

ADULT STEELHEAD RETURNS TO DWORSHAK NFH IN 2010-2011 AND PROGNOSIS FOR 2011-2012

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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.

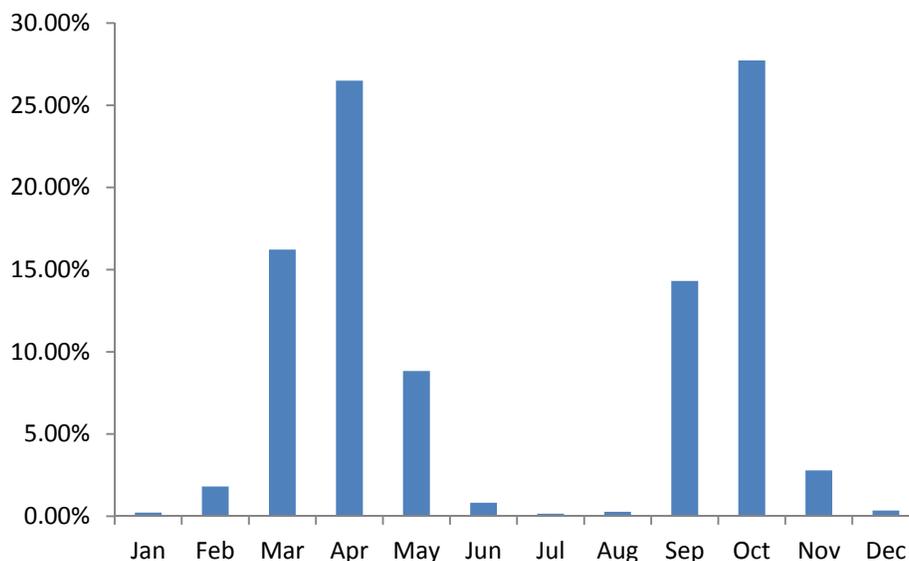


Figure 1. Mean monthly percentage of adult steelhead counted at Lewiston Dam from 1951 to 1971.

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). It is unknown if this distribution was representative of steelhead in the run or if selection for larger fish for broodstock may have skewed this age distribution.

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 2010-2011 return marked the 39th year that artificially spawned North Fork Clearwater River steelhead have returned to Dworshak NFH (Table 2).

2010-2011 Adult Returns

It was anticipated that 1,031 female steelhead would be required for broodstock for broodyear 2011 production. Of those, 563 would be used for Dworshak NFH production and the balance would be used for Clearwater and Magic Valley hatcheries and for the Nez Perce Tribe kelt program. A total of 4,404 steelhead were collected at the Dworshak NFH trap during fall of 2010 and spring 2011 (Table 2). The Dworshak NFH ladder was opened seven times between 5 October until 21 December to collect early returning steelhead. A total of 888 steelhead (20% of total rack collection) were collected during the approximately 24.2 hrs of trap operation, a catch rate of 36.7 fish per hour (Figure 2). Most of fish (842 of 888) were from three sort days, 14 October, 28 October and 22 November, averaging a catch rate of 65.4 fish per hour. The remaining days the trap was operated in the fall was to collect a sample of 30 fish to monitor for the presence of infectious hematopoietic necrosis virus (IHNV). The fish ladder was re-opened for steelhead collection on 6 January 2011 and operated for short periods (5 to 62 min.) intermittently on 17 separate days until 15 April 2011. A total of 3,516 adult steelhead entered the ladder during 7.3 total hrs of operation.

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
2010-11	4,404 ⁸	16,105	3,335	1,804	25,648

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 were modified to account for only Dworshak's contribution to the steelhead harvest in the Clearwater River.

By month, we collected 30 (1%) of the steelhead in January, 473 (11%) in February, 2,300 (53%) in March, and 649 (15%) in April. Trapping rates ranged from a low of 15/hr in January to a high of over 1600/hr in mid-March, and averaged a little under 622 fish/hr during the spring. Trapping rate values in 2010-2011 were about an order of magnitude higher than those observed during 2009-2010 and 2007-2008 but comparable to rates we observed during 2008-2009.

We collected 39 adult steelhead that were not adipose fin clipped. All 39 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 64 mortalities of the fish trapped, resulting in a total of 4,340 adult steelhead available for the 2011 broodstock.

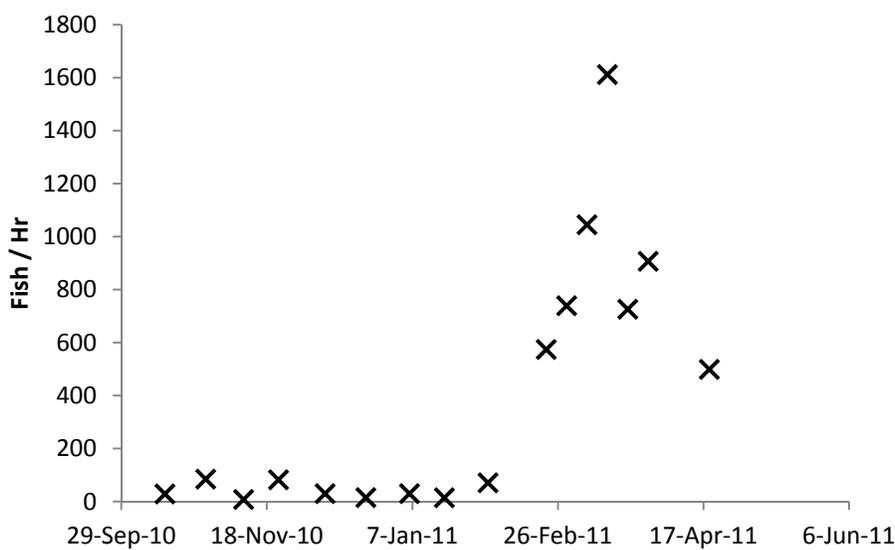


Figure 2. Trapping rate (fish/hr) for adult steelhead collected at Dworshak NFH for broodstock during fall 2010 and spring 2011. Each point represents one to three days trapping effort. Dates represent date fish collected in trap were processed, which varied from times trap was operated.

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 2010-11 brood was 3.4% 1-ocean fish, 95.8% 2-ocean, and 0.8% 3-ocean fish (Table 4). Fish collected were 32.4% male and 67.3% female (0.3% unknown sex at time of trapping), a F:M ratio of 2.1:1. By sex, the breakdown was 9.2% 1-ocean, 88.7% 2-ocean, and 2.1% 3-ocean for males, and 0.5% 1-ocean, 99.3% 2-ocean, and 0.1% 3-ocean returns for females (Table 4). There were 40 adult steelhead in this group that had received PIT tags at either Dworshak NFH (n = 38) or Clearwater Fish Hatchery (n = 2) as juveniles. Ocean ages based on PIT records for the 40 fish agreed with those estimated from fork lengths. There were 240 adult steelhead that returned with a coded-wire-tag

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

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

Table 4. Percent steelhead broodstock returns by age, sex and return time at Dworshak NFH rack, 2010-2011. Ages provided from length classes and MixDist procedure in R. Total number includes those individual whose sex was unknown at time fish were processed.

Description	1-Ocean	2-Ocean	3-Ocean	Total number
Length-based ages				
Total	3.4	95.8	0.8	4,404
Males	9.2	88.7	2.1	1,429
Females	0.5	99.3	0.1	2,963
Fall-all	8.0	91.5	0.5	888
Fall-males	18.2	81.0	0.9	336
Fall-females	1.3	98.5	0.2	540
Spring-all	2.2	96.9	0.9	3,516
Spring-males	6.4	91.1	2.5	1,093
Spring-females	0.4	99.5	0.1	2,423
MixDist-based ages				
Males	9.5	89.7	0.8	
Females	<0.1	99.9	<0.1	
CWT-based ages				
All	1.7	97.9	0.4	240
Males	3.8	95.0	1.3	80
Females	0.6	99.4	0	160

(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 99.2% of CWT steelhead. For males and females, ages were correctly classified 100% and 98.7% of the time, respectively. The two deviations occurred for two 2-ocean females, one that was incorrectly classified as a 1-ocean returnee and one that was misclassified as a 3-ocean returnee. The age classification for the sub-sample of returning adults with CWTs was 1.7% 1-ocean, 97.9% 2-ocean, and 0.4% 3-ocean with all the 1-ocean and 3-ocean fish with cwt's being male. The mixdist procedure in the statistical program R, provided estimate age-class breakdowns similar to that determined using lengths; 1-, 2- and 3-ocean ages were 9.5%, 89.7% and 0.8% for males and <0.1%, 99.9% and <0.1% for females (Table 4).

Steelhead from the trap at Kooskia NFH were processed on 24 March and 7 April 2011. A total of 238 adult steelhead were collected at Kooskia NFH (Table 6). These 238 fish included 231 hatchery fish (165 females, 66 males) and 7 natural (5 females, 2 males) steelhead. Ages were 5

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	3		
2-O	1	234	1
3-O			1
Correct = 99.2%			
MALES			
Age based on length			
CWT Age	1-O	2-O	3-O
1-O	3		
2-O		76	
3-O			1
Correct = 100%			
FEMALES			
Age based on length			
CWT Age	1-O	2-O	3-O
1-O	0		
2-O	1	157	1
3-O			0
Correct = 98.7%			

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
2011	6	229	1	231	7

(7.4%) 1-ocean, 62 (88.2%) 2-ocean, and 1 (4.4%) 3-ocean fish for males and 1 (0.6%) 1-ocean and 169 (99.4%) 2-ocean fish for females. Hatchery fish collected at Kooskia NFH were released into the South Fork Clearwater River and natural fish were released upstream of the weir in Clear Creek (Table 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 20,650 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 (2007, 2008, 2009), fish from Dworshak NFH (combination of outplanted and direct-release groups) have made up around 79% (range 75.1 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 16,202 Dworshak NFH steelhead. Using a proportional breakdown by year class produced a similar estimated harvest of 16,702 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 16,105 returning steelhead from Dworshak NFH harvested in the CWR during 2010-2011 (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.

The Nez Perce Tribal harvest estimate for hatchery steelhead in the Clearwater was 3,335 (Yearout and Johnson, pers. com. NPT DFRM).

Table 7. Numbers of marked steelhead juveniles released from Dworshak NFH (DNFH) and IDFG Clearwater Fish Hatchery (CFH) during 2007, 2008, and 2009, 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
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
2009	499,795	1,030,000	507,900	2,037,695	24.5	50.5
Total	1,838,151	3,641,334	1,504,165	6,983,650	26.3	52.1

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 2010-2011 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	0.008	83	21	44	18
2-ocean	0.958	9,889	2,877	5,144	1,868
1-ocean	0.034	<u>351</u>	<u>86</u>	<u>177</u>	<u>87</u>
Sub-total		10,323	2,984	5,365	1,974
In NFCWR					
3-ocean	0.008	31	0	31	0
2-ocean	0.958	3,703	0	3,703	0
1-ocean	0.034	<u>131</u>	<u>0</u>	<u>131</u>	<u>0</u>
Sub-total		3,865	0	3,865	0
Upstream of NFCWR					
3-ocean	0.008	21	11	0	10
2-ocean	0.958	2,520	1,528	0	992
1-ocean	0.034	<u>89</u>	<u>44</u>	<u>0</u>	<u>45</u>
Sub-total		2,630	1,583	0	1,047
All locations combined					
Total		<u>20,651</u>	<u>6,875</u>	<u>9,230</u>	4,546
Total for DNFH steelhead			16,105		

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 231 clipped steelhead were collected in 2011, using this method produced an estimate of 1,804 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 25,648 marked adult steelhead released from Dworshak NFH that returned to the Clearwater during the 2010-11 migration season (Table 2; Figure 3). 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;

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

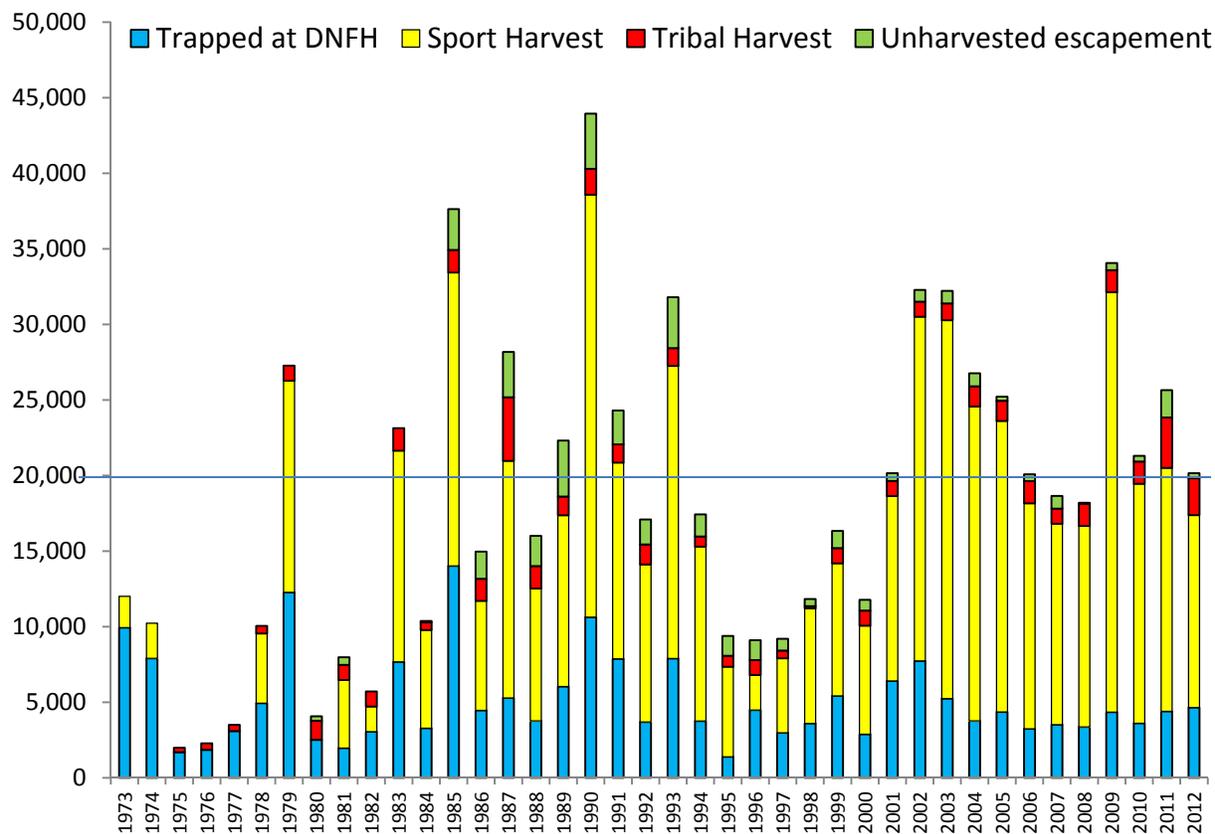


Figure 3. Estimated number of adult steelhead from Dworshak NFH returning to the Clearwater River annually from 1973 to 2011. Bars are divided into estimated components of Rack returns, sport and tribal harvest and unharvested escapement (see Table 2). Horizontal line represents mitigation goal of 20,000 adult steelhead back to the Clearwater River.

(Chapman 1951) where M is the original fish marked with tags (here the number of PIT tagged steelhead detected as they passed Lower Granite Dam), C is the number of fish sampled at some point later (here the number of steelhead screened at Dworshak NFH in the rack return), and R is the number of those fish recaptured with marks (here the steelhead in the rack return that contained Dworshak NFH PIT tags). N then is the population estimate, here the total number of Dworshak NFH steelhead (tagged and untagged) that passed Lower Granite Dam during a single migration season. This method is best when used for each age class separately but here we are clumping all fish as a rough estimator. During the sorting of the 4,404 steelhead for broodstock we identified 38 adults that had received PIT tags as juveniles from Dworshak NFH. A total of 312 Dworshak NFH steelhead were detected at Lower Granite Dam during the 2010-11 run. Using the formula above for each age group and summing produced an estimate of 34,579 (95% bootstrap CI 26,641-49,014) Dworshak NFH steelhead returning to the Snake River for the 2010-11 return year, a value in excess of the estimate described above (see Table 2) by about 9,000 steelhead. Potential sources of error include the small number of recaptured PIT tags and underestimates of harvest and unharvested values in Table 2.

Survival

The 3-ocean steelhead that returned in 2011 complete the returns from the 1,924,237 adipose fin-clipped smolts released from Dworshak NFH in 2007 (broodyear 2006); 1,312,486 released directly from the hatchery into the North Fork Clearwater River and the remaining outplanted to Clear Creek and the south fork Clearwater River. Total rack returns to Dworshak NFH for each age class in that brood year were 461 (14%) 1-ocean, 2,849 (85%) 2-ocean, and 34 (1%) 3-ocean fish (Table 9) based on fish length. The ten-year average return rate (1998-2007 release groups) to Dworshak NFH was 0.363%. 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 19,240 (marked) steelhead returned from smolts released in 2007 (broodyear 2006), an estimated smolt-to-adult return (SAR) rate of 1.0% (Table 10). This value appears about average based on the range of SAR values for Dworshak NFH steelhead (Figure 4). Using values in Table 10, we charted the estimates proportion of 1-, 2-, and 3-ocean aged adult steelhead returning to the Clearwater River for broodyears 1981 to 2006 (Figure 5). Visual inspection of this plot suggests that the proportion of 1-ocean adults returning is trending up over time at the expense of the proportion of fish returning as 2- and 3-ocean fish.

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 1,841 (included 55 fish recaptured at Dworshak NFH) adults were outplanted from Dworshak and Kooskia NFHs in March and April of 2010 (Table 11).

PIT Tag Recoveries

One-hundred and eight fish with PIT tags were collected from the 2011 broodstock during trapping and spawning activities at Dworshak NFH. Of these 108 fish, two were 1-ocean returnees and 36 were 2-ocean steelhead that were tagged as juveniles at Dworshak NFH and two were 2-ocean steelhead tagged as a juvenile at CFH. Of the remaining 68 fish, 34 were PIT-tagged as juveniles at Lower Granite (n = 30) or Lower Monumental (n = 4) dams as part of the NOAA Fisheries transport and survival studies (all 2-ocean fish). The remaining 34 PIT-tagged steelhead were tagged as adults at Bonneville Dam and at [Dworshak NFH](#).

Returning adult PIT-tagged steelhead from Dworshak NFH were detected at downstream Columbia and Snake River dams (Table 12). Overall, 433 Dworshak NFH steelhead were detected at Bonneville Dam, 21 1-ocean and 412 2-ocean, which represents 0.72% of the PIT-tagged fish released during the 2007-2009 migration years. Of the 433 Dworshak NFH fish, 312 (72%) were detected at Lower Granite Dam, or 0.52% of release groups. The detections by release year are shown in Table 12. The largest group (63%) 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 River and Lapwai Creek.

Table 9. Rack return vs. direct release numbers for summer steelhead at Dworshak NFH, release years 1980-2007. 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	4,372	0.362	
2007	1,312,486	461	2,849	34	3,344	0.255	
2008	1,298,848	757	4220				
2009	1,030,000	150					

¹Does not include twenty unmeasured fish.

² Intermittent ladder operation for broodstock management starting in 2001 and continue to present.

Table 10. Clipped steelhead smolts released from Dworshak NFH and estimated return numbers and smolt-to-adult (SAR) return rate for brood years 1979 to 2008.

Brood year	Release year	AD	Returns to Clearwater River			SAR	
		Smolts Released	Total	1-Ocean	2-Ocean		3-Ocean
1979	1980	2,696,601				2,062	
1980	1981	2,632,861			4,863	3,272	
1981	1982	2,678,497	38,466	3,459	33,654	1,352	0.01436
1982	1983	2,144,947	14,599	322	13,527	749	0.00681
1983	1984	1,961,372	28,503	2,349	25,650	505	0.01453
1984	1985	1,601,695	15,703	1,351	13,181	1,171	0.00980
1985	1986	2,965,084	22,414	713	20,810	891	0.00756
1986	1987	2,111,523	43,429	1,581	40,878	970	0.02057
1987	1988	2,699,618	25,268	2,019	22,092	1,156	0.00936
1988	1989	1,391,999	16,567	673	15,242	652	0.01190
1989	1990	2,663,550	32,064	1,448	29,907	710	0.01204
1990	1991	2,655,998	17,483	1,566	15,405	512	0.00658
1991	1992	2,309,052	8,929	283	8,501	145	0.00387
1992	1993	2,388,993	9,398	323	8,818	257	0.00393
1993	1994	1,823,877	8,795	784	7,886	125	0.00482
1994	1995	2,387,182	11,801	1,081	10,458	262	0.00494
1995	1996	2,480,639	16,458	832	15,344	282	0.00664
1996	1997	2,488,174	1,1165	1,073	9,790	302	0.00449
1997	1998	2,156,732	20,928	2,403	17,786	739	0.00970
1998	1999	2,106,390	3,1607	1,792	29,023	793	0.01501
1999	2000	2,048,724	30,789	5,552	24,519	718	0.01503
2000	2001	2,080,265	25,947	3,441	22,055	451	0.01247
2001	2002	2,108,703	26,338	4,817	21,310	211	0.01249
2002	2003	1,922,865	19,943	2,359	16,750	833	0.01037
2003	2004	1,600,000	18,920	2,304	16,443	173	0.01183
2004	2005	1,721,458	17,785	1,879	15,701	204	0.01033
2005	2006	1,987,410	32,854	3,110	31,169	222	0.01653
2006	2007	1,924,237	19,240	2,691	16,449	103	0.01000
2007	2008	2,025,453		4,636	25,145		
2008	2009	1,568,162		437			

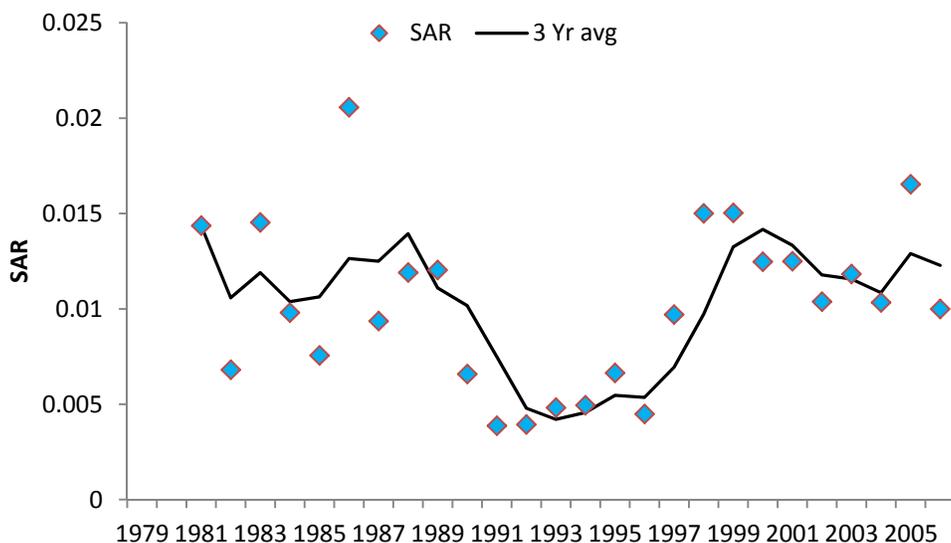


Figure 4. Three-year average for smolt-to-adult returns for Dworshak NFH steelhead returning to Clearwater River by year of release. Returns (y-axis) are cumulative 1-, 2-, and 3-ocean adults.

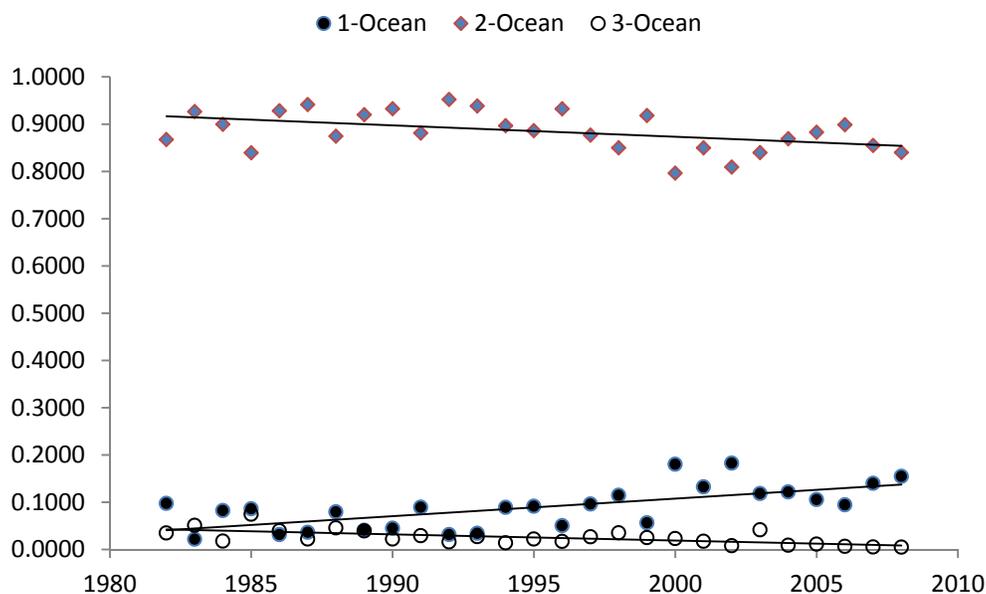


Figure 5. Proportion of adult steelhead returning to the Clearwater River that had spent 1, 2, and 3 years in the ocean.

Table 11. Number and location of adult summer steelhead outplanted from Dworshak and Kooskia NFHs for supplementation in 2010 and 2011.

Source	Release Location	Total
Dworshak NFH	Clearwater River	1,620
Kooskia NFH	SF Clearwater R	221
Total		1,841

Table 12. Numbers of Dworshak National Fish Hatchery (DNFH) PIT-tagged juvenile steelhead released and subsequently detected at Bonneville (BON) and Lower Granite (GRA) dams as returning migrating adults.

Release year	DNFH		Adults		Conversion to GRA
	PITs released	at BON	at GRA	% at GRA	
2007	1,491	0	0	0%	-
2008	28,775	412	293	1.0%	58%
2009	29,780	21	19	<0.1%	90%
Total	60,046	433	312	0.5%	72%

Coded-Wire Tag Recoveries

A total of 262 (5.9% of rack collection) adult steelhead collected at Dworshak NFH in 2010-11 contained coded-wire tags (CWT). Of these, 229 originated from Dworshak NFH and 33 (13%) originated from other known location(s) (Table 13). Of the fish from other known locations, 31 (12% of total) were CFH steelhead released to the SFCR, one was from Hagerman NFH and one was from Lyon's Ferry Hatchery.

There were a total of 366 records of Dworshak NFH CWT recoveries for the adult steelhead returning during 2010-11. The largest group of CWT recoveries were the 229 (63%) collected at the Dworshak NFH trap described above and three were recovered at Kooskia NFH. An additional 62 (17%) recoveries were made from fish inspected from fisheries in the Clearwater River, eight (2%) were caught in the Snake River, 61 (17%) recoveries were from fisheries occurring in the Columbia River, one fish was recovered from Drano Lake and two from the John Day 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 2011 and Forecast for 2012

2011 Steelhead Prediction.

The 2011 run prediction and actual rack return by age class is listed in Table 14. Our 2011 prediction overestimated the actual Clearwater River return by approximately 14,000 fish and underestimated the rack return by 900 fish. Predicted return of 1-ocean steelhead was derived

Table 13. 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 2001 to present.

Table 14. Comparison of predicted and actual adult rack returns for summer steelhead at Dworshak NFH, 2010-2011.

Ocean Age Class	Predicted rack	Actual rack	Predicted CWR	Actual CWR
1-Ocean	816	150	4,343	437
2-Ocean	6,261	4,220	23,230	25,145
3-Ocean	348	34	1,644	103
Total	7,425	4,404	29,217	25,995

from a 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 three independent variables: the number of smolts released, the mean May PDO value three years previous and the number of 2-ocean steelhead that were counted at Ice Harbor Dam the previous year.

2012 Steelhead Run Prediction.

Regression models were updated with latest available data for predictions of the 2011-12 return group. The regression equation for 1-ocean steelhead to return to the Clearwater River included only the mean PDO value in May of the year smolts outmigrated as a predictor variable. The 2-ocean regression equation retained the 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. Using these regression models, we estimate that 18,696 adult Dworshak NFH steelhead will return to the Clearwater River during the 2011-12 run year (Table 15). The anticipated age composition for these fish is 10% 1-ocean, 87% 2-ocean, and 3% 3-ocean returnees.

Juvenile Releases - 2011

During the spring of 2011, a total of 2,265,405 juvenile steelhead from broodyear 2010 were released. The largest group (1,264,509; 56%) received an adipose fin clip and were released directly from the hatchery into the North Fork Clearwater River during 28-31 March 2011. This

Table 15. Predicted returns of Dworshak NFH steelhead to Clearwater River and Dworshak NFH rack, 2011-2012.

	Clearwater River	
	Prediction	95% Confidence Interval
1-Ocean	1,964	0 - 4,414
2-Ocean	16,218	0 - 33,522
3-Ocean	514	0 - 1,684
Total	18,696	0 - 39,620

number is lower than typical (2007 to 2009 clipped releases ranged 1.5 to 2.0 million) because of some loss from IHNV that occurred while these steelhead were rearing in the outside Burrows ponds. But use of water from Dworshak Reservoir when fish were initially moved into the outside Burrows ponds, rather than water pumped from the North Fork Clearwater River as in the past, seemed to reduce the prevalence of IHNV in the steelhead as compared to last year. A power outage caused from a wind storm in November resulted in a loss of flow to the two experimental mixed-cell ponds and total loss of steelhead in those two ponds. The remainder of the released fish were split between four outplant sites; Lolo Creek and Clear and Peasley creeks and the Red House landing in the South Fork of the Clearwater River. Steelhead averaged about 71 g (ranged from a mean of 45.4 in take 10 to 75.6 g in take 1) in weight and were an estimated 188 mm (mean = 167 take 10 to 199 take 1) in length at release. The Clearwater River at time of release averaged 37 kcfs and 6.2°C (Figure 6). Ocean conditions at the time smolts would be arriving (e.g. mean May PDO) were about the middle of the range of possible values, suggesting average survival and returns of 1- and 2-ocean adults in the future.

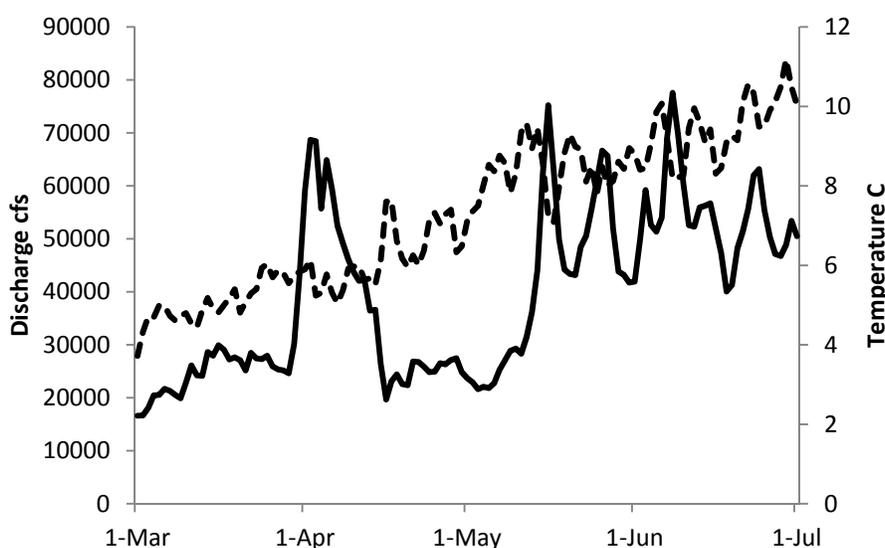


Figure 6. Flow (cfs) and water temperature of the Clearwater River near the town of Spalding, ID 2011. Source: http://www.cbr.washington.edu/dart/headwater_com.html.

An estimated 28,955 of the steelhead juveniles released spring 2011 contained passive integrated transponder (PIT) tags to be used to track travel times and survival, 58.0% of which were with the direct release group. The remaining PIT-tagged steelhead were split between those fish released into Lolo, Clear, and Peasley creeks and at Red House landing on the South Fork Clearwater River. 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 79.7% (standard error [SE] = 0.5%) to Lower Granite Dam and 41.9% (SE = 14.0%) to Bonneville Dam. Survival to Lower Granite and Bonneville dams for outplanted steelhead were lower than the direct released fish ranging from 68.9 to 74.3% (SE = 0.6 to 3.7%) to Lower Granite Dam and 34.3% to Bonneville Dam (SE = 22.9) collectively. The harmonic mean travel time for direct-released steelhead was 6.5 d (SE = 0.07) to Lower Granite Dam and 28.5 d (SE = 0.7) to Bonneville Dam. Harmonic mean travel times for three of the four groups of outplanted steelhead to Lower Granite Dam ranged 12.1 to 7.2 d (SE = 0.2 to 0.3) and 34.2 to 34.8 d (SE = 1.1 to 1.7) to Bonneville Dam. The fourth group, Peasley Creek, had mean travel times of 39 d to lower Granite Dam and 50.2 d to Bonneville Dam.

Research: Persistence of early Dworshak NFH steelhead in the Clearwater River

Background and Methods

B-run steelhead returning to the lower Clearwater River are primarily the progeny of Dworshak NFH. These fish begin arriving to the area during late summer and spawning primarily occurs the following spring, February through April. The early-arriving component of the steelhead run is prized because it provides fishing opportunities during fall and early winter prior to the arrival of the bulk of the returning steelhead in the spring. To promote this component of the steelhead run, a portion of early arriving steelhead have been routinely incorporated into broodstock at Dworshak NFH which requires that these fish be held on site for several months prior to spawning. It is unknown how long early fish persist in the system and if early-arriving steelhead are present in fish collected for broodstock later in the run (i.e., do early steelhead contribute to later steelhead takes at Dworshak NFH).

During the fall of 2010, a sample of 141 adult steelhead collected at Dworshak NFH during normal broodstock collection were outfitted with passive integrated transponder (PIT) tags and released back to the river. The sample fish were collected over two periods and tagged on 28 October (n = 38) and 10 November (n = 103). All fish were released to the Clearwater River just upstream from the North Fork Clearwater River the same day they were tagged. PIT-tagged steelhead could be detected in the Dworshak NFH ladder if they reentered the trap and at sites in the juvenile and adult salmon facilities at downstream dams on the Snake and Columbia rivers.

Results

A total of 21 of the original 141 (12.1%) steelhead were detected following release to the Clearwater River (Figure 7). Of those 21, 17 were only detected at the Dworshak NFH trap during broodstock collection. Recapture events ranged from 10 to 152 d post release, and averaged 58.2 d.

The latest recapture event occurred on 11 April 2011. These recapture time intervals are somewhat artificial since the trap was not run continuously during the period following release of the PIT tagged steelhead. It should be noted that the trap was operated more frequently than is typical during the winter of 2010-11 so that the Fish Health Center could monitor for IHNV in returning adults. Of the four remaining steelhead with detections, three were detected at Lower Granite Dam, two in the adult fishway and one in the juvenile fish facility (27 March 2011). The remaining detection occurred at the corner collector at Bonneville Dam on 18 April 2011.

Conclusions

In this limited evaluation, approximately 12% of the early fish with tags we released were available for recapture later in the run and approximately half of those were recaptured after 1 January. Of the remaining 88% of the fish not recaptured, potential fates were that these fish died without spawning, spawned naturally, or were harvested in a sport or tribal fishery. A preliminary conclusion from this data summary is that some of early-returning steelhead persist in the Clearwater River and are potentially included in broodstock used for later spawning takes and Dworshak NFH but the majority of these fish experience other fates that would preclude their capture in North Fork trap. Additional research is needed to estimate the proportion of early fish that can potentially contribute to later egg takes at Dworshak NFH.

Two of the PIT-tagged steelhead were detected in the adult fishway at Lower Granite Dam indicating they had fallen back and were reascending the dam. The two remaining fish were detected moving downstream at Lower Granite and Bonneville dams, indicative of kelting behavior.

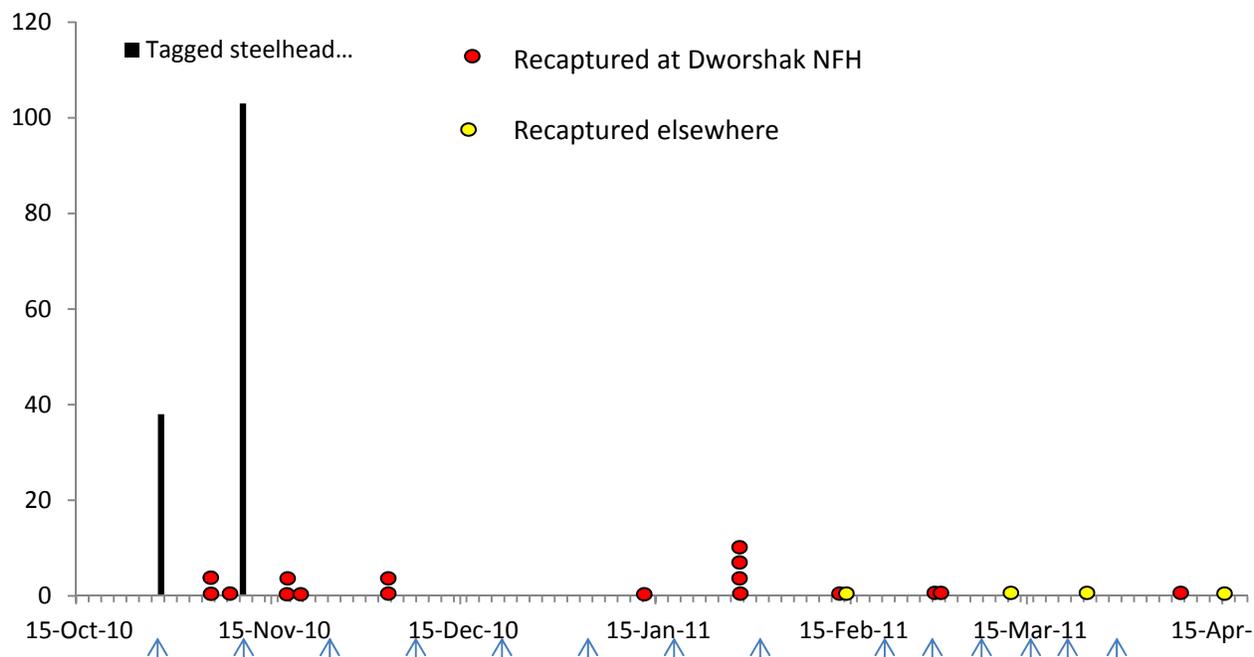


Figure 7. Dates that adult steelhead with PIT tags were released from Dworshak NFH (solid bars) and later detected in the Dworshak NFH trap (red dots) or other locations (yellow dots). Arrows below X-axis indicate dates fish were processed at the Dworshak NFH trap. .

References Cited

CQS (Center for Quantitative Science). 1994. Statistical survival analysis of fish and wildlife tagging studies SURPH. Developed by the Center for Quantitative Sciences, School of Fisheries, University of Washington, Seattle WA, for the Bonneville Power Administration, Portland, OR.

Keating, J.F. 1958. Clearwater River fisheries investigations, IV. Steelhead trout tagging study. Idaho Department of Fish and Game, Boise, Project F 15R.

Pettit, S.W. 1976. Dworshak fisheries studies, Job 2. Evaluation of game and rough fish populations below Dworshak Dam and relationship to changes in water quality. Idaho Department of Fish and Game, Boise, Performance report.

Whitt, C.R. 1954. The age, growth, and migration of steelhead trout in the Clearwater River, Idaho. Master's thesis. University of Idaho, Moscow.