

ADULT STEELHEAD RETURNS TO DWORSHAK NFH IN 2009-2010 AND PROGNOSIS FOR 2010-2011

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Introduction

Dworshak National Fish Hatchery (NFH) is located at the confluence of the North Fork and the main stem of the Clearwater River near Ahsahka, Idaho approximately 811 km from the Pacific Ocean. Construction of the hatchery was included in the authorization for Dworshak Dam and Reservoir (Public Law 87-847, October 23, 1962) to mitigate for losses of steelhead (*Oncorhynchus mykiss*) from the North Fork Clearwater River caused by the dam and reservoir.

The hatchery was designed and constructed by the U.S. Army Corps of Engineers and was administered and operated by the U.S. Fish and Wildlife Service following completion of the first phase of construction in 1969 until 2007. Since 2007, Dworshak NFH has been co-managed by U.S. Fish and Wildlife Service and the Nez Perce Tribe. In addition to steelhead, Dworshak NFH also rears spring Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*), reported separately.

Starting in 1969, the hatchery had 25 Burrows ponds on a single reuse system and 59 other Burrows ponds on single-pass water. In 1972, a second phase of construction placed all these ponds on three reuse systems with the option of operating on either reuse or single-pass. In 1986, the oldest system (25 ponds) was taken off reuse and put on single-pass.

The North Fork Clearwater River (NFCWR) steelhead stock maintained by Dworshak NFH is unique. At maturity, males and females of this particular stock of "B" run steelhead average about 91 cm (36 inches) and 82 cm (33 inches) in length, respectively. Spawning stock is comprised of three age classes; 1-, 2-, and 3-ocean fish. This nomenclature refers to the number of complete years fish have spent rearing in the ocean. Fish are actually two years older than this system indicates, as they are reared for one year in the hatchery and spend another year migrating to and from the ocean.

Most adult "B" run steelhead leave the ocean to return to the Columbia River in August through September. This is usually later than the smaller "A" run steelhead. "A" run steelhead are destined for lower Clearwater tributaries and the Salmon River. Some of the Clearwater "B" run steelhead arrive at Dworshak NFH in the fall (same year they entered freshwater). The remainder of the run may hold in the Snake and Clearwater rivers where they over-winter until their final run into the hatchery in late winter and early spring (of the year after they entered freshwater). The Dworshak NFH trap is operated during the fall to insure inclusion of adequate numbers of early arriving steelhead (~500 adults) into the hatchery brood stock. The trap is again operated, intermittently, from February through April to capture brood stock from the mid and late portions of the run. Steelhead are also trapped at Kooskia NFH located about 1.5 miles east of Kooskia, Idaho, near the confluence of Clear Creek and the Middle Fork Clearwater River. In low return years these steelhead are available for broodstock use at Dworshak NFH, although this has not occurred since 1995 and normally they are recycled to the South Fork Clearwater fishery.

Historical Clearwater River Steelhead.

Based on trap records at the Lewiston Dam, steelhead moved into the Clearwater River during both fall and spring (Whitt 1954). Fall migration started in September, peaked in October, and

stopped when water temperatures declined to about 3°C. The spring movement began when water temperatures reached above 4°C, usually peaking in April (Figure 1) and was correlated with spring flows. The spring component of the Clearwater River steelhead run overwintered downstream from Lewiston while the early-arriving fish overwintered between Spalding and Kooskia (as determined from tag returns from sport fishery). Fall movements were not correlated with flows.

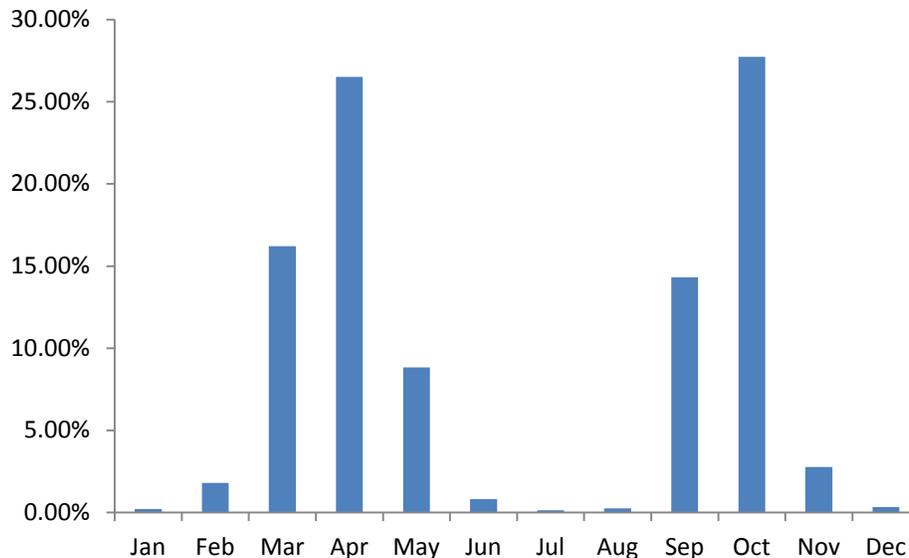


Figure 1. Mean monthly percentage of adult steelhead counted at Lewiston Dam from 1951 to 1971.

Scale analysis from 510 steelhead collected at the Lewiston Dam in 1952 suggested that 27% migrated to the ocean as 1 year olds, 59% when two years old and 14% after rearing in freshwater for three years (Whitt 1954). The percentages of these fish that reared 1, 2, and 3 years in the ocean were estimated to be 61, 38 and 1%, respectively. Mean fork lengths for the 1-, 2-, 3-ocean fish were 65, 86, and 102 cm, respectively. Females made up 64% of the sample, a ratio of 1.8 females per male. Whitt (1954) stated that the female steelhead averaged about one inch (2.54 cm) longer than males. Keating (1958) provided additional length distributions for steelhead sampled at Lewiston Dam, for 1955-56 and 1956-57. Ages of fish were not determined, but the size-frequency curve for 1955-56 resembled that observed in 1951-52, dominated by 1-ocean fish, while the peak abundance during 1956-57 was in the size group for 2-ocean fish.

The first years of broodstock collection for Dworshak NFH, 1968 through 1971 also provide information on the original population of the North Fork Clearwater River B run steelhead. For 1968-69, the first year of broodstock collection, 3,101 adults were collected from the North Fork Clearwater River, October 1968 to May 1969, 2,902 were retained. Female:male ratio was 2.5:1. Females averaged 81.8 cm length, 5.3 kg weight while males averaged 83.6 cm and 6.3 kg. Fecundity averaged 6,112 eggs per female. For the 1970 and 1971 broodyears, 2,856 and 2,312 steelhead were collected at the trap, respectively. Mean lengths and weights were 82.8 cm and 5.3

kg for females, 83.3 cm and 5.4 kg for males. Fecundity averaged 6,428 and 5,360 eggs per female for the two years. Ages of these fish varied among years on the proportional makeup of 2- and 3-ocean components. On average, returning wild steelhead were 57% 2-ocean, 39% 3-ocean for the 1969-1972 broodyears (Table 1; Pettit 1976).

Table 1. Mean ocean and freshwater (FW) age distribution for wild North Fork Clearwater River steelhead used for broodstock from 1969 to 1972 as determined from scale analysis. Source: Pettit (1976).

Year	% 1-Ocean	% 2-Ocean	% 3-Ocean	% 4-Ocean	% 1-FW	% 2-FW	% 3-FW
1969	4.5	70.1	25.3	0.0	10.0	82.8	7.2
1970	0.0	32.4	61.7	5.9	17.7	72.6	9.8
1971	2.2	51.1	46.7	0.0	2.2	66.7	31.1
1972*	0.0	54.6	45.5	0.0	14.6	67.3	18.2
All	2.6	57.0	39.0	1.4	11.7	76.4	11.9

*Excluded known returning hatchery fish.

Summer steelhead smolt releases from Dworshak NFH began in 1970. The first adults from released smolts returned to the hatchery in 1972. The 2009-2010 return marked the 38th year that artificially spawned North Fork Clearwater River steelhead have returned to Dworshak NFH (Table 2).

2009-2010 Adult Returns

A total of 3,615 steelhead were collected at the Dworshak NFH trap during fall of 2009 and spring 2010 (Table 2). The Dworshak NFH ladder was opened on 6, 22, and 29 October to collect early returning steelhead. A total of 788 (22% of total broodstock) steelhead were collected during the approximately 152 hrs of trap operation, a catch rate of 5.2 fish per hour (Figure 2). The fish ladder was re-opened for steelhead collection on 19 February 2010 and operated for short periods (10 min. to 3 hrs) intermittently on 21 separate days until 23 April 2010. A total of 2,827 adult steelhead entered the ladder during almost 25.5 hrs of operation. By month, we collected 155 (4%) steelhead in February, 2,134 (59%) in March, and 538 (15%) in April. Trapping rates ranged from a high of 539/hr on 1-2 April to a low of 29.3/hr during 21-23 April, and averaged a little under 111 fish/hr during the spring. Trapping rate values in 2009-2010 were about an order of magnitude lower than those observed during 2008-2009 but comparable to rates we observed during 2007-2008.

We collected 24 adult steelhead that were not adipose fin clipped. All 24 of these fish were transported and released in the main stem Clearwater River just upstream from the North Fork, in accordance with the NMFS FCRPS Biological Opinion. There were 16 mortalities of the fish trapped, resulting in a total of 3,599 adult steelhead available for the 2010 broodstock.

Table 2. Number of steelhead returning to Dworshak NFH, estimates of hatchery fish harvested, and total hatchery returns to the Clearwater River, Idaho, 1972-2008 (1972-73 to 1983-84 data based on Pettit (1985)).

Return year ¹	Number Back to Dworshak NFH	Estimated Clearwater Sport Harvest ²	Estimated North Fork Tribal Harvest ³	Unharvested Dworshak Hatchery Fish ⁴	Total Returning to Clearwater River
1972-73	9,938	2,068	-	0	12,006
1973-74	7,910	2,320	-	0	10,230
1974-75	1,698	N.S. ⁵	290	0	1,988
1975-76	1,858	N.S. ⁵	430	0	2,288
1976-77	3,100	N.S. ⁵	410	0	3,510
1978-79	4,939	4,610	(500) ⁶	0	10,049
1977-78	12,272	14,000	(1,000) ⁶	0	27,272
1979-80	2,519	N.S. ⁵	1,250	300	4,069
1980-81	1,968	4,510	(1,000) ⁶	500	7,978
1981-82	3,054	1,665	(1,000) ⁶	0	5,719
1982-83	7,672	13,967 ⁷	(1,500) ⁶	0	23,139
1983-84	3,284	6,500	(500) ⁶	100	11,384
1984-85	14,018	19,410	(1,500) ⁶	2,700	37,628
1985-86	4,462	7,240	1,471	1,800	15,002
1986-87	5,286 ⁸	15,679	4,210	3,000	28,175
1987-88	3,764	8,766	1,478	2,000	16,008
1988-89	6,041	11,332	1,242	3,700	22,315
1989-90	10,630	27,953	1,710	3,650	43,944 ⁹
1990-91	7,876	12,974	1,211	2,250	24,311
1991-92	3,700	10,415	1,326	1,650	17,091
1992-93	7,900	19,351	1,184	3,368	31,803
1993-94	3,757	11,538	675	1,457	17,427
1994-95	1,394	5,954	730	1,307	9,385
1995-96	4,480	2,319	992	1,315	9,106
1996-97	2,980	4,926	513	779	9,198
1997-98	3,601	7,611	145	479	11,836
1998-99	5,419	8,774	1,007	1,137	16,337
1999-00	2,882	7,177	1,000	720	11,779
2000-01	6,411	12,230	(1,000) ⁶	513	20,154

Table 2. Continued.

Return year ¹	Number Back to Dworshak NFH	Estimated Clearwater Sport Harvest ²	Estimated North Fork Tribal Harvest ³	Unharvested Dworshak Hatchery Fish ⁴	Total Returning to Clearwater River
2001-02	7,733	22,774 ¹⁰	(1,000) ⁶	774	32,281 ¹⁰
2002-03	5,244 ⁸	25,030	1,118	830	32,222
2003-04	3,767 ⁸	20,806	(1,336) ⁶	855	26,764
2004-05	4,362 ⁸	19,252	1,331	280	25,225
2005-06	3,243 ⁸	14,916	1,470	457	20,086
2006-07	3,514 ⁸	13,301	(1,000) ⁶	840	18,655
2007-08	3,374 ⁸	13,289	(1,470) ⁶	71	18,204
2008-09	4,350 ⁸	27,772	(1,470) ⁶	473	34,065
2009-10	3,615 ⁸	15,841	(1,470) ⁶	381	21,307

Table 1. Footnotes;

¹Return year is from October through May.

²Estimates of sport harvest in the Clearwater River provided by Idaho Department of Fish and Game.

³Estimates of tribal harvest in the Clearwater River provided by Nez Perce Tribe Department of Fishery, except as noted by Footnote 6.

⁴Estimated by using the return percentage to Kooskia NFH, applied to returning II-oceans from offsite releases.

⁵N.S. = no sport fishing season.

⁶() guesstimate on tribal harvest by authors.

⁷Pettit, IDFG, Lewiston, Idaho (personal communication) included an additional 2,000 fish in harvest from Snake River for a total of 15,967.

⁸Ladder was operated intermittently for broodstock management.

⁹We believe the sport estimate of 27,953 is about 8,000 too high and the total number of Dworshak steelhead to the Clearwater River was in the range of 32,000 to 35,000.

¹⁰Sport harvest estimates from this point on was modified to account for only Dworshak's contribution to the steelhead harvest in the Clearwater River.

Age and Sex Composition

Age class of returning adult steelhead were estimated at the time they were sorted using a fork length classification developed previously from known-aged (coded-wire tagged) fish that returned to Dworshak NFH (Table 3). Based on our length model, the 2009-10 brood was 20.9% 1-ocean fish, 78.8% 2-ocean, and 0.3% 3-ocean fish (Table 4). Fish collected were 40.5% male and 50.5% female, a F:M ratio of 1.5:1. By sex, the breakdown was 45.1% 1-ocean, 54.3% 2-ocean, and 0.6% 3-ocean for males, and 4.5% 1-ocean, 95.5% 2-ocean, and 0% 3-ocean returns for females (Table 4). There were 17 adult steelhead in this group that had received PIT tags as smolts. Ocean ages based on PIT records for the 12 fish agreed with those estimated from fork

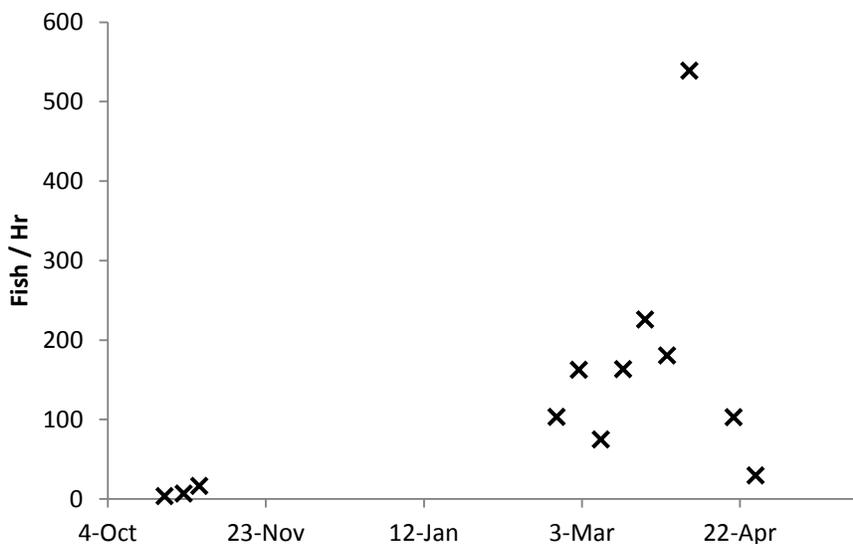


Figure 2. Trapping rate (fish/hr) for adult steelhead collected at Dworshak NFH for broodstock during fall 2009 and spring 2010. Each point represents one to three days trapping effort. Dates represent date fish collected in trap were processed, which varied from times trap was operated.

Table 3. Length-age classifications used for returning Dworshak NFH steelhead.

Ocean age	Fork length (cm)	
	Females	Males
1-Ocean	< 68	<73
2-Ocean	68-90	73-92
3-Ocean	> 91	>92

lengths. There were 193 adult steelhead that returned with a coded-wire-tag (CWT) that could be used to identify their brood year of origin and for which we had a length and sex designation. Overall, ages based on our length criteria (Table 5) were correct for 96.9% of CWT steelhead. For males and females, ages were correctly classified 96.3% and 97.4% of the time, respectively. The largest deviation occurred for 1-ocean females that were incorrectly classified as 2-ocean returnees. The age classification for the sub-sample of returning adults with CWTs was 21.4% 1-ocean, 77.3% 2-ocean, and 1.3% 3-ocean.

The trap at Kooskia NFH was operated from 24 March until 5 April 2011. Steelhead were processed on 5 April 2011. A total of 54 adult steelhead were collected at Kooskia NFH (Table 6). These 54 fish included 48 hatchery fish (28 females, 20 males) and 6 natural (4 females, 2 males) steelhead. Ages were 3 (13.6%) 1-ocean, 18 (81.8%) 2-ocean, and 1 (0.5%) 3-ocean fish for males and 4 (12.5%) 1-ocean and 28 (87.5%) 2-ocean fish for females. All hatchery fish collected at Kooskia NFH were released into the South Fork Clearwater River to spawn and natural fish were released upstream of the weir in Clear Creek (Table 6).

Table 4. Adult steelhead broodstock returns by sex, age, and return time at Dworshak NFH rack, 2009-2010.

Ocean Age Class by Run Time	Males	Females	Total
Fall Collection (10/6 to 10/29)			
I-Ocean	224	19	243
II-Ocean	195	349	544
<u>III-Ocean</u>	1	0	1
Total	420	368	788
Spring Collection (2/19 to 4/23)			
I-Ocean	436	78	514
II-Ocean	599	1,706	2,305
<u>III-Ocean</u>	8	0	8
Total	1,043	1,784	2,827
Combined Total			
I-Ocean	660	97	757
II-Ocean	794	2,055	2,849
<u>III-Ocean</u>	9	0	9
Total Measured Rack Return	1,463	2,152	3,615

Table 5. Comparative known (rows) and estimated (columns) ocean ages for adult steelhead with coded-wire tags (CWT) collected at Dworshak NFH during 2009-2010.

ALL STEELHEAD			
Age based on length			
CWT Age	1-O	2-O	3-O
1-O	40	2	
2-O	1	147	
3-O		2	0
Correct = 96.9%			
MALES			
Age based on length			
CWT Age	1-O	2-O	3-O
1-O	33		
2-O	7	44	1
3-O		1	0
Correct = 96.3%			
FEMALES			
Age based on length			
CWT Age	1-O	2-O	3-O
1-O	7	2	
2-O		103	
3-O		1	0
Correct = 97.4%			

Table 6. Rack returns and ocean age class structure for hatchery steelhead and naturals captured at Kooskia NFH, 1995-2010.

Return year	I-Ocean	II-Ocean	III-Ocean	Total Hatchery	Naturals
1995	20	381	20	421	48
1996	72	307	6	385	24
1997	26	420	4	450	61
1998	18	217	0	235	18
1999	36	685	1	722	53
2000	83	232	5	320	17
2001	12	253	1	266	10
2002	75	367	2	444	8
2003	40	350	4	394	16
2004	14	361	5	380	22
2005	2	100	2	104	4
2006	13	131	1	145	7
2007	21	368	3	392	0
2008	12	50	0	62	0
2009	9	208	4	213	8
2010	7	46	1	48	6

Return to the Clearwater River

It is difficult to estimate the number of adult steelhead returning to the Clearwater River as a result of hatchery-reared steelhead released from Dworshak NFH. In the past, an estimated return to the river has been generated using a combination of sources. In addition to the fish collected at the hatchery trap (rack return), an estimated 20,750 clipped steelhead were harvested in the sport fishery within the Clearwater River (Carl Stiefel, IDFG, unpublished data). This harvest would be from a combination of Dworshak NFH and Clearwater Fish Hatchery (CFH) releases. Over the three release years (2006, 2007, 2008), fish from Dworshak NFH (combination of outplanted and direct-release groups) have made up around 79% (range 77.9 to 81.1%) of the marked hatchery steelhead released to the Clearwater River (Table 7). Applying this proportion directly to the harvest estimate results in an estimated sport harvest of 16,437 Dworshak NFH steelhead. Using a proportional breakdown by year class produced a similar estimated harvest of 16,416 Dworshak NFH steelhead. If harvest is location-specific (i.e. returning adult steelhead sorted themselves according to release site), then we would assume that steelhead harvested in the Clearwater River downstream from the NFCWR would be made up of a mixture of about 79% Dworshak NFH and 21% CFH steelhead, and that all steelhead harvested in the NFCWR, and about 57% of the fish harvested upstream from the NFCWR would be the returning adults from marked fish released from Dworshak NFH. Partitioning sport harvest in this way yields an estimated 15,841 returning steelhead from Dworshak NFH harvested in the CWR during 2009-2010 (Table 8). This last number is the harvest number we selected to use in Table 2 since we believe it most accurately reflects the distribution of returning steelhead in the CWR. An inherent source of error in this estimate is the assumption that all steelhead harvest in the Clearwater River are B-run Clearwater River fish, when it is likely that an unknown portion are hatchery A-run steelhead that have dipped into the Clearwater River and are then caught in the sport fishery.

Table 7. Numbers of marked steelhead juveniles released from Dworshak NFH (DNFH) and IDFG Clearwater Fish Hatchery (CFH) during 2006, 2007, and 2008, and the proportion that were from Dworshak NFH outplant and direct-release groups.

Release year	DNFH	DNFH	CFH	Total released	% DNFH of total	
	outplants	direct release	all released		outplant	direct
2006	689,940	1,206,565	537,632	2,431,137	28.3	49.6
2007	611,751	1,312,486	524,444	2,448,681	25.0	53.6
2008	726,605	1,298,848	471,821	2,497,274	29.1	52.0
Total	2,028,296	3,817,899	1,533,897	7,380,092	27.5	51.7

Table 8. Estimated sport harvest of Dworshak NFH and CFH adult steelhead in the Clearwater River downstream, in, and upstream of the North Fork Clearwater River (NFCWR) and all locations combined. Ocean age proportions were estimated from CWT steelhead in the 2009-2010 rack return.

Ocean age	Ocean age proportion	Harvest by age class	Harvest by release group		
			DNFH outplant	DNFH direct	CFH outplant
Downstream of NFCWR					
3-ocean	0.010	136	38	67	30
2-ocean	0.772	10,066	2,515	5,395	3,156
1-ocean	0.218	<u>2,837</u>	<u>826</u>	<u>1,476</u>	<u>536</u>
Sub-total		13,039	3,379	6,938	2,722
In NFCWR					
3-ocean	0.010	29	0	29	0
2-ocean	0.772	2,175	0	2,175	0
1-ocean	0.218	<u>613</u>	<u>0</u>	<u>613</u>	<u>0</u>
Sub-total		2,818	0	2,818	0
Upstream of NFCWR					
3-ocean	0.010	51	29	0	22
2-ocean	0.772	3,777	2,034	0	1,744
1-ocean	0.218	<u>1,065</u>	<u>649</u>	<u>0</u>	<u>419</u>
Sub-total		4,893	2,708	0	2,185
All locations combined					
Total		<u>20,750</u>	<u>5,377</u>	<u>11,041</u>	4,332
Total for DNFH steelhead			15,841		

The Nez Perce Tribal harvest estimate is not yet available. The highest estimated Tribal harvest from recent years was 1,470 adult steelhead during the 2005-2006 period. This value was used as a place-holder for our calculations.

The number of Dworshak NFH fish that are not harvested and did not return to a hatchery is also difficult to determine. In the past this value was estimated from the number of steelhead collected

at the Kooskia NFH trap as a proportion of juveniles outplanted to Clear Creek, and extrapolating that proportion to all Dworshak NFH outplanted fish. As 48 clipped steelhead were collected in 2010, using this method produced an estimate of 381 unharvested Dworshak NFH steelhead in this system. Combining the estimates of the rack return, sport and tribal fishery harvests and unharvested fish, produces an estimate of 21,307 marked adult steelhead released from Dworshak NFH that returned to the Clearwater during the 2009-10 migration season (Table 2). There is no way to place bounds on these estimates or verify the veracity of any of the component values except the number of fish collected at adult traps.

We made a separate estimate of hatchery steelhead returning to the Clearwater River based on returns of PIT tagged steelhead using the generalized Chapman modification of the Peterson mark recapture estimator;

$$N = \frac{(C + 1)(M + 1)}{(R + 1)} - 1$$

(Chapman 1951) where M is the original fish marked with tags (here the number of PIT tagged Chinook salmon detected as they passed Lower Granite Dam), C is the number of fish sampled at some point later (here the number of Chinook salmon screened at Dworshak NFH in the rack return), and R is the number of those fish recaptured with marks (here the Chinook salmon in the rack return that contained Dworshak NFH PIT tags). N then is the population estimate, here the total number of Dworshak NFH Chinook salmon (tagged and untagged) that passed Lower Granite Dam during a single migration season. This method is more appropriately used for each age class separately but here we are clumping all fish as a rough estimator. During the sorting of the 3,615 steelhead for broodstock we identified five adults that had received PIT tags as juveniles from Dworshak NFH. A total of 35 Dworshak NFH steelhead were detected at Lower Granite Dam during the 2009-10 run. Using the formula above produced an estimate of 21,695 Dworshak NFH steelhead returning to the Snake River for the 2009-10 return year, a value similar to the estimate described above (see Table 2). The estimate itself should not be seen as reliable since it was based on a small number of PIT tagged steelhead returning to Dworshak NFH, but this information supports the previous estimate of about 21,000 steelhead returning to the Snake River.

Survival

The 3-ocean steelhead that returned in 2010 complete the returns from the 1,206,565 smolts directly released from Dworshak NFH in 2006 (broodyear 2005). Total rack returns to Dworshak NFH for each age class in that brood year were 574 (13%) 1-ocean, 3,789 (87%) 2-ocean, and 9 (<1%) 3-ocean fish (Table 9) based on fish length. The ten-year average return rate (1997-2006 release groups) to Dworshak NFH was 0.358%. The mean hatchery rack return rate for the 1980-1999 was 0.480% (Figure 3).

Based on the number of steelhead estimated to have returned to the Clearwater River (Table 2) and the age class breakdown as determined from fish returning with coded wire tags (see Table 5), we estimated a total adult escapement of 31,391 (marked) steelhead returned from smolts released in 2006 (broodyear 2005), an estimated smolt-to-adult return rate of 2.6%.

Table 9. Rack return vs. direct release numbers for summer steelhead at Dworshak NFH, release years 1980-2006. Beginning in 2001 we operated the ladder intermittently to manage for broodstock collection, since the rack return is manipulated the total and percent return is displayed for comparison purposes only.

Release Year	Smolts Released	1-Ocean	Returns			Total	Rack Return %
			2-Ocean	3-Ocean			
1980	2,666,085	400	6,613	652	7,665	0.2875	
1981	1,930,047	124	1,538	1,219	2,881	0.1493	
1982	2,108,319	1,094	12,679	403	14,176	0.6724	
1983	1,259,110	120	3,359	239	3,718	0.2953	
1984	1,208,319	700	8,318	119	9,137	0.7562	
1985	1,035,573	431	3,487	317	4,235	0.4090	
1986	1,239,541	168	5,296	215	5,679	0.4582	
1987	1,206,580	428	9,896	314	10,638	0.8817	
1988	1,432,125	487	7,339	250	8,076	0.5639	
1989	1,073,900	218	3,132	162	3,512	0.3270	
1990	1,466,664	313	7,349	153	7,815	0.6699	
1991	1,192,503	389	3,543	76	4,008	0.3361	
1992	1,224,101	61	1,270	71	1,402	0.115	
1993	1,217,990	48	4,005 ¹	83	4,136 ¹	0.3396	
1994	1,153,417	384	2,537	38	2,959	0.2565	
1995	1,213,577	349	3,308	87	3,744	0.3085	
1996	1,377,435	253	4,976	69	5,298	0.3846	
1997	1,361,034	356	2,225	96	2,677	0.1967	
1998	1,228,944	588	5,745	177	6,510	0.5297	
1999	1,249,237	570	6,226	129 ²	6,925	0.5543	
2000	1,311,447	1,330	4,555 ²	101	5,986	0.4564	
2001	1,247,550	560 ²	2,988	78	3,626	0.2906	
2002	1,365,823	678	3,876	34	4,588	0.3359	
2003	1,210,919	408	2,837	157	3,402	0.2809	
2004	1,202,055	372	3,003	32	3,407	0.2834	
2005	1,122,064	354	2,754	85	3,193	0.285	
2006	1,206,565	574	3,789	9	3,615	0.362	
2007	1,312,486	461	2,849				
2008	1,298,848	757					

¹Does not include twenty unmeasured fish.

² Intermittent ladder operation for broodstock management starting in 2005 and continue to present.

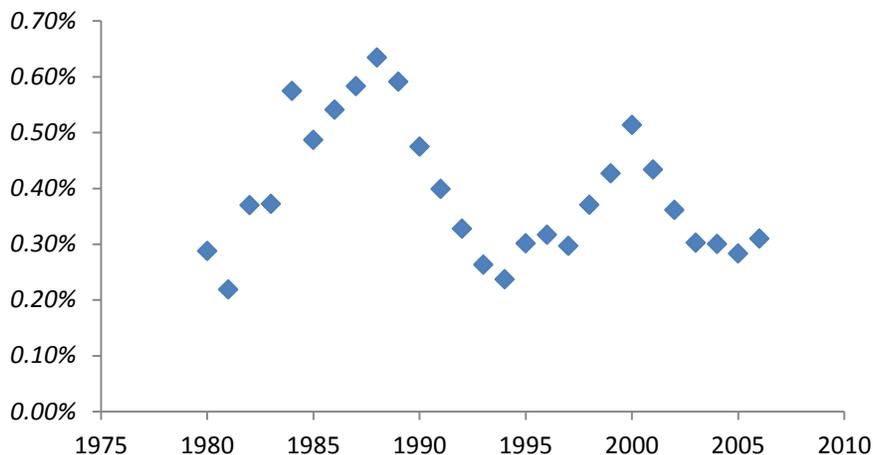


Figure 3. Three-year average of smolt-to-adult returns for steelhead returning to Dworshak NFH by year of release. Returns (y-axis) are cumulative 1-, 2-, and 3-ocean adults.

Adult Outplanting

When we trap more adult steelhead at the hatcheries than are necessary for broodstock, they are transported and released back to the Clearwater River, usually just upstream from the hatchery. Hatchery steelhead trapped at Kooskia Hatchery are transported to the South Fork Clearwater River near the town of Stites, ID. A total of 1,781 (included 99 fish recaptured at Dworshak NFH) adults were outplanted from Dworshak and Kooskia NFHs in March and April of 2010 (Table 10).

PIT Tag Recoveries

Sixty-three fish with PIT tags were collected from the 2010 broodstock during trapping and spawning activities. Of these 63 fish, three were 1-ocean returnees and two were 2-ocean steelhead that were tagged as juveniles at Dworshak NFH and one was a 1-ocean steelhead tagged as a juvenile at CFH. Of the remaining 57 fish, 14 were PIT-tagged as juveniles at Lower Granite (n = 13) or Lower Monumental (n = 1) dams as part of the NOAA Fisheries transport and survival studies (three 1-ocean and 11 2-ocean fish). The remaining 43 PIT-tagged steelhead were tagged as adults at Bonneville and Lower Granite dams.

Returning adult PIT-tagged steelhead from Dworshak NFH and CFH were detected at downstream Columbia and Snake River dams (Table 11). Overall, 52 Dworshak NFH and 43 CFH steelhead were detected at Bonneville Dam, which represents 0.15% of the PIT-tagged fish released during the 2006-2008 migration years from the two facilities. Thirty-five of these Dworshak NFH fish and 32 of the CFH fish were detected at Lower Granite Dam, or 0.1% of release groups from both facilities. The detections by release year are shown in Table 11. The largest group (65%) of these PIT tagged steelhead that reached Bonneville Dam but were not collected at Dworshak NFH were last detected at Lower Granite Dam. Two steelhead were documented straying to non-natal streams based on their PIT records, one each to the Walla Walla and Umatilla rivers.

Table 10. Number, location, and purpose of adult summer steelhead outplanted Dworshak and Kooskia NFHs for supplementation in 2010.

Source	Release Location	Total
Dworshak NFH	Clearwater River	1,733
Kooskia NFH	SF Clearwater R	48
Total		1,781

Table 11. Numbers of Dworshak National Fish Hatchery (DNFH) and Clearwater Fish Hatchery (CFH) PIT-tagged juvenile steelhead released and subsequently detected at Bonneville (BON) and Lower Granite (GRA) dams as returning migrating adults.

Release year	DNFH			CFH			Combined	
	PITs released	Adults at BON	Adults at GRA % at GRA	PITS released	Adults at BON	Adults at GRA % at GRA	% at GRA	% at GRA
2006	1,494	0	0	11,032	0	0	0%	0%
2007	1,491	12	9	2,400	14	12	0.5%	0.5%
2008	20,025	40	26	28,778	29	20	0.07%	0.09%

Coded-Wire Tag Recoveries

A total of 200 (5.5% of rack collection) adult steelhead collected at Dworshak NFH in 2009-10 contained coded-wire tags (CWT). Of these, 154 originated from Dworshak NFH and 46 (23%) originated from other known location(s) (Table 12). Of the fish from other known locations, 41 (20.5% of total) were CFH steelhead released to the SFCR, one was from the Umatilla Hatchery and four were from Lyon's Ferry Hatchery.

There were a total of 264 records of Dworshak NFH CWT recoveries for the adult steelhead returning during 2009-10. The largest group of CWT recoveries were the 154 (58.3%) collected at the Dworshak NFH trap described above. An additional 81 (30.7%) recoveries were made from fish inspected from fisheries in the Clearwater River, three (1.1%) were caught in the Snake River and the remaining 26 (9.8%) recoveries were from fisheries occurring in the Columbia River. Since the effort to recover CWT's varies by location and agency these values likely do not represent the relative harvest pressure on Dworshak NFH steelhead in the Columbia River.

Evaluation of Run Projection for 2010 and Forecast for 2011

2010 Steelhead Prediction.

The 2010 run prediction and actual rack return by age class is listed in Table 13. Our 2010 prediction overestimated the actual Clearwater River return by approximately 14,000 fish and underestimated rack return by 900 fish. Predicted return of 1-ocean steelhead was derived from a

Table 12. Summary of coded-wire tag recoveries for adult summer steelhead in the Dworshak and Kooskia NFH racks, 1987-2008.

Year	Total Recoveries	Recoveries of Dworshak Stock	Recoveries of Marks from Strays
1987 ⁴	397	388 ¹	9
1988	50	44	6
1989	284	279 ¹	5
1990	587	571 ¹	16
1991	738	738	0
1992	325	322 ¹	3
1993	511	508	3
1994	238	234	4
1995	108	108 ¹	0
1996	330	326 ²	4
1997	342	341 ²	1
1998	378	368 ³	10
1999	446	445 ³	1
2000	378	375	3
2001	405	403	2
2002	637	630	7
2003 ⁴	1,012	1,011	1
2004	713	708	5
2005	285	277	8
2006	577	574	3
2007	229	225 ³	4
2008	301	247	32 ³
2009	415	368	47 ³
2010	200	154	46 ³

¹Includes NMFS transportation study marks. ²Includes NMFS transportation study marks and Clearwater Hatchery marks from the South Fork Clearwater River releases. ³Includes Clearwater Hatchery marks from South Fork Clearwater and Clear Creek releases. ⁴Intermittent ladder operation for broodstock management from 2003 to present.

Table 13. Comparison of predicted and actual adult rack returns for summer steelhead at Dworshak NFH, 2009-20010.

Ocean Age Class	Predicted rack	Actual rack	Predicted CWR	Actual CWR
1-Ocean	521	757	4,005	4,560
2-Ocean	3,899	2,849	30,813	16,470
3-Ocean	68	9	547	277
Total	4,511	3,615	35,365	21,307

regression model containing the count of adult steelhead at Ice Harbor Dam from the previous year and two measures of ocean condition; May Pacific Decadal Oscillation (PDO) during the year of ocean entry and the Multivariate ENSO (El Nino Southern Oscillation) Index (MEI; <http://www.esrl.noaa.gov/psd/people/klaus.wolter/MEI/mei.html>). Similar to PDO, MEI is a measure of ocean conditions related to productivity. MEI is a composite of six variables: sea-level pressure, zonal and meridional components of the surface wind, sea surface temperature, surface air temperature, and total cloudiness fraction of the sky. Although MEI and PDO are both related to ocean conditions the values used in the regression were not autocorrelated and so could be included in this model. Predictions for 2-ocean fish were estimated from regression equation containing three independent variables: the number of smolts released and mean May PDO value two years previous and the number of 1-ocean (jacks) that returned the previous year. Predictions for 3-ocean fish were estimated from a regression equation containing four independent variables: the number of smolts released and mean May PDO value three years previous and the number of 2-ocean Chinook salmon and that were counted at Ice Harbor Dam the previous year.

2011 Steelhead Run Prediction.

Regression models were updated with latest available data for predictions of the 2010-11 return group. The regression equation for 1-ocean steelhead to return to the Clearwater River included the number of smolts released, the number of adult steelhead counted at Ice Harbor Dam during the previous year (broodyear source) and the mean PDO value in May of the year smolts outmigrated. The 2-ocean regression equation retained the number of smolts released and mean May PDO value for the year this year class migrated to the ocean, and the number of 1-ocean (jacks) returning to the Clearwater River the previous year. The 3-ocean regression equation was similar, retaining the number of smolts released and mean May PDO value for the year this group migrated to the ocean and the number of 2-ocean adults that returned to the Clearwater River the previous year. The anticipated age composition for these fish is 13% 1-ocean, 85% 2-ocean, and 2% 3-ocean returnees. Figure 4 illustrates relationship between 1-, 2-, and 3-ocean returns and the best univariate predictor for numbers of adult Dworshak NFH steelhead returning to the CWR.

Using similar regression models we predict 5,636 steelhead will return to the Dworshak NFH rack during 2010-11. The proportional breakdown by age and sex is shown in Table 14. However, since we manipulate the ladder openings to only collect what broodstock we need, we have not collected more than 4,600 adult steelhead in the past five years. So the 5,636 prediction is likely an overestimate of the number of fish that will be collected in the coming year.

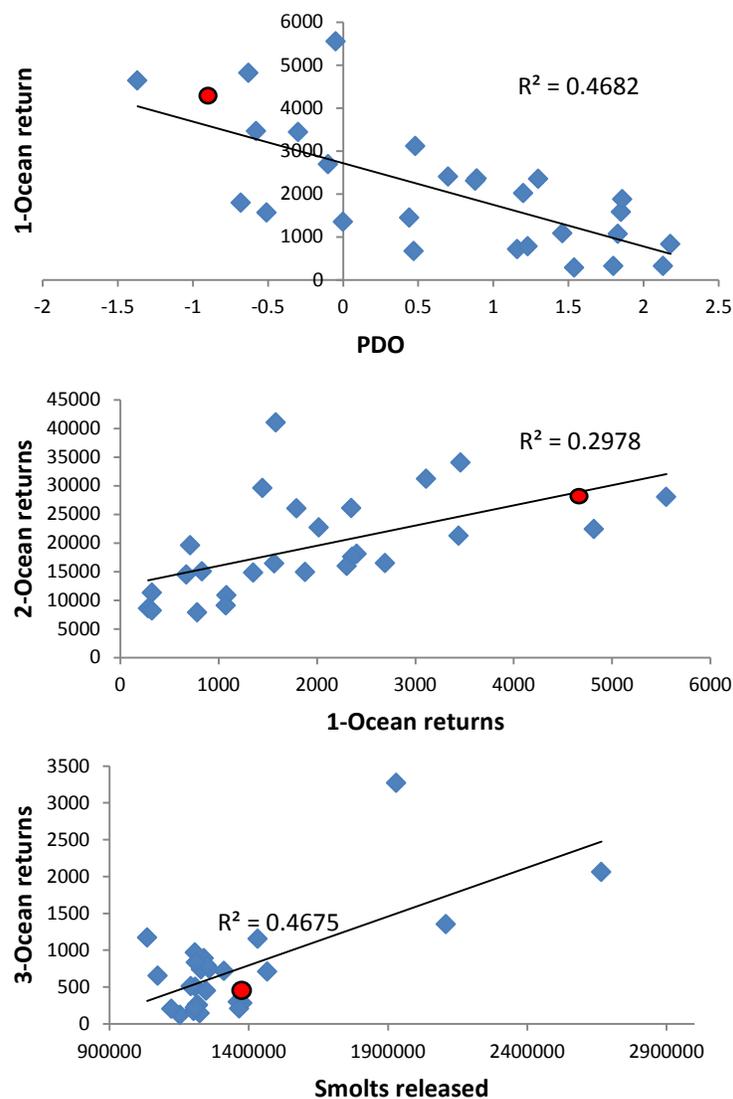


Figure 4. Regressions of 1- (top), 2- (middle), and 3-ocean (bottom) Dworshak NFH steelhead returning to the CWR plotted against the variable of greatest influence in multivariate predictive models. Circle represents predicted return for each ocean age class for 2010-11. R^2 values are for univariate models only.

Juvenile Releases - 2010

During the spring of 2010, a total of 1,240,000 juvenile steelhead from broodyear 2009 were released. The largest group (1,030,000; 83%) received an adipose fin clip and were released directly from the hatchery into the North Fork Clearwater River on 19 April 2010. This number is lower than typical (2007 to 2009 clipped releases ranged 1.5 to 2.0 million) because of significant losses from IHNV that occurred while these steelhead were rearing in the outside Burrows ponds. The remainder of the released fish were not clipped and were split between two outplant sites; Lolo

Table 14. Predicted returns of Dworshak NFH steelhead to Clearwater River and Dworshak NFH rack, 2010-2011.

	Clearwater River		DNFH Rack	
	Prediction	95% Confidence Interval	Prediction	95% Confidence Interval
1-Ocean	4,348	2,087 – 6,609	816	341 – 1,291
2-Ocean	27,875	10,591 – 45,159	4,736	4 – 9,467
3-Ocean	661	0 – 1,784	84	0 – 480
Total	32,884	12,678 – 53,552	5,636	345 – 11,238

Creek and Peasley Creek within the South Fork Clearwater River. Steelhead averaged about 71 g in weight and were an estimated 194 mm in length at release. The Clearwater River at time of release averaged 58 kcfs and 10.8°C (Figure 5). Ocean conditions at the time smolts would be arriving (e.g. mean May PDO) were less than favorable, combined with a lower than average number of smolts released suggests lower than average survival and returns of 1- and 2-ocean adults in the future.

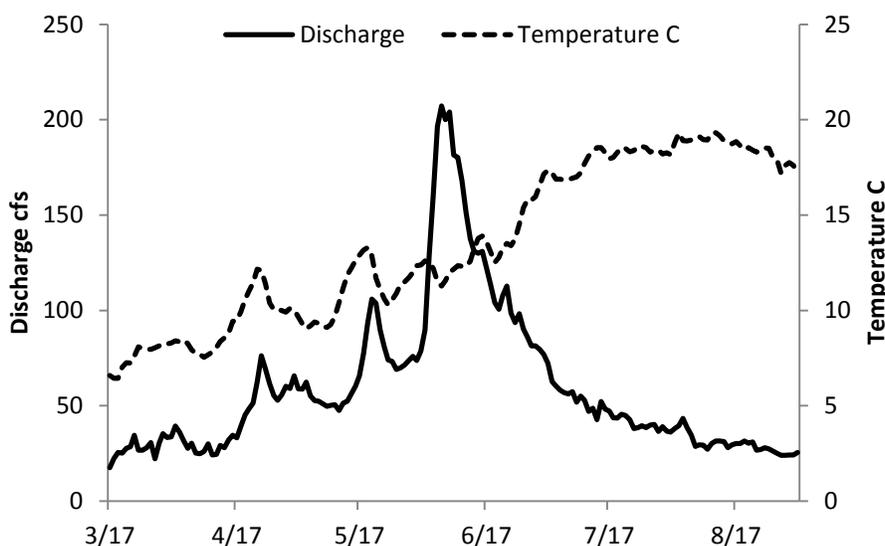


Figure 5. Flow (cfs) and water temperature of the Clearwater River near the town of Spalding, ID 2010. Source: http://www.cbr.washington.edu/dart/headwater_com.html.

An estimated 44,654 of the steelhead juveniles released spring 2010 contained passive integrated transponder (PIT) tags to be used to track travel times and survival, 89.3% of which were with the direct release group. The remaining PIT-tagged steelhead were split between those fish released into Peasley Creek on the South Fork Clearwater River and Lolo Creek. All steelhead were released mid-April 2010. Estimates of survival for PIT-tagged fish were calculated using a Cormack Jolly Seber mark-recapture estimator (SURPH Model; CQS 1994). Survival for steelhead was estimated to be 81.0% (standard error [SE] = 1.2%) to Lower Granite Dam and 36.7%

(SE = 2.3%) to Bonneville Dam. Survival to Lower Granite and Bonneville dams for outplanted steelhead were lower than the direct released fish at 72.6 and 71.7% (SE = 7.5 and 3.5%) and 19.1 and 16.2% (SE = 15.5 and 2.5%) for the Lolo and Peasley Creek releases, respectively. The harmonic mean travel time for direct-released steelhead was 8.0 d (SE = 0.06) to Lower Granite Dam and 20.0 d (SE = 0.1) to Bonneville Dam. Harmonic mean travel times for outplanted steelhead to Lower Granite and Bonneville dams were 22.1 and 22.5 d (SE = 0.5, 0.8) and 31.5 and 32.0 d (SE = 0.7, 1.1), for the Lolo and Peasley Creek releases respectively.

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