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

Mid-Columbia Coho Reintroduction Feasibility Study

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MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY:

2005 ANNUAL REPORT
February 1, 2005 through January 31, 2006

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1.0 INTRODUCTION

Wild stocks of coho salmon *Oncorhynchus kisutch* were once widely distributed within the Columbia River Basin (Fulton 1970; Chapman 1986). Since the early 1900s, the native stock of coho has been extirpated from the tributaries of the middle reach of the Columbia River (the Wenatchee, Entiat, and Methow rivers) (Mullan 1983). Efforts to restore coho within the mid and upper Columbia Basin rely upon releases of hatchery coho. The feasibility of reestablishing coho in the tributaries of the mid-Columbia River may initially depend upon the resolution of two central issues: the adaptability of domesticated lower Columbia coho stocks used in the re-introduction efforts and their associated survival rates; and the ecological risk to other species of concern.

The mid-Columbia coho reintroduction feasibility began with early-run stocks of hatchery coho smolts from state and federal facilities. Most of these facilities have a lengthy history of culture activities, which may have the potential to subject these stocks to genetic changes due to selective effects. This term is called domestication selection (Busack et al. 1997). The genetic composition of the endemic and extirpated coho of the mid-Columbia tributaries is unknown; however, it is likely that genotypic differences existed between the lower Columbia River hatchery coho salmon and original endemic mid-Columbia River stocks. It is possible that phenotypic differences between endemic mid-Columbia coho salmon populations and lower Columbia coho populations may have included maturation timing, run timing, stamina, or size of returning adults. Thus the reproductive potential of returning hatchery coho is a critical uncertainty which may ultimately determine if this project successfully re-establishes natural populations of coho.

If coho re-introduction efforts in the mid-Columbia tributaries are to succeed, parent stocks must possess sufficient genetic variability to allow phenotypic plasticity to respond to differing selective pressures between the environments of the lower Columbia River and mid-Columbia tributaries. The mid-Columbia Coho Hatchery and Genetic Management Plan (HGMP 2002) outlines strategies to track the local adaptation process.

We are optimistic that the project will observe positive trends in hatchery coho survival as the program transitions from the exclusive use of lower Columbia River hatchery coho to the exclusive use of in-basin locally adapted broodstock. Therefore, it is important to measure hatchery fish performance not only to use as an indicator of project performance but to track potential short- and long-term program benefits from the outlined strategies.

Additionally, if the re-introduction effort is to be successful in the long term, when habitat and hydro impacts might be reduced, adult returns must be sufficient to meet replacement levels.

This report documents coho restoration activities and results in 2005, including coho pre-smolt acclimation, broodstock collection, spawning, egg incubation, spawning ground surveys, and survival. In addition, the Yakama Nation operated a 5-foot rotary smolt trap to estimate the number of naturally produced coho emigrating from Nason Creek in 2005. This trap is operated with funding from two BPA projects (#2003-017-00, and #1996-040-00); therefore detailed smolt trapping results are not included in the body of this report, but in a separate document (Prevatte 2006) and provided in Appendix A.

2.0 SMOLT ACCLIMATION: WENATCHEE AND METHOW

2.1 ACCLIMATION SITES

In 2005, within the Wenatchee River Basin, coho pre-smolts were acclimated on Icicle Creek at the Leavenworth National Fish Hatchery (LNFH), Beaver Creek on the upper Wenatchee River, and on Nason Creek at Coulter Pond, Rolfing's Pond, and Butcher Creek Pond. In the Methow River Basin, coho presmolts were acclimated at the Winthrop National Fish Hatchery, both on-station, and in the 'back-channel'. A description of the acclimation sites follows.

2.1.1 Leavenworth National Fish Hatchery

The Leavenworth NFH is located at river kilometer (RK) 4.5 on Icicle Creek. Coho smolts were acclimated in refurbished raceways, also known as small and large Foster-Lucas (SFL & LFL) ponds. Originally, the Foster-Lucas ponds were designated for rearing steelhead, sockeye, and spring chinook, but are no longer used. The oval shape of these ponds was intended to create a low-maintenance raceway that could produce quality salmonids. The ponds were discontinued due to concerns with low flows and difficult maintenance in favor of the more widely used 40-foot by 100-foot raceways. The original Foster-Lucas ponds were refurbished by Yakama Nation Fisheries and supplied with second-use water for short-term acclimation of coho juveniles. The water supply line for the ponds originates where the effluent from the hatchery's spring chinook raceways is discharged. Second-use water is pumped from a sump area below the chinook rearing facility directly into the ponds. Oxygen is added to the water supply. Water to each individual pond is manually adjusted to achieve flow requirements for the densities on hand. Shade covers provide protection from predators and reduce stress for the acclimated coho juveniles.

2.1.2 Beaver Creek

The Beaver Creek acclimation site is located at RK 2.4 on Beaver Creek. Beaver Creek enters the Wenatchee River near Plain, Washington at RK 74.4. The Beaver Creek acclimation pond was constructed in the mid 1980s and is located behind Mountain Springs Lodge. Originally, the pond was stocked with Kamloops rainbow trout for aesthetic purposes. Predation on these year-round residents became too problematic and the stocking was discontinued in the early 1990's. Since then, the pond was not stocked with fish until coho juveniles were introduced in 2002. Prior to use as an acclimation pond, containment structures were installed at the pond inlet and outlet. Returning adults will be given the opportunity to naturally spawn in Beaver Creek and Wenatchee River.

2.1.3 Nason Creek

In 2005, coho pre-smolts were acclimated at three sites on Nason Creek: Butcher Creek, Coulter Creek, and Rolfing's Pond. The long-term goal of establishing a self-sustaining population in the upper Wenatchee River basin may depend on the success of these releases. All of these sites are non-conventional, ranging from natural to constructed earthen sites. These sites might have advantages compared to conventional hatchery raceways because of their low-rearing densities, readily available natural food sources, and ability to mimic natural environmental conditions.

Butcher Creek

The Butcher Creek acclimation site is located at RK 13.2 on Nason Creek. This site is a natural beaver pond at the mouth of Butcher Creek. Coho smolts were volitionally released directly into Nason Creek from the pond. Prior to transportation, a net was placed at the outlet to contain coho during acclimation. Immature fruit trees were clustered together and sunk into the pond to provide increased habitat complexity.

Coulter Pond

The Coulter Pond acclimation site is located at RK 1.6 on Coulter Creek. Coulter Creek enters Nason Creek at RK 13.7. This natural site is composed of multiple braided channels that coalesce into a large, widened waterway. A large net encircled the majority of the channel to ensure containment during acclimation. Before entering Nason Creek, Coulter and Roaring creeks connect to form a series of massive beaver ponds. These channels were monitored to ensure fish could pass through the beaver dams into Nason Creek.

Rolfing's Pond

Rolfing's Pond acclimation site is located on an unnamed seasonal creek which connects to the lower end of Mahar Creek before draining into Nason Creek at RK 20.3. The earthen pond was constructed and developed by the property owner. The migration corridor from the acclimation site to Nason Creek is approximately 200 meters long. The inflow is supplied by an intermittent stream. Prior to receiving pre-smolts, a barrier net was placed at the outlet.

2.1.4 Winthrop National Fish Hatchery (WNFH)

Coho smolts released into the Methow River in 2005 were acclimated and released at the Winthrop National Fish Hatchery, located at RK 80.6 on the Methow River. Both on-station raceways and spring creek (the hatchery outfall) were used for acclimating coho pre-smolts. Prior to releasing fish into Spring Creek, a barrier net was placed at the outlet.

2.2 TRANSPORTATION AND VOLITIONAL RELEASE

2.2.1 Wenatchee River Basin

Coho pre-smolts were transported to the Wenatchee Basin from Willard NFH and Cascade FH between January 18 and March 25, 2005. The brood year (BY) 2003 coho were 2nd generation mid-Columbia River (MCR) progeny. Juveniles were acclimated between 5 and 14 weeks at five acclimations sites within the Wenatchee River Basin (Table 1). The 14-week acclimation occurred at Leavenworth NFH (LNFH) and was comprised of four experimental test ponds transported January 18-25, 2005. This 'over winter' acclimation group will allow for survival comparisons between coho acclimated for 14 weeks versus coho acclimated for 5 weeks. We expect results fro this comparison in 2006.

All coho smolts acclimated at Leavenworth NFH in the small Foster-Lucas (SFL) and large Foster-Lucas (LFL) ponds at LNFH were force-released on April 14th. The Nason and Beaver Creek releases occurred between April 6th and 27th, 2005 and were 100% volitional. Most volitional releases were complete by mid June. All coho released in 2005 were 100% coded-wire tagged (CWT'ed; Table 1) with an additional 30,000 smolts containing passive integrated transponder tags (PIT-tags). The PIT tag groups provided a measure of release to McNary Dam survival (Section 5.0). A total of 947,401 hatchery-produced coho juveniles emigrated from the Wenatchee River Basin in 2005. Release numbers, size at release, and release locations can be found in Table 1. For detailed mark information see Appendix B.

Table 1. Mid-Columbia coho smolt release summary, 2005.

Location	Release Date	Release Number	Size @ release (FPP)
Beaver Pond	April 25	23,500	14.0
Butcher Creek Pond	April 27	61,593	15.2
Coulter Pond	April 6	29,275	14.9
Rolfing's Pond	April 25	63,869	15.8
Leavenworth NFH LFL's (large Foster-Lucas Ponds	April 14	278,916	
Leavenworth NFH SFL's (small Foster-Lucas Ponds)	April 14	490,248	15.8
Wenatchee Total		**947,401**	
Winthrop NFH (on-station)	April 19-29	173,216	16.3
Winthrop NFH (Spring Creek)	April 19-29	110,479	16.4
Methow Total		**283,695**	
Wenatchee/Methow Totals		**1,231,096**	

2.2.2 Methow River Basin

In the Methow Basin, a combination of lower-Columbia River origin (LCR) and MCR progeny coho were held for acclimation at Winthrop National Fish Hatchery (WNFH). The MCR brood represented progeny from both Methow and Wenatchee adult returns. LCR pre-smolts were transported from Willard NFH to Winthrop NFH on March 21st, 2005. A total of 110,479 coho were acclimated in the hatchery back-channel while the remaining 174,817 were held on-station. Volitional releases at WNFH began April 19th and concluded with a forced release on April 29th (Table 1). All coho released were CWT'ed with no other marks apparent. A total of 283,695 coho smolts were released in the Methow River in 2005. Release numbers, size and release, and release locations can be found in Table 1; for detailed mark information see Appendix B.

2.3 Fish Condition Assessment

At all Wenatchee Basin acclimation sites, juvenile coho were sampled weekly to determine growth rates and degree of smoltification (*n*=100), and just prior to release, fish condition was assessed (*n=20*) to estimate overall health by evaluating the normality of external features (eyes, fins, opercules, etc.), as well as internal organs and blood components. The purpose of the assessment was to note gross abnormalities, not to diagnose the cause of certain conditions. Results from the assessments indicated that, prior to release, individuals were in good condition, with only minor fin-fraying observed (Table 2).

Table 2. Pre-release fish condition assessment, 2005.

Acclimation Location	Eyes[1]	Gill[1]	Psuedo-branchs[1]	Thymus[1]	Mes. Fat[2]	Spleen[1]	Hind Gut[1]	Kidney	Liver[1]	Gender M/F	Fin Cond.	Opercl[1]
Leavenworth NFH- LFL's Short-term rearing	82.5	97.5	100	100	2.2	100	100	100	100	55/45	100	100
Leavenworth NFH-SFL's Short-term rearing	85	70	100	100	1.7	100	100	100	100	32/68	90	100
Leavenworth NFH- SFL's Over-winter groups	95	95	100	100	1.8	100	100	100	100	55/45	100	100
Mahar Pond	90	70	100	100	2.0	100	100	100	100	65/35	100	100
Butcher Ck	100	60	100	100	2.0	100	100	100	100	50/50	100	100

1- *All components were based on a normality index (% norm). Variance in organ color and size was not looked at.*
2- *Mesenteric fat was based on a 0-3 numerical system average. A value of 2 equals more than 50% of the ceaca covered with fat, which is healthy.*

3.0 BROODSTOCK COLLECTION AND SPAWNING

3.1 WENATCHEE RIVER

3.1.1 Broodstock Collection

Broodstock collection occurred primarily at Dryden Dam between September 7th and November 29th, 2005. A combination of both lower Columbia River (LCR) brood coho and mid-Columbia brood coho (MCR) returned in 2005 (brood year 2002). The Dryden Dam fish traps were passively operated five days per week, 24-hours per day. On Saturdays and Sundays, the collection/holding chamber was closed while the fish bypass was opened, allowing unimpeded upstream passage. Coho trapping at Dryden Dam occurred concurrently with the Washington Department of Fish and Wildlife's (WDFW) steelhead broodstock collection until November 11th when YN personnel became the sole operator the facility. After November 11th, we retained coho broodstock while releasing all steelhead and other incidental species upstream of the trapping facilities. We supplemented the broodstock collected at Dryden Dam through additional trapping efforts at Tumwater Dam, Dam 5 adult weirs located on the Icicle Creek side channel, and the LNFH adult ponds. We collected broodstock at Tumwater Dam no more than three days per week, up to 8 hours per day, between September 7th and November 1st, 2005. Coho were allowed to volunteer into the LNFH adult ponds for a two-week period between September 30th and October 16th. Dam 5 was not a major contributer to broodstock collection in 2005; The Dam 5 traps were only operated October 6-7, 12, 20, and 26. A summary of broodstock collection and fish handled at all trapping sites can be found in Table 3. All coho broodstock were transported to Entiat National Fish Hatchery (ENFH) for holding and spawning.

Table 3. Coho salmon and incidentals handled during trapping, 2005.

Location	Coho (*broodstock*)	Steelhead	Sockeye	Chinook	Bull Trout
Dryden Dam	1,359* (*1,336*)	50**	48**	112**	0
Tumwater Dam	71* (*68*)	47**	43**	36**	0
Icicle Cr. adult weir	2* (*0*)	0	0	0	0
LNFH adult pond	5* (*2*)	0	0	20	0

*Actual number of coho handled during trapping at Dryden Dam, Icicle Cr. weir, Tumwater Dam, and LNFH during broodstock collection efforts for 2005.
**Steelhead, chinook, and sockeye collection was from Nov. 11th to Nov. 29th, 2005 when Washington Department of Fish and Wildlife had discontinued trapping for broodstock and YN Fisheries became the primary operator.

3.1.2 Spawning

Of the 1406 coho collected, 47.2% were females (N=663) and 52.8% were males (n=743). While in the holding pond the pre-spawn mortality rate was 4.8%, a decrease of 3.4%, the previous year; representing the lowest observed pre-spawn mortality rate since the programs inception. Reduced stress during transportation due to the use of MS-222 and NaCl combined with segregated adult holding (use of two holding ponds to separate the males from the females, may have contributed to the reduced pre-spawn mortality).

A total of 1334 coho adults (649 females and 685 males) were spawned between October 13th and November 22nd, 2005. Peak spawn occurred on October 27th with 186 ripe females (Figure 1). Spawn timing for the 2005 brood was similar, although perhaps slightly earlier when compared to previous years (Figure 2).

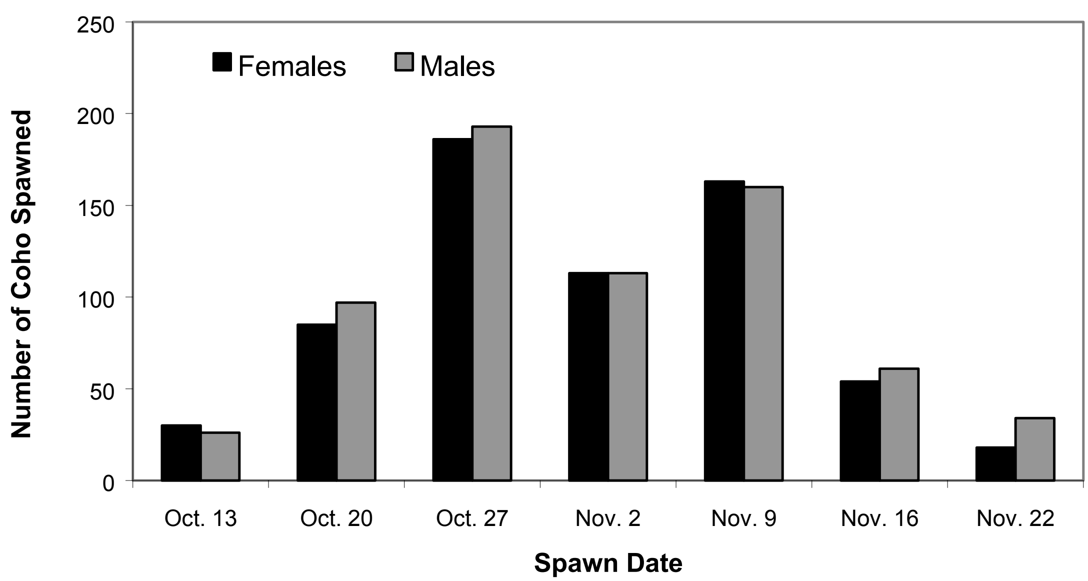

Figure 1. Number of coho spawned at Entiat National Fish Hatchery, 2005.

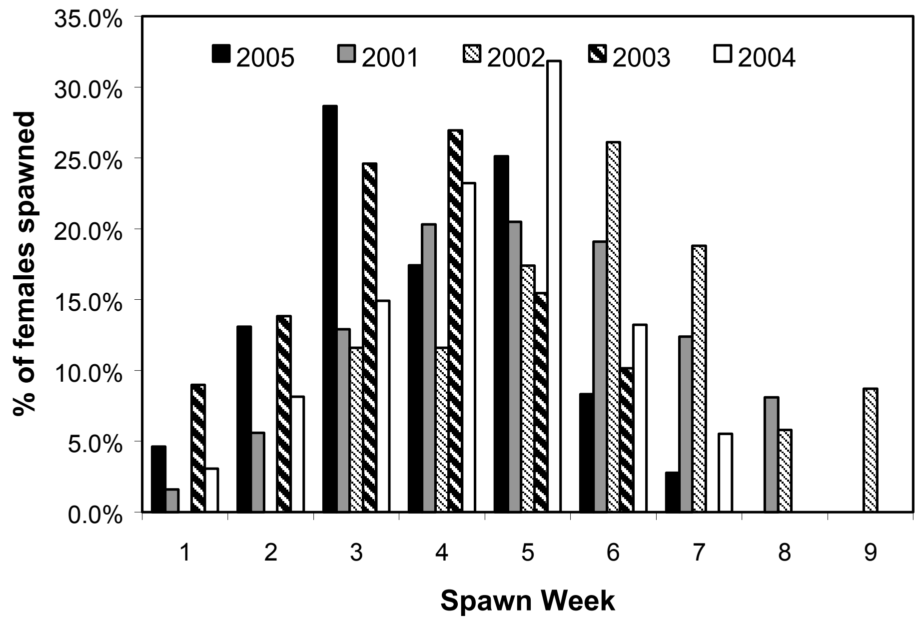

Figure 2. Temporal spawning distribution, brood years 2001 through 2005.

3.1.3 Incubation

A total of 1,821,726 green eggs were collected from the 2005 coho broodstock. Of these 1,032,336 green eggs were incubated at ENFH, while 789,390 green eggs were transported to YN's Peshastin Incubation Facility (PIF). At both facilities, the coho eggs were incubated in deep troughs supplied with 4-6 gal/minute chilled well water.

At both facilities (ENFH and PIF), eggs from each female were mated with one primary and one back-up male. During fertilization, a 1% saline solution was used to increase sperm motility. After fertilization, all excess liquid was strained from the eggs. The eggs were then soaked in 75 ppm iodine treatment for 30 minutes prior to being rinsed and placed in the incubator.

Eyed-egg totals for Entiat NFH and the PIF were 875,705 and 660,851, respectively. Average eye-up rate for the 2005 brood was 84.3%. Eyed-eggs were transported to Cascade FH and Willard NFH for hatching and rearing. A summary of spawn dates, number of green eggs collected, eye-up rate at ENFH and PIF, and transport to the rearing facility can be found in Table 4. Transportation from the incubation facility to the rearing facility occurred between 550 and 600 temperature units (F).

Table 4. Spawn dates, number of eggs collected, and eye-up rate at ENFH and Peshastin Incubation Facility, 2005.

Incubation Location	Spawn Date	Trans. Date	Number of Females	Number eyed eggs	Number dead eggs	Total green eggs	Eggs per Female	Eyed eggs per female	% Eye-up	Receiving / rearing hatchery
ENFH	13-Oct	02-Dec	25	52,406	14,664	67,070	2,682.8	2,096.2	78.1	Willard NFH
Peshastin	20-Oct	02-Dec	86	203,035	42,505	245,540	2,855.1	2,360.9	82.7	Willard NFH
ENFH	27-Oct	08-Dec	187	427,422	95,991	523,413	2,799.0	2,285.7	81.7	Willard NFH
ENFH	02-Nov	15-Dec	111	283,768	37,458	321,226	2,893.9	2,556.5	88.3	Cascade FH
ENFH	09-Nov	30-Dec	40	112,109	8,518	120,627	3,015.7	2,802.7	92.9	Cascade FH
Peshastin	09-Nov	30-Dec	121	296,706	62,804	359,510	2,983.5	2,462.3	82.5	Cascade FH
Peshastin	16-Nov	23-Dec	53	120,852	19,753	140,605	2,652.9	2,280.2	86.0	Cascade FH
Peshastin	22-Nov	04-Jan	13	40,258	3,476	43,735	3,364.2	3,096.8	92.1	Willard NFH
Totals			**636**	**1,536,556**	**285,170**	**1,821,726**	**2,866.6**	**2,417.9**	**84.3**	

3.2 METHOW RIVER BASIN

3.2.1 Broodstock Collection

Coho returning to the Methow River in 2005 were collected as swim-ins at the Winthrop NFH (Methow River RK 80.6), and the Wells Dam west and east fish ladder traps. At Winthrop NFH the hatchery ladder was opened on September 21st and remained open until November 14th. A total of 130 coho entered the hatchery volitionally (Table 5). At Wells Dam, between September 12th and October 10th, coho were trapped three days per week, concurrently with WDFW's steelhead broodstock collection. Between October 11th and November 14th, we operated the Wells Dam west and east fish ladder traps 7 days per week. A total of 224 coho (112F, 113M) were trapped at Wells Dam and transported to Winthrop NFH. Forty male coho were passed upstream at Wells Dam. Both ladder traps were actively operated and non-target species were diverted back into the adult ladders without handling. A summary of the numbers of coho and non-target species trapped can be found in Table 5. All non-target species were diverted back to the fish ladder. No bull trout were observed during trapping at Wells Dam or WNFH.

Table 5. Methow Basin coho salmon trapped and incidentals diverted back to the river, 2005.

Location	Coho (*broodstock*)	Steelhead	Chinook	Bull Trout
WNFH	130	0	0	0
Wells Dam East Ladder Trap	52*(44)	29	30	0
Wells Dam West Ladder Trap	212*(180)	156	218	0

* Passed coho were males that were recorded and passed upstream

3.2.2 Spawning

Of the 354 coho collected, 46.0% were females (n=163) and 54.0% were males (n=191). Coho broodstock collected at Wells Dam and WNFH were spawned at WNFH. A total of 282 coho adults (140 females and 142 males) were spawned between October 17th and November 14th. The pre-spawn mortality rate was 4.8%; Pre-spawn mortalities totaled 17 fish (11 females and 6 males) while 15 females and 40 males, in excess of incubation space at WNFH, were released back into the Methow River. Pre-spawn mortality decreased 14.9% compared to 2004 and represents the lowest mortality for the Methow program to date. Reduction in mortality could be attributed to limiting stress during transportation (MS-222 and salt) or overall improved fish condition as a result of increased broodstock collection at Wells Dam.

3.2.3 Incubation

A total of 364,880 green eggs were collected from the 2005 coho broodstock were incubated at WNFH. The mean eye-up rate was 84.6%, an increase of 22.1% over the previous years' brood. In 2005 a saline solution was used during fertilization which may account for the improved eye-up rate. A summary of spawn dates, number of eggs collected, fecundity and the eye-up rate at WNFH can be found in Table 6.

Table 6. Spawn dates, number of eggs collected, and eye-up rate at Winthrop NFH, 2005.

Spawn Date	Number of Females	Number eyed eggs	Number dead eggs	Total green eggs	Eggs per Female	Eyed eggs per female	% Eye-up
17-Oct	1	2,698	127	2825	2,825	2,698	95.5
24-Oct	28	55,643	25,319	80,962	2,892	1,987	68.7
31-Oct	35	79,694	11,489	91,183	2,605	2,277	87.4
07-Nov	41	89,006	10,665	99,671	2,431	2,171	89.3
14-Nov	35	81,656	8,583	90,239	2,578	2,333	90.5
	140	**308,697**	**56,183**	**364,880**	**2,866.6**	**2205**	**84.6**

4.0 SPAWNING GROUND SURVEYS

As in previous years, Wenatchee Basin spawning ground survey efforts focused on Nason Creek, Icicle Creek, and the Wenatchee River. Surveys also included other tributaries where coho were not released such as the Chiwawa River, Mission, and Peshastin creeks. Methow River survey efforts concentrated on the mainstem Methow River and lower portions of select tributaries in which we have previously identified coho spawning activity.

In the Wenatchee Basin, we surveyed Nason and Icicle creeks weekly. Frequent surveys allowed us to measure spawn timing as well as the number of redds. In high spawner density areas, such as Icicle Creek, weekly surveys were required to obtain clear and distinct redd identification. The mainstem Wenatchee River and tributaries (Beaver, Brender, Chiwaukum, Peshastin, and Mission creeks) were surveyed as often as possible, but at a minimum twice following peak spawn. Infrequent surveys after peak spawn allowed us to evaluate the distribution and number of naturally spawning coho in each basin, but did not allow a measure of spawn timing.

The mainstem Methow River was surveyed as often as possible, with the entire river being surveyed at least once during the spawning season. Other tributaries were surveyed as time allowed. Survey reaches for both basins are identified in Table 7. Complete survey records can be found in Appendix C.

We conducted the spawning ground surveys by either foot or raft, depending upon the size of the river/creek and the terrain. Surveys were completed by one- or two-person teams. Individual redds were marked and cataloged to get precise redd counts and timing. Coho redds were flagged with surveyor's tape tied to riparian vegetation. Each flag was marked with the date, approximate redd location, and redd number. The number of new redds, live and dead fish, time required to complete the survey, and the stream temperature were recorded. Surveyors checked all flags from previous surveys as they searched for new redds. Global positioning (GPS) was used to record the exact location of individual redds on all surveys.

During the surveys, coho carcasses were recovered. From the carcasses, we measured fork length (FL) and post-orbital hypural length (POH) to the nearest centimeter. Snouts were collected from all carcasses. The snouts were scanned for the presence of coded wire tags (CWT) in the laboratory; all snouts containing CWTs were dissected, recovered, and read. Carcass gender was recorded. Female carcasses were checked for egg retention by visual estimation of the number of eggs present in the body cavity. Egg voidance was calculated by subtracting the known eggs of an individual female from the average fecundity of the current years' broodstock. Egg voidance was expressed as a percentage of void eggs from the total fecundity. The caudal fin was removed from sampled carcasses to prevent re-sampling during later surveys.

Table 7. Spawning ground reaches for the Wenatchee and Methow river basins, 2005.

Reach Designation	Reach Description	Reach Location (RK)
	Icicle Creek	
I1	Mouth to E. Leavenworth Br.	0.0-3.7
I2	E. Leavenworth Br. to Hatchery	3.7-4.5
I3	Hatchery to Dam 5	4.5-4.7
	Nason Creek	
N1	Mouth to Kahler Cr. Br.	0.0-6.3
N2	Kahler Cr. Br. to High Voltage Lines	6.3-10.3

N3	High Voltage Lines to Old Wood Br.	10.3-13.3
N4	Old Wood Br. to Rayrock	13.3-20.9
N5	Rayrock to Whitepine Cr.	20.9-25.4
	Chiwaukum Creek	
CH1	Highway 2 Bridge to Mouth	0.0-0.8
	Chumstick Creek	
CS1	Mouth to North Rd culvert	0.0-1.6
	Peshastin Creek	
P1	Mouth to RM 4.0	0.0-6.4
	Mission Creek	
M1	Mouth to Brender Creek	0.0-0.8
M2	Brender Creek to RM 2.0	0.8-3.2
	Brender Creek	
BR1	Mouth to Mill Rd.	0.0-0.3
	Beaver Creek (WEN)	
BW1	Mouth to Acclimation Pond	0.0-2.4
	Little Wenatchee River	
LW1	Mouth to Log Jam	0.0-3.2
	Wenatchee River	
W1	Mouth to Sleepy Hollow Br.	0.0-5.6
W2	Sleepy Hollow Br. to Monitor Br.	5.6-9.3
W3	Monitor Br. to lower Cashmere Br.	9.3-15.3
W4	Lower Cashmere Br. to Dryden Dam	15.3-28.2
W5	Dryden Dam to Leavenworth Br.	28.2-38.5
W6	Leavenworth Br. to Icicle Rd. Br.	38.5-42.5
W7	Icicle Rd. Br. to Tumwater Br.	42.5-57.3
W8	Tumwater Br. to Lake Wenatchee	57.3-86.3
	Wolf Creek	
WF1	Mouth to RM 1.6	0.0-2.6
	Beaver Creek (MET)	
BM1	Mouth to RM 1.6	0.0-2.6
	Libby Creek	
L1	Mouth to RM 1.0	0.0-1.6
	Gold Creek	
G1	Mouth to RM 1.5	0.0-2.4
	Chewuch River	
CR1	Mouth to RM 1.0	0.0-1.6
	Twisp River	
T1	Mouth to RM 2.0	0.0-3.2
	Spring Creek	
S1	Mouth to WNFH	0.0-0.4
	Methow River	

M1	Mouth to Steel Br.	0.0-8.1
M2	Steel Br. to Methow	8.1-23.8
M3	Methow to Lower Gold Cr. Br.	23.8-34.3
M4	Lower Gold Cr. Br. to Carlton	34.3-44.4
M5	Carlton to Twisp	44.4-63.7
M6	Twisp to Winthrop	63.7-80.2
M7	Winthrop to Wolf Cr.	80.2-85.0

4.1 WENATCHEE BASIN REDD COUNTS

4.1.1 Icicle Creek

We conducted spawning ground surveys in Icicle Creek between October 14th and December 6th. Six-hundred and twenty nine coho redds were counted and recorded in 2005 (Table 8). The first redd was observed on October 21st. Peak spawn occurred during the third week of November. Two-hundred and three carcasses were recovered and sampled by YN personnel: 126 females and 77 males. The estimated carcass sample rate for Icicle Creek was 16%. Complete survey records can be found in Appendix C.

Table 8. Survey location, number of redds, and carcass recoveries by YN in the Wenatchee River basin, 2005.

Survey Location	Number of Coho Redds	Carcasses Recovered
Nason Creek	41	3
Icicle Creek	629	203
Wenatchee River	224	64
Peshastin Creek	25	6
Mission Creek	10	1
Brender Creek	7	1
Chiwaukum Creek	1	0
Beaver Creek	0	0
Total	**937**	**278**

4.1.2 Nason Creek

Spawning ground surveys were conducted on Nason Creek between October 25th and December 2nd (Appendix C). Nason Creek survey reaches can be found in Table 7. A total of 41 redds were found in Nason Creek, a program high. Peak spawn occurred between November 10th and November 17th (*n=25*). Three carcasses were recovered in Nason Creek, two males and one female. The estimated carcass sample rate from Nason Creek was 3.0%.

4.1.3 Wenatchee River

Wenatchee River surveys were conducted to determine distribution and number of redds rather than spawn timing. Wenatchee River survey reaches can be found in Table 7. A total of 221 redds were found in the Wenatchee River (Table 8). The majority (69.3%) of spawning activity occurred in reach W6 (*n=165*). YN personnel recovered 64 carcasses on the Wenatchee River, 44 females and 20 males.

4.1.4 Other Tributaries

We surveyed smaller tributaries to the Wenatchee River to investigate spawning distribution and counts rather than timing. Survey areas included the lower reach of Beaver Creek, Brender Creek, Chiwawa River (lower), Chiwaukum Creek, Peshastin Creek, and Mission Creek (Table 7). No redds were found in Beaver Creek or the Chiwawa River (lower). A combined total of 38 redds were found in Brender, Mission, Peshastin, and Chiwakum creeks (Table 8).

4.2 METHOW RIVER

Methow River surveys were conducted to document the geographical spawning distribution, rather than total count or spawn timing. All surveys occurred between November 12th and December 15th, 2005. These surveys included seven reaches of the Methow River and 6 tributaries: Beaver, Spring, Wolf, and Libby Creeks, and the Twisp and Chewuch Rivers. A total of 43 redds were identified in the Methow River Basin and sixteen carcasses were recovered (Table 9). This count should not be considered a total count due to lack of survey replication throughout the duration of spawning. Complete survey records can be found in Appendix C.

Table 9. Locations and counts of coho redds and carcasses found in the Methow River and Chelan Falls, 2005

Survey Location	Number of Coho Redds	Carcasses Recovered
Methow River	18	9
Methow Hatchery Outfall	3	2
Beaver Creek	0	0
Spring Creek (WNFH outfall)	22	4
Libby Creek	0	0
Twisp River	0	1
Chelan Falls FH Outfall	0	4
Chelan Falls	1	0
Total	**44**	**20**

4.3 CHELAN FALLS

In 2005 we also surveyed the lower end of Chelan Falls and the Chelan Falls hatchery outfall. One redd was observed in the lower end of Chelan Falls; No redds were found in the hatchery outfall, however four carcass were recovered (Table 9; Appendix C).

5.0 SURVIVAL RATES

5.1 Smolt Survival Rates – Release to McNary Dam

To obtain a McNary passage index of PIT-tagged fish released into the Wenatchee and Methow basins, the number of McNary Dam PIT tag detections were expanded by dividing by an estimate of the McNary detection-rate (efficiency). The McNary detection rate is the proportion of total PIT-tagged fish passing the dam that are detected by the dam's PIT tag detectors. McNary passage is stratified into sequential days having similar detection rates. The estimate of a stratum's passage is given in Neeley (2006; Appenidx D). The McNary detection rate was calculated by summing the number of PIT-tagged fish detected at McNary and at a downstream dam and dividing by the total number detected at the downstream dam. An index of survival to McNary Dam is the estimated total passage (stratum passage estimates added over all the strata) divided by either the number of tagged fish or the number of fish detected leaving the acclimation pond (number released). For survival rates from the 2005 releases (see section 2.0 for release numbers), detection-rate estimates were calculated for Nason Creek (Butcher Creek and Mahar Pond), and for Icicle Creek (LFLs and SFLs) separately. Detailed methods are described in Neeley (2006) (Appendix D). The calculated survival indices for all releases can be found in Table 10.

Table 10. Survival indices Mid-Columbia smolt releases, 2005.

Basin	Release Tributary	Release Location	Rearing Facility	Brood Origin	n	Survival to McNary
Wenatchee	Nason Creek	Rolfing Pond	Willard NFH	MCR	6011	0.1754[1]
		Butcher Creek	Willard NFH	MCR	5244	0.1637[2]
	Icicle Creek	SFL	Willard NFH	MCR	3106	0.4448[3]
		SFL	Cascade FH	MCR	3448	0.3981
		LFL	Willard NFH	MCR	3999	0.3448
		LFL	Cascade FH	MCR	3919	0.6181

Source: Neeley (2006); Appendix D

[1] Survival estimate was based upon the number of fish detected leaving Rolfing pond and therefore does not include in-pond mortality. The detection efficiency was estimated to be 98.2% (Neeley 2006).
[2] Survival estimate was based upon the number of fish detected leaving Butcher Pond, and therefore does not include in-pond mortality. The detection efficiency was estimated to be 97.9% (Neeley 2006).
[3] All Icicle Creek release-to-McNary survival rates are based upon the total number of fish tagged minus known and recovered mortalities. Detection during release was not possible.

5.2 Smolt-to-Adult Survival Rates for Brood Year 2002

In the Methow River, smolt-to-adult survival (SAR) was calculated based on two methods of enumerating adult coho:

1) redd counts plus broodstock collected[4],
2) Wells Dam counts plus broodstock collected at Wells Dam.

For coho returning to the Wenatchee River, we calculated smolt-to-adult survival using four equations:

1) Dryden Dam counts expanded by linear regression for non-trapping days, plus redd counts downstream from Dryden Dam[5]
2) Broodstock collected at Dryden Dam plus all redd counts[5]
3) Broodstock collected at Dryden Dam, Tumwater Dam counts, and redds counted downstream of Tumwater Dam[5]
3) Mainstem dam counts (Rock Island Dam – Rocky Reach Dam).

Method one may underestimate the total number of coho returning to the basin if the trapping efficiency of Dryden Dam is low (due to fall freshets) or may overestimate the number of coho returning if fallback rates of fish not collected in the broodstock are high. Method two and three may also underestimate the number of coho to return to the Wenatchee River because it does not take pre-spawn mortalities, or unidentified coho redds into account. Method four is likely an overestimate, as it assumes no fallbacks or drop-outs occurred between Rock Island and Rocky Reach Dams. SARs calculated from methods one and two have been very similar in previous years. Smolt to adult survival rates for the Wenatchee and Methow Basins is summarized in Tables 11 and 12.

Table 11. Methods, return numbers (hatchery fish) and smolt-to-adult survival rates for Wentachee River BY 2002.

Method	BY 2002 Return	SAR
1) Dryden Dam counts expanded for non-trapping days plus redds located below Dryden Dam*	3267 (3240 adults & 27 jacks)	0.29%
2) Redd counts plus broodstock collected**	3257 (3228 adults & 29 jacks)	0.29%
3)Tumwater Dam counts, redds below Tumwater Dam, and broodstock collected**	3610 (3574 adults & 36 jacks)	0.32%
4) Mainstem Dam Counts ***	5362 (5299 adults & 63 jacks)	0.47%

[4] Each redd count was expanded by 2.2 fish per redd based on the sex ratio of coho observed at Wells Dam, 1.2M:1.0F

[5] Each redd count was expanded by 2.1 fish per redd based on the sex ratio of coho observed at Dryden Dam, 1.1M:1.0F.

Table 12. Return numbers and smolt-to-adult survival rates for Methow River BY2002.

Method	BY 2002 Return	SAR
1) Redd counts plus broodstock collected*	336 (334 adults & 2 jacks)	0.11%
2) Wells Dam Counts plus Wells Dam broodstock collected**	571 (568 adults & 3 jacks)	0.19%

**Coho collected at Wells Dam were not incorporated into daily fish passage counts for 2005. Broodstock collected only reflects the proportion of fish taken at Wells Dam and not volunteer swim-ins at Winthrop NFH.

Further calculations of SARs based on CWT recovery allow for a comparison of survival between brood origin, rearing hatchery and release sites (Table 13 and 14). In both basins, coded wire tags (CWTs) and analysis of scale samples from non-CWT fish were used to distinguish naturally produced fish from hatchery fish. The population estimate of naturally produced coho smolts used in the SAR calculations was provided by WDFW and previously reported in Murdoch et al. (2006).

Table 13. Brood year 2002 SARs by release site, brood origin, and rearing facility, Wenatchee River Basin 2005

Release Site	Brood Origin	Rearing Facility	N (Adult Returns)	N (Release Number)	SAR
Beaver Creek Pond	LCR	Cascade FH	31	72,392	0.04%
Butcher Ck. Pond	LCR	Willard NFH	390	77,848	0.50%
	LCR x MCR	Willard NFH	209	31,674	0.66%
Coulter Ck. Pond	LCR	Cascade FH	197	66,495	0.30%
	LCR	Willard NFH	114	39,429	0.29%
Rolfing's Pond	MCR	Willard NFH	138	33,166	0.42%
	LCR	Cascade FH	206	70,666	0.29%
Dam 5 – Icicle Creek	LCR	Cascade FH	1072	288,741	0.37%
	LCR	Willard NFH	556	169,858	0.33%
	LCR x MCR	Willard NFH	101	34,106	0.30%
	MCR	Willard NFH	249	90184	0.28%
LNFH SFL	LCR	Cascade FH	270	63,365	0.43%
	MCR	Willard NFH	178	59,297	0.30%
Naturally Produced Coho	MCR	N/A	52	5,826	0.90%

Table 14. Brood year 2002 SARs by release site, brood origin, and rearing facility, Methow River Basin 2005.

Release Site	Brood Origin	Rearing Facility	N Adult Return	N Released	SAR
WNFH On-Station	MCR	Winthrop NFH	33	16,377	0.20%
	LCR	Willard NFH	70	49,947	0.14%
	LCR	Cascade FH	99	53,997	0.18%
WNFH Back Channel	LCR	Winthrop NFH	261	106,268	0.25%
	LCR	Willard NFH	83	77,597	0.11%
Naturally Produced Coho	**MCR**	**N/A**	**8**	**2875**	**0.29%**

A comparison of smolt-smolt survival and smolt-to-adult survival across years (1999 through 2005) can be found in Table 15.

Table 15. Comparison of smolt-smolt and smolt-to-adult survival rates for mid-Columbia coho releases, 1999-2005.

Release Year	Methow R. Smolt Survival	Methow R. Smolt-Adult Survival	Icicle Creek Smolt Survival*	Nason Creek Smolt Survival*	Wenatchee R. Smolt-Adult Survival
1999	N/A	N/A	53.9%	N/A	0.21% - 0.38%
2000	33.3%	0.17% - 0.27%	63.0%	N/A	0.17% - 0.86%
2001	9.9%	0.03%	21.6%	N/A	0.03%- .13%
2002	N/A	0.15%	87.4% - 78.5%	39.3%	0.32%- 0.51%
2003	N/A	0.16%	62.8%	37.2%	0.33% - 0.55%
2004	26.1% - 29.5%	0.19%	56.3% - 60.8%	30.5%- 36.2%	0.29%- 0.47%
2005	N/A	N/A	0.34%- 0.44%	0.16%- 0.18%	N/A

6.0 SUMMARY

The long-term vision for the mid-Columbia coho reintroduction project is to reestablish naturally reproducing coho salmon populations in mid-Columbia river basins at biologically sustainable levels which will provide opportunities for harvest for tribal and non-tribal fishers. The feasibility of reestablishing coho in mid-Columbia tributaries may initially rely upon the resolution of two central issues: the adaptability of a domesticated lower river coho stock used in the re-introduction efforts and associated survival rates, and the ecological risks to other species associated with coho re-introduction efforts.

We are optimistic that the project will continue to observe positive trends in hatchery coho survival as developing local broodstock continues to adapt to conditions in mid-Columbia tributaries. Therefore it is important to measure hatchery fish performance not only to use as an indicator of project performance but to track potential short-and long-term program benefits. This document reports the coho restoration activities completed in 2005; results are briefly summarized below.

- Acclimating pre-smolts on local waters is an essential component to the restoration program. Smolt release numbers for the Methow and Wenatchee rivers in 2005 were 283,695 and 947,401 fish, respectively. Coho within the Methow program were released from Winthrop NFH (on-station raceways and the outfall channel) and achieved an estimated 99.4% transport-to-release survival for the on-station releases. This was similar to the previous year's survival but is likely to be an overestimate because predation observations were not conducted or documented at Winthrop NFH for acclimation in the outfall channel. In the Wenatchee basin, overall survival was 96.7% from transport to release (Appendix B).

- Between September 7th and November 29th, we collected 1,406 coho at Dryden Dam, Leavenworth NFH, and Tumwater Dam on the Wenatchee River. At Winthrop NFH and Wells Dam, 354 coho were collected for the Methow River program. Broodstock goals for both basins were to collect enough females to fulfill future acclimation release needs of 500,000 juveniles in the Methow River and 1,000,000 juveniles in the Wenatchee River.

- We spawned 1,334 coho at Entiat NFH and 282 at Winthrop NFH. An eye-up rate of 84.3% was calculated for the Wenatchee program and 84.6% for the Methow program. There was a considerable increase in eye-up for the Methow program in 2005 versus 2004. Increased eye-up rates and improved eyed-egg quality should lead to improved survival from the eyed stage to smolt release.

- During spawning ground surveys in the Wenatchee Basin, we found a total of 937 coho redds: 629 redds in Icicle Creek, 41 redds in Nason Creek, 224 redds in the

Wenatchee River and a combined 43 redds in Brender, Mission, Peshastin, and Chiwaukum creeks. In the Methow Basin we located a total of 43 redds.

- Based on PIT-tag detections, we estimate that 35%-62% of brood year 2003 mid-Columbia River brood coho survived from release in Icicle Creek to McNary Dam. We estimated that 16%-17% of fish released into Nason Creek (Butcher Creek Pond, and Rolfing's Pond) survived to McNary Dam. No PIT tagged fish were released in the Methow River in 2005.

- We estimate that the overall smolt-to-adult survival rate (SAR) for brood year 2002 hatchery coho smolts released in the Wenatchee River basin is 0.32% (3574 adults and 36 jacks) for all release groups. However, the smolt-to-adult survival rate varied between release groups (range 0.04% - 0.66%; Table 13). Using scale analysis for verification of fish origin, we estimated the SAR for naturally produced coho to be 0.90%.

- In the Methow River, we estimate that the overall smolt-to-adult survival rate (SAR) for brood year 2002 hatchery coho is 0.19%. The SARs for each release group ranged from 0.11% to 0.25%. Using scale analysis for verification of fish origin we estimate the SAR for naturally produced coho in the Methow River to be 0.29%.

7.0 ACKNOWLEDGEMENTS

We are thankful to the many people involved in the coho reintroduction feasibility study. Bonneville Power Administration funded the study. Roy Beaty administered funding. Theresa Blodgett, Lily Sampson-Ohms, Victor Gardee, Michael Whitefoot, Kerby Wallahee, Markeyta Pinkham, John Jorgensen, Rick Alford, Ralph Kiona, Kraig Mott, and Louis Sweowat helped collect the field data. Doug Neeley (International Statistical Training and Technical Services) provided statistical consultation for survival estimates of PIT-tagged fish. Several employees at WDFW provided assistance throughout the year, including Rick Stillwater and his crew during broodstock collection; Todd Miller and Charlie Snow provided the population estimates of naturally produced coho emigrating from the Wenatchee and Methow rivers.

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APPENDIX A: Nason Creek Smolt Trap Operations, 2005

Integrated Status & Effectiveness Monitoring Program

Expansion of Existing Smolt Trapping Program in Nason Creek by Yakama Nation Fisheries Resource Management

2005 Annual Report

March 2006

Prepared by:
Scott A. Prevatte

Prepared for:
2003-017-00
Bonneville Power Administration
Portland, OR

YAKAMA NATION
FISHERIES RESOURCE MANAGEMENT

Abstract

In the fall of 2004, as one part of a Basin-Wide Monitoring Program developed by the Upper Columbia Regional Technical Team and Upper Columbia Salmon Recovery Board, the Yakama Nation Fisheries Resource Management program began monitoring downstream migration of ESA listed Upper Columbia River spring chinook salmon and Upper Columbia River steelhead in Nason Creek, a tributary to the Wenatchee River.

This report summarizes juvenile spring chinook salmon and steelhead trout migration data collected in Nason Creek during 2005 and also incorporates data from 2004. We used species enumeration at the trap and efficiency trials to describe emigration timing and to estimate population size. Data collection was divided into spring/early summer and fall periods with a break during the summer months occurring due to low stream flow. Trapping began on March 1st and was suspended on July 29th when stream flow dropped below the minimum (30 cfs) required to rotate the trap cone. The fall period began on September 28th with increased stream flow and ended on November 23rd when snow and ice began to accumulate on the trap.

During the spring and early summer we collected 311yearling (2003 brood) spring chinook salmon, 86 wild steelhead smolts and 453 steelhead parr. Spring chinook (2004 brood) outgrew the fry stage of fork length < 60 mm during June and July, 224 were collected at the trap. Mark-recapture trap efficiency trials were performed over a range of stream discharge stages whenever ample numbers of fish were being collected. A total of 247 spring chinook yearlings, 54 steelhead smolts, and 178 steelhead parr were used during efficiency trials. A statically significant relationship between stream discharge and trap efficiency has not been identified in Nason Creek, therefore a pooled trap efficiency was used to estimate the population size of both spring chinook (14.98%) and steelhead smolts (12.96%). We estimate that 2,076 (± 119 95%CI) yearling spring chinook and 688 (± 140 95%CI) steelhead smolts emigrated past the trap during the spring/early summer sample period along with 10,721 (± 1,220 95%CI) steelhead parr.

During the fall we collected 924 subyearling (2004 brood) spring chinook salmon and 1,008 steelhead parr of various size and age classes. A total of 732 spring chinook subyearlings and 602 steelhead parr were used during 13 mark-recapture trap efficiency trials. A pooled trap efficiency of 24.59% was used to calculate the emigration of spring chinook and 17.11% was used for steelhead parr during the period from September 28th through November 23rd. We estimate that 3758 (± 92 95%CI) subyearling spring chinook and 5,666 (± 414 95%CI) steelhead parr migrated downstream past the trap along with 516 (± 42 95%CI) larger steelhead pre-smolts during the 2005 fall sample period.

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Acknowledgements

This project is part of a basin wide monitoring program requiring close coordination between multiple fisheries management agencies. We would like to thank to Greg Thayer, USFS, for providing the trapping site at the Nason Creek Campground and accommodating the needs of this study. The hard work of the Yakama Nation Fisheries Technicians who operated the trap during all hours including nights and weekends is appreciated. We would like to thank Chris Jordan the project sponsor, and Gerald McClintock from the BPA for administering the funding. Also Andrew Murdoch and the WDFW crew for sharing data and ideas on smolt trapping in the Wenatchee Subbasin.

Introduction

Beginning in the fall of 2004, as one task within the basin wide monitoring effort of the Bonneville Power Administration (BPA) project # 2003-017-00 Integrated Status & Effectiveness Monitoring Program, the Yakama Nation, in coordination with the Washington Department of Fish and Wildlife (WDFW), Washington State Department of Ecology (DOE), the United States Fish and Wildlife Service (USFWS), the United States Forest Service (USFS), National Oceanographic and Atmospheric Administration Fisheries (NOAA Fisheries), the BPA, began extending the current smolt trapping effort in Nason Creek from three months per year to nine months per year with the project entitled Expansion of Existing Smolt Trapping Program in Nason Creek by Yakama Nation Fisheries Resource Management. The objectives of this project are:

1) Estimate the smolt production of spring chinook salmon and steelhead for the Nason Creek watershed within the Wenatchee Subbasin.

2) Describe the temporal variability of outmigrating spring chinook and steelhead within Nason Creek.

The data generated from this project will estimate spring chinook and steelhead natural production and productivity allowing fisheries researchers and managers to calculate annual population estimates, egg-to-emigrant survival, and emigrant-to-adult survival rates for these ESA listed fish. Population estimates will be used to evaluate the effects of supplementation programs in the Wenatchee River Basin as well as providing data to develop a spawner-recruit relationship in Nason Creek.

This report summarizes data collection from the Nason Creek smolt trap during the 2005 trapping periods of March 1st through July 29th, and from September 28th through November 23rd. The target species of the study were spring chinook and steelhead migrants. Data collected during fall 2004 is incorporated with the spring 2005 data to produce the population estimate for the 2003 brood spring chinook and to further develop the trap efficiency rating.

Watershed Description

The Nason Creek watershed drains 65,600 acres of alpine glaciated landscape where high precipitation and moderate rain on snow recurrence control the hydrology and aquatic communities (USFS et al. 1996). Nason Creek originates near the Cascade Crest at Stevens Pass and flows approximately 37 river kilometers until joining the Wenatchee River at Rk 86.3 just below Lake Wenatchee. The smolt trap is located below the majority of spring chinook and steelhead spawning grounds at Rk 0.8 (Figure 1). A photograph of the trapping site can be seen in Appendix D. There are 26.4 mainstem Rk accessible to salmon. Private land ownership comprises 52,300 acres (79.7%) of the watershed while 12,800 acres (19.5%) are federal and 480 acres (0.1%) are state owned (USFS et al. 1996).

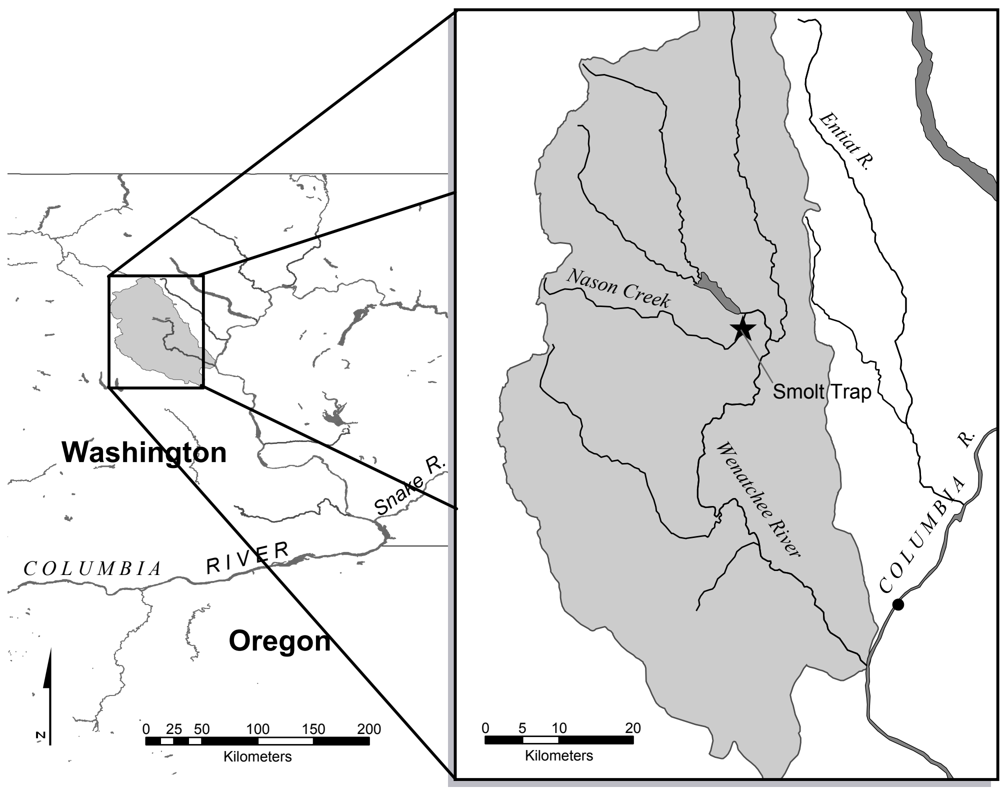

Figure 1. Nason Creek smolt trap location.

The channel morphology of the lower 25 kilometers of Nason Creek has been impacted by development of highways, railroads power lines, and residential development resulting in channel confinement and reduced side channel habitat. The present condition is a low gradient (<= 1.1%), low sinuosity (1.2 to 2.0 channel length to valley length ratio), and mainly depositional channel (USFS et al. 1996).

The Washington State Department of Ecology (DOE) began operating a stream monitoring station at Rk 1.0 of Nason Creek in May of 2002. The mean daily discharge during the 2005 trapping season (March 1, 2005 through December 1, 2005) was 144 cfs. Peak runoff typically occurs in May and June with occasional high water produced by rain on snow events in October and November. The discharge regime during the 2005 smolt trapping period was considered a severe drought (Figure 2). Daily mean stream discharge measurements taken by the Washington State DOE during the 2005 and 2006 water years can be found in Appendix A.

The Nason Creek water temperature recorded at the DOE monitoring station during the 2005 smolt trapping period ranged from 3.5 °C on March 1^{st} to 2.4 °C on November 23^{rd}. The peak temperature of 19.6 °C was reached on August 8^{th} and the minimum water temperature was 1.8 °C on November 16^{th} (Figure 3). The temperature regime during the 2005 smolt trapping period showed slightly higher sustained summer temperatures than that of the previous 4 years of record. Daily mean stream temperature measurements taken by the Washington State DOE during the 2005 and 2006 water years are also in Appendix A.

Fish present in Nason Creek are chinook salmon *Oncorhynchus tshawytscha*, steelhead trout and rainbow trout *Oncorhynchus mykiss*, coho salmon *Oncorhynchus kisutch*, cutthroat trout *Oncorhynchus clarki lewisi*, bull trout *Salvelinus confluentus*, mountain whitefish *Prosopium williamsoni*, redside shiner *Richardsonius balteatus*, sucker *Catostomus sp*, sculpin *Cottus sp*, dace *Rhinichthys sp* and northern pikeminnow *Ptychocheilus oregonensis.* Hatchery activity in Nason Creek includes the BPA funded coho reintroduction program, the Chelan County PUD funded hatchery steelhead direct plants, and the Grant County PUD funded spring chinook captive brood program (2004 was the first spring chinook captive brood release in Nason Creek).

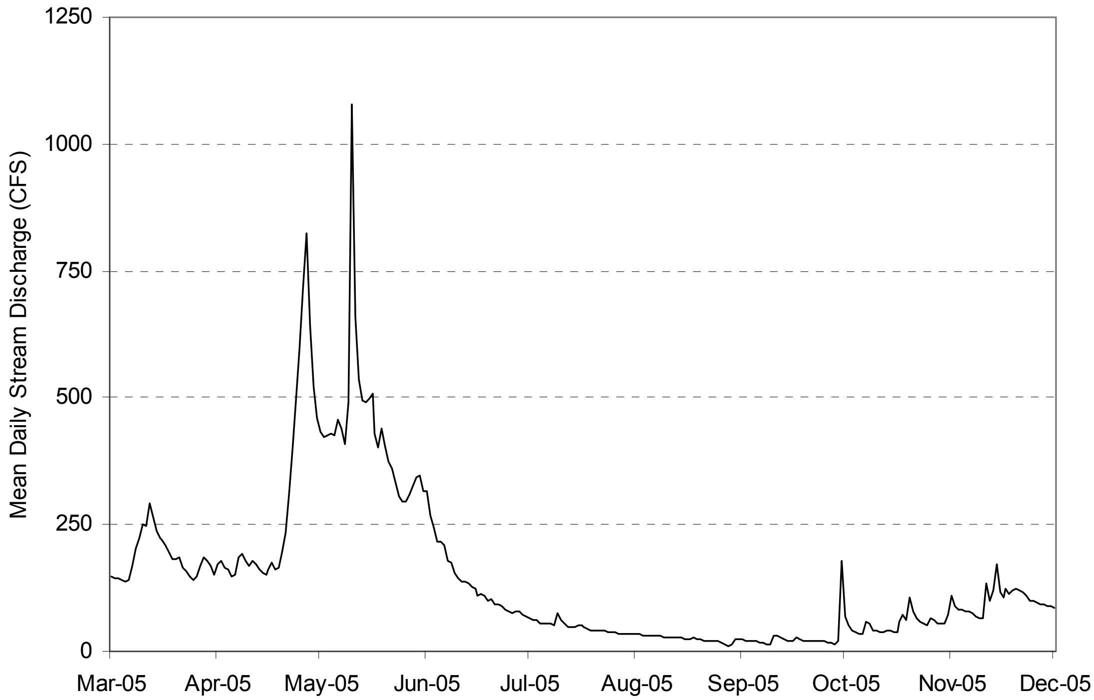

Figure 2. Mean daily stream discharge at the Nason Creek DOE stream monitoring station, Rk 1, from March 1 through December 1, 2005.

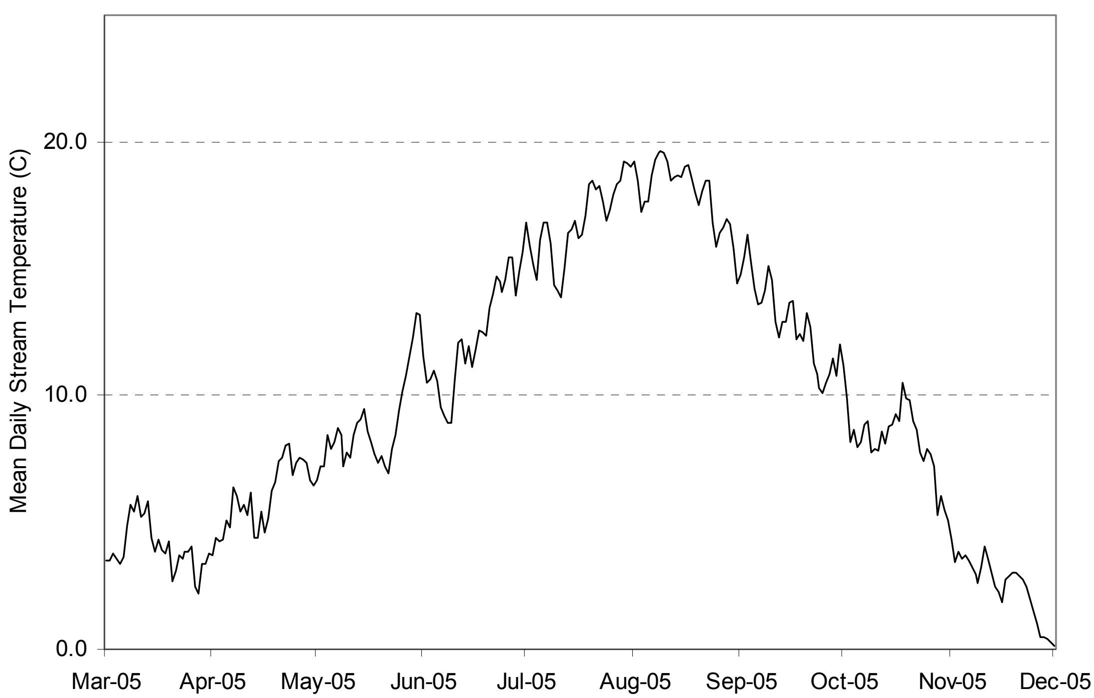

Figure 3. Mean daily water temperature at the Nason Creek DOE stream monitoring station, Rk 1, from March 1 through December 1, 2005.

Methods for Estimating Abundance of Juvenile Salmonids

Trapping Equipment and Operation

A floating rotary screw trap with a 5-foot diameter cone, manufactured by EG Solutions of Eugene, OR, was used to capture fish moving downstream. The trap retains live fish in a holding box until they are removed. A rotating drum screen constantly removes small debris from the live box. The trap was hung, with wire rope, from a snatch block connected to a stream spanning cable and was positioned laterally in the thalweg with a 'come-along' type puller. We used two trap positions during 2005; a back position during high water in the spring and forward 10 meters during low water in the fall. A photograph of the trapping equipment can be seen in Appendix D.

Data Collection

The protocol for trap operating procedures and techniques followed the standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team for the Upper Columbia Salmon Recovery Board (Hillman 2004), adapted from Murdoch et al. (2000).

We used water filled sanctuary nets to transfer fish from the holding box to 5 gallon plastic buckets. All fish were enumerated by species and size class. Fish to be sampled were anesthetized in a solution of MS-222, weighed with a portable electronic scale, and measured in a trough type measuring board. Anesthetized fish were allowed to fully recover before being released downstream from the trap. A photograph of the sampling equipment can be seen in Appendix D.

Length and weight measurements were recorded for all fish except on days when large numbers were collected, and then 25 of each size class of the target species were measured and weighed. Fork length was recorded to the nearest millimeter and weight to the nearest 0.1 gram. We used this data to calculate a Fulton-type condition factor (Kfactor), following methods described in the protocol, for all spring chinook and wild steelhead sampled using the formula:

$$K = (W/L^3) \times 100{,}000$$

Where K = Fulton-type condition metric, W = weight in grams, L = length in millimeters and 100,000 is a scaling constant.

Juvenile spring chinook trapped in 2005 represented two brood years and were classified by size and the time of year the fish were collected. Chinook yearlings (BY 2003; age 1+) that overwintered in Nason Creek were captured between March 1st and May 10th. Chinook subyearlings (BY 2004; age 0+), collected throughout the entire season, were classified by size as fry (< 60 mm) or parr (≥ 60 mm). Steelhead were also classified by size: fry (< 60 mm), parr (60mm to 124mm), parr/smolt (> 124 mm). Steelhead were further classified by their stage of smoltification (parr, transitional, smolt).

Trapping Efficiency and Emigration Estimate

Standard mark and recapture efficiency trials were conducted throughout the trapping period following the protocols and calculations described in Hillman (2004). The protocols suggest a minimum of 100 fish in each mark-recapture trial. However, with the limited number of fish caught in the Nason Creek trap, trials were done whenever possible with whatever numbers were available to support a pooled trap efficiency rating. When insufficient numbers of emigrating chinook or steelhead were captured, we held the fish up to three days, in live boxes, to increase the number available for the trial. Fish used in efficiency trials were marked with either an upper or lower caudal fin clip and held for 24 hours of recovery before being transported in 5-gallon buckets 1.4 km upstream to the release site. We have determined, through trial variations conducted in 2004, that there is no difference in fish dispersal when releasing from both banks, center of the stream, or one bank. Therefore our release method uses a holding pen on the right bank where marked fish can recover and be released at sunset. Typically fish were recaptured within the first 48 hours after release and were considered active migrants. Trap efficiency was calculated with the following formula:

$$\text{Trap efficiency} = E_i = R_i / M_i$$

Where E_i is the trap efficiency during time period i; M_i is the number of marked fish released during time period i; and R_i is the number of marked fish recaptured during time period i. The frequency that trap efficiency trials were conducted was limited by the number of fish collected. The daily emigration estimate was calculated by expanding the catch at the trap by trap efficiency using the following formula:

$$\text{Estimated daily migration} = \hat{N}_i = C_i / \hat{e}_i$$

Where N_i is the estimated number of fish passing the trap during time period i; C_i is the number of unmarked fish captured during time period i; and e_i is the estimated trap efficiency for time period i. A linear regression was used to correlate trap efficiency (from efficiency trials) with discharge (cfs). If a relationship was found ($p<0.05$; $r^2 >0.50$) the regression equation was used to estimate daily trap efficiency.

The variance for the total daily number of fish traveling downstream past the trap was calculated form the following formulas:

$$\text{Variance of daily migration estimate} = \operatorname{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{\text{MSE}\left(1 + \frac{1}{n} + \frac{\left(X_i - \overline{X}\right)^2}{(n-1)s_X^2}\right)}{\hat{e}_i^2}$$

Where X_i is the discharge for time period i, and n is the sample size. If a relationship between discharge and trap efficiency was not present (i.e., $P < 0.05$; r^2 . 0.5), a pooled trap efficiency was used to estimate daily emigration:

$$\text{Pooled trap efficiency} = E_p = \sum R / \sum M$$

The variance for daily emigration estimates using the pooled trap efficiency was calculated using the formula:

$$\text{Variance for daily emigration estimate} = \operatorname{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{E_p(1 - E_p)/\sum M}{E_p^2}$$

The total emigration estimate and confidence interval were calculated using the following formulas:

$$\text{Total emigration estimate} = \sum \hat{N}_i$$

$$\text{95\% confidence interval} = 1.96 \times \sqrt{\sum \operatorname{var}\left[\hat{N}_i\right]}$$

The following assumptions must be made for the population estimated to be valid (Murdoch et al. 2001):

1) All marked fish passed the trap or were recaptures during time period *i*.
2) The probability of capturing a marked or unmarked fish is equal.
3) All marked fish recaptured were identified.

Results

Trap Operation

We deployed the trap in Nason Creek on February 28th and began operating on March 1st. We fished the trap continuously until July 29th, except during periods of large hatchery smolt releases upstream of the trap or busy holiday weekends when public safety was a concern (Table 1). We did not operate the trap during the summer due to extremely low stream discharge. The low water conditions delayed continuous trap operation until the end of September when the watershed began to receive some precipitation. During the fall, we operated the trap between September 28th and November 23rd when snow and ice began to accumulate on the trap and prohibited operation.

Table 1. Nason Creek smolt trap operating dates, 2005.

Period	Trap Status	Description	Days Operating	Days Missed
1 Mar-4 May	Operating	Continuous	65	0
5 May-7 May	Not Operating	Hatchery Release	0	3
8 May-27 May	Operating	Continuous	20	0
28 May-31 May	Not Operating	Holiday Weekend	0	4
1 Jul-1 Jul	Operating	Continuous	31	0
2 Jul-4 Jul	Not Operating	Holiday Weekend	0	3
5 Jul-6 Jul	Operating	Continuous	2	0
7 Jul-8 Jul	Not Operating	Stopped by Debris	0	2
9 Jul-29 Jul	Operating	Continuous	21	0
30 Jul-26 Sep	Not Operating	Low Flow	0	59
27 Sep-Nov 23	Operating	Continuous	83	0
		Total Days	**222**	**71**
		Percent Season	**(76%)**	**(24%)**

Daily Emigration

Spring Chinook Fry (2004 Brood)

Between March 2nd and July 18th, 619 spring chinook fry were collected. Spring chinook fry were identified by their size of <60mm. The first BY2004 fry were captured on the second day of trapping and the majority of the chinook fry (53 %) were collected in June (Figure 4). Five chinook fry mortalities were found in the trap, likely caused by debris in the live box.

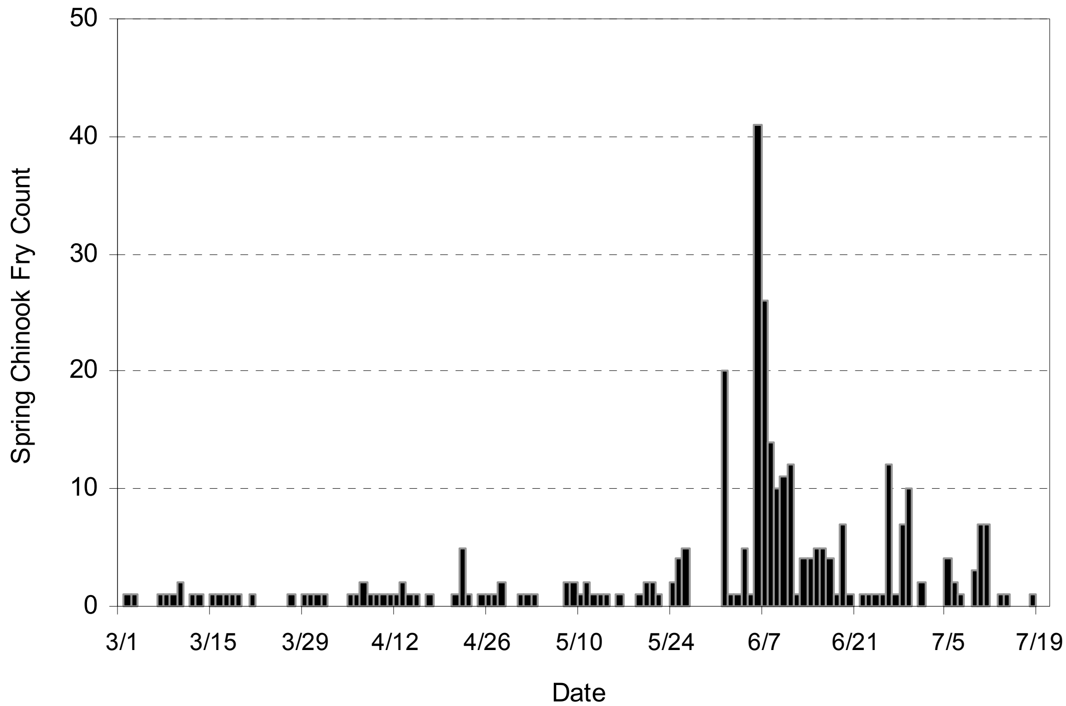

Figure 4. Spring chinook fry counts and run-timing at the Nason Creek smolt trap, March 2nd through July 18th 2005.

Spring Chinook Yearlings (2003 Brood)

We collected 311 yearling spring chinook smolts (BY2003) during the spring. The first smolt was trapped on March 1st, the first day of operation. Peak emigration (83% of the run) occurred throughout the month of April with a daily peak of 26 yearlings collected (8.4%) on April 23rd (Figure 5). During spring high water events two chinook yearling mortalities occurred, likely due to debris in the live box. In addition to the naturally produced yearling spring chinook smolts, 133 hatchery captive brood smolts were trapped,

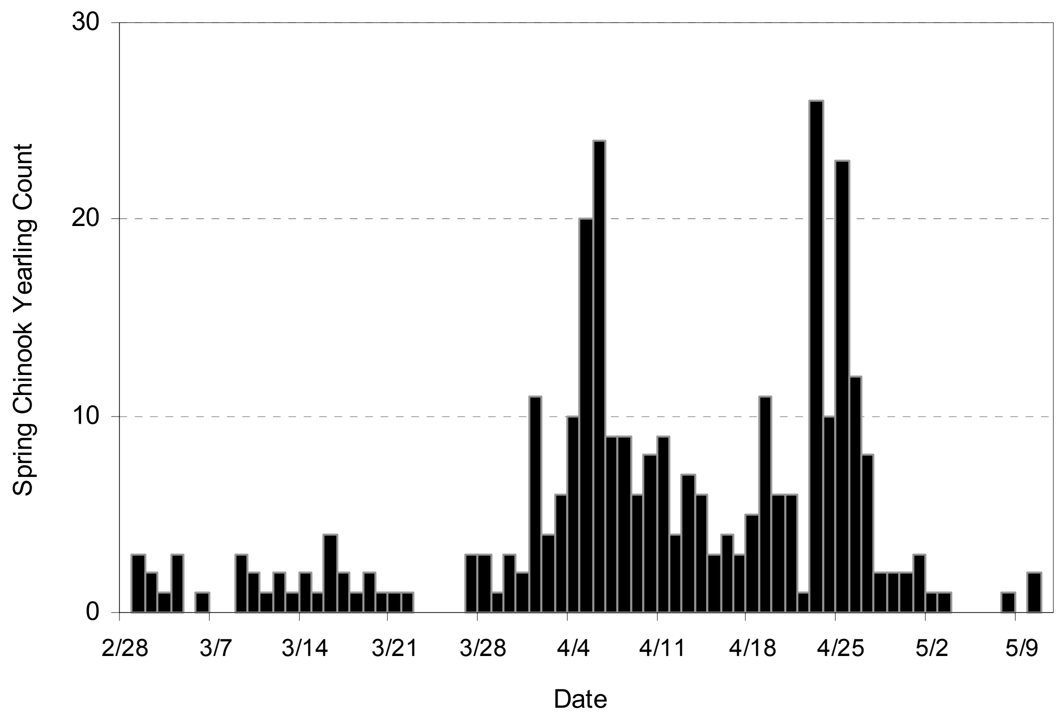

Figure 5. Yearling spring chinook smolt counts and run-timing at the Nason Creek smolt trap, March 1st through May 10th 2005.

Spring Chinook Subyearlings (2004 Brood)

We collected 1,148 subyearling spring chinook during the early summer and fall. We began trapping the 2004 brood subyearling size emigrants (>59mm) on May 25th, and continued to capture subyearlings throughout the rest of the season. Peak emigration (80.0%) occurred during October (38.3%) and November (41.7%) with a daily peak of 90 subyearlings (7.8%) on November 3rd (Figure 6). Twenty nine chinook subyearling mortalities occurred due to debris in the live box.

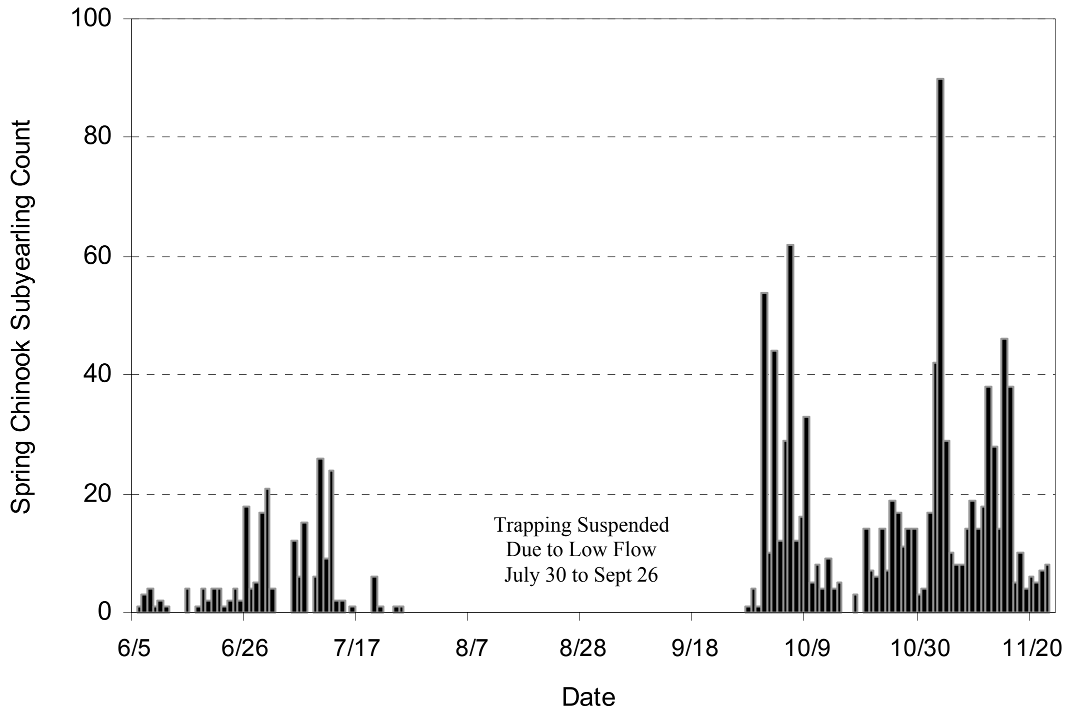

Figure 6. Spring chinook subyearling counts and run-timing at the Nason Creek smolt trap, May 25th through Nov 23rd 2005.

Steelhead/Rainbow Trout Fry

Newly emerged steelhead fry began to enter the trap on June 16th. Steeelhead were classified as fry until they obtained 60mm in length. Steelhead in this size class continued to be collected in the trap until November 15th (Figure 7) for a total 577. Steelhead fry mortality consisted of 24 fish of which 18 occurred due to high water and debris in the trap.

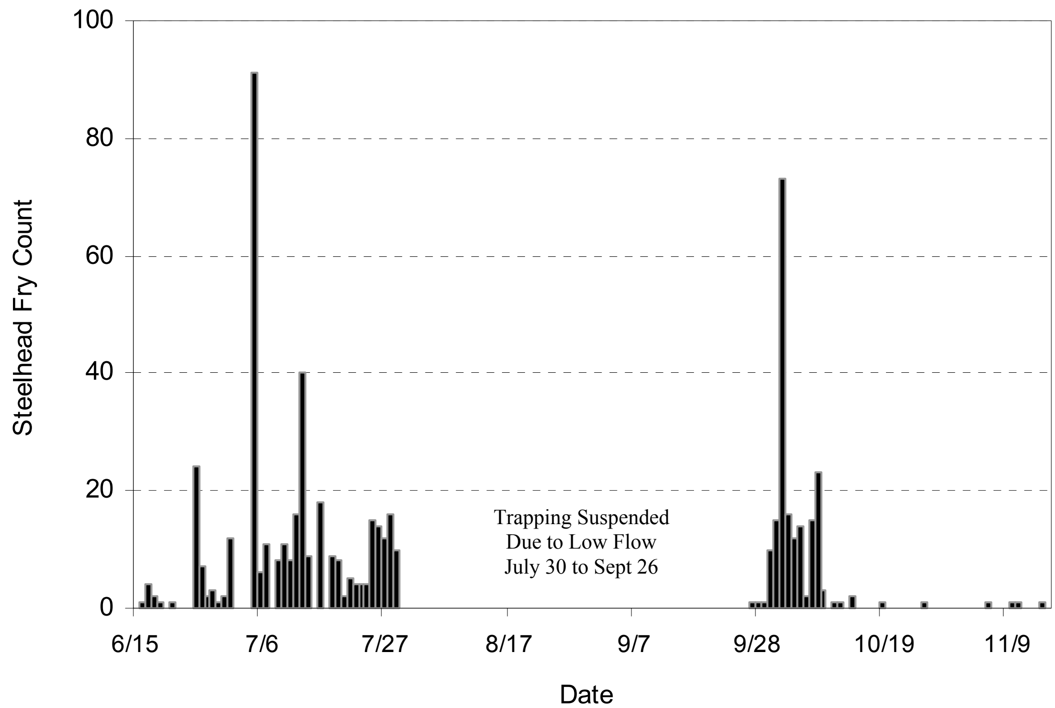

Figure 7. Steelhead fry counts and run-timing at the Nason Creek smolt trap from June 16th through November 15th 2005.

Steelhead/Rainbow Trout Parr

A total of 1,546 steelhead parr were trapped during the 2005 season with the first parr captured on March 1st (Figure 8). During March only 12 (0.8%) were collected. The month of April was the peak of the spring movement with 172 (11.8%) of the parr collected. However, the majority of steelhead parr 896 (61.5%) moved past the trap in the fall during the month of October with the first high flow events. Ninety two steelhead parr mortalities occurred during the trapping season. Two high water events on 9/30 and 10/1 that stopped the trap cone and filled it with debris accounted for 89 of the mortalities.

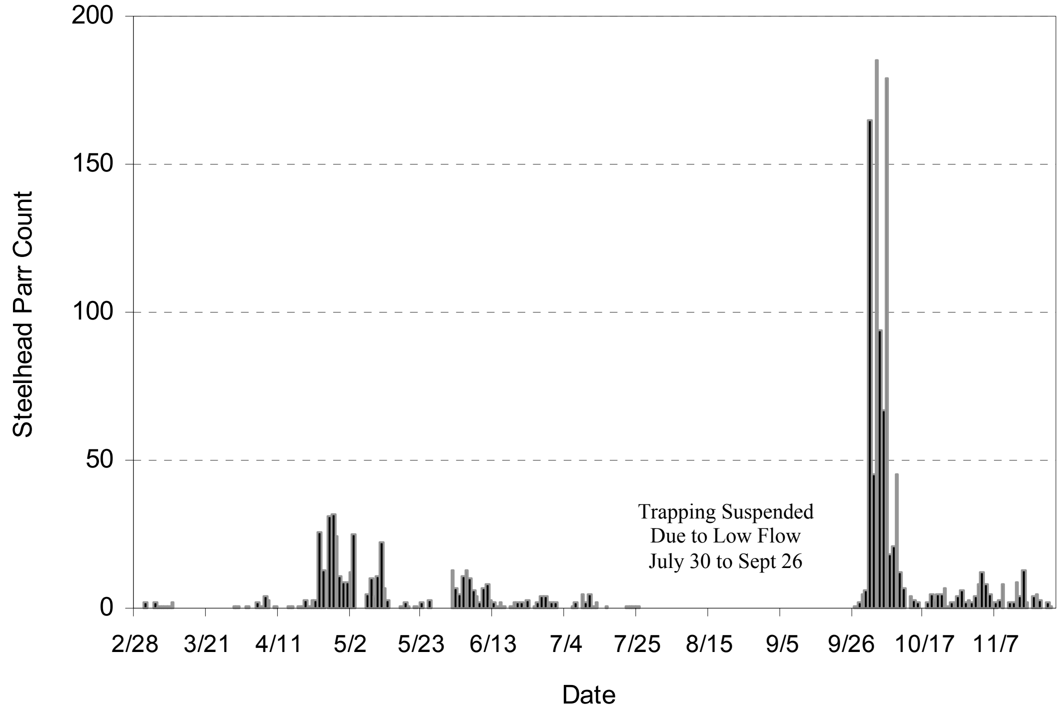

Figure 8. Steelhead parr counts and run-timing at the Nason Creek smolt trap, March 1st through Nov 23rd 2005.

Steelhead/Rainbow Trout Smolts

A total of 86 smolting steelhead were trapped during the spring with the first steelhead smolt captured on March 1st (Figure 9). During March only one transitional smolt was sampled. In April the ratio was 45% transitional and 55% smolt and by May it was 30% transitional and 70% smolt. During June and July another group of 19 transitional fish moved past the trap. Overall 35 fish (40.7%) were in the transitional stage and 51 (59.3%) were smolts. The peak smolt emigration was seen during the week of April 23rd through the 30th when 58.4% of the smolts were collected. In addition to the naturally produced steelhead smolts, 1394 hatchery steelhead smolts were captured from May 2nd through November 13th. Four steelhead smolt mortalities occurred at the trap.

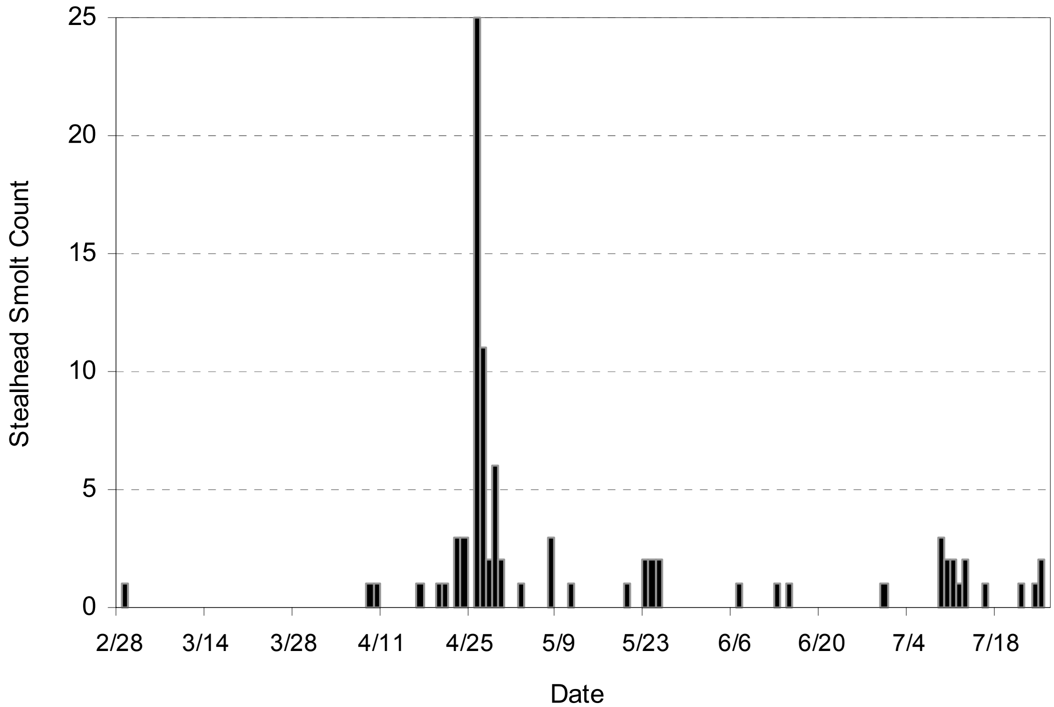

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Figure 9. Steelhead smolt counts and run-timing at the Nason Creek smolt trap, March 1st through July 25th 2005.

Length and Weight

Spring Chinook Yearlings (2003 Brood) and Subyearlings (2004 Brood)

Spring chinook fry (broodyear 2004), identified by their size of <60mm, were collected from March 2nd through July 18th, 2005. Fork length (FL) of the fry increased during the summer months, continuing into the fall. Mean fry Kfactor increased steadily through the spring from 0.76 in March to 1.03 in June, but then declined slightly in July to 0.97 (Table 2).

Spring chinook subyearlings (broodyear 2004), identified by their size of >59mm, were collected from June 6th until the end of the 2005 season on November 23rd. Mean FL of the parr increased 15.6 mm during this 6 month period. Mean parr Kfactor increased slightly from spring to summer from 1.06 in June to 1.08 in September, but declined slightly in October to 1.03 (Table 2).

Table 2. Fork length, weight and condition factor for spring chinook yearlings and subyearlings collected at the Nason Creek trap during 2005.

	Fork Length			Weight			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
				Spring Chinook Fry					
Mar-05	35.7	1.9	15	0.4	0.1	12	0.76	0.24	12
Apr-05	37.4	3.0	22	0.5	0.2	22	0.86	0.28	22
May-05	45.0	5.7	23	0.9	0.4	23	0.95	0.22	23
Jun-05	52.1	5.0	202	1.5	0.5	189	1.03	0.52	189
Jul-05	54.3	5.3	29	1.7	0.6	22	0.97	0.28	22
				Spring Chinook Subyearlings					
Jun-05	64.0	4.2	88	2.8	0.7	83	1.06	0.12	83
Jul-05	68.0	6.7	113	3.4	1.3	89	1.06	0.23	89
Sep-05	69.2	6.4	56	3.5	1.1	56	1.08	0.35	56
Oct-05	77.5	8.6	344	5.0	1.8	340	1.03	0.14	341
Nov-05	79.6	7.6	383	5.2	1.6	383	1.04	0.50	383

Spring chinook yearlings (broodyear 2003) were collected when trapping began in March and continued to be caught through May. We are able to relate this seasons yearling data with lengths and weights collected during the fall of 2004 and measure over-winter growth. Between November of 2004 and March of 2005 the mean FL of emigrants increased 6.3 mm and the mean Kfactor did not decline over the winter (Table 3).

Table 3. Fork length, weight, and condition factor for spring chinook (broodyear 2003) collected at the Nason Creek trap during 2004 and 2005.

	Fork Length			Weight			Condition Factor		
Date	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
				Spring Chinook Yearling Emigrants					
Sep-04	75.2	8.2	108	4.3	1.6	74	1.00	0.17	74
Oct-04	82.7	6.8	239	5.9	1.6	188	1.04	0.11	188
Nov-04	83.4	6.4	421	6.2	1.6	420	1.05	0.13	419
Mar-05	89.7	8.2	46	7.8	2.6	44	1.06	0.11	44
Apr-05	94.9	6.3	221	9.0	1.8	221	1.04	0.13	221
May-05	94.3	6.4	8	8.9	1.5	8	1.06	0.07	8

Steelhead Fry, Parr, and Smolts

Steelhead fry were identified by size and their FL ranged from 25 mm in June up to 59 mm in November. Mean fry condition factor began at 0.94, reached a high of 1.09 in September, and then dropped to 1.03 by November (Table 4).

Steelhead parr with FL measurements between 60 mm to 124 mm were trapped throughout both the spring and fall. The mean FL for this group was 80 mm in March and increased to 110 mm in July. Similarly, the mean condition factor increased from 1.01 in March to 1.09 in June. During the fall the mean FL for steelhead parr in this size class increased from 70 mm in September to 83 mm in November and the mean Kfactor decreased from 1.04 to 1.01 (Table 4).

Larger steelhead parr (125 mm to 190 mm) were caught in the trap during October and November. This sample group of 102 fish was comparable in FL to the smolts collected in the spring however they did not exhibit signs of smoltification. The mean FL was 145 mm and the mean Kfactor was 0.99 (Table 4).

Steelhead in the transitional stages of smoltification began appearing at the trap during March and continued into July of 2005 with an obvious peak emigration at the end of April. The smolts had a mean fork length of 142 mm in March, increasing to 161 mm in May, and then dropped to 135 mm in July. The mean condition factor of smolts started at 0.97 in March and peaked in June at 1.12 and fell to 0.94 in July (Table 4).

Table 4. Fork length, weight and condition factor for steelhead fry, parr, and smolts collected at the Nason Creek smolt during 2005.

	Fork Length			Weight			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
				Steelhead Fry					
Jun-05	31	4.3	22	0.3	0.2	14	0.94	0.37	14
Jul-05	41	8.5	270	0.7	0.5	261	0.83	0.35	261
Sep-05	54	3.7	20	1.8	0.6	20	1.09	0.13	20
Oct-05	54	4.5	92	1.6	0.5	84	0.97	0.28	84
Nov-05	56	2.3	7	1.8	0.2	7	1.03	0.09	7
				Steelhead Parr (60mm to 124mm)					
Mar-05	80	15.9	12	5.7	3.9	12	1.01	0.06	12
Apr-05	83	11.6	169	6.5	3.1	169	1.07	0.11	169
May-05	83	10.3	115	6.2	2.6	115	1.05	0.12	115
Jun-05	98	15.0	89	10.6	4.8	86	1.09	0.12	86
Jul-05	110	18.1	23	15.3	6.6	20	1.05	0.09	20
Sep-05	70	12.2	51	3.8	2.6	51	1.04	0.20	51
Oct-05	73	14.8	234	4.5	3.6	223	0.99	0.16	223
Nov-05	83	19.8	44	6.8	5.0	44	1.01	0.14	44
				Steelhead Parr/Pre-Smolt (>124mm)					
Oct-05	145	17.6	58	31.7	14.0	58	0.99	0.12	58
Nov-05	146	17.0	43	31.7	11.5	43	0.99	0.12	43
				Steelhead Smolt					
Mar-05	142	0.0	1	27.7	0.0	1	0.97	0.00	1
Apr-05	148	16.0	57	34.0	10.4	55	1.02	0.18	55
May-05	161	32.3	12	46.6	28.0	12	1.01	0.05	12
Jun-05	138	10.7	4	29.4	5.2	4	1.12	0.11	4
Jul-05	135	12.9	12	22.3	6.1	11	0.94	0.26	11

Trap Efficiency Calibration and Population Estimates

Mark and Recapture Trials

Standard mark/recapture efficiency trials were conducted over a range of stream discharge stages in Nason Creek throughout the duration of trapping. The fall season of 2004 was the first year we operated the trap with the objective of calculating population estimates for spring chinook and steelhead. The majority of the trials conducted in 2004 were used to test and establish an appropriate release location by determining the maximum upstream distance where fish could be released and recaptured within 24 hours. Throughout 2005, we conducted efficiency trials with as many fish of each target species as could be obtained without holding over for more than 3 days. A regression analysis was used to determine the relationship between stream discharges and trap efficiency (Appendix B). At this time no relationship is identified and a pooled trap efficiency is used for population estimates of all species.

Two trapping positions were used during 2005, forward for periods of low stream flow and back 10 meters during higher flow. We were able to conduct a total of 8 efficiency trials during March and April using spring chinook yearlings (Table 5). The trap efficiency ranged between 5.6% and 23.1% with a pooled efficiency for spring chinook smolts of 15.0 %. The trap was 24.6% efficient at capturing chinook subyearlings based on 13 efficiency trials conducted in October and November. Steelhead parr were marked and recaptured during four trials in the spring and 14 in the fall and were trapped at a rate of 4.2% and 15.6% respectively. Steelhead smolts caught during the spring were collected at 12.5% based on 3 mark group releases and larger parr/pre-smolts (>124 mm) during the spring were collected at 23.3 % based on 12 trials. Efficiency testing was not done on fry of any species. Additional data on mark/recapture efficiency trials can be found in Appendix B.

Table 5. Trap efficiency mark/recapture trial summary for Nason Creek 2005.

Number Marked	Total Recaptured	Percent Recaptured	Number of Trials	Trap Position
Spring Chinook Yearling				
247	37	15.0%	8	Back
Spring Chinook Subyearling				
99	3	3.0%	1	Back
732	180	24.6%	14	Forward
Steelhead Parr (60mm to 124mm)				
213	9	4.2%	4	Back
486	76	15.6%	14	Forward
Steelhead Smolt/pre-Smolt (>124mm)				
56	7	12.5%	3	Back
116	27	23.3%	12	Forward
Hatchery Coho Smolts				
494	9	1.8%	13	Back

Emigration Estimates

Spring Chinook Yearling (2003 Brood)

We did not find a significant relationship (p=0.07, r^2=0.23) between trap efficiency and stream discharge during the spring. The regression analysis can be found in Appendix C. A pooled efficiency of 15.0% was used to generate the daily emigration estimate of yearling spring chinook between March 1st and May 10th. During the spring there were 3 days out of 70 when we did not operate the trap while chinook smolts were emigrating. Daily catch for days when the trap was inoperable was estimated by averaging the 2 previous and 2 following days. We estimate that 2076 (± 119 95%CI) yearling spring chinook emigrated from Nason Creek from March 1st through May 10th.

Subyearling Spring Chinook (2004 Brood)

The results of the linear regression for subyearling spring chinook trap efficiencies and stream discharge indicated that the relationship was not significant for the forward trapping position (p=0.05, r^2=0.05), used during the fall period. Only one efficiency trial was conducted in the back position due to insufficient numbers of chinook parr collected. To generate the daily emigration estimate, a pooled trap efficiency of 3.0% was used during June and July when the trap was in the back position and 24.6% was used during the fall when the trap was in the forward position. We estimate that 8,811 (± 919 95%CI) subyearling spring chinook emigrated from Nason Creek between June 6th and July 29th. During the fall period we estimate that 3,758 (± 92 95%CI) emigrated from Nason Creek for a total population of 12,569 subyearling spring chinook.

Spring chinook fry were not included in the population estimate nor were they used in any of the marked groups released for efficiency trials. Although fry were collected during the spring it is likely that they were displaced during high flow events or emerging from redds upstream in the vicinity of the trap and not actively emigrating from Nason Creek.

Steelhead Smolts and Parr

A statistically significant relationship between stream discharge and trap efficiency has not yet been observed for steelhead smolts (p=0.08, r^2=0.02). Using the pooled trap efficiency of 12.5% we estimate that 688 (± 140 95%CI) steelhead smolts emigrated from Nason Creek between March 1st and July 29th.

During the fall we collected 102 steelhead parr with FL ranging between 125 mm and 190 mm. This group of fish did not exhibit signs of smoltification therefore a separate efficiency estimate was calculated for this pre-smolt size class. The pooled efficiency rating with the trap in the forward position was 23.3%. We estimate that 516 (± 42 95%CI) steelhead parr of FL >124 mm emigrated past the trap September 27th and November 23rd, 2005.

We collected steelhead parr throughout the entire trapping period, spring and fall. We are unsure as to whether all the parr were actively emigrating from Nason Creek, displaced during high water, or influenced by other environmental variables. Assuming that all steelhead parr were emigrating, we estimate that during the spring, with the trap in the back position and 4.2% efficient, 10721 (± 1220 95%CI) passed between March 1st and July 28th. During the fall, with the trap in the forward position and 15.6% efficient, we estimate that 5666 (± 414 95%CI) steelhead parr passed between September 27th and November 23rd for a total population of 16,387.

Incidental Species

All of the fish species present in Nason Creek, were represented in the trap catch: chinook salmon *Oncorhynchus tshawytscha*, steelhead trout and rainbow trout *Oncorhynchus mykiss*, coho salmon *Oncorhynchus kisutch*, cutthroat trout *Oncorhynchus clarki lewisi*, bull trout *Salvelinus confluentus*, mountain whitefish *Prosopium williamsoni*, redside shiner *Richardsonius balteatus*, sucker *Catostomus sp*, sculpin *Cottus sp*, dace *Rhinichthys sp* and northern pikeminnow *Ptychocheilus oregonensis.* Hatchery chinook, steelhead, and coho were also caught. Incidental species were enumerated and sampled for length and weight (Table 6).

Table 6. Number and fork length of incidental species collected in Nason Creek.

Species	Total Captured	Mean Fork Length
Hatchery Steelhead	1394	187.6
Hatchery Chinook	133	168.2
Hatchery Coho	3024	127.0
Coho Parr	12	77.5
Coho Smolt	18	119.6
Bull trout	13	198.8
Cutthroat Trout	2	167.5
Whitefish	383	107.3
Northern Pikeminnow	96	116.8
Sculpin sp.	67	90.0
Sucker sp.	211	104.0
Dace	433	53.6
Redside Shiner	62	75.8

Naturally Produced Coho

Eighteen naturally produced coho salmon smolts (broodyear 2003) were caught at the trap during the spring of 2005. This was an insufficient number to conduct efficiency trials, therefore hatchery coho and spring chinook yearling efficiency ratings were used as surrogates in the following population estimate. The trap was 1.8% efficient at catching hatchery coho, this yields an estimated emigrating coho population of 988 (± 341 95%CI). The trap was 3.0% efficient at catching spring chinook and with this figure we estimate the emigrating coho population to be 594 (± 353 95%CI). We believe that spring chinook yearlings better represent the emigration behavior of natural coho smolts due to their similar body size and migration timing. We used the population estimates above, redd counts, female fecundity, and egg retention estimates to generate the following egg to emigrant survival rates (Tables 7 and 8).

Table 7. Naturally produced coho (broodyear 2003) egg to emigrant survival in Nason Creek based on the spring chinook yearling efficiency rating.

Redds Observed	Mean Fecundity	Mean Retention	Total Egg Deposition	Parr Emigration (fall 04)	Smolt* Emigration (spring 05)	Total Smolt Production	Egg to Emigrant Survival (%)
6	2473	250	13338	0	594	594	4.45

* Estimate (± 353 95%CI) calculated using spring chinook yearlings as surrogates for trap efficiency rating.

Table 8. Naturally produced coho (broodyear 2003) egg to emigrant survival in Nason Creek based on the hatchery coho efficiency rating.

Redds Observed	Mean Fecundity	Mean Retention	Total Egg Deposition	Parr Emigration (fall 04)	Smolt* Emigration (spring 05)	Total Smolt Production	Egg to Emigrant Survival (%)
6	2473	250	13338	0	988	988	7.41

* Estimate (± 341 95%CI) calculated using hatchery coho surrogates for trap efficiency rating.

Discussion

This was the second year we operated the Nason Creek smolt trap for the purpose of generating population estimates for juvenile spring chinook and steelhead in Nason Creek. Previous to 2004, data collection at the trap was focused on hatchery and natural origin coho emigration and species interactions studies.

The juvenile freshwater life history of chinook results in the emigration of two brood years, subyearling parr in the fall and yearling smolts in the spring. This is the first time that a complete dataset for a brood (2003) has been available for Nason Creek spring chinook to provide a total population estimate. This is also the first year that emigrant population estimates, combined with ongoing egg deposition surveys, have produced an estimate of egg to emigrant survival rates of Nason Creek spring chinook. Furthermore with this data, overwinter growth and condition factor for spring chinook can be evaluated.

Steelhead also emigrate at different life stages, some as smolts in the spring and others as parr throughout the year. With multiple age classes of steelhead emigrating as both parr and smolt, scale sample analysis is necessary to calculate brood year population estimates. Scale sampling of steelhead smolts began in spring of 2005. Scales were taken from all steelhead parr >100mm. Results of the age class study are pending scale sample analysis being conducted by WDFW. Future work using PIT tags applied at the trap and at sites upstream of the trap may enable researchers to determine if steelhead parr captured at the trap are active migrants.

In 2006 we will continue to conduct as many mark-recapture trials as possible with both chinook and steelhead. As more data is collected, we should be able to develop a model to correlate trap efficiency with stream discharge, resulting in a more accurate population estimate. Population estimates from 2004 and 2005 can then be re-evaluated when trap efficiency curves for both steelhead and chinook are better developed.

Preliminary conclusions can be made regarding emigration timing of spring chinook and steelhead within Nason Creek. There appear to be two distinct emigrations of spring chinook, a group of yearlings which overwintered and emigrated in the spring and a subyearling group of migrants during summer and fall. Based on the 2004 and 2005 data, it appears that a greater proportion of Nason Creek chinook emigrate as subyearlings (73.5%) vs. yearlings (26.5%). This pattern is also seen in the Chiwawa River, another major tributary to the Wenatchee with a monitored spring chinook population (Murdoch et. al. 2001). In the Chiwawa River the ratio of yearlings to subyearlings varies considerably each year. In 1993, Chiwawa River trapping data produced a total emigration estimate of 8,662 (37.6%) yearlings and 14,036 (61.0%) subyearlings. The following year the ratio was reversed with 16,472 (65.4%) yearlings and 8,595 (34.1%) subyearlings (Murdoch et al. 2001). Factors which may influence whether a fish migrates as a subyearling or yearling may be a function of juvenile rearing densities, genetics, or environmental conditions.

Summary

This was the second year using a screw trap to estimate the production of juvenile spring chinook and steelhead in Nason Creek as part of an ongoing basin wide monitoring project.

- In 2005 the trap was operated from March 1st through July 29th with coho, spring chinook, and steelhead the target species. Trapping operations were postponed during the summer due to low stream flow. Trapping resumed on September 28th and continued through November 23rd with spring chinook and steelhead as the target species. Table 9 shows the summary of target species.

Table 9. Summary of the count, mean FL, and mortality for target species collected at the Nason Creek trap during 2005.

Species	Total Captured	Mean FL (mm)	Total Mortality
Chinook Fry	618	49.8	5
Chinook Subyearling	1148	75.4	29
Chinook Yearling	311	94.0	2
Hatchery Chinook	133	168.2	4
Steelhead Fry	577	43.6	24
Steelhead Parr	1546	80.9	96
Steelhead Smolt	86	146.6	0
Hatchery Steelhead	1394	187.6	1
Coho Fry	7	44.9	0
Coho Parr	12	77.5	0
Coho Smolt	18	119.6	0

- Chinook fry began entering the trap on March 2nd, 2005 and 618 were collected.

- During spring trapping, 311 yearling (2003 brood) spring chinook were captured compared to 336 in 2004.

- During fall trapping, 1,145 subyearling (2004 brood) spring chinook were captured compared to 1,458 in 2004.

- Steelhead fry began entering the trap on June 16th, 2005 and 577 were collected.

- Steelhead parr emigrated through out the entire season, 1,546 were collected.

- During the spring, 86 steelhead smolts were captured.

- Trap efficiency varies by trap position, stream discharge, and species. The overall average was 21.2% for the forward low water position and 7.3% for the back high water position.

- Population estimate summary (Table 10).

Table 10. Population estimate summary for target species in Nason Creek during 2005.

Species	Population Estimate
Spring Chinook Yearling (BY 03) spring migrants	2,096 (± 119 95%CI)
Spring Chinook (BY 04) spring migrants	8,811 (± 919 95%CI)
Spring Chinook (BY 04) fall migrants	3,758 (± 92 95%CI)
Steelhead Smolts spring migrants	688 (± 140 95%CI)
Steelhead Pre-Smolt FL (>124mm) fall migrants	451 (± 37 95%CI)
Steelhead Parr FL (<125mm) spring migrants	10,721 (± 1,220 95%CI)
Steelhead Parr FL (<125mm) fall migrants	5,666 (± 414 95%CI)

- There are two distinct emigrations of juvenile spring chinook in Nason Creek; subyearling parr emigrating in the fall and yearling smolts leaving the following spring. For BY 2003, 73.5 % emigrated as subyearling and 26.5 % overwintered in Nason Creek.

- This year's data produced the first estimate of Nason Creek spring chinook egg to emigrant survival (Table 11).

Table11. Spring chinook (broodyear 2003) egg to emigrant survival, Nason Creek.

Redds Observed*	Female Fecundity*	Average Egg Retention*	Total Egg Deposition	Subyearling Smolt Production (Fall 04)	Yearling Smolt Production (Spring 05)	Total Smolt Production	Egg to Emigrant Survival (%)
83	4231	25	349098	7899	2096	9995	2.86

*Data provided by WDFW, includes hatchery and natural origin adults

- Steelhead also emigrate from Nason Creek at various life stages and a scale sample analysis is underway to correlate size and age classes.

- Between November of 2004 and March of 2005 the mean FL of overwintering spring chinook increased 6.3 mm and the mean Kfactor did not decline over the winter (Table 3).

References

Hillman, T.W. 2004. Monitoring strategy for the Upper Columbia Basin: Draft report February 1, 2004. Prepared for Upper Columbia Regional Technical Team, Wenatchee, Washington.

US Forest Service 1996. Nason Creek Stream Survey Report

Murdoch, A., and Peterson, K. 2000. Freshwater Production and Emigration of Juvenile Spring Chinook from the Chiwawa River in 2000. Washington State Department of Fish and Wildlife

Appendix A

Nason Creek mean daily stream discharge (cfs) and temperature (c) recorded at Rk 0.8, provided by Washington State Depart of Ecology (J. Peterson, pers. comm.).

Date	Average Daily CFS	Average Daily Temp C	Date	Average Daily CFS	Average Daily Temp C
3/1/2005	146	3.5	4/11/2005	178	5.3
3/2/2005	144	3.5	4/12/2005	170	6.2
3/3/2005	143	3.8	4/13/2005	160	4.4
3/4/2005	140	3.5	4/14/2005	154	4.4
3/5/2005	138	3.3	4/15/2005	150	5.5
3/6/2005	141	3.7	4/16/2005	163	4.6
3/7/2005	169	4.9	4/17/2005	174	5.2
3/8/2005	202	5.7	4/18/2005	160	6.2
3/9/2005	224	5.4	4/19/2005	165	6.6
3/10/2005	251	6.0	4/20/2005	196	7.4
3/11/2005	248	5.2	4/21/2005	233	7.5
3/12/2005	291	5.4	4/22/2005	313	8.0
3/13/2005	263	5.8	4/23/2005	402	8.1
3/14/2005	237	4.4	4/24/2005	503	6.9
3/15/2005	222	3.8	4/25/2005	597	7.3
3/16/2005	219	4.4	4/26/2005	719	7.6
3/17/2005	210	3.9	4/27/2005	824	7.5
3/18/2005	196	3.8	4/28/2005	642	7.3
3/19/2005	183	4.2	4/29/2005	521	6.7
3/20/2005	181	2.7	4/30/2005	461	6.4
3/21/2005	187	3.1	5/1/2005	432	6.7
3/22/2005	166	3.7	5/2/2005	421	7.2
3/23/2005	157	3.5	5/3/2005	425	7.2
3/24/2005	147	3.8	5/4/2005	430	8.4
3/25/2005	140	3.8	5/5/2005	427	7.9
3/26/2005	147	4.1	5/6/2005	457	8.1
3/27/2005	168	2.5	5/7/2005	441	8.7
3/28/2005	187	2.2	5/8/2005	407	8.5
3/29/2005	177	3.4	5/9/2005	490	7.2
3/30/2005	168	3.3	5/10/2005	1080	7.8
3/31/2005	152	3.7	5/11/2005	660	7.6
4/1/2005	172	3.7	5/12/2005	534	8.4
4/2/2005	178	4.4	5/13/2005	495	8.9
4/3/2005	166	4.3	5/14/2005	491	9.1
4/4/2005	161	4.3	5/15/2005	497	9.5
4/5/2005	148	5.1	5/16/2005	509	8.6
4/6/2005	151	4.8	5/17/2005	430	8.2
4/7/2005	185	6.4	5/18/2005	401	7.7
4/8/2005	192	6.0	5/19/2005	438	7.4
4/9/2005	180	5.4	5/20/2005	404	7.6
4/10/2005	167	5.7	5/21/2005	376	7.2

Date	Average Daily CFS	Average Daily Temp C	Date	Average Daily CFS	Average Daily Temp C
5/22/2005	362	6.9	7/8/2005	53	16.0
5/23/2005	334	7.9	7/9/2005	76	14.4
5/24/2005	307	8.5	7/10/2005	62	14.2
5/25/2005	295	9.4	7/11/2005	55	13.9
5/26/2005	295	10.1	7/12/2005	50	15.0
5/27/2005	310	10.8	7/13/2005	47	16.4
5/28/2005	326	11.5	7/14/2005	49	16.6
5/29/2005	345	12.3	7/15/2005	50	16.9
5/30/2005	346	13.2	7/16/2005	51	16.2
5/31/2005	317	13.2	7/17/2005	49	16.4
6/1/2005	315	11.5	7/18/2005	45	17.1
6/2/2005	268	10.5	7/19/2005	41	18.3
6/3/2005	243	10.6	7/20/2005	40	18.5
6/4/2005	218	11.0	7/21/2005	40	18.1
6/5/2005	216	10.6	7/22/2005	40	18.3
6/6/2005	208	9.6	7/23/2005	42	17.6
6/7/2005	178	9.2	7/24/2005	39	16.9
6/8/2005	174	8.9	7/25/2005	38	17.3
6/9/2005	156	8.9	7/26/2005	37	17.9
6/10/2005	143	10.6	7/27/2005	36	18.3
6/11/2005	137	12.1	7/28/2005	35	18.5
6/12/2005	137	12.2	7/29/2005	34	19.2
6/13/2005	134	11.3	7/30/2005	34	19.1
6/14/2005	127	11.9	7/31/2005	33	19.1
6/15/2005	122	11.1	8/1/2005	33	19.3
6/16/2005	111	11.8	8/2/2005	33	18.5
6/17/2005	112	12.5	8/3/2005	33	17.2
6/18/2005	110	12.5	8/4/2005	32	17.6
6/19/2005	101	12.4	8/5/2005	31	17.6
6/20/2005	104	13.4	8/6/2005	30	18.7
6/21/2005	92	14.0	8/7/2005	30	19.3
6/22/2005	92	14.7	8/8/2005	29	19.6
6/23/2005	89	14.5	8/9/2005	29	19.6
6/24/2005	83	14.1	8/10/2005	28	19.6
6/25/2005	79	14.6	8/11/2005	28	19.2
6/26/2005	76	15.5	8/12/2005	28	18.5
6/27/2005	78	15.5	8/13/2005	27	18.6
6/28/2005	79	13.9	8/14/2005	26	18.7
6/29/2005	74	14.9	8/15/2005	25	18.6
6/30/2005	69	15.6	8/16/2005	23	19.0
7/1/2005	66	16.8	8/17/2005	24	19.1
7/2/2005	63	15.9	8/18/2005	27	18.5
7/3/2005	61	15.2	8/19/2005	24	18.0
7/4/2005	56	14.6	8/20/2005	23	17.5
7/5/2005	53	16.1	8/21/2005	22	18.1
7/6/2005	53	16.8	8/22/2005	20	18.5
7/7/2005	56	16.8	8/23/2005	20	18.5

Date	Average Daily CFS	Average Daily Temp C	Date	Average Daily CFS	Average Daily Temp C
8/24/2005	21	16.8	10/10/2005	40	7.9
8/25/2005	20	15.8	10/11/2005	39	7.8
8/26/2005	19	16.4	10/12/2005	39	8.6
8/27/2005	13	16.6	10/13/2005	40	8.1
8/28/2005	11	17.0	10/14/2005	41	8.8
8/29/2005	15	16.7	10/15/2005	39	8.9
8/30/2005	25	15.8	10/16/2005	39	9.2
8/31/2005	26	14.4	10/17/2005	59	9.0
9/1/2005	23	14.8	10/18/2005	72	10.5
9/2/2005	22	15.5	10/19/2005	62	9.9
9/3/2005	21	16.4	10/20/2005	106	9.9
9/4/2005	20	15.3	10/21/2005	79	9.0
9/5/2005	19	14.3	10/22/2005	66	8.7
9/6/2005	18	13.6	10/23/2005	60	7.8
9/7/2005	16	13.7	10/24/2005	56	7.4
9/8/2005	12	14.2	10/25/2005	52	7.9
9/9/2005	15	15.1	10/26/2005	65	7.7
9/10/2005	32	14.6	10/27/2005	61	7.2
9/11/2005	31	12.9	10/28/2005	56	5.3
9/12/2005	27	12.3	10/29/2005	55	6.0
9/13/2005	24	12.9	10/30/2005	54	5.5
9/14/2005	22	12.9	10/31/2005	71	5.1
9/15/2005	20	13.7	11/1/2005	110	4.3
9/16/2005	21	13.8	11/2/2005	91	3.4
9/17/2005	26	12.2	11/3/2005	84	3.8
9/18/2005	25	12.4	11/4/2005	81	3.6
9/19/2005	22	12.2	11/5/2005	80	3.7
9/20/2005	20	13.2	11/6/2005	78	3.5
9/21/2005	19	12.7	11/7/2005	76	3.2
9/22/2005	19	11.2	11/8/2005	69	3.0
9/23/2005	19	10.8	11/9/2005	65	2.6
9/24/2005	19	10.3	11/10/2005	66	3.2
9/25/2005	19	10.1	11/11/2005	134	4.1
9/26/2005	18	10.5	11/12/2005	100	3.6
9/27/2005	16	10.8	11/13/2005	120	3.0
9/28/2005	14	11.5	11/14/2005	171	2.5
9/29/2005	19	10.8	11/15/2005	117	2.3
9/30/2005	177	12.0	11/16/2005	107	1.8
10/1/2005	68	11.2	11/17/2005	125	2.7
10/2/2005	51	9.9	11/18/2005	113	2.9
10/3/2005	41	8.2	11/19/2005	121	3.0
10/4/2005	38	8.7	11/20/2005	123	3.0
10/5/2005	36	8.0	11/21/2005	120	2.9
10/6/2005	35	8.2	11/22/2005	118	2.7
10/7/2005	58	8.9	11/23/2005	110	2.4
10/8/2005	56	9.0	11/24/2005	100	2.0
10/9/2005	42	7.8	11/25/2005	98	1.5

Appendix B

Nason Creek spring chinook and steelhead screw trap efficiency trial details, 2005.

Date Released	Number Marked	Recap 1st day	Recap 2nd day	Total Recaps	Percent Recap	Average Daily CFS
			Spring Chinook Yearling			
back position						
03/31/05	12	1	0	1	8.3%	140
04/04/05	28	3	0	3	10.7%	147
04/07/05	55	8	0	8	14.5%	170
04/12/05	26	3	3	6	23.1%	156
04/15/05	16	1	0	1	6.3%	139
04/21/05	32	4	0	4	12.5%	218
04/25/05	60	13	0	13	21.7%	576
04/27/05	18	1	0	1	5.6%	780
Pooled	**247**	**34**	**3**	**37**	**15.0%**	
			Spring Chinook Subyearling			
back position						
07/11/05	99	3	0	3	3.0%	55
forward position						
10/03/05	44	23	1	24	54.5%	84
10/05/05	62	26	3	29	46.8%	80
10/07/05	28	1	0	1	3.6%	58
10/10/05	48	28	1	29	60.4%	40
10/17/05	36	5	0	5	13.9%	59
10/21/05	27	9	0	9	33.3%	79
10/25/05	57	19	1	20	35.1%	52
10/29/05	42	7	0	7	16.7%	55
11/03/05	178	16	1	17	9.6%	84
11/07/05	40	7	0	7	17.5%	76
11/10/05	51	6	1	7	13.7%	66
11/14/05	73	22	1	23	31.5%	171
11/18/05	46	2	0	2	4.3%	113
Pooled	**732**	**171**	**9**	**180**	**24.6%**	

		Steelhead Parr (60mm to 124mm)				
back position						
04/04/05	2	0	0	0	0.0%	147
04/21/05	8	0	1	1	12.5%	218
04/25/05	68	4	0	4	5.9%	576
04/27/05	100	4	0	4	4.0%	780
05/03/05	35	trap pulled, hatchery release			0.0%	404
Pooled	**213**	**8**	**1**	**9**	**4.2%**	
forward position						
10/03/05	176	34	1	35	19.9%	84
10/05/05	161	31	2	33	20.5%	80
10/07/05	37	2	0	2	5.4%	58
10/10/05	31	2	0	2	6.5%	40
10/17/05	9	0	0	0	0.0%	59
10/21/05	15	0	0	0	0.0%	79
10/25/05	8	0	0	0	0.0%	52
10/29/05	5	0	0	0	0.0%	55
11/03/05	14	1	0	1	7.1%	84
11/07/05	4	0	0	0	0.0%	76
11/10/05	1	1	0	1	100.0%	66
11/14/05	20	1	1	2	10.0%	171
11/18/05	5	0	0	0	0.0%	113
Pooled	**486**	**72**	**4**	**76**	**15.6%**	
		Steelhead Smolt/pre-Smolt (>124mm)				
back position						
04/25/05	5	0	0	0	0.0%	576
04/27/05	36	7	0	7	19.4%	780
05/03/05	2	trap pulled, hatchery release			0.0%	404
06/06/05	13	0	0	0	0.0%	203
Pooled	**56**	**7**	**0**	**7**	**12.5%**	
forward position						
10/03/05	24	5	0	5	20.8%	84
10/05/05	15	4	0	4	26.7%	80
10/10/05	7	3	0	3	42.9%	40
10/17/05	4	0	0	0	0.0%	59
10/21/05	3	0	0	0	0.0%	79
10/25/05	4	1	1	2	50.0%	52
10/29/05	10	0	0	0	0.0%	55
11/03/05	18	4	3	7	38.9%	84
11/07/05	8	2	0	2	25.0%	76
11/10/05	9	2	0	2	22.2%	66
11/14/05	8	2	0	2	25.0%	171
11/18/05	6	0	0	0	0.0%	113
Pooled	**116**	**23**	**4**	**27**	**23.3%**	

Appendix C

Nason Creek spring chinook and steelhead screw trap efficiency and stream discharge relationship regression analysis, 2005.

Spring Chinook Yearling
Eliminated sample size groups < 25

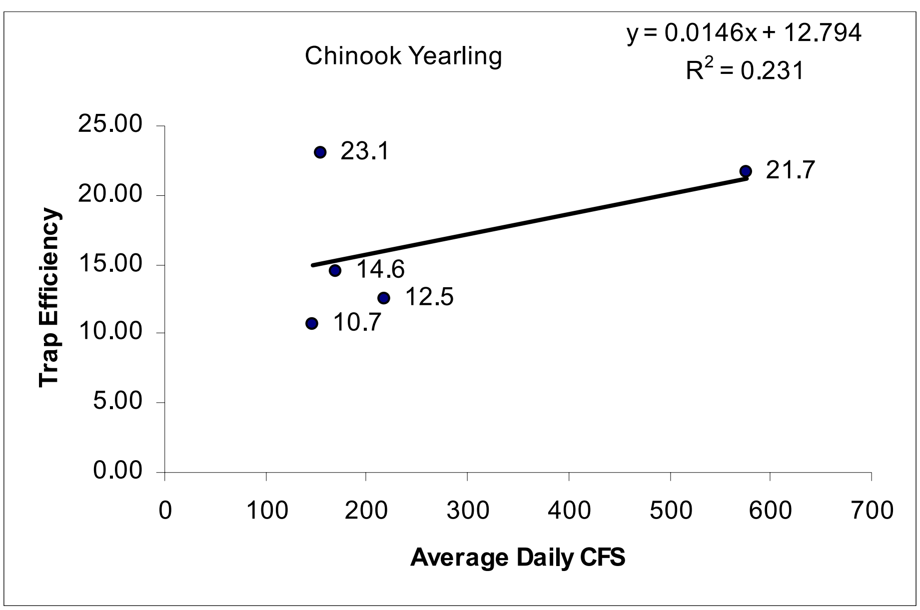
Marked	Efficiency	CFS
28	10.71	147
55	14.55	170
26	23.08	156
32	12.50	218
60	21.67	576

Regression Statistics	
Multiple R	0.480593
R Square	0.23097
Adjusted R Square	-0.02537
Standard Error	5.623206
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	28.49055	28.49055	0.901017	0.412537
Residual	3	94.86133	31.62044		
Total	4	123.3519			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	12.79443	4.645453	2.754184	0.070495	-1.98949	27.57835
X Variable 1	0.014631	0.015414	0.949219	0.412537	-0.03442	0.063686



Spring Chinook Subyearling
Eliminated sample size < 40

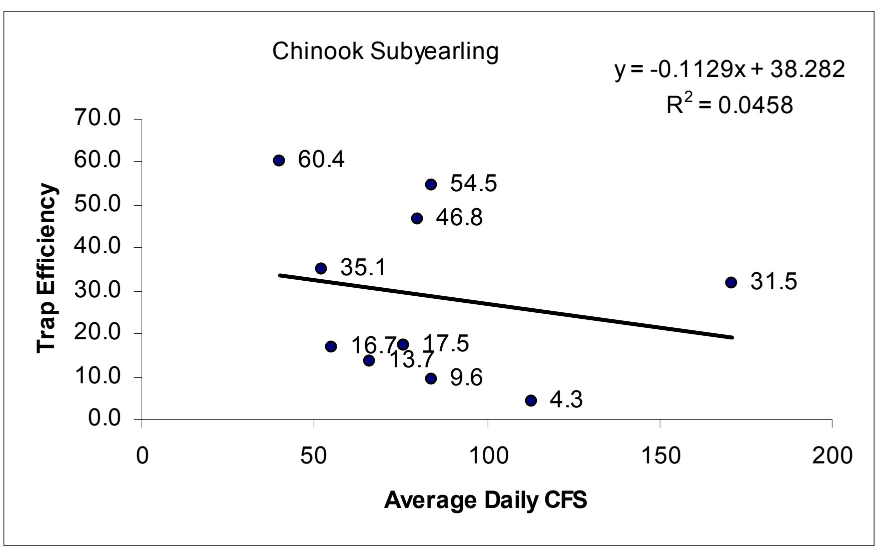
Marked	Efficiency	CFS
44	54.5	84
62	46.8	80
48	60.4	40
57	35.1	52
42	16.7	55
178	9.6	84
40	17.5	76
51	13.7	66
73	31.5	171
46	4.3	113

Regression Statistics	
Multiple R	0.213965
R Square	0.045781
Adjusted R Square	-0.0735
Standard Error	20.43947
Observations	10

ANOVA

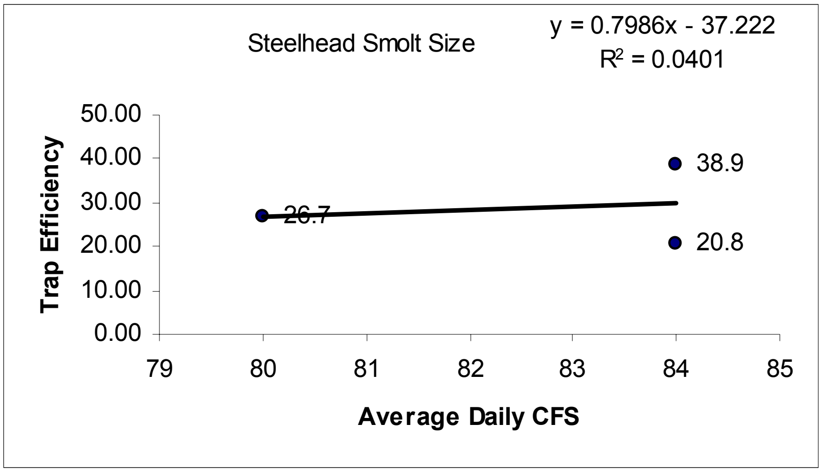
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	160.3489	160.3489	0.383819	0.552797
Residual	8	3342.175	417.7719		
Total	9	3502.524			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	38.28161	16.29848	2.348784	0.04677	0.697221	75.866
X Variable 1	-0.1129	0.182242	-0.61953	0.552797	-0.53316	0.307346



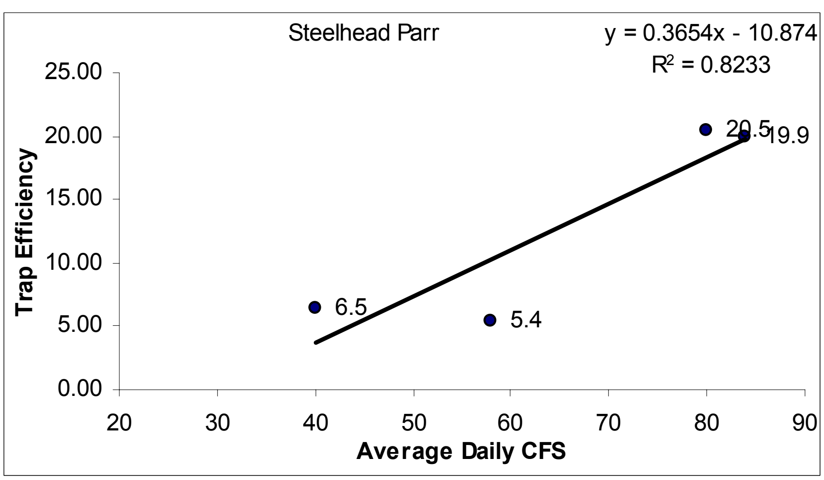
Steelhead Smolt/pre-Smolt (>120mm)
Eliminated sample size groups ≤ 10

Marked	Efficiency	CFS
24	20.83	84
15	26.67	80
18	38.89	84



Steelhead Parr (60mm to 120mm)
Eliminated sample size groups < 30

Marked	Efficiency	CFS
176	19.89	84.00
161	20.50	80.00
37	5.41	58.00
31	6.45	40.00



Appendix D

Nason Creek smolt trap photographs.

Photo 1. Trap site overview, March 2nd, 2004. Stream discharge was 133 cfs.

Photo 2. Trap in position, March 8th, 2004. Stream discharge was 366 cfs.

Photo 3. Trap in position, March 26th, 2005. Stream discharge was 147 cfs.


Photo 4. Fish work up, April 29th, 2004. Stream discharge was 776 cfs.

APPENDIX B: 2005 WENATCHEE AND METHOW BASIN COHO RELEASE NUMBER AND MARK GROUPS

APPENDIX B: 2005 Wenatchee and Methow Basin Coho Release Numbers and Mark Groups.

Basin	River	Acclimation Site	Rearing Hatchery	Brood Source*	Release Date	CWT Code	Retention	CWTs Released	Total Smolts Released	Total Smolts Received
Wenatchee	Nason Cr	Coulter Pond	Willard NFH	MCR-WEN	04/06/2005	**052168**	98.8%	28923	29275	32973
							Total	**28923**	**29275**	**32973**
Wenatchee	Nason Cr	Butcher Creek	Willard NFH	MCR-WEN	04/27/2005	**052167**	99.2%	31515	31769	35049
Wenatchee	Nason Cr	Butcher Creek	Willard NFH	MCR-WEN	04/27/2005	**052166**	99.4%	29645	29824	32902
							Total	**61160**	**61593**	**67951**
Wenatchee	Nason Cr	Mahar Pond	Willard NFH	MCR-WEN	04/25/2005	**052171**	99.6%	26092	26197	29049
Wenatchee	Nason Cr	Mahar Pond	Willard NFH	MCR-WEN	04/25/2005	**051572**	99.2%	37371	37672	41773
							Total	**63463**	**63869**	**70822**
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	04/25/2005	**052097**	99.6%	23406	23500	27806
							Total	**23406**	**23500**	**27806**
Wenatchee	Icicle Cr	LNFH SFL 23	Willard NFH	MCR-WEN	04/14/2005	**052164**	97.7%	28377	29045	29078
Wenatchee	Icicle Cr	LNFH SFL 8	Willard NFH	MCR-WEN	04/14/2005	**054857**	96.6%	28868	29884	30096
Wenatchee	Icicle Cr	LNFH SFL 7	Willard NFH	MCR-WEN	04/14/2005	**054859**	98.0%	29613	30217	30308
Wenatchee	Icicle Cr	LNFH SFL 11 &12	Cascade FH	MCR-WEN	04/14/2005	**052196**	95.6%	63612	66540	69902
Wenatchee	Icicle Cr	LNFH SFL 17 & 18	Cascade FH	MCR-WEN	04/14/2005	**052195**	96.9%	66103	68218	69631
Wenatchee	Icicle Cr	LNFH SFL 19 & 20	Cascade FH	MCR-WEN	04/14/2005	**052193**	97.6%	64624	66213	67200
Wenatchee	Icicle Cr	LNFH SFL 24 & 25	Cascade FH	MCR-WEN	04/14/2005	**052194**	97.1%	60996	62818	65190
Wenatchee	Icicle Cr	LNFH SFL 21 & 22	Cascade FH	MCR-WEN	04/14/2005	**052191**	98.1%	66940	68237	68820
Wenatchee	Icicle Cr	LNFH SFL 9 & 10	Cascade FH	MCR-WEN	04/14/2005	**052190**	98.0%	67694	69076	69526
							Total	**476828**	**490248**	**499751**

APPENDIX B: 2005 Wenatchee and Methow Basin Coho Release Numbers and Mark Groups.

Basin	River	Acclimation Site	Rearing Hatchery	Brood Source*	Release Date	CWT Code	Retention	CWTs Released	Total Smolts Released	Total Smolts Received
Wenatchee	Icicle Cr	LNFH LFL 1	Willard NFH	MCR-WEN	04/14/2005	**052098**	97.8%	27887	28514	28529
Wenatchee	Icicle Cr	LNFH LFL 3	Willard NFH	MCR-WEN	04/14/2005	**052165**	97.9%	29694	30331	30376
Wenatchee	Icicle Cr	LNFH LFL 3	Willard NFH	MCR-WEN	04/14/2005	**052099**	97.9%	26735	27308	27348
Wenatchee	Icicle Cr	LNFH LFL 2	Willard NFH	MCR-WEN	04/14/2005	**054856**	97.5%	30139	30912	31013
Wenatchee	Icicle Cr	LNFH LFL 2	Willard NFH	MCR-WEN	04/14/2005	**052170**	97.5%	32100	32923	33031
Wenatchee	Icicle Cr	LNFH LFL 2	Willard NFH	MCR-WEN	04/14/2005	**052169**	97.5%	27640	28349	28441
Wenatchee	Icicle Cr	LNFH LFL 3	Willard NFH	MCR-WEN	04/14/2005	**054858**	97.9%	29914	30556	30601
Wenatchee	Icicle Cr	LNFH LFL 1	Cascade FH	MCR-WEN	04/14/2005	**052192**	97.8%	68482	70023	70060
							total	**272591**	**278916**	**279399**

Methow	Methow	Winthrop NFH	Winthrop NFH	MCR-WEN	04/19/2005	**051583**	99.9%	70235	70305	70955
Methow	Methow	Winthrop NFH	Winthrop NFH	MCR-MET	04/19/2005	**051581**	99.9%	64539	64604	65501
Methow	Methow	Winthrop NFH	Willard NFH	LCR	04/19/2005	**051580**	98.8%	74881	75790	75818
Methow	Methow	Winthrop NFH	Willard NFH	LCR	04/19/2005	**051582**	98.2%	71682	72996	73022
							Total	**281337**	**283695**	**285296**

	Total Coho	Total CWTs
Wenatchee Basin	947401	926371
Methow Basin	283695	281337

APPENDIX C: SPAWNING GROUND SURVEY RECORDS FOR THE WENATCHEE AND METHOW RIVERS, 2005

Wenatchee	Reach Description	Date	Surveyors	New Redds	Live Fish	Dead Fish	Comments
Nason	Up White Pine Road to Ray Rock	11/10/05	KW, TB	0	0	0	
		Total		**0**	**0**	**0**	
	Ray Rock to Wood Bridge	10/25/05	CS, LS	1	1	0	
		11/03/05	CS, MP	2	1	0	
		11/10/05	SP	4	1	0	
		11/17/05	KW, MP	0	1	0	
		11/23/05	SP	1	0	0	
		Total		**8**	**4**	**0**	
	Wood Bridge to Old Kahler Bridge	10/25/05	TB, MP	0	0	0	Lower half of the reach only
		11/03/05	SP, KW	3	0	1	
		11/17/05	CS	8	2	0	
		11/23/05	CK	0	5	0	
		Total		**11**	**7**	**1**	
	Old Kahler Bridge to Mouth						
		10/25/05	SP, KW	4	3	0	
		11/03/05	KM, LS	3	0	0	
		11/10/05	CS	9	8	0	
		11/17/05	SP	4	0	1	
		11/23/05	CS	2	0	0	
		12/02/05	CK, CS	0	1	1	
		Total		**22**	**12**	**2**	
	Nason Creek Total			**41**	**23**	**3**	

Chiwaukum	Campground to Mouth	10/28/05	SP	1	1	0	
		Total		**1**	**1**	**0**	

APPENDIX C: Spawning ground survey records for the Wenatchee and Methow Rivers, 2005

Wenatchee	Reach Description	Date	Surveyors	New Redds	Live Fish	Dead Fish	Comments
Icicle	Dam 5 to Mouth	10/14/05	CK, SP	0	20+	0	
		10/21/05	CK, TB	10	275+	3	
		11/02/05	SP, TB	9	50+	16	
		11/08/05	CK, TB	112	250+	19	
		11/17/05	CK, TB	97	250+	50	
		11/21/05	CK, TB	115	250+	36	
		11/29/05	CK, KW	71	50+	22	
		12/06/05	CK, KW	38	20	43	Ice on the river
		Total		**452**	**1165+**	**189**	
	Side Channel head gate to Dam 5	10/31/05	TB, KW, MP	0	20+	0	
		11/08/05	SP	20	23	2	All 20 redds were covered by sediment during high flows after the survey was complete
		11/16/05	CK	86	50+	0	
		11/21/05	SP	63	75+	5	
		11/29/05	SP	8	10	5	
		12/07/05	KW	n/a	n/a	2	
		Total		**177**	**155**	**14**	
	Icicle Creek Total			**629**	**1320**	**203**	

Chiwawa	1st Bridge to Mouth		CPUD	0	0	0	
		Total		**0**	**0**	**0**	

Beaver	Pond to Mouth		SP, KW	0	0	0	
		Total		**0**	**0**	**0**	

APPENDIX C: Spawning ground survey records for the Wenatchee and Methow Rivers, 2005

Wenatchee	Reach Description	Date	Surveyors	New Redds	Live Fish	Dead Fish	Comments
Peshastin	Mill Creek to Office	10/21/05	TB	0	0	0	
		11/14/05	CK	0	0	0	
		11/29/05	CS, LS	0	0	0	
		Total		**0**	**0**	**0**	
	Office to Mouth	10/18/05	SP, KW, MP	3	3	1	
		10/28/05	KW, LS, MP	6	3	4	
		11/08/05	CS, LS, MP	6	4	1	
		11/14/05	CS	1	2	2	
		11/21/05	CS	9	6	1	
		11/29/05	TB, MP	0	0	0	
		Total		**25**	**18**	**9**	
	Peshastin Creek Total			**25**	**18**	**9**	

Brender	1st House to Mouth	10/28/05	TB	0	0	0	nearly dry
		11/14/05	SP, MP	5	4	1	
		11/22/05	CK, LS	2	4	0	
		Total		**7**	**8**	**1**	
Mission	Pioneer Street to Mouth	10/28/05	TB	0	0	0	dry
		11/14/05	SP, MP	5	0	1	
		11/22/05	CK, LS	5	6	0	
		Total		**10**	**6**	**1**	
	Mission/Brender Total			**17**	**14**	**2**	

APPENDIX C: Spawning ground survey records for the Wenatchee and Methow Rivers, 2005

Wenatchee	Reach Description	Date	Surveyors	New Redds	Live Fish	Dead Fish	Comments
Wenatchee	Lake to Plain	10/26/05	SP, TB, KW	1	8	0	too many chinook redds to ID coho redds
		10/28/05	SP	1	1	0	Chiwaukum to Bridge
	Plain to Tumwater Bridge	11/18/05	SP, TB	1	0	0	Chiwaukum to Bridge
		11/14/05	CK	6	5	0	
	Tumwater Bridge to Icicle Road Bridge	11/23/04	CK	4	2	0	
	Icicle Road to Boat Launch below Icicle	10/21/05	CK, TB	14	0	0	RB below Icicle
		11/02/05	SP, TB	4	13	0	RB below Icicle
		11/08/05	CK, TB	15	n/a	3	RB below Icicle
		11/16/05	SP, CS	74	49	3	
		11/22/05	SP, CS, MP	49	40	10	
		11/30/05	SP, LS	13	14	1	
		12/06/05	CK, KW	0	0	23	
	Black Bird Island side Channel	11/30/05	SP, LS	8	4	0	
	Boat Launch below Icicle to Peshastin	11/03/05	CK, TB	1	2	0	
		12/07/05	CK	3	0	0	
	Peshastin to Dryden	11/23/05	CK	4	6	4	
	Dryden to Cashmere	11/18/05	CK, CS	16	37	1	
	Cashmere to Mouth	10/24/05	TB, KW, LS	0	0	0	
		11/17/05	TB, LS	11	3	2	
		12/01/05	KW, MP	0	0	18	
	Wenatchee River Total			**224**	**176**	**64**	
	Wenatchee Basin Total			**917**	**1552**	**281**	

APPENDIX C: Spawning ground survey records for the Wenatchee and Methow Rivers, 2005

Methow River	Reach Description	Date	New Redds	Live Fish	Dead Fish	Comments
Spring Creek	Winthrop NFH Outfall - Hatchery to Mouth	11/15/02	0	0	2	
		11/21/05	22	13	2	Total count of all visible redds
		11/25/05	21	1	1	Total count of all visible redds
		Total	**22**	**14**	**5**	

Methow FH Outfall	Hatchery to Mouth	11/21/06	0	1	1	
		11/28/06	3	0	1	
		Total	**3**	**1**	**2**	

Twisp River	RM 2.0 to Mouth	11/28/05	0	0	0	Ice
		11/07/05	0	0	1	
		Total	**0**	**0**	**1**	

Wolf Creek	RM 1.6 to Mouth	10/28/05	0	0	0	
		Total	**0**	**0**	**0**	

Beaver Creek	RM 1.6 to Mouth	10/28/05	0	0	0	
		Total	**0**	**0**	**0**	

Libby Creek	RM 1.0 to Mouth	10/28/05	0	0	0	
		Total	**0**	**0**	**0**	

Methow River	Reach Description	Date	New Redds	Live Fish	Dead Fish	Comments
Methow River	Wolf Creek to Winthrop	11/12/05	0	0	1	
		11/22/05	0	0	1	
	Winthrop to Twisp	12/2/05	0	0	2	
	Twisp to Carlton	11/30/05	1	0	0	
	Carlton to Lower Gold Creek Bridge	12/5/05	4	0	0	
	Lower Gold Creek Bridge to Methow	11/10/05	0	0	1	
		11/22/05	7	1	2	
	Methow to Steel Bridge	11/17/05	0	0	1	
		11/21/05	5	2	0	
	Steel Bridge to Mouth	11/29/2005	1	1	0	
		Total	**18**	**4**	**8**	
Chelan FH Outfall	Hatchery to Mouth	11/11/05	0	0	3	
		11/22/05	0	0	1	
		Total	**0**	**0**	**4**	
Chelan Falls	North-end of Park to Bridge	11/22/05	1	0	0	
		Total	**1**	**0**	**0**	
	Methow Basin Total		**44**	**19**	**20**	

APPENDIX D: Release to McNary Survival Indices for 2005 Wenatchee Basin coho releases

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Release-to-McNary Survival Indices of

2005 Releases into the Wenatchee Basin

Submitted by Doug Neeley

1. Introduction

In this report I summarize two sets of smolt-to-smolt survivals: One presents survivals from to McNary Dam from Butcher Creek acclimation pond and from Rolfing's pond; the other presents survival from release sites to McNary Dam of Willard and Cascade stock Coho. I use comparable data sets from 2004 and 2005. Estimation techniques are discussed in Appendix A. The actual estimates are given in Appendix B.

2. Butcher Creek Pond and Rolfing's Pond Comparisons

Butcher Creek and Lucas Ponds are equipped with PIT-tag detectors which permits the estimation of:

a. In-stream post-release smolt-to-smolt survival from volition release to McNary Passage
b. Acclimation Pond Detection Efficiency
c. Joint Pre-Release Survival and Tag Retention

These estimates are respectively given in Tables 1.a., 1.b. and 1.c. for both outmigration years. Separate Logistic analyses of variation within each year reveal no significant differences between the two acclimation ponds' post-release survival indices (Table 2.a.) or PIT-Tag Detector efficiencies (Table 2.b.). However, the Butcher Creek Acclimation Pond has smaller mean pre-release survival/tag-retention rate than does Rolfing's pond which is nearly significant at the 5% in both 2004 and 2005 (Table 2.c).

Table 1. Estimates of A. Post Release Smolt-to-Smolt Survival Indices, B. Acclimation Pond Detection Efficiencies, and C. Pre-Release Survival and PIT-Tag Retention

A. Smolt-to-Smolt Survival* released from Butcher Creek and Rolfing Ponds

Pond	Year 2004	Year 2005
Butcher	0.3662	0.1637
Rolfing	0.3722	0.1754

* [Expanded Detections at McNary of Pond Detections] divided by [Number Detected leaving Pond]

B. Detection Efficiencies of Butcher Creek and Rolfing Pond PIT-Tag Detectors**

Pond	Year 2004	Year 2005
Butcher	0.9961	0.9821
Rolfing	0.9679	0.9791

** [Volitional release detections at McNary] divided by [Total detections at McNary]

C. Joint Prerelease Survival and Tag-Retention***

Pond	Year 2004	Year 2005
Butcher	0.8831	0.7622
Rolfing	0.9723	0.8884

*** { [Number Detected at Ponds]/ [Number Tagged into Ponds] } divided by [Detection Efficiency]

Table 2. Weighted Logistic Analysis of Variation for A. Post Release Smolt-to-Smolt Survival Indices, B. Acclimation Pond Detection Efficiencies, and C. Pre-Release Survival and PIT-Tag Retention

A. Weighted* Logistic Analysis of Variation of Smolt-to-Smolt-Survival Index**

1) Outmigration Year 2004 (Brood-Year 2002)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev [Dev/DF]	F-Ratio	Type 1 Error P
Butcher Creek vs Rolfing***	0.38	1	0.380	0.03	0.8892
Raceway within Site****	12.29	1	12.290	0.52	0.5244
Tag Group within Raceways	71.43	3	23.810	Chi-Square test for difference from binomial distribution	0.0000

2) Outmigration Year 2005 (Brood-Year 2003)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev [Dev/DF]	F-Ratio	Type 1 Error P
Butcher Creek vs Rolfing***	2.72	1	2.720	0.54	0.5394
Raceway within Site****	10.10	2	5.050	1.23	0.3835
Tag Group within Raceways	16.43	4	4.108	Chi-Square test for difference from binomial distribution	0.0025

* Weight is number detected leaving pond

** [Expanded Detections at McNary of Pond Detections]/ [Number Detected leaving Pond]

*** F test for source uses as denominator mean deviance that for Raceway within Site

**** F test for source uses as denominator mean deviance that for Tag Group within Raceway

B. Weighted* Logistic Analysis of Variation of Detection Efficiency**

1) Outmigration Year 2004 (Brood-Year 2002)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev [Dev/DF]	F-Ratio	Type 1 Error P
Butcher Creek vs Rolfing***	10.28	1	10.280	3.68	0.3058
Raceway within Site****	2.79	1	2.790	1.89	0.2630
Tag Group within Raceways	4.43	3	1.477	Chi-Square test for difference from binomial distribution	0.2186

2) Outmigration Year 2005 (Brood-Year 2003)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev [Dev/DF]	F-Ratio	Type 1 Error P
Butcher Creek vs Rolfing***	0.04	1	0.040	0.01	0.9146
Raceway within Site****	5.44	2	2.720	5.44	0.0723
Tag Group within Raceways	2.00	4	0.500	Chi-Square test for difference from binomial distribution	0.7358

* Weight is total detection at pond

** [Volitional-release detections at McNary]/ [Total detections at McNary]

*** F test for source uses as denominator mean deviance that for Raceway within Site

**** F test for source uses as denominator mean deviance that for Tag Group within Raceway

Table 2. (Continued)

C. Weighted* Logistic Analysis of Variation of Smolt-Smolt-Survival

1) Outmigration Year 2004 (Brood-Year 2002)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev [Dev/DF]	F-Ratio	Type 1 Error P
Butcher Creek vs Rolfing**	319.36	1	319.360	113.65	0.0595
Raceway within Site***	2.81	1	2.810	0.16	0.7179
Tag Group within Raceways	53.47	3	17.823	Chi-Square test for difference from binomial distribution	0.0000

2) Outmigration Year 2005 (Brood-Year 2003)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev [Dev/DF]	F-Ratio	Type 1 Error P
Butcher Creek vs Rolfing**	392.03	1	392.030	16.88	0.0545
Raceway within Site***	46.46	2	23.230	6.60	0.0541
Tag Group within Raceways	14.08	4	3.520	Chi-Square test for difference from binomial distribution	0.0070

* Weight is Number Tagged into Ponds

** { [Number Detected at Ponds]/ [Number Tagged into Ponds] }/ [Detection Efficiency]

*** F test for source uses as denominator mean deviance that for Raceway within Site

**** F test for source uses as denominator mean deviance that for Tag Group within Raceway

3. Willard and Cascade Stock

The Cascade and Willard Stock releases used from the 2004 releases are those that share common release sites and days of release within the release site: Those selected from Icicle Creek were those released on April 23 and those from Winthrop were released on April 20. The releases used from the 2005 releases are from Large Foster Pond made on April 14 and from Small Foster Pond on April 15. Since these release sites did not have detectors, the release-site-to-McNary-Dam survival index estimates are based on all tagged fish, and these survival estimates could be affected by pre-release tag shedding and pre-release mortality as well as in stream mortality.

Survival estimates are summarized in Table 3. The mean survival indices of the two stocks are similar in 2004. Although the mean survival indices of the Cascade stock is higher than that of the Willard stock in 2005, that difference is driven by the large survival difference from the Large Foster Pond releases; the Cascade survival index estimate from Small Foster Pond is actually somewhat smaller than from Willard. A weighted logistic analysis of variation is presented in Table 4, and as can be seen, none of the sources (Year, Stock, Year x Stock Interaction) when tested against the Pond x Stock within Year source) are significant.

Table 3 Tagging-to-McNary Smolt-to-Smolt Survival Indices for Willard and Cascade Coho Stock Releases into mid-Columbia Tributaries in 2004 and 2005

2004 Releases				
Stock	Measure	Icicle Creek (4/23 release)	Winthrop (4/20 release)	2004 Mean
Willard	Number Tagged	4341	4463	8804
	Survival Index	0.5509	0.2610	0.4040
Cascade	Number Tagged	3982	4481	8463
	Survival Index	0.6083	0.2951	0.4425
2005 Releases				
Stock	Measure	Large Foster (4/14 release)	Small Foster (4/15 release)	2005 Mean
Willard	Number Tagged	3999	3106	7105
	Survival Index	0.3448	0.4448	0.3885
Cascade	Number Tagged	3919	3448	7367
	Survival Index	0.6181	0.3981	0.5151

Table 4 Weighted Logistic Analysis of Variation comparing Willard and Cascade Coho Stock Smolt-to-Smolt Survival Indices over Release Years and Sites

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Dev [Dev/DF]	F-Ratio	Type 1 Error P
Year*	26.38	1	26.38	0.14	0.7428
Stock (unadj)*	202.8	1	202.80	1.09	0.4062
Stock (adj)*	200.16	1	200.16	1.08	0.4087
Year x Stock*	60.93	1	60.93	0.33	0.6250
Pond w/in Year*	1690.35	2	845.18	4.54	0.1805
Pond x Stock within Year**	372.38	2	186.19	14.88	0.0047
Tag Group within Pond***	75.08	6	12.51	Chi-Square test for difference from binomial distribution =	0.0000

* F test for source uses as denominator mean deviance that for Pond w/in Year x Pond

** F test for source uses as denominator mean deviance that for Tag Group with/in Pond

*** The Tag group within pond would be expected to be binomially distributed if tagging procedures were uniform, but the mean devince differs significantly from what would be expected from a binomial (Chi-Square test P)

Appendix A. Survival Index

The estimated smolt-to-smolt survival index to McNary Dam (McNary) is given in Equation A.1:

Equation A.1

$$\text{Smolt - to - Smolt Survival Index to McNary} = \frac{\sum_{\text{Strata}} \text{Estimated Number of Released (or Tagged) Fish Passing McNary during a given Stratum}}{\text{Number of Fish Released (or Tagged)}}$$

If PIT-tagged fish are actually enumerated (interrogated and tallied) at the time of volitional release from the acclimation pond, and if these fish are the only ones enumerated at McNary for passage estimation, then Equation A.1 estimates in-stream survival from release point to McNary passage. If the number of fish tagged is used as a base instead of the release number, then the survival-index is an estimate of survival from time of tagging to McNary passage, in which case Equation A.1 is affected by both pre-release mortality and tag-shedding in addition to in-stream mortality. Subsequent equations will denote volitional-release-to-McNary-passage survival, but the same procedures can be applied to time-of-tagging-to-McNary-passage survival.

Equation A.1's numerator's daily passage estimate is given in Equation A.2:

Equation A.2

$$\text{Estimated Number of Released Fish Passing McNary during Stratum} = \frac{\text{(Number of Fish Detected at McNary during Stratum) - (Number of Detected Fish Removed during Stratum)}}{\text{McNary Detection Rate associated with Stratum}} + \text{Number of Detected Fish Removed during Stratum}$$

The detected fish removed are those fish that may have inadvertently diverted into transportation vehicles at McNary or may have been sampled and sacrificed for research purposes unrelated to the research goals of the Mid-Columbia supplementation effort.

The McNary detection rate is the proportion of all fish passing McNary that are detected within the McNary bypass system (excluding those removed from at McNary).

The McNary detection efficiency is not constant over days, and fish from a release may pass McNary over a period within which the detection efficiency varies. Groups of contiguous days are identified within which the daily McNary detection efficiencies are relatively homogeneous.

These groups of days are referred to here as strata, and detection efficiencies are estimated for each of these strata by pooling the detections over days within the stratum. The number of a release's fish detected at McNary Dam during a given stratum is divided (expanded) by detection efficiency for the stratum containing the day to obtain the estimated passage.

The detection efficiency is based on detections made at dams downstream of McNary and is estimated for the stratum by dividing the number of fish jointly detected at McNary and the downstream dams by the total detections at the downstream dam within the stratum

Equation A.3

$$\text{Stratum's McNary Detection Efficieny} = \frac{\text{Stratum's Number of Joint Detections at NcNary and Downstream Dam}}{\text{Stratum's Total Number of Detections at Downstream Dam}}$$

Initially, detection rates are estimated for each day of McNary passage. There are two downstream detection sites, John Day Dam (John Day) and Bonneville Dam (Bonneville). In some recent years, experiments have been conducted at John Day that varied the proportion of flow spilled during the day relative to the proportion spilled during the night. To meet electric power needs, Bonneville's spill was also varied within twenty-four periods. Given this situation, it is deemed more appropriate to pool individual John Day and Bonneville Dam-based estimates. This is effectively "sampling with replacement" for which the some fish will enter into the joint McNary-downstream-site tally twice or into the downstream tally twice when detected at both John Day and Bonneville.

Detection efficiency Estimation: Benjamin Sandford (NOAA Fisheries, Pasco Field Station, Washington) and Steven Smith (NOAA Fisheries, Seattle) recommended the following method of estimating daily detection efficiencies:

a. For each downstream dam, joint McNary and downstream detections are cross-tabulated by McNary date of first detection and by down-stream-dam first date of detection [Table A.1)].

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

c. The resulting relative distribution frequencies are then multiplied by the total downstream dam's detections for the corresponding downstream-detection date [Table A.3)].

d. Once this is done for each downstream dam's detection date, the estimated total downstream detections allocated to a given McNary detection date are added over downstream-dam detection dates [Table A.3), far-right-hand column]. This gives the estimated total downstream-dam detections that pass McNary on the given McNary date.

e. The total joint detections on a given McNary detection date from Table A.1) is then divided by the corresponding total detections from Table A.3) to estimate that date's McNary detection efficiency [Table A.4)].

Actually, before this last step, Table A.1)'s numbers are pooled over John Day and Bonneville Dams, and the same is done for Table A.3)'s downstream estimated total counts.

Daily detection efficiencies are then stratified into contiguous days of relatively homogeneous detection efficiencies, and the daily detection-efficiency estimates are pooled over days within the strata. The strata's beginning and ending dates are chosen in a manner such that the variation among daily detection efficiencies within strata is minimized and the detection-rate variation among strata is maximized. This is done using step-wise logistic regression based on all possible partitionings. In the first step, the partitioning that minimized the variation among daily detection efficiencies within-strata is selected. Then, the second partitioning is selected in a similar fashion within the two groups formed by first partitioning. The process is continued as long as the detection efficiencies of the strata created by the step's partitioning significantly differ at the 10% significance level (Type 1 error p estimate ≤ 0.1).

There are two exceptions to this process:

a. Separate John-Day-detection-based and Bonneville-detection-based estimates of McNary detection efficiencies are also made for each stratum; and, if the Bonneville-based estimate in one of the created strata is greater (or alternatively less) than that in another adjacent stratum, but the John-Day-based McNary detection efficiency in the one is less (or alternatively greater) than that in the other, then the partitioning is not accepted.

b. If the joint McNary and down-stream detections, pooled over Bonneville and John Day, in either of the two strata resulting from the partitioning resulted in less than 20 joint detections, the partitioning is not accepted.

Table A. Conceptual method of estimating detection efficiencies

1) Joint McNary (McN), Downstream-Site (D.S.) Counts by McN and D.S. Dates

McNary Dam Date (Julian)	n(McNary Dam Date, DownstreamSite Dam) [n(McN,D.S.)]						TOTAL
	Downstream Site Date (Julian)						
	…	100	101	**102**	103	…	
90	…	…	…	**…**	…	…	**n(90,.)**
…	…	…	…	**…**	…	…	**…**
94	…	n(94,100)	n(94,101)	**0**	0	…	**n(94,.)**
95	…	n(95,100)	n(95,101)	**n(95,102)**	0	…	**n(95,.)**
96	…	0	n(96,101)	**n(96,102)**	n(96,103)	…	**n(96,.)**
97	…	0	0	**n(97,102)**	n(97,103)	…	**n(97,.)**
98	…	0	0	**n(98,102)**	n(98,103)	…	**n(98,.)**
99	…	0	0	**0**	0	…	**n(99,.)**
…	…	…	…	**…**	…	…	**…**
200	…	…	…	**…**	…	…	**n(200,.)**
TOTAL		n(.,100)	n(.,101)	**n(.,102)**		…	

2) For each Downstream Site Date, Estimate Distribution of McNary Date Contributions

McNary Dam Date (Julian)	p(McN,D.S.) = n(McN,D.S.)/n(D.S.) [n's from Table 1)]					
	Downstream Site 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	…	0	p(96,101)	**p(96,102)= n(96,102)/n(.,102)**	n(96,103)	…
97	…	0	0	**p(97,102)= n(97,102)/n(.,102)**	n(97,103)	…
98	…	0	0	**p(98,102)= n(98,102)/n(.,102)**	n(98,103)	…
99	…	0	0	**0**	0	…
…	…	…	…	**…**	…	…
200	…	…	…	**…**	…	…
TOTAL		1	1	**1**	1	

Table A. Conceptual method of estimating detection efficiencies (continued)

3) Allocate Daily Lower Site Counts [N(D.S.)] over McNary Dates using above distributions and add over Lower Dam Dates within McNary Dates [p's from Table 2)]

McNary Dam Date (Julian)	N'(McN,D.S.) = p(McN,D.S.)*N(D.S.)						McNary Dam TOTAL N'(McN,.)
	Downstream Site Date (Julian)						
	…	100	101	102	103	…	
		N(100)	N(101)	Lower Dam Detections = N(102)	N(103)		
90	…	…	…	…	…	…	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	…	0	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	0	0	…	N'(99,.)
…	…	…	…	…	…	…	
200	…	…	…	…	…	…	
TOTAL		N(100)	N(101)	N(102)	N(103)	…	

4) Use McN-Date Joint (Table 1) and total to compute McN Detection Rates

McNary Dam Date (Julian)	Table 1) n Total	Table 3) N' Total	Estimated Detection Rate, D.R. = n/N'
90	n(90,.)	N'(90,.)	D.R.(90) = n(90,.)/N'(90,.)
…	…	…	…
94	n(94,.)	N'(94,.)	D.R.(94) = n(94,.)/N'(94,.)
95	n(95,.)	N'(95,.)	D.R.(95) = n(95,.)/N'(95,.)
96	n(96,.)	N'(96,.)	D.R.(96) = n(96,.)/N'(96,.)
97	n(97,.)	N'(97,.)	D.R.(97) = n(97,.)/N'(97,.)
98	n(98,.)	N'(98,.)	D.R.(98) = n(98,.)/N'(98,.)
99	n(99,.)	N'(99,.)	D.R.(99) = n(99,.)/N'(99,.)
…	…	…	..
200	n(200,.)	N'(200,.)	D.R.(200) = n(200,.)/N'(200,.)

On completion of the stepwise process, each partitioning is shifted at one-day increments between the two adjacent partitionings to see if the among-day within-stratum variation could be further reduced. If so, the partitioning that resulted in the greatest significant reduction in the variation in among-day within-stratum detection rates is selected, again subject to the exceptions listed above.

There are instances for which downstream dam dates have total counts but have no joint downstream-dam and McNary Dam counts. Ignoring these dates would tend to over-estimate the detection efficiency. What is done to adjust for such an overestimation is to:

a. Take such a downstream dam date and use offset[6] McNary distributions from six contiguous downstream dates that immediately precede this non-joint detection date and from six contiguous dates that follow this non-joint detection date;

b. Pool the offset McNary passage-time distributions from these twelve adjacent group dates; and

c. Apply this distribution (as a relative distribution) to the total count for the non-joint-detection date.

The resulting McNary-date-distributed counts are then allocated to the stratum to which the McNary date of detection belongs. In most cases so far observed, these allocations occur for days very early in the passage or very late in passage. Usually the downstream dam detections from such non-joint-detection days are allocated to either the earliest or the latest detection stratum.

[6] The distribution for day I for the missing joint-count-distribution day J would use distributions from day I-1 for the downstream distribution day (ddd) J-1, day I-2 for the ddd J-2, …, I-6 for ddd J-6; similarly, it would use distributions from day I+1 for the ddd J+1, day I+2 for the ddd J+2, …, I+6 for ddd J+1.

Assumptions behind the detection efficiency estimation procedures are as follows:

a. For a given McNary-passage date, survivals from McNary to downstream dam(s) are equal for all routes of McNary passage.

b. For a given McNary-passage date, fish from all routes of McNary passage are temporally and spatially well mixed before reaching downstream dams.

c. The probability of a fish being detected at a downstream dam is independent of whether or not the fish has been detected at an evaluated upstream dam (e.g., probability of being detected at Bonneville is independent of detection at John Day or McNary, probability of detection at John Day is independent of detection at McNary).

d. For fish detected on a given day at a downstream dam, the distribution of McNary passage is the same for fish detected and for fish not detected at McNary.

Assumption a: Assumption a. is unlikely to hold. Downstream survivals from McNary of fish passing through the bypass, through the turbines, and over the spillway are unlikely to be equal.

Assumption b: An example of how Assumption b. could fail is if a fish passing through the turbines is more likely to hold in the tailrace longer than a fish passing, say, over the spillway or through the bypass system.

Assumption c: An example of how Assumption c. could fail would be if one fish tends to swim more shallowly than another fish when approaching the powerhouse. Such a fish would be more likely to be diverted into the bypass at each dam than the other fish.

Assumption d: Assumption d. is unlikely to hold. The fact that jointly detected fish can be subjected to differential daily McNary detection rates over McNary detection days for a given day of downstream dam passage would guarantee that the distribution of McNary passage would differ for fish detected and for fish not detected at McNary. Further, since the daily estimates share portions of total daily passages [Refer back to Table A.3)], the daily estimates will not be independent. The detection rates, as currently estimated, should be regarded as biased, and any derived estimates of passage time or of survival should be regarded as indices rather than absolute estimates.

The estimated detection rates and the survival estimates are given in Appendix B.

Appendix B. Estimates McNary Detection Rates, Passage, and Survival Indices

Table B.1. McNary Detection Rates

a) 2004 estimates

	McNary Passage Date				Bonneville			John Day		
	Beginning		Ending		Detections		McN Detection	Detections		McN Detection
Stratum	Calendar	Julian	Calendar	Julian	Total*	Joint**	Rate	Total*	Joint**	Rate
1	4/2/2004	92	5/28/2004	149	484.2	76.0	0.15697	831.5	117.0	0.14070
2	4/13/2004	150	6/1/2004	153	132.9	24.0	0.18062	376.2	67.0	0.17811
3	5/1/2004	154	6/4/2004	156	111.9	28.0	0.25024	213.1	58.0	0.27223
4	5/4/2004	157	9/30/2004	274	229.0	45.0	0.19647	436.2	79.0	0.18110

	McNary Passage Date				Pooled		
	Beginning		Ending		Detections		McN Detection
Stratum	Calendar	Julian	Calendar	Julian	Total*	Joint**	Rate
1	4/2/2004	92	5/28/2004	149	1315.7	193	0.14669
2	4/13/2004	150	6/1/2004	153	509.1	91	0.17876
3	5/1/2004	154	6/4/2004	156	325.0	86	0.26466
4	5/4/2004	157	9/30/2004	274	665.3	124	0.18639

* Total downstream-dam McN Dam count estimated from downstream daily count and joint count McNary date distributions

** Joint counts of fish detected at both downstream and McNary dams according to McNary day of first detection

b) 2005 estimates

	McNary Passage Date				Bonneville			John Day		
	Beginning		Ending		Detections		McN Detection	Detections		McN Detection
Stratum	Calendar	Julian	Calendar	Julian	Total*	Joint**	Rate	Total*	Joint**	Rate
1	5/11/2005	131	5/16/2005	136	32.2	5.0	0.15506	125.4	15.0	0.11957
2	5/17/2005	137	5/18/2005	138	44.3	9.0	0.20329	47.6	10.0	0.21004
3	5/19/2005	139	5/29/2005	149	149.8	53.0	0.35370	281.8	84.0	0.29810
4	5/30/2005	150	6/3/2005	154	63.9	11.0	0.17209	211.3	22.0	0.10412
5	6/4/2005	155	6/29/2005	180	82.7	13.0	0.15716	118.9	23.0	0.19350

	McNary Passage Date				Pooled		
	Beginning		Ending		Detections		McN Detection
Stratum	Calendar	Julian	Calendar	Julian	Total*	Joint**	Rate
1	5/11/2005	131	5/16/2005	136	157.7	20	0.12683
2	5/17/2005	137	5/18/2005	138	91.9	19	0.20679
3	5/19/2005	139	5/29/2005	149	431.6	137	0.31741
4	5/30/2005	150	6/3/2005	154	275.2	33	0.11990
5	6/4/2005	155	6/29/2005	180	201.6	36	0.17859

* Total downstream-dam McN Dam count estimated from downstream daily count and joint count McNary date distributions

** Joint counts of fish detected at both downstream and McNary dams according to McNary day of first detection

Table B.2. Expansions and Survival Indices

a) 2004 estimates

Volitional Release Estimates

	Stratum	Detection Rate	Release Date > Tag Group >	Butcher 04/28/04 KGM04022.BL1	04/28/04 KGM04022.BL2	05/06/04 KGM04022.MP1	05/06/04 KGM04022.MP2
STRATUM 1	1	0.1467	TOTAL (T)	33	32	23	18
	from		REMOVAL (R)	1	0	0	0
	01-May-04		T-R	32	32	23	18
	to		EXPANSIONS	218.15	218.15	156.80	122.71
	28-May-04		PASSAGE	219.15	218.15	156.80	122.71
STRATUM 2	2	0.1788	TOTAL (T)	26	30	18	34
	from		REMOVAL (R)	0	1	0	0
	29-May-04		T-R	26	29	18	34
	to		EXPANSIONS	145.44	162.23	100.69	190.20
	01-Jun-04		PASSAGE	145.44	163.23	100.69	190.20
STRATUM 3	3	0.2647	TOTAL (T)	23	32	37	25
	from		REMOVAL (R)	0	0	1	0
	02-Jun-04		T-R	23	32	36	25
	to		EXPANSIONS	86.91	120.91	136.03	94.46
	04-Jun-04		PASSAGE	86.91	120.91	137.03	94.46
STRATUM 4	4	0.1864	TOTAL (T)	43	36	43	62
	from		REMOVAL (R)	1	1	0	0
	05-Jun-04		T-R	42	35	43	62
	to		EXPANSIONS	225.33	187.78	230.70	332.64
	08-Sep-04		PASSAGE	226.33	188.78	230.70	332.64
Over Strata			Expanded Volitional McNary Passage	677.83	691.07	625.21	740.00
			Volitional Releas	1503	2036	1602	2325
			Volitional Survival Index	0.4510	0.3394	0.3903	0.3183

	Stratum	Detection Rate	Release Date > Tag Group >	Rolfing (Mahar) 04/28/04 KGM04023.BW1	04/28/04 KGM04023.BW2
STRATUM 1	1	0.1467	TOTAL (T)	2	7
	from		REMOVAL (R)	0	1
	01-May-04		T-R	2	6
	to		EXPANSIONS	13.63	40.90
	28-May-04		PASSAGE	13.63	41.90
STRATUM 2	2	0.1788	TOTAL (T)	20	19
	from		REMOVAL (R)	0	0
	29-May-04		T-R	20	19
	to		EXPANSIONS	111.88	106.29
	01-Jun-04		PASSAGE	111.88	106.29
STRATUM 3	3	0.2647	TOTAL (T)	24	28
	from		REMOVAL (R)	0	0
	02-Jun-04		T-R	24	28
	to		EXPANSIONS	90.68	105.80
	04-Jun-04		PASSAGE	90.68	105.80
STRATUM 4	4	0.1864	TOTAL (T)	72	99
	from		REMOVAL (R)	2	0
	05-Jun-04		T-R	70	99
	to		EXPANSIONS	375.56	531.14
	08-Sep-04		PASSAGE	377.56	531.14
Over Strata			Expanded Volitional McNary Passage	593.75	785.13
			Volitional Releas	1512	2193
			Volitional Survival Index	0.3927	0.3580

Table B.2. Expansions and Survival Indices (cont.)

a) 2004 estimates (cont.)

Release Estimates based on all Fish tagged

	Stratum	Detection Rate	Release Date > Tag Group >	Butcher 04/28/04 KGM04022.BL1	04/28/04 KGM04022.BL2	05/06/04 KGM04022.MP1	05/06/04 KGM04022.MP2
STRATUM 1	1	0.1467	TOTAL (T)	33	32	23	18
	from		REMOVAL (R)	1	0	0	0
	01-May-04		T-R	32	32	23	18
	to		EXPANSIONS	218.15	218.15	156.80	122.71
	28-May-04		PASSAGE	219.15	218.15	156.80	122.71
STRATUM 2	2	0.1788	TOTAL (T)	26	31	18	34
	from		REMOVAL (R)	0	1	0	0
	29-May-04		T-R	26	30	18	34
	to		EXPANSIONS	145.44	167.82	100.69	190.20
	01-Jun-04		PASSAGE	145.44	168.82	100.69	190.20
STRATUM 3	3	0.2647	TOTAL (T)	23	32	37	25
	from		REMOVAL (R)	0	1	1	0
	02-Jun-04		T-R	23	31	36	25
	to		EXPANSIONS	86.91	117.13	136.03	94.46
	04-Jun-04		PASSAGE	86.91	118.13	137.03	94.46
STRATUM 4	4	0.1864	TOTAL (T)	43	37	43	62
	from		REMOVAL (R)	1	0	0	0
	05-Jun-04		T-R	42	37	43	62
	to		EXPANSIONS	225.33	198.51	230.70	332.64
	08-Sep-04		PASSAGE	226.33	198.51	230.70	332.64
Over Strata			Expanded Volitional McNary Passage	677.83	703.61	625.21	740.00
			Volitional Releas	1741	2274	1837	2638
			Volitional Survival Index	0.3893	0.3094	0.3403	0.2805

	Stratum	Detection Rate	Release Date > Tag Group >	Rolfing (Mahar) 04/28/04 KGM04023.BW1	04/28/04 KGM04023.BW2
STRATUM 1	1	0.1467	TOTAL (T)	3	7
	from		REMOVAL (R)	0	1
	01-May-04		T-R	3	6
	to		EXPANSIONS	20.45	40.90
	28-May-04		PASSAGE	20.45	41.90
STRATUM 2	2	0.1788	TOTAL (T)	20	19
	from		REMOVAL (R)	0	0
	29-May-04		T-R	20	19
	to		EXPANSIONS	111.88	106.29
	01-Jun-04		PASSAGE	111.88	106.29
STRATUM 3	3	0.2647	TOTAL (T)	24	29
	from		REMOVAL (R)	0	0
	02-Jun-04		T-R	24	29
	to		EXPANSIONS	90.68	109.58
	04-Jun-04		PASSAGE	90.68	109.58
STRATUM 4	4	0.1864	TOTAL (T)	73	105
	from		REMOVAL (R)	2	0
	05-Jun-04		T-R	71	105
	to		EXPANSIONS	380.92	563.33
	08-Sep-04		PASSAGE	382.92	563.33
Over Strata			Expanded Volitional McNary Passage	605.94	821.10
			Volitional Releas	1611	2329
			Volitional Survival Index	0.3761	0.3526

Table B.2. Expansions and Survival Indices (cont.)

a) 2004 estimates (cont.)

Release Estimates based on all Fish tagged (cont)

	Stratum	Detection Rate	Release Date > Tag Group >	Icicle Creek			
				Cascade		Willard	
				KGM04020.IC3	KGM04020.IC4	KGM04027.IC5	KGM04027.IC6
STRATUM 1	1	0.1467	TOTAL (T)	73	60	72	87
	from		REMOVAL (R)	2	1	0	0
	01-May-04		T-R	71	59	72	87
	to		EXPANSIONS	484.02	402.22	490.84	593.10
	28-May-04		PASSAGE	486.02	403.22	490.84	593.10
STRATUM 2	2	0.1788	TOTAL (T)	60	50	42	43
	from		REMOVAL (R)	0	0	0	1
	29-May-04		T-R	60	50	42	42
	to		EXPANSIONS	335.64	279.70	234.95	234.95
	01-Jun-04		PASSAGE	335.64	279.70	234.95	235.95
STRATUM 3	3	0.2647	TOTAL (T)	52	34	39	43
	from		REMOVAL (R)	1	0	0	0
	02-Jun-04		T-R	51	34	39	43
	to		EXPANSIONS	192.70	128.47	147.36	162.48
	04-Jun-04		PASSAGE	193.70	128.47	147.36	162.48
STRATUM 4	4	0.1864	TOTAL (T)	69	42	42	57
	from		REMOVAL (R)	0	0	1	0
	05-Jun-04		T-R	69	42	41	57
	to		EXPANSIONS	370.19	225.33	219.97	305.81
	08-Sep-04		PASSAGE	370.19	225.33	220.97	305.81
Over Strata			Expanded Total Tag McNary Passage	1385.56	1036.72	1094.12	1297.33
			Total Tagged Release	2353	1629	2027	2314
			Tag Survival Index	0.5888	0.6364	0.5398	0.5606

	Stratum	Detection Rate	Release Date > Tag Group >	Methow			
				Cascade		Willard	
				KGM04020.MR1	KGM04020.MR2	KGM04026.MR3	KGM04026.MR4
STRATUM 1	1	0.1467	TOTAL (T)	31	12	16	30
	from		REMOVAL (R)	0	0	2	0
	01-May-04		T-R	31	12	14	30
	to		EXPANSIONS	211.33	81.81	95.44	204.52
	28-May-04		PASSAGE	211.33	81.81	97.44	204.52
STRATUM 2	2	0.1788	TOTAL (T)	19	12	13	26
	from		REMOVAL (R)	0	0	0	0
	29-May-04		T-R	19	12	13	26
	to		EXPANSIONS	106.29	67.13	72.72	145.44
	01-Jun-04		PASSAGE	106.29	67.13	72.72	145.44
STRATUM 3	3	0.2647	TOTAL (T)	30	10	10	17
	from		REMOVAL (R)	0	0	0	0
	02-Jun-04		T-R	30	10	10	17
	to		EXPANSIONS	113.35	37.78	37.78	64.23
	04-Jun-04		PASSAGE	113.35	37.78	37.78	64.23
STRATUM 4	4	0.1864	TOTAL (T)	77	56	27	75
	from		REMOVAL (R)	1	1	0	1
	05-Jun-04		T-R	76	55	27	74
	to		EXPANSIONS	407.75	295.08	144.86	397.02
	08-Sep-04		PASSAGE	408.75	296.08	144.86	398.02
Over Strata			Expanded Total Tag McNary Passage	839.72	482.80	352.81	812.21
			Total Tagged Release	2613	1868	1671	2792
			Tag Survival Index	0.3214	0.2585	0.2111	0.2909

Table B.2. Expansions and Survival Indices (cont)

b) 2005 estimates

Volitional Release Estimates

	Stratum	Rate	Tag Group >	Butcher Creek			
				KGM04349.BC1	KGM04349.BC2	KGM04349.BC3	KGM04349.BC4
STRATUM 1	1	0.1268	TOTAL (T)	1	0	0	1
	from		REMOVAL (R)	0	0	0	0
	11-May-05		T-R	1	0	0	1
	to		EXPANSIONS	7.88	0.00	0.00	7.88
	16-May-05		PASSAGE	7.88	0.00	0.00	7.88
STRATUM 2	2	0.2068	TOTAL (T)	0	0	0	0
	from		REMOVAL (R)	0	0	0	0
	17-May-05		T-R	0	0	0	0
	to		EXPANSIONS	0.00	0.00	0.00	0.00
	18-May-05		PASSAGE	0.00	0.00	0.00	0.00
STRATUM 3	3	0.3174	TOTAL (T)	16	14	10	7
	from		REMOVAL (R)	1	0	0	0
	19-May-05		T-R	15	14	10	7
	to		EXPANSIONS	47.26	44.11	31.51	22.05
	29-May-05		PASSAGE	48.26	44.11	31.51	22.05
STRATUM 4	4	0.1199	TOTAL (T)	4	5	6	5
	from		REMOVAL (R)	0	1	0	0
	30-May-05		T-R	4	4	6	5
	to		EXPANSIONS	33.36	33.36	50.04	41.70
	03-Jun-05		PASSAGE	33.36	34.36	50.04	41.70
STRATUM 5	4	0.1786	TOTAL (T)	23	22	25	26
	from		REMOVAL (R)	0	0	0	0
	04-Jun-05		T-R	23	22	25	26
	to		EXPANSIONS	128.79	123.19	139.99	145.59
	29-Jun-05		PASSAGE	128.79	123.19	139.99	145.59
Over Strata	Expanded Volitional McNary Passage			218.29	201.66	221.53	217.22
			Volitional Releas	1344	1331	1162	1407
			Volitional Survival Index	0.1624	0.1515	0.1906	0.1544

	Stratum	Rate	Tag Group >	Rolfing (Mahar)			
				KGM04350.MP1	KGM04350.MP2	KGM04350.MP3	KGM04350.MP4
STRATUM 1	1	0.1268	TOTAL (T)	0	0	0	0
	from		REMOVAL (R)	0	0	0	0
	11-May-05		T-R	0	0	0	0
	to		EXPANSIONS	0.00	0.00	0.00	0.00
	16-May-05		PASSAGE	0.00	0.00	0.00	0.00
STRATUM 2	2	0.2068	TOTAL (T)	0	0	0	0
	from		REMOVAL (R)	0	0	0	0
	17-May-05		T-R	0	0	0	0
	to		EXPANSIONS	0.00	0.00	0.00	0.00
	18-May-05		PASSAGE	0.00	0.00	0.00	0.00
STRATUM 3	3	0.3174	TOTAL (T)	12	10	17	19
	from		REMOVAL (R)	0	0	1	0
	19-May-05		T-R	12	10	16	19
	to		EXPANSIONS	37.81	31.51	50.41	59.86
	29-May-05		PASSAGE	37.81	31.51	51.41	59.86
STRATUM 4	4	0.1199	TOTAL (T)	10	18	15	14
	from		REMOVAL (R)	0	0	0	0
	30-May-05		T-R	10	18	15	14
	to		EXPANSIONS	83.40	150.12	125.10	116.76
	03-Jun-05		PASSAGE	83.40	150.12	125.10	116.76
STRATUM 5	4	0.1786	TOTAL (T)	19	14	20	19
	from		REMOVAL (R)	1	0	0	0
	04-Jun-05		T-R	18	14	20	19
	to		EXPANSIONS	100.79	78.39	111.99	106.39
	29-Jun-05		PASSAGE	101.79	78.39	111.99	106.39
Over Strata	Expanded Volitional McNary Passage			223.00	260.02	288.50	283.01
			Volitional Releas	1560	1435	1445	1571
			Volitional Survival Index	0.1429	0.1812	0.1997	0.1801

Table B.2. Expansions and Survival Indices (cont)

b) 2005 estimates (cont)

Release Estimates based on all Fish tagged

	Stratum	Rate	Tag Group >	Butcher Creek			
				KGM04349.BC1	KGM04349.BC2	KGM04349.BC3	KGM04349.BC4
STRATUM 1	1	0.1268	TOTAL (T)	1	0	0	1
	from		REMOVAL (R)	0	0	0	0
	11-May-05		T-R	1	0	0	1
	to		EXPANSIONS	7.88	0.00	0.00	7.88
	16-May-05		PASSAGE	7.88	0.00	0.00	7.88
STRATUM 2	2	0.2068	TOTAL (T)	0	0	0	0
	from		REMOVAL (R)	0	0	0	0
	17-May-05		T-R	0	0	0	0
	to		EXPANSIONS	0.00	0.00	0.00	0.00
	18-May-05		PASSAGE	0.00	0.00	0.00	0.00
STRATUM 3	3	0.3174	TOTAL (T)	16	14	10	7
	from		REMOVAL (R)	1	0	0	0
	19-May-05		T-R	15	14	10	7
	to		EXPANSIONS	47.26	44.11	31.51	22.05
	29-May-05		PASSAGE	48.26	44.11	31.51	22.05
STRATUM 4	4	0.1199	TOTAL (T)	5	6	6	5
	from		REMOVAL (R)	0	1	0	0
	30-May-05		T-R	5	5	6	5
	to		EXPANSIONS	41.70	41.70	50.04	41.70
	03-Jun-05		PASSAGE	41.70	42.70	50.04	41.70
STRATUM 5	4	0.1786	TOTAL (T)	24	22	25	26
	from		REMOVAL (R)	0	0	0	0
	04-Jun-05		T-R	24	22	25	26
	to		EXPANSIONS	134.39	123.19	139.99	145.59
	29-Jun-05		PASSAGE	134.39	123.19	139.99	145.59
Over Strata	Expanded Total Tag McNary Passage			232.23	210.00	221.53	217.22
	Total Tagged Release			1757	1735	1597	1914
	Tag Survival Index			0.1322	0.1210	0.1387	0.1135

	Stratum	Rate	Tag Group >	Rolfing (Mahar)			
				KGM04350.MP1	KGM04350.MP2	KGM04350.MP3	KGM04350.MP4
STRATUM 1	1	0.1268	TOTAL (T)	0	0	0	0
	from		REMOVAL (R)	0	0	0	0
	11-May-05		T-R	0	0	0	0
	to		EXPANSIONS	0.00	0.00	0.00	0.00
	16-May-05		PASSAGE	0.00	0.00	0.00	0.00
STRATUM 2	2	0.2068	TOTAL (T)	0	0	0	0
	from		REMOVAL (R)	0	0	0	0
	17-May-05		T-R	0	0	0	0
	to		EXPANSIONS	0.00	0.00	0.00	0.00
	18-May-05		PASSAGE	0.00	0.00	0.00	0.00
STRATUM 3	3	0.3174	TOTAL (T)	14	10	17	19
	from		REMOVAL (R)	0	0	1	0
	19-May-05		T-R	14	10	16	19
	to		EXPANSIONS	44.11	31.51	50.41	59.86
	29-May-05		PASSAGE	44.11	31.51	51.41	59.86
STRATUM 4	4	0.1199	TOTAL (T)	10	18	15	14
	from		REMOVAL (R)	0	0	0	0
	30-May-05		T-R	10	18	15	14
	to		EXPANSIONS	83.40	150.12	125.10	116.76
	03-Jun-05		PASSAGE	83.40	150.12	125.10	116.76
STRATUM 5	4	0.1786	TOTAL (T)	19	15	20	20
	from		REMOVAL (R)	1	0	0	0
	04-Jun-05		T-R	18	15	20	20
	to		EXPANSIONS	100.79	83.99	111.99	111.99
	29-Jun-05		PASSAGE	101.79	83.99	111.99	111.99
Over Strata	Expanded Total Tag McNary Passage			229.30	265.62	288.50	288.61
	Total Tagged Release			1782	1666	1653	1823
	Tag Survival Index			0.1287	0.1594	0.1745	0.1583

c) 2005 estimates (cont)

Release Estimates based on all Fish tagged (cont)

	Stratum	Rate	Pond > Stock > Tag Group >	Larger Foster Willard KGM04348.LF1	Larger Foster Willard KGM04348.LF2	Larger Foster Cascade KGM05040.LFL
STRATUM 1	1	0.1268	TOTAL (T)	3	9	69
	from		REMOVAL (R)	0	0	0
	11-May-05		T-R	3	9	69
	to		EXPANSIONS	23.65	70.96	544.04
	16-May-05		PASSAGE	23.65	70.96	544.04
STRATUM 2	2	0.2068	TOTAL (T)	6	4	50
	from		REMOVAL (R)	0	0	0
	17-May-05		T-R	6	4	50
	to		EXPANSIONS	29.02	19.34	241.80
	18-May-05		PASSAGE	29.02	19.34	241.80
STRATUM 3	3	0.3174	TOTAL (T)	64	83	299
	from		REMOVAL (R)	0	1	1
	19-May-05		T-R	64	82	298
	to		EXPANSIONS	201.63	258.34	938.86
	29-May-05		PASSAGE	201.63	259.34	939.86
STRATUM 4	4	0.1199	TOTAL (T)	32	26	58
	from		REMOVAL (R)	0	0	0
	30-May-05		T-R	32	26	58
	to		EXPANSIONS	266.88	216.84	483.72
	03-Jun-05		PASSAGE	266.88	216.84	483.72
STRATUM 5	4	0.1786	TOTAL (T)	25	27	38
	from		REMOVAL (R)	0	0	0
	04-Jun-05		T-R	25	27	38
	to		EXPANSIONS	139.99	151.19	212.78
	29-Jun-05		PASSAGE	139.99	151.19	212.78
Over Strata	Expanded Total Tag McNary Passage			661.17	717.68	2422.19
			Total Tagged Release	1988	2011	3919
			Tag Survival Index	0.3326	0.3569	0.6181

	Stratum	Rate	Pond > Stock > Tag Group >	Small Foster Willard KGM04348.SF1	Small Foster Willard KGM04348.SF2	Small Foster Cascade KGM05041.SFL
STRATUM 1	1	0.1268	TOTAL (T)	12	10	34
	from		REMOVAL (R)	0	1	0
	11-May-05		T-R	12	9	34
	to		EXPANSIONS	94.61	70.96	268.08
	16-May-05		PASSAGE	94.61	71.96	268.08
STRATUM 2	2	0.2068	TOTAL (T)	15	4	22
	from		REMOVAL (R)	0	0	0
	17-May-05		T-R	15	4	22
	to		EXPANSIONS	72.54	19.34	106.39
	18-May-05		PASSAGE	72.54	19.34	106.39
STRATUM 3	3	0.3174	TOTAL (T)	96	65	168
	from		REMOVAL (R)	3	0	1
	19-May-05		T-R	93	65	167
	to		EXPANSIONS	293.00	204.79	526.14
	29-May-05		PASSAGE	296.00	204.79	527.14
STRATUM 4	4	0.1199	TOTAL (T)	20	17	33
	from		REMOVAL (R)	0	0	0
	30-May-05		T-R	20	17	33
	to		EXPANSIONS	166.80	141.78	275.22
	03-Jun-05		PASSAGE	166.80	141.78	275.22
STRATUM 5	4	0.1786	TOTAL (T)	27	29	35
	from		REMOVAL (R)	0	0	0
	04-Jun-05		T-R	27	29	35
	to		EXPANSIONS	151.19	162.38	195.98
	29-Jun-05		PASSAGE	151.19	162.38	195.98
Over Strata	Expanded Total Tag McNary Passage			781.14	600.26	1372.81
			Total Tagged Release	1827	1279	3448
			Tag Survival Index	0.4276	0.4693	0.3981