FISHERY RESEARCH

2011 CALENDAR YEAR HATCHERY CHINOOK SALMON REPORT:

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

John Cassinelli
Regional Fisheries Biologist, Idaho Department of Fish and Game

Stuart Rosenberger
Anadromous Hatchery M&E Biologist, Idaho Power Company

Forrest Bohlen
Research Data Coordinator, Idaho Department of Fish and Game

IDFG Report Number 12-02
January 2012

2011 Calendar Year Hatchery Chinook Salmon Report: IPC and LSRCP Monitoring and Evaluation Programs in the State of Idaho

January 1, 2011—December 31, 2011

By

John Cassinelli
Stuart Rosenberger
Forrest Bohlen

Idaho Department of Fish and Game
600 South Walnut Street
P.O. Box 25
Boise, ID 83707

To

Idaho Power Company
1221 W. Idaho St.
Boise, ID 83702

U.S. Fish and Wildlife Service
Lower Snake River Compensation Plan Office
1387 S. Vinnell Way, Suite 343
Boise, ID 83709

LSRCP Agreement # 14110-B-J008

IDFG Report Number 12-02
January 2012

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

LIST OF APPENDICES

Page

INTRODUCTION

This report details various components of hatchery-origin spring, summer, and fall Chinook salmon monitoring, evaluation, and management for calendar year 2011. 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 programs include a spring Chinook salmon program at the Sawtooth Fish Hatchery, a summer Chinook salmon program at the McCall Fish Hatchery, and a combination spring/summer Chinook salmon program at the Clearwater Fish Hatchery. 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 1.7 million yearling smolts. The adult return goal for Sawtooth Fish Hatchery is 19,400 adults back to Lower Granite Dam (LGD). Clearwater Fish Hatchery is located at the confluence of the North Fork and mainstem Clearwater rivers near Ahsahka, Idaho. There are three satellite facilities associated with Clearwater Fish Hatchery. 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 current smolt release goal of 2.3 million yearling smolts and 0.3 million subyearling parr. The adult return goal is 11,900 adults back to LGD. 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 adult return goal is 8,000 adults back to LGD.

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 current 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, respectively, from the confluence with the Salmon River near the town of Ellis, Idaho (Figure 1). The hatchery was constructed in 1968 and has a current 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 current 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.

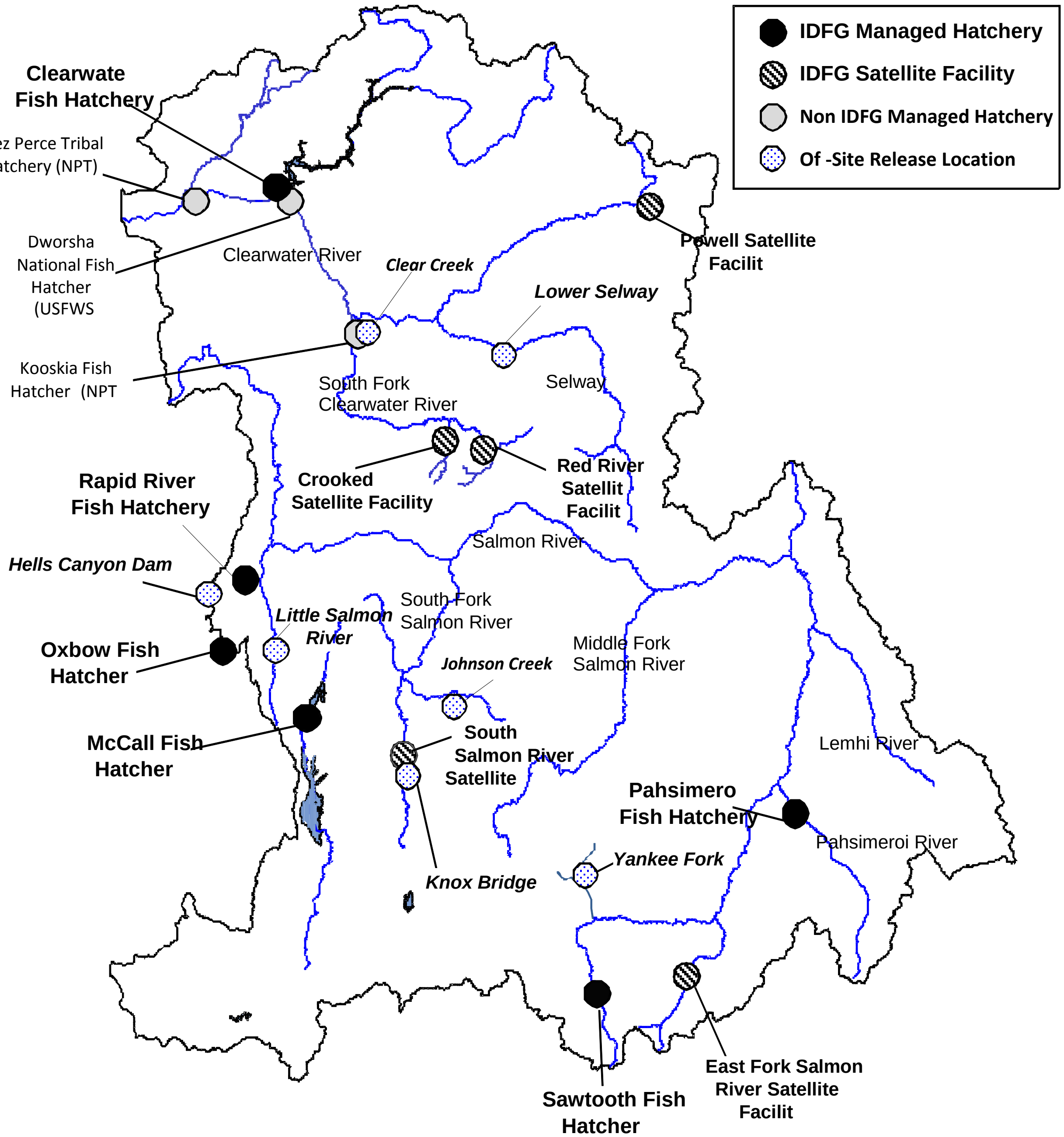


Figure 1. State, federally, and tribally operated anadromous fish hatcheries located in the Clearwater, Salmon, and mid-Snake river basins along with associated satellite facilities and off-site release locations.

JUVENILE PRODUCTION AND RELEASE

Marking

All marks and tags that were applied to Chinook salmon released in 2011 are outlined in Table 1 below. 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—2011 Marking Season." This report will be available through IDFG.

During calendar year 2011, various mark and loading plans were cooperatively developed to outline tagging and marking procedures in upcoming years. In May 2011, a mark plan was developed that outlined preliminary mark and tag numbers for brood year 2011 Chinook salmon. In November 2011, both a passive integrated transponder (PIT) tag loading plan for brood year 2010 and a mark/coded wire tag (CWT) loading plan for brood year 2011 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 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 2011 had a fin clip taken for a genetic sample. These genetic samples are used to identify juvenile fish produced from each parental cross. At any point in the offspring's life cycle, a tissue sample can be taken and through the genetic baseline, the fish can be assigned back to its hatchery, stock, cohort, and in many instances, its release site. PBT is beneficial because fish are 100% marked and sampling is non-lethal. PBT can be used to generate stock and age compositions of fisheries, on spawning grounds, and at hatchery traps.

Passive Integrated Transponder Tags

PIT tags serve multiple purposes and, like CWTs, are an important tool for monitoring and evaluating 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 used to manage fisheries in-season and 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. The purpose of the return-to-river groups are to ensure enough individual fish from a given release remain in the river throughout their juvenile outmigration so that juvenile survival estimates can be generated. 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 2001 annual report (Comparative Survival Study Oversight Committee and Fish Passage Center the 2011 annual report, 2011).

Releases

Juvenile Chinook salmon were released starting in March and continuing through May of 2011. 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 parr from Clearwater Fish Hatchery in the late summer. All 2011 Chinook salmon releases were at or near the release goals of each facility outlined in the Introduction section above (Table 1). All release information was submitted to the Regional Mark Information System (RMIS) by August of 2011. Release locations are shown in Figure 1.

Table 1. Juvenile Chinook salmon released in 2011 from hatcheries operated by IDFG.

Migr. Year	Hatchery	Rel. Site	Release Date(s)	AD Only	AD/CWT	CWT Only	PIT TAG*	Total Release
2011	McCall	SFSR-Knox	3/22 - 3/25	862,050	206,978	0	51,878	1,069,028
McCall Total Release				**862,050**	**206,978**	**0**	**51,878**	**1,069,028**
2011	Rapid River	Rapid R. Ponds	3/15 – 4/21	2,383,984	99,197	0	51,730	2,483,181
2011	Rapid River	Little Sal. R.	3/25	200,000	0	0	0	200,000
2011	Rapid River	Hells Can. Dam	3/21 -3/24	400,000	0	0	0	400,400
Rapid River Total Release				**2,983,984**	**99,197**	**0**	**51,730**	**3,083,181**
2011	Clearwater	Powell	4/5 - 4/6	290,597	123,160	0	17,098	413,757
2011	Clearwater	Red River	3/28 – 4/7	999,093	115,667	0	17,060	1,114,760
2011	Clearwater	Crooked River	3/28 – 3/29	0	0	204,061	25,488	204,061
2011	Clearwater	Selway River	3/23 - 3/24	155,921	115,992	142,357	17,083	414,270
2011	Clearwater	Clear Cr	3/24 - 3/25	172,086	119,158	0	17,095	291,604
2012**	Clearwater	Selway River	6/13, 6/20	0	0	0	0	302,782
Clearwater Total Release				**1,618,181**	**475,058**	**345,213**	**93,815**	**2,438,452**
2011	Sawtooth	Sawtooth Weir	4/1	1,222,530	114,772	0	18,938	1,337,302
2011	Sawtooth	Yankee F. (Dir.)	4/20	198,640	0	0	1,200	198,640
2011	Sawtooth	Yankee F. (Acc.)	4/19	199,237	0	199,237	1,195	201,714
Sawtooth Total Release				**1,421,170**	**114,772**	**199,237**	**21,333**	**1,735,179**
2011	Pahsimeroi	Pahsim. Ponds	4/1 - 4/22	907,036	122,992	0	21,131	1,030,028
Pahsimeroi Total Release				**907,036**	**122,992**	**0**	**21,131**	**1,030,028**
2011***	Oxbow	Hells Can. Dam	5/5	15,769	167,137	0	14,927	194,809
2011***	Irrigon	Hells Can. Dam	5/24, 5/26	435,100	195,414	397	36,925	638,900
Oxbow / Irrigon Total Release				**450,869**	**362,551**	**397**	**51,852**	**833,709**

* 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 2011, and will out-migrate in 2012.
*** 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 2011, juvenile smolt survival rates to LGD ranged from a low of 30.3% for the direct release into the Yankee Fork of the Salmon River, to a high of 78.9% for the spring Chinook salmon released into Clear Creek (Table 2). Survivals in 2011 were similar to, or greater than, the previous nine year unweighted average for all release sites except at Red River, where survival was about half that of the previous nine year unweighted average (Table 3). The low survival rates for the Red River release were likely caused by a significant spike in post release flows, as outlined below.

Monitoring and Evaluation staff began tracking and capturing river flow conditions during juvenile releases and out-migration in 2010. Those figures are included in Appendix A of this document. One set of figures shows smolt release timing vs. moon phase and release basin flow. These figures show that most 2011 smolt releases occurred prior to upswings in spring discharge. However, in the Clearwater basin there was a significant spike in flows that corresponded with some of the smolt releases. While most releases in the Clearwater basin occurred right before or right after this large spike, the Red River smolt release occurred during the upswing in flows (Appendix A4). This is likely why the juvenile survival for that release was about half of the previous nine-year unweighted average for that site (Table 3). The second set of figures shows arrival timing vs. spill and outflow at LGD. These figures show that the bulk of juvenile spring/summer Chinook salmon released in the Salmon River crossed LGD in a 30-day window from late April to late May, while Clearwater River releases arrived over 45 days from late March to early May. All spring/summer releases arrived at LGD prior to the substantial increase in spill and outflow that occurred on May 14. Fall Chinook salmon arrived at LGD from early May to early June, in conjunction with the spike in spill and outflow.

Table 2. Juvenile hatchery Chinook salmon survival and travel time estimates to Lower Granite Dam for release year 2011.

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	17,095	3/24,25	19.0	176	27 Days	24-Apr	4/22 - 5/5 (33 Days)	**78.9% ± 1.5**
Powell Pond	17,089	4/5,6	16.0	321	26 Days	4-May	4/16 - 5/10 (24 Days)	**76.1% ± 1.9**
Red River Pond	17,060	3/28- 4/7	16.0	299	43 Days	10-May	4/22 - 5/25 (33 Days)	**32.2% ± 1.5**
Crooked R. Trap	25,488	3/28- 3/29		280	36 Days	3-May	4/18 - 5/14 (26 Days)	**52.7% ± 1.3**
Selway River	17,083	3/23,24	17.0	240	30 Days	26-Apr	4/3 - 5/5 (32 Days)	**75.5% ± 1.6**
SF Salmon R. – Knox	51,878	3/22-3/25	18.5	457	50 Days	12-May	5/4 - 5/18 (14 Days)	**62.9% ± 1.3**
Pahsimeroi Ponds	21,131	4/1-4/22	14.1	630	N/A	28-Apr	4/18 - 5/7 (17 Days)	**51.1% ± 1.3**
Rapid River Ponds	51,730	3/15-4/21	18.6	283	N/A	10-May	5/1 - 5/15 (14 Days)	**77.6% ± 1.2**
Sawtooth Weir	18,938	4/1	23.0	747	39 Days	11-May	5/1 - 5/15 (14 Days)	**53.1% ± 1.4**
Yank. Fk. @ 2nd Bridge	1,195	4/20	26.0	729	24 Days	13-May	5/9 - 5/17 (8 Days)	**30.3% ± 5.4**
Yank. Fk. @ Dredge P.	1,200	4/19	26.0	721	26 Days	14-May	5/11 - 5/22 (11 Days)	**37.2% ± 7.2**
Oxbow (HCD)	14,927	5/5	48.2	222	21 Days	26-May	5/17 - 6/4 (18 Days)	**75.8% ± 3.6**
Irrigon (HCD)	36,925	5/24-5/26	81.0	222	15 Days	5-June	5/31 - 6/19 (19 Days)	**62.0% ± 2.8**

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	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Site Ave. (2002-2010)
Clearwater	Clear Cr.								78.7	80.7	**78.9**	**79.7**
	Powell Pond	82.1	86.2	77.5	83.6	79.0	77.5	36.1	63.1	67.1	**76.1**	**72.5**
	Red R. Pond	72.3	59.6	72.2	67.6	52.4	81.8	65.9	36.2	70.3	**32.2**	**64.2**
	Selway River							69.0	72.2	79.5	**75.5**	**73.6**
	Crooked R. Trap*										**52.7**	
McCall	SF Salmon R. - Knox	61.3	57.4	59.4	60.4	63.8	55.0	58.7	51.2	56.5	**62.9**	**58.2**
Pahsimeroi	Pahsimeroi Ponds	68.7	71.4	50.5	22.1	26.7	53.0	44.6	50.9	37.3	**51.1**	**47.2**
Rapid River	Rapid River Ponds	74.8	69.2	69.4	73.6	75.9	74.2	80.6	72.6	78.1	**77.6**	**74.3**
Sawtooth	Sawtooth Weir	48.5	61.1	58.0	22.0	65.3	57.5	34.1	36.6	42.3	**53.1**	**47.0**
	Yank. Fk. 2nd Bridge									47.7	**30.3**	**47.7**
	Yank. Fk. Dredge Ponds									54.2	**37.2**	**54.2**
Oxbow	Hells Canyon Dam		57.0	43.8	66.6	81.8	64.3	80.2	66.4	45.4	**75.8**	**63.2**
Irrigon	Hells Canyon Dam					75.7		80.6	59.9	58.9	**62.0**	**68.8**
Yearly Unweighted Average		**70.0**	**66.0**	**61.5**	**56.6**	**65.1**	**66.2**	**61.1**	**58.8**	**59.8**	**59.4**	**62.6**

* This is the first release of summer Chinook salmon from this location, so no historic data is available.

ADULT RETURNS

Adult Chinook salmon from brood years 2008, 2007, and 2006 returned to Idaho in 2011 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 above LGD, and back to hatchery traps for spring and summer Chinook salmon. Strays above LGD are also included. Escapement of hatchery fish above 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 returns based on the previous year's jack 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 2011 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 2011 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	1,382	1,101	760
Clearwater	Powell Pond	2,140	1,658	1,177
Clearwater	SF Clearwater*	2,622	2,152	1,442
Clearwater	Clear Creek	1,127	886	620
Total Clearwater R.		**7,271**	**5,797**	**3,999**
Rapid River	Rapid River Ponds	20,701	15,221	10,350
Rapid River	Hells Canyon Dam	4,096	3,012	2,048
Rapid River	Little Salmon River	1,666	1,225	833
Pahsimeroi	Pahsimeroi Ponds	4,900	4,594	3,675
Sawtooth	Sawtooth Hatchery	590	589	502
McCall	SF Salmon River	11,030	9,302	7,721
Total Salmon R.		**42,983**	**33,943**	**25,129**
	TOTALS	**50,254**	**39,740**	**29,128**

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

Returns to Bonneville and Lower Granite Dams

The majority of the age classes of Chinook salmon returning to Idaho in 2011 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 indicated 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. Adult returns in 2011 exceeded preseason forecasted estimates to Bonneville Dam for all release sites except Sawtooth Hatchery. However, the return from the Sawtooth Hatchery release was still about 92% of the preseason forecasted return estimate (Table 7).

Table 5. Estimated escapement of returning spring/summer Chinook salmon to Bonneville Dam in return year 2011. Estimates are based on expanded PIT tag detections.

Release Hatchery	Release Site	One-Ocean	Two-Ocean	Three-Ocean	Total
Clearwater	Selway River	795	3,673	152	4,620
Clearwater	Powell Pond	392	2,144	121	2,657
Clearwater	Crooked River*	NA	1,851	576	2,427
Clearwater	Red River*	1,989	1,209	393	3,591
Clearwater	Clear Creek	825	2,070	NA	2,895
Total Clearwater R.		**4,001**	**10,947**	**1,242**	**16,190**
Rapid River	Rapid River Ponds	7,796	24,038	2,396	34,230
Rapid River	Hells Canyon Dam**	1,566	4,808	479	6,853
Rapid River	Little Salmon River**	425	1,925	192	2,542
Sawtooth***	Sawtooth Weir	4,589	419	120	5,128
Sawtooth	Yankee Fork	784	NA	NA	784
Pahsimeroi	Pahsimeroi Ponds	546	3,741	1,323	5,610
McCall***	SF Salmon R. - Knox	4,413	7,794	1,830	14,037
Total Salmon R.		**20,119**	**42,725**	**6,340**	**69,184**
GRAND TOTAL		**24,120**	**53,672**	**7,582**	**85,374**

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

Table 6. Estimated escapement of returning spring/summer Chinook salmon to Lower Granite Dam in return year 2011. Estimates are based on expanded PIT tag detections.

Release Hatchery	Release Site	One-Ocean	Two-Ocean	Three-Ocean	Total
Clearwater	Selway River	672	2,502	77	3,251
Clearwater	Powell Pond	198	1,531	86	1,815
Clearwater	Crooked River*	NA	1,489	475	1,964
Clearwater	Red River*	1,718	860	316	2,894
Clearwater	Clear Creek	684	1,436	NA	2,120
Total Clearwater R.		**3,272**	**7,818**	**954**	**12,044**
Rapid River	Rapid River Ponds	5,921	17,462	1,553	24,936
Rapid River	Hells Canyon Dam**	1,189	3,499	304	4,992
Rapid River	Little Salmon River**	322	1,397	126	1,845
Sawtooth***	Sawtooth Weir	3,489	386	72	3,947
Sawtooth	Yankee Fork	396	NA	NA	396
Pahsimeroi	Pahsimeroi Ponds	470	2,274	784	3,528
McCall***	SF Salmon R. – Knox	3,615	4,397	1,321	9,333
Total Salmon R.		**15,402**	**29,415**	**4,160**	**48,977**
GRAND TOTAL		**18,674**	**37,233**	**5,114**	**61,021**

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

Table 7. Comparison of preseason forecasted returns and estimated returns from PIT tag expansions to Bonneville Dam.

Release Hatchery	Release Site	Preseason Forecasted Return (Two- and Three-Ocean Combined)	Estimated Return from PIT Expansions (Two- and Three-Ocean Combined)
Clearwater	Upper Selway	1,101	3,825
Clearwater	Powell Pond	1,658	2,265
Clearwater	SF Clearwater*	2,152	4,029
Clearwater	Clear Creek	886	2,070
Total Clearwater R.		**5,797**	**12,189**
Rapid River	Rapid River Hatchery	15,221	26,434
Rapid River	Hells Canyon Dam**	3,012	5,287
Rapid River	Little Salmon River**	1,225	2,117
Sawtooth***	Sawtooth Hatchery	589	539
Pahsimeroi	Pahsimeroi Hatchery	4,594	5,064
McCall***	SF Salmon River	9,302	9,624
Total Salmon R.		**33,943**	**49,065**
GRAND TOTAL		**39,740**	**61,254**

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

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

Due to the fact that the majority of Chinook salmon returning to Idaho in 2011 had 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 8 and 9).

Table 8. 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 2011 with return year 2010 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	69	7	10.1%	48	12	25.0%
Crooked River	34	9	26.5%	NA	NA	NA
Powell Pond	45	5	11.1%	11	0	0.0%
Selway River	88	12	13.6%	35	4	11.4%
Pahsimeroi Ponds	62	11	17.7%	7	0	0.0%
Sawtooth Hatchery	23	2	8.7%	25	3	12.0%
Knox Bridge	151	19	12.6%	136	9	6.6%
Rapid River	365	61	16.7%	118	31	26.3%
2011 TOTAL	**837**	**126**	**15.1%**	**380**	**59**	**15.5%**
2010 Total	**1,002**	**59**	**5.9%**	**189**	**14**	**7.4%**

Table 9. Percentages of after counting hours passage, by release site, at Lower Granite Dam in return year 2011 for jacks and adults with return year 2010 totals for comparison.

	Adults (Two- and Three-Ocean)			Jacks (One-Ocean)		
Release Location	**PIT Detections at LGD**	**After-Hours Passage**	**Percent**	**PIT Detections at LGD**	**After-Hours Passage**	**Percent**
Clear Creek	69	2	2.9%	48	2	4.2%
Crooked River	34	4	11.8%	NA	NA	NA
Powell Pond	45	3	6.7%	11	2	18.2%
Selway River	88	8	9.1%	35	1	2.9%
Pahsimeroi Ponds	62	9	14.5%	7	0	0.0%
Sawtooth Hatchery	23	1	4.3%	25	1	4.0%
Knox Bridge	151	12	7.9%	136	6	4.4%
Rapid River	365	23	6.3%	118	5	4.2%
2011 TOTAL	**837**	**62**	**7.4%**	**380**	**17**	**4.5%**
2010 Total	**1,002**	**29**	**2.9%**	**189**	**8**	**4.2%**

Similar to return year 2010, in 2011 the overall overestimation caused by double counting due to fallback/reascension is greater than the overall underestimation caused by fish passing the window outside of the counting period. Compared to return year 2010, total fallback/reascension rates for 2011 were over 2.5 times higher for adults and over 2 times higher for jacks (Table 17). Similarly, 2011 adult after-hours passage was nearly 2.5 times higher than return year 2010. However, jack after-hours passage rates were similar between the two return years. 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 2010, the average spill at LGD from April 15 through August 1 was 27.2 kcfs. In 2011, the average spill for the same interval was 44.2 kcfs. This increase in spill corresponds with the increase in the rate of fallback/reascension between the two years.

The net difference between fallback/reascension rates and after-hours passage resulted in the overall adult count at the LGD window being 7,952 fish (8.3%) high and the jack count being 4,157 fish (10.8%) high in 2011. Additionally, because PIT tags cannot be used to directly assess the frequency of fallback that does not result in reascension, this level of overestimation is likely a minimum estimate for 2011. 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 correct the window counts for the LGD accountability in Table 10.

<u>Accountability of the Run at LGD using PIT Tag Expansions</u>

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 (see Research section, this report). 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, and 2011 (Table 10). In 2009 and 2010, individual estimates for jacks and adults were similar, while overall accountability was higher in 2009. In 2011, the adult accountability was higher and the jack accountability lower than in the previous two years. However, overall accountability fell right between the 2009 and 2010 estimate. 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. However, the stock- and age-specific variation is still unclear and preliminary evidence from our in-trap arrays indicates there is likely a high degree of variability in tag loss between facilities. This research is ongoing and will be further evaluated in future reports.

Table 10. 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 2009, 2010, and 2011.

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

* 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 Sawtooth and SFSR stocks.

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

Conversion Rates Between Dams

Using the returning PIT-tagged Chinook salmon, conversion percentages 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 11 and are shown as conversion percentages, by release site, for jacks and adults. In 2011, spring Chinook stocks showed similar conversions to previous years for both jacks and adults with the exception of jacks from Powell and the Yankee Fork. It is not apparent why the jacks from these two release sites had such low conversions, but both groups had a fairly low number of tags returning overall, causing single tag losses to have a much higher impact on the conversion rate overall. Retuning summer Chinook salmon had lower than typical conversion rates in 2011. The summer returns were later than average in 2011. It appears that this later return timing made these stocks more susceptible to mainstem Columbia River fisheries as these stocks were moving through Zone 6 at the peak of the harvest in that section. The increased harvest rates of these stocks likely resulted in the lower conversions. The brood year specific harvest will be evaluated in future brood year reports when downriver harvest estimates are available.

Table 11. 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*	84.8%	77.9%	91.6%	86.4%
Clearwater	Powell Pond	75.5%	71.4%	67.4%	55.0%
Clearwater	Selway River	77.2%	67.4%	89.0%	84.5%
Clearwater	Clear Creek	82.0%	69.4%	96.6%	82.9%
McCall	SF Salmon R. – Knox	61.7%	57.8%	82.1%	79.7%
Pahsimeroi	Pahsimeroi Ponds	66.0%	60.4%	86.8%	86.1%
Rapid River	Rapid River Ponds	77.8%	71.9%	85.2%	75.9%
Sawtooth	Sawtooth Weir	86.3%	86.3%	89.1%	76.6%
Sawtooth	Yankee Fork	NA	NA	50.7%	50.5%

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

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 a run timing similar to that observed for the summer runs (Figure 2). This run timing pattern is typical of stocks returning to Idaho. By the time fish reached LGD, the pattern remained similar though the separation was not as drastic and the Sawtooth stock returned over LGD in a similar fashion to the other spring run stocks (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 2011, there was a distinct bimodal return distribution to the South fork Clearwater facilities with a lull in returns for the first two weeks in August (Figure 4). While this return pattern is typical for Clearwater River traps, the level at which it has occurred at the South Fork Clearwater River traps in 2010 (Cassinelli and Rosenberger 2011) and 2011 seems more pronounced. This pattern is of importance when managing for broodstock collection in the South Fork and will need to be considered and monitored in the future.

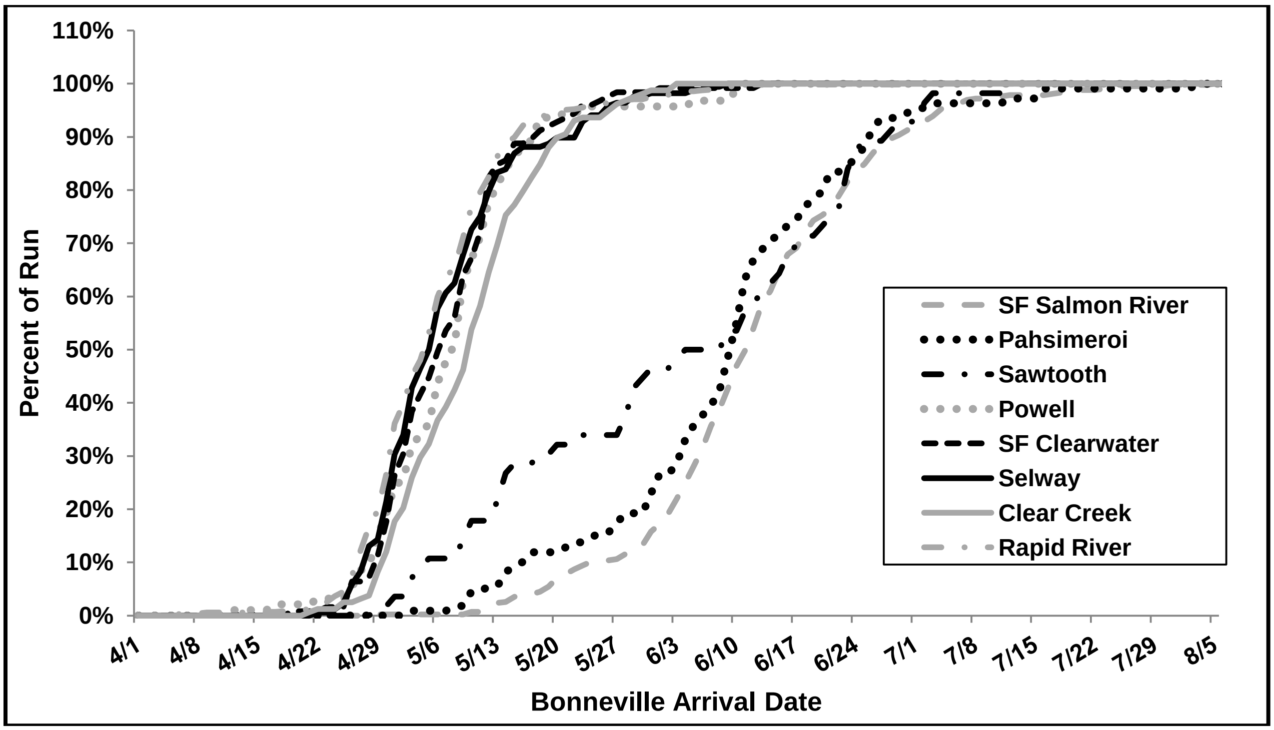


Figure 2. Cumulative run timing (all age classes) of hatchery origin Chinook salmon, by stock, to Bonneville Dam in return year 2011.

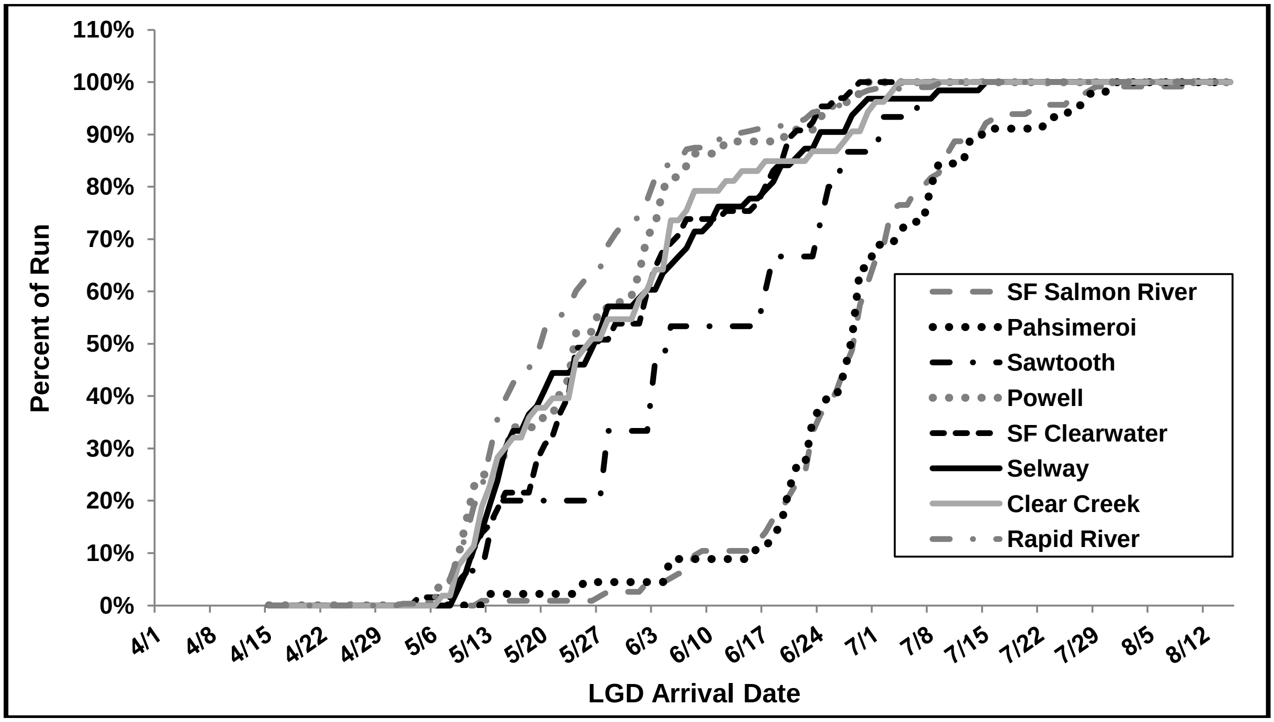


Figure 3. Cumulative run timing (all age classes) of hatchery origin Chinook salmon, by stock, to Lower Granite Dam in return year 2011.

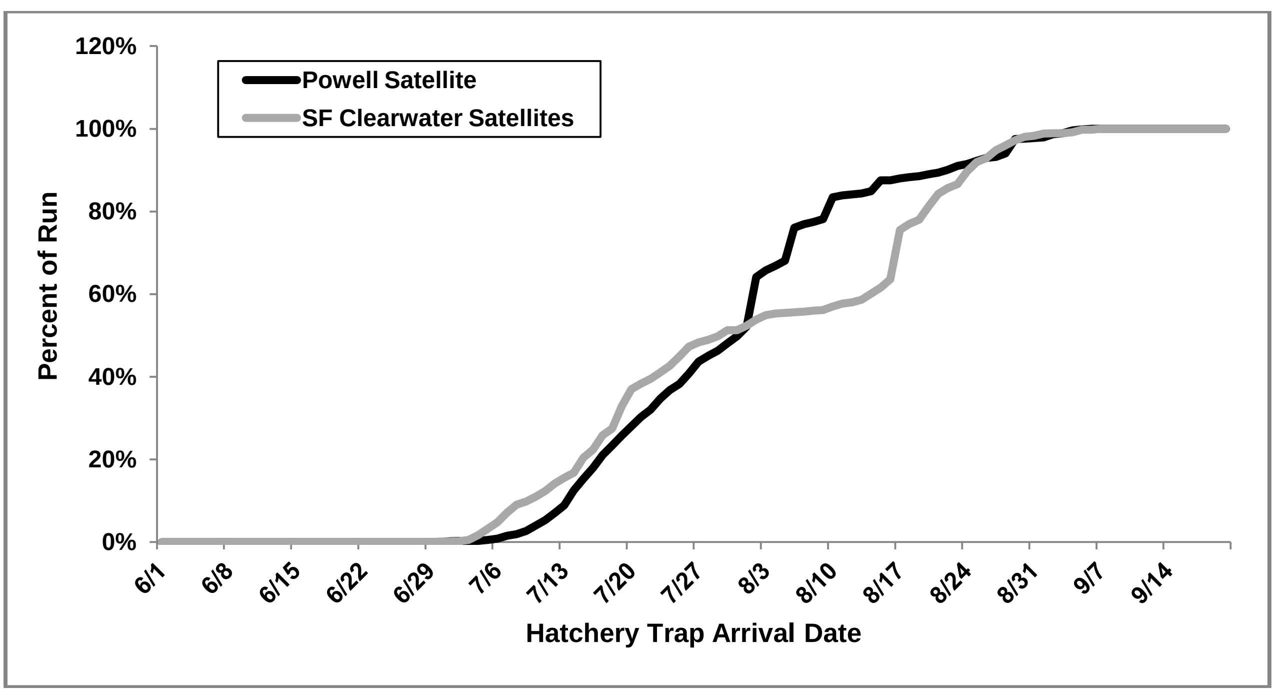


Figure 4. Cumulative run timing (all age classes), by stock, of hatchery origin Chinook salmon to hatchery traps in the Clearwater Basin in return year 2011.

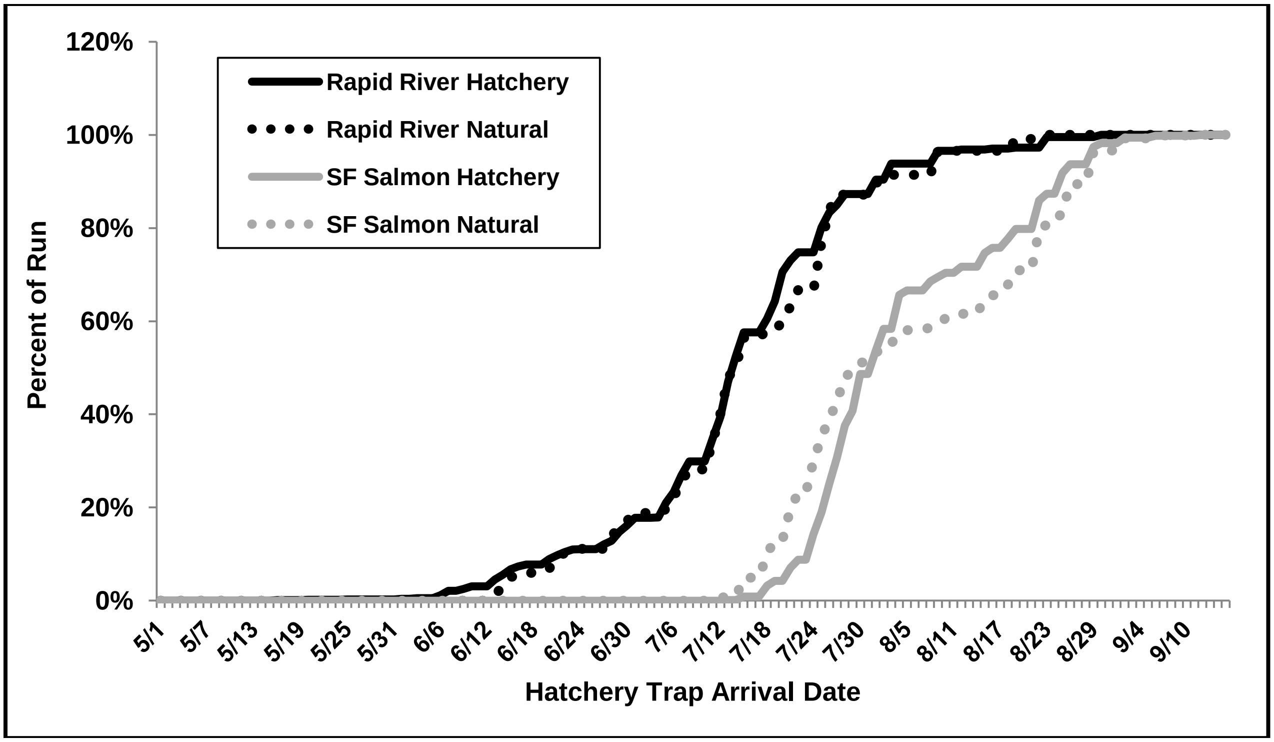


Figure 5. Cumulative run timing (all age classes), by stock, of hatchery and natural origin Chinook salmon to Rapid River and SF Salmon River traps in return year 2011.

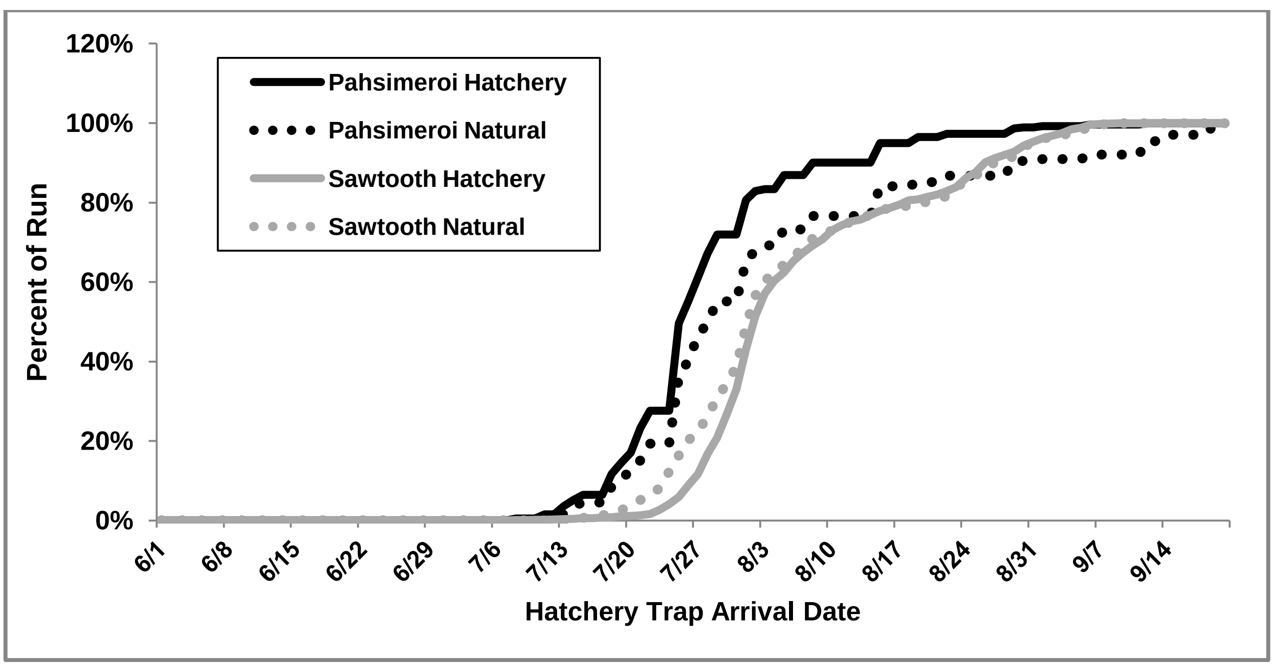


Figure 6. Cumulative run timing (all age classes), by stock, of hatchery and natural origin Chinook salmon to Pahsimeroi and Sawtooth traps in return year 2011.

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 and, also similar to past years, the summer run fish at Pahsimeroi and McCall fish hatcheries were slightly larger at age than their spring run counterparts (Table 12).

Table 12. 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 2011.

		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	1,501	54.3	873	77.8	48	94.0	1,208	76.6	310	89.4	**3,940**
SF Salmon R.	N	53	53.9	231	73.5	111	93.8	118	78.4	191	89.8	**704**
Sawtooth	H	3,494	51.6	68	77.1	11	91.8	156	75.3	61	86.4	**3,790**
Sawtooth	N	205	54.4	166	75.4	37	96.9	73	72.5	118	92.3	**599**
Crooked River	H	36	53.2	111	73.4	47	86.7	93	73.4	42	86.7	**329**
Crooked River	N	3	57.0	12	73.0	4	91.0	7	75.5	1	85.0	**27**
Red River	H	236	50.5	116	74.6	27	88.3	59	74.6	62	88.3	**500**
Red River	N	0	NA	15	71.4	4	84.8	8	68.3	3	88.3	**30**
Powell	H	218	50.6	324	72.9	30	87.8	493	72.9	36	87.8	**1,308**
Powell	N	3	55.0	3	71.7	1	90.0	1	81.0	1	88.0	**9**
Crooked Fork*	H	1	57.0	32	74.7	8	93.0	39	73.8	2	87.0	**82**
Pahsimeroi	H	239	52.9	867	78.4	296	92.8	1,545	76.9	480	89.1	**3,427**
Pahsimeroi	N	26	53.0	109	75.6	80	94.5	116	79.0	43	91.1	**374**
Rapid River	N	23	47.2	32	71.5	13	83.0	33	68.5	10	81.5	**111**
		Males / Females										
Rapid River**	H	1,387	47.0	4,694	72.4	452	86.5					**6,533**
Oxbow***	H	77	51.7	384	73.2	22	84.3					**483**
				Grand Total								**22,246**

* 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 the 120 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 2011, 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 183 miles of river, including sections of the lower and upper Salmon, Little Salmon, and South Fork Salmon rivers. Tables 13 and 14 list the location, duration, and extent of Chinook salmon fisheries in 2011.

Table 13. Dates and locations of spring/summer Chinook salmon recreational fisheries conducted in Idaho in 2011.

River	Date Open	Date Closed	Days Open	Downstream Boundary	Upstream Boundary	Miles Open
Clearwater R.	4/23	8/10	110	Railroad Bridge in Lewiston	Orofino Bridge	43
	4/23	8/10	110	Orofino Bridge	SF Clearwater River	30
NF Clearwater R.	4/23	8/10	110	Mouth	Dworshak Dam	2
SF Clearwater R.	4/23	8/10	110	Mouth	Confluence American and Red rivers	62
MF Clearwater R.	4/23	8/10	110	SF Clearwater River	Confluence Lochsa and Selway rivers	23
Lochsa R.	4/23	8/10	110	Mouth	Confluence Colt Killed and Crooked Fork Cr.	69
Snake R.	4/23	8/10	110	Dug Bar	Hells Canyon Dam	51
Lower Salmon R.	4/23	7/24	93	Rice Creek Bridge	Time Zone Bridge	46
	4/23	7/28	97	Time Zone Bridge	Short's Creek	3
	6/18	7/24	42	Short's Creek	Vinegar Creek	23
Little Salmon R.	4/23	8/10	110	Mouth	U.S. 95 Bridge near Smokey Boulder Road	25
SF Salmon R.	6/25	7/20	26	Forest Service Road 48 bridge	Posted Bound. Below Poverty Flat	16
	6/25	7/28	34	Posted Bound. Below Poverty Flat	Just downstream of hatchery weir	16
Upper Salmon R.	7/2	8/10	40	Jenkins Bridge	USGS flow station in Salmon	21
	6/25	8/10	47	USGS flow station in salmon	20 yards upstream of Pahsimeroi River	46
	7/9	7/17	9	20 yards upstream of Valley Creek	Just downstream of Sawtooth Hatchery weir	7

Table 14. Dates and locations of fall Chinook salmon recreational fisheries conducted in Idaho in 2011.

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 (i.e., SF Salmon River). For mainstem and lower river fisheries (i.e., main-stem Clearwater River), stock composition from mixed stock fisheries was determined 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. 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). Tables 15 and 16 summarize the estimated age and stock composition of the 2011 Chinook salmon harvest.

Table 15. Summary of 2011 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	1,316	973	92	**2,381**
Kooskia	819	755	71	**1,645**
Clearwater (Powell)	352*	464	44	**860**
Clearwater (South Fork)	736	664	63	**1,463**
Clearwater (Selway)	246	310	29	**585**
Clearwater (Clear Creek)	226	465	0	**691**
Nez Perce Tribal Hatchery	35	0	5	**40**
Total	**3,730**	**3,631**	**304**	**7,665**
Snake River Fishery				
Rapid River (Hells Canyon Dam)	798	771	73	**1,642**
Total	**798**	**771**	**73**	**1,642**
Lower Salmon River Fishery				
Rapid River Hatchery	1,271	2,592	225	**4,088**
Pahsimeroi Hatchery	0	32	3	**35**
McCall (SFSR)	143	42	4	**189**
Sawtooth Hatchery	480	0	0	**480**
Lookingglass (OR)	13	25	2	**40**
Total	**1,907**	**2,691**	**234**	**4,832**
Little Salmon River Fishery				
Rapid River Hatchery	1,168	2,638	254	**4,060**
Total	**1,168**	**2,638**	**254**	**4,060**
SF Salmon River Fishery				
McCall (SFSR)	727	1,128	470	**2,325**
Total	**727**	**1,128**	**470**	**2,325**
Upper Salmon River Fishery				
Pahsimeroi Hatchery	63	620	209	**892**
Sawtooth Hatchery	273	16	0	**289**
Total	**336**	**636**	**209**	**1,181**
Grand Total	***8,666***	***11,495***	***1,544***	***21,705***

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

Table 16. Summary of 2011 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*	19	17	3	**39**
Total	**19**	**17**	**3**	**39**
Snake River Fishery				
Multiple*	410	153	57	**620**
Total	**410**	**153**	**57**	**620**
Grand Total	***429***	***170***	***60***	***659***

* 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 2011. Jacks were harvested at a higher rate than adults, which would be expected considering there were more liberal limits for jack harvest. The overall harvest rate on jacks was 34.7% while the overall harvest rate on adults was 23.4% (Table 17). The harvest estimate for jacks returning to Powell was the only estimate that was greater than the corresponding estimate of passage at LGD. This is interesting because the low Powell jack estimate at LGD resulted in an unusually low estimated conversion rate for the Powell stock from Bonneville to LGD. That low conversion, coupled with the harvest estimate, suggests that some PIT tagged Powell-origin jacks may have gone undetected at LGD. However, there is no evidence to support this, as the four production PIT tags that were detected in jacks at the hatchery trap were also detected at LGD.

Table 17. Summary of 2011 spring/summer Chinook salmon sport harvest rates for jacks and adults, by stock.

		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	672	246	36.6%	2,656	339	12.8%
Clearwater	Powell Pond	198	352	177.8%*	1,703	508	29.8%
Clearwater	South Fork	1,718	736	42.8%	3,931	727	18.5%
Clearwater	Clear Creek	684	226	33.0%	1,436	465	32.4%
Total Clearwater R.		**3,272**	**1,560**	**47.7%**	**9,726**	**2,039**	**21.0%**
Rapid River	Rapid River Ponds	5,921	2,313	39.1%	20,568	5,285	25.7%
Rapid River	Hells Canyon Dam	1,189	798	67.1%	4,107	844	20.6%
Rapid River	Little Salmon R.	322	126	39.1%	1,649	424	25.7%
Sawtooth***	Sawtooth Weir	3,489	753	21.6%	530	16	3.0%
Pahsimeroi	Pahsimeroi Ponds	470	63	13.4%	3,842	864	22.5%
McCall***	SF Salmon R.	3,615	870	24.1%	7,039	1,644	23.4%
Total Salmon R.		**15,402**	**4,923**	**32.0%**	**37,735**	**9,077**	**24.1%**
GRAND TOTAL		**18,674**	**6,483**	**34.7%**	**47,461**	**11,116**	**23.4%**

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

CWT Processing and Data Submission

The CWT laboratory processed 2,249 Chinook salmon snouts collected in 2011. Pursuant to RMIS guidelines, Chinook salmon recovery information from the 2011 run will be submitted to RMIS in January 2012. Table 18 shows the number and type of Chinook salmon CWT recoveries that were processed in the CWT lab in 2011.

Table 18. Chinook salmon CWT recoveries by recovery type that were processed in the Idaho Department of Fish and Game Nampa Research CWT Laboratory in 2011.

Recovery Type	Snouts Collected
Hatchery Spawning Rack/Trap	1,707
Spawning Ground	103
Sport Fishery (Creel Census)	439
Total	**2,249**

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 snout was collected from a location outside of the direct migratory path from the ocean to the fish's release location. Table 19 outlines these recoveries, expanded by their tagging and sampling rates, for the 2011 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 2011 spring/summer Chinook salmon. The highest level of straying observed was at the Sawtooth Fish Hatchery trap from fish released from the Yankee Fork. The Yankee Fork jacks that were returning in 2011 were reared at Sawtooth Fish Hatchery and released in the Yankee Fork in mid to late April of 2010. The high number of these jacks 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 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 19, then there were no stray CWTs recovered from that location in 2011. 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 19. Chinook salmon stray CWT recoveries recovered by Idaho Department of Fish and Game in sport fisheries, on spawning grounds, and at hatchery traps in 2011.

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	42
			NPTH	1	4
			Powell	3	25
			Selway R.	1	8
		SF Clearwater R.	Newsome Cr.	1	4
	Hatchery Trap	Powell Trap	Clear Creek	2	6
			Dworshak	3	23
			Kooskia	1	7
			Lostine R.	1	1
			NPTH	2	2
			Selway R.	6	11
		Red River Trap	Clear Creek	12	33
			Crooked R.	6	71
			Dworshak	1	8
			Kooskia	12	75
			NPTH	2	2
			Selway R.	2	4
	Spawning Ground	American R.	Crooked R.	4	54
			Red R.	1	10
			Selway R.	2	4
		Red River	Clear Creek	2	6
			Crooked R.	9	111
			Newsome Cr.	2	8
			NPTH	1	1
			Dworshak	1	9
		Colt Killed Cr.	Powell	2	4
		Upper Lochsa R.	Powell	24	49
Salmon River	Fishery	Lower Salmon River Fishery	Lostine R.	4	16
			Rapid River*	3	84
			Catherine Cr.	1	7
			Grande Rhonde	3	11
	Hatchery Trap	Rapid River Trap	Lostine R.	1	1
			Grande Rhonde	1	1
			SFSR	1	4
		SF Salmon River Trap	Grande Rhonde	1	1
			Lookingglass Cr.	1	1
			Lostine R.	8	8
			Powell	1	2
			Selway R.	1	1
		Sawtooth Trap	Yankee Fork	379	391
	Spawning Ground	Upper Salmon R.	Yankee Fork	13	13
		Valley Creek	Sawtooth	1	12
			Yankee Fork	1	1
			Lostine R.	1	1
		Total Stray Recoveries		**529**	**1,137**

* This represents recoveries upstream of the confluence of the main Salmon and Little Salmon rivers

Estimating a Correction Factor for PIT Tag Expansions in Returning Chinook Salmon (Sawtooth Hatchery and SF Salmon River Satellite Facility)

Recent 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 both the Sawtooth Hatchery and South Fork Salmon River (SFSR) traps. The SFSR antenna system was installed in 2009, while the Sawtooth system was installed in 2010. 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 two 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 20 summarizes the corrected expansions at the Sawtooth and SFSR facilities and Table 21 shows the corrected estimates at LGD.

Table 20. Corrected expansion rates derived from in-ladder PIT tag arrays at Sawtooth and SF Salmon River traps for return year 2011.

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						
2006	12.8	3	1	38	72	**23.7**
2007	20.0	7	3	143	224	**31.6**
2008	122.1	17	4	2,080	3,120*	**183.3**
South Fork Salmon River Satellite						
2006	28.8	7	3	205	358	**50.7**
2007	30.2	44	17	1,346	2,081	**46.9**
2008	28.1	41	19	1,171	1,501	**36.1**

* Yankee Fork strays removed

Table 21. Corrected PIT tag expansion of Sawtooth and SF Salmon River origin adults returning to Lower Granite Dam for return year 2011.

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					
2006	3	1	23.7	39	**72**
2007	12	7	31.6	247	**386**
2008	19	6	183.3	2,326	**3,489**
South Fork Salmon River Satellite					
2006	26	3	50.7	752	**1,321**
2007	93	35	46.9	2,843	**4,397**
2008	99	41	36.1	2,801	**3,615**

* Corrected for 98% detection efficiency at LGD

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 estimate of age-specific returns to LGD, which in turn will give us more accurate smolt-to-adult return rates. However, if sexually maturing adults continue to lose tags as they mature closer to spawning grounds, then using these corrected expansions from trap tag ratios would result in an overestimation of returns to LGD. We have seen some evidence of possible tag loss related to sexual maturity through observations of higher levels of tag loss in adult females than in adult males as well as high loss rates in older fish for some brood years (see <u>Double Tagged PIT Tag Retention/Survival Study (Powell Satellite Facility): Estimating Rates of Tag Loss / Differential Survival Between PIT- and Non-PIT-Tagged Fish</u>, this report). 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. While these results indicate that maturing Chinook salmon do continue to lose PIT tags as they mature, they do not provide much insight into the high rate of tag loss or the differential loss observed between sexes. 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.

In the fall of 2011, similar in-ladder detection systems will be installed in the Red River and Crooked River traps on the South Fork Clearwater River. This will enable us to further evaluate the level at which PIT tag expansions need to be corrected from facility to facility and return year to return year as well as have more accurate return estimates to LGD for more facilities.

Completion Report: Double Tagged PIT Tag Retention/Survival Study (Powell Satellite Facility): Estimating Rates of Tag Loss / Differential Survival Between PIT- and Non-PIT-Tagged Fish

Brood year 2006 Chinook salmon from Clearwater Fish Hatchery destined to be released at the Powell Satellite Facility in 2008 were part of a double marking study designed to investigate shed rates of PIT tags from release to adult return and to estimate if PIT-tagged fish exhibit differential survival from non-PIT-tagged fish. Originally, just over 415,000 smolts were placed into the Powell Acclimation Pond where they were being held for release. Of these, 42,659 were both PIT and CWT tagged (treatment group) and 44,637 were CWT tagged only (control group). However, during the volitional release of these fish, the water intake for the pond froze over, resulting in a loss of water into the pond and a significant mortality event. After accounting for mortality, it was estimated that 224,000 smolts volitionally exited the acclimation pond prior to the mortality event. Of these, it was estimated that 18,941 were both PIT and CWT tagged (treatment group), and 23,207 were CWT tagged only (control group).

The fish from this study returned as one-ocean jacks in 2009, two-ocean adults in 2010, and three-ocean adults in 2011, thus marking the end of the study. All returning fish were thoroughly double scanned with both a CWT wand and handheld PIT tag reader to confirm the presence or absence of tags. Eight treatment fish and 12 control fish returned to Powell in 2009 as jacks, 36 treatment fish and 31 control fish returned in 2010 as two-ocean adults, and 6 treatment fish and zero control fish returned in 2011 as three-ocean adults (Table 22). Table 23 shows the original expanded return estimate, the expanded return estimate after correcting for shed tags, and the number of PIT tags still unaccounted for after correcting for shed tags for each return year.

Table 22. Comparison of brood year 2006 treatment (CWT and PIT) and control (CWT only) returns to the Powell Trap in 2009, 2010, and 2011.

Study Group	Return Year	# CWT Released	# CWT Returned	Return Rate	PIT Retained		Shed Tags		PIT Tag Shed Rate	
					M	F	M	F	M	F
Treatment	2009	18,941	8	0.044%	7	NA	1	NA	12.5%	NA
	2010		36	0.190%	18	7	1	10	5.3%	58.8%
	2011		6	0.032%	2	0	2	2	50.0%	100.0%
Treat. Total		**18,941**	**50**	**0.264%**	**27**	**7**	**4**	**12**	**12.9%**	**63.2%**
Control	2009	23,207	12	0.053%	NA	NA	NA	NA	NA	NA
	2010		31	0.134%	NA	NA	NA	NA	NA	NA
	2011		0	0.000%	NA	NA	NA	NA	NA	NA
Cont. Total		**23,207**	**43**	**0.185%**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Table 23. Summary of brood year 2006 PIT tag returns to Powell Satellite Facility in 2009, 2010, and 2011.

Return Year	Juvenile Expansion Rate	RAL PIT Tags @ Trap	Expanded Return Estimate	Corrected RAL PIT Tags Based On Year-Specific Shed Rate	Corrected Estimate	Actual Returns	Remaining Missing PIT Tags
2009	7.1	16	114	18	130	176	7
2010	7.1	50	356	72	511	661	21
2011	7.1	5	36	15	107	66	0

The results of a Z-test (Z = 19.45, CI for difference in proportions = 0.071 – 0.087) show that the overall SAR of the treatment group was significantly higher than the SAR of the Control group, indicating that PIT-tagged fish did not survive at a lower rate than non-PIT-tagged fish in this study. PIT tag shed rates elevated from 11.1% in jack returns in 2009 to 30.6% in two-ocean adults returning in 2010, to 66.7% in three-ocean adults returning in 2011 indicating that PIT tag loss continues throughout the life of Chinook salmon. Additionally, sex-specific shed rates were higher for females than for males. Overall PIT tag shed rates for females across all return years (63.2%) were significantly higher than for males (12.9%) (Z = 71.28, CI for difference in proportions = -0.5149 to -0.4911). This higher shed rate for females was also observed in an earlier study on Coho salmon (Prentice et al. 1994). That study found a 47.9% shed rate for females vs. an 11.3% shed rate for males. The authors of that study concluded that because female salmonids lack an oviduct and eggs fall directly into the body cavity, that a free-floating PIT tag in the body cavity of a maturing female could likely be expelled as an irritant. Both the significantly higher survival of PIT-tagged fish and the increase in PIT tag shed rates from jacks to two-ocean to three-ocean adults are contrary to the findings of Knudsen et al. (2009). In summary, this study showed that:

- PIT tagged fish do not have lower survival (SARs) when compared to non-PIT-tagged fish.
- Chinook appear to continue to shed PIT tags throughout their life cycle (this may be more true for females than for males).
- Female Chinook salmon appear to shed PIT tags at a higher rate than males and the male and female shed rates observed in this study are similar to those observed in a 1994 study on Coho.

While these results are intriguing and warrant additional research, the results of this study are limited in scope due to the fact that there was a significant fish kill in this brood year of smolts, during prerelease acclimation at the Powell satellite facility. The study was also limited by only being conducted for a single brood year, species, and location.

Length at Age of the Aggregate Hatchery Return at LGD and a Comparison of Chinook Salmon Age Composition at LGD using PIT Tag Expansions vs. Scale Samples

Starting in 2006, scales were collected from fish trapped in the LGD adult fish ladder for aging purposes. However, due to higher aging error rates, 2006 was not included in this analysis. Fish were sampled in the trap at rates that varied within and across years, and ranged from a low of 4% (2008 and 2010) to a high of 15% (2010). From the sampled scales, an average length at age was calculated for the aggregate hatchery-origin spring/summer Chinook salmon return to LGD (Table 24). Trapping rate should not have had an influence on length at age, and therefore samples were not adjusted. Additionally, scale-derived length at age was compared to the length at age of trapped PIT-tagged (known-age) fish (Table 24). Within return years, scale- and PIT tag-derived lengths at age were very similar and only the age-3 length distributions in return year 2009 had significantly different means between the two methods, indicating that either method is valid in determining length at age at LGD. Also, none of the PIT-tagged fish were significantly smaller at age when compared to non-tagged fish as has been reported in a previous study (Knudsen et al. 2009).

Table 24. Summary of return year 2007-2011 PIT tag- and scale-based average length at age for the aggregate spring/summer Chinook salmon return to LGD.

Return Year	Scale Aging Accuracy (%)	Ave. Length at Age at LGD (PIT)			Average Length at Age at LGD (Scales)		
		Age-3	Age-4	Age-5	Age-3	Age-4	Age-5
2007	98.7	51.3	76.8	88.2	51.9	74.8	86.9
2008	96.3	54.8	75.2	84.3	54.8	75.2	82.4
2009	97.9	56.0*	76.6	90.0	54.2*	76.5	87.5
2010	96.4	51.8	74.8	NA	53.4	74.8	89.8
2011	98.4	51.6	73.9	89.1	51.9	74.4	88.8

* Indicates a significance difference

In addition to generating an average length at age, sampled scales were also used to generate an aggregate hatchery-origin spring/summer Chinook salmon age composition at LGD. This age composition was compared to the age composition generated by PIT tag expansions as a means of comparing the two methods (Table 25). We were only able to compare return years 2010 and 2011 as prior to that, not all brood years in the hatchery returns had PIT tags. In 2010, the PIT tag-generated age comp was skewed more towards younger fish than the scale-based age composition. This makes some sense in light of our evidence showing that older fish appear to have a higher rate of tag loss and would therefore be underrepresented in the PIT estimate. However, in 2011 this type of difference was not as apparent and the two methods yielded almost identical age compositions at LGD. This two-year comparison is inconclusive in determining if there are indeed differences in the age composition based on the two methods at LGD. Differences in the two methods are likely variable from year to year and could be influenced by factors such as level of PIT tag loss, scale aging accuracy, and samples sizes. Future comparisons would be valuable in helping to establish if there are trends between the two methods.

Table 25. Summary of return year 2010 and 2011 scale-based versus PIT tag expanded age composition of the aggregate spring/summer Chinook salmon return to LGD.

Return Year	LGD PIT Tag Expansion Estimates			LGD Trap Scale Analysis		
	Age-3	**Age-4**	**Age-5**	**Age-3**	**Age-4**	**Age-5**
2010	13.1%	85.9%	1.0%	8.7%	90.5%	0.8%
2011	32.8%	59.2%	8.0%	32.8%	59.9%	7.3%

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 201,998 smolts (101,242 of which contained 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. The direct release group was released into Powell Acclimation Pond on April 1 and forced to exit on the same day. The one-ocean jacks from these releases returned to the Powell Satellite in 2010 and the two-ocean adults returned in 2011. Tags from these returns are summarized in Tables 26 and 27. The return rate of jacks was higher for the direct release group, but the return rates for two-ocean adults were very similar.

This evaluation will not be complete until the three-ocean adults return in 2012. In addition, a two-year lag will be required to obtain any downriver harvest information to complete the run reconstruction for these groups. Therefore, the 2012 report will contain a preliminary hatchery return summary of this study, while a complete summary of this study will be provided in the 2014 report.

Table 26. Comparison of CWT recoveries from volitional vs. direct release brood year 2007 Powell Chinook jacks returning in 2010.

Group	Total Release	# CW Tagged	CWT Expansion	CWT Recov. in Sport Fishery	CWT Recov. at Powell Trap	Total CWTs Recov.	Expanded Jacks Returns	Smolt to Jack Return Rate
Volitional	201,998	101,242	2.00	1	17	18	36	0.0178%
Direct	202,117	99,951	2.02	2	29	31	63	0.0311%

Table 27. Comparison of CWT recoveries from volitional vs. direct release brood year 2007 Powell Chinook 2-ocean adults returning in 2011.

Group	Total Release	# CW Tagged	CWT Expansion	CWT Recov. in Sport Fishery	CWT Recov. at Powell Trap	Total CWTs Recov.	Expanded Age 4 Returns	Smolt to Age 4 Return Rate
Volitional	201,998	101,242	2.00	28	184	212	424	0.2099%
Direct	202,117	99,951	2.02	22	204	226	457	0.2261%

Prerelease Feed Study (Sawtooth Fish Hatchery): Analyzing if Prerelease Diet 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 (11,608 of which were PIT tagged). 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 and two-ocean adults returned in 2011. 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 two return years, the control group has a slightly higher SAR rate than the treatment group. However, it is important to note that due to cold weather and ice conditions, not all of the planned treatment ration was administered. We are unsure how this will affect the treatment, but we plan to collect data through 2012 and provide a complete summary of the study in that year's report.

Table 28. Comparison of recoveries from two different feed groups of brood year 2007 Sawtooth Chinook salmon returning in 2010 and 2011.

Study Group	Return Year	# Released	# Returned (Hatch. Trap Only)	Hatchery Return Rate	Cumulative Return Rate
Treatment	2010	103,986	36	0.0346%	0.1164%
	2011		85	0.0817%	
Control	2010	170,658	80	0.0469%	0.1359%
	2011		152	0.0891%	

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

With above average numbers of jacks returning to the Columbia River basin in 2009, there has been an increasing level of interest in determining the causes of jacking, and to a lesser extent, minijacking. 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 has 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.

One of the ways in which we can monitor minijacking rates is with the use of PIT tag detections in adult ladders throughout the Snake River and Columbia River hydropower systems (Larsen et al. 2004). The use of PIT tags allows us to monitor not only seaward migration of juveniles but also return migration, whether it is the same year as release or subsequent years as they return as adults. Before juvenile detections in the adult ladders can be used to monitor minijacking rates, detections need to be verified as upstream migrants and not downstream migrating smolts. 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: This methodology differs from how minijacks were calculated in the 2010 Calendar Year Hatchery Chinook Report, in which all PIT tagged minijacks were expanded by the same rate, regardless of their separation by code status. Because of this, the estimates for 2008-2010 in the table below (Table 29) will differ slightly from the estimates from Table 23 in the 2010 report.

Using the above described methods to validate the number of PIT-tagged juveniles that are migrating upstream, we have found that minijacking does occur in Idaho's spring/summer Chinook salmon programs. The rate of minijacking is variable and release site-specific rates range from a low of 0.02% to a high of 1.76% of the number of smolts released (Table 29). The explanation for these variable minijack rates is not entirely known; however, recent studies are beginning 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 2011 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. 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 29. 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 2006-2011. Only detections after June 1 are included.

Migration Year	Basin	Hatchery	Total Release	# PIT Tag Detections	Est. Number of Minijacks	Percent of Release
2011	Salmon R.	McCall	1,069,028	135	3,208	0.30%
		Rapid River	2,483,181	14	549	0.02%
		Sawtooth	1,337,302	2	101	0.01%
		Pahsimeroi	1,030,028	7	416	0.04%
	Clearwater R.	Powell	413,757	26	490	0.12%
		Red River	1,114,760	22	1,493	0.13%
		Clear Creek	291,604	27	371	0.13%
		Selway	414,270	26	524	0.13%
		Crooked River	204,061	31	261	0.13%
2010	Salmon R.	McCall	1,037,600	57	1,170	0.11%
		Rapid River	2,492,454	78	4,503	0.18%
		Sawtooth	1,455,634	2	244	0.02%
		Pahsimeroi	1,169,701	0	0	0.00%
	Clearwater R.	Powell	413,158	37	875	0.21%
		Red River	1,206,110	53	3,788	0.31%
		Clear Creek	229,605	228	2,903	1.26%
		Selway	402,160	118	2,651	0.66%
2009	Salmon R.	McCall	1,106,700	169	3,799	0.34%
		Rapid River	2,503,711	76	3,735	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	40	1,188	0.29%
		Clear Creek	234,151	115	2,390	1.02%
		Selway	299,707	78	2,077	0.69%
		Crooked River	703,101	48	2,329	0.33%
2008	Salmon R.	McCall	1,060,540	798	18,372	1.73%
		Rapid River	2,493,719	251	12,469	0.50%
		Sawtooth	174,132	25	309	0.18%
		Pahsimeroi	1,037,772	117	8,173	0.79%
	Clearwater R.	Powell	223,714	12	640	0.29%
		Red River	424,719	37	1,413	0.33%
		Selway	205,659	48	1,644	0.80%
		Crooked River	708,483	45	2,759	0.39%
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	70	2,142	0.57%
		Red River	375,759	72	5,950	1.58%
		Crooked River	650,921	35	527	0.08%
2006	Salmon R.	McCall	1,094,264	472	11,080	1.01%
		Rapid River	2,530,528	104	5,774	0.23%
	Clearwater R.	Powell	423,633	17	502	0.12%
		Red River	423,603	4	125	0.03%
		Crooked River	749,461	7	388	0.05%

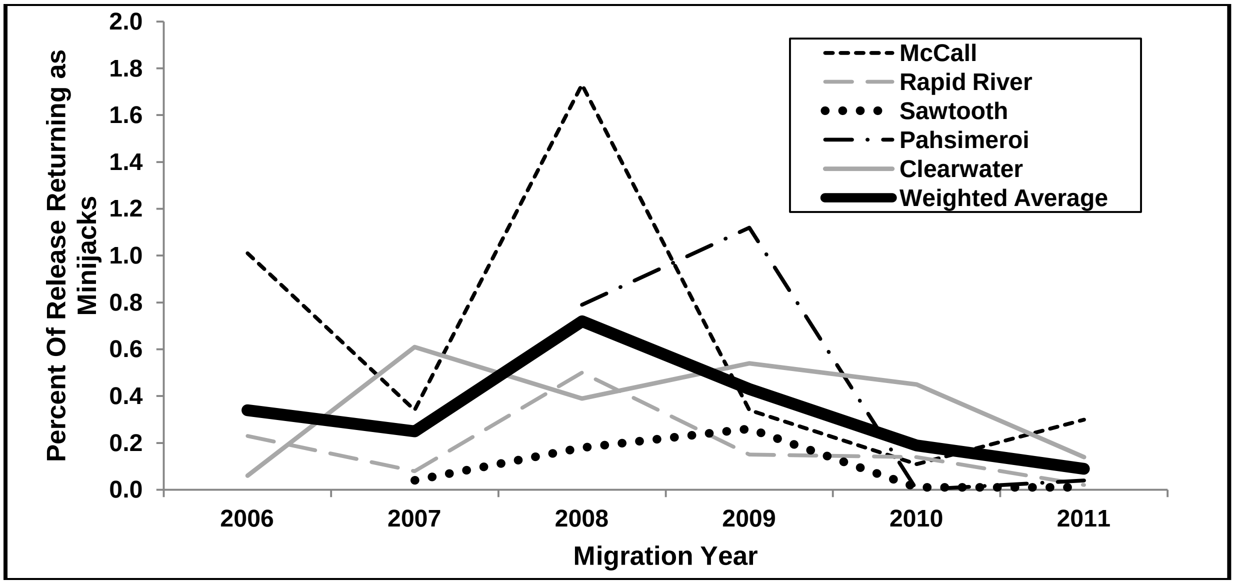


Figure 7. Percent of releases by hatchery that returned over all lower Snake River and Columbia River dams as minijacks and the weighted average percent of all releases that return as minijacks for migrations years 2008 through 2011.

We also 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 2006 for the five IDFG-managed hatcheries. None of the regressions had a significant relationship. However, the aggregate return (Figure 8) does have an R^2 value of 0.49 and there does appear to be a relationship between minijack returns and jack returns the following year, though this relationship is strongly influenced by a single date point. We will continue to build on this model in future years.

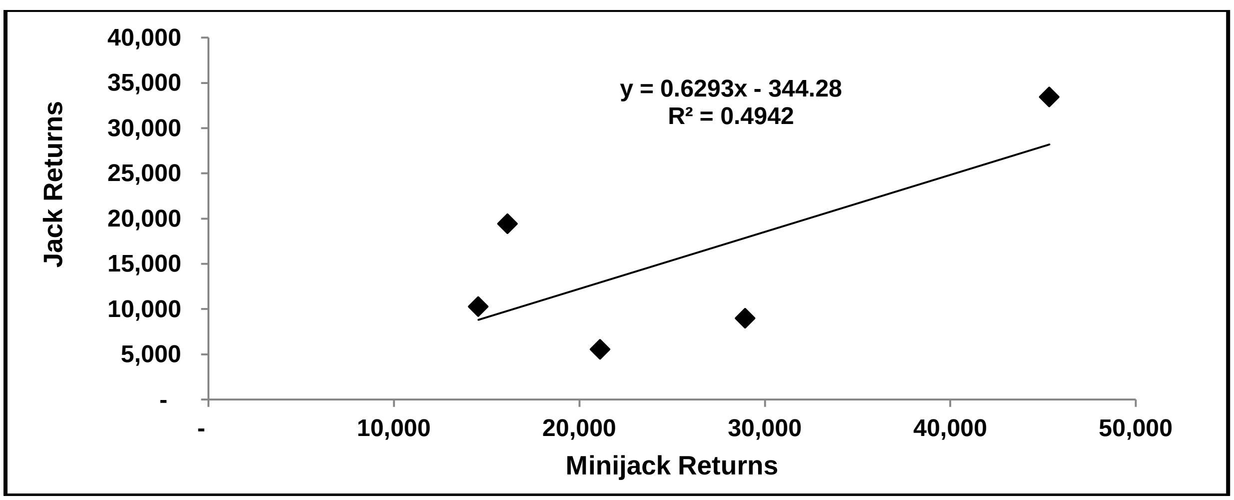


Figure 8. Minijack returns at all lower Snake River and Columbia River dams vs. jack returns at Bonneville Dam for the aggregate IDFG spring/summer Chinook salmon hatcheries for brood years 2006-2010.

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). We downloaded 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 2007-2010 are outlined in Table 30. Data for migration year 2011 were not available at the time of this report.

Table 30. Estimated lower Columbia River waterbird predation of spring/summer Chinook salmon from Idaho hatcheries from 2008-2010.

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
2010	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%
	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%**
2009	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%
	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%**
2008	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%
	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%**
2007	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%
	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 2010, 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 was 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.

Comparison of Percent Jacks used in the Broodstock Versus the Percent of Jacks that Return for that Brood Year: Do Higher Numbers of Jacks Spawned Result in Higher Numbers of Jack Returns?

As mentioned in the minijacks section above, substantially higher than normal Chinook salmon jack returns in 2009 sparked further basinwide interest in evaluating potential causes of higher jacking rates, especially among hatchery origin fish. This topic was covered extensively in an Age-at-Maturity Workshop that was held in Portland, Oregon in May 2011. Monitoring and evaluation staff from both IDFG and IPC attended this workshop to gain a regional perspective of potential issues and to contribute data and input from Idaho's stocks.

One of the topics of the workshop was the heritability of jacking and the idea that the proportions of jacks spawned in a given brood year could influence the proportion of the adult returns from that same brood year that return as jacks. Heritability of the jacking reproductive strategy has been shown in the literature (Heath et al. 1994, Heath et al. 2002). However, it has also been shown that other factors, such as size at release, can have an influence on age at return (Vøllestad et al. 2004).

We used linear regression to compare the percentage of jacks (of the total males) used in the broodstock to the percentage of the males that returned to Bonneville Dam as jacks the year after fish were released for McCall and Sawtooth fish hatcheries. Clearwater, Pahsimeroi, and Rapid River fish hatcheries were not included in this analysis due to a lack of adequate data. Run reconstruction to Bonneville Dam was generated for each brood year using either expanded PIT tag estimates or, prior to representative PIT tag groups, using estimates of all fish recovered above Bonneville from harvest, spawning ground, and trap estimates. Sex ratios of age-4 and age-5 fish at Bonneville Dam were based on ratios at hatchery traps. This method does not account for any age-specific sex biases in harvest or dropouts between Bonneville Dam and the hatchery traps (i.e. more age-4 females removed than males between Bonneville and hatchery trap, biasing sex ratio). However, that bias is likely less significant than the bias that would occur if percent of males that returned as jacks to hatchery traps were used (i.e. comparing percent jacks to age-4 and age-5 returns at hatchery trap instead of at Bonneville Dam for a given brood year, knowing the bias in age-specific harvest across return years).

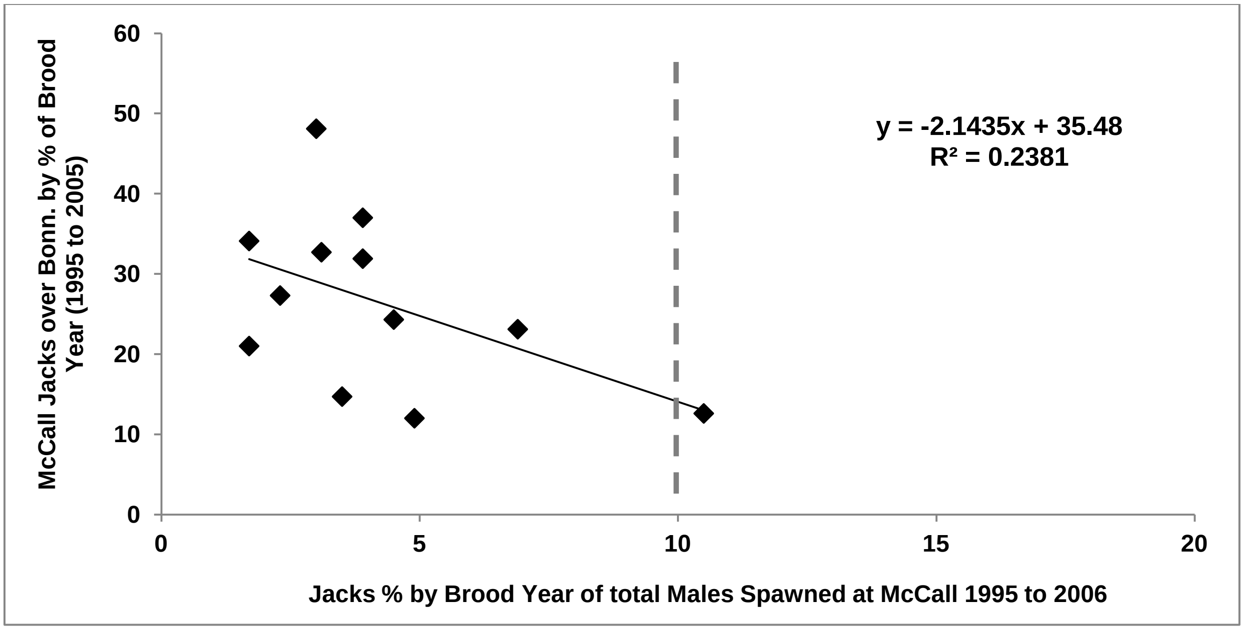


Figure 9. Percent of jacks used in the broodstock vs. the % of the male returns to Bonneville Dam that were jacks for McCall Fish Hatchery from brood year 1995–2006. The standard protocol for jacks spawned is 10% or less when there are adequate numbers of male broodstock.

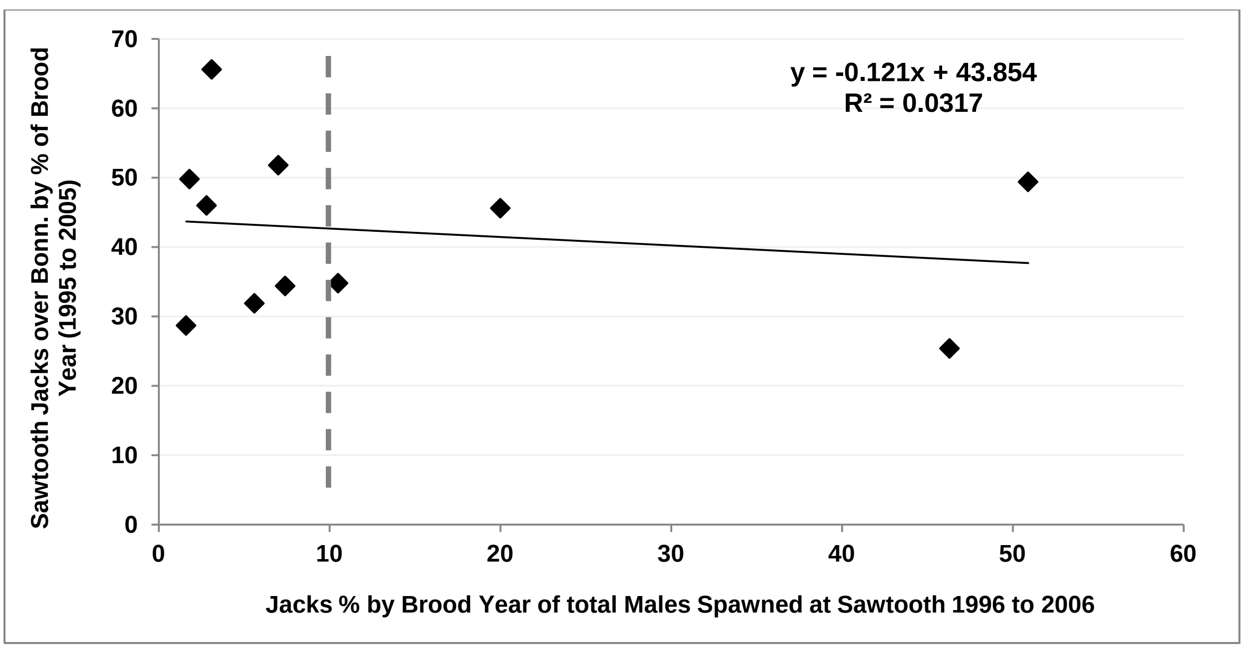


Figure 10. Percent of jacks used in the broodstock vs. the % of the male returns to Bonneville Dam that were jacks for Sawtooth Fish Hatchery from brood year 1995 – 2006. The standard protocol for jacks spawned is 10% or less when there are adequate numbers of male broodstock.

The regression analysis showed little to no relationship between the percentage of jacks in the broodstock and the percentage of the males that returned as jacks from that brood year (Figures 9 and 10). Both facilities showed a week inverse relationship between the percentage of jacks returning from the percentage of jacks spawned, but neither regression had significant slopes. This relationship was mostly driven by single brood years that were outliers (Figures 9 and 10). As noted above, heritability only plays a partial role in jacking rates, and other factors such as size at release, environmental conditions, and female age would likely have influenced jacking rates as well. The current protocol for IDFG-managed hatcheries is to have less than 10% of the contributing males to a given brood year be jacks. Exceptions to the 10% cutoff occur in years with low numbers of male returns or low numbers of age 4 and 5 males in comparison to the number of jack returns. This analysis does not provide any evidence that the current protocol needs to be changed. However, further monitoring of this relationship, along with future evaluations of other potential factors influencing the jacking rates of hatchery-origin Chinook salmon are needed.

ACKNOWLEDGEMENTS

We would like to thank the many folks who contributed to the material in this report. Firstly, thanks to the hatchery managers and their staff for all their efforts to collect data and adapt to ever-changing requests. Thanks to the PSMFC marking crew for their efforts in marking and tagging fish and to PSMFC employees Shane Knipper and Brad Wright for all their help in compiling and analyzing data. Thanks to IDFG regional staff who supplied harvest information, including Don Whitney, Kim Apperson, Laurie Janssen, Paul Janssen, and Jon Hansen. Thanks to Sam Sharr for providing preseason forecast numbers and draft feedback. Thanks to Brian Leth and Paul Abbott for providing draft edits and feedback on the content of this report. Thanks to Cheryl Zink for providing formatting and editing.

LITERATURE CITED

Boggs, C. T., M. L. Keefer, C. A. Peery, T. C. Bjornn, and L. C. Stuehrenberg. 2004. Fallback, reascension, and adjusted fishway escapement estimates for adult Chinook salmon and steelhead at Columbia and Snake River dams. Transactions of the American Fisheries Society 133:932-949.

Cassinelli, J., and S. Rosenberger. 2011. 2010 calendar year hatchery Chinook salmon report: IPC and LSRCP monitoring and evaluation programs in the state of Idaho. IDFG Report Number 11-02.

Collis, K., D. D. Roby, D. P. Craig, B. A. Ryan, and R. D. Ledgerwood. 2001. Colonial waterbird predation on juvenile Salmonids tagged with passive integrates transponders in the Columbia River estuary: vulnerability of different salmonid species, stocks, and rearing types. Transactions of the American Fisheries Society 130:385-396.

Comparative Survival Study Oversight Committee and Fish Passage Center. 2011. Comparative survival study (CSS) of PIT-tagged spring/summer Chinook and summer steelhead 2011 annual report http://www.fpc.org/documents/CSS/2011%20CSS%20Annual%20Report--Final.pdf

Cormack, R. M. 1964. Estimates of survival from the sighting of marked animals. Biometrika 51:429-438.

Finstad, B., M. Iverson, and R. Sandodden. 2003. Stress-reducing methods for releases of Atlantic salmon (*Salmo salar*) smolts in Norway. Aquaculture 222(1-4):203-214.

Gayanilo, F. C. Jr., P. Sparre, D. Pauly. 2005. FAO-ICLARM stock assessment tools II (FiSAT II). WorldFish Center, Food and Agriculture Organization of the United Nations. Rome, Italy. Available at http://www.fao.org/fishery/topic/16072/en.

Heath, D. D., R. H. Devlin, J. W. Heath, and G. K. Iwama. 1994. Genetic, environmental and interaction effects of the incidence of jacking in *Oncorhynchus tshawytscha* (Chinook salmon). Heredity 72:146-154.

Heath, D. D., L. Rankin. C. A. Bryden, J. W. Heath, and J. M. Shrimpton. 2002. Heritability and Y-chromosome influence in the jack male life history of Chinook salmon (*Oncorhynchus tshawytscha*). Heredity 89:311-317.

Jolly, G. M. 1965. Explicit estimates from capture-recapture data with both death and immigrations—stochastic model. Biometrika 52:225-247.

Knudsen, C. M., M. V. Johnston, S. L. Schroder, W. J. Bosch, D. E. Fast, and C. R. Strom. 2009. Effects of Passive Integrated Transponder tags on smolt-to-adult recruit survival, growth, and behavior of hatchery spring Chinook salmon. North American Journal of Fisheries Management 29:658-669.

Larsen, D. A., B. R. Beckman, K. A. Cooper, D. Barrett, M. Johnson, P. Swanson, and W. W. Dickhoff. 2004. Assessment of high rates of precocious male maturation in a spring Chinook salmon supplementation hatchery program. Transaction of the American Fisheries Society 133:98-120.

Macdonald, P. 2010. Mixdist: finite mixture distribution models (version 0.5-3). McMaster University. Ontario, Canada. Available at http://cran.us.r-project.org/.

Prentice, E. F., D. J. Maynard, S. L. Downing, D. A. Frost, M. S. Kellett, D. A. Bruland, P. Sparks-McConkey, F. W. Waknitz, R. N. Iwamoto, K. McIntyre, and N. Paasch. 1994. Comparison of long-term effects of PIT tags and CW tags on Coho salmon (*Oncorhynchus kisutch*). Pages 123-137 in A study to determine the biological feasibility of a new fish tagging system. Bonneville Power Administration Annual Report for 1990-1993, BPA Report DOE/BP-11982-5, Portland, Oregon.

R Development Core Team (2010). R: A language and environment for statistical computing. R. Foundation for Statistical Computing. Vienna, Austria. Available at http://www.R-project.org.

Roby, D. D., K. Collis, D. E. Lyons, D. P. Craig, J. Y. Adkins, A. M. Myers, and R. M. Suryan. 2002. Effects of colony relocation on diet and productivity of Caspian terns. The Journal of Wildlife Management 66(3):662-673.

Roby, D. D., D. E. Lyons, D. P. Craig, K. Collis, and G. H. Visser. 2003. Quantifying the effect of predators on endangered species using bioenergetics approach: Caspian terns and juvenile Salmonids in the Columbia River estuary. Canadian Journal of Zoology 81:250-265.

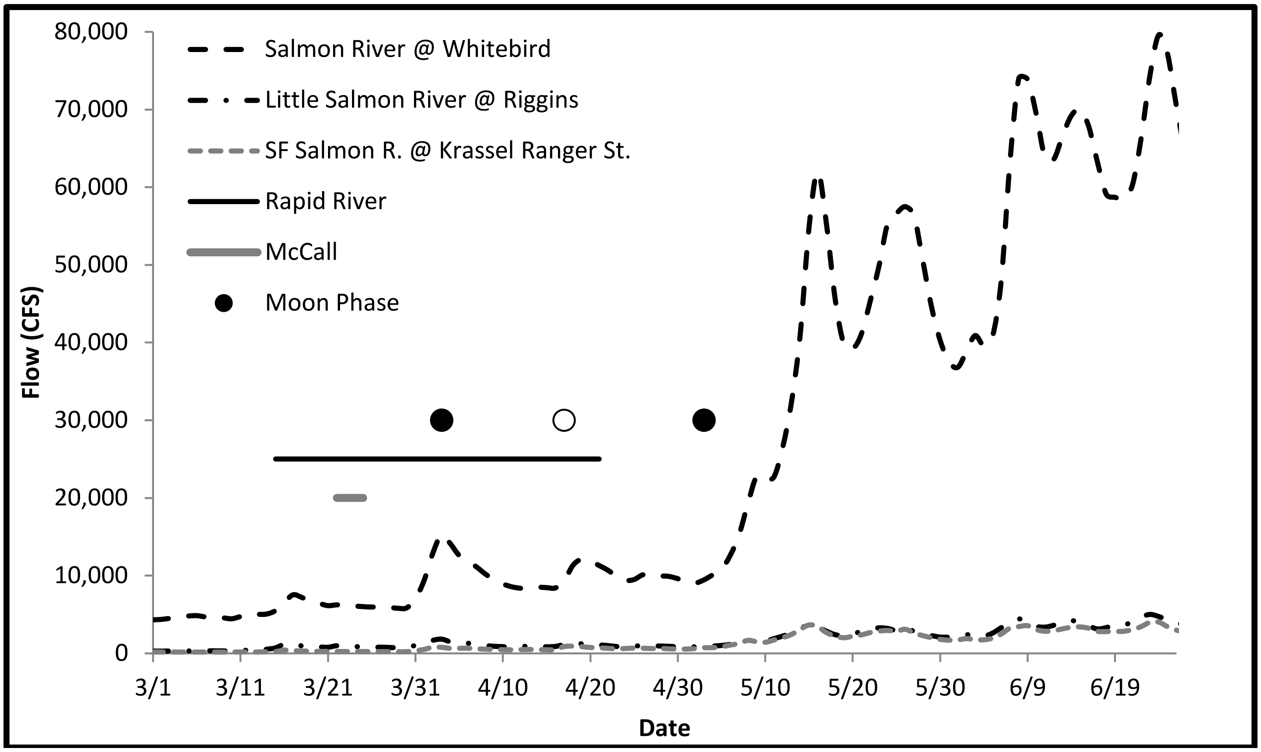
Seber, G. A. F. 1965. A note on the multiple recapture census. Biometrika 52:249-252.

Vøllestad, L. A., J. Peterson, and T. P. Quinn. 2004. Effects of freshwater and marine growth rates on early maturity in male Coho and Chinook salmon. Transactions of the American Fisheries Society 133:495-503.

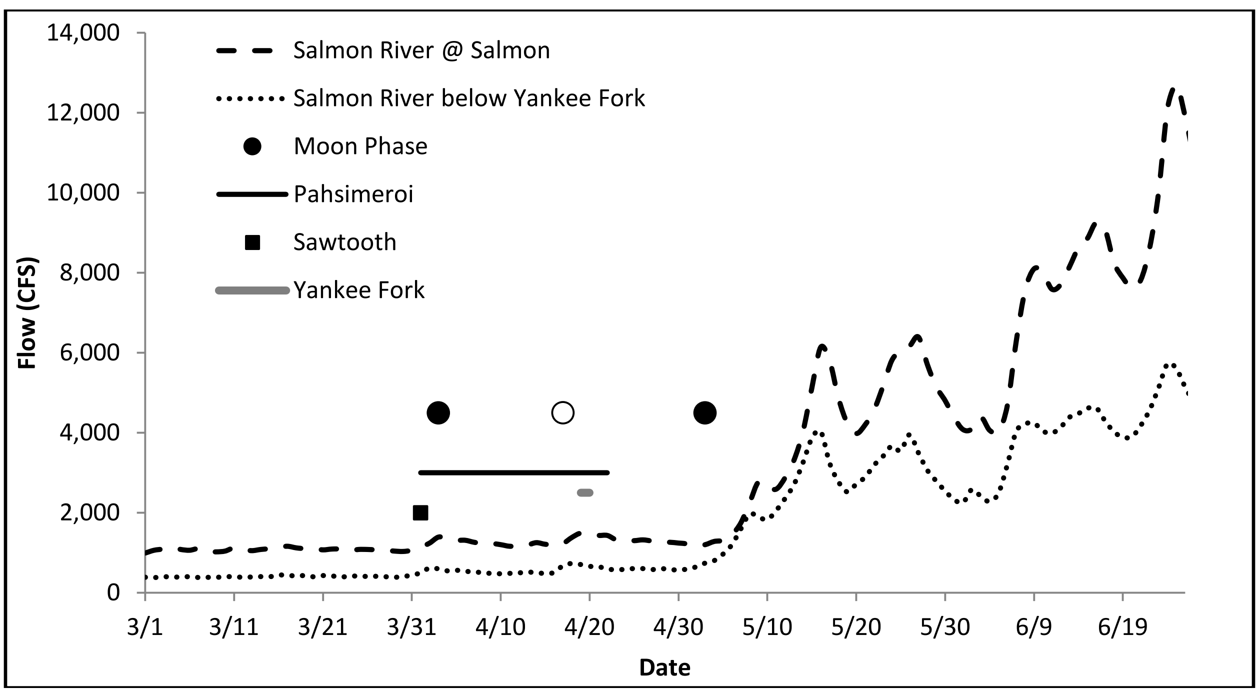
Westhagen, P., and J. R. Skalski. 2009. PitPro (version 4.0). School of Aquatic and Fishery Sciences. University of Washington. Seattle. Available at http://www.cbr.washington.edu/paramest/pitpro/.

APPENDICES

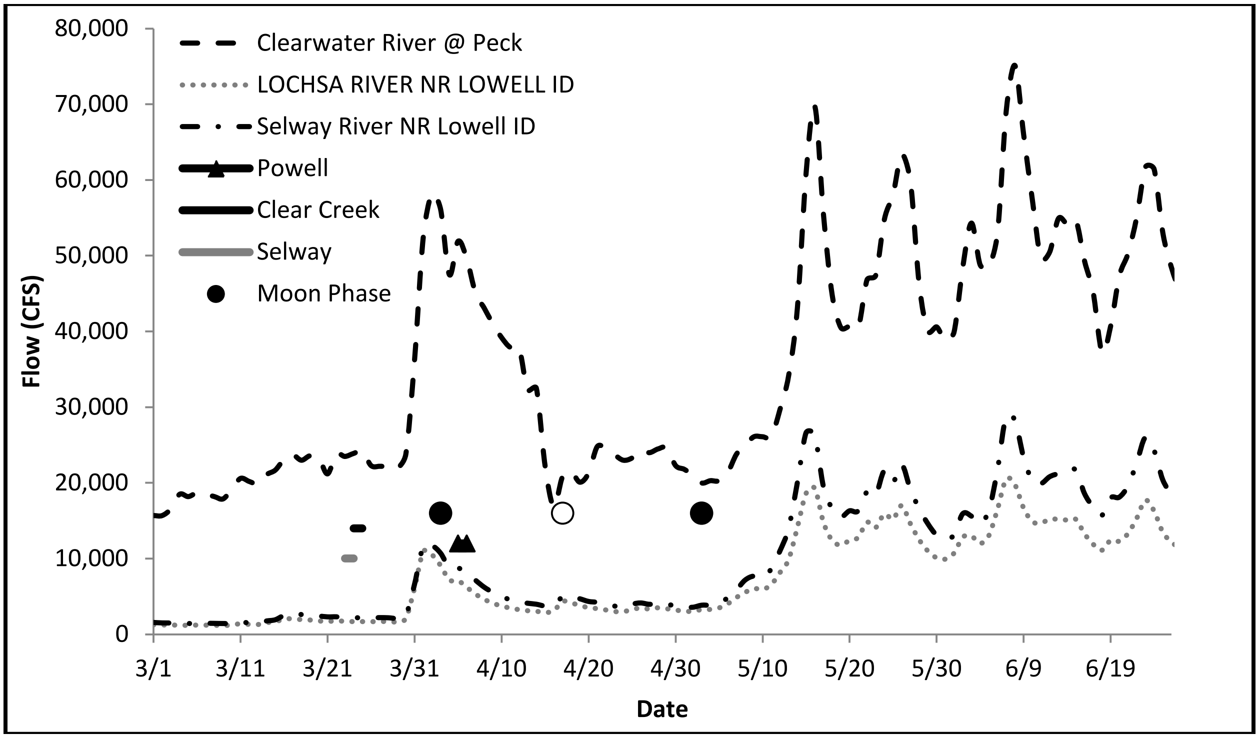
Appendix A1. 2011 SF Salmon River summer and Rapid River spring Chinook salmon smolt release timing vs. moon phase and flow.



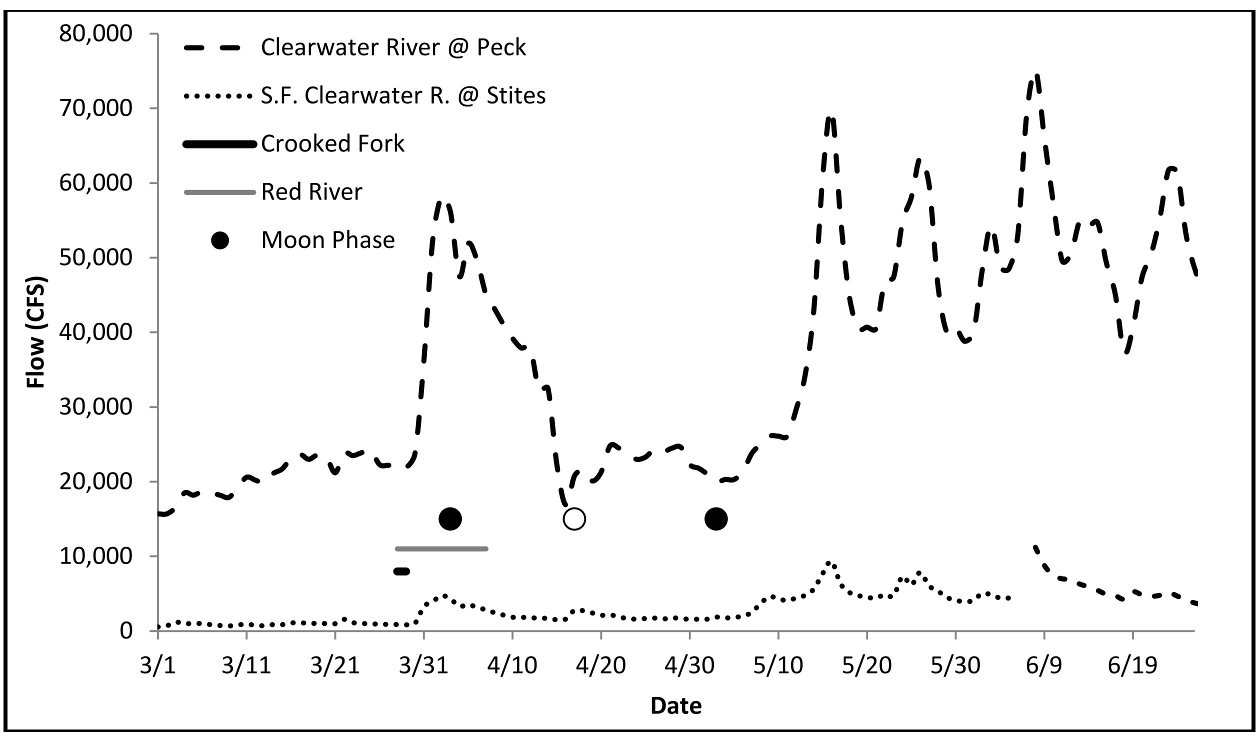
Appendix A2. 2011 Pahsimeroi summer and Sawtooth spring Chinook salmon smolt release timing vs. moon phase and flow.



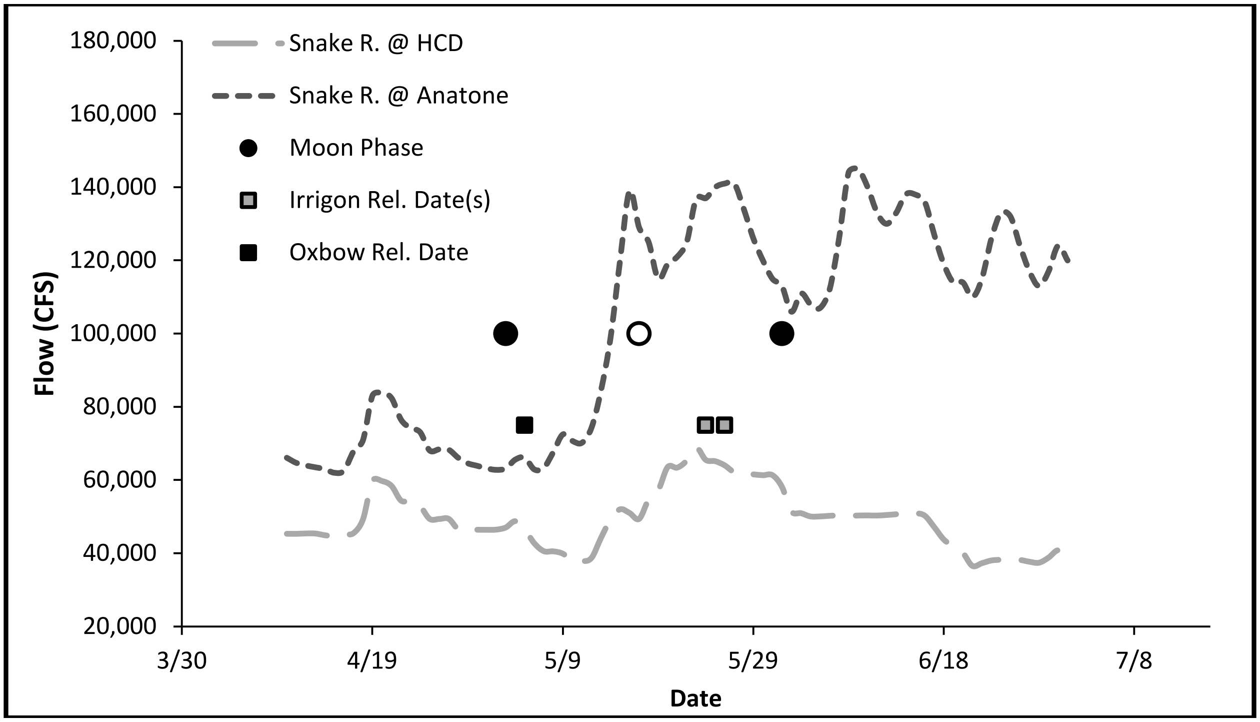
Appendix A3. 2011 Upper Clearwater spring Chinook salmon smolt release timing vs. moon phase and flow.



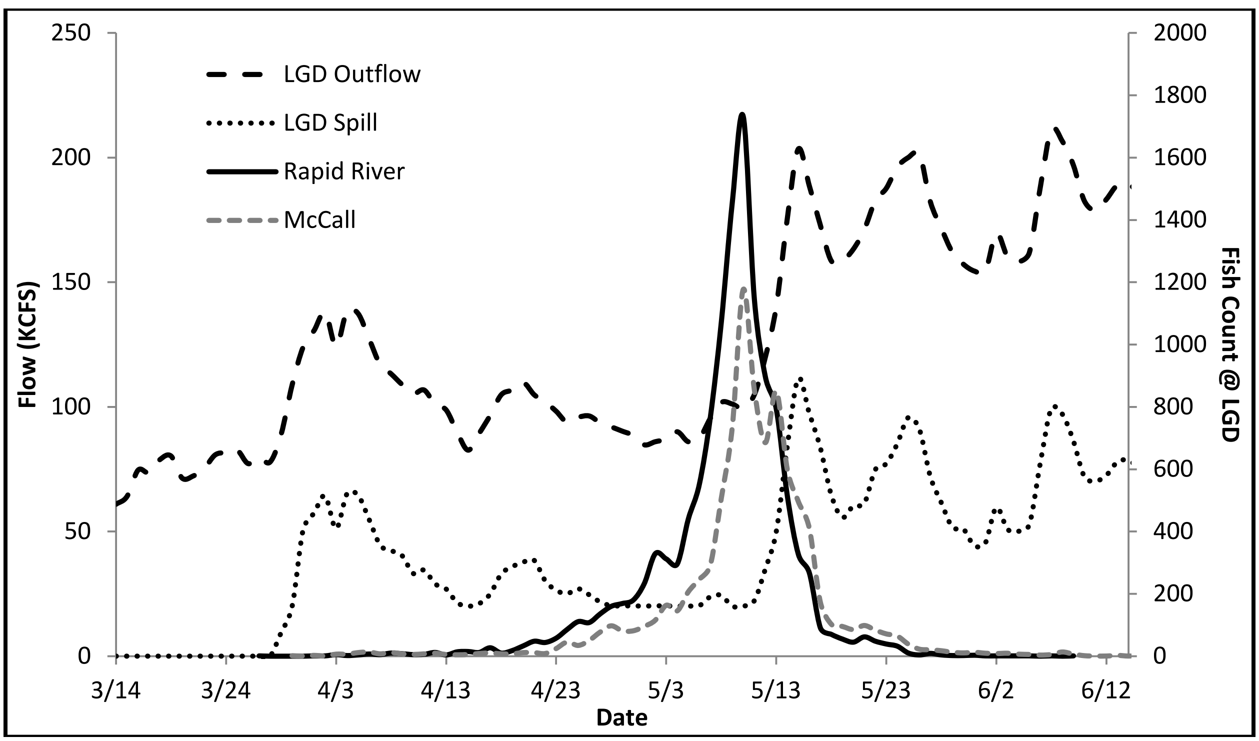
Appendix A4. 2011 South Fork Clearwater spring Chinook salmon smolt release timing vs. moon phase and flow



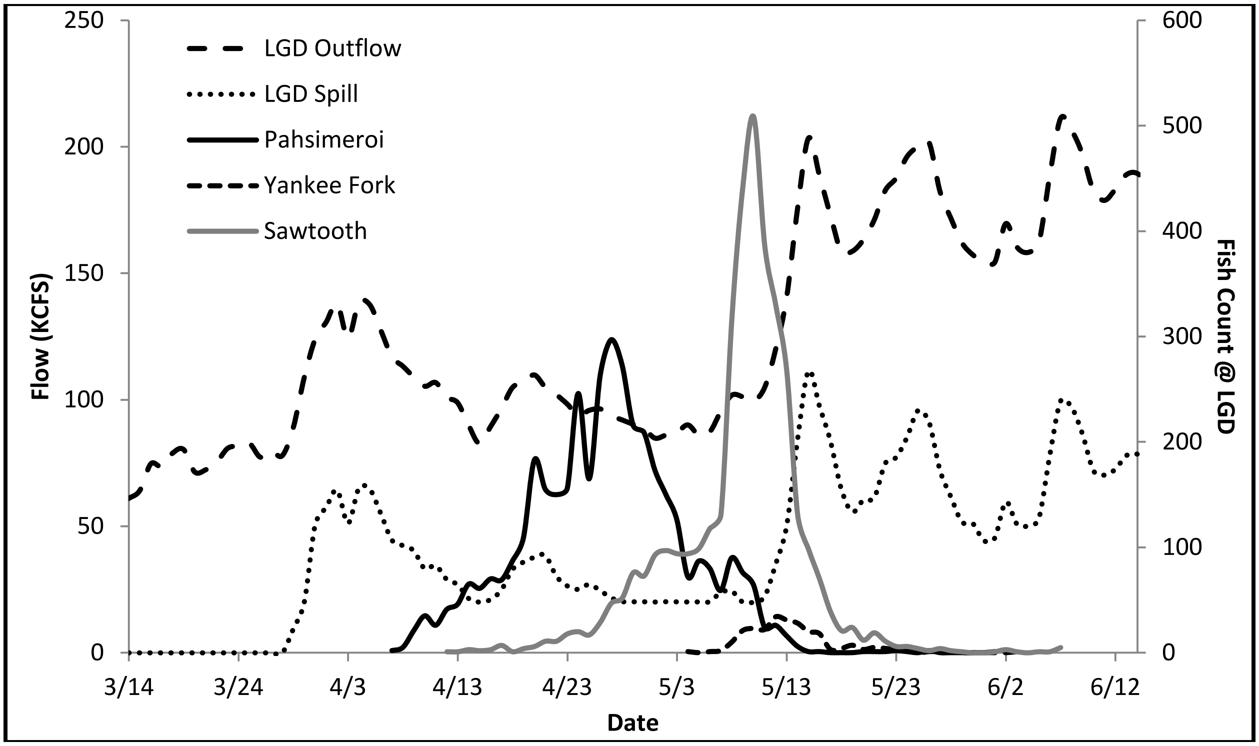
Appendix A5. 2011 Oxbow and Irrigon fall Chinook salmon smolt release timing vs. moon phase and flow.



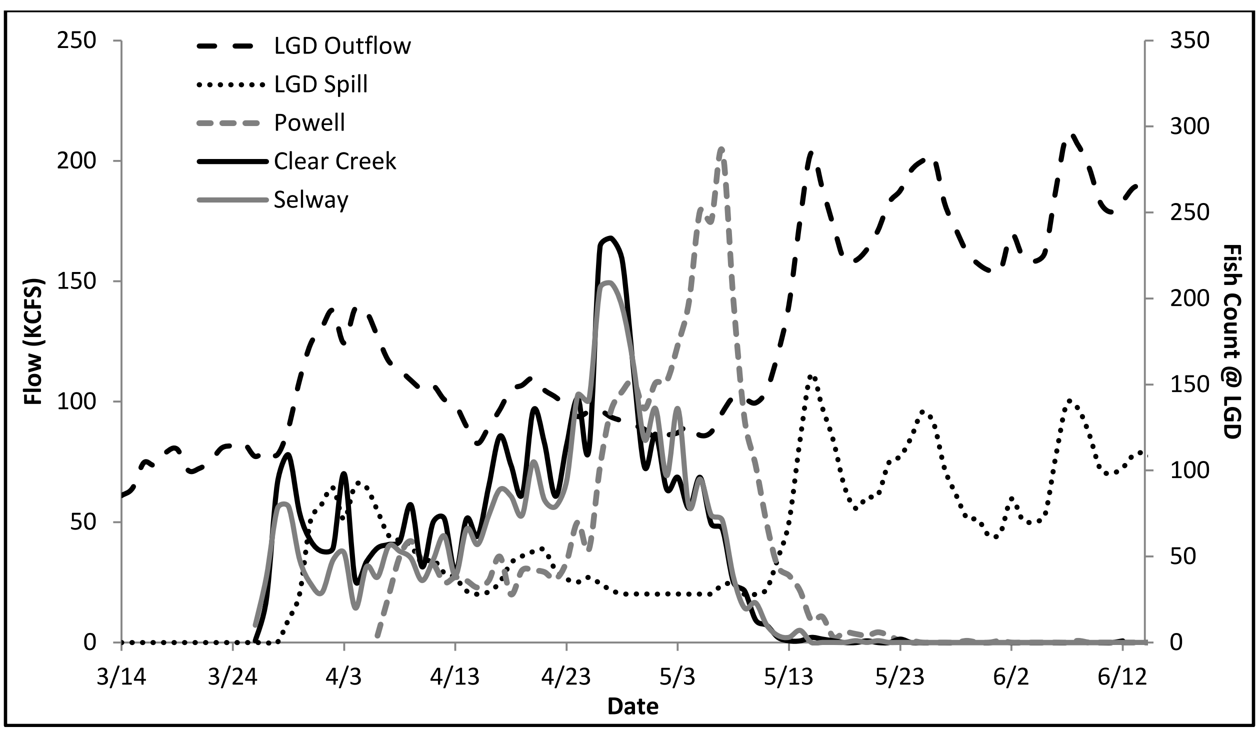
Appendix B1. 2011 SF Salmon River summer and Rapid River spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



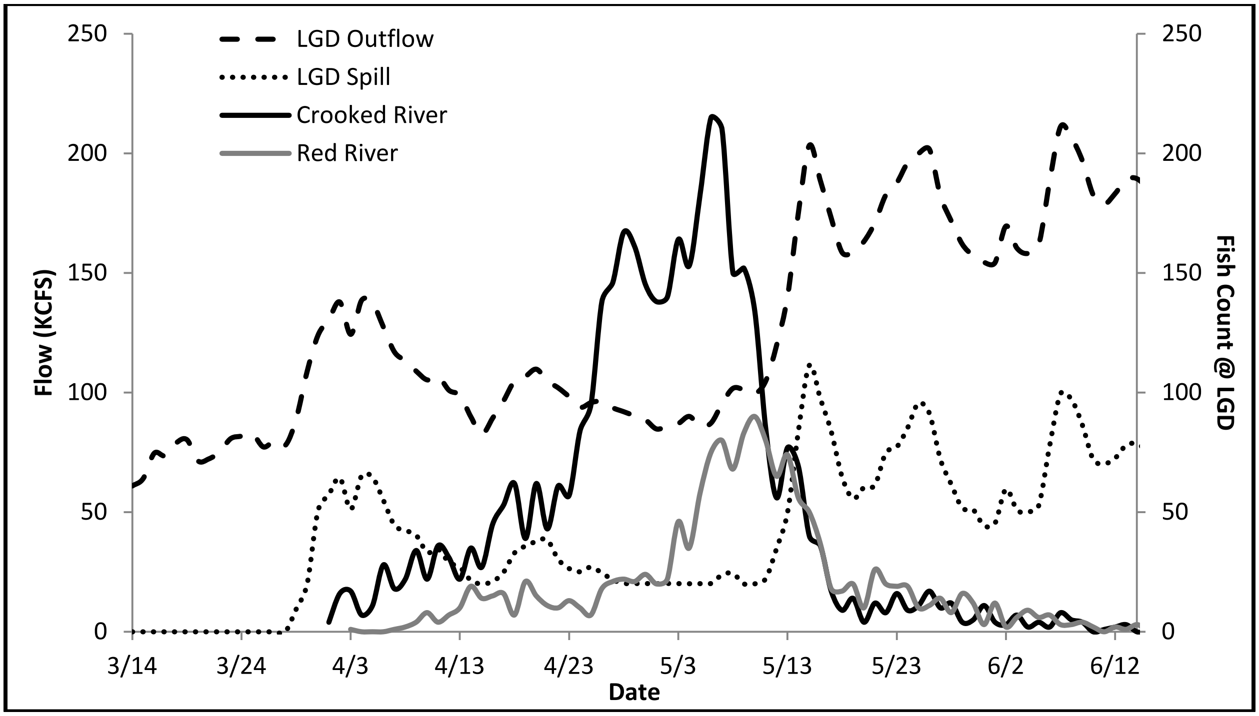
Appendix B2. 2011 Pahsimeroi summer and Sawtooth spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



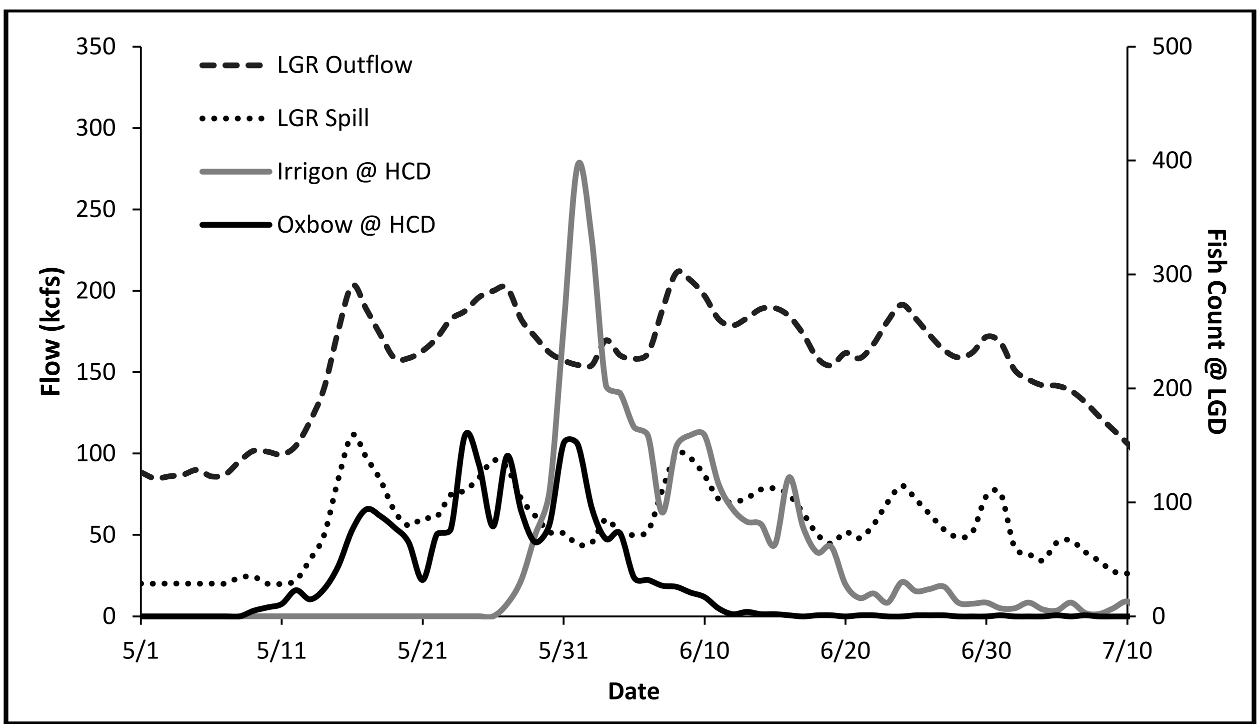
Appendix B3. 2011 Upper Clearwater spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



Appendix B4. 2011 South Fork Clearwater spring Chinook salmon smolt arrival timing vs. flow at Lower Granite Dam.



Appendix B5. 2011 Oxbow and Irrigon fall Chinook salmon arrival timing vs. flow at Lower Granite Dam.



Prepared by:

John Cassinelli
Regional Fisheries Biologist
Idaho Department of Fish and Game

Stuart Rosenberger
Anadromous Hatchery M&E Biologist
Idaho Power Company

Forrest Bohlen
Research Data Coordinator
Idaho Department of Fish and Game

Approved by:

James A. Chandler
Fisheries Program Supervisor
Idaho Power Company

Sam Sharr
Fisheries Anadromous Coordinator
Idaho Department of Fish and Game

Edward B. Schriever, Chief
Bureau of Fisheries
Idaho Department of Fish and Game