Characterize and Quantify Residual Steelhead in the Clearwater River, Idaho

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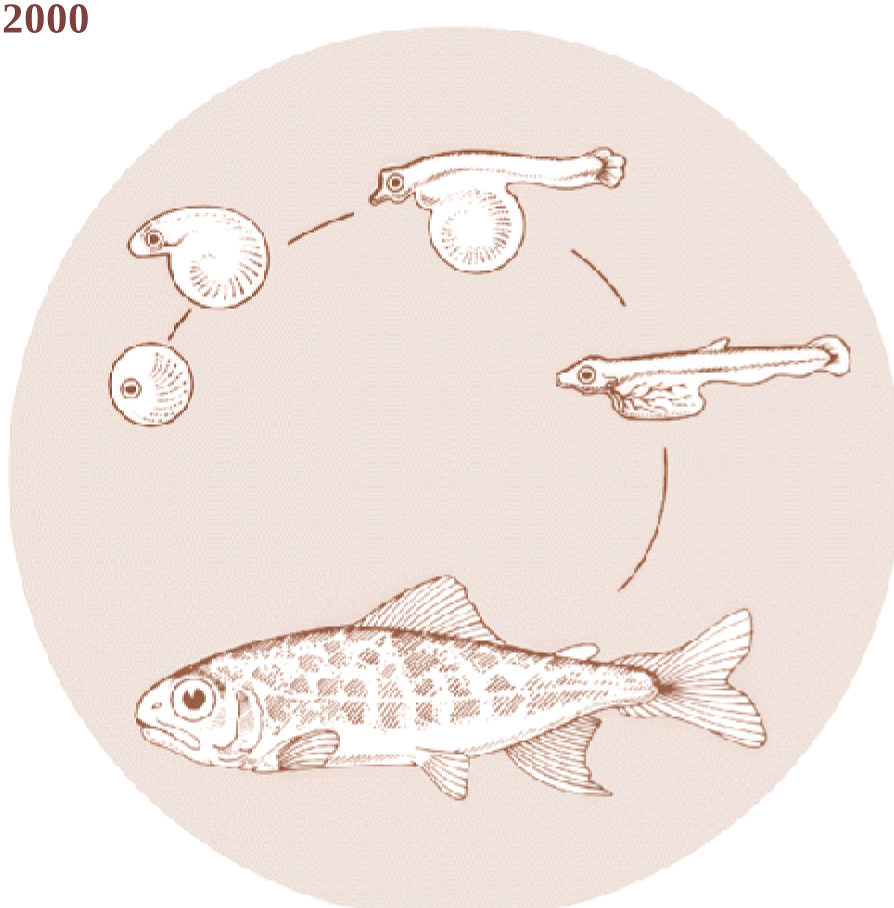

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CHARACTERIZE AND QUANTIFY RESIDUAL STEELHEAD IN THE CLEARWATER RIVER, IDAHO

ANNUAL REPORT 2000

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Abstract

We tagged 4,507 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 7mm less than those in faster growth ponds (System II) and travel times were 2 days faster. Steelhead were released into Clear Creek, South Fork Clearwater River, and from Dworshak NFH, and detection rates were 54.8%, 60.0% and 58.8%, respectively. The mean detection rates of steelhead analyzed by rearing system were, 51.5%, 59.8%, and 61.8% for System III, System I, and System II, respectively. We PIT tagged an additional 1,302 hatchery steelhead in the North Fork and mainstem Clearwater rivers between April 10 and August 28. Only 73 of these PIT-tagged steelhead were detected at a downstream dam and none were detected after June 14. In the 4 tributaries sampled, 77 steelhead were PIT tagged and released, 35.1% of which were detected emigrating downstream. Steelhead which were sacrificed for coded-wire tag information were also checked for sexual maturity. A total of 302 coded-wire tags were recovered; 87 from the Clearwater River, 119 from the North Fork Clearwater River, 80 from the Dworshak NFH adult return ladder, and 77 from the 4 tributaries. The precocious rate in males was 83.3% to 1.5% in females and the gender ratio was 79.8% males to 20.2% females. Although sample sizes were small, we were able to verify that at least one residual steelhead survived the winter to persist in the Clearwater River. 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 (at least three) for meaningful analysis.

Introduction

Upon completion of Dworshak dam in 1973, Dworshak National Fish Hatchery became responsible for maintaining the genetically unique B-run steelhead (*Oncorhynchus mykiss*) in the Clearwater basin. Dworshak NFH along with the Clearwater Fish Hatchery release 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 then 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 tend to 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 2000, 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 National Fish Hatchery.

Coded-wire tagged (approximately 10% of production) fish were collected for their tags and dissected 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 2000.

Our objectives are to:

1. Estimate emigration success of Dworshak National Fish Hatchery 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 characteristic of residualized steelhead, will be produced. A final project report will summarize these data over the three year period and include a fourth objective:

4. Determine if a relationship exists between in-river conditions (flow and temperature) to 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 National Fish Hatchery (NFH) to the river's confluence with the Snake River in Lewiston, Idaho, roughly 66 river kilometers (rkm) (Figure 1). We also sample several tributaries. Specifically, the North Fork Clearwater River downstream of Dworshak Dam to its confluence with the mainstem (about 3 rkm) and several smaller tributaries which enter the river downstream of the hatchery: Big Canyon, Jacks, Bedrock, and Cottonwood creeks.

Methods and Materials

Sampling.—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 increase beyond safe salmonid handling conditions (April into mid-June). Emigration and growth (of subsampled fish) was monitored through the PTAGIS database.

At the hatchery, 4,507 steelhead stratified by size at release, release site and rearing system, were sampled at Dworshak National Fish Hatchery. Each steelhead was PIT tagged. Length was measured on all tagged steelhead and weight was measured on subsamples from each pond. A total of 15 ponds were sampled: 5 in System I (freshwater), 6 in System II (reuse water), and 4 in

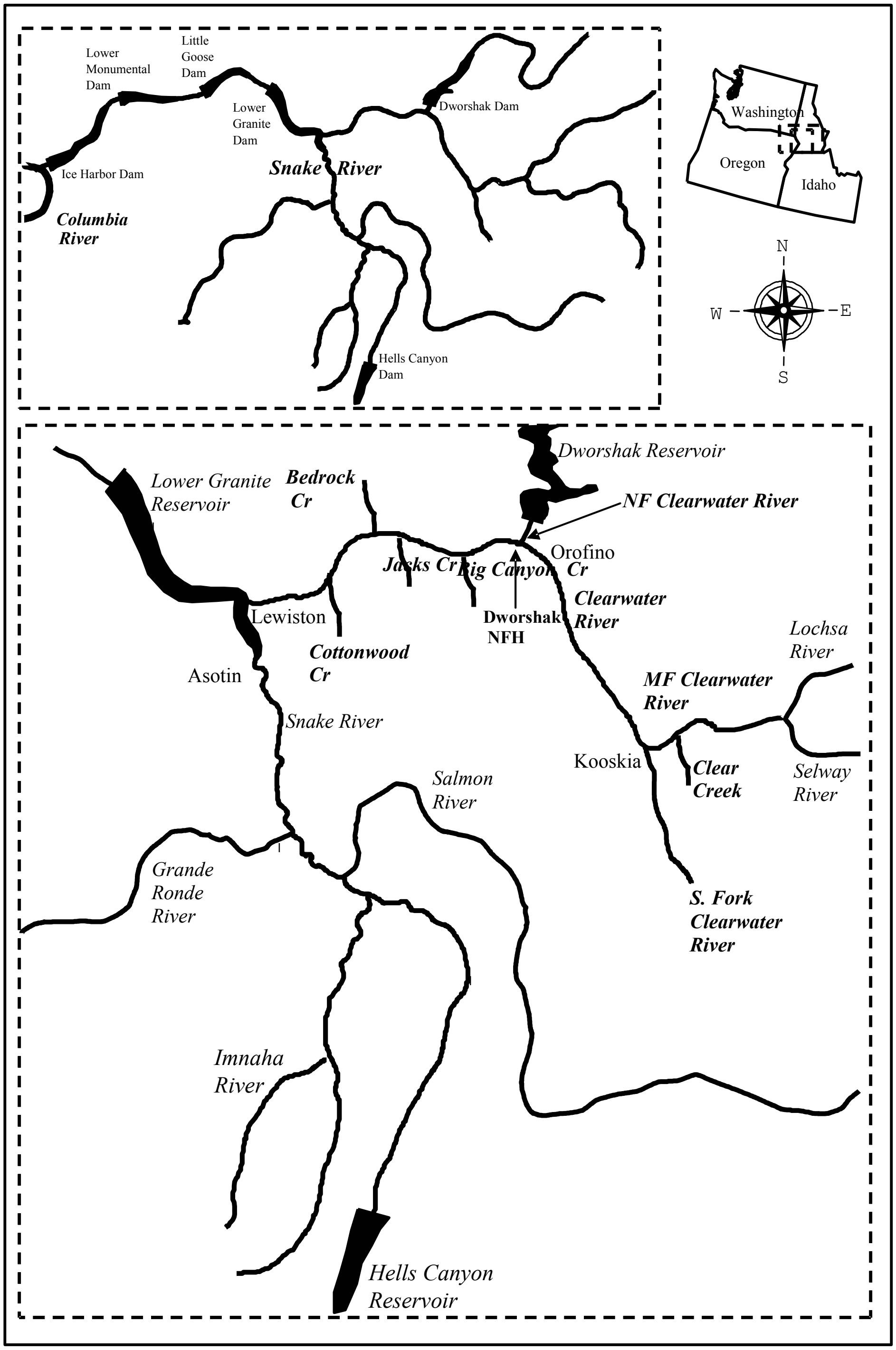

Figure 1. Map of the study area in relation to the Clearwater and Snake river drainages, Idaho.

System III (reuse water). Steelhead were also checked for precociousness. Electrofishing was used to sample steelhead on the mainstem Clearwater River and in the four tributaries. Approximately 10% of all hatchery-released steelhead receive coded-wire tags while being reared at the hatchery. Steelhead collected which were coded-wire tagged were sacrificed to determine hatchery rearing system, sex, maturity level, and stomach contents. Length data was also obtained from these fish. All steelhead captured without a coded-wire tag were measured for length and checked for precociousness and a PIT tag. Those not already PIT tagged were PIT tagged. All of the steelhead were released. Recaptured steelhead provided population and growth data for those fish residing in the mainstem.

Occasionally residualized steelhead will return to the hatchery through the fish ladder and end up in the adult holding ponds. When adult fish were handled for enumeration or spawning, all steelhead in the system were sampled in the same matter 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 also 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 which were coded-wire tagged 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. Regurgitated contents were collected in a 300 *u*m mesh strainer, preserved with 70% alcohol, and stored in *Whirl packs* until analysis could be completed.

Stomach contents for each steelhead were analyzed primarily to determine if piscivory was occurring. However, all contents were enumerated. For each stomach, contents were placed into six categories: aquatic insects, terrestrial insects, crustaceans, fishes, molluscs, and miscellaneous food items. Insects were categorized to order. Prey items such as fishes were categorized to the lowest easily identifiable taxa. The number and weight of each category in each stomach was recorded. When possible, parts of insects were placed into their proper order and weighed with that group. Unidentifiable insect parts were placed and weighed in an insect parts category. Prey categories were blotted dry and weighed to the nearest milligram (mg).

Statistical analysis.—Chi-square tests were used to test emigration success and residualism rate of hatchery steelhead based 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). For release site and rearing system comparisons, ponds were randomly selected from each system.

In-river conditions, including flow and temperature in the Clearwater River, will be correlated with residual rates and emigration success based on the stratifying factors over time at the end of the study. Growth rates of wild, residual, and emigrating steelhead will also be compared at the end of the study.

Results and Discussion

Steelhead were PIT tagged at Dworshak NFH on April 8th, 17th, and 19th, 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 2000. Steelhead in the 'faster growth' groups are from early takes and purposefully reared in the warmest system to obtain a greater mean fork length than general production.

Number of steelhead PIT tagged by Rearing system					
Release Site	Egg Take	I Freshwater 1,2,3,5	II Reuse water 1,2,3,7,8	III Reuse water 9,13,14	Total
Clearwater River at Dworshak NFH	1,2,3,7,8,9,14	900	1,201	606	2,707
Clear Creek	5,7,14	300	300	300	900
South Fork Clearwater River	5,7,13	300	300	300	900
Totals		1,500	1,801	1,206	4,507

Size at release.—Steelhead lengths from typical growth ponds (System I) were significantly less than those from the faster growth ponds ($P<0.01$); mean fork lengths were 205.7 mm (SD=18.46) and 212.6 mm (SD=19.52) (Figure 2). Despite the difference 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 58.4%; for the faster growth group, the detection rate was 59.6% ($P=0.09$). The detection rates at Lower Granite, Little Goose, and Lower Monumental Dams also showed no significant differences between the two systems. Detection rates at Lower Granite were the same for the typical growth group and the faster growth group, 44.6% ($P=0.02$). Detection rates at Little Goose were 9.0% for the typical growth group and 12.5% ($P=0.31$) for the faster growth group. Detection rates at Lower Monumental were 17.4% for the typical and 16.9% ($P=0.15$) for the faster growth group.

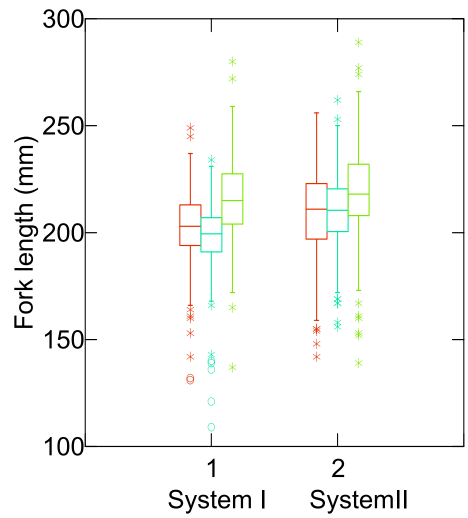

Figure 2. Mean fork lengths from steelhead reared in two water temperature regimes at Dworshak National Fish Hatchery, 2000. System II, with slightly warmer temperatures, produces a faster growing steelhead.

Travel times.—The travel times were faster for the typical growth group to Lower Granite Dam (P=0.95) (Figure 3). Median travel time to Lower Granite Dam was 3.5 days for both the typical growth group and for the faster growth group (Table 2).

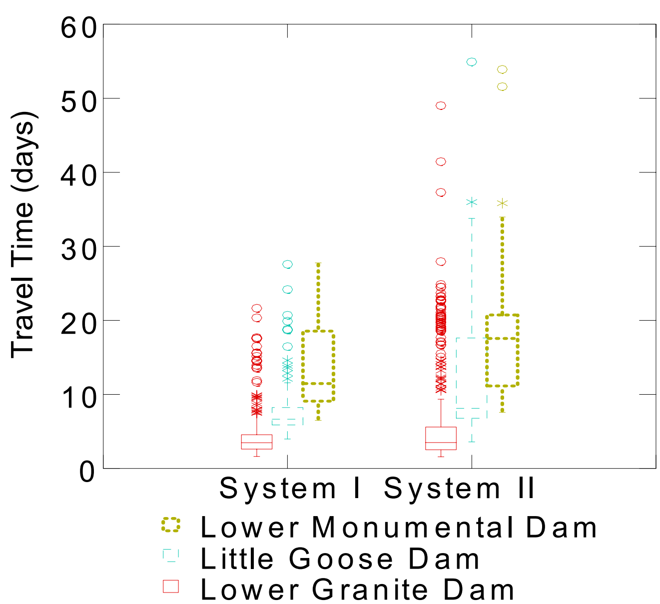

Figure 3. Travel time to Lower Granite, Little Goose, and Lower Monumental Dams on the Lower Snake River of steelhead reared at two growth rates, Dworshak National Fish Hatchery, 2000.

Table 2. Migration times (days) of steelhead from System I and System II, Dworshak NFH, 2000.

	System I				System II			
	Min.	Max.	Med.	Mean	Min.	Max.	Med.	Mean
LGR	1.6	21.7	3.5	4.2	1.6	49.0	3.5	6.0

Release site.—In 2000, steelhead released into Clear Creek had a slightly lower detection rate then those released directly from Dworshak NFH or from those fish released in the South Fork Clearwater River. Detection rates were 54.8%, 60.7%, and 58.8% for steelhead released at Clear Creek, South Fork Clearwater River, and at Dworshak NFH (P=0.03). The total detection rate for all steelhead released was 58.4%.

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 (51.5%) than either System I (59.8%) or System II (61.8%) 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 release of steelhead from Dworshak NFH in the spring. However, due to turbid stream conditions, sampling of the tributaries was not possible until a week after the offsite releases occurred. Also, sampling of the mainstem Clearwater River was limited to a week before offsite releases occurred, where it was only possible to sample 3 days.

Prior to releases of steelhead (offsite and onsite) in the Clearwater River, a total of 7 river kilometers was sampled. We collected 3 steelhead; they were PIT tagged and released. No coded-wire tagged fish or previously PIT-tagged fish were captured so the indication of residualism is unknown. However, the lengths of the 3 steelhead (283 mm, 206 mm, and 257 mm) all exceed the mean and median lengths (199.6 mm and 202 mm) of all steelhead PIT tagged prior to release. Only 1 of the 3 steelhead was observed emigrating through Lower Monumental Dam (a unique interrogation). Three of the four tributaries were sampled prior to releases directly from Dworshak NFH and 5 days after offsite releases to Clear Creek and South Fork Clearwater River. No hatchery steelhead were captured.

Summer sampling in the North Fork Clearwater River and the Clearwater River this summer yielded 1,508 steelhead. Of this sample, 286 were collected for coded-wire tag recovery and 1,302 were PIT tagged and released (Table 3).

A small percentage of fish were seen emigrating downstream. Of the 363 steelhead tagged between April 10 and June 13, 73 (20.1%) were detected at a downstream facility. However, 939 fish were PIT tagged between June 14 and August 28; none of these steelhead were detected at any of the downstream facilities. Therefore, out of 1,302 steelhead PIT tagged in the North Fork and Clearwater Rivers, only a total of 73 were detected (5.6%).

Many juvenile steelhead traveled back into Dworshak NFH through the adult fish ladder (Table 3). Most returned while the adult fish ladder was open for spring chinook. Steelhead were sampled from July 5 through November 11, with a total of 312 PIT tagged and 80 steelhead collected for coded-wire tag recovery. None of these steelhead were detected at facilities downstream of Dworshak NFH subsequent to tagging. Stomach samples were not collected from any of these steelhead.

Table 3. Hatchery steelhead sampled in the Clearwater and North Fork Clearwater rivers and Dworshak adult fish ladder, summer 2000.

River Kilometer	Sample site	Collected for coded-wire tags	PIT tagged and released	Recaptures
66-57	Orofino to Big Canyon	52	402	4
57-42	Big Canyon to Bedrock	14	123	0
42-29	Bedrock to Myrtle	7	85	0
29-15	Myrtle to Hog Island	14	42	1
15-1	Hog Island to Snake	0	9	0
1-3	North Fork Clearwater	119	641	26
65	Dworshak NFH rack	80	312	22
Totals		286	1,614	53

Tributaries.—In the four tributaries sampled, 77 steelhead were PIT tagged and released; another 16 steelhead were collected for coded-wire tags (Table 4). Twenty-seven (35.1%) steelhead PIT tagged in tributaries were detected emigrating downstream. Additionally, 140 wild steelhead were captured and released in the 4 tributaries.

Recaptured steelhead.—Recaptured steelhead tended to not stray far from their initial capture site. A total of 53 steelhead were recaptured. Forty-eight of the 53 were recaptured within 3 river kilometers of Dworshak NFH. Also, 22 steelhead were recaptured at Dworshak NFH. Of the 22 recaptures at the hatchery rack, 15 were PIT tagged at the hatchery rack, released back into the mainstem of the Clearwater River and then returned via the adult fish ladder. Additionally, 7 fish were tagged in the North Fork Clearwater River and returned to the hatchery through the adult fish ladder. Some of the recaptured steelhead had spent a total of 298 days in the river before returning to Dworshak NFH. We also recaptured 5 steelhead that were tagged prior to release. These steelhead had spent an average of 58 days within 3 river kilometers of

Dworshak NFH before recapture and up to 116 days in the river before recapture. Five of the steelhead recaptured occurred within 5 river kilometers below Dworshak NFH.

Table 4. Hatchery steelhead sampled in tributaries of the Clearwater River, summer 2000.

Tributary	Collected for coded-wire tags	PIT tagged and released	Recaptures
Jacks Creek	6	28	3
Big Canyon Creek	3	17	2
Cottonwood Creek	4	26	2
Bedrock Creek	3	6	0
Totals	16	77	7

Gender and maturity of residual steelhead.—Steelhead which were sacrificed for coded-wire tag information and steelhead mortalities were checked for sexual maturity. Gender ratio was 79.8% males to 20.2% female. The precocious rate in males was 83.3% to 1.5% female. Steelhead were also checked for sexual maturity (precocious) during PIT-tagging prior to release from Dworshak NFH. Since tagged fish were to be released only precocious males were detectable. Eleven percent of the System I steelhead were precocious, 7.7% of System II, and 3.7% of System III.

Coded-wire tag data.—Coded-wire tags were recovered from 302 steelhead (40 tags were unreadable or lost) (Table 5). Of these steelhead, 259 (98%) were reared and released from Dworshak NFH. Three recovered steelhead were reared at the Clearwater Hatchery. There was one coded-wire tag recovered from a steelhead reared at Dworshak NFH and released from Dworshak NFH in 1999. This steelhead was an early return progeny from take one that was reared in freshwater.

Table 5. Coded-wire tag recoveries from release year 2000 during sampling for residual steelhead, Clearwater River and selected tributaries, 2000. One coded-wire tagged steelhead, which was released in 1999, was recovered during 2000.

Coded-wire tag recoveries, Release year 2000						
Rearing System	Release Site					
	Dworshak NFH	Clear Creek	South Fork Clearwater	Total	Number Released	Percent
Dworshak NFH						
System I	116	0	0	116	44,416	.27
System II	106	0	0	106	66,472	.16
System III	37	0	0	37	66,229	.06
Total	259	0	0	259		
Number Released	177,117	22,330	0		199,447	
Percent	.15	0.0	0.0			

Stomach analysis.—During 2000 we sampled 241 stomachs of juvenile hatchery steelhead. Twenty, or 8.9%, of the steelhead had empty stomachs. Another 17 samples became desiccated or lost and were not included in the analysis.

Steelhead diets were fairly typical (Table 6, Figure 4). Diptera was the most common aquatic insect and accounted for 37% of the total weight excluding miscellaneous insect parts. Hymenoptera was the most common terrestrial insect and accounted for 17% of the total weight excluding miscellaneous insect parts. Crustaceans and molluscs contributed a combined total of 69%. In the 224 stomach samples analyzed, 1 sculpin and 16 larval fishes were found. Also found were 33 unidentified fish eggs.

Table 6. Food item, total number and total weight of stomach contents of juvenile steelhead sampled in the Clearwater River Basin from Dworshak National Fish Hatchery and downstream, summer, 2000. Some samples were collected in the tributaries. Empty stomachs were excluded.

Food item	Total number	Total weight (g)	Number of fish containing this item	Percent of fish containing this item
Aquatic insects				
Ephemeroptera	568	2.66	124	55.4
Diptera	2,959	1.60	174	77.7
Plecoptera	148	2.54	37	16.5
Odonata	1	0.05	1	0.4
Trichoptera	2,295	25.45	140	62.5
Coleoptera	240	2.20	51	22.8
Lepidoptera	18	1.05	10	4.5
Hemiptera	240	0.87	50	22.3
Terrestrial insects				
Hymenoptera	1,368	13.16	93	41.5
Crustaceans				
Isopoda	14	0.40	6	2.7
Cladocera	83	12.66	4	1.8
Decapoda (crayfish, parts)	1	0.01	1	0.4
Mollusca	54	3.24	13	5.8
Larval fishes (suckers)	16	0.0556	1	0.4
Cottidae	1	0.02	1	0.4
Fish eggs	33	0.64	3	1.3
Misc. fish flesh	X	0.94	1	0.4
Total		67.54	224	

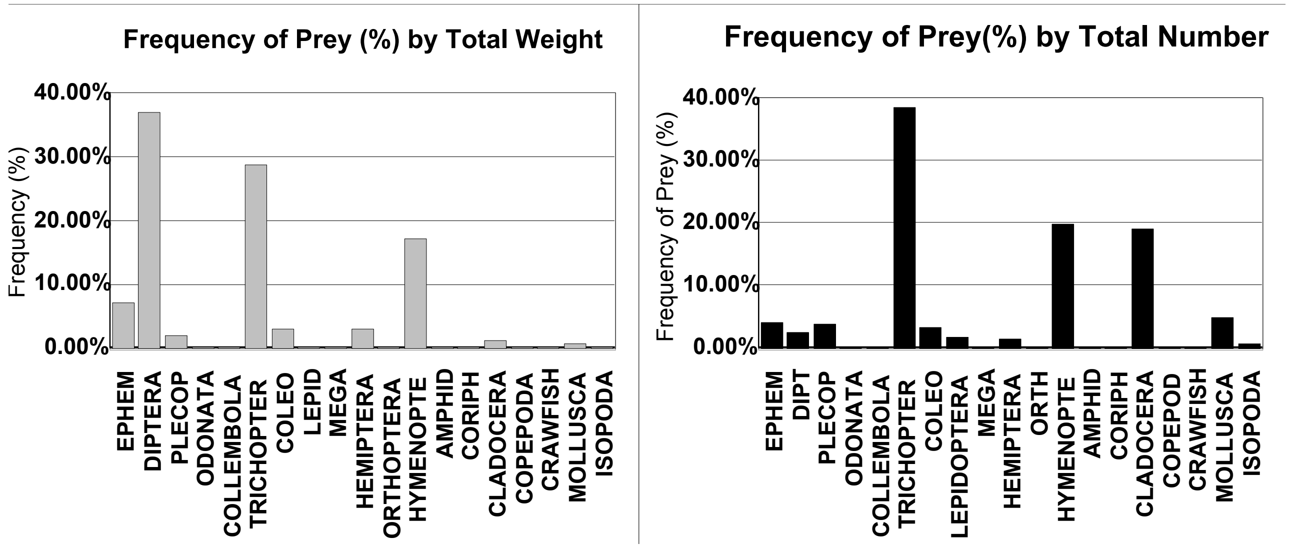

Figure 4. Prey items in stomachs of hatchery steelhead sampled in 2000. Excluding insect parts. Aquatic insects: Ephemeroptera - Ephem, Diptera - Dip, Plecoptera - Plecop, Odonata - Odo, Tricoptera - Tri, Coleoptera - Coleo, Lepidoptera - Lepid, Megaloptera - Mega, Hemiptera - Hemi. Terrestrial insects: Orthoptera - Orth, Hymenoptera - Hymen. Crustaceans: Isopoda- Isopoda, Amphipoda - Amphid, Corophium - Coriph, Cladocera, Molluscs: Mollusca

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 need to 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 or detection rates 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) rearing system did have a significant difference in detection rates, and 5) 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.

Characteristics of residual steelhead.—Very few of the steelhead captured were seen emigrating toward the ocean. Of the 363 steelhead tagged between April 10 and June 13, only 73 were detected emigrating to the ocean. Nine hundred thirty-nine steelhead were tagged between June 14 and August 28 in the Clearwater River; none of these steelhead were detected emigrating. Many steelhead exhibited a 'hatchery-happy' behavior: 312 steelhead were captured because they re-entered Dworshak NFH through the adult ladder, 22 fish were recaptured a second time via the adult fish ladder and another 48 steelhead were recaptured within 3 river kilometers of Dworshak NFH. The sex ratio of residualized steelhead was dominantly male, 70.8% male to

20.2% females. Whether or not these steelhead will rear in the river and choose to emigrate in a later year is yet to be seen. Data from later years will determine if residual steelhead are postponing emigration for a year or more or are simply not going to exhibit anadromy.

Stomach analysis indicated very little piscivory occurred in residual steelhead in 2000. We found less then 1% of sampled fish were preying on other fish species. Prey found were larval fishes and a sculpin.

Some hatchery steelhead temporarily reared in Clearwater River tributaries before emigrating. These steelhead could be impacting wild stocks and out competing wild fishes 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.—Sample size of PIT tagged steelhead in 1999 was small and no PIT tagged fish from 1999 were recaptured in 2000. However, one coded-wire tagged fish from 1999 was captured. In 1999, two coded-wire tagged steelhead were captured from 1998, so we know at least some steelhead survive through the winter. With the new frequencies of PIT tags, early spring interrogations were not possible on steelhead PIT tagged in 1999. Data from steelhead PIT tagged in 2000 will be queried through PTAGIS in the spring to see how many survived and chose to emigrate after the winter. Coded-wire tag data collection in subsequent years will also give more information regarding survival of steelhead who do not emigrate from the Clearwater River and four of its tributaries.

Effects of changes in PTAGIS operations.—During 1999, we were using 400MHZ PIT tags. Because of changes in the PTAGIS system, we were unable to track emigration of these steelhead in the next migration season. Sampling during the next years will allow us to track the emigration of steelhead residualizing in the river for more then one migration season. During the 2000 field season, we did check captured fish for both the 134.2 and 400 MHZ PIT tags and did not have any recaptures of fish tagged in 1999.

References

Bigelow, P.E. 1995a. Migration to Lower Granite Dam of Dworshak National Fish Hatchery steelhead. Pages 42-58 *in* Interactions of hatchery and wild steelhead in the Clearwater River of Idaho. United States Fish and Wildlife Service and Nez Perce Tribe. United States Fish and Wildlife Report. Fisheries Stewardship Project. 1994 Progress Report. Ahsahka, Idaho

Bigelow, P.E. 1995b. Survival to Lower Granite Dam of wild straying and non-straying Dworshak National FishHatchery steelhead. Pages 59-76 in Interactions of hatchery and wild steelhead in the Clearwater River of Idaho. Fisheries Stewardship Project. 1994 Progress Report. U.S. Fish and Wildlife Service and Nez Perce Tribe. U.S. Fish and Wildlife Report, Ahsahka, Idaho.

Bigelow, P.E. and R.S. Bowen. 1997. Emigration of wild A-run and straying Dworshak National Fish Hatchery steelhead. Pages IV-1 to IV-24 in Interactions of hatchery and wild steelhead in the Clearwater River of Idaho. 1995 Progress Report. Fisheries Stewardship Project. U.S. Fish and Wildlife Service and Nez Perce Tribe, Ahsahka, Idaho.

Connor, W.P. 1989. Mainstem Clearwater River study: assessment for salmonid spawning, incubation, and rearing. Annual report to Bonneville Power Administration by Nez Perce Tribe Department of Fisheries. Contract number DE-AI79-BP37474, Project number 88-15. Portland, Oregon.

Everitt, B. S. 1977. Analysis of contingency tables. John Wiley and Sons, Inc. New York. 128 pages.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponders (PIT) tags in salmonids. Pages 317-322 *in* N.C. Parker, A.E. Giorgi, R.C. Heidinger, D.B. Jester, E.D. Prince, and G.A. Winans, editors. Fish-Marking Techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

Wilkinson, L. 1990. SYSTAT: the system for statistics. Evanston, Illinois. SYSTAT, Inc., 1990.