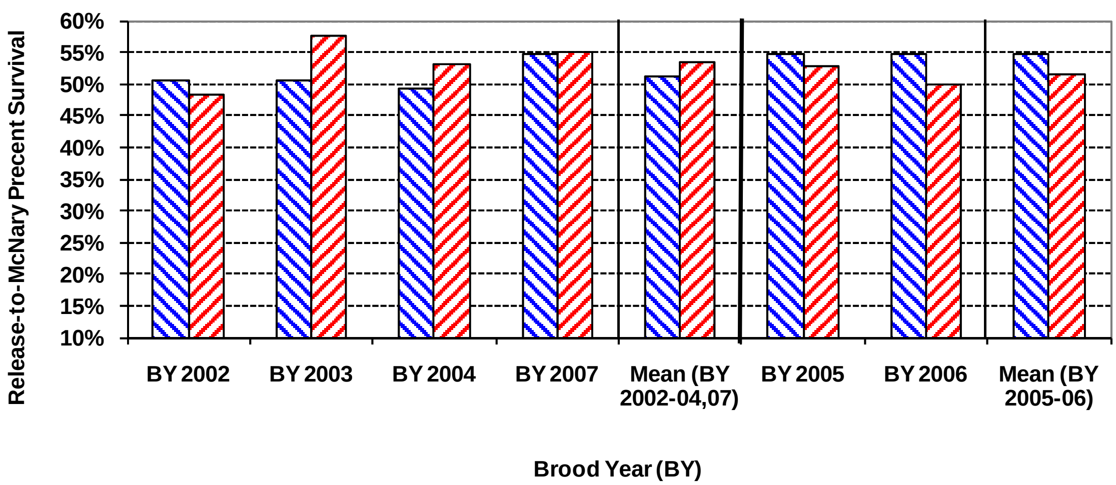
There were no significant differences involving HxH and NxN stock (neither main-effect nor interaction differences). And the mean percentage of males over all years, stock, and treatments was near 50%.[12]

The primary reason for statistically evaluating the male percentage is that, as will be seen later, there is a significant difference between the stocks' proportions of precocial males (mini-jacks), and later adjustments for mini-jack proportion are made to release numbers in order to evaluate smolt-to-smolt survival of smolt that do not include mini-jacks.

Table 3. **Male Percent of Pre-Release Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002-2007)**

		Group 1					Group 2		
	Brood Year (BY)	2002	2003	2004	2007	Mean (BY	2005	2006	Mean (BY
Source	Outmigration Year	2004	2005	2006	2009	2002-2004)	2007	2008	2005-2006)
NxN	Proportion Males	50.4%	50.4%	49.2%	54.6%	**51.1%**	54.6%	54.6%	**54.6%**
	Number Sampled	240	240	240	240		240	240	
HxH	Proportion Males	48.3%	57.5%	53.1%	55.0%	**53.5%**	52.9%	50.0%	**51.5%**
	Number Sampled	120	120	239	240		240	240	
NxN - HxH		2.1%	-7.1%	-4.0%	-0.4%	**-2.3%**	1.7%	4.6%	**3.1%**
Estimated Significance Level in Difference (p)		Group 1 Year x (HxH vs NN) Interaction (P = 0.5705)				(P = 0.3178)	Group 2 Year x (HxH vs NN) (P = 0.6243)		(P = 0.2973)

Figure 3. **Male Percent of Pre-Release Natural x Natural (downward slant) and Hatchery x Hatchery (upward slant) Upper-Yakima Spring Chinook Smolt (brood years 2002-2007)**



[12] 52.5% males, significantly but marginally different than 50% (P = 0.0096 based on sample size of 2,639 sampled fish). Table A.3 in Appendix A presents the associated analysis of variance with the "p" values. If "p" < 0.05, contrast is significant at the 5% level.

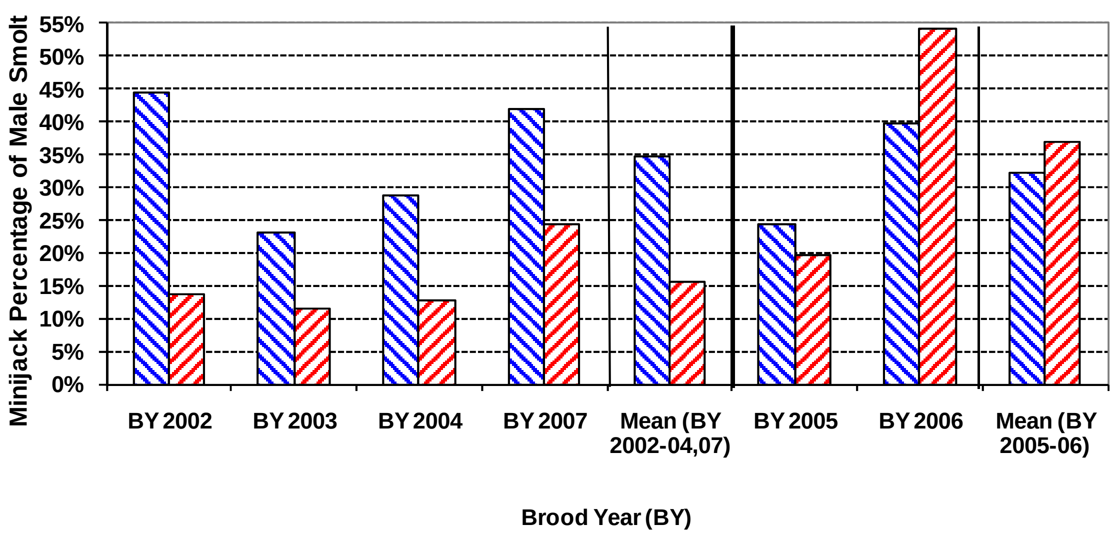
4. Pre-Release Mini-Jack Proportion of Males

Table 4 and Figure 4 present the individual year and BY-Group HxH and NxN mean Mini-Jack Percentages. The NxN Mini-Jack Percentages were significantly more than those of the HxH stock within BY-Group-1 years (P < 0.0001), but there were no significant differences between the stocks' means within BY-Group-2 years (P = 0.21). There was a significant Year x Stock interaction within BY-Group-2 years (P=0.029) reflecting the NxN Stock having a non-significantly higher Mini-Jack Percentage in BY 2005 but having a substantially and significantly smaller mean percentage in BY 2006 (the only year in which the NxN mean was less than that of the HxH).

Table 4. <u>Mini-Jack Percent</u> of Pre-Release Male Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)[13]

		Group 1					Group 2		
	Brood Year (BY)	2002	2003	2004	2007	Mean (BY	2005	2006	Mean (BY
Source	Outmigration Year	2004	2005	2006	2009	2002-2004)	2007	2008	2005-2006)
NxN	Mini-Jack Percentage	44.6%	23.1%	28.8%	42.0%	**34.6%**	24.4%	39.7%	**32.1%**
	Males Sample	121	121	118	131		131	131	
HxH	Mini-Jack Percentage	13.8%	11.6%	12.6%	24.2%	**15.6%**	19.7%	54.2%	**36.9%**
	Males Sample	58	69	131	132		127	120	
NxN - HxH		30.8%	11.5%	16.2%	17.7%	**19.1%**	4.7%	-14.5%	**-4.9%**
Estimated Significance Level in Difference (p)		Group 1 Year x (HxH vs NN) Interaction (P = 0.3356)				**(P = 0.00001)**	Group 2 Year x (HxH vs NN) Interaction (P = 0.0296)		(P = 0.2143)

Figure 4. <u>Mini-Jack Percent</u> of Pre-Release Male Natural x Natural (downward slant) and Hatchery x Hatchery (upward slant) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)



13 Appendix A.4 presents the associated analysis of variance with the significance levels.

5. Release-to-McNary Smolt Survival

For each individual raceway's fish, the survivals were based on dividing the total expanded detections of tagged fish previously detected at acclimation sites by the release number (in equation Eq. 1).

Eq.1. $$\text{Release - to - McNary Survival} = \frac{\text{Expanded Released Fish Detected at McNary}}{\text{Release Number (detected at release)}}$$

Stock x Year means are presented in Table 5.a and in Figure 5.a. BY-Group-1 HxH smolt survival to McNary was significantly greater than that of the NxN smolt (P = 0.0020), and that higher HxH survival was observed in all four years (BY 2002 –2004 and 2007). There was a reversal in the BY-Group-2 years, the NxN smolt having the significantly higher survival (P = 0.0073).

The brood years having the higher HxH survivals to McNary are also the years having lower HxH mini-jack percentages. The associated lower NxN survivals may be artificial. If the mini-jacks do not out-migrate past McNary but remain in the upper-Yakima and possibly contributing to reproduction, then these fish would not be counted as surviving smolt. The decision was made to perform an analysis that assumed that no mini-jacks survived to McNary. The numbers of released fish were then adjusted using equation Eq.2:

Eq.2. $$\begin{aligned}&\text{Adjusted Release Number} = [\text{Release Number}] * \\ &[(\text{Proportion Females}) + (\text{Proportion Males}) * (1 - Q)]\end{aligned}$$

$$\begin{aligned}&\text{wherein } Q = \text{Propotion of Mini - Jacks,} \\ &\text{Proportions Famales and Males equated to } 0.5\end{aligned}$$ [14]

This adjusted release number was then substituted into equation Eq.1 to estimate the adjusted survivals. Table 5.b. and Figure 5.b. present the resulting survivals. As can be seen, the differences between HxH- and NxN-stock adjusted survivals have either been reduced or reversed, with no significant differences in the overall BY-Group-1 or BY-Group-2 HxH and NxN mean survivals (P = 0.76 and P = 0.12, respectively) and no significant Year x Stock interactions within the BY-Groups (P = 0.16 and P = 0.95, respectively).

Some of the mini-jacks may have outmigrated below McNary, returning later if they survived. We have some evidence of smolt subsequently migrating up the ladders at Prosser Diversion Dam after having been previously been detected in the bypass system migrating downstream through that dam's diversion canal (Chandler Canal). The degree to which mini-jacks migrate downstream merits further study.

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14 Recall from earlier that the estimated male proportion was 0.525, the estimated female proportion was 0.475. Use of these proportions instead of 0.5's in Equation Eq.2 would have had a larger effect on the adjusted survivals.

Table 5. Volitional-Release-to-McNary-Dam Percent Survival of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)

a. Unadjusted for Mini-Jack Proportion[15]

Source	Brood Year (BY) / Outmigration Year	Group 1: 2002 / 2004	2003 / 2005	2004 / 2006	2007 / 2009	Mean (BY 2002-2004)	Group 2: 2005 / 2007	2006 / 2008	Mean (BY 2005-2006)
NxN	Survival to McNary	22.0%	15.4%	30.4%	42.7%	**27.6%**	34.4%	35.9%	**35.2%**
	Number Released	8,707	8,637	8,651	7,875		8,743	7,669	
HxH	Survival to McNary	22.1%	17.1%	36.4%	47.0%	**30.6%**	32.7%	30.7%	**31.7%**
	Number Released	4,286	4,269	4,311	7,395		4,322	7,508	
NxN - HxH		-0.2%	-1.7%	-6.0%	-4.3%	**-3.0%**	1.7%	5.2%	**3.5%**
Estimated Significance Level in Difference (p)		Group 1 Year x (HxH vs NN) Interaction (P = 0.2381)				**(P = 0.002)**	Group 2 Year x (HxH vs NN) (P = 0.1541)		**(P = 0.0073)**

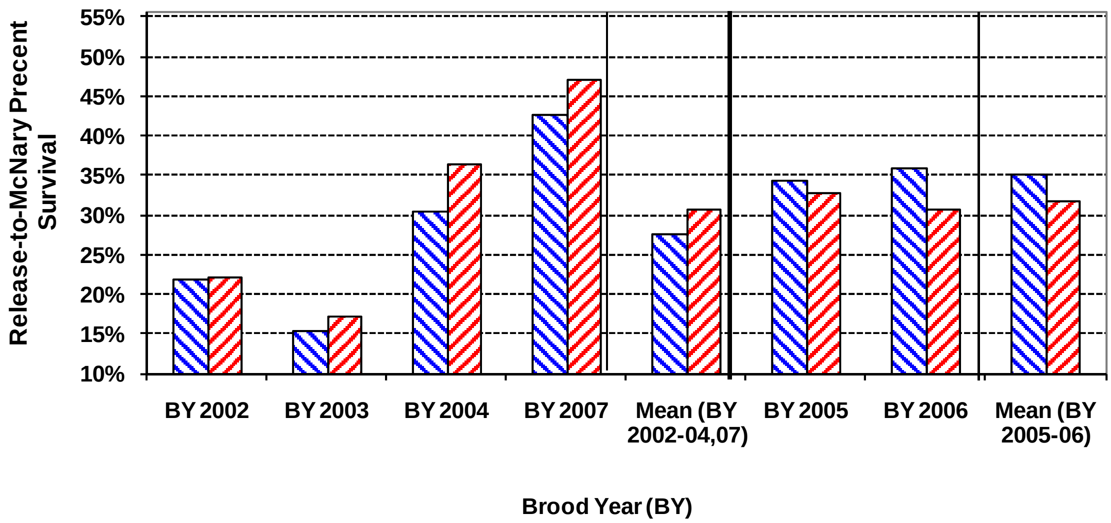
b. Adjusted for Mini-Jack Proportion[16]

Source	Brood Year (BY) / Outmigration Year	Group 1: 2002 / 2004	2003 / 2005	2004 / 2006	2007 / 2009	Mean (BY 2002-2004)	Group 2: 2005 / 2007	2006 / 2008	Mean (BY 2005-2006)
NxN	Survival to McNary	28.6%	17.4%	35.7%	54.0%	**33.9%**	39.2%	44.9%	**42.0%**
	Number Released*	1,672	1,913	1,846	1,556		1,921	1,534	
HxH	Survival to McNary	23.8%	18.0%	38.8%	53.4%	**33.5%**	36.2%	42.0%	**39.1%**
	Number Released*	1,995	2,018	2,020	3,255		1,950	2,737	
NxN - HxH		4.8%	-0.7%	-3.2%	0.6%	**0.4%**	2.9%	2.8%	**2.9%**
Estimated Significance Level in Difference (p)		Group 1 Year x (HxH vs NN) Interaction not Significant (P = 0.1645)				Significant (P = 0.7648)	Group 2 Year x (HxH vs NN) Significant (P = 0.9483)		Significant (P = 0.1241)

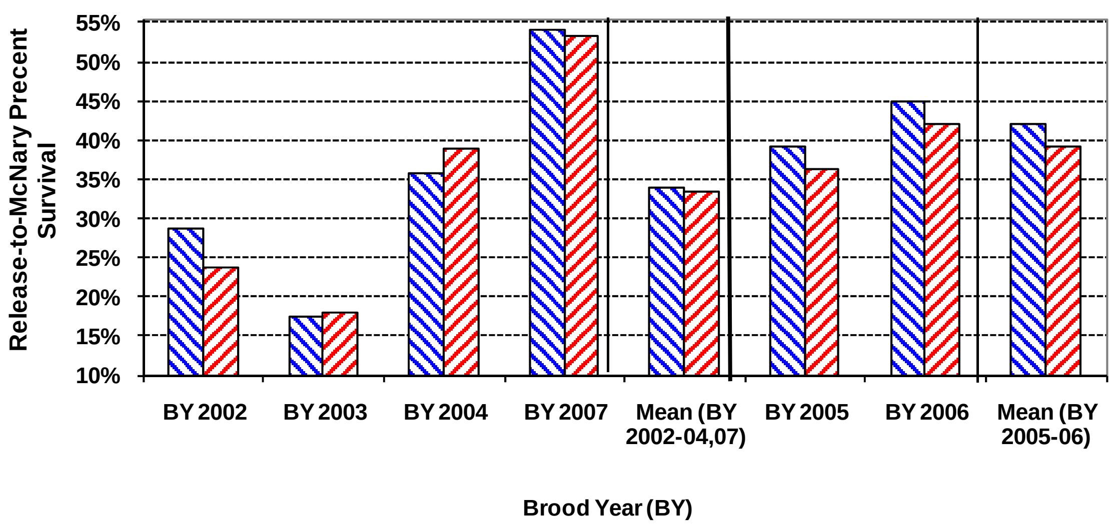
15 Appendix A.5.a presents the associated analysis of variance with the significance levels.
16 Appendix A.5.b presents the associated analysis of variance with the significance levels.

Figure 5. Volitional-Release-to-McNary-Dam Percent Survival of Natural x Natural (downward slant) and Hatchery x Hatchery (upward slant) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)

a. Unadjusted for Mini-Jack Proportion



b. Adjusted for Mini-Jack Proportion



6. Mean Dates of Juvenile Release and Mean McNary-Dam Juvenile Passage

The mean juvenile-release and mean McNary-passage dates are presented respectively in Tables 6.a and 6.b. and respectively in Figures 6.a and 6.b. The trends are the same for both measures. The stock differences are not significant for the BY-Group-1 years (over-all means P = 0.47 for mean release date and P = 0.95 for mean passage date; for respective stock x year interactions, P = 0.28 for release date and P = 0.77 for passage date). However, the overall BY-Group-2 years release-date means for the two measures are highest for the NxN stock and consistent for the two years (over-all means P = 0.047 for mean release date and P = 0.0015 for mean passage date; for respective stock x year interactions, P = 0.90 and P = 0.79).

Table 6.a. Mean <u>Acclimation-Release Julian Date</u> of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt Detection (brood years 2002 through 2007)[17]

		Group 1					Group 2		
	Brood Year (BY)	2002	2003	2004	2007	Mean (BY	2005	2006	Mean (BY
Source	Outmigration Year	2004	2005	2006	2009	2002-2004)	2007	2008	2005-2006)
NxN	Mean Release Date	97.3	77.0	102.2	110.1	**96.7**	88.8	116.7	**102.7**
	Number Released	8,707	8,637	8,651	7,875		8,743	7,669	
HxH	Mean Release Date	99.5	75.8	103.2	105.1	**95.9**	84.9	112.3	**98.6**
	Number Released	4,286	4,269	4,311	7,395		4,322	7,508	
NxN - HxH		-2.2	1.1	-1.0	5.0	**0.7**	3.9	4.4	**4.2**
Estimated Significance Level in Difference (p)		Group 1 Year x (HxH vs NN) Interaction (P = 0.2845)				(P = 0.4661)	Group 2 Year x (HxH vs NN) Interaction (P = 0.8953)		**(P = 0.0472)**

Table 6.b. Mean McNary-Dam Julian Passage Date of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt Detection (brood years 2002 through 2007)[18]

		Group 1					Group 2		
	Brood Year (BY)	2002	2003	2004	2007	Mean (BY	2005	2006	Mean (BY
Source	Outmigration Year	2004	2005	2006	2009	2002-2004)	2007	2008	2005-2006)
NxN	McNary Passage Date	121.9	123.5	126.0	131.3	**125.7**	126.2	136.3	**131.2**
	Expanded McN Passage	1,911	1,330	2,634	3,360		3,009	2,753	
HxH	McNary Passage Date	123.3	123.2	125.8	131.0	**125.9**	122.9	133.4	**128.1**
	Expanded McN Passage	949	728	1,569	3,476		1,413	2,302	
NxN - HxH		-1.4	0.3	0.2	0.2	**-0.2**	3.3	2.9	**3.1**
Estimated Significance Level in Difference (p)		Group 1 Year x (HxH vs NN) Interaction (P = 0.7706)				(P = 0.9537)	Group 2 Year x (HxH vs NN) Interaction (P = 0.7927)		**(P = 0.0015)**

17 Appendix A.6.a presents the associated analysis of variance with the significance levels.
18 Appendix A.6.b presents the associated analysis of variance with the significance levels.

Figure 6.a. **Mean <u>Acclimation-Release Julian Date</u> of Natural x Natural (downward slant) and Hatchery x Hatchery (upward slant) Upper-Yakima Spring Chinook Smolt Detection (brood years 2002 through 2007)**

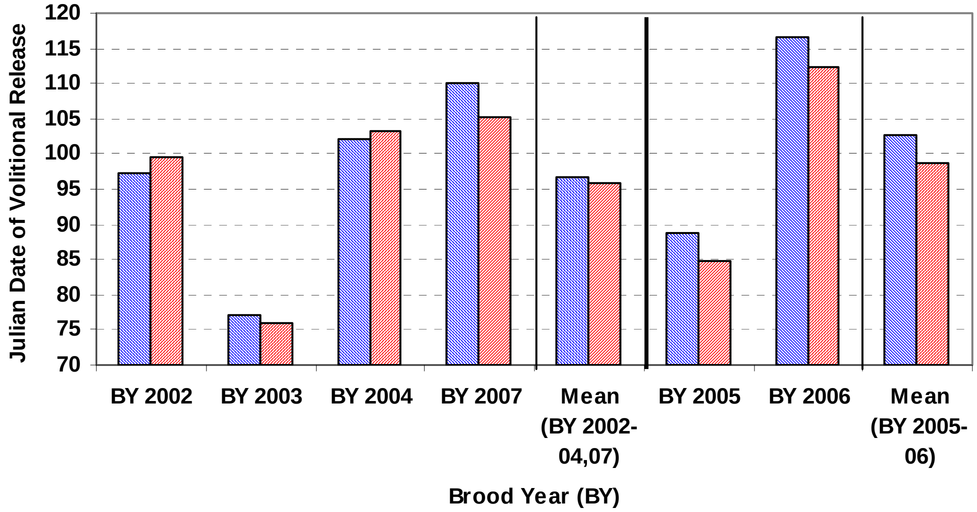
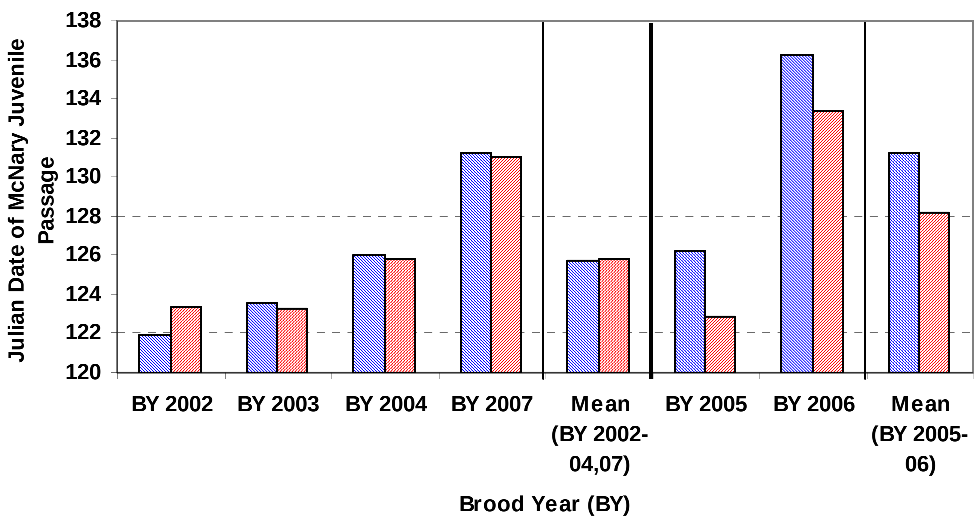


Figure 6.b. **Mean McNary-Dam Julian Passage Date of Natural x Natural (downward) and Hatchery x Hatchery (upward) Upper-Yakima Spring Chinook Smolt Detection (brood years 2002 through 2007)**



Interactions between NxN–HxH Comparisons with Treatment

The stock assignment was superimposed on different pairs of rearing or nutrition treatments. Various pairs of treatments were assessed over the years:

Set 1: Transfer versus (vs.) Vita (BY 2007, release year 2009)
Set 2: EWOS vs. Bio (BY 2006, release year 2008)
Set 3 STF vs. Control (BY 2005, release year 2007)
Set 4: Low- vs. High-feed levels (BY2002-BY2004, release years 2004-2006)

In this section comparisons between the NxN and HxH stock are made within treatments whenever within-year Stock x Treatment interactions are significant. Findings presented herein should be regarded as tentative since they are based on only one-year's worth of feed information within which there was only one replication of HxH and only two replications for NxN for each feed. Also there were many interaction comparisons made over the various trait measured, and, with so many comparisons, some interactions are likely to be detected as being significant just by chance. More years' data for the same feeds would be required before any meaningful conclusions about NxN vs HxH interactions with feed-comparisons can be reached.

As can be seen from Table 7, within brood-year 2007, there was a significant volitional-release-to-McNary-survival interaction between the stock and the Transfer versus Vita treatments (P = 0.0021, Appendix Table A.5.a.). The NxN-HxH survival difference unadjusted for mini-jack proportion was small and positive under the Transfer feed, but large but negative under the Vita feed.

Table 7. Volitional-Release-to-McNary-Dam Percent Survival[19] of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt under two Feed Treatment in brood year 2007.

	Feed	
	Transfer	Vita
NN	44.5%	40.8%
HH	42.5%	51.4%
Difference	2.0%	-10.6%

19 Survivals in Table 7 are unadjusted for mini-jack proportion of pre-release males. When adjusted for mini-jack proportion, the difference under Transfer was 6.3% and under Vita was –4.9%.

As can be seen from Table 8, within brood-year 2005, there was a significant proportion-of-tagged-fish-released interaction between the stock and the STF versus Control treatments (P = 0.012, Appendix Table A.2.). The interaction was in the nature of a difference in magnitude rather than in direction, with positive NxN–HxH difference under the STF treatment being 6 times greater than that under the Control treatment.

Table 8. Detected Released Percent of Tagged Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt under two Feed Treatment in brood year 2005.

	Feed	
Stock	**STF**	**Control**
NxN	98.5%	98.1%
HxH	96.7%	97.7%
Difference	1.8%	0.3%

Appendix A. Analyses of Variation for the Analyzed Measures

Table A.1. **Weighted* Analysis of Variance of Pre-Release Weight (grams) of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007).**

	Source	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	**Among Years**	5714	5	1142.8	28.99	**0.0000**
	HxH vs NxN	0	1	0.0	0.00	1.0000
	<u>Year x (HxH vs NxN)</u>	554	5	110.8	2.81	<u>0.0661</u>
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	Between Groups	551	1	551.0	13.98	**0.0028**
	(HxH vs NxN) x Between Groups	286	1	286.0	7.26	**0.0195**
Within Year Groups						
Within Group 1 Years	**Among Years**	5153	3	1717.67	43.58	**0.0000**
	HH vs NN	108	1	108.00	2.74	0.1238
	(HH vs NN) x Year	243	3	81	2.05	0.1599
	Hi vs LO	5134	1	5134.00	130.25	**0.0000**
	Transfer vs Vita	7	1	7.00	0.18	0.6809
	(HH vs NN) x (HI vs LO)	0	1	0.00	0.00	1.0000
	(HH vs NN) x (Transfer vs Vita)	43	1	43.00	1.09	0.3169
	Hi vs Lo x Year	40	2	20.00	0.51	0.6144
	(HH vs NN) x (Hi vs Lo) x Year	38	2	19.00	0.48	0.6290
Within Group 2 Years	Among Years	10	1	10.00	0.25	0.6236
	<u>HH vs NN</u>	178	1	178.00	4.52	<u>0.0550</u>
	Year x (HH vs NN)	25	1	25.00	0.63	0.4413
	STF vs Control	9	1	9.00	2.70	0.1075
	Bio vs Ewas	0	1	0.00	0.23	0.6414
	(HH vs NN) x (STF vs Control)	118	1	118.00	0.00	1.0000
	(HH vs NN) x (Bio vs Ewas)	15	1	15.00	2.99	0.1092
Pooled* Error over all Years**		473	12	39.42		

* Weight = Number of pre-released fish sampled for weights and mini-jack assessment

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Table A.2. **Weighted* Logistic Analysis of Variation of Pre-Release Survival of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)**

	Source	Deviance	Degrees of Freedom	Mean Deviance	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	**Among Years**	318.31	5	63.662	27.77	**0.0000**
	HxH vs NxN	282.25	1	282.250	123.12	**0.0000**
	Year x (HxH vs NxN)	164.38	5	32.876	14.34	**0.0001**
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	Between Groups	8.67	1	8.670	3.78	0.0756
	(HxH vs NxN) x Between Groups	15.93	1	15.930	6.95	**0.0217**
Within Year Groups						
Within Group 1 Years	**Among Years**	105.68	3	35.227	15.37	**0.0002**
	HH vs NN	249.00	1	249.000	108.62	**0.0000**
	(HH vs NN) x Year	148.12	3	49.373	21.54	**0.0000**
	Hi vs LO	10.69	1	10.690	4.66	0.0518
	Transfer vs Vita	21.92	1	21.920	9.56	**0.0093**
	(HH vs NN) x (HI vs LO)	1.58	1	1.580	0.69	0.4226
	(HH vs NN) x (Transfer vs Vita)	3.63	1	3.630	1.58	0.2322
	Hi vs Lo x Year	0.84	2	0.420	0.18	0.8349
	(HH vs NN) x (Hi vs Lo) x Year	14.65	2	7.325	3.20	0.0772
Within Group 2 Years	**Among Years**	203.96	1	203.960	88.97	**0.0000**
	HH vs NN	49.18	1	49.180	21.45	**0.0006**
	Year x (HH vs NN)	0.33	1	0.330	0.14	0.7110
	STF vs Control	0.01	1	0.010	0.84	0.4540
	Bio vs Ewas	20.13	1	20.130	0.00	0.9484
	(HH vs NN) x (STF vs Control)	7.39	1	7.390	8.78	**0.0118**
	(HH vs NN) x (Bio vs Ewas)	4.23	1	4.230	3.22	0.0978
Pooled* Error over all Years**		27.51	12	2.293		

* Weight = Number of fish tagged

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Table A.3. Weighted* Logistic Analysis of Variation of Male Percent of Pre-Release Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002-2007)

	Source	Deviance	Degrees of Freedom	Mean Deviance	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	Among Years	2.75	5	0.550	0.69	0.6374
	HxH vs NxN	0.02	1	0.020	0.03	0.8764
	Year x (HxH vs NxN)	3.64	5	0.728	0.92	0.5009
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	Between Groups	0.30	1	0.300	0.38	0.5497
	(HxH vs NxN) x Between Groups	1.78	1	1.780	2.25	0.1596
Within Year Groups						
Within Group 1 Years	Among Years	2.24	3	0.747	0.94	0.4503
	HH vs NN	0.86	1	0.860	1.09	0.3178
	(HH vs NN) x Year	1.66	3	0.553	0.70	0.5705
	Hi vs LO	0.07	1	0.070	0.09	0.7713
	Transfer vs Vita	0.07	1	0.070	0.09	0.7713
	(HH vs NN) x (HI vs LO)	1.61	1	1.610	2.03	0.1793
	(HH vs NN) x (Transfer vs Vita)	1.90	1	1.900	2.40	0.1473
	Hi vs Lo x Year	6.24	2	3.120	3.94	**0.0483**
	(HH vs NN) x (Hi vs Lo) x Year	1.36	2	0.680	0.86	0.4481
Within Group 2 Years	Among Years	0.21	1	0.210	0.27	0.6159
	HH vs NN	0.94	1	0.940	1.19	0.2973
	Year x (HH vs NN)	0.20	1	0.200	0.25	0.6243
	STF vs Control	0.04	1	0.040	0.87	0.4432
	Bio vs Ewas	0.21	1	0.210	0.05	0.8259
	(HH vs NN) x (STF vs Control)	1.20	1	1.200	0.27	0.6159
	(HH vs NN) x (Bio vs Ewas)	0.41	1	0.410	1.52	0.2418
Pooled* Error over all Years**		9.50	12	0.792		

* Weight = Number of pre-released fish sampled for weights and mini-jack assessment

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Table A.4. Weighted* Logistic Analysis of Variation of Mini-Jack Percent of Pre-Release Male Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)

	Source	Deviance	Degrees of Freedom	Mean Deviance	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	**Among Years**	66.10	5	13.220	16.84	**0.0000**
	HxH vs NxN	16.20	1	16.200	20.64	**0.0007**
	Year x (HxH vs NxN)	31.56	5	6.312	8.04	**0.0016**
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	Between Groups	8.40	1	8.400	10.70	**0.0067**
	(HxH vs NxN) x Between Groups	23.84	1	23.840	30.37	**0.0001**
Within Year Groups						
Within Group 1 Years	**Among Years**	22.91	3	7.637	9.73	**0.0016**
	HH vs NN	38.68	1	38.680	49.27	**0.0000**
	(HH vs NN) x Year	2.94	3	0.980	1.25	0.3356
	Hi vs LO	19.11	1	19.110	24.34	**0.0003**
	Transfer vs Vita	0.51	1	0.510	0.65	0.4359
	(HH vs NN) x (HI vs LO)	2.65	1	2.650	3.38	0.0910
	(HH vs NN) x (Transfer vs Vita)	1.33	1	1.330	1.69	0.2175
	Hi vs Lo x Year	3.26	2	1.630	2.08	0.1681
	(HH vs NN) x (Hi vs Lo) x Year	2.13	2	1.065	1.36	0.2943
Within Group 2 Years	**Among Years**	34.79	1	34.790	44.32	**0.0000**
	HH vs NN	1.35	1	1.350	1.72	0.2143
	Year x (HH vs NN)	4.78	1	4.780	6.09	**0.0296**
	STF vs Control	0.23	1	0.230	0.71	0.5096
	Bio vs Ewas	0.26	1	0.260	0.29	0.5982
	(HH vs NN) x (STF vs Control)	2.36	1	2.360	0.33	0.5756
	(HH vs NN) x (Bio vs Ewas)	0.19	1	0.190	3.01	0.1085
Pooled* Error over all Years**		9.42	12	0.785		

* Weight = Number of pre-released fish sampled that were males

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Table A.5. Weighted* Logistic Analysis of Variation of Volitional-Release-to-McNary-Dam Percent Survival of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)

a. Unadjusted for Mini-Jack Proportion

	Source	Deviance	Degrees of Freedom	Mean Deviance	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	**Among Years**	3374.68	5	674.936	168.66	**0.0000**
	HxH vs NxN	5.06	1	5.060	1.26	0.2828
	Year x (HxH vs NxN)	126.86	5	25.372	6.34	**0.0042**
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	Between Groups	232.89	1	232.890	58.20	**0.0000**
	(HxH vs NxN) x Between Groups	98.23	1	98.230	24.55	**0.0003**
Within Year Groups						
Within Group 1 Years	**Among Years**	3141.78	3	1047.260	261.71	**0.0000**
	HH vs NN	61.71	1	61.710	15.42	**0.0020**
	(HH vs NN) x Year	19.37	3	6.457	1.61	0.2381
	Hi vs LO	83.95	1	83.950	20.98	**0.0006**
	Transfer vs Vita	8.51	1	8.510	2.13	0.1704
	(HH vs NN) x (HI vs LO)	0.24	1	0.240	0.06	0.8107
	(HH vs NN) x (Transfer vs Vita)	61.26	1	61.260	15.31	**0.0021**
	Hi vs Lo x Year	17.64	2	8.820	2.20	0.1530
	(HH vs NN) x (Hi vs Lo) x Year	5.60	2	2.800	0.70	0.5159
Within Group 2 Years	Among Years	0.01	1	0.010	0.00	0.9610
	HH vs NN	41.59	1	41.590	10.39	**0.0073**
	Year x (HH vs NN)	9.26	1	9.260	2.31	0.1541
	STF vs Control	13.95	1	13.950	0.63	0.5495
	<u>Bio vs Ewas</u>	5.82	1	5.820	3.49	<u>0.0865</u>
	(HH vs NN) x (STF vs Control)	4.05	1	4.050	1.45	0.2511
	(HH vs NN) x (Bio vs Ewas)	5.72	1	5.720	1.01	0.3343
Pooled* Error over all Years**		48.02	12	4.002		

* Weight = Number of fish detected at release

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Table A.5. **(continued)**

b. Adjusted for Mini-Jack Proportion

	Source	Deviance	Degrees of Freedom	Mean Deviance	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	**Among Years**	4275.42	5	855.084	125.10	**0.0000**
	HxH vs NxN	10.62	1	10.620	1.55	0.2364
	Year x (HxH vs NxN)	50.21	5	10.042	1.47	0.2703
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	Between Groups	320.31	1	320.310	46.86	**0.0000**
	(HxH vs NxN) x Between Groups	8.70	1	8.700	1.27	0.2813
Within Year Groups						
Within Group 1 Years	**Among Years**	3877.11	3	1292.370	189.08	**0.0000**
	HH vs NN	0.64	1	0.640	0.09	0.7648
	(HH vs NN) x Year	41.48	3	13.827	2.02	0.1645
	Hi vs LO	239.63	1	239.630	35.06	**0.0001**
	Transfer vs Vita	3.25	1	3.250	0.48	0.5036
	(HH vs NN) x (HI vs LO)	19.71	1	19.710	2.88	0.1152
	(HH vs NN) x (Transfer vs Vita)	39.93	1	39.930	5.84	**0.0325**
	Hi vs Lo x Year	43.68	2	21.840	3.20	0.0772
	(HH vs NN) x (Hi vs Lo) x Year	9.06	2	4.530	0.66	0.5333
Within Group 2 Years	**Among Years**	78.00	1	78.000	11.41	**0.0055**
	HH vs NN	18.69	1	18.690	2.73	0.1241
	Year x (HH vs NN)	0.03	1	0.030	0.00	0.9483
	STF vs Control	26.56	1	26.560	3.89	0.0722
	Bio vs Ewas	12.86	1	12.860	1.88	0.1953
	(HH vs NN) x (STF vs Control)	0.05	1	0.050	0.01	0.9333
	(HH vs NN) x (Bio vs Ewas)	3.44	1	3.440	0.50	0.4916
Pooled* Error over all Years**		82.02	12	6.835		

* Weight = Number of fish detected at release adjusted to exclude mini-jacks

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Table A.6.a. Weighted* Analysis of Variance of Acclimation-Release Julian Detection Date of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)

	Source	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	**Among Years**	13225534	5	2645106.8	110.21	**0.0000**
	HxH vs NxN	87995	1	87995.0	3.67	<u>0.0797</u>
	Year x (HxH vs NxN)	145791	5	29158.2	1.21	0.3599
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	<u>Between Groups</u>	464884	1	464884.1	19.37	**0.0009**
	(HxH vs NxN) x Between Groups	42926	1	42925.7	1.79	0.2059
Within Year Groups						
Within Group 1 Years	**Among Years**	7531763	3	2510587.7	104.61	**0.0000**
	HH vs NN	13597	1	13597.0	0.57	0.4661
	(HH vs NN) x Year	102432	3	34144.0	1.42	0.2845
	Hi vs LO	120000	1	120000.0	5.00	**0.0451**
	Transfer vs Vita	11913	1	11913.0	0.50	0.4945
	(HH vs NN) x (HI vs LO)	16360	1	16360.0	0.68	0.4251
	(HH vs NN) x (Transfer vs Vita)	11183	1	11183.0	0.47	0.5078
	Hi vs Lo x Year	12376	2	6188.0	0.26	0.7769
	(HH vs NN) x (Hi vs Lo) x Year	64405	2	32202.5	1.34	0.2979
Within Group 2 Years	**Among Years**	5228887	1	5228886.9	217.87	**0.0000**
	HH vs NN	117323	1	117322.9	4.89	**0.0472**
	Year x (HH vs NN)	433	1	433.3	0.02	0.8953
	STF vs Control	468	1	468.3	0.61	0.5582
	Bio vs Ewas	574	1	573.5	0.02	0.8912
	(HH vs NN) x (STF vs Control)	232	1	231.6	0.02	0.8797
	(HH vs NN) x (Bio vs Ewas)	13163	1	13163.3	0.01	0.9234
Pooled* Error over all Years**		288002	12	24000.2		

* Weight = Number of fish detected at release

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Table A.6.b. Weighted* Analysis of Variance of McNary-Dam Julian Detection Date of Natural x Natural (NxN) and Hatchery x Hatchery (HxH) Upper-Yakima Spring Chinook Smolt (brood years 2002 through 2007)

	Source	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Estimated Type 1 Error Probability**
Over all Years	**Among Years**	504024	5	100804.7	80.63	**0.0000**
	HxH vs NxN	7437	1	7436.9	5.95	**0.0312**
	Year x (HxH vs NxN)	15044	5	3008.9	2.41	0.0987
Between Year Groups: Group 1--2002-2004, 2007, Group 2--2005-2006)						
	Between Groups	57326	1	57326.3	45.86	**0.0000**
	(HxH vs NxN) x Between Groups	13537	1	13536.7	10.83	**0.0065**
Within Year Groups						
Within Group 1 Years	**Among Years**	202935	3	67645.0	54.11	**0.0000**
	HH vs NN	4	1	4.4	0.00	0.9537
	(HH vs NN) x Year	1417	3	472.5	0.38	0.7706
	Hi vs LO	12291	1	12291.2	9.83	**0.0086**
	Transfer vs Vita	4005	1	4004.8	3.20	0.0987
	(HH vs NN) x (HI vs LO)	332	1	331.5	0.27	0.6159
	(HH vs NN) x (Transfer vs Vita)	4177	1	4177.4	3.34	0.0925
	Hi vs Lo x Year	649	2	324.3	0.26	0.7757
	(HH vs NN) x (Hi vs Lo) x Year	242	2	120.8	0.10	0.9086
Within Group 2 Years	**Among Years**	243762	1	243762.3	194.99	**0.0000**
	HH vs NN	20969	1	20969.2	16.77	**0.0015**
	Year x (HH vs NN)	90	1	90.3	0.07	0.7927
	STF vs Control	362	1	362.3	0.38	0.6904
	Bio vs Ewas	502	1	502.4	0.29	0.6002
	(HH vs NN) x (STF vs Control)	28	1	28.1	0.40	0.5380
	(HH vs NN) x (Bio vs Ewas)	72	1	71.6	0.02	0.8832
Pooled* Error over all Years**		15002	12	1250.1		

* Weight = Expanded number of fish detected at McNary Dam

** Sources significant at the 5% are in boldfaced type and at the 10% level are underlined

*** Pooling of both residual error and variation among NxN raceway-pair means over groups of years

Appendix B. Estimated Survival Index

The 2007 Annual report described estimation procedures and also presented the estimated detection rates at McNary Dam and the individual-acclimation-pond survival-rate and other estimates for release years 2004 through 2007 (Brood years 2002 through 2005). Tables B.1.a and B1.b provide the McNary detection rates for respective subsequent release years 2008 and 2009 (Brood Years 2006 and 2007); Tables B.2.a and B.2.b provide the individual-acclimation-pond tagging-to-McNary-survival for those respective years and Tables B.3.a and B.3.b provide the individual-acclimation-pond release-to-McNary-survival for those respective years.

Table B.1. Estimated McNary (McN) Detection (Det.) Rates based on Bonneville (Bonn.) and John Day (J.D.) Detections and Pooled

a. Release-Year 2008 (Brood-Year 2006)

Julian Date Strata		Bonneville (Bonn.) Based			John Day (J.D. based)			**Pooled over Bonn.and J.D. (applied detection rates)**		
Beginning	Ending	Total Bonn. Det.	Joint Bonn. McN. Det.	McN. Det. Rate	Total J.D. Det.	Joint J.D. McN. Det.	McN. Det. Rate	**Total Det.**	**Joint J.D. McN. Det.**	**Pooled Det. Rate**
	131	1030.7	356	0.3454	1095.1	341	0.3114	**2125.8**	**697**	**0.3279**
132	138	377.4	118	0.3126	867.3	255	0.2940	**1244.7**	**373**	**0.2997**
139	139	56.6	11	0.1943	325.7	84	0.2579	**382.4**	**95**	**0.2485**
140	142	156.6	27	0.1724	716.8	156	0.2176	**873.4**	**183**	**0.2095**
143		144.7	22	0.1521	421.0	67	0.1591	**565.7**	**89**	**0.1573**
Total		1766.0	534	0.3024	3426.0	903	0.2636	**5192.0**	**1437**	**0.2768**

b. Release-Year 2009 (Brood-Year 2007)

Julian Date Strata		Bonneville (Bonn.) Based			John Day (J.D. based)			**Pooled over Bonn.and J.D. (applied detection rates)**		
Beginning	Ending	Total Bonn. Det.	Joint Bonn. McN. Det.	McN. Det. Rate	Total J.D. Det.	Joint J.D. McN. Det.	McN. Det. Rate	**Total Det.**	**Joint J.D. McN. Det.**	**Pooled Det. Rate**
	114	91.8	27	0.2941	210.9	67	0.3177	**302.7**	**94**	**0.3105**
115	118	220.6	85	0.3853	351.8	133	0.3781	**572.4**	**218**	**0.3809**
119	132	755.7	360	0.4764	629.1	277	0.4403	**1384.8**	**637**	**0.4600**
133	138	499.2	208	0.4167	357.4	151	0.4225	**856.6**	**359**	**0.4191**
139	144	697.4	252	0.3613	743.0	238	0.3203	**1440.5**	**490**	**0.3402**
145	147	215.1	55	0.2557	150.2	23	0.1531	**365.3**	**78**	**0.2135**
148		153.2	25	0.1632	175.6	22	0.1253	**328.7**	**47**	**0.1430**
Total		2541.2	985	0.3876	2407.1	844	0.3506	**4948.3**	**1829**	**0.3696**

Table B.2. Tagging-to-McNary Survival-Index Estimates (within strata expanded total equals total divided by pooled detection rate in Table B.1)

a. 2008 Releases (Brood Year 2006) based on All PIT-Tagged Fish

	Acclimation Site >	Clark Flat					
	Tagging Group (File Extender) >	CFJ_05 EWOS HxH	CFJ_06 BIO HxH	CFJ_01 EWOS NxN	CFJ_02 BIO NxN	CFJ_03 EWOS NxN	CFJ_04 BIO NxN
Stratum 1	Total	206	194	78	78	41	73
	Removed	0	0	0	0	0	0
	Subtotal	206	194	78	78	41	73
	Expanded Total	628.3	591.7	237.9	237.9	125.0	222.6
Stratum 2	Total	52	63	45	56	72	52
	Removed	0	0	0	0	0	0
	Subtotal	52	63	45	56	72	52
	Expanded Total	173.5	210.2	150.2	186.9	240.3	173.5
Stratum 3	Total	15	14	19	11	13	18
	Removed	0	0	0	0	0	0
	Subtotal	15	14	19	11	13	18
	Expanded Total	60.4	56.3	76.5	44.3	52.3	72.4
Stratum 4	Total	38	39	31	23	31	23
	Removed	0	0	0	0	0	0
	Subtotal	38	39	31	23	31	23
	Expanded Total	181.4	186.1	148.0	109.8	148.0	109.8
Stratum 5	Total	10	34	13	17	19	20
	Removed	0	0	0	0	0	0
	Subtotal	10	34	13	17	19	20
	Expanded Total	63.6	216.1	82.6	108.1	120.8	127.1
Release Summary	Total over Strata	321	344	186	185	176	186
	Expanded Total over Strata	1107.1	1260.5	695.1	686.9	686.4	705.5
	Total Tagged	4000	4000	2000	2000	2000	2000
	Tagging-to-McN Survival	0.2768	0.3151	0.3476	0.3434	0.3432	0.3528
Source x Treatment Summary	Pooled Number Tagged		8000			4000	4000
	Pooled Tagging-to-McNary Survival		0.2960			0.3454	0.3481
Source Summary	Pooled Number Tagged		8000				8000
	Pooled Tagging-to-McNary Survival		0.2960				0.3467

Table B.2. Tagging-to-McNary Survival-Index Estimates (continued)

b. 2009 Releases (Brood Year 2007) based on All PIT-Tagged Fish

	Acclimation Site >	Clark Flat					
	Tagging Group (File Extender) >	CFJ_01 Transfer HxH	CFJ_02 Vita HxH	CFJ_03 Transfer NxN	CFJ_04 Vita NxN	CFJ_05 Transfer NxN	CFJ_06 Vita NxN
Stratum 1	Total	26	12	3	9	9	10
	Removed	0	0	0	0	0	0
	Subtotal	26	12	3	9	9	10
	Expanded Total	83.7	38.6	9.7	29.0	29.0	32.2
Stratum 2	Total	84	62	21	30	49	22
	Removed	0	0	0	0	0	0
	Subtotal	84	62	21	30	49	22
	Expanded Total	220.6	162.8	55.1	78.8	128.7	57.8
Stratum 3	Total	253	265	107	119	161	119
	Removed	0	0	0	0	0	0
	Subtotal	253	265	107	119	161	119
	Expanded Total	550.0	576.1	232.6	258.7	350.0	258.7
Stratum 4	Total	106	109	69	51	61	89
	Removed	0	0	0	0	0	0
	Subtotal	106	109	69	51	61	89
	Expanded Total	252.9	260.1	164.6	121.7	145.6	212.4
Stratum 5	Total	111	268	106	90	57	56
	Removed	0	0	0	0	0	0
	Subtotal	111	268	106	90	57	56
	Expanded Total	326.3	787.8	311.6	264.6	167.6	164.6
Stratum 6	Total	20.0	25.0	11.0	10.0	13.0	7.0
	Removed	0	0	0	0	0	0
	Subtotal	20	25	11	10	13	7
	Expanded Total	93.67208	117.0901	51.51964	46.83604	60.88685	32.78523
Stratum 7	Total	8	12	8	6	1	2
	Removed	0	0	0	0	0	0
	Subtotal	8	12	8	6	1	2
	Expanded Total	55.95552	83.93328	55.95552	41.96664	6.99444	13.98888
Release Summary	Total over Strata	608	753	325	315	351	305
	Expanded Total over Strata	1583.1	2026.5	881.1	841.5	888.6	772.4
	Number Tagged	4000	4000	2000	2000	2000	2000
	Tagging-to-McNary Survival	0.3958	0.5066	0.4406	0.4208	0.4443	0.3862
Source x Treatment Summary	Pooled Number Tagged		8000			4000	4000
	Pooled Tagging-to-McNary Survival		0.4512			0.4424	0.4035
Source Summary	Pooled Number Tagged		8000				8000
	Pooled Tagging-to-McNary Survival		0.4512				0.4230

Table B.3. Release-to-McNary Survival-Index (unadjusted for mini-jacks) and other Estimates (within strata expanded total equals total divided by pooled detection rate in Table B.1)

a. 2008 Releases (Brood Year 2006) based on Volitionally Released Fish

	Acclimation Site >	Clark Flat					
	Tagging Group (File Extender) >	CFJ_05 EWOS HxH	CFJ_06 BIO HxH	CFJ_01 EWOS NxN	CFJ_02 BIO NxN	CFJ_03 EWOS NxN	CFJ_04 BIO NxN
Stratum 1	Total	9	10	25	12	3	9
	Removed	0	0	0	0	0	0
	Subtotal	9	10	25	12	3	9
	Expanded Total	29.0	32.2	80.5	38.6	9.7	29.0
Stratum 2	Total	49	22	82	62	21	30
	Removed	0	0	0	0	0	0
	Subtotal	49	22	82	62	21	30
	Expanded Total	128.7	57.8	215.3	162.8	55.1	78.8
Stratum 3	Total	161	119	252	265	107	119
	Removed	0	0	0	0	0	0
	Subtotal	161	119	252	265	107	119
	Expanded Total	350.0	258.7	547.8	576.1	232.6	258.7
Stratum 4	Total	61	89	106	108	69	51
	Removed	0	0	0	0	0	0
	Subtotal	61	89	106	108	69	51
	Expanded Total	145.6	212.4	252.9	257.7	164.6	121.7
Stratum 5	Total	57	56	106	243	102	89
	Removed	0	0	0	0	0	0
	Subtotal	57	56	106	243	102	89
	Expanded Total	167.6	164.6	311.6	714.3	299.8	261.6
Release Summary	Total over Strata	313	339	185	183	175	186
	Expanded Total over Strata	1067.3	1234.2	688.8	677.3	681.6	705.5
	Volitional Releases	3703	3805	1918	1912	1905	1934
	Release-to-McN Survival	0.2882	0.3244	0.3591	0.3543	0.3578	0.3648
Source x Treatment Summary	Pooled Number Released		7508			3823	3846
	Pooled Tagging-to-McNary Survival		0.3065			0.3585	0.3596
Source Summary	Pooled Number Tagged		7508				7669
	Pooled Release-to-McNary Survival		0.3065				0.3590
Release Summary	Num Rel/Num Tag	0.9258	0.9513	0.9590	0.9560	0.9525	0.9670
	Number Tagged	4000	4000	2000	2000	2000	2000
Source x Treatment Summary	Num Rel/Num Tag		0.9385			0.9558	0.9615
	Total Tagged		8000			4000	4000
Source Summary	Num Rel/Num Tag		0.9385				0.9586
	Total Tagged		8000				8000

Table B.3. Release-to-McNary Survival-Index (unadjusted for mini-jacks) and other Estimates (continued)

b. 2009 Releases (Brood Year 2007) based on Volitionally Released Fish

	Acclimation Site >	Clark Flat					
	Tagging Group (File Extender) >	CFJ_01 Transfer HxH	CFJ_02 Vita HxH	CFJ_03 Transfer NxN	CFJ_04 Vita NxN	CFJ_05 Transfer NxN	CFJ_06 Vita NxN
Stratum 1	Total	25	12	3	9	9	10
	Removed	0	0	0	0	0	0
	Subtotal	25	12	3	9	9	10
	Expanded Total	80.5	38.6	9.7	29.0	29.0	32.2
Stratum 2	Total	82	62	21	30	49	22
	Removed	0	0	0	0	0	0
	Subtotal	82	62	21	30	49	22
	Expanded Total	215.3	162.8	55.1	78.8	128.7	57.8
Stratum 3	Total	252	265	107	119	161	119
	Removed	0	0	0	0	0	0
	Subtotal	252	265	107	119	161	119
	Expanded Total	547.8	576.1	232.6	258.7	350.0	258.7
Stratum 4	Total	106	108	69	51	61	89
	Removed	0	0	0	0	0	0
	Subtotal	106	108	69	51	61	89
	Expanded Total	252.9	257.7	164.6	121.7	145.6	212.4
Stratum 5	Total	106	243	102	89	57	56
	Removed	0	0	0	0	0	0
	Subtotal	106	243	102	89	57	56
	Expanded Total	311.6	714.3	299.8	261.6	167.6	164.6
Stratum 6	Total	19	22	11	9	12	7
	Removed	0	0	0	0	0	0
	Subtotal	19	22	11	9	12	7
	Expanded Total	89.0	103.0	51.5	42.2	56.2	32.8
Stratum 7	Total	7	11	8	6	1	2
	Removed	0	0	0	0	0	0
	Subtotal	7	11	8	6	1	2
	Expanded Total	49.0	76.9	56.0	42.0	7.0	14.0
Release Summary	Total over Strata	597	723	321	313	350	305
	Expanded Total over Strata	1546.1	1929.5	869.4	833.9	884.0	772.4
	Volitional Releases	3638	3757	1956	1966	1980	1973
	Release-to-McNary Survival	0.4250	0.5136	0.4445	0.4242	0.4464	0.3915
Source x Treatment Summary	Pooled Number Released		7395			3936	3939
	Pooled Tagging-to-McNary Survival		0.4700			0.4455	0.4078
Source Summary	Pooled Number Tagged		7395				7875
	Pooled Release-to-McNary Survival		0.4700				0.4266
Release Summary	Num Rel/Num Tag	0.9095	0.9393	0.9780	0.9830	0.9900	0.9865
	Number Tagged	4000	4000	2000	2000	2000	2000
Source x Treatment Summary	Num Rel/Num Tag		0.9244			0.9840	0.9848
	Total Tagged		8000			4000	4000
Source Summary	Num Rel/Num Tag		0.9244				0.9844
	Total Tagged		8000				8000

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Annual Report: Smolt Survival to McNary Dam of Year-2009 Spring Chinook Releases PIT-tagged and/or released at Roza Dam

Doug Neeley, Consultant to the Yakama Nation

Introduction

As in previous years, survivals to McNary Dam (McNary) of hatchery-brood (hatchery) released into the Roza bypass are compared to survivals of natural-brood (natural) smolt released contemporaneously with hatchery smolt. These contemporaneously Roza-passing natural smolt are referred to as “late” natural smolt. The survival of the late natural smolt is also compared to the survival of “early” natural smolt, passing Roza prior to the hatchery smolt passage.

There were also releases of smolt downstream of Roza made contemporaneously with some of bypass releases for the purpose of comparing survivals to McNary from these two release sites.

All smolt releases in this study were originally collected in the Roza bypass system, PIT-tagged, and released.

Comparison of Natural- and Hatchery-Origin Smolt Survival from Contemporaneous-Roza-Release to McNary

As was the case in the majority of the previous Roza-release years, late natural smolt released in 2009 had a significantly higher survival than hatchery smolt. Figure 1 presents the natural- and hatchery-smolt survivals to McNary for late natural and hatchery smolt from 1999 through 2009 Roza releases. Table 1.a presents the associated survival estimates. Weekly[1] release estimates of natural- and hatchery-smolt survival within each year are presented in Appendix A in the form of figures.

1 A week is defined as ending on a Julian date that is a multiple of 7.

Figure 1. Upper-Yakima Spring-Chinook Roza-to-McNary Smolt Survival for Late Natural Smolt (Downward Slash) and Hatchery Smolt (Upward Slash)

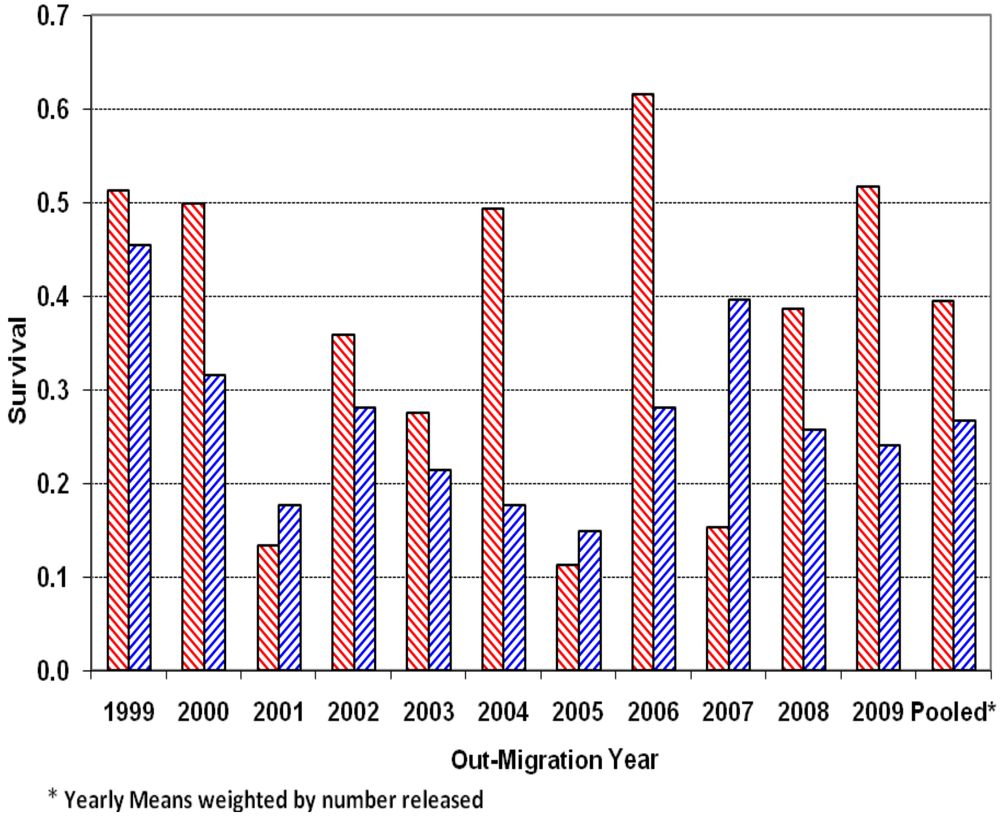


Table 1.a. Upper-Yakima Spring-Chinook Roza-to-McNary Smolt Survival for Late Natural Smolt and Hatchery Smolt

Stock	Measure	Outmigration Year 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Pooled*
Natural	**Survival**	**0.5122**	**0.4987**	**0.1339**	**0.3584**	**0.2750**	**0.4935**	**0.1122**	**0.6160**	**0.1529**	**0.3857**	**0.5161**	**0.3944**
(Nat)	Released	133	3196	1424	2114	1190	74	45	500	336	421	1804	11237
Hatchery	**Survival**	**0.4540**	**0.3155**	**0.1759**	**0.2803**	**0.2137**	**0.1768**	**0.1494**	**0.2810**	**0.3955**	**0.2573**	**0.2405**	**0.2664**
(Hat)	Released	675	2999	1744	1503	2146	2201	1344	3802	2477	4406	172	23469
Difference: Nat-Hat		**0.0582**	**0.1832**	**-0.0420**	**0.0781**	**0.0613**	**0.3167**	**-0.0371**	**0.3350**	**-0.2426**	**0.1284**	**0.2756**	**0.1280**
Type 1 Error P		0.1511	**0.0000**	0.5246	0.1732	0.1498	**0.0487**	0.9410	**0.0012**	**0.0352**	**0.0192**	**0.0726**	**0.0259**
(1-sided)		0.0755	**0.0000**	0.7377	0.0866	0.0749	**0.0243**	0.5295	**0.0006**	0.9824	**0.0096**	**0.0363**	**0.0130**

Because naturally-spawned smolt will have survived the in-stream environment longer than hatchery-spawned smolt, it has always been hypothesized that, for contemporaneously released fish, naturally-spawned-smolt Roza-release-to-McNary survival would be greater than that of hatchery-spawned smolt; therefore, one-sided tests of hypotheses for

$$\text{natural survival} - \text{hatchery survival} > 0$$

relative to the null-hypothesis have always been used. As can be seen from Table 1.a, the late natural smolt survival exceeded that of the hatchery smolt in eight of the eleven years. Of those eight, the difference was significant[2] in five (bold-faced probabilities in the Table 1.a) including 2009; and for the additional three, the differences were significant at the 10% level. Only in 2007 would there have been a significant indication that the naturally-spawned had a lower survival. The analyses on which individual year significance levels in Table 1.a. were based are presented in Appendix B.

The significance of brood-source comparison pooled over all years that is presented in Table 1.a is based on a two-way weighted logistic analysis of variation, the results of which are given in Table 1.b. The analysis indicates a significant year x stock interaction, which was driven primarily by the 2007 releases mentioned above.

Table 1.b. Weighted* Logistic Analysis of Variation of Upper-Yakima Spring-Chinook Roza-to-McNary Smolt Survival Indices for late Natural (Nat) Smolt and Comparison of Early and Late Roza Passage of Natural-Origin Smolt

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev (Dev/DF)	F-Ratio	2-Sided Type 1 Error	1-Sided Type 1 Error (Nat > Hat)
Nat vs Hat Stock (adjusted for Years)	279.05	1	279.05	6.83 ***	0.0259	0.0130
Among Years (adjusted for stock)	1175.77	10	117.58	2.88 ***	0.0554	
Stock x Year Interaction	408.8	10	40.88	8.00 ****	0.0000	
Error (Approximate)**		92	5.11			

* Weights are the separate number of total releases for the natural and of the hatchery stock within years.
** Error Mean Deviance is the weighted mean of Yearly Mean Deviances (Appendix B), weights being the total Roza releases over two stocks within years, Error Degrees of Freedom being based on Satterthwaite's approximation.
*** Year and Stock Tested against Interaction (Denominator Mean Deviance).
**** Tested against Error (Denominator Mean Deviance).

2 Significance is the estimated Type 1 Error probability is less than 0.05 (5% significance level).

Comparison of Early- and Late-Passage Natural-Origin Smolt Survival from Roza Release to McNary Passage

Beginning in release-year 2000, a sufficient number of natural smolt were released prior to the Roza trapping of hatchery-stock smolt to permit comparisons between early and late natural smolt-passage. Figure 2 presents the survivals to McNary for 2000 through 2009 Roza early and late natural smolt migrations. Table 2.a. presents the associated survival estimates. Again, weekly release estimates of natural- and hatchery-smolt survival within each year are presented in Appendix A.

Figure 2. Upper-Yakima Spring-Chinook Roza-to-McNary Smolt Survival Indices for Early (Downward Slash) and Late (Upward Slash) Natural Smolt

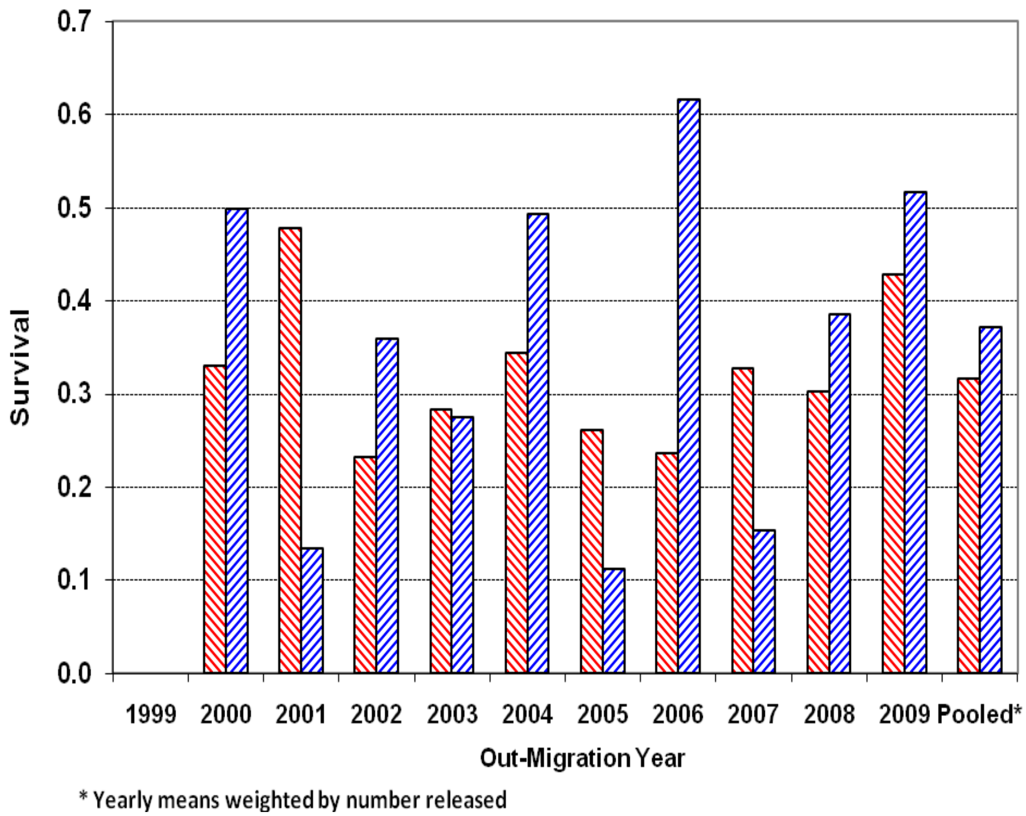


Table 2.a. Upper-Yakima Spring-Chinook Roza-to-McNary Smolt Survival Indices for Early and Late Natural Smolt

Natural Stock	Measure	Outmigration Year											Pooled*
		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Early	**Survival**		**0.3307**	**0.4771**	**0.2314**	**0.2837**	**0.3442**	**0.2608**	**0.2361**	**0.3273**	**0.3020**	**0.4286**	**0.3157**
	Released		3013	755	6604	6614	3857	1688	1833	1072	1254	1804	37966
Late	**Survival**		**0.4987**	**0.1339**	**0.3584**	**0.2750**	**0.4935**	**0.1122**	**0.6160**	**0.1529**	**0.3857**	**0.5161**	**0.3717**
	Released		3196	1424	2114	1190	74	45	500	336	421	172	9474
Difference: Early-Late			**-0.1679**	**0.3432**	**-0.1270**	0.0087	-0.1493	0.1485	**-0.3799**	0.1744	**-0.0837**	-0.0875	-0.0560
Type 1 Error P			**0.0000**	**0.0001**	**0.0004**	0.8230	0.4903	0.4035	**0.0010**	0.0671	**0.0000**	0.1001	0.2213

As noted in previous reports, there is no consistency over the release years as to whether the early or late natural-smolt passage had the highest survival to McNary. In five of the ten years, there were significant differences between the early- and late-run natural smolt, with four of those having late-run with the highest survival; the pooled survival estimates over all years gave similar late- and early-run estimates which were not significantly different. Individual year analyses of variation are given in Appendix C.

The significance of early-run versus late-run survival comparison pooled over all years that is presented in Table 2.a. is based on a two-way weighted logistic analysis of variation, the results of which are given in Table 2.b.

Table 2.b. Weighted* Logistic Analysis of Variation of Roza-to-McNary Smolt Survival for Early and Late Natural Smolt Upper-Yakima Spring-Chinook over years

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev (Dev/DF)	F-Ratio	Type 1 Error P	
Early vs Late Natural Smolt (adjusted for Years)	148.55	1	148.55	1.73	0.2213	**
Among Years (adjusted for Early and Late Smolt Passage)	631.15	9	70.13	0.82	0.6171	**
Brood x Year Interaction	774.2	9	86.02	9.87	0.0000	***
Error (Approximate0		76	8.71			

* Weights are the separate number of total releases for the late-natural and of the hatchery stock within years.
** Error Mean Deviance is the weighted mean of Yearly Mean Deviances from Appendix B, weights being the total Roza releases over two groups within years. Error Degrees of Freedom based on Satterthwaite's approximation.
*** Tested against Interaction (Denominator Mean Deviance).
**** Tested against Error (Denominator Mean Deviance).

Comparison of Survivals to McNary of Smolt Contemporaneously Released at Roza and downstream of Roza

Paired with the later releases made into Roza's Bypass were releases into the river a short distance below a Trestle located downstream of Roza. Mortality from the point of Bypass release to the point of Trestle release should result in the Trestle-Release-to-McNary survival being greater than the Bypass-Release-to-McNary survival and the division of the latter survival estimate by the former should be a ratio estimate of the survival between the two release points. Mean survivals are presented in Table 3.a. with an associated logistic analysis of the survivals given in table 3.b.

An examination of the means in Table 3.a reveals that the bypass-release survival estimates were nearly two-times greater than the below-trestle estimates for the natural brood-source and somewhat greater for the hatchery brood-source. This is the reverse of what would be expected if there were mortality between the release points. However, it should be emphasized that neither 1) the main-effect comparison between the Bypass-release and Trestle-releases (p = 0.30) nor 2) the interaction between the hatchery and wild bypass-versus-trestle comparisons were significant (p = 0.14); there is insufficient statistical evidence that the survival between the release points differs from 1[3]. This may simply be due to the limited number of replications from a single year's evaluation of the release sites.

Table 3.a. Weighted* Logistic Analysis of Variation of Roza-Bypass Release and below Trestle Release Survivals to McNary of Natural (Nat)

Release	Measure	Natural	Hatchery	Mean
Roza Bypass	Survival to McNary	0.7589	0.1876	0.2078
	Number Released	52	1421	1473
Below Trestle	Survival to McNary	0.3924	0.1665	0.1770
	Number Released	67	1385	1452
	Mean Survival to McNary	0.5525	0.1772	0.1925
	Number Released	119	2806	2925

Table 3.b. Weighted* Logistic Analysis of Variation of Roza-Bypass Release and below-Trestle Release Survivals to McNary of Natural (Nat)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Estimated Type 1 Error P
Block	65.48	2	32.740	6.29	0.0135
Nat vs Hat (N vs H)	65.14	1	65.140	12.52	**0.0041**
Bypass vs Trestle (B vs T)	6.09	1	6.090	1.17	0.3005
(N vs H) x (B vs T) Interaction	13.37	1	13.370	2.57	0.1349
Error	62.43	12	5.203		

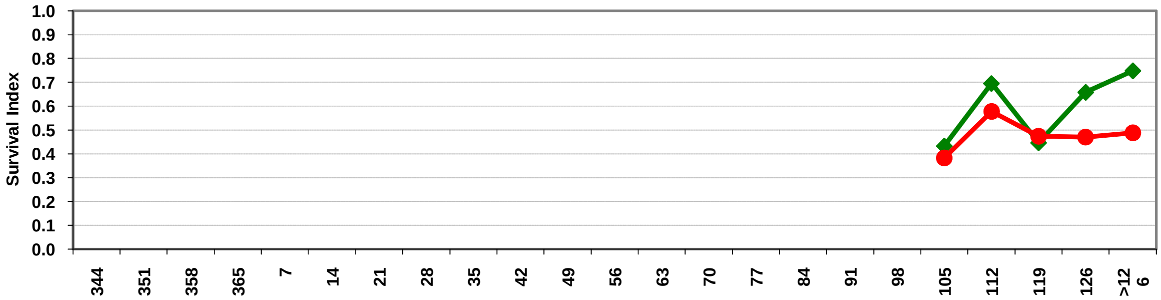
* Weight is Number Released, Block being Late-Release Week

3 The significant Nat vs Hat in Table 3.b. merely reflects the higher survival of the late natural fish for the paired late releases which is reflected in Table 3.a and was earlier reflected and in Table 1.a. for all late releases.

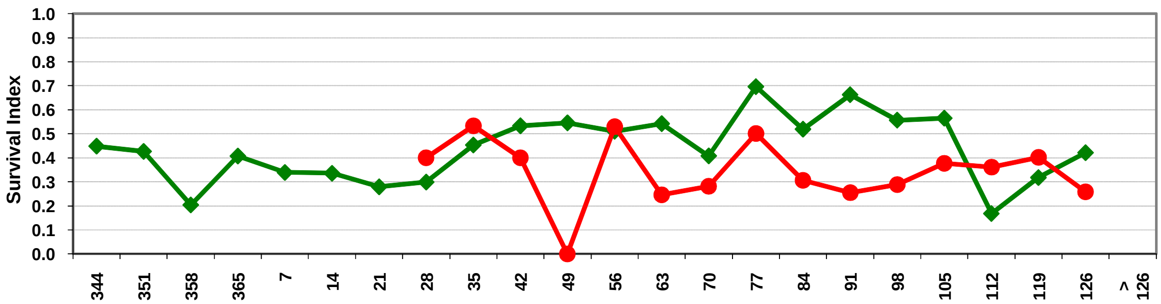
Appendix A.

Plotted Roza-Dam-to-McNary Smolt Survival of Roza-Released Upper-Yakima Natural- (diamonds) and Hatchery-Brood (circles) Spring Chinook

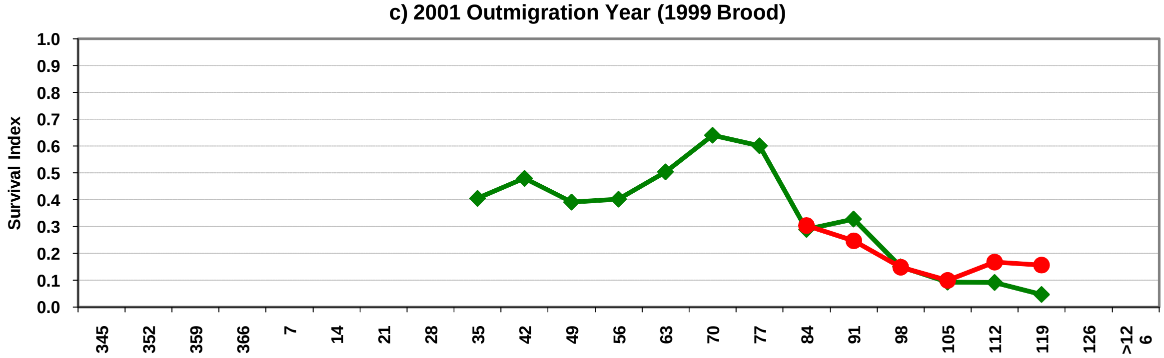
a) 1999 Outmigration Year (1997 Brood)



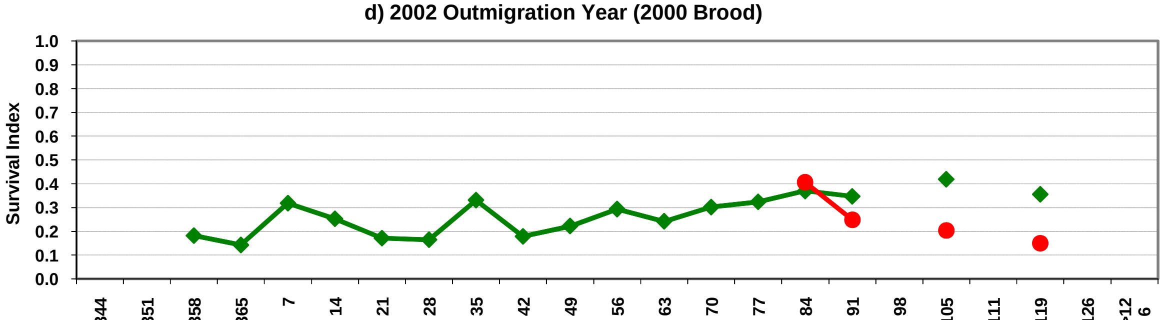
b) 2000 Outmigration Year (1998 Brood)



c) 2001 Outmigration Year (1999 Brood)

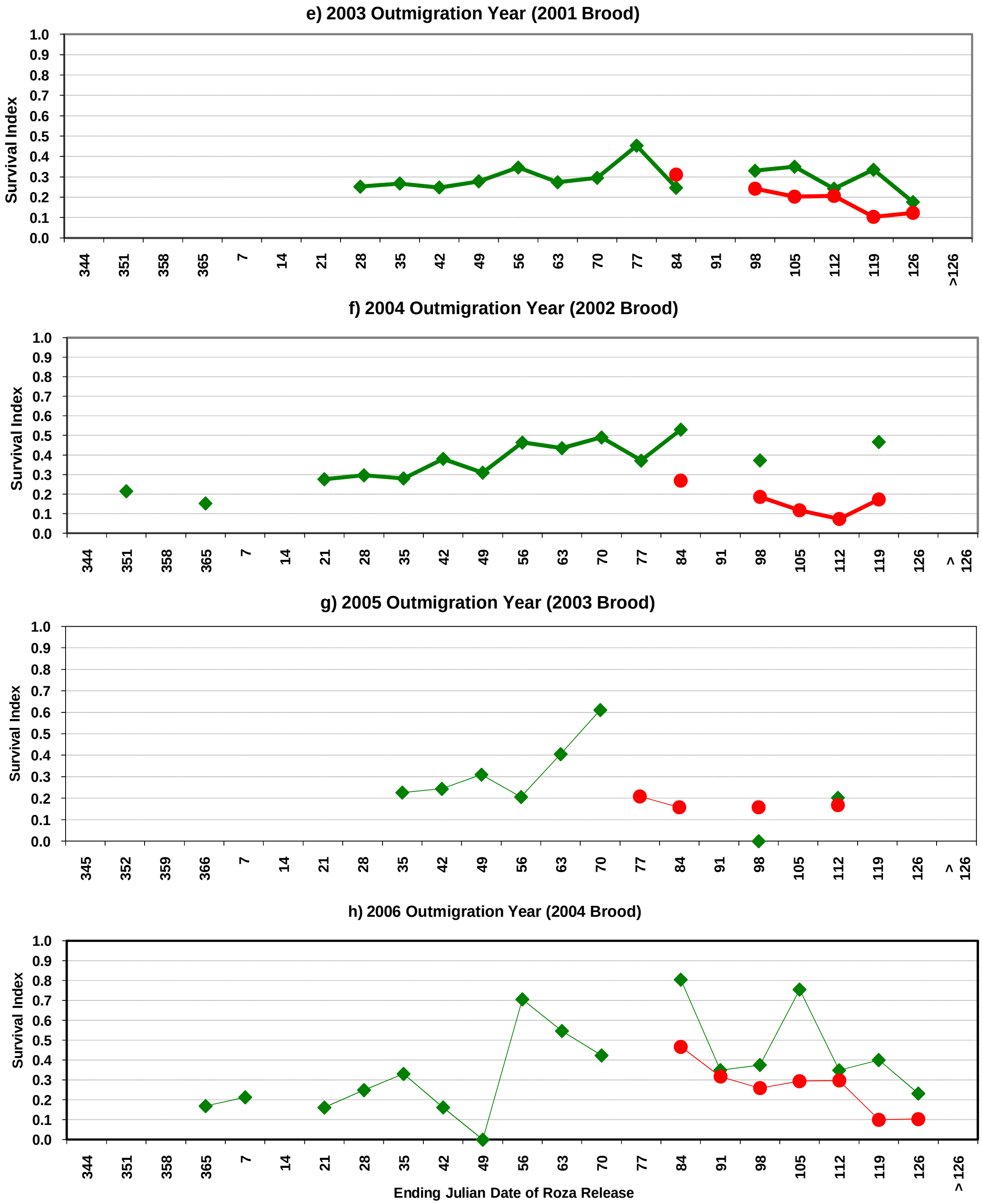


d) 2002 Outmigration Year (2000 Brood)

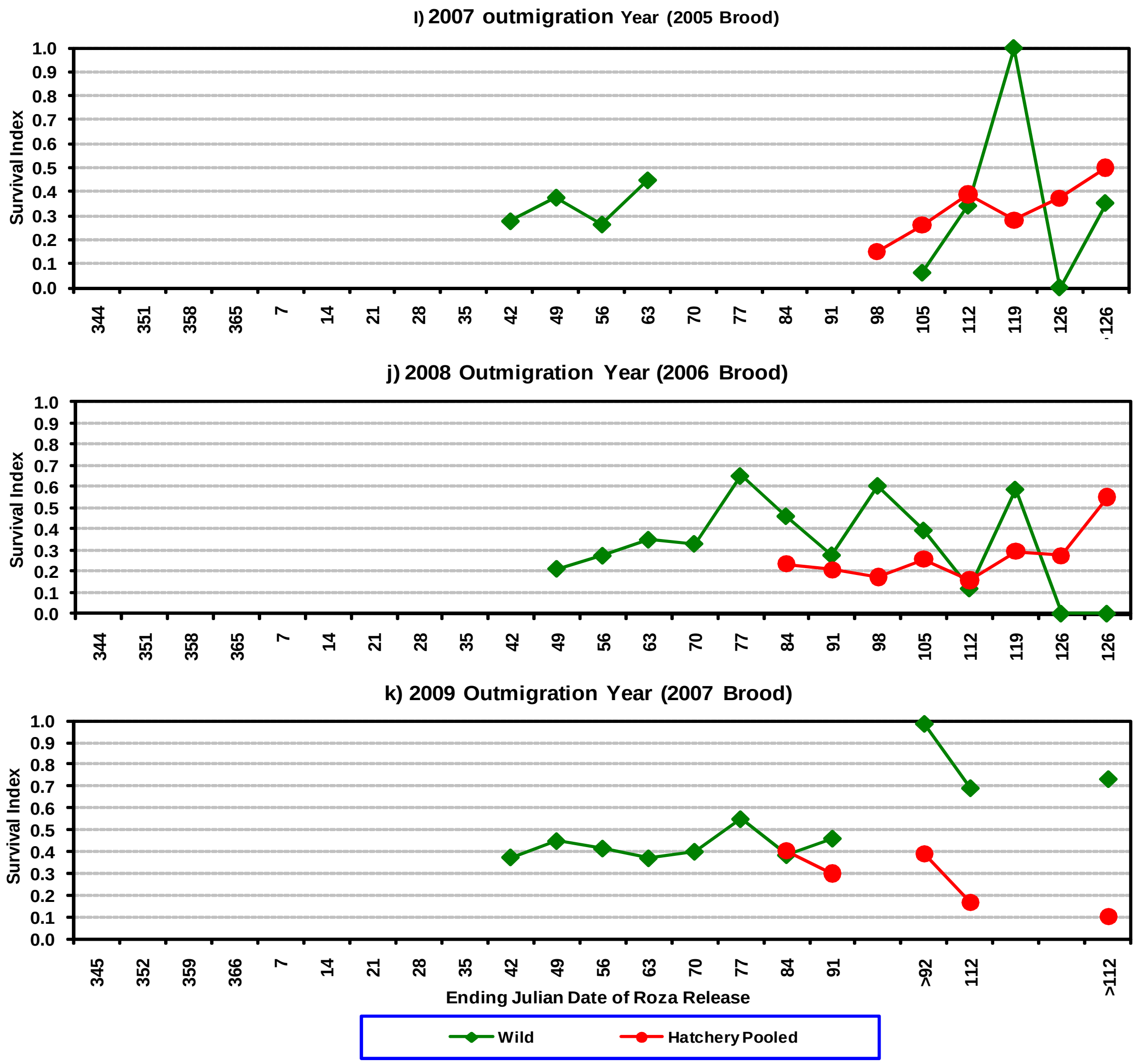


Note: The screens at the acclimation sites are generally pulled on March 15. In 2000 there was leakage that resulted in many of the hatchery fish leaving earlier.

Appendix A. (continued)



Appendix A. (continued)



For 2009, >92 is pooling of ending dates 98 and 105, > 112 is pooling of ending dates 119 and higher because non-pooling resulted in survival estimates of greater than 1

Appendix B

Weighted* Logistic Analysis of Variation of Roza-to-McNary Smolt Survival** of Contemporarily Roza-Released Natural- and Hatchery-Brood Upper-Yakima Spring Chinook (non-shaded-analysis basis of test)

a) 1999 Outmigration (1997 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	32.55	4	8.14	0.93	0.4943	
Natural Origin versus Hatchery Origin[1]	20.15	1	20.15	2.29	0.1683	
Tagged vs Untagged Hatchery Origin1	8.26	1	8.26	0.94	0.3606	
Error(1)	70.26	8	8.7825			
Natural Origin versus Hatchery Origin[2]	20.15	1	20.15	2.35	0.1511	0.0755
Tagged vs Untagged Hatchery Origin[2]	8.26	1	8.26	0.96	0.3455	
Error(2)[3]	102.81	12	8.57			

b) 2000 Outmigration (1998 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	177.90	14	12.71	3.90	0.0017	
Natural Origin versus Hatchery Origin[1]	135.38	1	135.38	41.51	0.0000	0.0000
Tagged vs Untagged Hatchery Origin[1]	0.16	1	0.16	0.05	0.8266	
Error(1)	78.27	24	3.26			
Natural Origin versus Hatchery Origin[2]	135.38	1	135.38	20.08	0.0001	
Tagged vs Untagged Hatchery Origin[2]	0.16	1	0.16	0.02	0.8784	
Error(2)[3]	256.17	38	6.74			

c) 2001 Outmigration (1999 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	119.01	5	23.80	11.89	0.0006	
Natural Origin versus Hatchery Origin[1]	0.87	1	0.87	0.43	0.5246	0.2623
Tagged vs Untagged Hatchery Origin[1]	1.78	1	1.78	0.89	0.3679	
Error(1)	20.02	10	2.002			
Natural Origin versus Hatchery Origin[2]	0.87	1	0.87	0.09	0.7635	
Tagged vs Untagged Hatchery Origin[2]	1.78	1	1.78	0.19	0.6675	
Error(2)[3]	139.03	15	9.27			

* Weight is Number Released, Block being Late-Release Week

** Roza-Dam-Release to McNary-Dam -Detection Smolt-to-Smolt Survival

[1] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(1)

[2] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(2)

[3] Error (2) is pooling of Error(1) and Block. Analysis is based on Error(1) if Block Type 1 Error P < 0.2, otherwise analysis based on Error(2) is used

[4] One-sided test for Hatchery Survival < Wild Survival

Weighted* Logistic Analysis of Variation of Roza-to-McNary Smolt Survival of Contemporarily Roza-Released Natural- and Hatchery-Brood Upper-Yakima Spring Chinook (non-shaded-analysis basis of test)**

d) 2002 Outmigration (2000 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	41.93	4	10.48	1.34	0.3553	
Natural Origin versus Hatchery Origin[1]	19.10	1	19.10	2.45	0.1689	
Tagged vs Untagged Hatchery Origin1	3.00	1	3	0.38	0.5582	
Error(1)	46.86	6	7.81			
Natural Origin versus Hatchery Origin[2]	19.10	1	19.1	2.15	0.1732	0.0866
Tagged vs Untagged Hatchery Origin[2]	3.00	1	3.00	0.34	0.5739	
Error(2)[3]	88.79	10	8.88			

e) 2003 Outmigration (2001 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	46.25	5	9.25	1.83	0.1953	
Natural Origin versus Hatchery Origin[1]	12.33	1	12.33	2.43	0.1498	0.0749
Tagged vs Untagged Hatchery Origin[1]	0.62	1	0.62	0.12	0.7337	
Error(1)	50.65	10	5.065			
Natural Origin versus Hatchery Origin[2]	12.33	1	12.33	1.91	0.1873	
Tagged vs Untagged Hatchery Origin[2]	0.62	1	0.62	0.10	0.7610	
Error(2)[3]	96.90	15	6.46			

f) 2004 Outmigration (2002 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	87.14	4	21.79	6.15	0.0257	
Natural Origin versus Hatchery Origin[1]	21.55	1	21.55	6.08	0.0487	0.0243
Tagged vs Untagged Hatchery Origin[1]	21.85	1	21.85	6.17	0.0476	
Error(1)	21.25	6	3.5416667			
Natural Origin versus Hatchery Origin[2]	21.55	1	21.55	1.99	0.1889	
Tagged vs Untagged Hatchery Origin[2]	21.85	1	21.85	2.02	0.1861	
Error(2)[3]	108.39	10	10.84			

* Weight is Number Released, Block being Late-Release Week

** Roza-Dam-Release to McNary-Dam -Detection Smolt-to-Smolt Survival

[1] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(1)

[2] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(2)

[3] Error (2) is pooling of Error(1) and Block. Analysis is based on Error(1) if Block Type 1 Error P < 0.2, otherwise analysis based on Error(2) is used

[4] One-sided test for Hatchery Survival < Wild Survival

Appendix B. (continued)

Weighted* Logistic Analysis of Variation of Roza-to-McNary Smolt Survival of Contemporarily Roza-Released Natural- and Hatchery-Brood Upper-Yakima Spring Chinook (non-shaded-analysis basis of test)**

g) 2005 Outmigration (2003 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	15.16	3	5.05	0.98	0.4845	
Natural Origin versus Hatchery Origin[1]	0.03	1	0.03	0.01	0.9427	
Tagged vs Untagged Hatchery Origin[1]	0.01	1	0.01	0.00	0.9669	
Error(1)	20.54	4	5.135			
Natural Origin versus Hatchery Origin[2]	0.03	1	0.03	0.01	0.9410	0.5295
Tagged vs Untagged Hatchery Origin[2]	0.01	1	0.01	0.00	0.9659	
Error(2)[3]	35.70	7	5.10			

h) 2006 Outmigration (2004 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	378.21	6	63.04	10.55	0.0003	
Natural Origin versus Hatchery Origin[1]	105.84	1	105.84	17.71	0.0012	0.0006
Tagged vs Untagged Hatchery Origin[1]	0.16	1	0.16	0.03	0.8727	
Error(1)	71.71	12	5.9758333	0.00		
Natural Origin versus Hatchery Origin[2]	105.84	1	105.84	4.23	0.0544	
Tagged vs Untagged Hatchery Origin[2]	0.16	1	0.16	0.01	0.9371	
Error(2)[3]	449.92	18	25.00			

i) 2007 Outmigration (2005 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	236.27	4	59.07	27.24	0.0001	
Natural versus Hatchery[1]	32.50	1	32.50	6.78	0.0352	0.0176
Tagged vs Untagged Hatchery	25.61	1	25.61	5.34	0.0541	
Error(1)	33.56	7	4.7942857			
Natural versus Hatchery[2]	142.21	1	142.21	1.56	0.2353	
Tagged vs Untagged Hatchery[2]	0.28	1	0.28	0.00	0.9567	
Error(2)3	1093.05	12	91.09			

* Weight is Number Released, Block being Late-Release Week

** Roza-Dam-Release to McNary-Dam -Detection Smolt-to-Smolt Survival

[1] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(1)

[2] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(2)

[3] Error (2) is pooling of Error(1) and Block. Analysis is based on Error(1) if Block Type 1 Error P < 0.2, otherwise analysis based on Error(2) is used

[4] One-sided test for Hatchery Survival < Wild Survival

Weighted* Logistic Analysis of Variation of Roza-to-McNary Smolt Survival** of Contemporarily Roza-Released Natural- and Hatchery-Brood Upper-Yakima Spring Chinook (non-shaded-analysis basis of test)

j) 2008 Outmigration (2006 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	272.61	7	38.94	5.84	0.0025	
Natural Origin versus Hatchery Origin[1]	46.66	1	46.66	7.00	0.0192	0.0096
Tagged vs Untagged Hatchery Origin[1]	0.78	1	0.78	0.12	0.7374	
Error(1)	93.33	14	6.67			
Natural Origin versus Hatchery Origin[2]	46.66	1	46.66	2.68	0.1167	
Tagged vs Untagged Hatchery Origin[2]	0.78	1	0.78	0.04	0.8345	
Error(2)[3]	365.94	21	17.43			

k) 2009 Outmigration (2007 Brood)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Analysis of Variation Type 1 P	1-sided Type 1 p[4]
Block[1]	152.80	5	30.56	4.44	0.0258	
Natural Origin versus Hatchery Origin[1]	28.47	1	28.47	4.13	0.0726	0.9637
Tagged vs Untagged Hatchery Origin[1]	8.52	1	8.52	1.24	0.2950	
Error(1)	62.01	9	6.89			
Natural Origin versus Hatchery Origin[2]	28.47	1	28.47	1.86	0.1947	
Tagged vs Untagged Hatchery Origin[2]	8.52	1	8.52	0.56	0.4685	
Error(2)[3]	214.81	14	15.34			

* Weight is Number Released, Block being Late-Release Week

** Roza-Dam-Release to McNary-Dam -Detection Smolt-to-Smolt Survival

[1] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(1)

[2] Block, Wild versus Hatchery, Tagged versus Untagged Hatchery tested against Error(2)

[3] Error (2) is pooling of Error(1) and Block. Analysis is based on Error(1) if Block Type 1 Error P < 0.2, otherwise analysis based on Error(2) is used

[4] One-sided test for Hatchery Survival < Wild Survival

Appendix C.

Weighted* Logistic Analysis of Variation of Smolt Survival** of Early and Late*** Roza-Released Natural Upper-Yakima Spring Chinook

a) 1999 Outmigration (1997 Brood Year)
[No early Roza releases]

b) 2000 Outmigration (1998 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error	Highest Survival Estimate:
Natural Origin Early versus Late	181.10	1	181.10	31.62	0.0000	Late
Error	114.54	20	5.73			

c) 2001 Outmigration (1999 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	297.69	1	297.69	34.62	0.0001	Early
Error	94.60	11	8.60			

d) 2002 Outmigration (2000 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	161.77	1	161.77	20.03	0.0004	Late
Error	121.16	15	8.08			

e) 2003 Outmigration (2001 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	0.38	1	0.38	0.05	0.8230	Early
Error	87.28	12	7.27	0.00		

f) 2004 Outmigration (2002 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	6.81	1	6.81	0.51	0.4903	Late
Error	161.35	12	13.45			

* Weight is Number Released

** Roza-Dam-Release to McNary-Dam -Detection Smolt-to-Smolt Survival

*** "Late" Outmigrating means migrating contemporaneously w ith Hatchery-produced Fish and "Early" means oumigrating before Hatchery-produced Fish

Appendix C. (continued)

Weighted* Logistic Analysis of Variation of Smolt Survival** of Early and Late*** Roza-Released Natural Upper-Yakima Spring Chinook

g) 2005 Outmigration (2003 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	5.98	1	5.98	0.81	0.4035	Late
Error	44.43	6	7.41			

h) 2006 Outmigration (2004 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	246.57	1	246.57	17.31	0.0010	Late
Error	199.40	14	14.24			

i) 2007 Outmigration (2005 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural-Origin Early versus Late	41.69	1	41.69	4.69	0.0671	Early
Error	62.24	7	8.89			

g) 2008 Outmigration (2006 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	72.51	11	6.59	0.00	0.0000	Late
Error	0.00	0	0.00			

h) 2009 Outmigration (2007 Brood Year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P	Highest Survival Estimate:
Natural Origin Early versus Late	0.42	1	0.42	0.10	0.7590	Late
Error	37.78	9	4.20			

* Weight is Number Released

** Roza-Dam-Release to McNary-Dam -Detection Smolt-to-Smolt Survival

*** "Late" Outmigrating means migrating contemporaneously with Hatchery-produced Fish and "Early" means oumigrating before Hatchery-produced Fish

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2009 Annual Report: Chandler Certification for Yearling Outmigrating Spring Chinook Smolt

Doug Neeley, Consultant to Yakama Nation

Introduction

Since 1998, the Washington Department of Fish and Wildlife (WDFW) has been genetically assessing subsampled yearling Chinook smolt passing Prosser Diversion Dam (Prosser) on the Lower Yakima River to determine what proportions of the passage was comprised of Upper-Yakima-, Naches-, and American-River brood sources. Yearling Chinook smolts that pass Prosser, are entrained into Chandler Canal (Canal), and survive the Canal into the fish bypass system to the river are then sampled and enumerated by the Yakima Nation (YN). The naturally-spawned enumerated fish are then subsampled and individually assessed genetically as to their brood source.

In the first five years of subsampling (1998-2000, 2002-2003) genetic assessment was only performed on subsamples during part of the passage period. Beginning in 2004, the total passage was subsampled within five passage strata: 1) before March, 2) March, 3) April, 4) May, and 5) after May. In 2009 subsamples were not taken during the March stratum because of the limited number of naturally-spawned yearling Chinook sampled during that month (average of six/day).

The same bypass and sampling facility was also used to estimate daily passage of all naturally-spawned Spring Chinook, irrespective of tributary source. The daily passage estimates were pooled within the five strata. Denoting the estimated naturally-spawned Spring Chinook total passage within the respective five strata as N(1), N(2), …, N(5), and the DNA-based proportions for a given brood source within those strata by p(1), p(2), …, p(5), the estimated proportion for the given source over all strata was estimated using the following weighted mean.

Eq. 1.
$$p = \frac{N(1) * p(1) + N(2) * p(2) + ... + N(5) * p(5)}{N(1) + N(2) + ... + N(5)}$$

The estimate of the variance and standard error of p are respectively given in equations Eq.2 and Eq.3 for the given weights.

Eq.2 $$s^2[p] = \frac{N(1)^2 * s^2[p(1)] + N(2)^2 * s^2[p(2)] + ... + N(5)^2 * s^2 p(5)}{[N(1) + N(2) + ... + N(5)]^2},$$

Eq.3. $$s[p] = \sqrt{s^2[p]}$$

Summary

The estimated smolt proportions of the three Yakima brood sources are given for each outmigration year, 1998 through 2009 in Table 1.

Table 1. Brood-Source Proportions of Spring-Chinook Passage at Prosser Diversion Dam on the Upper Yakima River and their Standard errors

Year		American		Naches		Upper Yakima	
Out-migration	Brood	Proportion (p)	Standard Error (SE(p))	Proportion (p)	Standard Error (SE(p))	Proportion (p)	Standard Error (SE(p))
1998	1996	0.025	0.0187	0.256	0.0291	0.720	0.0229
1999	1997	0.139	0.0233	0.248	0.0318	0.613	0.0232
2000	1998	0.293	0.0235	0.315	0.0183	0.392	0.0245
2001	1999	*	*	*	*	*	*
2002	2000	0.041	0.0051	0.197	0.0141	0.762	0.0174
2003	2001	0.139	0.0135	0.239	0.0230	0.623	0.0232
2004	2002	0.212	0.0187	0.353	0.0182	0.434	0.0201
2005	2003	0.272	0.0207	0.333	0.0214	0.395	0.0263
2006	2004	0.067	0.0108	0.328	0.0232	0.605	0.0239
2007	2005	0.097	0.0090	0.264	0.0156	0.639	0.0154
2008	2006	0.067	0.0119	0.324	0.0200	0.608	0.0215
2009	2007	0.229	0.0181	0.417	0.0141	0.354	0.0204

*** In outmigration year 2001, deterioration of subsamples precluded DNA analysis.**

The individual stratum estimates are given in Appendix A along the respective stratum passage weights. The Naches-source proportion exceeded that of the American in all years. The Upper-Yakima source proportion exceeded that of the Naches in all years except 2009.

Estimation of naturally-spawned Stratum Spring Chinook Prosser Smolt Passage

Using n(s,i) to denoted the total yearling smolt from the sample on day i within stratum s, the total Spring Chinook smolt passage at Prosser on that day was estimated using equation Eq.4.

Eq.4. $$N(s,i) = \frac{n(s,i)}{\text{Entrainment Rate}(s,i) * \text{Canal-Survival Rate}(s,i) * \text{Sampling Rate}(s,i)}$$

Within the equation, the Entrainment Rate (er) for ith day within the sth stratum is the predicted proportion of fish passing Prosser on that day that are entrained into Chandler Canal, the Canal-

Survival Rate (csr) is the predicted proportion of those entrained fish that survive the canal from below the head-gate into and down the bypass to the point just above the sampling facility, and Sampling Rate (sr) is the estimated proportion of fish that are sampled from the bypass and enumerated, n in equation Eq.4 being the number of fish sampled and enumerated on that day.

Methods of predicting the Entrainment, Canal-Survival, and Sampling Rates are discussed in Appendix C (the final appendix) along with prediction problems associated with the Entrainment and Canal-Survival Rates. (NOTE: The method of predicting entrainment rates is different than that presented in previous Annual Reports for reasons explained in that appendix.)

The N(s,i) estimates are then added over the days within strata (equation Eq.5) to obtain the weights given in equations Eq. 1 and 2.

Eq.5. $$N(s) = \sum_{i} N(s,i); \quad s \text{ being the sites}, s = 1,2,3,4,5$$

Consistency of Passage Estimates with Spawner Estimates

To assess the relative accuracy of estimated proportions of the brood sources, the decision was made to correlate the estimated Upper-Yakima brood-source proportion of Prosser passage to brood-source proportions of spawner measures. Yearly Upper-Yakima proportions of total Prosser passage should be strongly dependent on the Upper-Yakima spawner proportions as long as the within-year spawner-to-smolt survivals are reasonably constant over the three brood sources. If this is the case, then the Upper-Yakima smolt passage proportion and the associated spawner proportion should be highly correlated. Upper-Yakima stratified and un-stratified[1] proportion estimates were correlated with the following Upper-Yakima spawner measures:

1. **Proportion of all enumerated carcasses that were found in the Upper-Yakima Subbasin**
2. **Proportion of all enumerated female carcasses that were found in the Upper-Yakima Subbasin**
3. **Proportion of all reconstructed Yakima recruit numbers escaping to the Upper-Yakima Subbasin (above Roza Dam)**
4. **Proportion of reconstructed Yakima female recruit numbers escaping to the Upper-Yakima Subbasin (above Roza Dam)**
5. **Proportion of all enumerated redds that were found in the Upper-Yakima Subbasin**

The estimated proportions used to estimate the correlations are given in Table 2[2].

[1] In the case of the stratified estimates, the individual stratum Upper-Yakima proportions are, as described in the text, weighted by the stratum passage estimates to get the Upper Yakima proportion over the whole outmigration period. In the case of the un-stratified estimates, strata are ignored, and the estimated passage proportion over the whole outmigration period is simply total subsampled smolt allocated to the Upper Yakima brood source divided by the total of all subsampled smolt.

[2] Detailed information on spawner-source proportions in presented in Appendix B.

Table 2. Upper-Yakima Proportion of Total Prosser Smolt Passage and Upper-Yakima Proportions of Various Spawner Measures

		Estimated Upper-Yakima Proportion of Prosser Smolt Passage		Upper Yakima Proportion of Brood's Spawners of				
Outmigration Year	Brood Year	Stratified Passage	Un-Stratified Proportion	Female Carcass Count	Total Carcass Count	Female Escapement	Total Escapement	Redd Count
1998	1996	**0.7195**	**0.5902**	**0.9276**	0.9140	0.6615	0.6134	0.8156
1999	1997	**0.6135**	**0.5612**	**0.5913**	0.5970	0.5059	0.5064	0.5534
2000	1998	**0.3925**	**0.4327**	**0.2420**	0.2565	0.2881	0.3040	0.3096
2002	2000	**0.7620**	**0.7625**	**0.7087**	0.6411	0.7825	0.7294	0.8120
2003	2001	**0.6226**	**0.5378**	**0.3526**	0.2991	0.7023	0.6580	0.7369
2004	2002	**0.4343**	**0.4699**	**0.2121**	0.2386	0.7032	0.7341	0.7498
2005	2003	**0.3947**	**0.4319**	**0.0855**	0.1371	0.2576	0.3674	0.4877
2006	2004	**0.6053**	**0.6063**	**0.6712**	0.6860	0.7888	0.7988	0.8273
2007	2005	**0.6385**	**0.6470**	**0.7754**	0.7855	0.7106	0.7336	0.7780
2008	2006	**0.6085**	**0.5987**	**0.6418**	0.6621	0.6716	0.6622	0.7379
2009	2007	**0.3539**	**0.3689**	**0.6257**	0.6763	0.5915	0.6512	0.6981

The strata subsampled were not consistent over the years. This is illustrated in Table 3 where the early and later part of the run was not sampled from 1998 through 2004 and where proportions from the nearest period of sampling had to be used to estimate the Upper-Yakima proportions for those early and late parts.

Table 3. Strata Period within which Smolt were subsampled for Brood-Source Allocation (* or X)

Outmigration Year	Brood Year	Sampled Strata				
		Before March	March	April	May	After May
1998	1996	Used March	*	*	*	Used May
1999	1997	Used April	Used April	*	*	Used May
2000	1998	Used March	X	X	X	Used May
2002	2000	Used March	X	X	Used April	Used April
2003	2001	Used April	Used April	X	X	Used May
2004	2002	X	X	X	X	X
2005	2003	X	X	X	X	X
2006	2004	X	X	X	X	X
2007	2005	X	X	X	X	X
2008	2006	X	X	X	X	X
2009	2007	X	**XX**	X	X	X

* Brood-source allocation based on allozyme analysis
X Brood-source allocation based on allozyme analysis
XX No DNA sampling in March because of low sample numbers; March estimate is weighted mean of adjacent proportions,
weights = respective numbers of fish DNA-sampled in Before March and April strata

Correlation-coefficient estimates are given in Table 4.a. for outmigration years 1998-2008 (outmigration year 2009 will be included and discussed later) and are also given separately for grouped outmigration years 1998-2003 and outmigration years 2004-2008. Recalling Table 3, the reason for this partitioning into the two groups is that subsampling for brood-source identification was not performed for the whole passage-period in 1998-2003[3], whereas, all strata were subsampled in 2004-2008.

Table 4.a. Pearson's Correlation over Years between upper-Yakima Proportion of Total Spring-Chinook Smolt Passage at Prosser and Proportion of Total Spawner Measure (Outmigration Years 1998-2008)

Proportion Upper-Yakima Smolt Passage at Prosser Dam	Total-Carcass Proportion		Total-Escapement Proportion		Redd-Count Proportion	
	Stratified Smolt Estimate	Un-stratified Smolt Estimate	Stratified Smolt Estimate	Un-stratified Smolt Estimate	Stratified Smolt Estimate	Un-stratified Smolt Estimate
1998-2008 Outmigrants	**0.822**	0.757	0.611	**0.676**	**0.730**	0.707
1998-2003 Outmigrants	**0.745**	0.566	**0.931**	0.835	**0.954**	0.770
2004-2008 Outmigrants	0.998	**0.999**	0.666	**0.683**	0.746	**0.756**

Proportion Upper-Yakima Smolt Passage at Prosser Dam	Female-Carcass Proportion		Female-Escapement Proportion	
	Stratified Smolt Estimate	Un-stratified Smolt Estimate	Stratified Smolt Estimate	Un-stratified Smolt Estimate
1998-2008 Outmigrants	**0.881**	0.807	0.727	**0.742**
1998-2003 Outmigrants	**0.822**	0.654	**0.929**	0.825
2004-2008 Outmigrants	0.998	**0.999**	0.710	**0.719**

* Outmigrtion year 2001 (Brood year 1999) excluded because DNA samples could not be evaulated

All of the correlations are positive, and most of the correlations are moderate to very high[4]. Upper-Yakima smolt-passage proportion correlations over all outmigration years through 2008 are highest for the total and female carcass proportion, with higher correlations associated with female carcasses. For the outmigration years in which not all strata were subsampled (1998-2003), all spawner-measure correlations were much higher for the stratified than for un-stratified estimates, and, for those same years, the stratified estimated correlations for the total and female escapement and for redd-count measures were high (0.93 or more for all three measures); whereas, the estimates associated with carcass measures were moderate (0.74 for total carcass proportion and 0.82 for female carcass proportion). In contrast, in the case of stratified correlation measures for the outmigration years in which all strata were sampled (2004-2008), the opposite was true; the stratified-smolt-estimate correlations with the carcass measures were very high (greater than 0.99); whereas, those with the other spawner-measure estimates were moderate (0.68 for total escapement, 0.72 for female escapement, and 0.76 for redd count).

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[3] As indicated in Table 3, for those years in which not all strata were sampled, Upper-Yakima proportions for the nearest stratum of subsampling were applied to those strata for which there were no subsamples taken except in 2009 in which the estimate was a weighted mean from the two straddling strata from which subsamples were drawn. This is also indicated in Table A.1 of appendix A.

[4] The intent of estimating the correlations is to establish consistency, not to assess statistical significance of testing against the null hypothesis of no true correlation; however, for reference, the 1-sided 5% significance-level critical values are 0.411 for the 1998-2008 correlation coefficients based on 9 degrees of freedom 0.663 for the separate 1998-2003 and 2004-2008 estimates based on 3 degrees of freedom. All but two of the estimates in Table 4.a would be judged to be significantly greater than 0 at the 5% significance level.

For the 1998-2003 estimates for which not all strata were sampled, the stratified estimate was a good deal larger than the un-stratified estimate. The opposite was true for the 2004-2008 estimates for which all strata were sampled; however the differences between the two estimates ranged from small to miniscule. The reason these latter estimates were so similar is probably because that there have been efforts since 2004 on the part of the WDFW and the YN to have the sampling effort proportional to predicted passage.

There is no attempt here to advocate for one spawner measure over another. The point is that the passage proportions are positive and often highly correlated with various spawner measures, and that when the correlations are high they are associated with weighted stratified sampling based on passage or associated with sampling proportional to passage.

The inclusion of the 2009 out-migrant data in the correlations (Table 4.b) resulted in correlations that were not consistent with the correlations using only the 1998-2008 data sets.

Table 4.b. Pearson's Correlation over Years between upper-Yakima Proportion of Total Spring-Chinook Smolt Passage at Prosser and Proportion of Total Spawner Measure (Outmigration Years 1998-2008, and 2009)

Proportion Upper-Yakima Smolt Passage at Prosser Dam	Total-Carcass Proportion		Upper-Yakima Total-Escapement Proportion		Upper-Yakima Redd-Count Proportion	
	Stratified Smolt Estimate	Un-stratified Smolt Estimate	Stratified Smolt Estimate	Un-stratified Smolt Estimate	Stratified Smolt Estimate	Un-stratified Smolt Estimate
1998-2009 Outmigrants	**0.620**	0.543	0.496	**0.536**	**0.624**	0.588
2004-2009 Outmigrants	**0.619**	0.549	**0.549**	0.526	**0.636**	0.607

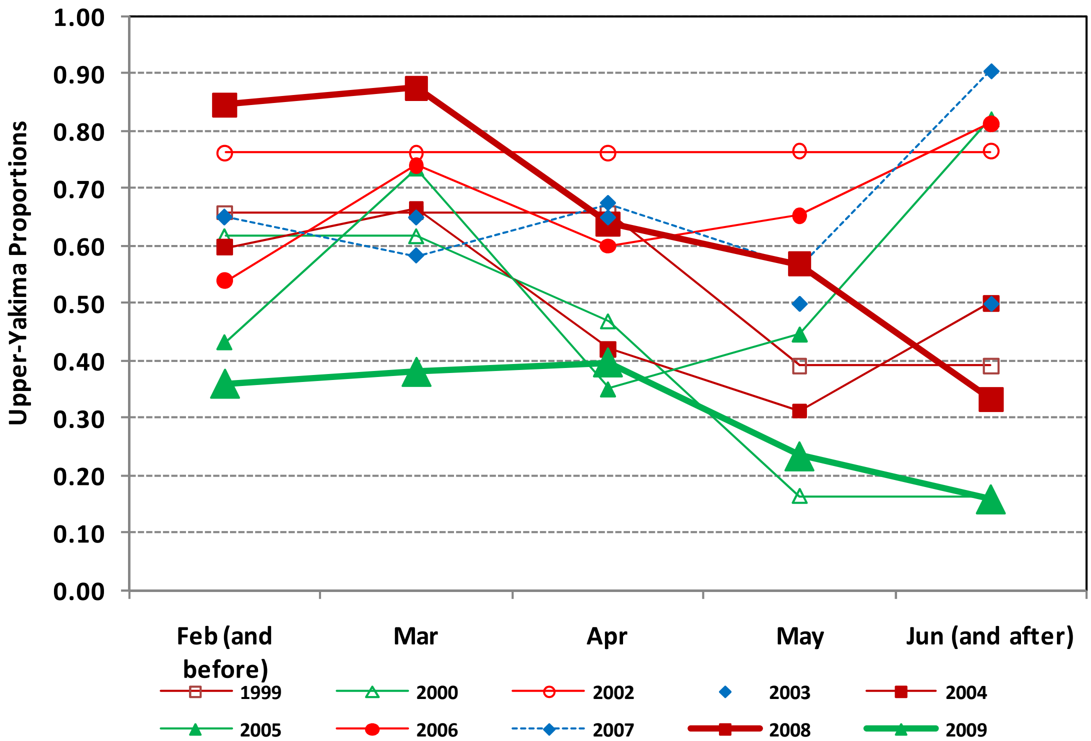
Proportion Upper-Yakima Smolt Passage at Prosser Dam	Upper-Yakima Female-Carcass Proportion		Upper-Yakima Female-Escapement Proportion	
	Stratified Smolt Estimate	Un-stratified Smolt Estimate	Stratified Smolt Estimate	Un-stratified Smolt Estimate
1998-2009 Outmigrants	**0.708**	0.624	0.648	**0.648**
2004-2009 Outmigrants	**0.656**	0.589	**0.614**	0.587

* Outmigrtion year 2001 (Brood year 1999) excluded because DNA samples could not be evaulated

For every measure, the correlation including the 2009 data in Table 4.b is less than that excluding the 2009 data in table 4.a, and in many cases, the decrease is substantial. This may seem to run counter to argument put forward earlier that "yearly Upper-Yakima proportions of total Prosser passage should be strongly dependent on the Upper-Yakima spawner proportions". However, the condition was "as long as the within-year spawner-to-smolt survivals are reasonably constant over the three brood sources".

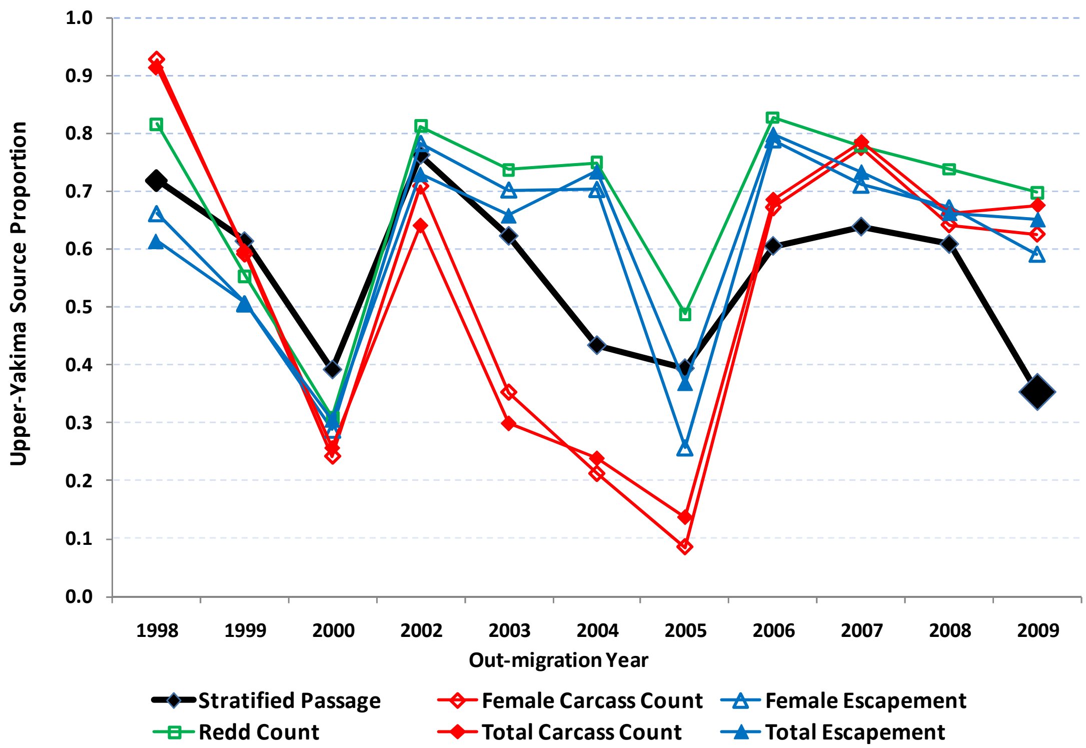
The Upper-Yakima proportions for each stratum are given in Figure 1. As can be seen, the Upper-Yakima proportion of the 2009 outmigrants is the lowest in all but one stratum, and its weighted mean is the lowest over years (0.354, Table 1). The Upper Yakima mean proportions are nearly as low for the 2000 and 2005 outmigrants (respective means are 0.392 and 0.395).

Figure 1. Individual-Stratum Upper-Yakima Proportions of Prosser Passage over Years



Now observe those low Upper-Yakima passage proportions in Figure 2 which presents the weighted mean passage proportions over years along with spawner-measure proportions. Note that the Upper Yakima-passage proportion drops going from 1999 to that of 2000 and going from 2004 to 2005. These drops in passage proportions are accompanied by rather substantial drop in all associated spawner-measure proportions. This is not the case for the dramatic drop in Upper-Yakima-passage proportion from 2008 to 2009 where all of the Upper-Yakima spawner-measure proportions remain fairly constant. Since this 2008 to 2009 drop occurred within all sampled strata (comparing the thick-lined 2008 and 2009 proportions in Figure 1), it is almost certain that spawner-to-smolt-passage survival was poorer for the Upper-Yakima brood than for the Naches broods in 2009.

Figure 2. Upper-Yakima-Source as Proportion of all Yakima-Basin Sources for Smolt-Passage at Prosser Dam and for three Spawner Measures



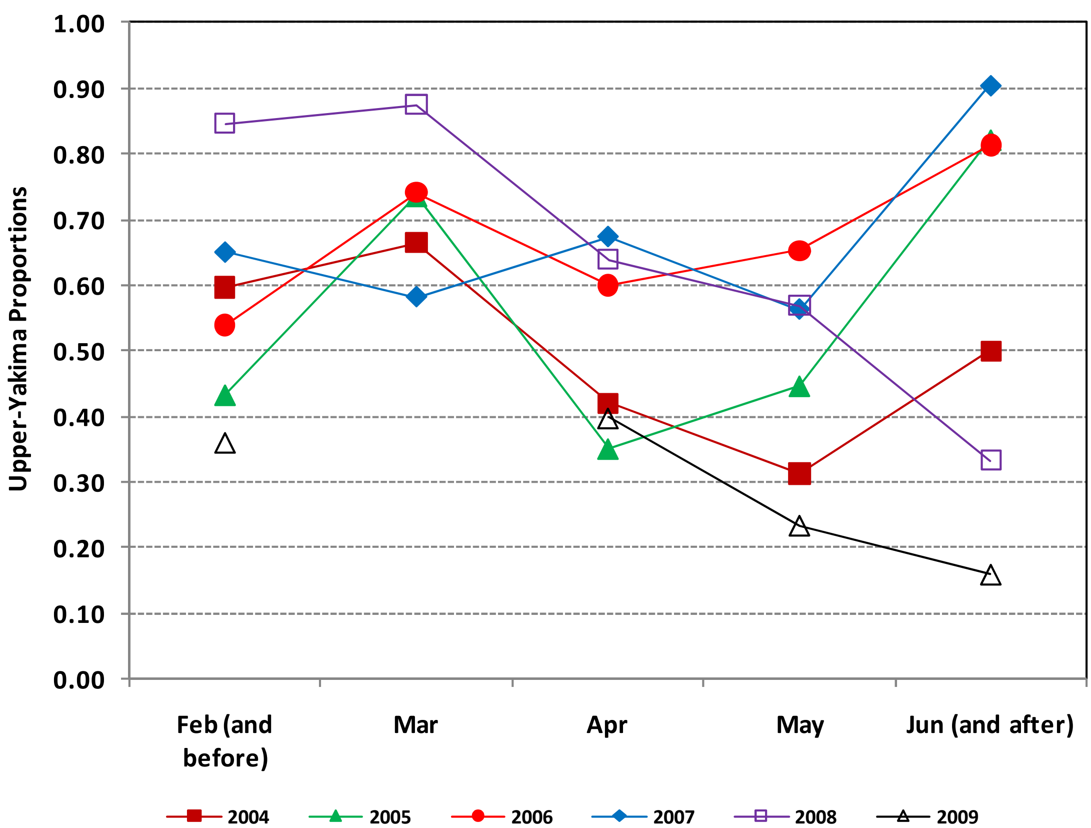
Now, for a more general discussion about the trends in Figure 2, a comparison of adjacent year-to-year changes reveals that direction of the change (increase or decrease) in the Upper-Yakima smolt-passage proportions from one year to the next is the same as the corresponding brood-year female carcass proportions over all adjacent years. The only inconsistency associated with the total carcass count was the large decrease from 2008 to 2009 in passage proportion due to poor Upper-Yakima spawner-to-Prosser passage survival which was accompanied by a slight increase in the associated total carcass proportion; the change in spawner proportions was slight in all those years. Regarding the other spawner measures, when the upper-Yakima Prosser Passage count went down from 2003 to 2004, the corresponding total and female escapement and redd count proportions went up slightly (imperceptibly for female escapement in Figure 2); conversely, when the upper-Yakima Prosser Passage count up went up slightly from 2006 to 2007, the same three corresponding spawner-measure proportions went down.

Based on these correlations, the stratification efforts and the use of equation Eq.4 predictors seem to lead to reasonably reliable estimates of the relative Upper-Yakima proportion of Prosser smolt passage. However, even though current estimates of passage may serve as appropriate measures for the purpose of weighting stratum Upper-Yakima proportion estimates of smolt passage, it has not yet been demonstrated that the current passage-estimation procedures give accurate estimates of the actual passage. In 2010 efforts will be made to determine whether the application of the passage-estimation procedures described in Appendix C are consistent with independent estimates of passage based on survival estimates from Roza Dam releases to Prosser using procedures that are currently used to estimate survival of hatchery Spring Chinook from acclimation sites to McNary Dam.

Consistency in Spawner Estimates over Outmigration Period

While the relation of Upper-Yakima Prosser-passage proportions is reasonably consistent with Upper-Yakima spawner proportions, there appears to be no indication of a strong consistency in the trend of the Upper-Yakima proportions over time strata. Figure 3 is the subset of years in Figure 1 for in which all strata were intended to be subsampled for brood source identification. In four of the five years in which there was subsampling in March, the Upper-Yakima estimated proportions increased from the before-March stratum to March stratum and then decreased to the April stratum, but in outmigration-year 2007 the reverse was the case. In four of all six years, the proportion estimates increased from May stratum to the after-May stratum; but in outmigration-years 2008 and 2009 this was not the case. It may take several years to determine whether or not there is general trend in the Upper-Yakima proportions over the out-migration period.

Figure 3. Individual-Stratum and Weighted Mean of Upper-Yakima Proportions of Prosser Passage over Years



Appendix A. Brood-Source Estimates (American, Naches, and Upper-Yakima)

1. Wild-Source Prosser-Smolt-Passage Proportions and their Standard Errors

Table A.1.a. Estimates Provided by WDFW for Allozyme Samples

1998 (Brood Year 1996)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	0.0203	0.0304	0.2437	0.0474	0.7360	0.0373	230,019
Mar	0.0203	0.0304	0.2437	0.0474	0.7360	0.0373	55,336
Apr	**0.0203**	**0.0304**	**0.2437**	**0.0474**	**0.7360**	**0.0373**	182,695
May	**0.1188**	**0.0600**	**0.5099**	**0.0800**	**0.3713**	**0.0600**	21,138
Jun (and after)	0.1188	0.0600	0.5099	0.0800	0.3713	0.0600	1,053
Weighted*	**0.0248**	**0.0187**	**0.2557**	**0.0291**	**0.7195**	**0.0229**	**490,241**

1999 (Brood Year 1997)

Stock >	American		Naches		Upper Yakima		
	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	0.1107	0.0324	0.2318	0.0460	0.6574	0.0335	188,986
Mar	0.1107	0.0324	0.2318	0.0460	0.6574	0.0335	2,994
Apr	**0.1107**	**0.0324**	**0.2318**	**0.0460**	**0.6574**	**0.0335**	76,807
May	**0.2795**	**0.0700**	**0.3292**	**0.0800**	**0.3913**	**0.0600**	50,900
Jun (and after)	0.2795	0.0700	0.3292	0.0800	0.3913	0.0600	2,278
Weighted*	**0.1386**	**0.0233**	**0.2479**	**0.0318**	**0.6135**	**0.0232**	**321,964**

Table A.1.b. Pooled Estimates over Dates within Strata

2000 (Brood Year 1998)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	0.162	0.046	0.221	0.048	0.618	0.069	5,787
Mar	**0.162**	**0.046**	**0.221**	**0.048**	**0.618**	**0.069**	330
Apr	**0.221**	**0.026**	**0.310**	**0.020**	**0.469**	**0.032**	20,089
May	**0.469**	**0.058**	**0.367**	**0.044**	**0.163**	**0.048**	12,112
Jun (and after)	0.469	0.058	0.367	0.044	0.163	0.048	580
Weighted*	**0.293**	**0.023**	**0.315**	**0.018**	**0.392**	**0.024**	**38,897**

2002 (Brood Year 2000)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	0.044	0.008	0.195	0.024	0.762	0.028	97,416
Mar	**0.044**	**0.008**	**0.195**	**0.024**	**0.762**	**0.028**	34,574
Apr	**0.044**	**0.008**	**0.195**	**0.024**	**0.762**	**0.028**	233,016
May	**0.028**	**0.011**	**0.208**	**0.000**	**0.764**	**0.037**	75,487
Jun (and after)	0.028	0.011	0.208	0.000	0.764	0.037	395
Weighted*	**0.041**	**0.005**	**0.197**	**0.014**	**0.762**	**0.017**	**440,888**

Table A.1.b. Pooled Estimates over Dates within Strata (continued)

2003 (Brood Year 2001)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	0.1343	0.0223	0.2164	0.0384	0.6493	0.0382	48,400
Mar	0.1343	0.0223	0.2164	0.0384	0.6493	0.0382	39,785
Apr	**0.1343**	**0.0223**	**0.2164**	**0.0384**	**0.6493**	**0.0382**	186,667
May	**0.1603**	**0.0163**	**0.3424**	**0.0197**	**0.4973**	**0.0305**	57,619
Jun (and after)	0.1603	0.0163	0.3424	0.0197	0.4973	0.0305	807
Weighted*	**0.1389**	**0.0135**	**0.2385**	**0.0230**	**0.6226**	**0.0232**	**333,278**

2004 (Brood Year 2002)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	**0.0646**	**0.0148**	**0.3384**	**0.0341**	**0.5970**	**0.0352**	6,726
Mar	**0.0427**	**0.0249**	**0.2927**	**0.0316**	**0.6646**	**0.0327**	12,881
Apr	**0.2150**	**0.0248**	**0.3647**	**0.0244**	**0.4203**	**0.0262**	109,680
May	**0.3472**	**0.0320**	**0.3403**	**0.0184**	**0.3125**	**0.0391**	20,966
Jun (and after)	**0.3125**	**0.1549**	**0.1875**	**0.1315**	**0.5000**	**0.1567**	440
Weighted*	**0.2122**	**0.0187**	**0.3535**	**0.0182**	**0.4343**	**0.0201**	**150,693**

2005 (Brood Year 2003)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	**0.2139**	**0.0295**	**0.3532**	**0.0380**	**0.4328**	**0.0328**	36,625
Mar	**0.1887**	**0.0697**	**0.0755**	**0.0368**	**0.7359**	**0.0721**	7,609
Apr	**0.2957**	**0.0287**	**0.3536**	**0.0291**	**0.3507**	**0.0370**	101,643
May	**0.3214**	**0.0565**	**0.2321**	**0.0447**	**0.4464**	**0.0936**	8,549
Jun (and after)	**0.0000**	**0.0000**	**0.1786**	**0.0925**	**0.8214**	**0.0925**	79
Weighted*	**0.2723**	**0.0207**	**0.3330**	**0.0214**	**0.3947**	**0.0263**	**154,504**

2006 (Brood Year 2004)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	**0.0893**	**0.0405**	**0.3715**	**0.0570**	**0.5392**	**0.0574**	33,175
Mar	**0.0000**	**0.0000**	**0.2591**	**0.0499**	**0.7409**	**0.0499**	719
Apr	**0.0661**	**0.0125**	**0.3346**	**0.0263**	**0.5993**	**0.0277**	108,632
May	**0.0546**	**0.0176**	**0.2925**	**0.0550**	**0.6529**	**0.0563**	56,056
Jun (and after)	**0.0833**	**0.0761**	**0.1032**	**0.0567**	**0.8135**	**0.0784**	380
Weighted*	**0.0665**	**0.0108**	**0.3282**	**0.0232**	**0.6053**	**0.0239**	**198,962**

2007 (Brood Year 2005)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	**0.0962**	**0.0079**	**0.2538**	**0.0118**	**0.6500**	**0.0122**	5,030
Mar	**0.1273**	**0.0328**	**0.2909**	**0.0589**	**0.5818**	**0.0560**	11,784
Apr	**0.0719**	**0.0097**	**0.2542**	**0.0210**	**0.6739**	**0.0202**	100,958
May	**0.1498**	**0.0236**	**0.2875**	**0.0277**	**0.5628**	**0.0296**	43,256
Jun (and after)	**0.0476**	**0.0569**	**0.0476**	**0.0392**	**0.9048**	**0.0667**	1,184

Table A.1.b. Pooled Estimates over Dates within Strata (continued)

2008 (Brood Year 2006)

Stock >	American		Naches		Upper Yakima		
Stratum	Proportion (P)	Standard Error (SE)	Proportion	Standard Error (SE)	Proportion	Standard Error (SE)	Stratum Passage
Feb (and before)	0.0769	0.1088	0.0769	0.1088	0.8462	0.1473	6,658
Mar	0.0000	0.0000	0.1250	0.0968	0.8750	0.0968	6,463
Apr	0.0548	0.0137	0.3065	0.0271	0.6387	0.0276	87,793
May	0.0766	0.0184	0.3548	0.0299	0.5686	0.0324	132,843
Jun (and after)	0.1539	0.0630	0.5128	0.0881	0.3333	0.0854	2,378
Weighted*	**0.0672**	**0.0119**	**0.3243**	**0.0200**	**0.6085**	**0.0215**	**236,135**

2009 (Brood Year 2007)

Stock >	American		Naches		Upper Yakima		
Stratum	(P)	Error (SE)	Proportion	Error (SE)	Proportion	Error (SE)	Passage
Feb (and before)	0.1683	0.0457	0.4713	0.0520	0.3604	0.0521	31,237
Mar	0.2168	0.0232	0.4023	0.0169	0.3810	0.0263	2,607
Apr	0.2147	0.0243	0.3878	0.0175	0.3975	0.0278	171,113
May	0.2865	0.0336	0.4790	0.0272	0.2345	0.0353	61,173
Jun (and after)	0.6533	0.0812	0.1867	0.0561	0.1600	0.0622	2,223
Weighted*	**0.2293**	**0.0181**	**0.4168**	**0.0141**	**0.3539**	**0.0204**	**268,352**

Note: The stratum DNA-based proportions for outmigration-years (2000 onward) are the pooled daily proportions (weighted[5] proportions) over days within stratum, the standard error being based on the variance of the weighted daily proportions around the pooled stratum's mean. For allozyme-based proportions outmigration years 1998 and 1999, daily-proportion assignments to source were not available; the estimated proportions and their standard errors were provided by WDFW.

[5] Weight here being the daily number of fish within strata sampled for DNA assignment to source.

Appendix A. Brood-Source Estimates (American, Naches, and Upper-Yakima)

2. Allocated Prosser Passage by Brood Source

Table A.2. Passage estimates by brood-Source

Outmigration-Year 1998 (Brood Year 1996)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	4,670	56,045	169,303	230,019
March	1,124	13,483	40,729	55,336
April	3,710	44,514	134,471	182,695
May	2,516	10,796	7,861	21,172
After May	121	520	379	1,019
Total	12,140	125,358	352,743	490,241
			Standard Error	64,732

Outmigration-Year 1999 (Brood Year 1997)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	20,926	43,813	124,247	188,986
March	331	694	1,968	2,994
April	8,505	17,806	50,496	76,807
May	14,197	16,721	19,876	50,794
After May	666	784	932	2,383
Total	44,625	79,819	197,519	321,964
			Standard Error	48,250

Outmigration-Year 2000 (Brood Year 1998)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	937	1,277	3,576	5,790
March	53	72	202	327
April	4,447	6,225	9,417	20,089
May	2,681	3,754	5,678	12,112
After May	128	180	272	580
Total	8,245	11,508	19,144	38,897
			Standard Error	2,151

Outmigration-Year 2002 (Brood Year 2000)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	4,247	18,974	74,195	97,416
March	1,507	6,734	26,333	34,574
April	6,545	48,437	178,033	233,016
May	2,120	15,691	57,675	75,487
After May	11	82	302	395
Total	14,432	89,918	336,538	440,888
			Standard Error	22,090

Table A.2. Passage estimates by brood-Source

Outmigration-Year 2003 (Brood Year 2001)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	6,502	10,475	31,424	48,400
March	5,344	8,610	25,830	39,785
April	25,075	40,399	121,194	186,667
May	9,238	19,728	28,653	57,619
After May	129	276	401	807
Total	46,288	79,488	207,502	333,278
			Standard Error	16,012

Outmigration-Year 2004 (Brood Year 2002)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	436	2,282	4,025	6,743
March	549	3,765	8,549	12,863
April	23,579	40,004	46,098	109,680
May	7,280	7,134	6,552	20,966
After May	137	82	220	440
Total	31,981	53,267	65,444	150,693
			Standard Error	6,725

Outmigration-Year 2005 (Brood Year 2003)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	7,835	12,937	15,853	36,625
March	1,436	574	5,599	7,609
April	30,051	35,943	35,648	101,643
May	2,748	1,984	3,816	8,549
After May	0	14	65	79
Total	42,069	51,453	60,981	154,504
			Standard Error	10,623

Outmigration-Year 2006 (Brood Year 2004)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	2,962	12,324	17,889	33,175
March	0	186	533	719
April	7,183	36,346	65,103	108,632
May	3,061	16,396	36,599	56,056
After May	32	39	309	380
Total	13,237	65,292	120,434	198,962
			Standard Error	35,544

Table A.2. Passage estimates by brood-Source

Outmigration-Year 2007 (Brood Year 2005)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	484	1,277	3,269	5,030
March	1,500	3,428	6,856	11,784
April	7,260	25,662	68,037	100,958
May	6,480	12,434	24,342	43,256
After May	56	56	1,072	1,184
Total	15,780	42,857	103,576	162,213
			Standard Error	39,240

Outmigration-Year 2008 (Brood Year 2006)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	512	512	5,634	6,658
March	0	808	5,655	6,463
April	4,815	26,904	56,074	87,793
May	10,177	47,138	75,528	132,843
After May	366	1,220	793	2,378
Total	15,870	76,582	143,684	236,135
			Standard Error	85,062

Outmigration-Year 2009 (Brood Year 2007)

Stratum\Stock	American	Naches	Upper Yakima	Total
Before March	5,258	14,721	11,258	31,237
March	565	1,049	993	2,607
April	36,745	66,349	68,019	171,113
May	17,525	29,304	14,343	61,173
After May	1,452	415	356	2,223
Total	61,545	111,838	94,969	268,352
			Standard Error	*

*No Estimate at this time

Appendix B. Spawner Measures:

Note: In the following tables bold faced data are for brood years covered in this report. Brood-year 1999 is shaded because no DNA subsampling was undertaken for brood's progeny as smolt in 2001.

1) Carcass Counts and Proportions

	Carcass Counts				Proportions		
Year	American	Naches	Upper Yakima	Total	American	Naches	Upper Yakima
1986	66	62	63	191	0.3455	0.3246	0.3298
1987	45	60	191	296	0.15203	0.2027	0.64527
1988	3	30	90	123	0.02439	0.2439	0.73171
1989	98	110	376	584	0.16781	0.18836	0.64384
1990	86	63	290	439	0.1959	0.14351	0.66059
1991	102	68	167	337	0.30267	0.20178	0.49555
1992	100	60	482	642	0.15576	0.09346	0.75078
1993	96	70	162	328	0.29268	0.21341	0.4939
1994	49	14	66	129	0.37984	0.10853	0.51163
1995	20	12	18	50	0.4	0.24	0.36
1996	**8**	**33**	**436**	**477**	**0.01677**	**0.06918**	**0.91405**
1997	**50**	**83**	**197**	**330**	**0.15152**	**0.25152**	**0.59697**
1998	**109**	**62**	**59**	**230**	**0.47391**	**0.26957**	**0.25652**
1999	**7**	**17**	**71**	**95**	**0.07368**	**0.17895**	**0.74737**
2000	**28**	**136**	**293**	**457**	**0.06127**	**0.29759**	**0.64114**
2001	**197**	**178**	**160**	**535**	**0.36822**	**0.33271**	**0.29907**
2002	**168**	**148**	**99**	**415**	**0.40482**	**0.35663**	**0.23855**
2003	**225**	**159**	**61**	**445**	**0.50562**	**0.3573**	**0.13708**
2004	**8**	**133**	**308**	**449**	**0.01782**	**0.29621**	**0.68597**
2005	**43**	**49**	**337**	**429**	**0.10023**	**0.11422**	**0.78555**
2006	**48**	**26**	**145**	**219**	**0.21918**	**0.11872**	**0.6621**
2007	**67**	**23**	**188**	**278**	**0.24101**	**0.08273**	**0.67626**

	Females Spawners							Subbasin Female Proportion of Subbasin Total		
	Carcass Counts				Proportions					
Year	American	Naches	Upper Yakima	Total	American	Naches	Upper Yakima	American	Naches	Upper Yakima
1986	45	42	51	138	0.3261	0.3043	0.3696	0.6818	0.6774	0.8095
1987	21	42	126	189	0.1111	0.2222	0.6667	0.4667	0.7000	0.6597
1988	1	18	48	67	0.0149	0.2687	0.7164	0.3333	0.6000	0.5333
1989	50	63	246	359	0.1393	0.1755	0.6852	0.5102	0.5727	0.6543
1990	46	28	194	268	0.1716	0.1045	0.7239	0.5349	0.4444	0.6690
1991	60	45	111	216	0.2778	0.2083	0.5139	0.5882	0.6618	0.6647
1992	48	34	315	397	0.1209	0.0856	0.7935	0.4800	0.5667	0.6535
1993	75	43	112	230	0.3261	0.1870	0.4870	0.7813	0.6143	0.6914
1994	30	10	50	90	0.3333	0.1111	0.5556	0.6122	0.7143	0.7576
1995	13	7	12	32	0.4063	0.2188	0.3750	0.6500	0.5833	0.6667
1996	**6**	**16**	**282**	**304**	**0.0197**	**0.0526**	**0.9276**	**0.7500**	**0.4848**	**0.6468**
1997	**45**	**49**	**136**	**230**	**0.1957**	**0.2130**	**0.5913**	**0.9000**	**0.5904**	**0.6904**
1998	**76**	**43**	**38**	**157**	**0.4841**	**0.2739**	**0.2420**	**0.6972**	**0.6935**	**0.6441**
1999	**5**	**9**	**36**	**50**	**0.1000**	**0.1800**	**0.7200**	**0.7143**	**0.5294**	**0.5070**
2000	**13**	**77**	**219**	**309**	**0.0421**	**0.2492**	**0.7087**	**0.4643**	**0.5662**	**0.7474**
2001	**106**	**118**	**122**	**346**	**0.3064**	**0.3410**	**0.3526**	**0.5381**	**0.6629**	**0.7625**
2002	**110**	**98**	**56**	**264**	**0.4167**	**0.3712**	**0.2121**	**0.6548**	**0.6622**	**0.5657**
2003	**151**	**95**	**23**	**269**	**0.5613**	**0.3532**	**0.0855**	**0.6711**	**0.5975**	**0.3770**
2004	**5**	**92**	**198**	**295**	**0.0169**	**0.3119**	**0.6712**	**0.6250**	**0.6917**	**0.6429**
2005	**25**	**37**	**214**	**276**	**0.0906**	**0.1341**	**0.7754**	**0.5814**	**0.7551**	**0.6350**
2006	**35**	**13**	**86**	**134**	**0.2612**	**0.0970**	**0.6418**	**0.7292**	**0.5000**	**0.5931**
2007	**48**	**19**	**112**	**179**	**0.2682**	**0.1061**	**0.6257**	**0.7164**	**0.8261**	**0.5957**

Appendix B. Spawner Measures (continued):

2. Escapement Estimates

Table B.2.a. Estimated Total Escapement*

Brood Year	Total: American	Total: Naches	Total: Upper Yakima*	Total: Total	Proportions: American	Proportions: Naches	Proportions: Upper Yakima*
1996	**151**	**842**	**1576**	**2569**	**0.0588**	**0.3278**	**0.6134**
1997	**364**	**748**	**1141**	**2253**	**0.1616**	**0.3320**	**0.5064**
1998	**381**	**463**	**369**	**1214**	**0.3142**	**0.3817**	**0.3040**
1999	**30**	**179**	**498**	**707**	**0.0429**	**0.2526**	**0.7045**
2000	**237**	**3655**	**10491**	**14383**	**0.0165**	**0.2541**	**0.7294**
2001	**1798**	**3670**	**10519**	**15987**	**0.1125**	**0.2296**	**0.6580**
2002	**1108**	**1747**	**7884**	**10740**	**0.1032**	**0.1627**	**0.7341**
2003	**1132**	**1330**	**1430**	**3892**	**0.2909**	**0.3416**	**0.3674**
2004	**300**	**2071**	**9412**	**11783**	**0.0255**	**0.1758**	**0.7988**
2005	**450**	**1376**	**5028**	**6854**	**0.0657**	**0.2007**	**0.7336**
2006	**479**	**1119**	**3132**	**4730**	**0.1012**	**0.2366**	**0.6622**
2007	**401**	**358**	**1417**	**2176**	**0.1844**	**0.1644**	**0.6512**
2008	425	907	3145	4477	0.0950	0.2026	0.7025

* Escapement above Rosa Dam

Table B.2.a. Estimated Female Escapement

Brood Year	Total*: American	Total*: Naches	Total*: Upper Yakima*	Total*: Total	Porportions: American	Porportions: Naches	Porportions: Upper Yakima*
1996	**113**	**408**	**1019**	**1541**	**0.0736**	**0.2650**	**0.6615**
1997	**328**	**442**	**788**	**1557**	**0.2105**	**0.2836**	**0.5059**
1998	**266**	**321**	**238**	**825**	**0.3224**	**0.3895**	**0.2881**
1999	**22**	**95**	**253**	**369**	**0.0587**	**0.2564**	**0.6849**
2000	**110**	**2070**	**7841**	**10021**	**0.0110**	**0.2065**	**0.7825**
2001	**968**	**2433**	**8021**	**11421**	**0.0847**	**0.2130**	**0.7023**
2002	**726**	**1157**	**4460**	**6342**	**0.1144**	**0.1824**	**0.7032**
2003	**760**	**794**	**539**	**2093**	**0.3629**	**0.3795**	**0.2576**
2004	**188**	**1433**	**6051**	**7671**	**0.0245**	**0.1868**	**0.7888**
2005	**262**	**1039**	**3193**	**4493**	**0.0582**	**0.2312**	**0.7106**
2006	**349**	**559**	**1858**	**2766**	**0.1261**	**0.2023**	**0.6716**
2007	**287**	**295**	**844**	**1427**	**0.2014**	**0.2070**	**0.5915**
2008	305	749	2246	3300	0.0923	0.2270	0.6807

* (Total Escapement in above table)*(Female Proportion based on Carcass Counts)

Appendix B. Spawner Measures (continued):

3. Redd Counts

	Redd Counts						
	Total				Porportions		
Brrod Year	American	Naches	Upper Yakima	Total	American	Naches	Upper Yakima
1986	464	849	1793	3106	0.1494	0.2733	0.5773
1987	222	455	1043	1720	0.1291	0.2645	0.6064
1988	187	303	443	933	0.2004	0.3248	0.4748
1989	187	354	968	1509	0.1239	0.2346	0.6415
1990	143	321	773	1237	0.1156	0.2595	0.6249
1991	170	290	630	1090	0.1560	0.2661	0.5780
1992	120	305	1246	1671	0.0718	0.1825	0.7457
1993	214	340	656	1210	0.1769	0.2810	0.5421
1994	89	183	290	562	0.1584	0.3256	0.5160
1995	46	58	117	221	0.2081	0.2624	0.5294
1996	**28**	**156**	**814**	**998**	**0.0281**	**0.1563**	**0.8156**
1997	**111**	**228**	**420**	**759**	**0.1462**	**0.3004**	**0.5534**
1998	**149**	**181**	**148**	**478**	**0.3117**	**0.3787**	**0.3096**
1999	**27**	**159**	**224**	**410**	**0.0659**	**0.3878**	**0.5463**
2000	**54**	**834**	**3836**	**4724**	**0.0114**	**0.1765**	**0.8120**
2001	**392**	**800**	**3339**	**4531**	**0.0865**	**0.1766**	**0.7369**
2002	**366**	**577**	**2826**	**3769**	**0.0971**	**0.1531**	**0.7498**
2003	**430**	**505**	**890**	**1825**	**0.2356**	**0.2767**	**0.4877**
2004	**91**	**628**	**3444**	**4163**	**0.0219**	**0.1509**	**0.8273**
2005	**142**	**434**	**2019**	**2595**	**0.0547**	**0.1672**	**0.7780**
2006	**133**	**311**	**1250**	**1694**	**0.0785**	**0.1836**	**0.7379**
2007	**166**	**148**	**726**	**1040**	**0.1596**	**0.1423**	**0.6981**
2008	158	337	1375	1870	0.0845	0.1802	0.7353
2009	91	387	1531	2009	0.0453	0.1926	0.7621

Appendix C. Estimation of Passage-based Weights

Recall from equation Eq.4, the estimated daily Prosser smolt passage (Eq.C.1 below):

Eq.C.1 $$N(s,i) = \frac{n(s,i)}{\text{Entrainment Rate}(s,i) * \text{Canal - Survival Rate}(s,i) * \text{Sampling Rate}(s,i)}$$

The entrainment and canal-survival rate predictors were based on releases of Yearling Chinook that were sampled and PIT-tagged at the facility. Periodically, if there was a sufficient number of fish in the daily sample from the bypass, a subsample[6] of these fish were PIT-tagged and then released as paired releases, one release into Prosser's forebay and the other into Chandler Canal below the headgates. Every time there was a forebay release, there was also a canal release; however there were days on which only canal releases were made.

There was a PIT-tag detector located in the bypass just upstream of a timer gate that directed a portion of the bypass flow into a live-box where fish were enumerated. All bypassed PIT-tagged fish (those directed to the live-box and those going directly into the river) were passed through this bypass detector. These bypass-detected forebay- and canal-released fish served as the base for predicting both the Entrainment and Canal Survival.

Canal survival is discussed first. For a given daily canal release (release i), Canal Survival was estimated by

Eq.C.2. $$cs(i) = \frac{bp(c,i)}{n(c,i)} * eff(c,i)$$

wherein n(c,i) was the number of PIT-tagged fish released into the canal on day i, bp(c,i) was the number of those canal-released fish that were detected in the bypass, and eff(c,i) was the estimated detection efficiency of the bypass detector, an estimate that will be discussed later. It should be noted, that, in some years, there were canal releases on days when there were no forebay releases as well as on all days when there were forebay releases.

For days when paired releases were made, the entrainment rate was estimated by

Eq.C.3. $$er(i) = \frac{\frac{bp(f,i)}{n(f,i)} * eff(f,i)}{cs(i)}$$

wherein n(f,i) was the number of PIT-tagged fish released into the forebay on day i, bp(f,i) was the number of those forebay-released fish that were detected in the bypass, and eff(f,i) was the associated estimated detection efficiency of the bypass detector for that release.

Regarding the detection efficiency measures [eff(c,i) and eff(f,i) respectively in equations Eq.C.2 and Eq.C.3] , there was second detector (sample detector) used to detect PIT-tagged fish that were directed into the live-box by the timer gate, those fish comprising the sample of those detected by the bypass detector. For any given release, the number of fish jointly detected by both the bypass and sample detectors was divided by the total number detected by the sample detector. This

[6] A different subsample than those fish subsampled for genetic allocation to stocks.

measure was the estimated efficiency of the bypass detector. If the bypass detector detected all fish passing through bypass, then the ratio would be 1 (100% detection efficiency), and the detection efficiency was rarely less than 1.

The Sample Rate was also estimated using information from both the bypass and sample detectors. However, the sample rates were based on all PIT-tagged Spring Chinook smolt passing Prosser, not just those used to estimate the entrainment and canal-survival rates. Timer-gate rates were changed by varying the proportion of the time that a timer gate was opened to the live box. The sample rate (sr) for a given timer-gate rate (TR) within a given year (Y) was estimated totaling the number of fish that were jointly detected by the bypass for that TR and dividing this pooled joint count by the total number of fish detected by the bypass detector on the days for that TR setting.

Eq.C.4.
$$\mathrm{sr(TR, Y)} = \frac{\sum_{\mathrm{i \mid TR, Y}} \text{Joint Bypass and Sample - Room Detections (i)}}{\sum_{\mathrm{i \mid TR, Y}} \text{Bypass Detections (i)}}$$

i|TR being day i for a given timer-gate-rate setting (TR). The timer-gate rate and the fish sample rate are not the same. The timer-gate samples flow, not fish. The sampled flow carries fish, but some fish are known to jump up into outfall from the timer-rate-directed flow into the live-box and return to the bypass while the timer-gate is opened to the live-box. It is also possible that fish are lost from the live-box in other ways.

Entrainment-Rate Predictor

The entrainment-rate predictor is based on logistically regressing the entrainment rate (er) on the canal-flow diversion rate (cdr) of Yakima River flow at Prosser Dam into the Canal. In previous years' Annual Reports[7], the model used was of the form:

Eq.C.5.a. Past Predictor**:**

$$\mathrm{er(cubic)} = \frac{1}{1 + \exp\{-[\mathrm{B(0)} + B(1) * \mathrm{cdr} + \mathrm{B(3)} * \mathrm{cdr}^2 + \mathrm{B(4)} * \mathrm{cdr}^3]\}}$$

This cubic predictor was used in previous years because the pooled out-migration-year predictor used for the 1997-2004 Prosser passages gave a significantly better fit of entrainment than a simple logistic predictor and also gave a desirable monotonically increasing function (not always true of cubic fits) as did the simple logistic regression. However, the extrapolation of this predictor for low flow-diversion rates (when few fish were enumerated and an insufficient number for both forebay and canal releases were available) led to impossibly high smolt counts in some years (e.g., nearly 11 million Prosser-passing smolt in 1998 giving 36 thousand

[7] In the last (1998) Annual Report, there was no certification report because there were known problems with passage estimates, but corrective measures were still being developed by the time of the reports development.

smolt/female-spawner-carcass). The model was refit using the following simple logistic model which gave more reasonable smolt/female-spawner-carcass ratios.

Eq.C.5.b. Current Predictor: $$\text{er(simple)} = \frac{1}{1 + \exp\{-[B(0) + B(1) * \text{cdr}]\}}$$

Fits from 1997 through 2004[8] were reasonably homogeneous; therefore all entrainment-rate estimates from these years were used to get single estimates of B(0) and B(1) for that set of years. Figure B.1 presents the predicted response and the estimates for those years.

However, there was a major change in the entrainment-rate response to flow-diversion-rate in subsequent years. The estimated entrainment rates from 2005 through 2009 are plotted in Figure 2.B with 1997-2004 predictor superimposed. The entrainment-rate estimates are clearly less than those predicted from the 1997-2004 estimates for low to moderate canal diversion rates. Fish biologists familiar with the Prosser site have noted an increase in milfoil in the forebay above the canal headgates and that flows through the milfoil have created channels pathways that may have directed fish in a manner that is different than was the case before 2005. This may have contributed to the change in entrainment rates.

Responses for the 2005, 2006, and 2007estimates were fitted separately and were found not to be homogeneous; however, as can be seen from Figure B.3, the flow-diversion-rate domains for the 2005 and 2007 releases barely overlapped, and there were flow-diversion rates in each of those years that were outside of sampled domains of their respective fits; therefore a single fit on those three years was made with the 2006 data set serving as a bridge. It should be noted that most of the 2006 estimates fell below the entrainment predictor based on all of the 2005-2007 estimates. None the less, it was felt that, at this time, using 2006 data as a bridge between the non-over lapping data sets of the straddling years (2005 and 2007) was preferable to only using the 2005 and 2007 data for the fit.

The fitted response for the 2008 and 2009 predictors were significantly different from each other and from the pooled 2005-2007 fitted response; therefore separate fits were made for 2008 and for 2009 even though there were only eight and ten data-points respectively available for those years (the fitted responses significantly differed between the two years as well). The 2008 and 2009 fitted responses and estimates are given in Figure B.4 which also has Figure B.3's 2005-2007 fitted response superimposed. As can be seen, at higher canal-diversion rates, the 2008 and 2009 estimates are all higher than the 2005-2007-based predictor and at lower diversion rates, the estimates are lower. The fitting of the post-2004 entrainment responses will be revisited as information is available from 2010 and subsequent years as a better understanding of why there has been a major change in entrainment rates since 2004.

[8] There were problems with 2000 release identifications, and the 2000 data was never used for fitting entrainment-rate and canal-survival-rate predictors.

Figure B.1. Historic Simple Logistic-Fit Fish-Entrainment-Rate Response and release-day Estimates for 1997-2004 Releases

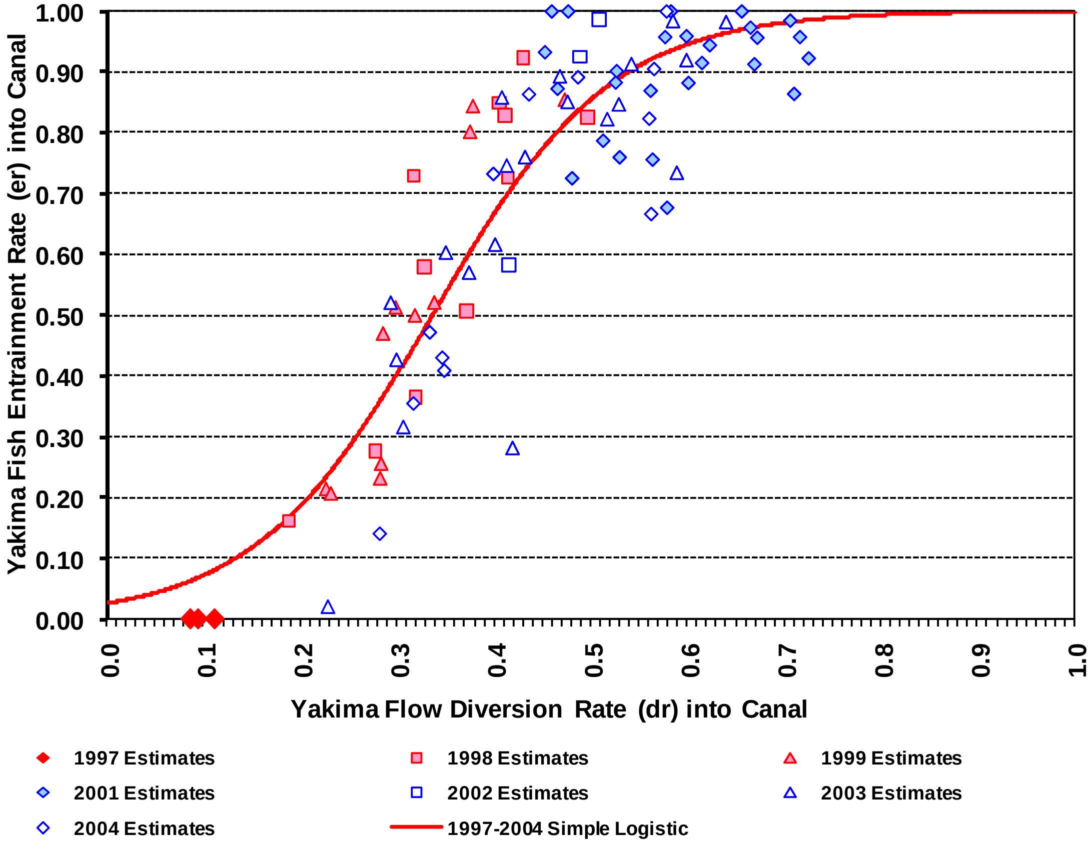


Figure B.2. Common Simple Logistic-Fit Fish-Entrainment-Rate Response for 2005-2007 with Sampled Days' Estimates

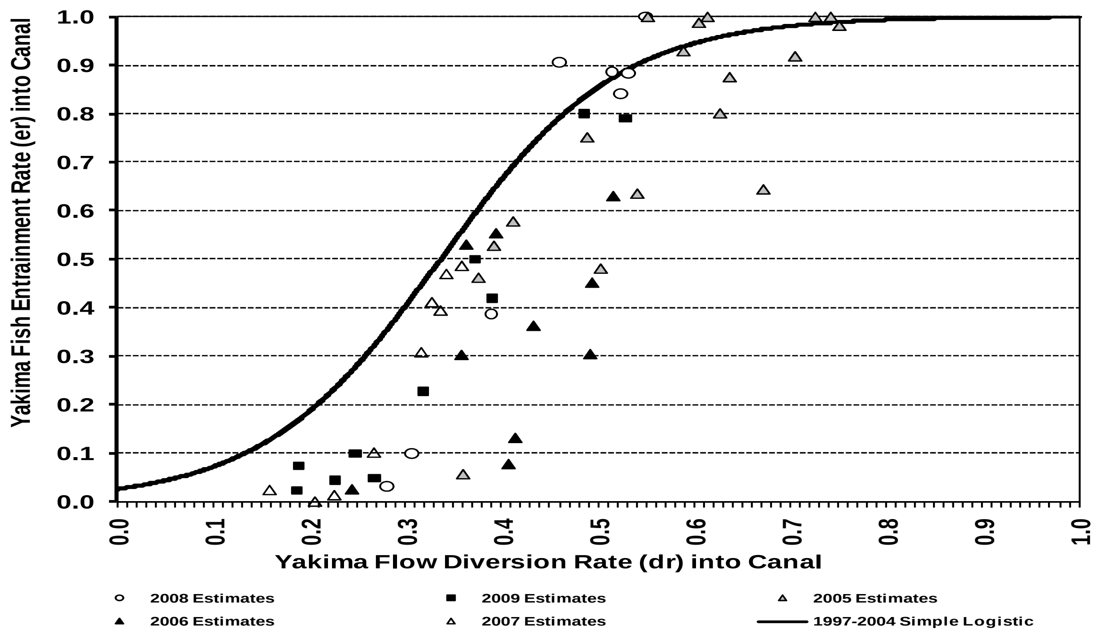


Figure B.3. Common Simple Logistic-Fit Fish-Entrainment-Rate Response for 2005-2007 with Sampled Days' Estimates

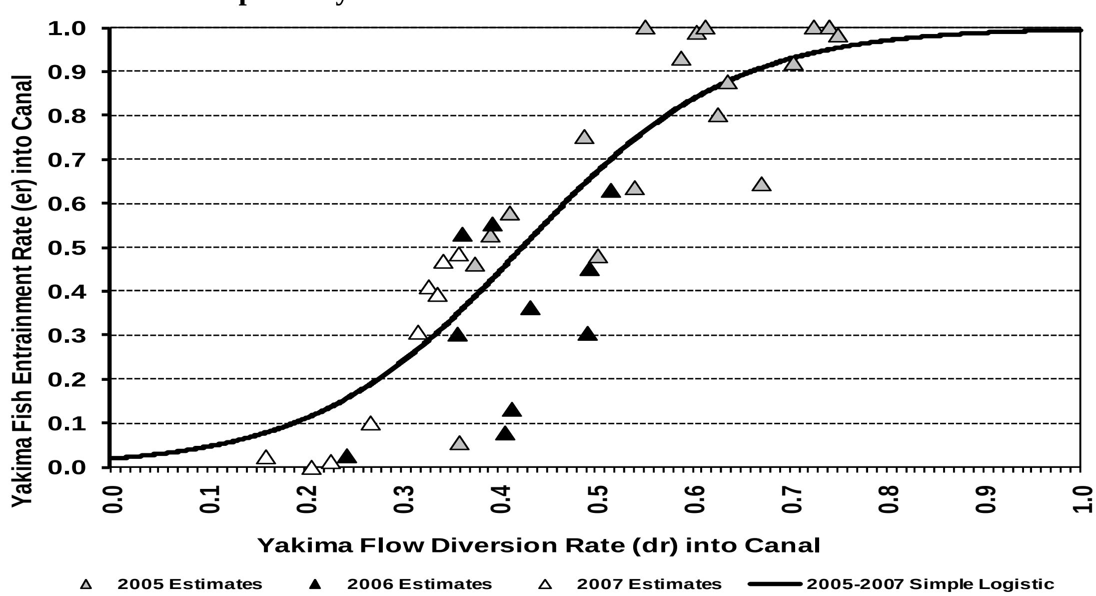
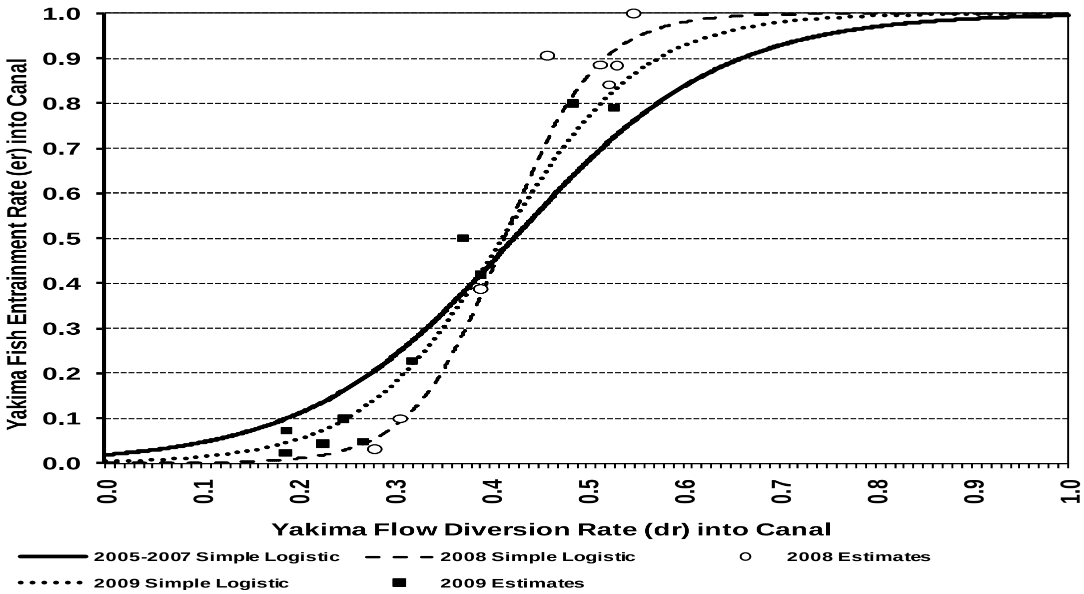


Figure B.4. Separate Simple Logistic-Fit Fish-Entrainment-Rate Response for 2008 and 2009 with Sampled Days' Estimates with Superimposed 2005-2007 Response Line



Estimates of the logistic entrainment coefficients used in the Eq. C.5.b. predictor are presented in Table B.1.

Table B.1. Coefficients in Entrainment Predictor given in equation Eq.C.5.b.

Logistic Coefficient	Coefficient Estimates			
	1997-2004	2005-2007	2008	2009
Intercept [B(0)]	-3.6332	-3.9552	-8.7444	-5.6008
Diversion-Rate Slope [Bl1)]	10.8066	9.3235	21.0993	13.5861

Canal Survival

The canal-survival-rate predictors from 1997 through 2004 are based on logistically regressing the canal-survival rate (csr) on the Julian Date (jd) and canal flow (cf) using the model in equation Eq.C.6.a. For 1997-2004, the best fitting models selected resulted from fitting separate intercepts [separate B(0) estimates] but common estimates for B(1) and B(2) over years.

Eq.C.6.a. 1997-2004 Predictor:

$$\mathrm{csr} = \frac{1}{1 + \exp\{-[B(0) + B(1) * jd + B(2) * cf]\}}$$

$$\text{with different yearly } B(0) \text{ estimates}$$

Reliable data were not available for 2000, so the intercepts from all years 1997-1999 and 2001-2004 were averaged using number of fish released into the canal as a weighting variable.

Separate fits were made for 2005 through 2009 since both the intercepts and the Julian date slopes significantly differed. The canal survival coefficient was not included because the associated

Julian Date coefficients adjusted for the canal survival did not have the same sign for all years. However, the canal-survival predictors will be reviewed in the future because the canal screen was replaced three years ago due to observed fish leakage into the irrigation system; consequently the correlation between the Julian-Date and Canal-Survival coefficient estimates may have changed from years 2005-2007 and 2008-2009.

Eq.C.6.b. 2005-2008 Predictor:

$$csr = \frac{1}{1 + \exp\{-[B(0) + B(1) * jd]\}},$$

$$\text{with different yearly } B(0) \text{ and } B(1) \text{ estimates}$$

Estimates of the currently-used coefficients are presented in Table B.2.

Table B.2. Coefficients in Canal Survival Predictor given in equations Eq.C.6.

Julian Date

Logistic Coefficient	Canal Survival Coefficients				
	1991	**1992**	**1997**	**1998**	**1999**
Intercept [B(0)]	2.99236	2.26937	2.81842	2.24517	2.18663
Julian Date Slope [B(1)]	-0.01333	-0.01333	-0.01333	-0.01333	-0.01333
Canal Flow [B(2)]	0.00115	0.00115	0.00115	0.00115	0.00115

Logistic Coefficient	Canal Survival Coefficients			
	2000	**2002**	**2003**	**2004**
Intercept [B(0)]	3.25658			
Julian Date Slope [B(1)]	-0.01333	-0.01333	-0.01333	-0.01333
Canal Flow [B(2)]	-0.01333	-0.01333	-0.01333	-0.01333

Logistic Coefficient	Canal Survival Coefficients				
	2005	**2006**	**2007**	**2008**	**2009**
Intercept [B(0)]	2.06728	3.6525	7.09215	3.1394	5.09091
Julian Date Slope [B(1)]	-0.00355	-0.02002	-0.04756	-0.01405	-0.0311
Canal Flow [B(2)]	------------- not estimated at this time -------------				

Canal Survival = 1/(1+exp{-[(B0)+(B1)*(Julian Date)+B(2)*(Canal Flow)]} through 2004

Canal Survival = 1/(1+exp{-[(B0)+(B1)*(Julian Date)]} after 2004

Sample-Rate Predictor

Fish were directed from the bypass into a live box by a timer gate. The crew controlled the proportion of time that the timer gate was opened to the live box. That proportion is referred to as the timer-gate rate (tr). The daily sample rate (sr) was estimated by taking the number of all PIT-tagged Spring Chinook that were detected in the bypass and then dividing that number into the number of those bypass-detected fish that were detected in the sample.

The daily sample rate was predicted using a weighted logistic regression of sr on separate indicator variables, I(y,tr), for each timer-gate rate setting (tr) within each year (y). The weights being the total daily detections by the bypass detector for the given timer-gate rate for the given year.

Eq.C.7. $$sr = \frac{1}{1 + \exp[-\sum_{r}\sum_{tr} b[I(y,tr)]}$$

If the timer-gate rate on a given day was followed by a different timer-gate rate on the next day, then both dates were dropped from the data set because the day/time of the change was not always certain. Occasionally a timer rate was only set for one day or two consecutive days, in which case there was no sample-rate estimate for that timer rate in that year. A given timer-gate-rate setting's date was excluded from the calculation if that date was preceded or followed by a different timer-gate-rate setting in case the setting change occurred on that excluded date.

If exclusion was always the case for a given timer-gate rate or if there were an insufficient number of days or detections to obtain an accurate estimate for a given timer-gate rate, then that timer-gate-rate setting's estimate was calibrated using the formula

$$sr(TR') = sr(TR'') * \frac{TR'}{TR''}$$

wherein TR' represents the timer-gate-rate setting for which there insufficient information to estimate the sample rate and TR" was the nearest setting to TR' for which there was a sample rate estimate based on sufficient information.

Estimates of the estimated sample-rate coefficients and associated standard errors are presented in Table B.3.

Note that the logistic prediction described prediction in Eq.C.7 appears differ than that given in Eq.C.4; however the estimates are consistent[9]. The estimate in EQ.C.4 is easier to understand.

[9] sr(Y,TR) from equation C.4 = 1/{1+exp(-b(y=Y, tr=TR)] from equation Eq.C.7 for the given timer-gate-rate setting (TR) within the given year (Y)

Table B.3. Predicted Sample Rates (SR) based on Logistic Regression of daily sample Rates on Timer-Gate-Rate Indicators

Timer-Gate	Out-Migration Year				
Rate*	1991	1992	1997	1998	1999
0.05	0.0491	0.0393	0.0482	0.0390	0.0411
0.10	0.0981	0.0785	0.0964	0.0780	0.0821
0.20	0.1963	0.1570	0.1928	0.1560	0.1643
0.25	0.2454	0.1963	0.2410	0.1950	0.2054
0.33	0.3239	0.2591	0.3182	0.2575	0.2711
0.40	0.3212	0.3140	0.3857	0.2993	0.3376
0.50	0.4015	0.3925	0.4821	0.3741	0.4221
0.75	0.7231	0.7231	0.7231	0.7231	0.7231
1.00	0.9642	0.9642	0.9642	0.9642	0.9642

Timer-Gate	Out-Migration Year				
Rate*	2000	2001	2002	2003	2004
0.05	0.0402	0.0153	0.0368	0.0350	0.0428
0.10	0.0804	0.0306	0.0736	0.0700	0.0855
0.20	0.1608	0.0611	0.1472	0.1400	0.1710
0.25	0.2010	0.0764	0.1840	0.1750	0.2138
0.33	0.2654	0.1008	0.2804	0.2310	0.2822
0.40	0.3139	0.0957	0.3399	0.2377	0.3421
0.50	0.3924	0.1197	0.4248	0.2972	0.4276
0.75	0.6544	0.7353	0.7252	0.7231	0.7231
1.00	0.8725	0.9804	0.9670	0.9642	0.9642

Timer-Gate	Out-Migration Year				
Rate*	2005	2006	2007	2008	2009
0.05	0.0609	0.0523	0.0404	0.0345	0.0385
0.10	0.1218	0.1045	0.0807	0.0690	0.0770
0.20	0.2436	0.2091	0.1614	0.1379	0.1539
0.25	0.3045	0.2613	0.2018	0.1590	0.1924
0.33	0.4019	0.3450	0.2664	0.2153	0.2540
0.40	0.2245	0.4181	0.2699	0.2061	0.3079
0.50	0.2806	0.5227	0.3373	0.2576	0.3849
0.75	0.7231	0.7231	0.7231	0.7231	0.7231
1.00	0.9642	0.9642	0.9642	0.9642	0.9642

* Proportion of time that the gate w ithin the bypass is opened to live-box from w hich fish are enumerater and sampled for the DNA evluation

Appendix E

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2009 Annual Report: Smolt-to-Smolt Survival to McNary Dam of Yakima Fall and Summer Chinook

Doug Neeley, Consultant to Yakama Nation

Introduction

In out-migration years 2007 through 2009, two stocks (Yakima and Little White) were released from Prosser as subyearlings (brood years 2006-2008). In outmigration years 2008 and 2009 there were also yearling Yakima-stock releases fish from Prosser (brood years 2005-2007). In outmigration-year 2009, Summer Chinook subyearlings were released from Stiles pond (broodyear 2008).

The analyses presented in this report are for:

1. Outmigration-year 2007 through 2009 smolt survival and date-of-detection comparisons between Little White and Yakima subyearlings (brood years 2006 through 2008).

2. Outmigration-year 2008 and 2009 smolt survival and date-of-detection comparisons between Yakima subyearling (brood years 2007 and 2008) and yearling releases (brood years 2006 and 2007).

3. Estimation of 2009 survival and date-of-release/detection of Summer Chinook subyearlings (2008 broodyear).

Levels of significance (p values) given in this report are from analyses of variation tables presented in the appendix. A comparison is referred to as significant if the comparison is significant at the 5% level ($p < 0.05$[1]). Estimation procedures and individual release and combined estimates are presented in Appendix B.

1 The 5% significance level represents a 0.05 probability of erroneously concluding that there is a true population difference based on sample estimates when there actually is no true population difference.

Little White and Yakima Stock

In spite of a higher Yakima-stock release-to-McNary survival compared to the Little White stock in 2007 (reported in previous annual reports), the Yakima-stock release-to-McNary survival was not significantly higher than that for the Little-White stock over the three years (Figure 1 and Table 1, $p = 0.31$). However, the pre-release survival estimates have been consistently higher for the Yakima stock in all three years, and the difference over years was significant (Figure 2 and Table 2; $p = 0.0066$). The higher pre-release survival was associated with a higher (although not significantly higher) overall relative survival for the Yakima stock from time of tagging to McNary passage compared to release-to-McNary survival, but the tagging-to-McNary-passage survival difference between the stocks was still not significant (Figure and Table 3, $p = 0.14$).

Mean volitional release and McNary-passage dates were marginally but significantly later for the Little White stock, a relation that was consistent in all three years (Figure and Table 4, $p = 0.0002$ for release date; Figure and Table 5, $p = 0.0055$ for McNary-passage date).

Subyearling and Yearling Releases

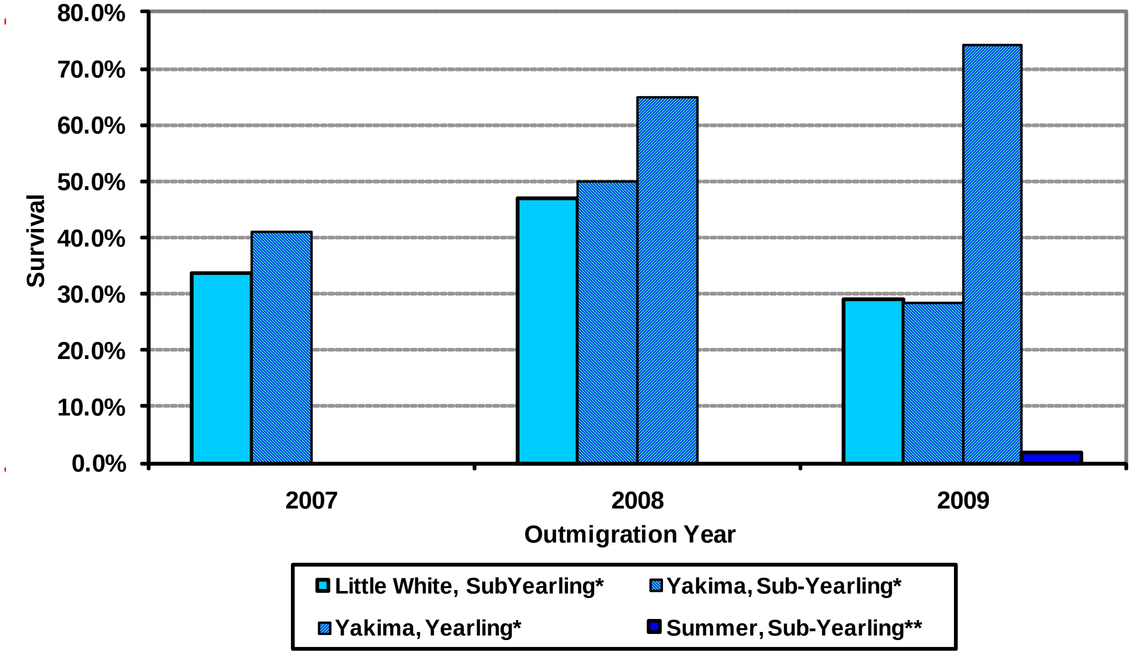
For the 2008 and 2009 migration years, the release-to-McNary survival has been significantly higher for the yearling releases (Figure and Table 1, $p < 0.0001$). The yearling-subyearling difference was substantially greater in 2009 than in 2008, and this is reflected in a significant interaction between the 2008-2009 effect and the yearling-subyearling-treatment effect ($p = 0.0022$). While the yearling mean pre-release survival was also higher than the subyearling for the two years, it was not significantly higher (Figure and Table 2, $p = 0.12$). The higher mean yearling pre-release survival (3.2% higher for the yearling) was associated with a higher overall Yearling- Subyearling difference in tagging-McNary survival (37.4% higher for the yearling, Figure and Table 3, $p < 0.0001$) compared to the release-to-McNary survival (0.31.9% higher for the yearling). Yearling release and McNary passage dates were significantly earlier than subyearling (Figure and Tables 4, $p = 0.038$ for release date; Figure and Table 5, $p <0.0001$ for McNary-passage date).

2009 Summer Chinook Estimates

The Summer Chinook, released as subyearlings, had an abysmal survival to McNary, 1.78% for both the release-to-McNary and time-of-tagging-to-McNary estimates (Figures and Tables 1 and 3). The fact that these estimates are identical is because the pre-release survival estimate is 100% (Figure and Table 2). Time-of-tagging-to-Prosser-Dam survival was also low (8.67%). These low survivals may be attributed to a late outmigration time--mean volitional release date of June 22 (Julian date 173, Figure and Table 4) and a mean McNary-detection date of July 9 (Julian date 190, Figure and Table 5). Also, substantial mortality of PIT-tagged summer Chinook was observed at the Wapato Dam smolt bypass in 2009 and bypass pipes were subsequently determined to be virtually blocked by debris (M. Porter, YN, Task 4.b Fish Predation, in the broader YKFP M&E annual report). The problem has been corrected.

Figures and Tables

Figure 1. Release-to-McNary Survival



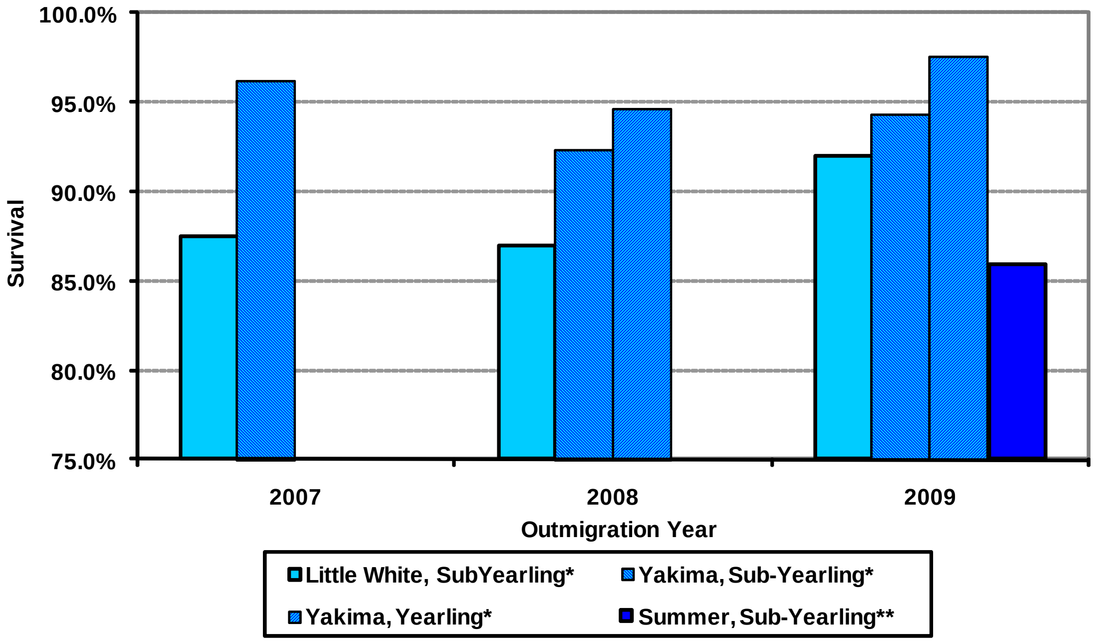
* Prosser Releases
** Stiles Release

Table 1. Fall/Summer Chinook Release-to-McNary Survival

Stock	Release Age	Measure	Out-Migration Year 2007	2008	2009	Pooled* over Years
Prosser Release						
Little White	**SubYearling**	**Survival**	**33.8%**	**47.0%**	**28.9%**	**39.2%**
		Number*	4,142	7,231	3,404	14,777
Yakima	**SubYearling**	**Survival**	**41.1%**	**49.9%**	**28.4%**	**39.9%**
		Number*	4,209	6,187	5,777	16,173
	Yearling	**Survival**		**65.2%**	**74.3%**	**71.8%**
		Number*		1,706	4,659	6,365
Stiles Release						
Summer	**SubYearling**	**Survival**			**1.8%**	
		Number*			17,054	

*Number Volitionally Released (Weight)

Figure 2. Pre-Release Survival



* Prosser Releases
** Stiles Release

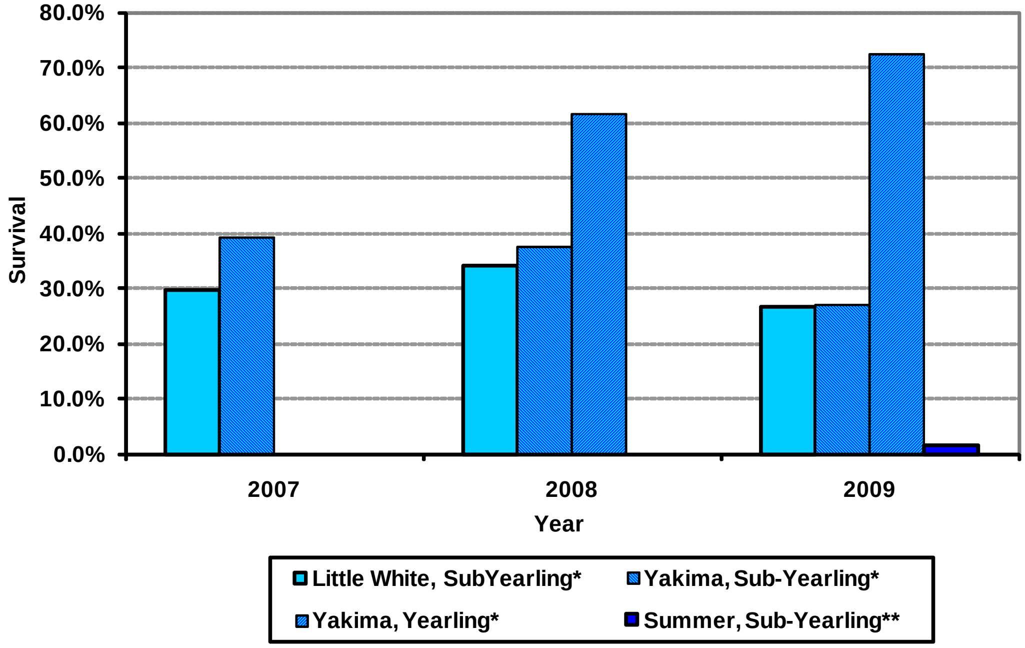
Table 2. Fall/Summer Chinook Pre-Release Survival

Stock	Release Age	Measure	Out-Migration Year 2007	2008	2009	Pooled* over Years
Prosser Release						
Little White	**SubYearling**	**Survival**	**87.5%**	**87.0%**	**92.0%**	**88.2%**
		Number*	5,009	10,001	4,060	19,070
Yakima	**SubYearling**	**Survival**	**96.2%**	**92.3%**	**94.3%**	**93.8%**
		Number*	5,002	10,005	7,565	22,572
	Yearling	**Survival**		**94.6%**	**97.6%**	**97.0%**
		Number*		1,831	7,516	9,347
Stiles Release						
Summer	**SubYearling**	**Survival**			**85.9%**	
		Number*			17,054	

*Number PIT-tagged (Weight)

Figures and Tables (continued)

Figure 3. Tagging-to-McNary Survival



* Prosser Releases
** Stiles Release

Table 3. Fall/Summer Chinook Tagging-to-McNary Survival

Stock	Release Age	Measure	Out-Migration Year 2007	2008	2009	Pooled* over Years
Prosser Release						
Little White	**SubYearling**	**Survival**	**29.6%**	**34.2%**	**26.5%**	**32.0%**
		Number*	5,009	10,001	4,060	14,061
Yakima	**SubYearling**	**Survival**	**39.3%**	**37.4%**	**26.8%**	**32.9%**
		Number*	5,002	10,005	7,565	17,570
	Yearling	**Survival**		**61.6%**	**72.4%**	**70.3%**
		Number*		1,831	7,516	9,347
Stiles Release						
Summer	**SubYearling**	**Survival**			**1.5%**	
		Number*			17,054	

*Number Tagged (Weight)

Figures and Tables (continued)

Figure 4. Mean Julian Date of Volitional Release

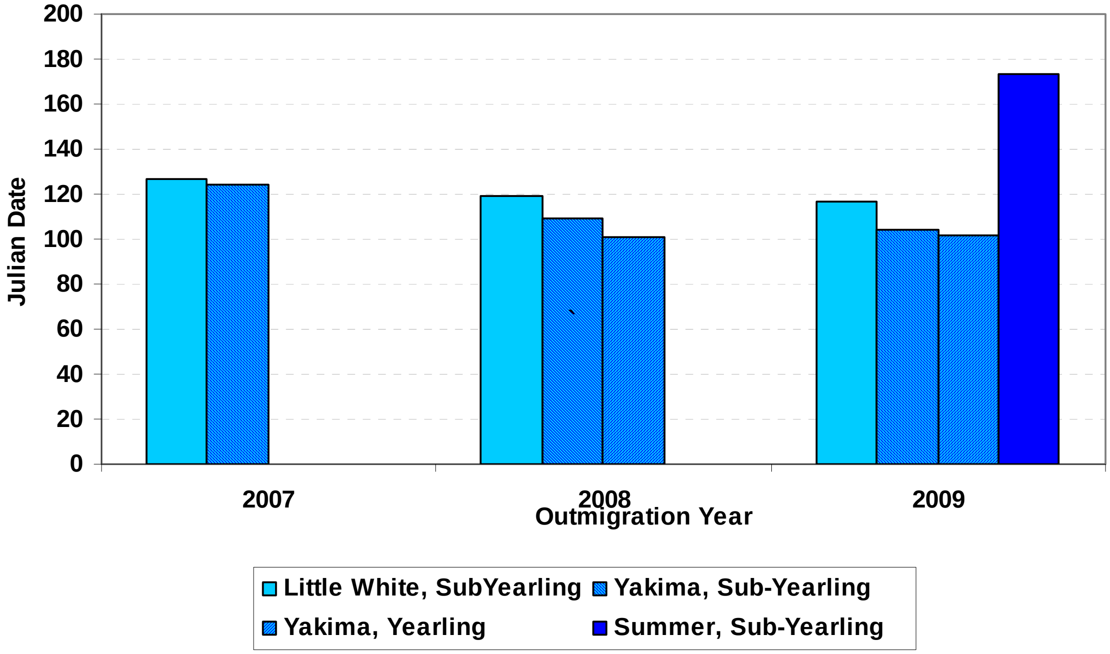


Table 4. Mean Julian Date of Volitional Release

Stock	Release Age	Measure	Out-Migration Year 2007	2008	2009	Pooled* over Years
Little White	**SubYearling**	**Date**	**127**	**119**	**117**	**118**
		Number*	4142	7,231	3,404	10,635
Yakima	**SubYearling**	**Date**	**123**	**109**	**103**	**106**
		Number*	4,209	6,187	5,777	11,964
	Yearling	**Date**		**101**	**102**	**101**
		Number*		1,706	4,659	6,365
Summer	**SubYearling**	**Date**			**173**	
		Number*				

* Weighted by Number Volitionally Released

Figure 5. Mean Julian Date of McNary Detection

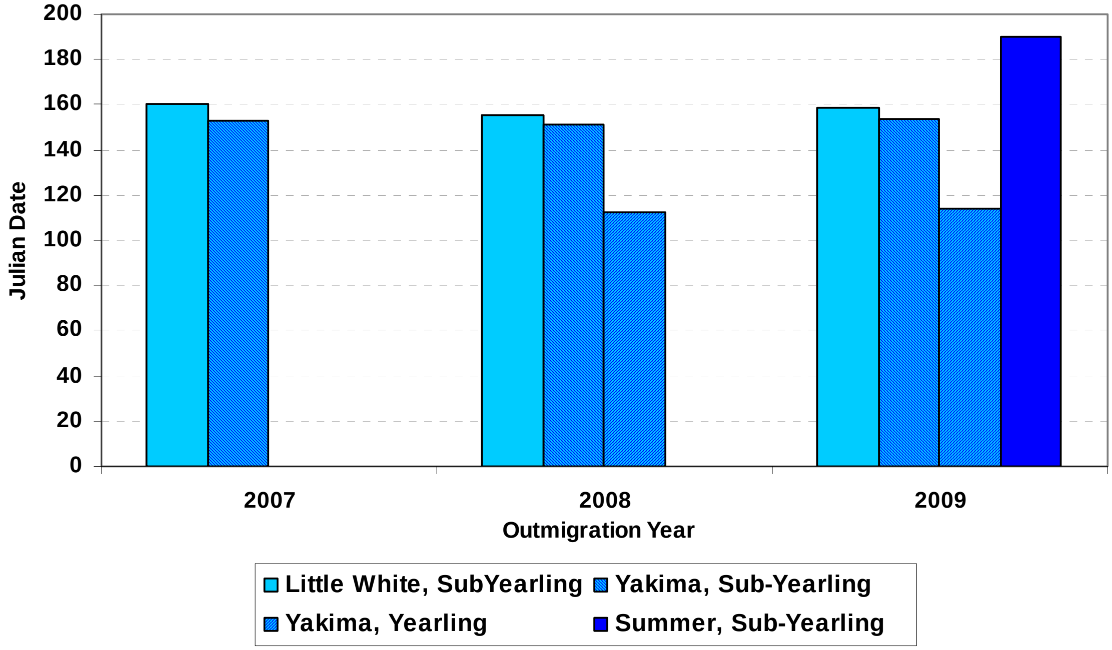


Table 5. Fall/Summer Chinook Mean Julian Date of McNary Detection

Stock	Release Age	Measure	Out-Migration Year 2007	2008	2009	Pooled* over Years
Little White	**SubYearling**	**Date**	**159**	**155**	**159**	**155**
		Number*	1483	3,416	1,078	4,493
Yakima	**SubYearling**	**Date**	**151**	**151**	**154**	**152**
		Number*	1,964	3,744	2,030	5,773
	Yearling	**Date**		**112**	**114**	**113**
		Number*		1,128	5,442	6,571
Summer	**SubYearling**	**Date**			**190**	
		Number*				

* Weighted by Expanded Number Detected at McNary

Appendix A: Logistic Analyses of Variance of Survivals and Least Squares Analyses of Variance of Volitional Dates of Release and McNary Dam Dates of Passage

Table A.1. Fall Cinook Release-to-McNary Survival

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev (Dev/DF)	F-Ratio	Type 1 Error P
Year	644.46	2	322.23	18.47	0.0010
Stock*	20.91	1	20.91	1.20	0.3055
Stock*	27.14	2	13.57	0.78	0.4913
Treatment**	2138.82	1	2138.82	122.58	0.0000
Treat x Year	342.24	1	342.24	19.61	0.0022
Residual	139.59	8	17.44875		

Table A.2 Fall Cinook Pre-Release Survival

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev (Dev/DF)	F-Ratio	Type 1 Error P
Year	128.9	2	64.45	2.38	0.1540
Stock*	357.92	1	357.92	13.24	0.0066
Stock*	74.97	2	37.485	1.39	0.3040
Treatment**	82.69	1	82.69	3.06	0.1184
Treat x Year	12.12	1	12.12	0.45	0.5219
Residual	216.19	8	27.02375		

Table A.3. Fall Chinook Tagging-to-McNary Survival

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev (Dev/DF)	F-Ratio	Type 1 Error P
Year	171.8	2	85.9	3.64	0.0750
Stock*	63.27	1	63.27	2.68	0.1400
Stock*	50.45	2	25.225	1.07	0.3875
Treatment**	3557.81	1	3557.81	150.90	0.0000
Treat x Year	229.48	1	229.48	9.73	0.0142
Residual	188.62	8	23.5775		

Table A.4. Fall Cinook Mean Julian Date of Volitional Release

Source	Sums of Squares (SS)	Degrees of Freedom (DF)	Mean Square (SS/DF)	F-Ratio	Type 1 Error P
Year	964394	2	482197	29.30	0.0002
Stock*	651576	1	651576	39.59	0.0002
Stock*	98241	2	49120.5	2.98	0.1076
Treatment**	101076	1	101076	6.14	0.0382
Treat x Year	49864	1	49864	3.03	0.1199
Residual	131673	8	16459.125		

Table A.5. Fall Cinook Mean Julian Date of McNary Detection

Source	Sums of Squares (SS)	Degrees of Freedom (DF)	Mean Square (SS/DF)	F-Ratio	Type 1 Error P
Year	30926.7	2	15463.35	2.72	0.1257
Stock*	80510.6	1	80510.6	14.15	0.0055
Stock*	10631.6	2	5315.8	0.93	0.4318
Treatment**	4025260.6	1	4025260.6	707.62	0.0000
Treat x Year	144.8	1	144.8	0.03	0.8772
Residual	45507.7	8	5688.4625		

* Stock - Little White versus Yakima

** Treatment - Subyearling Versus Yearling

Appendix B. Estimated Survival Index

Conceptual Computation

The smolt-to-smolt survival to McNary estimation method for Fall and Summer Chinook involves

1. Identifying time-of-passage strata within which estimated daily McNary detection rates of Fall Chinook are reasonably homogeneous. (Daily McNary detection rate is the proportion of all Yakima PIT-tagged Fall Chinook passing McNary Dam for each day that are detected at McNary)

2. Estimating the McNary detection rate for each stratum

3. Expanding (dividing) the given release's number[2] of detected fish not removed for transportation at McNary by the detection rate within the associated stratum and adjusting for the number removed for transportation[3]

4. Totaling the release's expanded numbers over strata

5. Taking that release's expanded total and dividing it by the appropriate "population number[4]"

The methods of identifying strata and estimating the individual stratum detection rates at McNary are discussed in my annual report *Comparison of Different Feed Treatments on Smolt-to-Smolt Survivals and Mini-Jack Percentages of Upper Yakima Spring Chinook for Brood-Years 2002-2006* (Appendix B in Sampson et al. 2009)

The steps given above can be basically summarized in the following equations. (In all of the following equations, the term "detections" is actually the number of detections.)

2 Total number of tagged fish detected at McNary within stratum in the case of tagging-to-McNary survival, total number of tagged fish detected at McNary within stratum that were previously detected at acclimation site in case of release-to-McNary survival.

3 Adjustments are given in Equation B.2, but so few (usually none) of the fish detected at McNary were transported from 2007 through 2009 that the adjustment was not made.

4 Total number of tagged fish in the case of tagging-to-McNary survival, total number of tagged fish detected at acclimation site in case of release-to-McNary survival.

Equation B.1.

$$\text{Stratum McNary detection rate} = \frac{\text{number of joint detections at McNary and downstream dams within Stratum}}{\text{estimated total number of detections at downstream dams within Stratum}}$$

Equation B.2.

$$\text{Smolt-to-Smolt Survival to McNary for a given release (Rel)} = \frac{\sum_{\text{strata}} \text{For Stratum}\left[\frac{\text{(McNary Rel Detections - Rel Detections Removed)}}{\text{Stratum's McNary Detection Rate (Equation B.1)}} + \text{Detections Rel Removed}\right]}{\text{Rel Number of Fish Tagged or Released}}$$

Pre-release survival was estimated using the Equation A.3.

Equation B.3.

$$\text{Pre-release Survival for a given Release (Rel)} =$$

$$\text{Tagging-to-Release Survival} =$$

$$\frac{\left[\frac{\text{Rel Detections at Acclimation Site}}{\text{Rel Number Tagged}}\right]}{\left[\frac{\text{Total Rel Detections at McNary previously Detected at Acclimation Site}}{\text{Total Rel Detections at McNary}}\right]}$$

The denominator in the above equation is a measure of the detection efficiency at the acclimation site for the release in question. In earlier years estimates for this detection efficiency was based on expanded detection numbers using the detection rate in Equation A.1 as the expansion factor rather than the unexpanded detections; however, there were occasional estimates in which the resulting estimated pre-release survival slightly exceeded 1 (100%). While this also occurred using the unexpanded numbers[5], it was even more unusual; therefore the unexpanded numbers were used.

5 This happened for Fall Chinook. When this occurred, the pre-release survival was equated to 1 (100%).

Detection Rate Estimates

Estimates for 2007 through 2009 are given Table B.1; Tagging-to-McNary Survival given in Table B.2; Volitional-Release-to McNary Survival and other estimates are given in table B.3.

Table B.1. McNary Dam Detection Rates for 2007 and 2009 Fall Releases.

	Julian Date Strata		Bonneville (Bonn.) Based			John Day (J.D. based)			Pooled over Bonn.and J.D. (applied detection rates)		
Year	Beginning	Ending	Total Bonn. Det.	Joint Bonn. McN. Det.	McN. Det. Rate	Total J.D. Det.	Joint J.D. McN. Det.	McN. Det. Rate	**Pooled Total Det.**	**Pooled J.D. Det**	**Pooled McN. Det. Rate**
2006		156	122.4	28.0	0.2287	548.8	123.0	0.2241	**671.3**	**151.0**	**0.2249**
	157	162	43.6	5.0	0.1148	142.2	29.0	0.2039	**185.8**	**34.0**	**0.1830**
	163		157.0	54.0	0.3439	299.9	105.0	0.3501	**456.9**	**159.0**	**0.3480**
	Total		323.0	87.0	0.2693	991.0	257.0	0.2593	**1314.0**	**344.0**	**0.2618**
2007		139	41.2	9.0	0.2185	114.8	28.0	0.2439	**156.0**	**37.0**	**0.2372**
	140	143	17.2	7.0	0.4060	62.5	22.0	0.3521	**79.7**	**29.0**	**0.3637**
	144	155	100.0	31.0	0.3101	371.2	107.0	0.2882	**471.2**	**138.0**	**0.2929**
	156		505.6	187.0	0.3698	1177.5	420.0	0.3567	**1683.1**	**607.0**	**0.3606**
	Total		664.0	234.0	0.3524	1726.0	577.0	0.3343	**2390.0**	**811.0**	**0.3393**
2008		142	160.1	25.0	0.1562	384.3	71.0	0.1847	**544.4**	**96.0**	**0.1763**
	143	163	402.4	101.0	0.2510	1427.0	339.0	0.2376	**1829.4**	**440.0**	**0.2405**
	164	175	287.7	90.0	0.3128	313.1	84.0	0.2683	**600.8**	**174.0**	**0.2896**
	176		555.8	114.0	0.2051	502.6	112.0	0.2228	**1058.4**	**226.0**	**0.2135**
	Total		1406.0	330.0	0.2347	2627.0	606.0	0.2307	**4033.0**	**936.0**	**0.2321**
2009-Fall		113	278.9	73.0	0.2617	800.0	239.0	0.2987	**1079.0**	**312.0**	**0.2892**
	114	120	119.7	43.0	0.3593	350.9	121.0	0.3448	**470.6**	**164.0**	**0.3485**
	121	138	115.3	50.0	0.4336	125.4	55.0	0.4387	**240.7**	**105.0**	**0.4363**
	139	146	29.0	9.0	0.3101	35.9	10.0	0.2784	**64.9**	**19.0**	**0.2926**
	147	154	89.0	18.0	0.2022	183.4	35.0	0.1908	**272.4**	**53.0**	**0.1946**
	155	164	125.2	30.0	0.2396	248.4	61.0	0.2455	**373.6**	**91.0**	**0.2436**
	165		64.8	25.0	0.3856	96.9	31.0	0.3199	**161.7**	**56.0**	**0.3463**
	Total		822.0	248.0	0.3017	1841.0	552.0	0.2998	**2663.0**	**800.0**	**0.3004**
2009-Summer*	Total		43	10	0.2326	39	10	0.2564	**82**	**20**	**0.2439**

*insufficient numbers for stratification

Table B.2. Tagging-to-McNary Survival Indices Estimates

a. Tagging-to-McNary 2007 Survival

	Rearing Pond >	Prosser: Little White, Subyearling		Prosser: Yakima, Subyearling		Prosser: Yakima, Yearling	Stiles: Summer, Subyearling
	Tagging Group (File Extender) >	LW1	LW3	PR1	PR3		
Stratum 1	Total	11	13	57	26		
	Removed	0	0	0	0		
	Subtotal	11	13	57	26		
	Expanded Total	46.4	54.8	240.3	109.6		
Stratum 2	Total	14	8	28	15		
	Removed	0	0	0	0		
	Subtotal	14	8	28	15		
	Expanded Total	38.5	22.0	77.0	41.2		
Stratum 3	Total	24	35	95	67		
	Removed	0	0	0	0		
	Subtotal	24	35	95	67		
	Expanded Total	81.9	119.5	324.4	228.8		
Stratum 4	Total	222	182	170	170		
	Removed	0	0	0	0		
	Subtotal	222	182	170	170		
	Expanded Total	615.6	504.6	471.4	471.4		
	Total over Strata	271	238	350	278		
	Expanded Total over Strata	782.4	701.0	1113.0	851.0		
	Number Tagged	2505	2504	2501	2501		
	Tagging-to-McNary Survival	0.3123	0.2799	0.4450	0.3403		
	Pooled Number Tagged		5009		5002		
	Pooled Tagging-to-McNary Survival		0.2961		0.3926		

Table B.2. (continued)

b. Tagging-to-McNary 2008 Survival

	Rearing Pond >	Prosser: Little White, Subyearling		Prosser: Yakima, Subyearling		Prosser: Yakima, Yearling		Stiles: Summer, Subyearling
	Tagging Group (File Extender) >	LW1	LW3	PS1	PS3	PY1	PY2	
Stratum 1	Total	31	19	35	20	125	74	
	Removed	0	0	0	0	0	0	
	Subtotal	31	19	35	20	125	74	
	Expanded Total	175.8	107.7	198.5	113.4	708.9	419.6	
Stratum 2	Total	259	266	336	356	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	259	266	336	356	0	0	
	Expanded Total	1076.8	1105.9	1397.0	1480.1	0.0	0.0	
Stratum 3	Total	106	112	62	81	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	106	112	62	81	0	0	
	Expanded Total	366.0	386.7	214.1	279.7	0.0	0.0	
Stratum 4	Total	16	26	8	5	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	16	26	8	5	0	0	
	Expanded Total	74.9	121.8	37.5	23.4	0.0	0.0	
	Total over Strata	412	423	441	462	125	74	
	Expanded Total over Strata	1693.6	1722.2	1847.0	1896.6	708.9	419.6	
	Number Tagged	5000	5001	5001	5004	1089	742	
	Tagging-to-McNary Survival	0.3387	0.3444	0.3693	0.3790	0.6509	0.5656	
	Pooled Number Tagged		10001		10005		1831	
	Pooled Tagging-to-McNary Survival		0.3415		0.3742		0.6163	

Table B.2. (continued)

c. Tagging-to-McNary 2009 Survival

	Rearing Pond >	Prosser: Little White, Subyearling		Prosser: Yakima, Subyearling		Prosser: Yakima, Yearling		Stiles: Summer, Subyearling
	Tagging Group (File Extender) >	LW1	LW3	PS1	PS3	PY1	PY3	WS1-WS6
Stratum 1	Total	0	0	4	4	526	313	112
	Removed	0	0	0	0	0	0	0
	Subtotal	0	0	4	4	526	313	112
	Expanded Total	0.0	0.0	13.8	13.8	1819.0	1082.4	459.2
Stratum 2	Total	0	0	3	26	190	337	
	Removed	0	0	0	0	0	0	
	Subtotal	0	0	3	26	190	337	
	Expanded Total	0.0	0.0	8.6	74.6	545.2	967.1	
Stratum 3	Total	1	0	3	7	148	249	
	Removed	0	0	0	0	0	0	
	Subtotal	1	0	3	7	148	249	
	Expanded Total	2.3	0.0	6.9	16.0	339.2	570.7	
Stratum 4	Total	9	4	27	9	10	19	
	Removed	0	0	0	0	0	0	
	Subtotal	9	4	27	9	10	19	
	Expanded Total	30.8	13.7	92.3	30.8	34.2	64.9	
Stratum 5	Total	21	21	64	46	1	2	
	Removed	0	0	0	0	0	0	
	Subtotal	21	21	64	46	1	2	
	Expanded Total	107.9	107.9	329.0	236.4	5.1	10.3	
Stratum 6	Total	71	60	105	111	1	0	
	Removed	0	0	0	0	0	0	
	Subtotal	71	60	105	111	1	0	
	Expanded Total	291.5	246.4	431.1	455.8	4.1	0.0	
Stratum 7	Total	39	57	46	65	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	39	57	46	65	0	0	
	Expanded Total	112.6	164.6	132.8	187.7	0.0	0.0	
	Total over Strata	141.0	142.0	252.0	268.0	876.0	920.0	112.0
	Expanded Total over Strata	545.1	532.6	1014.5	1015.2	2746.9	2695.5	459.2
	Number Tagged	2025	2035	3550	4015	3529	3987	30037
	Tagging-to-McNary Survival	0.2692	0.2617	0.2858	0.2528	0.7784	0.6761	0.0153
	Pooled Number Tagged		4060		7565		7516	30037
	Pooled Tagging-to-McNary Survival		0.2655		0.2683		0.7241	0.0153

Table B.3. Detection Numbers, Release-to-McNary Survival, and other Estimates

a. Release-to-McNary 2007 Survival and other estimates

	Rearing Pond >	Prosser: Little White, Subyearling		Prosser: Yakima, Subyearling		Prosser: Yakima, Yearling	Stiles: Summer, Subyearling
	Tagging Group (File Extender) >	LW1	LW3	PR1	PR3		
Stratum 1	Total	11	11	55	19		
	Removed	0	0	0	0		
	Subtotal	11	11	55	19		
	Expanded Total	46.4	46.4	231.9	80.1		
Stratum 2	Total	13	7	26	13		
	Removed	0	0	0	0		
	Subtotal	13	7	26	13		
	Expanded Total	35.7	19.2	71.5	35.7		
Stratum 3	Total	22	34	90	50		
	Removed	0	0	0	0		
	Subtotal	22	34	90	50		
	Expanded Total	75.1	116.1	307.3	170.7		
Stratum 4	Total	210	173	159	142		
	Removed	0	0	0	0		
	Subtotal	210	173	159	142		
	Expanded Total	582.3	479.7	440.9	393.7		
	Total over Strata	256	225	330	224		
	Expanded Total over Strata	739.5	661.4	1051.5	680.3		
	Number Released	2097	2045	2288	1921		
	Released-to-McNary Survival	0.3527	0.3234	0.4596	0.3541		
	Pooled Number Released		4142		4209		
	Pooled Tagging-to-McNary Survival		0.3382		0.4115		
	Total Tagged Det MCJ	271	238	350	278		
	Total Tagged	2505	2504	2501	2501		
	Accl Det Rate	0.9446494	0.9453782	0.9428571	0.8057554		
	Num Rel/Num Tag	0.8371257	0.8166933	0.9148341	0.7680928		
	Pre-Rel Survival*	0.8861761	0.86388	0.9702786	0.953258		
	Pre-Rel Survival**		0.8750		0.9618		
	Total Tagged		5009		5002		

* [(Volitional Releases)/(Number Tagged)]/
[(Total Released detected at McNary)/(Total Tagged detected at McNary)]

** Weighted by Number Tagged over Tagging Groups w ith Site

Table B.3. (continued)

b. Release-to-McNary 2008 Survival and other estimates

	Rearing Pond >	Prosser: Little White, Subyearling		Prosser: Yakima, Subyearling		Prosser: Yakima, Yearling		Stiles: Summer, Subyearling
	Tagging Group (File Extender) >	LW1	LW3	PS1	PS3	PY1	PY2	
Stratum 1	Total	179	217	230	194	123	73	
	Removed	0	0	0	0	0	0	
	Subtotal	179	217	230	194	123	73	
	Expanded Total	1015.1	1230.6	1304.3	1100.1	697.5	414.0	
Stratum 2	Total	31	22	24	26	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	31	22	24	26	0	0	
	Expanded Total	128.9	91.5	99.8	108.1	0.0	0.0	
Stratum 3	Total	86	91	52	53	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	86	91	52	53	0	0	
	Expanded Total	296.9	314.2	179.5	183.0	0.0	0.0	
Stratum 4	Total	26	43	11	13	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	26	43	11	13	0	0	
	Expanded Total	121.8	201.4	51.5	60.9	0.0	0.0	
	Total over Strata	322	373	317	286	123	73	
	Expanded Total over Strata	1562.7	1837.6	1635.1	1452.1	697.5	414.0	
	Number Released	3450	3781	3405	2782	1022	684	
	Released-to-McNary Survival	0.4529	0.4860	0.4802	0.5220	0.6825	0.6052	
	Pooled Number Released		7231		6187		1706	
	Pooled Tagging-to-McNary Survival		0.4702		0.4990		0.6515	
	Total Tagged Det MCJ	412.0	423.0	441.0	462.0	125.0	74.0	
	Total Tagged	5000.0	5001.0	5001.0	5004.0	1089.0	742.0	
	Accl Det Rate	0.7816	0.8818	0.7188	0.6190	0.9840	0.9865	
	Num Rel/Num Tag	0.6900	0.7560	0.6809	0.5560	0.9385	0.9218	
	Pre-Rel Survival*	0.8829	0.8574	0.9472	0.8981	0.9537	0.9345	
	Pre-Rel Survival**		0.8701		0.9226		0.9459	
	Total Tagged		10001		10005		1831	

* [(Volitional Releases)/(Number Tagged)]/[(Total Released detected at McNary)/(Total Tagged detected at McNary)]

** Weighted by Number Tagged over Tagging Groups with Site

Table B.3. (continued)

c. Release-to-McNary 2009 Survival and other estimates

	Rearing Pond >	Prosser: Little White, Subyearling		Prosser: Yakima, Subyearling		Prosser: Yakima, Yearling		Stiles: Summer, Subyearling
	Tagging Group (File Extender) >	LW1	LW3	PS1	PS3	PY1	PY3	WS1-WS6
Stratum 1	Total	0	0	2	4	347	183	74
	Removed	0	0	0	0	0	0	0
	Subtotal	0	0	2	4	347	183	74
	Expanded Total	0.0	0.0	6.9	13.8	1200.0	632.9	303.4
Stratum 2	Total	0	0	2	20	131	208	
	Removed	0	0	0	0	0	0	
	Subtotal	0	0	2	20	131	208	
	Expanded Total	0.0	0.0	5.7	57.4	375.9	596.9	
Stratum 3	Total	1	0	3	6	97	154	
	Removed	0	0	0	0	0	0	
	Subtotal	1	0	3	6	97	154	
	Expanded Total	2.3	0.0	6.9	13.8	222.3	353.0	
Stratum 4	Total	7	4	21	8	5	14	
	Removed	0	0	0	0	0	0	
	Subtotal	7	4	21	8	5	14	
	Expanded Total	23.9	13.7	71.8	27.3	17.1	47.9	
Stratum 5	Total	21	19	52	35	1	1	
	Removed	0	0	0	0	0	0	
	Subtotal	21	19	52	35	1	1	
	Expanded Total	107.9	97.7	267.3	179.9	5.1	5.1	
Stratum 6	Total	65	53	86	90	1	0	
	Removed	0	0	0	0	0	0	
	Subtotal	65	53	86	90	1	0	
	Expanded Total	266.9	217.6	353.1	369.5	4.1	0.0	
Stratum 7	Total	36	52	38	54	0	0	
	Removed	0	0	0	0	0	0	
	Subtotal	36	52	38	54	0	0	
	Expanded Total	104.0	150.2	109.7	156.0	0.0	0.0	
	Total over Strata	130.0	128.0	204.0	217.0	582.0	560.0	74.0
	Expanded Total over Strata	505.0	479.1	821.4	817.7	1824.6	1635.7	303.4
	Number Released	1703	1701	2674	3103	2324	2335	17054
	Released-to-McNary Survival	0.2965	0.2817	0.3072	0.2635	0.7851	0.7005	0.0178
	Pooled Number Released		3404.0		5777		4659	30037
	Pooled Tagging-to-McNary Survival		0.2891		0.2837		0.7427	0.0178
	Total Tagged Det MCJ	141.0	142.0	252.0	268.0	876.0	920.0	112.0
	Total Tagged	2025.0	2035.0	3550.0	4015.0	3529.0	3987.0	30037.0
	Accl Det Rate	0.9220	0.9014	0.8095	0.8097	0.6644	0.6087	0.6607
	Num Rel/Num Tag	0.8410	0.8359	0.7532	0.7729	0.6585	0.5857	0.5678
	Pre-Rel Survival*	0.9121	0.9273	0.9305	0.9545	0.9912	0.9621	0.8593
	Pre-Rel Survival**		0.9197		0.9432		0.9758	0.8593
	Total Tagged		4060.0		7565		7516	30037.0

* [(Volitional Releases)/(Number Tagged)]/[(Total Released detected at McNary)/(Total Tagged detected at McNary)]

** Weighted by Number Tagged over Tagging Groups with Site

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Annual Report: 2006-2009 Coho Smolt-to-Smolt Survival of Eagle Creek and Yakima Brood Releases into the Yakima Basin

Doug Neeley, Consultant to Yakama Nation

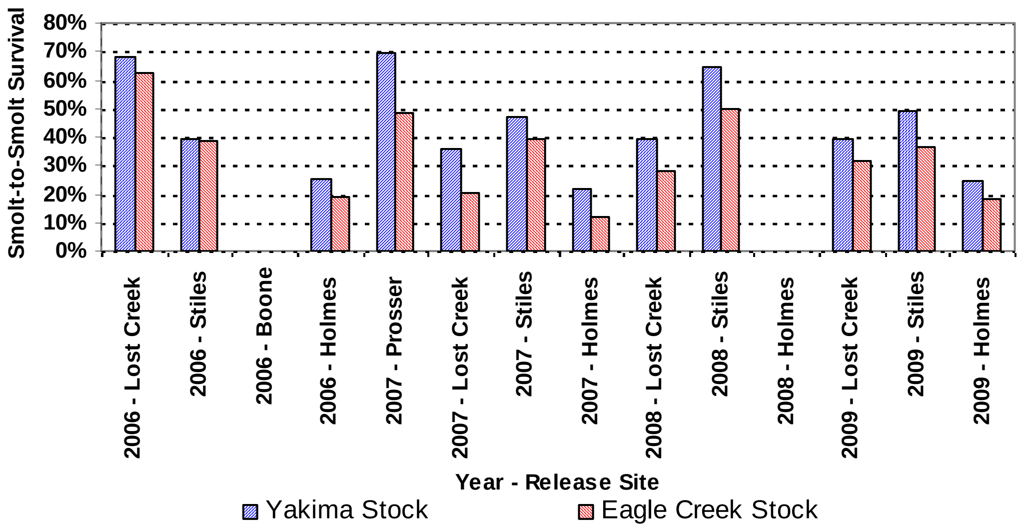
Introduction and Summary

This annual report focuses on smolt-estimate comparisons between early-release Eagle Creek and Yakima-origin stock. As such only sites and years from which both stocks were released are discussed in the body of this report. Smolt survival estimates derived from sites from which only one of the stocks was released is presented in Appendix A along with the dual-release sites for those outmigration years (2006-2009) during which both Eagle Creek and Yakima stock were used. Survival estimates of smolt releases into below-dam, flume, and above-dam releases at Cle Elum are presented in Appendix B. Estimates from parr for those same years are presented in Appendix C. Detailed survival-estimation procedures were presented in the 2008 annual report along with individual release survival estimates for releases made through release-year 2008. Individual release survival estimates for releases made in 2009 are presented in Appendix D.

Smolt Survival and Time of McNary Passage

Volitional Release-to-McNary survival for Yakima stock was higher than that of Eagle Creek stock for all 12 paired-release sites at which there were PIT-tag detectors[1]. The survival estimates are graphically presented in Figure 1 with the estimated values presented in Appendix Table A.1. The mean Yakima-stock release-to-McNary survival over sites and years was significantly greater than that of the Eagle Creek stock ($p < 0.0001$, Table 1.).

Figure 1. 2006-2009 Outmigration-Year Volitional-Release-to-McNary Survival for joint Yakima and Eagle Creek Stock Release Sites (Brood Years 2004-2007)



Yakima Stock has higher survival than Eagle Creek Stockin in 100% of the 12 Year-Sites

Table 1. Weighted* Logistic Analysis of Variation of Volitional-Release-to-McNary Smolt Survival for only those sites within years having both Yakima-Return and Eagle Creek Stock Releases

Source	Deviance (Dev)	Degrees of Freedom (DF)	Deviance (Dev/DF)	F-Ratio	Type 1 Error P
Years, Ponds (adjusted for stock)	2945.99	11	267.82	25.13	0.0000
Stock(adjusted for Years, Ponds)	393.56	1	393.56	36.93	0.0001
Error**	117.22	11	10.66	0.00	

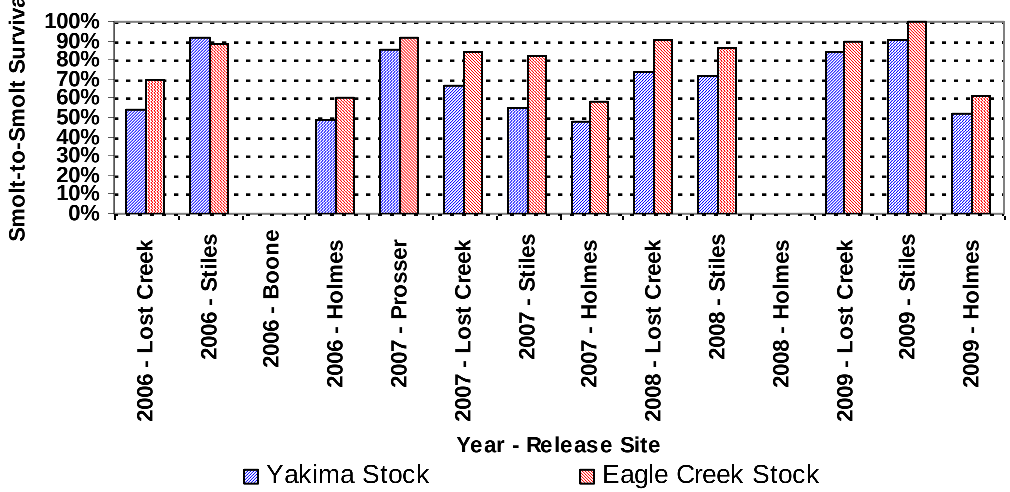
* Weight = number detected at release site (number released)

** Pooling of Year x Stock and Site x Stock Interaction Variation

1 There were sites at which there were there no PIT-tag detectors and from which Release-to-McNary survival were not possible since that survival is based on an expanded number of those fish detected leaving the site that later detected at McNary Dam.

Pre-Release survival, for Yakima stock, however, was lower than that of Eagle Creek stock for 11 of those 12 paired-releases. Pre-Release survival estimates are graphically presented in Figure 2 with the estimated values presented in Appendix Table A.2. The mean Pre-Release survival over sites and years is significantly greater for the Eagle Creek stock ($p < 0.0002$, Table 2.).

Figure 2. 2006-2009 Outmigration-Year Pre-Release Survival of Tagged Smolt (Brood Years 2004-2007)



Eagle Creek Stock has higher pre-release survival than Yakima Stock in 92% of the 12 Sites

Table 2. Weighted* Logistic Analysis of Variation of Pre-Release Survival of Tagged Fish for only those sites within years having both Yakima-Return and Eagle Creek Stock Releases

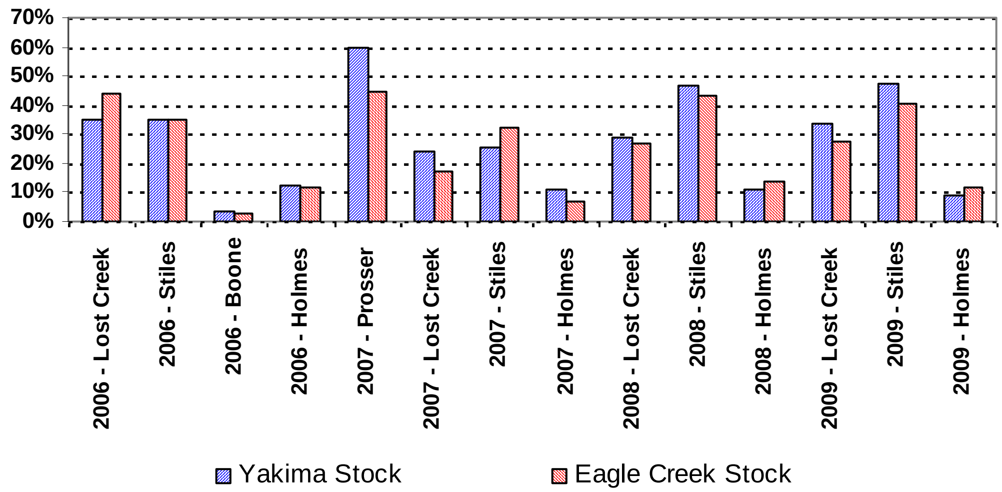
Source	Deviance (Dev)	Degrees of Freedom (DF)	Deviance (Dev/DF)	F-Ratio	Type 1 Error P
Years, Ponds (adjusted for stock)	30834.01	13	2371.85	50.18	0.0000
Stock(adjusted for Years, Ponds)	1218.09	1	1218.09	25.77	0.0002
Error**	614.44	13	47.26		

* Weight = Number tagged

** Pooling of Year x Stock and Site x Stock Interaction Variation

Time-of-Tagging-to-McNary survival for Yakima Stock was apparently affected by the inconsistency in the Yakima-stock's relatively higher Volitional-Release-to-McNary survivals and its lower Pre-Release survivals. The result was 9 out of the 12 comparable paired releases had higher Yakima-stock Time-of-Tagging-to-McNary survivals compared to the 12 out of 12 for the Volitional-Release-to-McNary survivals. There were two additional paired releases for which there were no PIT-tag detectors at the release sites, and of these, one had a higher Yakima-stock survival and the other had a lower Yakima-stock survival (respectively the 2006 Boone and the 2008 Holmes releases, giving a total of 10 of the 14 paired releases with higher Yakima-stock survivals). Figure 3 presents the relative survivals for all fourteen paired-release sites for which Time-of-Tagging-to-McNary survival-estimates were available for both stock. Because of the inconsistency in these relative survivals, there was no significant difference between the overall Yakima- and Eagle-Creek- stock time-of-tagging-to-McNary survivals (p = 0.30 from Table 3).

Figure 3. 2006-2009 Outmigration Year Tagging-to-McNary Survival for joint Yakima and Eagle Creek Stock Release Sites (Brood Years 2004-2007)



Yakima Stock has higher survival than Eagle Creek Stockin in 64% of the 14 Sites

Table 3. Weighted* Logistic Analysis of Variation of Volitional-Release-to-McNary Smolt Survival for only those sites within years having both Yakima-Return and Eagle Creek Stock Releases

Source	Deviance (Dev)	Degrees of Freedom (DF)	Deviance (Dev/DF)	F-Ratio	Type 1 Error P
Years, Ponds (adjusted for stock)	8476.94	13	652.07	33.21	0.0000
Stock(adjusted for Years, Ponds)	23.37	1	23.37	1.19	0.2951
Error**	255.28	13	19.64	0.00	0.0000

* Weight = number tagged

** Pooling of Year x Stock and Site x Stock Interaction Variation

McNary Detection Dates were estimated using the detections for all fourteen paired release sites. These are presented in Figure 4. The mean of the paired differences in detections between the stock was not significant ($p = 0.54$). The Pearson's correlation between the paired differences between the stocks' Time-of-Tagging-to-McNary survival estimates and their paired differences in mean Date-of-Detection estimates is small and not significant ($r = 0.4$, $p = 0.93$).

Figure 4. 2006-2009 Outmigration-Year Mean Julian McNary-Passage Date for joint Yakima and Eagle Creek Stock Release Sites (Brood Years 2004-2007)

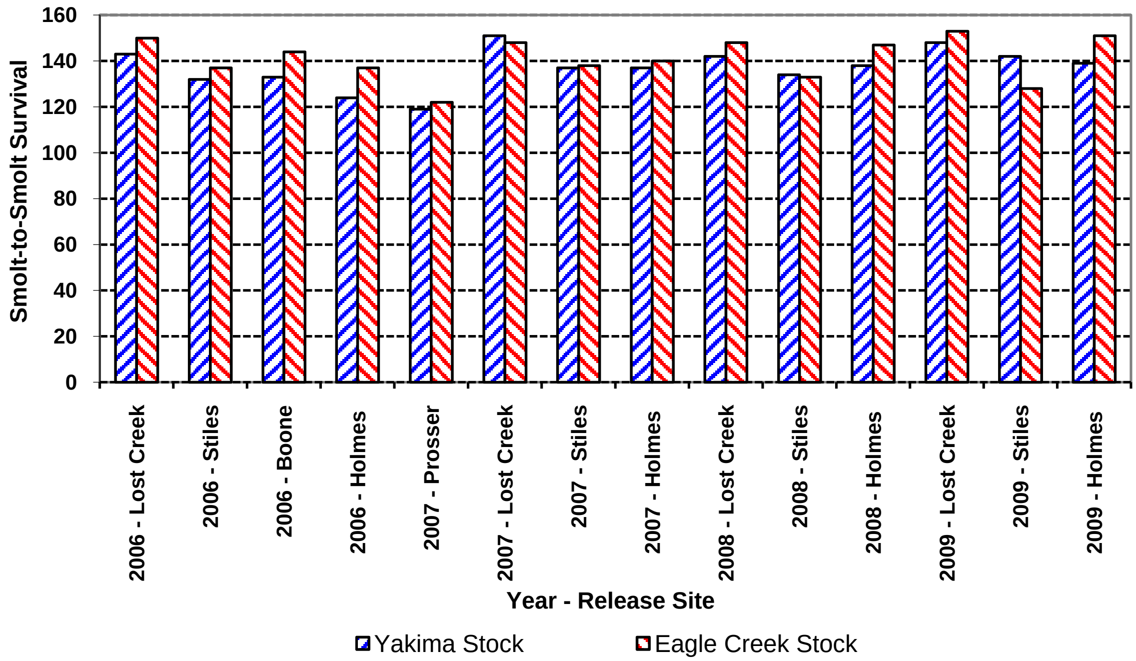


Table 4. Weighted* Least-Squares Analysis of Variance of Mean Julian Passage Date of Tagged Fish for only those sites within years having both Yakima-Return and Eagle Creek Stock Releases

Source	Sum of Squares (SS)	Degrees of Freedom (DF)	Mean Square (SS/DF)	F-Ratio	Type 1 Error P
Years, Ponds (adjusted for stock)	1410415.00	13	108493.46	5.91	0.0015
Stock(adjusted for Years, Ponds)	7113.00	1	7113.00	0.39	0.5444
Error**	238632.00	13	18356.31		

* Weight = expanded number detected at McNary, expansion--division by McNary detection efficiency

** Pooling of Year x Stock and Site x Stock Interaction Variation

Appendix A. Tables of Smolt Means

Table A.1. Outmigration-Year 2006-2009 Volitional-Release-to-McNary Smolt Survival (2004-2007 Brood)

			Release-Site Subbasin and Pond within Subbasin					
			Upper Yakima	Naches			Main Stem Yakima	
Release Year	Stock	Measure	Holmes	Stiles	Lost Creek	Pooled*	Prosser	Marion Drain
2006	**Yakima**	**Survival to McNary**	**25.01%**	**39.15%**	**68.02%**	**50.64%**		
		Number Volitionally Released	781	1598	1057	2655		
	Eagle Creek	**Survival to McNary**	**18.62%**	**38.81%**	**62.66%**	**49.72%**	**74.78%**	
		Number Volitionally Released	636	1974	1663	3637	912	
2007	**Yakima**	**Survival to McNary**	**22.01%**	**46.76%**	**35.83%**	**40.41%**	**69.75%**	
		Number Volitionally Released	920	1204	1671	2875	2112	
	Eagle Creek	**Survival to McNary**	**12.02%**	**39.39%**	**20.68%**	**29.53%**	**48.35%**	
		Number Volitionally Released	1293	1881	2092	3973	1136	
2008	**Yakima**	**Survival to McNary**	**	**64.75%**	**39.25%**	**52.37%**		**
		Number Volitionally Released		1731	1633	3364		
	Eagle Creek	**Survival to McNary**	**	**50.09%**	**28.37%**	**39.64%**	**5.53%**	
		Number Volitionally Released		2110	1956	4066	507	
2009	**Yakima**	**Survival to McNary**	**24.38%**	**49.24%**	**39.61%**	**42.05%**	**58.14%**	
		Number Volitionally Released	48	696	2053	2749	2299	
	Eagle Creek	**Survival to McNary**	**18.29%**	**36.23%**	**31.32%**	**32.88%**		
		Number Volitionally Released	130	908	1946	2854		

*** Pooled over only those Sites having both Yakima and Eagle Creek Releases (unshaded)**

**** No PIT-tag detections at McNary**

Appendix A. Tables of Smolt Means (continued)

Table A.2. Outmigration-Year 2006-2009 Pre-release Survival of Tagged Smolt (2004-2007 Brood)

			Release-Site Subbasin and Pond within Subbasin					
			Upper Yakima	Naches			Main Stem Yakima	
Release Year	Stock	Measure	Holmes	Stiles	Lost Creek	Pooled*	Prosser	Marion Drain
2006	**Yakima**	**Pre-Release Survival**	**48.69%**	**91.75%**	**53.84%**	**72.79%**		
		Number Tagged	2512	2490	2491	4981		
	Eagle Creek	**Pre-Release Survival**	**60.50%**	**88.55%**	**69.56%**	**79.04%**	**80.82%**	
		Number Tagged	2514	2506	2515	5021	1231	
2007	**Yakima**	**Pre-Release Survival**	**48.40%**	**54.99%**	**66.81%**	**60.96%**	**85.88%**	
		Number Tagged	2460	2449	2501	4950	2499	
	Eagle Creek	**Pre-Release Survival**	**58.62%**	**81.81%**	**84.26%**	**83.04%**	**91.67%**	
		Number Tagged	2504	2513	2511	5024	1246	
2008	**Yakima**	**Pre-Release Survival**	**	**71.98%**	**73.82%**	**72.90%**		**
		Number Tagged	2493	2492	2499	4991		3013
	Eagle Creek	**Pre-Release Survival**	**	**86.02%**	**91.13%**	**88.61%**	**100.00%**	
		Number Tagged	2508	2453	2524	4977	854	
2009	**Yakima**	**Pre-Release Survival**	**51.59%**	**91.12%**	**84.60%**	**87.87%**	**97.56%**	
		Number Tagged	2512	2515	2508	5023	2506	
	Eagle Creek	**Pre-Release Survival**	**61.49%**	**100.00%**	**89.56%**	**96.00%**		
		Number Tagged	1427	3755	2331	6086		

*** Pooled over only those Sites having both Yakima and Eagle Creek Releases (unshaded)**

** No PIT-tag detections at release site

Table A.3. Outmigration-Year 2006-2009 Time-of-Tagging-to-McNary Smolt Survival (2004-2007 Brood)

			Release-Site Subbasin/Pond within Subbasin							
			Upper Yakima							
Release Year	Stock	Measure	Holmes	Boone	CleElum	Cowiche	Taneum Creek	Umtanum Creek	Easton	Pooled*
2006	**Yakima**	**Survival to McNary**	**12.48%**	**3.69%**						**8.10%**
		NumberTagged	2512	2501						5013
	Eagle Creek	**Survival to McNary**	**11.82%**	**2.57%**						**7.21%**
		NumberTagged	2514	2500						5014
2007	**Yakima**	**Survival to McNary**	**10.77%**							**10.77%**
		NumberTagged	2460							2460
	Eagle Creek	**Survival to McNary**	**7.08%**							**7.08%**
		NumberTagged	2504							2504
2008	**Yakima**	**Survival to McNary**	**11.17%**							**11.17%**
		NumberTagged	2493							2493
	Eagle Creek	**Survival to McNary**	**13.89%**						**41.45%**	**13.89%**
		NumberTagged	2508						2500	2508
2009	**Yakima**	**Survival to McNary**	**9.19%**		**0.21%**	**45.42%**	**15.67%**	**44.32%**		**9.19%**
		NumberTagged	2512		11934	817	1300	150		2512
	Eagle Creek	**Survival to McNary**	**12.01%**						**16.38%**	**12.01%**
		NumberTagged	1427						2524	1427

*** Shaded are release sites with no PIT-tag detectors and, consequently with no estimates of pre-release or release-to-McNary survivals**

Appendix A. Tables of Smolt Means (continued)

Table A.3. Outmigration-Year 2006-2009 Time-of-Tagging-to-McNary Smolt Survival (2004-2007 Brood)

			Release-Site Subbasin/Pond within Subbasin				
			Naches			Main Stem Yakima	
Release Year	Stock	Measure	Stiles	Lost Creek	Pooled*	Prosser	Marion Drain
2006	**Yakima**	**Survival to McNary**	**34.99%**	**34.76%**	**34.87%**		
		NumberTagged	2490	2491	4981		
	Eagle Creek	**Survival to McNary**	**35.05%**	**43.81%**	**39.44%**	**60.52%**	
		NumberTagged	2506	2515	5021	1231	
2007	**Yakima**	**Survival to McNary**	**25.65%**	**23.94%**	**24.79%**	**59.84%**	
		NumberTagged	2449	2501	4950	2499	
	Eagle Creek	**Survival to McNary**	**32.07%**	**17.39%**	**24.73%**	**44.30%**	
		NumberTagged	2513	2511	5024	1246	
2008	**Yakima**	**Survival to McNary**	**46.59%**	**28.58%**	**37.57%**		**26.18%**
		NumberTagged	2492	2499	4991		3013
	Eagle Creek	**Survival to McNary**	**43.08%**	**26.76%**	**34.81%**	**20.13%**	
		NumberTagged	2453	2524	4977	854	
2009	**Yakima**	**Survival to McNary**	**47.27%**	**33.70%**	**40.49%**	**56.76%**	
		NumberTagged	2515	2508	5023	2506	
	Eagle Creek	**Survival to McNary**	**40.80%**	**27.76%**	**35.81%**		
		NumberTagged	3755	2331	6086		

*** Shaded are release sites with no PIT-tag detectors and, consequently with no estimates of pre-release or release-to-McNary survivals**

Appendix A. Tables of Smolt Means (continued)

Table 4.a. Outmigration-Year 2006-2009 Mean Julian Pasage Date of Tagged Smolt (2004-2007 Brood)

			Release-Site Subbasin/Pond within Subbasin							Release-Site Sub
			Upper Yakima							
Release Year	Stock	Measure	Holmes	Boone	CleElum	Cowiche	Taneum Creek	Umtanum Creek	Easton	Pooled*
2006	**Yakima**	**Julian Detection Date**	**124**	**133**						**126**
		Expanded McNary Passage	313	92						405
	Eagle Creek	**Julian Detection Date**	**137**	**144**						**138**
		Expanded McNary Passage	297	64						361
2007	**Yakima**	**Julian Detection Date**	**137**							**137**
		Expanded McNary Passage	265							265
	Eagle Creek	**Julian Detection Date**	**140**							**140**
		Expanded McNary Passage	177							177
2008	**Yakima**	**Julian Detection Date**	**138**							**138**
		Expanded McNary Passage	278							278
	Eagle Creek	**Julian Detection Date**	**147**						**135**	**147**
		Expanded McNary Passage	348						1036	348
2009	**Yakima**	**Julian Detection Date**	**139**		**164**	**139**	**160**	**143**		**139**
		Expanded McNary Passage	230		25	371	204	66		230
	Eagle Creek	**Julian Detection Date**	**151**						**147**	**151**
		Expanded McNary Passage	171						413	171

*** Pooled over only those Sites having both Yakima and Eagle Creek Releases (unshaded)**

Table 4.a. (continued) Outmigration-Year 2006-2009 Mean Julian Pasage Date of Tagged Smolt (2004-2007 Brood)

			Release-Site Subbasin/Pond within Subbasin				
			Naches			Main Stem Yakima	
Release Year	Stock	Measure	Stiles	Lost Creek	Pooled*	Prosser	Marion Drain
2006	**Yakima**	**Julian Detection Date**	**132**	**143**	**137**		
		Expanded McNary Passage	871	865	1736		
	Eagle Creek	**Julian Detection Date**	**137**	**150**	**138**	**122**	
		Expanded McNary Passage	878	110	988	744	
2007	**Yakima**	**Julian Detection Date**	**137**	**151**	**144**	**119**	
		Expanded McNary Passage	628	598	1226	1495	
	Eagle Creek	**Julian Detection Date**	**138**	**148**	**142**	**122**	
		Expanded McNary Passage	805	436	1241	552	
2008	**Yakima**	**Julian Detection Date**	**134**	**142**	**141**		**122**
		Expanded McNary Passage	116	714	830		788
	Eagle Creek	**Julian Detection Date**	**133**	**148**	**146**	**142**	
		Expanded McNary Passage	105	675	780	171	
2009	**Yakima**	**Julian Detection Date**	**142**	**148**	**144**	**133**	
		Expanded McNary Passage	1188	845	2033	1422	
	Eagle Creek	**Julian Detection Date**	**128**	**153**	**135**		
		Expanded McNary Passage	1532	647	2179		

*** Pooled over only those Sites having both Yakima and Eagle Creek Releases (unshaded)**

Appendix B. Table of Means from Cle Elum below-Dam, Flume and Above-Dam Releases

Table B. 2009 Time-of-Tagging-to-McNary Smolt Survival (2007 Brood)

		Below-Dam/Flume Releases		Above Dam Releases*		
Release Year	Measure	Below Cle-Elum Dam	Cle-Elum Dam Flume	Net Pen Cle-Elum Lake	Cle-Elum Forebay	Cle-Elum Upper Lake
2005	**Tagging-to-McNary Survival**	**3.43%**	**0.00%**			
	Number Tagged	3331	1001			
2006	**Tagging-to-McNary Survival**	**36.27%**	**18.13%**	**0.03%**		
	Number Tagged	1001	1000	9998 **		
2007	**Tagging-to-McNary Survival**			**5.52%**		
	Number Tagged			10269 **		
	Tagging-to-McNary Survival	**10.01%**	**3.82%**	**4.07%**		
	Number Tagged	999	1000	9999		
2008	**Tagging-to-McNary Survival**				**4.49%**	**5.18%**
	Number Tagged				5973	5944
2009	**Tagging-to-McNary Survival**					**0.21%**
	Number Tagged					11934
	Volitional-Release-to-McNary Survival					**0.00%**
	Number Released					193
	Proportion Released					**1.62%**

*** No above-dam survivals greater than 6%**

**** Same file name (DTL06059.CLE) associated with 2006 release year appeared in 2006 and 2007 year detection files with two different number of total number of PIT-tagged fish listed for the two years**

Appendix C. Tables of Parr Means

2005 Release Site	Boone Pond	Holmes Pond	Hanson Pond	Hanson River?
Number Tagged	2529	2527	994	997
Tagging-to-McN Survival	**0.0%**	**1.5%**	**10.1%**	**2.5%**
McN Detection Date		138	142	133

2006 Release Site	Boone Pond	Holmes Pond	Hanson Pond	Yakama at Hanson Pond	Lost Creek Pond	Upper Cle Elum Lake	Naches River	Yakima River
Number Tagged	1026	1024	1006	1009	1022	3004	30	70
Tagging-to-McN Survival	**1.7%**	**3.1%**	**2.8%**	**5.1%**	**28.2%**	**0.5%**	**19.3%**	**0.0%**
McN Detection Date	162	158	150	150	155	169	147	0

2007 Release Site	Holmes Pond	Hanson Pond	Yakama at Hanson Pond	Lost Creek Pond	Buchskin Slough, Nelson Springs	Bumping Lake	Cle Elum River, Tuquala Outlet
Number Tagged	1025	1026	1026	1026	1026	3002	2998
Tagging-to-McN Survival	**7.5%**	**16.9%**	**8.1%**	**25.3%**	**8.2%**	**11.8%**	**1.2%**
McN Detection Date	141	144	144	148	122	159	162

2008 Release Site	Boone Pond	Big Creek	Cowiche Creek	North Fork, Little Naches	Nile Creek	Reecer Creek	Wilson Creek
Number Tagged	2519	3001	3001	3001	3000	3001	3000
Tagging-to-McN Survival	**2.9%**	**12.9%**	**29.4%**	**13.6%**	**17.7%**	**30.9%**	**10.3%**
McN Detection Date	149	150	153	157	155	136	138

2009 Release Site	Big Creek	Cowiche Creek	North Fork, Little Naches	Nile Creek	Reecer Creek	Wilson Creek	Ahtanum Creek	Little Naches	Litle Rattlesnake	Yakima at Crystal Springs
Number Tagged	3003	3001	3003	2999	2965	3007	3002	3000	3005	3003
Tagging-to-McN Survival	**13.0%**	**23.6%**	**14.1%**	**8.5%**	**31.5%**	**19.2%**	**12.9%**	**14.5%**	**1.9%**	**10.1%**
McN Detection Date	155	157	161	147	118	120	151	159	152	158

Appendix D. Estimated Survival Index

The 2008 Annual report described estimation procedures and also presented the estimated detection rates at McNary Dam and the individual-acclimation-pond survival-rate and other estimates for release years 2006 through 2008. Table D.1 provides the McNary detection rates, Table D.2 provides the individual-acclimation-pond tagging-to-McNary-survival indices for 2009, and Table D.3 provides the individual-acclimation-pond release-to-McNary-survival indices for release-year 2009.

Table D.1. Estimated McNary (McN) Detection (Det.) Rates based on Bonneville (Bonn.) and John Day (J.D.) Detections and Pooled

Julian Date Strata		Bonneville (Bonn.) Based			John Day (J.D. based)			Pooled over Bonn.and J.D. (applied detection rates)		
Beginning	Ending	Total Bonn. Det.	Joint Bonn. McN. Det.	McN. Det. Rate	Total J.D. Det.	Joint J.D. McN. Det.	McN. Det. Rate	Total Det.	Joint J.D. McN. Det.	Pooled Det. Rate
	119	160.8	48	0.2985	196.9	69	0.3504	**357.7**	**117**	**0.3271**
120	128	59.0	15	0.2540	32.0	8	0.2501	**91.0**	**23**	**0.2527**
129	133	79.3	32	0.4036	42.6	9	0.2114	**121.9**	**41**	**0.3364**
134	143	485.5	121	0.2492	367.6	93	0.2530	**853.1**	**214**	**0.2508**
144	156	448.3	66	0.1472	654.8	77	0.1176	**1103.1**	**143**	**0.1296**
157	161	171.0	24	0.1403	281.9	29	0.1029	**452.9**	**53**	**0.1170**
162		204.0	56	0.2745	223.2	65	0.2912	**427.2**	**121**	**0.2832**
Total		1608.0	362	0.2251	1799.0	350	0.1946	**3407.0**	**712**	**0.2090**

Table D.2. Tagging-to-McNary Survival-Index Estimates (within strata expanded total equals total divided by pooled detection rate in Table B.1)

	Tagging Group (File Extender) >	DTL09062.CL1 Cle Elum, Upper Lake Yak Smolt	DTL09062.CL2 Cle Elum, Upper Lake Yak Smolt	DTL09041.HE1 Holmes Pond E.C. Smolt	DTL08247.HY1 Holmes Pond Yak Smolt	DTL08247.HY3 Holmes Pond Yak Smolt	DTL09041.LE2 Lost Creek E.C. Smolt
Stratum 1	Total	0	0	0	3	1	0
	Removed	0	0	0	0	0	0
	Subtotal	0	0	0	3	1	0
	Expanded Total	0.0	0.0	0.0	9.2	3.1	0.0
Stratum 2	Total	0	0	0	2	1	0
	Removed	0	0	0	0	0	0
	Subtotal	0	0	0	2	1	0
	Expanded Total	0.0	0.0	0.0	7.9	4.0	0.0
Stratum 3	Total	0	0	0	7	4	0
	Removed	0	0	0	0	0	0
	Subtotal	0	0	0	7	4	0
	Expanded Total	0.0	0.0	0.0	20.8	11.9	0.0
Stratum 4	Total	1	0	9	16	12	32
	Removed	0	0	0	0	0	0
	Subtotal	1	0	9	16	12	32
	Expanded Total	4.0	0.0	35.9	63.8	47.8	127.6
Stratum 5	Total	0	0	10	3	4	36
	Removed	0	0	0	0	0	0
	Subtotal	0	0	10	3	4	36
	Expanded Total	0.0	0.0	77.1	23.1	30.9	277.7
Stratum 6	Total	0	0	6	0	1	13
	Removed	0	0	0	0	0	0
	Subtotal	0	0	6	0	1	13
	Expanded Total	0.0	0.0	51.3	0.0	8.5	111.1
Stratum 7	Total	0	6	2	0	0	37
	Removed	0	0	0	0	0	0
	Subtotal	0	6	2	0	0	37
	Expanded Total	0.0	21.2	7.1	0.0	0.0	130.6
Release Summary	Total over Strata	1	0	4	0	2	110
	Expanded Total over Strata	4.0	0.0	23.8	0.0	11.7	609.5
	Number Tagged	79	114	130	15	33	1946
	tagghing-to-McN Survival	0.0008	0.0000	0.1829	0.0000	0.3546	0.3132
Source Summary	Pooled Number Released		193	130		48	1946
	Pooled Tagging-to-McNary Survival		0.0003	0.1829		0.2438	0.3132

Table D.2. Tagging-to-McNary Survival-Index Estimates (continued)

	DTL08246.LY1 Lost Creek Yak Smolt	DTL08246.LY3 Lost Creek Yak Smolt	DTL08247.PY1 Prosser Hatchery Yak Smolt	DTL08247.PY2 Prosser Hatchery Yak Smolt	DTL09041.SE1 Stiles Pond E.C. Smolt	DTL09041.SE3 Stiles Pond E.C. Smolt	DTL08246.SY1 Stiles Pond Yak Smolt	DTL08246.SY3 Stiles Pond Yak Smolt
Stratum 1	0	0	144	127	0	0	0	0
	0	0	0	0	0	0	0	0
	0	0	144	127	0	0	0	0
	0.0	0.0	440.3	388.3	0.0	0.0	0.0	0.0
Stratum 2	1	0	36	37	0	0	2	0
	0	0	0	0	0	0	0	0
	1	0	36	37	0	0	2	0
	4.0	0.0	142.5	146.4	0.0	0.0	7.9	0.0
Stratum 3	4	1	32	29	9	7	18	20
	0	0	0	0	0	0	0	0
	4	1	32	29	9	7	18	20
	11.9	3.0	95.1	86.2	26.7	20.8	53.5	59.4
Stratum 4	31	39	14	17	146	69	77	101
	0	0	0	0	0	0	0	0
	31	39	14	17	146	69	77	101
	123.6	155.5	55.8	67.8	582.0	275.1	307.0	402.6
Stratum 5	21	26	0	0	46	20	21	16
	0	0	0	0	0	0	0	0
	21	26	0	0	46	20	21	16
	162.0	200.6	0.0	0.0	354.8	154.3	162.0	123.4
Stratum 6	6	9	0	0	3	3	2	2
	0	0	0	0	0	0	0	0
	6	9	0	0	3	3	2	2
	51.3	76.9	0.0	0.0	25.6	25.6	17.1	17.1
Stratum 7	6	10	0	0	13	6	3	8
	0	0	0	0	0	0	0	0
	6	10	0	0	13	6	3	8
	21.2	35.3	0.0	0.0	45.9	21.2	10.6	28.2
Release Summary	68	81	215	195	45	28	36	46
	366.2	447.1	698.3	638.5	208.5	120.5	153.8	189.0
	1050	1003	1155	1144	603	305	360	336
	0.3487	0.4457	0.6046	0.5581	0.3457	0.3950	0.4271	0.5624
Source Summary	1050	2053		2299		908		696
	0.3487	0.3961		0.5814		0.3623		0.4924

Table D.3. Release-to-McNary Survival-Index (unadjusted for mini-jacks) and other Estimates (within strata expanded total equals total divided by pooled detection rate in Table B.1)

	Tagging Group (File Extender) >	DTL09062.CL1 Cle Elum, Upper Lake Yak Smolt	DTL09062.CL2 Cle Elum, Upper Lake Yak Smolt	DTL09041.HE1 Holmes Pond E.C. Smolt	DTL08247.HY1 Holmes Pond Yak Smolt	DTL08247.HY3 Holmes Pond Yak Smolt	DTL09041.LE2 Lost Creek E.C. Smolt
Stratum 1	Total	0	0	0	0	0	0
	Removed	0	0	0	0	0	0
	Subtotal	0	0	0	0	0	0
	Expanded Total	0.0	0.0	0.0	0.0	0.0	0.0
Stratum 2	Total	0	0	0	0	0	0
	Removed	0	0	0	0	0	0
	Subtotal	0	0	0	0	0	0
	Expanded Total	0.0	0.0	0.0	0.0	0.0	0.0
Stratum 3	Total	0	0	0	0	0	0
	Removed	0	0	0	0	0	0
	Subtotal	0	0	0	0	0	0
	Expanded Total	0.0	0.0	0.0	0.0	0.0	0.0
Stratum 4	Total	0	0	1	0	1	30
	Removed	0	0	0	0	0	0
	Subtotal	0	0	1	0	1	30
	Expanded Total	0.0	0.0	4.0	0.0	4.0	119.6
Stratum 5	Total	0	0	1	0	1	34
	Removed	0	0	0	0	0	0
	Subtotal	0	0	1	0	1	34
	Expanded Total	0.0	0.0	7.7	0.0	7.7	262.3
Stratum 6	Total	0	0	1	0	0	13
	Removed	0	0	0	0	0	0
	Subtotal	0	0	1	0	0	13
	Expanded Total	0.0	0.0	8.5	0.0	0.0	111.1
Stratum 7	Total	0	0	1	0	0	33
	Removed	0	0	0	0	0	0
	Subtotal	0	0	1	0	0	33
	Expanded Total	0.0	0.0	3.5	0.0	0.0	116.5
Release Summary	Total over Strata	0	0	4	0	2	110
	Expanded Total over Strata	0.0	0.0	23.8	0.0	11.7	609.5
	Volitional Releases	79	114	130	15	33	1946
	Release-to-McN Survival	0.0000	0.0000	0.1829	0.0000	0.3546	0.3132
Source Summary	Pooled Number Released		193	130		48	1946
	Pooled Tagging-to-McNary Survival		0.0000	0.1829		0.2438	0.3132
Release Summary	Num Rel/Num Tag	0.0158	0.0164	0.0911	0.0119	0.0263	0.8348
	Number Tagged	4990	6944	1427	1259	1253	2331
	Pond Detection Rate	0.0000	0.0000	0.1481	0.0000	0.0870	0.9322
	Pond Survival					0.3029	0.8956
Source Summary	Number Tagged		11934	1427		2512	1
	Pond Survival		0.0000	0.0000		0.1511	2331.0000

Table D.3. Release-to-McNary Survival-Index (unadjusted for mini-jacks) and other Estimates (continued)

	Tagging Group (File Extender) >	DTL08246.LY1 Lost Creek Yak Smolt	DTL08246.LY3 Lost Creek Yak Smolt	DTL08247.PY1 Prosser Hatchery Yak Smolt	DTL08247.PY2 Prosser Hatchery Yak Smolt	DTL09041.SE1 Stiles Pond E.C. Smolt	DTL09041.SE3 Stiles Pond E.C. Smolt	DTL08246.SY1 Stiles Pond Yak Smolt	DTL08246.SY3 Stiles Pond Yak Smolt
Stratum 1	Total	0	0	135	119	0	0	0	0
	Removed	0	0	0	0	0	0	0	0
	Subtotal	0	0	135	119	0	0	0	0
	Expanded Total	0.0	0.0	412.8	363.9	0.0	0.0	0.0	0.0
Stratum 2	Total	1	0	34	34	0	0	2	0
	Removed	0	0	0	0	0	0	0	0
	Subtotal	1	0	34	34	0	0	2	0
	Expanded Total	4.0	0.0	134.6	134.6	0.0	0.0	7.9	0.0
Stratum 3	Total	4	1	32	27	2	5	11	11
	Removed	0	0	0	0	0	0	0	0
	Subtotal	4	1	32	27	2	5	11	11
	Expanded Total	11.9	3.0	95.1	80.2	5.9	14.9	32.7	32.7
Stratum 4	Total	31	39	14	15	25	15	15	24
	Removed	0	0	0	0	0	0	0	0
	Subtotal	31	39	14	15	25	15	15	24
	Expanded Total	123.6	155.5	55.8	59.8	99.7	59.8	59.8	95.7
Stratum 5	Total	20	26	0	0	7	3	6	4
	Removed	0	0	0	0	0	0	0	0
	Subtotal	20	26	0	0	7	3	6	4
	Expanded Total	154.3	200.6	0.0	0.0	54.0	23.1	46.3	30.9
Stratum 6	Total	6	7	0	0	2	1	0	1
	Removed	0	0	0	0	0	0	0	0
	Subtotal	6	7	0	0	2	1	0	1
	Expanded Total	51.3	59.8	0.0	0.0	17.1	8.5	0.0	8.5
Stratum 7	Total	6	8	0	0	9	4	2	6
	Removed	0	0	0	0	0	0	0	0
	Subtotal	6	8	0	0	9	4	2	6
	Expanded Total	21.2	28.2	0.0	0.0	31.8	14.1	7.1	21.2
Release Summary	Total over Strata	68	81	215	195	45	28	36	46
	Expanded Total over Strata	366.2	447.1	698.3	638.5	208.5	120.5	153.8	189.0
	Volitional Releases	1050	1003	1155	1144	603	305	360	336
	Release-to-McN Survival	0.3487	0.4457	0.6046	0.5581	0.3457	0.3950	0.4271	0.5624
Source Summary	Pooled Number Released		2053		2299		908		696
	Pooled Tagging-to-McNary Survival		0.3961		0.5814		0.3623		0.4924
Release Summary	Num Rel/Num Tag	0.8393	0.7979	0.9203	0.9145	0.2407	0.2440	0.2862	0.2673
	Number Tagged	1251	1257	1255	1251	2505	1250	1258	1257
	Pond Detection Rate	0.9855	0.9529	0.9513	0.9286	0.2074	0.2667	0.2927	0.3129
	Pond Survival	0.8517	0.8373	0.9674	0.9848	1.1608	0.9150	0.9777	0.8542
Source Summary	Number Tagged		2508		2506		3755		2515
	Pond Survival		0.8445		0.9761		1.0790		0.9160

Appendix G

Monitoring and Evaluation of Avian Predation on Juvenile Salmonids on the Yakima River, Washington

Annual Report 2009

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EXECUTIVE SUMMARY

Gull numbers remain low in the Yakima River Basin and the focus of future studies has shifted towards: Pelican numbers and diet, management of extreme numbers of piscivorous birds in given areas, and surveys of PIT tags where mortality can be linked to predation.

Mergansers on their breeding grounds in the upper and middle Yakima River have not shown a numeric response to hatchery supplementation of spring Chinook and Coho salmon smolts yet remain a concern as they are known to congregate in large numbers below Roza Dam.

Pelican numbers remain a concern as in previous years. Pelican numbers at Chandler and Wanawish Dam have become a noteworthy concern as new findings of predation by Pelicans comes to light. PIT tag data from Badger Island and Chandler Juvenile bypass shows American White Pelicans are targeting YINN juvenile salmonids.

The Double Crested Cormorant presence of 2008 at the Sunnyside Wildlife Area Great Blue Heron Rookery has developed into a breeding colony. PIT tag surveys of the Double Crested Cormorant Colony produced high numbers of PIT tags, and when compared to similar nests numbers of nearby Great Blue Herons, Cormorants produced significantly higher numbers of PIT tags.

The Chandler Bypass outfall pipe makes fish of all species vulnerable to predation at low water, as the fish are disoriented and upwelling at right angles to the current The presence of large dead and disabled fish exiting from the bypass pipe may attract avian predators to the site. PIT tag detection at Chandler outlet pipe did show high mortality for both juvenile and adult salmonids.

PIT tag surveys in 2009 proved very productive as over 14,352 tags have been discovered in the Yakima Basin. PIT tag numbers are significantly larger than the previous 4100 from 2008 surveys. Tags detected were linked to sources of release and 4022 of these tags were from Yakima River juvenile salmonids. Predation by Herons showed correlation with river flow. High flow eliminates opportunity for wading bird foraging in many parts of the river. Conversely low flow creates foraging opportunities for Herons.

PIT tag analysis was developed by determining detection efficiencies in 2 diverse rookeries to assess a number of undetected PIT tags.

Plans for the 2010 field season include continued monitoring of river reaches and at hotspots with a focus on Pelican foraging. Heron rookeries and cormorant nesting colonies will continue to be surveyed. PIT tags found at pelican, heron nesting and roosting sites will be used to assign smolt predation estimates to specific bird species.

INTRODUCTION

Note:
For the purposes of this document the phrase "juvenile salmonids" refers to immature fish of the following stocks: Spring Chinook and Fall Chinook (*Oncorhynchus tshawytscha*), Coho (*O. kisutch*), and summer steelhead (*O. mykiss*). Please review the 2005 report for the goals and history of the avian predation project. For a more detailed description of previous years' results and the statistical methods involved in this monitoring effort please refer to this project's previous annual reports located on the Yakima Klickitat Fisheries Project's website, www.ykfp.org or the

Bonneville Power Administration's fish and wildlife technical publications and draft reports website, http://www.efw.bpa.gov/IntegratedFWP/reportcenter.aspx.

Avian Predation of Juvenile Salmon

Bird predation of juvenile salmonids is common throughout the Columbia River Basin, which supports some of the highest populations of piscivorous birds in North America and Europe (Ruggerone 1986; Roby et al. 1998). Many piscivorous birds within this basin are colonial nesters, including Ring-billed and California Gulls, Caspian and Forster's Terns, Double-crested Cormorants, Great Blue Herons, Black-crowned Night-herons, Great Egrets and American White Pelicans (See table 1 for Latin names). Colonial nesters are particularly suited to the exploitation of prey fish with fluctuating densities (Alcock 1968; Ward and Zahavi 1996). Prey fish density fluctuations can result from large migratory accumulations, releases from hatcheries, physical obstructions that concentrate or disorient fish, and other features and events which occur in complex river systems. Table 1 includes piscivorous birds and acronyms that are referred to in this document.

Common Merganser (*Mergus merganser*) COME
American White Pelican (*Pelecanus erythrorhynchos*) AWPE
California Gull (*Larus californicus*) GULL
Ring-billed Gull (*Larus delawarensis*) GULL
Belted Kingfisher (*Ceryle alcyon*) BEKI
Great Blue Heron (*Ardea herodias*) GBHE
Double-crested Cormorant (*Phalacrocorax auritus*) DCCO
Black-crowned Night-Heron (*Nycticorax nycticorax*) BCHE
Forster's Tern (*Sterna forsteri*) FOTE
Great Egret (*Ardea alba*) GREG
Hooded Merganser (*Lophodytes cucullatus*) HOME
Bald Eagle (*Haliaeetus leucocephalus*)
Osprey (*Pandion haliaetus*) OSPR
Caspian Tern (*Sterna caspia*) CATE

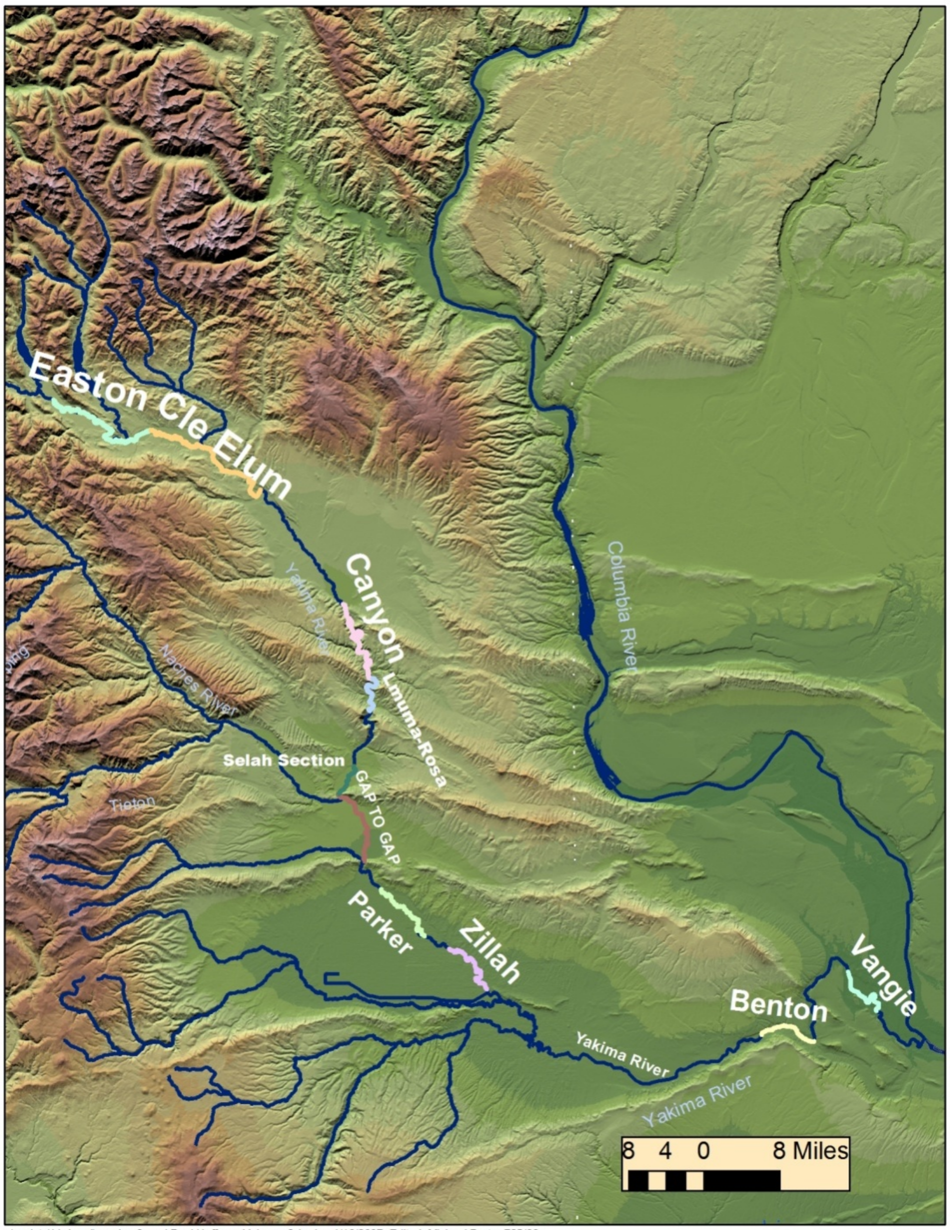
Table 1. Piscivorous birds observed along the Yakama River (note codes for graphs)

Study Area

The Yakima River Basin encompasses a total of 15,900 square kilometers in south-central Washington State. The Yakima River runs along the eastern slopes of the Cascade mountain range for a total length of approximately 330 kilometers (Figure 1). The terrain and habitat varies greatly along its length, which begins at 2,440 meters in elevation at the headwaters and ends at 104 meters elevation at its mouth on the Columbia River near the City of Richland, WA.

The upper reaches of the Yakima River, above the town of Cle Elum, are high gradient areas dominated by mixed conifer forests in association with a high degree of river braiding, log jams and woody debris. Middle reaches from Cle Elum to Selah are areas of intermediate gradient with less braiding and more varied terrain, including mixed hardwoods and conifers proximate to the river channel, frequent canyon type geography, and increasingly frequent arid shrub-steppe and irrigated agricultural lands. The lower reaches of the river, from Selah to the Columbia River, exhibit a low gradient, an infrequently braided river channel, and are dominated by hardwoods proximate to the river channel with some arid steppe and irrigated agricultural lands abutting the shoreline.

In 2009 river surveys included sections of the Yakima River near the towns Selah (6.42 km), Parker (18.31), and Yakima near the Greenway (15.85). These sections include areas where piscivorous birds are commonly seen and a section of the river thought to be a high source of mortality of juvenile salmonids. These river sections are included in the updated 2009 river drift map (Figure 1).



c:\avdata\birdpred\reaches3.mxd Paul Huffman Yakama fisheries 4/10/2007. Edited: Michael Porter 725/09

Figure 1. Yakima River Basin with locations of 2009 surveyed reaches

DEVELOPING STUDIES

Survey of PIT tags in the Yakima Basin: Water Flow effect on Predation Rate

Within the Yakima Basin YKFP is implementing a study to assess the impacts of the Great Blue Heron on anadromous salmonids. Goals of the study are to identify, map, and survey heron rookeries for salmonid PIT Tags. Heron Rookeries have been discovered to contain PIT tags under nested trees (Sampson and Fast 2000). In 2007 testing with a portable Pit Tag reader was conducted to determine whether surveys of Bird Colonies/Rookeries and gravel bars was possible. Testing found that it was possible for the portable Pit Tag reader to detect defecated pit tags. In 2008 YKFP began development of survey methods for PIT Tags within Great Blue Heron rookeries**.** For 2009 PIT tag surveys produced significantly great results of 7,609 PIT tags discovered (total includes all survey years).

For over a decade, research and supplementation of the various salmon run has been conducted within the Yakima Basin. Research to assess the survivability and return rates of supplemented salmon using information gathered from Passive Integrated Transponder (PIT Tags) is a designated work task for YKFP. PIT tags are implanted within a low percentage of Hatchery and wild salmon stocks, and were initially uses as a method to determine the returning number of adult salmon. PIT tag readers are strategically placed along salmon migration routes for interrogating outgoing and incoming PIT tagged salmon. Portable PIT Tag readers have been developed to assist in research and hatchery operation. The use of PIT tags for discovering the mortality rate of salmonid smolts will be the focus of this study. PIT tag data for the region is currently managed by the Pacific States Marine Fisheries Commission (PSMFC).

PIT tags contain a variety of information about the fish it is associated with. The type of information included is determined by the biologist and organization the tag was issued to. This information has helped fisheries biologists find the success of PIT tag fish returns as adult spawners and show the overall success of fisheries programs. Examples of some types of information available within PIT tags are; species, run, rear type, length, acclimation site, release, fish groups (tag file id) along with messages and organization info. The PSMFC under the data program maintains PTAGIS, "PIT Tag Information System (PTAGIS) is a data collection, distribution, and coordination project. The fundamental purpose of PTAGIS is to monitor the migratory habits of fish in migrating through the federal Columbia River power system dams (FCRPS) by collecting and distributing data via electronic PIT Tags" (PSMFC 2006).

Selah Rookery along Interstate 82 remains the focus of the study. The rookery consists of over 30 nests and comprises an area of 12.25 acres (GPS data). PIT tag numbers gained by survey of this rookery are currently being used in a comparison with flow below Roza Dam. Data gathered from the Bureau of Reclamation (BOR) records of water flow, corresponding to the years of the sampled PIT tags, will be used. 2000-2010 years of flow, between the time period beginning in March and ending in June, will examine water flow in the reach between Roza Dam and ending at the confluence of the Yakima and Naches Rivers. This reach is unique due to its low flow from the Roza Power Plant and irrigation system diversion at Roza Dam.

All rookeries in the Yakima Basin will be surveyed and a nest count along with bird counts will be conducted. If feasible all rookeries will be scanned for PIT tags. Selah rookery and the Wapato Wildlife rookery were chosen as sites for detection efficiency estimates.

Along with rookery survey of PIT tags a survey of Dams/Diversions was conducted in 2008. The initial focus was to identify PIT tags below the Chandler outlet pipe and Prosser hatchery release outlet. As a result of a high number of PIT tags found in this area a follow-up survey of the Chandler canal area's fish screens and trash racks was conducted. A high number of PIT tags were observed in this area. Subsequent surveys were expanded to include a number of other dams/diversions along the Yakima River for the 2009 season. PIT tags numbers discovered within the irrigation diversions total 6743 (information on Diversion PIT tags can be found in the 2009 YKFP annual report fish predation section). Combined numbers for total numbers of PIT tags found over all survey years and sites is 14,352.

American White Pelican in the Mid-Columbia Region

The American White Pelicans (pelican) appeared as a Washington breeder in 1994, when 50 birds nested on Crescent Island in the Columbia River, near Burbank, WA. They are currently listed as a Washington State endangered species. At present, the only breeding site in Washington is on Badger Island on the Columbia River, downstream from the mouth of the Yakima River. The Badger Island colony consists of about 500 breeding pairs. These colonial nesters are known to travel 50-80 km in search of food, so some of the birds observed on the Yakima River could be coming from this colony (Motschenbacher 1984). However, the behavior of the birds at Chandler and other Yakima River sites suggests most of these individuals are non-breeders. Leg bands that were recovered from three pelicans found dead on the lower Yakima Basin in recent years indicated the birds came from British Columbia, eastern Montana, and the Klamath National Wildlife Refuge in Oregon border (Tracy Hames, YNWRP, personal communication). Those findings suggest that Yakima River pelicans are birds dispersing from much of the western breeding range of the species.

In the YKFP study, pelicans were first recorded during hotspot surveys at Chandler in 2000 and during river reach surveys along the lower Yakima River in 2001. Based on the river reach model, pelicans in the lower Yakima River, below the Yakima Canyon to its mouth on the Columbia River, accounted for about half of the total fish biomass depredated by piscivorous birds in the entire Yakima River in spring 2001-2002.

Hotspot Surveys

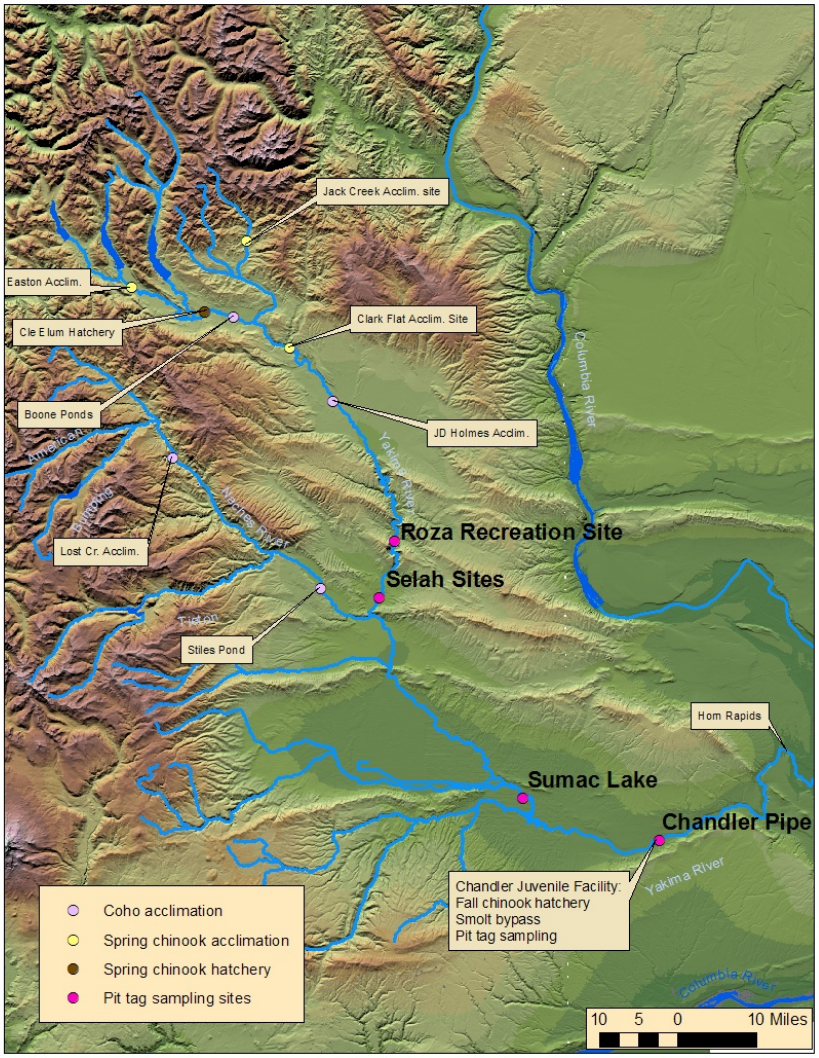
Surveys of high concentrations of piscicvorous birds have been conducted by YKFP from 2001-2009. Using data collected from the study, explained below, YKFP plans to target these areas for future studies of management of these birds.

Study areas are shown in Figure 2, which also includes areas of concern for high concentrations of piscivorous birds. At Chandler Bypass and Wanawish (Horn Rapids) Dam the abundance of gulls, pelicans and other predatory birds was estimated. Horn Rapids seasonal and diurnal patterns of gull abundance at hotspots were identified.

In 2009, 16 hotspot surveys were conducted at Chandler Bypass and 16 at Horn Rapids between April 2 and June 26. Both sites were generally surveyed on the same day at the same time period by different individuals. Leica 10x42 binoculars were used to help monitor bird behavior. The survey area for Chandler included 50 meters of river above the outfall pipe and 150 meters of river below the outfall pipe. All birds resting upon the shoreline lateral to the specified area at both hotspots were included in the abundance counts. The survey area for Horn Rapids included the area 50 meters of river above the dam and 150 meters below the dam. The buoy located above the dam was not included within the survey area; therefore any birds resting upon the buoy were not included in abundance counts. Observations at both sites were made from the shore. At

Horn Rapids observations were made from the south bank of the river, either inside or outside an automobile. At Chandler observations were made from a blind just downstream of the outlet pipe from the juvenile fish facility.

The hotspot survey design for 2009 was consistent with methods used since 2001 (Table 2). Observations either began on the nearest 15-minute interval after sunrise and ran for eight hours, or began at midday and ended on the nearest 15-minute interval before sunset. This allowed for observations during all periods of the day, to account for the diurnal patterns of avian piscivores. Regionally calibrated tables obtained from the National Oceanic and Atmospheric Administration was used to determine sunrise and sunset times at Richland, WA. Depending upon the length of the day and the start time, between seven and eight 2-hour windows existed for each day. Each day was divided into 2-hour survey windows, consisting of three 15-minute abundance and feeding blocks. Between each of these three blocks was a 15-minute period of no observation, unless a feeding interval was still being measured, in which case the observation period was extended into the next 15 minutes. This 75-minute cycle of blocks was followed by a 45-minute rest period before a new 2-hour window was begun. Within each 15-minute survey block the abundance of all piscivorous birds was counted. Sometimes survey periods were truncated because no birds were present for 1-2 hours, usually because of high water.



c:\avdata\birdpred\pelicanpoints2.mxd Paul Huffman 4/10/2007

Figure 2 Yakima River Basin with locations of hotspots (Chandler & Horn Rapids), Spring Chinook acclimation sites, and areas of concern of high concentrations of piscivorous birds.

Data collected from the previous year's studies have influenced a decision by YKFP biologists to look more closely at Pelican impacts on salmon runs. Study proposal plans will likely focus on Pelican use of Chandler Pipe Outlet with hopes of gaining Pelican diet preference, and their impacts on juvenile salmonids.

PIT tag surveys of the only known breeding colony of American White Pelican colony on Badger Island (Columbia River) produced data linking Yakama Nation fish to predation by pelicans. Coupled with YKFP PIT tag survey of a known Pelican foraging area it is becoming evident Pelicans are targeting salmonid smolts as they emigrate from the Yakima River on their way to the ocean.

Hazing of Pelicans at Chandler Juvenile fish bypass and Horn Rapids will be implemented subsequent years if Pelicans remain in large numbers at these Hotspots. Data collected of hazing effects will be presented in YKFP's avian predation 2010 annual report.

Common Mergansers

One of the original concerns of YKFP managers focused on whether mergansers and other avian predators are becoming more abundant in response to increases in Yakama Nation hatchery releases of Chinook and Coho salmon in the Yakima River over time. Data from 2004-2009 appears to indicate that mergansers are not showing a numeric response to increases in the numbers of salmon smolts in the Yakima River over time.

The diet analysis of 20 Common Mergansers collected along the middle and lower Yakima River by Phinney et al. (1998) challenges the assumptions of the worst case scenario above. During that study, only in fall/winter did salmonids make up a significant proportion of the prey, 42.2% (comprised of 15.8% Chinook salmon, 21.1% rainbow trout and 5.3% unidentified salmonids). In spring, middle Yakima River mergansers readily consumed sculpin (alone making up 71.9%), while lower river mergansers readily consumed chiselmouth (alone making up 50%). Yakima River mergansers consumed a wide variety of fish species based on their availability.

Based on the river reach model, Common Mergansers consumed an estimated 21.2% of the fish biomass consumed by birds in the entire Yakima River during the spring 2007 period. This is higher than the 11.3 -12.0% estimated consumption by mergansers during spring 2005-2006. Based on past WDFW data, small fish suitable as prey for small avian predators (5-75 g) make up an estimated average of 21.0% of the fish biomass in the entire Yakima River in spring (2.3% salmonids and 18.7% other taxa), although salmon smolt numbers may be under-estimated (WDFW 1997-2001). These three statistics suggest that mergansers consume salmonids and other fish taxa of the appropriate prey size at a proportion that is less than or equal to their availability in the Yakima River.

A conclusion that could be drawn from these varied data sources is that mergansers breeding along the Yakima River eat small fish and a diversity of species based on their local and seasonal availability. It should not be assumed that mergansers eat only juvenile salmonids. Nor can it be assumed that mergansers select salmonids in a greater proportion than their availability out of the entire fish community assemblage.

Previous data along with large numbers of mergansers located below Roza Dam in 2007 prompted a study of diet and management to be proposed to and permitted by the United States Forest and Wildlife Service. The proposed study was not implemented as drop in the numbers of mergansers was seen in 2008 and 2009. The study permit carried into 2009 and is attached as appendix A. If deemed necessary the permit for study of mergansers at Roza Dam will be requested to be renewed.

METHODS

Survey Seasonality

River reach are organized into two specific time frames within which the impacts of bird predation on juvenile salmon were assessed. The first time frame, from April 1 to June 30, "spring", addressed the impacts of avian predators on juvenile salmon during the spring migration of smolts out of the Yakima River. The second time frame, from July 1 to August 31, "summer", addressed impacts to Coho and Spring Chinook parr and/or residual Coho and Spring Chinook in the upper reaches of the Yakima River. Dividing the survey dates into these time periods allowed for all future sampling efforts to be accomplished on even numbers of 2-week blocks which best fits the consumption model. These two time frames followed the methodological design set forward in the 1999 annual report (Grassley and Grue 2001) and are referred to within this document as “spring” and “summer”. This report and subsequent analysis is organized into these two generalized time frames in an effort to focus on impacts to particular salmonid life histories. PIT tag surveys occur in the fall and winter after PIT tag deposition, Heron nesting, and water diversion.

Data Collection Methods

River Reach Surveys

The spring river surveys included nine river reaches (Figure 1, Table 2). All reaches surveyed in both the spring and summers were identical in length and location to those conducted in previous years, with the exception of the middle reach, Canyon, and new lower reaches Gap to Gap, and Selah Section, added in 2008. The entire Canyon from Ellensburg to Roza was surveyed this year in spring before fishermen and boaters disturbed pelicans and other birds in the Lmuma to Roza stretch. Afterward the lower stretch above Roza Recreation Site was avoided. The survey accounts for coverage of approximately 40% of the total length of the Yakima River.

Name	Start	End	Length (km)
Easton	Easton Acclimation Site	Bridge	29.3
Cle Elum	South Cle Elum Bridge	Thorp Hwy Bridge	28.3
Canyon	Ringer Road	Lmuma or Roza Recreation Site	20.8 or 29.8
Selah Section	Harrison Rd Bridge	Harlan Landing Park	6.42
Gap to gap	Harlan Landing Park	Union Gap	15.85
Parker	Below Parker Dam US Hwy 97	Hwy 8 Bridge	20.3
Zillah	US Hwy 97/ Hwy 8 Bridge	Granger Bridge Ave Hwy Bridge	16.0
Benton	Chandler Canal Power Plant	Benton City Bridge	9.6
Vangie	1.6 km above Twin Bridges	Van Giesen St Hwy Bridge	9.3

Table 2. River reach survey starting and end locations, and total length of reach.

All river reach surveys were conducted by a two-person team from a 16 foot drift boat or 12 foot raft. Surveys began between 8:00 am and 9:00 am and lasted between 2 to 6 hours depending upon the length of the reach and the water level. All surveys were conducted while actively rowing the drift boat or raft downstream to decrease the interval of time required to traverse the reach. One person rowed the boat while the other person recorded piscivorous birds encountered.

All birds detected visually or aurally were recorded, including time of observation, species, and sex and age if distinguishable. Leica 10x42 binoculars were used to help observe birds. All piscivorous birds encountered on the river were recorded at the point of initial observation. Most birds observed were only mildly disturbed by the presence of the survey boat and were quickly passed. Navigation of the survey boat to the opposite side of the river away from encountered birds minimized escape behaviors. If the bird attempted to escape from the survey boat by moving down river a note was made that the bird was being pushed. Birds being pushed were usually kept in sight until passed by the survey boat. If the bird being pushed down river moved out of sight of the survey personnel, a note was made, and the next bird of the same species/age/sex to be encountered within the next 1000 meters of river was assumed to be the pushed bird. If a bird of the same species/age/sex was not encountered in the subsequent 1000 meters, the bird was assumed to have departed the river or passed the survey boat without detection, and the next identification of a bird of the same species/age/sex was recorded as a new observation.

Acclimation Site Surveys

Three Spring Chinook acclimation sites in upper Yakima River (Clark Flat, Jack Creek, & Easton) and one Coho site (Holmes) were surveyed for piscivorous birds in 2008 (Figure 2). Surveys were conducted between January 23 and June 10, though dates varied for each site. Three surveys were conducted at the Spring Chinook sites each day, at 8:00 am, 12:00 noon, and 4:00 pm. The Coho site was surveyed once or twice on days hatchery personnel were feeding smolts. Surveys were conducted on foot. All piscivorous birds within the acclimation facility, along the length of the artificial acclimation stream, and 50 meters above and 150 meters below the acclimation stream outlet, into the main stem of the Yakima River or North Fork Teanaway, were recorded.

Pelican Aerial Surveys

One aerial survey was conducted to identity the abundance and distribution of pelicans. Surveys area focused along the Yakima River from its confluence with the Columbia River to the city of Ellensburg between May 30 and September 4. Based on aerial surveys conducted on the Yakima River in the past, surveys of the Yakima River were divided into 8 geographic reaches extending from the mouth of the Yakima to the northern part of the Canyon south of Ellensburg. Surveys were conducted in the morning between 0600 – 0730. Surveys lasted approximately three hours.

PIT Tag Surveys of Predation

A Passive Integrated Transponder (PIT) tag reader was used to survey for PIT tags deposited in various Yakima River Great Blue Rookeries and Fish Bypass Dams/Diversions in late summer and early fall.

Areas surveyed included: Chandler Fish Bypass/Canal, Wapato Diversion Canal in front and behind Screens, and Wanawish Dam canal right, Roza Dam Fish Screen, Naches River Fish Screens; Great Blue Heron Rookeries in Yakima Basin: Selah, Toppenish Creek, Buena, Wapato Wildlife area, Grandview, and Satus. Based on the salmon tags found at these sites consumption could be assigned to piscivorous fish, American White Pelicans, Double Crested Cormorants, and the Great Blue Herons. Predation is assignment is strictly by observation for example, the Chandler Bypass has been heavily used by pelicans since 2003 while the Selah Heronry supports herons and sometimes cormorants. Dams and Diversion canals sources of mortality may vary by source, possibly piscivorous fish, structure, avian, and flow.

PIT Tags surveys will be conducted using the *Portable Transceiver System: PTS Model FS2001F-ISO from Biomark.* The transceiver is designed to scan for Pit tags and identify them by their given code. A Garmin GPS unit will be used to navigate and map rookeries along with survey plots or points. Additional equipment will include the use of camouflage to limit disturbance for bird nest identification and counts.

Rookeries were surveyed to determine total rookery numbers and Great Blue Heron population numbers via jet boat, plane, and foot. Rookeries are surveyed in the spring and summer for population numbers using binoculars, rookeries are not entered for fear of causing bird abandonment. Once birds have fledged rookeries are cleared of debris under nests to scan for defecated/regurgitated PIT tags.

Dams/Diversions are scanned for PIT tags during the BOR annual maintenance in November and December.

Selah Rookery was chosen as an area of focus due to high concentrations of PIT tags surveyed in 2008. Methods for a study were developed and fall under these general criteria:

- Identify all Rookeries in the Yakima Basin
- Population surveys during nesting
- Detection efficiencies by seeding PIT Tags
- Clearing PIT Tag deposit areas after fledging
- PIT Tag reading post fledge and after flooding
- PIT Tag removal (Tag collision causes interference)
- Aerial flights and river surveys monitor populations

RESULTS & DISCUSSION

River Reach Surveys

In 2009, 14 different piscivorous bird species were observed on the Yakima River (see Table 1 for English and Latin names and alphabetic codes used in figures). These were the typical species observed in previous years.

The middle river reach, Canyon, exhibited the lowest diversity of bird species and the Zillah and Parker drift in the lower river had the highest. The Great Blue Heron and Common Merganser were the only species found on all seven reaches in the spring. The Parker reach appears to have the highest density of avian predators supporting higher numbers of pelicans, Common Mergansers and Great Blue Herons than any other reach.

Common Mergansers were most abundant in the upper reaches of the river as has been the case in all 9 previous years surveyed, followed by Belted Kingfishers (Figure 3 & 4). In the middle reach, Common Mergansers were the most common species in spring and summer as well (Figure 3 & 4). The species distribution along the lower reaches was more variable: pelicans were the most abundant bird at Parker, mergansers were the most abundant bird at Zillah; and gulls were the most abundant bird at Benton and Vangie (Figure 3 & 4)). The number of pelicans counted during the river reach surveys was significantly reduced from the counts in 2006 and similar to 2007. Caspian Terns, another major fish predator on the Lower Columbia River, were occasionally seen in the lower and middle Yakima, Chandler, Horn Rapids, and the Selah Ponds.

Common Mergansers are of particular importance because of their known utilization of salmon smolts in Europe and North America (White 1957; Wood and Hand 1985) and because as in the previous 9 years, they remain the primary avian predator of the upper Yakima River in both the spring and summer periods. Pelicans are important because of their high populations in the lower river and their high daily dietary requirements.

Double-crested Cormorants, a major fish predator on the Lower Columbia River, were found in increasingly high numbers in the lower river and occasionally in the middle river and seen up in the Easton river reach. Cormorants although only common in the river below the Yakima Canyon are the fourth most significant bird predator of small fish in the entire river and appear to have increased in numbers in the middle river and upper stretches of the lower river the last few years. Cormorants also invaded a Great Blue Heron rookery in the spring 2008, taking over nests and roosting, they are currently present to 2009. Figure 5 shows a map of the rookery and nesting cormorants located within the WDFW Sunnyside wildlife area.

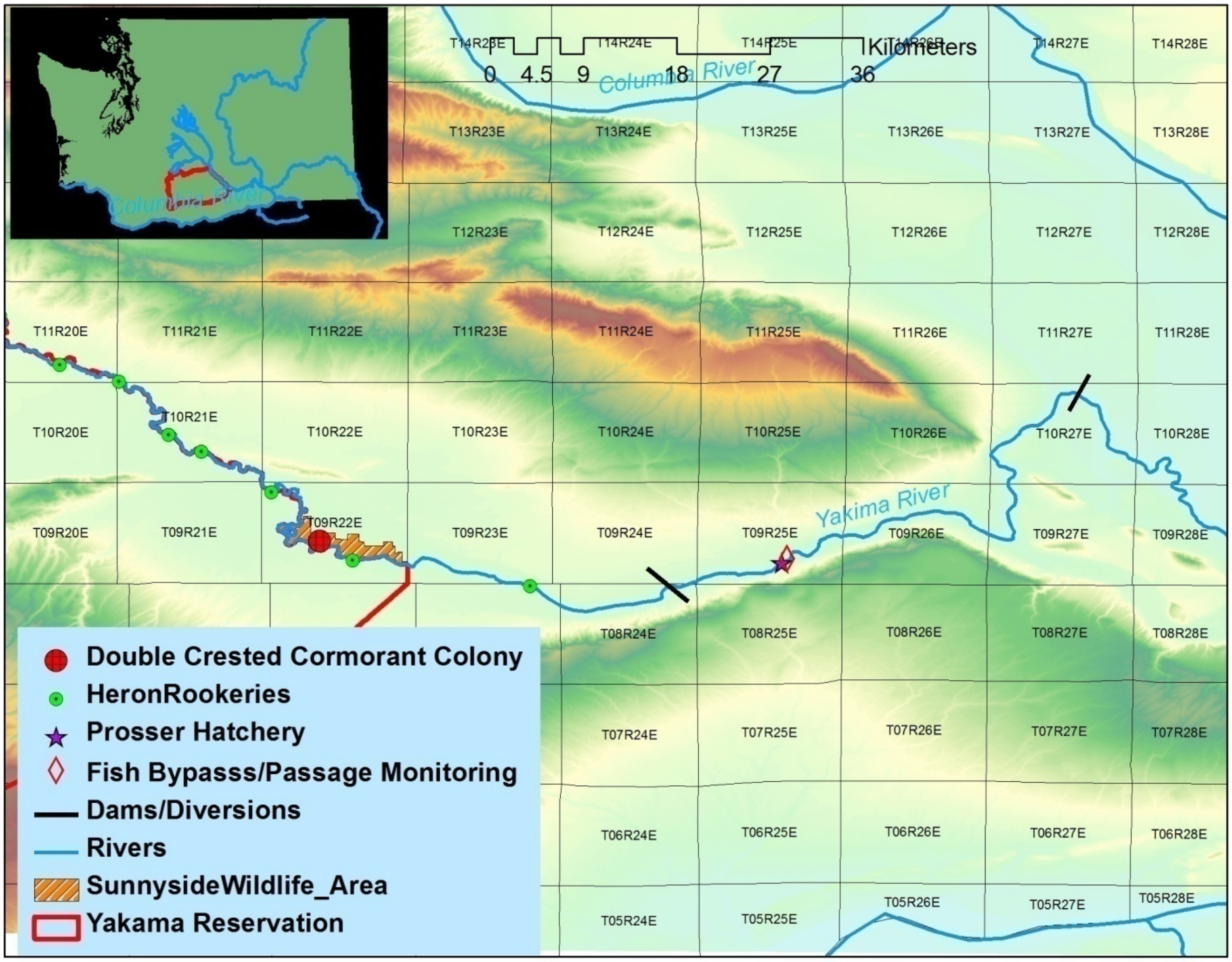


Figure 3. Double Crested Cormorant Colony

Lastly, the Great Blue Heron was the third most common piscivore in the Yakima Basin, previously considered a less significant consumer of smolts because they are known to prey on a wide variety of aquatic and terrestrial species including frogs, crayfish and rodents. New PIT tag studies have shown the Great Blue heron may have a more significant impact to juvenile salmonids than previously believed.

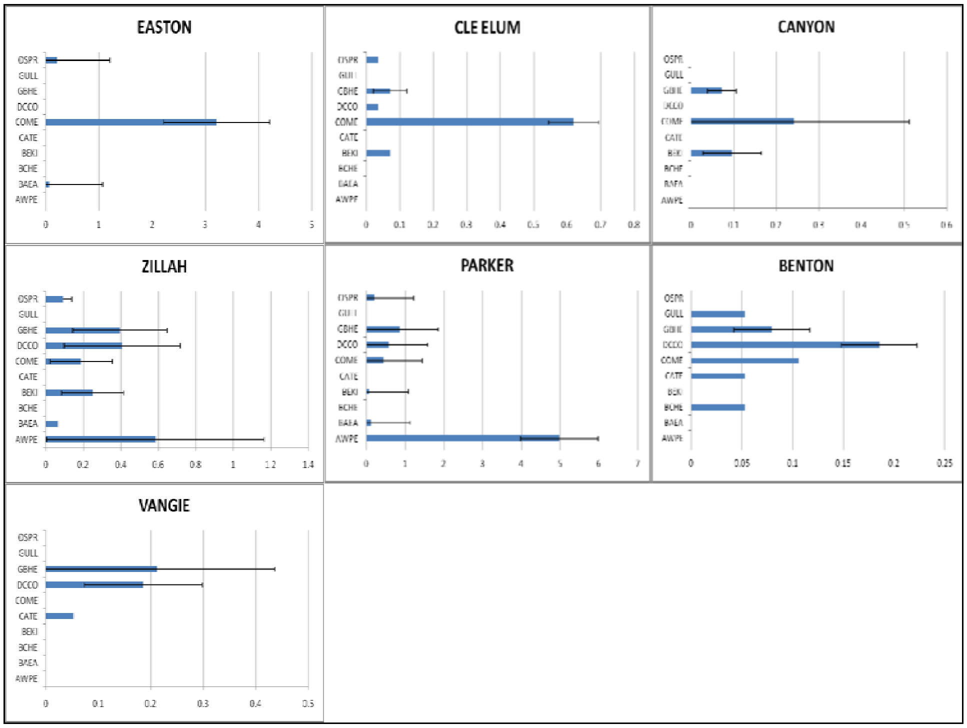


Figure 4. Spring bird abundance per kilometer shown with standard deviation error bars

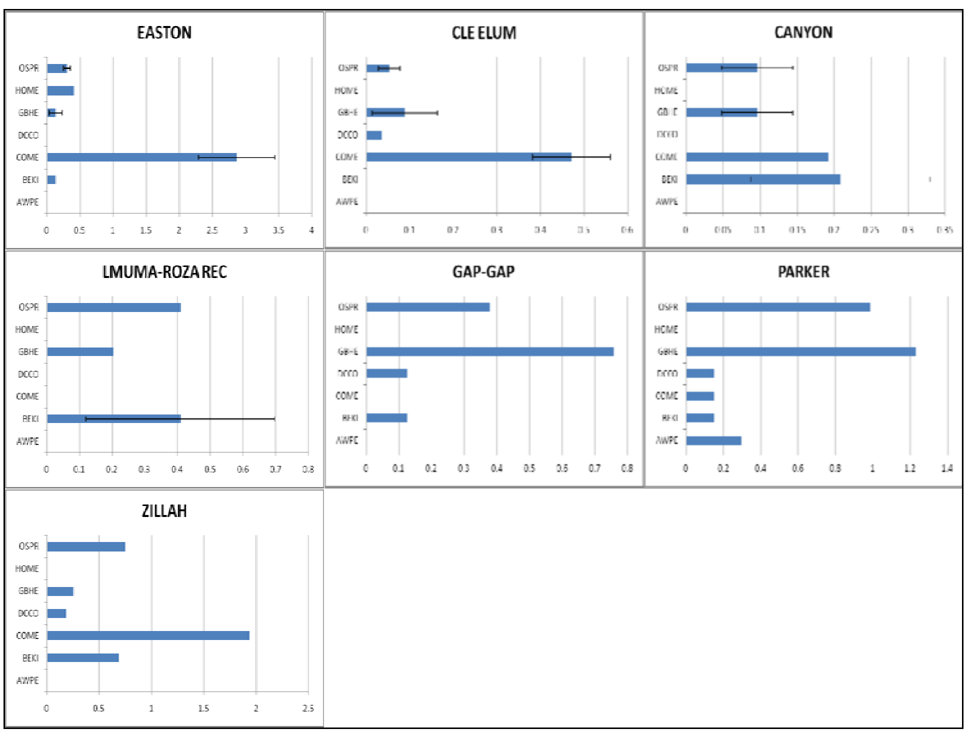


Figure 5. Summer bird abundance per kilometer shown with standard deviation error bars

Abundance for all bird species along with standard deviations is given for the spring (Figure 4) and the summer (Figure 5). These bird abundance show pelicans are found in high numbers in the spring in the Yakima from selah to the confluence of the Columbia River. Pelican numbers are greatly reduced in the summer in this area as nesting at badger island and greater foraging success at hotspots occurs during this time of year.

Total numbers of birds per reach are given by tables 3 & 4. Along the Yakima River and the Yakama reservation boundary it is notable that reaches of Parker and Zillah show the largest amount of piscivorous birds and the number in the reaches significantly increases between April and May.

REACH	REACH LENGTH (KM)	Date	TOTAL NUMBER BIRDS	TOTAL BIRDS PER KM
BENTON	18.9	4/7/2009	8	0.423280423
BENTON	18.9	6/17/2009	8	0.423280423
CANYON	20.8	5/12/2009	11	0.528846154
CANYON	20.8	6/18/2009	6	0.288461538
CLE ELUM	28.3	5/7/2009	19	0.671378092
CLE ELUM	28.3	6/18/2009	24	0.848056537
EASTON	29.3	6/23/2009	102	3.481228669
EMERALD RD-MABTON		5/4/2009	34	
GRANGER-SATUS		4/30/2009	90	
PARKER	20.3	4/9/2009	60	2.955665025
PARKER	20.3	6/16/2009	194	9.556650246
PARKER	20.3	6/25/2009	186	9.162561576
VANGIE	18.9	4/7/2009	10	0.529100529
VANGIE	18.9	6/17/2009	6	0.317460317
ZILLAH	16	4/27/2009	18	1.125
ZILLAH	16	6/6/2009	27	1.6875
ZILLAH	16	6/24/2009	41	2.5625

Table 3. Spring total of piscivorous birds per km and section shown by survey date.

REACH	REACH LENGTH (KM)	Date	TOTAL NUMBER BIRDS	TOTAL BIRDS PER KM
CANYON	20.8	7/8/2009	6	0.288461538
CANYON	20.8	7/30/2009	6	0.288461538
CANYON	20.8	8/26/2009	17	0.817307692
CLE ELUM	28.3	7/27/2009	12	0.424028269
CLE ELUM	28.3	8/5/2009	19	0.671378092
CLE ELUM	28.3	8/24/2009	18	0.636042403
EASTON	29.3	7/29/2009	88	3.003412969
EASTON	29.3	8/4/2009	122	4.163822526
GAP-GAP	15.85	7/16/2009	11	0.694006309
LMUMA-ROZA REC	9.8	7/8/2009	1	0.102040816
LMUMA-ROZA REC	9.8	7/30/2009	4	0.408163265
LMUMA-ROZA REC	9.8	8/26/2009	3	0.306122449
PARKER	20.3	8/13/2009	60	2.955665025
ZILLAH	16	8/12/2009	61	3.8125

Table 4. Summer total of piscivorous birds per km and section shown by survey date.

Common Mergansers along River Reaches

Abundance of Common Merganser in 2009 showed the continuing trend of mergansers as the primary piscivorous bird in the upper Yakima River. Figure 6 reflects this pattern and depicts total merganser numbers by reaches in river order.

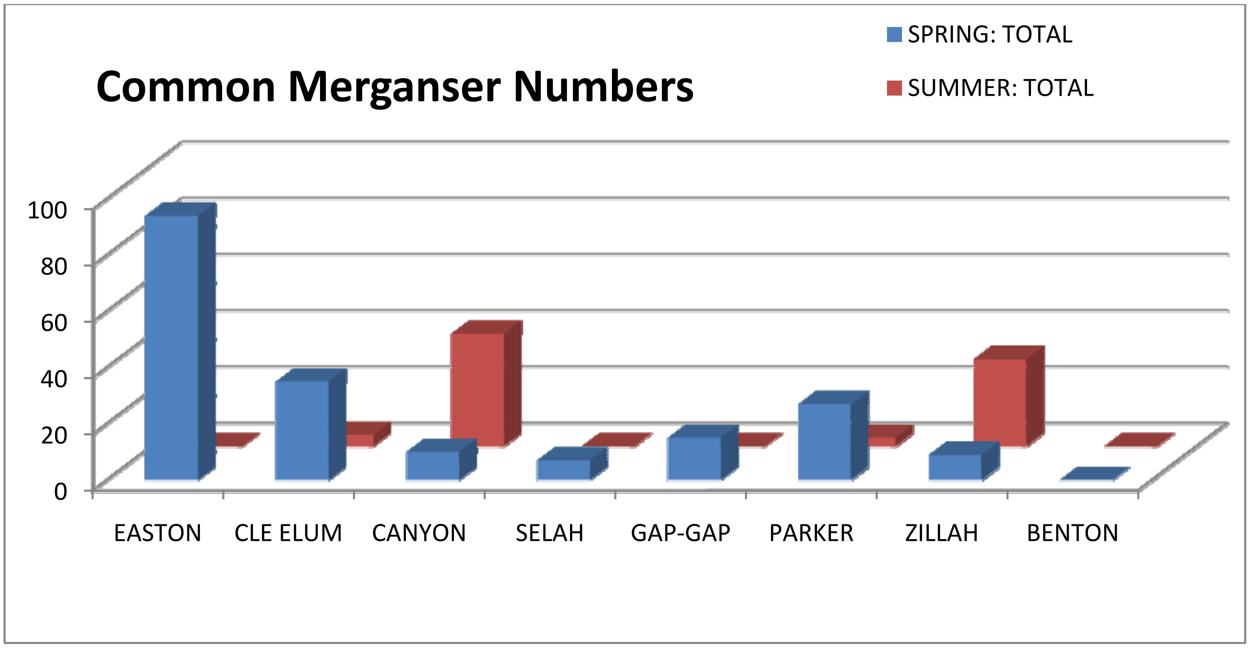


Figure 6. River reaches total number of surveyed COME for spring and summer of 2009.

A breeding pair of Common Mergansers

American White Pelicans along River Reaches

Pelicans were the most abundant avian piscivorous in the lower river in spring 2009, as in 2003-2006. Pelicans were common in the lower and middle river in spring.

Pelicans averaged 7 birds/km at Parker and Zillah in the spring, 1.85 birds/km at Parker and 0.40 birds/km in Zillah in the summer (Figures 3 & 4).   In 2006, pelicans averaged 2.6 birds/km at Parker, 1.5 birds/km in Zillah, 0.8 birds/km in Vangie and 0.02 birds/km in Benton. The birds per km number may be misleading as Pelicans could total anywhere between 250 to 300 birds on a given day in Parker and Zillah in the Spring while summer numbers drop off dramatically (Figure 7).

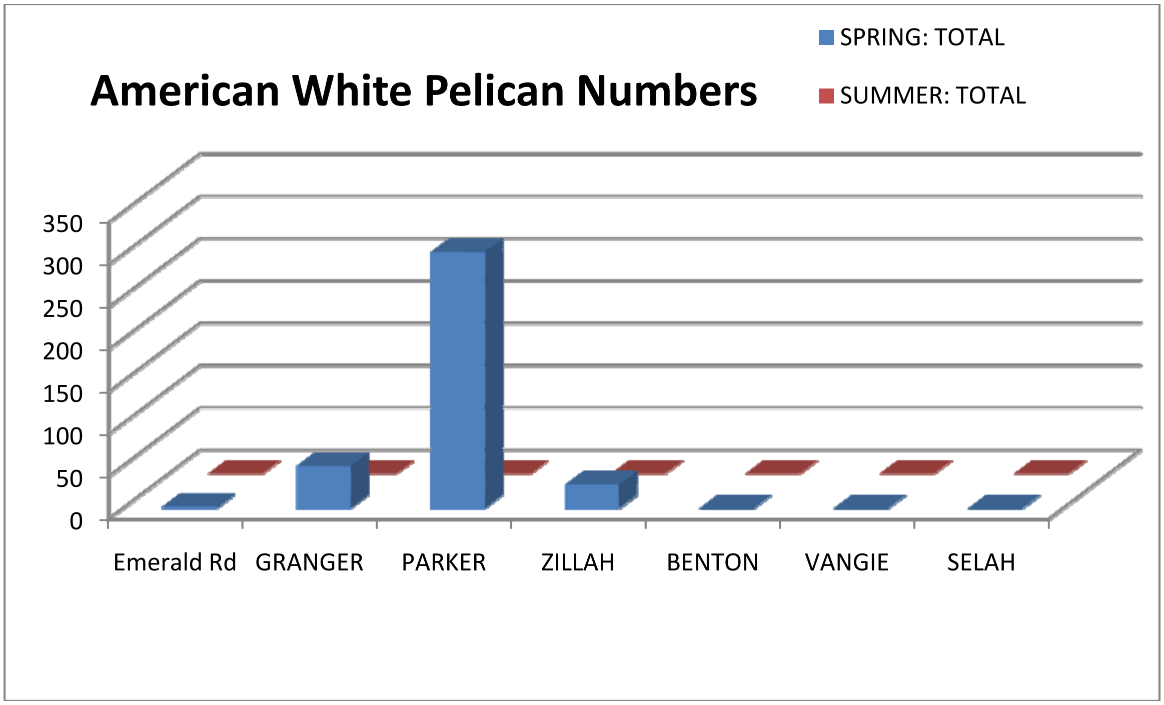


Figure 7. River reaches total number of surveyed American White Pelicans for spring and summer of 2009.

<u>Great Blue Heron along River Reaches</u>

On average, the number of Great Blue Herons in the lower river remained low and maintained similar numbers of 2008, when they averaged 0.5 birds/km, similar to the average of 0.8 birds/km in 2006. Heron numbers are more prevalent in along the Parker and Zillah reaches and it is possible to see up to 40 birds on a float in the Parker reach and 15 in the Zillah reach (Figure 8). This is to be expected as most Heron rookeries of the Yakima Basin are located along this reach.

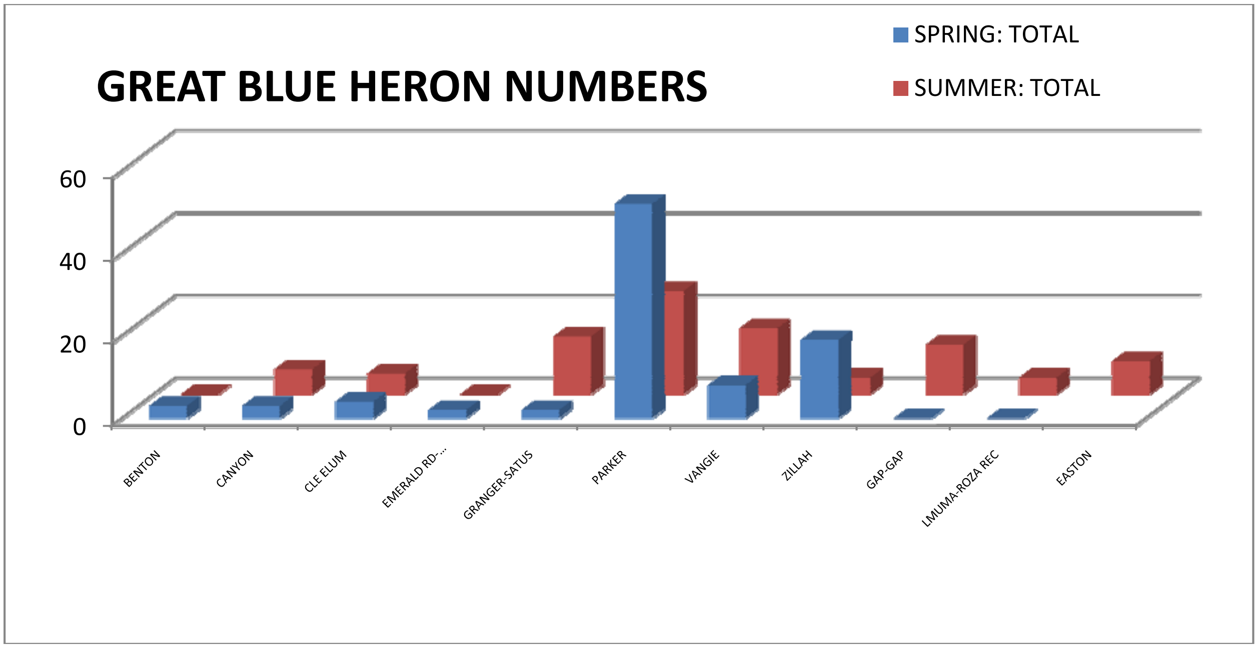


Figure 8. River reaches total number of surveyed Great Blue Herons for spring and summer of 2009.

Smolts Consumed at Acclimation Sites

At the three Spring Chinook and five Coho salmon acclimation sites in the upper Yakima River and its tributaries piscivorous bird surveys were conducted over a 3-5 month period in the winter and spring of 2009 (Clark Flat, Easton and Jack Creek). The most common birds preying on smolts were the Belted Kingfishers, Common Merganser, Great Blue Heron, Bald Eagles and Osprey. If it is assumed that birds feeding in acclimation ponds are consuming only smolts on bird days on site, an average of consumption can be calculated using the; average number of birds at each site, daily energy requirements of birds, and the average size of smolts. Smolt weights were averaged combination of in-basin and out-basin stocks for Coho acclimation site.

For Spring Chinook it was estimated that these bird species together consumed 732 smolts at Clark Flat, 1708 smolts at Easton and 320 smolts at Jack Creek. In 2008, Belted Kingfishers, Common Merganser and Great Blue Herons consumed 352 smolts at Clark Flat, 895 smolts at Easton and 432 smolts at Jack Creek.

At the Coho acclimation sites (Boone, Easton Pond, Holmes, Lost Creek and Stiles), the most common birds preying on smolts were Belted Kingfishers, Common Merganser, Great Blue Heron, Bald Eagle, Hooded Merganser and Osprey. It is estimated that these bird species together consumed 28,470 smolts at Boone, 2,131 smolts at Holmes, 10,922 smolts at Easton Pond, 1,017 smolts at Lost Creek and 2,485 smolts at Stiles. In 2008, Belted Kingfishers, Common Merganser, Great Blue Herons and Hooded Mergansers consumed 5,363 smolts at Holmes, 488 smolts at Lost Creek and 6,942 smolts at Stiles. Boone and Easton Pond were not used in 2009.

PIT Tag Surveys

In 2009 PIT tag surveys yielded a total of 14,350 distinct tags discovered within the 14 survey sites (Figure 9) (106 tags from Selah Rookery 2007 survey included). Of this total number 13,828 of the PIT tags were identified as Yakama Nation salmonid tagged fish. PIT tags associated with avian predation were linked to three bird species: Great Blue Heron, Double Crested Cormorant, and the American White Pelican. Associations were made by location of PIT tags: Great Blue Heron rookeries, Double Crested Cormorant Colony, and American White Pelican foraging and lounging site.

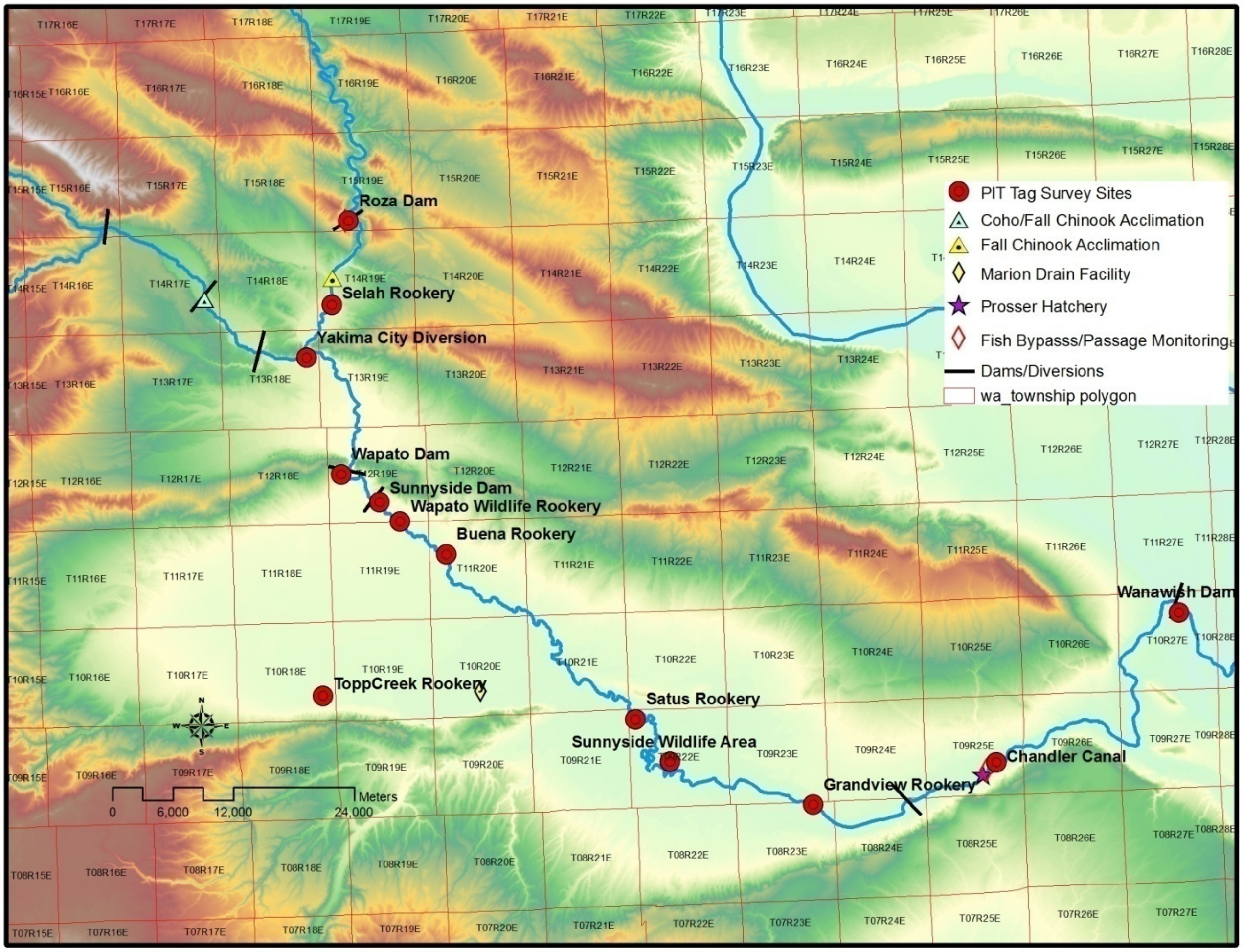
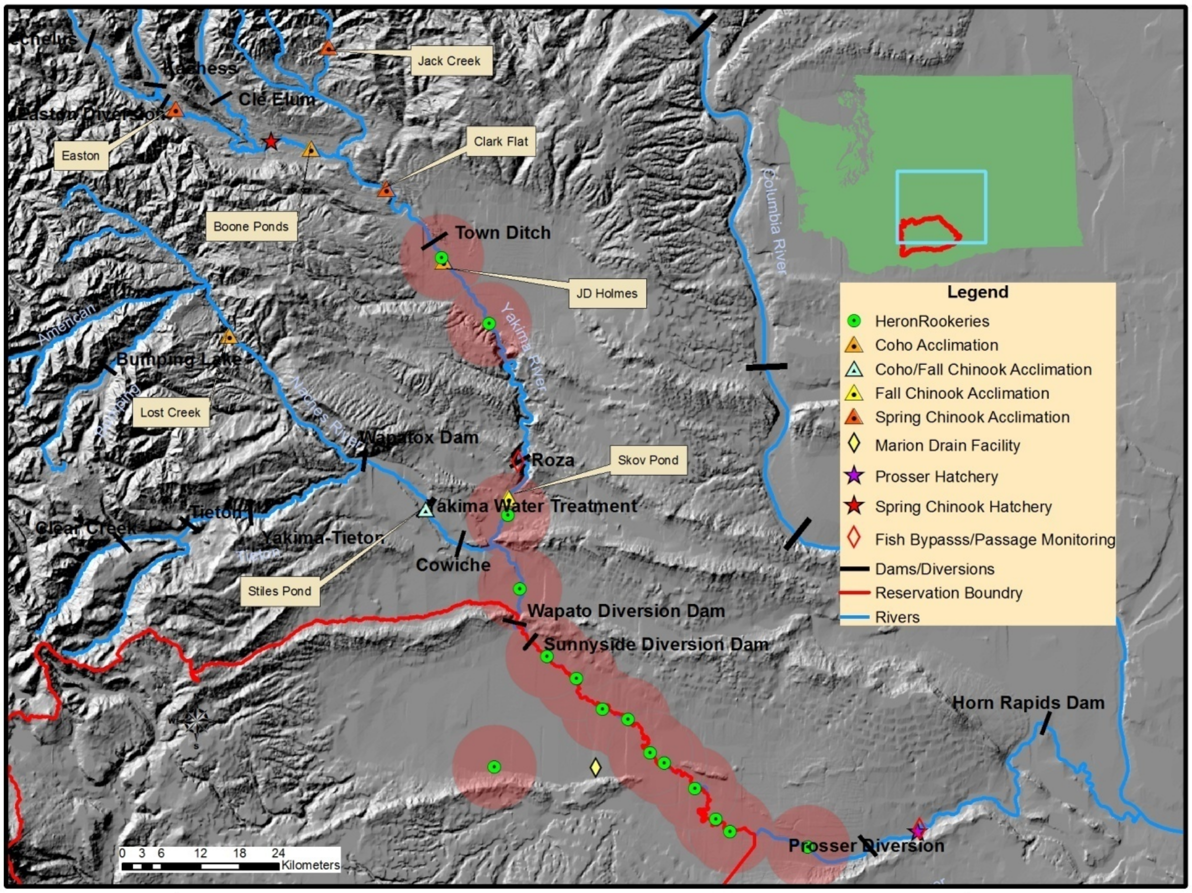


Figure 9. YKFP 2009 PIT Tag Survey Sites

Yakima Basin Rookeries Surveyed

In 2008 16 Great Blue Herons Rookeries were surveyed in the Yakima Basin (Figure 10). Of these 16 rookeries 13 were active with nesting Great Blue Herons. A nest count found that within these 16 rookeries there are approximately 395 Nests. These numbers remained similar for 2009 with a slight reduction in rookery size at the Selah rookery due to tree loss. 2009 was also the first PIT tag survey of the Double Crested Cormorant colony on the Yakima River.



Heron Rookeries are outlined with a 6.5 km transparent buffer representing an upper mean foraging area.

Figure 10. Map of Yakima Basin Great Blue Heron Rookeries surveyed.

Rookeries were surveyed after fledging of Great Blue Heron young and a table of survey dates for each rookery is provided below.

SURVEY SITE	SURVEY DATES						
Selah	10/1/2008	10/2/2008	1/14/2009	1/15/2009	8/17/2009	8/27/2009	2/16/2010
Wapato Wildlife	8/16/2008						
Toppenish Creek	9/30/2008	11/5/2008	2/3/2009	2/11/2009	2/17/2009	2/24/2010	
Satus							
Meninick	9/30/2008						
Ringer Loop							
Greenway							
Zillah							
Buena	4/1/2009						
Grandview	2/18/2009	1/22/2010					
Niemeyer Rd							
Sunnyside 1	1/15/2010	2/22/2010					
Sunnyside 2	1/19/2010						
Ztopp							
Holmes							
Union Gap							

Table 5. Table of PIT tag survey dates for Yakima Basin Rookeries

PIT tags surveyed at rookeries were designated to their specific rookeries, the tables below give specific information for by rookery.

Buena Great Blue Heron Rookery: PIT Tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Summer Chinook												
Spring Chinook	9	13	23	13	54	8	5	2	12	14		153
Fall Chinook		1	2	179	1							183
Coho	3	11	9	17	58	8	9	2	8	7		132
Steelhead	1		3		7	4						15
Unknown Chinook						1						1
Total	13	25	37	209	120	21	14	4	20	21	0	484

Table 6. Pit tag numbers by migration year/species surveyed in Buena Rookery.

Grandview Great Blue Heron Rookery

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook	5	24	24		6	6	3	1	1			70
Spring Chinook	26	44	44	17	10	13	17	5	11	2		189
Summer Chinook	15											15
Steelhead		1			3							4
Coho	12	26	55	5	3	6	7	3	4			121
Unknown Chinook												0
Total	58	95	123	22	22	25	27	9	16	2	0	399

Table 7. Pit tag numbers by migration year/species surveyed in Grandview Rookery.

Toppenish Creek Great Blue Heron Rookery: PIT Tag Numbers

	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook													0
Summer Chinook													0
Spring Chinook							2						2
Coho			238										238
Steelhead		36	4	5	3	4	4	1	1				58
Unknown Chinook													0
Total	0	36	242	5	3	4	6	1	1	0	0	0	298

Table 8. Pit tag numbers by migration year/species surveyed in Toppenish Creek Rookery.

For Toppenish Creek of the 298 PIT tags which returned a tagging detail 215 belonged to one tag file. These 215 were Coho released from a net pen in Cle Elum Lake in 2008 and it is thought that these Coho were late migrates.

Sunnyside Great Blue Heron: PIT Tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook	1	26	15	6	4	1		1				54
Spring Chinook	93	62	105	74	24	14	7	1	2	1		383
Summer Chinook												0
Steelhead		2			1							3
Coho	19	32	19	19	19	1	2		1	2		114
Unknown Chinook												0
Total	113	122	139	99	48	16	9	2	3	3	0	554

Table 9. Pit tag numbers by migration year/species surveyed in Sunnyside Wildlife Rookery Rookery the Great Blue Heron nesting trees.

Sunnyside Wildlife Area DCCO tree: PIT tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook	26	132	51	21	2	7						239
Spring Chinook	322	138	247	104	20	27						858
Summer Chinook	2	1										3
Steelhead	9	2	1	1		3						16
Coho	97	57	10	36	14	7						221
Unknown Chinook	1											1
Total	457	330	309	162	36	44	0	0	0	0	0	1338

Table 10. Pit tag numbers by migration year/species surveyed in Sunnyside Wildlife Rookery Rookery the Double Crested Cormorant nesting tree.

Wapato Wildlife Rookery

The Great Blue Heron Rookery within the Yakama Nation Wapato Wildlife area survey of 2009 was aided by YKFP technicians clearing of the brush beneath the Rookeries nests. The previous survey of 2008 provide a total of only 42 tags. High PIT tag numbers at the Wapato Wildlife

Rookery may be tied to the two irrigation diversion dams within close proximity: Wapato Dam and Sunnyside Dam. PIT tag surveys were conducted at each of the Dam's fish screening facilities in 2009, both sites produce high tag numbers (YKFP annual report 2009, Fish Predation). It was discovered that the Wapato Dam fish screening facility functioning at less than 90% efficiency creating high mortality for fish entering the diversion. It is conceivable that a high number of salmonid smolts were fatigue or damaged by these two fish screening facilities and subject to higher amounts of predation by Great Blue Herons at the nearby rookery.

Wapato Wildlife Great Blue Heron Rookery: PIT Tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	Yrs combined
Fall Chinook		74	105	273	40	1							493
Spring Chinook	61	78	118	66	126	55	89	57	163	33	1		847
Summer Chinook	120												120
Steelhead		1	1		5	3		1					11
Coho	74	108	155	88	124	58	106	57	70	55	2	1	898
Unknown Chinook													0
Total	255	261	379	427	295	117	195	115	233	88	3	1	2369

Table 11. Pit tag numbers by migration year/species surveyed in WapatoWildlife Rookery Rookery.

The Wapato Wildlife Rookery and the Holmes rookery were selected for tag detection efficiencies as each displays habitat characteristics of Rookeries within their give Stratum. These rookeries will be intensely scanned for PIT tags in the upcoming years.

Selah Heron Rookery

A total of 1861 PIT tags returned a tagging detail from the Selah rookery (Table 12). PIT tags are sorted by release year and species and showed significant correlation to flows varying by year. The foraging source of these tags is believed to be primarily gathered from the River Reach of Roza Dam to the confluence of the Naches (Figure 11).

2009 Data for Selah Great Blue Heron Rookery: PIT Tag Numbers

	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	Yrs combined
Fall Chinook		81	5	128	6							220
Spring Chinook	128	173	41	161	206		34	58	24	32		857
Summer Chinook	13					114						127
Coho	69	131	53	76	210	46	15	16	17	21		654
Steelhead	1	2										3
Unknown Chinook												0
Total	211	387	99	365	422	160	49	74	41	53	0	1861

Table 12. Selah Rookery PIT tag totals by species and year released.

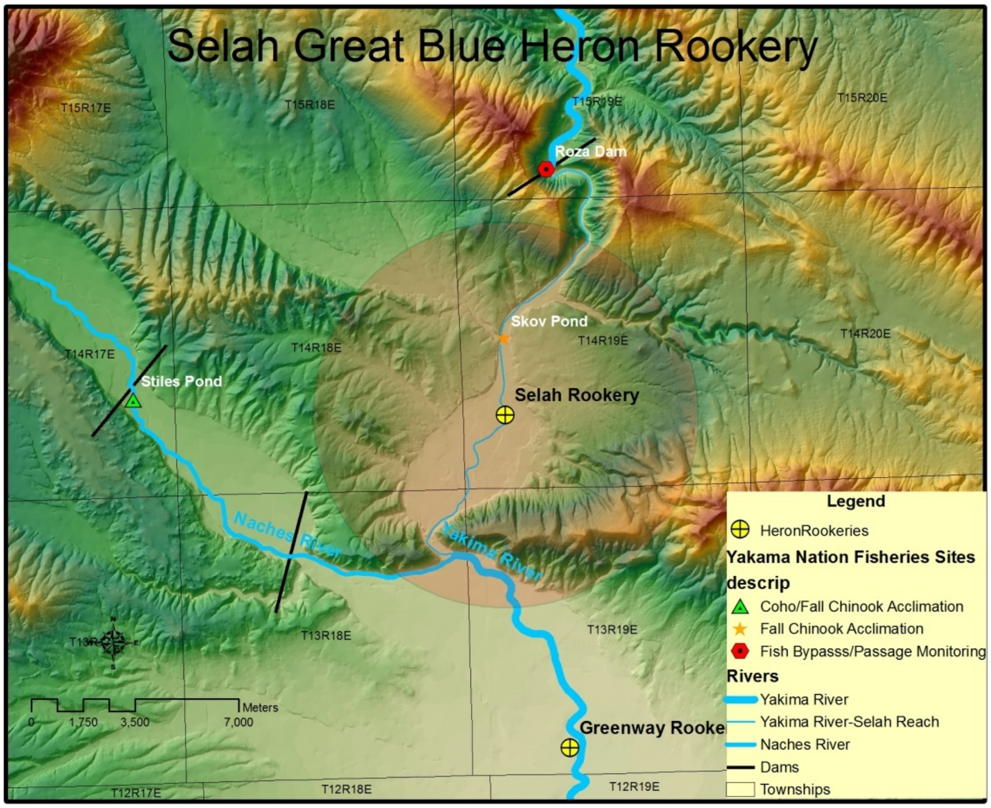


Figure 11. Selah Great Blue Heron Rookery.

Analysis of the data for Selah Great Blue Heron Rookery will attempt to answer the primary question; what effects do water flows have on the rate of Great Blue Heron predation on anadromous salmonids for the Selah Heron Rookery. For this analysis, variables of river flow (CFS) by date, PIT tag fish release timing, and species of fish will be analyzed by a comparing variable value across data source years. Data from the rookery varied with PIT tag sources over a time period of 2000 to 2008. Water flow recorded by the Bureau of Reclamation below Roza dam, provided baseline data to be used for comparison with PIT tags (BOR 2009).

Significant factors based on the life history and migration patterns of anadromous salmonid show a direct link to flow. Freshets (spikes in CFS) may be a main determining factor for migration and the number of freshets within migration period may directly affect predation. PIT tag numbers may be associated with Smolt Flushing Flows, which have been determined to be 1000 CFS for a period of three days. Flushing flow requirements for out-migrating smolts were agreed upon by biologists of the Yakama Nation, BOR, and WDFW under the SOAC group. Table 13 shows number of flushing flows within the Roza Reach by year and month. Figure 12 highlights 2005 low numbers of flushing flows and large numbers of Spring Chinook PIT tags (335) and 2007 high numbers of flushing flows and low numbers of Spring Chinook PIT tags (80).

Number of Flushing Flows									
	2009		2008		2007		2006		2005
March	0	March	0	March	0	March		March	2
April	12	April	4	April	3	April	10	April	3
May	10	May	10	May	10	May	5	May	1
June	6	June	3	June	3	June	5	June	8
Total	**16**	Total	**15**	Total	**16**	Total	**20**	Total	**14**
Average QD	1590		1188		1988		1240		861

Table 13. Number of Flushing Flows for the Roza Reach

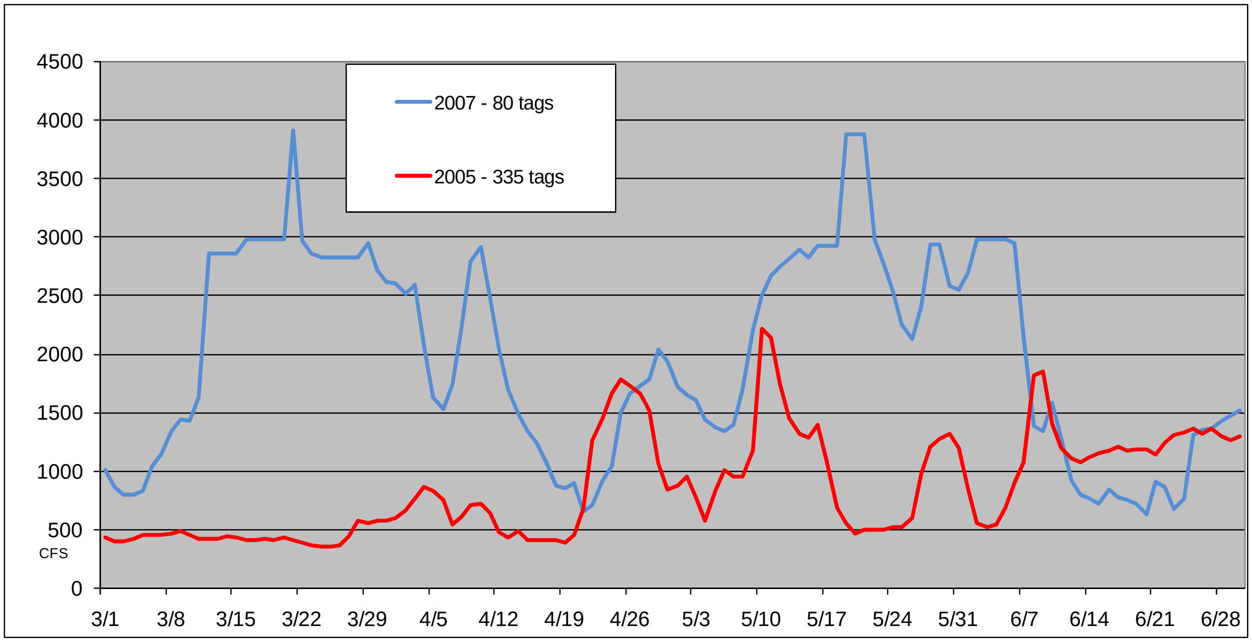


Figure 12. Yakima River water flow (CFS) below Roza dam for years of 2005 and 2008. Shown with number of tags found at the Selah Rookery for corresponding years.

Analysis of Species Composition within the Selah rookery found that over 50 percent of the tags belonged to Spring Chinook salmon smolts (Figure 13). This along with the value of the species has focused the Selah Rookery Study on Spring Chinook Salmon. Analysis of Spring Chinook tag data is aided by the fact that Hatchery smolts of Spring Chinook are released in a consistent ratio of PIT tagged fish released and total hatchery smolts released. These Spring Chinook from Cle Elum hatchery have been released in this fashion since 2001.

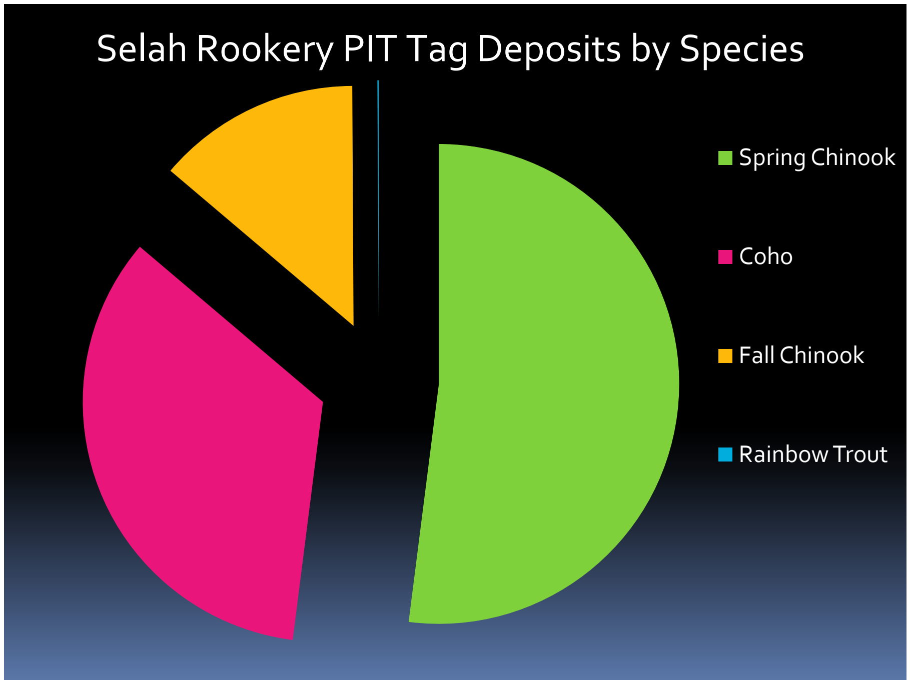


Figure 13. Selah Heron Rookery PIT tags pie chart of species composition.

PIT Tag Detection Efficiencies

Efforts to determine PIT tag detection efficiencies at two diverse rookeries were made in 2009. PIT tags were seeded haphazardly below nesting trees before nesting and subsequent to fledging of Great Blue Heron young. 50 PIT tags were spread at the Selah Great Blue Heron rookery and 50 at the Wapato Wildlife rookery in early April 2009. Another 50 each at both sites were seeded in late July. PIT tag surveys were conducted at each site multiple times after the last seeding effort.

Selah Rookery provided a unique environment for PIT tag survey as the land the Rookery resides on is owned and managed by the Treetop Company. Treetop clears and mows the areas below the rookery regularly which creates highly accessible areas for PIT tag surveys. Wapato Wildlife Rookery provided a significantly different environment as the rookery is located in an area with very limited accessibility. The understory in this rookery consisted of larger rose bush, stinging nettle, large woody debris, fallen trees. YKFP technicians used a weed whacker; pole saw, racks, and pruning loppers to clear the area below the rookery.

Results of the PIT tag detections efficiencies were quite surprising as the Wapato Wildlife rookery detection efficiency exceed that of the Selah rookery. The detection efficiency at Wapato Wildlife rookery was 71% and detection efficiency at the Selah rookery was 61%. Expanded numbers for 2009 migration year PIT tags were:

- Wapato Wildlife Rookery PIT tags surveyed – 255 (2009 Migration Year)
- Expanded number of Wapato Wildlife Rookery PIT tags with 71% detection efficiency – 436
- Selah Rookery PIT tags surveyed – 211 (2009 Release Year)
- Expanded number of Selah Rookery PIT tags with 61% detection efficiency - 339

PIT Tags Surveys: American White Pelican

Associating YINN juvenile salmonid predation to American White Pelicans has taken major steps forward with PIT tag surveys conducted in 2009. Surveys of the Yakima River below the Chandler Juvenile fish bypass facility provides PIT tags which may be directly linked to American White Pelican predation. Association was made by observation of foraging and lounging, along with fish takes by American White Pelicans at this location.

American White Pelican Chandler Outlet Pipe PIT tag surveys											
	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	
Summer	40										40
Spring	23	56	37	13	14	6	7	3	2	5	166
Fall	2	106	121	18	26	38	7		3	4	325
Coho	4	23	28	6	6	1		2	2	1	73
Steelhead	3	1			5			1			10
Total	72	186	186	37	51	45	14	6	7	10	614

Table 14. American White Pelican Chandler Outlet Pipe PIT tag surveys

The American White Pelican Colony on Badger Island, Columbia River, was surveyed for PIT tags in 2009 and produced 8279 PIT tags of which 2760 were YINN fish (Data provided by PSMFC). American White Pelicans consistently forage on the Yakima River during smolt outmigration times. Foraging is steady at two of the avian predation hotspot sites: Wanawish Dam and the Chandler Juvenile Fish Bypass pipe (YKFP annual report 2008; Avian Predation).

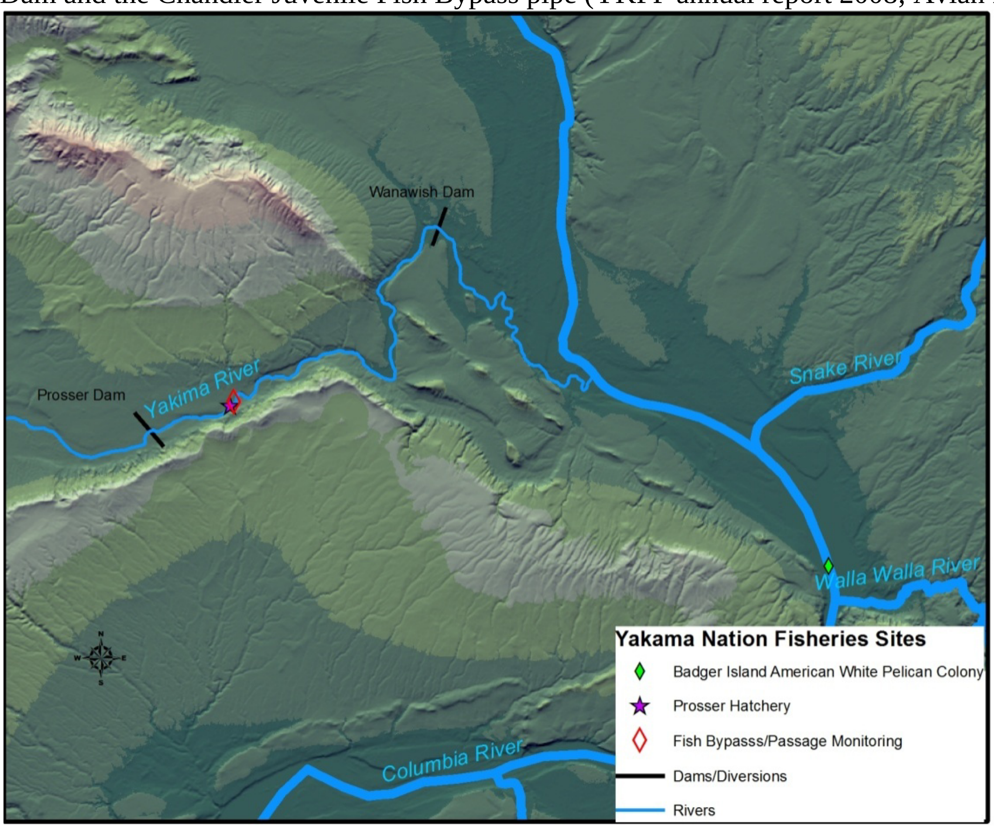


Figure 14. Map showing location of Badger Island American White Pelican colony.

American White Pelican Badger Island PIT tag surveys: PIT Tags for Yakama Nation Fish							
	2009	2008	2007	2006	2005	2004	Total
Spring Chinook	167	298	70	91	104	53	783
Summer Chinook	201	0	0	0	0	0	201
Fall Chinook	53	620	163	219	89	77	1221
Coho	81	186	96	58	93	27	541
Steelhead	1	4	3	1	4	1	14
PIT tag Total:	503	1108	332	369	290	158	2760

Table 15. American White Pelican Bager Island PIT tag surveys: YINN fish shown by migration year and species

It is likely that many of the PIT tags found on Badger Island were predated at either of these sites. Foraging distances for American White Pelicans range up to 611 kilometers for round trip forage (Cormorants, Darters, and Pelicans of the World. Paul Johnsgard 1993). Key points pointing out the likely hood that these are the primary foraging sites for Badger Island Pelicans:

- Distance of Wanawish Dam to Badger Island is 48.27 Kilometers
- Distance of Chandler Juvenile Fish Bypass to Badger Island is 64.36 Kilometer
- 2008 Fall Chinook PIT tags Deposited on Badger Island totaled 620:
  1. 349 - Released above Prosser Dam
  2. 52 – Chandler Canal - Juvenile Facility Calibration
  3. 73 – Detected by the Chandler PIT tag interrogator (*Interrogated late June early July)*
  4. 219 - Released from the Prosser Fish Hatchery

CONCLUSIONS

Gull numbers remain low in the Yakima River Basin and the focus of future studies have shifted towards: Pelican numbers and diet, management of extreme numbers of piscivorous birds in given areas, and surveys of PIT tags where mortality can be linked to predation.

The greater the amount of water that passes over Prosser and Horn Rapids Dams during peak smolt out-migration periods, the lesser the impact of bird predation on smolt survival. The Chandler Bypass outfall pipe makes fish of all species vulnerable to predation at low water, as the fish are disoriented and upwelling at right angles to the current. A simple reconfiguring of the outfall could largely eliminate smolt vulnerability at Chandler. The presence of large dead and disabled fish exiting from the bypass pipe may attract avian predators to the site. PIT tag detection at Chandler outlet pipe did show high mortality for both juvenile and adult salmonids.

PIT tag surveys in 2008 proved very productive as over 4100 tags were discovered in the Yakima Basin. Tags detected show a source of mortality for Yakima River juvenile salmonids as 4022 of these tags were from juvenile salmonids. Predation by Herons shows correlation with flow, not surprising as high flow eliminates opportunity for wading bird foraging in many parts of the river. Conversely low flow creates foraging opportunities for Herons.

Double Crested Cormorants maintained a breeding colony on the Yakima River for 2009. Their presence and numbers are becoming more prevalent as their habitat in the Columbia River Estuary is reduced by the Army Corps of Engineers. PIT tag surveys of the Double Crested Cormorant Colony produced high numbers of PIT tags, and when compared to similar nests numbers of nearby Great Blue Herons, Cormorants produced significantly higher numbers of PIT tags.

PIT tag analysis will continue to develop and new sites will be added to surveys. Detection efficiencies will continue in the two diverse rookeries to assess number of undetected tags.

PIT tags will be assessed by extrapolating a wild component utilizing salmon redd data and juvenile fish passage facilities. Temporal trends of predation will be tested by attempting to simulate smolt river travel through river flows and acclimation site detection. Work towards developing a PIT tag array will begin in an attempt to gain real time PIT tag deposition.

American White Pelican numbers at Chandler Juvenile Fish Bypass pipe and Wanawish Dam continue to be high. PIT tag surveys of breeding location and foraging site have proven American White Pelicans are targeting YINN juvenile salmonids for forage.

Management Options will be assessed by looking at: flow bumps during smolt migration, improving fish passage, earlier smolt releases, acclimation site placement/attributes, developing Pelican diet studies, testing Merganser hazing/lethal control effectiveness, expanded PIT tag surveys, expanded studies of flow vs. smolt rate of travel, and Dam/Diversion fish bypass mortality studies.

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Appendix A. Common Merganser Study 2008

Yakima Klickitat Fisheries Project: Monitoring and Evaluating Avian Predation on Juvenile Salmonids on the Yakima River, Washington.

Common Merganser Smolt Consumption near Roza Dam, WA.

Anadromous fish of the Yakima Basin have experienced severe declines in populations as a result of anthropogenic actions. In response to these declines, millions of dollars are spent annually in efforts to restore anadromous fish runs (Yakima Basin Fish and Wildlife Planning Board 2004). The Yakima Klickitat Fisheries Project (YKFP), co-managed by the Yakama Nation and Washington Department of Fish and Wildlife (WDFW), with funding from the Bonneville Power Administration, is leading the effort to restore salmon runs in the Yakima River. YKFP seeks to "test the hypothesis that new supplementation techniques can be used in the Yakima River Basin to increase natural production and to improve harvest opportunities, while maintaining the long-term genetic fitness of the wild and native salmonid populations and keeping adverse ecological interactions within acceptable limits" (Sampson and Fast 2000).

Predator and prey relationships have demonstrated considerable change as the result of developments within the Yakima River Basin. Some changes have resulted in “hotspots,” areas experiencing high predation of anadromous salmonids (Sampson, Fast, and Bosch 2008). Common Mergansers (Mergus Merganser) were found to be the major predator on the upper reaches of the Yakima River (Phinney et al.1998.) Surveys conducted from 1999 through 2002, by the Washington Cooperative Fish and Wildlife Research Unit, found that this trend is continuing thru time (Grassley and Grue 2001;Grassley, et al 2002; Major et al 2002). The Common Merganser has altered its predator prey relation with anadromous salmonids as a result of the development of Roza Dam, located in the upper Yakima River. Roza Dam has seen increased population numbers of Common Mergansers and has now become a “hotspot” for predation salmonids (Sampson, Fast, and Bosch 2008).

Under YKFP’s avian predation monitor and evaluation study, stomach content analysis and management studies of the Common Merganser will be implemented at Roza Dam. Roza Dam is fitted with passage via fish ladders for returning adults and bypass structures for migrating smolts. Structures of passage along with dam effects concentrate many fish in small areas during species migration timing (Sampson, Fast, and Bosch 2008). As a result of structure, Roza Dam becomes an area of high concentrations of smolts during this migration. Piscivorous species such as the Common Merganser is then attracted to Roza Dam and consumes large numbers of migrating smolts. YKFP is hoping to obtain a permit for the lethal taking of the Common Merganser to complete a stomach content analysis and assess anadromous salmonid consumption and management techniques. With study results YKFP will assess the impact these Mergansers are having on migrating smolts and possible management strategies.

Location

The area of study collection is located below Roza Dam on the Yakima River of Washington. Migrating Smolts pool above and below the dam from March to June between this time period it is expected that over 1 million smolts pass the dam. Mergansers have congregated in numbers reaching 150+ during days of smolt migration at the dam and are thought to have a severe impact on smolts through consumption (personnel communication, Mark Johnston Biologist YKFP).

Methods
The Common Merganser at Roza Dam they will be taken by shotgun. Dogs and boats will be used to recover the birds from the river below Horn Rapids Dam**.** 50 Mergansers will be taken over a period of 5 weeks, twice a week, 5 per day, during a timing of peak smolt migration of the second week of March to the third week of April. Smolt consumption thru diet analysis would entail species of fish identification using bone diagnostics. The study would involve using personnel from YKFP, Yakama Nation and WDFW, who have in the past taken Mergansers and completed bone diagnostics (Fritts and Pearsons 2006). Stomach contents of avian predators taken during lethal control efforts will be processed for whole and partial fish, diagnostic cranial bones, and otoliths.

Fish will be individually bagged and tagged with the date and place of collection, and kept frozen at -20oC at the Prosser Fish Hatchery until processed. Stomach contents will be collected, analyzed, and preserved according to techniques described in the Field Manual of Wildlife Diseases, General Field Procedure and Diseases of Birds (USGS 1999).

Conditioned Response for Management
Management of the Common Merganser for the smolt consumption near Roza Dam may be deemed necessary. A study concurrent with the lethal take for stomach content analysis would attempt to assess lethal control and conditioned response as a management tool. YKFP would study the effectiveness of lethal control combined with frightening techniques, which when combined have shown to be an effective management tool (Littauer 1990). After a count of Common Mergansers at the collection site a handheld horn would be blown during each lethal take as a frightening technique. Frightening techniques would extend for a period 5 weeks after lethal collection is completed. Numbers of Common Mergansers would be recorded over the 5 week period of lethal collection and a period extending 5 weeks after lethal collection.

Results
Results for the scientific collection study will be incorporated into the annual report, "The Monitoring and Evaluation of Avian Predation of Juvenile Salmonids on the Yakima River, Washington", for the Yakima Klickitat Fisheries Project, submitted to the U.S. Department of Energy, Bonneville Power Administration. Results may also be submitted to relevant scientific journals for publication. For a more detailed description of previous years' results of the monitoring effort and statistical methods involved please refer to the annual reports located at YKFP's website, www.ykfp.org or the Bonneville Power Administration website, www.efw.bpa.gov/Environment/EW/EWP/DOCS/REPORTS/YAKIMA

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