FISHERY RESEARCH

# IDAHO STEELHEAD MONITORING AND EVALUATION STUDIES

## ANNUAL PROGRESS REPORT

**January 1, 2013—December 31, 2013**

Photo: Ron Roberts


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**IDFG Report Number 14-06**
**March 2014**

# IDAHO STEELHEAD MONITORING AND EVALUATION STUDIES

## Project Progress Report

## 2013 Annual Report

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**IDFG Report Number 14-06**
**March 2014**

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## ABBREVIATIONS AND ACRONYMS

| | |
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| ASMS | Anadromous Salmonid Monitoring Strategy |
| BPA | Bonneville Power Administration |
| BY | Brood Year |
| CI | Confidence Interval |
| DPS | Distinct Population Segment |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| ESU | Evolutionary Significant Unit |
| FL | Fork Length |
| GPM | General Parr Monitoring |
| GSI | Genetic Stock Identification |
| ICBTRT | Interior Columbia Basin Technical Recovery Team |
| IDFG | Idaho Department of Fish and Game |
| ISEMP | Integrated Status and Effectiveness Monitoring Program |
| INPMEP | Idaho Natural Production Monitoring and Evaluation Project |
| ISMES | Idaho Steelhead Monitoring and Evaluation Studies |
| ISS | Idaho Supplementation Studies |
| JCAPE | Johnson Creek Artificial Propagation Enhancement |
| LGD | Lower Granite Dam |
| NOAA | National Oceanic and Atmospheric Administration |
| PIT | Passive Integrated Transponder |
| PTAGIS | PIT Tag Information System |
| SURPH | Survival Under Proportional Hazards |
| USER | User Specified Estimation Routine |
| VSP | Viable Salmonid Population |

## ABSTRACT

The goal of Idaho Steelhead Monitoring and Evaluation Studies (ISMES) is to monitor and evaluate the status of wild steelhead populations in the Clearwater and Salmon river drainages. Abundance and life history data were collected in Fish Creek (Lochsa River tributary), Rapid River (Little Salmon River tributary), and Big Creek (Middle Fork Salmon River tributary) during 2013. In general, weirs were operated to estimate adult escapement; snorkel surveys were conducted to estimate parr density; screw traps were operated to estimate juvenile emigrant abundance and to tag fish for survival estimation. We collected scale samples for age determination and tissue samples for genetic analysis. During 2013, adult steelhead were sampled in lower Big Creek by hook and line to estimate origin (hatchery or wild) and age, and to collect genetic samples. The estimated escapement into Fish Creek was 95 steelhead and into Rapid River was 27 steelhead; escapement into Big Creek was 474 steelhead. To estimate age composition in 2013, scale samples from 379 adults and 3,943 juveniles were aged. In Fish Creek, number of adult recruits per brood year (BY1992-2007) ranged from 41 steelhead to 363 steelhead and adult productivity ranged from 0.35 recruits/spawner to 10.25 recruits/spawner (geometric mean = 1.39 recruits/spawner). In Rapid River, number of adult recruits per brood year (BY2003-2007) ranged from 70 steelhead to 145 steelhead and productivity ranged from 0.83 recruits/spawner to 1.70 recruits/spawner (geometric mean = 1.35 recruits/spawner). The estimated juvenile emigration was 36,659 steelhead from Fish Creek, 4,664 steelhead from Rapid River, and 40,799 steelhead from Big Creek. In terms of juvenile productivity, Fish Creek (BY1995-2010) was the most productive with a range of 188.9-1,466.5 emigrants/female spawner (geometric mean = 422.3 emigrants/female). Rapid River (BY2006-2010) was much less productive with a range of 36.6-229.0 emigrants/female spawner (geometric mean = 72.7 emigrants/females). There was only one productivity estimate from Big Creek (BY2010), 58.4 emigrants/female spawner. Based on detections of PIT-tagged adults at Bonneville Dam, we estimated smolt-to-adult return rates for migratory years 1996-2010 varied from 0.15% to 4.36% (geometric mean 0.84%). Parr density estimates from snorkeling are reported separately. Water temperature was recorded at 23 locations in the Clearwater and Salmon river drainages.



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## INTRODUCTION

Populations of steelhead trout *Oncorhynchus mykiss* in the Snake River basin declined substantially following the construction of hydroelectric dams in the Snake and Columbia rivers. Raymond (1988) documented a decrease in survival of emigrating steelhead trout and Chinook salmon *O. tshawytscha* from the Snake River following the construction of dams on the lower Snake River during the late 1960s and early 1970s. Abundance rebounded slightly in the early 1980s, but then escapements over Lower Granite Dam into the Snake River basin declined again (Busby et al. 1996). In recent years, abundances in the Snake River basin have slightly increased. The increase has been dominated by hatchery fish, while the returns of naturally produced steelhead and Chinook salmon remain critically low, especially for stocks with later run timing (B-run populations; Busby et al. 1996). As a result, Snake River steelhead trout (hereafter steelhead) were classified as threatened under the Endangered Species Act (ESA) in 1997. Within the Snake River steelhead evolutionarily significant unit, there are six major population groups, of which three are located in Idaho (Clearwater River, Salmon River, and Hells Canyon tributaries; ICBTRT 2003). However, the Hells Canyon major population group is considered to be extirpated. A total of 17 demographically independent populations have been identified within Idaho (ICBTRT 2003).

Anadromous fish management programs in the Snake River basin include: 1) large-scale hatchery programs intended to mitigate for the impacts of hydroelectric dam construction and operation in the basin; and 2) recovery planning and implementation efforts aimed at recovering ESA-listed wild salmon and steelhead stocks. The Idaho Department of Fish and Game's long-range goal of its anadromous fish program, consistent with basinwide mitigation and recovery programs, is to preserve Idaho's salmon and steelhead runs and recover them to provide benefit to all users (IDFG 2013). Management to achieve these goals requires an understanding of how salmonid populations function (McElhany et al. 2000) as well as regular monitoring for status assessments. However, specific data on Idaho steelhead populations are lacking, particularly estimates of key parameters such as population abundance, age composition, genetic diversity, recruits per spawner, and survival rates (ICBTRT 2003). The relevant parameters needed to assess the population viability of salmonid populations are abundance, productivity, spatial structure and diversity (McElhany et al. 2000).

The goal of Idaho Steelhead Monitoring and Evaluation Studies (ISMES) is to provide information to guide restoration of wild steelhead populations in Idaho. Data are collected in selected spawning tributaries in the Clearwater and Salmon river basins to provide the population-specific demographic information needed for management (ASMS 2011). The aggregate escapement of Snake River steelhead is measured at Lower Granite Dam (LGD) in Washington State (excluding the Lower Snake population, which spawns primarily in the Tucannon River). Some of these fish are headed to Washington or Oregon, but the vast majority is destined for Idaho. Therefore, we also sample wild adult steelhead during the spring and fall at LGD. In Idaho, a portion of the escapement for some populations is measured at weirs, such as in Rapid River and in Fish Creek (Figure 1). The Fish Creek weir is the only weir in Idaho operated solely for wild B-run steelhead. Because of the collaborative nature of the work at LGD and the need for more timely reporting than the calendar-year cycle of this project, the full description of work at LGD will be contained in a separate report issued by all IDFG projects conducting operations at LGD (see Schrader et al. 2011 for an example using fall 2008 and spring 2009 data).

## OBJECTIVES

1. Conduct intensive, high-precision (fish in, fish out) monitoring of steelhead in Fish Creek (Lochsa River population), Rapid River (Little Salmon River population), and Big Creek (Lower Middle Fork Salmon River population).

2. Support and coordinate intensive, high-precision (fish in, fish out) monitoring of wild steelhead at other locations in Idaho.

3. Conduct extensive monitoring in selected streams (snorkel surveys and temperature monitoring).

4. Monitor temporal and spatial genetic patterns of steelhead populations in Idaho.

5. Monitor status and trends of wild steelhead at Lower Granite Dam.

### Report Topics

Evaluation of the status of steelhead populations in the Columbia River basin is conducted using the viable salmonid population (VSP) criteria (McElhany et al. 2000). This report is organized in the VSP framework with the following subsections: adult abundance and productivity, juvenile abundance and productivity, spatial structure, and diversity. The abundance and productivity subsections include age composition, sex ratio, and hatchery fraction, as well as abundance estimates. Ideally, spatial structure would be assessed by redd locations, but steelhead redd counts in Idaho are not reliable because of snowmelt-related turbidity and changing flow conditions during the spring spawning period (Thurow 1985); therefore, we use parr distribution as a surrogate. These parr data will be detailed in a separate report with all other IDFG snorkel surveys directed at anadromous salmonids. The diversity subsection will include migration timing and genetic data. The final subsection will be water temperature monitoring, which is directed towards habitat rather than fish. Population designations are also relevant. Most fieldwork took place in Fish Creek, which is part of the Lochsa River steelhead population; in Rapid River, which is part of the Little Salmon River population; and in Big Creek, which is part of the Lower Middle Fork Salmon River population (Figure 1).

## METHODS

### Adult Abundance and Productivity

#### Adult Abundance

We operated a temporary picket weir to estimate escapement in Fish Creek. Adult steelhead moving upstream entered a holding box that was checked several times daily. The trap tender removed the trapped fish with a net and placed them in a plastic livestock trough for processing. Gender was determined based on external sex characteristics, e.g., a developed kype for males. Fork length (FL) was measured to the nearest centimeter. Each fish was examined for marks and tags and scanned for the presence of a passive integrated transponder (PIT) tag or coded wire tag. Scales were collected and a small portion of the anal fin was removed for a genetics tissue sample. All fish were marked with a right opercular punch and released upstream of the weir, except hatchery fish, which were transported to the Lochsa River

and released without processing. Using software developed by Steinhorst et al. (2004), we estimated escapement above the weir with Bailey's modification of the Lincoln-Peterson estimator: $N = c(m+1)/(r+1)$, where *N* is adult abundance, *c* is the number of kelts captured, *m* is the number of adults passed upstream, and *r* is number marked kelts captured. The estimator was computed using an iterative maximization of the log likelihood, assuming fish are captured independently with probability *p* (equivalent to weir efficiency) and tagged fish mix thoroughly with untagged fish. The 95% confidence intervals were computed with the bootstrap option (2,000 iterations).

We assisted hatchery staff at the Rapid River Hatchery to operate a permanent weir to enumerate steelhead escapement in Rapid River. This weir is a velocity barrier with the trap located in the fish ladder. Steelhead were processed as in Fish Creek. All wild fish were marked with a right opercular punch. Hatchery fish are not released above the trap. Because fish cannot pass the trap without passing through the ladder, adult steelhead escapement was the total number of adults trapped. This number is considered a complete census with no variance.

We sampled adult steelhead in Big Creek by angling. Approximately 5 km of Big Creek in the vicinity of Taylor Ranch was sampled, concentrating on holding pools. Migrants were targeted and spawning steelhead were avoided. Upon capture, fish were held in the water in a landing net for processing at the site of capture. Steelhead were processed as in Fish Creek. Wild fish were released at the site of capture. Hatchery fish were euthanized, the caudal fin was removed by severing the caudal peduncle to indicate the fish was processed, and the carcass was returned to the river.

**Adult Age Composition**

Age data are required to estimate population productivity. To collect this information, technicians processed scale samples in the IDFG Nampa Fisheries Research aging laboratory. Scales were examined for regeneration and 6-10 non-regenerated scales were cleaned and mounted between two glass microscope slides. Scales were examined on a computer video monitor using a Leica DM4000B microscope and a Leica DC500 or DFC425 digital camera. A technician chose the best 2-4 scales for aging the fish and saved them as digitized images. The entire scale was imaged using 12.5x magnification. The freshwater portion was imaged using 40x magnification. Two technicians independently viewed each image to assign age without reference to fish length. If there was no age consensus among the readers, a third reader viewed the image and all readers collectively examined the image to resolve their differences before a final age was assigned. If a consensus was not attained, the sample was excluded from analysis.

Freshwater annuli were defined by pinching or cutting-over of circuli within the freshwater zone in the center of the scale. The criterion for a saltwater annulus was the crowding of circuli after the rapid saltwater growth had begun. We used only visible annuli formed on the scales, excluding time spent overwintering in fresh water prior to spawning. A spawn check was identified as a ragged scar-like mark within the saltwater zone. We use the European system to designate ages: freshwater age is separated from saltwater age by a decimal. Total age at spawning is the sum of freshwater and saltwater ages, plus 1.

**Adult Productivity**

Adult-to-adult productivity can be calculated over time by combining adult abundances with age composition. We updated the age data series for both Rapid River and Fish Creek

(which begins with the 1992 brood year, the first year of weir operation), estimated the age composition of those runs, and compared each brood year to the number of spawning steelhead to generate estimates of adult-to-adult productivity. Samples that did not have a total age were excluded. Age composition for each return year was then determined from the remaining samples and applied to the escapement estimate to get total number of fish at age per calendar year. Age categories were combined into brood years (e.g., ages 2.2 and 3.1 in a particular year have the same total age and are from the same brood year) to get adult returns by total age. Brood years are summed across return years and divided by parental escapement to get productivity rate (adult progeny per spawner). Repeat spawners (as indicated by a spawning scar on their scales) were dropped from the analysis because they had been accounted for in a previous year (n = 2). After last year's report, we noticed that some years had double samples (i.e., scale samples from the same individual collected prespawn and again as a kelt in the same year); all second samples were omitted and productivities re-calculated for affected brood years.

## Juvenile Abundance and Productivity

### Juvenile Abundance

Abundance of emigrating juvenile steelhead was estimated from data collected at rotary screw traps located near the mouths of Fish Creek, Rapid River, and Big Creek (Figure 1). The traps were checked daily, and the number of steelhead captured and tagged was recorded. Individuals that were too small to be distinguished from small westslope cutthroat trout *O. clarkia lewisi* with confidence were recorded as trout fry. Each fish was scanned before tagging to verify that it had not been previously tagged. All steelhead ≥80 mm were PIT tagged, measured (FL, nearest mm), and weighed (nearest 0.1 g). The tag files were uploaded to the PTAGIS database (www.ptagis.org). After PIT tagging, juvenile steelhead were allowed to recover and then released. A maximum of 50 newly tagged fish were released at least 300 m upstream of the trap each day for estimation of trap efficiency. The remainder were released downstream of the trap. Flow conditions were recorded, either as flow at nearby stream gauges or as depth below the sill of the trap. In Big Creek, flow is indexed by the distance from the bottom of the nearby pack bridge to the water surface.

Data from each trap are summarized by season in this report. The seasonal bounds we used approximate the major periods of fish movement during spring and fall and are consistent with past ISMES reports. Spring was from trap installation until May 31. Summer was from June 1 to August 14. Fall was from August 15 until trap removal. Using software developed by Steinhorst et al. (2004), we estimated emigrant abundance by season with Bailey's modification of the Lincoln-Peterson estimator:

$$N = \sum_{i=1}^{k} c_i (m_i + 1)/(r_i + 1),$$

where $N$ is abundance of juveniles emigrating in 2013, $i$ is season (spring, summer, fall), $c_i$ is the number of all fish captured in season $i$, $m_i$ is the number of tagged fish released in season $i$, and $r_i$ is number of recaptures in season $i$. The estimator was computed using an iterative maximization of the log likelihood, assuming fish are captured independently with probability $p$ (equivalent to trap efficiency) and tagged fish mix thoroughly with untagged fish. The 95% confidence intervals were computed with the bootstrap option (2,000 iterations).

### Juvenile Age Composition

We estimated emigrant age composition using scale samples collected at 14 of 28 screw traps operated in Idaho's anadromous production streams (Figure 1). Screw trap tenders from ISMES collected scale samples from juvenile steelhead caught in Fish Creek, Rapid River, and Big Creek. Scale samples were also collected at 11 screw traps operated by the Idaho Supplementation Studies (project 1989-098-00), the Shoshone-Bannock Tribes, and the Nez Perce Tribe for a total of 14 locations. We also processed scale samples from the Potlatch River Steelhead Monitoring and Evaluation project, but those results are reported by that project (Bowersox et al., in preparation). Scales were collected and processed as described above for adults, except that laboratory technicians examined scales using 40x magnification.

### Juvenile Productivity

The productivity of the spawning reaches can be estimated by using age composition data to decompose juvenile abundances into brood years and comparing brood year production to the number of female spawners. We summarized the 2007-2013 data for Rapid River as well as the 1996-2013 data for Fish Creek; 2007 and 1996 are the first year of scale sampling at each screw trap, respectively. Abundance and age composition estimates for spring (March-May) were calculated separately from summer and fall, which were combined (June-November). At Fish Creek, scales were not collected in the spring until 2004; therefore, we used the fall age composition from the previous year advanced one age category. For spring 1996 at Fish Creek, we used the fall 1996 age composition because there were no fall 1995 scale samples from which to extrapolate.

### Smolt-to-Adult Return Rates

Smolt-to-adult return (SAR) rate measures survival of juveniles after they leave their freshwater rearing habitat until they mature and return as adults. This measure is calculated on the basis of an emigrant cohort, regardless of the age of the smolts. We use detections of fish PIT tagged in Fish Creek as they return and move upstream past Bonneville Dam. Detections were queried from the PTAGIS database (www.ptagis.org). Adult status was confirmed by upstream movement, either between dams or in the adult ladder at Bonneville Dam ($SAR_{BON-LGR}$). Each adult was assigned to a cohort based on date of first detection as a smolt. Records of adults not detected emigrating as a smolt were omitted because they could not be assigned to a cohort with certainty. From the same PTAGIS query, we summarized the number of juvenile detections anywhere in the hydrosystem (including the towed array in the estuary). Numbers of smolts detected were summarized by year of detection. The $SAR_{BON-LGR}$ was computed as number of adults detected returning from a migratory year divided by the number of smolts detected. We used formulas from Fleiss (1981) to estimate the 95% confidence limits on $SAR_{BON-LGR}$ values.

We used the information from above to compute the number of PIT tags placed at the Fish Creek screw trap necessary to get a reliable $SAR_{BON-LGR}$ estimate. As a rule of thumb, we adopted a standard of at least 10 adult detections by migratory year. We summarized the numbers of tags placed at the trap by anticipated migratory year and compared that to the number of tags detected at Lower Granite Dam to get conversion rate to the smolt state. For each measure (conversion rate and $SAR_{BON-LGR}$) in the dataset, we computed the average, maximum, minimum, and five percentiles (10%, 25%, 50%, 75%, and 90%) to serve as benchmarks for all reasonable survival scenarios. The number of tags needed to get 10 adult detections was calculated for the 64 scenarios possible.

## Diversity

### Adult Migration Timing

We estimated the timing of adult steelhead returning to Fish Creek and Rapid River through the hydrosystem. The PTAGIS database (www.ptagis.org) was queried to obtain detection dates of fish PIT tagged as juveniles in Fish Creek or Rapid River and returning to spawn as adults. The query was for detections between July 1, 2012 and June 30, 2013 at Bonneville, McNary, Ice Harbor, and Lower Granite dams. We calculated the proportion detected at Bonneville Dam that were also detected at upstream dams and at the Fish Creek and Rapid River traps, i.e., the conversion rate.

### Smolt Migration Timing

We ascertained smolt detection rates and emigration timing during the 2013 emigration using PIT-tagged fish detections downstream of the three ISMES traps. The PTAGIS database (www.ptagis.org) was queried to obtain detection date and location, tagging date and location, and the length and weight at tagging of wild steelhead smolts tagged by ISMES. Potential interrogation sites were Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville dams and the estuary towed array. Passage date at LGD was calculated for three percentiles (10%, 50%, and 90%) for each trap location.

### Genetic Diversity

Since 2000, ISMES has collected tissue samples for genetic analysis from populations that span the range of geographic, temporal, and phenotypic variability observed in the Salmon and Clearwater basins (Nielsen et al. 2009). Data from past collections by ISMES are currently in use by Project 2010-026-00 to conduct genetic stock identification at LGD and to monitor genetic diversity of natural origin steelhead in the Snake River basin. The genetic diversity and structure of populations surveyed by ISMES will be evaluated with other Snake River steelhead populations in the annual report by Project 2010-026-00 (e.g., Ackerman and Campbell 2012). During this report period, activity in this category was confined to collection of tissue samples, which were archived pending future analysis.

## Water Temperature Monitoring

Water temperatures were monitored in tributaries throughout the Clearwater and Salmon river drainages with temperature recorders set to record every 30 min to obtain yearly temperature profiles from streams with wild steelhead populations. The streams span a range of elevation, geomorphic, and vegetative cover found in Idaho's steelhead streams. These data are stored in a database located at the IDFG Nampa Fisheries Research office. These data have been shared with researchers in the US Forest Service and are available on-line (http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html).

# RESULTS

## Adult Abundance and Productivity

### Adult Abundance

**Fish Creek—**Operation of the Fish Creek weir began March 10 and the first adult fish was captured on March 28, 2013 (Table 1). Median day of passage (all fish) was May 7. High flows from snowmelt began in late April and peaked in mid-May (Figure 2). Water flowed over the top of the weir on May 10 and some debris accumulated on the weir. One tripod was damaged but the weir face remained intact. Pickets were pulled the evening of May 11 but flows subsided quickly. The weir tenders cleaned the weir face and reinstalled pickets in the trap box the next morning. However, flows came up again that evening and the pickets in the trap box were again pulled. Flows dropped overnight and the pickets were replaced the next morning. In total, the weir was out of service for 22 hours during the period of May 11-May 13. The last prespawn adult moving upstream was captured on June 11. The first kelt was passed downstream on May 19 and 75 kelts were collected. The last kelt was captured on June 28. Median day of kelt passage was June 2.

Trap tenders passed 74 prespawn adults upstream and 17 unmarked kelts downstream, for a total of 91 unique individuals handled (Table 2). Only one hatchery fish was collected at the weir and was not passed; the hatchery proportion was 1%. The escapement estimate is based on 58 marked and 17 unmarked kelts returning back to the weir. One male had passed the weir twice going upstream and was handled twice going downstream; the second downstream record of this fish was excluded. Based on this information, we estimate that the 2013 escapement above the weir was 95 fish (95% CI 81 - 111 fish).

Sex ratio was biased towards females. Females comprised 69% of the anadromous spawners and 85% of the kelts collected (Table 2). The mean FL of all females, including kelts, was 79 cm and ranged from 61 cm to 89 cm. The mean FL of all males, including kelts, was 80 cm and ranged from 58 cm to 93 cm.

The spawning run extended from March until June. The first female prespawn migrant was trapped on March 30 and the first male on March 28 (Table 1). The midpoint for females sampled was May 7 and the midpoint for males sampled was May 8. The midpoint for both sexes combined was May 7.

**Rapid River—**Operation of the Rapid River Hatchery weir began March 19 and the first wild adult fish was captured April 10, 2013 (Table 1). The last prespawn adult moving upstream was captured on June 5. It is not possible to capture kelts at the Rapid River Hatchery weir.

Trap tenders passed 26 wild prespawn adults upstream (Table 2). One wild female was found dead in the trap and samples collected. Only one hatchery fish was also collected at the weir but was not passed. The number of trapped wild fish is considered a population census without error.

Sex ratio was biased towards females. Females comprised 56% of the wild fish (Table 2). The mean FL of females was 72 cm and ranged from 57 cm to 80 cm. The mean FL of males was 68 cm and ranged from 55 cm to 84 cm.

The spawning run extended from April until early June. The first female prespawn migrant was trapped April 10 and the first male migrant was trapped on April 22 (Table 1). The midpoint of the female run was April 29 and the midpoint of the male run was May 2. The midpoint for both sexes combined was April 29.

**Big Creek—**Stream and weather conditions allowed for only seven days of adult sampling in 2013. Angling began April 21 when the first wild adult steelhead was captured (Table 1). Angling continued until April 27, when high, turbid flows commenced.

There were 25 wild steelhead captured (Table 2) and 3 recaptures. No hatchery fish were collected. Sex ratio was biased towards females. Females comprised 56% of the wild fish (Table 2). The mean FL of females was 72 cm and ranged from 60 cm to 86 cm. The mean FL of males was 70 cm and ranged from 58 cm to 86 cm. Given the limited effort, run timing statistics were not calculated.

Adult escapement at the Big Creek PIT-tag array was estimated to be 474 steelhead (95% CI 356-625; Kevin See, Quantitative Consultants Inc., personal communication).

**Adult Age Composition**

**Fish Creek—**Of the unique steelhead adults collected at the weir, 91 were aged (Table 3). The majority (91%) spent two years in the ocean, although one spent three years. Seventy-four fish had both freshwater and ocean ages assigned; most smolted after two years (49%) or three years (47%) in freshwater. A few individuals had smolted at one or four years. Total ages ranged from four to seven years at spawning. Seven different age classes were identified.

**Rapid River—**Of the adult steelhead collected at the Rapid River Hatchery weir, 27 were aged (Table 3). Most (59%) spent two years in the ocean and the rest spent one year. Twenty-one fish had both freshwater and ocean ages assigned. They smolted after two years (52%) or three years (48%) in freshwater. Total ages ranged from four to six years at spawning. Four different age classes were identified.

**Big Creek—**Of the adult steelhead collected in Big Creek, scales were collected and aged from 24 fish (Table 3). Most fish spent two years in the ocean (75%) and the rest spent one year (25%). Nineteen fish had both freshwater and ocean ages assigned. Most fish in Big Creek smolted after three years (68%), but smolt ages ranged from two to four years. Total age at spawn ranged from four to six years. Five age classes were identified.

**Other Locations—**We received scale samples from wild adults collected at the following hatchery weirs: Crooked River, East Fork Salmon River, South Fork Salmon River (kelts only), Sawtooth Hatchery, and Pahsimeroi Hatchery (Table 3). We also processed scale samples from the Potlatch River Steelhead Monitoring and Evaluation project, but those results are reported by that project (Bowersox et al., in preparation).

Ages were assigned to 10 fish from Crooked River. All but one had spent two years in the ocean. The other fish had spent three years in the ocean. Nine fish were assigned both freshwater and ocean ages. Seven had smolted after two years and two had smolted after three years. Three age classes were identified and total ages ranged from five to six years.

Ages were assigned to 30 fish from the East Fork Salmon River; one was identified as a repeat spawner. The majority (79%) spent two years in the ocean and the rest spent one year,

not counting the repeat spawner. The repeat spawner first spawned after two years in the ocean and was returning the year after its first spawn. Twenty-five fish were assigned both freshwater and ocean ages. Most (60%) smolted after three years and the remainder after two years, including the repeat spawner. Five age classes were identified and total ages ranged from four to six years.

Four kelts from the South Fork Salmon River weir were assigned freshwater and ocean ages. Two had smolted after two years and spent two years in the ocean. The others had smolted after three years; one spent one year in the ocean and the other two years.

Ages were assigned to 33 fish from Sawtooth; one was identified as a repeat spawner. This fish was a skip-spawner: it first spawned after one year in the ocean, returned for another year in the ocean, and was on its second spawning run. Of the other fish, most (69%) spent two years in the ocean and the rest spent one year (31%). Twenty-six fish were assigned both freshwater and ocean ages. Most fish had smolted after two years (92%) but a few had smolted at either three or four years. Total ages ranged from four to six years. Four different age classes were identified.

From the Pahsimeroi River sample, 160 fish were assigned ages. Three were identified as repeat spawners. All were skip-spawners that first spawned after one year in the ocean, returned for another year in the ocean, and were on their second spawning run. Two had smolted after two years; the other was not assigned a freshwater age. Of the rest, the majority (58%) spent one year in the ocean and the rest spent two years. There were 129 fish assigned both freshwater and ocean ages. Most (73%) had smolted after two years but 20% smolted after only one year in freshwater. A few individuals had smolted at three or four. Eight age categories were identified. Total ages ranged from three to six years.

**Adult Productivity**

Adult productivity estimates were made for Fish Creek since brood year 1992 but the first brood year in Rapid River that is complete is brood year 2004 (Table 4). Steelhead from both locations spawned at total ages of three to seven years. It is possible that steelhead in Idaho may spawn at eight years but very rarely. The vast majority of steelhead in Idaho spawn at four to six years of age. Therefore, in Rapid River, abundances are complete for the 2004-2006 brood years. The portions are missing from the 2001-2003 brood years and returns are still possible for the 2007-2009 brood years. Nonetheless, estimates for the 2003 and 2007 brood years include the ages at which most fish spawn and will not likely change much; therefore we focus our analysis on brood years 2003-2007 for Rapid River.

Within a brood year, most steelhead in Fish Creek spawned at age 6 but most steelhead in Rapid River spawned at age 5 (Table 4). In Fish Creek, number of adult recruits per brood year (brood years 1992-2007) ranged from 41 steelhead to 363 steelhead and adult productivity ranged from 0.35 recruits/spawner to 10.25 recruits/spawner (geometric mean = 1.39 recruits/spawner). In Rapid River, number of adult recruits per brood year (brood years 2003-2007) ranged from 70 steelhead to 145 steelhead and productivity ranged from 0.83 recruits/spawner to 1.70 recruits/spawner (geometric mean = 1.35 recruits/spawner).

## Juvenile Abundance and Productivity

### Juvenile Abundance

**Fish Creek—**The Fish Creek screw trap operated from March 14 to November 7, 2013. The trap was not operated during peak snowmelt (May 9 to May 16). The cone was pulled at noon on May 9 and trapping resumed at 1530 hrs on May 16. High temperatures affected tagging operations beginning July 2 until September 7. There were 11 days in which fish were captured but not tagged due to water temperatures >15°C.

We trapped 55 juvenile steelhead during the spring, 1,537 during the summer, and 7,670 during the fall (excluding recaptures of recently tagged fish; Figure 2). These numbers include 283 fish <80 mm FL, which are not included in the population estimate below. Daily catches were <5 steelhead through the spring. Catches began to increase during June and fluctuated through the summer. Summer catch peaked at 87 on August 3. There were three peaks in the fall catch during September and October after rain events that caused flow to increase. Average daily catch was 89 steelhead during the fall but this was greatly influenced by two days when catches exceeded 500 fish. Excluding fish <80 mm FL, we captured 52 steelhead, 1,722 steelhead and 8,249 steelhead during the spring, summer, and fall periods, respectively. Of these, the totals tagged and released upstream were 45 steelhead, 1,231 steelhead, and 2,422 steelhead. Recaptures were 2 steelhead, 220 steelhead, and 763 steelhead. Seasonal trap efficiencies were 4%, 18%, and 32% for the spring, summer, and fall, respectively. We estimated 36,555 juvenile steelhead ≥80 mm FL (95% CI 34,286–38,287 fish) emigrated from Fish Creek during the trapping period.

The length distribution of fish collected during the spring was different from that of fish collected during the summer or fall (Figure 3). The spring distribution had three peaks, one at less than 80 mm, another at 100 mm, and a broader group with a mode at 170 mm. The summer distribution was broad with a peak at 110 mm FL. The fall length distribution was skewed left with a mode at 140 mm FL.

**Rapid River—**The Rapid River trap was installed on March 17, 2013 but not operated until April 13 because of the release of Chinook smolts from the Rapid River hatchery (Figure 4). We experimented with intermittent operations by fishing the trap during the night from April 13 to April 27. The trap was operated 5 minutes per hour during the night until catch rates of hatchery Chinook smolts declined. From April 23 to April 27 the trap was run for several hours during the night. Full operation began April 28. The trap was pulled because of high flows from May 9 to May 21 and from June 8 to July 13. Thereafter, the trap operated until November 7.

We trapped 275 juvenile steelhead during the spring, seven fish during the summer, and 118 fish during the fall (Figure 4). These numbers include 12 fish <80 mm FL, which are not included in the population estimate below. We collected 21 steelhead during the partial-day operations during the hatchery Chinook salmon release period. After April 27, daily average catch was >20 fish until the snowmelt peaked. Few juveniles were trapped after peak snowmelt until late August. The fall catch had a peak on October 1, which coincided with the first cool weather and rain of the season. We combined the summer and fall periods to estimate abundance. Excluding fish <80 mm FL, we captured 294 steelhead during the spring and 129 steelhead during the summer/fall periods. Of these, the totals tagged and released upstream were 265 steelhead during spring and 121 steelhead during summer/fall. Recaptures were 28 steelhead during spring and 7 steelhead during summer/fall. Seasonal trap efficiencies were

11% during spring and 6% during summer/fall. We estimated 4,664 juvenile steelhead ≥80 mm FL (95% CI 3,296–6,702 fish) emigrated from Rapid River during the trapping period.

The length distribution of fish collected in Rapid River was different in each season (Figure 5). In the spring, there was a mode at 180 mm. Too few fish were collected to describe length frequency during the summer. The length distribution of fall fish peaked at 160 mm.

**Big Creek—**The Big Creek trap operated from March 12 to November 4, 2013. Spring ice, snowmelt, and summer rain events caused upriver tributary blowouts that required the trap be pulled for a total of 41 days throughout the season. A mudslide approximately 32 km upstream in Monumental Creek, a tributary to Big Creek, caused frequent turbidity throughout the trapping season. In all, the trap operated for 194 days during 2013.

We trapped 518 juvenile steelhead during the spring, 401 fish during the summer, and 600 steelhead during the fall (Figure 6). These numbers include 450 fish <80 mm FL, which are not included in the population estimate below. The maximum daily catch in the spring was 39 fish and averaged 9.9 fish. Catch fluctuated at low levels for most of the summer (mean daily catch = 6.5 steelhead). Summer catch peaked at 32 fish on August 2. There were several peaks in the fall steelhead catch but it began to decline in late October. Excluding fish <80 mm FL, we captured 261 steelhead, 346 steelhead, and 462 steelhead during the spring, summer, and fall periods, respectively. Of these, the totals tagged and released upstream were 214 steelhead, 333 steelhead, and 448 steelhead. Recaptures were 5 steelhead, 4 steelhead, and 36 steelhead. Seasonal trap efficiencies were 3%, 1%, and 8% for the spring, summer, and fall, respectively. We estimated 40,799 juvenile steelhead ≥80 mm FL (95% CI 22,202–68,045 fish) emigrated from Big Creek during the trapping period.

The length frequency distribution of the steelhead in Big Creek had a peak <100 mm FL in each season (Figure 7). During the spring, the distribution of larger steelhead (>130 mm FL) was broad with a mode at 160 mm. Similarly, the larger modes during the summer and fall were at 170 mm and at 160 mm, respectively.

### Juvenile Age Composition

A total of 4,124 scale samples were taken from juvenile steelhead at 14 screw trap locations in 2013. This is the first time we have completed age compositions for juvenile steelhead from Bear Valley Creek, Lolo Creek, and Yankee Fork. Samples from locations with many fish collected were subsampled systematically. Targets for subsampling were 200 per season. A total of 3,943 samples had an age assigned. We present number of fish aged and length at age by season.

There were 1,603 fish aged from samples during the spring period (Table 5). Ages ranged from one to five years but most fish were either 2 or 3 years of age. The oldest average ages were from Rapid River (3.23 years). The location with the youngest average age was Salmon River at Sawtooth (1.45 years).

There were 1,181 fish aged from samples during the summer period (Table 6). Fish movement is reduced during the summer and ceases in some locations. In other locations, traps are pulled during snowmelt and may not be re-installed until mid-summer. Ages ranged from young-of-year to four years but most fish were aged 1 year. In general, age compositions of summer-caught fish were approximately 1 year younger and usually had fewer age classes than those in the spring.

There were 1,159 fish aged from samples during the fall period (Table 7). Ages ranged from young-of-year to three years but most fish were 1 year. Young-of-year fish were collected in five locations but were common only at Pahsimeroi River and Sawtooth. The locations with the oldest average ages were Big Creek and Rapid River (2.05 and 2.04 years, respectively). The locations with the youngest average ages were Pahsimeroi River and Sawtooth (0.31 and 0.78 years, respectively).

### Juvenile Productivity

Juvenile productivity estimates were made for Fish Creek since brood year 1995 and for Rapid River since brood year 2006 (Table 8). Reconstructions of prior brood years were judged too incomplete to include here. Steelhead from Fish Creek emigrate up to age 4; steelhead from Rapid River and Big Creek may emigrate up to 5 years of age. The majority of emigrants leave at 1-3 years, so analysis was done up to brood year 2010 but final estimates for BY2010 will increase slightly in the future.

Fish Creek was the most productive with a range of 188.9-1,466.5 emigrants/female spawner (geometric mean = 422.3 emigrants/female; Table 8). Most of the juveniles emigrating from Fish Creek left in the fall as age 2 fish, meaning that they would most likely smolt as age 3 fish the following spring. Rapid River was much less productive with a range of 36.6-229.0 emigrants/female spawner (geometric mean = 72.7 emigrants/female). Fewer emigrants leave and they are parsed more evenly across six age classes. There was only one productivity estimate from Big Creek (BY2010), 58.4 emigrants/female spawner. This was higher than the BY2010 estimate from Rapid River but much lower than in Fish Creek.

### Smolt-to-Adult Return Rates

Smolts PIT tagged in Fish Creek were detected in the hydrosystem beginning in 1994, ranging from 128 smolts detected in 1994 to 4,644 smolts detected in 2012. A total of 59 adults were detected that had not been detected as smolts, the majority detected during 2009-2012. Subtracting these detections left 484 adult detections to compute $SAR_{BON\text{-}LGR}$ for 15 migratory years. Adults were detected only from migratory years 1996 to 2010, ranging from 3 individuals from MY1996 to 134 fish from MY2008. There was an order of magnitude fluctuation in $SAR_{BON\text{-}LGR}$ rates (Figure 8). Median $SAR_{BON\text{-}LGR}$ was 0.88% (MY1999, 95% CI 0.52%-1.47%) and ranged from 0.15% (MY2001, 95% CI 0.06%-0.34%) to 4.36% (MY2008, 95% CI 3.68%-5.16%).

Number of PIT tags placed to obtain 10 adult detections varied over three orders of magnitude from 393 tags to 30,248 tags (Table 9). Variation was more extreme across the observed range of $SAR_{BON\text{-}LGR}$ (thirty-fold) than across the observed range of detections at Lower Granite Dam (by a factor of approximately 2.6). For the most likely scenarios (the middle 16 cells in Table 10), number of tags needed ranges from 1,360 to 6,870.

## Diversity

### Adult Migration Timing

**Fish Creek—**There were 32 individual adult steelhead detected in the hydrosystem during the 2012-2013 spawning run that had been PIT tagged in Fish Creek as juveniles. Median date of passage over Bonneville Dam was September 9, but fish passed from August 5

through October 12. All were first detected at Bonneville Dam. The conversion rate from Bonneville Dam to McNary Dam was 84%; from Bonneville Dam to Ice Harbor Dam was 69%; and from Bonneville Dam to Lower Granite Dam was 59%. Given that detection rates of adult salmonids is very high at main stem dams, these numbers approximate survival in the hydrosystem. Only two fish passed Lower Granite Dam during the spring (on March 17 and March 31, 2013). Median date of passage at Lower Granite Dam for fall migrants was October 11. Sixteen PIT-tagged fish were detected at the weir in Fish Creek, one of which had not been detected at Lower Granite Dam. Adjusting for estimated weir efficiency (78%), conversion rate from Lower Granite Dam was 100%; total conversion rate from Bonneville Dam to Fish Creek was 64%.

We also collected 10 PIT-tagged steelhead in Fish Creek that had been tagged elsewhere. Two were tagged as adults in the Columbia estuary near Sandy River, and the remainder were tagged as adults at Lower Granite Dam. There were 15 PIT-tagged kelts that were recovered, of which 11 were detected at the weir. Based on the latter 11 kelts, median time above the weir was 31 days but the range was from 3 to 48 days. The fish that spent only one day above the weir was a large male that was handled four times in a short time period: first passed upstream on June 11, passed downstream on June 12, upstream again on June 13, and downstream for the last time on June 14. This fish had likely spawned below the weir and was roaming.

**Rapid River—**There were three adult steelhead detected in the hydrosystem during the 2012-2013 spawning run that had been PIT tagged in Rapid River as juveniles. Additionally, another three fish passed at the weir had been tagged elsewhere. Of the latter three fish, two were tagged at Lower Granite Dam as adults and one was tagged at Lower Granite Dam as a juvenile. Using all fish tagged as juveniles, median date of passage over Bonneville Dam was September 8; fish passed from September 2 to September 15. The conversion rate from Bonneville Dam to McNary Dam (n = 4) was 100%, from Bonneville Dam to Ice Harbor Dam (n = 4) was 100%, and from Bonneville Dam to Lower Granite Dam (n = 4) was 100%. All fish passed Lower Granite Dam during the fall (including adult-tagged fish); median date of passage at Lower Granite Dam was September 27. Conversion rate from Lower Granite Dam to Rapid River was 25% (n = 1). Total conversion rate from Bonneville Dam to Rapid River was 25%.

**Big Creek—**There were 19 adult steelhead detected in the hydrosystem during the 2012-2013 spawning run that had been PIT tagged at the Big Creek trap as juveniles. Median date of passage over Bonneville Dam was August 11, but fish passed from July 15 through October 31. All fish subsequently detected in the hydrosystem were first detected at Bonneville Dam. The conversion rate from Bonneville Dam to McNary Dam (n = 12) and Bonneville Dam to Lower Granite Dam (n = 12) was 63%. All passed Lower Granite Dam during the fall. Median date of passage was September 24. Seven of these fish were detected at the antenna array at Taylor Ranch in Big Creek. This number is biased low because the detection efficiency of the Taylor Ranch antennae is less than 100% (average 75% for adult steelhead during 2011 and 2012). Adjusting for efficiency gives an estimated total conversion rate from Bonneville Dam to Big Creek of 78%. Median arrival date at Taylor Ranch was April 12 with arrivals ranging from April 3 to April 25.

### Smolt Migration Timing

During spring 2013, there were 2,675 unique detections in the hydrosystem of steelhead smolts tagged in ISMES study streams from 2010 to 2013 (Table 10). Most of the detections (80%) were from fish tagged in Fish Creek; most were tagged in 2012 and reared for a

substantial period downstream of the trap. In contrast, detections of smolts from Rapid River were dominated by fish tagged in 2013. Most detections of fish from Big Creek were from fish tagged during 2012.

The period of smolt emigration was similar among all three populations, although the 10$^{th}$ percentile passage date was not (Table 11). The median arrival dates at Lower Granite Dam were within 5 days of each other (May 6-11). Similarly, the 90$^{th}$ percentile arrival dates were within two days (May 13-15). The 10$^{th}$ percentile arrival dates were different among all locations: April 9, April 12, and April 25 for Fish Creek, Big Creek, and Rapid River, respectively. Most smolts from Rapid River started the spring emigration upstream of the Rapid River trap and were tagged during spring 2013, whereas most smolts from Fish Creek and Big Creek were tagged in fall 2012 and spent the winter downstream of those traps.

### Genetic Diversity

During 2013, we collected genetic samples from wild adult steelhead captured in the course of other project activities. In Fish Creek, 74 genetic samples were taken from adults passed over the weir and 17 samples taken from unmarked kelts. In Rapid River, tissue samples were collected from all 27 adults passed over the hatchery weir. In Big Creek, samples were collected from 25 adults. All samples were archived for later analysis.

## Water Temperature Monitoring

Water temperatures were recorded at 23 locations in the Clearwater River and Salmon River drainages (Table 12). For the Rapid River (Middle Fork Salmon drainage) location, we were unable to access that monitor during 2012 but retrieved it in 2013. Unfortunately, the unit was damaged and the data lost. That unit was replaced with a TidBit v2 monitor and all current locations are now monitored with this type of data logger. In addition to water temperature, we recorded air temperature at Fish Creek. Data were downloaded and stored at the Nampa Fisheries Research office.

# DISCUSSION

Evaluation of the status of steelhead populations in the Columbia basin is conducted using the viable salmonid population (VSP) criteria. As in the previous sections, the discussion is organized in the VSP framework with the following subsections: adult abundance and productivity, juvenile abundance and productivity, spatial structure, and diversity. The work at Lower Granite Dam will not be reviewed here, but will be contained in a separate report issued by all IDFG projects conducting operations at Lower Granite Dam.

## Adult Abundance and Productivity

Abundance and productivity data are of primary importance in ESA assessments of Idaho's steelhead populations. The current assessments by the ICBTRT (2007) use generic A- and B-run population models founded on aggregate data collected at Lower Granite Dam. Key inputs to these analyses were assumed length and age structures. All of Idaho's populations are considered to have a high risk of extinction within 100 years (probability >25%) based on the modeled abundances and productivities. Because distinct population segment (DPS) or evolutionary significant unit (ESU) viability is based on population-level assessments, development of more specific population data is a key data need.

Adult sampling by ISMES has been conducted annually in Fish Creek and Rapid River for many years. Comparison of this year's data with those from the past six years (Table 13) suggests that adult abundance has decreased significantly at Rapid River and Fish Creek. The 2013 abundances were approximately 20% of that observed in 2010. Starting with the 2010 spawn year, PIT-tag detections at the PIT antenna array at Taylor Ranch were used to estimate adult abundance in Big Creek. The estimated spawning run into Big Creek in 2013 was 474 steelhead (95% CI 356-625), which was 68% of the 2011 estimate. Overall abundance of all wild steelhead remains below recovery goals.

We continued to construct brood tables to estimate adult productivity in Fish Creek and Rapid River. The record at Fish Creek is much longer and shows how variable productivity rates can be. For this discussion, we focus on the 1992-2007 brood years. For an even sex ratio, replacement occurs when recruits/spawner = 1.00. Of the 16 brood years under consideration, eight did not replace themselves, with a geometric mean recruits/spawner ratio of 0.61 for those brood years. But when a generation did replace itself, the recruits/spawner ratio could be quite high (up to 10.39 for the 1997 brood year) with a geometric mean of 3.15 recruits/spawner. We speculate that the life history of Fish Creek steelhead (older, larger spawners that are mostly females) is a bet-hedging strategy (Wilbur and Rudolf 2006) that allows rapid population growth when conditions are right. However, productivity is low when spawner abundance is high (Figure 8), evidence of density-dependent forces acting on population production in the last two decades. Density dependence in smolt production has been observed in Potlatch River steelhead (Bowersox et al. 2012) and in spring/summer Chinook salmon in Idaho (Walters et al. 2013). Although the data are much more limited in Rapid River, the steelhead there also show a decline in productivity as spawner abundance increases (Figure 9). Surprisingly, the Rapid River data were consistent with the productivity relationship described for Fish Creek.

## Juvenile Abundance and Productivity

Juvenile abundances fluctuated widely at ISMES screw traps during 2007-2013 (Table 14). ISMES operates three screw traps: at Fish Creek, Big Creek, and Rapid River (Figure 1). Big Creek is the largest of the three streams in which we operate screw traps for this project, explaining the relatively low trapping efficiencies at that trap. However, juvenile abundance had increased in 2013 over that estimated in 2012. For the period 2007-2013, abundances were the second-highest observed in Big Creek and Fish Creek, and third-highest in Rapid River.

This is the first time we have reported juvenile productivity for Rapid River and Fish Creek. Juvenile productivity was strongly density-dependent in both locations (Figure 10). The habitat in Fish Creek is obviously much more productive than that in Rapid River, although the shape of the density relationship is similar. Both exhibit signs of density-dependent juvenile production within the spawning habitat, which is also observed in the Potlatch River (Bowersox et al. 2012). We do not have a long enough series of adult abundances in Big Creek (only the incomplete BY2010) but it would be an interesting comparison. But why is juvenile productivity in Rapid River so low? Almost all of the area upstream of the trap is protected by Wild and Scenic River designation and is in a roadless area, as is the case in Fish Creek also. There are several possibilities, none of which are mutually exclusive. Abundance estimates are biased low because the screw trap cannot be operated during the hatchery release period, but we do not believe we miss the bulk of the spring emigration. More likely is the effect of predation by the abundant bull trout in the drainage, which is exacerbated by older age structure. Regardless, this handicap is overcome later in the life cycle such that the adult productivity of Rapid River is similar to that of Fish Creek. Some out-of-basin force seems to act in a consistent manner

across the range of adult abundances observed. As a result, the strong density dependence in the juvenile habitat carries over to the adult phase and the relationship exhibits a similar shape (decreasing power function).

Another objective was to estimate smolt survival from selected tributaries to Lower Granite Dam, through the hydrosystem, and to adult return. The major confounding issue is that many steelhead do not migrate to the ocean during the anticipated year but frequently delay one or more years. The commonly used model for estimating survival in the Columbia River hydrosystem (SURPH, Lady et al. 2001) assumes that lack of movement equals mortality and that detection probability is equal among individuals. This model may yield biased estimates when used on groups with a flexible life history with respect to migration timing. An alternative has been suggested by Lowther and Skalski (1998) for fall Chinook salmon in the Snake River but it has not been adapted for use by non-statisticians. In October 2013, the Columbia Basin Research group from University of Washington demonstrated a beta version of a branched survival model called TribPit. The intention is to address bugs and feedback in order to have a general release of the software during the winter of 2014.

This is the first time SAR estimates have been produced for a specific steelhead population in Idaho. The estimates we produce start at Lower Granite Dam but end at Bonneville Dam because we desire to avoid the confounding effects of hydrosystem adult passage conditions and fisheries on this metric of ocean survival; therefore, these $SAR_{BON\text{-}LGR}$ estimates are not the same that are usually produced for Snake River stocks, which are Lower Granite-to-Lower Granite ($SAR_{LGR\text{-}LGR}$; e.g., by the Comparative Survival Study [CSS], Tuomikoski et al. 2013). We also differ from CSS methodology by not accounting for routes of juvenile passage. In general, the $SAR_{BON\text{-}LGR}$ reported here are not similar to the $SAR_{LGR\text{-}LGR}$ for the aggregate Snake River wild steelhead but are for the wild B-run $SAR_{LGR\text{-}LGR}$ calculated by Tuomikoski et al. (2013), shifted up because our estimates do not include mortality upstream of Bonneville Dam. However; the $SAR_{BON\text{-}LGR}$ estimates for wild B-run steelhead (MYs 2006-2010) calculated by Tuomikoski et al. (2013) are very similar to our estimates, which is not surprising because most PIT tags placed in B-run steelhead are done at Fish Creek. We also note that mean $SAR_{BON\text{-}LGR}$ during migratory years of court-mandated spill (MY2006 and later) are three times higher than the average before 2006.

We also reviewed the $SAR_{BON\text{-}LGR}$ data with an eye towards adaptive management of our PIT-tagging effort. The CSS group would like as many fish tagged as possible, so we focused more on the utility of our efforts for achieving a reliable $SAR_{BON\text{-}LGR}$ estimate. Over the last five years, we have placed an average of over 8,000 PIT tags in Fish Creek annually. The most likely scenarios in Table 9 show that this effort should be sufficient, especially if $SAR_{BON\text{-}LGR}$ remain >1.0%. The juvenile tag detection rates at Lower Granite Dam are not significantly correlated to $SAR_{BON\text{-}LGR}$ in our data set ($r^2$ = 0.05, $p$=0.42), so the likelihood of achieving 10 adult detections is controlled by the $SAR_{BON\text{-}LGR}$ value. For example, the two lowest juvenile detection rates were 25.01% in MY2005 and 22.04% in MY2007. Given the $SAR_{BON\text{-}LGR}$ experienced by those fish (0.47% in MY2005 and 2.44% in MY2007), the number of tags needed would be >7,700 and <2,000, respectively. Good survival to adult return means fewer tags are needed to estimate survival.

## Diversity

ISMES has contributed a major portion of the current genetic baseline for Snake River steelhead and has added collections from Fish Creek, Rapid River, and Big Creek during 2013. Emphasis has shifted towards application of these data as a baseline to inform genetic stock

identification (GSI) analyses. The GSI work became a separate project in 2010 (project 2010-026-00), but ISMES will continue to collect samples to support genetic baseline maintenance and GSI. Uses of the genetic baseline are reported by Schrader et al. (2011, 2012).

## Water Temperature Monitoring

Part of the extensive monitoring objective was to monitor water temperatures in selected tributaries of the Clearwater and Salmon drainages. ISMES temperature monitoring takes place year-round, whereas many other projects only monitor during the growing season. During 2013, we gathered the entire record of temperature records collected by ISMES into an Access database. These data have been shared with researchers in the US Forest Service and are available on-line (http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html).

## Other Project Activities

Project personnel have engaged in other activities beyond collection of the data reported above. The project leader was a co-author on three manuscripts published by peer-reviewed journals during the year (Walters et al. 2013; Kohler et al. 2013; Thorson et al. 2014). The latter was published online during 2013 but it was included in the first issue of the journal in 2014.

Project personnel have also made several professional presentations during 2013. Four oral papers (three with the Idaho Salmon Supplementation project) and one poster were presented at the 2013 annual meeting of the Western Division American Fisheries Society, April 15-18, 2013, in Boise. One oral paper was presented as an invited talk at the 2013 annual meeting of the Oregon Chapter American Fisheries Society, February 19-22, 2013 in Bend. The project leader organized a symposium at the Boise Western Division AFS meeting entitled "Advancing techniques for modeling salmonid life cycles and population production: considerations and case studies." Two presentations were made at the University of Idaho to the Fish Ecology class and the Palouse Student Subunit of the Idaho Chapter of the American Fisheries Society.

In 2013, we collaborated with the Army Corps of Engineers and Pacific Northwest National Laboratory to study survival and migration of steelhead kelts. We provided access to live steelhead kelts at the Fish Creek weir. The objective was to place acoustic tags in kelts in fair or good condition. A total of 41 kelts were tagged. Of these fish, 22 were detected at receivers at LGD or downstream (Colotelo et al. 2013). Survival rate of Fish Creek kelts declined below Little Goose Dam to <0.4 but a few made it to the Columbia River below Bonneville Dam.

In 2013, we began a collaboration with Dr. Brian Kennedy entitled '*Development of an analytical approach for improving estimates of juvenile salmon and steelhead abundance*' to address problems concerned with estimating abundance based on data collected at screw traps. In particular, recaptures of steelhead at many sites are often inadequate to make reliable abundance estimates, providing the impetus for ISMES to fund this collaboration. The masters-level student (Bryce Oldemeyer) was selected and is participating in the operation of the Big Creek screw trap. The student matriculated in May 2013 and the project is anticipated to continue until spring 2015. A summary of 2013 activities is included in the Appendix.

The scope of ISMES activities has increased the last few years and further increases took place during 2010. The first increase was in May 2008, a result of the Memorandum of Agreement between Bonneville Power and the State of Idaho for a period of 10 years (one of

the Fish Accord projects). In the Idaho Fish Accord, the need was identified for additional monitoring work of Snake River steelhead, particularly B-run populations. Consequently, ISMES was amended to collect scale and genetic samples from wild steelhead at Lower Granite Dam as a VSP assessment at the largest scale. Another increase came in 2010 as part of the regional 'fast-track' proposal solicitation. The largest increase was an expansion of the work at Lower Granite Dam to include sampling of smolts, essentially using Lower Granite Dam to do 'fish in, fish out' monitoring at the largest scale.

The profile of steelhead has risen in the Snake River basin and proposals by various entities are being funded that include work on steelhead; ISMES is collaborating with many of these. Work with the Potlatch River Steelhead Monitoring and Evaluation project and Army Corps of Engineers kelt project are described above. To support their population models, ISEMP is PIT-tagging adult steelhead at Lower Granite Dam; ISMES personnel work with ISEMP and NOAA Fisheries staff (project 2005-020-00) to collect samples from these fish. Reconstruction of steelhead runs into the Snake River was identified as a key part of the Anadromous Salmonid Monitoring Strategy developed for the Columbia River basin by the management agencies in 2009. The run reconstruction objective was developed into a proposal by the Nez Perce Tribe and Idaho Department of Fish and Game and approved for funding by Bonneville Power Administration in 2011. An interagency workgroup was first convened in 2012 under the aegis of ISMES and an initial approach outlined and completed. In 2013, the workgroup was convened again and a run reconstruction of the 2010-2011 steelhead spawning run to the Snake River basin was completed (Copeland et al. 2013). We conducted a run reconstruction of the 2011-2012 steelhead spawning run as this report was being finished (Copeland et al. 2014).

## SUMMARY

In conclusion, ISMES has been the primary monitoring and evaluation project collecting data on wild steelhead in Idaho. During 2013, ISMES continued to generate data relevant to the viable salmonid population criteria: abundance, productivity, spatial structure, and diversity. A large archive of adult and juvenile age data has been developed. We have begun to estimate adult-to-adult productivities for steelhead in Idaho using specific age data. The development of Big Creek as an intensively monitored watershed continues and individual data on adults were collected there for the second time in 2011. Other recent expansions to ISMES include data collection at Lower Granite Dam and a number of collaborations with other projects focusing on steelhead. The 2008 Biological Opinion for the operation of the Federal Columbia River Power System depends on the actions to avoid jeopardy including Reasonable and Prudent Alternative 50.5 (*Provide additional status monitoring to ensure a majority of Snake River B-Run steelhead populations are being monitored for population productivity and abundance*). ISMES fulfills the objective of more monitoring of Idaho's steelhead populations by the work it does and by coordination with cooperating projects. Two of the three watersheds where we conduct life cycle monitoring (Fish Creek and Big Creek) are in B-run steelhead populations. Work at Lower Granite Dam covers all steelhead populations upstream. We have developed relationships with projects running weirs for steelhead to provide age composition data. Similarly we are coordinating the collection of scale samples and PIT tagging of juvenile steelhead throughout Idaho. This project is vital to the assessment of the status of steelhead populations pursuant to the Endangered Species Act and the Federal Columbia River Power System 2008 Biological Opinion.

## ACKNOWLEDGEMENTS

We are grateful to the Bonneville Power Administration (BPA) and David Byrnes, our contracting officer's technical representative, for support and funding of this project (1991-055-00) conducted under contract number 59800. Fieldwork was conducted by Chrystal Allen, Matt Amick, Joseph Blackburn, Jesse Handy, Ryan Johnson, and Bryce Oldemeyer. Scales were aged by Kristin Ellsworth, Kala Hernandez, Cliff Hohman, Leslie Reinhardt and Will Schrader. Cheryl Zink helped format and edit the document. The final report was improved after reviews by Lance Hebdon and Bill Schrader.

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Table 1. Capture date percentiles of adult steelhead in Fish Creek (Lochsa River population), Rapid River (Little Salmon River population), and Big Creek (Lower Middle Fork Salmon River population) during 2013. N = number of fish.

| Life stage | Sex | N | Date percentile attained | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | First | 10% | 25% | 50% | 75% | 90% | Last |
| *Fish Creek* | | | | | | | | | |
| Spawner | Female | 51 | 3/30 | 4/21 | 4/27 | 5/7 | 5/18 | 5/26 | 6/4 |
| Spawner | Male | 23 | 3/28 | 3/29 | 4/22 | 5/8 | 5/16 | 5/28 | 6/11 |
| Spawner | All | 74 | 3/28 | 4/3 | 4/27 | 5/7 | 5/18 | 5/27 | 6/11 |
| Kelt | Female | 64 | 5/21 | 5/23 | 5/27 | 6/2 | 6/9 | 6/16 | 6/28 |
| Kelt | Male | 11 | 5/19 | 5/23 | 5/25 | 6/2 | 6/8 | 6/13 | 6/20 |
| Kelt | All | 75 | 5/19 | 5/23 | 5/26 | 6/2 | 6/9 | 6/16 | 6/28 |
| *Rapid River* | | | | | | | | | |
| Spawner | Female | 15 | 4/10 | 4/22 | 4/24 | 4/29 | 5/10 | 5/29 | 6/5 |
| Spawner | Male | 12 | 4/22 | 4/22 | 4/27 | 5/2 | 5/10 | 5/29 | 6/5 |
| Spawner | All | 27 | 4/10 | 4/22 | 4/24 | 4/29 | 5/10 | 5/29 | 6/5 |

Table 2. The number and mean fork length, by sex, of wild adult steelhead captured in Fish Creek (Lochsa River population), Rapid River (Little Salmon River population), and Big Creek (Lower Middle Fork Salmon River population) during 2013.

| Sex | Adult spawners trapped | Unmarked kelts recovered | Marked kelts recovered | Fork length (cm) | | |
|---|---|---|---|---|---|---|
| | | | | Mean | Minimum | Maximum |
| *Fish Creek* | | | | | | |
| Female | 51 | 17 | 47 | 79 | 61 | 89 |
| Male | 23 | 0 | 11 | 80 | 58 | 93 |
| All | 74 | 17 | 58 | 79 | 58 | 93 |
| *Rapid River* | | | | | | |
| Female | 15 | 0 | 0 | 72 | 57 | 80 |
| Male | 12 | 0 | 0 | 68 | 55 | 84 |
| All | 27 | 0 | 0 | 70 | 55 | 84 |
| *Big Creek* | | | | | | |
| Female | 14 | 0 | 0 | 72 | 60 | 86 |
| Male | 11 | 0 | 0 | 70 | 58 | 83 |
| All | 25 | 0 | 0 | 71 | 58 | 86 |

Table 3. Number of fish by age of adult steelhead sampled at weirs during spring 2013. Age values before the period denote freshwater ages and values after denote saltwater ages. X means a freshwater age was not assigned and R signifies repeat spawner.

| Location | Population | 1.1 | 1.2 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 4.1 | 4.2 | R | x.1 | x.2 | n/a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Clearwater MPG* | | | | | | | | | | | | | | |
| Fish Creek | Lochsa | -- | 2 | 6 | 29 | 1 | 1 | 34 | -- | 1 | -- | -- | 17 | -- |
| Crooked River | SF Clearwater | -- | -- | -- | 6 | 1 | -- | 2 | -- | -- | -- | -- | 1 | 2 |
| *Salmon MPG* | | | | | | | | | | | | | | |
| Rapid River | Little Salmon | -- | -- | 7 | 4 | -- | 3 | 7 | -- | -- | -- | 1 | 5 | -- |
| SF Salmon | South Fk Salmon | -- | -- | -- | 2 | -- | 1 | 1 | -- | -- | -- | -- | -- | 1 |
| Big Creek | Lower MF Salmon | -- | -- | 1 | 3 | -- | 3 | 10 | 2 | -- | -- | -- | 5 | 1 |
| Pahsimeroi | Pahsimeroi | 11 | 15 | 60 | 32 | -- | 5 | 3 | 1 | -- | 3 | 14 | 16 | 17 |
| EF Salmon | East Fork Salmon | -- | -- | 2 | 7 | -- | 4 | 11 | -- | -- | 1 | -- | 5 | -- |
| Sawtooth | Upper Salmon | -- | -- | 8 | 16 | -- | -- | 1 | 1 | -- | 1 | 1 | 5 | 6 |

Table 4. Age composition of adult recruits by brood year, number of parent spawners and adult-to-adult productivity estimates (recruits/spawner) of steelhead returning to Fish Creek and Rapid River. Accounting is incomplete for brood years with dashes in any age column.

| Brood | Number of adult recruits by age (years) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 3 | 4 | 5 | 6 | 7 | Sum | Parents | Productivity |
| *Fish Creek* | | | | | | | | |
| 1992 | 0 | 0 | 9 | 38 | 3 | 50 | 105 | 0.48 |
| 1993 | 0 | 2 | 39 | 51 | 0 | 92 | 267 | 0.35 |
| 1994 | 0 | 1 | 22 | 17 | 1 | 41 | 70 | 0.59 |
| 1995 | 0 | 1 | 14 | 42 | 3 | 60 | 70 | 0.86 |
| 1996 | 0 | 2 | 31 | 82 | 0 | 115 | 39 | 2.95 |
| 1997 | 0 | 1 | 119 | 167 | 0 | 287 | 28 | 10.25 |
| 1998 | 0 | 38 | 166 | 72 | 0 | 276 | 80 | 3.45 |
| 1999 | 0 | 9 | 124 | 71 | 0 | 204 | 77 | 2.65 |
| 2000 | 0 | 10 | 46 | 58 | 0 | 114 | 33 | 3.46 |
| 2001 | 0 | 4 | 59 | 4 | 0 | 67 | 75 | 0.89 |
| 2002 | 0 | 2 | 45 | 34 | 8 | 89 | 242 | 0.37 |
| 2003 | 0 | 29 | 67 | 170 | 2 | 268 | 343 | 0.78 |
| 2004 | 3 | 33 | 40 | 98 | 20 | 194 | 206 | 0.94 |
| 2005 | 0 | 0 | 89 | 271 | 3 | 363 | 121 | 3.00 |
| 2006 | 0 | 16 | 194 | 79 | 0 | 289 | 119 | 2.43 |
| 2007 | 0 | 6 | 64 | 44 | -- | 114 | 81 | 1.41 |
| 2008 | 3 | 6 | 40 | -- | -- | 49 | 134 | 0.37 |
| 2009 | 0 | 11 | -- | -- | -- | 11 | 218 | 0.05 |
| *Rapid River* | | | | | | | | |
| 2001 | -- | -- | -- | 2 | 4 | 6 | 31 | 0.19 |
| 2002 | -- | -- | 10 | 20 | 2 | 32 | 106 | 0.30 |
| 2003 | -- | 16 | 38 | 18 | 0 | 72 | 87 | 0.83 |
| 2004 | 3 | 26 | 67 | 22 | 1 | 119 | 120 | 0.99 |
| 2005 | 0 | 21 | 72 | 40 | 5 | 138 | 81 | 1.70 |
| 2006 | 0 | 53 | 70 | 22 | 0 | 145 | 99 | 1.47 |
| 2007 | 4 | 21 | 36 | 9 | -- | 70 | 32 | 2.19 |
| 2008 | 1 | 18 | 9 | -- | -- | 28 | 88 | 0.32 |
| 2009 | 0 | 9 | -- | -- | -- | 9 | 108 | 0.08 |

Table 5. Age composition of juvenile steelhead captured at screw traps within the Clearwater and Salmon drainages during spring 2013 (March 1–May 31).

| | | | Proportion | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Population** | **n** | **Age 1** | **Age 2** | **Age 3** | **Age 4** | **Age 5** |
| *Clearwater MPG* | | | | | | | |
| American River | SF Clearwater | 21 | -- | 0.238 | 0.714 | 0.048 | -- |
| Crooked River | SF Clearwater | 193 | 0.052 | 0.425 | 0.518 | 0.005 | -- |
| Red River | SF Clearwater | 41 | 0.195 | 0.537 | 0.244 | 0.024 | -- |
| Fish Creek | Lochsa | 39 | 0.077 | 0.615 | 0.154 | 0.154 | -- |
| Lolo Creek | Lolo Creek | 119 | 0.412 | 0.496 | 0.092 | -- | -- |
| Clear Creek | Lower Clearwater | 246 | 0.321 | 0.561 | 0.114 | 0.004 | -- |
| *Salmon MPG* | | | | | | | |
| Rapid River | Little Salmon | 185 | 0.011 | 0.108 | 0.551 | 0.303 | 0.027 |
| SF Salmon at Knox | SF Salmon | 93 | 0.086 | 0.860 | 0.054 | -- | -- |
| Big Creek | Lower MF Salmon | 233 | 0.361 | 0.172 | 0.361 | 0.107 | -- |
| Marsh Creek | Upper MF Salmon | 124 | 0.040 | 0.629 | 0.274 | 0.048 | 0.008 |
| Pahsimeroi River | Pahsimeroi | 92 | 0.315 | 0.630 | 0.054 | -- | -- |
| Yankee Fork | Upper Salmon | 74 | 0.256 | 0.500 | 0.230 | 0.014 | -- |
| Salmon at Sawtooth | Upper Salmon | 143 | 0.566 | 0.420 | 0.014 | -- | -- |

Table 6. Age composition of juvenile steelhead captured at screw traps in locations within the Clearwater and Salmon drainages during summer 2013 (June 1–August 14).

| | | | Proportion | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Population** | **n** | **Age 0** | **Age 1** | **Age 2** | **Age 3** | **Age 4** |
| *Clearwater MPG* | | | | | | | |
| American River | SF Clearwater | 41 | 0.024 | 0.829 | 0.146 | -- | -- |
| Crooked River | SF Clearwater | 62 | -- | 0.403 | 0.436 | 0.161 | -- |
| Red River | SF Clearwater | 87 | -- | 0.586 | 0.161 | 0.230 | 0.023 |
| Fish Creek | Lochsa | 72 | -- | 0.181 | 0.708 | 0.111 | -- |
| Lolo Creek | Lolo Creek | 61 | -- | 0.820 | 0.180 | -- | -- |
| *Salmon MPG* | | | | | | | |
| Rapid River | Little Salmon | 6 | -- | 0.833 | -- | 0.167 | -- |
| SF Salmon at Knox | SF Salmon | 208 | -- | 0.591 | 0.389 | 0.014 | 0.005 |
| Big Creek | Lower MF Salmon | 179 | -- | 0.553 | 0.413 | 0.034 | -- |
| Bear Valley Creek | Upper MF Salmon | 75 | -- | 0.613 | 0.347 | 0.040 | -- |
| Marsh Creek | Upper MF Salmon | 77 | -- | 0.377 | 0.520 | 0.104 | -- |
| Pahsimeroi River | Pahsimeroi | 10 | 0.400 | 0.400 | 0.100 | 0.100 | -- |
| Yankee Fork | Upper Salmon | 282 | 0.004 | 0.599 | 0.344 | 0.042 | 0.011 |
| Salmon at Sawtooth | Upper Salmon | 21 | -- | 0.905 | 0.095 | -- | -- |

Table 7. Age composition of juvenile steelhead captured at screw traps in locations within the Clearwater and Salmon drainages during fall 2013 (August 15–November 31).

| | | | Proportion | | | |
|---|---|---|---|---|---|---|
| **Location** | **Population** | **n** | **Age 0** | **Age 1** | **Age 2** | **Age 3** |
| *Clearwater MPG* | | | | | | |
| American River | SF Clearwater | 11 | -- | 0.636 | -- | 0.364 |
| Crooked River | SF Clearwater | 35 | -- | 0.800 | 0.200 | -- |
| Red River | SF Clearwater | 71 | -- | 0.873 | 0.113 | 0.014 |
| Fish Creek | Lochsa | 252 | -- | 0.242 | 0.698 | 0.060 |
| Lolo Creek | Lolo Creek | 58 | -- | 0.603 | 0.397 | -- |
| *Salmon MPG* | | | | | | |
| Rapid River | Little Salmon | 103 | -- | 0.165 | 0.631 | 0.204 |
| SF Salmon at Knox | SF Salmon | 78 | -- | 0.781 | 0.180 | 0.039 |
| Big Creek | Lower MF Salmon | 43 | 0.023 | 0.256 | 0.372 | 0.349 |
| Bear Valley Creek | Upper MF Salmon | 96 | 0.010 | 0.615 | 0.375 | -- |
| Marsh Creek | Upper MF Salmon | 36 | -- | 0.389 | 0.528 | 0.083 |
| Pahsimeroi River | Pahsimeroi | 121 | 0.703 | 0.289 | 0.528 | -- |
| Yankee Fork | Upper Salmon | 237 | 0.021 | 0.700 | 0.262 | 0.017 |
| Salmon at Sawtooth | Upper Salmon | 18 | 0.278 | 0.666 | 0.056 | -- |

Table 8. Age composition of juvenile emigrants by brood year, number of female spawners and adult-to-juvenile productivity estimates (emigrants/spawner) of steelhead spawned in Fish Creek, Rapid River, and Big Creek. Accounting is incomplete for brood years with dashes in any age column.

| Brood | Number of emigrants by age (years) | | | | | | | Female | |
|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | Sum | Parents | Productivity |
| *Fish Creek* | | | | | | | | | |
| 1995 | -- | 8,614 | 8,693 | 1,944 | 115 | 0 | 19,366 | 37 | 523.4 |
| 1996 | 0 | 5,144 | 9,088 | 1,684 | 141 | 0 | 16,057 | 26 | 617.6 |
| 1997 | 112 | 6,512 | 10,425 | 1,929 | 86 | 0 | 19,064 | 13 | 1,466.5 |
| 1998 | 58 | 11,840 | 13,225 | 2,964 | 49 | 0 | 28,136 | 46 | 611.7 |
| 1999 | 384 | 9,223 | 18,137 | 1,868 | 31 | 0 | 29,643 | 62 | 478.1 |
| 2000 | 146 | 9,882 | 6,591 | 1,987 | 0 | 0 | 18,606 | 19 | 979.3 |
| 2001 | 278 | 10,179 | 22,773 | 1,480 | 0 | 0 | 34,710 | 57 | 608.9 |
| 2002 | 0 | 19,994 | 21,926 | 2,391 | 0 | 0 | 44,311 | 163 | 271.8 |
| 2003 | 504 | 19,551 | 22,636 | 2,652 | 172 | 0 | 45,515 | 241 | 188.9 |
| 2004 | 332 | 26,736 | 16,206 | 2,168 | 76 | 0 | 45,518 | 129 | 352.9 |
| 2005 | 1,500 | 11,259 | 12,408 | 1,367 | 97 | 0 | 26,631 | 82 | 324.8 |
| 2006 | 382 | 9,323 | 9,762 | 1,467 | 173 | 0 | 21,107 | 74 | 285.2 |
| 2007 | 56 | 4,742 | 10,663 | 1,551 | 0 | 0 | 17,012 | 49 | 347.2 |
| 2008 | 0 | 6,188 | 12,152 | 1,218 | 0 | 0 | 19,558 | 87 | 224.8 |
| 2009 | 60 | 16,407 | 31,483 | 3,088 | 126 | -- | 51,164 | 157 | 325.9 |
| 2010 | 0 | 15,899 | 19,405 | 2,652 | -- | -- | 37,956 | 131 | 289.7 |
| 2011 | 0 | 8,207 | 25,566 | -- | -- | -- | 33,773 | 398 | -- |
| 2012 | 73 | 8,315 | -- | -- | -- | -- | 8,388 | 126 | -- |
| 2013 | 0 | -- | -- | -- | -- | -- | 0 | 71 | -- |
| *Rapid River* | | | | | | | | | |
| 2006 | -- | 1,433 | 1,955 | 1,271 | 261 | 0 | 4,920 | 71 | 69.3 |
| 2007 | 169 | 744 | 1,915 | 1,666 | 314 | 0 | 4,808 | 21 | 229.0 |
| 2008 | 102 | 486 | 881 | 1,135 | 235 | 73 | 2,912 | 46 | 63.3 |
| 2009 | 18 | 291 | 1,532 | 813 | 816 | -- | 3,470 | 63 | 55.1 |
| 2010 | 0 | 495 | 1,868 | 1,884 | -- | -- | 4,247 | 116 | -- |
| 2011 | 0 | 811 | 1,465 | -- | -- | -- | 2,276 | 101 | -- |
| 2012 | 25 | 426 | -- | -- | -- | -- | 451 | 57 | -- |
| 2013 | 0 | -- | -- | -- | -- | -- | 0 | 15 | -- |
| *Big Creek* | | | | | | | | | |
| 2006 | -- | 12,423 | 19,195 | 3,379 | 224 | 8 | 35,229 | -- | -- |
| 2007 | 427 | 18,912 | 12,277 | 4,883 | 1,014 | 0 | 37,513 | -- | -- |
| 2008 | 308 | 5,949 | 14,442 | 6,482 | 89 | 0 | 27,270 | -- | -- |
| 2009 | 68 | 9,166 | 19,462 | 6,242 | 703 | -- | 35,641 | -- | -- |
| 2010 | 0 | 7,926 | 18,995 | 5,601 | -- | -- | 32,522 | 594 | 58.4 |
| 2011 | 0 | 3,389 | 15,009 | -- | -- | -- | 18,398 | 478 | -- |
| 2012 | 89 | 19,332 | -- | -- | -- | -- | 19,421 | 259 | -- |
| 2013 | 154 | -- | -- | -- | -- | -- | 154 | 307 | -- |

Table 9. Number of PIT tags placed needed to achieve 10 adult detections at Bonneville Dam for selected scenarios with varying detection rate of smolts at Lower Granite Dam and smolt-to-adult return rates. Rates are based on detections from migratory years 1996-2010 of steelhead tagged in Fish Creek.

| Detection | Smolt-to-adult return rate | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rate** | **0.15%** | **0.32%** | **0.47%** | **0.88%** | **1.22%** | **1.65%** | **2.34%** | **4.36%** |
| 22.04% | 30,248 | 14,179 | 9,654 | 5,156 | 3,719 | 2,750 | 1,939 | 1,041 |
| 27.54% | 24,207 | 11,347 | 7,726 | 4,126 | 2,976 | 2,201 | 1,552 | 833 |
| 30.97% | 21,526 | 10,090 | 6,870 | 3,669 | 2,647 | 1,957 | 1,380 | 741 |
| 38.69% | 17,231 | 8,077 | 5,499 | 2,937 | 2,119 | 1,566 | 1,105 | 593 |
| 39.40% | 16,920 | 7,931 | 5,400 | 2,884 | 2,080 | 1,538 | 1,085 | 582 |
| 44.57% | 14,958 | 7,011 | 4,774 | 2,550 | 1,839 | 1,360 | 959 | 515 |
| 55.19% | 12,079 | 5,662 | 3,855 | 2,059 | 1,485 | 1,098 | 774 | 416 |
| 58.32% | 11,431 | 5,358 | 3,648 | 1,948 | 1,405 | 1,039 | 733 | 393 |

Table 10. Number of PIT-tagged steelhead smolts that were detected in the hydrosystem during 2013 by population and year tagged. See Methods for a list of interrogation sites.

| | | Number detected by year tagged | | | | |
|---|---|---|---|---|---|---|
| **Stream** | **Population** | **2010** | **2011** | **2012** | **2013** | **Total** |
| Fish Creek | Lochsa | 4 | 397 | 1736 | 6 | 2,143 |
| Rapid River | Little Salmon | 0 | 0 | 33 | 133 | 166 |
| Big Creek | Lower MF Salmon | 3 | 45 | 270 | 48 | 366 |

Table 11. Percentile dates of arrival at Lower Granite Dam for PIT-tagged steelhead smolts detected in spring 2013.

| | | Percentile | | |
|---|---|---|---|---|
| **Stream** | **Population** | **10%** | **50%** | **90%** |
| Fish Creek | Lochsa | 4/9 | 5/9 | 5/13 |
| Rapid River | Little Salmon | 4/25 | 5/11 | 5/14 |
| Big Creek | Lower MF Salmon | 4/12 | 5/6 | 5/15 |

Table 12. Streams sampled for water temperatures in 2013. Measurements were taken within 1 km of the mouth of each stream unless otherwise noted.

| |
|---|
| *Salmon River drainage* |
| Big Creek (tributary of Middle Fork Salmon River) at Taylor Ranch |
| Marsh Creek, 100 m downstream of screw trap site |
| Pahsimeroi River at weir |
| Rapid River (tributary of Middle Fork Salmon River), upstream of bridge |
| Rapid River at Rapid River Fish Hatchery |
| Redfish Lake Creek at weir |
| Salmon River at Sawtooth Fish Hatchery |
| Valley Creek, 200 m upstream of Meadow Creek |
| |
| *Clearwater River drainage* |
| Boulder Creek |
| Brushy Fork Creek |
| Crooked Fork Creek, 50 m upstream of Brushy Fork Creek |
| Fish Creek #1 at screw trap site |
| Fish Creek #2, 50 m downstream of screw trap site (backup) |
| Fish Creek #3, 2 km upstream of Hungery Creek |
| Gedney Creek, 2 km upstream of mouth |
| Hungery Creek |
| Indian Creek (tributary of Selway River) |
| Little Clearwater River (tributary of Selway River) |
| Red River, 100 m downstream of South Fork Red River |
| Selway River, at Magruder Cabin |
| Selway River, near Cache Creek (7.6 km downstream of Selway Falls) |
| White Cap Creek (tributary of Selway River), downstream of Paradise Cabin |
| Willow Creek (tributary of Fish Creek) |

Table 13. Abundance of wild adult steelhead in Fish Creek (Lochsa River population), Rapid River (Little Salmon River population), and Big Creek (Lower Middle Fork Salmon River population), 2007-2013. 95 % confidence intervals are given in parentheses; Rapid River abundance is a census.

| | Spawn Year | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Fish Creek | 81 (**79-96**) | 134 (**84-184**) | 218 (**152-312**) | 205 (**164-255**) | 494 (**355-689**) | 152 (**126-183**) | 95 (**81-111**) |
| Rapid River | 32 | 88 | 108 | 150 | 133 | 81 | 27 |
| Big Creek | -- | -- | -- | 803 **(368-2,532)** | 693 **(494-950)** | 386 **(221-832)** | 474 **(356-625)** |

Table 14. Abundance of wild juvenile steelhead in Fish Creek (Lochsa River population), Rapid River (Little Salmon River population), and Big Creek (Lower Middle Fork Salmon River population), 2007-2013. Confidence intervals (95%) are in parentheses.

| Location | Population | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| Fish Creek | Lochsa | 24,127 (22,008-24,492) | 15,946 (14,697-17,313) | 15,278 (14,352-16,048) | 30,282 (28,690-31,881) | 48,478 (46,360-50,843) | 30,451 (28,912-32,003) | 36,555 (34,286-38,287) |
| Rapid River | Little Salmon | 5,632 (4,108-7,091) | 5,165 (3,912-6,082) | 3,877 (2,844-5,316) | 3,099 (2,093-4,661) | 3,476 (2,167-4,019) | 3,615 (1,864-6,629) | 4,664 (3,266-6,702) |
| Big Creek | Lower MF Salmon | 23,527 (20,083-27,861) | 52,943 (41,825-67,623) | 24,683 (20,325-30,649) | 28,715 (25,006-33,426) | 34,891 (29,443-42,543) | 28,804 (21,141-41,524) | 40,799 (22,202-68,045) |

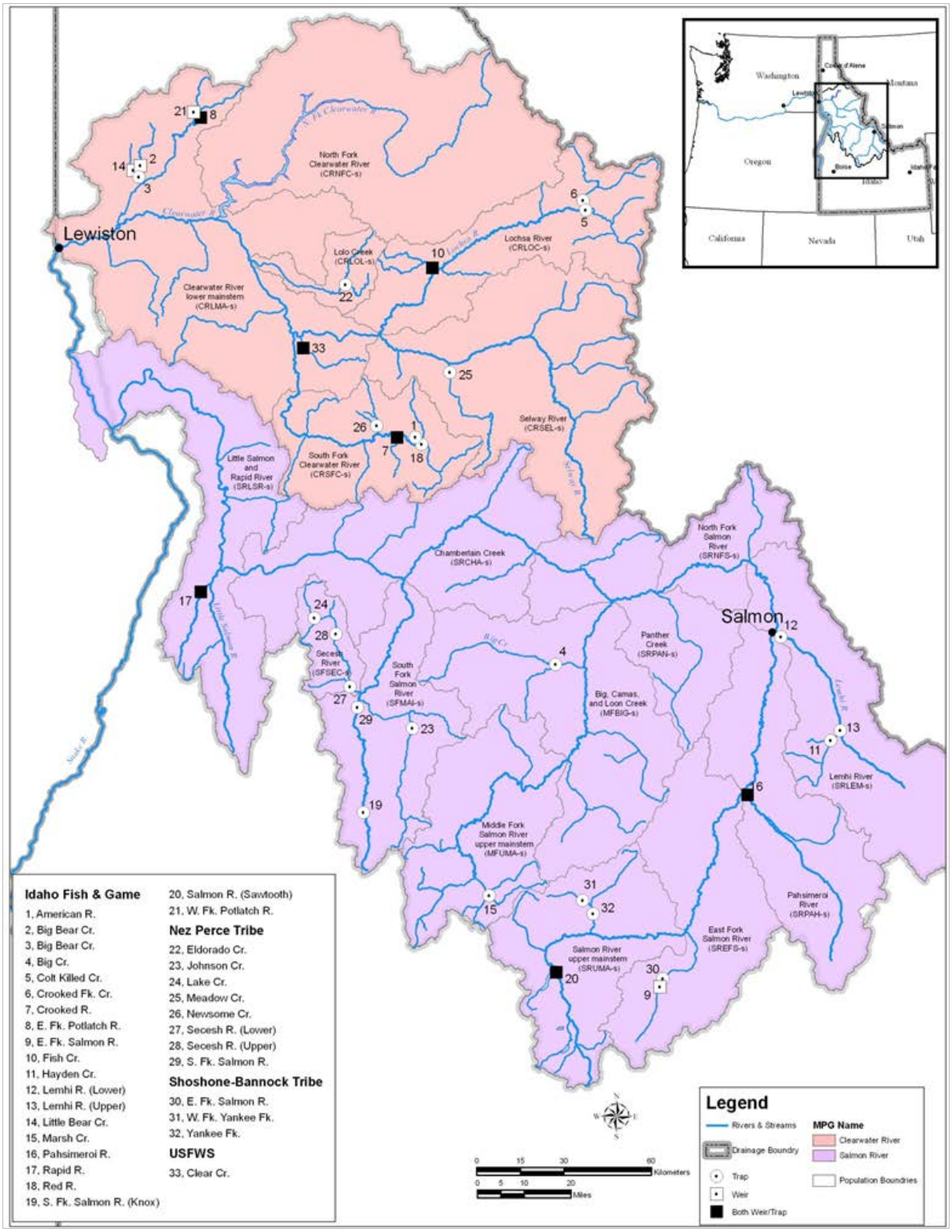


Figure 1. Locations of weirs and screw traps sampling steelhead in Idaho. The Clearwater River Major Population Group is in pink, the Salmon River is in purple. Populations are labeled and boundaries are shown as light gray lines.

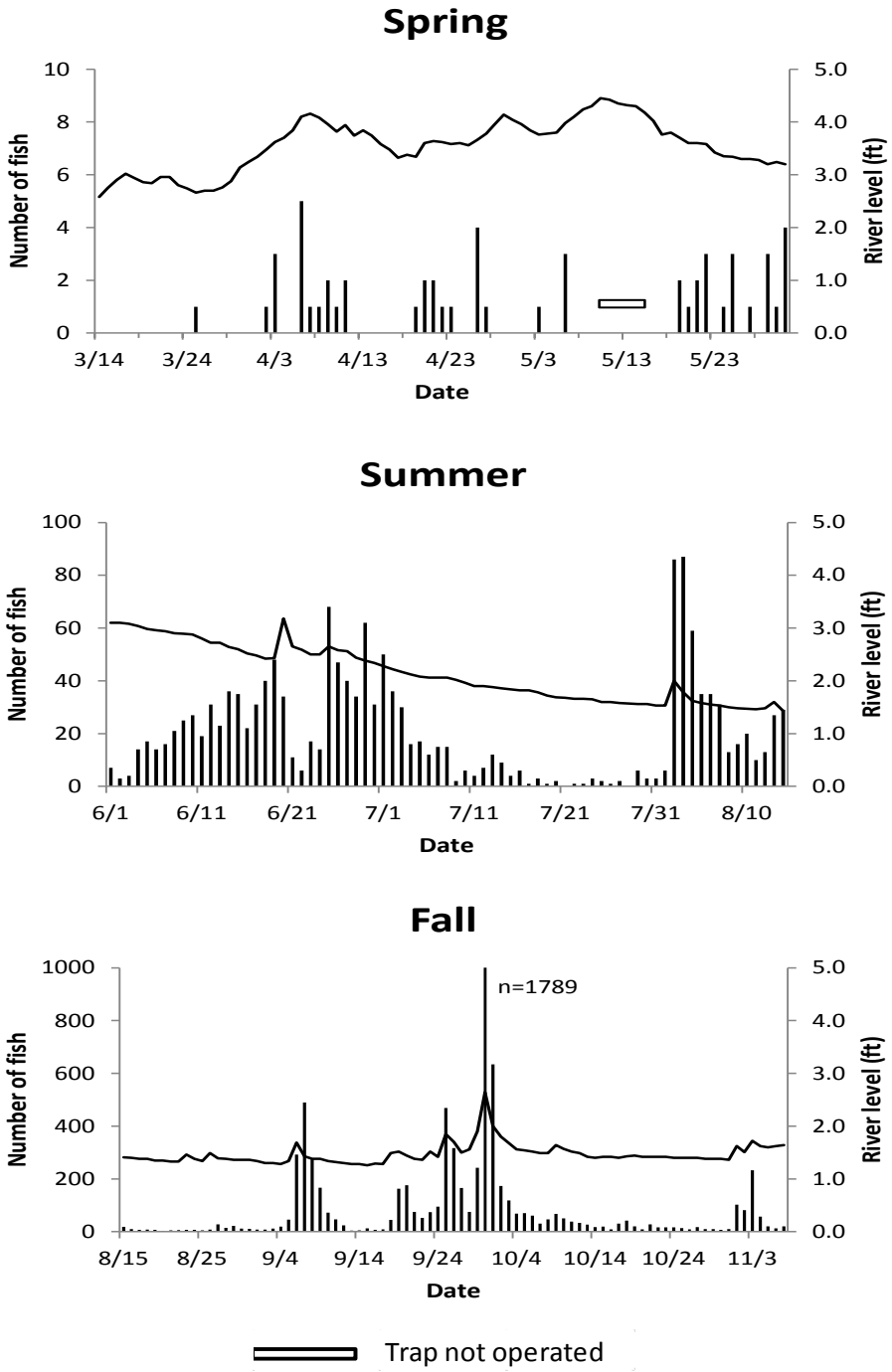


Figure 2. Daily number of newly-captured steelhead juveniles (bars) captured in the Fish Creek screw trap and river level (line; ft) during 2013. Spring (n = 55) is top panel; summer (n = 1,537) is middle panel; and fall (n = 7,670) is bottom panel. Note difference in the left-axis scale in each panel.

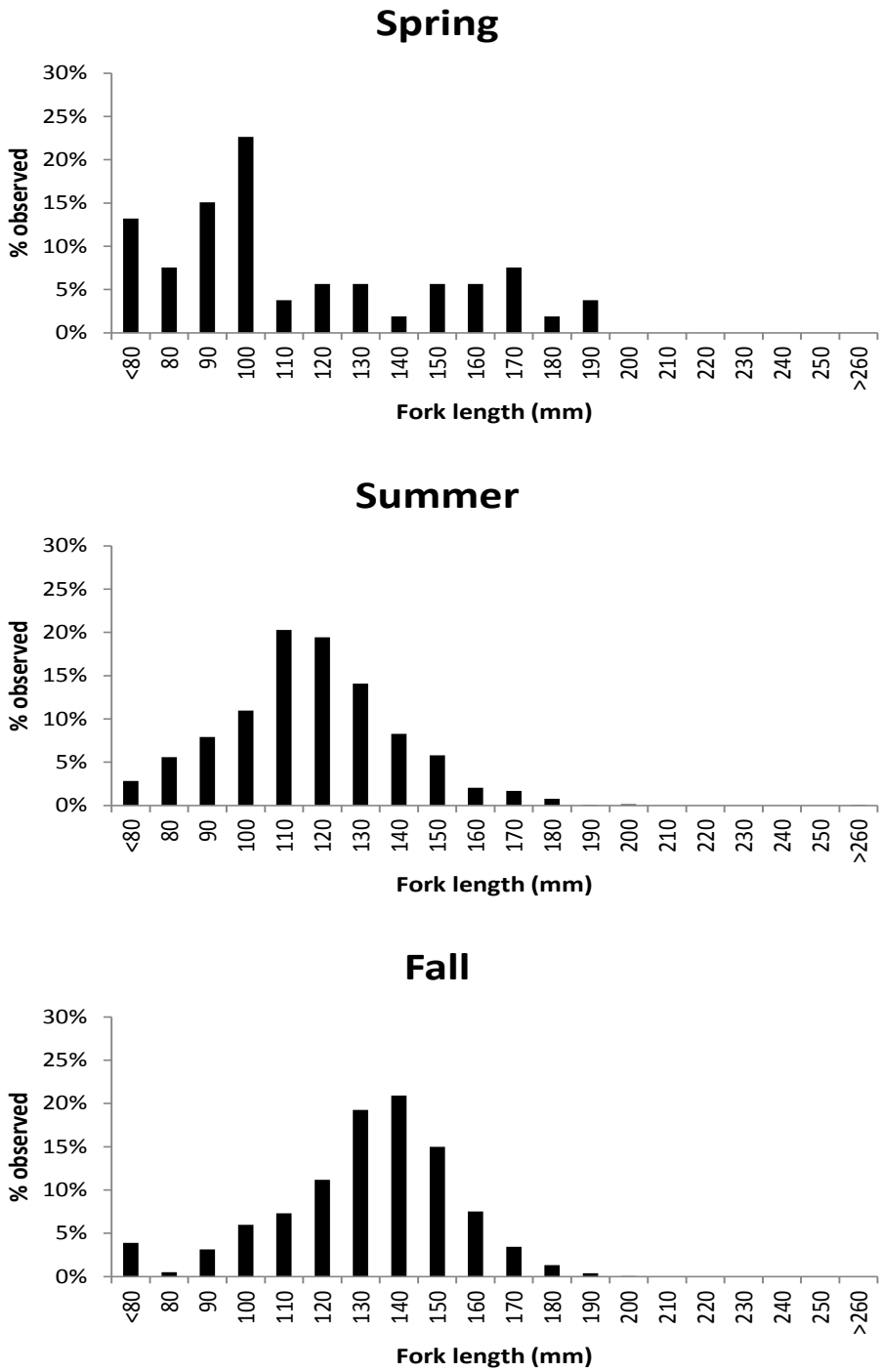


Figure 3. Relative length frequency of steelhead juveniles captured in the Fish Creek screw trap during 2011. Spring (n = 53) is top panel; summer (n = 1,414) is middle panel; and fall (n = 5,908) is bottom panel. Note that some fish were released without being measured.

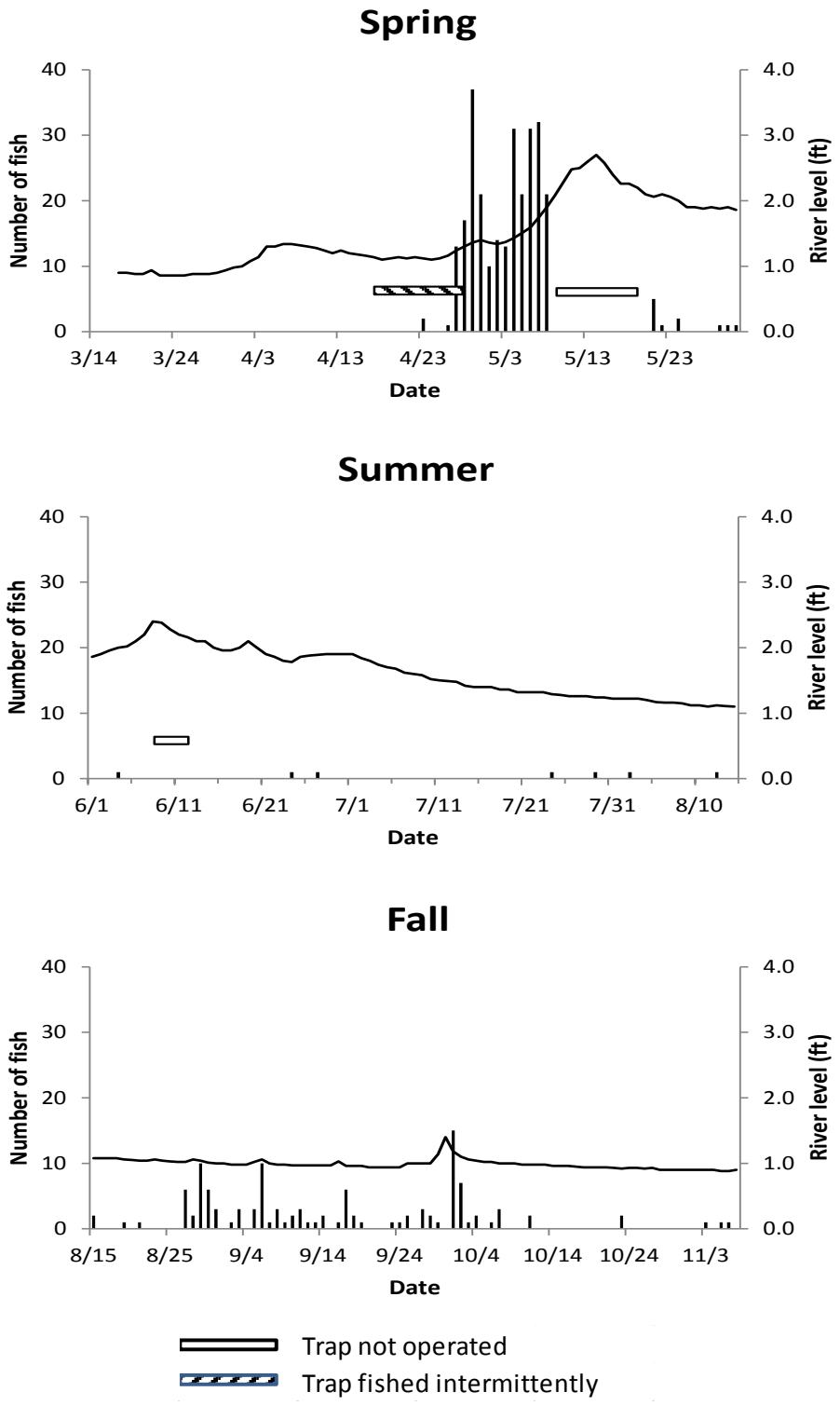


Figure 4. Daily number of steelhead juveniles (bars) captured in the Rapid River screw trap and river level (line; ft) during 2013. Spring (n = 275) is top panel; summer (n = 7) is middle panel; and fall (n = 118) is bottom panel.

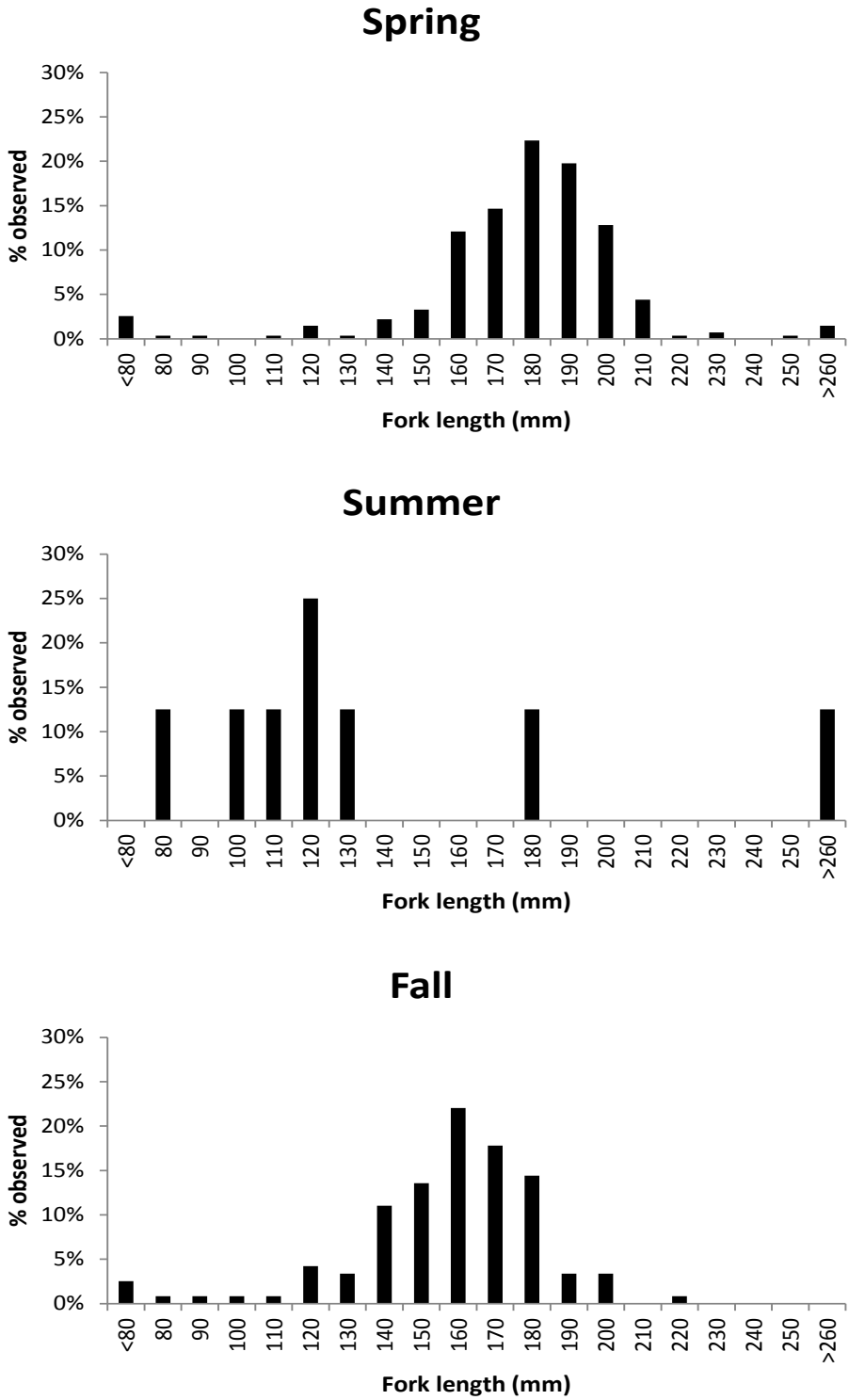


Figure 5. Relative length frequency of steelhead juveniles captured in the Rapid River screw trap during 2013. Spring (n = 273) is top panel; summer (n = 7) is middle panel; and fall (n = 118) is bottom panel. Note that some fish were released without being measured.

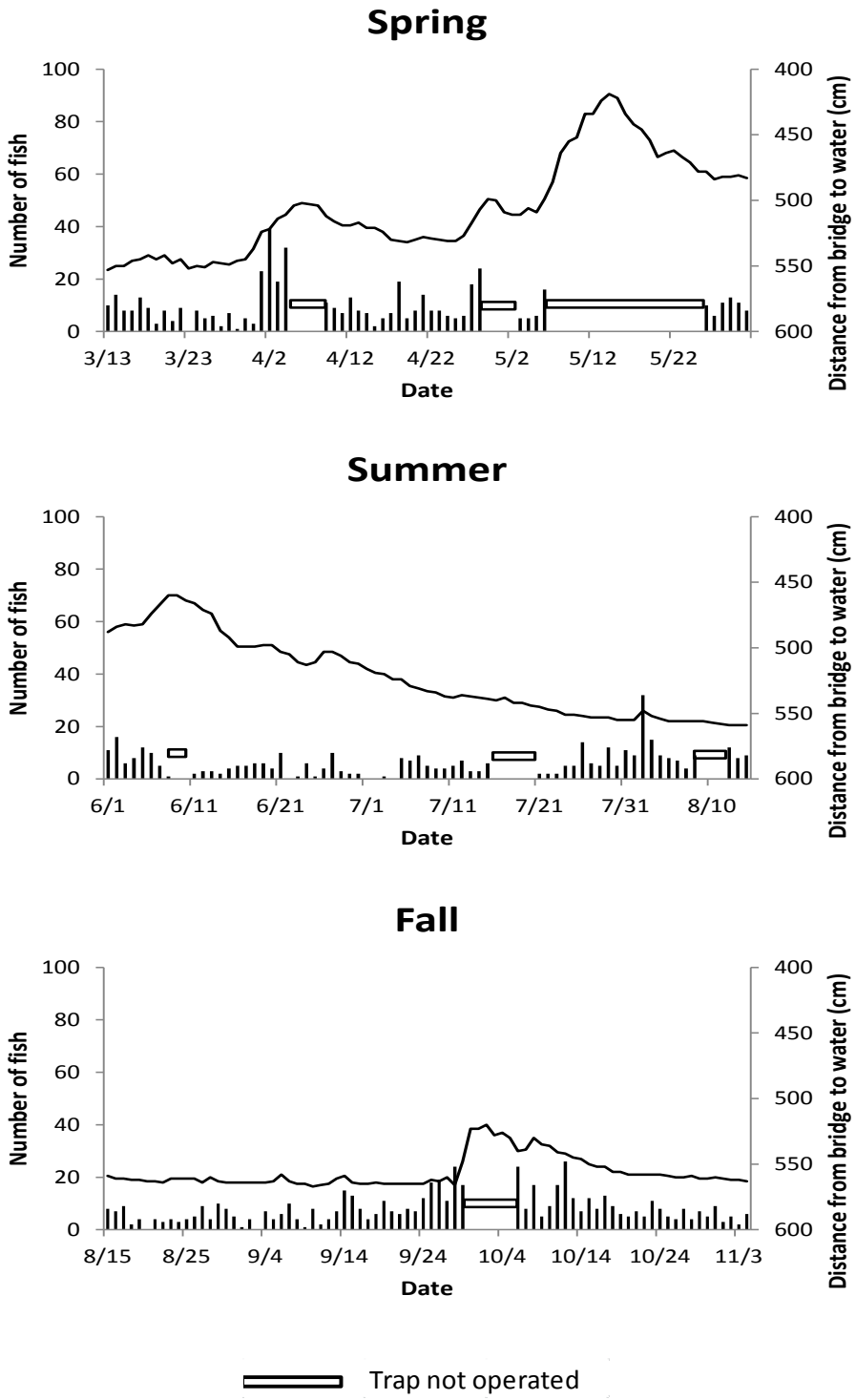


Figure 6. Daily number of steelhead juveniles (bars) captured in the Big Creek screw trap and distance from pack bridge to water surface (line; cm) during 2013. Spring (n = 517) is top panel; summer (n = 401) is middle panel; and fall (n = 600) is bottom panel.

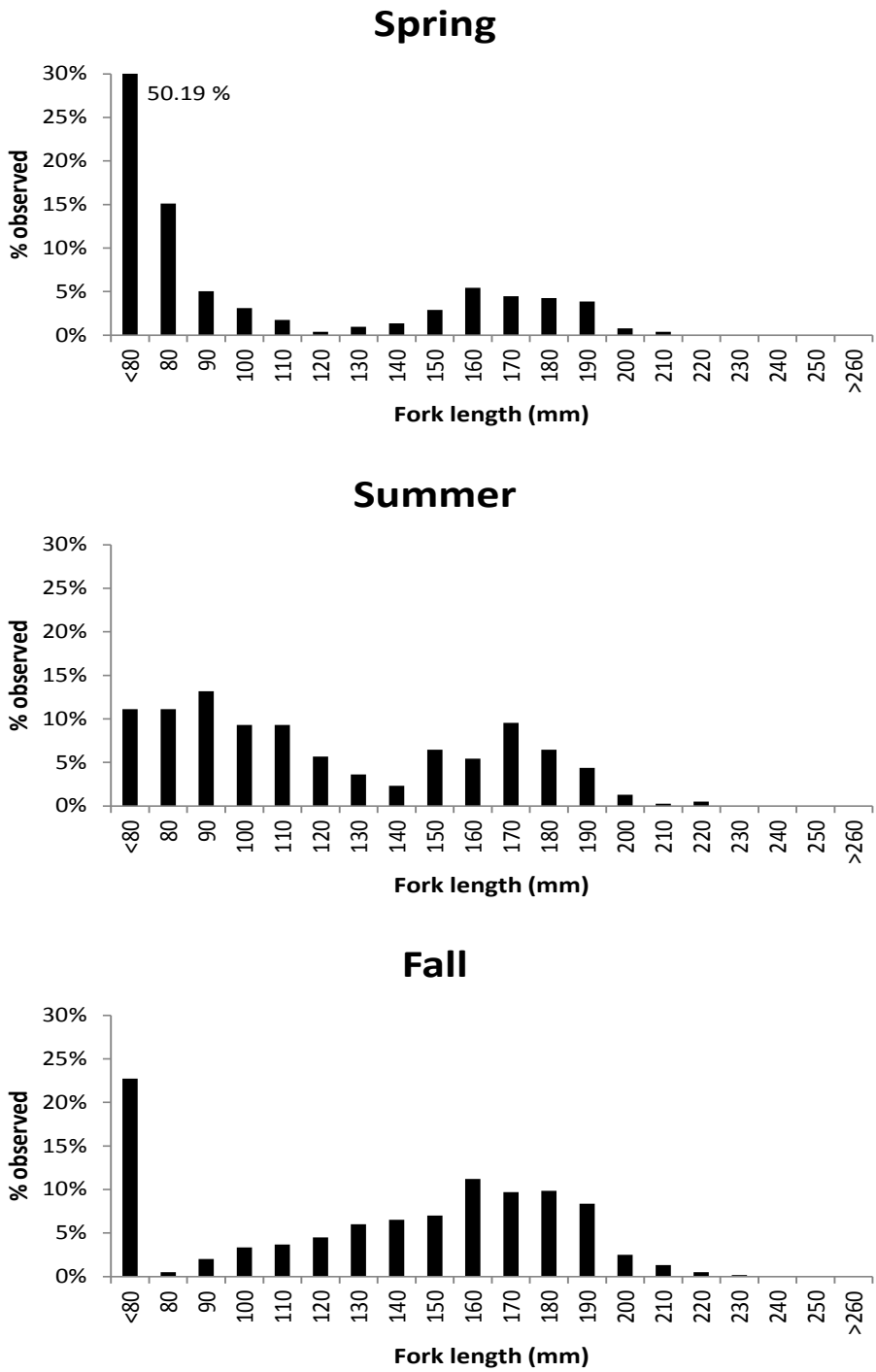


Figure 7. Relative length frequency of steelhead juveniles captured in the Big Creek screw trap during 2013. Spring (n = 516) is top panel; summer (n = 387) is middle panel; and fall (n = 598) is bottom panel. Note that some fish were released without being measured.

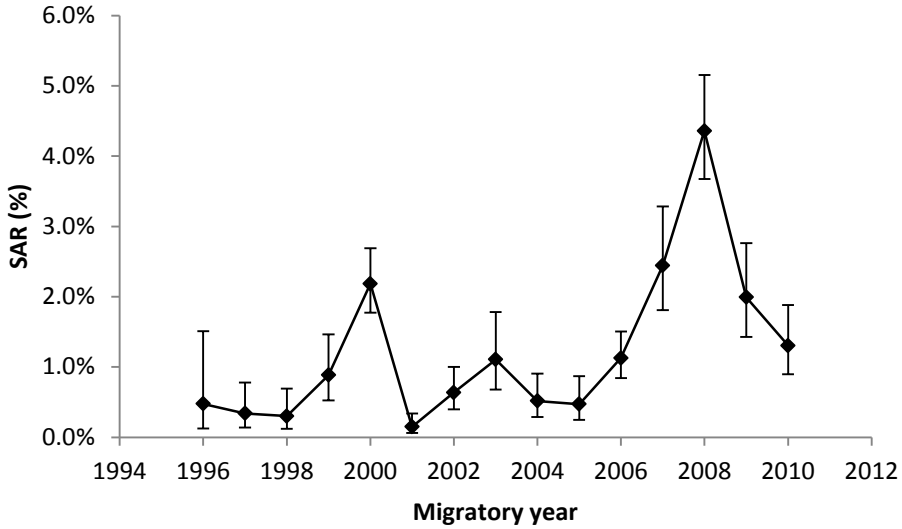


Figure 8. Smolt-to-adult return (SAR) rate estimates for steelhead tagged at Fish Creek. Estimates are based on smolt detections at Lower Granite Dam versus adult detections at Bonneville Dam.

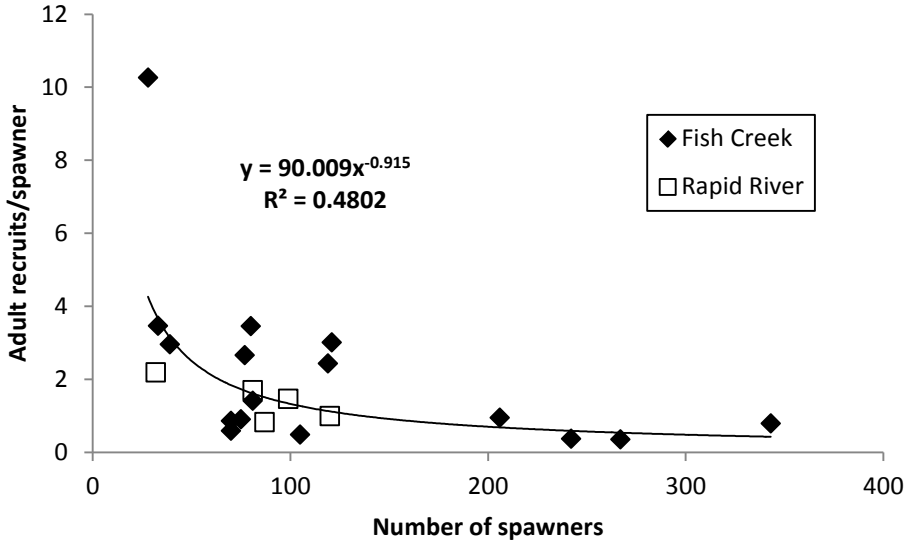


Figure 9. Relationship of adult productivity (recruits/spawner) to spawner abundance in steelhead from Fish Creek (brood years 1992-2007) and Rapid River (brood years 2003-2007). Trend line is shown for Fish Creek data only.

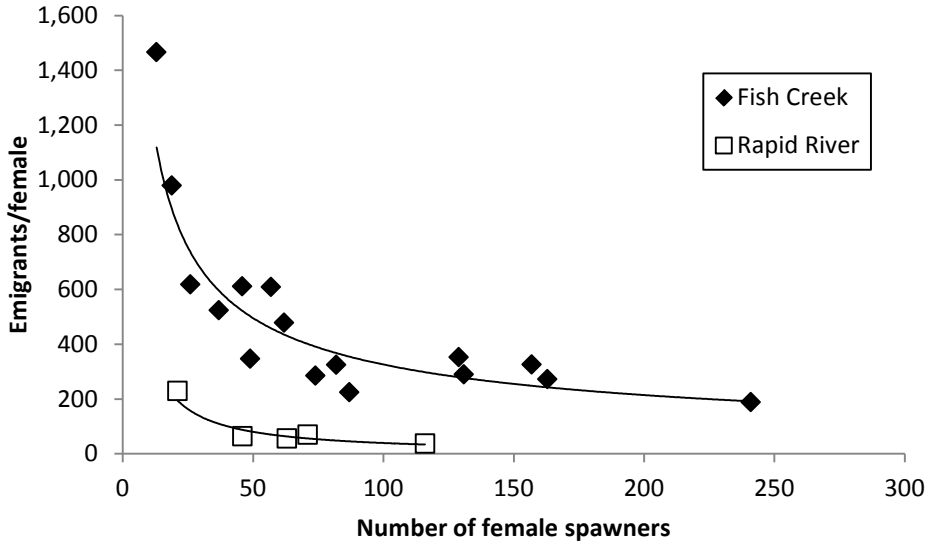


Figure 10. Relationship of juvenile productivity (emigrants/female spawner) to female spawner abundance in steelhead from Fish Creek (brood years 1995-2010) and Rapid River (brood years 2006-2010). Trend lines fit with a power function are shown for both data sets.

Appendix 1. Development of an Analytical Approach for Improving Estimates of Juvenile Salmon and Steelhead Abundance

**2013 PROGRESS REPORT**
**SUBMITTED BY DR. BRIAN KENNEDY, UNIVERSITY OF IDAHO**
**AND BRYCE OLDEMEYER, MS STUDENT, UNIVERSITY OF IDAHO, DEPT. OF FISH AND WILDLIFE SCIENCES**

This report summarizes 2013 activities of the collaborative graduate research project '*Development of an analytical approach for improving estimates of juvenile salmon and steelhead abundance*' between Idaho Department of Fish and Game (IDFG) and the University of Idaho (UI) (Master Agreement #UIIIDFG 09, Task Order #35880). Collaborators Dr. Brian Kennedy and Dr. Tim Copeland, solicited applicants from an open search for potential MS students and interviewed four appealing candidates. The graduate student selected, Bryce Oldemeyer, matriculated into the UI May 13, 2013. He worked as a trap tender at the rotary screw trap (RST) operated in Big Creek, at Taylor Wilderness Research Station (TWRS), alternating weekly duties with IDFG employees until August 24, 2013.

On August 26, 2013 he began classes at the UI and acquired a 4.0 GPA for the three upper level statistic classes he was enrolled in for the fall 2013 semester. During his coursework he became conversant with various statistical models and modeling software (primarily Program R and Program SAS) that will be used for the project's data analysis. Many people who came into contact with Bryce while at TWRS commented on his valuable contributions and helpful attitude. He is a good citizen of the University and a great ambassador for IDFG.

The goal of the project is to improve steelhead and Chinook salmon smolt population estimates at RSTs and to develop statistical models and software needed for the analysis. The project will compare smolt estimates calculated from a Bailey's modified Lincoln-Peterson model with various time stratifications against a hierarchical Bayesian model and a hierarchical Bayesian model with p-splines for three RSTs located in Idaho. The three RSTs for the analysis will be Big Creek, Marsh Creek, and Pahsimeroi and will represent "good," "marginal." and "poor" data sets that have varying degrees of recaptures rates and periods of operation. Once the analysis is done, identical procedures can be performed on other RSTs data to calculate more accurate juvenile abundance estimates throughout Idaho and the Pacific Northwest. Once new juvenile Chinook salmon population estimates have been calculated, an additional analysis will be performed looking at the effect that juvenile Chinook salmon density has on migration timing, individual size during migration, and the growth rates between juvenile Chinook smolts in the upper and lower portions of Big Creek, Idaho.

Activities in 2014 will focus on completing course work and beginning the main analysis. Spring 2014 semester the student is enrolled in two statistics classes, an advanced fisheries techniques course, and will audit a Program R course at Washington State University. Once the spring semester is complete he will begin field work at the RST at Big Creek, Idaho from May 2014 through trap removal in November 2014. In March 2014, Bryce Oldemeyer will present his research proposal to UI and IDFG affiliates via a paper and presentation. He will continue with data formatting and exploratory data analysis. After his course work is complete in May 2014 he will begin data analysis and document his findings while tending the RST at Big Creek.

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