Yakima/Klickitat Fisheries Project

Monitoring and Evaluation

Annual Report
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MONITORING AND EVALUATION

PROJECT NUMBER 95—063-25

THE CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION

YAKIMA/KLICKITAT FISHERIES PROJECT

FINAL REPORT 2002

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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 FY2002 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.e, 1.f., 1.g and 4.c are included in full as appendices to this report.

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.mbi.com.

Progress:

Yakima

The baseline and diagnostic reports were completed for upper Yakima and Naches spring chinook; lower Yakima and Marion Drain fall chinook; upper Yakima, Naches, Toppenish and Satus summer steelhead; and upper Yakima and Naches coho. The baseline report consists of abundance, productivity and diversity index values for specific geographic areas for each species. The baseline report includes output for both current and historic conditions.

Baseline reports for each species/subbasin are presented in Tables 1-9. The diagnostic reports for purposes of this report have been expressed in terms of Tornado charts (Figures 1-10), which depict the top restoration and preservation reaches in terms of abundance, productivity and diversity index for each species/spawning aggregate previously mentioned for the baseline reports. Restoration is defined in the EDT model as the difference between historic and current conditions for abundance, productivity and diversity index. Clearly in many cases it is not feasible to restore reach conditions completely back to historic conditions. Nevertheless, the restoration potential value provides a place to start when assessing which reaches may provide the best restoration opportunities. Obviously the next step is to assess realistically the ability to restore a specific reach given existing physical limitations (e.g.

freeways, roads, dikes, floodplain development) and community values. Preservation is defined as the relative importance a specific reach is to the overall abundance, productivity and diversity index for a particular species/spawning aggregate. A detailed reach level analysis depicting affected (or non affected) Level 3 attributes and specific salmonid life stages is presented in the EXCEL Report 2 Viewer files for each species/spawning aggregate. Because of their large size (output of one page per reach) these files have been posted to the YKFP website under **Technical Reports and Publications** at ykfp@yakama.com for readers interested in obtaining reach specific information on habitat conditions, etc.

Further calibration of the summer steelhead and coho models is warranted based on the initial baseline model runs complete. It was recognized two years ago that the EDT model over predicted the upper Yakima steelhead population abundance based on the available habitat. It was hypothesized that this was a consequence of past operational procedures at Roza Dam that resulted in the resident form of *O mykiss* to expand and eventually hold a competitive advantage over the anadromous form. A mathematical analog has been developed to correct for this biological interaction, but needs further refinement so that all four populations are calibrated in relative terms in proportions similar to those currently observed in the Yakima Basin. The coho EDT model may currently predict low numbers of adults. Because coho are currently being reintroduced into historic subbasins using a non-indigenous stock it's difficult to use current adult return rates as good means to calibrate the model since this population has not reach equilibrium in terms of geographic distribution and population size. We will be reviewing the habitat EDT Level 2 attributes for accuracy for the major floodplain reaches (most important for coho) before accepting current EDT model outputs parameters for coho.

With completion of the initial baseline and diagnostic EDT model runs for the key salmonid species attention in FY03 will focus on application of the model to assess specific habitat restoration projects (or scenarios in the EDT vernacular). Work will also focus on reviewing and upgrading Level 2 attributes for the Wilson-Nanuem watershed, which is the focus of current habitat assessment surveys and removal of passage barriers.

In FY2002 CWU was contracted to develop a biophysical classification scheme and measurement protocols designed to increase the precision of selected Level 2 attributes EDT model (see Appendix A for a complete discussion).

Table 1. Summary of upper Yakima basin spring chinook performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and historical conditions.

Baseline Performance Analysis, Upper Yakima Spring Chinook

CURRENT CONDITIONS

Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
Upper Yakima Tributaries (Cle Elum R and Taneum, Swauk, Manastash, Big and Little Creeks)	21,576	761	485	3.5%	166	6.0	5	13.0%
Upper Yakima Mainstem, Wilson Cr to Keechelus Dam	53,244	1,920	1,436	3.6%	120	4.4	3.5	96.0%
Upper Yakima Mainstem, Ahtanum Cr to Wilson Cr	32,557	1,095	680	3.4%	98	3.4	2.2	37.0%
Teanaway Watershed	2,985	100	46	3.4%	73	2.4	1.4	4.0%
Wilson/Naneum Watershed	1,964	66	32	3.4%	78	2.6	1.8	2.0%
Ahtanum/Wide Hollow Watershed	3,866	138	60	3.6%	76	2.8	1.4	1.0%
Wenas Creek Watershed	0	0	0	N.A.	0	0.0	0	0.0%

HISTORICAL/NORMATIVE CONDITIONS

Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
Upper Yakima Tributaries (Cle Elum R and Taneum, Swauk, Manastash, Big and Little Creeks)	239,072	26,096	20,064	10.9%	303	34.0	30	100%
Upper Yakima Mianstem, Wilson Cr to Keechelus Dam	285,528	31,425	27,801	11.0%	344	39.0	35	100%
Upper Yakima Mainstem, Ahtanum Cr to Wilson Cr	298,657	30,564	25,565	10.2%	366	39.0	35	100%
Teanaway Watershed	138,696	15,196	12,520	11.0%	326	37.0	34	99%
Wilson/Naneum Watershed	64,858	7,051	4,856	10.9%	208	23.0	20	100%
Ahtanum/Wide Hollow Watershed	169,798	17,581	13,491	10.4%	248	26.0	24	100%
Wenas Creek Watershed	42,854	4,259	3,170	9.9%	225	24.0	22	100%

Upper Yakima Spring Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank	Restoration benefit Category/rank
Yakima Ahtanum to Naches	**3**	**4**
Yakima Roza Dam to Wilson Cr	**5**	**3**
Yakima Manastash to Taneum	**1**	**9**
Columbia above Estuary	10	**1**
Yakima Wilson to Manastash	**5**	**6**
Yakima Naches to Roza Dam	**8**	**4**
Yakima Cle Elum to Easton Dam	**2**	12
Yakima Easton Dam to Keechelus Dam	**5**	15
Columbia Estuary	14	**7**
Yakima above storage dams	16	**7**
Yakima Teanaway to Cle Elum	**8**	17
Yakima Taneum to Teanaway	**4**	22
Teanaway drainge above forks	18	11
Teanaway drainge below forks	27	**2**
Yakima SSide Dam to Ahtanum Cr	17	16
Cle Elum R below Cle Elum Dam	11	24
Taneum Drainage	15	20
Wilson Drainage	21	14
Yakima Toppenish to Sunnyside Dam	12	24
Yakima Prosser Dam to Satus	19	18
Manastash drainge	26	12
Ahtanum Amer Fruit Br to Upper WIP	31	**10**
Yakima Satus to Toppenish	13	29
Lower Ahtanum & Wide Hollow	24	19
Ahtanum drainage above WIP	23	26
Yakima delta to Horn Dam	20	30
Wenas Cr Drainage	32	20
Yakima Horn Dam to Benton	24	28
Yakima Chandler Bypass Reach	22	31
Big Cr Drainage	33	23
Swauk Drainage	30	27
Yakima Benton to Powerplant	28	32
Yakima delta	29	33
Coastal Zone	33	34
Offshore Marine	33	34

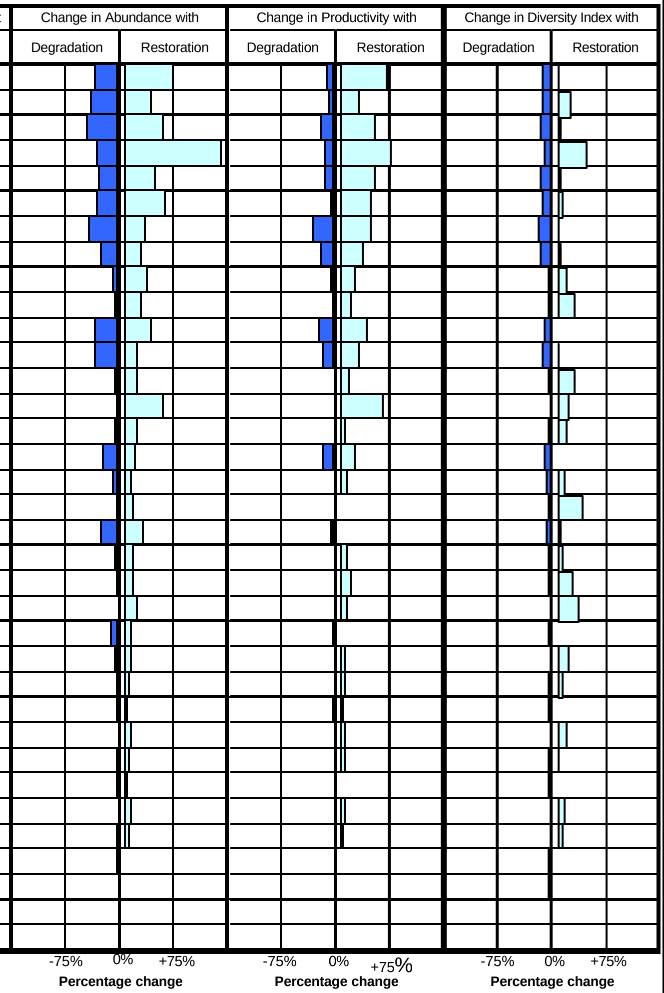

Figure 1. Summary of the relative importance of habitat (geographic area) restoration and preservation to spring chinook in the upper Yakima basin.

Table 2. Summary of Naches basin spring chinook performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and historical conditions.

Baseline Performance Analysis, Naches Drainage Spring Chinook

Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
CURRENT CONDITIONS								
American River and tributaries	12,091	335	303	2.8%	168	4.9	4.5	67.0%
Bumping River, below Bumping Dam	4,719	161	112	3.4%	115	4.0	2.9	81.0%
Bumping River, above Bumping Dam	0	0	0	N.A.	0	0.0	0	0.0%
Little Naches River and tributaries	11,579	357	264	3.1%	160	5.1	4.4	74.0%
Rattlesnake Creek and tributaries	5,248	166	127	3.2%	118	3.9	3.1	83.0%
Tieton River and tributaries below Rimrock Dam	0	0	0	N.A.	0	0.0	0	0.0%
Tieton River and tributaries above Rimrock Dam	0	0	0	N.A.	0	0.0	0	0.0%
Cowiche Creek and tributaries	211	8	5	3.8%	46	1.8	1.2	1.0%
Naches River mainstem below Tieton confluence	11,527	312	144	2.7%	142	4.5	2.1	24.0%
Naches River mainstem above Tieton confluence	15,617	494	328	3.2%	106	3.5	2.4	86.0%
HISTORICAL/NORMATIVE CONDITIONS								
Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
American River and tributaries	81,106	7,031	5,898	8.7%	448	41.2	38.9	95%
Bumping River, below Bumping Dam	51,976	5,260	4,491	10.1%	427	43.7	39.7	100%
Bumping River, above Bumping Dam	12,357	1,005	786	8.1%	399	37.4	34.4	100%
Little Naches River and tributaries	85,826	8,629	6,863	10.1%	469	47.7	43.5	100%
Rattlesnake Creek and tributaries	42,992	4,276	3,388	9.9%	396	39.8	35.8	100%
Tieton River and tributaries below Rimrock Dam	76,970	7,620	6,183	9.9%	404	40.6	35.2	100%
Tieton River and tributaries above Rimrock Dam	109,504	10,927	8,235	10.0%	342	34.8	32.2	100%
Cowiche Creek and tributaries	51,111	4,024	2,953	7.9%	469	44.5	39.6	100%
Naches River mainstem below Tieton confluence	146,932	12,129	10,507	8.3%	550	53.4	48.4	100%
Naches River mainstem above Tieton confluence	141,753	13,891	10,837	9.8%	479	48.4	44.7	100%

Naches River Drainage Spring Chinook (including the American River stock)

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category/rank		Restoration Category/rank	
Naches Cowiche to Tieton	A	3	A	2
Columbia above Estuary	B	7	A	1
Naches Nile to L Naches/Bumping	A	1	B	10
Bumping below Bumping Dam	B	7	B	7
Yakima Toppenish to Sunnyside Dam	A	4	B	12
L. Naches mouth to Salmon Falls	B	9	B	8
Naches Tieton to Rattlesnake	B	9	B	10
Yakima SSide Dam to Ahtanum Cr	C	14	B	5
L. Naches above Salmon Falls	B	6	C	15
Columbia Estuary	D	16	B	6
Yakima Ahtanum to Naches	B	5	C	17
American R. and tribs	A	1	D	22
Tieton below Rimrock Dam	D	22	B	3
Naches mouth to Cowiche	C	13	C	13
Rattlesnake Drainage	B	9	C	18
Naches Rattlesnake to Nile	C	12	C	16
Tieton drainage above Rimrock Dam	E	25	B	4
Yakima Prosser Dam to Satus	D	17	C	14
Cowiche Drainage	E	24	B	8
Yakima Satus to Toppenish	C	15	D	21
Yakima Horn Dam to Benton	D	20	D	19
Yakima delta to Horn Dam	D	18	E	23
Yakima Chandler Bypass Reach	D	18	E	24
Bumping above Bumping Dam	E	25	D	19
Yakima Benton to Powerplant	D	20	E	25
Yakima delta	E	23	E	26
Coastal Zone	E	25	E	27
Offshore Marine	E	25	E	27

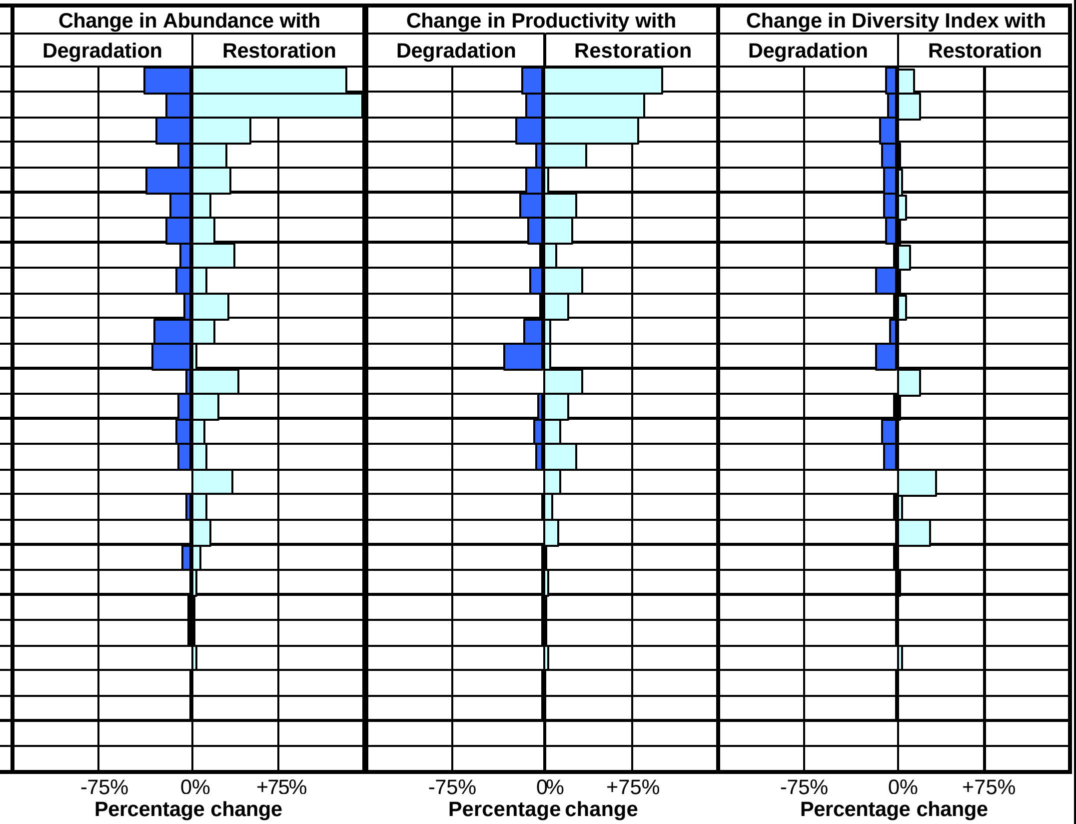

Figure 2. Summary of the relative importance of habitat (geographic area) restoration and preservation to spring chinook in the Naches basin.

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

Baseline Performance Analysis, Upper Yakima Coho

Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
CURRENT CONDITIONS								
Upper Yakima Tributaries (Cle Elum R and Taneum, Swauk, Manastash, Big and Little Creeks)	4,888	90	85	1.8%	81	1.5	1.48	4.6%
Upper Yakima Mainstem, Wilson Cr to Keechelus Dam	15,951	287	281	1.8%	88	1.6	1.58	0.2%
Upper Yakima Mainstem, Ahtanum Cr to Wilson Cr	5,326	78	75	1.5%	98	1.5	1.42	9.1%
Teanaway Watershed	2,691	45	43	1.7%	78	1.3	1.24	0.3%
Wilson/Naneum Watershed	132	2	2	1.5%	72	1.2	1.05	0.3%
Ahtanum/Wide Hollow Watershed	0	0	0	N.A.	0	0.0	0	0.0%
Wenas Creek Watershed	0	0	0	N.A.	0	0.0	0	0.0%
HISTORICAL/NORMATIVE CONDITIONS								
Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
Upper Yakima Tributaries (Cle Elum R and Taneum, Swauk, Manastash, Big and Little Creeks)	210,512	14,395	13,434	6.8%	206	14.1	13.9	68%
Upper Yakima Mainstem, Wilson Cr to Keechelus Dam	268,566	17,608	17,135	6.6%	234	15.8	15.6	98%
Upper Yakima Mainstem, Ahtanum Cr to Wilson Cr	207,970	13,054	12,648	6.3%	324	20.4	20.3	100%
Teanaway Watershed	449,730	30,818	28,499	6.9%	280	19.4	19.3	77%
Wilson/Naneum Watershed	77,059	5,014	4,666	6.5%	201	13.3	13.2	100%
Ahtanum/Wide Hollow Watershed	164,196	10,455	9,850	6.4%	230	14.8	14.7	96%
Wenas Creek Watershed	45,252	2,868	2,713	6.3%	216	13.9	13.7	77%

Upper Yakima Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category/rank	Restoration Category/rank
Columbia above Estuary	1	1
Yakima Easton Dam to Keechelus Dam	2	10
Yakima Cle Elum to Easton Dam	3	10
Yakima Ahtanum to Naches	5	9
Yakima Naches to Roza Dam	9	7
Yakima Roza Dam to Wilson Cr	4	13
Yakima Wilson to Manastash	12	6
Teanaway drainge above forks	14	5
Teanaway drainge below forks	16	3
Columbia Estuary	5	15
Yakima Manastash to Taneum	8	12
Wilson Drainage	21	2
Lower Ahtanum & Wide Hollow	16	8
Yakima Teanaway to Cle Elum	5	20
Ahtanum Amer Fruit Br to Upper WIP	24	4
Yakima Prosser Dam to Satus	15	17
Yakima Taneum to Teanaway	11	25
Yakima Toppenish to Sunnyside Dam	10	26
Cle Elum R below Cle Elum Dam	13	27
Taneum Drainage	19	22
Yakima SSide Dam to Ahtanum Cr	24	17
Wenas Cr Drainage	31	14
Yakima Horn Dam to Benton	21	24
Ahtanum drainage above WIP	27	19
Swauk Drainage	26	21
Yakima delta to Horn Dam	18	29
Manastash drainge	32	16
Yakima above storage dams	28	23
Yakima Chandler Bypass Reach	20	31
Yakima Satus to Toppenish	23	28
Yakima Benton to Powerplant	28	32
Big Cr Drainage	33	30
Yakima delta	30	33
Naches Cowiche to Tieton	34	34
Naches mouth to Cowiche	35	35
Coastal Zone	36	35

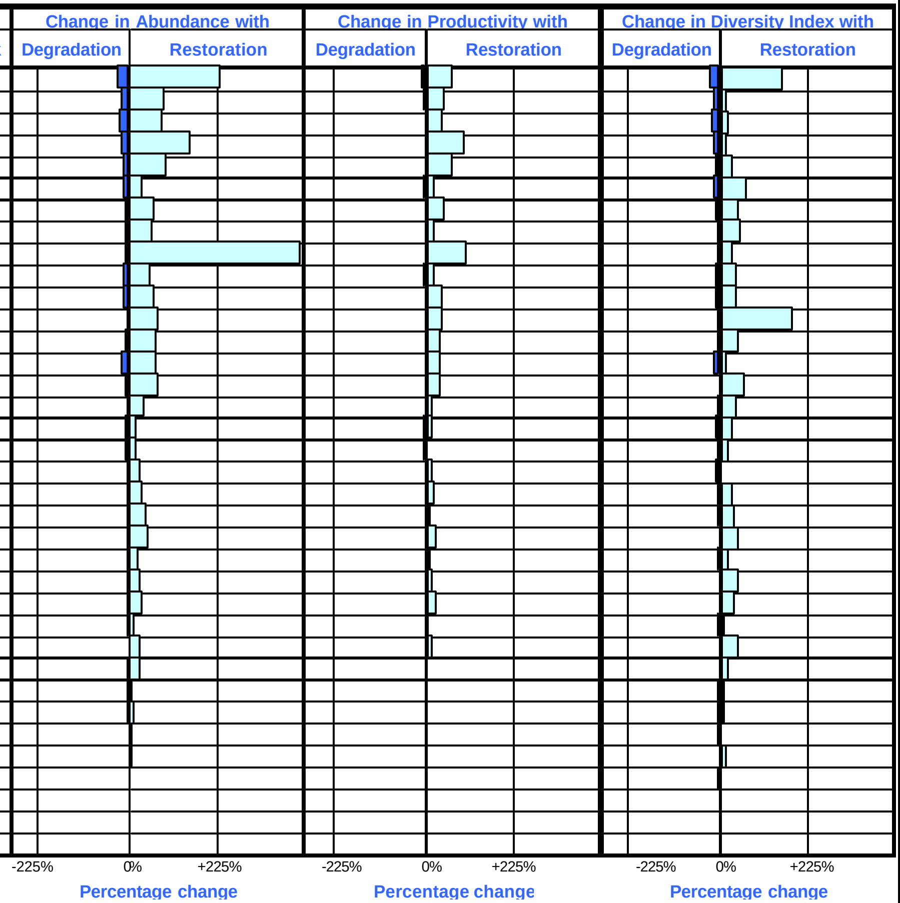

Figure 3. Summary of the relative importance of habitat (geographic area) restoration and preservation to coho in the upper Yakima basin.

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

Baseline Performance Analysis, Naches Drainage Coho

Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
CURRENT CONDITIONS								
American River and tributaries	340	4	4	1.2%	87	1.1	1.1	1.0%
Bumping River, below Bumping Dam	0	0	0	N.A.	0	0.0	0	0.0%
Bumping River, above Bumping Dam	0	0	0	N.A.	0	0.0	0	0.0%
Little Naches River and tributaries	2,015	34	33	1.7%	79	1.4	1.3	1.0%
Rattlesnake Creek and tributaries	0	0	0	N.A.	0	0.0	0	0.0%
Nile Cree	0	0	0	N.A.	0	0.0	0	0.0%
Tieton River and tributaries below Rimrock Dam	0	0	0	N.A.	0	0.0	0	0.0%
Tieton River and tributaries above Rimrock Dam	0	0	0	N.A.	0	0.0	0	0.0%
Cowiche Creek and tributaries	81	1	1	1.2%	68	1.2	1.1	1.0%
Naches River mainstem below Tieton confluence	2,439	37	33	1.5%	89	1.4	1.2	7.0%
Naches River mainstem above Tieton confluence	1,564	26	26	1.7%	73	1.3	1.2	1.0%
HISTORICAL/NORMATIVE CONDITIONS								
Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
American River and tributaries	42,507	3,103	2,867	7.3%	197	14.3	14.2	23%
Bumping River, below Bumping Dam	54,891	3,949	3,826	7.2%	174	12.7	12.6	94%
Bumping River, above Bumping Dam	8,189	605	562	7.4%	150	11.1	11	43%
Little Naches River and tributaries	97,712	7,204	6,664	7.4%	186	13.8	13.7	83%
Rattlesnake Creek and tributaries	27,135	1,903	1,797	7.0%	225	15.9	15.9	78%
Nile Cree	8,260	584	509	7.1%	216	15.5	15.4	100%
Tieton River and tributaries below Rimrock Dam	62,171	4,405	4,211	7.1%	221	15.7	15.6	100%
Tieton River and tributaries above Rimrock Dam	64,741	4,715	4,466	7.3%	168	12.4	12.3	67%
Cowiche Creek and tributaries	26,488	1,861	1,707	7.0%	271	19.0	18.9	100%
Naches River mainstem below Tieton confluence	106,601	7,434	7,192	7.0%	343	24.0	23.9	100%
Naches River mainstem above Tieton confluence	204,846	15,073	14,056	7.4%	237	17.5	17.4	100%

Naches Drainage Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category/rank	Restoration Category/rank
Naches Cowiche to Tieton	1	1
Columbia above Estuary	2	3
Naches Nile to L Naches/Bumping	5	2
Columbia Estuary	3	9
L. Naches above Salmon Falls	5	9
Yakima Ahtanum to Naches	3	16
Bumping below Bumping Dam	13	7
L. Naches mouth to Salmon Falls	11	11
Naches mouth to Cowiche	10	13
Tieton below Rimrock Dam	19	4
Naches Rattlesnake to Nile	9	15
Naches Tieton to Rattlesnake	8	17
Yakima Toppenish to Sunnyside Dam	7	18
Cowiche Drainage	22	5
Yakima Prosser Dam to Satus	13	14
Rattlesnake Drainage	20	8
Tieton drainage above Rimrock Dam	26	6
Yakima SSide Dam to Ahtanum Cr	20	12
Yakima Satus to Toppenish	15	20
Yakima Horn Dam to Benton	17	19
Yakima delta to Horn Dam	15	22
American R. and tribs	12	26
Yakima Chandler Bypass Reach	18	23
Yakima Naches to Roza Dam	25	21
Yakima Benton to Powerplant	23	25
Bumping above Bumping Dam	26	23
Yakima delta	24	27
Coastal Zone	26	28

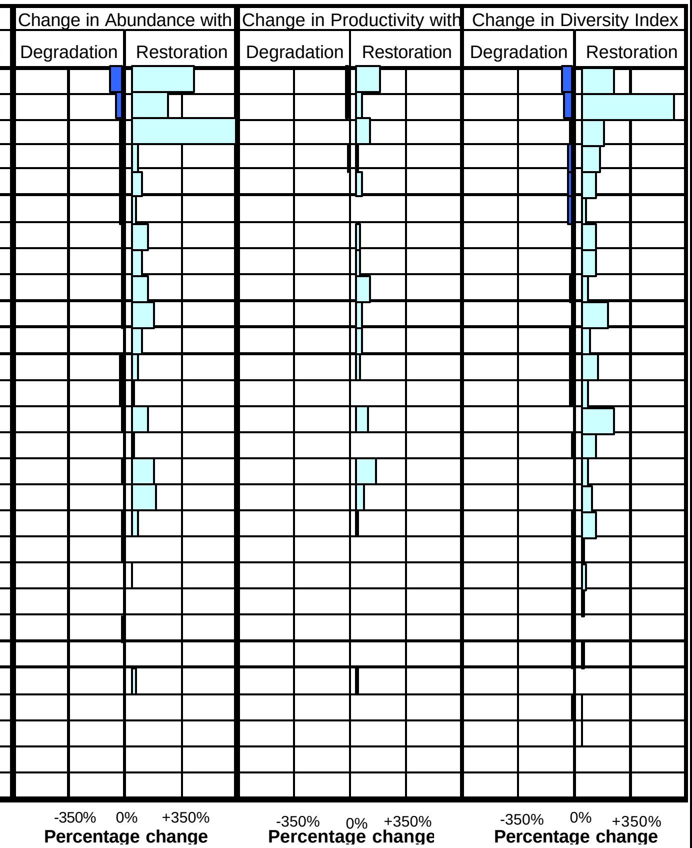

Figure 4. Summary of the relative importance of habitat (geographic area) restoration and preservation to coho in the Naches basin.

Table 5. Summary of upper Yakima basin steelhead performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and historical conditions.

Baseline Performance Analysis, Upper Yakima Summer Steelhead

("Upper Yakima" defined as all mainstem reaches and tributaries upstream of the Yakima-Ahtanum Cr confluence, excluding the Naches River.)

Diagnostic Area	Equilibrium Abundance				Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds	Adjusted Adults on Spawning Grounds[a]		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
CURRENT CONDITIONS									
Upper Yakima Tributaries	21,268	397	333	109	1.9%	85	1.8	1.62	3%
Yakima Mainstem above Roza Dam	6,016	108	95	31	1.8%	77	1.6	1.37	22%
Yakima Mainstem between Roza Dam and Ahtanum Cr.	0	0	0	0	N.A.	0	0.0	0	5%
Wilson/Naneum Cr. Watershed	0	0	0	0	N.A.	0	0.0	0	0%
Wenas Cr. Watershed	0	0	0	0	N.A.	0	0.0	0	0%
Ahranum/Wide Hollow Watershed	0	0	0	0	N.A.	0	0.0	0	0%
HISTORICAL/NORMATIVE CONDITIONS									
Upper Yakima Tributaries	280,375	24,492	18,713	18,713	8.7%	196	20.2	19.3	81%
Yakima Mainstem above Roza Dam	66,561	5,266	5,125	5,125	7.9%	185	17.7	16.6	100%
Yakima Mainstem between Roza Dam and Ahtanum Cr.	29,114	2,050	2,152	2,152	7.0%	234	20.2	19.1	100%
Wilson/Naneum Cr. Watershed	44,064	3,667	4,218	4,218	8.3%	142	14.8	14.3	100%
Wenas Cr. Watershed	70,103	5,330	5,457	5,457	7.6%	172	17.2	16.6	96%
Ahranum/Wide Hollow Watershed	10,975	994	1,087	1,087	9.1%	125	13.8	13.3	78%

a. The adjusted spawning escapement is the result of a provisional solution to the resident/anadromous equilibrium.

Upper Yakima Summer Steelhead
Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Columbia above Estuary	B	3	A	1
Teanaway drainge above forks	B	8	A	4
Taneum Drainage	B	10	B	7
Yakima Prosser Dam to Satus	A	2	B	15
Columbia Estuary	B	4	C	18
Ahtanum drainage above WIP	D	16	B	7
Yakima Ahtanum to Naches	B	8	B	15
Yakima Roza Dam to Wilson Cr	B	6	C	17
Teanaway drainge below forks	D	18	B	6
Yakima Satus to Toppenish	A	1	D	23
Ahtanum Amer Fruit Br to Upper WIP	D	20	B	5
Yakima Wilson to Manastash	C	13	B	12
Wilson Drainage	E	23	A	3
Yakima Manastash to Taneum	B	10	C	19
Yakima Naches to Roza Dam	D	19	B	10
Manastash drainge	E	28	A	2
Swauk Drainage	D	22	B	9
Yakima Toppenish to Sunnyside Dam	B	5	D	28
Lower Ahtanum & Wide Hollow	D	21	B	13
Yakima Cle Elum to Easton Dam	C	15	C	19
Yakima Easton Dam to Keechelus Dam	B	10	D	25
Cle Elum R below Cle Elum Dam	B	7	D	29
Yakima above storage dams	E	30	B	10
Yakima Teanaway to Cle Elum	C	13	D	27
Yakima Taneum to Teanaway	D	16	D	26
Wenas Cr Drainage	E	29	B	14
Yakima SSide Dam to Ahtanum Cr	E	26	C	21
Yakima Horn Dam to Benton	E	25	D	24
Yakima delta to Horn Dam	E	23	E	30
Big Cr Drainage	E	34	C	22
Yakima Chandler Bypass Reach	E	27	E	31
Yakima Benton to Powerplant	E	31	E	32
Yakima delta	E	32	E	33
Naches mouth to Cowiche	E	33	E	34
Coastal Zone	E	34	E	35
Offshore Marine	E	34	E	35

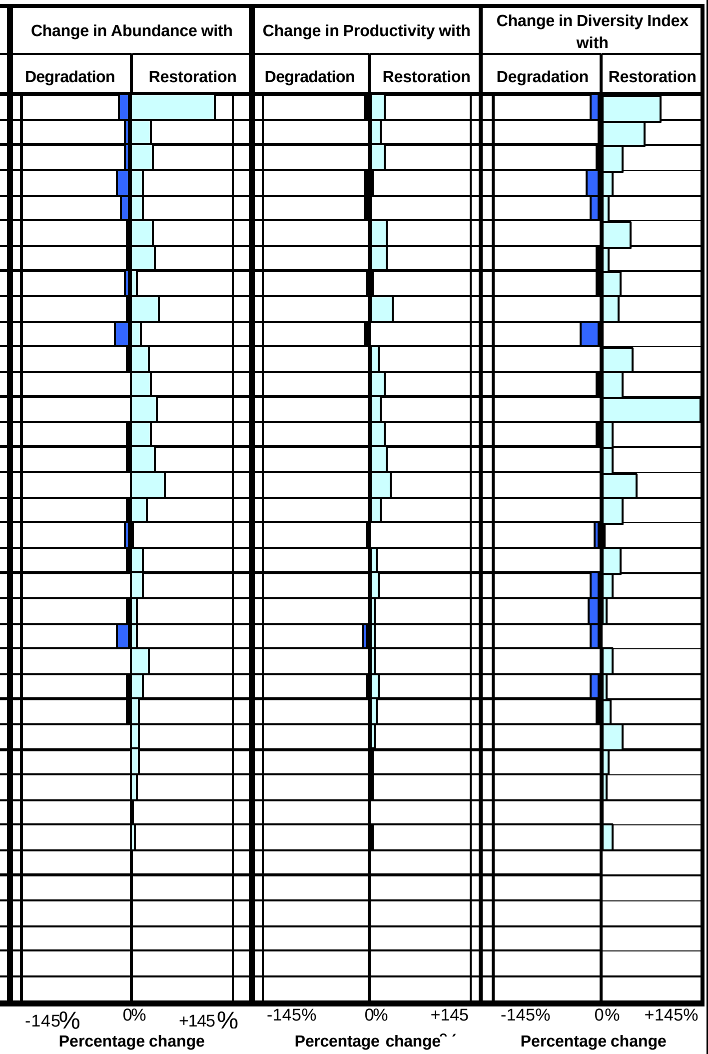

Figure 5. Summary of the relative importance of habitat (geographic area) restoration and preservation to steelhead in the upper Yakima basin.

Table 6. Summary of Naches basin steelhead performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and historical conditions.

Baseline Performance Analysis, Naches Drainage Summer Steelhead

(Naches Drainage" includes the American River.)

Diagnostic Area	Equilibrium Abundance				Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds	Adjusted Adults on Spawning Grounds[a]		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
CURRENT CONDITIONS									
AmericanSthd	6,810	99	90	90	1.5%	156	2.6	2.4	27%
Bumping above dam	0	0	0	0	N.A.	0	0.0	0	0%
Bumping below dam	824	21	19	19	2.5%	47	1.3	1.2	3%
Cowiche drainage	0	0	0	0	N.A.	0	0.0	0	0%
L Naches drainage	14,002	226	204	204	1.6%	105	1.9	1.7	19%
Lower Tieton drainage	5,721	87	77	77	1.5%	102	1.7	1.6	2%
Naches above Tieton	5,816	93	85	85	1.6%	86	1.5	1.3	16%
Naches below Tieton	7,229	113	104	104	1.6%	92	1.6	1.5	4%
Nile drainage	0	0	0	0	N.A.	0	0.0	0	0%
Rattlesnake drainage	7,325	115	105	105	1.6%	108	1.8	1.7	25%
Upper Tieton drainage	0	0	0	0	N.A.	0	0.0	0	0%
HISTORICAL/NORMATIVE CONDITIONS									
Diagnostic Area	**Equilibrium Abundance**				**Smolt-to-adult Survival (at Prosser Dam)**	**Productivity**			**Life History Diversity**
	Smolts at Prosser	**Adults at Prosser**	**Adults on Spawning Grounds**	**Adjusted Adults on Spawning Grounds[a]**		**Smolts per Spawner (at Prosser)**	**Adult Returns per Spawner (at Prosser)**	**Adult Returns per Spawner (on Spawning Grounds)**	
AmericanSthd	36,905	3,068	2,908	2,908	8.3%	251	25.0	24	63%
Bumping above dam	5,501	475	454	454	8.6%	212	19.0	18	35%
Bumping below dam	34,846	2,706	2,604	2,604	7.8%	185	19.0	18	97%
Cowiche drainage	17,237	1,501	1,438	1,438	8.7%	198	21.0	20	96%
L Naches drainage	77,389	6,756	6,438	6,438	8.7%	199	20.0	20	89%
Lower Tieton drainage	72,313	4,969	4,752	4,752	6.9%	214	21.0	20	98%
Naches above Tieton	89,627	7,703	7,318	7,318	8.6%	232	25.0	24	1%
Naches below Tieton	178,410	14,014	13,196	13,196	7.9%	268	27.0	26	95%
Nile drainage	5,795	701	670	670	12.1%	195	23.0	22	98%
Rattlesnake drainage	22,064	2,277	2,183	2,183	10.3%	186	21.0	20	90%
Upper Tieton drainage	68,446	5,872	5,519	5,519	8.6%	170	18.0	17	80%

a. The adjusted spawning escapement is the result of a provisional solution to the resident/anadromous equilibrium. In the case of the Naches drainage, no adjustment was necessary.

Naches Drainage (including American River) Summer Steelhead

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category/rank		Restoration Category/rank	
Columbia above Estuary	B	3	A	1
Naches Cowiche to Tieton	B	4	A	2
Naches Nile to L Naches/Bumping	B	4	B	3
Columbia Estuary	B	6	B	5
Yakima Prosser Dam to Satus	A	2	C	9
Yakima Satus to Toppenish	A	1	D	18
Tieton below Rimrock Dam	D	16	B	4
Bumping below Bumping Dam	D	15	B	6
L. Naches above Salmon Falls	B	7	C	14
Naches Tieton to Rattlesnake	C	10	C	11
L. Naches mouth to Salmon Falls	C	12	C	10
Naches mouth to Cowiche	D	17	B	6
Rattlesnake Drainage	B	7	D	17
Naches Rattlesnake to Nile	C	13	C	12
Cowiche Drainage	E	21	B	6
Yakima Toppenish to Sunnyside Dam	C	9	D	18
American R. and tribs	C	10	E	24
Yakima Ahtanum to Naches	C	13	E	21
Yakima Horn Dam to Benton	D	19	D	16
Yakima SSide Dam to Ahtanum Cr	E	22	C	13
Yakima delta to Horn Dam	D	18	E	20
Tieton drainage above Rimrock Dam	E	25	D	15
Yakima Chandler Bypass Reach	D	20	E	21
Bumping above Bumping Dam	E	25	E	23
Yakima Benton to Powerplant	E	23	E	25
Yakima delta	E	24	E	26
Coastal Zone	E	25	E	27
Offshore Marine	E	25	E	27

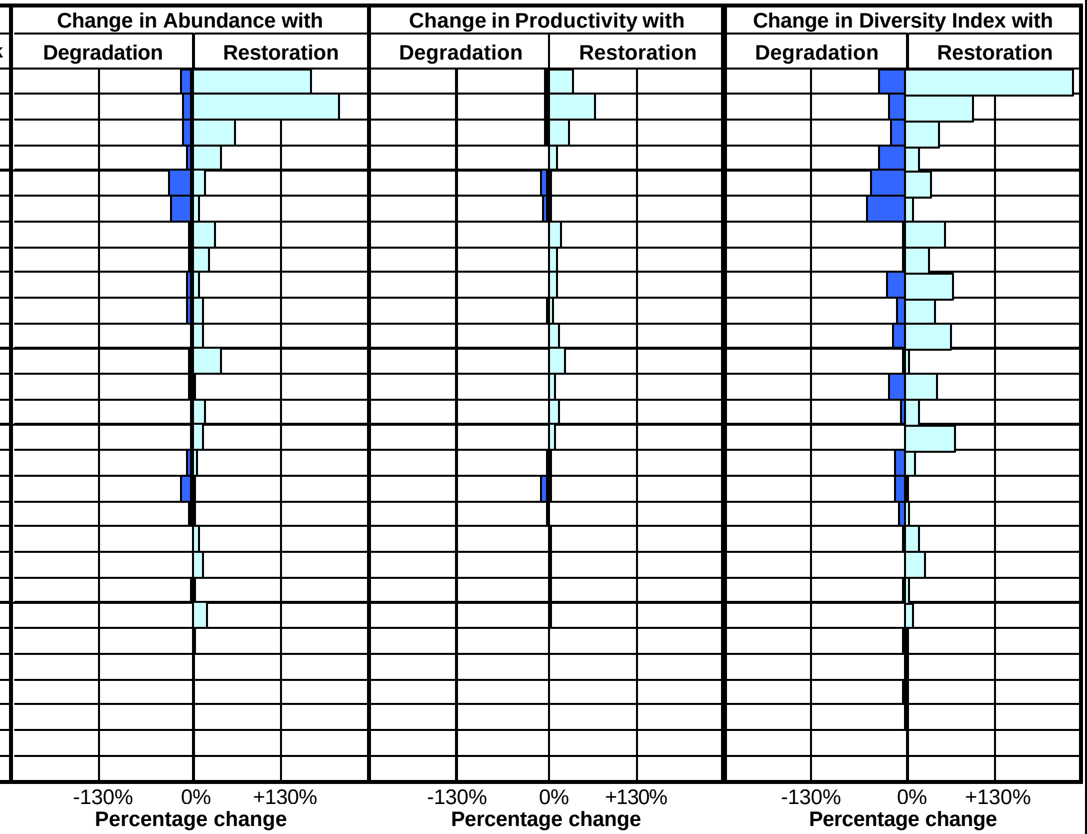

Figure 6. Summary of the relative importance of habitat (geographic area) restoration and preservation to steelhead in the Naches basin.

Table 7. Summary of Toppenish basin spring chinook performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and historical conditions.

Baseline Performance Analysis, Toppenish Creek Summer Steelhead

"Upper Toppenish Creek" consists of all of those reaches above the Toppenish Lateral Canal and the Simcoe Feeder Canal.
These irrigation diversions dewater Toppenish and Simcoe Creeks, respectively, from June through December.
Therefore, the progeny of fish that spawned above these diversions are effectively isolated and incapable of "normal" juvenile movement patterns.
Marion Drain, Wanity Slough and Harrah Drain are considered a part of Toppenish Creek because of hydraulic connections between Toppenish
reek and Marion Drain, and because of the high probability steelhead spawning in Marion Drain are Toppenish Creek strays.

CURRENT CONDITIONS								
Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
Upper Toppenish Creek	16,480	247	217	1.5%	131	2.4	2.1	45%
Lower Toppenish Creek	2,373	39	33	1.6%	87	1.5	1.3	1%
Marion Drain Complex	0	0	0	N.A.	0	0.0	0	0%

HISTORICAL/NORMATIVE CONDITIONS								
Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds		Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	
Upper Toppenish Creek	65,208	5,242	5,016	8.0%	183	16.9	16.3	97%
Lower Toppenish Creek	66,062	5,316	5,108	8.0%	189	16.9	16.3	95%
Marion Drain Complex	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Toppenish Creek Watershed Summer Steelhead

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category/rank		Restoration Category/rank	
Columbia above Estuary	B	4	A	1
Yakima Prosser Dam to Satus	B	3	B	3
Columbia Estuary	B	5	B	2
Simcoe Cr.-6	C	8	B	4
Toppenish Cr.-9	B	6	C	11
Toppenish Cr.-8	B	7	C	11
Yakima Satus to Toppenish	A	2	C	18
NF Toppenish Cr.-2	C	11	C	11
Toppenish Cr.-11	A	1	D	21
Toppenish Cr.-2	C	13	C	10
Simcoe Cr.-2	C	17	B	7
Toppenish Cr.-1	C	9	C	15
Toppenish Cr.-7	D	19	B	5
Toppenish Cr.-6	C	15	C	15
Toppenish Cr.-3	D	26	B	6
Yakima Horn Dam to Benton	D	27	C	9
Willy Dick Canyon Cr.-1	C	12	D	26
NF Toppenish Cr.-1	D	24	C	17
SF Simcoe Cr.-2	C	10	D	31
Agency Cr.-1	D	23	C	19
Yakima delta to Horn Dam	D	20	D	22
Simcoe Cr.-3	E	37	C	8
Toppenish Cr.-5	D	27	D	20
Wahtum Cr.	D	21	D	27
Simcoe Cr.-1	E	30	D	22
Willy Dick Canyon Cr.-3	C	15	E	38
Toppenish Cr.-10	C	13	E	41
Toppenish Cr.-3A (Unit II Pump Diversion)	E	40	C	14
Toppenish Cr.-4	E	29	D	25
Agency Cr.-2	D	22	D	33
Willy Dick Canyon Cr.-2	C	18	E	39
Yakima Chandler Bypass Reach	E	31	D	28
NF Simcoe Cr.-1A (Hoptowit Ditch)	E	40	D	22
NF Simcoe Cr.-1	E	33	D	31
Simcoe Cr.-5	E	36	D	29
NF Simcoe Cr.-2	D	25	E	44
Toppenish Cr.-7A (Toppenish Lateral Canal)	E	40	D	30
Yakima Benton to Powerplant	E	33	E	37
Marion Drain complex	E	38	E	35
SF Simcoe Cr.-1	E	32	E	41
Simcoe Cr.-4 (Simcoe Feeder Canal)	E	40	E	34
nish Cr.-1A (Tainer Gate Diversion and Juvenile E	E	40	E	36
SF Simcoe Cr.-1A (SF Feeder Canal)	E	40	E	40
Yakima Toppenish to Sunnyside Dam	E	35	E	45
Yakima delta	E	39	E	43
Coastal Zone	E	40	E	45
Offshore Marine	E	40	E	45

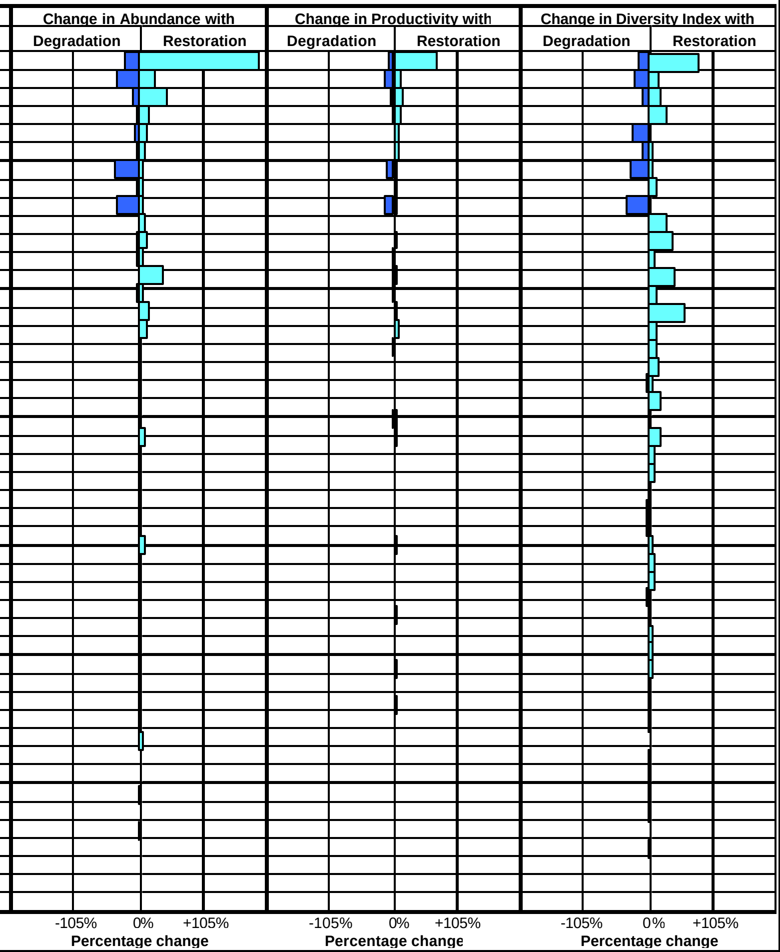

Figure 7. Summary of the relative importance of habitat (geographic area) restoration and preservation to steelhead in the Toppenish basin.

Table 8. Summary of Satus basin spring chinook performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and historical conditions.

Baseline Performance Analysis, Satus Creek Summer Steelhead								
CURRENT CONDITIONS								
	Equilibrium Abundance				Productivity			
Diagnostic Area	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds	Smolt-to-adult Survival (at Prosser Dam)	Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	Life History Diversity
Satus Creek Watershed	53,568	799	747	1.5%	134	2.3	2.2	42%
HISTORICAL/NORMATIVE CONDITIONS								
	Equilibrium Abundance				Productivity			
Diagnostic Area	Smolts at Prosser	Adults at Prosser	Adults on Spawning Grounds	Smolt-to-adult Survival (at Prosser Dam)	Smolts per Spawner (at Prosser)	Adult Returns per Spawner (at Prosser)	Adult Returns per Spawner (on Spawning Grounds)	Life History Diversity
Satus Creek Watershed	180,388	14,460	13,671	8.0%	231	21.1	20.4	98%

Satus Creek Summer Steelhead

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank	Restoration benefit Category/rank
Columbia above Estuary	4	1
Satus Cr.-2	4	4
Logy Cr.	6	3
Satus Cr.-4	2	7
Columbia Estuary	8	2
Satus Cr.-1	1	9
Satus Cr.-3	9	5
Yakima Prosser Dam to Satus	3	13
Dry Cr. (Satus)-2	7	11
Satus Cr.-7	10	9
Dry Cr. (Satus)-1	14	8
Mule Dry Cr.	19	5
Satus Cr.-6	12	12
Satus Cr.-5	11	14
Kusshi Cr.	13	15
Yakima delta to Horn Dam	15	16
Bull Cr.	15	19
Yakima Horn Dam to Benton	17	18
Wilson Charlie Cr.	19	17
Yakima Chandler Bypass Reach	18	19
Yakima Benton to Powerplant	21	21
Yakima delta	22	22
Coastal Zone	23	23
Offshore Marine	23	23

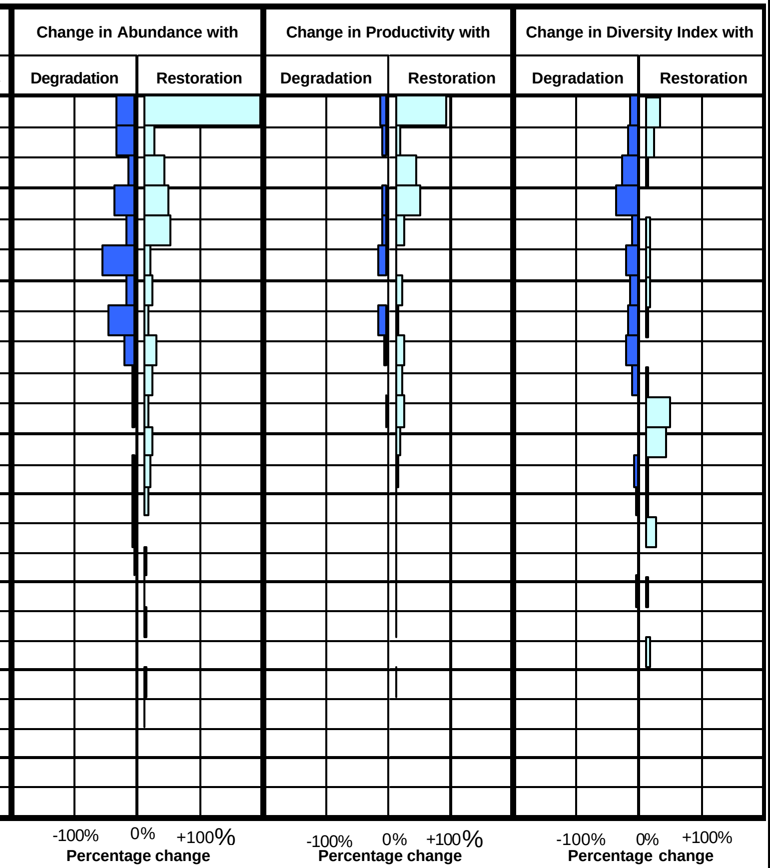

Figure 8. Summary of the relative importance of habitat (geographic area) restoration and preservation to steelhead in the Satus basin.

Table 9. Summary of Yakima basin fall chinook performance (by diagnostic area) in terms of equilibrium abundance, productivity and life history diversity for current and historical conditions.

Baseline Performance Analysis, Yakima Fall Chinook

Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Yakima mouth)	Productivity			Life History Diversity
	Adults on Spawning Grounds	Adults at Yakima mouth	Smolts at Yakima mouth		Smolts per Spawner (at Yakima mouth)	Adult Returns per Spawner (at Yakima mouth)	Adult Returns per Spawner (on Spawning Grounds)	
CURRENT CONDITIONS								
Lower Yakima Mainstem (mouth to Sunnyside Dam): Natural Spawners	3,150	4,309	617,533	0.7%	224	2.3	1.7	9.0%
Lower Yakima Mainstem: F1 Hatchery Fish	1,863	2,469	791,196	0.3%	851	2.8	2.1	31.0%
Marion Drain	104	155	4,169	3.7%	54.2	2.1	1.7	8.0%
Combined Hatchery/Natural Mainstem Population: Natural-origin spawners only	4,289							
Combined Hatchery/Natural Mainstem Population: Hatchery-origin spawners only	1,887							
Supplemented Total (including Marion Drain)	6,280							
HISTORICAL/NORMATIVE CONDITIONS								
Diagnostic Area	Equilibrium Abundance			Smolt-to-adult Survival (at Prosser Dam)	Productivity			Life History Diversity
	Adults on Spawning Grounds	Adults at Yakima mouth	Smolts at Yakima mouth		Smolts per Spawner (at Yakima mouth)	Adult Returns per Spawner (at Yakima mouth)	Adult Returns per Spawner (on Spawning Grounds)	
Lower Yakima Mainstem (mouth to current location of Sunnyside Dam)	75,744	81,201	8,216,607	1.0%	396	22.5	21.8	100%

Marion Drain Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category/rank		Restoration Category/rank	
Columbia above Estuary	A	1	A	1
Columbia Estuary	B	3	C	5
Marion Drain-4	A	2	C	6
Wanity Slough	B	7	B	3
Yakima Prosser Dam to Satus	C	9	B	2
Yakima Satus to Toppenish	B	4	D	9
Harrah Drain	B	5	D	10
Marion Drain-1	B	7	E	11
Marion Drain-3	B	5	E	13
Yakima Chandler Bypass Reach	D	11	D	8
Yakima Horn Dam to Benton	D	12	C	7
Coastal Zone	E	16	C	4
Yakima Toppenish to Sunnyside Dam	C	10	E	12
Yakima Benton to Powerplant	D	13	E	14
Yakima delta to Horn Dam	D	14	E	15
Marion Drain-2 (Gate Structure)	E	16	E	15
Yakima delta	D	15	E	17

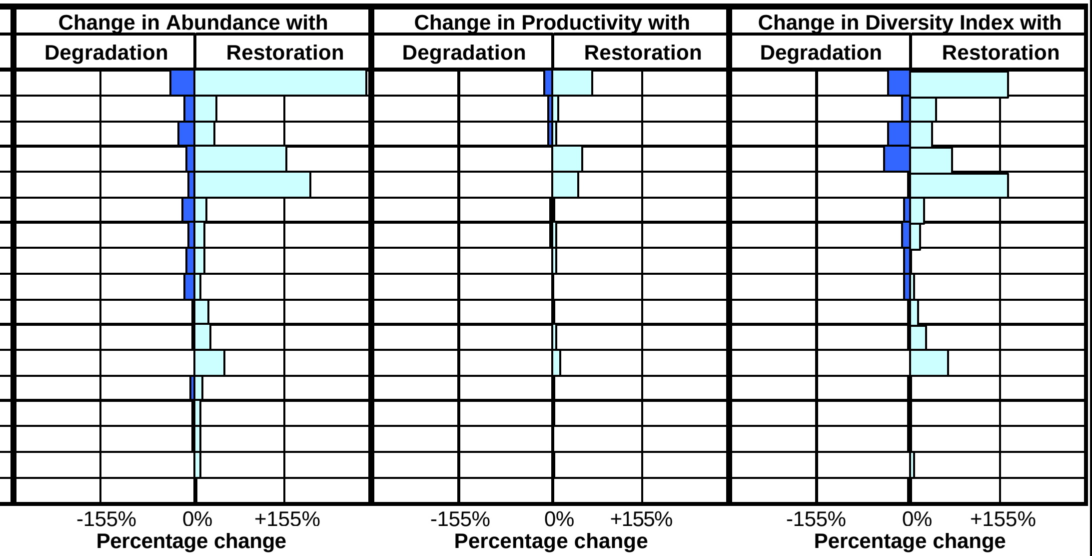

Figure 9. Summary of the relative importance of habitat (geographic area) restoration and preservation to fall chinook in Marion Drain.

Lower Yakima Mainstem Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category	Protection rank	Restoration Category	Restoration rank
Columbia above Estuary	A	1	A	1
Yakima delta to Horn Dam	B	2	A	1
Yakima Horn Dam to Benton	B	2	B	4
Yakima Toppenish to Sunnyside Dam	B	5	B	5
Yakima Chandler Bypass Reach	B	5	B	6
Yakima Prosser Dam to Satus	C	8	B	3
Columbia Estuary	B	4	C	8
Yakima delta	B	5	B	7
Yakima Satus to Toppenish	C	9	C	9
Yakima Benton to Powerplant	C	10	C	10
Coastal Zone	D	11	D	11

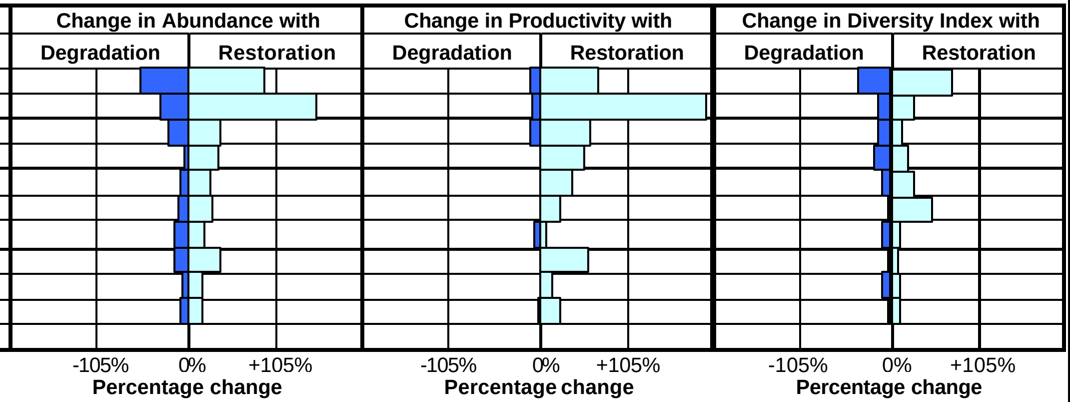

Figure 10. Summary of the relative importance of habitat (geographic area) restoration and preservation to fall chinook in lower Yakima River.

Klickitat

Work initiated in the last quarter of FY01 to delineate additional reaches/obstructions and input of Level 2 attributes was continued in FY02. A biologist was hired in FY02 to specifically construct the Klickitat EDT model. Through FY02 the hydrography stream routing layer had been defined for the model and hydrological data was being summarized for input of the Level 2 hydrological attributes to the EDT model. All information is simultaneously being input into the GIS for future use in producing graphical outputs of the EDT products, which is considered an improvement over past methods of displaying model outputs using tables and figures.

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 2001 beach seine sites were established at Toppenish, Granger and Benton City.

Progress: Growth profiles of naturally rearing fall chinook juveniles in the lower Yakima River were successfully monitored via beach seining during the month of May in 2002. High river discharge precluded any sampling during the month of April. Beach seining areas were located in nine sections of the Yakima River, at Van Giesen Street Bridge (Rm 8.4), West Richland (Rm 9), Horn Rapids Dam (Rm 18), Benton City (Rm 29.8), below Granger (Rm 69-83), above Granger (Rm 83-90), Toppenish (Rm 90), Union Gap (Rm106.9-116, and Sundown Ranch (Rm 123.5). Seining was conducted using a 60 ft beach seine. Areas were seined until 100 fork lengths of juvenile fall chinook salmon were gathered. Any additional fish were enumerated, identified to species and released back into the river.

The data set indicates a continued large spatial distribution of spawning fall chinook throughout the middle and lower Yakima River. Juvenile fall chinook, were found rearing from Rm 106 at Union Gap down to the mouth of the Yakima River. The rearing juveniles throughout the river showed faster growth down river, possibly due to the warmer water.

A freshet resulting in the loss of two temperature loggers caused the 2002 temperature data set to be incomplete. However, the water temperatures observed in 2001 (Figure 11) are likely an appropriate representation of typical water temperatures at Benton City, Granger and Toppenish under which juvenile fall chinook reared in 2002.

As observed in 2001 the mean fork length of juvenile fall chinook generally increased in size from Union Gap to West Richland (Table 10). The mean fork length for sites sampled upstream of Granger was 47 mm compared to 61 mm for sites below Granger. There was also a greater range in fork lengths for sites sampled above Granger (23, 43 and 28 mm) compared to site below Granger (75, 60 and 58 mm). This difference observed in the range of size could be attributed to either greater variance in fry emergence timing or from the emigration of selectively larger fish from upstream reaches.

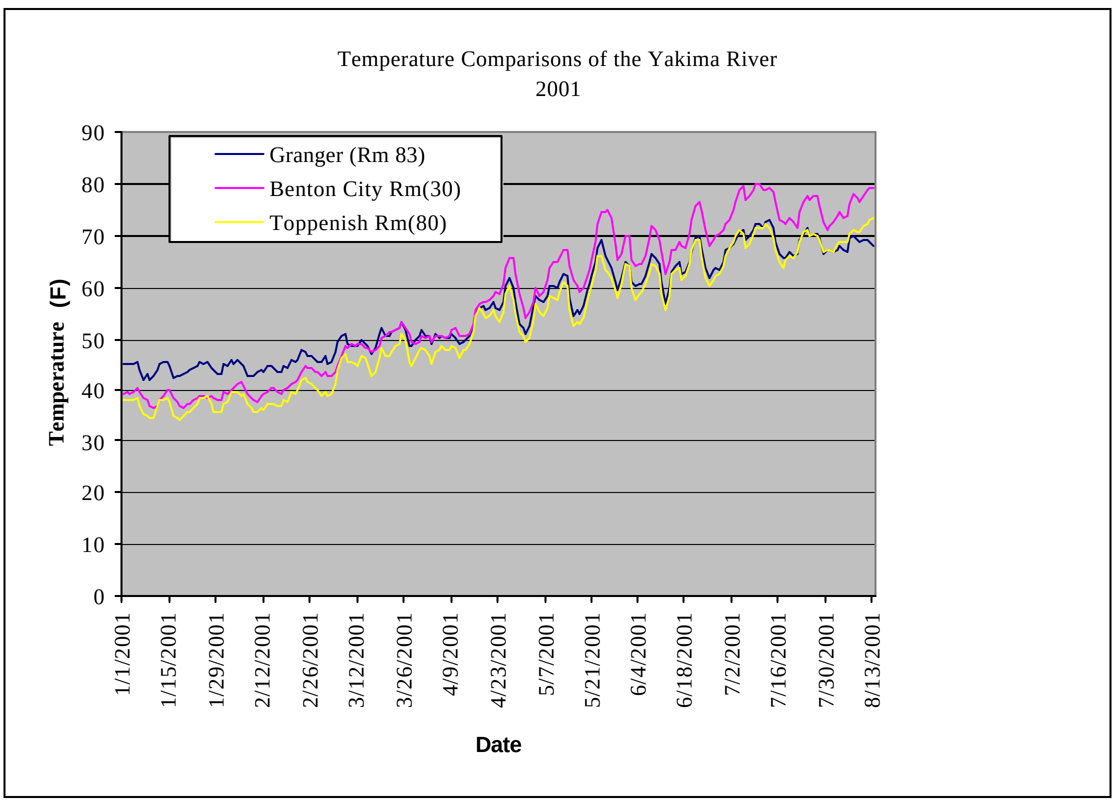

Figure 11. Temperature comparisons of the Yakima River.

Table 10. 2002 Growth profiles of naturally rearing juvenile fall chinook salmon.

		Total Counts		Average FL		Max FL		Min FL	
	RM	April	May	April	May	April	May	April	May
Sundown	123.5								
Union Gap	106.9-116		83		46		60		37
Toppenish	90		164		52		78		35
Above Granger	83-90		94		43		61		33
Below Granger	69-83		307		48		106		31
Benton City	29.8		248		69		100		40
Horn Rapids	18								
West Richland	9		178		67		98		40
Van Giesen	8.4								

Of interest were the 414 wild juvenile coho, presumably all age-0 that were captured. Their mean fork length was 48 mm (standard deviation was 7.4) and ranged in length from 33 to 75 mm (Figure 12). The Age-0, wild coho were

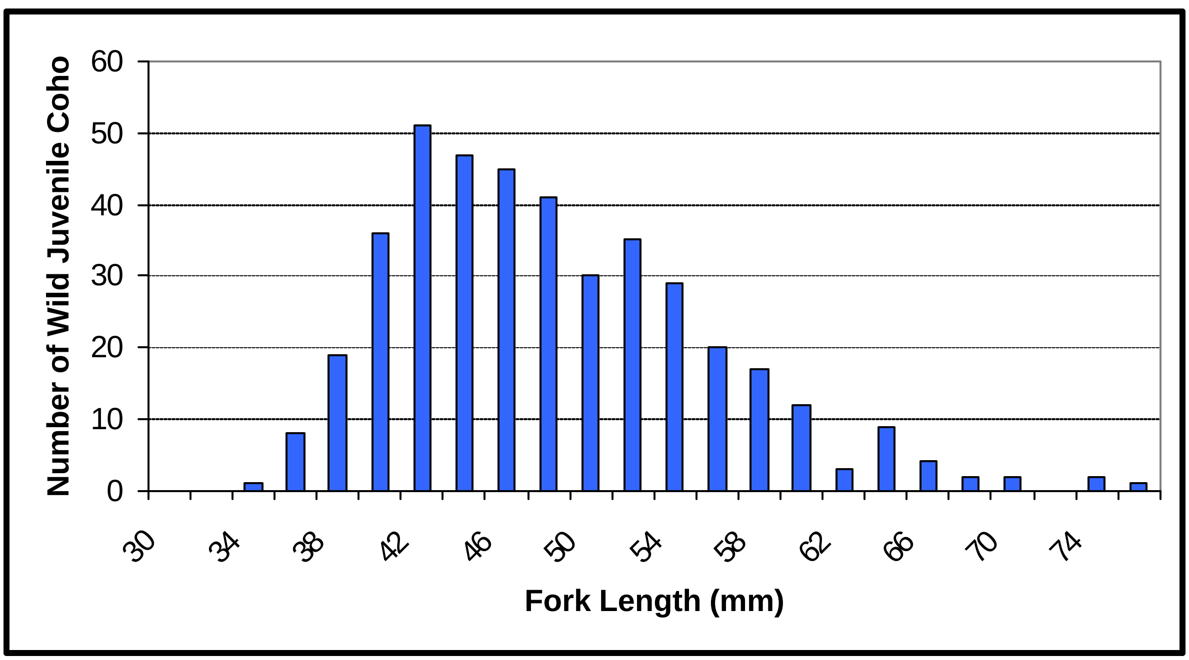

Figure 12. Length (fork) histogram of age-0 wild coho captured in the fall chinook beach seining surveys on the Yakima River, spring 2002.

most prevalent in the Toppenish reach (205 fish); followed by the Granger reach (119 fish) and the Union Gap reach (90 fish). No wild juveniles were captured in the Benton City reach. This distribution follows closely the distribution of spawning in the mainstem Yakima River based on current coho spawner radio telemetry studies.

Personnel Acknowledgements: Todd Newsome is the project biologist for this task. Technicians Linda Lamebull, Joe Jay Pinkham, Jason Allen, Conan Northwind and Wilda Watlamet conducted all 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., B. James, C. L. Johnson, A. L. Fritts, and G. M. Temple. 2003. Spring chinook salmon interactions indices and residual/precocial monitoring in the upper Yakima River. Annual Report FY 2001-2002 submitted to Bonneville Power Administration, Portland, Oregon. DOE/BP-00004666-14.

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: To estimate smolt-to-smolt survival by rearing treatment (OCT/SNT), 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 2001 fish began at the Cle Elum hatchery on October 14, 2002 and was completed on November 15, 2002. Marking results are summarized in Table 11. This brood suffered a significant BKD mortality at pre-spawn/spawn time, so had fewer fish in the rearing ponds for marking. As in prior years, all fish were adipose fin-clipped. Approximately 4,000 fish (9.3% to 10.2% of the fish) in each of 8 raceways were CWT tagged in the snout and then PIT tagged. For the Predator Avoidance Training raceways (PAT), a total of 8,000 fish (about 20% of these fish) were CWT tagged in the snout and then PIT tagged. The remainder of the fish (334,360) had a CWT placed in their body (i.e. left/right cheek, anterior/posterior dorsal fin, caudal 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 OCT treatment and the right eyelid to the SNT 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. A final quality control check by YN staff took place in late December, 2002.

Table 11. Summary of 2001 brood year marking activities at the Cle Elum Supplementation and Research Facility.

CE RW ID	Treatment	AcclId	Comment	Est. Number	Elastomer Eye Site/Color	CWT Body site	Total No. Tagged	Total No. PIT-Tagged	Grand total Tagged	Start Date	Finish Date
CLE01	OCT	CFJ04	BKD 6	41727	Right/Red	Anterior dorsal fin	38809	4000	42809	10/31/2002	11/6/2002
CLE02	SNT	CFJ03	BKD 6	41733	Left/Red	Posterior dorsal fin	38496	4000	42496	11/6/2002	11/12/2002
CLE03											
CLE04											
CLE05	SNT	JCJ03	Production	40174	Left/Green	Posterior dorsal fin	37765	4017	41782	10/14/2002	10/17/2002
CLE06	OCT	JCJ04	Production	41127	Right/Green	Anterior dorsal fin	36700	4000	40700	10/17/2002	10/23/02
CLE07	SNT	CFJ01	Production	42638	Left/Red	Right cheek	39081	4000	43081	10/23/2002	10/29/02
CLE08	OCT	CFJ02	Production	41829	Right/Red	Left cheek	39048	4000	43048	10/29/2002	11/04/02
CLE09	SNT	CFJ05	Production	41001	Left/Red	Caudal peduncle	37655	4001	41656	11/5/2002	11/08/02
CLE10	OCT	CFJ06	Production	40126	Right/Red	Adipose fin	35321	4000	39321	11/12/2002	11/15/02
CLE11											
CLE12											
CLE13	PAT	ESJ01	Control	6427	Left/Orange	Right cheek	3618	1333	6788	10/31/2002	10/31/02
CLE14	PAT	ESJ02	Treatment	6427	Right/Orange	Left cheek	3587	1333	6585	10/30/2002	10/30/02
CLE15	PAT	ESJ03	Control	6427	Left/Orange	Posterior dorsal fin	3280	1336	6314	10/30/2002	10/30/02
CLE16	PAT	ESJ04	Control	6427	Left/Orange	Anterior dorsal fin	3248	1333	6493	10/29/2002	10/29/2002
CLE17	PAT	ESJ05	Treatment	6427	Right/Orange	Caudal peduncle	3452	1334	6678	10/29/2002	10/29/02
CLE18	PAT	ESJ06	Treatment	6427	Right/Orange	Adipose fin	3218	1333	6627	10/28/2002	10/28/02

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-adult survival between winter versus a 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 December 19, 2001 and ended on April 26, 2002. The trap was fished five days per week, 24 hours per day. Fish were removed from the trap each morning and PIT tagged on site and released the following day after recovery.

Progress: A total of 10,221 (8,718 wild and 1,503 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 December 19, 2001 through April 26, 2002; and hatchery fish March 18 through April 26, 2002.

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-v-wild and hatchery optimum conventional treatment (OCT) reared fish-v-hatchery semi-natural treatment (SNT) reared fish survival rates (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, 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 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 used to develop current, future and passage estimates with confidence intervals.

Hand held CWT detectors were used to scan for body-tags on hatchery spring chinook smolts. This is a monitoring and evaluation protocol is built in as a backup in the event that the corresponding PIT tagged fish from each treatment group (OCT/SNT) 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 2002 smolt passage estimates were as follows: wild spring chinook–367,006; OCT spring chinook– 193,430 (Easton: 52,835; Jack Creek: 66,224 and Clark Flat: 74,371); SNT spring chinook– 132,232 430 (Easton: 26,469; Jack Creek: 57,502 and Clark Flat: 48,261); wild fall chinook– 41,571; Marion Drain hatchery fall chinook– 0; wild coho– 19,793; hatchery coho– 30,006; and wild steelhead– 38,509. These estimates are provisional and subject to change as better entrainment estimates are developed.

Personnel Acknowledgements: Biologists Mark Johnston and David Lind; 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.

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 (pelvic fins), 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 of approximately 165,000 accelerated incubation and rearing, and 100,000 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-smolt survival to the lower Columbia River. There was no significant difference in the smolt-at-CJMF to smolt-at-McNary Dam survival-index between the accelerated (0.22) and conventional (030) groups (Neeley, 2003).

The survival indice for the Marion Drain conventional group was 0.30 and was not significantly different to either of the two Prosser released groups.

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: A nested factorial experimental design was intended to be used to test for survival differences between out of basin hatchery and Prosser Hatchery stocks; release location (upper Yakima and Naches subbasins); and release date (May 7 and May 31). Each release date had two replicates per sub-basin). Within each replicate 2,500 coho smolts were PIT tagged (1,250 out of basin stock and Prosser Hatchery stock were intended to be PIT tagged) to evaluate survival to CJMF and lower Columbia projects. In addition to PIT tags to monitor juvenile survival, a portion of the smolts were CWT'ed in order to assess the survival of returning adult to Prosser Dam. Beginning with the 1997 broodyear 100% of the locally produced and out of basin smolts have been CWT in order to monitor smolt-adult survival, and relative wild contribution of both smolt and adult coho production. The 2000 returning adults was the first year where wild and hatchery smolt-adult return rates could be compared. In order to determine the relative abundance of hatchery coho smolt residuals, we conducted surveys in the upper Yakima and Naches rivers to enumerate coho that did not migrate during the spring. Since 1999 about 98 spawners have been radio tagged at Prosser Dam to evaluate spawning distribution. In 2000 105 fish were tagged and 75 fish were successfully tracked until spawning.

Progress: The first hatchery smolt release under the auspices of Phase I of the coho feasibility study occurred in 1998. Completion of Phase I will occur in the fall of 2003 with the adult returns from the 2002 smolt release (BY2000). A complete summary of Phase I results will be reported in next year's FY2003 YKFP M&E annual report. The experimental design for Phase II of the coho feasibility study is near completion at the time of this writing and will be reported on in the YKFP Yakima Coho Master Plan to be made public in the summer of 2003 (2003)

The Yakima stock, late-release (pooled across release sites) survival index (to McNary Dam) was significantly higher than that of the early-released group; however, there was no difference between releases for the Willard stock. For the Stiles Pond site the late-release groups (pooled across stocks) had a significantly higher survival index value to that of the early-release groups. The Yakima stock (pooled across pooled across Naches sites) late-release survival index was significantly greater than for the Willard late-release groups.

The Yakima stock late-release had the highest mean survival index (0.405) followed by Willard late-release (0.2482), Willard early-release (0.200) and Yakima early-release (0.1713) (Table 12). As observed last year smolt releases from Stiles pond on the Naches had the highest survival index (0.3541), followed by Lost Creek pond (0.2395) and Easton pond (0.0580, 6.1 x lower than for Stiles pond).

Table 12. Summary of release-to-McNary survival index by stock, timing and location[1].

Survival Index					
Site	Willard Early	Willard Late	Yakima Early	Yakima Late	Mean
Easton	0.0580	0.1971	0.0154	0.0100	0.0580
Lost Creek	0.2492	0.1317	0.2297	0.4002	0.2395
Stiles Pond	0.2928	0.4153	0.2688	0.8059	0.3541
Mean	0.2000	0.2482	0.1713	0.405	

- We estimated that wild smolt-to-adult survival rate for 40,605 natural origin coho smolts (counted at CJMF) in 2001 was .87%, which was 42 times greater than that observed for hatchery smolts.

- We estimated that hatchery smolt-to-adult survival rate for 442,249 hatchery coho smolts (counted at CJMF) released in the Naches and upper Yakima rivers in 2001 was .04%.

- The 2002 adult coho run was comprised of 65% (352fish) naturally produced fish and 35% hatchery fish. This was the second year where this distinction could be made due the 100% CWT'ing of smolts beginning with the 2000 release.

- Smolt-smolt survival (CJMF to McNary Dam) was higher for the Yakima stock (mean= 43.5%) than for the Willard stock (mean= 27%) in 2001. Reasons for this are not readily understood at this time.

- There was no significant difference in smolt-smolt survival (CJMF to McNary Dam) between the early and late release groups for either basin. The lack of a differential survival difference between the two groups is most likely due to the extremely poor outmigration conditions, which persisted the entire smolt outmigration period in 2001.

1 Data is summarized from Neeley (2003).

- A total of 105 coho spawners were radio tagged at Prosser Dam in the fall of 2001, of which 75 were subsequently successfully tracked. The spawner distribution throughout the Yakima basin was as follows: Prosser Dam (rm 47.1)-Granger (rm 83.0)- 6.7%, Granger-Sunnyside Dam reach (rm 103.8)- 37.1%, Sunnyside Dam-Naches River (rm 116.3)- 5.7%, mid-Yakima River tributaries- 4.8%, lower Naches River- 3.8%, Naches River above Cowiche Dam (rm 2.7)- 13.3%, Naches River confluence to above Roza Dam (rm 127.9)- 9.5%.

- 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. Despite this, the majority of spawning appears to occur in the Yakima River downstream to the Naches River confluence. It's believed that three factors are contributing to this, 1) lack of stamina primarily by females to reach their areas of release located further upstream, 2) straying and delay due to false attraction from irrigation return flow and 3) from natural production occurring in the Yakima River above Granger. Nevertheless, with the exception of 2002 (9%), the percentage of spawners returning to the Naches River has steadily increased from 8.2% in 1999 to 26.7% in 2001. Correspondingly the percentage of fish spawning in the Granger to Sunnyside Dam reach has decreased from 61.6% in 1999 to 37.1% in 2001, to 19% in 2002. In addition, nearly 13% of radio tagged coho spent various amounts of time in Sulfur Drain.

- Residual coho smolt survey sites on the upper Yakima River (Easton reach) were from the Easton acclimation site (Rkm 325.4) to the confluence of Cle Elum River (Rkm 294.6). The Naches River (Lost Cr. reach) surveys were done from the Lost Creek acclimation site (Rkm 61.8) to the confluence with Rock Creek (Rkm 53.9). In 2002, residual coho were generally absent from all snorkel surveys. One residual coho was seen in the Lost Cr. Reach, which equates to less than 0.25 fish per river kilometer. No residuals were observed in the upper Yakima River reach. Sub-yearling coho were generally absent from index areas, however, there were some small numbers of sub yearling coho found in adjacent areas, indicating continued natural production. Results in 2002 are consistent with those the past two years, where relatively low densities of residuals and sub-yearlings were observed in both subbasins.

Personnel Acknowledgements: They are the same as for Task 1.i with the following additions. PIT tagging occurred at Prosser Hatchery with assistance

from Biologist Mark Johnston and Fisheries Technicians Leroy Senator, Tammy Swan, Sy Billy, Joe Hoptowit, and Gerry Lewis.

Task 1.i Yakima Spring Chinook Juvenile Behavior

Rationale: This Three year study (1999-2001) is part of an effort to evaluate the rearing of spring chinook salmon (*Oncorhynchus tshawytscha*), at the Cle Elum Supplementation and Research Facility. Yearling spring chinook (*Oncorhynchus tshawytscha)* smolts from two hatchery treatment groups, conventional and semi natural rearing treatments, were compared to wild smolts in an experiment designed to assess differences in cover utilization, and survival to a predation (pikeminnow, *Ptychocheilus oregonensis)* threat.

Methods: Groups of five smolts from each of the three treatment groups, (Wild, OCT & SNT), were placed sequentially into an aquarium. Cover and a predation threat were present in the aquarium. Typically, upon introduction, smolts will dive for cover and remain hidden for several minutes before emerging to explore or school with other smolts. Observers recorded the amount of time smolts spent in cover and made qualitative assessments of the smolt's cover utilization. Northern Pikeminnows, *Ptcocheilus oregonensis*, were then allowed to feed on the smolts until approximately one-half were consumed. Surviving smolts were then counted and measured by treatment group.

Progress: Yearling Spring Chinook smolts, *Onchorhynchus tshawytsha*, from two hatchery treatment groups, conventional, (OCT), and semi natural (SNT), rearing treatments were compared to wild smolts in an experiment designed to assess differences in cover utilization, and survival to a predation threat. Survival to Northern Pikeminnows was seen to be size dependant for hatchery fish, ($p=0.001$), with the largest fish (141-158mm) surviving at over twice the rate as the smallest fish (90-120mm). Survival was not size dependant for wild fish however, ($p=0.713$). Overall survival rates were similar between the three groups, although wild smolts tended to be smaller. Among the smaller smolts ($<=130$mm), wild smolts survived at higher rates, and rate was significantly different from the OCT group, ($p=0.033$).

The order of introduction did not significantly affect the time any of the three groups of smolts remained in cover, indicating that the presents or absence of other smolts did not influence a newly introduced smolts decision on how long to remain in cover. No significant difference was found between the two hatchery treatments in time spent in cover. The semi-naturally reared smolts spent the least time in cover, and the difference from the wild was significant, (p=0.023). Qualitative observations also revealed little difference between the conventional and semi-naturally reared smolts. In comparison to wild smolts, hatchery smolts appeared less adept at finding and concealing themselves in cover. Wild smolts also tended to swim less, i.e. in cover they appeared nearly motionless, whereas hatchery fish were almost always swimming.

Personnel Acknowledgements: John McConnaughey, (YKFP Research Center) and Dr. Terry DeVietti, (CWU Psychology Dept).

Task 1.j Yakima Spring Chinook Juvenile Morphometric/Coloration

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, S. Young and J. Rau. 2003. Comparing the reproductive success of Yakima River hatchery- and wild-origin spring chinook. Annual Report 2002, Project Number 1995-064-24.

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 was accomplished through use of time-lapse video recorders (VHS) and a video camera located at each of the three fishways. The videotapes were played back and various types of information/data were recorded for each fish that migrated past, and data was entered into the YKFP database.

Progress:
<u>Spring Chinook (2002 run)</u>

Estimated 14,771 spring chinooks were counted past Prosser Dam. The total adult count was 14,054 (95.1%) fish, while the jack count was 717 (4.9%) fish. Of the adult count, 7,762 were identified as hatchery origin. Returning hatchery adults this year comprised 4 and 5 year olds (brood years 1997 and 1998). The ratio of wild jacks to hatchery jacks was 48.5% to 51.5%, respectively.

The 25%, 50% and 75% dates of cumulative passage were May 11, May 15 and May 21, respectively.

The estimated mean fork length for adults (wild and hatchery) and jacks (wild and hatchery) was 67.6 cm and 51.8 cm, respectively. The estimated video fork length for adults was 3 cm smaller than that measured "hands-on" at Roza in the broodstock collection. The difference between jacks was 4.7 cm bigger than those collected at Roza. This suggests that video based fork lengths at Prosser are not a reliable measurement to estimate true fork length. It's 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 (2002)

The estimated coho run was 818 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 58.1% and jacks 41.9% of the run. A total of 118 adipose clipped fish were counted, 60 were adults and 58 were jacks. Of the estimated run, 41.8% were processed at the Denil.

The 25%, 50% and 75% dates of cumulative passage were October 5, October 19 and November 8, respectively.

The estimated mean adult and jack fork length was 64.7 cm and 35.2 cm, respectively, which is smaller than measured fish collected for broodstock. This indicates a size bias (underestimate) of the true fork length for fish measured from the videotapes. This same bias has been observed in past years for all salmonid species at Prosser Dam.

Fall Chinook (2002 run)

Estimated fall chinook passage at Prosser Dam was 6,241 fish. Adults comprised 98.5% of the run, and jacks 1.5%. Of the total number of fish, 681 were adipose clipped, 669 fish were adults and 12 fish were jacks. The median passage date was October 13, while the 25% and 75% dates of cumulative passage were September 15 and October 23, respectively. Of the total fish estimate, 15.5% were counted at the Denil.

The mean adult and jack fork length was 75 cm and 49 cm, respectively.

Steelhead (2001-02 run)

The estimated steelhead run was 4,525 fish. Of the total, 34 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 November 19th, 2001, while the 25% and 75% cumulative dates of passage were October 30th, 2001 and January 15th, 2002 respectively.

The mean fork length was 56.7 cm, and fish ranged in size from 39.9 cm to 85 cm.

Personnel Acknowledgements: Biologists, Melinda Davis and Joel Hubble, 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 broodstock activity.

Progress:

Roza Dam

Steelhead

A total of 216 steelhead were counted past Roza Dam for the 2001-02 run. As shown in Figure 13, most steelhead migrated past Roza Dam from late March through early May of 2002.

Spring Chinook

At Roza Dam 8,922 (98% adults and 2% jacks) spring chinook were counted at the adult facility between May 3 and September 7, 2002. The adult return was comprised of natural- (28%) and CESRF-origin (72%) fish. The jack return was comprised of natural- (61%) and CESRF-origin (39%) fish. Figure 14 shows passage and wild brood collection timing at Roza in 2002.

Coho

A total of 5 adult and 1 jack coho were observed passing Roza Dam from November 18, 2002 through January 7, 2003. Of the total, 2 adults and 1 jack were 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 2002.

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.

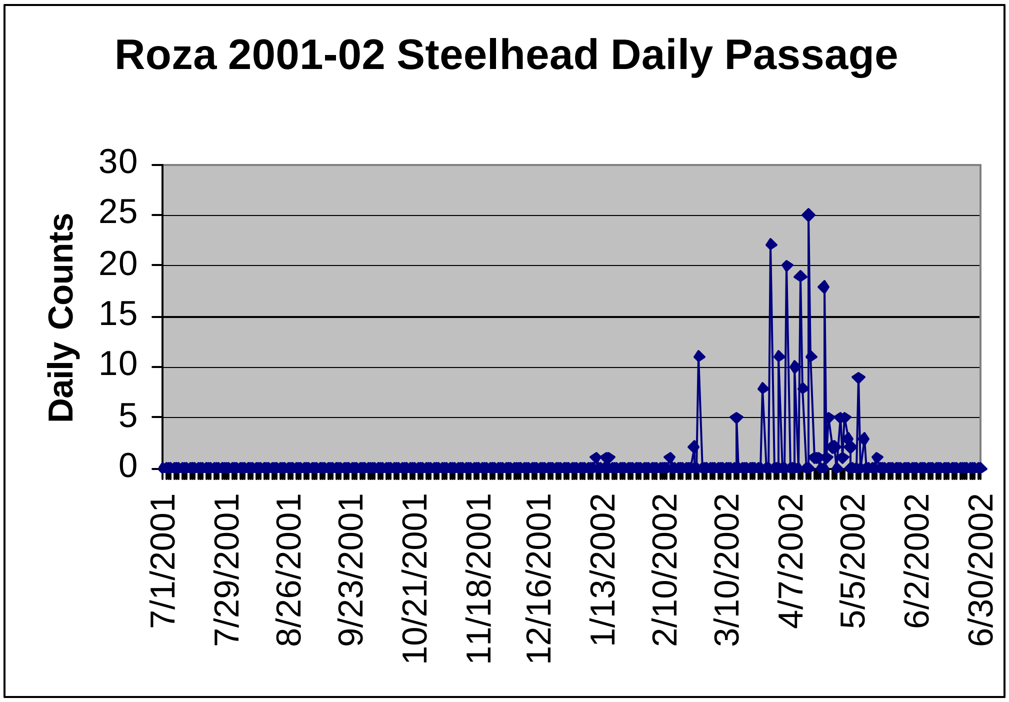

Figure 13. Daily steelhead passage at Roza Dam, 2001-02.

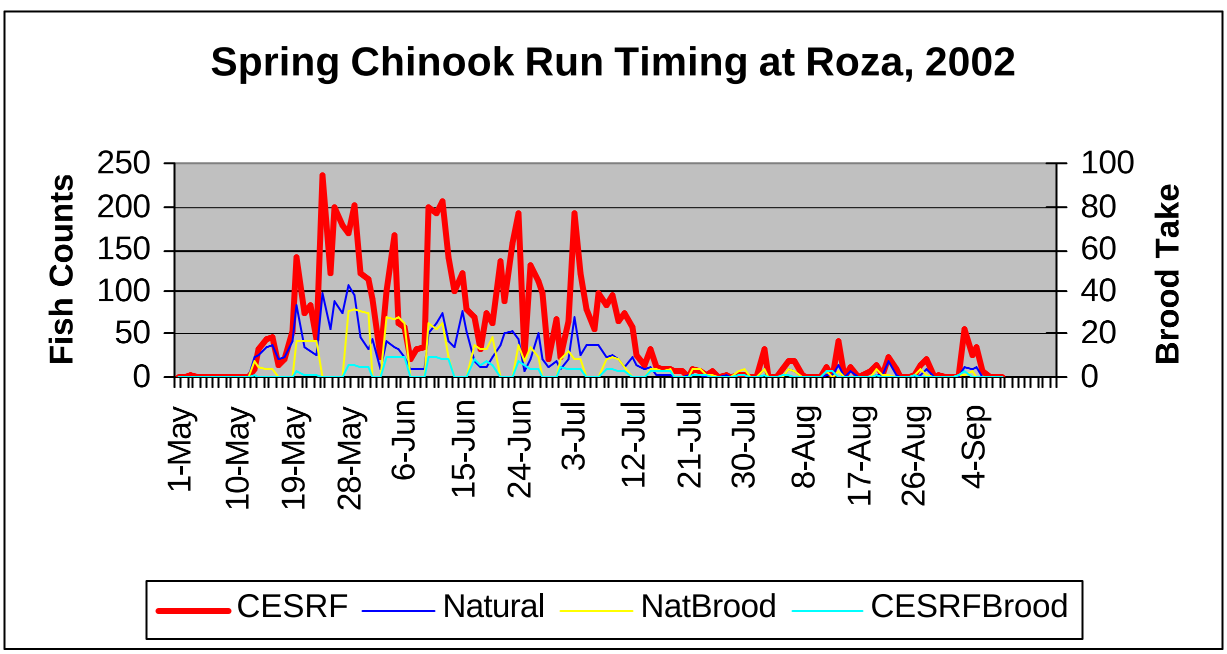

Figure 14. Daily spring chinook passage for CESRF-origin, natural, and broodstock collected at Roza Dam, 2002.

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- 172, Toppenish basin- 354, and Ahtanum Creek- 8. For all three basins a total of 534 redds were counted.

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, 366, 262, 89, 203, and 23 redds. Redds counts in the upper Yakima, Teanaway and the Cle Elum rivers were, 2,441, 110 and 275, respectively. The entire Yakima basin had a total of 3,769 redds (Naches- 943 redds, upper Yakima- 2,826).

Fall Chinook: Marion Drain fall chinook surveys were conducted three times in 2001. A total of 34 redds were counted. The number of redds located for each survey was as follows: October 31 – 15 redds, November 10- 15 redds, and November 24- 4 redds.

Coho: Surveys began in early November and ended in late December in the Yakima River basin. A total of 151 redds were located in the Yakima Basin. Surveys were concentrated where radio telemetry fish were located to maximize survey effort. Due to untimely winter freshets, river conditions prevented accurate enumeration of coho redds. Nearly all the redds were located before the first winter freshet. The redd distribution was as follows:

Yakima R.- 27 redds. Most redds were located between the Zillah Bridge and Roza Dam. Two redds were located in the upper Yakima Canyon.

Naches R.- 124 redds. Most redds were located from the confluence to below the Tieton River confluence.
Ahtanum Cr.- 37 redds.

Cowiche Cr.- 10 redds.

Buckskin Cr.- 29 redds.

Teanaway R.- 0 redds.

Task 1.p Yakima Spring Chinook Residuals/Precocials 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., B. James, C. L. Johnson, A. L. Fritts, and G. M. Temple. 2003. Spring chinook salmon interactions indices and residual/precocial monitoring in the upper Yakima River. Annual Report FY 2001-2002 submitted to Bonneville Power Administration, Portland, Oregon. DOE/BP-00004666-14.

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, S. Young and J. Rau. 2003. Comparing the reproductive success of Yakima River hatchery- and wild-origin spring chinook. Annual Report 2002, Project Number 1995-064-24.

Task 1.r Yakima Spring Chinook Gamete Quality Monitoring

Refer to WDFW report:

C.M. Knudsen, S.L. Schroder, T.N. Pearsons, J.A. Rau, A.L. Fritts, and C.R. Strom. 2003. Monitoring Phenotypic and Demographic Traits of upper Yakima River Hatchery and Wild Spring Chinook: Gametic and juvenile Traits. YKFP Annual Report 2002.

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 13 by species and sampling method.

Table 13. The 2002 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	475	18.4	26	46.8	1535	70.4	34	80.8
Upper Yakima Wild/Natural			45	50.7	525	72.3	29	85.1
Spawner Survey Samples								
Upper Yakima Supplementation			6	56.7	187	73.7	24	84.0
Upper Yakima Wild/Natural			5	56.2	73	76.7	21	84.5
American River Wild/Natural			1	51.0	93	80.4	74	94.6
Naches River Wild/Natural			1	50.0	99	78.0	48	90.7
Yakima R. Fall Chinook								
Hatchery	12	47.6	69	68.6	42	85.0	3	97.0
Wild/Natural	48	45.2	455	70.5	265	86.7	27	100.6
Yakima R. Coho								
Hatchery	54	36.9	45	66.7	1	83.0		
Wild/Natural	133	39.5	62	70.2				

Note: Length is average fork length.

Task I.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: A Piper Cub 180 airplane was used in combination with a hand held digital video camera to record habitat conditions for all the major subbasins of the Klickitat Basin. The flight was conducted in late February 2003 over a two day period prior to spring leaf out. The survey was conducted at approximately 300 to 400 feet above river level. The goal was to record habitat conditions for the bankfull conditions, as well as, record habitat conditions across that portion of the floodplain inundated by moderate flood events.

The video tape was captured and stored in a digital format on a Fisheries Resource Management computer. The images are being used to calculate or estimate the best input rank value for various Level 2 EDT attributes.

Progress: Flight survey data has been used to estimate the area of habitat types and other physical attributes in tributaries where access is difficult or non existent. Small sections of these tributaries with access have been used to ground truth aerial estimates from the flight survey. Mainstem aerial survey data has been examined for spatial variances within habitat types for defined reaches. This is currently being utilized for appropriate habitat sampling points on the ground, reflecting the diversity of habitat within a given reach. Aerial surveys are also being examined in conjunction with past flight surveys to document and track geomorphic changes in the riverine system over space and time, enabling us to better understand the rivers natural tendencies.

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 increase sediment loads in stream utilized by all 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 2002. 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 sampled collected in the upper Yakima and Naches basins can be obtained from Jim Mathews, fisheries biologist for the Yakama Nation.

<u>Upper Yakima</u>

Sixty samples were collected; with the control reach located above Lake Easton (Stampede Pass) and the treatment reaches extending from Easton to the Cle Elum River confluence. Mean percent fines (<0.85 mm) by sample reach were- Stampede Pass (control): 6.3%, upper Easton: 11.4%, lower Easton: 11.6%, Elk Meadows: 10.2% and Cle Elum: 17.5.

<u>Naches</u>

Thirteen sites were sampled in the Naches Basin in 2002. The mean percent fines (<0.85 mm) in the Little Naches River (mainstem) was 14.0%; North

Fork- 11.6%; South Fork- 13.1%; Bear Creek- 12.7% and Pyramid Creek- 11.8; Rattlesnake Creek- 12.5% and in the Tieton South Fork- 17.3%.

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).

Method: Predator avoidance training will consist of introducing a hungry hooded or red-breasted merganser into a cage submerged in a raceway three times per week for three weeks prior to release. The predator will be allowed to feed for 30 minutes. The design will consist of SNT fish randomly divided into control and treatment PIT tagged groups. Survival both groups will be estimated at CJMF and McNary and John Day dams.

Progress: Initial predator avoidance training took place at the Cle Elum Hatchery in August, 2002. Three training sessions took place where experimental raceways were exposed to a hooded merganser for 30 minutes. The training resumed at the Easton acclimation site in February, 2003, for a total of 14 separate sessions using red-breasted mergansers. Direct observations were taken during all sessions from behind tall, camouflage platforms set next to experimental ponds. Distance observations of fish from the predator were recorded three times per minute for 30 minutes, made possible by 1 foot square green and white checkered grid patterns painted on the avian cage surfaces, as well as a description of predator activity. Fish from all ponds were force-out released on March 28, 2003. Provisional survival indexes will be available in a thesis/report format late fall, 2003.

Task 1.y Biometrical Support:

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

- Annual Report: Smolt Survival to McNary of Year-2002 Coho and Fall Chinook Releases into the Yakima Basin
- 2002 Annual Report OCT-SNT Survival

- 2002 Annual Report, Wild and Hatchery Smolt Survival of Roza Spring Chinook Releases

- 2002 Annual Report, Indirect Predation

All for reports are attached to the YKFP, M&E annual report as appendices, and 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 14.

Personnel Acknowledgements: Biologist Bill Bosch, Mark Johnston and Fisheries Technicians Russ Olney and Arnold Barney.

GENETICS

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

Table 14. A summary of Yakama Nation tributary estimated harvest in the Yakima and Klickitat subbasins, 2002.

River	Dates	Weekly Schedule	Notes	Chinook	Jacks	Steelhead	Coho
Klickitat River	4/2-6/1	Noon Tues to 6 PM Saturday	1	225	29	48	0
Klickitat River	6/4-8/3	Noon Tues to 6 PM Saturday	2	189	16	394	0
Klickitat River	8/6-12/28	Noon Tues to 6 PM Saturday	3,4	701	73	732	2,623
Klickitat Total	**4/2-11/9**	**Noon Tues to 6 PM Saturday**		**1,115**	**118**	**1,174**	**2,623**
Yakima River	4/9-7/27	Noon Tues to 6 PM Saturday	5	2,507	73	11	0
Yakima River	9/24-11/23	Noon Tues to 6 PM Saturday	6	0	0	0	0

1. Commericail Sale allowed during Spring Zone 6 Commercial Sale Periods.
2. Summer Fishery extended through June, and considered to be addition to Spring Fishery.
3. Commercial ticket landings not fully included.
4. Commercial Sale allowed for Chinook and Coho from 10/15 to 12/14.
5. YKFP Staff collected Data and Bill Bosch did Harvest Estimate.
6. No Observed Effort or Catch.

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, Craig. F. Sewall, Anthony Fritts, Janet Loxterman, James Shaklee, Steven Schroder, Curtis Knudsen, Jason Rau. 2003. Genetic studies in the Yakima River Basin, Yakima/Klickitat Fisheries Project, Monitoring and Evaluation, Annual Report 2002. Project No. 1995-06424; BPA Report DOE/BP-00004666-13.

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 Basin.

Method:

Hotspot Survey—Spring

In 2002, hotspot surveys were conducted systematically, on Mondays, Wednesdays, and Fridays at Horn Rapids and Chandler Pipe, with two additional survey days at Horn Rapids during four of the survey weeks. During these four weeks at Horn Rapids, three different survey methods were used. These additional surveys were conducted to make comparisons between current and past survey methods. The data from the other survey methods are not included as part of this report. A total of 32 surveys were conducted at Chandler Pipe and a total of 41 surveys were conducted at Horn Rapids for the 2002 field season, which occurred between April 11 and June 28. Both sites were surveyed simultaneously by different personnel. Observations on survey days 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. Depending upon the length of day and start time, between seven and eight 2-hour periods existed within a single day.

The survey area for Horn Rapids Dam included 50 meters of river above the dam and 150 meters below the dam. Since the buoy located above the dam was not included within the survey area the birds resting upon the buoy were not included in abundance counts. The survey area for the Chandler Canal Bypass outfall included 50 meters of river above the outfall pipe and 150 meters of river below the outfall pipe. All birds resting upon the shoreline lateral to the specified 50 meters of river above and 150 of river meters below both hotspots were included in abundance counts.

Observations at both sites were made from shore stations. At Horn Rapids Dam observations were made from either inside or outside an automobile. At Chandler Canal Bypass observations were made from a blind, to avoid disrupting normal bird activity. The bird blind at Chandler was used intermittently due to high water conditions. Binoculars (Leica, 10x42) were used to aid in identification. At Horn Rapids Dam, survey personnel stationed themselves on the windward bank of the river such that the preferred orientation of feeding birds, primarily gulls, was towards the observer. At the Chandler Canal Bypass outfall, altering the side of the river from which observations were made was not feasible. However, the distance from one side of the river to the other was considerably less than at Horn Rapids Dam, which improved the observer's ability to accurately monitor bird behavior.

The hotspot survey design for 2002 followed the method used in 2001. Each day was divided into 2-hour survey 'windows', consisting of three, 15-minute abundance/feeding 'blocks'. Each of these blocks was divided by a 15-minute period of no observation, unless a feeding interval was still being measured, in which case the observation period was extended into the next 15 minutes. This 75-minute cycle of 'blocks' was followed by a 45-minute rest period before beginning a new 2-hour 'window'. Within the 15-minute survey 'blocks', abundance of all piscivorous birds, foraging ratios, the number feeding to total number present, and foraging rates, fish consumed/min, of gulls were determined. Gulls flying within the study area were considered foraging. Gulls within the study area foraging on terrestrial prey items—such as insects, seeds, plants—were not considered feeding, but were included in total abundance counts. Gulls sitting or standing on rocks emerging from the river or along the river edge were not counted as part of the foraging fraction. Although gulls sometimes utilized such rocks as fishing platforms, more frequently such platforms were used for loafing and other non-foraging activities. In addition, it was not feasible to distinguish foraging gulls standing on rocks from those loafing.

The gull chosen to be observed for foraging rate was the first individual observed consuming a fish within the study area. Once a gull was chosen it was followed continuously until a second successful capture occurred or a maximum of 30 minutes had passed. Initial successful feeding attempts were those in which a foraging bird captured a fish by plunging from the air into the water. Second takes were counted regardless of the means of capture. This accounted for the rare instance in which the second successful take by a gull was accomplished by stealing from another bird or jumping from an exposed rock or log into the water to catch a fish.

River Reach Surveys—Spring and Summer

Spring river surveys included six river reaches. Each reach was surveyed approximately once every 2 weeks, from April 15 through June 28. These reaches included Benton, Vangie, Zillah, the Canyon, Cle Elum and Easton. During the summer, river surveys included only the Canyon, Cle Elum and

Easton reaches, which were surveyed every week from July 1 through August 28. The Canyon was an additional drift in the summer in 2002, compared with previous years, when only Cle Elum and Easton were surveyed during this time of year. All reaches surveyed in both the spring and summer were identical in length and location to those conducted in previous years.

All river reach surveys were conducted by a two-person survey team from either a 5.2 m aluminum drift boat or a two-person raft, depending upon water conditions. Most surveys began between 0800 and 0900 and lasted between 2.5 to 5.5 hours, depending upon length of reach, water flow and wind speed. All surveys were preformed while actively rowing the drift boat or raft down stream to decrease the interval of time required to traverse the reach.

Of the two-person survey team, one person was responsible for navigation while the other was responsible for identifying and recording birds. Team members alternated between rowing and bird identification duties approximately every hour. All piscivorous birds detected visually or aurally were recorded, including time of observation, species, and sex and age if they were distinguishable. Binoculars (Leica, 10x42) were used to aid in identification. All birds positively identified by the navigator were included, although the team member responsible for bird identification at the time of the encounter made final decisions for uncertain or potential repeat identifications, that is, double counting.

All piscivorous birds encountered on the river by survey personnel were recorded at the point of initial observation. Most birds observed were only slightly disturbed by the presence of the survey boat and were quickly passed. Navigation of the survey boat to the opposite side of the river away from encountered birds minimized escape behaviors. If subsequent to the encounter the bird attempted to escape from the survey boat by moving down river a note was made that the bird was being pushed. Birds being pushed were usually kept in sight until passed by the survey boat. Passage usually occurred when the river widened sufficiently to let the pushed bird pass to the side of the survey boat.

If the bird being pushed down river moved out of sight of the survey personnel, a note was made, and the next bird of the same species/age/sex to be encountered within the next 1000 meters of river was assumed to be the pushed bird. If a bird of the same species/age/sex was not encountered in the subsequent 1000 meters, the bird was assumed to have departed the river or passed the survey boat without detection, and the next identification of a bird of the same species/age/sex was recorded as a new observation.

Acclimation Site Surveys—Spring

Beginning February 1 and continuing until May 29, YN hatchery personnel at the Clark Flat, Jack Creek and Easton acclimation sites conducted piscivorous bird surveys. Jack Creek was surveyed from February 22 to May 23, Easton from March 1 to May 17, and Clark Flat from February 1 to May 29. In addition, a few observations were made at the Cle Elum Hatchery site from February 13 to April 3. Surveys were conducted at various times throughout the day. In general, each site had at least three surveys conducted, one in the morning, one around noon, and one later in the afternoon. All piscivorous birds within the acclimation facility, along the length of the artificial acclimation stream, and 50 meters above and 150 meters below the acclimation stream outlet, into the main stem of the Yakima River or N. Fork Teanaway, were identified and recorded within their respective zones. Surveys were conducted on foot by hatchery personnel.

North Fork Teanaway River Surveys—Spring and Summer

The survey reach included the river and its banks from the Jungle Creek/North Fork Teanaway confluence down river past the Jack Creek acclimation site continuing downstream for approximately 3.5 km. One surveyor moved down from Jungle Creek, noting the presence of piscivorous birds. If navigation of the river-bank was not possible, the river was crossed and surveys were continued on the opposite bank. If it was not possible to cross the river, detours were taken away from the river-bank, down stream, and paths through the underbrush were located to enable periodic return to the river-bank. Once there, a visual search up and down the stream was conducted. All piscivorous birds detected visually were recorded including time of observation, species of bird, and sex and age if distinguishable. A pair of Leica (10x42) binoculars was utilized to aid in identification. This area was surveyed nine times between May 2 and August 20, 2002, approximately once every two weeks.

Secondary Hotspot Surveys—Spring

Additional surveys were conducted in 2002 at four dam sites along the Yakima River. These surveys were conducted to ensure that potential hotspot sites were not being overlooked. These sites, in addition to others, were initially identified by Phinney et al. (1998) as areas for potential heavy predation and were also surveyed in 2000, but not in 2001. Sites surveyed in 2002 included Prosser Dam, Sunnyside Dam, Wapato Dam and Roza Dam. Each site was visited approximately nine times, once every one to two weeks between April

16 and June 25. Wapato Dam was only visited seven times due to high water conditions, which made the road to one part of the dam inaccessible. Observations were made for one hour at each site, with birds present noted every 15 minutes. Bird species, time, number and location, either above or below the dam, or at the canal intake at Prosser Dam, were all noted.

In addition, checks were made at Prosser Dam when time permitted, to determine if there were a significant number of birds feeding at the head of the canal, where fish are susceptible to predation due to upwelling.

Progress: Avian predation of fish is suspected to contribute to the loss of out-migrating juvenile salmonids in the Yakima River Basin, potentially constraining natural and artificial production. In 1997 and 1998, the Yakima/Klickitat Fisheries Project (YKFP), whose goal is to increase the natural production of salmonids within the Yakima River, initiated investigations to assess the feasibility of developing an index to avian predation of juvenile salmon within the river. This research, conducted by Dr. Steve Mathews and David Phinney of the University of Washington and the Washington Department of Fish and Wildlife (WDFW), confirmed that Ring-billed Gulls and Common Mergansers were the primary avian predators of juvenile salmon on the Yakima River (Phinney et al. 1998), and that under certain conditions could significantly impact migrating smolt populations.

Beginning in 1999, the Washington Cooperative Fish and Wildlife Research Unit (WACFWRU) was asked by the YKFP to continue development of avian consumption indices. Monitoring methods developed by Phinney et al. (1998) were adopted with modifications and the monitoring of impacts to juvenile salmon along river reaches and at areas of high predator/prey concentrations, referred to here as "hotspots", has continued each year through 2002. Beginning in 2002, the YKFP Yakama Nation (YN) personnel joined the monitoring of avian predation, working cooperatively with the WACFWRU.

In 2002, 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.

General survey methods used in 2002 were the same as those used in 2001. Changes to the survey schedule in 2002 included the addition of surveys on the Easton reach during the early spring, and in the Canyon during the summer. Methods for measuring gull feeding rates at hotspots were the same as those used in 2001.

Primary avian predators in 2002 were again gulls, California and Ring-billed, at hotspots and Common Mergansers within the upper river reaches. Consumption on the lower reaches was distributed among a number of species. As in 2001, slightly more then half of all fish consumption in the lower reaches can be attributed to American White Pelicans. Estimated consumption by gulls at both hotspots combined, between April 11 to June 30, was 279,482 fish. Assuming a worst case scenario, that all fish taken were smolts, this represented approximately 10% of all smolts estimated passing or being released from the Prosser Dam area during the 2002 smolt migration season. Total gull abundances and estimates of consumption at the two hotspot sites showed an increase from that seen in 2001.

Total estimated take by Common Mergansers across all strata surveyed was 11,938 kg between April 8 and August 31, a decrease of 2,839 kg from 2001. Approximately 64 percent of that consumption was within the upper river reaches, where there is a known breeding population of 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 pikeminnow population estimates are attempted from March through June at Toppenish (RM 94-100), Sunnyside Dam (RM 103.2-103.8) and Granger (RM 80-83). 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 15 are the population estimates for the Toppenish, Granger and Sunnyside Dam sample sites since 1999 when the project was initiated. In 2002 successful population estimates were made at Toppenish for April and May; at Granger for April, 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 15. Summary of pikeminnow population estimates for the Toppenish, Granger and Sunnyside Dam sites, spring 2002.

Year	Toppenish			Granger			Sunnyside Dam		
	April	May	June	April	May	June	April	May	June
1999	933	1722	1220	nv	476	nv	nv	83	nv
2000	nv	2622	4811	nv	nv	nv	nv	nv	nv
2001	511	2167	1420	nv	568	828	nv	nv	nv
2002	2266	1432	nv	1627	nv	1149	nv	nv	nv

nv indicates that a valid population estimate was not successfully made.

A summary of hatchery spring chinook and coho identified in the 2002 pikeminnow stomachs is presented in Table 16. Fish were identified as to their origin (when possible) from recovered CWT and PIT tags and colored elastomer fragments. A total of 59 fish were identified- 5 hatchery coho and 54 hatchery spring chinook. Of the 54 hatchery spring chinook smolts 21 were OCT, 20 SNT and 13 were unidentifiable. Of the four hatchery coho smolts, three were from the Naches releases and one from the upper Yakima releases.

A summary of pikeminnow stomachs collected at Toppenish, Sunnyside Dam and Granger is presented in Table 17. A total of 805 stomachs (Toppenish-452, Sunnyside Dam- 16 and Granger- 326) were collected during the spring 2002 field season. The mean percent of stomachs collected in March, April, May and June that contained fish at the Toppenish, Sunnyside Dam and Granger sites was 47% (25 % - 65%), 59% (43% - 78%) and 36% (23% - 38%), respectively. This represents the initial analysis. All stomachs with fish present will be further analyzed to determine the species using diagnostic bones to identify them, which will be reported on in the FY2003 annual report.

Within the sampling period from March through June of 2002 the pikeminnow population displayed fidelity within the reach they were initially marked. A total of 78 (Granger- 22, Toppenish- 49 and Sunnyside Dam- 7) pikeminnows were tagged and subsequently recaptured during the course of the spring sampling period. Of those fish tagged in the Granger reach, three fish were found in the Toppenish reach and later had returned to the upper end of the Granger reach. Within the Toppenish reach six fish out of 49 were re-sampled outside the reach on at least one occasion. Of these six occurrences, five fish were subsequently captured within the Toppenish reach by the end of the season. Fish were found moving both up and down stream out of their "home" reach. In the Sunnyside Dam reach one fish was sampled in the Toppenish reach and then later was found in its original reach.

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: Survival from Prosser Dam to McNary Dam was estimated for separate releases of PIT-tagged spring chinook made in 2002 (coho and fall chinook releases were not analyzed because McNary detection rates had not yet been developed at the time of the analysis). All releases were "self-selected": made up of tagged fish released at various points above Prosser Dam and detected at the main PIT-tag detector at the Chandler trap over a one- to two-day period. Fish detected at the secondary Chandler detector were excluded from analysis because the detector is located at the exit of the live-box, and fish detected at this point might have incurred stresses or injuries attributable solely to handling.

Survival was estimated from the main detector at Chandler trap at Prosser Dam to McNary Dam on the Columbia River. The method of estimating survival consisted of dividing daily McNary tag detections by the estimated McNary detection rate for the appropriate time period. McNary detection rates were estimated by Dr. Doug Neeley, and were based on the ratio of joint John Day\McNary detections to John-Day-only detections on a given day:

Detection rate (day i) = (number joint detections McNary and John Day)/(number detections at John Day).

Dr. Neeley developed statistical techniques to determine appropriate intervals over the outmigration season during which it is most reasonable to use a mean detection rate as the interval-specific estimate.

Multiple logistic regression was used to detect a survival impact attributable to a number of factors acting both just below Prosser Dam and in the McNary fore bay. The variables that were examined were: flow (below Prosser and in McNary fore bay); water temperature (Prosser and McNary); and smolt density (daily passage estimate at Prosser and Smolt Passage Index at McNary). Unlike analyses in earlier years, turbidity could not be included in this analysis because the turbidity detector at Prosser Dam malfunctioned. Similarly, the mean size of smolts in the self-selected releases could not be used because none of the fish used in these releases were subsampled.

This procedure assumes a number of factors affect smolt survival and that if there is a real indirect predation effect on survival, *it should be statistically apparent after the effects of the other factors have been accounted for.* Accordingly, a statistical test of developed by Dr. Doug Neeley, a YN biometrical consultant, was developed which determines the significance of one of two independently significant independent variables when both are acting simultaneously. *The only factors considered to exert a real effect on survival were those whose impact remained significant after the affect of other (independent significant) factors had been accounted for (by Dr. Neeley's analysis).*

Again, the 2002 analysis included only spring chinook and only "unhandled" spring chinook– those detected only at the main PIT-tag detector at Chandler.

Progress: There is evidence from 2002 outmigrants that survival to McNary Dam of hatchery-produced spring chinook smolt increases with an increase in the number of fish volitionally exiting acclimation ponds. Even though survival for these 2002 outmigrants also increased with increased release-site stream flow, the relation of survival to fish number appears to be independent of stream flow's effect.

Table 16. Summary of hatchery coho and spring chinook found in pikeminnows in 2002.

Reach	Species	CWT code	Pit tag #	Acclimation release site	Rearing treatment	Total # salmon in stomach
Granger	hat spck	63-12-96		Jack Cr	OCT	1
Granger	hat spck	63-12-96		Jack Cr	OCT	1
Granger	hat spck	63-12-96		Jack Cr	OCT	1
Granger	hat spck	63-05-83		Clark Flat	OCT	1
Granger	hat spck	63-09-74		Easton	OCT	1
Granger	hat spck	63-09-79		Easton	OCT	1
Granger	hat spck	63-13-63		Jack Cr	OCT	1
Granger	hat spck	63-12-99		Easton	OCT	1
Sunnyside Dam	hat spck	63-09-79		Easton	OCT	1
Sunnyside Dam	hat spck	63-09-79		Easton	OCT	1
Sunnyside Dam	hat spck	63-09-79		Easton	OCT	1
Toppenish	hat spck	63-09-80		Clark Flat	OCT	1
Toppenish	hat spck	63-09-72		Jack Cr	OCT	1
Toppenish	hat spck	63-13-65		Clark Flat	OCT	1
Toppenish	hat spck	63-13-63		Jack Cr	OCT	1
Toppenish	hat spck	63-13-63		Jack Cr	OCT	1
Toppenish	hat spck	63-05-83		Clark Flat	OCT	1
Toppenish	hat spck	63-13-65		Clark Flat	OCT	1
Toppenish	hat spck	63-13-65		Clark Flat	OCT	1
Toppenish	hat spck	63-12-99		Easton	OCT	1
Toppenish	hat spck	63-12-99		Easton	OCT	1
Granger	hat spck		3D9.1BF1302576		SNT	1
Granger	hat spck	63-13-64		Clark Flat	SNT	1
Granger	hat spck	63-12-98		Easton	SNT	1
Granger	hat spck	63-12-98		Easton	SNT	1
Granger	hat spck	63-11-76		Easton	SNT	1
Sunnyside Dam	hat spck	63-13-60		Jack Cr	SNT	1
Sunnyside Dam	hat spck	63-13-60		Jack Cr	SNT	1
Sunnyside Dam	hat spck	63-13-60		Jack Cr	SNT	1
Toppenish	hat spck	63-13-60		Jack Cr	SNT	1
Toppenish	hat spck	63-11-76		Easton	SNT	1
Toppenish	hat spck	63-11-76		Easton	SNT	1
Toppenish	hat spck	63-12-97		Jack Cr	SNT	1
Toppenish	hat spck	63-13-60		Jack Cr	SNT	1
Toppenish	hat spck	63-13-64		Clark Flat	SNT	1
Toppenish	hat spck	63-13-64		Clark Flat	SNT	1
Toppenish	hat spck	63-09-78		Easton	SNT	1
Toppenish	hat spck	63-12-97		Jack Cr	SNT	1
Toppenish	hat spck	63-09-81		Clark Flat	SNT	1
Toppenish	hat spck	63-09-81		Clark Flat	SNT	1
Toppenish	hat spck	63-09-81		Clark Flat	SNT	1
Granger	hat spck					1
Sunnyside Dam	hat spck					1
Sunnyside Dam	hat spck					1
Sunnyside Dam	hat spck					1
Toppenish	hat spck					1
Toppenish	hat spck					1
Toppenish	hat coho	5-43-13		lost Cr Yakima Early		1
Toppenish	hat spck					1
Toppenish	hat spck					1
Toppenish	hat spck					1
Toppenish	hat spck					1
Toppenish	hat spck					1
Toppenish	hat spck					1
Toppenish	hat spck		3D9.1BF12F4938			1
Toppenish	hat coho	5-43-15		Stiles Willard Early		1
Toppenish	hat coho	5-44-45		Stiles Willard Early		1
Toppenish	hat coho	5-43-11		Easton Willard Late		2
Total						59

Table 17. Summary of pikeminnow stomach samples for the Toppenish, Sunnyside Dam and Granger sample sites, spring 2002.

	Toppenish					Sunnyside					Granger				
Date	No. of fish sacrificed	No. of empty stomaches	No. stomachs with biomass	No. stomachs with fish	% stomachs with fish	No. of fish sacrificed	No. of empty stomaches	No. stomachs with biomass	No. stomachs with fish	% stomachs with fish	No. of fish sacrificed	No. of empty stomaches	No. stomachs with biomass	No. stomachs with fish	% stomachs with fish
3/21	17	9	8	7		5	2	3	3						
3/22											11	6	5	4	
3/28	66	30	36	27		6	1	5	3						
3/29											16	6	10	4	
Monthly Total	**83**	**39**	**44**	**34**	**41%**	**11**	**3**	**8**	**6**	**55%**	**27**	**12**	**15**	**8**	**30%**
4/4	36	6	30	25		3	2	1	1						
4/5	41	15	26	16		3	2	1	1						
4/11											58	21	37	16	
4/12											42	10	32	15	
4/18	42	2	40	38		1	0	1	1		26	5	21	17	
4/19															
4/22	22	3	18	13											
Monthly Total	**141**	**26**	**114**	**92**	**65%**	**7**	**4**	**3**	**3**	**43%**	**126**	**36**	**90**	**48**	**38%**
5/2	40	6	34	16		7	0	7	5						
5/3	35	8	37	16		2	0	2	2						
5/9											30	12	18	6	
5/13											37	10	27	8	
5/14	25	3	22	14							10	2	8	3	
5/20	25	5	20	9											
5/21	23	11	12	10											
5/22											22	8	14	6	
Monthly Total	**148**	**33**	**125**	**65**	**44%**	**9**	**0**	**9**	**7**	**78%**	**99**	**32**	**67**	**23**	**23%**
6/6	24	9	15	4		0	0	0	0						
6/7	15	5	10	2		0	0	0	0						
6/13															
6/14											33	5	28	11	
6/17	25	13	12	7							10	1	9	3	
6/18	16	7	9	7							31	6	25	7	
Monthly Total	**80**	**34**	**46**	**20**	**25%**	**0**	**0**	**0**	**0**	**----**	**74**	**12**	**62**	**21**	**28%**
Seasonal Totals	**452**	**132**	**329**	**211**	**47%**	**27**	**7**	**20**	**16**	**59%**	**326**	**92**	**234**	**100**	**31%**

There was no evidence of a change in survival with a change in volitional release number for 2000 and 2001 outmigrants.

A complete read of this study is presented in Appendix D.

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

This task is assigned to WDFW and they will report on its status in their annual progress report to BPA.

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

Pearsons, Todd, Brenda James, Christopher Johnson, Anthony Fritts, Gabriel Temple. 2003. Spring chinook salmon interactions indices and residual/precocial monitoring in the upper Yakima Basin, Yakima/Klickitat Fisheries Project, Annual Report 2002. Project No. 1995-06424, BPA Report DOE/BP-00004666-14.

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

Pearsons, Todd, Joan Thomas. 2003. Pathogen screening of naturally produced Yakima River spring chinook smolts, Annual Report 2001. Project No. 1995-06424, BPA Report DOE/BP-00004666-8.

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Woodward, J. (editor), Yakama Nation and Washington State Department of Fish and Wildlife. 2003. Yakima Coho Master Plan [in draft], Yakima Klickitat Fisheries Project, Toppenish, WA.

APPENDICES

A through H

A.	Task 1.a.	Modeling (CWU subcontract)
B.	Task 1.e.	Roza juvenile wild/hatchery spring chinook smolt PIT tagging
C.	Task 1.f.	Yakima River wild/hatchery salmonid survival and enumeration (Chandler)
D.	Task 1.g.	Yakima River fall chinook M&E
E.	Task 1.i.	Yakima Spring Chinook Juvenile Behavior
F.	Task 4.c.	Indirect Predation (and environmental analysis)
G.		M&E Financial Report
H.		M&E Equipment Inventory List

Appendix A

Protocols to Measure and Assess Select Geomorphic and Habitat Correlates
For the YKFP EDT Model (draft report)

Protocols to Measure and Assess Select Geomorphic and Habitat Correlates For the YKFP EDT Model

Draft Report

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August 2003

The purpose of this work is to develop a biophysical classification scheme and measurement protocols that will increase the precision of environmental data for the Yakima Klickitat Fisheries Project (YKFP) Ecosystem Diagnosis and Treatment (EDT) model. The first goal focuses on establishing a classification scheme that systematically defines and identifies ecologically homogenous stream reaches within a river basin. The second goal is the development of protocols used to measure select level two correlates within the EDT model; they include the following: gradient, natural and anthropogenic confinement, minimum and maximum channel width, habitat type composition, riparian function, and measurements of woody debris. The third goal applies the results of protocols for the level two correlates described above to the EDT reaches found within the Easton and Cle Elum floodplains of the Yakima River basin. Utilizing data generated from the previous three goals, the fourth goal is the initial development of a preservation-restoration scheme for the Easton floodplain.

All of the methods described below were developed or chosen for their level of precision relative to assessment scale and the expenditure of both time and money needed to implement them. This is a key point, since the range of index values associated with each of the level two correlates within EDT does not necessitate absolute precision. By making this statement, we are not implying that inherent inaccuracies exist within the EDT model itself, but are merely discounting many of the criticisms that have surfaced surrounding the amount of time and money needed to populate an EDT database. This is not to say that generating data for all level two correlates in a chosen river basin will necessarily be without difficulty; nevertheless, we do believe that the following protocols will serve to expedite the EDT process wherever it is implemented.

Using Stream Gradient and Confinement to Derive a Geomorphic Channel Classification Scheme

An inherent and crucial step in the development of regional watershed classification schemes is the systematic definition and identification of ecologically homogenous stream reaches within a river basin. Classification permits stream reaches to be identified and inventoried within an objective, quantifiable, hierarchical, and communicable framework (Kondolf 1995). Many geomorphically-based classification systems have been developed over the last 100 years (see reviews by Bauer and Ralph 1999; Hawkes 1975; Kondolf 1995; Montgomery and Buffington 1996; Mosley 1987; Naiman et al. 1992), each as a varied as the stream morphologies they try to represent (Montgomery and Buffington 1996). General classifications of stream channels have been developed based on stream order (Horton 1945; Strahler 1957), relationships between slope and discharge (e.g. Leopold and Wolman 1957), modes of sediment transport (e.g. Schumm 1977), and longitudinal zonation (e.g. Palmer 1976). Classifications have become increasingly more descriptive and complex, emphasizing differences in channel patterns based on additional factors such as landform setting and degree of confinement (e.g. Galay et al. 1973), sediment supply and channel stability (e.g. Kellerhaus et al. 1976; Church 1992), island and bar types (e.g. Galay et al. 1973; Kellerhaus et al. 1976; Church 1992), valley stability and characteristics (e.g. Galay et al. 1973; Cupp 1989), as well as floodplain energy and sediment characteristics (e.g. Nanson and Croke 1992). As an extreme example of complexity, a channel reach classification developed by Rosgen (1994) includes 7 major and 42 minor channel types based on variables including channel pattern, entrenchment, width-to-depth ratios, sinuosity, gradient, and bed material size.

Each of these channel classification has advantages and disadvantages for biophysical, engineering and ecological applications (Kondolf 1995), while no classification can address all possible channel types (Montgomery and Buffington 1996). In addition, most of these classifications are largely descriptive characterizations of channel patterns, and are not process-based. One notable exception is Whiting and Bradley's (1993) process-based classification for headwater channels that links patterns based on factors such as gradient, channel widths and depth, valley-channel width ratios, and substrate size to potentials for debris flow impacts and sediment transport rate and processes.

We have chosen to use a geomorphic, process-based classification system developed within the Pacific Northwest by Montgomery and Buffington to classify the EDT reaches of the Yakima River Basin. Based on classifying bedforms, it is a comprehensive classification scheme used regularly by agencies such as the United States Forest Service (USFS) (Arend 1999). Lacking the complexity of Rosgen's (1994) hierarchical classification system, the Montgomery-Buffington approach integrates well with channel geomorphic unit classifications (e.g. Hawkins et al. 1993), thereby providing a useful tool for classifying aquatic habitats at intermediate landscape scales (Bisson and Montgomery 1996). Being process-based also allows for better analysis of the relationships between geomorphic and habitat correlates/variables used within the EDT model.

The Montgomery-Buffington classification approach focuses on the physical relationships between three internal forcing mechanisms, including variations in transport capacity, sediment supply, and large woody debris (LWD) within a stream reach. The interrelated processes between these variables ultimately determine a channel's morphology. It is important to note that any alteration to one or more of these three mechanisms, whether natural or anthropogenic, can elicit a concomitant response in channel form. For instance, fluxes in discharge, sediment supply, and riparian vegetation that result from external mechanisms such as climate change, mass-wasting, dam and reservoir construction, confinement, and clearing of riparian vegetation will be reflected by alterations to a channel's width, depth, slope, grain size, bedform, and pattern (Montgomery and Buffington 1998). The dynamic relationship between internal and external forcing mechanisms determines, at least in part, the condition of the aquatic habitat present within a watershed (Montgomery et al. 1999).

A channel's morphology within the Montgomery-Buffington classification scheme is initially based on information from topographic maps and aerial photographs, though site visits are necessary to verify reach boundaries and their classifications (Arend 1999). The first step in classifying a channel reach within this system is to derive slope gradient. Once generated, these data allow the initial empirical association of gradient to channel form. Frequency distributions of surveyed gradients for Pacific Northwest rivers west of the Cascade crest within the state of Washington and their associated forms are presented in Table 1. Bedrock, and forced alluvial reaches (forced pool-riffle and forced step-pool) can occur across the various range of slope gradients listed above; however, bedrock and forced step-pool reaches are commonly found on slopes with higher gradients, while forced pool-riffle reaches will more often be found on lower gradient slopes. Because each channel form is more or less sensitive to the external influences that effect one or more of the three internal forcing mechanisms, we should expect discontinuities between slope gradient measurements and the present channel form predicted by valley slope alone. For example, cascade, bedrock, and step-pool channels show little response to perturbations. Conversely, colluvial and plane-bed channels exhibit a moderate response, while pool-riffle and dune-ripple channels are most sensitive to fluxes (Montgomery and MacDonald 2002).

Table 1. Slope gradient and associated channel forms (Montgomery and Buffington, 1998).

	Slope Gradient	**<1%**	**2% -4%**	**4% -8%**	**8% -20%**	**>20%**
Channel Form		Dune-Ripple & Pool-Riffle	Plane-Bed	Step-Pool	Cascade	Colluvial

Since the effects of confinement can significantly transform a channel's morphology, determining the degree of confinement, whether natural or anthropogenic, is the second step in classifying a channel and its potential response to perturbations within this system. Together, valley slope and the degree of channel confinement more accurately describe the channel form of a given reach (Montgomery and MacDonald 2002). Field verification of slope gradient measurements for various channels within the Yakima River basin shows that a low gradient pool-riffle reach can exhibit characteristics of a plane-bed channel form and is most likely the result of an increase in transport capacity, sediment supply, or both (Figures 1-3). Slope gradient and the degree of channel confinement for large order streams (4^{th} order and up) are easily derived using contemporary geo-spatial software; nevertheless, field verification of channel form remains an essential step in assessing the accuracy of measured results. There is simply no substitute for on-the-ground observations, which become essential when working on smaller order streams (3^{rd} to 1^{st} order). For example, field verification of slope gradient measurements that projected a plane-bed channel revealed a forced step-pool morphology may result from woody debris inputs (Figure 4), while slope gradient measurements that projected a pool-riffle channel revealed a plane-bed morphology in areas of increased confinement.

Gradient

EDT Definition:

The average gradient of the main channel of the reach over its entire length.

Note: Categorical levels are shown here but values are required to be input as point estimates for each reach.

EDT Categories:

Index 0	Index 1	Index 2	Index 3	Index 4
0 – 0.1%	>0.10% and <0.5%	>0.5% and <1%	>1% and <2%	>2% and <4%

Measurement Techniques

Gradient measurements may be conducted via field surveys, a combination of digital elevation models (DEMs) and Geographic Information System (GIS) hydrology layers, or topographic map interpretation using either a map wheel, piece of string or software such as MAPTECH Terrain Navigator. In all cases, the percent gradient is then calculated by dividing the change in elevation (i.e. rise) by the distance between the points (i.e. run), and multiplying by 100. Gradient should be recorded to the nearest 0.1% (Johnston and Slaney 1996; Overton et al. 1997).

Field survey techniques

Slopes may be measured on the ground using a stadia rod and either line of sight or level line methods (Murdoch et al. 2001), a hand held clinometer (Hogan et al. 1996), or a hand level and surveying rod (Fitzpatrick et al. 1998). Overton et al. (1997) caution against using clinometers due to the high variability in results when applied to stream gradients, while Fitzpatrick et al (1998) suggest that accurate slope measurements on low-gradient streams requires using a surveyor's level on a tripod and a surveyor's rod. Bauer and Ralph (1999) contend that the most accurate method of measuring gradient is by creating a longitudinal profile of an entire stream reach using surveying equipment, though this may not be cost-effective for most EDT modeling exercises.

In terms of measurement spacing, Hogan et al. (1996) propose calculating average channel gradient from five evenly spaced measurements along a reach, each taken over similar distances, generally over the longest length of channel visible between field surveyors, with a minimum length of several channel widths. Harrelson et al. (1994) argue for longitudinal profile lengths of approximately 20 times the bankfull channel width, while Overton et al. (1997) suggest measurement distances of 200-300 m, taken along relatively straight sections of river at least 20-30 m in length, and between similar morphological features (e.g. from one riffle crest to the next). Measurements may also be taken between transects used to calculate channel width (Fitzpatrick et al. 1997).

Measurements are taken at the water's edge or surface, relative to semi-permanent markers with either known or assumed elevations, and are corrected for the height of the measuring instrument (see Fitzpatrick et al. 1998, Harrelson et al. 1994, Murdoch et al. 2001, or Overton et al. 1997 for more detail). The distance should also be taken between measurement points using a tape measure or line held taut between the points. Note: Arend and Bain (1999) make a further distinction between measuring the "energy gradient" (i.e. the surface of the stream), which is generally assumed to be synonymous with stream gradient by other authors, and their definition of stream gradient (measured along the thalweg).

Topographic map interpretation

Using large scale maps (scales 1:24,000 or greater), the main channel length of larger streams may be obtained by subtracting the river mile estimate for the upstream boundary of the reach from the river mile estimate for the downstream reach, while the elevations for the two boundary points may be estimated from the contour lines (USFS 2001). A more exact estimate of stream channel length (i.e. the blue line distance) may be measured by tracing the main channel using either a map wheel or string, and converting the distance by the scale of the map (Allen and Guenther 1996; Murdock et al. 2001; Overton et al. 1997; Watershed Professional Network 1999). One can also calculate slope using a gradient template printed on a clear piece of Mylar (Pleus and Schuett-Hames 1998), though the latter should only be used for relatively straight channels (Watershed Professional Network 1999). Software such as MAPTECH Terrain Navigator may also be used to measure gradient from topographic maps.

GIS tools

If available, gradients may be calculated using a combination of digital elevation models and a GIS hydrology layer (Allen and Guenther 1996; Johnston and Slaney 1996), using the GIS system to calculate channel gradients between individual contours or “smooth” them by a running average (Watershed Professional Network 1999).

Comparison of Methods

We compared the precision of three different methods for measuring the average gradient of a reach over its entire length. The three methods assessed include using ArcGIS Geographic Information System (GIS) software, MAPTECH Terrain Navigator software, and a handheld map planimeter. The advantages and disadvantages for each method are presented in Table 2.

Table 2. Advantages and disadvantages for methods used to determine slope gradient.

	Method	GIS	MAPTECH Terrain Navigator	1:24000 USGS Map & Map Planimeter
Advantages/Disadvantages		High Precision	High Precision	Moderate Precision
		Retrievable Spatial Digital Data	Retrievable Spatial Digital Data	No Digital Data Generated
		Data easily merged with EDT Database	Data entry into EDT Database required	Data entry into EDT Database required
		Expensive	Inexpensive	Inexpensive

Results of the two-tailed Wilcoxon signed-rank test for slope gradient measurements on ~490 river miles within the Yakima River basin were not significant at the .05 confidence level when comparing ArcGIS and MAPTECH Terrain Navigator software. Likewise, comparing results of the two-tailed Wilcoxon signed-rank test for slope gradient on 45 river miles using a map planimeter with United States Geological Survey (USGS) 1:24000 Quadrangles, ArcGIS, and MAPTECH Terrain Navigator were also not significant at the .05 confidence level.

Given that there is no significant difference in the level of precision for measuring slope gradient by any of the three methods tested, the decision to use one method over another becomes more subjective. If for example, a GIS is already in place and the skill level of the technician operating the software is advanced, then generating slope gradient measurements for an entire river basin is practical. However, if an up and running GIS does not exist, or a skilled operator is lacking, then we highly recommend implementing one of the two other methods explored here. Given its advantages, we recommend the use of MAPTECH Terrain Navigator software. Not only is Terrain Navigator somewhat more precise, but it also generates retrievable digital data in less time. Furthermore, a cost comparison shows that Terrain Navigator software is by far less expensive than purchasing the large quantities of USGS 1:24000 Quadrangles required for use with a map planimeter over an entire drainage basin.

Results for slope gradient measurements for all EDT reaches within the Yakima River basin are presented in appendices A-1 through A-3. Only those cells colored green have been field verified. In those cases where two channel forms are listed, the first form predominates within the reach and the second occurs where the channel is influenced by one or more of the internal and/or external variables mentioned above. Given these results, we believe the Montgomery-Buffington classification system, while initially developed for use in forested watersheds on the west side of the Cascades, may be readily used to classify reaches in eastern Washington.

Confinement - Natural

EDT Definition:

The extent that the valley floodplain of the reach is confined by natural features -determined as the ratio between the width of the valley floodplain and the bankfull channel width.

Note: this attribute addresses the natural (pristine) state of valley confinement only. The extent that reaches are confined by hydromodifications (e.g., diking) is addressed under a separate attribute.

EDT Categories

Index 0	Index 1	Index 2	Index 3	Index 4
Reach mostly unconfined by natural features – Average valley width > 4 channel widths.	Reach comprised approximately equally of unconfined and moderately confined sections.	Reach mostly moderately confined by natural features -- Average valley width 2 - 4 channel widths.	Reach comprised approximately equally of moderately confined and unconfined sections.	Reach mostly confined by natural features – Average valley width < 2 channel widths.

Confinement – Hydromodifications

EDT Definition:

The extent that man-made structures within or adjacent to the stream channel constrict flow (as at bridges) or restrict flow access to the stream's floodplain (due to streamside roads, revetments, diking or levees) or the extent that the channel has been ditched or channelized, or has undergone significant streambed degradation caused by channel incision/entrenchment (associated with the process called "headcutting"). Flow access to the floodplain can be partially or wholly cut off due to channel incision.

Note: Setback levees are to be treated differently than narrow-channel or riverfront levees--consider the extent of the setback and its effect on flow and bed dynamics and micro-habitat features along the stream margin in reach to arrive at rating conclusion. Reference condition for this attribute is the natural, undeveloped state.

EDT Categories

Index 0	Index 1	Index 2	Index 3	Index 4
The stream channel within the reach is essentially fully connected to its floodplain. Very minor structures may exist in the reach that do not result in flow constriction or restriction. Note: this describes both a natural condition within a naturally unconfined channel as well as the natural condition within a canyon.	Some portion of the stream channel, though less than 10% (of the sum of lengths of both banks), is disconnected from its floodplain along one or both banks due to man-made structures or ditching.	More than 10% and less than 40% of the entire length of the stream channel (sum of lengths of both banks) within the reach is disconnected from its floodplain along one or both banks due to man-made structures or ditching.	More than 40% and less than 80% of the entire length of the stream channel (sum of lengths of both banks) within the reach is disconnected from its floodplain along one or both banks due to man-made structures or ditching.	Greater than 80% of the entire length of the stream channel (sum of lengths of both banks) within the reach is disconnected from its floodplain along one or both banks due to man-made structures or ditching.

Measurement Techniques

While many authors agree that natural confinement may be calculated as a ratio of bankfull width to its floodplain (e.g. Bauer and Ralph 1999; Overton et al. 1997), little guidance is given in the literature on how to best calculate this correlate. Bauer and Ralph (1999) suggest calculating confinement as a ratio between bankfull width (often correlated with the 1.5 year recurrence interval flood) and either the 100 year floodplain or the channel migration zone. The Watershed Professionals Network (1999) use a similar ratio, though they define the modern floodplain as the flood-prone area, which may not correspond to the 100-year floodplain. For example, USFS (2001) defines the flood-prone are as the width of the valley floor inundated during the 50-year flood, which may be estimated by doubling the maximum bankfull depth and extending the resulting flood-prone elevation across the floodplain. Moore et al. (2002), who define confinement as a ratio of active channel width to valley width, similarly distinguish confinement using the flood-prone elevation, defining "constrained" valleys as those with terrace heights greater than flood-prone elevations. Both floodplain and bankfull channel widths can be estimated using topographic maps and aerial photographs, though measurements should be verified in the field along evenly spaced intervals along the longitudinal profile of the reach (Pleus and Schuett-Hames 1998; Watershed Professionals Network 1999). All width measurements should be measured perpendicular to their feature's corresponding centerlines (Pleus and Schuett-Hames 1998).

We believe that the degree of natural and anthropogenic confinement may be derived via a simple two-step process. Using aerial photography with Mylar overlays, or enlarged copies of USGS 1:24000 quadrangles, the investigator performs a field reconnaissance of the entire reach. All natural and cultural features that confine the channel from its 100-year floodplain are drawn onto the aerial photographs or map copies (Fitzpatrick et al. 1998; Pleus and Schuett-Hames 1998). Once complete, this data is then entered into either a GIS or MAPTECH's Terrain Navigator. Again, the investigator's choice should be based on practicability, since either of the two technologies will return the same level of precision. Figures 5-6 depict examples of both natural and anthropogenic confinement along portions of the Easton reach.

Definitions for determining the degree of both natural and anthropogenic confinement as described within the EDT model should be closely followed. According to the definition for confinement induced by hydro-modifications, anthropogenic confinement is measured along that portion of the reach where cultural features are present either on one or both banks of the channel. Once all measurements are made, the length of the confined channel is then divided by the total length of the entire reach. Multiplying the resulting quotient by 100 produces the percentage of the reach that is confined. This percentage determines the index value for confinement within the EDT model.

With the exception of differing index values, deriving the degree of natural confinement is similar to the method described above. Using a combination of topographic maps, Federal Emergency Management Agency (FEMA) floodplain maps, and aerial photographs, measure the width of the 100-year floodplain at systematic intervals along a reach (e.g. 500 m), and compare it to 2 and 4 times the average bankfull channel width for the reach. For larger streams lacking 100-year floodplain information, the flood-prone area may be estimated from aerial photographs using the extent of riparian vegetation as a proxy indicator.

The degree of confinement for smaller streams must be measured along systematically spaced intervals in the field, using the 50-year floodplain estimated by doubling the maximum bankfull depth and extending the resulting flood-prone elevation across the floodplain (USFS 2001). To determine flood-prone width, pieces of flagging are temporarily tied to vegetation corresponding to the flood-prone elevation, and a measuring tape is stretched level at that elevation to determine the extent of the flood-prone elevation. Flood-prone widths are measured to the nearest foot if less than 4 times the bankfull width at that transect.

Results for measures of confinement within the Cle Eum and Easton reaches show the effects of anthropogenic features on channel form within these two alluvial floodplains. For instance, of the total ~10.03 river miles with the Cle Elum reach, 3.4 river miles, or ~33.86 percent of its length is confined by human-induced features, yet a much greater proportion of the channel's length seems to be affected. As already mentioned, gradient measurements projected that a pool-riffle channel form should predominate throughout this reach; however, habitat unit measurements show that nearly 83 percent of the channel exhibits a plane-bed morphology. Similarly, anthropogenic features confine 4.95 river miles, or ~26.29 percent of the total ~18.82 river miles within the Easton reach; an additional 2.68 percent is naturally confined. Even though habitat unit measurements have not been completed for the entire reach at this time, preliminary surveys show that the majority of the reach exhibits a plane-bed channel morphology rather than a pool-riffle form.

Channel Widths

EDT Definitions:

Month Maximum Width:

Average width of the wetted channel during high flow month (average monthly conditions). If the stream is braided or contains multiple channels, then the width would represent the sum of the wetted widths along a transect that extends across all channels. Channel width – month maximum width (ft) is to be rated for the month when average flow tends to be highest. This month will typically be during some part of March-June east of the Cascade crest and during December or January on the west side of the crest.

Month Minimum Width:

Average width of the wetted channel during low flow month (average monthly conditions). If the stream is braided or contains multiple channels, then the width would represent the sum of the wetted widths along a transect that extends across all channels.

EDT Categories

Index 0	Index 1	Index 2	Index 3	Index 4
< 15 ft	> 15 ft and < 60 ft	> 60 ft and < 100 ft	> 100 ft and 360 ft	> 360 ft

Note: categorical index levels are presented because they are used in some bio-rules. However, it is now required that Level 2 attribute values for this attribute be input as non-categorical estimates, i.e., point estimates.

Measurement Techniques

Measuring maximum and minimum channel widths was conducted using a combination of aerial photo interpretation, field survey, and estimation methods.

Aerial photo interpretation

For the aerial photo interpretation, we compared three spatial sampling approaches commonly used to sample streams and rivers: random, systematic, and stratified (Conquest and Ralph 1998) (Figure 7).

Simple random samples were generated by dividing each EDT reach into 100 m segments, numbering each segment, and choosing a representative sample of 30 using a random number table (see Note A). This method allowed channel measurements to be randomly distributed, though the samples tended to be more time consuming to generate. In addition, a random sample may not provide uniform, representative coverage with limited numbers of samples. Systematic samples were also taken by dividing each EDT reach into 30 regular sampling intervals, providing uniform coverage of each reach. The systematic sampling method is easier than the random method to implement, and generally allows for a representative sample as long as there is no underlying periodicity corresponding with the spatial sampling intervals. Finally, we established stratified samples for each reach by classifying the reaches into homogeneous subsets based on a combination of: 1) number of channels (single or multiple); and 2) degree of confinement (unconfined, naturally confined, or 100% anthropogenically confined) (Table 3; Figures 8-9).

Table 3. Stratified sample categories and proportions for the Easton and Cle Elum EDT reaches.

Category	Cle Elum	Easton
Unconfined single channel	68.8%	53.8%
Confined single channel	13.8%	8.2%
Unconfined multiple channel	17.4%	36.3%
Confined multiple channel	0%	1.7%

The stratified approach allowed smaller samples to be taken while still ensuring smaller subsets were represented in the sample. As all three EDT reaches in the Easton reach were classified as one geomorphic unit using Montgomery and Buffington's classification scheme , we combined all three reaches into a single sampling unit, making sure to generate 10 random and systematic sampling points for each EDT. This process of "lumping" stream segments (Pleus and Schuett-Hames 1998) for the purpose of sampling is justifiable for EDT reaches that have homogenous geomorphic categories, and no substantial differences in flow due to the confluence of significant tributaries.

Each stratified sample consisted of 4-5 channel measurements (Hogan et al. 1996), which were spaced approximately 5-7 channel widths apart. Several authors suggest determining sample stream segments based on 20 average channel widths, with the smallest possible segment being 300 ft (100 m) (Fitzpatrick et al. 1998; MacDonald et al. 1991; Pleus and Schuett-Hames 1998). The 20-channel width criteria attempts to encompass at least one complete meander wavelength, based on the classic pool-riffle channel system proposed by Leopold et al. (1964), with pools spaced every 5-7 channel widths. Having a minimum of 3-4 repeated habitat association patterns ensures that all habitat types are represented in the stream segment (Fitzpatrick et al. 1998), and allows for more effective statistical analysis and confidence (Pleus and Schuett-Hames 1998). Fitzpatrick et al. (1998) further contend that a minimum sample reach length is necessary for representative samples, while a maximum length is needed to prevent a reduction in sampling efficiency. They suggest that the minimum and maximum sample reach lengths for wadeable streams are 150 and 300 m, respectively, while the recommended minimum and maximum lengths for nonwadeable streams are 500 and 100 m, respectively. Fitzpatrick et al. (1998) also suggest that each stream segment be further divided into 10 equal parts for sampling, and that habitat units such as channel width be measured at 11 equal points (i.e. approximately 2 channel widths apart). However, given the similarity in channel measurements we found at each location, such sampling intensity might not be warranted in most cases.

Wetted channel widths were measured using ArcGIS and rectified aerial photos taken during flow conditions approximating month-maximum and month-minimum flows. The width of gravel bars and vegetated islands were excluded from the overall channel width, while multiple channels were summed for a total width measurement. Measurements were recorded to the nearest 1.0 ft, given the degree of precision required by EDT model. The measurements were averaged for each subset category, and applied proportionally by the percentage of the reach with a similar classification to obtain an overall average channel width for the EDT reach.

Field survey

For the field assessment, we used the stratified sampling approach to obtain channel width measurements, as obstructions to navigation and limited public access prohibited application of random and systematic sampling in the field. Public access locations representing each of the stratified sample categories were located using a combination of USGS topographic maps, aerial photographs, and field reconnaissance. Each stratified sample consisted of 4-5 regularly spaced channel measurements (Hogan et al. 1996). Arend and Bain (1999) suggest that transects should be spaced approximately 5-7 channel widths and up to 40 channel widths apart, depending on research objectives. Schuett-Hames et al. (1999) recommend adjusting transect intervals to stream segment lengths, with transect intervals varying from 10% of segment lengths for segments less than 100 m, to 100 m intervals for stream segments over 2500 m.

Measurements were taken at representative locations (Johnston and Slaney 1996; Overton et al. 1997), usually in riffle areas (USFS 2001) or other straight sections with no signs of water stacking or piling (such as the outside of a bend or near channel obstructions) (Allen and Guenther 1996; Harrelson et al. 1994; USFS 2001). In addition, transects were located at locations with clear bankfull indicators (Allen and Guenther 1996; Harrelson et al. 1994; USFS 2001). Areas with undercut banks or actively eroding banks are to be avoided, since bank slumping tends to obscure true bankfull conditions (USFS 2001).

Both the minimum and maximum channel widths were measured at the same transect locations during the low flow month, based on average monthly conditions. Using a Bushnell Yardage Pro 400 laser range finder, the minimum channel width was estimated by measuring the wetted width from one side of the stream to the other, perpendicular to the flow or channel axis (i.e. thalweg). The wetted edge was defined as the point where sediment particles are no longer surrounded by water (Johnston and Slaney 1996). Cross-channel measurements excluded any dry channel bars (Johnston and Slaney 1996; Fitzpatrick et al. 1998), and multiple channel widths were summed for a total width. Channel widths less than 17 feet (the lower threshold of the laser range finder) were measured using a measuring tape stretched tight from one wetted edge to the other. Measurements were recorded to the nearest 1.0 ft, given the degree of precision required by EDT model. Maximum channel widths were measured from the top of one stream bank to the other, again perpendicular to stream flow. The height/extent of bankfull flow was estimated using a variety of indicators widely used in the literature, including: 1) change in bank morphology (e.g. slope changes, top of point bar deposits and undercut banks); 2) change in sediment composition (e.g. sand to pebbles); 3) vegetative indicators (e.g. beginning of perennial terrestrial vegetation, lower limit of lichens and mosses; 4) scour lines (e.g. exposed roots,); and 5) defined water marks (e.g. stain lines, line of organic debris on the ground)(Allen and Guenther 1996; Arend and Bain 1999; Fitzpatrick, et al. 1998; Harrelson et al. 1994; Hogan et al. 1996; Johnston and Slaney 1996; Moore et al. 2002; Pleus and Schuett-Hames 1998; USFS 2001). The width of vegetated islands with perennial terrestrial vegetation > 1 m in height were not included in the overall width measurement, and multiple channel widths were summed for a total width (Hogan et al. 1996; Johnston and Slaney 1996; Moore et al. 2002).

Again, the stratified approach allowed smaller samples to be taken while ensuring that smaller subsets were still represented in the sample. Each stratified sample consisted of 4-5 channel measurements, which were spaced approximately 5-7 channel widths apart. The measurements were averaged for each subset category, and applied proportionally by the percentage of the reach with a similar classification to obtain an overall average channel width for the EDT reach.

Estimation techniques

The EDT primer suggests that if empirical width data are not available for the reach of interest, reasonable conclusions can usually be based on personal knowledge of the area. In some cases, a better characterization of flow may exist than channel width. Here, an estimate of width (in feet) for larger streams might be obtained from flow data (cfs) using an equation formulated for streams on the east side of the Cascade crest using an equation given in Johnson et al. (1988) as follows:

$$Width = a * CFS^b$$

Where a = 4.5789 and b = 0.5660

Comparison of Methods:

Aerial photo interpretation vs. Field survey

In comparing 30 replicate channel width measurements, no significant difference was found between the GIS and field based measuring methods for either minimum or maximum flow widths (two sample t-test, $p<0.05_{\text{two-tailed}}$) (Tables 4-5).

Table 4. Comparison of maximum channel width measurements.

	Random	Systematic	Stratified GIS Measures	Stratified Field Measures	Estimation Technique
Easton					
Mean (ft.)	123	110	103	115	181
SE Mean (ft.)	5.9	5.8	3.0	5.0	
EDT Index Value	3	3	3	3	3
Cle Elum					
Mean (ft.)	185	185	232	247	463
SE Mean (ft.)	6.6	6.1	8.9	13	
EDT Index Value	3	3	3	3	4

Table 5. Comparison of minimum channel width measurements.

	Random	Systematic	Stratified GIS Measures	Stratified Field Measures	Estimation Technique
Easton					
Mean (ft.)	89	93	93	93	94
SE Mean (ft.)	3.5	5.0	4.9	3.9	
EDT Index Value	2	2	2	2	2
Cle Elum					
Mean (ft.)	129	142	134	159	158
SE Mean (ft.)	4.9	7.5	7.8	13	
EDT Index Value	3	3	3	3	3

Sample designs

No significant difference was found between the minimum channel widths determined through the various sampling methods (random, systematic, stratified) (Kruskal-Wallis test, $p<0.05_{\text{two-tailed}}$) (Table 5). In addition, no significant difference was found between the maximum channel widths determined through the random and systematic sampling methods (two sample t-test, $p<0.05_{\text{two-tailed}}$) (Table 4). However, we did find a significant difference between the maximum channel widths determined through the various sampling methods for the Cle Elum reach (Kruskal-Wallis test, $p<0.05_{\text{two-tailed}}$), though no significant difference was found for the Easton reach (Table 4). The estimation technique using the equation derived by Johnson et al. (1988) seems to be consistent with the minimum channel width measurements derived through the other methods. However, the formula greatly overestimated the maximum channel widths, illustrating the problem of using a generalized equation on a regulated river with sustained high flows and a relatively high degree of confinement.

Habitat Type

Using Hawkins et al. (1993), the EDT model distinguishes between three different categories of habitat types: 1) slow water (e.g. primary pools, pool-tailouts/glides, beaver ponds, and backwater pools); 2) fast water habitat types (e.g. small cobble/gravel riffles and large cobble/boulder riffles); and 3) off-channel habitat.

EDT Definitions:

Slow Water Habitat Types

Backwater pools:

Percentage of the wetted channel surface area comprising backwater pools. Backwater pools are habitat units located along the channel margins but are otherwise enclosed—though still connected to the main channel (or side channel).

Note: backwater pools as defined here include "alcoves" as described by Nickleson et al. (1992).

Beaver ponds:

Percentage of the wetted channel surface area comprising beaver ponds.

Note: this includes only those sites associated with the main channel or its side channels. Off-channel sites are addressed through the Off-Channel Habitat Factor.

Pool tailouts:

Percentage of the wetted channel surface area comprising pool tailouts.

Glides:

Percentage of the wetted channel surface area comprising glides.

Note: There is a general lack of consensus regarding the definition of glides (Hawkins et al. 1993), despite a a commonly held view that it remains important to recognize a habitat type that is intermediate between pool and riffle. The definition applied here is from the ODFW habitat survey manual (Moore et al. 1997): an area with generally uniform depth and flow with no surface turbulence, generally in reaches of <1% gradient. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. They are generally deeper than riffles with few major flow obstructions and low habitat complexity.

Primary pools:

Percentage of the wetted channel surface area comprising pools, excluding beaver ponds

Fast Water Habitat Types

Large cobble/boulder riffles:

Percentage of the wetted channel surface area comprising large cobble/boulder riffles. Particle sizes of substrate modified from Platts et al. (1983) based on information in Gordon et al. (1991): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).

Small cobble/gravel riffles:

Percentage of the wetted channel surface area comprising small cobble/gravel riffles. Particle sizes of substrate modified from Platts et al. (1983) based on information in Gordon et a. (1991): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).

EDT Categories

Index 0	Index 1	Index 2	Index 3	Index 4
0 - <0.25% of wetted surface area encompasses this habitat type	>0.25% and <5% of wetted surface area encompasses this habitat type	>5% and <25% of wetted surface area encompasses this habitat type	>25% and <50% of wetted surface area encompasses this habitat type	>50% of wetted surface area encompasses this habitat type

Note: Where an index value is associated with a range, the integer value is assumed for modeling to be the midpoint. Index values can be identified as non-integers to represent the lower or upper ends of a range.

Off-Channel Habitat Factor

EDT Definition

A multiplier used to estimate the amount of off-channel habitat based on the wetted surface area of the all combined in-channel habitat. Off-channel habitats consist of oxbows, backswamps, riverine ponds, and the channels that connect them to the main channel or its side channels.

EDT Categories

Index 0	Index 1	Index 2	Index 3	Index 4
No off-channel habitat present	>0 X and < 0.05 X	>0.05 X and < 0.25 X	>0.25 X and < 0.5 X	>0.5 X

Note: Where an index value is associated with a range, the integer value is assumed for modeling to be the midpoint. Index values can be identified as non-integers to represent the lower or upper ends of a range.

Identifying Habitat Types

The EDT habitat types are based on a variety of hierarchical classification schemes focused primarily on water velocity, channel morphology, turbulence, substrate characteristics, and water depth (e.g. Armantrout 1996; Flosi and Reynolds 1994; Hawkins et al. 1993). These classification frameworks are more complex, expanding on the primary habitat units used by the EDT model. Several authors provide good descriptions, cross-sectional diagrams, and/or ground photos of each classification type (e.g. Arend 1999; Fitzpatrick et al. 1998; Johnston and Slaney 1996; Moore et al. 2002; Overton et al. 1997; Pleus et al. 1999; USFS 2001; Watershed Professionals Network 1999).

Habitat types are distinguished by fluvial hydraulic and geomorphic descriptors, including water speed and depth, surface turbulence, substrate characteristics, bed roughness and uniformity, as well as bed and water surface slopes (Moore et al. 2002; Overton et al. 1997; Pleus et al. 1999). Boundaries between these discrete channel units are based on identifying changes in stream channel slopes along the thalweg of the channel bottom, such as the riffle crest (i.e. the high point in channel bed below a pool) (Overton et al. 1997; Pleus et al. 1999).

Pools are geomorphic channel units where water is impounded within a scour depression associated with a channel obstruction (i.e. hydraulic control). These features are characterized by reduced velocity, little surface turbulence (with the exception of eddies), and deeper water. In sharp contrast, riffles are relatively shallow, occur in straight stretches of the river, and have relatively fast flows over completely or partially submerged obstructions, leading to surface turbulence. Riffles also have coarser substrates. Glides (i.e. runs), typically found in the transition zone between pool tail-outs and riffles and in low-gradient reaches with no flow obstructions, have moderate depth, moderate to high flows, and no apparent surface turbulence. Glide cross-sections are U-shaped, with uniform substrates.

Measurement Techniques

Field survey

Several authors (e.g. Arend 1999; Pleus et al. 1999) suggest that habitat surveys be conducted during moderate to low flow conditions, preferably during the late summer/early fall when discharge conditions are generally the most stable and allow repeat surveys to be conducted at similar discharges. While repeat surveys can be conducted during higher flows, Pleus et al. (1999) contend that such flows generally increase data variability because of decreased visibility and access due to increased turbidity, turbulence and water depths. Moderate or most frequent flows may also aid proper identification of the habitat types most commonly found in a stream segment throughout the year, as both higher and lower lows can change habitat classifications and sizes (Roper and Scarnecchia 1995). For example, a riffle might resemble a glide during high flow conditions, while a glide may become a riffle during low flow conditions (Fitzpatrick et al. 1998). In addition to the influence of stream discharge, Roper and Scarnecchia (1995) have noted variability in classifying habitat types can be related to differences in: 1) the level of distinction required in classification (e.g. pools in general vs. several specific subtypes of pools); 2) the level and uniformity of observer training; as well as 3) differences in other stream characteristics (e.g. gradient).

Bisson and Montgomery (1996) state that habitat unit inventories of small to mid-size streams are often time consuming, typically requiring teams of 2-3 people to cover 1-5 km per day. In addition, other factors such as reach length, available time, and access may make the study of an entire reach impractical. They suggest studying representative sections of a reach, providing that the sections include examples of each type of habitat unit present in the whole reach. As obstructions to navigation and limited public access prohibited measuring all the habitat units in the reach, we established stratified samples for each reach by classifying the reaches into homogeneous subsets based on a combination of: 1) number of channels (single or multiple); and 2) degree of confinement (unconfined, natural confined, or 100% anthropogenically confined) (Table 1). The stratified approach allowed smaller samples to be taken while ensuring smaller subsets were still represented in the sample.

Each stratified sample consisted of stream segments representing each reach category. Several authors suggest determining sample stream segments based on 20-50 average channel widths, with the smallest possible segment being 300 ft (100 m) (Bisson and Montgomery 1996; Fitzpatrick et al.1998; MacDonald et al. 1991; Pleus and Schuett-Hames 1998). The 20-channel width criteria attempts to encompass at least one complete meander wavelength, based on the classic pool-riffle channel system proposed by Leopold et al. (1964), with pools spaced every 5-7 channel widths. Having a minimum of 3-4 repeated habitat association patterns ensures that all habitat types are represented in the stream segment (Fitzpatrick et al. 1998), and allows for more effective statistical analysis and confidence (Pleus and Schuett-Hames 1998).

Fitzpatrick et al. (1998) maintain that a minimum sample reach length is necessary for representative samples, while a maximum length is needed to prevent a reduction in sampling efficiency. They suggest that the minimum and maximum sample reach lengths for wadeable streams are 150 and 300 m, respectively, while the recommended minimum and maximum lengths for nonwadeable streams are 500 and 100 m, respectively. In addition, each stream segment should include at least two examples of each type of habitat unit, and only habitat units greater than 50% of the channel width should be measured and recorded. Similarly, Pleus et al. (1999) require that riffle and pool habitat units meet certain minimum surface size criteria based on the stream segment's mean bankfull width (Table 2). In order to be considered a habitat unit, its length has to be equal to or greater than the wetted width. The USFS (2001) requires that the sampling frequency must ensure that at least 10 pools and 10 riffles as well as 10% of all pools and riffles are measured for each stream.

Habitat type surveys typically begin at the downstream portion of a stream segment, moving systematically upstream (Bisson and Montgomery 1996; Fitzpatrick et al. 1998; Moore et al. 2002; Overton et al. 1997; Pleus et al. 1999; USFS 2001). Using a combination of field notes and a mylar sheet superimposed over a large-scale aerial photograph, each habitat unit was given a unique unit number, increasing sequentially upstream. Where multiple channels were present, geomorphic habitat units were first assessed and numbered in the main channel from the downstream outlet of the secondary channel to the upstream inlet, returning to the downstream portion of the secondary channel and continuing the sequential numbering of habitat units until the main channel was reached. Geomorphic habitat units were further labeled according to the EDT habitat types, distinguishing primary pools (PP), pool-tailouts (PT), glides (GL), beaver ponds (BV), backwater pools (BP), small cobble/gravel riffles (SCR) and large cobble/boulder riffles (LCR).

The two riffle habitat types are further distinguished on the relative size of cobbles. Dominant cobble sizes can be estimated using the Wolman Pebble count (Wolman 1954), or an ocular estimate method (Overton 1997). The Wolman Pebble count method collects pebbles and cobbles along a transect, moving one step at a time from one stream bank at the bankfull elevation to the other. At each step, you pick up the first cobble one finger length from the toe of your boot, and measure its intermediate axis. To reduce sampling bias further, you must look across the channel rather than down at its bed. The transect is generally traversed several times to measure the recommended 100 pebbles/cobbles, though 25-50 may be enough in some instances. The ocular estimate method simply estimates the proportion of each sediment size class along an entire riffle, again from the bankfull elevation on each stream bank.

The length of each pool, riffle, and glide was measured along its thalweg using a Bushnell Yardage Pro 400 laser rangefinder, though a measuring tape, hip chain, or pacing technique could also have been used (Murdoch et al. 2001). Bisson and Montgomery (1996) suggest that rangefinders be calibrated at the beginning of each field trip by measuring the distance between two points with a tape and adjusting the readings on the rangefinder, which can become misaligned if dropped. GPS units have also been used for some reach surveys, though problems can occur in areas with heavy forest canopies or high topographic relief (Bisson and Montgomery 1996). Habitat units less than 17 feet in length or width (the lower threshold of the laser range finder) were measured using a measuring tape. Measurements were recorded to the nearest 1.0 ft, given the degree of precision required by EDT model. The maximum thalweg distance was recorded for each habitat unit, as well as one representative width measurement at the habitat unit's midpoint (Arend and Bain 1999). For sinuous habitats, the length was measured as the sum of straight line lengths along the thalweg (Johnston and Slaney 1996). Several authors suggest that habitat unit widths should be measured and averaged at a minimum of three points, especially when working within irregularly shaped habitat (Allen and Guenther 1996; Johnston and Slaney 1996; Overton et al. 1997), located one-quarter, one-half, and three-quarters of the habitat's length (Dolloff et al. 1997). Longer fast-water habitat units may also require several width measurements taken along the habitat unit (Overton et al. 1997).

During the stream inventory, the extent of off-channel habitat was observed and located on the aerial photographs to be measured later using ArcGIS. Where possible, the widths of side channels were measured entering and leaving the stream channel, and then averaged.

Area values for each habitat type (length x width) were summed to determine total length for the stream segment (Murdoch et al. 2001). The measurements were averaged for each subset category, and applied proportionally by the percentage of the reach with a similar classification to obtain overall average habitat unit proportions for the EDT reach.

As an alternative, Macdonald, et al. (1991) and Johnson and Slaney (1996) suggest visually estimating the area of each habitat unit for a reach based on the method developed by Hankin and Reeves (1988), as well as accurately measuring a systematic sample of each habitat type to develop calibration ratios. Moore et al. (2002) similarly propose estimating the size of each habitat unit, verifying every tenth unit with accurate measurements, while Dolloff et al. (1997) suggest verification of 20% of pools and 10% of riffles and cascades. Visual assessment methods and verification procedures are best applied when one has access and wishes to rapidly sample an entire EDT reach, either by foot or by boat. However, these methods are less appropriate when sampling stratified subsets, and then applying the less precise results to the overall reach.

Dolloff et al. (1997) have compared estimates of stream habitat using basin-wide visual estimation techniques versus extrapolating habitat information from 3-4 "representative reaches" of approximately 100 m in length. They found that the representative reach extrapolation technique tended to overestimate numbers of pools, while underestimating the number of cascades and the average area of all habitat types. However, representative reaches were chosen on the basis of professional judgment of whether they represented a stream or watershed as a whole, rather than stratifying the reaches further on the basis of differences in channel type, gradient and confinement, and only applying the results at a reach scale.

Aerial photography

While aerial photographs may be used to classify stream types (Mollard 1973), identify channel disturbance (Grant 1988), and determine the size and shape of riparian areas (Platts et al. 1987), identification of channel geomorphic units such as pools and riffles may be difficult for many streams (Arend 1999). Aerial photographs at 1:12,000 scale may be used to measure the widths of streams and riparian areas as well as the extent of large woody debris (Ham 1996), though timely photos at this scale as well as at appropriate flows (e.g. minimum, maximum, and most frequent) are difficult and expensive to obtain, especially for all the reaches in a watershed.

Channel characteristics on small to medium size streams may also be difficult to detect because of steep slopes, dense riparian cover, and shading effects (Bisson and Montgomery 1996; Grant 1988). Large-scale, color aerial photographs ranging from 1:1,000 to 1:5,000 are needed to interpret more detailed information on stream habitats (Johnston and Slaney 1996; Platts et al. 1987).

Aerial videography

Videography is being increasingly used to map linear features such as coastlines and fluvial environments, including assessment of pool-riffle spacing, large woody debris, and riparian vegetation (Ham 1996). However, the nature of these studies has been largely reconnaissance based, as detailed mapping and interpretation is limited by the difficulty of tying the imagery to known ground coordinates. While data can generally be transferred onto a map with an accuracy of plus or minus 100 m, detailed inventories with accuracy of 3-10 m require differentially corrected GPS coordinates, laser altimeters, and onboard compensation for aircraft movement.

Riparian Function

EDT Definition

The correlate "riparian function" is defined by EDT as a measure of riparian function that has been altered within the reach.

EDT Categories

Index 0	Index 1	Index 2	Index 3	Index 4
Strong linkages with no anthropogenic influences.	>75-90% of functional attributes present (overbank flows, vegetated streambanks, groundwater interactions typically present).	50-75% functional attribute rating- significant loss of riparian functioning- minor channel incision, diminished riparian vegetation structure and inputs etc.	25-50% similarity to natural conditions in functional attributes- many linkages between the stream and its floodplain are severed.	< 25% functional attribute rating: complete severing of floodplain-stream linkages

The riparian zone adjacent to a stream channel is important for proper stream functioning (Naiman et al. 1998). A stream is connected to the riparian zone by pathways of water, organisms, and resources that involve the stream channel, shallow groundwater aquifer, flood plain, and adjacent uplands (Ward and Stanford 1995).

Riparian function is evaluated in terms of overbank flows, vegetated banks, and groundwater interactions. The quickest and most effective method to evaluate these functional attributes is by describing riparian vegetation, and using riparian vegetation as a proxy for the other two attributes, since riparian vegetation influences many fluvial geomorphic processes (Hickin 1984). In addition, riparian vegetation provides several critical habitat functions, including: 1) filtering surface runoff and promoting nutrient uptake, 2) channel shading, 3) streambank stability, 4) spawning habitat and cover for fish, and input of litter and woody debris (Quinn et al. 2001). Vegetation in the floodplain is dependent on over-bank flows and/or groundwater interactions (Decamps 1996). Therefore, a lack of vegetation indicates a significant loss of riparian function.

Measurement Techniques

Aerial photo interpretation

Aerial photographs may be used to describe riparian vegetation on mainstem rivers. Once the photos are scanned and rectified, GIS software may be used to measure loss of riparian vegetation. A FEMA 100-year flood plain digital coverage for the reach of interest is laid over the corresponding aerial photography, as it is assumed that in an unaltered state, riparian vegetation would occur within the 100-year flood plain (Knutson and Naef, 1997). This assumption can be verified by selecting a location along the reach that remains unaffected by human modification and determining the percentage of the 100-year floodplain that has riparian vegetation occurring within it. This percentage can then be used as a benchmark from which to adjust further measurements. If historic aerial photographs are available, they may be used as a measure of quality assurance since they demarcate the extent of riparian vegetation prior to human disturbance.

Riparian vegetation should be measured at 500m intervals along a reach in terms of what percentage of the 100-year floodplain is vegetated. This percentage is then converted into a corresponding correlate score (0-4), as shown in Table 6. If there is great variation in riparian vegetation, measurements should be taken at shorter (250m) intervals. This methodology is only useful for large mainstem rivers with adequate riparian coverage. For smaller streams, tributaries, and areas without extensive riparian coverage, a field assessment of riparian function will be necessary.

Table 6. Percent of riparian vegetation lost and corresponding correlates.

% Riparian Vegetation Lost	EDT Correlate
<10	0
10 – 25	1
25 – 50	2
50 – 75	3
75+	4

Field survey

Several field survey techniques of riparian function focus on bank stability. MacDonald (1991) suggests visual estimation techniques (i.e. Platts et al.1987) using a multi-parameter approach that assigns values to the following streambank parameters as presented in Table 7.

Table 7. Streambank parameters and corresponding values for determining riparian function (Platts, 1987).

Channel location	Parameter	Range of values
Upper bank	Side slope gradient	0-8
	Mass wasting potential	0-12
	Debris jam potential	0-8
	Vegetative cover	0-12
Lower bank	Channel capacity	0-4
	Bank rock content	0-8
	Obstructions and flow Deflectors	0-8
	Bank cutting	0-16
	Sediment deposition	0-16

Allen and Guenther (1996) suggest, at a minimum, measuring lineal distance of actively eroding bank along sides of stream above wetted edge/bankfull channel. For a more representative characterization they suggest separate measurements along both the upper and lower bank. Active eroding banks are characterized by the presence of one or more of these factors: bare exposed colluvial or alluvial substrates, exposed mineral soil, or evidence of tension cracks. This method is also suggested by the United States Department of Agriculture (USDA 2001).

Other field assessments of riparian function use a combination of bank stability and vegetation measurements. Platts et al. (1987) measure streambank stability by classifying the percent of streambank covered by vegetation or by boulders or rubble, using intervals of 0-24%, 25-49%, 50-74%, and 75-100%. Streamsides are also rated on a scale of 1 to 5 based on vegetation present (5-shrubs, 4-trees, 3-grass, 2-forbs dominant streamside vegetation, and 1-> 50% of streambank transect line has no vegetation present). Murdoch et al. (2001) suggests the following: 1) classify vegetation on stream banks as abundant, moderately sparse, or non-existent; 2) estimate the percent of banks covered by vegetation; 3) evaluate bank stability, noting specific areas which are eroding or have collapsed; 4) note bank steepness and effects of anthropogenic change; 5) describe types of vegetation present, and estimate width of riparian zone. Plafkin et al. (1989) similarly measure bank stability in terms of bank failure, slopes, eroded areas, and potential for future erosion. Their method measures bank vegetation stability in terms of percent of stream bank surface covered by vegetation of boulders and cobbles, and describes dominant type of streamside cover as shrubs, trees, grass/forbs, or none. These parameters are classified as excellent, good, fair, or poor.

Several methods quantify riparian function using average scores or index values based on a number of criteria. For example, Bain and Stevenson (1999) use rating criteria for vegetative cover, rocky cover, and total cover for transects with boundaries evenly spaced 5 to 7 average channel widths apart. They compute mean bank scores by multiplying rated values by the number of observations and dividing the sum of products by the number of transect segments. Similarly, Fitzpatrick et al. (1998) use a bank stability index based on criteria presented in Table 8.

Table 8. Vegetative and bank characteristics and their corresponding scores (Bain and Stevenson, 1999).

Characteristic	Measurement	Score
Angle of bank (degrees)	0-30	1
	31-60	2
	>60	3
Vegetation cover (%)	>80	1
	50-80	2
	<20	3
Bank height (m)	0-1	1
	1.1-2	2
	2.1-3	3
	3.1-4	4
	>4	5
Substrate (category)	Bedrock, artificial	1
	Boulder, cobble	3
	Silt	5
	Sand	8
	Gravel/sand	10

Total score

4-7: stable **11-15: unstable**

8-10: at risk **16-22: very unstable**

Large Woody Debris (LWD)

EDT Definition:

The correlate "Large Woody Debris" (LWD) is defined by EDT as a measure of the amount of wood within a reach. Dimensions of what constitutes LWD are defined here as pieces >0.1 m diameter and >2 m in length. Numbers and volumes of LWD corresponding to index levels are based on Peterson et al. (1992), May et al. (1997), Hyatt and Naiman (2001), and Collins et al. (2002).

Note: channel widths here refer to average wetted width during the high flow month (< bank full), consistent with the metric used to define high flow channel width. Ranges for index values are based on LWD pieces/CW and presence of jams (on larger channels). Reference to "large" pieces in index values uses the standard TFW definition as those > 50 cm diameter at midpoint.

EDT Categories:

Index 0	Index 1	Index 2	Index 3	Index 4
A complex mixture of single large pieces and accumulations consisting of all sizes, decay classes, and species origins; cross-channel jams are present where appropriate vegetation and channel conditions facilitate their existence; large wood pieces are a dominant influence on channel diversity (e.g., pools, gravel bars, and mid-channel islands) where channel gradient and flow allow such influences. Density of LWD (pieces per channel width CW) consistent with the following: channel width <25 ft -- 3-10 pieces/CW, 25-50 ft -- 3-10 pieces/CW, 50-150 ft -- 7-30 pieces/CW , 150-400 ft -- 20-50 pieces/CW in conjunction with large jams in areas where accumulations might occur, >400 ft -- 15-37 pieces/CW in conjunction with large jams in areas where accumulations might occur.	Complex array of large wood pieces but fewer cross channel bars and fewer pieces of sound large wood due to less recruitment than index level 1; influences of large wood and jams are a prevalent influence on channel morphology where channel gradient and flow allow such influences. Density of LWD (pieces per channel width CW) consistent with the following: channel width <25 ft -- 2-3 pieces/CW, 25-50 ft -- 2-4 pieces/CW, 50-150 ft -- 3-7 pieces/CW , 150-400 ft -- 10-20 pieces/CW (excluding large jams) in conjunction with large jams in areas where accumulations might occur, >400 ft -- 8-15 pieces/CW (excluding large jams) in conjunction with large jams in areas where accumulations might occur.	Few pieces of large wood and their lengths are reduced and decay classes older due to less recruitment than in index level 1; small debris jams poorly anchored in place; large wood habitat and channel features of large wood origin are uncommon where channel gradient and flow allow such influences. Density of LWD (pieces per channel width CW) consistent with the following: channel width <25 ft -- 1-2 pieces/CW, 25-50 ft -- 1-2 pieces/CW, 50-150 ft -- 1-3 pieces/CW , 150-400 ft -- 10-20 pieces/CW without large jams in areas where accumulations might occur, >400 ft -- 8-15 pieces/CW without large jams in areas where accumulations might occur.	Large pieces of wood rare and the natural function of wood pieces limited due to diminished quantities, sizes, decay classes and the capacity of the riparian streambank vegetation to retain pieces where channel gradient and flow allow such influences. Density of LWD (pieces per channel width CW) consistent with the following: channel width <25 ft -- 0.33-1 pieces/CW, 25-50 ft -- 0.33-1 pieces/CW, 50-150 ft -- 0.33-1 pieces/CW , 150-400 ft -- 3-10 pieces/CW without large jams in areas where accumulations might occur, >400 ft -- 2-8 pieces/CW without large jams in areas where accumulations might occur.	Pieces of LWD rare. Density of LWD (pieces per channel width CW) consistent with the following: channel width <25 ft -- <0.33 pieces/CW, 25-50 ft -- <0.33 pieces/CW, 50-150 ft -- <0.33 pieces/CW , 150-400 ft -- <3 pieces/CW with accumulations where they might occur, >400 ft -- <2 pieces/CW with no accumulations where they might occur.

Large woody debris can have a profound impact on streams, creating important habitat and cover for many fish species, trapping sediment, and providing food for invertebrates (Bilby and Bisson, 1998). While single logs can influence smaller streams, LWD must accumulate in jams to influence habitat in larger rivers (Montgomery and Buffington, 1998). LWD can armor banks, form pools, bars, and side channels (most often in combination with other processes), and can also foster channel avulsion or bank cutting in some cases (Montgomery and Buffington, 1998). LWD is also important in Montgomery and Buffington's channel reach morphology system, as LWD can force reaches into a type of habitat that would typically be expected on a steeper gradient (Montgomery and Buffington, 1998).

Measurement Techniques

The original EDT assessment proposed a qualitative description of the effect of LWD on stream morphology. It has subsequently been expanded to include a quantitative description of LWD density. The former description may be provided by aerial photo interpretation. The latter description requires a field survey, which may be executed concurrently with the other field surveys described in this document.

Aerial photo interpretation

LWD may be assessed by airphoto analysis (Johnston and Slaney 1996). LWD is evaluated in terms of its presence, extent, influence on channel morphology and diversity, and effect on cross channel jams. LWD pieces should be at least partially in the stream channel to be considered (USFS, 2001). "Functional LWD" is defined as those LWD pieces that are the primary cause of formation or geometry of a pool (Johnston and Slaney, 1996).

This assessment may be conducted at the same time as riparian function, at similar 250m or 500m intervals along the reach. At each measurement site (a cell consisting of the habitat area at the particular interval) evaluate the influence of woody debris on the environment. Note the appropriate environmental correlate for each measurement site. Characterize the entire reach by the most common correlate from all measurement sites along the reach. As with the aerial photo riparian function methodology, this methodology is only appropriate for large streams. Tributaries, streams covered by tree canopy, and streams without aerial photo coverage will require on-the-ground surveys.

Field survey

Field techniques utilize a tally of LWD pieces, a set of measurements of LWD pieces in the stream channel, or a combination of the two. The USFS (2001) suggests the following (also in Allen and Guenther 1996): record number of pieces of LWD within the bankfull channel for each habitat unit, providing the trunk or root swell (the area between roots and trunk) interacts with stream flow at bankfull conditions. In addition, LWD is counted in small streams only if the tree's length is greater than two times the bankfull width.

Bain and Stevenson (eds.) (1999) suggest measuring LWD at transects across the channel. For each transect section, count and measure diameter (to nearest cm) of all pieces of woody debris larger than 1 cm in diameter that intersect transect line. Record the number of wood pieces by diameter class (1-5, 6-10, 11-50, >51 cm) for each section. Sum number of pieces in each size class for all transect sections. Calculate length of all transect sections and average the number of pieces per section or length of transect. Platts et al. (1987) suggest that the amount of debris may be described as biomass (weight or volume), number of individual pieces, or percentage of stream area covered. For volume measure each end of LWD piece (d1 and d2) with calipers, and measure length with a meter stick or fiber tape (L). $V=[p(d1^2 + d2^2)L]/8$. Weight = volume x 0.5. This method is time consuming. A quicker method is to take counts of individual pieces or accumulations (divide into size of accumulation and position in the stream). A third method is to measure percentage area of stream affected Overton et al. (1997) suggests measuring the length and diameter of all individual pieces in the bankfull channel that meet both of the following criteria: length must be =3 m or > 2/3 wetted width of stream. Diameter must be 0.1 m 1/3 of the way up the base. Measure the percent of single pieces submerged. For aggregates, count, or estimate if counting is difficult. Measure with a stadia rod, or estimate. If estimation is used, occasionally check the estimate with a measurement.

Schuett-Hames et al. (1999) state that LWD logs, root wads, and jams must meet the following criteria:

<u>LWD log criteria:</u>
1. Dead
2. Root system (if present) no longer supports weight of stem/bole
3. Minimum diameter 10 cm along 2 m of length; and
4. Minimum 10 cm of length extending into bankfull channel

<u>Note</u>: Forked LWD are counted as 1 piece with diameter taken at midpoint.

LWD root wad criteria:
1. Dead
2. Root system detached from original position
3. Minimum diameter of 0.2 m with total length < 2 m and
4. Minimum 0.1 m of length extending into bankfull channel

LWD jam criteria:
1. Minimum 10 qualifying pieces of LWD either physically touching at 1+ points, or associated with jam structure
2. Minimum 0.l m of 1 LWD piece's length extending into bankfull channel

Schuett-Hames et al. (1999) also describe several survey procedures, including a: level 1 survey where one categorizes LWD by diameter and location, including a tally of key pieces; a more detailed level 2 survey; and a jam survey procedure.

EDT ATTRIBUTE VALUES FOR THE CLE ELUM AND EASTON REACHES

EDT Attribute	Cle Elum		Easton	
	Correlate Value	***Index Value***	***Correlate Value***	***Index Value***
Gradient	.28	1	.30	1
Confinement				
- Natural	0 %	0	2.68%	0
- Hydromod	22.44 %	2	17.58%	2
Channel Width				
- Maximum	185-247 ft.	3	103-123 ft.	3
- Minimum	129-159 ft.	3	89-93 ft.	2
Habitat Type				
- riffle (s. cobble)	1.98%	1		
- riffle (l. cobble)	8.97%	2		
- glide	84.55%	4		
- pool	1.25%	1		
- pool tailout	.36%	1		
Off-Channel Habitat				
- side channel	.02X	1		
- beaver pond	.007X	1		
Riparian Function		3		1
Large Woody Debris		3		3

APPENDIX A

RESULTS OF SLOPE GRADIENT ANALYSIS
FOR ALL EDT REACHES WITHIN THE YAKIMA RIVER BASIN

*Note, only those cells colored green have been field verified.

Appendix A1-Slope Gradient Analysis for WRIA 37

					Gradient/Slope Analysis		Cnannel Reach Form
WRIA NUMBER	STREAM NAME	WATERSHED	RNAME	DESCRIPTION	GRADIENT	% SLOPE	
37	Agency Cr	Toppenish	Agency Cr.-1	Mouth to Job Corps site (RM 0 to 6.3).	0.0142	1.4174	Pool-Riffle
37	Agency Cr	Toppenish	Agency Cr.-2	Job Corps site to impassible falls (RM 6.3 to 9.0)	0.0310	3.1040	Plane-Bed
37	Ahtanum Cr NF	Ahtanum	Ahtanum Cr. NF-1	Mouth to historical spring chinook access limit (RM 0 to	0.0165	1.6483	Plane-Bed
37	Ahtanum Cr NF	Ahtanum	Ahtanum Cr. NF-2	Spring chinook access limit to Nasty Cr. (Rm 2.0 to 5.3)	0.0192	1.9162	Plane-Bed
37	Ahtanum Cr NF	Ahtanum	Ahtanum Cr. NF-3	Nasty Cr. to Foundation Cr. (RM 5.3 to 10.2)	0.0199	1.9910	Plane-Bed
37	Ahtanum Cr NF	Ahtanum	Ahtanum Cr. NF-4	Foundation Cr. to MF Ahtanum Cr. (RM 10.2 to 11.6)	0.0267	2.6735	Plane-Bed
37	Ahtanum Cr NF	Ahtanum	Ahtanum Cr. NF-5	MF Ahtanum Cr. to McLain Canyon (RM 11.6 to 13.1)(upper	0.0351	3.5130	Plane-Bed
37	Ahtanum Cr NF	Ahtanum	Ahtanum Cr. NF-6	McLain Canyon to upper access limit for steelhead (RM 13	0.0397	3.9664	Plane-Bed
37	Ahtanum Cr SF	Ahtanum	Ahtanum Cr. SF-1	Mouth to historical spring chinook access limit (RM 0 to	0.0174	1.7379	Plane-Bed
37	Ahtanum Cr SF	Ahtanum	Ahtanum Cr. SF-2	Spring chinook access limit to coho/steelhead access lim	0.0282	2.8209	Plane-Bed
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-1	Mouth to Bachelor Cr. Return (RM 0 to 3.2)	0.0084	0.8357	Pool-Riffle
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-2	Bachelor return to Hatton return (RM 3.2 to 8.5)	0.0105	1.0472	Pool-Riffle
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-3	Hatton return to lower WIP diversion (RM 8.5 to 9.9)	0.0102	1.0234	Pool-Riffle
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-3A (Lower WIP Diversion Dam)	Lower WIP Diversion Dam (RM 9.9).			
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-4	Lower WIP Diversion Dam to American Fuit Rd. Bridge (RM	0.0094	0.9357	Pool-Riffle
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-5	American Fruit Rd. Bridge to Bachelor/Hatton Diversion (	0.0112	1.1193	Pool-Riffle
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-5A (Bachelor /Hatton Diversion	Bachelor/Hatton Diversion Dam (RM 18.9)			
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-6	Bachelor/Hatton Diversion to Upper WIP Diversion Dam (RM	0.0131	1.3102	Pool-Riffle
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-6A (Upper WIP Diversion Dam)	Upper WIP Diversion Dam (RM 19.6)			
37	Ahtanum Cr	Ahtanum	Ahtanum Cr.-7	Upper WIP Diversion Dam to confluence of NF and SF (RM 1	0.0130	1.3019	Pool-Riffle
37	Ahtanum Cr	Ahtanum	Bachelor Cr.-1	Bachelor Cr. Diversion at dam to diversion from Bachelor			
37	Bachelor Cr.	Ahtanum	Bachelor Cr.-2	Bachelor Cr. Re-entry point into Ahtanum (RM 0) to diver			
37	Bull Cr	Satus	Bull Cr.	Mouth to headwaters (RM 0 to 1.5).	0.0450	4.4989	Step-Pool
37	Corral Canyon	Lower Yakima Trib	Corral Canyon Cr.	Mouth to steelhead access limit (RM 0 to 4.15)	0.0279	2.7945	Plane-Bed
37	Dry Cr (Satus	Satus	Dry Cr. (Satus)-1	Mouth to Fortyday Cr. (Intermittent Zone) (RM 0 to 14.5)	0.0108	1.0845	Pool-Riffle
37	Dry Cr (Satus	Satus	Dry Cr. (Satus)-2	Fortyday to SF Dry Cr. (RM 14.5 to 28.5).	0.0152	1.5191	Pool-Riffle
37	Foundation Cr	Ahtanum	Foundation Cr.	Mouth to steelhead/coho access limit (RM 0 to 0.8)	0.0682	6.8220	Step-Pool
37	Hatton Cr.	Ahtanum	Hatton Cr.	Re-entry point into Ahtanum to diversion point from Bach	0.0105	1.0514	Pool-Riffle
37	Harrah Drain	Lower Yakima Trib	Harrah Drain	Mouth to Impassible RR Br. In Harrah (RM 0 to 5.3)			
37	Yakima R	Lower Yakima	Horn Dam	Horn Dam			
37	Kusshi Cr	Satus	Kusshi Cr.	Mouth to headwaters (RM 0 to 5).	0.0161	1.6118	Plane-Bed
37	Logy Cr	Satus	Logy Cr.	Mouth to falls (RM 0 to 14).	0.0175	1.7464	Plane-Bed
37	Marion Drain	Lower Yakima Trib	Marion Drain-1	Mouth to Gate Structure (RM 0 to 1.5).	0.0025	0.2463	Pool-Riffle
37	Marion Drain	Lower Yakima Trib	Marion Drain-2 (Gate Structure)	Gate Structure (RM 1.5).			
37	Marion Drain	Lower Yakima Trib	Marion Drain-3	Gate Structure to Wanity Slough (RM 1.5 to 5.0).	0.0001	0.0126	Pool-Riffle
37	Marion Drain	Lower Yakima Trib	Marion Drain-4	Wanity Slough to Harrah Drain (RM 5.0 to 17.8)	0.0010	0.1009	Pool-Riffle
37	MF Ahtanum Cr	Ahtanum	MF Ahtanum Cr.	Mouth to steelhead/coho access limit (RM 0 to 0.9)	0.0398	3.9787	Plane-Bed
37	Mule Dry Cr	Satus	Mule Dry Cr.	Mouth to limit of accessibiility (RM 0 to 17).	0.0126	1.2571	Pool-Riffle
37	Nasty Cr.	Ahtanum	Nasty Cr.	Mouth to steelhead/coho access limit (RM 0 to 3.7)	0.0553	5.5343	Step-Pool
37	Simcoe Cr NF	Toppenish	NF Simcoe Cr.	Mouth to access limit (RM 0 to 4).	0.0268	2.6764	Plane-Bed
37	Toppenish Cr	Toppenish	NF Toppenish Cr.-1	Mouth to Tie Rd. (RM 0 to 2.9)	0.0354	3.5392	Plane-Bed
37	Toppenish Cr	Toppenish	NF Toppenish Cr.-2	Tie Rd to impassible falls (RM 2.9 to 6.6)	0.0417	4.1687	Step-Pool
37	Satus Cr	Satus	Satus Cr.-1	Mouth to Mule Dry (RM 0 to 8.5).	0.0015	0.1455	Pool-Riffle
37	Satus Cr	Satus	Satus Cr.-2	Mule Dry Cr. to Dry Cr. (RM 8.5 to 18.7).	0.0041	0.4143	Pool-Riffle
37	Satus Cr	Satus	Satus Cr.-3	Dry Cr. to Logy Cr. (RM 18.7 to 23.6).	0.0059	0.5890	Pool-Riffle
37	Satus Cr	Satus	Satus Cr.-4	Logy Cr. to Bull Cr. (RM 23.6 to 36).	0.0102	1.0190	Pool-Riffle
37	Satus Cr	Satus	Satus Cr.-5	Bull Cr. to Kusshi Cr. (RM 36 to 37.2)	0.0159	1.5928	Plane-Bed/Bedrock
37	Satus Cr	Satus	Satus Cr.-6	Kusshi to Wilson Charlie Cr. (RM 37.2 to 39.3).	0.0191	1.9149	Pool-Riffle/Plane-Bed
37	Satus Cr	Satus	Satus Cr.-7	Wilson Charlie Cr. to Falls (RM 39.3 to 45.0).	0.0295	2.9469	Plane-Bed
37	Simcoe Cr SF	Toppenish	SF Simcoe Cr.	Mouth to acess limit (RM 0 to 4).	0.0276	2.7605	Plane-Bed
37	Toppensish Cr	Toppenish	SF Toppenish Cr.	Mouth to access limit (RM 0 to 1).	0.0587	5.8711	Step-Pool
37	Simcoe CR	Toppenish	Simcoe Cr.-1	Mouth to Stephenson Rd. (RM 0 to 5.9).	0.0023	0.2344	Pool-Riffle
37	Simcoe CR	Toppenish	Simcoe Cr.-2	Stephenson R. to Agency Cr. (RM 5.9 to 9.5)	0.0057	0.5741	Pool-Riffle
37	Simcoe CR	Toppenish	Simcoe Cr.-3	Agency Cr. to Wesley Rd. (RM 9.5 to 10.4)	0.0076	0.7622	Pool-Riffle

37	Simcoe CR	Toppenish	Simcoe Cr.-4	Wesley Rd. to Simcoe Feeder Canal Dam (RM 10.4 to 13.9)	0.0084	0.8426		Pool-Riffle
37	Simcoe CR	Toppenish	Simcoe Cr.-4A	Simcoe Feeder Canal (RM 13.0)				
37	Simcoe CR	Toppenish	Simcoe Cr.-5	Simcoe Feeder Canal to Wahtum Cr. (RM 13.9 to 14.4)	0.0090	0.8994		Pool-Riffle
37	Simcoe CR	Toppenish	Simcoe Cr.-6	Wahtum Cr. to forks (RM 14.4 to 19.9)	0.0164	1.6370		Plane-Bed
37	Spring Cr	Lower Yakima Trib	Snipes Cr.-1	Mouth to Spring Cr. (RM 0 to 0.2).	0.0191	1.9147		Plane-Bed
37	Spring Cr	Lower Yakima Trib	Snipes Cr.-2	Spring Cr. to Roza outfall flume (RM 0.2 to 3.6)	0.0201	2.0128		Plane-Bed
37	Spring Cr	Middle Yakima Tri	Spring Branch Cr.	Mouth to spring source (RM 0 to 1.5)	0.0065	0.6529		Pool-Riffle
37	Snipes Cr.	Lower Yakima Trib	Spring Cr.	Mouth to impassible culvert at Hess Rd. (RM 0 to 0.8)	0.0255	2.5450		Plane-Bed
37	Sulphur Cr.	Lower Yakima Trib	Sulphur Cr.	Mouth to Sheller R. culverts (RM 0 to 7.2)				
37	Toppenish Cr	Toppenish	Toppenish Cr.-1	Mouth to Tainer Gate Diversion and Juvenile Bypass (RM 0	0.0014	0.1418		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-10	NF Toppenish Cr. to SF Toppenish Cr. (RM 57.4 to 60.6)	0.0211	2.1127		Plane-Bed
37	Toppenish Cr	Toppenish	Toppenish Cr.-11	SF Toppenish Cr. to East Bank Access (RM 60.6 to 65.0)	0.0263	2.6325		Plane-Bed
37	Toppenish Cr	Toppenish	Toppenish Cr.-12	Toppenish Cr. East Bank Access to Panther Creek	0.0331	3.3064		Plane-Bed
37	Toppenish Cr	Toppenish	Toppenish Cr.-1A (Tainer Gate Diversion and	Tainer Gate Diversion and Juvenile Bypass)				
37	Toppenish Cr	Toppenish	Toppenish Cr.-2	Tainer Gate to Highway 97 Bridge (RM 3.4 to 10.7)	0.0004	0.0449		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-3	Highway 97 Bridge to Toppenish Unit II Pump Diversion (R	0.0008	0.0831		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-4	Unit II Pump Diversion to Mud Lake Drain (RM 26.5 to 31.	0.0005	0.0483		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-5	Mud Lake Drain to Simcoe Cr. (RM31.5 to 32.7)	0.0024	0.2430		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-6	Simcoe Cr. to Signal Point Rd. Bridge (RM 32.7 to 35.9)	0.0069	0.6931		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-7	Signal Point Rd. Bridge to Toppenish Lateral Canal (RM 3	0.0115	1.1481		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-7A	Toppenish Lateral Canal Diversion				
37	Toppenish Cr	Toppenish	Toppenish Cr.-8	Toppenish Lateral Canal to Willy Dick Canyon Cr. (RM 44.	0.0121	1.2134		Pool-Riffle
37	Toppenish Cr	Toppenish	Toppenish Cr.-9	Willy Dick Canyon Cr. to NF Toppenish Cr. (RM 49.6 to 57	0.0156	1.5581		Plane-Bed
37	Wahtum Cr.	Lower Yakima Trib	Wahtum Cr.	Mouth to access limit (RM 0 to 4.0)	0.0180	1.8035		Plane-Bed
37	Wanity Slough	Lower Yakima Trib	Wanity Slough	Mouth to impassible diversion at Lateral 3 (RM 0 to 14.5	0.0016	0.1575		Pool-Riffle
37	Wide Hollow C	Middle Yakima Tri	Wide Hollow Cr.-1	Mouth to Spring Branch Cr. at RM .25	-0.0005	-0.0466		Pool-Riffle
37	Wide Hollow C	Middle Yakima Tri	Wide Hollow Cr.-2	Spring Branch Cr. to Alaska steep-pass ladder at old mil	0.0029	0.2900		Pool-Riffle
37	Wide Hollow C	Middle Yakima Tri	Wide Hollow Cr.-3	Steep-pass ladder to 64th St. culvert (upstream limit fo	0.0049	0.4893		Pool-Riffle
37	Wide Hollow C	Middle Yakima Tri	Wide Hollow Cr.-4	64th St. culvert to Dazet Rd (upsteam limit for steelhea	0.0068	0.6767		Pool-Riffle
37	Willy Dick Ca	Toppenish	Willy Dick Canyon Cr.-1	Mouth to new culvert (RM 0 to 1,8)	0.0268	2.6793		Plane-Bed
37	Willy Dick Ca	Toppenish	Willy Dick Canyon Cr.-2	New culvert to forks (RM 1.8 to 2.6)	0.0236	2.3593		Plane-Bed
37	Willy Dick Ca	Toppenish	Willy Dick Canyon Cr.-3	Forks to steelhead access limit (RM 2.6 to 4.0)	0.0335	3.3461		Plane-Bed
37	Wilson Charli	Lower Yakima Trib	Wilson Charlie Cr.	Mouth to headwaters (RM 0 to 1.5).	0.0302	3.0215		Plane-Bed
37	Yakima R	Lower Yakima	Yakima R.-1A	Yakima Delta (RM 0 to 2.1).	0.0000	0.0000		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-1B	Delta to Horn Dam (RM 2.1 to 18).	0.0008	0.0843		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-1C	Horn Dam to Benton Bridge (RM 18 to 29.8).	0.0007	0.0732		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-1D	Benton Bridge to Corral Canyon Cr. (RM 29.8 to 33.5).	0.0012	0.1213		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-1D1	Corral Canyon Cr. to Prosser Powerplant Outfall (RM 33.5	0.0010	0.1041		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-1E	Chandler Powerplant Outfall to Spring Cr. (RM 35.8 to 41	0.0020	0.2011		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-2A	Spring Cr. to Prosser Dam (RM 41.8 to 47.1).	0.0027	0.2667		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-2B (Prosser Dam)	Prosser Dam (RM 47.1)				
37	Yakima R	Lower Yakima	Yakima R.-2C	Prosser Dam to Mabton (RM 47.1 to 55).	0.0001	0.0121		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-2C1	Mabton to Sulpur Cr. Wasteway (RM 55 to 61)	0.0003	0.0294		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-2D	Sulphur Cr. to Satus Cr. (RM 61 to 69.6).	0.0001	0.0095		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-3	Satus Cr. to Toppenish Cr. (RM 69.6 to 80.4).	0.0005	0.0478		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-4	Toppenish Cr. to Marion Drain (RM 80.4 to 82.6).	0.0005	0.0539		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-4A	Marion Drain to Granger Drain (RM 82.6 to 83.2)	0.0011	0.1070		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-5A	Granger Drain to Sunnyside Dam (RM 83.2 to 103.8).	0.0019	0.1885		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-5B (Sunnyside Dam)	Sunnyside Dam (RM 103.8).				
37	Yakima R	Lower Yakima	Yakima R.-5C	Sunnyside Dam to Wapato Dam (RM 103.8 to 106.6).	0.0020	0.1972		Pool-Riffle
37	Yakima R	Lower Yakima	Yakima R.-5D (Wapato Dam)	Wapato Dam (RM 106.6).				
37	Yakima R	Lower Yakima	Yakima R.-5E	Wapato Dam to Ahtanum Cr. (RM 106.6 to 106.9).	-0.0002	-0.0154		Pool-Riffle
37	Yakima R	Middle Yakima	Yakima R.-6	Ahtanum Cr. to Wide Hollow Cr. (RM 106.9 to 107.4)	0.0015	0.1542		Pool-Riffle
37	Yakima R	Middle Yakima	Yakima R.-6A	Wide Hollow Cr. to Roza Powerplant Outfall (RM 107.4 to	0.0029	0.2884		Pool-Riffle
37	Yakima R	Middle Yakima	Yakima R.-6B	Roza Powerplant Outfall to Naches R. (RM 113.3 to 116.3)	0.0030	0.3048		Pool-Riffle

Appendix A2-Slope Gradient Analysis for WRIA 38

38	American R	American	American R.-1	Mouth to Bumping Rd. Br. (RM 0 to 0.96)	0.0201	2.0065		Pool-Riffle/Step-Pool
38	American R	American	American R.-2	Bumping R. Br. to Hell's Crossing Br. (RM 0.96 to 5.4)	0.0169	1.6858		Pool-Riffle/Step-Pool
38	American R	American	American R.-3	Hells' Crossing to Miner Cr. (RM 5.4 to 8.7)	0.0032	0.3209		Pool-Riffle/Step-Pool
38	American R	American	American R.-3A	Miner Cr. to Kettle Cr. (RM 8.7 to 9.7)	0.0040	0.4028		Pool-Riffle/Step-Pool
38	American R	American	American R.-3B	Kettle Cr. to 4th Br. (RM 9.7 to 11.1)	0.0068	0.6817		Pool-Riffle/Step-Pool
38	American R	American	American R.-4	4th Br. to Union Cr. (RM 11.1 to 11.5)	0.0039	0.3886		Pool-Riffle/Step-Pool
38	American R	American	American R.-4A	Union Cr. to Lodgepole Campground (RM 11.5 to 12.4)	0.0080	0.7964		Pool-Riffle/Step-Pool
38	American R	American	American R.-5	Lodgepole Campground to Morse Cr. Footbridge (RM 12.4	0.0272	2.7230		Pool-Riffle/Step-Pool
38	American R	American	American R.-6	Morse Cr. Footbridge to Morse Cr. (RM 14.6 to 15.6)	0.0037	0.3666		
38	American R	American	American R.-6A	Morse Cr. to Rainier Fork (RM 15.6 to 16.9)	0.0060	0.6044		Pool-Riffle/Step-Pool
38	American R	American	American R.-6B	Rainier Fork to braided section with impassible cascade	0.0050	0.4962		Pool-Riffle
38	Bear Cr.	Naches Trib	Bear Cr. (Lit. Nac	Mouth to low-flow section (RM 0 to 0.5)	0.0123	1.2332		Pool-Riffle
38	Blowout Cr.	Naches Trib	Blowout Cr.	Mouth to impassible road crossing at RM 0.6	0.0181	1.8071		Step-Pool/Forced Step-Pool
38	Buckskin Slou	Naches Trib	Buckskin Slough	Mouth to upstream end at RM 5.5	0.0065	0.6516		Pool-Riffle
38	Bumping R	Naches Trib	Bumping R.-1	Mouth to American R. (RM 0 to 3.5).	0.0105	1.0548		Pool-Riffle
38	Bumping R	Naches Trib	Bumping R.-2a	American R. to dam (RM 3.5 to 17).	0.0107	1.0730		Pool-Riffle/Plane-Bed
38	Bumping R	Naches Trib	Bumping R.-2b(Bump	Bumping Dam				
38	Bumping R	Naches Trib	Bumping R.-3a (Bum	Bumping Lake, Dam to Deep Cr. mouth (RM 17 - 18.9)				
38	Bumping R	Naches Trib	Bumping R.-3b (Bum	Bumping Lake, Deep Cr. mouth to Bumping River lake int				
38	Bumping R	Naches Trib	Bumping R.-4	Bumping River lake inlet to Cougar Cr. (RM 21.1 to 22.	0.0264	2.6394		Plane-Bed/Step-Pool
38	Bumping R	Naches Trib	Bumping R.-5	Bumping River, Cougar Cr. to falls (RM 22.3 - 25.8)	0.0100	1.0034		Pool-Riffle
38	Clear Cr	Naches Trib	Clear Cr.	Mouth to falls. (RM 0 to 4). Stopped at fork for routi	0.0156	1.5602		Plane-Bed
38	Clear Cr	Naches Trib	Clear Cr.-2	Mouth to falls. (RM 0 to 4). (fork to falls)	0.1868	18.6824		Cascade
38	Clear Lake Da	Naches Trib	Clear Lake Dam	Clear Lake Dam				
38	Cougar Cr	Naches Trib	Cougar Cr.	Mouth to accessibility limit (RM 0 to 4).	0.0669	6.6924		Step-Pool
38	Cowiche Cr	Naches Trib	Cowiche Cr.	Mouth to forks (RM 0 to 7.5).	0.0108	1.0787		Pool-Riffle
38	Crow Cr.	Naches Trib	Crow Cr.	Mouth to impassible slide at Falls Cr. (RM 0 to 9.8)	0.0256	2.5638		Plane-Bed/Step-Pool
38	Deep Cr	Naches Trib	Deep Cr.	Mouth to impassible falls (RM 0 to 4.9).	0.0149	1.4886		Pool-Riffle/Forced Step-Pool
38	Hindoo Cr.	Naches Trib	Hindoo Cr.	Mouth to falls (RM 0 to 0.8)	0.0629	6.2943		Step-Pool
38	Indian Cr	Naches Trib	Indian Cr. (NF Tie	Mouth to impassible falls (RM 0 to 5.1).	0.0403	4.0259		Step-Pool
38	American R	American	Kettle Cr.	Mouth to impassibly steep section (RM 0 to 0.4)	0.0154	1.5400		Plane-Bed
38	Little Naches	Naches Trib	Little Naches Fall	Little Naches Falls (RM 4.5).				
38	Little Naches	Naches Trib	Little Naches R.-1	Mouth to Crow Cr. (RM 0 to 3.2).	0.0094	0.9357		Pool-Riffle
38	Little Naches	Naches Trib	Little Naches R.-2	Crow Cr. to Quartz Cr. (RM 3.2 to 3.4).	0.0117	1.1702		Pool-Riffle
38	Little Naches	Naches Trib	Little Naches R.-3	Quartz Cr. to Little Naches Falls (RM 3.4 to 4.5).	0.0103	1.0333		Pool-Riffle
38	Little Naches	Naches Trib	Little Naches R.-4	Little Naches Falls to Matthew Cr. (RM 4.5 to 9.5)	0.0101	1.0130		Pool-Riffle
38	Little Naches	Naches Trib	Little Naches R.-5	Matthew Cr. to SF Little Naches R. (RM 9.5 to 9.9).	0.0066	0.6561		Pool-Riffle
38	Little Naches	Naches Trib	Little Naches R.-6	SF L. Naches to Bear Cr. (RM 9.9 to 10.9)	0.0086	0.8625		Pool-Riffle
38	Little Naches	Naches Trib	Little Naches R.-7	Bear Cr. to MF/NF Confluences Little Naches R. (RM 10.	0.0095	0.9522		Pool-Riffle
38	Little Rattle	Naches Trib	Little Rattlesnake	Mouth to steelhead access limit (RM 0 to 7.6)	0.0393	3.9347		Plane-Bed/Step-Pool
38	Matthew Cr.	Naches Trib	Matthew Cr.	Mouth to steep, low-flow section (RM 0 to 3.5)	0.0666	6.6614		Step-Pool
38	Little Naches	Naches Trib	MF Little Naches R	Mouth to impassible falls (RM 0 to 2.5).	0.0364	3.6404		Step-Pool/Forced Step-Pool
38	American R	American	Miner Cr.	Mouth to impassibly steep section (RM 0 to 0.5)	0.0541	5.4067		Step-Pool
38	American R	American	Morse Cr.	Mouth to impassibly steep section (RM 0 to 0.3)	0.0232	2.3195		Plane-Bed
38	Naches R	Naches	Naches R.-1	Mouth to Cowiche Cr. (RM 0 to 2.7)	0.0040	0.4050		Pool-Riffle

38	Naches R	Naches	Naches R.-1a	Cowiche Cr. to Buckskin Slough (RM 2.7 to 3.3)	0.0056	0.5573		Pool-Riffle
38	Naches R	Naches	Naches R.-1b	Buckskin Slough to S Naches Channel return (RM 3.3 to	0.0055	0.5478		Pool-Riffle
38	Naches R	Naches	Naches R.-1c	S Naches Channel return to S Naches Channel diversion	0.0056	0.5588		Pool-Riffle
38	Naches R	Naches	Naches R.-2A	S Naches Channel diversion to Wapatox Dam (RM 14.0 to	0.0057	0.5699		Pool-Riffle
38	Naches R	Naches	Naches R.-2B (Wapa	Wapatox Dam (RM 17.1).				
38	Naches R	Naches	Naches R.-2C	Wapatox Dam to Tieton (RM 17.1 to 17.5).	0.0066	0.6633		Pool-Riffle
38	Naches R	Naches	Naches R.-3	Tieton R. to Rattlesnake Cr. (RM 17.5 to 27.8)	0.0070	0.6958		Plane-Bed
38	Naches R	Naches	Naches R.-4	Rattlesnake Cr. to Nile Cr. (RM 27.8 to 29.4).	0.0075	0.7538		Plane-Bed
38	Naches R	Naches	Naches R.-5	Nile Cr. to Little Naches/Bumping R. (RM 29.4 to 44.6)	0.0062	0.6167		Plane-Bed
38	NF Cowiche Cr	Naches Trib	NF Cowiche Cr.	Mouth to forested area (RM 0 to 3.3)	0.0106	1.0628		Pool-Riffle
38	Little Naches	Naches Trib	NF Little Naches R	Mouth to Blowout Cr. (RM 0 to 0.6)	0.0047	0.4702		Pool-Riffle
38	Little Naches	Naches Trib	NF Little Naches R	Blowout Cr. to steep gradient section (RM 0.6 to 2.3)	0.0095	0.9513		Pool-Riffle
38	Little Naches	Naches Trib	NF Little Naches R	Beginning of steep gradient section to Pyramid Cr. (RM	0.0136	1.3563		Pool-Riffle
38	NF Rattlesnak	Naches Trib	NF Rattlesnake Cr.	Mouth to impassible falls (RM 0 to 3.0)	0.0399	3.9870		Plane-Bed
38	Tieton R NF	Naches Trib	NF Tieton R.-1	Mouth to Indian Cr. -- currently inundated by Rimrock				
38	Tieton R NF	Naches Trib	NF Tieton R.-2	Indian Cr. to inundation limit by Rimrock Reservoir (R				
38	Tieton R NF	Naches Trib	NF Tieton R.-3	Inundation point to Clear Cr. (RM 6.5 to 7.2)	0.0113	1.1328		Pool-Riffle
38	Tieton R NF	Naches Trib	NF Tieton R.-4	Clear Cr. to Clear Lake Dam (RM 7.2 to 7.3)	0.0006	0.0590		Pool-Riffle
38	Tieton R NF	Naches Trib	NF Tieton R.-5	Clear Lake Dam to toe of alluvial fan (RM 7.3 to 17.4)	0.0078	0.7808		Pool-Riffle
38	Nile Cr.	Naches Trib	Nile Cr.	Mouth to falls (RM 0 to 9.4).	0.0259	2.5883		Plane-Bed/Step-Pool
38	Oak Cr.	Naches Trib	Oak Cr.	Mouth to steep, low-flow section (RM 0 to 3.2)	0.0326	3.2630		Plane-Bed
38	Quartz Cr.	Naches Trib	Quartz Cr.	Mouth to steep, low-flow section (RM 0 to 3.7)	0.0380	3.7978		Step-Pool
38	American R	American	Rainier Fork	Mouth to impassible falls (RM 0 to 2.0)	0.0295	2.9465		Plane-Bed
38	Rattlesnake C	Naches Trib	Rattlesnake Cr.-1	Mouth to Little Rattlesnake Cr. (RM 0 to 1.1).	0.0152	1.5178		Pool-Riffle
38	Rattlesnake C	Naches Trib	Rattlesnake Cr.-2	Little Rattlesnake to North Fork (RM 1.1 to 7.7).	0.0161	1.6085		Pool-Riffle
38	Rattlesnake C	Naches Trib	Rattlesnake Cr.-3	North Fork to Hindoo (RM 7.7 to 13.2)	0.0178	1.7773		Pool-Riffle
38	Rattlesnake C	Naches Trib	Rattlesnake Cr.-4	Hindoo Cr. to uppermost observed spring chinook spawni	0.0168	1.6765		Pool-Riffle
38	Rattlesnake C	Naches Trib	Rattlesnake Cr.-5	Uppermost chinook site to Little Wildcat Cr. (RM 17.5	0.0228	2.2793		Plane-Bed
38	Reynold's Cr.	Naches Trib	Reynold's Cr.	Mouth to steep, intermittant section (RM 0 to 5)	0.0372	3.7204		Plane-Bed
38	Rimrock Dam	Naches Trib	Rimrock Dam	Rimrock Dam				
38	S Naches Chan	Naches	S Naches Channel	Diversion to re-entry point (RM 0 to 4.2)	0.0059	0.5903		Pool-Riffle
38	Cowiche Cr SF	Naches Trib	SF Cowiche Cr.-1	Mouth to Reynold's Cr. (RM 0 to 11.8)	0.0156	1.5623		Plane-Bed
38	Cowiche Cr SF	Naches Trib	SF Cowiche Cr.-2	Reynold's Cr. to confluence of Unnamed RB trib @ RM 17	0.0309	3.0945		Plane-Bed
38	Little Naches	Naches Trib	SF Little Naches R	Mouth to unnamed RB trib and low-flow section (RM 0 to	0.0241	2.4098		Step-Pool/Forced Step-Pool
38	Little Naches	Naches Trib	SF Little Naches R	Unnamed RB trib to impassible falls (RM 1.8 to 4.0)	0.0375	3.7461		Step-Pool
38	Tieton R SF	Naches Trib	SF Tieton R.-1	Original mouth to limit of inundation by Rimrock Reser				
38	Tieton R SF	Naches Trib	SF Tieton R.-2	Inundation point to impassible falls (RM 1.6 to 14.0)	0.0139	1.3902		Pool-Riffle
38	Tieton R	Naches Trib	Tieton R.-1	Mouth to Oak Cr. (RM 0 to 1.8)	0.0091	0.9082		Pool-Riffle
38	Tieton R	Naches Trib	Tieton R.-2	Oak Cr. to Yakima/Tieton Diversion Dam (RM 1.8 to 14.2	0.0092	0.9218		Pool-Riffle
38	Tieton R	Naches Trib	Tieton R.-3	Yakima/Tieton Diversion Dam to Wildcat Cr. (RM 14.2 to	0.0119	1.1907		Pool-Riffle
38	Tieton R	Naches Trib	Tieton R.-4	Wildcat Cr. to Rimrock Dam (RM 20.7 to 21.3)	0.0587	5.8691		Step-Pool
38	Tieton R	Naches Trib	Tieton R.-5	Rimrock Dam to pre-inundation confluence of NF and SF				
38	American R	American	Union Cr.	Mouth to impassible falls (RM 0 to 1.0)	0.0528	5.2758		Step-Pool
38	Wildcat Cr.	Naches Trib	Wildcat Cr.	Mouth to impassibly steep section (RM 0 to 1.7)	0.0821	8.2069		Cascade
38	Yakima/Tieton	Naches Trib	Yakima/Tieton Dive	Yakima/Tieton Diversion Dam				

Appendix A3-Slope Gradient Analysis for WRIA 39

39	Badger Cr	Upper Yakima Tribs	Badger Cr.-1	Mouth to Impassible irrigation diversion (RM 0 to 0.7)	0.0072	0.7194		Pool-Riffle
39	Badger Cr	Upper Yakima Tribs	Badger Cr.-2	Passage barrier to Highline Canal (RM 0.7 to 10.2)	0.0085	0.8484		Pool-Riffle
39	Badger Cr	Upper Yakima Tribs	Badger Cr.-3	Highline Canal to steep, intermittant section (RM 10.2 to 10.	0.0123	1.2332		Pool-Riffle
39	Bear Cr.(TWay	Teanaway	Bear Cr.(TWay)-1	Mouth to small falls (spring chinook access limit)(RM 0 to 0.5)	0.0264	2.6432		Plane-Bed
39	Bear Cr.(TWay	Teanaway	Bear Cr.(TWay)-2	Mouth to steelhead access limit (RM 0.5 to 2.0)	0.0370	3.7014		Plane-Bed
39	Beverly Cr.	Teanaway	Beverly Cr.	Mouth to steelhead access limit (RM 0 to 1.0)	0.0888	8.8780		Cascade
39	Big Cr	Upper Yakima Tribs	Big Cr.-1	Mouth to impassible diversion dam (RM 0 to 2.1).	0.0143	1.4317		Pool-Riffle
39	Big Cr	Upper Yakima Tribs	Big Cr.-2	Diversion dam to estimated spring chinook access limit (RM 2.1 to 4.8)	0.0167	1.6742		Plane-Bed
39	Big Cr	Upper Yakima Tribs	Big Cr.-3	Spring chinook access limit to Greek Cr. (RM 4.8 to 7.5)	0.0261	2.6075		Plane-Bed
39	Big Cr	Upper Yakima Tribs	Big Cr.-4	Greek Cr. to steelhead access limit (RM 7.5 to 10)	0.0357	3.5654		Plane-Bed
39	Box Canyon Cr	Upper Yakima Tribs	Box Canyon Cr.	Mouth to forks (RM 0 to 1.4).	0.0207	2.0683		Plane-Bed
39	Wilson Cr	Upper Yakima Tribs	Bull Ditch	Bull Ditch from Yakima take-off to Wilson Cr. Outlet	0.0028	0.2794		Pool-Riffle
39	Cabin Cr	Upper Yakima Tribs	Cabin Cr.	Mouth to falls (RM 0 to 3.3).	0.0244	2.4350		Plane-Bed
39	Caribou Cr	Upper Yakima Tribs	Caribou Cr.-1	Mouth to Highline Canal (RM 0 to 10.0)	0.0119	1.1892		Pool-Riffle
39	Caribou Cr	Upper Yakima Tribs	Caribou Cr.-2	Highline Canal to steep, intermittant section (RM 10 to 17.9)	0.0381	3.8105		Plane-Bed
39	Cherry Cr	Upper Yakima Tribs	Cherry Cr.-1	Mouth to Badger Cr. (RM 0 to 0.3)	0.0003	0.0301		Pool-Riffle
39	Cherry Cr	Upper Yakima Tribs	Cherry Cr.-2	Badger Cr. to impassible irrigation diversion (RM 0.3 to 1.3)	0.0046	0.4572		Pool-Riffle
39	Cherry Cr	Upper Yakima Tribs	Cherry Cr.-3	Passage barrier to Cooke Cr. (RM 1.3 to 1.6)	0.0039	0.3893		Pool-Riffle
39	Cherry Cr	Upper Yakima Tribs	Cherry Cr.-4	Cooke Cr. to Caribou/Park confluence (RM 1.6 to 2.7)	0.0038	0.3764		Pool-Riffle
39	ClarkFlatAccl	Upper Yakima Tribs	ClarkFlatHatchery	Taneum Cr. to Swauk Cr. (RM 166.1 to 169.9).	0.0061	0.6092		Pool-Riffle
39	Cle Elum R	Upper Yakima Tribs	Cle Elum R.-1	Mouth to dam (RM 0 to 8.2).	0.0072	0.7209		Pool-Riffle
39	Cle Elum R	Upper Yakima Tribs	Cle Elum R.-2A (Cle Elum Dam)	Cle Elum Dam				
39	Cle Elum R	Upper Yakima Tribs	Cle Elum R.-2B (Lake Cle Elum)	Dam to Cle Elum R. confluence (RM 8.2 to 15.9).				
39	Cle Elum R	Upper Yakima Tribs	Cle Elum R.-3	Lake inlet to Cooper R. (RM 15.9 to 19.2).	0.0060	0.6016		Pool-Riffle
39	Cle Elum R	Upper Yakima Tribs	Cle Elum R.-4	Cooper R. to Waptus R. (RM 19.2 to 21.5).	0.0135	1.3513		Pool-Riffle
39	Cle Elum R	Upper Yakima Tribs	Cle Elum R.-5	Waptus R. to headwaters (RM 21.5 to 34.2).	0.0138	1.3767		Pool-Riffle
39	Coleman Cr	Upper Yakima Tribs	Coleman Cr.-1	Mouth to impassible irrigation diversion (RM 0 to 0.5)	0.0054	0.5385		Pool-Riffle
39	Coleman Cr	Upper Yakima Tribs	Coleman Cr.-2	Passage barrier to Highline Canal (RM 0.5 to 10.3)	0.0113	1.1317		Pool-Riffle
39	Coleman Cr	Upper Yakima Tribs	Coleman Cr.-3	Highline Canal to Coleman Falls (RM 10.3 to 16.7)	0.0294	2.9353		Plane-Bed
39	Cooke Cr	Upper Yakima Tribs	Cooke Cr.-1	Mouth to Highline Canal (RM 0 to 10.4)	0.0128	1.2808		Pool-Riffle
39	Cooke Cr	Upper Yakima Tribs	Cooke Cr.-2	Highline Canal to steep, intermittant section (RM 10.4 to 19.	0.0374	3.7372		Plane-Bed
39	Cooper R	Upper Yakima Tribs	Cooper R.	Mouth to impassible falls (RM 0 to 3.2).	0.0216	2.1613		Plane-Bed
39	Currier Cr.	Upper Yakima Tribs	Currier Cr.	Mouth to steep, intermittant scetion (RM 0 to 8.1)	0.0135	1.3497		Pool-Riffle
39	Dickey Cr.	Teanaway	Dickey Cr.	Mouth to steelhead access limit (RM 0 to 1.0)	0.0315	3.1520		Plane-Bed
39	East Branch Wilson Cr	Upper Yakima Tribs	East Branch Wilson Cr.-1	Mouth to impassible irrigation barrier (RM 0 to 1.1)	0.0072	0.7156		Pool-Riffle
39	East Branch Wilson Cr	Upper Yakima Tribs	East Branch Wilson Cr.-2	Passage barrier to point of diversion from Wilson Cr. (RM 1.1	0.0111	1.1066		Pool-Riffle
39	EastonAcclima	Upper Yakima	EastonHatchery	Easton Hatchery without enhancement				
39	Gold Cr	Upper Yakima Tribs	Gold Cr.	Mouth to steep, intermittant section (RM 0 to 4.3).	0.0134	1.3450		Plane-Bed
39	Greek Cr.	Upper Yakima Tribs	Greek Cr.	Mouth to steelhead access limit (RM 0 to 1.5)	0.0845	8.4504		Cascade
39	Indian Cr. (T	Teanaway	Indian Cr. (Teanaway)	Mouth to steelhead access limit (RM 0 2.8)	0.0292	2.9195		Plane-Bed
39	Iron Cr.	Upper Yakima Tribs	Iron Cr.	Mouth sto steelhead access limit (RM 0 to 2.0)	0.0559	5.5907		Plane-Bed/Step-Pool
39	Jack Cr.	Teanaway	Jack Cr.	Mouth to ateelhead access limit (RM 0 to 2.1)	0.0193	1.9336		Plane-Bed
39	Johnson Cr.	Teanaway	Johnson Cr.	Mouth to steelhead access limit (RM 0 to 1.0)	0.0419	4.1871		Step-Pool/Forced Step-Pool
39	Jungle Cr.	Teanaway	Jungle Cr.	Mouth to ateelhead access limit (RM 0 to 1.0)	0.0241	2.4116		Plane-Bed
39	Kachess R	Upper Yakima Tribs	Kachess R.-1	Mouth to Kachess Dam (RM 0 to 1).	0.0080	0.7993		Pool-Riffle
39	Kachess R	Upper Yakima Tribs	Kachess R.-2A (Kachess Dam)	Kachess Dam				
39	Kachess R	Upper Yakima Tribs	Kachess R.-2B (Kachess Lake first reach)	Dam to Box Canyon Cr. (RM 1 to 7.9).	0.0000	0.0001		Pool-Riffle
39	Kachess R	Upper Yakima Tribs	Kachess R.-3 (Kachess Lake second reach)	Box Canyon to Kachess R. (RM 7.9 to 11.1)	0.0002	0.0159		Pool-Riffle
39	Kachess R	Upper Yakima Tribs	Kachess R.-4	Lake confluence to falls (RM 11.1 to 11.6).	0.0196	1.9621		Plane-Bed
39	Lick Cr.	Teanaway	Lick Cr.	Mouth to steelhead access limit (RM 0 to 1.5)	0.0108	1.0795		Pool-Riffle
39	Little Cr	Upper Yakima Tribs	Little Cr.-1	Mouth to passge/flow problems associated with subdivision (RM 0 to 0.9)	0.0118	1.1773		Pool-Riffle
39	Little Cr	Upper Yakima Tribs	Little Cr.-2	Subdivion to steep gradient (access limit spring chinook)(RM 0.9 to 3.6	0.0212	2.1200		Plane-Bed
39	Little Cr	Upper Yakima Tribs	Little Cr.-3	Steep gradient section to estimated steelhead access limit (RM 3.6 to 5	0.0374	3.7430		Plane-Bed
39	Little Naneum	Upper Yakima Tribs	Little Naneum Cr.	Mouth to diversion point out of Lower Naneum Cr. (RM 0 to 4.5)				
39	Lower Naneum	Upper Yakima Tribs	Lower Naneum Cr.-1	Mouth to Little Naneum Cr. inflow (RM 0 to 0.7)	0.0022	0.2245		Pool-Riffle
39	Lower Naneum	Upper Yakima Tribs	Lower Naneum Cr.-2	Little Naneum Cr. to Coleman Cr. (RM 0.7 to 1.1)	0.0064	0.6370		Pool-Riffle
39	Lower Naneum	Upper Yakima Tribs	Lower Naneum Cr.-3	Coleman Cr. to impassible irrigation diversion (RM 1.1 to 1.9)	0.0044	0.4422		Pool-Riffle
39	Lower Naneum	Upper Yakima Tribs	Lower Naneum Cr.-4	Passage barrier to diversion into Little Naneum Cr. (RM 1.9 to 4.5)	0.0079	0.7870		Pool-Riffle
39	Lower Naneum	Upper Yakima Tribs	Lower Naneum Cr.-5	Little Naneum diversion to Highline Canal (RM 4.5 to 11.1)	0.0140	1.3975		Pool-Riffle
39	Lower Naneum	Upper Yakima Tribs	Lower Naneum Cr.-6	Highline Canal to diversion point from Wilson Cr. (RM 11.1 to 13.2)	0.0182	1.8196		Plane-Bed

39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-1	Mouth to dewatered Barnes Rd. Diversion Dam (RM 0 to 1.4)	0.0163	1.6259		Plane-Bed
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-10	Manastash Diversion Dam to forks (RM 5.7 to 8.5)	0.0188	1.8758		Pool-Riffle/Plane-Bed
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-1A	Barnes R. Diversion Dam (RM 1.4)				
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-2	Barnes R. Diversion Dam to Westside Canal inflow (RM 1.4 to 1	0.0182	1.8187		
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-3	Westside Canal inflow to old Anderson Diversion Dam (RM 1.7 t	0.0149	1.4946		Pool-Riffle
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-3A	Old Anderson Diversion Dam (RM 3.0)				
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-4	Old Anderson Diversion to new Anderson Diversion (RM 3.0 to 3	0.0177	1.7692		Plane-Bed
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-5	New Anderson Diversion to Reed Diversion Dam (RM 3.4 to 4.9)	0.0184	1.8404		Plane-Bed
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-5A	Reed Diversion Dam (RM 4.9)				
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-6	Reed Diversion Dam to Hadfield Diversion Dam (RM 4.9 to 5.3)	0.0177	1.7684		Plane-Bed
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-6A	Hadifeld Diversion Dam (RM 5.3)				
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-7	Hadfield Diversion Dam to KRD siphon and inflow (RM 5.3 to 5.	0.0314	3.1405		Plane-Bed
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-8	KRD siphon/inflow to Keach/Jenson Diversion Dam (RM 5.4 to 5.	0.0293	2.9307		Plane-Bed
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-8A	Keach/Jenson Diversion Dam (RM 5.5)				
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-9	Keach/Jenson Diversion Dam to Manastash Ditch Diversion Dam (	0.0096	0.9634		Pool-Riffle
39	Manastash Cr	Upper Yakima Tribs	Manastash Cr.-9A	Manastash Ditch Diversion Dam (RM 5.7)				
39	Mercer Cr	Upper Yakima Tribs	Mercer Cr.-1	Mouth of Mercer Cr. to mouth of Whisky Cr. (RM 0 to 0.8)	0.0031	0.3091		Pool-Riffle
39	Mercer Cr	Upper Yakima Tribs	Mercer Cr.-2	Whisky Cr. to impassible irrigation diversion (RM 0.8 to 1.1)	0.0131	1.3064		Pool-Riffle
39	Mercer Cr	Upper Yakima Tribs	Mercer Cr.-3	Passage barrier to point of diversion from Wilson Cr. (RM 1.1	0.0098	0.9801		Pool-Riffle
39	Teanaway R MF	Teanaway	MF Teanaway R.-1	Mouth to spring chinook acces limit (RM 0 to 2.45)	0.0148	1.4838		Pool-Riffle
39	Teanaway R MF	Teanaway	MF Teanaway R.-2	Spring chinook access limit to Jolly Cr. (Steelhead access li	0.0228	2.2826		Plane-Bed
39	Middle Cr.	Teanaway	Middle Cr.	Mouth to steelhead access limit (RM 0 to 1.4	0.0349	3.4931		Step-Pool
39	Manastash Cr	Upper Yakima Tribs	NF Manastash Cr.	Mouth to Forest Service Boundary (RM 0 to 10.4).	0.0302	3.0179		Plane-Bed
39	Taneum Cr NF	Upper Yakima Tribs	NF Taneum Cr.	Mouth to impassibly steep gradient above Fishhook Flats (RM 0	0.0223	2.2286		Pool-Riffle/Plane-Bed
39	Teanaway R NF	Teanaway	NF Teanaway R.-1	Mouth to Lick Cr. (RM 0 to 1.5).	0.0097	0.9662		Pool-Riffle
39	Teanaway R NF	Teanaway	NF Teanaway R.-2	Lick Cr. to Dickey Cr. (RM 1.5 to 1.8)	0.0105	1.0453		Pool-Riffle
39	Teanaway R NF	Teanaway	NF Teanaway R.-3	Dickey Cr. to Middle Cr. (RM 1.8 to 3.9)	0.0036	0.3630		Pool-Riffle
39	Teanaway R NF	Teanaway	NF Teanaway R.-4	Middle Cr. to Indian Cr. (RM 3.9 to 4.3)	0.0138	1.3817		Pool-Riffle
39	Teanaway R NF	Teanaway	NF Teanaway R.-5	Indian Cr. to Jack Cr. (RM 4.3 to 5.9)	0.0132	1.3249		Pool-Riffle
39	Teanaway R NF	Teanaway	NF Teanaway R.-6	Jack Cr. to Jungle Cr. (RM 5.9 to 7.1)	0.0110	1.1037		Pool-Riffle
39	Teanaway R NF	Teanaway	NF Teanaway R.-7	Jungle Cr. to Stafford Cr.(RM 7.1 to 8.3)	0.0160	1.6046		Pool-Riffle/Plane-Bed
39	NF Teanaway R	Teanaway	NF Teanaway R.-7A	Stafford Cr. to Beverly Cr. (RM 8.3 to 10.8; limit of spring	0.0229	2.2877		Plane-Bed/Step-Pool
39	Teanaway R NF	Teanaway	NF Teanaway R.-8	Beverly Cr. to Johnson Cr. (RM 10.8 to 11.6)	0.0275	2.7471		Plane-Bed/Step-Pool
39	Teanaway R NF	Teanaway	NF Teanaway R.-9	Johnson Cr. to DeRoux Cr. (NF Teanaway steelhead access limit	0.0281	2.8114		Plane-Bed/Step-Pool
39	Wenas Cr NF	Middle Yakima Trib	NF Wenas Cr.	Mouth to impassible falls (RM 0 to 8).	0.0408	4.0799		Step-Pool
39	Park Cr	Upper Yakima Tribs	Park Cr.-1	Mouth to Highline Canal (RM 0 to 9.2)	0.0110	1.0968		Pool-Riffle
39	Park Cr	Upper Yakima Tribs	Park Cr.-2	Highline Canal to steep, intermittant section (RM 9.2 to 12.2	0.0224	2.2424		Plane-Bed
39	Reecer Cr.	Upper Yakima Tribs	Reecer Cr.-1	Mouth to Currier Cr. (RM 0 to 1.7)	0.0019	0.1855		Pool-Riffle
39	Reecer Cr.	Upper Yakima Tribs	Reecer Cr.-2	Currier Cr. to steep, intermittant section (RM 1.7 to 9.8)	0.0136	1.3602		Pool-Riffle
39	Manastash Cr	Upper Yakima Tribs	SF Manastash Cr.-1	Mouth to end of Manastash Canyon (RM 0 to 9).	0.0260	2.6049		Plane-Bed/Step-Pool
39	Manastash Cr	Upper Yakima Tribs	SF Manastash Cr.-2	Canyon entrance to steep, low-flow section upstream of Herefo	0.0339	3.3868		Plane-Bed/Step-Pool
39	Taneum Cr SF	Upper Yakima Tribs	SF Taneum Cr.	Mouth to Case Knife Cr. (estimated steelhead access limit) (R	0.0268	2.6758		Plane-Bed/Step-Pool
39	SF Wenas Cr.	Middle Yakima Trib	SF Wenas Cr.	Mouth to estimated historical access limit (RM 0 to 3)	0.0293	2.9262		Plane-Bed
39	Stafford Cr	Teanaway	Stafford Cr.-1	Mouth to Standup Cr. (RM 0 tp 1.0)	0.0187	1.8747		Plane-Bed
39	Stafford Cr	Teanaway	Stafford Cr.-2	Standup Cr. to Bear Cr. (RM 1 to 6)	0.0269	2.6871		Plane-Bed/Step-Pool
39	Stafford Cr	Teanaway	Stafford Cr.-3	Bear Cr. to impassibly steep section (steelhead access limit)	-0.0163	-1.6349		Step-Pool/Forced Step-Pool
39	Standup Cr.-1	Teanaway	Standup Cr.-1	Mouth to gradient break (spring chinook access limit)(RM 0 to	0.0589	5.8863		Step-Pool
39	Standup Cr.-1	Teanaway	Standup Cr.-2	Mouth to steelhead access limit (RM 0.5 to 2.0)	0.0710	7.0981		Step-Pool
39	Swauk Cr	Upper Yakima Tribs	Swauk Cr.-1	Mouth to Williams Cr. (RM 0 to 11.0).	0.0116	1.1588		Pool-Riffle
39	Swauk Cr	Upper Yakima Tribs	Swauk Cr.-2	Willimas Cr. to Iron Cr. (Steelhead access limit)(RM 11.0 to	0.0168	1.6770		Plane-Bed/Step-Pool
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-1	Mouth to Bruton Diversion Dam (RM 0 to 1.6).	0.0193	1.9282		Pool-Riffle/Plane-Bed
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-1A	Bruton Diversion Dam (RM 1.6)				
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-2	Bruton Diversion Dam to Taneum Ditch Diversion Dam (RM 1.6 to	0.0119	1.1918		Pool-Riffle/Plane-Bed
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-2A	Taneum Ditch Diversion Dam (RM 2.4)				
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-3	Taneum Ditch Diversion Dam to KRD inflow (RM 2.4 to 2.6)	0.0299	2.9914		Plane-Bed

39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-4	KRD inflow to Knudsen Diversion Dam (RM 2.6 to 3.5)	0.0129	1.2892		Pool-Riffle/Plane-Bed
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-4A	Knudsen Diversion Dam (RM 3.5)				
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-5	Knudsen Diversion Dam to Taneum C.G. and beginning of confine	0.0146	1.4579		Pool-Riffle/Step-Pool
39	Taneum Cr	Upper Yakima Tribs	Taneum Cr.-6	Taneum C.G. to forks (RM 8.2 to 12.7)	0.0176	1.7619		Pool-Riffle/Step-Pool
39	Teanaway R	Teanaway	Teanaway R.-1	Mouth to NF Teanaway R. (RM 0 to 10.6).	0.0065	0.6483		Pool-Riffle
39	Teanaway R	Teanaway	Teanaway R.-2	NF to MF/WF (RM 10.6 to 11.7).	0.0070	0.7031		Pool-Riffle
39	TeanawayAccli	Teanaway	TeanawayHatchery	Acclimation Site in this reach: NF T'way, Jack Cr. to Staffor				
39	Tucker Cr.	Upper Yakima Tribs	Tucker Cr.-1	Mouth to impassible KRD siphon (RM 0 to 0.9)	0.0149	1.4924		Pool-Riffle
39	Tucker Cr.	Upper Yakima Tribs	Tucker Cr.-2	KRD siphon to access limit (RM 0.9 to 2.4)	0.0310	3.1031		Plane-Bed
39	Umtanum Cr	Upper Yakima Tribs	Umtanum Cr.	Mouth to headwaters (RM 0 to 8).	0.0246	2.4575		Plane-Bed
39	Upper Naneum	Upper Yakima Tribs	Upper Naneum Cr.	Confluence with Wilson Cr. to steep, intermittant section (RM 0 to 8.5)	0.0224	2.2435		Plane-Bed
39	Waptus R	Upper Yakima Tribs	Waptus R.	Mouth to impassibly steep section (RM 0 to 3.5).	0.0161	1.6128		Plane-Bed
39	Wenas Cr	Middle Yakima Trib	Wenas Cr.-1	Mouth to dewatered section above Cottonwood Cr. (RM 0 to 1.4)	0.0052	0.5154		Pool-Riffle
39	Wenas Cr	Middle Yakima Trib	Wenas Cr.-2	Mouth to confluence of NF and SF Wenas (RM 1.4 to 22.1)	0.0101	1.0052		Pool-Riffle
39	Teanaway R WF	Teanaway	WF Teanaway R.-1	Mouth to spring chinook access limit (RM 0 to 3).	0.0105	1.0486		Pool-Riffle
39	Teanaway R WF	Teanaway	WF Teanaway R.-2	Spring chinook access limit to impassibly steep gradient (RM 3 to 7.3)	0.0150	1.4992		Pool-Riffle
39	Whisky Cr.	Upper Yakima Tribs	Whisky Cr.-1	Mouth to impassible irrigation diversion (RM 0 to 2.1)	0.0103	1.0348		Pool-Riffle
39	Whisky Cr.	Upper Yakima Tribs	Whisky Cr.-2	Passage barrier to diversion point from Wilson Cr. (RM 2.1 to	0.0206	2.0583		Plane-Bed
39	Williams Cr.	Upper Yakima Tribs	Williams Cr.	Mouth to steelhead access limit at Cougar Gulch (RM 0 to 2.8)	0.0305	3.0544		Plane-Bed/Step-Pool
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-1	Mouth to Cherry Cr. (RM 0 to 1.1).	0.0044	0.4360		Pool-Riffle
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-10	Diversion point of Whisky Cr. to diversion point of Lower Naneum Cr. (R	0.0179	1.7866		Plane-Bed
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-11	Diversion point of Lower Naneum Cr. to confluence with Upper Naneum Cr.	0.0184	1.8420		Plane-Bed
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-12	Upper Naneum Cr. confluence to steep, intermittant section (RM 19.5 to	-0.1626	-16.2554		Plane-Bed
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-2	Cherry Cr. to Lower Naneum Cr. (RM 1.1 to 1.7)	0.0007	0.0744		Pool-Riffle
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-3	Lower Naneum to East Branch Wilson Cr. (RM 1.7 to 5.9)				
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-4	Mouth of East Branch Wilson Cr. to Bull Ditch inlet (RM 5.9 to 7.8)				
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-4A	Bull Ditch inlet to mouth of Mercer Cr. (RM 7.8 to 8.5)	0.0032	0.3214		Pool-Riffle
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-5	Mercer Cr. mouth to impassible irrigation diversion (RM 8.5 to 9.0)	0.0090	0.8960		Pool-Riffle
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-6	Passage barrier to diversion point of East Branch Wilson Cr. (RM 9.0 to	0.0110	1.0976		Pool-Riffle
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-7	Diversion point of East Branch Wilson Cr. to Highline Canal (RM 11.3 to	0.0147	1.4712		Pool-Riffle
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-8	Highline Canal to diversion point of Mercer Cr. (RM 15.9 to 16.4)	0.0181	1.8132		Plane-Bed
39	Wilson Cr	Upper Yakima Tribs	Wilson Cr.-9	Diversion point of Mercer Cr. to diversion point of Whisky Cr. (RM 16.4	0.0154	1.5411		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-10	Umtanum Cr. to Wilson Cr. (RM 139.8 to 147).	0.0019	0.1918		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-11	Wilson Cr. to Bull Ditch outtake (RM 147 to 153.5).	0.0026	0.2638		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-11A	Bull Ditch outtake to Reecer Cr. (RM 153.5 to 153.7).	0.0025	0.2488		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-11B	Reecer Cr. to Manastash Cr. (RM 153.7 to 154.5)	0.0005	0.0541		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-12	Manastash Cr. to Taneum Cr. (RM 154.5 to 166.1).	0.0026	0.2628		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-13	Taneum Cr. to Swauk Cr. (RM 166.1 to 169.9).	0.0028	0.2753		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-14	Swauk Cr. to Teanaway R. (RM 169.9 to 176.1).	0.0022	0.2233		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-15	Teanaway R. to Cle Elum R. (RM 176.1 to 185.6).	0.0025	0.2458		Plane-Bed/Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-16	Cle Elum R. to Little Cr. (RM 185.6 to 194.6).	0.0028	0.2834		Plane-Bed/Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-17	Little Cr. to Big Cr. (RM 194.6 to 195.8).	0.0016	0.1633		Plane-Bed/Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-17A	Little Cr. to Tucker Cr. (RM 194.6 to 199.9)	0.0022	0.2226		Plane-Bed/Pool-Riffle
39	Yakima R.	Upper Yakima	Yakima R.-18	Tucker Cr. to Easton Dam/Lake Easton (RM 199.9 to 202.5).	0.0052	0.5193		Plane-Bed/Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-19A (Easton Dam)	Easton Dam (RM 202.5)				
39	Yakima R	Upper Yakima	Yakima R.-19B (Lake Easton)	Lake Easton -- Easton Dam to Kachess R. (RM 202.5 to 203.4).				
39	Yakima R	Upper Yakima	Yakima R.-20	Kachess R. (upstream end of Lake Easton) to Cabin Cr. (RM 203	0.0024	0.2423		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-21	Cabin Cr. to Keechelus Dam (RM 205 to 214.5).	0.0063	0.6346		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-22A (Keechelus Dam)	Keechelus Dam				
39	Yakima R	Upper Yakima	Yakima R.-22B (Keechelus Lake)	Dam to Gold Cr. (RM 214.5 to 220).				
39	Yakima R	Middle Yakima	Yakima R.-7	Naches R. to Wenas Cr. (RM 116.3 to 122.4)	0.0019	0.1910		Pool-Riffle
39	Yakima R	Middle Yakima	Yakima R.-8	Wenas Cr. to Roza Dam (RM 122.4 to 127.9).	0.0027	0.2681		Pool-Riffle
39	Yakima R	Upper Yakima	Yakima R.-9A (Roza Dam)	Roza Dam (RM 127.9).				
39	Yakima R	Upper Yakima	Yakima R.-9B	Roza Dam to Umtanum Cr. (RM 127.9 to 139.8).	0.0019	0.1938		Pool-Riffle

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APPENDIX B

2002 Annual Report
Wild and Hatchery Smolt Survival of
Roza Spring Chinook Releases

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2002 Annual Report
Wild and Hatchery Smolt Survival of Roza Spring Chinook Releases

Doug Neeley, Consultant to Yakama Nation
Submitted April 1, 2003

1. Introduction

In outmigration years 1999, 2000, 2001, and 2002, outmigrating spring Chinook smolt were trapped at Roza, anesthetized, and PIT-tagged if not previously tagged in OCT-SNT raceways. The fish were identified as to whether they were wild in origin (wild: not adipose-fin clipped), were hatchery fish that were previously PIT-tagged (tagged: adipose-fin clipped and PIT-tag found), or were hatchery fish not previously tagged (untagged: adipose-fin clipped but PIT-tag not found). Fish that were not previously tagged (wild and untagged) were then tagged, and all tagged fish, including previously tagged fish, were measured for fork-length and released.

The main purpose of this trial was to determine whether there was a difference in wild and hatchery release-to-smolt survival indices. The survival index was estimated from release to McNary passage using the same estimation procedures that were used to estimate OCT and SNT survival to McNary (refer to Doug Neeley's 2002 Annual Report: OCT-SNT Survival).

Data from releases were pooled into weekly groupings. The numbers of fish released within a given week were pooled, and the numbers of expanded McNary detections[1] from those weeks of release were also pooled. Within each weekly groupings, the total of the pooled expanded McNary detections was divided by the pooled release number as an index of release-to-McNary survival. The estimations were performed separately for wild, tagged hatchery, and untagged hatchery fish. The week was selected such that the beginning date of the week shared a common starting Julian date over years; for example, one week began with Julian date 28, the next began with Julian date 35 (35 = 28+7), the next began with Julian date 42 (42 = 35+7), etc. The same Julian dates were used for each year. The weekly survival-index estimates are given in Appendix A.

[1] Expansions involved dividing the number of daily detections by the McNary detection efficiency for that day of McNary passage. Methods of estimating detection efficiencies and the detection efficiency estimates are given in 2002 Annual Report: OCT-SNT Survival by Doug Neeley.

2. Wild versus Hatchery Survival Indices

First, survival indices for previously tagged and untagged hatchery fish were compared to determine whether their estimates could be pooled to provide more precise estimates of survival indices for hatchery fish. The weighted logistic analysis of variation was performed in which the data-summary weeks for which there were hatchery releases were treated as blocks. The weighting variable was the number of fish released during the weekly blocks. In the analysis, tagged and untagged treatment means, adjusted for block effects, were compared. In none of the four years did the tagged and untagged mean survival indices differ significantly (P = 0.552, P = 1.000, P = 0.248, and P = 0.362 respectively for out-migration years 1999-2002; see Appendix B). The tagged and untagged estimates were therefore pooled within blocks for common estimates of hatchery survival indices.

Wild and pooled hatchery survival indices for each Julian week are presented in Figures 1.a., through 1.d. respectively for outmigration years 1999 through 2002[2] (brood years 1997 through 2000, respectively). Formal weighted logistic analyses of variation and means for 1999 through 2002 survival indices are respectively presented in Tables 1.a through 1.d. using as blocks Julian weeks having both wild and hatchery estimates. There was a significant difference only in outmigration-year 2000 [P = 0.001 in year 2000, Table 1.b.1)]. In that year the survival index of the wild was greater than that of the hatchery. In outmigration years 1999 and 2002 the survival index of wild also exceeded that of hatchery, but the differences were not significant [respectively, P = 0.252, Table 1.a.1); P = 0.212, Table 1.d.1)].

In outmigration-year 2001, the wild survival index was less then that of the hatchery, but not significantly so [P = 0.619, Table 1.c.1)]. In last year's annual report, a significant difference was attributed to outmigration-year 2001. This conclusion was based on an analysis error in which Prosser detections of hatchery fish were inadvertently used for McNary detections, and the 2001 outmigration-year survival-indices presented in that report are incorrect. It should be noted that outmigration-year 2001 had protracted, record-low flows. The outmigration-2001 analyses, means, and data presented in this report have been corrected.

As can be seen in Figure 1.c., the wild fish survival index was much higher for releases prior to the outmigration of hatchery fish than survival index of wild fish released concurrently with hatchery fish. The week beginning Julian date 77 when hatchery fish were first being trapped at Roza corresponded to a large drop in wild fish survival. Wild fish survival prior to Julian date 77 consistently exceeded that of both wild and hatchery fish from Julian date 77 onward; if wild fish passed McNary prior to

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[2] The figures essentially start with releases made after the beginning of the calendar year. However, in brood years 1998 and 2000 (respectively outmigration years 2000 and 2002), releases were made earlier than January 1. Survival indices for these earlier releases are not presented in the figures, but the estimates are given in tables given in Appendix A. However, survival-index estimates for any releases made before mid-March may be underestimates since McNary detectors were not on line until late March or early April. Some fish released before mid-March may have passed McNary and may not have been included in the McNary detections.

April 1 (Julian Date 91), the date McNary detectors came on line, the pre-Julian date 77 wild survival estimate may actually have been relatively higher than indicated in Figure 1.c.

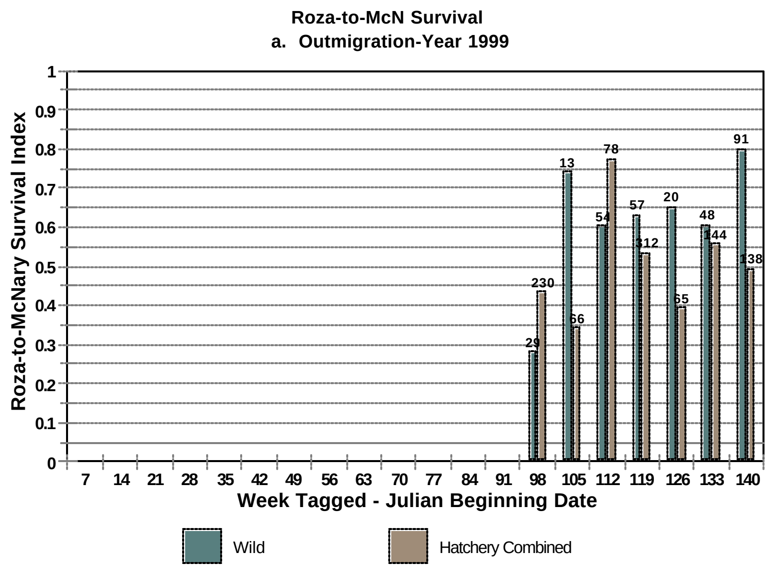
Fish lengths are plotted in Figure 2.a., 2.b., 2.c., and 2.d., respectively for 1999, 2000, 2001, and 2002 outmigrants. In 1999, 2001, and 2002 wild fish tagged at Roza were significantly smaller than hatchery fish [respectively P = 0.007, Table 2.a.1); P < 0.001, Table 2.c.1); P =< 0.001, Table 2.d.1)]. In the outmigration-year 2000, the mean lengths of hatchery and wild fish were nearly identical [Table 2.b.2); P = 0.754, Table 2.b.1)].

3. Informal Descriptive Findings

The initiation of trapping and release at Roza varied dramatically over years, starting late (early April) in water-year 1999, very early in water-year 2000 and 2002 (actually commencing in the previous calendar year), and not as early in 2001 (late January). Survival indices using wild fish released on or after Julian date 98 can be used as an indicator for survival comparisons among years; the week commencing Julian date 98 being the latest starting week of trapping for the four years of evaluation. For survival of fish released on or after Julian date 98, the wild indicator survival index was highest for outmigration-year 1999 (64.5% survival); 1999 also had the second highest flows on record. The wild indicator was lowest for outmigration-year 2001 (8.9% survival); 2001 had the lowest protracted flow on record. The wild indicator was moderate in years 2000 and 2002 (36.5% and 26.0%, respectively). Comparable hatchery indicators for Julian date 98 onward followed the same general trend; highest in 1999 (50.8%), lowest in 2001 (12.5%); in between in 2000 and 2002 (34.2% and 16.4%, respectively). The low hatchery survival-index in 2002 may be associated with the effect of BKD observed in the hatchery in that year[3].

[3] Refer to 2002 Annual Report: OCT-SNT Survival by Doug Neeley, Consultant to the Yakama Nation.

Figure 1. Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Survival Indices to McNary Dam of Wild and Hatchery Spring Chinook Smolt Released at Roza Dam. (NOTE: Numbers above bars in figures are number of fish released at Roza.)



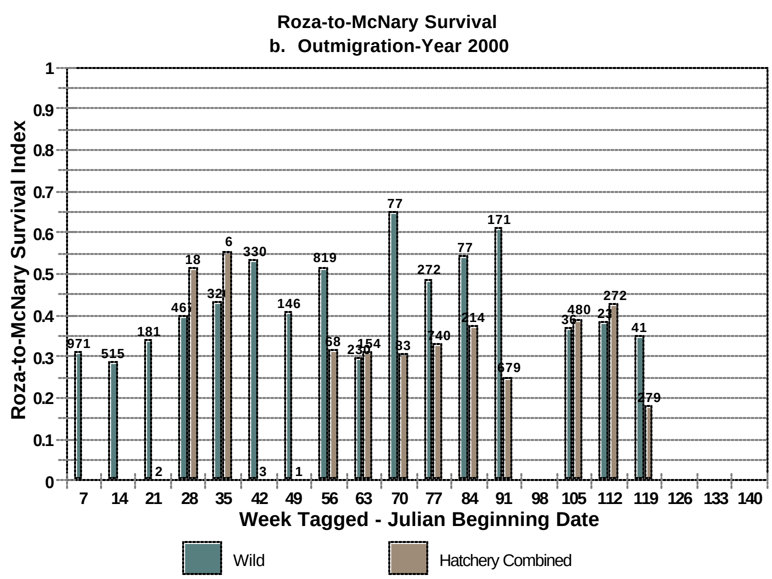
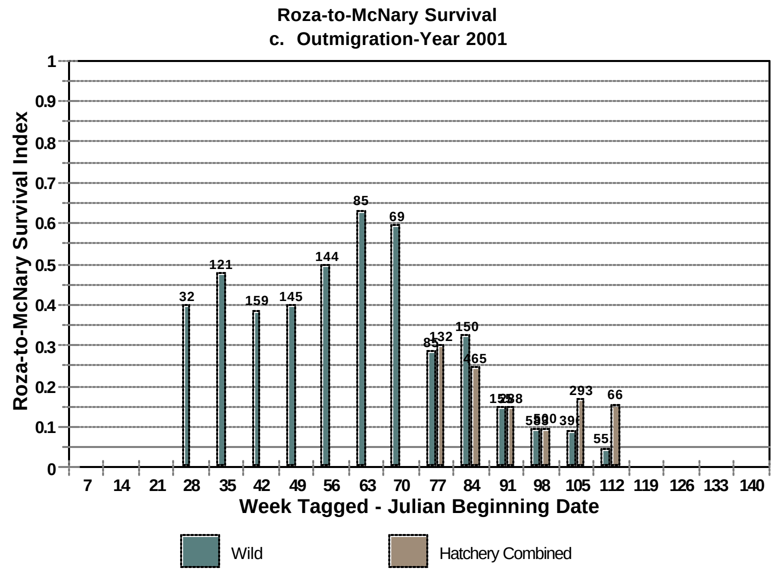


Figure 1. **Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Survival Indices to McNary Dam of Wild and Hatchery Spring Chinook Smolt Released at Roza Dam (continued)**



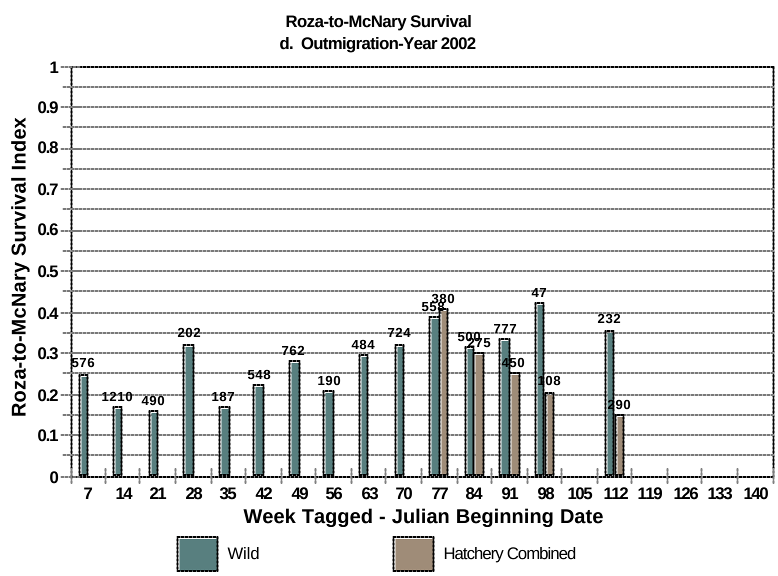


Table 1. Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Logistic Analysis of Variation between Wild and Hatchery Survival Indices adjusted for common Julian Weeks for which both estimates are available and Associated Means

Table 1.a.1) 1999 Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 Error P
Julian Week and Wild versus Hatchery	53.40	7	7.63		
Julian Week	44.28	6	7.38		
Wild versus Hatchery (adjusted for Julian Week)	9.12	1	9.12	1.60	0.2525
Error	34.15	6	5.69		

Table 1.a.2) 1999 Wild and Hatchery Mean Release-to-McNary Survival Indices

	Hatchery	Wild
Mean over common Julian Weeks (adjusted**)	0.549	0.611
Mean over common Julian Weeks (unadjusted**)	0.508	0.645

Table 1.b.1) 2000 Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Wild versus Hatchery	255.89	15	17.06		
Julian Week	168.71	14	12.05		
Wild versus Hatchery (adjusted for Julian Week)	87.18	1	87.18	17.43	0.0013
Error	60.02	12	5.00		

Table 1.b.2) 2000 Wild and Hatchery Mean Release-to-McNary Survival Indices

	Hatchery	Wild
Mean over common Julian Weeks (adjusted**)	0.236	0.487
Mean over common Julian Weeks (unadjusted**)	0.318	0.463

*Variable is survial index, weight is number of released fish

** Respectively adjusted and unadjusted for common Julian Week effects

Table 1.c.1) 2001 Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Wild versus Hatchery	118.89	6	19.82		
Julian Week	118.01	5	23.60		
Wild versus Hatchery (adjusted for Julian Week)	0.88	1	0.88	0.28	0.6189
Error	15.67	5	3.13		

Table 1.c.2) 2001 Wild and Hatchery Mean Release-to-McNary Survival Indices

	Hatchery	Wild
Mean over common Julian Weeks (adjusted**)	0.135	0.149
Mean over common Julian Weeks (unadjusted**)	0.174	0.132

*Variable is survial index, weight is number of released fish

** Respectively adjusted and unadjusted for common Julian Week effects

Table 1. **Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Logistic Analysis of Variation between Wild and Hatchery Survival Indices adjusted for common Julian Weeks for which both estimates are available and Associated Means (continued)**

Table 1.d.1) 2002 Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Wild versus Hatchery	60.28	5	12.06		
Julian Week	43.29	4	10.82		
Wild versus Hatchery (adjusted for Julian Week)	16.99	1	16.99	2.20	0.2120
Error	30.86	4	7.72		

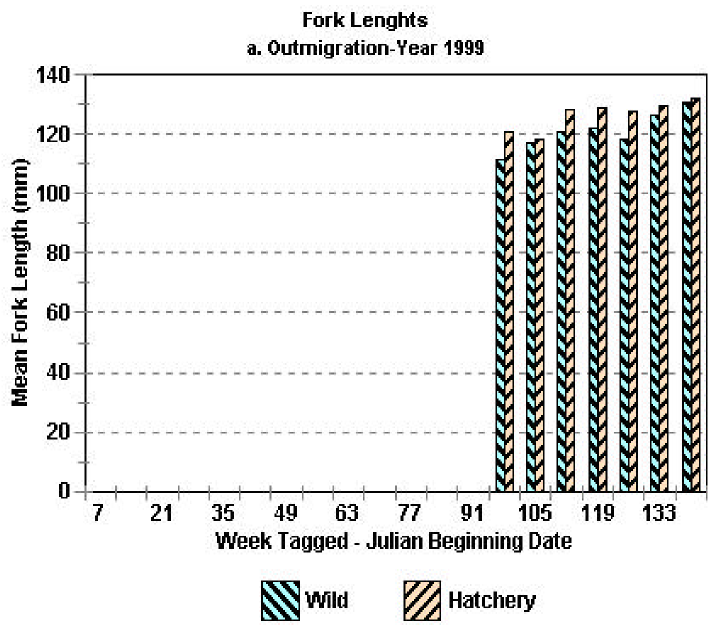
Table 1.d.2) 2002 Wild and Hatchery Mean Release-to-McNary Survival Indices

	Hatchery	Wild
Mean over common Julian Weeks (adjusted**)	0.280	0.339
Mean over common Julian Weeks (unadjusted**)	0.276	0.347

*Variable is survial index, weight is number of released fish

** Respectively adjusted and unadjusted for common Julian Week effects

Figure 2. **Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Mean Lengths of Wild and Hatchery Spring Chinook Smolt at Roza Dam**



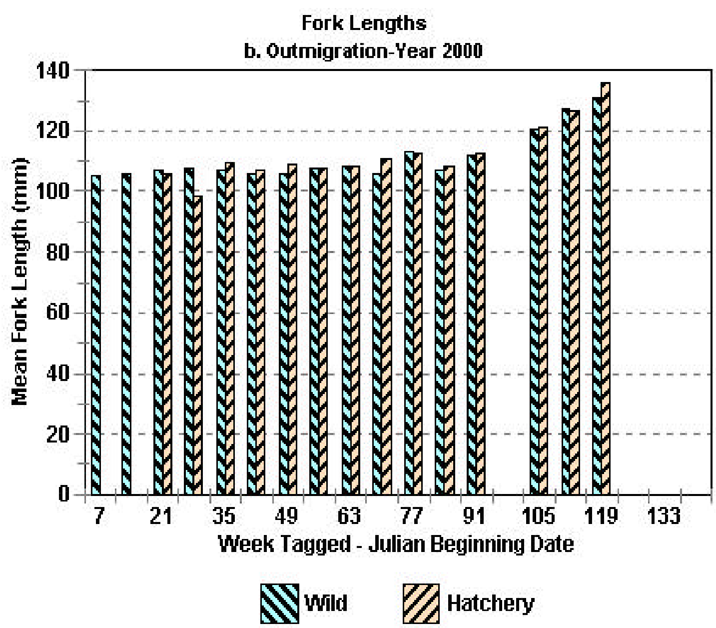
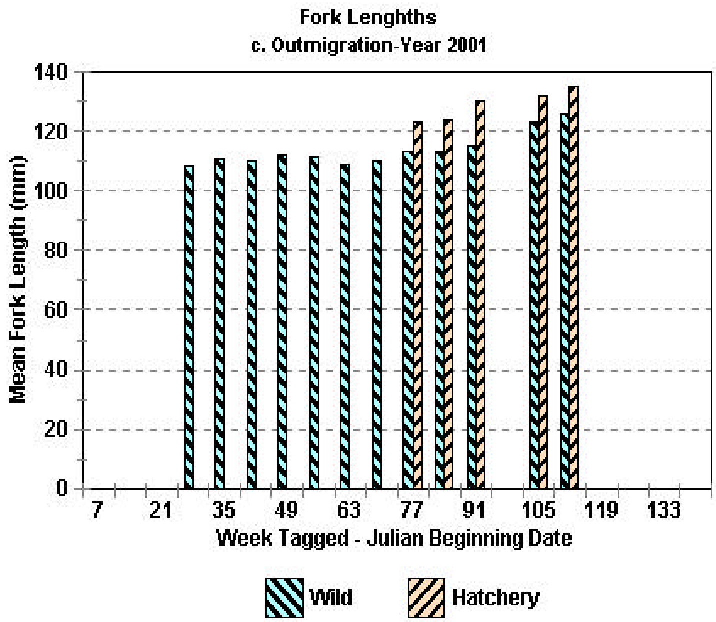


Figure 2. **Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Mean Lengths of Wild and Hatchery Spring Chinook Smolt at Roza Dam (continued)**



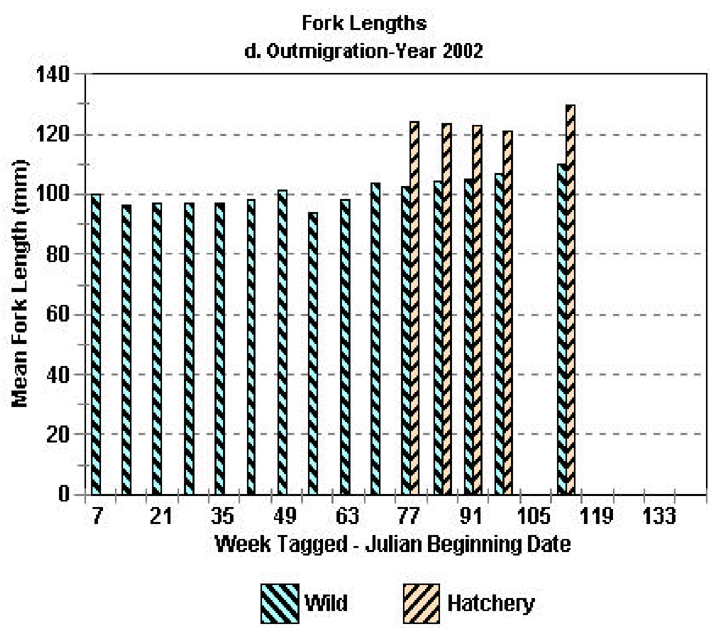


Table 2. **Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Analysis of Variance and Means of Rosa-Released Wild and Hatchery Fish Lengths (mm) for Weeks of Common Passage**

Table 2.a.1) 1999 Wild versus Hatchery: Fish Length Least Squares Analysis of Variance

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Wild versus Hatchery	451.45	7	64.49		
Julian Week	347.76	6	57.96		
Wild versus Hatchery (adjusted for Julian Week)	103.69	1	103.69	16.26	0.0069
Error	38.26	6	6.38		

Table 2.a.2) 1999 Mean Fish Lengths at Release

	Hatchery	Wild
Mean over common Julian Weeks	126.4	121.0

Table 2.b.1) 2000 Wild versus Hatchery: Fish Length Least Squares Analysis of Variance

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Wild versus Hatchery	1,047.65	13	80.59		
Julian Week	1,047.06	12	87.26		
Wild versus Hatchery (adjusted for Julian Week)	0.59	1	0.59	0.10	0.7538
Error	68.79	12	5.73		

Table 2.b.2) 2000 Mean Fish Lengths at Release

	Hatchery	Wild
Mean over common Julian Weeks	110.7	110.4

Table 2.c.1) 2001 Wild versus Hatchery: Fish Length Least Squares Analysis of Variance

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Wild versus Hatchery	517.90	5	103.58		
Julian Week	230.60	4	57.65		
Wild versus Hatchery (adjusted for Julian Week)	287.30	1	287.30	85.61	0.0008
Error	13.42	4	3.36		

Table 2.c.2) 2001 Mean Fish Lengths at Release

	Hatchery	Wild
Mean over common Julian Weeks	128.8	118.0

Table 2. Outmigration-Year 1999-2002 (Brood-Year 1997-2000) Analysis of Variance and Means of Rosa-Released Wild and Hatchery Fish Lengths (mm) for Weeks of Common Passage (continued)

Table 2.d.1) 2002 Wild versus Hatchery: Fish Length Least Squares Analysis of Variance

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Wild versus Hatchery	919.28	5	183.86		
Julian Week	57.85	4	14.46		
Wild versus Hatchery (adjusted for Julian Week)	861.43	1	861.43	256.54	0.0001
Error	13.43	4	3.36		

Table 2.d.2) 2002 Mean Fish Lengths at Release

	Hatchery	Wild
Mean over common Julian Weeks	124.2	105.6

Appendix A. 1999-2002 Outmigration-Year (1997-2000 Brood-Year) Mean Roza-to-McNary Smolt Survival Indices and Mean Fork Lengths at Roza Release

Table A.1.a. 1999 Outmigrant Roza-to-McNary Survival Indices and Fork-Lengths at Roza

Week	Wild			Hatchery						
Beginning				Previously Untagged		Previously Tagged		Combined		
Julian Date	Released	S.I.	Length	Released	S.I.	Released	S.I.	Released	S.I.	Length
98	29	0.2812	111.5	77	0.5637	153	0.3727	230	0.4366	120.7
105	13	0.7420	117.2	21	0.2767	45	0.3740	66	0.3430	118.1
112	54	0.6032	120.7	42	0.7465	36	0.8097	78	0.7757	128.4
119	57	0.6316	122.0	107	0.4228	205	0.5926	312	0.5344	128.9
126	20	0.6525	118.5	21	0.4930	44	0.3484	65	0.3951	127.4
133	48	0.6068	126.4	48	0.6543	96	0.5109	144	0.5587	129.7
140	91	0.7995	130.6	46	0.6734	92	0.4045	138	0.4941	131.8

Table A.1.b. 2000 Outmigrant Roza-to-McNary Survival Indices and Fork-Lengths at Roza

Week	Wild			Hatchery						
Beginning				Previously Untagged		Previously Tagged		Combined		
Julian Date	Released	S.I.	Length	Released	S.I.	Released	S.I.	Released	S.I.	Length
344	62	0.2092	104.0							
351	0	0.0000	0.0							
358	55	0.3700	102.0							
365	1369	0.3009	104.4							
7	971	0.3091	105.3							
14	515	0.2867	106.0							
21	181	0.3395	107.3	0	0.0000	2	0.0000	2	0.0000	106.0
28	467	0.3977	107.8	1	0.0000	17	0.5437	18	0.5135	98.3
35	326	0.4315	106.8	0	0.0000	6	0.5540	6	0.5540	109.6
42	330	0.5339	105.8	0	0.0000	3	0.0000	3	0.0000	106.8
49	146	0.4081	105.7	0	0.0000	1	0.0000	1	0.0000	109.0
56	819	0.5159	107.5	19	0.2320	49	0.3464	68	0.3145	107.5
63	230	0.2947	108.1	115	0.3405	39	0.2183	154	0.3095	108.5
70	77	0.6486	105.9	78	0.3261	5	0.0000	83	0.3065	110.7
77	272	0.4870	113.0	558	0.3231	182	0.3529	740	0.3304	112.6
84	77	0.5426	106.8	150	0.2654	64	0.6232	214	0.3724	108.5
91	171	0.6118	112.0	351	0.2639	328	0.2342	679	0.2495	112.8
98	0	0.0000	0.0	0	0.0000	0	0.0000	0	0.0000	0.0
105	36	0.3693	120.68249	300	0.3871	180	0.3933	480	0.3894	121.45399
112	23	0.3834	127.175	201	0.4786	71	0.2806	272	0.4269	126.88444
119	41	0.3507	131.13756	177	0.1935	102	0.1516	279	0.1782	135.59597

Table A.1.c. 2001 Outmigrant Roza-to-McNary Survival Indices and Fork-Lengths at Roza

Week	Wild			Hatchery						
Beginning				Previously Untagged		Previously Tagged		Combined		
Julian Date	Released	S.I.	Length	Released	S.I.	Released	S.I.	Released	S.I.	Length
28	32	0.3999	108.4							
35	121	0.4759	110.5							
42	159	0.3863	110.3							
49	145	0.3972	112.0							
56	144	0.4977	111.4							
63	85	0.6328	109.2							
70	69	0.5935	109.9							
77	85	0.2861	113.3	111	0.3344	21	0.1219	132	0.3006	123.1
84	150	0.3245	113.2	350	0.2489	115	0.2337	465	0.2451	123.8
91	155	0.1489	115.0	250	0.1433	38	0.1695	288	0.1468	130.2
98	583	0.0923	0.0	424	0.0996	76	0.0842	500	0.0973	0.0
105	396	0.0905	122.9	250	0.1740	43	0.1190	293	0.1660	131.9
112	55	0.0465	125.8	50	0.1536	16	0.1600	66	0.1551	134.8

Appendix A. 1999-2002 Outmigration-Year (1997-2000 Brood-Year) Mean Roza-to-McNary Smolt Survival Indices and Mean Fork Lengths at Roza Release (continued)

Table A.1.d. 2002 Outmigrant Roza-to-McNary Survival Indices and Fork-Lengths at Roza

Week	Wild			Hatchery						
Beginning				Previously Untagged		Previously Tagged		Combined		
Julian Date	Released	S.I.	Length	Released	S.I.	Released	S.I.	Released	S.I.	Length
351	500	0.1794	105.0							
358	501	0.1361	102.9							
365	230	0.3191	101.1							
7	576	0.2487	99.8							
14	1210	0.1682	96.2							
21	490	0.1586	96.6							
28	202	0.3216	96.9							
35	187	0.1688	96.8							
42	548	0.2199	97.9							
49	762	0.2803	100.9							
56	190	0.2080	93.8							
63	484	0.2950	98.0							
70	724	0.3220	103.6							
77	558	0.3869	102.5	309	0.3961	71	0.4561	380	0.4073	123.8
84	500	0.3143	104.3	251	0.3201	24	0.0812	275	0.2992	123.3
91	777	0.3327	104.8	379	0.2636	71	0.1782	450	0.2501	122.8
98	47	0.4212	106.7	100	0.1940	8	0.3229	108	0.2036	121.2
105	0		0.0	0		0		0		0.0
112	232	0.3560	109.6	233	0.1772	57	0.0323	290	0.1487	129.7

Appendix B. Weighted Logistic Analysis of Variation between Tagged and Untagged Hatchery Survival Indices adjusted for common Blocks (Julian Weeks for which both estimates are available) and Associated Means

B.1.a. 1999 Tagged versus Untagged: Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 Error P
Julian Week and Tagged versus Untagged	43.35	7	6.19		
Julian Week	41.51	6	6.92		
Tagged versus Untagged (adjusted for Julian Week)	1.84	1	1.84	0.40	0.5525
Error	27.90	6	4.65		

B.1.b. 1999 Untagged and Tagged Hatchery Mean Release-to-McNary Survival Indices

	Untagged	Tagged
Mean over common Julian Weeks (adjusted**)	0.553	0.487
Mean over common Julian Weeks (unadjusted**)	0.548	0.486

*Variable is survial index, weight is number of released fish

** Respectively adjusted and unadjusted for common Julian Week effects

B.2.a. 2000 Tagged versus Untagged: Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Tagged versus Untagged	80.74	14	5.77		
Julian Week	80.74	13	6.21		
Tagged versus Untagged (adjusted for Julian Week)	0.00	1	0.00	0.00	1.0000
Error	43.33	9	4.81		

B.2.b. 2000 Untagged and Tagged Hatchery Mean Release-to-McNary Survival Indices

	Untagged	Tagged
Mean over common Julian Weeks (adjusted**)	0.317	0.297
Mean over common Julian Weeks (unadjusted**)	0.322	0.310

Appendix B. Weighted Logistic Analysis of Variation between Tagged and Untagged Hatchery Survival Indices adjusted for common Blocks (Julian Weeks for which both estimates are available) and Associated Means (continued)

B.3.a. 2001 Tagged versus Untagged: Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Tagged versus Untagged	54.50	6	9.08		
Julian Week	53.05	5	10.61		
Tagged versus Untagged (adjusted for Julian Week)	1.45	1	1.45	1.71	0.2479
Error	4.24	5	0.85		

B.3.b. 2001 Untagged and Tagged Hatchery Mean Release-to-McNary Survival Indices

	Untagged	Tagged
Mean over common Julian Weeks (adjusted**)	0.180	0.140
Mean over common Julian Weeks (unadjusted**)	0.177	0.162

*Variable is survial index, weight is number of released fish

** Respectively adjusted and unadjusted for common Julian Week effects

B.4.a. 2002 Tagged versus Untagged: Weighted* Survival Index Logistic Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev.DF)	F-Ratio	Type 1 P
Julian Week and Tagged versus Untagged	66.71	5	13.34		
Julian Week	62.26	4	15.57		
Tagged versus Untagged (adjusted for Julian Week)	4.45	1	4.45	1.06	0.3624
Error	16.87	4	4.22		

B.4.b. 2002 Untagged and Tagged Hatchery Mean Release-to-McNary Survival Indices

	Untagged	Tagged
Mean over common Julian Weeks (adjusted**)	0.276	0.210
Mean over common Julian Weeks (unadjusted**)	0.286	0.223

*Variable is survial index, weight is number of released fish

** Respectively adjusted and unadjusted for common Julian Week effects

APPENDIX C

2002 Annual Report OCT-SNT Survival

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2002 Annual Report
OCT-SNT Survival

Doug Neeley, Consultant to Yakama Nation
Submitted April 1, 2003

1. Summary

Smolt-Smolt Survival: The release-to-McNary-Dam survivals of brood-year 2000 (2002-outmigrant) PIT-tagged smolt reared under the semi-natural treatment (SNT) were uniformly less than those reared under the optimal conventional treatment (OCT). There was also a significant difference between the two treatments' effects on pre-release survival as measured by the released-to-tagged-number ratio. There were no significant differences in release-to-McNary survival between the SNT and OCT fish in any of the previous brood years (1997 through 1999). The 2000 brood-year survivals were highly and negatively correlated with mean BKD severity measures. When adjusted for these BKD measure means, there were no significant SNT-OCT differences in either the release-to-McNary survival indices or the released-to-tagged-number ratios. It is likely that SNT rearing conditions increased the severity of BKD and increased the impact of the disease on survival in PIT-tagged fish.

Smolt-to-Adult Survival: For the 1997 brood based on combined Age-3, Age-4, and Age-5 PIT-tagged returns (return years 2000, 2001, and 2002, respectively), there were no significant differences between the OCT and SNT effects on the survival from juvenile-tagging[1]-to-adult passage at Roza Dam on the Upper Yakima River. For the 1998 brood there were no significant differences between the SNT and OCT effects on juvenile-release[1]-to-Roza-return survival at the Clark Flats and Easton release sites based on combined Age-3 and Age-4 returns (return-years 2001 and 2002, respectively); however, SNT's survival was significantly less than the OCT's at the Jack Creek Site. The Jack Creek site was not available to the 1997 brood.

The 1998-brood results should be regarded as tentative because age-5 adults are not included. In last year's report, when only age-4 returns were analyzed for the brood-year 1997 analysis, there was some statistical evidence that SNT fish had higher survival than

[1] For the 1997 brood, the number of fish tagged-per-raceway served as the base for survival estimates. For 1998 and subsequent brood years, fish volitionally leaving the raceways were read by PIT-tag detectors, and this number of detected fish per raceway served as the base for survival estimates.

OCT fish; however, as indicated above, when all age groups were included, the analysis indicated no significant difference between the treatment effects.

2. Brood-2000 OCT-SNT Release-to-McNary-Dam Smolt-to-Smolt Survival

Table 1.a. presents the estimated SNT and OCT release-to-McNary survival-index proportions[2] for each acclimation site (Clark Flats, Jack Creek, and Easton) as well as treatment main-effect estimates and site main-effect estimates for brood-year 2000 (2002 outmigrant) PIT-tagged smolt. Table 1.a. also presents the ratio of the number of detected volitionally released fish to the number of fish PIT-tagged (release-to-tagged-number ratio) expressed as a proportion. Table 1.b.1) presents the weighted logistic analysis of variation[3] of the release-to-McNary survival indices as a measure of post-release smolt-to-smolt survival, and Table 1.b.2) presents a comparable analysis for the released-to-tagged-number ratio as a measure of pre-release survival. There was a significant difference between the release-to-McNary survival indices of SNT- and OCT-reared fish [P = 0.045 from Table 1.b.1)] and a significant difference between the SNT and OCT released/tagged-number ratios [P = 0.001 from Table 1.b.2)].

The underlying hypothesis to be tested was that the survival index of the SNT-reared fish exceeded that of the OCT-reared fish relative to the hypothesis that the treatments' survival indices did not differ. However, what is clear is that the SNT measures of survival are significantly less than those of the OCT. There were no significant treatment-effect differences in smolt-to-smolt survival in previous brood years (brood years 1997 through 1999[4]). Figure 1, which plots SNT and OCT release-to-McNary survival indices for all sites within each brood year, graphically contrasts the OCT and SNT differences for brood-year 2000 and those of previous brood years.

One possibility for the treatment difference in brood-year 2000 is that there were greater disease symptoms associated with rearing conditions under the SNT than under the OCT. Several diseases were monitored, and one found to be present was Bacterial Kidney Disease (BKD). The survival indices were reanalyzed adjusting the survival indices for BKD averages of severity measures taken from sampled sacrificed juveniles from each pond[5]. This analysis was a logistic analysis of covariation using the per-raceway BKD severity mean as a concomitant variable or covariate. The covariate-adjusted analysis revealed no significant difference between the SNT and OCT BKD-

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[2] Methods of estimating the release-to-McNary survival index are presented in Appendix A.

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

[4] For Spring Chinook, brood years 1997 through 1999 respectively correspond to outmigration years 1999 through 2001. Data summaries from pre-2002 brood years are presented in 2001 Annual Report: OCT-SNT Survival by Doug Neeley. There were somewhat different methods of estimating survival indices in previous years, and those methods are discussed in Appendix A.

[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 raceway. Refer to Table 1.e.

adjusted smolt-to-smolt treatment survival indices [P = 0.616 for BKD-adjusted analysis from Table 1.c.1) compared to P = 0.045 for the BKD-unadjusted analysis from Table 1.b.1)]. The same was true for the released-to-tagged-number ratio [P = 0.654 for BKD-adjusted analysis from Table 1.c.2) compared to P = 0.001 for BKD-unadjusted analysis from Table 1.b.2)].

Individual raceway BKD-severity measure means are given in Table 1.d. along with the release-to-McNary survival indices and released-to-tagged-number ratios. The raceway pairs presented in the tables are blocks. The SNT and OCT raceways within the pairs are adjacent to each other, but, more importantly, the fish from the OCT and SNT raceways within the same block share the same sets of parental crosses (different blocks have fish from different sets of parental crosses). It can be seen from Table 1.d. that 1) the SNT survival index was lower than that of the OCT within all nine raceway pairs, 2) the SNT released-to-tagged-number ratio was lower than that of the OCT within seven of the nine raceway pairs[6], and 3) the BKD measure mean of the SNT exceeded that of the OCT within eight of the nine raceway pairs. This disease difference could not be because of parental-source differences in BKD levels because the pairs shared the same parental crosses[7]. The disease differences can most likely be attributed to a rearing difference between SNT and OCT treatments. It is also likely that these disease differences contributed to the differences in the survival indices. Table 1.e. gives the relative distribution of severity measures for the sampled fish within each acclimation pond.

Table 1.a. 2000-Brood (2002-Outmigrant) SNT and OCT Release-to-McNary-Dam Survival Indices and Tagged-to-Release-Number Ratio Estimates within Sites and Treatment and Site Main Effect Estimates

		Release-McNary Survival Index				Released-to-Tagged Numbers Ratio			
		Means within Sites		Site Main Effect		Means within Sites		Site Main Effect	
Site	Treatment	Release Number	Survival Index	Release Number	Survival Index	Tagged Number	Ratio	Tagged Number	Ratio
Clark Flats	OCT	6340	0.4093	12198	0.3535	6677	0.9495	13352	0.9136
	SNT	5858	0.2930			6675	0.8776		
Jack Creek	OCT	6480	0.3654	12946	0.3313	6675	0.9708	13353	0.9695
	SNT	6466	0.2971			6678	0.9683		
Easton	OCT	6512	0.3167	12436	0.2533	6677	0.9753	13352	0.9314
	SNT	5924	0.1837			6675	0.8875		
Treatment Main Effect	OCT	19332	0.3634	37580	0.3127	20029	0.9652	40057	0.9382
	SNT	18248	0.2590			20028	0.9111		

[6] The two pairs of raceways for which the OCT ratio exceeded that of the SNT were both at Jack Creek, which had three pairs total. This probably resulted in the fact that the Site x Treatment interaction was significant at the 10% level [P = 0.079 in Table 1.b.2)].

[7] There may have also been differences in survival effects of the different parental sets. Such differences would be reflected in the Block source of the analysis of variation. The significant levels for the release-to-McNary and the released-to-tagged-number ratio respectively were P = 0.143 [Table 1.b.1)] and P = 0.003 [Table 1.b.2)].

Table 1.b.1) Weighted Logistic Analysis of Variation of 2000-Brood (2002-Outmigrant) Release-to-McNary-Dam Survival Indices (weight is number released)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio*	Type 1 P
Site	336.74	2	168.37	0.77	0.5025
Block (Raceway Pair)	1306.02	6	217.67	2.52	0.1431
Treatment (OCT versus SNT)	549.22	1	549.22	6.35	0.0453
Site x Treatment Interaction	64.59	2	32.30	0.37	0.7034
Error	519.09	6	86.52		

* Site tested against block; block, treatment, and interaction tested against error

Table 1.b.2) Weighted Logistic Analysis of Variation of 2000-Brood (2002-Outmigrant) Released-to-Tagged-Number Ratio (weight is number tagged)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio*	Type 1 P
Site	415.33	2	207.67	0.87	0.4652
Block (Raceway Pair)	1429.1	6	238.18	13.80	0.0028
Treatment	551.62	1	551.62	31.95	0.0013
Site x Treatment Interaction	138.04	2	69.02	4.00	0.0788
Error	103.59	6	17.27		

* Site tested against block; block, treatment, and interaction tested against error

Figure 1. Outmigrant SNT and OCT Treatment Release-to-McNary-Dam Survival Indices within Sites for Brood Years 1997 through 2000 (1999 through 2002 Outmigrants)

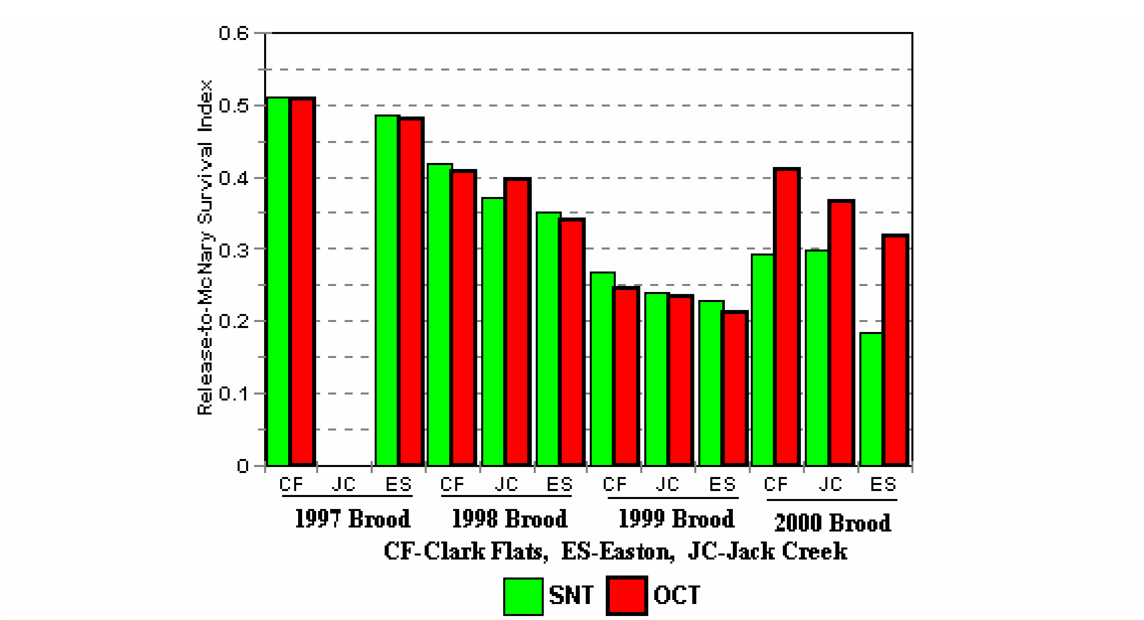


Table 1.c.1) Weighted Logistic Analysis of Covariation of 2000-Brood (2002-Outmigrant) Release-to-McNary-Dam Survival Indices adjusted for Mean BKD Severity Measure as Covariate (weight is number released)[8]

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio*	Type 1 P
Site	10.83	2	5.42	0.06	0.9440
Block (Raceway Pair)	558.66	6	93.11	1.65	0.2995
Treatment (OCT versus SNT)	16.11	1	16.11	0.29	0.6160
Site x Treatment	80.86	2	40.43	0.72	0.5326
Error	282.12	5	56.42		

* Site tested against block; block, treatment, and interaction tested against error

Table 1.c.2) Weighted Logistic Analysis of Covariation of 2000-Brood (2002-Outmigrant) Released-to-Tagged-Number Ratio adjusted for Mean BKD Severity Measure as Covariate (weight is number tagged)[9]

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 P
Site	792	2	396.00	6.35	0.0330
Block (Raceway Pair)	374.27	6	62.38	3.59	0.0911
Treatment	3.93	1	3.93	0.23	0.6545
Site x Treatment	30.42	2	15.21	0.88	0.4722
Error	86.9	5	17.38		

* Site tested against block; block, treatment, and interaction tested against error

[8] The weighted estimated logistic covariate coefficient associated with the error source of Table 1.c.1) was –1.1883 for logit of release-to-McNary survival index regressed on BKD severity mean as well as site, raceway-pair, treatment and site x treatment interaction indicators.

[9] The weighted estimated logistic covariate coefficient associated with the error source of Table 1.c.2) was –0.6419 for logit of released-to-tagged-number ratio regressed on BKD severity mean as well as site, raceway-pair, treatment and site x treatment interaction indicators.

Table 1.d. Number of Spring Chinook Tagged and Released, Release-to-McNary Survival Index and Released-to-Tagged-Number Ratio, and Mean BKD Severity Measure[10] by Raceway for 2000 Brood (CF--Clark Flats, JC--Jack Creek, ES--Easton)

Raceway Pair	Acclimation Pond Raceway*	Treatment**	Number Tagged	Overall Number Released	Overall Survival Index	Released/ Tagged Ratio	Average BKD Index
1	CF-01	SNT	2225	1618	0.0456	0.7272	2.1695
1	CF-02	OCT	2226	1953	0.2802	0.8774	1.3333
2	CF-03	SNT	2225	2094	0.3124	0.9411	1.5000
2	CF-04	OCT	2225	2186	0.4400	0.9825	1.1833
3	CF-05	SNT	2225	2146	0.4606	0.9645	1.2034
3	CF-06	OCT	2226	2201	0.4935	0.9888	1.0169
7	JC-01	SNT	2225	2179	0.3046	0.9793	1.9333
7	JC-02	OCT	2225	2137	0.3084	0.9604	1.3000
8	JC-03	SNT	2226	2185	0.3619	0.9816	1.4500
8	JC-04	OCT	2225	2182	0.4346	0.9807	1.5000
9	JC-05	SNT	2227	2102	0.2220	0.9439	1.5500
9	JC-06	OCT	2225	2161	0.3518	0.9712	1.2459
4	ES-01	SNT	2225	2161	0.3229	0.9712	1.9667
4	ES-02	OCT	2226	2185	0.3556	0.9816	1.1667
5	ES-03	SNT	2225	2026	0.1406	0.9106	2.4667
5	ES-04	OCT	2225	2160	0.2796	0.9708	1.3500
6	ES-05	SNT	2225	1737	0.0607	0.7807	3.1167
6	ES-06	OCT	2226	2167	0.3143	0.9735	1.3000

[10] Weighted Pearson correlation of BKD index and logit of survival index is –0.816 (weight is number released). Weighted Pearson correlation of BKD index and logit of released-to-tagged-number ration is –0.693 (weight is number tagged).

Table 1.e. Relative Distribution over BKD Severity Measure (Rank) of Sampled Fish within Raceway as well as Number of Fish Sampled and Sample Mean per Raceway for 2000-Brood (2002-Outmigrant) OCT-SNT Spring Chinook. [Data provided by Ray Brunson (United States Fish and Wildlife Service, Olympia, Washington.]

	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

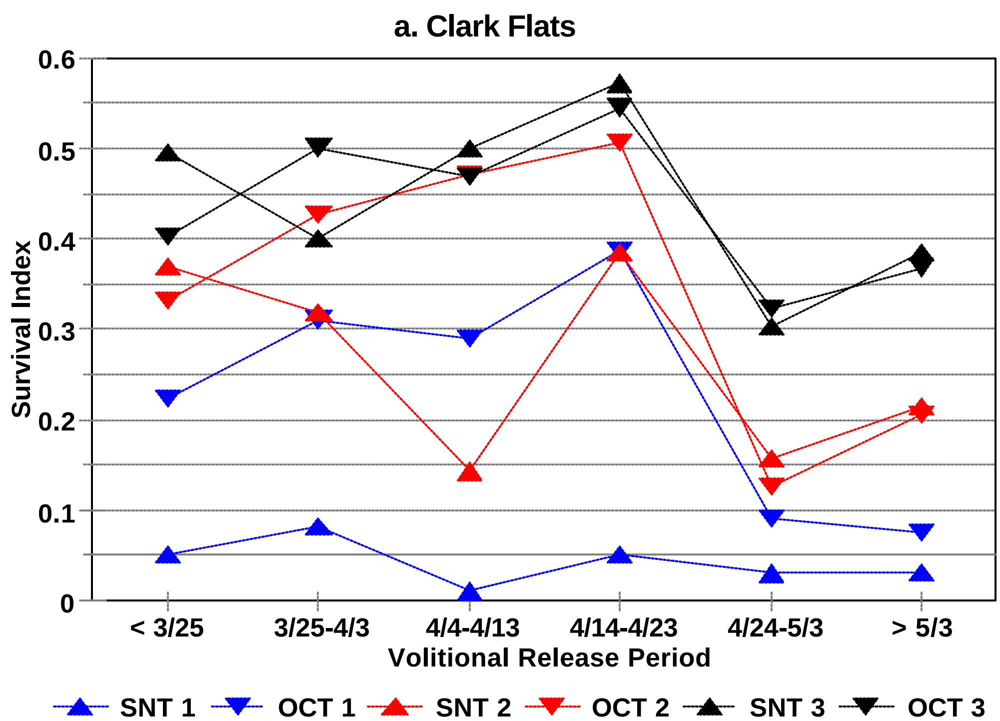
** Mean = Sum over ranks of product of rank and relative frequency within acclimation pond

The differences in the survival indices tended to persist throughout the volitional release period. For the Clark Flats, Jack Creek, Easton sites respectively, Figures 2.a through 2.c present individual raceway survival indices for six periods of volitional release:

1) before March 25[11],
2) March 25 through April 3,
3) April 4 through April 13,
4) April 14 though April 23,
5) April 24 through May 3, and
6) after May 3.

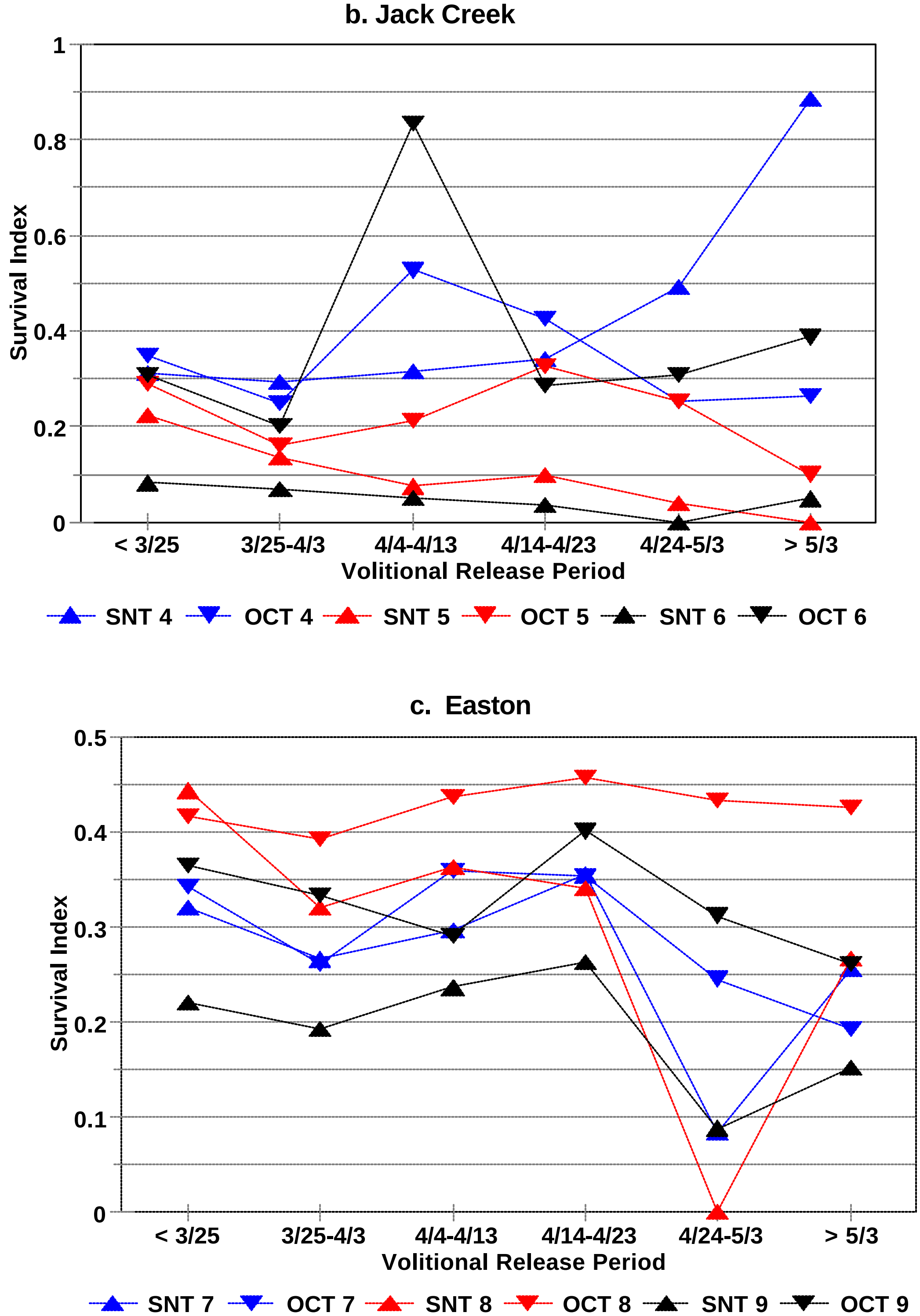
The general trend observable from these figures is that the SNT release-to-McNary survival index tends to be less than for the OCT for most raceway pairs over the volitional release period. (Data used to produce Figure 2 are given in Appendix B.)

Figure 2. **Brood-Year 2000 (2002-Outmigrant) SNT and OCT Treatment Release-to-McNary-Dam Survival Indices for Different Periods of Volitional Release**



[11] The acclimation pond screens were pulled on March 15

Figure 2. Brood-Year 2000 (2002-Outmigrant) SNT and OCT Treatment Release-to-McNary-Dam Survival Indices for Different Periods of Volitional Release



3. Brood-Year 1997 and 1998 OCT-SNT Smolt Release-to-Adult-Return Dam Survival

Release-to-Adult survival estimates based on PIT-tagged fish for the 1997 brood have been revised to include age-5 returns in addition to the age-3 and age-4 returns which were used to provide the estimates given in the 2001 annual report. Estimates presented here for the 1998 brood are based on age-3 and age-4 returns and should be regarded as incomplete because age-5 returns are not yet available.

3.a. Brood-Year 1997 Release-to-Adult Survival (age-3 through age-5 returns)

Brood-year 1997 release-to-adult survival indices were computed on a raceway basis by dividing the number of PIT-tagged adults detected at Roza by the number of juveniles that were originally tagged. In last year's annual report, there was an indication of a higher survival associated with the SNT treatment. The logistic analysis of variation's F-ratio associated with the OCT versus SNT treatment comparison had an associated estimated Type 1 error probability of P = 0.141 when based on only age-4 returns. This was the equivalent of P = 0.070 for a one-sided test for the SNT survival exceeding the OCT survival. However, the survival estimate based on the combined age-3 (year 2000) returns, age-4 (year 2001) returns, and age-5 (year 2002) returns revealed no significant difference between the OCT and SNT treatments. Table 2.a.1) presents the OCT and SNT weighted[12] means within each site as well as the treatment and site main effect means. Table 2.a.2) presents the associated logistic analysis of variation. Since the variation among blocks (among raceway pairs) was not significantly greater than that of error [Error (1) in Table 2.A.2)] at the 20% significance level (P = 0.205), the block and error sources were pooled to give the source of error [Error (2) in Table 2.a.2)] that is used for the statistical tests. None of the sources were significant when tested against Error (2) (P = 0.518 for Site, P = 0.339 for the Oct versus SNT Treatment comparison, and P = 0.400 for the Site x Treatment interaction). Individual raceway survival information is given in Table 2.a.3).

Table 2.a.1) 1997-Brood OCT and SNT Juvenile-Tagging[13]-to-Adult-Return Survival to Roza Dam on the Upper Yakima

Treatment		Site		
		Clark Flats	Jack Creek	Mean
SNT	Survival Index	0.0171	0.0143	0.0160
	Number Tagged	11879	7891	19770
OCT	Survival Index	0.0141	0.0145	0.0142
	Number Tagged	11867	7933	19800
Mean	Survival Index	0.0156	0.0144	0.0151
	Number Tagged	23746	15824	39570

[12] Weights are the number of fish PIT-tagged for each raceway.

[13] Based on number of fish PIT-tagged in raceways

Table 2.a.2) Logistic Analysis of Variation of 1997-Brood-Year Juvenile-Tagging-to-Adult-Return Survival to Roza Dam on the Upper Yakima

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio*	Type 1 Error P
Site	0.88	1	0.88	0.32	0.6122
Block	8.3	3	2.77	2.86	0.2054
Treatment (Trt)	2.01	1	2.01	2.08	0.2450
Site x Trt	1.53	1	1.53	1.58	0.2974
Error (1)	2.9	3	0.97		0.4073
Block and Error (1) Pooled serving as base for statitsical tests below					
	Dev	**DF**	**Dev/DF**	**F-Ratio****	**P**
Site	0.88	1	0.88	0.47	0.5180
Trt	2.01	1	2.01	1.08	0.3394
Site x Trt	1.53	1	1.53	0.82	0.4002
Error(2)	11.2	6	1.87		

* Site initially tested against Block source; Block, Treatment and Interaction tested against Error(1)

** Site, Treatment and Interaction tested against Error(2)

Table 2.a.3) Individual raceway survival information for the 1998-brood SNT and OCT releases.

Site	Raceway Pair	Treatment	Returns Age 3	Age 4	Age 5	Total to Date	Number Released
Easton	1	SNT	11	58	1	70	3958
Easton	1	OCT	9	44	6	59	3969
Easton	2	SNT	2	40	1	43	3933
Easton	2	OCT	0	55	1	56	3964
Clark Flats	3	SNT	5	53	0	58	3936
Clark Flats	3	OCT	4	41	1	46	3929
Clark Flats	4	SNT	5	70	0	75	3968
Clark Flats	4	OCT	10	47	2	59	3972
Clark Flats	5	SNT	9	59	2	70	3975
Clark Flats	5	OCT	10	50	2	62	3966

Site	Raceway Pair	Treatment	Proportion Age 3	Age 4	Age 5	Total to Date
Easton	1	SNT	0.002779	0.014654	0.000253	0.017686
Easton	1	OCT	0.002268	0.011086	0.001512	0.014865
Easton	2	SNT	0.000509	0.010170	0.000254	0.010933
Easton	2	OCT	0.000000	0.013875	0.000252	0.014127
Clark Flats	3	SNT	0.001270	0.013465	0.000000	0.014736
Clark Flats	3	OCT	0.001018	0.010435	0.000255	0.011708
Clark Flats	4	SNT	0.001260	0.017641	0.000000	0.018901
Clark Flats	4	OCT	0.002518	0.011833	0.000504	0.014854
Clark Flats	5	SNT	0.002264	0.014843	0.000503	0.017610
Clark Flats	5	OCT	0.002521	0.012607	0.000504	0.015633

3.b. Brood-Year 1998 Release-to-Adult Survival (age-3 through age-4 returns)

Brood-year 1998 release-to-adult survival indices were computed on a raceway basis by dividing the number of PIT-tagged adults detected at Roza by the number of juveniles detected leaving the raceway. The survival index based on the combined age-3 (year 2001) returns and age-4 (year 2002) returns revealed evidence of an interaction of the OCT and SNT comparisons with sites. Table 2.b.1) presents the OCT and SNT weighted[14] means. Table 2.b.2) presents the associated logistic analysis. Referring to Table 2.b.2) a), as with the 1997 brood, the Block and Error (1) source were pooled to produce Error (2) because the F-test of Block against Error (1) was not significant at the 20% level (P = 0.451). The OCT versus SNT Treatment x Site Interaction was nearly significant at the 5% level (P = 0.051); therefore comparisons were made between the OCT and SNT treatments within the individual sites. Referring to Table 2.b.2) b), the treatments did not significantly differ within Clark Flats and Easton (P = 0.431 and P = 0.207, respectively) but did significantly differ within Jack Creek (P = 0.029) with the survival of the SNT fish being less than that of the OCT fish.

The significant reduction in the SNT survival relative to OCT is driven primarily by the results for raceway pair 8 which are boldfaced in Table 2.b.3). The number of fish released from the OCT raceway is less than half of that in the SNT (1109 for OCT compared to 2279 for SNT) because of a major loss of the raceway-pair-8 OCT fish when transferred from Cle Elum to Jack Creek. The returns, however, are slightly higher for the OCT (14 for the OCT and 13 for the SNT). The result for raceway pair 8 is that the adult-return survival for the OCT is more than twice that of the SNT (0.0126 compared to 0.0057). The OCT adult survival from Jack Creek's other raceway pair (raceway pair 7) is also greater than that of SNT, but the magnitude of the difference is much less than that of raceway pair 8 (survival were 0.0118 for OCT and 0.0085 for SNT). Final determination of the effects of the treatments will require the inclusion of brood-year 1998's age-5 returns in 2003. Also presented in the Table 2.b.3) are the estimated smolt-to-smolt survival indices from release to McNary (2000 outmigrants). As can be seen in Table 2.b.3), the OCT and SNT juvenile survival indices to McNary for raceways 7 and 8 indicate little difference between the Jack Creek OCT and SNT estimates, although the direction of the juvenile survival is the same as that for the release-to-adult survival proportion (OCT's survival index > SNT's).

[14] Weights are the number of PIT-tagged detections leaving the raceway.

Table 2.b.1) 1998-Brood OCT and SNT Juvenile-Release[15]-to-Adult-Return Survival to Roza Dam on the Upper Yakima

Treatment		Clark Flats	Jack Creek	Easton	Mean
		Site			
SNT	Survival Index	0.0120	0.0071	0.0095	0.0099
	Release Number	7253	4619	7151	19023
OCT	Survival Index	0.0107	0.0121	0.0076	0.0098
	Retelease Number	7287	3562	7192	18041
Mean	Survival Index	0.0113	0.0093	0.0086	0.0098
	Release Number	14540	8181	14343	37064

Table 2.b.2) Logistic Analysis of 1998-Brood Juvenile-Release-to-Adult-Return Survival to Roza Dam on the Upper Yakima

a) Analysis of Variation

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio*	Type 1 Error P
Site	5.96	2	2.98	3.52	0.1110
Block	4.23	5	0.85	1.12	0.4513
Treatment (SNT vs, OCT)	0.06	1	0.06	0.08	0.7892
Site x Treatment	6.47	2	3.24	4.29	0.0822
Error (1)	3.77	5	0.75		0.5830
Block and Error (1) Pooled serving as base for statitsical tests below					
	Dev	**DF**	**Dev/DF**	**F-Ratio****	**P**
Site	5.96	2	2.98	3.73	0.0618
Treatment	0.06	2	0.03	0.08	0.9283
Site x Treatment	6.47	2	3.24	4.04	0.0517
Error(2)	8	10	0.80		0.6288

* Site initially tested against Block source; Block, Treatment and Interaction tested against Error(1)

** Site, Treatment and Interaction tested against Error(2)

[15] Based on number of PIT-tagged fish detected volitionally leaving the raceways.

Table 2.b.2) Logistic Analysis of 1998-Brood Juvenile-Release-to-Adult-Return Survival to Roza Dam on the Upper Yakima (continued)

b) Mean Comparisons

Treatment		Site			
		Clark Flats	Jack Creek	Easton	Mean
SNT	Survival Index	0.0120	0.0071	0.0095	0.0099
	Logit Transform	-4.4112	-4.9343	-4.6459	
	SE(Logit)	0.0965	0.1562	0.1090	
	Release Number	7253	4619	7151	19023
OCT	Survival Index	0.0107	0.0121	0.0076	0.0098
	Logit Transform	-4.5264	-4.4047	-4.8657	
	SE(Logit)	0.1018	0.1372	0.1211	
	Release Number	7287	3562	7192	18041
Mean	Survival Index	0.0113	0.0093	0.0086	0.0098
	Release Number	14540	8181	14343	37064
SNT versus OCT					
	Difference	0.001291	-0.004927	0.001862	
	Logit Difference	0.1152	-0.5295	0.2198	
	SE(Logit Difference)	0.1403	0.2079	0.1629	
	t-ratio	0.82	-2.55	1.35	
	Type 1 P	0.4307	0.0290	0.2070	

Table 2.b.3) Individual raceway survival information for the 1998-Brood SNT and OCT releases.

Site	Raceway Pair	Treatment	Adult Returns Age 3	Adult Returns Age 4	Adult Returns Total to Date	Number Released
Easton	1	SNT	3	11	14	2343
Easton	1	OCT	5	13	18	2404
Easton	2	SNT	7	19	26	2392
Easton	2	OCT	1	18	19	2349
Easton	3	SNT	1	27	28	2416
Easton	3	OCT	0	18	18	2439
Clark Flats	4	SNT	3	27	30	2426
Clark Flats	4	OCT	0	23	23	2453
Clark Flats	5	SNT	5	23	28	2429
Clark Flats	5	OCT	5	23	28	2423
Clark Flats	6	SNT	7	22	29	2398
Clark Flats	6	OCT	1	26	27	2411
Jack Creek	7	SNT	5	15	20	2340
Jack Creek	7	OCT	2	27	29	2453
Jack Creek	**8**	**SNT**	**3**	**10**	**13**	**2279**
Jack Creek	**8**	**OCT**	**6**	**8**	**14**	**1109**

Site	Raceway Pair	Treatment	Adult Proportion Age 3	Adult Proportion Age 4	Adult Proportion Total to Date	Juvenile Survival to McNary
Easton	1	SNT	0.001280	0.004695	0.005975	0.3969
Easton	1	OCT	0.002080	0.005408	0.007488	0.3663
Easton	2	SNT	0.002926	0.007943	0.010870	0.3921
Easton	2	OCT	0.000426	0.007663	0.008089	0.4190
Easton	3	SNT	0.000414	0.011175	0.011589	0.3740
Easton	3	OCT	0.000000	0.007380	0.007380	0.3595
Clark Flats	4	SNT	0.001237	0.011129	0.012366	0.2832
Clark Flats	4	OCT	0.000000	0.009376	0.009376	0.3063
Clark Flats	5	SNT	0.002058	0.009469	0.011527	0.3367
Clark Flats	5	OCT	0.002064	0.009492	0.011556	0.3355
Clark Flats	6	SNT	0.002919	0.009174	0.012093	0.3209
Clark Flats	6	OCT	0.000415	0.010784	0.011199	0.2956
Jack Creek	7	SNT	0.002137	0.006410	0.008547	0.3600
Jack Creek	7	OCT	0.000815	0.011007	0.011822	0.3879
Jack Creek	**8**	**SNT**	**0.001316**	**0.004388**	**0.005704**	**0.3390**
Jack Creek	**8**	**OCT**	**0.005410**	**0.007214**	**0.012624**	**0.3442**

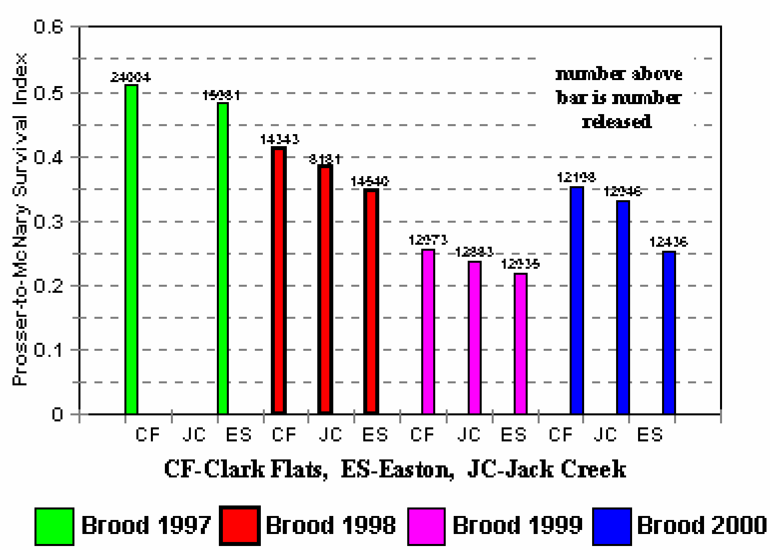
3.c. Consistency between release-to-adult survival and juvenile release-to-McNary survival

For the 1997-brood adult returns, Clark Flats release survival exceeded that of Easton. For the 1998-brood adult returns, Clark Flats (CF) survival exceeded that of Jack Creek[16] (JC), and Jack Creek survival exceeded that of Easton (ES). The same relations held for smolt-to-smolt survival indices (release-to-McNary passage survival). Referring to Figure 3 for all brood years to date (1997, 1998, 1999, 2000), the relative release-to-McNary smolt survival-index estimates over the sites have been the same:

Survival Index (CF) > Survival Index (JC) > Survival Index (ES).

For the 1997-brood release-to-McNary smolt survival index, neither the treatment nor the treatment x site interactions were significant [respectively P = 0.811 and P = 0.873, refer to Table 2.d.1)]. This was also the case for the tagged-to-adult-return analysis [respectively P= 0.339 and P = 0.400, refer back to Table 2.a.2)]. However, for the 1998 brood, there was not a consistency in the degrees of significance between the smolt-survival and the adult-survival analyses. Neither the treatment nor the treatment x site interactions were significant for the smolt survival-index analysis [respectively P = 0.713 and P = 0.673, refer to Table 2.d.2)], but recall that, for the adult analysis, the site x treatment interaction was nearly significant at the 5% level [Site x Treatment interaction P = 0.052, refer back to Table 2.b.2)a)]. Even so, the direction of OCT and SNT smolt-to-smolt survival-index differences was the same as that of the smolt-to-adult survival for the 1998 brood: the SNT survival index being less than that of the OCT for Jack Creek but not for Clark Flats or Easton (refer to Figure 4); however, the difference for Jack Creek is far more dramatic for smolt-to-adult survival than for smolt-smolt survival.

Figure 3. Smolt Survival to McNary Dam for Brood Years 1997 through 2000



[16] There were no Jack Creek releases for the 1997 brood.

Figure 4. **Relative 1998-Brood SNT and OCT Smolt Survivals (release-to-McNary Dam) and Adult Survivals (Release to Roza Dam Return--Age 3 and 4)**

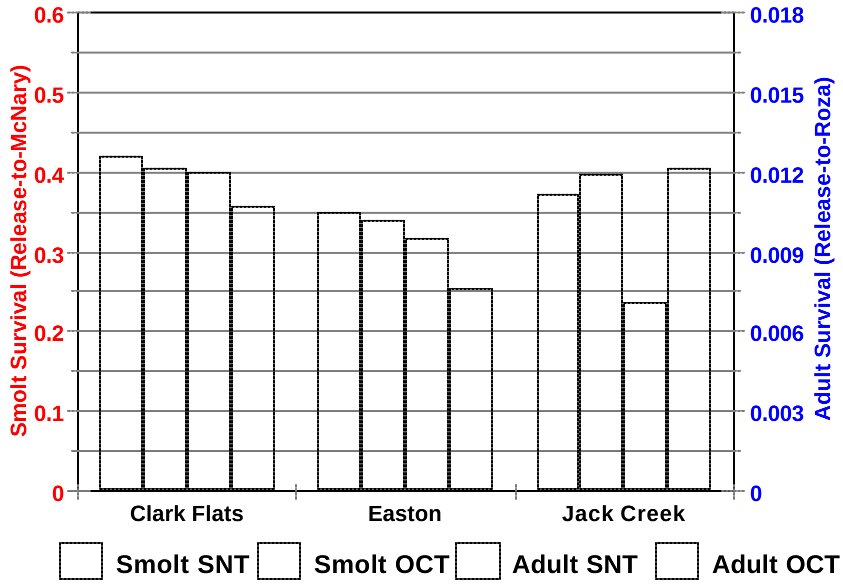


Table 2.d.1) **Weighted Logistic Analysis of Variation of OCT and SNT Smolt-to-Smolt Survival Indices over Sites for 1997-Brood Outmigrants (Weight = Number of PIT-Tagged Fish Released)**

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P
Site[1]	30.86	1	30.86	1.89	0.2628
Block[2]	48.96	3	16.32	1.29	0.4187
Treatment (Trt)[2]	0.90	1	0.90	0.07	0.8067
Site x Trt Interaction [2]	0.40	1	0.40	0.03	0.8700
Error(1)	37.84	3	12.61		
Site[3]	30.86	1	30.86	2.13	0.1944
Trt[3]	0.90	1	0.90	0.06	0.8114
Site x Trt Interaction[3]	0.40	1	0.40	0.03	0.8734
Error(2)[4]	86.80	6	14.47		

[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 2.d.2) Weighted Logistic Analysis of Variation of OCT and SNT Smolt-to-Smolt Survival Indices over Sites for 1998-Brood Outmigrants (Weight = Number of PIT-Tagged Fish Released)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P
Site[1]	137.31	2	68.66	7.18	0.0339
Block[2]	47.82	5	9.56	9.56	0.2405
Treatment (Trt)[2]	1.00	1	1.00	0.23	0.6539
Site x Trt Interaction [2]	5.76	2	2.88	0.65	0.5595
Error(1)	22.03	5	4.41		
Site[3]	137.31	2	68.66	9.83	0.0044
Trt[3]	1.00	1	1.00	0.14	0.7131
Site x Trt Interaction[3]	5.76	2	2.88	0.41	0.6729
Error(2)[4]	69.85	10	6.99		

[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

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[17]. Least squares analysis assumes that the variance of the estimates is constant over releases. In the case of survival proportions, this is not expected to be true. The assumption behind the logistic analysis of variation used is that the variance in survival is proportional to what would be expected in the case of a binomially distributed proportion:

$$\text{Variance proportional to } \frac{S*(1-S)}{n}$$

wherein S is the expected proportion surviving for the release and n is the number of fish released. The variance of the survival estimate would change as the survival changed over releases, making the traditional analysis of variance inappropriate. Further, the number released varied over releases; this variation in n in the above equation would also contribute to the variance of the survival proportion estimate changing 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

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

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

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

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

In running the analysis, site main effect, treatment main effect, and site x treatment measures of variation were computed as follows

Site Main Effect = Difference in
Regression on Site and Treatment Indicators and
Regression on Treatment Indicators

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

Treatment Main Effect = Difference in
Regression on Block (including Site) and Treatment Indicators and
Regression on Block Indicators

Site x Treatment Indicator = Difference between
Regression on Block, and Treatment, and Interaction Indicators and
Regression on Block, and Treatment Indicators

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

$$\text{Release-to-McNary Survival Index} = \frac{\displaystyle\sum_{\text{strata}} \frac{\text{Number of Fish Detected at McNary during Stratum}}{\text{Stratum's McNary Detection Efficiency}}}{\text{Number of PIT-Tagged Fish Released}}$$

wherein a stratum is a group of contiguous McNary detection dates among which the daily detection efficiencies[18] are sufficiently homogeneous to permit the use of a pooled estimate of the detection efficiency for that stratum. The pooled estimate is a pooling of the daily detection efficiency estimates over all dates within the stratum.

Within a stratum, the detection efficiency is estimated as follows:

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

The method of pooling is given in Appendix B. The downstream-dam count actually represents a pooling of counts from John Day and Bonneville dams[19]. A major reason for

[18] 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.

[19] 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 the fish detected at both John Day and Bonneville dams were used twice to estimate the McNary detection efficiency (an effective “sampling with replacement”).

referring to the survival measure as a survival index instead of survival is that there are known biases associated estimate, which are discussed in Appendix B.

The release-to-McNary smolt-to-smolt survival-index estimates for the different volitional release periods as well as the estimates for the whole volitional release are given in Table A.1 for each acclimation pond; this is the data-base summary used to generate Figure 2 in the text as well a data-base used for the analysis summaries for release-to-McNary smolt survival indices in the text. The number of detections for each McNary detection-efficiency stratum, the associated estimated detection efficiencies, and the number of expanded McNary detections are given in Table A.2; the information in this table was that used to create the data summaries given in Table A.1.

The Brood-Year-2000 estimators for Release-to-McNary survival indices are somewhat different than those for previous brood years. For the 2000-brood (2002-outmigrant) McNary detection efficiencies were based on detections of all Spring Chinook released into the Upper Yakima; in previous years the efficiencies were based on only OCT-SNT releases. Further, for the 2000 brood, McNary detections of OCT-SNT fish were restricted to only those fish previously detected when exiting the acclimation ponds; for previous broods, all OCT-SNT detections at McNary were used, whether or not previously detected exiting raceways. Efforts will be made next year to standardize the estimation procedures over all brood years (1997 through 2001). Alternative survival estimation procedures will also be investigated.

Weighted logistic analyses of variation were also used to analyze the released-to-tagged-number ratios and to analyze the release-to-Roza adult return survival estimates; the weighting variable for the former being the number of fish tagged, and the weighting variable for the latter being the number of volitionally released fish[20]. The tagged number and tagged-to-released-number ratio in text Table 1.d) served as the database used for the analyses of the released-to-tagged-number ratio. The data in text Tables 2.a.3) and 2.b.3) were used respectively for the 1997-brood and 1998-brood smolt-to-adult survival analyses.

Whenever standard errors are presented, the binomially based standard errors from computer output were expanded by the error mean deviance. The underlying assumption is not that the variance of the survival proportion is that for the binomial; rather, the assumption is that variance is proportional to that for the binomial, the mean deviance serving as an estimate of the proportionality constant.

[20] Recall that the number tagged served as the base for the 1997-brood release-to-McNary smolt survival index because the number of fish volitionally released was not available.

Table A.1. Estimates of Release-to-McNary Survival Indices within Release-Day Periods[21] and over the Whole Release Period

Site Pond	Treat-ment	Ending Exit Date 3/24/02 Number Released	Survival Index	Ending Exit Date 4/3/02 Number Released	Survival Index	Ending Exit Date 4/13/02 Number Released	Survival Index	Ending Exit Date 4/23/02 Number Released	Survival Index
CF-01	SNT	151	0.05072	438	0.08163	400	0.01025	345	0.05097
CF-02	OCT	110	0.22380	298	0.311	460	0.28992	675	0.38709
CF-03	SNT	203	0.36923	983	0.31901	198	0.14313	542	0.38474
CF-04	OCT	198	0.33230	573	0.42616	382	0.47036	878	0.50649
CF-05	SNT	135	0.49492	932	0.40021	113	0.49991	706	0.57202
CF-06	OCT	120	0.40213	707	0.5012	208	0.4685	914	0.54506
CF-Total		917	0.31417	3931	0.35959	1761	0.2836	4060	0.45176
JC-01	SNT	325	0.32059	616	0.26605	449	0.29584	673	0.35453
JC-02	OCT	668	0.34291	124	0.26099	225	0.35853	499	0.35276
JC-03	SNT	479	0.44313	514	0.32033	492	0.36269	671	0.34086
JC-04	OCT	525	0.41620	208	0.39241	320	0.43631	894	0.45612
JC-05	SNT	338	0.22071	354	0.1921	332	0.23627	793	0.26268
JC-06	OCT	805	0.36533	116	0.33281	217	0.29117	650	0.4006
JC_Total		3140	0.36074	1932	0.28423	2035	0.3308	4180	0.36359
ES-01	SNT	1469	0.31048	142	0.2923	68	0.31491	396	0.33975
ES-02	OCT	1249	0.34783	42	0.24894	43	0.52654	540	0.42618
ES-03	SNT	767	0.22171	273	0.13526	180	0.07432	599	0.09668
ES-04	OCT	1643	0.28811	43	0.15946	21	0.21123	236	0.32748
ES-05	SNT	666	0.08191	352	0.06921	209	0.05115	367	0.03715
ES-06	OCT	1203	0.30710	61	0.20266	55	0.83463	614	0.28665
ES-Total		6997	0.27983	913	0.14509	576	0.20567	2752	0.25055

Site Pond	Treat-ment	Ending Exit Date 5/3/02 Number Released	Survival Index	Ending Exit Date 5/13/02 Number Released	Survival Index	Ending Exit Date 5/23/02 Number Released	Survival Index	Ending Exit Date 6/2/02 Number Released	Survival Index	Ending Exit Date Total Number Released	Survival Index
CF-01	SNT	212	0.03039	56	0.04045	11	0.00000	5	0.00000	1618	0.04561
CF-02	OCT	253	0.09186	88	0.11018	60	0.03775	9	0.00000	1953	0.28016
CF-03	SNT	127	0.15757	31	0.28396	10	0.00000	0	0.00000	2094	0.31243
CF-04	OCT	56	0.12672	42	0.06150	32	0.27958	25	0.35333	2186	0.43999
CF-05	SNT	144	0.30253	36	0.35437	55	0.49930	25	0.17667	2146	0.46055
CF-06	OCT	107	0.32265	83	0.33623	42	0.41918	20	0.39547	2201	0.49350
CF-Total		899	0.15003	336	0.19051	210	0.26799	84	0.25190	12198	0.35346
JC-01	SNT	31	0.08333	30	0.07550	55	0.35399	0	0.00000	2179	0.30464
JC-02	OCT	404	0.24546	192	0.21760	25	0.00000	0	0.00000	2137	0.30841
JC-03	SNT	4	0.00000	19	0.35166	6	0.00000	0	0.00000	2185	0.36190
JC-04	OCT	95	0.43308	86	0.26144	54	0.68714	0	0.00000	2182	0.43457
JC-05	SNT	96	0.08830	139	0.20672	50	0.00000	0	0.00000	2102	0.22196
JC-06	OCT	127	0.31195	233	0.27587	13	0.00000	0	0.00000	2161	0.35176
JC_Total		757	0.25229	699	0.23780	203	0.27870	0	0.00000	12946	0.33127
ES-01	SNT	81	0.49146	3	1.47222	2	0.00000	0	0.00000	2161	0.32290
ES-02	OCT	225	0.25159	46	0.34420	40	0.16987	0	0.00000	2185	0.35557
ES-03	SNT	163	0.04011	28	0.00000	9	0.00000	6	0.00000	2026	0.14058
ES-04	OCT	133	0.25346	61	0.07240	22	0.17976	1	0.00000	2160	0.27964
ES-05	SNT	96	0.00000	32	0.07078	14	0.00000	1	0.00000	1737	0.06074
ES-06	OCT	164	0.30739	44	0.26204	26	0.59673	0	0.00000	2167	0.31434
ES-Total		862	0.21703	214	0.17972	113	0.23243	8	0.00000	12436	0.25331

[21] Release periods indicted in table by ending exit date which is the last volitional-release detection day for the period, the next volitional-release day being associated with the next period.

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima

a. Site--Clark Flats, Raceway 1, SNT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	0	0	0	0	1	2	0	0	1	0	0	0	0
4/3/02	93	2	1	0	1	1	5	3	2	1	1	0	0	0
4/13/02	103	0	0	0	0	0	0	1	0	1	0	0	0	0
4/23/02	113	0	1	0	0	1	5	1	0	0	1	0	0	0
5/3/02	123	0	0	0	0	0	0	1	1	0	1	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	0	1	0	0
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	0.00	0.00	0.00	0.00	1.95	3.45	0.00	0.00	2.26	0.00	0.00	0.00	0.00	7.6585429	151	0.0507
4/3/02	93	6.01	2.58	0.00	2.18	1.95	8.63	5.53	4.03	2.26	2.58	0.00	0.00	0.00	35.752554	438	0.0816
4/13/02	103	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	2.26	0.00	0.00	0.00	0.00	4.0994644	400	0.0102
4/23/02	113	0.00	2.58	0.00	0.00	1.95	8.63	1.84	0.00	0.00	2.58	0.00	0.00	0.00	17.583612	345	0.0510
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	1.84	2.02	0.00	2.58	0.00	0.00	0.00	6.4426686	212	0.0304
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	0.00	2.2649351	56	0.0404
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	11	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	5	0.0000
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	
	Total	6.01	5.15	0.00	2.18	5.85	20.72	11.06	6.05	6.77	7.75	2.26	0.00	0.00	73.801777	1618	0.0456

b. Site--Clark Flats, Raceway 2, OCT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	3	3	1	0	0	2	0	1	0	0	0	0	0
4/3/02	93	7	8	8	5	2	6	1	0	1	1	0	0	0
4/13/02	103	2	2	3	10	10	22	6	10	2	0	0	0	0
4/23/02	113	1	0	5	9	11	66	15	17	5	7	0	0	0
5/3/02	123	0	0	0	0	0	0	0	4	1	5	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	2	2	0	0
5/23/02	143	0	0	0	0	0	0	0	0	0	0	1	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	9.02	7.73	2.40	0.00	0.00	3.45	0.00	2.02	0.00	0.00	0.00	0.00	0.00	24.618266	110	0.2238
4/3/02	93	21.05	20.61	19.18	10.90	3.90	10.36	1.84	0.00	2.26	2.58	0.00	0.00	0.00	92.679089	298	0.3110
4/13/02	103	6.01	5.15	7.19	21.79	19.49	37.98	11.06	20.17	4.51	0.00	0.00	0.00	0.00	133.36127	460	0.2899
4/23/02	113	3.01	0.00	11.99	19.61	21.44	113.95	27.64	34.29	11.28	18.08	0.00	0.00	0.00	261.28595	675	0.3871
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.07	2.26	12.92	0.00	0.00	0.00	23.239563	253	0.0919
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.17	4.53	0.00	0.00	9.6960469	88	0.1102
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	0.00	2.2649351	60	0.0377
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	9	0.0000
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	
	Total	39.09	33.50	40.76	52.30	44.82	165.74	40.54	64.54	20.31	38.75	6.79	0.00	0.00	547.14512	1953	0.2802

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

c. Site--Clark Flats, Raceway 3, SNT Treatment

Total Detections

Total Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	6	5	3	2	6	7	1	1	1	1	0	0	0
4/3/02	93	7	11	19	15	12	55	12	12	6	3	0	0	0
4/13/02	103	0	0	1	0	3	6	2	3	0	0	0	0	0
4/23/02	113	0	0	3	3	4	37	11	27	10	10	0	0	0
5/3/02	123	0	0	0	0	0	0	0	0	2	6	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	1	1	1	0
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	18.04	12.88	7.19	4.36	11.69	12.09	1.84	2.02	2.26	2.58	0.00	0.00	0.00	74.95	203	0.3692
4/3/02	93	21.05	28.34	45.56	32.69	23.39	94.96	22.11	24.20	13.54	7.75	0.00	0.00	0.00	313.58	983	0.3190
4/13/02	103	0.00	0.00	2.40	0.00	5.85	10.36	3.69	6.05	0.00	0.00	0.00	0.00	0.00	28.34	198	0.1431
4/23/02	113	0.00	0.00	7.19	6.54	7.80	63.88	20.27	54.45	22.57	25.83	0.00	0.00	0.00	208.53	542	0.3847
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.51	15.50	0.00	0.00	0.00	20.01	127	0.1576
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	2.26	3.95	0.00	8.80	31	0.2840
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	39.09	41.22	62.35	43.58	48.72	181.28	47.91	86.72	42.88	54.24	2.26	3.95	0.00	654.22	2094	0.3124

d. Site--Clark Flats, Raceway 4, OCT Treatment

Total Detections

Total Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	4	5	3	2	2	6	1	4	0	2	0	0	0
4/3/02	93	8	8	11	10	11	43	11	7	6	3	0	0	0
4/13/02	103	2	0	3	8	8	42	16	10	5	0	0	0	0
4/23/02	113	0	0	5	7	12	92	37	43	22	11	1	0	0
5/3/02	123	0	0	0	0	0	0	0	0	2	1	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	1	0	0	0
5/23/02	143	0	0	0	0	0	0	0	0	0	0	2	0	1
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	2
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	12.03	12.88	7.19	4.36	3.90	10.36	1.84	8.07	0.00	5.17	0.00	0.00	0.00	65.80	198	0.3323
4/3/02	93	24.06	20.61	26.38	21.79	21.44	74.24	20.27	14.12	13.54	7.75	0.00	0.00	0.00	244.19	573	0.4262
4/13/02	103	6.01	0.00	7.19	17.43	15.59	72.51	29.48	20.17	11.28	0.00	0.00	0.00	0.00	179.68	382	0.4704
4/23/02	113	0.00	0.00	11.99	15.25	23.39	158.84	68.18	86.72	49.65	28.41	2.26	0.00	0.00	444.70	878	0.5065
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.51	2.58	0.00	0.00	0.00	7.10	56	0.1267
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	0.00	0.00	0.00	2.58	42	0.0615
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.53	0.00	4.42	8.95	32	0.2796
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.83	8.83	25	0.3533
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	42.10	33.50	52.75	58.84	64.31	315.94	119.78	129.08	78.99	46.50	6.79	0.00	13.25	961.82	2186	0.4400

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

e. Site--Clark Flats, Raceway 5, SNT Treatment

Total Detections

Total Detections		Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency
Ending Release Date		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	9	4	3	2	1	7	1	1	0	0	0	0	0
4/3/02	93	18	17	16	17	15	55	10	11	4	10	0	0	0
4/13/02	103	0	3	2	2	2	9	6	1	2	1	0	0	0
4/23/02	113	0	4	5	8	11	78	21	38	21	16	0	1	0
5/3/02	123	0	0	0	0	0	0	1	0	3	12	0	1	0
5/13/02	133	0	0	0	0	0	0	0	0	0	1	1	2	0
5/23/02	143	0	0	0	0	0	0	0	0	0	1	4	4	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	1
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	27.06	10.31	7.19	4.36	1.95	12.09	1.84	2.02	0.00	0.00	0.00	0.00	0.00	66.814619	135	0.4949
4/3/02	93	54.13	43.80	38.37	37.04	29.23	94.96	18.43	22.19	9.03	25.83	0.00	0.00	0.00	372.99765	932	0.4002
4/13/02	103	0.00	7.73	4.80	4.36	3.90	15.54	11.06	2.02	4.51	2.58	0.00	0.00	0.00	56.489479	113	0.4999
4/23/02	113	0.00	10.31	11.99	17.43	21.44	134.67	38.70	76.64	47.39	41.33	0.00	3.95	0.00	403.84415	706	0.5720
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	6.77	31.00	0.00	3.95	0.00	43.564655	144	0.3025
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	2.26	7.91	0.00	12.757357	36	0.3544
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	9.06	15.82	0.00	27.461495	55	0.4993
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.42	4.4166667	25	0.1767
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	
	Total	81.19	72.14	62.35	63.19	56.52	257.24	71.87	102.86	67.70	105.91	11.32	31.64	4.42	988.34607	2146	0.4606

f. Site--Clark Flats, Raceway 6, OCT Treatment

Total Detections

Total Detections		Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency
Ending Release Date		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	7	2	1	2	1	4	1	1	0	1	0	0	0
4/3/02	93	25	24	16	7	15	39	10	15	3	3	0	1	0
4/13/02	103	1	1	3	3	2	23	6	7	3	1	0	0	0
4/23/02	113	1	2	13	12	20	110	34	41	15	8	0	1	0
5/3/02	123	0	0	0	0	0	0	0	4	6	5	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	3	5	0	2
5/23/02	143	0	0	0	0	0	0	0	0	0	2	2	2	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	2	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	21.05	5.15	2.40	4.36	1.95	6.91	1.84	2.02	0.00	2.58	0.00	0.00	0.00	48.26	120	0.4021
4/3/02	93	75.17	61.84	38.37	15.25	29.23	67.33	18.43	30.25	6.77	7.75	0.00	3.95	0.00	354.35	707	0.5012
4/13/02	103	3.01	2.58	7.19	6.54	3.90	39.71	11.06	14.12	6.77	2.58	0.00	0.00	0.00	97.45	208	0.4685
4/23/02	113	3.01	5.15	31.17	26.15	38.98	189.91	62.65	82.69	33.85	20.66	0.00	3.95	0.00	498.19	914	0.5451
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.07	13.54	12.92	0.00	0.00	0.00	34.52	107	0.3226
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.75	11.32	0.00	8.83	27.91	83	0.3362
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.17	4.53	7.91	0.00	17.61	42	0.4192
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.91	0.00	7.91	20	0.3955
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	102.24	74.72	79.13	52.30	74.06	303.86	93.98	137.15	60.93	59.41	15.85	23.73	8.83	1086.19	2201	0.4935

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

g. Site--Jack Creek, Raceway 1, SNT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	4	7	6	1	5	17	1	2	1	4	0	0	0
4/3/02	93	1	2	6	6	5	28	8	10	5	6	2	1	0
4/13/02	103	1	1	1	3	4	27	6	11	7	4	2	0	0
4/23/02	113	0	0	1	2	4	21	16	25	13	28	1	1	0
5/3/02	123	0	0	0	0	0	0	0	0	0	1	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	0	1	0	0
5/23/02	143	0	0	0	0	0	0	0	0	0	0	1	1	3
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	12.03	18.04	14.39	2.18	9.74	29.35	1.84	4.03	2.26	10.33	0.00	0.00	0.00	104.19	325	0.3206
4/3/02	93	3.01	5.15	14.39	13.07	9.74	48.34	14.74	20.17	11.28	15.50	4.53	3.95	0.00	163.88	616	0.2660
4/13/02	103	3.01	2.58	2.40	6.54	7.80	46.61	11.06	22.19	15.80	10.33	4.53	0.00	0.00	132.83	449	0.2958
4/23/02	113	0.00	0.00	2.40	4.36	7.80	36.26	29.48	50.42	29.34	72.33	2.26	3.95	0.00	238.60	673	0.3545
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	0.00	0.00	0.00	2.58	31	0.0833
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	0.00	2.26	30	0.0755
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	3.95	13.25	19.47	55	0.3540
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	18.04	25.77	33.57	26.15	35.08	160.56	57.12	96.81	58.68	111.07	15.85	11.86	13.25	663.82	2179	0.3046

h. Site--Jack Creek, Raceway 2, OCT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	9	10	9	5	9	32	12	6	8	4	0	1	1
4/3/02	93	1	1	1	1	2	3	2	1	1	2	0	0	0
4/13/02	103	1	0	1	1	1	10	8	4	4	7	0	1	0
4/23/02	113	0	0	0	3	1	10	8	17	16	20	4	0	1
5/3/02	123	0	0	0	0	0	0	0	1	3	25	4	2	2
5/13/02	133	0	0	0	0	0	0	0	0	0	4	3	4	2
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	27.06	25.77	21.58	10.90	17.54	55.25	22.11	12.10	18.05	10.33	0.00	3.95	4.42	229.06	668	0.3429
4/3/02	93	3.01	2.58	2.40	2.18	3.90	5.18	3.69	2.02	2.26	5.17	0.00	0.00	0.00	32.36	124	0.2610
4/13/02	103	3.01	0.00	2.40	2.18	1.95	17.26	14.74	8.07	9.03	18.08	0.00	3.95	0.00	80.67	225	0.3585
4/23/02	113	0.00	0.00	0.00	6.54	1.95	17.26	14.74	34.29	36.11	51.66	9.06	0.00	4.42	176.03	499	0.3528
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.02	6.77	64.58	9.06	7.91	8.83	99.17	404	0.2455
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.33	6.79	15.82	8.83	41.78	192	0.2176
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	33.08	28.34	26.38	21.79	25.34	94.96	55.28	58.49	72.22	160.15	24.91	31.64	26.50	659.07	2137	0.3084

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

i. Site--Jack Creek, Raceway 3, SNT Treatment

Total Detections

Total Detections Ending Release Date Calendar	 Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	14	7	8	7	5	26	9	12	3	6	0	0	0
4/3/02	93	7	4	4	10	4	20	9	13	3	3	1	0	0
4/13/02	103	1	1	3	3	7	26	13	14	9	10	1	0	0
4/23/02	113	0	0	2	1	4	26	10	21	16	24	1	2	0
5/3/02	123	0	0	0	0	0	0	0	0	0	0	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	0	1	0	1
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	 Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	42.10	18.04	19.18	15.25	9.74	44.89	16.58	24.20	6.77	15.50	0.00	0.00	0.00	212.26	479	0.4431
4/3/02	93	21.05	10.31	9.59	21.79	7.80	34.53	16.58	26.22	6.77	7.75	2.26	0.00	0.00	164.65	514	0.3203
4/13/02	103	3.01	2.58	7.19	6.54	13.64	44.89	23.96	28.24	20.31	25.83	2.26	0.00	0.00	178.44	492	0.3627
4/23/02	113	0.00	0.00	4.80	2.18	7.80	44.89	18.43	42.35	36.11	61.99	2.26	7.91	0.00	228.72	671	0.3409
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4	0.0000
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	4.42	6.68	19	0.3517
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	66.15	30.92	40.76	45.76	38.98	169.19	75.55	121.01	69.96	111.07	9.06	7.91	4.42	790.75	2185	0.3619

j. Site--Jack Creek, Raceway 4, OCT Treatment

Total Detections

Total Detections Ending Release Date Calendar	 Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	17	14	11	6	8	20	4	6	3	6	0	0	0
4/3/02	93	2	2	8	2	2	13	0	3	3	3	0	0	0
4/13/02	103	1	2	2	7	7	27	5	8	8	3	0	0	0
4/23/02	113	0	1	4	5	10	49	32	41	30	25	1	0	1
5/3/02	123	0	0	0	0	0	0	0	2	4	5	3	1	1
5/13/02	133	0	0	0	0	0	0	0	0	0	2	2	1	2
5/23/02	143	0	0	0	0	0	0	0	0	0	1	2	2	5
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	 Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	51.12	36.07	26.38	13.07	15.59	34.53	7.37	12.10	6.77	15.50	0.00	0.00	0.00	218.50	525	0.4162
4/3/02	93	6.01	5.15	19.18	4.36	3.90	22.44	0.00	6.05	6.77	7.75	0.00	0.00	0.00	81.62	208	0.3924
4/13/02	103	3.01	5.15	4.80	15.25	13.64	46.61	9.21	16.13	18.05	7.75	0.00	0.00	0.00	139.62	320	0.4363
4/23/02	113	0.00	2.58	9.59	10.90	19.49	84.60	58.97	82.69	67.70	64.58	2.26	0.00	4.42	407.77	894	0.4561
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.03	9.03	12.92	6.79	3.95	4.42	41.14	95	0.4331
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.17	4.53	3.95	8.83	22.48	86	0.2614
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	4.53	7.91	22.08	37.11	54	0.6871
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	60.14	48.95	59.95	43.58	52.62	188.19	75.55	121.01	108.32	116.24	18.12	15.82	39.75	948.24	2182	0.4346

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

k. Site--Jack Creek, Raceway 5, SNT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	3	1	4	1	0	15	6	1	2	3	0	0	0
4/3/02	93	1	1	2	1	4	8	4	8	0	4	0	0	0
4/13/02	103	0	0	2	1	1	11	4	7	6	6	0	0	0
4/23/02	113	0	0	1	1	3	25	13	17	20	19	1	0	0
5/3/02	123	0	0	0	0	0	0	0	0	1	0	1	1	0
5/13/02	133	0	0	0	0	0	0	0	0	0	1	2	1	4
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	9.02	2.58	9.59	2.18	0.00	25.90	11.06	2.02	4.51	7.75	0.00	0.00	0.00	74.60	338	0.2207
4/3/02	93	3.01	2.58	4.80	2.18	7.80	13.81	7.37	16.13	0.00	10.33	0.00	0.00	0.00	68.00	354	0.1921
4/13/02	103	0.00	0.00	4.80	2.18	1.95	18.99	7.37	14.12	13.54	15.50	0.00	0.00	0.00	78.44	332	0.2363
4/23/02	113	0.00	0.00	2.40	2.18	5.85	43.16	23.96	34.29	45.13	49.08	2.26	0.00	0.00	208.31	793	0.2627
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	2.26	3.95	0.00	8.48	96	0.0883
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	4.53	3.95	17.67	28.73	139	0.2067
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	12.03	5.15	21.58	8.72	15.59	101.86	49.75	66.56	65.45	85.24	9.06	7.91	17.67	466.56	2102	0.2220

l. Site--Jack Creek, Raceway 6, OCT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	11	10	12	7	13	47	16	13	6	6	0	0	0
4/3/02	93	2	2	1	0	1	6	1	3	1	1	0	0	0
4/13/02	103	1	1	1	0	1	11	2	7	4	2	1	0	0
4/23/02	113	0	0	1	3	3	30	21	22	21	18	2	2	1
5/3/02	123	0	0	0	0	0	0	1	0	2	12	1	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	7	5	1	7
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	33.08	25.77	28.77	15.25	25.34	81.14	29.48	26.22	13.54	15.50	0.00	0.00	0.00	294.09	805	0.3653
4/3/02	93	6.01	5.15	2.40	0.00	1.95	10.36	1.84	6.05	2.26	2.58	0.00	0.00	0.00	38.61	116	0.3328
4/13/02	103	3.01	2.58	2.40	0.00	1.95	18.99	3.69	14.12	9.03	5.17	2.26	0.00	0.00	63.18	217	0.2912
4/23/02	113	0.00	0.00	2.40	6.54	5.85	51.79	38.70	44.37	47.39	46.50	4.53	7.91	4.42	260.39	650	0.4006
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	4.51	31.00	2.26	0.00	0.00	39.62	127	0.3120
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.08	11.32	3.95	30.92	64.28	233	0.2759
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	42.10	33.50	35.97	21.79	35.08	162.29	75.55	90.76	76.73	118.82	20.38	11.86	35.33	760.16	2161	0.3518

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

m. Site--Easton, Raceway 1, SNT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	21	15	12	14	19	70	15	13	11	20	3	0	0
4/3/02	93	0	0	2	0	3	7	2	2	1	1	1	1	0
4/13/02	103	0	0	0	0	1	4	2	2	1	1	0	0	0
4/23/02	113	0	0	0	2	0	8	9	6	6	22	2	1	2
5/3/02	123	0	0	0	0	0	0	0	0	1	7	1	1	3
5/13/02	133	0	0	0	0	0	0	0	0	0	0	0	0	1
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	63.15	38.65	28.77	30.51	37.03	120.85	27.64	26.22	24.82	51.66	6.79	0.00	0.00	456.10	1469	0.3105
4/3/02	93	0.00	0.00	4.80	0.00	5.85	12.09	3.69	4.03	2.26	2.58	2.26	3.95	0.00	41.51	142	0.2923
4/13/02	103	0.00	0.00	0.00	0.00	1.95	6.91	3.69	4.03	2.26	2.58	0.00	0.00	0.00	21.41	68	0.3149
4/23/02	113	0.00	0.00	0.00	4.36	0.00	13.81	16.58	12.10	13.54	56.83	4.53	3.95	8.83	134.54	396	0.3398
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	18.08	2.26	3.95	13.25	39.81	81	0.4915
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.42	4.42	3	1.4722
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	63.15	38.65	33.57	34.87	44.82	153.66	51.60	46.39	45.13	131.74	15.85	11.86	26.50	697.79	2161	0.3229

n. Site--Easton, Raceway 2, OCT Treatment

Total Detections

Total Detections Ending Release Date Calendar	Julian	Detection Efficiency Stratum 1 4/21/2002	Detection Efficiency Stratum 2 4/25/2002	Detection Efficiency Stratum 3 4/29/2002	Detection Efficiency Stratum 4 5/1/2002	Detection Efficiency Stratum 5 5/2/2002	Detection Efficiency Stratum 6 5/5/2002	Detection Efficiency Stratum 7 5/6/2002	Detection Efficiency Stratum 8 5/8/2002	Detection Efficiency Stratum 9 5/14/2002	Detection Efficiency Stratum 10 5/24/2002	Detection Efficiency Stratum 11 5/27/2002	Detection Efficiency Stratum 12 5/30/2002	Detection Efficiency Stratum 13 7/31/2002
3/24/02	83	21	22	15	18	15	60	23	16	5	8	0	0	0
4/3/02	93	0	1	0	0	0	2	1	0	0	1	0	0	0
4/13/02	103	0	0	1	0	2	4	0	1	1	2	0	0	0
4/23/02	113	0	0	0	2	3	20	17	13	24	27	0	1	0
5/3/02	123	0	0	0	0	0	0	0	0	2	10	4	1	3
5/13/02	133	0	0	0	0	0	0	0	0	0	1	0	0	3
5/23/02	143	0	0	0	0	0	0	0	0	0	0	3	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections Ending Release Date Calendar	Julian	Detection Efficiency 0.3325609	Detection Efficiency 0.388115	Detection Efficiency 0.4170322	Detection Efficiency 0.4589023	Detection Efficiency 0.5131199	Detection Efficiency 0.579215	Detection Efficiency 0.5426723	Detection Efficiency 0.4958233	Detection Efficiency 0.4431187	Detection Efficiency 0.3871335	Detection Efficiency 0.4415138	Detection Efficiency 0.2528658	Detection Efficiency 0.2264151	Expanded Detection Total	Release Number	Survival Index
3/24/02	83	63.15	56.68	35.97	39.22	29.23	103.59	42.38	32.27	11.28	20.66	0.00	0.00	0.00	434.45	1249	0.3478
4/3/02	93	0.00	2.58	0.00	0.00	0.00	3.45	1.84	0.00	0.00	2.58	0.00	0.00	0.00	10.46	42	0.2489
4/13/02	103	0.00	0.00	2.40	0.00	3.90	6.91	0.00	2.02	2.26	5.17	0.00	0.00	0.00	22.64	43	0.5265
4/23/02	113	0.00	0.00	0.00	4.36	5.85	34.53	31.33	26.22	54.16	69.74	0.00	3.95	0.00	230.14	540	0.4262
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.51	25.83	9.06	3.95	13.25	56.61	225	0.2516
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	0.00	0.00	13.25	15.83	46	0.3442
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.79	0.00	0.00	6.79	40	0.1699
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	63.15	59.26	38.37	43.58	38.98	148.48	75.55	60.51	72.22	126.57	15.85	7.91	26.50	776.92	2185	0.3556

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

o. Site--Easton, Raceway 3, SNT Treatment

Total Detections

Total Detections		Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency
Ending Release Date		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	9	10	7	6	3	22	9	6	2	4	0	0	0
4/3/02	93	0	0	1	2	1	5	1	4	2	2	0	0	0
4/13/02	103	0	0	0	0	0	3	2	0	2	0	0	0	0
4/23/02	113	0	0	0	0	0	2	6	2	6	10	0	0	0
5/3/02	123	0	0	0	0	0	0	0	0	0	1	0	1	0
5/13/02	133	0	0	0	0	0	0	0	0	0	0	0	0	0
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	27.06	25.77	16.79	13.07	5.85	37.98	16.58	12.10	4.51	10.33	0.00	0.00	0.00	170.05	767	0.2217
4/3/02	93	0.00	0.00	2.40	4.36	1.95	8.63	1.84	8.07	4.51	5.17	0.00	0.00	0.00	36.93	273	0.1353
4/13/02	103	0.00	0.00	0.00	0.00	0.00	5.18	3.69	0.00	4.51	0.00	0.00	0.00	0.00	13.38	180	0.0743
4/23/02	113	0.00	0.00	0.00	0.00	0.00	3.45	11.06	4.03	13.54	25.83	0.00	0.00	0.00	57.91	599	0.0967
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	0.00	3.95	0.00	6.54	163	0.0401
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28	0.0000
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6	0.0000
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1	
	Total	27.06	25.77	19.18	17.43	7.80	55.25	33.17	24.20	27.08	43.91	0.00	3.95	0.00	284.81	2026	0.1406

p. Site--Easton, Raceway 4, OCT Treatment

Total Detections

Total Detections		Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency	Detection Efficiency
Ending Release Date		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	17	13	16	11	22	69	24	30	15	10	0	0	0
4/3/02	93	0	0	0	0	0	0	0	1	1	1	0	0	0
4/13/02	103	0	0	0	1	0	0	0	0	1	0	0	0	0
4/23/02	113	0	0	0	0	0	5	1	12	4	13	0	0	0
5/3/02	123	0	0	0	0	0	0	0	0	0	7	3	0	2
5/13/02	133	0	0	0	0	0	0	0	0	0	0	0	0	1
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	1	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	51.12	33.50	38.37	23.97	42.87	119.13	44.23	60.51	33.85	25.83	0.00	0.00	0.00	473.36	1643	0.2881
4/3/02	93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.02	2.26	2.58	0.00	0.00	0.00	6.86	43	0.1595
4/13/02	103	0.00	0.00	0.00	2.18	0.00	0.00	0.00	0.00	2.26	0.00	0.00	0.00	0.00	4.44	21	0.2112
4/23/02	113	0.00	0.00	0.00	0.00	0.00	8.63	1.84	24.20	9.03	33.58	0.00	0.00	0.00	77.28	236	0.3275
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.08	6.79	0.00	8.83	33.71	133	0.2535
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.42	4.42	61	0.0724
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.95	0.00	3.95	22	0.1798
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1	0.0000
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	51.12	33.50	38.37	26.15	42.87	127.76	46.07	86.72	47.39	80.08	6.79	3.95	13.25	604.02	2160	0.2796

Table. A.2. Numbers Used to Estimate Release-to-McNary Survival Indices for 2002 OCT-SNT releases into the Upper Yakima (continued)

q. Site--Easton, Raceway 5, SNT Treatment

Total Detections

		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection
Total Detections		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
Ending Release Date		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	1	4	1	1	5	3	3	1	4	2	0	0	0
4/3/02	93	0	2	1	2	0	1	1	2	0	1	1	0	0
4/13/02	103	0	0	1	0	0	2	0	0	1	1	0	0	0
4/23/02	113	0	0	0	1	0	0	0	2	1	2	0	0	0
5/3/02	123	0	0	0	0	0	0	0	0	0	0	0	0	0
5/13/02	133	0	0	0	0	0	0	0	0	0	0	1	0	0
5/23/02	143	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	3.01	10.31	2.40	2.18	9.74	5.18	5.53	2.02	9.03	5.17	0.00	0.00	0.00	54.55	666	0.0819
4/3/02	93	0.00	5.15	2.40	4.36	0.00	1.73	1.84	4.03	0.00	2.58	2.26	0.00	0.00	24.36	352	0.0692
4/13/02	103	0.00	0.00	2.40	0.00	0.00	3.45	0.00	0.00	2.26	2.58	0.00	0.00	0.00	10.69	209	0.0512
4/23/02	113	0.00	0.00	0.00	2.18	0.00	0.00	0.00	4.03	2.26	5.17	0.00	0.00	0.00	13.64	367	0.0372
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	96	0.0000
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	0.00	2.26	32	0.0708
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14	0.0000
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1	0.0000
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	3.01	15.46	7.19	8.72	9.74	10.36	7.37	10.08	13.54	15.50	4.53	0.00	0.00	105.50	1737	0.0607

r. Site--Easton, Raceway 6, OCT Treatment

Total Detections

		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection
Total Detections		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
Ending Release Date		Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Stratum 7	Stratum 8	Stratum 9	Stratum 10	Stratum 11	Stratum 12	Stratum 13
Calendar	Julian	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002
3/24/02	83	11	11	15	9	18	57	23	21	5	8	1	0	0
4/3/02	93	0	0	0	0	0	3	0	1	0	2	0	0	0
4/13/02	103	0	0	2	3	0	4	1	4	1	6	0	0	0
4/23/02	113	0	0	0	2	0	11	7	16	7	22	8	2	2
5/3/02	123	0	0	0	0	0	0	0	1	4	12	0	1	1
5/13/02	133	0	0	0	0	0	0	0	0	0	1	2	0	1
5/23/02	143	0	0	0	0	0	0	0	0	0	0	1	0	3
6/2/02	153	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/02	163	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded Total Detections

Expanded Detections		Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Detection	Expanded		
Ending Release Date		Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Detection	Release	Survival
Calendar	Julian	0.3325609	0.388115	0.4170322	0.4589023	0.5131199	0.579215	0.5426723	0.4958233	0.4431187	0.3871335	0.4415138	0.2528658	0.2264151	Total	Number	Index
3/24/02	83	33.08	28.34	35.97	19.61	35.08	98.41	42.38	42.35	11.28	20.66	2.26	0.00	0.00	369.44	1203	0.3071
4/3/02	93	0.00	0.00	0.00	0.00	0.00	5.18	0.00	2.02	0.00	5.17	0.00	0.00	0.00	12.36	61	0.2027
4/13/02	103	0.00	0.00	4.80	6.54	0.00	6.91	1.84	8.07	2.26	15.50	0.00	0.00	0.00	45.90	55	0.8346
4/23/02	113	0.00	0.00	0.00	4.36	0.00	18.99	12.90	32.27	15.80	56.83	18.12	7.91	8.83	176.01	614	0.2867
5/3/02	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.02	9.03	31.00	0.00	3.95	4.42	50.41	164	0.3074
5/13/02	133	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	4.53	0.00	4.42	11.53	44	0.2620
5/23/02	143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00	13.25	15.51	26	0.5967
6/2/02	153	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
6/12/02	163	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
	Total	33.08	28.34	40.76	30.51	35.08	129.49	57.12	86.72	38.36	131.74	27.18	11.86	30.92	681.17	2167	0.3143

Appendix B. Detection Efficiency Estimation

B.1. Conceptual Computation

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)].

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

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)].

4. Once this was done for each downstream dam's detection date, the estimated total downstream detections that were allocated to a given McNary-detection date then were 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.

5. 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[22].

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. 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 partitioning based on all possible partitionings. 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

[22] This was done for the 1999, 2000, 2001, and 2002 emigrants, except that Bonneville Powerhouse 1 was omitted from the 2001 detection efficiency estimation. There were few Powerhouse 1 detections of fish in 2001 because Powerhouse 1 was essentially offline due to the extremely low flows in 2001.

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 two 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.

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 were rare cases for which downstream dam dates had total counts but had no associated joint downstream-dam and McNary Dam counts. Ignoring these dates would tend to over-estimate the detection efficiency. What was done to adjust for such an overestimation was to augment the joint counts in the following manner:

1. Take such a downstream dam date and use the McNary distributions from six contiguous downstream dates that immediately preceded this non-joint detection date and from six contiguous dates that followed this non-joint detection date.

2. Pool offset[23] McNary passage-time distributions from these twelve adjacent dates; and

3. Apply this pooled distribution (as a relative distribution) to the total downstream count for the non-joint-detection date. The resulting McNary-date-distributed counts were then allocated to the stratum to which the McNary date of detection belonged.

[23] What is meant by offset is: If McNary Julian date d's relative distribution was being estimated from the twelve downstream adjacent dates, then, for the 1st preceding downstream adjacent day, the joint count from McNary day d-1 was used; for the 2nd preceding downstream adjacent day, the joint count from McNary day d-2 was used; … for the 6th preceding downstream adjacent day, the joint count from McNary day d-6 was used; for the 1st following downstream adjacent day, the joint count from McNary day d+1 was used; for the 2nd following downstream adjacent day, the joint count from McNary day d+2 was used; … for the 6th following downstream adjacent day, the joint count from McNary day d+6 was used.

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)								Total
	…	98	99	100	101	**102**	103	….	
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. 2002 Detection Efficiencies

The detection efficiencies used are given in Table B.2. In the table, the “Augmented” includes downstream detections from days for which there were no associated joint downstream-dam and McNary Dam counts. The detection efficiencies actually used and presented before in Appendix Table A.2 are those listed under “Augmented” under “Pooled over John Day and Bonneville” in Table B.2. The stepwise logistic analysis of variation leading to the stratification is given in Table B.3.

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 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 pooled detection rate estimates from John Dam and Bonneville Dams are accurate.

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.

The stratification was more effective in explaining variation in daily detection efficiencies than either the daily proportion of McNary flow that is spilled (spill proportion) or the daily proportion of flow that is passed through the turbines (turbine proportion). Table B.4 gives a logistic analysis of variation that assesses the effects of strata, spill proportion, and turbine proportion on estimated daily McNary detection efficiencies; Table B.5 gives the data used in the regression. The effect of strata was stronger than those of spill proportion and turbine proportion. Although the effects of spill and turbine proportions are significant ($P < 0.0001$, Table B.4), their effects when adjusted for the effects of strata are not significant ($P = 0.347$ for Spill and Turbine separately, $P = 0.672$ for both Spill and Turbine Proportions included in regression, Table B.4.). This does not mean that spill and turbine proportions are not important; rather, it means that the strata differences account for the effects of the spill and turbine proportions. In fact, the effects of strata explain more than the effects of spill and turbine proportions; the strata effects when adjusted for the effects of spill proportion, turbine proportion, and both are still highly significant ($P < 0.0001$, Table B.4).

Table B.2. Detection efficiencies used to estimate Survival Indices

			Bonneville-Based					
			Joint Detection based			Augmented		
Stratum	1st Date	Last Date	BO Total	BO-MCJ Total	Estimate	BO Total	BO-MCJ Total	Estimate
1		4/21/02	179.85	59	0.328046	180.85	59	0.326232
2	4/22/02	4/25/02	183.85	75	0.407935	183.85	75	0.407935
3	4/26/02	4/29/02	109.53	50	0.456515	109.53	50	0.456515
4	4/30/02	5/1/02	89.80	45	0.501104	89.80	45	0.501104
5	5/2/02	5/2/02	85.68	45	0.525226	85.68	45	0.525226
6	5/3/02	5/5/02	448.52	265	0.590826	448.52	265	0.590826
7	5/6/02	5/6/02	150.52	84	0.558056	150.52	84	0.558056
8	5/7/02	5/8/02	180.00	93	0.516677	180.00	93	0.516677
9	5/9/02	5/14/02	150.38	68	0.452189	150.38	68	0.452189
10	5/15/02	5/24/02	351.31	148	0.421278	351.31	148	0.421278
11	5/25/02	5/27/02	44.55	21	0.471332	44.55	21	0.471332
12	5/28/02	5/30/02	34.00	9	0.264706	34.00	9	0.264706
13	5/31/02		20.00	9	0.450000	37.00	9	0.243243
			John Day Based					
			Joint Detection based			Augmented		
Stratum	1st Date	Last Date	JD Total	JD-MCJ Total	Estimate	JD Total	JD-MCJ Total	Estimate
1		4/21/02	478.68	161	0.336342	480.68	161	0.334942
2	4/22/02	4/25/02	388.14	147	0.378727	388.14	147	0.378727
3	4/26/02	4/29/02	312.50	126	0.403194	312.50	126	0.403194
4	4/30/02	5/1/02	239.24	106	0.443062	239.24	106	0.443062
5	5/2/02	5/2/02	288.50	147	0.509525	288.50	147	0.509525
6	5/3/02	5/5/02	1334.92	768	0.575314	1334.92	768	0.575314
7	5/6/02	5/6/02	241.98	129	0.533103	241.98	129	0.533103
8	5/7/02	5/8/02	289.93	140	0.482877	289.93	140	0.482877
9	5/9/02	5/14/02	391.24	172	0.439632	391.24	172	0.439632
10	5/15/02	5/24/02	410.70	147	0.357926	410.70	147	0.357926
11	5/25/02	5/27/02	70.96	30	0.422790	70.96	30	0.422790
12	5/28/02	5/30/02	64.87	16	0.246660	64.87	16	0.246660
13	5/31/02		37.33	11	0.294643	51.33	11	0.214286
			Pooled over John Day and Bonneville (Down-stream Dam -based)					
			Joint Detection based			Augmented (**Actually Used**)		
Stratum	1st Date	Last Date	DS Total	DS-MCJ Tota	Estimate	DS Total	DS-MCJ Total	Estimate
1		4/21/02	658.53	220	0.334076	661.53	220	0.332561
2	4/22/02	4/25/02	572.00	222	0.388115	572.00	222	0.388115
3	4/26/02	4/29/02	422.03	176	0.417032	422.03	176	0.417032
4	4/30/02	5/1/02	329.05	151	0.458902	329.05	151	0.458902
5	5/2/02	5/2/02	374.18	192	0.513120	374.18	192	0.513120
6	5/3/02	5/5/02	1783.45	1033	0.579215	1783.45	1033	0.579215
7	5/6/02	5/6/02	392.50	213	0.542672	392.50	213	0.542672
8	5/7/02	5/8/02	469.93	233	0.495823	469.93	233	0.495823
9	5/9/02	5/14/02	541.62	240	0.443119	541.62	240	0.443119
10	5/15/02	5/24/02	762.01	295	0.387133	762.01	295	0.387133
11	5/25/02	5/27/02	115.51	51	0.441514	115.51	51	0.441514
12	5/28/02	5/30/02	98.87	25	0.252866	98.87	25	0.252866
13	5/31/02		57.33	20	0.348837	88.33	20	0.226415

Table B.3. Weighted Stepwise Logistic Analysis of Year 2002 Daily Detection Efficiencies leading to Stratified McNary Detection Efficiency Estimates (weight is estimated number of downstream dam detections associated with McNary date of detection)

Source				Degrees of			
	Stratum Separating McNary		Deviance	Freedom			
Step	Julian Detection Dates		(Dev)	(DF)	Dev/DF	F	Type 1 P
Step 1	119	120	77.42	1	77.4200	31.28	0.0000
Step 2	128	129	88.67	1	88.6700	85.40	0.0000
Step 3	122	123	11.33	1	11.3300	13.11	0.0006
Step 4	147	148	9.48	1	9.4800	13.25	0.0006
Step 5	126	127	9.2	1	9.2000	16.24	0.0002
Step 6	134	135	3.28	1	3.2800	6.33	0.0148
Step 7	111	112	7.49	1	7.4900	19.14	0.0001
Step 8	121	122	2.06	1	2.0600	5.72	0.0203
Step 9	125	126	1.75	1	1.7500	5.24	0.0261
Step 10	144	145	1.23	1	1.2300	3.88	0.0542
Step 11 *	150	151	1.61	1	1.6100	5.52	0.0227
Step 12	115	116	0.84	1	0.8400	2.99	0.0898
Step 13 **	109	110	0.68	1	0.6800	2.50	0.1206
ERROR							
Error	Variation with no partition		228.39	62	3.6837		
Error For Step 1	119	120	150.97	61	2.4749		
Error For Step 2	128	129	62.3	60	1.0383		
Error For Step 3	122	123	50.97	59	0.8639		
Error For Step 4	147	148	41.49	58	0.7153		
Error For Step 5	126	127	32.29	57	0.5665		
Error For Step 6	134	135	29.01	56	0.5180		
Error For Step 7	111	112	21.52	55	0.3913		
Error For Step 8	121	122	19.46	54	0.3604		
Error For Step 9	125	126	17.71	53	0.3342		
Error For Step 10	144	145	16.48	52	0.3169		
Error For Step 11	150	151	14.87	51	0.2916		
Error For Step 12	115	116	14.03	50	0.2806		
Error For Step 13	109	110	13.35	49	0.2724		

* A subsequent shifting of stratum boundaries actually resulted in a separation between Julian dates 151 and 152 giving lower error mean deviance; however, this left less than 20 joint detections in last stratum, so the separation between 150 and 151 maintained

** Omitted and terminated stepwise process because 10% significance level not attained (P = 0.121)

Table B.4. Weighted Logistic Analysis of Variation of Year 2002 Effects of Strata, Spill Proportion of Flow, and Turbine Proportion of Flow on McNary Daily Detection Efficiencies (weight is estimated number of downstream dam detections associated with McNary date of detection)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Dev/DF	F-Ratio	Type 1 P
Spill Proportion (Spill)	127.88	1	127.88	446.09	0.0000
Turbidity Proportion (Turb)	129.03	1	129.03	450.10	0.0000
Spill, Turb	132.24	2	66.12	230.65	0.0000
Turb adjusted for Spill	4.36	1	4.36	15.21	0.0003
Spill adjusted for Turb	3.21	1	3.21	11.20	0.0016
Among Strata (Strata)	214.36	12	17.86	62.31	0.0000
Spill adjusted for Strata	0.27	1	0.27	0.94	0.3367
Turbidity adjusted for Strata	0.27	1	0.27	0.94	0.3367
Spill, Turb adjusted for Strata	0.27	2	0.14	0.47	0.6273
Spill adjusted for Strata, Turb	0	1	0.00	0.00	1.0000
Turb adjusted for Strata, Spill	0	1	0.00	0.00	1.0000
Strata adjusted for Spill	86.48	11	7.86	27.42	0.0000
Strata adjusted for Turb	85.6	12	7.13	24.88	0.0000
Strata adjusted for Spill, Turb	82.39	12	6.87	23.95	0.0000
Error	13.76	48	0.29		

Table B.5. Data[24] used in Table B.4 Analysis

McNary Date	Estimated Detection Efficiency	Estimated Down-Stream Dam Detections (weight)	Stratum Number	Spill Proportion of McNary Flow	Turbine Proportion of McNary Flow
04-Apr-02	0.2000	5.0	1	0.0000	0.9614
06-Apr-02	0.3695	2.7	1	0.0000	0.9614
07-Apr-02	0.3544	2.8	1	0.0000	0.9601
10-Apr-02	0.3418	5.9	1	0.1856	0.7839
13-Apr-02	0.4000	5.0	1	0.3326	0.6454
14-Apr-02	0.2941	3.4	1	0.3782	0.5982
15-Apr-02	0.2449	4.1	1	0.5039	0.4785
16-Apr-02	0.2993	43.4	1	0.4736	0.5117
17-Apr-02	0.3206	84.2	1	0.4773	0.5011
18-Apr-02	0.3168	85.2	1	0.4897	0.4947
19-Apr-02	0.3336	170.8	1	0.4668	0.5173
20-Apr-02	0.3540	130.0	1	0.4738	0.5096
21-Apr-02	0.3535	116.0	1	0.4430	0.5393
22-Apr-02	0.3847	119.6	2	0.4375	0.5446
23-Apr-02	0.3866	119.0	2	0.4797	0.5032
24-Apr-02	0.3840	127.6	2	0.5027	0.4791
25-Apr-02	0.3935	205.8	2	0.4668	0.5137
26-Apr-02	0.4204	130.8	3	0.4380	0.5418
27-Apr-02	0.4023	101.9	3	0.4572	0.5199
28-Apr-02	0.4332	92.3	3	0.4117	0.5632
29-Apr-02	0.4126	96.9	3	0.3663	0.6120
30-Apr-02	0.4578	107.0	4	0.3885	0.5906
01-May-02	0.4594	222.0	4	0.3609	0.6169
02-May-02	0.5131	374.2	5	0.2337	0.7444
03-May-02	0.5702	477.0	6	0.2626	0.7166
04-May-02	0.5878	718.0	6	0.2852	0.6952
05-May-02	0.5761	588.5	6	0.2615	0.7169
06-May-02	0.5427	392.5	7	0.3057	0.6721
07-May-02	0.5106	270.3	8	0.3644	0.6162
08-May-02	0.4758	199.7	8	0.3171	0.6639
09-May-02	0.4616	136.5	9	0.3627	0.6140
10-May-02	0.4363	155.8	9	0.3666	0.6095
11-May-02	0.4526	90.6	9	0.3229	0.6545
12-May-02	0.4488	44.6	9	0.3248	0.6451
13-May-02	0.4174	50.3	9	0.3637	0.6143
14-May-02	0.4231	63.8	9	0.3208	0.6568
15-May-02	0.3923	61.2	10	0.2933	0.6844
16-May-02	0.3651	131.5	10	0.2966	0.6800
17-May-02	0.3790	142.5	10	0.3161	0.6622
18-May-02	0.3813	94.4	10	0.3351	0.6423
19-May-02	0.3991	100.2	10	0.3391	0.6384
20-May-02	0.4132	50.8	10	0.3231	0.6561
21-May-02	0.4482	42.4	10	0.3906	0.5924
22-May-02	0.4284	37.3	10	0.3987	0.5838
23-May-02	0.3483	51.7	10	0.4150	0.5678
24-May-02	0.3802	50.0	10	0.4178	0.5645
25-May-02	0.4408	59.0	11	0.4264	0.5541
26-May-02	0.4484	40.1	11	0.4306	0.5491
27-May-02	0.4272	16.4	11	0.4461	0.5364
28-May-02	0.2956	13.5	12	0.4158	0.5672
29-May-02	0.2598	42.3	12	0.4518	0.5322
30-May-02	0.2326	43.0	12	0.4164	0.5676
31-May-02	0.2857	3.5	13	0.4638	0.5216
01-Jun-02	0.3000	6.7	13	0.4953	0.4910
02-Jun-02	0.2158	23.2	13	0.4309	0.5535
04-Jun-02	0.5714	3.5	13	0.5391	0.4478
06-Jun-02	0.4000	2.5	13	0.5658	0.4217
08-Jun-02	0.3333	9.0	13	0.5739	0.4134
14-Jun-02	1.0000	1.0	13	0.4303	0.5530
15-Jun-02	0.6667	3.0	13	0.4404	0.5442
16-Jun-02	0.5000	2.0	13	0.3618	0.6209
17-Jun-02	0.5000	2.0	13	0.4739	0.5103
01-Jul-02	1.0000	1.0	13	0.4519	0.5328

[24] Spill proportion is McNary spill flow divided by total McNary discharge. Turbine proportion is McNary turbine flow divided by total McNary discharge. McNary flow database used was provided by Fish Passage Center, Portland, Oregon. Database originally created by U.S. Army Corps of Engineers.

APPENDIX D

Annual Report:
Smolt Survival to McNary of Year-2002 Coho and
Fall Chinook Releases into the Yakima Basin

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Annual Report: Smolt Survival to McNary of Year-2002 Coho and Fall Chinook Releases into the Yakima Basin

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Submitted April 1, 2003

1. Summary

Coho: As in years 1999, 2000, and 2001, there were early and late releases of Coho into Yakima tributaries in 2002[1]. And, as in 2001, there were releases from Willard Hatchery (Willard) and Yakima-return (Yakima) broodstock.

For Yakima-brood smolt released into the Naches Rivers in 2002, those released on May 6 had a significantly lower (P = 0.029) survival index to McNary Dam (25%) than those released on May 28 (60%). However, for Willard-brood smolt released into the Upper Yakima and Naches, the difference between the early and late survival indices (20% and 24%, respectively) was not significant (P = 0.620). In previous years of release (1999, 2000, and 2001) there were no significant differences between early and late releases (P>0.20).

The above time-of-release x stock interaction is also manifested

1) by the survival indices of late-released Yakima having a significantly higher survival index then that of late-released Willard Stock (respective survival indices of 60% and 27%; P = 0.036), but

2) by the early released Yakima and Willard stock survival indices not differing significantly (respective survival indices of 25% and 27%; P = 0.828).

Outmigration-year 2001 was the only other release year when Willard was used, and in that year, the survival index of Yakima stock was significantly greater than that of Willard stock at the 10% level over both release times (respective survival indices of 19%

[1] For Coho, release-years 1999, 2000, 2001, and 2002 release years respectively corresponds to brood-years 1998, 1999, and 2000.

and 7%; P < 0.001). In outmigration-year 1999, Yakima and Cascade stock were released, and the Yakima survival index was significantly less than the Cascade stock at the 10% level over early and late releases (respective survival indices of 43% and 54%; P = 0.058). In outmigration year 2000, no hatchery stock was available, and only Yakima stock was used.

In 2002 Willard-brood McNary Dam passage was generally later than Yakima-brood passage. The passage distributions of the Willard stock early and late releases were more similar than those for the Yakima stock.

Fall Chinook: As in years 2000 and 2001, there were replicated releases in 2002[2] below Prosser Dam of fish experiencing accelerated rearing and conventional rearing. There were also replicated releases made into Marion drain. Analysis of the 2002 data resulted in no significant survival-index differences among the releases (survival indices were 23%, 22%, and 30% for the accelerated rearing, conventional rearing, and Marion Drain releases, respectively; P = 0.374). In year 2001, there were also no significant differences among survival indices (2001 survival indices 39%, 27%, and 30% respectively for accelerated, conventional, and Marion Drain; P = 0.480), but in year 2000, the survival index of the conventional reared significantly exceed those of both the accelerated rearing (P = 0.033) and the Marion drain releases (P = 0.025) [2000 survival indices 43%, 82% and 27% respectively for accelerated, conventional, and Marion Drain].

2. 2002 Coho Survival to McNary Dam and McNary Dam Passage

2.a. Tagging to McNary Passage Survival

In year 2002, Coho releases were made at two sites in the Naches (Lost Creek and Stiles) and at one site in the Upper Yakima (Easton). Cle Elum, which served as a second site in the Upper Yakima in previous years, was dropped in 2002. The releases were treatments comprised of two factors with primarily two levels each. The factors were time of release (early release on May 6 and late release on May 25) and stock (Willard and Yakima returns) as an intended complete factorial at each site. There was also an augmented very early release on March 28 at Easton of Willard stock. The intended May 6 early-release of Yakima stock at Easton was erroneously released on March 28. The late release at Easton of the intended Yakima stock was comprised of mixed stock[3]. A portion of all of these releases were PIT-tagged, and survival was estimated using the PIT-tagged fish.

The PIT-tagged releases made in 2002 are listed in Table 2.a. along with the number of fish PIT-tagged per release and the estimated PIT-tagging-to-McNary survival indices.

[2] For Fall Chinook, release-years 2000, 2001, and 2002 release years respectively corresponds to brood-years 1999, 2000, and 2001.
[3] The stock was comprised of 60,560 Yakima and 23,308 Willard Coho prior to PIT-tagging

The methodology for estimating the survival indices is discussed in Appendix A along with the analysis procedures followed.

Table 2.a. Year 2002 Coho Releases made into the Yakima Basin with Associated Number of Fish PIT-tagged and Estimated Survival Index from Tagging to McNary Passage

Release Site, Stock, Release Date*	Reason for Omission	Number PIT-tagged	Release-to-McNary Survival Index	File Name Extender
"Easton", Willard, "Early"	Released during transport before reaching Easton	1251	0.0559	MBT
Easton, Willard, Early		1248	0.0580	EWE
Easton, Willard, Late		2497	0.1971	EWL
Easton, Yakima, "Early"	Release is Extra Early	1249	0.0154	EYE
Easton, "Yakima", Late**	Actually Mixed Stock	2500	0.1100	EYL
Lost Creek, Willard, Early		1249	0.2492	LWE
Lost Creek, Willard, Late		1247	0.1317	LWL
Lost Creek, Yakima, Early**		1192	0.2297	LYE
Lost Creek, Yakima, Late**		1250	0.4002	LYL
Stiles, Willard, Early		1249	0.2928	SWE
Stiles, Willard, Late		1251	0.4153	SWL
Stiles, Yakima, Early		1250	0.2688	SYE
Stiles, Yakima, Late		1250	0.8059	SYL

*Release Date: Extra Early - March 28
Early - May 6
Late - May 25

** Excessive pre-release escape

Omitted from formal analyses are the following treatments from Table 2.a:

1. "Easton" Site, Willard Brood, "Early" Release (shaded in Table 2.a.)--Omitted because this release was actually dumped on March 28 at Mabton on the Lower Yakima River during its transfer from Willard Hatchery to Easton. Therefore the release site was not Easton and the release date was not May 6, and the fish were presumably neither sufficiently smoltified nor acclimated.

2. Easton Site, Yakima Brood, "Early" Release (shaded in Table 2.a.)--Omitted because the release was at the wrong time (extra early on March 28 instead of early on May 6).

3. Easton Site, "Yakima" Brood, Late Release (shaded in Table 2.a.)--Omitted because the release was made up of mixed brood.

The last of the above treatments will be discussed informally after discussing the formal analysis.

A weighted logistic analysis of variation was performed using the number of fish released as the weighting variable (discussed in Appendix A). In previous years analyses, there was no statistical evidence of two factor interactions between site and release time, between site and stock, or between stock and release time (P > 0.2; refer to Appendix B). This was not the case for the 2002 outmigrants. As can be seen in the upper portion of Table 2.b., all main effects and two-factor interactions were significant or nearly significant the 10% significance level except for the two-factor interaction of stock with site. Because the error source, against which the main effects and two-factor interactions were tested, was based on only one degree of freedom, the decision was made to pool all two-way interactions that were not significant at the 10% significance level with the one-degree-of-freedom error as a new source of error (lower portion of Table 2.b.). All main effects as well as the Stock x Release-Time interactions were significant at the 10% significance level when using this pooled error's measure of variation (error mean deviance, analogous to error mean square from traditional analyses of variation).

Table 2.b. Weighted Logistic Analysis of Variation among Sites (Easton, Lost Creek, and Stiles), Stock (Willard and Yakima), and Release Times (May 6 and May 25)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	P
Site (adjusted for Stock and Time)	676.85	2	338.43	137.57	0.0602
Stock (adjusted for Site and Time)	294.33	1	294.33	119.65	0.0580
Time* (adjusted for Site and Stock)	505.41	1	505.41	205.45	0.0443
Site x Stock	0.66	1	0.66	0.27	0.6957
Site x Time	214.10	2	107.05	43.52	0.1066
Stock x Time	261.57	1	261.57	106.33	0.0615
Error(1)	2.46	1	2.46		
Site (adjusted for Stock and Time)	676.85	2	338.43	6.23	0.0590
Stock (adjusted for Site and Time)	294.33	1	294.33	5.42	0.0804
Time* (adjusted for Site and Stock)	505.41	1	505.41	9.31	0.0380
Stock x Time	261.57	1	261.57	4.82	0.0932
Error(2)	217.22	4	54.31		

*Time of release

In the likely presence of a time-of-release interaction with stock, main effect comparisons among times of release and among stock are not meaningful. Instead, statistical comparisons are made between:

1. The Early and Late release times within the different stock

2. The stock within release times.

Because the initial analysis (based on an error with only one degree of freedom) resulted in Stock x Time interaction being nearly significant at the 10% level, the decision was made to also make the following comparison:

3. The Early and Late release times within the different sites.

For all the comparisons, the pooled four-degree-of-freedom error measure of variation in the lower portion of Table 2.b. was used as the statistical base for comparing survival indices.

Early Release versus Late Release: For time-of-release comparisons within stock, refer to Table 2.c.1). For the Yakima stock, the late-release survival index significantly exceeded that of the early-release (P = 0.029), but the time-of-release difference for the Willard stock was not significant (P = 0.620).

For time-of-release comparisons within site, refer to Table 2.c.2). For the Stiles-release site, the survival index for the late release significantly exceeded that for the early release (P = 0.036). The time-of-release difference was not significant for the other two sites (P = 0.226 for Easton and P = 0.787 for Lost Creek). Recall that there was no true Yakima release included in the analysis of the Easton releases. These within-site comparisons should be regarded as less certain than indicated by the probabilities presented because, in the original logistic analysis of variation (upper portion of Table 2.a.), the interaction of time of release with site was not significant at the 10% level (P = 0.107).

In previous years (Appendix B), there were no significant differences between early and late releases nor were there significant two-factor interactions among release date, site, and stock.

Yakima Stock versus Willard Stock: Referring to Table 2.c.3), the Yakima-stock survival index to McNary significantly exceeded that of the Willard stock for Late releases (P = 0.036). There was no significant difference between the two stock for early releases (P = 0.828).

Referring to Appendix B for previous year's comparisons, the main effect survival index of Yakima stock over both release dates and over all sites significantly exceeded that of the Willard stock for 2001 outmigrants (P < 0.001). For 2000 outmigrants, the only broodstock available was Yakima brood. For 1999 outmigrants, the hatchery stock available was Cascade, and the main-effect survival index for that stock exceeded that for Yakima (P = 0.026).

Informal Comparisons: Refer to Table 2.a. for the releases omitted from the formal analysis. Regarding the extremely early dumping on March 28 of the Willard stock at Mabton, near Sunnyside on the Lower Yakima, the survival index for this release was low but, surprisingly, barely lower than that of the early Willard release actually made on May 6 at Easton (extremely early dumped Willard stock survival index = 0.056 and early release Willard survival index = 0.058 at Easton). The erroneous extremely early release of the Yakima stock at Easton on March 28 had a far lower survival index than the Willard stock dumped into the lower Yakima also on March 28 (Yakima-stock March 28 release survival index = 0.015 and dumped Willard-stock survival index = 0.056). The erroneous Yakima-stock extremely early release survival index was by far the lowest of all releases.

Table 2.c.1) For 2002 Coho Outmigrants, Comparison of May 6 (Early) and May 28 (Late) releases' McNary-passage Survival Indices within Stock

	Number Released	Survival Index	Logit Transform*	Standard Error of Logit (SE)	Late-Early Difference (Diff) Survival	Late-Early Difference (Diff) Logit	Comparison in Logit Transform SE Logit Diff	Comparison in Logit Transform t = Diff/ SE(Diff)	Comparison in Logit Transform Type-1 P
Easton, Lost Creek, Stiles Pooled									
Early w/in Willard	3746	0.2000	-1.38603	0.3002	0.0354	0.2079	0.3878	0.5361	0.6203
Late w/in Willard	4995	0.2354	-1.1781	0.2455					
Lost Creek, Stiles Pooled									
Early w/in Yakima	2442	0.2497	-1.10002	0.3441	0.3533	1.5183	0.4572	3.3205	0.0294
Late w/in Yakima	2500	0.6031	0.41825	0.3011					

Table 2.c.2) For 2002 Coho Outmigrants, Comparison of May 6 (Early) and May 28 (Late) releases' McNary-passage Survival Indices within Site

	Number Released	Survival Index	Logit Transform*	Standard Error of Logit (SE)	Late-Early Difference (Diff) Survival	Late-Early Difference (Diff) Logit	Comparison in Logit Transform SE Logit Diff	Comparison in Logit Transform t = Diff/ SE(Diff)	Comparison in Logit Transform Type-1 P
Lost Creek, Stiles Pooled									
Willard within Early	2498	0.2710	-0.98947	0.3320	-0.0213	-0.1106	0.4781	-0.2312	0.8285
Yakima within Early	2442	0.2497	-1.10002	0.3441					
Lost Creek, Stiles Pooled									
Willard within Late	2498	0.2737	-0.97582	0.3304	0.3293	1.3941	0.4470	3.1185	0.0356
Yakima within Late	2500	0.6031	0.41825	0.3011					

Table 2.c.3) For 2002 Coho Outmigrants, Comparison of Willard- and Yakima-Stock Releases' McNary-passage Survival Indices within early and late time of release

	Number Released	Survival Index	Logit Transform*	Standard Error of Logit (SE)	Late-Early Difference (Diff) Survival	Late-Early Difference (Diff) Logit	Comparison in Logit Transform SE Logit Diff	Comparison in Logit Transform t = Diff/ SE(Diff)	Comparison in Logit Transform Type-1 P
Willard Stock									
Early within Easton	1248	0.0580	-2.78797	0.8926	0.1391	1.3831	0.9665	1.4311	0.2256
Late within Easton	2497	0.1971	-1.40483	0.3707					
Willard, Yakima Pooled									
Early within Lost Creek	2441	0.2397	-1.1542	0.3496	0.0264	0.1399	0.4832	0.2895	0.7866
Late within Lost Creek	2497	0.2661	-1.0144	0.3337					
Willard, Yakima Pooled									
Early within Stiles	2499	0.2808	-0.9405	0.3279	0.3297	1.3900	0.4458	3.1178	0.0356
Late within Stiles	2501	0.6105	0.44947	0.3020					

*** logit transform = natural log [(survival index)/[1 –(survival index)]; refer to Appendix A.**

2.b. McNary Passage Summaries

Smolt Leakage from Rearing Ponds: As in previous years, there is evidence of fish leaving the rearing ponds prior to the release date (referred to here as leakage). The measure used for this leakage is the proportion of the McNary PIT-tagged passage that was detected on or before the release date. These proportions are presented in Table 2.d. for the various releases. For the Willard 2002 outmigrants, the evidence of leakage was confined to the late releases with some fish from each of the three release sites being detected at McNary on or before the late release date (May 25). In the case of Easton late releases of Willard stock, an estimated 14% of the PIT-tagged passage was detected on or before May 25. In the case of Yakima stock, there was evidence of leakage for both early and late releases[4]. For three of the Yakima releases, the proportion of PIT-tagged passage detected before release date exceeded 25% (39% for the late Easton release[5]; 41% for the early Lost Creek release; and 27% for the late Lost Creek release). For all Yakima late releases, some of the fish passed McNary on or before the early release date (May 6). The lack of evidence of leakage for early release Willard stock may be due to these fish leaving the Yakima later than Yakima stock rather than due to lack of leakage; evidence for such late outmigration of Willard stock is presented below.

Passage time: Table 2.e. presents the estimated Julian dates of quartile passage[6] of PIT-tagged fish for each of the releases. There are several points worth making:

1. Passage of Willard brood is generally later than that of Yakima brood. The exception is the late releases from Stiles where the Julian dates of 25%, 50%, and 75% are almost identical for the Willard and Yakima brood.

2. Although the early releases generally have earlier passage than the late releases, the differences in quartile passage dates between the early and late releases for the Willard brood are substantially less than those for the Yakima brood.

3. When comparing within release pairs, the difference in the Julian dates for 75% passage between early and late releases is substantially less than those for the other quartile passages[7]. This suggests that, within a stock, some of the fish tend to hold in the Yakima whether the releases were made on May 6 or May 25.

[4] The only Yakima release showing no evidence of leakage was the erroneous extra early release from Easton.

[5] The stock is actually mixed Yakima and Willard broodstock.

[6] Estimated Julian dates when 25%, 50%, and 75% of total McNary passage occurred.

[7] This ignores the Easton Yakima brood releases for which the "early" release was erroneously made on Mach 28 instead of May 6.

Table 2.d. Proportion of PIT-Tagged Fish passing McNary on or before Designated Release Date (bold faced proportions).

Easton (Upper Yakima)						
		Willard Stock			Yakima Stock	
		Cumulative Proportion Detected at McNary on or before "Release" Date				
Release Date		Extra Early	Early	Late	Early*	Late**
03/28/02	(extra early)	**0.0000**	0.0000		**0.0000**	
05/06/02	(early)	0.9412	**0.0000**	0.0000	0.7506	0.0225
05/25/02	(late)	1.0000	0.4630	**0.1434**	1.0000	**0.3933**

Lost Creek (Naches)					
		Willard Stock		Yakima Stock	
		Cumulative Proportion Detected at McNary on or before "Release" Date			
Release Date		Early	Late	Early	Late
03/28/02	(extra early)	0.0000		0.0000	
05/06/02	(early)	**0.0000**	0.0000	**0.4058**	0.0535
05/25/02	(late)	0.0743	**0.0719**	0.7773	**0.2674**

Stiles (Naches)					
		Willard Stock		Yakima Stock	
		Cumulative Proportion Detected at McNary on or before "Release" Date			
Release Date		Early	Late	Early	Late
03/28/02	(extra early)	0.0000		0.0000	
05/06/02	(early)	**0.0000**	0.0000	**0.0061**	0.0082
05/25/02	(late)	0.5929	**0.0276**	0.9164	**0.0309**

* Actually Extra Early Release

** Actually mixed Willard and Yakima broodstock

Table 2.e. Estimated Julian Date for 25%, 50%, and 75% of Total McNary Smolt Passage of PIT-tagged Fish for each 2002 Coho Release into the Yakima

Easton (Upper Yakima)

Quartile (when % passage attained)		Willard Stock: Extra Early	Willard Stock: Julian Date when % passage attained — Early	Willard Stock: Julian Date when % passage attained — Late	Willard Stock: Difference in Julian Dates Late - Early	Yakima Stock: Julian Date when % passage attained — Early*	Yakima Stock: Julian Date when % passage attained — Late**	Yakima Stock: Difference in Julian Dates Late - Early
Q1	(25% passage)	108	144	150	6	112	144	32
Q2	(50% passage)	110	150	152	2	118	151	33
Q3	(75% passage)	119	153	154	1	124	154	30
Total Passage***		70	72	492		19	275	

Lost Creek (Naches)

Quartile (when % passage attained)		Willard Stock: Julian Date when % passage attained — Early	Willard Stock: Julian Date when % passage attained — Late	Willard Stock: Difference in Julian Dates Late - Early	Yakima Stock: Julian Date when % passage attained — Early	Yakima Stock: Julian Date when % passage attained — Late	Yakima Stock: Difference in Julian Dates Late - Early
Q1	(25% passage)	151	153	2	124	145	21
Q2	(50% passage)	153	154	1	137	151	14
Q3	(75% passage)	155	155	0	145	153	8
***Total Expanded PIT-Tag Passage		311	164		274	500	

Stiles (Naches)

Quartile (when % passage attained)		Willard Stock: Julian Date when % passage attained — Early	Willard Stock: Julian Date when % passage attained — Late	Willard Stock: Difference in Julian Dates Late - Early	Yakima Stock: Julian Date when % passage attained — Early	Yakima Stock: Julian Date when % passage attained — Late	Yakima Stock: Difference in Julian Dates Late - Early
Q1	(25% passage)	143	150	7	137	150	13
Q2	(50% passage)	145	152	7	138	151	13
Q3	(75% passage)	150	153	3	142	151	9
***Total Expanded PIT-Tag Passage		366	520		336	1007	

* Actually Extra Early

** Actually mixed Willard and Yakima broodstock

3. 2002 Fall Chinook Survival to McNary Dam and McNary Dam Passage

3.a. Tagging to McNary Passage Survival

There were three major Fall Chinook release groups made into the Yakima River in 2002:

1. Below Prosser Dam release, accelerated rearing

2. Below Prosser Dam release, conventional rearing

3. Marion Drain release

There were two releases (replicates) for each of the release groups.

Table 3.a. presents the number of fish PIT-tagged per release and the estimated PIT-tagging-to-McNary survival indices. The group survival-index means, associated logit transforms, and their standard errors are also presented for each of the three release groups. The standard errors utilize the error mean deviance given in the logistic analysis of variation table (Table 3.b.). The methodology for estimating the survival indices is discussed in Appendix A along with the analysis procedures followed.

As can be seen from the logistic analysis of variation table (Table 3.b.). There were no significant differences among the survival indices for the three groups (P = 0.374).

Table 3.a. Year 2002 Fall Chinook Releases made into the Yakima Basin with Associated Number of Fish Released and Estimated Survival Index from Tagging to McNary Passage

Release	Date Released	Number PIT-tagged	Survival Index
Accelerated Rearing			
Replication 1	04/15/02	1001	0.2331
Replication 2	04/16/02	1000	0.2286
Pooled Mean		2001	0.2308
Conventional Rearing			
Replication 1	05/15/02	1000	0.2662
Replication 2	05/16/02	1000	0.1791
Pooled Mean		2000	0.2227
Marion Drain			
Replication 1	04/01/02	500	0.3208
Replication 2	04/01/02	500	0.2777
Pooled Mean		1000	0.2993

Table 3.b. Weighted Logistic Analysis of Variation among Release Groups (Prosser Accelerated Rearing, Prosser Conventional Rearing, and Marion Drain Releases).

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 P
Release Group	22.54	2	11.27	1.39	0.3739
Error	24.32	3	8.11		

Referring to Appendix B, there were also no significant differences among similar releases made in year 2001 (P = 0.480); however, for releases made in year 2000, the conventional rearing survival index significantly exceeded that of the accelerated (P = 0.033) and also exceeded that of fish released at Marion Drain (P = 0.025).

3.b. McNary Passage Summaries

Smolt Leakage from Rearing Ponds: Based on McNary detections, there was no evidence of fish leakage from any of the six Fall Chinook releases; i.e., none of the PIT-tagged fish were detected at McNary before the associated release date.

Passage time: Table 3.c. presents the estimated Julian dates of quartile passage of PIT-tagged fish for each of the releases. As might be expected, the conventional rearing treatment, which was released in mid-May, passed later than that of the accelerated rearing treatment, which was released in mid-April, a month earlier than the conventionally reared fish. The first quartile passage of the Marion Drain release, which was released on April 1, was comparable to that of the Prosser released conventionally reared fish, which were released on May 15 and 16. However, the passage of the Marion Drain release was more compressed than that of the Prosser releases. There is between 4 and 5 days separating the 25% and 75% McNary passage dates for the Marion Drain releases. For the below-Prosser Dam releases, the differences between the 25% and 75% passage dates were 12 and 16 days for the accelerated treatment and were 7 and 15 days for the conventional treatment.

Table 3.c. Estimated Julian Date for 25%, 50%, and 75% of Total McNary Smolt Passage of PIT-tagged Fish for each 2002 Fall Chinook Release into the Yakima

Quartile (when % passage attained)		Julian Date when % Passge Attained					
		Below-Prosser Dam Release				Marion Drain Releases	
		Accelerated Rearing		Conventional Rearing			
		Release 1	Release 2	Release 1	Release 2	Release 1	Release 2
Q1	(25% passage)	140	138	152	153	150	151
Q2	(50% passage)	150	144	156	157	153	153
Q3	(75% passage)	152	154	159	168	155	155
Estimated Total Passage		233	229	266	179	160	139

Appendix A. Estimated Survival Index and Logistic Analysis

A weighted logistic analysis of variation was undertaken using release number as the weighting variable. The basic nature of and justification for the use of the logistic analysis of variation is discussed in Appendix A. of 2002 Annual Report: OCT-SNT Survival by Doug Neeley.

The 2002-release estimators for Release-to-McNary survival indices are somewhat different than those for previous brood years. For the 2002 releases, McNary detection efficiencies were based on detections of all Coho and all Fall Chinook released into the Upper Yakima; in previous release years the efficiencies were based on the releases within the specific study (early and late releases for Coho, and accelerated, conventional, and Marion Drain releases for Fall Chinook). Efforts will be made next year to standardize the estimation procedures over all release years. Alternative survival estimation procedures will also be investigated.

A.1. Coho

The total number of Coho detections per stratum, the expanded number (detected number divided by detection efficiency) per stratum, the total expanded number over strata, the total number tagged, and the survival index are given for 2002 Coho releases in Table A.1.

The detection efficiencies used for Coho are given in Table A.2. In the table, the "Augmented" includes downstream detections from days for which there were no associated joint downstream-dam and McNary Dam counts. The detection efficiencies actually used are those listed under "Augmented" under "Pooled over John Day and Bonneville" in Table A.2. The stepwise logistic analysis of variation leading to the stratification is given in Table A.3

The stratification explained more of the variation in McNary daily detection efficiencies for Coho than was explained by the daily proportion of McNary flow that is spilled (spill proportion) or the daily proportion of flow that is passed through the turbines (turbine proportion). This is reflected in the significance levels in Table A.4 for strata adjusted 1) for spill proportion, 2) for turbidity proportion, and 3) for both (respectively $P = 0.001$, $P = 0.003$, $P = 0.002$). However, stratification does not explain all of the variability explained by the effects of spill proportion and of turbine proportion; the effect of spill proportion and turbine proportion being significant. (Type 1error probability estimates associated with strata adjusted for spill proportion, for turbine proportion, and for both respectively are $P = 0.090$, $P = 0.036$, and $P < 0.001$, Table A.4.)

Table A.5 gives the data used in the analyses.

Table A.1. Numbers used to estimate Survival Indices for 2002 Coho releases into the Upper Yakima and Naches

Site >	Easton					Lost Creek			
Stock >	Willard		Mixed	Yakima		Willard		Yakima	
Release Time >	Very Early	Early	Late	Very Early	Late	Early	Late	Early	Late
Stratum	Number of Detections								
1 Beginning - 5/8/02	34	0	0	7	4	1	0	55	17
2 5/9/02 - 5/18/02	0	0	0	0	0	0	0	8	9
3 5/19/02 - 5/22/02	0	0	8	0	4	3	1	7	11
4 5/23/02 - 5/29/02	0	7	13	1	23	8	3	13	17
5 5/30/02 - End	0	5	53	0	19	34	19	6	41
Total over Strata	34	12	74	8	50	46	23	89	95
	Expanded Detections = (Number of Detections)/(Detection Efficiency)								
Stratum / Detection Efficiency									
1 / 0.48591	70.0	0.0	0.0	14.4	8.2	2.1	0.0	113.2	35.0
2 / 0.22148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.1	40.6
3 / 0.44602	0.0	0.0	17.9	0.0	9.0	6.7	2.2	15.7	24.7
4 / 0.20896	0.0	33.5	62.2	4.8	110.1	38.3	14.4	62.2	81.4
5 / 0.12868	0.0	38.9	411.9	0.0	147.7	264.2	147.7	46.6	318.6
Total Expanded Detections	70.0	72.4	492.0	19.2	274.9	311.3	164.3	273.8	500.3
Number Released	1251	1248	2497	1249	2500	1249	1247	1192	1250
Survival Index = (Total Expanded Detections)/(Number Released)	0.0559	0.0580	0.1971	0.0154	0.1100	0.2492	0.1317	0.2297	0.4002

Site >	Stiles			
Stock >	Willard			
Release Time >	Number of Detections			
	Early	Late	Early	Late
Stratum				
1 Beginning - 5/8/02	0	0	6	5
2 5/9/02 - 5/18/02	0	0	35	2
3 5/19/02 - 5/22/02	22	0	40	1
4 5/23/02 - 5/29/02	45	3	11	16
5 5/30/02 - End	13	65	3	117
Total over Strata	80	68	95	141
	Expanded Detections			
Stratum / Detection Efficiency				
1 / 0.48591	0.0	0.0	12.3	10.3
2 / 0.22148	0.0	0.0	158.0	9.0
3 / 0.44602	49.3	0.0	89.7	2.2
4 / 0.20896	215.3	14.4	52.6	76.6
5 / 0.12868	101.0	505.1	23.3	909.3
Total Expanded Detections	365.7	519.5	336.0	1007.4
Number Released	1249	1251	1250	1250
Survival Index = (Total Expanded Detections)/(Number Released)	0.2928	0.4153	0.2688	0.8059

Table A.2. Detection efficiencies used to estimate 2002-Outmigrant Coho Survival Indices

			Bonnville-based					
			Joint Detection Based			Augmented		
Stratum	1st Date	Last Date	BO Total	BO-McN Total	Estimate	BO Total	BO-McN Total	Estimate
1		5/8/02	56.00	36	0.642857	65.52	36	0.549481
2	5/9/02	5/18/02	49.66	13	0.261768	53.80	13	0.241631
3	5/19/02	5/22/02	20.23	10	0.494438	20.57	10	0.486149
4	5/23/02	5/29/02	125.52	25	0.199164	125.52	25	0.199164
5	5/30/02		298.59	43	0.144011	351.59	43	0.122302
			John Day-based					
			Joint Detection Based			Augmented		
Stratum	1st Date	Last Date	JD Total	JD-McN Total	Estimate	JD Total	JD-McN Total	Estimate
1		5/16/02	48.33	26	0.537931	62.08	26	0.418818
2	5/17/02	5/26/02	11.90	3	0.252101	18.44	3	0.162690
3	5/27/02	5/30/02	27.97	12	0.429082	28.76	12	0.417316
4	5/31/02	6/6/02	77.08	18	0.233516	80.25	18	0.224290
5	6/7/02		350.72	53	0.151119	394.47	53	0.134357
			Pooled over John Day and Bonneville					
			Joint Detection Based			Augmented (Actually Used)		
Stratum	1st Date	Last Date	JD Total	JD-McN Total	Estimate	JD Total	JD-McN Total	Estimate
1		5/24/02	104.33	62	0.594249	127.60	62	0.485910
2	5/25/02	6/3/02	61.56	16	0.259900	72.24	16	0.221481
3	6/4/02	6/7/02	48.19	22	0.456510	49.32	22	0.446021
4	6/8/02	6/14/02	202.61	43	0.212234	205.78	43	0.208963
5	6/15/02		649.31	96	0.147850	746.06	96	0.128676

Table A.3. Weighted Stepwise Logistic Analysis of Year 2002 Yakima-Released Coho Detection Efficiencies leading to Stratified McNary Detection Efficiency Estimates (weight is estimated number of downstream dam detections associated with McNary date of detection)

Source			Deviance	Degrees of Freedom			
Step	Stratum Separating McNary Julian Detection Dates		(Dev)	(DF)	Dev/DF	F	Type 1 P
Step 1	142	143	80.74	1	80.74	68.46	0.0000
Step 2 *	126	127	13.91	1	13.91	15.22	0.0003
Step 3	149	150	4.47	1	4.47	5.33	0.0254
Step 4 **	139	140	3.73	1	3.73	4.81	0.0334
Step 5 ***	150	151	1.08	1	1.08	1.40	0.2422
ERROR			Deviance	DF	Mean Dev		
Error	Variation with no partition		138.53	50	2.77		
Error For Step 1			57.79	49	1.18		
Error For Step 2			43.88	48	0.91		
Error For Step 3			39.41	47	0.84		
Error For Step 4			35.68	46	0.78		
Error For Step 5			34.6	45	0.77		

* Shifting of strata after all steps completed actually produced smaller error for separation between Julian dates 128 and 129 which was the separation selected

** Partitioning produced a stratum that had less than 20 total joint McNary, down-stream dam detections, separation actually selected was between Julian dates 138 and 139

*** Omitted and terminated stepwise process because 10% significance level not attained (P = 0.242)

Table A.4. Weighted Logistic Analysis of Variation of Year 2002 Effects of Strata, Spill Proportion of Flow, and Turbine Proportion of Flow on Yakima-Released Coho McNary Daily Detection Efficiencies (weight is estimated number of downstream dam detections associated with McNary date of detection)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Dev/DF	F-Ratio	Type 1 P
Spill Proportion (Spill)	1.12	1	1.12	20.97	0.0000
Turbidity Proportion (Turb)	1.35	1	1.35	25.28	0.0000
Spill, Turb	1.45	2	0.73	13.57	0.0000
Spill adjusted for Turb	0.1	1	0.10	1.87	0.1782
Turb adjusted for Spill	0.33	1	0.33	6.18	0.0168
Among Strata (Strata)	1.25	4	0.31	5.85	0.0007
Spill adjusted for Strata	1.03	1	1.03	19.29	0.0001
Turb adjusted for Strata	1.12	1	1.12	20.97	0.0000
Spill adjusted for Strata, Turb	0.16	1	0.16	3.00	0.0905
Turb adjusted for Strata, Spill	0.25	1	0.25	4.68	0.0360
Spill, Turb adjusted for Strata	1.28	2	0.64	11.98	0.0001
Strata adjusted for Spill	1.16	4	0.29	5.43	0.0012
Strata adjusted for Turb	1.02	4	0.26	4.77	0.0028
Strata adjusted for Spill, Turb	1.08	4	0.27	5.06	0.0019
Error	2.35	44	0.05		

Table A.5. Data[8] used in Table A.4 Analysis

McNary Date	Estimated Detection Efficiency	Estimated Downstream Detections (weight)	Stratum Number	Spill Propotion of McNary Flow	Turbine Propotion of McNary Flow
4/7/02	0	0.388888889	1	0.0000	0.9601
4/9/02	1	1	1	0.0000	0.9660
4/10/02	0	0.333333333	1	0.1856	0.7839
4/11/02	0	0.433333333	1	0.3572	0.6151
4/12/02	0.639593909	1.563492063	1	0.3779	0.5950
4/13/02	0	1.111111111	1	0.3326	0.6454
4/14/02	0	0.748917749	1	0.3782	0.5982
4/15/02	0.583333333	5.142857143	1	0.5039	0.4785
4/16/02	0.328125	3.047619048	1	0.4736	0.5117
4/17/02	0.61192053	4.902597403	1	0.4773	0.5011
4/18/02	0.394551433	2.53452381	1	0.4897	0.4947
4/19/02	0.481305707	6.233044733	1	0.4668	0.5173
4/20/02	0.431692769	9.265848966	1	0.4738	0.5096
4/21/02	0.267423015	3.739393939	1	0.4430	0.5393
4/22/02	0	2.004184704	1	0.4375	0.5446
4/23/02	0	1.015305942	1	0.4797	0.5032
4/24/02	0.207385684	4.821933622	1	0.5027	0.4791
4/25/02	0.687159147	1.455266955	1	0.4668	0.5137
4/26/02	0.391752577	2.552631579	1	0.4380	0.5418
4/27/02	0.623465601	3.207875458	1	0.4572	0.5199
4/28/02	0.681572304	4.401587302	1	0.4117	0.5632
4/29/02	0.326213592	3.06547619	1	0.3663	0.6120
4/30/02	0.194895592	5.130952381	1	0.3885	0.5906
5/1/02	0	0.763888889	1	0.3609	0.6169
5/2/02	0.491848074	10.16574074	1	0.2337	0.7444
5/3/02	0.885664592	5.645478036	1	0.2626	0.7166
5/4/02	0.719212937	11.12327044	1	0.2852	0.6952
5/5/02	0.64516129	9.3	1	0.2615	0.7169
5/6/02	0.475038487	12.63055556	1	0.3057	0.6721
5/7/02	0.375782881	5.322222222	1	0.3644	0.6162
5/8/02	0.4400978	4.544444444	1	0.3171	0.6639
5/9/02	0.139878254	7.149074074	2	0.3627	0.6140
5/10/02	0	1.962287664	2	0.3666	0.6095
5/11/02	0	0.846075124	2	0.3229	0.6545
5/12/02	0	0.924958229	2	0.3248	0.6451
5/13/02	0	1.235779269	2	0.3637	0.6143
5/14/02	0	0.848183678	2	0.3208	0.6568
5/15/02	0.220478736	9.071169586	2	0.2933	0.6844
5/16/02	0.14556636	13.73943818	2	0.2966	0.6800
5/17/02	0.305508506	9.819693859	2	0.3161	0.6622
5/18/02	0.300250536	26.6444154	2	0.3351	0.6423

[8] Spill proportion is McNary spill flow divided by total McNary discharge. Turbine proportion is McNary turbine flow divided by total McNary discharge. McNary flow database used was provided by Fish Passage Center, Portland, Oregon. Database originally created by U.S. Army Corps of Engineers.

Table A.5. Data used in Table A.4 Analysis (continued)

McNary Date	Estimated Detection Efficiency	Estimated Downstream Detections (weight)	Stratum Number	Spill Propotion of McNary Flow	Turbine Propotion of McNary Flow
05/19/02	0.361620411	13.83	3	0.3391	0.6384
05/20/02	0.514096494	11.67	3	0.3231	0.6561
05/21/02	0.507502951	13.79	3	0.3906	0.5924
05/22/02	0.398630273	10.03	3	0.3987	0.5838
05/23/02	0.209957069	47.63	4	0.4150	0.5678
05/24/02	0.199390789	50.15	4	0.4178	0.5645
05/25/02	0.254258452	35.40	4	0.4264	0.5541
05/26/02	0.171625177	23.31	4	0.4306	0.5491
05/27/02	0.333333333	3.00	4	0.4461	0.5364
05/28/02	0.22613769	4.42	4	0.4158	0.5672
05/29/02	0.191064906	41.87	4	0.4518	0.5322
05/30/02	0.166872117	239.70	5	0.4164	0.5676
05/31/02	0.125669443	167.11	5	0.4638	0.5216
06/01/02	0.137381275	65.51	5	0.4953	0.4910
06/02/02	0.12189195	82.04	5	0.4309	0.5535
06/03/02	0.133489461	22.47	5	0.4460	0.5390
06/04/02	0	7.87	5	0.5391	0.4478
06/05/02	0.07640897	26.17	5	0.5876	0.3999
06/06/02	0.078428974	38.25	5	0.5658	0.4217
06/07/02	0.095846645	20.87	5	0.5340	0.4523
06/08/02	0	7.10	5	0.5739	0.4134
06/09/02	0	6.71	5	0.4915	0.4943
06/10/02	0	7.59	5	0.4359	0.5482
06/11/02	0	12.49	5	0.4980	0.4882
06/12/02	0	12.39	5	0.4877	0.4965
06/13/02	0	8.12	5	0.4664	0.5183
06/14/02	0	4.15	5	0.4303	0.5530
06/15/02	0.148148148	6.75	5	0.4404	0.5442
06/16/02	0.558139535	3.58	5	0.3618	0.6209
06/17/02	0.52173913	3.83	5	0.4739	0.5103
06/18/02	0	0.67	5	0.5078	0.4778
06/19/02	0	0.67	5	0.5191	0.4673
06/20/02	0.6	1.67	5	0.5226	0.4644
06/21/02	0	0.33	5	0.5037	0.4829

A.2. Fall Chinook

The total number of Fall Chinook detections per stratum, the expanded number (detected number divided by detection efficiency) per stratum, the total expanded number over strata, the total number tagged, and the survival index are given for 2002 Fall Chinook releases in Table A.6.

The detection efficiencies used for Fall Chinook are given in Table A.7. In the table, the "Augmented" includes downstream detections from days for which there were no associated joint downstream-dam and McNary Dam counts. The detection efficiencies actually used are those listed under "Augmented" under "Pooled over John Day and Bonneville" in Table A.7. The stepwise logistic analysis of variation leading to the stratification is given in Table A.8.

The stratification was more effective in explaining variation in daily detection efficiencies than either the daily proportion of McNary flow that was spilled (spill proportion) or the daily proportion of flow that was passed through the turbines (turbine proportion). Table A.9 gives a logistic analysis of variation that assesses the effects of strata, spill proportion, and turbine proportion on estimated daily McNary detection efficiencies. Table A.10 gives the data used in the regression. The effect of strata was stronger than those of spill proportion and turbine proportion. In fact, the effects of spill and turbine proportions are not significant ($P > 0.2$, Table A.9), nor are their effects when adjusted for the effect of strata. However, the effects of strata are significant, whether or not the adjusted for the effects of spill proportion, turbine proportion, and both are still highly significant ($P < 0.001$, Table A.9).

Table. A.6. Numbers used to estimate Survival Indices for 2002 Fall Chinook releases into the Upper Yakima and Naches

Release >				Below-Prosser Releases					
				Accelerated		Conventional		Marion Drain	
				Release 1	Release 2	Release 1	Release 2	Release 1	Release 2
Stratum				Number of Detections					
1	Beginning	-	5/31/02	48	50	20	10	16	12
2	6/1/00	-	6/4/02	13	6	15	10	18	16
3	6/5/02	-	End	7	13	41	31	9	9
Total over Strata				68	69	76	51	43	37
				Expanded Detections = (Number of Detections)/(Detection Efficiency)					
Stratum			Detection Efficiency						
1			0.3148	152.497676	158.851745	63.5406982	31.7703491	50.8325586	38.1244189
2			0.2260	57.5279659	26.5513689	66.3784222	44.2522814	79.6541066	70.8036503
3			0.3008	23.2748577	43.2247356	136.324166	103.07437	29.924817	29.924817
Total Expanded Detections				233.300499	228.62785	266.243287	179.097	160.411482	138.852886
Number Released				1001	1000	1000	1000	500	500
Survival Index = (Total Expanded Detections)/ (Number Released)				0.2331	0.2286	0.2662	0.1791	0.3208	0.2777

Table A.7. Detection efficiencies used to estimate 2002-Outmigrant Fall Chinook Survival Indices

			Bonnville-based					
			Joint Detection Based			Augmented		
Stratum	1st Date	Last Date	BO Total	BO-McN Total	Estimate	BO Total	BO-McN Total	Estimate
1		5/31/02	49.33	22	0.445946	65.74	22	0.334634
2	6/1/02	6/4/02	27.67	9	0.325301	30.78	9	0.292394
3	6/5/02	5/22/02	18.00	8	0.444444	26.93	8	0.297083
			John Day-based					
			Joint Detection Based			Augmented		
Stratum	1st Date	Last Date	JD Total	JD-McN Total	Estimate	JD Total	JD-McN Total	Estimate
1		5/16/02	105.81	34	0.321332	112.17	34	0.303110
2	5/17/02	5/26/02	60.83	12	0.197260	62.15	12	0.193083
3	5/27/02	5/30/02	65.36	24	0.367213	79.47	24	0.301998
			Pooled over John Day and Bonneville					
			Joint Detection Based			Augmented (Actually Used)		
Stratum	1st Date	Last Date	JD Total	JD-McN Total	Estimate	JD Total	JD-McN Total	Estimate
1		5/24/02	155.14	56	0.360958	177.91	56	0.314759
2	5/25/02	6/3/02	88.50	21	0.237288	92.93	21	0.225977
3	6/4/02	6/7/02	83.36	32	0.383890	106.40	32	0.300754

Table A.8. Weighted Stepwise Logistic Analysis of Year 2002 Yakima-Released Fall Chinook Daily Detection Efficiencies leading to Stratified McNary Detection Efficiency Estimates (weight is estimated number of downstream dam detections associated with McNary date of detection)

Source			Degrees of				
Step	Stratum Separating McNary Julian Detection Dates		Deviance (Dev)	Freedom (DF)	Dev/DF	F	Type 1 P
Step 1 *	143	144	2.00	1	2	5.25	0.0291
Step 2	155	156	2.59	1	2.59	8.51	0.0068
Step 3 **	151	152	1.87	1	1.87	7.52	0.0105
Step 3 ***	152	153	1.56	1	1.56	6.01	0.0207
Step 3 ***	154	155	1.24	1	1.24	4.57	0.0413
ERROR			Deviance	DF	Mean Dev		
Error	Variation with no partition		13.42	31	0.43		
Error Step 1 *			11.42	30	0.38		
Error Step 2			8.83	29	0.30		
Error Step 3 **			6.96	28	0.25		
Error Step 4 ***			7.27	28	0.26		
Error Step 5 ***			7.59	28	0.27		

* Shifting of strata after all steps completed actually produced smaller error for separation between Julian dates 151 and 152 which was the separation selected (same as first Step 3) with elimination of Step 143 and 144 Julian date separation, first Step 3 inconsistency disappears

** Inconsistency between John Data-based and Bonneville-based detection efficiencies

*** Partitioning produced a stratum that had less than 20 total joint McNary, down-stream dam detections

Table A.9. Weighted Logistic Analysis of Variation of Year 2002 Effects of Strata, Spill Proportion of Flow, and Turbine Proportion of Flow on Yakima-Released Fall Chinook McNary Daily Detection Efficiencies (weight is estimated number of downstream dam detections associated with McNary date of detection)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Dev/DF	F-Ratio	Type 1 P
Spill Proportion (Spill)	0.34	1	0.34	1.27	0.2691
Turbidity Proportion (Turb)	0.33	1	0.33	1.24	0.2761
Spill, Turb	0.45	2	0.23	0.84	0.4416
Spill adjusted for Turb	0.12	1	0.12	0.45	0.5083
Turb adjusted for Spill	0.11	1	0.11	0.41	0.5264
Among Strata (Strata)	5.35	2	2.68	10.02	0.0006
Spill adjusted for Strata	0.48	1	0.48	1.80	0.1912
Turb adjusted for Strata	0.5	1	0.50	1.87	0.1825
Spill adjusted for Strata, Turb	0.36	1	0.36	1.35	0.2558
Turb adjusted for Strata, Spill	0.38	1	0.38	1.42	0.2433
Spill, Turb adjusted for Strata	0.86	2	0.43	1.61	0.2184
Strata adjusted for Spill	5.49	2	2.75	10.28	0.0005
Strata adjusted for Turb	5.52	2	2.76	10.34	0.0005
Strata adjusted for Spill, Turb	5.76	2	2.88	10.79	0.0004
Error	7.21	27	0.27		

Table A.10. Data[9] used in Table B.9 Analysis

McNary Date	Estimated Detection Efficiency	Estimated Downstream Detections (weight)	Stratum Number	Spill Propotion of McNary Flow	Turbine Propotion of McNary Flow
05/07/02	0.5	2.00	1	0.3644	0.6162
05/08/02	0.4	2.50	1	0.3171	0.6639
05/10/02	0	1.00	1	0.3666	0.6095
05/11/02	0	1.00	1	0.3229	0.6545
05/12/02	0	0.25	1	0.3248	0.6451
05/13/02	0	0.95	1	0.3637	0.6143
05/14/02	0	0.91	1	0.3208	0.6568
05/15/02	0.24742268	4.04	1	0.2933	0.6844
05/16/02	0	0.49	1	0.2966	0.6800
05/17/02	0.208309223	4.80	1	0.3161	0.6622
05/18/02	0.328295389	6.09	1	0.3351	0.6423
05/19/02	0.378511154	13.21	1	0.3391	0.6384
05/20/02	0.324559366	12.32	1	0.3231	0.6561
05/21/02	0.478712822	10.44	1	0.3906	0.5924
05/22/02	0.356422564	5.61	1	0.3987	0.5838
05/23/02	0.409223154	7.33	1	0.4150	0.5678
05/24/02	0.151538701	13.20	1	0.4178	0.5645
05/25/02	0.325540924	15.36	1	0.4264	0.5541
05/26/02	0.227757017	8.78	1	0.4306	0.5491
05/27/02	0.315459678	9.51	1	0.4461	0.5364
05/28/02	0.31700832	12.62	1	0.4158	0.5672
05/29/02	0.239103362	16.73	1	0.4518	0.5322
05/30/02	0.455840456	8.78	1	0.4164	0.5676
05/31/02	0.350355474	19.98	1	0.4638	0.5216
06/01/02	0.251927628	19.85	2	0.4953	0.4910
06/02/02	0.228426851	30.64	2	0.4309	0.5535
06/03/02	0.254602734	19.64	2	0.4460	0.5390
06/04/02	0.175438596	22.80	2	0.5391	0.4478
06/05/02	0.208742013	4.79	3	0.5876	0.3999
06/06/02	0.349768146	22.87	3	0.5658	0.4217
06/07/02	0.304477724	22.99	3	0.5340	0.4523
06/08/02	0.305546799	16.36	3	0.5739	0.4134
06/09/02	0	1.10	3	0.4915	0.4943
06/10/02	0	0.48	3	0.4359	0.5482
06/11/02	0	2.14	3	0.4980	0.4882
06/12/02	0	2.33	3	0.4877	0.4965
06/13/02	0	1.55	3	0.4664	0.5183
06/14/02	0	2.89	3	0.4303	0.5530
06/15/02	0.296296296	3.38	3	0.4404	0.5442
6/16/02	0.313017306	6.389423077	3	0.3618	0.6209
6/17/02	0.440366972	9.083333333	3	0.4739	0.5103
6/18/02	0.352941176	2.833333333	3	0.5078	0.4778
6/19/02	0.393442623	5.083333333	3	0.5191	0.4673
6/20/02	0.466666667	2.142857143	3	0.5226	0.4644

[9] Spill proportion is McNary spill flow divided by total McNary discharge. Turbine proportion is McNary turbine flow divided by total McNary discharge. McNary flow database used was provided by Fish Passage Center, Portland, Oregon. Database originally created by U.S. Army Corps of Engineers.

Appendix B: Corrected 2001 Annual Report

Release-to-McNary Survival Indices of Coho and Fall Chinook 2001 Releases (Review of Coho Brood Year 1999 and Fall Chinook Brood Year 2000)

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Submitted April 30, 2002
Corrected April 1, 2003

1. Coho

1.a. Summary

In 2001, releases of juvenile Coho were made from two sites, Cle Elum and Easton, in the Upper Yakima and from two sites, Lost Creek and Stiles, in the Naches. There were two treatment factors assessed at each release site: 1) Release time comprised of two levels--a May 7 early release and a May 25 late release, and 2) bloodstock comprised of two levels—a Yakima-return brood and a Willard Hatchery brood.

The survival index from release to McNary Dam passage varied dramatically over subbasins and between sites within subbasins, the lowest survival indices being from the upper Yakima (as survival-index proportions, 0.014 from Cle Elum and 0.064 from Easton) and the highest being from the Naches (0.12 from Lost Creek and 0.30 from Stiles). Pre-release escape from the rearing ponds was high. The proportion of fish detected at McNary before the official release date was 0.21 from Cle Elum, 0.06 from Easton, 0.25 from Lost Creek, and 0.13 from Stiles. These escape estimates will be under-estimates because of the time required to migrate from the release site to McNary Dam. For the year-2000 releases, which were made at the same sites, there was evidence that fish designated for early release and late release at Stiles intermingled prior to release date. For the 1999 releases, there was little evidence of pre-release mixing of the early and late release groups; however, there were major adjustments made in the 1999 databases that were never discussed in the 1999 Annual Report but are discussed in this report.

The 2001 early and late release-to-McNary-passage survival indices respectively were 0.13 and 0.12 and did not significantly differ (P = 0.61). This mirrors the lack of a significant difference from the analysis of the 2000 outmigrants, the 2000 main effect survival-index means for early and late releases respectively being 0.24 and 0.18 and not differing significantly (P = 0.53). Based on the analysis of the 1999 outmigrants, there was statistical evidence of a difference between that year's early- and late-releases (the main effect survival-index means of 0.53 and 0.44 respectively for early and late releases did differ significantly, P = 0.05); however, the adjustments to the 1999 data basis, alluded to above, would have affected the early versus late comparisons.

Yakima-brood 2001 outmigrants had greater survival indices than did Willard-brood outmigrants ($P < 0.001$, survival indices being 0.051 for Yakima and 0.028 for Willard broodstock smolt released from the Upper Yakima and being 0.32 for Yakima and 0.10 for Willard broodstock released from the Naches). Only the Willard broodstock was available for 2000 outmigrants. For 1999 outmigrants, Yakima and Cascade Hatchery broodstock were available, and the Cascade brood survival index was significantly greater than that of the Yakima broodstock ($P = 0.02$).

It should be noted that the method of estimating the smolt survival index from release to McNary passage in 2001 differed from the methods used in 1999 and 2000. The 1999 and 2000 data sets will be re-analyzed in the future to make the methods consistent.

1.b. Release to McNary Smolt-Passage Survival Indices

Tables 1.a.1, 1.a.2, and 1.a.3 respectively give the 1999, 2000, and 2001 main effect means for time of release and for stock for each site. Tables 1.b.1, 1.b.2, and 1.b.3 give the associated logistic analyses of variation. Only one brood source, that from Willard Hatchery, was available in 2001. In 1999, Jack Creek was one of the release sites in the Upper Yakima. In 2000 and 2001, Easton was used in place of Jack Creek. In 1999, Lost Creek was dropped from the analysis because of high disease incidence.

As can be seen in the logistic analyses of variation for the 1999 outmigrants (Table 1.b.1, means given in Table 1.a.1), the hatchery brood source (Cascade hatchery) had a significantly greater smolt survival index than did the Yakima-return brood. However, referring to Tables 1.b.3 and 1.a.3, the 2001 smolt survival index for the Yakima brood was significantly higher than the survival index for the hatchery source (Willard hatchery was used for the broodstock for the 2001 outmigrants instead of the Cascade hatchery which was the broodstock which was used for the 1999 outmigrants).

Only for the 1999 outmigrants was there a significant difference between the early versus late[10] release survival indices (analysis of variation in Table 1.b.1, means in Table 1.a.1). The method of analysis for the 1999 outmigrants was different than that used for the 2000 and 2001 outmigrants, and the analysis of variation method used for the 1999 outmigrants needs to be revised to correspond to the analysis procedure used in the subsequent outmigrant years' analyses[11]. There are other issues regarding the 1999 analysis procedures. The tagging files identified as early- and late-releases for sites Jack Creek

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[10] Early releases: May 17, May 7, and May 7 respectively in 1999, 2000, and 2001
Late releases: May 27, May 31, and May 25 respectively in 1999, 2000, and 2001

[11] The currently used method is that of fitting constants in which, when analyzing main effects, first a weighted regression is run which includes all main effect factors, then a weighted regression is run that drops the main effect factor of interest, after which the differences in the deviance and degrees of freedom between the two regression fits are used to evaluate the main effect of interest. Analogous procedures are utilized in evaluating two-factor interactions. In 1999, the main effect of interest was included and not adjusted for the other factors. In the presence of varying release numbers, this procedure can produce biased results. In all analyses, weighted logistic analyses of variation on the survival indices were used where the weight was the number of PIT tags released.

(one of the two Upper Yakima subbasin sites) and Stiles (one of the two Naches subbasin sites) were apparently misidentified since the "early"-release McNary-passage-time distribution was later than was the "late"-release passage. With the agreement of the Coho researcher and the field staff, the "early" releases were treated as late, and the "late" as early in the analysis. This was not pointed out in my 1999 Annual Report on Coho. If any of the reassignments were erroneous, then the early and late comparisons will be biased.

There are also problems associated with the 2000 and 2001 releases. In 2000, the proportion of PIT-tagged fish "released" from Stiles on May 31 (late-release date) that were detected at McNary on or before May 27 was 0.59. Either there was excessive pre-release escapement from the Stiles late-release pond or there was excessive leakage between the early and late group at Stiles, the early and late groups being separated by a net in the same pond. In 2001 there was evidence of pre-release date escapement from most ponds (Table 1.c). Under these conditions, it is doubtful that accurate early and late release comparisons can be made.

It should be noted from Tables 1.a.1 through 1.a.3 that the overall survival indices decreased over years (0.485 in 1999, 0.129 in 2000, and 0.129 in 201), perhaps reflecting the reduction in flows over those years. In 2001, there were significant and substantial differences among sites. An overview over all sites suggests that survival out of the Naches may be greater than out of the Upper Yakima. The difference among sites within subbasins is not necessarily associated with distance from McNary. In the Upper Yakima, Cle Elum, with the lowest survival index, is closer to McNary than is Easton. There may be issues with rearing conditions at the different sites.

Table 1.a.1. Weighted Release-to-McNary Survival-Index (S.I.) Main Effect Means for Year 1999 Coho Releases (weight = release number).

Subbasin	Site	Survival Index (S.I.)	Time of Release: Early	Time of Release: Late	Stock: Cascade	Stock: Yakima	Site Mean
Upper Yakima	Cle Elum	S.I.	0.503	0.373	0.459	0.423	0.438
		Release Number	1958	1995	1608	2345	3953
	Jack Creek	S.I.	0.522	0.452	0.587	0.386	0.487
		Release Number	2491	2477	2493	2475	4968
Naches	Lost Creek (Omitted)*	S.I.	0.265	0.043	0.212	0.083	0.150
		Release Number	2209	2364	2380	2193	4573
	Stiles	S.I.	0.561	0.489	0.552	0.486	0.522
		Release Number	2135	2493	2527	2101	4628
Yakima Basin	Pooled Mean	S.I.	0.529	0.443	0.543	0.429	0.485
		Release Number	6584	6965	6628	6921	13549

* Lost Creek Omitted from analysis and pooled Yakima Basin means because of high disease incidence

Table 1.a.2. Weighted Release-to-McNary Survival-Index (S.I.) Main Effect Means for Year 2000 Coho Releases (weight = release number).

Subbasin	Site	Survival Index (S.I.)	Time of Release Early	Time of Release Late	Site Mean
Upper Yakima	Cle Elum	S.I.	0.136	0.020	0.078
		Release Number	2487	2462	4949
	Easton	S.I.	0.278	0.182	0.230
		Release Number	2476	2476	4952
Naches	Lost Creek	S.I.	0.271	0.148	0.209
		Release Number	2489	2488	4977
	Stiles	S.I.	0.259	0.358	0.31
		Release Number	2488	2493	4981
Yakima Basin	Pooled Mean	S.I.	0.236	0.177	0.207
		Release Number	9940	9919	19859

* Insufficient 1998 trapped adult returns to produce Yakima broodstock, Willard hatchery only broodstock.

Table 1.a.3. Weighted Release-to-McNary Survival-Index (S.I.) Main Effect Means for Year 2001 Coho Releases (weight = release number).

Subbasin	Site	Survival Index (S.I.)	Time of Release Early	Time of Release Late	Stock Willard	Stock Yakima	Site Mean
Upper Yakima	Cle Elum	S.I.	0.012	0.017	0.014	0.015	0.015
		Release Number	2404	2459	2416	2447	4863
	Easton	S.I.	0.070	0.061	0.043	0.088	0.065
		Release Number	2483	2481	2468	2496	4964
Naches	Lost Creek	S.I.	0.145	0.109	0.028	0.226	0.127
		Release Number	2490	2496	2485	2501	4986
	Stiles	S.I.	0.307	0.308	0.183	0.430	0.307
		Release Number	2485	2486	2473	2498	4971
Yakima Basin	Pooled Mean	S.I.	0.135	0.124	0.067	0.191	0.129
		Release Number	9862	9922	9842	9942	19784

Table 1.b.1. Logistic Analysis of Variation on Release-to-McNary Survival Indices of Year 1999 Coho Releases (bottom segment of table is a pooling of top segment, all two- and three-factor interactions being pooled into a common error).

Source	Deviance (Dev)	Freedom (DF)	Deviance (Dev/DF)	F-Ratio	Type 1 P
Subbasin	39.65	1	39.65	1.36	0.2957
Subbasin x Release Time*	6.98	1	6.98	0.24	0.6450
Subbasin x Stock	1.4	1	1.40	0.05	0.8350
Site (within Subbasin)	21.61	1	21.61	0.74	0.4282
Site (within Subbasin) x Release Time*	8.01	1	8.01	0.28	0.6222
Site (within Subbasin) x Stock	50.32	1	50.32	1.73	0.2455
Release Time*	100.71	1	100.71	3.46	0.1219
Stock	**176.35**	**1**	**176.35**	**6.06**	**0.0571**
Release Time* x Stock (adj for Site)	8.01	1	8.01	0.28	0.6222
Error (3 factor interactions)	145.47	5	29.09		
Subbasin	39.65	1	39.65	1.8007	0.2093
Site (within Subbasin)	21.61	1	21.61	0.9814	0.3452
Release Time*	**100.71**	**1**	**100.71**	**4.5738**	**0.0582**
Stock	**176.35**	**1**	**176.35**	**6.8677**	**0.0256**
Error (All 3 and 2 factor interactions)	220.19	10	22.019		

* Release Time: Early--May 17, Late--May 27

Table 1.b.2. Logistic Analysis of Variation on Release-to-McNary Survival Indices of Year 2000 Coho Releases (bottom segment of table is a pooling of top segment, all two-factor interactions being pooled into a common error).

Source	Deviance (Dev)	Freedom (DF)	Deviance (Dev/DF)	F-Ratio	Type 1 P
Subbasin	337.57	1	337.57	2.53	0.2524
Site (within Subbasin)	584.88	2	292.44	2.20	0.3129
Release Time* (adj for Site and Stock)	110.31	1	110.31	0.83	0.4589
Subbasin x Release Time*	112.02	1	112.02	0.84	0.4559
Error (Site x Release Time)	266.4	2	133.2		
Subbasin	337.57	1	337.57	2.68	0.2004
Site (within Subbasin)	584.88	2	292.44	2.32	0.2462
Release Time* (adj for Site and Stock)	110.31	1	110.31	0.87	0.4187
Error (All 2 factor interctions)	378.42	3	126.14	1.00	0.5000

* Release Time: Early--May 7, Late--May 31

Table 1.b.3. Logistic Analysis of Variation on Release-to-McNary Survival Indices of Year 2001 Coho Releases (bottom segment of table is a pooling of top segment, all two-factor and three-factor interactions being pooled into a common error).

Source	Deviance (Dev)	Freedom (DF)	Deviance (Dev/DF)	F-Ratio	Type 1 P
Subbasin	**1551.51**	**1**	**1551.51**	**37.66**	**0.0087**
Subbasin x Release Time*	0.02	1	0.02	0.00	0.9838
Subbasin x Stock	41.87	1	41.87	1.02	0.3877
Site (within Subbasin)	**697.54**	**2**	**348.77**	**8.47**	**0.0584**
Site (within Subbasin) x Release Time*	9.68	2	4.84	0.12	0.8931
Site (within Subbasin) x Stock	76.55	2	38.28	0.93	0.4853
Release Time* (adj for Site and Stock)	5.53	1	5.53	0.13	0.7384
Stock (adj for Site and Release Time*)	**784.31**	**1**	**784.31**	**19.04**	**0.0223**
Release Time*x Stock (adj for Site)	5.07	1	5.07	0.12	0.7489
Error (3 factor interactions)	123.59	3	41.20		
Subbasin	**1551.51**	**1**	**1551.51**	**60.422**	**0.0000**
Site (within Subbasin)	**697.54**	**2**	**348.77**	**13.582**	**0.0014**
Release Time* (adj for Site and Stock)	5.53	1	5.53	0.2154	0.6525
Stock (adj for Site and Release Time*)	**784.31**	**1**	**784.31**	**30.544**	**0.0003**
Error (All 3 and 2 factor interactions)	256.78	10	25.678		

* Release Time: Early--May 7, Late--May 25

Table 1.c. Mean McNary Detection Date, Mean Release-to-McNary "Travel Time" = Mean McNary Detection Date – "Release Date, Proportion of McNary Detections Prior to "Release Date", and Related Information.

Stock >	Willard		Yakima	
Date of "Release" >	Early 07-May-01	Late 25-May-01	Early 07-May-01	Late 25-May-01
Cle Elum				
Mean Detection Date	06/20/01	06/10/01	05/12/01	06/06/01
Difference: Detection Date - "Release" Date	44	16	5	12
Total Detected At McNary on/before "release" Date	0	1	5	2
Total McNary Detections	8	10	8	12
Proportion seen at McNary on/before "release" Date	0.0000	0.1000	0.6250	0.1667
Easton				
Mean Detection Date	06/11/01	06/04/01	05/29/01	06/03/01
Difference: Detection Date - "Release" Date	35	11	23	10
Total Detected At McNary on/before "release" Date	0	0	4	6
Total McNary Detections	8	49	86	32
Proportion seen at McNary on/before "release" Date	0.0000	0.0000	0.0465	0.1875
Lost Creek				
Mean Detection Date	06/12/01	06/08/01	05/22/01	05/26/01
Difference: Detection Date - "Release" Date	36	14	15	1
Total Detected At McNary on/before "release" Date	0	0	21	65
Total McNary Detections	18	19	177	128
Proportion seen at McNary on/before "release" Date	0.0000	0.0000	0.1186	0.5078
Stiles				
Mean Detection Date	06/05/01	05/28/01	05/21/01	05/31/01
Difference: Detection Date - "Release" Date	30	3	14	7
Total Detected At McNary on/before "release" Date	0	46	17	44
Total McNary Detections	136	108	275	304
Proportion seen at McNary on/before "release" Date	0.0000	0.4259	0.0618	0.1447

1.c. Survival-index estimators

The general form of the survival-index estimator is:

$$\text{Survial Index} = \frac{\text{Expanded PIT - Tag Detections at McNary}}{\text{Number of PIT - Tagged Fish Released}}$$

wherein

$$\text{Expanded PIT - Tag Detections at McNary} = \frac{\text{Number PIT - Tags Detected at McNary}}{\text{McNary Detection Rate}}$$

wherein

$$\text{McNary Detection Rate} = \frac{\text{Number of Joint Detections at NcNary and Down - Stream Dam}}{\text{Number of Detections at Down - Stream Dam}}$$

In previous years (1999 and 2000 outmigration years), the detections were based on the down-stream dam date of detection; the downstream dams used being either John Day or Bonneville. The downstream dam used was the one that had the greatest number of detections. In 1999 this dam was John Day, but in 2001 the dam used was Bonneville. The daily McNary detection rate was first estimated for each date of detection at the downstream dam, these daily estimates were pooled over dates within strata. The beginning and ending dates of each stratum were established using detections of OCT-SNT[12] Spring Chinook releases. The strata beginning and ending dates were chosen in a manner such that the variation among Spring Chinook daily detection rates within strata was minimized and the detection-rate variation among strata was maximized. The OCT-SNT detections were used to establish the strata instead of Coho because of the large number of daily detections at the Columbia River Dams of the approximately 40,000 OCT-SNT PIT-tagged fish released. The number of Coho detections was insufficient to establish the strata. However, even though the strata were established using OCT-SNT Spring Chinook, the detection rate estimates for Coho were based on the lower dam detections of Coho, not OCT-SNT Spring Chinook.

The lower dam stratum dates were then offset by the mean travel time from McNary to the downstream dam to establish a McNary Day of passage. In 1999, John Day served as the downstream dam because there were more Coho (and Spring Chinook) detections at John Day than at Bonneville; whereas, in 2000, Bonneville served as the downstream dam because there were more Coho detections there than at John Day.

McNary Detections on a given date were allocated to the downstream-dam detection stratum by applying the McNary-to-downstream-dam migration-time relative distribution based on joint McNary and lower dam detections to the total detections at McNary. The allocated counts were then divided by the respective stratum's McNary detection rate

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[12] OCT – Optimal Conventional Treatment
SNT – Semi-Natural Treatment

estimate to get the expanded count; these expanded values were then totaled over strata and McNary detection dates to get the expanded counts for the release; and these totals were then divided by the release numbers to obtain the estimated survival indices.

The stratified estimates for 1999 are given in Appendix Table 1.a. The 2000 downstream dam detections were so small so as to render stratification meaningless, so the total joint downstream and McNary Dam count divided by the total downstream dam count was used as a single, non-stratified estimate of McNary detection rate. The non-stratified estimates for 2000 are given in Appendix Table 1.b.

A different method of detection rate estimation was developed in 2001 and was applied to 1999, 2000, and 2001 OCT-SNT Spring Chinook outmigrants. This method was applied to the 2001 Coho releases, and among other things, the method permitted the pooling of the John-Day-based and the Bonneville-based McNary detection rates. The reason for the pooling is that in recent years, notably 2000, experiments were conducted at John Day which varied the proportion of flow spilled in the daytime relative to the proportion spilled at night. To stabilize the electric power available, contravening action was taken at Bonneville; when the relative daytime spill proportion was increased at John Day, the relative daytime spill proportion was decreased at Bonneville[13]. Given this situation, it was deemed more appropriate to pool John Day and Bonneville Dam-based estimates of the McNary detection rate. This was done for the 2001 outmigrants even though there was minimal spill during this outmigration year. Time constraints precluded the new method's application to the 1999 and 2000 Coho outmigration data.

The 2001 downstream dam detections of Coho were also too small for stratification purposes, so the total joint downstream and McNary Dam count, pooled over Bonneville[14] and John Day dams, divided by the total downstream dam count, pooled over Bonneville and John Day dams, served as a single, non-stratified estimate of the detection rate for the 2001 outmigrants. The non-stratified estimates for 2001 are given in Appendix Table 1.c.

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[13] Personal Communication, Rock Peters, U.S. Corps of Engineers, Portland, Oregon

[14] In 2001 only the counts from Powerhouse 2 at Bonneville were used because there were almost no detections at Powerhouse 1 due to low flows and the resulting limited use of Powerhouse 1.

Next year, the methodology developed for the OCT-SNT Spring Chinook will be applied to all years of Coho outmigration as well, which will require an updating of the 1999 and 2000 estimates. For the purpose of estimating the detection rates in the future, joint McNary and downstream dam detections and total downstream detections will be based all Yakima PIT-tag releases of Coho, not only those associated with this study. The resulting increased number of detections may facilitate the stratification process. If this is done in the future, the 2001 estimates will also be updated. As was the case for the 2001 estimates presented here, future downstream dam estimates of the McNary detection rates will be pooled over the two downstream dams. See the report Release-to-McNary Survival Index of 1999-2001 Spring Chinook Releases for the methodology to be used.

2. Fall Chinook

2.a. Summary

Three PIT-tagged sets of replicated releases were made of Fall Chinook in 2001, a Marion Drain release set, and two sets in the Yakima River below Prosser Dam--a replicated accelerated rearing treatment set which brought the fish up to release size more rapidly than the other set, a replicated conventional rearing treatment set. The replicates consisted of releases made 1 day apart (the initial release dates for the three sets differed among the release sets). The analyses were combined over all three sets to increase the degrees of freedom associated with the statistical tests. The tests were not powerful because of the low degrees of freedom (3 degrees of freedom) and the large variation in the survival-index estimates[15] between the replicates within the accelerated and conventional rearing treatment sets; therefore there were no significant differences (P = 0.48) among the release-to-McNary survival indices of the three sets (proportional survival-index estimates being 0.39, 0.27, and 0.30 respectively for below-Prosser accelerated, below-Prosser conventional, and Marion Drain releases).

For the 2000 releases, the accelerated treatment had a significantly lower (P = 0.03) survival index than did the conventional treatment (0.43 for the accelerated and 0.82 for the conventional rearing releases). The 0.27 survival index for the Marion Drain release differed significantly from the conventionally reared below-Prosser release (P = 0.02) but not from the accelerated release (P = 0.29).

For the 1999 releases, there was no replication and, therefore, no basis for statistical testing. The survival-index estimate in 1999 was 0.49 for the accelerated, 0.26 for the control, and 0.44 for the Marion Drain releases.

2.b. Release to McNary Smolt-Passage Survival Indices

Tables 2.a.1 and 2.a.2 respectively give the 2001 and 2000 survival-index means for the three release sets. Tables 2.b.1 and 2.b.2 give the logistic analysis of variation associated with the means. As stated before, the 1999 data set involved no replication. The

[15] Individual data estimates are given in Appendix Table 2.c.

databases for the 1999, 2000, and 2001 releases are given respectively in Appendix Tables 2.a, 2.b, and 2.3. For the 1999 and 2001 releases, the accelerated treatment survival-index mean was greater than the conventional mean; however, in neither year was the difference significant. For the 1999 releases an assessment of significance was not possible because of the lack of replication. For the 2001 releases, the individual two replicate estimates for each of the two treatments actually overlapped--0.33 and 0.45 for the accelerated and 0.18 and 0.35 for the conventional (Appendix Table 2.c). The result is that the 1999 accelerated survival-index estimate (0.49) and the conventional estimate (0.26) are not judged to differ significantly (P = 0.28), nor is the 2001 accelerated estimate (0.39) and 2001 conventional estimate (0.30) (P not estimable for 1999).

The differences between the 2000 accelerated and conventional release estimates is the opposite of that in 1999 and 2001, the convention survival-index mean of 0.82 exceeding accelerated estimate of 0.43; and, in this case, the difference was significant (P = 0.03).

Normally, there would be no interest in comparing the Marion Drain releases to the other two treatment sets, the Marion Drain releases being made in a different location upstream of the below-Prosser Dam releases of the accelerated and conventional treatment sets. However, there is one point of concern. In 1999, the Marion Drain release date (May 27) was much closer to that of the below-Prosser conventional release (May 25) than that of the below-Prosser accelerated release (April 25). However, in subsequent years, the Marion Drain release dates were more comparable to those of the below-Prosser accelerate treatment: 2000 Marion Drain--April 10-11, Accelerated -- April 20-21, and Conventional--May 25-26; 2001 Marion Drain--April 12-13, Accelerated--April 19-20, and Conventional--May 16-17. The concern is whether Marion Drain fish were being reared in 2000 and 2001 using the accelerated method because the 1999 accelerated survival index was greater than that of the conventional. If this is the case, then the decision was premature. The only year in which a significant difference could be detected between the Marion Drain release and the other releases is 2000; and in that year, the Marion Drain release mean survival index of 0.27 was significantly less than the 0.82 of the conventional (P = 0.02) and did not significantly differ from the 0.43 of the accelerated (P = 0.29). At this time, there is no statistically significant evidence that accelerated rearing improves survival of Fall Chinook; and there is statistically significant evidence that accelerated rearing can lead to a reduction in survival in some years.

2.c. Survival-index estimators

The general form of the survival-index estimator is the same as presented for Fall Chinook. In previous years (1999 and 2000) outmigration years, the McNary detection rates were based on the John Day Dam detections using the John Day date of detection. The reason for using John Day Dam instead of Bonneville in those two years is that the number of Fall Chinook detections was greater than at Bonneville.

As was the case for Coho, the John Day and Bonneville detections were pooled to obtain the 2001 McNary detection rate estimate. And, again, as was the case for Coho, there were not enough downstream detections of Fall Chinook to permit stratification. This was true for 2000 outmigrants as well. Strata in 1999 were established separately from those established for 1999 Spring Chinook outmigrants (and used for Coho).

The same future plans discussed for Coho will be applied to Fall Chinook.

Table 2.a.1. Weighted Release-to-McNary Survival-Index (S.I.) Means for Year-2000 Fall Chinook Releases. (weight = release number).

	Logistic Estimates		Survival Index	
	Logistic Coefficient	Standard Error (SE)	Estimate[2]	Standard Error[3] (SE)
Accelerated	-0.2896	0.29229	0.4281	0.07156
Conventional	1.4930	0.37446	0.8165	0.05610
Marion Drain	-0.9898	0.46329	0.2709	0.09152
Accelerated - Conventional	-1.7826	0.47504		
t-test	-3.7526			
Type 1 P	0.0331			
Accelerated - Marion Drain	0.7002	0.54779		
t-test	1.2782			
Type 1 P	0.2911			
Conventional - Marion Drain	2.4828	0.59570		
t-test	4.1679			
Type 1 P	0.0251			

[1] Standard Error from Logistic Output * Square Root (Mean Deviance)
[2] Estimate = 1/{1+exp[-(Logistic Coefficient)]}
[3] SE(Estimate) = Estimate^2*exp(-Logistic Coefficient)*SE(Logisitic Coefficient)
exp in above is exponential constant

Table 2.a.2. Weighted Release-to-McNary Survival-Index (S.I.) Means for Year-2001 Fall Chinook Releases. (weight = release number).

	Logistic Estimates		Survival Index	
	Logistic Coefficient	Standard Error[1] (SE)	Estimate[2]	Standard Error[3] (SE)
Accelerated	-0.4659	0.26604	0.3856	0.06303
Conventional	-0.9954	0.29532	0.2699	0.05819
Marion Drain	-0.8550	0.39766	0.2984	0.08325
Accelerated - Conventional	0.5295	0.39748		
t-test	1.3320			
Type 1 P	0.2750			
Accelerated - Marion Drain	0.3891	0.47844		
t-test	0.8133			
Type 1 P	0.4756			
Conventional - Marion Drain	-0.1404	0.49533		
t-test	-0.2834			
Type 1 P	0.7953			

[1] Standard Error from Logistic Output * Square Root (Mean Deviance)
[2] Estimate = 1/{1+exp[-(Logistic Coefficient)]}
[3] SE(Estimate) = Estimate^2*exp(-Logistic Coefficient)*SE(Logisitic Coefficient)
exp in above is exponential constant

Table 2.b.1. Logistic Analysis of Variation on Release-to-McNary Survival Indices of Year 2000 Fall Chinook Releases.

Source	Deviation (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error (P)
Among Release Sets	1079.89	2	539.95	12.70	0.0328
Within Release Sets	127.59	3	42.53		

Table 2.b.2. Logistic Analysis of Variation on Release-to-McNary Survival Indices of Year 2001 Fall Chinook Releases.

Source	Deviation (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error (P)
Among Release Sets	64.07	2	32.04	0.95	0.4795
Within Release Sets	101.31	3	33.77		

Appendix (2001 Annual Report)

Table 1.a. 1999 Coho Release-to-McNary-Passage Smolt-Survival-Index Database

Cle Elum (UPPER YAKIMA)

	McNary Detections[1]				John Day Detectiions			Passage (Expanded Values)			
SRATUM	Cascade Early	Cascade Late	Yakima Early	Yakima Late	J.D.	J.D. McN	Detection Rates	Cascade Early	Cascade Late	Yakima Early	Yakima Late
3	8.0	0.0	13.8	0.0	55	15	0.2727	29.2	0.0	50.6	0.0
4	55.4	24.8	74.3	33.8	1542	284	0.1842	300.8	134.9	403.3	183.5
5	7.5	16.4	7.4	18.4	306	62	0.2026	36.9	80.8	36.3	91.0
6	4.4	11.0	10.5	13.9	406	72	0.1773	25.0	62.3	59.0	78.4
7	0.7	6.7	4.1	5.9	471	52	0.1104	6.6	61.0	37.1	53.2
Total[2]	76.0	59.0	110.0	72.0	2780	485		398.5	339.0	586.3	406.0
Number Released								799.0	809.0	1159.0	1186.0
Survival Index								0.50	0.42	0.51	0.34

JACK CREEK (UPPER YAKIMA)

	McNary Detections[1]				John Day Detectiions			Passage (Expanded Values)			
SRATUM	Cascade Early[3]	Cascade Late[4]	Yakima Early[3]	Yakima Late[4]	J.D.	J.D. McN	Detection Rates	Cascade Early	Cascade Late	Yakima Early	Yakima Late
3	2.9	0.0	0.2	0.0	55	15	0.2727	10.8	0.0	0.6	0.0
4	103.4	25.4	38.4	6.1	1542	284	0.1842	561.4	137.8	208.7	33.3
5	19.6	31.1	14.3	6.6	306	62	0.2026	97.0	153.7	70.5	32.8
6	16.3	20.6	11.1	18.1	406	72	0.1773	91.8	116.3	62.8	102.1
7	5.7	26.9	16.0	33.1	471	52	0.1104	52.0	243.3	144.7	300.1
Total[2]	151.0	104.0	80.0	64.0	2780	485		812.9	651.1	487.3	468.2
Number Released								1246	1247	1245	1230
Survival Index								0.6524	0.5221	0.3914	0.3807

LOST CREEK (NACHES) [not used in analyses because of disease]

	McNary Detections[1]				John Day Detectiions			Passage (Expanded Values)			
SRATUM	Cascade Early	Cascade Late	Yakima Early	Yakima Late	J.D.	J.D. McN	Detection Rates	Cascade Early	Cascade Late	Yakima Early	Yakima Late
3	3.6	0.9	0.2	0.0	55	15	0.2727	13.3	3.5	0.6	0.0
4	37.3	1.4	7.4	0.0	1542	284	0.1842	202.5	7.4	39.9	0.0
5	6.3	2.4	2.9	0.0	306	62	0.2026	31.0	12.0	14.2	0.0
6	7.1	1.3	3.8	0.0	406	72	0.1773	40.2	7.1	21.6	0.0
7	14.7	6.0	9.8	2.0	471	52	0.1104	132.8	54.3	88.4	18.1
Total[2]	69.0	15.0	24.0	2.0	2780	485		419.8	84.3	164.8	18.1
Number Released								1160.0	1220.0	1049.0	1144.0
Survival Index								0.36	0.07	0.16	0.02

STILES (NACHES)

	McNary Detections[1]				John Day Detectiions			Passage (Expanded Values)			
SRATUM	Cascade Early[3]	Cascade Late[4]	Yakima Early[3]	Yakima Late[4]	J.D.	J.D. McN	Detection Rates	Cascade Early	Cascade Late	Yakima Early	Yakima Late
3	23.7	0.0	7.2	0.0	55	15	0.2727	87.0	0.0	26.5	0.0
4	95.8	63.8	64.5	27.9	1542	284	0.1842	520.2	346.6	350.4	151.2
5	10.3	38.5	7.8	21.4	306	62	0.2026	50.6	190.1	38.6	105.5
6	3.7	21.7	9.5	21.7	406	72	0.1773	20.8	122.6	53.3	122.3
7	1.5	4.9	4.0	15.1	471	52	0.1104	13.9	44.4	35.9	136.5
Total[2]	136.0	132.0	93.0	86.0	2780	485		692.4	703.7	504.7	515.6
Number Released								1277.0	1250.0	858.0	1243.0
Survival Index								0.54	0.56	0.59	0.41

1 McNary (McN) to John Day (J.D.) Travel-Time Distribution Adjusted

2 Total includes Stratum 1 and 2, the detection numbers for which were so small that they were excluded from the survival index estimattion

3 Presumed early that is identified as late in tagging file

4 Presumed late that is identified as early in tagging file

SRATUM	John Day Stratum Dates			McNary Stratum Dates		
1	4/1/99	to	5/9/99	4/1/99	to	5/3/99
2	5/10/99	to	5/19/99	5/4/99	to	5/14/99
3	5/20/99	to	5/28/99	5/15/99	to	5/24/99
4	5/29/99	to	6/7/99	5/25/99	to	6/4/99
5	6/8/99	to	6/10/99	6/5/99	to	6/7/99
6	6/11/99	to	6/17/99	6/8/99	to	6/14/99
7	6/18/99	to	7/31/99	6/15/99	to	7/31/99

Table 1.b. 2000 Coho Release-to-McNary-Passage Smolt-Survival-Index Database

Site	Stock	Release Time	McNary Detections	Detection Rate[1]	Passage (Expanded Values)	Release Size	Survival Index
Cle Elum (Upper Yakima)	Willard	Early	70	0.2063	339.3	2487	0.1364
Cle Elum (Upper Yakima)	Willard	Late	10	0.2063	48.5	2462	0.0197
Easton (Upper Yakima)	Willard	Early	142	0.2063	688.3	2476	0.2780
Easton (Upper Yakima)	Willard	Late	93	0.2063	450.8	2476	0.1821
Lost Creek (Naches)	Willard	Early	139	0.2063	673.8	2489	0.2707
Lost Creek (Naches)	Willard	Late	76	0.2063	368.4	2488	0.1481
Stiles (Naches)	Willard	Early	133	0.2063	644.7	2488	0.2591
Stiles (Naches)	Willard	Late	184	0.2063	891.9	2493	0.3578

[1] Detection Rate = (Number Jointly Detected at McNary and Bonneville)/(Number Detected at Bonneville)
Joint at McN and Bonn = 59
Total at Bonn = 286
Detection Rate = 0.2063

Table 1.c. 2000 Coho Release-to-McNary-Passage Smolt-Survival-Index Database

Site	Stock	Release Time	McNary Detections	Detection Rate[1]	Passage (Expanded Values)	Release Number	Survival Index
Cle Elum (Upper Yakima)	Willard	Early	8	0.5388	14.8	1197	0.0124
Cle Elum (Upper Yakima)	Willard	Late	10	0.5388	18.6	1219	0.0152
Cle Elum (Upper Yakima)	Yakima	Early	8	0.5388	14.8	1207	0.0123
Cle Elum (Upper Yakima)	Yakima	Late	12	0.5388	22.3	1240	0.0180
Easton (Upper Yakima)	Willard	Early	8	0.5388	14.8	1234	0.0120
Easton (Upper Yakima)	Willard	Late	49	0.5388	90.9	1234	0.0737
Easton (Upper Yakima)	Yakima	Early	86	0.5388	159.6	1249	0.1278
Easton (Upper Yakima)	Yakima	Late	32	0.5388	59.4	1247	0.0476
Lost Creek (Naches)	Willard	Early	18	0.5388	33.4	1240	0.0269
Lost Creek (Naches)	Willard	Late	19	0.5388	35.3	1245	0.0283
Lost Creek (Naches)	Yakima	Early	177	0.5388	328.5	1250	0.2628
Lost Creek (Naches)	Yakima	Late	128	0.5388	237.6	1251	0.1899
Stiles (Naches)	Willard	Early	136	0.5388	252.4	1236	0.2042
Stiles (Naches)	Willard	Late	108	0.5388	200.4	1237	0.1620
Stiles (Naches)	Yakima	Early	275	0.5388	510.4	1249	0.4086
Stiles (Naches)	Yakima	Late	304	0.5388	564.2	1249	0.4517

[1] Detection Rate = (Number Jointly Detected at McNary and Bonneville)/(Number Detected at Bonneville)

Joint at McN	and JD = 131	and JD = 119	Pooled = 250.0000
Total	at JD = 236	at JD = 228	Pooled = 464.0000
Detection Rate =	0.5551	0.5219	0.5388

Table 2.a. 1999 Fall Chinook Release-to-McNary-Passage Smolt-Survival-Index Database

	McNary Detections[1]			John Day Detections			Passage (Expanded Values)		
Stratum	Accel-erated	Conven-tional	Marion Drain	J.D.	J.D. McN	Detection Rates	Accel-erated	Conven-tional	Marion Drain
1	24.5	0.0	0.0	30	2	0.0667	367.8	0.0	0.0
2	160.5	4.2	0.1	196	62	0.3163	507.4	13.4	0.4
3	12.9	38.6	17.3	162	22	0.1358	95.0	284.5	127.4
4	0.0	40.6	66.0	150	32	0.2133	0.0	190.1	309.2
5	0.0	15.2	7.5	21	10	0.4762	0.0	31.9	15.7
Total	197.9	98.6	90.9	559	128	0.2290	970.3	519.9	452.7
Number Released							2000	1973	1032
Survival Index							0.4851	0.2635	0.4386
Rlease Date							4/25/99	5/25/99	5/26/99

[1] McNary (McN) to John Day (J.D.) Travel-Time Distribution Adjusted

Stratum	John Day Stratum Dates			McNary Stratum Dates		
1	05/06/99	to	05/27/99		to	05/14/99
2	05/28/99	to	06/08/99	05/15/99	to	05/29/99
3	06/09/99	to	06/22/99	05/30/99	to	06/14/99
4	06/23/99	to	07/06/99	06/15/99	to	07/01/99
5	07/07/99	to	07/27/99	07/02/99	to	

Table 2.b. 2000 Fall Chinook Release-to-McNary-Passage Smolt-Survival-Index Database

Treatment/ Release Site	Replicate	Release Date	McNary Detections	Detection Rate1	Passage (Expanded Value)	Release Number	Survival Index
Accelerated	Replicate 1	4/20/00	126	0.2907	433.44	1000	0.4334
Accelerated	Replicate 2	4/21/00	127	0.2907	436.88	1033	0.4229
Conventional	Replicate 1	5/25/00	233	0.2907	801.52	1008	0.7952
Conventional	Replicate 2	5/26/00	246	0.2907	846.24	1010	0.8379
Marion Drain	Replicate 1	4/11/00	17	0.2907	58.48	495	0.1181
Marion Drain	Replicate 2	4/10/00	62	0.2907	213.28	508	0.4198

1 Detection Number = (Number Jointly Detected at McN and J.D.)/(Number Detected at J.D.)
Joint at McN and J.D. = 75
Total at J.D. = 258
Detection Rate = 0.2907

Table 2.c. 2001 Fall Chinook Release-to-McNary-Passage Smolt-Survival-Index Database

Treatment/ Release Site	Replicate	Release Date	McNary Detections	Detection Rate[1]	Passage (Expanded Value)	Release Number	Survival Index
Accelerated	Replicate 1	4/19/01	285	0.6374	447.1	1002	0.4462
Accelerated	Replicate 2	4/20/01	210	0.6374	329.5	1012	0.3255
Conventional	Replicate 1	5/16/01	226	0.6374	354.6	1011	0.3507
Conventional	Replicate 2	5/17/01	112	0.6374	175.7	954	0.1842
Marion Drain	Replicate 1	4/13/01	96	0.6374	150.6	510	0.2953
Marion Drain	Replicate 2	4/12/01	98	0.6374	153.7	510	0.3015

[1] Detection Number = (Number Jointly Detected at McN and J.D.)/(Number Detected at J.D.)

Joint at McN	and J.D. =	303	and Bonn. =	82	Pooled =	385
Total	J.D. =	473	Bonn. =	131	Pooled =	604
Detection Rate =		0.6406		0.6260		0.6374

APPENDIX E

Yakima Spring Chinook Juvenile Behavior:

Comparisons of Hatchery and Wild Spring Chinook *Oncorhynchus tshawytsha* Smolts in Cover Utilization and Avoidance of Predation by Northern Pikeminnows, *Ptychocheilus oregonensis*

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Abstract

Yearling Spring Chinook smolts, *Onchorhynchus tshawytsha*, from two hatchery treatment groups, conventional, (OCT), and semi natural (SNT), rearing treatments were compared to wild smolts in an experiment designed to assess differences in cover utilization, and survival to a predation threat. Survival to Northern Pikeminnows was seen to be size dependant for hatchery fish, (p=0.001), with the largest fish (141-158mm) surviving at over twice the rate as the smallest fish (90-120mm). Survival was not size dependant for wild fish however, (p=0.713). Overall survival rates were similar between the three groups, although wild smolts tended to be smaller. Among the smaller smolts (<=130mm), wild smolts survived at higher rates, and rate was significantly different from the OCT group, (p=0.033).

The order of introduction did not significantly affect the time any of the three groups of smolts remained in cover, indicating that the presents or absence of other smolts did not influence a newly introduced smolts decision on how long to remain in cover. No significant difference was found between the two hatchery treatments in time spent in cover. The semi-naturally reared smolts spent the least time in cover, and the difference from the wild was significant, (p=0.023). Qualitative observations also revealed little difference between the conventional and semi-naturally reared smolts. In comparison to wild smolts, hatchery smolts appeared less adept at finding and concealing themselves in cover. Wild smolts also tended to swim less, i.e. in cover they appeared nearly motionless, whereas hatchery fish were almost always swimming.

Introduction

Chinook salmon culture efforts in the Northwest have produced only very modest returns. The high cost of operating hatchery facilities, combined with their low returns and uncertainties concerning their impacts on wild stocks have led some to question their effectiveness as a tool in salmon restoration efforts, (Winton and Hilborn, 1994).

The low levels of returning fish of hatchery origin is due largely to the much lower survival of hatchery smolts compared to their wild counterparts. For example, in sub basins of the Columbia River, depending upon the race of the species and the particular sub basin, between 8 and 100 times the numbers of wild chinook salmon return to spawn compared to hatchery-reared fish (Fast, et. all., 1991; Mullan et al., 1992).

The phenotypic expression of wild fish differs from that of their hatchery reared counterparts. In salmonids, a host of investigations have reported differences in behavior, (e.g., Bachman, 1984; DeVietti, 1992; Dickson & MacCrimmon, 1982; Miller, 1958; Vincent, 1960), physiology (e.g., Miller, Sinclair, & Hochachka, 1959; Vincent, 1960), and morphology (e.g., Sosiak, 1982; Swain, Riddell, and Murray, 1991) between wild and hatchery-reared fish (See White, Karr, & Nohlson, 1995 for a review). These differences in traits correlate with a large survival advantage favoring the wild fish. Traits of the wild fish have evolved through natural selection over generations from the genesis of anadromy to the present time. It follows that traits in hatchery-reared fish that differ from the wild fish offer little or no survival advantage. Moreover, some have argued that these different traits established through hatchery rearing are actually counterproductive to survival in the wild (DeVietti, 1992; Dickson & MacCrimmon, 1982; Fast, et al. 1991; Hilborn, 1992; Mullan, at al. 1992, While et al., 1995).

Variances in behaviors between species and systems are large, however. The recommendation by two reviewers is that the lessons learned in one system are not necessarily transferable to another, thus culture strategies may have to be investigated and tailored to the system they are applied, (Winton and Hilborn, 1994).

There is growing interest in the innovative rearing of hatchery fish in which the specific aim is to increase the return to spawn numbers and thus, explicitly or implicitly, to alter the traits of the cultured fish toward those shown by the wild fish. One such effort is currently underway at the Cle Elum Supplementation and Research Facility, (CESRF). CESRF is a Spring Chinook hatchery located on the Yakima River near the headwaters on the eastern slopes of the Cascade Mountains in South Central Washington, 832 river kilometers from the Pacific Ocean. CESRF is operated by the Yakima Nation, with funding provided by the Bonneville Power Administration. It's mission is help restore runs of Spring Chinook in the Yakima Basin by raising and releasing the progeny of wild origin fish into the Yakima River.

Since the spring of 1999, this facility has released from400,000 to 800,000 spring chinook (*Oncorhynchus tshawytscha*) each year. Smolts are reared in one of two treatments, 1) Optimum Conventional Treatment (OCT), or 2) Semi-Natural Treatment (SNT). In brief, OCT smolts are raised according to conventional hatchery practices, in a barren concrete raceway and surface fed by hand. SNT smolts are raised in similar raceways, with the raceway walls and floors painted to provide a varied colored background. Floating plastic hoops approximately 2m in diameter and small submerged pine trees provide cover. Feeding is accomplished using an underwater feed delivery system. The objective for SNT is to attempt to produce smolts that are more similar to their wild counterparts in terms of coloration, utilization of cover, and feeding behaviors. A detailed description and rational of the OCT and SNT treatments can be found in the Spring Chinook Monitoring Plan, (Busack et. all., 1997).

Only wild reared fish are used for brood stock at CESRF, although the parentage of these fish may be wild, hatchery, or mix of fish that had spawned naturally in the wild. During spawning, each female's eggs are divided into 2 to 4 approximately equal groups, and each group fertilized with sperm from a different male. After fertilization, the eggs are re-combined and incubated in a heath tray system similar to other Pacific Northwest salmon hatcheries. The egg lots from females are summed together to produce groups of approximately 80,000 each, and these are divided equally between two raceways, one OCT, one SNT, thus producing an OCT/SNT raceway pair. Thus the parentage of each OCT/SNT pair is identical.

Northern Pikeminnow (*Ptychocheilus oregonensis)* have been identified as a major predator on outmigrating salmonid smolts in the Columbia River (NMFS, 2000.), and so were selected as the predator threat in this study. They are also abundant in the Yakima River, relatively easy to collect, and fairly tolerant of repeated handling and confinement in a laboratory setting.

As part of the overall monitoring efforts associated with the Yakima spring chinook supplementation effort, it is important to quantify and qualify differences produced by the various experimental regimes being tested at the Cle Elum Supplementation and Research Facility. The present experiment addresses these needs by comparing the behavior of CESRF's two rearing treatments with wild spring chinook smolts.

The goals of the present study was to assess differences between rearing treatments (OCT, SNT and Wild), in terms of 1) amount of time spent by smolts in cover after introduction into the tank, 2) effectiveness of cover utilization, 3) influence of the presents of other conspecifics on time smolts spent in cover, and 4) to quantify the smolt's susceptibility to a predator threat.

Methods

Groups of five smolts from each of the three treatment groups, (Wild, OCT & SNT), were placed sequentially into an aquarium. Cover and a predation threat was present in the aquarium. Typically, upon introduction, smolts will dive for cover and remain hidden for several minutes before emerging to explore or school with other smolts. Observers record the amount of time smolts spend in cover and make qualitative assessments of the smolt's cover utilization. Northern Pikeminnows, *Ptychocheilus oregonensis*, are then allowed to feed on the smolts until approximately ½ are consumed. Surviving smolts are then counted and measured by treatment group. These procedures are described in more detail below:

Apparatus: The experiment was conducted in different locations using mostly different apparatus in the two years we ran the study. The following is a general description of the apparatus with year specific differences discussed at the end. The aquarium dimensions were 3.05m long, 1.22m wide and 0.91m deep, with a volume of about 3400 liters. Cover objects were provided, these consisted of about 100 river rocks 5 to 15cm in size, several irregular concrete pieces measuring about 15-20cm and 2.5 cm thick, and small dead pine tree submerged on the bottom. The rocks, tree and concrete pieces were arranged to provide refugia for the smolts, with spaces between and underneath objects large enough for the smolts, but too small for the pikeminnows. Areas underneath the concrete blocks were arranged to be visible to observers through the tank windows.

Lighting was provided by a rack of 4 incandescent lights suspended over the aquarium which were controlled by both a dimmer and a timer switch. Normally, these lights were only used while making behavior observations, and room lights were also turned off during observations. Room lights were normally left off except when needed by us for setting up experiments. Some ambient light was also available through windows, thus fish were not subjected to changes in day length from their natural environment.

A 1HP irrigation pump was used to provide a current through the aquarium. Water was pulled from the drain on the bottom of one end of the aquarium, and pumped into the headworks at the other end. Hereafter, the drain end will be referred to as the "downstream" end, and the headworks the "upstream end". The headworks consisted of two parallel 50mm diameter PVC pipes submerged at about 5cm and 17cm from the bottom. Water exited these pipes through a series of 7mm holes pointed towards the far downstream end. Water velocities approximately 30cm downstream of the headworks, where the smolts tended to school measured about 0.6m s^{-1}. The current degenerated rapidly into vortices and was barely perceivable in the downstream half of the tank.

Elastomer marked OCT and SNT smolts, spawned and reared at the Cle Elum Facility, were used for ease of identification. The elastomer mark was injected into the clear tissue behind the fish's left or right eye, identifying the fish as OCT or SNT. The side (left or right) and color (red, orange and green) is alternated between OCT and SNT and the three acclimation sites, (Easton, Clark Flat, and Jack Creek) each brood year. All hatchery fish were adipose fin clipped. These marks had been applied in October-November as a part of the marking program for all Cle Elum hatchery fish. For this experiment, a single raceway pair was selected each year as the source of OCT and SNT fish in order to reduce the genetic differences between these groups. Wild fish were collected at smolt tagging stations at Roza and Prosser dams, and had no clips or marks. All fish were kept in holding tanks for periods of 1 to 10 days before used in this experiment.

Northern Pikeminnows, *Ptychocheilus oregonensis*, were used as the predation threat in these studies. This species is considered a major predator of salmon smolts in the Columbia basin, (Poe, et all 1991, and Zimmerman 1999), and is the subject of a bounty program aimed at reducing their numbers, (see www.pikeminnow.org for details). These were collected via boat electroshocking from the Yakima River. While the experiment was in progress, pikeminnows were not fed except for the spring Chinook smolts they consumed during the predation phase of the experiment.

Only relatively large pikeminnow, (350-560mm), were selected. These proved to be very hearty and resistant to handling mortality. Of the 16 original minnows captured in February 2000, and used at the Cle Elum facility, most were alive one year later, the only mortalities were two that jumped out of the aquarium.

Initially, we confined the pikeminnows in an area of the downstream end of the aquarium with a sliding partition during our observations of the smolts, and then release them to begin the predation test. We had assumed that the Pikeminnows would feed voraciously on the smolts, and thought we would need to block their access to the smolts while making the cover behavior observations. This expectation was not born out in the first year of the experiment. Generally, the pikeminnows showed little interest in the smolts while the lights were on, or when we were observing them. For all replicates presented in this paper, we did not employ sliding partition, thus allowing the pikeminnows access to the whole aquarium and smolts. This normally worked well, although three of the 180 smolts used were eaten during the observation periods of this experiment. Otherwise all predation that occurred when the room lights were dimmed below the point where we could make observations, or when we were not present.

Normally we allowed each replicate to continue until approximately ½ of the smolts had been consumed. This normally took from 2 to 5 days. The exception was when we needed to cycle a replicate early in order to complete the entire set. This occurred in 2000 for replicate #1 (2 hours), and replicates #3 and #4 (24 hours).

Groups of five smolts from each of the three treatment groups (OCT, SNT and Wild) were introduced separately into the observation tank. At the start of each replicate, smolts were netted from their holding tanks, and transferred to a 20 liter bucket, and given a 10 minute recovery period. The bucket was then half submerged and gently poured into behavior arena. Each group was observed for 30 minutes, then the next group was introduced. The order of introduction was counterbalanced across replicates to control for a hypothesized effect that the presents of smolts already in the tank would effect the cover seeking behaviors of newly introduced smolts. The order of introduction of the smolts was completely counterbalanced yielding 6 orders of introduction.

During the observation period we noted the position (in or out of cover) of each smolt, and the time when the smolt emerged from cover up to a maximum score of 30 minutes. The observation period for each replicate ended 30 minutes after the 5 smolts comprising the last group was added. At this point, approximately 90 minutes after the introduction of the first group of smolts, typically most or all of the 15 smolts would be out of cover and swimming in the tank with the majority of these schooling in an open area in the high velocity zone created by the recirculating pump.

At the end of the replicate, all surviving smolts were collected, anesthetized with tricaine methanesulfonate, (MS-222), and measured. Initially, we did not measure smolts at the start of the replicate due to concerns that the anesthesia, stress and trauma would adversely affect the behavior study. This procedure, however, only gave us lengths of the surviving smolts, making it difficult to analyze length as a covariate to survival. We started with replicate #10 in 2000, and continuing in 2001, we anesthetized and measured the smolts, and placed them in separate holding tanks for 24 hour recovery period prior to the start of the each replication. Specific smolts eaten by the pikeminnows was determined from individual fish lengths recorded prior to initiation of the experiment, which were deduced from the lengths of fish missing at the end of the experiment.

<u>2000 v.s. 2001 Laboratory Setup</u>. This experiment was initially set up in the incubation room at CESRF, and experiments run in 2000 were conducted there. Due to water permit problems and the over use of CESRF's well fields, this experiment was moved in 2001 to a wet lab at the Central Washington University's campus in Ellensburg, Washington.

In 2000, pumped ground water from the CESRF's well field was used for the aquarium and fish holding tanks, the temperature was a nearly constant 9.8^{o}C. The water delivery system ensured the water was degassed and oxygenated. Water flow into the tanks was not measured, but flow through was sufficient to replace the total volume several times per day. In 2001, Ellensburg city water was used in a recirculating system, and water temperatures were controlled with chillers (Frigid Units, Inc, Model RT-430-F). The city water was dechlorinated and aerated for several days before use. Additionally, "Instant Ocean" sea salts were added to increase the salinity to about 0.1ppt. Water temperatures were adjusted to match water temperatures in the Yakima River that the smolts were experiencing at the time of collection (about 14^{o}C.).

In 2000, a fiberglass tank with Plexiglas windows was used. The ability of observers to view all areas of this tank was compromised due to the spaces between windows. In 2001, this tank was substituted for a glass aquarium with a stainless steal bottom and framing, and of approximately the same dimensions as the original fiberglass tank. This new tank afforded much improved abilities to observe the smolts.

In 2001, a “predation only” tank was added to the experiment, to increase the number of replicates and experimental power to differentiate the survival rates between groups of smolts. This was a modular Living Stream fiberglass tank, which we arranged to form a 2700 liter donut shaped tank. This tank lacked good observation windows, so no behavior observations were attempted. An airlift style water pump was constructed of PVC pipe fitted with an airstone, and this was used to both oxygenate and circulate water around the tank. Due to concerns that gravel would damage this tank, gray and black colored PVC pipe fittings of various sizes and shapes were used to provide cover. These pipe fittings were thought to provide comparable if not greater refugia than did the river gravel. Procedures for handling and measuring the smolts were the same as for the glass tank. The introduction method differed though, as we were not making behavior observations on these groups. Instead, after the initial measurement, all smolts were placed together in section of the tank separated from the pike minnows by removable barriers. The smolts were given 24 hours to recover from the anesthesia and handling before the barriers were removed to allow the pikeminnows access to the smolts, and to allow the smolts access to all areas of the tank.

RESULTS

Typically, upon introduction, the smolts immediately dove to the bottom of the tank, and those that chose to hide under cover would do so in the first 10-15 seconds, where they would remain for periods up to an hour before emerging. Typically, once emerged, the smolts would swim to an open area of the tank just downstream of the head box that had current provided by the recirculating pump. There they would maintain station 5 to 20cm above the bottom. They generally remained in that area for the duration of the experiment, though sometimes would explore the rest of the tank. Occasionally the smolts would return to cover for periods of time, but this was the exception rather than the rule.

In general, wild smolts tended to be in or close to cover more often during the observation periods than the two hatchery groups following introduction to the aquarium. Also, many wild smolts were observed to lay on the bottom, in narrow places between stones or under the substrate at times without appreciable movement. They also appeared more adept at finding crevices or places to hide under rocks. Contrarily, hatchery fish appeared to take longer, and be less adept at finding hiding spots, and when in hiding spots they had nearly constant fin movements, and were rarely perfectly still. The difference in hiding and remaining motionless appeared to be one of degree, not kind.

Time to Leave Cover. The time for the smolts to leave cover during the 30 minutes following their introduction to the aquarium was analyzed in two ways. First using a 3X6X2 factorial, which combined the three rearing conditions with the six counterbalanced orders of placement, and the two years (2000 and 2001) that the experiment was conducted in. The 6 counterbalanced orders of placement represented all the possible orders three treatment groups, for example Wild, SNT, OCT was one order, and SNT, Wild, OCT was another order). The resulting 36 conditions contained 5 smolts each[1] . A second analysis recoded the order variable to represent the order that each group of fish was introduced (first, second or third). This resulted in a 3X3X2 factorial design, with 18 conditions of 5 smolts each.

The order in which the smolt groups were introduced appeared to make little difference. Using either the 3X6X2 or 3X3X2 factorial design, the main effect of order fails to reach statistical significance (for the 3X6X2 design, $F(1,144)=0.481$, $p=0.790$. For the 3X3X2 design, $F(1,162)=0.218$, $p=0.804$. The interaction between treatment and order also fails to reach statistical significance. For the 3X6X2 design, $F(10,144)=1.321$, $p=0.224$. For the 3X3X2 design, $F(4,166)=0.499$, $p=0.736$.

The weighted means analysis indicated that in the trials conducted in 2001, the smolts left cover significantly sooner than smolts did in 2000. The average time in 2000 was 11.1 minutes, but only 5.4 minutes in 2001. Using the 3X6X2 design, the main effect of Year gives $F(1,144)=17.084$, $p=0.000$. Interactions between year and treatment did not reach statistical significance $F(2,144)=1.310$, $p=0.273$.

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[1] with the exception that in one replication done in 2000, a wild fish apparently jumped from it's holding tank into the OCT holding tank, resulting in 6 wild and 4 OCT fish were run in the OCT, Wild, SNT replicate.

Several changes in the experimental design probably account for this difference, 1) the 2001 smolts were older than their 2000 counterparts, as the 2000 observations were performed mostly in April, whereas the 2001 replicates were conducted mostly in May of that year, thus the 2001 smolts were about a month older during a critical time in their normal outmigration and smoltification stage of development. A second difference was in water temperatures, in 2000 all trials were conducted at about 10°C, whereas in 2001 water temperatures were set to 14.4°C, and a third may be due to the configuration of the observation aquariums.

The effect main effect of treatment was seen to be significant, $F(2,144)=4.148$, $p=0.018$. The results are summarized in Figure 1. Using a subsequent pairwise comparison (SYSTAT Tukey HSD multiple comparison procedure), the SNT fish were found to have spent significantly less time in cover than did the wild for both years combined ($p=0.023$). However when analyzing the data separately by year, the comparisons are more ambiguous. In 2001 the difference between the wild and SNT only approached significance ($p=0.072$), and no difference was seen between the OCT and Wild. In 2001, the difference between the OCT and SNT approached significance, but no difference was seen between either of the two hatchery group and the wild group, but the difference between OCT and SNT approached significance ($p=0.093$), (Table 1.) In both years, the SNT spent the least amount of time in cover of the three groups.

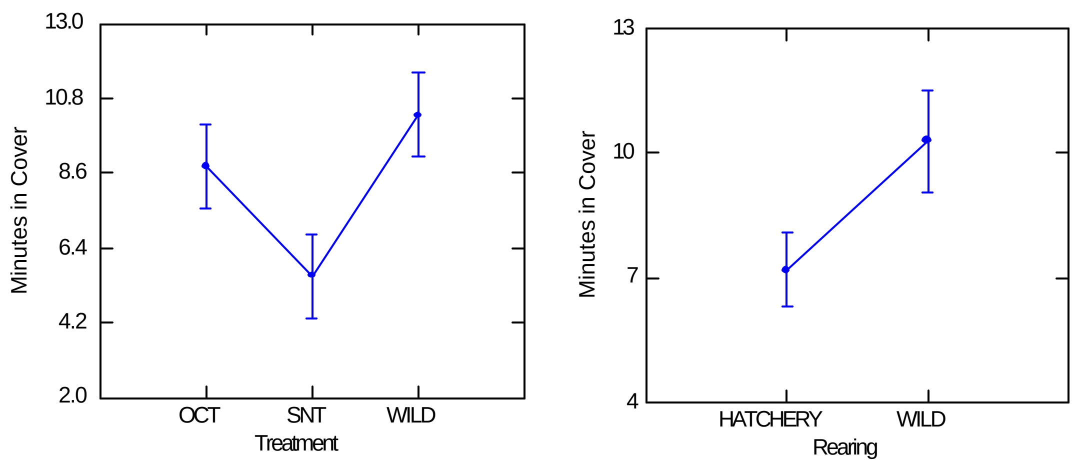

Figure 1. Average Time Spent in Cover after Introduction to the Aquarium. (all replicates, both years). Standard error bars of the means are show.

Tukey HSD Multiple Comparisons.							
Matrix of pairwise mean differences: (Minutes in cover)				Matrix of pairwise comparison probabilities:			
Both years: Using model MSE of 99.720 with 177 df.							
	OCT	**SNT**	**WILD**		**OCT**	**SNT**	**WILD**
OCT	0			**OCT**	1		
SNT	-3.185	0		**SNT**	0.19	1	
WILD	1.596	**4.782**	0	**WILD**	0.656	**0.023**	1
For 2000: Using model MSE of 121.108 with 87 df.							
	OCT	**SNT**	**WILD**		**OCT**	**SNT**	**WILD**
OCT	0			**OCT**	1		
SNT	-2.113	0		**SNT**	0.742	1	
WILD	4.169	6.282	0	**WILD**	0.312	0.072	1
For 2001: Using model MSE of 62.518 with 87 df.							
	OCT	**SNT**	**WILD**		**OCT**	**SNT**	**WILD**
OCT	0			**OCT**	1		
SNT	-4.312	0		**SNT**	0.093	1	
WILD	-1.169	3.142	0	**WILD**	0.835	0.278	1

Table 1. Pairwise mean differences between treatment groups (left) and the statistical significance of those differences (right). Table shows mean differences for all replicates combined, and for 2000 and 2001 analyzed separately. Bolded red highlights comparisons found significant at p<0.05, and violet indicates comparisons only approaching significance, 0.05<p<0.10.

Survival to a predation challenge: A total of 18 replications with smolts from each of the three rearing conditions were run to assess relative survival rates to a predation challenge (Northern pikeminnows). Fourteen replicates had five smolts from each rearing condition, and three replicates only three or four due to mortalities during the acclimation period[2]. One replicate in 2000 had six wild and four OCT smolts due to a wild smolt jumping from its holding tank to the OCT tank. Six replicates were run in 2000, and 12 in 2002. Data from a total of 261 smolts are presented in these results. In 2001 we measured all smolts before the start of each replicate in order to be able to analyze length as a covariate to survival. Unfortunately, we only measured surviving smolts in 2000, and so are unable to analyze that data using length as a covariate as we did not have length data on the smolts that were consumed.

Overall, using data from both years, the effect of rearing condition on survival failed to reach significance ($F(2,252) = 0.704$, $p=0.496$). That overall survival rates were higher in 2000 is an artifact of the experimental conditions, water temperature at the Cle Elum facility were only 10^{O} C, to cold to induce sufficient feeding activity in the pikemouth for us to consistently obtain the target level of 50% consumption rates in the time window for this experiment. In 2001 we were able to manipulate water temperatures to mirror temperatures in the river, which also had the effect of increasing pikeminnow feeding rates.

Using the 2001 data, where survival vs. length comparisons could be made, the effect of fork length on survival was found to be significant ($F(1,164)=8.514$, $p=0.004$), with larger[3] hatchery smolts surviving at higher rates than smaller ones, (Figure 2). An ANOVA on the survival of small smolts, (<130mm), found a significant effect on rearing condition, ($F(2,89)=3.357$, $p=0.039$). This relationship did not hold for larger smolts, ($F(2,70)=1.202$, $p=0.307$). A subsequent comparison of the mean survival of small smolts found that the Wild had a 31.6% higher survival rate than did the OCT smolts, (**Table 2**).

[2] The acclimation period is the 24 hour time period starting when the smolts are selected and measured for a replicate, and ending just before they are introduced into the tank with the pikeminnows.

[3] The mean, median, and mode lengths of all smolts used in 2001 was 130.4, 128 and 126mm respectively.

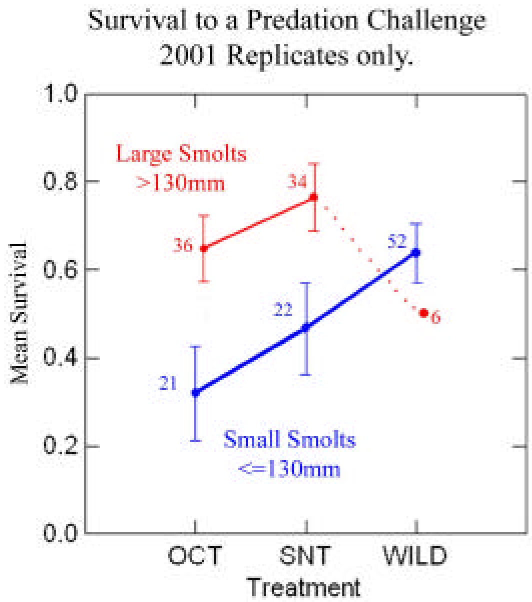

Figure 2. Survival of large (red) and small (blue) smolts to a predation challenge. Mean survival and standard error bars are shown. Numbers represent sample size. Trend line and error bars for large wild fish are not show due to small sample size (6 fish).

PAIRWISE MEAN DIFFERENCES				PAIRWISE COMPARISON PROBABILITIES			
	OCT	SNT	WILD		OCT	SNT	WILD
OCT	0.000			OCT	1.000		
SNT	0.098	0.000		SNT	0.774	1.000	
WILD	0.316	0.218	0.000	WILD	0.033	0.172	1.000

Table 2. Tukey HSD Multiple Comparisons of survival rates for small (<=130mm) smolts).

The wild smolts used in 2001averaged about 11mm smaller than the hatchery smolts, (123mm compared to 134 for the OCT and SNT combined. This difference was significant (F(2,171)=20.130, p<0.001). The difference between OCT and SNT smolts was small (133.9 vs. 134.7mm) and fails to reach statistical significance.

Survival rates of OCT and SNT smolts were similar within size classes. When these treatment groups are pooled we find a significant effect of size class on survival, (F(3,109)=4.421, p=0.006), with the largest size class measured enjoying a 41% higher survival rate than the smallest size class, (Figure 2). The survival rate for wild fish in Figure 2 appears negatively correlated with size, however this trend fails to reach statistical significance.

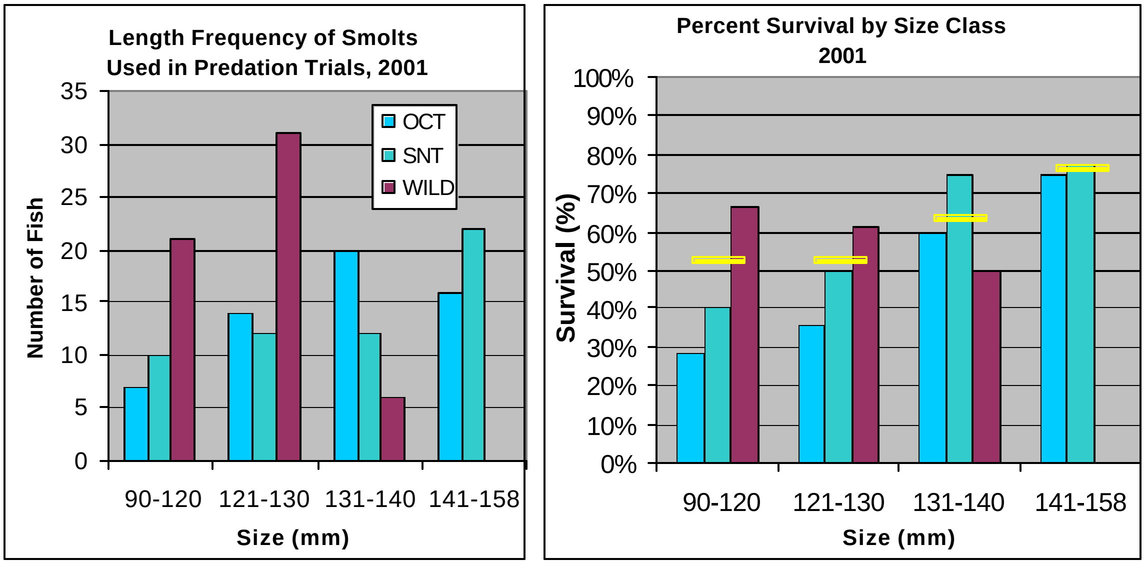

Figure 2. Length vs. smolt survival to a Northern Pikeminnow predation challenge, 2001. Left graph shows length frequencies of smolts used in the experiment, right shows the percent surviving by size class. Yellow bars on the right graph show average survival across treatments for each size class. There were no wild smolts in the largest size class (141-158mm).

DISCUSSION

The analysis of the amount of time spent in cover after introduction by treatment group showed that the wild smolts tended to stay in cover longer than either the SNT fish and the two hatchery-reared groups did not significantly differ from one another on this measure. In addition to this quantitative evidence of superior use of cover by the wild smolts, several qualitative observations also support the view that the wild smolts are more adept at using cover relative to their hatchery-reared counterparts. For example, wild smolts were observed to be in tight proximity to cover, often under cover objects, more often than hatchery smolts who tended, in the main, only to be close to cover rather than "in it." Also, when in cover, wild smolts tended to remain motionless, resting on the substrate, whereas hatchery smolts tended to paddle with their fins even when being more or less stationary. Because of the constant movement, and perhaps larger size, we found hatchery smolts generally easier to locate, even when in the same hiding places as the wild. It is probable that visually oriented predators would also find hatchery fish more easily for the same reasons.

The analysis of the time for the smolts to leave cover after introduction into the test tank also revealed no significant effect of order of introduction and no interaction between rearing condition and order. Thus, smolts of a specific rearing group were not influenced to leave cover by the presence or absence of other smolts in the tank. This was contrary to our expectations, as Chinook Salmon are known for their schooling behaviors. For example in one study, observers found that hatchery salmon drifting downstream from their release site tended to "pull" wild salmon from cover in what has become known as the "pied piper effect":

> "Upon seeing the hatchery salmon, wild salmon and steelhead moved from their stations and aggregated with hatchery fish. When aggregated with hatchery salmon, wild salmon and steelhead appeared to behave like hatchery fish, with no apparent social structure, and they moved with the hatchery fish in to areas wild fish would not normally use." (Hillman and Mullan, 1989).

Other examples of behavioral interactions between groups of fish abound in the literature, and indeed we observed a number of interactions between the salmon smolts once they emerged from cover and became more acclimated to their new surroundings. Thus the lack of effect of other fish in the tank on time to leave cover suggests that the fishes initial dive for cover and time spent there represents a response to the smolt's involuntary introduction to a novel environment, and the time spent hiding and acclimating to the new environment is not influenced by the presents or absence of conspecifics.

Several authors have found differences in coloration between hatchery and wild fish, and attributed increased vulnerability of hatchery fish to decreased crypsis in stream environments, (Maynard et all., 1996 and Donnelly and Whoriskey 1991, 1993). Indeed, one of the objectives of the SNT treatment at the CESRF was to raise fish in raceways painted with varied naturalistic colors in an attempt to produce fish who's coloration was more like their wild counterparts. However we could not discern any consistent difference in coloration between the OCT, SNT or Wild fish, although variations were observed within each group.

Northern Pikeminnows are thought to be mainly corpuscular feeders. A study of movements of radio tagged pikeminnow below two dams on the Snake river showed that these fish are most active during the corpuscular, (sunrise and sunset), periods of the day, and least active immediately following these periods, and intermediately active during the rest of the day, (Isaak and Bjornn, 1996). Another study that extrapolated diurnal feeding patterns from stomach contents found differences in diurnal consumption rates between locations in the John Day dam pool on the Columbia River, (Vigg, et. all., 1991a). Within 1km downstream of the McNary dam, peak feeding rates by Northern Pikeminnow was observed from dawn to around 0900 AM, and again from midnight to around 0300 AM. However, in the rest of the John Day dam pool (from 1km downstream of the McNary dam to the John Day dam), feeding rates of Northern Pikeminnow although showed a diurnal pattern, did not appear to be as corpuscular as in the dam tailrace. In that part of the river, feeding rates were seen to increase from sunrise through the day, then dropped to a low level toward evening and remaining low through the night. No mention was made in these papers how the affects of artificial lights around the McNary dam may have influenced pikeminnow activity, or how the presents of injured and disoriented smolts in the tailrace may have affected diurnal feeding patterns.

In our observations, the pikeminnow tended to rest on the bottom when room lights or tank lights were on, and showed little interest in the smolts. However, when light levels were lowered to the point where we could only see vague outlines of fish, pikeminnow were observed to raise off the bottom, and stalk the smolts from underneath and behind. It is doubtful, in our opinion, that cryptic coloration would play a significant roll in predator avoidance in these circumstances. Other behaviors, such as the smolts ability to detect pikeminnow in close proximity, or escape response, positioning relative to other smolts, or ability to avoid detection through lack of movement probably explain the survival advantage observed in the wild fish.

The analysis of the survival data showed an overall similar survival between the three groups of fish, and this was seen in both years the experiment was conducted. In the 2001 data, where survival could be analyzed as a function of size, we saw a significant positive correlation of survival with fish fork length for hatchery fish, but not for wild. The largest size group of hatchery fish had a survival rate comparable to the wild, however the survival rate of the smaller hatchery fish was only about half the wild rate.

The largest Pike minnows available were intentionally selected for use in this study, as previous studies have reported that salmonids were generally an important diet component only for large, older northern pikeminnows (Vigg et al. 1991) and that consumption rates of juvenile salmonids by northern pikeminnow increased exponentially as size increased (Beamesderfer et al. 1996). The length frequencies of Northern Pikeminnow used in this study compared to the overall length frequency distribution of Northern Pikeminnow in the Yakima are shown in Figure 3, (left).

The predicted prey diet composition of the Yakima Northern Pikeminnow population and the sizes of Spring Chinook smolts are shown in Figure 3 (right). In the wild, pikeminnow of the sizes used in this study can and do consume prey items up to the largest sized smolt used in this study (240mm), however the majority of their diet consists of fish considerably less than the average sized smolt (130mm). Data on predator vs. prey lengths from fish captured in the wild can suggest what size of fish a predator targets, however it is not definitive as it is not known precisely what sizes of fish were available to the predator. There is also evidence that body depth is more important than length to piscivorous fish in selecting prey, (Hambright, 1991). Data from this experiment shows that the Pikeminnows preferentially preyed on the smaller fish, at least in this experimental setting where only one species of prey was available, and in a limited size range.

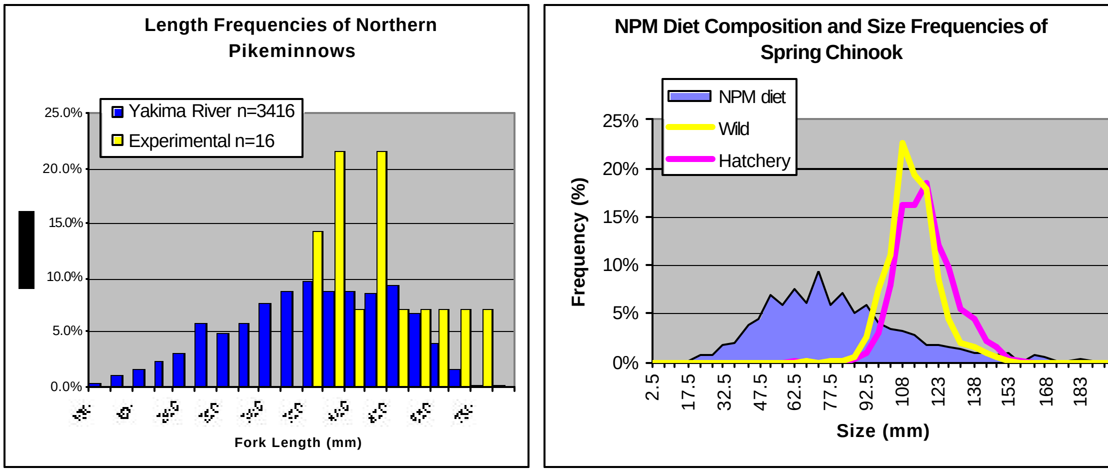

Figure 3. Left, comparison of pikeminnow sizes in the Yakima River (blue) to thos e used in this experiment, (yellow). Right, predicted size composition of pikeminnow diets (blue) to the size of wild and hatchery spring chinook smolts captured at Roza dam in 2000 (yellow and pink). The predicted NPM diet composition is based on the size distribution of Pikeminnows in the Yakima (left graph) and the diet composition of various sized Pikemouth shown in Figure 4.

The Cle Elum hatchery OCT and SNT smolt population, are in fact larger than the wild smolt population. Of fish passing Roza in March through May of 2000, hatchery smolts averaged 116.9mm, and wild smolts were 111.5mm, a small, but statistically significant difference. By the time they reached Prosser Dam, the fish averaged 137.8 and 128.1mm.

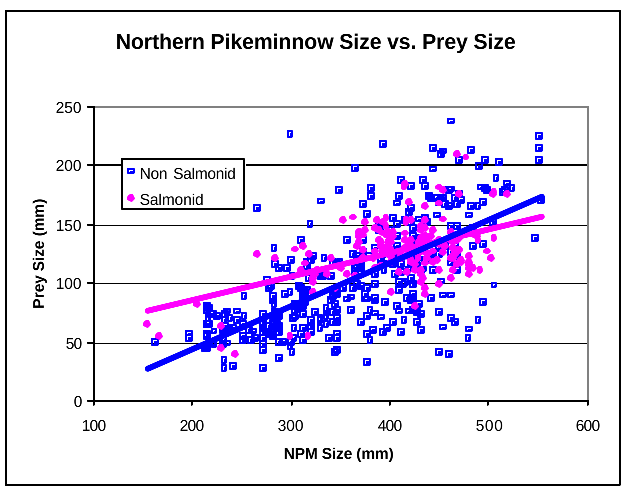

Figure 4. Prey size vs. Northern Pikeminnow sizes for pikeminnow captured in the Yakima River 1998-2000. Pink are salmonids, blue are non salmonid fish consumed by pikeminnow. Length of prey items are directly measured when relatively whole, or estimated from bones when partially digested.

<u>Survival of Out migrating Smolts.</u> Smolt monitoring programs operated by the Yakama Nation Fisheries Program are used to compare relative survival rates of hatchery and wild spring Chinook salmon smolts using passive integrated transponders (PIT tags). The PIT tags provide a unique identification number for each fish, and the tag can be interrogated as the fish passes through smolt monitoring stations designed for this purpose. There is one such site on the Yakima river at Prosser Dam, and three on the Columbia River, McNary Dam , John Day Dam, and the Bonneville Dam. The McNary Dam provides some of the best information for comparing smolt survival of Yakima river releases because McNary detection efficiencies can be estimated using further downstream detections at Bonneville and John Dams. These detection efficiencies can be used to expand the PIT-tag detection rates at

McNary Dam to obtain an index of survival. This expanded survival estimate is considered an index, not as an absolute figure, as not all of the assumptions that go into the model are likely to hold, (Neeley 2002a and 2002b).

Approximately 40,000 CESRF hatchery fish are PIT tagged each year before release, the tags allocated equally between raceways and treatments. Downstream detections of these fish can be used to compare survival of the OCT vs. SNT treatment groups. The survival index of outmigrating smolts to McNary for SNT fish has been greater than OCT fish in each of the three years 1999 through 2001, (Table 3). The difference is small, only 0.8% averaged over three years, and fails to reach statistical significance, (p=0.26), (Neeley 2002b).

Table 3. Survival index of outmigrating OCT and SNT fish from the acclimation ponds to McNary Dam. A weighted logistic analysis of variation was used to test for survival differences, using acclimation site, treatment and year as factors, (Neeley, 2002b).

Out - Migration Year	McNary Survival Index		Difference (SNT – OCT)	Type 1 error, P
	SNT	OCT		
1999	50.61%	50.13%	+0.48%	0.41
2000	38.12%	37.75%	+0.37%	0.36
2001	**24.55%**	**23.01%**	**+1.54%**	**0.03**
Mean	37.76%	36.96%	+0.80%	0.26

Differences in survival indexes between years are probably explained by environmental conditions. 1999 was a year of higher than normal flows during the outmigration period, with accompanying cooler temperatures and more turbid conditions. 2000 was an average water year, and 2001 was a year of severe drought.

Another monitoring project involves the collection and tagging of wild and hatchery fish at Roza Dam, which is 60.3 kilometers downstream of Clark Flat, the lowest of the three acclimation sites. At Roza Dam a portion of the river is diverted into a canal for power generation and irrigation purposes. Fish screens mounted in the canal forebay prevent fish from entering the canal, and these fish are bypassed back to the river. Outmigrating smolts can be captured in a holding pen mounted in the bypass unit.

The Roza smolt tagging operation has been run each year since 1999. Wild smolts are PIT tagged, and hatchery smolts are scanned for the presents of an existing PIT tag, and those fish without pre-existing PIT tags are PIT tagged. This results in three groups PIT tagged fish, wild, hatchery smolts tagged at Roza, and hatchery fish PIT tagged several months previously at CESRF. A logistic analysis of variance variation was used to compare relative survival rates to McNary dam of hatchery and wild fish tagged and released at Roza, (Table 4).

Table 4. Survival indexes and difference in sizes of hatchery and wild spring smolts. Fish are tagged and released at Roza Dam and interrogated 697 kilometers downstream at McNary Dam. Indexes shown only include data from time periods where estimates of both wild and hatchery survival were available. Bolded numbers show where differences were statistically significant, (from Neeley 2002b).

Year	McNary Survival Index*			Average size at Tagging (mm)		
	Wild	Hatchery	Difference	Wild	Hatchery	Difference
1999	61.1%	50.9%	10.2%, p=0.252	**121.0**	**126.4**	**-5.4 p=0.007**
2000	**47.6%**	**30.6%**	**17.0%, p=0.002**	110.4	110.7	-0.3 p=0.750
2001	**15.1%**	**22.2%**	**-7.1%, p=0.008**	**118.0**	**128.7**	**-10.7 p<0.001**
*Mean over common blocks (adjusted).						

Wild fish significantly outperformed hatchery smolts in 2000, when their mean sizes were similar. Hatchery fish though outperformed wild in 2001 when their mean size was significantly larger. There was no significant difference in survival or migration timing of the hatchery fish tagged at Roza, and those previously tagged at CESRF, indicating the PIT tagging itself does not induce a significant short term mortality or substantially effect outmigration timing. This is not to say that the process of capturing and handling fish has no effect, as this could not be tested with these data. The results of the two hatchery groups are shown pooled in the above table.

<u>Adult Returns</u>. As of this writing, there is only one year of adult 4-year-old return data to compare, that of the 1999 smolts which returned in 2001. The overall return rate to Roza Dam of the SNT was 1.42% and 1.31% for OCT, (Neeley 2002b). The SNT outperformed the OCT in 4 out of 5 raceway pairs, and the overall return rate was about 8.4% higher for the SNT. This was marginally significant (p=0.07) based on an approximate 1-sided t-test. All returning hatchery fish are interrogated at Roza, but only those wild fish that are collected for brood stock are interrogated, the majority released without scanning for PIT tags, making it difficult to compare hatchery vs. wild adult return rates using Roza adult data.

In conclusion, it appears from both our study and monitoring studies of out migrating smolts that wild fish enjoy a survival advantage over hatchery fish when their sizes are similar, and that there is little appreciable difference between the OCT and SNT treatments in smolt survival in our laboratory or from release site to McNary Dam.

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APPENDIX F

2002 Annual Report Indirect Predation

IntSTATS

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2002 Annual Report
Indirect Predation

Doug Neeley, Consultant to Yakama Nation
Submitted April 17, 2003

Summary

There is evidence from 2002 outmigrants that survival to McNary Dam of hatchery-produced Spring Chinook Smolt increases with an increase in the number of fish volitionally exiting acclimation ponds. Even though survival for these 2002 outmigrants also increased with increased release-site stream flow, the relation of survival to fish number appears to be independent of stream flow's effect.

There was no evidence of a change in survival with a change in volitional release number for 2000 and 2001 outmigrants.

Introduction

The indirect predation study was initially envisioned as a study to determine whether survival was partially a function of the number of outmigrating smolt. The concept was that either 1) a large number of outmigrating smolt might confuse predators, thereby the increasing smolt survival, or 2) a large number of outmigrating smolt might attract a predator swarm, thereby decreasing smolt survival. It would be difficult, perhaps impossible, to develop an in-river experiment that could test these hypotheses.

Bruce Watson[1] felt that it would be possible to use smolt survival to McNary Dam on the mid-Columbia River for PIT-tagged smolt detected in the bypass system at Prosser dam on the lower Yakima River to assess the effect of indirect predation. Under my recommendation, the statistical tool he used was to regress[2] estimates of survival to McNary of fish passing Prosser on estimates of total smolt passage at Prosser. The notion was that a significant positive regression-coefficient estimate on flow would

[1] Formally the fisheries biologist working on the indirect predation study for the Yakima Nation, currently with Mobrand Biometrics, Vashon Island, Washington.

[2] Logistic regression of smolt survival on total passage was the specific regression tools used.

indicate that survival would tend to increase with fish number and that a significant negative regression-coefficient estimate would indicate that survival would tend to decrease with increasing fish number. Unfortunately it proved difficult to isolate the effect of fish passage on survival from the effects of other uncontrollable factors such as flow[3].

A different method was considered for the year-2000 through year-2002 Spring Chinook hatchery outmigrants and is presented here. Hatchery Spring Chinook volitionally exit acclimation sites. There is little variation in flow into the acclimation ponds. Therefore, survival to McNary for fish leaving the ponds within prescribed time periods were related to the number (release number) of fish volitionally leaving during those periods under the assumption the release number would not be related to stream flow. The decision was made to partition the volitional release period into equal release-period segments, arbitrarily set at ten continuous days each. Estimates of smolt survival to McNary and the number of fish exiting the acclimation ponds for each release period constituted the primary database. The coefficient resulting from the logistic regression of smolt survival to McNary on the number of fish leaving the raceway was used a measure of the effect of fish number on size.

Methodology and Findings

The methods of estimating survival and the regression methods are discussed in Appendix A.

The starting date used for the equal length periods was March 15, which was the date on which the exit screens from the acclimation ponds were pulled. The periods used in the analysis were March 15-24; March 25-April 3; April 4-April 13, April 14-April 23, April 24-May 3, May 4-May 13, and May 14-May 23. There was evidence of fish leakage from the acclimation ponds prior to March 15 in outmigration 2000; however, since free access to the river was not possible during this period because the screens had not been pulled, pre-March 15th releases were not used. For all years, fish remaining in the ponds after May 23 were not used because some of the fish had to be eventually forced out of the ponds; therefore, their release could not be considered to be volitional. Further, there has been a high rate of precocialism in these hatchery fish populations; and, if precocial fish tend to remain in the ponds, the survival index of fish leaving after May 23 may be artificially low because the precocial fish may have survived without outmigrating to McNary Dam.

The databases used in the logistic regression are presented in Table 1. The underlying data used to develop the database in Table 1 are given in Appendix B. The weighted[4] logistic analyses of variation for the survival index regressed on site indicators

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[3] For example, there is evidence that, as flow increases, passage tends to increase. It was not possible to meaningfully isolate the effect of number of fish on survival from the effects of flow and other measured variables

[4] The weights used were number of fish released. The reason for the weighting is explained in Appendix A.

and number of fish released and stream flow are presented in Table 2 along with other measures Data and analysis summaries are presented for the following outmigration years: a. 2000, b. 2001, and c. 2002. Analysis was not possible for outmigration-year 1999 (the first year of acclimation site operations) because volitional release monitoring was not possible.

Outmigration-year 2002 was the only year in which the regression of survival index on release number was significant ($P < 0.001$, Table 2.c.). In that year, the sign of the logistic regression coefficient was positive, suggesting an increase in survival with increasing number of fish. However, as indicated in Table 1, within each acclimation site[5] within each year, the Pearson's correlation coefficients between release number and stream flow were positive (significantly so for some sites in outmigration-years 2000 and 2001, $P < 0.05$; Tables 1.a. and 1.b.). The implication is that fish number increased as stream flow increased even though water flow into the ponds was kept relatively constant. Even if flows into the acclimation ponds do not vary with stream flow, it is possible that there are stream-flow clues in the water entering the ponds of flow stream-flow changes that stimulate fish to move out of the ponds when stream flows increases (e.g., chemical changes or turbidity changes in water entering the pond that may be related to stream flow changes).

Because of the correlations between release number and stream flow, the survival index was regressed on flow as well as release number. Daily flows were obtained from the Bureau of Reclamation's WEB site,

http://mac1.pn.usbr.gov/yakima/yakwebarcread.html,

for the bureau's monitor sites on the Yakima River at Easton and at Cle Elum and on Teanaway Creek near its confluence with the Yakima near Cle Elum. Weighted[6] flow estimates are also presented in Table 1. Based on a conversation with Mark Johnston[7], the Easton monitor-site flows were used for the Easton acclimation site, the combined Cle Elum and Teanaway monitor-site flows were used for Clark Flats acclimation site, and the Teanaway monitor-site flows were used for the Jack Creek acclimation site. Another flow-monitor site further upstream on the Teanaway (below Lambert) may have been a more appropriate flow-monitoring site for the Jack Creek acclimation ponds; however, that flow-monitoring site did not have enough flow data points from the three years to be useful.

As was the case for the logistic regression of survival index on release number, only in outmigration-year 2002 was the logistic regression on flow significant; and, again as with number released, the logistic coefficient of survival index on flow was positive,

[5] The hatchery is located at Cle Elum. The acclimation ponds are Clark Flats and Easton on the upper Yakima River and Jack Creek on the Teanaway.

[6] Time-period flow estimates are weighted means of daily flows within the period for the site, the weights being the daily number of fish detected exiting the site.

[7] Fisheries Biologist, Yakama Nation, Toppenish Washington.

indicating that as flow increased, survival increased. To get a handle on whether the survival index was affected by number released independent of flow's effect, survival index was regressed on both number released and flow. The effect of release number on the survival index adjusted for the effect flow ("release number | flow" in Table 2) as well as the effect of flow on the survival index adjusted for the effect release number ("flow | release number" in Table 2) was then assessed. Both adjusted coefficients are significantly different, suggesting that, if the logistic model used accurately portrays the relation between survival index and the predictor variables (number volitionally released and stream flow), then 1) an increase in release number may have increased the survival index above what might have been attributed to an associated increase in flow, and 2) an increase in stream flow may have increased the survival index above what might have been attributed to an associated increase in release number. Further, the adjustment for flow had almost no effect on either the magnitude or the significance level of the logistic regression coefficient of survival index on release number (unadjusted-for-flow coefficient = 0.000118 and adjusted-for-flow coefficient = 0.000112; unadjusted -for-flow P = 0.0005 and adjusted-for-flow P = 0.0008, Table 2.c.). These findings, combined with the fact that Pearson's correlation coefficients between number released and stream flow were of low magnitude and were not significant for all three sites in outmigration year 2001 (P = 0.309, P = 0.952, and P = 0.274 respectively for Clark Flats, Easton, and Jack Creek, Table 1.c.), indicates that the year-2002 increase in the survival index with increase release number is independent of stream flow. However, it should be borne in mind that, for the three years of study, this relation was only manifest in outmigration-year 2002.

It should be noted that in outmigration-year 2002, individual acclimation pond survival to McNary Dam was associated with the severity of Bacterial Kidney Disease[8] (BKD) measured on a pond-by-pond basis (2002 Annual Report: OCT-SNT Survival by Doug Neeley). However, since the analyses presented in this report are based on data pooled over ponds within acclimation site, I know of no reason to suspect that the BKD variability biased this reports findings.

Figures 1.a through 1.c. respectively plot for outmigration-years 2000, 2001, and 2002 the survival indices against stream flows and the resulting logistic fit unadjusted for flow.

[8] BKD severity measures provided by Data provided by Ray Brunson (United States Fish and Wildlife Service, Olympia, Washington.]

Table 1. **Release-to-McNary Survival-Index Estimates for Fish Volitionally Exiting Acclimation Ponds during Ten-Day Intervals along with Number of Fish Released and Flow Estimates (estimates after May 23 not used in assessment).**

a. Year-2000 Outmigrants

		Clark Flats		
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/00	327	98.2	0.30039261	1613.8
4/3/00	572	261.1	0.45655581	3109.1
4/13/00	1780	646.3	0.363093223	3512.1
4/23/00	2458	807.8	0.328658083	3543.9
5/3/00	1063	335.4	0.315528427	2177.3
5/13/00	1114	467.6	0.419775291	1920.7
5/23/00	1840	1007.5	0.547532016	2632.4
Clark	Rel	Correlation between Num.Rel., Flow		
Flats	9154	Correlation	0.673671	Type 1 P
		DF	6	0.0670
		Easton		
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/00	113	22.6	0.200297691	422.4
4/3/00	2378	839.4	0.352975655	788.9
4/13/00	4691	1408.3	0.300216357	979.6
4/23/00	997	250.5	0.251260483	737.1
5/3/00	584	218.7	0.374557397	478.9
5/13/00	386	148.0	0.38337832	589.1
5/23/00	632	261.7	0.41404838	552.4
Easton	Rel	Correlation between Num.Rel., Flow		
	9781	Correlation	0.918252	Type 1 P
		DF	6	0.0013
		Jack Creek		
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/00	340	95.8	0.28189823	361.3
4/3/00	1078	284.7	0.264090294	1131.6
4/13/00	810	249.0	0.307394516	1558.6
4/23/00	1055	359.3	0.340538197	1219.8
5/3/00	447	164.6	0.368129296	655.4
5/13/00	190	95.4	0.502074178	466.3
5/23/00	1847	884.6	0.478926283	970.0
Jack	Rel	Correlation between Num.Rel., Flow		
Creek	5767	Correlation	0.554903	Type 1 P
		DF	6	0.1534
Weighted	Rel	Correlation between Num.Rel., Flow		
over	24702	Correlation	0.742787	Type 1 P
Sites		DF	18	0.0002

*Weight is daily number released applied to daily flow

Table 1. (continued)

b. Year-2001 Outmigrants

Clark Flats				
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/01	1043	312.8	0.29993	1104.9
4/3/01	1063	319.4	0.30047	1501.9
4/13/01	1164	407.4	0.34998	1132.5
4/23/01	1827	570.4	0.31223	1080.0
5/3/01	4361	1,171.4	0.26862	1879.9
5/13/01	1583	211.7	0.13376	1511.9
5/23/01	1814	256.8	0.14156	1464.8
Clark	Num.Rel.	Correlation between Num.Rel., Flow		
Flats	12855	Correlation	0.74246	Type 1 P
		DF	6	0.0349
Easton				
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/01	2007	570.1	0.28408	371.5
4/3/01	709	203.6	0.28714	547.7
4/13/01	1252	336.5	0.26874	427.6
4/23/01	1178	298.9	0.25377	329.5
5/3/01	2887	635.9	0.22026	478.4
5/13/01	2045	351.8	0.17204	234.2
5/23/01	2780	344.4	0.12389	228.0
Overall	12935	2,741.3	0.211925951	
Easton	Num.Rel.	Correlation between Num.Rel., Flow		
	12858	Correlation	-0.42754	Type 1 P
		DF	6	0.2907
Jack Creek				
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/01	326	72.9	0.22354	247.7
36984	728	241.7	0.33198	441.3
4/13/01	716	209.7	0.29293	205.1
4/23/01	5101	1,393.8	0.27323	223.6
5/3/01	3064	690.6	0.22539	731.8
5/13/01	1626	221.1	0.13598	530.4
5/23/01	1285	135.2	0.10523	522.3
Jack	Num.Rel.	Correlation between Num.Rel., Flow		
Creek	12846	Correlation	0.069292	Type 1 P
		DF	6	0.8705
Weighted*	Num.Rel.	Correlation between Num.Rel., Flow		
over	38559	Correlation	0.128043	Type 1 P
Sites		DF	18	0.5906

*Weight is daily number released applied to daily flow

Table 1. (continued)

c. Year-2002 Outmigrants

Clark Flats				
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/02	917	288.1	0.31417	968.8
4/3/02	3931	1413.6	0.35959	1284.9
4/13/02	1761	499.4	0.28360	3633.7
4/23/02	4060	1834.1	0.45176	5085.7
5/3/02	899	134.9	0.15003	2405.3
5/13/02	336	64.0	0.19051	1793.0
Clark	Num.Rel.	Correlation between Num.Rel., Flow		
Flats	12114	Correlation	0.41301	Type 1 P
		DF	6	0.3092

Easton				
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/02	6995	1957.9	0.27991	294.3
4/3/02	913	132.5	0.14509	406.3
4/13/02	576	118.5	0.20567	783.5
4/23/02	2752	689.5	0.25055	1700.8
5/3/02	862	187.1	0.21703	424.6
5/13/02	214	38.5	0.17972	370.7
5/23/02	113	26.3	0.23243	455.0
Easton	Num.Rel.	Correlation between Num.Rel., Flow		
	12425	Correlation	0.02540	Type 1 P
		DF	6	0.9524

Jack Creek				
Ending Release Date	Number Released (Rel)	McNary Passage (McN)	Survival Index (McN/Rel)	Weighted* Flow
3/24/02	3135	1132.7	0.36131	304.7
37349	1932	549.1	0.28423	600.8
4/13/02	2035	673.2	0.33080	1612.6
4/23/02	4180	1519.8	0.36359	2519.5
5/3/02	757	191.0	0.25229	1178.3
5/13/02	699	166.2	0.23780	708.8
5/23/02	203	56.6	0.27870	1033.2
Jack	Num.Rel.	Correlation between Num.Rel., Flow		
Creek	12941	Correlation	0.439906	Type 1 P
		DF	6	0.2754
Weighted*	Num.Rel.	Correlation between Num.Rel., Flow		
over	37480	Correlation	0.293798	Type 1 P
Sites		DF	18	0.2087

*Weight is daily number released applied to daily flow

Table. 2. Analysis of Variation from Logistic Regression of Hatchery Spring Chinook Release-to-McNary Smolt-Survival Index on Number Released and Flow with Ten-Day Volitional Release Periods Serving as Database

a. Year-2000 Outmigrants

Source*	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 P
Site	115.35	2	57.68	1.76	0.2014
Number | Site**	4.8	1	4.80	0.15	0.7064
Flow | Site	43.05	1	43.05	1.32	0.2671
Number | Flow, Site	0.62	1	0.62	0.02	0.8921
Flow | Number,Site	38.87	1	38.87	1.19	0.2908
Error	555.92	17	32.70		

b. Year-2001 Outmigrants

Source*	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 P
Site	56.77	2	28.39	0.49	0.6218
Number | Site**	13.55	1	13.55	0.23	0.6353
Flow	29.29	1	29.29	0.50	0.4873
Number | Flow	25.71	1	25.71	0.44	0.5148
Flow | Nunber	41.45	1	41.45	0.71	0.4100
Error	987.62	17	58.10		

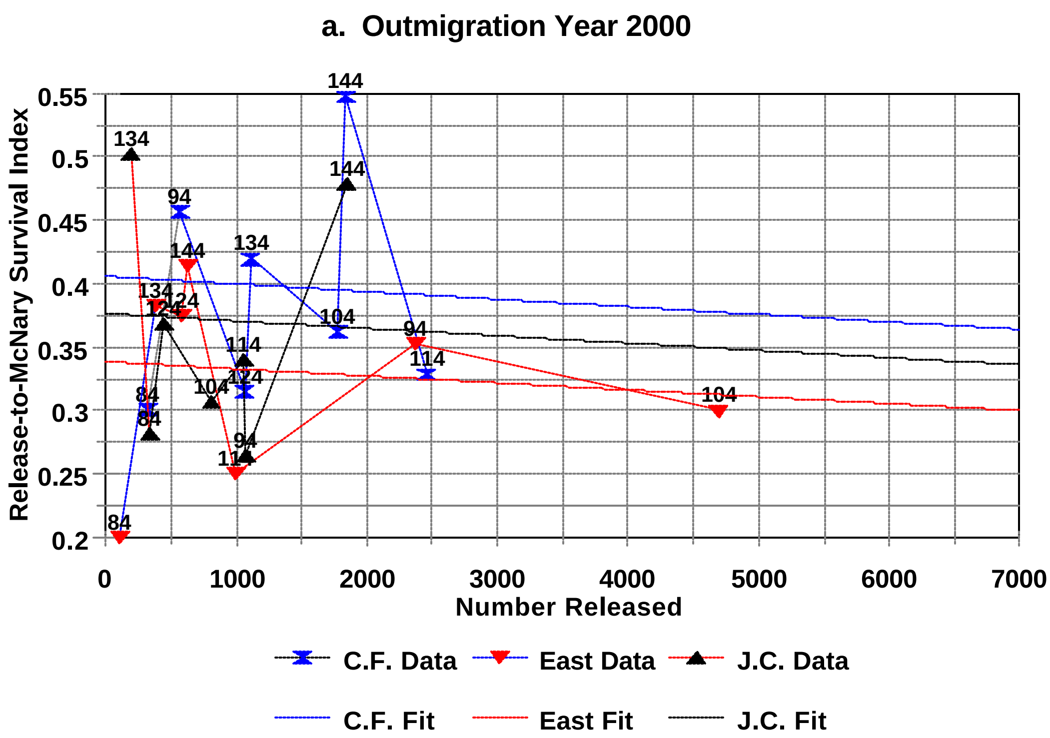
c. Year-2002 Outmigrants

Source*	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 P
Site	325.92	2	162.96	8.64	0.0026
Number | Site**	343.78	1	343.78	18.22	0.0005
Flow	111.75	1	111.75	5.92	0.0263
Number | Flow	308.95	1	308.95	16.38	0.0008
Flow | Nunber	76.92	1	76.92	4.08	0.0595
Error	320.69	17	18.86		

* Within source, the symbol "|" means "adusted for"

** Number is volitional release number

Figure 1. **Estimated Release-to-McNary Survival Estimates plotted against Volitional Release Number and Associated Survival-Index Logistic Fits adjusted for Site (number above estimate is ending Julian Date for Ten-Day Volitional Release Period; C.F.--Clark Flats, East--Easton and J.C.--Jack Creek).**

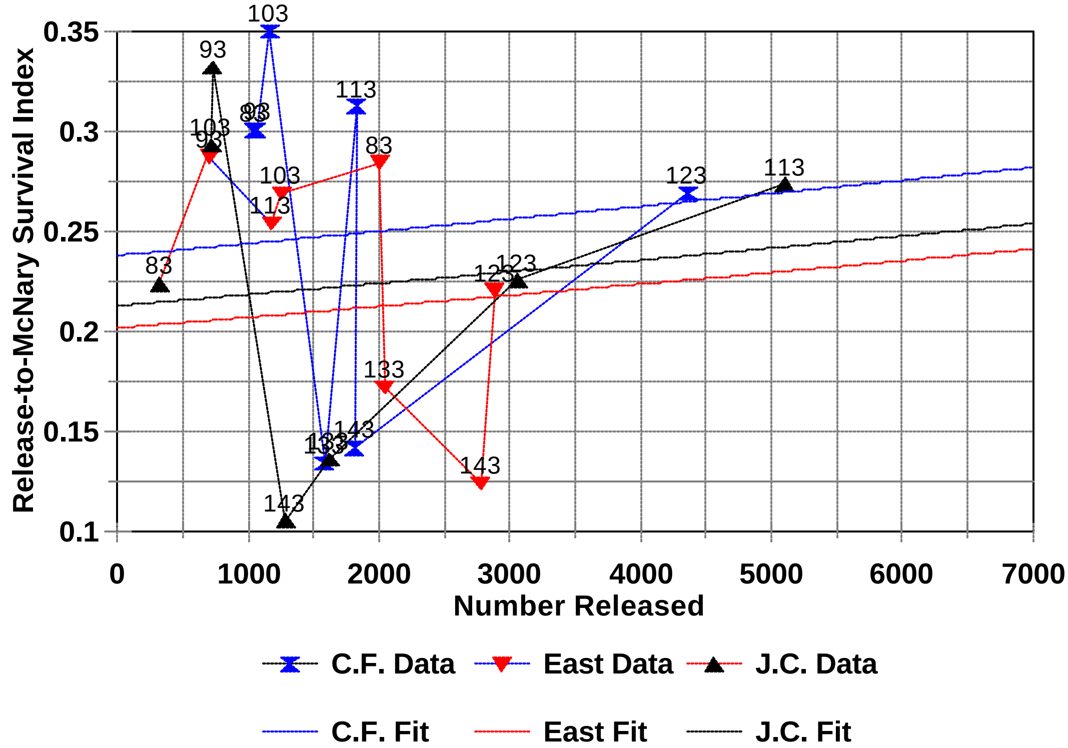


$$\text{suvival index} = \frac{1}{1+\exp(a+0.0000252*[\text{number released})]};\ \text{wherein}$$

$a = 0.38024$ for Clark Flats, $a = 0.66891$ for Easton, $a = 0.50335$ Jack Creek

Figure 1. **(continued)**

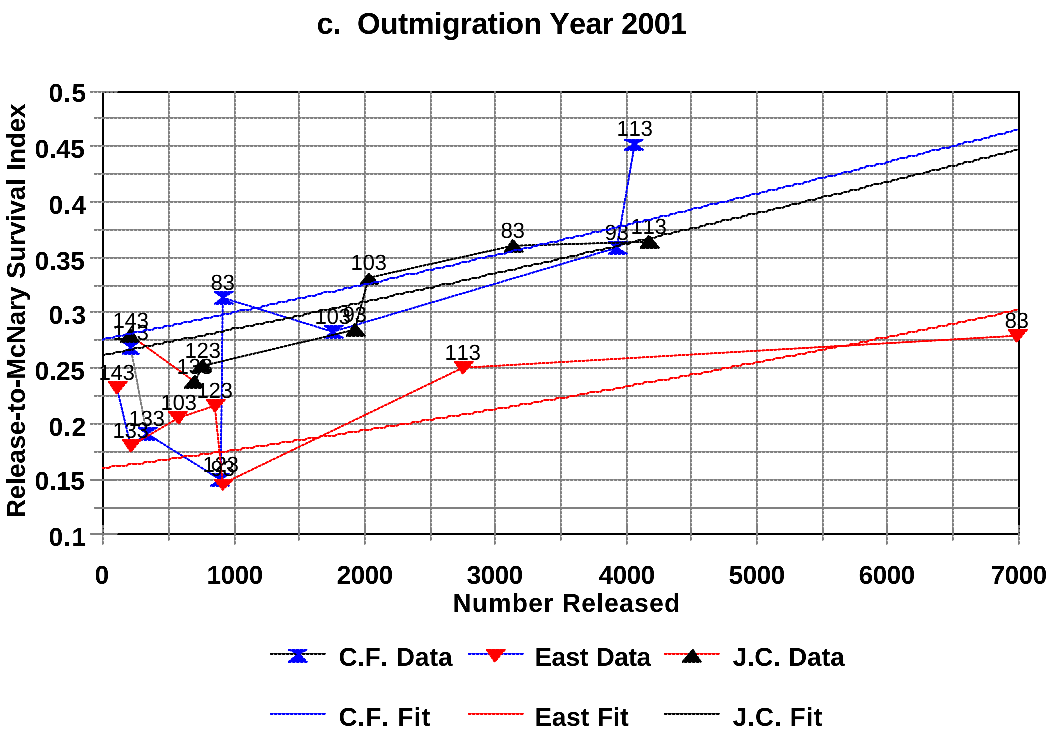
b. Outmigration Year 2001



$$\text{suvival index} = \frac{1}{1+\exp(a - 0.0000328*[\text{number released})]} ; \text{ wherein}$$

a =1.16506 for Clark Flats, a =1.37666 for Easton, a =1.30892 Jack Creek

Figure 1. (continued)



$$\text{suvival index} = \frac{1}{1+\exp(a - 0.000175*[\text{number released})]}; \text{ wherein}$$

a = 0.96234 for Clark Flats, a = 1.65793 for Easton, a = 1.03487 Jack Creek

Appendix A. Estimation and Analysis Methods

Estimation of Survival Index

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

$$\text{Release-to-McNary Survival Index} = \frac{\sum_{\text{strata}} \frac{\text{Number of Fish Detected at McNary during Stratum}}{\text{Stratum's McNary Detection Efficiency}}}{\text{Number of PIT-Tagged Fish Released}} = \frac{\sum_{\text{strata}} \text{Expanded McNary Detections within Stratum}}{\text{Number of PIT-Tagged Fish Released}}$$

wherein a stratum is a group of contiguous McNary detection dates among which the daily detection efficiencies[9] are sufficiently homogeneous to permit the use of a pooled estimate of the detection efficiency for that stratum. The pooled estimate is a pooling of the daily detection efficiency estimates over all dates within the stratum.

The estimation of the stratum's McNary-detection efficiency is discussed in greater detail in Appendix B of my 2002 Annual Report: OCT-SNT Survival. However, it should be noted that the detection efficiency estimates for the 2000 and 2001 outmigrant used in this annual report on indirect predation are different than those used in the annual reports on OCT-SNT survival. This is because the currently used detection-efficiency estimates are based on all releases of PIT-tagged Spring Chinook into the Yakima River; whereas previous years' OCT-SNT overall survival-index estimates utilized detection efficiencies that were based on only OCT-SNT releases. Next year, overall survival-index estimates for 2000 and 2001 outmigrants will be updated.

The strata's detection efficiencies used for estimating survival indices are presented in Appendix B along with the strata's McNary detections, expanded McNary detections, and the survival index estimates.

[9] 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.

Logistic Regression Analysis

Weighted logistic regression of release-to-McNary survival-index estimates on predictor variables was performed using release number as the weighting variable instead of performing a more traditional least-squares regression. The reason for using logistic regression procedures are discussed in more detail in Appendix B of my 2002 Annual Report: OCT-SNT Survival. Suffice it to say here, the logit transform of the survival index is assumed to be linearly related to the predictor variable. The logit transform of the estimated survival index (s), which is a proportion, is:

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

and the assumed underlying model is

logit(s) = Site Intercept + Coefficient*(Predictor Variable)

One major benefit of this model is that the predicted value of the survival index,

$$s = \frac{1}{1+e^{\text{logit}}}$$

can never be negative nor be greater than 1, which is appropriate for a predicted survival proportion. (In the above equation, e is the exponential constant.)

Another assumption behind the logistic regression procedures used in this study is that the variance of the survival index is proportional to what would be expected for binomially distributed proportion.

$$\text{Variance (s) is proportional to } \frac{S*(1-S)}{n}$$

wherein S is the expected ("true") proportion surviving and n is the number of fish released. The number released varied over releases; the variation in n would contribute to a variation in the variance of the survival proportion (as n increases in the above equation, the variance in s decreases). To stabilize the variance in s with respect to a change n, the release number was used as a weighting variable.

Appendix B. Within Ten-Day Volitional Release Periods: McNary Detections, McNary Detection Efficiencies, and Expanded McNary Detections[10]; and Total Expanded McNary Detections, Release Numbers, and Estimated McNary Survival Indices[11].

1. Outmigration-Year 2000, Clark Flats Volitional Releases

	Detection Efficiency Strata									
Beginning McNary Date >		4/15/00	5/17/00	5/20/00	5/26/00	5/28/00	6/1/00			
Ending McNary Date >	4/14/00	5/16/00	5/19/00	5/25/00	5/27/00	5/31/00		Total		
Release Date	McNary Detections									
24-Mar-00	1	26	1	2	0	0	0	30		
03-Apr-00	0	70	4	5	0	0	0	79		
13-Apr-00	0	174	15	7	0	1	0	197		
23-Apr-00	0	193	14	14	11	5	5	242		
03-May-00	0	14	11	23	21	15	6	90		
13-May-00	0	2	3	34	28	45	15	127		
23-May-00	0	0	0	15	47	174	63	299		
02-Jun-00	0	0	0	0	0	50	488	538		
12-Jun-00	0	0	0	0	0	0	0	0		
	Dectection Efficiencies							Total		McNary
	0.422458	0.312317	0.273358	0.2233586	0.264487	0.337151	0.255567	Expanded	Release	Survival
Release Date	Expanded McNary Detections							Detections	Number	Index
24-Mar-00	2.37	83.25	3.66	8.95	0.00	0.00	0.00	98.23	327	0.300393
03-Apr-00	0.00	224.13	14.63	22.39	0.00	0.00	0.00	261.15	572	0.456556
13-Apr-00	0.00	557.13	54.87	31.34	0.00	2.97	0.00	646.31	1780	0.363093
23-Apr-00	0.00	617.96	51.21	62.68	41.59	14.83	19.56	807.84	2458	0.328658
03-May-00	0.00	44.83	40.24	102.97	79.40	44.49	23.48	335.41	1063	0.315528
13-May-00	0.00	6.40	10.97	152.22	105.87	133.47	58.69	467.63	1114	0.419775
23-May-00	0.00	0.00	0.00	67.16	177.70	516.09	246.51	1007.46	1840	0.547532
02-Jun-00	0.00	0.00	0.00	0.00	0.00	148.30	1909.48	2057.78	4926	0.417738
12-Jun-00	0	0	0	0	0	0	0	0	263	0

2. Outmigration-Year 2000, Easton Volitional Releases

	Detection Efficiency Strata									
Beginning McNary Date >	1/0/00	4/15/00	5/17/00	5/20/00	5/26/00	5/28/00	6/1/00			
Ending McNary Date >	4/14/00	5/16/00	5/19/00	5/25/00	5/27/00	5/31/00	7/19/2000	Total		
Release Date	McNary Detections									
24-Mar-00	0	5	1	0	0	1	0	7		
03-Apr-00	0	206	16	20	5	3	1	251		
13-Apr-00	0	329	31	36	15	4	3	418		
23-Apr-00	0	25	4	16	10	13	2	70		
03-May-00	0	2	3	19	13	20	2	59		
13-May-00	0	0	0	5	9	19	9	42		
23-May-00	0	0	0	0	6	41	30	77		
02-Jun-00	0	0	0	0	0	2	433	435		
12-Jun-00	0	0	0	0	0	0	0	0		
	Dectection Efficiencies							Total		McNary
	0.422458	0.312317	0.273358	0.2233586	0.264487	0.337151	0.255567	Expanded	Release	Survival
Release Date	Expanded McNary Detections							Detections	Number	Index
24-Mar-00	0.00	16.01	3.66	0.00	0.00	2.97	0.00	22.63	113	0.200298
03-Apr-00	0.00	659.59	58.53	89.54	18.90	8.90	3.91	839.38	2378	0.352976
13-Apr-00	0.00	1053.42	113.40	161.18	56.71	11.86	11.74	1408.31	4691	0.300216
23-Apr-00	0.00	80.05	14.63	71.63	37.81	38.56	7.83	250.51	997	0.251260
03-May-00	0.00	6.40	10.97	85.07	49.15	59.32	7.83	218.74	584	0.374557
13-May-00	0.00	0.00	0.00	22.39	34.03	56.35	35.22	147.98	386	0.383378
23-May-00	0.00	0.00	0.00	0.00	22.69	121.61	117.39	261.68	632	0.414048
02-Jun-00	0.00	0.00	0.00	0.00	0.00	5.93	1694.27	1700.20	4707	0.361207
12-Jun-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52	0.000000

[10] Expanded McNary Detections = (McNary Detections)/(Detection Efficiency)

[11] Survival Index = (Expanded McNary Detections)/(Release Number)

Appendix B. Within Ten-Day Volitional Release Periods: McNary Detections, McNary Detection Efficiencies, and Expanded McNary Detections; and Total Expanded McNary Detections, Release Numbers, and Estimated McNary Survival Index (Continued).

3. Outmigration-Year 2000, Jack Creek Volitional Releases

	Detection Efficiency Strata									
Beginning McNary Date >	1/0/00	4/15/00	5/17/00	5/20/00	5/26/00	5/28/00	6/1/00			
Ending McNary Date >	4/14/00	5/16/00	5/19/00	5/25/00	5/27/00	5/31/00	7/19/2000	Total		
Release Date	McNary Detections									
24-Mar-00	1	25	0	3	0	0	0	29		
03-Apr-00	0	56	6	13	2	2	3	82		
13-Apr-00	0	47	12	9	3	1	0	72		
23-Apr-00	0	21	7	21	13	31	8	101		
03-May-00	0	0	4	12	8	13	7	44		
13-May-00	0	0	0	1	4	15	8	28		
23-May-00	0	0	0	0	6	65	171	242		
02-Jun-00	0	0	0	0	0	0	214	214		
12-Jun-00	0	0	0	0	0	0	0	0		
	Dectection Efficiencies							Total		McNary
	0.422458	0.312317	0.273358	0.2233586	0.264487	0.337151	0.255567	Expanded	Release	Survival
Release Date	Expanded McNary Detections							Detections	Number	Index
24-Mar-00	2.37	80.05	0.00	13.43	0.00	0.00	0.00	95.85	340	0.281898
03-Apr-00	0.00	179.31	21.95	58.20	7.56	5.93	11.74	284.69	1078	0.264090
13-Apr-00	0.00	150.49	43.90	40.29	11.34	2.97	0.00	248.99	810	0.307395
23-Apr-00	0.00	67.24	25.61	94.02	49.15	91.95	31.30	359.27	1055	0.340538
03-May-00	0.00	0.00	14.63	53.73	30.25	38.56	27.39	164.55	447	0.368129
13-May-00	0.00	0.00	0.00	4.48	15.12	44.49	31.30	95.39	190	0.502074
23-May-00	0.00	0.00	0.00	0.00	22.69	192.79	669.10	884.58	1847	0.478926
02-Jun-00	0.00	0.00	0.00	0.00	0.00	0.00	837.35	837.35	2412	0.347161
12-Jun-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2	0.000000

4. Outmigration-Year 2001, Clark Flats Volitional Releases

	Detection Efficiency Strata							
Beginning McNary Date >	4/1/2001	5/6/2001	5/24/2001	5/29/2001	6/2/2001	Total		
Ending McNary Date >	5/5/2001	5/23/2001	5/28/2001	6/1/2001	7/31/2001	Detections		
Release Date	McNary Detections							
24-Mar-01	36	199	10	0	0	245		
03-Apr-01	31	201	13	3	2	250		
13-Apr-01	23	270	18	8	0	319		
23-Apr-01	19	393	19	12	4	447		
03-May-01	2	594	202	88	25	911		
13-May-01	0	23	76	43	20	162		
23-May-01	0	0	12	133	49	194		
02-Jun-01	0	0	0	0	2	2		
	Dectection Efficiencies					Total		McNary
	0.770785	0.786313	0.766575	0.748928	0.771139	Expanded	Release	Survival
Release Date	Expanded McNary Detections					Detections	Number	Index
24-Mar-01	46.71	253.08	13.05	0.00	0.00	312.83	1043	0.299933
03-Apr-01	40.22	255.62	16.96	4.01	2.59	319.40	1063	0.300470
13-Apr-01	29.84	343.37	23.48	10.68	0.00	407.38	1164	0.349980
23-Apr-01	24.65	499.80	24.79	16.02	5.19	570.45	1827	0.312231
03-May-01	2.59	755.42	263.51	117.50	32.42	1171.45	4361	0.268619
13-May-01	0.00	29.25	99.14	57.42	25.94	211.74	1583	0.133761
23-May-01	0.00	0.00	15.65	177.59	63.54	256.78	1814	0.141557
02-Jun-01	0.00	0.00	0.00	0.00	2.59	2.59	116	0.022358

Appendix B. Within Ten-Day Volitional Release Periods: McNary Detections, McNary Detection Efficiencies, and Expanded McNary Detections; and Total Expanded McNary Detections, Release Numbers, and Estimated McNary Survival Index (Continued).

5. Outmigration-Year 2001, Easton Volitional Releases

	Detection Efficiency Strata							
Beginning McNary Date >	4/1/2001	5/6/2001	5/24/2001	5/29/2001	6/2/2001	Total		
Ending McNary Date >	5/5/2001	5/23/2001	5/28/2001	6/1/2001	7/31/2001	Detections		
Release Date	McNary Detections							
24-Mar-01	46	326	32	25	16	445		
03-Apr-01	13	119	17	6	4	159		
13-Apr-01	6	184	35	27	10	262		
23-Apr-01	1	144	35	37	15	232		
03-May-01	1	169	144	127	48	489		
13-May-01	0	8	52	140	67	267		
23-May-01	0	0	3	154	104	261		
02-Jun-01	0	0	0	0	0	0		
	Dectection Efficiencies					Total		McNary
	0.770785	0.786313	0.766575	0.748928	0.771139	Expanded	Release	Survival
Release Date	Expanded McNary Detections					Detections	Number	Index
24-Mar-01	59.68	414.59	41.74	33.38	20.75	570.15	2007	0.284079
03-Apr-01	16.87	151.34	22.18	8.01	5.19	203.58	709	0.287137
13-Apr-01	7.78	234.00	45.66	36.05	12.97	336.46	1252	0.268742
23-Apr-01	1.30	183.13	45.66	49.40	19.45	298.94	1178	0.253772
03-May-01	1.30	214.93	187.85	169.58	62.25	635.89	2887	0.220261
13-May-01	0.00	10.17	67.83	186.93	86.88	351.83	2045	0.172042
23-May-01	0.00	0.00	3.91	205.63	134.87	344.41	2780	0.123887
02-Jun-01	0.00	0.00	0.00	0.00	0.00	0.00	76	0.000000

6. Outmigration-Year 2001, Jack Creek Volitional Releases

	Detection Efficiency Strata							
Beginning McNary Date >	4/1/2001	5/6/2001	5/24/2001	5/29/2001	6/2/2001	Total		
Ending McNary Date >	5/5/2001	5/23/2001	5/28/2001	6/1/2001	7/31/2001	Detections		
Release Date	McNary Detections							
24-Mar-01	10	44	2	1	0	57		
03-Apr-01	17	150	13	6	3	189		
13-Apr-01	11	129	17	4	3	164		
23-Apr-01	29	785	149	102	21	1086		
03-May-01	0	189	155	144	43	531		
13-May-01	0	5	18	84	61	168		
23-May-01	0	0	0	43	60	103		
02-Jun-01	0	0	0	0	0	0		
	Dectection Efficiencies					Total		McNary
	0.770785	0.786313	0.766575	0.7489276	0.771139	Expanded	Release	Survival
Release Date	Expanded McNary Detections					Detections	Number	Index
24-Mar-01	12.97	55.96	2.61	1.34	0.00	72.88	326	0.223544
03-Apr-01	22.06	190.76	16.96	8.01	3.89	241.68	728	0.331977
13-Apr-01	14.27	164.06	22.18	5.34	3.89	209.74	716	0.292927
23-Apr-01	37.62	998.33	194.37	136.19	27.23	1393.75	5101	0.273231
03-May-01	0.00	240.36	202.20	192.27	55.76	690.60	3064	0.225391
13-May-01	0.00	6.36	23.48	112.16	79.10	221.10	1626	0.135980
23-May-01	0.00	0.00	0.00	57.42	77.81	135.22	1285	0.105231
02-Jun-01	0.00	0.00	0.00	0.00	0.00	0.00	0	#DIV/0!

Appendix B. Within Ten-Day Volitional Release Periods: McNary Detections, McNary Detection Efficiencies, and Expanded McNary Detections; and Total Expanded McNary Detections, Release Numbers, and Estimated McNary Survival Index (Continued).

7. Outmigration-Year 2002, Clark Flats Volitional Releases

	Detection Efficiency Strata							
Beginning McNary Date >	3/1/2002	4/22/2002	4/26/2002	4/30/2002	5/2/2002	5/3/2002	5/6/2002	5/7/2002
Ending McNary Date >	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002
Release Date	McNary Detections							
24-Mar-02	29	19	11	8	11	28	4	8
03-Apr-02	67	69	70	55	56	203	47	47
13-Apr-02	5	6	12	23	25	102	37	31
23-Apr-02	2	7	31	39	59	388	119	166
03-May-02	0	0	0	0	0	0	2	9
13-May-02	0	0	0	0	0	0	0	0
23-May-02	0	0	0	0	0	0	0	0
02-Jun-02	0	0	0	0	0	0	0	0
	Dectection Efficiencies							
	0.332561	0.388115	0.417032	0.458902	0.513120	0.579215	0.542672	0.495823
Release Date	Expanded McNary Detections							
24-Mar-02	87.20	48.95	26.38	17.43	21.44	48.34	7.37	16.13
03-Apr-02	201.47	177.78	167.85	119.85	109.14	350.47	86.61	94.79
13-Apr-02	15.03	15.46	28.77	50.12	48.72	176.10	68.18	62.52
23-Apr-02	6.01	18.04	74.33	84.99	114.98	669.87	219.29	334.80
03-May-02	0.00	0.00	0.00	0.00	0.00	0.00	3.69	18.15
13-May-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23-May-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-Jun-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Detection Efficiency Strata							
Beginning McNary Date >	5/9/2002	5/15/2002	5/25/2002	5/28/2002	5/31/2002			
Ending McNary Date >	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002	Total		
Release Date								
24-Mar-02	2	4	0	0	0	124		
03-Apr-02	21	21	0	1	0	657		
13-Apr-02	13	2	0	0	0	256		
23-Apr-02	73	53	1	2	0	940		
03-May-02	14	30	0	1	0	56		
13-May-02	0	8	10	3	2	23		
23-May-02	0	3	9	6	1	19		
02-Jun-02	0	0	0	2	3	5		
	Dectection Efficiencies					Total		McNary
	0.443119	0.387133	0.441514	0.252866	0.226415	Expanded	Release	Survival
Release Date						Detections	Number	Index
24-Mar-02	4.51	10.33	0.00	0.00	0.00	288.10	917	0.314173
03-Apr-02	47.39	54.24	0.00	3.95	0.00	1413.56	3931	0.359592
13-Apr-02	29.34	5.17	0.00	0.00	0.00	499.42	1761	0.283599
23-Apr-02	164.74	136.90	2.26	7.91	0.00	1834.13	4060	0.451755
03-May-02	31.59	77.49	0.00	3.95	0.00	134.88	899	0.150032
13-May-02	0.00	20.66	22.65	11.86	8.83	64.01	336	0.190510
23-May-02	0.00	7.75	20.38	23.73	4.42	56.28	210	0.267992
02-Jun-02	0.00	0.00	0.00	7.91	13.25	21.16	84	0.251897

Appendix B. Within Ten-Day Volitional Release Periods: McNary Detections, McNary Detection Efficiencies, and Expanded McNary Detections; and Total Expanded McNary Detections, Release Numbers, and Estimated McNary Survival Index (Continued).

8. Outmigration-Year 2002, Easton Volitional Releases

	Detection Efficiency Strata							
Beginning McNary Date >	3/1/2002	4/22/2002	4/26/2002	4/30/2002	5/2/2002	5/3/2002	5/6/2002	5/7/2002
Ending McNary Date >	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002
Release Date	McNary Detections							
24-Mar-02	29	19	11	8	11	28	4	8
03-Apr-02	67	69	70	55	56	203	47	47
13-Apr-02	5	6	12	23	25	102	37	31
23-Apr-02	2	7	31	39	59	388	119	166
03-May-02	0	0	0	0	0	0	2	9
13-May-02	0	0	0	0	0	0	0	0
23-May-02	0	0	0	0	0	0	0	0
02-Jun-02	0	0	0	0	0	0	0	0
12-Jun-02	0	0	0	0	0	0	0	0
	Dectection Efficiencies							
	0.332561	0.388115	0.417032	0.458902	0.513120	0.579215	0.542672	0.495823
Release Date	Expanded McNary Detections							
24-Mar-02	240.56	193.241693	158.261179	128.567679	159.806706	485.139358	178.745089	175.46572
03-Apr-02	0	7.72966771	9.59158658	8.71645281	7.79544907	31.0765425	9.2136644	20.1684736
13-Apr-02	0	0	9.59158658	8.71645281	5.8465868	29.3500679	9.2136644	14.1179315
23-Apr-02	0	0	0	15.2537924	5.8465868	79.4178308	73.7093152	102.859215
03-May-02	0	0	0	0	0	0	0	2.01684736
13-May-02	0	0	0	0	0	0	0	0
23-May-02	0	0	0	0	0	0	0	0
02-Jun-02	0	0	0	0	0	0	0	0
12-Jun-02	0	0	0	0	0	0	0	0

	Detection Efficiency Strata							
Beginning McNary Date >	5/9/2002	5/15/2002	5/25/2002	5/28/2002	5/31/2002			
Ending McNary Date >	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002	Total		
Release Date								
24-Mar-02	2	4	0	0	0	124		
03-Apr-02	21	21	0	1	0	657		
13-Apr-02	13	2	0	0	0	256		
23-Apr-02	73	53	1	2	0	940		
03-May-02	14	30	0	1	0	56		
13-May-02	0	8	10	3	2	23		
23-May-02	0	3	9	6	1	19		
02-Jun-02	0	0	0	2	3	5		
12-Jun-02	0	0	0	0	0	0		
	Dectection Efficiencies					Total		McNary
	0.443119	0.387133	0.441514	0.252866	0.226415	Expanded	Release	Survival
Release Date						Detections	Number	Index
24-Mar-02	94.7827229	134.320596	9.05974026	0	0	1957.95	6995	0.27990678
03-Apr-02	9.02692599	20.664707	4.52987013	3.95466667	0	132.468007	913	0.14509092
13-Apr-02	15.7971205	25.8308838	0	0	0	118.464294	576	0.20566718
23-Apr-02	108.323112	247.976485	22.6493506	15.8186667	17.6666667	689.521021	2752	0.2505527
03-May-02	15.7971205	95.5742701	18.1194805	15.8186667	39.75	187.076385	862	0.21702597
13-May-02	0	5.16617676	6.79480519	0	26.5	38.460982	214	0.17972421
23-May-02	0	0	9.05974026	3.95466667	13.25	26.2644069	113	0.23242838
02-Jun-02	0	0	0	0	0	0	0	#DIV/0!
12-Jun-02	0	0	0	0	0	0	0	#DIV/0!

Appendix B. Within Ten-Day Volitional Release Periods: McNary Detections, McNary Detection Efficiencies, and Expanded McNary Detections; and Total Expanded McNary Detections, Release Numbers, and Estimated McNary Survival Index (Continued).

9. Outmigration-Year 2002, Jack Creek Volitional Releases

	Detection Efficiency Strata							
Beginning McNary Date >	3/1/2002	4/22/2002	4/26/2002	4/30/2002	5/2/2002	5/3/2002	5/6/2002	5/7/2002
Ending McNary Date >	4/21/2002	4/25/2002	4/29/2002	5/1/2002	5/2/2002	5/5/2002	5/6/2002	5/8/2002
Release Date	McNary Detections							
24-Mar-02	29	19	11	8	11	28	4	8
03-Apr-02	67	69	70	55	56	203	47	47
13-Apr-02	5	6	12	23	25	102	37	31
23-Apr-02	2	7	31	39	59	388	119	166
03-May-02	0	0	0	0	0	0	2	9
13-May-02	0	0	0	0	0	0	0	0
23-May-02	0	0	0	0	0	0	0	0
02-Jun-02	0	0	0	0	0	0	0	0
	Dectection Efficiencies							
	0.332561	0.388115	0.417032	0.458902	0.513120	0.579215	0.542672	0.495823
Release Date	Expanded McNary Detections							
24-Mar-02	174.40	126.2512393	119.8948323	58.8360565	77.9544907	271.0565096	88.45117828	80.6738944
24-Mar-02	42.09755628	30.91867084	52.7537262	43.58226407	35.07952082	134.6650175	44.22558914	76.64019968
03-Apr-02	15.03484153	12.88277952	23.97896646	32.68669806	40.92610762	193.3651533	70.02384947	102.8592154
13-Apr-02	0	2.576555903	21.58106981	32.68669806	48.72155669	277.9624079	184.2732881	288.4091725
23-Apr-02	0	0	0	0	0	0	1.842732881	6.05054208
03-May-02	0	0	0	0	0	0	0	0
13-May-02	0	0	0	0	0	0	0	0
23-May-02	0	0	0	0	0	0	0	0

Beginning McNary Date >	5/9/2002	5/15/2002	5/25/2002	5/28/2002	5/31/2002			
Ending McNary Date >	5/14/2002	5/24/2002	5/27/2002	5/30/2002	7/31/2002	Total		
Release Date								
24-Mar-02	2	4	0	0	0	124		
03-Apr-02	21	21	0	1	0	657		
13-Apr-02	13	2	0	0	0	256		
23-Apr-02	73	53	1	2	0	940		
03-May-02	14	30	0	1	0	56		
13-May-02	0	8	10	3	2	23		
23-May-02	0	3	9	6	1	19		
02-Jun-02	0	0	0	2	3	5		
	0.443119	0.387133	0.441514	0.252866	0.226415	Total Expanded Detections	Release Number	McNary Survival Index
Release Date								
24-Mar-02	51.90482447	74.90956304	0	3.954666667	4.416666667	1132.71	3135	0.361310393
24-Mar-02	29.33750948	49.07867924	6.794805195	3.954666667	0	549.1282051	1932	0.284227849
03-Apr-02	85.75579694	82.65882819	9.05974026	3.954666667	0	673.1866434	2035	0.330804247
13-Apr-02	261.7808538	346.133843	22.64935065	19.77333333	13.25	1519.79813	4180	0.363588069
23-Apr-02	22.56731499	111.0728004	20.38441558	15.81866667	13.25	190.9864726	757	0.252293887
03-May-02	0	36.16323733	31.70909091	27.68266667	70.66666667	166.2216616	699	0.23779923
13-May-02	0	2.583088381	6.794805195	11.864	35.33333333	56.57522691	203	0.278695699
23-May-02	0	0	0	0	0	0	0	#DIV/0!

APPENDIX G

Financial Reports

Yakama Nation-Fisheries Program

Project No. 1995-63-25
Project Name: Monitoring & Evaluation
Contract No. : 5881
Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458101 M&E

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
512111	WAGES	$ 157,059.00				
	100-Modeling		$ 54,516.50	$ 46,556.10	$ 7,960.40	
	105-Juv. Spring Chinook Marking		$ -	$ -	$ -	
	107-Chandler		$ 23,187.58	$ 23,187.58	$ -	
	110-Behavior		$ -	$ -	$ -	
	400-Avian Predation		$ 39,588.88	$ 35,518.80	$ 4,070.08	
	401-Predation		$ 6,404.85	$ 1,956.21	$ 4,448.64	
	403-Indirect Predation		$ 7,521.12	$ 16,007.73	$ (8,486.61)	
	Sub-Total		$ 131,218.93	$ 123,226.42	$ 7,992.51	$ 25,840.07
519111	FRINGE	$ 34,804.00				
	100-Modeling		$ 9,014.98	$ 7,385.86	$ 1,629.12	
	105-Juv. Spring Chinook Marking		$ -	$ -	$ -	
	107-Chandler		$ 4,010.32	$ 4,010.32	$ -	
	110-Behavior		$ -	$ -	$ -	
	400-Avian Predation		$ 7,151.66	$ 6,208.47	$ 943.19	
	401-Predation		$ 1,317.90	$ 310.19	$ 1,007.71	
	403-Indirect Predation		$ 1,751.30	$ 2,039.66	$ (288.36)	
	Sub-Total		$ 23,246.16	$ 19,954.50	$ 3,291.66	$ 11,557.84
521161	Aerial Flights	$ 5,019.00				
	124-Aerial Flights		$ 2,298.40	$ 1,577.60	$ 720.80	
	Sub-Total		$ 2,298.40	$ 1,577.60	$ 720.80	$ 2,720.60
541122	Sensitve Equipment	$ 11,775.00				
	100-Modeling		$ 4,199.90	$ 3,420.00	$ 779.90	
	400-Avian Predation		$ 4,751.98	$ -	$ 4,751.98	
	Sub-Total		$ 8,951.88	$ 3,420.00	$ 5,531.88	$ 2,823.12
541161	Operations & Maintenance	$ 3,270.00				
	105-Juv. Spring Chinook Marking		$ -	$ -	$ -	
	107-Chandler		$ 2,146.58	$ 2,146.58	$ -	
	401-Predation		$ 1,596.25	$ 250.00	$ 1,346.25	
	Sub-Total		$ 3,742.83	$ 2,396.58	$ 1,346.25	$ (472.83)
551111	Operating Supplies	$ 95,230.00				
	100-Modeling		$ 4,810.27	$ 3,974.35	$ 835.92	
	105-Juv. Spring Chinook Marking		$ 67,783.00	$ 67,783.00	$ -	
	107-Chandler		$ 710.60	$ 710.60	$ -	
	400-Avian Predation		$ 746.03	$ -	$ 746.03	
	401-Predation		$ 2,627.69	$ 2,314.22	$ 313.47	
	131-Predator Avoidance Training		$ 8,062.59	$ 7,878.09	$ 184.50	
	Sub-Total		$ 84,740.18	$ 82,660.26	$ 2,079.92	$ 10,489.82

Yakama Nation-Fisheries Program

Project No. 1995-63-25
Project Name: Monitoring & Evaluation
Contract No. : 5881
Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458101 M&E Cont'

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
551295	Vehicle Rental	$ 7,035.00				
	100-Modeling		$ 1,238.71	$ 763.32	$ 475.39	
	107-Chandler		$ 1,358.05	$ 1,358.05	$ -	
	115-Roza		$ -	$ 170.50	$ (170.50)	
	400-Avian Predation		$ 2,734.56	$ 1,556.29	$ 1,178.27	
	401-Predation		$ -	$ -	$ -	
	Sub-Total		$ 5,331.32	$ 3,848.16	$ 1,483.16	$ 1,703.68
561171	Telephone	$ 2,424.00				
	100-Modeling		$ 1,014.17	$ 882.29	$ 131.88	
	107-Chandler		$ 324.13	$ 324.13	$ -	
	401-Predation		$ 251.58	$ 251.58	$ -	
	Sub-Total		$ 1,589.88	$ 1,458.00	$ 131.88	$ 834.12
571111	Insurance	$ 1,465.00				
	100-Modeling		$ 390.78	$ -	$ 390.78	
	107-Chandler		$ 73.74	$ 73.74	$ -	
	400-Avian Predation		$ 570.84	$ -	$ 570.84	
	401-Predation		$ 424.00	$ -	$ 424.00	
	Sub-Total		$ 1,459.36	$ 73.74	$ 1,385.62	$ 5.64
581110	Travel Holding	$ -				
	100-Modeling		$ -	$ 375.18	$ (375.18)	
	401-Predation		$ -	$ -	$ -	
	Sub-Total		$ -	$ 375.18	$ (375.18)	$ -
581121	Per Diem	$ 2,500.00				
	100-Modeling		$ 3,039.98	$ 2,254.38	$ 785.60	
	401-Predation		$ -	$ 173.04	$ (173.04)	
	Sub-Total		$ 3,039.98	$ 2,427.42	$ 612.56	$ (539.98)
621251	Indirect Cost	$ 63,031.00				
	100-Modeling		$ 14,655.65	$ 12,778.08	$ 1,877.57	
	105-Juv. Spring Chinook Marking		$ 13,217.69	$ 13,217.69	$ -	
	107-Chandler		$ 6,802.89	$ 6,203.15	$ 599.74	
	110-Behavior		$ -	$ -	$ -	
	115-Roza		$ -	$ 33.25	$ (33.25)	
	400-Avian Predation		$ 9,922.65	$ 8,382.50	$ 1,540.15	
	401-Predation		$ 2,138.98	$ 991.03	$ 1,147.95	
	403-Indirect Predation		$ 3,913.38	$ 3,519.24	$ 394.14	
	124-Aerial Flights		$ 307.63	$ 307.63	$ -	
	131-Predator Avoidance Training		$ 1,572.21	$ 1,536.23	$ 35.98	
	No Poject		$ (735.39)	$ -	$ (735.39)	
	Sub-Total		$ 51,795.69	$ 46,968.80	$ 4,826.89	$ 11,235.31
522251	Sub-Contracts	$ 69,200.00				
	100-Modeling		$ 4,200.00	$ 4,200.00	$ -	
	403-Indirect Predation		$ 10,933.65	$ -	$ 10,933.65	
	133-Biometrical Support		$ 42,084.98	$ 42,084.98	$ -	
	Sub-Total		$ 57,218.63	$ 46,284.98	$ 10,933.65	$ 11,981.37
651171	Capital Equipment	$ 129,600.00				
	105-Juv. Spring Chinook Marking		$ 129,600.00	$ 129,600.00	$ -	
	Sub-Total		$ 129,600.00	$ 129,600.00	$ -	$ -
	TOTAL:	**$ 588,293.00**	**$ 504,233.24**	**$ 464,271.64**	**$ 39,961.60**	**$ 78,178.76**

Yakama Nation-Fisheries Program

Project No. 1995-63-25
Project Name: Monitoring & Evaluation
Contract No. : 5881
Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458102 Tech's

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
512111	WAGES	$ 626,597.00				
	105-Juv. Spring Chinook Marking		$ 75,006.11	$ 73,935.99	$ 1,070.12	
	106-Smolt PIT Tagging		$ 31,727.76	$ 31,727.76	$ -	
	107-Chandler		$ 181,771.06	$ 162,493.41	$ 19,277.65	
	109-Coho		$ 53,974.62	$ 51,104.22	$ 2,870.40	
	115-Roza		$ 120,852.18	$ 110,123.29	$ 10,728.89	
	116-Spawning Ground Surveys		$ 37,976.02	$ 37,976.02	$ -	
	122-Scale Analysis		$ 19,179.72	$ 19,179.72	$ -	
	127-Sediment Samples		$ 25,023.92	$ 21,820.72	$ 3,203.20	
	201-Monitoring Crew		$ 16,598.29	$ 15,907.89	$ 690.40	
	302-Stray Recovery		$ -	$ -	$ -	
	401-Predation		$ 25,905.66	$ 23,355.26	$ 2,550.40	
	402-Predation Monitoring		$ 700.47	$ 700.47	$ -	
	405-NTTOC Monitoring		$ 19,331.25	$ 18,002.23	$ 1,329.02	
	Sub-Total		$ 608,047.06	$ 566,326.98	$ 41,720.08	$ 18,549.94
519111	FRINGE	$ 112,286.00				
	105-Juv. Spring Chinook Marking		$ 11,589.45	$ 11,439.56	$ 149.89	
	106-Smolt PIT Tagging		$ 5,023.22	$ 5,023.22	$ -	
	107-Chandler		$ 19,831.45	$ 16,681.63	$ 3,149.82	
	109-Coho		$ 8,906.49	$ 8,172.25	$ 734.24	
	115-Roza		$ 21,497.10	$ 19,707.23	$ 1,789.87	
	116-Spawning Ground Surveys		$ 5,746.66	$ 5,746.66	$ -	
	122-Scale Analysis		$ 3,705.82	$ 3,705.82	$ -	
	127-Sediment Samples		$ 4,872.47	$ 4,295.75	$ 576.72	
	201-Monitoring Crew		$ 1,331.98	$ 1,285.04	$ 46.94	
	302-Stray Recovery		$ -	$ -	$ -	
	401-Predation		$ 4,492.22	$ 4,064.08	$ 428.14	
	402-Predation Monitoring		$ 138.41	$ 138.41	$ -	
	405-NTTOC Monitoring		$ 1,922.09	$ 1,825.98	$ 96.11	
	Sub-Total		$ 89,057.36	$ 82,085.63	$ 6,971.73	$ 23,228.64
541161	Operations & Maintenance	$ 2,000.00				
	107-Chandler		$ 1,389.15	$ 687.18	$ 701.97	
	115-Roza		$ 516.23	$ 516.23	$ -	
	116-Spawning Ground Surveys		$ -	$ -	$ -	
	Sub-Total		$ 1,905.38	$ 1,203.41	$ 701.97	$ 94.62
551111	Operating Supplies	$ 20,000.00				
	105-Juv. Spring Chinook Marking		$ 13,206.74	$ 13,206.74	$ -	
	107-Chandler		$ 8,738.91	$ 8,463.10	$ 275.81	
	109-Coho		$ 891.74	$ 891.74	$ -	
	115-Roza		$ 2,024.14	$ 1,983.03	$ 41.11	
	116-Spawning Ground Surveys		$ 837.26	$ 837.26	$ -	
	201-Monitoring Crew		$ -	$ -	$ -	
	401-Predation		$ 507.93	$ 507.93	$ -	
	402-Coho/Chinook Predation		$ -	$ -	$ -	
	405-NTTOC Monitoring		$ 81.48	$ 81.48	$ -	
	Sub-Total		$ 26,288.20	$ 25,971.28	$ 316.92	$ (6,288.20)
551295	Vehicle Rental	$ 51,403.00				
	105-Juv. Spring Chinook Marking		$ 3,058.15	$ 3,058.15	$ -	
	106-Smolt PIT Tagging		$ 2,070.50	$ 1,247.31	$ 823.19	
	107-Chandler		$ 12,403.99	$ 9,245.71	$ 3,158.28	
	109-Coho		$ 695.91	$ 695.91	$ -	
	115-Roza		$ 11,503.49	$ 9,036.83	$ 2,466.66	
	116-Spawning Ground Surveys		$ 7,869.28	$ 7,869.28	$ -	
	201-Monitoring Crew		$ 4,922.69	$ 3,942.17	$ 980.52	
	302-Stray Recovery		$ -	$ -	$ -	
	401-Predation		$ 2,780.50	$ 1,589.35	$ 1,191.15	
	405-NTTOC Monitoring		$ 4,761.72	$ 3,352.60	$ 1,409.12	
	Sub-Total		$ 50,066.23	$ 40,037.31	$ 10,028.92	$ 1,336.77

Yakama Nation-Fisheries Program

Project No. 1995-63-25
Project Name: Monitoring & Evaluation
Contract No. : 5881
Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458102 Tech's Cont'

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
561131	Waste Disposal	$ 1,500.00				
	107-Chandler		$ 1,525.50	$ 1,248.00	$ 277.50	
	Sub-Total		$ 1,525.50	$ 1,248.00	$ 277.50	$ (25.50)
561171	Telephone	$ 9,200.00				
	106-Smolt PIT Tagging		$ 219.40	$ 219.40	$ -	
	107-Chandler		$ 1,689.73	$ 1,606.39	$ 83.34	
	109-Coho		$ 312.79	$ 271.12	$ 41.67	
	115-Roza		$ 1,298.20	$ 1,200.61	$ 97.59	
	201-Monitoring Crew		$ 472.65	$ 430.98	$ 41.67	
	401-Predation		$ 809.43	$ 765.02	$ 44.41	
	Sub-Total		$ 4,802.20	$ 4,493.52	$ 308.68	$ 4,397.80
571111	Insurance	$ 5,021.00				
	107-Chandler		$ 236.38	$ (154.40)	$ 390.78	
	115-Roza		$ 73.74	$ 73.74	$ -	
	201-Monitoring Crew		$ -	$ -	$ -	
	405-NTTOC Monitoring		$ -	$ -	$ -	
	Sub-Total		$ 310.12	$ (80.66)	$ 390.78	$ 4,710.88
581111	Commercial Air	$ 2,500.00				
	107-Chandler		$ -	$ -	$ -	
	Sub-Total		$ -	$ -	$ -	$ 2,500.00
581110	Travel Holding	$ -				
	107-Chandler		$ 453.54	$ 1,581.91	$ (1,128.37)	
	109-Coho			$ 289.89	$ (289.89)	
	Sub-Total		$ 453.54	$ 1,871.80	$ (1,418.26)	$ (453.54)
581121	Per Diem	$ 3,997.00				
	107-Chandler		$ 3,728.97	$ 2,320.81	$ 1,408.16	
	No project		$ -	$ -	$ -	
	Sub-Total		$ 3,728.97	$ 2,320.81	$ 1,408.16	$ 268.03
621251	Indirect Cost	$ 162,728.00				
	105-Juv. Spring Chinook Marking		$ 20,100.57	$ 19,948.10	$ 152.47	
	106-Smolt PIT Tagging		$ 7,570.19	$ 7,409.67	$ 160.52	
	107-Chandler		$ 44,951.11	$ 39,790.01	$ 5,161.10	
	109-Coho		$ 12,651.90	$ 11,977.89	$ 674.01	
	115-Roza		$ 30,485.97	$ 27,814.98	$ 2,670.99	
	116-Spawning Ground Surveys		$ 10,223.69	$ 10,223.69	$ -	
	122-Scale Analysis		$ 4,462.68	$ 4,462.68	$ -	
	127-Sediment Samples		$ 5,829.80	$ 5,255.13	$ 574.67	
	201-Monitoring Crew		$ 4,486.72	$ 4,205.39	$ 281.33	
	302-Stray Recovery		$ -	$ -	$ -	
	401-Predation		$ 5,904.92	$ 5,904.92	$ -	
	402-Predation Monitoring		$ 163.58	$ 163.58	$ -	
	405-NTTOC Monitoring		$ 4,536.15	$ 4,536.15	$ -	
	Sub-Total		$ 151,367.28	$ 141,692.19	$ 9,675.09	$ 11,360.72
	TOTAL:	**$1,003,113.00**	**$ 937,551.84**	**$ 867,170.27**	**$ 70,381.57**	**$ 59,680.16**

Yakama Nation-Fisheries Program

Project No. 1995-63-25
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Contract No. : 5881
Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458103 **Modeling**

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
522251	Sub-Contracts	$ 277,835.00				
	100-Modeling Mobrand		$ 106,162.50	$ 91,217.50	$ 14,945.00	
	100-CWU		$ 96,337.69	$ 75,419.60	$ 20,918.09	**$ 75,334.81**
	TOTAL:	**$ 277,835.00**	**$ 202,500.19**	**$ 166,637.10**	**$ 35,863.09**	**$ 75,334.81**

Yakama Nation-Fisheries Program

Project No. 1995-63-25
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Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458104 **Video**

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
512111	WAGES	$ 110,420.00				
	114-Prosser		$ 98,586.94	$ 91,407.97	$ 7,178.97	
	115-Roza		$ 12,169.84	$ 11,276.24	$ 893.60	
	Sub-Total		$ 110,756.78	$ 102,684.21	$ 8,072.57	$ (336.78)
519111	FRINGE	$ 15,280.00				
	114-Prosser		$ 13,898.65	$ 12,713.78	$ 1,184.87	
	115-Roza		$ 1,146.41	$ 1,076.54	$ 69.87	
	Sub-Total		$ 15,045.06	$ 13,790.32	$ 1,254.74	$ 234.94
541122	Sensitive Equipment	$ 5,144.00				
	114-Prosser		$ 3,429.96	$ 2,643.96	$ 786.00	$ 1,714.04
541161	Operations & Maintenance	$ -				
	114-Prosser		$ -	$ -	$ -	$ -
551111	Operating Supplies	$ 1,900.00				
	114-Prosser		$ 1,253.40	$ 561.91	$ 691.49	$ 646.60
551295	Vehicle Rental	$ 3,909.00				
	114-Prosser		$ 4,253.18	$ 4,248.48	$ 4.70	$ (344.18)
571111	Insurance	$ 750.00				
	114-Prosser		$ 659.94	$ (15.44)	$ 675.38	$ 90.06
561171	Telephone	$ 1,200.00				
	114-Prosser		$ 1,090.11	$ 870.97	$ 219.14	$ 109.89
581121	Per Diem	$ 711.00				
	114-Prosser		$ 710.08	$ 710.08	$ -	$ 0.92
621251	Indirect Cost	$ 27,167.00				
	114-Prosser		$ 24,120.40	$ 22,011.49	$ 2,108.91	
	115-Roza		$ 2,633.31	$ 2,408.79	$ 224.52	
	Sub-Total		$ 26,753.71	$ 24,420.28	$ 2,333.43	$ 413.29
522251	Sub Contracts	$ 15,000.00				
	114-Prosser		$ 15,000.00	$ 15,000.00	$ -	$ -
	TOTAL:	**$ 181,481.00**	**$ 178,952.22**	**$ 164,914.77**	**$ 14,037.45**	**$ 2,528.78**

Yakama Nation-Fisheries Program

Project No. 1995-63-25
Project Name: Monitoring & Evaluation
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Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458106 Fall Chinook

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
512111	WAGES	$ 47,760.00				
	108-Fall Chinook		$ 52,150.44	$ 49,670.18	$ 2,480.26	$ (4,390.44)
519111	FRINGE	$ 9,131.00				
	108-Fall Chinook		$ 7,777.42	$ 7,225.42	$ 552.00	$ 1,353.58
541122	Sensitive Equipment	$ 17,367.00				
	108-Fall Chinook		$ 16,691.79	$ 15,055.79	$ 1,636.00	$ 675.21
551111	Operating Supplies	$ 8,478.00				
	108-Fall Chinook		$ 4,997.51	$ 4,343.00	$ 654.51	$ 3,480.49
551295	Vehicle Rental	$ 8,043.00				
	108-Fall Chinook		$ 6,189.87	$ 5,518.61	$ 671.26	$ 1,853.13
561171	Telephone	$ 960.00				
	108-Fall Chinook		$ 673.87	$ 590.53	$ 83.34	$ 286.13
571111	Insurance	$ 867.00				
	108-Fall Chinook		$ 101.19	$ -	$ 101.19	$ 765.81
581110	Travel Holding	$ -				
	108-Fall Chinook		$ -	$ -	$ -	$ -
581121	Per Diem	$ 2,800.00				
	108-Fall Chinook		$ 2,612.38	$ 2,612.38	$ -	$ 187.62
621251	Indirect Cost	$ 18,605.00				
	108-Fall Chinook		$ 17,763.19	$ 16,463.87	$ 1,299.32	$ 841.81
	TOTAL:	**$ 114,011.00**	**$ 108,957.66**	**$ 101,479.78**	**$ 7,477.88**	**$ 5,053.34**

Yakama Nation-Fisheries Program

Project No. 1995-63-25
Project Name: Monitoring & Evaluation
Contract No. : 5881
Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458107 Coho

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance
512111	WAGES	$ 65,020.00				
	109-Coho		$ 69,415.40	$ 66,938.94	$ 2,476.46	$ (4,395.40)
519111	FRINGE	$ 10,628.00				
	109-Coho		$ 11,076.16	$ 10,718.14	$ 358.02	$ (448.16)
541122	Sensitive Equipment	$ 10,808.00				
			$ 10,870.94	$ -	$ 10,870.94	$ (62.94)
551111	Operating Supplies	$ 29,885.00				
	109-Coho		$ 27,303.27	$ 26,848.27	$ 455.00	$ 2,581.73
551295	Vehicle Rental	$ 14,112.00				
	109-Coho		$ 17,437.67	$ 15,093.45	$ 2,344.22	$ (3,325.67)
561171	Telephone	$ 1,120.00				
	109-Coho		$ 575.33	$ 575.33	$ -	$ 544.67
571111	Insurance	$ 750.00				
	109-Coho		$ 1,124.72	$ -	$ 1,124.72	$ (374.72)
581110	Travel Holding	$ -				
	109-Coho		$ -	$ -	$ -	$ -
581121	Per Diem	$ 2,962.00				
	109-Coho		$ 1,195.31	$ 1,195.31	$ -	$ 1,766.69
621251	Indirect Cost	$ 26,381.00				
	109-Coho		$ 27,104.77	$ 23,453.99	$ 3,650.78	$ (723.77)
522251	Sub-Contracts	$ -				
	109-Coho		$ -	$ -	$ -	$ -
651171	Capital Equipment	$ 19,100.00				
	109-Coho		$ 19,100.00	$ -	$ 19,100.00	$ -
	TOTAL:	**$ 180,766.00**	**$ 185,203.57**	**$ 144,823.43**	**$ 40,380.14**	**$ (4,437.57)**
8458101	Sub-Total	$ 582,412.00	$ 504,233.24	$ 464,271.64	$ 39,961.60	$ 78,178.76
8458102	Sub-Total	$ 1,001,432.00	$ 1,045,769.09	$ 937,551.84	$ 108,217.25	$ (44,337.09)
8458103	Sub-Total	$ 277,835.00	$ 202,500.19	$ 166,637.10	$ 35,863.09	$ 75,334.81
8458104	Sub-Total	$ 181,481.00	$ 178,952.22	$ 164,914.77	$ 14,037.45	$ 2,528.78
8458106	Sub-Total	$ 114,011.00	$ 108,957.66	$ 101,479.78	$ 7,477.88	$ 5,053.34
8458107	Sub-Total	$ 180,766.00	$ 185,203.57	$ 144,823.43	$ 40,380.14	$ (4,437.57)
845 ALL	**GRAND TOTAL**	**$ 2,337,937.00**	**$ 2,225,615.97**	**$ 1,979,678.56**	**$ 245,937.41**	**$ 112,321.03**
					$ 245,937.41	
					$ -	

I CERTIFY THIS IS TRUE AND ACCURATE

Chairman
Yakama Tribal Council

Yakama Nation-Fisheries Program

Project No. 1995-63-25
Project Name: Monitoring & Evaluation
Contract No. : 5881
Period Covered: 4/1/02-4/30/03
Prepared by: Ida Sohappy-Ike
Contact Person: Ida Sohappy-Ike @ 509-865-6262 x6630

8458107 Coho Cont'

Code	Description	Approved Budget	YTD Exp	Prior Claimed	Claimed this Invoice	Balance

Current Year Invoices Submitted

Period claimed	Amount Claimed	Cumulative Total Invoiced	Cash Rc'd	C/R #	
4/1/03 to 4/30/03	$ 245,937.41	$ 8,055,201.20			
3/1/03 to 3/31/03	$ 185,940.44	$ 7,809,263.79	$ 185,940.44	Voucher #	80295
2/1/03 to 2/28/03	$ 191,202.80	$ 7,623,323.35	$ 191,202.80	Voucher #	80295
1/1/03 to 1/31/03	$ 149,597.84	$ 7,432,120.55	$ 149,597.84	Voucher #	80295
10/1/02 to 12/31/02	$ 453,149.11	$ 7,282,522.71	$ 453,149.11	Voucher #	75005
9/1/02 to 9/30/02 resubmit	$ 24,788.21	$ 6,829,373.60	$ 24,788.21	Voucher #	74851
9/1/02 to 9/30/02	$ 356,434.38	$ 6,804,585.39	$ 356,434.38	Voucher #	71841
8/1/02 to 8/31/02	$ 136,062.72	$ 6,447,301.81	$ 136,062.72	Voucher #	70622
7/1/02 to 7/31/02	$ 122,155.10	$ 6,311,239.09	$ 122,155.10	Voucher #	70188
4/1/02 to 6/30/02	$ 360,543.78	$ 6,189,083.99	$ 360,543.78	Voucher #	70187
3/1/02 to 3/31/02	$ 235,247.88	$ 5,828,540.21	$ 235,247.88	Voucher #	69917
1/1/02 to 2/28/02	$ 228,983.60	$ 5,593,292.33	$ 228,983.60	Voucher #	65967
10/1/01 to 12/31/01	$ 557,923.58	$ 5,364,308.73	$ 557,923.58	Voucher #	65187
4/1/01 to 9/30/01 resubmit	$ 52,300.55	$ 4,806,385.15	$ 52,300.55	Voucher #	65185
4/1/01 to 9/30/01	$ 615,678.08	$ 4,754,084.60	$ 615,678.08	Voucher #	63676
10/1/00 to 3/31/01	$ 1,207,246.23	$ 4,138,406.52	$ 1,207,246.23	Voucher #	62000
4/1/00 to 9/30/00	$ 1,086,844.83	$ 2,931,160.29	$ 1,086,844.83	Voucher #	52021
3/1/00 to 3/31/00	$ 127,466.89	$ 1,844,315.46	$ 127,466.89	Voucher #	45981
2/1/00 to 2/29/00	$ 197,339.77	$ 1,716,848.57	$ 197,339.77	Voucher #	43952
1/1/00 to 1/31/00	$ 208,214.69	$ 1,519,508.80	$ 208,214.69	Voucher #	42585
10/1/99 to 12/31/99	$ 398,100.80	$ 1,311,294.11	$ 398,100.80	Voucher #	42465
9/1/99 to 9/30/99	$ 298,646.21	$ 913,193.31	$ 298,646.21	Voucher #	42463
7/1/99 to 8/31/99	$ 289,822.96	$ 614,547.10	$ 289,822.96	Voucher #	37870
3/1/99 to 6/31/99	$ 324,724.14	$ 324,724.14	$ 324,724.14	Voucher #	37876
Total	$ 8,054,352.00		$ 7,808,414.59		
	$ 245,937.41				

APPENDIX H

Equipment Inventory List

CAPITALIZED EQUIPMENT LIST FOR BPA | Contract Number: 5881 | PROJECT NUMBER: 1995-063-25 | S.T. 4/22/03

YKFP Monitoring & Evaluation

Location: 1. Headquarters 2. Chandler 3. Prosser 4. Roza 5. Nelson Springs 6. Hatchery 7. Klickitat 8. Cle Elum 9. WDFW 10. Missing/Stolen

Condition: 4. Good 5. Fair 6. Poor 7. Salvageable 8. Missing/Stolen

ORIGINAL SHEET BEFORE 5/6/03 UPDATES

No.	ITEM DESCRIPTION	VENDOR	MAKE/ MODEL	SERIAL NUMBER	YEAR	FUND NUMBER	PROPERTY NUMBER	DOC. NUMBER	ITEM COST	LOCATION CONDITION CODE	COMMENTS
1	OFFICE XP PRO	INCOMMAND	OEM		2002	8458101.100		128636	779.90	5/4	
2	HI BACK CHAIR	INSIDE OREGON ENTERP			2002	8458101.100		127827	350.00	5/4	
3	32X71 COPY BOARD	TRIBUNE OFFICE SUPPL	32X71 COPY BOARD		2002	8458101.100		122273	2,395.00	5/4	
4	SNORKEL, MASKS, BOOTS	QUALITY SCUBA			2002	8458101.100		116845	675.00	5/4	
5	TAGGING UNIT	NORTHWEST MARINE TEC	AUTO TAGGING UNIT		2002	8458101.105		117544	129,600.00	5/4	
6	SUPPLIES	NORTHWEST RIVER SUPP			2002	8458101.400		130412	2,252.00	5/4	
7	OAR WRAPPING PROTECTOR	LAVRO			2002	8458101.400		130413	510.00	5/4	
1	19" MONITORW/INTEL PROC	GATEWAY COMPANIES	MONITOR / PROCESSOR	19009B0004575	2002	8458104.114		130658	1,598.00	5/4	
2	JVC 14" MONITOR	THE GOOD GUYS	AV14F703		2002	8458104.114		121247	1,045.96	5/4	
3	DIGITAL CAMERA	CDW, GOV	MVC-CD400	S010419649J	2002	8458104.114		730415	786.00	5/4	
1	450LINTEL NOTEBOOK	GATEWAY COMPANIES			2002	8458106.108		123965	1,792.00	5/4	
2	FS2001FR/150 READER	BIOMARK	125KH2/134.2		2002	8458106.108		123858	10,810.00	5/4	
3	DIGITAL CAMERA	CDW GOV	MVC-CD400	S010419691G	2002	8458106.108		130415	786.00	5/4	
4	PRO TECH TOOL BOXES	PEPIN 4 WHEELIN			2002	8458106.108		129740	850.00	5/4	
5	FISHING SUPPLIES	NORTHWEST RIVER SUPP			2002	8458106.108		123857	2,453.79	5/4	
	PENTIUM III W/17"MON/SPKF	GATEWAY COMPANIES	INTEL GP7-700		2000	8458101.4		77135	1,949.00	5/4	
	PENTIUM 4 W/19"MON/SPKF	GATEWAY COMPANIES	ATXSTF MNT E4600	23232434	2001	8458101.1		92824	4,222.00	5/4	
	LAPTOP COMP SOLO 9500	GATEWAY COMPANIES	ATXSTF MNT E4600	23248801	2001	8458101.1		92824	3,209.00	5/4	
	8MM AME CART/INTERNAL I	GENERAL MICROSYSTEMS	SGXMED8MMAMEPK/X6174A		2001	8458101.1		89228	1,287.50	5/4	
	SUNSTOR UNIPKW/9MM TPE	GENERAL MICROSYSTEMS	SGXTAP8MM011A/X3856A		2001	8458101.1		89988	2,784.25	5/4	
	MULTNETWRK CBL TST/GNF	PACIFIC FIRST COMPUTERS			2000	8458101.1		87551	139.00	5/4	
	3-LAPTOP 5300	GATEWAY COMPANIES	3-LAPTOP SOLO 5300	227941-00,10,08	2002	8458102.1		91317	5,055.00	5/4	
	3-PALMVXW/HOTSYNECRAD	PACIFIC FIRST COMPUTERS	3-PALMVX	50GK12G1-3649,224	2001	8458102.1		91790	1,289.85	5/4	
	2-PALMVXW/HOTSYNECRAD	PACIFIC FIRST COMPUTERS	2-PALMVX	50GK12G1-1949,497	2001	8458102.1		91790	859.90	5/4	
	2-TYPEWRITTERS	RONS COMMERICAL OFFICE	2-LEXMARK 3500	11ZV088	2002	8458102.1		110070	2,278.00		
	FILE	NATIONAL BUSINESS FURN	LATERAL 36" W5DRWR		2002	8458102.1		110069	695.00	1/4	
	HANGING CUBES/S&H	NATIONAL BUSINESS FURN	YKFP BKKPRS		2002	8458102.1		110669	215.90	1/4	
	2-INTEL PENT 4 PROC/VIDEO	GATEWAY COMPANIES	ATXSTF PO47006	26,526,529	2002	8458104.1		109719	4,560.00		
	PRINTER HP INKJET 2250	PACIFIC FIRST COMPUTERS	C2691A	SG08V12085	2002	8458104.1		91236	724.00	5/4	
	SONY SPRESSA,SUPER DISK	PACIFIC FIRST COMPUTERS	CDRW,LS-120,3COM3C905CX		2001	8458104.1		91053	420.00	5/4	
	WESTERN DIGITAL HARD DF	PACIFIC FIRST COMPUTERS			2001	8458104.1		91053	230.00	5/4	
	VIDEO MONITORING EQUIP	VISION 1	PCWPIII DUAL PROC, S/H		2000	8458109.1		73588	14,465.00	5/4	
	STORAGE CABINET	HARRIS OFFICE EQUIPMENT	OID88129		2000	8458109.1		73427	1,050.00		
	AGILE MODULATOR/DEMODI	C & C COMMUNICATIONS	M369CADO,375CADO,S/H		1999	8458109.1		66507	3,763.00		
	2 WAND STYLE TAG DECTO	NORTHWEST MARINE TEC		1,078,810,790	2000	8458109.7		74731	13,000.00		
	PRINTER R80	GATEWAY COMPANIES	HP OFFICE JET R80	SGF99AH2P9	2000	8458109.7		74732	824.00		
	3-PNTMIII17"MON,SPKR,BAT	GATEWAY COMPANIES	LP MINI TWR TB3 GP7	18596571	2000	8458109.7		74732	5,535.00		
	CHINK OBSRVTN AQURM	MILLER GLASS CORP	1/2 CLR GLASS,STNLES FRAM		2000	8458109.7		74726	5,545.00		
	12' FLTBD UTL TRLR	INDEPENDENT TRAILER & EQUIP	2K-T8 UTILITY TRAILER		2000	8458109.7		73822	2,280.00		
	SECURITY SYSTEM	MANSFIELD ALARM CO	SECURITY FIRE SYSTEM		1999	8458109.7		56909	1,028.00		
	SECURITY SYSTEM	MANSFIELD ALARM CO	SECURITY ALARM SYSTEM		1999	8458109.7		27181	1,417.25		
	SECURITY SYSTEM	MANSFIELD ALARM CO	FIRE ALARM SYSTEM		1999	8458109.7		27181	465.00		
	MONTHLY MAINTENANCE	MANSFIELD ALARM CO	MAINTNCE & MONITORING		1999	8458109.7		27181	80.00		
	SECURITY SYSTEM	MANSFIELD ALARM CO	SECURITY ALARM SYSTEM		1999	8458109.7		27181	907.25		
	TRAILER	RENEGADE METALCRAFT	PIT TAGGING		2002	8458101.1		108950	10,000.00		
	WOOLRIDGE	DON'S DRY DOCK MARINA	19' JET BOAT		2000	8458106.1		77139	8,712.46		
	TAG DETECTOR	NORTHWEST MARINE TEC	HANDHELD		2001	8458101.1		66382	68,230.00		
		PACIFIC FIRST COMPUTERS			2000	8458101.4			250.00		
		PACIFIC FIRST COMPUTERS			2001	8458101.1		89229	459.00		
	COMP HAND HELDW/CASE	PACIFIC FIRST COMPUTERS	10GK11K16ECA		2002	8458101.1		90638	429.95		
		BIOMARK			2000	8458102.1		84316	11,225.00		
		COMMERCIAL OFFICE			2002	8458102.1		110070	505.50		
		PACIFIC FIRST COMPUTERS			2001	8458104.1		91140	45.00		
		COSTCO WHOLESALE			2000	8458104.1		76626	599.98		
		GATEWAY COMPANIES			2001	8458104.1			4,702.00		
		MECCO INC			2000	8458109.1			95.00		
		VISION 1			2000	8458109.1			895.00		
		AQUA CENTER			2000	8458109.2		72942	8,497.00		
		GATEWAY COMPANIES			1999	8458109.3			389.00		
		GATEWAY COMPANIES			1999	8458109.3			2,492.48		
		GATEWAY COMPANIES			2000	8458109.7			4,607.00		
		GATEWAY COMPANIES			2000	8458109.7		74732	1,557.00		
		PACIFIC FIRST COMPUTERS			2000	8458109.7			886.26		
		TRI COSTAL INDUSTRIES			2000	8458109.7			432.11		
		PACIFIC FIRST COMPUTERS			2000	8458109.7			483.00		
		VWR SCIENTIFIC			2000	8458109.7			1,281.92		
		PACIFIC FIRST COMPUTERS			1999	8458109.7			3,055.00		
		NORTHWEST MARINE TEC			2001	8458102.1		106775	41,715.00		
		GATEWAY COMPANIES			2000	8458109.7		75155	9,649.00		

CAPITALIZED EQUIPMENT LIST FOR BPA

YKFP Monitoring & Evaluation

Location: 1. Headquarters 2. Chandler 3. Prosser 4. Roza 5. Nelson Springs 6. Hatchery 7. Klickitat 8. Cle Elum 9. WDFW 10. Missing/Stolen

Condition: 4. Good 5. Fair 6. Poor 7. Salvageable 8. Missing/Stolen

Contract Number	PROJECT NUMBER
5881	1995-063-25

S.T. 4/22/03

THIS SHEET UPDATED AS OF 5/6/03 BY S.T.

No.	ITEM DESCRIPTION	VENDOR	MAKE/ MODEL	SERIAL NUMBER	YEAR	FUND NUMBER	PROPERTY NUMBER	DOC. NUMBER	ITEM COST	LOCATION CONDITION CODE	COMMENTS
1	AGILE MODULATOR/DEMODULATOR	C & C COMMUNICATIONS	M369CADO,375CADO,S/H		**1999**	8458109.1		66507	3,763.00		
2	LIBRARY SOFTWARE	VISION 1			**1999**	8458109.1		67161	895.00		
3	VIDEO MONITORING EQUIP	VISION 1	PCWPIII DUAL PROC, S/H		**1999**	8458109.1		73588	15,515.00		
4	POWER SUPPLY	MECCO INC.	PS120-12	PN 100 00026	**1999**	8458109.1		67167	95.00		
5	2/FISH CULTURE TANKS	AQUA CENTER			**1999**	8458109.2		72942	8,497.00	5/4	
6	LEFT RTN DESK W/ORGANIZER	INSIDE OREGON			**1999**	8458109.2		72941	1,665.00	1/4	
7	PENTIUM PROCESSOR	GATEWAY COMPANIES			**1999**	8458109.3		62545	2,881.48	5/4	
8	HP COLOR LASER JET 4500N	PACIFIC FIRST COMPUTERS			**1999**	8458109.7		56115	3,100.00		
9	2 WAND STYLE TAG DETECTOR	NORTHWEST MARINE TEC	10788 10790		**1999**	8458109.7		74731	13,000.00		
10	3/PENTIUM III COMPUTERS	GATEWAY COMPANIES	LP MINI TWR TB3 GP7	18596571	**1999**	8458109.7		74732	5,535.00		
11	HP JET PRINTER/DIGITALVIDEOCREAT	GATEWAY COMPANIES			**1999**	8458109.7		74732	1,557.00		
12	CHINOOK OBSERVATION AQUARIUM	MILLER GLASS CORP	1/2 CLR GLASS,STNLES FRAM		**1999**	8458109.7		74726	5,545.00		
13	CCI-GS SERIES 3.0KG	TRI COSTAL INDUSTRIES			**1999**	8458109.7		72952	432.11		
14	PENTIUM lll PROCESSOR NOTEBOOK	GATEWAY COMPANIES			**1999**	8458109.7		75155	10,473.00		
15	12' FLTBD UTL TRLR	INDEPENDENT TRAILER & EQUIP	2K-T8 UTILITY TRAILER		**1999**	8458109.7		73822	2,280.00		
16	PENTIUM PROCESSOR	GATEWAY COMPANIES			**1999**	8458109.7		74732	4,607.00		
								TOTAL	**79,840.59**		
1	DIGI ACCELLIPORT	PACIFIC FIRST COMPUTERS	PORT USB		2000	8458101.132		74418	306.00	5/4	
2	COMPU CABLE	PACIFIC FIRST COMPUTERS			2000	8458101.132		87551	139.00		
3	SUNSTOR UNIPKW/9MM TPE DRV/KIT	GENERAL MICROSYSTEMS	SGXTAP8MM011A/X3856A		2000	8458101.132		89988	2,784.25		
4	HAND HELD COMP/CASE	PACIFIC FIRST COMPUTERS	10GK11K16ECA		2000	8458101.132		90638	429.95		
5	8MM AME CART/INTERNAL HRD DRV	GENERAL MICROSYSTEMS	SGXMED8MMAMEPK/X6174A		2000	8458101.132		89228	1,287.50		
6	UNIX POWER TOOL	PACIFIC FIRST COMPUTERS			2000	8458101.132		89229	459.00		
7	PENTIUM PROCESSOR	GATEWAY COMPANIES			2000	8458101.132		92482	2,023.00	1/4	
8	PLOTTER PRINTER	CDW, GOVT. INC.			2000	8458101.132		92414	5,760.60	5/4	
9	OFFICE PANELS	OFFICE PLUS NORTHWEST			2000	8458101.132		92487	1,749.99	5/4	
10	PENTIUM PROCESSOR	GATEWAY COMPANIES	INTEL GP7-700		2000	8458101.132		80461	3,169.00	5/4	
11	PENTIUM PROCESSOR	GATEWAY COMPANIES	INTEL GP7-700		2000	8458101.401		77135	1,949.00	5/4	
12	CD ROM	PACIFIC FIRST COMPUTERS			2000	8458101.401		81995	250.00	5/4	
13	PALM V CRADLE&CASE	PACIFIC FIRST COMPUTERS	PALM X		2000	8458102.106		91790	2,149.75		
14	3-LAPTOP 5300	GATEWAY COMPANIES	3-LAPTOP SOLO 5300	227941-00,10,08	2000	8458102.106		91317	5,055.00		
15	PALM V CRADLE&CASE	PACIFIC FIRST COMPUTERS	PALM X		2000	8458102.106		92743	1,719.80		
16	DATA COLLECTION STATION	BIOMARK	12X12 DIGITIZER, 6000 GRAM SCALE		2000	8458102.115		84316	11,225.00		
17	2 COMPUTER MONITORS	COSTCO WHOLESALE			2000	8458104.114		76626	599.98	1/4	
18	PRINTER HP INKJET 2250	PACIFIC FIRST COMPUTERS	C2691A	SG08V12085	2000	8458104.114		91236	724.00	1/4	
19	KEYBOARD	PACIFIC FIRST COMPUTERS	ELITE		2000	8458104.114		91140	45.00	1/4	
20	SONY SPRESSA,SUPER DISK	PACIFIC FIRST COMPUTERS	CDRW,LS-120,3COM3C905CX		2000	8458104.115		91053	420.00	1/4	
21	HARD DRIVE	PACIFIC FIRST COMPUTERS	60 G, 7200 RPM		2000	8458104.115		91053	230.00	1/4	
22	OFFICE FURNITURE	HARRIS OFFICE EQUIPMENT			2000	8458104.115		91789	1,730.00	1/4	
23	CODED WIRE DETECTOR	NORTHWEST MARINE TECHNOLOGY			2000	8458105.127		92960	6,815.00	1/4	
24	BOAT MOTOR	DON'S DRY DOCK MARINA	MERCURY JET BOAT MOTOR		2000	8458106.108		77139	6,712.46	1/4	
								TOTAL	**57,733.28**		
1	PENTIUM 4 W/19"MON/SPKR	GATEWAY COMPANIES	ATXSTF MNT E4600	23232434	2001	8458101.100		92824	4,222.00	5/4	
2	LAPTOP COMP SOLO 9500	GATEWAY COMPANIES	ATXSTF MNT E4600	23248801	2001	8458101.100		92824	3,209.00	5/4	
3	TAG DETECTOR	NORTHWEST MARINE TEC	HANDHELD		2001	8458101.105		66382	68,040.00	4/4	
4	AUTO TAGGING WAND	NORTHWEST MARINE TEC			2001	8458102.105		106775	41,715.00	4/4	
5	2-TYPEWRITTERS	COMMERCIAL OFFICE OUTFITTERS	2-LEXMARK 3500	11ZV088	2001	8458102.116		110070	2,278.00	4/4	2@1139.00 EA.
6	FILE CABINET	NATIONAL BUSINESS FURN	LATERAL 36" W5DRWR		2001	8458102.116		110069	695.00	1/4	
7	2-INTEL PENT 4 PROC/VIDEO EQUIP	GATEWAY COMPANIES	ATXSTF PO47006		2001	8458104.114		109719	4,560.00	1/4	2@2280.00 EA
8	INTEL PENT PROC/MONT	GATEWAY COMPANIES			2001	8458104.115		92825	4,702.00	5/1	
								2001 TOTAL	**129,421.00**		
1	OFFICE XP PRO	INCOMMAND	OEM		2002	8458101.100		128636	779.90	5/4	
2	HI BACK CHAIR	INSIDE OREGON ENTERP			2002	8458101.100		127827	350.00	5/4	
3	32X71 COPY BOARD	TRIBUNE OFFICE SUPPL	32X71 COPY BOARD		2002	8458101.100		122273	2,395.00	5/4	
4	SNORKEL, MASKS, BOOTS	QUALITY SCUBA			2002	8458101.100		116845	675.00	5/4	
5	TAGGING UNIT	NORTHWEST MARINE TEC	AUTO TAGGING UNIT		2002	8458101.105		117544	129,600.00	5/4	
6	19" MONITORW/INTEL PROC	GATEWAY COMPANIES	MONITOR / PROCESSOR	19009B0004575	2002	8458104.114		130658	1,598.00		
7	JVC 14" MONITOR	THE GOOD GUYS	AV14F703		2002	8458104.114		121247	1,045.96	5/4	
8	DIGITAL CAMERA	CDW, GOVT. INC.	MVC-CD400	S010419649J	2002	8458104.114		730415	786.00	5/4	
9	SUPPLIES	NORTHWEST RIVER SUPP			2002	8458101.400		130412	2,252.00	5/4	
10	OAR WRAPPING PROTECTOR	LAVRO			2002	8458101.400		130413	510.00	5/4	
11	450L INTEL NOTEBOOK	GATEWAY COMPANIES			2002	8458106.108		123965	1,792.00	5/4	
12	4- DUAL FREQ READER	BIOMARK	125KH2/134.2		2002	8458106.108		123858	10,810.00	5/4	
13	DIGITAL CAMERA	CDW, GOVT. INC.	MVC-CD400	S010419691G	2002	8458106.108		130415	786.00	5/4	
14	PRO TECH TOOL BOXES	PEPIN 4 WHEELIN			2002	8458106.108		129740	850.00	5/4	
15	FISHING SUPPLIES	NORTHWEST RIVER SUPP			2002	8458106.108		123857	2,453.79	5/4	
								2002 TOTAL	**156,683.65**		

CAPITALIZED EQUIPMENT LIST FOR BPA

YKFP Monitoring & Evaluation

Location: 1. Headquarters 2. Chandler 3. Prosser 4. Roza 5. Nelson Springs 6. Hatchery 7. Klickitat 8. Cle Elum 9. WDFW 10. Missing/Stolen

Condition: 4. Good 5. Fair 6. Poor 7. Salvageable 8. Missing/Stolen

Contract Number	PROJECT NUMBER	
5881	1995-063-25	4/22/03 S.T. 4/22/03
UPDATED 8/26/03	S.T.	

No.	ITEM DESCRIPTION	VENDOR	MAKE/ MODEL	SERIAL NUMBER	YEAR	FUND NUMBER	PROPERTY NUMBER	DOC. NUMBER	ITEM COST	LOCATION CONDITION CODE	COMMENTS
1	OFFICE XP PRO	INCOMMAND	OEM		2002	8458101.100		128636	779.90	5/4	
2	HI BACK CHAIR	INSIDE OREGON ENTERP			2002	8458101.100		127827	350.00	5/4	
3	32X71 COPY BOARD	TRIBUNE OFFICE SUPPL	32X71 COPY BOARD		2002	8458101.100		122273	2,395.00	5/4	
4	SNORKEL, MASKS, BOOTS	QUALITY SCUBA			2002	8458101.100		116845	675.00	5/4	
5	10X42 BINOCULARS	CABELA'S PROMOTION			2002	8458101.100		113385	994.99	1/4	
6	RAFTING SUPPLIES:SEAT/PUMPETC	NORTHWEST RIVER SUPP	#1220,1222,1709,1703,		2002	8458101.400		130412	816.00		
7	11' OTTER SELF BAILING RAFT	NORTHWEST RIVER SUPP	#1126		2002	8458101.400		130412	1,436.00	5/4	
8	OAR WRAPPING PROTECTOR	LAVRO			2002	8458101.400		130413	510.00	5/4	
9	(2) 10X42 BINOCULARS	CABELA'S PROMOTION			2002	8458101.400		130411	1,989.98	5/4	
10	NEOSTRECTH WADERS 3MM	CABELA'S PROMOTION			2002	8458101.400		130411	82.75	5/4	
11	TAGGING UNIT	NORTHWEST MARINE TEC	AUTO TAGGING UNIT		2002	8458101.105		117544	129,600.00	5/4	
12	KEPCO POWER TRANSDUCER	HALCO INC			2002	8458102.105		121034	908.64		
13	19" MONITORW/INTEL PROC	GATEWAY COMPANIES	MONITOR / PROCESSOR	19009B0004575	2002	8458104.114		130658	1,598.00	1/4	
14	JVC 14" MONITOR	THE GOOD GUYS	AV14F703		2002	8458104.114		121247	1,045.96	1/4	
15	DIGITAL CAMERA	CDW, GOVT. INC.	MVC-CD400	S010419649J	2002	8458104.114		730415	786.00	1/4	
16	450L INTEL NOTEBOOK	GATEWAY COMPANIES			2002	8458106.108		123965	1,792.00	1/4	
17	4- DUAL FREQ READER	BIOMARK	125KH2/134.2		2002	8458106.108		123858	10,810.00	1/4	
18	DIGITAL CAMERA	CDW, GOVT. INC.	MVC-CD400	S010419691G	2002	8458106.108		130415	786.00	1/4	
19	PRO TECH TOOL BOXES	PEPIN 4 WHEELIN			2002	8458106.108		129740	850.00	1/4	
20	FISHING SUPPLIES	NORTHWEST RIVER SUPP			2002	8458106.108		123857	2,453.79	1/4	
21	NEOPN WADERS, PARKAS,RAINGR	CABELA'S PROMOTION			2002	8458106.108		123095	869.55		
22	(2) SRX 400 RECVR/DATA LOGGER	LOTEX WIRELESS	W-5		2002	8458107.109		130414	9,990.00		
23	(2)4MHzRECVR	LOTEX WIRELESS	W31C,148-152		2002	8458107.109		130414	19,100.00		
24	(4) ELEMENT ANTENNA'S	LOTEX WIRELESS			2002	8458107.109		130414	880.94		
25	GPS UNIT	FORESTRY SUPPLIERS			2002	8458107.109		113384	370.06		
26	3V MICRO CODED FISH TRNSMITRS	LOTEX WIRELESS			2002	8458107.109		117307	23,068.89		
								TOTAL	**214,939.45**		