Characterize and Quantify Residual Steelhead in the Clearwater River, Idaho

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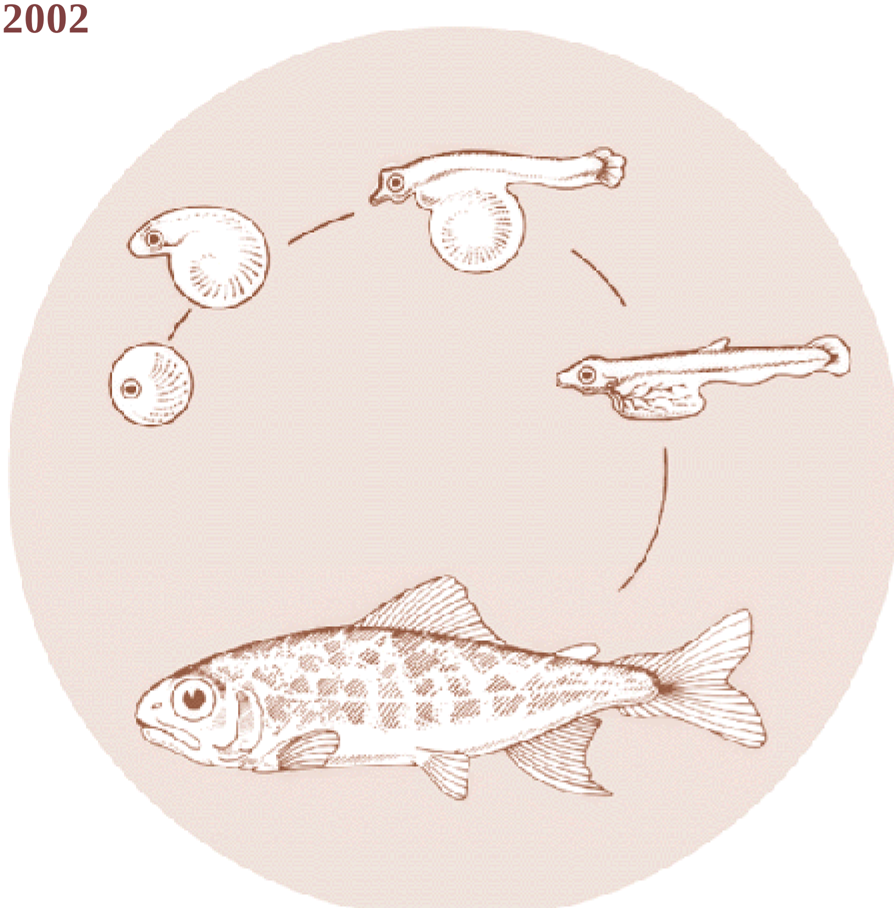
2002



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CHARACTERIZE AND QUANTIFY RESIDUAL STEELHEAD IN THE CLEARWATER RIVER, IDAHO

ANNUAL REPORT 2002

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract

We tagged 4,513 hatchery steelhead from Dworshak National Fish Hatchery (NFH), with Passive Integrated Transponder (PIT) tags to evaluate factors contributing to residualism. Steelhead from typical growth ponds (System I) averaged eight mm less and traveled two days faster to Lower Granite Dam than those in faster growth ponds (System II). The mean detection rates of steelhead by rearing system were 57.4%, 55.9%, and 57.8% for System I, System II, and System III. Steelhead released into Clear Creek, South Fork Clearwater River and directly from Dworshak NFH had detection rates of 55.0%, 59.1%, and 57.8%, respectively. Overall detection rate for all release sites, rearing sytems and egg takes was 54.1%. We PIT tagged an additional 270 hatchery steelhead in the North Fork and mainstem Clearwater rivers and the adult ladder at Dworshak National Fish Hatchery between May 15 and October 29. In the four tributaries sampled, no hatchery steelhead were captured or observed. A total of 51 coded-wire tags were recovered; 3 were released at Dworshak NFH in 2001 and 47 in 2002. One fish was released at Clear Creek. Although sample sizes were small, we were able to verify that at least 33 residual steelhead tagged in 2001 persisted in the Clearwater River during winter and were detected at downstream dams in 2002. Final analysis will include influences of water flow and temperature in emigration success.

Introduction

Upon completion of Dworshak Dam in 1973, Dworshak National Fish Hatchery (NFH) became responsible for maintaining the genetically unique B-run steelhead in the Clearwater basin. Dworshak NFH releases over 2.3 million smolts annually into the Clearwater River Basin. Most of the Dworshak NFH steelhead smolts are released directly into the Clearwater River, with less than half released upstream of the hatchery. A large percentage of these steelhead released into the Clearwater River from Dworshak NFH never reach Lower Granite Dam 116 km downstream from Dworshak NFH (Bigelow 1995a, Bigelow 1997). These non-migrating B-run steelhead, termed residuals, have been found cohabitating with wild A-run steelhead (Connor 1989, Bigelow 1995b, Bigelow and Bowen 1997). This has caused a region wide concern that residuals may be having a negative impact on wild fish in the Clearwater River basin, yet little is known about characteristics of hatchery steelhead which residualize. Our project goals are to maximize efficiency of hatchery operations and minimize impacts of residual steelhead on wild fish in the basin. Specific objectives include characterizing successful smolts, unsuccessful smolts (residuals), and comparing the differences. In 2002, information on hatchery gender, maturity and piscivory of hatchery steelhead was collected by electrofishing the mainstem Clearwater River and its tributaries. By injecting hatchery steelhead with Passive Integrated Transponder (PIT) tags (Prentice et al. 1990) and utilizing mark/recapture techniques, we estimated numbers and growth rates of residuals in the Clearwater River Basin below Dworshak NFH. Steelhead with coded-wire tags, distinguished by fin clips, were collected for their tags to provide information on rearing systems, techniques, gender and sexual maturity. Stomach samples were also collected to check for piscivory among hatchery steelhead. In this report, we present a summary of the data collected and findings for the year 2002.

Our objectives are to:

1. Estimate emigration success of Dworshak NFH steelhead smolts, evaluated by size at release, release site, and rearing system.
2. Estimate number of unsuccessful smolts residing in the Clearwater Basin throughout the summer.
3. Describe hatchery-reared steelhead, which are residualizing in the basin, by size, sex, sexual maturity, and relevant hatchery practices (e.g., release site, rearing system, release size, health history).

Annual reports, summarizing emigration success, estimate of residualism rate throughout the summer, and characterstics of residual steelhead, were produced for 1999-2001. A final project report will summarize the data over a four-year period and include a fourth objective:

4. Determine if a relationship exist between in-river conditions (flow and temperature), emigration success, residualism rate, and persistence of residual steelhead over time.

Project Area

Our project area was the mainstem Clearwater River Basin from just upstream of Dworshak (NFH) to the river's confluence with the Snake River in Lewiston, Idaho, roughly 66 river kilometers (Figure 1). We also sampled several tributaries, specifically, the North Fork Clearwater River downstream of Dworshak Dam to its confluence with the mainstem (about 3 km) and four smaller tributaries which enter the river downstream of the hatchery: Big Canyon, Jacks, Bedrock, and Cottonwood creeks.

Methods and Materials

Sampling and data collection was conducted on three levels: at the hatchery prior to steelhead releases, sampling in the mainstem Clearwater river two weeks after hatchery release and continuing throughout the summer (May through early September), and in the tributaries downstream of release sites after release and continuing until stream water temperatures increased beyond safe salmonid handling conditions (April into mid-June). Emigration and growth (of sub sampled fish) was monitored through the PIT_TAG Information System (PTAGIS) database. A shift in project personnel and high water conditions resulted in less sampling effort than in past years.

At the hatchery, 4,513 steelhead stratified by size at release, release site and rearing system, were sampled at Dworshak NFH. Each steelhead was PIT tagged. Length was measured on all tagged steelhead and weight was measured on sub samples from each pond. A total of 15 ponds were sampled: 5 in System I, 6 in System II, and 4 in System III. Steelhead were also checked for precociousness at time of tagging.

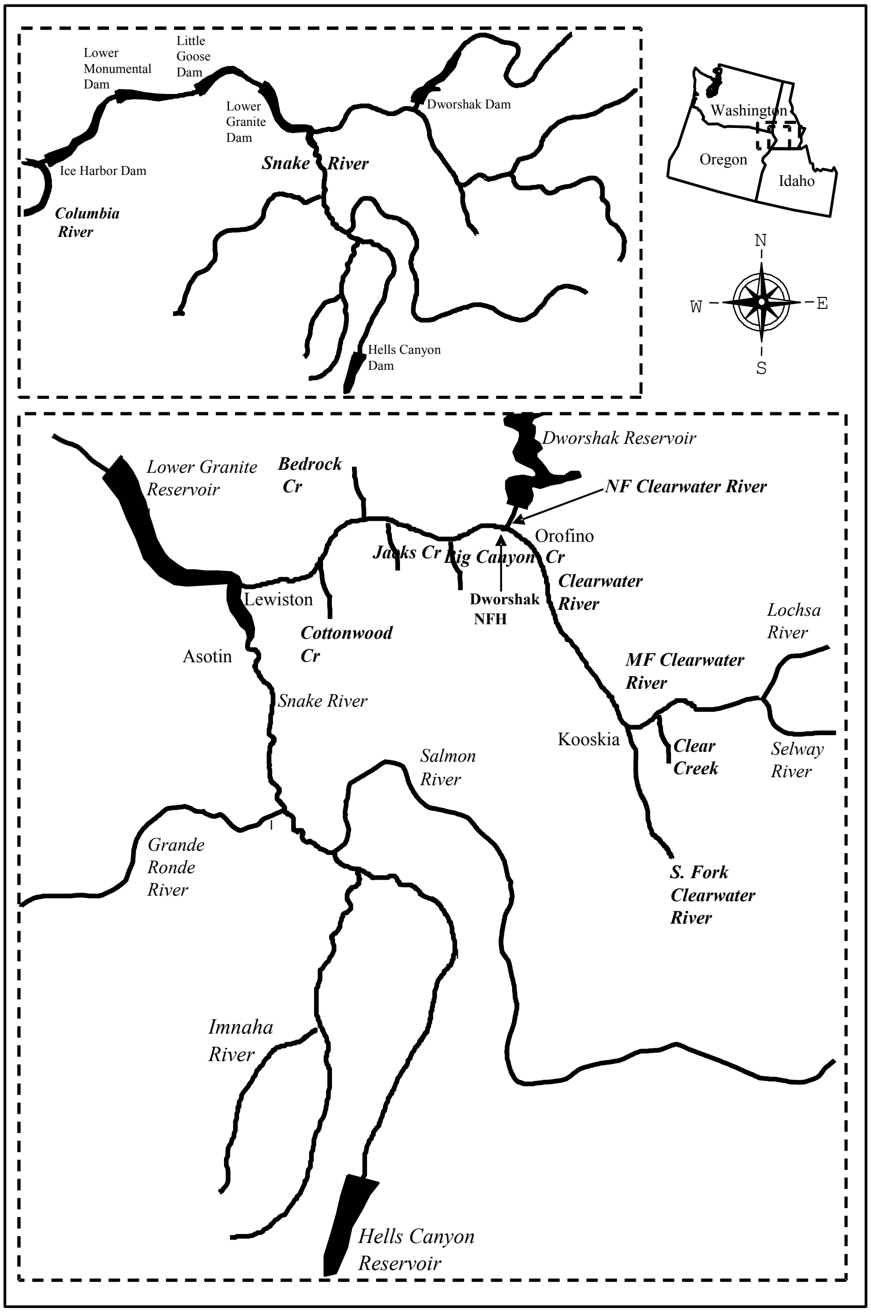

Figure 1. Map of the study area in relation to the Clearwater and Snake river drainages, Idaho.

Occasionally residualized steelhead will return to the hatchery through the fish ladder and become captured in the adult holding ponds. When adult fish were handled for enumeration or spawning, all juvenile steelhead in the system were sampled in the same manner as if they were in the Clearwater River.

Tributaries to the Clearwater River downstream of Dworshak NFH (Big Canyon, Jacks, Bedrock, and Cottonwood) were sampled using backpack electrofishing. Length, sex (if obvious), maturity level (if obvious), stomach contents, and marks were obtained from all hatchery fish sampled. All steelhead that had coded-wire tags were sacrificed to obtain hatchery and pond-of-origin information and to obtain more detailed sex and maturity information. Non-coded-wire tagged steelhead were injected with a PIT tag and released for later identification and to monitor emigration. All wild fish were enumerated and released.

Stomach analysis: Steelhead were placed in a live well upon capture. Stomach contents were evacuated using a pressurized water container. Pressure was used to pump water into the stomachs to induce regurgitation into a 300 *u*m mesh strainer. If fish parts were observed, the regurgitated contents were preserved with 70% alcohol, and stored in *Whirl packs* until analysis could be completed.

Statistical analysis: Chi-square tests were used to test emigration success and residualism rate of hatchery steelhead on rearing system, size at release, and release site (Everitt 1977). Descriptive characteristics of residuals include sex, maturity, and piscivory.

Steelhead from the first three takes of the season were split between System I (strictly fresh water) and System II (some reused water; the warmer temperatures lead to faster growth). Three of these ponds were selected from each system to represent typical versus faster growing steelhead. Because of unequal variance in steelhead lengths and travel times to Lower Snake River Dams between System I ponds, these variables were tested using a Kruskal-Wallis ANOVA (Wilkinson 1990).

Population analysis: Residual steelhead populations were estimated by using the modified Schnabel estimator. The equation used is as follows:

$$N = \sum(C_t M_t) / R + 1 \quad \text{(Ricker 1975)}$$

Where:

N = estimate of population density,
C_t = total sample taken on day t,
M_t = total marked fish at large at the start of the t^{th} day,
R = recaptures.

Confidence limits were calculated for the population estimates by treating the number of recaptures as a Poisson variable. This results in a skewed distribution with the upper limits showing the greatest divergence from the mean. Confidence coefficients were calculated using the equation:

For $1 - P = 0.95$; $R + 1.92 \pm 1.96\sqrt{R + 1.0}$ (Ricker 1975).

Confidence coefficients were substituted as recaptures in the modified Schnabel estimator to determine confidence limits.

Results and Discussion

Steelhead were PIT tagged at Dworshak NFH on April 10-12, 2 weeks prior to release (Table 1). Tagging was stratified by size, release site and hatchery rearing system.

Table 1: Steelhead PIT tagged at Dworshak National Fish Hatchery, spring 2002.

Release Site	Number of steelhead PIT tagged by Rearing system				
	Egg take	I Freshwater 1,2,3	II Reuse 1,2,3,8	III Reuse 10,11	Total
Clearwater River at Dworshak NFH	1,2,3,8,10	901	1,212	600	2,713
Clear Creek	1,8,11	300	300	300	900
South Fork Clearwater River	1,8,11	300	300	300	900
Totals		1,501	1,812	1,500	4,513

Size at Release: Steelhead lengths from typical growth ponds (System I) were significantly less than those from the faster growth ponds (System II): mean fork lengths were 200.8 mm (SD=18.31) and 208.8 mm (SD=24.9) ($P<0.01$) (Figure 2). This difference in length did not significantly affect the detection rates throughout the Columbia River Basin. For all dams combined on the Lower Snake and Columbia rivers the detection rate was 57.0% for the typical growth group and 55.3% for the faster growth group (P=0.45). For the first three dams on the Snake River, detection rates for the typical growth group and faster growth group were 18.6% and 16.8% at Lower Granite (P=0.13), 19.5% and 18.9% at Little Goose (P=0.13) and 35.8% and 32.0% at Lower Monumental (P=0.08), respectively.

Travel Times: The travel times were faster for the typical growth group to Lower Granite Dam (P=0.00) (Figure 3). Median travel time to Lower Granite Dam was 4.6 days for the typical growth group and 5.7 days for the faster growth group (Table 2).

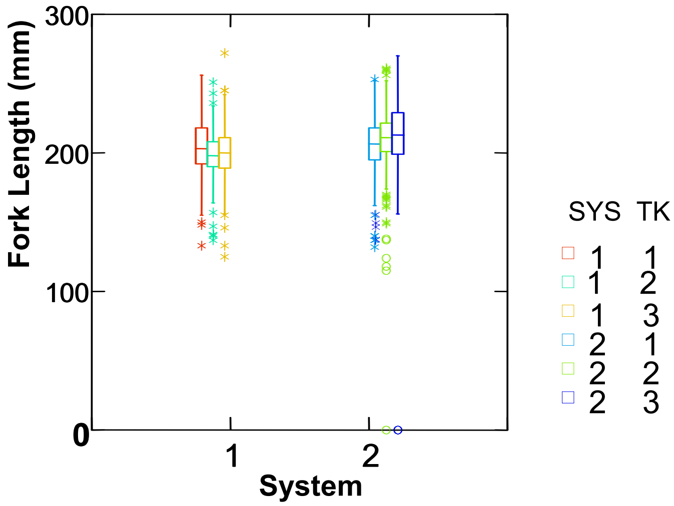

Figure 2: Mean fork lengths from steelhead reared in two water temperature regimes at Dworshak National fish Hatchery, 2002. System II, with slightly warmer temperatures, produces a faster growing steelhead.

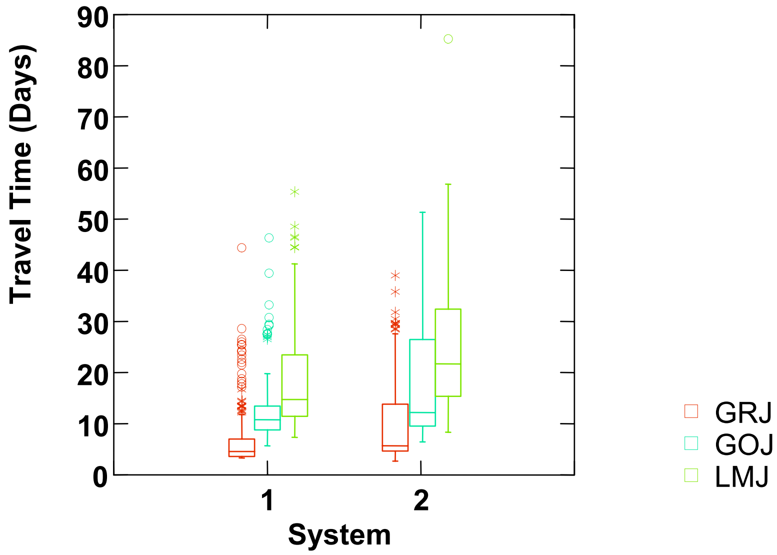

Figure 3: Travel time to Lower Granite, Little Goose, and Lower Monumental Dams on the Lower Snake River of steelhead reared at two growth rates, Dworshak National Fish Hatchery, 2002.

Table 2: Migration times (days) of steelhead from System I and System II, Egg takes 1-3, Dworshak NFH, 2002.

	System I				System II			
	Min.	Max.	Med.	Mean	Min.	Max.	Med.	Mean
Lower Granite Dam	3.3	44.4	4.6	7.4	2.7	39.0	5.7	10.6
Little Goose Dam	5.7	46.4	10.8	12.5	6.5	51.4	12.3	16.7
Lower Monumental Dam	7.4	55.4	14.8	18.4	8.4	85.3	21.8	24.7

Release Site: In 2002, steelhead released into Clear Creek had a slightly lower detection rate (55.0%) than those released in the South Fork Clearwater River (59.1%) and from those fish released directly from Dworshak NFH (57.8%) (P=0.20). The total detection rate for all steelhead released from all sites, rearing systems and egg takes was 54.1%.

Rearing System: Detection rates of steelhead based on rearing system were not significantly different between systems (P=0.51). System II fish were seen at a slightly lower rate (55.9%) than either System I (57.4%) or System II (57.8%) steelhead.

Mainstem and North Fork Clearwater Rivers: The intent of the project was to sample the Clearwater River and our four study streams prior to releases of steelhead from Dworshak NFH in the spring. However, due to turbid stream conditions, sampling of the four study tributaries was not possible until five weeks after releases. Sampling was not possible before releases occurred in the mainstem Clearwater River because of high water conditions.

We sampled 243 steelhead during summer in the North Fork and mainstem Clearwater rivers. Of this sample, 46 were collected for coded-wire tag recovery, 187 were PIT tagged and 4 were recaptures (Table 3).

A small percentage of fish were seen emigrating downstream. Of the 79 steelhead PIT tagged between May 15 and July 1, 36 (45.5%) were detected at a downstream facility. However, 108 fish were PIT tagged between July 1 and September 6; none of these were detected at a downstream facility.

Many juvenile steelhead moved back into Dworshak NFH through the adult fish ladder when it was open for spring chinook and summer steelhead (Table 3). Of the 135 juvenile steelhead captured from July 17 to November 26, 83 were PIT tagged and released, 13 fish were collected for coded-wire tag recovery and 5 were recaptures. None of these steelhead were detected at facilities downstream of Dworshak NFH subsequent to tagging. Therefore, out of 270 steelhead PIT tagged at the Dworshak NFH ladder and in the North Fork and Clearwater rivers, only 36 were detected (13.0%) in 2002.

Table 3. Hatchery steelhead sampled in the Clearwater and North Fork Clearwater rivers and Dworshak adult ladder, summer 2002.

River Kilometer	Sample site	Collected for coded-wire tags	PIT tagged and released	Recaptures
66-57	Orofino to Big Canyon	10	35	0
57-42	Big Canyon to Bedrock	11	59	3
42-29	Bedrock to Myrtle	1	4	0
29-15	Myrtle to Hog island	1	1	0
15-1	Hog Island to Snake	1	0	0
1-3	North Fork Clearwater	22	88	1
65	Dworshak NFH rack	13	83	4
Totals		59	270	8

Tributaries: The four tributaries were sampled once. Ninety wild steelhead were captured and released, but no hatchery steelhead were captured or observed.

Recaptured steelhead: Recaptured steelhead tended to not stray far from their initial capture site. A total of eight steelhead were recaptured. One fish was originally released into the South Fork Clearwater River and recaptured 167 km downstream. Four fish were tagged in the Dworshak NFH adult ladder, tagged and released 2 km upstream. They returned to the ladder within three weeks. One fish was recaptured in the same vicinity as tagged. The remaining two fish were recaptured within 2 km of where they were tagged.

Gender and maturity of residual steelhead: Steelhead which were sacrificed for coded-wire tag information and incidental mortalities were checked for sexual maturity. Of steelhead that could be sexed, 88.1% were males. The precocious rate in males was 25.4%. Steelhead were also checked for sexual maturity and precociousness during PIT tagging prior to releases from Dworshak NFH. Since tagged fish were to be released, only males were detectable. In System I there were 4.13% precocious steelhead, System II and III did not have any.

Coded-wire tag data: Coded wire tags were recovered from 51 of the 59 steelhead collected in 2002. Of these 51 coded-wire tags, 3 were released from Dworshak NFH in 2001. The rest of the coded-wire tags were from fish released in from Dworshak NFH in 2002 (Table 5).

Table 5. Coded-wire tag recoveries from release year 2002 during sampling period for residual steelhead. Clearwater River, North Fork Clearwater River and Dworshak NFH adult ladder, 2002.

Coded-wire tag recoveries, Release year 2002						
Rearing System	Release Site					
	Dworshak NFH	Clear Creek	South Fork Clearwater	Total	Number Released	Percent
Dworshak NFH						
System I	13	0	0	13	43,854	0.03
System II	24	0	0	24	66,012	0.04
System III	10	1	0	11	66,740	0.02
Total	47	1	0	48		
Number Released	154,750	21,856	0		176,606	
Percent	0.03	0.005	0.0			

Population Estimate: Using interrogation data from Lower Granite Dam we determined that the majority of PIT-tagged steelhead stop emigrating after June 28 and the mark-recapture experiment was adjusted to fit this time frame. Therefore, a Modified Schnabel (closed population model) was used to calculate the number of residualized steelhead in the study area on June 28. In 2002 the estimated residual population in the Clearwater River below Dworshak NFH and the North Fork Clearwater River was 3,249 (95% confidence limits, 1,741 -6,647) (Table 6).

Stomach analysis: During 2002 we sampled 98 stomachs of juvenile hatchery steelhead. Three, or 3.1% of the steelhead had empty stomachs. Predation on other unidentified fishes was only found in one (1.0%) of the stomach samples.

Summary and Conclusions

Hatchery rearing practices: Detection rates for size at release, release site, and rearing systems will need to be compared over the length of the study for meaningful analysis. Using multiple years will increase the power of our statistics and may reveal differences not apparent in data analyzed one year at a time. Water flow and temperature data will also be incorporated into the final analysis. We have reported the following results from this year of the study: 1) size at release did appear to effect travel time through the Lower Snake River, 2) size at release did not appear to have a significant difference in emigration successes, 3) release site and rearing system did not have a significant difference in detection rates, and 4) steelhead released into Clear Creek had a lower detection rate then those released into the South Fork Clearwater River and those released directly into the Clearwater River.

Table 6: Data used for population estimates (June 28 to November 26) for steelhead 2002.

DATE	CT Total sample	TAGGED & RELEASED	CWT & MORTS	Mt Marked fish at large	R Number of recaptures	Ct Mt	SUM CtMt
6/28/02	15	11	4	0	0	0	0
7/1/02	5	4	1	11	0	55	55
7/2/02	5	4	1	15	0	75	130
7/10/02	4	4	0	19	0	76	206
7/12/02	0	0	0	23	0	0	206
7/16/02	5	3	1	23	2	115	321
7/17/02	3	2	1	26	0	78	399
7/18/02	1	0	1	28	0	28	427
7/19/02	4	2	2	28	0	112	539
7/23/02	11	9	1	30	1	330	869
7/24/02	17	10	7	39	0	663	1532
7/26/02	3	1	2	49	0	147	1679
8/1/02	6	5	1	50	0	300	1979
8/2/02	3	3	0	55	0	165	2144
8/6/02	7	7	0	58	0	406	2550
8/9/02	4	2	2	65	0	260	2810
8/27/02	32	27	6	67	0	2144	4954
9/3/02	12	8	4	94	0	1128	6082
9/6/02	48	40	7	102	1	4896	10978
9/10/02	1	1	0	142	0	142	11120
9/17/02	9	6	2	143	0	1287	12407
9/24/02	10	9	0	149	0	1490	13897
10/15/02	11	10	1	158	0	1738	15635
10/22/02	23	22	1	168	0	3864	19499
10/29/02	20	12	5	190	1	3800	23299
11/5/02	14	0	1	202	1	2828	26127
11/19/02	7	0	0	202	2	1414	27541
1126/02	8	0	1	202	0	1616	29157

Characteristics of residual steelhead: Very few of the steelhead captured were detected emigrating toward the ocean. Of the 79 steelhead tagged between May 15 and July 1, 36 (45.6%) were detected at a downstream facility. None of the 191 steelhead tagged between July 1 and October 29 in the Dworshak NFH ladder and North Fork Clearwater and Clearwater rivers were detected at downstream facilities. Many juvenile steelhead simply returned to Dworshak NFH through the adult fish ladder. One hundred thirty-nine hatchery steelhead were captured at Dworshak NFH and four fish were recaptured at Dworshak NFH.

Stomach analysis indicated very little piscivory occurred in residual steelhead in 2002. We found unidentified fish and unidentified fish parts in only one of ninety-eight samples analyzed.

No hatchery steelhead were observed rearing in Clearwater River tributaries before emigrating in 2002.

Persistence of residual steelhead in the Clearwater River: There were no recaptures of juvenile hatchery steelhead that had been PIT tagged in 1999-2001. However, three coded-wire tagged fish from 2001 were captured in 2002. We also found that 33 steelhead PIT-tagged in the summer and fall of 2001 over-wintered in the Clearwater River and emigrated downstream in 2002, so we know at least some steelhead survive through the winter and chose to migrate the following year. Coded-wire tag and PIT-tag data from subsequent years will give more information regarding survival of steelhead that do not emigrate from the Clearwater River system in the release year.

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