FISHERY MANAGEMENT INVESTIGATIONS

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FISHERIES MANAGEMENT ANNUAL REPORT

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SOUTHWEST REGION

2015

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LOWLAND LAKE SURVEYS

KOKANEE AND RAINBOW TROUT EVALUATIONS AT ARROWROCK AND LUCKY PEAK RESERVOIRS

ABSTRACT

The kokanee *Oncorhynchus nerka* fisheries at Arrowrock and Lucky Peak reservoirs are two of the most popular in the state and have experienced a sizeable increase in angler interest during the last decade. The Idaho Department of Fish and Game is currently evaluating these fisheries using a combination of angler creel, hydroacoustics, and curtain nets. In 2015, a total of 512 anglers were interviewed to collect catch information. Of the anglers interviewed, 235 (46%) anglers had fished at Arrowrock Reservoir and the remaining 277 (54%) anglers had fished at Lucky Peak Reservoir. On average, kokanee anglers harvested 3.7 kokanee at Arrowrock Reservoir and 2.1 kokanee at Lucky Peak Reservoir. At Arrowrock Reservoir, approximately 30% of anglers didn't harvest a kokanee, while 53% of kokanee anglers at Lucky Peak Reservoir were unsuccessful. Mean catch rates for kokanee increased by 36% at Arrowrock Reservoir, but declined by 60% at Lucky Peak Reservoir from 2014. Stocking density appears to be strongly associated with mean total length of kokanee in the May creel, though only four years of data are available. However, the relationship between the two variables differs considerably between reservoirs. Stocking density (kg/ha) was positively correlated with mean fish length (r = 0.77) in the creel at Arrowrock Reservoir, but inversely correlated at Lucky Peak Reservoir (r = -0.59). Hydroacoustic estimates of kokanee abundance continue to provide confounding results and are difficult to relate to known stocking numbers. We recommend that discontinuing hydroacoustic surveys in 2016. In comparison, curtain nets showed promise for monitoring of relative abundance and size structure for kokanee. A cooperative research project scheduled for 2016 should provide additional insight into the effectiveness of curtain nets as a kokanee monitoring tool.

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INTRODUCTION

Kokanee *Oncorhynchus nerka* are the landlocked form of Sockeye Salmon *O. nerka* and provide recreational fisheries in many waters of the western United States (Foerster 1968; Paragamian 1995; Rieman and Maolie 1995). Kokanee life history differs considerably from other inland salmonids. Kokanee are a semelparous salmon that feed and grow in lakes or reservoirs for 2.5 to 3.5 years, then spawn in tributaries or along shorelines during fall before subsequently dying. Eggs incubate in the streambed or shoreline gravels until hatching in late winter. Alevins remain in the gravel for several more weeks before emerging at night and migrating to the lake or reservoir. Fry commonly migrate directly to pelagic areas (Foerster 1968), but can spend time feeding in the littoral habitats, particularly in lakes or reservoirs with pronounced littoral regions (Burgner 1991; Gemperle 1998). Juvenile and adult kokanee are primarily found in pelagic zones of lakes and reservoirs, where they feed almost exclusively on zooplankton.

Managing kokanee fisheries is often elusive and complex because of the wide variation of population responses to system productivity, habitat, predation, and angling effort (Paragamian 1995). These responses lead to changes in growth, fecundity, recruitment, age-at-maturity, and survival, which can also vary substantially annually and between year classes. Many kokanee populations exhibit density-dependent growth and this central characteristic of kokanee biology is important to fisheries managers (Rieman and Myers 1992; Rieman and Maolie 1995; Grover 2006). Many kokanee populations in the western United States exhibit a strong negative relationship between population density and mean body size. Kokanee size and growth not only influences the number and size of fish available to anglers, but also angler's perception of the quality of the fishery (Martinez and Wiltzius 1995; Rieman and Maolie 1995). The tradeoff between density and growth is the key component to kokanee management in most waters and examples of efforts to influence density, growth, and survival are well documented.

During the last decade, kokanee have become increasingly popular with anglers in many areas of the western United States. States including Idaho, Oregon, Washington, and California have experienced increased enthusiasm for kokanee fishing. This popularity is reflected in fishing magazine articles, social media, kokanee tournaments, and online forums dedicated to kokanee fishing. Information including stocking histories and regional management reports have become more accessible and easier to distribute to anglers through the World Wide Web. Idaho Department of Fish and Game (IDFG) has observed a notable increase in angler interest in the management of kokanee fisheries across the state, particularly inquiries into stocking rates.

Arrowrock and Lucky Peak reservoirs are two of the most popular kokanee fisheries in the state and have experienced a sizeable increase in angler interest. Prior to the initiation of annual kokanee stocking in Arrowrock Reservoir, only a marginal fishery existed. This fishery was thought to be supported by kokanee entrained from Anderson Ranch Reservoir with minor natural recruitment from the MF and SF Boise rivers. IDFG has stocked fingerling kokanee annually since 1999 at Lucky Peak Reservoir and since 2009 at Arrowrock Reservoir. In 2015, the default stocking request for Arrowrock Reservoir was 100,000 fish or 80 fish/ha in May (Table 1). This is a two-fold increase in stocking numbers compared to each of the previous three years. In addition, the Arrowrock Reservoir fishery is supported by wild production from the Middle Fork Boise River (MFBR) and South Fork Boise River (SFBR), as well as entrainment from Anderson Ranch Reservoir. The magnitude and variability of these sources of recruitment are not well understood and are likely influenced by inflows, water temperatures, predation, and reservoir levels.

The kokanee population in Lucky Peak Reservoir appears to rely primarily on annual stocking with an unknown amount of entrainment from upstream reservoirs. Although mature kokanee migrate into Mores and Grimes creeks in August, production of wild fry is likely low due to marginal or lethal stream temperatures and poor habitat conditions. The annual default stocking request for Lucky Peak Reservoir is 250,000 kokanee fingerlings or 217 fish/ha in May (Table 1).

Annual variations in angler catch rates at these reservoirs have led IDFG to examine if this variation may be attributed to size at stocking, timing of stocking, stocking density, or reservoir conditions. Prior to 2012, IDFG had a sense of which years had produced good fishing from angler reports, but no actual catch or catch rate data. It is difficult to recommend or implement management changes without data on annual kokanee size or angler catch rates for each year class. Due to the growing popularity of kokanee fishing with anglers, IDFG recognizes the need to monitor these fisheries more quantitatively. Specifically, IDFG should more clearly define kokanee management goals for catch rates and size-at-maturity. Additionally, obtaining a better understanding of how reservoir management, spawning conditions, and stocking affect survival and growth of individual year classes should improve IDFG's ability to effectively manage these fisheries. Annual catch rate and fish size, primarily CPUE, length-at-age, and length in the creel, will also be used as indices to help describe the effect of stocking practices or reservoir conditions, and will thus help to better understand the potential of the fisheries and angler preferences.

STUDY SITES

Arrockrock Reservoir is a 1,255 ha dendritic impoundment located approximately 32 km northeast of Boise, Idaho in the Boise River drainage (Figure 1). It is a 29 km-long, narrow canyon reservoir that impounds two major tributaries; the MFBR and SFBR. Arrowrock Dam is located directly upstream of Lucky Peak Reservoir and is operated by the U.S. Bureau of Reclamation (BOR). Arrowrock Reservoir is managed primarily for flood control and irrigation. In a typical year, the reservoir is maintained at approximately 60-80% storage capacity during winter months and generally reaches 100% capacity by May. Beginning in June, the reservoir is drafted, and by August usually reaches 10-35% of capacity, after which the reservoir slowly refills during the fall and winter.

Lucky Peak Reservoir is a 1,141 ha mesotrophic impoundment in the Boise River drainage, immediately downstream from Arrowrock Reservoir (Figure 1). It has a mean depth of 32.8 m, a total capacity of 3,615 x 10^5 m^3, and is managed by the U.S. Army Corps of Engineers to provide flood control, irrigation, power generation, recreation, and winter flows in the Boise River. In a typical water year, the reservoir is kept at 20-40% of storage capacity during winter and reaches 100% capacity by early summer. Subsequently, Arrowrock Reservoir releases are utilized to keep Lucky Peak Reservoir near full pool for recreation during the summer months. After Labor Day, Arrowrock begins refilling while Lucky Peak is then drafted to lower pool elevations.

METHODS

Angler catch rate and fish size

We used check stations to collect creel data and index fisheries metrics. Kokanee creel information has been collected at both Arrowrock and Lucky Peak reservoirs during the month of May since 2012. Data was collected by surveying anglers at a check station, similar to a portion of the access-access survey design described by Pollock et al. (1994). I did not count anglers, to allow estimation of total effort or catch for May, due to personnel limitations. May was selected as an appropriate month because anecdotal observations and angler reports suggest that May is one of the peak months for angling effort directed at kokanee. May also provides the opportunity to directly target and interact primarily with anglers as recreational boaters do not become a significant portion of reservoir users until after Memorial Day. The focus of creel surveys was on kokanee and Rainbow Trout *Oncorhynchus mykiss,* but we collected data on all fish species encountered.

Creel clerks were stationed at a single site to intercept anglers as they left the fisheries. The creel station was located just east of state Highway 21 at Spring Shores Road turnoff (Figure 1). This creel station intercepted anglers from Spring Shores Marina, and Mack's Creek boat ramp, and Arrowrock Reservoir. Six dates, with three days of both weekday and weekend/holiday sampling units were randomly selected during May of 2013 and have been used in subsequent years. Two time periods were used: (1) An early time period (0900 - 1500 hours) and (2) a late time period (1500 - 2100 hours).

Data collection focused on completed fishing trips. Each interview or contact was assigned a unique interview number for that day, based on the numerical order by which anglers were contacted. We also recorded fishing license numbers, number of anglers in each party, fishing effort (hours), target species, and species/number of fish that were harvested or released. Creel clerks were directed to obtain a catch rate per individual angler, although it may be difficult in trolling situations with multiple anglers. Fishing method, gear type, and total length (mm) and weight (g) of harvested fish were also recorded. Mean catch rate ($\widehat{R_2}$) was estimated using the ratio of means (ROM), where trip interviews were considered complete:

$$\widehat{R_2} = \frac{\frac{\sum_{i=1}^{n} c_i}{n}}{\frac{\sum_{i=1}^{n} e_i}{n}}$$

where $\hat{R}$ is the mean catch rate in fish/angler-hour, c_i is the number of fish caught during the trip, and e_i is the length of the trip in hours (equation $\widehat{R_2}$ from Pollock et al 1994). However, this rate will be abbreviated as CPUE hereafter.

When possible, all fish sampled from the creel were measured and weighed. Sagittal otoliths were collected from a sub-sample of kokanee r to estimate age distribution. Clerks collected at least five fish for every 1-cm length group, if possible. During high-traffic periods, clerks collected all angler trip time and catch/harvest information, but may have foregone fish measurements to avoid traffic congestion or major inconveniences for anglers.

Relationships between stocking density, catch rates, and fish length were examined by comparing correlation coefficient (*r*), which measures the linear relationship between two variables. The Pearson correlation coefficient(*r)* was calculated as

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\left(\frac{X_i - \bar{X}}{s_X}\right)\left(\frac{Y_i - \bar{Y}}{s_Y}\right)$$

where X_i *and* Y_i are paired data variables (Zar 1999).

Hydroacoustics

Hydroacoustic surveys were conducted to estimate kokanee abundance and density. Estimating density over multiple years will allow managers to determine adult kokanee size and density relationships for each reservoir. Six transects were sampled with hydroacoustic gear at Arrowrock Reservoir on July 15, 2015, and Lucky Peak Reservoir on July 16, 2015 (Figure 1). Sampling transects were determined prior to surveys and were followed using Global Positioning System (GPS) coordinates. Hydroacoustic estimates of fish densities, lengths, and vertical depth distributions were obtained with a Hydroacoustic Technology, Inc. (HTI) Model 241-2 split-beam digital echosounder. The 200-kHz sounder was equipped with a 15° vertically-aimed transducer (downlooking) which was suspended at a 1-m depth using a retractable pole mounted on the port side of the boat. Boat speed during data collection ranged from 1 to 1.5 m/s. Data were collected at a sampling rate of 10 pings/s and a transmit pulse width of 0.2 m/s. A full description of target tracking and acoustic data analysis can be found in Koenig et al. (2015).

Only pelagic targets located within depths that kokanee inhabit (kokanee layer) were included in density and abundance analysis. All fish in the kokanee layer were assumed to be kokanee. Abundance and density estimates were partitioned by size information collected from converted target strengths and the May creel survey. On May 18, 2015, approximately 101,198 kokanee fry were stocked in Arrowrock Reservoir and 250,515 were stocked into Lucky Peak Reservoir. The mean length of stocked fish was 81 mm (Table 1). Kokanee are known to spawn in the SFBR and MFBR, but the extent to which natural production contributes to the Arrowrock Reservoir kokanee population is unknown. At the time of the survey and during analysis of hydroacoustics data, we assumed that wild age-0 kokanee ranged from 30 to 80 mm and hatchery age-0 kokanee were assumed to range from 81 to 130 mm. Age-1 kokanee were assumed to range from 201 to 320 mm, whereas age-2 kokanee were assumed to range from 321 to 430 mm, based on age assignments in previous years.

Net Curtains

The pelagic fish species composition in Arrowrock and Lucky Peak reservoirs was sampled with curtain nets curtains during July 21-22, 2015 (Figure 1). Curtain nets were 55-m long x 6-m deep and composed of 13, 19, 25, 38, 51, 64, 76, 89, and 102-mm stretch mesh panels randomly ordered. Each mesh panel was 3-m wide by 6-m deep and repeated twice. Curtain nets were specifically constructed to be neutrally buoyant so that they fish level when set suspended at various depths in the water column with focus on the thermocline. . Each curtain net, fished for one night, equaled one unit of gill net effort. Four net curtains were deployed for one night at each reservoir.

Captured fish were identified to species, measured for total length (± 1 mm). Weights were not collected in 2015 due to equipment failure. Larger kokanee were necropsied to determine sex, maturity, and to assess mean length of females during the spawning run. Otoliths were removed from kokanee to estimate length-at-age. Catch data were summarized as the number of fish caught per unit of effort (CPUE).

RESULTS

Angler catch rate and fish size

In 2015, angler use was nearly evenly distributed between the two reservoirs. A total of 512 anglers were interviewed for catch information. Of the 512 anglers interviewed, 235 (46%) anglers had fished at Arrowrock Reservoir and the remaining 277 (54%) anglers had fished at Lucky Peak Reservoir (Table 2). Average trip duration of anglers fishing at Arrowrock and Lucky Peak reservoirs were 4.5 and 4.4 h, respectively. Over half of the interviewed anglers reported their primary target species as kokanee (57% at Arrowrock Reservoir; 64% at Lucky Peak Reservoir). Approximately 25% of the anglers at both reservoirs targeted Rainbow Trout (Figure 2). Anglers indicating they had no preference on fish species represented 19% and 12% of anglers at Arrowrock and Lucky Peak reservoirs, respectively. Finally, less than 1% of all anglers at Arrowrock and Lucky Peak reservoirs targeted Smallmouth Bass.

Individual catch and catch rates varied by reservoirs in 2015. On average, anglers targeting kokanee harvested 3.7 kokanee at Arrowrock Reservoir and 2.1 kokanee at Lucky Peak Reservoir. At Arrowrock Reservoir, approximately 30% of kokanee anglers did not harvest a kokanee during that specific trip, while 53% of anglers did not harvest a kokanee at Lucky Peak Reservoir (Figure 3). Conversely, close to 20% of kokanee anglers harvested their bag limit at Arrowrock Reservoir while only 3% harvested a bag limit at Lucky Peak Reservoir. At Arrowrock Reservoir, overall CPUE of kokanee was 0.35 fish/h, while CPUE at Lucky Peak Reservoir was 0.15 fish/h (Table 3). For anglers targeting kokanee, catch rates were somewhat higher, with 0.5 fish/h estimated at Arrowrock Res. and 0.2 fish/h at Lucky Peak Reservoir. Length of kokanee in the creel from Arrowrock Reservoir ranged from 272 to 501 mm, with a mean of 407 mm (Figure 4). Two age classes were represented in the creel based on otolith age (Figure 5). At Lucky Peak Reservoir, koknanee ranged from 249 to 470 mm, with a mean of 356 mm (Figure 4). Two year classes were represented in the creel at Lucky Peak Reservoir (Figure 5).

Catch rates for Rainbow Trout were higher at Lucky Peak Reservoir in 2015, but this was not reflected in mean harvest which was nearly identical among reservoirs. Overall, anglers targeting Rainbow Trout harvested an average of 1.5 Rainbow Trout at Arrowrock Reservoir and 1.6 Rainbow Trout at Lucky Peak Reservoir. Approximately 82% and 52% of Rainbow Trout anglers were unsuccessful in harvesting Rainbow Trout at Arrowrock and Lucky Peak reservoirs, respectively (Figure 3). No interviewed anglers harvested their bag limit of Rainbow Trout (six fish) at Arrowrock Reservoir and only 3% harvested their bag limit at Lucky Peak Reservoir. Rainbow Trout were caught at overall rates of 0.11 and 0.25 fish/h at Arrowrock and Lucky Peak reservoirs, respectively (Table 3). Catch rate for anglers specifically targeting Rainbow Trout was 0.08 fish/h at Arrowrock Reservoir and 0.25 fish/h at and Lucky Peak Reservoir. Rainbow Trout at Arrowrock Reservoir ranged from 264 to 448 mm with a mean of 351 mm, while fish from Lucky Peak Reservoir ranged from 206 to 395 mm with a mean of 326 mm (Figure 6).

Stocking density appears to be strongly associated with mean total length of kokanee in the May creel, despite only four years of data. However, this relationship differs considerably between reservoirs. Stocking density (kg/ha) was positively correlated with mean fish length (r = 0.73) at Arrowrock Reservoir, but these variables were inversely related at Lucky Peak Reservoir (r = -0.59; Table 4). At Arrowrock Reservoir, angler catch rate for kokanee does not appear to be predicted by initial stocking density. However, kokanee catch rates at Lucky Peak Reservoir appear to be negatively associated with stocking density (number/ha; r = -0.89). It should be stressed that these relationships were built on few data points (n = 4) and inferences are preliminary.

Hydroacoustics

At Arrowrock Reservoir, fish densities at depths that kokanee inhabit ranged from 53 to 110 fish/ha among transects (Table 5). Mean density for lengths that corresponded with wild age-0 kokanee (30-80 mm) was 49 fish/ha. Mean density for lengths that corresponded with age-0 hatchery kokanee (81-130 mm) was 8 fish/ha. Age-1 kokanee density (131-200 mm) was estimated at 11 fish/ha and age-2 and older fish (>201 mm) was 12 fish/ha. Mean fish density of all lengths combined was 87 fish/ha, and total pelagic abundance was 61,149 fish in 2015.

At Lucky Peak Reservoir, fish densities at depths kokanee inhabit ranged from 4 to 42 fish/ha among transects with the lower densities occurring in the upstream portion of the reservoir (Table 6). Mean fish density for lengths that corresponded with age-0 hatchery kokanee (159 to 250 mm) was 7 fish/ha. Mean fish density for lengths that correspond with age-1 kokanee (251 to 380 mm) was 35 fish/ha. Mean fish density for lengths that correspond to age-2 kokanee (381 to 500 mm) was 4 fish/ha. Mean fish density of all lengths combined was 16 fish/ha, and total pelagic abundance was 18,514 fish in 2015.

Curtain Nets

At Arrowrock Reservoir, curtain nets captured a number of game and nongame species in similar proportions. A total of 72 fish were captured with curtain nets, with kokanee composing approximately 31% (n = 22) of the catch. Rainbow Trout, Yellow Perch, Largescale Sucker, and Northern Pikeminnow were also captured in similar numbers (Table 7). CPUE for kokanee was 5.5 fish / net night, while WPUE was 4.1 kg / net night. Kokanee ranged from 128 to 490 mm with a mean of 383 mm total length (Figure 7). Rainbow Trout CPUE was 3.5 fish / net night and WPUE was 1.3 kg / net night (Figure 8). Rainbow Trout ranged from 260 to 406 mm with a mean total length of 323 mm.

The vast majority of fish captured in curtain nets were kokanee in Lucky Peak Reservoir. A total of 152 fish were captured in net curtains with 87% of the catch comprised of kokanee (n = 132; Table 7). CPUE for kokanee was 33 fish / net night, and WPUE was 17.8 kg / net night (Table 7). Kokanee ranged from 115 to 467 mm with a mean total length of 342 mm (Figure 7). Only three Rainbow Trout were captured in pelagic net curtains, approximately 2% of total catch. Rainbow Trout CPUE was 0.75 fish / net night, and WPUE was 0.3 kg / net night (Table 7). Rainbow Trout ranged from 291 to 364 mm with a mean total length of 326 mm (Figure 8).

DISCUSSION

Since IDFG began using a check station to monitor the kokanee fisheries at Arrowrock and Lucky Peak reservoirs, proportional effort has varied annually among the reservoirs based on catch rates and fish size. Although kokanee in Arrowrock Reservoir were longer than in Lucky Peak Reservoir in 2015, early-season fishing reports were poor and anglers had a difficult time locating and catching fish. Shortly after the May 13 check station, anglers began catching kokanee on a consistent basis at Arrowrock Reservoir. This resulted in a shift in angler effort towards Arrowrock Reservoir where kokanee were approximately 5 cm larger (2 in; Table 2).

Finally, in 2015, the total number of anglers interviewed increased slightly at both reservoirs from 2014 (Figure 9).

Fishing success for kokanee improved at Arrowrock Reservoir but declined at Lucky Peak Reservoir in 2015 compared to 2014. Mean catch rate for kokanee increased by 36% at Arrowrock Reservoir for anglers targeting kokanee (Figure 9). Additionally, the proportion of anglers who obtained a bag limit of six kokanee increased from 6% in 2014 to 18% in 2015. Similarly, the percentage of anglers who were unable to harvest a kokanee at Arrowrock Reservoir decreased from 66% to 30% among years. At Lucky Peak Reservoir, however, mean catch rate declined by approximately 60% from 2014 to 2015 (0.3 to 0.2 fish/h; Figure 9). At Lucky Peak, only 3% of anglers that harvested a six-kokanee limit (compared to 2% in 2014). Within our four year data set, the highest catch rates for Kokanee occurred in 2013, when anglers caught 0.47 kokanee/h at Arrowrock Reservoir and 0.65 kokanee/h at Lucky Peak Reservoir.

Catch rates for anglers targeting Rainbow Trout declined at Arrowrock Reservoir but increased at Lucky Peak Reservoir from 2014. A 62% decline in CPUE for Rainbow Trout was observed in Arrowrock Reservoir, where angler catch rates declined from 0.13 to 0.08 fish/h (Figure 9). In contrast, CPUE for Rainbow Trout for Lucky Peak increased by 20%, from 0.24 to 0.3 fish/h. Rainbow Trout anglers remained at approximately 25% of all anglers interviewed, similar to previous years. Mean length of Rainbow Trout in the creel was similar to the reservoir-specific mean reported for 2014. Rainbow Trout from Arrowrock Reservoir measured and continued to be approximately 30 mm (1 ¼ inch) longer than Rainbow trout from Lucky Peak Reservoir.

Initial attempts at linking kokanee catch rates and mean fish length to stocking densities or weather variables were mixed. In 2014, we were unable to find relationships between catch rates and air temperature, barometric pressure, or wind (Butts et al. 2016). However, linking stocking densities to mean fish length in the creel continues to show promise. The linear relationship between stocking density (fish/ha) and fish length was positive at Arrowrock Reservoir (r = 0.77), suggesting that more kokanee could be stocked. In contrast, the relationship between stocking density (kg/ha) and kokanee length-in-creel was negative at Lucky Peak Reservoir (r = -0.59; Table 4). However, it should be noted that creel data included smaller age-1 fish. The strength of both relationships decreased slightly with the addition of the 2015 data. The relationships suggest that Lucky Peak Reservoir may be near carrying capacity for achieving the current desired growth rates. However, the rate and influence of entrainment from Arrowrock Reservoir is also currently unknown and may be complicating our interpretation of these results. Further investigation is warranted into how the relationship between stocking and mean fish length is influenced by reservoir productivity, fish entrainment, and wild fish production. Angler catch rates are highly influenced by skill, knowledge, and a host of other variables that are not readily measurable. Accounting for this variation among anglers and relating fishing success with other independent variables is therefore extremely difficult. Angler catch rates should still be useful to compare the same water bodies across years. Due to these factors, angler catch rates may not be an ideal metric to evaluate management practices. However, check stations are still valuable as much may be learned from length- and age-in-the-creel.

Hydroacoustic estimates of pelagic fish abundance have been difficult to interpret, particularly when connecting age classes to known stocking numbers of kokanee. At Arrowrock Reservoir, the estimate of total pelagic fish abundance declined by 56% from 2014. This was preceded by a 74% decline between 2013-2014. While the estimated decline in abundance supports the decline in catch rates and increased kokanee size, there have been disparities in linking kokanee stocking numbers to hydroacoustic estimates. For example, in early May, IDFG stocked 101,000 fingerling-sized kokanee, averaging 81 mm. The hydroacoustic abundance estimate for that size group in July was 5,628 fish. This would suggest a 94% mortality or entrainment rate over two months which is inconsistent with survival of previous year classes based on the resulting fisheries. Because of conflicting results due to mixed-species assemblages and size structures, hydroacoustics has not proven to be a useful monitoring tool for kokanee at either reservoir.

Alternatively, curtain nets were effective at capturing three year classes of kokanee at both reservoirs. Net curtain surveys were limited to only four net nights at each reservoir. These netting efforts captured a wider range of lengths and ages at each reservoir when compared to creel sampling efforts, which are biased towards larger fish. However, our ability to relate CPUE in curtain nets to actual population density or angler catch rates will take multiple years of netting to allow comparisons of survival and relative abundance. Additionally, biologists will need to determine how many net nights are needed to adequately estimate size structure and relative abundance. Based on catch rates and size structures, curtain nets deployed at depths targeting kokanee are not effective for estimating Rainbow Trout size structures. Additional curtain nets deployed at shallower depths may be required to make this tool effective at monitoring both species. In 2016, IDFG will partner with University of Idaho researchers to examine and compare curtain nets and mid-water trawling as kokanee monitoring tools. Arrowrock and Lucky Peak reservoirs are scheduled to be included in these evaluations and the results of this research should estimate sample sizes needed to estimate relative abundance and size structures. Because angler catch rates have been highly variable and difficult to relate to environmental conditions or management practices, curtain nets may be a better sampling tool for indexing kokanee abundance as well as size and age structure in these reservoirs.

Water management at Arrowrock Reservoir, slight shifts in stocking practices, or reduced entrainment from Anderson Ranch reservoir during the previous two seasons likely contributed to the inconsistent fishing observed in 2014 and15 at Arrowrock Reservoir. In 2013, Arrowrock Reservoir was drafted to approximately 20% capacity by the end of July, and was maintained at low levels through September. This period at low reservoir levels coincided with a period of warm air temperatures that was longer in duration than other years (Figure 10). Water temperatures at this time ranged from 18 to 24ºC through the entire water column (Butts et al. 2016). It is possible that these reservoir conditions resulted in entrainment of kokanee downstream through the dam. Typically, Arrowrock Reservoir begins refilling after the Labor Day weekend, when water managers use storage from Lucky Peak Reservoir to meet demands. Currently, there are no entrainment estimates of sport fishes through Arrowrock Dam to Lucky Peak Reservoir although managers are aware that it occurs. In 2015, we marked (adipose clip) approximately 10,000 hatchery kokanee fingerlings destined for Arrowrock Reservoir. Recovering marked kokanee in Lucky Peak Reservoir through gill netting or creel check stations should provide a better understanding for the amount of entrainment through Arrowrock Dam. Regardless, IDFG should discuss options with water managers to prevent or minimize extreme reservoir conditions. Alternatives such as using storage from Lucky Peak Reservoir earlier, rather than keeping it full through Labor Day, should be considered in poor water years.

The timing and size of kokanee stocking has also shifted over the last few years which may also be contributing to the inconsistent fisheries. In 2013, anglers experienced the highest catch rates of kokanee for this study at both reservoirs. These kokanee were primarily from fish stocked in 2011. These fish were stocked in early June rather than early May, which has been the typical stocking period for kokanee at both reservoirs since 2012 (Table 1). The shift has occurred to accommodate raceway space needs for other programs. However, there is growing evidence that stocking in June rather than early May results in higher survival and catch rates. IDFG hatchery and management personnel are currently working to address this situation to re-examine stocking kokanee in June.

RECOMMENDATIONS

1. Monitor the effect of kokanee and Rainbow Trout stocking practices at Arrowrock and Lucky Peak Reservoirs by indexing catch rates using annual check stations during May. A fixed sampling design will be used at the check station between years and should continue through at least 2018.

2. Participate in statewide investigation into using curtain nets to evaluate kokanee populations and fisheries. Determine if curtain nets curtains are a better sampling tool than check stations and the creel index.

3. Monitor water temperatures profiles in Arrowrock Reservoir during low pool in August to assess availability of water temperatures <21ºC.

4. Discontinue hydroacoustic surveys at Arrowrock and Lucky Peak Reservoirs.

Table 1. Stocking densities, average total length, and stocking dates by reservoir for kokanee in Arrowrock and Lucky Peak reservoirs, Idaho 2004-2015.

Waterbody	Year	Date	No. Fish	Mean size (mm)	Fish/kg	Stocking density (fish/ha)	Stocking density (kg/ha)
Arrowrock Reservoir	2004	14-Jun	77,025	100	24.8	61	2.5
1,255 ha	2006	9-May	70,000	89	35.8	56	1.6
	2010	3-Jun	29,000	76	52.6	23	0.4
	2011	8-Jun	30,000	76	45.4	24	0.5
	2012	2-May	50,130	76	50.5	40	0.8
	2013	1-May	50,160	69	68.9	40	0.6
	2014	15-May	49,995	76	44	40	0.9
	2015	13-May	101,198	81	43.4	81	1.9
Lucky Peak Reservoir	2004	14-Jun	155,950	90	32.9	135	4.1
1,153 ha	2005	3-Jun	200,150	86	39.1	174	4.4
	2006	24-May	308,050	83	45.8	267	5.8
	2007	31-May	245,000	89	39.7	212	5.4
	2008	3-Jun	195,570	57	130.8	170	1.3
	2009	3-Jun	199,800	83	45.3	173	3.8
	2010	3-Jun	151,050	79	45.7	131	2.9
	2011	8-Jun	174,640	76	42.8	151	3.5
	2012	2-May	200,910	76	48.9	174	3.6
	2013	1-May	251,877	69	67.4	218	3.2
	2014	15-May	237,120	76	44.8	206	4.6
	2015	13-May	250,515	81	39.9	217	5.4

Table 2. Dates, day type, time period, and number of anglers interviewed during each sampling period for creel check stations at Arrowrock and Lucky Peak reservoirs in May 2015. Dates, day type, and time period were initially selected randomly in 2012.

Date	Day Type	Time Period	Arrowrock	LuckyPeak
5/3	Weekday	Late	32	97
5/4	Weekend/Hol	Late	8	51
5/13	Weekday	Early	21	18
5/22	Weekend/Hol	Early	49	23
5/24	Weekday	Late	81	63
5/29	Weekend/Hol	Early	43	25
Total			234	277

Table 3. Catch rates by time periods, day type, angling methods, and gear types for kokanee and Rainbow Trout at Arrowrock and Lucky Peak reservoirs, Idaho in 2015.

	Kokanee (fish/h)		Rainbow trout (fish/h)	
	Arrowrock	Lucky Peak	Arrowrock	Lucky Peak
Weekday	0.46	0.19	0.15	0.26
Weekend/Hol	0.21	0.12	0.06	0.24
Early Period	0.40	0.12	0.13	0.26
Late Period	0.25	0.22	0.07	0.23
Shore	0.00	0.02	0.08	0.29
Still boat	0.00	0.00	0.00	0.00
Trolling boat	0.47	0.19	0.12	0.24
Lures	0.47	0.19	0.13	0.24
Bait	0.00	0.02	0.05	0.28
Kokanee targeted	0.50	0.20	-	-
Rainbow trout targeted	-	-	0.08	0.30
Overall	0.35	0.15	0.11	0.25

Table 4. Pearson correlations of stocking densities and mean fish length for kokanee at Arrowrock and Lucky Peak reservoirs, Idaho 2011-2015.

	Stocking density	
	no./ha	kg/ha
Arrowrcock CPUE	0.3	0.07
(Sample size n)	(n=4)	(n=4)
Lucky Peak CPUE	-0.89	-0.14
(Sample size n)	(n=4)	(n=4)
Arrowrock TL (mm)	0.77	0.73
(Sample size n)	(n=4)	(n=4)
Lucky Peak TL (mm)	-0.23	-0.59
(Sample size n)	(n=4)	(n=4)

Table 5. Kokanee densities (number/ha) per transect and total abundance estimates calculated by arithmetic and geometric mean densities at Arrowrock Reservoir, Idaho on July 15, 2015.

		Fish densities (number / ha)					
Transect	Transect length (m)	30-80 mm	81-130 mm	131-200 mm	201-350 mm	351-500 mm	Total
1	1,003	41	23	15	5	16	100
2	948	83	10	8	4	5	110
3	1,017	46	16	11	4	9	85
4	738	56	5	12	4	12	89
5	992	22	2	10	9	9	53
6	991	76	6	12	4	2	101
	Geometric Mean (GM)	49	8	11	5	7	87
	90% CI (GM)	42 to 59	6 to 11	10 to 12	4 to 6	6 to 10	80 to 96
	Abundance (GM)	34,669	5,628	7,883	3,499	5,067	61,149
		29,178 to 41,169	4,135 to 7,583	7,265 to 8,549	3,099 to 3,942	3,840 to 6,625	55,699 to 67,124

Table 6. Kokanee densities (number/ha) per transect and total abundance estimates calculated by arithmetic and geometric mean densities at Lucky Peak Reservoir, Idaho on July 16, 2015.

		Fish densities (number / ha)			
Transect	Transect length (m)	159-250 mm	251-380 mm	381-500 mm	Total
1	1,599	2	1	2	4
2	1,612	3	2	2	8
3	1,557	6	1	2	9
4	1,578	17	15	9	42
5	1,593	17	12	5	34
6	1,577	14	20	5	39
	Geometric Mean (GM)	7	5	4	16
	90% CI (GM)	8 to 15	26 to 59	17 to 25	101 to 162
	Abundance (GM)	8,375	5,769	4,250	18,514
		5,978 to 11,580	3,472 to 9,210	3,372 to 5,298	13,034 to 26,112

Table 7. Number, catch-per-unit-effort (CPUE), and weight-per-unit-effort (WPUE) for fish captured in net curtains Arrowrock and Lucky Peak reservoirs. Netting occurred during July 21-22, 2016.

Waterbody	Species	Number	CPUE	WPUE (kg)
Arrowrock Res	Rainbow x Cutthroat	1	0.3	0.1
	Kokanee	22	5.5	4.1
	Largescale Sucker	12	3.0	3.5
	Northern Pikeminnow	10	2.5	0.8
	Rainbow Trout	14	3.5	1.3
	Yellow Perch	13	3.3	0.7
Lucky Peak Res	Chiselmouth	1	0.3	0.1
	Kokanee	132	33.0	17.8
	Largescale Sucker	4	1.0	0.8
	Northern Pikeminnow	4	1.0	1.0
	Rainbow Trout	3	0.8	0.3
	Redside Shiner	8	2.0	0.0

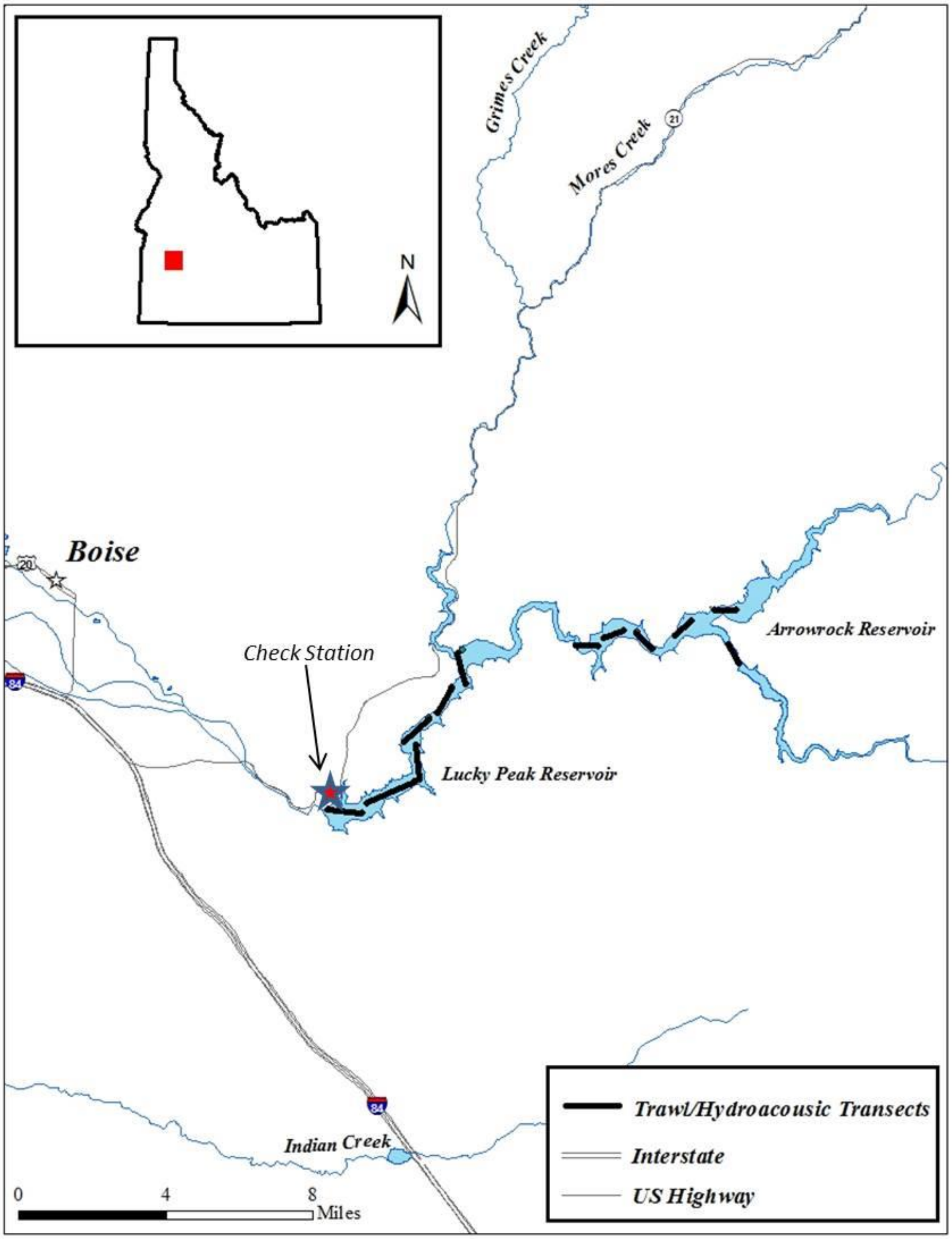

Figure 1. Map of Arrowrock and Lucky Peak reservoir, Idaho, with location of the creel station where clerks can intercept anglers from both waters. Hydroacoustic surveys were conducted in both reservoirs in 2015.

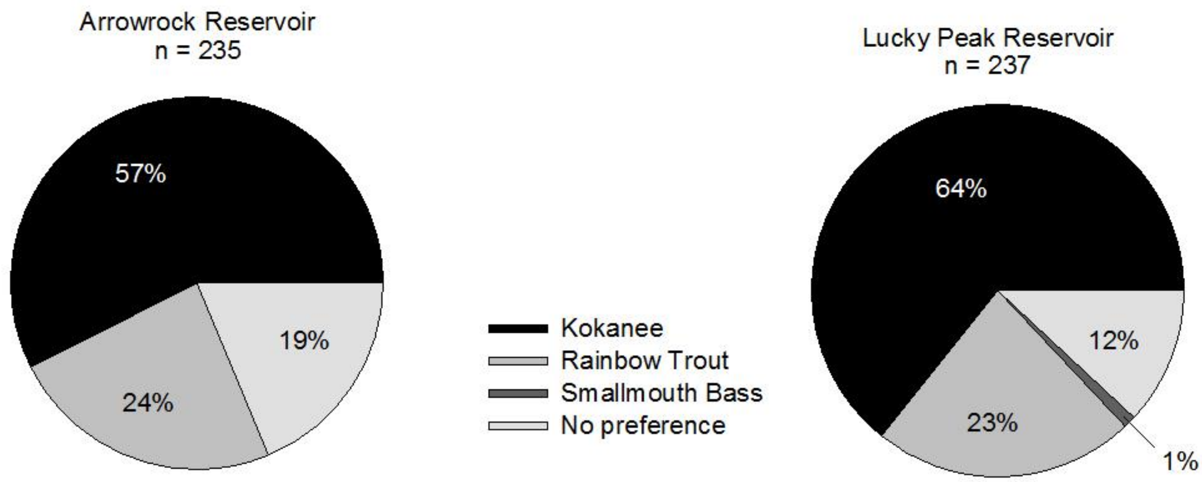

Figure 2. Proportion of anglers targeting game fish species at Arrowrock and Lucky Peak reservoirs in May 2015.

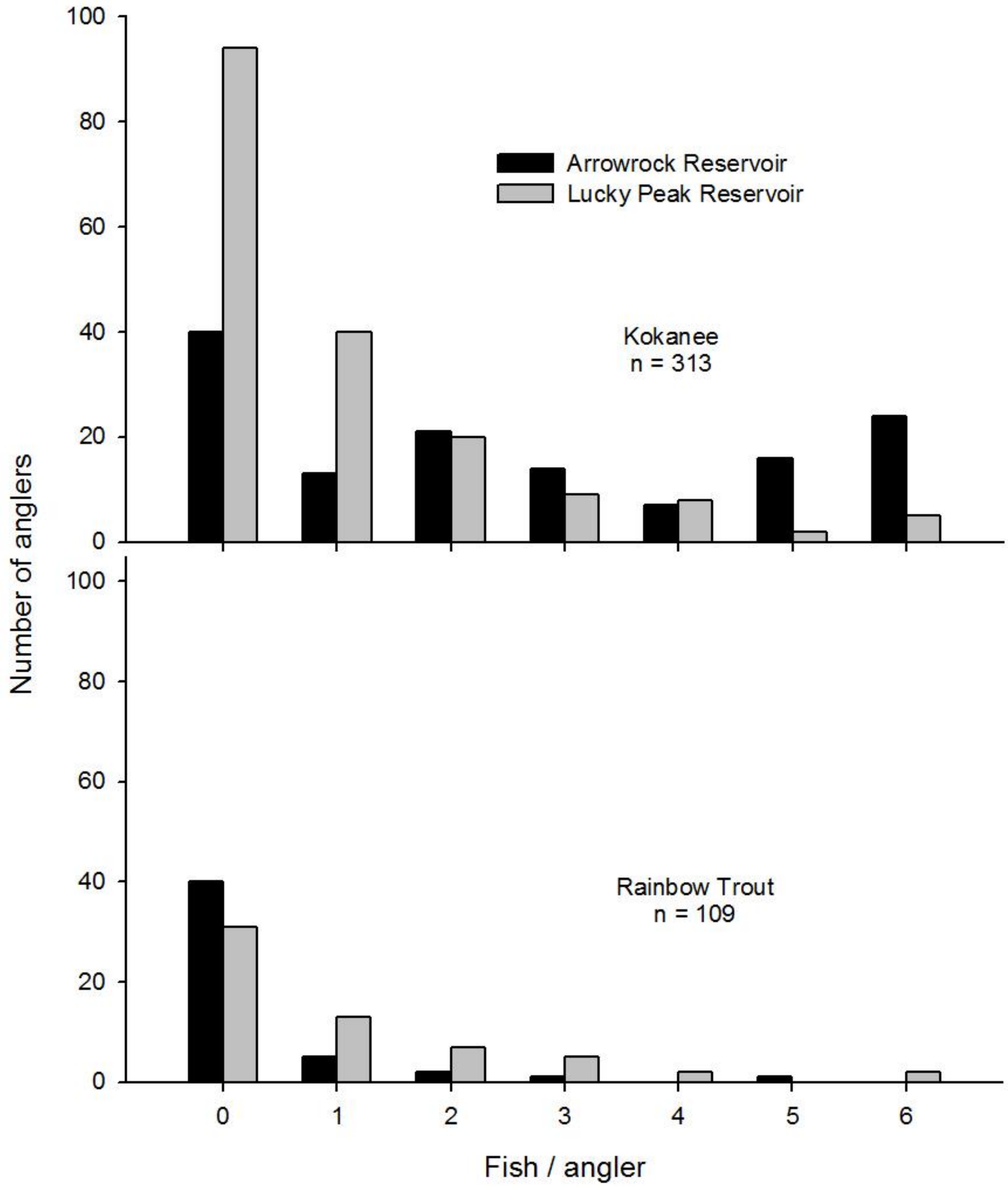

Figure 3. Frequency of harvest by angler for kokanee and Rainbow Trout at Arrowrock and Lucky Peak reservoirs in 2015.

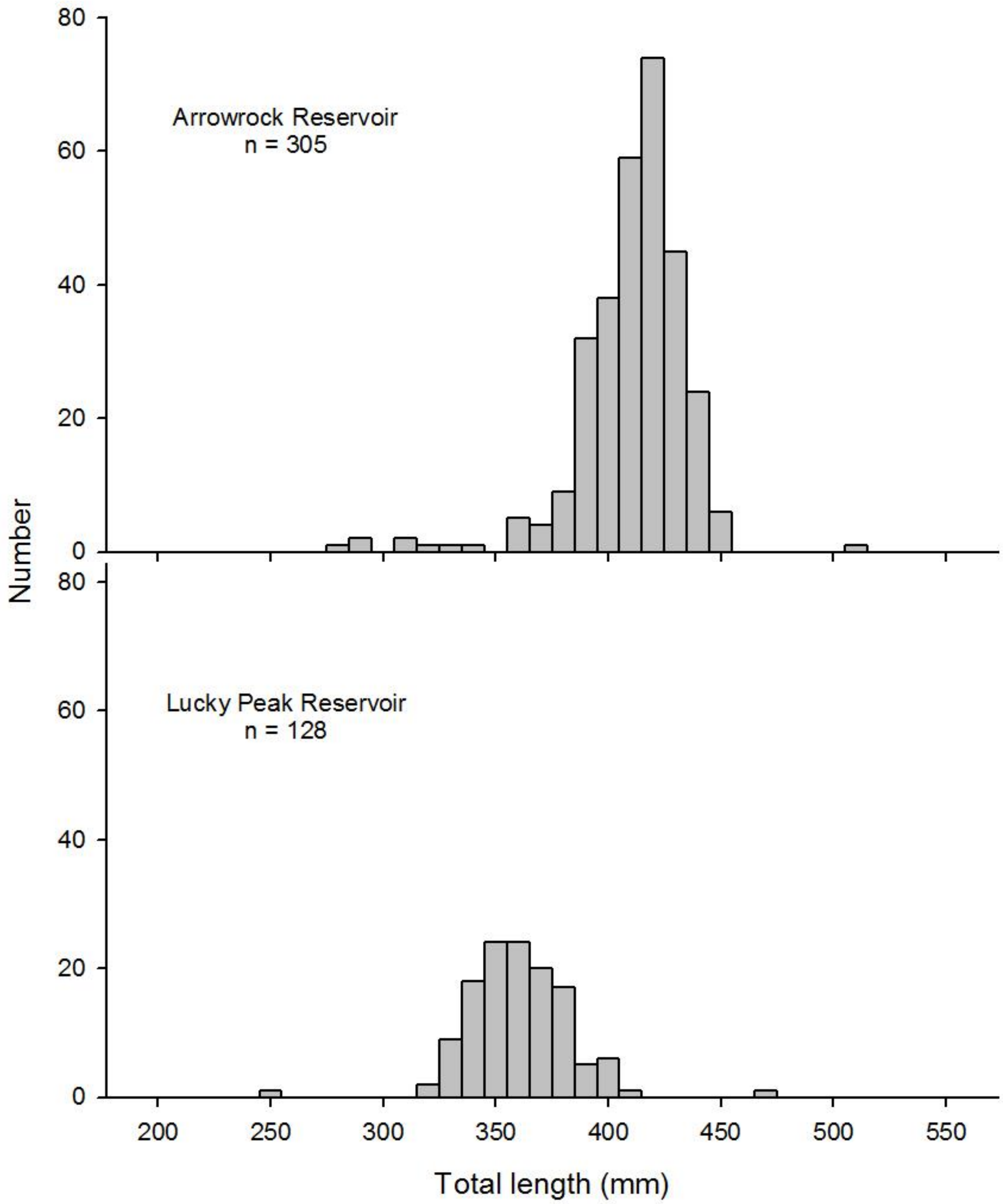

Figure 4. Length frequency distributions of kokanee observed in the creel in May 2015 at Arrowrock and Lucky Peak reservoirs.

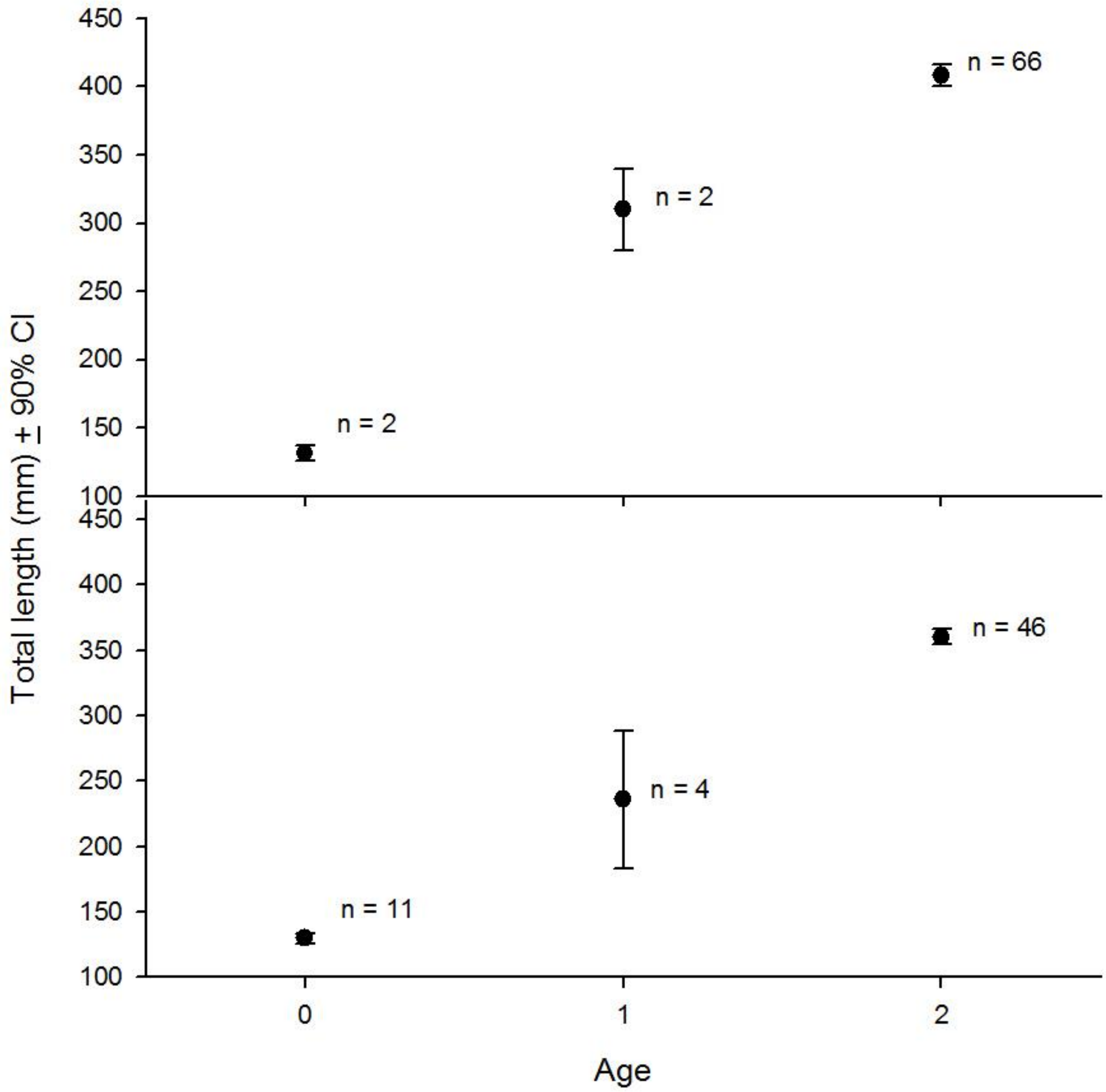

Figure 5. Length-at-age for kokanee sampled during the creel survey and net curtains in May-July 2015 and net curtains at Arrowrock and Lucky Peak reservoirs.

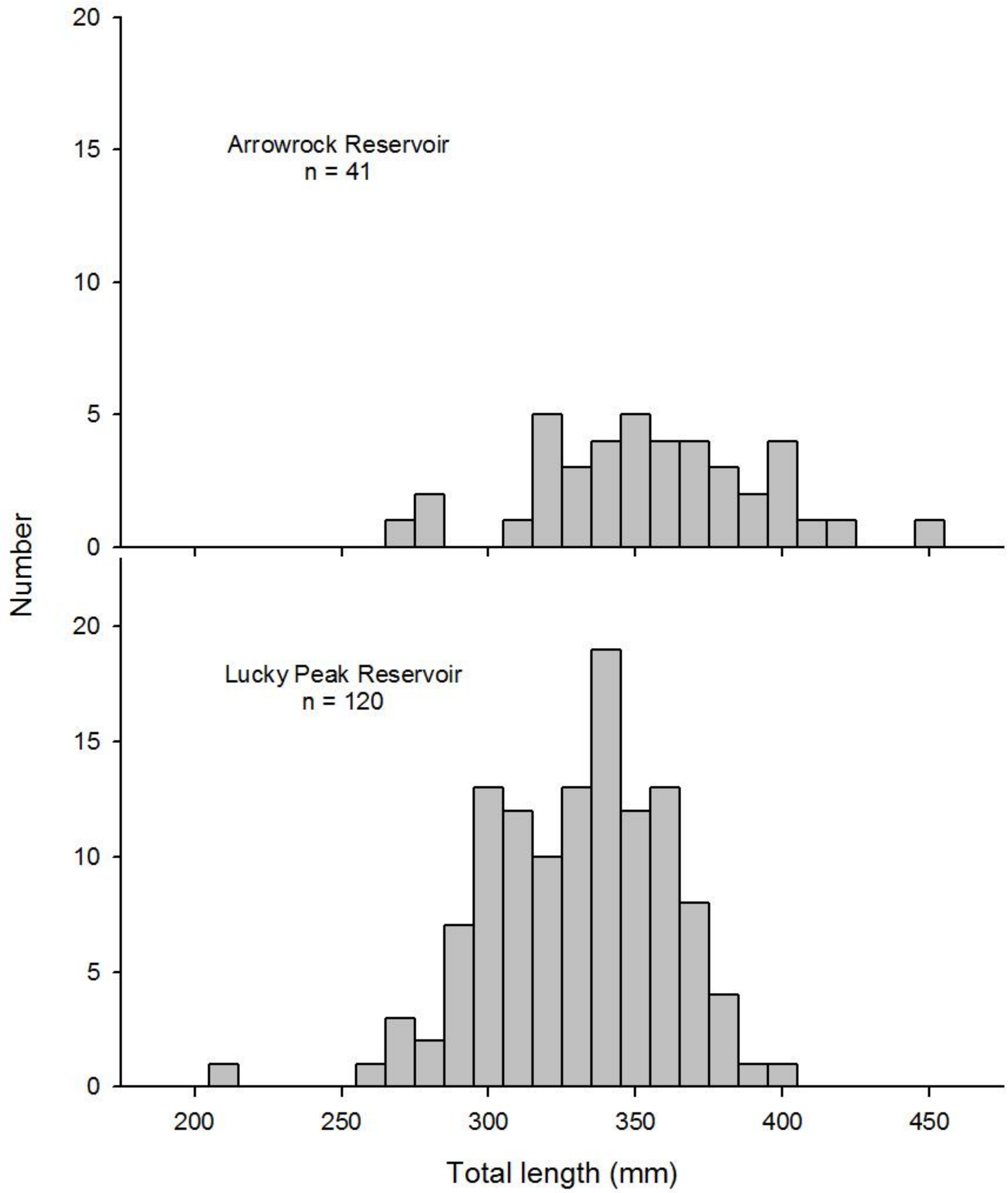

Figure 6. Length frequency distributions of Rainbow Trout observed in the creel in May 2015 at Arrowrock and Lucky Peak reservoirs.

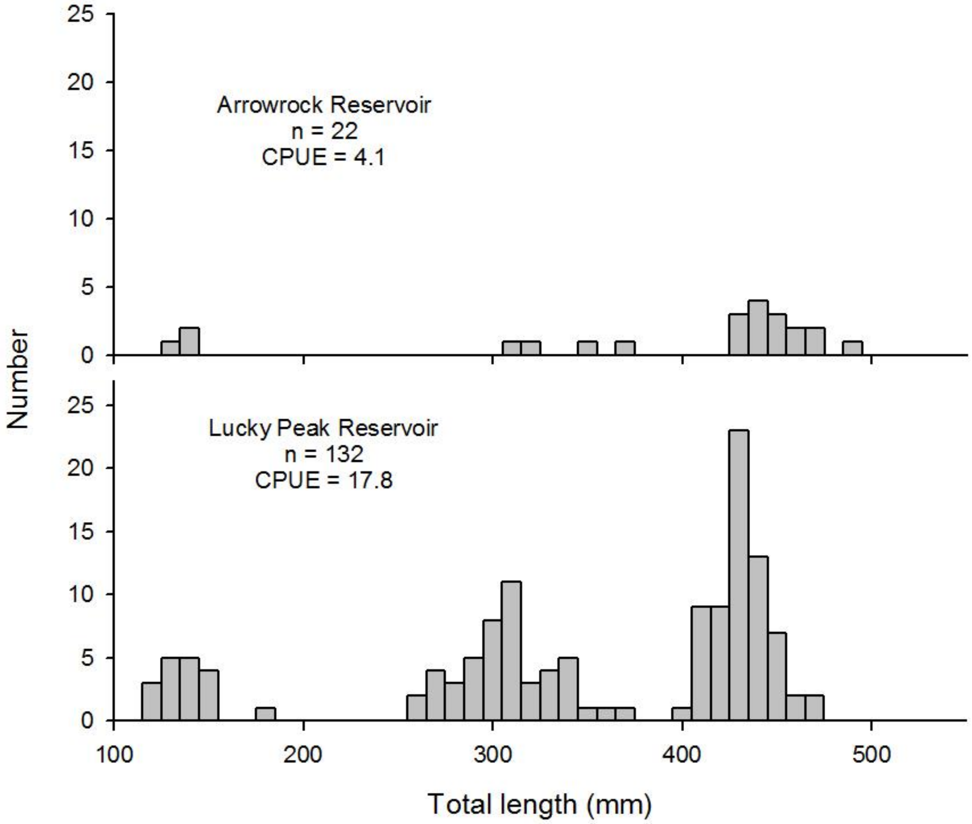

Figure 7. Length frequency distributions and catch-per-unit-effort (CPUE) of kokanee captured in curtain nets in May 2015 at Arrowrock and Lucky Peak reservoirs.

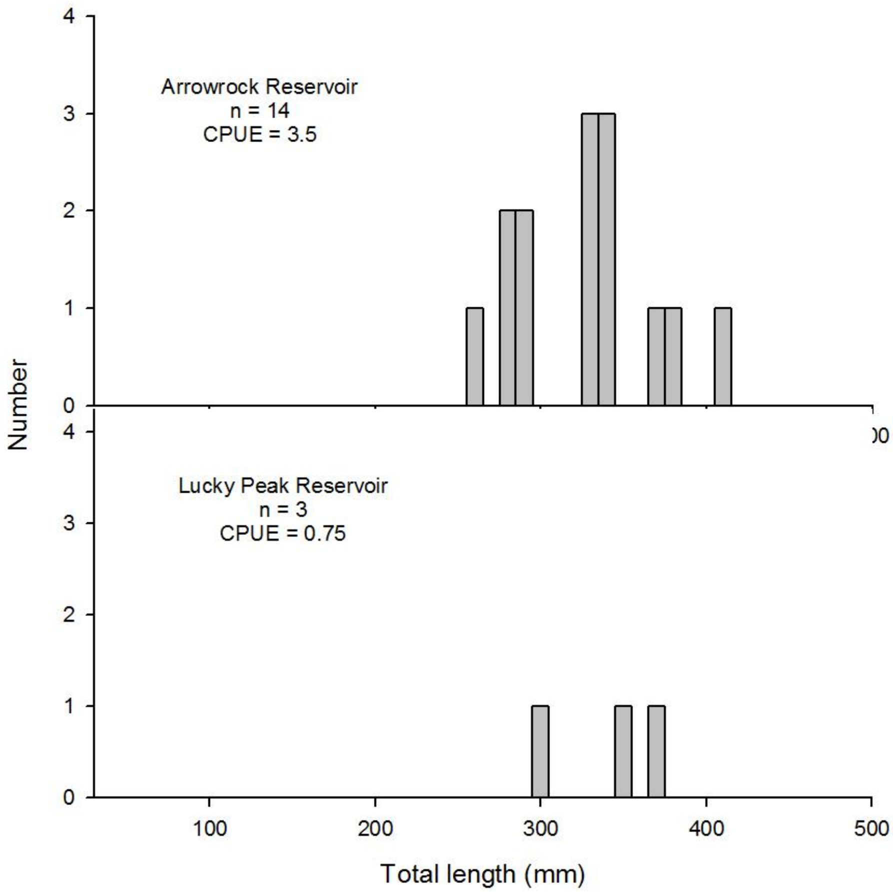

Figure 8. Length frequency distributions and catch-per-unit-effort (CPUE) of Rainbow Trout captured in curtains net in May 2015 at Arrowrock and Lucky Peak reservoirs.

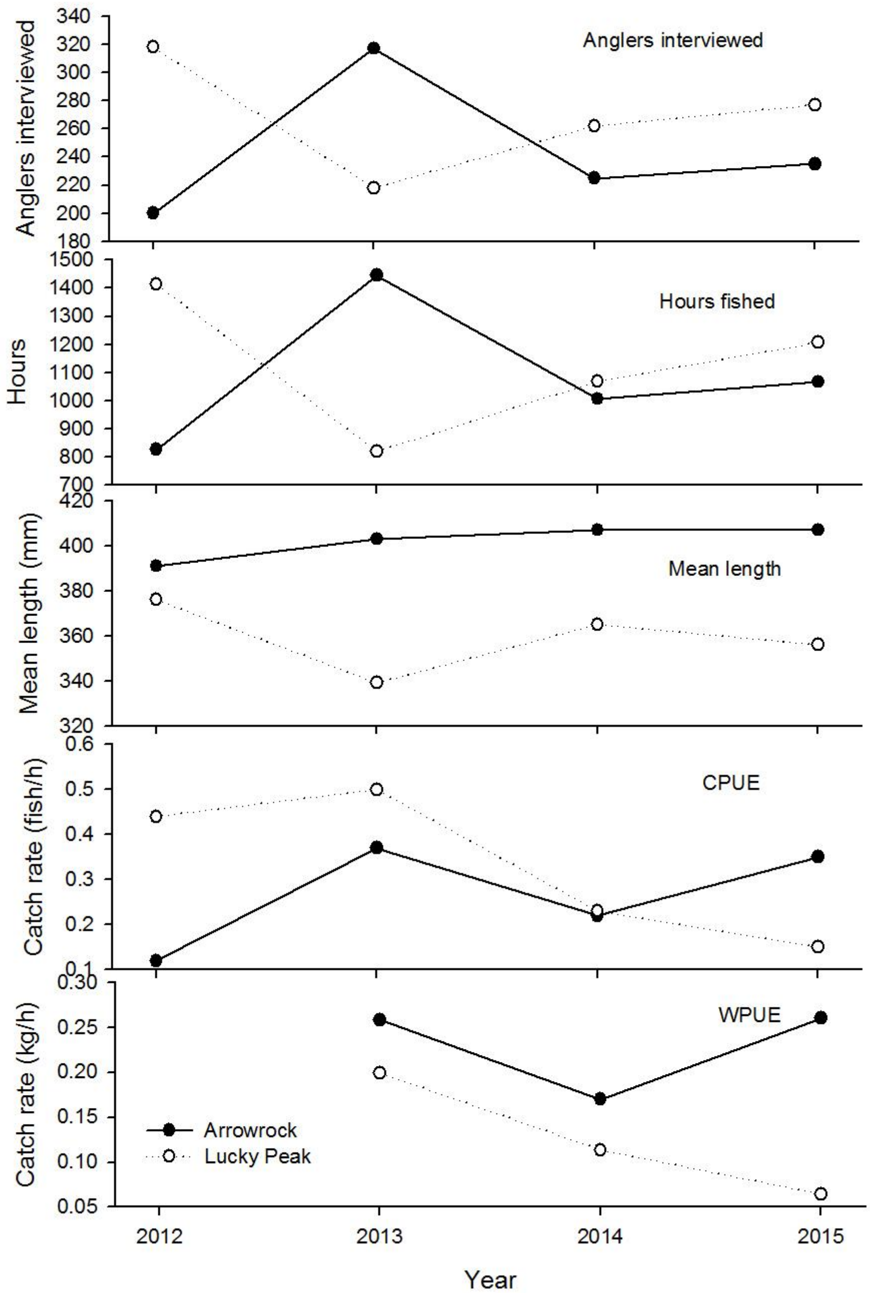

Figure 9. Trends in anglers interviewed, hours fished, kokanee mean length in creel (mm), and kokanee catch rates (fish/h and weight/h) at Arrowrock and Lucky Peak reservoirs during May 2012 to 2015 .

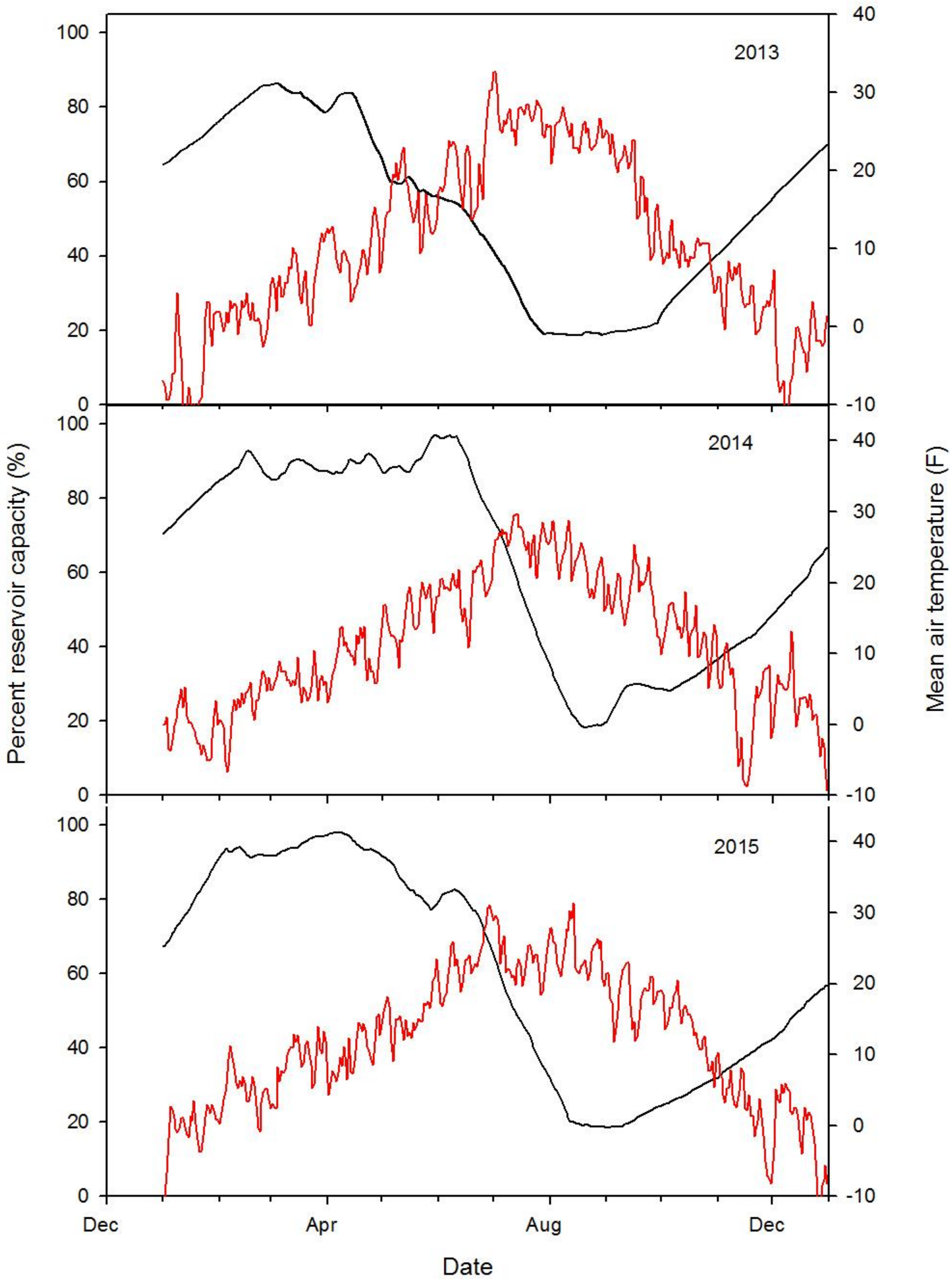

Figure 10. Annual reservoir capacity and mean daily air temperature (ºC) at Arrowrock Reservoir, Idaho 2013-2015.

DEADWOOD RESERVOIR MONITORING IN 2015

ABSTRACT

Kokanee *Oncorhynchus nerka* are the landlocked form of Sockeye Salmon *O. nerka* and provide recreational fisheries and a prey base in many waters of the western United States. Deadwood Reservoir provides important sport fisheries for kokanee and fall Chinook Salmon *O. tshawytscha*. The Deadwood Reservoir kokanee population is also Idaho's primary egg source for hatchery kokanee, providing early spawning kokanee for stocking throughout the state. Annual kokanee population control efforts conducted by IDFG have led to larger fish, higher fecundities, and improved yields of kokanee eggs. Monitoring this kokanee population, utilizing netting and hydroacoustics, is important for setting escapement targets and monitoring the effectiveness of management strategies. During 2015, kokanee densities among transects ranged from 229 fish/ha to 1,134 fish/ha with the highest densities corresponding to age-0 fish. Densities of Age-2 and older kokanee were the lowest (66 fish/ha) of all age classes, as expected. Overall, mean kokanee density was 455 (range 379 to 546) fish/ha. When expanded to an abundance estimate using the reservoir surface area (1,183 ha) on the survey date, the total number of kokanee was 543,352 (range 452,968 to 651,724). Age-0 kokanee were 64% of this total or 348,764 (range 282,103 to 431,110) fish. Hydroacoustic evaluations of the Deadwood Reservoir kokanee population indicate that kokanee abundance has responded to consistent and annual control efforts. The kokanee population has declined to approximately 86% of estimated abundance in 2011 when total kokanee abundance was estimated at 3.9 million. In 2015, kokanee density was slightly less than the target density of 500 fish/ha. Mean length-at-maturity of females has increased to 341 mm from 267 mm in 2014. During the 2015 kokanee spawning run, nearly 5,000 females were released upstream of the Deadwood River weir, which was modeled to result in roughly 800,000 age-0 kokanee in 2016. Finally, fall Chinook Salmon have been monitored by netting surveys and redd counts in the Deadwood River since 2012. In 2015, eight fall Chinook Salmon were captured in curtain nets, ranging from 416 to 576 mm. Additionally, only 5 redds were observed. It has become apparent that the abundance of fall Chinook Salmon has remained low and that natural spawning is not contributing to this population; therefore, I recommended that annual redd counts and large-mesh netting surveys be discontinued.

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INTRODUCTION

Deadwood Reservoir is a 1,260-ha impoundment located on the Deadwood River in Valley County, approximately 40 km southeast of Cascade, Idaho and 85 km northeast of Boise, Idaho (Figure 11). The reservoir offers a scenic setting at a relatively high elevation, and is a popular destination for many during the summer. Deadwood Reservoir offers abundant sport fishing opportunities for kokanee *Oncorhynchus nerka,* resident Fall Chinook Salmon *O. tshawytscha*, Rainbow Trout *O. mykiss,* and Westslope Cutthroat Trout *O. clarki lewisi*. Bull Trout *Salvelinus confluentus* are present in Deadwood Reservoir at very low abundance.

During the last 10-12 years, the kokanee population in Deadwood Reservoir has fluctuated drastically. Because kokanee exhibit density-dependent growth, increased abundance typically results in decreased mean length at maturity. This relationship has been especially evident at Deadwood Reservoir because the kokanee population experiences low anglingr pressure, has five tributaries with excellent spawning habitat, and abundances have increased quickly when not managed. In addition, Deadwood Reservoir, at times, had low densities of piscivorous predators that were incapable of suppressing kokanee abundance.

Deadwood Reservoir's kokanee population also serves as Idaho's primary egg source for producing early spawning kokanee. Annually, this population provides from 3 to 7 million eggs to IDFG hatcheries. Resultant fry and fingerlings are distributed to 15-20 waters statewide. Our management goal is to achieve a mean total length of 325 mm for spawning adult kokanee. Mean total length of female kokanee at the spawning trap on the Deadwood River has fluctuated widely over the past decade. From 2006 to 2008, we sought to reduce kokanee abundance and increase mean length by limiting escapement into a number of the Deadwood Reservoir tributaries (Kozfkay et al. 2010). High flow events that washed out the picket weirs and access restrictions due to forest fires contributed to the variable success of these efforts. However, efforts in 2008 were considered successful, particularly in Trail Creek and the Deadwood River. Egg collection efforts at Deadwood Reservoir were discontinued for one year in 2009 to evaluate the South Fork Boise River (SFBR) weir location. Egg collection and escapement management efforts resumed in 2010 to the present and are expected to continue for the foreseeable future.

Escapement targets for the Deadwood River are determined using annual hydroacoustic estimates of abundance, mean female fish length determined from gill net samples, and length-fecundity relationships. We expect that these targets will be beneficial for the management of this fishery. Current kokanee population management and monitoring activities include annual hydroacoustic and nettings surveys as well as limiting and monitoring escapement with weirs on the Deadwood River and Trail Creek. In 2010 and 2011, kokanee escapement was limited successfully in the Deadwood River and Trail Creek, using picket weirs and traps, until the egg collection quota was met, after which the weirs were removed with an unknown number of prospective spawning kokanee remaining. This practice could have potentially altered the spawn timing as additional kokanee may have migrated upstream and spawned after weir operations ceased. To avoid shifting the spawn timing, weir operations in 2012 and since have incorporated weekly escapement targets for female kokanee and required that the weirs were operated through the entire run.

Additionally, IDFG re-instituted fall Chinook Salmon stocking in 2009 to diversify the sport fishery and perhaps assist in kokanee population control through the introduction of an additional piscivore. Previously, fall Chinook Salmon were stocked from 1995 through 1998 at densities of 4 to 9 fish/ha, but the program was discontinued when the kokanee population declined in 1998. Currently, IDFG annually stocks approximately 5,000-7,000 Fall Chinook Salmon fingerlings, which equates to a stocking density of 4 to 5.7 fish/ha. Despite low stocking densities, biologists need to ensure that fall Chinook Salmon abundance does not increase and consequently depress kokanee abundance beyond management goals. We used curtain nets to assess survival, growth, and diet of fall Chinook Salmon. Additionally, redd counts were conducted on the Deadwood River in October 2015 to monitor population abundance. Fall Chinook redd counts were conducted previously in 2000 and 2001, but were discontinued as abundances waned. Redd counts were resumed during 2012 and have been conducted annually since.

METHODS

Hydroacoustics

Hydroacoustic estimates of fish densities, lengths, and vertical depth distributions were obtained with a Hydroacoustic Technology, Inc. (HTI) Model 241-2 split-beam digital echosounder on July 13, 2015. Hydroacoustic methodology and analysis is described in detail in Butts et al. (2011).

Curtain Nets

The pelagic fish species composition in Deadwood Reservoir was assessed with four small-mesh and two large-mesh curtain nets during July 13-15, 2015 (Figure 11). In 2013, pelagic curtain nets were more effective than IDFG standard lowland lake sampling gear at capturing kokanee and Fall Chinook Salmon, the target species (Koenig et al. 2015). Curtain nets were 55-m wide x 6-m deep and were suspended at various depths in the water column with focus on the thermocline. Mesh sizes were randomly ordered. Each mesh panel was 3-m wide by 6-m deep and each mesh size was repeated twice. The small-mesh net designed for kokanee was comprised of 13, 19, 25, 38, 51, 64, 76, 89, and 102-mm stretch mesh, while the large-mesh net intended for Chinook was comprised of 51, 76, 102, 114, 127, 133, 140, 152, 159, and 165-mm stretch mesh. Each curtain net, fished for one night, equaled one unit of gill net effort. The small-mesh nets were fished for three net nights, while the large-mesh nets were fished for four net nights.

Captured fish were identified to species, measured for total length (± 1 mm). Weights were not collected in 2015 due to equipment failure. Larger kokanee were necropsied to determine sex, maturity, and to assess mean length of females during the spawning run. Necropsies were also conducted on all captured Chinook Salmon to assess sex, maturity, and diet. Otoliths were removed from kokanee to estimate length-at-age. Catch data were summarized as the number of fish caught per unit of effort (CPUE).

Chinook Redd Surveys

Spawning Chinook Salmon abundance was estimated using a redd count on October 20, 2015. Redds were counted on the Deadwood River, from the confluence of Deer Creek downstream to the reservoir (approximately 6-km) Redd counts were performed to (Figure 11). A two-person crew began at the confluence of Stratton Creek and walked downstream, while another two-person crew surveyed upstream from the reservoir. All redds and live or dead

Chinook Salmon were enumerated. GPS coordinates of redds, fish, and carcasses were recorded.

RESULTS

Hydroacoustics

Hydroacoustic data were analyzed to estimate kokanee abundance. Converted target strengths of fish ranged between 30 to 700 mm, and kokanee were assumed to range between 30 and 400 mm (Figure 12). Kokanee densities among transects ranged from 229 fish/ha to 1,134 fish/ha with the highest densities corresponding to age-0 fish (Table 8). The lowest densities (66 fish/ha) among all age classes corresponded to age-2 and age-3 kokanee. Over all transects, geometric mean kokanee density was 455 (range 379 to 546) fish/ha. When expanded to a population estimate using the reservoir surface area (1,183 ha) on the survey date, the total kokanee abundance was 543,352 (range 452,968 to 651,724). Age-0 kokanee were 64% of this total or 348,764 (range 282,103 to 431,110) fish (Figure 13).

From 2002 through 2015, mean female length (mm) at maturity (measured at the Deadwood weir) and total kokanee density (fish/ha) have exhibited a negative relationship (Figure 14; $r^2 = 0.52$, $P < 0.05$). This model predicts the management objective for adult kokanee length is met when reservoir kokaneedensities are approximately 550 fish/ha. This relationship may be considered when determining how many fish to pass upstream of the weir during a spawning run based on the hydroacoustic density estimate and mean length of adults for that year.

Net Curtains

A total of 205 fish were captured in curtain nets during the pelagic survey (Table 9). Approximately 81% of the catch was kokanee (*n* = 167), followed by Mountain Whitefish *Prosopium williamsoni* (11%; *n* = 22). Chinook Salmon made up only 4% of the entire catch (*n* = 8). Westslope Cutthroat Trout and Rainbow Trout were also captured, but in very low numbers.

The kokanee captured in curtain nets ranged from 70 to 390 mm (Figure 12) and were composed of four age classes (ages 0-4; Figure 15). Kokanee CPUE was 24 fish/net night (Table 9). From specimens collected in curtain nets, we projected the mean length of a mature female at the weir three weeks later to be 344 mm.

Eight fall Chinook Salmon were captured in curtain nets, ranging from 416 to 576 mm (Figure 12). All fish were marked with adipose clips. Five of the fish were female and all eight fish were determined to be sexually immature. Two of the fall Chinook Salmon had 180-mm kokanee in their stomachs, one contained leeches, and five stomachs were empty. Fall Chinook Salmon CPUE was 1.1 fish/net (Table 9).

Mountain Whitefish, Rainbow Trout, and Westslope Cutthroat Trout were also captured in curtain nets (Figure 12). Total length of Mountain Whitefish ranged from 285 to 447 mm, and CPUE was 3.1 fish/net night (Table 9). Total length of Rainbow Trout ranged from 325 to 365 mm, and CPUE was 0.4 fish/net. Total length of Westslope Cutthroat Trout ranged from 360 to 380 mm, and CPUE was 0.6 fish/net.

Chinook Salmon Redd Counts

A total of five Fall Chinook Salmon redds were counted along 6 km of the mainstem Deadwood River in 2015 (Figure 11). All redds were observed between Deer Creek and the reservoir. One carcass and one live fish were also surveyed.

DISCUSSION

Annual kokanee population management efforts have resulted in larger kokanee with higher fecundities, and improved yields of kokanee eggs. Hydroacoustic evaluations of the Deadwood Reservoir kokanee population indicate abundance is declining due to escapement control. Total abundance of kokanee during 2015 has declined approximately 86% compared to 2011, when total abundance was estimated at 3.9 million kokanee (Figure 13). Overall, kokanee density was slightly less than target densities of 550 fish/ha, and mean length at maturity of females has increased to 341 mm from 267 mm in 2014. This is the second consecutive year for which mean length at maturity of females has increased. Additionally, the abundance of age-0 kokanee decreased to approximately 350,000, the lowest estimate since 2009.

Kokanee densities and adult length are near objectives, presumably due to effectively managing escapement annually. These management efforts should continue. Annual monitoring has shown how quickly the Deadwood Reservoir kokanee population can increase when escapement is not managed, as in 2009. Mean length-at-maturity for female kokanee has continued to increase annually since 2013, and currently exceeds the objective of 325 mm by 16 mm (Figure 16). Generally, there appears to be a one year lag-time between detected abundance declines and a response in mean length. Therefore, mean length at maturity of female kokanee should continue to surpass objectives in 2016 and it appears kokanee escapement needs to be increased.

Staff used historical data, in-year data, modeling, and practical experience to set escapement objectives. Beginning in 2012, fisheries staff have managed escapement throughout the spawning run by passing anywhere between 350-500 females above the weir each week, depending on annual fecundity measurements. We arrived at these escapement estimates by projecting the number of kokanee spawners needed to produce roughly 800,000 age-0 kokanee using the slope of the line in Figure 14. An important assumption in our modeling was that true female kokanee escapement were assumed to be double (700-800 females) that passed by staff. We assumed spawning fish would be missed before and after weir operations and the potential for weir failure is always present. However, this assumption was likely invalid since there has not been a weir failure since 2012, and itwas in place and operating for the entire spawning season. Therefore, we likely did not pass sufficient numbers of female kokanees to meet our objectives. Because density estimates and kokanee length are trending beyond management objectives, more females will need to be passed above the weir to continue to meet both adult length and egg collection objectives.

By operating the weir for the entire spawning run and by passing a limited number of individuals above the weir throughout the spawning run, IDFG should be able to continue aggressive control measures and egg collections without altering spawn timing. In 2015, passage of females was shaped to follow the natural run timing. A total of 4,925 females were released upstream of the weir, with peak releases occurring the first week of September (Becker et al. 2016). Based on the model, this resulted in over 3.4 million eggs deposited into the gravel above the weir in 2015 and 255,000 age-1 kokanee in 2017. Overall, kokanee abundance estimates and mean length-at-maturity of spawning females suggested that managing for a total populations size of 800,000 to 1.3 million kokanee provides a quality kokanee fishery in terms of both size and abundance, and also appears sufficient for meeting egg collection quotas for the hatchery system (Figure 16).

Pelagic curtain nets continue to provide important information on kokanee and Chinook Salmon at Deadwood Reservoir. Collecting kokanee with curtain nets was useful for determining mature female kokanee lengths and thus escapement objectives for the upcoming spawning run in addition to size verification of hydroacoustic data.

Chinook Salmon abundance has remained relatively stable, low, and has not been supported by natural spawning or production. During the previous three years, only 13, 7, and 5 Chinook Salmon redds were counted during surveys. This suggests the spawning population is not increasing. Furthermore, no natural (i.e. adipose-intact) Chinook Salmon have been captured during surveys, observed in creels, or during spawning ground surveys. Because of these observations and since these fish are not adapted to spawning and rearing at these elevations or temperatures, staff do not anticipate substantial increases in Chinook Salmon abundance; therefore, annual spawning ground surveys should be discontinued. Future monitoring of Chinook Salmon may be continued periodically using curtain nets. Additionally, IDFG plans to evaluate sterile triploid (3N) fall Chinook Salmon in Deadwood Reservoir and other Idaho waterbodies in the near future. Approximately half of the fall Chinook Salmon stocked into Deadwood Reservoir in 2016 will be 3N to compare performance with 2N fish. If 3N Chinook Salmon prove to be successful, this will further negate the need for redd surveys in the Deadwood River. .

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring the kokanee population in Deadwood Reservoir with hydroacoustics and sample pre-spawning fish with curtain nets to project mean length in 2016. Compare the number of 2016 age-0 kokanee hydroacoustic estimates to projected escapement objectives.

2. Participate in development of statewide kokanee monitoring evaluations using curtain nets with the intention of developing age-class specific indices

3. Operate spawning weirs on the Deadwood River to limit kokanee escapement on an annual basis. Weir installation should occur by the first week of August. Continue to develop and improve escapement targets and protocols.

4. Maintain annual stocking of 5,000 fall Chinook Salmon fingerlings in spring or early summer. In 2016, approximately half of allocation will be 3n.

5. Discontinue October fall Chinook Salmon redd counts.

Table 8. Kokanee densities (number/ha) per transect and total abundance estimates calculated by arithmetic and geometric mean densities at Deadwood Reservoir, Idaho on July 13, 2015.

		Fish densities (number / ha)				
Transect	Transect length (m)	Age-0	Age-1	Age-2	Age-3	Total
1	753	382	161	132	73	747
2	756	320	72	18	53	462
3	860	492	142	31	67	733
4	797	123	44	10	52	229
5	771	147	56	27	28	259
6	857	197	99	11	42	349
7	840	784	235	46	68	1,134
8	583	542	136	19	33	730
9	729	161	54	25	49	288
10	832	194	61	28	15	298
11	753	267	45	33	23	368
12	827	506	20	25	25	575
	Geometric Mean (GM)	292	76	26	40	455
	90% CI (GM)	236 to 361	60 to 97	21 to 34	33 to 48	379 to 546
	Abundance (GM)	348,764	90,989	31,594	47,591	543,352
		282,103 to 431,110	71,113 to 116,327	24,807 to 40,153	39,915 to 56,700	452,968 to 651,724

Table 9. Total catch and catch per unit effort (CPUE) by species in seven pelagic net curtains in Deadwood Reservoir, Idaho on July 13-14, 2015.

Species	Number	CPUE
Fall Chinook Salmon	8	1.1
Kokanee	167	23.9
Mountain Whitefish	22	3.1
Rainbow Trout	3	0.4
Rainbow x Cutthroat Hybrid	1	0.1
Westslope Cutthroat Trout	4	0.6

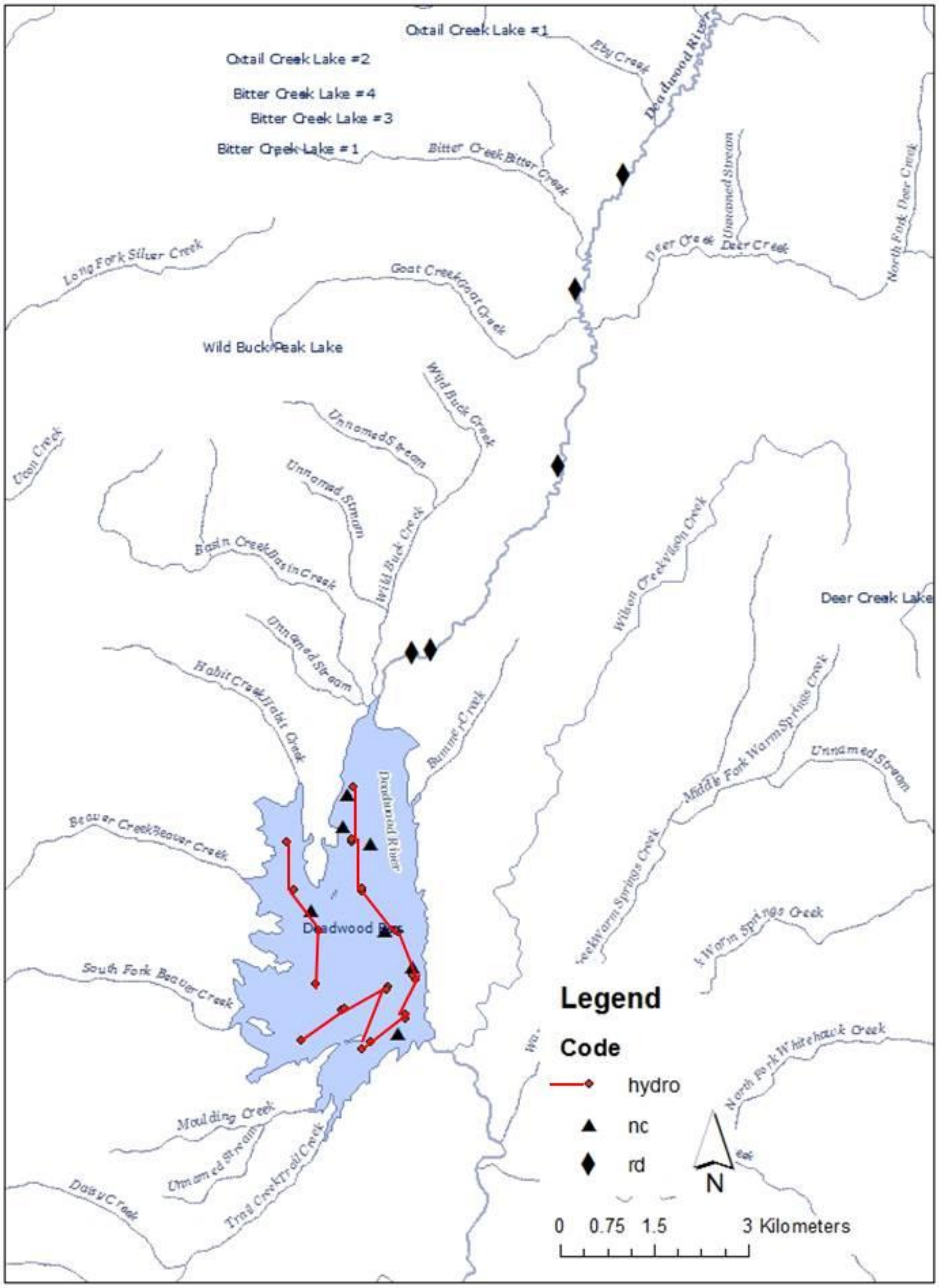

Figure 11. Map of Deadwood Reservoir, Idaho showing hydroacoustic transects (hydro), net curtain locations (nc), and redd locations (rd) during 2015.

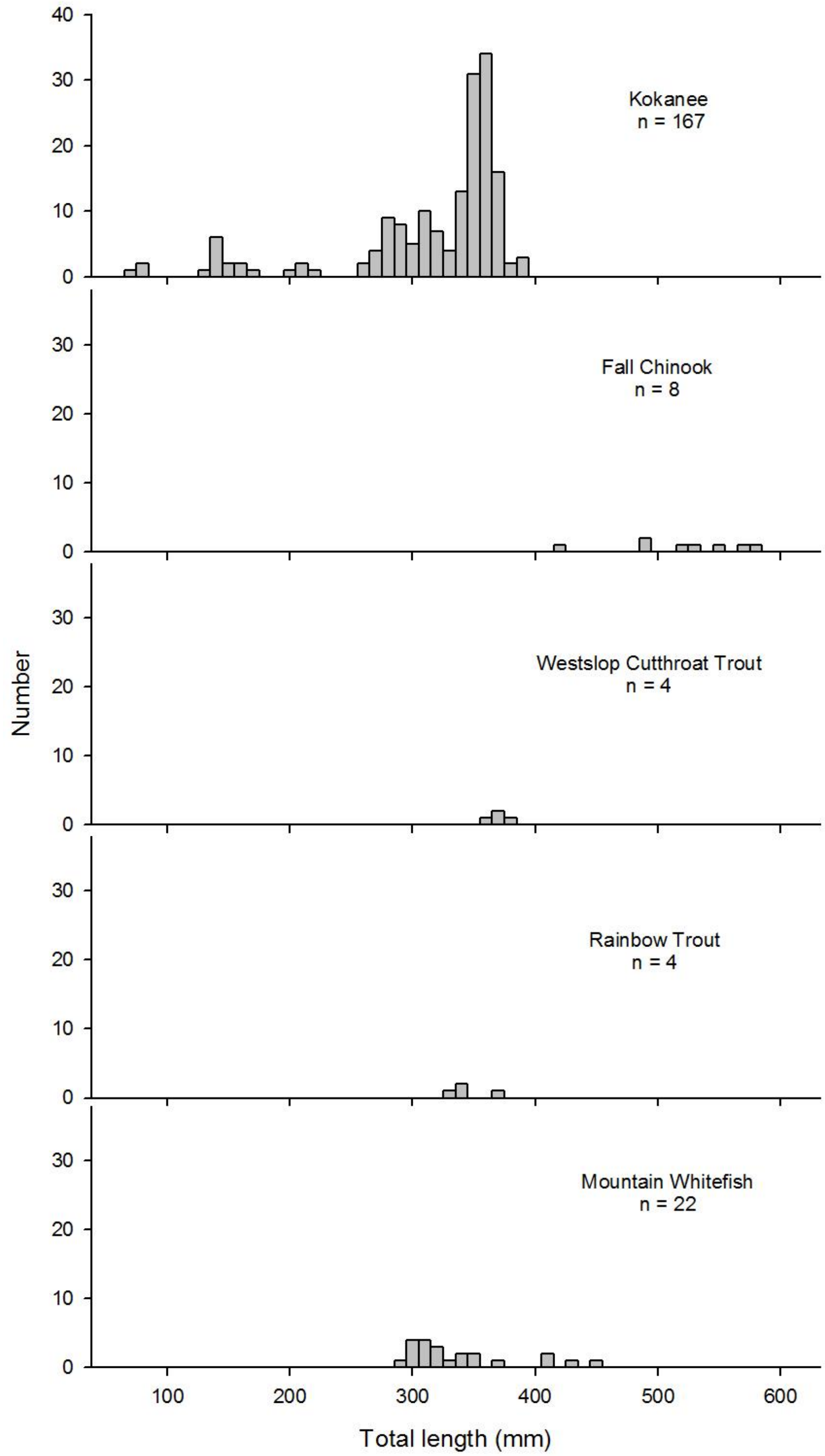

Figure 12. Length distributions for kokanee, fall Chinook Salmon, Mountain Whitefish, Rainbow Trout, and Westslope Cutthroat Trout caught in curtain nets at Deadwood Reservoir, Idaho on July 13-14, 2015.

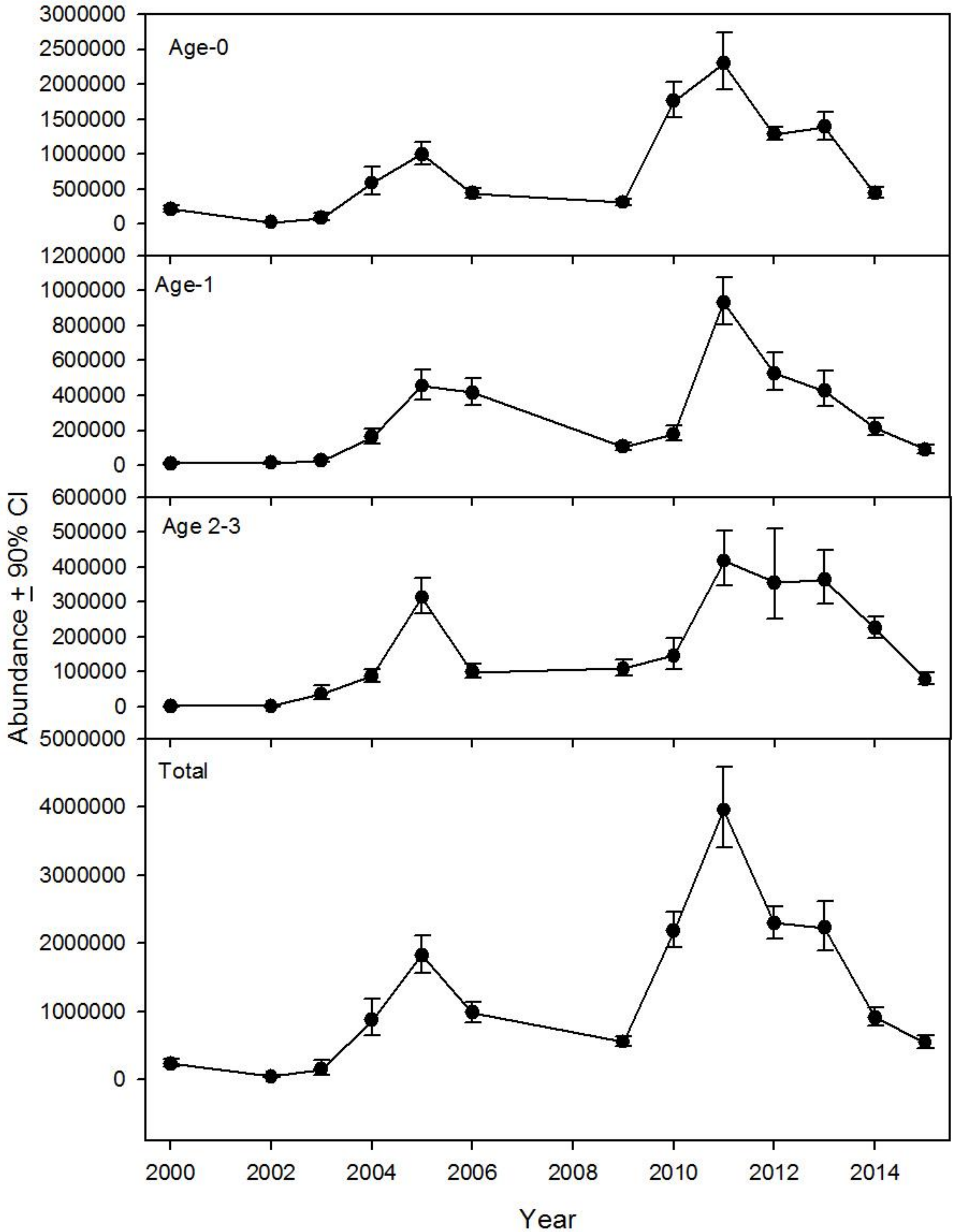

Figure 13. Comparison of kokanee abundance estimates ± 90% Confidence Intervals for fish <100 mm (age-0), 100-200 mm (age-1), >200 mm (age 2+), and total fish as estimated from annual hydroacoustic surveys from 2000-2015 at Deadwood Reservoir, Idaho.

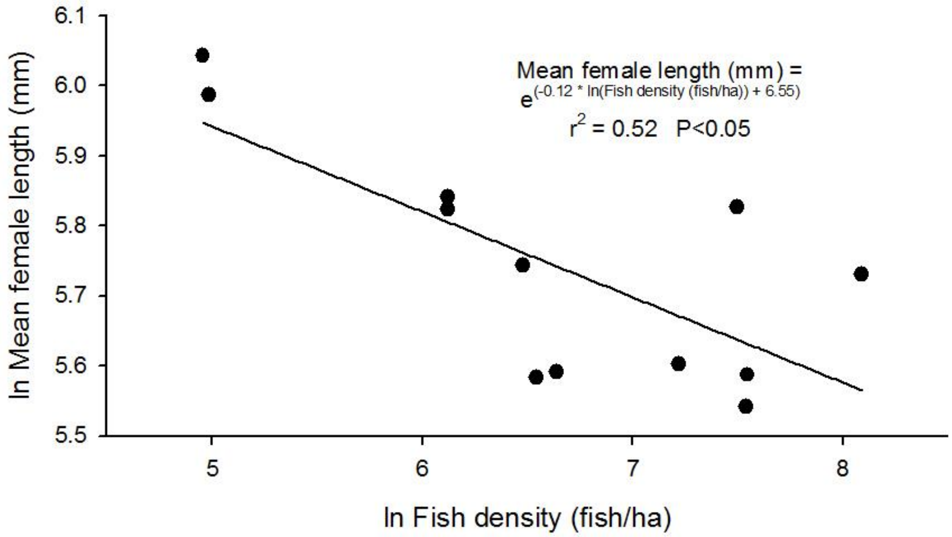

Figure 14. Density-dependent relationship plotted as a function of fish density and lenth-at-maturity of females, for kokanee at Deadwood Reservoir, Idaho. Fish density was estimated using summer hydroacoustic estimates while mean female length at maturity was obtained from weir data on Deadwood River.

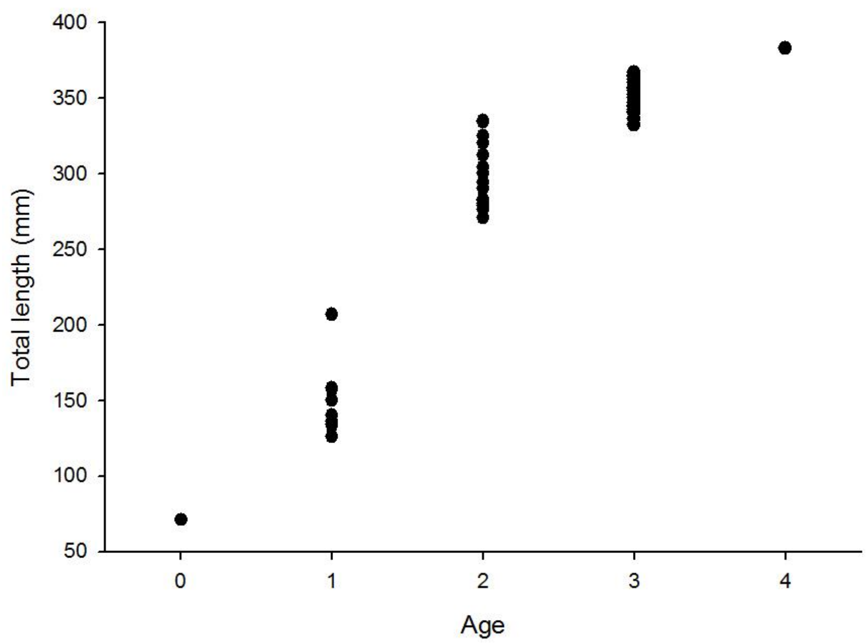

Figure 15. Length at age of kokanee collected in curtain nets at Deadwood Reservoir during July 13-14, 2015.

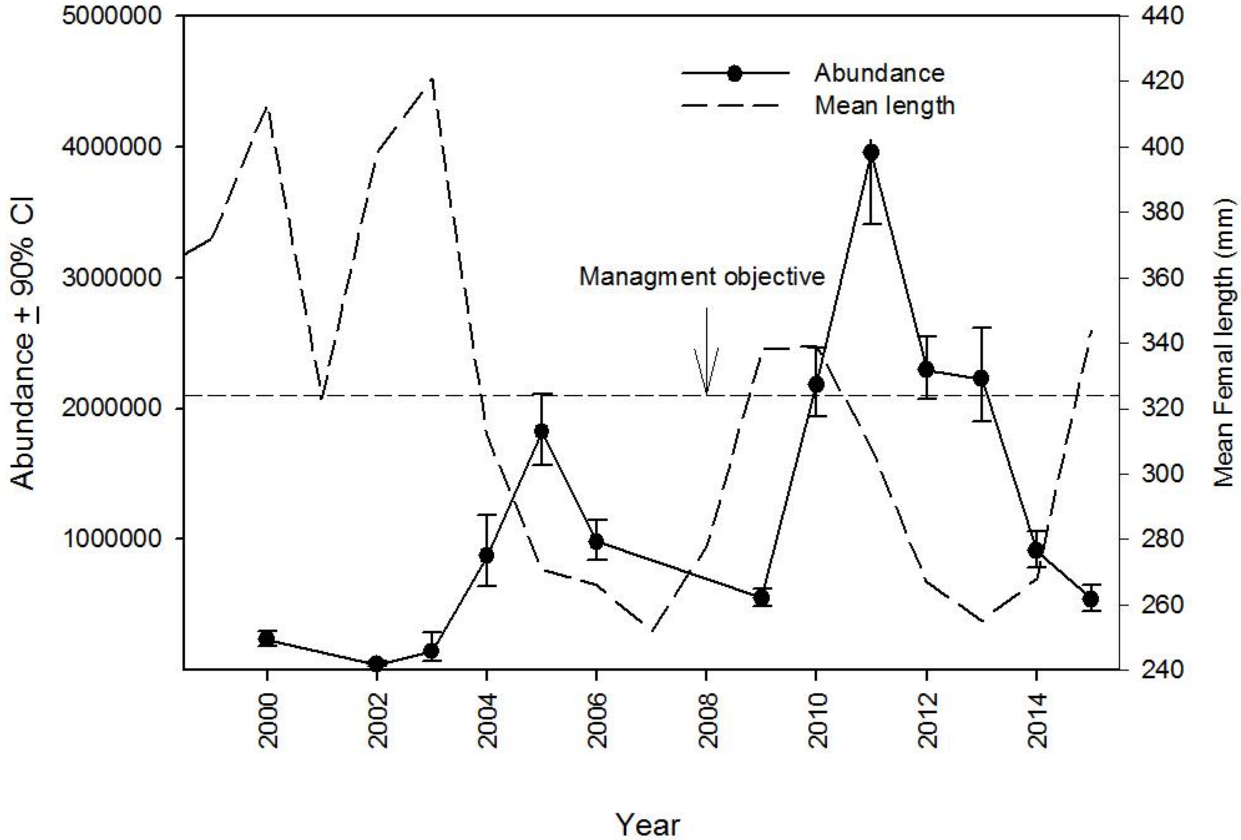

Figure 16. Hydroacoustic abundance estimates and mean female total length (mm) collected at the Deadwood River trap from 1998-2015. The management goal for mean adult length is represented by the horizontal dotted line.

ASSESSMENT OF LARVAL FISH PRODUCTION IN BROWNLEE AND CJ STRIKE RESERVOIRS

ABSTRACT

Larval fish production has been monitored within Brownlee and CJ Strike reservoirs since 2005 to identify trends in crappie *Pomoxis spp* reproduction. Monitoring continued in 2015, using a horizontal Neuston trawl net towed near the water surface at eleven sites in Brownlee Reservoir and ten sites in CJ Strike Reservoir. Species sampled were similar between reservoirs and included crappies, Bluegill *Lepomis macrochirus*, Channel Catfish *Ictalurus punctatus*, Largemouth Bass *Micropterus salmoides*, Smallmouth Bass *Micropterus dolomieu,* and Yellow Perch *Perca flavescens*. Prior to 2015, peak mean density of larval crappies for Brownlee Reservoir have ranged from 5 to 264 crappies/100 m^3, with a mean of 72 crappies/100 m^3. Peak mean density of larval crappies in Brownlee Reservoir during 2015 was 585 crappies/100 m^3. The peak mean density was more than double the previous high of 264 crappies/100 m^3, sampled in 2010. Densities of larval crappies have typically been lower in CJ Strike Reservoir compared to Brownlee Reservoir. Since 2005, peak mean density of larval crappies for CJ Strike Reservoir has ranged from 1 to 58 crappies/100 m^3. During 2015, peak mean density was 105 crappies/100 m^3, which represented the highest density observed in CJ Strike Reservoir. Both reservoirs appeared to produce high larval crappies abundances during the 2015 spawning season. Additional work should be conducted to identify what abiotic factors lead to successful recruitment of harvestable crappies.

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INTRODUCTION

Fisheries for Black Crappie *Pomoxis nigromaculatus* and White Crappie *P. annularis*, Bluegill *Lepomis macrochirus*, and Yellow Perch *Perca flavescens* are popular among anglers in southwest Idaho when abundant. However, year-class strength for these varies widely between years, often leading to inconsistent fisheries. Year-class strength seems to be determined at early life stages, whether this occurs before or after the first winter is unknown. Fisheries personnel are interested in quantifying year-class strength before fish become vulnerable to anglers, so that anglers may be informed to anticipate potential quality year classes. Monitoring larval fish densities with Neuston nets is one way to provide information on reproductive success and potential year-class strength, assuming recruitment isn't affected substantially by population bottlenecks at later life stages (e.g. survival during winter). Documenting years with low larval production could predict years of poor fishing two to three years later, when crappies would typically enter the fishery. Monitoring of year-class strength in Brownlee and CJ Strike reservoirs was conducted by IDFG's fisheries research personnel since 2005 as part of a statewide research project (Lamansky 2011). However, that project was discontinued by 2010, and Southwest Region fisheries staff has continued this work (Butts et al 2011).

OBJECTIVES

1. Assess reproductive success of recreationally important warm-water fishes, primarily crappies.
2. Identify abiotic factors that affect recruitment success of crappies within surveyed waterbodies.

METHODS

Horizontal surface trawls were used to sample larval fish at 10 or 11 sites in Brownlee and CJ Strike reservoirs. Trawls were conducted throughout each of the reservoirs (Figure 17and 18, respectively) using a 1-m high x 2-m wide x 4-m long Neuston net with 1.3-mm mesh. Trawling commenced at dusk and all sites were completed within three to four hours. Each trawl was 5 minutes in duration and we used a flow meter fitted to the net to estimate the volume of water sampled. The average water volume sampled was 273 and 202 m^3/tow at Brownlee and CJ Strike reservoirs, respectively. Trawling was conducted on three separate dates including June 8, June 23, and July 9, 2015, which overlapped peaks of crappies production in previous years. Specimens were fixed in 10% formalin for 2 weeks then rinsed and stored in 70% ethanol. Sampled fish were viewed under a dissecting microscope, identified to species, and measured for length. If the total number of larval fish exceeded 50 individuals, we randomly selected a subsample 50 individuals, identified and measured those, then counted the remainder and extrapolated to the whole sample. The week that had the highest densities averaged across all sample sites was indexed as the peak larval density for the year and reported as fish/100 m^3. Data was compared across years to categorize trends in crappies production.

RESULTS

Brownlee Reservoir

A total of 33 trawls tows (11 per date) were completed on Brownlee Reservoir during 2015. Species collected included crappies, Bluegill, Channel Catfish *Ictalurus punctatus*, Largemouth Bass *Micropterus salmoides*, and Yellow Perch. Crappies were the most represented larval species at 84.9%, followed by Bluegill (13.5%), Channel Catfish (0.7%), Largemouth Bass (0.4%), Yellow Perch (<0.05%), and unknown species (0.5%). The peak larval densities were observed during the first sampling event on June 9, 2015. Peak larval crappie densities have ranged from 48 (site BR08) to 1,594 fish/100 m^3 (BR05; Figure 19) among site sampled in Brownlee Reservoir. The average of peak larval densities for the past ten years (2005 to 2014) was 72 fish/100 m^3 within the reservoir. The point estimate for peak larval density was substantially higher in 2015 at 585 fish/100 m^3 than any previous year since sampling was initiated in 2005. However, it was not statistically higher than 2006, 2010, and 2012 (Figure 20).

CJ Strike Reservoir

A total of 30 trawl tows (10 per date) were completed on CJ Strike Reservoir during 2015. Species composition for samples collected from CJ Strike Reservoir included crappies (79.6%), Bluegill (7.0%), Largemouth Bass (3.2%), Smallmouth Bass *Micropterus dolomieu* (0.5%), Channel Catfish (0.4%), Yellow Perch (0.05%), and unknown species (9.3%). The peak larval densities were observed during the first sampling event conducted on June 8, 2015. Peak larval crappie densities ranged from 9 fish/100 m^3 (CJ08) to 188 fish/100 m^3 (CJ01; Figure 21) among sites sampled in CJ Strike Reservoir. Peak larval densities recorded since 2005 have averaged 17 fish/100 m^3 within CJ Strike Reservoir. The point estimate for peak larval densities estimated in 2015 was 103 fish/100 m^3, which was higher than previous estimates for the reservoir (Figure 22).

DISCUSSION

Peak larval crappies densities, in both reservoirs, were estimated at the highest levels observed since trawl tows were initiated in 2005 (Lamansky 2011; Figure 20 and 22). Peak larval densities represented a 122% and 78% increase over the previous high measured during the past ten years for Brownlee and CJ Strike reservoirs, respectively. A significant gap in understanding of population dynamics of crappies exists. Better understanding is needed of factors that may affect larval fish and survival to adult abundance, including overwinter survival (Pine and Allen 2001; McCollum et al 2003), especially for Idaho populations. Allen et al (1999) suggested that otter trawl surveys provided precise estimates of mean CPUE and less sampling effort was needed to index advanced age-0 to adult crappies survival. Currently, for these fisheries, the survival of age-0 crappies to older age classes in not well understood and reduces our ability to predict fisheries quality from larval densities. Experimenting with the use of an otter trawl to index age-0 crappie density should be considered. The high densities of larval crappies sampled in 2015 may provide a unique sampling opportunity to determine whether larval densities translate into successful recruitment of harvestable crappies.

Relative production of crappies has been indexed for the past eleven years in Brownlee and CJ Strike reservoirs. The primary purpose of the index data was to develop a forecast of fishing potential, in subsequent years. Spatial and temporal variation was observed in both reservoirs during the 2015 assessment, which indicated the importance of sampling multiple weeks and locations to identify the peak abundance period. Larval production during 2015 tended to be higher within most sample locations in both reservoirs. Further work should be conducted to identify if additional year classes such as 2006 (that produced good fishing) experienced similar environmental factors (such as water temperature or flow regime). Based on peak density of larval crappies sampled in 2015, there may be crappies available for harvest in subsequent years. Sampling these fish at older age classes (if present) could provide additional population dynamic data to improve our ability to forecast future fisheries.

MANAGEMENT RECOMMENDATIONS

1. Experiment with alternative methods to sample older age classes of crappies, such as using otter trawls for advanced age-0 fish.

2. Continue to sample larval crappies. Collect age structure data from harvested crappies at Brownlee and CJ Strike reservoirs to compare current growth data to previous information (Lamansky 2011) and to identify whether growth is consistent over time or is density dependent.

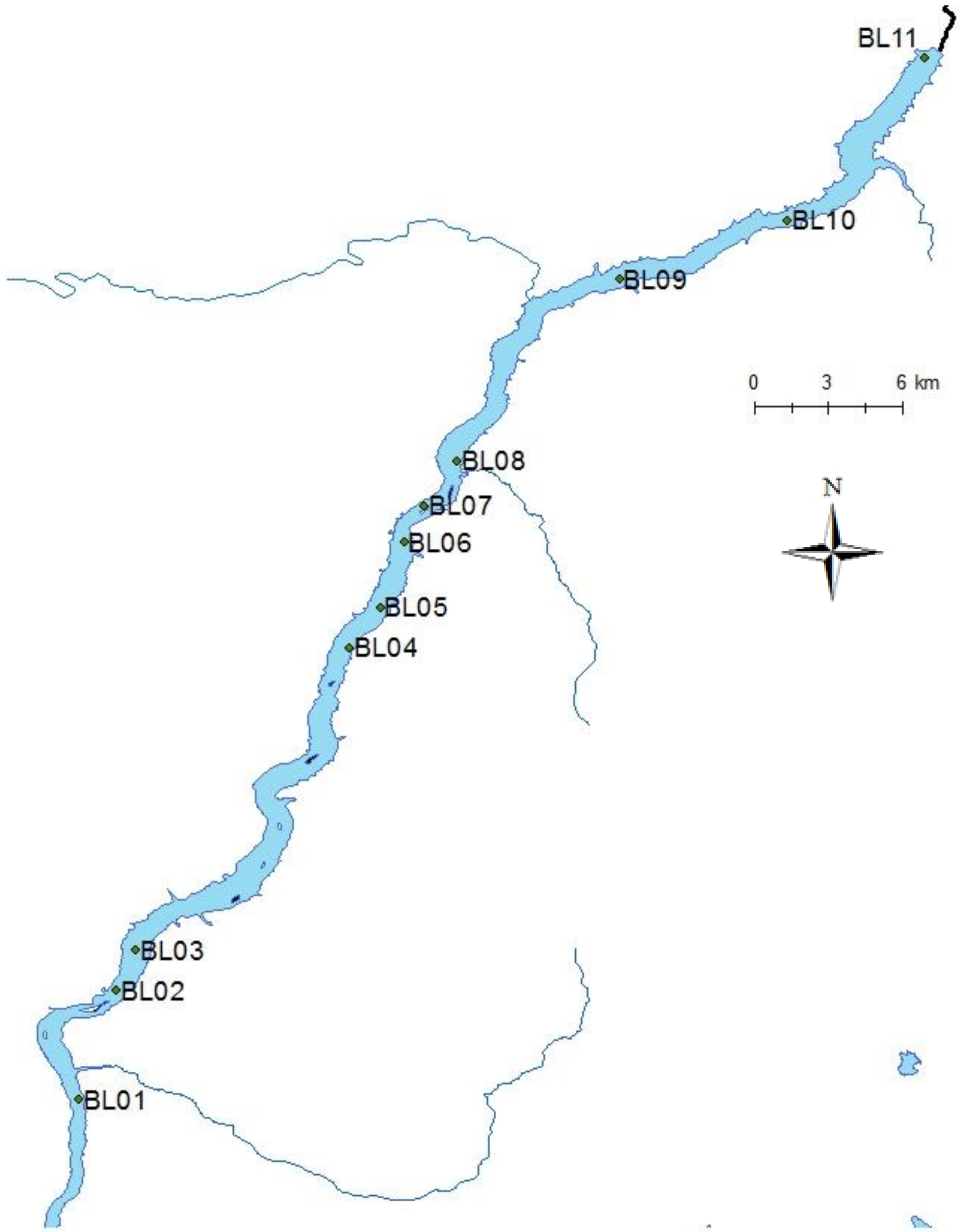

Figure 17. Location of 11 trawl sites used to index the abundance of larval fish in Brownlee Reservoir from 2005-2015.

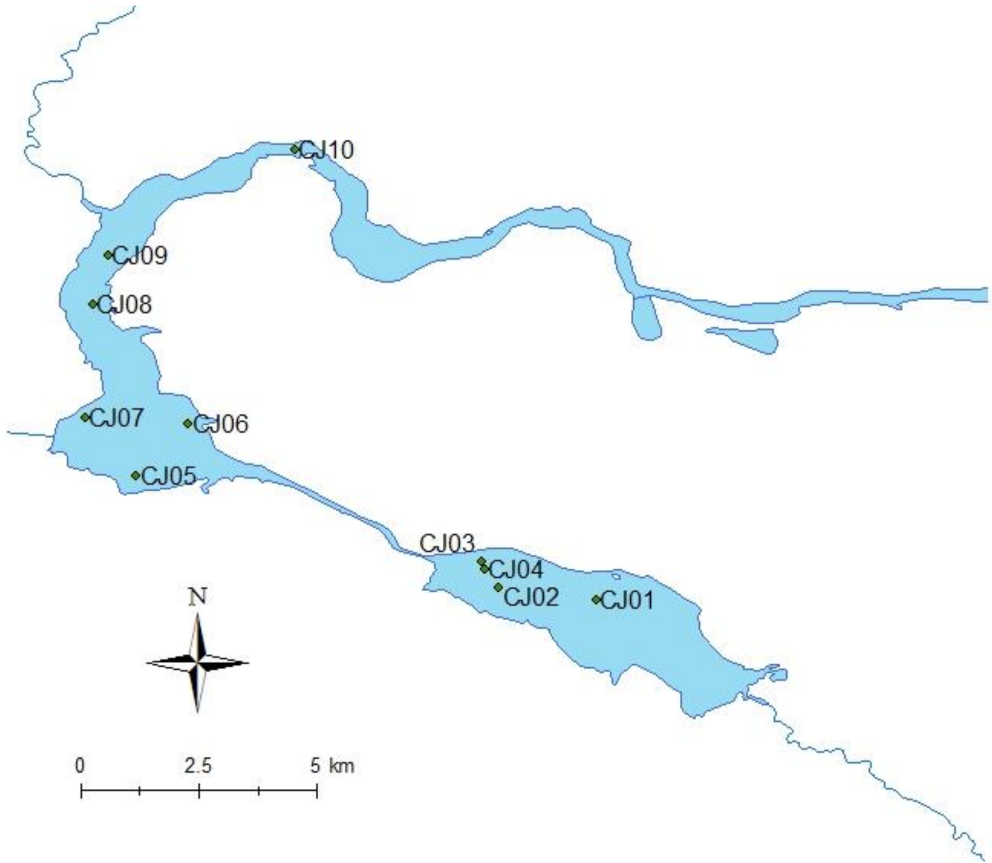

Figure 18. Location of 10 trawl sites used to index the abundance of larval fish in CJ Strike Reservoir from 2005-2015.

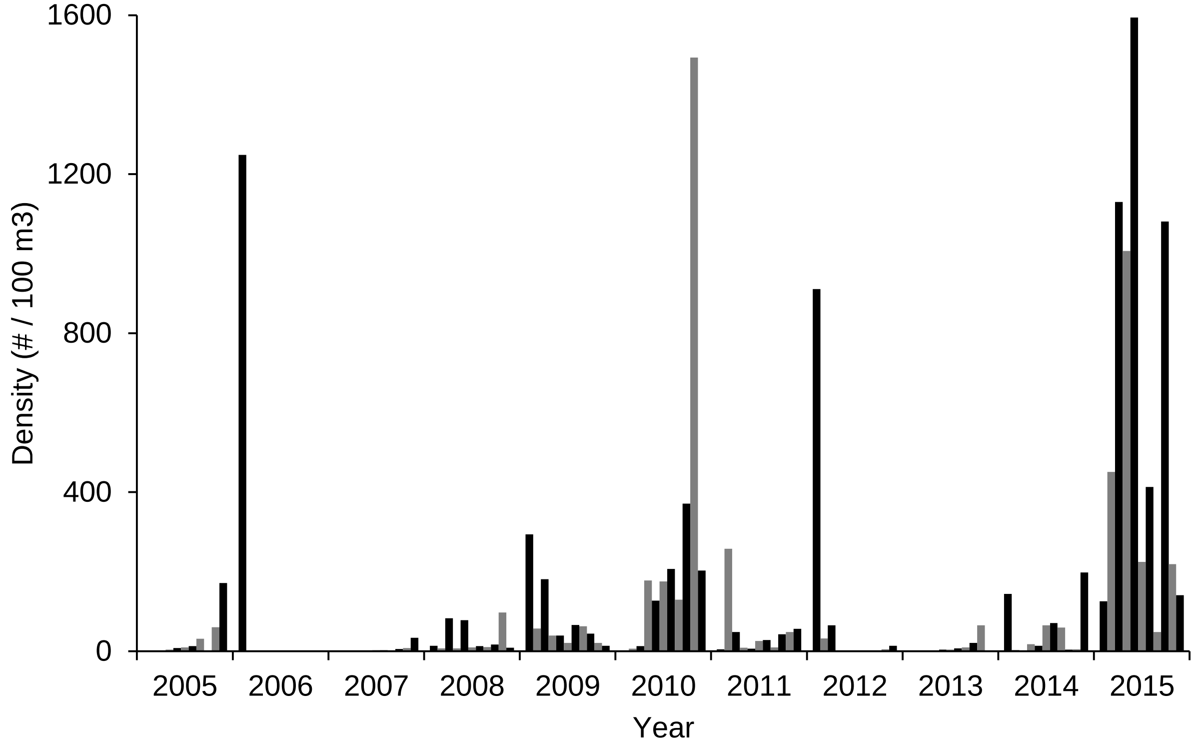

Figure 19. Densities of larval crappies (#/100 m^3) in Brownlee Reservoir during 2005 through 2015. Bars within each year represent 11 individual sites. Site 1 (upstream) through site 11 (near Brownlee Dam) is displayed from left to right within each year.

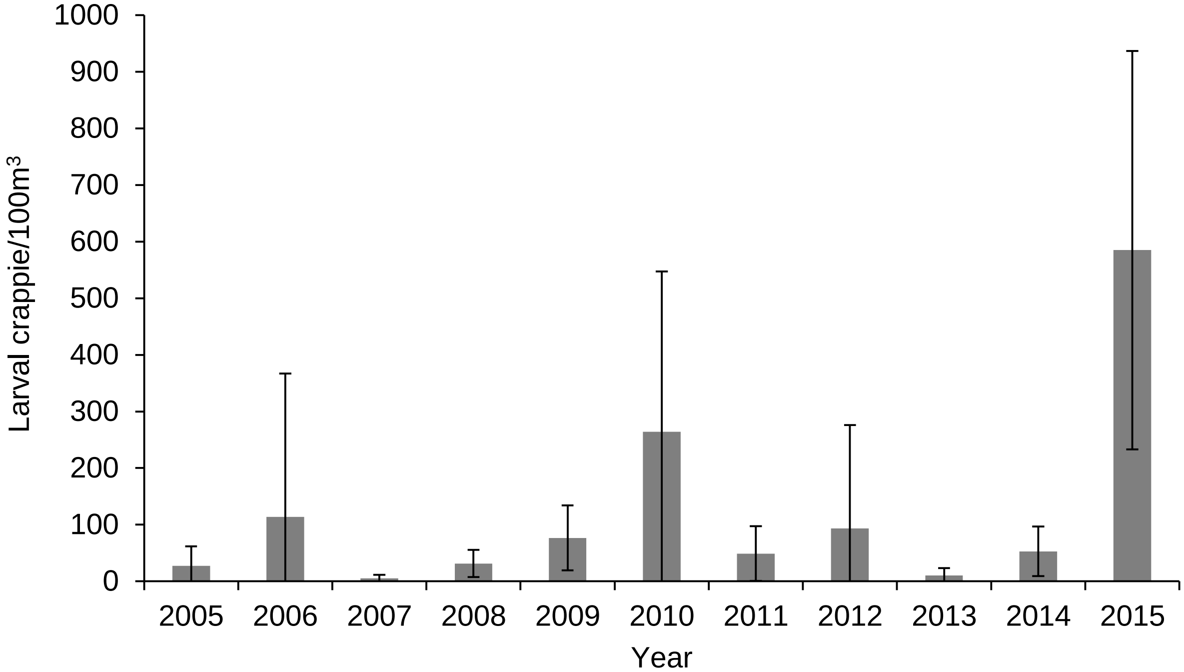

Figure 20. Bars represent peak density of larval crappies (averaged across the sample sites) within Brownlee Reservoir from 2005 to 2015. Error bars represent 95% confidence intervals developed for the estimates.

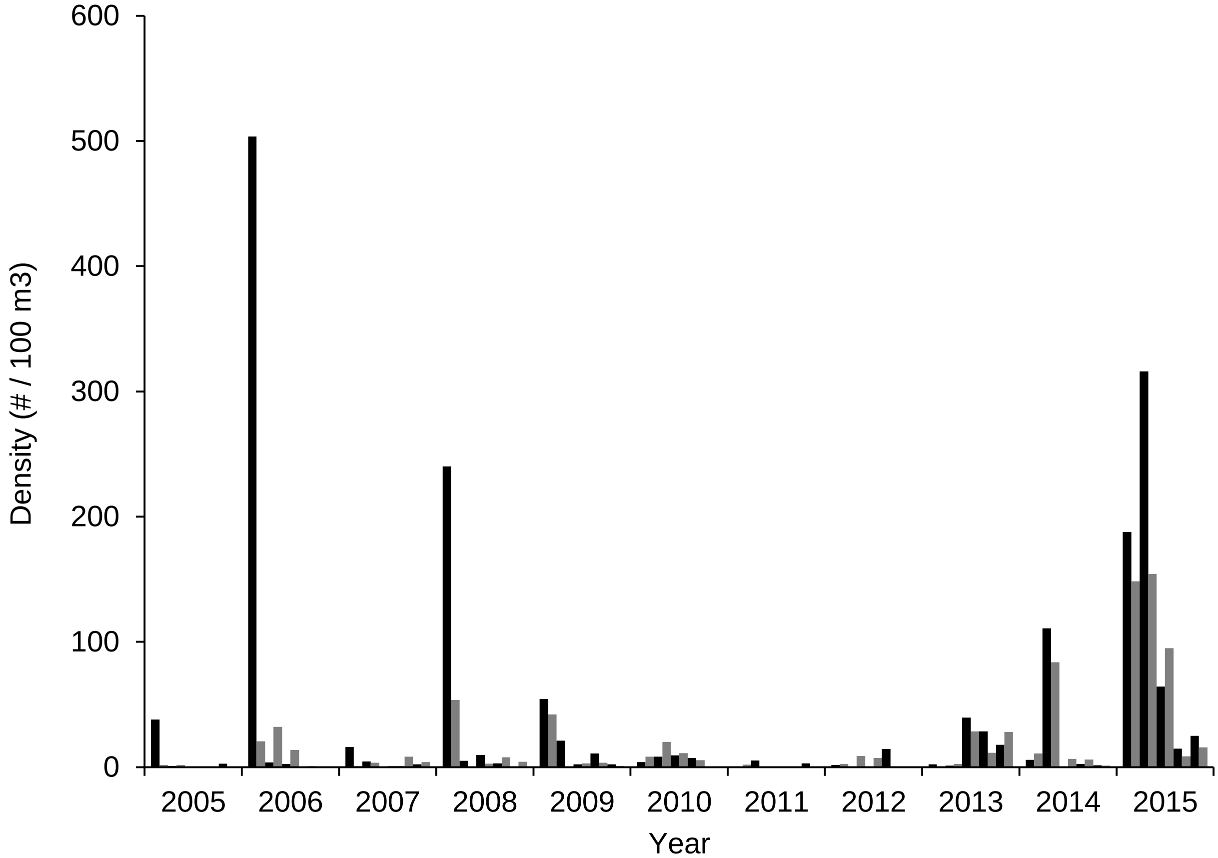

Figure 21. Densities of larval crappies (#/100 m^3) measured in CJ Strike Reservoir during 2005 through 2015. Bars within each year represent 10 individual sites. Site 1 through site 10 is displayed from left to right within each year.

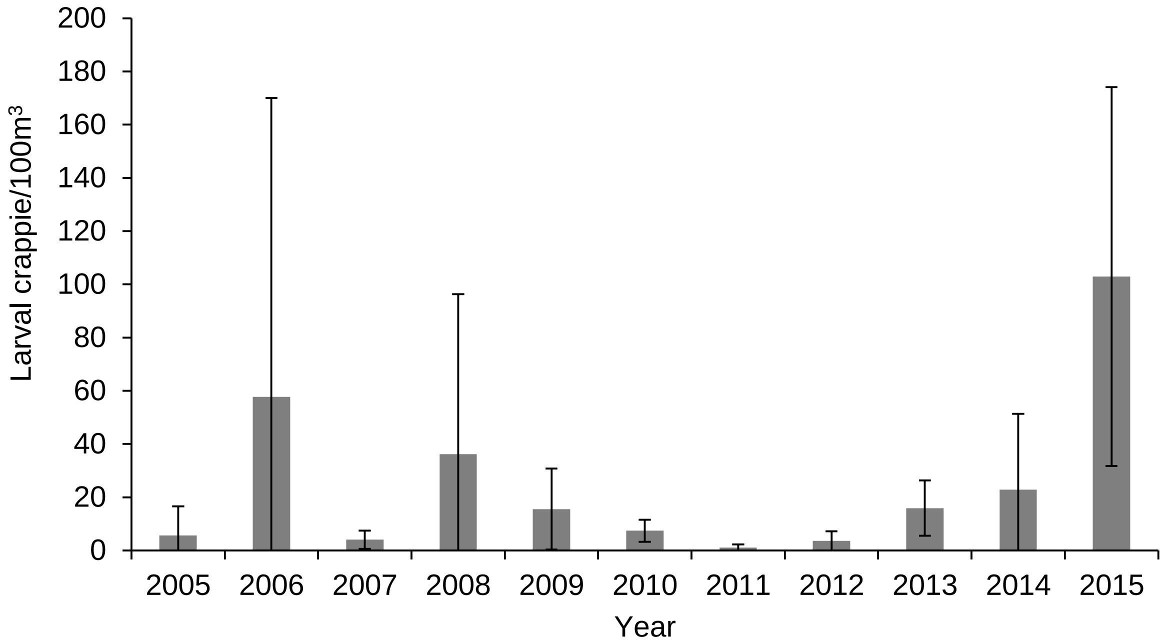

Figure 22. Bars represent peak density of larval crappies (averaged across the sample sites) within CJ Strike Reservoir from 2005 to 2015. Error bars represent 95% confidence intervals developed for the estimates.

EXPLOITATION OF SELECT SMALLMOUTH AND LARGEMOUTH BASSES AND CHANNEL CATFISH POPULATIONS

ABSTRACT

Brownlee, CJ Strike, and Lake Lowell reservoirs support popular warm water angling opportunities near the population center in Southwest Idaho. Understanding how Smallmouth Bass *Micropterus dolomieu* (SMB), Largemouth Bass *Micropterus salmoides* (LMB) and Channel Catfish *Ictalurus punctatus* (CAT) are utilized by anglers is important to managing these fisheries. Currently, a variety of fishing regulations, including general and restrictive, are used to manage the fisheries. Regardless of regulation type, it is important to understand estimates of annual exploitation and total use (catch plus harvest) to determine if populations are being altered by angling. I sampled, tagged, and evaluated these species to develop estimates of annual angler exploitation and total use (with 90% CI). SMB exploitation and total use in Brownlee Reservoir were 24.4% (± 7.6%) and 44% (± 11.3%), respectively. Exploitation for SMB in CJ Strike Reservoir was similar to Brownlee and estimated to be 22.6% (± 10.4%) and total use was 44.0% (± 14.8%). The exploitation estimate for LMB in Lake Lowell was not statistically different from either SMB estimate listed above; however, the total use estimate of 99.0% (± 16.4%) was much higher than the SMB estimates. Channel Catfish in Lake Lowell had the lowest estimates of both exploitation (7.1% ± 5.1%) and total use (14.2% ± 7.3). Using angler-reported tags and the Tag-You're-It program to estimate exploitation was an affordable way to monitor annual exploitation and total use patterns and should be repeated periodically to monitor harvest trends.

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INTRODUCTION

Brownlee, CJ Strike, and Lake Lowell reservoirs are primarily managed for water storage (irrigation delivery) or hydroelectric power. These reservoirs support popular self-sustaining warm water fisheries.. These waters provide angling opportunity for Smallmouth Bass *Micropterus dolomieu* (SMB), Largemouth Bass *Micropterus salmoides* (LMB) and Channel Catfish *Ictalurus punctatus* (CAT), among other species. Limited stocking of SMB and LMB within the region, prior to the 1970's, coupled with recent fisheries data suggest populations are naturally reproducing, self-sustaining, and maintaining quality size structure at current fishing levels. Prior survey data (Kozfkay et al 2009; Koenig et al 2015) suggests that the CAT population within Lake Lowell is primarily supported by release of hatchery fish and Idaho Department of Fish and Game (IDFG) currently stocks 5,000 fingerling CAT annually.

Due to their proximity to southwest Idaho's population center, these reservoirs receive substantial fishing pressure. General bass regulations (CJ Strike and Brownlee reservoirs) and quality bass regulations (Lake Lowell) are utilized to manage these bass populations. Smallmouth Bass residing in Brownlee and CJ Strike reservoirs are currently managed under general regional-based rules, which allows for an angler to harvest up to six bass over 305 mm per day. Bass rules for Lake Lowell are intended to produce larger averages size No bass harvest is allowed prior to July 1. Afterwards, anglers may harvest of up to two bass per day, none between 305-406 mm, though boating closures (beginning October 1) or low reservoir levels often shorten the fishing season. CAT in Lake Lowell is managed with no daily bag limit or size restrictions. This chapter aims to describe annual angler exploitation and total use estimates for SMB in Brownlee and CJ Strike reservoirs and LMB and CAT in Lake Lowell. Understanding how these species are utilized by anglers is important to determine if current regulations are maintaining quality population size structure and abundance.

OBJECTIVES

1. Develop annual exploitation and total use estimates for Smallmouth Bass, Largemouth Bass and Channel Catfish located in regionally-important fisheries.

2. Increase our knowledge of how these species are utilized by anglers.

3.

METHODS

SMB, LMB, and CAT were sampled using various sample gears or methods (Table 10). SMB were collected during 11 dates between April and July of 2014 within Brownlee Reservoir and two dates (July and September) in CJ Strike Reservoir. All SMB, from both reservoirs, were collected using shoreline boat electrofishing or by anglers during bass tournaments. LMB were collected during five dates between March and July 2014 (Table 10) in Lake Lowell using a combination of gears. LMB were collected as bycatch using a commercial beach seine targeting Common Carp *Cyprinus carpio*. LMB were also sampled using shoreline boat electrofishing and by anglers during the largest bass tournament held at the reservoir. All shoreline electrofishing was also conducted, during day or night, using a Smith-Root electrofishing boat. Pulsed direct current was set at 120 pulses per second and a pulse width of 40, which yielded an output of 5-6 amps. CAT were collected during three dates between March and June 2014. CAT were collected as bycatch from the commercial beach seine used to capture Common Carp and using tandem baited hoop nets (Butts et al. 2016).

All collected SMB, LMB and CAT were measured for total length (mm) and weighed (nearest g). SMB and LMB greater than legal harvest length (≥ 305 within Brownlee and CJ Strike reservoirs and ≥ 406 mm in Lake Lowell) were tagged using 70 mm (51 mm of tubing) fluorescent orange Floy® FD-68BC T-bar anchor tags. All captured Channel Catfish were tagged using Carlin dangler tags and stainless steel wire (Wydoski and Emery 1983). A detailed description of tagging methods using Carlin dangler tags can be found in Butts et al. (2016). Tagging numbers can be found in Table 10. Each tag included a unique identification number, the abbreviation IDFG, and the Tag-You're-It tag reporting hotline phone number (1-866-258-0338). Anglers could report tagged fish caught using the phone number on the tag, or through a tag reporting portal available on IDFG's website (https://fishandgame.idaho.gov/feedback/fish/forms/reportTaggedFishAngler.cfm). Tagged fish were released away from tagging locations (typically near the middle of the reservoir or lake) to encourage random mixing.

Tagged fish were self-reported by anglers and data was compiled for one year from the date of each tagging event (e.g. Brownlee SMB tagged on 4/21/2014 was evaluated until 4/21/2015). I calculated annual exploitation (fish harvested) and total use (harvested plus caught and released) according to the methods presented in Meyer et al. (2010) and Koenig (2012) for each tagging event. I also produced a combined estimate of annual exploitation and total use, for each species and reservoir, by merging all tagging dates and tag report data. All estimates of exploitation and total use are presented with 90% confidence intervals (± %). Exploitation estimates were adjusted to account for tagging mortality, angler reporting rate and tag loss based on rates from previous IDFG tag studies (Meyer et al. 2010, presented in Table 11). To reduce bias of exploitation estimates, anglers that reported harvesting bass, only because they were tagged, as determined from a question in the reporting survey, were not included. I calculated the median days-at-large (DAL; time until fish was caught or harvested) for each release group. Information from fish that were reported multiple times were used to adjust total use estimates. No adjustments were made to account for hooking or natural mortality. I used tag report information to identify the proportion of tags returned from March 1 to June 30 to identify angler use patterns for all three reservoirs. These dates were selected to characterize the spring fisheries and within Lake Lowell to identify harvest and total use prior to the July 1 opener for bass harvest.

RESULTS AND DISCUSSION

SMB annual exploitation and total use were essentially the same for both Brownlee and CJ Strike reservoirs. SMB annual exploitation and total use in Brownlee were 24.4% (± 7.6%) and 43.9% (± 11.3%), respectively (Figure 23). SMB exploitation for individual sampling dates at Brownlee Reservoir ranged from 0.0% to 77.3% (Table 10). Total use ranged from 5.9% to 90.2% (Table 10). Annual exploitation of SMB in CJ Strike was 22.6 (± 10.4%), whereas total use was 43.8% (± 14.8%; Figure 23). Exploitation and total use for individual sampling dates at CJ Strike Reservoir ranged from 9.6% to 28.0% and 9.6% to 58.0%, respectively (Table 10). These exploitation estimates fall within the range presented by Meyer et al (2010b) for additional water in Idaho. Also, exploitation of SMB in Lake Gogebic, Michigan (similar in size to Brownlee Reservoir) was 19.3%, similar to exploitation in Brownlee and CJ Strike reservoirs (Hanchin 2011).

The median DAL was different among reservoirs with 18 in Brownlee and 244 in CJ Strike, though this disparity may be partially explained by the timing of tagging events. In Brownlee Reservoir, 84% (27 of 32) of reported tags occurred between March 1 and June 30, as well as 87% (41 of 47) of the harvested fish. This indicated spring and early summer were important time periods for anglers on Brownlee Reservoir. In CJ Strike Reservoir, 62% (9 of 15) of the tags and 63% (10 of 16) of the harvested fish were reported between March 1 and June 30. While the spring fishery appeared to be important in CJ Strike Reservoir, fishing for SMB was more evenly distributed throughout the year. The majority of SMB tagged at CJ Strike occurred in the fall (September 21, 2014) and tags were reported most commonly during the following spring, which also indicates angling effort or catch rates decreased during winter months.

Annual exploitation for LMB in Lake Lowell was 17.9% (± 5.7%; Figure 23), which was slightly lower than SMB. LMB exploitation resulting from individual sampling dates ranged from 0.0% to 21.5% (Table 10). Total use for LMB was 99.0% (± 16.4%), which was much higher than estimates for SMB (Figure 23). Total use for individual sampling dates ranged from 49.3% to 124.6% (Table 10). These results are consistent with Meyer et al. (2010b) who also found LMB exploitation in Idaho to be lower than SMB in 2006 and 2007. Exploitation of LMB in Lake Lowell appears to be higher than rates reported by Kerns et al. (2015). These authors estimated LMB fishing mortality to be 9.0% in a regional study of 30 large Florida lakes (Kerns et al 2015). Butts et al (2016) provided preliminary results for these tagging groups (prior to one year at large) and additional discussion related to the LMB fishery at Lake Lowell.

The Median DAL for LMB in Lake Lowell was 53. Tag report data indicated that the spring fishery on Lake Lowell for LMB was very popular. In Lake Lowell for LMB, 70.0% (52 of 74) of reported tags occurred between March 1 and June 30, as well as 35.0% (7 of 20) of the harvested fish. Fish harvested during this time period represent illegal harvest under current fishing regulations. Gigliotti and Taylor (1990) suggested that benefits to a fishery, in terms of increased fish abundance and size, may be impacted when illegal harvest was in excess of 15.0% to 20.0%. During 2014 and 2015, Southwest Region enforcement staff issued several violations (Butts et al 2016) and increased patrols on Lake Lowell to deter illegal harvest.

Annual exploitation of CAT in Lake Lowell was 7.1% (± 5.1%), whereas total use was 14.2% (± 7.3%; Figure 23). CAT were tagged during three separate dates and exploitation ranged from 0.0% to 10.4% (Table 10). Total use was lower for Lake Lowell CAT than the other species and ranged from 0.0% to 20.9% (Table 10). Exploitation for CAT in Lake Lowell was lower than four of six lakes, measured during 2007-2012, in northern Idaho (Cater-Lynn et al 2015). Tag loss associated with Carlin dangler tags have been estimated at approximately 10.0% (Quinn et al 2012), which was slightly lower than the 13.0% we used to develop our estimate. If tag loss was lower than 13.0%, the exploitation rate would decrease and underrepresent true exploitation and use rates. Michaletz et al (2008) estimated tag loss to be 0.0% after one year. If we would have applied this rate, our exploitation estimate would have decrease by approximately one percent. Carlin dangler tags have good long-term tag retention (Michaletz et al 2008; Quinn et al 2012); therefore, I will continue to monitor this tag group until the spring of 2016 to see if additional exploitation or total use occurs. Median DAL for Lake Lowell CAT was 45. Tag reports indicated that few CAT were harvested or released between March 1 and June 30. Tag report data suggests Lake Lowell provided a tiered fishery, most of the catch in the spring and early summer consisted of LMB, whereas CAT supported this fishery later in the summer.

Exploitation and total use estimates provide only a piece of the annual total mortality that affects these populations. Other sources of mortality include hooking or natural mortality. Assuming sources of mortality do not change drastically over time, these estimates provided us with an index of exploitation and total use. Tagging additional fish in these populations at three- to five-year intervals may allow us to identify changes in angler harvest or fishing patterns through time. The Tag-You're-It program provided an affordable way to monitor both exploitation and total use within these recreationally-important fisheries.

MANAGEMENT RECOMMENDATIONS

1. Tag additional SMB, LMB, and CAT at three-five year intervals to monitor for potential changes in exploitation or total use patterns within these waters.

Table 10. Individual tagging events, locations, sampling gear types, species, number of fish tagged, and number of harvested and released fish used to develop Smallmouth (SMB) and Largemouth (LMB) basses and Channel Catfish (CAT) adjusted exploitation and total use estimates, presented with 90% confidence bounds. Median days-at-large (DAL) are reported for each individual tagging event.

Date	Location	Sample Gear Type	Species	Tags released	Reported harvested	Reported released	exploitation (%)	90% CI (%)	Adjusted use (%)	90% CI (%)	Median DAL
4/21/2014	Brownlee Reservoir	Electrofishing	SMB	30	4	7	27.5	23.3	75.6	35.2	22.0
4/22/2014	Brownlee Reservoir	Electrofishing	SMB	23	4	2	35.8	29.8	53.8	35.1	11.0
4/23/2014	Brownlee Reservoir	Electrofishing	SMB	16	5	2	64.4	44.2	90.2	48.5	27.0
4/29/2014	Brownlee Reservoir	Electrofishing	SMB	8	3	0	77.3	64.4	77.3	64.4	8.0
4/30/2014	Brownlee Reservoir	Electrofishing	SMB	11	1	1	18.7	32.0	37.5	43.3	57.0
5/7/2014	Brownlee Reservoir	Electrofishing	SMB	12	0	2	0.0	0.0	34.4	40.0	60.0
5/13/2014	Brownlee Reservoir	Electrofishing	SMB	93	15	14	31.0	14.8	64.3	21.3	6.5
5/17/2014	Brownlee Reservoir	Tournament Anglers	SMB	57	3	0	10.8	11.0	10.8	11.0	63.0
5/21/2014	Brownlee Reservoir	Electrofishing	SMB	63	8	4	22.9	15.1	39.3	19.6	12.0
6/3/2014	Brownlee Reservoir	Electrofishing	SMB	23	3	0	17.9	21.8	26.9	26.3	74.0
7/12/2014	Brownlee Reservoir	Tournament Anglers	SMB	35	1	0	5.9	10.4	5.9	10.4	5.0*
7/8/2014	CJ Strike Reservoir	Electrofishing	SMB	43	2	0	9.6	11.9	9.6	11.9	12.5
9/21/2014	CJ Strike Reservoir	Tournament Anglers	SMB	103	14	15	28.0	13.4	58.0	19.5	247.0
3/8/2014	Lake Lowell	Beach Seine	LMB	71	4	13	16.7	10.3	70.9	20.7	68.0
4/19/2014	Lake Lowell	Tournament Anglers	LMB	165	14	50	21.5	7.9	114.8	20.3	41.0
6/27/2014	Lake Lowell	Electrofish	LMB	19	2	6	15.6	18.9	124.6	44.6	20.5
7/2/2014	Lake Lowell	Electrofish	LMB	20	0	4	0.0	0.0	59.2	33.7	305.0
7/10/2014	Lake Lowell	Electrofish	LMB	6	0	1	0.0	0.0	49.3	56.2	11.0*
3/8/2014	Lake Lowell	Beach Seine	CAT	35	1	1	6.1	10.4	12.2	14.6	173.5
6/25/2014	Lake Lowell	Hoop net	CAT	43	0	0	0.0	0.0	0.0	0.0	NA
6/27/2014	Lake Lowell	Hoop net	CAT	102	7	3	10.4	8.1	20.9	11.4	36.5

*Indicates only one fish was reported to determine median days at large.

Table 11. Tag non-reporting, tag loss, and a 7-day tagging mortality rates used to calculate exploitation within one year of tagging for Smallmouth Bass (SMB), Largemouth Bass (LMB), and Channel Catfish CAT.

Species	SMB	LMB	CAT
Non reporting rate (%)	54.1	39.2	54.5
Tag loss (%)	9.6	13.1	13.1
7 day mortality rate (%)	0.8	0.8	0.8

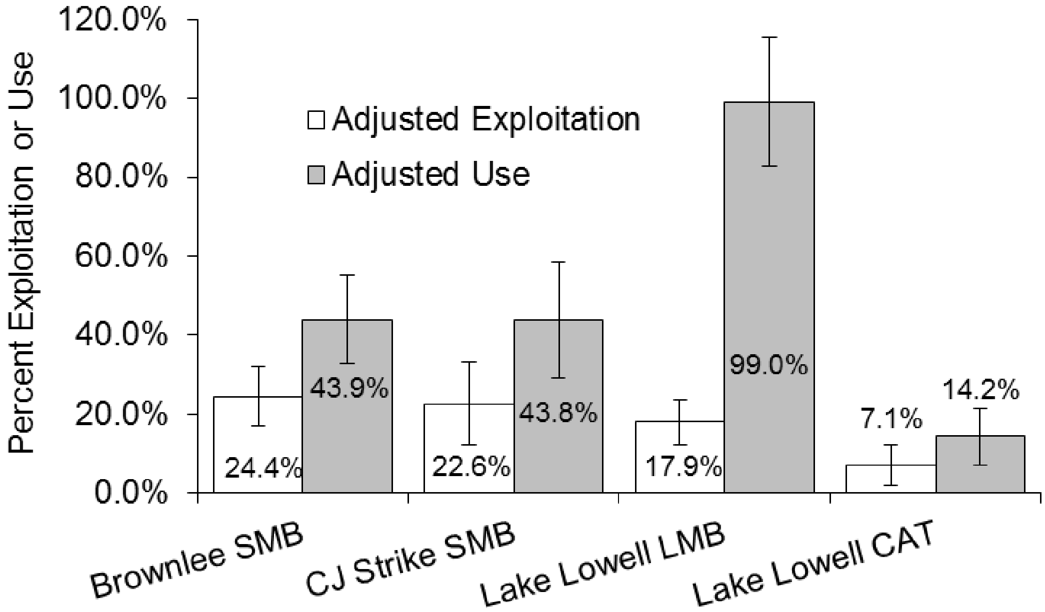

Figure 23. Estimates of annual adjusted exploitation (harvest) and total use (combined harvest or release), which combined all tagging events that occurred in 2014 for Brownlee and CJ Strike SMB, and Lake Lowell LMB and CAT. Error bars represent the 90% CI produced around the estimates.

CHEMICAL TREATMENT OF NUISANCE AQUATIC PLANTS IN SMALL WATERS

ABSTRACT

Excessive aquatic plant growth in Beachs, Duff Lane, and Lowman ponds was hampering boating and fishing opportunities. In order to maintain fishery quality in Beachs Pond, we purchased and stocked Grass Carp *Ctenopharyngodon idella* to reduce Brittle Naiad *Najas marina*. Also, we treated Eurasian water milfoil *Myriophyllum spicatum* at Duff Lane and Lowman ponds with Navigate™, a granular 2, 4 D aquatic herbicide, at application rates of 100-150 lbs/acre. Submerged aquatic plant abundance was reduced in Duff Lane and Lowman ponds by late summer. Effective long-term weed management will require vigilance and balancing between eradication and maintaining adequate amounts and types of aquatic plants for invertebrates and cover for fish.

Author

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INTRODUCTION

Idaho Department of Fish and Game's (IDFG) Southwest Region manages fisheries in about 38 publicly-accessible small ponds and reservoirs. These waters receive significant fishing pressure and are an important resource for providing family-friendly fishing opportunities. Excess plant growth, especially during the summer months, in some ponds may limit access or in extreme cases may totally preclude fishing. Furthermore, excess plant growth may create other problems such as high oxygen consumption during decomposition or may provide too much cover for juvenile fish, leading to high abundances and small average sizes. Excess plant growth was reducing fishing opportunities and potentially impacting fish populations in Beachs (4.3 acres), Duff Lane (5.5 acres), and Lowman (1.8 acres) ponds. Brittle Naiad *Najas marina*, Eurasian Water Milfoil *Myriophyllum spicatum*, and Northern Water Milfoil *Myriophyllum exalbescens*, were the predominant species present at Beach, Duff Lane, and Lowman ponds, respectively. In Beachs Pond, Grass Carp *Ctenopharyngodon idella* were stocked at 20-25 fish/acre to reduce plant abundance and biomass. Herbicide was utilized to reduce plant abundance and biomass at Duff Lane and Lowman ponds.

METHODS

Treatment rates and techniques accounted for pond size, target plant species biology, and pond hydrology. We used Global Information Systems to estimate surface acreage. We selected Navigate™, a granular 2, 4 d, to treat milfoil it two waters, based on past efficacy in nearby waters and low fish toxicity. Recommended treatment levels were 100-150 lbs/surface acre for targeted plant species. On May 12, 2015, we treated Lowman Ponds with 270 lbs of Navigate. On May 18, 2015, we treated Duff Lane Pond with 550 lbs of Navigate. At Beachs Pond, a total of 90 Grass Carp were released on October 15, 2015.

RESULTS AND DISCUSSION

Herbicide treatments were effective in ponds treated during 2015. Based on visual estimates, > 90% of rooted submerged vegetation was killed. No significant plant re-growth occurred in treated areas prior to fall. At this time, survival of Grass Carp and contribution to plant control is not known. Despite the lack of survival estimates, it was apparent that at least some Grass Carp survived to fall as several were observed in near-shore areas. Continued effective aquatic plant management will require vigilance and finding a balance between plant eradication and maintaining aquatic plants for invertebrates and as cover for fish.

RECOMMENDATIONS

1. Monitor plant mortality and re-growth in ponds treated during 2014 and 2015. Apply herbicide or stock Grass Carp on a semi-annual basis or as needed.

2. Monitor aquatic plant abundance in other waters that have a tendency to possess nuisance levels and initiate treatments where necessary.

3. Conduct multi-species mark-recapture population estimates at ponds in which Grass Carp have been stocked. Determine whether Grass Carp stocking densities and survival are adequate to contribute to the control of nuisance levels of aquatic plants.

RIVERS AND STREAMS INVESTIGATIONS

LOWER BOISE RIVER INVESTIGATIONS

ABSTRACT

In 2015, we investigated production, relative abundance, distribution, and exploitation of wild trouts in the Lower Boise River using raft electrofishing gear. Additionally we evaluated the survival and distribution of hatchery Brown Trout *Salmo trutta* stocked as fingerlings. Lastly, juvenile Rainbow Trout *Oncorhynchus mykiss* and Brown Trout production was evaluated using shoreline backpack electrofishing. We sampled a total of 463 wild Rainbow Trout and 89 wild Brown Trout during the raft-electrofishing surveys. Wild Rainbow Trout catch-per-unit effort (CPUE) averaged 32.4 fish/h, with a low of 2.1 fish/h in the Harris Ranch reach to high of 81.6 fish/h in the Eagle South reach. Wild Brown Trout CPUE averaged 6.9 fish/h, with 0 fish/h caught in the Barber reach to 19.8 fish/h in the Star North reach. Only one hatchery Brown Trout was captured during 2015 raft electrofishing efforts. Based on this finding and the paucity of hatchery Brown Trout sampled during recent triennial population estimates, stocking of Brown Trout has been discontinued. Age-0 trout density differed spatially between species with Rainbow Trout showing higher densities upstream of Eagle and Brown Trout having higher densities downstream of Eagle. A great deal of useful information was learned about wild Rainbow and Brown trout populations in the Lower Boise River in 2015. This information will be enhanced by repeating the relative abundance and exploitation tagging surveys in the summer of 2016. Additionally, a better understanding of the locations and variation in age-0 production of wild trouts will be gained by repeating the fall shoreline surveys for an additional 2-3 years.

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INTRODUCTION

The Lower Boise River section of the Boise River watershed begins at Lucky Peak Dam and continues for 103 km (64 mi) to its confluence with the Snake River near Parma, Idaho. The river flows through a variety of urban and agricultural settings and has been heavily affected by associated land and water uses (MacCoy 2004). Flows are regulated for both agricultural demands and flood control; while channel alteration has occurred throughout the system. Higher than natural flows generally occur between April and September (mean = 48 m^3/s) and lower than natural flows occur between October and March (mean = 14 m^3/s). Furthermore, there are approximately 28 diversions along the Boise River that supply water to various irrigation districts. There are approximately fourteen major water inputs to the Lower Boise River, including drains or tributaries, water treatment facilities, and irrigation returns. The surrounding land and water use practices have resulted in significant impacts on water quality and biological integrity including elevated sediment and nutrient levels, as well as increased water temperatures (MacCoy 2004).

Fish and invertebrate species composition shifts from primarily coldwater obligate species in the upper sections above Glenwood Bridge, to a warmwater species assemblage near Middleton and downstream to the Snake River, with a transition zone in between. Species include Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta,* Mountain Whitefish *Prosopium williamsoni*, and sculpin *Cottus sp.* in the upstream coldwater portion of the river. Warmwater species including Smallmouth Bass *Micropterus dolomieui*, Channel Catfish *Ictalurus punctatus*, and Common Carp *Cyprinus carpio* are found more frequently in the lower portion below Middleton, Idaho.

The Lower Boise River and its riparian corridor are valued for irrigation, recreation, and the inhabiting fish and wildlife. Prior to the 1970s, water quality and quantity were not conducive for sustaining quality fish populations. The Clean Water Act of 1977 and the resulting temperature and suspended sediment criteria acted as a catalyst for initiating water-quality improvements on the river. During the past 20-30 years, several agencies and municipalities have worked to improve water quality by improving agricultural and industrial practices as well as waste water, and storm water management. The establishment of a minimum winter flow of 7 m^3/s in 1984 was another major improvement for increasing coldwater sportfish abundance in the Lower Boise River.

The Lower Boise River fishery supports substantial angling effort throughout the year (Kozfkay et al. 2010), supported primarily by both wild and hatchery-origin Rainbow and Brown trouts. IDFG currently stocks approximately 40,000 catchable Rainbow Trout and 20,000 fingerling Brown Trout on an annual basis. Rainbow Trout are stocked at 10 locations from Barber Park downstream to the Star Bridge. Annual exploitation (± 90% confidence intervals) on hatchery Rainbow Trout varies by location, from a low of 13% ± 9% in the Eagle North Channel location to 31% ± 11% at the Glenwood Bridge location. A year-long creel survey indicated that 33,056 h were expended from Barber Dam to Americana Bridge (Kozfkay et al. 2010). An estimated 20,704 (± 4,068) Rainbow Trout (wild and hatchery combined) were caught, and the release rate of Rainbow Trout was 79%. Combining the 2007 population and creel survey estimates, annual exploitation of wild Rainbow Trout was approximately 5% of the population.

Standardized monitoring sites were established in 2004 to monitor populations of wild Rainbow Trout, Brown Trout, and Mountain Whitefish in the Lower Boise River between Barber Park and the East Parkcenter Bridge. These sections have been sampled at three-year intervals. Prior to 2004, non-standardized sampling efforts captured few wild trout. More recent survey data and anecdotal information suggests that the number of wild Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta* in the river has improved over the last 20 years. Wild Rainbow Trout in particular has increased nearly seventeen-fold between 1994 and 2010 (Kozfkay et al. 2011). The increase in wild trout abundance coincides with the establishment of minimum winter flows of 7 m^3/s in the mid-1980s. Wild trout populations were also likely enhanced by water quality improvements and an increase in catch-and-release practices over the same period.

Compared to Rainbow Trout, Brown Trout are less abundant but no less popular with anglers. Brown Trout have been intermittently stocked into the Boise River since 1935. Annual stocking occurred for over two decades between 1974 and 1998 when IDFG lost their source for Brown Trout eggs (Figure 25). In 2009, IDFG resumed stocking Brown Trout with a target of 20,000 fingerlings each year. All hatchery Brown Trout were marked by the removal of adipose fins prior to stocking. However, biologists have been unable to find evidence of long-term survival of hatchery Brown Trout during two population surveys in 2010 and 2013 (Koenig et al. 2015). A limitation with evaluating hatchery Brown Trout survival using the triennial population survey sites is that only a small section of river is sampled. Sampling nearly 40 km of the Boise River between Barber Dam and Middleton with raft electrofishing gear should provide a comprehensive evaluation of whether hatchery Brown Trout stocking is effective.

METHODS

In 2015, we investigated production, relative abundance, and exploitation of wild trout in the Lower Boise River. Additionally, we evaluated the survival and distribution of hatchery Brown Trout. The study included approximately 48 km of river between Hwy 21 Bridge and Middleton, which is the known lower extent of year-round trout habitat in the Lower Boise River (Figure 25). We delineated 12 river sections in this reach to describe spatial differences in wild trout abundance, exploitation, and production (Table 12). The 12 river sections (1.4 to 7.6 km in length) were chosen based on locations of prominent access points, landmarks, or river barriers.

Exploitation and relative abundance of wild trout and survival of hatchery Brown Trout were evaluated by raft-mounted electrofishing gear during June 22-July 7, 2015. River flow at the Glenwood Bridge gauging station was 23 m^3/s during the first week of the study (Table 13). Flows increased to 38 m^3/s prior to the second week of the survey on June 29, 2015. Consequently, mean speed of the raft while electrofishing increased from 2.2 to 3.7 km/h. Fish were collected in a single pass utilizing electrofishing gear mounted to two rafts. Each 3.7 x 1.8 m Maravia® raft was fitted with a pole-mounted anode to the bow and cathodes that hung from the starboard and port sides of the rafts. Each raft was equipped with a Midwest Lake Electrofishing Systems (MLES) Infinity electrofisher, a 5,000 watt generator (Honda EG500X), and a livewell for holding fish. Electrofisher settings for duty cycle, pulse frequency, voltage, and peak power output were 25%, 60 pulses per second, 300-400 volts, 1,500-2,200 watts, respectively. Crews consisted of two people: a rower and netter. Only trout were placed in the livewell. Oxygen was introduced to the live well (2 L/m) through an airstone. When the livewell was judged to be at capacity, the crews stopped at the nearest riffle to process fish.

Rainbow Trout were identified as hatchery or wild origin based on visual characteristics such as fin condition, deformities, and coloring, while hatchery Brown Trout were identified by an adipose fin clip. Trout were measured for total length (mm) and weighed (g). Wild Rainbow and Brown trout $\geq$200 mm were tagged using 70 mm (51 mm of tubing) fluorescent orange

Floy® FD-68BC T-bar anchor tags. Fish were released 20 to 50 m upstream from the processing site to avoid downstream drift into the next sampling area.

Tag return data were collected from anglers using the IDFG Tag-You're-It phone system and IDFG website. Catch and harvest rates of wild Rainbow and Brown trout were calculated using tag return data according to the methods presented in Meyer et al (2012) and were adjusted for tag loss and tagging mortality. Mean non-reward tag reporting rate for wild trout was 53%, based on angler tag returns of $50 reward tags in wild Rainbow Trout (Cassinelli 2015). One year tag loss rate was 8.9% and 7-day tagging mortality rate was 0.8%. Tag return data were analyzed for tags returned through December 1, 2015 and annual exploitation rates will be reported in a future report as data become available.

Pelvic fin rays were collected to estimate age structure and growth rates of wild Rainbow and Brown trout in the Lower Boise River. Pelvic fin rays have been shown to provide a non-lethal method of obtaining accurate and precise ages in other salmonid populations (Zymonas and McMahon 2009; Williamson and Macdonald 1997). Removing pelvic fin rays is thought to have less impact on growth and survival than dorsal or pectoral fins (Zymonas and McMahon 2006). The leading three pelvic fin rays were clipped and removed near the base from a subsample of Rainbow Trout (5 fish/10-mm TL interval). Spines were sectioned according the methods described by Butts et al. (2016) for South Fork Boise River Rainbow Trout. Fish age was estimated by two independent readers. Disagreements in age assignments were revisited and the consensus age was used in further analysis. A von Bertalanffy growth model was fitted to age-at-length data using FAMS software (Slipke and Maceina 2014). Mean length for age-4 fish was calculated for comparisons with other Idaho fluvial Rainbow Trout populations (Schill 1991).

We calculated catch-per-unit-effort (CPUE) as the number of fish captured per hour of electrofishing. CPUE was calculated for both wild Rainbow and Brown trout by river section by combing catch and electrofishing hours from both rafts.

To characterize the size distribution of wild Rainbow Trout between river sections, proportional size distribution (PSD) was calculated as,

$$PSD - X = \frac{Number\ of\ fish\ \geq 350\ mm}{Number\ of\ fish\ \geq 250\ mm} \times 100,$$

where *X* was calculated for 350 mm fish, which corresponds to minimum length harvest restrictions in one section of the river (Neumann et al. 2012). A minimum stock length of 250 mm is recommended for Rainbow Trout in lotic environments (Simpkins and Hubert 1996).

Age-0 Rainbow and Brown trout production was evaluated at 63 sites from Hwy 21 Bridge to Middleton from October 27 -November 3, 2015 (Figure 25). Sites were stratified by river section with half of the mainstem locations selected randomly and the other half selected by crews. For the non-random sites, crews selected sites suspected to be good juvenile trout habitat based on visual habitat features such as near shore complexity, presence of woody debris or vegetation, and proper flow and depth. Additionally, nine sites were sampled in tributary/side channel habitat in Dry, Loggers, Heron, and Warm creeks. Age-0 Rainbow and Brown trout were sampled using a Smith-Root® LR-24 battery powered backpack shocker. Sites were 33-m long and located along the shoreline. During sampling, the area from the shoreline out to approximately 4 m was sampled. A single, upstream electrofishing pass was completed at each site. All fish were identified, counted and measured for total length. Fish densities (fish/m) ± 90% confidence intervals were calculated.

RESULTS

Catch of Rainbow Trout exceeded that of Brown Trout by a 5:1 ratio. Rainbow and Brown trout catch differed spatially between 12 river sections, with a total of 463 wild Rainbow Trout and 89 wild Brown Trout handled during the raft surveys (Table 14). In general, we sampled relatively more brown trout in the Eagle Island area, whereas more RBT were sampled in upstream areas. Fifteen hatchery-origin Rainbow Trout and one hatchery-origin Brown Trout were also collected.

Catch rates of wild Rainbow Trout also varied greatly between sites, from a low of 2.1 fish/h in the Harris Ranch reach to high of 81.6 fish/h in the Eagle South reach (Figure 27). Morrison, Star South, Special Regulation, and Star reaches also had relatively high catch rates for wild Rainbow Trout. Brown Trout CPUE ranged from 0 fish/h caught in the Barber reach to 19.8 fish/h in the Star North reach (Figure 27). Relatively high Brown Trout catch rates were also observed in the Morrison and Eagle North reaches. One hatchery Brown Trout was captured during 2015 raft electrofishing efforts. The fish was collected in the Eagle South reach and was 457-mm long.

Length distributions of trout were biased towards larger fish because the near-shore habitats, where juvenile trout often reside, were difficult to sample with rafts. Mean length of Rainbow Trout was 279 mm and ranged between 89 to 545 mm (Figure 28). Smaller trout ($\leq$ 250 mm) were captured more frequently in sections upstream of Glenwood Bridge. While catches of wild Rainbow Trout were highest in the Star and Eagle South reaches, these areas contained relatively few smaller fish suggesting that those areas are not ideal spawning and rearing habitats. Values for the PSD-350 mm ranged from 0% at Harris Ranch to 83% at Barber Park. The Eagle South, Special Regulation, and Morrison reaches all had PSD-350 mm values of 50% or higher. The Star South reach had a notably low PSD-350 mm value of only 4%.

Brown Trout tended to be larger in downstream sections, especially in the north and south channels around Eagle Island. Length of Brown Trout ranged from 156 to 605 mm with an overall mean of 342 mm (Figure 29). The Morrison, Star North, and Star reaches contained the widest size ranges and highest catch rates of Brown Trout, suggesting that those areas were favorable to Brown Trout. The PSD-350 mm index was not calculated for Brown Trout because of low sample sizes.

Mean length-at-age were similar for Brown and Rainbow trout. Ages were obtained from a total of 285 Rainbow Trout and 63 Brown Trout (Figures 31-32). Rainbow Trout ages ranged from 1 to 7 years and Brown Trout ages ranged from 1 to 8 years. Age-4 Rainbow Trout averaged 405 mm while Brown Trout averaged 371 mm. A von Bertalanffy growth model for wild Rainbow Trout was also constructed with values of L_∞ = 653.5 mm, K = 0.21, and t_0 = -0.273 (Figure 31). In comparison, the growth model values for wild Brown Trout were L_∞ = 994.76 mm, K = 0.09, and t_0 = -0.999 (Figure 32).

A total of 63 Brown Trout and 257 Rainbow Trout were released with tags. Partial year estimates of exploitation and angler use of wild trout were relatively low and tag reports were mainly limited to sections downstream of Eagle. After five months at large, only six Rainbow Trout tags and one Brown Trout tag were reported (Table 15). Of these, two Rainbow Trout were harvested, while the others were released. As of December 1, 2015, partial-year exploitation of wild Rainbow Trout was 1% ± 2%, and total use was 4% ± 4% in the Boise River. In comparison, the estimate for total use of wild Brown Trout in the Boise River was 3% ± 6%.

At least 11 different species were observed during shoreline surveys for juvenile trout, including dace sp., sculpin sp., and sucker sp. (Table 16). A total of 112 Brown Trout and 235 Rainbow Trout were captured during the survey. Brown Trout catch ranged from 0 to 20 fish per site, while Rainbow Trout catch ranged from 0 to 31 fish per site in the 63 sites sampled in 2015 (Table 16). Brown Trout lengths ranged from 75 to 360 mm, and Rainbow Trout lengths ranged from 59 to 323 mm (Figure 31-32). Length-frequency distribution analysis suggested that Rainbow Trout <120 mm and Brown Trout <130 mm were likely age-0 trout.

Age-0 trout densities varied by location, habitat type, and species. The highest densities of with Rainbow Trout were sampled upstream of Eagle, whereas the highest densities of Brown were sampled downstream of Eagle (Figure 34). Mean density for age-0 Rainbow Trout was 0.09 ± 0.04 fish/m for the entire survey. Main channel sites typically had lower densities than side channel/tributary sites (Figure 35). In mainstem habitats, mean density of age-0 Rainbow Trout (fish/m) was 0.07 ± 0.04 and 0.2 ± 0.2 in tributary/side channel sites. Similarly, mean density of age-0 Brown Trout was 0.02 ± 0.01 in mainstem sites and 0.17 ± 0.12 in tributary/side channel sites. For tributary/side channel sites, age-0 Brown Trout density was highest in Loggers and Heron creek sites. For the mainstem sites, age-0 Brown Trout density was highest in sites around Eagle Island. Heron Creek had the highest density of age-0 Rainbow Trout where nearly 1 fish/m was observed. Within mainstem sites, densities of age-0 Rainbow Trout were highest upstream of Americana. Finally, mean densities age-0 trouts were higher in non-random sites selected by crews than random sites (36). However, differences between random and non-random sites were not statistically significant due to overlapping 90% CI.

DISCUSSION

Raft-mounted electrofishing equipment enabled us to assess relative abundance of wild Rainbow and Brown trout on a larger scale than previous surveys conducted by canoe. During a typical triennial population survey, IDFG samples 3-4 sites, each approximately 1 km in length. Mark-recapture methodologies are used in two of the sites, requiring two passes at each site. The surveys are intensive in terms of time and manpower, but yield higher resolution estimates of trout abundance. Prior to this effort, information on relative abundance of wild trout along the entire reach between Barber Dam and Middleton was sparse. MacCoy (2004) documented shifts within the fish communities in relation to water quality and temperature at five sites between Diversion Dam to Parma, Idaho to evaluate biotic integrity. However, this study was not intended to have the resolution needed to identify reaches that are important to wild trout. The results of the 2015 raft electrofishing survey compliments MacCoy (2004) and previous IDFG surveys in that it offers a snapshot of wild trout abundance for approximately 48 km of river and 12 different river sections.

One of the primary goals of the survey was to identify areas that contain higher numbers of wild trout. Rainbow Trout were most abundant in the Special Regulation, Morrison, Eagle South, and Star South sections as determined by CPUE estimates. The size distributions of Rainbow Trout within these sections contained a mix of both juvenile and adult fish. Excluding the Star South section, these areas also had PSD-350 mm values of 50 or higher. This suggests that these sections contain habitat that supports multiple life stages of Rainbow Trout and a high proportion of quality-sized Rainbow Trout. Unfortunately, quantitative habitat measurements such as the number of riffles, runs, pools, mean depth, and velocity, are not available for these sections. Qualitatively, these sections contain numerous riffle-run areas with rocky substrate and a mixture of deep pools. Additionally, the Special Regulation, Morrison, and Eagle South sections likely have higher water velocities than other sections in the study.

Catches of Brown Trout were higher and more consistent in the Eagle Island channels and farther downstream suggesting these areas were more favorable for the species. Overall, Brown Trout were captured less frequently than Rainbow Trout (1:5). Literature suggests that Brown Trout do not perform as well in rivers with high spring flows and faster water velocities (Dibble et al. 2015; Wood and Budy 2009). Downstream from Eagle, the Lower Boise River can be characterized as having slower water velocities and in many areas, especially the North Channel, more complex habitat in the form of woody debris. In fact, during a single-pass electrofishing survey in 2013, wild Brown Trout were the predominant trout species in the North Channel of the Boise River. The Eagle North, Star North, and Star sections also contained a wider size range of Brown Trout, with both juveniles and adults. Farther upstream, juvenile Brown Trout were relatively rare in comparison. It is possible that early flood control releases scour gravel or displace Brown Trout fry at a higher rate in the upstream sections. Further investigation into the factors influencing Brown Trout abundance in the Lower Boise River would be beneficial for future understanding and management.

Analysis of length-at-age data from fin rays yielded useful models for characterizing growth in the Lower Boise River Rainbow and Brown trout populations. Components from this analysis can be used for comparing growth to similar populations or predicting impacts of different management scenarios. Length-at-age-4 estimates for Rainbow trout indicate that these are among some of the fastest growing fluvial Rainbow Trout in Idaho (Figure 37). Brown Trout, on the other hand, appears to be average for fluvial forms of that species in Idaho. It is important to note that comparisons with other Idaho waters utilized different hard structures to estimate age. Schill (1991) utilized scales to estimate length at age 4, while we utilized fins rays. Age estimates obtained from scales commonly under-estimate age, especially in older individuals. Additionally, using fin rays to estimate age has not been verified or compared with other body structures in the Lower Boise River, but age and growth estimates appear to be reasonable. Age-at-length estimates such as these help biologists describe and compare fish growth for anglers. These age estimates may be used in concert with future mark-recapture surveys in 2016 to estimate natural mortality.

Another objective of these surveys was to determine whether stocking fingerling hatchery Brown Trout was increasing Brown Trout abundance. Only one hatchery origin Brown Trout was collected out of 90 total Brown Trout captured during the 2015 survey (1%). This result is consistent with previous surveys. The occurrence of hatchery Brown Trout in the mark-recapture sites was rare (Koenig et al. 2015). From 2009-2014, IDFG has stocked nearly 155,000 fingerling Brown Trout into the Lower Boise River (Figure LBR14). Managers have struggled with the timing of stocking and onset of progressive culture-related mortality at the hatchery prior to stocking. Brown Trout are notoriously difficult to culture because they have a tendency to crowd at the bottom of the raceway, thereby creating high rearing-density related issues even at moderate loading densities in transport containers. With the exception of 2011, stocking was delayed until after the peak flows had largely subsided (Figure 38). By comparison, flows in 2013 and 2014 were relatively low and managers hoped to see increased survival of Brown Trout from those release years. Results from the 2013 mark-recapture and 2015 raft electrofishing surveys suggest survival was negligible.

Therefore, we recommend discontinuing stocking hatchery Brown Trout in the Lower Boise River. Furthermore, abundance and distribution of wild Brown Trout in the Lower Boise

River seems to be influenced by flow regime and water velocity. Wild Brown Trout appear to be performing well in sections of the river that hold favorable habitat and current velocities such as the north and south channels of the Boise River. Therefore, efforts to construct or re-establish connections to side channels, and reduce or modify channelized portions of the river with high velocities offers more promise for increasing wild Brown Trout numbers, rather than additional or altered supplementation. The 2015 allotment of hatchery Brown Trout for the Lower Boise River were stocked into the Harris Ranch section above Barber Dam. Because of this section's lentic-like conditions resulting from the impoundment, hatchery Brown Trout may experience higher survival rates than the river below Barber Dam. IDFG intends to monitor this singular stocking event through angler reports and future surveys to assess whether Brown Trout supplementation in this section results in a sport fishery.

Exploitation estimates of wild trout in the Lower Boise River are incomplete because tagged fish had been at large for only six months, when we queried the tag reporting database. During this period, estimates of total angler use and exploitation were quite low for both wild Brown and Rainbow trout. Previous research has also suggested very low exploitation rates for wild trout in the Lower Boise River. A creel survey conducted in 2008-09 estimated a 5% annual exploitation rate for wild Rainbow Trout upstream of Americana diversion (Kozfkay et al. 2010). Further evaluation of annual exploitation of wild trout in the Lower Boise River will include repeating the raft electrofishing and tagging surveys in 2016. Annual estimates and analysis will not be complete until June 2017.

The 2015 fall shoreline survey for age-0 trout offered insight into identifying important spawning and rearing areas in the Lower Boise River. The survey was the most comprehensive effort to date to investigate wild trout production in the Lower Boise River. Fall age-0 density of Rainbow Trout (0.09 fish/m) was substantially lower than estimates in the SF Boise River, where fall densities average 2 fish/m (Butts et al. 2016). Side channels and tributaries appear to be preferred spawning and rearing areas based on relative abundance of age-0 trout. During the survey, tributary/side channel sites had three times the densities of age-0 Rainbow Trout and nine times the densities of age-0 Brown Trout than mainstem sites. Because the Lower Boise River has been extensively developed and channelized, these habitat types are relatively rare compared to a more naturally-functioning river. The Heron Creek tributary, where the highest densities of age-0 Rainbow Trout were sampled, is approximately 35-40 m in total length. A habitat improvement project was completed by the Ted Trueblood chapter of Trout Unlimited (TU) at this location during 2009. Members removed 6 yards of accumulated sand and fine sediment and placed appropriately-sized gravel for spawning substrate. We speculate that this project increased trout densities at this location, though it is not possible to draw a direct causative link as no pre-project data was collected. Finding additional opportunities to improve larger sections of side channel or connected tributary habitat would be beneficial for trout populations.

We used a combination of random and nonrandom site selection during the 2015 shoreline survey. This approach allowed biologists to sample areas that appeared to be good age-0 trout habitat based on visual characteristics learned during years of sampling age-0 trout in the SF Boise. As expected, the perimeters of gravel bar islands and shallow banks with some flow and some form of over-head cover held more age-0 trout than random sites, although the comparisons weren't statistically significant due to the wide variation in densities among sites. These complex, near-shore and low velocity habitat types are a relatively rare in the Lower Boise River because of channelization and modified fluvial and geomorphic processes.

The shoreline survey results showed spatial differences in recruitment between Rainbow and Brown trout in the Lower Boise River. Wild Rainbow Trout production is highest in areas upstream of Americana diversion. In contrast, wild Brown Trout production is highest around the Eagle Island channels and downstream towards Star, Idaho. The spatial differences in production are indicative of species-specific habitat preferences. Flow, water velocity, and habitat complexity are likely factors that influence the spatial variation in production between the two species. Identifying these differences will allow managers to quantitatively describe these habitat differences in the future and also describe why Brown Trout are not present in the numbers that some anglers expect. The 2015 fall shoreline survey should be replicated for 2-3 years to assess variability in age-0 production in the system. Additionally, a better understanding of the habitat types and areas important to wild trout production would benefit fishery management and future habitat enhancement efforts in the Lower Boise River.

A great deal of useful information was learned about wild Rainbow and Brown trout populations in the Lower Boise River in 2015. This information will be enhanced by repeating the relative abundance and exploitation tagging surveys in the summer of 2016. Additionally, a better understanding of the locations and variation in age-0 production of wild trout will be gained by repeating the fall shoreline surveys for an additional 2-3 years.

RECOMMENDATIONS

1. Discontinue Brown Trout stocking in the Lower Boise River. Monitor the Brown Trout stocked in the Harris Ranch section above Barber Dam in 2015 to determine if fish survive and recruit to the fishery.

2. Repeat the raft electrofishing survey in June/July 2016 to further evaluate relative abundance and angler exploitation of wild Rainbow and Brown trout.

3. Complete the Lower Boise River triennial mark-recapture population surveys for Rainbow and Brown trout in October 2016.

4. Repeat the fall shoreline electrofishing surveys for age-0 Rainbow and Brown trout to assess annual variability in production.

Table 12. River sections, description, distance based on river mileage, and river accesses for sampling in the Lower Boise River in summer 2015.

River section	Description	Upstream Km	Downstream Km	Total km	Boat Launch	Take Out
Harris Ranch	Hwy 21, Diversion Dam to Barber Dam	99.8	95.0	4.8	United Water pump	Barber Dam
Barber	Barber Dam to East Parkcenter Bridge	95.0	91.7	3.2	Barber Dam	East Parkcenter
Special Reg	East Parkcenter Bridge to Boise Footbridge	91.6	88.7	2.9	East Parkcenter bridge	Mallard Dr ramp
Morrison	West Parkcenter Bridge to Americana	86.9	83.7	3.2	IDFG HQ	Americana Bridge
Americana	Americana to Cascade Outfitters (45th St)	83.7	81.3	2.4	Americana	Cascade Outfitters
Plantation	Cascade Outfitters (45th St) to Glenwood	81.3	75.6	5.6	Cascade Outfitters	West Moreland
Glenwood	Glenwood to start of Eagle Island Start	75.6	73.2	2.4	West Moreland	Concrete
Eagle South	Behind Concrete plant near start of Eagle Island	10.5	6.6	3.9	Concrete Plant	Eagle Road
Eagle North	Behind Concrete plant near start of Eagle Island	73.2	69.0	4.2	Concrete Plant	Eagle Road
Linder North	Eagle Rd (N. Bridge) to Linder North	69.0	62.9	6.1	Hilton	Linder North
Linder South	Eagle Rd (S. Bridge) to Linder South	6.6	1.6	5.0	S Bridge	Linder South
Star (North)	Linder Road (N. Bridge) to confluence with south channel	63.1	61.2	1.9	Linder North	Star Bridge
Star (South)	Linder Road (S. Bridge) to confluence with north channel	1.6	0.0	1.6	Linder South	Star Bridge
Star	North & South channel confluence to Star Bridge	61.2	54.7	6.4	Linder bridges	Star Bridge
Can-Ada	Star Bridge to Lansing Lane	54.7	47.0	7.7	Star Bridge	Lansing Ln
Middleton	Lansing Ln. to Middle Bridge	47.0	42.6	4.3	Lansing	Middleton

Table 13. River sections, sampling dates, flow, water temperature, and conductivity during raft electrofishing in the Lower Boise River in summer 2015.

Section	Date	Flow (m^3/s)	Water temperature (°C)	Conductivity (µs/cm)
Harris Ranch	July 7	39	15.1	64
Barber	June 30	39	13.1	60
Special Reg	June 30	39	13.1	60
Morrison	June 30	39	13	60
Americana	June 23	39	14.7	60
Plantation	June 24	22	13.8	71
Eagle North	June 29	19	16	70
Eagle South	June 29	18	-	-
Star North	June 25	10	15.9	130
Star South	June 25	13	15	130
Star	June 25	23	20.2	113
Can-Ada	June 22	24	24.2	123

Table 14. Catch of wild and hatchery Brown and Rainbow trout by river section during raft electrofishing in the Lower Boise River in summer 2015.

Section	Brown Trout	Brown Trout (Hatchery)	Rainbow Trout	Rainbow Trout (Hatchery)
Harris Ranch			3	
Barber			13	
Special Reg	6		44	3
Morrison	12		43	3
Americana	3		30	
Plantation	3		28	
Eagle North	13		17	
Eagle South	5	1	68	1
Star North	14		21	3
Star South	4		33	4
Star	24		127	1
Can-Ada	5		36	
Total	89	1	463	15

Table 15. Adjusted exploitation and total use of wild Brown and Rainbow trout by river section. Trout were collected and tagged during raft electrofishing in the Lower Boise River in summer 2015.

					Disposition			Adjusted Exploitation		Adjusted Total Use	
Water Body	Species	Release Location	Tagging Date	Tags Released	Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Boise River	Brown Trout	Barber	6/30/2015	0	-	-	-	-	-	-	-
		Special Reg	6/30/2015	6	-	-	-	-	-	-	-
		Morrison	6/30/2015	8	-	-	-	-	-	-	-
		Americana	6/23/2015	2	-	-	-	-	-	-	-
		Plantation	6/24/2015	2	-	-	-	-	-	-	-
		Eagle North	6/29/2015	8	-	-	-	-	-	-	-
		Eagle South	6/29/2015	2	-	-	-	-	-	-	-
		Star	6/25/2015	18	-	-	1	-	-	10%	20%
		Star North	6/25/2015	10	-	-	-	-	-	-	-
		Star South	6/25/2015	4	-	-	-	-	-	-	-
		Can-Ada	6/22/2015	3	-	-	-	-	-	-	-
		Total		63	-	-	1	-	-	3%	6%
	Rainbow Trout	Barber	6/30/2015	6	-	-	-	-	-	-	-
		Special Reg	6/30/2015	13	-	-	-	-	-	-	-
		Morrison	6/30/2015	25	-	-	-	-	-	-	-
		Americana	6/23/2015	13	-	-	-	-	-	-	-
		Plantation	6/24/2015	10	-	-	-	-	-	-	-
		Eagle North	6/29/2015	8	-	-	-	-	-	-	-
		Eagle South	6/29/2015	49	-	-	1	-	-	4%	8%
		Star	6/25/2015	63	1	-	1	3%	6%	5%	8%
		Star North	6/25/2015	17	1		1	10%	21%	20%	29%
		Star South	6/25/2015	26	-	-	-	-	-	-	-
		Can-Ada	6/22/2015	27	-	-	1	-	-	6%	13%
		Total		257	2	-	4	1%	2%	4%	4%

Table 16. Catch of wild and hatchery Brown and Rainbow trout by river section during raft electrofishing in the Lower Boise River in November 2015.

Section	Brown Trout	Rainbow Trout	Mountain Whitefish	Dace (Var. Sp.)	Redside Shiner	Northern Pikeminnow	Sculpin (Var. Species)	Largemouth Bass	Green Sunfish	Largescale Sucker	Yellow Perch
Harris Ranch		45	4	200			160			150	3
Barber		5		92	5					6	
Special Regulation		11		54	6						
Morrison	2	41		0							
Americana	3	10	1	715			62	22			
Plantation				1,700			21			2	
Glenwood	2	11		1,301				50		12	
Eagle North	9	3	1	50	1			10		22	
Eagle South	7	17	1	270				39		10	
Linder North	23	16	5	6						4	
Star North	4		2	0				20		60	
Star South				10				10		20	
Star	1			0		1		69		65	
Can-Ada				9				2		6	
Loggers Creek	49	35		0							
Heron Creek	8	32	1	3	2			4		9	21
Warm Creek	1	1		15	6						1
Dry Creek	3	8		30					1	15	
Grand Total	112	235	15	4,455	20	1	243	226	1	366	25

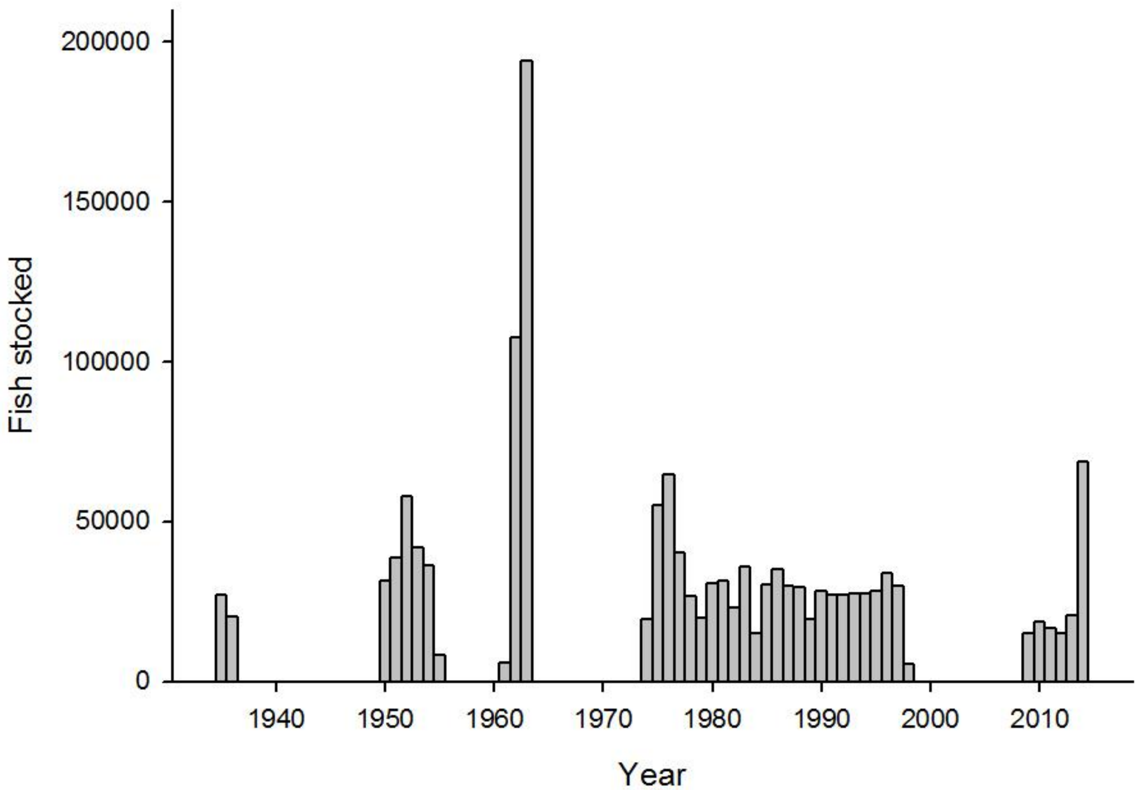

Figure 25. Numbers of Brown Trout stocked by year into the Lower Boise River, Idaho.

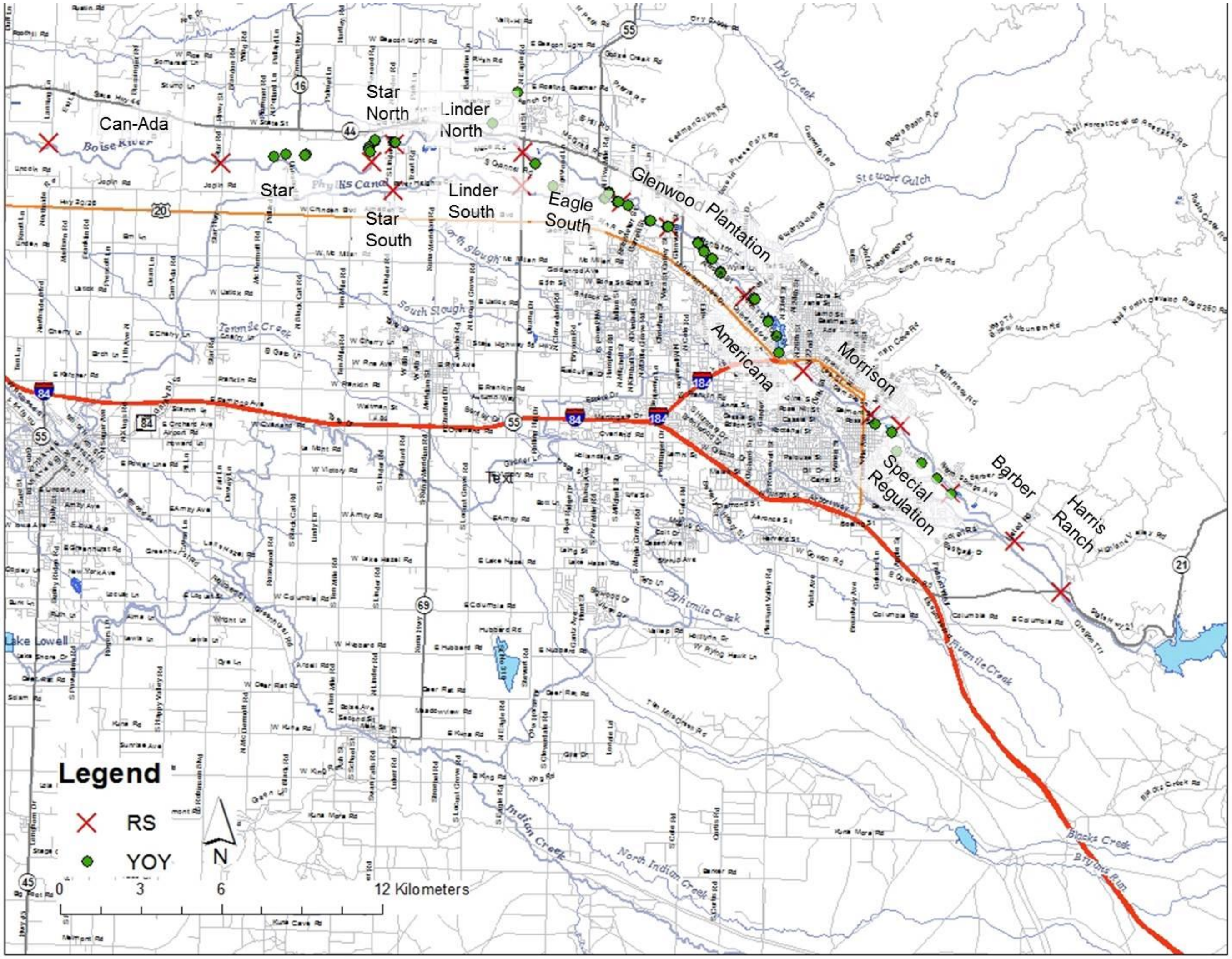

Figure 26. Map of the Lower Boise River sections used during electrofishing surveys during summer 2015. Sites marked by RS denote raft shocking boundaries and YOY denotes age-0 survey sites.

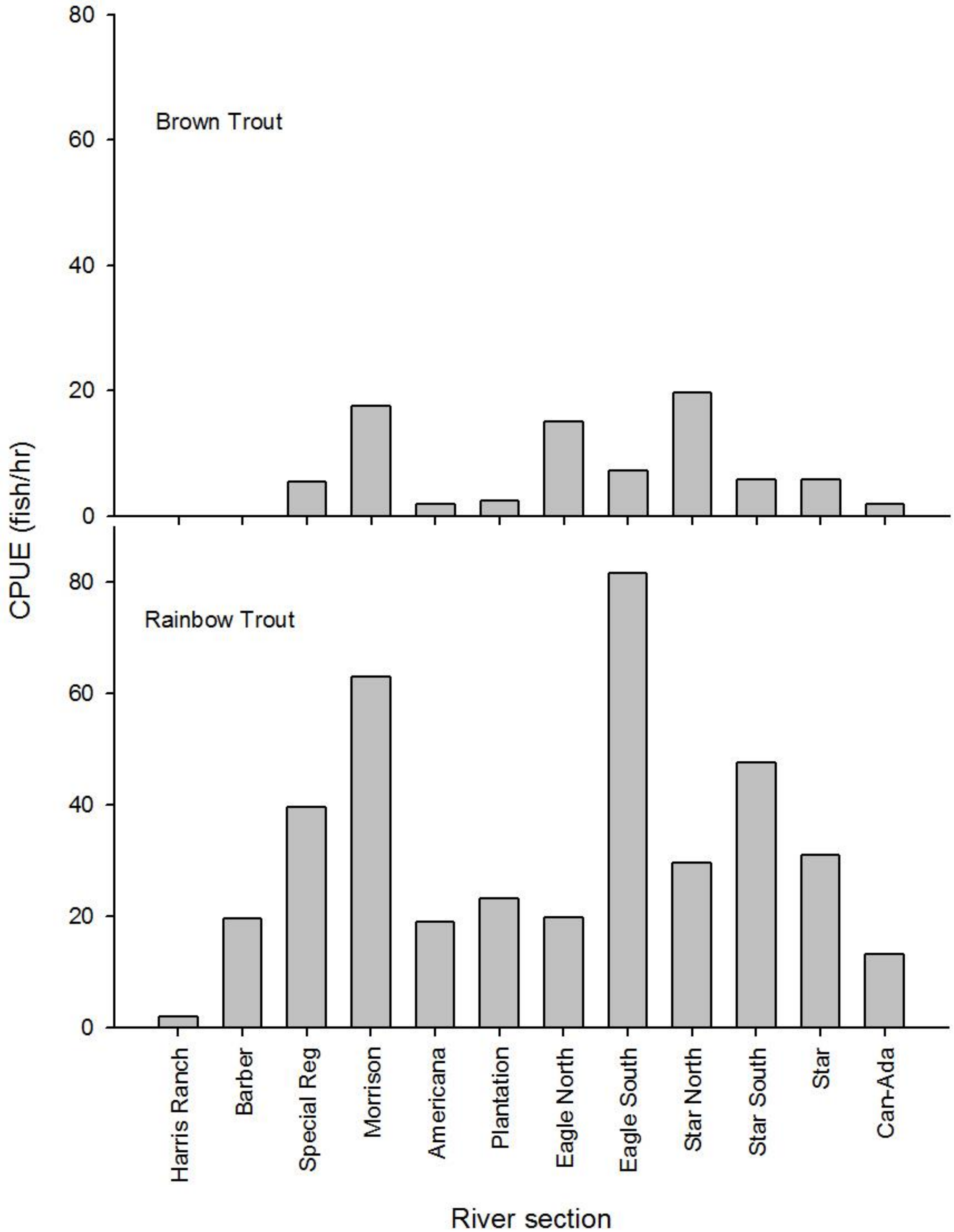

Figure 27. Catch per unit effort (CPUE) of wild Brown and Rainbow trout sampled during raft electrofishing surveys in the Lower Boise River surveys in summer 2015.

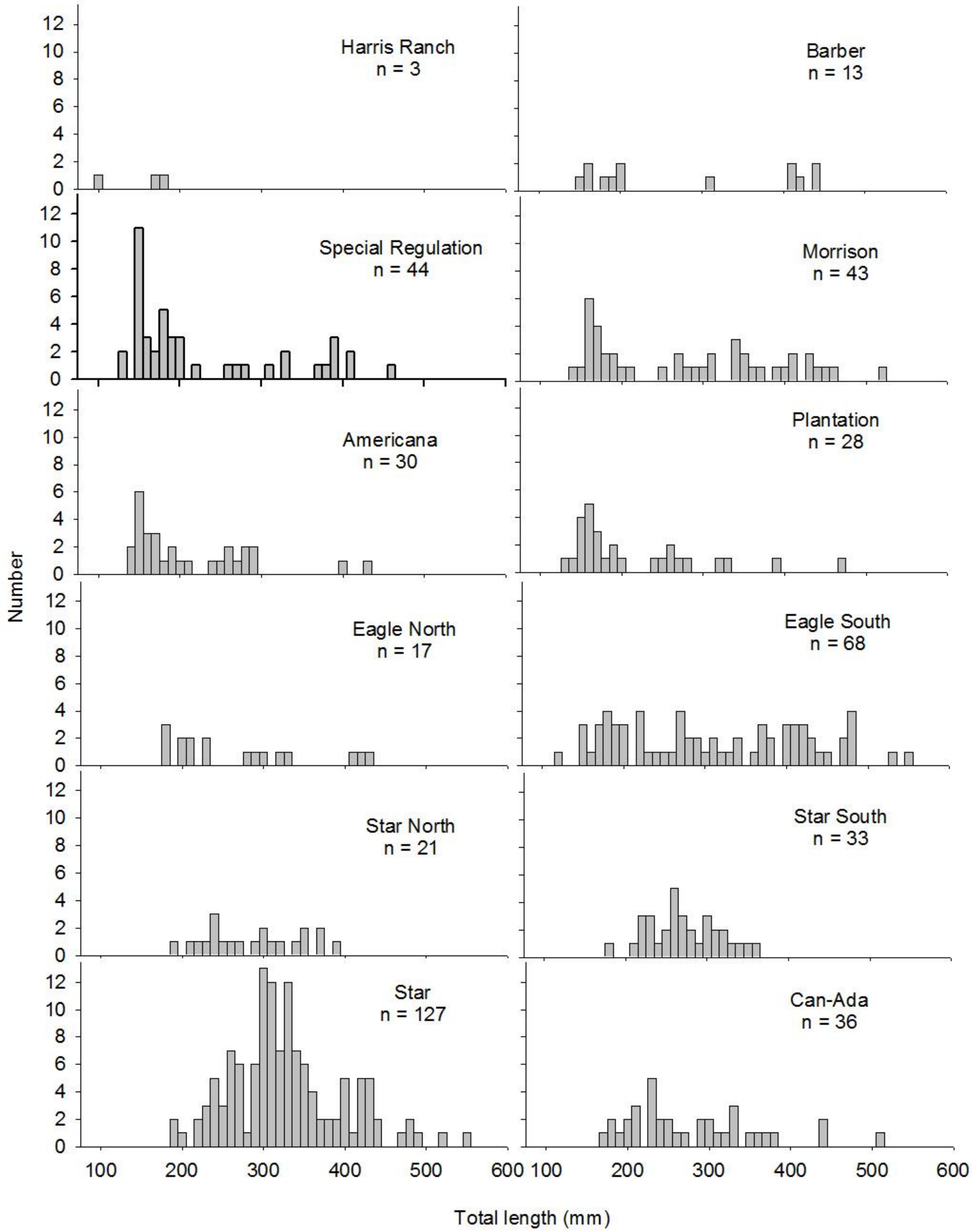

Figure 28. Length distribution of wild Rainbow Trout by river section sampled during raft electrofishing surveys in the Lower Boise River surveys in summer 2015.

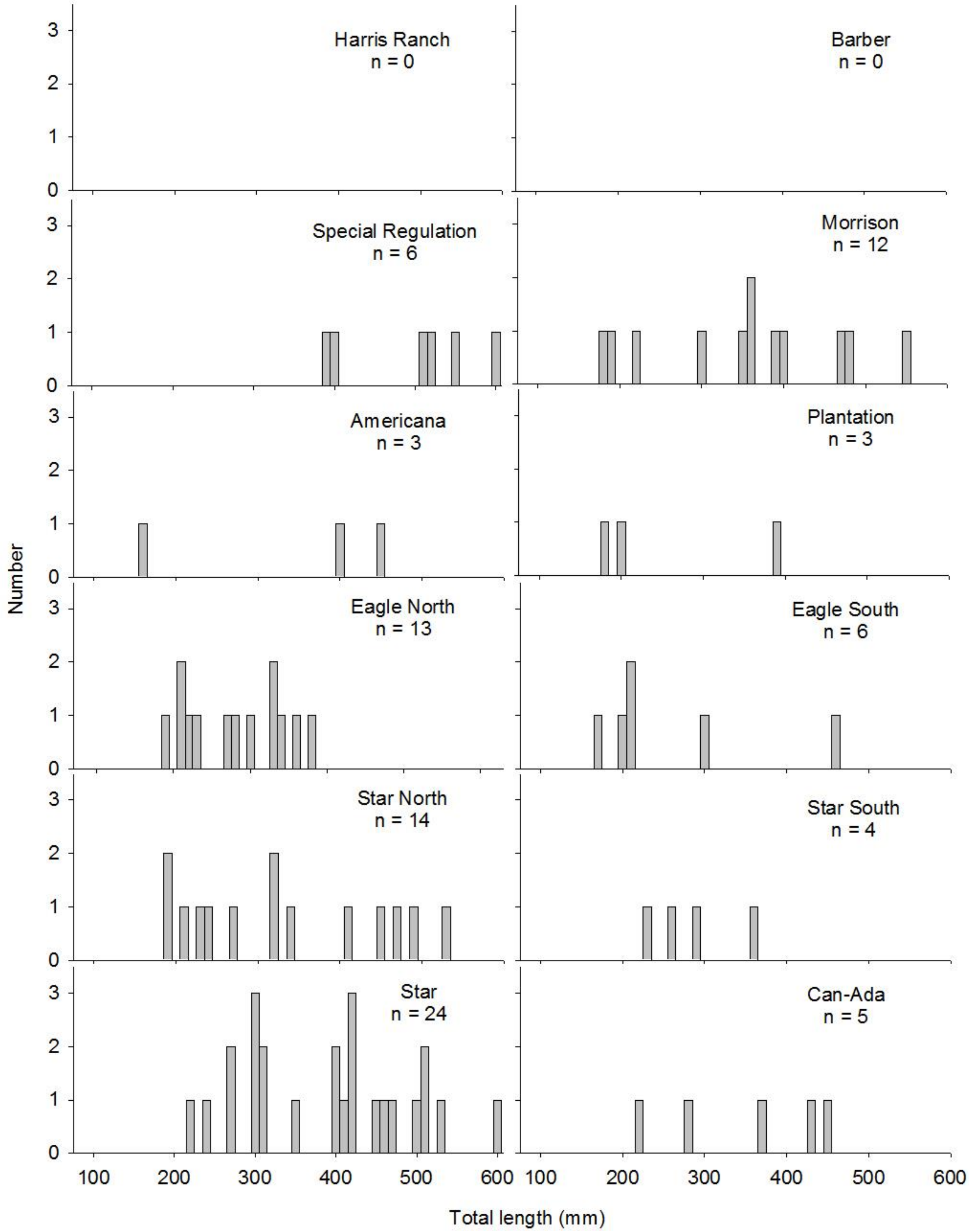

Figure 29. Length distribution of wild Brown Trout by river section sampled during raft electrofishing surveys in the Lower Boise River surveys in summer 2015.

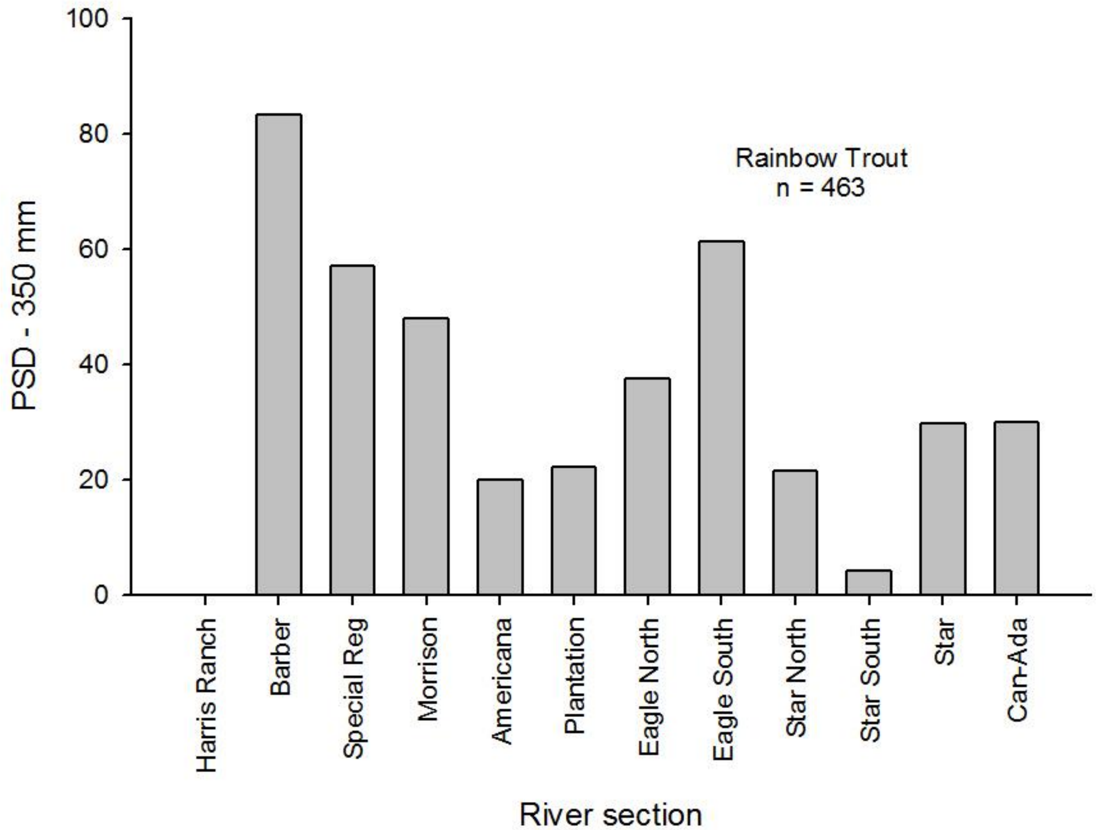

Figure 30. Proportional size distribution (PSD) of wild Rainbow Trout sampled during raft electrofishing surveys in the Lower Boise River surveys in summer 2015.

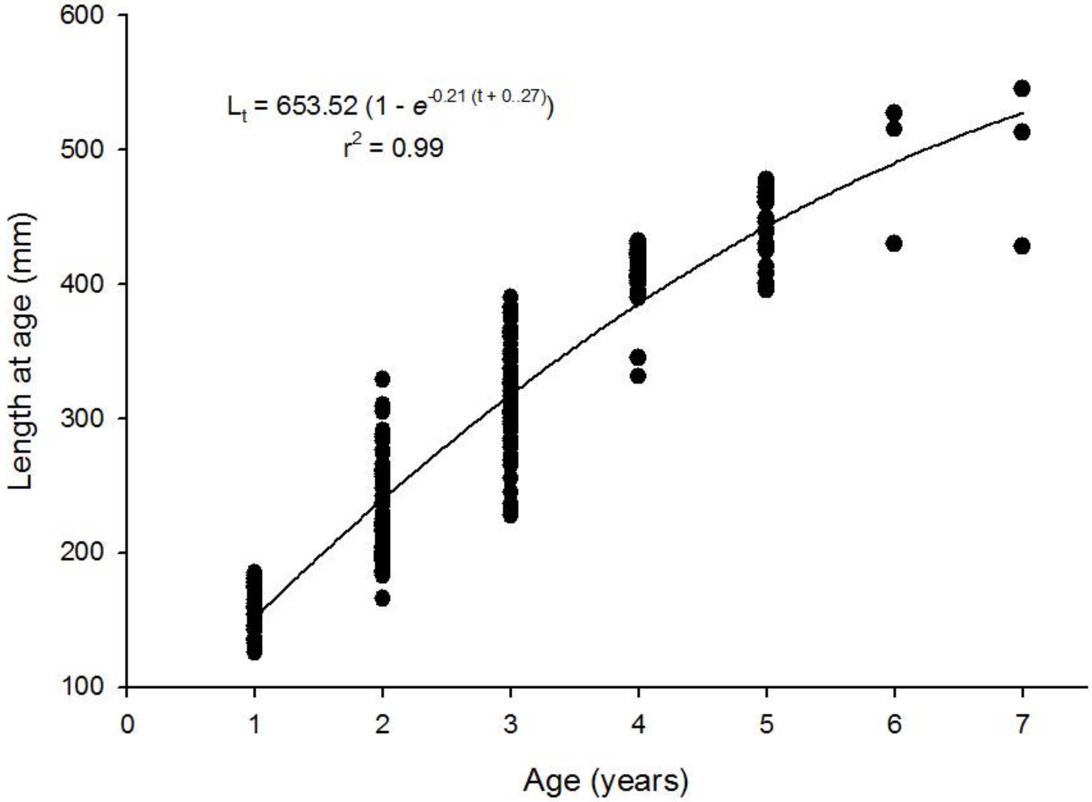

Figure 31. Von Bertalanffy growth model for Rainbow Trout in the Lower Boise River, Idaho. Ages were assigned using cross-sectioned pelvic fin rays of fish collected during raft electrofishing in summer 2015.

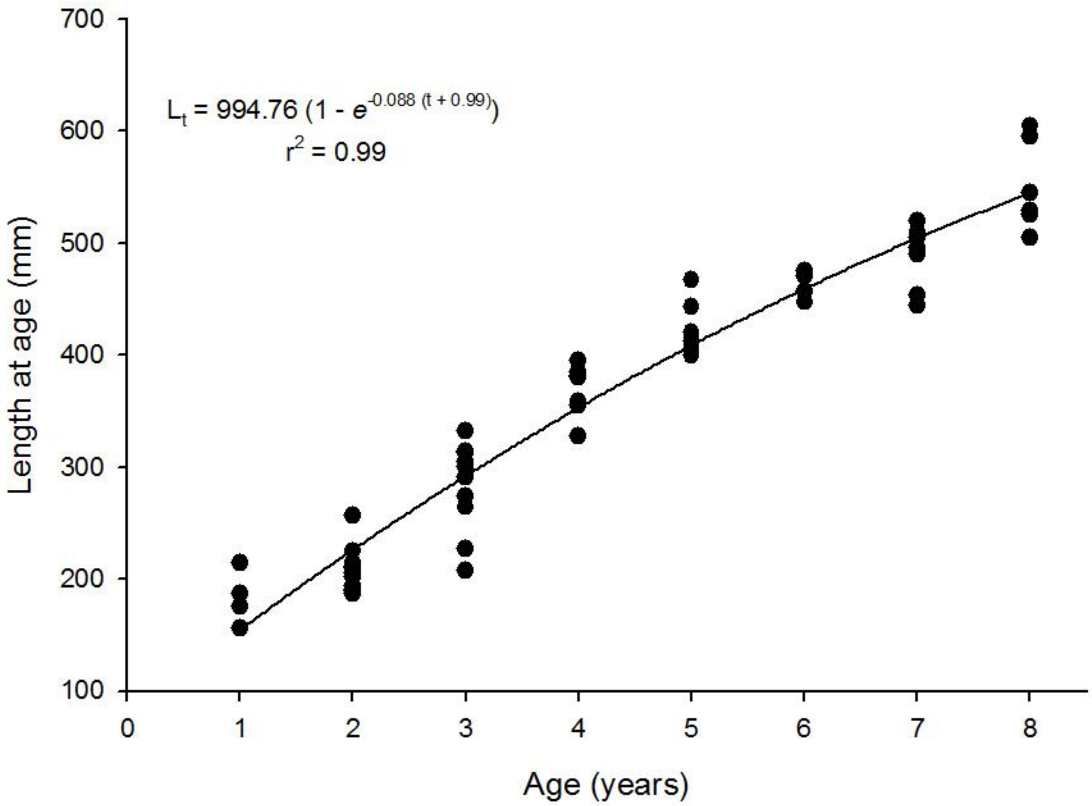

Figure 32. Von Bertalanffy growth model for Brown Trout in the Lower Boise River, Idaho. Ages were assigned using cross-sectioned pelvic fin rays of fish collected during raft electrofishing in summer 2015.

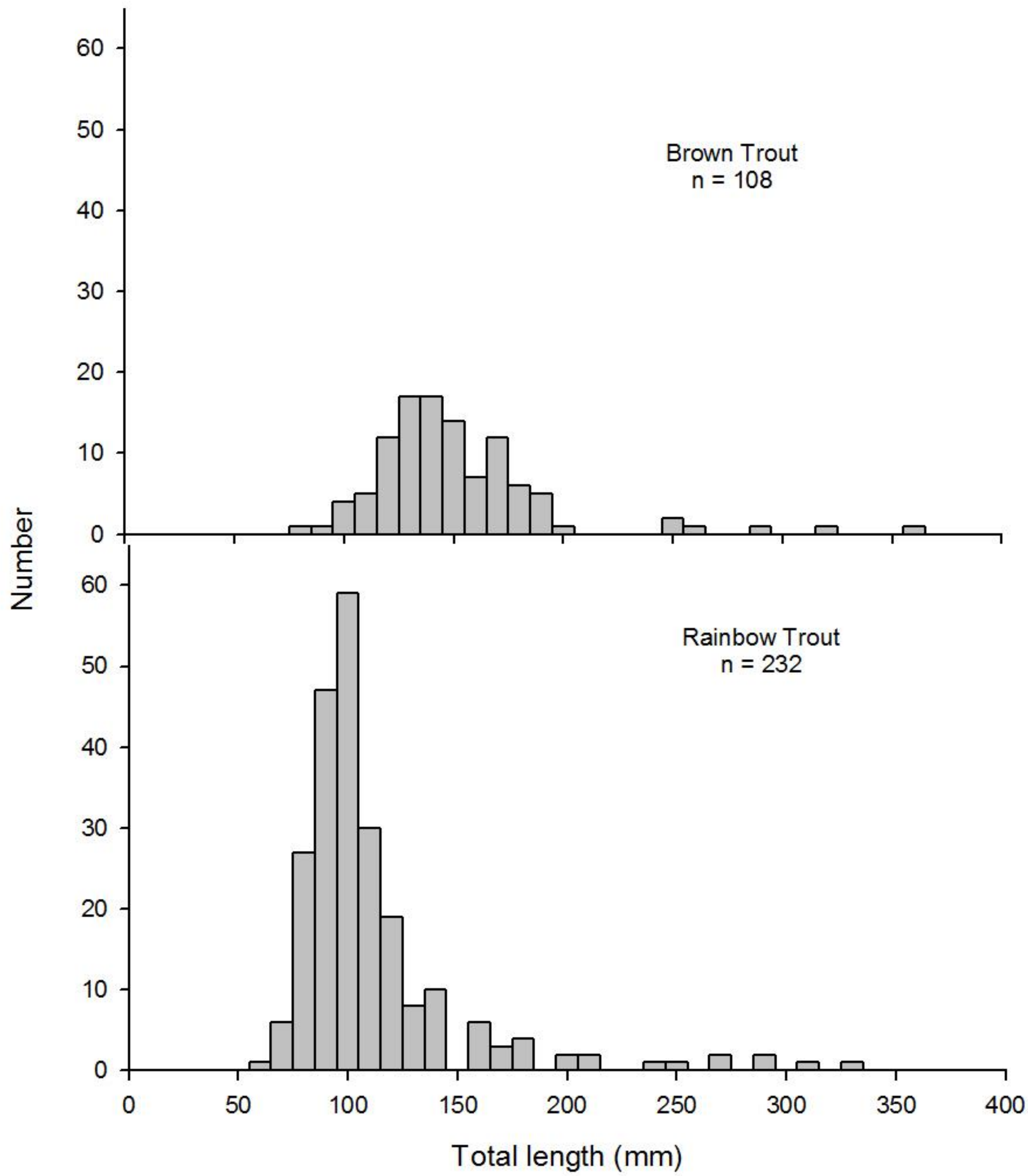

Figure 33. Length distributions of wild Brown and Rainbow trout by river section during backpack electrofishing surveys in the Lower Boise River surveys in November 2015.

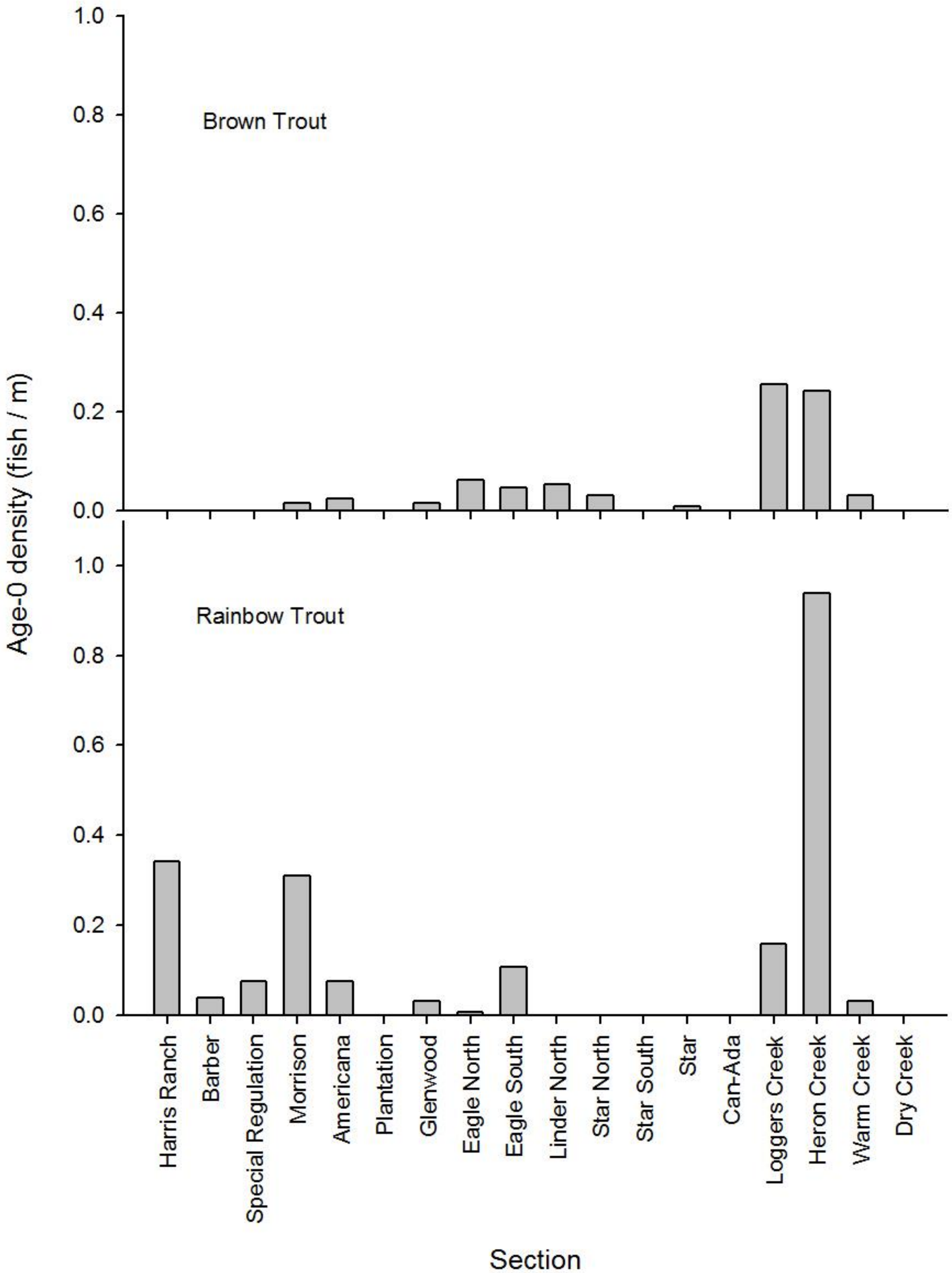

Figure 34. Catch per unit effort (CPUE) of wild age-0 Brown and Rainbow trout sampled during backpack electrofishing surveys in the Lower Boise River surveys in November 2015.

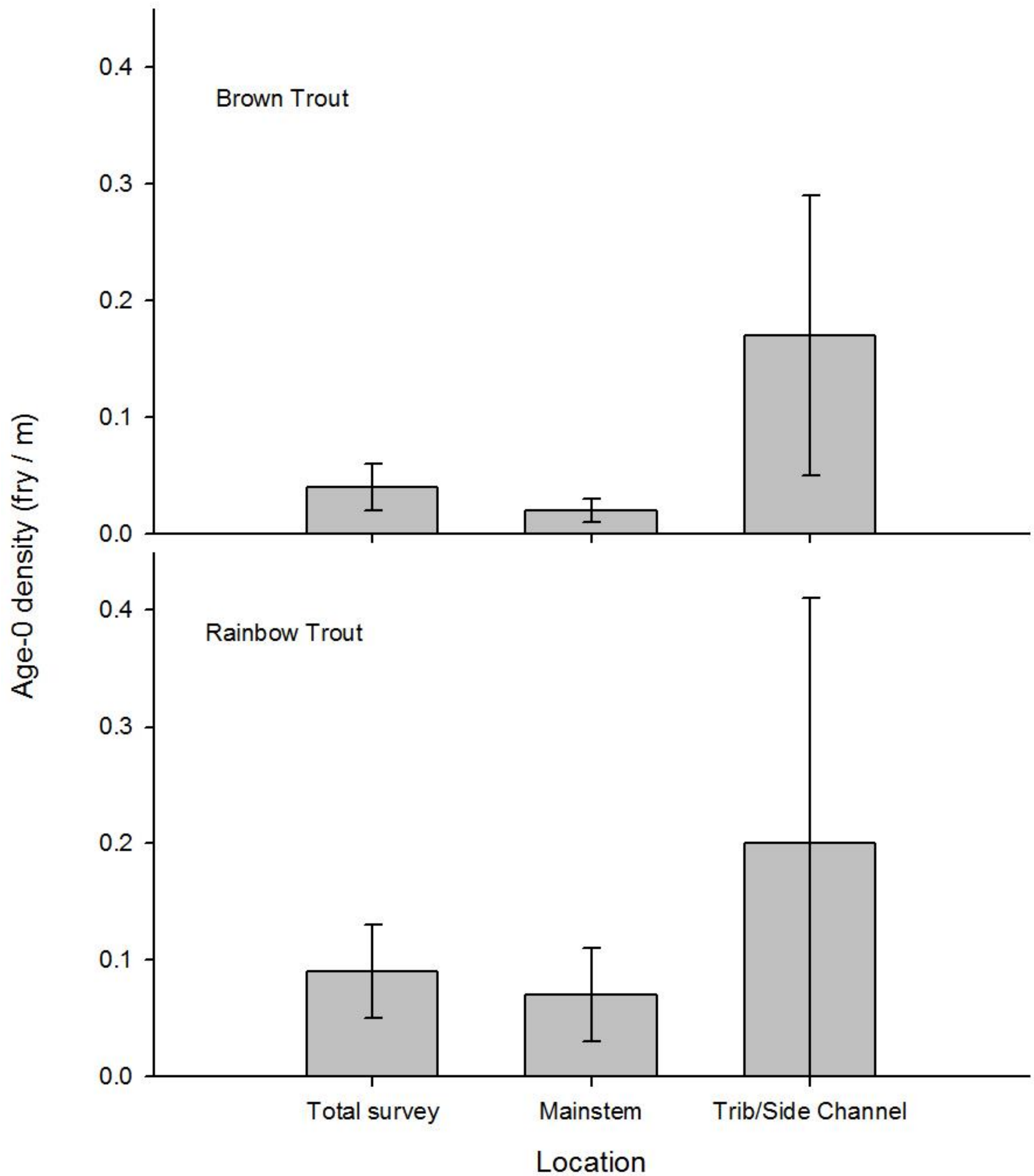

Figure 35. Density of age-0 wild Brown and Rainbow trout sampled during backpack electrofishing surveys in the Lower Boise River surveys in November 2015.

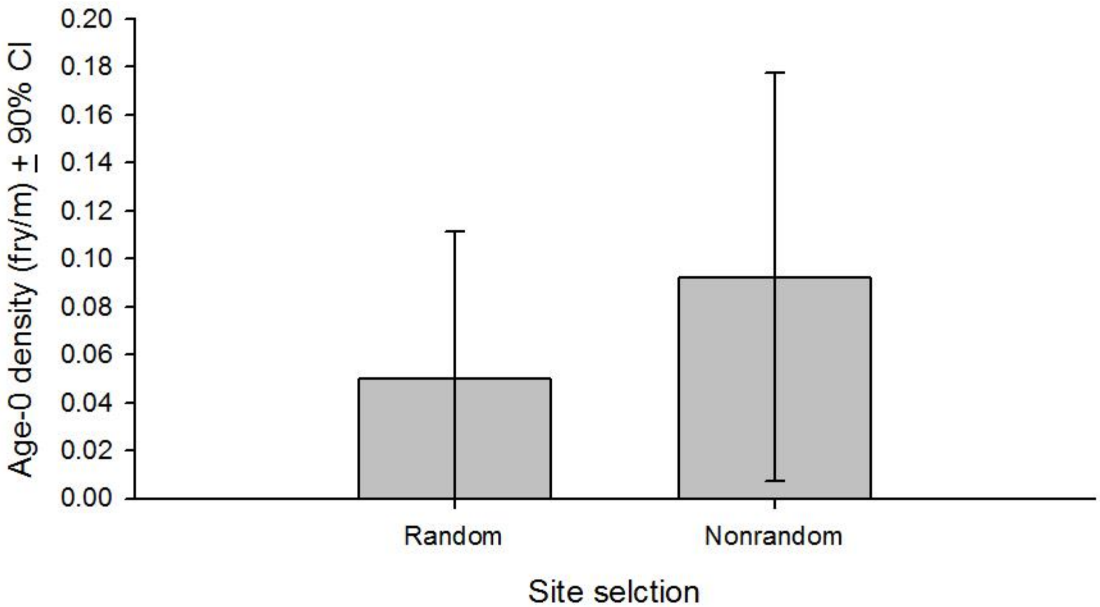

Figure 36. Density of age-0 wild Brown and Rainbow trout sampled during backpack electrofishing surveys in the Lower Boise River surveys in November 2015.

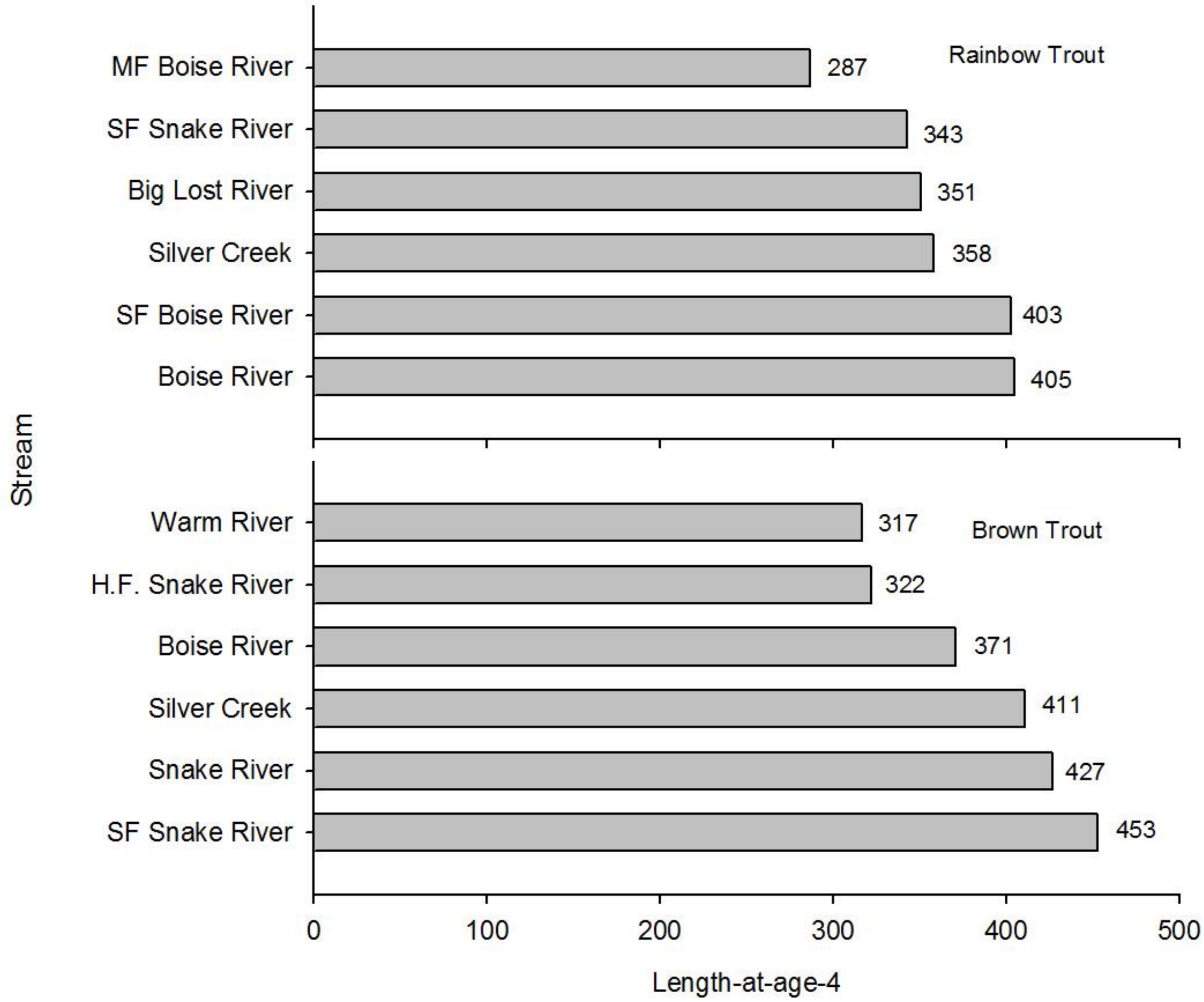

Figure 37. Length-at-age-4 for fluvial Rainbow and Brown trout in various Idaho streams. Lower Boise River fish were collected during raft electrofishing in summer 2015. South Fork Boise River information was collected during fall 2014. All other age-data was gathered and reported by Schill (1991).

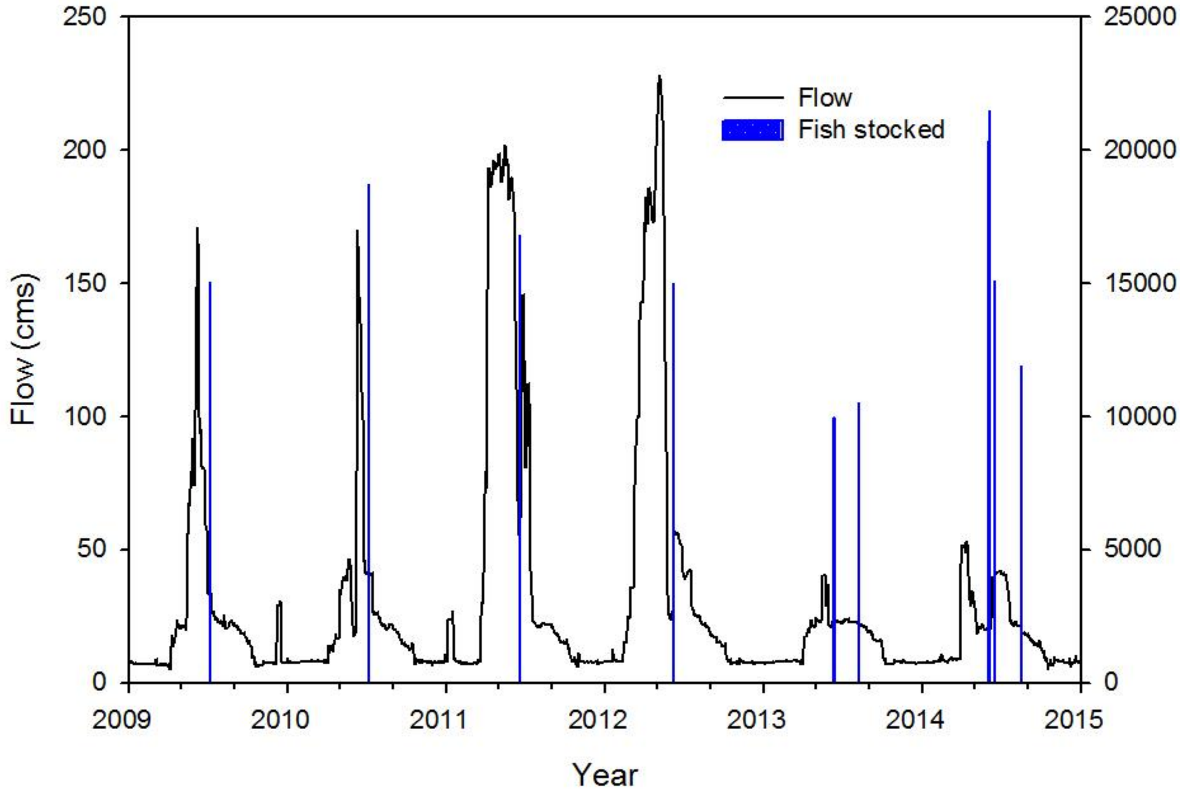

Figure 38. Numbers and timing of Brown Trout stocking in the Lower Boise River, Idaho in relation to annual hydrograph.

REDBAND AND BULL TROUT SURVEYS IN THE SOUTH FORK BOISE AND SOUTH FORK PAYETTE RIVER DRAINAGES DURING 2015

ABSTRACT

Idaho Department of Fish and Game and US Forest Service are working collaboratively to conserve trout species in Southwest Idaho. We collected distribution and abundance data necessary to inform conservation efforts. Tributaries of the South Fork Boise and South Fork Payette rivers were surveyed to gather information on the abundance and distribution of Redband Trout *Oncorhynchus mykiss gairdneri* and Bull Trout *Salvelinus confluentus*. Four sites were surveyed on Rattlesnake Creek, a South Fork Boise River tributary. Also, two South Fork Payette River tributaries were surveyed with three sites on Jackson Creek and one site on Tenmile Creek. Multiple-pass electrofishing surveys were completed at all sites. Redband Trout were sampled in all tributaries, and Bull Trout were sampled in Rattlesnake Creek only. A total of 476 Redband Trout and 3 Bull Trout were sampled. Approximately 69% of Redband Trout sampled were less than 100 mm in length. Redband Trout density ranged from 2.4 - 41.8 fish/100 m^2.

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INTRODUCTION

The tailwater section of the South Fork Boise River (SFBR) between Anderson Ranch Dam and Arrowrock Reservoir is one of the most popular trout fisheries in Southwest Idaho. During the last several years, IDFG has been working to improve understanding of fishes located within tributaries of this reach. Rattlesnake Creek, one of these tributaries, is located along Forest Service Road 117 and enters the SFBR about eight miles upstream of Arrowrock Reservoir.

The South Fork Payette River (SFPR) possesses cold, well connected salmonid habitats, though productivity is low. The mainstem is oriented in east-west direction and, due to basin morphology, most tributaries of sizes capable of supporting fishes enter from the north side of the river. The SFPR and tributaries are managed with special rules with a daily bag limit of two trout. Similarly to the SFBR, IDFG is interested in monitoring the distribution and abundance of fishes in tributaries of the SFPR. Jackson Creek is located about 10 miles from the confluence of the SFPR and the NF Payette River. Tenmile Creek enters the SFPR about seven miles upstream of Jackson Creek.

Historical surveys have primarily focused on Bull Trout and Redband Trout. Bull Trout were listed as a threatened species in 1998. Several management strategies have been used to conserve or restore Bull Trout including prohibiting harvest, eliminating migration barriers, and reducing sedimentation. Bull Trout require cold water and clean spawning gravel (Stewart et al. 2007). Bull Trout inhabit streams between 8.5 and 19.5˚C though the highest densities occur between 11 and 14˚C (Hillman and Essig 1998). Anthropogenic habitat changes related to timber harvest and road development, livestock grazing, mining, dams, fire, hydro-electric development, and irrigation diversions have negatively impacted Bull Trout (U.S. Fish and Wildlife Service 2002). Additional habitat alteration has occurred as a result of wildfires. The nearly 37,000-acre Middle Fork Complex fire burned the Tenmile Creek drainage in 2007 (GeoMac 2015), causing significant changes to stream habitat conditions. Monitoring changes to bull trout distribution and abundance are important to conserving and recovering the species.

Redband Trout are found throughout the interior Columbia Basin and exhibit two major life histories, both anadromy and potamodromy (Muhlfeld et al 2015). In Idaho, Redband Trout are managed to minimize risks to Redband Trout metapopulations (e.g. stocking sterile fish in areas with native populations; IDFG 2014). Redband Trout are common throughout mid- and high-elevation streams and rivers in the Southwest Region. Redband Trout can live in warmer water temperatures, up to 27˚C (Meyer et al. 2010), though the highest densities of Redband Trout occur between 9 and 16˚C (Meyer et al. 2010). Similarly, recent population data is important for identifying proper management strategies. Our objective was to assess the distribution and abundance of Bull trout and Redband Trout in tributaries to the South Fork Boise and South Fork Payette rivers and to compare them to historical survey information.

METHODS

In 2015, we sampled one tributary of the SFBR and two tributaries of the SFPR to evaluate presence, distribution, and abundance of Redband Trout and Bull Trout. Four sites were sampled on Rattlesnake Creek, the only tributary of the SFBR sampled (Figure 39). In the SFPR drainage, three sites were sampled on Jackson Creek (Figure 40), and one site on Tenmile Creek (Figure 41). Sites were selected based on the location of federal grazing allotments, as well as locations historically sampled by IDFG or USFS. All sites were surveyed during September 2015. When possible, I compared metrics measured in 2015 to previous surveys.

Fish Sampling

Fish were sampled using a backpack electrofisher (Smith-Root Model LR-24) in an upstream direction using pulsed DC current. The electrofisher was set at a 12% duty cycle, 30 Hz, and between 475 and 600 volts. Block nets were placed at both the upper and lower ends of the 100-m sites to prevent fish from entering or leaving the site. Two passes were completed at most sites with the exception of Jackson Creek sites JC1 and JC3, where less than 10 fish were sampled during the first pass (Table 17). A three person crew conducted the survey on Rattlesnake Creek, whereas on the smaller streams, Jackson and Tenmile creeks, only two crew members participated. Once captured, fish were identified, counted, measured to the nearest millimeter (total length), weighed to the nearest gram, and released downstream of the sample site. For the sites where multiple passes were conducted, maximum-likelihood population estimates were calculated with the MicroFish software package (Van Deventer 2006; Van Deventer and Platts 1989). When all trout were sampled on the first pass, total catch was assumed as the abundance. Since electrofishing is characteristically size selective (Sullivan 1956; Reynolds 1996), Redband Trout density estimates were calculated for two length groups (<100 mm and >100 mm) separately and combined. Any herptiles and nongame fish observed were noted on datasheets.

A site on Rattlesnake Creek had previous density estimates that allowed trend analyses. Site #93RSINT5 was previously sampled in 2012; however, only one pass was completed. For comparative purposes, we utilized the 2015 capture efficiency to develop a fish density estimate for the 2012 single pass survey to compare trends between sampling events.

Habitat Sampling

We measured several habitat variables at 10-m intervals throughout the 100-m sites.. Wetted width (m) was measured at each of the 10 transects. The sum of the wetted width measurements was divided by 10 to calculate the average wetted width for the site sampled. Total area of the site (m^2) was determined by multiplying the site length by the mean wetted width. Water depth (m) was measured at ¼, ½, and ¾ distances across the stream. Mean depth was calculated by summing measurements dividing by four to account for zero depths at the stream margins for trapezoidal-shaped channels (Platts et al. 1983, Arend 1999). Percent substrate composition, percent shading, and bank stability were recorded, but the data is not reported here. Stream temperature (°C) and conductivity (µS/cm) measurements were also recorded with a calibrated hand-held reader accurate to ± 2%, with the exception of JC3 where the reader malfunctioned. Habitat measurements were entered into the Stream Survey database, but and are not presented here.

RESULTS

For the four sites on Rattlesnake Creek (SFBR), I sampled a total of 405 Redband Trout and 3 Bull Trout. Redband Trout density estimates ranged from 25 to 42 fish/100 m^2 (Table 17; Figure 42). Length of Redband Trout in Rattlesnake Creek ranged from 41 to 382 mm (Figure 43). The majority of the Redband Trout sampled in Rattlesnake Creek were putative age-0s and ranged in TL from 45 to 80 mm. Of the total density estimates, 72% was comprised of fish less than 100 mm. During the 2012 survey of site 93RSINT5, 11 Redband Trout were sampled in a single pass. Based on 2015 capture efficiencies and assuming equal capture probability among years, density during 2012 was estimated as 4.2 Redband Trout/100m². This is much lower than the 2015 estimate of 33.5 Redband Trout/100 m². At another site (93RSINT7) in Rattlesnake Creek during 2014, density during 2014 was estimated as 5.5 fish/100m². This is much lower than the 2015 estimate of 25.3 Redband Trout/100 m². Bull Trout density estimates are not possilbe due to low sample sizes. All three Bull Trout were sampled at 94RSINT6 and ranged in length from 148 to 153 mm.

For Jackson Creek (SFPR), I sampled three sites; JC1, JC2, and JC3. No fish were present at JC1. A total of 27 Redband Trout were sampled at JC2 and JC3 (Table 17). Densities estimates for Jackson Creek were relatively low and ranged from 2 to 10 Redband Trout/100m² (Table17; Figure 42). Total length of Redband Trout in Jackson Creek ranged from 37 to 156 mm (Figure 44). Of the total density estimates for Jackson Creek, 40% was comprised of fish less than 100 mm. I sampled 82 Redband Trout in Tenmile Creek. Total length of Redband Trout in Tenmile Creek ranged between 41 and 203 mm (Figure 44). Of the total density estimate for Tenmile Creek, 45% was comprised of fish less than 100 mm. Similarly to other sites, the density estimate for Tenmile Creek was only 8 Redband Trout/100 m². No Bull Trout were sampled in these SFPR sites.

DISCUSSION

Survey information collected during 2015 improved understanding of abundance, distribution, and sizes of Redband Trout and Bull Trout in tributaries of the SFBR and SFPR. Data collected during 2015 suggest Rattlesnake Creek utilized primarily as spawning habitat. The majority of Redband Trout sampled were small and likely age-0s, which is consistent with previous survey information (Butts et al. 2013, Butts et al. 2016). Densities of Redband Trout in Rattlesnake Creek have seemed to increase recently. Density estimates for 2015 were 4.6 or 8 times higher than for surveys at the same sites during 2012 and 2014. The reason for this increase in density is not understood. Also, it appears that Rattlesnake Creek functions as spawning and rearing habitat for Bull Trout based on the presence of various length groups during multiple years (Butts et al. 2013, Butts et al. 2016).

For the SFPR tributaries, neither IDFG nor USFS have historical data on Jackson Creek. Data collected in 2015 suggests that Jackson Creek is utilized as spawning and early rearing habitat, as more than 50% of the Redband Trout were less than 100 mm in length. Tenmile Creek had been sampled by USFS staff during 1999 and 2005. In 1999, USFS conducted a snorkel survey and counted a total of 16 Redband Trout and 7 Bull Trout. During 2005, two Bull Trout and no Redband Trout were sampled with electrofishing equipment. In contrast, we sampled many Redband Trout, but no Bull Trout during 2015. Highly variable fish densities over several survey years in Tenmile Creek may indicate largely migratory and seasonal occupancy by Redband and Bull trout. Having observed relatively high densities of Redband Trout less than 100 mm in 2015, I conclude that Redband Trout utilize Tenmile Creek primarily for spawning and as early rearing habitat. Also, the presence of longer Redband Trout in September suggests this stream also provides habitat for resident adults.

RECOMMENDATIONS

1. Sample additional sites in Tenmile Creek and continue sampling Rattlesnake Creek for Bull Trout and Redband Trout to gain a better understanding of the distribution and abundance throughout these drainages.

2. Sample additional sites in Jackson Creek to build baseline historical data on the stream and to better understand the abundance and distribution of Redband Trout and Bull Trout.

Table 17. Summary of site information, effort, sample size (*n*), and density estimates (Est) for electrofishing surveys conducted in tributaries of the South Forks of the Boise and Payette rivers.

					< 100 mm			>100 mm			Total		
Stream	Date	Site	Temp (°C)	Passes	n	Est	95% CI	n	Est	95% CI	n	Est	fish/100 m^2
Rattlesnake Creek	9/1	93RSINT7	15.9	2	68	92	56-128	24	25	21-29	92	117	25.3
	9/1	94RSINT6	15.3	2	81	90	77-103	27	27	27-27	111	120	26.8
	9/2	94RS5.5	14.1	2	87	147	56-238	36	40	31-49	123	187	41.8
	9/2	93RSINT5	16.7	2	56	62	51-73	26	56	50-162	82	118	33.5
Jackson Creek	9/9	JC1	8.2	1	0	-	-	0	-	-	-	-	-
	9/10	JC2	8.3	2	11	11	8-14	10	10	10-10	21	21	9.9
	9/10	JC3	-	1	6	-	-	6	-	-	6	6	2.4
TenMile Creek	9/29	TC1	10	2	18	21	11-31	23	26	17-35	41	47	8.1

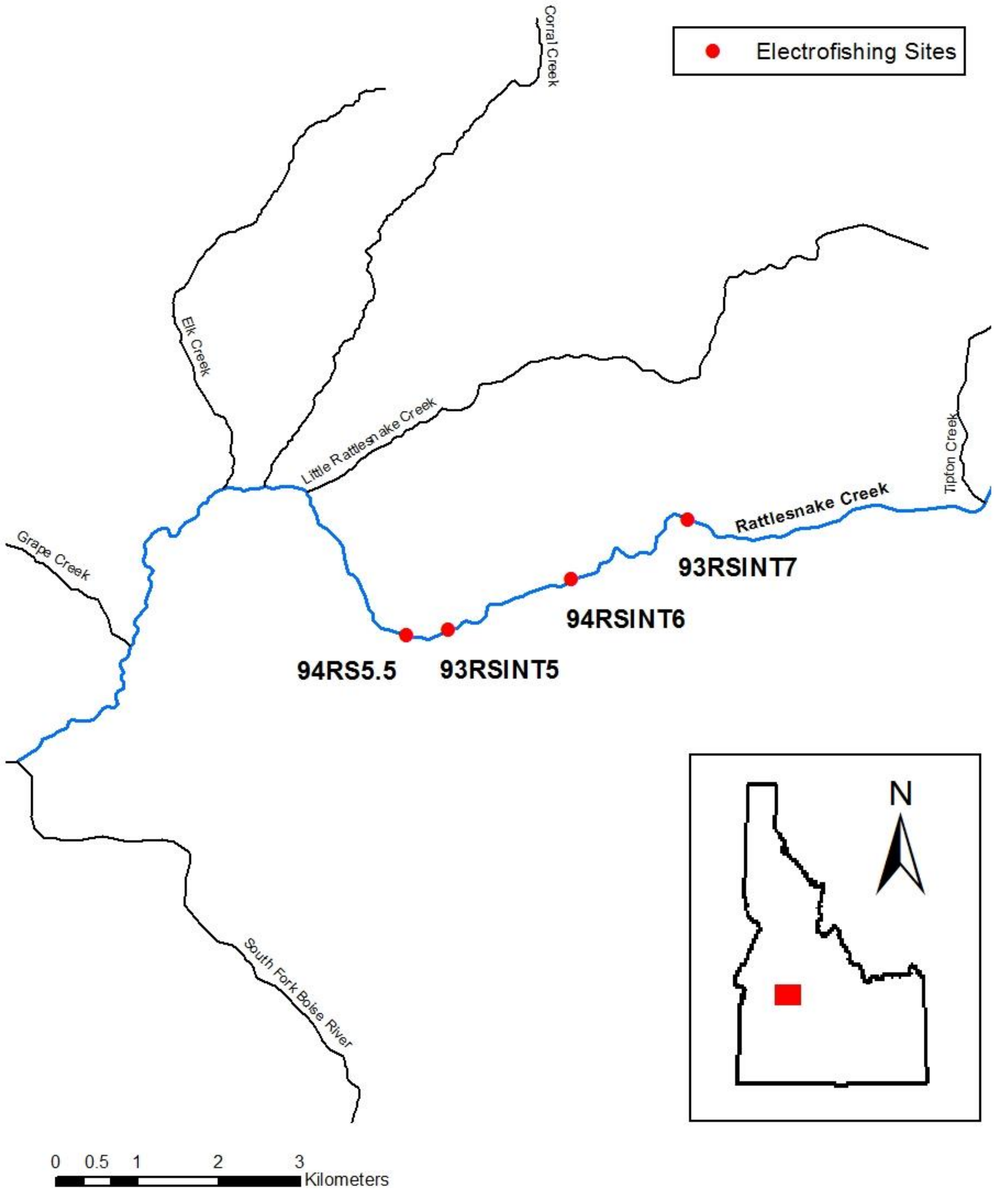

Figure 39. Map of electrofishing sites on Rattlesnake Creek, a South Fork Boise River Tributary, Idaho.

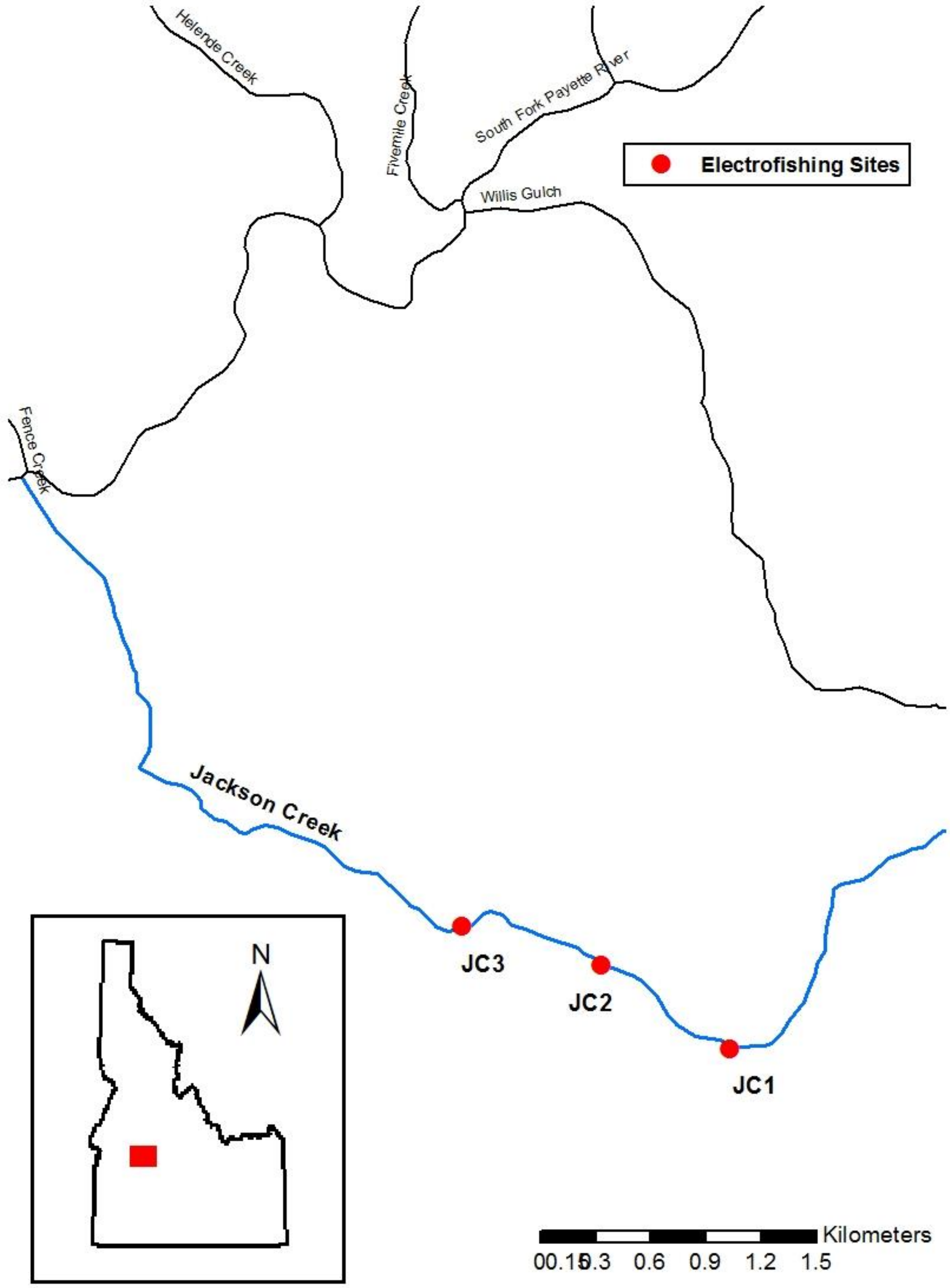

Figure 40. Map of electrofishing sites on Jackson Creek, a tributary of the South Payette River, Idaho.

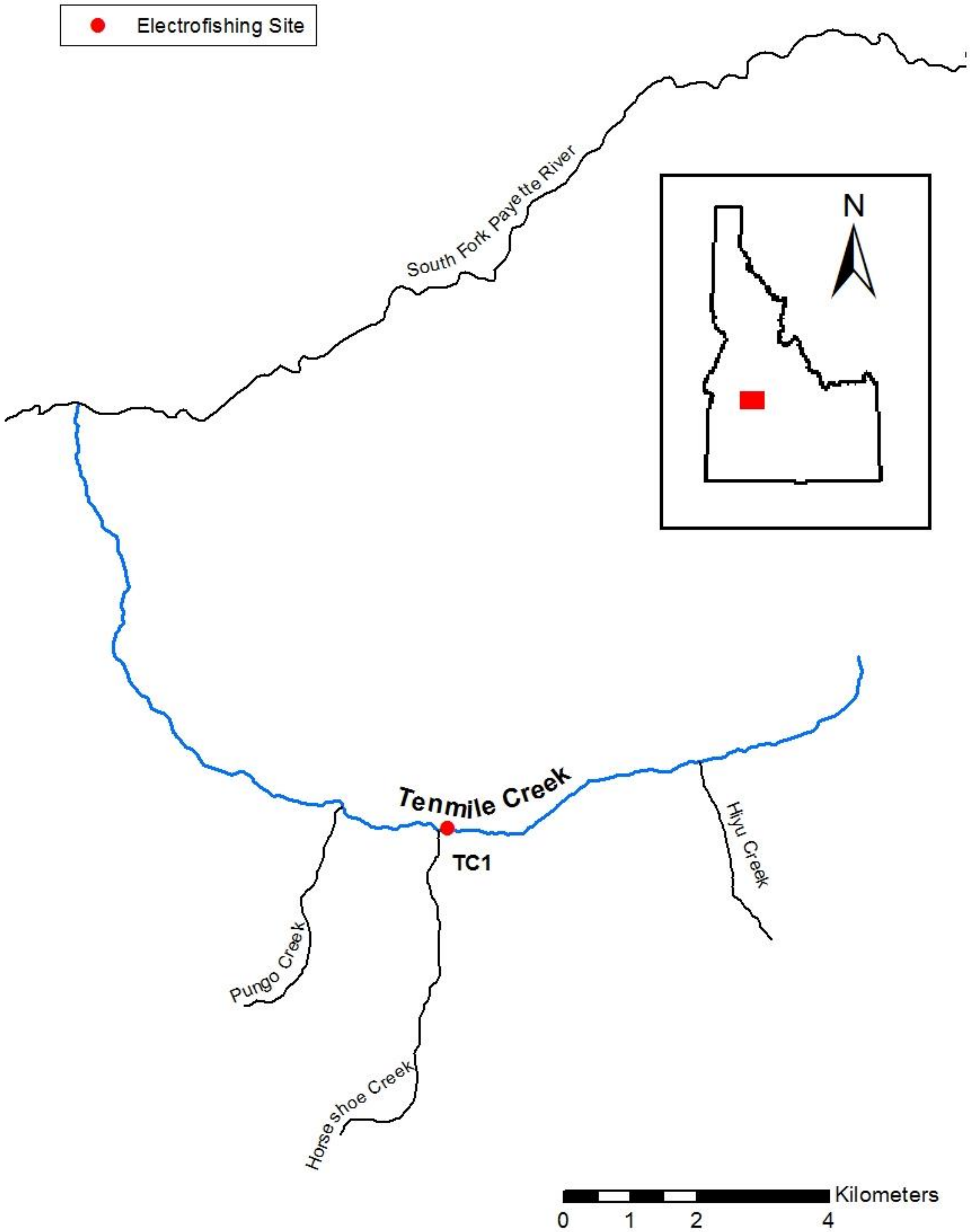

Figure 41. Map of electrofishing sites on Tenmile Creek, a tributary of the South Payette River, Idaho.

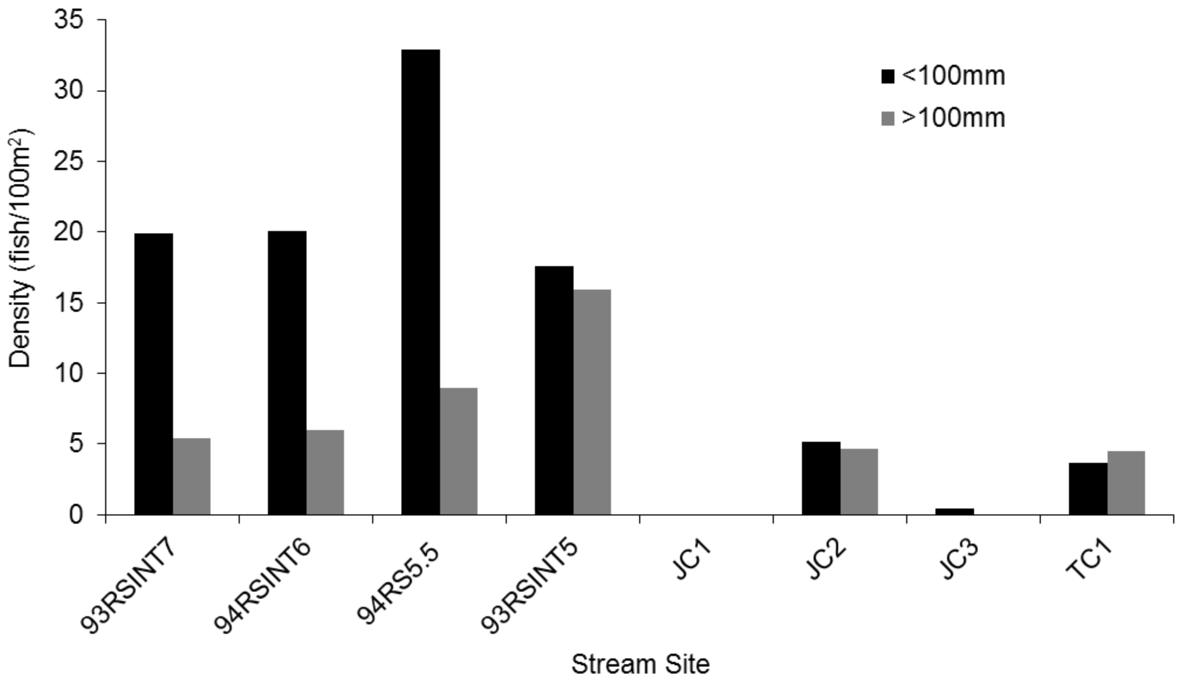

Figure 42. Redband Trout density (fish/100 m^2) estimates for electrofishing surveys completed during 2015 in tributary sites in the South Fork Payette and South Fork Boise river drainages.

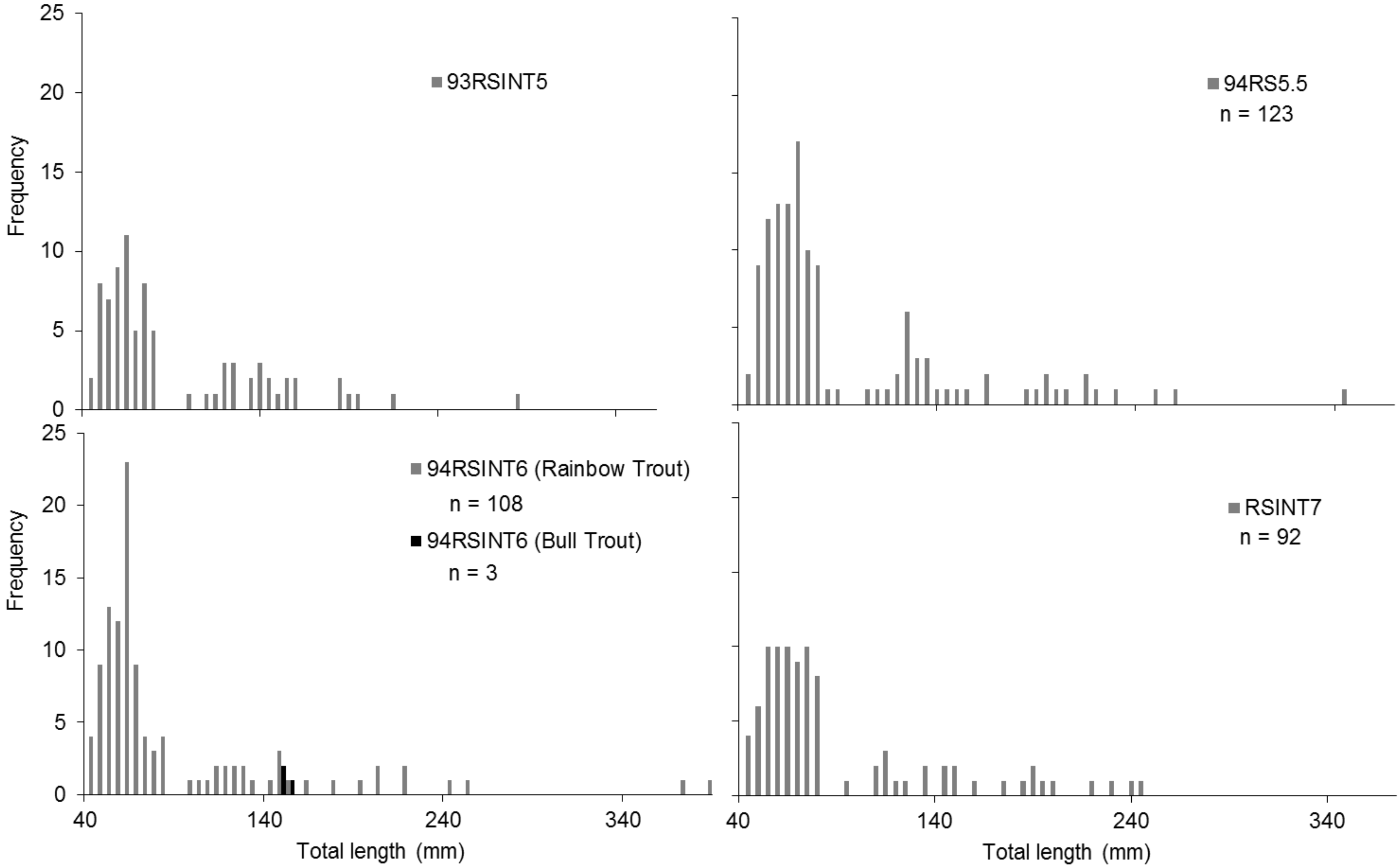

Figure 43. Length-frequency distribution of Redband Trout and Bull Trout sampled with electrofishing in Rattlesnake Creek, September 2015.

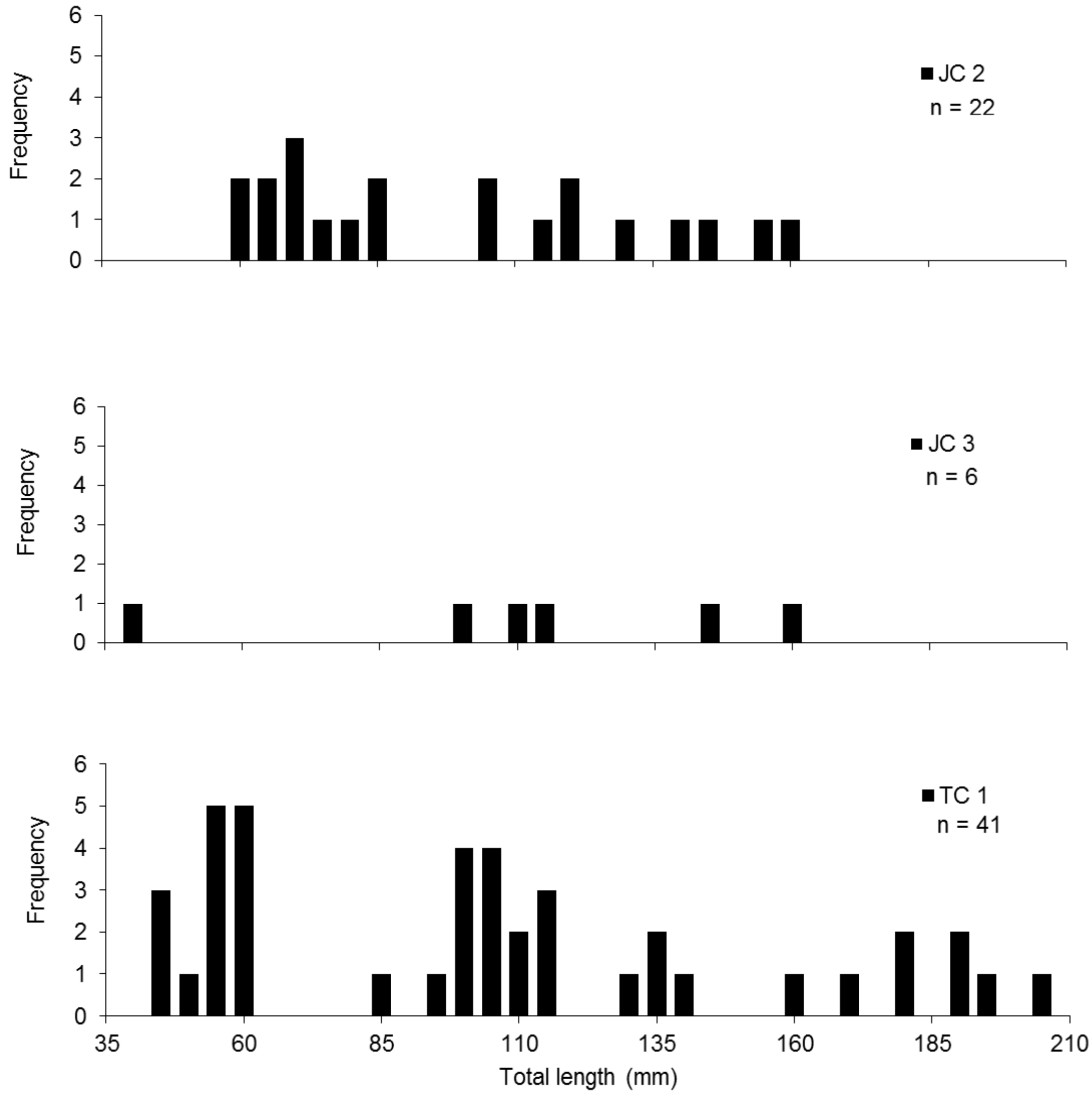

Figure 44. Length-frequency distribution of Redband Trout sampled in Jackson Creek site 2 (JC2), site 3 (JC3), and in Tenmile Creek (TC1).

EXPLOITATION AND USE OF CATCHABLE-SIZED HATCHERY RAINBOW TROUT IN STREAMS AND RIVERS

ABSTRACT

During 2015, IDFG stocked almost one million catchable-sized Rainbow Trout *Oncorhynchus mykiss* (catchables) statewide, with about 36% of this total stocked in streams or rivers. Recent information describing return-to-creel (exploitation or use) rates for hatchery catchables in streams or rivers in the Southwest Region is sparse. I conducted this study to estimate exploitation (harvested) and total use (harvested and/or released fish) rates in five streams or rivers. Secondly, I assessed whether water temperature and stocking period may have affected exploitation rates. I tagged catchables with t-bar anchor tags and collected angler-reported tag information with the Tag You're-It! program. Combined exploitation and total use rates across all five study waters were 6.6% and 9.9%, respectively. For Silver Creek, adjusted exploitation and total use rates were 13.3% and 16.9%, respectively. For the Middle Fork Payette River, adjusted exploitation and total use rates were 6.5% and 8.4%, respectively. For Grimes Creek, overall adjusted exploitation and total use rates were 5.1% and 6.8%, respectively. For Mores Creek, overall adjusted exploitation and total use rates were 4.2% and 12%, respectively. For Crooked River, overall adjusted exploitation and total use rates were 4% and 5.8%, respectively. Water temperatures suggested poor conditions for trout, with 55% of the season being within the reported upper lethal temperature (21-27 C°). Historical flow data for the two study waters with nearby gauges showed that 2015 was an abnormally low flow year. Low flows likely exacerbated high water temperatures that may have reduced catchability or survival of stocked trout. Our results indicated that higher use and exploitation rates were associated with earlier stocking events and more accessible locations.

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INTRODUCTION

Idaho Department of Fish and Game (IDFG) stock Rainbow Trout *Oncorhynchus mykiss* (203-254 mm; catchables) to provide fishing and harvest opportunities where wild stocks are incapable of supporting fisheries. During 2015, nearly one million catchables were stocked statewide, with approximately 36% being stocked in streams and rivers. Default stocking requests for the Southwest Region approximate 250,000 catchables annually, with about 34% allocated to streams or rivers.

Hatchery trout are an expensive yet valuable tool in the management of many trout streams (Trushenski et al. 2010). Expenditures on catchables account for over 50% of the IDFG annual resident hatchery budget (Cassinelli 2014). The costs of rearing a catchable was about $1.27 per fish, including costs associated with staff, purchasing or producing eggs, rearing, and transporting. On a statewide basis, this equated to expenditures of approximately $1.25 million during 2015.

Due to high costs and the desire to maximize benefits to anglers, it is important to have recent information on harvest (i.e. exploitation) and catch-and-release rates of catchables stocked in streams or rivers (Koenig 2012). The 2013-2018 Fish Management Plan sets a return-to-creel objective for catchables of 40%. Understanding of return-to-creel data (i.e. adjusted exploitation and adjusted total use) for regional streams is important for prioritizing hatchery resources and adjusting stocking strategies. Adjusted exploitation (harvest, hereafter exploitation), and adjusted total use (i.e. exploitation plus release; hereafter total use) rate information could be used to adjust stocking rates, locations, or timing in an effort to increase return-to-creel rates and improve trout fishing quality.

OBJECTIVES

1. Estimate exploitation and total use rates of catchables stocked in five rivers or streams in the Southwestern Region.
2. Assess variables (temperature, stocking period) that may affect exploitation and use of catchables.

STUDY AREA

Mores Creek is located about 11 km east of Boise, Idaho (Figure 45). The mainstem is 61.4-km long with elevations that range from 866 to 2,765 m. Mores Creek flows into Lucky Peak Reservoir. This drainage includes Grimes Creek which is 58.8-km long with elevations that range from 1,017 to 2,277 m and is a primary tributary of Mores Creek. The Middle Fork Payette River is located about 65 km north of Boise, Idaho (Figure 46). The mainstem of the Middle Fork Payette River is 67-km long with elevations that range from 923 to 2,011 m and drains into the main stem of the Payette River near Banks, Idaho. Silver Creek is located in the Boise National Forest about 13 km north of Crouch, Idaho. The mainstem is 20.1-km long with elevations that range from 1,137 to 1,829 m and drains into the Middle Fork Payette River. Crooked River is located about 24 km south of Lowman on highway 21 (Figure 47). The mainstem of Crooked River is 20.6-km long with elevations that range from 1,315 to 2,415 m and drains into the North Fork of the Boise River.

METHODS

Study streams were divided into two strata: upper and lower. These strata were determined by assessing access, stocking locations, and temperature profiles of inflowing tributaries. Water temperature was measured with two different models of Hobo temperature sensors (model U22 and U10). Temperature sensors were placed in protective PolyVinyl Chloride pipes and secured to the bank with cable and rebar. Weights were attached to position the pipes on the bottom. Sensors were allowed to acclimate for five days before temperatures were recorded. Temperature sensors were placed near the upstream end of the upper stratum (upper sensor), one at the boundary between upper and lower strata (middle sensor), and one at the downstream end of the lower stratum (lower sensor). Sensors recorded temperature at 30 minutes intervals. We measured temperatures and compared graphically to the upper lethal temperature (Hillman et al. 1999). Upper lethal temperature (ULT) is the temperature at which survival is 50% in a 10-minute exposure, given a prior acclimation to temperatures within the tolerance zone. Upper lethal temperature varies between stocks and systems, and therefore is reported as a range (21-27°C for Rainbow Trout). Furthermore, we compared mean and maximum water temperature for the first week after stocking to exploitation and use for each respective stocking event. These data were plotted and lines were fit using simple linear regression.

Catchables were reared at Nampa Hatchery that is supplied with single-pass well water (15 °C) in each raceway (Koenig 2012). Catchables were crowded, dip netted, and anesthetized to reduce stress while tagging. T-bar tags were inserted just below the dorsal fin to anchor the tag between the dorsal bones. Tags were inserted on a slight angle with the distal end towards the fish's posterior to reduce drag and to reduce snagging during swimming (High and Meyer 2009). Approximately ten percent of the fish for each stocking event were tagged. Tags were fluorescent orange and possessed a unique identification number and the phone number for the Tag You're-It! hotline. Catchables were stocked at several locations throughout stocking reaches (Figure 45-47). Typical IDFG stocking protocol was followed with no on-site acclimation. Exploitation and total use rates were calculated using tag reporting data from the "Tag You're-It!" program. Stocking occurred once per month in Mores and Grimes creeks and Crooked River began in mid-May and ended in late-July or early August. Stocking in the Middle Fork Payette River and Silver Creek occurred bi-weekly and began in mid-May and concluded in late-August.

Flow data from two nearby USGS gauging sites was analyzed to compare 2015 flows to the preceding 10-year average to determine how flow may have differed from average conditions. Mean monthly discharge was compared for the months when most catchables were stocked or reported caught by anglers. Comparisons were made for the Mores Creek (at Robie Creek) and the MF Payette River (near Crouch) USGS gauging stations. Both of these gauging stations were located near stocking reaches.

DATA ANALYSIS

The tag reporting database was queried during January 2016. The angler tag return rate (λ) was estimated by using the relative reporting rate of non-reward tags in relation to the high-reward tags (Pollock et al. 2001).The associated variance was estimated according to Henny and Burnham (1976) and were used to produce 90%

confidence intervals. This equation was calibrated to account for the fact that an estimated 88% of $50 tags are actually reported, where R_r and R_t are the number of tags reported divided by the number of tags released (Meyer et al. 2010). I used the mean reporting rate for non-reward tags in Idaho from Koenig (2012).

$$\lambda = \frac{R_r/R_t}{N_r/N_t}$$

The unadjusted exploitation rate (*u)* was calculated as the number of non-reward tags reported as harvested within one year of release, divided by the total number of non-reward tags released (Koenig 2012). The unadjusted exploitation and total use were calculated (*u'*) by incorporating the average angler tag reporting rate ($\lambda = 58\%$), first year tag loss ($Tag_l = 2.5\%$), and tag mortality ($Tag_m = 8\%$) as shown in Meyer et al. (2010). I acquired Tag loss rates (Tag_l) from IDFG staff (John Cassinelli; unpublished data).

$$u' = \frac{u}{\Lambda(1 - Tag_l)(1 - Tag_m)}$$

Variance for the denominator in the above equation was estimated using the formula for the variance of a product in Yates (1953). Variance for *u'* was calculated using the approximate formula for variance of a ratio (Yates 1953) and was used to calculate the 90% CIs (Cassinelli 2014). A more complete description of these methods and associated formulas is presented in Meyer et al. (2010) and Cassinelli (2014). In circumstances where anglers voluntarily released the fish after catching it, I calculated total use by replacing (*u*) in the above equation to include the total fish caught (i.e. the summation of fish harvest or released) for each release group.

RESULTS

From May through August, we stocked a total of 17,370 untagged catchables and 1,930 tagged catchables in the five study waters. Mean length (± 90% CI) was 263.3 mm (± 7.3) and mean weight was 207.1 g (± 18.5; Table 18). For the five waters combined, mean exploitation and use rates were 6.6% was 9.9%, respectively. Mean days at large (± 90% CI) was 24.5 d (± 3.9). When water temperatures increased, we observed a relationship of decreased exploitation ($R^2 = 0.40$) and total use (R2 = 0.38; Figures 48-49) within all five streams evaluated.

A total of 2,990 catchables were stocked in Mores Creek during 2015. During the summer of 2015, average exploitation and total use were 4.2% and 12%, respectively (Table 19). During May and June, exploitation ranged from 0.0-10.7%, while total use ranged from 14.3-19.8% (Figure 50). Exploitation and total use in August were both 1.8%), meaning all tag reports indicated harvest. At the lower sensor of Mores Creek, temperatures were within the ULT range from the week of June 1st until the week of September 7th (Figure 51). At the middle sensor, temperatures were within the ULT range from the week of June 1st until the week of September 21st (Figure 51). At the upper sensor, temperature was within the ULT range during the week of June 8th then again from June 22nd through July 6th and lastly the weeks of September 7th through September 21st (Figure 51).

A total of 3,500 catchables were stocked in the Crooked River during 2015. Average exploitation (4.0%) and total use (5.8%) rates for Crooked River were lower than for other study waters (Table 19). Exploitation ranged from 5.3-10.7% for May and June, while total use ranged from 5.3-14.3% during the same period (Figure 52). Exploitation and total use rates for June were 5.3%. Exploitation and use rates for both July and August were 0% and 1.8%, respectively. Water temperature at the lower sensor was within the ULT range during the week of June 29th then not again until the week of September 14th through the week of September 21st (Figure 53). The middle sensor was missing data from the week of May 18th through August 31st. Temperature was within the ULT range during the week of September 14th through the week of the 21st. At the upper sensor, temperature was within the ULT range from the week of September 14th through the end of September 21st.

A total of 2,990 catchables were stocked in Grimes Creek during 2015. Average exploitation and total use rates for Grimes Creek were 5.1% and 6.8%, respectively (Table 19). Within Grimes Creek, exploitation during May and June ranged from 3.6-11.9% and total use ranged from 3.6-15.8% (Figure 54). During the July stocking events, exploitation and use declined further and were both less than 1.8%. At the lower sensor, temperature was within the ULT range from the weeks of June 1st through then September 21st respectively (Figure 55). At the middle sensor, temperatures were within the ULT range from the weeks of June 1st through August 3rd. No data was available for the weeks of August 10th through September 21st. At the upper sensor, temperatures were within the ULT range from the week of June 8th until the end of the stocking season.

A total of 5,100 catchables were stocked in the Middle Fork Payette River during 2015. Average exploitation and use rates were 6.5% and 8.4%, respectively. May and June exploitation ranged from 7.9-14.5%, while total use ranged from 9.5-14.5% (Figure 56). During July, exploitation and total use rates declined to an average of 3.6% and 5.9%, respectively. For August, exploitation declined further to an average of 2.4% and total use averaged 3.6%. At the lower sensor, temperature was within the ULT range from the week of June 8th through the week of the July 13th (Figure 57). Data was lost for the week of the July 13th through the week of August 10th. Temperatures reached the ULT range again on the September 14th through the week of September 21st. At the middle sensor, temperatures were within the lethal range from the week of June 22nd through the week of August 10th, during the week of August 24th, and from the week of September 14th through the week of September 21st. At the upper sensor, temperatures were within the ULT range during the week of June 8th and from June 22nd through the week of August 24th and from the week of September 14th through the week of September 21st.

A total of 4,720 catchables were stocked in Silver Creek during 2015. Average exploitation (13.3%) and total use (16.9%) rates in Silver Creek were the highest among the streams evaluated this year (Table 19). Exploitation, during May and June, ranged from were 4.8-27.7% and total use ranged from 9.5-31.7% (Figure 58). Both exploitation and total use decreased to an average of 9.5% during July. Exploitation and total use rates continued to decline in August to an average of 3.1% and 8.6%, respectively. At the lower sensor in Silver Creek, temperatures were within the ULT range from the week of June 22nd through the week of July 13th, from the week of July 20th through the week of August 10th, and the week of September 14th through the week of September 21st (Figure 59). At the middle sensor, temperatures were within the lethal range from the weeks of June 22nd through the week of June 29th, the week of the July 27th, the week of August 10th, and from the week of September 14th through the week of the September 21st. At The upper sensor, temperatures were within the ULT range from the week of September 14th through the week of September 21st.

Discharge data for 2015 compared to the 10-year average indicated that flows in these study streams were consistently low throughout the summer fishing season. The mean discharge for Mores Creek from May through September of 2015 was only 32% of the 10-year average (Figure 60). Flows during May, June, July, August, and September 2015 were 31%, 35%, 26%, 35%, and 43% of the 10-year average, respectively. Mean discharge for the Middle Fork Payette from May through September of 2015 was 38% of the 10-year average (Figure 61). Flows during May, June, July, August, and September 2015 were 48%, 35%, 25%, 46%, and 59% of the 10-year average, respectively.

DISCUSSION

Exploitation and total use of hatchery catchable Rainbow Trout varied greatly between stocking periods and study streams. The average rate of exploitation and total use for all five study waters were 6.6% and 9.9%, respectively. These rates were much lower than average exploitation and total use estimated for the Boise River (for stocking events occurring during summer months from 2011 to 2013) which were 32.2% and 50.6%, respectively (Koenig et al 2015). While these are relatively poor rates, some stocking periods had much higher returns. For instance, catchables stocked during May were reported at approximately double the overall mean rates, whereas rates for June were similar to the overall means. In contrast, rates for July and August were much lower. Better exploitation rates in May were likely related to much more favorable water temperatures early in the summer.

Accessibility seemed to affect return-to-creel rates in addition to stocking period. Study waters possessed a range of accessibility. Though I didn't attempt to quantify accessibility, waters that had good access and well-developed camping areas tended to have higher return-to-creel rates. Crooked River has a fairly good access road, but is remote. Mores Creek has a major highway along much of the stream, though portions are not as easily accessed as other study waters due to sections of private property. Grimes Creek's access road was in fair condition for the first 4-8 km, but becomes rough and arduous farther upstream. The Middle Fork of the Payette has a well-developed road, many residences and cabins, as well as several camping opportunities nearby. Silver Creek was very accessible and has well-developed camping opportunities nearby. These areas both had the highest exploitation rates we measured, which may have been related to their easy recreational access or other amenities nearby.

Water temperature during the week of stocking was negatively correlated with exploitation and total use rates. The regression of temperature and exploitation or use showed a consistent pattern with increasingly and consistently poor returns when water temperatures increased above 16°C. This was surprising as catchables are reared on constant 15°C water. We do not think a 1°C difference in mean temperature could explain poor return rates. However, further evaluation indicated that maximum temperatures were often 5-6°C warmer than mean values. At maximum temperatures of 21-22°C, this relationship becomes more biologically meaningful and possibly explanatory. However, this relationship was not evident in all cases. For instance, the Crooked River temperature and associated exploitation and use rate data seemed to be an anomaly. Crooked River had a cooler temperature profile than other study waters for the duration of the stocking season, but exploitation and use were relatively low. Exploitation and use during May were acceptable, but less than so in all remaining months. This suggests that temperature is not the singular controlling variable for producing adequate return-to-creel rates. Variables such as mortality, dispersal, or access may also influence these metrics.

The relatively low exploitation and total use rates reported for this study were likely negatively biased when compared to a theoretical average year for this stocking program. Flows were very low during 2015 and likely negatively impacted habitat suitability for catchables, especially due to elevated temperatures. Although temperature was not the singular variable that predicted return-to-creel rates, it seemed to be an important factor in this study. Temperature has been shown to be an important abiotic factor affecting catchables (Fry 1971). Temperatures in my five study waters were in the range of ULTs reported in the literature for 55% of the weeks of our stocking season. In general, water temperatures began to rise in June to the ULT range and remained within the range for much of the fishing season. This could partially explain the poor return-to-creel rates from low survival or poor catchability related to periods of stressful water temperatures.

We believe the estimates presented above represent nearly all the exploitation and use realized from catchables stocked during 2015, despite querying the tagging database prior to the expiration of a one-year interval. This assumption is based on tag return data that show few catchables live more than a couple of months after stocking in streams and rivers. Dillon et al. (2000) found a large percentage, 90%, of tags were reported within 57 days of stocking. Similarly, High and Meyer (2009) reported that 85% of stream-stocked catchables were dead with 30 days and mean days at large was 14.3 days (Meyer et al. 2012). Several studies have indicated that over-winter survival rates are very low (Dillon et al. 2000); therefore, we expect that few tags will be reported during 2016.

Where estimates are available, return-to-creel rates and days at large for catchables in rivers and streams have been relatively low. Return-to-creel return rates for catchables in a variety of water types are often less than 50% for catchables (High and Meyer 2009). Higher rates were more common for lentic waters rather than lotic waters. Dillon et al. (2000) estimated return-to-creel rate of 17% for 18 Idaho streams, though non-response bias was not included in this calculation. These poor return rates and times at large may be attributed to predation, delay in adapting to wild food, and or poor habitat quality. Regardless, very few stream of river stocking sites have ever exceeded the 40% return-to-creel objective. A lower and more realistic threshold may need to be developed as a benchmark to gauge the performance of catchables in streams and river in Idaho.

While this study is limited by only a single year of data collected during an abnormally low flow year, I recommend ceasing catchable stocking at the end of June. This would allow angling opportunities for campers prior to and through the 4^{th} of July weekend, and avoid inefficient and costly stocking later in the summer. This would reduce stocking numbers for July and August by a combined 11,680 catchables, which could be reallocated earlier in the season or elsewhere. Furthermore, I recommend replicating this study during a more normal flow year to determine how flows affect return to creel and whether these recommendations would be relevant under a broader array of conditions.

Table 18. Number of catchable-sized Rainbow Trout stocked in five study waters by month in 2015.

Waterbody	May	June	July	August	Total
Mores Creek	500	500	1990	-	2990
Crooked River	500	1000	1000	1000	3500
Grimes Creek	500	500	1990	-	2990
Middle Fork Payette	500	1610	1500	1490	5100
Silver Creek	500	1510	1500	1210	4720
Monthly totals	2500	5120	7980	3700	19300

Table 19. Adjusted exploitation (harvested) and total use (harvested and released) rates for catchable-sized hatchery Rainbow Trout stocked in five study waters during 2015.

Waterbody	# Tagged	Tags harvested	Harvested because tagged	Tags released	Adjusted exploitation (± 95% CI)	Adjusted use (± 95% CI)
Mores Creek	294	4	2	4	4.2 ± 5.1%	12.0 ± 11.6%
Crooked River	350	6	3	0	4.0 ± 4.7%	5.8 ± 7.0%
Grimes Creek	294	4	1	1	5.1 ± 7.1%	6.8 ± 8.4%
MF Payette River	505	18	0	4	6.5 ± 8.2%	8.4 ± 9.5%
Silver Creek	467	28	2	7	13.3 ± 11.7%	16.9 ± 13.5%

Table 20. Estimated rearing and stocking costs for catchable-sized hatchery Rainbow Trout stocked in five study waters during 2015.

Water body	May	June	July	August	Total Cost
Mores Creek	$495	$495	$1,970	$0	$2,960
Crooked River	$385	$770	$770	$1,350	$3,275
Grimes Creek	$465	$390	$1,851	$0	$2,706
Middle Fork Payette	$715	$1,707	$1,590	$1,579	$5,591
Silver Creek	$400	$1,148	$1,140	$920	$3,607
Monthly totals	$2,460	$4,509	$7,321	$3,849	$18,139

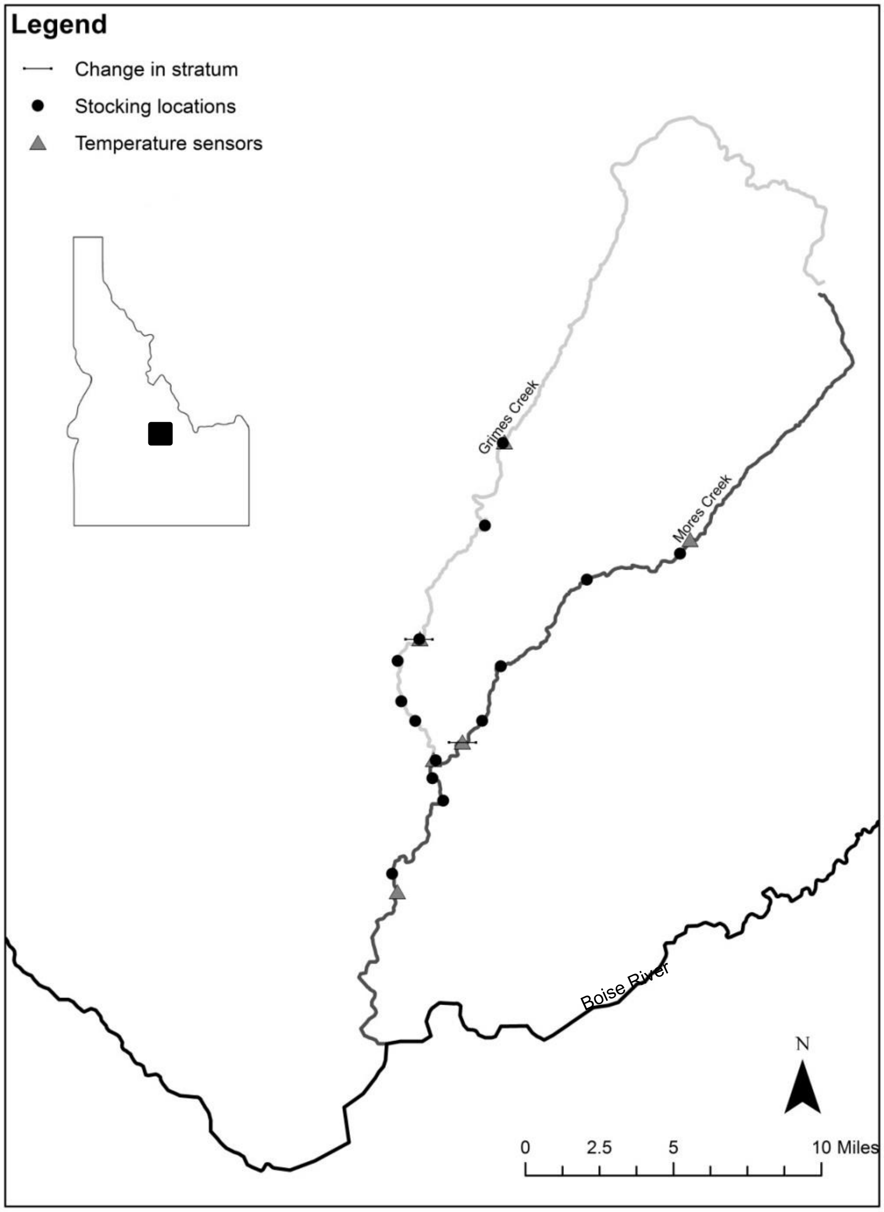

Figure 45. Map of temperature sensors (gray triangles), strata (black bars), and stocking locations (black circles) in Grimes and Mores creeks, Idaho.

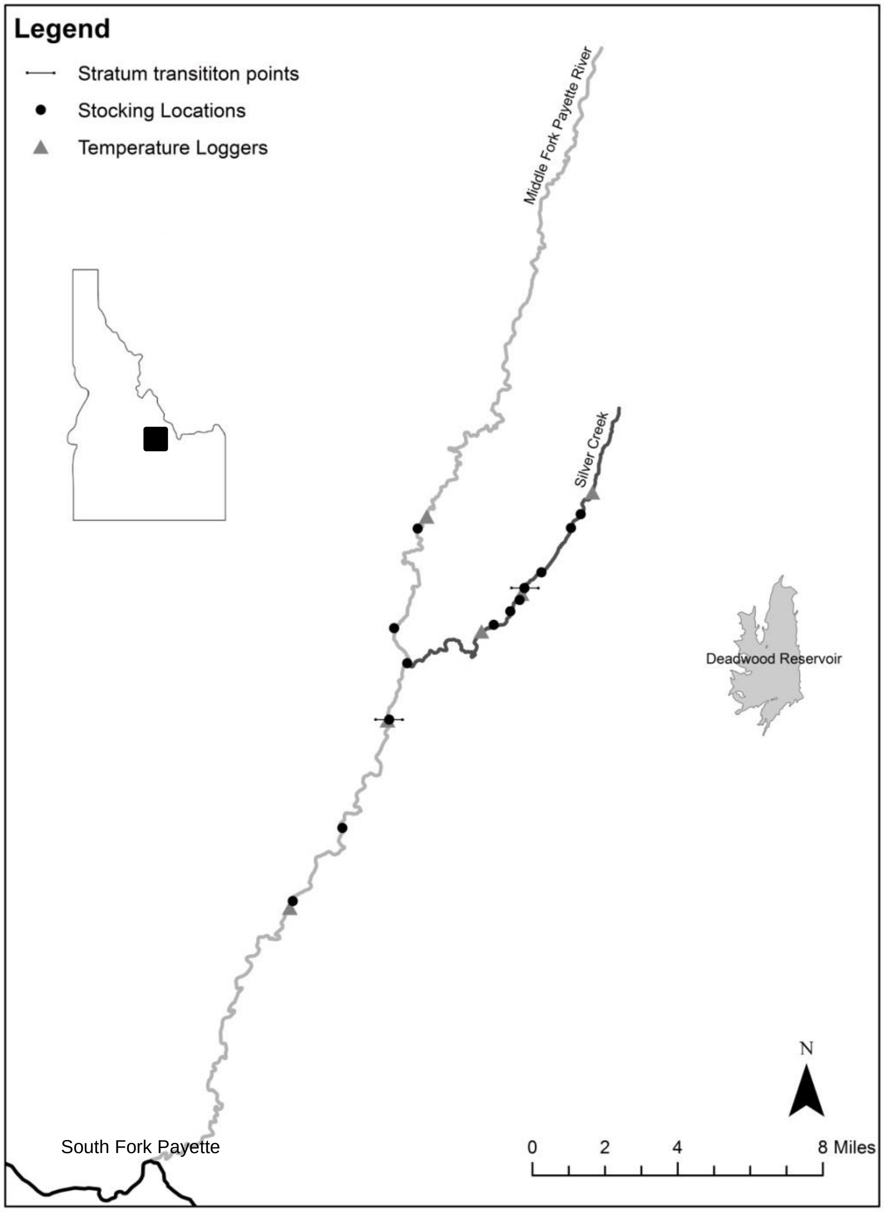

Figure 46. Map of temperature sensors (gray triangles), strata (black bars), and stocking locations (black circles) in Middle Fork Payette River, Idaho.

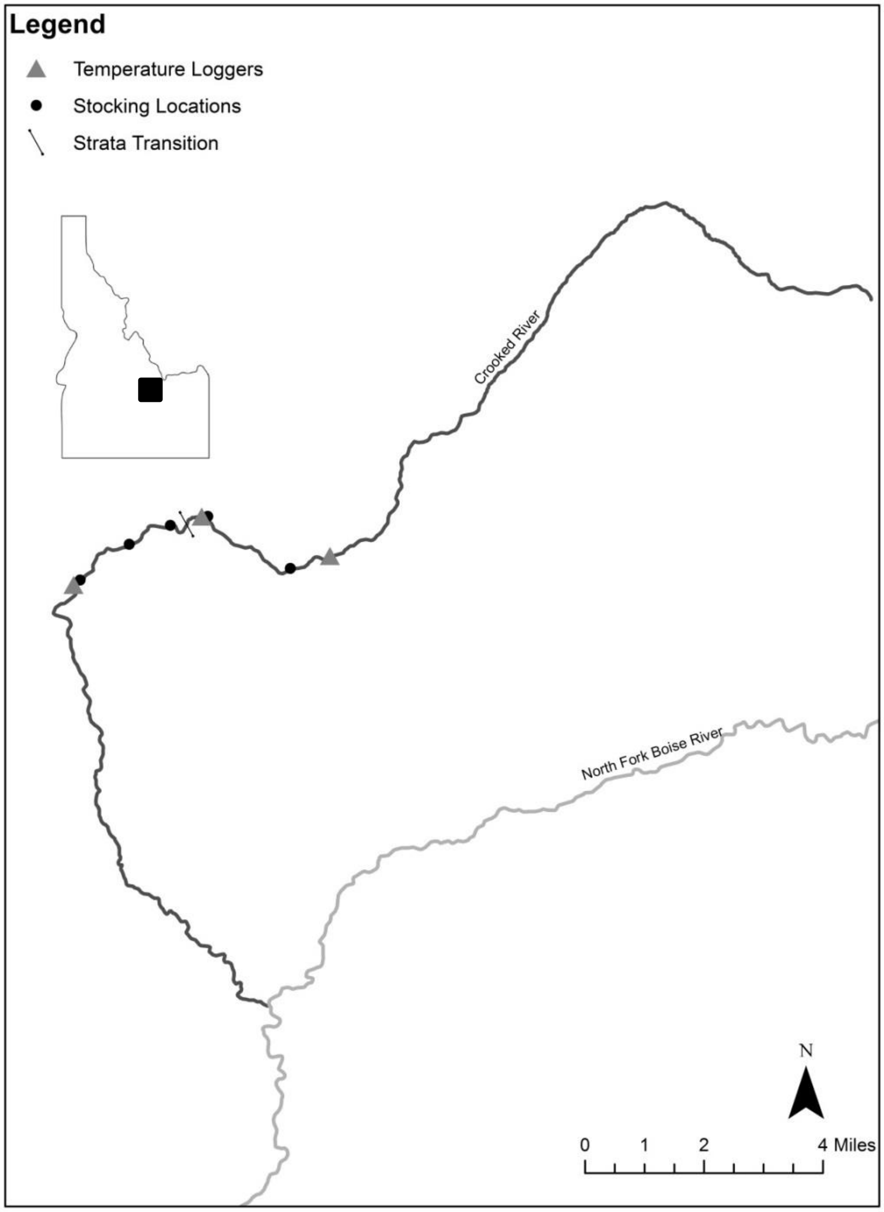

Figure 47. Map of temperature sensors (gray triangles), strata (black bars), and stocking locations (black circles) in Crooked River, Idaho.

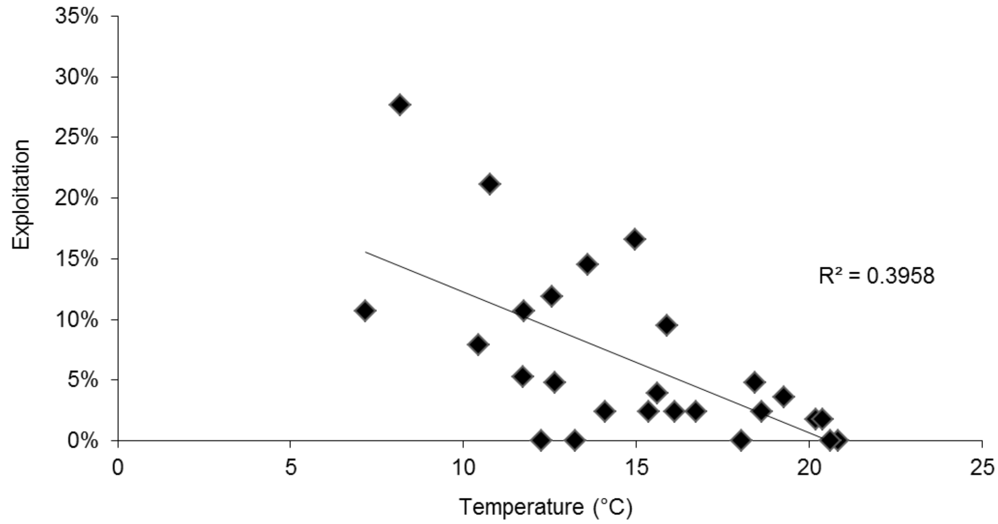

Figure 48. Relationship between adjusted exploitation rates and the mean weekly temperature during the week after stocking for all five streams evaluated.

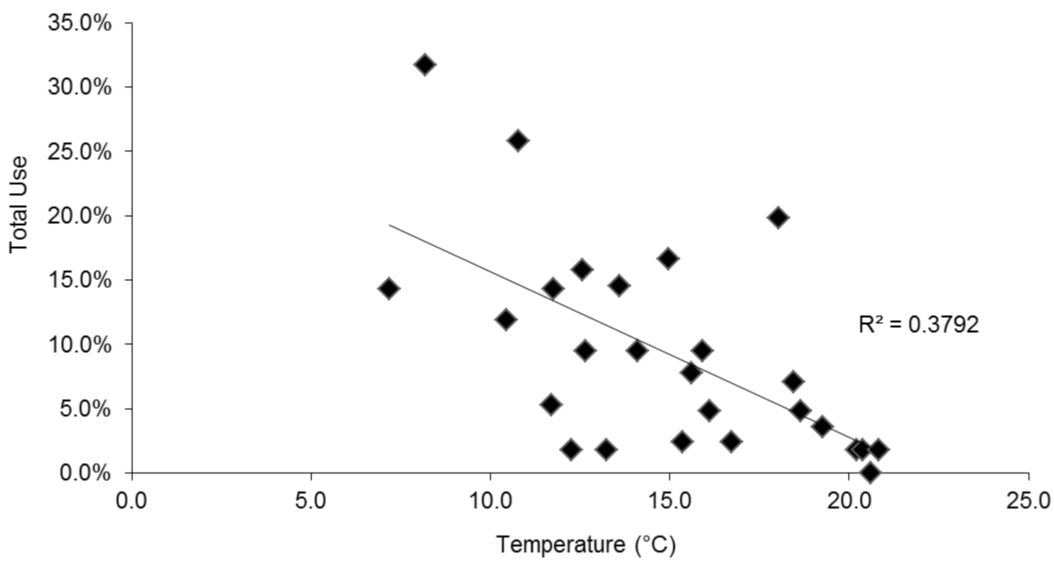

Figure 49. Relationship between adjusted total use rates and mean weekly temperature during the week after stocking for all five streams evaluated.

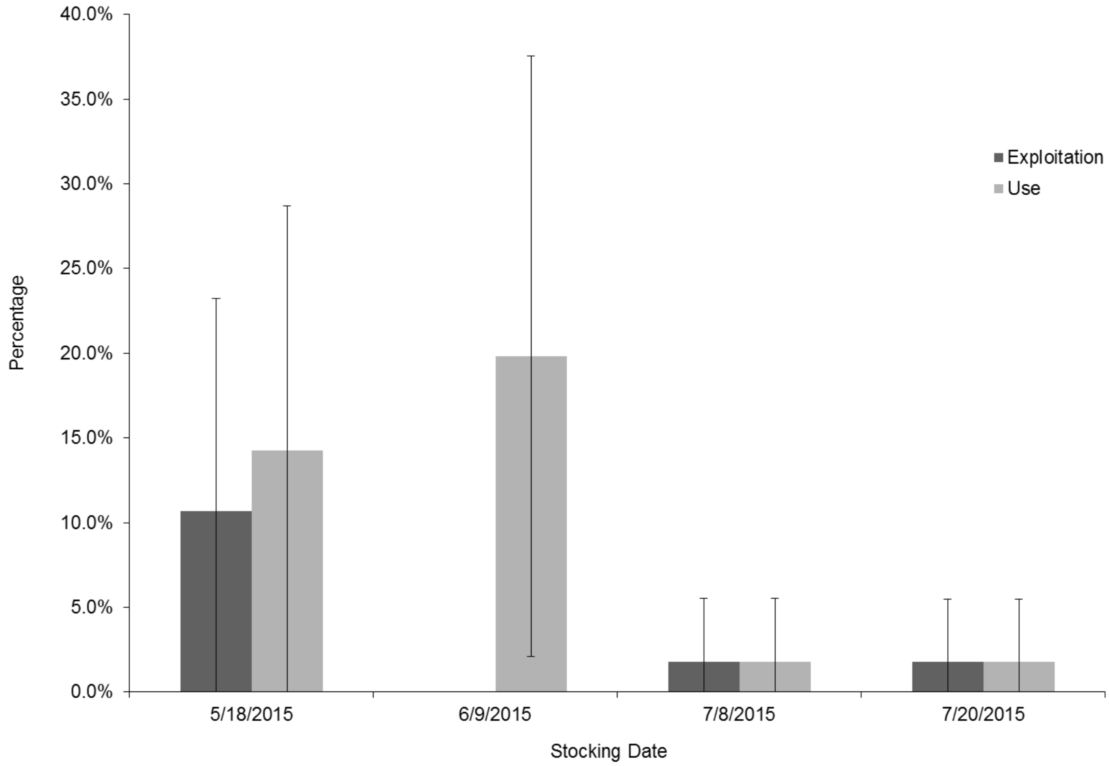

Figure 50. Adjusted exploitation and total use rates for catchable-sized hatchery Rainbow Trout stocked in Mores Creek by individual stocking dates. Error bars represent 90% confidence intervals.

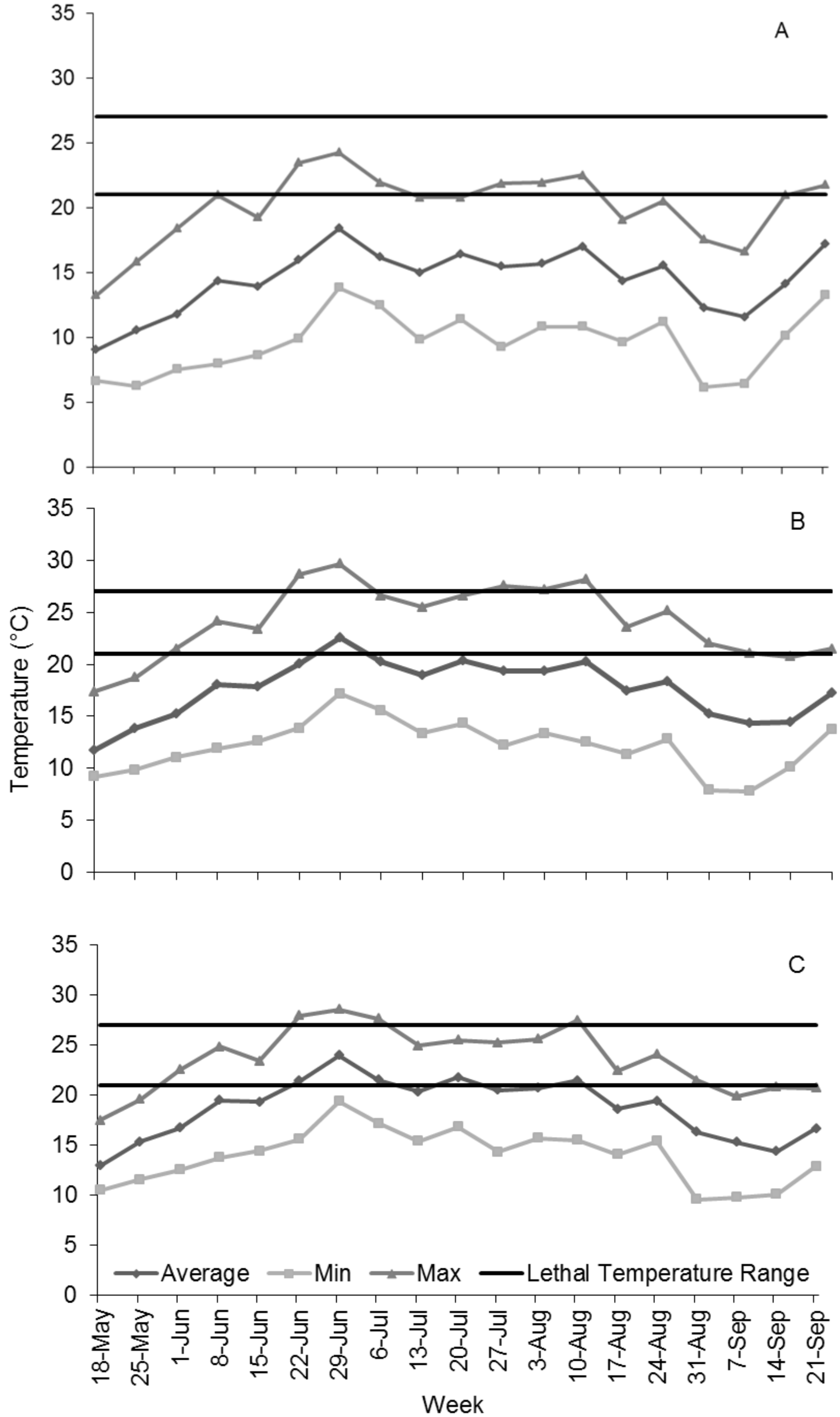

Figure 51. Weekly water temperature at Mores Creek, Idaho during 2015 (A=upper sensor, B=middle sensor, C=lower sensor). The upper and lower range of lethal temperatures is shown with the horizontal lines.

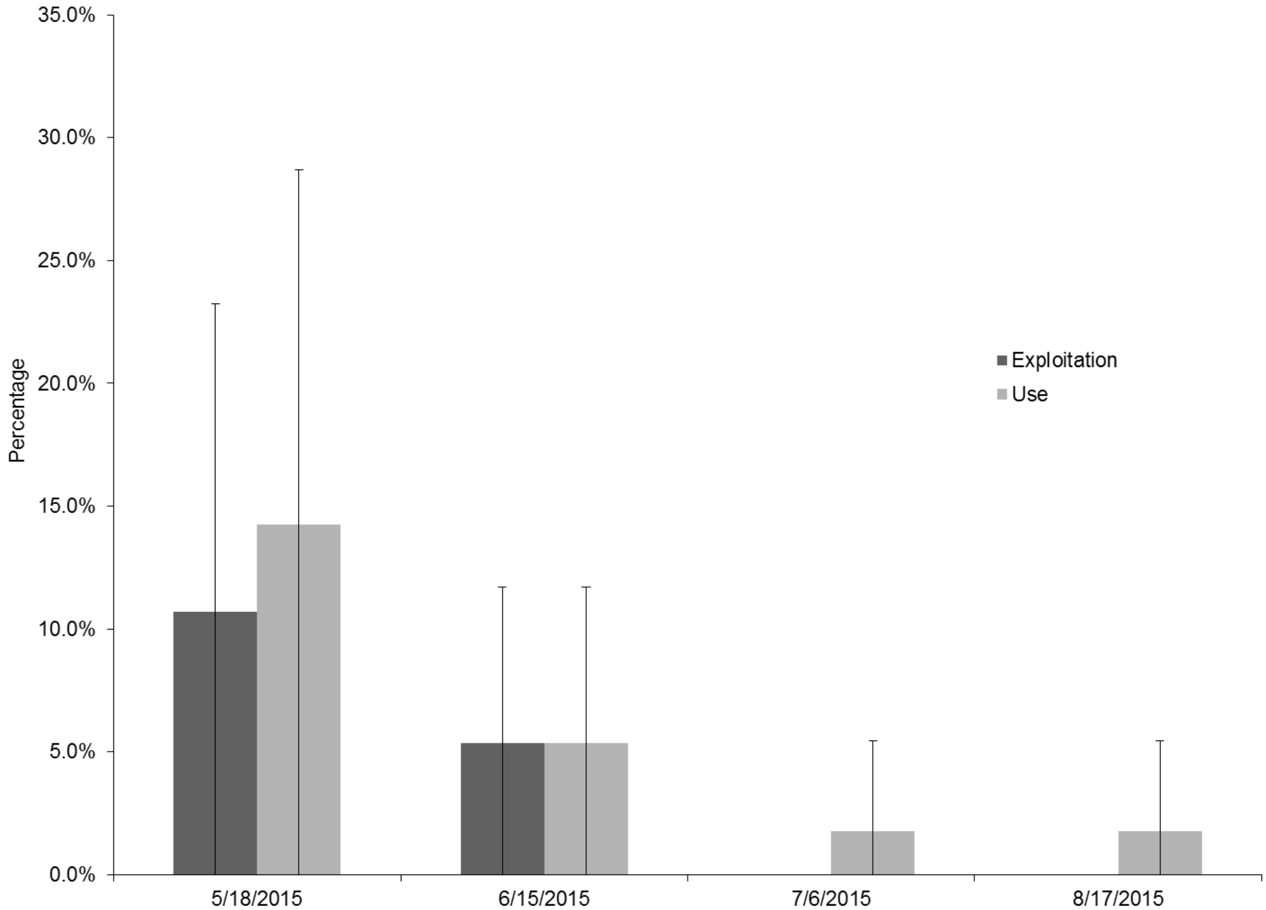

Figure 52. Adjusted exploitation and total use rates for catchable-sized hatchery Rainbow Trout stocked in Crooked River by individual stocking dates. Error bars represent 90% confidence intervals.

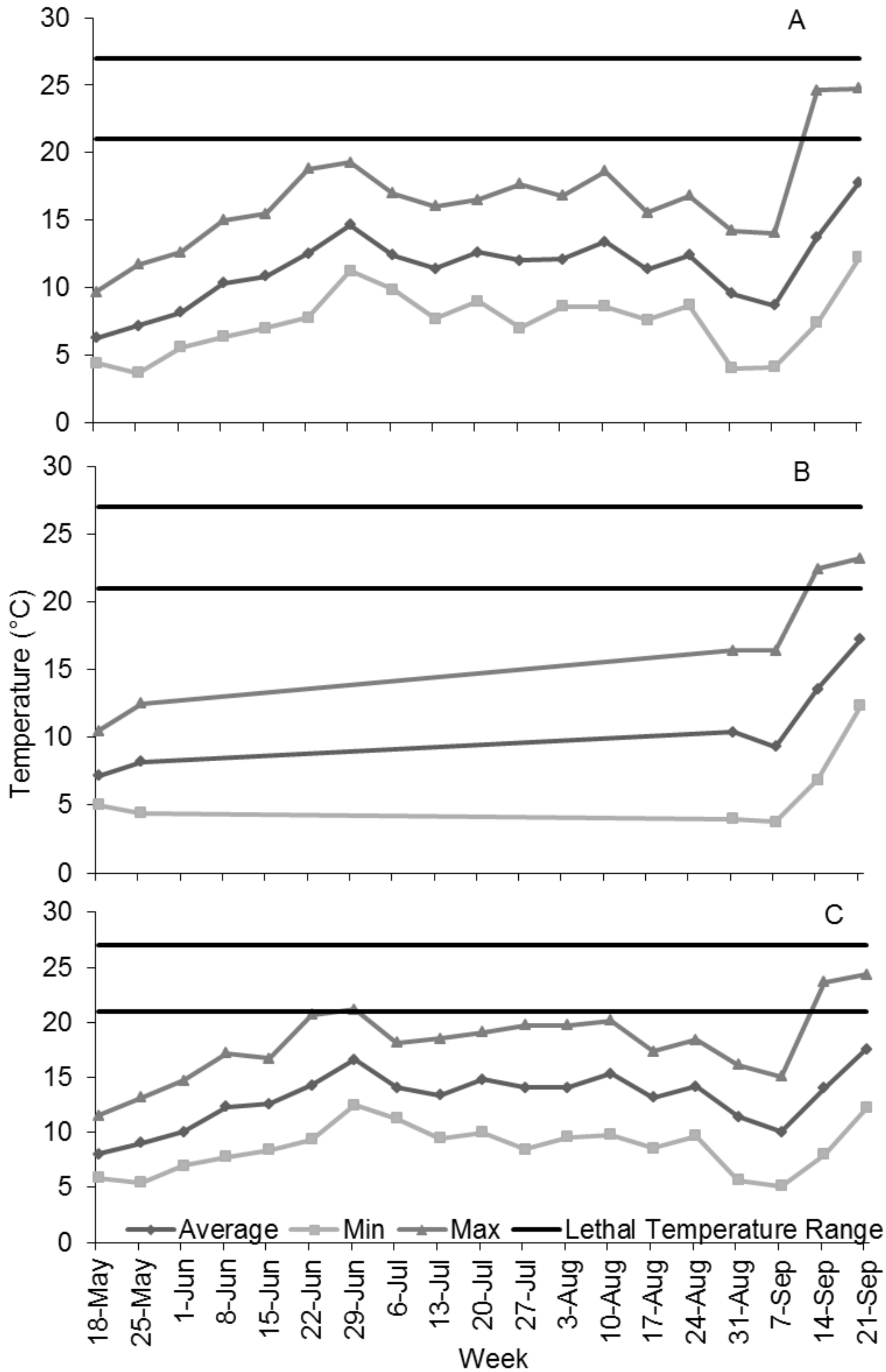

Figure 53. Weekly water temperature at Crooked River, Idaho during 2015 (A=upper sensor, B=middle sensor, C=lower sensor). The upper and lower range of lethal temperatures is shown with the horizontal lines.

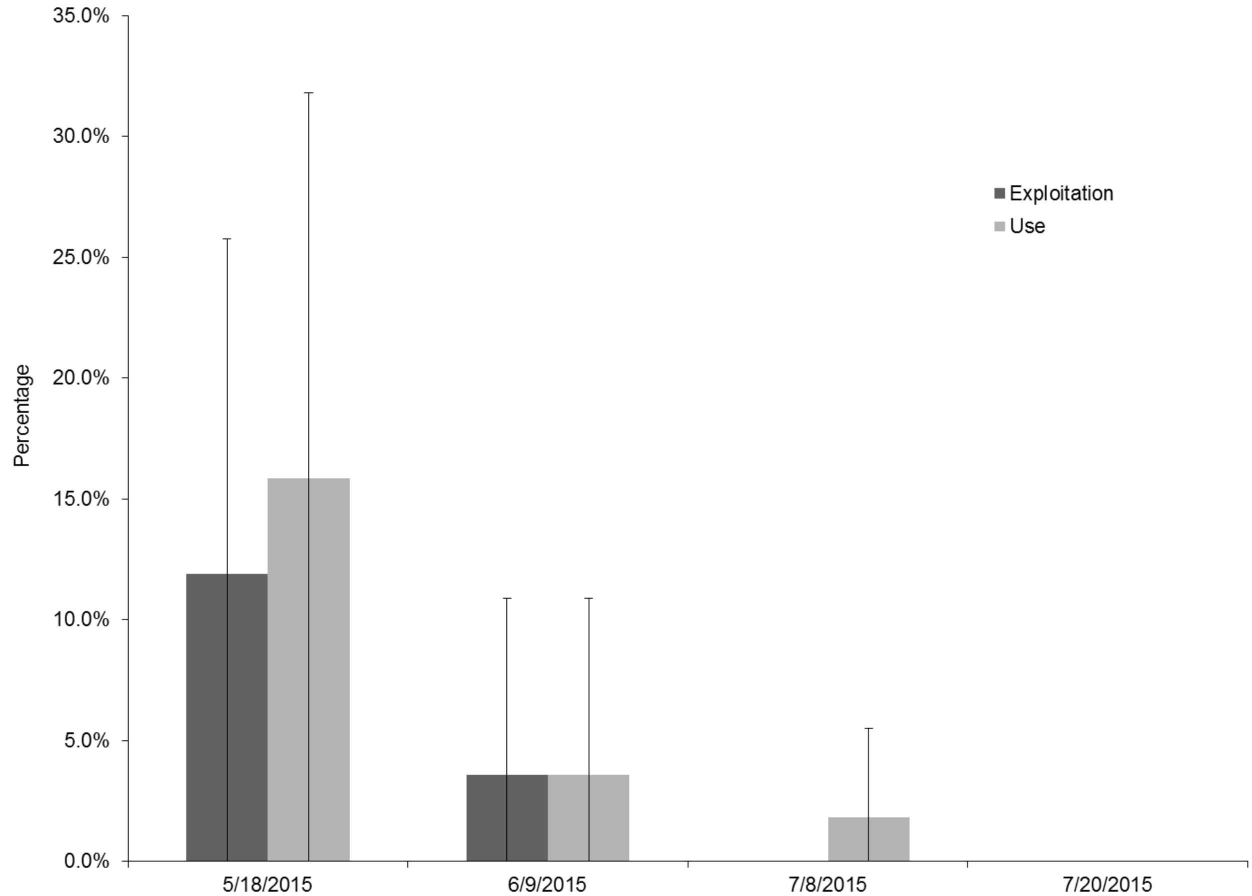

Figure 54. Adjusted exploitation and total use rates for catchable-sized hatchery Rainbow Trout stocked in Grimes Creek by individual stocking dates. Error bars represent 90% confidence intervals.

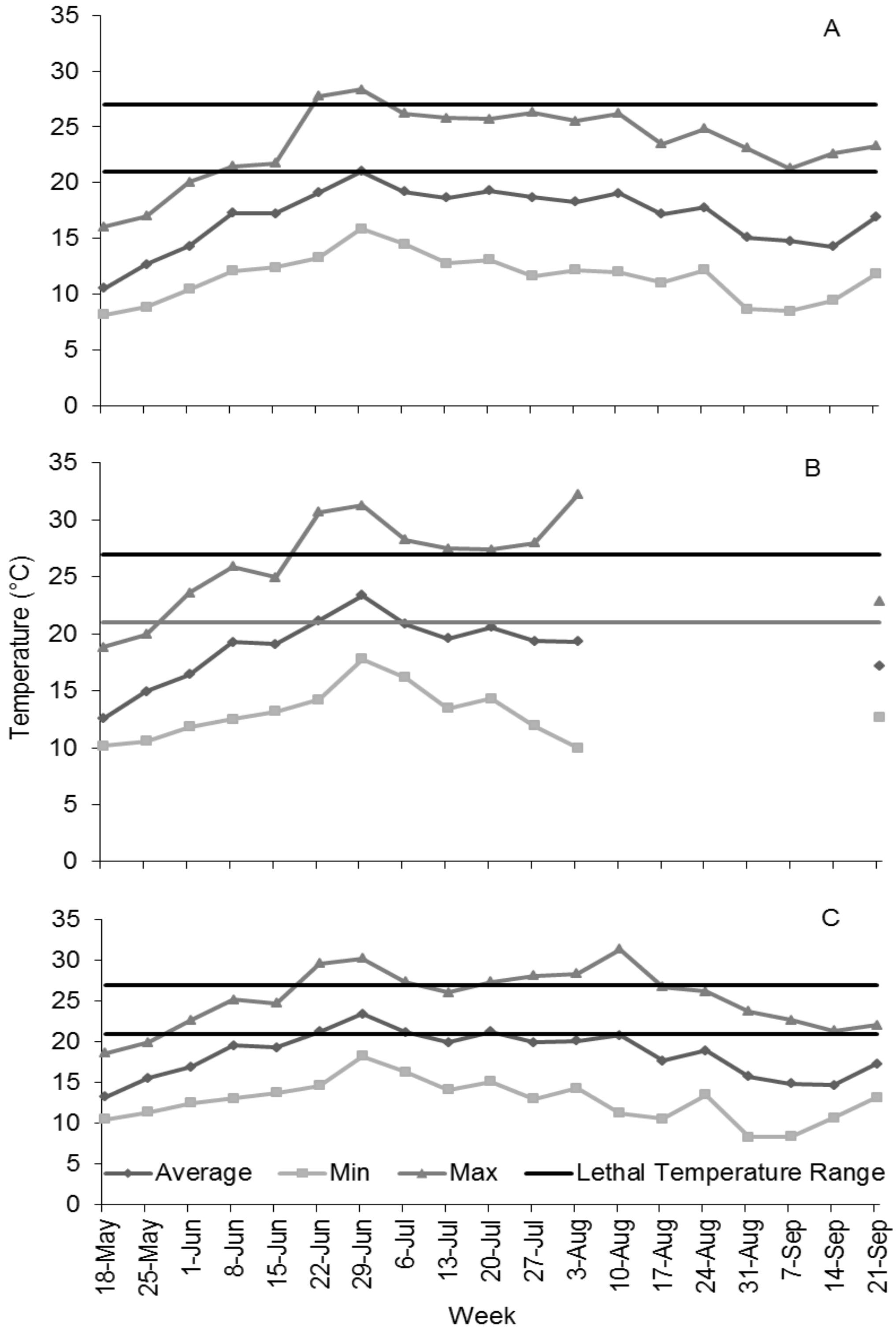

Figure 55. Weekly water temperature at Grimes Creek, Idaho during 2015 (A=upper sensor, B=middle sensor, C=lower sensor). The upper and lower range of lethal temperatures is shown with the horizontal lines.

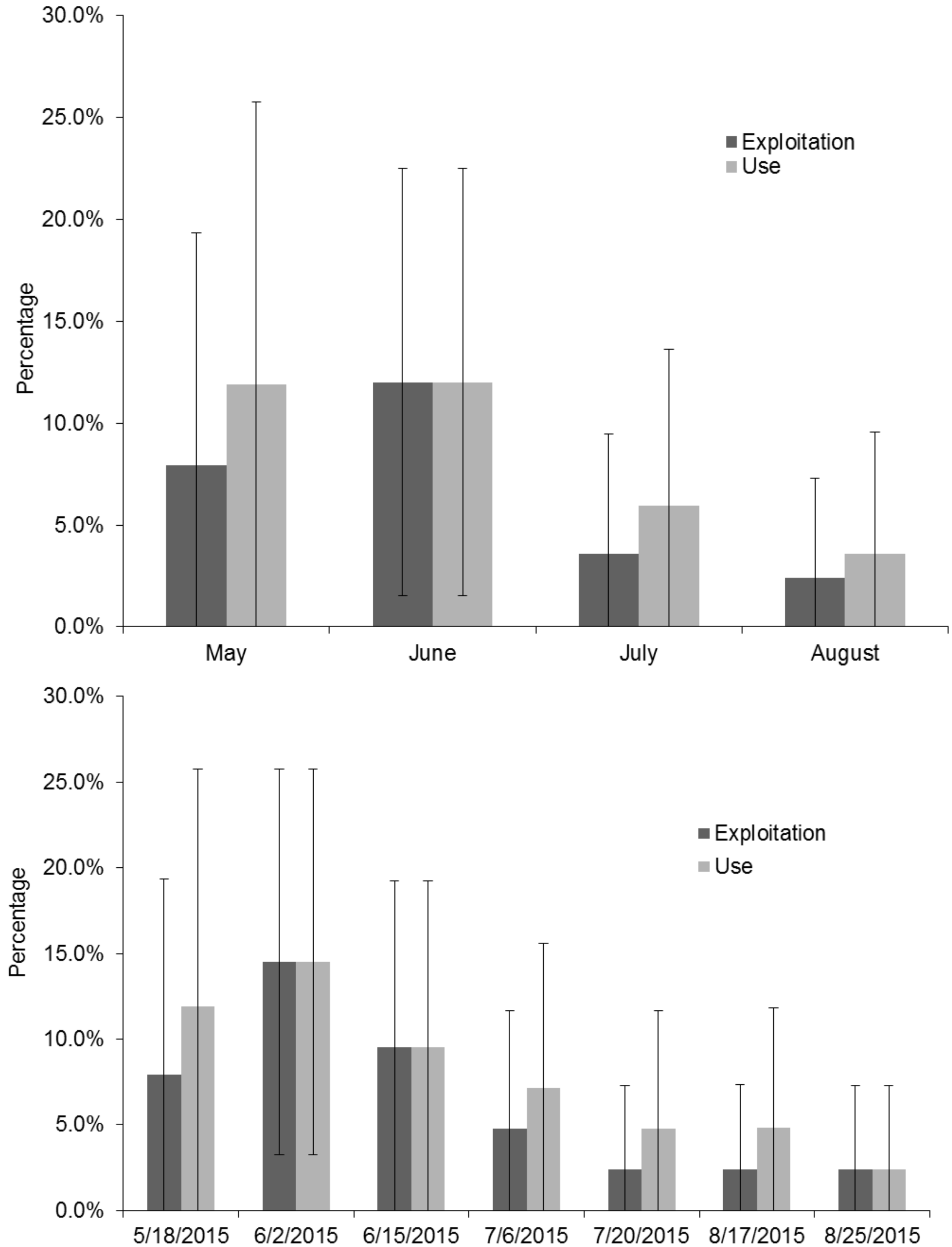

Figure 56. Adjusted exploitation and total use rates for catchable-sized hatchery Rainbow Trout stocked in the Middle Fork Payette River by individual stocking dates (top) and by month (bottom). Error bars represent 90% confidence intervals.

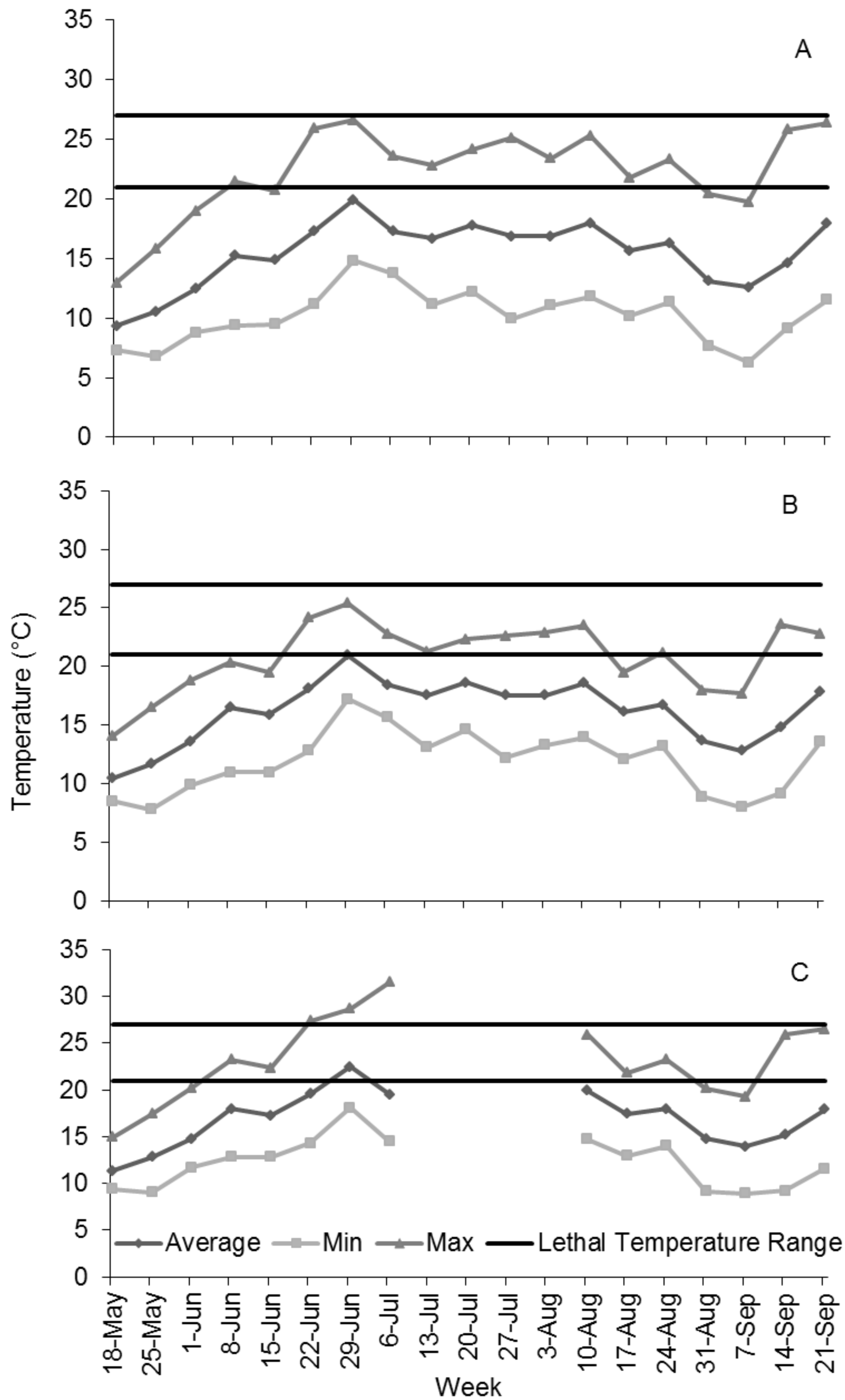

Figure 57. Weekly water temperature at Middle Fork Payette River, Idaho during 2015 (A=upper sensor, B=middle sensor, C=lower sensor). The upper and lower range of lethal temperatures is shown with the horizontal lines.

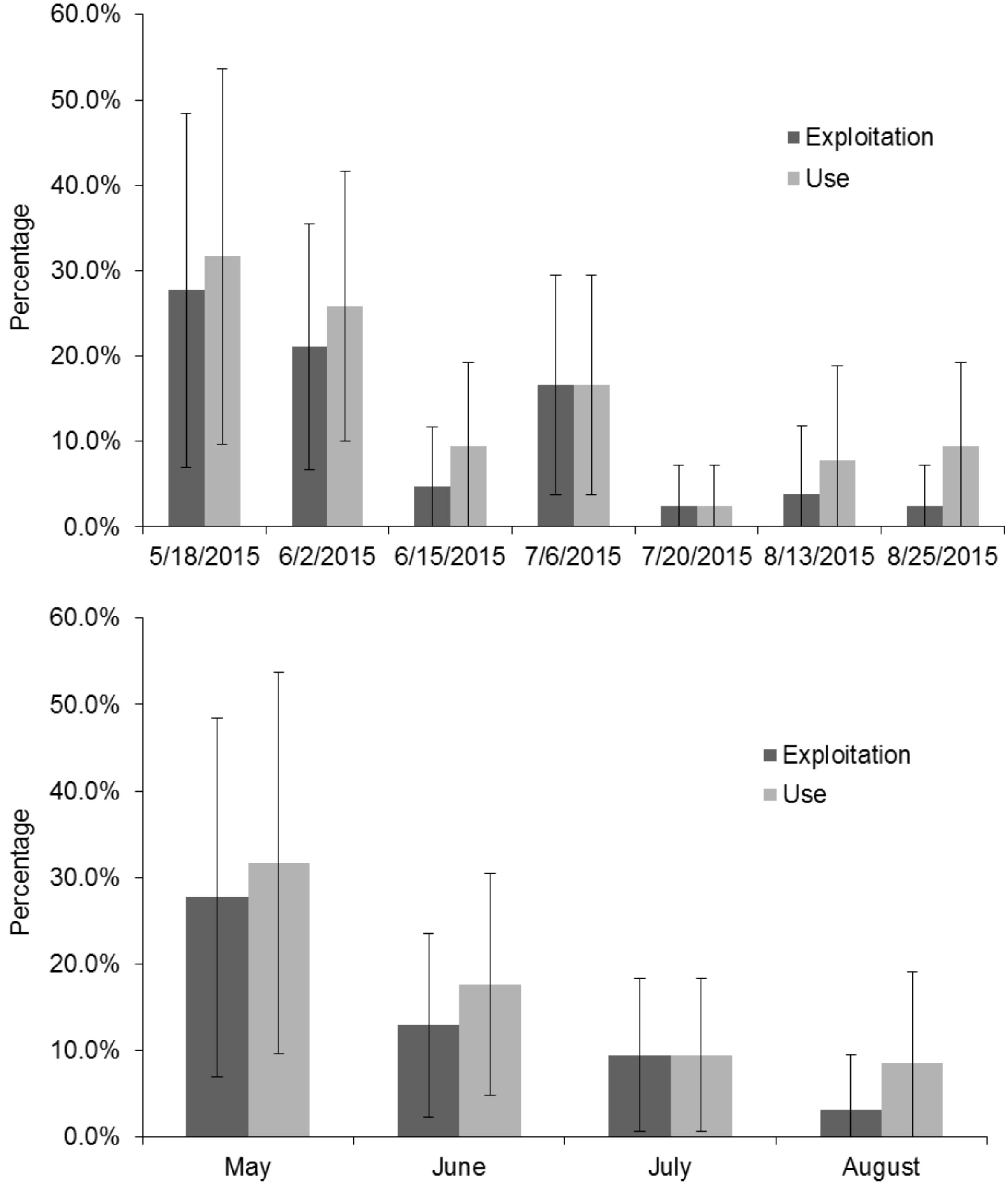

Figure 58. Adjusted exploitation and total use rates for catchable-sized hatchery Rainbow Trout stocked in Silver Creek by individual stocking dates (top) and by month (bottom). Error bars represent 90% confidence intervals.

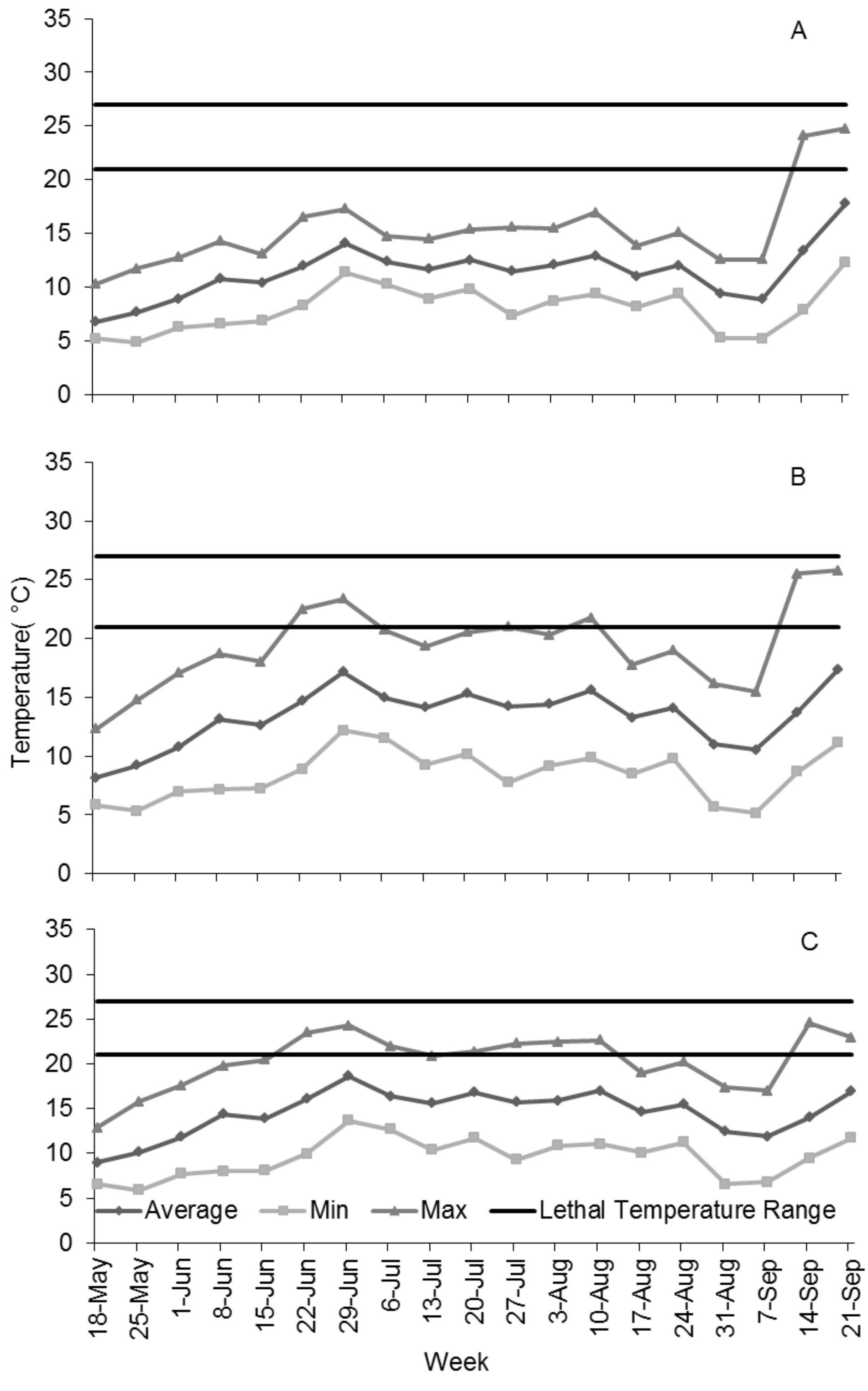

Figure 59. Weekly water temperature at Silver Creek, Idaho during 2015 (A=upper sensor, B=middle sensor, C=lower sensor). The upper and lower range of lethal temperatures is shown with the horizontal lines.

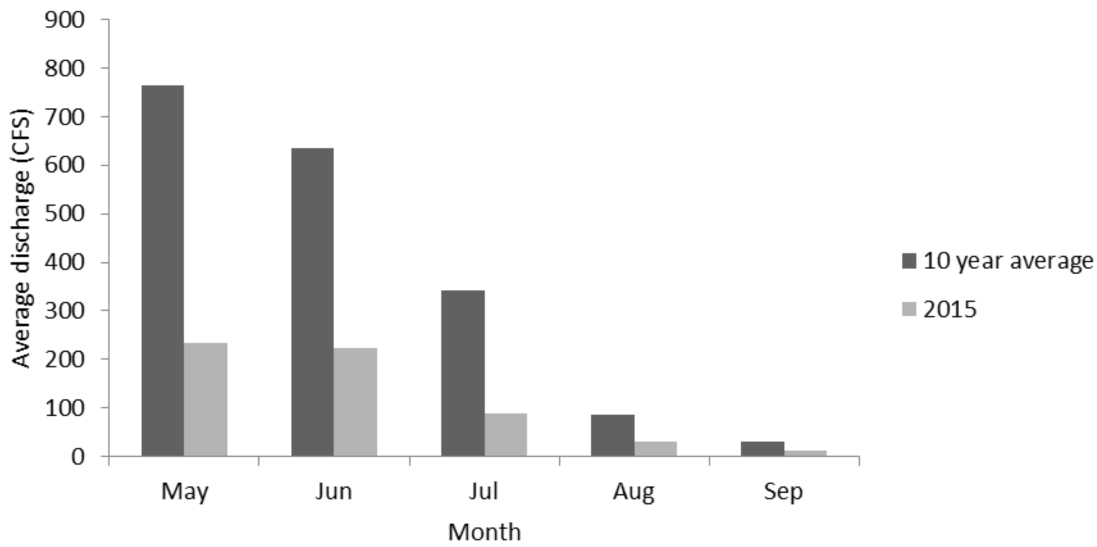

Figure 60. Monthly mean discharge during 2015 and the 10-year average for the Mores Creek gauging station at Robie Creek.

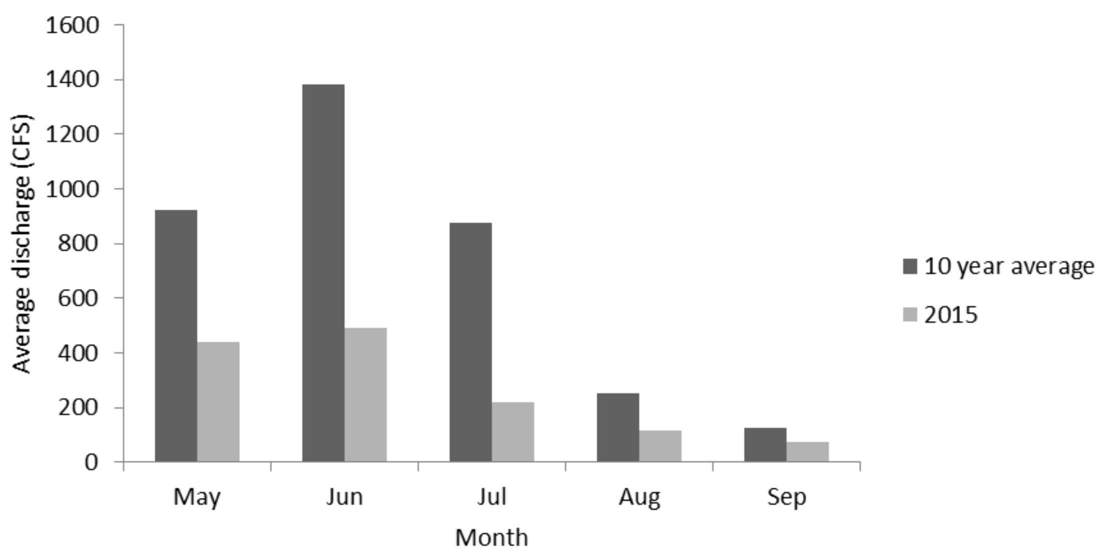

Figure 61. Monthly mean discharge during 2015 and the 10-year average for the Middle Fork Payette River at Crouch gauging station.

STATUS OF RAINBOW TROUT IN THE SOUTH FORK BOISE RIVER

ABSTRACT

The South Fork Boise River (SFBR) downstream of Anderson Ranch Dam is a nationally-renowned tailwater trout fishery. Idaho Department of Fish and Game staff has monitored Rainbow Trout *Oncorhynchus mykiss* populations in the SFBR every three years since 1994. These monitoring efforts only effectively sample trout longer than 100 mm. Since 2009, IDFG has conducted annual spring and fall surveys along standardized transects to gain a better understanding of the production of Rainbow Trout (i.e. age-0 juveniles prior to fall and less than 100 mm), over-winter survival, and recruitment to age-1. During the spring survey in 2015, catch of age-1 Rainbow Trout ranged from 0 to 40 fish/site, which equated to a mean density was 0.2 fish/m. Comparing fall and spring fry densities, overwinter survival for 2014-15 was estimated to be 51%. Mean density of age-0 Rainbow Trout during fall 2015 was 1.9 fish/m, which marks a return to near pre-wildfire densities. Fall density estimates in 2013 and 2014 (0.4 fish/m) were approximately 80% lower than the mean 2.3 fish/m estimated for years prior to the wildfire events of 2013. Results from 2015 continue to indicate that overwinter survival or carrying capacity rather than reproduction, determines year class abundance in the South Fork Boise River.

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INTRODUCTION

The South Fork Boise River (SFBR) downstream from Anderson Ranch Dam is a nationally-renowned tailwater-trout fishery and was the first river section in the Southwest Region to be managed under "Trophy Trout" regulations. This fishery is supported by populations of wild Rainbow Trout *Oncorhynchus mykiss* and Mountain Whitefish *Prosopium williamsoni*. Migratory Bull Trout *Salvelinus confluentus* are present at very low densities, and native nongame fish include Largescale Sucker *Catostomus macrocheilus*, Northern Pikeminnow *Ptychocheilus oregonensis* and sculpin *Cottus sp*. are present also.

During the past decade, the Rainbow Trout population in the SFBR has been relatively stable, although the relative paucity of trout in the 200 to 400 mm length range upstream of Danskin Bridge has puzzled anglers and biologists. Concerns over the irregular size structure, evidence of fry mortality during fall stream flow reductions, along with a belief by some anglers that the SFBR lacked spawning habitat led some to conclude that the river was spawning habitat or production limited. To evaluate this notion, IDFG staff began revisiting age-0 trout sampling transects that were established in 1994 during a whirling disease study (Elle 1997 and 1998). Staff began annual sampling of these sites during 2009. However, in 2013, we added 34 additional sites to ensure random site selection, sample a longer river segment, and to develop more precise estimates. From 2009 through 2012, staff sampled high densities of age-0 trout with backpack electrofishing equipment and visually observed many age-0 trout in near-shore habitat throughout the roaded section of the tailwater reach. Our results and observations indicated that reproduction was not limiting the Rainbow Trout population.

The SFBR drainage is still undergoing dramatic changes as a result of the Elk-Pony complex wildfires in August 2013. Following a rainstorm event on September 12, 2013, a number of large debris and sediment flows occurred on at least six tributaries between Anderson Ranch Dam and the Neal Bridge. The loss of vegetation along adjacent hill slopes and tributary riparian areas has created dynamic and unstable conditions. During the first week of August 2014, another series of debris and sediment flows occurred in several south-facing drainages following a series of rainstorms. Notably, Pierce and Granite creeks experienced additional damage, including large sediment flows, further down-cutting and scouring, and the loss of any natural re-vegetation that may have occurred subsequent to the 2013 events. Large debris flows occurred in a few drainages in the canyon section, including Devils Hole, Buffalo and Little Fiddler creeks, and created multiple large rapids. These new rapids are expected to reduce recreational fishing in the canyon because of the technical whitewater expertise now required to safely navigate the section.

Fall densities of age-0 Rainbow Trout declined after the fire and subsequent debris slides. From 1996 through 2012, annual fall age-0 Rainbow Trout densities had appeared to be stable. However, following the fires, fall density estimates declined by approximately 80%. The decline in fall age-0 Rainbow Trout densities could be attributed to a number of factors including reduced spawning habitat quality due to higher fine sediment levels, reduced spawning production from adult mortality, poor fry survival due to lack of cover, or direct mortality from extended exposure to suspended sediment and debris (Bozek and Young 1994; Rieman et al. 2012).

Fire restoration efforts are primarily focused on aquatic, terrestrial, and riparian habitats. Access and grazing closures have been in place since November 2013 to minimize disturbance to wildlife and vegetation in the most heavily-burned areas. The majority of terrestrial vegetation plantings are currently scheduled for early spring 2015. Multiple agencies have been involved with damage assessments and restoration plans for the areas affected by the wildfires and landslides, including US Forest Service (USFS), US Bureau of Reclamation (BOR), Trout Unlimited, and IDFG.

Restoration of aquatic habitat has primarily involved addressing the vast amount of fine sediment that has been deposited into the river. Researchers from University of Idaho modeled sediment transport under various flushing flows to determine the amount and duration of flow required to mobilize sediment and improve habitat. Models suggested that a flushing flow of 68 m^3/s or greater for at least 8 d was needed to mobilize fine sediments (Benjankar and Tonina 2014). Traditional increases in spring flows for Rainbow Trout spawning were postponed and stored to provide flushing flows in the summer. Beginning on August 18, 2014 flows were increased from 48 m^3/s to a maximum of 69 m^3/s on August 23, 2014. Flows returned to 45 m^3/s by August 29, 2014 and flows were reduced to 8.5 m^3/s (i.e. typical minimum winter flow) by September 19, 2014. The flushing flow improved the condition of the substrate, particularly upstream of Granite Creek. However, additional rain events during August 2014 caused further deposits of sediment from Granite and Pierce creeks into the main stem SFBR. Currently the erosion of alluvial fans created by these sediment flows are transporting sediment into the river and at least 4 km of river between these tributaries are extremely embedded with sand, fine silt, and mud. A combination of terrestrial stabilization and flushing flows will be required for future rehabilitation efforts.

During the past two years, the primary objective for IDFG regarding SFBR has been to describe the extent of the effects of the sediment flows on fish populations and habitat. In 2015, densities of age-0 and age-1 trout and overwinter survival were evaluated and compared to pre-fire estimates. Finally, IDFG continues to partner with other agencies in planning and prescribing rehabilitation efforts that will take place over the next several years.

METHODS

Production of Age-0 Rainbow Trout has been monitored annually along fixed transects in the fall since 2009 to index abundance in the SFBR. Beginning in 2012, IDFG also began investigating overwinter survival of age-0 Rainbow Trout. Age-0 and age-1 Rainbow Trout were sampled using a Smith-Root Type LR-24 backpack shocker. Thirty-nine fixed trend sites were sampled on March 26-27, 2015 and October 22-23, 2015 (Figure 62). Sites were 33-m long by 4-m wide and located throughout the roaded section between Anderson Ranch Dam and the Danskin Bridge. A single, upstream electrofishing pass was completed at each site. All fish were identified, counted, and measured for total length. Mean linear density of age-0 Rainbow Trout was calculated as described by Elle (1996) and Koenig et al. (2015). Age-0 and age-1 density estimates were compared to those collected in previous years. Overwinter survival S_t was estimated as

$$S_t = \frac{N_t}{N_o}$$

where N_o was the initial abundance in the fall and N_t was the abundance in the spring (Ricker 1975).

RESULTS

During the spring survey, catch of age-1 Rainbow Trout ranged from 0 to 40 fish/site, which equated to a mean density was 0.2 fish/m (Figure 63). Length of Rainbow Trout ranged from 46 to 121 mm with a mean of 74 mm (Figure 64). Using age-0 Rainbow Trout density estimates from the previous October (Koenig et al. 2015), overwinter survival for 2014-15 was estimated to be 51% (Fig 63).

In October 2015, catch of age-0 Rainbow Trout ranged from 0 to 281 fish/site, and total catch equaled 688 trout. Mean length of age-0 Rainbow Trout was 56 mm with a range of 29 to 119 mm (Figure 65). Mean density of age-0 Rainbow Trout during was 1.9 fish/m (Figure 66).

The increase in fry production marked a return to pre-wildfire age-0 density estimates. Mean density of age-0 Rainbow Trout in 2013 and 2014 (0.4 fish/m) were approximately 80% lower than the years prior to the wildfire-related events of 2013 and 2014.) Prior to the wildfires, mean density was approximately 2.0 fish/m and appeared stable from 2009-2012.

DISCUSSION

Fall densities of age-0 Rainbow Trout have returned to levels that were typical prior to the fire and subsequent debris slides. From 1996 through 2012, annual fall age-0 Rainbow Trout densities had appeared to be stable. However, during the two years immediately after the fires, fall density estimates declined by approximately 80% (Butts et al. 2016). The decline in fall densities of age-0 Rainbow Trout could be attributed to a number of factors including reduced spawning habitat quality due to higher fine sediment levels, poor survival, or direct mortality from extended exposure to suspended sediment and debris (Bozek and Young 1994; Rieman et al. 2012).

Spring densities of age-1 Rainbow Trout have been relatively stable, despite widely differing fall densities. This indicates that fall densities of age-0 trout may not be the appropriate index of year-class strength and recruitment. For instance during the 2012-2013 winter, a large number of age-0 Rainbow Trout entered the winter, but mortality was relatively high. In contrast during the 2013-2014 winter, a relatively few age-0 trout entered the winter, but mortality was low. From these limited observations, it appears that year-class-strength may be constrained by the carrying capacity of winter habitat rather than overall abundance of age-0 trout at the start of winter. Also, it appears that overwinter survival favors larger age-0 trout as very few fry <50 mm survived the winter. Length-based differences in mortality were evident in laboratory and field settings where age-0 Rainbow Trout less than 50 mm were unlikely to survive a 150-d winter due to lipid depletion (Biro et al. 2004). A number of studies have implicated the amount of suitable habitat as the primary factor regulating overwinter survival of age-0 salmonids (Cunjak 1996; Mitro et al. 2003; Koenig 2006). IDFG plans to collect one additional year of spring age-1 density information to allow one more calculation of overwinter survival, between fall 2015 and spring 2016.

Delayed negative effects to fish populations from wildfires have been documented in several systems and can occur for a decade or more following wildfires (Meyer and Pierce 2003; Rieman et al 2012). Currently, many hillsides and drainages such as Pierce and Granite creeks are very unstable and prone to additional erosion events. Restoration efforts began in the spring of 2015 and are expected to hasten the recovery and stabilization of many of these areas. In contrast, a number of beneficial effects may occur from the fire and related events, such as increased spawning gravel after fine sediments are flushed, an influx of woody debris, increased delivery of nutrients, and perhaps increased fish growth. Thus far and despite the lack of full recovery of upland, riparian, and aquatic habitats, our data has indicated that the rainbow trout population in the SFBR is resilient as production has rebounded to near pre-fire levels after only two seasons and recruitment to age-1 has been stable throughout.

RECOMMENDATIONS

1. Continue shoreline electrofishing in the spring 2016 to monitor age-1 Rainbow Trout production and overwinter survival; summarize four-year study in 2016 annual report.

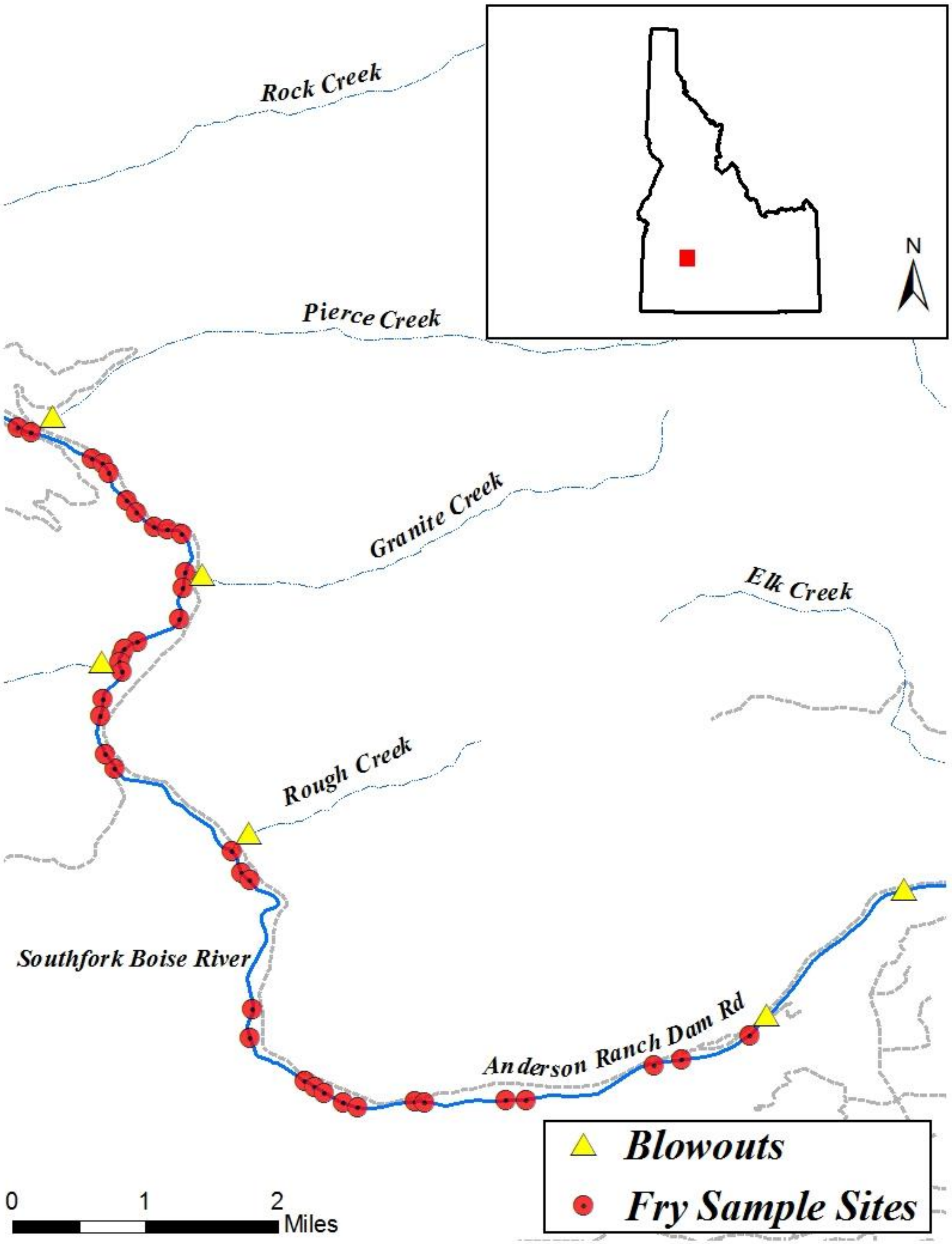

Figure 62. Map of South Fork Boise River, Idaho tailwater section showing location of major debris slides near age-0 Rainbow Trout monitoring sites.

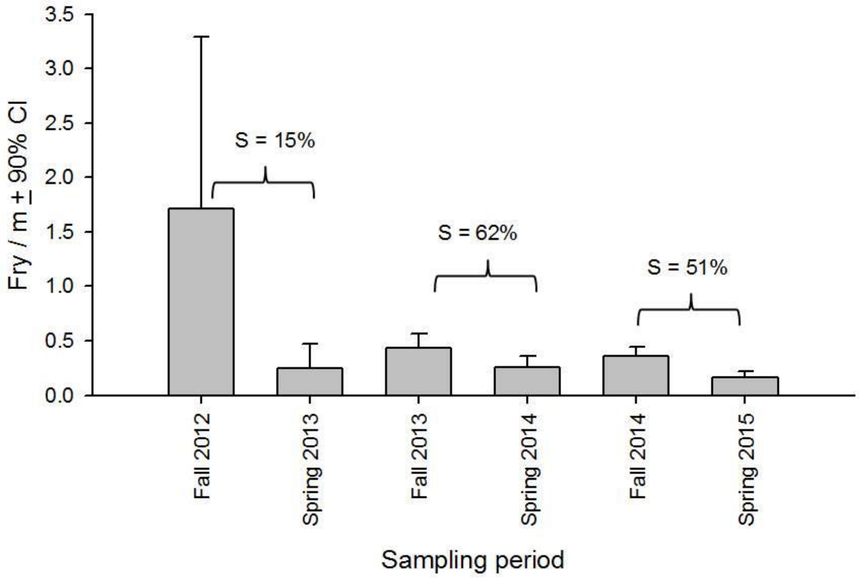

Figure 63. Comparison of mean densities age-0 and age-1 Rainbow Trout collected at 39 3-m long shoreline trend sections between fall and spring for three years at the South Fork Boise River, Idaho. Overwinter survival was estimated from comparing fall and spring age-0 trout densities.

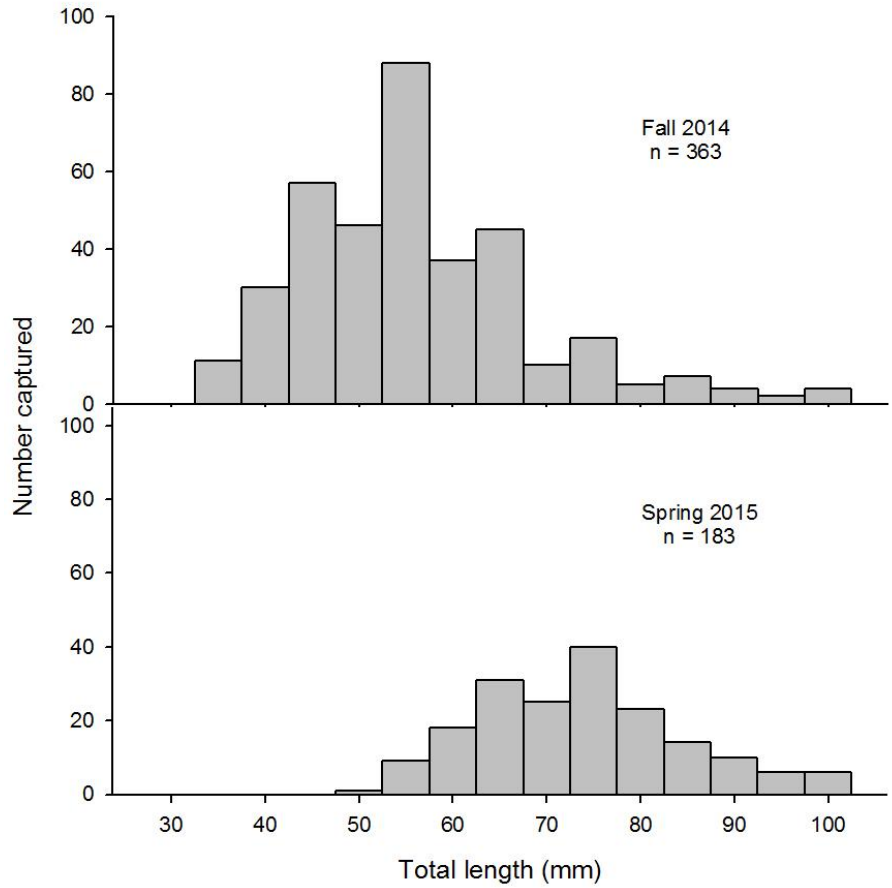

Figure 64. Length distributions of age-0 and age-1 Rainbow Trout, sampled during fry surveys during October 2014 and March 2015 in the South Fork Boise River downstream of Anderson Ranch Dam.

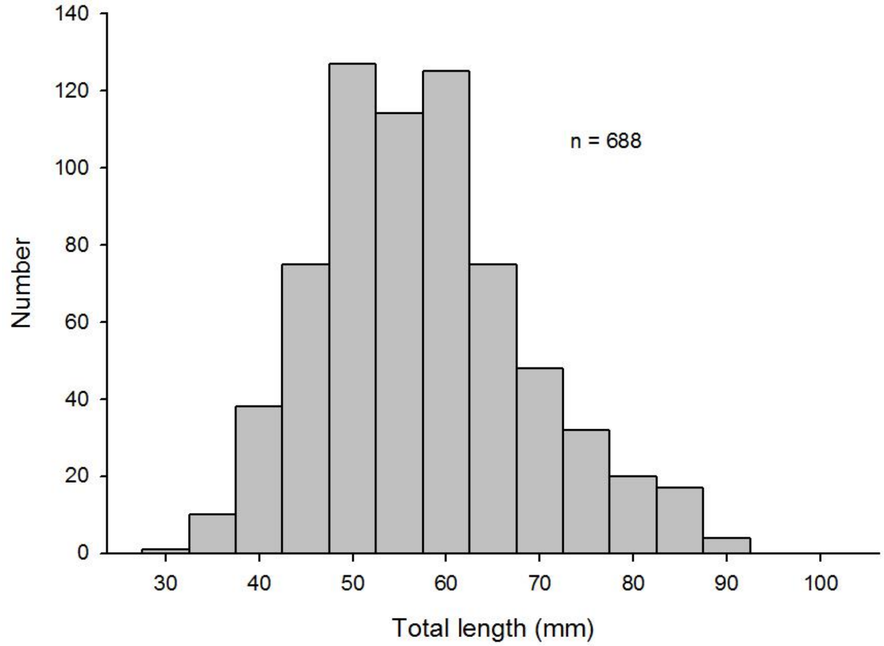

Figure 65. Length distributions of age-0 and Rainbow Trout, sampled during fry surveys during October 2015 in the South Fork Boise River downstream of Anderson Ranch Dam.

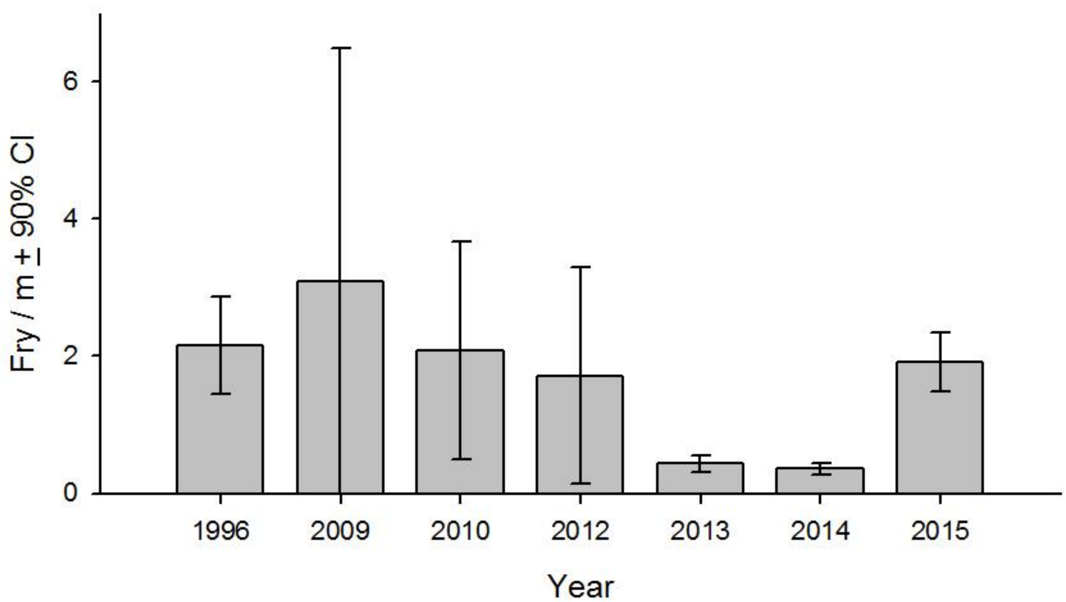

Figure 66. Comparison of mean age-0 Rainbow Trout densities collected during the fall at 39 33-m long shoreline trend sites from 1996 through 2015 at the South Fork Boise River, Idaho.

LOWER WEISER RIVER FISH POPULATION MONTIORING

ABSTRACT

Our current understanding of species composition and size structure of fish populations in the lower Weiser River is limited. Surveys in 1974 and 1999 indicated that Smallmouth Bass *Micropterus dolomieu* (SMB) were the most numerous species. To acquire more current information, I sampled nine sites in the lower Weiser River between Cambridge, ID and the confluence with the Snake River, at Weiser, ID, to determine fish distribution, species composition, relative abundance, and biomass. The survey occurred in early October and was completed with a canoe electrofishing unit. A total of 3,343 fish, comprised of 18 species, were sampled. Native species composed only 7% of the fish sampled. SMB were the most abundant species in all survey sites and contributed 76.8% of the species composition and 43.1% of the biomass. Pumkinseed *Lepomis gibbosus* and Largescale Sucker *Catostomus macrocheilus* were the second (7.8%) and third (5.2%) most numerous species, respectively. The total catch-per-unit-effort (CPUE) and weight-per-unit-effort (WPUE) for all species was estimated at 485 fish/h (90% CI, ± 144) and 30.5 kg/h (± 17.4). The mean SMB CPUE and WPUE were 372 f/h (± 152) and 12.1 kg/h (± 5.5). SMB mean length and weight was 130 mm (± 2) and 51 g (± 4). Proportional stock density (PSD) and relative stock density (RSD) for SMB were calculated at 21 and 13, respectively, indicating an unbalanced size structure skewed towards small fish. An unbalanced size structure may indicate slow growth, high mortality, or movement of larger individuals. Relative weights were generally near 100, which indicated SMB had average body condition compared to other populations. The survey sites and results serve as baseline data for comparisons with future surveys in the lower Weiser River.

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INTRODUCTION

The Weiser River is located in southwestern Idaho and enters the Snake River near the town of Weiser, ID. The basin drains approximately 4,300 square kilometers traversing through multiple habitat types, transitioning from forested mountains at high elevations to grassland or agricultural at lower elevations (IDFG 2014). Primary land-use practices include forestry, grazing, and farming. Average annual discharge for the drainage is approximately 742,000 acre-feet of water (IDFG 2014). Irrigation diversions and reduction of riparian shading in the lower Weiser River (Cambridge, ID to the confluence with the Snake River near Weiser, ID) has led to reduced flows and increased water temperatures. Contemporary flow and temperature regimes are more suitable for introduced warmwater fish species, such as Smallmouth Bass *Micropterus dolomieu* (SMB) for much of the year. During the past two surveys, SMB was the most abundant game fish, within the reach (Gibson 1975; Flatter and Allen 2001). Anecdotal fishing reports, provided by anglers and the area conservation officer, indicate that SMB are abundant. Also, native Redband or Rainbow Trout *Oncorhynchus mykiss* are reported to utilize this section of river, during cooler water periods.

Since 1954, there has been an on-going proposal to build a dam near the Galloway Diversion structure (Figure 67) to provide additional water storage and flood control. Currently, no water storage exists within the mainstem Weiser River. As water demand has increased in Idaho, the proposal continues to be considered. The last fish survey conducted in the proposal area occurred in 1999 (Flatter and Allen 2001). To better understand the fish resources within the proposal area, we surveyed the fish community in the fall of 2015. Data collected, during this survey, provided a current look at fish populations and increased our knowledge of available fisheries resources.

OBJECTIVES

1. Describe fish distribution, species composition, relative abundance and biomass in the lower Weiser River from Cambridge, ID to its confluence with the Snake River.

2. Compare the current fish distribution, species composition, relative abundance and biomass to historical information collected in 1974 and 1999.

METHODS

I selected nine survey sites (WR1-WR9) on the lower Weiser River (LWR) starting near Cambridge, ID and continuing downstream to the town of Weiser, ID (near the confluence with the Snake River; Figure 67). Sites were selected using satellite imagery (Goggle Earth Pro, v7.1.5.1557). I selected sites based on accessibility to public and private lands (for repeatable future surveys) and to allow characterization of the fish community throughout the entire study reach (quasi-systematically) and from a diverse array of habitat types. The survey was conducted from October 6 to October 14, 2015. Flows measured on the LWR at the Weiser, ID U.S. Geological Survey (USGS) gauging station ranged from 0.99 to 1.78 m^3/s during the survey. Sites were surveyed starting at a pre-selected downstream GPS coordinate, continued upstream for a distance which ranged in length from 164 to 475 m and depending on habitat features, typically ended near the bottom of a riffle. In total, I sampled 2.9 km of the lower Weiser River.

Fish were collected with an electrofishing unit, which consisted of a 5.2-m Grumman aluminum canoe fitted with three mobile anodes connected to 15.2-m cables. The canoe served as the cathode and carried the generator, Midwest Lake Electrofishing Systems (MLES) Infinity electrofisher, and a live well for holding fish. Pulsed direct current was produced by a 5,000-watt generator (Honda EG5000). Frequency was set at 25-30 pulses per second with a power output of 1,600-2,200 watts. Crews consisted of eight or nine people. Three operators managed the mobile anodes; one person guided the canoe and operated the safety switch which controlled the output, while the remaining crew of four or five people netted stunned fish. Single pass electrofishing was conducted at each site. Electrofishing time ranged from 0.32 to 1.02 hours (h) with a mean effort of 0.76 h (90% CI, ± 0.14 h). An attempt was made to capture all stunned fish during the survey. Captured fish were placed in the live well and oxygen was introduced through an air-stone at 2 L/min.

Captured fish were identified to species, measured total length (TL; ± 1 mm), and weighed (±1 g for fish < 5,000 g or ± 10 g for fish > 5,000 g) with a digital scale. When fish weight was not collected, length-weight relationships (power function equations; Pope and Kruse 2007) were generated, allowing for estimation of weight for each sampled individual. Length-weight relationships were developed for all species that had five or more individuals sampled. Biomass estimates were calculated for all species collected. For samples containing high densities of juveniles, total counts (fish < 100 mm TL) were expanded by multiplying the average weight per fish (by species) to estimate total biomass. Species composition proportions were generated using fish data collected from all nine sites.

Electrofishing effort was converted to hours to standardize catch (number) per unit effort (CPUE) and weight (kg) per unit effort (WPUE). Catch data were summarized by species and site to develop CPUE and WPUE indices. Mean CPUE and WPUE for the survey (across all sites), were generated by dividing the total catch (or weight) of a species by the total effort at each site and then averaging across all sites and calculating α = 0.10 confidence intervals. CPUE and WPUE was calculated using data derived from first pass electrofishing only (no data from the recapture pass at sites WR4, WR6 and WR7; Figure 67).

Proportional stock density (PSD) and relative stock density (RSD) was calculated to characterize the length-frequency data collected for SMB as

$$PSD = \frac{Number\ of\ fish\ \geq Quality\ size}{Number\ of\ fish\ \geq Stock\ size} \times 100,$$

and

$$RSD = \frac{Number\ of\ fish\ \geq specified\ length}{Number\ of\ fish\ \geq Stock\ size} \times 100,$$

where quality size (280 mm total length) and stock size (180 mm total length) were identified in Anderson and Neumann (1996). Total length of ≥ 300 mm was used for the RSD (RSD-300) formula because SMB over 300 mm are available to anglers for harvest. All SMB ≥ 300 mm in total length were tagged using 70 mm (51 mm of tubing) fluorescent orange Floy® FD-68BC T-bar anchor tags to develop future exploitation and angler use estimates, as well as determine movement patterns associated with these fish. All survey and individual fish data were stored in IDFG’s standard stream survey and tagging databases.

Relative weights (W_r) were calculated to index body condition for species which standard weight (W_s) equations exist (Brown Bullhead *Ameriurus nebulosus* (BBH), Bluegill *Lepomis macrochirus* (BLG), Channel Catfish *Ictalurus punctatus* (CAT), Largemouth Bass *Micropterus salmoides* (LMB), Pumpkinseed *Lepomis gibbosus* (PKS), SMB, White Crappie *Pomoxis annularis* (WCR), Warmouth *Lepomis gulosus* (WRM) and Yellow Perch *Perca flavescens* (YLP), Blackwell et al 2000; Largescale Sucker *Catostomus macrocheilus* (LSS) and Bridgelip Sucker *Catostomus columbianus* (BLS), Richter 2007; Common Carp *Cyprinus carpio* (CRP), Bister et al 2000). W_r were calculated for fish larger than the minimum total lengths presented in each respective paper. A W_r value of 100 is considered average body condition, whereas, less than 100 indicated a fish in below average condition and a value greater than 100 indicated a robust healthy fish (Pope and Kruse 2007).

The survey design was based on single pass electrofishing. However, it was important to understand and estimate sampling efficiency. At sites WR4, WR6, and WR7, a second recapture pass was conducted to collect SMB and Sucker *spp.* (LSS and BLS) that were marked during the first pass. SMB greater than 100 mm received a hole punch in the caudal fin at site WR4 and WR6, whereas Sucker *spp.* greater than 100 mm were marked at sites WR4 and WR7. During the recapture pass, all SMB and Sucker *spp.* greater than 100 mm were examined for marks and recorded on data sheets.

To estimate sampling efficiency, the formula below was used,

$$Eff = (exp(-5+\beta_1 L+ \beta_2 L^2)) / (1+ exp(-5+\beta_1 L+ \beta_2 L^2))$$

where *Eff* was the probability of capturing a fish of length L, and β_1 and β_2 are estimated parameters (MFWP 2004). Once *Eff* was calculated by length group, *N* is estimated as follows,

$$N = M / Eff$$

where M was the number of fish marked by length group. Due to the limited number of recaptures, I combined data from both sites for each fish type, producing log likelihood estimates. Confidence intervals were calculated using $\alpha = 0.10$. Population estimates were standardized and expressed as n/100 m^2.

RESULTS

A total of 3,343 fish (18 species) were collected during the LWR fall electrofishing survey of 2015. Native species included BLS, Chiselmouth *Acrocheilus alutaceus* (CSL), Longnose Dace *Rhinichthys cataractae* (LND), LSS, Northern Pikeminnow *Ptychocheilus oregonensis* (NPM), Redside Shiner *Richardsonius balteatus* (RSS), and Speckled Dace *Rhinichthys osculus* (SPD). These species composed only 7% of the sample and were distributed throughout the surveyed reach. Non-native species included BBH, BLG, CAT, CRP, LMB, Oriental Weatherfish *Misgurnus anguillicaudatus* (OWF), PKS, SMB, WCR, WRM, and YLP and composed 93% of the survey. Game fish species included BBH, BLG, CAT, LMB, PKS, SMB, WCR, WRM, and YLP and composed 90.1% of sampled fish. SMB were sampled at all sites. BBH, BLG, LMB, and SMB were the only game fish species sampled upstream of Galloway Diversion. A minimum of five species were collected at all sites and species diversity increased moving downstream towards the confluence with the Snake River. The catch from Site WR9 was comprised of 13 different species, which had the maximum species diversity sampled at one site.

SMB were the most abundant species sampled (n = 2,566) followed by PKS (n = 259) and LSS (n = 224). SMB composed 76.8% of the species composition (Figure 68). PKS and LSS composed 7.8% and 5.2% of the species composition, respectively. The remaining species composed 10.2% of the species composition and ranged from 0.03% (RSS) to 2.9% (BLG). A total of 8 species, which included CAT, CSL, LND, RSS, SPD, WCR, WRM, and YLP, contributed less than 0.3% of the species composition (all combined totaled 0.99%).

The extrapolated biomass (estimated weight of all fish sampled) for the survey was 218.6 kg. SMB composed 43.1% of the biomass collected, followed by LSS at 36.6% (Figure 68). Common Carp and BLS also contributed to the biomass estimates at 10.8% and 3.8%, respectively. The remaining species composed 5.7% of the estimated biomass and ranged from less than 0.1% (RSS and SPD) to 1.9% (NPM). Species that contributed less than 0.25% of estimated biomass included BLG, CSL, LND, RSS, SPD, WCR, WRM, and YLP.

Mean CPUE for all sites was 485 f/h (90% CI, ± 144). Maximum CPUE was calculated at 840 f/h and was collected at site WR2 (Figure 67). Smallmouth Bass CPUE ranged from 68 to 782 f/h with a mean of 372 f/h (± 152; Table 21). Following SMB, with a mean CPUE of 37 f/h (± 71) was PKS and then LSS at 25 f/h (± 24). The remaining species had mean CPUE that ranged from 0.2 (RSS) to 13.9 f/h (BLG).

Mean WPUE for all species combined was 30.5 kg/h (90% CI, ± 17.4). Mean WPUE for SMB was 12.1 kg/h (± 5.5; Table 22). Mean WPUE for LSS (12.0 kg/h ± 15.5) and CRP (11.3 kg/h ± 29.8) were the second and third highest. The remaining species had mean WPUE that ranged from less than 0.1 (RSS and SPD) to 4.4 kg/h (BLS). The maximum combined WPUE was sampled at site WR8 (89.0 kg/h) and consisted mainly of LSS (55.7 kg/h), CRP (24.1 kg/h), and SMB (6.9 kg/h).

Length frequency data for game fish species indicate that few large fish were present in the fall (Figure 69); however, most species had multiple size classes present. PSD could only be calculated for SMB due to the lack of quality size fish in other species. PSD and RSD-300 equaled 21 and 13, respectively, indicating an unbalanced size structure skewed towards small fish. Out of 2,566 SMB sampled 310 were stock size (≥ 180 mm), 66 were quality size (≥ 280 mm), and 39 were used to calculate RSD-300. A total of 62 SMB over 300 mm (39 first pass and an additional 23 during the recapture pass) were tagged and released. Mean length and weight of SMB was 130 mm (± 2) and 51 g (± 4). Length-weight relationships possessed high correlation values ranging from 0.91-0.99 (Figure 70). Relative weights for most calculated species were near 100, ranging from 86 (WCR) to 114 (LMB) and indicated these fish had average body condition and were in balance with food supply within the LWR (Figure 71).

The estimated electrofishing sample efficiency for SMB and Sucker *spp.* ranged from 10.7% to 18.6% and 14.3% to 18.8%, respectively (Table 23). The mean sampling efficiency for SMB was 14.7%, whereas the mean for Sucker *spp.* was 16.6%. Using the mark-recapture data, I estimated SMB density to be 16 fish/100 m^2 (Table 23). SMB between 100 and 199 mm composed 82% of the total. Mean density estimates for Sucker *spp.* was 3 fish/100 m^2 (Table 23).

DISCUSSION

The current survey marks the third consecutive effort for which SMB was the most numerous game fish sampled (Gibson 1975; Flatter and Allen 1999). Mean CPUE for SMB sampled in the LWR are among the highest observed within the Southwest Region. Size structure and estimates of PSD for the LWR population appeared similar to those observed during fall sampling in Brownlee Reservoir (Richter et al 2014) and CJ Strike Reservoir (Richter et al 2011). Gibson (1975) reported that 30% of the SMB collected in the 1974 survey were larger than 150 mm total length which was slightly higher than the current survey (25%). It is possible that the small size structure and low PSD were artificially influenced by when the survey was conducted. Size structure and PSD indices has been shown to vary seasonally (Pope and Willis 1996) as well as temporally (day vs night; Paragamian 1989). For comparative purposes, future LWR surveys should occur in the fall; however, fall surveys may not fully characterize the fish community that utilizes this reach. Other seasonal surveys may be necessary to determine if species composition and size structure varies seasonally.

The proportion of native species sampled during the present survey decreased compared to the 1999 survey. The present estimate of 7% represents a 91% decrease from 75% that was reported in 1999 (Flatter and Allen, unpublished data). Several factors could be leading to the decrease in native species within the LWR. One explanation is that increased abundance of SMB in the system has led to direct declines of native species through competition or predation. SMB have been documented to decrease abundance and disturb behavior of several native species in systems where they have been introduced or expanded (Brown et al 2009; Loppnow et al 2013). SMB have been present in the system, since at least 1974 (Gibson 1975) and have increased 16 fold in relative abundance. Similar increased relative abundance of SMB have been observed in other regional fish surveys conducted on the Snake River from CJ Strike Dam to Swan Falls and from Swan Falls to Brownlee Reservoir (Kozfkay et al 2009; Hebdon et al 2009). It is important to note that survey designs, capture efficiencies, and equipment for these sampling efforts differed somewhat; therefore, the results aren’t perfectly comparable. Regardless, these very large shifts in fish species composition are unlikely to have been caused by minor differences in methodologies.

Low flow conditions, during 2015, may have negatively biased the proportion of native species sampled in the present survey. Mean flows over the two week sample period were 68% lower than the 77-year median and were near all-time recorded lows (flows in 1911 were measured as low as 0.4 m^3/s, USGS 2016). Low flows and high water temperatures may have forced cold-water species such as Redband Rainbow Trout or Mountain Whitefish *Prosopium williamsoni* out of the surveyed reach and into higher elevation tributaries in search of cooler water. In previous surveys, Rainbow Trout were sampled, but represented a low proportion of the catch, 2.9% (Gibson 1975) and 2.4% (Flatter and Allen, unpublished data). No Redband Rainbow Trout were sampled during 2015. Uncertainty remains, regarding whether SMB are a proximate or ultimate cause to the shifts in native species proportions. Specifically, it is uncertain, whether SMB have moved into habitat that native species have vacated due to changes or if these shifts are a direct result of predation or competition. Differences between survey designs (seasonal and capture efficiencies), habitat changes, and temperature and flow changes have likely played a part in the shift away from native species.

SMB tags have not been reported by anglers prior to the preparation of this report. I plan to continue monitoring tag reports for the upcoming year. Exploitation estimates or movement patterns will be summarized in future reports. Anecdotal fishing reports suggest that the LWR has higher catch rates of larger SMB in early spring near the confluence of the Snake River. If fish that were tagged during the fall 2015 survey start being reported during spring 2016, I may be able to start identifying movement patterns within this area.

These data which included fish distribution, relative abundance, species composition, and biomass provide a baseline of information, tied to specific sample locations, for future trend monitoring surveys. The current survey sites were accessed by gaining permission through private property or using access provided by the Friends of the Weiser River Trail. Contact information for the private property access points can be found in IDFG's Stream Survey Database and the coordinates for the survey sites are archived in Appendix A. These data provided an up-to-date look at fishery metrics related to LWR fisheries and the Galloway Dam proposal.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor fish distribution, relative abundance, and species composition at approximately 10-year intervals. Use the 2015 survey data and sites to serve as baseline information and revisit identified sample locations to identify potential shifts in species composition or relative abundance.

2. Continue monitoring SMB tag report data to develop exploitation estimates and describe movement patterns within the Weiser River and potentially Snake River drainage. Investigate using anglers or electrofishing gear to capture additional SMB (> 300 mm) in the LWR to produce more precise exploitation and angler use estimates and improve understanding of movement patterns within the system.

3. Conduct other seasonal surveys to determine if species composition or size structure differs from fall surveys.

Table 21. Electrofishing catch per unit effort (f/h) for 9 sites on the lower Weiser River during fall 2015. Species names were abbreviated as Brown Bullhead (BBH), Bluegill (BGL), Bridgelip Sucker (BLS), Channel Catfish (CAT), Common Carp (CRP), Chiselmouth (CSM), Largemouth Bass (LMB), Longnose Dace (LND), Largescale Sucker (LSS), Northern Pikeminnow (NPM), Oriental Weatherfish (OWF), Pumpkinseed (PKS), Redside Shiner (RSS), Smallmouth Bass (SMB), Speckled Dace (SCP), White Crappie (WCR), Warmouth Sunfish (WRM) and Yellow Perch (YLP).

Site	Effort (h)	BB	BL	BL	CA	CR	CS	LM	LN	LS	NP	OW	PKS	RS	SMB	SP	WC	WR	YL
WR1	0.704	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	1.4	0.0	1.4	200.	1.4	0.0	0.0	0.0
WR2	0.658	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	6.1	0.0	48.7	0.0	0.0	781.	1.5	0.0	0.0	0.0
WR3	0.321	3.1	0.0	0.0	0.0	0.0	0.0	0.0	6.2	9.4	21.8	12.5	0.0	0.0	445.	0.0	0.0	0.0	0.0
WR4	1.001	2.0	0.0	24.	0.0	0.0	0.0	0.0	0.0	30.	8.0	12.0	0.0	0.0	335.	0.0	0.0	0.0	0.0
WR5	0.926	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	2.2	3.2	0.0	0.0	294.	0.0	0.0	0.0	0.0
WR6	1.028	1.9	1.9	0.0	0.0	0.0	0.0	19.5	0.0	12.	5.8	6.8	0.0	0.0	720.	0.0	0.0	0.0	0.0
WR7	0.793	8.8	90.	0.0	1.3	13.9	0.0	1.3	0.0	89.	2.5	26.5	282.	0.0	129.	0.0	0.0	0.0	0.0
WR8	0.653	19.9	1.5	1.5	0.0	13.8	0.0	3.1	0.0	64.	0.0	1.5	19.9	0.0	68.9	0.0	0.0	0.0	0.0
WR9	0.737	4.1	31.	0.0	4.1	8.1	6.8	1.4	0.0	5.4	0.0	4.1	29.8	0.0	366.	0.0	2.7	8.1	13.
Average	for	4.4	13.	2.8	0.6	4.0	0.8	2.8	0.9	25.	4.5	13.0	36.9	0.2	371.	0.3	0.3	0.9	1.5

Table 22. Electrofishing weight per unit effort (kg of f/h) for 9 sites on the Lower Weiser River during fall 2015. Species names were abbreviated as Brown Bullhead (BBH), Bluegill (BGL), Bridgelip Sucker (BLS), Channel Catfish (CAT), Common Carp (CRP) Chiselmouth (CSM), Largemouth Bass (LMB), Longnose Dace (LND), Largescale Sucker (LSS), Northern Pikeminnow (NPM), Oriental Weatherfish (OWF), Pumpkinseed (PKS), Redside Shiner (RSS), Smallmouth Bass (SMB), Speckled Dace (SCP), White Crappie (WCR), Warmouth Sunfish (WRM) and Yellow Perch (YLP). Dashed lines indicated missing values where the species was not collected.

Site	Effort (h)	BB	BLG	BL	CA	CRP	CS	LM	LN	LSS	NP	OW	PK	RSS	SMB	SPD	WC	WR	YL
WR1	0.704	-	-	-	-	-	-	-	-	0.30	-	0.04	-	0.01	4.44	0.01	-	-	-
WR2	0.658	-	-	-	-	-	-	-	0.0	0.28	-	0.83	-	-	13.0	0.01	-	-	-
WR3	0.321	0.0	-	-	-	-	-	-	0.0	0.65	0.24	0.12	-	-	3.85	-	-	-	-
WR4	1.001	0.3	-	7.3	-	-	-	-	-	10.5	2.25	0.26	-	-	24.9	-	-	-	-
WR5	0.926	-	-	-	-	-	-	-	-	0.59	0.20	0.10	-	-	15.6	-	-	-	-
WR6	1.028	0.2	0.04	-	-	-	-	0.5	-	2.22	1.20	0.14	-	-	26.5	-	-	-	-
WR7	0.793	0.0	0.44	-	2.5	9.53	-	0.3	-	36.6	0.36	0.44	1.5	-	2.85	-	-	-	-
WR8	0.653	0.5	>0.00	1.3	-	24.1	-	0.0	-	55.7	-	0.05	0.2	-	6.91	-	-	-	-
WR9	0.737	0.1	0.19	-	0.0	0.33	0.3	0.0	-	0.94	-	0.05	0.2	-	10.6	-	0.55	0.09	0.1
Average	for	0.2	0.17	4.3	1.3	11.3	0.3	0.2	0.0	11.9	0.85	0.23	0.6	>0.0	12.0	>0.0	0.55	0.09	0.1

Table 23. Population statistics for SMB and Sucker *spp.* marked, captured, and recaptured at the sample efficiency and population sites (WR4 and WR6 combined for SMB and WR4 and WR7 combined for Sucker *spp.*). Population estimates by length group (90% CI) and estimates of fish per 100 m^2 are also presented. Columns labeled M, C, and R represent marked, captured, and recaptured, respectively.

Species	Size Class	M	C	R	Estimated sampling efficiency	Population Estimate	90% CI (±)	Fish/100m^2
SMB	100-199 mm	400	334	36	10.7%	3,711	961	12.9
	200-432 mm	153	129	24	18.6%	822	249	2.9
	Total	553	463	60		4,533	993	15.8
Sucker *spp.*	100-174 mm	30	32	6	18.8%	160	97	0.7
	175-560 mm	84	35	5	14.3%	595	405	2.6
	Total	114	67	11		755	417	3.3

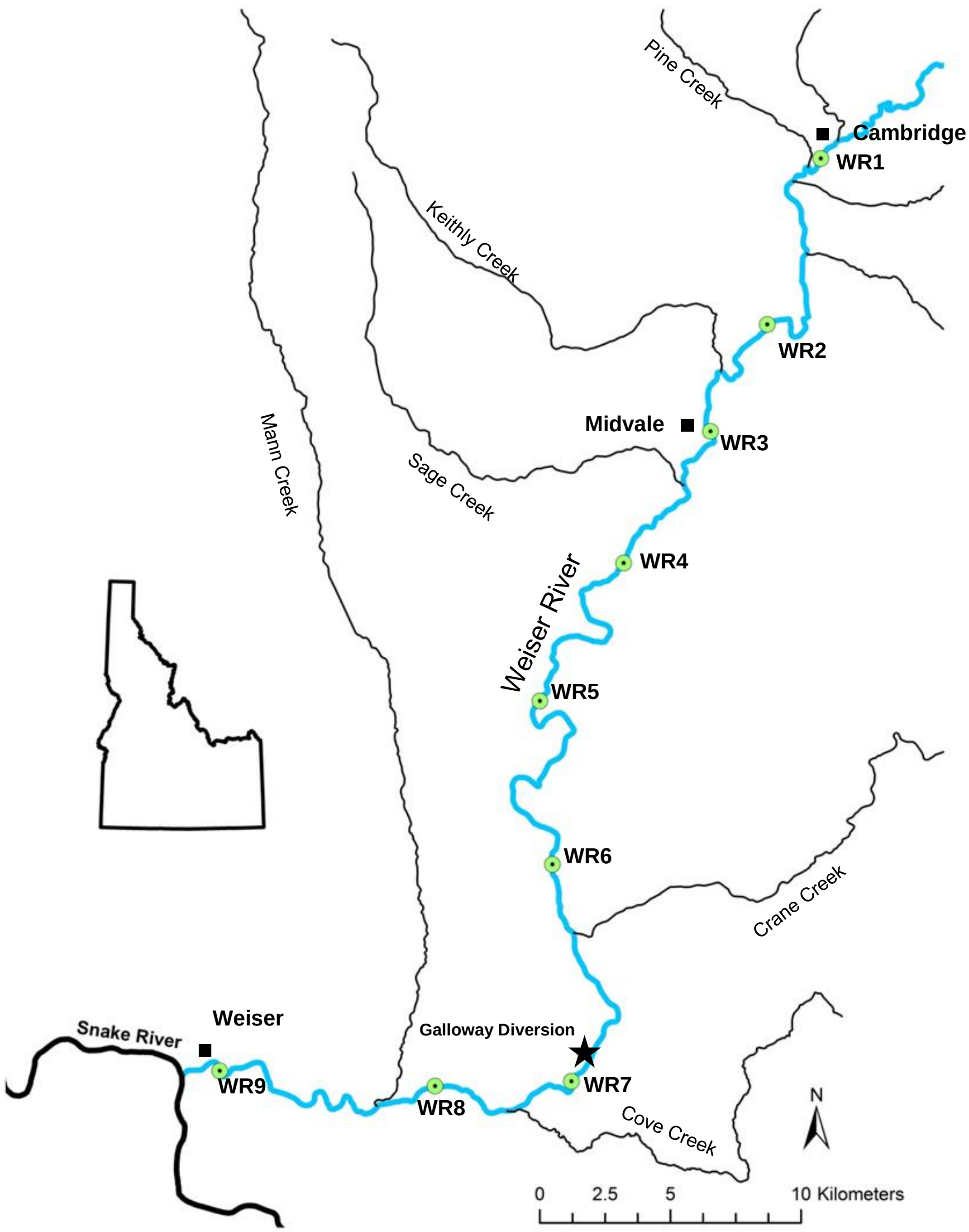
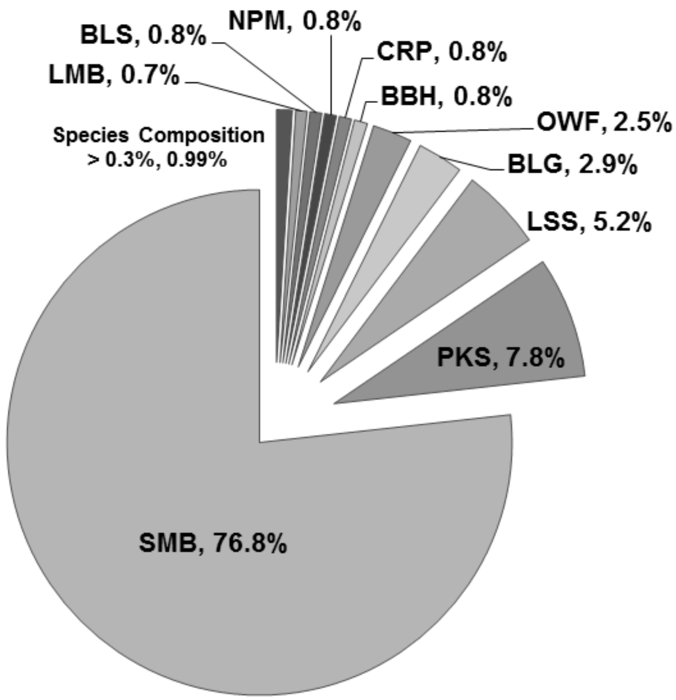


Figure 67. Electrofishing sites on the Lower Weiser River, Idaho utilized during fall 2015.



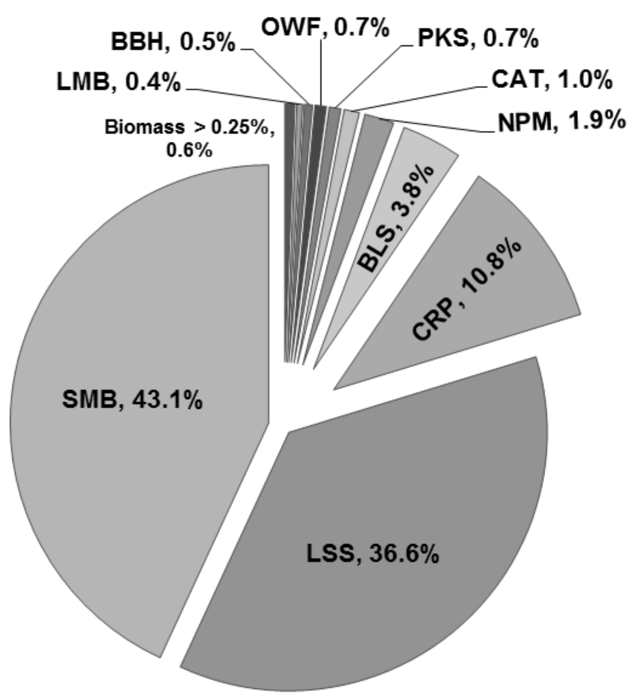


Figure 68. Species composition (top panel) and biomass proportions (bottom panel) from fish surveyed in the lower Weiser River during the fall 2015. See Table 21 for species abbreviations.

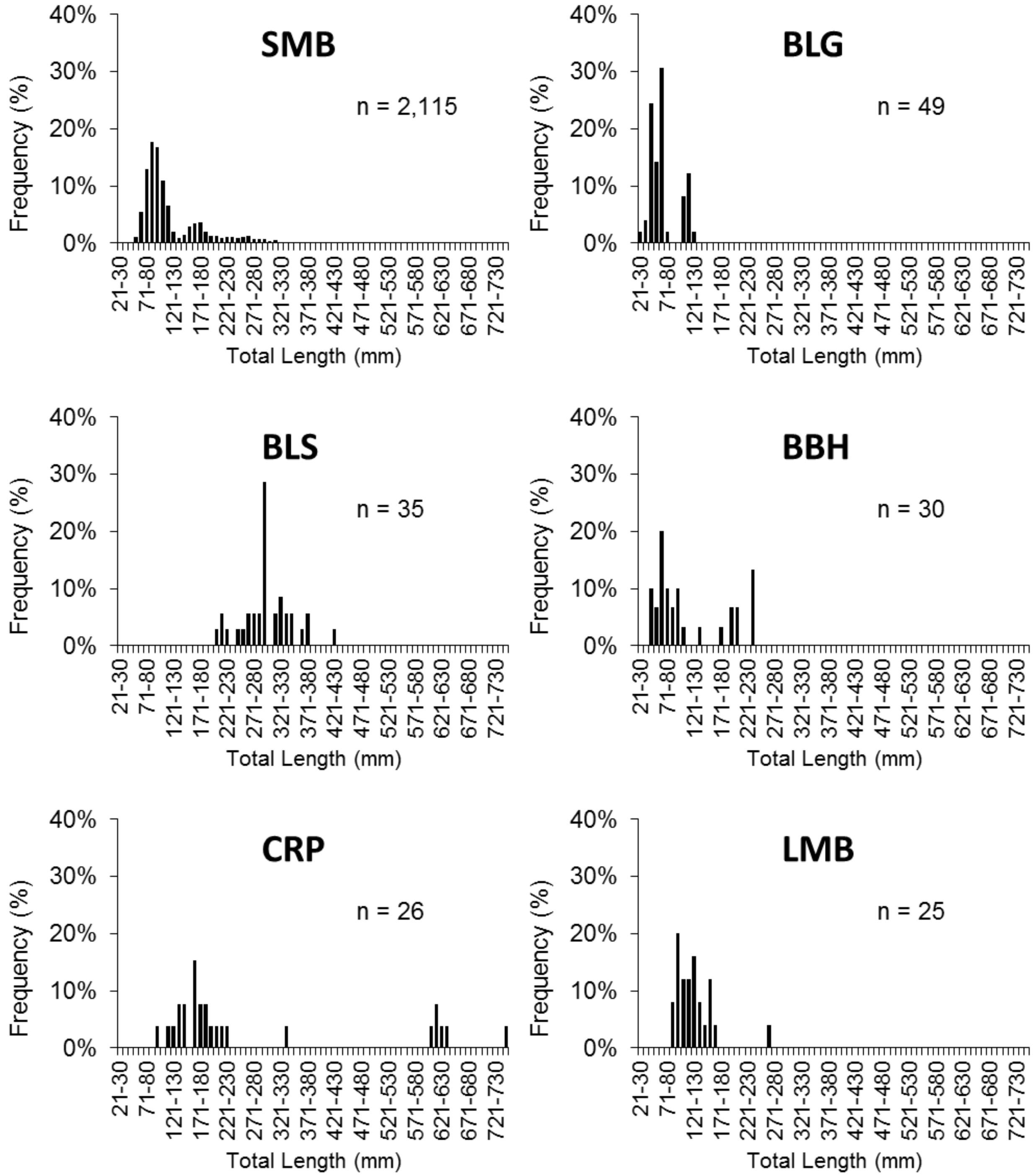


Figure 69. Length-frequency histograms for various species sampled in the lower Weiser River during fall 2015. See Table 21 for species abbreviations.

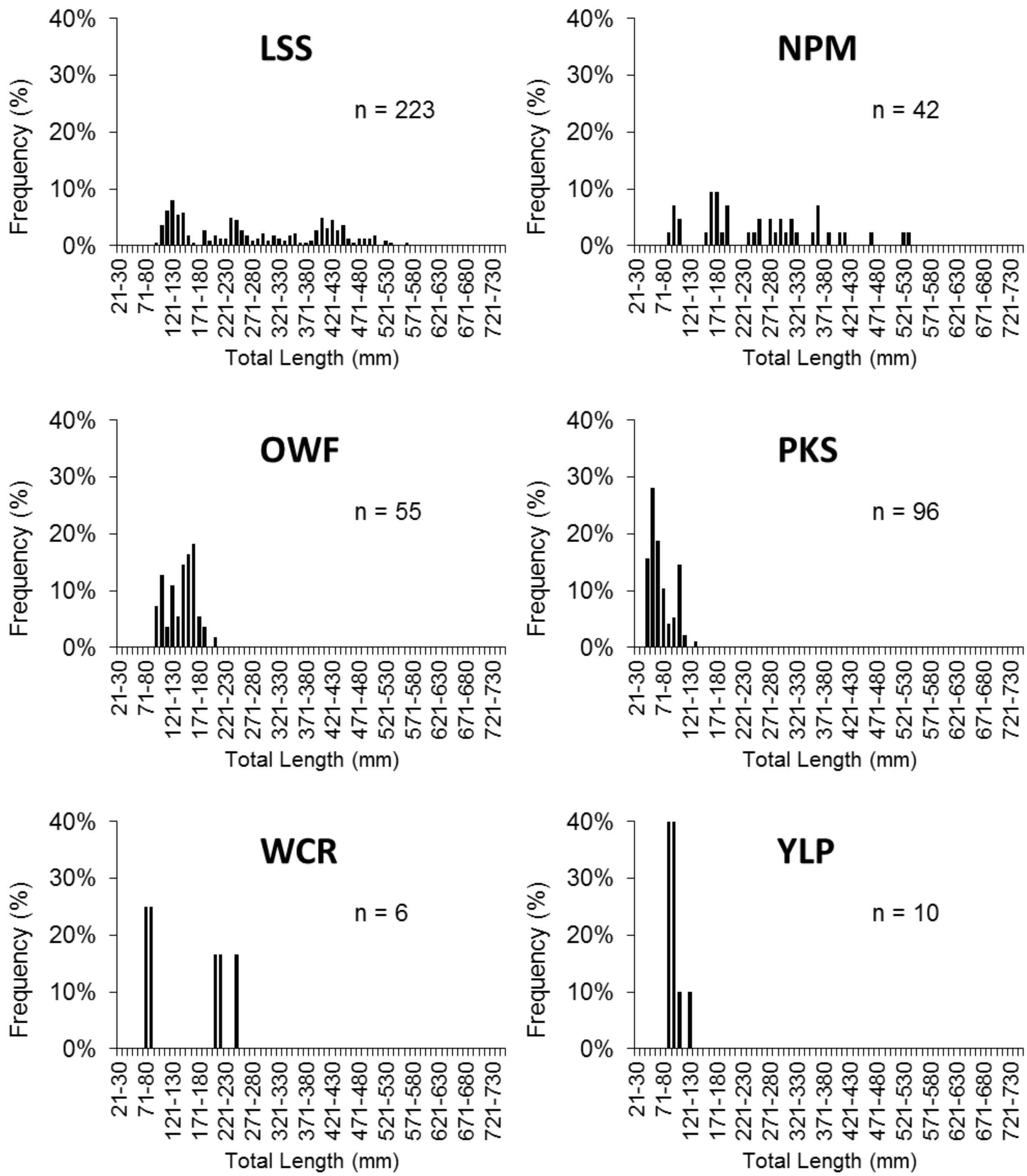


Figure 69. Continued.

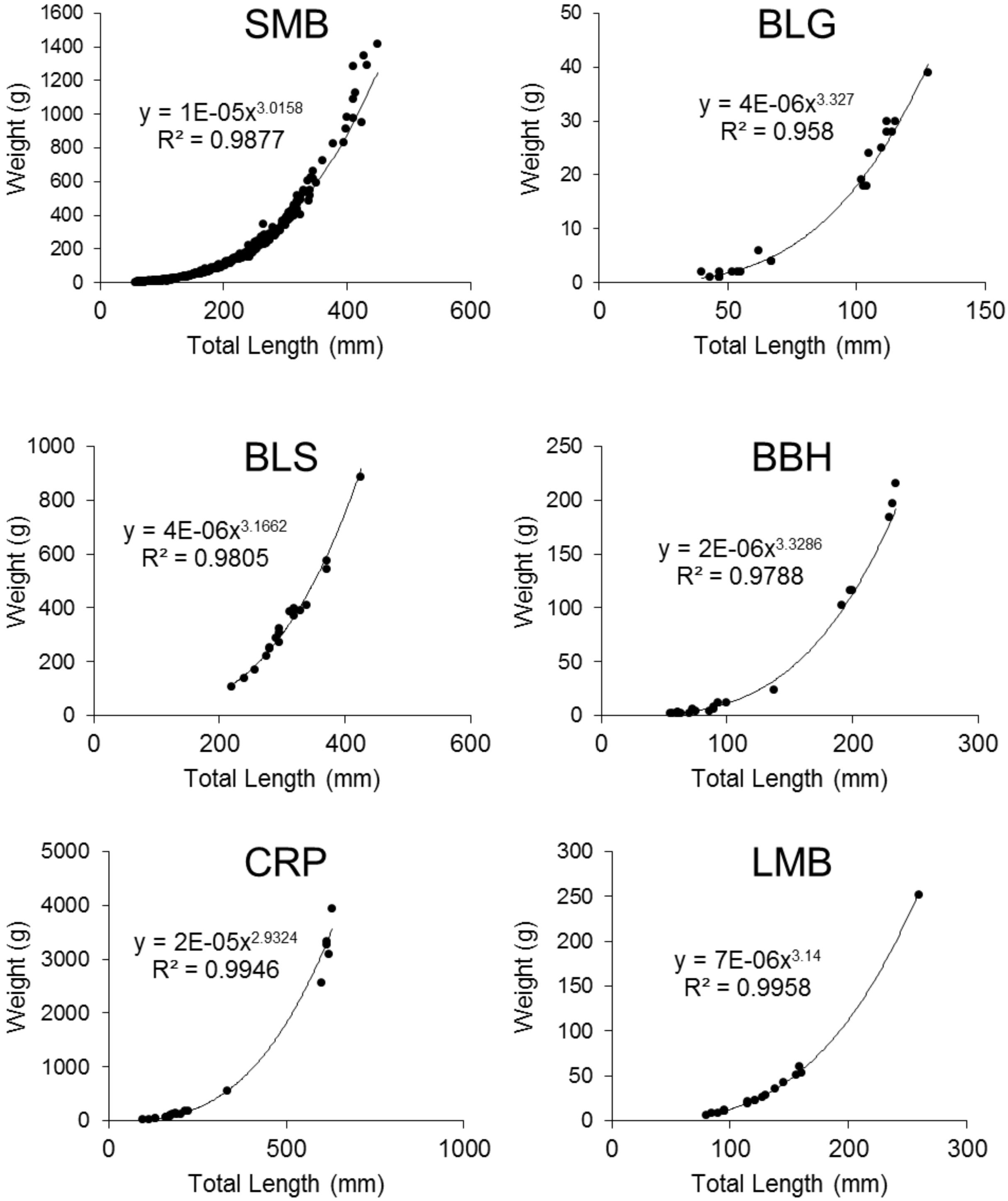


Figure 70. Length-weight relationships for various species sampled in the lower Weiser River and used to estimate weights for biomass estimates (see Table 21 for species abbreviations). Only species with 5 or more individuals sampled are shown (CAT, CSL, LND, RSS, SPD, and WRM are not represented).

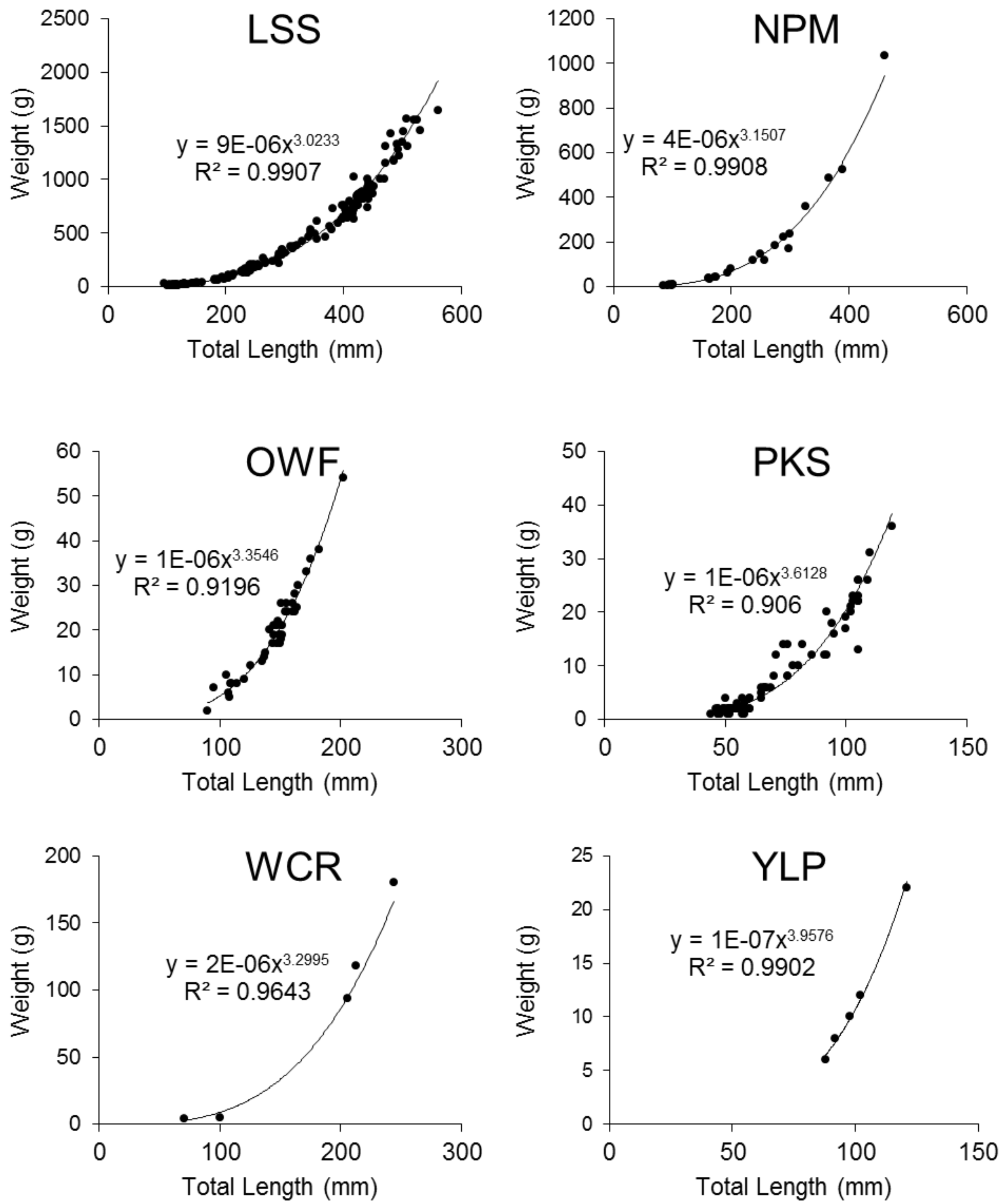


Figure 70. Continued.

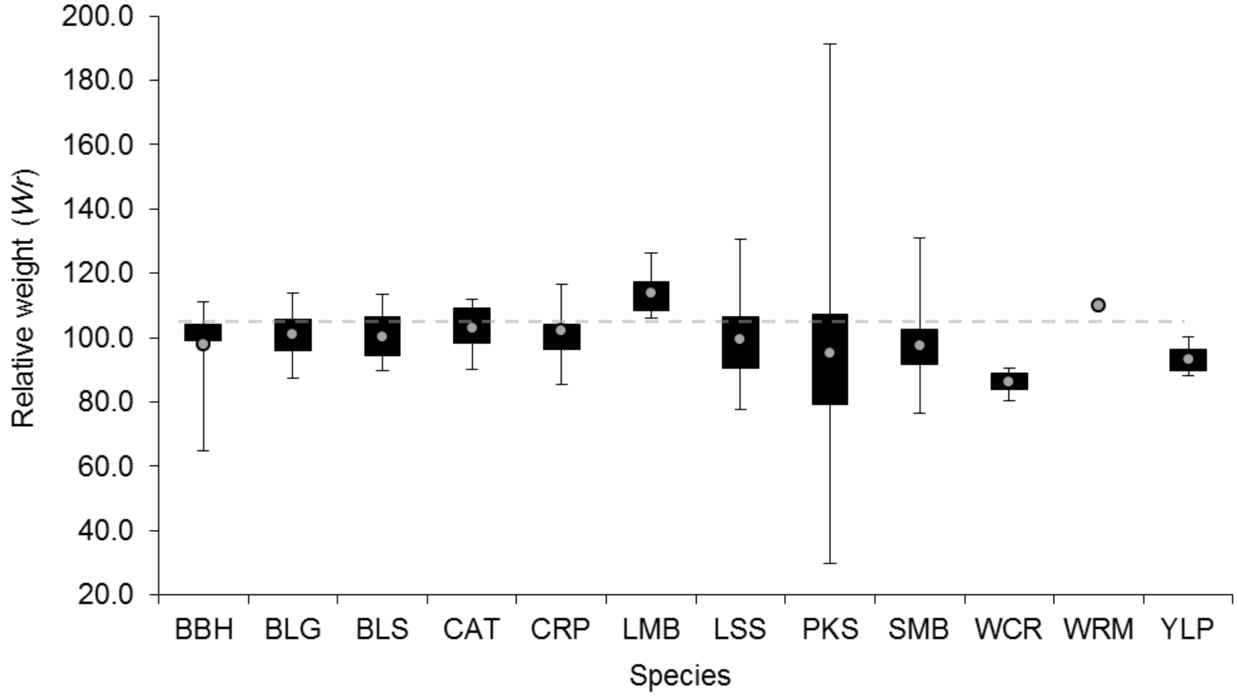


Figure 71. Relative weights shown for species (identified in Table 21) collected from the lower Weiser River during fall 2015. The bottom and top of the black box represents the first and third quartile, respectively. The bars represent the minimum and maximum relative weights observed. The dashed line represents the good body condition of a standard fish. The grey circles represent the mean relative weight for each species identified.

Appendix A. Weiser River survey site coordinates presented in WGS84.

Site Label	Starting Point Latitude	Starting Point Longitude	Ending Point Latitude	Ending Point Longitude
WR1	44.56106	-116.68097	44.56352	-116.67900
WR2	44.50334	-116.70410	44.50485	-116.70117
WR3	44.46592	-116.72969	44.46669	-116.73140
WR4	44.41954	-116.76931	44.42342	-116.76724
WR5	44.37112	-116.80729	44.37324	-116.80535
WR6	44.31505	-116.79859	44.31836	-116.79890
WR7	44.24057	-116.78589	44.24310	-116.78359
WR8	44.23739	-116.84716	44.23734	-116.85116
WR9	44.23997	-116.95445	44.23782	-116.95324

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