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MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY:

2006 ANNUAL REPORT
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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 spring and summer activities and results in 2006, including coho pre-smolt acclimation, underwater observations, and juvenile survival analysis. 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. Data collected in the fall of 2006, including spawning ground surveys, broodstock collection, and survival rates, will be presented in the 2007 report.

2.0 SMOLT ACCLIMATION: WENATCHEE AND METHOW

2.1 ACCLIMATION SITES

In 2006, within the Wenatchee River Basin, we acclimated coho pre-smolts at the Leavenworth National Fish Hatchery (LNFH), Beaver Creek, and two sites on Nason Creek. For the Methow River broodstock development program, we acclimated coho pre-smolts at Winthrop National Fish Hatchery (WNFH), both on-station and in the Spring Creek 'back-channel', and at Wells Fish Hatchery. A description of these 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 designed for rearing steelhead, sockeye, and spring Chinook. The oval shape of these ponds was intended to create a low-maintenance raceway that could produce quality salmonids. These ponds were discontinued due to insufficient turnover rates and maintenance difficulties in favor of more widely used 8x100 and 10x100-foot raceways. Both the small and large Foster-Lucas ponds were partially refurbished by Yakama Nation Fisheries and supplied with second-use water for coho acclimation. The water supply line for the large ponds originates from first-pass effluent from the hatchery's 10x100 juvenile spring Chinook raceways. Second-use water supplied to the small Foster-Lucas ponds is pumped from a sump area below the adult holding ponds which is used to rear juvenile chinook until release in mid-April. Water to each Foster-Lucas pond is manually adjusted to achieve flow requirements for the coho densities on-hand.

2.1.2 Beaver Creek

The Beaver Creek acclimation pond is located at RK 2.4 on Beaver Creek. Beaver Creek enters the Wenatchee River near Plain, Washington at RK 74.4. The acclimation pond was constructed in the mid 1980's and is located behind Mountain Springs Lodge. Originally, the property owner stocked the pond with Kamloops rainbow trout for aesthetic purposes. River otter predation on the year-round resident trout became too problematic and the stocking was discontinued in the early 1990's. Since then, the pond had been void of salmonids until we began using the pond to acclimate coho salmon in 2002. Prior to our use of the pond for acclimation, we installed containment structures at the ponds' inlet and outlet. We expect that returning adults not captured for broodstock will spawn in Beaver Creek or in the upper Wenatchee River.

2.1.3 Nason Creek

In 2006, coho pre-smolts were acclimated at two sites on Nason Creek: Coulter Creek Pond and Rolfing's Pond. Additionally, we directly planted a small group of coho smolts into the larger Coulter Pond Wetlands Complex (Nason Creek Wetlands) for evaluation purposes. Butcher Creek was not used for acclimation in 2006 in attempt to reduce avian predation which has become problematic at this location. All acclimation sites in Nason Creek are non-conventional, ranging from natural to constructed earthen sites. Natural and earthen ponds have some advantages over conventional hatchery raceways such as lower rearing densities, natural food sources, and ability to create natural environmental conditions.

Nason Creek Wetlands

The Nason Creek Wetlands site is part of the wetlands complex that includes Coulter Pond. The 26- acre wetland complex encompassed the lower portions of Roaring and Coulter creeks. These creeks converge to form a complex series of natural beaver ponds that eventually empty into Nason Creek at RK 13.7. Coho smolts were released directly into the wetlands without containment or feeding. The fish released into the complex were allowed to volitionally immigrate into Nason Creek. We consider this release 'experimental' and will closely monitor survival rates to determine whether this release/acclimation strategy should be pursued in the future.

Coulter Pond

The Coulter Pond acclimation site is located at RK 1.6 on Coulter Creek. Fish released from Coulter Pond emigrate through the Nason Creek Wetlands and enter Nason Creek at RK 13.7. This natural site is composed of multiple braided channels that coalesce into a large, widened waterway. We used a large net to encircle the majority of the channel to ensure containment during acclimation. The release was closely monitored to ensure fish could pass through the multiple 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 reaching Nason Creek at RK 20.3. The earthen pond was constructed and developed by the property owner. In 2003, to create a more suitable acclimation environment, we enlarged the pond and planted native riparian vegetation. We used a barrier net at the outlet of the pond to contain the fish until release.

2.1.4 Winthrop National Fish Hatchery (WNFH)

Coho smolts released into the Methow River in were acclimated at the WNFH, located at RK 80.6. Both on-station raceways and the 'back-channel' were used for coho acclimation. The back-channel is a portion of the hatchery outfall, also known as Spring

Creek. Prior to acclimating fish in Spring Creek, predation netting as well as a containment screen was installed .

2.1.5 Wells Fish Hatchery

In 2006, coho were acclimated at Wells Fish Hatchery located at RK 829.0 on the Columbia River. Wells Fish Hatchery, funded by Douglas Public Utility District (PUD) for operation and maintenance, is operated by Washington Department of Fish and Wildlife (WDFW). Under contract with YN, WDFW acclimated coho pre-smolts in a 2.2 acre earthen pond historically used to raise summer steelhead. We expect that coho acclimation at Wells Dam will aid in achieving the goals of 'Broodstock Development Phase I' as described in Mid-Columbia Coho Restoration Master Plan (YN 2005).

2.2 TRANSPORTATION AND VOLITIONAL RELEASE

2.2.1 Wenatchee River Basin

Second generation mid-Columbia coho pre-smolts were transported to the Wenatchee Basin from Willard NFH and Cascade FH between January 10 and April 6, 2006. These two hatcheries are the primary rearing facilities for the program. The coho were acclimated between 3 and 13 weeks at five acclimations sites within the Wenatchee River Basin (Table 1). The 3-week acclimation occurred at Coulter Creek; the fish were volitionally released so the actual acclimation duration ranged up to 8 weeks. The 13-week acclimation occurred at Leavenworth NFH (LNFH). Fish were transported into four experimental test ponds between January 10-16, 2006. These coho were part of an ongoing study to determine whether an extended acclimation on a natal water source would result in increased smolt-to-adult survival.

All coho smolts acclimated in both the SFL and LFL ponds at LNFH were force-released April 12-15. Coho acclimated at the Nason Creek and Beaver Creek releases were volitionally released with start dates between April 6 and 27, 2006. Most volitional releases were complete by mid-June.

All coho released in 2006 were coded-wire tagged with retentions ranging from 97.1-99.6%. In addition to the CWT's, blank-wire body-tags were inserted into adipose fin tissue of the Coulter, Rolfings, and Nason Creek Wetlands release groups. These body-tags will provide the means to implement 'Broodstock Development Phase II' (YN 2005) by allowing us to identify coho released in the upper Wenatchee basin as returning adults, facilitating broodstock collection at the capture site farthest upstream (Tumwater Dam).

In addition to CWT, approximately 28,000 smolts were marked with passive integrated transponder tags (PIT-tags). PIT tagged fish were released from LNFH, Beaver Creek, Coulter Creek, and Nason Creek Wetlands (Table 1). Monitoring detection systems were installed at Beaver Creek and Coulter Creek to measure in-pond survival and release-to-McNary Dam survival (Section 4.0).

A total of 1,070,539 hatchery-produced coho smolts were released in the Wenatchee River Basin in 2006. 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, 2006.

Location	Release Date	Release Number	Size @ release (FPP)	No. PIT Tags
Beaver Pond	May 6	83,356	17.1	6983
Coulter Creek	April 23	110,213	21.6	6,481
Rolfing's Pond	May 7	105,247	16.8	0
Nason Creek Wetlands	April 6	34,088	22.7	3,495
Leavenworth NFH LFL's (large Foster-Lucas Ponds	April 15	262,175	18.9	6,156
Leavenworth NFH SFL's (small Foster-Lucas Ponds)	April 12	475,460	16.9	6,204
Wenatchee Total		**1,070,539**		28,319
Winthrop NFH (on-station)	April 20-30	236,133	17.0	0
Winthrop NFH (Spring Creek)	April 20-30	74,858	22.6	0
Wells FH	April 21	149,804	14.7	0
Methow Total		**460,795**		0
Wenatchee/Methow Totals		**1,531,334**		28,319

2.2.2 Methow River Basin

All fish released in the Methow Basin in 2006 were either 1st or 2nd generation mid-Columbia coho, progeny from returns to both the Methow and Wenatchee basins respectively. A total of 74,858 coho were transported from Cascade FH and acclimated in the hatchery back-channel while the remaining 236,133 were held on-station. Volitional releases at WNFH began April 20 and concluded with a forced release on April 30 (Table 1). To help meet the goals of 'broodstock development phase II' (YN 2005), an additional 149,804 coho pre-smolts were acclimated at Wells Fish Hatchery (WDFW).

All coho released for the Methow River program were CWT'ed with no other marks. A total of 460,795 coho smolts were released in 2006. 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 acclimation sites, coho were sampled weekly to measure growth and degree of smoltification (*n*=100). 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 fish condition assessment was to note gross abnormalities, not to diagnose the cause of certain conditions (Table 2).

At Methow Basin acclimation sites, and at Wells FH, coho were sampled pre-release for growth and fish condition. All of the pre-release growth and condition assessments demonstrated that the smolts were in good condition, with the exception of coho released from the WNFH back-channel group. The growth sample performed indicated that coho acclimated in the back-channel did not grow as expected; they lost weight prior to release.

Table 2. Pre-release fish condition assessment, 2006.

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	100	100	100	100	2.1	100	100	100	100	50/50	100	100
Leavenworth NFH-SFL's Short-term rearing	100	100	100	100	2.0	100	100	100	100	37/63	100	100
Leavenworth NFH- SFL's Over-winter groups	100	100	100	100	2.0	100	100	100	100	60/40	100	100
Beaver Creek	100	100	100	100	2.0	100	100	100	100	45/55	100	100
Rolfing's Pond	95	100	100	100	2.1	100	100	100	100	55/45	100	100
Coulter Pond	95	100	100	100	2.0	100	100	100	100	75/25	90	100
Wells FH	100	100	100	100	2.2	100	100	100	100	55/45	100	100
Winthrop NFH on-station	95	100	100	100	2.1	100	100	100	100	45/55	100	100
Winthrop NFH channel	100	100	100	100	1.5	100	100	100	100	45/55	70	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 UNDERWATER OBSERVATIONS

3.1 Nason Creek Observations

Snorkel surveys were conducted in Nason Creek in August, 2006, with purpose of document the rearing distribution of naturally produced coho salmon. A random sample of approximately 20% of the pools, riffles, and glides were snorkeled in two reaches of Nason Creek. Reach one extends from the mouth to RK 6.8 near Coles Corner at U.S. Highway 2, and reach three (the second reach surveyed) extends from RK 13.3 at Woodbridge to RK 17.7 near White Pine Road. Three observers recorded the number and size of all species encountered during each selected habitat unit. Results of the observations for the target species are summarized in Table 3.

Table 3. Summary of snorkel observations for Nason Creek, August 2006.

	Chinook Fry	Chinook Parr	Steelhead Fry	Steelhead Parr <130mm	Steelhead Parr >129mm	Hatchery Steelhead	Coho Fry	Coho Parr	Total Length (m)	Total Width (m)
R 1										
Pool	5	16	23	3	0	0	0	13	338.1	90.2
Riffle	10	28	83	24	9	0	0	0	653.9	117.1
Glide	137	357	138	12	3	0	0	7	677.5	105.1
R 3										
Pool	3	27	109	3	5	0	0	7	231	59.9
Riffle	24	96	128	5	3	0	0	26	244.4	53.2
Glide	26	125	203	4	2	0	30	31	600.4	79.3

4.0 SURVIVAL RATES

4.1 Smolt Survival Rates – Release to McNary Dam

To obtain a McNary passage index of PIT-tagged fish released into the Wenatchee River Basin, the total number of McNary Dam PIT tag detections was 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 McNary detection rate was calculated by summing the number of PIT-tagged fish detected at both McNary and a downstream dam and then dividing by the total number detected at that particular 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 2006 releases (see section 2.0 for release numbers), detection-rate estimates were calculated for Nason Creek (Coulter Creek and Nason Wetlands), Upper Wenatchee River (Beaver Creek) and for Icicle Creek (LFLs and SFLs) separately. The calculated survival indices for all releases can be found in Table 4. A detailed summary of survival indices can be found in Neeley (2007); Appendix D.

Table 4. Survival indices Mid-Columbia smolt releases, 2006.

Basin	Release Tributary	Release Location	Rearing Facility	Brood Origin	n	Survival to McNary
Wenatchee	Upper Wenatchee River	Beaver Creek Pond	Willard NFH	MCR	6184	0.4875[1]
	Nason Creek	Coulter Creek Pond	Willard NFH	MCR	2746	0.3445[2]
			Cascade FH	MCR	2332	0.5501
		Nason Wetlands	Willard NFH	MCR	3495	0.1594[3]
	Icicle Creek	SFL	Cascade FH	MCR	3083	0.4539[3]
		SFL	Willard NFH	MCR	3121	0.4556
		LFL	Cascade FH	MCR	3040	0.5064
		LFL	Willard NFH	MCR	3116	0.3665

Source: Neeley (2007); Appendix D

[1] Survival estimate was based upon the number of fish detected leaving Beaver Creek pond and therefore does not include in-pond mortality. The detection efficiency was estimated to be 99.1% (Neeley 2007).
[2] Survival estimate was based upon the number of fish detected leaving Coulter Creek Pond, and therefore does not include in-pond mortality. The detection efficiency was estimated to be 90.1% (Neeley 2007).
[3] All Icicle Creek release-to-McNary and the Nason Wetland survival rates were based upon the total number of fish tagged minus known and recovered mortalities. Detection during release was not possible.

5.0 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 re-establishing 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 2006; 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 2006 were 1,070,539 and 460,795 fish, respectively. Coho within the Methow program were released from Winthrop NFH (on-station raceways and the outfall channel) and Wells FH. An estimated 98.1% transport-to-release survival for these releases was observed. 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 any of the locations. In the Wenatchee basin, overall survival was 98.4% from transport to release (Appendix B).

- Underwater observations were conducted on two reaches of Nason Creek in August, 2006. Reaches were dissected into three habitat units; pool, rifle, and glide. Approximately 20% of these units were randomly sampled within the selected reaches. The totals for all target species encountered during underwater observations are as follows: 205 chinook fry, 649 chinook parr, 684 steelhead fry, 73 steelhead parr, 0 hatchery steelhead, 30 coho fry, and 84 coho parr.

- Based on PIT-tag detections within the '04 brood, we estimated that 37%-51% of the MCR coho released from Icicle Creek survived to McNary Dam. We also estimated that 16%-55% of fish released into Nason Creek (Coulter Pond and Nason Wetlands) survived to McNary Dam. In addition to the Nason and Icicle creek releases, 49% of the fish released into the upper Wenatchee River (Beaver Creek) survived to McNary Dam. No PIT tagged fish were released in the Methow River in 2006 but are scheduled for 2007.

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7.0 LITERATURE CITED

Busack, C., B. Watson, T. Pearsons, C. Knudsen, S. Phelps, M.. Johnston. 1997. Yakima fisheries project spring chinook supplementation monitoring plan. Unpublished Yakima/Klickitat Fisheries Project internal report, Toppenish, Washington.

Chapman, D. W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Transaction of the American Fisheries Society 115:662-670.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River Basin-past and present. United States Fish and Wildlife Service. Special scientific report-Fisheries Number 618. Washington D.C.

HGMP. 2002. Hatchery and genetics management plan: Mid-Columbia coho reintroduction program. Yakama Nation, Washington Department of Fish and Wildlife, Bonneville Power Administration.

Mullan J.W. 1983. Overview of Artificial and Natural Propagation of Coho Salmon (*Oncorhynchus kisutch*) on the mid-Columbia River. Fisheries Assistance Office, U.S. Fish and Wildlife Service, Leavenworth, Washington. December 1983.

Murdoch, K.G., S.A. Prevatte, and C.M Kamphaus. 2006. Mid-Columbia coho reintroduction feasibility study: 2004 Monitoring and Evaluation Report, February 1, 2004 through January 31, 2005. *Prepared for:* Bonneville Power Administration, project #1996-040-00. Portland, OR.

Neeley, D. Release-to-McNary survival indices of 2005 releases into the Wenatchee and Methow Rivers. *Prepared for:* Yakama Nation Fisheries Resource Management. Toppenish WA.

Prevatte, S. A. 2006. Integrated status and effectiveness monitoring program – Expansion of existing smolt trapping program in Nason Creek. *Prepared for*: Bonneville Power Administration project #2003-017-00. Portland OR.

Yakama Nation Fisheries Resource Management (YN). 2005. Mid-Columbia coho restoration master plan. Yakama Nation Fisheries Resource Management, Toppenish WA. 204 pgs.

Integrated Status & Effectiveness Monitoring Program
Population Estimates for Juvenile Salmonids in Nason Creek, WA
2006 Annual Report Draft

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YAKAMA NATION
FISHERIES RESOURCE MANAGEMENT

Executive Summary

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

This report summarizes juvenile coho salmon, spring Chinook salmon, and steelhead migration data collected in Nason Creek during 2006 and incorporates data from previous years to provide population estimates by brood year rather than calendar year. We used species enumeration at the trap and efficiency trials to describe emigration timing and to estimate population size. Trapping began on March 1st and was suspended on November 22nd when snow and ice accumulation prevented operation. There were three intermittent periods during September and October when stream discharge dropped below the minimum required (approximately 40 cfs) to rotate the trap cone; trapping was suspended until flow increased.

During the period of March 1st to July 9th, with the trap in the 'back' position due to high stream discharge, we collected 49 brood year (BY) 2004 coho, 10 BY 2005 coho, 483 BY 2004 spring Chinook salmon, 97 naturally produced steelhead smolts, 1,118 steelhead parr, and 53 steelhead fry. Spring Chinook (BY 2005) began to outgrow the fry stage (fork length ≥50 mm) during June when 401 fry and 95 subyearling parr were collected at the trap.

Mark-recapture trap efficiency trials were performed over a range of stream discharge stages. A total of 364 spring Chinook yearlings, 72 steelhead smolts, and 780 steelhead parr were implanted with Passive Integrated Transponder (PIT) tags and used for trap efficiency trials. Combining two years (2005 & 2006) of mark-recapture trap efficiency trials, we were able to identify a statically significant relationship between stream discharge and trap efficiency for steelhead parr captured during the spring. We estimate that 18,896 (± 4,204 95% CI) steelhead parr emigrated from Nason Creek during the period of March 1st to July 10th. An efficiency-discharge relationship was not apparent for other species/age classes. A pooled trap efficiency model was used to estimate the population size of BY 2004 coho (15.95%), BY 2004 spring Chinook (15.95%) and steelhead smolts (5.71%). We estimate that 431 BY 2004 coho emigrated from Nason Creek between March 1st to July 9th, 2006 along with 3,276 (± 141 95%CI) yearling spring Chinook and 2,468 (± 626 95%CI) steelhead smolts emigrated past the trap.

During the period of July 10th to November 22nd we collected 1 subyearling (BY 2005) coho, 3,091 subyearling (BY 2005) spring Chinook salmon, 1,742 steelhead parr of various size and age classes, and 547 steelhead fry. A total of 1237 PIT tagged spring Chinook subyearlings and 213 PIT tagged steelhead parr were used during mark-recapture trap efficiency trials during this period. Using a pooled trap efficiency of 18.11% we estimate that 24,348 (± 410 95% CI) subyearling spring Chinook passed the trap during the period of July 10th to November 22nd. During this same time period using a pooled trap efficiency of 7.04% we estimate that 32,703 (± 2,104 95% CI) steelhead parr migrated downstream.

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Acknowledgements

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Introduction

Beginning in the fall of 2004, the Integrated Status & Effectiveness Monitoring Program (ISEMP, BPA project #2003-017-000), began sharing the cost of operating a rotary smolt trap in Nason Creek, with the mid-Columbia Coho Reintroduction Feasibility Study (BPA project #1996-040-00), extending previous trap operations from three months per year to nine months per year. The objectives of these projects are to:

1) Estimate the juvenile production and productivity of spring Chinook, steelhead (#2007-017-00), and coho salmon (#1996-040-00) in Nason Creek.

2) Describe the temporal variability of spring Chinook, steelhead (#2003-017-00), and coho salmon (#1996-040-00) emigrating from Nason Creek.

The data generated from this project will be used to calculate annual population estimates, egg-to-emigrant survival, and emigrant-to-adult survival rates. Combined with other monitoring and evaluation (M&E) data, population estimates, may 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. Tissue samples are collected from Chinook and bull trout captured in the trap to supply DNA for ongoing studies in the basin.

In 2006 the ISEMP implemented a remote PIT tagging program at smolt traps in the Wenatchee Basin consistent with the upper Columbia Basin monitoring strategy (Hillman 2003). The monitoring strategy describes the methods used to determine parr abundance, distribution, and survival; the strategy recommends that at least 5,000 juvenile spring Chinook and 5,000 juvenile steelhead be PIT tagged in order to estimate life-stage survival rates. The objective of the PIT tagging program is to determine if smolt traps, in collaboration with other monitoring activities (i.e. snorkel surveys, electrofishing, detection arrays) can provide the necessary data to resolve uncertainties regarding life history, growth, and survival of juvenile spring Chinook and steelhead in the Wenatchee Basin (Murdoch et. al. 2005).

This document reports data collected from the Nason Creek smolt trap between March 1st and November 22nd, 2006. Data collected during fall of 2005 is presented with the spring 2006 data to produce a complete population estimate for the BY 2004 spring Chinook salmon and an estimate of egg-to-emigrant survival. Population estimates are also provided for steelhead and coho salmon.

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 (RK) 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 A. There are 26.4 mainstem RKs accessible to anadromous fish in Nason Creek. 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).

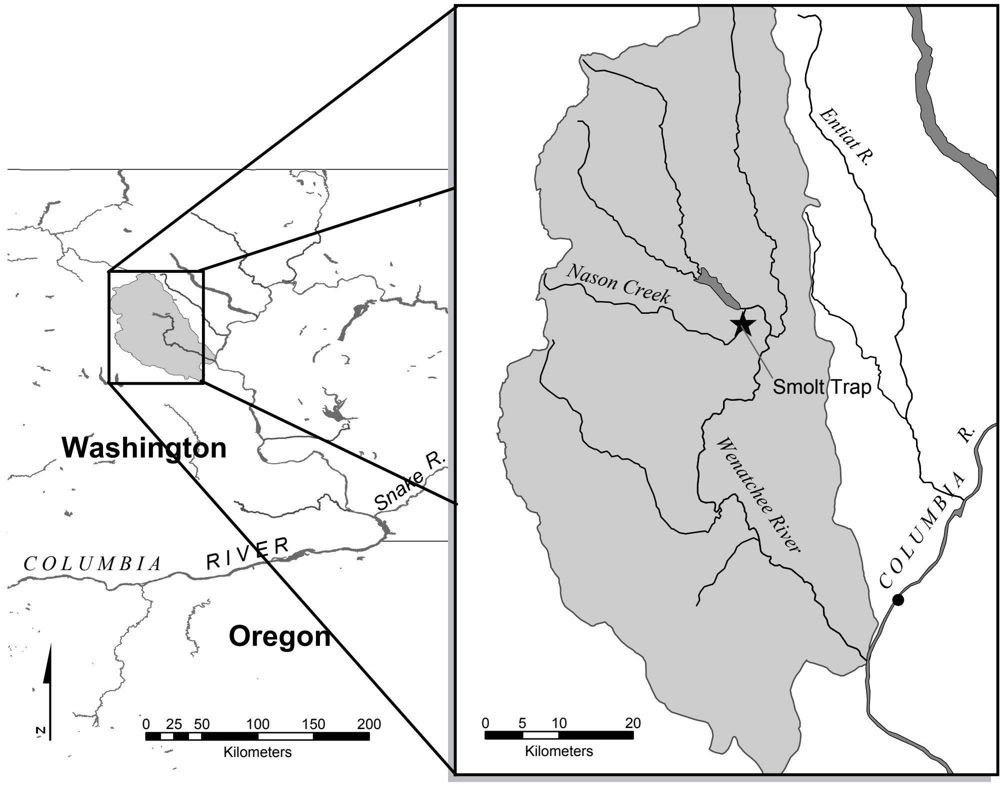

Figure 1. Nason Creek smolt trap location.

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 2006 trapping season (March 1, 2006 through December 1, 2006) was 337 cfs (Figure 2 and Appendix B). Peak runoff typically occurs in May and June with occasional high water produced by rain on snow events in October and November.

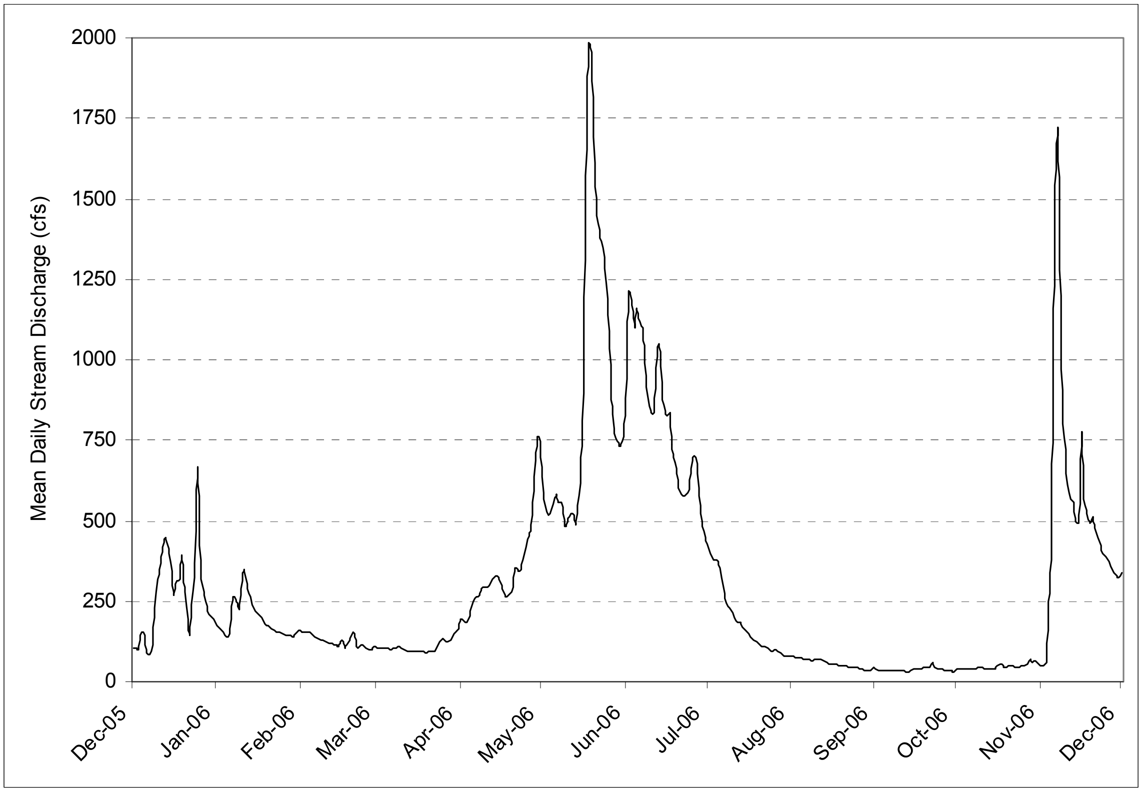

Figure 2. Mean daily stream discharge at the Nason Creek DOE stream monitoring station, RK 1, December 1, 2005 through December 1, 2006.

During the months we operated the trap, the mean daily water temperatures recorded at the DOE monitoring station ranged from a low of 0.5 °C to a high of 21.8°C (Figure 3). Daily mean stream temperature measurements taken by the Washington State DOE during water years 2005 and 2006 are provided in Appendix B.

The maximum safe fish handling temperature (as defined in Section 10 Permit # 1493) is 21° C. Fish were handled in the morning when temperatures were at a minimum. While the daily mean water temperature exceed 21°C on two dates in July, the temperatures when fish were handled remained below the maximum permitted handling temperature (less than 21°C).

Figure 3. Mean daily water temperature at the Nason Creek DOE stream monitoring station, Rk 1, from December 1st, 2005 through November 20th, 2006.

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.* Two fish that we identified as fathead minnow, *Pimephales promelas,* were collected at the trap for the first time during 2006. Hatchery activity in Nason Creek includes the BPA funded coho reintroduction program, the Chelan County PUD funded hatchery steelhead direct plants, and previously the Grant County PUD funded spring Chinook captive brood program (2004 and 2005).

Methods

Trapping Equipment and Operation

A floating rotary smolt 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 suspended 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 main trap positions during 2006; a 'back' position during high water (~500 to 1000 cfs) in the spring and 'forward' position located 10 meters upstream during low water (~ 40 to 500 cfs) in the summer/fall. When discharge exceeded 1000 cfs we positioned the trap half-way between the streambank and thalweg. Stream discharge lower than 40 cfs necessitated raising the cone slightly to avoid touching the streambed. Trap operating positions and discharge range can be found in Table 1.

Table 1. Nason Creek smolt trap operating positions and generalized discharge range, 2006.

Trap Position	CFS Range
Back	500 to 1000
Back and 1/2 Out	1000 to 1500
Forward	40 to 500
Pulled	> 1500

On June 14th, 2006, the trap was retrofitted with an experimental alarm system designed to call trap operators in the event of a cone rotation stop. The alarm system was tested during the summer/fall; it appears that the system is working to help reduce fish mortality as a result of excessive debris which can prevent the cone from turning. Photographs of the alarm system can be seen in Appendix A.

Biological Sampling

Trap operating procedures and techniques followed a standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team (RTT) for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was 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 (Table 2). 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. Scale samples were collected from steelhead measuring ≥ 100 mm FL to facilitate assigning these fish to age-classes and brood years. The scale samples were provided to WDFW for analysis. Anesthetized fish received oxygen through a portable aquarium bubbler and were allowed to fully recover before being released downstream from the trap.

Length and weight were recorded for all fish except on days when large numbers of a single species were collected, and then a sub-sample 25 of each species and size/age class) were measured and weighed. Fork length (FL) was recorded to the nearest millimeter and weight to the nearest 0.1 gram. We used these data to calculate a Fulton-type condition factor (Kfactor) using the formula:

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

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

During periods when the trap was not operating (e.g. high discharge, high debris, mechanical problems) the number of target species captured was estimated. The estimated number of fish captured was calculated using the average number of fish captured two days prior and two days after the break in operation.

Mark-Recapture Trials

Groups of marked salmonids were used for trap efficiency trials. Marked groups of fish were released over the greatest range of discharge possible in order to increase the efficacy of the efficiency-discharge regression model used to estimate the daily trap efficiency (See '**data analysis**'). Mark-recaptured trials followed the protocol described in Hillman (2004). The protocol suggests a minimum sample size of 100 fish for each mark-recapture trial. Due to the limited number of fish caught in the trap, mark-recapture trials were often completed with smaller sample sizes.

We typically combined the catch over a maximum of 3-days to provide the largest mark group possible within ESA section 10 permit limitations. Fish being held for mark-recapture trials were kept in auxiliary live boxes attached to the end of each pontoon. Mark groups were released regardless of sample size but only those groups counting ≥30 fish of a single size class and species were used in the linear regression model (See '**Emigration Estimate and Expansion of Daily Catch'**). Mark groups consisting of less than 30 fish were used to support a pooled estimate if needed.

Marking and PIT tagging

Fish used in efficiency trials were marked with either an upper or lower caudal fin clip, a PIT tag, or both. PIT tags were only included as a mark for naturally produced spring Chinook and steelhead measuring 60 mm FL and greater. Fin clips were used for efficiency trials with hatchery coho salmon, and a dye, bismark brown was used to test the efficiency of steelhead fry. Fin clips of naturally produced spring Chinook were retained for genetics research being conducted be WDFW.

Fish to be PIT tagged were handled as described above (See '**Biological Sampling'**). Once anesthetized, each fish was examined for any wounds, or descaling, then scanned for the presence of a previously implanted PIT tag. A 12mm Digital Angel 134.2 kHz type TX 1411ST PIT tag was inserted into the body cavity using a 12-gauge hypodermic needle. To prevent disease transmission, each hypodermic needle was soaked in ethyl alcohol for approximately 10 minutes prior to use and re-use. Each unique tag code was recorded along with date of tag implantation, date of fish release, tagging personnel, fork length, weight, and water temperature. These data were entered into a data base and submitted to the PIT Tag Information System (PTAGIS) upon returning to the office. PIT tagging methods were consistent with methodology described in the PIT Tag Marking Procedures Manual (CBFWA 1999).

After marking and/or PIT tagging, fish were transported in 5-gallon buckets 1.4 km upstream to the release site. At the release site the marked and/or PIT tagged fish were held for a minimum of 24-hours in a large (1 sq. meter) live box to ensure complete recovery, assess tagging mortality and to recover any shed tags.

Marked fish were released directly from the live box at sunset. The live box was located on the right bank which was accessible by vehicle. The left bank is not easily accessible, and we were unable to cross the creek at higher flows. During 2004 we compared marked groups released from the right bank, stream center, and both banks and found no difference in the recovery rate (Prevatte and Murdoch 2004); we are confident that the stream hydraulics between the release site and the smolt trap facilitate adequate fish dispersal when released exclusively from the right bank.

Data Analysis

Trap Efficiency
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.

Emigration Estimate and Expansion of Daily Catch
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 individual efficiency trials (dependant variable) with discharge (cfs; independent variable). If the results of the regression were significant (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:

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

Where X_i is the discharge for time period i, and n is the sample size.

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:

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:

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

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

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

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

The following assumptions must be made for the population estimated to be valid (Everhart and Youngs 1953):

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

Dates of Operation

We deployed the trap on February 28th and began operating on March 1st. We fished the trap continuously 24 hours a day 7 days per week, except during periods of large hatchery smolt releases upstream of the trap or busy holiday weekends when public safety was a concern (Table 2). We were unable to operate the trap for 22 days in late summer and early fall due to low stream discharge. Water conditions delayed continuous trap operation until September 28th when stream discharge increased as a result of precipitation. We were able to continue trap operation with minimal interruption until November 22nd when snow and ice accumulation prohibited trap operation. Detailed documentation of operating dates can be found in Appendix C.

Table 2. Nason Creek smolt trap operating days, 2006.

Trap Status	Description	Days Operating	Days Not Operating
Operating	Continuous	207	
Interrupted	Stopped by Debris		4
Interrupted	Stopped by Ice		4
Not Operating	Low Flow		22
Not Operating	High Flow		18
Not Operating	Snow and ice		8
Not Operating	Holiday		5
Not Operating	Hatchery Release		4
Not Operating	Trap Repair		4
	Total Days	**207 (75%)**	**69 (25%)**

Emigration Timing

Coho Yearlings (BY 2004)

We collected 49 yearling coho parr and smolts during 2006. The first parr was trapped on March 28th. Peak catch (51%) occurred between April 20th and April 29th (Figure 4). The trap did not cause any mortality to yearling coho.

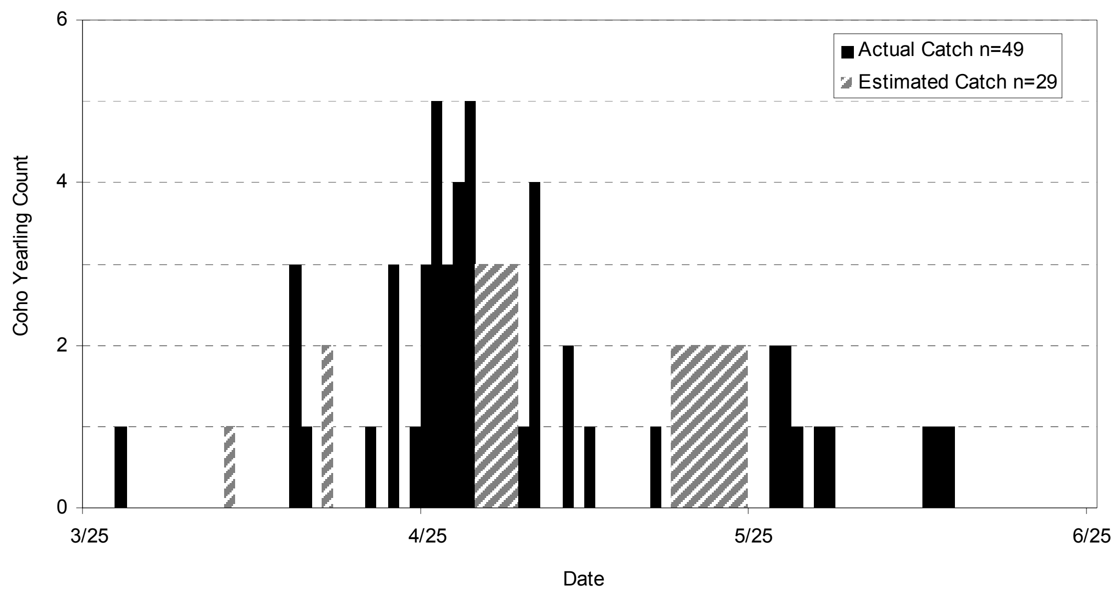

Figure 4. Coho yearling counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap, March 25th through June 25th, 2006.

Coho Subyearlings (BY 2005)

We collected 11 subyearling coho fry and parr during 2006. The first parr was trapped on May 31st. Peak catch (45%) occurred in July (Figure 5). No naturally produced coho were caught during August and September; one coho subyearling was caught in October. The trap did not cause any mortality to subyearling coho.

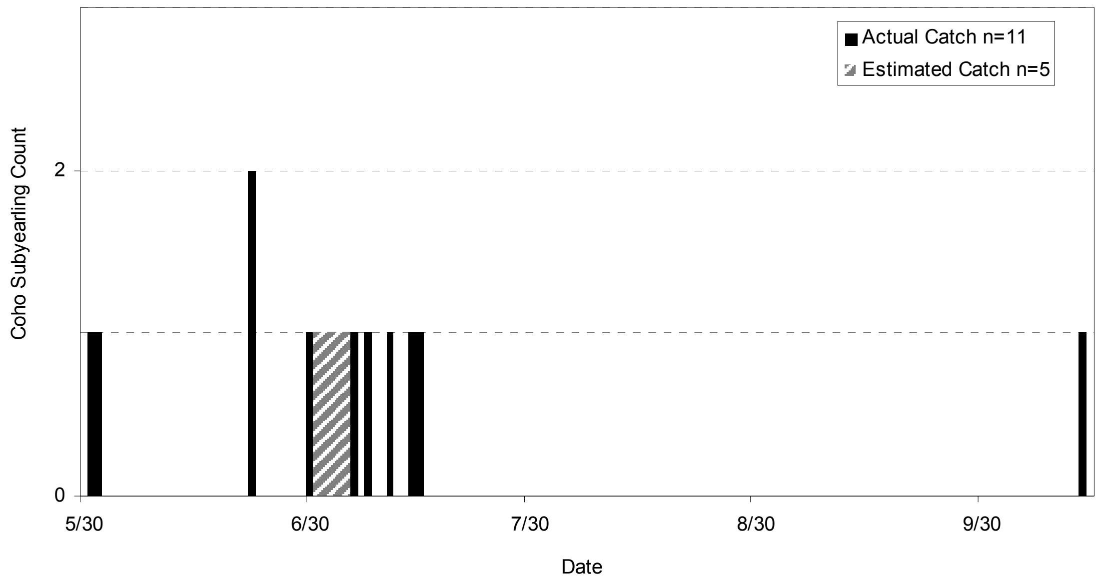

Figure 5. Coho subyearling counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap, May 30th through October 15th, 2006.

Spring Chinook Yearlings (BY 2004)

We collected 483 BY 2004 yearling spring Chinook smolts during 2006. The first smolt was trapped on March 2nd the second day of operation. Peak catch (71%) occurred during April with 40 (8.3%) yearlings collected on April 5th (Figure 6). No yearling spring Chinook were captured after May 9th. Seven Chinook yearling mortalities were found in the trap (Table 3).

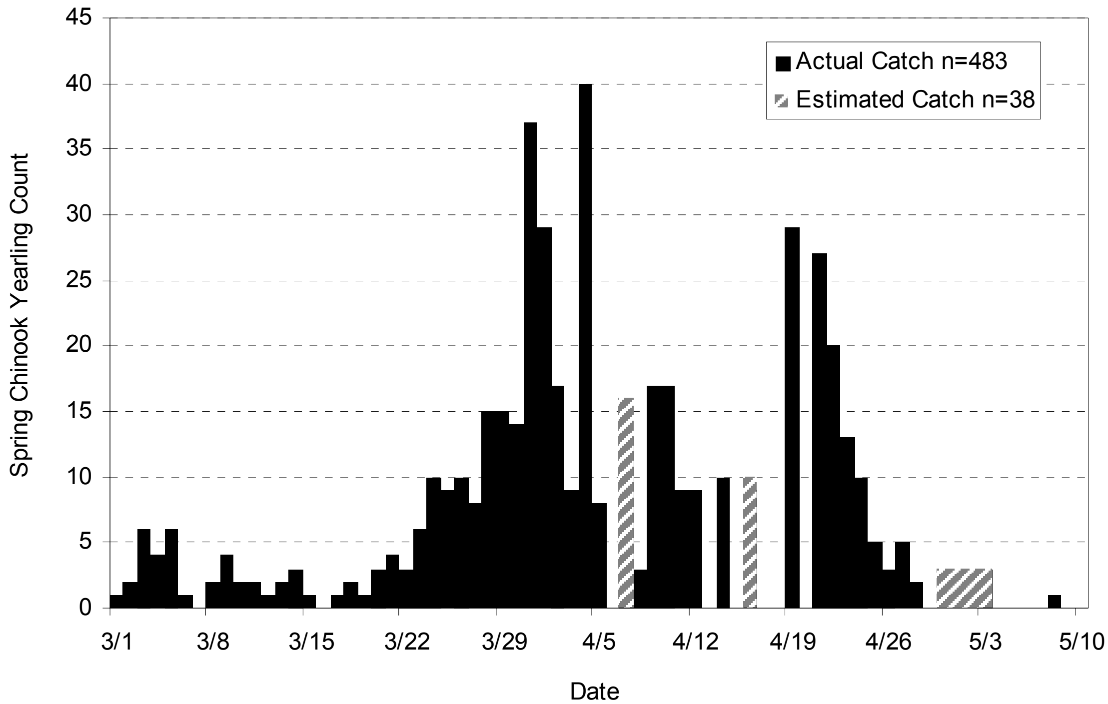

Figure 6. Yearling spring Chinook smolt counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap, March 1st through May 10th, 2006.

Table 3. Nason Creek ESA listed species handling and mortality summary.

Species	**Total Collected**	**Population Estimate**	**Total Mortality**	**% Population Handled**	**% Handled Mortality**
Spring Chinook Fry (BY 05)	401	n/a*	7	n/a	1.7%
Spring Chinook Yearling (BY 04)	483	3,267 (± 141)	8	14.8%	1.7%
Spring Chinook Sub (BY 05)	3,186	24,348 (± 410)	32	13.1%	1.0%
Spring Chinook BY 04 Total **	2383	15,835	42	15.0%	1.8%
Steelhead Fry	600	n/a*	9	n/a	1.5%
Steelhead Parr	1,860	32,703 (± 2,104)	15	5.7%	0.8%
Steelhead Smolt	97	2,468 (± 863)	0	3.9%	0.0%
Steelhead Smolt Hatchery	4,268	n/a	10	n/a	0.2%
Bull Trout	2	n/a	0	n/a	0.0%

*Fry were not included in population estimate. It is unknown if they are actively emigrating.

**BY 2004 spring Chinook capture included 619 fry, 1148 subs, 483 yearlings, and 133 hatchery origin fish.

Spring Chinook Fry (BY2005)

We collected 401 BY 2005 spring Chinook fry during 2006 The first fry was trapped on March 9th Peak catch (85.0%) occurred in June with 32 (8.0%) fry collected on June 17th (Figure 7). Spring Chinook fry continued to be trapped until the last day of the set cut off period on June 30th. Seven spring Chinook fry mortalities were found in the trap (Table 3).

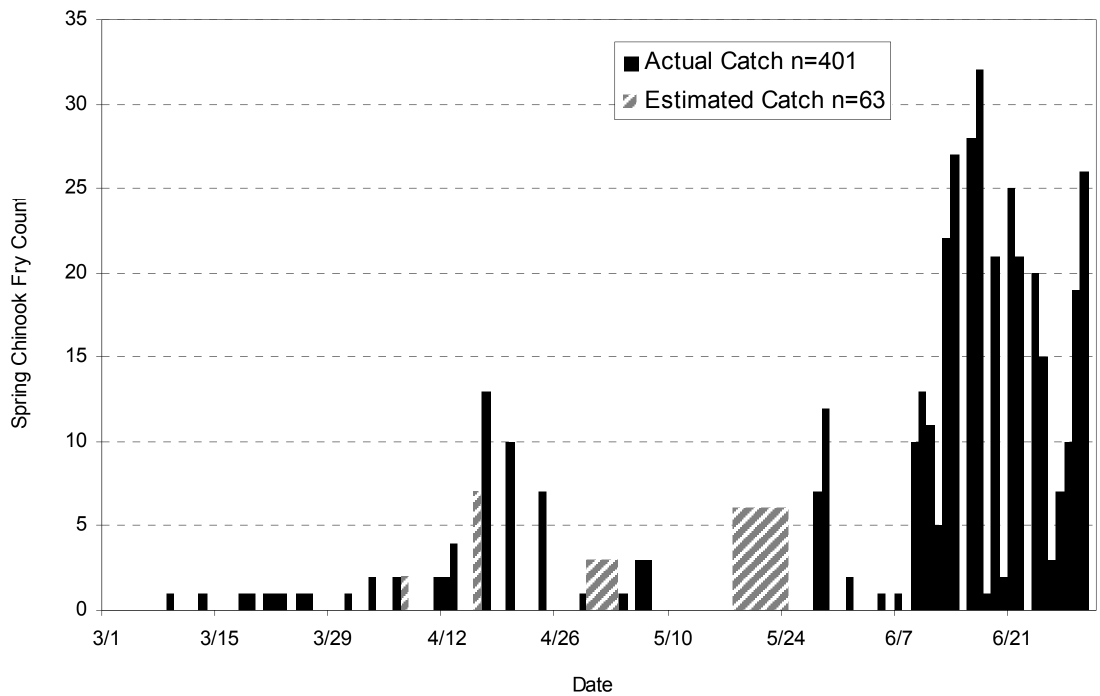

Figure 7. Spring Chinook fry counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap, March 1st through November 1st 2006.

Spring Chinook Subyearling (BY 2005)

We collected 3,186 BY 2005 subyearling spring Chinook parr during 2006. The first 'parr' were trapped on July 5th based on date and size criteria (< yearling size and > June 30th) used to distinguish fry from emigrating subyearling parr. Peak catch (29.5%) occurred during the week of July 13th with 390 (12.2%) subyearlings collected on July 14th (Figure 8). Subyearling spring Chinook continued to be trapped until the last day of operation on November 22nd. Twenty six Chinook subyearling mortalities were found in the trap (Table 3).

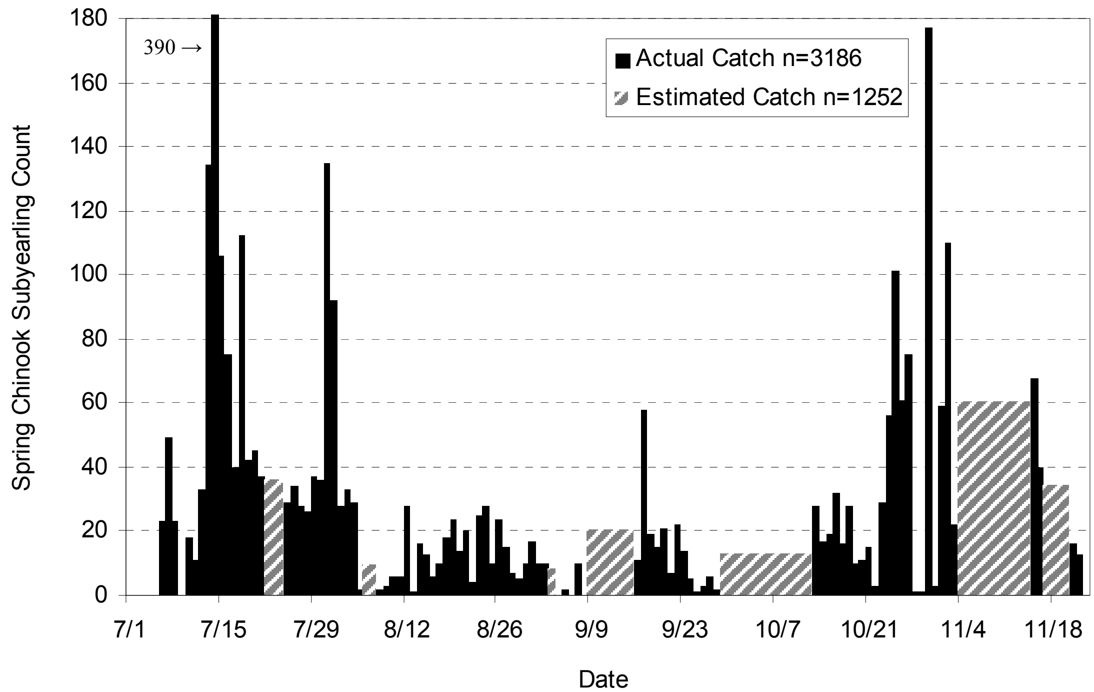

Figure 8. Spring Chinook subyearling counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap, June 20th through Nov 22nd, 2006.

Steelhead/Rainbow Trout Smolts

We collected 97 steelhead smolts and transitional smolts during 2006. The first smolt was trapped on April 13th. Peak catch (90.7%) occurred during April with 42 (43.2%) smolts collected on April 27th (Figure 9). No steelhead smolts were captured after June 8th. No steelhead smolt mortalities occurred due to trapping (Table 3). Additionally, 4,268 hatchery steelhead smolts were captured between April 4th and August 18th.

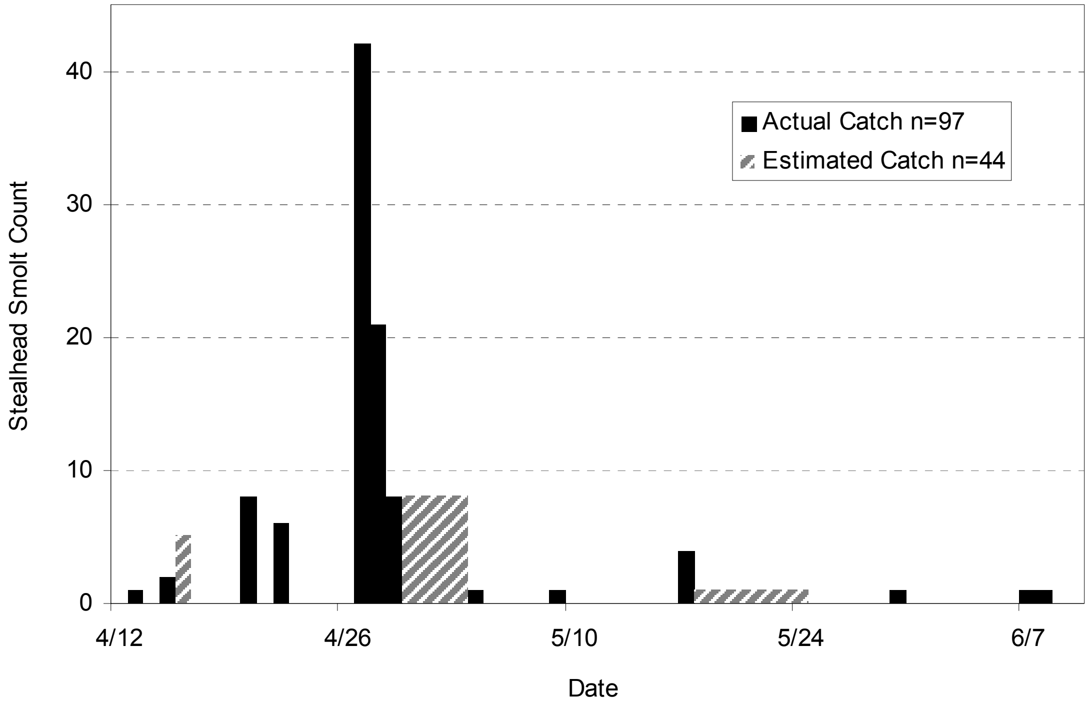

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Figure 9. Steelhead smolt counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap, April 12th through June 10th, 2006.

Steelhead/Rainbow Trout Fry

We collected 600 BY 2005 steelhead/rainbow trout fry during 2006. The first fry was trapped on June 29th. Peak catch (47.2%) occurred August 14th to September 2nd with 42 (7.0%) fry collected on August 14th (Figure 10). Steelhead fry continued to be trapped until the last day of September 30th, after which date BY 2005 steelhead were considered 'parr'. Nine steelhead fry mortalities were found in the trap (Table 3).

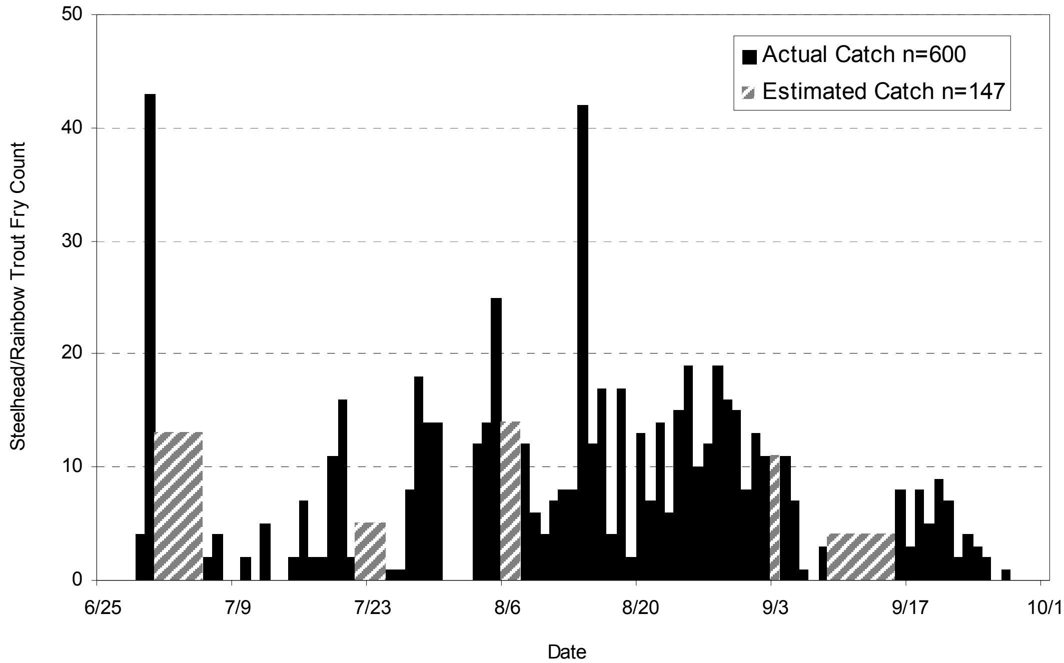


Figure 10. Steelhead/rainbow trout fry counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap from June 29th through November 22nd, 2006.

Steelhead/Rainbow Trout Parr

We collected 2,860 steelhead parr from multiple age classes during 2006. The first parr was trapped on March 2nd. Peak catch (31.5%) occurred in August with 94 (3.3%) collected on August 31st (Figure 11). Steelhead parr continued to be trapped until the last day of operation on November 22nd. Ten steelhead parr mortalities were found in the trap (Table 3).

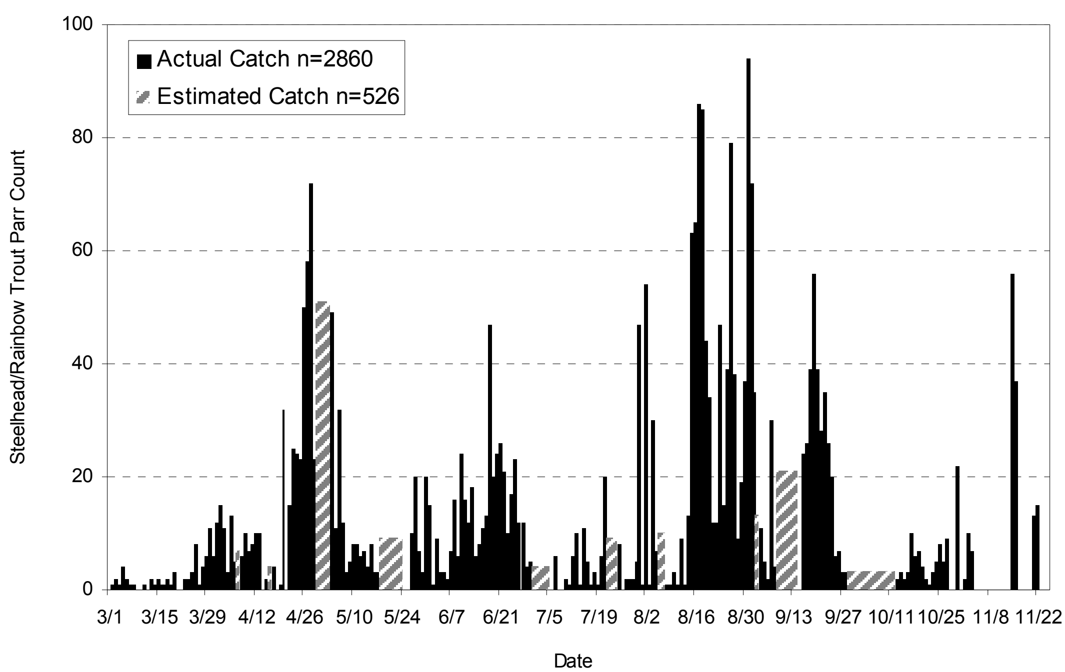


Figure 11. Steelhead parr counts, run-timing, and estimated catch for days not trapping at the Nason Creek smolt trap, March 1st through Nov 22nd, 2006.

Size and Growth

Coho Yearlings (BY 2004)

The first yearling coho smolt was collected on March 28th. The mean FL of BY 2004 coho increased from 96 mm in April to 119 mm in June of 2006. Mean condition factor fluctuated from 1.15 in Mar to 1.05 in June (Table 4).

Table 4. Fork length, weight and condition factor for coho yearlings (BY 2004) collected at the Nason Creek trap during 2006.

	Fork Length (mm)			Weight (g)			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
Coho Yearling									
Mar-07	121	na	1	20.5	na	1	1.15	na	1
Apr-07	96	9	28	9.3	2.8	28	1.01	0.09	28
May-06	101	8	13	11.1	2.5	13	1.08	0.14	13
Jun-06	116	11	4	16.2	4.2	4	1.05	0.15	4

Coho Subyearlings (BY 2005)

The first and only coho fry (47 mm) was collected on June 30th. The mean FL of BY 2005 coho increased from 67 mm in May to 91 mm in October of 2006. Mean subyearling condition factor fluctuated from 1.06 in May to 1.41 in July and then to 1.10 in October (Table 5).

Table 5. Fork length, weight and condition factor for coho subyearlings (BY 2005) collected at the Nason Creek trap during 2006.

	Fork Length (mm)			Weight (g)			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
Coho Subyearling									
May-06	67	na	1	3.2	na	1	1.06	na	1
Jun-06	57	9	4	2.4	0.6	3	1.14	0.21	3
Jul-06	63	8	5	3.6	1.6	3	1.41	0.14	3
Oct-06	91	na	1	8.3	na	1	1.10	na	1

Spring Chinook Yearlings (BY 2004)

Size and growth data collected from yearling spring Chinook salmon smolts in 2006 is presented along-side 2005 data from the same cohort to provide a measure of over-winter growth. Between November 2005 and March 2006 the mean FL of emigrants increased 8.9 mm; it appears that the mean condition factor did not decline over the winter (Table 6).

Table 6. Fork length, weight, and condition factor for spring Chinook yearlings (BY 2004) collected at the Nason Creek trap during 2006.

	Fork Length (mm)			Weight (g)			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
				Spring Chinook Yearling					
Sep-05	69	6	56	3.5	1.1	56	1.08	0.35	56
Oct-05	78	9	344	5.0	1.8	340	1.03	0.14	341
Nov-05	80	8	383	5.2	1.6	383	1.04	0.50	383
Mar-06	89	7	138	7.4	1.7	138	1.07	0.19	138
Apr-06	92	7	319	8.2	1.8	319	1.04	0.11	319
May-06	96	11	4	9.2	3.3	4	1.02	0.03	4

Spring Chinook Subyearlings (BY 2005)

The mean FL of BY 2005 spring Chinook increased from 36 mm in March to 81 mm in November. Mean subyearling condition factor increased from 0.77 in March to 1.09 in November (Table 7).

Table 7. Fork length, weight and condition factor for spring Chinook (BY 2005) collected at the Nason Creek trap during 2006.

	Fork Length (mm)			Weight (g)			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
				Chinook BY 2005					
Mar-06	36	2	9	0.4	0.1	9	0.77	0.19	9
Apr-06	37	2	27	0.3	0.1	25	0.67	0.31	25
May-06	38	na	1	0.5	na	1	0.91	na	1
Jun-06	51	8	95	1.4	0.8	95	0.99	0.22	95
Jul-06	61	7	779	2.5	1.1	752	1.06	0.23	752
Aug-06	62	8	416	2.6	1.1	403	1.05	0.15	403
Sep-06	69	10	194	3.7	1.7	193	1.05	0.13	193
Oct-06	78	9	680	5.3	1.9	675	1.06	0.11	675
Nov-06	81	8	326	5.8	1.8	325	1.09	0.13	325

Steelhead Fry, Parr, and Smolts

Steelhead smolts and transitional smolts had a mean FL of 158 mm when they began emigrating in April, declining to 148 mm in May. The mean condition factor of smolts started at 0.96 in April and decreased to 0.94 in May (Table 8).

Table 8. Fork length, weight and condition factor for steelhead smolts collected at the Nason Creek smolt during 2006.

	Fork Length (mm)			Weight (g)			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
				Steelhead Smolts					
Apr-06	158	16	88	38.3	11.9	88	0.96	0.13	88
May-06	148	10	5	30.8	7.6	5	0.94	0.07	5

The mean FL for BY 2006 steelhead fry ranged from 35 mm in July to 46 mm in November. Mean fry condition factor was generally at or below 1.00 with a low of 0.90 in June and a high of 1.00 in September (Table 9).

Table 9. Fork length, weight and condition factor for steelhead fry collected at the Nason Creek trap during 2006.

	Fork Length (mm)			Weight (g)			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
Steelhead Fry									
Jun-06	41	6	8	0.7	0.4	8	0.90	0.33	8
Jul-06	35	6	111	0.5	0.2	92	1.00	0.47	92
Aug-06	44	4	344	0.8	0.3	317	0.97	0.31	317
Sep-06	46	3	98	1.0	0.3	97	1.00	0.23	97

Steelhead parr from multiple brood years measuring from 50 mm to 191 mm FL emigrated throughout the entire season (Table 10). A scale sample analysis will be conducted by WDFW on the 2006 scales to correlate size to age at emigration, and to allow for brood year specific population estimates. The results of the 2005 scale sample analysis are presented in Table 11 and Appendix D. The larger steelhead parr (FL 120 mm to 190 mm) appeared to emigrate primarily in July as stream flow decreased and water temperature increased and in October when the flow and temperature regime changed again.

Table 10. Fork length, weight and condition factor for steelhead parr collected at the Nason Creek trap during 2006.

	Fork Length (mm)			Weight (g)			Condition Factor		
Date	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
Steelhead Parr									
Mar-06	70	9	69	4.0	1.7	69	1.08	0.24	69
Apr-06	78	14	307	5.4	3.4	307	1.04	0.10	307
May-06	78	12	218	5.4	3.4	218	1.03	0.12	218
Jun-06	85	14	384	7.6	7.3	384	1.13	0.75	384
Jul-06	103	22	74	13.4	10.4	66	1.04	0.10	66
Aug-06	57	13	252	2.2	3.3	228	0.94	0.19	227
Sep-06	62	19	327	3.2	6.5	324	0.98	0.13	324
Oct-06	108	49	92	17.7	20.1	89	1.00	0.13	89
Nov-06	83	32	140	8.9	10.4	140	1.09	0.62	140

Table 11. Scale analysis size and age summary for steelhead parr collected in Nason Creek during 2005.

	Fork Length (mm)		Weight (g)		
Age	**Mean**	**SD**	**Mean**	**SD**	***N***
1	117.00	15.15	18.23	6.80	45
2	148.69	18.23	33.71	10.60	55
3	172.00	13.38	62.65	27.51	2

Trap Efficiency Calibration and Population Estimates

Coho Yearlings (BY 2004)

No mark group releases were performed with yearling coho due to insufficient numbers collected at the trap. Spring Chinook yearlings were used as surrogates for trap efficiency for the following population estimate. A pooled trap efficiency of 15.95% (Table 12) was used to estimate yearling coho (smolt) production in Nason Creek. We estimate that 431 (± 10 95% CI) yearling coho emigrated from Nason Creek from March 28th through June 12th. During 2005 we estimated that 41 (± 0 95% CI) subyearling coho emigrated from Nason Creek, based on a pooled trap efficiency of 24.60% for spring Chinook subyearlings, resulting in a total population estimate of 472 emigrants. Detailed records of each efficiency trial can be found in Appendix E.

Table 12. Trap efficiency mark/recapture trial summary for Nason Creek 2006.

Number Marked	Total Recaptured	Percent Recaptured	Number of Trials	Trap Position
		Spring Chinook Yearling		
370	59	15.95%	16	Back
		Spring Chinook Subyearling		
1237	224	18.11%	20	Forward
		Steelhead Parr		
719	64	8.90%	22	Back
213	15	7.04%	15	Forward
		Steelhead Smolt		
70	4	5.71%	7	Back
		Steelhead Fry <50 mm		
214	32	14.95%	1	Forward
		Hatchery Coho Smolts		
140	11	7.86%	2	Back

Spring Chinook Yearlings (BY 2004)

We completed 16 marked group releases for yearling Chinook smolts in 2006. Of these releases six had sample sizes greater than 30 and were included in the linear regression analysis (Appendix E). Releases in 2006 were combined with 3 releases in 2005 to increase the sample size and statistical power. The result of the linear regression was not significant (p=0.0029, r^2=0.19). A pooled trap efficiency of 15.95% (Table 11 was used to estimate yearling spring Chinook (smolt) production in Nason Creek. We estimate that 3,267 (± 141 95% CI) yearling spring Chinook emigrated from Nason Creek from March 1st through May 9th. During 2005 we estimated that 12,568 subyearling spring Chinook emigrated from Nason Creek for a total population estimate of 15,835 emigrants. Detailed records of each efficiency trial can be found in Appendix F.

Spring Chinook Subyearlings (BY 2005)

We completed 20 marked group releases for subyearling Chinook in 2006. Of these releases 15 had sample sizes greater than 30 and were included in the linear regression analysis (Appendix E). Releases in 2006 were combined with 11 releases in 2005 to increase the sample size and statistical power. The result of the regression analysis was not significant (p = 0.0040; r^2 = 0.074). A pooled trap efficiency of 18.11% (Table 11) was used to estimate the production of subyearling Chinook (BY 2005) in Nason Creek. We estimate that 24,348

(± 410 95% CI) subyearling spring Chinook emigrated from Nason Creek in 2006. Detailed records of each efficiency trial can be found in Appendix F.

Steelhead/Rainbow Trout Smolts

We completed 7 marked group releases for steelhead smolts in 2006. Of the 7 releases only 1 met the criteria to be included in the analysis (n≥30). There were no releases in 2005 of sufficient size to include in the model. A linear regression was not performed due to an insufficient number of samples. A pooled trap efficiency of 5.71% (Table 11) was used to estimate the production of steelhead smolts in Nason Creek. We estimate that 2,468 (± 863 95% CI) steelhead smolts emigrated from Nason Creek in 2006. Detailed records of each efficiency trial can be found in Appendix F.

Steelhead/Rainbow Trout Parr

We completed 22 marked group releases for steelhead parr in 2006 with the trap in the back position. Of these releases 9 had sample sizes greater than 30 and were included in the analysis (Appendix E). Releases in 2006 were combined with 2 releases in 2005 to increase the sample size and statistical power. The result of the regression was significant (p = 3.17E-5; r^2 = 0.69). Predicted trap efficiency ranging from 3.77% to 16.81% with an average of 10.97% was used to estimate the production of steelhead parr in Nason Creek with the trap in the back position. We estimate that 18,896 (± 4,204 95% CI) steelhead parr emigrated from Nason Creek during the period of March 1st to July 10th. We completed 15 marked group releases for steelhead parr in 2006 with the trap in the forward position. Of the 15 releases only 1 met the criteria to be included in the linear regression analysis (n≥30). A linear regression was not performed due to an insufficient number of samples. A pooled trap efficiency of 7.04% (Table 11) was used to estimate the production of steelhead parr in Nason Creek with the trap in the forward position. was used to estimate the production of steelhead parr in Nason Creek. We estimate that 32,703 (± 2,104 95% CI) steelhead parr emigrated from Nason Creek during the period of July 11th to November 22nd for a total steelhead parr emigration of 51,599. Detailed records of each efficiency trial can be found in Appendix F.

Egg to Emigrant Survival

We used the population estimates above, redd counts, female fecundity, and egg retention estimates to generate the following egg-to-emigrant survival rates for BY 2004 coho (Table 13) and BY 2004 spring Chinook (Table 14).

Table 13. Coho (BY 2004) egg to emigrant survival in Nason Creek based on the spring chinook yearling efficiency rating.

Redds Observed	Mean Fecundity	Mean Egg Retention	Total Egg Deposition	Parr* Emigration (fall 05)	Smolt** Emigration (spring 06)	Total Smolt Production	Egg to Emigrant Survival (%)
35	3084	428	92,925	41	431	472	0.51%

*based on the spring chinook yearling efficiency rating of 24.60%
** based on the spring chinook yearling efficiency rating of 15.95%

Table 14. Spring Chinook (BY 2004) egg to emigrant survival in Nason Creek.

Redds Observed	Mean Fecundity	Mean Egg Retention	Total Egg Deposition	Parr Emigration (fall 05)	Smolt Emigration (spring 06)	Total Smolt Production	Egg to Emigrant Survival (%)
169	4700	na	794,300	12,568	3,267	15,835	1.99%

PIT Tagging

During the 2006 trapping season we PIT tagged 1,799 spring Chinook and 1,167 steelhead of various size and age (Table 15). This equates to 73.7% of the total Chinook and 68.7% of the total steelhead collected at the trap. Tagging related mortality observed during the 24 hour holding period was 0.4 % (7 fish) of the 1,799 Chinook tagged and also 0.4 % (5 fish) of 1,167 steelhead tagged. Tag loss during the first 24 hours was also minimal, 0.3% (9 tags) overall.

Table 15. PIT tagging summary for Nason Creek spring Chinook and steelhead, 2006.

Species	Tags Implanted	Average FL (mm)	Average Weight (g)	24 Hour Mortality	Shed Tags	% of Catch Tagged
Chinook Yearling	364	91	8.0	1	2	75.4%
Chinook Sub	1435	73	4.3	6	4	73.3%
Stl Parr Spring	780	81	5.8	2	2	71.2%
Stl Parr Fall	315	93	11.4	3	1	62.4%
Steelhead Smolt	72	157	38.4	0	0	74.2%

Incidental Species

All of the known 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 16).

Table 16. Number and mean fork length of incidental species collected in Nason Creek.

Species	Total Captured	Mean Fork Length
Hatchery Steelhead	4268	183.9
Hatchery Coho	4415	128.9
Bull trout	2	181.5
Cutthroat Trout	2	172.5
Whitefish	540	66.1
Northern Pikeminnow	39	112.1
Sculpin sp.	85	95.8
Sucker sp.	309	97.4
Dace	193	77.8
Redside Shiner	12	77.2
Fathead Minnow	2	44.0

Discussion

This was the third year YN 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 annual emigration of two brood years, subyearling parr in the fall and yearling smolts in the spring. Data collected during the spring of 2007 will provide a complete emigration dataset for the Nason Creek spring Chinook 2005 brood. This years emigrant population estimates from the spring of 2006 combined with the fall subyearling counts in 2005, combined with ongoing egg deposition surveys, have been combined to produce an estimate of egg-to-emigrant survival rates of Nason Creek 2004 brood spring Chinook and coho.

Steelhead 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 >100 mm. Results from the 1st year of the age class study were presented in Table 10 and Appendix D. Because steelhead are multi-year smolts, a complete population estimate is not yet available. We expect the population estimate for BY 2005 to be available in 2008. Ongoing work using PIT tags applied at the trap and at sites upstream of the trap in combination with instream detection arrays will enable researchers to determine if steelhead parr captured at the trap are actually emigrating out of Nason Creek.

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 number of 2004 brood Chinook caught in the trap, it appears that a greater proportion of Nason Creek Chinook emigrate as subyearlings (70.4%) vs. yearlings (29.6%)

In 2007 we will continue to conduct as many mark-recapture trials as possible with PIT tags in both spring Chinook and steelhead. As more data is collected, we will be able to further develop a model to correlate trap efficiency with stream discharge, resulting in a more accurate population estimate. Population estimates from previous years can then be re-evaluated when trap efficiency to stream discharge relationships for both steelhead and Chinook are better developed.

Literature Cited

CBFWA (Columbia Basin Fish and Wildlife Authority). 1999. PIT tag marking procedures manual, version 2.0. Columbia Basin Fish and Wildlife Authority, Portland OR.

Everhart, W.H. and W.D. Youngs. 1953. Principles of Fishery Science, second edition. Comstock Publishing Associates, *a division of* Cornell University Press, Ithica and London.

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

Murdoch, A., T. Miller, K. Murdoch, S. Prevatte, M. Cooper, and D. Carie. 2005. A Proposal to Examine Specific Life History Traits of Juvenile Steelhead and Spring Chinook in the Wenatchee River Basin Using PIT Tags. *Prepared for* Regional Technical Team of the Upper Columbia River Salmon Recovery Board, Wenatchee, Washington.

PIT Tag Steering Committee. 1999. PIT Tag Marking Procedures Manual V.2.0. The Columbia Basin Fish and Wildlife Authority

Appendix A

Nason Creek smolt trap photographs.

Photo 1. Trap in back position, June 14th, 2006. Stream discharge was 898 cfs.

Photo 2. Trap in position, March 8th, 2005. Stream discharge was 366 cfs.

Photo 3. Trap stopped by snow, November 23rd, 2006. Stream discharge was 425 cfs.

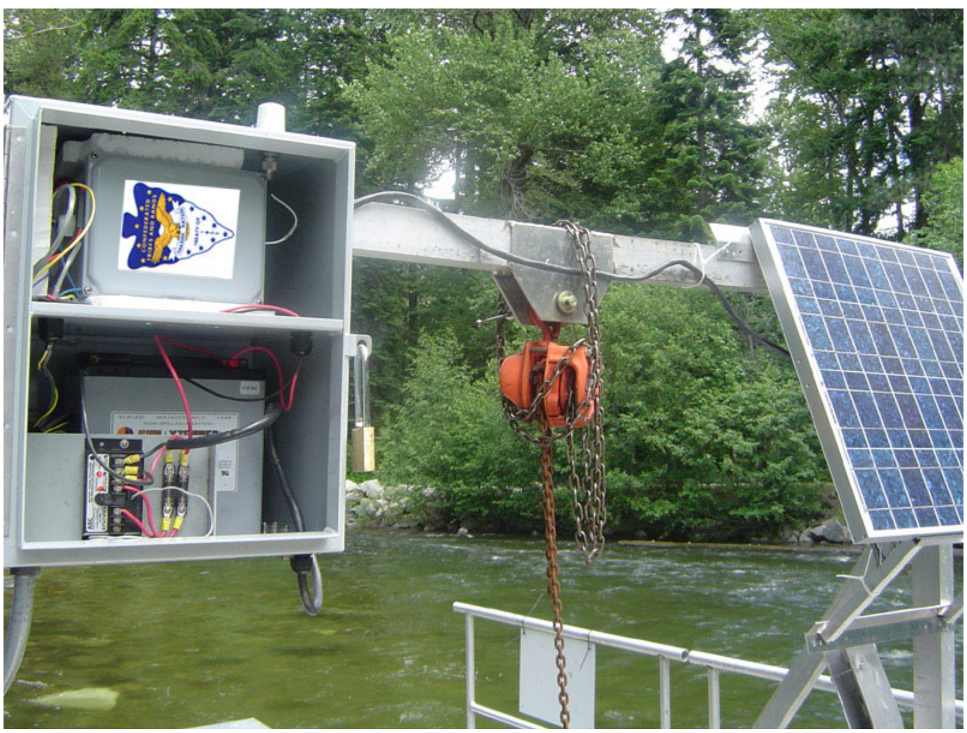


Photo 4. Trap stop alarm with solar panel, June 2006.

Appendix B

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
12/1/2005	104	0.3	1/11/2006	347	1.1
12/2/2005	102	-0.1	1/12/2006	290	1.3
12/3/2005	100	-0.3	1/13/2006	262	1.5
12/4/2005	153	-0.3	1/14/2006	239	2.3
12/5/2005	146	0.1	1/15/2006	219	1.8
12/6/2005	90	1.4	1/16/2006	208	1.0
12/7/2005	86	0.2	1/17/2006	203	0.1
12/8/2005	116	-0.3	1/18/2006	188	1.6
12/9/2005	227	-0.3	1/19/2006	176	1.8
12/10/2005	318	-0.3	1/20/2006	174	1.1
12/11/2005	368	-0.3	1/21/2006	163	1.4
12/12/2005	402	-0.3	1/22/2006	157	2.2
12/13/2005	450	-0.3	1/23/2006	156	2.6
12/14/2005	399	-0.3	1/24/2006	154	2.2
12/15/2005	342	-0.3	1/25/2006	150	2.6
12/16/2005	271	-0.3	1/26/2006	146	2.5
12/17/2005	315	-0.3	1/27/2006	143	2.2
12/18/2005	317	-0.3	1/28/2006	144	0.8
12/19/2005	394	-0.3	1/29/2006	141	0.9
12/20/2005	280	-0.3	1/30/2006	149	-0.2
12/21/2005	192	-0.3	1/31/2006	160	0.5
12/22/2005	149	-0.3	2/1/2006	154	0.1
12/23/2005	280	-0.3	2/2/2006	155	1.4
12/24/2005	470	-0.3	2/3/2006	154	1.7
12/25/2005	668	-0.3	2/4/2006	155	1.6
12/26/2005	346	0.7	2/5/2006	147	1.7
12/27/2005	268	1.6	2/6/2006	139	1.7
12/28/2005	234	1.4	2/7/2006	133	1.7
12/29/2005	211	1.9	2/8/2006	131	2.1
12/30/2005	201	0.9	2/9/2006	127	1.2
12/31/2005	185	1.2	2/10/2006	125	0.2
1/1/2006	173	1.5	2/11/2006	121	0.0
1/2/2006	162	2.2	2/12/2006	118	0.9
1/3/2006	153	1.9	2/13/2006	116	1.4
1/4/2006	145	1.4	2/14/2006	114	1.1
1/5/2006	140	1.9	2/15/2006	109	-0.2
1/6/2006	194	2.1	2/16/2006	127	-0.3
1/7/2006	266	2.3	2/17/2006	105	-0.3
1/8/2006	248	2.1	2/18/2006	113	-0.3
1/9/2006	224	1.1	2/19/2006	127	-0.3
1/10/2006	270	0.2	2/20/2006	156	-0.3

Date	Average Daily CFS	Average Daily Temp C	Date	Average Daily CFS	Average Daily Temp C
2/21/2006	119	-0.3	4/9/2006	292	4.3
2/22/2006	103	0.6	4/10/2006	292	4.8
2/23/2006	114	1.4	4/11/2006	296	5.3
2/24/2006	110	0.2	4/12/2006	306	5.1
2/25/2006	104	0.1	4/13/2006	323	4.6
2/26/2006	100	0.9	4/14/2006	327	4.7
2/27/2006	100	1.9	4/15/2006	321	4.1
2/28/2006	110	2.2	4/16/2006	290	4.4
3/1/2006	105	2.0	4/17/2006	271	4.7
3/2/2006	106	2.9	4/18/2006	263	5.7
3/3/2006	105	2.5	4/19/2006	272	6.1
3/4/2006	103	2.2	4/20/2006	294	5.9
3/5/2006	102	2.0	4/21/2006	354	5.3
3/6/2006	101	2.9	4/22/2006	341	4.8
3/7/2006	103	3.5	4/23/2006	347	5.3
3/8/2006	106	2.2	4/24/2006	380	5.5
3/9/2006	107	0.5	4/25/2006	418	5.9
3/10/2006	102	1.2	4/26/2006	461	5.1
3/11/2006	98	1.9	4/27/2006	469	6.0
3/12/2006	95	1.7	4/28/2006	591	5.9
3/13/2006	94	1.6	4/29/2006	760	4.8
3/14/2006	94	3.0	4/30/2006	748	4.8
3/15/2006	93	3.4	5/1/2006	639	4.1
3/16/2006	95	2.8	5/2/2006	546	4.6
3/17/2006	94	3.3	5/3/2006	515	5.2
3/18/2006	92	3.6	5/4/2006	521	5.4
3/19/2006	91	3.5	5/5/2006	552	5.2
3/20/2006	93	4.4	5/6/2006	583	4.4
3/21/2006	95	4.7	5/7/2006	556	4.2
3/22/2006	96	4.5	5/8/2006	555	4.0
3/23/2006	103	5.0	5/9/2006	488	4.3
3/24/2006	122	5.4	5/10/2006	482	5.8
3/25/2006	134	4.5	5/11/2006	510	5.5
3/26/2006	128	4.0	5/12/2006	522	5.5
3/27/2006	126	3.8	5/13/2006	487	5.5
3/28/2006	129	4.4	5/14/2006	520	6.4
3/29/2006	139	4.6	5/15/2006	669	6.3
3/30/2006	155	4.6	5/16/2006	989	5.6
3/31/2006	164	4.8	5/17/2006	1430	5.2
4/1/2006	193	3.5	5/18/2006	1980	5.4
4/2/2006	190	3.3	5/19/2006	1940	5.1
4/3/2006	183	3.9	5/20/2006	1760	5.2
4/4/2006	204	5.0	5/21/2006	1480	4.8
4/5/2006	232	4.8	5/22/2006	1390	4.8
4/6/2006	260	5.0	5/23/2006	1370	4.8
4/7/2006	265	4.4	5/24/2006	1320	5.2
4/8/2006	267	4.3	5/25/2006	1140	5.2

Date	Average Daily CFS	Average Daily Temp C	Date	Average Daily CFS	Average Daily Temp C
5/26/2006	21	16.8	7/12/2006	40	7.9
5/27/2006	20	15.8	7/13/2006	39	7.8
5/28/2006	19	16.4	7/14/2006	39	8.6
5/29/2006	13	16.6	7/15/2006	40	8.1
5/30/2006	11	17	7/16/2006	41	8.8
5/31/2006	15	16.7	7/17/2006	39	8.9
6/1/2006	25	15.8	7/18/2006	39	9.2
6/2/2006	26	14.4	7/19/2006	59	9
6/3/2006	23	14.8	7/20/2006	72	10.5
6/4/2006	22	15.5	7/21/2006	62	9.9
6/5/2006	21	16.4	7/22/2006	106	9.9
6/6/2006	20	15.3	7/23/2006	79	9
6/7/2006	19	14.3	7/24/2006	66	8.7
6/8/2006	18	13.6	7/25/2006	60	7.8
6/9/2006	16	13.7	7/26/2006	56	7.4
6/10/2006	12	14.2	7/27/2006	52	7.9
6/11/2006	15	15.1	7/28/2006	65	7.7
6/12/2006	32	14.6	7/29/2006	61	7.2
6/13/2006	31	12.9	7/30/2006	56	5.3
6/14/2006	27	12.3	7/31/2006	55	6
6/15/2006	24	12.9	8/1/2006	54	5.5
6/16/2006	22	12.9	8/2/2006	71	5.1
6/17/2006	20	13.7	8/3/2006	110	4.3
6/18/2006	21	13.8	8/4/2006	91	3.4
6/19/2006	26	12.2	8/5/2006	84	3.8
6/20/2006	25	12.4	8/6/2006	81	3.6
6/21/2006	22	12.2	8/7/2006	80	3.7
6/22/2006	20	13.2	8/8/2006	78	3.5
6/23/2006	19	12.7	8/9/2006	76	3.2
6/24/2006	19	11.2	8/10/2006	69	3
6/25/2006	19	10.8	8/11/2006	65	2.6
6/26/2006	19	10.3	8/12/2006	66	3.2
6/27/2006	19	10.1	8/13/2006	134	4.1
6/28/2006	18	10.5	8/14/2006	100	3.6
6/29/2006	16	10.8	8/15/2006	120	3
6/30/2006	14	11.5	8/16/2006	171	2.5
7/1/2006	19	10.8	8/17/2006	117	2.3
7/2/2006	177	12	8/18/2006	107	1.8
7/3/2006	68	11.2	8/19/2006	125	2.7
7/4/2006	51	9.9	8/20/2006	113	2.9
7/5/2006	41	8.2	8/21/2006	121	3
7/6/2006	38	8.7	8/22/2006	123	3
7/7/2006	36	8	8/23/2006	120	2.9
7/8/2006	35	8.2	8/24/2006	118	2.7
7/9/2006	58	8.9	8/25/2006	110	2.4
7/10/2006	56	9	8/26/2006	100	2
7/11/2006	42	7.8	8/27/2006	98	1.5

Date	Average Daily CFS	Average Daily Temp C	Date	Average Daily CFS	Average Daily Temp C
5/26/2006	942	5.1	7/12/2006	182	12.0
5/27/2006	830	5.2	7/13/2006	186	12.5
5/28/2006	756	5.7	7/14/2006	171	13.1
5/29/2006	740	6.1	7/15/2006	157	12.7
5/30/2006	733	6.2	7/16/2006	147	12.4
5/31/2006	782	6.4	7/17/2006	137	14.0
6/1/2006	1000	6.0	7/18/2006	129	14.0
6/2/2006	1210	5.7	7/19/2006	124	14.0
6/3/2006	1170	5.9	7/20/2006	113	14.3
6/4/2006	1100	6.0	7/21/2006	110	16.4
6/5/2006	1160	7.7	7/22/2006	109	16.8
6/6/2006	1120	8.4	7/23/2006	103	17.9
6/7/2006	1090	8.6	7/24/2006	97	18.5
6/8/2006	1020	7.1	7/25/2006	94	18.9
6/9/2006	888	7.1	7/26/2006	99	20.2
6/10/2006	837	6.0	7/27/2006	95	21.3
6/11/2006	835	6.9	7/28/2006	91	21.8
6/12/2006	942	6.7	7/29/2006	82	19.6
6/13/2006	1050	5.5	7/30/2006	78	16.9
6/14/2006	898	6.2	7/31/2006	81	14.4
6/15/2006	859	6.1	8/1/2006	79	14.4
6/16/2006	828	6.1	8/2/2006	77	16.2
6/17/2006	834	6.4	8/3/2006	77	15.8
6/18/2006	735	8.0	8/4/2006	74	16.2
6/19/2006	680	8.7	8/5/2006	71	16.4
6/20/2006	613	10.8	8/6/2006	69	16.9
6/21/2006	593	10.2	8/7/2006	68	17.6
6/22/2006	579	9.3	8/8/2006	64	17.3
6/23/2006	580	8.3	8/9/2006	64	16.9
6/24/2006	597	10.4	8/10/2006	69	16.8
6/25/2006	664	10.7	8/11/2006	69	16.5
6/26/2006	702	10.7	8/12/2006	67	16.1
6/27/2006	676	10.8	8/13/2006	64	16.4
6/28/2006	601	10.3	8/14/2006	60	16.8
6/29/2006	500	9.8	8/15/2006	56	17.1
6/30/2006	449	10.5	8/16/2006	55	16.5
7/1/2006	427	11.1	8/17/2006	53	16.6
7/2/2006	398	11.1	8/18/2006	51	16.8
7/3/2006	378	11.4	8/19/2006	50	17.0
7/4/2006	377	11.6	8/20/2006	49	16.9
7/5/2006	371	11.4	8/21/2006	48	17.0
7/6/2006	321	11.4	8/22/2006	45	17.6
7/7/2006	275	11.2	8/23/2006	44	16.6
7/8/2006	246	11.9	8/24/2006	43	16.3
7/9/2006	227	13.0	8/25/2006	43	16.0
7/10/2006	216	13.3	8/26/2006	41	16.4
7/11/2006	199	12.1	8/27/2006	40	16.5

Date	Average Daily CFS	Average Daily Temp C	Date	Average Daily CFS	Average Daily Temp C
8/28/2006	36	16.9	10/14/2006	41	8.5
8/29/2006	33	16.2	10/15/2006	42	9.2
8/30/2006	37	14.1	10/16/2006	51	8.6
8/31/2006	43	13.7	10/17/2006	53	8.9
9/1/2006	39	13.6	10/18/2006	48	8.7
9/2/2006	37	13.9	10/19/2006	47	9.6
9/3/2006	35	14.6	10/20/2006	52	9.1
9/4/2006	35	15.7	10/21/2006	49	7.8
9/5/2006	37	16.3	10/22/2006	47	6.7
9/6/2006	36	16.6	10/23/2006	46	6.4
9/7/2006	34	16.5	10/24/2006	46	6.4
9/8/2006	34	16.3	10/25/2006	50	6.4
9/9/2006	33	15.8	10/26/2006	51	6.5
9/10/2006	35	14.7	10/27/2006	56	8.2
9/11/2006	34	14.7	10/28/2006	68	7.0
9/12/2006	32	15.1	10/29/2006	59	7.0
9/13/2006	31	14.5	10/30/2006	63	4.6
9/14/2006	35	12.4	10/31/2006	54	2.5
9/15/2006	40	11.9	11/1/2006	49	1.5
9/16/2006	38	11.0	11/2/2006	52	1.9
9/17/2006	39	10.9	11/3/2006	60	2.0
9/18/2006	40	11.7	11/4/2006	209	2.3
9/19/2006	46	11.3	11/5/2006	469	3.2
9/20/2006	44	10.7	11/6/2006	1440	4.6
9/21/2006	47	10.9	11/7/2006	1720	6.2
9/22/2006	58	10.5	11/8/2006	1410	5.2
9/23/2006	45	11.3	11/9/2006	857	4.7
9/24/2006	41	11.7	11/10/2006	699	3.4
9/25/2006	38	11.9	11/11/2006	611	3.2
9/26/2006	36	12.0	11/12/2006	569	2.7
9/27/2006	35	12.3	11/13/2006	557	2.4
9/28/2006	34	12.6	11/14/2006	496	2.9
9/29/2006	33	12.6	11/15/2006	491	3.0
9/30/2006	32	12.2	11/16/2006	777	2.7
10/1/2006	41	11.7	11/17/2006	593	2.4
10/2/2006	41	10.6	11/18/2006	521	2.7
10/3/2006	42	10.2	11/19/2006	494	3.2
10/4/2006	42	10.5	11/20/2006	512	3.3
10/5/2006	42	11.3	11/21/2006	478	
10/6/2006	41	11.3	11/22/2006	448	
10/7/2006	41	10.1	11/23/2006	425	
10/8/2006	42	9.9	11/24/2006	400	
10/9/2006	43	9.3	11/25/2006	390	
10/10/2006	42	8.2	11/26/2006	375	
10/11/2006	42	8.1	11/27/2006	360	
10/12/2006	42	8.4	11/28/2006	338	
10/13/2006	41	8.3	11/29/2006	330	

Appendix C

Nason Creek smolt trap operating and not operating days, 2006.

Period	Trap Status	Description	Days Operating	Days Missed
1 Mar - 6 Apr	Operating	Continuous	37	
7 Apr	Not Operating	Stopped by Debris		1
8 Apr - 15 Apr	Operating	Continuous	8	
16 Apr	Not Operating	Trap Repair		1
17 Apr - 29 Apr	Operating	Continuous	13	
30 Apr - 3 May	Not Operating	Hatchery Release		4
4 May - 17 May	Operating	Continuous	14	
18 May - 24 May	Not Operating	High Water		7
25 May - 30 Jun	Operating	Continuous	37	
1 Jul - 5 Jul	Not Operating	Holiday		5
6 Jul - 21 Jul	Operating	Continuous	16	
22 Jul - 24 July	Not Operating	Trap Repair		3
25 Jul - 5 Aug	Operating	Continuous	12	
6 Aug - 7 Aug	Not Operating	Stopped by Debris		2
8 Aug - 2 Sep	Operating	Continuous	26	
3 Sep	Not Operating	Low Flow		1
4 Sep - 8 Sep	Operating	Continuous	5	
9 Sep - 15 Sep	Not Operating	Low Flow		7
16 Sep - 28 Sep	Operating	Continuous	13	
29 Sep - 12 Oct	Not Operating	Low Flow		14
13 Oct - 3 Nov	Operating	Continuous	22	
4 Nov	Not Operating	Stopped by Debris		
5 Nov - 14 Nov	Not Operating	High Water		11
15 Nov - 16 Nov	Operating	Continuous	2	
17 Nov - 20 Nov	Not Operating	Stopped by Ice		4
21 Nov - 22 Nov	Operating	Continuous	2	
23 Nov - 30 Nov	Not Operating	Stopped by Ice		8

Appendix D

Steelhead scale sample analysis for Nason Creek, 2005

DATE	FORK	WEIGHT	AGE
03/09/2005	75.00	4.2	1
06/19/2005	96.00	10.7	1
03/08/2005	100.00	10.4	1
04/23/2005	100.00	7.2	1
05/01/2005	101.00	13.4	1
06/27/2005	101.00	15.2	1
07/07/2005	102.00	11.4	1
07/10/2005	102.00	12.4	1
06/20/2005	102.00	11.3	1
07/09/2005	104.00	12	1
05/02/2005	105.00	12.3	1
07/10/2005	106.00	12.7	1
06/26/2005	106.00	13.5	1
07/09/2005	108.00	14.7	1
07/09/2005	108.00	13.8	1
06/21/2005	108.00	13.8	1
06/28/2005	108.00	13.9	1
05/02/2005	110.00	14.4	1
04/23/2005	111.00	15.4	1
06/16/2005	111.00	16	1
07/09/2005	111.00	16.6	1
06/19/2005	112.00	17.6	1
06/23/2005	114.00	16.4	1
07/09/2005	115.00	16.1	1
04/24/2005	115.00	16.7	2
05/01/2005	115.00	14.3	2
06/17/2005	117.00	19.4	1
04/30/2005	117.00	16.3	2
06/09/2005	119.00	18.5	1
04/27/2005	119.00	17.9	2
06/28/2005	120.00	19.1	1
04/26/2005	120.00	18.7	2
04/26/2005	120.00	18.7	2
06/01/2005	122.00	18.8	1
06/06/2005	122.00	18.4	1
06/29/2005	124.00	21.8	1
06/29/2005	124.00	19	1
05/05/2005	125.00		2
07/09/2005	126.00	20.2	1
07/01/2005	128.00	23	1
07/11/2005	128.00	28.5	1
05/25/2005	130.00	24.4	1
06/30/2005	130.00	22	1

DATE	FORK	WEIGHT	AGE
07/09/2005	130.00	23	1
04/24/2005	130.00	21.6	2
05/05/2005	130.00		2
04/26/2005	131.00	26.2	2
04/26/2005	132.00	24.3	2
05/05/2005	132.00		2
06/28/2005	133.00	26.7	1
04/26/2005	133.00	27.2	2
04/26/2005	134.00	24.1	2
04/26/2005	135.00	28.4	2
04/26/2005	135.00	25	2
04/26/2005	135.00	28.6	2
06/06/2005	136.00	29.7	1
07/06/2005	136.00	25.2	1
07/11/2005	136.00		1
04/27/2005	136.00	27.8	2
07/07/2005	138.00	30.8	1
07/09/2005	138.00	22.4	1
04/26/2005	138.00	29.9	2
06/30/2005	139.00	30.5	1
04/27/2005	139.00	28.2	2
07/10/2005	142.00	27.8	1
06/07/2005	142.00		2
07/10/2005	143.00	32.6	2
04/29/2005	144.00	43.2	3
04/26/2005	145.00	25	2
06/13/2005	148.00	35.8	1
04/10/2005	149.00	36.7	2
04/29/2005	149.00	32.2	2
04/29/2005	150.00	34.2	2
05/05/2005	150.00		2
05/27/2005	150.00	32	2
05/25/2005	151.00		2
04/09/2005	154.00	33.4	2
04/23/2005	155.00	37.1	2
04/27/2005	155.00	38.1	2
05/20/2005	155.00	37.9	2
04/23/2005	157.00	35.5	2
04/24/2005	157.00	37.1	2
04/26/2005	158.00	37.2	2
04/26/2005	158.00	36.7	2
04/30/2005	158.00	38.9	2
04/28/2005	160.00	39.6	2
04/29/2005	162.00	41.7	2
04/29/2005	162.00	45.9	2
04/30/2005	162.00	42.8	2
05/23/2005	162.00	41.5	2
04/23/2005	163.00	45.2	2

DATE	FORK	WEIGHT	AGE
04/27/2005	164.00	41.7	2
04/26/2005	165.00	42.3	2
05/23/2005	165.00	43.7	2
06/14/2005	168.00	39.5	2
04/26/2005	170.00	35.3	2
04/30/2005	170.00	47.4	2
05/03/2005	175.00	55.6	2
05/05/2005	175.00		2
04/26/2005	178.00	35.2	2
05/05/2005	184.00		2
06/24/2005	186.00	68.3	2
04/21/2005	200.00	82.1	3

Appendix E

Nason Creek spring Chinook and steelhead screw trap efficiency trial details, 2006.

Tag Date	Count Marked	Species	Recapture Date	Count Recaps	Mean Daily CFS
Trap Position Back					
3/20/2006	4	Chinook	3/22/2006	1	95
3/23/2006	9	Chinook	3/24/2006	2	103
3/23/2006		Chinook	3/25/2006	1	
3/23/2006		Chinook	3/26/2006	1	
3/27/2006	35	Chinook	3/29/2006	6	129
3/30/2006	36	Chinook	4/1/2006	7	164
3/30/2006		Chinook	4/2/2006	1	
4/3/2006	81	Chinook	4/4/2006	9	183
4/3/2006		Chinook	4/5/2006	1	
4/6/2006	42	Chinook	4/8/2006	9	265
4/13/2006	34	Chinook	4/15/2006	6	327
4/17/2006	19	Chinook	4/18/2006	2	271
4/20/2006	28	Chinook	4/22/2006	7	354
4/24/2006	59	Chinook	4/26/2006	3	418
4/27/2006	14	Chinook	4/29/2006	2	591
5/5/2006	2	Chinook	5/6/2006	1	583
5/8/2006	0	Chinook		0	
5/11/2006	1	Chinook		0	487
6/15/2006	1	Chinook	6/16/2006	0	859
6/22/2006	3	Chinook	6/24/2006	1	580
6/26/2006	2	Chinook		0	676
Trap Position Forward					
7/13/2006	52	Chinook	7/15/2006	8	171
7/17/2006	138	Chinook	7/19/2006	14	129
7/17/2006		Chinook	7/20/2006	1	
7/20/2006	74	Chinook	7/21/2006	5	113
7/28/2006	54	Chinook	7/29/2006	4	91
7/28/2006		Chinook	7/30/2006	1	
7/31/2006	99	Chinook	8/2/2006	7	79
8/3/2006	43	Chinook	8/4/2006	1	77
8/6/2006	18	Chinook	8/8/2006	2	71
8/14/2006	31	Chinook	8/17/2006	2	56
8/21/2006	27	Chinook	8/23/2006	5	45
8/24/2006	31	Chinook	8/26/2006	4	43
8/24/2006		Chinook	8/27/2006	2	
8/28/2006	18	Chinook		0	36
8/31/2006	23	Chinook	9/1/2006	3	43
9/18/2006	55	Chinook	9/20/2006	10	46
9/21/2006	35	Chinook	9/22/2006	5	47
9/21/2006		Chinook	9/23/2006	2	
9/25/2006	17	Chinook	9/27/2006	2	36

Tag Date	Count Marked	Species	Recapture Date	Count Recaps	Mean Daily CFS
9/28/2006	7	Chinook		0	Invalid test, trap stopped
10/16/2006	91	Chinook	10/18/2006	17	53
10/19/2006	34	Chinook	10/20/2006	2	47
10/23/2006	46	Chinook	10/24/2006	1	47
10/23/2006		Chinook	10/25/2006	24	
10/23/2006		Chinook	10/26/2006	1	
10/26/2006	183	Chinook	10/27/2006	50	51
10/30/2006	168	Chinook	11/1/2006	52	63
11/2/2006	103	Chinook		0	Invalid test, trap stopped
11/17/2006	54	Chinook		0	Invalid test, trap stopped
11/22/2006	28	Chinook		0	Invalid test, trap stopped
Trap Position Back and Half Out					
5/31/2006	102	coho	6/1/2006	10	1000
5/31/2006		coho	6/2/2006	1	
6/6/2006	38	coho		0	1120
Trap Position Back					
3/20/2006	3	steelhead		0	
3/23/2006	2	steelhead	3/24/2006	1	
3/23/2006		steelhead	3/25/2006	1	
3/27/2006	11	steelhead	3/30/2006	2	
3/30/2006	14	steelhead	4/1/2006	2	
4/3/2006	38	steelhead	4/4/2006	4	
4/3/2006		steelhead	4/5/2006	1	
4/6/2006	16	steelhead	4/8/2006	3	
4/13/2006	28	steelhead	4/15/2006	1	
4/17/2006	8	steelhead		0	
4/20/2006	38	steelhead	4/22/2006	5	
4/24/2006	70	steelhead	4/26/2006	7	
4/27/2006	155	steelhead	4/29/2006	12	
5/5/2006	60	steelhead	5/6/2006	6	
5/8/2006	43	steelhead	5/10/2006	5	488
5/8/2006		steelhead	5/11/2006	1	
5/11/2006	19	steelhead	5/13/2006	1	
5/11/2006		steelhead	5/14/2006	1	
Trap Position Back and Half Out					
6/2/2006	30	steelhead		0	1170
6/5/2006	14	steelhead		0	1120
Trap Position Back					
6/8/2006	14	steelhead	6/10/2006	1	888
6/12/2006	52	steelhead	6/14/2006	2	835
6/15/2006	31	steelhead	6/16/2006	3	
6/15/2006		steelhead	6/17/2006	2	
6/19/2006	60	steelhead	6/21/2006	1	613
6/19/2006		steelhead	6/22/2006	1	
6/22/2006	65	steelhead	6/24/2006	6	
6/26/2006	63	steelhead			
6/29/2006	18	steelhead	6/30/2006	1	500
Trap Position Forward					

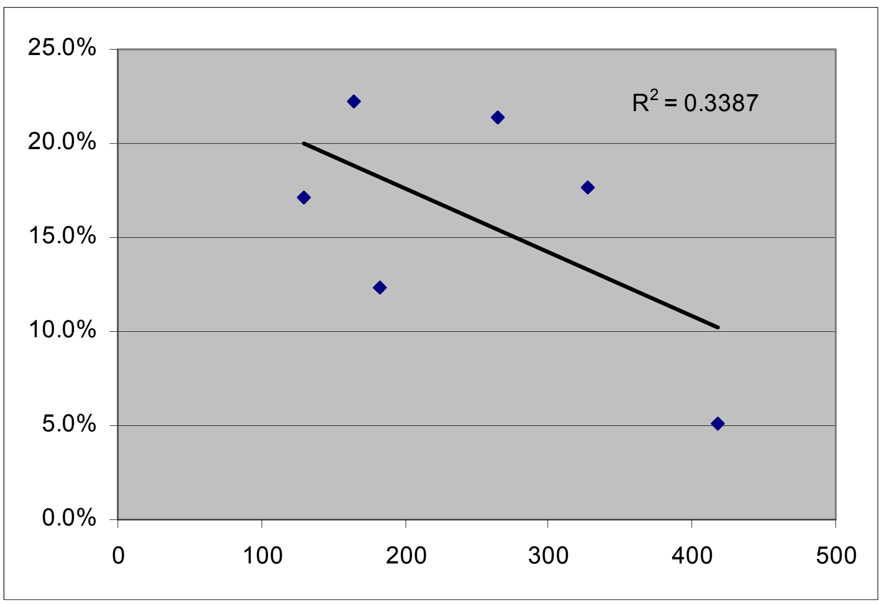
Tag Date	Count Marked	Species	Recapture Date	Count Recaps	Mean Daily CFS
7/13/2006	11	steelhead		0	
7/17/2006	10	steelhead		0	
7/20/2006	9	steelhead	7/21/2006	1	
7/28/2006	11	steelhead		0	
7/31/2006	12	steelhead	8/2/2006	1	
8/3/2006	0	steelhead		0	
8/6/2006	0	steelhead		0	
8/14/2006	2	steelhead		0	
8/21/2006	6	steelhead			
8/24/2006	3	steelhead	8/26/2006	1	
8/28/2006	8	steelhead		0	
8/31/2006	9	steelhead		0	
9/18/2006	31	steelhead	9/20/2006	2	
9/21/2006	40	steelhead	9/22/2006	2	
9/21/2006		steelhead	9/23/2006	1	
9/25/2006	22	steelhead		0	
9/28/2006	4	steelhead		0	Invalid test, trap stopped low flow
10/16/2006	9	steelhead	10/18/2006	1	
10/19/2006	16	steelhead	10/20/2006	1	
10/23/2006	5	steelhead		0	
10/26/2006	16	steelhead	10/27/2006	5	
10/30/2006	23	steelhead	11/1/2006	1	
11/2/2006	11	steelhead		0	Invalid test, trap stopped ice
11/17/2006	34	steelhead		0	Invalid test, trap stopped ice
11/22/2006	21	steelhead		0	Invalid test, trap stopped ice
Trap Position Forward					
8/31/2006	214	steelhead fry	9/1/2006	32	43

Appendix F

Nason Creek spring Chinook and steelhead screw trap efficiency and stream discharge relationship regression analysis, 2006.

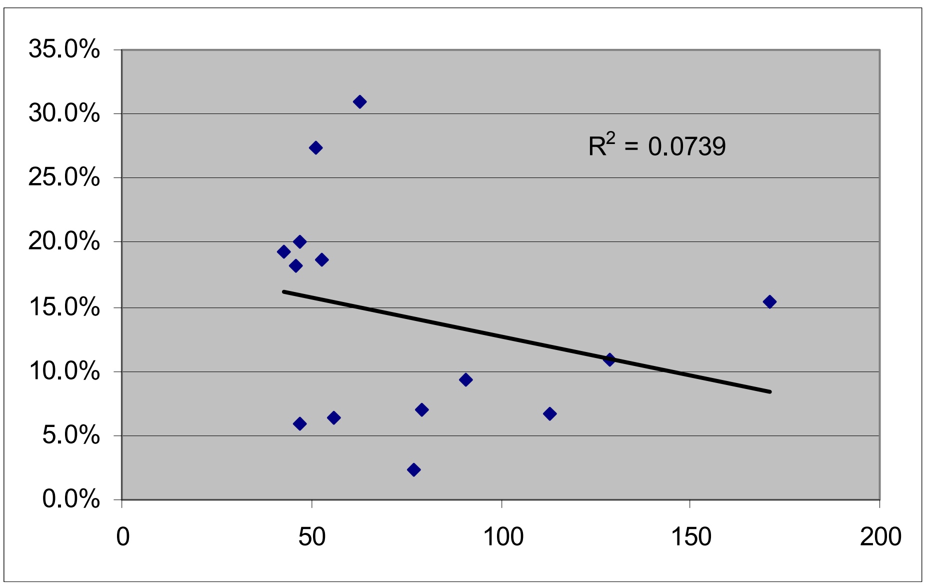
Spring Chinook Yearling
Sample size > 30

Marked	Efficiency	CFS
35	17.1%	129
36	22.2%	164
81	12.3%	183
42	21.4%	265
34	17.6%	327
59	5.1%	418



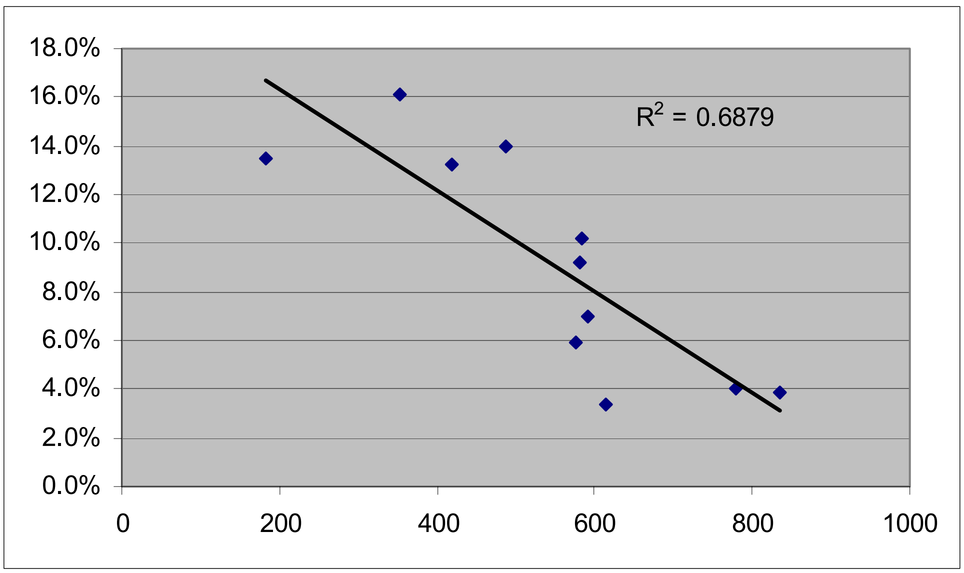
Spring Chinook Subyearling
Sample size > 30

Marked	Efficiency	CFS
52	15.4%	171
138	10.9%	129
74	6.8%	113
54	9.3%	91
99	7.1%	79
43	2.3%	77
31	6.5%	56
31	19.4%	43
55	18.2%	46
35	20.0%	47
91	18.7%	53
34	5.9%	47
183	27.3%	51
168	31.0%	63



Steelhead Parr with trap in back position
Sample size > 30

Marked	Efficiency	CFS
31	16.1%	354
37	13.5%	183
43	14.0%	487
52	3.8%	835
53	13.2%	418
59	10.2%	583
60	3.3%	613
65	9.2%	580
114	7.0%	591
68	5.9%	576
100	4.0%	780



APPENDIX B: 2006 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	04/23/2006	**052688+BT**	na	31918	31918	33398
Wenatchee	Nason Cr.	Coulter Pond	Cascade FH	MCR-WEN	04/23/2006	**052668+BT**	na	78295	78295	81917
							Total	**110213**	**110213**	**115315**
Wenatchee	Nason Cr	Nason Wetlands	Willard NFH	MCR-WEN	04/06/2006	**052687+BT**	na	34088	34088	34088
							Total	**34088**	**34088**	**34088**
Wenatchee	Nason Cr	Rolfing's Pond	Willard NFH	MCR-WEN	05/07/2006	**052689+BT**	na	31931	31931	33168
Wenatchee	Nason Cr	Rolfing's Pond	Cascade FH	MCR-WEN	05/07/2006	**052667+BT**	na	73316	73316	76160
							Total	**105247**	**105247**	**109328**
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	05/06/2006	**052684**	99.2%	27298	27518	28874
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	05/06/2006	**052685**	99.4%	27241	27405	28761
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	05/06/2006	**052686**	99.0%	28149	28433	29831
							Total	**82688**	**83356**	**87466**
Wenatchee	Icicle Cr	LNFH SFL 24	Willard NFH	MCR-WEN	04/12/2006	**052690**	99.8	28247	28304	28619
Wenatchee	Icicle Cr	LNFH SFL 25	Willard NFH	MCR-WEN	04/12/2006	**052691**	98.4	28762	29230	29538
Wenatchee	Icicle Cr	LNFH SFL 12	Willard NFH	MCR-WEN	04/12/2006	**052692**	99.4	28450	28622	28934
Wenatchee	Icicle Cr	LNFH SFL 11	Willard NFH	MCR-WEN	04/12/2006	**052693**	99.0	27412	27689	27997
Wenatchee	Icicle Cr	LNFH SFL 18	Willard NFH	MCR-WEN	04/12/2006	**052696**	99.8	28082	28138	28256
Wenatchee	Icicle Cr	LNFH SFL 17	Willard NFH	MCR-WEN	04/12/2006	**052696**	99.2	27790	28014	28035
Wenatchee	Icicle Cr	LNFH SFL 16	Willard NFH	MCR-WEN	04/12/2006	**052697**	99.4	27824	27992	28019
Wenatchee	Icicle Cr	LNFH SFL 19 & 20	Cascade FH	MCR-WEN	04/12/2006	**052669**	97.2	75524	77700	77810
Wenatchee	Icicle Cr	LNFH SFL 9	Willard NFH	MCR-WEN	04/12/2006	**052698**	99.0	28865	29157	29184
Wenatchee	Icicle Cr	LNFH SFL 10	Willard NFH	MCR-WEN	04/12/2006	**052697**	99.4	28842	29016	29037
Wenatchee	Icicle Cr	LNFH SFL 23	Cascade FH	MCR-WEN	04/12/2006	**052683**	99.2	34591	34870	34918
Wenatchee	Icicle Cr	LNFH SFL 21 & 22	Cascade FH	MCR-WEN	04/12/2006	**052682**	97.9	75483	77102	77188
Wenatchee	Icicle Cr	LNFH SFL 8	Willard NFH	MCR-WEN	04/12/2006	**052698**	99.2	29389	29626	29640
							Total	**469261**	**475460**	**477173**

APPENDIX B: 2006 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 2	Willard NFH	MCR-WEN	04/15/2006	**052694**	99.4%	57796	58145	58586
Wenatchee	Icicle Cr	LNFH LFL 2	Willard NFH	MCR-WEN	04/15/2006	**052695**	99.6%	27662	27773	27984
Wenatchee	Icicle Cr	LNFH LFL 1	Willard NFH	MCR-WEN	04/15/2006	**052695**	99.2%	28141	28368	28540
Wenatchee	Icicle Cr	LNFH LFL 1	Cascade FH	MCR-WEN	04/15/2006	**052681**	96.5%	71591	74188	74635
Wenatchee	Icicle Cr	LNFH LFL 3	Cascade FH	MCR-WEN	04/15/2006	**052680**	98.0%	72227	73701	74400
							Total	**257417**	**262175**	**264145**

Methow	Methow	Winthrop NFH	Winthrop NFH	MCR-WEN	04/20/2006	**052572**	90.1%	174601	193786	201473
Methow	Methow	Winthrop NFH	Winthrop NFH	MCR-MET	04/20/2006	**052591**	88.5%	37477	42347	43768
Methow	Methow	Winthrop NFH	Willard NFH	MCR-WEN	04/20/2006	**052666**	99.2%	74259	74858	74858
							Total	**286337**	**310991**	**320099**

Methow	Columbia	Wells FH Pd. 2	Cascade FH	MCR-WEN	04/21/2006	**052665**	96.1%	71962	74882	74882
Methow	Columbia	Wells FH Pd. 2	Cascade FH	MCR-WEN	04/21/2006	**052664**	98.6%	73873	74922	74922
							Total	**145835**	**149804**	**149804**

	Total Coho	Total CWTs
Wenatchee Basin	1,070,539	1,058,914
Methow Basin (inc. Wells FH)	460,795	432,172

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Release-to-McNary Survival Indices of

2006 Releases into the Wenatchee and Methow Basins

Submitted by Doug Neeley

1. Introduction

In this report I analyze smolt-to-smolt survival estimates for release sites over brood years 2003 through 2005 (release years 2004 through 2006) for which two Coho stock were evaluated, one from Cascades and the other from Willard Hatcheries. I also present estimates from other 2006 release sites for which only one stock was used.

Smolt-to-smolt Survival estimation methods are presented in Appendix A. and the Application of the methods to the 2006 releases are presented in Appendix B.

2. Willard and Cascade Stock Comparisons

Cascade and Willard Stock releases were made: 1) from Icicle Creek and Winthrop in 2004, 2) from Large Foster Small Foster Creeks in both 2005 and 2006, and 3) from Nason Creek (Coulter Pond) in 2006. There were PIT-tag detectors located at Nason

Creek that permitted the estimation of the number of fish volitionally leaving the ponds. Since the other release sites did not have detectors, the release-site-to-McNary-Dam survival index estimates could only be 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. Estimates based on all tagged fish were also made for Nason Creek releases for the purpose of a formal analysis of Willard and Cascade stock comparisons; estimates of Nason Creek release-to-McNary-Dam survival based on only those fish detected leaving the pond are also presented in this report.

Survival estimates along with release dates and mean passages dates based on tagged fish are summarized in 1) Table 1.a. for 2004 releases at Icicle Creek and Winthrop, 2) Table 1.b. for 2005 releases at Large Foster and Small Foster Creeks, and 3) Table 1.c.1) for 2006 releases at Large Foster and Small Foster Creeks. Table 1.c.2 gives the estimates for 2006 releases at Nason Creek and also gives estimates based on volitionally released fish. Volitional release estimates also included estimates of proportion of tagged fish detected leaving the ponds and estimates of pre-release tag survival and tag retentions (the estimated proportion of tagged fish detected leaving the pond divided by the pond detectors' detection efficiency[2]). Tagging-to-McNary survival indices are also plotted in Figure 1.

A logistic analysis of variation was performed on tagging-to-McNary survival to assess whether the two stock differed in their survival performance. Although there were multiple tag groups per release, the multiple tag groups were tagged at different stations and did not represent different replicates. The analysis performed used the remaining pooled site x stock, site x year, stock x year interactions as a source of error after partitioning out the interactions associated with the Large Foster and Small Foster sites. The Large Foster and Small Foster sites had both stock for more than one year (2005 and 2005 release years). The logistic analysis of variation is presented in Table 2.

In addition to a significant main effect difference between the two stock, there is also a significant two-factor interaction that between stock and the Large Foster and Small Foster Site comparison; this interaction can be attributed to Small Foster pond where the Willard stock had a comparable survival to Cascade stock in 2006 (Table 1.c.1) and a higher survival in 2005 (Table 1.b.). For all other sites in all other years for which both stocks were assessed, the Cascade stock had a higher survival rate (Table 1 and Figure 1). Not only were the Cascade stock survivals usually higher than the Willard, but, at Nason Creek in 2006, where there was an on-site PIT-tag detector, Cascade's pre-release survival/tag-retention rate was also higher (0.85 for Cascade, 0.79 for Willard, Table 1.c.2).

[2] Detector efficiency is estimated by the number of the pond's fish jointly detected at the acclimation pond and McNary Dam divided by the total number detected at McNary Dam.

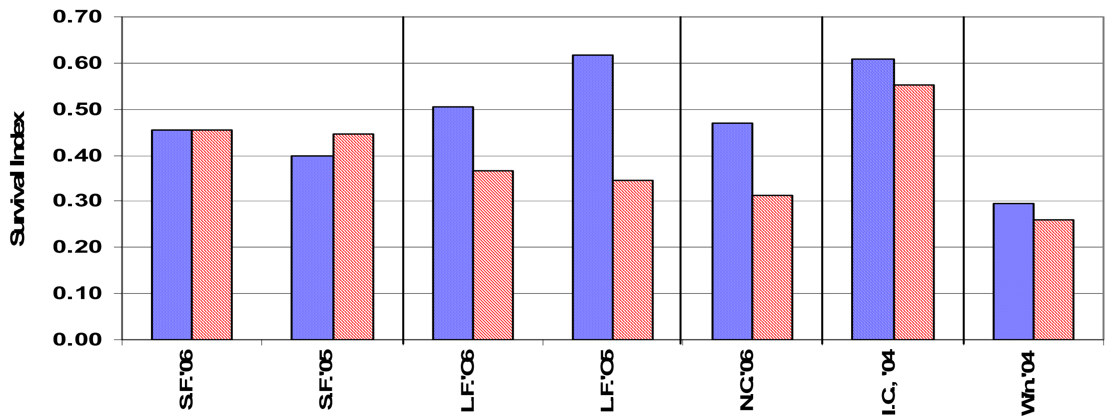

Figure 1. Relative Tagging-to-McNary Smolt-to-Smolt Survival Indices for Cascade (upward slant) and Willard Stock (downward slant) from Small Foster Creek (S.F.), Large Foster Creek (L.F.), Nason Creek (N.C.), Icicle Creek (I.C.), and Winthrop (Win.) in 2004 through 2006.

Table 1. Release and McNary-Passage Dates and Smolt Survival Indices to McNary for Willard and Cascade Coho Stock Releases into mid-Columbia Tributaries

a. 2004 Releases (releases with no volitional release measure)

Stock	Measure	Icicle Creek	Winthrop
Willard	Number Tagged	4341	4463
	Release Date	04/23/04	04/20/04
	Mean McNary Detection Date	05/29/04	06/08/04
	Survival-Index to McNary	**0.5509**	**0.2610**
		(Tagging-to-McNary)	
Cascade	Number Tagged	3982	4481
	Release Date	04/23/04	04/20/04
	Mean McNary Detection Date	05/31/04	06/08/04
	Survival-Index to McNary	**0.6083**	**0.2951**
		(Tagging-to-McNary)	

b. 2005 Releases (releases with no volitional release measure)

Stock	Measure	Large Foster	Small Foster
Willard	Number Tagged	3999	3106
	Release Date	04/14/05	04/15/05
	Mean McNary Detection Date	05/29/05	05/24/05
	Survival-Index to McNary	**0.3448**	**0.4448**
		(Tagging-to-McNary)	
Cascade	Number Tagged	3919	3448
	Release Date	04/14/05	04/15/05
	Mean McNary Detection Date	06/03/05	06/03/05
	Survival-Index to McNary	**0.6181**	**0.3981**
		(Tagging-to-McNary)	

c.1) 2006 Releases (releases with no volitional release measure)

Stock	Measure	Large Foster	Small Foster
Willard	Number Tagged	3116	3121
	Release Date	04/15/06	04/12/06
	Mean McNary Detection Date	05/26/06	05/23/06
	Survival-Index to McNary	**0.3665**	**0.4556**
	(Tagging-to-McNary)	(Tagging-to-McNary)	
Cascade	Number Tagged	3040	3083
	Release Date	04/15/06	04/12/06
	Mean McNary Detection Date	05/25/06	05/26/06
	Survival-Index to McNary	**0.5064**	**0.4539**
		(Tagging-to-McNary)	

Table 1. Release and McNary-Passage Dates and Smolt Survival Indices to McNary for Willard and Cascade Coho Stock Releases into mid-Columbia Tributaries (continued)

c.2) 2006 Releases (releases with volitional release measure)

Nason Creek				
Stock	**Measure**	**All Tagged**	**Measure**	**Volitional Release**
Willard	**Number Tagged**	3492	**Number Detected at Pond**	2746
	Release Date	04/22/06	**Mean Pond-Detection Date**	05/05/06
	Mean McNary Detection Date	06/03/06	**Mean McNary Detection Date**	06/03/06
	Survival-Index to McNary	**0.3120** (Tagging-to-McNary)	**Survival-Index to McNary**	**0.3445** (Release-to-McNary)
			Proportion Detected at Pond	0.7864
			Pond Survival/Tag-Retention Proportion	0.8994
Cascade	**Number Tagged**	2989	**Number Detected at Pond**	2332
	Release Date	04/22/06	**Mean Pond-Detection Date**	05/13/06
	Mean McNary Detection Date	06/04/06	**Mean McNary Detection Date**	06/04/06
	Survival-Index to McNary	**0.4692** (Tagging-to-McNary)	**Survival-Index to McNary**	**0.5501** (Release-to-McNary)
			Proportion Detected at Pond	0.7802
			Pond Survival/Tag-Retention Proportion	0.8461

Table 2. Weighted Logistic Analysis of Variation comparing Tagging-to-McNary Smolt-to-Smolt Survival Indices for Willard and Cascade Coho Stock over Release Years and Sites (2004-2006)

Source	Deviance (Dev)	Degrees of Freedom (DF)	Mean Deviance (Dev/DF)	F-Ratio	Type 1 Error P
Main Effects					
Hatchery* adjusted for Year and Site	421.45	1	421.45	13.00	**0.0226** ***
Site adjusted for Hatchery and Year**	1726.63	3	575.54	17.76	**0.0089** ***
Year adjusted for Hatchery and Site**	0.76	1	0.76	0.02	0.8857 ***
Interactions					
Hatcher x Large Foster vs Small Foster	381.08	1	381.08	11.76	0.0266 ***
Hatchery x Year for Small and Large Foster	14.63	1	14.63	0.45	0.5385 ***
Hatcher x Large vs Small Foster	41.89	1	41.89	1.29	0.3191 ***
Remaining Interaction	129.63	4	32.41	2.78	0.0762 ****
Within Ponds	140.09	12	11.67		

* Hatchery is source of fish (Cascade compared to Willard)

** Sites: Nason in 2006, Large and Small Foster in 2006 and 2005, Icilcle and Winthrop in 2004

*** Tested against Remaining Interaction

**** Tested against PIT-tag groups within ponds

3. All Releases

There were other releases in 2006 that did not involve the releases of both stocks. These release sites were: 1) Beaver Creek where PIT-tag detectors were installed enabling separate estimates of post-release survival indices to McNary and pre-release survival, and 2) Nason Wetlands where there was no PIT-tag detector installed. Table 3 presents estimates for each tag group for each release group including those discussed in the previous section.

Table 4. Estimates from all Releases

a. Sites with PIT-Tag Detectors

	Wenatchee River Beaver Creek Pond				
Tag File >	KGM05346.BC1	KGM05346.BC2	KGM05347.BC3	KGM05347.BC4	Pooled over Releases
Numbers at Pond					
Number of Tagged Fish	2291	1198	2499	995	6983
Number Detected at Pond	2003	1056	2242	883	6184
Proportion Detected at Pond	**87.43%**	**88.15%**	**89.72%**	**88.74%**	**88.56%**
Unexpanded Total Detected at McNary					
All Tagged Fish	219	124	242	95	680
Previously Detected at Ponds	219	122	239	94	674
Pond Detection Efficiency	1.0000	0.983870968	0.987603306	0.989473684	0.991176471
Pre-release Survival/Tag-retention	**87.43%**	**89.59%**	**90.84%**	**89.69%**	**89.35%**
Release Date					
Date Screens Pulled	**05/06/06**	**05/06/06**	**05/06/06**	**05/06/06**	**05/06/06**
Mean Date of Volitional Release	**05/18/06**	**05/18/06**	**05/18/06**	**05/18/06**	**05/18/06**
Mean McNary Passage Date					
All Tagged Fish	**05/30/06**	**06/01/06**	**05/29/06**	**05/29/06**	**05/30/06**
Fish previously detected at Ponds	**05/30/06**	**06/01/06**	**05/30/06**	**05/29/06**	**05/30/06**
Expanded Detections (E.D.) at McNary					
E.D. at McNary of all tagged Fish	958.95	618.7307514	1069.833828	390.9965985	3038.507009
Number of Tagged Fish	2291	1198	2499	995	6983
Tagging-to-McNary Survival Index	**41.86%**	**51.65%**	**42.81%**	**39.30%**	**43.51%**
E.D. at McNary of Fish previously detected at McNary	958.95	609.9439646	1058.555652	387.2372064	3014.682653
Number Detected at Ponds	2003	1056	2242	883	6184
Release-to-McNary Survival Index	**47.88%**	**57.76%**	**47.21%**	**43.85%**	**48.75%**

	Nason Creek Coulter Pond from Willard Hatchery			Nason Creek Coulter Pond from Cascade Hatchery		
Tag File >	KGM05348.CC1	KGM05348.CC2	Pooled over Releases	KGM05349.CC3	KGM05349.CC4	Pooled over Releases
Numbers at Pond						
Number of Tagged Fish	2495	997	3492	2126	863	2989
Number Detected at Pond	1964	782	2746	1714	618	2332
Proportion Detected at Pond	**78.72%**	**78.44%**	**78.64%**	**80.62%**	**71.61%**	**78.02%**
Unexpanded Total Detected at McNary						
All Tagged Fish	150	49	199	176	68	244
Previously Detected at Ponds	130	44	174	166	59	225
Pond Detection Efficiency	0.866666667	0.897959184	0.874371859	0.943181818	0.867647059	0.922131148
Pre-release Survival/Tag-retention	**90.83%**	**87.35%**	**89.94%**	**85.48%**	**82.53%**	**84.61%**
Release Date						
Date Screens Pulled	**04/22/06**	**04/22/06**	**04/22/06**	**04/22/06**	**04/22/06**	**04/22/06**
Mean Date of Volitional Release	**05/05/06**	**05/04/06**	**05/05/06**	**05/13/06**	**05/13/06**	**05/13/06**
Mean McNary Passage Date						
All Tagged Fish	**06/03/06**	**06/03/06**	**06/03/06**	**06/04/06**	**06/04/06**	**06/04/06**
Fish previously detected at Ponds	**06/03/06**	**06/04/06**	**06/03/06**	**06/04/06**	**06/05/06**	**06/04/06**
Expanded Detections (E.D.) at McNary						
E.D. at McNary of all tagged Fish	835.0971299	254.5208977	1089.618028	1015.252353	387.3180274	1402.57038
Number of Tagged Fish	2495	997	3492	2126	863	2989
Tagging-to-McNary Survival Index	**33.47%**	**25.53%**	**31.20%**	**47.75%**	**44.88%**	**46.92%**
detected at McNary	711.6637733	234.4559344	946.1197077	954.1696761	328.7267399	1282.896416
Number Detected at Ponds	1964	782	2746	1714	618	2332
Release-to-McNary Survival Index	**36.24%**	**29.98%**	**34.45%**	**55.67%**	**53.19%**	**55.01%**

Table 4. Estimates from all Releases (cont.)
b. Sites without PIT-Tag Detectors

	Large Foster Lucus Ponds from Willard			Large Foster Lucus Ponds from Cascade		
Tag File >	KGM05346.LF1	KGM05346.LF2	Pooled over Releases	KGM05349.LF3	KGM05349.LF4	Pooled over Releases
Numbers at Pond						
Number of Tagged Fish	2361	755	3116	2267	773	3040
Unexpanded Total Detected at McNary						
All Tagged Fish	158	65	223	215	67	282
Release Date						
Date Screens Pulled	**04/15/06**	**04/15/06**	**04/15/06**	**04/15/06**	**04/15/06**	**04/15/06**
Mean McNary Passage Date						
All Tagged Fish	**05/27/06**	**05/26/06**	**05/26/06**	**05/26/06**	**05/24/06**	**05/25/06**
Expanded Detections (E.D.) at McNary						
E.D. at McNary of all tagged Fish	809.693257	332.1795932	1141.87285	1186.097415	353.4864922	1539.583907
Number of Tagged Fish	2361	755	3116	2267	773	3040
Tagging-to-McNary Survival Index	**34.29%**	**44.00%**	**36.65%**	**52.32%**	**45.73%**	**50.64%**

	Small Foster Lucus Ponds from Willard			Small Foster Lucus Ponds from Cascade		
Tag File >	KGM05346.SF1	KGM05346.SF2	Releases	KGM05349.SF3	KGM05349.SF4	Releases
Numbers at Pond						
Number of Tagged Fish	2119	1002	3121	1950	1133	3083
Unexpanded Total Detected at McNary						
All Tagged Fish	188	89	277	190	91	281
Release Date						
Date Screens Pulled	**04/12/06**	**04/12/06**	**04/12/06**	**04/12/06**	**04/12/06**	**04/12/06**
Mean McNary Passage Date						
All Tagged Fish	**05/23/06**	**05/22/06**	**05/23/06**	**05/25/06**	**05/26/06**	**05/26/06**
Expanded Detections (E.D.) at McNary						
E.D. at McNary of all tagged Fish	967.789762	454.0981452	1421.887907	924.2418104	475.0899812	1399.331792
Number of Tagged Fish	2119	1002	3121	1950	1133	3083
Tagging-to-McNary Survival Index	**45.67%**	**45.32%**	**45.56%**	**47.40%**	**41.93%**	**45.39%**

	Nason Wetlands Acclimation Ponds		
Tag File >	KGM05347.NW1	KGM05347.NW2	Releases
Numbers at Pond			
Number of Tagged Fish	2706	789	3495
Unexpanded Total Detected at McNary			
All Tagged Fish	77	22	99
Release Date			
Date Screens Pulled	**04/06/06**	**04/06/06**	**04/06/06**
Mean McNary Passage Date			
All Tagged Fish	**06/03/06**	**05/30/06**	**06/02/06**
Expanded Detections (E.D.) at McNary			
E.D. at McNary of all tagged Fish	466.6	90.5	557.1
Number of Tagged Fish	2706	789	3495
Tagging-to-McNary Survival Index	**17.24%**	**11.47%**	**15.94%**

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

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

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 purpose.

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 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[3] 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.

[3] 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 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 of 2006 McNary Detection Rates, Passage, and Survival Indices (2004 and 2005 estimates in 2005 Report)

Table B.1. McNary Detection Rates

			Bonneville			John Day			Pooled		
			Detections		McN	Detections		McN	Detections		McN
Stratum	Beginning Julian Date	Ending Julian Date	Total*	Joint**	Detection Rate	Total*	Joint**	Detection Rate	Total*	Joint**	Detection Rate
1		133	18.2	12.0	0.65975	31.0	8.0	0.25806	49.2	20	0.40660
2	134	142	53.0	5.0	0.09442	258.5	30.0	0.11607	311.4	35	0.11239
3	143	143	13.1	2.0	0.15217	92.4	19.0	0.20556	105.6	21	0.19891
4	144	154	192.7	48.0	0.24907	1235.9	332.0	0.26864	1428.6	380	0.26600
5	155		57.0	8.0	0.14035	302.3	23.0	0.07609	359.3	31	0.08629

* Total McN Dam count estimated from downstream-dam 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 for All Tagged Fish

	Site >	Beaver Creek				Coulter Pond			
	Stock >					Willard		Cascade	
Stratum	Tag File Extension >	BC1	BC2	BC3	BC4	CC1	CC2	CC3	CC4
Stratum 1	Total (T)	0	0	0	0	0	0	0	0
from JD 91	Removed (R)	0	0	0	0	0	0	0	0
to JD 133	T-R	0	0	0	0	0	0	0	0
detection	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
rate 0.4066	Passage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum 2	Total (T)	0	0	0	0	0	0	0	0
from JD 134	Removed (R)	0	0	0	0	0	0	0	0
to JD 142	T-R	0	0	0	0	0	0	0	0
detection	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
rate 0.1124	Passage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum 3	Total (T)	164	88	177	77	77	31	95	29
from JD 143	Removed (R)	0	0	0	0	0	0	0	0
to JD 143	T-R	164	88	177	77	77	31	95	29
detection	Expanded	824.5	442.4	889.8	387.1	387.1	155.8	477.6	145.8
rate 0.1989	Passage	619.1	334.6	692.4	292.0	302.3	124.2	358.4	115.4
Stratum 4	Total (T)	38	17	48	14	40	10	36	23
from JD 144	Removed (R)	0	0	0	0	0	0	0	0
to JD 154	T-R	38	17	48	14	40	10	36	23
detection	Expanded	142.9	63.9	180.5	52.6	150.4	37.6	135.3	86.5
rate 0.2660	Passage	142.9	63.9	180.5	52.6	150.4	37.6	135.3	86.5
Stratum 5	Total (T)	17	19	17	4	33	8	45	16
from JD 155	Removed (R)	0	0	0	0	0	0	0	0
to JD 273	T-R	17	19	17	4	33	8	45	16
detection	Expanded	197.0	220.2	197.0	46.4	382.4	92.7	521.5	185.4
rate 0.0863	Passage	197.0	220.2	197.0	46.4	382.4	92.7	521.5	185.4
Over Strata	Total Detected	219	124	242	95	150	49	176	68
	Total McN Passage	958.9	618.7	1069.8	391.0	835.1	254.5	1015.3	387.3
	Number Tagged	2291	1198	2499	995	2495	997	2126	863
	Survival Index	0.4186	0.5165	0.4281	0.3930	0.3347	0.2553	0.4775	0.4488
	Julian Release Date	126.6	126.6	126.6	126.6	112.6	112.6	112.6	112.6
	Julian Passage Date	150.9	152.5	150.0	149.3	154.7	154.4	155.4	155.9

Table B.2. Expansions and Survival Indices for All Tagged Fish (continued)

	Site >	Large Foster				Small Foster				Nason Wetlands	
	Stock >	Willard		Cascade		Willard		Cascade			
Stratum	Tag File Extension >	LF1	LF2	LF3	LF4	SF1	SF2	SF3	SF4	NW1	NW2
Stratum 1	Total (T)	12	7	14	2	29	15	9	6	0	0
from JD 91	Removed (R)	0	0	0	0	0	0	0	0	0	0
to JD 133	T-R	12	7	14	2	29	15	9	6	0	0
detection	Expanded	29.5	17.2	34.4	4.9	71.3	36.9	22.1	14.8	0.0	0.0
rate 0.4066	Passage	61.7	27.6	60.2	4.9	116.4	53.7	41.4	21.2	0.0	0.0
Stratum 2	Total (T)	2	0	5	0	7	7	5	4	0	0
from JD 134	Removed (R)	0	0	0	0	0	0	0	0	0	0
to JD 142	T-R	2	0	5	0	7	7	5	4	0	0
detection	Expanded	17.8	0.0	44.5	0.0	62.3	62.3	44.5	35.6	0.0	0.0
rate 0.1124	Passage	17.8	0.0	44.5	0.0	62.3	62.3	44.5	35.6	0.0	0.0
Stratum 3	Total (T)	112	49	167	56	134	60	149	66	42	14
from JD 143	Removed (R)	0	0	0	0	0	0	0	0	0	0
to JD 143	T-R	112	49	167	56	134	60	149	66	42	14
detection	Expanded	563.1	246.3	839.6	281.5	673.7	301.6	749.1	331.8	211.2	70.4
rate 0.1989	Passage	515.9	239.4	855.0	299.1	666.6	296.1	682.0	307.1	178.4	52.6
Stratum 4	Total (T)	20	5	14	7	11	5	20	8	15	7
from JD 144	Removed (R)	0	0	0	0	0	0	0	0	0	0
to JD 154	T-R	20	5	14	7	11	5	20	8	15	7
detection	Expanded	75.2	18.8	52.6	26.3	41.4	18.8	75.2	30.1	56.4	26.3
rate 0.2660	Passage	75.2	18.8	52.6	26.3	41.4	18.8	75.2	30.1	56.4	26.3
Stratum 5	Total (T)	12	4	15	2	7	2	7	7	20	1
from JD 155	Removed (R)	0	0	0	0	0	0	0	0	0	0
to JD 273	T-R	12	4	15	2	7	2	7	7	20	1
detection	Expanded	139.1	46.4	173.8	23.2	81.1	23.2	81.1	81.1	231.8	11.6
rate 0.0863	Passage	139.1	46.4	173.8	23.2	81.1	23.2	81.1	81.1	231.8	11.6
Over Strata	Total Detected	158	65	215	67	188	89	190	91	77	22
	Total McN Passage	809.7	332.2	1186.1	353.5	967.8	454.1	924.2	475.1	466.6	90.5
	Number Tagged	2361	755	2267	773	2119	1002	1950	1133	2706	789
	Survival Index	0.3429	0.4400	0.5232	0.4573	0.4567	0.4532	0.4740	0.4193	0.1724	0.1147
	Julian Release Date	105.5	105.5	105.6	105.6	102.6	102.6	102.6	102.6	96.6	96.6
	Julian Passage Date	147.2	146.4	146.2	144.8	143.9	142.2	145.9	146.8	154.3	150.2

Table B.3. Expansions and Survival Indices for Fish Detected Leaving Acclimation Site

	Site >	Beaver Creek				Coulter Pond			
	Stock >					Willard		Cascade	
Stratum	Tag File Extension >	BC1	BC2	BC3	BC4	CC1	CC2	CC3	CC4
Stratum 1	Total (T)	0	0	0	0	0	0	0	0
from JD 91	Removed (R)	0	0	0	0	0	0	0	0
to JD 133	T-R	0	0	0	0	0	0	0	0
detection	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
rate 0.4066	Passage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum 2	Total (T)	0	0	0	0	0	0	0	0
from JD 134	Removed (R)	0	0	0	0	0	0	0	0
to JD 142	T-R	0	0	0	0	0	0	0	0
detection	Expanded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
rate 0.1124	Passage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratum 3	Total (T)	164	86	174	76	68	27	89	25
from JD 143	Removed (R)	0	0	0	0	0	0	0	0
to JD 143	T-R	164	86	174	76	68	27	89	25
detection	Expanded	824.5	432.4	874.8	382.1	341.9	135.7	447.4	125.7
rate 0.1989	Passage	619.1	325.8	681.1	288.2	267.2	107.9	335.9	99.1
Stratum 4	Total (T)	38	17	48	14	35	9	35	21
from JD 144	Removed (R)	0	0	0	0	0	0	0	0
to JD 154	T-R	38	17	48	14	35	9	35	21
detection	Expanded	142.9	63.9	180.5	52.6	131.6	33.8	131.6	78.9
rate 0.2660	Passage	142.9	63.9	180.5	52.6	131.6	33.8	131.6	78.9
Stratum 5	Total (T)	17	19	17	4	27	8	42	13
from JD 155	Removed (R)	0	0	0	0	0	0	0	0
to JD 273	T-R	17	19	17	4	27	8	42	13
detection	Expanded	197.0	220.2	197.0	46.4	312.9	92.7	486.7	150.7
rate 0.0863	Passage	197.0	220.2	197.0	46.4	312.9	92.7	486.7	150.7
Over Strata	Total Detected at McNary	219.00	124	242	95	150	49	176	68
	Total McNary Passage	958.9	618.7	1069.8	391.0	835.1	254.5	1015.3	387.3
	Number Detected at Release Site	2003	1198	2499	995	2495	997	2126	863
	Survival Index	0.4788	0.5165	0.4281	0.3930	0.3347	0.2553	0.4775	0.4488
	Mean Acclimation-Site Julian Detection Date	138.9	138.9	138.9	138.9	138.9	138.9	138.9	138.9
	Mean Julian McNary-Passage Date	150.9	150.9	150.9	150.9	150.9	150.9	150.9	150.9