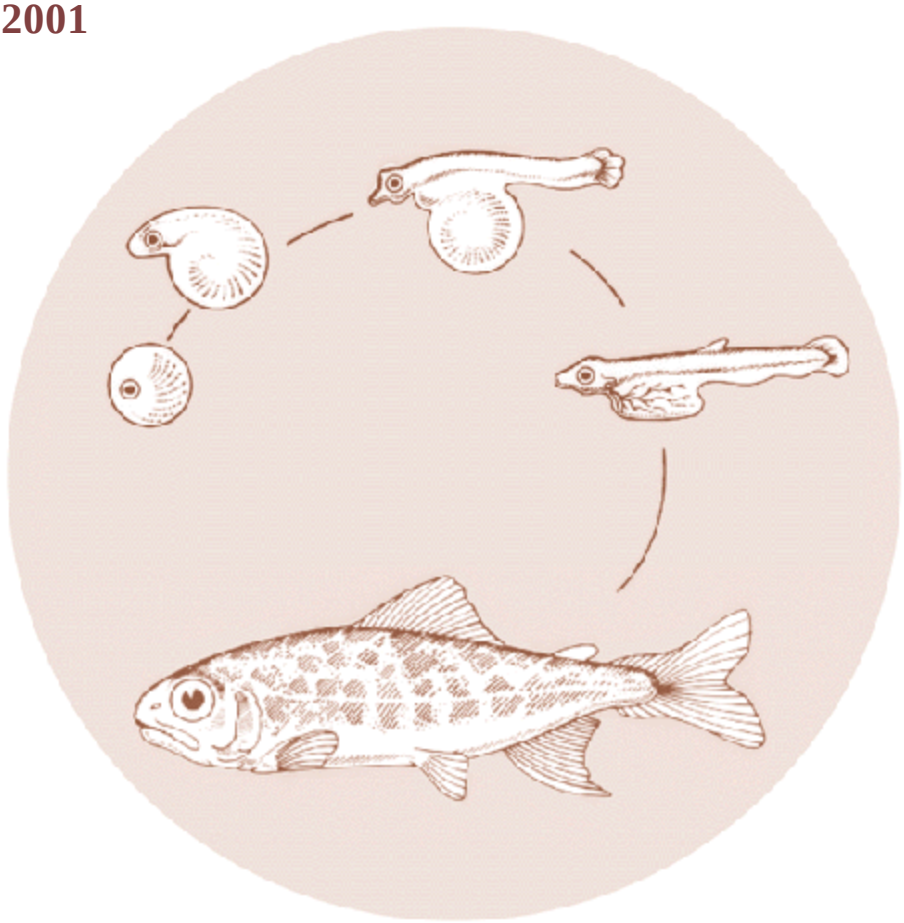
Characterize and Quantify Residual Steelhead in the Clearwater River, Idaho

Annual Report
2001



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Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

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CHARACTERIZE AND QUANTIFY RESIDUAL STEELHEAD IN THE CLEARWATER RIVER, IDAHO

ANNUAL REPORT 2001

Prepared by:

Chris A. Larsen
Micheal P. Faler

United States Fish and Wildlife Service
Idaho Fishery Resource Office
P.O. Box 18, 4147 Ahsahka Road
Ahsahka, ID 83520, USA

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-3621

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Abstract

We tagged 4,505 hatchery steelhead from Dworshak National Fish Hatchery (NFH), with Passive Integrated Transponder (PIT) tags to evaluate factors contributing to residualism. Steelhead lengths from typical growth ponds (System I) averaged 8 mm less than those in System II and travel times were two days faster. Steelhead were released into Clear Creek, South Fork Clearwater River and directly from Dworshak NFH; detection rates were 75.7%, 77.9%, and 76.4%, respectively. The mean detection rates of steelhead by rearing system were 75.8%, 78.4%, and 74.7% for System I, System II, and System III. We PIT tagged an additional 1,131 hatchery steelhead in the North Fork and mainstem Clearwater rivers between April 9 and September 19. In the four tributaries sampled, 85 steelhead were PIT tagged and released, 57.6% were detected emigrating downstream. A total of 149 coded-wire tags were recovered; 18 were tagged at Dworshak NFH in 2000 and two in 1999. Additionally, 20 were released from the Clearwater Fish Hatchery and nine were released in Oregon. Although sample sizes were small, we were able to verify that at least 52 residual steelhead survived the winter to persist in the Clearwater River. These 52 steelhead were PIT tagged in 2000 and detected at Lower Granite Dam emigrating in 2001. Based on this years data, the majority of steelhead, which do not emigrate during the first couple of weeks after release, are unlikely to emigrate. Final analysis will also include influences of water flow and temperature in emigration success. This information needs to be compared over several years for meaningful analysis.

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 the 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 2001, 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. Coded-wire tagged fish 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 the conclusions for the year 2001.

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, will be produced. 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 consists of 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 beginning just prior to hatchery releases and continuing throughout the summer (April through August), and in the tributaries downstream of release sites beginning just prior to hatchery releases 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.

At the hatchery, 4,505 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.

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

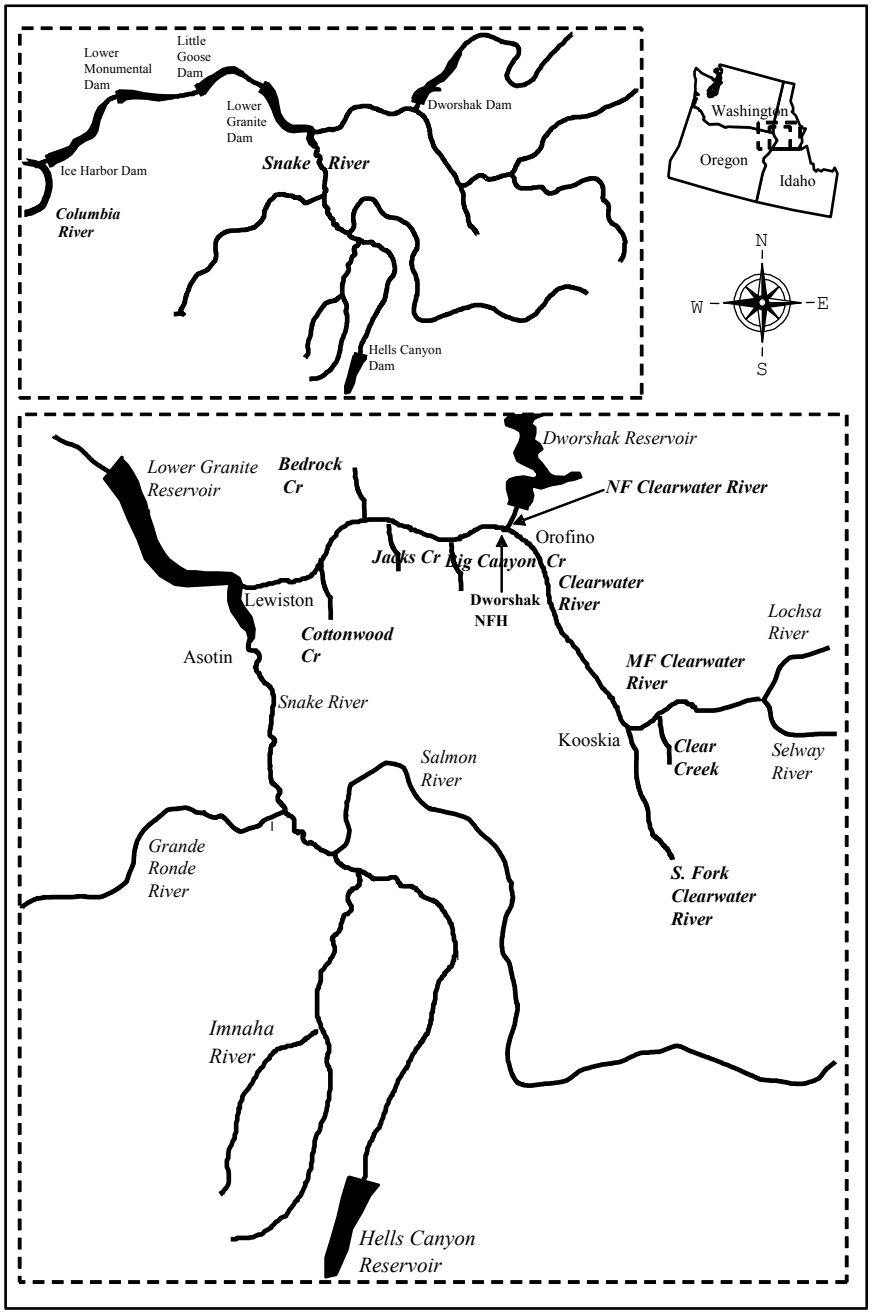

Figure 1. Map of the study area in relation to the Clearwater and Snake river drainages, Idaho.

spawning, all juvenile steelhead in the system were sampled in the same manner as if they were in the Clearwater River system.

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: Captured steelhead were placed in a live well upon capture. Fish stomach contents were evacuated using a pressurized water container. Pressure was used to pump water into the stomachs to induce regurgitation. In 1999 and 2000, all fish stomach contents were collected and analyzed. Since less than 2% of those stomachs had fish parts in them, in 2001 we only collected the stomach contents 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:

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

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:

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

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 5th and April 12th, 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 2001.

	Number of steelhead PIT tagged by Rearing system				
Release Site	Egg Take	I Freshwater 1,2,3,5	II Reuse 1,2,3,8	III Reuse 10,11	Total
Clearwater River at Dworshak NFH	1,2,3,8,11	906	1200	600	2,706
Clear Creek	1,8,10	299	300	300	899
South Fork Clearwater River	5,8,10	300	300	300	900
Totals		1,505	1,800	1,200	4,505

Size at Release: Steelhead lengths from typical growth ponds (System I) were significantly less than those from the faster growing ponds ($P<0.01$): mean fork lengths were 197.8 mm (SD=19.06) and 206.0 mm (SD=18.82) (Figure 2). Despite the differences in the lengths of the steelhead in the two systems no significant difference was seen in the detection rates throughout the Columbia River Basin. The detection rate at the dams on the Lower Snake and Columbia Rivers combined for the typical growth group was 77.5%; for the faster growth group, the detection rate was 74.1% ($P>0.01$). Detection rates at Lower Granite were 54.4% for the typical growth group and 68.1% for the faster growth group ($P>0.01$). Detection rates at Little Goose were 35.1% for the typical growth group and 39.8% ($P>0.01$) for the faster growth group. Detection rates at Lower Monumental were 23.8% for the typical growth group and 26.6% ($P>0.01$) for the faster growth group.

Travel Times: The travel times were faster for the typical growth ponds to Lower Granite Dam ($P>0.01$) (Figure 3). Median travel time to Lower Granite Dam was 5.8 days for the typical growth group and 7.6 days for the faster growth group (Table 2).

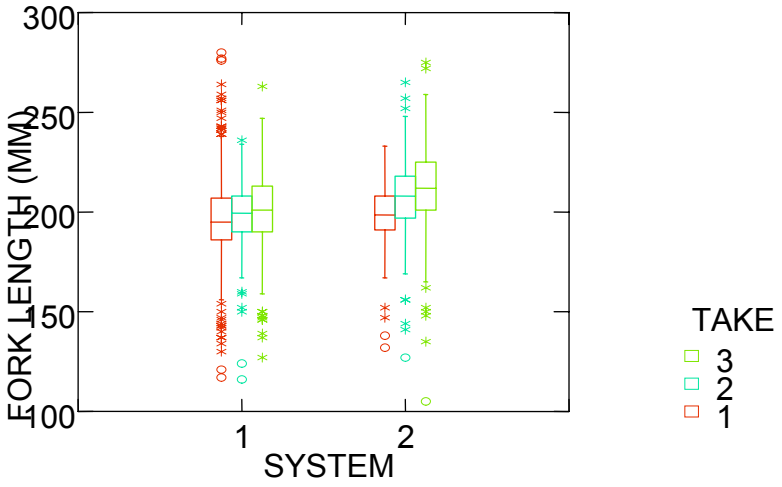

Figure 2: Mean fork lengths from steelhead reared in two water temperature regimes at Dworshak National fish Hatchery, 2001. System II, with slightly warmer temperatures, produces a faster growing steelhead.

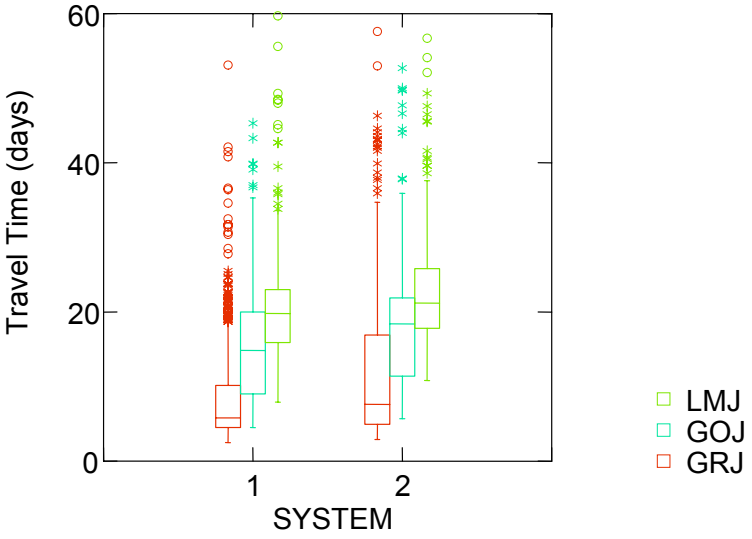

Figure 3: Travel time to Lower Granite, Little Goose, and Lower Monumental Dams on the Lower Snake River of steelhead reared at two growth rates, Dworshak National Fish Hatchery, 2001.

Table 2: Migration times (days) of steelhead from System I and System II, Dworshak NFH, 2001.

	System I				System II			
	Min.	Max.	Med.	Mean	Min.	Max.	Med.	Mean
Lower Granite Dam	2.5	92.1	5.8	9.1	2.9	77.7	7.6	12.1
Little Goose Dam	4.5	76.4	14.9	15.6	5.7	146.3	18.6	19.6
Lower Monumental Dam	7.9	79.6	19.9	21.0	10.8	105.6	21.4	23.9

Release Site: In 2001, steelhead released into Clear Creek had a slightly lower detection rate then those released in the South Fork Clearwater River and from those fish released directly from Dworshak NFH. Detection rates were 75.7%, 77.9%, and 76.4% for steelhead released at Clear Creek, South Fork Clearwater River, and at Dworshak NFH. The total detection rate for all steelhead released was 76.5%.

Rearing System: Detection rates of steelhead based on rearing system was also significantly different between systems (P=0.00). System III fish were seen at a slightly lower rate (74.7%) than either System I (75.8%) or System II (78.4%) 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 two weeks after releases. Sampling on the mainstem was only possible one time before releases occurred.

Prior to releases of steelhead (offsite and onsite) in the Clearwater River, we were able to sample three kilometers of the North Fork Clearwater River. We collected 20 steelhead, 18 of them were PIT-tagged and released, two of the steelhead were recaptures. No coded-wire tagged fish were captured. The recaptured steelhead show an indication that residulism is occurring

Summer sampling in the North Fork and mainstem Clearwater River this summer yielded a total of 1,131 steelhead. Of this sample, 140 were collected for coded-wire tag recovery, 976 were PIT tagged and 15 were recaptures (Table 3).

A small percentage of fish were seen emigrating downstream. A total of 386 steelhead were PIT tagged between April 9 and June 13. Out of these 386 steelhead, 167 (43.3%) were detected at a downstream facility. However, 590 fish were PIT tagged between June 14 and September 19; only 22 (3.7%) of these were detected at a downstream facility. Therefore, out of 976 steelhead PIT tagged in the North Fork and Clearwater Rivers, only 189 were detected (19.4%).

Many juvenile steelhead moved back into Dworshak NFH through the adult fish ladder (Table 3). Most of the fish returned while the adult fish ladder was open for spring chinook. Juvenile steelhead were captured from July 18 to October 23. Two hundred fifty one steelhead entered the hatchery through the adult fish ladder; 196 were PIT tagged and released and 44 fish were collected for coded-wire tag recovery and eleven were recaptures. Eight of these steelhead were

detected at facilities downstream of Dworshak NFH subsequent to tagging. No stomach samples were taken on any of these steelhead.

Table 3. Hatchery steelhead sampled in the Clearwater and North Fork Clearwater rivers and Dworshak adult ladder, summer 2001.

River Kilometer	Sample site	Collected for coded-wire tags	PIT tagged and released	Recaptures
66-57	Orofino to Big Canyon	5	7	0
57-42	Big Canyon to Bedrock	32	188	6
42-29	Bedrock to Myrtle	33	205	3
29-15	Myrtle to Hog island	30	225	2
15-1	Hog Island to Snake	0	0	0
1-3	North Fork Clearwater	40	351	6
65	Dworshak NFH rack	44	196	11
Totals		184	1,172	28

Tributaries: In the four tributaries 85 steelhead were PIT tagged and released; another 10 steelhead were collected for coded-wire tags and one was a recapture (Table 4). Forty-nine (57.6%) steelhead PIT tagged in tributaries were detected emigrating downstream.

Table 4. Hatchery steelhead sampled in tributaries of the Clearwater River, summer 2001.

Tributary	Collected for coded-wire tags	PIT tagged and released	Recaptures
Jacks Creek	2	26	0
Big Canyon Creek	0	7	0
Cottonwood Creek	4	35	1
Bedrock Creek	4	17	0
Totals	10	85	1

Recaptured steelhead: Recaptured steelhead tended to not stray far from their initial capture site. A total of 28 steelhead were recaptured. Of the 28 recaptured 11 were recaptured in the Dworshak NFH adult rack. Eight of those were originally caught in the ladder, PIT tagged, released back into the mainstem of the Clearwater River and then returned via the adult fish ladder. We also recaptured 2 steelhead that were released in 2000.

Gender and maturity of residual steelhead: Steelhead which were sacrificed for coded-wire tag information and steelhead mortalities were checked for sexual maturity. The precocious rate in males was 13.9%. Steelhead were also checked for sexual maturity during PIT tagging prior to

releases from Dworshak NFH. Since tagged fish were to be released, only precocious males were detectable. Five percent of the System I steelhead were precocious, 4.5% of System II, and 1.3% of System III.

Coded-wire tag data: Coded wire tags were recovered from 149 steelhead in 2001 (Table 5). Of these 149 coded-wire tags, 18 were released from Dworshak NFH in 2000 and two were released in 1999. Additionally, 20 were released from the Clearwater Fish Hatchery. We also captured nine coded-wire tagged fish that were tagged in Oregon.

Table 5. Coded-wire tag recoveries from release year 2001 during sampling period for residual steelhead. Clearwater River and selected tributaries, 2001.

Coded-wire tag recoveries, Release year 2001						
Rearing System	Release Site					
	Dworshak NFH	Clear Creek	South Fork Clearwater	Total	Number Released	Percent
Dworshak NFH						
System I	47	0	0	47	43,602	0.1
System II	38	0	0	38	67,454	0.06
System III	15	0	0	15	68,254	0.02
Total	100	0	0	100		
Number Released	133,637	22,924	0		156,561	
Percent	0.07	0.0	0.0			

Population Estimate: Using our interagation data from Lower Granite Dam we determined that the majority of PIT-tagged steelhead stop emigrating after June 14 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 14. In 2001 the estimated residual population in the Lower Clearwater River (approximately half the river segment downstream of Dworshak NFH) was 15,746 (95% confidence limits, 10,091-23,619) (Table 6).

Stomach analysis: During 2001 we sampled 262 stomachs of juvenile hatchery steelhead. Seven of these steelhead (2.6%) had empty stomachs. Predation on other unidentified fishes was only found in two of the stomach samples.

Table 6: Data used for population estimates (June 18 to October 23) for steelhead 2001.

DATE	CT Total sample	TAGGED & RELEASED	CWT & MORTS	Mt Marked fish at large	R Number of recaptures	Ct Mt	SUM CtMt
6/18/01	53	46	7	0	0	0	0
6/19/01	53	43	9	46	1	2438	2438
6/20/01	31	27	4	89	1	2759	5197
6/21/01	15	9	6	116	0	1740	6937
6/25/26	74	65	9	125	0	9250	16187
6/26/01	15	10	3	190	2	2850	19037
6/28/01	10	4	6	200	0	2000	21037
7/9/01	35	28	7	204	0	7140	28177
7/10/01	27	24	2	232	0	6264	34441
7/17/01	26	19	7	256	0	6656	41097
7/18/01	34	26	6	275	2	9350	50447
7/19/01	27	23	4	301	0	8127	58574
7/23/01	30	24	6	324	0	9720	68294
7/24/01	31	17	4	348	0	10788	79082
7/25/01	28	26	2	365	0	10220	89302
7/26/01	6	3	3	391	0	2346	91648
7/31/01	26	23	2	394	1	10244	101892
8/1/01	16	15	0	417	1	6672	108564
8/2/01	22	18	3	432	1	9504	118068
8/6/01	2	2	0	450	0	900	118968
8/7/01	4	3	1	452	0	1808	120776
8/8/01	17	14	3	455	0	7735	128511
8/14/01	9	7	1	469	1	4221	132732
8/16/01	19	14	5	476	0	9044	141776
8/20/01	9	8	1	490	0	4410	146186
8/21/01	39	35	3	498	0	19422	165308
8/23/01	9	6	3	533	0	4797	170405
8/27/01	15	11	3	539	1	8085	178490
8/28/01	30	27	2	550	1	16500	194990
8/29/01	69	63	5	577	1	39813	234803
9/4/01	21	18	1	640	2	13440	248243
9/5/01	44	42	1	658	1	28952	277195
9/11/01	65	55	7	700	3	45500	322695
9/12/01	3	3	0	755	0	2265	324960
9/13/01	35	32	2	758	1	26530	351490
9/17/01	27	23	2	790	2	21330	372820
9/18/01	30	27	3	813	1	24390	397210
9/19/01	1	1	0	840	0	840	398050
10/16/01	23	20	1	841	2	19343	417393
10/23/01	9	8	0	861	1	7749	425142

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 not significantly 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 did not have a significant difference in detection rates, 4) steelhead released into Clear Creek had a lower detection rate then those released into the South Fork Clearwater River and directly into the Clearwater River, 5) detection rates also showed a significant difference between rearing systems, and detection rates were significantly greater for steelhead reared in System I than those reared in Systems II and III.

Characteristics of residual steelhead: Very few of the steelhead captured by electrofishing were detected emigrating toward the ocean. Of the 386 steelhead tagged between April 9 and June 13, only 167 were detected at a downstream facility. Five hundred ninety fish were tagged between June 14 and September 19 in the Clearwater River; only 22 of these were detected at downstream facilities. Many juvenile steelhead simply returned to Dworshak NFH through the adult fish ladder. Two-hundred fifty-nine steelhead were captured because they re-entered Dworshak NFH and 11 fish were recaptured a second time.

Stomach analysis indicated very little piscivory occurred in residual steelhead in 2001. We found unidentified fish and unidentified fish parts in only two of 262 samples analyzed.

Some hatchery steelhead temporarily reared in Clearwater River tributaries before emigrating. These steelhead could be impacting wild stocks and out competing wild fish for valuable resources. Potentially these steelhead could be imprinting on these tributaries and returning adults could displace or spawn with wild A-run steelhead. More data collection in the tributaries will be obtained to see if this is a potential problem.

Persistence of residual steelhead in the Clearwater River: The sample size of PIT tagged steelhead in 1999 was small and no PIT-tagged fish from 1999 were recaptured in 2000 or in 2001. However, two coded-wire tagged fish from 1999 were captured in 2001 and 18 coded-wire tagged fish from 2000 were captured in 2001. Data from steelhead PIT tagged in 2000 was updated in 2001 PTAGIS. We found that 52 steelhead that were PIT-tagged in the summer of 2000 over-wintered in the Clearwater River and emigrated downstream in 2001, 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 who do not emigrate from the Clearwater River system in the release year.

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