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

Integrated Status and Effectiveness Monitoring Program

Expansion of Existing Smolt Trapping Program in Nason Creek

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Integrated Status & Effectiveness Monitoring Program

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

2005 Annual Report

March 2006

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Prepared for:
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YAKAMA NATION
FISHERIES RESOURCE MANAGEMENT

Abstract

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

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

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

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

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Acknowledgements

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

Introduction

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

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

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

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

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

Watershed Description

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

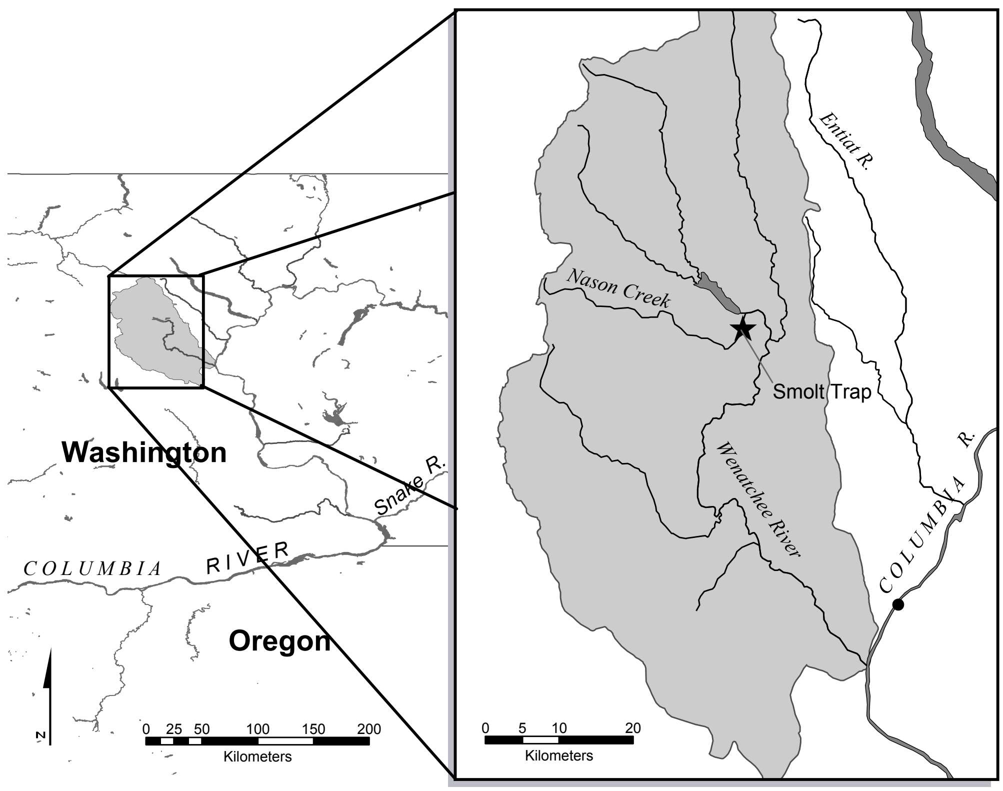

Figure 1. Nason Creek smolt trap location.

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

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

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

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

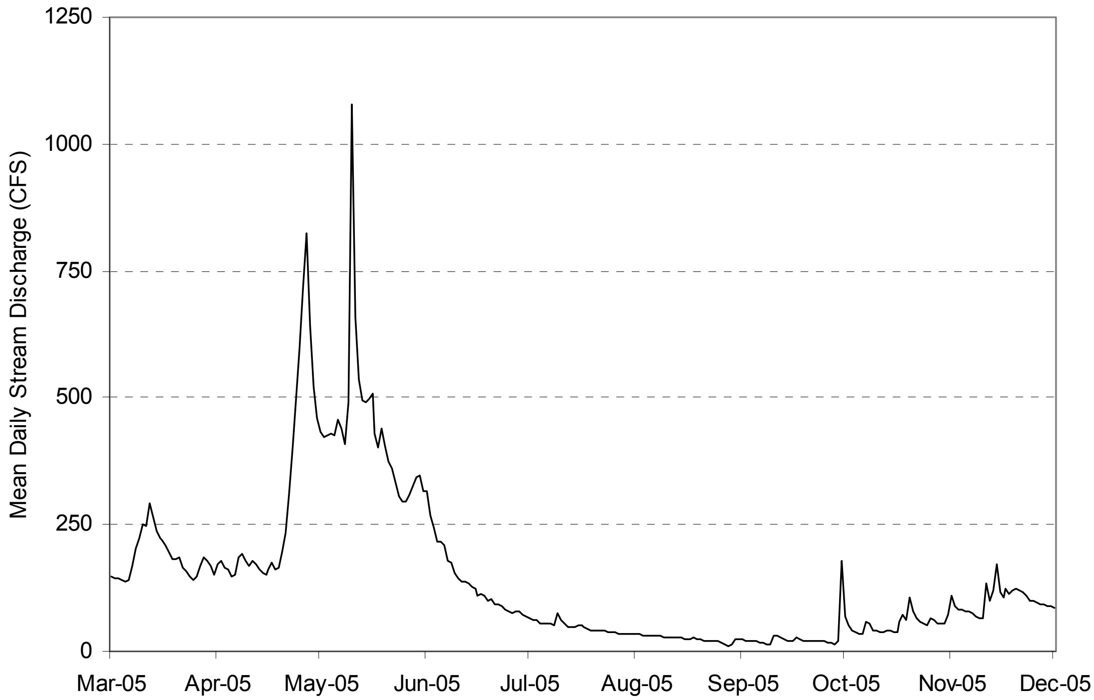

Figure 2. Mean daily stream discharge at the Nason Creek DOE stream monitoring station, Rk 1, from March 1 through December 1, 2005.

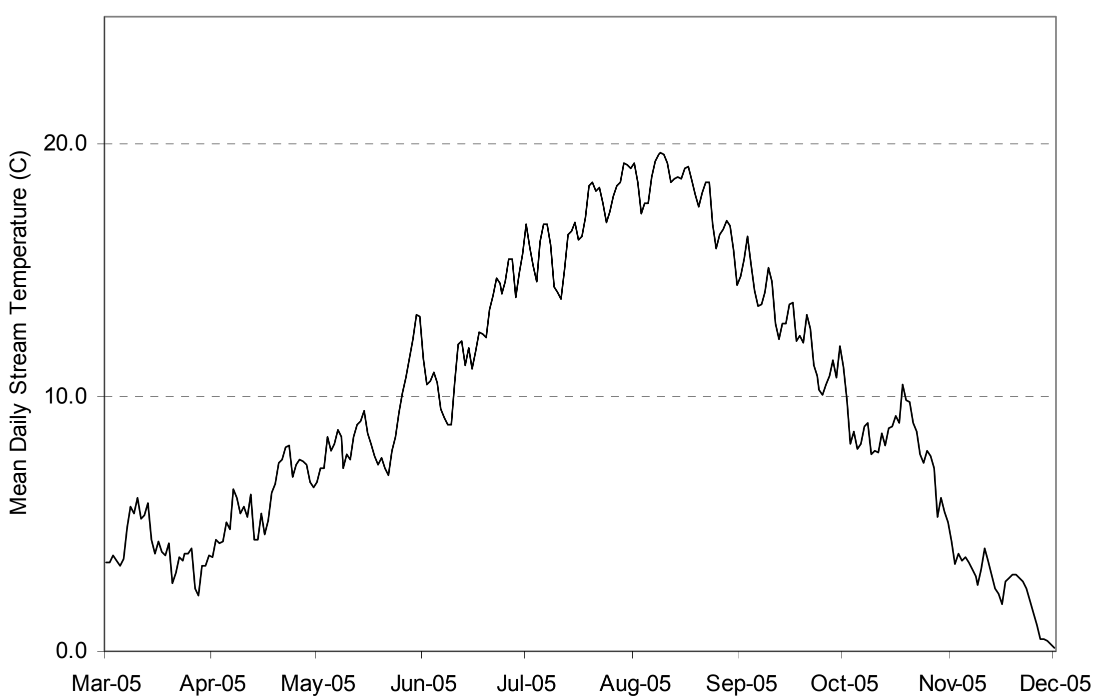

Figure 3. Mean daily water temperature at the Nason Creek DOE stream monitoring station, Rk 1, from March 1 through December 1, 2005.

Methods for Estimating Abundance of Juvenile Salmonids

Trapping Equipment and Operation

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

Data Collection

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

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

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

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

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

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

Trapping Efficiency and Emigration Estimate

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Results

Trap Operation

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

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

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

Daily Emigration

Spring Chinook Fry (2004 Brood)

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

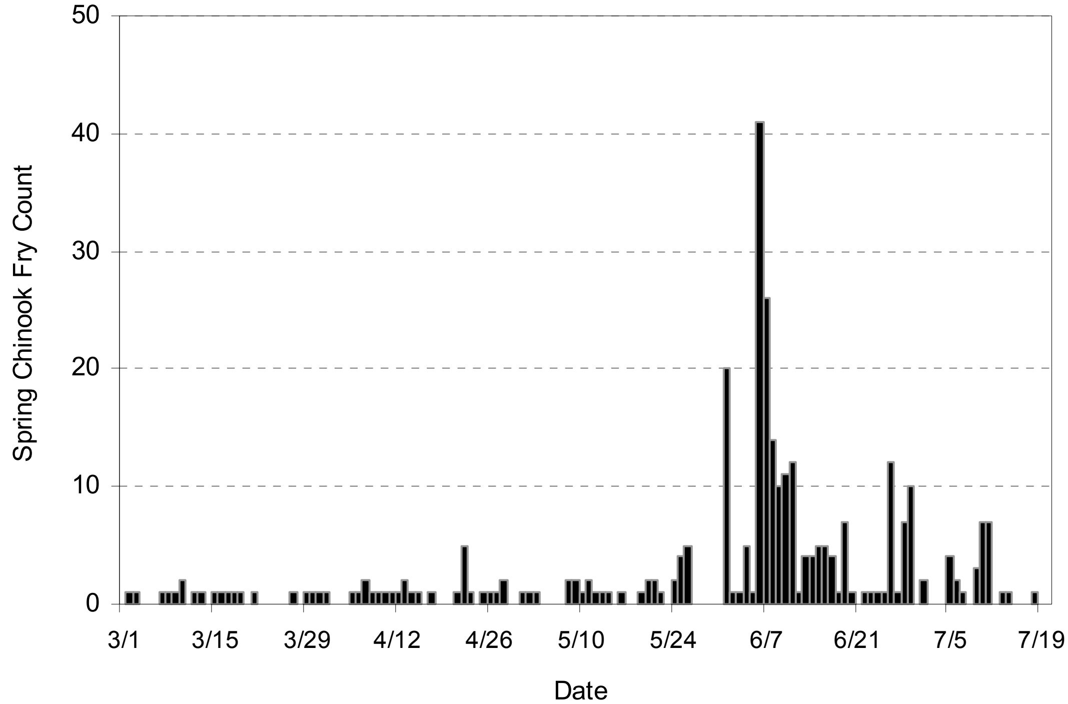

Figure 4. Spring chinook fry counts and run-timing at the Nason Creek smolt trap, March 2nd through July 18th 2005.

Spring Chinook Yearlings (2003 Brood)

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

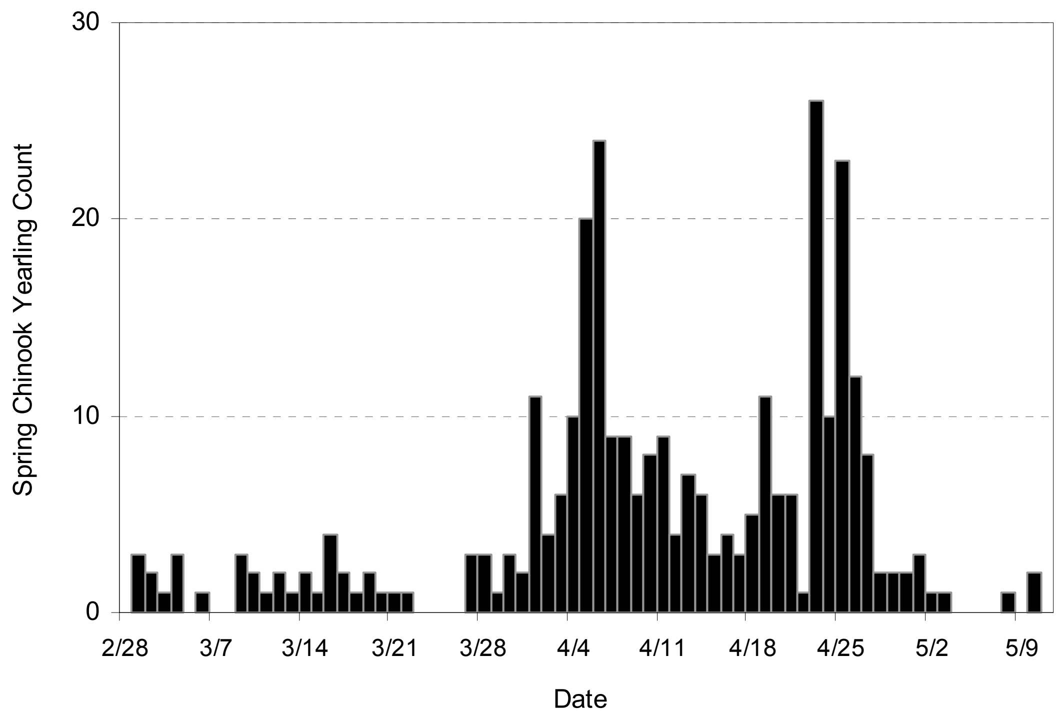

Figure 5. Yearling spring chinook smolt counts and run-timing at the Nason Creek smolt trap, March 1st through May 10th 2005.

Spring Chinook Subyearlings (2004 Brood)

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

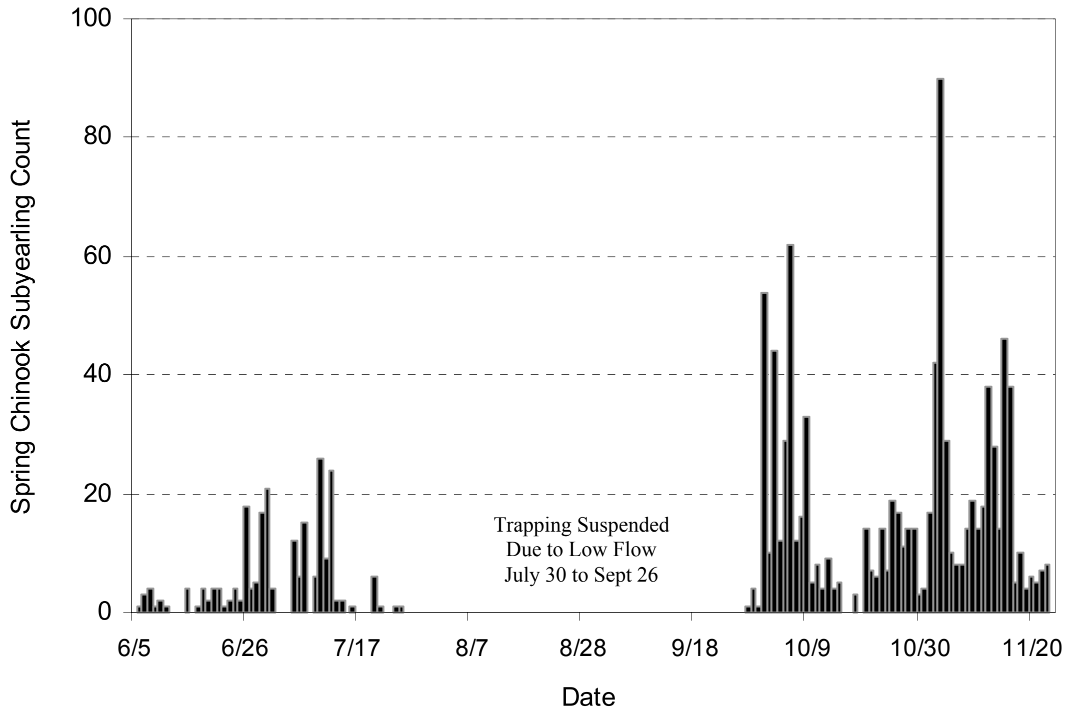

Figure 6. Spring chinook subyearling counts and run-timing at the Nason Creek smolt trap, May 25th through Nov 23rd 2005.

Steelhead/Rainbow Trout Fry

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

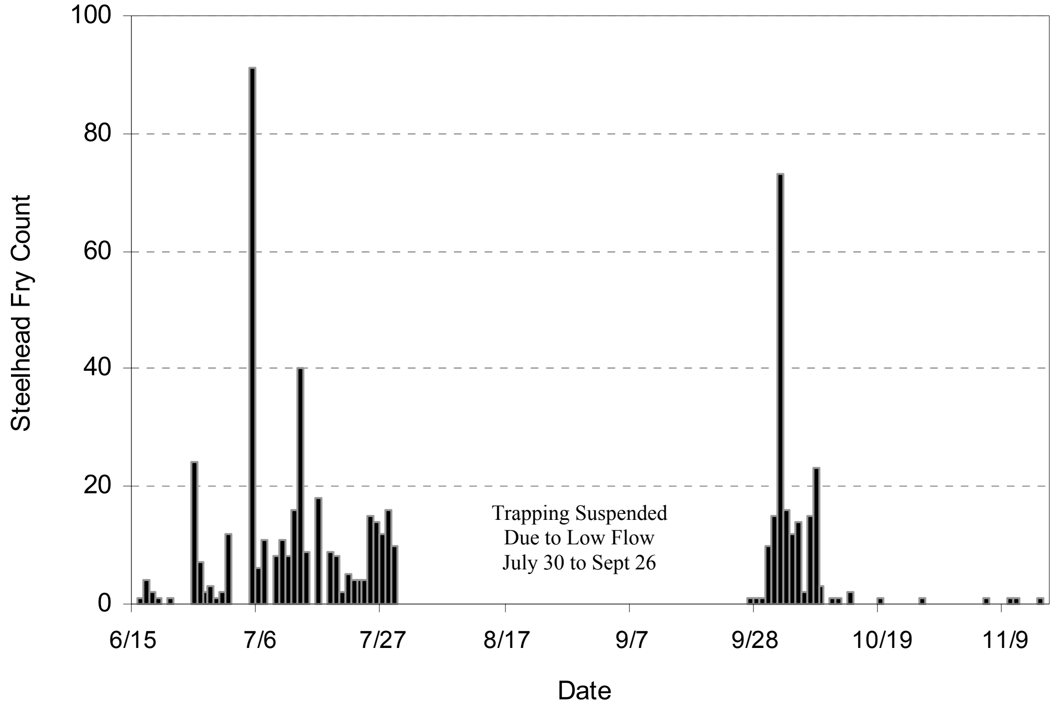

Figure 7. Steelhead fry counts and run-timing at the Nason Creek smolt trap from June 16th through November 15th 2005.

Steelhead/Rainbow Trout Parr

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

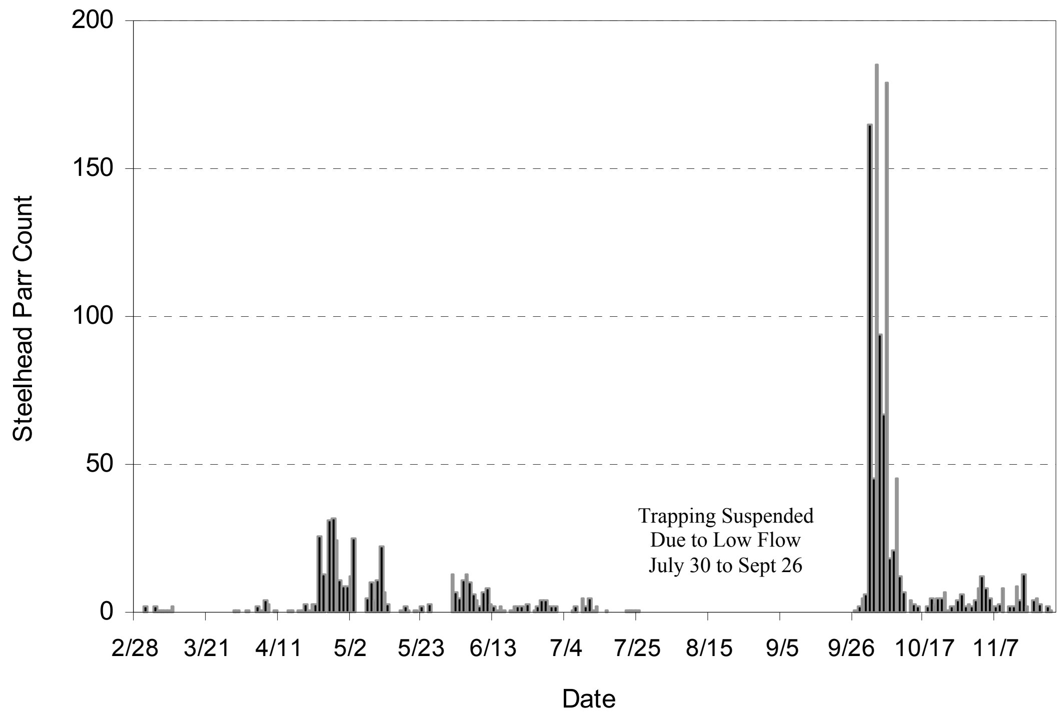

Figure 8. Steelhead parr counts and run-timing at the Nason Creek smolt trap, March 1st through Nov 23rd 2005.

Steelhead/Rainbow Trout Smolts

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

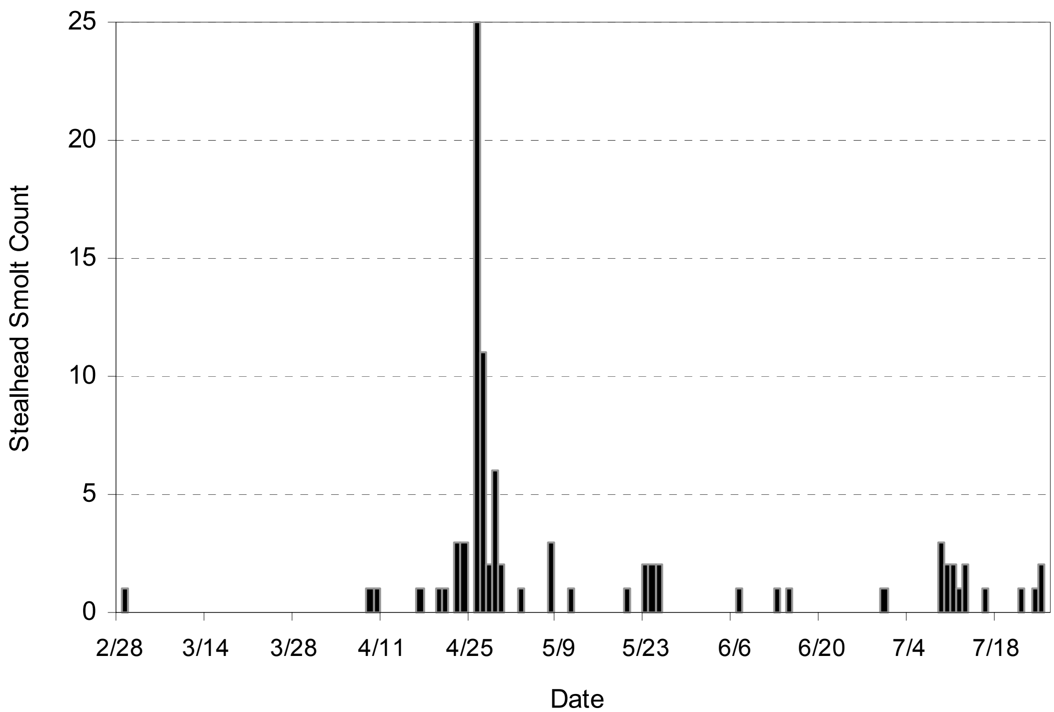

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Figure 9. Steelhead smolt counts and run-timing at the Nason Creek smolt trap, March 1st through July 25th 2005.

Length and Weight

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

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

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

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

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

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

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

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

Steelhead Fry, Parr, and Smolts

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

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

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

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

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

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

Trap Efficiency Calibration and Population Estimates

Mark and Recapture Trials

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

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

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

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

Emigration Estimates

Spring Chinook Yearling (2003 Brood)

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

Subyearling Spring Chinook (2004 Brood)

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

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

Steelhead Smolts and Parr

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

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

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

Incidental Species

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

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

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

Naturally Produced Coho

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

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

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

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

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

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

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

Discussion

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

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

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

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

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

Summary

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

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

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

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

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

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

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

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

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

- During the spring, 86 steelhead smolts were captured.

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

- Population estimate summary (Table 10).

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

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

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

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

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

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

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

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

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

References

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

US Forest Service 1996. Nason Creek Stream Survey Report

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

Appendix A

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

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

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

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

Appendix B

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

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

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

Appendix C

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

Spring Chinook Yearling
Eliminated sample size groups < 25

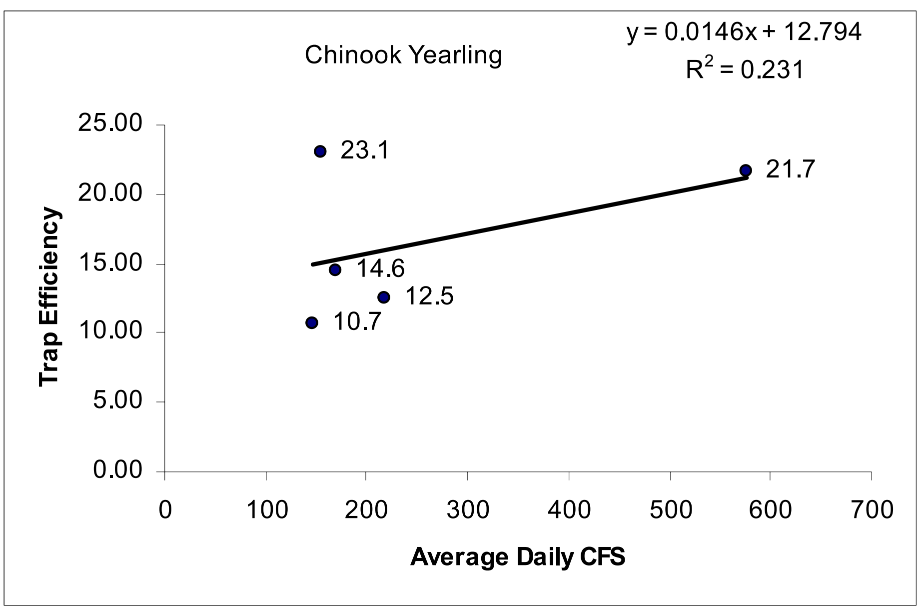
Marked	Efficiency	CFS
28	10.71	147
55	14.55	170
26	23.08	156
32	12.50	218
60	21.67	576

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

ANOVA

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

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



Spring Chinook Subyearling
Eliminated sample size < 40

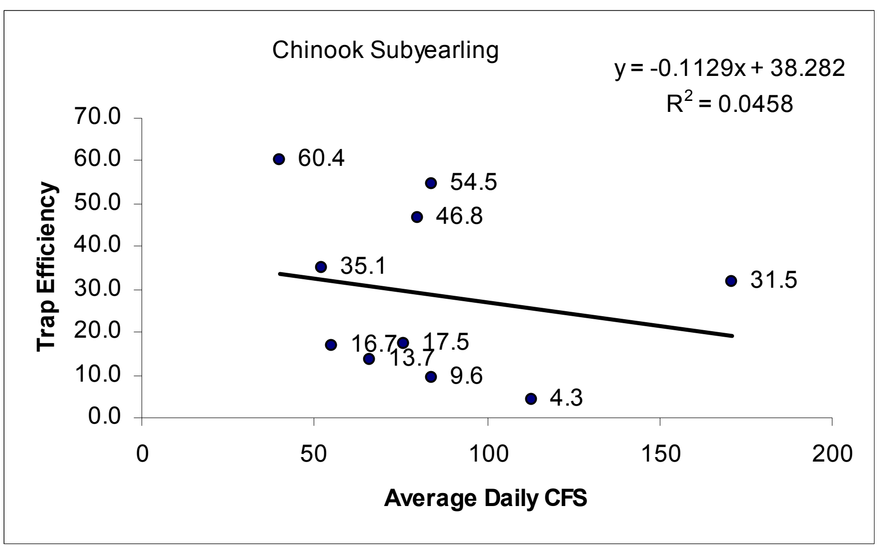
Marked	Efficiency	CFS
44	54.5	84
62	46.8	80
48	60.4	40
57	35.1	52
42	16.7	55
178	9.6	84
40	17.5	76
51	13.7	66
73	31.5	171
46	4.3	113

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

ANOVA

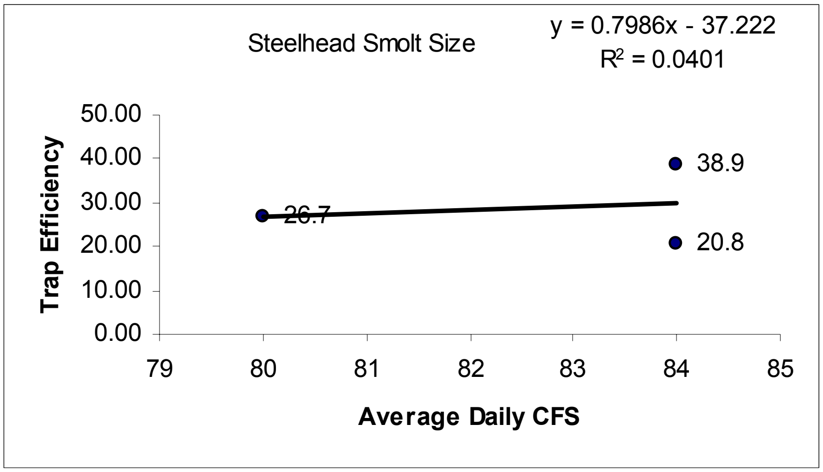
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	160.3489	160.3489	0.383819	0.552797
Residual	8	3342.175	417.7719		
Total	9	3502.524			

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



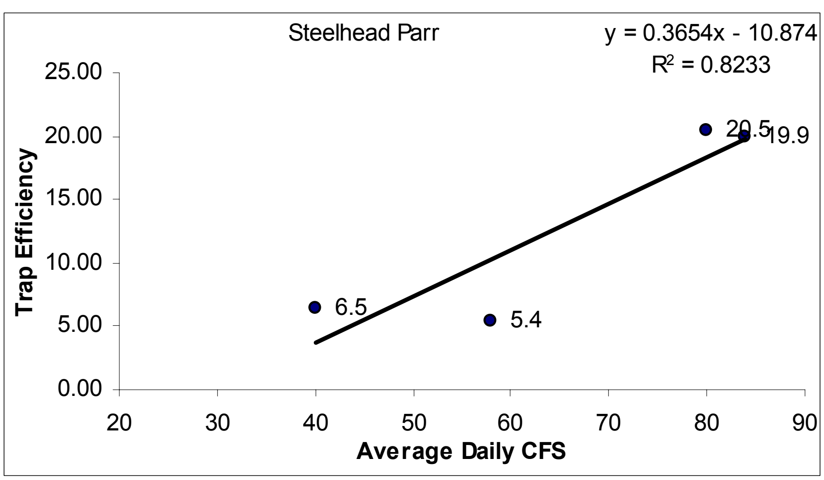
Steelhead Smolt/pre-Smolt (>120mm)
Eliminated sample size groups ≤ 10

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



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

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



Appendix D

Nason Creek smolt trap photographs.

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

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

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

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