B O N N E V I L L E   P O W E R   A D M I N I S T R A T I O N

Yakima/Klickitat Fisheries Project

Monitoring and Evaluation

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YAKIMA/KLICKITAT FISHERIES PROJECT MONITORING AND EVALUATION

PROJECT NUMBER 1995-063-25
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THE CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION

FINAL REPORT
For the Performance Period
May 1, 2003 through April 30, 2004

Submitted: August 10, 2004

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MONITORING AND EVALUATION PROJECT REPORT

Preface

The monitoring and evaluation objectives and tasks have been developed through a joint process between the co-managers, Yakama Nation (YN, Lead Agency) and Washington Department of Fish and Wildlife (WDFW). The Science/Technical Advisory Committee (STAC), which consists of core members from the co-managers, employs the services of a work committee of scientists, the Monitoring Implementation Planning Team (MIPT) to develop the Monitoring and Evaluation (M&E) Plan.

The process employed by STAC to verify these designated activities and the timing of their implementation involved the utilization of the following principles:

1. YKFP monitoring should evaluate the success (or lack of it) of project supplementation efforts and its impacts, including juvenile post release survival, natural production and reproductive success, ecological interactions, and genetics;
2. YKFP monitoring should be comprehensive and,
3. YKFP monitoring should be done in such a way that results are of use to salmon production efforts throughout and Columbia basin and the region.

Utilizing these principles, STAC and MIPT developed this M&E action plan in three phases. The first phase was primarily conceptual. STAC and MIPT defined critical issues and problems and identified associated response variables. The second phase was quantitative, which determined the scale and size of an effective monitoring effort. A critical element of the quantitative phase was an assessment of the precision with which response variables can be measured, the probability of detecting real impacts and the sample sizes required for a given level of statistical precision and power. The third phase is logistical. The feasibility of monitoring measures was evaluated as to practicality and cost. The Policy Group has determined that the M&E activities covered by this agreement are necessary, effective and cost-efficient.

Introduction

The FY2003 monitoring and evaluation program for the YKFP was organized into four categories- Natural Production (tasks 1.a - 1.y), Harvest (task 2.b), Genetics (tasks 3.a – 3.c) and Ecological Interactions (tasks 4.a – 4.f). This annual report specifically discusses tasks directly conducted by the Yakama Nation. 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. IntStats provides the biometrical support for the YKFP and IntStats' written reports for tasks 1.d, 1.e, 1.g and 1.h are included in full as appendices to this report.

Contributing authors from the Yakama Nation YKFP in alphabetical order are: Michael Berger, Bill Bosch, Melinda Davis, Chris Frederiksen, David Lind, Todd Newsome, Jason Rau, and Ann Stephenson. Doug Neeley of Intstats Consulting and Bruce Watson of Mobrand BioMetrics 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.

NATURAL PRODUCTION

Overall Objective: Develop methods of detecting indices of increasing natural production, as well as methods of detecting a realized increase 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 & 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 the "Ecosystem Diagnosis and Treatment" (EDT) model. A brief description of the EDT model can be found on the Mobrand Biometrics Incorporated (MBI) website at www.mobrand.com.

Progress: Two separate utilities of the EDT model have been developed over the course of the last year that are specific to management actions addressing restoration and supplementation. Currently, the Yakima Subbasin planning process is using the EDT model to evaluate the effectiveness of future restoration actions through baseline model outputs defined as the reference conditions. These outputs are considered to reflect attainable goals with respect to a population's performance parameters (productivity, abundance and life history diversity) that are species specific. Yakima Subbasin planning is also using the EDT model as a basis of comparison of recently published data and habitat studies due to the completeness of the EDT model data set. As for supplementation, MBI was contracted in the year 2003 to develop a scientifically based procedure addressing re-establishment of the natural producing population of Coho Salmon in the Yakima River system with the enhancement of supplementation. This procedure utilizes a variety of EDT model outputs defined as population performance parameters by geographic proximity, representing individual spawning populations respectively. This product was developed to assist the Yakama Nation's efforts for the attainment of natural production goals of this species.

The EDT model depicts the environment in its current and historic state (pre settlement era) which is commonly referred to as the patient and template. The restoration potential that a geographic proximity displays is directly related to the differentiation between the patient and template conditions. This restoration potential shown by the model may not depict real world potential due to current land use practices and community priorities (e.g.-relocation of a highway causing habitat simplification due to confinement may not be a feasible solution due to cost and proximity). For this reason, unique outputs were created for the EDT model representing "reference conditions" or attainable conditions within today's society with respect to current land use and community values.

A technical aquatic advisory committee assisted with the re-ranking of level 2 attributes representing the restoration reference conditions. Revisions included only primary or direct affects of restoration actions to individual attributes. In many cases, improving the conditions of one attribute results in improved conditions for other attributes, defined here as a cascading effect or secondary benefits. An example of this would involve improving the flow regime for a specific reach. By restoring flows to a normative condition, you may also be increasing the off channel habitat rearing capacity and riparian function of the stream corridor. These secondary benefits were not included due to the complex assumptions associated with the task of quantifying the potential cascading effects from one attribute to another. Therefore, numbers depicted from the reference conditions are undoubtedly low estimates of the true restoration potential for any species in the Yakima Subbasin. Model changes for the reference conditions included removal of obstructions where so desired, and improved flows in localized areas. Also, in some instances were urban growth is inevitable, changes were made to deteriorate the quality of habitat in areas where exceptional habitat remains for depiction of possible unfortunate circumstances. Baseline reports representing current and reference conditions are summarized in tables 1-4 by species and geographic scope of a species population.

Table 1. Summary of Yakima basin Spring Chinook performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and reference conditions.

YAKIMA BASIN SPRING CHINOOK					
Population	**Scenario**	**Diversity index**	**Productivity**	**Capacity**	**Abundance**
YSBP AMERICAN RIVER	Current without harvest	69.8%	4.85	343	272
	Current with harvest	67.2%	4.54	320	249
	Reference Conditions	71.9%	5.92	407	338
YSBP NACHES RIVER	Current without harvest	42.0%	2.67	1753	1095
	Current with harvest	40.3%	2.53	1635	988
	Reference Conditions	64.5%	3.42	4123	2918
YSBP UPPER YAKIMA RIVER	Current without harvest	23.0%	3.07	4672	3152
	Current with harvest	21.8%	2.94	4353	2870
	Reference Conditions	41.7%	3.32	6588	4604

Table 2. Summary of Yakima basin Fall Chinook performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and reference conditions.

YAKIMA BASIN FALL CHINOOK					
Population	**Scenario**	**Diversity index**	**Productivity**	**Capacity**	**Abundance**
LOWER YAKIMA RIVER	Current without harvest	22.6%	2.89	13351	8724
	Current with harvest	4.4%	1.82	6085	2735
	Reference Conditions	55.0%	5.18	17601	14200

Table 3. Summary of Yakima basin Steelhead performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and reference conditions.

YAKIMA BASIN STEELHEAD					
Population	**Scenario**	**Diversity index**	**Productivity**	**Capacity**	**Abundance**
YSBP AMERICAN RIVER	Current without harvest	27.3%	2.29	245	138
	Current with harvest	27.3%	2.29	245	138
	Reference Conditions	32.3%	5.01	578	463
YSBP NACHES RIVER	Current without harvest	10.9%	1.64	2348	920
	Current with harvest	10.9%	1.64	2348	920
	Reference Conditions	60.2%	2.85	7563	4911
YSBP SATUS CREEK	Current without harvest	36.7%	2.44	1516	894
	Current with harvest	36.7%	2.44	1516	894
	Reference Conditions	48.6%	5.23	3379	2733
YSBP TOPPENISH CREEK	Current without harvest	12.7%	2.45	866	513
	Current with harvest	12.7%	2.45	866	513
	Reference Conditions	37.2%	4.94	2238	1784
YSBP UPPER YAKIMA RIVER	Current without harvest	6.4%	1.87	3177	1479
	Current with harvest	6.4%	1.87	3177	1479
	Reference Conditions	33.1%	2.94	9931	6553

Table 4. Summary of Yakima basin Coho performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and reference conditions.

YAKIMA BASIN COHO					
Population	**Scenario**	**Diversity index**	**Productivity**	**Capacity**	**Abundance**
YSBP AMERICAN RIVER	Current without harvest	3.1%	1.62	77	29
	Current with harvest	3.1%	1.62	77	29
	Reference Conditions	5.7%	2.28	111	62
YSBP NACHES RIVER	Current without harvest	3.5%	1.37	755	204
	Current with harvest	3.5%	1.37	755	204
	Reference Conditions	14.7%	1.73	1244	527
YSBP UPPER YAKIMA RIVER	Current without harvest	5.1%	1.78	2265	996
	Current with harvest	5.1%	1.78	2265	996
	Reference Conditions	11.9%	1.93	3453	1667

The second utility of the model completed this year was developed by Mobrand Biometrics under a sub contract of YKFP. The application developed addresses the supplementation opportunities with respect to Coho in the Yakima Subbasin. Ultimately, the analysis presented in the report will provide guidance to the Yakama Nation for re-establishment of a natural producing coho population oriented toward specific management objectives. The analysis developed by Mobrand Biometrics has the following specific goals:

- Estimation of release numbers and distribution pertaining to geographic locations within a potential spawning population's vicinity.

- Estimate benefits generated by supplementation in terms of total returns (Including both first generation hatchery returns and natural origin fish returns).

- Estimate optimal coho release numbers in relation to maximizing the returns of natural originating fish or maximizing the total return numbers (NOR's + HOR's).

- Development of a method that estimates the benefits of releasing hatchery reared adult coho vs. smolts along with assessment of negative impacts associated with false attraction for both natural and hatchery reared coho adults Yakima basin specific.

Subbasin Modeling partitions: The Yakima Subbasin drains a large number of tributaries ranging in stream order size, shaped by a variety of climatic and geomorphic variables differing across the watershed. This ultimately results in a broad range of physical environments offered to a given species throughout its life history. Quality and quantity of the physical environment is expressed in the biological sense in the form of population performance parameters associated with the EDT model. Due to the spatial variability linked to these performance parameters (productivity and capacity), the Yakima Subbasin was broken into management units located in 3 separate watersheds. These 3 separate watersheds represent individual spawning populations for coho. Supplementation analysis was done for each individual watershed utilizing the productivity and capacity numbers generated from the EDT model for the management units within. The population performance parameters were calculated for both natural producing coho and hatchery produced coho. The Upper Yakima Watershed consist of the mainstem Yakima and all tributaries above Roza Dam excluding Wilson Creek, due to the poor quality of environmental attributes inputted into the model at this time. The Middle Yakima Watershed consists of the mainstem Yakima between Satus Creek and Roza Dam, the Naches mainstem from the mouth to the Tieton confluence, and all tributaries entering these reaches except the Tieton River. The Upper Naches Watershed consists of the Naches mainstem and tributaries above and inclusive of the Tieton River.

A variety of outputs were generated for each Watershed (or spawning population) and allocation of release numbers tailored to management units within the individual watersheds. For a complete description of outputs and results of the supplementation analysis, see Appendix A. Due to the extirpation of the endemic stock of coho in the Yakima Subbasin in the early 1980's, there is very little natural production occurring in isolated locations within the Subbasin. For reasons related to this, results presented from the supplementation analysis reflect a rather long time series for establishment of natural producing populations in the designated management units.

Klickitat

The Klickitat EDT model was completed in mid-March of 2004. Up to this date, the model has been a useful tool that has aided the Subbasin planning process. Outputs from the model that were used in the Klickitat Subbasin planning consisted of the restoration and preservation rankings by stream reach for Steelhead and Spring Chinook. For both restoration and preservation, the model ranks a stream reach's overall importance within a given population's geographic distribution. The rankings are based on the population's performance parameters which include equilibrium abundance, productivity and life history diversity. The restoration rankings display a stream reach's ability to increase the overall performance of a species population with restoration actions oriented to benefit the input parameters existing in the model. The preservation rankings prioritize a stream reach's importance to a given population in its current state. To some degree, these rankings represent the decline of a population's performance if any degradation were to occur with negative biologic impacts. Both of these outputs provided guidance in the Klickitat Subbasin planning process for prioritizing areas in need of restoration and areas identified for preservation concerning anadromous and resident fish stocks. Appendix B has the top 10 stream reaches for restoration for both Steelhead and Spring Chinook by geographic proximity. A brief description and interpretation of the reach accompanies its ranking in this document.

Personnel Acknowledgements: Chris Frederiksen, Joel Hubble and William Sharp YN biologists are handling this task for Yakima and Klickitat basins.

Task 1.b Yakima River Fall Chinook Fry Survival Study

Rationale: To determine the optimal locations within the lower Yakima basin where fall chinook production is feasible, and to guide location of future acclimation/release sites.

Methods: The feasibility of beach seining for juvenile fall chinook was initiated in 2001, with the long-term objective of initiating a PIT tag study to evaluate smolt-smolt survival between different reaches of the Yakima River. In April of 2004, beach seine sites were established at Richland, Toppenish and Granger to target juvenile fall chinook for growth profiling and marking via PIT tag or caudal clip.

Progress: Growth profiles of naturally rearing fall chinook juveniles in the lower Yakima River are currently being monitored via beach seining efforts during the months of April, May and June of 2004. Beach seining areas are located in three sections of the Yakima River, below Van Giessen Street Bridge (Rm 8.4-7.9), Benton City (Rm 29.8), above Granger (Rm 83-100.3) and Union Gap (Rm107.1-111.6). Seining is conducted using a 30 ft beach seine. All Fall Chinook >=58 mm are targeted to PIT tag. Those <58 mm captured in the Granger reach will receive a Lower Caudal (LC) clip and those in Union Gap reach an Upper Caudal (UC) clip. Forklengths will be taken on all PIT tagged fish and a proportion of clipped fish. Marked fish will be monitored at the Chandler Juvenile Monitoring Facility (CJMF). A "UC/LC" clipped fish observed at CJMF without a PIT tag meeting the size criteria (>=58mm) will be PIT tagged at that time. Fish below Prosser Dam will not be clipped. PIT tag detections will be monitored at CJMF, McNary and Bonneville Dam.

Fish captured at the Van Giessen reach in April had a larger range of sizes than those captured in the Granger and Union Gap reaches (35-75mm, 37-67mm and 32-56mm) respectively. Fish above Prosser Dam did not reach the minimum PIT tagging length until April 28th, 2004 whereas, we were able to PIT tag fish (>=58 mm) in the Van Giessen reach on our first visit April 14th. The larger sizes at Van Giessen are likely related to warmer temperatures as you move downstream. Average temperatures for April at Union Gap, Granger and Van Giessen were 49.6, 53.3 and 55.9 (°F), respectively. Temperature loggers are located in each of the three reaches to evaluate this relationship.

Personnel Acknowledgements: Melinda Davis is the project biologist for this task. Technicians Andrew Lewis, Ernie Reynolds, Jason Allan, Quincy Wallahee and Conan Northwind conducted all the field activities.

Task 1.c Yakima River Juvenile Spring Chinook Micro-habitat Utilization

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/cgi-bin/FW/publications.cgi

Pearsons, T. N., C. L. Johnson, B. B. James, and G. M.Temple. 2004. Spring Chinook Salmon Interactions Indices and Residual/Precocial Monitoring in the Upper Yakima Basin; Yakima/Klickitat Fisheries Project Monitoring and Evaluation Report 5 of 7. Annual Report 2003. DOE/BP-00013756-5.

Task 1.d 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 year of the OCT/SNT treatment cycle. Beginning with brood year 2002, the YKFP will test two different feeding regimes to determine whether a slowed-growth regime can reduce the incidence of precocialism without a reduction in survival (Larsen et al 2004). The two growth regimes to be tested are a normal (HI) growth regime resulting in fish which are about 30/pound at release and a slowed growth regime (LO) resulting in fish which are about 45/pound at release. To estimate smolt-to-smolt survival by rearing treatment (HI/LO), 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 will be adipose fin clipped and tagged with multiple body placement coded wire tags unique for rearing treatment, acclimation location, and raceway. Returning adults that are adipose clipped at Roza Dam Broodstock Collection Facility (RDBCF) will be interrogated using a hand-held CWT detector to determine the presence/absence of body tags. We will recover CWT during spawning ground surveys. We will use ANOVA to determine significant differences between groups for both smolt-to-smolt and smolt-to-adult survival.

Progress: Tagging of brood year 2002 fish began at the Cle Elum hatchery on October 13, 2003 and was completed on December 4, 2003. Marking results are summarized in Table 5. As in prior years, all fish were adipose fin-clipped. Approximately 2,200 fish (4.2% to 5.6% of the fish) in each of 18 raceways were CWT tagged in the snout and then PIT tagged. The remainder of the fish (722,400) had a CWT placed in their body (i.e. left/right cheek, anterior/posterior dorsal fin, anal fin and adipose fin) and 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, green = Jack Creek and orange = Easton). Fish with the elastomer dye in the left eyelid corresponded to the LO treatment and the right eyelid to the HI treatment. The six different CWT body tags corresponded to the rearing raceway (numbers 1-6, 7-12 and 13-18) at the Cle Elum Hatchery. Two raceways containing approximately 88,000 fish were hatchery control fish. These fish were differentially marked with a CWT in the snout. A final quality control check by YN staff took place in December 16-18, 2003.

Appendix C contains an analysis of OCT and SNT smolt-to-smolt survival for brood years 1997-2001 and smolt-to-adult survival for brood years 1997-1999.

Table 5. Summary of 2002 brood year marking activities at the Cle Elum Supplementation and Research Facility.

CE RW ID	Treat-ment	Accl ID	Comment	Est. Number	Elastomer Eye Site	Elastomer Eye Color	CWT Body site	Number Tagged CWT	Number Tagged PIT	Number Tagged Total	Start Date	Finish Date
CLE01	HI	JCJ06		47229	Right	Green	Anal Fin	45007	2222	47229	10/13/2003	10/16/2003
CLE02	LO	JCJ05		48495	Left	Green	Adipose Fin	46273	2222	48495	10/16/2003	10/21/2003
CLE03	HI	ESJ03		51249	Right	Orange	Anterior Dorsal	49027	2222	51249	10/21/2003	10/24/2003
CLE04	LO	ESJ04		52569	Left	Orange	Posterior Dorsal	50347	2222	52569	10/27/2003	10/30/2003
CLE05	LO	CFJ05		48038	Left	Red	Adipose Fin	45816	2222	48038	10/30/2003	11/4/2003
CLE06	HI	CFJ06		48690	Right	Red	Anal Fin	46468	2222	48690	11/5/2003	11/7/2003
CLE07	LO	ESJ05		47269	Left	Orange	Adipose Fin	45047	2222	47269	11/10/2003	11/12/2003
CLE08	HI	ESJ06		50515	Right	Orange	Anal Fin	48293	2222	50515	11/13/2003	11/19/2003
CLE09	LO	JCJ03		43844	Left	Green	Anterior Dorsal	41622	2222	43844	11/20/2003	11/25/2003
CLE10	HI	JCJ04		48568	Right	Green	Posterior Dorsal	46346	2222	48568	11/25/2003	12/3/2003
CLE11	LO	ESJ02		45841	Left	Orange	Right Cheek	43619	2222	45841	12/1/2003	12/4/2003
CLE12	HI	ESJ01		46313	Right	Orange	Left Cheek	44091	2222	46313	11/21/2003	12/1/2003
CLE13	HI	JCJ01		46601	Right	Green	Right Cheek	44379	2222	46601	11/17/2003	11/21/2003
CLE14	LO	JCJ02		48463	Left	Green	Left Cheek	46241	2222	48463	11/10/2003	11/17/2003
CLE15	LO	CFJ01	HxH	44414	Left	Red	Snout	42192	2222	44414	11/6/2003	11/10/2003
CLE16	HI	CFJ02	HxH	43924	Right	Red	Snout	41702	2222	43924	11/4/2003	11/6/2003
CLE17	HI	CFJ03		39991	Right	Red	Anterior Dorsal	37769	2222	39991	10/30/2003	11/4/2003
CLE18	LO	CFJ04		44288	Left	Red	Posterior Dorsal	42066	2222	44288	10/27/2003	10/30/2003

Task 1.e 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 January 21, 2003 until May 2, 2003. 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.

Progress: A total of 9,950 (7,804 wild and 2,146 hatchery) juvenile spring chinook were PIT tagged from fish collected at the Roza juvenile fish bypass trap. A maximum of 250 fish were tagged per day. Wild fish were tagged from January 22, 2003 through May 2, 2003; and hatchery fish March 19 through May 2, 2003.

Appendix D contains an analysis of wild/natural and CESRF (hatchery) smolt-to-smolt survival for brood years 1997-2001 (migration years 1999-2003).

Task 1.f 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.

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 2003 smolt passage estimates were as follows: wild spring chinook–207,250; OCT spring chinook– 48,079 (Jack Creek: 34,896 and Clark Flat: 13,183); SNT spring chinook– 59,819 (Jack Creek: 49,313 and Clark Flat: 10,506); wild fall chinook– 85,508; Marion Drain hatchery fall chinook– 634; wild coho– 9,260; hatchery coho– 14,356; and wild steelhead– 29,522. The Easton acclimation site was devoted to a spring chinook predator avoidance study in 2003. Control group passage was estimated at 8,929, while treatment group passage was 8,962. These estimates are provisional and subject to change as better entrainment estimates are developed.

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.g Yakima River Fall Chinook Monitoring & Evaluation

Rationale: To determine the optimal release timing (April vs. May) to increase overall smolt and smolt-to-adult survival.

Method: Approximately 365,409 fall chinook smolts were produced from fish spawned during the fall of 2002. These smolts were divided into two equal groups. One group was reared using conventional methods using ambient river temperature incubation and rearing profiles. The other group was incubated and reared using warmer well water to accelerate emergence and rearing and ultimately smoltification. Both groups of fish were spawned, incubated and reared at the Prosser Hatchery. Fish from both groups were 100% marked using ventral fin clips, and approximately 2,000 fish from each group were PIT tagged to evaluate survival and migration timing to the lower Columbia River. Approximately, 1,000 PIT tagged Marion Drain hatchery fall chinook juveniles were released to estimate survival from Marion Drain Hatchery to CJMF and McNary Dam.

Progress: Yakama Nation collected a total of 130 fall Chinook broodstock between Prosser Dam Denil ladder and from fish taken from Chandler canal at

Prosser. This resulted in 365,409 smolts that were split into two groups: approximately 165,000 smolts received accelerated incubation and rearing treatment, and about 100,000 smolts were incubated and reared on ambient river water (conventional group). All fish were ventral clipped, either left (conventional group) or right (accelerated group), to distinguish treatment groups as returning adults at Prosser Dam (video monitoring) and from carcasses recovered by WDFW during their fall chinook redd surveys conducted downstream of Prosser Dam. A total of 1,000 PIT tagged fish were marked from each of the two treatment groups (non-accelerated and accelerated) in order to estimate smolt-to-smolt survival to the lower Columbia River. The Prosser accelerated rearing had a higher survival index (0.30) than the conventionally reared fish (0.09).

The survival index for the Marion Drain conventional group was higher (0.25) than the Prosser reared conventional fish (0.09) and was not significantly different to the Prosser accelerated release group. Five years of combined survival indices to McNary Dam releases are given below in Table 6 followed by the graphical representation of the same estimates in Figure 1. See Appendix E for a detailed report and analysis of fall chinook smolt-to-smolt survival.

Table 6. Outmigration-Year 1999-2003 Tagging-to-McNary-Passage Survival Indices of PIT-tagged Lower-Yakima Fall Chinook reared under Accelerated and Conventional Rearing Procedures and Released below Prosser Dam and of PIT-Tagged Marion Drain Fall Chinook released in the Yakima River near Marion Drain.

Outmigration Year		Below-Prosser Release*		Marion	Over
		Accelerated	Conventional	Release**	Treatments
	Number Tagged	2000	1973	1032	5005
1999	**Survival Index**	**0.5407**	**0.3008**	**0.4981**	**0.4374**
	Number Tagged	2033	2018	1003	5054
2000	**Survival Index**	**0.4782**	**0.5985**	**0.3209**	**0.4950**
	Number Tagged	2014	1965	1020	4999
2001	**Survival Index**	**0.3844**	**0.2687**	**0.2976**	**0.3212**
	Number Tagged	2001	2000	1000	5001
2002	**Survival Index**	**0.0899**	**0.0834**	**0.1051**	**0.0903**
	Number Tagged	2000	1938	994	4932
2003	**Survival Index**	**0.2983**	**0.0947**	**0.2506**	**0.2087**
Over	Number Tagged	10048	9894	5049	24991
Years	**Survival Index**	**0.3587**	**0.2708**	**0.2958**	**0.3112**

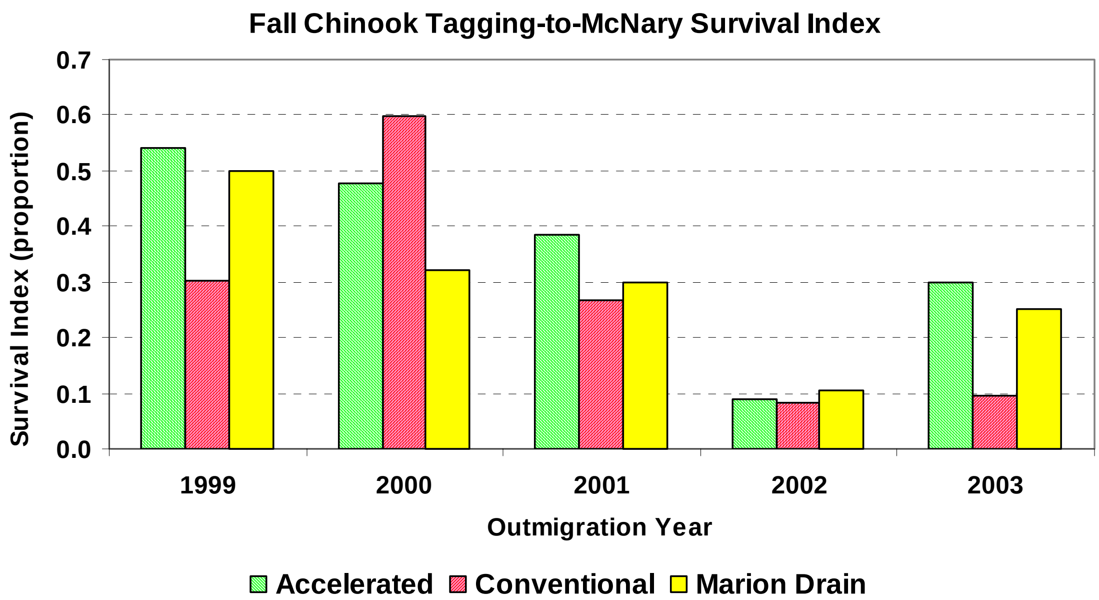


Figure 1. Tagging-to-McNary-Passage Survival Indices of PIT-tagged Lower-Yakima Fall Chinook reared under Accelerated and Conventional Rearing Procedures and Released below Prosser Dam and of PIT-Tagged Marion Drain Fall Chinook released in The Yakima River near Marion Drain.

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

Rationale: To determine the optimal location, date, and stock of release to maximize the feasibility of coho re-introduction into the Yakima Basin, and to determine the spawning distribution of returning adults.

Method: ***Phase I (1999-2003)*** The design of the phase 1 coho optimal stock consisted of a nested factorial experiment intended to test for survival differences between: out-of-basin and Prosser hatchery stocks; release location (upper Yakima and Naches sub basins); and early versus late release date (May 7 and May 31). Each release date had two replicates per sub-basin. Within each replicate approximately 2,500 coho smolts were PIT tagged (1,250 fish from both out-of-basin and Prosser hatchery stock were PIT tagged) to evaluate survival to CJMF and lower Columbia projects. The completion of phase I was with the return of 2003 adult coho.

Phase II (2003-2007) Implementation plans and guidance for phase II of the coho feasibility study are documented in the current coho master plan (Hubble and Woodward 2003). The design of the coho optimal stock has evolved toward testing survival from specific acclimation sites (including the current four), and trying to keep in-basin stock (Yakima Stock) acclimating in Lost Creek (Naches) and Boone Pond (Upper Yakima) in the upper portions of both watersheds. In this design, acclimation sites can only be compared geographically across sub-basins (Yakima and Naches). Out-of-basin coho will be acclimated further down in both sub-basins. Approximately 2,500 pit tags will represent each acclimation site during the normal acclimation period of February through May. Releases will continue to be volitional beginning the first Monday of April. An additional 3,000 PIT-tagged coho will be planted into each acclimation site during late summer to assess and monitor over winter acclimation and survival. Acclimation sites will have PIT tag detectors to evaluate fish movement during the late winter and early spring.

Progress: The first hatchery smolt release under Phase I of the coho feasibility study occurred in 1998. Completion of Phase I occurred in the fall of 2003 with the adult returns from the 2002 smolt release (BY2000). Our goal is to publish a summary of Phase I results by 2005. The experimental design for Phase II of the coho feasibility study is documented in the YKFP Yakima Coho Master Plan (Hubble and Woodward 2003).

Coho releases in 2003 mark the beginning of Phase II of the feasibility study. During the 2001 drought year we observed that out-migrating coho suffered significant mortality in the Yakima River. To alleviate this occurrence, Phase II calls for a volitional release beginning April 7 with the 2003 release. However, the timing of the releases may differ each year depending on water forecasts and stream conditions. We will monitor out-migration from the acclimation sites annually with PIT tag detectors.

In 2003, the measure of detection efficiency for PIT-tagged juveniles exiting the acclimation sites was poor ranging from 24% to 73% for the Naches sites to as low as 15% for the two upper Yakima River sites.

Release-to-McNary survival indices for 2003 hatchery smolt releases are given in Table 7. For both out-of-basin (Willard) and Yakima stocks, release-to-McNary survival indices for Naches releases significantly exceeded survival indices for releases in the Upper Yakima River (p=0.007). Acclimation site comparisons showed that in the Upper Yakima, the Holmes (acclimation site) survival index was higher than that of Easton for the Willard stock[1]. While in the Naches, the Stiles survival index was higher than that of Lost Creek for both out-of-basin and Yakima stocks. Stock comparisons showed that in all three of the possible stock interaction comparisons (Yakima stock versus

Willard stock) the Yakima stock outperformed the Willard stock. However, only at Lost Creek was the observed survival difference significant (p=.018). In past trials wherever the differences were significant, the Yakima stock also had the higher survival rates. See Appendix F for a detailed report and analysis of Yakima Basin coho smolt survival to McNary Dam.

Table 7. Summary of 2003 release-to-McNary survival index by stock, timing and location.

Survival Index			
Site	**Willard Stock**	**Yakima Stock**	**Mean Survival**
Easton	Pooled		.0980
Holmes	Pooled		.1155
Upper Yakima Mean Survival	**.0994**	**.1163**	**.1080**
Stiles	.2367	.2571	.2469
Lost Creek	.0898	.2098	.1498
Naches River Mean Survival	**.1641**	**.2361**	**.2001**

- We estimated that the smolt-to-adult survival rate for 19,859 wild/natural origin coho smolts (counted at CJMF in 2002) was 7.6%. This was considerably higher than the survival of hatchery smolts (next bullet).

- The estimated smolt-to-adult survival rate for 30,006 hatchery coho smolts (counted at CJMF in 2002) from releases in the Upper Yakima and Naches Rivers was 2.3%.

- The 2003 adult coho run was comprised of 1,523 wild/natural (69.5%) and 669 (30.5%) hatchery adult coho. This was the third year this distinction could be made. The entire hatchery release group is 100% CWT marked allowing for identification.

- Each year we attempt to radio tag approximately 100 adult coho spawners. In 2001, 105 spawners were radio tagged, in 2002 approximately 48 radio tags were inserted into coho, and in 2003 approximately 71 radio tags were inserted into adult coho. Radio tag numbers represent final resting areas or spawning areas before the fish moved back down stream. Radio tags entering the Naches River have risen from a low of nearly 5% in 1999 to the high of nearly 29% in 2003.

Table 8. Results of 1999-2003 Radio Telemetry Studies for Yakima Basin Coho

Year	1999	2000	2001	2002	2003	Average
Number Radio Tagged	86	102	105	48	71	
Never Seen	3.5%	5.9%	5.7%	4.0%	4.0%	4.6%
Mortality/Regurgitated Tag	3.5%	2.0%	7.6%	6.0%	6.0%	5.0%
Fell Back at Prosser	4.7%	7.8%	5.7%	4.0%	4.0%	5.3%
Prosser Dam to Granger	4.7%	1.0%	6.7%	13.0%	9.0%	6.9%
Granger to Sunnyside Dam	61.6%	41.1%	37.1%	19.0%	28%	37.4%
Sunnyside Dam to Naches conf.	12.8%	16.6%	5.7%	6.0%	9.0%	10.0%
Lower Naches	4.7%	2.0%	3.8%	6.0%	0%	3.3%
Naches above Cowiche Dam	3.5%	1.0%	13.3%	3.0%	29%	10.0%
Naches conf. To above Roza Dam		7.9%	9.5%	11.0%	9.0%	9.4%
Mid-Yakima Tributaries	1.2%	14.6%	4.8%	1.0%	11%	6.4%
Total above Naches Confluence	**8.2%**	**10.9%**	**26.1%**	**20.0%**	**38%**	**22.6%**
Total Coho into Naches River	8.2%	3.0%	17.1%	9.0%	29%	13.3%

- Since 1999 all smolts have been released in the Naches and the Upper Yakima Rivers, and in 1998 a portion of the smolts were released from Lost Creek in the Upper Naches River. Acclimation sites are now located in the Upper Yakima and Naches Rivers. Despite this, the majority of spawning appears to occur in the Yakima River downstream to the Naches River confluence. There are varying beliefs of why this occurs, these include: 1) lack of stamina, primarily by females trying to reach their release locations, 2) unspecific acclimation, all four acclimation sites use main stem water for acclimation, 3) straying and delay due to false attraction from irrigation returns, and 4) natural production occurring above Granger to the confluence of the Naches River. Nevertheless, with the exception of 2002, the percentage of adult coho spawning above the Yakima river's confluence with the Naches River has steadily increased from 8.2% in 1999 to 38% in 2003. In 2003, it is estimated that approximately 4% of the entire coho run spent various amounts of time in Sulfur Drain. This estimate was derived from radio tag detections. Of the first 17 radio tagged coho released at Mabton, 4 swam into Sulfur Drain and eventually 105 adult coho were captured from the head box at the top of the drain. This problem was not as evident in 2002 due to the lower numbers of adult coho returning (541), and nearly 7% of the coho run spent various amounts of time in the drain in 2001.

- Snorkel surveys to look for residualized coho were conducted on the Upper Yakima River (Easton Reach) from the Easton acclimation site (Rkm 325.4) to the confluence of the Cle Elum River (Rkm 294.6). 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 (Rkm53.9). A total of 1,500 meters of river was snorkeled in these surveys in 2002 and we found no incidence of age-0 precocials. However, one yearling coho was observed in the Lost Creek reach which equates to 0.25 fish per river kilometer. In June of 2003, nearly 2,500 meters of river was snorkeled. There were no yearling or sub yearling coho observed in the 2003 surveys.

Personnel Acknowledgements: Special thanks to all the people involved in the coho monitoring and evaluation activities. These people include but are not limited to Joe Jay Pinkham III, Linda Lamebull, Jason Allen, Conan Northwind, and Quincy and Kirby Wallahee. Also thanks to the Prosser Fish Culturing facility for their cooperation.

Task 1.j Yakima Spring Chinook Juvenile Morphometric/Coloration

The WDFW annual report(s) for this task can be located on the BPA website: http://www.efw.bpa.gov/cgi-bin/FW/publications.cgi

Schroder, S.L., C.M. Knudsen, B. Watson, T. Pearsons, D. Fast, S. Young and J. Rau. 2004. Comparing the reproductive success of Yakima River

hatchery-and wild-origin spring chinook. Annual Report 2003, Project Number 1995-063-25. BPA Report DOE/BP-00013756-4.

And

Busack, C., A. Frye, T. Kassler, T. Pearsons, S. R. Phelps, S. L. Schroder, J. B. Shaklee, J. Von Bargen, S. F. Young, C. M. Knudsen, and G. Hart. 2004. Yakima Fisheries Project Genetic Studies, Yakima/Klickitat Fisheries Project Monitoring and Evaluation, Annual Report 2003. Project No. 1995-064-24; BPA Report DOE/BP-00013756-1.

Task 1.l 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 is recorded for each fish run.

Methods: Monitoring is accomplished through use of time-lapse video recorders (VHS) and a video camera located at each of the three fishways. The videotapes are played back and various types of information/data are recorded for each fish that migrates upstream via the ladders. These data are recorded on paper, 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 (2003 run)

An estimated 6,898 spring chinook passed upstream of Prosser Dam in 2003. The total adult count was 4,999 (72.5%) fish, while the jack count was 1,899 (27.5%) fish. Of the adult count, 1,257 were identified as hatchery origin. Returning hatchery adults this year comprised 4 and 5 year olds (brood years 1998 and 1999). The ratios of wild to hatchery fish were 75:25 and 48:52, for adults and jacks respectively.

The 25%, 50% and 75% dates of cumulative passage were April 25, May 10 and May 23, respectively.

The estimated mean fork length for adults (wild and hatchery) and jacks (wild and hatchery) was 77.2 cm and 50.7 cm, respectively. The estimated video fork length for adults was 0.8 cm and 1.0 cm larger for adults and jacks respectively, than that measured "hands-on" at Roza in the broodstock collection. The average size of adults was larger in 2003 due to the high proportion of age-5 fish (44%) in the 2003 return. Historical video data suggests that video based fork lengths at Prosser are not a reliable measurement to estimate true fork length. It is believed this is a result of a "mismatch" in the applied multiplier value (video length x multiplier value = true length) relative to the horizontal passage trajectory of the fish as it passes by the viewing window.

Fall Run (coho and fall chinook)

Coho (2003)

The estimated coho run was 2,354 fish. It should be mentioned that an undetermined number of fish "dropped out" below Prosser Dam and are not reflected in this count. Some fish were harvested while others were falsely attracted into tributaries such as Spring Creek. Adults comprised 93.1% and jacks 6.9% of the run. Of the estimated run, 43.8% were processed at the Denil and mark sampling there indicated the run was comprised of approximately 69.6% wild/natural and 30.4% hatchery coho.

The 25%, 50% and 75% dates of cumulative passage were October 4, October 16 and October 24, respectively.

The estimated mean adult and jack fork length was 64.4 cm and 39.6 cm, respectively, compared to 65.3 cm and 39.6 cm for measured fish collected for broodstock. This indicates a possible size bias of the true fork length for fish measured from the videotapes. This bias has been observed in past years for all salmonid species at Prosser Dam.

Fall Chinook (2003 run)

Estimated fall chinook passage at Prosser Dam was 4,875 fish. Adults comprised 98.4% of the run, and jacks 1.6%. Of the total number of fish, 458 were adipose clipped, 437 fish were adults and 21 fish were jacks. The median passage date was October 5, while the 25% and 75% dates of cumulative passage were September 18 and October 21, respectively. Of the total fish estimate, 2,259 (46.3%) were counted at the Denil.

The mean estimated adult and jack fork lengths were 83.7 cm and 46.6 cm, respectively.

Steelhead (2002-03 run)
The estimated steelhead run was 2,235 fish. Of the total, 45 were adipose clipped fish, which were all out-of-basin strays since no hatchery returns were expected to the Yakima River. The median passage date was December 15th, 2002, while the 25% and 75% cumulative dates of passage were November 12th, 2002 and January 26th, 2003 respectively.

The mean fork length was 68.2 cm, and fish ranged in size from 38.8 cm to 88.2 cm.

Personnel Acknowledgements: Biologists, Melinda Davis and Mike Berger, Data Manager Bill Bosch, and Fisheries Technicians Winna Switzler, Florence Wallahee and Sara Sohappy.

Task 1.m Adult Salmonid Enumeration and Broodstock Collection at Roza/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 is 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 were played back and various types of information/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.

Progress:
Roza Dam
Steelhead
A total of 133 steelhead were counted past Roza Dam for the 2002-03 run. As shown in Figure 2, most steelhead migrated past Roza Dam from February through early May of 2003.

Spring Chinook

At Roza Dam 3,842 (50.4% adults and 49.6% jacks) spring chinook were counted at the adult facility between April 23 and September 11, 2003. The adult return was comprised of natural- (40.5%) and CESRF-origin (59.5%) fish. The jack return was comprised of natural- (40.6%) and CESRF-origin (59.4%) fish. Figure 3 shows passage and wild brood collection timing at Roza in 2003.

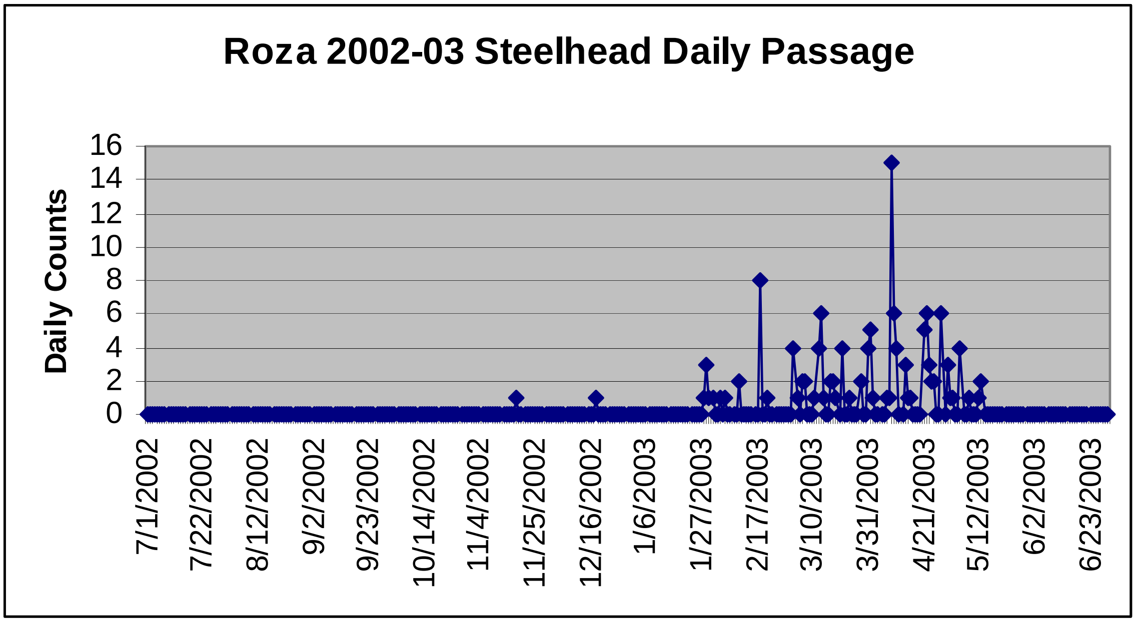


Figure 2. Daily steelhead passage at Roza Dam, 2002-03.

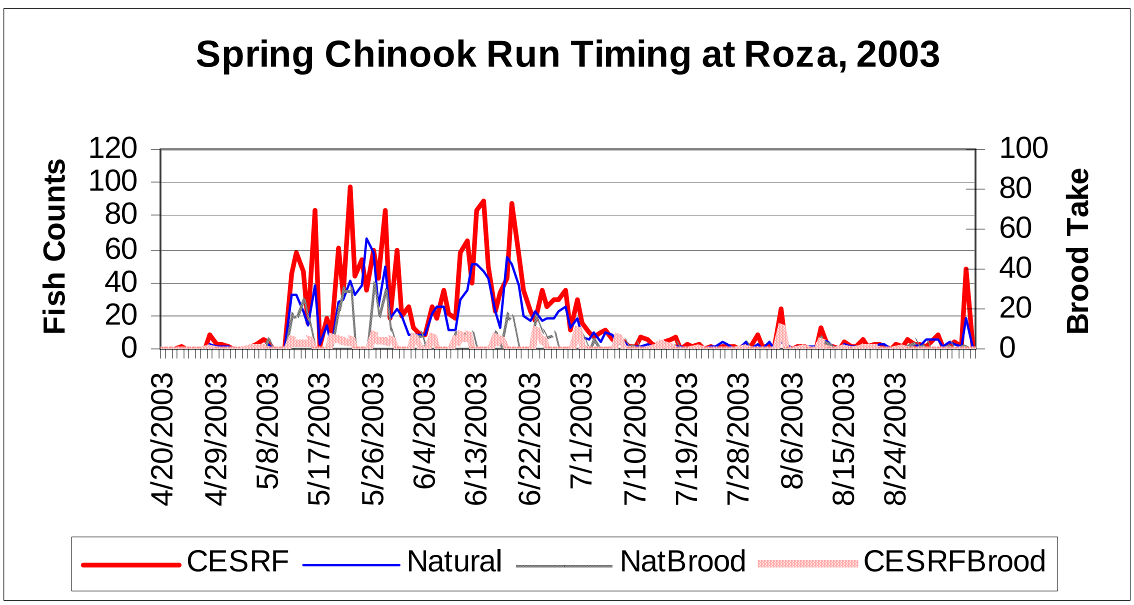


Figure 3. Daily spring chinook passage for CESRF-origin, natural, and broodstock collected at Roza Dam, 2003.

Coho

A total of 9 adult and no jack coho were observed passing Roza Dam from September 13, 2003 through November 17, 2003. Of the total, 1 adult was observed to have a CWT in the snout (hatchery-origin).

Cowiche Dam

Coho

The persistence of moderate turbidity levels resulting primarily from Tieton River water releases through the most of the coho upmigration period negated the opportunity to video monitor adult counts for spawning coho in 2003.

Task 1.n Spawning Ground Surveys (Redd Counts)

Rationale: To enumerate the temporal-spatial distribution of spring chinook, fall chinook, steelhead and coho redd deposition in the Klickitat and Yakima basins. To collect biological information from spawned out carcasses.

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 are 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: Steelhead surveys in Satus and Toppenish basins and Ahtanum Creek began in mid-March and end in late April. Total redd counts by subbasin were as follows: Satus basin- 93, Toppenish basin- 56, and Ahtanum Creek- 12. For all three basins a total of 161 redds were counted.

Steelhead redd surveys in the Naches River system were conducted jointly by the U.S. Forest Service and the Washington Dept. of Fish and Wildlife. These surveys counted 94 total redds in the Naches system between March 24 and May 27, 2004 (G. Torretta, USFS, personal communication).

Spring Chinook: Redd counts began in late July in the American River and ended in early October in the upper Yakima River. Total counts for the American, Bumping, Little Naches, Naches, and Rattlesnake rivers were, respectively, 430, 216, 61, 200, and 23 redds. Redds counts in the upper Yakima, Teanaway and the Cle Elum rivers were, 772, 31 and 87, respectively. The entire Yakima basin had a total of 1,825 redds (Naches- 935 redds, upper Yakima- 890).

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

Yakima R.: 1271 redds. Most redds were located between the Donald-Wapato Bridge and below the Granger Bridge.

Naches R.: 11 redds. Three surveys were conducted from the end of October to mid-November from Wapatox Dam to Cowiche Dam.

Marion Drain: 86 redds. The majority of redds were located between Old Goldenale Rd and approximately two-miles below HWY 97.

Coho: Surveys begin the first week of November and end in late December in the Yakima River Basin. Redd surveys are conducted daily in conjunction with fall Chinook surveys. The Yakima and Naches Rivers are broken into sections that are checked via boat or foot weekly. Coho redds are difficult to find throughout the Yakima and Naches Rivers. Untimely fall/winter freshets and weather hinder many spawning surveys. Many redds are intermixed with fall chinook redds, tucked under cut banks or just too small to recognize. Tributary redd enumeration and identification is much more accurate due to the low water and ease of foot access. Although coho redd surveys have proven to be difficult, redds have been found and there has been shifts in redd densities into the Naches and in and out of tributaries.

Table 9. Yakima Basin Adult Coho Redd Counts, 1998-2003.

River	1998	1999	2000	2001	2002	2003
Yakima River	53	104	142	27	4	32
Naches River	6	NA	137	95	23	56
Tributaries	193	62	67	29	16	21
Total	**252**	**166**	**346**	**151**	**43**	**109**

Task 1.p 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/cgi-bin/FW/publications.cgi

Pearsons, T. N., C. L. Johnson, B. B. James, and G. M.Temple. 2004. Spring Chinook Salmon Interactions Indices and Residual/Precocial Monitoring in the Upper Yakima Basin; Yakima/Klickitat Fisheries Project Monitoring and Evaluation Report 5 of 7. Annual Report 2003. DOE/BP-00013756-5.

Task 1.q Yakima River Relative Hatchery/Wild Spring Chinook Reproductive Success

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/cgi-bin/FW/publications.cgi

Schroder, S.L., C.M. Knudsen, B. Watson, T. Pearsons, D. Fast, S. Young and J. Rau. 2004. Comparing the reproductive success of Yakima River hatchery-and wild-origin spring chinook. Annual Report 2003, Project Number 1995-063-25. BPA Report DOE/BP-00013756-4.

Task 1.r Yakima Spring Chinook Gamete Quality Monitoring

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/cgi-bin/FW/publications.cgi

Knudsen, C.M. (editor). 2004. Reproductive Ecology of Yakima River hatchery and wild spring chinook. Annual Report 2003, Project Number 1995-063-25. BPA Report DOE/BP-00013756-3.

Task 1.s Scale Analysis

Rationale: To determine age/length and stock (hatchery vs. wild) composition of adult salmonids 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 is entered into the YKFP database maintained by the Data Management staff.

Progress: Adult scale sample results are summarized in Table 10 by species and sampling method.

Table 10. The 2003 adult scale sample data summary for salmonids in the Yakima Basin.

	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	137	15.7	394	41.8	255	60.6	215	71.4
Upper Yakima Wild/Natural			55	43.5	314	62.3	63	72.4
Spawner Survey Samples								
Upper Yakima Supplementation								
Upper Yakima Wild/Natural			24	45.1	34	61.3	3	67.8
American River Wild/Natural					18	63.8	207	77.6
Naches River Wild/Natural			6	41.3	34	62.5	119	76.9
Yakima R. Fall Chinook								
Hatchery	3	35.8	25	54.4	44	67.7	23	75.6
Wild/Natural	21	36.2	67	57.4	259	67.7	153	75.3
Yakima R. Coho								
Hatchery	26	30.9	276	50.9				
Wild/Natural	63	32.2	591	52.6	4	65.3	2	72.3

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 l.u Habitat Monitoring Flights and Ground Truthing

Rationale: To record an aerial video record of a particular subbasin that can be used to aid in the EDT Level 2 data input to the model.

Methods:

Progress: No work was budgeted for this task in fiscal year 2003.

Task 1.w 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 the upper Yakima River (upstream of the Cle Elum River) and the Naches Basin in the fall of 2003. 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 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: A complete summary of the field data 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).

Upper Yakima

Sixty samples were collected from a control reach located above Lake Easton (Stampede Pass) and treatment reaches extending from Easton to the Cle Elum River confluence. Mean percent fines (<0.85 mm) by sample reach were- Stampede Pass (control): 5.81%, upper Easton: 7.41%, lower Easton: 10.69%, Elk Meadows: 10.08%, and Cle Elum: 8.54%.

Naches

Thirteen sites were sampled in the Naches Basin in 2003. The mean percent fines (<0.85 mm) in the Little Naches River (mainstem) was 12.06%; North Fork- 11.05%; South Fork- 11.86%; Bear Creek- 11.67%; Pyramid Creek- 11.08%; and in the Tieton South Fork- 13.33%.

Task 1.x Predator Avoidance Training

Rationale: Hatchery fish have been shown to be more susceptible to predation than wild counterparts and it has been suggested that hatchery fish lack skills required to avoid predators (Wiley et al. 1993; Olla et al. 1994; Maynard et al. 1995). Spring chinook (*Oncorhynchus tshawytscha*) in the Easton Reach of the upper Yakima River encounter heavy avian predation, migration impediments, and a significant migration distance to saltwater (Figure 4).

A predator avoidance training (PAT) experiment was conducted upon a population of hatchery Yakima spring chinook juvenile salmon reared at the Cle Elum Supplementation & Research Facility (CERSF), in a pilot test that evaluates this type of behavioral conditioning as a fish culture methodology to enhance/improve hatchery juvenile smolt survival. This study tests the hypothesis that by predator avoidance training in a test population composed of hatchery reared juvenile salmon, trained fish would survive in proportionally higher numbers than that of a comparable sized population of un-trained juvenile salmon. This study also employed a grid matrix to measure salmonids' behavioral response to avian predator activity. Avian predators were employed as training agents to three experimental raceways stocked with hatchery spring chinook juveniles, and three raceways, also stocked with chinook juveniles, were designated as experimental controls. Approximately 40,000 spring chinook from brood year 2001 were used in this tri-replicate experimental design conducted during their rearing at the CESRF in 2002 and eventual release from the Easton acclimation site in the spring of 2003.

Method: Six empty production raceways (Cle Elum ponds 13 through 18) were used for the PAT study. Of these, three experimental raceways (ponds 14, 17 and 18) were randomly selected by drawing their respective numbers out of a hat. CESRF and acclimation site raceways measure 100'x 10' x 3.5' and 100' x 12' x 3.5', respectively, and have built-in pond divider slots that allowed for sectioning the raceway into four 25' compartments. Perforated aluminum pond divider screens were wedged into the second and third slots of all six raceways, providing a rearing space of 875 cubic feet per raceway, and three 10' x 8' x 4' conduit frame cages, with 2" dark green hog-wire on the sides and top, were placed into the three experimental raceways (Figure 5). Changes to the cages prior to Easton Acclimation site PAT training constituted a one foot square white checker grid, with yellow trim, contrasting with green wire mesh checkers, painted atop of each cage. The checkered grid allowed for an observer to view activity and record distance (to the nearest foot) for fish from bird in the predator cage. Three 6' high x 4' wide camouflage blinds were mounted on 4' high legs so that an observer could look directly down into the cage galley, and observe merganser and fish activity. The mergansers used in the study were Hooded (*Lophódytes cucullátus*) and Red-Breasted mergansers (*Mérgus serrátor*). All birds were kept in an aviary built over raceway 20, the last production pond on the north end of the raceway battery. A temporary aviary was constructed at the Easton Acclimation site to house PAT mergansers. Two adult pairs of Red-Breasted mergansers were purchased in October 2002 for use at Easton.

PAT sessions involved placing a bird into a wood box, then releasing it into an experimental pond cage for a proscribed period of time. Initial individual trial session times at Cle Elum were 60 minute PAT sessions using Hooded mergansers. The trial session timing was reduced to 30 minutes per session during acclimation PAT events. Observations were recorded for predator activity and prey response. No PAT trials took place in control ponds. Data derived from observations consisted of three grid matrix measurements of nearest fish to bird, every 20 seconds, counts of predator actions per minute (lunge, dive, chase and consume), and number of fish consumed. Three PAT sessions took place for each trial event.

The release of PAT/control groups of salmonids from Easton was timed to occur at the same time for acclimated juvenile salmonids release from the Jack Creek and Clark Flats Acclimation sites. A force-out strategy, that took place on March 28, 2003, was deemed the best release option due to the small test population size (<39,000 fish total), to subject the PAT/control groups to natural predation at roughly the same time. A volitional release strategy, as that conducted at the other two acclimation sites, might incur some biased survival variation arising from a small population temporally trickling through differential rates of predation. Survival indices for the PAT and control groups were derived from PIT-tag and passage enumeration sample data collected by YKFP staff at the Chandler Juvenile Trap facilities, and from smolt passage sampling facilities at McNary and John Day Dams. Out-migration survival differences between these six raceways were examined from PTAGIS data interrogation information from the designated acclimation site.

Brief Summary of Results: Usable observation data was collected from the first seven out of fourteen PAT trials, as poor water clarity after Trial 7 obstructed good visual conditions for observations between predator and prey. Significant differences in DISTANCE means were evident in early versus late trials as shown in Table 11, when no bird activity counts were analyzed. The difference in DISTANCE means when bird activity counts were analyzed between early and late trials were weakly significant (Table 12). When pooled counts were analyzed between early and late trials, significant differences between PERIODS were detected (Table 13). A multiple comparison based upon a regression of ACTION and trial PERIODS, Dunnett's test, revealed significant differences in DISTANCE means when one and up to four sequential ACTIONS were compared against no ACTION (Table 14).

The critical measure in this study, the survival index, was derived from PIT-Tag interrogations from out-migrating chinook smolts passing through John Day and McNary Dams. The estimation method took John Day daily expansions, adjusted for passage timing rates based upon Bonneville detections, and the total number quantified was divided by the total number of PAT and control fish PIT-Tagged, with tag shedding rates held at less than 1%. The force-out release at Easton reduced the tag detection efficiency of the PIT-Tag detection system at that site, though the effect on the total PIT-Tagged denominator should be minimal for this analysis. No significant difference in survival was detected between PAT and control fish at John Day and McNary Dams (Table 15) based upon all PIT-Tagged fish and volitional releases. Cumulative frequency passages, based upon PAT and control PIT-Tag smolt passage at John Day and McNary Dams, can be viewed in Figures 6 and 7.

Discussion: The noted reactionary effect PAT training had on experimental smolts was washed out by the zero difference in survival indices to John Day and McNary Dams. It should be noted that this study in terms of release strategy, differed markedly in terms of numbers of fish available for the study with that of the overall Optimum Conventional Treatment/Semi-Natural Treatment (OCT/SNT) production, and in the manner in which PAT and OCT/SNT fish were released, volitional versus force-out release. In recent past years, smolt survival from releases in the Easton reach of the Yakima River, for both coho and chinook hatchery smolts, have been somewhat variable overall, and in most instances poor survival indices have been the norm. The small population in this study may not have experienced the heavy avian predation known to occur in this reach, as a population undergoing a volitional release would be more susceptible, given the temporal and volitional flow of fish from this site. An argument can be made that a production-sized PAT regimen, in the manner of an experiment and control design with a volitional release migration strategy, may determine more accurately if detectable differences in overall smolt survival indices between PAT and control fish, can be attributed to anti-predator training.

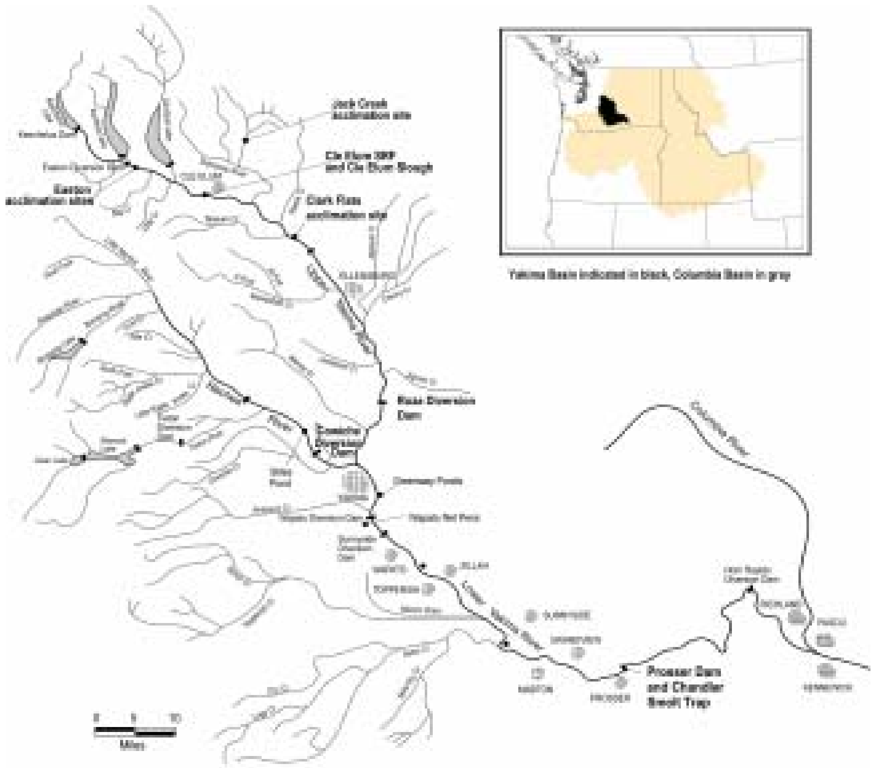


Figure 4. Location of Cle Elum Supplementation Facility and Easton Acclimation Site.

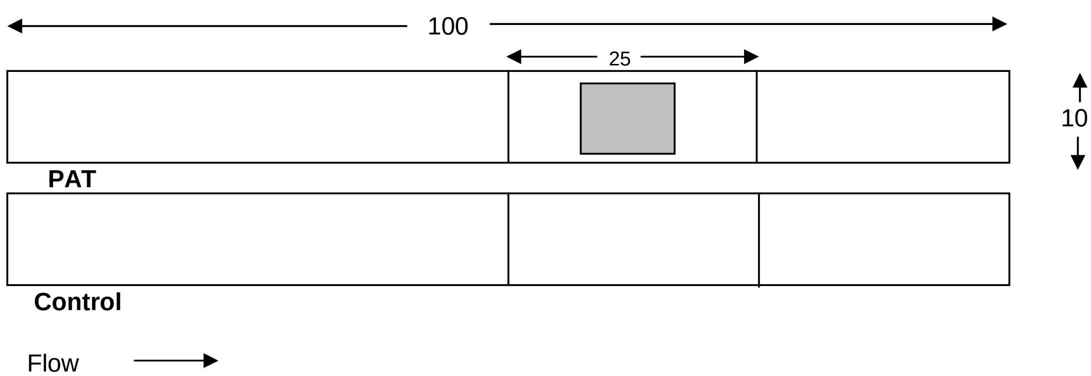


Figure 5. CESRF and acclimation site raceway Control and PAT setup (acclimation site raceways measure 12’ width), with a 10’ x 8’ x 4’ wire mesh cage center in the PAT divided compartment.

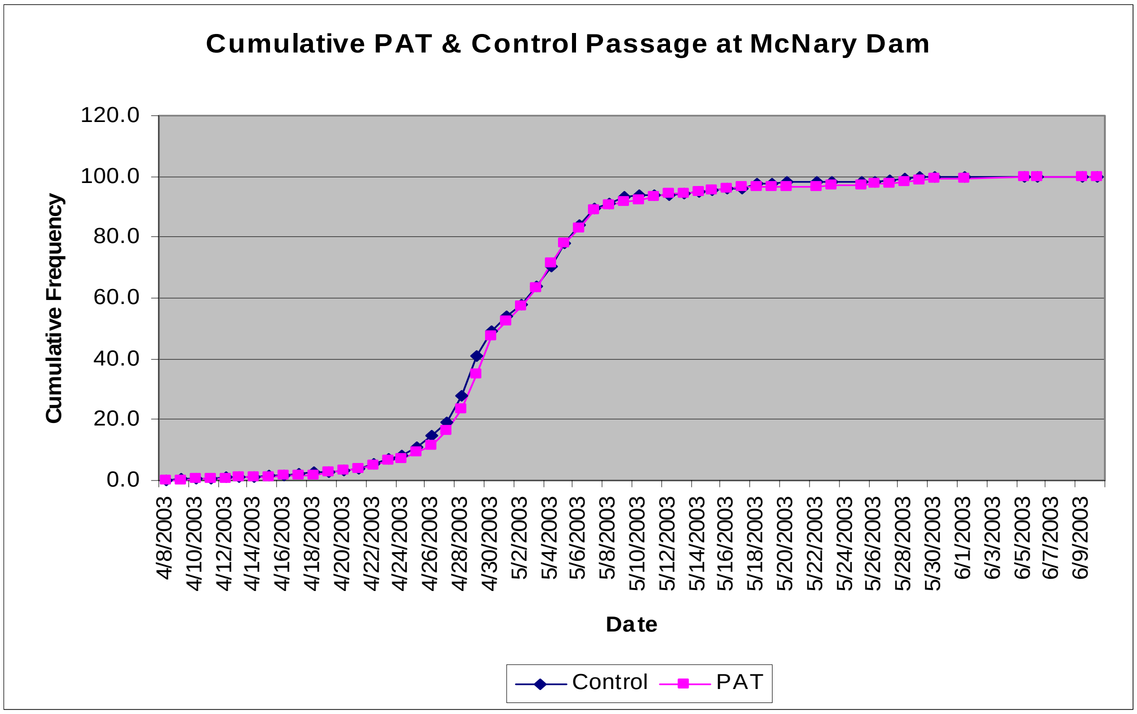


Figure 6. Cumulative PAT and Control Passage at McNary Dam.

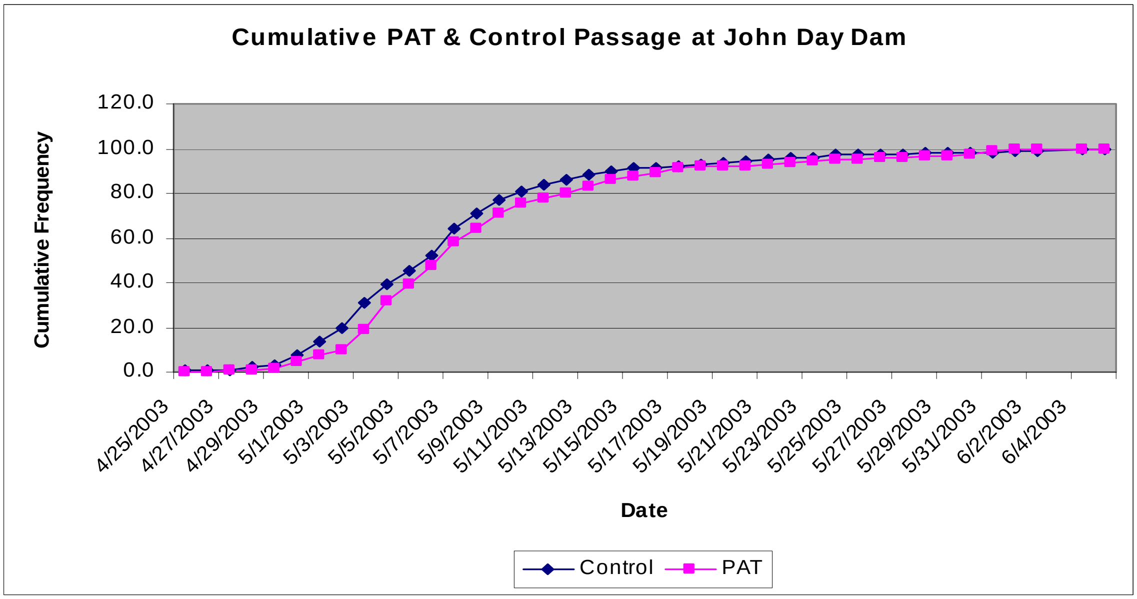


Figure 7. Cumulative PAT and Control Passage at John Day Dam.

Table 11. Two Sample T-Test on DISTANCE Grouped by Periods.

		N	Mean	SD	P
N[a]	Early	900	7.05	1.92	0.000
	Late	678	7.65	1.5	

[a] No bird activity.

Table 12. Two Sample T-Test on DISTANCE Grouped by Periods.

		N	Mean	SD	P
Y[a]	Early	180	8.00	2.13	0.039
	Late	132	8.44	1.62	

[a] Bird activity.

Table 13. Two Sample T-Test on DISTANCE Grouped by Periods.

	N	Mean	SD	P
Early	1080	7.214	1.992	0.000
Late	810	7.773	1.549	

Table 14. Multiple Comparisons of DISTANCE Means with No ACTION versus ACTIONS.

	Adjusted Means Adjusted Means for Ponds & Trial	S.E .	ACTION(S) Compared to Zero ACTION	S.E. for Comparison	t-ratio[a,b]
ACT 0	7.371	0.037			
ACT 1	8.146	0.106	0.775	0.1125	6.89
ACT 2	8.636	0.225	1.266	0.2274	5.57
ACT 3	8.652	0.403	1.282	0.4047	3.17
ACT 4	9.876	1.208	2.505	1.2083	2.07

[a] Fisher's Protected LSD Infinity Degrees of Freedom (2-Sided Test) Alpha = 0.05, T-critical = 1.960; Alpha = 0.01, T-critical = 2.576.
[b] Dunnetts's Value for Infinity Degrees of Freedom (2-Sided Test) Alpha = 0.05, T-critical = 4.03; Alpha = 0.01, T-critical = 4.76.

Table 15. Easton PIT-Tagging and John Day Detection Numbers and 2003 CNT and PAT Survival Indices from PIT-Tagging to John Day Passage.

	McNary Based on all PIT-Tagged Fish		John Day Based on all PIT-Tagged Fish	
	CNT	PAT	CNT	PAT
Detections (Det)	617	582	246	260
Expanded Det	1238.8	1180.5	919.3	936.1
Number PIT-Tagged	4007	4000	4007	4000
Survival Index	0.3092	0.2951	0.2294	0.2340

Task 1.y Biometrical Support

Doug Neeley of IntSTATS was contracted by the YKFP to conduct the following statistical analyses:

- 2003 Annual Report OCT-SNT Survival (See Appendix C)
- 2003 Annual Report, Wild and Hatchery Smolt Survival of Roza Spring Chinook Releases (See Appendix D)
- Annual Report: Smolt Survival to McNary of Year-2003 Fall Chinook (Appendix E) and Coho (Appendix F) Releases into the Yakima Basin

All four reports are attached to the 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 Yakima and Klickitat Subbasin Harvest Monitoring

Rationale: To develop a database to track the contribution of target stocks to in-basin fisheries.

Method: The two co-managers, Yakama Nation and WDFW, are responsible for monitoring their respective fisheries in both the Klickitat and Yakima rivers. 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 and Klickitat River in-basin Tribal harvest for salmon and steelhead are presented in Table 16.

Personnel Acknowledgements: Biologist Bill Bosch, Mark Johnston and Fisheries Technicians Steve Blodgett and Arnold Barney.

Table 16. A summary of Yakama Nation tributary estimated harvest in the Yakima and Klickitat subbasins, 2003.

River	Dates	Weekly Schedule	Notes	Chinook	Jacks	Steelhead	Coho
Klickitat River	4/1 to 8/2	Noon Tuesday to 6 p.m. Saturday	1	994	14	236	
Klickitat River	8/5 to 8/23	Noon Tuesday to 6 p.m. Saturday	2	59	0	53	
Klickitat River	10/14 to 11/2	Noon Tuesday to 6 p.m. Saturday	3	133	10	26	6,201
Klickitat Total				1,186	24	315	6,201
Yakima River	4/8-7/26	Noon Tues to 6 PM Saturday	4	352	88	0	0
Yakima River	9/16-11/22	Noon Tues to 6 PM Saturday		0	0	0	0

1. Commercial sale open from April 24 to May 31, July 3 to July 16, and from July 21 to July 26.
2. Commercial sale opened August 14; August 26 to October 11 landings included in commercial landings.
3. Commercial sale of Chinook and Coho open from October 14 to December 13.
4. Monitoring data collected by YKFP monitors and catch estimates made by Bill Bosch.

GENETICS

Overall Objective: Develop methods of detecting significant PAPS genetic changes in extinction risk, within-stock genetic variability, between-stock variability and domestication selection.

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 Allozyme/DNA data collection and analysis.
- Task 3.b Stray recovery on Naches and American river spawning grounds.
- Task 3.c Yakima spring chinook domestication.

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/cgi-bin/FW/publications.cgi

Busack, C., A. Frye, T. Kassler, T. Pearsons, S. R. Phelps, S. L. Schroder, J. B. Shaklee, J. Von Bargen, S. F. Young, C. M. Knudsen, and G. Hart. 2004. Yakima Fisheries Project Genetic Studies, Yakima/Klickitat Fisheries Project Monitoring and Evaluation, Annual Report 2003. Project No. 1995-064-24; BPA Report DOE/BP-00013756-1.

ECOLOGICAL INTERACTIONS

Overall Objective: To develop monitoring methods to determine if supplementation and enhancement efforts keep ecological interactions on non-target taxa of concern within prescribed limits and to determine if ecological interactions limit supplementation or enhancement success.

Task 4.a Avian Predation Index

Rationale: To assess the annual impact of avian predation upon juvenile salmonid populations in the Yakima River Basin.

Methods:

Methods used to monitor avian predation on the Yakima River in 2003 were the same as were used in 2002, with the exception of no monitoring of secondary acclimation sites.

Hotspot Surveys—Spring

The hotspot survey design for 2003 followed the methods used in 2001 and 2002, designed by the Washington Cooperative Fish and Wildlife Research Unit. Details of these methods can be found in the annual reports.

In 2003, hotspot surveys were conducted on Mondays, Wednesdays, and Fridays at Horn Rapids Dam and the outlet pipe at the Chandler Juvenile Fish Facility (Chandler) in Prosser between April 7th and June 30th. A total of 36 days of surveying were conducted at each site. Survey effort increased as the season progressed as additional personnel became available. In April, both sites were visited by one person each day surveyed. Both sites were surveyed simultaneously by different personnel beginning on May 12th. Observations began on the nearest 15-minute interval after sunrise and ran for eights hours, or began at midday, eight hours after the nearest 15-minute interval after sunrise, 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 were used to determine sunrise and sunset times. The number of survey windows within a day varied between seven, but the first and the eighth windows were not surveyed due to limited personnel.

River Reach Surveys—Spring and Summer

Spring river surveys included all of the six river reaches that have been surveyed in previous years. Each reach was surveyed approximately once every 2 weeks, from April 7 through June 28. Reaches included Benton, Vangie, Zillah, Canyon, Cle Elum and Easton, accounting for approximately 37% of the Yakima River. During the summer, river surveys included the following upper three reaches, the Canyon, Cle Elum and Easton. Each reach was surveyed once a week from July 1 through August 28. All reaches surveyed in both the spring and summer were identical in length and location to those conducted in 2002.

North Fork Teanaway River Surveys—Spring and Summer

The section of river from the Jack Creek acclimation sites downstream for 3.5 km was again surveyed in 2003. The time, species, and total number of piscivorous birds were noted as the surveyor(s) walked downstream. This area was surveyed ten times between May 6 and August 20, 2003, twice in the spring, and eight times in the winter.

Acclimation Site Surveys—Winter / Spring

Spring chinook acclimation sites associated with the Cle Elum Supplementation and Research Facility were again monitored by hatchery personnel in 2003. All surveys were conducted between January 15 and May 12. Sites surveyed included Easton, Clark Flat, and Jack Creek. The majority of these surveys were conducted at 8:00am, 12:00pm, and 4:00 pm. All piscivorous birds within the acclimation facility, along the artificial acclimation stream, and above and below the acclimation stream outlet were identified and recorded.

Beginning in 2003, four coho acclimation sites were monitored as well: Easton Pond and Holmes on the Yakima River, and Lost Creek and Stiles on the Naches River. All observations were made between February 28 and April 16. Sites were generally surveyed twice a day when personnel visited these sites, once in the morning and once in the afternoon, although the majority of the surveys were conducted in the morning.

Progress:

The predation of birds on fish continues to contribute to the loss of some out-migrating juvenile salmonids in the Yakima River Basin, potentially constraining natural and artificial production.

In 2003, as in previous years, piscivorous birds were counted from river banks at hotspots and from a raft or drift boat along river reaches. Consumption by gulls at hotspots was based on direct observations of foraging success and modeled abundance while consumption by all other piscivorous birds was estimated using published dietary requirements and modeled abundance. Seasonal patterns of avian piscivore abundance were identified, diurnal patterns of gull abundance at hotspots were identified, and predation indices were calculated for hotspots and river reaches, for both the spring and summer.

Hotspot Surveys—Spring

Average daily gull numbers at Chandler remained 25 birds per day until the end of April, peaked on May 9th at 67 birds per day, and then remained low for the rest of the season. Gull numbers at Horn were low all season, peaking at 27 gulls per day on May 28th.

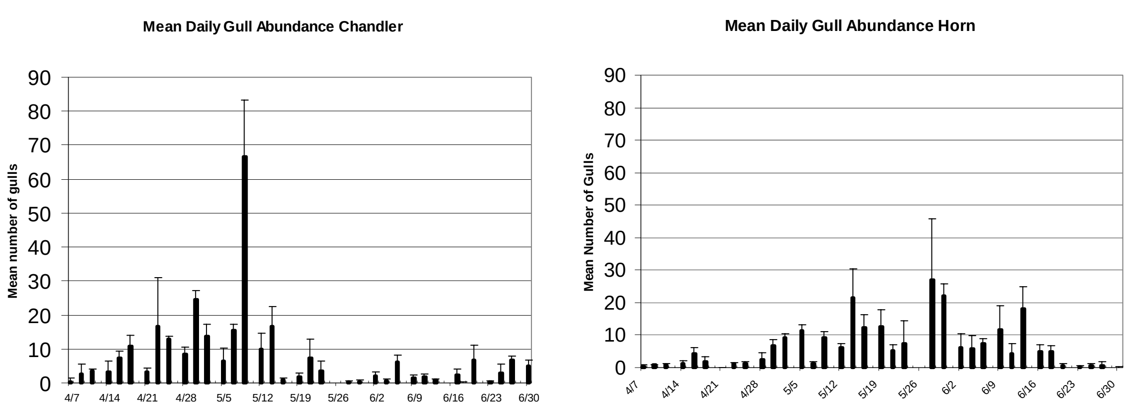


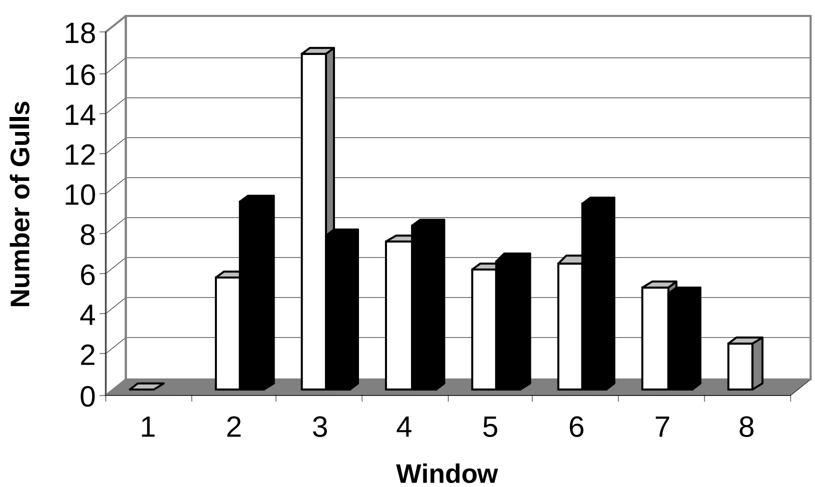
Figure 8. Mean Daily Gull Abundance at Chandler and Horn Rapids.

Throughout the 2003 season, 78,436 fish were consumed by gulls at Chandler, compared with 195,279 fish consumed in 2002. This major decrease in the consumption of fish by gulls can be accounted for by the major increase in the number of American White Pelicans that were seen at this site.

The number of fish consumed by gulls in 2003 at Horn Rapids was 62,913, compared to 84,203 fish consumed in 2002. The number of gulls at Horn Rapids was decreased in 2003, but they were not displaced by another species as at Chandler.

No clear diurnal pattern of gull use emerges at either hotspot. Gull numbers peak in the third window after sunrise at Chandler (White), and were roughly equal during the second and sixth windows after sunrise at Horn (Black). Minimal data was collected during the first and last windows, as past years showed greatly reduced numbers during these time periods.

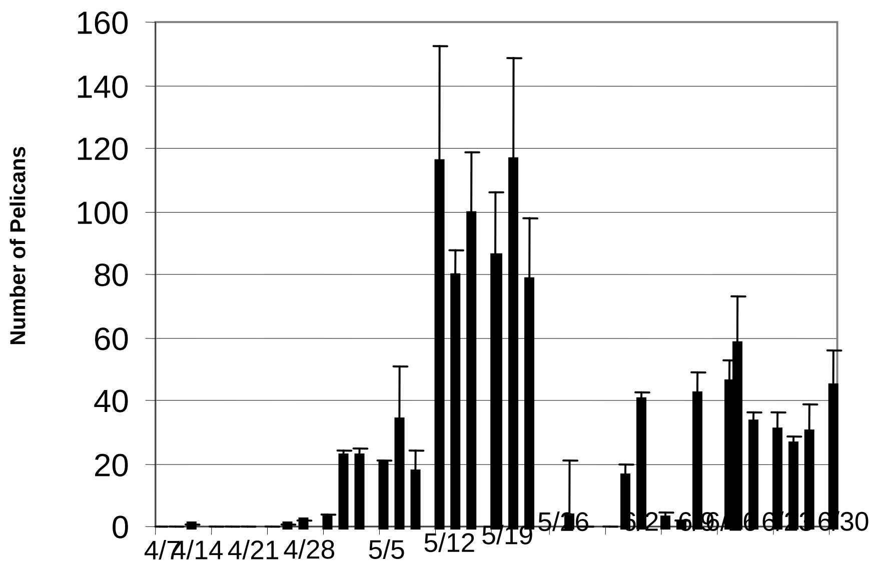
Figure 9. Mean Daily Number of Gulls by Window



Other species observed at Chandler included: American White Pelican, Great Blue Heron, Caspian Tern, Black-crown Night Heron, Double Crested Cormorant, Great Egret, and Osprey. Other species observed at Horn Rapids included: Double Crested Cormorant, American White Pelican, Caspian Tern, Great Blue Heron, Opsrey, Black Tern, Forster's Tern, and Belted Kingfisher.

The dramatic increase in the number of American White Pelicans (*Pelecanus erythrorhynchos*) at Chandler is worth expanding on. Pelicans were first observed in the lower Yakima River in the mid to late 1980s, and have been increasing in the areas upstream of Prosser since 1994 (Tracy Hames, personal communications). Pelicans were first seen during river reach surveys by the WCFWRU along the lower reaches of the Yakima River in 2001. Based on the model of avian consumption developed by the WCFWRU, pelicans in the lower Yakima River, below the Yakima Canyon to the mouth, accounted for about half of the total fish biomass depredated by piscivorous in 2001 and 2002. Pelicans were first recorded during hotspot surveys at Chandler in 2000. The average number of pelicans seen in a day increased from .5 birds per day in 2002 to 35 birds per day in 2003. As the numbers of pelicans increased, they began to displace gulls at foraging and loafing sites. Instances of klepto-parasitism, where pelicans stole the fish the gulls had caught, were observed. As water levels decreased and more rocks were exposed, more loafing sites became available. As pelican numbers increased gull numbers significantly decreased. Although sprinklers were run at Chandler in 2003 to deter birds, they had little to no effect on the number of gulls at this site. The birds became acclimated to the sprinklers and could easily avoid them.

Figure 10. 2003 Mean Daily American White Pelicans at Chandler

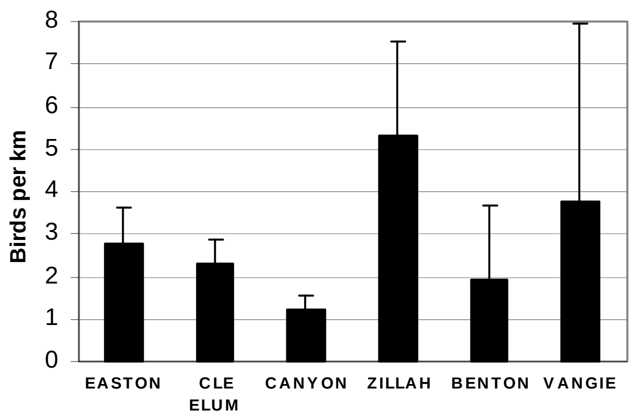


River Reach Surveys—Spring and Summer

In the spring of 2003, 13 different piscivorous bird species were seen including: American White Pelican, Bald Eagle, Black-crowned Night Heron, Belted Kingfisher, Caspian Tern, Common Merganser, Double-crested Cormorant, Forster's Tern, Great Egret, Great Blue Heron, Gull species, Hooded Merganser, and Osprey.

The Zillah drift had the most number of birds per kilometer overall, with 5.3 birds per km on average. The day with the most birds per kilometer was on the Vangie reach, with 10.2 birds per km on June 26th.

Figure 11. Spring abundance of all avian piscivores by reach, April 7 to June 30, 2003. Error bars represent standard deviation.



If gulls are excluded from these counts, the only reaches that are significantly affected are the Benton and Vangie reaches, the two lowest reaches on the river. Osprey, Great Blue Heron, and Belted Kingfisher were found on all reaches, and Common Mergansers were seen on all except the Vangie reach. Common Mergansers were again most abundant in the upper most reaches of the river in the Easton and Cle Elum reaches.

Figure 12. Spring abundance of Common Mergansers by reach, April 7 to June 31, 2003. Error bars represent standard deviation.

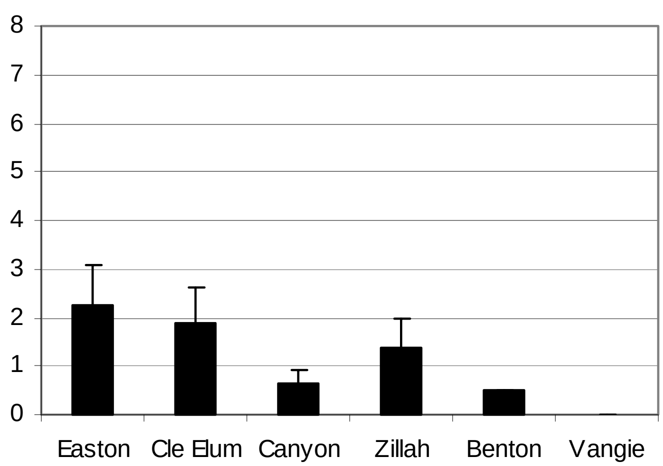


Figure 13. Average spring avian piscivore abundance per kilometer on the **Benton** river reach, April 7 to June 30, 2003. Error bars represent standard deviations.

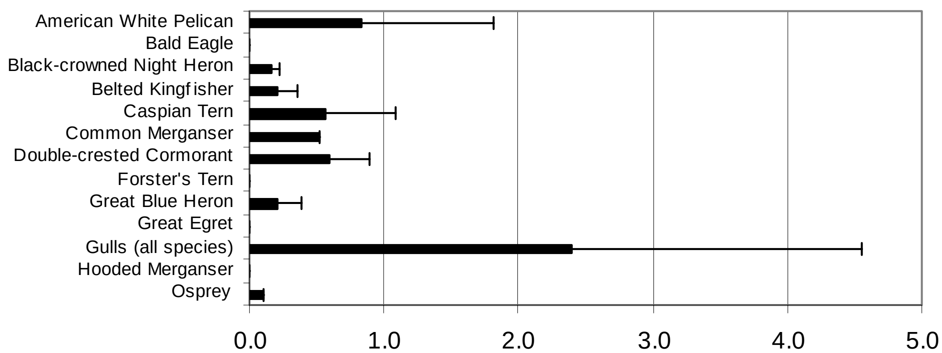


Figure 14. Average spring avian piscivore abundance per kilometer on the **Vangie** river reach, April 7 to June 30, 2003. Error bars represent standard deviations.

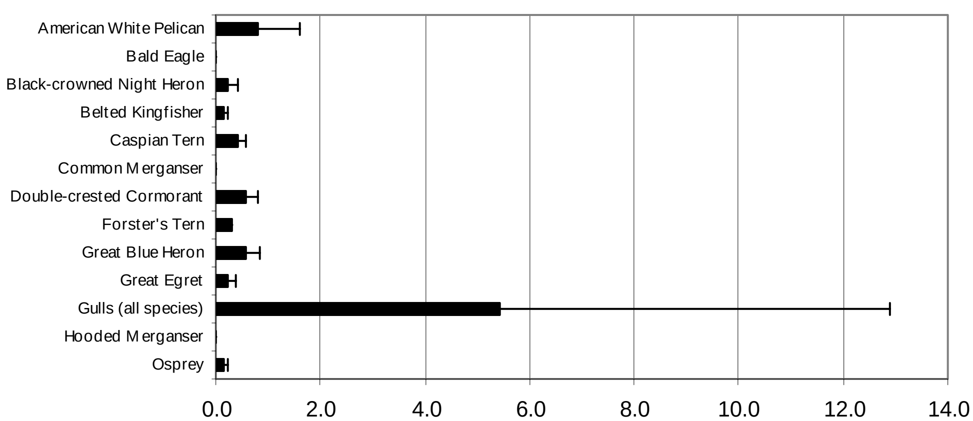
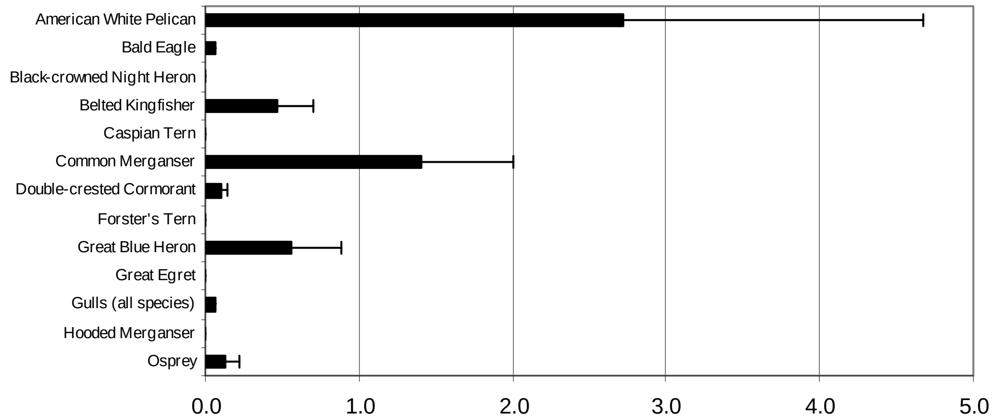


Figure 15. Average spring avian piscivore abundance per kilometer on the **Zillah** river reach, April 7 to June 30, 2003. Error bars represent standard deviations.



Please Note the differences in scale.

Figure 16. Average spring avian piscivore abundance per kilometer on the **Canyon** river reach, April 7 to June 30, 2003. Error bars represent standard deviations.

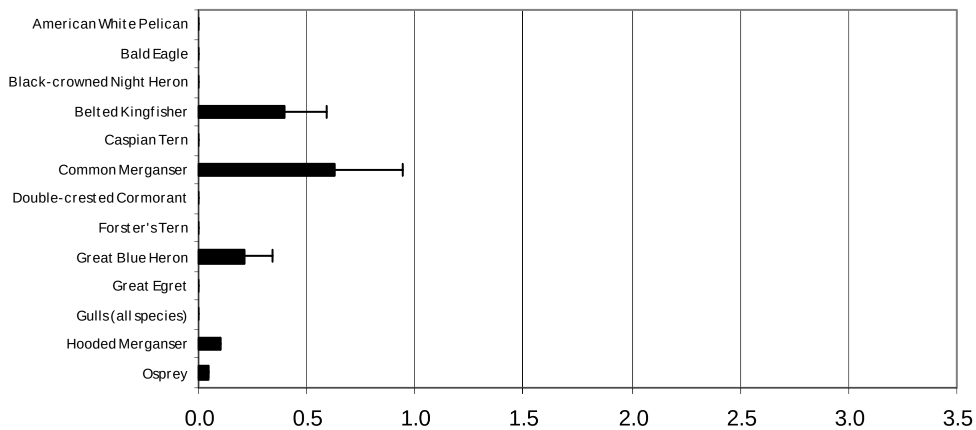


Figure 17. Average spring avian piscivore abundance per kilometer on the **Cle Elum** river reach, April 7 to June 30, 2003. Error bars represent standard deviations.

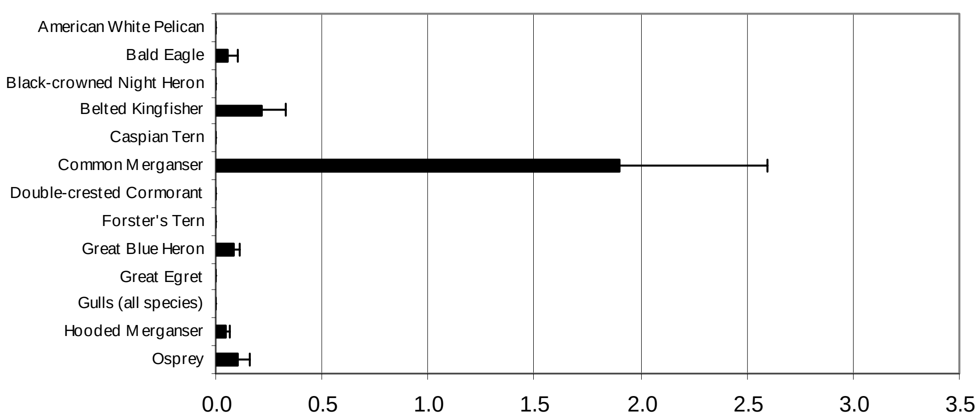
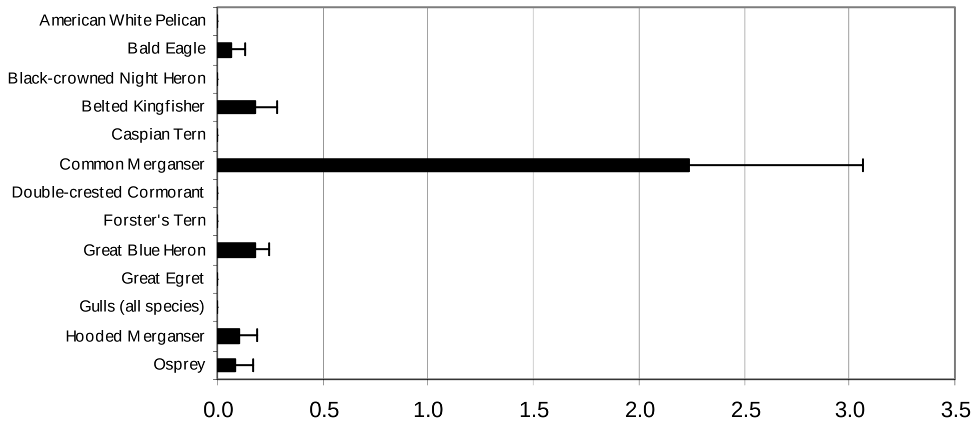
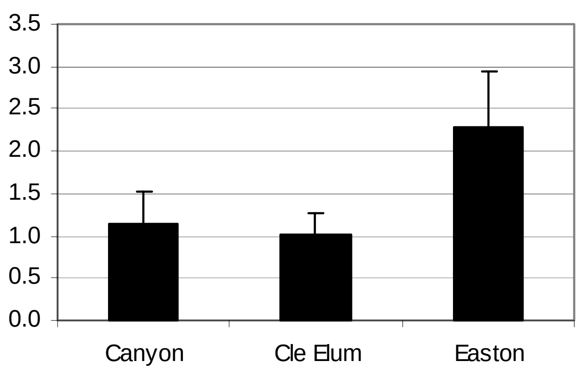


Figure 18. Average spring avian piscivore abundance per kilometer on the **Easton** river reach, April 7 to June 30, 2003. Error bars represent standard deviations.



Due to increasing water temperatures and drop in water level occurring in the lower sections of the river, monitoring efforts are shifts to summer parr and residential salmonid smolts during the summer. Drifts were limited to the Easton, Cle Elum and Canyon reaches. Common Merganser, Belted Kingfisher, Great Blue Heron, and Osprey were found on all three reaches.

Figure 19. Summer abundance of all avian piscivores by reach, July 1 to August 31, 2003. Error bars represent standard deviation.



Common Mergansers were by far the most abundant piscivorous bird species found in the upper Yakima River in the summer.

Figure 20. Summer abundance of Common Mergansers by reach, July 1 to August 31, 2003. Error bars represent standard deviation.

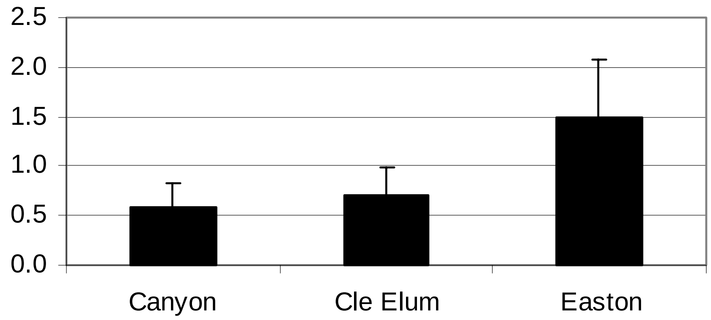


Figure 21. Average summer avian piscivore abundance per kilometer on the **Canyon** river reach, July 1 to August 31, 2003. Error bars represent standard deviations.

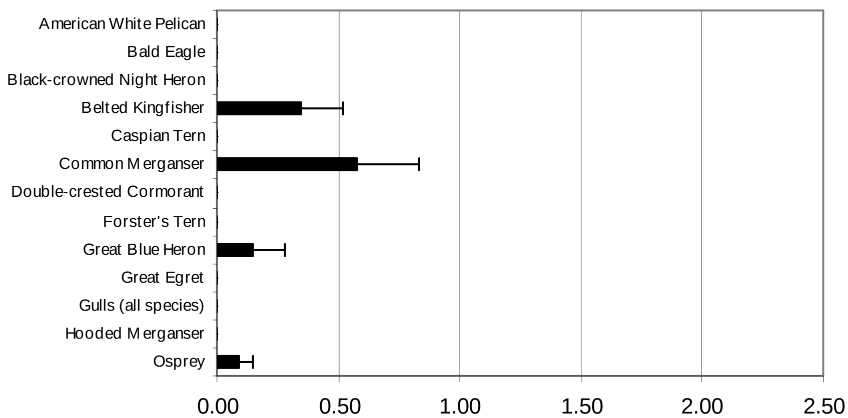


Figure 22. Average summer avian piscivore abundance per kilometer on the **Cle Elum** river reach, July 1 to August 31, 2003. Error bars represent standard deviations.

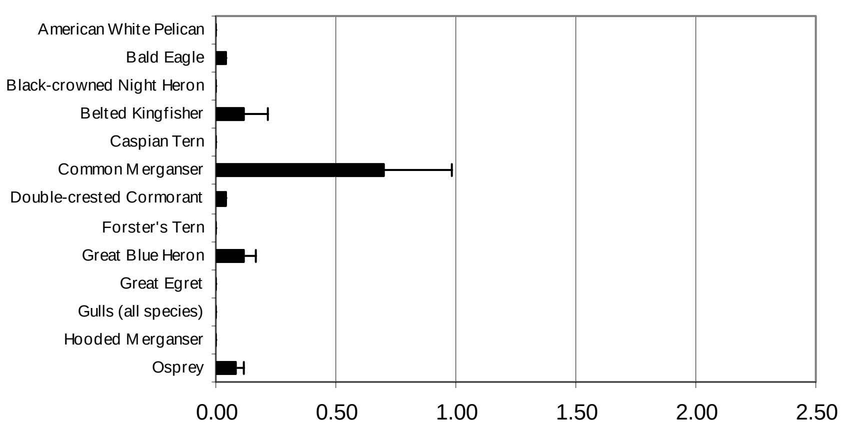
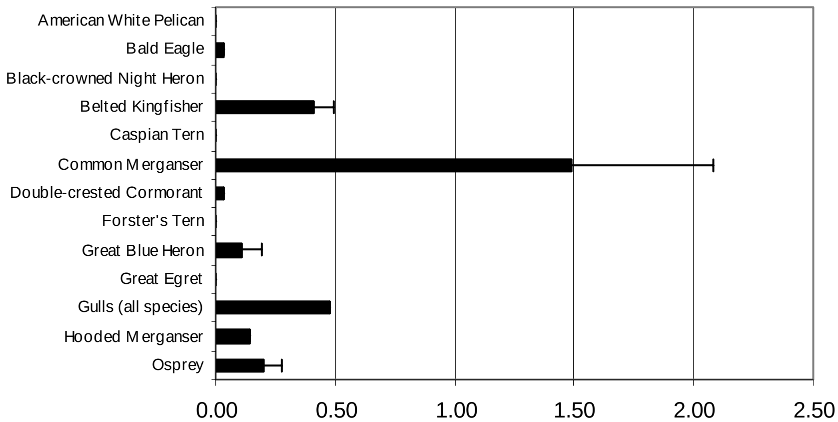


Figure 23. Average summer avian piscivore abundance per kilometer on the **Easton** river reach, July 1 to August 31, 2003. Error bars represent standard deviations.



The Yakima River was divided into three main strata based on geographic differences with one or more of the river reaches used to calculate the kilograms of fish consumed by birds in that strata. Stratum 1 is made up of the upper most reaches of the Yakima, including the Easton and Cle Elum reaches, Stratum 2 consists of the Yakima Canyon, and Stratum three is made up of the area downstream of the Yakima Canyon to its confluence with the Columbia, represented by the Zillah, Benton, and Vangie reaches. Mean biomass consumed in Stratum 1 in the spring of 2003 was 87.5 kg/km, 30.2 kg/km in Stratum 2, and 246.5 kg/km in Stratum 3. In the spring, Common Mergansers accounted for 91% of the consumption in Stratum, 80% of Stratum 2, and 10% of Stratum 3. American White Pelicans accounted for 69% of the total consumption in Stratum 3 in the spring. Mean biomass consumed in Stratum 1 in the summer was 43.2 kg/km and 24.1 kg/km in Stratum 2. Common Mergansers were again the major consumer in these two reaches in the summer, where they accounted for 82% of the consumption in Stratum 1 and 60% of the consumption in Stratum 2. Overall, the majority of fish were consumed in the spring for these two strata.

North Fork Teanaway River Surveys—Spring and Summer

Bird species seen along the North Fork of the Teanaway during surveys in 2003 included five Belted Kingfisher, 21 Common Merganser, one Great Blue Heron, and one Osprey. 9.6 kg of fish were consumed during the spring and .83 kg in the summer. The difference in consumption between seasons can be accounted for by the presence of a large brood of Common Mergansers, 20 juveniles and one female, seen during the spring. Only 28 piscivorous birds were seen over all, reaffirming that the Jack Creek Acclimation Site has not become a major attractant of fish eating birds, either during the release of smolts, or later in the summer.

Acclimation Site Surveys—Winter / Spring

A total of 152 birds were observed at the spring chinook acclimation sites, with 67% being Belted Kingfish, and the remainder made up of Bald Eagles, Hooded Mergansers, Great Blue Heron, and one Black-crowned Night Heron. The spring chinook acclimation sites do not seem to be a major attractant for piscivorous birds. At the coho acclimation sites, 84% of the birds observed were Common Mergansers, with the remainder being Belted Kingfisher, Great Blue Heron, Bald Eagle, Double-crested Cormorant, Hooded Merganser, and Great Egret. The coho acclimation sites, especially Easton Pond, attracted a large number of Common Mergansers.

Summary

In the upper Yakima River Common Mergansers continue to be the major avian predator on fish. The lower Yakima River has seen a steady increase in the number of American White Pelicans seen over the last few years. Pelicans were the major avian consumer along these river reaches. In 2003 we observed a dramatic increase in the number of Pelicans at Chandler over the number observed in 2002 and preceding years, to the point where they displaced the gull species that had been the main predator up until that point. Gulls remained the major avian predator at Horn Rapids Dam. The spring chinook acclimation sites have not been a major attractant for piscivorous birds, but some of the coho acclimation sites were attracting large numbers of Common Mergansers.

Task 4.b Fish Predation Index (Yakama Nation Portion Only)

Rationale: Develop an index of the mortality rate of upper Yakima spring chinook attributable to non-salmonid piscivorous fish in the lower Yakima. This index will be used to estimate the contribution of in-basin predation to fluctuations in hatchery and wild smolt-to-adult survival rate.

Methods: Monthly mark-recapture pike minnow population estimates are attempted from March through June at Gap to Gap, Sunnyside pool and Toppenish (RM 94-100). In the past, valid estimates have not been successful for Granger and Sunnyside, thus population estimates were not made for these river sections. In addition, stomach samples are collected from pikeminnows 200+ cm in fork length, which are collected primarily above and below the population estimate sites. Pikeminnow stomachs with fish present are further analyzed to determine what species and how many were consumed. This analysis is performed using diagnostic bones which allows determination of species (though for salmonids this is more difficult) and approximate body length. All new pikeminnows over 200+ cm are tagged with a PIT tag and subsequently all fish are scanned for the presence of a PIT tag. If a PIT tag is found its code is recorded along with the fish's location (GPS) and its fork length recorded. An estimate of total salmonids consumed by the pikeminnow population on an annual basis is attempted based on the population estimates and the salmonid consumption rate measured from the pikeminnow stomach samples. The lack of valid population estimates over the years and across sites and months has made this last task difficult to achieve with precision.

Progress: Summarized in Table 17 are the population estimates for the Gap to Gap sites, Toppenish and Sunnyside dam sample sites. In 2003 successful population estimates were made at Toppenish for May and June; at Gap to Gap for June, and no successful population estimates were made at Sunnyside Dam. Typically the lack of valid population estimates was a function of insufficient recaptures to validate the estimate.

Table 17. Population estimates for April-June 2003.

	April	**May**	**June**
Gap to Gap 1	nv	nv	nv
Gap to Gap 2	nv	nv	nv
Gap to Gap 3	nv	nv	125
Sunnyside Dam	nv	nv	nv
Toppenish 1	nv	232	nv
Toppenish to Zillah	nv	2167	1420

Note*- nv stands for not valid.

Within the sampling period from April through June of 2003 the pikeminnow population displayed fidelity within the reach they were initially marked. A total of 79 (GG1-GG3: 39, Toppenish: 40, and Sunnyside Dam- 0) pikeminnows were tagged and subsequently recaptured during the course of the spring sampling period. Of those fish tagged in the GG1-3 reach, seven fish were found to move between GG1 and GG2, while 2 from the Toppenish reach traveled to Sunnyside and Granger areas. Floy tagged individual #3645 was originally tagged in Toppenish site 1 and was later found in Sunnyside, while floy tag # 8320 was originally tagged in T1 and later found in Granger (Table 18).

Table 18. Example of movement table, Toppenish site fish.

FLOY TAG #	Tag #	Date Found	Site Found	Date Originally Tagged	Site Originally Tagged	Number of Days From Originally Tagged	Other Dates Seen
	3D9.1BF1399708	4/30/2003	T1	3/31/2003	T1	30	
	3D9.1BF139E3D4	5/30/2003	T1	3/31/2003	T1	60	
	3D9.1BF13A0CC4	4/1/2003	T1	3/31/2003	T1	32	4/30/2003
	3D9.1BF156BF8F	5/1/2003	T1	3/31/2003	T1	31	
	3D9.1BF156CB12	4/29/2003	T1	3/31/2003	T1	29	
	3D9.1BF1693872	5/2/2003	T1	3/31/2003	T1	32	
	3D9.1BF169DE4B	4/3/2003	T1	3/31/2003	T1	3	
	3D9.1BF13A0429	4/24/2003	T1	4/1/2003	T1	23	
	3D9.1BF1566B94	5/2/2003	T1	4/2/2003	T1	45	5/27/2003
	3D9.1BF13A745E	4/28/2003	T1	4/2/2003	T1	56	4/30/2003
	3D9.1BF13A4EEA	4/24/2003	T1	4/3/2003	T1	54	4/29/2003
	3D9.1BF156B484	4/24/2003	T1	4/3/2003	T1	56	4/30/2003
	3D9.1BF156CE18	4/24/2003	T1	4/3/2003	T1	29	5/2/2003
	3D9.1BF1563FC4	4/24/2003	T1	4/4/2003	T1	20	
	3D9.1BF139567E	4/30/2003	T1	4/24/2003	T1	6	
	3D9.1BF13A4732	4/29/2003	T1	4/24/2003	T1	5	
	3D9.1BF156D562	4/28/2003	T1	4/24/2003	T1	4	5/1/2003
	3D9.1BF166ACDE	5/2/2003	T1	4/24/2003	T1	8	
	3D9.1BF1698CF8	5/2/2003	T1	4/28/2003	T1	4	
	3D9.1BF1699915	4/30/2003	T1	4/28/2003	T1	2	
	3D9.1BF169A2E7	4/30/2003	T1	4/28/2003	T1	2	5/1/2003
3645	**3D9.1BF1395A21**	**4/29/2003**	**T1**	**4/11/2000**	**SSD**	1113	
	3D9.1BF139800E	5/27/2003	T1	4/29/2003	T1	28	
	3D9.1BF1398FFF	5/30/2003	T1	4/29/2003	T1	28	
8320	**3D9.1BF13997F4**	**5/28/2003**	**T1**	**4/19/1999**	**Granger**	1500	

Highlighted color means moved out of site originally tagged

A summary of pikeminnow stomach contents collected at Gap to Gap, Toppenish, and Sunnyside Dam is presented in Table 19. A total of 222 stomachs were collected during the spring 2003 field season (86 at GG1-3, 0 at SS, and 139 at Toppenish). The mean percent of stomachs collected in April, May and June that contained fish at the Gap to Gap sites, Sunnyside Dam, and Toppenish sites was (82% Gap to Gap, 0% at Sunnyside, and 73.5%), respectively. This represents the initial analysis. All stomachs with fish present were further analyzed to determine the species using diagnostic bones to identify them.

Table 19. Summary of species found in Northern Pikeminnow stomachs sampled in the Yakima Basin in 2003.

Species	**Count found in NPM stomachs**
Chiselmouth	8
Sculpin	26
Dace	41
Hatchery Spring Chinook	5
Hatchery Coho	8
Lamprey	4
Mountain White Fish	8
Northern Pikeminnow	6
Pumpkin Seed	1
Red Side Shiner	3
Salmon (unknown species)	16
Steelhead	2
Sucker	7
Unknown Species	4
Total All Species	**139**

Task 4.c Indirect Predation (and environmental analysis)

Rationale: The release of hatchery salmonids may enhance or decrease the survival of randomly commingled wild salmonid smolts by altering the functional or numerical response of predators. For example, predators may increase consumption of wild fish by switching prey preferences from invertebrates to fish, or may be attracted to areas where hatchery fish are released. Conversely, large numbers of hatchery fish may confuse or satiate predators, resulting in enhanced survival of wild fish.

Methods:

Progress: No work was budgeted for this task in fiscal year 2003.

See Appendix F in 2002 Annual Report for latest information on this study.

Task 4.d Yakima River Spring Chinook Competition/Prey Index

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/cgi-bin/FW/publications.cgi

Pearsons, T. N., C. L. Johnson, B. B. James, and G. M.Temple. 2004. Spring Chinook Salmon Interactions Indices and Residual/Precocial Monitoring in the Upper Yakima Basin; Yakima/Klickitat Fisheries Project Monitoring and Evaluation Report 5 of 7. Annual Report 2003. DOE/BP-00013756-5.

Task 4.e 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/cgi-bin/FW/publications.cgi

Temple, G. M., T. N. Pearsons, C. L. Johnson, T. D. Webster, and N. H. Pitts. 2004. Results of non-target taxa monitoring after the fifth release of hatchery salmon smolts in the upper Yakima Basin. Pages 6-31 in Pearsons, T. N., A. L. Fritts, G. M. Temple, C. L. Johnson, T. D. Webster, and N. H. Pitts. 2004. Yakima River Species Interactions Studies; Yakima/Klickitat Fisheries Project Monitoring and Evaluation Report 7 of 7. Annual Report 2003-2004 submitted to Bonneville Power Administration, Portland, Oregon. DOE/BP-00013756-7.

Task 4.f Pathogen Sampling

The WDFW annual report for this task can be located on the BPA website: http://www.efw.bpa.gov/cgi-bin/FW/publications.cgi

Thomas, J. 2004. Pathogen Screening of Naturally Produced Yakima River Spring Chinook Smolts; Yakima/Klickitat Fisheries Project Monitoring and Evaluation Report 6 of 7. Annual Report 2003. DOE/BP-00013756-6.

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Olla, B.L., M.W. Davis, and C.H. Ryer. 1994. Behavioural deficits in hatchery-reared fish: potential effects on survival following release. Aquaculture and Fisheries Management 25 (Suppl. 1):19-34.

APPENDICES A through H

	Task	
A.	1.a.	Modeling (Mobrand Biometrics Inc. subcontract)
B.	1.a.	Klickitat EDT Modeling Output
C.	1.d.	Yakima River juvenile spring chinook marking (IntStats, Inc. subcontract to analyze OCT/SNT survival)
D.	1.e.	Yakima River wild/hatchery salmonid survival and enumeration (IntStats, Inc. subcontract)
E.	1.g.	Yakima River fall chinook M&E
F.	1.h.	Yakima River coho feasibility study
G.		M&E Financial Report
H.		M&E Equipment Inventory List

APPENDIX A

Coho Supplementation Opportunities in the Yakima Subbasin Based on an EDT Analysis of Habitat Productivity and Carrying Capacity

April 2004

Prepared for

The Yakama Nation

By

Bruce Watson

Mobrand Biometrics, Inc.

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INTRODUCTION

The Yakima Subbasin supported a large run of coho salmon (O*ncorhynchus kisutch)* historically, and as recently as the late 1960's runs of one to two thousand fish were counted at Roza Dam (Yakima River, RM 127; Haring 2001). By the early 1980's, however, a combination of high harvest rates in the lower Columbia River and habitat degradation within the Yakima Subbasin extirpated the endemic population (Fast et al. 1991). Since the early 1980's, the Yakama Nation has tried at first to enhance and later to re-establish a meaningful level of natural coho production in the Yakima Subbasin. This report is intended to provide guidance to the Yakama Nation in their attempt to develop a rational, scientifically-grounded procedure to utilize hatchery-produced coho salmon to re-establish naturally-produced coho throughout the Yakima Subbasin. The analyses presented are based largely on output from the Ecosystem Diagnosis and Treatment (EDT) model and have the following specific goals:

- To estimate the total number of hatchery fish to be released and the way these fish should be distributed among various mainstem river reaches and tributaries;
- To estimate the benefit of the supplementation program in terms of total returns (first generation hatchery fish plus naturally spawned fish), the return of first generation hatchery fish, and the return of natural origin fish;
- To estimate optimal coho release numbers where "optimal" is defined either as producing the maximum number of Natural Origin Returns (NOR's), or maximum total returns (NOR's + Hatchery Origin Returns or HOR's) subject to the condition that NOR abundance is at least as large as it would have been in the absence of supplementation; and
- To develop a method of estimating the relative benefits of releasing hatchery-reared coho as adults rather than smolts, and to estimate the negative impact of false attraction hazards to natural and hatchery-reared coho within the Yakima Subbasin.

The coho population envisioned is to be a "supplemented population" for the indefinite future. In this context, "supplemented" is to be understood as implying a naturally spawning population augmented by artificially produced individuals intended to interbreed with the natural population. Much of the Yakima Subbasin does not now support naturally spawning coho. Therefore, the results presented here assume a sufficiently long time series of outplants to allow for reestablishment of natural populations. It is also to be understood that the supplementation program would be managed in such a way as to guarantee that the proportion of hatchery-origin fish on the spawning grounds would always be less than the proportion of natural-origin fish in the hatchery. The purpose of the latter condition is to ensure that natural selection is greater than artificial selection within the population and that, over time, the supplemented population would acquire local adaptations to the Yakima Subbasin (HSRG 2004). As supplementation was modeled with 100% of the broodstock being drawn from a natural population, the genetic condition described above will always be met.

METHODS

General Procedure

This analysis entailed the completion of three general tasks: determining optimal release numbers for the entire Yakima Subbasin, determining the optimal allocation of these fish among a large number of mainstem reaches and tributaries, and adjusting the mainstem reach/tributary release numbers to account for competitive interactions between coho and steelhead.

The necessity of addressing the latter issue in some manner is due to the fact that many tributaries suitable for coho reintroduction already support sizeable populations of steelhead (or the resident form of *O mykiss*, rainbow trout). Moreover, some of these tributaries – Satus Creek, for example – have very low base flows, and the potential for serious interspecific competition during the late summer and fall is clear. Although the EDT model incorporates parameters, such as fish community species richness, that are intended to account for interspecific competition, they may not accurately reflect the intensity of competition to be expected in exceptional circumstances such as those encountered in some Yakima tributaries. Therefore, at least for this initial evaluation, additional measures to account for competition between coho and other species were restricted to coho/steelhead/rainbow interactions. It was assumed that interactions between coho and Chinook salmon, which occur primarily in larger mainstem reaches, were adequately addressed by "standard" EDT model output.

Optimal Release Number and Distribution

As applied here the EDT model estimates the performance of a supplemented population subject to the caveat that genetic fitness impacts are not assumed to persist beyond a single generation. That is to say, F1 hatchery fish may be assigned a fitness substantially less than 1.0, the value assumed for an endemic wild stock, but their progeny are assumed to have the fitness of wild fish. There is no scientific consensus on the degree of genetic fitness loss to be expected from a specific type of supplementation program, nor is there agreement on the rate of fitness recovery as successive generations of fish with hatchery ancestry spawn in the wild. Although such considerations may be less significant in the present scenario, which does not include an endemic population to be supplemented, it should be borne in mind.

The EDT model treats supplementation as a special case of a Beverton-Holt production function. More specifically, Beverton-Holt population dynamics are assumed to apply to a supplemented population in which the number of natural spawners is augmented by returning hatchery fish. Without supplementation, the number of adult recruits, R, produced by a given number of spawners, S, would be:

$$R = Sp / (1 + Sp/K) \qquad \text{(eq. 1)}$$

where p is the population productivity (zero-density limit of the adult recruitment rate) and K is the adult carrying capacity of the population. With supplementation, however, the number of spawners becomes:

$$S = (1 - n)S + nfSr \qquad \text{(eq. 2)}$$

where n is the percent of the natural population taken for broodstock, f is the fitness of F1 hatchery fish, and r is the adult recruitment rate for hatchery fish.

At equilibrium, the number of adult returns is by definition equal to the number of spawners, allowing eq. 2 to be solved for the number of hatchery and natural spawners, given specific values for n, f and r. Although this procedure and equations 1 and 2 do summarize the essence of the way EDT simulates supplementation, eq. 2 does not include all of the variables that must be considered in a real supplementation program. These additional variables are summarized in Table 1.

Table 1. Parameters used in modeling coho supplementation by the EDT model: Upper Yakima example.

Upper Yakima Coho with current tributary obstructions	
Natural Origin Recruits (NOR)	
Productivity (NOR in Nature)	2.32
Capacity (NOR in Nature)	1,987
Fitness	0.9
Spawning Dates	Nov 5 - Jan 28
Harvest Pattern	Willamette coho
Eggs/Spawner	1,500
Hatchery Origin Recruits (HOR)	
Hatchery productivity	9.14 - 11.3[a]
Hatchry Capacity	1,050 - 3,687[a]
Fitness (HOR in Nature)	0.9
Spawning Dates	Nov 5 - Jan 28
Harvest Pattern	Willamette coho
Eggs/Spawner	1,500
Juveniles released	condition specific
Pre-spawning survivial in hatchery	95%
Egg-to-smolt survival in hatchery	85%
Hatchery Broodstock required	condition specific
% NOR in broodtock	100%
% Hatchery fish spwning in nature	100%

[1]/The value used in simulations is a weighted mean over all release sites where the weighting factor is the relative number of smolts released from each site.

Many of the values in Table 1 were used in all simulations, not just simulations for the upper Yakima watershed ("watersheds" are described in greater detail below). Both NOR's and HOR's were always assumed to have a fitness of 0.9 because both represent non-endemic stocks. Both hatchery and natural fish were assumed to spawn (or be spawned) at the same time, November 5 – January 28, and fecundity was the same for hatchery and natural fish as well (1,500 eggs/spawner). Pre-spawning survival for hatchery broodstock was always 95%, and egg-to-smolt survival for hatchery fish was always 85%. Hatchery coho smolts were always released over a three-week period beginning May 14. All hatchery broodstock was drawn entirely from the natural population, and all hatchery fish were assumed to spawn in the wild. The only parameters that vary geographically (by watershed) are natural and hatchery productivity and natural and hatchery carrying capacity.

Because productivity and carrying capacity for both natural and hatchery origin coho vary significantly by location, the Yakima Subbasin was divided into three large "watersheds" for supplementation analysis – the "Upper Yakima", the "Middle Yakima" and the "Upper Naches". No density-dependent interactions between coho in different watersheds were assumed. The Upper Yakima Watershed consists of the mainstem Yakima and all tributaries above Roza Dam excluding Wilson Creek, which was omitted because of the poor quality of environmental input data for the Wilson Creek drainage. The Middle Yakima Watershed consists of the mainstem Yakima between Satus Creek and Roza Dam, the Naches mainstem from the mouth to the Tieton confluence, and all tributaries entering these reaches except the Tieton River (viz., Satus Creek, Toppenish Creek, Ahtanum Creek, Wide Hollow Creek and Cowiche Creek are included; the Tieton River is excluded). The Upper Naches Watershed consists of the Naches mainstem and tributaries above and inclusive of the Tieton River.

Adult and juvenile passage is partially or totally blocked by man-made irrigation diversion dams and other kinds of obstructions on a number of tributaries with significant coho production potential[1]. Because work to restore passage on these tributaries has already reached and in some cases passed the planning stage, simulations were made both for current passage conditions in the affected tributaries and for a scenario in which all obstructions are eliminated. Major storage reservoirs (Rimrock, Bumping, Keechelus, Kachess and Cle Elum) were always assumed to represent total passage barriers. Similarly, the smolt and juvenile mortalities attributed to predation at juvenile bypass outfalls (e.g., the Chandler Juvenile Monitoring Facility) were retained in all simulations.

Each of these three watersheds was further broken down into smaller mainstem reaches and tributaries, called "management units". Geographic lumping obscures important local differences in natural productivity and capacity, and therefore limits the accuracy with which releases can be tailored to local conditions. Each management unit was assumed to have a release site for hatchery-reared coho, a "hatchery", and the EDT model was used to estimate "hatchery" productivity and carrying capacity for every management unit. The EDT model was also used to estimate natural coho and steelhead productivity and carrying capacity for every management unit. The population performance parameters for the three Yakima Watersheds are summarized in Table 2, and the performance parameters for the management units within each watershed are summarized in Tables 3, 4 and 5. The values summarized in Tables 2-5 are based on the current registered EDT dataset for the Yakima Subbasin.

[1] The list of tributaries modeled both with and without current obstructions includes: NF and SF Simcoe Creek, Simcoe Creek, Toppenish Creek, Ahtanum Creek, SF Cowiche Creek, Manastash Creek, Taneum Creek, and Little Creek.

Table 2. Summary of habitat-based performance parameters for naturally spawning coho in three Yakima River watersheds evaluated for supplementation.

Subwatershed	Definition	Life History Diversity	Fitness	Eggs per Spawner	Productivity (adult returns to spawning grounds/spawner)	Carrying Capacity (adults on spawning grounds)	Equilibrium Abundance (adults on spawning grounds)	Equilibrium Abundance (smolts at Prosser)	Equilibrium Abundance (adults at Prosser)	Smolt to Adult Survival (at Prosser)
Middle Yakima, with current tributary passage obstructions.	Yakima mainstem from Satus Creek to Roza Dam, Naches mainstem mouth to Tieton Confluence, and all tributaries entering these reaches except the Tieton River. Current passage obstructions of the NF and SF of Simcoe Cr, Simcoe Cr, Toppenish Cr (Toppenish Lateral Canal, Unit II Pumpback and Tainer Gate), Ahtanum Cr and Cowiche Cr are in place.	11%	0.9	1,500	1.93	3,818	1,835	138,414	1,963	1.42%
Middle Yakima, all tributary passage obstructions eliminated	Yakima mainstem from Satus Creek to Roza Dam, Naches mainstem mouth to Tieton Confluence, and all tributaries entering these reachesexcept the Tieton River. Passage problems on all trinutaries (NF and SF of Simcoe Cr, Simcoe Cr, Toppenish Cr (Toppenish Lateral Canal, Unit II Pumpback and Tainer Gate), Ahtanum Cr and Cowiche Cr) are eliminated.	14%	0.9	1,500	2.01	3,925	1,975	145,312	2,080	1.43%
Upper Yakima, with current tributary passage obstructions	Yakima mainstem and all tributaries above Roza Dam. Access on the Cle Elum, Kachess and Yakima Rivers ends at Cle Elum, Kachess and Keechelus Dams, respectively. Current passage obstructions on Little Cr, Taneum Cr and Manastash Cr are in place.	13%	0.9	1,500	2.32	1,987	1,130	64,822	1,190	1.84%
Upper Yakima, all tributary passage obstructions eliminated	Yakima mainstem and all tributaries above Roza Dam. Access on the Cle Elum, Kachess and Yakima Rivers ends at Cle Elum, Kachess and Keechelus Dams, respectively. All passage problems on Little Cr, Taneum Cr and Manastash Cr are eliminated.	14%	0.9	1,500	2.31	2,100	1,191	67,222	1,235	1.84%
Upper Naches	Naches mainstem and all tributaries above and inclusive of the Tieton River to Roza Dam.	20%	0.9	1,500	2.10	833	437	25,338	448	1.77%

Table 3. Summary of habitat-based coho and steelhead population performance parameters for the Management Units comprising the Upper Yakima Watershed.

Management Unit	Comments	Coho Natural Productivity	Coho Natural Carrying Capacity	Steelhead Equilibrium Abundance	Coho Hatchery Productivity	Coho Hatchery Capacity
Big Creek	Natural spawning RM 0 - 12.7 , hatchery just below Big Cr Dam (RM 2.1)	1.61	75	16	9.91	1,980
Cle Elum River	Natural spawning mouth to Cle Elum Dam (RM 8.2), hatchery just below Cle Elum Dam.	2.65	125	62	9.74	2,945
Little Creek, No Obstructions	Natural spawning mouth to impassibly steep section ar RM 3.6, hatchery just below diversion dam at RM 1.2. All passage problems eliminated.	1.5	10	6	9.87	1,824
Little Creek With Obstructions	Natural spawning mouth to impassibly steep section ar RM 3.6, hatchery just below diversion dam at RM 1.2. Curent passage problems in place.	1.41	9	3	9.90	1,824
Manastash Creek, No Obstructions	Natural spawning mouth to forks (RM 8.5) plus 19.4 mi of SF and 10.4 mi of NF. Hatchery just below forks on mainstem Manastash. All passage problems eliminated.	1.15	104	137	10.32	1,050
Manastash Creek With Obstructions	Natural spawning mouth to forks (RM 8.5) plus 19.4 mi of SF and 10.4 mi of NF. Hatchery just below forks on mainstem Manastash. Current passage obstructions in place.	1.3	9	0	0.00	0
Middle Fork Teanaway River	Natural spawning mouth to impassible falls at RM 12.6, hatchery just below FS Road 113 crossing (RM 5.2)	1.16	48	67	9.88	2,351
NF Teanaway River	Natural spawning mouth to DeRoux Cr (RM 15.2) plus the following lengths in Lick, Dickey, Middle, Indian, Jack, Jungle, Stafford, Bear and Johnson Creeks: 1.5 mi, 1.0 mi, 1.4 mi, 2.8 mi, 2.1 mi, 1.0 mi, 7.5 mi, 2.4 mi and 1.0 mi, respectively. Hatchery at existing Jack Cr acclimation facility (RM 5.6)	1.19	85	45	9.81	2,122
Swauk Creek	Natural spawning mouth to Iron Cr (RM 17.3) plus 2.8 mi Willimas Cr and 2.0 mi Iron Cr, hatchery juts below Willimans Cr (RM 11.0)	0.96	61	0	9.66	2,559
Taneum Creek, No Obstructions	Natural spawning mouth to forks (RM 12.7) plus 5,3 mi of NF and 2.3 mi of SF, hatchery just below Taneum Ditch diversion dam (RM 2.4). All passage problems eliminated.	1.03	85	88	9.91	2,623
Taneum Creek With Obstructions	Natural spawning mouth to forks (RM 12.7) plus 5,3 mi of NF and 2.3 mi of SF, hatchery just below Taneum Ditch diversion dam (RM 2.4). Current partial passage estimates in place.	1.02	85	25	9.66	2,559
Teanaway River, mainstem only	Natural spawning mouth to confluence of MF and WF (RM 11.7), hatchery just below forks	1.64	112	0	9.67	2,819
Umtanum Creek	Natural spawning mouth to impassible falls at RM 8.0, hatchery just below Old Stage Rd (~RM 6)	1.29	29	0	11.13	1,813
WF Teanaway River	Natural spawning mouth to impassible falls ar RM 12.2, hatchery just below Corral Cr (RM 6.7)	1.6	61	56	10.05	2,240
Yakima mainstem, Easton Dam - Keechelus Dam	Natural spawning Easton Dam - Keechelus Dam (RM 202.5 - 214.5), hatchery at base of Keechelus Dam	2.51	166	29	9.14	2,002
Yakima mainstem, Cle Elum R - Easton Dam	Natural spawning Cle Elum R - Easton Dam (RM 185.6 - 202.5), hatchery at existing Easton acclimation site (RM 201.9)	2.4	248	51	9.78	2,574
Yakima mainstem, Teanaway R - Cle Elum R	Natural spawning Teanaway confl. - Cle Elum confl. (RM 176.1 - 185.6), hatchery just below Cle Elum confl.	2.21	271	74	9.74	3,153
Yakima mainstem, Taneum Cr - Teanaway R	Natural spawning Taneum confl. - Teasanway confl. (RM 166.1 - 176.1), hatchery at existing Clark Flats site (RM 167.7)	1.2	87	39	9.80	3,217
Yakima mainstem, Wilson Cr - Taneum Cr	Natural spawning Wilson confl. - Taneum confl. (RM 147.0 - 166.1), hatchery just below Bull Ditch diversion (RM 153.5)	1.59	349	192	10.20	3,371
Yakima mainstem, Roza Dam - Wilson Cr	Natural spawning Roza Dam - Wilson Cr (RM 127.9 - 147.0), hatchery just below Wilson Cr mouth	0.26	119	0	10.42	3,687

Table 4. Summary of habitat-based coho and steelhead population performance parameters for the Management Units comprising the Middle Yakima Watershed.

MIDDLE YAKIMA SUBWATERSHED						
Management Unit	Comments	Coho Natural Productivity	Coho Natural Carrying Capacity	Steelhead Equilibrium Abundance	Coho Hatchery Productivity	Coho Hatchery Capacity
Ahtanum Cr, No Obstructions	Natural spawning mouth to forks (RM 23.1) plus the following distances in the NF, SF, MF, Foundation, Nasty, Bachelor and Hatton Creeks: 14.5 mi, 6.3 mi, 0.9 mi, 0.8 mi, 17.2 mi and 10.5 mi, respectively. Hatchery just below Upper WIP Diversion Dam (RM 19.6). All passage problems eliminated.	1.54	279	27	12.60	1,937
Ahtanum Cr, With Obstructions	Natural spawning mouth to forks (RM 23.1) plus the following distances in the NF, SF, MF, Foundation, Nasty, Bachelor and Hatton Creeks: 14.5 mi, 6.3 mi, 0.9 mi, 0.8 mi, 17.2 mi and 10.5 mi, respectively. Hatchery just below Upper WIP Diversion Dam (RM 19.6). Current passage problems in place.	1.53	279	10	11.81	1,929
Cowiche Cr, NO Obstructions	Natural spawning mouth to forks (RM 7.5) , plus 17.5 mi of SF, 3.3 mi of NF and 5.0 mi of Reynold's Cr. Hatchery just below forks. All passage problems eliminated.	1.28	61	31	12.61	1,958
Cowiche Cr, With Obstructions	Natural spawning mouth to forks (RM 7.5) , plus 17.5 mi of SF, 3.3 mi of NF and 5.0 mi of Reynold's Cr. Hatchery just below forks. Current passage problems in place.	1.08	27	0	12.61	1,958
Naches mainstem mouth to Tieton confluence	Natural spawning mouth to Tieton (RM 17.5) plus 5.5 mi Buckskin Slough & 4.2 mi S. Naches Channel. Hatchery just below Wapatox Dam (RM 17.1).	1.4	197	82	11.88	3,740
Satus Creek	Natural spawning mouth to impassible falls (RM 46) plus the following distances in Mule Dry, Dry, Logy, Bull, Kusshi & Wilson Chahrlie Creeks: 17.2 mi, 28.5 mi, 14.0 mi, 1.5 mi, 6.3 mi & 1.6 mi, respectively. Hatchery just below impassible falls on maisntem (RM 46).	2.12	1,085	1,113	18.60	1,721
Simcoe Cr, NO Onstructions	Natural spawning mouth to forks (RM 19.9) plus the following distances in the NF, the SF, Wahtum and Agency Creeks: 4.0 mi, 4.0 mi, 4.0 mi & 9.0 mi, respectively. All passage problems eliminated.	1.37	98	97	17.50	1,235
Simcoe Cr, With Obstructions	Natural spawning mouth to forks (RM 19.9) plus the following distances in the NF, the SF, Wahtum and Agency Creeks: 4.0 mi, 4.0 mi, 4.0 mi & 9.0 mi, respectively. Current passage problems in place.	1.38	95	72	7.90	1,067
Toppenish Cr, NO Obstructions	Naural spawning mouth to Panther Cr (RM 68.3) access limit, plus 4.0 mi in Willy Dick Canyon Cr, 6.6 mi in the NF & 1.0 mi in the SF. Hatchery lust below Toppenish Lateral Canal (RM 46.8). All passage problems eliminated.	2.56	823	469	18.10	1,908
Toppenish Cr, With Obstructions	Naural spawning mouth to Panther Cr (RM 68.3) access limit, plus 4.0 mi in Willy Dick Canyon Cr, 6.6 mi in the NF & 1.0 mi in the SF. Hatchery lust below Toppenish Lateral Canal (RM 46.8). Current passage problems in place.	1.51	797	428	14.90	1,768
Wide Hollow Cr	Natural spawning mouth to Dazet Rd access limit (RM 10.4) plus 1.5 mi of spring Branch Cr. Hatchery just above fish ladder (RM 0.3).	0.35	42	0	10.98	3,219
Yakima mainstem, Satus Cr - Ahtanum Cr	Natural spawning from Satus - Ahtanum Creeks (RM 69.6 - 107.4). Hatchery just below Ahtanum confluence.	1.3	732	192	12.21	4,927
Yakima mainstem, Ahtanum Cr - Naches R	Natural spawning from Ahtanum Cr confluence to Naches River confluence (RM 107.4 - 116.3). Hatchery fish released just below Naches confluence.	1.6	140	19	12.51	4,749
Yakima mainstem, Naches R - Roza Dam	Natural spawning from Naches R to Roza Dam (RM 116.3 - 127.9). Hatchery fish released just below Roza Dam.	1.49	90	3	11.90	4,405

Table 5. Summary of habitat-based coho and steelhead population performance parameters for the Management Units comprising the Upper Naches Watershed.

Management Unit	Comments	Coho Natural Productivity	Coho Natural Carrying Capacity	Steelhead Equilibrium Abundance	Coho Hatchery Productivity	Coho Hatchery Capacity
American River	Natural spawning from mouth impassible cascade (RM 19.9) plus the following distances in Rainier Fork, Miner, Morse, Kettle and Union Creeks: 2.0 mi, 0.5 mi, 0.3 mi, 0.4 mi & 1.0 mi, respectively. Hatchery fish released just below 4th bridge (RM 11.1)	2.26	222.8	83.6	10.77	1,434
Little Naches River	Natural spawning from mouth to forks (RM 13.3) plus the following distances in Corw, Quartz, Pileup, Matthews, SF, Bear, WF Bear, MF, NF, Blowout and Pyramid Creeks: 9.8 mi, 3.7 mi, 2.2 mi, 3.5 mi, 3.7 mi, 2.4 mi, 3.4 mi, 2.5 mi, 6.5 mi, 3.6 mi and 2.6 mi, respectively. Hatchery fish released just below forks at the confluence of the NF & MF.	1.81	225.2	228.6	10.77	1,394
Little Rattlesnake Cr	Natural spawning mouth to access limit at RM 7.6. Hatchery fish released near access limit (~RM 7.6).	1.35	10.7	27.1	12.62	1,738
Naches mainstem, Tieton - confluence of Bumping and Little Naches Rivers	Natural spawning from Tieton R to forks at confluence of Bumping River and Little Naches River (RM 17.5 - 44.6). Hatchery fish released just below forks.	1.25	189.9	115.8	11.09	1,970
Nile Cr	Natural spawning mouth to impassible falls at RM 9.91. Hatchery located at upper end of accessible area (~RM 9.9)	1.38	21.1	27.5	11.25	1,416
Rattlesnake Cr	Natural spawning from mouth to Little Wildcat Cr (RM 18.8) plus 4.2 mi of the NF and 0.8 mi of Hindoo Cr. Hatchery fish released just below NF (RM 7.7)	1.39	41.7	129.1	11.04	2,777
Tieton River, mouth to Rimrock Dam	Natural spawning mouth to Rimrock Dam (RM 21.3), plus 11.8 mi of Oak Cr and 1.7 mi of Wildcat Cr. Hatchery fish released just below Rimrock Dam.	1.35	74.9	89.7	10.60	2,365

Figure 1 shows the fundamental relationship between the number of NOR's produced by a supplementation program and the productivity and carrying capacity of the targeted habitat. A supplementation hatchery essentially acts as a super-productive tributary. Because of the much higher number of juveniles produced per spawner in a hatchery environment, supplementation increases the productivity of the composite population, but does not affect the carrying capacity for naturally produced fish. As the productivity of a supplemented population increases, the "steepness" of the composite natural/hatchery production function increases as well, intersecting the replacement line at larger and larger levels of spawner abundance. In the limiting case, the replacement line is intersected at a spawner abundance equal to the natural carrying capacity. Therefore, as shown in Figure 1, the limit of the number of additional NOR's that can be produced from supplementation is equal to the difference between the natural carrying capacity and the current natural equilibrium abundance.

For every combination of natural productivity and carrying capacity, there is a unique number of hatchery fish that must be released to maximize NOR's, or to maximize total returns conditioned on no net loss of NOR's. Releases that exceed this value begin to "mine" the natural population, increasing the number of hatchery returns at the expense of natural production.

Clearly, hatchery productivity and capacity must also affect the performance of the supplemented population. Hatchery productivity determines the maximum increase in NOR abundance that can be attained, up to the limit of the difference between carrying capacity and equilibrium abundance, but not the number of fish that must be released to obtain maximum natural production. Optimal release number for either

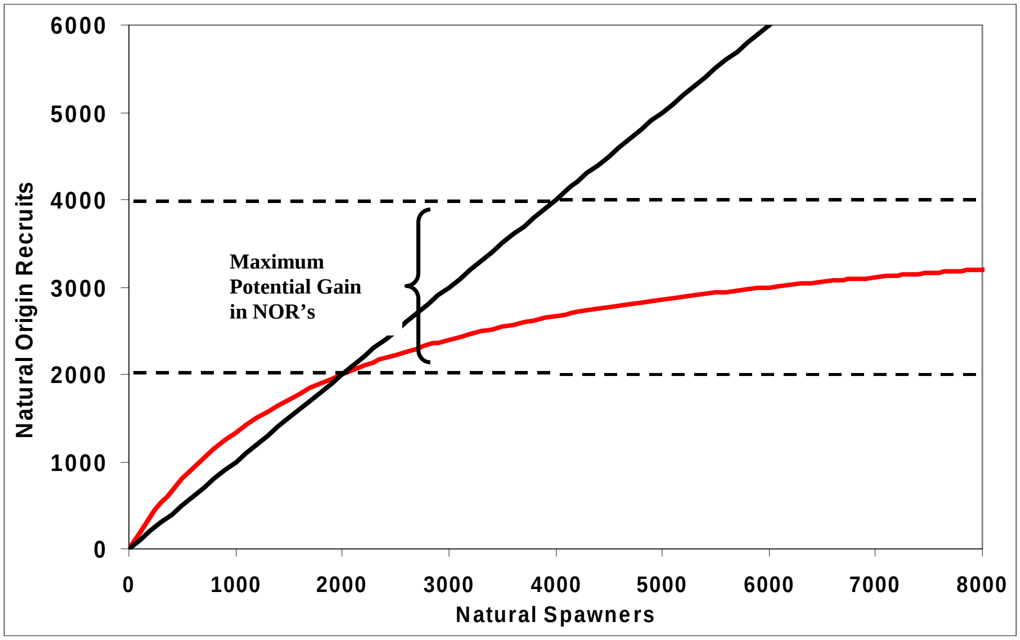

Figure 1. Relationship between natural productivity, natural carrying capacity and potential gain in NOR's from supplementation assuming no genetic impacts from artificial propagation. In the example shown, natural carrying capacity is 4,000 adults and natural productivity is 2.0.

NOR's or total returns is determined solely by natural productivity and capacity. Finally, hatchery capacity has the obvious impact of limiting the total number of hatchery-reared fish that can be produced.

Optimal release number and distribution were estimated with two linked spreadsheets. One of them, the "release number spreadsheet", solved a fully parameterized[2] version of eq 2 for equilibrium NOR's and HOR's for an entire watershed over a wide range of smolt release numbers. The other, "the recruitment rate spreadsheet", identified the management unit providing the highest adult recruitment rate for a specified number of spawners distributed over all management units. The recruitment rate spreadsheet added adults one at a time to the management unit with the highest recruitment rate for a specified number of spawners distributed over all management units in a watershed. It used the Beverton-Holt expression for recruits/spawner

$$\text{Adult recruitment rate} = p / (1 + Sp/K) \qquad \text{(eq. 3)}$$

where p and K are productivity and carrying capacity for each management unit, and S is the "adjusted number" of coho spawners that have been added to the management unit. The process begins by adding the first coho adult to the management unit with the highest

2 "Fully parameterized" means that terms corresponding to percent NOR's used as broodstock, mean fecundity per spawner, and all of the other factors summarized in Table 1, have been added to eq 2, the basic "supplemented Beverton-Holt" expression. This fully parameterized equation can be solved for the number of spawners S in the special case where S equals the subsequent recruits, R. This special case is of course the equilibrium condition.

recruitment rate, then recomputes recruitment rate to account for the increase in spawners, adds the second fish to whichever management unit has the highest recruitment rate for a watershed population of 2 fish, and so on. There is thus a unique distribution of coho adults over management units for every total watershed abundance, and this distribution makes optimal use of the productivity of the watershed at a specified watershed spawner density.

The spawners added to different management units by this process were considered to be hatchery fish, added either as pre-spawning adults or as "adult-equivalent numbers[3]" of smolts. Coho spawners enter eq 2 as an "adjusted" number because, as previously mentioned, steelhead (or *O. mykiss* of some type) reside in most management units, thereby inflating the effective density of coho above the actual number of number of coho added.

The two spreadsheets were used iteratively to estimate the overall release number for a watershed and the distribution of this number over management units. The release number spreadsheet gave an initial estimate of the number of hatchery smolts and broodstock – N_{sm} and N_{br}, respectively -- required either to maximize NOR's or to maximize conditional total returns. This initial estimate assumed hatchery productivity and capacity were equal to the mean of the hatchery productivity and capacity estimates over all management units. The recruitment rate spreadsheet was then used to determine how the N_{br} adults should be distributed over management units to produce the highest collective recruitment rate. The distribution of adults (or adult-equivalent numbers of smolts) was also used as a weighting factor for a refined estimate of hatchery productivity and capacity. Specifically, hatchery p and K were estimated as weighted means over all management units, where the weighting factor was simply the relative spawner abundance from the recruitment rate spreadsheet. At this point, or perhaps with one additional iteration, an optimal release number and distribution was defined for the scenario, and the release number spreadsheet was consulted for the number of NOR's and HOR's expected at equilibrium for the entire watershed.

Estimation of Interspecific Competition Between Coho and Steelhead

The recruitment rate spreadsheet was modified to model the impact on coho production of prior-resident populations of steelhead. As mentioned, the modification consisted of increasing the number of coho spawners by some additional number of "effective coho spawners" based on the equilibrium abundance of ***adult steelhead*** as estimated by the EDT model. For the purposes of this initial evaluation of coho supplementation, it was assumed that an adult steelhead was either identical to an adult coho in terms of its impact on density-dependent mortality, or it was equal to 50% of an adult coho. Thus, the initial effective density of coho in every management unit was increased either by the equilibrium abundance of steelhead (competition factor = 1.0) or by half of this value (competition factor = 0.5). Equation 3 thus becomes:

$$\text{Adult recruitment rate} = p / [1 + (S_{coho} + c*S_{steelhead})p/K] \qquad \text{(eq. 4)}$$

Where S_{coho} and $S_{steelhead}$ are the respective numbers of coho and steelhead spawners, and c is the steelhead-coho competition coefficient (0.5 or 1.0 in this analysis).

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3 An adult equivalent number of smolts in this exercise is the product of the following: (Mean eggs/spawner)*(Pre-spawning survival)*(Egg-to-smolt survival). Given estimates for eggs/spawner, pre-spawning survival and egg-to-smolt survival of 1,500, 0.95 and 0.85, an adult-equivalent number of smolts is ~1,200.

Evaluating Adult Supplementation and False Attraction Mortality

As “adult supplementation” is relatively rare in the Pacific Northwest at this time, it is probably useful to explain exactly what is meant by the term. Taking the current coho hatchery at Prosser Dam as an example, adult supplementation would occur if all smolts were released at Prosser and the returning adults were captured at volunteer traps at the hatchery and/or the fish trap at Prosser Dam and transported to various management units to spawn naturally. This alternative initiates natural production immediately, and increases hatchery productivity as well. The reason for the boost in hatchery performance is that a substantial amount of smolt mortality is eliminated -- the mortality, say, associated with migration from the Yakima below Keechelus Dam to Prosser Dam – as well as a substantial amount of pre-spawning adult mortality – say the losses suffered by adults moving from Prosser Dam to the vicinity of Keechelus Dam.

The benefits of adult supplementation were estimated assuming hatchery smolts were released from, and returning hatchery adults were transported from, one of 3 places: Prosser Dam/Hatchery, Cowiche Dam and Roza Dam. Transported adult s from Prosser Hatchery, Cowiche Dam and Roza Dam were assumed to be outplanted into management units in the Middle Yakima, Upper Naches and Upper Yakima watersheds, respectively. The calculation for the adult supplementation runs were identical to those for smolt supplementation, except that hatchery productivity and capacity were estimated for these three specific locations, and not as a weighted mean over many management units.

The impact of false attraction losses at Sulphur Creek, Granger Drain, the Roza Powerplant outfall, etc, could be estimated rather easily if the losses of natural and hatchery pre-spawners could be estimated for all, or at least a representative sample, of the false attraction sites. A limited amount of data (personal communication, Joel Hubble, Yakama Nation, 2004), indicates that the impact of false attraction may be the same for NOR’s as HOR’s. If so, and if the cumulative impact over all sites could somehow be estimated, it could be modeled by dividing the initial natural and hatchery productivity estimates by the overall false attraction survival rate. That is to say, given that the EDT productivity parameter represents the product of a large number of life-stage-specific survival rates, of one of which is a “false-attraction-prespawning-mortality” factor, the elimination of false attraction would be reflected by an increase in total productivity equal to the initial value divided by the false attraction survival estimate.

RESULTS

Optimal Smolt Release Number and Distribution by Watershed

Optimal Release Number and Resultant Coho Production

Table 6 summarizes the number of broodstock and smolts necessary to maximize coho NOR’s or to maximize conditional total returns (NOR’s + HOR’s). Results are presented separately for each watershed as no interactions between watersheds were assumed.

Table 6. Performance of supplemented populations of coho in the Upper Yakima, Middle Yakima and Upper Naches watersheds under three supplementation scenarios: current tributary passage vs. restored tributary passage, moderate or high steelhead/coho competition, and a goal of maximum NOR production vs. maximum total coho production conditioned on no net loss of NOR’s.

Scenario (Steelhead Competition Factor, Optimality Condition, Obstruction Status)	Total Broodstock	Total Smolts	NOR's	HOR's	TOTAL RETURNS
Upper Yakima Watershed					
Steelhead = 0.5 Coho, max NOR's, Obstructions on	119	144,139	1,124	790	1,914
Steelhead = 0.5 Coho, max Returns, Obstructions on	444	537,795	931	1,644	2,575
Steelhead = 0.5 Coho, max NOR's, No trib Obstructions	124	150,195	1,183	813	1,996
Steelhead = 0.5 Coho, max Returns, No trib Obstructions	466	564,443	980	1,684	2,664
Steelhead = 1.0 Coho, max NOR's, Obstructions on	117	141,716	1,122	769	1,891
Steelhead = 1.0 Coho, max Returns, Obstructions on	439	531,739	931	1,599	2,530
Steelhead = 1.0 Coho, max NOR's, No trib Obstructions	122	147,773	1,182	799	1,981
Steelhead = 1.0 Coho, max Returns, No trib Obstructions	461	558,386	981	1,644	2,625
Middle Yakima Watershed					
Steelhead = 0.5 Coho, max NOR's, Obstructions on	230	278,588	2,011	1,632	3,643
Steelhead = 0.5 Coho, max Returns, Obstructions on	718	869,678	1,686	2,452	4,138
Steelhead = 0.5 Coho, max NOR's, No trib Obstructions	182	220,448	2,089	1,382	3,471
Steelhead = 0.5 Coho, max Returns, No trib Obstructions	654	792,158	1,823	2,338	4,161
Steelhead = 1.0 Coho, max NOR's, Obstructions on	230	278,588	2,012	1,635	3,647
Steelhead = 1.0 Coho, max Returns, Obstructions on	854	1,034,408	1,607	2,809	4,416
Steelhead = 1.0 Coho, max NOR's, No trib Obstructions	231	279,799	2,116	1,687	3,803
Steelhead = 1.0 Coho, max Returns, No trib Obstructions	774	937,508	1,758	2,680	4,438
Upper Naches Watershed					
Steelhead = 0.5 Coho, max NOR's	58	70,253	465	434	899
Steelhead = 0.5 Coho, max returns	234	283,433	353	945	1,298
Steelhead = 1.0 Coho, max NOR's	58	70,253	465	434	899
Steelhead = 1.0 Coho, max returns	236	285,855	352	955	1,307

It is immediately apparent that the strategy of maximizing conditional total returns is quite inefficient compared to the strategy of maximizing NOR's. Over all watersheds and tributary obstruction scenarios, from 2.1 to 3.1 times as many broodstock and smolts are required to maximize total returns as to maximize NOR's, but the relative increase in total adult returns gained by these larger releases ranges only from 14 to 45%.

Table 6 reveals no clear pattern to the way the degree of competition between steelhead and coho affects supplemented coho production. Intuitively, one would assume total returns, or maximum NOR production, or at least NOR's per broodstock adult collected, would be greater when the competition factor was 0.5 than when it was 1.0. None of these expectations is fully borne out. It is likely that the process of always adding additional hatchery coho to the management unit with greatest recruitment rate is not driven primarily by the degree of competition between coho and steelhead, at least for the steelhead densities estimated by the EDT model and for competition coefficients between 0.5 and 1.0.

There is, however, one very significant and consistent result of including some measure of steelhead competition in the analysis: in the absence of any such consideration, the Middle Yakima analysis indicated that the great majority of coho smolts should be released in Satus and Toppenish Creeks. For reasons already stated, such a policy would not be prudent for steelhead nor probably even very effective for coho. Therefore, the inclusion of even so basic a consideration of interspecific competition as was employed here resulted in a very different distribution pattern.

The alternative of restoring full passage to tributaries with existing obstructions in the Middle Yakima and Upper Yakima watersheds pays only modest benefits in terms of coho production. In the Upper Yakima, total return increases 4-5% after passage restoration, while NOR abundance increases about 5%. The impact is more variable in the Middle Yakima. Total returns after passage restoration range from 5% lower to 4% higher, and NOR abundance ranges from 4 to 9% higher.

It would be appropriate for an initial coho supplementation strategy to be both cautious in terms of the steelhead/coho competition issue, and cost-efficient, in terms of the numbers of broodstock adults collected and smolts released. Given these conditions, the appropriate scenario would have 1.0 for the competition factor and an optimality condition that maximized NOR abundance. Under such a scenario, with tributary obstructions left as they are, this analysis suggests that 490,556 smolts (from 405 NOR broodstock) should be released in the subbasin under current conditions. Such a release would produce 6,437 returning adult coho -- 3,599 NOR's and 2,838 HOR's. The distribution of these 490,556 smolts over management units is described in the next section. If tributary passage is viewed as very likely to be fully restored in the near future, the optimal release number becomes 497,824 smolts from 411 adult broodstock. A release of this magnitude with tributary passage restored is estimated to produce a total return of 6,683 adults, comprising 3,763 NOR's and 2,920 HOR's. Again, the distribution of these smolts among management units will be described in the next section.

Optimal Smolt Distribution

Tables 7 - 9 summarize the distribution of smolts by management unit for the Upper Yakima, Middle Yakima and Upper Naches watersheds, respectively. Regardless of the scenario or watershed, these tables indicate that the areas to target with hatchery coho releases are the unconfined portions of the mainstem Yakima, the lower Cle Elum, the mainstem Teanaway, Ahtanum Creek and the American River. The results also indicate that the mainstem Naches River and Satus, Toppenish and Cowiche Creeks are never or only rarely significant release sites.

If attention is restricted to the scenario that seems most prudent with regard to steelhead/coho interactions (competition factor = 1.0), and most cost-effective (maximum NOR production), the proportion of smolts allocated to the preferred areas approaches 100%. For the Upper Yakima under this scenario, approximately 98 - 99% of all smolts are allocated to the mainstem Yakima between the Teanaway confluence and Keechelus Dam, the lower Cle Elum River and the mainstem Teanaway River, regardless of the status of tributary obstructions. In the Middle Yakima, all of the smolts are allocated to the Yakima mainstem between Satus Creek and Roza Dam and to Ahtanum Creek. Similarly, in the Upper Naches watershed, all of the smolts are allocated to the American River when NOR's are maximized and the steelhead competition factor is 1.0. Naturally confined areas like Thorp Canyon (Yakima, Taneum to Teanaway), the Yakima Canyon (Yakima, Roza to Wilson), and much of the Naches mainstem above the Tieton confluence, receive few or no outplants except when total returns are maximized and a great many smolts are released. The lower Naches mainstem, perhaps partly because of anthropogenic confinement, never receives more than 17% of the total smolt release number under any scenario.

The suitability of Satus and Toppenish Creeks for coho supplementation is dramatically affected by steelhead/coho competition. When no steelhead impact is assumed and total returns are maximized, 86% of the smolts are allocated to Satus and Toppenish Creeks. When steelhead impacts are ignored and NOR's are maximized, *all* smolts are allocated to Satus Creek. When, on the other hand, the steelhead/coho competition factor is set to 1.0, no outplants are allocated to Satus Creek under any scenario, and Toppenish Creek receives outplants only for the large releases that maximize total returns.

Optimal Adult Release Number and Distribution by Watershed

Optimal Release Number and Resultant Coho Production

Table 10 summarizes the number of hatchery adult "outplants" necessary to maximize coho NOR's or to maximize conditional total returns (NOR's + HOR's). Again, results are presented separately for each watershed as no interactions between watersheds were assumed.

Table 7. Distribution of hatchery coho smolts by management unit under various supplementation scenarios for the Upper Yakima watershed. Scenarios include current or restored tributary passage, moderate or high steelhead/coho competition, and a goal of either maximum coho NOR abundance at equilibrium or maximizing total coho returns (NOR's + HOR's) conditioned on no net loss of NOR's from the unsupplemented condition. EDT 99-31 model, April 2004.

Scenario (Steelhead Competition Factor, Optimality Condition, Obstruction Status)	Yakima, Easton to Keechelus	Yakima, Cle Elum to Easton	Yakima, Teanaway to Cle Elum	Yakima, Taneum to Teanaway	Yakima, Wilson to Taneum	Yakima, Roza to Wilson	Big Cr	Little Cr	Cle Elum River	Teanaway Mainstem	NF Teanaway	WF Teanaway	MF Teanaway	Swauk	Taneum	Manastash	Umtanum Cr
Steelhead = 0.5 Coho, max NOR's, Obstructions on	41,183	50,873	31,493	0	0	0	0	0	9,690	10,901	0	0	0	0	0	0	0
Steelhead = 0.5 Coho, max returns, Obstructions on	99,323	138,083	128,393	0	32,704	0	23,014	1,211	54,506	50,873	0	0	0	0	0	2,423	7,268
Steelhead = 0.5 Coho, max NOR's, No trib Obstructions	42,394	52,084	33,915	0	0	0	0	0	10,901	10,901	0	0	0	0	0	0	0
Steelhead = 0.5 Coho, max returns, No trib Obstructions	102,956	144,139	133,238	0	39,971	0	24,225	1,211	56,929	53,295	0	0	0	0	0	0	8,479
Steelhead = 1.0 Coho, max NOR's, Obstructions on	43,605	50,873	20,591	0	0	0	0	0	0	24,225	0	0	0	0	0	1,211	1,211
Steelhead = 1.0 Coho, max returns, Obstructions on	107,801	146,561	124,759	0	0	0	25,436	1,211	36,338	67,830	0	0	0	4,845	0	4,845	12,113
Steelhead = 1.0 Coho, max NOR's, No trib Obstructions	46,028	52,084	23,014	0	0	0	0	0	0	25,436	0	0	0	0	0	0	1,211
Steelhead = 1.0 Coho, max returns, No trib Obstructions	112,646	153,829	133,238	0	0	0	26,648	0	39,971	71,464	0	0	0	7,268	0	0	13,324

Table 8. Distribution of hatchery coho smolts by management units under various supplementation scenarios for the Middle Yakima watershed. Scenarios include current or restored tributary passage, moderate or high steelhead/coho competition, and a goal of either maximum coho NOR abundance at equilibrium or maximizing total coho returns (NOR's + HOR's) conditioned on no net loss of NOR's from the unsupplemented condition. EDT 99-31 model, April 2004.

Scenario (Steelhead Competition Factor, Optimality Condition, Obstruction Status)	Yakima, Satus to Ahtanum	Yakima, Ahtanum to Naches	Yakima, Naches to Roza	Naches, Mouth to Tieton	Cowiche Cr	Satus	Toppenish Cr	Simcoe Cr	Ahtanum Cr	Wide Hollow Cr
Steelhead = 0.5 Coho, optimality = max NOR's, Obstructions on	130,815	38,760	25,436	0	0	0	0	0	83,576	0
Steelhead = 0.5 Coho, optimality = max returns, no net NOR loss, Obstructions on	283,433	67,830	43,605	39,971	6,056	136,871	151,406	0	140,505	0
Steelhead = 0.5 Coho, optimality = max NOR's, No trib Obstructions	29,070	18,169	13,324	0	0	0	124,759	0	35,126	0
Steelhead = 0.5 Coho, optimality = max returns, no net NOR loss, No trib Obstructions	213,180	54,506	35,126	20,591	0	31,493	331,883	0	105,379	0
Steelhead = 1.0 Coho, optimality = max NOR's, Obstructions on	141,716	29,070	25,436	0	1,211	0	0	0	81,154	0
Steelhead = 1.0 Coho, optimality = max returns, no net NOR loss, Obstructions on	486,923	94,478	67,830	44,816	13,324	0	115,069	0	211,969	0
Steelhead = 1.0 Coho, optimality = max NOR's, No trib Obstructions	155,040	31,493	26,648	0	0	0	0	0	66,619	0
Steelhead = 1.0 Coho, optimality = max returns, no net NOR loss, No trib Obstructions	387,600	76,309	55,718	18,169	0	0	244,673	0	155,040	0

Table 9. Distribution of hatchery coho smolts by management unit under various supplementation scenarios for the Upper Naches watershed. Scenarios include moderate or high steelhead/coho competition, and a goal of either maximum coho NOR abundance at equilibrium or maximizing total coho returns (NOR's + HOR's) conditioned on no net loss of NOR's from the unsupplemented condition. EDT 99-31 model, April 2004.

Scenario (Steelhead Competition Factor, Optimality Condition)	Naches, Tieton to Bumping/Little Naches	Rattlesnake Cr	Little Rattlesnake Cr	Tieton River	Nile Cr	Little Naches River	American River
Steelhead = 0.5 Coho, optimality = max NOR's	0	0	0	0	0	0	70,253
Steelhead = 0.5 Coho, optimality = max returns, no net NOR loss	42,394	0	0	0	0	62,985	178,054
Steelhead = 1.0 Coho, optimality = max NOR's	0	0	0	0	0	0	70,253
Steelhead = 1.0 Coho, optimality = max returns, no net NOR loss	49,661	0	0	0	0	16,958	219,236

All of the relationships – or the lack of relationships – previously described for smolt outplants are true also for adult outplants. The strategy of maximizing conditional total returns is still inefficient compared to the strategy of maximizing NOR's, and the relationship between coho performance and steelhead competition is still obscure, except for the fact that outplants to Toppenish and Satus Creek are eliminated when significant competition is assumed and NOR's are maximized.

Perhaps the most important thing to note about performance under adult supplementation is the increase in production it affords. As mentioned, outplanting hatchery adults eliminates a considerable portion of subbasin smolt and adult mortalities by eliminating the necessity of a smolt migration from upper watershed release points to the rearing hatchery, and by eliminating pre-spawning mortalities in adults in the migration from the hatchery to their upriver acclimation sites. This increase in hatchery productivity boosts total returns significantly. Over all scenarios, total returns under adult supplementation for the upper Yakima watershed are from 23 – 38% greater than under smolt supplementation. Similarly, total returns under adult supplementation are 44 – 79% greater than under smolt supplementation in the Middle Yakima watershed, and from 34 – 77% greater under smolt supplementation for the Upper Naches watershed.

Perhaps counterintuitively, adult supplementation does not increase NOR abundance to the same degree as total returns. When the optimality condition is maximum NOR's, NOR abundance under adult supplementation always exceeds NOR abundance under smolt supplementation, although usually only by a small margin.

When, however, optimal is defined as maximum total returns, NOR abundance under adult supplementation can be either equal to or even less than NOR abundance under smolt supplementation. In the upper Yakima, NOR abundance under adult supplementation was only 5% greater than under smolt supplementation when the optimality condition was maximum total return. This is so even though total abundance under adult supplementation in the Upper Yakima was 34 – 38% greater under adult supplementation. Similarly, NOR abundance in the Upper Naches under

Table 10. Performance of coho salmon supplemented by hatchery adult outplants in the Upper Yakima, Middle Yakima and Upper Naches watersheds under three supplementation scenarios: current tributary passage vs. restored tributary passage, moderate or high steelhead/coho competition, and a goal of maximum NOR production vs. maximum total coho production conditioned on no net loss of NOR's.

Scenario (Hatchery Location, Steelhead Competition Factor, Optimality Condition, Obstruction Status)	Adults Outplanted	NOR's Produced	HOR's Produced	TOTAL RETURNS
Upper Yakima Watershed				
Roza Dam, Steelhead = 0.5 Coho, max NOR's, Obstructions on	132	1,181	1,168	2,349
Roza Dam, Steelhead = 0.5 Coho, max returns, Obstructions on	523	932	2,552	3,484
Roza Dam, Steelhead = 0.5 Coho, max NOR's, No trib Obstructions	139	1,243	1,210	2,453
Roza Dam, Steelhead = 0.5 Coho, max returns, No trib Obstructions	550	981	2,601	3,582
Roza Dam, Steelhead = 1.0 Coho, max NOR's, Obstructions on	132	1,181	1,168	2,349
Roza Dam, Steelhead = 1.0 Coho, max returns, Obstructions on	523	932	2,552	3,484
Roza Dam, Steelhead = 1.0 Coho, max NOR's, No trib Obstructions	139	1,243	1,210	2,453
Roza Dam, Steelhead = 1.0 Coho, max returns, No trib Obstructions	550	981	2,601	3,582
Middle Yakima Watershed				
Prosser Hatchery, Steelhead = 0.5 Coho, max NOR's, Obstructions on	236	2,270	3,144	5,414
Prosser Hatchery, Steelhead = 0.5 Coho, max returns, Obstructions on	1,253	1,504	5,860	7,364
Prosser Hatchery, Steelhead = 0.5 Coho, max NOR's, No trib Obstructions	234	2,362	3,131	5,493
Prosser Hatchery, Steelhead = 0.5 Coho, max returns, No trib Obstructions	1,253	1,594	5,860	7,454
Prosser Hatchery, Steelhead = 1.0 Coho, max NOR's, Obstructions on	236	2,270	3,144	5,414
Prosser Hatchery, Steelhead = 1.0 Coho, max returns, Obstructions on	1,253	1,504	5,860	7,364
Prosser Hatchery, Steelhead = 1.0 Coho, max NOR's, No trib Obstructions	234	2,362	3,131	5,493
Prosser Hatchery, Steelhead = 1.0 Coho, max returns, No trib Obstructions	1,253	1,594	5,860	7,454
Upper Naches Watershed				
Cowiche Dam, Steelhead = 0.5 Coho, max NOR's	71	493	713	1,206
Cowiche Dam, Steelhead = 0.5 Coho, max returns	291	352	1,941	2,293
Cowiche Dam, Steelhead = 1.0 Coho, max NOR's	71	493	713	1,206
Cowiche Dam, Steelhead = 1.0 Coho, max returns	291	352	1,941	2,293

adult supplementation was the same as under smolt supplementation, even though total returns under adult supplementation were 75 – 77% greater. In the Middle Yakima, NOR abundance was actually less under adult supplementation than smolt supplementation when total returns were maximized. Depending on the steelhead competition factor and obstruction status, NOR abundance in the Middle Yakima under adult supplementation was 6 to 13% less than under smolt supplementation. The differential impact of adult supplementation on NOR abundance and total returns simply reflects the greater productivity of hatchery fish under adult supplementation, and the fact that the maximum total return under adult supplementation occurs at a point at which hatchery production is significantly greater than natural production.

Assuming again that the best alternative for an initial coho supplementation program would minimize steelhead/coho competition and maximize cost-effectiveness, the best coho supplementation alternative among those analyzed would have a steelhead competition factor of 1.0 and an optimality condition of maximizing NOR abundance. Under these conditions and with existing tributary obstructions, the optimal adult supplementation program entails the outplanting of 439 hatchery adults, 132 in the upper Yakima, 236 in the Middle Yakima and 71 in the Upper Naches. These outplants are estimated to produce a total return of 8,969 adults -- 3,944 NOR's and 5,025 HOR's. Relative to smolt supplementation under the same conditions, total return under adult supplementation is 39% greater, and NOR and HOR abundances are 10% and 77% greater, respectively.

The impact of removing tributary obstructions on the performance of an adult coho supplementation program is minimal. If tributary obstructions are eliminated for the scenario described above (steelhead competition factor = 1.0, NOR abundance maximized), the optimal number of outplanted adults increases from 439 to 444, total production increases from 8,969 to 9,152 (a 2% increase), NOR's increase from 3,944 to 4,098 (4% increase) and HOR's increase from 5,025 to 5,054 (0.5% increase). The proportional increases in total, NOR and HOR production under adult supplementation vs. smolt supplementation are approximately the same with or without tributary obstructions.

Optimal Distribution of Outplanted Adults

Tables 11 – 13 summarize the optimal distribution of outplanted adults by management unit in the Upper Yakima, Middle Yakima and Upper Naches watershed. All of the relationships observed earlier for smolt supplementation are still evident in these tables:

- The unconfined portions of the mainstem Yakima, the lower Cle Elum, the mainstem Teanaway, Ahtanum Creek and the American River are still the preferred areas for coho supplementation, and
- Whenever the optimality condition is maximum NOR abundance and the steelhead competition factor is 1.0, the mainstem Naches River and Satus, Toppenish and Cowiche Creeks are still minor outplanting sites.

Table 11. Distribution of outplanted hatchery coho adults by management unit under various supplementation scenarios for the Upper Yakima watershed. Scenarios include current or restored tributary passage, moderate or high steelhead/coho competition, and a goal of either maximum coho NOR abundance at equilibrium or maximizing total coho returns (NOR's + HOR's) conditioned on no net loss of NOR's from the unsupplemented condition. EDT 99-31 model, April 2004.

Scenario (Hatchery Location, Steelhead Competition Factor, Optimality Condition, Obstruction Status)	Yakima, Easton Dam to Keechelus Dam	Yakima, Cle Elum River to Easton Dam	Yakima, Teanaway River to Cle Elum River	Yakima, Taneum Cr to Teanaway River	Yakima, Wilson Cr to Taneum Cr	Yakima, Roza Dam to Wilson Cr	Big Cr	Little Cr	Cle Elum River	Teanaway Mainstem	NF Teanaway	WF Teanaway	MF Teanaway	Swauk Cr	Taneum Cr	Manastash Cr	Umtanum Cr
Roza Dam, Steelhead = 0.5 Coho, max NOR's, Obstructions on	36	45	30	0	0	0	0	0	10	11	0	0	0	0	0	0	0
Roza Dam, Steelhead = 0.5 Coho, max returns, Obstructions on	92	128	121	0	46	0	23	2	52	48	0	0	0	0	0	3	8
Roza Dam, Steelhead = 0.5 Coho, max NOR's, No trib Obstructions	38	47	32	0	0	0	0	0	11	11	0	0	0	0	0	0	0
Roza Dam, Steelhead = 0.5 Coho, max returns, No trib Obstructions	95	133	127	0	53	0	25	1	55	51	0	0	0	1	0	0	9
Roza Dam, Steelhead = 1.0 Coho, max NOR's, Obstructions on	40	46	22	0	0	0	0	0	0	22	0	0	0	0	0	1	1
Roza Dam, Steelhead = 1.0 Coho, max returns, Obstructions on	102	139	123	0	2	0	26	1	40	65	0	0	0	9	0	4	12
Roza Dam, Steelhead = 1.0 Coho, max NOR's, No trib Obstructions	41	48	24	0	0	0	0	0	0	24	0	0	0	0	0	0	2
Roza Dam, Steelhead = 1.0 Coho, max returns, No trib Obstructions	105	145	130	0	9	0	28	0	43	67	0	0	0	10	0	0	13

Table 12. Distribution of outplanted hatchery coho adults by management unit under various supplementation scenarios for the Middle Yakima watershed. Scenarios include current or restored tributary passage, moderate or high steelhead/coho competition, and a goal of either maximum coho NOR abundance at equilibrium or maximizing total coho returns (NOR's + HOR's) conditioned on no net loss of NOR's from the unsupplemented condition. EDT 99-31 model, April 2004.

Scenario (Hatchery Location, Steelhead Competition Factor, Optimality Condition, Obstruction Status)	Yakima, Satus Cr to Ahtanum Cr	Yakima, Ahtanum Cr to Naches River	Yakima, Naches River to Roza Dam	Naches, Mouth to Tieton River	Cowiche Cr	Satus Cr	Toppenish Cr	Simcoe Cr	Ahtanum Cr	Wide Hollow Cr
Prosser Hatchery, Steelhead = 0.5 Coho, max NOR's, Obstructions on	112	32	22	0	0	0	0	0	70	0
Prosser Hatchery, Steelhead = 0.5 Coho, max returns, Obstructions on	348	78	50	64	9	281	250	13	160	0
Prosser Hatchery, Steelhead = 0.5 Coho, max NOR's, No trib Obstructions	42	19	13	0	0	0	124	0	36	0
Prosser Hatchery, Steelhead = 0.5 Coho, max returns, No trib Obstructions	305	69	45	52	9	218	419	0	136	0
Prosser Hatchery, Steelhead = 1.0 Coho, max NOR's, Obstructions on	121	25	21	0	1	0	0	0	68	0
Prosser Hatchery, Steelhead = 1.0 Coho, max returns, Obstructions on	531	103	71	72	16	0	235	1	224	0
Prosser Hatchery, Steelhead = 1.0 Coho, max NOR's, No trib Obstructions	130	26	22	0	0	0	0	0	56	0
Prosser Hatchery, Steelhead = 1.0 Coho, max returns, No trib Obstructions	473	92	64	56	8	0	373	0	187	0

Table 13. Distribution of hatchery coho smolts by management unit under various supplementation scenarios for the Upper Naches watershed. Scenarios include moderate or high steelhead/coho competition, and a goal of either maximum coho NOR abundance at equilibrium or maximizing total coho returns (NOR's + HOR's) conditioned on no net loss of NOR's from the unsupplemented condition. EDT 99-31 model, April 2004.

Scenario (Hatchery Location, Steelhead Competition Factor, Optimality Condition, Obstruction Status)	Naches, Tieton River to Bumping/Little Naches confluence	Rattlesnake Cr	Little Rattlesnake Cr	Tieton River	Nile Cr	Little Naches River	American River
Cowiche Dam, Steelhead = 0.5 Coho, max NOR's	0	0	0	0	0	0	71
Cowiche Dam, Steelhead = 0.5 Coho, max returns	51	0	0	3	0	71	166
Cowiche Dam, Steelhead = 1.0 Coho, max NOR's	0	0	0	0	0	0	71
Cowiche Dam, Steelhead = 1.0 Coho, max returns	58	0	0	0	0	33	200

Impact of False Attraction on Coho Production

The results presented in this analysis assumed no loss of coho productivity attributable to false attraction into irrigation wasteways and powerplant outfalls. That is to say, the EDT model *did not* specify some number of coho adults that spawned inside known false attraction areas and in so doing suffered specified pre-spawning losses and/or radically reduced levels of reproductive success. The reason for this omission is simply that these factors are unknown.

The most quantitative description of the false attraction hazard in the Yakima Subbasin derives from a Yakama Nation radiotracking study conducted in 2000. In this study, 102 adult coho were radiotagged as they passed Prosser Dam and tracked until they spawned and died or until the signal was lost. Of this number, 8 (7.8%) were determine to have spawned in Sulphur Creek, a man-made irrigation wasteway wholly lacking in spawning habitat. Another 27 fish (26.5%) were observed inside or in the immediate vicinity of Roza Wasteway #3, another irrigation return with minimal spawning habitat. The fish that were observed near the latter site, however, may not have spawned in it: many signals from these fish were lost before a definitive spawning location could be established. Although tagged fish were also detected inside or very near another irrigation return and the Roza Powerplant outfall, it is the opinion of Yakama Nation biologists that these fish probably did not spawn in these areas, but merely "dipped in" to rest or possibly to take advantage of cooler water. Solely on the basis of this radiotagging data, then, it has been speculated (personal communication, Joel Hubble, Yakama Nation, 2004) that all of the fish that entered Sulphur Creek either died before spawning or spawned with essentially zero reproductive success, and that perhaps 10% of the fish observed near and inside of Roza Wasteway #3 met the same fate. Therefore, an extremely speculative initial estimate of false attraction mortality for Yakima coho would be something on the order of 10%.

It is interesting and useful to examine the impact on this analysis if this speculative 10% loss – considered a pre-spawning mortality – were actually true. It is perhaps even more useful to examine the impact of a range of pre-spawning mortality rates centered on 10%. Accordingly, three analyses were run in which all hatchery and natural adults were subjected either to a 5, 10 or 20% pre-spawning mortality attributable to false attraction. As previously described, this impact was modeled as a diminution of hatchery and natural productivity – as the product of productivity and 0.95, 0.9 and 0.8.

The results of this analysis are summarized in Table 14. The scenario analyzed in Table 14 entailed the following assumptions:

- Steelhead/coho competition was high (competition factor = 1.0);
- Optimality condition was maximum NORs;
- Tributary obstructions are in place; and
- Supplementation was smolt-based.

As false attraction mortality increases from 0 to 20%, the optimal number of broodstock collected and smolts released increases, as does total return, although returns per broodstock adult collected falls steadily, especially the return of NOR's.

Table 14. Impact on Yakima Subbasin coho supplementation performance under a speculative 5, 10 or 20% pre-spawning mortality attributed to false attraction. The scenario modeled assumed a steelhead competition factor of 1.0, an optimality condition of maximum NOR abundance, and existing tributary obstructions. Smolt supplementation was assumed.

Broodstock	Smolts	# NOR's	# HOR's	Total Return	NOR Produced per Brood Adult	Returns per Brood Adult	Percent HOR
No False Attraction Mortality							
405	490,556	3,599	2,828	6,437	8.9	15.9	44%
False Attraction Mortality = 5%							
505	616,527	3,631	3,938	7,569	7.2	15.0	52%
False Attraction Mortality = 10%							
532	644,386	3,521	3,910	7,431	6.6	14.0	53%
False Attraction mortality = 20%							
585	708,582	3,263	3,844	7,107	5.6	12.1	54%

The proportion of hatchery origin fish in the return steadily increases with false attraction mortality, while the absolute number of NOR's initially increases and then declines.

To reiterate, the figures presented in this analysis assumed zero false attraction mortality. Therefore, to some degree, the measures recommended underestimate broodstock needs and overestimate total production and the proportion of natural origin fish in the returns. If the degree of error summarized in Table 14 is large enough to cause concern, it would be well to follow up on the 2000 study to determine more precisely the magnitude of pre-spawning mortality to be expected over a range of years with varying instream flows and temperatures. If, on the other hand, it can reasonably be expected that the false attraction issue will be essentially eliminated in the near future, then this entire discussion becomes merely a historical curiosity, and the numbers presented in this analysis can be accepted as descriptive of the current condition.

SUMMARY

The analysis presented in this report could be used as a starting point for a coho supplementation/reintroduction program throughout the Yakima Subbasin. Although it is clearly subject to revision and undoubtedly contains errors (e.g., erroneous estimates of natural steelhead or coho performance by management unit, erroneous estimates of pre-spawning mortality and its relative severity over fish of different origin type), the analytical method at its core is logical and should benefit from iterative refinements in data. Moreover, the options presented here lend themselves to the "logistical geography" of the Yakima Subbasin. In particular, the division of the subbasin into three large watersheds corresponds to the logistical possibility of collecting broodstock. Natural Origin coho adults collected at Cowiche Dam are likely to consist primarily of fish spawned in the Upper Naches. Similarly, natural origin coho collected at Roza Dam are likely to consist mainly of Upper Yakima fish. Although the NOR's that could be collected at Prosser Dam would include fish spawned in all three watersheds, it might be possible to distinguish Middle Yakima NOR's from Upper Naches and Upper Yakima NOR's by scale pattern. Water temperatures throughout the Middle Yakima area are considerably higher than anywhere else in the subbasin, and growth rates and emergence timing can be expected to diverge over time. If the scale patterns of Yakima fall Chinook and spring Chinook smolts are any indication, it should be possible to discriminate lower river coho from upper river coho by the number and spacing of juvenile circuli on the scales of natural origin adults.

One final point should be made. Recent genetic thinking (HSRG 2004) suggests that natural selection should dominate artificial selection in a supplemented population so long as the proportion of NOR's in the hatchery is greater than the proportion of HOR's on the spawning grounds. This analysis assumed hatchery broodstock consisted entirely of natural origin fish; therefore, it is difficult to envision a scenario in which natural selection did not dominate artificial selection. Thus, it is not unreasonable to suppose that a variation of one of the supplementation alternatives presented here might be implemented and, over time, lead to the development of three locally adapted stocks.

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Appendix B
Klickitat EDT Model Output: Restoration potential for Steelhead and Spring Chinook

1.1 Lower Klickitat EDT reaches analysis for restoration potential referencing the overall steelhead population below Castile Falls.

Sections 1.2 – 1.5 of the document discusses the top ten restoration reaches with the following objectives:

1.) Discussion of potential increases of population performance parameters and primary parameter associated with the overall restoration potential rank
2.) Identification of primary level 3 survival correlates and/or level 2 attributes with greatest impacts to survival and related life stages with highest mortality
3.) Miscellaneous caveats potentially affecting the overall restoration ranking a reach has received

1.21 Reach rankings in order of restoration potential: The overall rankings are based on a summation of individual population performance parameters which results in several reaches displaying the same overall ranking. Reaches that have the same restoration ranking are grouped together but are not displayed in any order of importance.

1.) Swale 2
Description: Swale Cr- SE tributary to NW tributary (begins 3.967 miles upstream from mouth of swale cr)
Length: 3.808 mi

Swale 2 exhibits minor potential increases in Abundance, Productivity and life history diversity but is one of the few reaches that exhibits restoration potential for all three performance parameters. Among all reaches, swale 2 possesses the ability to contribute substantially to the life history diversity index for the lower Klickitat steelhead population, ranking 3rd overall in this category. The EDT model shows a 30% decrease in the life history diversity index for the entire Steelhead population below Castile Falls. Of this 30%, the model states that restoration in this reach alone could restore up to 4% of this decline. It also shows a potential increase in abundance and productivity of 2% each.

Because of the physical degradation this reach has undergone due to the railroad prism and in channel work, a combination of level 3 attributes have severely impacted several life stages in the following order: Egg incubation displays an 88.4% decline in productivity from high temperatures, increases in sediment and loss of key habitat. Active rearing life stages show a decrease in productivity by 69.3% from an overwhelming combination of level 3 attributes with major hits from loss of key habitat, high temperatures, potential pathogens, loss of flow and habitat diversity. Fry colonization productivity has decreased by 41.9% primarily from loss of key habitat, temperatures, and habitat diversity. There are no underlining caveats for the ranking of this reach due to severity of degradation it has undergone and the potential it possesses for steelhead.

2.) Klick 12

Description: Klickitat R- Dead Canyon to Summit Cr
Length: 6.271 mi

Klick 12 restoration potential incorporates substantial potential for increases in productivity (9%) and abundance (4%). The productivity potential ranks 1st among all the reaches and 2nd overall with respect to abundance for the individual categories. The combined affect from the two of this account for the overall ranking since the model shows no potential increase for the life history diversity index. A 9% increase in productivity would be a modest improvement in productivity considering the difference in this parameter from historic to current (13.5 to 4.2). This contributes to rationalization of restoration importance of this reach with respect to the overall population performance. Level 3 correlates contributing to the degradation of this reach is broad with none displaying a dominating affect on productivity. The model illustrates a decrease of survival during the egg incubation life stage due to elevated concentrations of fine sediment. Physical degradations appear on the upper and lower ends of the reach affecting the habitat diversity in the forms of riparian vegetation, hydro confinement and loss of wood. Changes in the Biologic community also contribute to the restoration potential this reach displays. Biological affects include an increase in competition and predation from hatchery outplants and species introduction in the rearing life stages. The model also shows a probable increase in mortality from pathogens due to these outplants and the proximity of Klickitat hatchery. Two caveats exist with the restoration ranking this reach receives: First, this is a rather long reach which correlates to a large capacity (length x channel width). This increase of area will have a slight impact on the magnitude of relative potential increases in the population performance parameters. Second, a high proportion of factors affecting the restoration potential actually lye outside of this reach such as increased levels of turbidity and fine sediment during the late winter, early spring months and biologic community impacts from the hatchery upstream.

2.) Swale 1
Description: Swale Cr- Mouth to SE tributary 3.967 miles upstream
Length: 3.967 mi

Swale 1 also received an overall restoration ranking of 2 with potential increases in abundance by 3%, increases in productivity by 1% and increases in the life history diversity index by 4%. The potential increase in productivity itself ranks fairly low among all reaches associated with the steelhead population compared to the overall rankings for increases in abundance and diversity index. This would lead one to the conclusion that the potential increases in abundance and the diversity index are the primary parameters associated with the overall restoration ranking this reach receives. Another aspect to consider with the potential abundance is it's relation to productivity and capacity. Abundance is a function of both productivity and capacity and because the productivity potential is fairly low, one could relate the potential abundance to a decrease in the overall capacity that is associated with the biological response to the amount of available key habitat. The model shows loss of key habitat for nearly every life stage which results in this decrease of capacity encompassing the entire life cycle spent within Swale Creek.

Like Swale 2, this reach exhibits a substantial potential for increasing the life history diversity index by 4%. An interpretation of this hypothesizes that the low survival for the egg incubation and 0 age active rearing life stages have a substantial number of unsuccessful life history trajectories associated with them. These decreases in productivity for the egg incubation life stage are heavily impacted from increased levels of fine sediment over background levels and elevated temperatures. 0 age rearing life stages have major hits from loss of key habitat, elevated temperature, potential pathogens, habitat diversity and low flow. Other life stages have decreases in productivity as well with similar biological affects from habitat diversity, elevated temperatures, loss of late summer flow and decreases in key habitat. The last component to consider with this reach's restoration ranking is its geographic proximity for steelhead utilizing the Swale Cr watershed. All life trajectories in the Swale Cr. watershed are eventually routed through Swale1. Any decreases in survival for a portion of life stages will affect a greater amount of trajectories than reaches above swale 1 in the watershed.

3.) Klick 11
Description: Klickitat **R- Beeks Canyon to Dead Canyon**
Length: 5.518 mi

The overall restoration ranking of 3 for klick 11 from the EDT model has the following potential increases: 4% abundance, 6% productivity and no potential for the life history diversity index. Even without any potential increases in the diversity index this reach ranks fairly high due to the high individual rankings for abundance and productivity. Degradations to the quality and quantity of habitat occur in isolated locations on the right bank of the Klickitat river in this reach. These degradations are strongly linked to the hydro confining affect the Champion haul road has on the river along with the vegetation loss in the form of canopy cover and accelerated bank erosion. These physical factors relate the degradations of quantity and quality of habitat directly to productivity and abundance which is reflected in the loss of key habitat quantity for nearly every single life stage. Biological community affects also contribute to the restoration potential this reach displays. Competition from hatchery outplants have decreased the productivity for the rearing life stages of wild juvenile steelhead along with potential increases in predation. This increase in predation is reflected in the active, inactive, migrant and colonization life stages that are also impacted from species introduction and community richness. Another level 3 biologic attribute contributing to the restoration potential is the presence of pathogens. This value is derived from a synergistic affect from several level 2 attributes. A single level 2 attribute affecting this biological response in the form of species introductions is present so the overall impact is minimal from this level 3 attribute.

4.) Klick 10
Description: Klickitat R- Little Klickitat to Beeks Canyon
Length: 5.510 mi

The overall restoration ranking of 4 this reach received from the EDT model has a potential increase in abundance of 3%, increase of productivity by 5% and a 0% increase in the life history diversity index. This reach receives very similar potentials for productivity and abundance as those in Klick 11. This is not a surprise due to similar degradations these 2 reaches have undergone. Interpretations of physical and biologic level 3 attributes affecting productivity and life stages from Klick 11 could be applied to the restoration potential this reach displays in conjunction with one other level 3 component. The model displays a larger impact to the habitat diversity for several life stages for Klick 10 over Klick 11. Greater decreases in the presence of large woody debris and a higher percent of linear distance confined from the champion haul road result in this additional impact to the marginal habitat diversity. Because of this, one might expect this reach to rank higher than Klick 11 for the overall restoration potential. Klick 11 receives a higher ranking because of its higher capacity that lends itself to greater channel widths, higher percentage of off channel habitat and the unconfined nature of the reach.

4.) Klick 8
Description: Klickitat R- Snyder Cr to Swale Cr
Length: 3.258 mi

The overall restoration ranking of 4 Klick 8 receives displays a potential increase in abundance by 2%, increase of productivity by 3% and an increase in the life history diversity index of 1%. This reach does not possess the ability to contribute to increases for abundance and productivity to those seen in other reaches with the same restoration ranking but unlike other reaches with the same restoration ranking, the model shows an existing potential to increase the life history diversity by 1% for the overall Klickitat steelhead population. The potential increases in the productivity have a strong case as the primary component driving the overall restoration ranking. Decreases in productivity are related to the quality of available habitat for all life stages occurring within a given reach. The level 3 attribute expression of this is habitat diversity that is a compilation of several physical level 2 attributes. This level 3 parameter has the most significant impact on nearly all existing life stages occurring in this reach. Degradations of the habitat diversity include hydro confinement from the main road paralleling the river along with the old railroad prism in some areas, degraded riparian function in the form of canopy cover and loss of wood which acts as pockets of refugia and channel roughness.

The model also has several biological components contributing to the restoration potential that include the following: competition form hatchery outplants, increased levels of predation and the presence of pathogens. These biological level 3 attributes are present in several but not all life stages and appear to be secondary components with respect to any of the population performance parameters. The model also shows a decrease in the level 3 attribute of food. Of the level 2 attributes that are compiled into this level 3 (biological response), decreases in salmon carcasses appears to be most heavily weighted for a decrease in the food supply. This decrease in the food supply is also related to the sustainable capacity of this reach for all life stages and is reflected in the restoration potential for abundance.

4.) Swale 3
Description: Swale Cr- NW tributary (tributary that overlays the Warwick fault) to a south tributary
Length: 3.438 mi

The overall restoration ranking for this reach has the potential increases for abundance of 2%, increases of productivity equivalent to 1% and potential increases in the diversity index of 3%. This potential increase in the diversity index is the primary population parameter associated with the overall restoration ranking. The individual potential increases for abundance and productivity affect a smaller proportion of life history trajectories for any given life stage than the number in the reaches below which results in a decreased impact to the overall productivity and abundance of the entire population. This is not to say that these are the sole reasons as to why this reach has a lower potential for increases in productivity and abundance (with respect to swale 1 & Swale 2) because other factors are contributing as well. For instance, swale 2 may have loss a greater amount of marginal habitat than swale 3 which contributes to decreases in capacity and abundance. A major limiting factor identified in the EDT reach analysis points to increased temperatures that have substantial impacts to the productivity for the egg incubation, spawning, fry colonization and 0 age active rearing life stage. The other level 3 with the greatest impact on productivities of specific life stages is loss of key habitat for spawning, egg incubation and fry colonization due to the physical changes and historic channel work that has occurred. Other biologic level 3 attributes contribute less but some to the overall restoration potential along with loss of late summer flow. The synergistic affect of elevated temperatures, loss of key habitat quantity and other level 3 attributes has resulted with in reach mortalities for a portion of the trajectories routed through this particular reach. This is reflected in the potential increases of the life history diversity index.

4.) Klick 13
Description: Klickitat R- Summit Cr to White Cr
Length: 2.541 mi

Restoration potential for Klick 13 consists of the following: 2% increase for abundance, 4% increase in productivity and a 1% increase in the life history diversity index. Of the 3 population parameters associated with the overall population performance and restoration ranking, the potential increase displayed in the productivity is substantially larger than the potential for increases in abundance and diversity index. Assessment of the level 3 components having negative impacts on the productivity of a given life stage suggests that the quality of habitat diversity has been degraded in conjunction with increases of fine sediment over background levels. The level 3 analysis also suggests that increases in predation due to hatchery outplants and competition from hatchery outplants has contributed to decreases in productivity for several life stages. Of all the reach rankings, this reach displays the least amount of confidence with its overall ranking. This hypothesis lends itself to the uncertainty associated with the impact of hydro confinement affecting the habitat diversity and channel stability. This is identified because of the confined nature the canyon walls existing along this entire reach. Needless to say, this is not stating that there hasn't been alteration in the canopy and habitat diversity due to the existing road but simply stating that the impact may not be as significant as the model suggests.

5.) White 4
Description: White Cr- Brush Cr To 1st meadow

Length: 4.737 mi

Restoration potential for individual population performance parameters are as follows for White 4: potential increase in abundance of 2%, potential increases in productivity of 1% and potential increases in the life history diversity index of 5%. With respect to the entire lower Klickitat steelhead population below Castile Falls, the potential increases for the life history diversity index is the primary component for the overall restoration ranking. This individual population performance parameter for White 4 ranks first among all other reach potentials.

Level 3 attributes affecting the restoration rankings are primarily physical degradations that the reach has undergone. Degradations in the habitat diversity have negative affects on productivity for almost all life stages. Level 2 attributes with degradations affecting the level 3 attribute of habitat diversity include riparian function, amounts of large woody debris and hydro confinement (or entrenchment). These physical attributes have also resulted in altered habitat types that in turn have decreased the capacity for given habitat type associated with specific life stages. Decreases of late summer flow and elevated temperatures also contribute to the demise of this reach. The overall affect of these level 3 attributes results with reach specific mortalities affecting the trajectories associated with them. Nearly 2/3 of all life history trajectories in the White cr watershed spend some portion of their life cycle in this reach. Because of the relative importance the White cr watershed inherently displays to the overall steelhead population, there is no surprise or caveats associated with this reach's ranking as it should remain top priority for any physical restoration actions.

6.) Klick 5
Description: Klickitat R- Dillacort Canyon to Logging Camp Canyon
Length: 4.001 mi

The overall restoration potential ranking for this reach has the following potential increases: abundance increase of 2%, productivity increase of 3% and an increase of diversity index by 1%. Of the three population performance parameters, none seem to display an overwhelming affect on the overall restoration ranking associated with this reach. Restoration potential for this reach is primarily associated with physical degradations with slight contributions from biological factors and water quality parameters. Habitat diversity has impacted the most life stages over any other level 3 attribute. Level 2 attributes associated with this include Riparian function in the form of canopy cover and vegetation, loss of wood and hydro confinement from proximity of the main road. Level 3 biological attributes having negative impacts on productivity are represented in the form of hatchery outplants resulting in an increased competition for food and space. This biological attribute along with diminished food sources due to declined amounts of salmon carcasses are components contributing to the potential increases of abundance in the form of decreased food resources. The last element to consider with this reaches high ranking is related to the high percentage of the populations life history trajectories (97%) routed through the reach through space and time. This reach displays a high sensitivity and increased magnitude of negative affects on a given life stages productivity due to the proximity of the reach.

7.) Klick7
Description: Klickitat R- Wheeler Canyon to Snyder Cr
Length: 3.337 mi

The overall restoration potential ranking for this reach has the following potential increases: abundance increase of 2%, productivity increase of 3% and an increase of diversity index by 0%. The restoration rankings for this particular reach has nearly the same level 3 attributes affecting productivity of life stage as those seen in Klick 5 above. The only discrepancy between the two is the proximity of Klick 7 to or near a human population center of which would be the town of Klickitat. Reach 7 receives a slightly increased affect on the harassment attribute due to this. The reach is ranked just below Klick 5 due to a decreased amount of life history trajectories routed through this reach.

1.2 Upper Klickitat EDT reaches analysis for restoration potential referencing the overall steelhead population above Castile Falls.

1.) Klick 30
Description: Klickitat R- Klickitat R meadows (RM 78.2) to Huckleberry Cr
Length: 8.545 mi

Klick 30 restoration potential ranks 1st among the upper Klickitat reaches for steelhead that incorporates substantial potential for increases in productivity (9%), abundance (9%) and Life history diversity index (7%). All three of these population performance parameters are contributing to the overall restoration ranking Klick 30 has been diagnosed with by the EDT model. The high potential increases for productivity are a function of the quality habitat that has been degraded in isolated areas of this reach. One of the level 3 attributes displaying decreases in productivity related to this is the habitat diversity. In this case, decreases of productivity occur in the colonization, rearing and inactive life stages. The degradation of habitat diversity is a function of deteriorated riparian conditions in isolated locations in the form of decreased canopy and stream bank vegetation, loss of wood and local entrenchment. Local entrenchment has also accelerated bank erosion in some areas and may be the primary contributor to the slight increases of fine sediment over background levels. This is expressed in the level 3 attribute of sediment load of which also has decreased productivity in the egg incubation life stage. Other secondary level 3 attributes contributing to decreased productivity in the egg incubation life stage are slight increases of temperature and decreased channel stability due to local entrenchment.

The high potential increases of abundance for steelhead in this reach are a function of both the potential productivity and capacity. Potential increases and factors affecting productivity are listed in the above paragraph. Potential increases in abundance from decreased capacity are associated with the loss of food resources from decreases of salmon carcasses that primarily impact the fry colonization and early stages of active rearing. The potential displayed for the life history diversity parameter is a result of unsuccessful life history trajectories that result in mortality for fish in this reach. All of the listed degradations above impact this parameter in one form or another. Another factor that may be contributing to the mortality of over wintering life stages could be related to the cold temperatures. This hypothesis speculates the possible decreases of ground water sources offering pockets of refugia for overwintering life stages that will require further research. One caveat exists with this reaches ranking that is related to the stream reaches length. This reach is abnormally longer in length of which results in an increased capacity of area offered for all life stages. This will have increased the individual increases for restoration potential but because all three parameters rank very high individually, this reach would still rank among the top three if had a linear length equivalent to other reaches in the upper Klickitat.

2.) Klick 27
Description: Klickitat R- McCreedy Cr to Piscoe Cr
Length: 3.877 mi

Klick 27 restoration potential ranks 2nd among the upper Klickitat reaches for steelhead that incorporates potential for increases in productivity of 9%, substantial increases in abundance (13%) and increases for Life history diversity index of 4%. The high restoration ranking this reach has received is correlated to the potential increases of abundance primarily, the model also displays a substantial increase in productivity and should be viewed as an important component as well.

Of all the reaches in the upper Klickitat mainstem, this reach has the greatest linear length of hydro confinement due to the main road next to it. The stream bank has been rip rapped to protect the road in areas of which contributes to the simplification of habitat in isolated areas of this reach. From this, the model shows decreases of key habitat for several life stages that ultimately results in decreased capacity. The EDT model also shows a decrease of food resources due to declined number of salmon carcasses. This decrease in food source contributes to the declined capacity for several life stages that is expressed in decreased productivity and overall restoration potential for increases of abundance. Sediment load has been identified as a major limiting factor for several life stages. Egg incubation has the greatest decline in productivity due to fine sediment. Other life stages affected by fine sediment or turbidity include spawning, colonization and migrant life stages.

3.) Klick 25
Description: Klickitat R- Upper end of Castile Falls to Chaparrel Cr
Length: 3.038 mi

Restoration potential for Klick 25 consists of the following: 8% increase for abundance, 6% increase in productivity and a 1% increase in the life history diversity. Both abundance and productivity are key components for this reaches overall restoration potential. Increases in the life history diversity index from restoration are minimal as compared to the other parameters. This low potential displays the high success rate of life history trajectory paths offered to a given fish. This is also related to the fact that this reach offers a tremendous amount of habitat diversity and has very minimal physical alterations from anthropogenic impacts. Within reach level 3 parameters affecting overall productivity and abundance are food and sediment load. Declined food resources are the result of decreased salmon carcasses affecting colonization and early rearing life stages. The model also identifies sediment load as a major level 3 component affecting productivity for egg incubation, spawning and migrant life stages due to increases of fine sediment and turbidity. Sources of increased sediment load occur upstream of this reach in tributaries exhibiting road densities from forest management activities.

3.) Piscoe 3
Description: Piscoe Cr- piscoe2 to Piscoe road crossing (reach begins 3.65 mi from the mouth)
Length: 2.993 mi

Restoration potential for Piscoe 3 consists of the following: 3% increase for abundance, 2% increase in productivity and a 5% increase in the life history diversity. The overall restoration ranking for piscoe 3 is driven by the potential for increasing the life history diversity relative to the upper Klickitat steelhead population. Several level 3 attributes contribute to the potential this reach displays with sediment load as the key limiting factor expressed in the egg incubation life stage. The model identifies other parameters that consist of habitat diversity, key habitat quantity, channel stability, food resources and elevated temperatures. Of all the top ten reach rankings for the upper Klickitat, this reach exhibits the least confidence and highest uncertainty associated with its overall ranking for 2 reasons. First, available data sources were scarce that addressed piscoe cr and ground truthing was limited due to time constraints. Second, the upper Klickitat has not been thoroughly seeded with steelhead due to passage issues at Castile Falls up until this point. As a result, distribution and future seeding of natural populations of tributaries is not known. Professional biological opinions also have identified other tributaries with higher priorities due to experience and knowledge of that particular area.

4.) Klick 26
Description: Klickitat R- Chaparrel Cr to McCreedy Cr
Length: 2.70 mi

Restoration potential for Klick 26 consists of the following: 8% increase for abundance, 5% increase in productivity and a 1% increase in the life history diversity. The primary population parameter influencing the overall restoration potential is the potential this reach displays for increasing the populations abundance. Degradations undergone in this reach are very similar to the degradations in Klick 27 that is located upstream. In fact, the analysis of klick 27 could be applied to this reach with one exception. This reach has a decreased linear length of stream bank influenced by hydro confinement than the amount in Klick 27. This is expressed in the habitat diversity level 3 attribute. If one was to look at the individual population parameter potentials, you'll notice that Klick 27 has a greater potential for the productivity parameter. This is directly related to the quality of habitat linked to the level 3 correlate habitat diversity. With this one exception, all other level 3 correlates affect similar life stages as those identified in Klick 27.

5.) Klick 28
Description: Klickitat R- Piscoe Cr to Diamond Fork
Length: 1.627 mi

Restoration potential for Klick 28 consists of the following: 4% increase for abundance, 3% increase in productivity and a 1% increase in the life history diversity. The ability of this reach to contribute to the overall steelhead productivity and abundance are the key components driving this overall restoration ranking. A current high success rate of life history trajectories is reflected in the slight potential that exists for the increases in the diversity index. Level 3 components identified by the model that are negatively impacting productivity include sediment load in the form of fines and turbidity, channel stability, and increased predation associated with the presence of hatchery fish. Although the presence of hatchery fish exists due to outplanting of adult spawners and parr, effects are minimal compared to sediment load and decreased food sources. Decreases in food sources identified from the model are a consequence of declined salmon carcasses. This decrease in food resource coupled with a slight decrease of key habitat for several life stages has reduced the overall capacity this reach once exhibited and is identified in the potential increases for abundance.

6.) Diamond 1
Description: Diamond Fork - Mouth pt upstream ~1.58 miles
Length: 1.586 mi

Restoration potential for Diamond 1 consists of the following: 2% increase for abundance, 1% increase in productivity and a 3% increase in the life history diversity. The overall restoration ranking associated with this reach is a product of all three population performance parameters. This reaches limiting factors include declines in productivity for the egg incubation life stage due to fine sediment and elevated temperatures. The overwintering life stage has the largest decline in productivity as a result of decreased habitat diversity and low winter temperatures. The model identifies a loss of key habitat for nearly every life stage which translates to a decrease in the overall capacity and abundance. Other biological level 3 factors have had slight affects are the existence of hatchery fish from a scarce amount of outplantings. Also, 100% of steelhead life history trajectories in the Diamond Fork are routed through this reach at some point so degradations in this reach will affect the sub population of the Diamond Fork.

7.) Diamond 5
Description: Diamond Cr- Butte Meadows Cr to top of last meadow
Length: 2.183 mi

Restoration potential for Diamond 5 consists of the following: 2% increase for abundance, 1% increase in productivity and a 3% increase in the life history diversity. The overall restoration ranking associated with this reach is a product of all three population performance parameters. The model identifies the same limiting level 3 correlates for this reach as Diamond 1. High levels of fine sediment combined with elevated temperatures have substantially decreased productivity for the egg incubation life stage. The model displays major decreases in productivity for the inactive life stages due to decreases of food resources, habitat diversity, and low winter temperatures. Decreases of key habitat for nearly every life stage have negatively influenced the capacity which is reflected in the potential increases for abundance.

8.) Klick 18
Description: Klickitat R- Trout Cr to Big Muddy Cr

Length: 10.865 mi

Restoration potential for Klick 18 consists of the following: 2% increase for abundance, 1% increase in productivity and a 1% increase in the life history diversity. All 3 of the population parameters contribute to this reaches overall ranking. This reach is located in a relatively isolated area that has not undergone any physical degradation. Restoration potential associated with this reach is reflected and driven by the decrease of food resources. Historically, this reach is thought to have had a higher number of salmon carcasses. The model also displays a slight predation increase do to the presence of hatchery outplants and decreases in productivity for the migrant life stage from elevated concentrations of turbidity during spring runoff months.

9.) Klick 29
Description: Klickitat R- Diamond Fork to bottom Klickitat R meadows
Length: 1.518 mi

Restoration potential for Klick 29 consists of the following: 3% increase for abundance, 3% increase in productivity and a 0% increase in the life history diversity. The potential increases for abundance and productivity both are driving parameters with the overall restoration potential rank this reach displays. This reach has 1 major limiting factor that has negatively impacted the productivity and appears to be fine sediment. With fine sediment, elevated temperatures work synergistically to decrease to productivity of the egg incubation life stage. Other life stages have minor decreases in productivity due to decreased food resources, decreased habitat diversity and competition with the few hatchery fish that exist in this reach.

1.3 Lower Klickitat EDT reaches analysis for restoration potential referencing the overall Spring Chinook population below Castile Falls.

1.) Klick 18
Description: Klickitat R- Trout Cr to Big Muddy Cr
Length: 10.865 mi

Klick 18 ranks 1st for the overall restoration potential associated with the three population performance parameters. This reach displays a potential increase of abundance equal to 7% and a potential increase in productivity equal to 6% and no potential increase for the life history diversity index. The combined affect from the two of this account for the overall ranking since the model shows no potential increase for the life history diversity index. The restoration potential exhibited by this reach is weighted upon the level 3 attribute of food. A decrease in salmon carcasses negatively affects the productivity of the fry colonization, 0, 1 age rearing and the inactive wintering life stages of Spring Chinook. This decrease in food source not only results in decreased productivity but diminishes the capacity of the reach as well. Due to the location of this isolated reach, no physical alterations from anthropogenic impacts influence the restoration potential, it is considered to remain in a pristine state. The other level 3 correlate the model has identified impacting survival of several life stages is the sediment load. This sediment load is linked to the increases of concentrations of suspended sediment (turbidity) during the late winter and spring months of the year. Potential sources are located upstream from the reach itself from incoming tributaries displaying resource management implications with road densities. The overall ranking of this reach was a bit unexpected as there are two other factors influencing the reaches ranking of 1. First, this reach is the lowest reach in the system designated as a spawning reach for the Spring Chinook population below Castile Falls. This translates to nearly 100% of the populations life history trajectories either rear or migrate through this reach resulting in exposure to the environmental conditions. Second, this reach is one of the longest reaches in the Klickitat EDT model. This extended length contributes to an increased capacity which magnifies the restoration potential related to this and abundance.

2.) Klick 12
Description: Klickitat R- Dead Canyon to Summit Cr
Length: 6.271 mi

Klick 12 ranks 2nd for the overall restoration potential associated with the three population performance parameters. This reach displays a potential increase of abundance equal to 6% and a potential increase in productivity equal to 4% and no potential increase for the life history diversity index. The combined affect from the two of this account for the overall ranking since the model shows no potential increase for the life history diversity index. Physical degradations appear on the upper and lower ends of the reach affecting the habitat diversity in the forms of riparian vegetation, hydro confinement and loss of wood. Changes in the Biologic community also contribute to the restoration potential this reach displays. Biological affects include an increase in predation from hatchery outplants and species introduction in the migrant and rearing life stages. The model also indicates a decrease in key habitat quantity affecting the productivity for the rearing life stages that occur in this reach.

3.) Klick 10
Description: Klickitat R- Little Klickitat to Beeks Canyon
Length: 5.510 mi

Klick 10 ranks 3rd for the overall restoration potential associated with the three population performance parameters. This reach displays a potential increase of abundance equal to 3% and a potential increase in productivity equal to 2% and no potential increase for the life history diversity index. The model displays a decrease of survival from the habitat diversity level 3 attribute for several life stages. Level 2 attributes affecting the habitat diversity included hydro confinement from the champion haul road, diminished amounts of large woody debris and loss of Canopy cover expressed in the Riparian function attribute. The habitat diversity has affected the quality of habitat and is linked to the restoration parameter of productivity. Decreases of key habitat and food have been identified for several life stages and are articulated in the restoration parameter for abundance. Very little biological influences affect the restoration potential of this reach in the form of hatchery outplants.

3.) Klick 11
Description: Klickitat **R- Beeks Canyon to Dead Canyon**
Length: 5.518 mi

The overall restoration ranking of 3 for klick 11 from the EDT model has the following potential increases: 3% abundance, 2% productivity and no potential for the life history diversity index. Even without any potential increases in the diversity index this reach ranks fairly high due to the high individual rankings for abundance and productivity. Degradations to the quality and quantity of habitat occur in isolated locations on the right bank of the Klickitat River in this reach. These degradations are strongly linked to the hydro confining affect the Champion haul road has on the river along with the vegetation loss in the form of canopy cover and accelerated bank erosion. These physical factors relate the degradations of quantity and quality of habitat directly to productivity and abundance which is reflected in the loss of key habitat quantity for several life stages. Biological community affects contribute little to the decreases of productivity for rearing and migrant life stages in the form of predation. Hatchery outplants act as the modifying component influencing this level 3 correlate.

3.) Klick 13
Description: Klickitat R- Summit Cr to White Cr

Length: 2.541 mi

Restoration potential for Klick 13 consists of the following: 3% increase for abundance, 2% increase in productivity and a 0% increase in the life history diversity index. Of the 3 population parameters associated with the overall population performance and restoration ranking, the potential increase displayed in the productivity and abundance are obviously the key components to the ranking since the diversity index potential is 0. Assessment of the level 3 components having negative impacts on the productivity of a given life stage suggests that the quality of habitat diversity has been degraded in conjunction with increases of fine sediment over background levels. The level 3 analysis also suggests that increases in predation due to hatchery outplants and competition from hatchery outplants has contributed to decreases in productivity for several life stages. Of all the reach rankings, this reach displays the least amount of confidence with its overall ranking. This hypothesis lends itself to the uncertainty associated with the impact of hydro confinement affecting the habitat diversity and channel stability. This is identified because of the confined nature the canyon walls existing along this entire reach. Needless to say, this is not stating that there hasn't been alteration in the canopy and habitat diversity due to the existing road but simply stating that the impact may not be as significant as the model suggests.

1.4 Upper Klickitat EDT reaches analysis for restoration potential referencing the overall Spring Chinook population above Castile Falls.

1.) Klick 30
Description: Klickitat R- Klickitat R meadows (RM 78.2) to Huckleberry Cr
Length: 8.545 mi

Klick 30 restoration potential ranks 1st among the upper Klickitat reaches for steelhead that incorporates substantial potential for increases in productivity (30%), abundance (21%) and no potential increases for the Life history diversity index (0%). The high potential increases for productivity are a function of the quality habitat that has been degraded in isolated areas of this reach. One of the level 3 attributes displaying decreases in productivity related to this is the habitat diversity. In this case, decreases of productivity occur in the colonization, migrant and inactive life stages. The degradation of habitat diversity is a function of deteriorated riparian conditions in isolated locations in the form of decreased canopy and stream bank vegetation, loss of wood and local entrenchment. Local entrenchment has also accelerated bank erosion in some areas and may be the primary contributor to the slight increases of fine sediment over background levels. This is expressed in the level 3 attribute of sediment load of which also has decreased productivity in the egg incubation life stage. Other secondary level 3 attributes contributing to decreased productivity in the egg incubation life stage are slight increases of temperature and decreased channel stability due to local entrenchment.

The high potential increases of abundance for spring Chinook in this reach are a function of both the potential productivity and capacity. Potential increases and factors affecting productivity are listed in the above paragraph. Potential increases in abundance from decreased capacity are associated with the loss of food resources from decreases of salmon carcasses that primarily impact the fry colonization and early stages of active rearing. Another factor that may be contributing to the mortality of over wintering life stages could be related to the cold temperatures. This hypothesis speculates the possible decreases of ground water sources offering pockets of refugia for overwintering life stages that will require further analysis and research. One caveat exists with this reaches ranking that is related to the stream reaches length. This reach is abnormally longer in length of which results in an increased capacity of area offered for all life stages. This will magnify the affects of the individual increases for restoration potential but because two of the three parameters rank very high individually, this reach would still rank among the top three if had a linear length equivalent to other reaches in the upper Klickitat.

2.) Klick 27

Description: Klickitat R- McCreedy Cr to Piscoe Cr
Length: 3.877 mi

Klick 27 restoration potential ranks 2nd among the upper Klickitat reaches for spring Chinook that incorporates potential for increases in productivity of 15%, increases in abundance of 11% and no increases for Life history diversity index. The high restoration ranking this reach has received is correlated to the potential increases of productivity primarily, the model also displays a substantial increase in abundance and should be viewed as an important component as well.

Of all the reaches in the upper Klickitat mainstem, this reach has the greatest linear length of hydro confinement due to the main road next to it. The stream bank has been rip rapped to protect the road in areas of which contributes to the simplification of habitat in isolated areas of this reach. From this, the model shows decreases of key habitat for several life stages that ultimately results in decreased capacity. The EDT model also shows a decrease of food resources due to declined number of salmon carcasses. This decrease in food source contributes to the declined capacity for several life stages that is expressed in decreased productivity and overall restoration potential for increases of abundance. Sediment load has been identified as a major limiting factor for several life stages. Egg incubation has the greatest decline in productivity due to fine sediment. Other life stages affected by fine sediment or turbidity include colonization, migrant and prespawning holding life stages.

3.) Klick 26
Description: Klickitat R- Chaparrel Cr to McCreedy Cr
Length: 2.70 mi

Restoration potential for Klick 26 consists of the following: 8% increase for abundance, 11% increase in productivity and a 0% increase in the life history diversity. The primary population parameter influencing the overall restoration potential is the potential this reach displays for increasing the populations productivity. Degradations undergone in this reach are very similar to the degradations in Klick 27 that is located upstream. In fact, the analysis of klick 27 could be applied to this reach with one exception. This reach has a decreased linear length of stream bank influenced by hydro confinement than the amount in Klick 27. This is expressed in the habitat diversity level 3 attribute. If one was to look at the individual population parameter potentials, you'll notice that Klick 27 has a greater potential for the productivity parameter. This is directly related to the quality of habitat linked to the level 3 correlate habitat diversity. With this one exception, all other level 3 correlates affect similar life stages as those identified in Klick 27.

4.) Klick 25
Description: Klickitat R- Upper end of Castile Falls to Chaparrel Cr
Length: 3.038 mi

Restoration potential for Klick 25 consists of the following: 5% increase for abundance, 7% increase in productivity and a 0% increase in the life history diversity. Both abundance and productivity are key components for this reaches overall restoration potential. Within reach level 3 parameters affecting overall productivity and abundance are food and sediment load. Declined food resources are the result of decreased salmon carcasses affecting colonization and early rearing life stages. The model also identifies sediment load as a major level 3 component affecting productivity for egg incubation, spawning and migrant life stages due to increases of fine sediment and turbidity. Sources of increased sediment load occur upstream of this reach in tributaries exhibiting road densities from forest management activities. This reach offers a tremendous amount of habitat diversity with a healthy riparian corridor and wood recruitment that exhibits minimal physical alterations from anthropogenic impacts.

5.) Klick 28
Description: Klickitat R- Piscoe Cr to Diamond Fork

Length: 1.627 mi

Restoration potential for Klick 28 consists of the following: 4% increase for abundance, 5% increase in productivity and a 0% increase in the life history diversity. The ability of this reach to contribute to the overall steelhead productivity and abundance are both key components associated with the overall restoration ranking. Level 3 components identified by the model that are negatively impacting productivity include sediment load in the form of fines and turbidity, channel stability, and increased predation associated with the presence of hatchery fish. Although the presence of hatchery fish exists due to outplanting of adult spawners and parr, effects are minimal compared to sediment load and decreased food sources. Decreases in food sources identified from the model are a consequence of declined salmon carcasses. This decrease in food resource coupled with a slight decrease of key habitat for several life stages has reduced the overall capacity this reach once exhibited and is identified in the potential increases for abundance.

Appendix C

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2003 Annual Report: OCT-SNT Survival

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Submitted July 9, 2004

1. Summary

Smolt-to-Smolt Survival: The 2003 outmigration year was the last outmigration year for the five-year[1] experimental releases of fish reared using one of two treatments: the semi-natural treatment (SNT) and the optimal conventional treatment (OCT). Smolt-to-smolt survival indices from release[2] to McNary Dam passage were estimated for PIT-tag releases for each treatment from each rearing pond within each acclimation site within each year.

In previous years there was no attempt to adjust survival-index estimates for fish that were removed at McNary Dam (McNary) and not returned to the river. Further, over the broods, inconsistent methods of estimating McNary detection efficiencies were inadvertently used to expand numbers of fish detected at McNary to obtain the estimates of the survival indices. The smolt-to-smolt survival-index data from all five outmigration years were reviewed, corrected, and reanalyzed. General findings for prior brood years do not differ from those given in previous annual reports.

There is insufficient evidence that the SNT treatment resulted in higher smolt-to-smolt survival index than did the OCT treatment over the five broods (the hypothesis to be tested). Based on a one-sided sign tests, the SNT fish had a significantly higher smolt-to-smolt survival index than did the OCT fish for the first three broods; however, other statistical tests did not result in the same level of significance. For the fourth brood, there was an elevated level of BKD infestation. The SNT-treated smolt had a significantly higher mean BKD index than did the OCT and also had a significantly lower smolt-to-smolt survival index. When the survival index was adjusted for a BKD index as a covariate, there was no significant difference between the SNT and OCT smolt-to-smolt survival indices. For the last brood, there was no significant difference between the SNT and OCT survival indices.

Smolt-to-Adult Survival: There are estimates of smolt-to-adult survival for the first three broods. There are no significant differences between the OCT and SNT effects on the survival from juvenile-release-to-adult passage at Roza Dam on the Upper Yakima River. The 1997- and 1999-brood analyses are

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[1] The years being brood-years 1997-2001, respectively corresponding to outmigration-years 1999-2003.

[2] From the 1998 brood on, survival index was based on volitional releases (only those fish detected leaving the acclimation ponds were used to estimate survival index and the number detected at the ponds serves as the release number); however for the 1997 brood it was not possible to use data from the acclimation site detectors; therefore, the survival index for the 1997 brood is actually based on number of fish tagged adjusted for PIT-tagged mortalities detected in the ponds prior to release.

based on a pooling of all return-age cohorts (age 3 to age 5 returns); the 2000-brood analysis is based on only age 3 and 4 returns, 2004-return-year age-5 adults are still being evaluated.

2. OCT-SNT Release-to-McNary-Dam Smolt-to-Smolt Survival

A total of approximately 40,000 hatchery Spring Chinook smolt are tagged per-year with Passively Integrated Transponders (PIT). This represents approximately 5.5% to 10% of the total hatchery Spring Chinook smolt, depending on the number of acclimation ponds stocked. It is these PIT-tagged fish that can be detected during dam passage as they outmigrate to the ocean; therefore, all smolt-to-smolt survival-index estimates are based on PIT-tagged fish.

Table 1 presents the estimated SNT and OCT release-to-McNary smolt-to-smolt survival indices for each acclimation site (Clark Flats, Jack Creek, and Easton) for each brood (brood years 1997 through 2001, which respectively correspond to outmigration years 1999 through 2003). Methods of estimating survival indices are discussed in Appendix A. Tables 2.a through 2.e present respective weighted logistic analyses of variation[3] of the survival indices for each of those brood years. The analyses reflect the experimental design used. There were up to three pairs of ponds per acclimation site. Each pair of ponds received progeny from the same sets of diallel parental crosses, the different pairs of ponds differed in the parental-cross sets assigned to them. The SNT and OCT treatments were assigned to different ponds within each pair. The design layout was thus treated as a nested complete block design, the pairs of ponds being the blocks within the acclimation sites. If the block effect was not significant at the $\alpha = 0.1$ (10%) significance level, the block and the error [Error (1)] sources were pooled into a new error source [Error (2)] to provide more powerful statistical tests resulting from the greater error degrees of freedom. Both analyses, that using Error (1) and that using Error (2), are presented. The one not shaded is the one used for testing the effects of the treatments.

Figure 1 graphically presents the SNT and OCT survival-index estimates for each acclimation site within each year. The total acclimation sites differed from year to year due to variation over years in the number of parents available for the brood.

[3] Appendix A contains a discussion on logistic analysis of variation.

Table 1. Total release numbers* and weighted release-to-McNary smolt-to-smolt survival indices (as proportions) for PIT-tagged OCT and SNT Spring Chinook Released into the Upper Yakima (weights are number released)

		Brood Year 1997		Brood Year 1998		
		Acclimation Site		Acclimation Site		
Treatment		Clark Flat	Easton	Clark Flat	Jack Creek	Easton
OCT	Volitional Release Number	11978	7979	7194	3732	7309
	Survival Index	**0.4884**	**0.4607**	**0.3905**	**0.3594**	**0.3298**
SNT	Volitional Release Number	11974	7961	7196	4693	7261
	Survival Index	**0.4916**	**0.4734**	**0.3933**	**0.3495**	**0.3353**

		Brood Year 1999			Brood Year 2000			Brood Year 2001	
		Acclimation Site			Acclimation Site			Acclimation Site	
Treatment		Clark Flat	Jack Creek	Easton	Clark Flat	Jack Creek	Easton	Clark Flat	Jack Creek
OCT	Volitional Release Number	6519	6473	6480	6340	6480	6512	3559	11601
	Survival Index	**0.2402**	**0.1917**	**0.1922**	**0.4239**	**0.3716**	**0.3249**	**0.2780**	**0.3067**
SNT	Volitional Release Number	6454	6410	6455	5858	6466	5924	3372	11555
	Survival Index	**0.2648**	**0.1973**	**0.2067**	**0.3030**	**0.3001**	**0.1899**	**0.2072**	**0.3380**

Table 2. Weighted Logistic Analyses of Variation of Release-to-McNary Smolt-to-Smolt Survival Indices of PIT-tagged OCT and SNT Spring Chinook Released into the Upper Yakima (weights are number released)

a. Brood-Year 1997 (Released in 1999)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	20.30	1	20.30	1.31	0.3354	
Block within Site[2]	46.47	3	15.49	0.89	0.5384	
Treatment (OCT vs SNT)[2]	1.96	1	1.96	0.11	0.7598	0.3799
Site x Treatment[2]	0.88	1	0.88	0.05	0.8369	
Error(1)	52.44	3	17.48			
Site[3]	20.30	1	20.30	1.23	0.3096	
Treatment[3]	1.96	1	1.96	0.12	0.7420	**0.3710**
Site x Treatment[3]	0.88	1	0.88	0.05	0.8250	
Error(2)[4]	98.91	6	16.49			

[1] Site is initially tested against Block

[2] Block, Treatment, Ineraction initially tested against Error(1)

NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects

[3] Block, Treatment, Ineraction finally tested against Error(2)

[4] Error (2) is pooling of Error(1) and Block

Table 2. (continued)

b. Brood-Year 1998 (Released in 2000)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	112.37	2	56.19	4.66	0.0721	
Block within Site[2]	60.32	5	12.06	1.88	0.2528	
Treatment (OCT vs SNT)[2]	0.25	1	0.25	0.04	0.8514	0.4257
Site x Treatment[2]	0.39	2	0.195	0.03	0.9703	
Error(1)	32.11	5	6.42			
Site[3]	112.37	2	56.19	6.08	0.0187	
Treatment[3]	0.25	1	0.25	0.03	0.8726	**0.4363**
Site x Treatment[3]	0.39	2	0.20	0.02	0.9792	
Error(2)[4]	92.43	10	9.24			

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

c. Brood-Year 1999 (Released in 2001)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	155.33	2	77.67	11.21	0.0094	
Block within Site[2]	41.56	6	6.93	3.10	0.0970	
Treatment (OCT vs SNT)[2]	12.83	1	12.83	5.75	0.0535	**0.0267**
Site x Treatment[2]	2.48	2	1.24	0.56	0.6006	
Error(1)	13.39	6	2.23			
Site[3]	155.33	2	77.67	16.96	0.0003	
Treatment[3]	12.83	1	12.83	2.80	0.1200	0.0600
Site x Treatment[3]	2.48	2	1.24	0.27	0.7673	
Error(2)[4]	54.95	12	4.58			

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

Table 2. (continued)

d. Brood-Year 2000 (Released in 2002)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	319.06	2	159.53	0.77	0.5053	
Block within Site[2]	1248.78	6	208.13	2.40	0.1557	
Treatment (OCT vs SNT)[2]	546.19	1	546.19	6.29	0.0460	0.9770
Site x Treatment[2]	58.89	2	29.445	0.34	0.7252	
Error(1)	520.96	6	86.83			
Site[3]	319.06	2	159.53	1.08	0.3699	
Treatment[3]	546.19	1	546.19	3.70	0.0783	**0.9608**
Site x Treatment[3]	58.89	2	29.45	0.20	0.8217	
Error(2)[4]	1769.74	12	147.48			

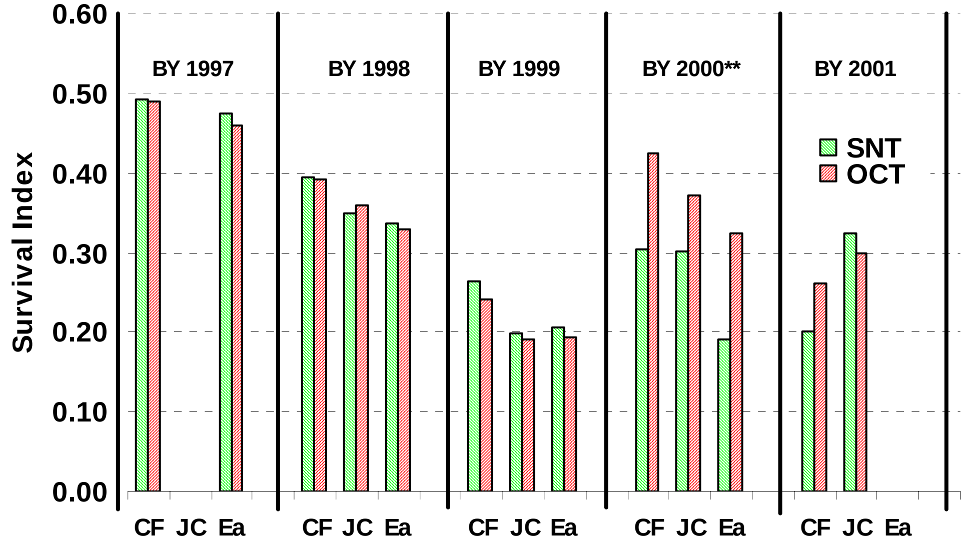
[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

e. Brood-Year 2001 (Released in 2003)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	161.16	1	161.16	9.17	0.0940	
Block within Site[2]	35.16	2	17.58	1.25	0.4447	
Treatment (OCT vs SNT)[2]	2.18	1	2.18	0.15	0.7319	0.3660
Site x Treatment[2]	71.29	1	71.29	5.06	0.1533	
Error(1)	28.16	2	14.08	0.00	0.0000	
Site[3]	161.16	1	161.16	10.18	0.0332	
Treatment[3]	2.18	1	2.18	0.14	0.7294	**0.3647**
Site x Treatment[3]	71.29	1	71.29	4.50	0.1011	
Error(2)[4]	63.32	4	15.83			

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

* In brood-year 1997, release number was number of fish PIT-tagged adjusted for detected pre-release mortalities. In brood-years 1998-2001, release number was number of fish detected leaving acclimation sites.



Acclimation Sites: CF--Clark Flat, JC--Jack Creek, Ea--Easton

SNT-Semi-Natural Treatment, OCT-Optimal Conventional Treatment

* BY-1997 release number = number tagged corrected for pre-release mortalities, BY-1998 through BY-2001 release numbers = number detected volitionally leaving ponds

** **Unadjusted for BKD index**

Figure 1. Release-to-McNary smolt-to-smolt survival indices for OCT and SNT Spring Chinook Released into the Upper Yakima [release/outmigration years 2 years following brood year (BY)]

Before discussing the SNT and OCT comparisons, there are a couple of observations to be made from Figure 1. Brood-year 1997 smolt had the highest survival index. They outmigrated in 1999 which had one of the highest protracted flows on record and the highest for the five broods studied. Brood-year 1999 smolt had the lowest survival index. They outmigrated in 2001 which had one of the lowest protracted flows on record and the lowest for the five broods studied.

Regarding the relative SNT and OCT survival-index comparisons, unless otherwise stated, statistical significance is based one-sided tests for concluding that the SNT survival index is greater than the OCT survival index when the hypothesis that there is no difference in SNT and OCT survival indices is true (Type 1 error).

For each of the first three broods, the mean survival index over sites for SNT smolt was greater than that for OCT smolt; however, of those first three broods, only the third indicated a significant difference (p = 0.027, 1-sided test, Table 2.c). The SNT survival index exceeded that for OCT in seven of the eight year x acclimation-pond combinations for those three broods; indicating that the SNT had a significantly higher survival index than the OCT at the 5% level (p = 0.035 based on a 1-sided sign test). Referring to the individual blocked pairs of ponds for those three broods, the SNT had a higher survival index than the OCT in 14 of the total of 22 blocked pond pairs, significant at the 10% level (P = 0.076 based on a 1-sided sign test). A combined logistic analysis of variation was performed for those first three years[4], and the survival index associated with the SNT treatment is not significantly greater than that associated with the OCT (p = 0.137, 1-sided test, Table 3). The statistical assessment is not clear for those first three brood years, but, if the survival index associated with the SNT treatment was truly greater than that of the OCT, the estimates suggest that it was only marginally greater.

Table 3. Weighted Logistic Analysis of Variation of Release-to-McNary Smolt-to-Smolt Survival Index for OCT and SNT Spring Chinook Released into the Upper Yakima for 1997 through 1999 Broods Combined (weights are number released)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev (Dev/DF)	F-Ratio	Type 1 Error p	1-sided p for SNT > OCT
Year	6221.64	2	3110.82	444.68	0.0000	
Site (adjusted for Year)	226.22	2	113.11	16.17	0.0002	
Year x Site Interaction	61.80	3	20.60	2.94	0.0695	
Block within (Year x Site)*	148.34	14	10.60	1.51	0.2235	
Treatment (OCT vs SNT)	9.05	1	9.05	1.29	0.2745	**0.1372**
Treatment x Year	5.99	2	3.00	0.43	0.6600	
Treatment x Site	2.18	2	1.09	0.16	0.8572	
Treatment x Site x Brood Year	1.57	3	0.52	0.07	0.9725	
Error**	97.94	14	7.00			

* Serves as denominator source in F-Tests for Year, Site, and Year x Site Sources

** Serves as denominator source in F-Tests for Block, Treatment, and all Intercations involving Treatment

If there is ambiguity associated with statistical tests for first three broods, there is none associated with the fourth brood. The SNT treatment performed significantly worse than OCT in terms of the smolt-to-smolt survival index (p = 0.078, F-test which is two-sided for treatment comparison, Table 2.d). In fact, the SNT treatment had a lower survival index than that of the OCT in eight of the nine blocked pond pairs. One possible reason for this is that there were greater levels of Bacterial Kidney Disease (BKD) in that brood than in the other four broods (almost absent in the other broods). It turns out that the SNT fish had a significantly higher BKD index than did the OCT fish (p = 0.001, analysis of variance on mean BKD index[5], F-test which is two-sided for treatment comparison, Table 4). A logistic analysis of covariation was run on the survival index using the BKD index as the covariate or concomitant variable and is presented in Table 5. When survival indices were adjusted for the BKD effect, there was no longer a significant difference between the treatments' mean survival indices (p = 0.644, logistic analysis of variation, F-test which is two-sided for treatment comparison, Table 5). Table 6 presents the unadjusted mean survival index, the mean BKD index, and the mean survival index adjusted for the BKD index for brood-year 2000. Table 7 presents the database used to estimate the mean BKD index.

[4] The combined analysis over the first three brood years indicated no year or acclimation site interactions with treatment; therefore, the comparison of mean survival indices across these sites and years is justified.

[5] Ray Brunson (United States Fish and Wildlife Service, Olympia, Washington) provided disease data. Between 59 and 61 fish were sampled and measured for BKD severity per pond. Refer to Table 7.

Table 4. Analysis of Variance of Brood-Year 2000 Mean BKD Indices for OCT and SNT Hatchery Spring Chinook

Source	Sums of Squares (SS)	Degrees of Freedom (DF)	Mean Square (MS=SS/DF)	F-Ratio	P
Site (CF vs JC)[1]	0.8218	2	0.4109	2.79	0.1390
Block within Site[2]	0.8833	6	0.1472	1.75	0.2573
Treatment (OCT vs SNT)[2]	1.9736	1	1.9736	23.42	0.0029
Site x Treatment[2]	0.7797	2	0.3899	4.63	0.0609
Error(1)	0.5056	6	0.0843		
Site[3]	0.8218	2	0.4109	3.55	0.0615
Treatment[3]	1.9736	1	1.9736	17.05	**0.0014**
Site x Treatment[3]	0.7797	2	0.3899	3.37	0.0690
Error(2)[4]	1.3889	12	0.1157		

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

Table 5. Analysis of Covariance of Broodyear 2000 Release-to-McNary Smolt-to-Smolt Survival Index to McNary Dam using Mean BKD Index as the Covariate

Source	Deviance	Degrees of Freedom	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	15.58	2	7.79	0.08	0.9237	
Block within Site[2]	581.23	6	96.87	1.68	0.2934	
Treatment (OCT vs SNT)[2]	17.82	1	17.82	0.31	0.6025	0.3012
Site x Treatment[2]	80.08	2	40.04	0.69	0.5423	
BKD	232.21	1	232.21	4.02	0.1828	
Error(1)	288.75	5	57.75	0.00	0.0000	
Site[3]	15.58	2	7.79	0.10	0.9070	
Treatment[3]	17.82	1	17.82	0.23	**0.6443**	0.3222
Site x Treatment[3]	80.08	2	40.04	0.51	0.6161	
BKD	232.21	1	232.21	2.94	0.1146	
Error(2)[4]	869.98	11	79.09	0.00	0.0000	

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

Table 6. Release Numbers, Unadjusted Mean Smolt-to-Smolt Survival Indices, Mean BKD Indices, and Mean Smolt-to-Smolt Survival Indices adjusted for Mean BKD Indices for brood-year 2000

Treatment		Site			Over
		Clark Flats	Jack Creek	Easton	Sites
OCT	Volitional Release Number	6340	6480	6512	19332
	Survival Index	**0.4239**	**0.3716**	**0.3249**	**0.3730**
	Mean BKD Index	1.1778	1.3486	1.2722	1.2662
	Survival Index (adjusted for BKD Index)	**0.3187**	**0.3297**	**0.2756**	**0.3079**
SNT	Volitional Release Number	5858	6466	5924	18248
	Survival Index	**0.3030**	**0.3001**	**0.1899**	**0.2652**
	Mean BKD Index	1.6243	1.6444	2.5167	0.0000
	Survival Index (adjusted for BKD Index)	**0.2875**	**0.3304**	**0.3825**	**0.3335**
Over Treatments	Volitional Release Number	12198	12946	12436	37580
	Survival Index	**0.3658**	**0.3359**	**0.2606**	**0.3207**
	Mean BKD Index	1.4011	1.4965	1.8945	0.0000
	Survival Index (adjusted for BKD Index)	**0.3037**	**0.3300**	**0.3265**	**0.3203**

For the final brood, there was no significant difference between the two treatment's survival indices. The site x treatment interaction was approaching significance at the 10% significance level ($p = 0.101$, Table 2.e.), and this is reflected in Figure 1 wherein the survival index for SNT is lower than that OCT for the Clark Flat acclimation site but higher for the Jack Creek site. However, there was only one pair of ponds stocked at Clark Flat, but three pairs stocked at Jack Creek. For one of the Jack Creek pond pairs, the SNT survival index was actually lower than the OCT; whereas for the other two pairs the SNT was higher. There is insufficient evidence of a site x treatment interaction in any of the brood years.

Table 7. Relative Distribution of Ranked BKD Severity Measure Index for Sampled Fish within Raceway, Number Sampled, and Sample Index Mean for Brood-Year 2000 OCT-SNT Spring Chinook smolt. (Data provided by Ray Brunson, United States Fish and Wildlife Service, Olympia, Washington.) (CF, JC, ES designate respective acclimation sites Clark Flat, Jack Creek, Easton; numbers following designation are pond numbers within site; number sets 1,2; 3,4; 5,6 designating the three pond pairs within site.)

	Site >	Clark Flats (CF)					
	Treatment >	SNT			OCT		
	Acclimation Pond >	CF-1	CF-3	CF-5	CF-2	CF-4	CF-6
Risk*	Rank						
ND	0	0.05085	0.08333	0.08475	0.11667	0.20000	0.13559
VL	1	0.44068	0.45000	0.69492	0.60000	0.58333	0.71186
	2	0.32203	0.45000	0.16949	0.25000	0.18333	0.15254
	3	0.03390	0.00000	0.03390	0.00000	0.00000	0.00000
L	4	0.03390	0.00000	0.01695	0.00000	0.00000	0.00000
	5	0.01695	0.00000	0.00000	0.00000	0.00000	0.00000
M	6	0.00000	0.00000	0.00000	0.01667	0.00000	0.00000
H	7	0.06780	0.00000	0.00000	0.00000	0.03333	0.00000
VH	8	0.01695	0.00000	0.00000	0.01667	0.00000	0.00000
	9	0.01695	0.01667	0.00000	0.00000	0.00000	0.00000
	Total Sampled >	59	60	59	60	60	59
	Mean Severity Rank** >	2.169	1.500	1.203	1.333	1.183	1.017

	Site >	Jack Creek (JC)					
	Treatment >	SNT			OCT		
	Acclimation Pond >	JC-1	JC-3	JC-5	JC-2	JC-4	JC-6
Risk*	Rank						
ND	0	0.00000	0.16667	0.10000	0.13333	0.08333	0.09836
VL	1	0.41667	0.36667	0.45000	0.43333	0.45000	0.55738
	2	0.45000	0.43333	0.36667	0.43333	0.40000	0.34426
	3	0.06667	0.00000	0.03333	0.00000	0.03333	0.00000
L	4	0.01667	0.00000	0.01667	0.00000	0.01667	0.00000
	5	0.00000	0.00000	0.01667	0.00000	0.01667	0.00000
M	6	0.00000	0.01667	0.00000	0.00000	0.00000	0.00000
H	7	0.05000	0.01667	0.01667	0.00000	0.00000	0.00000
VH	8	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	9	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	Total Sampled >	60	60	60	60	60	61
	Mean Severity Rank** >	1.933	1.450	1.550	1.300	1.500	1.246

	Site >	Easton (ES)					
	Treatment >	SNT			OCT		
	Acclimation Pond >	ES-1	ES-3	ES-5	ES-2	ES-4	ES-6
Risk*	Rank						
ND	0	0.03333	0.03333	0.00000	0.26667	0.05000	0.06667
VL	1	0.36667	0.35000	0.16667	0.36667	0.61667	0.66667
	2	0.41667	0.36667	0.36667	0.33333	0.31667	0.23333
	3	0.08333	0.05000	0.11667	0.01667	0.00000	0.00000
L	4	0.05000	0.05000	0.15000	0.00000	0.00000	0.01667
	5	0.00000	0.00000	0.05000	0.01667	0.00000	0.00000
M	6	0.03333	0.06667	0.05000	0.00000	0.01667	0.01667
H	7	0.01667	0.03333	0.08333	0.00000	0.00000	0.00000
VH	8	0.00000	0.05000	0.01667	0.00000	0.00000	0.00000
	9	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	Total Sampled >	60	60	60	60	60	60
	Mean Severity Rank** >	1.967	2.467	3.117	1.167	1.350	1.300

* ND--Not Detected, VL--Very Low, L--Low, M--Moderate, H--High, VH--Very High

** Mean = Sum over ranks of product of rank and relative frequency within acclimation pond

3. OCT-SNT Release-to-Roza-Dam Smolt-to-Adult Survival

All fish from the 1997 brood were body-tagged with multiple wire tags to identify them according to raceway. For the 1998 and 1999 broods, combinations of elastomer-tags and body-tags were used. There has been evidence of substantial differential pre-release body-tag shedding that depended on the tag's position in the body, a combination of positions identifying the raceway source of the fish. Since there was way of knowing whether there was post-release differential shedding, the decision was made to not utilize body-tagged fish to estimate adult survival[6] at this time.

The elastomer-tag colors and positions (left versus right eye) can be used to identify treatment x acclimation-site origins but not the individual pond (the identification by pond requires identifying body-tag position). If there is no differential shedding of elastomer tags over color and position, it may be possible to analyze tagging-to-return survival under the assumptions of 1) no site x treatment interaction and 2) correct age-at-return assignment based on scale sampling. Since there is little or no indication of site x treatment interaction for the smolt-to-smolt survival indices based on PIT-tag detections at McNary, the first assumption may be reasonable. Measures in error in age classification based on size of fish can be estimated using analysis of scales from sampled fish and by using PIT-tagged adult returns. Smolt-to-adult survival analyses using elastomer tag and age data may be performed in the future, but for now, analyses of smolt-to-adult survival are based on PIT-tagged returns under the assumption that there is no differential PIT-tag loss or differential PIT-tag related mortality over ponds. There are approximately 40,000 fish PIT-tagged per brood. These PIT-tagged fish represent between approximately 5.5% and 10% of the total fish released, depending on the number of ponds stocked in a given brood year.

Table 8 gives the mean survival indices of the first three broods. The first two broods represent complete adult returns (age 3, 4, and 5 returns), and the third brood represents partial returns (age 3 and 4). While there are age 3 returns of the fourth brood, the data are regarded as being insufficient for assessment until at least age-4 returns are available for inclusion. Precocial age-2 returns to Roza Dam are not included in the survival estimates. Logistic analyses of variation of the three broods' data are presented in Table 9. Figure 2 graphically presents the survival data from Table 8.

Table 8. Release-to-Roza smolt-to-adult survival (as a percentage) for Optimal Conventional Treated (OCT) and Semi-Natural Treated (SNT) Spring Chinook Released into the Upper Yakima

	1997 Brood		1998 Brood			1999 Brood		
Treatment	**Clark Flat**	**Easton**	**Clark Flat**	**Jack Creek**	**Easton**	**Clark Flat**	**Jack Creek**	**Easton**
OCT	1.40%	1.44%	1.20%	1.23%	0.88%	0.08%	0.05%	0.06%
STN	1.70%	1.43%	1.26%	0.77%	1.03%	0.05%	0.09%	0.03%

[6] It would not be possible to determine whether potential differences were due to survival or differential shedding.

Table 9. Weighted Logistic Analysis of Variation of Release-to-Roza Smolt-to-Adult Survival of OCT and SNT Spring Chinook Released into the Upper Yakima (weights are number released)

a. Brood-Year 1997 (Outmigration-Year 1999)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	0.90	1	0.900	0.93	0.4058	
Block within Site[2]	8.32	3	2.773	2.87	0.2049	
Treatment (OCT vs SNT)[2]	1.99	1	1.990	2.06	0.2468	0.1234
Site x Treatment[2]	1.53	1	1.530	1.58	0.2974	
Error(1)	2.90	3	0.967			
Site[3]	0.90	1	0.9	0.4813	0.5138	
Treatment[3]	1.99	1	1.99	1.0642	0.3420	**0.1710**
Site x Treatment[3]	1.53	1	1.53	0.8182	0.4006	
Error(2)[4]	11.22	6	1.87			

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

b. Brood-Year 1998 (Outmigration-Year 2000)

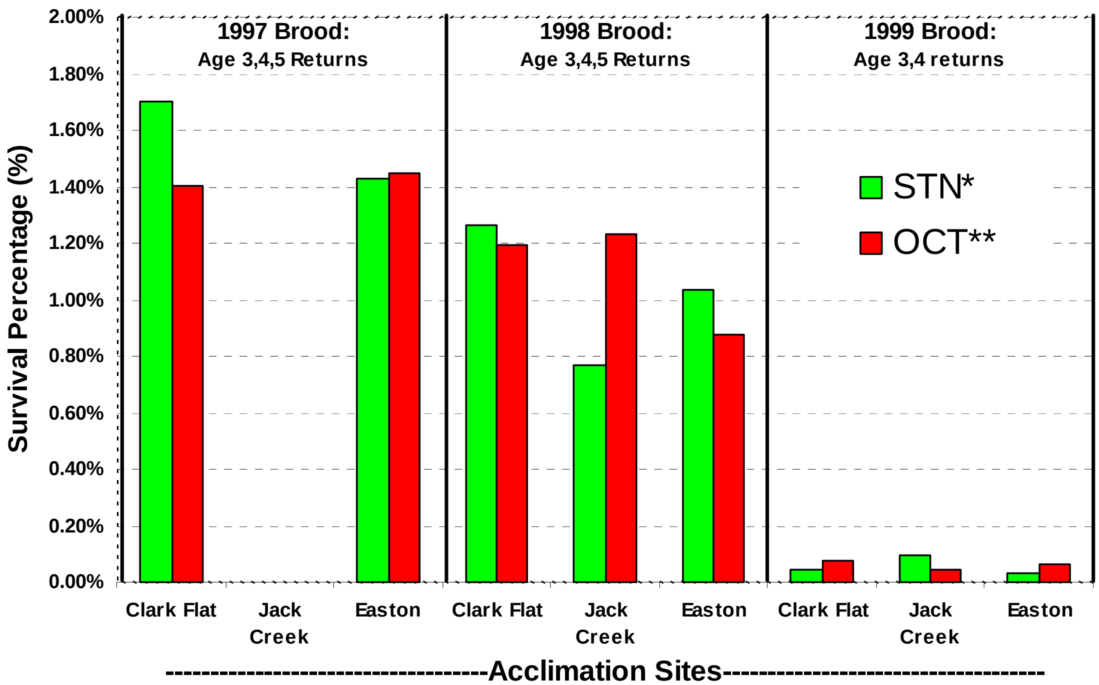
Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	6.00	2	3.000	4.02	0.0910	
Block within Site[2]	6.35	5	1.270	1.70	0.2867	
Treatment (OCT vs SNT)[2]	0.00	1	0.000	0.00	1.0000	0.5000
Site x Treatment[2]	4.92	2	2.460	3.30	0.1221	
Error(1)	3.73	5	0.746			
Site[3]	6.00	2	3	2.9762	0.0968	
Treatment[3]	0.00	1	0	0.0000	1.0000	**0.5000**
Site x Treatment[3]	4.92	2	2.46	2.4405	0.1370	
Error(2)[4]	10.08	10	1.008			

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block

c. Brood-Year 1999 (Outmigration-Year 2001)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P	1-sided p for SNT > OCT
Site (CF vs JC)[1]	0.63	2	0.315	0.14	0.8692	
Block within Site[2]	5.35	6	0.892	0.41	0.8513	
Treatment (OCT vs SNT)[2]	0.03	1	0.030	0.01	0.9107	0.4554
Site x Treatment[2]	2.19	2	1.095	0.50	0.6304	
Error(1)	13.17	6	2.195			
Site[3]	0.63	2	0.315	0.2041	0.8182	
Treatment[3]	0.03	1	0.03	0.0194	0.8914	**0.4457**
Site x Treatment[3]	2.19	2	1.095	0.7095	0.5114	
Error(2)[4]	18.52	12	1.54			

[1] Site is initially tested against Block
[2] Block, Treatment, Ineraction initially tested against Error(1)
NOTE: Weighted Treatment and Ineraction effects adjusted for weighted Site and Block effects
[3] Block, Treatment, Ineraction finally tested against Error(2)
[4] Error (2) is pooling of Error(1) and Block



***SNT-Semi-Natural Treatment, **OCT-Optimal Conventional Treatment**

Figure 2. Release-to-Roza smolt-to-adult survival for OCT and SNT Spring Chinook Released into the Upper Yakima (release/outmigration years 2 years following brood year)

There were no significant differences between the SNT and OCT smolt-to-adult survival estimates in any of the brood years, nor were there any significant treatment x site interactions. The brood-year-1999 age-3 and age-4 return numbers were extremely low, there being several raceways from which there were no PIT-tag returns Table 10 gives the PIT-tag returns per age group for each brood year along with the survivals for each acclimation pond.

Table 10. **Age of Adult Return to Roza Dam for Brood-Years 1997-2002 OCT-SNT Spring Chinook and Associated Survival Estimates**

Brood	Acclimation			Release	Adult Returns				Survival
Year	Site	Pond	Treatment	Number (Rel)	Age 3	Age 4	Age 5	Total (Ret)	Ret/Rel
1997	Clark	1	SNT	3947	5	53	0	58	0.014695
	Flat	2	OCT	3946	4	41	1	46	0.011657
		3	SNT	3985	5	70	0	75	0.018821
		4	OCT	3980	10	47	2	59	0.014824
		5	SNT	3986	9	59	2	70	0.017561
		6	OCT	3975	10	50	2	62	0.015597
	Easton	1	SNT	3975	11	58	1	70	0.017610
		2	OCT	3982	9	44	6	59	0.014817
		3	SNT	3949	2	40	1	43	0.010889
		4	OCT	3977	0	55	1	56	0.014081
1998	Clark	1	SNT	2358	3	27	1	31	0.013147
	Flat	2	OCT	2406	0	23	3	26	0.010806
		3	SNT	2412	5	23	2	30	0.012438
		4	OCT	2349	5	23	3	31	0.013197
		5	SNT	2426	7	22	1	30	0.012366
		6	OCT	2439	1	26	2	29	0.011890
	Easton	1	SNT	2427	3	11	1	15	0.006180
		2	OCT	2454	5	13	3	21	0.008557
		3	SNT	2436	7	19	4	30	0.012315
		4	OCT	2432	1	18	1	20	0.008224
		5	SNT	2398	1	27	2	30	0.012510
		6	OCT	2423	0	18	5	23	0.009492
	Jack	1	SNT	2414	5	15	2	22	0.009114
	Creek	2	OCT	2453	2	27	3	32	0.013045
		3	SNT	2279	3	10	1	14	0.006143
		4	OCT	1279	6	8	0	14	0.010946
1999	Clark	1	SNT	2158	0	2		2	0.000927
	Flat	2	OCT	2165	0	2		2	0.000924
		3	SNT	2149	0	1		1	0.000465
		4	OCT	2185	0	1		1	0.000458
		5	SNT	2147	0	0		0	0.000000
		6	OCT	2169	0	2		2	0.000922
	Easton	1	SNT	2159	0	0		0	0.000000
		2	OCT	2173	0	2		2	0.000920
		3	SNT	2164	0	2		2	0.000924
		4	OCT	2148	0	0		0	0.000000
		5	SNT	2132	0	0		0	0.000000
		6	OCT	2159	0	2		2	0.000926
	Jack	1	SNT	2148	1	4		5	0.002328
	Creek	2	OCT	2196	0	1		1	0.000455
		3	SNT	2115	0	0		0	0.000000
		4	OCT	2157	0	1		1	0.000464
		5	SNT	2147	0	1		1	0.000466
		6	OCT	2120	0	1		1	0.000472

Referring back to Figure 2, as was the case for the smolt-to-smolt survival indices, the first brood with the associated highest 1999-outmigration flows had the highest smolt-to-adult survival, and the third brood with the associated lowest 2001-outmigration flows had the lowest smolt-to-adult survival. However, the relative differences between the first and third brood years smolt-to-adult survivals is far more dramatic than those of the smolt-to-smolt survival indices. This can be seen by comparing Figures 1 and 2; it can also be seen by comparing the brood-year means for each site that the brood years had in common in Table 11.

The 1998 brood-year smolt-to-smolt survival indices ranged from 71% to 80% of those of the 1997 brood-year; the range for the smolt-to-adult survival was similar, from 66% to 79%. However, the two sets of ranges differed dramatically when comparing the 1999-brood-year/1997-brood-year survival ratios: 43% to 52% for smolt-to-smolt survival index and 3% to 4% for smolt-to-adult survival; this suggest that there was ten-fold increase in relative smolt-to-adult mortality when comparing the 1999 brood to the 1997 brood relative to the comparable brood-year 1999-to-1997 increase in smolt-to-smolt survival index. As Mark Johnston (fisheries biologist, Yakima Nation) pointed out (personal communication), since the ocean conditions for the 1999 brood were thought to be excellent, it is likely that the was high level of smolt mortality between McNary Dam and the ocean. Most of this high mortality was likely between McNary and Bonneville Dams since adult returns to Bonneville of other agencies hatchery fish released at Bonneville were high.

Table 11. Smolt-to-Smolt and Smolt-to-Adult Survival Estimates for Brood-Years 1997 through 1999 Hatchery Spring Chinook for Common Sites and associated 1998/1997 and 1999/1997 Brood-Year Survival Ratios

		Brood Year 1997		Brood Year 1998		Brood Year 1999	
		Clark Flats	Easton	Clark Flats	Easton	Clark Flats	Easton
Smolt-to-Smolt	**Survival Index**	49.00%	46.70%	39.19%	33.25%	25.25%	19.94%
	Brood-Year/Brood-Year-1999 Ratio (%)			**79.97%**	**71.20%**	**51.52%**	**42.70%**
Smolt-to-Adult	**Survival**	1.55%	1.44%	1.23%	0.95%	0.06%	0.05%
	Brood-Year/Brood-Year-1999 Ratio (%)			**79.18%**	**66.46%**	**3.97%**	**3.23%**

In last year's report it was mentioned that half of the smolt for one of Jack Creek's ponds for the 1998 brood were lost in the transfer to the acclimation pond, but that pond had almost the same number of adult returns as the other pond in the block pair, and, therefore, its survival estimate was highest of the two. It was pointed out in the report that the data set was incomplete; age 5 returns were not then available. They are now available, and the release and complete return numbers are given in Table 12 for each pond for brood-year 1998. Based on the complete enumeration, the total returns for that block's two pairs of ponds are identical (Block 8, Table 12) in spite of the large difference in the total smolt released. However, it should be pointed out that both of those ponds had the smallest number of returns of all ponds.

Table 12. Release and Return Numbers for Brood-Year-1998 Acclimation Ponds

Site	Block	Treatment	Release Number	Return Number	Survival Estimate
Clark Flat	1	SNT	2358	31	0.0131
	1	OCT	2406	26	0.0108
	2	SNT	2412	30	0.0124
	2	OCT	2349	31	0.0132
	3	SNT	2426	30	0.0124
	3	OCT	2439	29	0.0119
Easton	4	SNT	2427	15	0.0062
	4	OCT	2454	21	0.0086
	5	SNT	2436	30	0.0123
	5	OCT	2432	20	0.0082
	6	SNT	2398	30	0.0125
	6	OCT	2423	23	0.0095
Jack Creek	7	SNT	2414	22	0.0091
	7	OCT	2453	32	0.0130
	8	**SNT**	**2279**	**14**	**0.0061**
	8	**OCT**	**1279**	**14**	**0.0109**

Weighted logistic analyses of variation of release-to-McNary survival-index estimates were undertaken using release number as the weighting variable instead of a traditional least-squares-based analysis of variance[7]. Least squares analysis assumes that the variance of the estimates is constant over releases. In the case of survival-index proportions, this is not expected to be true; the variance is expected to be higher for survival-index proportions nearer 0.5 and lower as survival-index proportions approach 0 or 1. The assumption behind the logistic analysis of variation used is that the variance in the survival index is proportional to what would be expected in the case of a binomially distributed survival-index estimate. The number of PIT-tagged fish released varied over releases; variation in release number would also contribute to the variance of the survival-index estimate varying over releases. For this reason, the release number was used as a weighting variable. The number tagged adjusted for detected pre-release moralities was used as the release number for the 1997 brood; in subsequent years, fish detected volitionally exiting the raceways was used.

In the logistic analysis of variation, the comparison is effectively made among the estimated logit transforms of the survival index, the logit transform being

Equation A.1.

$$y = \text{logit}(s) = \text{natural log}\left(\frac{s}{1 - s}\right)$$

s being the estimated proportion surviving. The reverse transform, survival index as a function of the logit, is

Equation A.2.

$$s = \frac{1}{1 + \exp(-y)}$$

wherein exp(-y) is the exponential constant raised to the power given within the parentheses.

Smolt-to-smolt survival index**: The release-to-McNary smolt-to-smolt survival index in this study is estimated as follows:**

[7] Recommended reading on logistic regression: McCullagh, P. and Nelder, J.A. (1989) Generalized Linear Models (2nd edition), Chapman and Hall, London.

Equation A.3.

$$\text{Release - to - McNary Survival Index} = \frac{\sum_{\text{strata}} \text{For Stratum}\left[\dfrac{(\text{McNary Detections} - \text{Detections Removed})}{\text{Stratum's McNary Detection Efficiency}} + \text{Detections Removed}\right]}{\text{Number of PIT - Tagged Fish Released}}$$

wherein

1) **"Stratum" is a group of contiguous McNary detection dates among which the daily detection efficiencies[8] were sufficiently homogeneous to permit the use of a pooled estimate of the detection efficiency for that stratum;**

2) **"McNary Detections" is the release's fish detected at McNary during the stratum;**

3) **"Detections Removed" is the number of the stratum's "McNary Detections" that were removed for transportation or for sampling and not returned to the river (Fish detected at McNary's Raceways A and B not subsequently detected at McNary); and**

4) **"Detection Efficiency" is the estimated proportion of all[9] those Yakima PIT-tagged Spring Chinook passing McNary Dam during the stratum that were detected at McNary (Equation A.4).**

Equation A.4.

$$\text{McNary detection efficiency} = \frac{\text{number of joint detections at McNary and downstream dam}}{\text{estimated total number of detections at downstream dam}}$$

The downstream-dam counts actually represents a pooling of counts from John Day and Bonneville dams[10]. The method of estimating the detection efficiency and the pooling procedure are discussed in

[8] The daily McNary detection efficiency is the proportion of PIT-tagged fish passing McNary that are actually detected at McNary. It is the total number of fish jointly detected at McNary on the McNary date and that are also detected at downstream dams (John Day and Bonneville) divided by the total detected at the downstream dams that are estimated to have passed McNary on that date.

[9] All PIT-tagged Spring Chinook releases into the Yakima, upper Yakima, and Naches, not only the OCT-SNT fish tagged prior to release.

[10] In recent years experiments were conducted at John Day and Bonneville that varied the proportion of flow spilled in the daytime relative to the proportion spilled at night. To offset the electric power lost at one dam during a given period, contravening action was often taken at the other dam (Personal

Appendix B. A major reason for referring to the survival measure as a survival index instead of survival is that there are known biases associated with the detection rate and which are discussed in Appendix B.

Table A. gives the values of the variables presented in Equation A.3 for each acclimation pond along with the resulting survival-index estimates; these estimates form the data-base summary used for the analyses, survival-index estimates, and the figure presented in Section 2.

Communication, Rock Peters, U.S. Army Corps of Engineers, Portland, Oregon.) Given this situation, it was deemed more appropriate to pool John Day and Bonneville Dam-based estimates of the McNary detection rate. This means that some of the fish detected at both John Day and Bonneville dams were used twice to estimate the McNary detection efficiency (an effective "sampling with replacement").

Table A. Stratum Detection Numbers and Detection Efficiencies and Resulting Survival Indices for Each Acclimation Pond

1. Brood-year 1997 (Outmigration-year 1999)

a. Clark Flat (C.F.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	C.F. 1 SNT	C.F. 2 OCT	C.F. 3 SNT	C.F. 4 OCT	C.F. 5 SNT	C.F. 6 OCT
Sratum	1	Total (T)	2	0	4	0	0	1
First Date	4/21/99	Removed (R)	0	0	0	0	0	0
Last Date	4/26/99	T-R	2	0	4	0	0	1
Detection Efficiency	0.2502	Expanded	8.0	0.0	16.0	0.0	0.0	4.0
Sratum	2	Total (T)	32	29	32	19	24	25
First Date	4/27/99	Removed (R)	0	0	0	0	0	0
Last Date	5/4/99	T-R	32	29	32	19	24	25
Detection Efficiency	0.3434	Expanded	93.2	84.5	93.2	55.3	69.9	72.8
Sratum	3	Total (T)	68	59	48	43	67	60
First Date	5/5/99	Removed (R)	0	0	0	0	0	0
Last Date	5/9/99	T-R	68	59	48	43	67	60
Detection Efficiency	0.4306	Expanded	157.9	137.0	111.5	99.9	155.6	139.4
Sratum	4	Total (T)	152	118	105	87	121	75
First Date	5/10/99	Removed (R)	2	1	2	0	0	0
Last Date	5/16/99	T-R	150	117	103	87	121	75
Detection Efficiency	0.3884	Expanded	388.2	302.2	267.2	224.0	311.5	193.1
Sratum	5	Total (T)	218	150	153	94	167	159
First Date	5/17/99	Removed (R)	0	0	0	0	0	0
Last Date	5/25/99	T-R	218	150	153	94	167	159
Detection Efficiency	0.3029	Expanded	719.8	495.3	505.2	310.4	551.4	525.0
Sratum	6	Total (T)	17	19	16	20	15	25
First Date	5/26/99	Removed (R)	0	0	0	0	0	0
Last Date	5/26/99	T-R	17	19	16	20	15	25
Detection Efficiency	0.2325	Expanded	73.1	81.7	68.8	86.0	64.5	107.5
Sratum	7	Total (T)	114	123	137	191	115	145
First Date	5/27/99	Removed (R)	0	0	0	0	0	0
Last Date	6/14/99	T-R	114	123	137	191	115	145
Detection Efficiency	0.1758	Expanded	648.3	699.5	779.1	1086.2	654.0	824.6
Sratum	8	Total (T)	2	6	6	18	6	6
First Date	6/15/99	Removed (R)	0	0	0	0	0	0
Last Date	7/11/99	T-R	2	6	6	18	6	6
Detection Efficiency	0.0932	Expanded	21.5	64.4	64.4	193.2	64.4	64.4
		Total (T)	605	504	501	472	515	496
		Removed (R)	2	1	2	0	0	0
		T-R	603	503	499	472	515	496
		Expanded	2110.0	1864.6	1905.3	2055.0	1871.3	1930.7
		Tagged adjusted for mortalities	3975	3981	3998	3997	4001	4000
		Survival Index	**0.5308**	**0.4684**	**0.4766**	**0.5141**	**0.4677**	**0.4827**

Table A.1. Brood-year 1997 (Outmigration-year 1999) (continued)

b. Easton (East.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	East. 1 SNT	East. 2 OCT	East. 3 SNT	East. 4 OCT
Sratum	1	Total (T)	1	3	1	0
First Date	4/21/99	Removed (R)	0	0	0	0
Last Date	4/26/99	T-R	1	3	1	0
Detection Efficiency	0.2502	Expanded	4.0	12.0	4.0	0.0
Sratum	1	Total (T)	20	16	12	19
First Date	4/27/99	Removed (R)	0	0	0	0
Last Date	5/4/99	T-R	20	16	12	19
Detection Efficiency	0.3434	Expanded	58.2	46.6	34.9	55.3
Sratum	1	Total (T)	47	25	18	29
First Date	5/5/99	Removed (R)	0	0	0	0
Last Date	5/9/99	T-R	47	25	18	29
Detection Efficiency	0.4306	Expanded	109.2	58.1	41.8	67.4
Sratum	1	Total (T)	70	49	31	48
First Date	5/10/99	Removed (R)	0	0	0	0
Last Date	5/16/99	T-R	70	49	31	48
Detection Efficiency	0.3884	Expanded	180.2	126.2	79.8	123.6
Sratum	1	Total (T)	144	126	87	103
First Date	5/17/99	Removed (R)	0	0	0	0
Last Date	5/25/99	T-R	144	126	87	103
Detection Efficiency	0.3029	Expanded	475.5	416.0	287.3	340.1
Sratum	1	Total (T)	24	15	23	18
First Date	5/26/99	Removed (R)	0	0	0	0
Last Date	5/26/99	T-R	24	15	23	18
Detection Efficiency	0.2325	Expanded	103.2	64.5	98.9	77.4
Sratum	1	Total (T)	154	196	198	163
First Date	5/27/99	Removed (R)	0	0	0	0
Last Date	6/14/99	T-R	154	196	198	163
Detection Efficiency	0.1758	Expanded	875.8	1114.6	1126.0	926.9
Sratum	1	Total (T)	12	13	15	10
First Date	6/15/99	Removed (R)	0	0	0	0
Last Date	7/11/99	T-R	12	13	15	10
Detection Efficiency	0.0932	Expanded	128.8	139.5	161.0	107.3
		Total (T)	472	443	385	390
		Removed (R)	0	0	0	0
		T-R	472	443	385	390
		Expanded	1934.9	1977.5	1833.7	1698.0
		Tagged adjusted for mortalities	3986	3989	3975	3990
		Survival Index	**0.4854**	**0.4957**	**0.4613**	**0.4256**

Table A. (continued)

2. Brood-year 1998 (Outmigration-year 2000)

a. Clark Flat (C.F.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	C.F. 1 SNT	C.F. 2 OCT	C.F. 3 SNT	C.F. 4 OCT	C.F. 5 SNT	C.F. 6 OCT
Sratum	1	Total (T)	1	1	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0
Last Date	4/14/00	T-R	1	1	0	0	0	0
Detection Efficiency	0.4191	Expanded	2.4	2.4	0.0	0.0	0.0	0.0
Sratum	2	Total (T)	110	64	92	39	107	82
First Date	4/15/00	Removed (R)	0	0	1	1	0	1
Last Date	5/16/00	T-R	110	64	91	38	107	81
Detection Efficiency	0.3123	Expanded	352.2	204.9	292.4	122.7	342.6	260.4
Sratum	3	Total (T)	9	5	12	2	9	5
First Date	5/17/00	Removed (R)	0	0	0	0	0	0
Last Date	5/19/00	T-R	9	5	12	2	9	5
Detection Efficiency	0.2734	Expanded	32.9	18.3	43.9	7.3	32.9	18.3
Sratum	4	Total (T)	22	24	23	24	23	19
First Date	5/20/00	Removed (R)	0	0	0	0	0	0
Last Date	5/25/00	T-R	22	24	23	24	23	19
Detection Efficiency	0.2234	Expanded	98.5	107.5	103.0	107.5	103.0	85.1
Sratum	5	Total (T)	24	19	36	11	12	22
First Date	5/26/00	Removed (R)	0	0	0	0	0	0
Last Date	5/27/00	T-R	24	19	36	11	12	22
Detection Efficiency	0.2645	Expanded	90.7	71.8	136.1	41.6	45.4	83.2
Sratum	6	Total (T)	53	36	54	36	34	63
First Date	5/28/00	Removed (R)	0	0	0	0	0	0
Last Date	5/31/00	T-R	53	36	54	36	34	63
Detection Efficiency	0.3372	Expanded	157.2	106.8	160.2	106.8	100.8	186.9
Sratum	7	Total (T)	58	105	56	164	83	65
First Date	6/1/00	Removed (R)	2	5	1	4	9	1
Last Date	6/18/00	T-R	56	100	55	160	74	64
Detection Efficiency	0.2556	Expanded	221.1	396.3	216.2	630.1	298.6	251.4
		Total (T)	277	254	273	276	268	256
		Removed (R)	2	5	2	5	9	2
		T-R	275	249	271	271	259	254
		Expanded	955.1	907.9	951.7	1015.9	923.3	885.2
		Volitional Release Number	2358	2406	2412	2349	2426	2439
		Survival Index	**0.4050**	**0.3774**	**0.3946**	**0.4325**	**0.3806**	**0.3629**

Table A.2. Brood-year 1998 (Outmigration-year 2000) (continued)

b. Easton (East.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	Easton Acclimation Pond East. 1 SNT	East. 2 OCT	East. 3 SNT	East. 4 OCT	East. 5 SNT	East. 6 OCT
Sratum	1	Total (T)	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	0	0
Detection Efficiency	0.4191	Expanded	0.0	0.0	0.0	0.0	0.0	0.0
Sratum	2	Total (T)	77	92	110	52	191	62
First Date	4/15/00	Removed (R)	2	0	0	0	1	0
Last Date	5/16/00	T-R	75	92	110	52	190	62
Detection Efficiency	0.3123	Expanded	242.1	294.6	352.2	166.5	609.4	198.5
Sratum	3	Total (T)	8	11	12	7	9	6
First Date	5/17/00	Removed (R)	0	0	0	0	0	0
Last Date	5/19/00	T-R	8	11	12	7	9	6
Detection Efficiency	0.2734	Expanded	29.3	40.2	43.9	25.6	32.9	21.9
Sratum	4	Total (T)	18	9	22	17	16	28
First Date	5/20/00	Removed (R)	0	0	0	0	0	0
Last Date	5/25/00	T-R	18	9	22	17	16	28
Detection Efficiency	0.2234	Expanded	80.6	40.3	98.5	76.1	71.6	125.4
Sratum	5	Total (T)	5	4	12	13	7	10
First Date	5/26/00	Removed (R)	0	0	0	0	0	0
Last Date	5/27/00	T-R	5	4	12	13	7	10
Detection Efficiency	0.2645	Expanded	18.9	15.1	45.4	49.2	26.5	37.8
Sratum	6	Total (T)	13	11	20	24	13	16
First Date	5/28/00	Removed (R)	0	0	0	0	0	0
Last Date	5/31/00	T-R	13	11	20	24	13	16
Detection Efficiency	0.3372	Expanded	38.6	32.6	59.3	71.2	38.6	47.5
Sratum	7	Total (T)	82	95	69	120	15	85
First Date	6/1/00	Removed (R)	0	1	0	1	1	0
Last Date	6/18/00	T-R	82	94	69	119	14	85
Detection Efficiency	0.2556	Expanded	320.9	368.8	270.0	466.6	55.8	332.6
		Total (T)	203	222	245	233	251	207
		Removed (R)	2	1	0	1	2	0
		T-R	201	221	245	232	249	207
		Expanded	730.3	791.7	869.3	855.2	834.7	763.7
		Volitional Release Number	2427	2454	2436	2432	2398	2423
		Survival Index	**0.3009**	**0.3226**	**0.3568**	**0.3516**	**0.3481**	**0.3152**

Table A.2. Brood-year 1998 (Outmigration-year 2000) (continued)

c. Jack Creek (J.C.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	J.C. 1 SNT	J.C. 2 OCT	J.C. 3 SNT	J.C. 4 OCT
Sratum	1	Total (T)	0	0	0	1
First Date	4/6/00	Removed (R)	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	1
Detection Efficiency	0.4191	Expanded	0.0	0.0	0.0	2.4
Sratum	1	Total (T)	72	43	25	35
First Date	4/15/00	Removed (R)	0	0	1	0
Last Date	5/16/00	T-R	72	43	24	35
Detection Efficiency	0.3123	Expanded	230.5	137.7	77.8	112.1
Sratum	1	Total (T)	12	11	1	2
First Date	5/17/00	Removed (R)	0	0	0	0
Last Date	5/19/00	T-R	12	11	1	2
Detection Efficiency	0.2734	Expanded	43.9	40.2	3.7	7.3
Sratum	1	Total (T)	23	34	7	7
First Date	5/20/00	Removed (R)	0	0	0	0
Last Date	5/25/00	T-R	23	34	7	7
Detection Efficiency	0.2234	Expanded	103.0	152.2	31.3	31.3
Sratum	1	Total (T)	22	12	3	7
First Date	5/26/00	Removed (R)	0	0	0	0
Last Date	5/27/00	T-R	22	12	3	7
Detection Efficiency	0.2645	Expanded	83.2	45.4	11.3	26.5
Sratum	1	Total (T)	41	52	16	24
First Date	5/28/00	Removed (R)	0	0	0	0
Last Date	5/31/00	T-R	41	52	16	24
Detection Efficiency	0.3372	Expanded	121.6	154.2	47.5	71.2
Sratum	1	Total (T)	75	115	156	35
First Date	6/1/00	Removed (R)	3	7	3	2
Last Date	6/18/00	T-R	72	108	153	33
Detection Efficiency	0.2556	Expanded	284.7	429.6	601.7	131.1
		Total (T)	245	267	208	111
		Removed (R)	3	7	4	2
		T-R	242	260	204	109
		Expanded	866.9	959.3	773.3	381.9
		Volitional Release Number	2414	2453	2279	1279
		Survival Index	**0.3591**	**0.3911**	**0.3393**	**0.2986**

Table A. (continued)

3. Brood-year 1999 (Outmigration-year 2001)

a. Clark Flat (C.F.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	C.F. 1 SNT	C.F. 2 OCT	C.F. 3 SNT	C.F. 4 OCT	C.F. 5 SNT	C.F. 6 OCT
No Stratification		Total (T)	417	403	471	425	432	382
First Date	4/8/01	Removed (R)	2	5	4	2	3	3
Last Date	6/21/01	T-R	415	398	467	423	429	379
Detection Efficiency	0.7711	Expanded	540.2	521.1	609.6	550.5	559.3	494.5
		Volitional Release Number	2158	2165	2149	2185	2147	2169
		Survival Index	**0.2503**	**0.2407**	**0.2837**	**0.2520**	**0.2605**	**0.2280**

b. Easton (East.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	East. 1 SNT	East. 2 OCT	East. 3 SNT	East. 4 OCT	East. 5 SNT	East. 6 OCT
No Stratification		Total (T)	370	392	349	288	313	283
First Date	4/8/01	Removed (R)	7	3	7	4	0	4
Last Date	6/21/01	T-R	363	389	342	284	313	279
Detection Efficiency	0.7711	Expanded	477.732007	507.448349	450.499577	372.286198	405.892887	365.802286
		Volitional Release Number	2159	2173	2164	2148	2132	2159
		Survival Index	**0.2213**	**0.2335**	**0.2082**	**0.1733**	**0.1904**	**0.1694**

c. Jack Creek (J.C.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	J.C. 1 SNT	J.C. 2 OCT	J.C. 3 SNT	J.C. 4 OCT	J.C. 5 SNT	J.C. 6 OCT
No Stratification		Total (T)	337	308	318	334	323	319
First Date	4/8/01	Removed (R)	2	9	5	3	4	5
Last Date	6/21/01	T-R	335	299	313	331	319	314
Detection Efficiency	0.7711	Expanded	436.4221	396.737934	410.892887	432.23497	417.673582	412.18967
		Volitional Release Number	2148	2196	2115	2157	2147	2120
		Survival Index	**0.2032**	**0.1807**	**0.1943**	**0.2004**	**0.1945**	**0.1944**

Table A. (continued)

Table A.4 Brood-year 2000 (Outmigration-year 2002)

a. Clark Flat (C.F.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	C.F. 1 SNT	C.F. 2 OCT	C.F. 3 SNT	C.F. 4 OCT	C.F. 5 SNT	C.F. 6 OCT
Sratum	1	Total (T)	4	26	29	27	55	63
First Date	4/4/02	Removed (R)	0	0	0	1	0	0
Last Date	4/21/02	T-R	4	26	29	26	55	63
Detection Efficiency	0.3326	Expanded	12.0	78.2	87.2	79.2	165.4	189.4
Sratum	2	Total (T)	0	17	26	22	26	33
First Date	4/22/02	Removed (R)	0	0	0	0	0	1
Last Date	4/29/02	T-R	0	17	26	22	26	32
Detection Efficiency	0.4004	Expanded	0.0	42.5	64.9	54.9	64.9	80.9
Sratum	3	Total (T)	1	24	20	27	29	24
First Date	4/30/02	Removed (R)	0	0	0	1	0	0
Last Date	5/1/02	T-R	1	24	20	26	29	24
Detection Efficiency	0.4589	Expanded	2.2	52.3	43.6	57.7	63.2	52.3
Sratum	4	Total (T)	3	23	25	33	29	38
First Date	5/2/02	Removed (R)	0	0	0	0	2	1
Last Date	5/2/02	T-R	3	23	25	33	27	37
Detection Efficiency	0.3349	Expanded	9.0	68.7	74.6	98.5	82.6	111.5
Sratum	5	Total (T)	12	96	105	183	149	176
First Date	5/3/02	Removed (R)	0	3	3	3	3	5
Last Date	5/5/02	T-R	12	93	102	180	146	171
Detection Efficiency	0.5792	Expanded	20.7	163.6	179.1	313.8	255.1	300.2
Sratum	6	Total (T)	6	22	26	65	39	51
First Date	5/6/02	Removed (R)	0	0	1	1	1	0
Last Date	5/6/02	T-R	6	22	25	64	38	51
Detection Efficiency	0.5427	Expanded	11.1	40.5	47.1	118.9	71.0	94.0
Sratum	7	Total (T)	3	32	43	64	51	68
First Date	5/7/02	Removed (R)	1	0	2	1	2	3
Last Date	5/8/02	T-R	2	32	41	63	49	65
Detection Efficiency	0.4958	Expanded	5.0	64.5	84.7	128.1	100.8	134.1
Sratum	8	Total (T)	3	9	19	35	30	27
First Date	5/9/02	Removed (R)	0	2	1	2	2	2
Last Date	5/14/02	T-R	3	7	18	33	28	25
Detection Efficiency	0.4431	Expanded	6.8	17.8	41.6	76.5	65.2	58.4
Sratum	9	Total (T)	3	15	21	18	41	23
First Date	5/15/02	Removed (R)	0	1	1	4	2	0
Last Date	5/24/02	T-R	3	14	20	14	39	23
Detection Efficiency	0.3871	Expanded	7.7	37.2	52.7	40.2	102.7	59.4
Sratum	10	Total (T)	1	3	1	3	5	7
First Date	5/25/02	Removed (R)	0	1	1	0	2	0
Last Date	5/27/02	T-R	1	2	0	3	3	7
Detection Efficiency	0.4415	Expanded	2.3	5.5	1.0	6.8	8.8	15.9
Sratum	11	Total (T)	0	0	1	3	9	8
First Date	5/28/02	Removed (R)	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	1	3	9	8
Detection Efficiency	0.2391	Expanded	0.0	0.0	4.2	12.5	37.6	33.5
		Total (T)	36	267	316	480	463	518
		Removed (R)	1	7	9	13	14	12
		T-R	35	260	307	467	449	506
		Expanded	76.8	570.7	680.7	987.0	1017.4	1129.6
		Volitional Release Number	1618	1953	2094	2186	2146	2201
		Survival Index	**0.0474**	**0.2922**	**0.3251**	**0.4515**	**0.4741**	**0.5132**

Table A.4 Brood-year 2000 (Outmigration-year 2002) (continued)

b. Easton (East.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	East. 1 SNT	East. 2 OCT	East. 3 SNT	East. 4 OCT	East. 5 SNT	East. 6 OCT
Sratum	1	Total (T)	36	44	19	30	7	22
First Date	4/4/02	Removed (R)	1	0	0	0	0	0
Last Date	4/21/02	T-R	35	44	19	30	7	22
Detection Efficiency	0.3326	Expanded	106.2	132.3	57.1	90.2	21.0	66.2
Sratum	2	Total (T)	14	16	8	16	3	17
First Date	4/22/02	Removed (R)	0	0	0	0	0	0
Last Date	4/29/02	T-R	14	16	8	16	3	17
Detection Efficiency	0.4004	Expanded	35.0	40.0	20.0	40.0	7.5	42.5
Sratum	3	Total (T)	16	20	8	12	4	14
First Date	4/30/02	Removed (R)	0	1	0	0	0	0
Last Date	5/1/02	T-R	16	19	8	12	4	14
Detection Efficiency	0.4589	Expanded	34.9	42.4	17.4	26.1	8.7	30.5
Sratum	4	Total (T)	23	20	4	22	5	18
First Date	5/2/02	Removed (R)	0	0	0	0	0	0
Last Date	5/2/02	T-R	23	20	4	22	5	18
Detection Efficiency	0.3349	Expanded	68.7	59.7	11.9	65.7	14.9	53.7
Sratum	5	Total (T)	89	86	32	74	6	75
First Date	5/3/02	Removed (R)	3	3	0	0	1	4
Last Date	5/5/02	T-R	86	83	32	74	5	71
Detection Efficiency	0.5792	Expanded	151.5	146.3	55.2	127.8	9.6	126.6
Sratum	6	Total (T)	28	41	18	25	4	31
First Date	5/6/02	Removed (R)	2	3	0	2	0	0
Last Date	5/6/02	T-R	26	38	18	23	4	31
Detection Efficiency	0.5427	Expanded	49.9	73.0	33.2	44.4	7.4	57.1
Sratum	7	Total (T)	23	30	12	43	5	43
First Date	5/7/02	Removed (R)	0	1	0	1	1	1
Last Date	5/8/02	T-R	23	29	12	42	4	42
Detection Efficiency	0.4958	Expanded	46.4	59.5	24.2	85.7	9.1	85.7
Sratum	8	Total (T)	20	32	12	21	6	17
First Date	5/9/02	Removed (R)	1	1	1	1	0	0
Last Date	5/14/02	T-R	19	31	11	20	6	17
Detection Efficiency	0.4431	Expanded	43.9	71.0	25.8	46.1	13.5	38.4
Sratum	9	Total (T)	51	49	17	31	6	51
First Date	5/15/02	Removed (R)	1	4	0	2	0	2
Last Date	5/24/02	T-R	50	45	17	29	6	49
Detection Efficiency	0.3871	Expanded	130.2	120.2	43.9	76.9	15.5	128.6
Sratum	10	Total (T)	7	7	0	3	2	12
First Date	5/25/02	Removed (R)	0	1	0	1	0	0
Last Date	5/27/02	T-R	7	6	0	2	2	12
Detection Efficiency	0.4415	Expanded	15.9	14.6	0.0	5.5	4.5	27.2
Sratum	11	Total (T)	9	8	1	4	0	10
First Date	5/28/02	Removed (R)	0	0	0	0	0	0
Last Date	7/1/02	T-R	9	8	1	4	0	10
Detection Efficiency	0.2391	Expanded	37.6	33.5	4.2	16.7	0.0	41.8
		Total (T)	316	353	131	281	48	310
		Removed (R)	8	14	1	7	2	7
		T-R	308	339	130	274	46	303
		Expanded	720.0	792.4	293.0	625.2	111.8	698.2
		Volitional Release Number	2161	2185	2026	2160	1737	2167
		Survival Index	**0.3332**	**0.3627**	**0.1446**	**0.2894**	**0.0644**	**0.3222**

Table A.4 Brood-year 2000 (Outmigration-year 2002) (continued)

c. Jack Creek (J.C.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	J.C. 1 SNT	J.C. 2 OCT	J.C. 3 SNT	J.C. 4 OCT	J.C. 5 SNT	J.C. 6 OCT
Sratum	1	Total (T)	16	22	34	39	6	27
First Date	4/4/02	Removed (R)	0	0	1	0	0	0
Last Date	4/21/02	T-R	16	22	33	39	6	27
Detection Efficiency	0.3326	Expanded	48.1	66.2	100.2	117.3	18.0	81.2
Sratum	2	Total (T)	14	11	17	25	9	15
First Date	4/22/02	Removed (R)	0	0	0	0	0	0
Last Date	4/29/02	T-R	14	11	17	25	9	15
Detection Efficiency	0.4004	Expanded	35.0	27.5	42.5	62.4	22.5	37.5
Sratum	3	Total (T)	12	10	21	20	4	10
First Date	4/30/02	Removed (R)	0	1	0	0	0	0
Last Date	5/1/02	T-R	12	9	21	20	4	10
Detection Efficiency	0.4589	Expanded	26.1	20.6	45.8	43.6	8.7	21.8
Sratum	4	Total (T)	18	13	20	27	8	18
First Date	5/2/02	Removed (R)	0	0	0	0	0	0
Last Date	5/2/02	T-R	18	13	20	27	8	18
Detection Efficiency	0.3349	Expanded	53.7	38.8	59.7	80.6	23.9	53.7
Sratum	5	Total (T)	93	55	98	109	59	94
First Date	5/3/02	Removed (R)	3	0	3	0	3	2
Last Date	5/5/02	T-R	90	55	95	109	56	92
Detection Efficiency	0.5792	Expanded	158.4	95.0	167.0	188.2	99.7	160.8
Sratum	6	Total (T)	31	30	41	41	27	41
First Date	5/6/02	Removed (R)	0	2	2	0	1	1
Last Date	5/6/02	T-R	31	28	39	41	26	40
Detection Efficiency	0.5427	Expanded	57.1	53.6	73.9	75.6	48.9	74.7
Sratum	7	Total (T)	48	29	60	60	33	45
First Date	5/7/02	Removed (R)	1	1	2	2	4	0
Last Date	5/8/02	T-R	47	28	58	58	29	45
Detection Efficiency	0.4958	Expanded	95.8	57.5	119.0	119.0	62.5	90.8
Sratum	8	Total (T)	26	32	31	48	29	34
First Date	5/9/02	Removed (R)	0	1	1	0	1	2
Last Date	5/14/02	T-R	26	31	30	48	28	32
Detection Efficiency	0.4431	Expanded	58.7	71.0	68.7	108.3	64.2	74.2
Sratum	9	Total (T)	43	62	43	45	33	46
First Date	5/15/02	Removed (R)	2	3	5	6	4	5
Last Date	5/24/02	T-R	41	59	38	39	29	41
Detection Efficiency	0.3871	Expanded	107.9	155.4	103.2	106.7	78.9	110.9
Sratum	10	Total (T)	7	11	4	8	4	9
First Date	5/25/02	Removed (R)	0	1	1	0	0	2
Last Date	5/27/02	T-R	7	10	3	8	4	7
Detection Efficiency	0.4415	Expanded	15.9	23.6	7.8	18.1	9.1	17.9
Sratum	11	Total (T)	6	14	3	13	6	11
First Date	5/28/02	Removed (R)	0	0	0	1	1	0
Last Date	7/1/02	T-R	6	14	3	12	5	11
Detection Efficiency	0.2391	Expanded	25.1	58.6	12.5	51.2	21.9	46.0
		Total (T)	314	289	372	435	218	350
		Removed (R)	6	9	15	9	14	12
		T-R	308	280	357	426	204	338
		Expanded	681.8	667.6	800.2	971.0	458.3	769.5
		Volitional Release Number	2179	2137	2185	2182	2102	2161
		Survival Index	**0.3129**	**0.3124**	**0.3662**	**0.4450**	**0.2180**	**0.3561**

Table A. (continued)

5. Brood-year 2001 (Outmigration-year 2003)

a. Clark Flat (C.F.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	C.F. 1 SNT	C.F. 2 OCT
Sratum	1	Total (T)	74	177
First Date	4/5/03	Removed (R)	2	2
Last Date	4/15/03	T-R	72	175
Detection Efficiency	0.5145	Expanded	141.9	342.104201
Sratum	2	Total (T)	97	137
First Date	4/28/03	Removed (R)	3	4
Last Date	5/2/03	T-R	94	133
Detection Efficiency	0.5187	Expanded	184.2	260.411032
Sratum	3	Total (T)	81	106
First Date	5/3/03	Removed (R)	2	5
Last Date	5/10/03	T-R	79	101
Detection Efficiency	0.4876	Expanded	164.0	212.147219
Sratum	4	Total (T)	37	23
First Date	5/11/03	Removed (R)	1	0
Last Date	5/19/03	T-R	36	23
Detection Efficiency	0.3908	Expanded	93.1	58.8583895
Sratum	5	Total (T)	30	19
First Date	5/26/03	Removed (R)	1	2
Last Date	5/31/03	T-R	29	17
Detection Efficiency	0.3424	Expanded	85.7	51.6565374
Sratum	6	Total (T)	3	0
First Date	6/1/03	Removed (R)	0	0
Last Date	6/17/03	T-R	3	0
Detection Efficiency	0.4316	Expanded	7.0	0
		Total (T)	322	462
		Removed (R)	9	13
		T-R	313	449
		Expanded	676.0	925.2
		Volitional Release Number	3372	3559
		Survival Index	**0.2005**	**0.2600**

Table A.5. Brood-year 2001 (Outmigration-year 2003) (continued)

b. Jack Creek (J.C.) Acclimation Ponds

Detection Efficiency Strata		McNary Detections	J.C. 1 SNT	J.C. 2 OCT	J.C. 3 SNT	J.C. 4 OCT	J.C. 5 SNT	J.C. 6 OCT
Sratum	1	Total (T)	182	54	195	57	114	178
First Date	4/5/03	Removed (R)	5	0	4	1	1	2
Last Date	4/15/03	T-R	177	54	191	56	113	176
Detection Efficiency	0.5145	Expanded	348.991106	104.946439	375.199442	109.833344	220.610141	344.047653
Sratum	2	Total (T)	228	74	223	97	218	227
First Date	4/28/03	Removed (R)	6	2	6	4	3	8
Last Date	5/2/03	T-R	222	72	217	93	215	219
Detection Efficiency	0.5187	Expanded	433.994355	140.80898	424.354842	183.294932	417.499037	430.210647
Sratum	3	Total (T)	157	83	146	85	195	151
First Date	5/3/03	Removed (R)	4	0	5	3	7	6
Last Date	5/10/03	T-R	153	83	141	82	188	145
Detection Efficiency	0.4876	Expanded	317.797273	170.229893	294.185722	171.17893	392.580963	303.389572
Sratum	4	Total (T)	29	34	16	31	48	34
First Date	5/11/03	Removed (R)	0	0	0	0	1	2
Last Date	5/19/03	T-R	29	34	16	31	47	32
Detection Efficiency	0.3908	Expanded	74.212752	87.0080541	40.9449666	79.3308728	121.275839	83.8899333
Sratum	5	Total (T)	9	164	29	145	31	40
First Date	5/26/03	Removed (R)	0	5	1	4	0	0
Last Date	5/31/03	T-R	9	159	28	141	31	40
Detection Efficiency	0.3424	Expanded	26.2887551	469.434673	82.787238	415.857163	90.5501564	116.838911
Sratum	6	Total (T)	6	43	10	50	15	16
First Date	6/1/03	Removed (R)	0	1	0	0	1	0
Last Date	6/17/03	T-R	6	42	10	50	14	16
Detection Efficiency	0.4316	Expanded	13.9021273	98.314891	23.1702121	115.851061	33.438297	37.0723394
		Total (T)	611	452	619	465	621	646
		Removed (R)	15	8	16	12	13	18
		T-R	596	444	603	453	608	628
		Expanded	1215.2	1070.74293	1240.64242	1075.3463	1275.95443	1315.44906
		Volitional Release Number	3837	3887	3863	3830	3855	3884
		Survival Index	**0.3167**	**0.2755**	**0.3212**	**0.2808**	**0.3310**	**0.3387**

Smolt-to-Adult Survival**: Weighted logistic analyses of variation were also used to analyze the release-to-Roza adult return survival estimates; the weighting variable being the same release numbers used for smolt-to-smolt survival.**

An individual pond estimate was simply the number of the pond's PIT-tagged fish detected as adult returns at Roza divided by the number released from the pond.

Appendix B. Detection Efficiency Estimation

B.1. Conceptual Computation

The methods used were similar to those developed by Sandford and Smith[11]. The steps are given below.

Step 1. For each downstream dam, joint McNary and downstream detections were cross-tabulated by McNary Dam's first date and downstream-dams' first date of detection [Table B.1.a)].

Step 2. Within each downstream dam's detection date, the relative distribution of joint counts over McNary detection dates was estimated [Table B.1.b)].

Step 3. The resulting relative distribution frequencies from Table B.1.b) were then multiplied by the total downstream dam's detections (whether or not previously detected at McNary) for the given downstream date to obtain estimates of the cross-tab number for the downstream dam's total detections [Table B.1.c)].

Step 4. There were cases where there were downstream detections for a given date but there were no joint downstream and McNary detections for that downstream date. In such cases there was no direct way of allocating the downstream detections to a given McNary date. What was done was to obtain a pseudo-distribution for McNary detection dates by offsetting the six previous downstream dates' and the six following downstream-dates' McNary-date distributions, and applying their pooled offset distributions to the downstream-dam detection date having no joint McNary distribution. (This step probably differs from Smith and Sanford's, their generated daily detection efficiencies being based on a far larger number of total releases from the Snake River basin than those given here for the Yakima basin.)

Step 5. Once the above was done for each downstream dam's detection date, the estimated total downstream detections that were allocated to a given McNary-detection date were then added over downstream-dam detection dates [Table B.1.c), far-right-hand column]. This gave the estimated total downstream-dam detections that passed McNary on the given McNary date.

Step 6. The total joint downstream-dam McNary detections on a given McNary-detection date [Table B.1.a), far-right column] were then divided by the downstream-dam total from step 4 above [Table B.1.c), far-right column], giving an estimated McNary-detection efficiency associated with the McNary date [Table B.1.d), far-right-hand column].

Actually, before the last step, Table B.1.a)'s and Table B.1.b)'s numbers were pooled over John Day and Bonneville Dams.

Daily detection efficiencies were then stratified into contiguous days of relatively homogeneous detection efficiencies, and the daily detection efficiencies were pooled over days within the strata. This was done to increase the precision of detection-efficiency estimates. The strata's beginning and ending dates were chosen in a manner that minimized the variation among OCT-SNT daily detection efficiencies within strata, thereby maximizing the detection-rate variation among strata. This was done using step-wise logistic regression. In the first step, the partitioning between all possible sets of two strata that minimized the variation among daily detection efficiencies within strata was selected. With that partitioning fixed, establishing two strata, the second partitioning was then selected in a similar manner among all possible sets of two strata within the strata that were already created in the

[11] Sandford, B.P. and S.G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River Basin anadromous salmonids, 1990-1997. J. Agric. Biol. Environ. Stat. 7:243-263.

first partitioning. Again, the partitioning that minimized variation among daily detection efficiencies within the strata was selected. This second partitioning was then fixed and, along with the first fixed partitioning, established three strata. A third partitioning was similarly developed within the three established strata to form a fourth stratum. The process was continued as long as the difference between the step's created detection rates was significant at the 10% significance level ($P \leq 0.1$).

In the stratification process, there were three exceptions that would lead to the rejection of a given partitioning:

1. If either one of the resulting strata had less than twenty joint McNary detections, or

2. If the difference between the John Day Dam-based and Bonneville Dam-based detection-efficiency estimates were inconsistent in sign. For example, if the combined Bonneville-based McNary detection efficiency in one of the created strata was greater than that in an adjacent stratum, but the John Day-based McNary detection efficiency in the one was less than that in the adjacent, then the partitioning was not accepted.

3. When the logistic variation[12] of daily detection efficiencies within strata was less than 25% of that expected from the binomial (mean deviance < 0.25).

On completion of the stepwise process, each partitioning was shifted at one-day increments between the two adjacent partitionings to see if the variation within strata could be further reduced. If so, the partitioning that resulted in the greatest reduction was selected.

There was an occasional downstream-dam date for which there was a downstream-dam count but no joint downstream-dam and McNary Dam count within +/- six days of the date (refer Step 4, earlier). Such dates were either very early or very late in the passage period. The downstream count for such days were added into the pooled downstream count for either the first stratum or the last stratum, whichever was appropriate, and the respective detection efficiencies were adjusted accordingly.

[12] As measured by mean deviance = residual deviance/(residual degrees of freedom).

Table B.1. Conceptual method of estimating detection efficiencies

a) Joint McNary Dam (McN) and Downstream Dam (D.S.) Detections (n) by McN and D.S. Detection Dates

McN Date (Julian)	D.S. Date (Julian)								
	…	98	99	100	101	**102**	103	….	Total
90	…	0	0	0	0	**0**	0	…	n(90,.)
…	…	…	…	…	…	**…**	…	…	…
94	…	n(94,98)	n(94,99)	n(94,100)	n(94,101)	**0**	0	…	n(94,.)
95	…	0	n(95,99)	n(95,100)	n(95,101)	**n(95,102)**	0	…	n(95,.)
96	…	0	0	n(96,100)	n(96,101)	**n(96,102)**	n(96,103)	…	n(96,.)
97	…	0	0	0	0	**n(97,102)**	n(97,103)	…	n(97,.)
98	…	0	0	0	0	**n(98,102)**	n(98,103)	…	n(98,.)
99	…	0	0	0	0	**0**	0	…	n(99,.)
…	…	…	…	…	…	**…**	…	…	…
200	…	0	0	0	0	**0**	0	…	n(200,.)
Total	…	n(.,98)	n(.,99)	n(.,100)	n(.,101)	**n(.,102)**	n(.,103)	…	

b) For Each Downstream Site, Estimate Distribution of McNary Date Contributions

McN Date (Julian)	p(McN,D.S.) = n[McN,D.S.)/n(., D.S.)					
	D.S. Date (Julian)					
	…	100	101	**102**	103	…
90	…	…	…	**…**	…	…
…	…	…	…	**…**	…	…
94	…	p(94,100)	p(94,101)	**0**	0	…
95	…	p(95,100)	p(95,101)	**p(95,102)=n(95,102)/n(.,102)**	0	…
96	…	p(96,100)	p(96,101)	**p(96,102)=n(96,102)/n(.,102)**	p(96,103)	…
97	…	0	0	**p(97,102)=n(97,102)/n(.,102)**	p(97,103)	…
98	…	0	0	**p(98,102)=n(98,102)/n(.,102)**	p(98,103)	…
99	…	0	0	**p(99,102)=n(99,102)/n(.,102)**	p(99,103)	…
…	…	…	…	**…**	…	…
200	…	0	0	**0**	0	…
Total		1.000	1.000	**1.000**	1.000	

Table B.1. Conceptual method of estimating detection efficiencies (continued)

c) Allocate Daily Lower Site Counts [N(D.S.)] over McNary Dates using above Distributions and total over Lower Dam Dates within McNary Dates

McN Date (Julian)	N'(McN,D.S.) = N(D.S.)*P(McN,D.S.)						McN Dam Total
	D.S. Date (Julian)						
	…	100	101	**102**	103	…	
90	…	0	0	**0**	0	…	**N'(90,.)**
…	…	…	…	**…**	…	…	**…**
94	…	N'(94,100)	N'(94,101)	**0**	0	…	**N'(94,.)**
95	…	N'(95,100)	N'(95,101)	**N'(95,102)=p(95,102)*N(.,102)**	0	…	**N'(95,.)**
96	…	N'(96,100)	N'(96,101)	**N'(96,102)=p(96,102)*N(.,102)**	N'(96,103)	…	**N'(96,.)**
97	…	0	0	**N'(97,102)=p(97,102)*N(.,102)**	N'(97,103)	…	**N'(97,.)**
98	…	0	0	**N'(98,102)=p(98,102)*N(.,102)**	N'(98,103)	…	**N'(98,.)**
99	…	0	0	**N'(99,102)=p(99,102)*N(.,102)**	N'(99,103)	…	**N'(99,.)**
…	…	…	…	**…**	…	…	**…**
200	…	0	0	**0**	0	…	**N'(200,.)**
Total		N(100)	N(101)	**N(102)**	N(103)	…	

d) Use Total Joint McNary and Downstream Dam Detections [Table a)] and Total Downstream Dam Detections [Table c)] to estimate McNary Detection Efficiencies (McN D.E.)

McNary Dam Date (Julian)	Table a) n Total	Table c) N' Total	McNary Detection Efficiency McN D.E. = n/N'
90	n(90,.)	N'(90,.)	**McN D.E.(90,.)=n(90,.)/N'(90,.)**
…	…	…	**…**
94	n(94,.)	N'(94,.)	**McN D.E.(94,.)=n(94,.)/N'(94,.)**
95	n(95,.)	N'(95,.)	**McN D.E.(95,.)=n(95,.)/N'(95,.)**
96	n(96,.)	N'(96,.)	**McN D.E.(96,.)=n(96,.)/N'(96,.)**
97	n(97,.)	N'(97,.)	**McN D.E.(97,.)=n(97,.)/N'(97,.)**
98	n(98,.)	N'(98,.)	**McN D.E.(98,.)=n(98,.)/N'(98,.)**
99	n(99,.)	N'(99,.)	**McN D.E.(99,.)=n(99,.)/N'(99,.)**
…	…	…	**…**
200	n(200,.)	N'(200,.)	**McN D.E.(200,.)=n(200,.)/N'(200,.)**

B.2. Efficiency Estimates

The Bonneville Dam-based and John Day Dam-based McNary detection-efficiency estimates are given in Table B.2 along with the estimates pooled over those two downstream dams, which were the estimates used.

Assumptions behind the detection efficiency estimation procedures are as follows:

1. Detected and undetected fish passing McNary on a given date are temporally and spatially mixed before reaching the downstream detectors so that their proportional composition at the time of McNary passage will be the same for the surviving fish passing through downstream detectors;

2. Survivals from McNary to downstream-dam detectors are the same for all routes of McNary passage (e.g., survival is the same for fish whether they pass through the bypass, the turbines, or the spillway);

3. The allocations of total downstream dam counts to McNary days of passage are accurate; and

4. The detection rates estimated from John Dam and Bonneville Dams are estimating the same parameters.

Assumption 2 is unlikely to hold.

Assumption 3 is also unlikely to hold, because the method of allocation assumes that the McNary detection efficiencies for a given day of downstream-dam detection are homogeneous. It is unlikely that all fish detected on a given downstream date passed McNary on days for which the detection rates were homogeneous. The estimated detection efficiencies are probably biased, but the bias would be less than assuming a single detection-efficiency value for the whole of McNary passage.

For Assumption 4 to hold for the methods used in this report, the probability of a fish being entrained into the bypass at Bonneville would have to be independent of whether or not that fish was entrained into a bypass at John Day or McNary, and the probability of a fish being entrained into the bypass at John Day would have to be independent of whether or not that fish was entrained into the bypass at McNary.

Table B.2. Estimated McNary (McN) Detection Rates based on Bonneville (Bonn) and (John Day) Detections and their Pooled Detections with McNary and Based on the Pooling of the Detections of those two dams Downstream (DS) of McNary

Applicable Passage Dates		Bonneville-Based Estimates			John Day-Based Estimates			Pooled Estimates		
Beginning Date	Ending Date	Detections Bonn	Detections Bonn, McN	Detection Rate	Detections JD	Detections JD, McN	Detection Rate	Detections DS	Detections DS,McN	Detection Rate
Outmigration Year 1999										
	04/26/99	37.0	10	0.2703	82.9	20	0.2412	119.9	30	0.2502
04/27/99	05/04/99	226.7	81	0.3572	320.7	107	0.3336	547.5	188	0.3434
05/05/99	05/09/99	212.9	98	0.4604	483.9	202	0.4174	696.8	300	0.4306
05/10/99	05/16/99	454.8	189	0.4156	904.6	339	0.3747	1359.4	528	0.3884
05/17/99	05/25/99	935.7	295	0.3153	1302.9	383	0.2940	2238.6	678	0.3029
05/26/99	05/26/99	185.3	47	0.2537	236.2	51	0.2159	421.5	98	0.2325
05/27/99	06/14/99	830.1	150	0.1807	2371.5	413	0.1742	3201.6	563	0.1758
06/15/99		82.5	11	0.1333	132.2	9	0.0681	214.7	20	0.0932
Outmigration Year 2000										
	04/14/00	44.7	18	0.4030	81.8	35	0.4279	126.5	53	0.4191
04/15/00	05/16/00	1807.0	629	0.3481	1936.0	540	0.2789	3743.0	1169	0.3123
05/17/00	05/19/00	374.5	110	0.2937	93.7	18	0.1920	468.3	128	0.2734
05/20/00	05/25/00	415.1	105	0.2530	189.3	30	0.1585	604.4	135	0.2234
05/26/00	05/27/00	287.0	80	0.2787	49.5	9	0.1820	336.5	89	0.2645
05/28/00	05/31/00	242.4	84	0.3465	75.0	23	0.3069	317.4	107	0.3372
06/01/00		308.3	83	0.2692	184.8	43	0.2327	493.0	126	0.2556
Outmigration Year 2001										
		2514.0	1940	0.7717	3612.0	2784	0.7708	6126.0	4724	0.7711
Outmigration Year 2002										
	04/03/00	180.9	59	0.3262	480.7	161	0.3349	661.5	220	0.3326
04/22/02	04/21/00	293.4	125	0.4261	700.6	273	0.3896	994.0	398	0.4004
04/30/02	04/29/00	89.8	45	0.5011	239.2	106	0.4431	329.0	151	0.4589
05/02/02	05/01/00	480.7	161	0.3349	480.7	161	0.5095	961.4	322	0.3349
05/03/02	05/02/00	448.5	265	0.5908	1334.9	768	0.5753	1783.4	1033	0.5792
05/06/02	05/05/00	150.5	84	0.5581	242.0	129	0.5331	392.5	213	0.5427
05/07/02	05/06/00	180.0	93	0.5167	289.9	140	0.4829	469.9	233	0.4958
05/09/02	05/08/00	150.4	68	0.4522	391.2	172	0.4396	541.6	240	0.4431
05/15/02	05/14/00	351.3	148	0.4213	410.7	147	0.3579	762.0	295	0.3871
05/25/02	05/24/00	44.6	21	0.4713	71.0	30	0.4228	115.5	51	0.4415
05/28/02		71.0	18	0.2535	117.2	27	0.2324	188.2	45	0.2391
Outmigration Year 2003										
	04/04/00	84.5	48	0.5678	94.3	44	0.4668	178.8	92	0.5145
04/16/03	04/15/00	632.9	273	0.4314	955.6	387	0.4050	1588.5	660	0.4155
04/27/03	04/26/00	175.8	87	0.4949	145.0	64	0.4413	320.8	151	0.4707
04/28/03	04/27/00	914.1	484	0.5295	1254.8	641	0.5108	2168.9	1125	0.5187
05/03/03	05/02/00	683.4	339	0.4961	1297.9	627	0.4831	1981.2	966	0.4876
05/11/03	05/10/00	353.4	134	0.3792	634.4	252	0.3972	987.8	386	0.3908
05/20/03	05/19/00	87.3	43	0.4927	174.1	72	0.4136	261.3	115	0.4400
05/26/03	05/25/00	315.6	113	0.3581	768.1	258	0.3359	1083.7	371	0.3424
06/01/03		100.0	46	0.4598	96.9	39	0.4025	196.9	85	0.4316

Appendix D

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2003 Annual Report:
Natural and Hatchery-Origin Smolt Survival of Roza Spring Chinook Smolt

Doug Neeley, Consultant to Yakama Nation
Submitted July 31, 2003

1. Introduction

In outmigration years 1999 through 2003[1] outmigrating spring Chinook smolt were trapped at Roza Dam (Roza), anesthetized, and PIT-tagged if not previously tagged in OCT-SNT raceways. The smolt were identified as to whether they were one of three treatment groups[2]: natural origin smolt, hatchery-origin smolt that were not previously PIT-tagged, and hatchery-origin smolt that were previously tagged. These are respectively referred to as natural origin, untagged hatchery-origin, and tagged hatchery-origin smolt. All smolt that were not previously tagged (natural origin and untagged hatchery-origin) were then tagged at Roza and released, and those that were previously tagged were also released.

The main purpose of this trial was to determine whether there was a difference in natural and hatchery-origin smolt-to-smolt survival indices. The survival index was estimated from release at Roza Dam on the Upper Yakima River to McNary Dam (McNary) passage on the Columbia River using the same estimation procedures that were used to estimate OCT and SNT survival to McNary (refer to Appendix A in this report and to Appendix B in Doug Neeley's *2003 Annual Report: OCT-SNT Survival*).

The numbers of fish detected at McNary were expanded by the McNary detection efficiency for each release. The expanded total detections at McNary and the release numbers at Roza were pooled into weekly release-day groups to have large enough numbers to provide reasonably precise survival-index estimates, the estimates being the weekly pooled[3] expanded McNary detections divided by the weekly pooled release numbers. There were separate estimates for natural origin and untagged hatchery-origin and hatchery-origin smolt.

[1] 1999 through 2003 Upper-Yakima Spring Chinook outmigrants were respectively brood-year 1997 through 2001 smolt.

[2] Natural origin fish are those that were not adipose-fin clipped (and had no PIT-tag); tagged hatchery-origin fish are those that were adipose-fin clipped and had a PIT-tag; and untagged hatchery-origin fish are those that were adipose-fin clipped but had no PIT-tag.

[3] The expanded numbers and release numbers from each Roza release were added (or pooled) over the release days within a Roza release week.

In previous annual reports, there were inconsistencies in the way that weekly groupings were made. In some years the weekly pooling was inadvertently based on date of tagging; in other years the pooling was based on date of release. Further, in some years, the pooling sometimes used beginning date of week as a reference, and in other years the pooling was based on ending date. There were other inconsistencies: In previous years there was no attempt to adjust survival-index estimates for fish that were removed at McNary and not returned to the river. Further, over the broods, inconsistent methods of estimating McNary detection efficiencies were inadvertently used to expand numbers of fish detected at McNary.

The smolt-to-smolt survival-index data from all five outmigration years were reviewed, corrected, and reanalyzed. All weekly poolings reflect ending release date (for example, a survival rate given for a week ending Julian date 14 refers to survival of fish released at Roza Dam from Julian dates 8 through 14). All estimates of survival from release to McNary passage are adjusted for fish removed at McNary and are based on revised estimates of McNary detection rates. The databases used for the estimates of survival estimates are given in Appendix A. Methods of estimation and analysis are also described in that appendix.

Natural origin smolt passing Roza prior to hatchery-origin smolt passage are referred to as early natural origin smolt; those passing contemporaneously with hatchery-origin smolt are referred to as late natural origin smolt.

2. Summary

Hatchery- and natural origin fish survival indices are compared only during the late period when they outmigrated contemporaneously (late outmigrants). There are also comparisons made between survivals of early and late natural origin smolt; however, these comparisons are not particularly meaningful for two reasons: 1) the early and late classifications are artificial because they are based on the outmigration timing of hatchery fish, not of natural origin fish, and 2) smolt passing McNary before early April could not be detected at McNary because the main bypass at McNary had not yet been watered up.

Figure 1 presents estimated smolt-to-smolt survival indices by week of Roza release. Screens at the acclimation sites were generally pulled on March 15. In outmigration year 1999 (Figure 1.a), sampling at Roza did not begin until later in the season, and the early part of the hatchery-origin outmigration was missed along with the early and the first part of the late natural origin outmigration. In outmigration year 2000 (Figure 2.b), there was leakage at the acclimation site that resulted in hatchery fish volitionally leaving the ponds prior to the screens being pulled. This resulted in very early trapping and tagging of hatchery fish at Roza. In subsequent outmigration years, the week of Roza detection of hatchery fish was the week ending Julian date 84 (Figures 2.c through 2.e).

Natural origin versus hatchery-origin smolt survival: Natural origin smolt-to-smolt survival was significantly greater than that for hatchery-origin fish for four of five brood years. Higher survival of natural origin fish was expected since they were exposed to and adapted to the river environment, including predation, above Roza for a much longer period than hatchery-origin fish. For the single brood year, 1999, when the natural origin and hatchery-origin smolt survival indices did not significantly or substantially differ, the flows for the associated outmigration year, 2001, were extremely low. The natural origin fish outmigrating late in that year may have in been in poorer condition than those outmigrating earlier in that year because of possibly poor late-rearing river conditions associated with the low flows. Consequently, the late natural origin fish may have lost their edge over hatchery-origin fish.

Early versus late natural origin smolt survival: This comparison is biased by the fact that much of the potential early out-migrant passage could not be detected at McNary. Under this situation it is possible that the early estimate would be lower than the late estimate even if the true survivals of the two groups were identical. In two of the four brood years (1998 and 2001 of brood years 1998-2001) for which early survival-index estimates are available, the early survival index is, in fact, significantly less than the late survival index. However, in one year (brood year 1999), the early survival index was significantly greater than that of the late (Figure 1.c). Again, brood year 1999 corresponds to outmigration year 2001, the low flow year when the late outmigration-period conditions may have been far from optimal for smolt survival. Because of the late watering-up of the McNary bypass, the actual difference between the early and late survivals may have actually been greater than indicted in the figure.

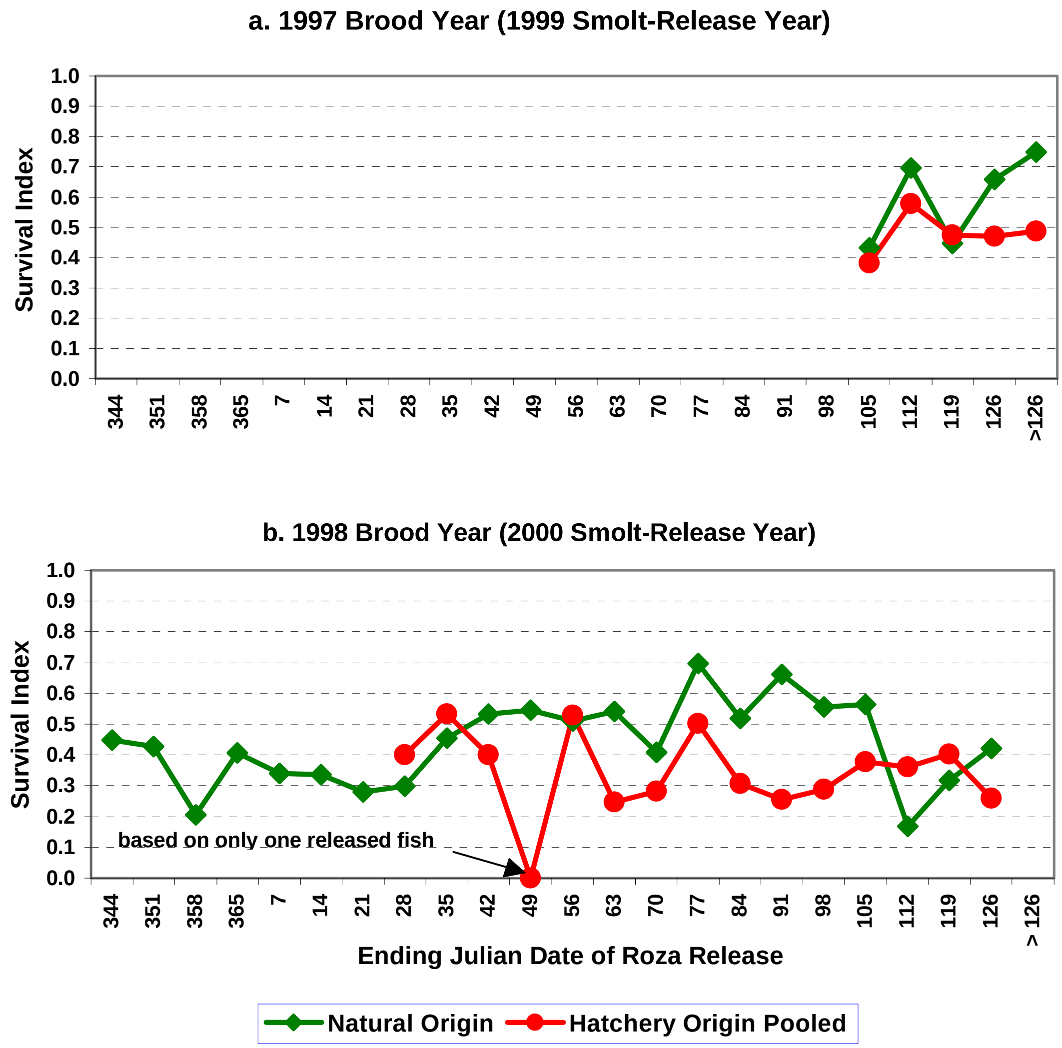

Figure 1. **Roza-to-McNary Smolt-to-Smolt Survival-Index Estimates for Natural Origin and Hatchery-Origin Spring Chinook Smolt (Julian Date refers to the ending Date of the Week that the Fish were Released at Roza Dam)**

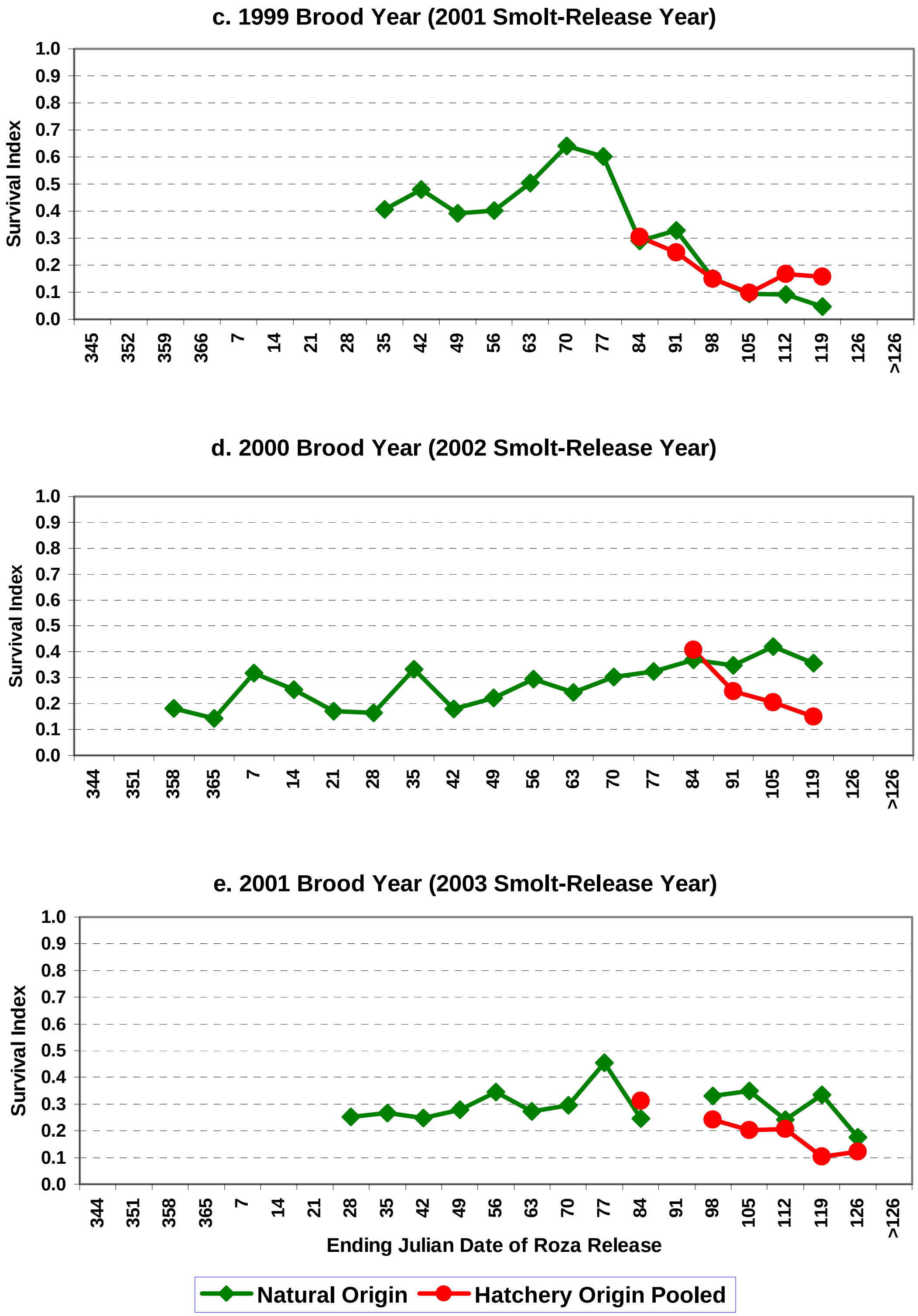

Figure 1. (continued)

3. Analysis

Tables 1.a through 1.e give survival-index means respectively for brood years 1997 through 2001. The means are given for late and early natural origin smolt and for untagged and tagged hatchery-origin smolt contemporaneously outmigrating with the late natural origin smolt. The survival-index means of hatchery fish pooled over the previously tagged and untagged groupings are also presented.

Natural origin versus hatchery-origin smolt survival: Survivals of natural and hatchery-origin fish were compared only over the period during which there was contemporaneous natural and hatchery-origin Roza passage. Earlier weeks of passage for which there were only natural origin fish were excluded from this analysis.

Weighted logistic analyses of variation were performed in which the weekly groupings of data were treated as blocks. The weighting variable was the number of fish released per treatment group[4] during the weekly blocks. If the block effect was not significant at the $\alpha = 0.1$ (10%) significance level, the block and the error [Error (1)] sources were pooled into a new error source [Error (2)] to provide more powerful statistical tests resulting from the greater error degrees of freedom. Both analyses [that using Error (1) and that using Error (2)] are presented in Tables 2.a through 2.e for brood years 1997 though 2001, respectively. The within-year analysis not used for testing the effects of the treatment groups is shaded.

In the analysis, natural origin smolt were compared to hatchery-origin smolt pooled over the two hatchery groups (previously tagged or untagged at the hatchery). The previously tagged and untagged hatchery groupings were ignored because survival-index comparisons between these two hatchery groups were not significant within any of the brood years ($P = 0.346$, $P = 0.827$, $P = 0.368$, $P = 0.574$, and $P = 0.761$ respectively for brood years 1997-2001; Table 2).

In four of the five brood years (1997, 1998, 2000, and 2001), the survival indices of the natural origin smolt were significantly greater than those of the hatchery origin at the 10% level ($P = 0.076$, <0.0001, 0.087, and 0.094; Tables 2.a, 2.b, 2.d, and 2.e for 1-sided test), the mean survival-index estimates being given in Table 1.a, 1.b, 1.d, and 1.e, and the week-of-release estimates being given in Figures 1.a, 1.b, 1.d, and 1.e. In outmigration year 1999, the survival index of natural origin fish did not exceed that of the hatchery-origin ($P = 0.738$), the mean survival-index estimates being given in Table 1.c, and the week-of-release estimates being given in Figures 1.c.

[4] Three treatment groups: 1) Natural origin, 2) hatchery-origin previously tagged at the hatchery, and 3) hatchery-origin not previously tagged at the hatchery (natural origin, tagged hatchery-origin, and untagged hatchery-origin, respectively).

Table 1. Roza-to-McNary Smolt-to-Smolt Survival-Index Estimates for Natural Origin and Hatchery-Origin Spring Chinook Smolt

a. 1997 brood year (1999 outmigration year)

		Period of Roza Passage		
		Early*	Late**	Overall
Natural Origin	Number Released		133	
	Expanded McNary Passage Number		68.1	
	Survival-Index Estimate		**0.5122**	
Hatchery Origin Pooled	Number Released		675	
	Expanded McNary Passage Number		306.4	
	Survival-Index Estimate		**0.4540**	
Hatchery Origin Untagged***	Number Released		227	
	Expanded McNary Passage Number		118.7	
	Survival-Index Estimate		0.5229	
Hatchery Origin Tagged****	Number Released		448	
	Expanded McNary Passage Number		187.7	
	Survival-Index Estimate		0.4191	

b. 1998 brood year (2000 outmigration year)

		Period of Roza Passage		
		Early*	Late**	Overall
Natural Origin	Number Released	3013	3196	6209
	Expanded McNary Passage Number	996.5	1593.8	2590.3
	Survival-Index Estimate	**0.3307**	**0.4987**	**0.4172**
Hatchery Origin Pooled	Number Released		2999	2999
	Expanded McNary Passage Number		946.1	946.1
	Survival-Index Estimate		**0.3155**	**0.3155**
Hatchery Origin Untagged***	Number Released		1950	1950
	Expanded McNary Passage Number		617.0	617.0
	Survival-Index Estimate		0.3164	**0.3164**
Hatchery Origin Tagged****	Number Released		1049	1049
	Expanded McNary Passage Number		329.1	329.1
	Survival-Index Estimate		0.3137	**0.3137**

c. 1999 brood year (2001 outmigration year)

		Period of Roza Passage		
		Early*	Late**	Overall
Natural Origin	Number Released	755	1424	2179
	Expanded McNary Passage Number	360.2	190.6	550.8
	Survival-Index Estimate	**0.4771**	**0.1339**	**0.2528**
Hatchery Origin Pooled	Number Released		1744	
	Expanded McNary Passage Number		306.7	
	Survival-Index Estimate		**0.1759**	
Hatchery Origin Untagged***	Number Released		1435	
	Expanded McNary Passage Number		256.2	
	Survival-Index Estimate		0.1785	
Hatchery Origin Tagged****	Number Released		309	
	Expanded McNary Passage Number		50.6	
	Survival-Index Estimate		0.1637	

Table 1. (continued)

d. 2000 brood year (2002 outmigration year)

		Period of Roza Passage		
		Early*	Late**	Overall
Natural Origin	Number Released	6604	2114	8718
	Expanded McNary Passage Number	1528.3	757.6	2286.0
	Survival-Index Estimate	**0.2314**	**0.3584**	**0.2622**
Hatchery Origin Pooled	Number Released		1503	1503
	Expanded McNary Passage Number		421.3	421.3
	Survival-Index Estimate		**0.2803**	**0.2803**
Hatchery Origin Untagged***	Number Released		1272	1272
	Expanded McNary Passage Number		367.5	367.5
	Survival-Index Estimate		0.2889	**0.2889**
Hatchery Origin Tagged****	Number Released		231	231
	Expanded McNary Passage Number		53.8	53.8
	Survival-Index Estimate		0.2329	**0.2329**

e. 2001 brood year (2003 outmigration year)

		Period of Roza Passage		
		Early*	Late**	Overall
Natural Origin	Number Released	6614	1190	7804
	Expanded McNary Passage Number	1876.5	327.2	2203.7
	Survival-Index Estimate	**0.2837**	**0.2750**	**0.2824**
Hatchery Origin Pooled	Number Released		2146	
	Expanded McNary Passage Number		458.5	
	Survival-Index Estimate		**0.2137**	
Hatchery Origin Untagged***	Number Released		1642	
	Expanded McNary Passage Number		339.7	
	Survival-Index Estimate		0.2069	
Hatchery Origin Tagged****	Number Released		504	
	Expanded McNary Passage Number		118.8	
	Survival-Index Estimate		0.2356	

* period preceding Hatchery Origin outmigration

** period of Hatchery Origin outmigration

, * not PIT-tagged and PIT-tagged during rearing

Table 2. **Weighted* Logistic Analysis of Variation of Roza-Release-to-McNary Spring Chinook Smolt Survival Indices among Contemporary (Late Release) Hatchery Origin and Natural Origin Release Groups (1997-2001 brood years)**

a. 1997 brood year (1999 outmigration year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P	1-sided Type 1 p**
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 Origin[1]	8.26	1	8.26	0.94	0.3606	
Error(1)	70.26	8	8.7825			
Natural Origin versus Hatchery Origin[2]	20.15	1.00	20.15	2.35	**0.1511**	**0.0755**
Tagged vs Untagged Hatchery Origin[2]	8.26	1.00	8.26	0.96	**0.3455**	
Error(2)[3]	102.81	12.00	8.57			

b. 1998 brood year (2000 outmigration year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P	1-sided Type 1 p**
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. 1999 brood year (2001 outmigration year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P	1-sided Type 1 p**
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**	**0.7377**
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			

d. 2000 brood year (2002 outmigration year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P	1-sided Type 1 p**
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 Origin[1]	3	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			

Table 2. (Continued)

e. 2001 brood year (2003 outmigration year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P	1-sided Type 1 p**
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	
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	1.00	12.33	1.91	**0.1873**	**0.0937**
Tagged vs Untagged Hatchery Origin[2]	0.62	1.00	0.62	0.10	**0.7610**	
Error(2)[3]	96.90	15.00	6.46			

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

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

[3] Error (2) is pooling of Error(1) and Block

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

** Test for Hypothesis that Hatchery Origin Survival < Natural Origin Survival

Early versus late natural origin smolt survival: Figure 1 and Table 1 also present survival-index estimates for natural origin fish released earlier than hatchery origin fish for brood years 1998 through 2001, and the early and late natural origin smolt survival indices to McNary can be compared for those brood years. Table 3 gives a weighted logistic analysis of variation for those comparisons. However, these comparisons are not particularly meaningful because the primary bypass at McNary is not generally watered up before April 1, and many of the early released fish may have passed McNary before that date. For three of the four brood years, the late releases' survival estimates were either greater than or did not differ substantially from the early (Figures or Tables 1.a, 1.b, 1.d., and 1.e.), but the early survival index would have been an underestimate because of the failure to detect fish at McNary before April 1.

In the other brood year, brood-year 1999 (outmigration-year 2001), the early release natural-origin smolt survival index (0.477) was much higher than that (0.113) for the late release (Table 1.c.). The difference was highly significant (P = 0.0001, Table 3.c). Brood year 1999 corresponds to outmigration year 2001, the low flow year when the late outmigration-period conditions may have been far from optimal for smolt survival. Because of the late watering-up of the McNary bypass, the actual difference between the early and late survivals may have actually been greater than indicted in the Table 1.c. and Figure 1.c.

Table 3. Weighted* Logistic Analysis of Variation between Early and Late Roza-Release-to-McNary-Passage Natural Origin Smolt-to-Smolt Survival Indices**

a. 1997 brood year (1999 outmigration year) No Early Releases

b. 1998 brood year (2000 outmigration year)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Devivance (Dev/DF)	F-Ratio	P
Natural Origin Early versus Late	181.09	1	181.09	30.78	0.0000
Error	111.79	19	5.88		

c. 1999 brood year (2001 outmigration year)

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

d. 2000 brood year (2002 outmigration year)

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

e. 2001 brood year (2003 outmigration year)

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

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

** Late refers to period when Hatchery Origin fish are also trapped and tagged

Appendix A. Adjusted 1999-2003 Outmigration-Year (1997-2001 Brood-Year) Expanded McNary Detections for each Release and pooled Weekly Expansion and Release Numbers and Survival Index Numbers

Weighted logistic analyses of variation of Roza-release-to-McNary-passage survival-index estimates were undertaken using release number as the weighting variable instead of a traditional least-squares-based analysis of variance[5]. Least squares analysis assumes that the variance of the estimates is constant over releases. In the case of survival-index proportions, this is not expected to be true; the variance is expected to be highest for survival-index proportions nearer 0.5 and is expected become lower as survival-index proportions approach 0 or 1. The assumption behind the logistic analysis of variation used is that the variance in the survival index is proportional to what would be expected in the case of a binomially distributed survival-index estimate. The number of PIT-tagged fish released varied over releases; variation in release number would also contribute to the variance of the survival-index estimate varying over releases. For this reason, the release number was used as a weighting variable.

Smolt-to-smolt survival index**: The release-to-McNary smolt-to-smolt survival index in this study is estimated as follows:**

Equation A.2.

$$\text{Release - to - McNary Survival Index} = \frac{\sum_{\text{strata}} \text{Stratum}\left[\dfrac{\text{Total McNary Detections (T) - Detections Removed (R)}}{\text{Stratum's McNary Detection Efficiency}} + \text{Detections Removed (R)}\right]}{\text{Number of PIT - Tagged Fish Released}}$$

wherein

5) **"Stratum" is a group of contiguous McNary detection dates among which the daily detection efficiencies[6] were sufficiently homogeneous to permit the use of a pooled estimate of the detection efficiency for that stratum;**

6) **"McNary Detections" is the release's fish detected at McNary during the stratum;**

7) **"Detections Removed" is the number of the stratum's "McNary Detections" that were removed for transportation or for sampling and not returned to the bypass for passage**

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[5] Recommended reading on logistic regression: McCullagh, P. and Nelder, J.A. (1989) Generalized Linear Models (2nd edition), Chapman and Hall, London.

[6] A stratum's McNary detection efficiency is the proportion of PIT-tagged fish passing McNary during the stratum that are actually detected at McNary. It is estimated by the total number of fish jointly detected at McNary during the McNary stratum and that are also detected at downstream dams (John Day and Bonneville) divided by the total detected at the downstream dams that are estimated to have passed McNary during that stratum.

(Fish detected at McNary's Raceways A and B not subsequently detected at McNary); and

8) "Detection Efficiency" is the estimated proportion of <u>all</u>[7] those Yakima PIT-tagged Spring Chinook passing McNary Dam during the stratum that were detected at McNary (Equation A.4).

Equation A.4.

$$\text{McNary detection efficiency} = \frac{\text{number of joint detections at McNary and downstream dam}}{\text{estimated total number of detections at downstream dam}}$$

The downstream-dam counts actually represents a pooling of counts from John Day and Bonneville dams[8]. The method of estimating the detection efficiency and the pooling procedure are discussed in Appendix B of Doug Neeley's *2003 Annual Report: OCT-SNT Survival***.**

In the following tables, expanded detections are given for each stratum and for each release, as are the total expanded detections over strata and release numbers for each release. The expanded totals and release numbers pooled over releases within weeks are also given, as are the survival indices for each week of Roza release. Tables A.1 through A.5 give the estimates for outmigration years 1999 through 2003, respectively (brood-years 1997 through 2001, respectively). Within these tables, Tables a. though c. give the individual release McNary-detection expansions and Roza release numbers respectively for natural origin, previously untagged hatchery-origin, and previously tagged hatchery origin smolt. Table d. gives the pooled expanded McNary detections, number released, and survival-index estimates for each Rosa release week.

[7] All PIT-tagged Spring Chinook releases into the Yakima, upper Yakima, and Naches, not only the fish PIT-tagged in this study.

[8] In recent years experiments were conducted at John Day and Bonneville that varied the proportion of flow spilled in the daytime relative to the proportion spilled at night. To offset the electric power lost at one dam during a given period, contravening action was often taken at the other dam (Personal Communication, Rock Peters, U.S. Army Corps of Engineers, Portland, Oregon.) Given this situation, it was deemed more appropriate to pool John Day and Bonneville Dam-based estimates of the McNary detection rate. This means that some of the fish detected at both John Day and Bonneville dams were used twice to estimate the McNary detection efficiency (an effective "sampling with replacement").

Table A.1. 1999 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin

Detection Efficiency (DE) Stratum		McNary Detections	R01	R02	R03	R04	R05	R06	R07	R08	R09
			99	100	105	107	112	114	119	121	126
			4/9/99	4/10/99	4/15/99	4/17/99	4/22/99	4/24/99	4/29/99	5/1/99	5/6/99
Stratum	1	Total (T)	1	0	0	0	0	0	0	0	0
First Date	4/21/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/26/99	T-R	1	0	0	0	0	0	0	0	0
DE	0.2502	Expanded	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	2	1	3	0	0	0	0
First Date	4/27/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/4/99	T-R	0	0	2	1	3	0	0	0	0
DE	0.3434	Expanded	0.0	0.0	5.8	2.9	8.7	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	1	0	0	0	1	1	0	0	0
First Date	5/5/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/9/99	T-R	1	0	0	0	1	1	0	0	0
DE	0.4306	Expanded	2.3	0.0	0.0	0.0	2.3	2.3	0.0	0.0	0.0
Stratum	4	Total (T)	1	0	0	0	2	1	5	1	0
First Date	5/10/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/99	T-R	1	0	0	0	2	1	5	1	0
DE	0.3884	Expanded	2.6	0.0	0.0	0.0	5.1	2.6	12.9	2.6	0.0
Stratum	5	Total (T)	0	0	0	0	2	1	2	4	2
First Date	5/17/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/99	T-R	0	0	0	0	2	1	2	4	2
DE	0.3029	Expanded	0.0	0.0	0.0	0.0	6.6	3.3	6.6	13.2	6.6
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/26/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.2325	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/27/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/14/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.1758	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/15/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/11/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.0932	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	8.9	0.0	5.8	2.9	22.8	8.2	19.5	15.8	6.6
		Number Released	23	6	5	8	29	25	37	20	14

Column header: Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.1. 1999 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

Detection Efficiency (DE) Stratum		McNary Detections	R10	R11	R12	R13	R14
			128	133	135	140	142
			5/8/99	5/13/99	5/15/99	5/20/99	5/22/99
Stratum	1	Total (T)	0	0	0	0	0
First Date	4/21/99	Removed (R)	0	0	0	0	0
Last Date	4/26/99	T-R	0	0	0	0	0
DE	0.2502	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	0	0	0
First Date	4/27/99	Removed (R)	0	0	0	0	0
Last Date	5/4/99	T-R	0	0	0	0	0
DE	0.3434	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0
First Date	5/5/99	Removed (R)	0	0	0	0	0
Last Date	5/9/99	T-R	0	0	0	0	0
DE	0.4306	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	1	0	0	0	0
First Date	5/10/99	Removed (R)	0	0	0	0	0
Last Date	5/16/99	T-R	1	0	0	0	0
DE	0.3884	Expanded	2.6	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	1	5	2	4	0
First Date	5/17/99	Removed (R)	0	0	0	0	0
Last Date	5/25/99	T-R	1	5	2	4	0
DE	0.3029	Expanded	3.3	16.5	6.6	13.2	0.0
Stratum	6	Total (T)	0	0	1	4	0
First Date	5/26/99	Removed (R)	0	0	0	0	0
Last Date	5/26/99	T-R	0	0	1	4	0
DE	0.2325	Expanded	0.0	0.0	4.3	17.2	0.0
Stratum	7	Total (T)	0	0	0	5	1
First Date	5/27/99	Removed (R)	0	0	0	0	0
Last Date	6/14/99	T-R	0	0	0	5	1
DE	0.1758	Expanded	0.0	0.0	0.0	28.4	5.7
Stratum	8	Total (T)	0	0	0	1	0
First Date	6/15/99	Removed (R)	0	0	0	0	0
Last Date	7/11/99	T-R	0	0	0	1	0
DE	0.0932	Expanded	0.0	0.0	0.0	10.7	0.0
		Total Expanded	5.9	16.5	10.9	69.6	5.7
		Number Released	6	21	27	72	19

Column header over R10–R14: Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.1. 1999 Outmigrant McNary-Passage Expansions of Roza Dam Releases

b. Previously Untagged Hatchery Origin

Detection Efficiency (DE) Stratum		McNary Detections	R01	R02	R03	R04	R05	R06	R07	R08	R09
			109	110	115	117	122	124	129	131	136
			4/9/99	4/10/99	4/15/99	4/17/99	4/22/99	4/24/99	4/29/99	5/1/99	5/6/99
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0
First Date	4/21/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/26/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.2502	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	3	1	0	1	0	0	0	0	0
First Date	4/27/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/4/99	T-R	3	1	0	1	0	0	0	0	0
DE	0.3434	Expanded	8.7	2.9	0.0	2.9	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	2	4	0	0	3	0	3	0	0
First Date	5/5/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/9/99	T-R	2	4	0	0	3	0	3	0	0
DE	0.4306	Expanded	4.6	9.3	0.0	0.0	7.0	0.0	7.0	0.0	0.0
Stratum	4	Total (T)	3	1	0	1	2	2	1	0	0
First Date	5/10/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/99	T-R	3	1	0	1	2	2	1	0	0
DE	0.3884	Expanded	7.7	2.6	0.0	2.6	5.1	5.1	2.6	0.0	0.0
Stratum	5	Total (T)	1	1	0	0	4	0	8	1	1
First Date	5/17/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/99	T-R	1	1	0	0	4	0	8	1	1
DE	0.3029	Expanded	3.3	3.3	0.0	0.0	13.2	0.0	26.4	3.3	3.3
Stratum	6	Total (T)	0	0	0	0	0	0	1	0	0
First Date	5/26/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/26/99	T-R	0	0	0	0	0	0	1	0	0
DE	0.2325	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/27/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/14/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.1758	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/15/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/11/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.0932	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	24.4	18.1	0.0	5.5	25.3	5.1	40.3	3.3	3.3
		Number Released	54	23	12	9	24	18	87	20	13

Column header: Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.1. 1999 Outmigrant McNary-Passage Expansions of Roza Dam Releases

b. Previously Untagged Hatchery Origin (continued)

Detection Efficiency (DE) Stratum		McNary Detections	R10	R11	R12	R13	R14
			138	143	145	150	152
			5/8/99	5/13/99	5/15/99	5/20/99	5/22/99
Stratum	1	Total (T)	0	0	0	0	0
First Date	4/21/99	Removed (R)	0	0	0	0	0
Last Date	4/26/99	T-R	0	0	0	0	0
DE	0.2502	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	0	0	0
First Date	4/27/99	Removed (R)	0	0	0	0	0
Last Date	5/4/99	T-R	0	0	0	0	0
DE	0.3434	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0
First Date	5/5/99	Removed (R)	0	0	0	0	0
Last Date	5/9/99	T-R	0	0	0	0	0
DE	0.4306	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0
First Date	5/10/99	Removed (R)	0	0	0	0	0
Last Date	5/16/99	T-R	0	0	0	0	0
DE	0.3884	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	2	4	2	0
First Date	5/17/99	Removed (R)	0	0	0	0	0
Last Date	5/25/99	T-R	0	2	4	2	0
DE	0.3029	Expanded	0.0	6.6	13.2	6.6	0.0
Stratum	6	Total (T)	0	0	1	0	0
First Date	5/26/99	Removed (R)	0	0	0	0	0
Last Date	5/26/99	T-R	0	0	1	0	0
DE	0.2325	Expanded	0.0	0.0	4.3	0.0	0.0
Stratum	7	Total (T)	1	0	1	4	0
First Date	5/27/99	Removed (R)	0	0	0	0	0
Last Date	6/14/99	T-R	1	0	1	4	0
DE	0.1758	Expanded	5.7	0.0	5.7	22.7	0.0
Stratum	8	Total (T)	0	0	0	0	0
First Date	6/15/99	Removed (R)	0	0	0	0	0
Last Date	7/11/99	T-R	0	0	0	0	0
DE	0.0932	Expanded	0.0	0.0	0.0	0.0	0.0
		Total Expanded	5.7	6.6	23.2	29.4	0.0
		Number Released	8	22	26	28	18

Column header: Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.1. 1999 Outmigrant McNary-Passage Expansions of Roza Dam Releases

c. Previously Tagged Hatchery Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R01	R02	R03	R04	R05	R06	R07	R08	R09
Detection Efficiency		McNary	109	110	115	117	122	124	129	131	136
(DE) Stratum		Detections	4/9/99	4/10/99	4/15/99	4/17/99	4/22/99	4/24/99	4/29/99	5/1/99	5/6/99
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0
First Date	4/21/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/26/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.2502	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	5	2	0	1	0	1	0	0	0
First Date	4/27/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/4/99	T-R	5	2	0	1	0	1	0	0	0
DE	0.3434	Expanded	14.6	5.8	0.0	2.9	0.0	2.9	0.0	0.0	0.0
Stratum	3	Total (T)	2	2	1	0	1	1	5	1	0
First Date	5/5/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/9/99	T-R	2	2	1	0	1	1	5	1	0
DE	0.4306	Expanded	4.6	4.6	2.3	0.0	2.3	2.3	11.6	2.3	0.0
Stratum	4	Total (T)	3	4	1	2	2	1	9	3	1
First Date	5/10/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/99	T-R	3	4	1	2	2	1	9	3	1
DE	0.3884	Expanded	7.7	10.3	2.6	5.1	5.1	2.6	23.2	7.7	2.6
Stratum	5	Total (T)	1	1	0	1	3	1	12	4	1
First Date	5/17/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/99	T-R	1	1	0	1	3	1	12	4	1
DE	0.3029	Expanded	3.3	3.3	0.0	3.3	9.9	3.3	39.6	13.2	3.3
Stratum	6	Total (T)	0	0	0	0	0	0	2	0	0
First Date	5/26/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/26/99	T-R	0	0	0	0	0	0	2	0	0
DE	0.2325	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	8.6	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	1	1	1
First Date	5/27/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/14/99	T-R	0	0	0	0	0	0	1	1	1
DE	0.1758	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	5.7	5.7	5.7
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/15/99	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/11/99	T-R	0	0	0	0	0	0	0	0	0
DE	0.0932	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	30.2	24.1	4.9	11.4	17.4	11.1	88.7	28.9	11.6
		Number Released	106	47	24	21	49	36	165	40	27

Table A.1. 1999 Outmigrant McNary-Passage Expansions of Roza Dam Releases

c. Previously Tagged Hatchery Origin (continued)

Detection Efficiency (DE) Stratum		McNary Detections	R10	R11	R12	R13	R14
			Sequential Release (R**)/Julian Release Date/Calendar Release Date				
			138	143	145	150	152
			5/8/99	5/13/99	5/15/99	5/20/99	5/22/99
Stratum	1	Total (T)	0	0	0	0	0
First Date	4/21/99	Removed (R)	0	0	0	0	0
Last Date	4/26/99	T-R	0	0	0	0	0
DE	0.2502	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	0	0	0
First Date	4/27/99	Removed (R)	0	0	0	0	0
Last Date	5/4/99	T-R	0	0	0	0	0
DE	0.3434	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0
First Date	5/5/99	Removed (R)	0	0	0	0	0
Last Date	5/9/99	T-R	0	0	0	0	0
DE	0.4306	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0
First Date	5/10/99	Removed (R)	0	0	0	0	0
Last Date	5/16/99	T-R	0	0	0	0	0
DE	0.3884	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	1	6	4	3	0
First Date	5/17/99	Removed (R)	0	0	0	0	0
Last Date	5/25/99	T-R	1	6	4	3	0
DE	0.3029	Expanded	3.3	19.8	13.2	9.9	0.0
Stratum	6	Total (T)	0	1	2	2	0
First Date	5/26/99	Removed (R)	0	0	0	0	0
Last Date	5/26/99	T-R	0	1	2	2	0
DE	0.2325	Expanded	0.0	4.3	8.6	8.6	0.0
Stratum	7	Total (T)	0	0	0	2	1
First Date	5/27/99	Removed (R)	0	0	0	0	0
Last Date	6/14/99	T-R	0	0	0	2	1
DE	0.1758	Expanded	0.0	0.0	0.0	11.4	5.7
Stratum	8	Total (T)	0	0	0	0	0
First Date	6/15/99	Removed (R)	0	0	0	0	0
Last Date	7/11/99	T-R	0	0	0	0	0
DE	0.0932	Expanded	0.0	0.0	0.0	0.0	0.0
		Total Expanded	3.3	24.1	21.8	29.9	5.7
		Number Released	17	43	53	57	35

Table A.1. 1999 Outmigrant McNary-Passage Expansions of Roza Dam Releases

d. Weekly Expansion Summary and Survival-Index Estimates

Julian Date	Beginning	99	106	113	120	>126
	Ending	105	112	119	126	
Natural Origin	Expanded	14.7	25.7	27.7	22.4	108.6
	Release Number	34	37	62	34	145
	Survival Index	0.4329	0.6952	0.4464	0.6584	0.7487
Untagged Hatchery	Expanded	42.5	30.8	45.4	6.6	64.8
	Release Number	89.00	33	105	33	102
	Survival Index	0.4774	0.9337	0.4324	0.2001	0.6356
Tagged Hatchery	Expanded	59.2	28.7	99.8	40.5	84.8
	Release Number	177	70	201	67	205
	Survival Index	0.3345	0.4106	0.4965	0.6045	0.4136
Pooled Hatchery	Expanded	101.7	59.6	145.2	47.1	149.6
	Release Number	266	103	306	100	307
	Survival Index	0.3823	0.5782	0.4746	0.4711	0.4874

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R01	R02	R03	R04	R05	R06	R07	R08	R09
Detection Efficiency		McNary	342	343	344	345	348	349	350	363	364
(DE) Stratum		Detections	12/08/99	12/09/99	12/10/99	12/11/99	12/14/99	12/15/99	12/16/99	12/29/99	12/30/99
Stratum	1	Total (T)	0	1	0	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	1	0	0	0	0	0	0	0
DE	0.4	Expanded	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	2	2	1	2	3	0	0	0	2
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	2	2	1	2	3	0	0	0	2
DE	0.3	Expanded	6.4	6.4	3.2	6.4	9.6	0.0	0.0	0.0	6.4
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	6.4	8.8	3.2	6.4	9.6	0.0	0.0	0.0	6.4
		Number Released	11	22	8	15	35	7	5	5	10

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R10	R11	R12	R13	R14	R15	R16	R17	R18
Detection Efficiency (DE) Stratum		McNary Detections	364 12/30/99	4 01/04/00	5 01/05/00	6 01/06/00	7 01/07/00	7 01/07/00	11 01/11/00	12 01/12/00	12 01/12/00
Stratum	1	Total (T)	0	10	3	0	1	2	5	2	2
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	10	3	0	1	2	5	2	2
DE	0.4	Expanded	0.0	23.9	7.2	0.0	2.4	4.8	11.9	4.8	4.8
Stratum	2	Total (T)	5	80	18	16	17	24	51	1	11
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	5	80	18	16	17	24	51	1	11
DE	0.3	Expanded	16.0	256.2	57.6	51.2	54.4	76.8	163.3	3.2	35.2
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	1	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	1	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	16.0	280.0	64.8	51.2	56.8	81.6	175.2	12.5	40.0
		Number Released	40	847	187	181	154	206	514	67	110

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R19	R20	R21	R22	R23	R24	R25	R26	R27
Detection Efficiency		McNary	14	14	19	19	26	27	28	28	32
(DE) Stratum		Detections	01/14/00	01/14/00	01/19/00	01/19/00	01/26/00	01/27/00	01/28/00	01/28/00	02/01/00
Stratum	1	Total (T)	3	3	4	0	1	2	5	1	6
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	3	3	4	0	1	2	5	1	6
DE	0.4	Expanded	7.2	7.2	9.5	0.0	2.4	4.8	11.9	2.4	14.3
Stratum	2	Total (T)	4	9	29	6	3	4	7	2	31
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	4	9	29	6	3	4	7	2	31
DE	0.3	Expanded	12.8	28.8	92.9	19.2	9.6	12.8	22.4	6.4	99.3
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	20.0	36.0	102.4	19.2	12.0	17.6	34.3	8.8	113.6
		Number Released	74	80	395	40	26	65	90	62	184

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R28	R29	R30	R31	R32	R33	R34	R35	R36
Detection Efficiency		McNary	33	34	35	35	39	40	41	42	46
(DE) Stratum		Detections	02/02/00	02/03/00	02/04/00	02/04/00	02/08/00	02/09/00	02/10/00	02/11/00	02/15/00
Stratum	1	Total (T)	0	1	1	1	3	1	0	2	1
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	1	1	1	3	1	0	2	1
DE	0.4	Expanded	0.0	2.4	2.4	2.4	7.2	2.4	0.0	4.8	2.4
Stratum	2	Total (T)	7	7	8	8	26	0	11	20	25
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	1
Last Date	5/16/00	T-R	7	7	8	8	26	0	11	20	24
DE	0.3	Expanded	22.4	22.4	25.6	25.6	83.2	0.0	35.2	64.0	77.8
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	22.4	24.8	28.0	28.0	90.4	2.4	35.2	68.8	80.2
		Number Released	81	76	64	73	179	17	57	116	142

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R37	R38	R39	R40	R41	R42	R43	R44	R45
Detection Efficiency (DE) Stratum		McNary Detections	47 02/16/00	48 02/17/00	49 02/18/00	49 02/18/00	54 02/23/00	56 02/25/00	60 02/29/00	61 03/01/00	62 03/02/00
Stratum	1	Total (T)	0	1	1	0	2	3	12	2	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	1	1	0	2	3	12	2	0
DE	0.4	Expanded	0.0	2.4	2.4	0.0	4.8	7.2	28.6	4.8	0.0
Stratum	2	Total (T)	1	5	6	2	17	22	91	7	9
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	1	5	6	2	17	22	91	7	9
DE	0.3	Expanded	3.2	16.0	19.2	6.4	54.4	70.4	291.4	22.4	28.8
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	3.2	18.4	21.6	6.4	59.2	77.6	320.0	27.2	28.8
		Number Released	16	27	29	24	122	146	573	62	38

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R46	R47	R48	R49	R50	R51	R52	R53	R54
Detection Efficiency (DE) Stratum		McNary Detections	63 03/03/00	67 03/07/00	69 03/09/00	70 03/10/00	74 03/14/00	76 03/16/00	77 03/17/00	81 03/21/00	83 03/23/00
Stratum	1	Total (T)	0	4	2	2	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	4	2	2	0	0	0	0	0
DE	0.4	Expanded	0.0	9.5	4.8	4.8	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	5	7	7	10	5	0	5	15	5
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	5	7	7	10	5	0	5	15	5
DE	0.3	Expanded	16.0	22.4	22.4	32.0	16.0	0.0	16.0	48.0	16.0
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	16.0	32.0	27.2	36.8	16.0	0.0	16.0	48.0	16.0
		Number Released	50	82	98	55	20	2	24	96	38

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R55	R56	R57	R58	R59	R60	R61	R62	R63
Detection Efficiency (DE) Stratum		McNary Detections	84 03/24/00	88 03/28/00	91 03/31/00	95 04/04/00	97 04/06/00	105 04/14/00	110 04/19/00	111 04/20/00	117 04/26/00
Stratum	1	Total (T)	3	2	0	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	3	2	0	0	0	0	0	0	0
DE	0.4	Expanded	7.2	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	18	11	17	13	3	3	0	1	0
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	18	11	17	13	3	3	0	1	0
DE	0.3	Expanded	57.6	35.2	54.4	41.6	9.6	9.6	0.0	3.2	0.0
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	2
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	2
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3
Stratum	4	Total (T)	0	1	1	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	1	1	0	0	0	0	0	0
DE	0.2	Expanded	0.0	4.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	64.8	44.5	58.9	41.6	9.6	9.6	0.0	3.2	7.3
		Number Released	114	77	79	59	33	17	11	8	15

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date		
			R64	R65	R66
Detection Efficiency (DE) Stratum		McNary Detections	119 04/28/00	123 05/02/00	126 05/05/00
Stratum	1	Total (T)	0	0	0
First Date	4/6/00	Removed (R)	0	0	0
Last Date	4/14/00	T-R	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0
Stratum	2	Total (T)	0	3	1
First Date	4/15/00	Removed (R)	0	0	0
Last Date	5/16/00	T-R	0	3	1
DE	0.3	Expanded	0.0	9.6	3.2
Stratum	3	Total (T)	0	0	0
First Date	5/17/00	Removed (R)	0	0	0
Last Date	5/19/00	T-R	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0
Stratum	4	Total (T)	0	1	0
First Date	5/20/00	Removed (R)	0	0	0
Last Date	5/25/00	T-R	0	1	0
DE	0.2	Expanded	0.0	4.5	0.0
Stratum	5	Total (T)	0	0	0
First Date	5/26/00	Removed (R)	0	0	0
Last Date	5/27/00	T-R	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0
First Date	5/28/00	Removed (R)	0	0	0
Last Date	5/31/00	T-R	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0
First Date	6/1/00	Removed (R)	0	0	0
Last Date	6/18/00	T-R	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0
		Total Expanded	0.0	14.1	3.2
		Number Released	8	22	19

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

b. Previously Untagged Hatchery Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R27	R45	R46	R47	R48	R49	R50	R51	R52
Detection Efficiency		McNary	32	62	63	67	69	70	74	76	77
(DE) Stratum		Detections	02/01/00	03/02/00	03/03/00	03/07/00	03/09/00	03/10/00	03/14/00	03/16/00	03/17/00
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	3	5	4	0	4	1	9
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	0	0	3	5	4	0	4	1	9
DE	0.3	Expanded	0.0	0.0	9.6	16.0	12.8	0.0	12.8	3.2	28.8
Stratum	3	Total (T)	0	0	0	0	0	0	1	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	1	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0
Stratum	4	Total (T)	0	1	0	0	0	1	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	1	0	0	0	1	0	0	0
DE	0.2	Expanded	0.0	4.5	0.0	0.0	0.0	4.5	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	0.0	4.5	9.6	16.0	12.8	4.5	16.5	3.2	28.8
		Number Released	1	19	25	41	49	29	40	9	48

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

b. Previously Untagged Hatchery Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R53	R54	R55	R56	R57	R58	R59	R60	R61
Detection Efficiency (DE) Stratum		McNary Detections	81 03/21/00	83 03/23/00	84 03/24/00	88 03/28/00	91 03/31/00	95 04/04/00	97 04/06/00	105 04/14/00	110 04/19/00
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	13	12	20	8	10	9	5	5	9
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	13	12	20	8	10	9	5	5	9
DE	0.3	Expanded	41.6	38.4	64.0	25.6	32.0	28.8	16.0	16.0	28.8
Stratum	3	Total (T)	0	0	1	2	0	0	0	0	1
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	1	2	0	0	0	0	1
DE	0.3	Expanded	0.0	0.0	3.7	7.3	0.0	0.0	0.0	0.0	3.7
Stratum	4	Total (T)	0	1	0	1	0	2	0	1	1
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	1	0	1	0	2	0	1	1
DE	0.2	Expanded	0.0	4.5	0.0	4.5	0.0	9.0	0.0	4.5	4.5
Stratum	5	Total (T)	0	0	0	0	0	0	1	0	1
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	1	0	1
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	3.8
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	41.6	42.9	67.7	37.4	32.0	37.8	19.8	20.5	40.7
		Number Released	203	76	231	150	160	121	70	50	150

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

b. Previously Untagged Hatchery Origin (continued)

Detection Efficiency (DE) Stratum		McNary Detections	R62	R63	R64	R65	R66
			111	117	119	123	126
			04/20/00	04/26/00	04/28/00	05/02/00	05/05/00
Stratum	1	Total (T)	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	9	7	4	5	2
First Date	4/15/00	Removed (R)	0	0	0	0	0
Last Date	5/16/00	T-R	9	7	4	5	2
DE	0.3	Expanded	28.8	22.4	12.8	16.0	6.4
Stratum	3	Total (T)	3	0	3	2	1
First Date	5/17/00	Removed (R)	0	0	0	0	0
Last Date	5/19/00	T-R	3	0	3	2	1
DE	0.3	Expanded	11.0	0.0	11.0	7.3	3.7
Stratum	4	Total (T)	1	7	0	1	0
First Date	5/20/00	Removed (R)	0	0	0	0	0
Last Date	5/25/00	T-R	1	7	0	1	0
DE	0.2	Expanded	4.5	31.3	0.0	4.5	0.0
Stratum	5	Total (T)	1	2	0	1	0
First Date	5/26/00	Removed (R)	0	0	0	0	0
Last Date	5/27/00	T-R	1	2	0	1	0
DE	0.3	Expanded	3.8	7.6	0.0	3.8	0.0
Stratum	6	Total (T)	0	0	2	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	2	0	0
DE	0.3	Expanded	0.0	0.0	5.9	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0
		Total Expanded	48.0	61.3	29.7	31.6	10.1
		Number Released	100	101	100	100	77

Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

c. Previously Tagged Hatchery Origin

Detection Efficiency (DE) Stratum		McNary Detections	Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R25	R26	R27	R28	R29	R30	R32	R33	R35
			28	28	32	33	34	35	39	40	42
			01/28/00	01/28/00	02/01/00	02/02/00	02/03/00	02/04/00	02/08/00	02/09/00	02/11/00
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	1	2	0	0	0	1	0	0
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	0	1	2	0	0	0	1	0	0
DE	0.3	Expanded	0.0	3.2	6.4	0.0	0.0	0.0	3.2	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	0.0	3.2	6.4	0.0	0.0	0.0	3.2	0.0	0.0
		Number Released	2	6	7	2	1	1	5	1	2

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

c. Previously Tagged Hatchery Origin (Continued)

Detection Efficiency (DE) Stratum		McNary Detections	R36 46 02/15/00	R41 54 02/23/00	R42 56 02/25/00	R43 60 02/29/00	R44 61 03/01/00	R45 62 03/02/00	R46 63 03/03/00	R47 67 03/07/00	R48 69 03/09/00
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	2	2	0	0	0	2	1
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	0	0	2	2	0	0	0	2	1
DE	0.3	Expanded	0.0	0.0	6.4	6.4	0.0	0.0	0.0	6.4	3.2
Stratum	3	Total (T)	0	0	1	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	1	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	0.0	0.0	10.1	6.4	0.0	0.0	0.0	6.4	3.2
		Number Released	1	1	18	16	11	4	8	25	6

Header spanning release columns: Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

c. Previously Tagged Hatchery Origin (Continued)

Detection Efficiency (DE) Stratum		McNary Detections	Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R49	R50	R52	R53	R54	R55	R56	R57	R58
			70	74	77	81	83	84	88	91	95
			03/10/00	03/14/00	03/17/00	03/21/00	03/23/00	03/24/00	03/28/00	03/31/00	04/04/00
Stratum	1	Total (T)	0	0	0	0	1	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	1	0	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	1	4	0	11	12	10	6
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	0	0	1	4	0	11	12	10	6
DE	0.3	Expanded	0.0	0.0	3.2	12.8	0.0	35.2	38.4	32.0	19.2
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	1	0	1	0	0	0
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	0	1	0	1	0	0	0
DE	0.2	Expanded	0.0	0.0	0.0	4.5	0.0	4.5	0.0	0.0	0.0
Stratum	5	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	0.0	0.0	3.2	17.3	2.4	39.7	38.4	32.0	19.2
		Number Released	2	3	3	73	29	77	64	173	53

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

c. Previously Tagged Hatchery Origin (Continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date							
			R59	R60	R61	R62	R63	R64	R65	R66
Detection Efficiency (DE) Stratum		McNary Detections	97 04/06/00	105 04/14/00	110 04/19/00	111 04/20/00	117 04/26/00	119 04/28/00	123 05/02/00	126 05/05/00
Stratum	1	Total (T)	0	0	0	0	0	0	0	0
First Date	4/6/00	Removed (R)	0	0	0	0	0	0	0	0
Last Date	4/14/00	T-R	0	0	0	0	0	0	0	0
DE	0.4	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	6	6	1	5	1	1	2	2
First Date	4/15/00	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/16/00	T-R	6	6	1	5	1	1	2	2
DE	0.3	Expanded	19.2	19.2	3.2	16.0	3.2	3.2	6.4	6.4
Stratum	3	Total (T)	1	1	0	1	0	1	0	0
First Date	5/17/00	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/19/00	T-R	1	1	0	1	0	1	0	0
DE	0.3	Expanded	3.7	3.7	0.0	3.7	0.0	3.7	0.0	0.0
Stratum	4	Total (T)	0	0	1	2	0	1	2	2
First Date	5/20/00	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/25/00	T-R	0	0	1	2	0	1	2	2
DE	0.2	Expanded	0.0	0.0	4.5	9.0	0.0	4.5	9.0	9.0
Stratum	5	Total (T)	0	0	1	0	0	0	0	0
First Date	5/26/00	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/27/00	T-R	0	0	1	0	0	0	0	0
DE	0.3	Expanded	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	0	0	0	1	0	0	0	0
First Date	5/28/00	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/31/00	T-R	0	0	0	1	0	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	1	0	0	0
First Date	6/1/00	Removed (R)	0	0	0	0	0	0	0	0
Last Date	6/18/00	T-R	0	0	0	0	1	0	0	0
DE	0.3	Expanded	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0
		Total Expanded	22.9	22.9	11.5	31.6	7.1	11.3	15.4	15.4
		Number Released	102	65	41	74	46	25	55	47

Table A.2. 2000 Outmigrant McNary-Passage Expansions of Roza Dam Releases

d. Weekly Expansion Summary and Survival-Index Estimates

Julian Date	Beginning	338	345	352	359	1	8	15	22	29
	Ending	344	351	358	365	7	14	21	28	35
Natural Origin	Expanded	18.4	6.4	9.6	22.4	534.5	283.6	121.6	72.7	216.8
	Release Number	41	15	47	55	1575	845	435	243	478
	Survival Index	0.4487	0.4269	0.2044	0.4075	0.3393	0.3356	0.2796	0.2992	0.4535
Untagged Hatchery	Expanded									0.0
	Release Number									1
	Survival Index									0.0000
Tagged Hatchery	Expanded								3.2	6.4
	Release Number								8	11
	Survival Index								0.4002	0.5822
Pooled Hatchery	Expanded								3.2	6.4
	Release Number								8	12
	Survival Index								0.4002	0.5336

Julian Date	Beginning	36	43	50	57	64	71	78	85	92
	Ending	42	49	56	63	70	77	84	91	98
Natural Origin	Expanded	196.8	129.8	136.8	392.0	95.9	32.0188	128.829	103.379	51.2301
	Release Number	369	238	268	723	235	46	248	156	92
	Survival Index	0.5334	0.5455	0.5105	0.5422	0.4082	0.69606	0.51947	0.66268	0.55685
Untagged Hatchery	Expanded				14.1	33.3	48.4845	152.22	69.4274	57.5614
	Release Number				44	119	97	510	310	191
	Survival Index				0.3201	0.2798	0.49984	0.29847	0.22396	0.30137
Tagged Hatchery	Expanded	3.2	0.0	10.1	6.4	9.6	3.20188	59.3684	70.4413	42.0808
	Release Number	8	1	19	39	33	6	179	237	155
	Survival Index	0.4002	0.0000	0.5296	0.1642	0.2911	0.53365	0.33167	0.29722	0.27149
Pooled Hatchery	Expanded	3.2	0.0	10.1	20.5	42.9	51.6864	211.588	139.869	99.6422
	Release Number	8	1	19	83	152	103	689	547	346
	Survival Index	0.4002	0.0000	0.5296	0.2468	0.2822	0.5018	0.3071	0.2557	0.28798

Julian Date	Beginning	99	106	113	120	>126
	Ending	105	112	119	126	
Natural Origin	Expanded	9.60564	3.20188	7.31642	17.2846	
	Release Number	17	19	23	41	
	Survival Index	0.56504	0.16852	0.31811	0.42158	
Untagged Hatchery	Expanded	20.4865	88.7827	91.0289	41.6458	
	Release Number	50	250	201	177	
	Survival Index	0.40973	0.35513	0.45288	0.23529	
Tagged Hatchery	Expanded	22.8695	43.0477	18.4519	30.7159	
	Release Number	65	115	71	102	
	Survival Index	0.35184	0.37433	0.25989	0.30114	
Pooled Hatchery	Expanded	43.356	131.83	109.481	72.3617	
	Release Number	115	365	272	279	
	Survival Index	0.37701	0.36118	0.4025	0.25936	

Table A.3. 2001 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin

		Sequential Release (R**)/Julian Release Date/Calendar Release Date								
		R01	R02	R03	R04	R05	R06	R07	R08	R09
Detection Efficiency	McNary	32	33	37	40	44	46	47	52	54
(DE) Stratum	Detections	2/1/01	2/2/01	2/6/01	2/9/01	2/13/01	2/15/01	2/16/01	2/21/01	2/23/01
Stratum	Total (T)	4	6	23	22	17	16	15	32	13
First Date 4/8/01	Removed (R)	0	0	1	0	0	0	0	0	0
Last Date 6/21/01	T-R	4	6	22	22	17	16	15	32	13
DE 0.7711	Expanded	5.2	7.8	29.5	28.5	22.0	20.7	19.5	41.5	16.9
	Number Released	9	23	57	64	71	45	43	98	47

		Sequential Release (R**)/Julian Release Date/Calendar Release Date								
		R10	R11	R12	R13	R14	R15	R16	R17	R18
Detection Efficiency	McNary	60	61	65	68	72	75	79	81	82
(DE) Stratum	Detections	3/1/01	3/2/01	3/6/01	3/9/01	3/13/01	3/16/01	3/20/01	3/22/01	3/23/01
Stratum	Total (T)	38	18	34	8	19	13	17	1	1
First Date 4/8/01	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date 6/21/01	T-R	38	18	34	8	19	13	17	1	1
DE 0.7711	Expanded	49.3	23.3	44.1	10.4	24.6	16.9	22.0	1.3	1.3
	Number Released	102	42	63	22	37	32	80	4	1

		Sequential Release (R**)/Julian Release Date/Calendar Release Date								
		R19	R20	R21	R22	R23	R24	R25	R26	R27
Detection Efficiency	McNary	86	87	88	89	89	92	94	95	96
(DE) Stratum	Detections	3/27/01	3/28/01	3/29/01	3/30/01	3/30/01	4/2/01	4/4/01	4/5/01	4/6/01
Stratum	Total (T)	3	12	14	6	3	4	3	2	6
First Date 4/8/01	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date 6/21/01	T-R	3	12	14	6	3	4	3	2	6
DE 0.7711	Expanded	3.9	15.6	18.2	7.8	3.9	5.2	3.9	2.6	7.8
	Number Released	4	42	62	20	22	36	25	21	45

		Sequential Release (R**)/Julian Release Date/Calendar Release Date									
		R28	R29	R30	R31	R32	R33	R34	R35	R36	R37
Detection Efficiency	McNary	96	100	101	101	103	103	108	110	110	115
(DE) Stratum	Detections	4/6/01	4/10/01	4/11/01	4/11/01	4/13/01	4/13/01	4/18/01	4/20/01	4/20/01	4/25/01
Stratum	Total (T)	3	3	7	3	6	23	4	16	8	2
First Date 4/8/01	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date 6/21/01	T-R	3	3	7	3	6	23	4	16	8	2
DE 0.7711	Expanded	3.9	3.9	9.1	3.9	7.8	29.8	5.2	20.7	10.4	2.6
	Number Released	28	131	40	18	156	238	76	174	146	55

Table A.3. 2001 Outmigrants

b. Previously Untagged Hatchery Origin

Detection Efficiency (DE) Stratum		McNary Detections	Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R16	R17	R18	R19	R20	R21	R22	R23	R24
			79	81	82	86	87	88	89	89	92
			3/20/01	3/22/01	3/23/01	3/27/01	3/28/01	3/29/01	3/30/01	3/30/01	4/2/01
Stratum		Total (T)	11	2	16	16	9	13	18	12	4
First Date	4/8/01	Removed (R)	0	0	0	0	1	0	1	0	0
Last Date	6/21/01	T-R	11	2	16	16	8	13	17	12	4
DE	0.7711	Expanded	14.3	2.6	20.7	20.7	11.4	16.9	23.0	15.6	5.2
		Number Released	50	10	51	50	50	100	100	50	50

Detection Efficiency (DE) Stratum		McNary Detections	Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R25	R26	R27	R28	R29	R30	R31	R32	R33
			94	95	96	96	100	101	101	103	103
			4/4/01	4/5/01	4/6/01	4/6/01	4/10/01	4/11/01	4/11/01	4/13/01	4/13/01
Stratum		Total (T)	9	3	9	3	5	7	2	8	11
First Date	4/8/01	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/21/01	T-R	9	3	9	3	5	7	2	8	11
DE	0.7711	Expanded	11.7	3.9	11.7	3.9	6.5	9.1	2.6	10.4	14.3
		Number Released	50	50	50	50	100	50	25	99	150

Detection Efficiency (DE) Stratum		McNary Detections	Sequential Release (R**)/Julian Release Date/Calendar Release Date			
			R34	R35	R36	R37
			108	110	110	115
			4/18/01	4/20/01	4/20/01	4/25/01
Stratum		Total (T)	6	17	11	6
First Date	4/8/01	Removed (R)	0	0	0	0
Last Date	6/21/01	T-R	6	17	11	6
DE	0.7711	Expanded	7.8	22.0	14.3	7.8
		Number Released	50	100	100	50

Table A.3. 2001 Outmigrants

b. Previously Tagged Hatchery Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R16	R18	R19	R20	R21	R22	R23	R24	R25
Detection Efficiency		McNary	79	82	86	87	88	89	89	92	94
(DE) Stratum		Detections	3/20/01	3/23/01	3/27/01	3/28/01	3/29/01	3/30/01	3/30/01	4/2/01	4/4/01
Stratum		Total (T)	1	1	2	4	11	3	1	4	1
First Date	4/8/01	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/21/01	T-R	1	1	2	4	11	3	1	4	1
DE	0.7711	Expanded	1.3	1.3	2.6	5.2	14.3	3.9	1.3	5.2	1.3
		Number Released	15	6	7	17	65	14	12	13	9

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R26	R27	R28	R29	R30	R31	R32	R33	R34
Detection Efficiency		McNary	95	96	96	100	101	101	103	103	108
(DE) Stratum		Detections	4/5/01	4/6/01	4/6/01	4/10/01	4/11/01	4/11/01	4/13/01	4/13/01	4/18/01
Stratum		Total (T)	0	0	0	0	1	1	2	1	1
First Date	4/8/01	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/21/01	T-R	0	0	0	0	1	1	2	1	1
DE	0.7711	Expanded	0.0	0.0	0.0	0.0	1.3	1.3	2.6	1.3	1.3
		Number Released	7	3	6	27	6	5	21	17	5

			Sequential Release (R**)/Julian Release Date/Calendar Release Date		
			R35	R36	R37
Detection Efficiency		McNary	110	110	115
(DE) Stratum		Detections	4/20/01	4/20/01	4/25/01
Stratum		Total (T)	1	2	2
First Date	4/8/01	Removed (R)	0	0	0
Last Date	6/21/01	T-R	1	2	2
DE	0.7711	Expanded	1.3	2.6	2.6
		Number Released	13	25	16

Table A.3. 2001 Outmigrant McNary-Passage Expansions of Roza Dam Releases

d. Weekly Expansion Summary and Survival-Index Estimates

Julian Date	Beginning	29	36	43	50	57	64	71	78	85
	Ending	35	42	49	56	63	70	77	84	91
Natural Origin	Expanded	13.0	58.1	62.2	58.4	72.6	54.5	41.5	24.6	49.3
	Release Number	32	121	159	145	144	85	69	85	150
	Survival Index	0.4052	0.4798	0.3915	0.4024	0.5043	0.6408	0.6014	0.2899	0.3285
Untagged Hatchery	Expanded								37.6	87.6
	Release Number								111	350
	Survival Index								0.3388	0.2503
Tagged Hatchery	Expanded								2.6	27.2
	Release Number								21	115
	Survival Index								0.1235	0.2368
Pooled Hatchery	Expanded								40.2	114.8
	Release Number								132	465
	Survival Index								0.3045	0.2469

Julian Date	Beginning	92	99	106	113
	Ending	98	105	112	119
Natural Origin	Expanded	23.3	54.5	36.3	2.6
	Release Number	155	583	396	55
	Survival Index	0.1506	0.0934	0.0917	0.0472
Untagged Hatchery	Expanded	36.3	42.8	44.1	7.8
	Release Number	250	424	250	50
	Survival Index	0.1452	0.1009	0.1764	0.1556
Tagged Hatchery	Expanded	6.5	6.5	5.2	2.6
	Release Number	38	76	43	16
	Survival Index	0.1706	0.0853	0.1206	0.1621
Pooled Hatchery	Expanded	42.8	49.3	49.3	10.4
	Release Number	288	500	293	66
	Survival Index	0.1486	0.0986	0.1682	0.1572

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R01	R02	RO3	RO4	R05	RO6	R07	R08	R09
Detection Efficiency		McNary	353	355	361	362	3	4	7	8	9
(DE) Stratum		Detections	12/19/01	12/21/01	12/27/01	12/28/01	1/3/02	1/4/02	1/7/02	1/8/02	1/9/02
Stratum	1	Total (T)	4	7	0	3	9	2	0	5	6
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	4	7	0	3	9	2	0	5	6
DE	0.3326	Expanded	12.0	21.0	0.0	9.0	27.1	6.0	0.0	15.0	18.0
Stratum	2	Total (T)	7	11	4	5	9	4	0	8	12
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	7	11	4	5	9	4	0	8	12
DE	0.4004	Expanded	17.5	27.5	10.0	12.5	22.5	10.0	0.0	20.0	30.0
Stratum	3	Total (T)	1	0	4	3	1	0	0	1	1
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	1	0	4	3	1	0	0	1	1
DE	0.4589	Expanded	2.2	0.0	8.7	6.5	2.2	0.0	0.0	2.2	2.2
Stratum	4	Total (T)	0	1	2	1	0	0	1	1	3
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	1	0
Last Date	5/2/02	T-R	0	1	2	1	0	0	1	0	3
DE	0.3349	Expanded	0.0	3.0	6.0	3.0	0.0	0.0	3.0	1.0	9.0
Stratum	5	Total (T)	2	0	2	1	0	0	4	3	4
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	1	0
Last Date	5/5/02	T-R	2	0	2	1	0	0	4	2	4
DE	0.5792	Expanded	3.5	0.0	3.5	1.7	0.0	0.0	6.9	4.5	6.9
Stratum	6	Total (T)	1	0	1	1	3	0	0	0	1
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	1	0	1	1	3	0	0	0	1
DE	0.5427	Expanded	1.8	0.0	1.8	1.8	5.5	0.0	0.0	0.0	1.8
Stratum	7	Total (T)	0	0	1	0	0	0	1	0	1
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	0	0	1	0	0	0	1	0	1
DE	0.4958	Expanded	0.0	0.0	2.0	0.0	0.0	0.0	2.0	0.0	2.0
Stratum	8	Total (T)	0	1	1	1	0	0	2	1	1
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	0	1	1	1	0	0	2	1	1
DE	0.4431	Expanded	0.0	2.3	2.3	2.3	0.0	0.0	4.5	2.3	2.3
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	1
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	0	0	0	0	0	0	0	0	1
DE	0.3871	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Stratum	10	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	37.0	53.8	34.2	36.9	57.2	16.0	16.4	44.9	74.8
		Number Released	250	250	251	250	141	89	65	155	250

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R10	R11	R12	R13	R14	R15	R16	R17	R18
Detection Efficiency		McNary	10	11	14	15	16	17	18	22	23
(DE) Stratum		Detections	1/10/02	1/11/02	1/14/02	1/15/02	1/16/02	1/17/02	1/18/02	1/22/02	1/23/02
Stratum	1	Total (T)	0	0	3	6	2	5	1	2	1
First Date	4/4/02	Removed (R)	0	0	0	1	0	0	0	0	0
Last Date	4/21/02	T-R	0	0	3	5	2	5	1	2	1
DE	0.3326	Expanded	0.0	0.0	9.0	16.0	6.0	15.0	3.0	6.0	3.0
Stratum	2	Total (T)	0	0	5	7	4	4	9	1	2
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	0	0	5	7	4	4	9	1	2
DE	0.4004	Expanded	0.0	0.0	12.5	17.5	10.0	10.0	22.5	2.5	5.0
Stratum	3	Total (T)	0	0	0	2	4	2	0	0	0
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	0	0	0	2	4	2	0	0	0
DE	0.4589	Expanded	0.0	0.0	0.0	4.4	8.7	4.4	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	1	2	2	0	1	1
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	0	0	0	1	2	2	0	1	1
DE	0.3349	Expanded	0.0	0.0	0.0	3.0	6.0	6.0	0.0	3.0	3.0
Stratum	5	Total (T)	1	3	1	0	3	2	7	0	1
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	1	3	1	0	3	2	7	0	1
DE	0.5792	Expanded	1.7	5.2	1.7	0.0	5.2	3.5	12.1	0.0	1.7
Stratum	6	Total (T)	0	0	0	1	1	3	1	1	1
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	0	0	0	1	1	3	1	1	1
DE	0.5427	Expanded	0.0	0.0	0.0	1.8	1.8	5.5	1.8	1.8	1.8
Stratum	7	Total (T)	0	0	1	1	3	0	1	0	0
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	0	0	1	1	3	0	1	0	0
DE	0.4958	Expanded	0.0	0.0	2.0	2.0	6.1	0.0	2.0	0.0	0.0
Stratum	8	Total (T)	0	0	0	0	0	2	0	0	0
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	0	0	0	0	0	2	0	0	0
DE	0.4431	Expanded	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0
Stratum	9	Total (T)	0	1	1	0	0	0	0	0	0
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	0	1	1	0	0	0	0	0	0
DE	0.3871	Expanded	0.0	2.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	10	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	1.7	7.8	27.8	44.7	43.8	48.8	41.4	13.3	14.6
		Number Released	12	94	250	210	250	250	250	106	72

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

Detection Efficiency (DE) Stratum		McNary Detections	R19	R20	R21	R22	R23	R24	R25	R26	R27
			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			24	25	28	29	30	31	32	35	36
			1/24/02	1/25/02	1/28/02	1/29/02	1/30/02	1/31/02	2/1/02	2/4/02	2/5/02
Stratum	1	Total (T)	2	2	1	1	1	1	4	0	0
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	2	2	1	1	1	1	4	0	0
DE	0.3326	Expanded	6.0	6.0	3.0	3.0	3.0	3.0	12.0	0.0	0.0
Stratum	2	Total (T)	1	8	1	0	0	1	0	1	0
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	1	8	1	0	0	1	0	1	0
DE	0.4004	Expanded	2.5	20.0	2.5	0.0	0.0	2.5	0.0	2.5	0.0
Stratum	3	Total (T)	0	1	0	1	1	1	0	0	0
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	0	1	0	1	1	1	0	0	0
DE	0.4589	Expanded	0.0	2.2	0.0	2.2	2.2	2.2	0.0	0.0	0.0
Stratum	4	Total (T)	1	0	1	0	1	2	0	0	0
First Date	5/2/02	Removed (R)	0	0	1	0	0	0	0	0	0
Last Date	5/2/02	T-R	1	0	0	0	1	2	0	0	0
DE	0.3349	Expanded	3.0	0.0	1.0	0.0	3.0	6.0	0.0	0.0	0.0
Stratum	5	Total (T)	2	2	1	0	1	0	3	1	0
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	2	2	1	0	1	0	3	1	0
DE	0.5792	Expanded	3.5	3.5	1.7	0.0	1.7	0.0	5.2	1.7	0.0
Stratum	6	Total (T)	0	1	0	2	0	0	0	0	0
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	0	1	0	2	0	0	0	0	0
DE	0.5427	Expanded	0.0	1.8	0.0	3.7	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	1	0	1	0	0	0	0	0
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	0	1	0	1	0	0	0	0	0
DE	0.4958	Expanded	0.0	2.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0
Stratum	8	Total (T)	0	1	1	1	0	0	0	0	0
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	0	1	1	1	0	0	0	0	0
DE	0.4431	Expanded	0.0	2.3	2.3	2.3	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	1	0	1
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	0	0	0	0	0	0	1	0	1
DE	0.3871	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	2.6
Stratum	10	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	15.0	37.7	10.5	13.1	9.9	13.7	19.8	4.2	2.6
		Number Released	62	250	43	36	26	49	48	19	34

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R28	R29	R30	R31	R32	R33	R34	R35	R36
Detection Efficiency		McNary	37	38	39	42	43	44	45	46	50
(DE) Stratum		Detections	2/6/02	2/7/02	2/8/02	2/11/02	2/12/02	2/13/02	2/14/02	2/15/02	2/19/02
Stratum	1	Total (T)	1	1	1	2	4	1	0	1	4
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	1	1	1	2	4	1	0	1	4
DE	0.3326	Expanded	3.0	3.0	3.0	6.0	12.0	3.0	0.0	3.0	12.0
Stratum	2	Total (T)	1	2	0	4	2	0	3	2	13
First Date	4/22/02	Removed (R)	0	0	0	1	0	0	0	0	0
Last Date	4/29/02	T-R	1	2	0	3	2	0	3	2	13
DE	0.4004	Expanded	2.5	5.0	0.0	8.5	5.0	0.0	7.5	5.0	32.5
Stratum	3	Total (T)	0	0	0	0	1	0	0	0	2
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	0	0	0	0	1	0	0	0	2
DE	0.4589	Expanded	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	4.4
Stratum	4	Total (T)	0	1	1	2	0	0	0	1	0
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	0	1	1	2	0	0	0	1	0
DE	0.3349	Expanded	0.0	3.0	3.0	6.0	0.0	0.0	0.0	3.0	0.0
Stratum	5	Total (T)	0	0	0	3	5	1	4	5	5
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	0	0	0	3	5	1	4	5	5
DE	0.5792	Expanded	0.0	0.0	0.0	5.2	8.6	1.7	6.9	8.6	8.6
Stratum	6	Total (T)	0	0	0	3	0	1	1	0	2
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	0	0	0	3	0	1	1	0	2
DE	0.5427	Expanded	0.0	0.0	0.0	5.5	0.0	1.8	1.8	0.0	3.7
Stratum	7	Total (T)	2	0	0	2	0	0	1	1	1
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	2	0	0	2	0	0	1	1	1
DE	0.4958	Expanded	4.0	0.0	0.0	4.0	0.0	0.0	2.0	2.0	2.0
Stratum	8	Total (T)	0	0	0	2	0	0	0	0	1
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	0	0	0	2	0	0	0	0	1
DE	0.4431	Expanded	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	2.3
Stratum	9	Total (T)	0	0	0	0	1	0	1	1	3
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0	0	1
Last Date	5/24/02	T-R	0	0	0	0	1	0	1	1	2
DE	0.3871	Expanded	0.0	0.0	0.0	0.0	2.6	0.0	2.6	2.6	6.2
Stratum	10	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	9.5	11.0	6.0	39.7	30.4	6.6	20.8	24.2	71.6
		Number Released	54	28	52	220	100	18	68	142	250

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R37	R38	R39	R40	R41	R42	R43	R44	R45
Detection Efficiency		McNary	51	52	53	56	57	58	59	60	63
(DE) Stratum		Detections	2/20/02	2/21/02	2/22/02	2/25/02	2/26/02	2/27/02	2/28/02	3/1/02	3/4/02
Stratum	1	Total (T)	5	0	5	1	0	0	1	0	5
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0	0	1
Last Date	4/21/02	T-R	5	0	5	1	0	0	1	0	4
DE	0.3326	Expanded	15.0	0.0	15.0	3.0	0.0	0.0	3.0	0.0	13.0
Stratum	2	Total (T)	13	1	5	2	1	1	0	1	7
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	13	1	5	2	1	1	0	1	7
DE	0.4004	Expanded	32.5	2.5	12.5	5.0	2.5	2.5	0.0	2.5	17.5
Stratum	3	Total (T)	3	0	1	0	1	0	0	0	1
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	3	0	1	0	1	0	0	0	1
DE	0.4589	Expanded	6.5	0.0	2.2	0.0	2.2	0.0	0.0	0.0	2.2
Stratum	4	Total (T)	1	0	2	0	2	0	0	0	1
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	1	0	2	0	2	0	0	0	1
DE	0.3349	Expanded	3.0	0.0	6.0	0.0	6.0	0.0	0.0	0.0	3.0
Stratum	5	Total (T)	3	0	7	0	3	0	0	2	7
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	3	0	7	0	3	0	0	2	7
DE	0.5792	Expanded	5.2	0.0	12.1	0.0	5.2	0.0	0.0	3.5	12.1
Stratum	6	Total (T)	2	0	3	1	0	0	0	0	0
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	2	0	3	1	0	0	0	0	0
DE	0.5427	Expanded	3.7	0.0	5.5	1.8	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	1	0	2	0	0	0	1	0	0
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	1	0	2	0	0	0	1	0	0
DE	0.4958	Expanded	2.0	0.0	4.0	0.0	0.0	0.0	2.0	0.0	0.0
Stratum	8	Total (T)	4	0	1	0	0	0	0	0	0
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	4	0	1	0	0	0	0	0	0
DE	0.4431	Expanded	9.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	1	0	1	0	1	0	0	0	5
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	1	0	1	0	1	0	0	0	5
DE	0.3871	Expanded	2.6	0.0	2.6	0.0	2.6	0.0	0.0	0.0	12.9
Stratum	10	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	79.5	2.5	62.2	9.8	18.4	2.5	5.0	6.0	60.7
		Number Released	250	23	239	42	50	18	31	49	250

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

Detection Efficiency (DE) Stratum		McNary Detections	R46 64 3/5/02	R47 65 3/6/02	R48 66 3/7/02	R49 67 3/8/02	R50 70 3/11/02	R51 71 3/12/02	R52 72 3/13/02	R53 73 3/14/02	R54 74 3/15/02
Stratum	1	Total (T)	4	1	0	0	4	10	4	1	2
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	1	0	0
Last Date	4/21/02	T-R	4	1	0	0	4	10	3	1	2
DE	0.3326	Expanded	12.0	3.0	0.0	0.0	12.0	30.1	10.0	3.0	6.0
Stratum	2	Total (T)	0	5	3	1	8	11	6	0	1
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	0	5	3	1	8	11	6	0	1
DE	0.4004	Expanded	0.0	12.5	7.5	2.5	20.0	27.5	15.0	0.0	2.5
Stratum	3	Total (T)	2	0	1	1	0	3	1	0	0
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	2	0	1	1	0	3	1	0	0
DE	0.4589	Expanded	4.4	0.0	2.2	2.2	0.0	6.5	2.2	0.0	0.0
Stratum	4	Total (T)	1	1	0	2	1	3	0	0	0
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	1	1	0	2	1	3	0	0	0
DE	0.3349	Expanded	3.0	3.0	0.0	6.0	3.0	9.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	1	1	1	6	6	2	2	2
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	0	1	1	1	6	6	2	2	2
DE	0.5792	Expanded	0.0	1.7	1.7	1.7	10.4	10.4	3.5	3.5	3.5
Stratum	6	Total (T)	1	0	0	0	2	3	2	0	0
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	1	0	0	0	2	3	2	0	0
DE	0.5427	Expanded	1.8	0.0	0.0	0.0	3.7	5.5	3.7	0.0	0.0
Stratum	7	Total (T)	2	0	1	0	3	1	1	0	1
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	2	0	1	0	3	1	1	0	1
DE	0.4958	Expanded	4.0	0.0	2.0	0.0	6.1	2.0	2.0	0.0	2.0
Stratum	8	Total (T)	2	0	0	1	0	0	1	1	0
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	2	0	0	1	0	0	1	1	0
DE	0.4431	Expanded	4.5	0.0	0.0	2.3	0.0	0.0	2.3	2.3	0.0
Stratum	9	Total (T)	1	0	1	0	6	2	1	0	0
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	1	0	1	0	6	2	1	0	0
DE	0.3871	Expanded	2.6	0.0	2.6	0.0	15.5	5.2	2.6	0.0	0.0
Stratum	10	Total (T)	0	0	1	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	1	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	1	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	1	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0
		Total Expanded	32.3	20.2	18.3	14.6	74.8	96.1	41.2	8.7	14.0
		Number Released	116	47	46	25	250	250	133	46	45

Column header: Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R55	R56	R57	R58	R59	R60	R61	R62	R63
Detection Efficiency		McNary	77	78	79	80	81	84	88	91	92
(DE) Stratum		Detections	3/18/02	3/19/02	3/20/02	3/21/02	3/22/02	3/25/02	3/29/02	4/1/02	4/2/02
Stratum	1	Total (T)	1	3	4	1	0	3	3	0	2
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	1	3	4	1	0	3	3	0	2
DE	0.3326	Expanded	3.0	9.0	12.0	3.0	0.0	9.0	9.0	0.0	6.0
Stratum	2	Total (T)	7	7	8	1	1	6	5	1	4
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	7	7	8	1	1	6	5	1	4
DE	0.4004	Expanded	17.5	17.5	20.0	2.5	2.5	15.0	12.5	2.5	10.0
Stratum	3	Total (T)	0	1	2	0	1	1	2	0	1
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	0	1	2	0	1	1	2	0	1
DE	0.4589	Expanded	0.0	2.2	4.4	0.0	2.2	2.2	4.4	0.0	2.2
Stratum	4	Total (T)	2	0	1	3	1	4	2	0	6
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	2	0	1	3	1	4	2	0	6
DE	0.3349	Expanded	6.0	0.0	3.0	9.0	3.0	11.9	6.0	0.0	17.9
Stratum	5	Total (T)	3	5	10	3	1	10	13	0	9
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	3	5	10	3	1	10	13	0	9
DE	0.5792	Expanded	5.2	8.6	17.3	5.2	1.7	17.3	22.4	0.0	15.5
Stratum	6	Total (T)	1	0	0	2	0	4	4	0	6
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	1	0	0	2	0	4	4	0	6
DE	0.5427	Expanded	1.8	0.0	0.0	3.7	0.0	7.4	7.4	0.0	11.1
Stratum	7	Total (T)	1	2	1	1	0	3	3	0	2
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	1	2	1	1	0	3	3	0	2
DE	0.4958	Expanded	2.0	4.0	2.0	2.0	0.0	6.1	6.1	0.0	4.0
Stratum	8	Total (T)	3	0	2	0	1	0	3	1	1
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	3	0	2	0	1	0	3	1	1
DE	0.4431	Expanded	6.8	0.0	4.5	0.0	2.3	0.0	6.8	2.3	2.3
Stratum	9	Total (T)	2	4	5	0	2	3	5	2	7
First Date	5/15/02	Removed (R)	0	0	1	0	0	0	0	0	0
Last Date	5/24/02	T-R	2	4	4	0	2	3	5	2	7
DE	0.3871	Expanded	5.2	10.3	11.3	0.0	5.2	7.7	12.9	5.2	18.1
Stratum	10	Total (T)	0	0	1	0	0	0	0	0	2
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	1	0	0	0	0	0	2
DE	0.4415	Expanded	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	4.5
Stratum	11	Total (T)	0	0	0	0	1	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	1	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0
		Total Expanded	47.4	51.7	76.7	25.3	21.0	76.6	87.4	9.9	91.6
		Number Released	143	119	202	48	46	250	250	27	250

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date						
			R64	R65	R66	R67	R68	R69	R70
Detection Efficiency		McNary	93	94	101	102	113	114	116
(DE) Stratum		Detections	4/3/02	4/4/02	4/11/02	4/12/02	4/23/02	4/24/02	4/26/02
Stratum	1	Total (T)	3	6	0	1	0	0	0
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	3	6	0	1	0	0	0
DE	0.3326	Expanded	9.0	18.0	0.0	3.0	0.0	0.0	0.0
Stratum	2	Total (T)	5	4	0	1	0	0	0
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	5	4	0	1	0	0	0
DE	0.4004	Expanded	12.5	10.0	0.0	2.5	0.0	0.0	0.0
Stratum	3	Total (T)	0	2	0	1	0	0	0
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	0	2	0	1	0	0	0
DE	0.4589	Expanded	0.0	4.4	0.0	2.2	0.0	0.0	0.0
Stratum	4	Total (T)	3	2	0	0	0	0	0
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	3	2	0	0	0	0	0
DE	0.3349	Expanded	9.0	6.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	7	10	2	1	3	1	3
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	7	10	2	1	3	1	3
DE	0.5792	Expanded	12.1	17.3	3.5	1.7	5.2	1.7	5.2
Stratum	6	Total (T)	2	0	0	0	0	0	1
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	2	0	0	0	0	0	1
DE	0.5427	Expanded	3.7	0.0	0.0	0.0	0.0	0.0	1.8
Stratum	7	Total (T)	2	1	0	1	1	1	1
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	2	1	0	1	1	1	1
DE	0.4958	Expanded	4.0	2.0	0.0	2.0	2.0	2.0	2.0
Stratum	8	Total (T)	5	3	0	1	3	0	3
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	5	3	0	1	3	0	3
DE	0.4431	Expanded	11.3	6.8	0.0	2.3	6.8	0.0	6.8
Stratum	9	Total (T)	8	7	0	1	2	7	5
First Date	5/15/02	Removed (R)	1	0	0	0	0	0	0
Last Date	5/24/02	T-R	7	7	0	1	2	7	5
DE	0.3871	Expanded	19.1	18.1	0.0	2.6	5.2	18.1	12.9
Stratum	10	Total (T)	2	0	0	0	1	1	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	2	0	0	0	1	1	0
DE	0.4415	Expanded	4.5	0.0	0.0	0.0	2.3	2.3	0.0
Stratum	11	Total (T)	0	0	0	0	0	1	1
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	1	1
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	4.2	4.2
		Total Expanded	85.2	82.5	3.5	16.3	21.4	28.3	32.9
		Number Released	250	250	22	25	50	82	100

Table A.4. 2002 Outmigrants

b. Previously Untagged Hatchery Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R55	R56	R57	R58	R59	R60	R61	R62	R63
Detection Efficiency		McNary	77	78	79	80	81	84	88	91	92
(DE) Stratum		Detections	3/18/02	3/19/02	3/20/02	3/21/02	3/22/02	3/25/02	3/29/02	4/1/02	4/2/02
Stratum	1	Total (T)	5	4	5	3	2	12	4	0	2
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0	0	1
Last Date	4/21/02	T-R	5	4	5	3	2	12	4	0	1
DE	0.3326	Expanded	15.0	12.0	15.0	9.0	6.0	36.1	12.0	0.0	4.0
Stratum	2	Total (T)	5	4	5	1	0	3	2	0	6
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	5	4	5	1	0	3	2	0	6
DE	0.4004	Expanded	12.5	10.0	12.5	2.5	0.0	7.5	5.0	0.0	15.0
Stratum	3	Total (T)	1	0	0	1	0	1	2	0	2
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	1	0	0	1	0	1	2	0	2
DE	0.4589	Expanded	2.2	0.0	0.0	2.2	0.0	2.2	4.4	0.0	4.4
Stratum	4	Total (T)	3	1	0	0	1	1	0	0	1
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	3	1	0	0	1	1	0	0	1
DE	0.3349	Expanded	9.0	3.0	0.0	0.0	3.0	3.0	0.0	0.0	3.0
Stratum	5	Total (T)	2	0	1	0	2	2	3	0	0
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	2	0	1	0	2	2	3	0	0
DE	0.5792	Expanded	3.5	0.0	1.7	0.0	3.5	3.5	5.2	0.0	0.0
Stratum	6	Total (T)	0	0	0	0	0	0	0	0	1
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	0	0	0	0	0	0	0	0	1
DE	0.5427	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Stratum	7	Total (T)	0	0	0	1	0	0	0	0	1
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	0	0	0	1	0	0	0	0	1
DE	0.4958	Expanded	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	2.0
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	1
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	0	0	0	0	0	0	0	0	1
DE	0.4431	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Stratum	9	Total (T)	1	0	0	0	0	0	1	0	0
First Date	5/15/02	Removed (R)	1	0	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	0	0	0	0	0	0	1	0	0
DE	0.3871	Expanded	1.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0
Stratum	10	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0	0	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	43.1	25.0	29.2	15.7	12.5	52.2	29.1	0.0	32.5
		Number Released	74	59	101	50	25	126	125	4	125

Table A.4. 2002 Outmigrants

b. Previously Untagged Hatchery Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date						
			R64	R65	R66	R67		R69	R70
Detection Efficiency		McNary	93	94	101	102	113	114	116
(DE) Stratum		Detections	4/3/02	4/4/02	4/11/02	4/12/02	4/23/02	4/24/02	4/26/02
Stratum	1	Total (T)	6	6	1	0	0	0	0
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	6	6	1	0	0	0	0
DE	0.3326	Expanded	18.0	18.0	3.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	2	2	0	2	0	0	0
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	2	2	0	2	0	0	0
DE	0.4004	Expanded	5.0	5.0	0.0	5.0	0.0	0.0	0.0
Stratum	3	Total (T)	3	1	0	0	0	0	0
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	3	1	0	0	0	0	0
DE	0.4589	Expanded	6.5	2.2	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	1	0	0	0	0	0
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	0	1	0	0	0	0	0
DE	0.3349	Expanded	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	4	0	0	4	0	3	0
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	4	0	0	4	0	3	0
DE	0.5792	Expanded	6.9	0.0	0.0	6.9	0.0	5.2	0.0
Stratum	6	Total (T)	0	0	0	0	0	1	2
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	0	0	0	0	0	1	2
DE	0.5427	Expanded	0.0	0.0	0.0	0.0	0.0	1.8	3.7
Stratum	7	Total (T)	0	0	0	0	0	2	4
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	0	0	0	0	0	2	4
DE	0.4958	Expanded	0.0	0.0	0.0	0.0	0.0	4.0	8.1
Stratum	8	Total (T)	0	0	0	2	0	1	2
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	0	0	0	2	0	1	2
DE	0.4431	Expanded	0.0	0.0	0.0	4.5	0.0	2.3	4.5
Stratum	9	Total (T)	0	1	0	0	0	2	1
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	0	1	0	0	0	2	1
DE	0.3871	Expanded	0.0	2.6	0.0	0.0	0.0	5.2	2.6
Stratum	10	Total (T)	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0
DE	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	1	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	1	0
DE	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	4.2	0.0
		Total Expanded	36.5	30.8	3.0	16.4	0.0	22.7	18.8
		Number Released	125	125	50	50	50	82	101

Table A.4. 2002 Outmigrants

c. Previously Tagged Hatchery Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R55	R56	R57	R58	R59	R60	R61	R62	R63
		McNary	77	78	79	80	81	84	88	91	92
etection Efficiency Strat		Detections	3/18/02	3/19/02	3/20/02	3/21/02	3/22/02	3/25/02	3/29/02	4/1/02	4/2/02
Stratum	1	Total (T)	0	1	2	1	0	0	0	0	0
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	0	1	2	1	0	0	0	0	0
n Efficiency	0.3326	Expanded	0.0	3.0	6.0	3.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	2	0	2	0	0	0	0	0	0
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	2	0	2	0	0	0	0	0	0
n Efficiency	0.4004	Expanded	5.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	1	0	0	0	0
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	0	0	0	0	1	0	0	0	0
n Efficiency	0.4589	Expanded	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	1	0	1
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	0	0	0	0	0	0	1	0	1
n Efficiency	0.3349	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	3.0
Stratum	5	Total (T)	0	0	1	0	0	0	0	0	1
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	0	0	1	0	0	0	0	0	1
n Efficiency	0.5792	Expanded	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	1.7
Stratum	6	Total (T)	0	1	0	0	0	0	0	0	0
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	0	1	0	0	0	0	0	0	0
n Efficiency	0.5427	Expanded	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	0	0	0	0	0	0	0	0	0
n Efficiency	0.4958	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	8	Total (T)	1	0	0	0	0	0	0	0	0
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	1	0	0	0	0	0	0	0	0
n Efficiency	0.4431	Expanded	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	1	0	0	0	0
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	0	0	0	0	1	0	0	0	0
n Efficiency	0.3871	Expanded	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
Stratum	10	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0	0	0
n Efficiency	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0	0	0
n Efficiency	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	7.3	4.8	12.7	3.0	4.8	0.0	3.0	0.0	4.7
		Number Released	15	26	19	7	4	11	13	2	21

Table A.4. 2002 Outmigrants

c. Previously Tagged Hatchery Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date						
			R64	R65	R66	R67	R68	R69	R70
		McNary	93	94	101	102	113	114	116
etection Efficiency Strat		Detections	4/3/02	4/4/02	4/11/02	4/12/02	4/23/02	4/24/02	4/26/02
Stratum	1	Total (T)	0	1	0	0	0	0	0
First Date	4/4/02	Removed (R)	0	0	0	0	0	0	0
Last Date	4/21/02	T-R	0	1	0	0	0	0	0
n Efficiency	0.3326	Expanded	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	1	0	0	0	0	0	0
First Date	4/22/02	Removed (R)	0	0	0	0	0	0	0
Last Date	4/29/02	T-R	1	0	0	0	0	0	0
n Efficiency	0.4004	Expanded	2.5	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0	0	0
First Date	4/30/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/1/02	T-R	0	0	0	0	0	0	0
n Efficiency	0.4589	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	0	0	0	0	0	0
First Date	5/2/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	0	0	0	0	0	0	0
n Efficiency	0.3349	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	1	0	0	0	0	0	0
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/5/02	T-R	1	0	0	0	0	0	0
n Efficiency	0.5792	Expanded	1.7	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	6	Total (T)	1	0	0	0	0	1	0
First Date	5/6/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	1	0	0	0	0	1	0
n Efficiency	0.5427	Expanded	1.8	0.0	0.0	0.0	0.0	1.8	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0
First Date	5/7/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/8/02	T-R	0	0	0	0	0	0	0
n Efficiency	0.4958	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	8	Total (T)	0	0	0	0	0	0	0
First Date	5/9/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/14/02	T-R	0	0	0	0	0	0	0
n Efficiency	0.4431	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	1	0	0	0
First Date	5/15/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/24/02	T-R	0	0	0	1	0	0	0
n Efficiency	0.3871	Expanded	0.0	0.0	0.0	2.6	0.0	0.0	0.0
Stratum	10	Total (T)	0	0	0	0	0	0	0
First Date	5/25/02	Removed (R)	0	0	0	0	0	0	0
Last Date	5/27/02	T-R	0	0	0	0	0	0	0
n Efficiency	0.4415	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	11	Total (T)	0	0	0	0	0	0	0
First Date	5/28/02	Removed (R)	0	0	0	0	0	0	0
Last Date	7/1/02	T-R	0	0	0	0	0	0	0
n Efficiency	0.2391	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	6.1	3.0	0.0	2.6	0.0	1.8	0.0
		Number Released	23	25	2	6	15	13	29

Table A.4. 2002 Outmigrant McNary-Passage Expansions of Roza Dam Releases

d. Weekly Expansion Summary and Survival-Index Estimates

Julian Date	Beginning	352	359	1	8	15	22	29	36	43
	Ending	358	365	7	14	21	28	35	42	49
Natural Origin	Expanded	90.7	71.1	73.3	145.6	206.6	80.6	67.0	33.3	121.8
	Release Number	500	501	230	576	1210	490	202	187	548
	Survival Index	0.1815	0.1419	0.3185	0.2527	0.1707	0.1645	0.3316	0.1782	0.2222
Untagged Hatchery	Expanded									
	Release Number									
	Survival Index									
Tagged Hatchery	Expanded									
	Release Number									
	Survival Index									
Pooled Hatchery	Expanded									
	Release Number									
	Survival Index									

Julian Date	Beginning	50	57	64	71	78	85	99	113
	Ending	56	63	70	77	84	91	105	119
Natural Origin	Expanded	153.6	103.9	146.1	234.8	298.8	356.6	19.7	82.6
	Release Number	523	429	484	724	808	1027	47	232
	Survival Index	0.2937	0.2422	0.3019	0.3242	0.3698	0.3472	0.4196	0.3559
Untagged Hatchery	Expanded					177.7	128.9	19.4	41.5
	Release Number					435	504	100	233
	Survival Index					0.4086	0.2557	0.1942	0.1782
Tagged Hatchery	Expanded					32.6	16.8	2.6	1.8
	Release Number					82	84	8	57
	Survival Index					0.3976	0.1997	0.3229	0.0323
Pooled Hatchery	Expanded					210.3	145.6	22.0	43.4
	Release Number					517	588	108	290
	Survival Index					0.4068	0.2477	0.2037	0.1495

Table A.5. 2003 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin

Detection Efficiency (DE) Stratum		McNary Detections	R01	R02	R03	R04	R05	R06	R07	R08	R09
		Sequential Release (R**)/Julian Release Date/Calendar Release Date	23	29	30	31	32	37	38	39	43
			1/23/03	1/29/03	1/30/03	1/31/03	2/1/03	2/6/03	2/7/03	2/8/03	2/12/03
Stratum	1	Total (T)	0	4	1	0	2	1	0	1	1
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	0	4	1	0	2	1	0	1	1
DE	0.5145	Expanded	0.0	7.8	1.9	0.0	3.9	1.9	0.0	1.9	1.9
Stratum	2	Total (T)	7	13	15	13	20	5	8	12	9
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/26/03	T-R	7	13	15	13	20	5	8	12	9
DE	0.4155	Expanded	16.8	31.3	36.1	31.3	48.1	12.0	19.3	28.9	21.7
Stratum	3	Total (T)	2	1	3	2	2	2	3	3	5
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	2	1	3	2	2	2	3	3	5
DE	0.4707	Expanded	4.2	2.1	6.4	4.2	4.2	4.2	6.4	6.4	10.6
Stratum	4	Total (T)	3	17	18	17	13	13	15	14	12
First Date	4/28/03	Removed (R)	0	0	1	0	1	0	0	0	0
Last Date	5/2/03	T-R	3	17	17	17	12	13	15	14	12
DE	0.5187	Expanded	5.8	32.8	33.8	32.8	24.1	25.1	28.9	27.0	23.1
Stratum	5	Total (T)	1	12	9	9	13	13	16	20	20
First Date	5/3/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/10/03	T-R	1	12	9	9	13	13	16	20	20
DE	0.4876	Expanded	2.1	24.6	18.5	18.5	26.7	26.7	32.8	41.0	41.0
Stratum	6	Total (T)	0	1	5	1	6	1	3	4	3
First Date	5/11/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	0	1	5	1	6	1	3	4	3
DE	0.3908	Expanded	0.0	2.6	12.8	2.6	15.4	2.6	7.7	10.2	7.7
Stratum	7	Total (T)	0	0	0	0	1	2	2	1	1
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	0	0	0	0	1	2	2	1	1
DE	0.4400	Expanded	0.0	0.0	0.0	0.0	2.3	4.5	4.5	2.3	2.3
Stratum	8	Total (T)	0	0	0	0	0	1	0	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	0	0	0	0	0	1	0	0	0
DE	0.3424	Expanded	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	28.9	101.1	109.4	89.3	124.7	80.0	99.6	117.7	108.3
		Number Released	115	400	400	394	394	400	400	400	400

Table A.5. 2003 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

Detection Efficiency (DE) Stratum		McNary Detections	R10	R11	R12	R13	R14	R15	R16	R17	R18
		Julian Release Date	44	45	46	51	52	53	57	58	59
		Calendar Release Date	2/13/03	2/14/03	2/15/03	2/20/03	2/21/03	2/22/03	2/26/03	2/27/03	2/28/03
Stratum	1	Total (T)	2	0	0	1	3	1	1	0	0
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	2	0	0	1	3	1	1	0	0
DE	0.5145	Expanded	3.9	0.0	0.0	1.9	5.8	1.9	1.9	0.0	0.0
Stratum	2	Total (T)	12	5	4	2	16	3	1	5	12
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	1	0
Last Date	4/26/03	T-R	12	5	4	2	16	3	1	4	12
DE	0.4155	Expanded	28.9	12.0	9.6	4.8	38.5	7.2	2.4	10.6	28.9
Stratum	3	Total (T)	2	1	1	0	1	0	0	2	2
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	2	1	1	0	1	0	0	2	2
DE	0.4707	Expanded	4.2	2.1	2.1	0.0	2.1	0.0	0.0	4.2	4.2
Stratum	4	Total (T)	19	2	5	5	11	5	16	16	17
First Date	4/28/03	Removed (R)	0	0	0	0	1	0	0	2	0
Last Date	5/2/03	T-R	19	2	5	5	10	5	16	14	17
DE	0.5187	Expanded	36.6	3.9	9.6	9.6	20.3	9.6	30.8	29.0	32.8
Stratum	5	Total (T)	17	5	6	2	6	5	18	20	17
First Date	5/3/03	Removed (R)	1	0	0	0	0	0	1	0	0
Last Date	5/10/03	T-R	16	5	6	2	6	5	17	20	17
DE	0.4876	Expanded	33.8	10.3	12.3	4.1	12.3	10.3	35.9	41.0	34.9
Stratum	6	Total (T)	4	1	0	1	2	0	8	3	3
First Date	5/11/03	Removed (R)	1	0	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	3	1	0	1	2	0	8	3	3
DE	0.3908	Expanded	8.7	2.6	0.0	2.6	5.1	0.0	20.5	7.7	7.7
Stratum	7	Total (T)	0	0	0	0	0	0	1	0	3
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	0	0	0	0	0	0	1	0	3
DE	0.4400	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	6.8
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.3424	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	116.1	30.8	33.7	23.1	84.2	29.1	93.8	92.6	115.3
		Number Released	400	139	100	85	214	95	400	399	390

Column header: Sequential Release (R**)/Julian Release Date/Calendar Release Date

Table A.5. 2003 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R19	R20	R21	R22	R23	R24	R25	R26	R27
Detection Efficiency		McNary	60	64	65	66	67	71	73	74	79
(DE) Stratum		Detections	3/1/03	3/5/03	3/6/03	3/7/03	3/8/03	3/12/03	3/14/03	3/15/03	3/20/03
Stratum	1	Total (T)	5	0	0	0	1	1	4	1	1
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	5	0	0	0	1	1	4	1	1
DE	0.5145	Expanded	9.7	0.0	0.0	0.0	1.9	1.9	7.8	1.9	1.9
Stratum	2	Total (T)	5	7	3	1	1	2	16	4	4
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0	2
Last Date	4/26/03	T-R	5	7	3	1	1	2	16	4	2
DE	0.4155	Expanded	12.0	16.8	7.2	2.4	2.4	4.8	38.5	9.6	6.8
Stratum	3	Total (T)	5	3	0	1	0	0	3	0	0
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	5	3	0	1	0	0	3	0	0
DE	0.4707	Expanded	10.6	6.4	0.0	2.1	0.0	0.0	6.4	0.0	0.0
Stratum	4	Total (T)	11	15	4	2	2	1	16	7	5
First Date	4/28/03	Removed (R)	0	0	0	0	0	0	1	0	0
Last Date	5/2/03	T-R	11	15	4	2	2	1	15	7	5
DE	0.5187	Expanded	21.2	28.9	7.7	3.9	3.9	1.9	29.9	13.5	9.6
Stratum	5	Total (T)	14	9	6	2	5	1	13	7	6
First Date	5/3/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/10/03	T-R	14	9	6	2	5	1	13	7	6
DE	0.4876	Expanded	28.7	18.5	12.3	4.1	10.3	2.1	26.7	14.4	12.3
Stratum	6	Total (T)	2	3	0	0	0	1	1	2	3
First Date	5/11/03	Removed (R)	0	1	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	2	2	0	0	0	1	1	2	3
DE	0.3908	Expanded	5.1	6.1	0.0	0.0	0.0	2.6	2.6	5.1	7.7
Stratum	7	Total (T)	2	0	1	0	0	0	0	0	1
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	2	0	1	0	0	0	0	0	1
DE	0.4400	Expanded	4.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0	2.3
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.3424	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	92.0	76.7	29.5	12.5	18.5	13.3	111.8	44.5	40.7
		Number Released	250	245	110	60	50	36	251	87	166

Table A.5. 2003 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R28	R29	R30	R31	R32	R33	R35	R36	R37
Detection Efficiency (DE) Stratum		McNary Detections	80 3/21/03	81 3/22/03	92 4/2/03	93 4/3/03	94 4/4/03	95 4/5/03	100 4/10/03	101 4/11/03	102 4/12/03
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.5145	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	2	1	0	0	0	1	2	2	0
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/26/03	T-R	2	1	0	0	0	1	2	2	0
DE	0.4155	Expanded	4.8	2.4	0.0	0.0	0.0	2.4	4.8	4.8	0.0
Stratum	3	Total (T)	2	0	0	1	0	0	0	0	0
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	2	0	0	1	0	0	0	0	0
DE	0.4707	Expanded	4.2	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	10	2	2	2	3	3	2	0	1
First Date	4/28/03	Removed (R)	1	1	0	0	0	0	1	0	0
Last Date	5/2/03	T-R	9	1	2	2	3	3	1	0	1
DE	0.5187	Expanded	18.4	2.9	3.9	3.9	5.8	5.8	2.9	0.0	1.9
Stratum	5	Total (T)	7	5	1	6	4	6	3	1	0
First Date	5/3/03	Removed (R)	1	0	0	0	0	0	0	0	0
Last Date	5/10/03	T-R	6	5	1	6	4	6	3	1	0
DE	0.4876	Expanded	13.3	10.3	2.1	12.3	8.2	12.3	6.2	2.1	0.0
Stratum	6	Total (T)	1	1	1	3	2	3	1	2	0
First Date	5/11/03	Removed (R)	0	1	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	1	0	1	3	2	3	1	2	0
DE	0.3908	Expanded	2.6	1.0	2.6	7.7	5.1	7.7	2.6	5.1	0.0
Stratum	7	Total (T)	1	0	1	0	1	2	0	0	1
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	1	0	1	0	1	2	0	0	1
DE	0.4400	Expanded	2.3	0.0	2.3	0.0	2.3	4.5	0.0	0.0	2.3
Stratum	8	Total (T)	1	1	0	1	0	0	2	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	1	1	0	1	0	0	2	0	0
DE	0.3424	Expanded	2.9	2.9	0.0	2.9	0.0	0.0	5.8	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	48.5	19.5	10.7	28.9	21.4	32.7	22.3	12.0	4.2
		Number Released	195	80	29	75	70	110	45	40	25

Table A.5. 2003 Outmigrant McNary-Passage Expansions of Roza Dam Releases

a. Natural Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date							
			R38	R40	R41	R42	R43	R44	R45	R46
Detection Efficiency		McNary	106	108	109	114	115	116	121	123
(DE) Stratum		Detections	4/16/03	4/18/03	4/19/03	4/24/03	4/25/03	4/26/03	5/1/03	5/3/03
Stratum	1	Total (T)	0	0	0	0	0	0	0	0
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	0	0	0	0	0	0	0	0
DE	0.5145	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	0	0	0	0	0	0
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0
Last Date	4/26/03	T-R	0	0	0	0	0	0	0	0
DE	0.4155	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0	0	0	0
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	0	0	0	0	0	0	0	0
DE	0.4707	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	1	0	2	0	0	0	0	0
First Date	4/28/03	Removed (R)	1	0	0	0	0	0	0	0
Last Date	5/2/03	T-R	0	0	2	0	0	0	0	0
DE	0.5187	Expanded	1.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	1	1	1	3	4	1	1	1
First Date	5/3/03	Removed (R)	0	1	0	0	1	0	0	0
Last Date	5/10/03	T-R	1	0	1	3	3	1	1	1
DE	0.4876	Expanded	2.1	1.0	2.1	6.2	7.2	2.1	2.1	2.1
Stratum	6	Total (T)	0	2	1	0	1	4	2	3
First Date	5/11/03	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	0	2	1	0	1	4	2	3
DE	0.3908	Expanded	0.0	5.1	2.6	0.0	2.6	10.2	5.1	7.7
Stratum	7	Total (T)	0	0	0	0	1	1	1	1
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	0	0	0	0	1	1	1	1
DE	0.4400	Expanded	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3
Stratum	8	Total (T)	0	0	1	1	1	0	2	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	0	0	1	1	1	0	2	0
DE	0.3424	Expanded	0.0	0.0	2.9	2.9	2.9	0.0	5.8	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	3.1	6.1	11.4	9.1	14.9	14.6	15.3	12.0
		Number Released	15	25	45	35	40	40	75	80

Table A.5. 2003 Outmigrants

b. Previously Untagged Hatchery Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date								
			R27	R28	R29	R30	R31	R32	R33	R35	R36
Detection Efficiency		McNary	79	80	81	92	93	94	95	100	101
(DE) Stratum		Detections	3/20/03	3/21/03	3/22/03	4/2/03	4/3/03	4/4/03	4/5/03	4/10/03	4/11/03
Stratum	1	Total (T)	0	2	1	0	0	0	0	0	0
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	0	2	1	0	0	0	0	0	0
DE	0.5145	Expanded	0.0	3.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	2	1	6	2	2	1	1	0	0
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/26/03	T-R	2	1	6	2	2	1	1	0	0
DE	0.4155	Expanded	4.8	2.4	14.4	4.8	4.8	2.4	2.4	0.0	0.0
Stratum	3	Total (T)	0	0	2	0	1	2	0	0	0
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	0	0	2	0	1	2	0	0	0
DE	0.4707	Expanded	0.0	0.0	4.2	0.0	2.1	4.2	0.0	0.0	0.0
Stratum	4	Total (T)	6	1	8	3	3	3	3	1	5
First Date	4/28/03	Removed (R)	0	0	0	1	0	0	0	0	1
Last Date	5/2/03	T-R	6	1	8	2	3	3	3	1	4
DE	0.5187	Expanded	11.6	1.9	15.4	4.9	5.8	5.8	5.8	1.9	8.7
Stratum	5	Total (T)	4	3	6	5	4	5	4	1	8
First Date	5/3/03	Removed (R)	0	1	0	1	0	0	0	0	0
Last Date	5/10/03	T-R	4	2	6	4	4	5	4	1	8
DE	0.4876	Expanded	8.2	5.1	12.3	9.2	8.2	10.3	8.2	2.1	16.4
Stratum	6	Total (T)	1	0	0	2	0	0	1	1	1
First Date	5/11/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	1	0	0	2	0	0	1	1	1
DE	0.3908	Expanded	2.6	0.0	0.0	5.1	0.0	0.0	2.6	2.6	2.6
Stratum	7	Total (T)	0	0	1	0	0	0	0	0	0
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	0	0	1	0	0	0	0	0	0
DE	0.4400	Expanded	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	8	Total (T)	1	0	0	0	0	0	0	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	1	0	0	0	0	0	0	0	0
DE	0.3424	Expanded	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	30.1	13.3	50.6	24.0	20.9	22.7	19.0	6.5	27.7
		Number Released	100	100	100	100	100	100	100	26	100

Table A.5. 2003 Outmigrants

b. Previously Untagged Hatchery Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date									
			R37	R38	R39	R40	R41	R42	R43	R44	R45	R46
Detection Efficiency		McNary	102	106	107	108	109	114	115	116	121	123
(DE) Stratum		Detections	4/12/03	4/16/03	4/17/03	4/18/03	4/19/03	4/24/03	4/25/03	4/26/03	5/1/03	5/3/03
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.5145	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/26/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.4155	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.4707	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	4	0	0	2	0	0	0	0	0
First Date	4/28/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/2/03	T-R	0	4	0	0	2	0	0	0	0	0
DE	0.5187	Expanded	0.0	7.7	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	3	5	6	6	9	1	5	1	1	0
First Date	5/3/03	Removed (R)	0	0	0	0	1	0	0	0	0	0
Last Date	5/10/03	T-R	3	5	6	6	8	1	5	1	1	0
DE	0.4876	Expanded	6.2	10.3	12.3	12.3	17.4	2.1	10.3	2.1	2.1	0.0
Stratum	6	Total (T)	0	1	1	1	0	0	2	1	3	2
First Date	5/11/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	0	1	1	1	0	0	2	1	3	2
DE	0.3908	Expanded	0.0	2.6	2.6	2.6	0.0	0.0	5.1	2.6	7.7	5.1
Stratum	7	Total (T)	0	0	0	0	0	1	0	0	0	1
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	0	0	0	0	0	1	0	0	0	1
DE	0.4400	Expanded	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	2.3
Stratum	8	Total (T)	0	0	0	0	1	0	0	1	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	0	0	0	0	1	0	0	1	0	0
DE	0.3424	Expanded	0.0	0.0	0.0	0.0	2.9	0.0	0.0	2.9	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	6.2	20.5	14.9	14.9	24.2	4.3	15.4	7.5	9.7	7.4
		Number Released	50	51	100	100	100	60	100	100	75	80

Table A.5. 2003 Outmigrants

c. Previously Tagged Hatchery Origin

			Sequential Release (R**)/Julian Release Date/Calendar Release Date									
			R27	R28	R29	R30	R31	R32	R33	R34	R35	R36
Detection Efficiency		McNary	79	80	81	92	93	94	95	99	100	101
(DE) Stratum		Detections	3/20/03	3/21/03	3/22/03	4/2/03	4/3/03	4/4/03	4/5/03	4/9/03	4/10/03	4/11/03
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.5145	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	3	1	2	0	0	0	0	0	0	0
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/26/03	T-R	3	1	2	0	0	0	0	0	0	0
DE	0.4155	Expanded	7.2	2.4	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	2	0	0	1	1	0	0	0	0
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	0	2	0	0	1	1	0	0	0	0
DE	0.4707	Expanded	0.0	4.2	0.0	0.0	2.1	2.1	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	3	1	0	4	3	0	1	0	0	0
First Date	4/28/03	Removed (R)	1	0	0	0	0	0	0	0	0	0
Last Date	5/2/03	T-R	2	1	0	4	3	0	1	0	0	0
DE	0.5187	Expanded	4.9	1.9	0.0	7.7	5.8	0.0	1.9	0.0	0.0	0.0
Stratum	5	Total (T)	2	2	2	6	5	1	0	0	1	0
First Date	5/3/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/10/03	T-R	2	2	2	6	5	1	0	0	1	0
DE	0.4876	Expanded	4.1	4.1	4.1	12.3	10.3	2.1	0.0	0.0	2.1	0.0
Stratum	6	Total (T)	0	1	0	0	2	0	1	0	0	0
First Date	5/11/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	0	1	0	0	2	0	1	0	0	0
DE	0.3908	Expanded	0.0	2.6	0.0	0.0	5.1	0.0	2.6	0.0	0.0	0.0
Stratum	7	Total (T)	0	0	0	0	0	0	0	1	0	0
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	0	0	0	0	0	0	0	1	0	0
DE	0.4400	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.3424	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	16.2	15.2	8.9	20.0	23.3	4.2	4.5	2.3	2.1	0.0
		Number Released	47	35	49	82	52	18	22	10	9	12

Table A.5. 2003 Outmigrants

c. Previously Tagged Hatchery Origin (continued)

			Sequential Release (R**)/Julian Release Date/Calendar Release Date									
			R37	R38	R39	R40	R41	R42	R43	R44	R45	R46
Detection Efficiency		McNary	102	106	107	108	109	114	115	116	121	123
(DE) Stratum		Detections	4/12/03	4/16/03	4/17/03	4/18/03	4/19/03	4/24/03	4/25/03	4/26/03	5/1/03	5/3/03
Stratum	1	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	4/5/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/15/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.5145	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	2	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	4/16/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/26/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.4155	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	3	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	4/27/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	4/27/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.4707	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	4	Total (T)	0	1	0	0	0	0	0	0	0	0
First Date	4/28/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/2/03	T-R	0	1	0	0	0	0	0	0	0	0
DE	0.5187	Expanded	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	5	Total (T)	0	1	0	0	2	1	0	0	1	0
First Date	5/3/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/10/03	T-R	0	1	0	0	2	1	0	0	1	0
DE	0.4876	Expanded	0.0	2.1	0.0	0.0	4.1	2.1	0.0	0.0	2.1	0.0
Stratum	6	Total (T)	0	0	0	0	0	1	0	1	0	1
First Date	5/11/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/19/03	T-R	0	0	0	0	0	1	0	1	0	1
DE	0.3908	Expanded	0.0	0.0	0.0	0.0	0.0	2.6	0.0	2.6	0.0	2.6
Stratum	7	Total (T)	0	0	1	0	0	0	0	0	0	0
First Date	5/20/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/25/03	T-R	0	0	1	0	0	0	0	0	0	0
DE	0.4400	Expanded	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	8	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	5/26/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	5/31/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.3424	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum	9	Total (T)	0	0	0	0	0	0	0	0	0	0
First Date	6/1/03	Removed (R)	0	0	0	0	0	0	0	0	0	0
Last Date	6/17/03	T-R	0	0	0	0	0	0	0	0	0	0
DE	0.4316	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total Expanded	0.0	4.0	2.3	0.0	4.1	4.6	0.0	2.6	2.1	2.6
		Number Released	14	15	13	17	15	6	20	46	9	13

Table A.5. 2003 Outmigrant McNary-Passage Expansions of Roza Dam Releases

d. Weekly Expansion Summary and Survival-Index Estimates

Julian Date	Beginning	22	29	36	43	50	57	64	71	78
	Ending	28	35	42	49	56	63	70	77	84
Natural Origin	Expanded	28.9	424.6	297.3	289.0	136.3	393.6	137.2	169.6	108.6
	Release Number	115	1588	1200	1039	394	1439	465	374	441
	Survival Index	0.2516	0.2674	0.2477	0.2781	0.3459	0.2735	0.2950	0.4536	0.2463
Untagged Hatchery	Expanded									94.0
	Release Number									300
	Survival Index									0.3134
Tagged Hatchery	Expanded									40.3
	Release Number									131
	Survival Index									0.3079
Pooled Hatchery	Expanded									134.4
	Release Number									431
	Survival Index									0.3117

Julian Date	Beginning	85	92	99	106	113	120	>126		
	Ending	91	98	105	112	119	126			
Natural Origin	Expanded		93.7	38.5	20.6	38.5	27.3			
	Release Number		284	110	85	115	155			
	Survival Index		0.3300	0.3498	0.2418	0.3351	0.1760			
Untagged Hatchery	Expanded		86.6	40.4	74.4	27.2	17.1			
	Release Number		400	176	351	260	155			
	Survival Index		0.2164	0.2294	0.2121	0.1047	0.1104			
Tagged Hatchery	Expanded		52.0	4.3	10.4	7.2	4.6			
	Release Number		174	45	60	72	22			
	Survival Index		0.2986	0.0961	0.1726	0.0996	0.2095			
Pooled Hatchery	Expanded		138.5	44.7	84.8	34.4	21.7			
	Release Number		574	221	411	332	177			
	Survival Index		0.2413	0.2022	0.2063	0.1036	0.1228			

Appendix E

2003 Annual Report: Smolt-to-Smolt Survival of Lower-Yakima Fall Chinook reared under Accelerated and Conventional Conditions (and Survival of Marion Drain Fall Chinook)

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Submitted July 11, 2004

1. Introduction

From 1999 through 2003, there have been three release groups of Fall Chinook. Two of the groups were lower-Yakima Fall Chinook, one being assigned to conventional rearing conditions and the other assigned to rearing conditions designed to accelerate smoltification and outmigration timing during a period that is believed to more optimal for survival. These two groups were released below Prosser Diversion Dam on the lower Yakima.

The third group involves another stock of hatchery-reared Fall Chinook, Marion Drain Fall Chinook, which are genetically distinct from the lower-Yakima stock. The Marion Drain releases are part of a supplementation program that involves taking Marion Drain returns as broodstock and releasing their hatchery-reared progeny back into Marion Drain.

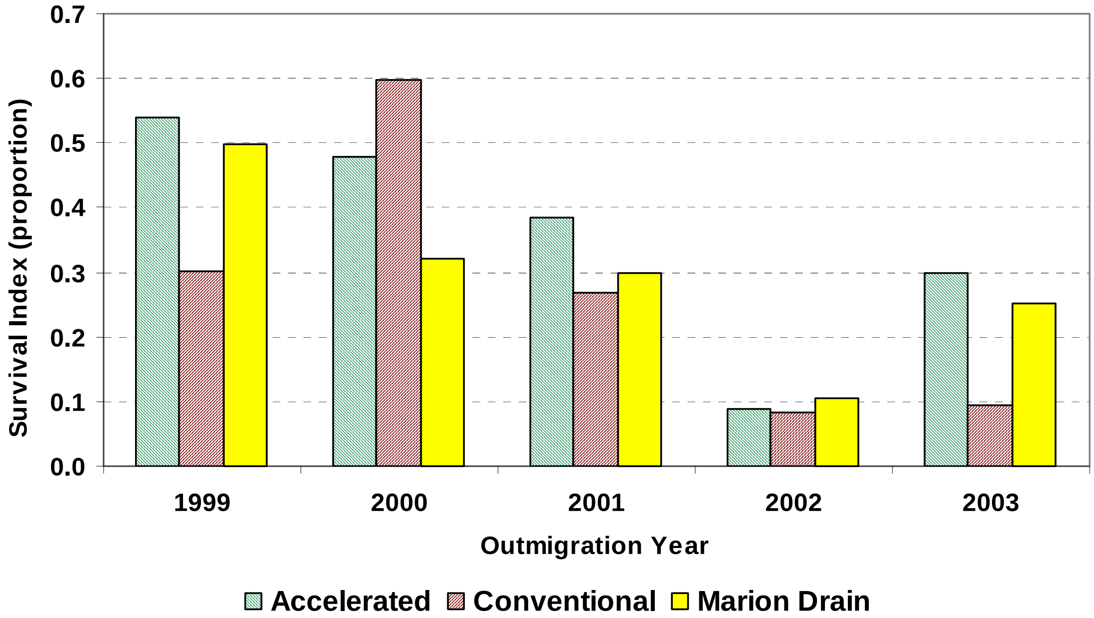
A portion of each release is PIT-tagged, and the survivals of the PIT-tagged portion of each group from release to McNary Dam (McNary) passage are estimated using the PIT-tag detection tallies at McNary expanded (divided) by an estimate of McNary's detection efficiency. The expanded McNary tally for each group divided by the number originally tagged is the estimated survival index. In previous annual reports, there was no attempt made to adjust survival-index estimates for fish that were removed at McNary Dam and not returned to the river. Such fish were treated in the estimate as if they were returned to the river. Further, over the brood years, inconsistent methods of estimating McNary detection efficiencies were inadvertently used to expand numbers of fish detected at McNary. For outmigration years 2000 through 2002, separate releases from each of the three release groups were treated as independent replicates; it turns out they were probably not independent.

The smolt-to-smolt survival-index data from all five outmigration years were reviewed, corrected, and reanalyzed.

2. Summary

The smolt-to-smolt survival indices of the lower-Yakima Coho assigned to the accelerated rearing treatment exceeded those of Coho assigned to the conventional rearing treatment in four of the five years (Figure 1). Although the mean travel time from release to McNary is longer for the accelerated releases in all five years, the accelerated releases' mean date of McNary passage is earlier.

Figure 1. Weighted Tagging-to-McNary-Passage Smolt-to-Smolt Survival Indices for 1999-2003* Outmigrants of three Groups of Fall Chinook (weights are release numbers)**



* Brood-years 1998-2002, respectively.

** Lower Yakima Stock under Accelerated Rearing, Lower Yakima Stock under Conventional Rearing, and Marion Drain Stock

3. Analysis

In outmigration years 1999 and 2003 there were unreplicated releases of the three groups--accelerated, conventional, and Marion Drain. In outmigration-years 2000 through 2002, there were replicated releases of each group, the second release made one day following the first. In previous annual reports, these replicated releases were treated as independent replicates for the purpose of estimating a within-year source of error for statistical analysis purposes. However, Todd Newsome[1] feels that most of the released Fall Chinook do not immediately move out of the release area after release and that it is likely that the fish from the two replicated releases would tend to mix before outmigrating. If this were the case, the replicates would not be independent and the measure of error variation would be too small, leading to an inflated chance of concluding there were statistically significant differences among the groups' survival indices when there were not (overly liberal statistical tests). Therefore, the databases from the two releases within each group within each year were pooled, and the group x year interaction source of variation was used as a source of error. If there are true group x year interactions, the statistical test comparing the groups' means when averaged over years would be overly conservative.

Survival indices were estimated by first estimating the number of PIT-tagged fish reaching McNary. The number of fish detected at McNary was expanded (divided) by McNary's PIT-tag detection efficiency (the estimated proportion of PIT-tagged fish passing McNary that were detected at

[1] Fisheries Biologist, Yakima Nation, personal communication

McNary). The expanded passage, adjusted for removal of PIT-tagged fish at McNary, was then divided by the number of fish tagged, the result being an index of survival. These survival indices were then subjected to a logistic analysis of variation. The estimation and analysis techniques are discussed in Appendix A as are the expansions used to estimate the survival indices.

The logistic analysis of variation is presented in Table 1. The group assigned to the accelerated rearing conditions had a higher mean survival over years compared to the conventionally reared group. The difference was significant at the 10% level (P = 0.072 based on a 1-sided test derived from the logistic analysis of variation, Table 1).

The individual yearly survival-index estimates are given in Table 2 along with mean date of McNary passage and mean travel time from release to McNary passage. The estimates of the accelerated were greater than those of the conventional in 4 of the 5 years. The travel time was greater for the accelerated group in all five years, but the accelerated-rearing group's mean date of McNary passage was always earlier.

The Marion group is not truly comparable to the other two groups because it is a different stock, its release site (Marion Drain) is well upstream of the other two groups' release site (Prosser), and its release time is different than those of the others. With the exception of the first release year, the Marion Drain stock was released before the accelerated rearing treated group. In the first release year, the Marion Drain stock was released later than the conventional rearing group. In all years, the mean travel time from Marion Drain to McNary was greater than the travel time from Prosser to McNary for the other two groups, possibly partially due to the greater distance the Marion Drain stock had to travel. In all but the second year of release, the Marion Drain survival was intermediate between the survivals of the two lower-Yakima stock release groups (less than the accelerated and more than the conventional). In the second year, the Marion Drain had the lowest survival; the second year was the only year in which the accelerated survival index was less than the conventional.

Table 1. Weighted Logistic Analysis of Variation of Tagging-to-McNary Smolt Survival for 1999-2003 Outmigrants of three Groups*** of Fall Chinook (weights are release numbers)**

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev (Dev/DF)	F-Ratio	Type 1 p	
Year	2764.13	4	691.03	9.04	0.0046	
Marion versus Lower Yakima Releases	8.20	1	8.20	0.11	0.7517	
Accelerated versus Conventional	199.47	1	199.47	2.61	0.1449	*
Error (Year x Treatment Interaction)	611.63	8	76.45			

*Type 1 error p (for 1-sided test that Accelerated Survival > Conventional Survival) = 0.0725

** Brood years 1998 through 2002, respectively.

*** Lower-Yakima Stock under Accelerated Rearing, Lower Yakima Stock under Conventional Rearing, and Marion Drain Stock

Table 2. Tagging-to-McNary-Passage Smolt-to-Smolt Survival Indices and Passage Measures for 1999-2003* Outmigrants of three Groups of Fall Chinook (weights are release numbers)**

Outmigration Year		Below-Prosser Release* Accelerated	Below-Prosser Release* Conventional	Marion Release**	Over Treatments
	Expanded McNary Passage	1081.5	593.5	514.1	
	Number Tagged	2000	1973	1032	5005
1999	**Survival Index**	**0.5407**	**0.3008**	**0.4981**	**0.4374**
	Release Date	4/25/99	5/25/99	5/22/99	
	McNary Passage Date	05/22/99	06/17/99	06/21/99	
	Release-to-Passage Time	28	24	31	
	Expanded McNary Passage	972.1	1207.8	321.8	
	Number Tagged	2033	2018	1003	5054
2000	**Survival Index**	**0.4782**	**0.5985**	**0.3209**	**0.4950**
	First* Release Date	4/20/00	5/25/00	4/10/00	
	McNary Passage Date	05/27/00	06/19/00	05/28/00	
	Release-to-Passage Time	36	27	48	
	Expanded McNary Passage	774.1	528.1	303.6	
	Number Tagged	2014	1965	1020	4999
2001	**Survival Index**	**0.3844**	**0.2687**	**0.2976**	**0.3212**
	First* Release Date	4/19/01	5/16/01	4/12/01	
	McNary Passage Date	05/27/01	06/07/01	05/26/01	
	Release-to-Passage Time	38	22	44	
	Expanded McNary Passage	179.9	166.8	105.1	
	Number Tagged	2001	2000	1000	5001
2002	**Survival Index**	**0.0899**	**0.0834**	**0.1051**	**0.0903**
	First* Release Date	4/15/01	5/15/01	4/1/01	
	McNary Passage Date	06/08/02	06/21/02	06/15/02	
	Release-to-Passage Time	54	37	76	
	Expanded McNary Passage	596.6	183.5	249.1	
	Number Tagged	2000	1938	994	4932
2003	**Survival Index**	**0.2983**	**0.0947**	**0.2506**	**0.2087**
	Release Date	4/16/01	5/16/01	4/1/01	
	McNary Passage Date	05/24/03	06/08/03	06/02/03	
	Release-to-Passage Time	23	19	32	
Over Years	Number Tagged	10048	9894	5049	24991
	Survival Index	**0.3587**	**0.2708**	**0.2958**	**0.3112**

* The second release was made on the next day in all cases

** Brood-years 1998-2002, respectively

*** Lower-Yakima Stock under Accelerated Rearing, Lower Yakima Stock under Conventional Rearing, and Marion Drain Stock

Appendix A. Estimated Survival Index and Logistic Analysis

Weighted logistic analyses of variation of release-to-McNary survival-index estimates were undertaken using release number as the weighting variable instead of a traditional least-squares-based analysis of variance[2]. Least squares analysis assumes that the variance of the estimates is constant over releases. In the case of survival-index proportions, this is not expected to be true; the variance is expected to be higher for survival-index proportions nearer 0.5 and lower as survival-index proportions approach 0 or 1. The assumption behind the logistic analysis of variation used is that the variance in the survival index is proportional to what would be expected in the case of a binomially distributed survival-index estimate. The number of fish PIT-tagged varied over releases; variation in release number would also contribute to the variance of the survival-index estimate varying over releases. For this reason, the release number was used as a weighting variable.

In the logistic analysis of variation, the comparison is effectively made among the estimated logit transforms of the survival index, the logit transform being

Equation A.1.

$$y = \text{logit}(s) = \text{natural log}\left(\frac{s}{1-s}\right)$$

s being the estimated proportion surviving. The reverse transform, survival index as a function of the logit, is

Equation A.2.

$$s = \frac{1}{1 + \exp(-y)}$$

wherein exp(-y) is the exponential constant raised to the power given within the parentheses.

Smolt-to-smolt survival index: The release-to-McNary smolt-to-smolt survival index in this study is estimated as follows:

Equation A.3.

$$\text{Release - to - McNary Survival Index} = \frac{\sum\limits_{\text{strata}} \text{For Stratum}\left[\dfrac{(\text{McNary Detections - Detections Removed})}{\text{Stratum's McNary Detection Efficiency}} + \text{Detections Removed}\right]}{\text{Number of PIT - Tagged Fish Released}}$$

[2] Recommended reading on logistic regression: McCullagh, P. and Nelder, J.A. (1989) Generalized Linear Models (2nd edition), Chapman and Hall, London.

wherein

9) “Stratum” is a group of contiguous McNary detection dates among which the daily detection efficiencies[3] were sufficiently homogeneous to permit the use of a pooled estimate of the detection efficiency for that stratum;

10) “McNary Detections” is the release’s fish detected at McNary during the stratum;

11) “Detections Removed” is the number of the stratum’s “McNary Detections” that were removed for transportation or for sampling and not returned to the river (Fish detected at McNary’s Raceways A and B not subsequently detected at McNary); and

12) “Detection Efficiency” is the estimated proportion of <u>all</u>[4] Yakima PIT-tagged Fall Chinook passing McNary Dam during the stratum that were detected at McNary (Equation A.4).

Equation A.4.

$$\text{McNary detection efficiency} = \frac{\text{number of joint detections at McNary and downstream dam}}{\text{estimated total number of detections at downstream dam}}$$

[3] The daily McNary detection efficiency is the proportion of PIT-tagged fish passing McNary that are actually detected at McNary. It is the total number of fish jointly detected at McNary on the McNary date and that are also detected at downstream dams (John Day and Bonneville) divided by the total detected at the downstream dams that are estimated to have passed McNary on that date.

[4] All PIT-tagged Fall Chinook releases into the Yakima, not only those of the three release groups.

The downstream-dam counts actually represent a pooling of counts from John Day and Bonneville dams[5]. The method of estimating the detection efficiency and the pooling procedure are discussed in Appendix B. A major reason for referring to the survival measure as a survival index instead of survival is that there are known biases associated with the detection rate and which are discussed in Appendix B.

Table A. gives the values of the variables presented in Equation A.3 for each acclimation pond along with the resulting survival-index estimates; these estimates form the data-base summary used for the analyses, survival-index estimates, and the figure presented in the main text.

Table A. Stratum Detection Numbers and Detection Efficiencies and Resulting Survival Indices for Each Acclimation Pond

1. Brood-Year 1998 (Outmigration-Year 1999)

Detection Efficiency Strata		McNary Detections	Accelerated	Convetional	Marion Drain
Sratum	1	Total (T)	101	0	0
First Date	4/26/99	Removed (R)	0	0	0
Last Date	5/24/99	T-R	101	0	0
Detection Efficiency	0.2443	Expanded	413.4	0.0	0.0
Sratum	2	Total (T)	157	1	0
First Date	5/25/99	Removed (R)	0	0	0
Last Date	5/31/99	T-R	157	1	0
Detection Efficiency	0.3073	Expanded	510.9	3.3	0.0
Sratum	3	Total (T)	30	94	85
First Date	6/1/99	Removed (R)	0	0	0
Last Date	6/26/99	T-R	30	94	85
Detection Efficiency	0.1908	Expanded	157.3	492.7	445.6
Sratum	4	Total (T)	0	32	22
First Date	6/27/99	Removed (R)	0	1	0
Last Date	8/24/99	T-R	0	31	22
Detection Efficiency	0.3211	Expanded	0.0	97.5	68.5
		Total Expanded	1081.5	593.5	514.1
		Number Tagged	2000	1973	1032
		Survival Index	**0.5407**	**0.3008**	**0.4981**
		Release Date	04/25/99	05/25/99	05/22/99
		McNary Mean Detection Date	05/22/99	06/17/99	06/21/99
		Release to McNary Passage Days	28	24	31

[5] In recent years experiments were conducted at John Day and Bonneville that varied the proportion of flow spilled in the daytime relative to the proportion spilled at night. To offset the electric power lost at one dam during a given period, contravening action was often taken at the other dam (Personal Communication, Rock Peters, U.S. Army Corps of Engineers, Portland, Oregon.) Given this situation, it was deemed more appropriate to pool John Day and Bonneville Dam-based estimates of the McNary detection rate. This means that some of the fish detected at both John Day and Bonneville dams were used twice to estimate the McNary detection efficiency (an effective "sampling with replacement").

2. Brood-Year 1999 (Outmigration-Year 2000)

Detection Efficiency Strata		McNary Detections	Accelerated Release 1	Accelerated Release 2	Convetional Release 1	Convetional Release 2	Marion Drain Release 1	Marion Drain Release 2
Sratum	1	Total (T)	50	51	0	1	5	34
First Date	4/20/00	Removed (R)	0	0	0	0	0	0
Last Date	5/28/00	T-R	50	51	0	1	5	34
Detection Efficiency	0.2050	Expanded	243.9	248.8	0.0	4.9	24.4	165.9
Sratum	2	Total (T)	76	74	82	113	12	28
First Date	5/29/00	Removed (R)	2	6	4	2	0	0
Last Date	6/18/00	T-R	74	68	78	111	12	28
Detection Efficiency	0.3040	Expanded	245.4	229.7	260.6	367.2	39.5	92.1
Sratum	3	Total (T)	0	2	117	117	0	0
First Date	6/19/00	Removed (R)	0	0	0	0	0	0
Last Date	6/28/00	T-R	0	2	117	117	0	0
Detection Efficiency	0.4699	Expanded	0.0	4.3	249.0	249.0	0.0	0.0
Sratum	4	Total (T)	0	0	34	15	0	0
First Date	6/29/00	Removed (R)	0	0	0	0	0	0
Last Date	7/30/00	T-R	0	0	34	15	0	0
Detection Efficiency	0.6354	Expanded	0.0	0.0	53.5	23.6	0.0	0.0
		Total Expanded	489.3	482.7	563.1	644.6	63.9	258.0
		Number Released	1000	1033	1008	1010	495	508
		Survival Index	**0.4893**	**0.4673**	**0.5586**	**0.6383**	**0.1290**	**0.5078**
		Release Date	04/20/00	04/21/00	05/25/00	05/26/00	04/11/00	04/10/00
		McNary Mean Detection Date	05/26/00	05/28/00	06/21/00	06/17/00	05/29/00	05/28/00
		Release to McNary Passage Days	36	37	27	23	48	48
		Pooled Treatment Expanded		972.1		1207.8		321.8
		Pooled Treatment Number Released		2033		2018		1003
		Survival Index		**0.4782**		**0.5985**		**0.3209**
		Pooled McNary Mean Detection Date		05/27/00		06/19/00		05/28/00
		Pooled Release to McNary Passage Days		36		25		48

3. Brood-Year 2000 (Outmigration-Year 2001)

Detection Efficiency Strata		McNary Detections	Accelerated Release 1	Accelerated Release 2	Convetional Release 1	Convetional Release 2	Marion Drain Release 1	Marion Drain Release 2
Sratum	1	Total (T)	285	210	226	112	96	98
First Date		Removed (R)	3	3	2	3	1	1
Last Date		T-R	282	207	224	109	95	97
Detection Efficiency	0.6366	Expanded	446.0	328.2	353.9	174.2	150.2	153.4
		Number Released	1002	1012	1011	954	510	510
		Survival Index	**0.4451**	**0.3243**	**0.3500**	**0.1826**	**0.2946**	**0.3007**
		Release Date	04/19/01	04/20/01	05/16/01	05/17/01	04/13/01	04/12/01
		McNary Mean Detection Date	05/27/01	05/28/01	06/07/01	06/06/01	05/26/01	05/27/01
		Release to McNary Passage Days	38	38	22	21	43	45
		Pooled Treatment Expanded		774.1		528.1		303.6
		Pooled Treatment Number Released		2014		1965		1020
		Survival Index		**0.3844**		**0.2687**		**0.2976**
		Pooled McNary Mean Detection Date		05/27/01		06/07/01		05/26/01
		Pooled Release to McNary Passage Days		38		22		44

4. Brood-Year 2001 (Outmigration-Year 2002)

Detection Efficiency Strata		McNary Detections	Accelerated Release 1	Accelerated Release 2	Convetional Release 1	Convetional Release 2	Marion Drain Release 1	Marion Drain Release 2
Sratum	1	Total (T)	68	69	76	51	43	37
First Date	5/3/02	Removed (R)	0	0	0	0	0	0
Last Date	6/25/02	T-R	68	69	76	51	43	37
Detection Efficiency	0.7615	Expanded	89.3	90.6	99.8	67.0	56.5	48.6
		Number Released	1001	1000	1000	1000	500	500
		Survival Index	**0.0892**	**0.0906**	**0.0998**	**0.0670**	**0.1129**	**0.0972**
		Release Date	04/15/02	04/16/02	05/15/02	05/16/02	04/01/02	04/01/02
		McNary Mean Detection Date	06/09/02	06/07/02	06/19/02	06/22/02	06/14/02	06/16/02
		Release to McNary Passage Days	55	52	36	38	75	77
		Pooled Treatment Expanded		179.9		166.8		105.1
		Pooled Treatment Number Released		2001		2000		1000
		Survival Index		**0.0899**		**0.0834**		**0.1051**
		Pooled McNary Mean Detection Date		06/08/02		06/21/02		06/15/02
		Pooled Release to McNary Passage Days		54		37		76

5. Brood-Year 2002 (Outmigration-Year 2003)

Detection Efficiency Strata		McNary Detections	Accelerated	Convetional	Marion Drain
Sratum	1	Total (T)	72	0	0
First Date	1/0/00	Removed (R)	1	0	0
Last Date	5/19/03	T-R	71	0	0
Detection Efficiency	0.3804	Expanded	187.6	0.0	0.0
Sratum	2	Total (T)	51	0	11
First Date	5/20/03	Removed (R)	1	0	0
Last Date	5/29/03	T-R	50	0	11
Detection Efficiency	0.2429	Expanded	206.8	0.0	45.3
Sratum	3	Total (T)	34	12	33
First Date	5/30/03	Removed (R)	1	0	0
Last Date	6/1/03	T-R	33	12	33
Detection Efficiency	0.3117	Expanded	106.9	38.5	105.9
Sratum	4	Total (T)	35	47	39
First Date	6/2/03	Removed (R)	0	0	1
Last Date	6/15/03	T-R	35	47	38
Detection Efficiency	0.3919	Expanded	89.3	119.9	98.0
Sratum	5	Total (T)	4	17	0
First Date	6/16/03	Removed (R)	0	0	0
Last Date	1/0/00	T-R	4	17	0
Detection Efficiency	0.6775	Expanded	5.9	25.1	0.0
Sratum	6	Total (T)	193	76	83
First Date	1/0/00	Removed (R)	596.5694068	183.5229936	249.1203575
Last Date	1/0/00	T-R	2000	1938	994
Detection Efficiency	0.0000	Expanded	0.3	0.1	0.3
		Total Expanded	596.6	183.5	249.1
		Number Tagged	2000	1938	994
		Survival Index	**0.2983**	**0.0947**	**0.2506**
		Release Date	05/01/03	05/20/03	05/01/03
		McNary Mean Detection Date	05/24/03	06/08/03	06/02/03
		Release to McNary Passage Days	23	19	32

Appendix B. Detection Efficiency Estimation

B.1. Conceptual Computation

The methods used were similar to those developed by Sandford and Smith[6]. The steps are given below.

Step 1. For each downstream dam, joint McNary and downstream detections were cross-tabulated by McNary Dam's first date and downstream-dams' first date of detection [Table B.1.a)].

Step 2. Within each downstream dam's detection date, the relative distribution of joint counts over McNary detection dates was estimated [Table B.1.b)].

Step 3. The resulting relative distribution frequencies from Table B.1.b) were then multiplied by the total downstream dam's detections (whether or not previously detected at McNary) for the given downstream date to obtain estimates of the cross-tab number for the downstream dam's total detections [Table B.1.c)].

Step 4. There were cases where there were downstream detections for a given date but there were no joint downstream and McNary detections for that downstream date. In such cases there was no direct way of allocating the downstream detections to a given McNary date. What was done was to obtain a pseudo-distribution for McNary detection dates by offsetting the six previous downstream dates' and the six following downstream-dates' McNary-date distributions, and applying their pooled offset distributions to the downstream-dam detection date having no joint McNary distribution. (This step probably differs from Smith and Sanford's, their generated daily detection efficiencies being based on a far larger number of total releases from the Snake River basin than those given here for the Yakima basin.)

Step 5. Once the above was done for each downstream dam's detection date, the estimated total downstream detections that were allocated to a given McNary-detection date were then added over downstream-dam detection dates [Table B.1.c), far-right-hand column]. This gave the estimated total downstream-dam detections that passed McNary on the given McNary date.

Step 6. The total joint downstream-dam McNary detections on a given McNary-detection date [Table B.1.a), far-right column] were then divided by the downstream-dam total from step 4 above [Table B.1.c), far-right column], giving an estimated McNary-detection efficiency associated with the McNary date [Table B.1.d), far-right-hand column].

Actually, before the last step, Table B.1.a)'s and Table B.1.b)'s numbers were pooled over John Day and Bonneville Dams.

Daily detection efficiencies were then stratified into contiguous days of relatively homogeneous detection efficiencies, and the daily detection efficiencies were pooled over days within the strata. This was done to increase the precision of detection-efficiency estimates. The strata's beginning and ending dates were chosen in a manner that minimized the variation among daily detection efficiencies within strata, thereby maximizing the detection-rate variation among strata. This was done using step-wise logistic regression. In the first step, the partitioning between all possible sets of two strata that minimized the variation among daily detection efficiencies within strata was selected. With that partitioning fixed, establishing two strata, the second partitioning was then selected in a similar manner among all possible sets of two strata within the strata that were already created in the first partitioning. Again, the partitioning that minimized variation

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[6] Sandford, B.P. and S.G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River Basin anadromous salmonids, 1990-1997. J. Agric. Biol. Environ. Stat. 7:243-263.

among daily detection efficiencies within the strata was selected. This second partitioning was then fixed and, along with the first fixed partitioning, established three strata. A third partitioning was similarly developed within the three established strata to form a fourth stratum. The process was continued as long as the difference between the step's created detection rates was significant at the 10% significance level ($P \leq 0.1$).

In the stratification process, there were three exceptions that would lead to the rejection of a given partitioning:

4. If either one of the resulting strata had less than twenty joint McNary detections, or

5. If the difference between the John Day Dam-based and Bonneville Dam-based detection-efficiency estimates were inconsistent in sign. For example, if the combined Bonneville-based McNary detection efficiency in one of the created strata was greater than that in an adjacent stratum, but the John Day-based McNary detection efficiency in the one was less than that in the adjacent, then the partitioning was not accepted.

6. When the logistic variation[7] of daily detection efficiencies within strata was less than 25% of that expected from the binomial (mean deviance < 0.25).

On completion of the stepwise process, each partitioning was shifted at one-day increments between the two adjacent partitionings to see if the variation within strata could be further reduced. If so, the partitioning that resulted in the greatest reduction was selected.

There was an occasional downstream-dam date for which there was a downstream-dam count but no joint downstream-dam and McNary Dam count within +/- six days of the date (refer Step 4, earlier). Such dates were either very early or very late in the passage period. The downstream count for such days were added into the pooled downstream count for either the first stratum or the last stratum, whichever was appropriate, and the respective detection efficiencies were adjusted accordingly.

[7] As measured by mean deviance = residual deviance/(residual degrees of freedom).

Table B.1. Conceptual method of estimating detection efficiencies

a) Joint McNary Dam (McN) and Downstream Dam (D.S.) Detections (n) by McN and D.S. Detection Dates

McN Date (Julian)	D.S. Date (Julian)								
	…	98	99	100	101	**102**	103	….	Total
90	…	0	0	0	0	**0**	0	…	n(90,.)
…	…	…	…	…	…	**…**	…	…	…
94	…	n(94,98)	n(94,99)	n(94,100)	n(94,101)	**0**	0	…	n(94,.)
95	…	0	n(95,99)	n(95,100)	n(95,101)	**n(95,102)**	0	…	n(95,.)
96	…	0	0	n(96,100)	n(96,101)	**n(96,102)**	n(96,103)	…	n(96,.)
97	…	0	0	0	0	**n(97,102)**	n(97,103)	…	n(97,.)
98	…	0	0	0	0	**n(98,102)**	n(98,103)	…	n(98,.)
99	…	0	0	0	0	**0**	0	…	n(99,.)
…	…	…	…	…	…	**…**	…	…	…
200	…	0	0	0	0	**0**	0	…	n(200,.)
Total	…	n(.,98)	n(.,99)	n(.,100)	n(.,101)	**n(.,102)**	n(.,103)	…	

b) For Each Downstream Site, Estimate Distribution of McNary Date Contributions

McN Date (Julian)	p(McN,D.S.) = n[McN,D.S.)/n(., D.S.) D.S. Date (Julian)					
	…	100	101	**102**	103	…
90	…	…	…	**…**	…	…
…	…	…	…	**…**	…	…
94	…	p(94,100)	p(94,101)	**0**	0	…
95	…	p(95,100)	p(95,101)	**p(95,102)=n(95,102)/n(.,102)**	0	…
96	…	p(96,100)	p(96,101)	**p(96,102)=n(96,102)/n(.,102)**	p(96,103)	…
97	…	0	0	**p(97,102)=n(97,102)/n(.,102)**	p(97,103)	…
98	…	0	0	**p(98,102)=n(98,102)/n(.,102)**	p(98,103)	…
99	…	0	0	**p(99,102)=n(99,102)/n(.,102)**	p(99,103)	…
…	…	…	…	**…**	…	…
200	…	0	0	**0**	0	…
Total		1.000	1.000	**1.000**	1.000	

Table B.1. Conceptual method of estimating detection efficiencies (continued)

c) Allocate Daily Lower Site Counts [N(D.S.)] over McNary Dates using above Distributions and total over Lower Dam Dates within McNary Dates

McN Date (Julian)	N'(McN,D.S.) = N(D.S.)*P(McN,D.S.)						McN Dam Total
	D.S. Date (Julian)						
	…	100	101	**102**	103	…	
90	…	0	0	**0**	0	…	**N'(90,.)**
…	…	…	…	**…**	…	…	**…**
94	…	N'(94,100)	N'(94,101)	**0**	0	…	**N'(94,.)**
95	…	N'(95,100)	N'(95,101)	**N'(95,102)=p(95,102)*N(.,102)**	0	…	**N'(95,.)**
96	…	N'(96,100)	N'(96,101)	**N'(96,102)=p(96,102)*N(.,102)**	N'(96,103)	…	**N'(96,.)**
97	…	0	0	**N'(97,102)=p(97,102)*N(.,102)**	N'(97,103)	…	**N'(97,.)**
98	…	0	0	**N'(98,102)=p(98,102)*N(.,102)**	N'(98,103)	…	**N'(98,.)**
99	…	0	0	**N'(99,102)=p(99,102)*N(.,102)**	N'(99,103)	…	**N'(99,.)**
…	…	…	…	**…**	…	…	**…**
200	…	0	0	**0**	0	…	**N'(200,.)**
Total		N(100)	N(101)	**N(102)**	N(103)	…	

d) Use Total Joint McNary and Downstream Dam Detections [Table a)] and Total Downstream Dam Detections [Table c)] to estimate McNary Detection Efficiencies (McN D.E.)

McNary Dam Date (Julian)	Table a) n Total	Table c) N' Total	McNary Detection Efficiency McN D.E. = n/N'
90	n(90,.)	N'(90,.)	**McN D.E.(90,.)=n(90,.)/N'(90,.)**
…	…	…	**…**
94	n(94,.)	N'(94,.)	**McN D.E.(94,.)=n(94,.)/N'(94,.)**
95	n(95,.)	N'(95,.)	**McN D.E.(95,.)=n(95,.)/N'(95,.)**
96	n(96,.)	N'(96,.)	**McN D.E.(96,.)=n(96,.)/N'(96,.)**
97	n(97,.)	N'(97,.)	**McN D.E.(97,.)=n(97,.)/N'(97,.)**
98	n(98,.)	N'(98,.)	**McN D.E.(98,.)=n(98,.)/N'(98,.)**
99	n(99,.)	N'(99,.)	**McN D.E.(99,.)=n(99,.)/N'(99,.)**
…	…	…	**…**
200	n(200,.)	N'(200,.)	**McN D.E.(200,.)=n(200,.)/N'(200,.)**

B.2. Efficiency Estimates

The Bonneville Dam-based and John Day Dam-based McNary detection-efficiency estimates are given in Table B.2 along with the estimates pooled over those two downstream dams, which were the estimates used.

Assumptions behind the detection efficiency estimation procedures are as follows:

1. Detected and undetected fish passing McNary on a given date are temporally and spatially mixed before reaching the downstream detectors so that their proportional composition at the time of McNary passage will be the same for the surviving fish passing through downstream detectors;

2. Survivals from McNary to downstream-dam detectors are the same for all routes of McNary passage (e.g., survival is the same for fish whether they pass through the bypass, the turbines, or the spillway);

3. The allocations of total downstream dam counts to McNary days of passage are accurate; and

4. The detection rates estimated from John Dam and Bonneville Dams are estimating the same parameters.

Assumption 2 is unlikely to hold.

Assumption 3 is also unlikely to hold, because the method of allocation assumes that the McNary detection efficiencies for a given day of downstream-dam detection are homogeneous. It is unlikely that all fish detected on a given downstream date passed McNary on days for which the detection rates were homogeneous. The estimated detection efficiencies are probably biased, but the bias would be less than assuming a single detection-efficiency value for the whole of McNary passage.

For Assumption 4 to hold for the methods used in this report, the probability of a fish being entrained into the bypass at Bonneville would have to be independent of whether or not that fish was entrained into a bypass at John Day or McNary, and the probability of a fish being entrained into the bypass at John Day would have to be independent of whether or not that fish was entrained into the bypass at McNary.

Table B.2. **Estimated McNary (McN) Detection Rates based on Bonneville (Bonn) and (John Day) Detections and their Pooled Detections with McNary and Based on the Pooling of the Detections of those two dams Downstream (DS) of McNary**

Applicable Passage Dates		Bonneville-Based Estimates			John Day-Based Estimates			Pooled Estimates		
Beginning Date	Ending Date	Detections Bonn	Detections Bonn, McN	Detection Rate	Detections JD	Detections JD, McN	Detection Rate	Detections DS	Detections DS,McN	Detection Rate
Outmigration Year 1999										
	05/24/99	47.1	15	0.3186	100.3	21	0.2095	147.3	36	0.2443
05/25/99	05/31/99	53.7	18	0.3352	167.6	50	0.2984	221.3	68	0.3073
06/01/99	06/26/99	286.8	61	0.2127	787.7	144	0.1828	1074.6	205	0.1908
06/27/99		55.4	17	0.3070	103.4	34	0.3287	158.8	51	0.3211
Outmigration Year 2000										
	05/28/00	42.9	6	0.1398	64.4	16	0.2485	107.3	22	0.2050
05/29/00	06/18/00	82.7	30	0.3629	157.5	43	0.2731	240.1	73	0.3040
06/19/00	06/28/00	4.4	2	0.4545	50.9	24	0.4712	55.3	26	0.4699
06/29/00		3.0	1	0.3333	33.2	22	0.6627	36.2	23	0.6354
Outmigration Year 2001										
		159.0	99	0.6226	551.0	353	0.6407	710.0	452	0.6366
Outmigration Year 2002										
05/03/02	06/25/02	125.0	39	0.3120	265.0	258	0.9736	390.0	297	0.7615
Outmigration Year 2003										
01/00/00	05/19/03	29.4	11	0.3744	31.1	12	0.3861	60.5	23	0.3804
05/20/03	05/29/03	46.7	11	0.2358	113.9	28	0.2458	160.6	39	0.2429
05/30/03	06/01/03	52.5	19	0.3620	188.1	56	0.2977	240.6	75	0.3117
06/02/03	06/15/03	129.0	53	0.4110	253.8	97	0.3822	382.8	150	0.3919
06/16/03	07/08/03	64.5	43	0.6664	52.1	36	0.6912	116.6	79	0.6775

Appendix F

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Annual Report: Smolt Survival to McNary of Year-2003

Coho Releases into the Yakima Basin

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Submitted August 7, 2004

1. Introduction

The 2003 Coho releases differed from those made from 1999 through 2002. The 1999 through 2002 releases were experimental releases that involved two release periods into different sites within the Upper Yakima and Naches subbasins. These releases are referred to here as early and late releases, although the actual timing between the releases differed somewhat from year to year. In 2003 early and late release treatments were discontinued, and smolt were permitted to volitionally the ponds beginning in early April.

For all but the 2000 outmigrants, two different broodstock were evaluated: Yakima returns and a hatchery stock; for the 2000 outmigrants, only a hatchery broodstock was used. For the 1999 outmigrants, the hatchery broodstock used was from Cascade Hatchery (Cascade); for the 2001 through 2003 outmigrants, the hatchery broodstock was from Willard Hatchery (Willard).

Prior to release, a portion of the smolt were PIT-tagged. For each release group, smolt-to-smolt survival was estimated by dividing the number of PIT-tagged smolt estimated to have passed McNary Dam by the number of smolt PIT-tagged. In the year 2003, PIT-tag detectors were installed above the outfall from each pond into the river with the intention of estimating the survival from time of volitional release instead of from time of tagging, since the time-of-tagging estimate would have been impacted by pre-release survival. However, the efficiency of the acclimation pond detectors was poor; therefore, as in previous years, the survival from time-of-tagging was used instead of from time of volitional release.

In previous annual reports, there was no attempt made to adjust survival-index estimates for fish that were removed at McNary Dam (McNary) and not returned to the river. Such fish were treated as non-removed fish. Further, over the brood years, inconsistent methods of estimating McNary detection efficiencies were inadvertently used to expand numbers of fish detected at McNary. In the 1999 and 2001 outmigration years, there was strong evidence that some of the early and late treatment pairs' actual time-of-release (early versus late) and their intended time of release were actually switched. This error for the 1999 outmigrants was accounted for in previous annual reports, but the errors for the 2001 outmigrants was not discovered until this year.

The smolt-to-smolt survival-index data from all five outmigration years were reviewed, corrected and reanalyzed.

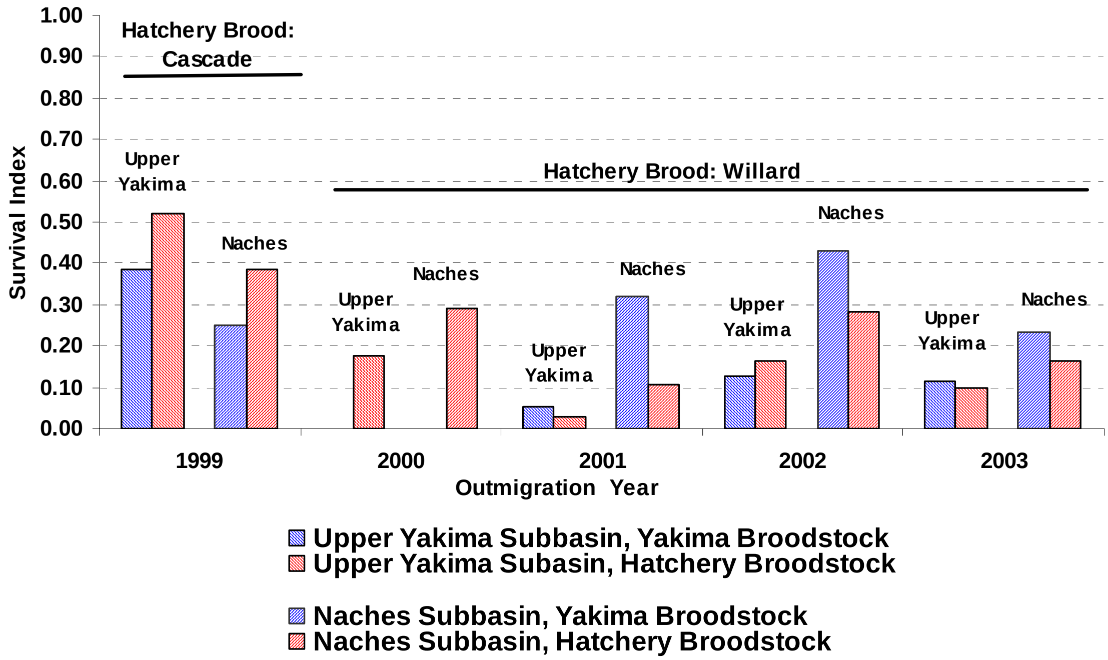
2. Summary

There was no significant difference between the smolt-to-smolt survival indices of early and late released smolt. There was evidence of a significant difference between the survival from fish derived from Yakima-return broodstock and those derived from hatchery broodstock. The 1999-outmigrants derived from Cascade broodstock had a significantly higher smolt-to-smolt survival to McNary than did than those derived from Yakima-return-derived broodstock; however, the 2001-2003 broods derived from the Yakima-return broodstock had a significant higher survival than those derived from the Willard broodstock when averaged over release sites and years. While there is evidence of higher order interactions of broodstock with years and subbasins, these relative relations between broodstock held for almost every year x subbasin combination for which there was information (Figure 1).

2. Analysis

In outmigration-year 2003, Coho were volitionally released from two sites on the Upper Yakima River (Easton and Holms) and from two sites on the Naches River (Lost Creek and Stiles). In previous years, fish were transferred from ponds directly into the rivers on two different fixed released dates. The two releases date varied from year to year, but the releases are generally characterized as early and late releases. With the exception of releases made in year 2000, there were two broodstock sources (hatchery-broodstock and Yakima adult-return broodstock) evaluated. The hatchery broodstock used for releases made in outmigration-year 1999 (broodyear 1997) was from Cascade Hatchery. The hatchery broodstock for releases made in outmigration years 2000 through 2003 (broodyears 1998 through 2001, respectively) were from Willard Hatchery. There were insufficient Yakima adult returns in 1998 to establish Yakima-return-broodstock releases in Year 2000.

Figure 1. Tagging-to-McNary-Passage Smolt-to-Smolt Survival Indices from Hatchery- and Yakima-derived brood released into the Upper Yakima and Naches Rivers (outmigration years 1999-2003).



Data Base. In previous years there was usually a unique tag code for each combination of treatment and stock at each site. In year 2003, there often were multiple tag codes.

Since the treatment combinations were superimposed on production ponds, errors were sometimes made. In 2003 the same tag code was used for Yakima stock released from both of the Upper Yakima sites. Therefore, for the purpose of statistically comparing the two stocks, the Willard-stock databases for those two sites were pooled.

It was also discovered that, for the 2001 outmigrants, the mean dates of McNary detections from Naches ponds designated for late releases of Willard stock were always earlier than from comparable ponds designated for early releases. This was not true of Upper Yakima releases of Willard stock or for any of the Yakima stock releases. While it may be possible that early released Willard stock stayed in the system longer than late released stock, this is unlikely to be the case. For one of the sites of Willard release (Stiles on the Naches), it was discovered that an estimated 34% of the McNary passage of the "late" released fish occurred before the late release date at Stiles, whereas only 2% of the "early" release fish was detected before the late release date[1]. It seems likely that the intended release times were switched; therefore, for analysis purposes, reassignment of release pairs to the early and late categories were generally based on mean date of McNary detection. Such reassignments were made for some of the 1999 releases as well; however, these reassignments were made prior to writing of the 1999 (and subsequent) annual reports. I failed to catch the problem for the 2001 outmigrants until this

[1] There have been early escapes from ponds that led to early McNary detections in all years for which there were early and late detection (e.g., McNary detections preceding release date for some releases). For the 2001 outmigrants, the percentages of McNary passage occurring prior to release date were 0% for both the "early" and "late" for all Naches-site Willard releases except for the late Stiles release.

year, and no such corrections were made for the analyses presented in the 2001 and 2002 annual reports. Appendix A gives individual release information summaries with indications as to data adjustments that were made with the actual data used in the analyses flagged with an asterisk.

Results. Table 1 presents the combined weighted logistic analysis of variation[2] of smolt-to-smolt survival indices over years, the weights being the number of fish released. Neither the effect of release time (early versus late) nor the effects of the interaction between stock and release time were significant (P = 0.464 and P = 0.292, respectively, Table 1). There are significant differences between the survival indices of the Cascade and Yakima-return broods and between the Willard and Yakima-return broods (P = 0.014 and P < 0.001, respectively, Table 1). As can be seen from Figure 1 and from the means in Table 2, smolt from the Yakima-return broodstock in outmigration year 1999 had a lower smolt-to-smolt survival than smolt from the Cascade broodstock. Referring to Table 3, the actual data base used in the analysis, there are eight pairs of possible comparisons for the 1999 data set (4 sites x 2 release times), and for all 8, the Cascade outperforms the Yakima-returns in terms of the survival index (P = 0.008 based on two sided sign test). Smolt from the Yakima-return broodstock in outmigration years 2001 through 2003 generally had a higher smolt-to-smolt survival than smolt from the Willard broodstock (Figure 1 and Table 2 means). There is some evidence that the Yakima Broodstock did not outperform the Willard at all sites in all years (note Willard had a slightly higher survival index than Yakima for the Upper Yakima release in 2002 and note the significant higher-order interaction in Table 1, P = 0.015). Referring to Table 3, there were 15 pairs of comparisons over those three years, and the Yakima-returns outperformed the Willard Hatchery in 12 out of the 15 (P = 0.028 based on 2-sided sign test).

It is interesting to note from Table 3 that the earlier McNary-passing stock tended to have the highest survival index. For 7 of 8 pairs of releases involving Yakima-return and Cascade broodstock, the Cascade broodstock, which had the highest mean survival index, passed McNary earlier than the Yakima (P = 0.008, based on 2-sided sign test). For all 15 pairs involving Yakima-return and Willard broodstock, the Yakima-return broodstock, which had the highest mean survival index, passed McNary earlier than the Willard (P < 0.001, based on 2-side sign test).

Table 1. Weighted Logistic Analysis of Variation of Release-to-McNary Smolt Survival for 1999-2003 Coho Outmigrants (respectively Brood-years 1997-2001) released into the Upper Yakima and Naches Subbasins (weights are release numbers)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 P
Year	4430.82	4	1107.71	13.91	**0.0000**
Basin (adjusted for year)	917.12	1	917.12	11.52	**0.0011**
Basin x Year Interaction	2136.02	4	534.01	6.71	**0.0001**
Site	2728.44	3	909.48	11.42	**0.0000**
Site x Year Interaction	398.2	5	79.64	base for above F-tests	
Stock	1189.87	2	594.94	10.42	**0.0004**
Willard vs Yakima	394.26	1	394.26	6.90	**0.0140**
Cascade vs Yakima	795.62	1	795.62	13.93	**0.0009**
Treatment (Trt--Early vs Late)	31.24	1	31.24	0.55	0.4659
Stock x Trt Interaction*	147.13	2	73.57	1.29	0.2922
Other Interactions**	1114.76	6	185.79	3.25	**0.0154**
Within-Year Error***	1542.12	27	57.12	base for stock, treatment F-tests	

* (Willard vs Yakima) x Trt; (Cascade vs Yakima) x Trt

** Iteractions not included within Error

*** Includes Interactions of Stock, Trt, and Stock x Trt with Basin and Site within Basin within Year

[2] The logistic analysis of variation is discussed briefly in Appendix B.

Table 2. Weighted Coho Release-to-McNary Smolt Survival Indices from Hatchery and Yakima-Return Broodstock for Upper Yakima and Naches Releases in Years 1999 through 2003 (Brood-Years 1997 through 2001, respectively) (weights are release numbers)

		Outmigration Year				
Subbasin	**Broodstock**	**1999**	**2000**	**2001**	**2002**	**2003**
Upper Yakima	**Yakima Returns**	0.3866		0.0512	0.1287	0.1155
	Hatchery Source	0.5200	0.1758	0.0286	0.1647	0.0980
Naches	**Yakima Returns**	0.2490		0.3185	0.4283	0.2334
	Hatchery Source	0.3841	0.2930	0.1059	0.2936	0.1633

Table 3. Database used in the Analysis of Coho Release-to-McNary Smolt Survival Indices from Hatchery and Yakima-Return Broodstock for Upper Yakima and Naches Releases in Years 1999 through 2003 (Brood-Years 1997 through 2001, respectively)

Year	Subbasin	Site	Stock	Assigned Release Treatment	Number Released	Survival Index	Mean McNary Dam Passage Date
1999	Upper Yakima	Cle Elum	Cascade	Early	799	**0.5041**	**5/29/99**
			Yakima	Early	1158	**0.4958**	**5/30/99**
			Cascade	Late	809	**0.4021**	**6/6/99**
			Yakima	Late	1181	**0.3319**	**6/5/99**
		Jack Creek	Cascade	Early	1245	**0.6351**	**5/31/99**
			Yakima	Early	1243	**0.3733**	**6/7/99**
			Cascade	Late	1246	**0.4916**	**6/9/99**
			Yakima	Late	1229	**0.3498**	**6/15/99**
	Naches	Lost Creek	Cascade	Early	1160	**0.3410**	**6/4/99**
			Yakima	Early	1047	**0.1499**	**6/10/99**
			Cascade	Late	1220	**0.0744**	**6/5/99**
			Yakima	Late	1144	**0.0139**	**7/9/99**
		Stiles	Cascade	Early	1274	**0.5485**	**5/28/99**
			Yakima	Early	1244	**0.3989**	**5/31/99**
			Cascade	Late	1248	**0.5589**	**6/4/99**
			Yakima	Late	1240	**0.3991**	**6/7/99**
2000	Upper Yakima	Cle Elum	Willard	Early	2487	**0.1555**	**6/1/00**
				Late	2462	**0.0224**	**6/11/00**
		Easton	Willard	Early	2476	**0.3169**	**5/31/00**
				Late	2476	**0.2076**	**6/13/00**
	Naches	Lost Creek	Willard	Early	2489	**0.3032**	**6/3/00**
				Late	2488	**0.1670**	**6/12/00**
		Stiles	Willard	Early	2488	**0.2954**	**5/27/00**
				Late	2493	**0.4061**	**6/1/00**
2001	Upper Yakima	Cle Elum	Willard	Early	**1219**	**0.0148**	**6/9/01**
			Yakima	Early	**1207**	**0.0119**	**5/12/01**
			Willard	Late	1197	**0.0129**	**6/20/01**
			Yakima	Late	1240	**0.0182**	**6/6/01**
		Easton	Willard	Early	**1234**	**0.0734**	**6/5/01**
			Yakima	Early	**1249**	**0.1250**	**5/30/01**
			Willard	Late	1234	**0.0125**	**6/11/01**
			Yakima	Late	1247	**0.0484**	**6/4/01**
	Naches	Lost Creek	Willard	Early	**1245**	**0.0292**	**6/8/01**
			Yakima	Early	**1250**	**0.2502**	**5/22/01**
			Willard	Late	1240	**0.0279**	**6/12/01**
			Yakima	Late	1251	**0.1839**	**5/26/01**
		Stiles	Willard	Early	**1237**	**0.1575**	**5/28/01**
			Yakima	Early	**1249**	**0.3897**	**5/21/01**
			Willard	Late	1236	**0.2099**	**6/5/01**
			Yakima	Late	1249	**0.4507**	**5/31/01**

Table 3. (continued)

Year	Subbasin	Site	Stock	Assigned Release Treatment	Number Released	Survival Index	Mean McNary Dam Passage Date
2002	Upper Yakima	Easton	Willard	Early	1248	**0.0634**	**5/30/02**
				Late	2497	**0.2153**	**6/2/02**
	Naches	Lost Creek	Willard	Early	1249	**0.2804**	**6/3/02**
			Yakima	Early	1192	**0.2320**	**5/13/02**
			Willard	Late	1247	**0.1452**	**6/3/02**
			Yakima	Late	1250	**0.4308**	**5/28/02**
		Stiles	Willard	Early	1249	**0.3182**	**5/26/02**
			Yakima	Early	1250	**0.2680**	**5/19/02**
			Willard	Late	1251	**0.4300**	**6/1/02**
			Yakima	Late	1250	**0.7734**	**5/30/02**
2003	Upper Yakima	Holms,Easton	Willard	Volitional	4960	**0.0980**	**6/4/03**
			Yakima	Volitional	3355	**0.1155**	**5/26/03**
	Naches	Lost Creek	Willard	Volitional	2497	**0.0898**	**6/6/03**
			Yakima	Volitional	3333	**0.2098**	**6/3/03**
		Stiles	Willard	Volitional	2501	**0.2367**	**5/30/03**
			Yakima	Volitional	3332	**0.2571**	**5/22/03**

Appendix A. Survival Index Estimates used for Data Base

Table A. Date summaries from which data base was selected (Method of estimation and estimation computations used to estimate survival indices in above table presented in Appendix B.)

Year	File Extender	Site	Stock	Intended Release Treatment	Assigned Release Treatment	Stated Release Date	McNary Detection Date	Number Released	Survival Index
1999	CCE	Cle Elum	Cascade	Early	Early	5/17	5/29	799	**0.5041** *
1999	CCL	Cle Elum	Cascade	Late	Late	5/27	6/6	809	**0.4021** *
1999	CYE	Cle Elum	Yakima	Early	Early	5/17	5/30	1158	**0.4958** *
1999	CYL	Cle Elum	Yakima	Late	Late	5/27	6/5	1181	**0.3319** *
1999	JCE	Jack Creek	Cascade	Early	**Late**	**5/17**	**6/9**	1246	**0.4916** *,**
1999	JCL	Jack Creek	Cascade	Late	**Early**	**5/27**	**5/31**	1245	**0.6351** *,**
1999	JYE	Jack Creek	Yakima	Early	**Late**	**5/17**	**6/15**	1229	**0.3498** *,**
1999	JYL	Jack Creek	Yakima	Late	**Early**	**5/27**	**6/7**	1243	**0.3733** *,**
1999	LCE	Lost Creek	Cascade	Early	Early	5/17	6/4	1160	**0.3410** *
1999	LCL	Lost Creek	Cascade	Late	Late	5/27	6/5	1220	**0.0744** *
1999	LYE	Lost Creek	Yakima	Early	Early	5/17	6/10	1047	**0.1499** *
1999	LYL	Lost Creek	Yakima	Late	Late	5/27	7/9	1144	**0.0139** *
1999	SCE	Stiles	Cascade	Early	**Late**	**5/17**	**6/4**	1248	**0.5589** *,**
1999	SCL	Stiles	Cascade	Late	**Early**	**5/27**	**5/28**	1274	**0.5485** *,**
1999	SYE	Stiles	Yakima	Early	**Late**	**5/17**	**6/7**	1240	**0.3991** *,**
1999	SYL	Stiles	Yakima	Late	**Early**	**5/27**	**5/31**	1244	**0.3989** *,**
2000	CWE	Cle Elum	Willard	Early	Early	5/7	6/1	2487	**0.1555** *
2000	CWL	Cle Elum	Willard	Late	Late	5/31	6/11	2462	**0.0224** *
2000	EWE	Easton	Willard	Early	Early	5/7	5/31	2476	**0.3169** *
2000	EWL	Easton	Willard	Late	Late	5/31	6/13	2476	**0.2076** *
2000	LWE	Lost Creek	Willard	Early	Early	5/7	6/3	2489	**0.3032** *
2000	LWL	Lost Creek	Willard	Late	Late	5/31	6/12	2488	**0.1670** *
2000	SWE	Stiles	Willard	Early	Early	5/7	5/27	2488	**0.2954** *
2000	SWL	Stiles	Willard	Late	Late	5/31	6/1	2493	**0.4061** *
2001	CWE	Cle Elum	Willard	Early	**Late**	**5/7**	**6/20**	**1197**	**0.0129** *,**
2001	CWL	Cle Elum	Willard	Late	**Early**	**5/25**	**6/9**	**1219**	**0.0148** *,**
2001	CYE	Cle Elum	Yakima	Early	EARLY	5/7	5/12	1207	**0.0119** *
2001	CYL	Cle Elum	Yakima	Late	Late	5/25	6/6	1240	**0.0182** *
2001	EWE	Easton	Willard	Early	**Late**	**5/7**	**6/11**	**1234**	**0.0125** *,**
2001	EWL	Easton	Willard	Late	**Early**	**5/25**	**6/5**	**1234**	**0.0734** *,**
2001	EYE	Easton	Yakima	Early	EARLY	5/7	5/30	1249	**0.1250** *
2001	EYL	Easton	Yakima	Late	Late	5/25	6/4	1247	**0.0484** *
2001	LWE	Lost Creek	Willard	Early	**Late**	**5/7**	**6/12**	**1240**	**0.0279** *,**
2001	LWL	Lost Creek	Willard	Late	**Early**	**5/25**	**6/8**	**1245**	**0.0292** *,**
2001	LYE	Lost Creek	Yakima	Early	EARLY	5/7	5/22	1250	**0.2502** *
2001	LYL	Lost Creek	Yakima	Late	Late	5/25	5/26	1251	**0.1839** *
2001	SWE	Stiles	Willard	Early	**Late**	**5/7**	**6/5**	**1236**	**0.2099** *,**
2001	SWL	Stiles	Willard	Late	**Early**	**5/25**	**5/28**	**1237**	**0.1575** *,**
2001	SYE	Stiles	Yakima	Early	EARLY	5/7	5/21	1249	**0.3897** *
2001	SYL	Stiles	Yakima	Late	Late	5/25	5/31	1249	**0.4507** *

*** Estimates actually used in analysis**

**** Change of release-date category--detection dates suggest early and late release dates switched**

Appendix A. (continued)

Year	File Extender	Site	Stock	Intended Release Treatment	Assigned Release Treatment	Stated Release Date	McNary Detection Date	Number Released	Survival Index	
2002	EWE	Easton	Willard	Early	Early	5/6	5/30	1248	**0.0634** *	
2002	EWL	Easton	Willard	Late	Late	5/25	6/2	2497	**0.2153** *	
2002	EYE	Easton	Yakima, Willard	Early	Early	3/28	5/2	1249	0.0163	**of mixed stock and erroneous release site**
2002	EYL	Easton	Yakima, Willard	Late	Late	5/25	5/28	2500	0.1287	**Omitted because of mixed stock**
2002	LWE	Lost Creek	Willard	Early	Early	5/6	6/3	1249	**0.2804** *	
2002	LWL	Lost Creek	Willard	Late	Late	5/25	6/3	1247	**0.1452** *	
2002	LYE	Lost Creek	Yakima	Early	Early	5/6	5/13	1192	**0.2320** *	
2002	LYL	Lost Creek	Yakima	Late	Late	5/25	5/28	1250	**0.4308** *	
2002	SWE	Stiles	Willard	Early	Early	5/6	5/26	1249	**0.3182** *	
2002	SWL	Stiles	Willard	Late	Late	5/25	6/1	1251	**0.4300** *	
2002	SYE	Stiles	Yakima	Early	Early	5/6	5/19	1250	**0.2680** *	
2002	SYL	Stiles	Yakima	Late	Late	5/25	5/30	1250	**0.7734** *	
2003	EWB	Easton	Willard	Volitional	Volitional	4/8	6/9	833	0.0767	**Due to common stock (HWY below), Willard releases pooled to permit stock comparison**
2003	EWD	Easton	Willard	Volitional	Volitional	4/8	6/9	864	0.0596	
2003	EWF	Easton	Willard	Volitional	Volitional	4/8	6/9	764	0.0495	
2003	HW9	Holms	Willard	Volitional	Volitional	4/8	5/31	1249	0.1179	
2003	HWA	Holms	Willard	Volitional	Volitional	4/8	6/2	1250	0.1484	
2003	EW,HW pooled	Upper Yakima	Willard	Volitional	Volitional	4/8	6/4	4960	**0.0980** *	**Pooling of EWB,EWD.EWF,HW9,HWA above**
2003	HYV	Holms,Easton	Yakima	Volitional	Volitional	4/7	5/26	3355	**0.1155** *	**Common release from two sites**
2003	LW1	Lost Creek	Willard	Volitional	Volitional	4/8	6/6	1276	0.0724	
2003	LW3	Lost Creek	Willard	Volitional	Volitional	4/8	6/6	1221	0.1080	
2003	LW pooled	Lost Creek	Willard	Volitional	Volitional	4/8	6/6	2497	**0.0898** *	
2003	LYV	Lost Creek	Yakima	Volitional	Volitional	4/7	6/3	3333	**0.2098** *	
2003	SW5	Stiles	Willard	Volitional	Volitional	4/8	5/30	1250	0.2522	
2003	SW7	Stiles	Willard	Volitional	Volitional	4/8	5/30	1251	0.2213	
2003	SW pooled	Stiles	Willard	Volitional	Volitional	4/8	5/30	2501	**0.2367** *	
2003	SYV	Stiles	Yakima	Volitional	Volitional	4/1	5/22	3332	**0.2571** *	

Appendix B. Estimated Survival Index and Logistic Analysis

Weighted logistic analyses of variation of release-to-McNary survival-index estimates were undertaken using release number as the weighting variable instead of a traditional least-squares-based analysis of variance[3]. Least squares analysis assumes that the variance of the estimates is constant over releases. In the case of survival-index proportions, this is not expected to be true; the variance is expected to be higher for survival-index proportions nearer 0.5 and lower as survival-index proportions approach 0 or 1. The assumption behind the logistic analysis of variation used is that the variance in the survival index is proportional to what would be expected in the case of a binomially distributed survival-index estimate. The number of PIT-tagged fish released varied over releases; variation in release number would also contribute to the variance of the survival-index estimate varying over releases. For this reason, the release number was used as a weighting variable.

In the logistic analysis of variation, the comparison is effectively made among the estimated logit transforms of the survival index, the logit transform being

Equation B.1.

$$y = \text{logit(s)} = \text{natural log}\left(\frac{s}{1-s}\right)$$

s being the estimated proportion surviving. The reverse transform, survival index as a function of the logit, is

Equation B.2.

$$s = \frac{1}{1 + \exp(-y)}$$

wherein exp(-y) is the exponential constant raised to the power given within the parentheses.

Smolt-to-smolt survival index: The release-to-McNary smolt-to-smolt survival index in this study is estimated as follows:

[3] Recommended reading on logistic regression: McCullagh, P. and Nelder, J.A. (1989) Generalized Linear Models (2nd edition), Chapman and Hall, London.

Equation B.3.

$$\text{Release - to - McNary Survival Index}$$
$$=$$
$$\frac{\sum_{\text{strata}} \text{For Stratum}\left[\frac{(\text{McNary Detections - Detections Removed})}{\text{Stratum's McNary Detection Efficiency}} + \text{Detections Removed}\right]}{\text{Number of PIT - Tagged Fish Released}}$$

wherein

13) "Stratum" is a group of contiguous McNary detection dates among which the daily detection efficiencies[4] were sufficiently homogeneous to permit the use of a pooled estimate of the detection efficiency for that stratum;

14) "McNary Detections" is the release's fish detected at McNary during the stratum;

15) "Detections Removed" is the number of the stratum's "McNary Detections" that were removed for transportation or for sampling and not being returned to the river (Fish detected at McNary's Raceways A and B not subsequently detected at McNary); and

16) "Detection Efficiency" is the estimated proportion of <u>all</u>[5] those Yakima PIT-tagged Coho passing McNary Dam during the stratum that were detected at McNary (Equation A.4).

Equation B.4.

$$\text{McNary detection efficiency}$$
$$=$$
$$\frac{\text{number of joint detections at McNary and downstream dam}}{\text{estimated total number of detections at downstream dam}}$$

[4] The daily McNary detection efficiency is the proportion of PIT-tagged fish passing McNary that are actually detected at McNary. It is the total number of fish jointly detected at McNary on the McNary date and that are also detected at downstream dams (John Day and Bonneville) divided by the total detected at the downstream dams that are estimated to have passed McNary on that date.

[5] All PIT-tagged Coho releases into the Yakima, upper Yakima, and Naches, not only those of the this study's release groups.

The downstream-dam counts actually represent a pooling of counts from John Day and Bonneville dams[6]. The method of estimating the detection efficiency and the pooling procedure are discussed in Appendix C. A major reason for referring to the survival measure as a survival index instead of survival is that there are known biases associated with the detection rate which are also discussed in Appendix C.

Table B. gives the values of the variables presented in Equation A.3 for each acclimation pond along with the resulting survival-index estimates; these estimates form the data-base summary used for the analyses, survival-index estimates, and the figure presented in Section 2.

[6] In recent years experiments were conducted at John Day and Bonneville that varied the proportion of flow spilled in the daytime relative to the proportion spilled at night. To offset the electric power lost at one dam during a given period, contravening action was often taken at the other dam (Personal Communication, Rock Peters, U.S. Army Corps of Engineers, Portland, Oregon.) Given this situation, it was deemed more appropriate to pool John Day and Bonneville Dam-based estimates of the McNary detection rate. This means that some of the fish detected at both John Day and Bonneville dams were used twice to estimate the McNary detection efficiency (an effective “sampling with replacement”).

Table B. Stratum Detection Numbers and Detection Efficiencies and Resulting Survival Indices for Each Acclimation Pond

1. Brood-year 1997 (Outmigration-year 1999)

			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date							
			Upper Yakima							
			Cle Elum	Cle Elum	Cle Elum	Cle Elum	Jack Creek	Jack Creek	Jack Creek	Jack Creek
			Cascade	Cascade	Yakama	Yakama	Cascade	Cascade	Yakama	Yakama
			Early	Late	Early	Late	Late	Early	Late	Early
Detection Efficiency		McNary	137	147	137	147	137	147	137	147
(DE) Stratum		Detections	5/17/99	5/27/99	5/17/99	5/27/99	5/17/99	5/27/99	5/17/99	5/27/99
Stratum	1	Total (T)	4	0	2	0	0	5	0	0
First Date	4/25/99	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/25/99	T-R	4	0	2	0	0	5	0	0
DE	0.2297	Expanded	17.4	0.0	8.7	0.0	0.0	21.8	0.0	0.0
Stratum	2	Total (T)	72	51	104	64	76	139	28	61
First Date	5/26/99	Removed (R)	0	0	0	0	0	0	0	0
Last Date	6/14/99	T-R	72	51	104	64	76	139	28	61
DE	0.1949	Expanded	369.5	261.7	533.7	328.4	390.0	713.3	143.7	313.0
Stratum	3	Total (T)	2	8	4	8	28	7	36	19
First Date	6/15/99	Removed (R)	0	0	0	0	0	0	0	0
Last Date	7/4/99	T-R	2	8	4	8	28	7	36	19
DE	0.1258	Expanded	15.9	63.6	31.8	63.6	222.6	55.7	286.2	151.1
		Total Expanded	402.8	325.3	574.2	392.0	612.6	790.7	429.9	464.1
		Number Releasec	799	809	1158	1181	1246	1245	1229	1243
		Survival Index	**0.5041**	**0.4021**	**0.4958**	**0.3319**	**0.4916**	**0.6351**	**0.3498**	**0.3733**

			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date							
			Naches							
			Lost Creek	Lost Creek	Lost Creek	Lost Creek	Stiles	Stiles	Stiles	Stiles
			Cascade	Cascade	Yakama	Yakama	Cascade	Cascade	Yakama	Yakama
			Early	Late	Early	Late	Late	Early	Late	Early
Detection Efficiency		McNary	137	147	137	147	137	147	137	147
(DE) Stratum		Detections	5/17/99	5/27/99	5/17/99	5/27/99	5/17/99	5/27/99	5/17/99	5/27/99
Stratum	1	Total (T)	1	4	0	0	3	6	0	1
First Date	4/25/99	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/25/99	T-R	1	4	0	0	3	6	0	1
DE	0.2297	Expanded	4.4	17.4	0.0	0.0	13.1	26.1	0.0	4.4
Stratum	2	Total (T)	53	5	12	0	121	128	67	85
First Date	5/26/99	Removed (R)	0	0	0	0	0	0	0	0
Last Date	6/14/99	T-R	53	5	12	0	121	128	67	85
DE	0.1949	Expanded	272.0	25.7	61.6	0.0	620.9	656.8	343.8	436.2
Stratum	3	Total (T)	15	6	12	2	8	2	19	7
First Date	6/15/99	Removed (R)	0	0	0	0	0	0	0	0
Last Date	7/4/99	T-R	15	6	12	2	8	2	19	7
DE	0.1258	Expanded	119.3	47.7	95.4	15.9	63.6	15.9	151.1	55.7
		Total Expanded	395.6	90.772846	156.97781	15.900226	697.55831	698.83871	494.85402	496.17118
		Number Releasec	1160	1220	1047	1144	1248	1274	1240	1244
		Survival Index	**0.3410**	**0.0744**	**0.1499**	**0.0139**	**0.5589**	**0.5485**	**0.3991**	**0.3989**

Table B. (continued)

2. Brood-year 1998 (Outmigration-year 2000)

			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date							
			Upper Yakima				Naches			
			Cle Elum	Cle Elum	Easton	Easton	Lost Creek	Lost Creek	Stiles	Stiles
			Willard	Willard	Willard	Willard	Willard	Willard	Willard	Willard
			Early	Late	Early	Late	Early	Late	Early	Late
Detection Efficiency		McNary	128	152	128	152	128	152	128	152
(DE) Stratum		Detections	5/7/00	5/31/00	5/7/00	5/31/00	5/7/00	5/31/00	5/7/00	5/31/00
Stratum	1	Total (T)	70	10	142	93	139	76	133	184
First Date	4/6/00	Removed (R)	0	0	0	0	3	1	0	1
Last Date	7/17/00	T-R	70	10	142	93	136	75	133	183
DE	0.1810	Expanded	386.8	55.3	784.7	513.9	754.6	415.5	735.0	1012.3
		Total Expanded	386.8	55.3	784.7	513.9	754.6	415.5	735.0	1012.3
		Number Released	2487	2462	2476	2476	2489	2488	2488	2493
		Survival Index	**0.1555**	**0.0224**	**0.3169**	**0.2076**	**0.3032**	**0.1670**	**0.2954**	**0.4061**

3. Brood-year 1999 (Outmigration-year 2001)

			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date							
			Upper Yakima							
			Late	Early	Early	Late	Late	Early	Early	Late
			Cle Elum	Cle Elum	Cle Elum	Cle Elum	Easton	Easton	Easton	Easton
			Willard	Willard	Yakima	Yakima	Willard	Willard	Yakima	Yakima
Detection Efficiency		McNary	127	145	127	145	127	145	127	145
(DE) Stratum		Detections	5/7/01	5/25/01	5/7/01	5/25/01	5/7/01	5/25/01	5/7/01	5/25/01
Stratum	1	Total (T)	0	2	7	4	0	20	56	9
First Date	4/24/01	Removed (R)	0	0	0	0	0	1	1	0
Last Date	5/31/01	T-R	0	2	7	4	0	19	55	9
DE	0.5657	Expanded	0.0	3.5	12.4	7.1	0.0	34.6	98.2	15.9
Stratum	2	Total (T)	8	8	1	8	8	29	30	23
First Date	6/1/01	Removed (R)	0	1	0	0	0	0	0	0
Last Date	6/21/01	T-R	8	7	1	8	8	29	30	23
DE	0.5179	Expanded	15.4	14.5	1.9	15.4	15.4	56.0	57.9	44.4
		Total Expanded	15.4	18.1	14.3	22.5	15.4	90.6	156.1	60.3
		Number Released	1197	1219	1207	1240	1234	1234	1249	1247
		Survival Index	**0.0129**	**0.0148**	**0.0119**	**0.0182**	**0.0125**	**0.0734**	**0.1250**	**0.0484**

Table B. (continued)

3. Brood-year 1999 (Outmigration-year 2001) (continued)

			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date Naches							
			Late	Early	Early	Late	Late	Early	Early	Late
			Lost Creek	Lost Creek	Lost Creek	Lost Creek	Stiles	Stiles	Stiles	Stiles
			Willard	Willard	Yakima	Yakima	Willard	Willard	Yakima	Yakima
Detection Efficiency		McNary	127	145	127	145	127	145	127	145
(DE) Stratum		Detections	5/7/01	5/25/01	5/7/01	5/25/01	5/7/01	5/25/01	5/7/01	5/25/01
Stratum	1	Total (T)	1	2	159	105	8	79	257	104
First Date	4/24/01	Removed (R)	0	0	4	0	0	1	3	2
Last Date	5/31/01	T-R	1	2	155	105	8	78	254	102
DE	0.5657	Expanded	1.8	3.5	278.0	185.6	14.1	138.9	452.0	182.3
Stratum	2	Total (T)	17	17	18	23	128	29	18	200
First Date	6/1/01	Removed (R)	0	0	0	0	2	0	0	6
Last Date	6/21/01	T-R	17	17	18	23	126	29	18	194
DE	0.5179	Expanded	32.8	32.8	34.8	44.4	245.3	56.0	34.8	380.6
		Total Expanded	34.6	36.359139	312.73689	230.00962	259.42392	194.86859	486.73196	562.8764
		Number Released	1240	1245	1250	1251	1236	1237	1249	1249
		Survival Index	**0.0279**	**0.0292**	**0.2502**	**0.1839**	**0.2099**	**0.1575**	**0.3897**	**0.4507**

Table B. (continued)

4. Brood-year 2000 (Outmigration-year 2002)

			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date			
			Upper Yakima			
			EWE	EWL	EYE	EYL
			Easton	Easton	Easton	Easton
			Willard	Willard	Yakima and Willard	
			Early	Late	Early	Late
Detection Efficiency		McNary	126	145	87	145
(DE) Stratum		Detections	05/06/02	05/25/02	03/28/02	05/25/02
Stratum	1	Total (T)	0	0	5	2
First Date	4/7/02	Removed (R)	0	0	0	0
Last Date	5/2/02	T-R	0	0	5	2
DE	0.4225	Expanded	0.0	0.0	11.8	4.7
Stratum	2	Total (T)	0	0	2	1
First Date	5/3/02	Removed (R)	0	0	0	0
Last Date	5/6/02	T-R	0	0	2	1
DE	0.6454	Expanded	0.0	0.0	3.1	1.5
Stratum	3	Total (T)	0	0	0	1
First Date	5/7/02	Removed (R)	0	0	0	0
Last Date	5/18/02	T-R	0	0	0	1
DE	0.2436	Expanded	0.0	0.0	0.0	4.1
Stratum	4	Total (T)	0	8	0	4
First Date	5/19/02	Removed (R)	0	0	0	0
Last Date	5/22/02	T-R	0	8	0	4
DE	0.4460	Expanded	0.0	17.9	0.0	9.0
Stratum	5	Total (T)	8	21	1	26
First Date	5/23/02	Removed (R)	0	0	0	0
Last Date	5/30/02	T-R	8	21	1	26
DE	0.1863	Expanded	42.9	112.7	5.4	139.5
Stratum	6	Total (T)	4	45	0	18
First Date	5/31/02	Removed (R)	0	0	0	0
Last Date	6/21/02	T-R	4	45	0	18
DE	0.1106	Expanded	36.2	406.9	0.0	162.8
		Total Expanded	79.1	537.5	20.3	321.7
		Number Released	1248	2497	1249	2500
		Survival Index	**0.0634**	**0.2153**	**0.0163**	**0.1287**
					Omitted because Yakima and Willard Mixed	

Table B. (continued)

4. Brood-year 2000 (Outmigration-year 2002) (continued)

Detection Efficiency (DE) Stratum		McNary Detections	LWE Lost Creek Willard Early 126 05/06/02	LWL Lost Creek Willard Late 145 05/25/02	LYE Lost Creek Yakima Early 126 05/06/02	LYL Lost Creek Yakima Late 145 05/25/02	SWE Stiles Willard Early 126 05/06/02	SWL Stiles Willard Late 145 05/25/02	SYE Stiles Yakima Early 126 05/06/02	SYL Stiles Yakima Late 145 05/25/02
			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date — Naches							
Stratum	1	Total (T)	0	0	27	3	0	0	1	3
First Date	4/7/02	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/2/02	T-R	0	0	27	3	0	0	1	3
DE	0.4225	Expanded	0.0	0.0	63.9	7.1	0.0	0.0	2.4	7.1
Stratum	2	Total (T)	0	0	32	10	0	0	0	1
First Date	5/3/02	Removed (R)	0	0	0	0	0	0	0	0
Last Date	5/6/02	T-R	0	0	32	10	0	0	0	1
DE	0.6454	Expanded	0.0	0.0	49.6	15.5	0.0	0.0	0.0	1.5
Stratum	3	Total (T)	1	0	9	13	0	0	40	3
First Date	5/7/02	Removed (R)	0	0	2	0	0	0	2	0
Last Date	5/18/02	T-R	1	0	7	13	0	0	38	3
DE	0.2436	Expanded	4.1	0.0	30.7	53.4	0.0	0.0	158.0	12.3
Stratum	4	Total (T)	3	1	7	11	22	0	40	1
First Date	5/19/02	Removed (R)	0	0	0	0	0	0	1	0
Last Date	5/22/02	T-R	3	1	7	11	22	0	39	1
DE	0.4460	Expanded	6.7	2.2	15.7	24.7	49.3	0	88.439769	2.2420454
Stratum	5	Total (T)	11	3	15	26	48	16	11	62
First Date	5/23/02	Removed (R)	0	0	0	0	0	0	0	3
Last Date	5/30/02	T-R	11	3	15	26	48	16	11	59
DE	0.1863	Expanded	59.0	16.1	80.5	139.5	257.6	85.876125	59.039836	319.66821
Stratum	6	Total (T)	31	18	4	33	10	50	3	69
First Date	5/31/02	Removed (R)	0	0	0	0	0	0	0	0
Last Date	6/21/02	T-R	31	18	4	33	10	50	3	69
DE	0.1106	Expanded	280.3	162.8	36.2	298.4	90.4	452.10335	27.126201	623.90262
		Total Expanded	350.2	181.1	276.6	538.6	397.4	537.97948	334.93856	966.77659
		Number Released	1249	1247	1192	1250	1249	1251	1250	1250
		Survival Index	**0.2804**	**0.1452**	**0.2320**	**0.4308**	**0.3182**	**0.4300395**	**0.2679509**	**0.7734213**

Table B. (continued)

5. Brood-year 2001 (Outmigration-year 2003)

			Basin/Site/Stock/Release Time/Julian Release Date/Calendar Release Date						
			Upper Yakima						
			For Willard Stock, Easton and Holm are Pooled together						
			Easton	Easton	Easton	Holms	Holms	Holms and Easton	Holms and Easton
			Willard	Willard	Willard	Willard	Willard	Willard	Yakima
			Volitional	Volitional	Volitional	Volitional	Volitional	Volitional	Volitional
Detection Efficiency		McNary	98	98	98	98	98	98	97
(DE) Stratum		Detections	4/8/03	4/8/03	4/8/03	4/8/03	4/8/03	4/8/03	4/7/03
Stratum	1	Total (T)	1	0	0	22	26	49	69
First Date	4/26/03	Removed (R)	0	0	0	0	2	2	1
Last Date	5/31/03	T-R	1	0	0	22	24	47	68
DE	0.2520	Expanded	4.0	0.0	0.0	87.3	97.2	188.5	270.8
Stratum	2	Total (T)	19	17	12	19	28	95	37
First Date	6/1/03	Removed (R)	0	1	0	0	0	1	0
Last Date	6/16/03	T-R	19	16	12	19	28	94	37
DE	0.3170	Expanded	59.9	51.5	37.9	59.9	88.3	297.5	116.7
		Total Expanded	63.9	51.5	37.9	147.2	185.6	486.0	387.5
		Number Released	833	864	764	1249	1250	4960	3355
		Survival Index	**0.0767**	**0.0596**	**0.0495**	**0.1179**	**0.1484**	**0.0980**	**0.1155**

Releases combined to permit comaprison with Yakima stock, pooled Willard stock estimate in next column

Detection Efficiency (DE) Stratum		McNary Detections	Naches Lost Creek Willard Volitional 98 4/8/03	Lost Creek Willard Volitional 98 4/8/03	Lost Creek Yakima Volitional 97 4/7/03	Stiles Willard Volitional 98 4/8/03	Stiles Willard Volitional 98 4/8/03	Stiles Yakima Volitional 91 4/1/03
Stratum	1	Total (T)	5	7	74	54	48	211
First Date	4/26/03	Removed (R)	0	0	4	0	1	2
Last Date	5/31/03	T-R	5	7	70	54	47	209
DE	0.2520	Expanded	19.8	27.8	281.7	214.3	187.5	831.3
Stratum	2	Total (T)	23	33	133	32	29	8
First Date	6/1/03	Removed (R)	0	0	1	0	1	0
Last Date	6/16/03	T-R	23	33	132	32	28	8
DE	0.3170	Expanded	72.6	104.1	417.4	100.9	89.3	25.2
		Total Expanded	92.4	131.9	699.14161	315.20489	276.81233	856.5024
		Number Released	1276	1221	3333	1250	1251	3332
		Survival Index	**0.0724**	**0.1080**	**0.2097635**	**0.2521639**	**0.2212728**	**0.2570535**

Appendix C. Detection Efficiency Estimation

C.1. Conceptual Computation

The methods used were similar to those developed by Sandford and Smith[7]. The steps are given below.

Step 1. For each downstream dam, joint McNary and downstream detections were cross-tabulated by McNary Dam's first date and downstream-dams' first date of detection [Table B.1.a)].

Step 2. Within each downstream dam's detection date, the relative distribution of joint counts over McNary detection dates was estimated [Table B.1.b)].

Step 3. The resulting relative distribution frequencies from Table B.1.b) were then multiplied by the total downstream dam's detections (whether or not previously detected at McNary) for the given downstream date to obtain estimates of the cross-tab number for the downstream dam's total detections [Table B.1.c)].

Step 4. There were cases where there were downstream detections for a given date but there were no joint downstream and McNary detections for that downstream date. In such cases there was no direct way of allocating the downstream detections to a given McNary date. What was done was to obtain a pseudo-distribution for McNary detection dates by offsetting the six previous downstream dates' and the six following downstream-dates' McNary-date distributions, and applying their pooled offset distributions to the downstream-dam detection date having no joint McNary distribution. (This step probably differs from Smith and Sanford's, their generated daily detection efficiencies being based on a far larger number of total releases from the Snake River basin than those given here for the Yakima basin.)

[7] Sandford, B.P. and S.G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River Basin anadromous salmonids, 1990-1997. J. Agric. Biol. Environ. Stat. 7:243-263.

Step 5. Once the above was done for each downstream dam's detection date, the estimated total downstream detections that were allocated to a given McNary-detection date were then added over downstream-dam detection dates [Table B.1.c), far-right-hand column]. This gave the estimated total downstream-dam detections that passed McNary on the given McNary date.

Step 6. The total joint downstream-dam McNary detections on a given McNary-detection date [Table B.1.a), far-right column] were then divided by the downstream-dam total from step 4 above [Table B.1.c), far-right column], giving an estimated McNary-detection efficiency associated with the McNary date [Table B.1.d), far-right-hand column].

Actually, before the last step, Table B.1.a)'s and Table B.1.b)'s numbers were pooled over John Day and Bonneville Dams.

Daily detection efficiencies were then stratified into contiguous days of relatively homogeneous detection efficiencies, and the daily detection efficiencies were pooled over days within the strata. This was done to increase the precision of detection-efficiency estimates. The strata's beginning and ending dates were chosen in a manner that minimized the variation among cohol daily detection efficiencies within strata, thereby maximizing the detection-rate variation among strata. This was done using step-wise logistic regression. In the first step, the partitioning between all possible sets of two strata that minimized the variation among daily detection efficiencies within strata was selected. With that partitioning fixed, establishing two strata, the second partitioning was then selected in a similar manner among all possible sets of two strata within the strata that were already created in the first partitioning. Again, the partitioning that minimized variation among daily detection efficiencies within the strata was selected. This second partitioning was then fixed and, along with the first fixed partitioning, established three strata. A third partitioning was similarly developed within the three established strata to form a fourth stratum. The process was continued as long as the difference between the step's created detection rates was significant at the 10% significance level ($P \leq 0.1$).

In the stratification process, there were three exceptions that would lead to the rejection of a given partitioning:

1. If either one of the resulting strata had less than twenty joint McNary detections, or

2. If the difference between the John Day Dam-based and Bonneville Dam-based detection-efficiency estimates were inconsistent in sign. For example, if the combined Bonneville-based McNary detection efficiency in one of the created strata was greater than that in an adjacent stratum, but the John Day-based McNary detection efficiency in the one was less than that in the adjacent, then the partitioning was not accepted.

3. When the logistic variation[8] of daily detection efficiencies within strata was less than 25% of that expected from the binomial (mean deviance < 0.25).

On completion of the stepwise process, each partitioning was shifted at one-day increments between the two adjacent partitionings to see if the variation within strata could be further reduced. If so, the partitioning that resulted in the greatest reduction was selected.

There was an occasional downstream-dam date for which there was a downstream-dam count but no joint downstream-dam and McNary Dam count within +/- six days of the date (refer Step 4, earlier). Such dates were either very early or very late in the passage period. The downstream count for such days were added into the pooled downstream count for either the first stratum or the last stratum, whichever was appropriate, and the respective detection efficiencies were adjusted accordingly.

[8] As measured by mean deviance = residual deviance/(residual degrees of freedom).

Table C.1. Conceptual method of estimating detection efficiencies

a) Joint McNary Dam (McN) and Downstream Dam (D.S.) Detections (n) by McN and D.S. Detection Dates

McN Date (Julian)	D.S. Date (Julian)								
	…	98	99	100	101	**102**	103	….	Total
90	…	0	0	0	0	**0**	0	…	n(90,.)
…	…	…	…	…	…	**…**	…	…	…
94	…	n(94,98)	n(94,99)	n(94,100)	n(94,101)	**0**	0	…	n(94,.)
95	…	0	n(95,99)	n(95,100)	n(95,101)	**n(95,102)**	0	…	n(95,.)
96	…	0	0	n(96,100)	n(96,101)	**n(96,102)**	n(96,103)	…	n(96,.)
97	…	0	0	0	0	**n(97,102)**	n(97,103)	…	n(97,.)
98	…	0	0	0	0	**n(98,102)**	n(98,103)	…	n(98,.)
99	…	0	0	0	0	**0**	0	…	n(99,.)
…	…	…	…	…	…	**…**	…	…	…
200	…	0	0	0	0	**0**	0	…	n(200,.)
Total	…	n(.,98)	n(.,99)	n(.,100)	n(.,101)	**n(.,102)**	n(.,103)	…	

b) For Each Downstream Site, Estimate Distribution of McNary Date Contributions

McN Date (Julian)	p(McN,D.S.) = n[McN,D.S.)/n(., D.S.)					
	D.S. Date (Julian)					
	…	100	101	**102**	103	…
90	…	…	…	**…**	…	…
…	…	…	…	**…**	…	…
94	…	p(94,100)	p(94,101)	**0**	0	…
95	…	p(95,100)	p(95,101)	**p(95,102)=n(95,102)/n(.,102)**	0	…
96	…	p(96,100)	p(96,101)	**p(96,102)=n(96,102)/n(.,102)**	p(96,103)	…
97	…	0	0	**p(97,102)=n(97,102)/n(.,102)**	p(97,103)	…
98	…	0	0	**p(98,102)=n(98,102)/n(.,102)**	p(98,103)	…
99	…	0	0	**p(99,102)=n(99,102)/n(.,102)**	p(99,103)	…
…	…	…	…	**…**	…	…
200	…	0	0	**0**	0	…
Total		1.000	1.000	**1.000**	1.000	

Table C.1. Conceptual method of estimating detection efficiencies (continued)

c) Allocate Daily Lower Site Counts [N(D.S.)] over McNary Dates using above Distributions and total over Lower Dam Dates within McNary Dates

McN Date (Julian)	N'(McN,D.S.) = N(D.S.)*P(McN,D.S.) D.S. Date (Julian)						McN Dam Total
	…	100	101	**102**	103	…	
90	…	0	0	**0**	0	…	**N'(90,.)**
…	…	…	…	**…**	…	…	**…**
94	…	N'(94,100)	N'(94,101)	**0**	0	…	**N'(94,.)**
95	…	N'(95,100)	N'(95,101)	**N'(95,102)=p(95,102)*N(.,102)**	0	…	**N'(95,.)**
96	…	N'(96,100)	N'(96,101)	**N'(96,102)=p(96,102)*N(.,102)**	N'(96,103)	…	**N'(96,.)**
97	…	0	0	**N'(97,102)=p(97,102)*N(.,102)**	N'(97,103)	…	**N'(97,.)**
98	…	0	0	**N'(98,102)=p(98,102)*N(.,102)**	N'(98,103)	…	**N'(98,.)**
99	…	0	0	**N'(99,102)=p(99,102)*N(.,102)**	N'(99,103)	…	**N'(99,.)**
…	…	…	…	**…**	…	…	**…**
200	…	0	0	**0**	0	…	**N'(200,.)**
Total		N(100)	N(101)	**N(102)**	N(103)	…	

d) Use Total Joint McNary and Downstream Dam Detections [Table a)] and Total Downstream Dam Detections [Table c)] to estimate McNary Detection Efficiencies (McN D.E.)

McNary Dam Date (Julian)	Table a) n Total	Table c) N' Total	McNary Detection Efficiency McN D.E. = n/N'
90	n(90,.)	N'(90,.)	**McN D.E.(90,.)=n(90,.)/N'(90,.)**
…	…	…	**…**
94	n(94,.)	N'(94,.)	**McN D.E.(94,.)=n(94,.)/N'(94,.)**
95	n(95,.)	N'(95,.)	**McN D.E.(95,.)=n(95,.)/N'(95,.)**
96	n(96,.)	N'(96,.)	**McN D.E.(96,.)=n(96,.)/N'(96,.)**
97	n(97,.)	N'(97,.)	**McN D.E.(97,.)=n(97,.)/N'(97,.)**
98	n(98,.)	N'(98,.)	**McN D.E.(98,.)=n(98,.)/N'(98,.)**
99	n(99,.)	N'(99,.)	**McN D.E.(99,.)=n(99,.)/N'(99,.)**
…	…	…	**…**
200	n(200,.)	N'(200,.)	**McN D.E.(200,.)=n(200,.)/N'(200,.)**

C.2. Detection Efficiency Estimates

The Bonneville Dam-based and John Day Dam-based McNary detection-efficiency estimates are given in Table B.2 along with the estimates pooled over those two downstream dams, which were the estimates used.

Assumptions behind the detection efficiency estimation procedures are as follows:

1. Detected and undetected fish passing McNary on a given date are temporally and spatially mixed before reaching the downstream detectors so that their proportional composition at the time of McNary passage will be the same for the surviving fish passing through downstream detectors;

2. Survivals from McNary to downstream-dam detectors are the same for all routes of McNary passage (e.g., survival is the same for fish whether they pass through the bypass, the turbines, or the spillway);

3. The allocations of total downstream dam counts to McNary days of passage are accurate; and

4. The detection rates estimated from John Dam and Bonneville Dams are estimating the same parameters.

Assumption 2 is unlikely to hold.

Assumption 3 is also unlikely to hold because the method of allocation assumes that the McNary detection efficiencies for a given day of downstream-dam detection are homogeneous. It is unlikely that all fish detected on a given downstream date passed McNary on days for which the detection rates were homogeneous. The estimated detection efficiencies are probably biased, but the bias would be less than assuming a single detection-efficiency value for the whole of McNary passage.

For Assumption 4 to hold for the methods used in this report, the probability of a fish being entrained into the bypass at Bonneville would have to be independent of whether or not that fish was entrained into a bypass at John Day or McNary, and the probability of a fish being entrained into the bypass at John Day would have to be independent of whether or not that fish was entrained into the bypass at McNary.

Table C.2. Estimated McNary (McN) Detection Rates based on Bonneville (Bonn) and (John Day) Detections and their Pooled Detections with McNary and Based on the Pooling of the Detections of those two dams Downstream (DS) of McNary

Applicable Passage Dates		Bonneville-Based Estimates			John Day-Based Estimates			Pooled Estimates		
Beginning Date	Ending Date	Detections Bonn	Detections Bonn, McN	Detection Rate	Detections JD	Detections JD, McN	Detection Rate	Detections DS	Detections DS,McN	Detection Rate
Outmigration Year 1999										
	05/25/99	234.4	54	0.2303	447.4	103	0.2302	448.4	103	0.2297
05/26/99	06/14/99	2757.0	522	0.1893	3294.3	642	0.1949	3294.3	642	0.1949
06/15/99		810.6	98	0.1209	1080.2	136	0.1259	1081.2	136	0.1258
Outmigration Year 2000										
		309.0	53	0.1715	618.0	114	0.1845	630.0	114	0.1810
Outmigration Year 2001										
	05/31/01	164.2	96	0.5848	369.4	209	0.5657	369.4	209	0.5657
06/01/01		105.8	55	0.5196	179.6	93	0.5179	179.6	93	0.5179
Outmigration Year 2002										
	05/02/02	35.5	17	0.4782	42.6	16	0.3759	78.1	33	0.4225
05/03/02	05/06/02	23.1	16	0.6920	12.5	7	0.5594	35.6	23	0.6454
05/07/02	05/18/02	58.6	15	0.2558	23.4	5	0.2133	82.1	20	0.2436
05/19/02	05/22/02	20.6	10	0.4861	28.8	12	0.4173	49.3	22	0.4460
05/23/02	05/30/02	243.5	44	0.1807	202.0	39	0.1931	445.5	83	0.1863
05/31/02		233.6	24	0.1027	272.7	32	0.1173	506.4	56	0.1106
Outmigration Year 2003										
	05/31/03	682.1	161	0.2361	1178.4	297	0.2520	1178.4	297	0.2520
06/01/03		195.0	63	0.3232	499.6	159	0.3183	501.6	159	0.3170

Appendix G – Financial Report

Confederated Tribes and Bands of the Yakama Nation
Yakama Nation Fisheries Program
P.O. Box 151, Toppenish, WA 98948

SCHEDULE B

Project No.: **1995-063-25**

Project Name: **YKFP Monitoring & Evaluation Sub-Budgets 1, 2, 3, 4, 5, & 6**

Contract No.: **00013769**

Prepared by: **Ida Sohappy-Ike (509) 865-5121 ext. 6345**

Invoice Date: 7/14/04

Performance Period: May 1, 2003 to April 30, 2004

Invoice Period: March 1, 2004-April 30, 2004

Invoice No. : 08-FY04-13769

	2245.ALL			**5/1/03-02/29/04**	**3/1/04-4/30/04**	
Cost Code	**Description**	**Original Budget**	**Expenditures to date**	**Previously Reported**	**Claimed This Invoice**	**Budget balance for FY 03**
512111	WAGES	1,187,103	1,129,196.15	920,603.63	208,592.52	57,907.03
519111	Fringe	203,999	179,828.18	143,741.85	36,086.33	24,171.13
521161	Aerial Flights	5,019	2,765.20	809.00	1,956.20	2,253.80
541122	Sensitive Equipment	23,596	22,510.27	3,542.04	18,968.23	1,085.29
541161	Operation & Maintenance	6,662	6,434.74	4,967.95	1,466.79	227.25
551111	Operating Supplies	249,201	239,829.73	190,878.26	48,951.47	9,370.89
551295	GSA	119,717	108,704.58	68,219.84	40,484.74	11,011.92
561131	Waste Disposal	3,155	3,154.50	2,227.50	927.00	-
561171	Telephone	10,814	9,112.52	6,750.07	2,362.45	1,701.81
571111	Insurance	9,716	9,458.00	9,243.00	215.00	258.00
581110	Travel Holding	-	-	806.70	(806.70)	-
581111	Commercial Air	-	-	-	-	-
581121	Per Diem	7,460	4,347.91	1,606.61	2,741.30	3,111.95
621251	Indirect Cost	357,315	334,491.64	263,912.33	70,579.31	22,823.51
522251	Sub Contracts	197,065	167,790.42	83,323.44	84,466.98	29,274.58
651171	Capital Equipment	82,358	82,358.00	6,000.00	76,358.00	-
	TOTAL:	**2,463,179.00**	**2,299,981.84**	**1,706,632.22**	**593,349.62**	**163,197.16**

Sub-Budget 1	**Sub-Total**	662,968.69	$607,098.07	$423,877.47	$183,220.60	$55,870.62
Sub-Budget 2	**Sub-Total**	1,143,359.34	$1,089,698.13	$869,357.21	$220,340.92	$53,661.21
Sub-Budget 3	**Sub-Total**	132,065.00	$106,647.18	$41,981.65	$64,665.53	$25,417.82
Sub-Budget 4	**Sub-Total**	179,456.63	$151,761.33	$120,047.72	$31,713.61	$27,695.30
Sub-Budget 6	**Sub-Total**	116,615.23	$116,615.23	$67,476.60	$49,138.63	$-
Sub-Budget 7	**Sub-Total**	228,714.11	$228,161.90	$183,891.57	$44,270.33	$552.21
All Sub-Budgets	**GRAND TOTAL**	**2,463,179.00**	**$2,299,981.84**	**$1,706,632.22**	**$593,349.62**	**$163,197.16**
					$593,349.62	
					$-	

I CERTIFY THIS IS TRUE AND ACCURATE

Jerry Meninick, Chairman
Yakama Tribal Council

Date

Current Year Invoices submitted

Period Claimed	Amount Claimed	Cumulative Total Invoiced	Cash Rc'd	C/R #
5/1/03-6/30/03	244,229.57	244,229.57	244,229.57	82898
7/1/03-9/30/03	551,248.36	795,477.93	551,248.36	82898
9/1/03-9/30/03 resubmit	94,792.86	890,270.79	94,792.86	84067
10/1/03-10/31/03	78,328.23	968,599.02	78,328.23	84699
11/1/03-11/30/03	203,505.13	1,172,104.15	203,505.13	84699
12/1/03-12/31/03	204,617.95	1,376,722.10	204,617.95	85052
1/1/04-1/31/04	156,164.19	1,532,886.29	156,164.19	87188
2/1/04-2/29/04	173,745.93	1,706,632.22	173,745.93	87188
3/1/04-4/30/04	593,349.62	2,299,981.84		
Total	2,299,981.84		1,706,632.22	

Appendix H: Equipment Inventory List

YKFP Monitor & Evaluation
Award Budget Period: May 1, 2003 to April 30, 2004
Contract No: 13769
Project No : 1995-063-25
Fund Acct: 2245.8101

Donald Isadore 8/10/04

No.	ITEM DESCRIPTION	VENDOR	MAKE/ MODEL	SERIAL NUMBER	YEAR	FUND NUMBER	ITEM COST	CONTRACT NUMBER
1	Camera, Digital Sony	CDW	DSCF828	S011379967S	2003	22458101	997.00	13769
2	Boat Cover, Custom Drift	Cabelas	G-016630	00022-970	2003	22458101	269.99	13769
3	Camera, Digital Canon	Cabelas	Elph A70	70003-770	2003	22458101	284.99	13769
4	Pump, Trash	Cessco, Inc.	ZTSEPT2-50HA	TAI-20664	2003	22458101	955.04	13769
5	Pump, Water w/Trailer 12'	RDO Equipment Co	John Deere	438213137	2003	22458101	39,500.00	13769
6	Boat, 17' custom weld	Riverview Marina, Inc	17' Outboard Sport	VIN:WFE02416D404	2003	22458101	9,500.00	13769
7	Detector, Portable Sampling	Northwest Marine Technology Inc	FSD000001	677	2003	22458101	6,000.00	13769
8	Receiver, Data Logger	Lotek Wireless Inc	SRX400A		2003	22458101	12,758.00	13769
9	Detectors, Handheld Wand	Northwest Marine Technology Inc	WAN000002	11109	2003	22458101	7,300.00	13769
10	Detectors, Handheld Wand	Northwest Marine Technology Inc	WAN000002	11110	2003	22458101	7,300.00	13769
11	Otter, NRS 10'6"	Northwest River Supplies			2003	22458101	3,108.00	13769
12	Cutters	Northwest Marine Technology Inc	for cwt machine		2003	22458101	7,840.00	13769
						Total	**95,813.02**	

Fish Passage Video Monitoring
Fund Acct: 2245.8104

No.	DESCRIPTION	VENDOR	MODEL	NUMBER	YEAR	NUMBER	COST	NUMBER
1	Camera, Basic System	Applied Microvideo, Inc.	10 Basic System 100' cable		2003	22458104	638.00	13769
2	Recorder, Digital Video	URS Electronics, Inc.	Sanyo	74810136	2003	22458104	499.00	13769
3	Recorder, Digital Video	URS Electronics, Inc.	Sanyo	74810161	2003	22458104	499.00	13769
						Total	**1,636.00**	

Yakima Fall Chinook/Steelhead M&E
Fund Acct: 2245.8106

No.	ITEM DESCRIPTION	VENDOR	MAKE/ MODEL	SERIAL NUMBER	YEAR	FUND NUMBER	ITEM COST	CONTRACT NUMBER
1	Computer	Gateway Companies, Inc.	Intel Pentium 4 Processor 2.6GHz		2003	22458106	2587.00	13769
2	Raft, Self Bailing	Northwest River Supplies, Inc	11'6" Otter SB w/repair kit		2003	22458106	4,832.25	13769
3								
						Total	**7,419.25**	

Grand Total **104,868.27**