FISHERY RESEARCH

LOWER SNAKE RIVER COMPENSATION PLAN
Hatchery Program

IDAHO POWER
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2011 CALENDAR YEAR HATCHERY STEELHEAD REPORT:

IPC and LSRCP Monitoring and Evaluation Programs for the State of Idaho

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INTRODUCTION

This report summarizes the various components of hatchery steelhead monitoring and evaluation (M&E) activities associated with the Idaho Power Company (IPC) and Lower Snake River Compensation Plan (LSRCP) mitigation programs, which occurred in Idaho during the 2011 calendar year. Information is provided for steelhead from four rearing hatcheries and six broodstock collection sources operated by Idaho Fish and Game (IDFG) and the US Fish and Wildlife Service (USFWS).

Because this report summarizes information for a calendar year, data from multiple brood years are included. Brood year specific reports are produced annually by monitoring and evaluation staff and are available as IDFG reports at the following address: https://researchidfg.idaho.gov/Fisheries%20Research%20Reports/Forms/Show%20All%20Reports.aspx. Because of the five-year life cycle of steelhead and to allow for downriver harvest to be reported, the most recent brood year report available is current year minus seven.

Steelhead Broodstock Collection Facilities

The IPC and LSRCP mitigation programs utilize steelhead eggs collected from four hatchery weirs and two satellite facilities (Table 1, Figure 1, and Figure 2). It is important to note that with the exception of Clearwater Fish Hatchery, which initiated an angler broodstock collection program in 2010, none of the other steelhead rearing hatcheries discussed in this report (see below) collect broodstock, but receive eggs and/or fry from off-site sources. Eggs collected from each broodstock source are managed as a unique stock within the hatchery programs, regardless of where smolts are released. In most cases, these egg collection operations are managed as segregated programs; one exception is the integrated supplementation program in the East Fork Salmon River (EFNAT).

Table 1. Broodstock collection facilities that provide steelhead eggs to the LSRCP and IPC mitigation hatcheries in Idaho.

Broodstock Collection Facilities	Stock Abbreviation	Mitigation Program
Dworshak National Fish Hatchery[1]	DWOR	USACOE
Oxbow Fish Hatchery	OXA	IPC
Pahsimeroi Fish Hatchery	PAH	IPC
Sawtooth Fish Hatchery	SAW	LSRCP
East Fork Satellite Facility[2]	EFNAT	LSRCP
Squaw Creek Temporary Weir[2]	USAL	LSRCP
South Fork Clearwater River[3]	SFCLW	LSRCP

[1] Dworshak National Fish Hatchery operates a steelhead mitigation program funded by the U.S. Army Corps of Engineers (USACOE) that is not included in this report.
[2] Satellite facilities operated by the Sawtooth Fish Hatchery.
[3] Broodstock is collected by hook and line.

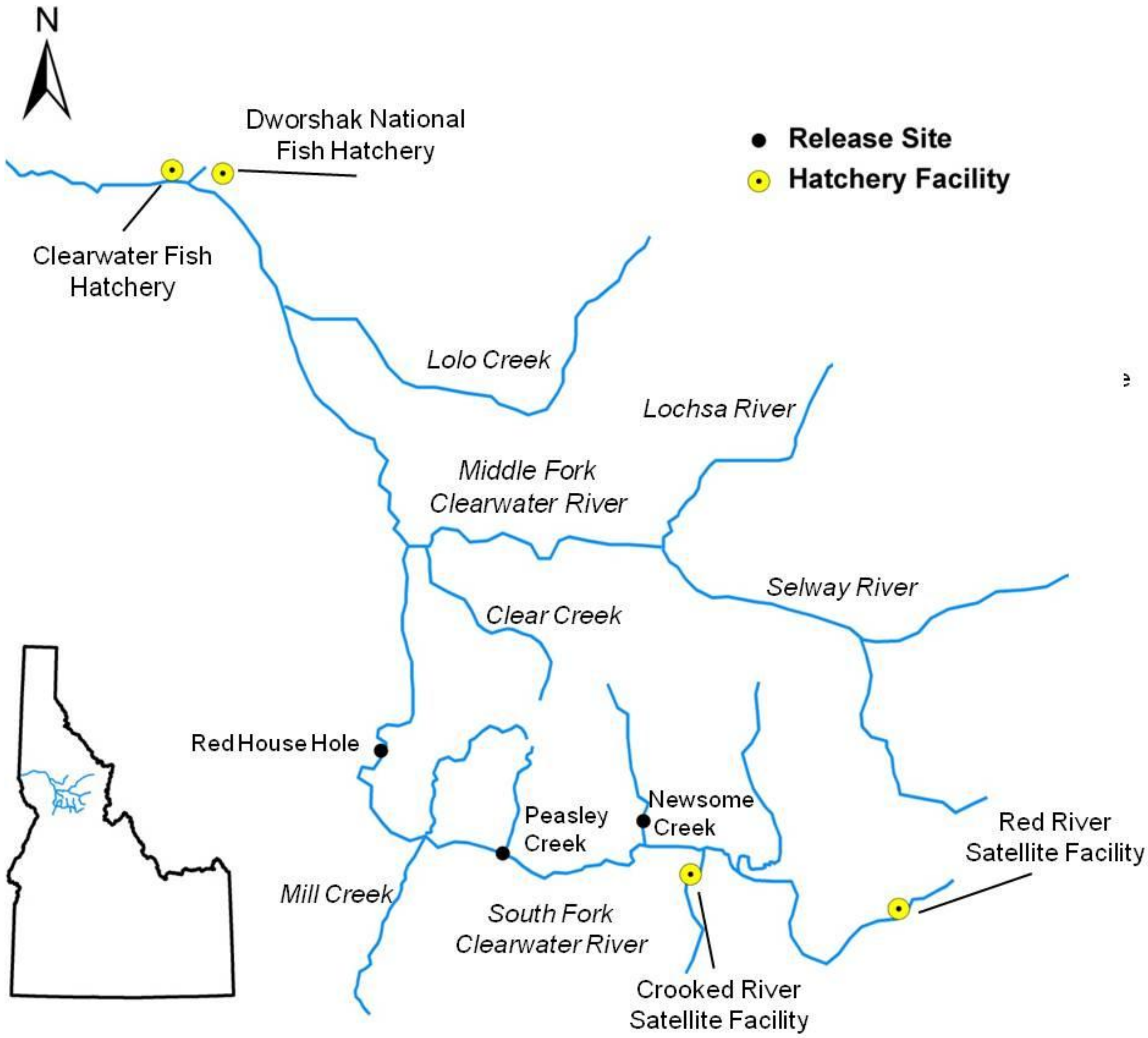

Figure 1. The location of steelhead release sites and hatchery facilities in the Clearwater River basin associated with the LSRCP mitigation program.

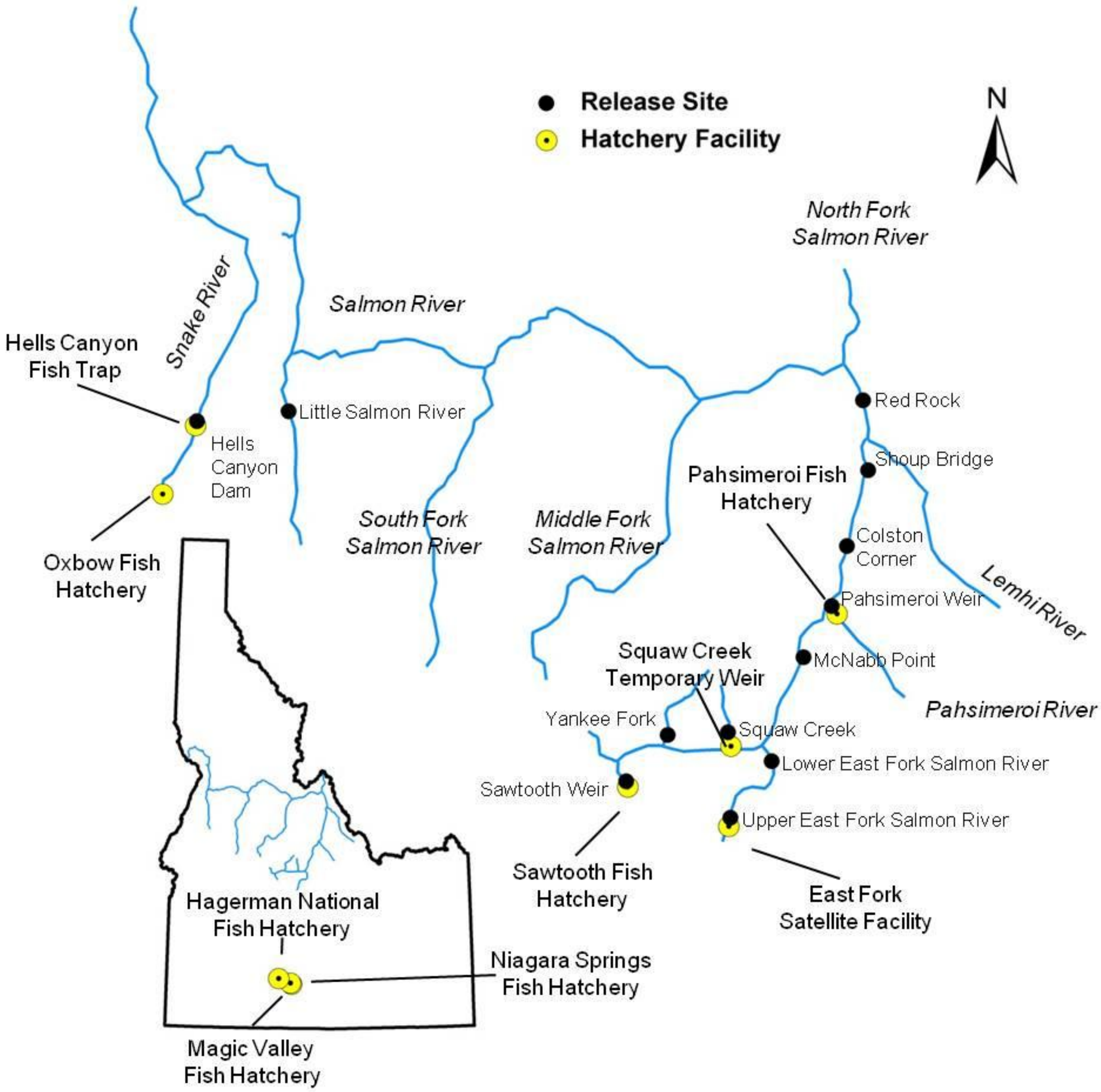

Figure 2. The location of steelhead release sites and hatchery facilities in the Salmon and Snake river basins associated with the LSRCP and IPC mitigation programs.

IPC Rearing Facilities

Niagara Springs Fish Hatchery (Niagara Springs) is located on the Snake River near Wendell, Idaho. Unlike other facilities, which receive only eyed eggs, Niagara Springs receives eyed eggs and fry from two stocks (OXA and PAH). Steelhead produced at Niagara Springs are released in the Snake and Salmon rivers (Table 2, Figure 2). The smolt production goal for Niagara Springs is 400,000 pounds of smolts annually, which equates to approximately 1,800,000 yearling smolts at 4.5 fish per pound.

LSRCP Rearing Facilities

Clearwater Fish Hatchery (Clearwater) is located at the confluence of the North Fork Clearwater River near Ahsahka, Idaho and is the only LSRCP steelhead rearing facility located in current day anadromous waters within Idaho. Clearwater receives green eggs from one stock (DWOR) and rears them to yearling smolts for release into the South Fork Clearwater River (Table 2, Figure 1). In 2010, an angler broodstock collection program was initiated in the South Fork Clearwater River near Peasley Creek to develop a locally adapted broodstock (SFCLW) for the area (see the Localized Broodstock Development section of this report). The annual mitigation goal for this facility is to return 14,000 adult steelhead to the project area above Lower Granite Dam. Clearwater annually releases 843,000 smolts to achieve this goal. Clearwater's annual production goal was originally 1,750,000 smolts; however, production was reduced to 843,000 smolts to provide more rearing space for the Chinook salmon program at that facility. Despite these changes, the adult return goal remains the same. In addition to its primary mitigation function, Clearwater also receives green DWOR eggs that are incubated to the eyed egg stage before being transferred to Magic Valley Fish Hatchery for final rearing and release into the Salmon River. Transferring DWOR eggs to Magic Valley will be phased out in the future as USAL, a B-run stock locally adapted to the Upper Salmon River, production increases.

Hagerman National Fish Hatchery (Hagerman National) is located along the Snake River in southern Idaho near the town of Hagerman, Idaho. Hagerman National receives eyed eggs from two stocks (SAW and EFNAT), which are reared to yearling smolts and released in the upper Salmon River (Table 2, Figure 2). In brood year 2009, Hagerman began rearing EFNAT smolts, which were subsequently released in 2010. Prior to this, EFNAT smolts were reared at Magic Valley. The annual mitigation goal for this facility is to return 13,600 adult steelhead to the project area above Lower Granite Dam. Hagerman National's annual production goal was originally 1,700,000 smolts; however, production has been reduced to 1,460,000 smolts in recent years due to limited water availability. Hagerman National's production capacity was again reduced in brood year 2010 to 1,360,000 smolts due to continued reductions in flow from the springs that provide water for the hatchery. This resulted in the elimination of the Tunnel Rock release group (60,000) as well as a reduction in the Sawtooth release group (40,000); both were SAW releases.

Magic Valley Fish Hatchery (Magic Valley) is located along the Snake River near Filer, Idaho. Magic Valley receives eyed eggs from four stocks (DWOR, PAH, SAW, and USAL), which are reared to yearling smolts. In brood year 2009, Magic Valley assumed responsibility for rearing all LSRCP funded DWOR and PAH production released into the Salmon River in 2010. Prior to this, a portion of these stocks was reared at Hagerman National. This change was prompted by recommendations from the USFWS Hatchery Review Team (HRT) and the Bonneville Power Administration-sponsored Hatchery Scientific Review Group (HSRG). The annual mitigation goal for this facility is to return 11,600 adult steelhead to the project area above Lower Granite Dam. Magic Valley's annual production goal was originally 1,749,000 smolts; however, production has been reduced to 1,600,000 smolts in recent years due to limited water availability. Production was further reduced to 1,540,000 smolts in brood year 2010 due to continued water declines. This resulted in the Little Salmon DWOR release being reduced by 60,000 smolts.

JUVENILE PRODUCTION AND RELEASES

Marking

All marks and tags that were applied to steelhead released in 2011 are outlined in Table 2. All marks and tags were applied by the Pacific States Marine Fisheries Commission (PSMFC) marking crew. For more information and a complete overview of the fish marking program, see the "2011 Idaho Anadromous Fish Marking Program" report. This report will be available through IDFG in January 2012.

During calendar year 2011, various mark and loading plans were cooperatively developed to outline tagging and marking procedures in upcoming years. In May of 2011, a mark plan was developed that outlined preliminary mark and tag numbers for Brood Year 2012 steelhead. In November of 2011, both a Passive Integrated Transponder (PIT) Tag loading plan for Brood Year 2011 and a mark/Coded Wire Tag (CWT) loading plan for Brood Year 2012 were developed cooperatively between M&E and hatchery staffs with input from marking personnel. Loading plans are designed to indicate where specific groups of marks and tags should be applied at each individual hatchery taking into account family units, rearing containers, and any specific treatments of fish. Plans are developed in an effort to maximize tag representation while at the same time maintaining a manageable tagging and rearing scheme.

Under current operations, steelhead typically can receive an adipose fin clip (Ad clip) mark and two types of tags (CWT and/or PIT). In addition, all hatchery-origin Chinook salmon are parental based tagged (PBT) through genetic analysis of tissue samples collected from every fish that contributes to broodstock. The purpose and uses of those marks and tags are outlined below.

Adipose Fin Clips

The presence or absence of an Ad clip is used as the sole designator of hatchery- or natural-origin in Idaho sport fisheries and is also one of the primary indicators of origin at hatchery traps. Some non-Ad clipped hatchery smolts are released to meet other management objectives. However, these fish can be identified as hatchery origin by secondary characteristics (fin erosion).

Coded Wire Tags

CWTs are an important tool for monitoring and evaluating steelhead post release and are used to generate stock- and brood year-specific harvest and stray estimates outside of Idaho. These tags are also used to generate stock and age composition of mixed stock fisheries within the state of Idaho and provide a known age component at hatchery traps to use in assigning an age composition to the entire hatchery return at each trap.

Parental Based Tags

All broodstock spawned at Idaho hatcheries in 2011 had a fin clip taken for a genetic sample. These genetic samples are used to identify juvenile fish produced from each parental cross. At any point in the offspring's life cycle, a tissue sample can be taken and through the genetic baseline, the fish can be assigned back to its hatchery, stock, cohort, and in many instances, its release site. PBT is beneficial because fish are 100% marked and sampling is non-lethal. PBT can be used to generate stock and age compositions of fisheries, on spawning grounds, and at hatchery traps.

Passive Integrated Transponder Tags

PIT tags serve multiple purposes and like CWTs are an important tool for monitoring and evaluating steelhead. PIT tags allow us to generate estimates of juvenile survival to Lower Granite Dam and juvenile run timing through the Snake and Columbia river hydropower system. In adult returns, PIT tags provide stock- and age-specific estimates of return numbers to various dams, adult return timing through the hydropower system, adult conversions between dams, and rates of fallback/reascension and after-hours passage at the dams. All of these parameters are outlined in this report.

PIT-tagged steelhead go through the sort-by-code process where groups are assigned as 70% run-at-large (treated similarly to the untagged population) and 30% return-to-river (treated independently of the untagged population and automatically returned to the river, if detected). The 70% run-at-large component is used to generate adult return estimates because it represents the untagged population. The 30% return-to-river component is mainly used as a part of the ongoing Comparative Survival Study (CSS) (Comparative Survival Study Oversight Committee and Fish Passage Center 2007); however, they are also incorporated into juvenile survival estimates.

Release Information

From March through May 2011, brood year 2010 yearling steelhead smolts were released at locations in the Clearwater, Salmon, and Snake rivers (Figure 1 and Figure 2). A total of 5,541,193 (1,781,650 IPC, 3,759,543 LSRCP) yearling smolts were released (Table 2). Release information was submitted to the Regional Mark Information System (RMIS) in August 2011.

Table 2. Summary of brood year 2010 hatchery steelhead released in 2011.

Hatchery	Release Site	Stock	Total Release	AD only	AD/ CWT	CWT Only	Not Marked	PIT Tag[1]
Clearwater	Newsome Creek	DWOR	134,904	-	-	-	134,904	3,591
	Peasley Creek	DWOR	230,183	181,431	48,752	-	-	5,195
			70,618	-	-	-	70,618	2,098
		SFCLW	74,501	74,501	-	-	-	11,277
			138,672	-	-	137,054	1,618	3,987
	Red House Hole	DWOR	229,509	158,238	71,271	-	-	7,674
		Clearwater Total	**878,387**	**414,170**	**120,023**	**137,054**	**207,140**	**33,822**
Hagerman National	Upper East Fork Salmon River	EFNAT	158,577	-	-	152,279	6,298	6,981
	Sawtooth Weir	SAW	728,632	652,480	76,152	-	-	13,409
	Yankee Fork	SAW	213,919	130,013	83,906	-	-	4,070
	Yankee Fork	SAW	220,419	-	-	-	220,419	4,142
		Hagerman Total	**1,321,547**	**782,493**	**160,058**	**152,279**	**226,717**	**28,602**
Magic Valley	Colston Corner	PAH	125,106	63,680	61,426	-	-	2,095
	Lower East Fork Salmon River	DWOR	282,118	220,521	61,597	-	-	4,983
	Little Salmon	DWOR	218,167	95,308	122,859	-	-	3,981
		PAH	187,107	156,466	30,641	-	-	3,678
	McNabb Point	SAW	124,942	33,351	91,591	-	-	2,093
	Pahsimeroi Weir	DWOR	30,303	-	-	29,242	1,061	1,795
		USAL	91,525	-	-	89,139	2,386	5,371
	Red Rock	PAH	125,803	32,737	93,066	-	-	2,081
	Shoup Bridge	PAH	93,785	62,712	31,073	-	-	1,599
	Squaw Creek	DWOR	280,753	220,150	60,603	-	-	5,076
		Magic Valley Total	**1,559,609**	**884,925**	**552,856**	**118,381**	**3,447**	**32,752**
Niagara Springs	Hells Canyon Dam	OXA	538,580	452,150	86,430	-	-	8,234
	Little Salmon	OXA	92,317	92,317	-	-	-	-
		PAH	330,900	271,628	59,272	-	-	6,922
	Pahsimeroi Weir	PAH	819,853	730,923	88,930	-	-	12,840
		Niagara Springs Total	**1,781,650**	**1,547,018**	**234,632**	**-**	**-**	**27,996**
		Grand Total	**5,541,193**	**3,628,606**	**1,067,569**	**407,714**	**437,304**	**123,172**

[1] PIT tag release numbers are not in addition to other mark tag combinations but are included in those groups.

Outmigration Survival and Environmental Conditions

Juvenile survival rates of PIT-tagged steelhead are estimated using the PitPro program (Westhagen and Skalski 2009) developed in the School of Aquatic and Fishery Sciences at the University of Washington. This program generates a point estimate and a standard error that is used to generate 95% confidence intervals. The program uses the Cormack-Jolly-Seber model (Cormack 1964; Jolly 1965; Seber 1965) for single release and multiple recapture events, which accounts for differences in collection efficiency at the mainstem Snake and Columbia river dams.

Juvenile survival to Lower Granite Dam in 2011 averaged 77.5% (Range 60.4-89.3%), which was similar to previous years. Table 4 shows a comparison of 2011 to the previous eight years' survival estimates for each release group. Appendix A provides juvenile release timing information and environmental conditions in the upstream migration corridor. Appendix B summarizes arrival timing at Lower Granite Dam as well as spill and outflow that coincided with the migration period.

Table 3. Estimated survival from release to Lower Granite Dam for brood year 2010 steelhead released from IPC and LSRCP hatchery facilities in 2011. All release groups were AD-clipped unless otherwise noted.

Hatchery	Release Group	Stock	PIT-tagged Fish Released	Release Date	Size at Release (ffp)	50% Passage Date	80% Arrival Window (# Days)	% Survival (95% CI)
Clearwater	Newsome Creek	DWOR	3,591	4/11-4/18	5.1	5/15	4/28 - 6/2	74.7 (± 4.1)
	Peasley Creek	DWOR	5,195	4/15	5	5/9	4/21 - 5/20	81.1 (± 2.5)
		DWOR[1]	2,098	4/15	4.9	4/28	4/20 - 5/16	83.2 (± 3.9)
		SFCLW	11,277	4/15	5.4	5/10	4/21 - 5/22	80.3 (± 1.7)
		SFCLW[1]	3,987	4/15-4/15	5.4	5/10	4/21 - 5/23	80.5 (± 2.6)
	Red House Hole	DWOR	7,674	4/12-4/13	5	4/21	4/17 - 5/11	81.8 (± 1.6)
Hagerman	Upper East Fork Salmon River	EFNAT[1]	6,981	5/3-5/5	4.1	5/19	5/13 - 6/5	79.9 (± 4.1)
National	Sawtooth Weir	SAW	13,409	4/13-4/29	3.9	5/9	4/29 - 5/16	82.8 (± 2.5)
	Yankee Fork	SAW	4,070	5/6-5/16	3.6	5/26	5/19 - 6/12	77.9 (± 4.5)
	Yankee Fork	SAW[1]	4,142	5/6-5/16	3.6	5/29	5/17 - 6/15	72.3 (± 4.3)
Magic Valley	Colston Corner	PAH	2,095	4/6-4/8	5.3	5/12	4/25 - 5/8	71.6 (± 4.3)
	Little Salmon River	DWOR	3,981	4/12-4/14	5.3	5/13	4/29 - 5/27	85.0 (± 3.1)
		PAH	3,678	4/8-4/12	5.1	5/10	4/21 - 5/22	85.7 (± 2.7)
	Lower East Fork Salmon River	DWOR	4,983	4/14-4/18	5.2	5/14	5/9 - 5/23	72.1 (± 3.9)
	McNabb Point	SAW	2,093	4/22-4/25	5	5/10	5/3 - 5/15	87.1 (± 5.8)
	Pahsimeroi Weir	DWOR[1]	1,795	4/26	5.4	5/12	5/9 - 5/21	83.9 (± 5.9)
		USAL[1]	5,371	4/26-4/27	4.8	5/12	5/8 - 5/21	89.3 (± 3.8)
	Red Rock	PAH	2,081	4/4-4/5	5.3	5/11	4/26 - 5/16	75.9 (± 4.4)
	Shoup Bridge	PAH	1,599	4/5-4/6	5	5/11	4/24 - 5/14	76.4 (± 5.3)
	Squaw Creek	DWOR	5,076	4/19-4/22	5	5/14	5/9 - 5/26	60.4 (± 3.2)
Niagara	Hells Canyon Dam	OXA	8,234	3/28-4/4	8.3	5/2	4/6 - 5/21	72.8 (± 2.0)
Springs	Little Salmon River	PAH	6,922	4/5-4/11	6.8	5/11	4/20 - 5/28	79.4 (± 2.4)
	Pahsimeroi Weir	PAH	12,840	4/12-4/28	5.1	5/12	5/5 - 5/19	75.2 (± 2.3)

[1] Smolts released with intact adipose fin.

Table 4. Annual (weighted) and eight-year estimated survival (percent) from release to Lower Granite Dam for steelhead smolts released from IPC and LSRCP hatcheries, by stock. Prior to migration year 2008, PIT tag sample sizes were small resulting in spurious survival estimates in some years.

		2003	2004	2005	2006	2007	2008	2009	2010	2011	2003-2010 Average
Clearwater	DWOR	75.3	83.2	83.4	80.4	80.5	69.5	83.1	83.3	80.3	79.8
	SFCLW									80.4	
Clearwater Average		**75.3**	**83.2**	**83.4**	**80.4**	**80.5**	**69.5**	**83.1**	**83.3**	**80.3**	**79.8**
Hagerman	EFNAT[1]						78.2	71.8	70.9	79.9	73.6
National	SAW		67.2	75.7	76.5	60.1	85.5	80.8	74.6	79.9	74.4
Hagerman Average				**67.2**	**75.7**	**76.5**	**60.1**	**85.5**	**80.8**	**74.3**	**74.3**
Magic	DWOR	65.1	74.1	69.4	71.9	83.8	76.4	78.9	76.5	72.0	74.5
Valley	PAH	85.2	84.1	75.8	85.8	78.0	79.6	81.7	86.6	78.4	82.1
	SAW	60.3	71.5	76.9	69.7	102.0	85.0	76.9	90.6	87.1	79.1
	USAL[2]					69.9	78.7	73.5	84.3	89.3	76.6
Magic Valley Average		**65.9**	**68.4**	**78.1**	**73.3**	**75.9**	**84.2**	**81.6**	**79.7**	**81.2**	**77.8**
Niagara	OX	66.1	80.2	71.2	49.0	80.2	87.9	88.9	91.8	72.8	76.9
Springs	PAH	76.2	83.0	77.4	76.3	129.5	83.8	89.7	95.2	76.4	88.9
Niagara Average		**73.5**	**82.3**	**74.6**	**65.1**	**109.2**	**85.7**	**89.3**	**93.6**	**75.3**	**84.2**
Grand Average[3]		**72.4**	**78.3**	**76.6**	**72.3**	**87.9**	**81.0**	**83.8**	**83.7**	**77.5**	**79.5**

[1] Prior to migration year 2010, EFNAT smolts were reared at Magic Valley Fish Hatchery.
[2] Prior to migration year 2010, the USAL smolts were released at Squaw Pond or Squaw Creek.
[3] The annual survival estimate is a weighted average.

ADULT RETURNS

Adult hatchery steelhead from brood years 2008, 2007, and 2006 returned to Idaho during the 2010/2011 run as one-, two-, and three-ocean adults, respectively. This section accounts for adult hatchery steelhead returning to Bonneville Dam, Lower Granite Dam, and back to hatchery traps in Idaho.

Returns to Bonneville and Lower Granite Dams

The 2010/2011 run was the first steelhead run that contained a sufficient number of one- and two-ocean PIT-tagged steelhead to allow for relatively accurate adult return estimate for the hatcheries covered in this report. Adult return estimates for Niagara Springs could only be made for one-ocean fish because PIT tagging rates were not increased until brood year 2008 for this facility. Unlike the 2009/2010 run, the Sawtooth Weir release from Hagerman National was not corrected post-season using tagged to untagged ratios obtained from in-ladder PIT tag arrays at the release site due to small sample size (see “Estimating a Correction Factor for PIT Tag Expansions in Steelhead Returning to Sawtooth Fish Hatchery Trap” in Research section; Stiefel and Rosenberger 2011). Adult return estimates were generated for steelhead at Bonneville Dam from 21 June through 19 November 2010 and Lower Granite Dam from 25 June 2010 through 12 May 2011. These date ranges may extend beyond dates identified for other management purposes, such as dates used by the US v. OR Technical Advisory Committee. Tables 5 and 6 summarize the expanded adult return estimates for each rearing hatchery by stock at Bonneville and Lower Granite dams; these estimates were corrected for detection efficiency, which was high for all dams (≥99%). These adult returns estimates are likely underestimates, as they are not corrected for tag loss or differential mortality. Hagerman and Magic Valley exceeded their goals of returning adult steelhead to the project area above Lower Granite Dam, 13,600 and 11,600 respectively. Clearwater was substantially below its adult return goal of 14,000; however, this was heavily influenced by management decisions, which reduced smolts releases to 48% of its intended production (see “LSRCP Rearing Facilities“ section of this report).

Table 5. Summary of expanded PIT tag estimates for one- and two-ocean (Brood Year 2008 and 2007) steelhead returning to Bonneville Dam by hatchery and stock.

Hatchery	Stock	1-Ocean	2-Ocean	Total
Clearwater	DWOR	485	11,473	11,958
	Clearwater Total	**485**	**11,473**	**11,958**
Hagerman	DWOR	88	1,014	1,102
	PAH	2,895	1,327	4,222
	SAW	14,070	6,163	20,232
	Hagerman Total	**17,052**	**8,504**	**25,556**
Magic Valley	DWOR	302	2,927	3,229
	EFNAT	313	1,043	1,357
	PAH	5,876	1,704	7,580
	SAW	4,618	3,202	7,820
	USAL	61	826	887
	Magic Valley Total	**11,170**	**9,702**	**20,872**
Niagara Springs	OX	16,238	-	16,238
	PAH	27,261	-	27,261
	Niagara Total	**43,499**	**-**	**43,499**
	Grand Total	**72,207**	**29,678**	**101,885**

Table 6. Summary of expanded PIT tag estimates for one- and two-ocean (Brood Year 2008 and 2007) hatchery steelhead returning to Lower Granite Dam. Estimates are corrected for detection efficiency.

		One-Ocean	Two-Ocean	Total
Clearwater	DWOR	373	7,384	7,756
	Clearwater Total	**373**	**7,384**	**7,756**
Hagerman	DWOR	87	688	775
	PAH	2,431	1,058	3,489
	SAW	10,977	4,724	15,701
	Hagerman Total	**13,495**	**6,469**	**19,964**
Magic Valley	DWOR	224	2,192	2,416
	EFNAT	309	826	1,135
	PAH	4,695	1,445	6,141
	SAW	3,529	2,292	5,821
	USAL	25	482	507
	Magic Valley Total	**8,782**	**7,237**	**16,019**
Niagara Springs	OX	10,625		10,625
	PAH	19,187		19,187
	Niagara Total	**29,812**	**-**	**29,812**
	Grand Total	**52,462**	**21,090**	**73,551**

Conversion Rates Between Dams

Using PIT tag expansion estimates, conversion percentages were calculated for each stock from Bonneville to McNary and Lower Granite dams. For the purposes of this report, interdam conversion represents all loss between dams (harvest, strays, and mortality). Table 7 summarizes the conversion rates of one-ocean and two-ocean steelhead from Bonneville Dam to McNary Dam and Lower Granite Dam. EFNAT, PAH, and SAW steelhead (A-run type stocks) had similar conversion patterns between dams, whereas the conversion rates of DWOR and USAL steelhead (B-run type stocks) appears to be more variable, particularly between Bonneville Dam and McNary Dam. It is important to note, sample sizes of one-ocean fish from B-run type stocks are small due to the relatively low number of one-ocean adults (<20% of a brood); therefore, there is likely more error associated with conversion rate estimates for one-ocean fish from B-run type stocks. Conversely, the sample sizes of two-ocean fish from A-run type stocks are small due to the relatively low number of two-ocean adults (<20% of a brood) which increases the error associated with these estimate as well.

Table 7. Conversion percentages of one-ocean (Brood Year 2008) and two-ocean (Brood Year 2007) PIT-tagged hatchery steelhead through the Columbia and Snake river hydropower system during the 2010/2011 run. Estimates are corrected for detection efficiency. DWOR adults are grouped into the basin in which they were released.

	Bonneville to McNary		Bonneville to Lower Granite	
	One-ocean	Two-ocean	One-ocean	Two-ocean
DWOR (Clearwater)	88.3	71.1	84.5	70.8
DWOR (Salmon)	80.3	88.7	79.7	73.1
EFNAT	99.4	79.7	98.7	79.2
OX	78.8		65.4	
PAH	79.1	82.8[1]	73.0	82.6
SAW	85.0	80.6	77.6	74.9
USAL	79.1	68.9	40.9	58.3

[1] Magic Valley Releases

Run Timing

Run timing curves were generated at Bonneville Dam, Lower Granite Dam, and hatchery traps by graphing the cumulative percentage of return by return date. For returns to Bonneville and Lower Granite dams, PIT tag detections were used to generate stock specific timing curves for adult hatchery-origin fish. The run timing difference between A-run and B-run type stocks is clearly visible at Bonneville Dam in Figure 3; B-run stocks (DWOR and USAL) arrive approximately one month later than A-run stocks (EFNAT, OX, PAH, and SAW). This difference in run timing becomes less pronounced at Lower Granite Dam; however, B-run stocks do arrive slightly later than A-run stocks (Figure 4). One interesting pattern that was observed during the 2009/2010 run and again during the 2010/2011 run is that DWOR adults returning from Salmon River releases arrive later than DWOR adults returning from Clearwater releases (Stiefel and Rosenberger 2011).

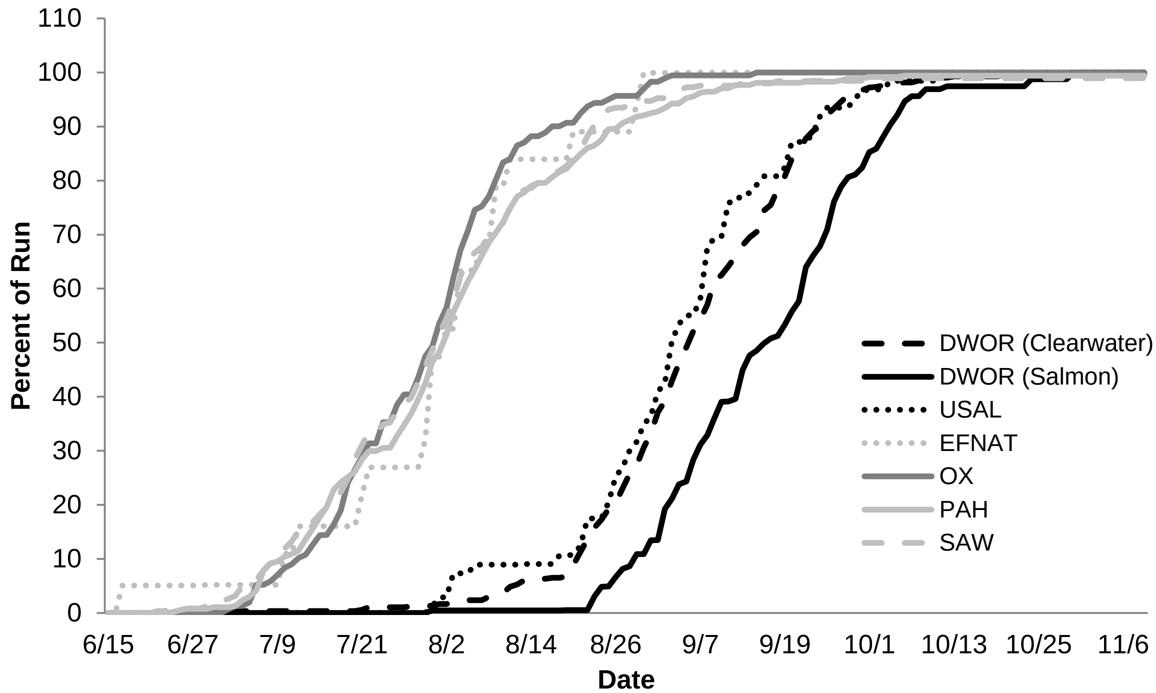

Figure 3. Run timing of one- and two-ocean (Brood Year 2008 and 2007) hatchery steelhead at Bonneville Dam based on PIT tag detections during the 2010/2011 run. DWOR adults are grouped into the basin in which they are released.

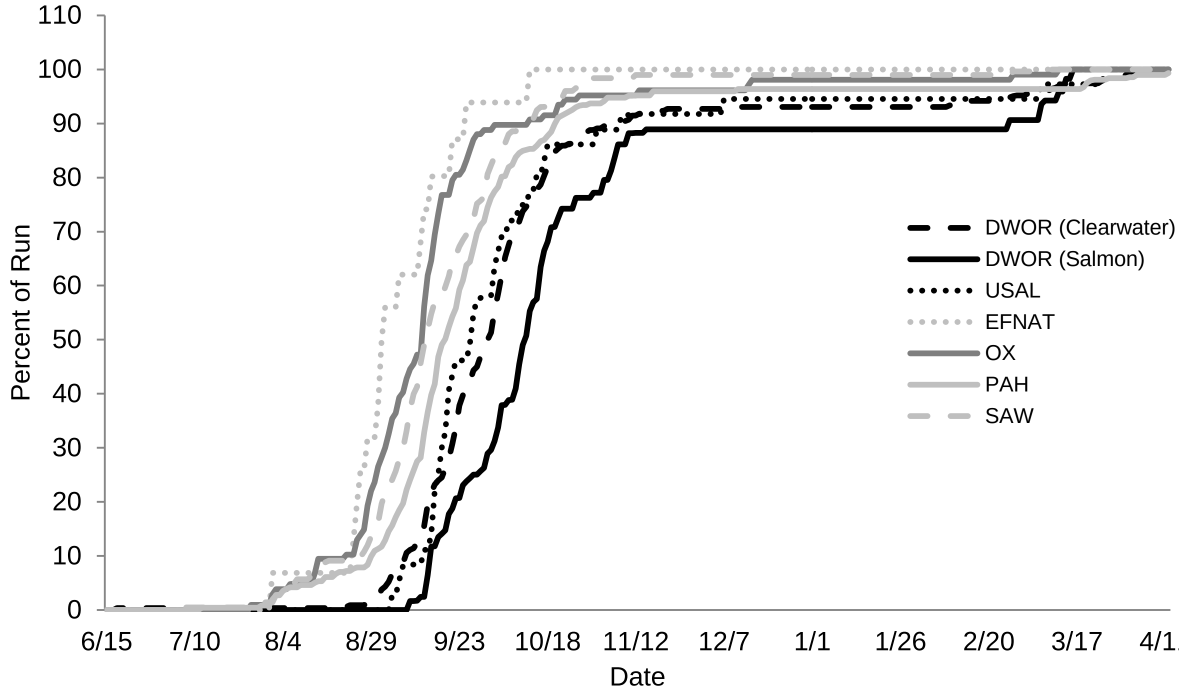

Figure 4. Run timing of one- and two-ocean (Brood Year 2008 and 2007) hatchery steelhead at Lower Granite Dam based on PIT tag detections during the 2010/2011 run. DWOR adults are grouped into the basin in which they are released.

For returns to hatchery traps, daily trapping numbers were used to summarize the run timing for hatchery- and natural-origin fish. Arrival timing at Crooked River satellite facility and the Squaw Creek temporary weir was not included due to the low number of adults returning. Arrival timing at the Hells Canyon Dam was also not included, as the trap is operated intermittently (primarily in the fall) and would not show representative run timing. Figures 5 and 6 summarize the run timing of steelhead returning to hatchery traps in the upper Salmon River 2011, which is similar to 2010 and previous years (Stiefel and Rosenberger 2011).

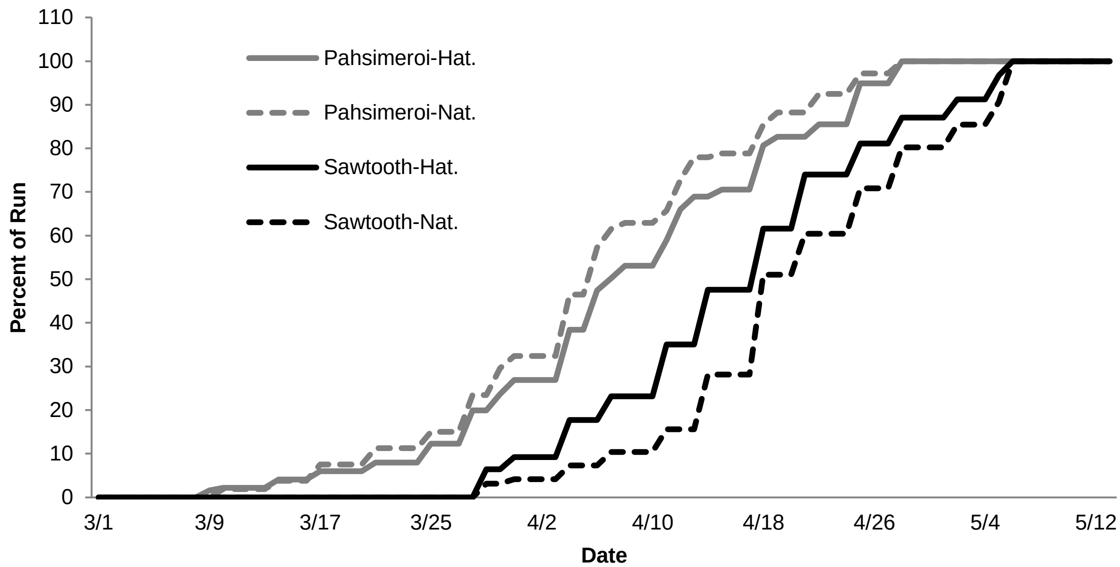

Figure 5. Run timing of adult hatchery and natural steelhead returning to the Pahsimeroi and Sawtooth traps, two major broodstock collection facilities, in 2011.

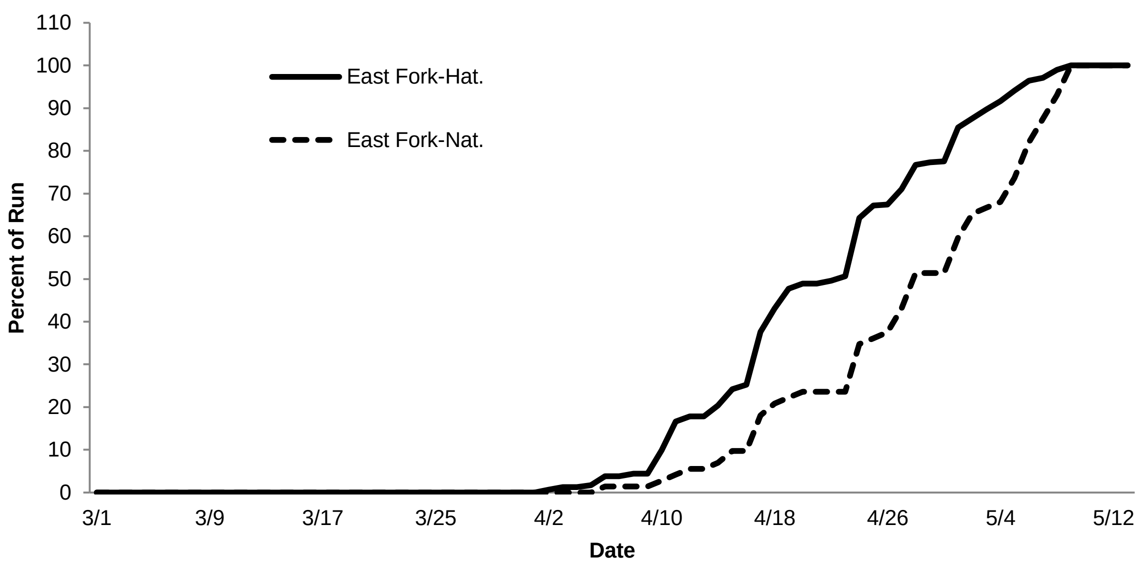

Figure 6. Run timing of adult hatchery and natural steelhead returning to the East Fork satellite facility, the broodstock collection source for the integrated East Fork Natural Program, in 2011.

Hatchery Trap Returns

Steelhead that escaped fisheries were collected at hatchery weirs and traps where they were enumerated and processed. We estimated the age composition of adults returning to individual hatchery facilities by one of three methods, depending on the availability of known age information (CWTs) recovered from returning adults. In cases where enough known age information is available, the statistical computer program *R* (R Development Core Team 2010) was used with the *mixdist* library package (Macdonald 2010) to estimate the proportion of each age group that was used to calculate the size of each age class. *Rmix*, as it is called, was designed to estimate the parameters of a mixture distribution with overlapping components, such as the overlapping length distributions associated with adult steelhead returns composed of multiple age classes, and applies the maximum likelihood estimation method to a population based on a known-age subsample. If known age information was lacking, then age composition was estimated using the FAO-ICLARM Stock Assessment Tools (FiSAT) II software (Gayanilo et al. 2005). This method also applies the maximum likelihood concept and provides an estimated proportion of fish for each age class that is used to calculate the size of each age class. In some cases, where neither program could be used because of few returning adults, an age was assigned by applying a length cutoff after visually reviewing length frequencies. A summary of adults trapped by age is shown in Table 8. Although three-ocean fish have been observed in the past (IDFG unpublished information), no three-ocean adult steelhead were observed at hatchery traps in 2012.

Table 8. Age composition and average fork length (cm) of adult steelhead returning to hatchery traps in 2011.

		Males				Females				
		One-ocean		Two-ocean		One-ocean		Two-ocean		
Rack	Origin	Num.	Avg. Len.	Num.	Avg. Len.	Num.	Avg. Len.	Num.	Avg. Len.	Total Return
Crooked R.	H			2	85.0			1	81.0	3
	N	1	67.0			1	67.0	3	82.0	5
East Fork	H	158	57.3	103	73.5	62	57.6	153	70.6	476
	N	11	61.3	17	76.7	3	60.0	41	74.1	72
Pahsimeroi	H	3,508	56.5	212	70.1	3,269	55.3	927	67.4	7,916
	N	59	57.0	27	70.1	68	55.2	85	68.0	239
Sawtooth	H	1,289	58.8	431	71.6	711	57.0	572	68.3	3,003
	N	16	57.6	16	72.0	16	57.2	48	69.5	96
Squaw Cr.	H	3	59.0	7	77.9	7	55.5	10	73.8	27
	N	3	56.7	3	75.5	1	55.0	5	71.6	12
Hells Canyon	H	1,525	59.9	655	73.3	1,090	58.9	1,482	70.2	4,752
	N	5	62.6	15	73.8	22	68.7	16	76.8	58

Localized Broodstock Development

East Fork Natural Program

This is a summary of field operations that occurred in 2011 for the East Fork Natural Supplementation Program. From 29 March through 10 May, 583 adult steelhead were trapped at Sawtooth Fish Hatchery's East Fork Salmon River satellite facility (weir). Of the adults trapped, 476 were hatchery-origin fish from the program (261 males/215 females) and 72 were natural-origin steelhead (28 males/44 females). An additional 34 hatchery-origin non-program steelhead (intact adipose fin but no CWT) and one AD-clipped hatchery-origin fish were also trapped but not released above the weir or spawned and excluded from further analysis. In 2011, a sliding scale (driven by natural-origin fish escapement) was used to manage the proportion of natural-origin and hatchery-origin fish to be incorporated as broodstock and released above the weir to spawn naturally. Projections for the escapement of natural-origin fish were made multiple times in-season to determine the proportion of natural-origin fish to retain for broodstock. By season's end, 55 males (40 hatchery-origin, 15 natural-origin) and 45 females (27 hatchery-origin, 18 natural-origin) were retained for broodstock and spawned. The remaining 409 hatchery-origin and 39 natural-origin fish were released above the weir to spawn naturally. The proportion of natural-origin fish retained for broodstock varied through the run as a result of updated projection estimates; however, by season's end 46% (39/72) of the natural-origin fish were retained for broodstock. Similarly, the proportion of hatchery-origin fish released above the weir to spawn naturally was 91%, which is slightly above the maximum identified in the sliding scale of 90%. Therefore, the weir management protocol was essentially successful in retaining and releasing the correct proportion of hatchery and natural fish at this level of natural fish escapement. A more detailed summary of 2011 field operations related to the East Fork Natural Program is available in Appendix C in this report.

Upper Salmon B-run Program

This is a summary of operations that occurred at Pahsimeroi Fish Hatchery and Squaw Creek in 2011 for the ongoing Upper Salmon B-run Program. To provide broodstock for the program, 91,023 locally adapted USAL smolts and 30,303 out-of-basin DWOR smolts were released with intact adipose fins and CWT at the Pahsimeroi Fish Hatchery. Juvenile survival, from release to Lower Granite Dam, for these fish was 89.3% and 83.9%, respectively. An additional 280,753 DWOR AD-clipped smolts were released at Squaw Creek with clipped adipose fins to provide harvest mitigation. Juvenile survival from release to Lower Granite Dam for this release group was 60.4%; this relatively low survival was due to a mortality event post-release. A more detailed summary of this mortality event and field operations related to the Upper Salmon B-run Program in 2011 is available in Appendix D in this report. From 29 March through 7 May 2011, adult steelhead were collected using a temporary weir 100 meters from the mouth of Squaw Creek, as well as from anglers (fishing in the Salmon River near Squaw Creek) who voluntarily contributed fish to be used as broodstock. A total of 48 (6 from the weir and 42 from anglers) adult steelhead were collected during this period and transported to the East Fork Salmon River satellite facility for holding and spawning. Twenty-six females and 23 males were spawned producing a total of 117,984 eye-eggs (74.9% eye-up rate), which were incubated at Pahsimeroi Fish Hatchery prior to being shipped to Magic Valley Fish Hatchery. These eggs should yield approximately 95,000 smolts for release at the Pahsimeroi Fish Hatchery in 2012. Preliminary stock performance using PIT tags for brood year 2007 indicates USAL smolts have significantly higher survival to the adult life stage than DWOR smolts ($Z = 2.56$; $P = 0.011$).

South Fork Clearwater River Program

In 2010, the IDFG initiated an angler broodstock collection program to develop a hatchery stock that was locally adapted to the South Fork Clearwater River. Although hatchery fish had been released for years at Red River and Crooked River satellite facilities, very few hatchery adult steelhead returned to these sites, likely the result of fallout due to a migration barrier near Golden, Idaho. To overcome the lack of an adequate broodstock collection site, a volunteer angler contribution program was initiated in 2010 that allowed anglers to contribute fish to be used as broodstock. Due to the success at collecting and spawning broodstock in 2010, the program was continued and the smolt production goal was increased from 70,000 to 210,000 smolts in 2011. To achieve this level of smolt production, a broodstock collection goal of 50 males and 50 females was identified.

Staff from Clearwater and IDFG's Lewiston Regional Office assisted by sport anglers who voluntarily contributed fish collected 50 females and 45 males of hatchery origin from 2 March through 6 March 2011 (Sundquist et al. in progress). These fish were temporarily held in fish tubes before being transported to Dworshak National Fish Hatchery for spawning. Forty-seven females were spawned with all of the males collected. Eggs from five females were culled because the females tested positive for Infectious Hematopoietic Necrosis and one female's eggs did not fertilize. These crosses produced 240,213 eyed-eggs, which based on the eyed-egg-to-smolt survival observed in brood year 2010 will produce approximately 216,000 smolts.

M&E activities were also initiated in 2011 to compare growth and survival of the locally adapted SFCLW and DWOR stocks throughout their life cycle. Smolt survival and growth rates were monitored during rearing at Clearwater and smolts were PIT-tagged to evaluate survival from release to Lower Granite Dam (Table 2). PIT tagging rates were also sufficient to evaluate survival to the adult life stage when these fish return in 2012-2015. There was little to no difference in size and survival within the hatchery as well as from release to Lower Granite Dam between stocks (Table 9). These results are significant because it demonstrates that offspring from adults collected near Peasley Creek in the spring can be spawned and their offspring successfully reared to a desired release size within one year, which was a major consideration when implementing this program due to the facility's relatively cold water source that results in slow growth rates.

Table 9. Summary of growth, onsite survival, and survival from release to Lower Granite Dam (LGD) for Brood Year 2010 DWORB and SFCLW smolts released at Peasley Cr. (Sundquist et al. in progress).

Stock	Eye-up Rate (%)	Eyed-egg-to-smolt survival (%)	Size at Release (fpp)	Survival from Release To LGD (%)
DWORB	93.7	92.8	5.0	81.5
SFCLW	96.4	89.7	5.4	80.4

RESEARCH

Evaluation of an Alternative Method to Estimate the Number of Released PIT-tagged Steelhead

For the second year in a row, a fish pump PIT tag array with multiple antennas was tested to determine if it was a viable option to more accurately report PIT-tagged fish release numbers at Hagerman National than the typical deduction method in which the number of recovered shed tags and mortalities is deducted from the number of tagged fish. The array was comprised of four FS2001F-ISO PIT tag readers, each having a round 11-inch pass-through antenna. Antennas were arranged on the intake line of the fish pump and spaced approximately one meter apart to minimize interference. These readers were connected to a laptop computer that recorded detections from each antenna.

All steelhead from 21 of the 24 raceways that contained PIT-tagged fish (4.7-6.6% for each raceway) passed through the fish pump PIT tag array as they were loaded onto transport trucks. This included all of the raceways with PIT-tagged smolts for three release groups and half the raceways with PIT-tagged smolts for the remaining release group. Detection efficiency of the array was estimated for each raceway using PIT tag detections at the dams in the Snake River and Columbia River hydropower system. Overall, the detection efficiency of the array was high and averaged 88.4%; (Range 74.0-96.0; SD 5.3%).

These detection efficiencies were then used to adjust the estimated number of PIT-tagged fish released from each raceway. The adjusted release numbers accounted for 98.2% of the tags assumed to be in the raceways by deduction, which was similar to last year's estimate of 98.6% (Stiefel and Rosenberger 2011). It is interesting to note, the tags unaccounted for by the array represent 1.8% of the tags in the raceways, which is similar to the 1.3% shed rate observed in a controlled experiment at Hagerman National (Hagerman National Hatchery Evaluation Team 2010).

The deduction method of estimating PIT-tagged fish release numbers was compared with the adjusted estimate to evaluate the benefits of using the fish pump array. The deduction method has a negative bias when expanding for adult returns; however, this is relatively low when compared to the error associated with the adult return estimates due to the sample size of PIT-tagged fish (Table 10). For example, if 113 PIT-tagged adult steelhead were detected from the Sawtooth release, the difference between the expanded adult return estimate derived from the deduction method and the fish pump method would be 116 adult fish or 1.3% of the estimate. This is substantially less than the confidence interval for the expanded adult return estimate of 1,501 (18%) for the release group to Lower Granite Dam based on the sample size of PIT-tagged juvenile steelhead. Therefore, increasing PIT tagging rates would have a greater influence on increasing the precision of adult return estimates than operating the fish pump array and continued or expanded use of the array is unwarranted. These results also suggest the error observed in expanding adult PIT-tagged fish returns is primarily a result of differences (survival or shedding) that occur after juveniles are released. However, this needs to be further evaluated when Brood Year 2010 fish return as adults before any conclusions can be made.

Table 10 Summary of adult expansion values for Hagerman National steelhead releases based on the deduction and fish pump array methods of estimating juvenile PIT-tagged fish release numbers, as well as the modeled adult return estimates.

		PIT-tagged Fish Release #'s		Expansion Values		Modeled Adult Return Estimates			
Release Site	# Fish Released	Deduction	Array Correction	Deduction	Array Correction	Number of Detection[2]	Deduction	Array Correction	CI (+/-)[3]
Sawtooth	728,632	9,386	9,264	77.6	78.7	113	8,772	8,888	1,501
Yankee (Sup)	220,419	2,899	2,798	76.0	78.8	17	1,292	1,339	529
Yankee (Prod)	213,919	2,849	2,802	75.1	76.3	24	1,802	1,832	606
East Fork	158,577	4,887	4,786[1]	32.5	33.1	59	1,915	1,955	484

[1] Includes PIT tags enumerated by the array and deduction method as half of the raceways did not pass through the array.
[2] Adult return estimates were modeled using an SAR of 1.2%.
[3] The 95% confidence interval (CI) was estimated based on the number of PIT-tagged fish in the release group.

Estimating a Correction Factor for PIT Tag Expansions in Steelhead Returning to Sawtooth Fish Hatchery Trap

Recent research has shown that PIT-tagged adult Chinook salmon return at lower rates than non-PIT-tagged fish due to tag loss and/or differential survival (Knudsen et al. 2009). More recent evaluations of hatchery one-ocean (Brood Year 2007) steelhead returning to the Sawtooth trap in 2009 indicate PIT-tagged fish return rates are lower than that of non- tagged fish, suggesting that tag loss and/or differential survival occurs in steelhead as well (Stiefel and Rosenberger 2011). In 2011 we again examined PIT-tagged fish return rates at Sawtooth Fish Hatchery for each age group using the same methods to determine if they could be used to correct expansion rates that are used to generate adult return estimates.

Correcting PIT tag expansion estimates for Hagerman's Sawtooth release group was not feasible due to the limited sample size of adult PIT-tagged steelhead returning to the release site in 2011. Although there were apparent differences between juvenile and corrected PIT tag expansion rates (Table 11), those differences were highly influenced by the small sample size of PIT-tagged fish from each release group. Since its inception, the goal of the PIT-tagging program for Idaho hatchery steelhead facilities has been to estimate adult returns to Lower Granite Dam for each facility as a whole. Because of this, evaluating adult returns at a scale smaller than at the hatchery level and/or at another location where fewer fish escape harvest, such as a single release group at Sawtooth Fish Hatchery, results in substantially more error. This high error rate needs to be taken into account when correcting expansion values. Unlike the Idaho hatchery Chinook salmon program where most facilities have one large release and therefore less error when expanding PIT-tagged adults, correcting expansion estimates for the few individual steelhead releases that occur at permanent weirs is not feasible due to low sample sizes, which is an accepted limitation of the current PIT tagging program (Cassinelli and Rosenberger 2011; Cassinelli et al. 2012).

Table 11. PIT tag expansion rates, adult detections, and expanded adult return estimates for Brood Year 2008 (one-ocean) and 2007 (two-ocean) steelhead returning to Sawtooth Fish Hatchery in 2011. Detections have been corrected for PIT array efficiency. Actual return estimates were generated using CWT and trapping information.

Brood Year	Juvenile Expansion Rate	Run At Large PIT Tags at Trap Array	Return to River PIT Tags at Trap Array	Estimated Expanded Return	Actual Return	Corrected Expansion Rate
2008	141.3 (+/- 67)	20	3	2,799 (+/- 1,319)	2,000	101.6
2007	113.6 (+/- 89)	6	0	656 (+/- 514)	1,003	173.5

CWT Shed Rates

CWT retention checks are conducted annually at steelhead hatcheries to correct CWT release numbers for shed tags. These checks typically occur just prior to release, up to seven months post-tagging, and can only be done in raceways where 100% of the fish are tagged with CWTs. In brood year 2009, the mark crew initiated three-week post tagging retention checks to evaluate tagging quality. The results of the three-week retention checks were compared with the prerelease checks, and an intermediate seven-week check, to determine if earlier checks would provide the same results as the prerelease checks. If so, the three-week check would provide accurate retention estimates that could be used for both quality control checks as well as correcting CWT release numbers. The three-week checks would also allow for retention checks in raceways that are not 100% CWT. Checks performed in partial raceways would be accomplished by segregating a subsample of fish that were 100% CWT for three weeks (a logistically feasible period of time) and then released back into the raceway from which they came. Another added benefit of using the three-week check is a reduction in handling of fish just prior to release.

Retention checks were conducted on Brood Year 2010 steelhead at three and seven weeks post tagging, as well as prerelease (approximately seven months post tagging). A v-board CWT detector was used to evaluate CWT retention for 300 fish in raceways or raceway sections that were 100% CWT tagged at Clearwater, Hagerman National, Magic Valley, and Niagara Springs fish hatcheries as well as Chinook salmon at Clearwater Fish Hatchery. Confidence intervals were generated for each time period to determine if there were significant differences (Scheaffer et al. 1996).

In both brood years, there were small but significant differences between periods for steelhead at some facilities while there were no differences detected for Chinook salmon (Table 12 and Table 13). The maximum difference of .68% was observed in Brood Year 2009 steelhead at Niagara Springs (Stiefel and Rosenberger 2011).

Table 12. CWT retention estimates and 95% confidence intervals (CI) for the three time periods sampled from Brood Year 2010 hatchery steelhead and Chinook salmon. * indicates significant difference between three-week and prerelease retention checks.

		Three Week		Seven Week		Prerelease	
Hatchery	**Raceways**	**Retention**	**CI (+/-)**	**Retention**	**CI (+/-)**	**Retention**	**CI (+/-)**
Clearwater (ST)	3	98.7	0.75	98.1	0.90	98.7	0.76
Clearwater (CH)	4	98.2	0.76	-	-	98.1	0.79
Hagerman Nat.*	14	98.0	0.42	97.6	0.48	96.8	0.53
Magic Valley	22	98.5	0.29	98.2	0.32	97.9	0.35
Niagara Springs*	6	98.9	0.48	99.4	0.36	97.7	0.69

Table 13. CWT retention estimates and 95% confidence intervals (CI) for the three time periods sampled from Brood Year 2009 hatchery steelhead and Chinook salmon (Stiefel and Rosenberger 2011). * indicates significant difference between three-week and prerelease retention checks.

		Three Week		Seven Week		Prerelease	
Hatchery	**Raceways**	**Retention**	**CI (+/-)**	**Retention**	**CI (+/-)**	**Retention**	**CI (+/-)**
Clearwater (CH)	6	98.2	0.61	-	-	97.9	0.66
Hagerman Nat.*	12	98.6	0.38	98.1	0.44	97.4	0.52
Magic Valley	9	98.3	0.49	98.0	0.53	98.1	0.52
Niagara Springs*	8	99.1	0.38	98.5	0.49	97.4	0.64

Differences, if any, in CWT retention between sampling periods (three-week and prerelease) would carry over to harvest estimates at the same rate but have minimal impact on harvest estimates. For example, an 800,000 steelhead release group is estimated to include 90,000 CWT smolts from prerelease retention estimates (Table 14). To provide a worst-case scenario for differences in release numbers, the retention rate was increased by 0.68% (the maximum significant difference detected between retention periods) to simulate the number of CWT smolts that would have been released if the three-week retention rate was applied. Assuming 113 CWTs were recovered from fisheries with an average sampling rate of 15%, the difference between the harvest estimates (based on the number of CWT fish released from three-week and prerelease retention checks) would be 45 fish or 0.68% of the harvest. This difference is insignificant relative to the error associated with the recreational harvest survey design, which at 20% is considered relatively low (Hansen, personal communication). Therefore, using three-week retention checks to generate CWT fish release numbers will have minimal impact on the error associated with harvest estimates and prerelease checks can be eliminated.

Table 14 Comparison of harvest estimated from expansion rates derived from three-week and prerelease retention estimates. The retention of the three-week retention estimate was increased by .68% (the maximum significant difference detected), to provide a worst-case scenario for differences in release numbers.

Retention Check	Total Release	CWT Fish Released	Expansion Value	CWT Recoveries	Survey Rate (%)	Harvest estimate
Three-week	800,000	90,612	8.83	113	15	6,651
Prerelease	800,000	90,000	8.89	113	15	6,696

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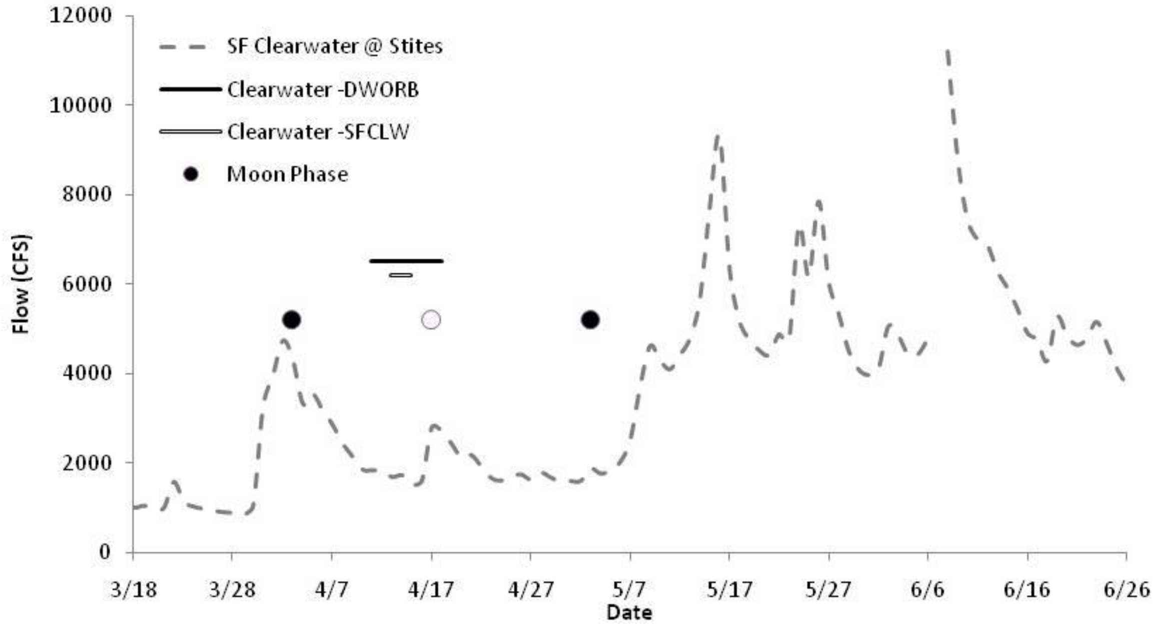
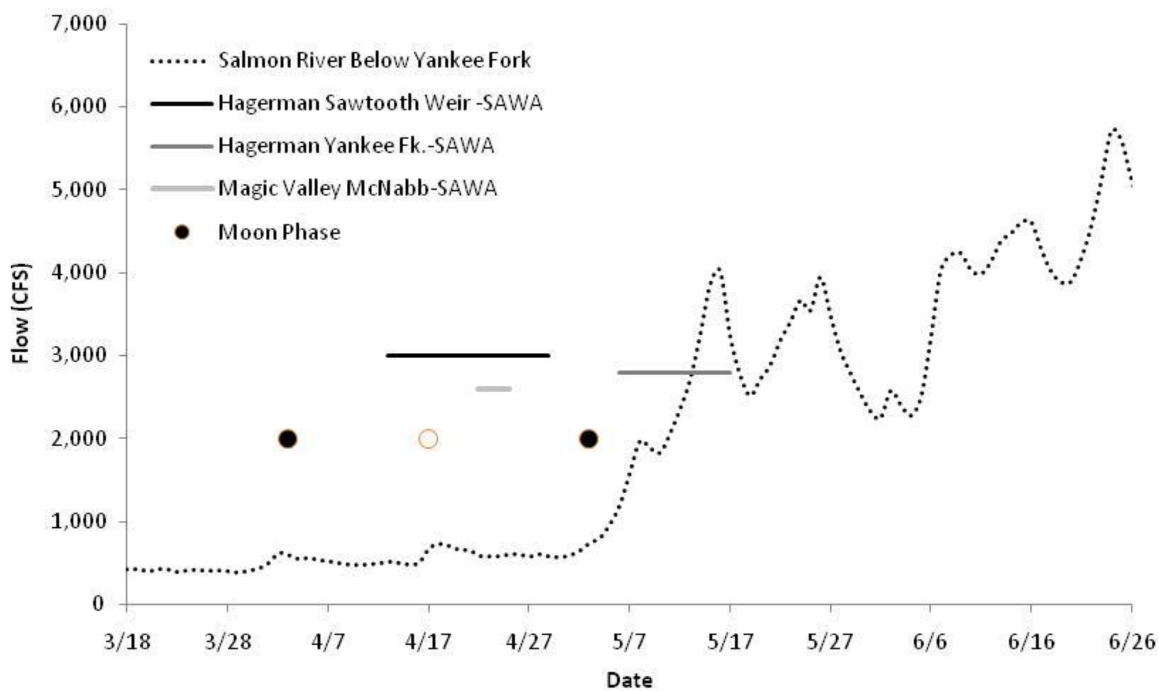
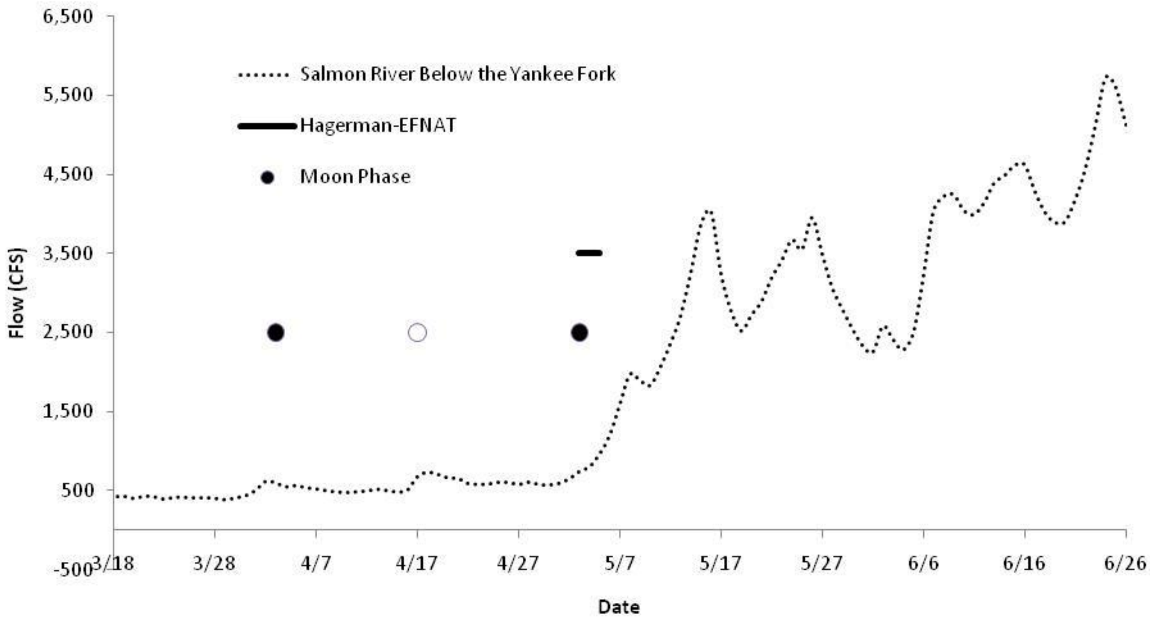
APPENDICES



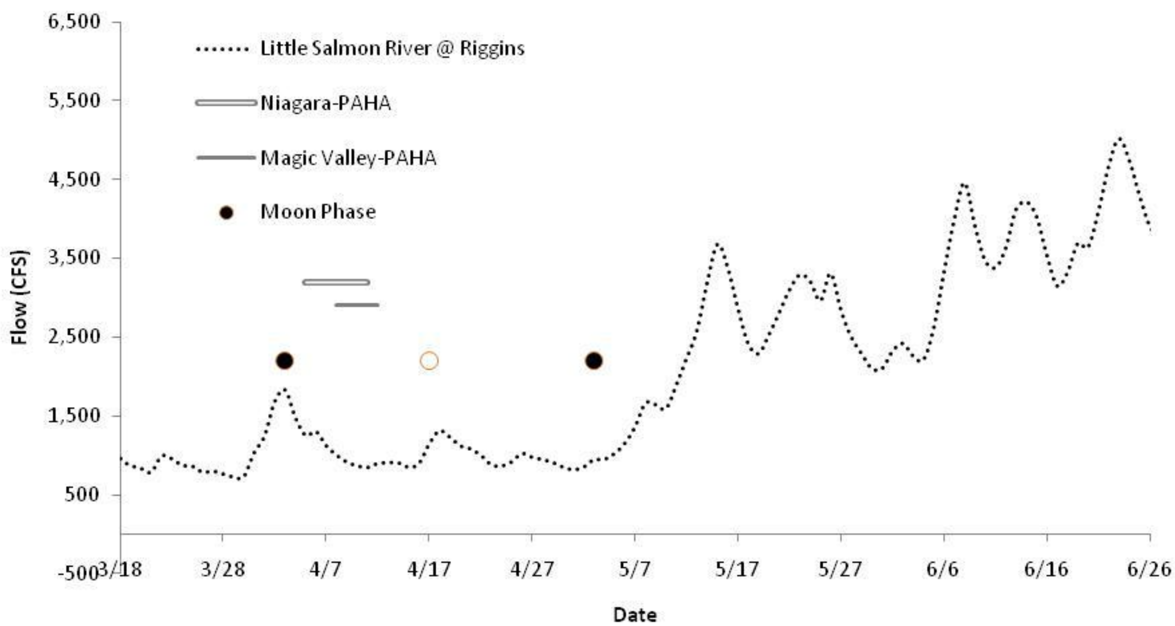
Appendix A1. Release timing for DWOR steelhead smolts released into the Clearwater River basin from Clearwater Fish Hatchery in 2011 vs. moon phase and flow.



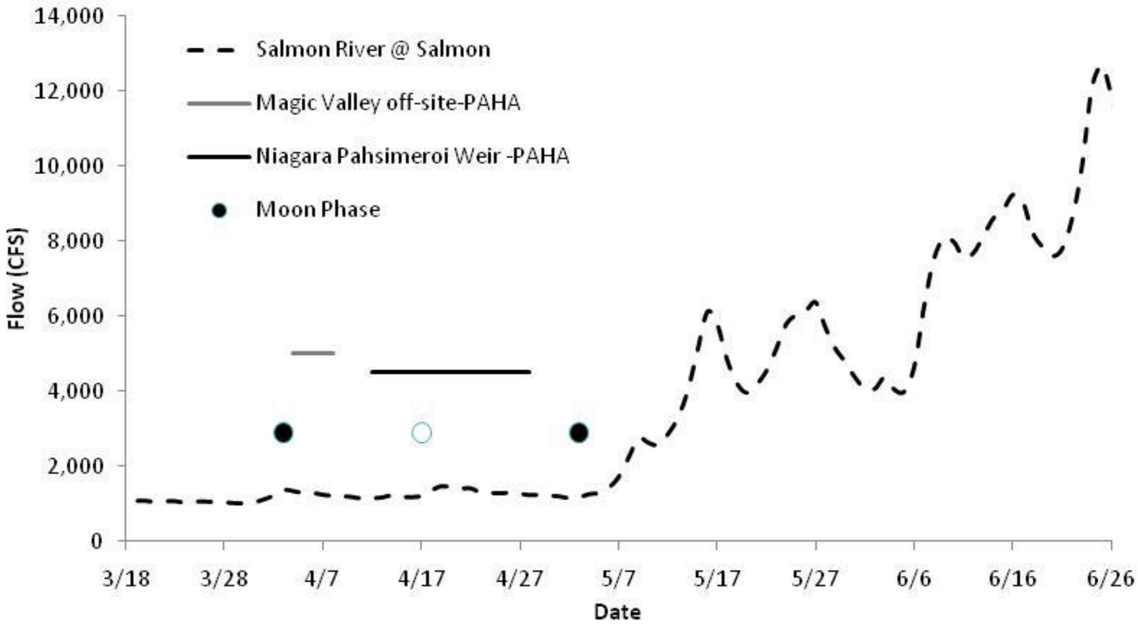
Appendix A2. Release timing for SAW steelhead smolts released from Hagerman National and Magic Valley fish hatcheries into the upper Salmon River in 2011 vs. moon phase and flow.



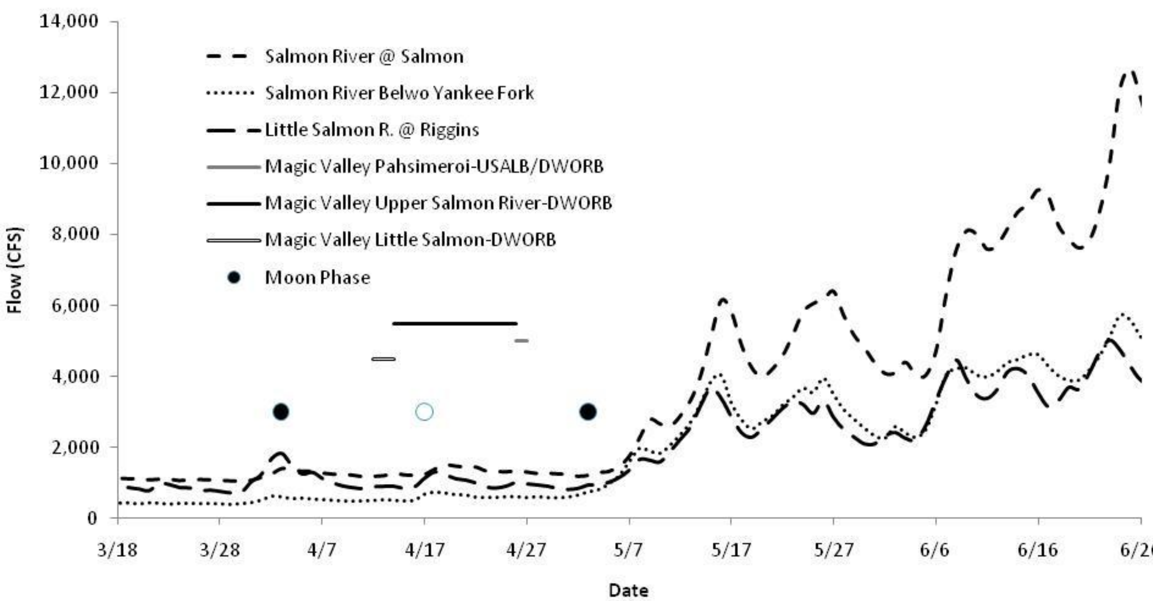
Appendix A3. Release timing for EFNAT steelhead smolts released into the East Fork Salmon River from Hagerman National Fish Hatchery in 2011 vs. moon phase and flow.



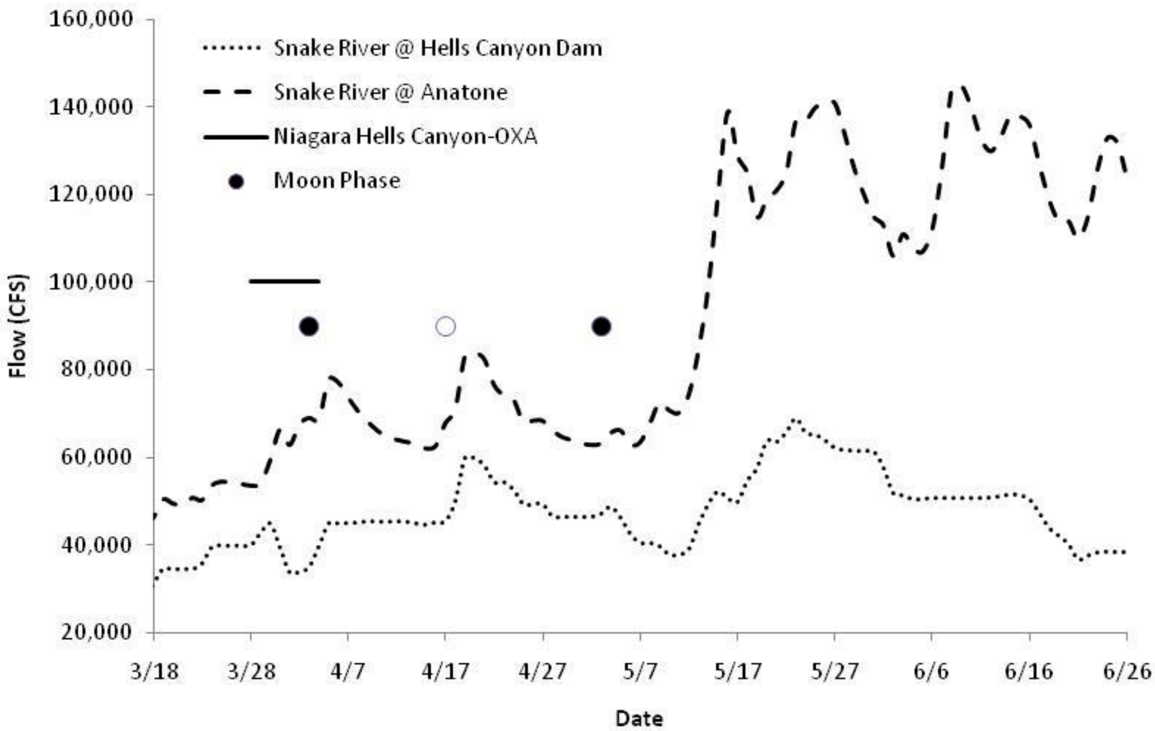
Appendix A4. Release timing for steelhead smolts released into the Little Salmon River from Magic Valley and Niagara Springs fish hatcheries in 2011 vs. moon phase and flow.



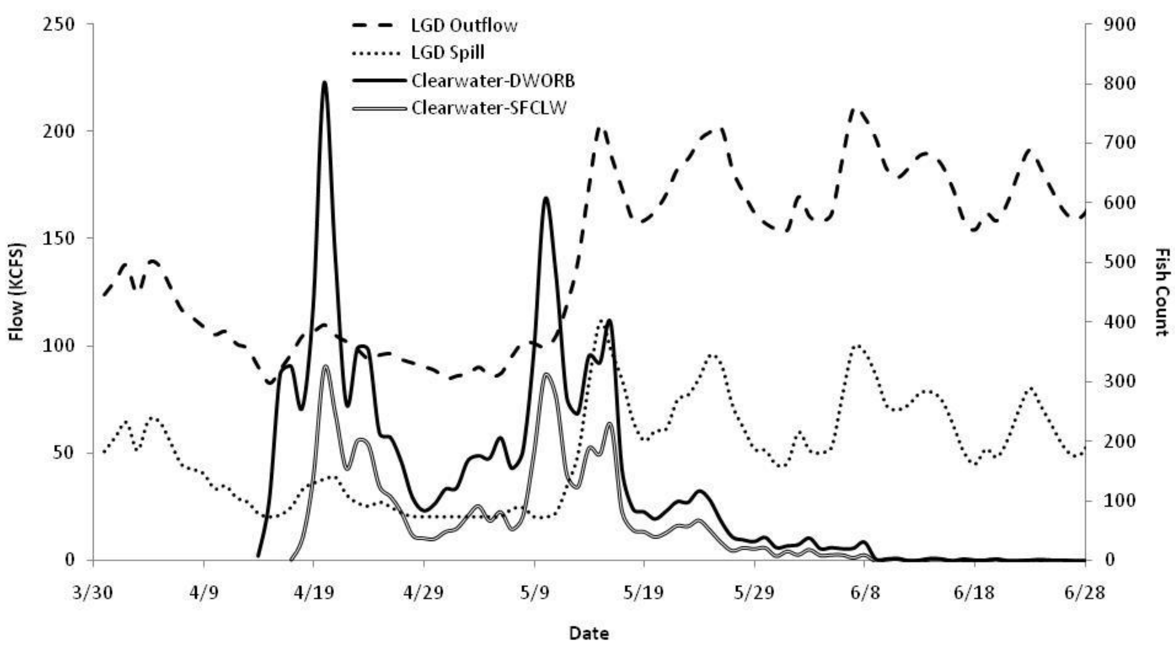
Appendix A5. Release timing for PAH steelhead smolts released from Magic Valley and Niagara Springs fish hatcheries into the upper Salmon River in 2011 vs. moon phase and flow.



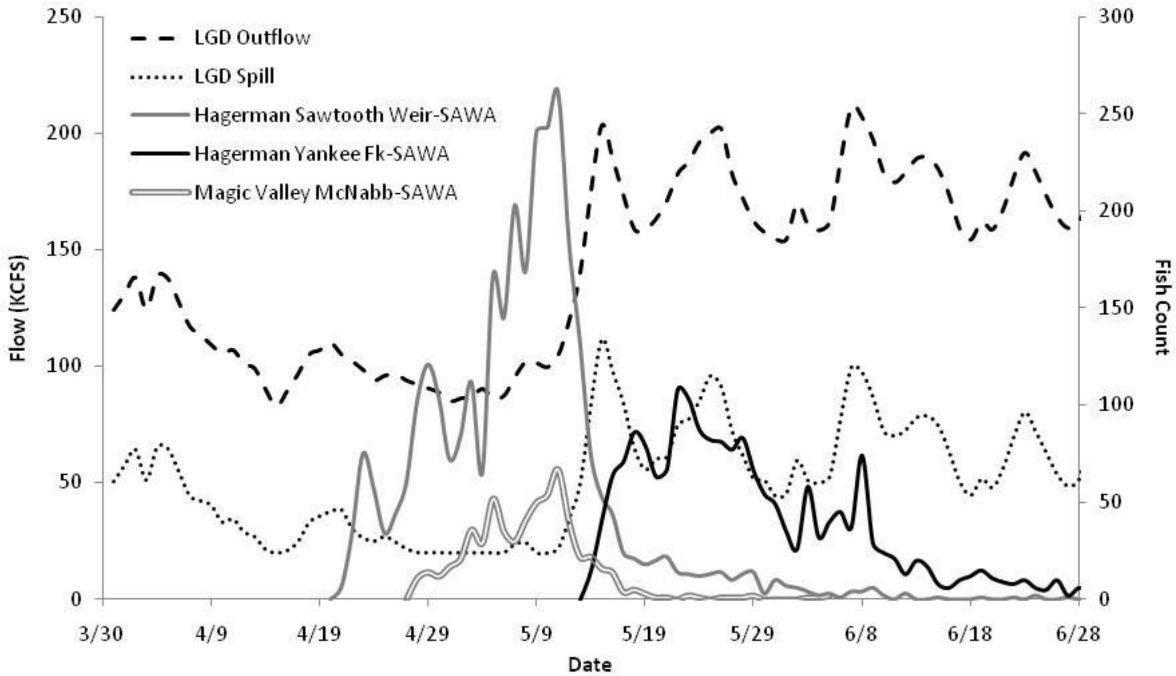
Appendix A6. Release timing for DWOR and USAL steelhead smolts released from Magic Valley Fish Hatchery into the upper Salmon River in 2011 vs. moon phase and flow.



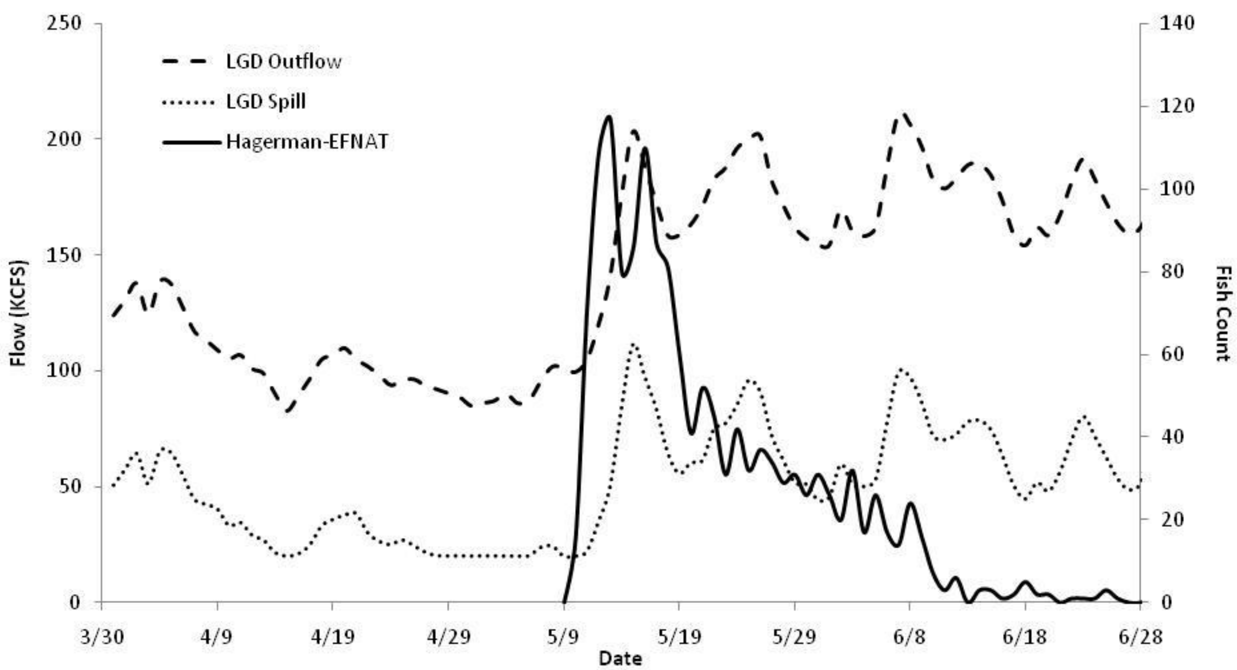
Appendix A7. Release timing for OXA steelhead smolts released from Niagara Springs Fish Hatchery into the Snake River in 2011 vs. moon phase and flow.



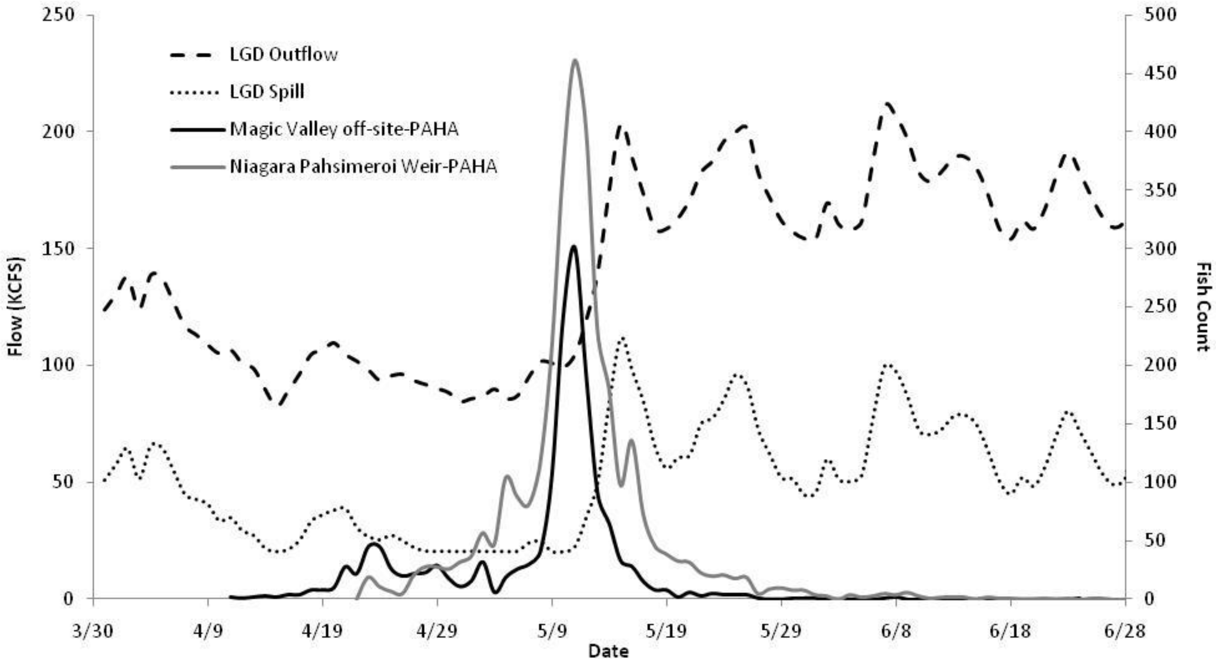
Appendix B1. Smolt arrival timing at Lower Granite Dam (LGD) for DWOR and SFCLW steelhead released from Clearwater Fish Hatchery in 2011 vs. outflow and spill.



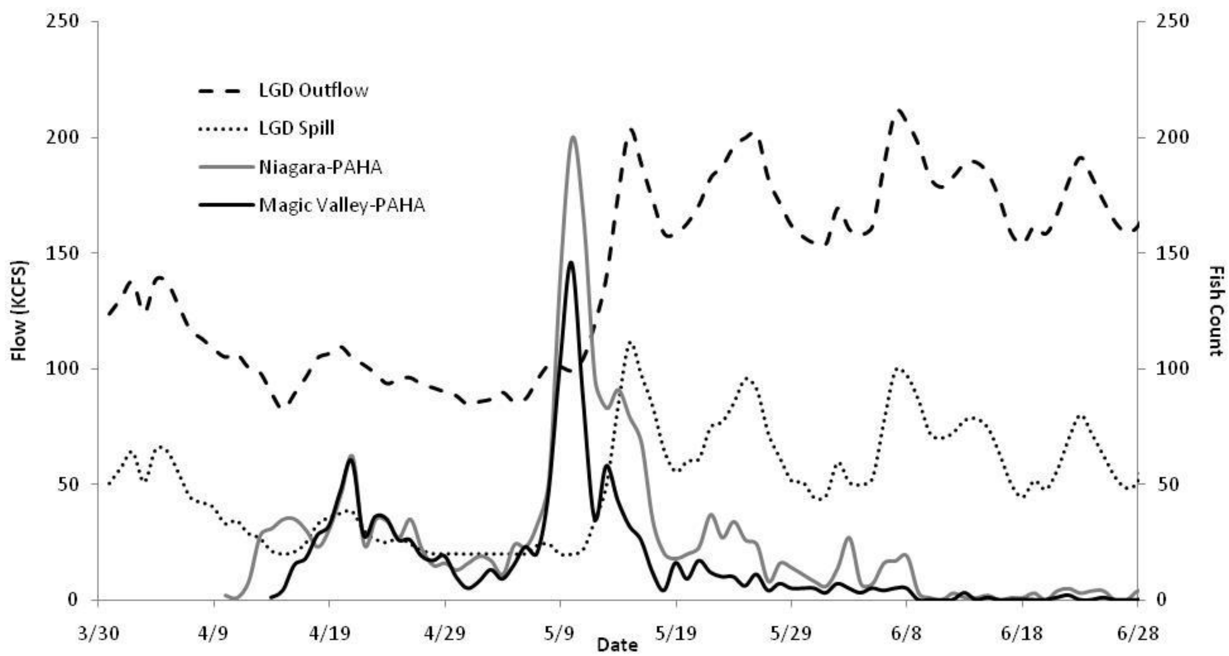
Appendix B2. Smolt arrival timing at Lower Granite Dam (LGD) for SAW steelhead smolts released from Hagerman National and Magic Valley fish hatcheries in 2011 vs. outflow and spill.



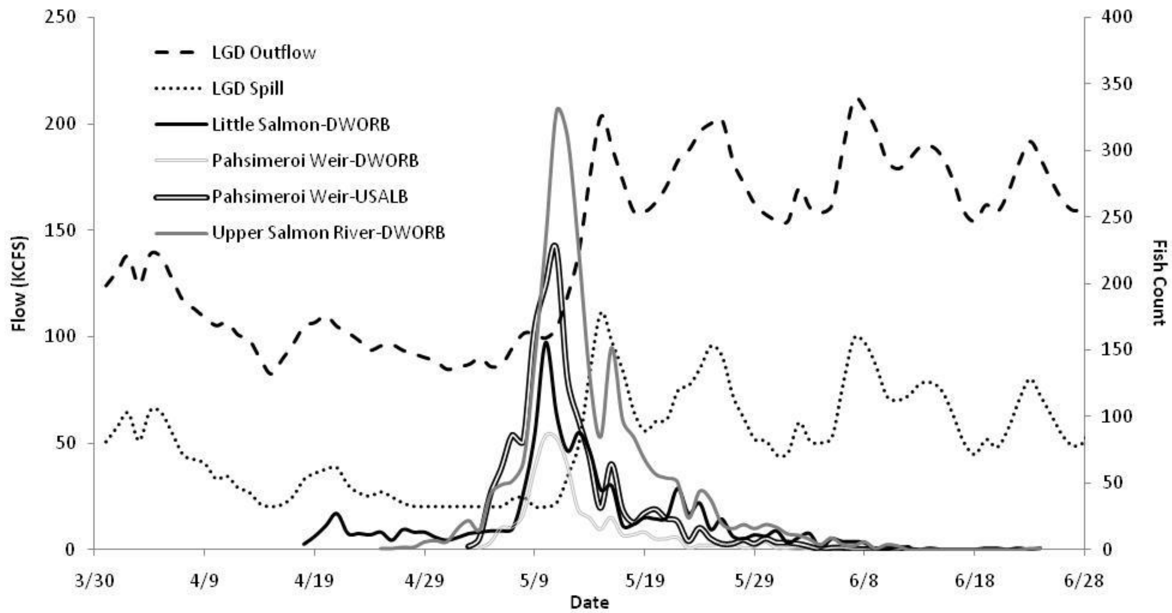
Appendix B3. Smolt migration timing at Lower Granite Dam (LGD) for EFNAT steelhead released from Hagerman National Fish Hatchery in 2011 vs. outflow and spill.



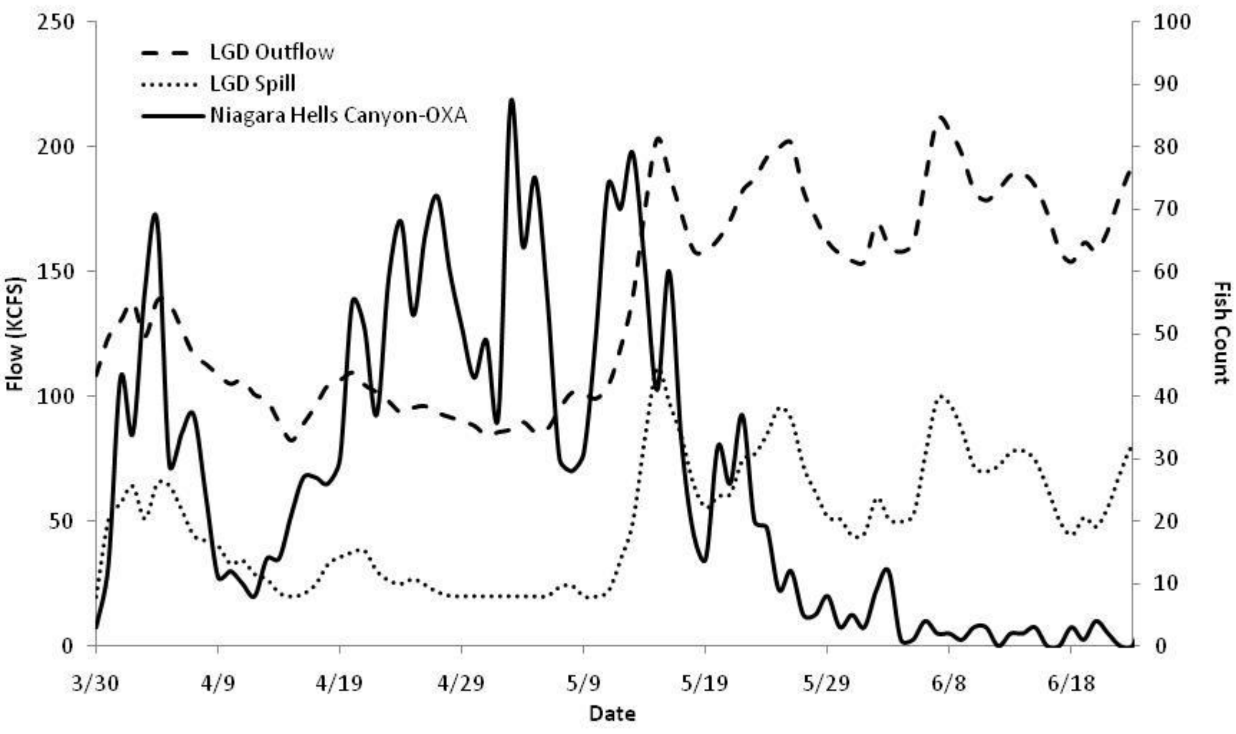
Appendix B4. Smolt arrival timing at Lower Granite Dam (LGD) vs. outflow and spill for PAH steelhead released from Magic Valley and Niagara Springs fish hatcheries in 2011.



Appendix B5. Smolt arrival timing at Lower Granite Dam (LGD) for PAH steelhead released from Magic Valley and Niagara Springs fish hatcheries into the Little Salmon River in 2011 vs. outflow and spill.



Appendix B6. Smolt arrival timing at Lower Granite Dam (LGD) for DWOR and USAL steelhead released from Magic Valley Fish Hatchery into the upper Salmon River in 2011 vs. outflow and spill.



Appendix B7. Smolt arrival timing at Lower Granite Dam (LGD) for OXA steelhead released from Niagara Springs Fish Hatchery at Hells Canyon Dam in 2011 vs. outflow and spill.

Appendix C. 2011 East Fork Natural Program Field Operations Summary

This document summarizes 2011 field operations related to weir management for the East Fork Natural Program. In particular, this document summarizes weir and broodstock management as well as the subsequent smolt production. The East Fork Natural program is a supplementation program, initiated in 2001, that is intended to increase the number of natural-origin steelhead in the EF Salmon River. The current hatchery production goal for the program is to release 170,000 integrated steelhead smolts annually at the East Fork satellite facility with intact adipose fins and coded wire tags (CWT) so that they can be identified as broodstock when they returned as adults. To achieve this level of smolt production approximately 45 females and 45 males are collected for broodstock.

Incorporating Natural Fish into the Broodstock- The Sliding Scale

In 2011, a sliding scale driven by natural-origin fish escapement was implemented to guide broodstock and weir management with respect to the proportion of natural-origin fish to be retained for broodstock as well as the proportion of hatchery-origin fish to be released above the weir. The sliding scale is described more thoroughly in the East Fork Natural Program's draft Hatchery Genetic Management Plan (IDFG draft). This supplementation effort is intended to increase the number of natural spawners while reducing risk to the natural population. When natural-origin escapements are at very low levels, guidelines are relaxed to allow a larger influence from hatchery-origin fish in both the hatchery and natural environments (Table 1). As natural-origin escapement increases, the proportional influence from the natural-origin population in both environments will increase.

Table 1. Sliding scale weir and broodstock management for the East Fork Natural integrated hatchery program. This program is described in detail in the East Fork Salmon Steelhead Hatchery Genetic Management Plan Draft (IDFG draft).

Tier	Natural-origin Escapement Projection Estimate	Maximum % of Natural-origin Fish Retained For Broodstock	Minimum % of Broodstock Made of Natural-origin Adults	Maximum % of Naturally Spawning Adults that are Hatchery-origin
1	0-49	100	NA	100
2	50-99	50	30	90
3	100-149	40	30	80
4	150-199	30	40	50
5	300-599	30	50	50
6	600-899	20	60	40
7	900-1,199	20	70	35
8	1,200-1,999	20	80	25
9	2,000-3,000	10	90	10

Because no preseason escapement forecast is available for natural fish in this subbasin, in-season projections were used to estimate the number of natural-origin fish that would escape to the East Fork satellite facility. These projections establish which tier on the sliding scale is used to guide broodstock and weir management. Estimates of natural-origin fish escapement to the East Fork weir were projected at 7 and 15 days after the arrival of the first natural-origin fish. The later projection was intended to provide a mid-season check in case the run size deviated substantially from the early projection. Projection estimates were made by expanding the total number of natural-origin fish returning at that point in the run with the average proportion of the run they represent based on historical run timing of natural-origin fish.

As in previous years, the goal was to retain adult steelhead (hatchery-origin and natural-origin) for broodstock that represented the entire range of size, age, and run-timing of fish returning to the weir. Each female was spawned with two males and hatchery-origin by natural-origin crosses were prioritized for broodstock; however, depending on availability of fish, same origin crosses did occur. Only hatchery-origin fish known to be from the program (intact adipose fin and CWT) were used as broodstock or released above the weir; hatchery-origin fish with an AD clip or no CWT were not released or used as broodstock.

Weir Management

The weir was operated from 29 March through 10 May 2011. The first fish arrived on 2 April and the weir remained operational until it was removed on 10 May 2011 (Figure 1). A total of 548 adult steelhead were trapped for the East Fork Natural Steelhead Program; 476 were hatchery-origin (261 males/215 females) and 72 were natural-origin steelhead (28 males/ 44 females, Table 2). It is important to note that this represents a fraction of hatchery-origin fish from the East Fork Natural program that returned to the Snake River basin, as the PIT-tagged fish conversion rate from Lower Granite Dam to the weir was only 16%. A substantial number of fish likely fell out in the East Fork Salmon River below the weir, which is 18 miles upstream of the mouth.

An additional 34 hatchery-origin steelhead with an intact adipose fin but no CWT and one AD-clipped hatchery-origin fish were also trapped but excluded from further analysis. The release location of the hatchery-origin fish with intact adipose fins but no CWT is unknown, which is why they were excluded from the program (i.e. not spawned or released above the weir to spawn). These fish may be smolts from the East Fork Natural Program that shed their CWT or strays from intact adipose fish released into the Yankee Fork Salmon River.

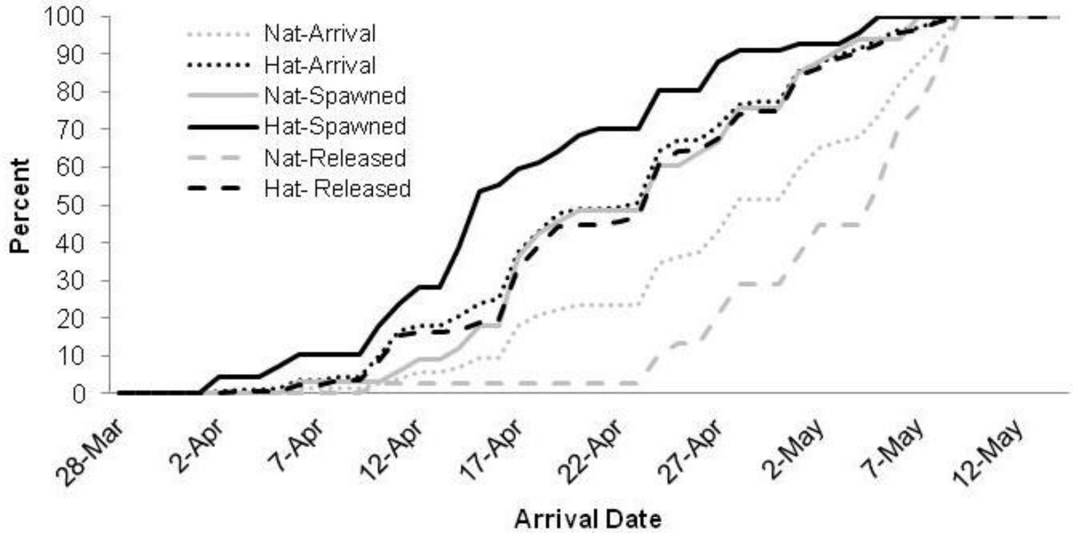


Figure 1. Approximate timing of arrival, retention as broodstock (spawned), and release above the weir, for natural-origin and hatchery-origin steelhead collected at the weir in 2011. The arrival date of individual fish was used to standardize the timing of retention for broodstock and release above the weir, because some fish were temporarily held while others were not.

Table 2. Origin, age, and sex summary of steelhead collected at the East Fork satellite facility in 2011.

		One-ocean		Two-ocean	
Origin	**Sex**	**Number**	**Avg. Length (cm)**	**Number**	**Avg. Length (cm)**
Hatchery	Female	62	58	153	71
	Male	158	57	103	74
Natural	Female	3	60	41	74
	Male	11	61	17	77

The proportion of natural-origin fish retained for broodstock varied through the season based on updated projection estimates for natural-origin fish escapement (Figure 1). As a conservative approach, until a natural-origin fish projection estimate could be made, natural-origin fish were held for spawning or released above the weir at a ratio of 2:1. The first natural-origin fish was trapped on 6 April. By 13 April, three additional natural-origin fish were collected (four total) and the projection estimated less than 50 natural-origin fish were expected to return to the weir. Based on the first projection estimate, hatchery staff operated the trap at Tier 1, retaining all newly arriving natural-origin fish for broodstock. On 21 April, the second projection estimate was made with a total of 17 natural-origin fish trapped and hatchery staff continued to operate at Tier 1. However, on 29 April it became apparent more than 50 natural-origin fish would be trapped by the end of the season and hatchery staff began operating at Tier 2 by releasing some natural-origin fish being held, which were still green, as well as other newly trapped natural-origin fish above the weir.

Based on the actual natural-origin fish escapement to the weir, the program operated within the guidelines established in the sliding scale (Table 1). By the end of the season, 46% of the natural-origin fish trapped were retained and used as broodstock as if the trap was operated at Tier 2 throughout the season. This level of integration is within the goal range of 30-50%. Similarly, the proportion of hatchery-origin fish released above the weir to spawn naturally was 91%, which is slightly above the maximum identified in the sliding scale of 90%.

The broodstock collection protocol successfully managed the proportion of natural-origin fish retained for broodstock and hatchery-origin fish released above the weir to spawn naturally; however, the run timing of natural-origin fish returning to the weir was not fully represented in the broodstock or in the group released above the weir. This is because the natural-origin fish returning early in the run were largely retained for broodstock, which left the majority of late arriving fish to be released above the weir. Due to the nature of the program, this situation is likely to occur in the future as long as natural-origin fish escapement is near the Tier 1 and 2 threshold because there is little flexibility for correction due to the narrow window in which in-season projections are made as well as the relatively small broodstock collection goal.

Spawning

A total of 55 males (40 hatchery-origin, 15 natural-origin) and 45 females (27 hatchery-origin, 18 natural-origin) were used as broodstock in 2011 (Snider personal communication). Broodstock represented the entire range of size and age of fish returning to the weir (Tables 2 and 3). Spawning operations occurred from 5 April through 10 May (11 spawn dates). Spawning activities yielded a total of 262,969 green eggs (average fecundity 5,844), which produced 213,436 eyed eggs (81.2% eye-up rate). All 213,436 eyed eggs produced from these crosses were transferred to Hagerman National for final incubation and rearing. These eyed eggs should meet or slightly exceed the production goal of 170,000 smolts based on average eyed egg to smolt survival for brood years 2009 and 2010.

Table 3. Origin, age, and sex summary of steelhead spawned for the East Fork Natural program.

		One-ocean		Two-ocean	
Origin	**Sex**	**Number**	**Avg. Length (cm)**	**Number**	**Avg. Length (cm)**
Hatchery	Female	7	56.9	20	71.3
	Male	15	60.6	25	74.4
Natural	Female	2	58.0	16	73.3
	Male	5	61.2	10	75.7

Appendix D. 2011 Upper Salmon B-run Program Field Operations Summary.

Beginning in 2002, large adult steelhead have been collected at Squaw Creek in an effort to develop a locally adapted stock that returns predominantly after two or more years in the ocean. It was hypothesized that a locally adapted broodstock would perform better than the out-of-basin stock from Dworshak National Fish Hatchery (DWOR) and would result in increased adult returns. As a result, the Upper Salmon River (USAL) stock was developed. USAL smolts are the progeny of eggs collected from adults returning to Squaw Creek, regardless of whether the adults were one or more generations removed from Dworshak National Fish Hatchery. Since 2002, performance (survival) of adults returning to Lower Granite Dam was evaluated with coded wire tags (CWT) and it was determined that USAL smolts survived at a higher rate to the adult life stage than DWOR smolts (IDFG unpublished data).

In 2010 (Brood Year 2009), the first USAL smolts were released at Pahsimeroi weir to transfer the broodstock collection point to this location. The broodstock collection point for the program was changed because the temporary weir used to collect adult fish in Squaw Creek frequently became inoperable (due to ice and high water) and the fluvial fan at the mouth of the creek was suspected of being a migration barrier at low flows encountered early in the collection season. Smolts were released at Pahsimeroi Fish Hatchery with intact adipose fins and CWT to provide a differential mark so that the USAL adults could be distinguished from other fish returning to the weir and to eliminate harvest in selective fisheries of fish intended for broodstock. The combination of eliminating harvest in selective fisheries and collecting adults at Pahsimeroi Fish Hatchery’s permanent weir is suspected to increase the number of adults collected when these fish begin to return as two-ocean adults in 2013 and ultimately increase the size of the USAL production to the desired level of 660,000 smolts in the upper Salmon River and 290,000 smolts in the Little Salmon River. As USAL production increases, the DWOR releases will be incrementally phased out of the Salmon River.

This document summarizes 2011 field operations related to the Upper Salmon B-run program at Squaw Creek and Pahsimeroi Fish Hatchery as well as preliminary stock evaluations using PIT tags, which unlike CWT account for all adult returns and not just those recovered in fisheries or at hatchery weirs.

Juvenile Releases

In 2011, DWOR smolt releases occurred at Squaw Creek from 17 April through 22 April and DWOR and USAL releases occurred at Pahsimeroi weir on 26 and 27 April. DWOR smolts were used to backfill the Pahsimeroi release because USAL production was below the production goal of 120,000 and to increase genetic diversity within broodstock for the program. Table 1 summarizes the release information.

Table 1. The number of smolts released into Squaw Creek and the Pahsimeroi River in 2011 (Brood Year 2010). CWT release numbers have been corrected for shed tags, hence the unmarked fish. Survival estimates are from the release site to Lower Granite Dam.

Stock	Release Site	Number Released	AD	AD/CWT	CWT	Unmarked	PIT	Survival (95% CI)
DWOR	Squaw Cr.	280,753	220,150	60,603			5,076	60.4 (± 3.2)
DWOR	Pahsimeroi Weir	30,303			29,242	1,061	1,795	83.9 (± 5.9)
USAL	Pahsimeroi Weir	91,525			89,139	2,386	5,371	89.3 (± 3.8)

On the afternoon of Friday 22 April, dead hatchery steelhead smolts were first observed in Squaw Creek. Mortalities increased through the weekend (the weir was not operated from 23-26) and began to subside on Monday the 25th. Over 4,000 dead smolts were collected at the weir or observed in Squaw Creek and the Salmon River. However, this is a minimum estimate because it does not include smolts that were flushed out of the creek and into the Salmon River. All indications are that the smolts died after release likely due to weather related conditions. Releases in Squaw Creek occurred during a period of unseasonable cold temperatures (22 through 25 April). These weather conditions decreased water temperatures in the creek to 37°C at release, which was at or below the thermal threshold for fish being released from transport trucks with relatively warm water. Furthermore these temperatures also reduced flows in the creek to 12 cfs at night, which was insufficient to sustain the fish released into the creek in the days leading up to the mortality event due to the oxygen demand they required. It is suspected that these unusual environmental conditions resulted in the mortality event.

Juvenile survival from release to Lower Granite Dam was estimated using the methods described in the “Outmigration Survival and Environmental Conditions” section in the main body of the report. Survival for DWOR and USAL smolts released at Pahsimeroi and Magic Valley fish hatcheries were similar to previous years (Table 1 and 2). However, survival for the DWOR smolts released into Squaw Creek was substantially lower than the DWOR and USAL releases at Pahsimeroi, which was likely influenced by the mortality event observed shortly after release for this group.

Table 2. Estimated percent survival from release to Lower Granite Dam for Magic Valley DWOR and USAL smolts released at Pahsimeroi Fish Hatchery and Squaw Creek from migration years 2003 through 2011.

Stock	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003-2010
DWORB	69.9	67.5	62.0	71.2	69.5	68.2	75.2	68.8	62.7	68.3
USALB[1]					69.9	78.7	73.5	84.3	89.3	79.1

[1] Prior to migration year 2010, the USAL smolts were released at Squaw Pond or Squaw Creek.

Broodstock Collection

A picket weir was installed in Squaw Creek approximately 100 m upstream from the mouth to collect returning adult steelhead. This location was chosen to limit the available spawning habitat below the weir and presumably make fish more likely to swim upstream into the trap. In the past, the weir frequently became inoperable as a result of ice or high water. One of the problems previously encountered was the trap box lifting from its position, thus allowing adults to pass around it. Since 2008, the front edge of the trap box has been fastened to the creek bottom using anchors (from American Earth Anchors) driven into the substrate, which have allowed the trap to operate a higher flows than were previously possible.

During trap operations in 2011, the trap was checked at least once per day. Captured adult steelhead were measured and DNA samples taken. All females >75 cm and males >79 cm were transferred to the East Fork facility and held until spawning. In an effort to increase the number of fish available for spawning, all CWT males (regardless of size) and females (greater than 68 cm) were also transported to the East Fork facility for possible spawning. However, only undersized fish identified as being DWOR or USAL (by reading CWT immediately prior to spawning) were used as broodstock.

Additional adults were collected from anglers who voluntarily (angler program) contributed B-run steelhead to the program. This was done because anglers are efficient at catching these large B-run fish, particularly in the hole immediately below Squaw Creek (Stiefel and Rosenberger 2011). Advertisement of the angler program was focused on the immediate area around Squaw Creek and consisted of small posters, as well as “getting the word out” through volunteers. Staff from IDFG and the Sawtooth Fish Hatchery placed and monitored live boxes and fish tubes in the Squaw Creek hole on the Salmon River. Steelhead meeting the size criteria described above were placed in the live box by anglers and subsequently transported to the East Fork facility by IDFG staff. In addition to steelhead that met the size criteria described above, steelhead that scanned positive for CWT and were within 4 cm of the minimum size criteria were also retained and transported to the East Fork facility.

Squaw Creek weir was operated from 29 March through 7 May 2011 and trapped 39 adult steelhead. The first fish retained for broodstock was trapped on 2 April and the last fish was captured on 3 May (Figure 1). Six (three females and three males) of the fish at the weir met the length criteria and were transported to the East Fork facility. One additional undersized male and four additional undersized females with CWT were transported to the East Fork facility to potentially be used as broodstock. Twelve unmarked steelhead, which averaged 68 cm in fork length (range 55- 86 cm), were released above the weir to spawn naturally.

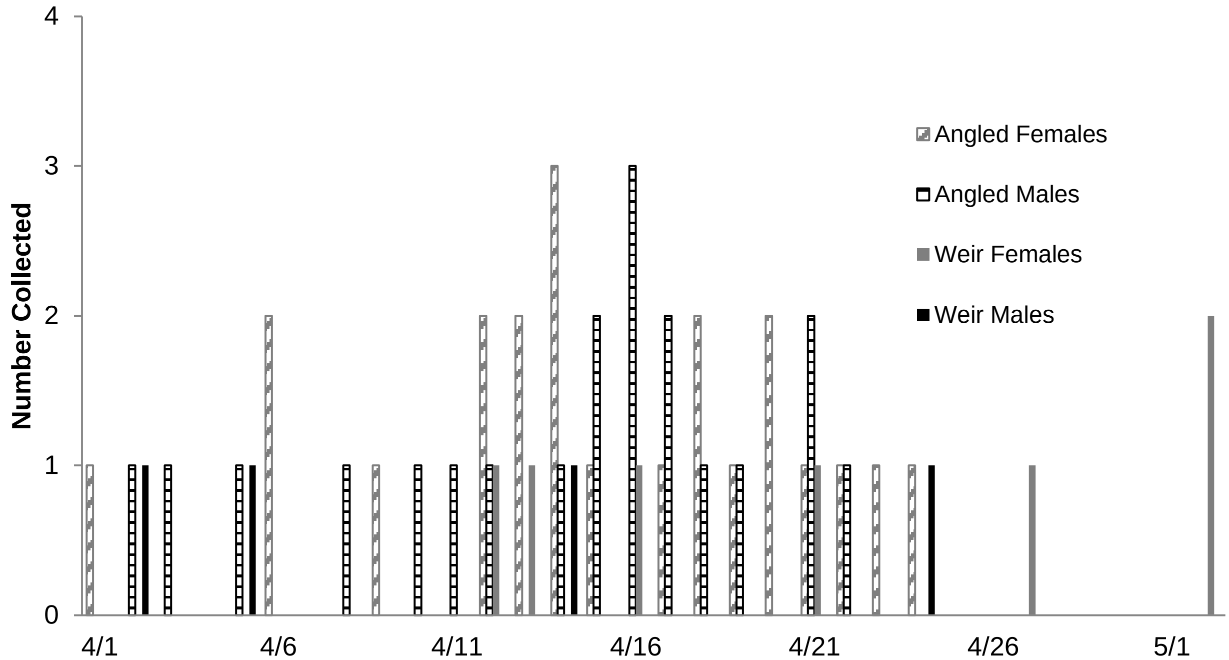


Figure 1. Run timing of adult steelhead collected for broodstock as part of the Upper Salmon River B-run project in and near Squaw Creek during the spring of 2011. "Weir" fish were collected at a temporary weir located 100 m above the mouth of Squaw Creek while the "Angler" fish were voluntarily contributed by sportsman who caught these fish in the Squaw Creek hole on the Salmon River.

The angler program was operated from 29 March through early May (due to the spring 2011 season extension) and provided an additional 42 adults (22 females, 20 males) that met the criteria for broodstock. Anglers contributed the first fish on 1 April and provided additional fish through 24 April, at which time angler success and effort substantially decreased (Figure 1). A total of 133 anglers submitted volunteer forms to contribute fish to the program and were provided postcards to report the hours which they fished to collect broodstock for the program. Shortly after the season, postcards were mailed to anglers who did not return the original postcard. As of July 2011, 50 of the 133 anglers responded (38%) accounting for 2,071 total hours (average hours per angler 41.4, range 2-414 hours). Hours of fishing contributed for the program were not estimated for non-respondents.

The 42 adult steelhead contributed by anglers represent 88% of the broodstock collected in 2011, which is substantially higher than previous three year average of approximately 50% (Stiefel and Rosenberger 2011). Two factors likely led to this skewed contribution, low flows in Squawk Creek and increased angler participation. The cold weather experienced in the spring of 2011 substantially reduced flows in Squaw Creek, which is known to reduce the number of fish entering the creek due to a barrier at its mouth during periods of flow. These conditions not only reduced trapping success of the weir but also increased the susceptibility of the fish being caught by anglers as the fish hold in the Salmon River below the creek. Although there were substantially more anglers that volunteered to be part of the program in 2011 (57 volunteered in 2010), the vast majority of fish (approximately 85-90%) were contributed by a core group of anglers which had contributed to the program in the past. Therefore the increased participation of anglers was likely not as influential as the flows in Squaw Creek in skewing the success of the programs. Regardless, the angler and weir broodstock collection programs complement one another in that early in the season when flows are low angler success is higher, while later in the season (when flows are usually higher) the weir is more successful as turbidity reduces angler success.

Spawning

The combined efforts of the weir and angler program resulted in the collection of 49 adult steelhead (26 females and 23 males) used for broodstock including two undersized females and 1 undersized male. (Snider personal communication). This is higher than the long-term average for the program (Figure 2). Of the undersized fish spawned, both females were two-ocean fish while the male was one-ocean. The majority of broodstock (40) were determined to be from USAL releases by reading CWT, while the remaining fish (9) were from DWOR releases. A total of 157,483 green eggs were produced. As in 2010, eggs were incubated to the eye-up life stage at Pahsimeroi Fish Hatchery before transfers to Magic Valley for final incubation and rearing.

A total of 117,984 eye-eggs were shipped to Magic Valley Fish Hatchery for an average eye-up rate of 74.9%. This eye-up rate was slightly higher than the long-term program average of 68.8%, but still within the range observed in the past (45.2-87.5%).

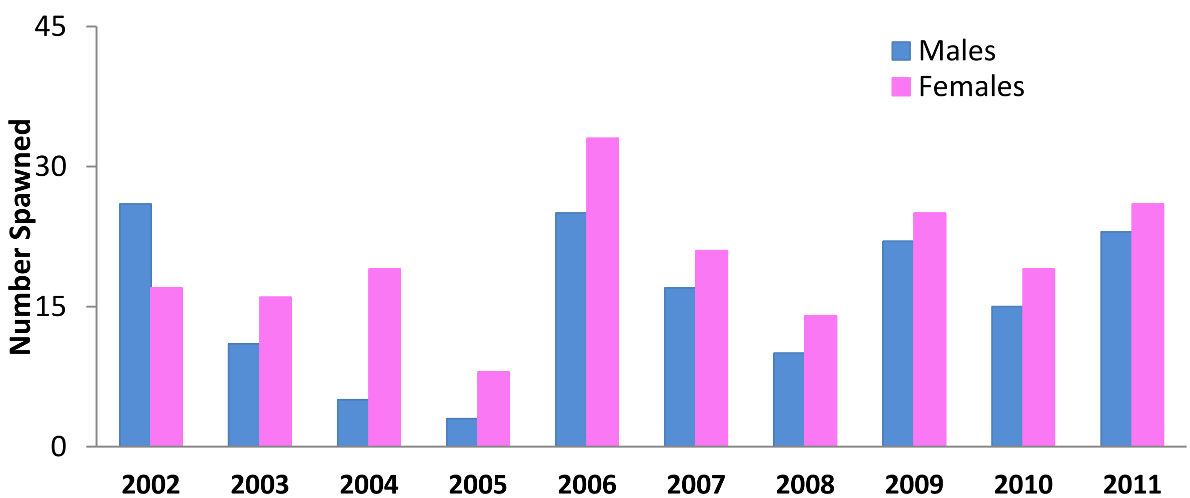


Figure 2. Annual spawning summary for the Upper Salmon River B-run program. From 2002 through 2011, a temporary weir was operated on Squaw Creek to collect steelhead. In 2008, a volunteer angler program was initiated and expanded in subsequent years.

Brood Year 2011 Smolt Production Projection

The 117,984 eyed-eggs shipped to Magic Valley Fish Hatchery should produce approximately 95,000 smolts for release in 2012 at Pahsimeroi Fish Hatchery based on the average survival for brood years 2009 and 2010. While this is below the production goal of 120,000, it will be the third largest release of USAL steelhead in the program's history (Table 2). In addition to USAL smolts, an additional 85,000 DWOR smolts will be released at Pahsimeroi Fish Hatchery as well. A portion of these DWOR smolts (25,000) is intended as backfill for USAL production, while the remaining 60,000 are being released to increase the genetic diversity of the broodstock. This was determined to be necessary after evidence of inbreeding was observed in the program.

Table 2. Summary of smolt releases associated with the Upper Salmon B-run program. The majority of releases associated with this program have occurred in Squaw Creek or Squaw Pond. Since brood year 2009, all USAL smolts have been released at the Pahsimeroi Weir.

	Stock		
Brood Year	**DWOR**	**USAL**	**Total**
2002	265,009	58,140	323,149
2003	263,576	58,377	321,953
2004	295,897	35,448	331,345
2005	249,508	31,015	280,523
2006	191,726	127,266	318,992
2007	246,495	62,314	308,809
2008	279,050	57,649	336,699
2009	277,619	95,023	372,642
2010	280,753	91,525*	372,278

*An additional 30,307 DWOR smolts were released.

Preliminary Stock Performance Evaluation

Stock performance (survival) was evaluated for Brood Year 2007 USAL and DWOR releases at Squaw Creek throughout the majority of their life cycle. Eyed-egg-to-smolt survival information was compiled from hatchery reports. Significant differences in survival from release to Lower Granite Dam were determined by reviewing the confidence intervals for the survival estimates; see the "Outmigration Survival and Environmental Conditions" section of this report. Adult PIT tag detections at Lower Granite Dam were used to estimate age composition, and overall smolt-to-adult return rate for total returns (both ocean age classes combined). A Z-test (alpha = .05) was used to test for differences in smolt-to-adult survival for PIT-tagged DWOR and USAL smolts.

The 2010/2011 run marked the first return of two-ocean adults (Brood Year 2007), which were PIT-tagged in sufficient quantities allowing for the estimation of SARs for each stock. It is important to note that the three-ocean returns for these releases have not yet returned, which may influence these results. However, three-ocean adults are rare even for these stocks; therefore, these results are not likely to change significantly. Regardless, data for Brood Year 2007 will be reanalyzed once the 2011/2012 run is complete to include any three-ocean adults that return.

Survival for USAL and DWOR smolts was similar during the hatchery rearing phase of the life cycle but differences in survival did become apparent after release (Table 3, Lowell et al. 2008). USAL smolts had significantly higher juvenile survival rates to Lower Granite Dam than DWOR smolts. This difference in survival increased even further when the fish returned as adults with the USAL stock having significantly higher survival rates to Lower Granite Dam (Z = 2.56; P = 0.011). These results are similar to previous evaluations using CWT in that USAL smolts survived at higher rates to the adult life stage (IDFG unpublished data). PIT-tagged DWOR adult returns were entirely two-ocean fish, while 77% of USALB adults returned as two-ocean fish. This pattern of the USAL stock returning a lesser proportion of two-ocean than its ancestral DWOR stock has been observed in CWT recoveries in the past as well; however, one-ocean DWOR typically account for approximately 15% of a brood (IDFG unpublished data). The reason for this apparent shift in the age at maturation is unknown. Potential explanations include accidental inclusion of A-run genetics into the program, as broodstock releases were previously not differentially marked, or selective pressures that may have shifted the age at maturity for these fish. Regardless, USAL releases currently return significantly more adult steelhead than a similarly sized DWOR smolt release and the majority of USAL resides in the ocean for two years, which is the program's goal.

Table 3. Comparison of survival throughout life cycle for Brood Year 2007 DWOR and USAL releases at Squaw Creek from PIT tag data. A smolt-to-adult rate (SAR) was generated for each release group returning to Lower Granite Dam (LGD).

Stock	**DWOR**	**USAL**
Eyed-egg to Smolt Survival	89.6	88.2
Number of PIT-tagged Smolts*	3,393	4,359
Survival from Release to LGD as Juveniles (95% CI)	70.7 (±2.3)	78.7(±2.7)
SAR (%)	0.47	1.01
PIT-tagged adults detected at LGD*	16	44
Proportion of two-ocean adults	100	77

* Run-at-large juvenile migration group.

LITERATURE CITED

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