FISHERY RESEARCH

LOWER SNAKE RIVER COMPENSATION PLAN
*Hatchery Program*

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# 2013 CALENDAR YEAR HATCHERY CHINOOK SALMON REPORT:

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

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# 2013 Calendar Year Hatchery Chinook Salmon Report: IPC and LSRCP Monitoring and Evaluation Programs in the State of Idaho

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## INTRODUCTION

This report details various components of hatchery-origin spring, summer, and fall Chinook Salmon monitoring, evaluation, and management for calendar year 2013. 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 (SFH), a summer Chinook Salmon program at the McCall Fish Hatchery (MFH), and a combination spring/summer Chinook Salmon program at the Clearwater Fish Hatchery (CFH). Sawtooth Fish Hatchery is located on the upper Salmon River approximately six miles upriver from Stanley, Idaho and has a satellite facility on the East Fork Salmon River (Figure 1). The hatchery was constructed in 1985 and has a current production goal of 1.8 million yearling smolts. The adult escapement goal upstream of Lower Granite Dam (LGD) for SFH is 19,445 Chinook Salmon. Initial modeling specified the need to release 2.3 million smolts to meet the production goal. However, current hatchery capacity at SFH is 1.8 million yearling smolts. Clearwater Fish Hatchery is located at the confluence of the North Fork and mainstem Clearwater rivers near Ahsahka, Idaho. There are three satellite facilities associated with CFH. One satellite facility is on the upper Lochsa River at Powell and the other two are on tributaries to the South Fork Clearwater River: one on Red River and one on Crooked River (Figure 1). The hatchery was constructed in 1992 and has a release goal of 2.7 million yearling smolts. The adult escapement goal upstream of LGD is 11,900. 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 escapement goal upstream of LGD is 8,000 adults.

The IPC programs include a spring Chinook Salmon program at the Rapid River Fish Hatchery, a summer Chinook Salmon program at the Pahsimeroi Fish Hatchery, and a fall Chinook Salmon program at Oxbow and Irrigon fish hatcheries. Rapid River Fish Hatchery is located on Rapid River, a tributary of the Little Salmon River approximately seven miles upriver from the town of Riggins, Idaho (Figure 1). The hatchery was constructed in 1964 and has a production goal of three million yearling smolts. Pahsimeroi Fish Hatchery is comprised of two separate facilities located on the Pahsimeroi River approximately one and seven miles from the confluence with the Salmon River near the town of Ellis, Idaho (Figure 1). The hatchery was constructed in 1968 with a major renovation of the upper facility occurring in 2007. Pahsimeroi Fish Hatchery has a production goal of one million yearling smolts. Oxbow Fish Hatchery is located on the Snake River downriver of Oxbow Dam near the IPC village known as Oxbow, Oregon (Figure 1). The hatchery was constructed in 1962 and has a production goal of 200,000 sub yearling 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 sub yearlings reared at the Oregon Department of Fish and Wildlife's (ODFW) Irrigon Hatchery near the town of Irrigon, Oregon. For release year 2013, all fall Chinook were reared at Irrigon Hatchery and were transported by IPC and released into the Snake River downstream of Hells Canyon Dam at the US Forest Service boat launch.

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.as

px. 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.

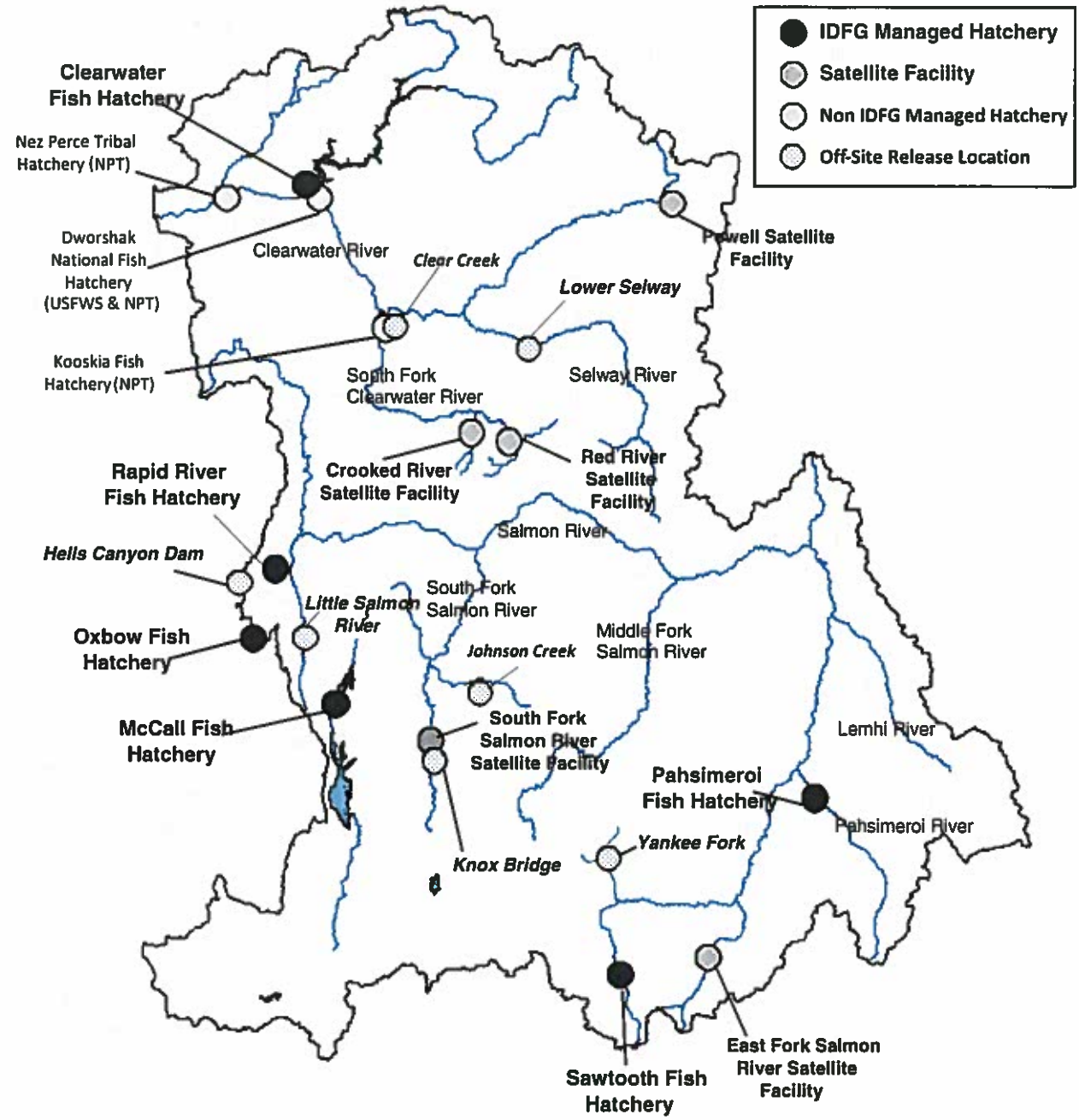


Figure 1. State, federally, and tribally operated anadromous fish hatcheries located in the Clearwater, Salmon, and mid-Snake river basins along with associated satellite facilities and off-site release locations.

## JUVENILE PRODUCTION AND RELEASE

### Marking

All marks and tags that were applied to Chinook Salmon released in 2013 are outlined in Table 1. All marks and tags were applied by the Pacific States Marine Fisheries Commission (PSMFC) marking crew, with the exception of the fall Chinook Salmon at Irrigon Hatchery, which were marked and tagged by ODFW staff. 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—2013 Marking Season". This report will be available through IDFG.

During calendar year 2013, various mark and loading plans were cooperatively developed to outline tagging and marking procedures in upcoming years. In May 2013, a mark plan was developed that outlined preliminary mark and tag numbers for brood year 2013 Chinook Salmon. A passive integrated transponder (PIT) tag loading plan for brood year 2012 and a mark/coded wire tag (CWT) loading plan for brood year 2013 were developed by M&E staff with input from hatchery staff and marking personnel. Loading plans are designed to indicate where specific groups of marks and tags should be applied at each individual hatchery taking into account family units, rearing containers, and any specific treatments of fish. Plans are developed in an effort to maximize tag representation while maintaining a manageable tagging and rearing scheme.

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

#### Adipose Fin Clips

The presence or absence of an adipose fin clip is used as the sole designator of hatchery- or natural-origin in Idaho sport fisheries and is also one of the primary indicators of origin at hatchery traps. Some non-adipose clipped hatchery fish are released to meet other management objectives. However, these fish contain a secondary mark or tag that makes them distinguishable as hatchery-origin when they return.

#### Coded Wire Tags

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

#### Parental Based Tags

All broodstock spawned at Idaho hatcheries since 2008 had a fin clip taken for a genetic sample. These genetic samples are used to identify juvenile fish produced from each parental cross. At any point in the offspring's life cycle, a tissue sample can be taken and through the

genetic baseline, can be assigned back to its hatchery, stock, cohort, and in many instances, its release site. PBT is beneficial because fish are 100% marked and sampling is non-lethal. PBT can be used to generate stock and age compositions of fisheries, on spawning grounds, and at hatchery traps.

**Passive Integrated Transponder Tags**

PIT tags serve multiple purposes and like CWTs, are an important tool for monitoring and evaluating Chinook Salmon. PIT tags allow us to generate estimates of juvenile survival to LGD and juvenile travel time through the Snake River and Columbia River hydrosystem. During adult returns, PIT tags provide adult return timing through the hydrosystem, adult conversions between dams, and rates of fallback/reascension and after-hours passage at the dams. Additionally, PIT tags are used to generate stock- and age-specific estimates of return numbers to various dams. These estimates are available in real-time and are used to manage fisheries in-season. 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 where a PIT-tagged fish will be directed if detected in one of the juvenile bypass systems at a Snake River or Columbia River dam. As part of ongoing research for the Comparative Survival Study (CSS), sort-by-code is used to determine if a PIT tag fish should be treated as the run-at-large or by default, returned to the river. The majority of PIT tags (about 70%) are assigned to the run-at-large group, which means if detected, they will either be transported downriver on a barge or truck, or returned back to the river based on what the current protocol is at that particular dam for the untagged population. The remaining 30% are assigned to the return-to-river group and are treated independently of the untagged population and automatically returned to the river, if detected. Because the run-at-large component represents the untagged population, they are the only tags that are expanded to generate the adult return estimates outlined above. More details on the CSS study can be found in the study's 2013 annual report (Comparative Survival Study Oversight Committee and Fish Passage Center the 2013 annual report, 2013 (http://www.fpc.org/documents/CSS.html)).

## Releases

Juvenile Chinook Salmon were released starting in March and continued through May of 2013. The majority of these releases were spring/summer yearling smolt releases. However, the fall Chinook Salmon from Irrigon Fish Hatchery were released as sub yearlings. Nearly all 2013 Chinook Salmon releases were at or near the release goals of each facility outlined in the Introduction section (Table 1). Sawtooth and Irrigon hatcheries were the only facilities that did not meet their smolt release goals. The shortage at Irrigon was due to egg losses that occurred during final incubation. Sawtooth's shortage was due to a low adult return in 2011 that did not meet broodstock needs. As a result of the low number of eggs available at Sawtooth Hatchery, there were no releases of Chinook Salmon smolts into the Yankee Fork River in 2013. However, in a cooperative effort, the empty rearing space at Sawtooth Hatchery was filled with excess eggs collected from Pahsimeroi Hatchery. The Pahsimeroi eggs were reared to smolt size at Sawtooth Hatchery and were then transferred and released at Pahsimeroi Hatchery Ponds in 2013. All release information was submitted to the Regional Mark Information System (RMIS) by August of 2013. Release locations are shown in Figure 1.

Table 1. Juvenile Chinook Salmon released in 2013 from hatcheries operated by IDFG.

| Hatchery | Release Site | Release Date(s) | AD Only | AD/CWT | CWT Only | No Tag | PIT TAG* | Total Release |
|---|---|---|---|---|---|---|---|---|
| McCall (Seg.) | SFSR-Knox | 3/25 - 3/28 | 700,963 | 120,038 | 0 | 0 | 25,950 | 821,001 |
| McCall (Int.) | SFSR-Knox | 3/25 - 3/28 | 0 | 0 | 253,849 | 0 | 25,952 | 253,849 |
| *McCall Total Release* | | | **700,963** | **120,038** | **253,849** | **0** | **51,902** | **1,074,850** |
| Rapid River | Rapid R. Ponds | 3/12 - 4/26 | 2,377,397 | 120,271 | 0 | 0 | 51,899 | 2,497,668 |
| Rapid River | Little Sal. R. | 3/14 | 200,000 | 0 | 0 | 0 | 0 | 200,000 |
| Rapid River | Hells Can. Dam | 3/12 | 414,000 | 0 | 0 | 0 | 0 | 414,000 |
| *Rapid River Total Release* | | | **2,991,397** | **120,271** | **0** | **0** | **51,899** | **3,111,668** |
| Clearwater | Powell | 20-Mar | 290,264 | 118,157 | 0 | 0 | 17,059 | 408,421 |
| Clearwater | Red River | 27-Mar | 967,141 | 118,345 | 0 | 0 | 16,850 | 1,085,486 |
| Clearwater | Crooked River | 20-Mar | 0 | 0 | 207,023 | 1,424 | 25,451 | 208,447 |
| Clearwater | Selway River | 18-Mar | 176,754 | 116,909 | 132,250 | 783 | 17,063 | 426,696 |
| Clearwater | Clear Cr | 19-Mar | 260,020 | 118,063 | 0 | 0 | 17,083 | 378,083 |
| *Clearwater Total Release* | | | **1,694,179** | **471,474** | **339,273** | **2,207** | **93,506** | **2,507,133** |
| Sawtooth (Seg.) | Sawtooth Weir | 5-Apr | 652,732 | 0 | 0 | 0 | 21,282 | 652,732 |
| Sawtooth (Int.) | Sawtooth Weir | 5-Apr | 0 | 0 | 133,684 | 448 | 996 | 134,132 |
| Sawtooth | Yankee F. (Dir.) | | There were no Yankee Fork releases in 2013 | | | | | |
| Sawtooth | Yankee F. (Acc.) | | | | | | | |
| *Sawtooth Total Release* | | | **652,732** | **0** | **133,684** | **448** | **22,278** | **786,864** |
| Pahsimeroi (Seg.) | Pahsim. Ponds | 4/5 - 4/17 | 721,471 | 117,193 | 0 | 0 | 21,393 | 838,664 |
| Pahsimeroi (Int.) | Pahsim. Ponds | 4/5 - 4/17 | 0 | 0 | 166,971 | 238 | 998 | 167,209 |
| Sawtooth** | Pahsim. Ponds | 4/5 - 4/17 | 8,365 | 431,024 | 0 | 0 | | 439,389 |
| *Pahsimeroi Total Release* | | | **729,836** | **548,217** | **166,971** | **238** | **22,391** | **1,445,262** |
| Irrigon*** | Hells Can. Dam | 5/20 - 5/22 | 651,123 | 228,054 | 156 | 413 | 2,994 | 879,746 |
| *Irrigon Total Release* | | | **651,123** | **228,054** | **156** | **413** | **2,994** | **879,746** |
| **Totals** | | | **7,420,230** | **1,488,054** | **893,933** | **3,306** | **244,970** | **9,805,523** |

* PIT tag total is not in addition to other mark/tag columns but is included in those groups.
** Pahsimeroi segregated stock reared at Sawtooth Fish Hatchery because of available extra rearing space
*** 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 2013, juvenile smolt survival rates to LGD ranged from 54.5% for the release into the Powell Ponds on the Lochsa River, to 82.7% for the spring Chinook Salmon released into Clear Creek (Table 2). Survivals in 2013 were variable when compared to the previous nine year unweighted averages, but the yearly unweighted average for 2013 was slightly higher than the overall previous nine year average (Table 3). In September of 2012, a group of 2,000 PIT tags were applied at McCall Fish Hatchery to compare juvenile survival rates to LGD between fall-tagged and the two 25,000 tag groups (one integrated, one segregated) tagged in the spring. The group tagged in the fall had similar juvenile survival rates to LGD as the two groups that were tagged in the spring (Table 2). This evaluation will be continued for the 2014 releases.

River flow conditions during juvenile releases and out-migration are included in Appendix A of this document. In 2013, all smolt releases occurred prior to upswings in spring discharge. Appendix B shows that the majority of juvenile spring/summer Chinook Salmon released in the

Salmon River crossed LGD in a 30-day window from mid-April to mid-May. During this period, there was a significant increase in flow at LGR and spill over the dam was held constant around 20K CFS. Fall Chinook Salmon arrived at LGD from late-May to mid- June after the peak flows had subsided.

Table 2. Juvenile hatchery Chinook Salmon survival and travel time estimates to Lower Granite Dam (LGD) for release year 2013.

| 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 | 17,083 | 19-Mar | 20.1 | 176 | 36 days | 29-Apr | 4/9 - 5/5 (26 days) | 82.7 ± 4.8 |
| Powell Pond | 17,059 | 20-Mar | 22.5 | 321 | 41 days | 30-Apr | 4/12 - 5/14 (32 days) | 54.5 ± 3.4 |
| Red River Pond | 16,850 | 27-Mar | 19.5 | 299 | 40 days | 7-May | 4/26 - 5/15 (19 days) | 59.2 ± 3.7 |
| Crooked R. Trap | 25,451 | 20-Mar | 20.0 | 280 | 44 days | 2-May | 4/15 - 5/15 (30 days) | 55.3 ± 2.5 |
| Selway River | 17,063 | 18-Mar | 20.0 | 240 | 32 days | 18-Apr | 4/4 - 5/5 (31 days) | 59.1 ± 3.3 |
| SF Salmon R. (Seg.) | 25,950 | 3/25 - 3/28 | 17.1 | 457 | 45 days | 9-May | 5/6 - 5/14 (8 days) | 63.3 ± 3.0 |
| SF Salmon R. (Int.) | 25,952 | 3/25 - 3/28 | 16.6 | 457 | 44 days | 9-May | 5/4 - 5/13 (9 days) | 70.0 ± 3.7 |
| SF Salmon R. (Fall Tag) | 2,002 | 3/25 - 3/28 | 17.1 | 457 | 44 days | 9-May | 5/6 - 5/13 (7 days) | 67.4 ± 6.4 |
| Pahsimeroi Ponds (Seg.) | 21,393 | 5-Apr | 13.8 | 630 | 22 days | 28-Apr | 4/17 - 5/6 (19 days) | 61.0 ± 3.3 |
| Pahsimeroi Ponds (Int.) | 998 | 5-Apr | 14.0 | 630 | 22 days | 29-Apr | 4/16 - 5/6 (20 days) | 74.0 ± 18.7 |
| Rapid River Ponds | 51,899 | 12-Mar | 15.8 | 283 | 28 days | 9-May | 5/3 - 5/13 (10 days) | 73.6 ± 2.1 |
| Sawtooth Weir (Seg.) | 21,282 | 5-Apr | 19.7 | 747 | 35 days | 10-May | 5/6 - 5/14 (8 days) | 57.1 ± 2.3 |
| Sawtooth Weir (Int.) | 996 | 5-Apr | 24.9 | 747 | 35 days | 10-May | 5/4 - 5/13 (9 days) | 58.3 ± 7.5 |
| Irrigon (HCD) | 2,994 | 20-May | 50.4 | 222 | 19 days | 8-Jun | 6/4 - 6/13 (9 days) | 63.2 ± 4.7 |

Table 3. Ten-year comparison of juvenile hatchery Chinook Salmon survival estimates (percent survival) to Lower Granite Dam and unweighted averages for the time series available, by site.

| Hatchery | Release Site | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Site Ave. (2004-2012) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clearwater | Clear Cr. | | | | | | 78.7 | 80.7 | 78.9 | 75.5 | 82.7 | 78.5 |
| | Powell Pond | 77.5 | 83.6 | 79.0 | 77.5 | 36.1 | 63.1 | 67.1 | 76.1 | 68.1 | 54.5 | 68.3 |
| | Red R. Pond | 72.2 | 67.6 | 52.4 | 81.8 | 65.9 | 36.2 | 70.3 | 32.2 | 64.8 | 59.2 | 60.3 |
| | Selway River | | | | | 69.0 | 72.2 | 79.5 | 75.5 | 70.6 | 59.1 | 71.0 |
| | Crooked R. Trap | | | | | | | | 52.7 | 57.4 | 55.3 | 55.1 |
| McCall | SF Salmon R. (Seg.) | 59.4 | 60.4 | 63.8 | 55.0 | 58.7 | 51.2 | 56.5 | 62.9 | 55.0 | 63.3 | 58.6 |
| | SF Salmon R. (Int.) | | | | | | | | | 59.2 | 70.0 | 59.2 |
| Pahsimeroi | Pahsimeroi (Seg.) | 50.5 | 22.1 | 26.7 | 53 | 44.6 | 50.9 | 37.3 | 51.1 | 58.0 | 61.0 | 45.5 |
| | Pahsimeroi (Int.) | | | | | | | | | 59.1 | 74.0 | 59.1 |
| Rapid River | Rapid River Ponds | 69.4 | 73.6 | 75.9 | 74.2 | 80.6 | 72.6 | 78.1 | 77.6 | 74.5 | 73.6 | 75.0 |
| Sawtooth | Sawtooth (Seg.) | 58.0 | 22.0 | 65.3 | 57.5 | 34.1 | 36.6 | 42.3 | 53.1 | 47.4 | 57.1 | 47.3 |
| | Sawtooth (Int.) | | | | | | | | | 42.6 | 58.3 | 42.6 |
| | Yank. Fk. 2nd Bridge* | | | | | | | 47.7 | 30.3 | 29.6 | NA | 35.9 |
| | Yank. Fk. Dredge Ponds* | | | | | | | 54.2 | 37.2 | 29.9 | NA | 40.4 |
| Oxbow** | Hells Canyon Dam | 43.8 | 66.6 | 81.8 | 64.3 | 80.2 | 66.4 | 45.4 | 75.8 | 73.6 | NA | 66.4 |
| Irrigon | Hells Canyon Dam | | | 75.7 | | 80.6 | 59.9 | 58.9 | 62.0 | 75.2 | 63.2 | 67.9 |
| Yearly Unweighted Average | | 61.5 | 56.6 | 65.1 | 66.2 | 61.1 | 58.8 | 59.8 | 58.9 | 58.8 | 63.9 | 60.7 |

*There were no releases into the Yankee Fork River in 2013.
**Oxbow Hatchery did not raise Fall Chinook to be released in 2013.

## ADULT RETURNS

Adult Chinook Salmon from brood years 2010, 2009, and 2008 returned to Idaho in 2013 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, sport harvest

upstream of LGD, and back to hatchery traps for spring and summer Chinook Salmon. Strays recovered upstream of LGD are also included. Due to differences in management practices and data availability for fall Chinook Salmon, they are not included in the majority of the adult return sections, with the exception of the Idaho Sport Harvest section, where preliminary numbers are reported.

## Preseason Forecasted Adult Returns

Forecasted adult returns for Idaho stocks are generated by IDFG using sibling regressions. A regression of historic jack vs. the two-ocean returns, from the same cohort, is used to forecast an individual hatchery's two-ocean return. The same methodology is used to forecast three-ocean returns from the previous year's two-ocean return. The regressions use hatchery-specific run reconstructions, by age, at the Columbia River mouth. The forecasted total adult return to the Columbia River mouth, for each hatchery, is the sum of the forecasted two- and three-ocean returns. Stock-specific conversion rates based on historic interdam conversions are applied to each hatchery-specific forecast to the Columbia River mouth to generate stock-specific forecasts to LGD. To generate forecasts for untagged off-site releases, a surrogate release group is used. For example, to forecast a return for Rapid River spring Chinook Salmon released at Hells Canyon Dam, the forecasted adult return per smolt released for Rapid River Hatchery is multiplied by the known number of smolts released at Hells Canyon Dam. Table 4 shows the 2013 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 2013 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 | 785 | 612 | 422 |
| Clearwater | Powell Pond | 1,078 | 817 | 580 |
| Clearwater | Red River | 2,386 | 1,860 | 1,246 |
| Clearwater | Crooked River* | N/A | N/A | N/A |
| Clearwater | Clear Creek | 724 | 557 | 390 |
| **Total Clearwater R.** | | **4,973** | **3,846** | **2,638** |
| Rapid River | Rapid River Ponds | 12,676 | 8,829 | 6,004 |
| Rapid River | Hells Canyon Dam | 1,584 | 1,102 | 750 |
| Rapid River | Little Salmon River | 1,054 | 733 | 499 |
| Pahsimeroi | Pahsimeroi Ponds | 525 | 438 | 350 |
| Sawtooth | Sawtooth Hatchery | 1,739 | 1,676 | 1,428 |
| McCall | SF Salmon River | 3,378 | 3,048 | 2,530 |
| **Total Salmon R.** | | **20,956** | **15,826** | **11,561** |
| **TOTALS** | | **25,929** | **19,672** | **14,199** |

*2013 was the first year for summer Chinook returns to the Crooked River, thus no preseason forecast could be made.

## PIT Tag Return Estimates to Bonneville and Lower Granite Dams

The majority of the release groups of Chinook Salmon returning to Idaho in 2013 had a representative group of PIT tagged fish. The detections of run-at-large tags in returning fish at Bonneville, McNary, Ice Harbor, and Lower Granite dams were expanded by the juvenile tagging rates to generate an estimate of age-3, -4, and -5 Chinook Salmon, by stock and release site, back to each dam. For releases that were not PIT tagged, a surrogate release was

used to generate return estimates. Some returns are corrected postseason using tagged to untagged ratios obtained from in-ladder PIT tag arrays at hatchery traps (see Research section, Estimating a Correction Factor for PIT Tag Expansions in Returning Chinook Salmon, in this report). Previous data indicates that PIT tags generally underestimate the number of untagged fish returning due to tag shedding and differential mortality (IDFG unpublished data). Return estimates that are not corrected postseason are likely an underestimate of actual returns. Table 5 provides these expanded estimates to Bonneville Dam, and Table 6 provides the estimates to LGD. Table 7 compares preseason forecasted adult return estimates to LGD and estimated returns from PIT tag expansions. All PIT tag detections are corrected for interrogation efficiencies at each dam. In 2013, adult returns at Bonneville Dam were very similar to the preseason forecasted estimates (Table 7).

Table 5. Estimated escapement of returning spring/summer Chinook Salmon to Bonneville Dam in return year 2013. Estimates are based on expanded PIT tag detections.

| Release Hatchery | Release Site | One-Ocean | Two-Ocean | Three-Ocean | Total |
|---|---|---|---|---|---|
| Clearwater | Selway River | 734 | 684 | 31 | 1,449 |
| Clearwater | Powell Pond | 373 | 649 | 64 | 1,086 |
| Clearwater** | Crooked River | 349 | 196 | 0 | 545 |
| Clearwater** | Red River | 1,869 | 1,288 | 94 | 3,251 |
| Clearwater | Clear Creek | 607 | 551 | 35 | 1,193 |
| **Total Clearwater R.** | | **3,932** | **3,368** | **224** | **7,524** |
| Rapid River | Rapid River Ponds | 3,637 | 6,317 | 680 | 10,634 |
| Rapid River | Hells Canyon Dam* | 609 | 1,021 | 137 | 1,767 |
| Rapid River | Little Salmon River* | 291 | 510 | 63 | 864 |
| Sawtooth** | Sawtooth Weir | 3,183 | 1,737 | 672 | 5,592 |
| Sawtooth | Yankee Fork | 84 | 0 | 0 | 84 |
| Pahsimeroi | Pahsimeroi Ponds | 738 | 69 | 0 | 807 |
| McCall** | SF Salmon R. – Knox | 1,995 | 3,423 | 817 | 6,235 |
| **Total Salmon R.** | | **10,537** | **13,077** | **2,369** | **25,983** |
| **GRAND TOTAL** | | **14,469** | **16,445** | **2,593** | **33,507** |

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

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

Table 6. Estimated escapement of returning spring/summer Chinook Salmon to Lower Granite Dam in return year 2013. Estimates are based on expanded PIT tag detections.

| Release Hatchery | Release Site | One-Ocean | Two-Ocean | Three-Ocean | Total |
|---|---|---|---|---|---|
| Clearwater | Selway River | 698 | 452 | 32 | 1,182 |
| Clearwater | Powell Pond | 340 | 350 | 66 | 756 |
| Clearwater** | Crooked River | 293 | 193 | 0 | 486 |
| Clearwater** | Red River | 1,337 | 858 | 94 | 2,289 |
| Clearwater | Clear Creek | 528 | 437 | 36 | 1,001 |
| **Total Clearwater R.** | | **3,196** | **2,290** | **228** | **5,714** |
| Rapid River | Rapid River Ponds | 3,500 | 5,181 | 612 | 9,293 |
| Rapid River | Hells Canyon Dam* | 586 | 835 | 123 | 1,544 |
| Rapid River | Little Salmon River* | 280 | 417 | 56 | 753 |
| Sawtooth** | Sawtooth Weir | 2,605 | 1,161 | 672 | 4,438 |
| Sawtooth | Yankee Fork | 84 | 0 | 2 | 86 |
| Pahsimeroi | Pahsimeroi Ponds | 511 | 70 | 0 | 581 |
| McCall** | SF Salmon R. – Knox | 1,681 | 2,680 | 612 | 4,973 |
| **Total Salmon R.** | | **9,247** | **10,344** | **2,077** | **21,668** |
| **GRAND TOTAL** | | **12,443** | **12,634** | **2,305** | **27,382** |

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

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

Table 7. Comparison of preseason forecasted returns of adult Chinook Salmon 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 Tags (Two- and Three-Ocean Combined) |
|---|---|---|---|
| Clearwater | Upper Selway | 612 | 715 |
| Clearwater | Powell Pond | 817 | 713 |
| Clearwater | Clear Creek | 557 | 586 |
| Clearwater** | Red River | 1,860 | 1,382 |
| **Total Clearwater R.** | | **3,846** | **3,396** |
| Rapid River | Rapid River Hatchery | 8,829 | 6,997 |
| Rapid River | Hells Canyon Dam* | 1,102 | 1,158 |
| Rapid River | Little Salmon River* | 733 | 573 |
| Sawtooth** | Sawtooth Hatchery | 1,676 | 2,409 |
| Pahsimeroi | Pahsimeroi Hatchery | 438 | 69 |
| McCall** | SF Salmon River | 3,048 | 4,240 |
| **Total Salmon R.** | | **15,826** | **15,446** |
| **GRAND TOTAL** | | **19,672** | **18,842** |

* These releases did not have PIT tags; therefore 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, Red River, and SFSR traps.

## Accountability of the Run at LGD using PIT Tag Expansions

Using PIT tag expansions to estimate stock-, age-, and origin-specific returns to LGD is a valuable in-season harvest management tool as well as a valuable post-season run

reconstruction tool. However, we know from double marking studies and analysis of in-trap PIT tag arrays at hatcheries that PIT tags tend to underrepresent untagged fish due to tag loss and potentially differential survival of tagged and untagged fish. To better understand how well PIT tag expansions account for the total hatchery return to LGD, we compared the expanded PIT tag estimates of all stocks combined to the corrected window count at LGD (Table 8). The corrected window count is estimated using the following formula:

$$Corrected\ Window\ Count = \left(\frac{Window\ Count}{\frac{5}{6}}\right) - Reascension\ Estimate + After\ Hrs.Passage\ Estimate$$

The Army Corps of Engineeers (ACOE) window count needs to be corrected to account for the 10 minute break period every hour when personnel do not enumerate fish passing the window in the adult ladder. The corrected window count also accounts for fish that fall back over the dam and re-ascend the adult fish ladder (reascension), and those fish that pass the window between the hours of 2000 – 0400 (after hours passage). It's important to note that the corrected window count does not account for lock passage, or those Chinook Salmon that fallback over Lower Granite Dam without re-ascending the adult fish ladder.

In 2013, PIT tags underestimated both adults and jacks at LGD, which was similar to what we have observed in the previous years of monitoring. Our results indicate that PIT tags do indeed underestimate returning hatchery-origin Chinook Salmon and that the overall level of underestimation is fairly consistent across time when all stocks and cohorts are combined. However, it is important to note that the underestimation by PIT tags is not consistent across stocks or cohorts (see Research section, Estimating a Correction Factor for PIT Tag Expansions in Returning Chinook Salmon, in this report).

Table 8. Percentage of the corrected window counts at LGD that expanded PIT tags account for in returning jacks, adults, and total returns of spring/summer Chinook Salmon from 2010-2013.

| Final LGD Accountability | 2010 | | 2011 | | 2012 | | 2013 | |
|---|---|---|---|---|---|---|---|---|
| | Adults | Jacks | Adults | Jacks | Adults | Jacks | Adults | Jacks |
| LGD Window Count | 122,234 | 11,499 | 96,106 | 38,488 | 79,529 | 5,242 | 43,454 | 27,512 |
| Adjustment for Reascension | -7,212 | -851 | -14,512 | -5,966 | -4,326 | -215 | -2,733 | -2,052 |
| Adjustment for after hrs. passage | 3,545 | 483 | 6,920 | 1,809 | 3,046 | 222 | 1,168 | 822 |
| LGD-Corrected Window Count | 118,567 | 11,131 | 88,514 | 34,331 | 78,249 | 5,249 | 41,889 | 26,282 |
| SUM of Corrected Counts | 129,698 | | 122,845 | | 83,498 | | 68,171 | |
| Estimate Of Unclipped Fish* | 31,281 | 2,526 | 23,987 | 6,111 | 24,941 | 1,791 | 16,230 | 9,945 |
| Estimate of Clipped ID Hatchery Fish** | 53,332 | 7,830 | 42,269 | 20,978 | 31,270 | 1,912 | 15,262 | 11,433 |
| Estimate of Clipped OR / NPT Hatchery Fish*** | 8,018 | 1,897 | 5,002 | 4,878 | 5,077 | 378 | 1,622 | 3,778 |
| Total LGD Estimate | 92,631 | 12,253 | 71,258 | 31,967 | 61,288 | 4,081 | 33,114 | 25,156 |
| SUM of LGD Estimates | 104,884 | | 103,225 | | 65,369 | | 58,270 | |
| **% of Window Count Adult/Jack Estimate** | **78.1%** | **110.1%** | **80.5%** | **93.1%** | **78.3%** | **77.7%** | **79.1%** | **95.7%** |
| **% of Window Count for Total Estimate** | **80.9%** | | **84.0%** | | **78.3%** | | **85.5%** | |

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

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

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

## Parental Based Tagging Return Estimates to Lower Granite Dam

In return year 2013, Parental Based Tagging (PBT) was used to partition out stock- and age-specific Chinook Salmon returns to LGD. Due to discontinuous trap operation that resulted from high water temperatures at the LGD adult trap, other methods were combined with the PBT analysis to estimate the stock and age composition for the entire run at LGD in 2013. The methods used for this analysis are described below.

The ACOE estimates the number of Chinook Salmon daily at LGD by enumerating fish that pass a counting window located in the adult fish ladder from the hours of 0400-2000. The window counts are split into clipped and unclipped groups based on the presence or absence of an adipose fin when they are observed. The adipose clipped group consists of hatchery fish, and the unclipped group is composed of natural and unclipped hatchery fish. Counting only occurs for 50 of the 60 minutes in each hour, thus the window counts are expanded by (5/6) to account for all fish passing the counting window during counting hours. It is important to note that the COE window counts do not account for after-hours passage, lock passage, or Chinook Salmon that fall back over LGD with or without subsequent reascension. The window counts are then separated into stock and origin based on information (CWT detection and PBT analysis) obtained from fish sampled at the LGD adult trap.

The adult trap at LGD is located in the fish ladder upstream from the fish counting window and is used to collect systematic samples from Chinook Salmon passing LGD. Fish are trapped by operating a trap gate that diverts fish migrating up the fish ladder into a collection chamber according to a predetermined sample rate. The sample rate determines how long the trap gate remains open during four intervals each hour, and the trap is operated 24 hours per day under normal operation. Data and biological samples are collected from Chinook Salmon that are captured in the LGD adult trap according to established protocols. If the trapping rate changes during the season, subsample rates for Chinook Salmon captured in the trap can also change to maintain a consistent sample rate across the run. Additional information about the LGD adult trap can be found in Schrader et al. (2014).

The sampling regimes for clipped and unclipped Chinook Salmon differs at the LGD adult trap, thus the two groups were analyzed separately for this report. Although the intent was to use PBT to estimate stock and age composition of the entire hatchery return, high water temperatures forced the trap to shut down after July 10$^{th}$, resulting in several weeks where fish were not trapped and therefore no genetic samples could be collected for PBT analysis. To account for fish that crossed LGD during the period when the trap was closed, we used other methods (see LGD Stock and Age Estimates During Closure Period) to estimate stock and age composition of the hatchery return.

### LGD Stock and Age Estimates During Normal Trap Operation

For most of the 2013 return, Chinook Salmon were trapped five days per week at LGD at a rate of 25%. From this group of fish, tissue samples were collected at specific rates based on the presence or absence of an adipose fin. For clipped Chinook Salmon, one out of four fish (25%), or roughly 6% of the overall return, was tissue sampled. In 2013 there were 2,256 samples collected from clipped Chinook Salmon which were then subsampled to achieve the 1,023 samples (2.3% of the ad-clipped return at LGD) that were used to estimate stock and age composition of adipose-clipped hatchery-origin spring/summer Chinook Salmon at LGD.

Unclipped Chinook Salmon were subsampled at variable rates (25-50%) throughout the season in accordance with the LGD trapping protocol determined by the co-managers. The subsample rate for both clipped and unclipped Chinook Salmon varied to achieve a consistent overall sampling rate throughout the return. Tissue samples from 161 unclipped hatchery Chinook Salmon (identified by presence of a coded-wire-tag) were collected during the 2013 trapping season. In addition there were 293 samples from unclipped Chinook Salmon that were identified as wild at the time of trapping (identified by no coded-wire-tag detection), but PBT results identified them as hatchery origin Chinook Salmon. The two groups of samples were combined and then subsampled to achieve a consistent sampling rate across the run. After subsampling, 209 samples (3.3% of the unclipped hatchery return at LGD) were used to estimate the stock and age composition at LGD for unclipped hatchery fish.

The proportion of the total number of PBT assignments that were made of each stock and cohort was multiplied by the total window count to provide the estimated number of each stock and cohort that passed upstream of LGD for both the clipped and unclipped groups (Table 9).

Of the 1,023 samples analyzed from the clipped Chinook Salmon at LGD, 50 assigned to brood year 2008 stocks, 485 assigned to brood year 2009 stocks, 418 assigned to brood year 2010 stocks, and 70 samples did not assign to the baseline prior to expanding samples by their tagging rates. After expanding by the tagging rate we were able to account for 100.6% of the samples, suggesting the tagging rates for some groups may have been slightly under-estimated.

Of the 209 samples used to estimate stock and age of the unclipped hatchery Chinook Salmon, 16 assigned to brood year 2008 stocks, 80 assigned to brood year 2009 stocks, and 113 assigned to brood year 2010 stocks.

**LGD Stock and Age Estimates During Trap Closure Period**

On July 10th, 2013, water temperatures in the adult trap at LGD exceeded 70°F, forcing trapping operations to stop in the interest of fish health. During the remainder of the spring/summer Chinook Salmon run that continued until August 17th, no adult Chinook Salmon were trapped or tissue sampled for PBT analysis at LGD, however the ACOE continued to enumerate clipped and unclipped Chinook Salmon that passed the counting window. To account for the adipose-clipped Chinook Salmon that passed LGD during that period, we used expanded PIT tag detections to decompose the adipose-clipped window count by stock and age. This resulted in an additional 900 adipose-clipped Chinook Salmon (1.9% of the total adipose-clipped return) from various stocks and cohorts that were combined with the PBT result for a total season estimate. These additional fish are shown in the 'PIT' columns in Table 9 for each cohort.

To estimate the number of unclipped hatchery Chinook Salmon that passed LGD during the closure period, we first used expanded PIT tags to account for unclipped fall Chinook Salmon that passed the window during the closure period, and after subtracting those fish there were 240 remaining spring and summer Chinook Salmon (3.9% of the total unclipped return in 2013) that passed the counting window during the closure period. Unclipped hatchery Chinook Salmon are not PIT tagged at high rates or may not be PIT tagged at all, so using PIT tags to estimate those groups was not feasible. Instead we used stock and age proportions that were

estimated from PBT samples collected during the week prior to the trap closure to parse out the window count from July 10th through August 17th. The estimated stock- and age-specific returns at LGD were highly variable in 2013 and are outlined in Table 9.

Due to the unexpected trap closure and combination of methods used to estimate the stock- and age-specific returns of Chinook Salmon to LGD in 2013, we were unable to calculate confidence intervals for these estimates that encompassed the entire season.

**Adipose Mis-clip Rates**

Results of the PBT analysis revealed that some of the unclipped hatchery Chinook Salmon that crossed LGD in 2013 were from releases that were intended to be 100% adipose fin clipped, suggesting some fish may have been mis-clipped or there were errors in the PBT tracking information. With the exception of BY2009 returns from Red River, the percent of each returning adipose fin clipped group that was composed of unclipped fish ranged from 0.0-5.0%, which is slightly higher than expected but not alarming. The actual mis-clip rates were probably lower than we observed at LGD because the ad-clipped Chinook Salmon from those release groups would have been harvested at higher rates than the unclipped/mis-clipped fish in the mark-selective fisheries downriver, resulting in higher escapement rates for the unclipped groups which would have inflated the mis-clip rates observed at LGD.

The high rate observed for the BY09 Red River release group (22.9% unclipped) is concerning because the hatchery staff reported a mis-clip rate for that group at the time of release of < 1%. It is unlikely that the ad-clip quality was poor and went undetected, and a more likely explanation is an error in the PBT tracking information. In BY2009 some smolts destined for other release sites where all or some are intentionally left unclipped were produced from the same South Fork Clearwater stock (i.e., Red River). If some of the parents were used to produce the unclipped smolts for other release sites and were not accounted for correctly, it could explain the higher observed mis-clip rates. Our ability to track PBT information to release site is improving with each passing brood year, so in the future we will be able to better determine the source of anomalous mis-clip rates if they occur.

Table 9. Estimated stock-specific brood year 2008, 2009, and 2010 returns to LGD in 2013 based on PBT and PIT detections.

| Stock/Release Group | BY 2010 | | | BY 2009 | | | BY 2008 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ad-Clipped | PIT | Unclipped | Ad-Clipped | PIT | Unclipped | Ad-Clipped | PIT | Unclipped |
| Dworshak | 1,384 | 0 | 53 | 2,130 | 0 | 27 | 572 | 0 | 0 |
| **Dworshak Hatchery Total** | | 1,437 | | | 2,157 | | | 572 | |
| Kooskia | 828 | 0 | 27 | 1,691 | 3 | 198 | 174 | 0 | 0 |
| **Kooskia Hatchery Total** | | 855 | | | 1,892 | | | 174 | |
| Clear Creek* | 488 | 0 | 0 | | | | | | |
| Powell* | 403 | 0 | 0 | 3,605 | 0 | 558 | 77 | 0 | 159 |
| Selway (smolt)* | 518 | 0 | 214 | | | | | | |
| Selway (parr) | 0 | 0 | 26 | 0 | 0 | 91 | 0 | 0 | 0 |
| Red River | 1,596 | 0 | 0 | 717 | 0 | 213 | 44 | 0 | 82 |
| Crooked River | 0 | 0 | 171 | 0 | 13 | 149 | N/A | N/A | N/A |
| **Clearwater Hatchery Total** | | 3,416 | | | 5,346 | | | 362 | |
| NPTH | 0 | 0 | 133 | 0 | 0 | 509 | 0 | 0 | 27 |
| Lolo Creek | 0 | 0 | 27 | 0 | 0 | 54 | 0 | 0 | 0 |
| Newsome Creek | 50 | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 0 |
| **NPT Hatchery Total** | | 210 | | | 590 | | | 27 | |
| **Clearwater River Total**** | **5,267** | | **651** | **8,159** | | **1,826** | **867** | | **268** |
| Rapid River/Hells Canyon | 5,674 | 0 | 53 | 10,423 | 0 | 87 | 878 | 0 | 27 |
| **Rapid River Hatchery Total** | | 5,727 | | | 10,510 | | | 905 | |
| Sawtooth (Segregated)*** | 1,394 | 0 | 106 | 1,199 | 3 | 105 | 50 | 0 | 80 |
| Sawtooth (Integrated) | 0 | 0 | 390 | N/A | N/A | N/A | N/A | N/A | N/A |
| **Sawtooth Hatchery Total** | | 1,890 | | | 1,307 | | | 130 | |
| Pahsimeroi (Segregated) | 267 | 57 | 26 | 296 | 3 | 39 | 50 | 0 | 0 |
| Pahsimeroi (Integrated) | 0 | 0 | 176 | N/A | N/A | N/A | N/A | N/A | N/A |
| **Pahsimeroi Hatchery Total** | | 526 | | | 338 | | | 50 | |
| McCall (Segregated) | 977 | 187 | 0 | 3,171 | 98 | 55 | 273 | 47 | 27 |
| McCall (Integrated) | 0 | 0 | 1,149 | N/A | N/A | N/A | N/A | N/A | N/A |
| Johnson Creek | 0 | 0 | 288 | 0 | 9 | 196 | 0 | 3 | 38 |
| **McCall Hatchery Total** | | 2,601 | | | 3,529 | | | 388 | |
| **Salmon River Total**** | **8,556** | | **2,188** | **15,202** | | **482** | **1,301** | | **172** |
| Imnaha River | 1,110 | 59 | 39 | 1,046 | 55 | 27 | 45 | 25 | 0 |
| Lostine River | 720 | 0 | 0 | 48 | 7 | 68 | 0 | 3 | 0 |
| Catherine Creek | 244 | 0 | 0 | 100 | 21 | 0 | 0 | 0 | 0 |
| Grande Ronde R. | 74 | 0 | 213 | 36 | 0 | 166 | 0 | 0 | 0 |
| Lookingglass Creek | 1,302 | 0 | 0 | 382 | 0 | 0 | 140 | 0 | 0 |
| **Oregon Total**** | **3,509** | | **252** | **1,695** | | **261** | **213** | | **0** |
| **Total by Age**** | **17,332** | | **3,091** | **25,056** | | **2,569** | **2,381** | | **440** |
| **Grand Total** | | | | | **50,869** | | | | |

* These estimates were combined for BY2008 and BY2009 because Powell stock was used for all three releases

** Totals for the ad-clipped groups include the PIT estimates

*** Unclipped returns may include fish from the Yankee Fork smolt release

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

Since return year 2008, IDFG has been using PIT tagged hatchery Chinook Salmon expansions as both an in- and post-season tool to generate adult return estimates to LGD. In season, these estimates help to manage fisheries and brood stock acquisitions while post season, they provide estimates of smolt-to-adult survival and return rates. While valuable, this methodology has limitations (as described in Accountability of the Run at LGD using PIT Tag Expansions section above). Underrepresentation of stock- and age-specific untagged returns by PIT tagged fish has been an ongoing issue, but the levels at which it occurs, by stock and age, have been unknown for many release groups. Starting in return year 2013, with the implementation of PBT, we now have an alternative method to estimate stock- and age-specific returns at LGD.

For 2013 returns, in-season PIT tag estimates accounted for 65.8% of the PBT-based stock/age-specific estimates at LGD (Table 10). However, we were able to correct PIT tag expansion rates for three (McCall, Sawtooth, SF Clearwater) of the five return groups using in-trap PIT tag arrays. Corrected post-season PIT tag estimates accounted for 78.8% of the PBT-based estimates. The ability to correct PIT tags post season for all 5 return groups (especially at Rapid River) would likely allow us to generate post-season PIT tag estimates similar to the PBT estimates. These results also further validate PBT as a valuable tool for generating stock- and age-specific returns to LGD. Continued use of PBT will likely eliminate the need for corrected post season PIT tag estimates and place the emphasis of PIT tag use on in season return estimates to aid in the management of fisheries and brood stock acquisition.

Table 10. Comparison of stock-specific brood year 2008, 2009, and 2010 returns to LGD in 2013 based on in-season PIT tag estimates, adjusted post-season PIT tag estimates, and PBT.

| Stock/Release Group | In-Season PIT Estimate | | | Post-Season PIT Estimate | | | PBT Estimate | | |
|---|---|---|---|---|---|---|---|---|---|
| | BY 2010 (Jacks) | BY 2009 (Age 4) | BY 2008 (Age 5) | BY 2010 (Jacks) | BY 2009 (Age 4) | BY 2008 (Age 5) | BY 2010 (Jacks) | BY 2009 (Age 4) | BY 2008 (Age 5) |
| Clearwater | 2,322 | 1,803 | 228 | 2,926 | 2,097 | 228 | 3,286 | 4,931 | 241 |
| Rapid River/Hells Canyon | 4,390 | 6,433 | 791 | 4,390 | 6,433 | 791 | 5,709 | 10,537 | 899 |
| Sawtooth/Yankee Fork | 850 | 611 | 244 | 2,605 | 1,161 | 672 | 1,536 | 1,361 | 120 |
| Pahsimeroi | 516 | 70 | 0 | 516 | 70 | 0 | 331 | 313 | 50 |
| McCall SFSR | 1,843 | 1,995 | 339 | 1,681 | 2,680 | 612 | 1,164 | 3,298 | 334 |
| **Total Salmon R.** | **7,599** | **9,109** | **1,374** | **9,192** | **10,344** | **2,075** | **8,740** | **15,509** | **1,403** |
| **Total by Age** | **9,921** | **10,912** | **1,602** | **12,118** | **12,441** | **2,303** | **12,026** | **20,440** | **1,644** |
| **Grand Total** | | **22,435** | | | **26,862** | | | **34,110** | |

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

With the majority of Chinook Salmon returning to Idaho in 2013 having representative PIT tag groups, we were able to evaluate levels of fallback resulting in reascension as well as after-counting-hours passage rates by release site and age, at LGD. 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 and potentially tissue sampled for PBT multiple times at the LGD adult trap (overestimate) while fish passing after counting hours results in some fish not being counted at all (underestimate). Fallback resulting in reascension was calculated 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 fallback and reascension occurred was monitored by release site for both jacks and adults returning to LGD in 2013 (Tables 11 and 12).

Table 11. Percent 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 2013 with return year 2012 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 | 25 | 1 | 4.00% | 37 | 3 | 8.11% |
| Crooked River | 23 | 3 | 13.04% | 38 | 0 | 0.00% |
| Knox Bridge | 110 | 7 | 6.36% | 164 | 9 | 5.49% |
| Pahsimeroi Ponds | 2 | 0 | 0.00% | 16 | 2 | 12.50% |
| Powell Pond | 22 | 1 | 4.55% | 15 | 3 | 20.00% |
| Rapid River | 104 | 3 | 2.88% | 75 | 8 | 10.67% |
| Red River | 7 | 2 | 28.57% | 14 | 1 | 7.14% |
| Sawtooth Hatchery | 17 | 1 | 5.88% | 14 | 0 | 0.00% |
| Selway River | 22 | 3 | 13.64% | 28 | 4 | 14.29% |
| Yankee Fork | 2 | 0 | 0.00% | 1 | 0 | 0.00% |
| **2013 TOTAL** | **334** | **21** | **6.29%** | **402** | **30** | **7.46%** |
| **2012 Total** | **423** | **37** | **8.75%** | **52** | **3** | **5.77%** |

Table 12. Percent of after counting hour's passage, by release site, at Lower Granite Dam in return year 2013 for jacks and adults with return year 2012 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 | 25 | 1 | 4.00% | 37 | 0 | 0.00% |
| Crooked River | 23 | 1 | 4.35% | 38 | 1 | 2.63% |
| Knox Bridge | 110 | 2 | 1.82% | 164 | 10 | 6.10% |
| Pahsimeroi Ponds | 2 | 0 | 0.00% | 16 | 0 | 0.00% |
| Powell Pond | 22 | 1 | 4.55% | 15 | 0 | 0.00% |
| Rapid River | 104 | 2 | 1.92% | 75 | 0 | 0.00% |
| Red River | 7 | 0 | 0.00% | 14 | 1 | 7.14% |
| Sawtooth Hatchery | 17 | 1 | 5.88% | 14 | 0 | 0.00% |
| Selway River | 22 | 1 | 4.55% | 28 | 0 | 0.00% |
| Yankee Fork | 2 | 0 | 0.00% | 1 | 0 | 0.00% |
| **2013 TOTAL** | **334** | **9** | **2.69%** | **402** | **12** | **2.99%** |
| **2012 Total** | **423** | **23** | **5.44%** | **52** | **3** | **5.77%** |

Similar to recent years, in 2013 the overestimation caused by double counting due to fallback/reascension is greater than the underestimation resulting from fish passing the window outside of the counting period. Compared to return year 2012, total fallback/reascension rates for 2013 were similar for both adults and jacks (Table 12), however the adult after-hours passage rate was lower in 2013 than return year 2012. 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' fallback rates at LGD is spill because it was shown to be positively correlated with fallback rates at LGD (Boggs et al. 2004). In 2012, the average spill at LGD from April 15 through August 1 was 30.0 kcfs. In 2013, the average spill for the same interval was 19.4 kcfs which may explain the lower fallback rates observed in 2013.

The net difference between fallback/reascension rates and after-hours passage would have resulted in the overall adult count at the LGD window being 1,565 (3.6%) fish high and the jack count being 1,230 (4.4%) fish high in 2013. However, PIT tags cannot be used to directly assess the frequency of fallback that does not result in reascension, nor can they be used to assess lock passage. It is unknown what effect these two additional pieces would have on overall window counts as fallback without reascension would further bias counts high, but lock passage would bias counts low. Previous work done by Boggs et al. (2004) using radio tags and PIT tags, found that adjusting for both fallback and reascension resulted in window counts that were 1.7% high at LGD from 1996 to 2001 which is slightly lower than what we observed. Both the fallback/reascension and after-hours rates were used to adjusted the window counts for the LGD accountability in Table 8.

## Conversion Rates Between Dams

Using the returning PIT-tagged Chinook Salmon, conversion rates were calculated from Bonneville Dam upriver to McNary and Lower Granite dams. For the purposes of this report, inter-dam conversion represents all loss between dams (harvest, strays, mortality). Conversions are outlined in Table 13 and are shown as conversion percentages, by release site, for jacks and adults. In 2013, spring Chinook Salmon from Clearwater Hatchery showed similar conversions to previous years for both jacks and adults, but in the Salmon River basin, all stocks had above average conversion rates. The conversion rates were higher than normal for the Salmon River stocks. This high conversion rate is may be because the tribal fishing seasons that occurred in Zone 6 on the Columbia River during the 2013 spring Chinook Salmon management period ended prior to the time when the later-arriving stocks from the Salmon River began migrating past Bonneville Dam. Similarly, the summer Chinook Salmon seasons in Zone 6 did not begin until after most of the fish from Sawtooth, McCall, and Pahsimeroi hatcheries had already passed upstream which allowed more Chinook Salmon destined for the Salmon River to escape the Zone 6 fisheries. Chinook Salmon destined for Rapid River also had higher than normal conversion rates in 2013, but they exhibited run timing similar to the Clearwater stocks which had average conversion rates so it is unclear why the Rapid River fish converted at such high rates.

Table 13. Conversion percentages of PIT-tagged Chinook Salmon, by stock and age, from Bonneville Dam to McNary and Lower Granite dams.

| Hatchery | Release Site | Adults From Bonneville To: | | Jacks From Bonneville To: | |
|---|---|---|---|---|---|
| | | McNary | Lower Granite | McNary | Lower Granite |
| Clearwater | Red River | 63.6% | 63.6% | 82.3% | 82.3% |
| Clearwater | Crooked River* | 82.1% | 82.1% | 95.3% | 88.4% |
| Clearwater | Powell Pond | 81.8% | 66.7% | 93.8% | 93.8% |
| Clearwater | Selway River | 71.9% | 68.8% | 96.7% | 93.3% |
| Clearwater | Clear Creek | 78.8% | 75.8% | 86.4% | 84.1% |
| McCall | SFSR – Knox B. | 83.8% | 80.9% | 92.5% | 83.6% |
| Pahsimeroi | Pahsimeroi Ponds | 100.0% | 100.0% | 75.0% | 70.0% |
| Rapid River | Rapid River Ponds | 84.8% | 82.4% | 98.7% | 96.2% |
| Sawtooth | Sawtooth Weir | 95.0% | 85.0% | 84.6% | 84.6% |
| Sawtooth | Yankee Fork | 100.0% | 100.0% | 100.0% | 100.0% |

* First release year was 2011, only 2-ocean adults retuned for this group in 2013.

## Run Timing

Adult run timing curves were generated for 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 Chinook Salmon. Run timing at Bonneville Dam was distinctly separated for spring run stocks from the Clearwater River and Rapid River and summer run stocks from Clearwater, McCall, and Pahsimeroi fish hatcheries. Sawtooth Fish Hatchery returns fell in between the spring and summer stocks (Figure 2). This run timing pattern is typical of stocks returning to Idaho and comparable to past years with the exception of Chinook Salmon destined for Pahsimeroi Hatchery. There was only 1 adult PIT tag detected in 2013 for Pahsimeroi Chinook Salmon, so the run timing curve for that group is based almost entirely on jack PIT tag detections which have later run timing than adults. The pattern remained similar as fish crossed LGD for all stocks (Figure 3).

Clearwater Hatchery began releasing summer Chinook Salmon at Crooked River in 2011 and 2013 was the first year of adult returns from those releases. Previously only spring Chinook Salmon were reared at Clearwater Hatchery. The run timing of the spring and summer stocks from Clearwater Hatchery were nearly a month apart at LGD (Figure 3), so the summer Chinook Salmon program at Clearwater Hatchery has the potential to increase angling opportunity in the future by extending the harvest season to target the later-arriving fish.

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). Hatchery- and natural-origin Chinook Salmon at Rapid River and the South Fork Salmon River had similar run timing in 2013, but at Sawtooth and Pahsimeroi hatcheries the natural Chinook Salmon arrived later than the hatchery-origin fish.

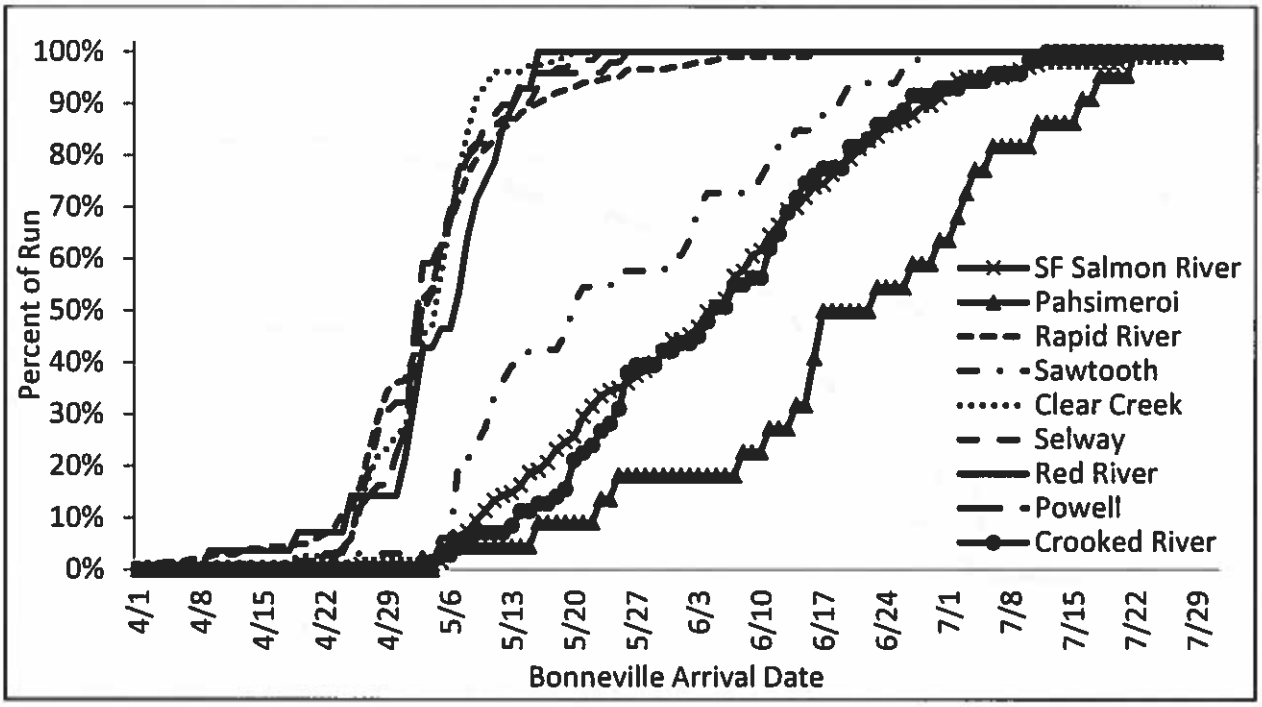


Figure 2. Cumulative run timing (all age classes) of hatchery origin Chinook Salmon, by stock, to Bonneville Dam in return year 2013.

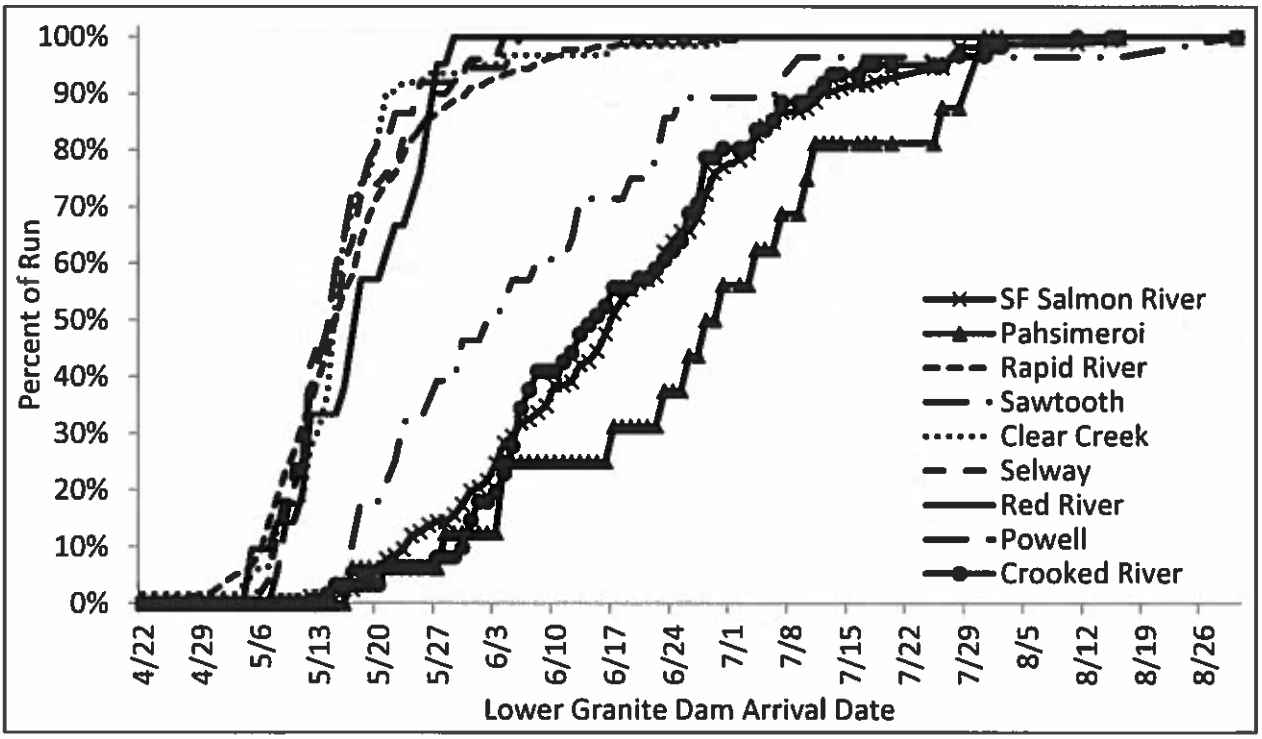


Figure 3. Cumulative run timing (all age classes) of hatchery origin Chinook Salmon, by stock, to Lower Granite Dam in return year 2013.

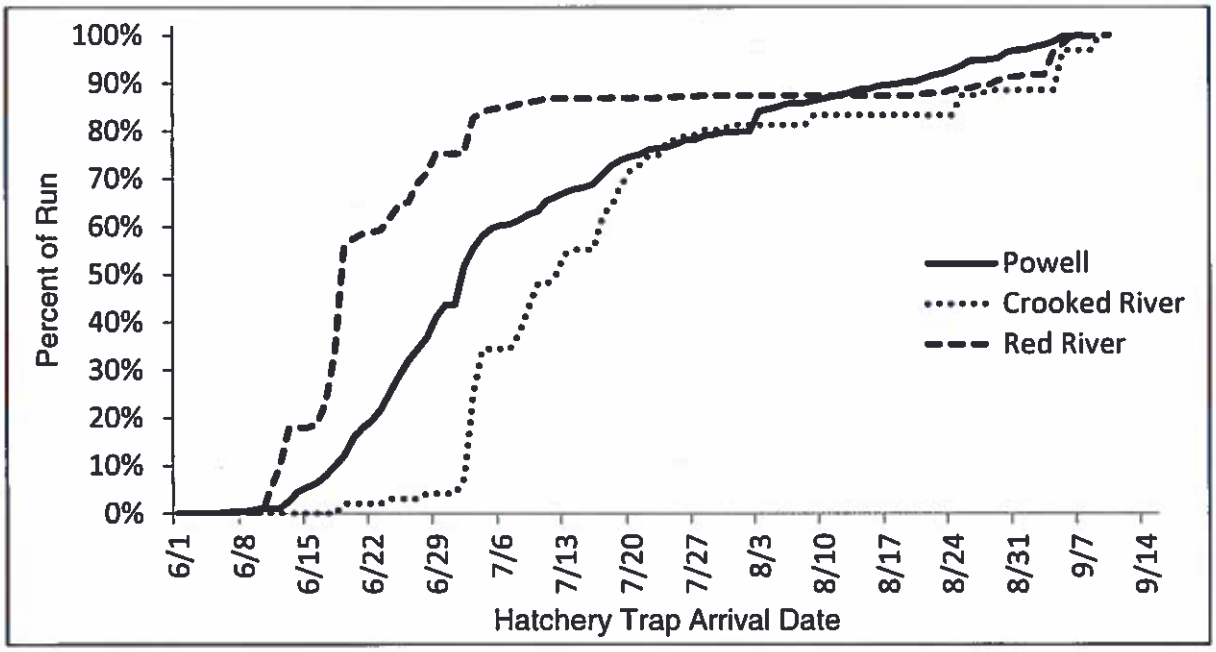


Figure 4. Cumulative run timing (all age classes), by stock, of hatchery origin Chinook Salmon to hatchery traps in the Clearwater Basin in return year 2013.

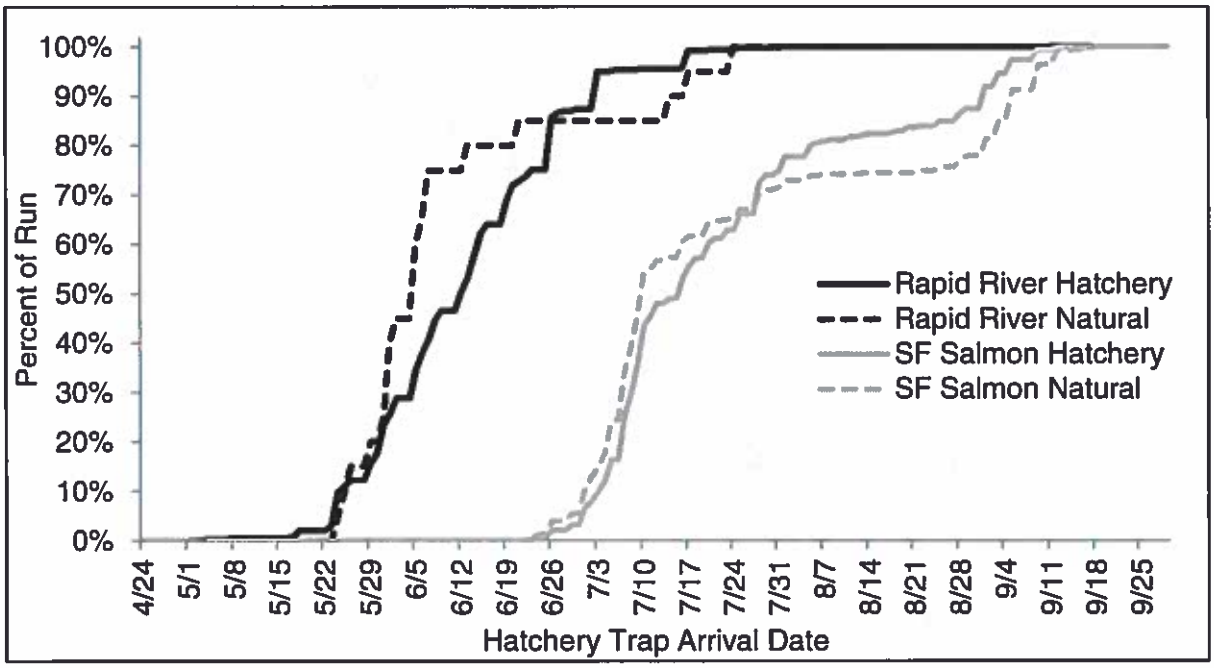


Figure 5. Cumulative run timing (all age classes), by stock, of hatchery and natural origin Chinook Salmon to Rapid River and SF Salmon River traps in return year 2012.

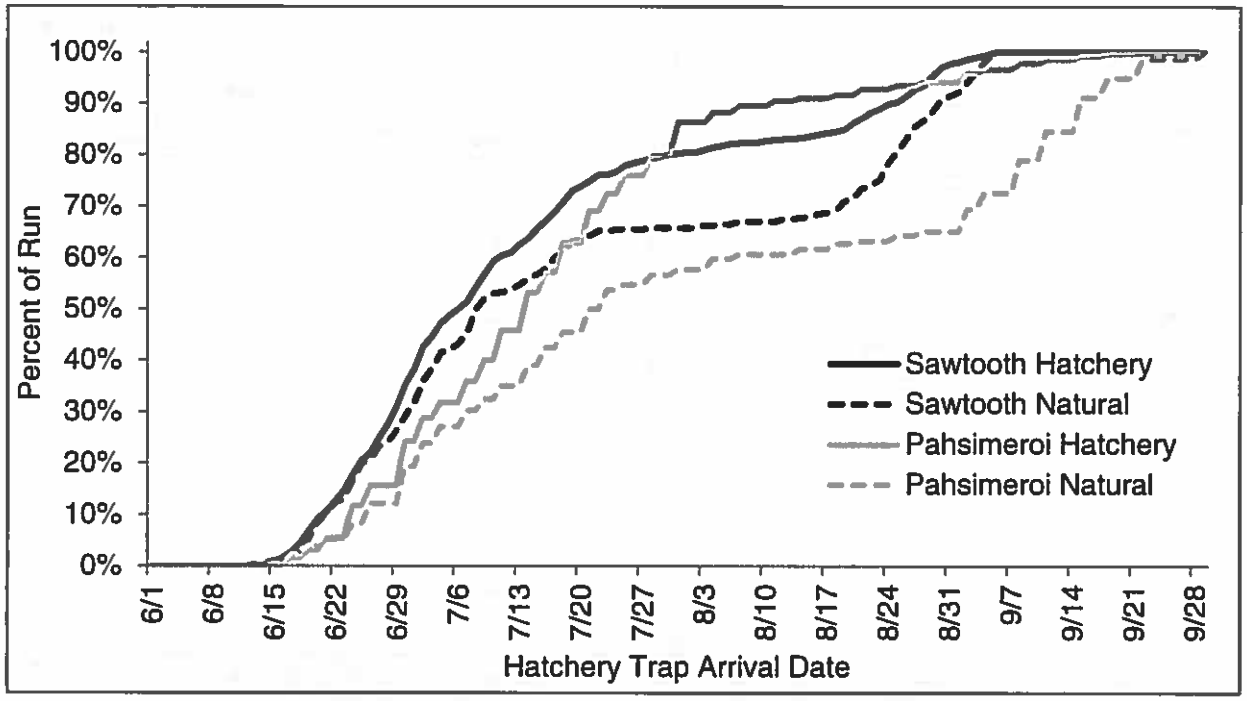


Figure 6. Cumulative run timing (all age classes), by stock, of hatchery and natural origin Chinook Salmon to Pahsimeroi and Sawtooth traps in return year 2013.

## Hatchery Trap Returns

Chinook Salmon 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 using known age information obtained from CWT's and PIT tags in returning adults, and PBT samples collected from broodstock. The inclusion of known information from PBT dramatically increased the amount of known-age information for return year 2013 and will be very useful in the future. After compiling the known age information, 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. The results from this analysis are presented in Table 14. Average lengths at age were similar to past years.

Table 14. Summary of adult spring/summer Chinook Salmon returns to IDFG hatchery racks, by trap, sex, age, and origin for return year 2013.

| Trap | Origin | Males | | | | | | Females | | | | Total Return |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age-3 | Ave. Len. | Age-4 | Ave. Len. | Age-5 | Ave. Len. | Age-4 | Ave. Len. | Age-5 | Ave. Len. | |
| SF Salmon R. | H-seg | 1,097 | 58.8 | 882 | 77.9 | 86 | 90.2 | 950 | 75.1 | 168 | 87.8 | 3,183 |
| SF Salmon R. | H-int | 830 | 55.6 | - | - | - | - | - | - | - | - | 830 |
| SF Salmon R. | N | 141 | 55.5 | 117 | 73.3 | 36 | 89.3 | 30 | 74.4 | 82 | 86.5 | 406 |
| Sawtooth | H-seg | 1,444 | 50.6 | 801 | 70.3 | 26 | 89.3 | 398 | 73.3 | 274 | 87.1 | 2,943 |
| Sawtooth | H-int | 345 | 51.9 | - | - | - | - | - | - | - | - | 345 |
| Sawtooth | N | 90 | 51.7 | 198 | 72.4 | 22 | 94.0 | 28 | 77.5 | 62 | 89.3 | 400 |
| Pahsimeroi | H-seg | 673 | 51.7 | 306 | 69.3 | 8 | 78.3 | 193 | 72.1 | 7 | 88.0 | 1,187 |
| Pahsimeroi | H-int | 260 | 50.7 | - | - | - | - | - | - | - | - | 260 |
| Pahsimeroi | N | 109 | 51.4 | 140 | 72.3 | 42 | 85.3 | 62 | 75.7 | 23 | 88.2 | 376 |
| | | Males / Females | | | | | | | | | | |
| Crooked R.* | H | 64 | 56.3 | 32 | 70.2 | 0 | n/a | | | | | 96 |
| Crooked R.* | N | 8 | 56.8 | 22 | 72.0 | 7 | 86.1 | | | | | 37 |
| Red River* | H | 529 | 50.5 | 258 | 71.2 | 42 | 87.3 | | | | | 829 |
| Red River* | N | 8 | 55.0 | 39 | 69.9 | 7 | 94.7 | | | | | 54 |
| Powell* | H | 219 | 52.0 | 206 | 71.4 | 28 | 82.9 | | | | | 453 |
| Powell* | N | 3 | 53.2 | 1 | 75.0 | 2 | 84.6 | | | | | 6 |
| Rapid River** | H | 1,396 | 46.8 | 1,741 | 68.1 | 149 | 80.9 | | | | | 3,286 |
| Rapid River** | N | 68 | 48.8 | 11 | 68.4 | 4 | 84.8 | | | | | 83 |
| Oxbow*** | H | 260 | 49.9 | 498 | 69.9 | 52 | 84.6 | | | | | 810 |
| Oxbow*** | N | 18 | 53.5 | 22 | 68.1 | 2 | 83.5 | | | | | 42 |
| | | | | | *Grand Total* | | | | | | | 15,626 |

* Red River, Crooked River, and Powell satellite facilities do not make a sex determination at trapping.
** Rapid River Hatchery does not make a sex determination at trapping for hatchery origin returns. This total excludes hatchery spring Chinook Salmon transferred to Rapid River Hatchery from Oxbow Hatchery.
*** Oxbow Hatchery does not make a sex determination at trapping for hatchery origin returns and trapping there is done as needed, to provide fish for Rapid River broodstock, C & S distribution, and transfers to OR and ID fisheries.

## Idaho Sport Harvest

In 2013, Chinook Salmon fisheries occurred on sections of the Clearwater, Snake, and Salmon rivers. In the Clearwater River basin, spring Chinook Salmon fisheries were held on 160 miles of river including the North Fork, South Fork, Middle Fork, and main-stem Clearwater rivers. 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 106 miles of river, including sections of the lower Salmon, Little Salmon, and South Fork Salmon rivers. There was also a fall Chinook Salmon fishery on the lower Salmon River from the mouth upstream to eye-of-the-needle rapids. Due to a low adult return to the upper Salmon River, no fisheries were conducted to target returning adults from Pahsimeroi and Sawtooth hatcheries. Tables 15 and 16 list the location, duration, and extent of Chinook Salmon fisheries in 2013.

Table 15. Dates and locations of spring/summer Chinook Salmon recreational fisheries conducted in Idaho in 2013.

| River | Date Open | Date Closed | Days Open | Downstream Boundary | Upstream Boundary | Miles Open |
|---|---|---|---|---|---|---|
| | 5/4 | 6/3 | 31* | Railroad Bridge in Lewiston | SF Clearwater River | 73 |
| NF Clearwater R. | 5/4 | 6/3 | 31* | Mouth | Dworshak Dam | 2 |
| SF Clearwater R. | 5/4 | 6/3 | 31* | Mouth | Confluence American and Red rivers | 62 |
| MF Clearwater R. | 5/4 | 6/3 | 31* | SF Clearwater River | Confluence Lochsa and Selway rivers | 23 |
| Lochsa R. | No Fishery in 2013 | | | Mouth | Confluence Colt Killed and Crooked Fork | 0 |
| Snake R. | 5/4 | 7/19 | 77 | Dug Bar | Hells Canyon Dam | 51 |
| Lower Salmon R. | 5/4 | 6/2 | 30 | Rice Creek Bridge | Time Zone Bridge | 46 |
| | 5/4 | 6/2 | 30 | Time Zone Bridge | Short's Creek | 3 |
| | No Fishery in 2013 | | | Short's Creek | Vinegar Creek | 0 |
| Little Salmon R. | 5/4 | 6/23 | 42** | Mouth | U.S. 95 Bridge by Smokey Boulder Rd. | 25 |
| SF Salmon R. | 7/5 | 7/19 | 15 | Forest Service Road 48 bridge | 100 yds downstream of hatchery weir | 32 |
| Upper Salmon R. | No Fishery in 2013 | | | North Fork Salmon River | 100 yards upstream of Pahsim. R. | 0 |
| Upper Salmon R. | No Fishery in 2013 | | | 100 yards above Pahsim. R. | Highway 75 Bridge above EFSR | 0 |
| | No Fishery in 2013 | | | US 75 Bridge above EFSR | Just downstream of Sawtooth Hat. weir | 0 |

* The final 14 days of these fisheries were only open to the harvest of adipose-clipped jack Salmon

** The fishery closed temporarily from 6/2 through 6/7 at which point the season was re-opened for 4 days per week (Friday-Monday) through the end of the season on 6/23.

Table 16. Dates and locations of fall Chinook Salmon recreational fisheries conducted in Idaho in 2013.

| 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 |
| Salmon R. | 9/1 | 10/31 | 61 | River Mouth | Eye-of-the-Needle Rapids | 0.5 |

Managers rely on abundance estimates in excess of brood needs to set harvest levels for Idaho's sport fisheries. Abundance estimates are generated in real-time throughout the season as PIT tagged Chinook Salmon pass detectors during their migration through the fish ladders in the Columbia and Snake river dams, and the PIT detections are expanded by the stock-specific juvenile tag rate to estimate the number of adults returning to individual release sites. To calculate harvest shares, the brood need for a stock is subtracted from the stock-specific abundance estimate and the remaining fish are split evenly among the tribal and non-tribal anglers. At the end of the season we used data from PBT analysis to generate stock-specific post-season estimates at LGD and calculated harvest rates based on the post-season estimates.

Stock-specific sport harvest rates for jack and adult spring/summer Chinook Salmon were variable in 2013. Jacks were harvested at a higher rate than adults, which would be expected considering there were more liberal limits for jack harvest in the sport fisheries. The overall harvest rate on jacks was 20.9% while the overall harvest rate on adults was 12.1% (Table 17).

The variable harvest rates observed in 2013 for different release groups were driven by the availability of fish in excess of broodstock needs. In the Clearwater drainage, low adult returns resulted in a non-tribal harvest share of 645 adult Chinook Salmon which were harvested in a short, 31-day season. For Rapid River and McCall, there were larger numbers of adult Chinook Salmon that were in excess of brood needs which resulted in a combined non-tribal harvest share in the Salmon River of 2,636 adults, therefore larger harvest occurred and resulted in a higher sport harvest rate for those release groups. Fisheries were not initiated in the upper Salmon River due to low numbers of adults returning to Sawtooth and Pahsimeroi

hatcheries, but a low level of harvest did occur on these two stocks as they passed through the lower Salmon River fishery. The non-tribal sport fisheries were successfully managed, resulting in the harvest of a high percentage of the available adult harvest shares in the Clearwater River (86.3%) and Salmon River (98.3%) fisheries (Table 17).

Table 17. Summary of 2013 spring/summer Chinook Salmon sport harvest management metrics and harvest rates for adults and jacks, by stock.

**Adults**

| Release Hatchery | Release Site | In-Season LGD Estimate | Brood Need | Non-Tribal Harvest Share | ID Sport Harvest | Post-Season LGD Estimate | Sport Harvest Rate |
|---|---|---|---|---|---|---|---|
| Dworshak | N.F. Clearwater R. | 1,483 | 1,000 | | 142 | 2,702 | 9.6% |
| Kooskia | Clear Creek | 1,505 | 600 | | 140 | 1,868 | 9.3% |
| Clearwater | Selway River | | | | | | |
| Clearwater | Powell Pond | 1,371 | 996 | | 214* | 3,682* | 5.8% |
| Clearwater | Clear Creek | | | | | | |
| Clearwater | Red River | 468 | 940 | | 61 | 761 | 13.0% |
| **Total Clearwater R. Adults** | | **4,827** | **3,536** | **645** | **557** | **9,013** | **6.2%** |
| Rapid River | Rapid River Ponds | 6,267 | 2,000 | | 1,936 | 11,301 | 30.9% |
| Sawtooth | Sawtooth Weir | 855 | 950 | | 56 | 1,252 | 6.5% |
| Pahsimeroi | Pahsimeroi Ponds | 70 | 700 | | 5 | 349 | 7.1% |
| McCall | SF Salmon R. | 2,335 | 1,300 | | 596 | 3,589 | 25.5% |
| **Total Salmon R. Adults** | | **9,527** | **4,950** | **2,636** | **2,593** | **16,491** | **15.7%** |
| **GRAND TOTAL ADULTS** | | **14,354** | **8,486** | **3,281** | **3,150** | **25,504** | **12.4%** |

**Jacks**

| Release Hatchery | Release Site | In-Season LGD Estimate | Brood Need** | Non-Tribal Harvest Share** | ID Sport Harvest | Post-Season LGD Estimate | Sport Harvest Rate |
|---|---|---|---|---|---|---|---|
| Dworshak | N.F. Clearwater R. | 1,507 | 0 | | 402 | 1,384 | 29.0% |
| Kooskia | Clear Creek | 533 | 0 | | 202 | 828 | 24.4% |
| Clearwater | Selway River | 698 | 0 | | 45 | 518 | 8.7% |
| Clearwater | Powell Pond | 340 | 0 | | 77 | 403 | 19.1% |
| Clearwater | Clear Creek | 528 | 0 | | 117 | 488 | 24.0% |
| Clearwater | Red River | 477 | 0 | | 239 | 1,596 | 15.0% |
| NPTH | Clearwater R. | 95 | 0 | | 12 | 50 | 24.0% |
| **Total Clearwater R. Jacks** | | **4,178** | **0** | **N/A** | **1,094** | **5,267** | **20.8%** |
| Rapid River | Rapid River Ponds | 3,780 | 0 | | 1,828 | 5,674 | 32.2% |
| Sawtooth | Sawtooth Weir | 768 | 0 | | 47 | 1,394 | 3.4% |
| Pahsimeroi | Pahsimeroi Ponds | 511 | 0 | | 0 | 324 | 0.0% |
| McCall | SF Salmon R. | 1,843 | 0 | | 184 | 1,164 | 15.8% |
| Lookingglass | Lookingglass Cr. | 880 | 0 | | 12 | 1,302 | 0.9% |
| **Total Salmon R. Jacks** | | **7,782** | **0** | **N/A** | **2,071** | **9,858** | **21.0%** |
| **GRAND TOTAL JACKS** | | **11,960** | **0** | **N/A** | **3,165** | **15,125** | **20.9%** |

* The adult estimate cannot be separated by release site because powell stock was used for all three releases (Selway, Powell, Clear Cr.).

** Brood needs and non-tribal harvest shares are not identified for Chinook Salmon jacks.

For terminal area fisheries (e.g., SF Salmon, Little Salmon, and SF Clearwater rivers), all harvest was assumed to be the stock released in that terminal area. For mainstem and lower river fisheries (e.g., main-stem Clearwater and Salmon rivers), stock and age composition from mixed stock fisheries was determined using creel and PBT data obtained from DNA samples. There were 452 DNA samples analyzed from the lower Salmon River fishery and 250 samples analyzed from the Clearwater River fishery. The PBT data from each river section were expanded by stock-specific tagging rates. There were 13 samples from the Clearwater River fisheries and 17 from the Salmon River fisheries that did not assign to the PBT baseline, but after expanding samples by their tagging rates we were able to assign 100% of the PBT samples collected from the 2013 sport fisheries. The proportion of each stock and age in the expanded PBT-based stock composition was applied to the total harvest for each fishery to generate a final stock and age composition. We estimated the variance for stock composition using the script *resampit.r* which is a bootstrapping routine performed in RStudio (R Development Core Team 2010). For complete methods for this analysis, see the Parental Based Tagging Analysis of Adult Returns to Lower Granite Dam section in Cassinelli et al. (2013). Variance around the harvest estimates was calculated using the Creel Application Software V1.0 developed by Soupir and Brown (2002). Variance from the harvest and stock composition estimates were combined to generate 95% confidence intervals using methods described in Goodman (1960) for the variance of products. Table 18 summarizes the estimated age and stock composition of the 2013 Chinook Salmon harvest.

Table 18. Summary of 2013 spring/summer Chinook Salmon sport harvest (95% confidence interval) in Idaho by fishery, stock, and age.

| Fishery and Stock | Age-3 | Age-4 | Age-5 | Total |
|---|---|---|---|---|
| **Clearwater River Fishery** | | | | |
| Dworshak | 402 (270-533) | 121 (54-187) | 21 (1-48) | **544** |
| Kooskia | 202 (119-285) | 133 (62-205) | 7 (1-20) | **342** |
| Clearwater (Powell) | 77 (30-125) | | | |
| Clearwater (Selway) | 45 (10-79) | 214 (87-344)* | 0 | **453** |
| Clearwater (Clear Creek) | 117 (59-176) | | | |
| Clearwater (South Fork) | 239 (160-320) | 54 (10-99) | 7 (1-20) | **300** |
| Nez Perce Tribal Hatchery | 12 (1-31) | 0 | 0 | **12** |
| **Total** | **1,094** | **522** | **35** | **1,651** |
| **Snake River Fishery*** | | | | |
| Rapid River (Hells Canyon Dam) | 256 (168-344) | 248 (163-333) | 28 (18-38) | **532** |
| **Total** | **256** | **248** | **28** | **532** |
| **Lower Salmon River Fishery** | | | | |
| Rapid River Hatchery | 917 (718-1,116) | 996 (784-1,207) | 66 (32-99) | **1,979** |
| McCall (SFSR) | 6 (1-18) | 45 (16-73) | 10 (1-22) | **61** |
| Pahsimeroi Hatchery | 0 | 5 (0-14) | 0 | **5** |
| Sawtooth Hatchery | 47 (13-80) | 51 (22-80) | 5 (0-14) | **103** |
| Lookingglass Hatchery | 12 (1-29) | 0 | 0 | **12** |
| **Total** | **982** | **1,097** | **81** | **2,160** |
| **Little Salmon River Fishery*** | | | | |
| Rapid River Hatchery | 655 (269-1,041) | 541 (289-793) | 57 (30-84) | **1,253** |
| **Total** | **655** | **541** | **57** | **1,253** |
| **SF Salmon River Fishery*** | | | | |
| McCall (SFSR) | 178 (99-257) | 480 (306-654) | 61 (39-83) | **719** |
| **Total** | **178** | **480** | **61** | **719** |
| ***Grand Total*** | ***3,165*** | ***2,888*** | ***262*** | ***6,315*** |

* These are terminal fisheries so all harvest was assumed to be from the local stock.

We compared harvest estimates in the mixed stock fisheries in the Clearwater and Lower Salmon rivers using both PBT and CWT's (Table 19). The most notable advantage of the PBT analysis was the increase in samples used to make the harvest estimates that resulted in the ability to detect groups that were harvested in low numbers that were not detected with CWT. The number of CWT samples collected in the Salmon and Clearwater rivers were 18 and 79, respectively, while the number of PBT samples collected in the same fisheries were 452 and 250 respectively. The larger number of samples collected from the PBT analysis allows more precise harvest estimates to be made, and allows for easier detection of less abundant groups such as the age-5 Chinook harvested in 2013.

Table 19. Comparison of PBT and CWT stock- and age-specific harvest estimates from Chinook Salmon harvested in mixed-stock fisheries.

| | PBT Analysis | | | | CWT Analysis | | | |
|---|---|---|---|---|---|---|---|---|
| **Fishery and Stock** | **Age-3** | **Age-4** | **Age-5** | **Total** | **Age-3** | **Age-4** | **Age-5** | **Total** |
| **Clearwater River Fishery** | | | | | | | | |
| Dworshak | 402 | 121 | 21 | **544** | 229 | 103 | 0 | **332** |
| Kooskia | 202 | 133 | 7 | **342** | 368 | 142 | 0 | **510** |
| Clearwater (Powell)* | 77 | | | | 94 | 115 | 0 | |
| Clearwater (Selway)* | 45 | 214* | 0 | **453*** | 41 | 23 | 0 | **349** |
| Clearwater (Clear Creek)* | 117 | | | | 40 | 36 | 0 | |
| Clearwater (South Fork) | 239 | 54 | 7 | **300** | 322 | 94 | 0 | **416** |
| Nez Perce Tribal Hatchery | 12 | 0 | 0 | **12** | 0 | 44 | 0 | **44** |
| **Total** | **1,094** | **522** | **35** | **1,651** | **1,094** | **557** | **0** | **1,651** |
| **Lower Salmon River Fishery** | | | | | | | | |
| Rapid River Hatchery | 917 | 996 | 66 | **1,979** | 762 | 861 | 0 | **1,623** |
| McCall (SFSR) | 6 | 45 | 10 | **61** | 0 | 250 | 0 | **250** |
| Pahsimeroi Hatchery | 0 | 5 | 0 | **5** | 0 | 0 | 0 | **0** |
| Sawtooth Hatchery | 47 | 51 | 5 | **103** | 203 | 67 | 0 | **270** |
| Lookingglass Hatchery | 12 | 0 | 0 | **12** | 17 | 0 | 0 | **17** |
| **Total** | **982** | **1,097** | **81** | **2,160** | **982** | **1,178** | **0** | **2,160** |
| ***Grand Total*** | ***2,076*** | ***1,619*** | ***116*** | ***3,811*** | ***2,076*** | ***1,735*** | ***0*** | ***3,811*** |

*For Age-4 and Age 5 returns from these Clearwater Hatchery releases, no stock separation can be achieved via PBT analysis

Fall Chinook Salmon harvest in 2013 was the highest observed in Idaho's sport fisheries in recent history. The record return enabled a long season which resulted in the harvest of 2,667 fall Chinook Salmon in the Clearwater and Snake rivers (Table 20).

Table 20. Summary of 2013 fall Chinook Salmon sport harvest (95% confidence interval) in Idaho by fishery, stock, and age.

| **Fishery and Stock** | **Age-3** | **Age-4** | **Age-5** | **Total** |
|---|---|---|---|---|
| **Clearwater River Fishery** | | | | |
| Multiple* | 180 (115-245) | 242 (144-340) | 27 (16-38) | **449** |
| **Snake River Fishery** | | | | |
| Multiple* | 898 (744-1,052) | 1,194 (993-1,396) | 126 (105-147) | **2,218** |
| **Total** | **1,078** | **1,436** | **153** | **2,667** |

## CWT Processing and Data Submission

The CWT laboratory processed 1,102 spring/summer Chinook Salmon snouts collected in 2013. Pursuant to RMIS guidelines, Chinook Salmon recovery information from the 2013 run was submitted to RMIS in January 2014. Table 21 shows the number and type of Chinook Salmon CWT recoveries that were processed in the CWT lab in 2013.

Table 21. Chinook Salmon CWT recoveries by recovery type that were processed in the Idaho Department of Fish and Game Nampa CWT Laboratory in 2013.

| Recovery Type | Snouts Collected |
|---|---|
| Hatchery Spawning Rack/Trap | 551 |
| Spawning Ground | 82 |
| Sport Fishery (Creel Census) | 469 |
| **Total** | **1,102** |

## 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 Salmon CWT was considered a stray if the fish was found at a location outside of the direct migratory path to the fish's release location. Table 22 outlines these recoveries, expanded by their tagging rates, for the 2013 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 may have recovered strays as well. CWT recoveries from those other agencies were not available at the time of this report but are included in IDFG's Chinook Salmon brood year reports. In addition to the CWT stray recoveries, we were able to examine PBT data obtained from fish used for broodstock at all facilities. Through this analysis, we detected additional strays at Rapid River Hatchery. The ability to use PBT as an additional tool to detect strays will be useful in the future because the tagging rate for PBT is usually much higher than the CWT tagging rates, thus allowing for increased "recoveries" and a higher probability of stray detection.

In general, stray recoveries were low to moderate for returning 2013 spring/summer Chinook Salmon. The highest level of straying observed was at the Sawtooth Fish Hatchery trap from fish released in the Yankee Fork. The Yankee Fork four year olds that were returning in 2013 were reared at Sawtooth Fish Hatchery and released in the Yankee Fork in mid to late April of 2011. The high number of these adults that returned to the Sawtooth trap are likely due to the late release time of these smolts resulting in many of these fish imprinting on the water at Sawtooth Fish Hatchery. Numerous jacks from this release group also strayed to SFH in 2012.

If a fishery, trap, or spawning ground does not appear in Table 22, then there were no stray CWTs recovered from that location in 2013. 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 22. Chinook Salmon stray CWT recovered by Idaho Department of Fish and Game in sport fisheries, on spawning grounds, and at hatchery traps in 2013.

| Basin | Recovery Type | Recovery Location | Release Location | Number of CWT Recovered | Expanded for Tagging Rate |
|---|---|---|---|---|---|
| Clearwater River | Fishery | NF Clearwater R. | Clear Creek | 2 | 4 |
| | | | Kooskia | 3 | 19 |
| | | | Selway R. | 2 | 3 |
| | | | Powell | 2 | 7 |
| | | | NPTH | 1 | 1 |
| | Hatchery | Powell Trap | Selway R. | 1 | 1 |
| | | SF Clearwater R. | Clear Creek | 2 | 5 |
| | | | Kooskia | 2 | 11 |
| | | | Dworshak | 6 | 50 |
| | | | NPTH | 9 | 10 |
| | Spawning Ground | American R. | Clear Creek | 1 | 2 |
| | | | Crooked R. | 9 | 9 |
| | | | Newsome Cr. | 1 | 1 |
| | | | NPTH | 1 | 1 |
| | | | Yoosa Cr. | 1 | 1 |
| | | | Umatilla R. | 1 | 1 |
| | | Red River | Clear Creek | 1 | 2 |
| Salmon River | Hatchery | Sawtooth Trap | Yankee Fork | 45 | 45 |
| | | Rapid R. Trap | Imnaha R. | 4 | 8 |
| | | | Knox Bridge | 13* | 13 |
| | Spawning Ground | Upper Salmon R. | Yankee Fork | 16 | 17 |
| | | | **Total Stray Recoveries** | **123** | **211** |

*These strays were detected using PBT analysis of the broodstock at Rapid River Hatchery

## RESEARCH

### Estimating a Correction Factor for PIT Tag Expansions in Returning Chinook Salmon (Sawtooth Hatchery, SF Salmon, and SF Clearwater Satellite Facilities)

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

The data from 2013 suggest that PIT tag loss, malfunction, or differential survival of tagged fish occurred in Chinook Salmon released at Sawtooth Hatchery, the South Fork Salmon River, and Red River (Table 23). This resulted in corrected PIT tag expansion rates for

returning adults that were 100-300% higher than the juvenile expansion rate at some facilities. It is important to note that at Sawtooth Hatchery and Red River and Crooked River satellite facilities, the sample sizes were small, and the detection of a few more tags at any of those facilities would have made a large difference in the corrected expansion rates. This does not suggest that tag loss and/or differential survival of tagged fish is not occurring, but rather the differences between the corrected expansion rates and juvenile expansion rates may not have been as extreme as they appear.

Table 23. Corrected expansion rates derived from in-ladder PIT tag arrays at Sawtooth, SF Salmon River, and SF Clearwater River traps for return year 2013.

| 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** | | | |
| 2008 | 122.1 | 1 | 0 | 122 | 336 | **336.0** |
| 2009 | 100.3 | 6 | 8 | 610 | 1,160 | **192.0** |
| 2010 | 85.1 | 5 | 1 | 427 | 1,447 | **289.2** |
| | | | **South Fork Salmon River Satellite** | | | |
| 2008 | 28.1 | 7 | 1 | 198 | 357 | **50.9** |
| 2009 | 28.9 | 43 | 17 | 1,260 | 1,694 | **39.0** |
| 2010 | 42.7 | 29 | 7 | 1,245 | 1,133 | **38.8** |
| | | | **Red River Satellite** | | | |
| 2008 | 94.4 | 0 | 0 | 0 | 82 | **N/A** |
| 2009 | 92.9 | 1 | 1 | 94 | 215 | **214.0** |
| 2010 | 93.5 | 2 | 1 | 188 | 532 | **265.5** |
| | | | **Crooked River Satellite** | | | |
| 2008* | N/A | N/A | N/A | N/A | N/A | N/A |
| 2009 | 11.0 | 3 | 0 | 33 | 27 | **9.0** |
| 2010 | 11.1 | 6 | 2 | 68 | 69 | **11.2** |

*The Crooked River summer Chinook Salmon program was not initiated until brood year 2009.

If we assume that tag loss does not occur after fish pass upstream of LGD as adults, then the estimates that we are able to generate from these corrected expansion rates give us our best PIT tag-generated estimate of age-specific returns to LGD. However, if adults continue to lose tags after they pass upstream of LGD, then using these corrected expansions from trap tag ratios would result in an overestimation of returns to LGD. We have seen some evidence of possible tag loss related to total age of fish with higher tag loss/malfunction increasing with fish age. In a preliminary effort to understand when tag loss is occurring, all PIT-tagged Chinook Salmon detected at time of trapping at the SFSR trap in 2011 were caudal marked with zip ties and examined again for PIT tags at time of spawning. Out of 47 fish that had PIT tag detections at trapping and were later scanned at spawning, only 2 (1 male and 1 female) had lost their tags on-station. Additionally, some returning PIT tagged adults were jaw-tagged at LGD to evaluate tag retention from the dam to hatchery racks and tag retention was 100%. The results from these two studies suggest significant tag loss does not occur after fish pass upstream of LGD. Further research is needed in this area and we will continue to work towards answering the question of where the majority of tag loss is occurring and how to account for it.

Regardless of when tag loss, malfunction, or differential mortality is occurring, the corrected PIT tag expansion rates for returning adults differ from the juvenile tagging rates. In some cases, the corrected expansion is 3 to 4 times higher than the juvenile expansion rates. Using the uncorrected PIT tag expansion rates can have implications on the management of fisheries and hatchery operations because the true number of fish returning is underestimated

by the expansion rates that are used during the season to estimate adult returns. We will continue to monitor these data and in the future we may be able to detect consistent patterns that could be used as in-season management tools.

## The Use of PIT Tags to Estimate Mini-jack Rates in Spring/Summer Chinook Salmon

We have been monitoring yearly numbers of mini-jacks since 2009 when unusually high numbers of jacks returning to the Columbia River Basin generated an increasing level of interest in better understanding causes and patterns of age at maturity.

For this analysis, a mini-jack 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 mini-jacks to hatchery racks in Idaho previously led us to believe that mini-jacking occurs at very low levels. PIT tag detections in the lower Snake River and Columbia River hydropower systems suggest that mini-jacking may occur more frequently than originally thought.

We monitor mini-jacking rates with the use of PIT tag detections in adult ladders throughout the Snake River and Columbia River hydropower systems. To help ensure that detections are from returning fish and not from out-migrating juveniles, only detections occurring after June 1 are included. PIT-tagged mini-jacks were expanded using the same methodology used for adult returns in that run-at-large tags were expanded by the juvenile tagging rate, and return-to-river tags only represented themselves and were not expanded. NOTE: Prior to the 2012 report, some of the returning mini-jacks at Ice Harbor Dam were missed in our analysis due to the exclusion of one of the detectors at that dam. This report contains the updated mini-jack numbers for Ice Harbor Dam.

The rate of mini-jacking is variable across years and release site-specific rates ranged from a low of 0.08% to a high of 1.80% of the number of smolts released in 2013 (Figure 7). The explanation for these variable mini-jack rates is not entirely known; however, ongoing studies are continuing to explore variables such as growth rates, size at release, feed content, and environmental conditions as potential influences. Patterns observed between hatcheries and trends across time would indicate that mini-jacking 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. Most Chinook Salmon releases in 2013 had mini-jack rates that were lower than the previous 5-10 year averages. Both IPC and IDFG biologists will continue to monitor mini-jacking 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.

Release of smolts from McCall Fish Hatchery into the South Fork of the Salmon River provided an opportunity to investigate the difference in mini-jack rates between segregated (i.e., all hatchery-origin broodstock) and integrated (i.e., hatchery-origin crossed with natural-origin broodstock) programs. A study by Harstad et al. (2014) showed that smolts produced from integrated broodstocks have higher mini-jack rates than segregated stocks and our data from migration years 2012 and 2013 corroborate their results, with integrated smolts returning as mini-jacks at a 50% higher rate than segregated smolts. We will continue to monitor these releases and will be investigating the mini-jack rates of segregated and integrated stocks at McCall, Pahsimeroi, and Sawtooth hatcheries in 2014 and into the future.

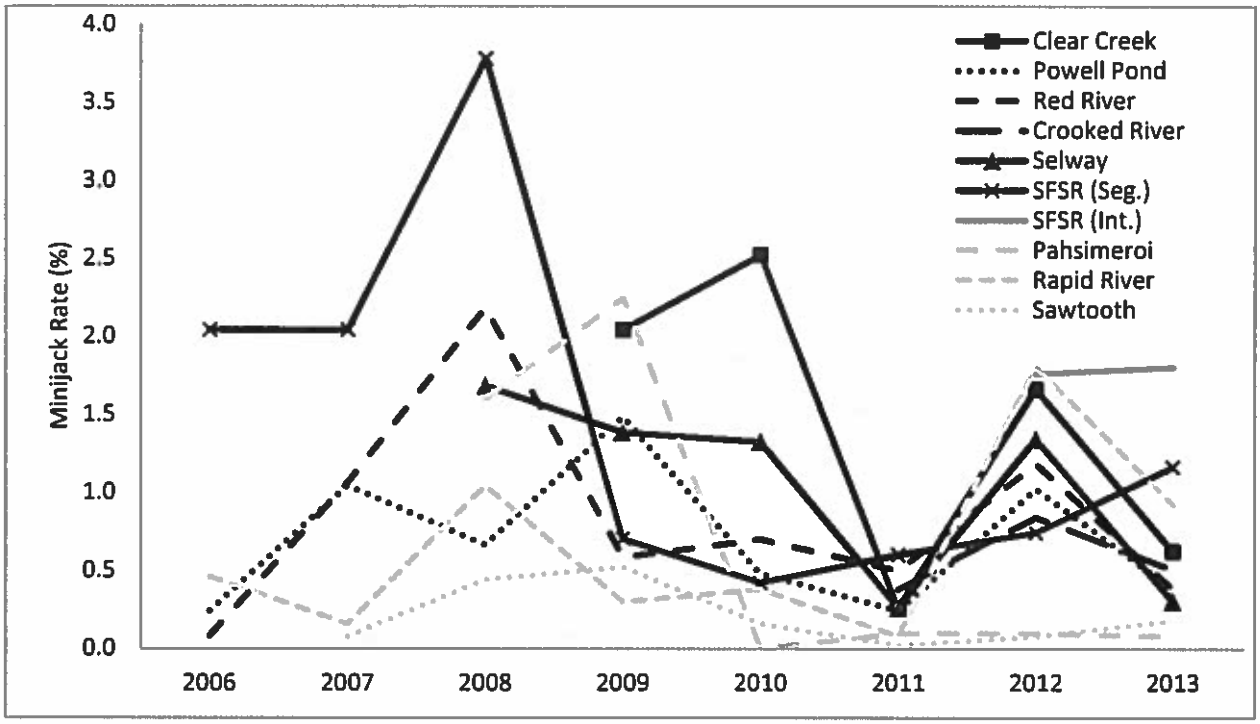


Figure 7. Percent of releases by hatchery that returned over all lower Snake River and Columbia River dams as mini-jacks and the weighted average percent of all releases that returned as mini-jacks for migration years 2006-2013.

Cassinelli et al. (2011) investigated if mini-jack returns were a good predictor of jacks returns the following year. Mini-jack numbers were estimated using the methods listed above, and returning adults were estimated using unadjusted expanded PIT tag estimates at Bonneville Dam. Regressions were generated for both hatchery-specific returns and the aggregate return since brood year 2004 for the five IDFG-managed hatcheries (Clearwater, Rapid River, McCall, Sawtooth, and Pahsimeroi). There were no significant relationships and the aggregate return had an $R^2$ value of 0.63. As a follow up, we have continued to monitor mini-jack relationships and have recently discovered a strong significant correlation between overall mini-jack returns (all facilities combined) and two-ocean adult returns for the same facilities and timeline described above (Figure 8). This relationship indicates that mini-jacks may prove to be a better predictor of two-ocean adult returns than jacks and their usefulness as a forecasting tool needs to be investigated further.

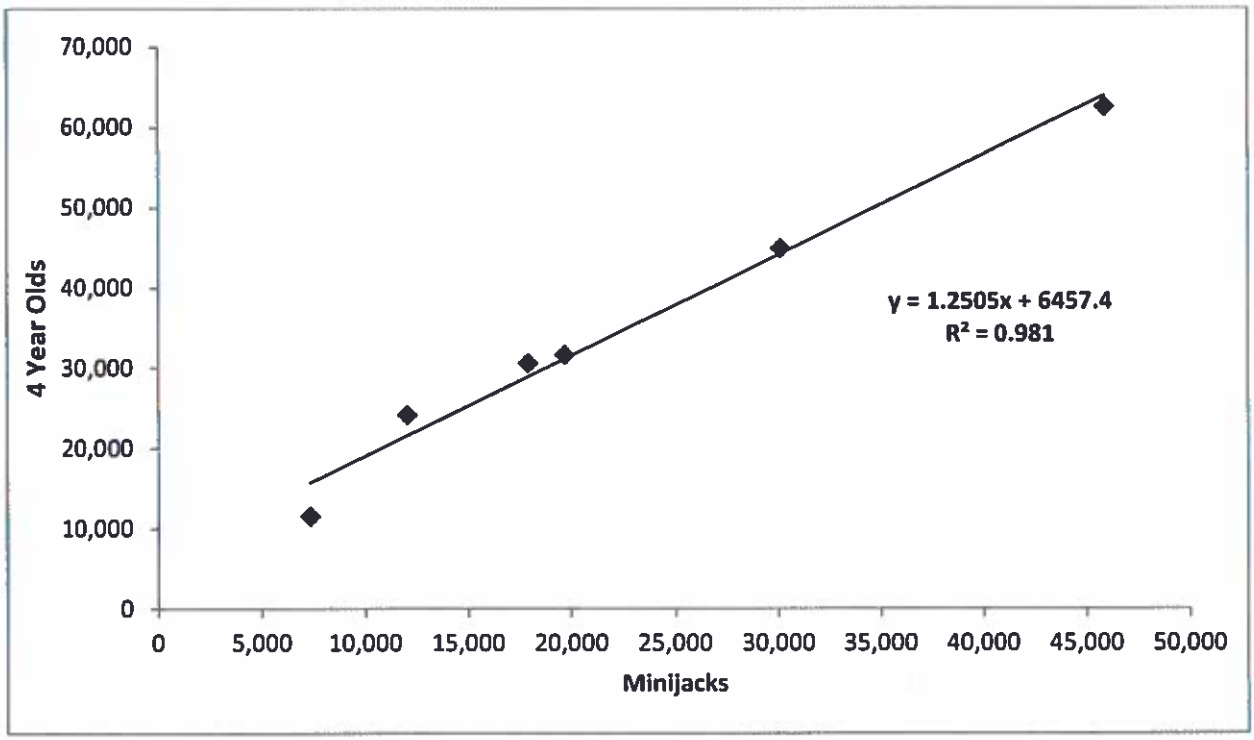


Figure 8. Mini-jack returns at all lower Snake River and Columbia River dams vs. 4 year old returns at Bonneville Dam for the aggregate IDFG spring/summer Chinook Salmon hatcheries for brood years 2004-2009. Data were generated from unadjusted expanded PIT tag estimates.

## ACKNOWLEDGEMENTS

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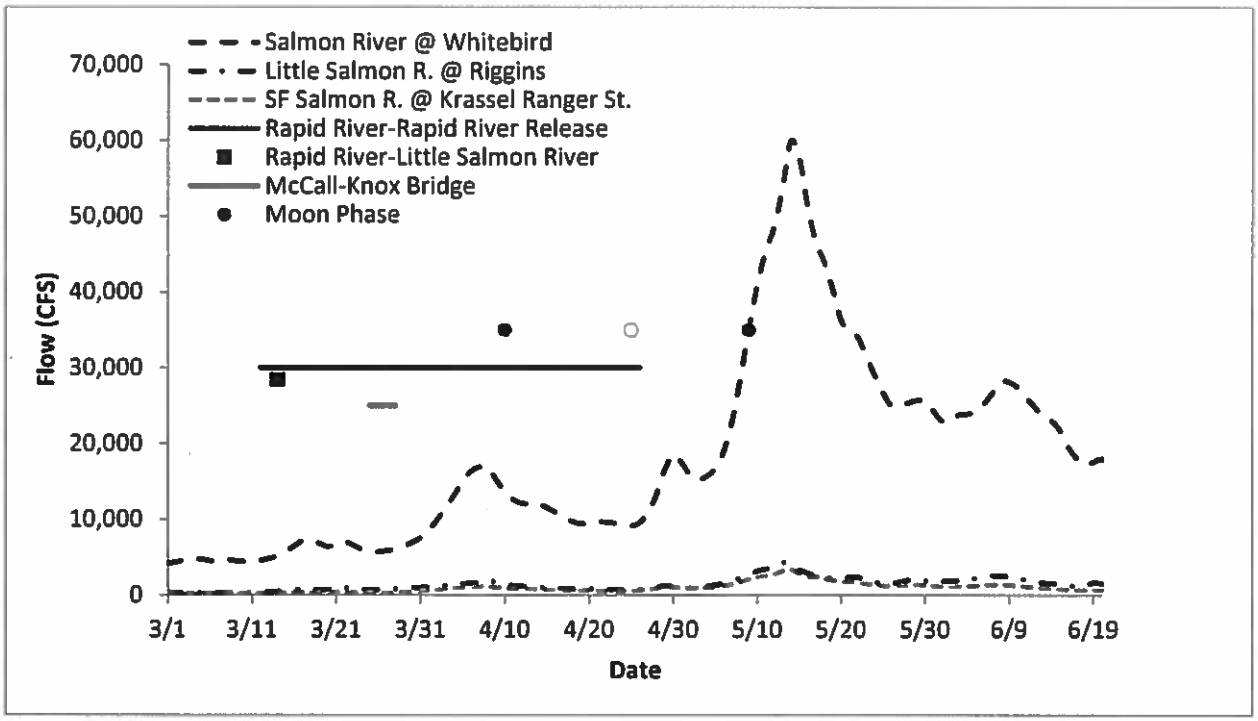
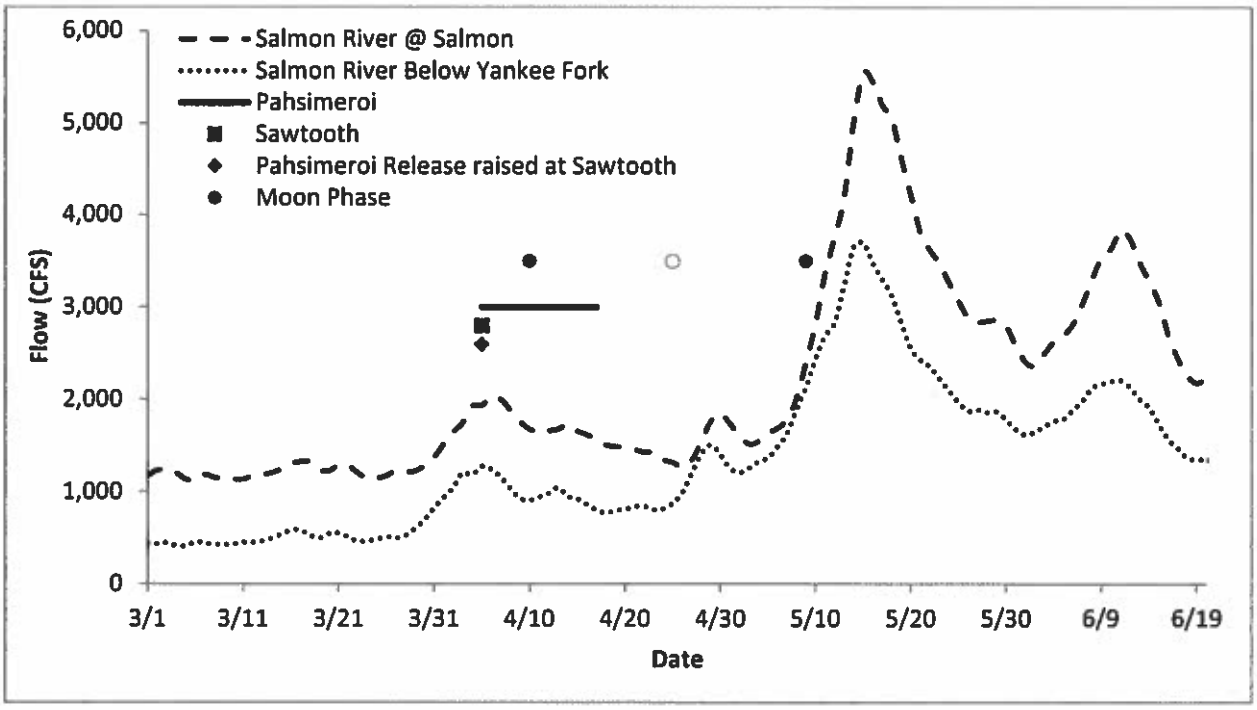
# APPENDICES

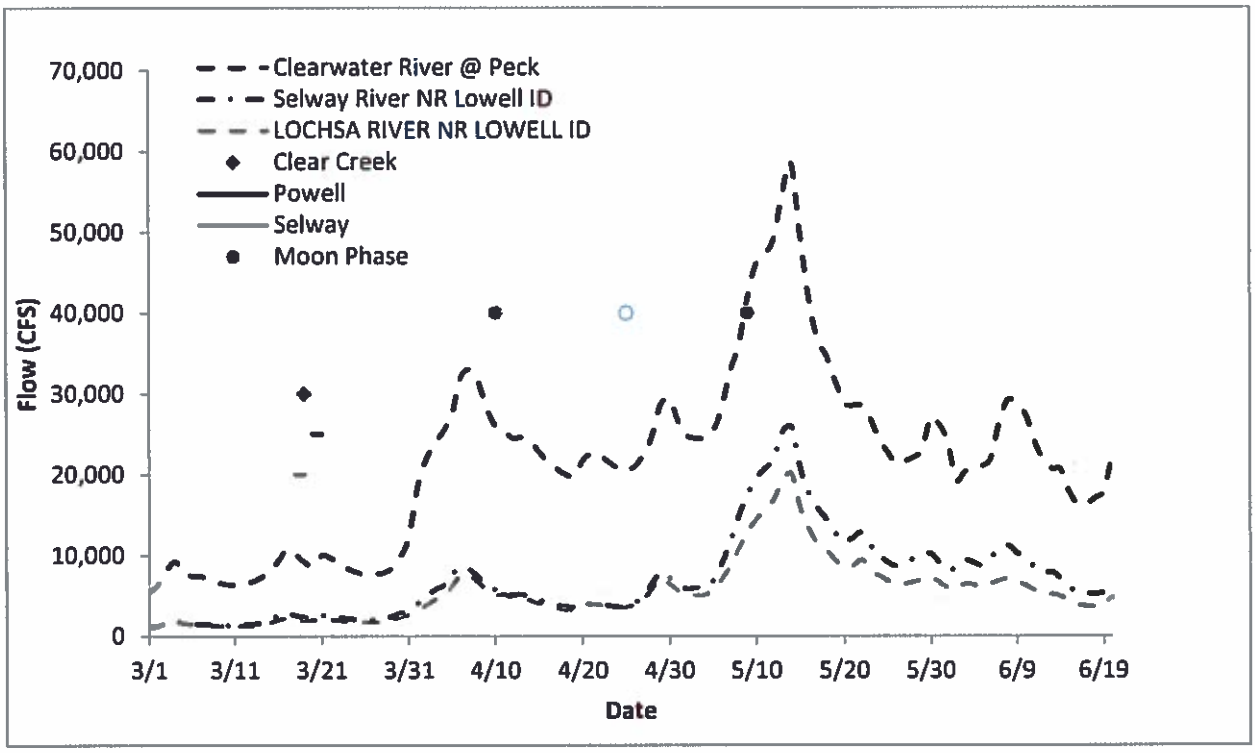
Appendix A1. 2013 SF Salmon River summer and Rapid River spring Chinook Salmon smolt release timing vs. moon phase and flow.



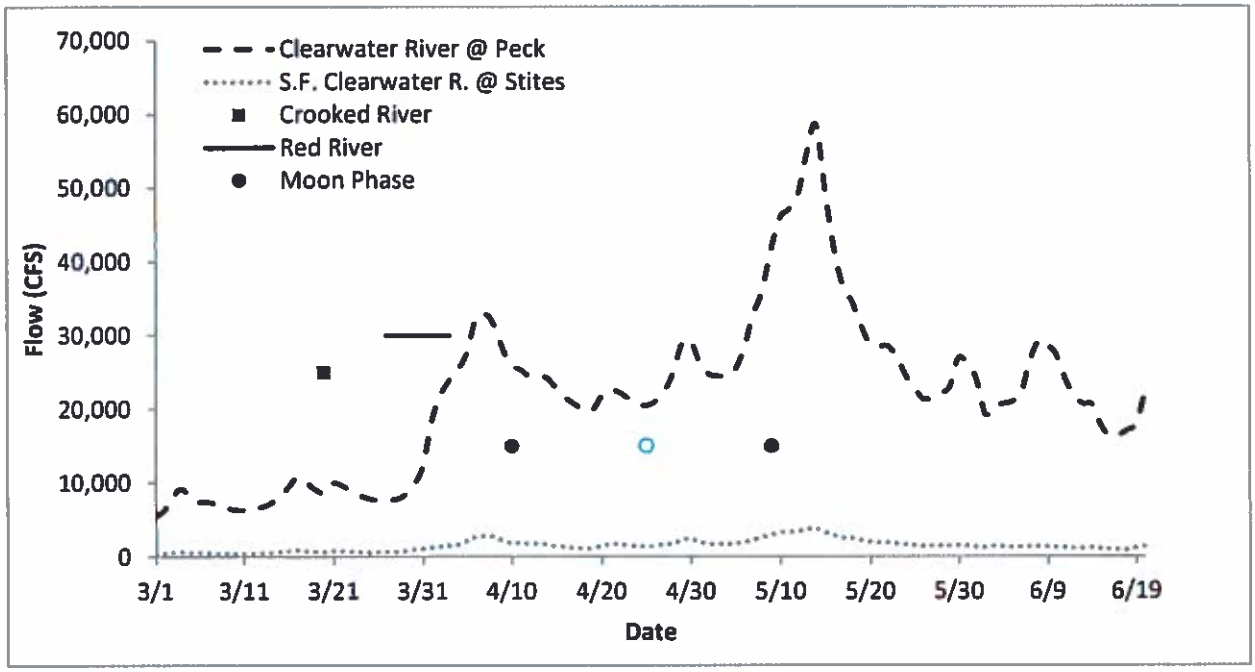

Appendix A2. 2013 Pahsimeroi summer and Sawtooth spring Chinook Salmon smolt release timing vs. moon phase and flow.



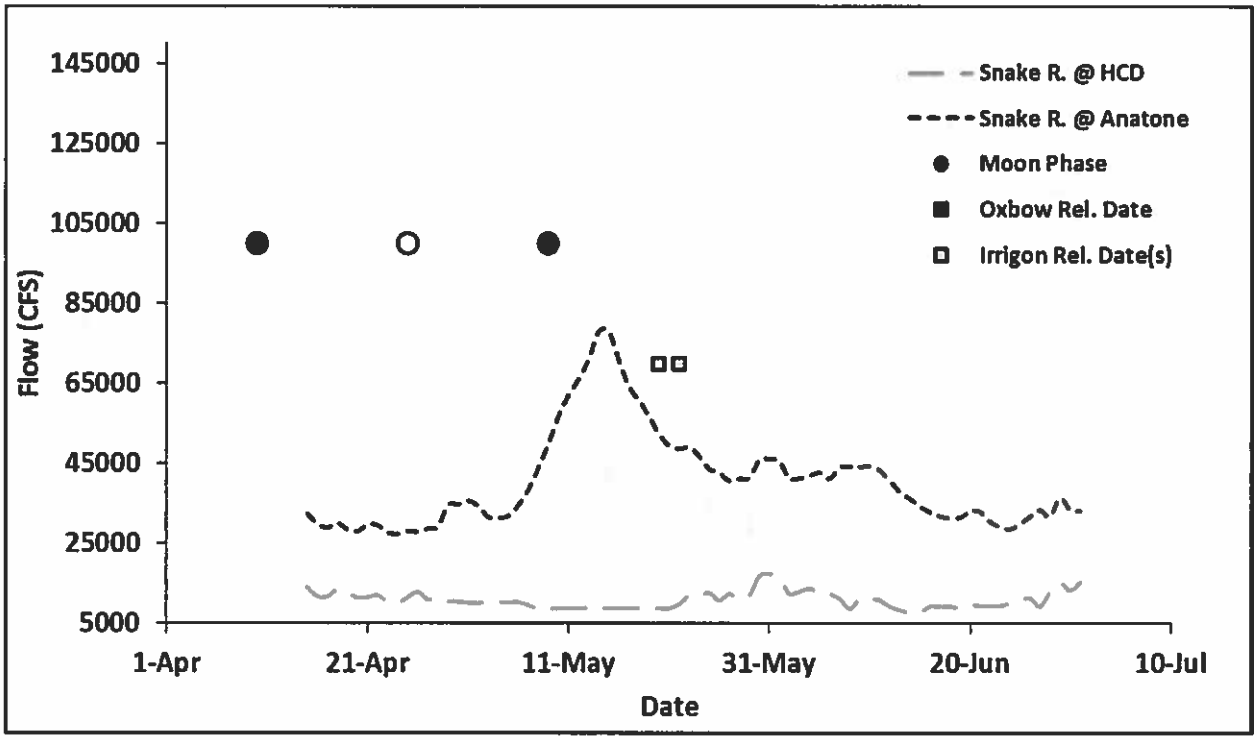
Appendix A3. 2013 Upper Clearwater spring Chinook Salmon smolt release timing vs. moon phase and flow.



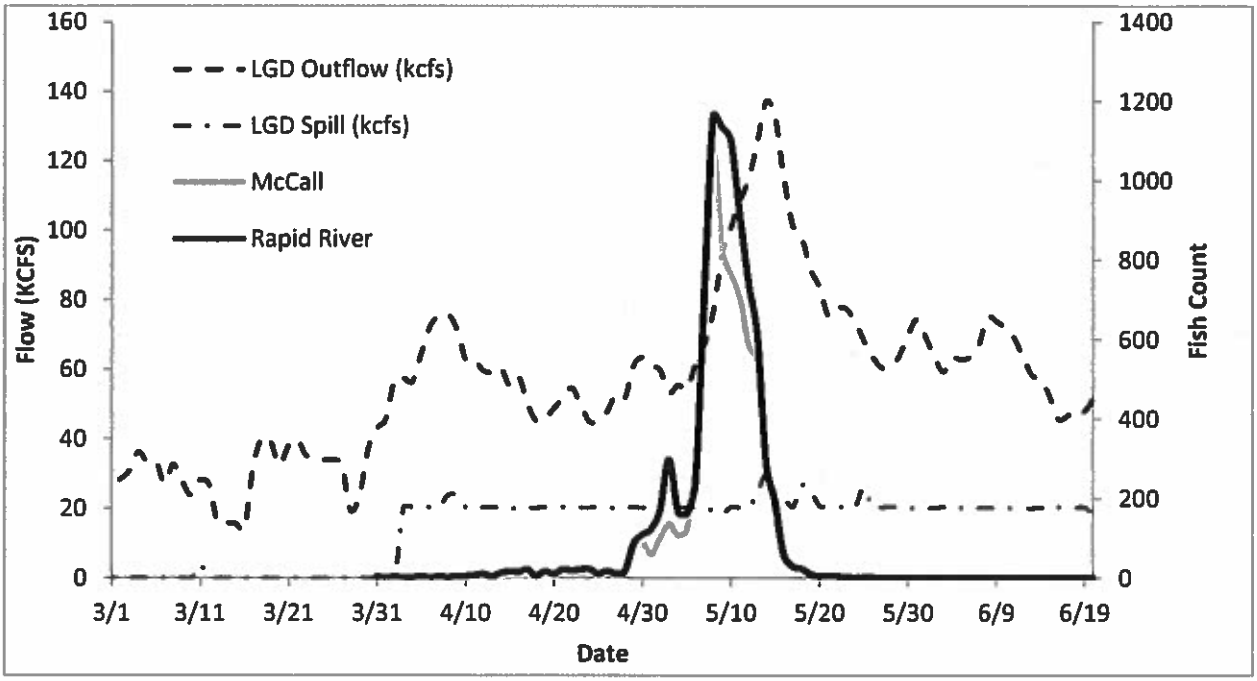

Appendix A4. 2013 South Fork Clearwater spring Chinook Salmon smolt release timing vs. moon phase and flow



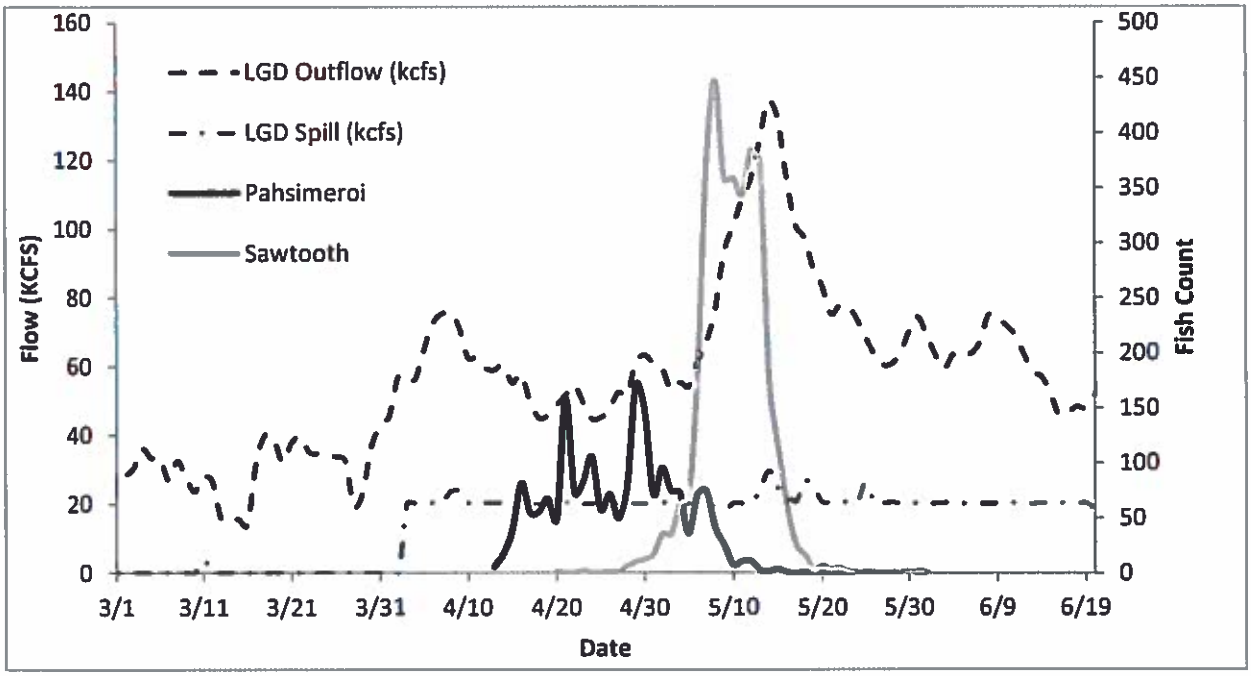
Appendix A5. 2013 Oxbow and Irrigon fall Chinook Salmon smolt release timing vs. moon phase and flow.



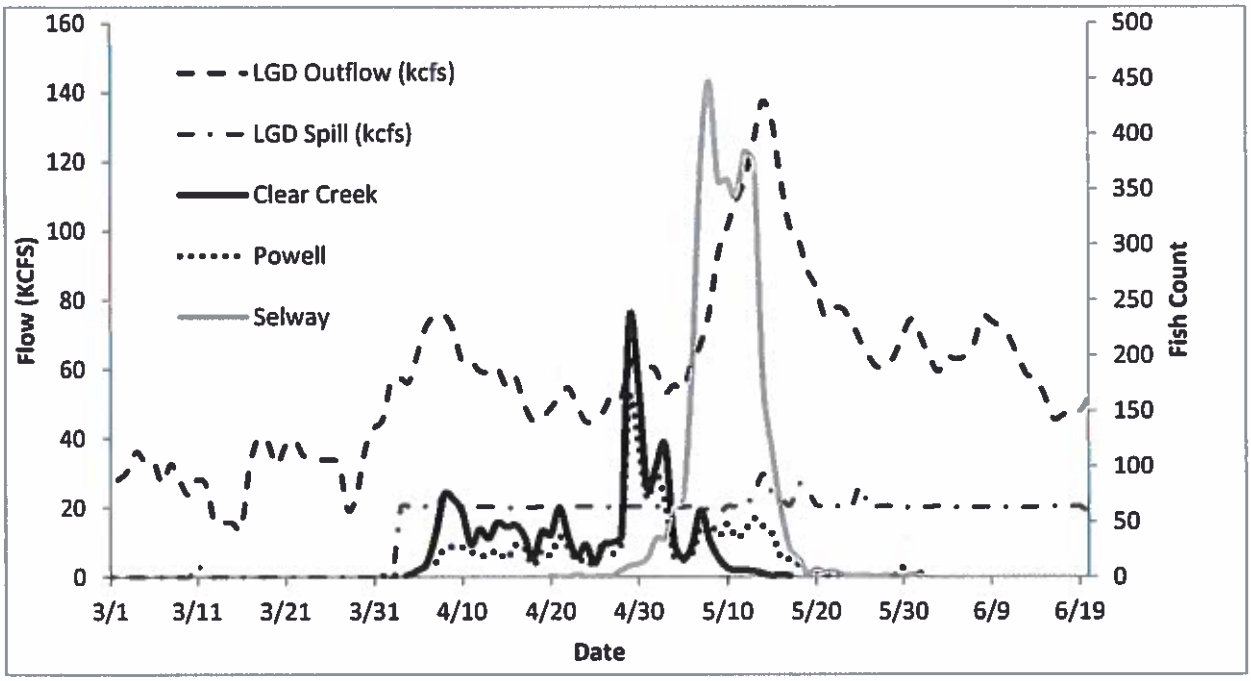

Appendix B1. 2013 SF Salmon River summer and Rapid River spring Chinook Salmon smolt arrival timing vs. flow at Lower Granite Dam.



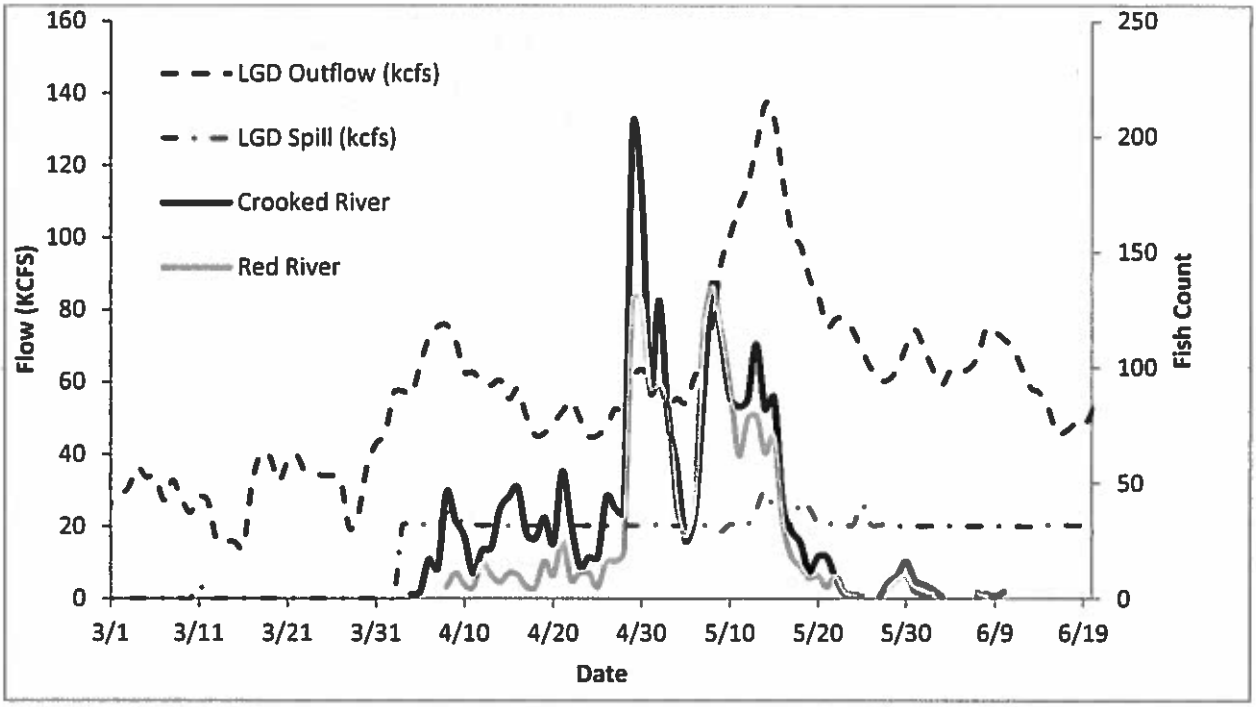
Appendix B2. 2013 Pahsimeroi summer and Sawtooth spring Chinook Salmon smolt arrival timing vs. flow at Lower Granite Dam.



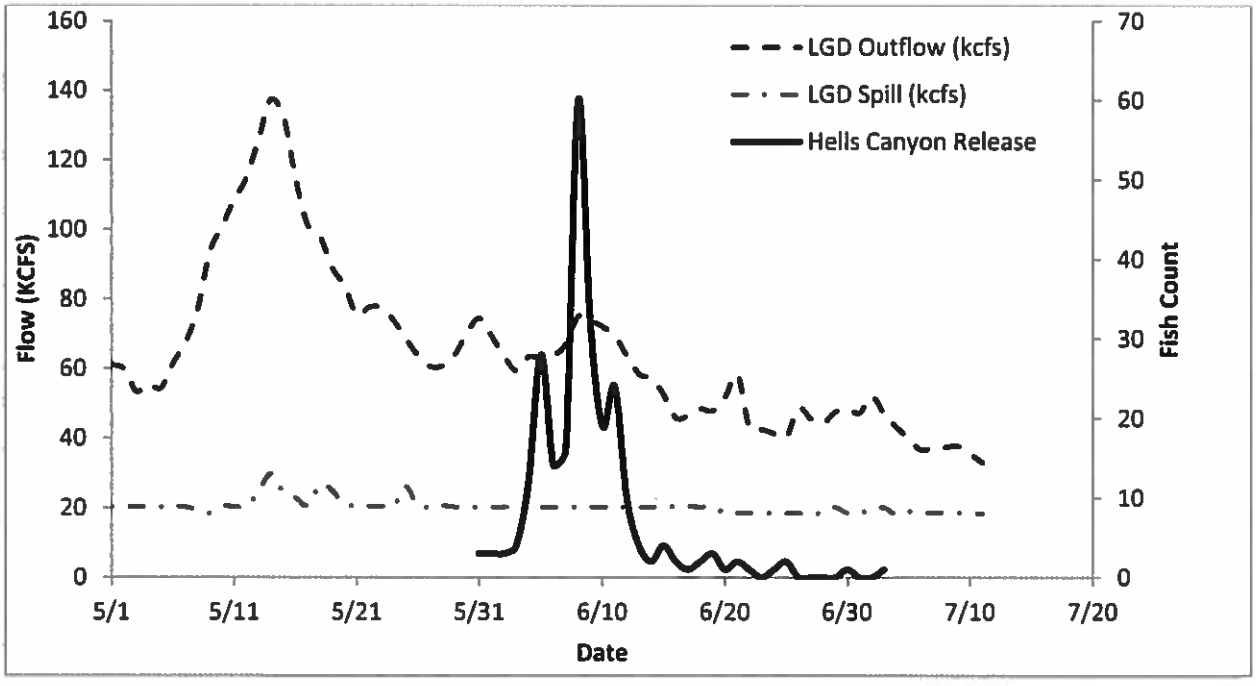

Appendix B3. 2013 Upper Clearwater spring Chinook Salmon smolt arrival timing vs. flow at Lower Granite Dam.



Appendix B4. 2013 South Fork Clearwater spring Chinook Salmon smolt arrival timing vs. flow at Lower Granite Dam.




Appendix B5. 2013 arrival timing vs. flow at Lower Granite Dam for Irrigon Hatchery's fall Chinook Salmon smolts released from Hells Canyon Dam.



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