FISHERY RESEARCH

2012 CALENDAR YEAR HATCHERY CHINOOK SALMON REPORT:

IPC AND LSRCP MONITORING AND EVALUATION PROGRAMS IN THE STATE OF IDAHO

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2012 Calendar Year Hatchery Chinook Salmon Report: IPC and LSRCP Monitoring and Evaluation Programs in the State of Idaho

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INTRODUCTION

This report details various components of hatchery-origin spring, summer, and fall Chinook salmon monitoring, evaluation, and management for calendar year 2012. Information is provided for Chinook salmon from six different hatcheries operated by the Idaho Department of Fish and Game (IDFG). These facilities include three hatcheries funded by the Lower Snake River Compensation Plan (LSRCP) and three hatcheries funded by the Idaho Power Company (IPC).

The LSRCP Chinook salmon hatchery mitigation program was established to provide in-kind and in-place mitigation for lost harvest opportunity resulting from the construction and operation of the four lower Snake River hydroelectric dams. The total mitigation goal for the LSRCP is 293,500 adults to be produced annually. This goal is based on an assumed 4:1 ratio of catch (downstream of project area; Lower Granite Dam) to escapement (upstream of the project area) (Corps of Engineers 1975). During the program development, it was anticipated that the majority of the harvest mitigation benefits would be distributed downstream of the project area. However, less than expected returns of hatchery fish produced within the program and the depressed status of natural-origin fish influenced Columbia River fisheries management programs. The anticipated 4:1 distribution of harvest benefits downstream: upstream of Lower Granite Dam has not been realized. Regardless of the actual distribution of harvest benefits, it was anticipated that the spring/summer Chinook salmon hatchery programs in Idaho operated by IDFG at Clearwater, McCall and Sawtooth fish hatcheries would contribute 196,800 (67% of the total) adults annually towards the total LSRCP mitigation goal.

The LSRCP program operated by IDFG includes a spring Chinook salmon program at the Sawtooth Fish Hatchery (SFH), a summer Chinook salmon program at the McCall Fish Hatchery (MFH), and a combination spring/summer Chinook salmon program at the Clearwater Fish Hatchery (CFH). Sawtooth Fish Hatchery is located on the upper Salmon River approximately six miles upriver from Stanley, Idaho and has a satellite facility on the East Fork Salmon River (Figure 1). The hatchery was constructed in 1985 and has a current production goal of 1.8 million yearling smolts. The annual adult production goal for SFH is 97,225. Initial modeling specified the need to release 2.3 million smolts to meet the production goal. However, current hatchery capacity at SFH is 1.8 million yearling smolts. Clearwater Fish Hatchery is located at the confluence of the North Fork and main-stem Clearwater rivers near Ahsahka, Idaho. There are three satellite facilities associated with CFH. One satellite facility is on the upper Lochsa River at Powell and the other two are on tributaries to the South Fork Clearwater River: one on Red River and one on Crooked River (Figure 1). The hatchery was constructed in 1992 and has a smolt release goal of 2.3 million yearling smolts and 0.3 million subyearling parr. The annual adult production goal for CFH is 59,575. McCall Fish Hatchery is located on the Payette River just downstream from Payette Lake in McCall, Idaho and has a satellite facility on the South Fork Salmon River (Figure 1). The hatchery was constructed in 1980 and has a production goal of 1.0 million yearling smolts. The total annual production goal for MFH is 40,000 adults.

The IPC programs include a spring Chinook salmon program at the Rapid River Fish Hatchery, a summer Chinook salmon program at the Pahsimeroi Fish Hatchery, and a fall Chinook salmon program at the Oxbow Fish Hatchery. Rapid River Fish Hatchery is located on Rapid River, a tributary of the Little Salmon River approximately seven miles from the town of Riggins, Idaho (Figure 1). The hatchery was constructed in 1964 and has a production goal of three million yearling smolts. Pahsimeroi Fish Hatchery is comprised of two separate facilities located on the Pahsimeroi River approximately one and seven miles from the confluence with the Salmon River near the town of Ellis, Idaho (Figure 1). The hatchery was constructed in 1968 and

has a production goal of one million yearling smolts. Oxbow Fish Hatchery is located on the Snake River downriver of Oxbow Dam near the IPC village known as Oxbow, Oregon (Figure 1). The hatchery was constructed in 1962 and has a production goal of 200,000 subyearling fall Chinook salmon. In addition to fall Chinook salmon production at Oxbow Fish Hatchery, IPC also funds the production of up to 800,000 fall Chinook salmon subyearlings reared at the Oregon Department of Fish and Wildlife's Irrigon Hatchery near the town of Irrigon, Oregon. The fall Chinook salmon reared at both Oxbow and Irrigon fish hatcheries are transported by IPC and released into the Snake River immediately downriver from Hells Canyon Dam.

Because this report outlines a calendar year, data from multiple brood years are included. Brood year-specific reports are produced annually by monitoring and evaluation (M&E) staff and are available as IDFG reports at the following web address: https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Forms/Show%20All%20Reports.aspx. Because of the five-year life cycle of Chinook salmon and the typical two-year delay in downriver harvest reporting, the most recent brood year report available is current year minus seven.

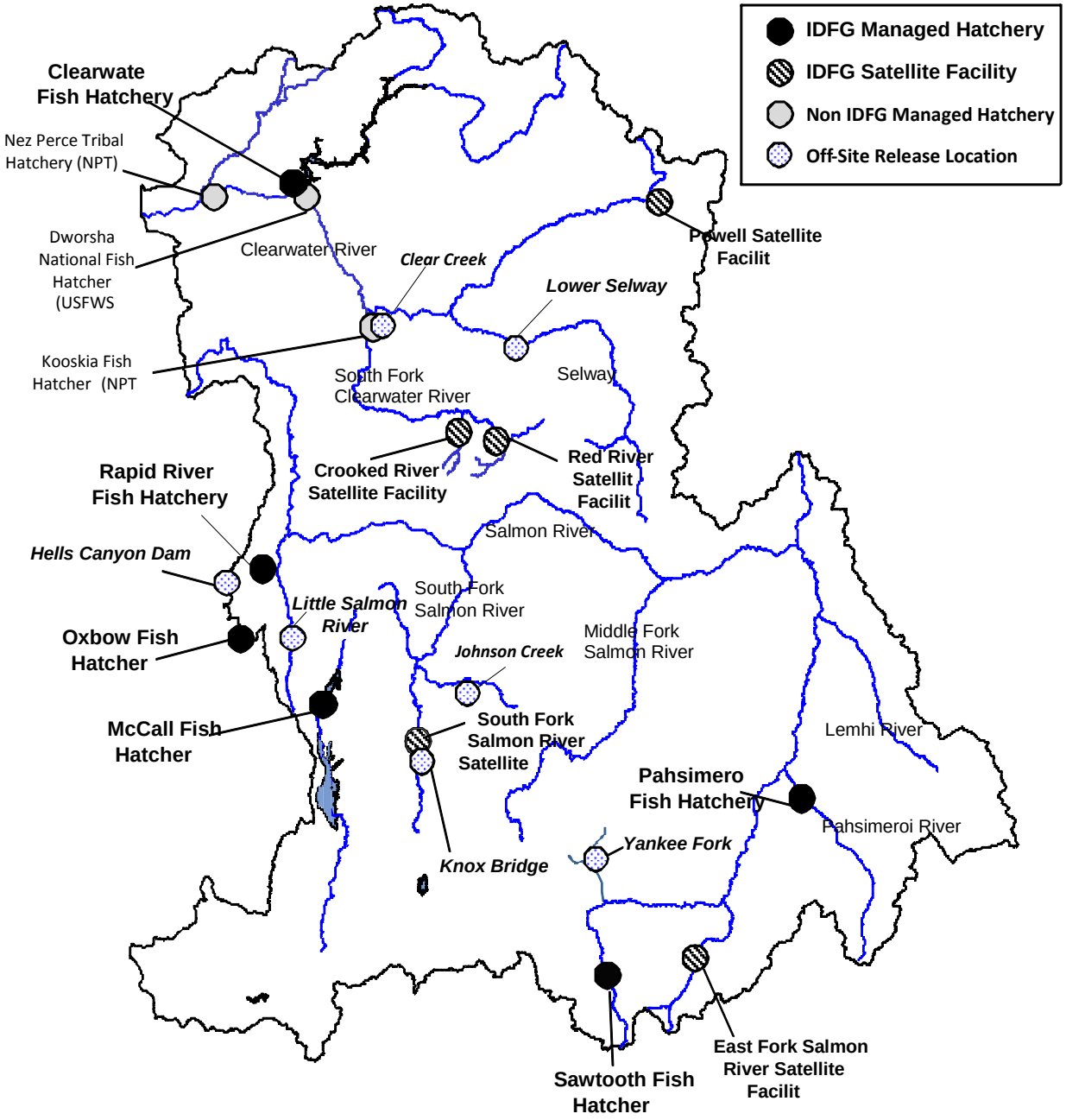

Figure 1. State, federally, and tribally operated anadromous fish hatcheries located in the Clearwater, Salmon, and mid-Snake river basins along with associated satellite facilities and off-site release locations.

JUVENILE PRODUCTION AND RELEASE

Marking

All marks and tags that were applied to Chinook salmon released in 2012 are outlined in Table 1. 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 "Idaho Anadromous Fish Marking Program for Steelhead and Chinook and Sockeye Salmon—2012 Marking Season". This report will be available through IDFG at the following web site: https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Forms/Show%20All%20Reports.aspx.

During calendar year 2012, various mark and loading plans were cooperatively developed to outline tagging and marking procedures in upcoming years. In May 2012, a mark plan was developed that outlined preliminary mark and tag numbers for brood year 2012 Chinook salmon. In November 2012, 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 by M&E staff with input from hatchery staff and 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 maintaining a manageable tagging and rearing scheme.

Under current operations, Chinook salmon typically can receive one type of mark (Adipose fin clip) and two types of physical tags (CWT and 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 adipose fin 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-adipose clipped hatchery fish are released to meet other management objectives. However, these fish contain a secondary mark or tag that makes them distinguishable as hatchery-origin when they return.

Coded Wire Tags

Coded wire tags are an important tool for monitoring and evaluating Chinook salmon post release and are used to generate stock and brood year specific harvest and stray rate estimates outside of Idaho. These tags are also used to estimate the stock and age composition of Chinook salmon harvest in mixed stock fisheries within the state of Idaho. In addition, CWTs 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 2012 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, 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 Chinook salmon. PIT tags allow us to generate estimates of juvenile survival to LGD and juvenile travel time through the Snake River and Columbia River hydrosystem. In adult returns, PIT tags provide adult return timing through the hydrosystem, adult conversions between dams, and rates of fallback/reascension and after-hours passage at the dams. Additionally, PIT tags are used to generate stock- and age-specific estimates of return numbers to various dams. These estimates are available in real-time and are used to manage fisheries in-season. They are also used to assess smolt-to-adult return rates and levels of mitigation goals met, post-season. All of these parameters are outlined in this report.

All PIT tags implanted in spring/summer Chinook salmon go through the sort-by-code process prior to juvenile outmigration. The sort-by-code process enables managers to predetermine how a PIT-tagged fish will be treated if detected in one of the juvenile bypass systems at a Snake River or Columbia River dam. As part of ongoing research for the Comparative Survival Study (CSS), sort-by-code is used to determine if a PIT tag fish should be treated as the run-at-large or by default, returned to the river. The majority of PIT tags (about 70%) are assigned to the run-at-large group, which means if detected, they will either be transported downriver on a barge or truck, or returned back to the river based on what the current protocol is at that particular dam for the untagged population. The remaining 30% are assigned to the return-to-river group and are treated independently of the untagged population and automatically returned to the river, if detected. Because the run-at-large component represents the untagged population, they are the only tags that are expanded to generate the adult return estimates outlined above. More details on the CSS study can be found in the study's 2011 annual report (Comparative Survival Study Oversight Committee and Fish Passage Center the 2011 annual report, 2011) (http://www.fpc.org/documents/CSS.html).

Releases

Juvenile Chinook salmon were released starting in March and continued through May of 2012. The majority of these releases were spring/summer yearling smolt releases. However, the fall Chinook salmon from Oxbow and Irrigon fish hatcheries were released as subyearlings. In addition to the spring releases, there was also a release of subyearling spring Chinook salmon parr from Clearwater Fish Hatchery into the Selway River in the late summer. All 2012 Chinook salmon releases were at or near the release goals of each facility outlined in the Introduction section (Table 1). All release information was submitted to the Regional Mark Information System (RMIS) by August of 2012. Release locations are shown in Figure 1.

Table 1. Juvenile Chinook salmon released in 2012 from hatcheries operated by IDFG.

Migr. Year	Hatchery	Rel. Site	Release Date(s)	AD Only	AD/CWT	CWT Only	PIT TAG*	Total Release
2012	McCall (Seg.)	SFSR-Knox	3/19 - 3/21	661,599	125,489	0	27,935	787,088
2012	McCall (Int.)	SFSR-Knox	3/20 - 3/21	0	0	241,265	25,966	241,265
McCall Total Release				**661,599**	**125,489**	**241,265**	**53,901**	**1,028,353**
2012	Rapid River	Rapid R. Ponds	3/12 - 4/27	2,383,165	115,032	0	51,938	2,498,197
2012	Rapid River	Little Sal. R.	3/16	200,000	0	0	0	200,000
2012	Rapid River	Hells Can. Dam	3/12 - 3/15	418,000	0	0	0	418,000
Rapid River Total Release				**3,001,165**	**115,032**	**0**	**51,938**	**3,116,197**
2012	Clearwater	Powell	3/27 - 3/28	290,002	117,968	0	17,121	407,970
2012	Clearwater	Red River	3/28 - 4/5	1,002,863	120,076	0	17,045	1,122,939
2012	Clearwater	Crooked River	3/26	0	0	206,317	25,482	206,317
2012	Clearwater	Selway River	3/21 - 3/22	152,915	122,220	140,234	16,978	415,369
2012	Clearwater	Clear Cr	3/22	119,266	115,245	0	17,087	234,511
2013**	Clearwater	Selway River	6/18 - 6/25	0	0	0	0	340,020
Clearwater Total Release				**1,565,046**	**475,509**	**346,551**	**93,713**	**2,387,106**
2012	Sawtooth (Seg.)	Sawtooth Weir	4/6	961,443	118,721	0	18,051	1,080,164
2012	Sawtooth (Int.)	Sawtooth Weir	4/6	0	0	179,021	990	179,021
2012	Sawtooth	Yankee F. (Dir.)	4/4	0	0	98.518	1,687	98,518
2012	Sawtooth	Yankee F. (Acc.)	4/3	0	0	98,518	1,694	98,518
Sawtooth Total Release				**961,443**	**118,721**	**376,057**	**22,422**	**1,456,221**
2012	Pahsimeroi (Seg.)	Pahsim. Ponds	4/1 – 4/18	729,344	118,236	0	21,374	847,580
2012	Pahsimeroi (Int.)	Pahsim. Ponds	4/1 – 4/18	0	0	179,269	999	179,269
Pahsimeroi Total Release				**729,344**	**118,236**	**179,269**	**22,373**	**1,026,849**
2012***	Oxbow	Hells Can. Dam	5/3	14,954	187,146	0	14,910	202,281
2012***	Irrigon	Hells Can. Dam	5/22, 5/24	587,232	200,844	273	36,927	800,400
Oxbow / Irrigon Total Release				**602,186**	**387,990**	**273**	**51,837**	**1,002,681**
Totals				**7,520,783**	**1,340,977**	**1,143,415**	**296,184**	**10,017,407**

* PIT tag total is not in addition to other mark/tag columns but is included in those groups.
** Brood year 2010 parr that were only PBT marked, released in 2012, and will out-migrate in 2013.
*** These groups are fall Chinook salmon released as sub-yearlings.

Juvenile Survival and Out-migration Conditions

Juvenile survival rates of PIT-tagged Chinook salmon are estimated from release to LGD 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% confident intervals. The program uses the Cormack-Jolly-Seber model (Cormack 1964; Jolly 1965; Seber 1965) for single release and multiple recapture events that accounts for differences in collection efficiency at the main-stem Snake River and Columbia River dams.

In 2012, juvenile smolt survival rates to LGD ranged from 29.6% for the release into the Yankee Fork of the Salmon River, to 75.5% for the spring Chinook salmon released into Clear Creek (Table 2). Survivals in 2012 were variable when compared to the previous nine-year unweighted averages. The yearly unweighted average for 2012 was slightly lower than the overall previous nine-year average (Table 3). In September of 2011, a group of 2,000 PIT tags were applied at McCall Fish Hatchery to compare juvenile survivals to LGD between fall tagged and the two 25,000 tag groups (one integrated, one segregated) tagged in the spring. The group tagged in the fall had significantly higher juvenile survival rates to LGD (Table 2) and the comparison will be continued for the 2013 releases.

River flow conditions during juvenile releases and out-migration are included in Appendix A of this document. Based on previous year's monitoring, releasing fish prior to increases in spring discharge appears to be correlated with higher juvenile survivals to LGD. In 2012, all

smolt releases occurred prior to upswings in spring discharge. Appendix B shows that the majority of juvenile spring/summer Chinook salmon released in the Salmon River crossed LGD in a 30-day window from mid-April to mid-May. However, there was also a bimodal arrival of juveniles from the Selway and Clear Creek releases and a significant pulse of those groups arrived in late March (Appendix B3). Unlike 2011, there was not a significant increase in outflow at LGD during juvenile outmigration, but only a moderate spike in late April. Fall Chinook salmon arrived at LGD from late May to mid- June.

Table 2. Juvenile hatchery Chinook salmon survival and travel time estimates to Lower Granite Dam for release year 2012.

Release Group	PIT Tags Released	Release Date	Size at Rel. (fpp)	Km to LGD	Average Travel Time	50% Passage Date	80% Arrival Window	Survival ± 95% CI
Clear Creek	17,087	3/22	15.6	176	25 Days	19-Apr	3/28 - 4/29 (33 Days)	**75.5% ± 2.0**
Powell Pond	17,121	3/27, 28	16.8	321	30 Days	25-Apr	4/15 - 5/10 (25 Days)	**68.1% ± 2.0**
Red River Pond	17,045	3/28- 4/5	16.6	299	31 Days	1-May	4/18 - 5/17 (29 Days)	**64.8% ± 2.2**
Crooked R. Trap	25,482	3/26	17.8	280	29 Days	23-Apr	4/12 - 5/8 (26 Days)	**57.4% ± 1.3**
Selway River	16,978	3/21, 22	17.3	240	26 Days	19-Apr	3/28 - 4/28 (31 Days)	**70.6% ± 2.6**
SF Salmon R. (Seg.)	25,951	3/19- 3/21	21.4	457	45 Days	30-Apr	4/25 - 5/16 (21 Days)	**55.0% ± 1.4**
SF Salmon R, (Int.)	25,966	3/20, 21	18.7	457	43 Days	29-Apr	4/24 - 5/14 (20 Days)	**59.2% ± 1.7**
SF Salmon R. (Fall Tag)	1,984	3/19- 3/21	21.4	457	46 Days	2-May	4/26 - 5/15 (19 Days)	**68.1% ± 7.1**
Pahsimeroi Ponds (Seg.)	21,374	4/1- 4/18	14.4	630	N/A	19-Apr	4/13 - 4/25 (12 Days)	**58.0% ± 1.1**
Pahsimeroi Ponds (Int.)	999	4/1- 4/18	14.4	630	N/A	20-Apr	4/13 - 4/25 (12 Days)	**59.1% ± 5.2**
Rapid River Ponds	51,938	3/12- 4/27	16.4	283	27 Days	10-May	4/25 - 5/17 (22 Days)	**74.5% ± 1.3**
Sawtooth Weir (Seg.)	18,051	4/6	28.3	747	29 Days	4-May	4/26 - 5/17 (21 Days)	**47.4% ± 1.5**
Sawtooth Weir (Int.)	990	4/6	27.0	747	27 Days	4-May	4/25 - 5/16 (21 Days)	**42.6% ± 4.4**
Yank. Fk. @ 2nd Bridge	1,687	4/4	23.0	729	30 Days	2-May	4/25 - 5/17 (22 Days)	**29.6% ± 3.2**
Yank. Fk. @ Dredge P.	1,694	4/3	23.0	721	32 Days	3-May	4/25 - 5/18 (23 Days)	**29.9% ± 2.8**
Oxbow (HCD)	14,910	5/3	48.0	222	29 Days	2-June	5/23 - 6/7 (16 Days)	**73.6% ± 3.1**
Irrigon (HCD)	36,927	5/22, 5/24	46.0	222	19 Days	9-June	6/3 - 6/19 (16 Days)	**75.2% ± 3.2**

Table 3. Ten-year comparison of juvenile hatchery Chinook salmon survival estimates (percent survival) to Lower Granite Dam and a nine-year unweighted average, by site.

Hatchery	Release Site	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Site Ave. (2003-2011)
Clearwater	Clear Cr.							78.7	80.7	78.9	**75.5**	**79.4**
	Powell Pond	86.2	77.5	83.6	79.0	77.5	36.1	63.1	67.1	76.1	**68.1**	**71.8**
	Red R. Pond	59.6	72.2	67.6	52.4	81.8	65.9	36.2	70.3	32.2	**64.8**	**59.8**
	Selway River						69.0	72.2	79.5	75.5	**70.6**	**74.1**
	Crooked R. Trap									52.7	**57.4**	**52.7**
McCall	SF Salmon R. (Seg.)	57.4	59.4	60.4	63.8	55.0	58.7	51.2	56.5	62.9	**55.0**	**58.4**
	SF Salmon R. (Int.)										**59.2**	
Pahsimeroi	Pahsimeroi (Seg.)	71.4	50.5	22.1	26.7	53.0	44.6	50.9	37.3	51.1	**58.0**	**45.3**
	Pahsimeroi (Int.)										**59.1**	
Rapid River	Rapid River Ponds	69.2	69.4	73.6	75.9	74.2	80.6	72.6	78.1	77.6	**74.5**	**74.6**
Sawtooth	Sawtooth (Seg.)	61.1	58.0	22.0	65.3	57.5	34.1	36.6	42.3	53.1	**47.4**	**47.8**
	Sawtooth (Int.)										**42.6**	
	Yank. Fk. 2nd Bridge								47.7	30.3	**29.6**	**39.0**
	Yank. Fk. Dredge Ponds								54.2	37.2	**29.9**	**45.7**
Oxbow	Hells Canyon Dam	57.0	43.8	66.6	81.8	64.3	80.2	66.4	45.4	75.8	**73.6**	**64.6**
Irrigon	Hells Canyon Dam				75.7		80.6	59.9	58.9	62.0	**75.2**	**67.4**
Yearly Unweighted Average		**66.0**	**61.5**	**56.6**	**65.1**	**66.2**	**61.1**	**58.8**	**59.8**	**58.9**	**58.8**	**60.6**

ADULT RETURNS

Adult Chinook salmon from brood years 2009, 2008, and 2007 returned to Idaho in 2012 as one-, two-, and three-ocean adults, respectively. This section outlines various metrics of adult monitoring as well as adult accounting back to Bonneville Dam, LGD, in the sport harvest upstream of LGD, and back to hatchery traps for spring and summer Chinook salmon. Strays recovered upstream of LGD are also included. Escapement of hatchery fish upstream of IDFG weirs is not included in this report, as those estimates are not all available prior to the deadline of this report. Due to differences in management practices and data availability for fall Chinook salmon, they are not included in the majority of the adult return sections, with the exception of the Idaho Sport Harvest section, where preliminary numbers are reported.

Preseason Forecasted Adult Returns

Forecasted adult returns for Idaho stocks are generated by IDFG using sibling regressions. A regression of historic jack vs. the two-ocean returns, from the same cohort, is used to forecast an individual hatchery's two-ocean return. The same methodology is used to forecast three-ocean returns from the previous year's two-ocean return. The regressions use hatchery-specific run reconstructions, by age, at the Columbia River mouth. The forecasted total adult return to the Columbia River mouth, for each hatchery, is the sum of the forecasted two- and three-ocean returns. Stock-specific conversion rates based on historic interdam conversions are applied to each hatchery-specific forecast to the Columbia River mouth to generate stock-specific forecasts to LGD. To generate forecasts for untagged off-site releases, a surrogate release group is used. For example, to forecast a return for Rapid River spring Chinook salmon released at Hells Canyon Dam, the forecasted adult return per smolt released for Rapid River Hatchery is multiplied by the known number of smolt released at Hells Canyon Dam. Table 4 provides a breakdown of the 2012 adult return forecast by hatchery and stock to the Columbia River mouth, Bonneville Dam, and LGD.

Table 4. Summary of forecasted adult (two- and three-ocean) spring/summer Chinook salmon returns in 2012 by hatchery and stock to the Columbia River mouth, Bonneville Dam, and Lower Granite Dam.

Hatchery	Release Site	Columbia River Mouth Preseason Forecast	Bonneville Dam Preseason Forecast	Lower Granite Dam Preseason Forecast
Clearwater	Upper Selway	4,215	3,335	2,268
Clearwater	Powell Pond	6,418	5,078	3,453
Clearwater	SF Clearwater*	10,442	8,262	5,453
Clearwater	Clear Creek	2,613	2,067	1,406
Total Clearwater R.		**23,688**	**18,742**	**12,580**
Rapid River	Rapid River Ponds	36,498	26,191	17,286
Rapid River	Hells Canyon Dam	7,300	5,239	3,457
Rapid River	Little Salmon River	3,322	2,384	1,573
Pahsimeroi	Pahsimeroi Ponds	2,317	2,036	1,547
Sawtooth	Sawtooth Hatchery	12,612	11,509	10,358
McCall	SF Salmon River	15,550	13,863	11,645
Total Salmon R.		**75,599**	**61,222**	**45,866**
	TOTALS	**99,287**	**79,964**	**58,446**

***** The Crooked River and Red River release sites are combined to make up the South Fork Clearwater stock.

PIT Tag Return Estimates to Bonneville and Lower Granite Dams

The majority of the release groups of Chinook salmon returning to Idaho in 2012 had a representative group of PIT tags. The detections of run-at-large tags in returning fish at Bonneville, McNary, Ice Harbor, and Lower Granite dams were expanded by the juvenile tagging rates to generate an estimate of age-3, -4, and -5 Chinook salmon, by stock and release site, back to each dam. For releases that were not PIT tagged, a surrogate release was used to generate return estimates. Some returns are corrected postseason using tagged to untagged ratios obtained from in-ladder PIT tag arrays at hatchery traps (see Research section, Estimating a Correction Factor for PIT Tag Expansions in Returning Chinook Salmon, in this report). Previous data indicates that PIT tags generally underestimate the number of untagged fish returning due to tag shedding and differential mortality (IDFG unpublished data). Return estimates that are not corrected postseason are likely an underestimate of actual returns. Table 5 provides these expanded estimates to Bonneville Dam, and Table 6 provides the estimates to LGD. Table 7 compares preseason forecasted adult return estimates to LGD and estimated returns from PIT tag expansions. All PIT tag detections are corrected for interrogation efficiencies at each dam. In 2012, adult returns from most of the release sites were less than the preseason forecasted estimates to Bonneville Dam (Table 7).

Table 5. Estimated escapement of returning spring/summer Chinook salmon to Bonneville Dam in return year 2012. Estimates are based on expanded PIT tag detections.

Release Hatchery	Release Site	One-Ocean	Two-Ocean	Three-Ocean	Total
Clearwater	Selway River	35	2,455	239	2,729
Clearwater	Powell Pond	36	1,389	180	1,605
Clearwater**	Crooked River	68	NA	62	130
Clearwater**	Red River	93	5,869	144	6,106
Clearwater	Clear Creek	49	1,491	109	1,649
Total Clearwater R.		**281**	**11,204**	**734**	**12,219**
Rapid River	Rapid River Ponds	615	14,409	2,553	17,577
Rapid River	Hells Canyon Dam*	99	2,893	512	3,504
Rapid River	Little Salmon River*	50	785	204	1,039
Sawtooth**	Sawtooth Weir	402	5,139	100	5,641
Sawtooth	Yankee Fork	0	1,042	NA	1,042
Pahsimeroi	Pahsimeroi Ponds	0	466	322	788
McCall**	SF Salmon R. - Knox	1,021	6,916	1,973	9,910
Total Salmon R.		**2,187**	**31,650**	**5,664**	**39,501**
GRAND TOTAL		**2,478**	**42,854**	**6,398**	**51,720**

***** Because these releases did not have PIT tags, estimates for these release sites were generated using SARs from the Rapid River Hatchery release as a surrogate.

****** Estimates for these facilities were corrected postseason using true adult PIT tag rates generated from in-ladder arrays at the Sawtooth, SFSR, Crooked River, and Red River traps.

Table 6. Estimated escapement of returning spring/summer Chinook salmon to Lower Granite Dam in return year 2012. Estimates are based on expanded PIT tag detections.

Release Hatchery	Release Site	One-Ocean	Two-Ocean	Three-Ocean	Total
Clearwater	Selway River	35	1,704	160	1,899
Clearwater	Powell Pond	36	1,096	46	1,178
Clearwater**	Crooked River	67	NA	62	129
Clearwater**	Red River	93	4,268	73	4,434
Clearwater	Clear Creek	49	1,012	55	1,116
Total Clearwater R.		**280**	**8,080**	**396**	**8,756**
Rapid River	Rapid River Ponds	547	8,748	1,312	10,607
Rapid River	Hells Canyon Dam*	88	1,757	263	2,108
Rapid River	Little Salmon River*	44	476	105	625
Sawtooth**	Sawtooth Weir	402	4,188	80	4,670
Sawtooth	Yankee Fork	0	783	NA	783
Pahsimeroi	Pahsimeroi Ponds	0	389	193	582
McCall**	SF Salmon R. – Knox	830	5,349	1,077	7,256
Total Salmon R.		**1,911**	**21,690**	**3,030**	**26,631**
GRAND TOTAL		**2,202**	**29,770**	**3,426**	**35,398**

***** Because these releases did not have PIT tags, estimates for these release sites were generated using SARs from the Rapid River Hatchery release as a surrogate.

****** Estimates for these facilities were corrected postseason using true adult PIT tag rates generated from in-ladder arrays at the Sawtooth, SFSR, Crooked River, and Red River traps.

Table 7. Comparison of preseason forecasted returns versus estimated returns to Bonneville Dam based on expansions of PIT tag detections.

Release Hatchery	Release Site	Preseason Forecasted Return (Two- and Three-Ocean Combined)	Estimated Return from PIT Expansions (Two- and Three-Ocean Combined)
Clearwater	Selway River	3,335	2,694
Clearwater	Powell Pond	5,078	1,569
Clearwater**	SF Clearwater	8,262	6,075
Clearwater	Clear Creek	2,067	1,600
Total Clearwater R.		**18,742**	**11,938**
Rapid River	Rapid River Hatchery	26,191	16,962
Rapid River	Hells Canyon Dam*	5,239	3,405
Rapid River	Little Salmon River*	2,384	989
Sawtooth**	Sawtooth Hatchery	11,509	5,239
Pahsimeroi	Pahsimeroi Hatchery	2,036	788
McCall**	SF Salmon River	13,863	8,889
Total Salmon R.		**61,222**	**36,272**
GRAND TOTAL		**79,964**	**48,210**

***** Because these releases did not have PIT tags, estimates for these release sites were generated using SARs from the Rapid River Hatchery release as a surrogate.

****** Estimates from PIT tags for these facilities were corrected postseason using true adult PIT tag rates generated from in-ladder arrays at the Sawtooth, SFSR, Crooked River, and Red River traps.

Accountability of the Run at LGD using PIT Tag Expansions

Using PIT tag expansions to estimate stock-, age-, and origin-specific returns to LGD is a valuable in-season harvest management tool as well as a valuable post-season run reconstruction tool. However, we know from double marking studies and analysis of in-trap PIT tag arrays at hatcheries, that returning adults have a lower ratio of tagged to untagged fish than those same groups had when they were tagged as juveniles. This difference in tagged to untagged ratios in the adult return is likely due to some level of tag shedding, tag malfunction, and differential survival between tagged and untagged fish. To better understand how well PIT tag expansions account for hatchery returns to LGD, we evaluated the percentage of the corrected window counts that were accounted for by expanded PIT tag estimates for jacks and adults, and the total return in return years 2009, 2010, 2011, and 2012 (Table 8). In 2012, jack accountability was the lowest we have seen in the four years of monitoring but overall accountability was similar to previous years. The main driver between the differential accountability percentages between jacks and adults is the 52 cm length cutoff used at the LGD window to determine if a fish is a jack or an adult. Because many of the jacks returning to Idaho are greater than this cutoff, window counts of jacks are biased low and counts of adults are biased high. Our accountability exercise has indicated that PIT tags do indeed underestimate returning hatchery-origin Chinook salmon and that the overall level of underestimation is fairly consistent across time.

Table 8. Percentage of the corrected window counts at LGD that expanded PIT tags account for in returning jacks, adults, and total returns of spring/summer Chinook salmon in 2010, 2011, and 2012.

Final LGD Accountability	2009		2010		2011		2012	
	Adults	**Jacks**	**Adults**	**Jacks**	**Adults**	**Jacks**	**Adults**	**Jacks**
LGD Window Count	64,097	47,402	122,234	11,499	96,106	38,488	79,529	5,242
Adjustment for Reascension	-3,910	-5,072	-7,212	-851	-14,512	-5,966	-4,326	-215
Adjustment for after hrs. passage	2,692	1,564	3,545	483	6,920	1,809	3,046	222
Adjusted Lower Granite Count	62,879	43,894	118,567	11,131	88,514	34,331	78,249	5,249
SUM of Adjusted Counts	106,773		129,698		122,845		83,498	
Estimate Of Unclipped Fish*	15,057	6,503	31,281	2,526	23,987	6,111	24,941	1,791
Estimate of Clipped ID Hatchery Fish**	27,409	31,022	53,607	7,828	43,053	20,978	33,917	1,925
Estimate of Clipped OR / NPT Hatchery Fish***	4,400	10,444	8,018	1,897	5,002	4,878	5,077	378
Total LGD Estimate	46,866	48,034	92,906	12,251	72,042	31,967	63,935	4,094
SUM of LGD Estimates	94,900		105,157		104,009		68,029	
% of Window Count Adult/Jack Estimate	**74.5%**	**109.4%**	**78.4%**	**110.1%**	**81.4%**	**93.1%**	**81.7%**	**78.0%**
% of Window Count for Total Estimate	**88.9%**		**81.1%**		**84.7%**		**81.5%**	

* Estimates of unclipped fish are provided by the U.S. Army Corps of Engineers (John Dalen, personal communication).

** ID hatchery fish estimate is NOT corrected for PIT tag expansions for sites with in-ladder PIT arrays (Sawtooth, SF Clearwater, and SFSR) as this table represents in-season accountability.

*** Estimates of Oregon and NPT returns are provided directly or estimated using data provided by each agency.

Parental Based Tagging Analysis of Adult Returns to Lower Granite Dam

In return year 2012, Parental Based Tagging (PBT) was utilized at LGD as a method to estimate the brood year 2008 and 2009 stock and cohort specific hatchery-origin Chinook salmon returns to the dam. Brood year 2007 (age-5) returns were not represented in this analysis as that specific brood year was not genotyped as part of the PBT baseline. Starting in return year 2013, all returning age classes of hatchery-origin Chinook salmon will be included. Throughout the 2012 return, spring/summer Chinook salmon were trapped at LGD at a rate of 10%. From this 10% trapping, one out of five hatchery-origin Chinook salmon (20%), or roughly 2% of the overall return, were sampled for PBT throughout the run. This 2% sampling resulted in 1,262 samples being collected. These samples were randomly subsampled and 1,025 samples were ultimately used to estimate stock and age composition of hatchery-origin spring/summer Chinook salmon at LGD. The proportion of the total number of PBT assignments that were made of each stock and cohort was multiplied by the total hatchery-origin return to provide the estimated number of each stock and cohort that passed upstream of LGD (Table 9). Confidence intervals for hatchery stock composition estimates were generated using the script *resampit.r* performed in the R programming environment (R Development Core Team 2010). The *resampit.r* script resamples (bootstraps) with replacement from the original PBT assignment data set. Within each iteration, the original stock assignments (including unassigned fish) were resampled with replacement *s* number of times (*s* = the number of samples in the original dataset) and stock assignment frequencies for that iteration were tabulated. Stock frequencies for each stock/cohort in each iteration were then divided by the PBT tagging rate (to account for untagged fish) for that stock to estimate the true number of fish from each stock within the mixture. Finally, the expanded stock assignments were then divided by *s* to estimate stock proportions. We performed 1,000 iterations and the 95% confidence intervals were then generated by removing α/2 proportions from the extremes of the 1,000 ordered stock proportions. The *resampit.r script* was written and provided by M. Ackerman (PSMFC, Eagle Fish Genetics Lab).

Of the 1,025 tissue samples analyzed, 63 assigned to brood year 2009 stocks, 802 assigned to brood year 2008 stocks, and 160 did not assign to the baseline (Table 9a). To estimate the age specific PBT assignment rates, an age composition of the unassigned fish was estimated by aging scale samples from each of the unassigned fish in the sample. Age data from the PBT and scale analysis was combined to generate a composite age composition of the hatchery-origin return. Based on this, approximately 91.4% and 96.8% of the brood year 2008 and 2009 returns, respectively, assigned to the PBT baseline. Brood year 2008 and 2009 adults that did not assign to the baseline could have resulted from any one or a combination of reasons including: 1) hatchery stocks/cohorts sampled at LGD are not part of the PBT baseline, 2) overestimation of tagging rates for stocks that are in the baseline, 3) genotyping errors that incorrectly excluded fish that actually have parents in the baseline, or 4) an overestimation of brood year 2008 and 2009 returns in the LGD window count (conversely, an underestimate of the brood year 2007 component of the hatchery return). We know that the PBT baseline does not include some of the broodstocks from Oregon in brood year 2008 and 2009 (Lostine, Catherine Creek, and Grande Ronde captive programs) so some of the unassigned fish likely belong to these stocks/cohorts. We have not attempted to adjust the estimates for those releases not in the baseline.

Table 9. Stock-specific brood year 2008 and 2009 returns to LGD in 2012 based on PBT with 95% bootstrap confidence intervals.

Hatchery/Stock	BY 2009 (95% CI)	BY 2008 (95% CI)
Dworshak/Kooskia Hatcheries	619 (247-1,052)	9,386 (8,063-10,898)
Clearwater/Powell	127 (0-508)	4,241 (3,305-5,238)
Clearwater/SF Clearwater	0	5,514 (4,373-6,655)
Nez Perce Tribal Hatchery	0	251 (63-502)
Total Clearwater R.	**746**	**19,392**
Rapid River/Hells Canyon	1,040 (585-1,561)	13,871 (12,246-15,497)
Sawtooth/Yankee Fork	370 (123-679)	5,031 (3,973-6,087)
Pahsimeroi	62 (0-187)	250 (62-500)
McCall SFSR	829 (446-1,339)	4,976 (3,969-6,047)
Johnson Cr.	61 (0-184)	184 (0-430)
Total Salmon R.	**2,362**	**24,312**
Imnaha R.	505 (189-884)	2,418 (1,736-3,161)
Lostine R.(Conventional Brood)	63 (0-188)	781 (390-1,237)
Lostine R.(Captive Brood)	NA	NA
Catherine Cr.(Conventional Brood)	63(0-189)	553 (246-922)
Catherine Cr.(Captive Brood)	NA	75 (0-226)
Grande Ronde R.(Conventional Brood)	0	184 (0-430)
Grande Ronde R.(Captive Brood)	129 (0-322)	NA
Lookingglass Cr.	0	1,558 (998-2,183)
Tucannon	0	68 (0-206)
Total Oregon and Washington	**760**	**5,638**
Total by Age	**3,868**	**49,342**

Table 9a. Estimated age composition of the composite spring/summer hatchery-origin Chinook salmon return to Lower Granite Dam and brood year specific PBT assignment rates.

Brood Year	Estimated number of fish at LGD[1]	Number of samples assigned to stock	Expanded number assigned by PBT to Stock	Number of unassigned individuals	Percent of Return Assigned to Stock
2009	3,997	63	3,868	129	96.8%
2008	53,986	802	49,342	4,644	91.4%
2007[2]	5,042	0	0	5,042	0.0%
Total	**63,025**		**53,210**	**9,815**	

[1]Estimated number is based on the combined PBT and scale aging data.
[2]PBT sampling did not begin until brood year 2008. None of the brood year 2007 returns are in the PBT baseline

Comparison of PIT Tag and PBT Return Estimates to Lower Granite Dam

Since return year 2008, IDFG has been using PIT-tagged hatchery Chinook expansions as both an in- and post-season tool to generate adult return estimates to LGD. In season, these estimates help to manage fisheries and broodstock acquisitions, while post season they provide alternative estimates of smolt-to-adult survival and return rates. While valuable, this methodology has limitations (as described in Accountability of the Run at LGD using PIT Tag Expansions section above). Underrepresentation of stock- and age-specific untagged returns by PIT-tagged fish has been an ongoing issue, but the levels at which it occurs, by stock and age, have been unknown for many release groups. Starting in return year 2012 with the implementation of PBT, we now have a secondary stock- and age-specific estimator that can be used to assess PIT tag estimates and provide insight into the levels of stock- and age- specific bias in each return year.

For 2012 returns, in-season PIT tag estimates accounted for 72.6% of the PBT-based stock/age-specific estimates at LGD. However, we were able to correct PIT tag expansion rates for three (McCall, Sawtooth, SF Clearwater) of the five return groups using in-trap PIT tag arrays. Corrected post-season PIT tag estimates accounted for 88.7% of the PBT-based estimates. The ability to correct PIT tags post season for all return groups would likely allow us to generate post-season PIT tag estimates more similar to the PBT estimates. For the Sawtooth/Yankee Fork release, the difference between the PBT and PIT estimates was less than one percent. For McCall, the difference was less than seven percent. These data confirm the assumption that the post-season correction procedure provides a reliable method to estimate returning adults using PIT tags. These results also further validate PBT as a valuable tool for generating stock and age specific returns to LGD. Continued use of PBT will likely eliminate the need for corrected post season PIT tag estimates and place the emphasis of PIT tag use on in season return estimates to aid in the management of fisheries and brood stock acquisition.

Table 10. Comparison of stock-specific brood year 2008 and 2009 returns to LGD in 2012 based on in-season PIT tag estimates, adjusted post-season PIT tag estimates, and PBT.

Stock/Release Group	In-Season PIT Estimate		Post-Season PIT Estimate		PBT Estimate	
	BY 2009 (Jacks)	BY 2008 (Age 4)	BY 2009 (Jacks)	BY 2008 (Age 4)	BY 2009 (Jacks)	BY 2008 (Age 4)
Clearwater (Powell and SF Clearwater)	214	6,837	280	8080	127	9,755
Total Clearwater R.	**214**	**6,837**	**280**	**8,080**	**127**	**9,755**
Rapid River/Hells Canyon	679	10,981	679	10,981	1,040	13,871
Sawtooth/Yankee Fork	402	3,480	402	4,970	370	5,031
Pahsimeroi	0	389	0	389	62	250
McCall SFSR	376	3,017	830	5,349	829	4,976
Total Salmon R.	**1,457**	**17,867**	**1,911**	**21,689**	**2,301**	**24,128**
Total by Age	**1,671**	**24,704**	**2,191**	**29,769**	**2,428**	**33,883**
Grand Total	**26,375**		**31,960**		**36,311**	

Fallback / Reascension Rates and After-Hours Passage Rates at Lower Granite Dam

With the majority of Chinook salmon returning to Idaho in 2012 having representative PIT tag groups, we were able to evaluate levels of fallback resulting in reascension as well as after-counting-hours passage rates, by release site and age, at Columbia River and Snake River dams. The levels at which these two actions occur are of interest because fallback that results in reascension of an adult ladder results in some fish being counted more than once in dam window counts (overestimate) while fish passing after counting hours results in some fish not being counted at all (underestimate). Fallback resulting in reascension was defined by looking at PIT tag coil reads within the LGD adult fish ladder. A fish was determined to have fallen back and reascended when it had more than one distinct PIT tag tracking event from the bottom to the top of the adult ladder. Counting hours at LGD occur for 16 hours per day from 0400 hours to 2000 hours. A fish was considered to have passed after hours if it was detected in the lower set of PIT tag antennas outside of this 16-hour period. However, because the counting window is below all PIT tag detectors in the LGD adult ladder, fish detected in the adult ladder in the first 15 minutes after the counting period ended were excluded from the after-hours estimate, while fish detected within the first 15 minutes of the counting period starting were counted as having passed after hours. The level that each of these behaviors occurred was monitored by release site for both jacks and adults returning to LGD (Tables 11 and 12).

Table 11. Percentages of PIT-tagged jack and adult Chinook salmon that fell back and reascended the adult ladder, by release site, at Lower Granite Dam in return year 2012 with return year 2011 totals for comparison.

	Adults (Two- and Three-Ocean)			Jacks (One-Ocean)		
Release Location	**PIT Detections at LGD**	**Fallback / Reascension**	**Percent**	**PIT Detections at LGD**	**Fallback / Reascension**	**Percent**
Clear Creek	43	3	6.98%	2	0	0.00%
Crooked River	1	0	0.00%	7	0	0.00%
Knox Bridge	151	13	8.61%	24	1	4.17%
Pahsimeroi Ponds	9	1	11.11%	0	0	N/A
Powell Pond	26	2	7.69%	2	0	0.00%
Rapid River	80	6	7.50%	9	0	0.00%
Red River	20	3	15.00%	1	1	100.00%
Sawtooth Hatchery	32	5	15.63%	5	1	20.00%
Selway River	54	4	7.41%	2	0	0.00%
Yankee Fork	7	0	0.00%	0	0	N/A
2012 TOTAL	**423**	**37**	**8.75%**	**52**	**3**	**5.77%**
2011 Total	**837**	**126**	**15.10%**	**380**	**59**	**15.50%**

Table 12. Percentages of after-counting-hour's passage, by release site, at Lower Granite Dam in return year 2012 for jacks and adults with return year 2011 totals for comparison.

Release Location	Adults (Two- and Three-Ocean)			Jacks (One-Ocean)		
	PIT Detections at LGD	After-Hours Passage	Percent	PIT Detections at LGD	After-Hours Passage	Percent
Clear Creek	43	1	2.33%	2	0	0.00%
Crooked River	1	0	0.00%	7	2	28.57%
Knox Bridge	151	8	5.30%	24	1	4.17%
Pahsimeroi Ponds	9	0	0.00%	0	0	N/A
Powell Pond	26	2	7.69%	2	0	0.00%
Rapid River	80	4	5.00%	9	0	0.00%
Red River	20	1	5.00%	1	0	0.00%
Sawtooth Hatchery	32	3	9.38%	5	0	0.00%
Selway River	54	4	7.41%	2	0	0.00%
Yankee Fork	7	0	0.00%	0	0	N/A
2012 TOTAL	**423**	**23**	**5.44%**	**52**	**3**	**5.77%**
2011 Total	**837**	**62**	**7.40%**	**380**	**17**	**4.50%**

Similar to recent years, in 2012 the overestimation caused by double counting due to fallback/reascension is greater than the underestimation caused by fish passing the window outside of the counting period. Compared to return year 2011, total fallback/reascension rates for 2012 were lower for both adults and jacks (Table 11). Similarly, 2012 adult after-hours passage rate was lower than return year 2011. However, jack after-hours passage rates were higher in 2012 than in 2011. There are many factors that may influence fallback/reascension rates at a given dam including river inflow, dam structure, turbine discharge, proximity to spawning grounds, and dam spill (Boggs et al. 2004). Of these, the one that likely has the largest impact on upper Snake River stocks at LGD is spill. In 2011, the average spill at LGD from April 15 through August 1 was 44.7kcfs. In 2012, the average spill for the same interval was 30.0kcfs. This decrease in spill corresponds with the decrease in the rate of fallback/reascension between the two years.

The net difference between fallback/reascension rates and after-hours passage would have resulted in the overall adult count at the LGD window being 2,881 fish (3.3%) high and the jack count being unadjusted in 2012. Additionally, PIT tags cannot be used to directly assess the frequency of fallback that does not result in reascension, nor can they be used to assess lock passage. It is unknown what effect these two additional pieces would have on overall window counts as fallback without reascension would further bias counts high, but lock passage would bias counts low. Previous work done by Boggs et al. (2004) using radio tags and PIT tags, found that adjusting for both fallback and reascension resulted in window counts that were 1.7% high at LGD from 1996 to 2001. Both the fallback/reascension and after-hours rates are used to adjust the window counts for the LGD accountability in Table 8.

Conversion Rates Between Dams

Using the returning PIT-tagged Chinook salmon, conversion rates were calculated from Bonneville Dam upriver to McNary and Lower Granite dams. For the purposes of this report,

inter-dam conversion represents all loss between dams (harvest, strays, mortality). Conversions are outlined in Table 13 and are shown as conversion percentages, by release site, for jacks and adults. In 2012, spring Chinook stocks showed similar conversions to previous years for both jacks and adults with the exception of adults from Rapid River, which had lower than average conversions. Adults from this release had a lower than average conversion and were likely harvested at a higher than average rate in Zone 6 fisheries. The brood year specific harvest will be evaluated in future brood year reports when downriver harvest estimates are available.

Table 13. Conversion percentages of PIT-tagged fish, corrected for detection efficiency, by stock and age from Bonneville Dam to McNary and Lower Granite dams.

		Adults From Bonneville To:		Jacks From Bonneville To:	
Hatchery	**Release Site**	**McNary**	**Lower Granite**	**McNary**	**Lower Granite**
Clearwater	SF Clearwater River*	78.3%	71.7%	100.0%	100.0%
Clearwater	Crooked River Summers	NA**	NA**	100.0%	100.0%
Clearwater	Powell Pond	83.6%	72.1%	100.0%	100.0%
Clearwater	Selway River	80.2%	73.0%	100.0%	100.0%
Clearwater	Clear Creek	74.8%	71.4%	100.0%	100.0%
McCall	SF Salmon R. – Knox	79.4%	75.0%	89.7%	86.2%
Pahsimeroi	Pahsimeroi Ponds	91.7%	75.0%	NA***	NA***
Rapid River	Rapid River Ponds	69.4%	62.5%	100.0%	92.3%
Sawtooth	Sawtooth Weir	84.1%	81.8%	100.0%	100.0%
Sawtooth	Yankee Fork	77.8%	77.8%	NA***	NA***

* The Crooked River and Red River release sites are combined to make up the South Fork Clearwater stock prior to release year 2009.
** First release year was 2011, no returning adults for this group in 2012.
*** No PIT tagged fish returned for this age class from this release group.

Run Timing

Adult run timing curves were generated at Bonneville, LGD, and the hatchery traps by graphing the cumulative percentage of return vs. return date. For returns to Bonneville and LGD, PIT tag detections were used to generate stock-specific curves for hatchery origin fish. Run timing at Bonneville Dam was distinctly separated for spring run stocks from the Clearwater River and Rapid River and summer run stocks from McCall and Pahsimeroi fish hatcheries. Sawtooth Fish Hatchery returns fell in between but exhibited run timing similar to that observed for the summer runs (Figure 2). This run timing pattern is typical of stocks returning to Idaho and comparable to past years. The pattern remained similar as fish crossed LGD (Figure 3).

At hatchery traps, daily trapping numbers were used to generate stock-specific run timing curves for both hatchery- and natural-origin fish in the Salmon River basin and hatchery origin fish in the Clearwater River basin (Figures 4, 5, and 6). In 2012, there was not a distinct bimodal return distribution to the South Fork Clearwater facilities as in 2010 and 2011 (Figure 4). This pattern has been of interest for the past few years as it has been an important consideration when managing for broodstock collection in the South Fork and will need to be considered and monitored in the future.

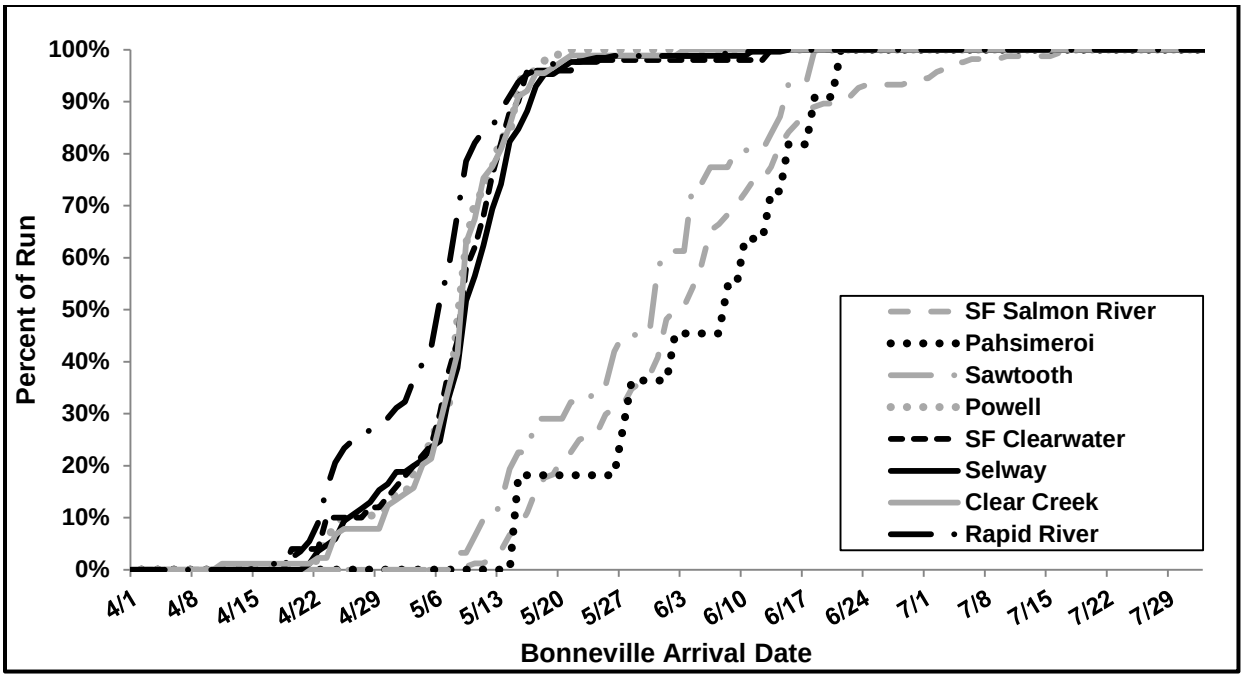

Figure 2. Cumulative run timing (all age classes) of hatchery origin Chinook salmon, by stock, to Bonneville Dam in return year 2012.

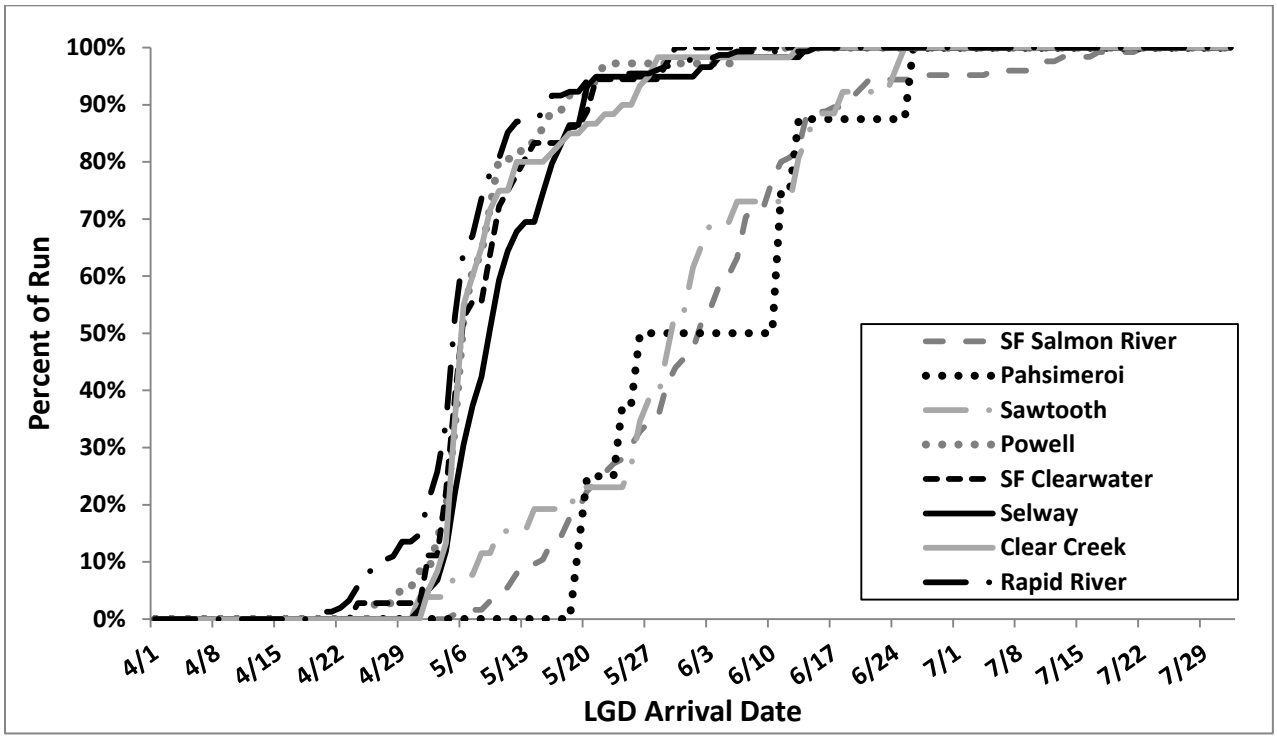

Figure 3. Cumulative run timing (all age classes) of hatchery origin Chinook salmon, by stock, to Lower Granite Dam in return year 2012.

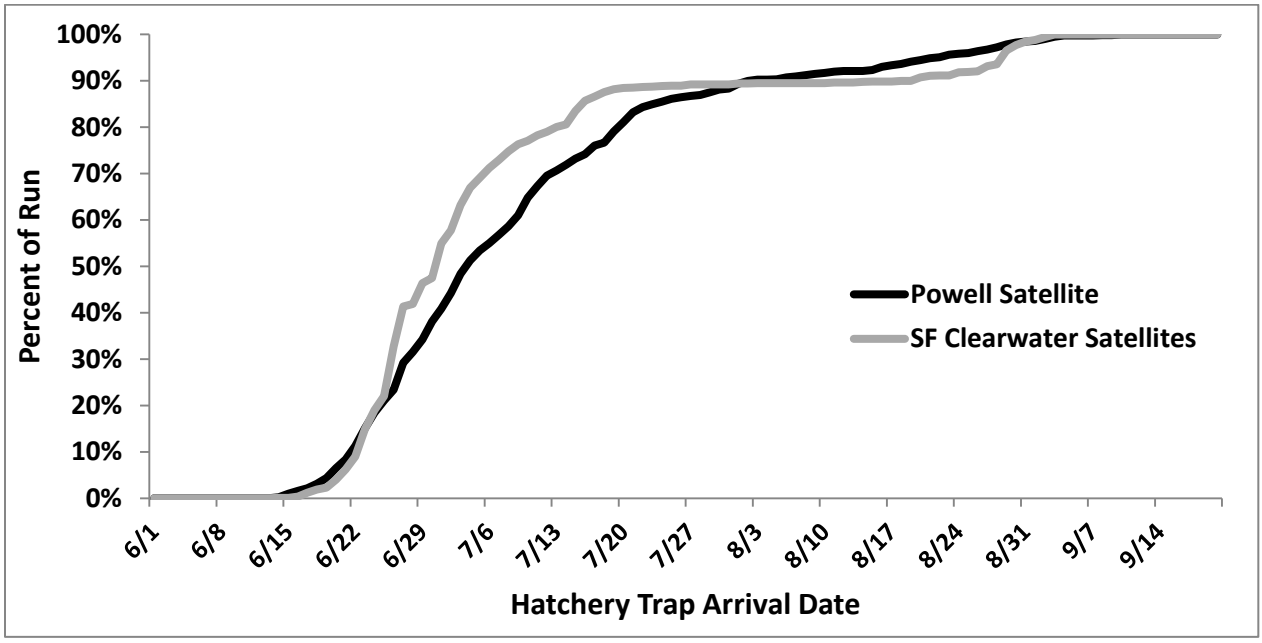

Figure 4. Cumulative run timing (all age classes), by stock, of hatchery origin Chinook salmon to hatchery traps in the Clearwater Basin in return year 2012.

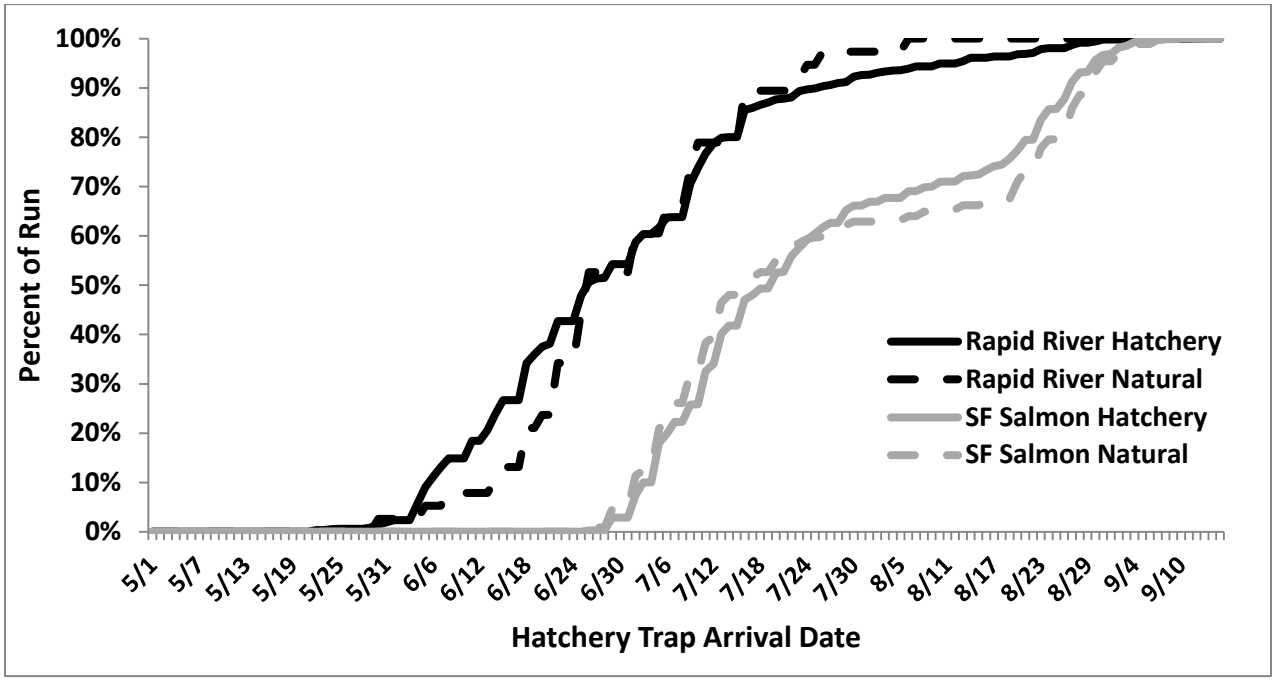

Figure 5. Cumulative run timing (all age classes), by stock, of hatchery and natural origin Chinook salmon to Rapid River and SF Salmon River traps in return year 2012.

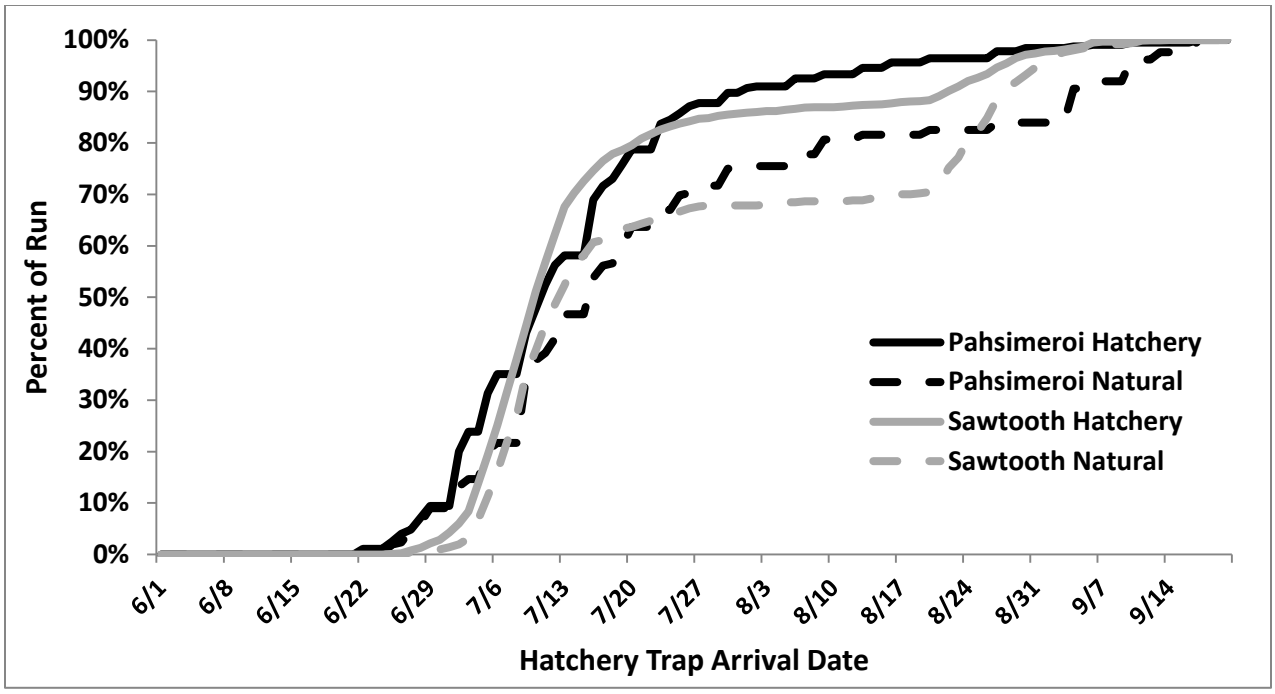

Figure 6. Cumulative run timing (all age classes), by stock, of hatchery and natural origin Chinook salmon to Pahsimeroi and Sawtooth traps in return year 2012.

Hatchery Trap Returns

Fish that escaped fisheries were trapped 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 two methods depending on the availability of known age information (CWTs and PIT tags) recovered from returning adults. In cases where enough known age information was available, the statistical computer program *R* (R Development Core Team 2010) was used with the *mixdist* library package (Macdonald 2010). *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 salmon 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 length frequency histograms imputed into the FAO-ICLARM Stock Assessment Tools (FiSAT) II software (Gayanilo et al. 2005). This method also applies the maximum likelihood concept, but does so to the separation of the normally distributed components of a length frequency sample and provides an estimated number of fish for each age class. Average lengths at age were similar to past years (Table 14).

Table 14. Summary of adult spring/summer Chinook salmon returns to IDFG hatchery racks, by trap, sex, age, and origin, back to IDFG hatchery racks for return year 2012.

		Males						Females				
Trap	Origin	Age-3	Ave. Len.	Age-4	Ave. Len.	Age-5	Ave. Len.	Age-4	Ave. Len.	Age -5	Ave. Len.	Total Return
SF Salmon R.	H	258	53.2	827	75.6	32	96.4	993	74.8	148	87.4	**2,258**
SF Salmon R.	N	8	50.5	192	73.2	51	90.1	119	75.3	86	87.0	**456**
Sawtooth	H	215	49.9	1,301	72.3	15	93.4	1,242	74.1	15	83.4	**2,788**
Sawtooth	N	9	50.8	242	73.2	57	98.7	110	76.38	86	92.1	**504**
Crooked River	H	12	51.6	19	70.2	3	85.8	30	70.2	4	85.8	**68**
Crooked River	N	2	57.3	10	68.3	7	84.0	20	67.8	1	90.0	**40**
Red River	H	18	46.0	311	70.5	7	87.7	490	70.5	10	87.7	**836**
Red River	N	6	56.4	39	70.9	2	97.5	39	69.1	1	91.0	**87**
Powell	H	12	45.8	255	75.0	40	85.7	434	71.9	54	83.3	**795**
Powell	N	0	NA	13	74.6	1	89.0	5	73.6	0	NA	**19**
Crooked fork*	H	0	NA	3	76.6	1	98.5	6	76.6	1	98.5	**11**
Pahsimeroi	H	34	50.8	240	67.9	69	93.5	123	71.6	178	87.5	**644**
Pahsimeroi	N	10	48.4	91	71.3	26	97.4	54	77.9	35	90.6	**216**
		Males / Females										
Rapid River**	H	265	47.8	1,276	69.5	264	83.6					**1,805**
Rapid River**	N	2	50.5	19	67.3	17	84.5					**38**
Oxbow***	H	29	46.1	938	70.8	97	85.8					**1,064**
Oxbow***	N	2	51.5	20	68.8	1	89.0					**23**
					Grand Total							**11,640**

* The Crooked Fork Trap is a temporary weir operated on the Crooked Fork by the IDFG ISS project and located a mile upriver from the Powell Trap. Hatchery origin Chinook salmon trapped there are considered Powell strays and transferred to Powell for spawning.

** Rapid River Hatchery does not make a sex determination at trapping for hatchery origin returns. This total excludes hatchery spring Chinook salmon transferred to Rapid River Hatchery from Oxbow Hatchery.

*** Oxbow Hatchery does not make a sex determination at trapping for hatchery origin returns and trapping there is done as needed, to provide fish for Rapid River broodstock, C & S distribution, and transfers to OR and ID fisheries.

Idaho Sport Harvest

In 2012, Chinook salmon fisheries occurred on various water bodies throughout Idaho. In the Clearwater River basin, spring Chinook salmon fisheries were held on 207 miles of river including the North Fork, South Fork, Middle Fork, and main-stem Clearwater rivers as well as on the Lochsa River. A fall Chinook salmon fishery was held on two miles of the main-stem Clearwater River from the mouth to the Highway 12 Memorial Bridge. On the Snake River, a spring Chinook salmon fishery was held on 51 miles of river from the Dug Bar boat ramp upstream to Hells Canyon Dam. A fall Chinook salmon fishery was held on 109 miles of river from where the Snake River leaves Idaho at the Idaho/Washington state line to Hells Canyon Dam. In the Salmon River drainage, spring/summer Chinook salmon fisheries were held on 217 miles of river, including sections of the lower and upper Salmon, Little Salmon, and South Fork Salmon rivers. Tables 15 and 16 list the location, duration, and extent of Chinook salmon fisheries in 2012.

Table 15. Dates and locations of spring/summer Chinook salmon recreational fisheries conducted in Idaho in 2012.

River	Date Open	Date Closed	Days Open	Downstream Boundary	Upstream Boundary	Miles Open
Clearwater R.	4/22	8/5	106	Railroad Bridge in Lewiston	SF Clearwater River	73
NF Clearwater R.	4/22	8/5	106	Mouth	Dworshak Dam	2
SF Clearwater R.	4/22	8/5	106	Mouth	Confluence American and Red rivers	62
MF Clearwater R.	4/22	8/5	106	SF Clearwater River	Confluence Lochsa and Selway rivers	23
Lochsa R.	4/22	8/5	106	Mouth	Confluence Colt Killed and Crooked Fork Cr.	69
Snake R.	4/22	8/5	106	Dug Bar	Hells Canyon Dam	51
Lower Salmon R.	4/22	7/8	78	Rice Creek Bridge	Time Zone Bridge	46
	4/22	7/15	85	Time Zone Bridge	Short's Creek	3
	4/22	7/8	78	Short's Creek	Vinegar Creek	23
Little Salmon R.	4/22	7/15	85	Mouth	U.S. 95 Bridge near Smokey Boulder Road	25
SF Salmon R.	6/23	7/19	27	Forest Service Road 48 bridge	Just downstream of hatchery weir	32
Upper Salmon R.	7/3	8/5	34	100 yards upstream of Pahsim. R.	Highway 75 Bridge above EFSR	42
	6/23	8/5	44	Highway 75 Bridge above EFSR	Just downstream of Sawtooth Hatchery weir	46

Table 16. Dates and locations of fall Chinook salmon recreational fisheries conducted in Idaho in 2012.

River	Date Open	Date Closed	Days Open	Downstream Boundary	Upstream Boundary	Miles Open
Clearwater R.	9/1	10/31	61	River Mouth	Highway 12 Memorial Bridge	2
Snake R.	9/1	10/31	61	Idaho / Washington State Line	Hells Canyon Dam	109

For terminal area fisheries, all harvest was assumed to be the stock released in that terminal area (e.g., SF Salmon River). For mixed stock fisheries (e.g., main-stem Clearwater River), stock composition was estimated using creel data and CWT recoveries. The CWT recoveries were expanded by stock-specific tagging rates for each river section. Then the proportions of each stock in the expanded CWT-based stock composition was applied to the total harvest estimate for that same section to generate a final stock composition by river section (Table 17a and 18). Age composition was estimated using both CWT recoveries and length frequencies from fish sampled in the creel (See Hatchery Trap Returns section for age comp methods). In addition to using CWT to estimate the stock and age composition of the harvest, managers implemented PBT sampling in the lower Salmon River sport harvest in 2012. This represents the first effort in Idaho to estimate the stock and age composition of a Chinook salmon fishery using PBT (Table 17b). Methods for estimating the stock and age composition for PBT is the same used for CWT. The primary difference between the two methods is the sample size of known stock and age fish sampled in the fishery. Because nearly all (~98%) of the one- and two-ocean Idaho stocks of spring/summer Chinook salmon returning in 2012 were tagged with PBT, nearly every fish sampled in the fishery could be assigned to stock and cohort (with the exception of three-ocean returns). Beginning in 2013, all stocks and age classes of returning adults will be PBT tagged. For the 2012 lower Salmon River Chinook salmon sport fishery, 21 CWTs and 499 tissue samples were recovered from the 550 fish observed in the creel. All 21 CWTs were decoded and assigned to stock and age (no three-ocean CWTs were recovered). Of the 499 tissue samples collected, 260 were subsampled and genotyped. Of the 260 PBT samples analyzed, 234 assigned to one-ocean and two-ocean returns. It was assumed that all 26 of the samples that did not assign to the baseline were three-ocean returns.

A comparison of the PBT and CWT harvest contribution estimates in the lower Salmon River sport fishery provides two important observations (Table 17a and Table 17b). First, the PBT analysis revealed two contributing stocks that were not identified with CWT. Secondly, the estimated numbers of fish from stocks with lower contribution rates to the fishery were all higher in the PBT estimate. These differences provide managers the ability to more efficiently manage mixed stock fisheries particularly with regards to how the stock composition changes temporally across the fisheries.

Table 17. Summary of 2012 spring/summer Chinook salmon sport harvest in Idaho. Stock and age composition based on CWT recoveries.

Fishery and Stock	Age-3	Age-4	Age-5	Total
Clearwater River Fishery				
Dworshak	100	1750	219	**2,069**
Kooskia	50	513	64	**627**
Clearwater (Powell)	44*	325	41	**410**
Clearwater (South Fork)	113	1,146	143	**1,402**
Clearwater (Selway)	7	169	21	**197**
Clearwater (Clear Creek)	13	322	40	**375**
Nez Perce Tribal Hatchery	4	44	6	**54**
Total	**331**	**4,269**	**534**	**5,134**
Snake River Fishery				
Rapid River (Hells Canyon Dam)	29	193	16	**238**
Total	**29**	**193**	**16**	**238**
Lower Salmon River Fishery				
Rapid River Hatchery	273	2,408	307	**2,988**
McCall (SFSR)	54	190	24	**268**
Sawtooth Hatchery	25	175	22	**222**
Total	**352**	**2,773**	**353**	**3,478**
Little Salmon River Fishery				
Rapid River Hatchery	93	1,634	201	**1,928**
Total	**93**	**1,634**	**201**	**1,928**
SF Salmon River Fishery				
McCall (SFSR)	145	1,401	140	**1,686**
Total	**145**	**1,401**	**140**	**1,686**
Upper Salmon River Fishery				
Sawtooth Hatchery	82	763	36	**881**
Total	**82**	**763**	**36**	**881**
Grand Total	***1,029***	***11,033***	***1,279***	***13,341***

* This is the only harvest estimate that is greater than its equivalent stock- and age-specific estimate over LGD.

Table 17b. Summary of 2012 Lower Salmon River spring/summer Chinook salmon sport harvest. Stock and age composition based on PBT analysis.

Fishery and Stock	Age-3	Age-4	Age-5	Total
Lower Salmon River Fishery				
Rapid River Hatchery	203	2,251	302	**2,756**
McCall (SFSR)	89	271	23	**383**
Sawtooth Hatchery	60	220	4	**284**
Pahsimeroi	0	31	17	**48**
Imnaha	0	7	0	**7**
Total	**352**	**2,780**	**346**	**3,478**

Table 18. Summary of 2012 fall Chinook salmon sport harvest in Idaho by fishery, stock, and age.

Fishery and Stock	Age-3	Age-4	Age-5	Total
Clearwater River Fishery				
Multiple*	76	60	5	**141**
Total	**76**	**60**	**5**	**141**
Snake River Fishery				
Multiple*	557	391	56	**1,004**
Total	**557**	**391**	**56**	**1,004**
Grand Total	***633***	***451***	***61***	***1,145***

* Fall Chinook salmon harvested in Idaho can be from IPC's Hells Canyon Dam release or from numerous other releases that occur on the Snake and Clearwater rivers by other agencies. Stock composition of fall Chinook salmon harvest was not generated.

Stock-specific sport harvest rates for jack and adult spring/summer Chinook salmon were variable in 2012. Jacks were harvested at a higher rate than adults, which is expected considering there were more liberal limits for jack harvest in the sport fisheries. The overall harvest rate on jacks was 43% while the overall harvest rate on adults was 30% (Table 19). The harvest estimate for jacks returning to Powell was the only estimate that was greater than the corresponding estimate of passage at LGD.

Table 19. Summary of 2012 spring/summer Chinook salmon sport harvest rates for jacks and adults, by stock. LGD estimates are from PIT tags.

		Jacks			Adults		
Release Hatchery	**Release Site**	**LGD Estimate**	**ID Sport Harvest**	**Sport Harvest Rate**	**LGD Estimate**	**ID Sport Harvest**	**Sport Harvest Rate**
Clearwater	Selway River	35	7	20%	1,864	190	10%
Clearwater	Powell Pond	36	44	122%	1,142	366	32%
Clearwater**	South Fork	160	113	71%	4,403	1,289	29%
Clearwater	Clear Creek	49	13	27%	1,067	362	34%
Total Clearwater R.		280	177	63%	8,476	2,207	26%
Rapid River	Rapid River Ponds	547	339	62%	10,060	4,149	41%
Rapid River	Hells Canyon Dam	88	29	33%	2,020	209	10%
Rapid River	Little Salmon R.	44	27	61%	581	239	41%
Sawtooth**	Sawtooth Weir	402	142	35%	4,268	1023	24%
Pahsimeroi	Pahsimeroi Ponds	0	0	0%	582	48	8%
McCall**	SF Salmon R.	830	234	28%	6,426	1,835	29%
Total Salmon R.		1,911	771	40%	23,937	7,503	31%
GRAND TOTAL		**2,191**	**948**	**43%**	**32,413**	**9,710**	**30%**

* This is the only harvest estimate that is greater than its equivalent stock- and age-specific estimate over LGD.
** Estimates from PIT tags for these facilities were corrected postseason using true adult PIT tag rates generated from in-ladder arrays at the Sawtooth, SFSR, and SF Clearwater traps.

CWT Processing and Data Submission

The CWT laboratory processed 1,078 spring/summer Chinook salmon snouts collected in 2012. Pursuant to RMIS guidelines, Chinook salmon recovery information from the 2012 run will be submitted to RMIS in January 2013. Table 20 shows the number and type of Chinook salmon CWT recoveries that were processed in the CWT lab in 2012.

Table 20. Chinook salmon CWT recoveries by recovery type that were processed in the Idaho Department of Fish and Game Nampa Research CWT Laboratory in 2012.

Recovery Type	Snouts Collected
Hatchery Spawning Rack/Trap	903
Spawning Ground	66
Sport Fishery (Creel Census)	109
Total	**1,078**

In-Idaho Straying

CWT recoveries from Chinook salmon sport fisheries, IDFG trap and weir recoveries, and IDFG spawning ground surveys were analyzed for strays. A recovered Chinook CWT was considered a stray if the fish was found at a location outside of the direct migratory path to the fish's release location. Table 21 outlines these recoveries, expanded by their tagging and sampling rates, for the 2012 returns. It is important to note that the table below only includes snouts recovered and processed by IDFG and that these stray estimates should be considered minimum, as there are traps operated and spawning ground surveys conducted by other agencies in Idaho that likely recovered strays as well. CWT recoveries from those other agencies were not available at the time of this report.

In general, stray recoveries were low to moderate for returning 2012 spring/summer Chinook salmon. The highest level of straying observed was at the Sawtooth Fish Hatchery trap from fish released in the Yankee Fork. The Yankee Fork four-year-olds that were returning in 2012 were reared at Sawtooth Fish Hatchery and released in the Yankee Fork in mid- to late April of 2010. The high number of these adults that returned to the Sawtooth trap are likely due to the late release time of these smolts resulting in many of these fish imprinting on the water at Sawtooth Fish Hatchery. These fish also strayed to SFH at a high rate as returning jacks in 2011.

These data are only intended to provide a snapshot of the general in-Idaho stray levels within a return year within Idaho's sport fisheries, at hatchery traps, and on the spawning grounds. If a fishery, trap, or spawning ground does not appear in Table 21, then there were no stray CWTs recovered from that location in 2012. Brood year and stock-specific stray rates will be included in the brood year reports once all strays from a given brood year/release site have been recovered across all appropriate return years.

Table 21. Chinook salmon stray CWT recoveries recovered by Idaho Department of Fish and Game in sport fisheries, on spawning grounds, and at hatchery traps in 2012.

Basin	Recovery Type	Recovery Location	Release Location	Number of CWT Recovered	Expanded for Tagging and Sample Rate*
Clearwater River	Fishery	NF Clearwater R.	Clear Creek	**4**	33
			NPTH	**3**	14
			Selway R.	**1**	5
	Hatchery	Crooked Fork Trap	NPTH	**1**	1
		Powell Trap	NPTH	**2**	2
			Selway R.	**1**	1
		SF Clearwater R.	Luke's Gulch	**1**	1
			Newsome Cr.	**1**	1
			Selway R	**1**	1
			NPTH	**3**	3
	Spawning Ground	American R.	Clear Creek	**1**	2
			Crooked R.	**1**	1
			Newsome Cr.	**1**	1
			NPTH	**1**	1
		Red River	Clear Creek	**1**	2
			Newsome Cr.	**1**	1
			NPTH	**1**	1
		Upper Lochsa R.	Powell	**1**	3
Salmon River	Hatchery	Sawtooth Trap	Yankee Fork	**273**	282
		Rapid R. Trap	Imnaha R.	**1**	2
	Spawning Ground	Upper Salmon R.	Yankee Fork	**22**	23
			Lostine R.	**1**	1
Total Stray Recoveries				**323**	**382**

*Only fishery recoveries are expanded by a sampling rate. Recoveries on spawning grounds represent minimum estimates.

RESEARCH

Estimating a Correction Factor for PIT Tag Expansions in Returning Chinook Salmon

Ongoing research has shown that PIT-tagged Chinook salmon are detected among adult returns at lower rates than expected based on tagging rates at the time of juvenile release. This difference in the rate of tagged to untagged fish between the adult returns and the juvenile release is likely due to tag loss and differential survival (Knudsen et al. 2009). In an effort to quantify the level at which PIT-tagged Chinook salmon return to hatcheries operated by IDFG, we installed in-ladder PIT tag array antennas to the South Fork Salmon River (SFSR) Trap in 2009, the Sawtooth Trap in 2010, and the Crooked River and Red River traps in 2012. These systems, coupled with regular hand scanning of fish removed from the traps, enable researchers to obtain antenna efficiencies and, in turn, get a true proportion of PIT-tagged adults in the returns to each of these four facilities. These proportions provide a corrected PIT tag expansion rate that can be used to correct return estimates to LGD and provide some insight into the discrepancies between juvenile PIT tag rates vs. the rate of PIT tags in the adult

return. Table 22 summarizes the corrected expansions at the four facilities and Table 23 shows the corrected estimates at LGD.

Table 22. Corrected expansion rates derived from in-ladder PIT tag arrays at Sawtooth, SF Salmon River, and SF Clearwater River traps for return year 2012.

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
Sawtooth Hatchery						
2007	20.0	2	0	40	30	**20.0***
2008	122.1	12	5	1,470	2,284	**189.9**
2009	100.3	2	0	201	200	**100.3***
South Fork Salmon River Satellite						
2007	30.2	1	1	31	180	**179.0**
2008	28.1	36	18	1,030	1,820	**50.1**
2009	28.9	4	6	122	258	**63.0**
Red River Satellite						
2007	35.3	0	0	0	17	**35.3***
2008	94.4	6	2	568	801	**133.2**
2009	92.9	0	1**	11	18	**92.9**
Crooked River Satellite						
2007	61.6	0	0	0	7	**61.6***
2008	NA	1***	0	94	44	NA
2009	11.0	1	0	11	12	**11.0***

* Actual return was equal to or less than the estimated return so expansion was kept the same.
** Crooked River stray, so expanded by Crooked River expansion rate.
*** Red River stray, so expanded by Red River expansion rate. There were no Chinook salmon released at Crooked River for Brood Year 2008.

Table 23. Corrected PIT tag expansion of Sawtooth, SF Salmon River, and SF Clearwater River origin adults returning to Lower Granite Dam for return year 2012.

Brood Year	Run At Large PIT Tags at Lower Granite Dam*	Return to River PIT Tags at Lower Granite Dam*	Corrected Expansion	Original Estimate from Juvenile PIT Tag Rate	Estimated Number from Corrected Expansions
Sawtooth Hatchery					
2007	4	0	20.0	80	**80**
2008	22	10	189.9	2,696	**4,188**
2009	4	1	100.3	402	**402**
South Fork Salmon River Satellite					
2007	6	3	179.0	182	**1,077**
2008	106	38	50.1	3,007	**5,349**
2009	13	11	63.0	387	**830**
Red River Satellite					
2007	2	2	35.3	73	**73**
2008	32	6	133.2	3,027	**4,268**
2009	1	0	92.9	93	**93**
Crooked River Satellite					
2007	1	0	61.6	62	**62**
2008	NA	NA	NA	NA	**NA**
2009	7	1	11.0	78	**78**

* LGD efficiency calculated at 100% for 2012.

If we assume that tag loss is occurring before fish return to LGD as adults, then the estimates that we are able to generate from these corrected expansion rates give us our best PIT tag-generated estimate of age-specific returns to LGD. However, if sexually maturing adults continue to lose tags after they pass upstream of LGD, then using these corrected expansions from trap tag ratios would result in an overestimation of returns to LGD. We have seen some evidence of higher tag loss rates in adult females that may be related to sexual maturation and conformational changes in the body cavity of females as they near ovulation. In a preliminary effort to understand when tag loss is occurring, all PIT-tagged Chinook salmon detected at time of trapping at the SFSR trap in 2011 were caudal marked with zip ties and examined again for PIT tags at time of spawning. Out of 47 fish that had PIT tag detections at trapping and were later scanned at spawning, only 2 (1 male and 1 female) had lost their tags on-station. Additionally, select returning PIT tagged adults were Jaw tagged at LGD to track tag retention from the dam to hatchery racks (see Use of Jaw Tags to Access PIT Tag Retention in Returning Adult Chinook Salmon Between LGD and Hatchery Racks research section, this report). While both of these studies were limited in scope, neither suggest significant tag loss occurring after the fish pass upstream of LGD. Further research is needed in this area and we will continue to work towards answering the question of where the majority of tag loss is occurring.

Volitional vs. Direct Release Study (Powell Satellite Facility): Analyzing if Volitionally Released Fish Have Higher Return Rates with Fewer Strays

Brood year 2007 Chinook salmon from Clearwater Fish Hatchery that were released at the Powell Satellite Facility in 2009 were part of a volitional vs. direct release study. The hypothesis behind allowing fish to volitionally release from a pond post-hauling is that it may allow fish to recover from the stress associated with the loading and transportation prior to out-

migration, and may also increase homing fidelity similar to acclimation. These benefits were shown by Finstad et al. (2003) in Atlantic salmon smolts.

The volitional group contained 101,242 smolts tagged with CWT. These fish were placed into the Powell Acclimation Pond on March 23, 2009 and allowed to volitionally exit for nine days before being forced from the pond on April 1. Volitionally released fish were not fed while in the acclimation pond. The direct release group contained 99,951 CWT-tagged fish and was released into Powell Acclimation Pond on April 1 and forced to exit on the same day. Fish from the two release groups were the same size and length at release (16.73 fish/lb and 148 mm) and both groups were temperature acclimated on transport trucks before being released into the pond.

The one-ocean jacks from these releases returned to the Powell Satellite in 2010, the two-ocean adults returned in 2011, and the three-ocean adults returned in 2012. Tags from these returns are summarized in Table 24. The total SAR for the direct release group was slightly higher than the SAR for the group released volitionally (Table 24). Using a Z-test at 95% confidence, these SARs are not significantly different ($\alpha = 0.05$, $p = 0.19$) and we can conclude that fish directly and volitionally released into the Powell Pond did not return at significantly different rates. Management decisions should not be made based on a single brood year of data and should managers want to move away from volitional releases at Powell Pond and use exclusively direct releases, additional brood years should be evaluated.

A two-year lag will be required to obtain any downriver harvest information to complete the run reconstruction for these groups. Therefore, a complete summary of this study comparing SAS will be provided in the 2014 report.

Table 24. Comparison of CWT recoveries from volitional vs. direct release brood year 2007 Powell Chinook adults returning in 2010, 2011, and 2012.

Group	# CW Tagged	Return Year	CWT Recov. in Sport Fishery	CWT Recov. at Powell Trap	Total CWTs Recov.	Smolt to Adult Return Rate
Volitional	101,242	2010	1	17	18	0.0178%
		2011	28	184	212	0.2094%
		2012	0	15	15	0.0148%
Volitional Total			**29**	**216**	**245**	**0.2420%**
Direct	99,951	2010	2	29	31	0.0310%
		2011	22	204	226	0.2261%
		2012	0	16	16	0.0160%
Direct Total			**24**	**249**	**273**	**0.2731%**

Feed Study (Sawtooth Fish Hatchery): Analyzing if a High-Salt Diet Just Prior to Release Influences Survival Through Adulthood

High salt diets are being developed by feed companies and advertised as a means to increase smolt survival by better preparing smolt for the rigors of smoltification. We tested these claims with brood year 2007 Chinook salmon reared and released at Sawtooth Fish Hatchery. This brood year was part of a feed study comparing a high-salt diet (Bio-Oregon BioTransfer) to

a conventional diet (Bio-Oregon BioDiet Grower) in the few weeks leading up to release. The high-salt diet (treatment) group was 100% adipose clip/CWT and contained 103,986 smolts (7,063 of which were PIT tagged). The conventional diet (control) group was 100% adipose clip only and contained 170,658 smolts. These fish were released in 2009. The treatment group had a 36% juvenile survival estimate to LGD while the control group had a 38% juvenile survival estimate. Further details on the two diets can be found on the Bio-Oregon website at http://www.bio-oregon.com/Products-C7.aspx and will be included in the summary report.

One-ocean jacks from this brood year returned to the Sawtooth weir in 2010, the two-ocean adults returned in 2011, and the three-ocean adults returned in 2012. Returns were analyzed using the presence or absence of a CWT to determine study group. Returning CWT fish were adjusted for a 4.4% shed rate (determined through prerelease retention checks) and a 2.3% adult wanding error (determined through above weir carcass surveys). The return summary of the two age classes is outlined in Table 28. Through the three return years, the control group had a slightly higher SAR rate than the treatment group but there was no significant difference between the two SARs ($\alpha = 0.05$, $p = 0.11$). However, it is important to note that due to cold weather and ice conditions, not all of the planned treatment ration was administered. Due to the limitations of this study, we cannot conclude that the high salt diet caused a decrease in SAR to Sawtooth Fish Hatchery for brood year 2007.

Table 25. Comparison of recoveries from two different feed groups of brood year 2007 Sawtooth Chinook salmon returning in 2010, 2011, and 2012.

Study Group	Return Year	# Released	# Returned (Hatch. Trap Only)	Hatchery Return Rate	Cumulative Return Rate
Treatment	2010	103,986	36	0.0346%	0.124%
	2011		85	0.0817%	
	2012		8	0.0077%	
Control	2010	170,658	80	0.0469%	0.149%
	2011		152	0.0891%	
	2012		22	0.0129%	

The Use of PIT Tags to Estimate Minijack Rates in Spring/Summer Chinook Salmon

Monitoring and evaluation staff has been monitoring yearly numbers of minijacks since 2009, when unusually high numbers of jacks returning to the Columbia River basin generated an increasing level of interest in better understanding causes and patterns of age at maturity.

For this analysis, a minijack is defined as a Chinook salmon smolt that is released, migrates downstream below any of the lower Snake River or lower Columbia River dams, and then migrates back upstream within the same migration year. The lack of returning minijacks to hatchery racks in Idaho previously led us to believe that minijacking occurs at very low levels. PIT tag detections in the lower Snake River and Columbia River hydropower systems suggest that minijacking may occur more frequently than originally thought.

We monitor minijacking rates with the use of PIT tag detections in adult ladders throughout the Snake River and Columbia River hydropower systems. To help ensure that

detections are from returning fish and not from out-migrating juveniles, only detections occurring after June 1 are included. PIT-tagged minijacks were expanded using the same methodology used for adult returns in that run-at-large tags were expanded by the juvenile tagging rate, and return-to-river tags only represented themselves and were not expanded. NOTE: Prior to the 2012 report, some of the returning minijacks at Ice Harbor Dam were missed in our analysis due to the exclusion of one of the detectors at that dam. Therefore, numbers reported in this report may include more minijacks for previous years than reported in earlier reports.

The rate of minijacking is variable across years and release site-specific rates range from a low of 0.02% to a high of 1.89% of the number of smolts released (Table 26). The explanation for these variable minijack rates is not entirely known; however, ongoing studies are continuing to explore variables such as growth rates, size at release, feed content, and environmental conditions as potential influences. Figure 7 shows the hatchery-specific rates of minijacking from 2006 through 2012 along with the weighted average rate for all hatcheries. Patterns observed between hatcheries and trends across time would indicate that minijacking rates may be environmentally influenced. However, there is enough variation within years between facilities to indicate that variables such as rearing conditions and practices across hatchery facilities could also play a role. Chinook salmon outmigrating in 2012 showed an increase in minijacking rates from the previous two years. Both IPC and IDFG biologists will continue to monitor minijacking rates in Idaho and look for possible correlations with hatchery practices or environmental factors that may explain this life history trait. A follow-up on this monitoring will be provided in future reports.

Table 26. Estimated numbers of minijacks associated with releases of spring/summer Chinook salmon from Idaho hatcheries that returned to all Columbia and Snake river dams from 2006-2012. Only detections after June 1 are included.

Migration Year	Basin	Hatchery	Total Release	# PIT Tag Detections	Est. Number of Minijacks	Percent of Release
2012	Salmon R.	McCall	1,028,353	330	6,421	0.62%
		Rapid River	2,498,197	433	22,592	0.90%
		Sawtooth	1,259,185	7	472	0.04%
		Pahsimeroi	1,026,849	9	479	0.05%
	Clearwater R.	Powell	407,970	80	2,093	0.51%
		Red River	1,122,939	101	6,577	0.59%
		Clear Creek	234,511	144	1,943	0.83%
		Selway	415,369	115	2,796	0.67%
		Crooked River	206,317	113	873	0.42%
2012	**Total**		**8,199,690**	**1,332**	**44,246**	**0.54%**
2011	Salmon R.	McCall	1,069,028	157	3,257	0.30%
		Rapid River	2,483,181	22	959	0.04%
		Sawtooth	1,337,302	6	304	0.02%
		Pahsimeroi	1,030,028	8	485	0.05%
	Clearwater R.	Powell	413,757	28	492	0.12%
		Red River	1,114,760	50	2,808	0.25%
		Clear Creek	291,604	27	371	0.13%
		Selway	414,270	26	524	0.13%
		Crooked River	204,061	51	391	0.19%
2011	**Total**		**8,357,991**	**375**	**9,591**	**0.12%**

Table 26 Continued

Migration Year	Basin	Hatchery	Total Release	# PIT Tag Detections	Est. Number of Minijacks	Percent of Release
2010	Salmon R.	McCall	1,037,600	135	2,225	0.21%
		Rapid River	2,492,454	84	4,777	0.19%
		Sawtooth	1,455,634	13	1224	0.08%
		Pahsimeroi	1,169,701	0	0	0.00%
	Clearwater R.	Powell	413,158	40	971	0.24%
		Red River	1,206,110	68	4,270	0.35%
		Clear Creek	229,605	228	2,903	1.26%
		Selway	402,160	118	2,651	0.66%
2010		**Total**	**8,406,422**	**686**	**19,021**	**0.23%**
2009	Salmon R.	McCall	1,106,700	174	3,833	0.35%
		Rapid River	2,503,711	80	3,874	0.15%
		Sawtooth	274,644	49	715	0.26%
		Pahsimeroi	870,842	198	9,729	1.12%
	Clearwater R.	Powell	404,115	89	2,993	0.74%
		Red River	404,856	43	1,191	0.29%
		Clear Creek	234,151	115	2,390	1.02%
		Selway	299,707	78	2,077	0.69%
		Crooked River	703,101	49	2,330	0.33%
2009		**Total**	**6,801,827**	**875**	**29,132**	**0.43%**
2008	Salmon R.	McCall	1,060,540	916	20,022	1.89%
		Rapid River	2,493,719	271	13,029	0.52%
		Sawtooth	174,132	33	377	0.22%
		Pahsimeroi	1,037,772	122	8,331	0.80%
	Clearwater R.	Powell	223,714	15	748	0.33%
		Red River	424,719	136	4,646	1.09%
		Selway	205,659	50	1,720	0.84%
		Crooked River	708,483	117	6,449	0.91%
2008		**Total**	**6,328,738**	**1,660**	**55,322**	**0.87%**
2007	Salmon R.	McCall	1,087,170	165	3,703	0.34%
		Rapid River	2,396,602	36	1,859	0.08%
		Sawtooth	995,262	9	374	0.04%
	Clearwater R.	Powell	373,977	75	1,940	0.52%
		Red River	375,759	79	2,007	0.53%
		Crooked River	650,921	38	1,691	0.26%
2007		**Total**	**5,879,691**	**402**	**11,574**	**0.20%**
2006	Salmon R.	McCall	1,094,264	473	11,111	1.02%
		Rapid River	2,530,528	104	5,774	0.23%
	Clearwater R.	Powell	423,633	17	502	0.12%
		Red River	423,603	5	157	0.04%
		Crooked River	749,461	10	500	0.07%
2006		**Total**	**5,221,489**	**609**	**18,044**	**0.35%**

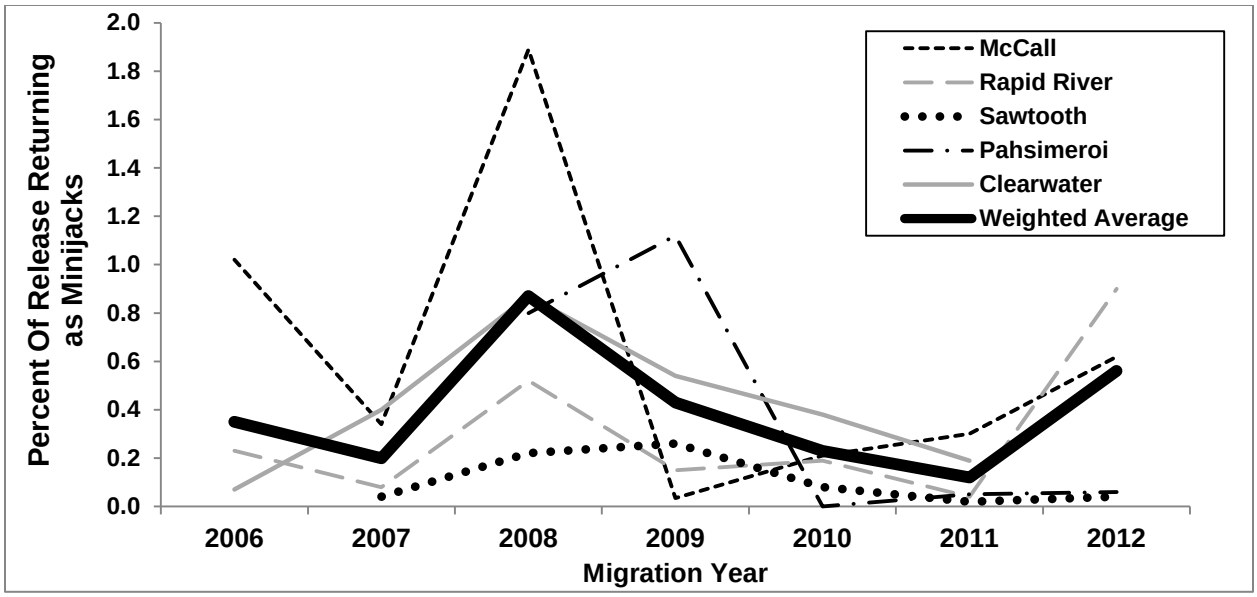

Figure 7. Percent of releases by hatchery that returned over all lower Snake River and Columbia River dams as minijacks and the weighted average percent of all releases that return as minijacks for migrations years 2008 through 2012.

In the 2011 report, we investigated if minijack returns were a good predictor of jacks returns the following year. Regressions were generated for both hatchery-specific returns and the aggregate return since brood year 2004 for the five IDFG-managed hatcheries. There were no significant relationships and aggregate return had an R^2 value of 0.49. As a follow up, we have continued to monitor minijack relationships and have recently discovered a strong significant correlation between overall minijack returns (all facilities combined) and two-ocean adult returns for the same facilities and timeline described above (Figure 8). This relationship indicates that minijacks may prove to be a better predictor of two-ocean adult returns than jacks and their usefulness as a forecasting tool needs to be investigated further.

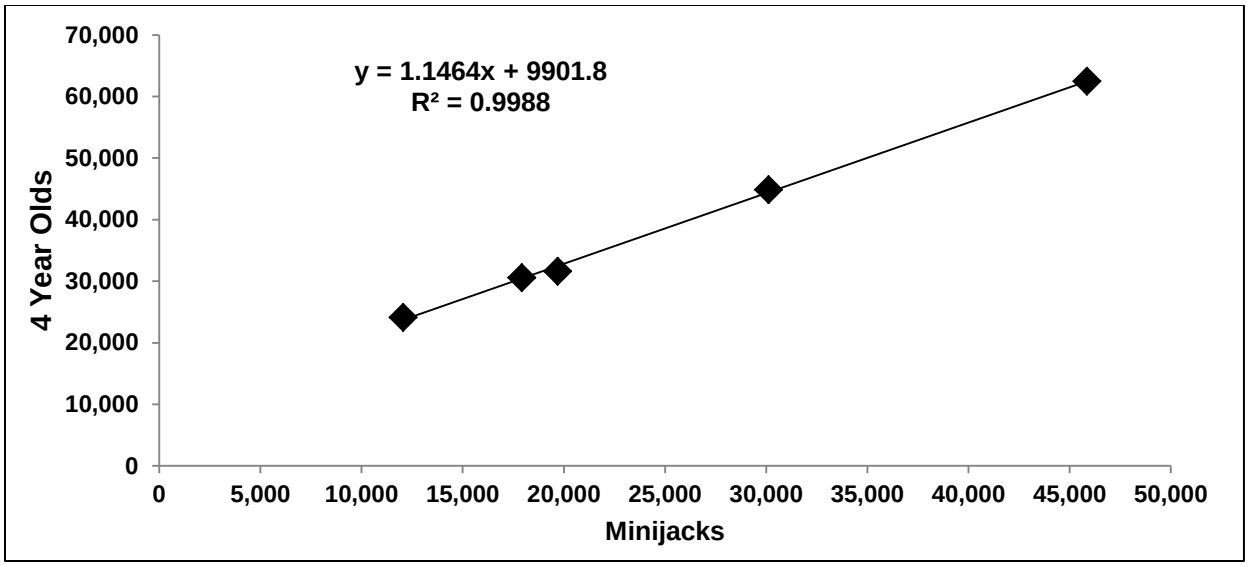

Figure 8. Minijack returns at all lower Snake River and Columbia River dams vs. four-year-old returns at Bonneville Dam for the aggregate IDFG spring/summer Chinook salmon hatcheries for brood years 2004-2008. Data generated from unadjusted expanded PIT tag estimates.

The Use of PIT Tags to Estimate Bird Predation Rates in Spring/Summer Chinook Salmon in the Lower Columbia River

Each year, known breeding colonies of Caspian terns (*Sterna caspia*) and double-crested cormorants (*Phalacrocorax auritus*) on the lower Columbia River are scanned for PIT tags. These breeding colonies exist on various islands below Bonneville Dam that are the result of river channel dredging activities. PIT tag scanning is conducted as part of various studies that are looking at predation rates on anadromous salmonids by these waterbirds (Collis et al. 2001, Roby et al. 2002, Roby et al. 2003). Yearly, we download the tag recoveries from these colonies from the PTAGIS website (www.ptagis.org) and expanded them by the juvenile tagging rates to generate hatchery- and run year-specific predation estimates of Chinook salmon released from IDFG-managed hatcheries. PIT tags were expanded using the same methodology used for adult returns in that run-at-large tags were expanded by the juvenile tagging rate and return-to-river tags only represented themselves and were not expanded. In addition to looking at the overall expanded estimate of predation for each release, we also looked at the percentage of out-migrants that were preyed upon using the estimate of juveniles surviving to LGD as the baseline. All predation estimates should be considered minimum estimates since they are based on actual tags recovered, and it is impossible to recover 100% of the tags from fish that are preyed upon. Hatchery-specific predation estimates for migrations years 2007-2011 are outlined in Table 27. Data for migration year 2012 were not available at the time of this report.

Table 27. Estimated lower Columbia River waterbird predation of spring/summer Chinook salmon from Idaho hatcheries from 2008-2011.

Juvenile Migration Year	Hatchery	Total Smolts Release	Est. Predation	Percent Predation of Release	Est. No. Juv. Surviving to LGD	Percent Predation of Juv. below LGD
	McCall	1,069,028	20,091	1.88%	672,419	2.99%
	Rapid River	3,090,066	60,386	1.95%	2,397,891	2.52%
2011	Sawtooth	1,337,302	24,124	1.39%	921,380	2.62%
	Pahsimeroi	1,030,028	10,419	1.02%	526,344	1.98%
	Clearwater	2,438,452	45,219	1.85%	1,516,717	2.98%
2011 Total		**8,964,876**	**160,239**	**1.79%**	**6,034,751**	**2.66%**
	McCall	1,037,600	19,836	1.91%	586,244	3.38%
	Rapid River	2,492,454	69,127	2.77%	1,946,607	3.55%
2010	Sawtooth	1,455,634	25,989	1.79%	615,733	4.22%
	Pahsimeroi	1,169,701	16,872	1.44%	436,298	3.87%
	Clearwater	2,251,033	73,391	3.26%	1,613,270	4.55%
2010 Total		**8,406,422**	**205,215**	**2.44%**	**5,198,152**	**3.95%**
	McCall	1,106,700	32,993	2.98%	566,630	5.82%
	Rapid River	2,503,711	111,254	4.44%	1,897,614	5.86%
2009	Sawtooth	274,644	6,953	2.53%	101,344	6.86%
	Pahsimeroi	870,842	22,313	2.56%	443,259	5.03%
	Clearwater	2,145,480	84,575	3.94%	1,132,575	7.47%
2009 Total		**6,901,377**	**258,088**	**3.74%**	**4,141,422**	**6.23%**
	McCall	1,060,540	28,583	2.70%	622,537	4.59%
	Rapid River	2,493,719	95,307	3.82%	2,009,938	4.74%
2008	Sawtooth	174,132	1,838	1.05%	59,379	3.09%
	Pahsimeroi	1,037,772	17,954	1.73%	462,846	3.88%
	Clearwater	1,666,295	48,874	2.93%	889,802	5.49%
2008 Total		**6,432,458**	**192,556**	**2.99%**	**4,044,502**	**4.76%**
	McCall	1,087,170	20,986	1.93%	597,944	3.50%
	Rapid River	2,396,602	50,004	2.09%	1,778,279	2.81%
2007	Sawtooth	995,262	15,194	1.53%	572,276	2.66%
	Pahsimeroi	Not enough PIT tags in release group to generate estimate				
	Clearwater	1,400,657	51,324	3.66%	1,088,473	4.72%
2007 Total		**5,879,691**	**137,508**	**2.34%**	**4,036,972**	**3.41%**

From migration year 2007 to 2011, overall waterbird predation rates on IDFG released spring/summer Chinook salmon surviving to LGD ranged from a low of 3.3% to a high of 6.2%. The point of this analysis is to quantify another measurable component in accounting for hatchery Chinook salmon post release. We will continue to monitor and build upon this dataset for future migration years and as the dataset grows, we will be able to better investigate trends and try to gain a further understanding of factors that may influence predation rates. Currently, variation of yearly recovery rates is unknown and should be considered when looking at these data and comparing trends across years.

Use of Jaw Tags to Access PIT Tag Retention in Returning Adult Chinook Salmon Between LGD and Hatchery Racks

Previous work looking at PIT-tagged to untagged ratios of returning male and female adult Chinook salmon to the South Fork Salmon River Trap, has shown a higher proportion of returning four-year-old males with PIT tags than females (Table 28). If we assume that male and

female Chinook salmon are tagged at a ratio of about 50:50, then these data indicate a differential rate of tag loss between male and female Chinook salmon. If females are indeed loosing tags at a higher rate, it seems practical that this tag loss could be occurring as females develop gametes. Similar differential tag loss has been shown in a study evaluating Coho salmon (Prentice et al. 1994) and the authors of that study hypothesized that females were rejecting PIT tags from their body cavity as an irritant as they developed gametes.

Table 28. Comparison of estimated PIT tag loss in age-4 male and female Chinook salmon returning to the South Fork Salmon River Trap.

Brood Year	Return Year	Males Trapped	Expected PIT Tags	Actual PIT Tags	Estimated PIT Loss	Females Trapped	Expected PIT Tags	Actual PIT Tags	Estimated PIT Loss
2005	2009	1,480	70	53	24.77%	2,170	103	62	39.98%
2006	2010	1,686	82	62	24.39%	3,286	160	63	60.63%
2007	2011	873	29	19	34.48%	1,208	40	25	37.50%

To analyze whether or not male and female Chinook salmon shed tags as they neared spawning, we used the separation by code gates in the LGD adult trap to target specific PIT tagged returning adults from the McCall and Rapid River fish hatcheries. Once trapped, these PIT-tagged fish had a uniquely numbered jaw tag applied as a secondary mark and were released upstream of the dam. When recovered at the South Fork Salmon River or Rapid River traps, jaw tagged fish were carefully scanned for PIT tags to see if they had retained their tags from LGD back to the traps. Though 258 individual Chinook salmon were jaw tagged, only 36 of those fish were recovered at the hatchery traps. Of those 36, six had either lost their jaw tags or had them removed by anglers. None of the 36 recovered fish had lost their PIT tag (Table 29). While conversions from LGD to the adult traps were below average in 2012 and our sample size was much smaller than expected, we still did not observe any PIT tag loss in adult Chinook salmon from LGD to the hatchery traps. This study may be repeated in the future but with anticipated lower numbers of returning adults in 2013, it will not be repeated next year.

Table 29. Estimated PIT tag loss in hatchery-origin Chinook salmon returning to the South Fork Salmon River and Rapid River traps in 2012.

South Fork Salmon River						
Age	Tagged at LGD	Recovered at Hatchery	Lost PIT Tag	% Loss (PIT)	Lost Jaw Tag	% Loss (Jaw)
Jack	10	2	0	0.00%	0	0.00%
2-Ocean	69	22	0	0.00%	4	18.18%
3-Ocean	5	1	0	0.00%	0	0.00%
Rapid River						
Age	Tagged at LGD	Recovered at Hatchery	Lost PIT Tag	% Loss (PIT)	Lost Jaw Tag	% Loss (Jaw)
Jack	4	3	0	0.00%	1	33.33%
2-Ocean	151	8	0	0.00%	1	12.50%
3-Ocean	20	0	0	0.00%	0	0.00%

Harvest Composition of 2007, 2008, and 2009 Idaho Sport Chinook Salmon Fisheries

Idaho Chinook salmon sport harvest, by stock and age, for return years 2007, 2008, and 2009 has not previously been reported in a statewide summary. Summaries for the three return years are provided in Tables 30, 31, and 32.

Table 30. Summary of 2007 spring/summer Chinook salmon sport harvest in Idaho by fishery, stock, and age.

Fishery and Stock	Age-3	Age-4	Age-5	Total
Clearwater River Fishery				
Dworshak	0	148	108	**256**
Kooskia	85	43	0	**128**
Clearwater (Powell)	0	89	0	**89**
Clearwater (South Fork)	0	171	0	**171**
Clearwater (Selway)	81	0	0	**81**
Total	**166**	**451**	**108**	**725**
Snake River Fishery				
Rapid River (Hells Canyon Dam)*	/	/	/	**20**
Total	***/***	***/***	***/***	**20**
Lower Salmon River Fishery				
Rapid River Hatchery	88	214	107	**409**
McCall (SFSR)	0	6	0	**6**
Total	**88**	**220**	**107**	**415**
Little Salmon River Fishery				
Rapid River Hatchery	32	343	164	**539**
Total	**32**	**343**	**164**	**539**
SF Salmon River Fishery				
McCall (SFSR)	182	504	38	**724**
Total	**182**	**504**	**38**	**724**
Grand Total	***468***	***1,518***	***417***	***2,423***

* A creel survey was not conducted for this fishery. Only volunteer angler survey card information was available. Age composition of the catch was not estimated.

Table 31. Summary of 2008 spring/summer Chinook salmon sport harvest in Idaho by fishery, stock, and age.

Fishery and Stock	Age-3	Age-4	Age-5	Total
Clearwater River Fishery				
Dworshak	166	846	97	**1,109**
Kooskia	57	546	20	**623**
Clearwater (Powell)	270	432	37	**739**
Clearwater (South Fork)	462	1,027	0	**1,489**
Clearwater (Selway)	118	170	0	**288**
Total	**1,073**	**3,021**	**154**	**4,248**
Snake River Fishery				
Rapid River (Hells Canyon Dam)	584	300	40	**924**
	584	**300**	**40**	**924**
Lower Salmon River Fishery				
Rapid River Hatchery	903	2,171	100	**3,174**
McCall (SFSR)	19	235	0	**254**
Sawtooth Hatchery	163	47	0	**210**
Total	**1,085**	**2,453**	**100**	**3,638**
Little Salmon River Fishery				
Rapid River Hatchery	337	1,160	133	**1,630**
Total	**337**	**1,160**	**133**	**1,630**
SF Salmon River Fishery				
McCall (SFSR)	807	2,860	185	**3,852**
Total	**807**	**2,860**	**185**	**3,852**
Upper Salmon River fishery				
Sawtooth Hatchery	282	388	0	**670**
Total	**282**	**388**	**0**	**670**
Grand Total				***14,962***

Table 32. Summary of 2009 spring/summer Chinook salmon sport harvest in Idaho by fishery, stock, and age.

Fishery and Stock	Age-3	Age-4	Age-5	Total
Clearwater River Fishery				
Dworshak	744	629	0	**1,373**
Kooskia	79	109	0	**188**
Clearwater (Powell)	62	377	0	**439**
Clearwater (South Fork)	1,082	762	46	**1,890**
Clearwater (Selway)	293	70	0	**363**
Total	**2,260**	**1,947**	**46**	**4,253**
Snake River Fishery				
Rapid River (Hells Canyon Dam)	1,169	390	72	**1,631**
Total	**1,169**	**390**	**72**	**1,631**
Lower Salmon River Fishery				
Rapid River Hatchery	3,762	894	38	**4,694**
McCall (SFSR)	260	237	0	**497**
Pahsimeroi	79	422	0	**501**
Total	**4,101**	**1,553**	**38**	**5,692**
Little Salmon River Fishery				
Rapid River Hatchery	2,490	1,240	75	**3,805**
Total	**2,490**	**1,240**	**75**	**3,805**
SF Salmon River Fishery				
McCall (SFSR)	1,181	2,727	241	**4,149**
Total	**1,181**	**2,727**	**241**	**4,149**
Upper Salmon River fishery				
Sawtooth Hatchery	0	1,862	0	**1,862**
Pahsimeroi Hatchery	601	1,056	0	**1,657**
Total	**601**	**2,918**	**0**	**3,519**
Grand Total				***23,049***

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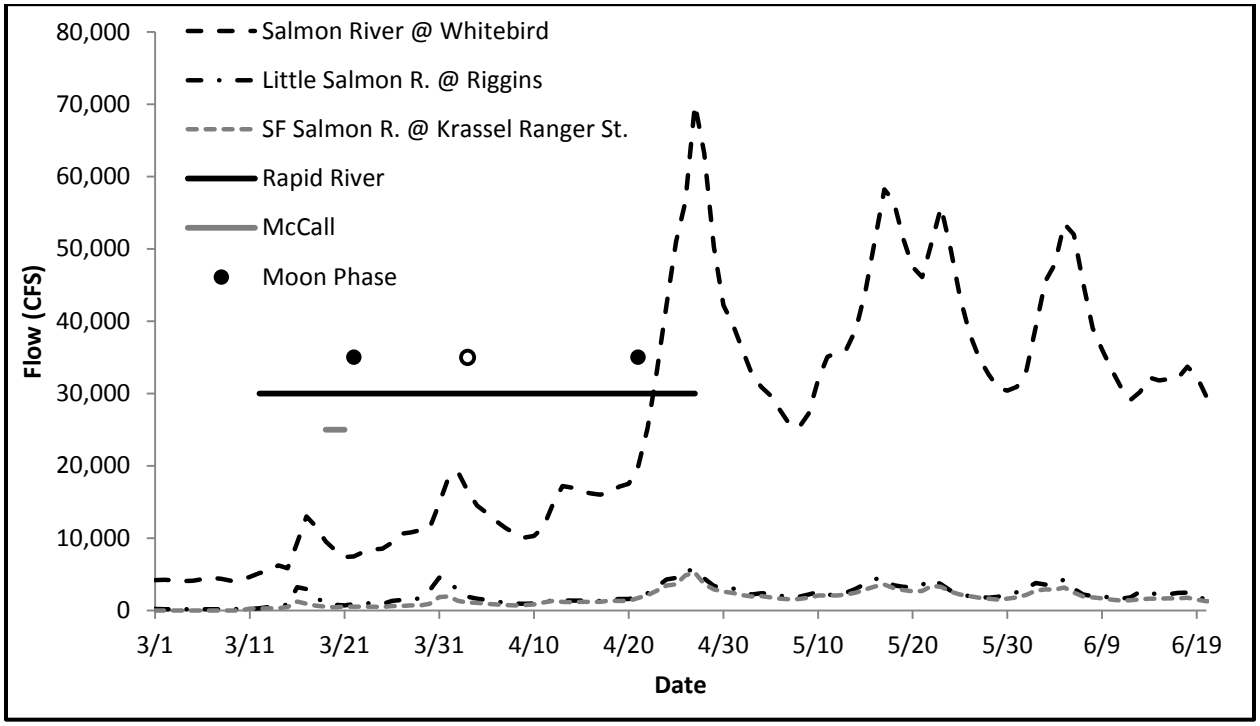
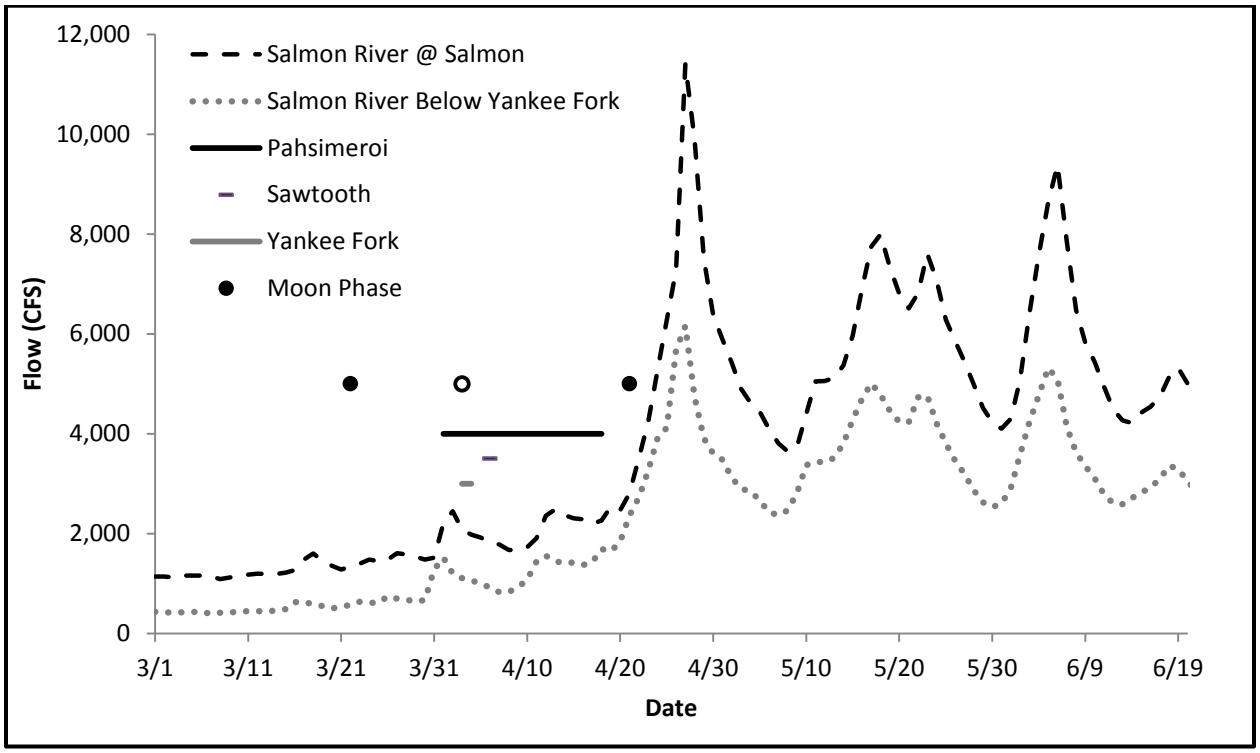
APPENDICES

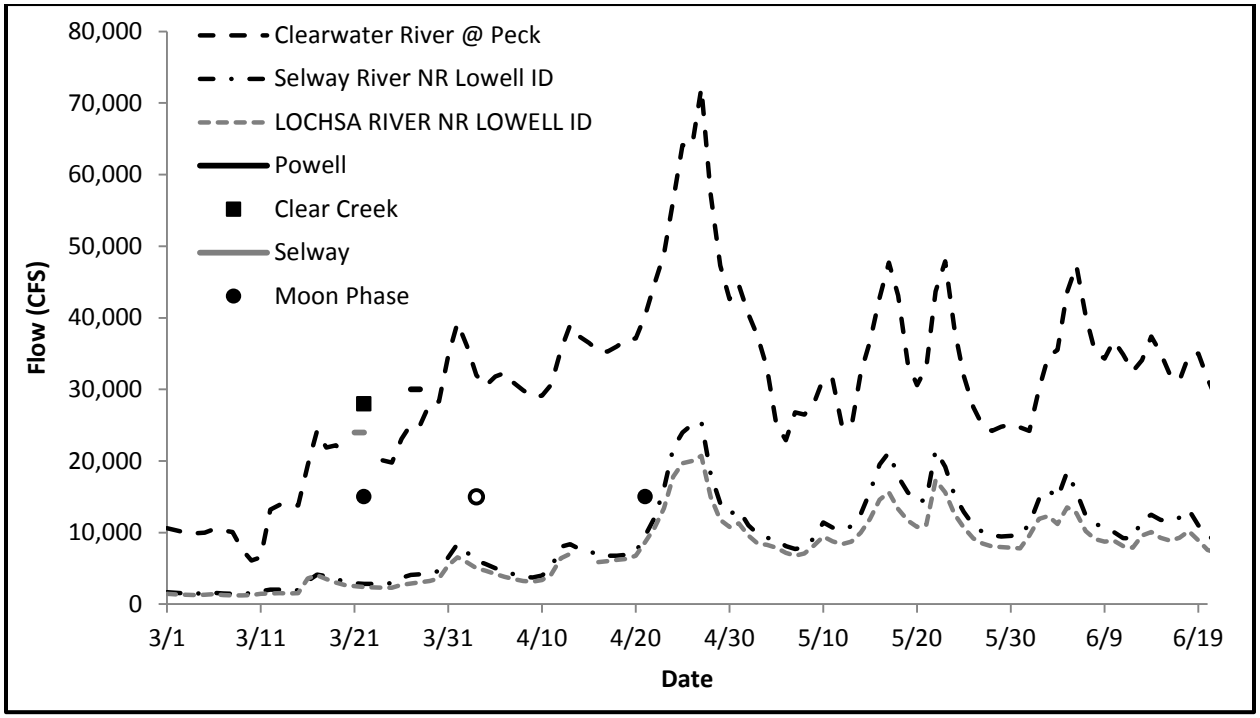
Appendix A1. 2012 SF Salmon River summer and Rapid River spring Chinook salmon smolt release timing vs. moon phase and flow.



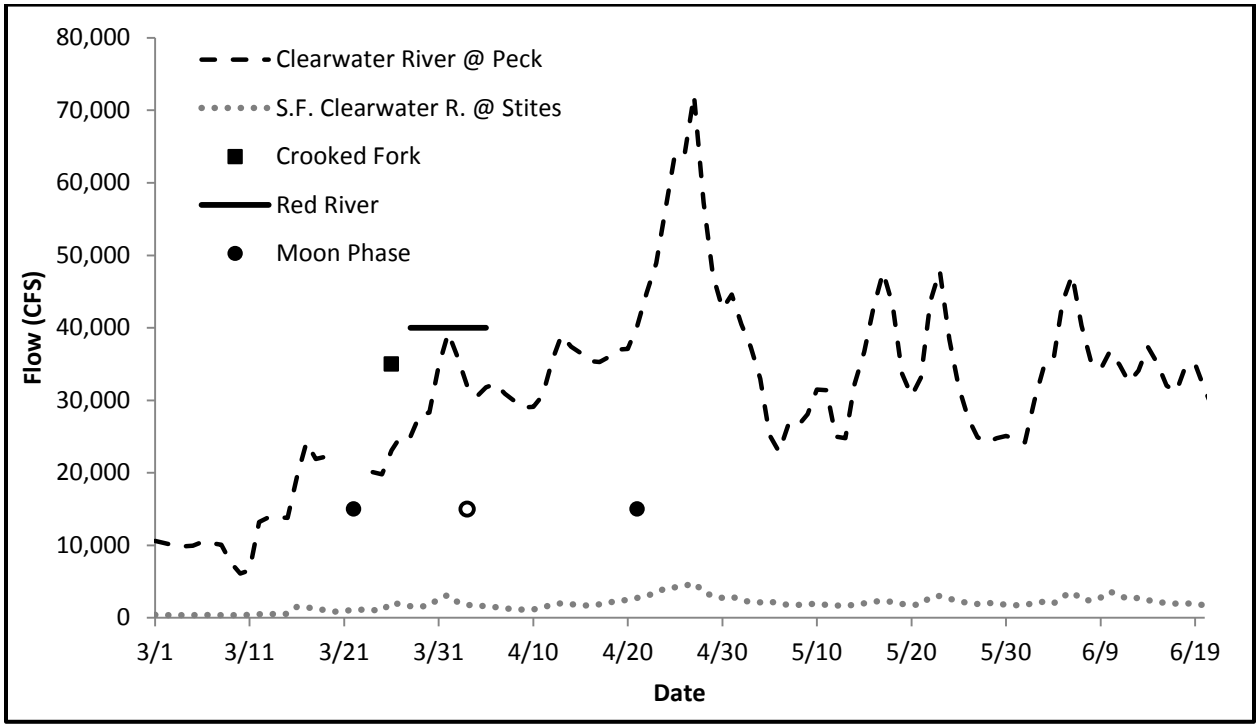
Appendix A2. 2012 Pahsimeroi summer and Sawtooth spring Chinook salmon smolt release timing vs. moon phase and flow.



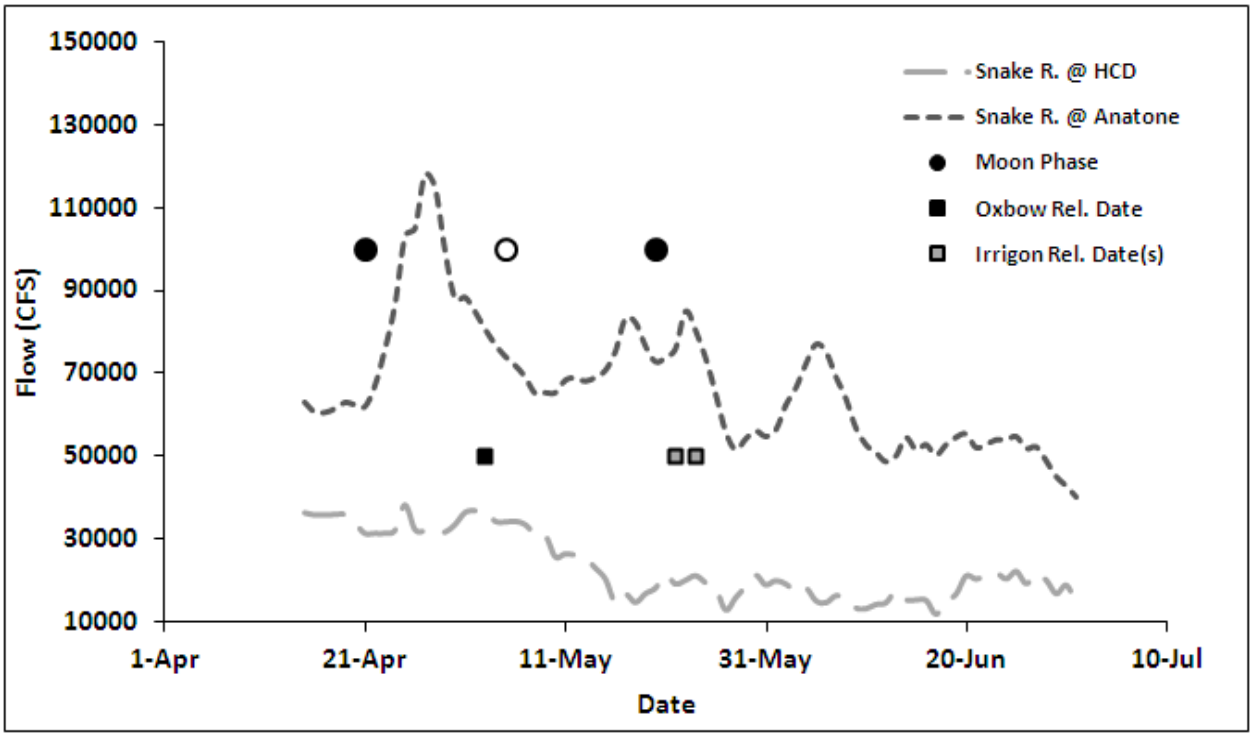
Appendix A3. 2012 Upper Clearwater spring Chinook salmon smolt release timing vs. moon phase and flow.



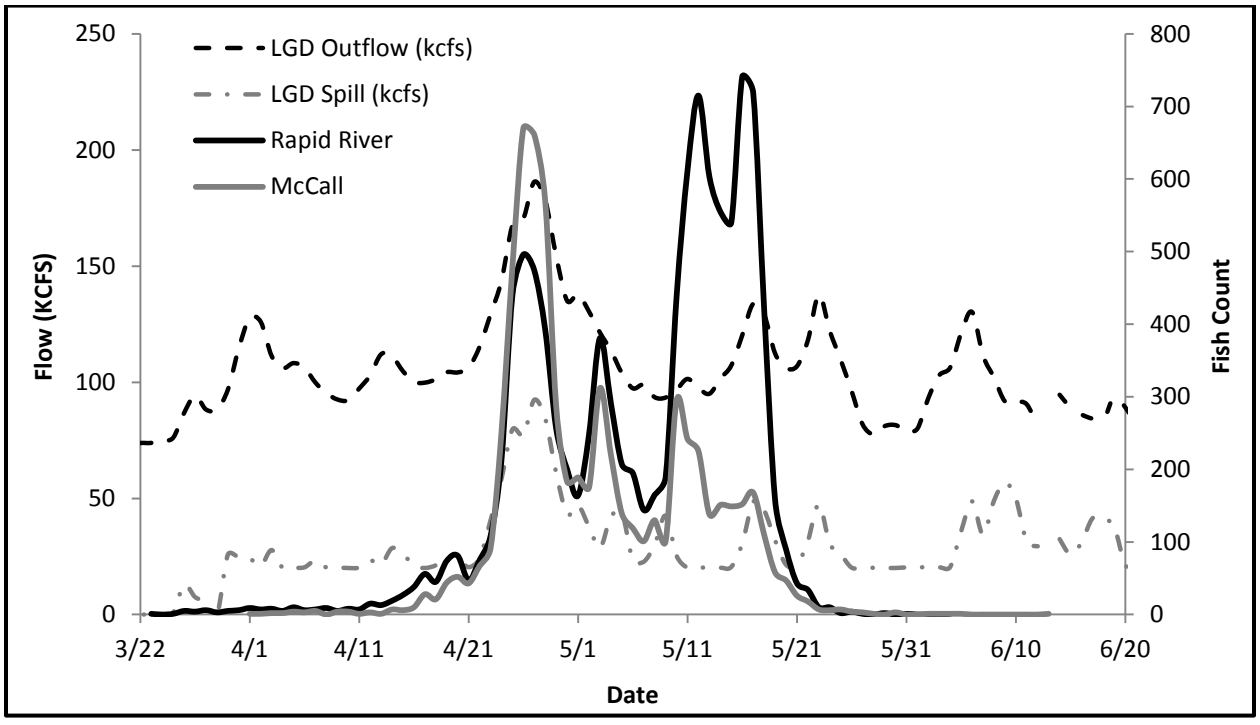
Appendix A4. 2012 South Fork Clearwater spring Chinook salmon smolt release timing vs. moon phase and flow



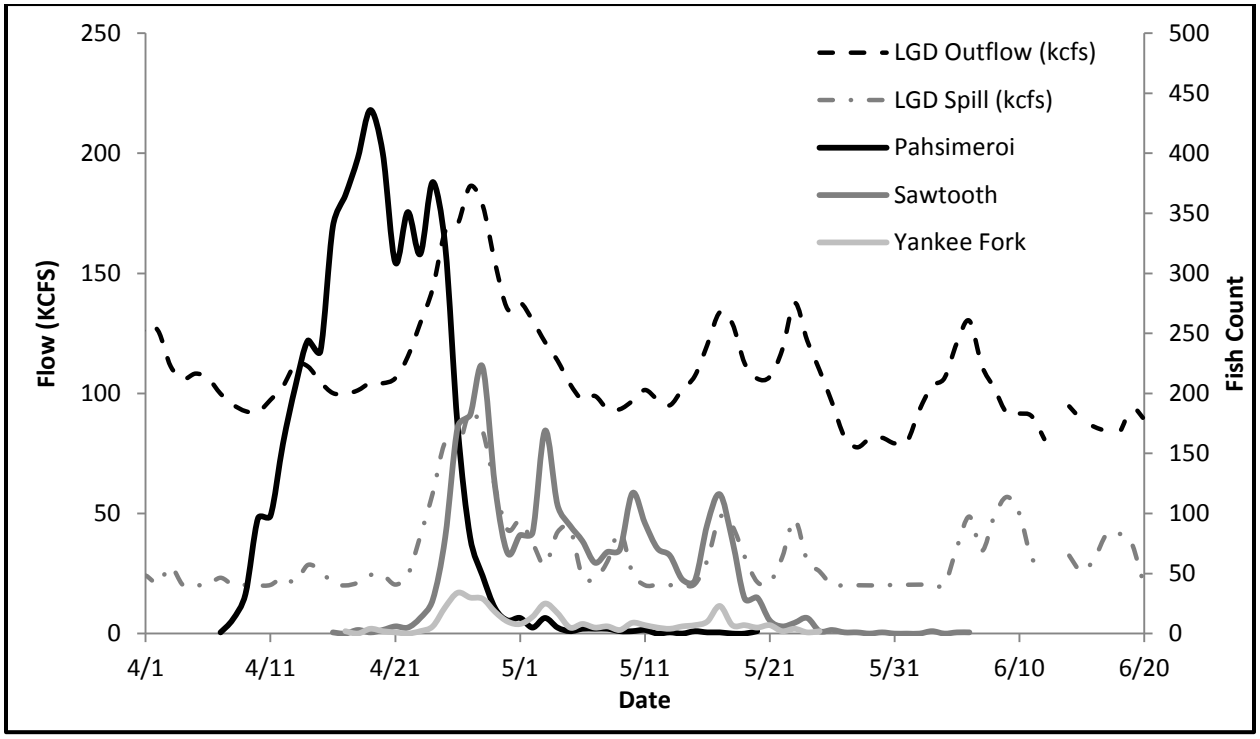
Appendix A5. 2012 Oxbow and Irrigon fall Chinook salmon smolt release timing vs. moon phase and flow.



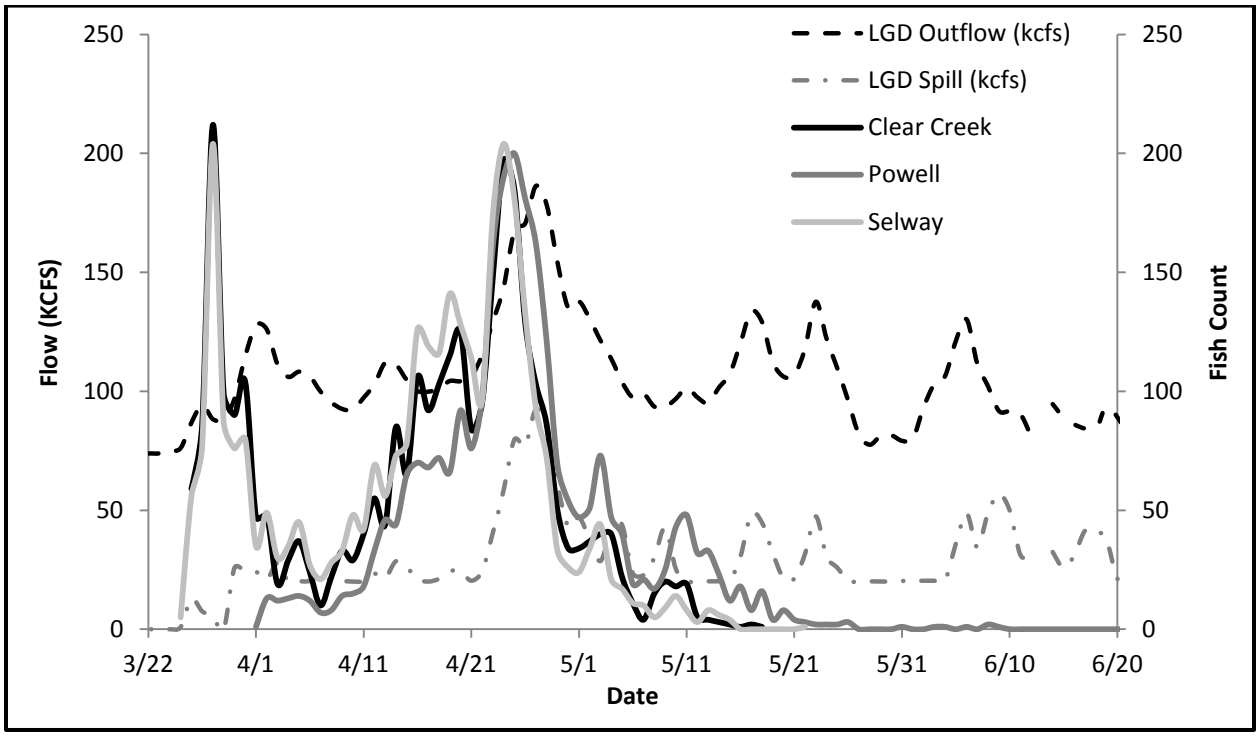
Appendix B1. 2012 SF Salmon River summer and Rapid River spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



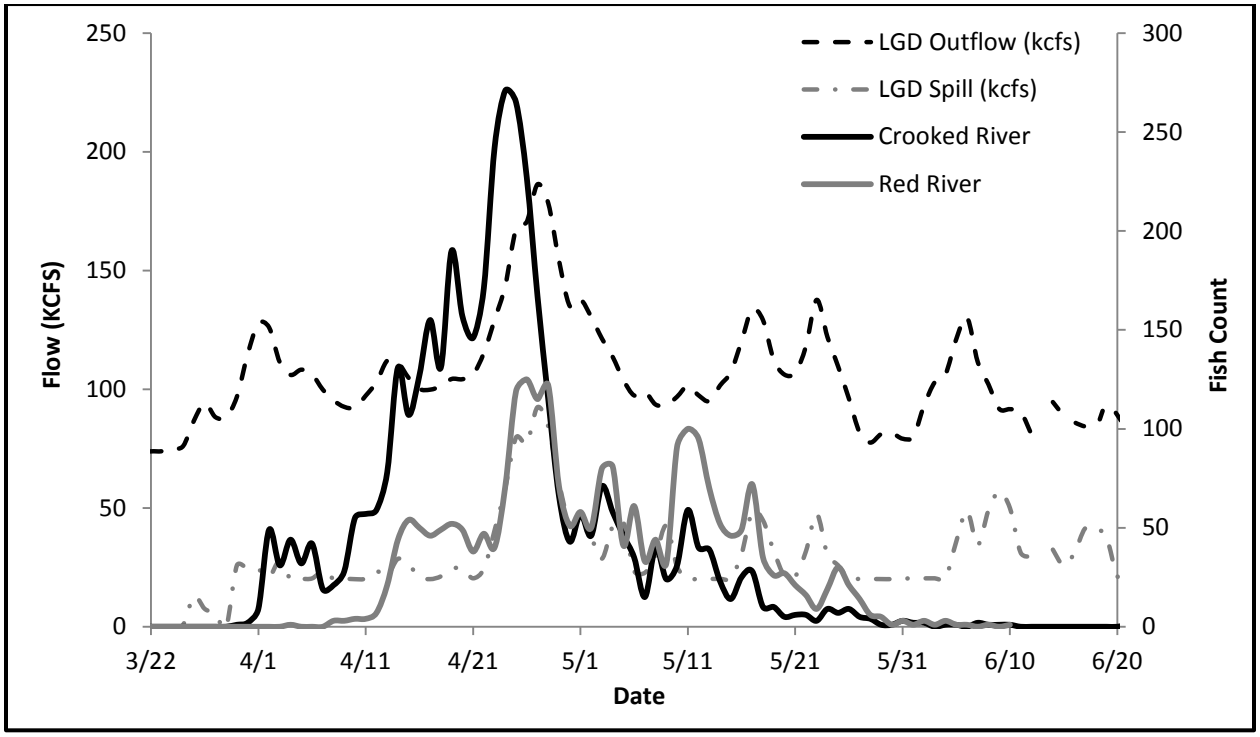
Appendix B2. 2012 Pahsimeroi summer and Sawtooth spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



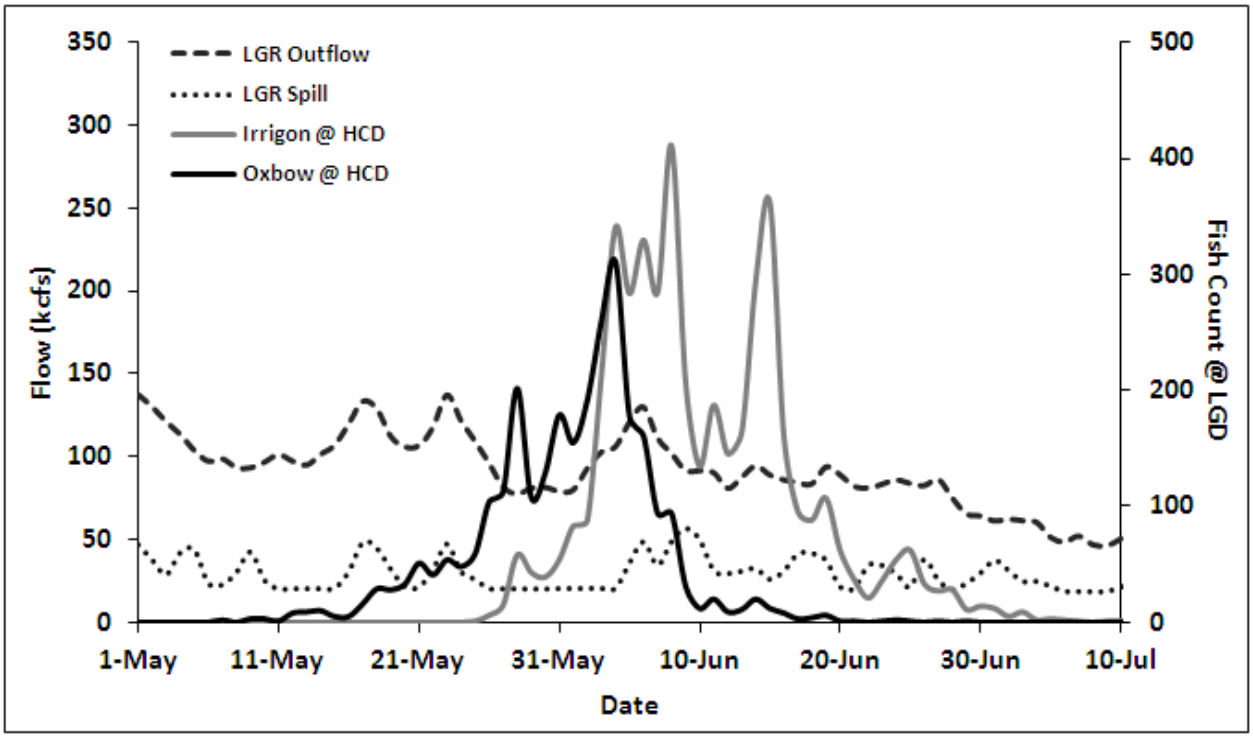
Appendix B3. 2012 Upper Clearwater spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



Appendix B4. 2012 South Fork Clearwater spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



Appendix B5. 2012 Oxbow and Irrigon fall Chinook salmon arrival timing vs. flow at Lower Granite Dam.



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