FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERIES MANAGEMENT ANNUAL REPORT

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SOUTHWEST REGION

2016

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April 2018
IDFG 17-105

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LOWLAND LAKE SURVEYS

KOKANEE AND RAINBOW TROUT EVALUATIONS AT ARROWROCK AND LUCKY PEAK RESERVOIRS, IDAHO

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 has evaluated these fisheries using a combination of angler creel, trawling, and gill nets. In 2016, 110 (23%) creeled anglers fished at Arrowrock Reservoir and 365 (77%) fished at Lucky Peak Reservoir. On average, anglers targeting kokanee harvested 0.3 kokanee at Arrowrock Reservoir and 1.5 kokanee at Lucky Peak Reservoir. At Arrowrock Reservoir, approximately 82% of kokanee anglers were unable to harvest a kokanee while 45% of anglers did not harvest a kokanee at Lucky Peak Reservoir. At both reservoirs, angler catch per unit effort (CPUE) of adult kokanee at age-2 appear to be strongly and positively correlated with inflow and outflow rates throughout the fish's lifetime. Additionally, catch and length of age-2 kokanee appear to be positively correlated with later stocking and larger fingerling size. Inflows at time of stocking at Arrowrock Reservoir and low water (during winter) storage levels at Lucky Peak were both important to eventual catch. Gill nets were more efficient than the trawl at capturing a representative sample of kokanee in both reservoirs. At Arrowrock Reservoir, gill nets captured 5.8 kokanee/net night ranging in length from 59 to 450 mm (207 mm mean), while at Lucky Peak, gill nets captured 35.8 fish/net night ranging in length from 57 to 427 mm (229 mm mean). Adipose clipped hatchery-origin kokanee released in Arrowrock Reservoir and recovered in Lucky Peak Reservoir indicated a high level (>60%) of entrainment. Due to high angler interest and variability in these fisheries, continued angler and population monitoring are important. Ongoing investigations evaluating relationships between stocking or environmental metrics and angler CPUE or growth are an important component of ongoing management.

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INTRODUCTION

Kokanee Salmon *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 Maiolie 1995). Kokanee life history differs considerably from other inland salmonids. Kokanee are 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.

Management of kokanee fisheries is often elusive and complex because of the wide variation of population responses to system productivity, habitat, predation, and harvest (Paragamian 1995). These responses lead to changes in growth, fecundity, recruitment, age-at-maturity, and survival, which can also vary substantially between year classes and years. Many kokanee populations exhibit density-dependent growth and this central characteristic of kokanee biology is important for fisheries managers to quantify and understand (Rieman and Myers 1992; Rieman and Maiolie 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 influence 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 Maiolie 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 (Rieman and Myers 1992; McGurk 1999).

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. The 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 recruitment from the Middle Fork Boise, North Fork Boise, and South Fork Boise rivers. 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. IDFG began annual stocking of fingerling kokanee at Arrowrock Reservoir in 2009. Since 2015, the default stocking request for Arrowrock Reservoir has been 100,000 fish or 80 fish/ha stocked in early June (Table 1). This is a two-fold increase in stocking numbers compared to 2012-14.

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. IDFG began annual stocking of Lucky Peak Reservoir in 1999. Currently, the default request is 250,000 kokanee fingerlings or 217 fish/ha in early June (Table 1).

Annual variations in angler CPUE (catch per unit effort) at these reservoirs have led IDFG to examine if the cause of this variability may be attributed to size at stocking, timing of stocking, stocking density, or hydrologic conditions. Prior to 2012, IDFG had a sense of which years had produced good fishing, but no actual catch or CPUE data. It is difficult to recommend or implement management changes without data on annual kokanee size or angler CPUE 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 angler CPUE 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 angler CPUE 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.

METHODS

Study Areas

Arrowrock 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 (de facto minimum of 50,000 af), 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 $3,615 \times 10^5$ 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 and Anderson Ranch 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.

Angler CPUE 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). 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 with mostly 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 exited the fisheries. The creel station was just east of state Highway 21 at Spring Shores Road turnoff (Figure 1). This creel station intercepted anglers from Spring Shores Marina, Mack's Creek 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 party, time fishing, target species, and the number of each species that were harvested or released. Creel clerks were directed to obtain a CPUE per individual angler, although it may be difficult in trolling situations with multiple anglers. Fishing method, gear type, and total length (nearest mm to the tip of the non-pinched tail) and weight (g) of harvested fish were also recorded. Mean angler CPUE ($\widehat{R_2}$) 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 CPUE 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).

When possible, all fish sampled from the creel were measured and weighed. 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.

Kokanee ages were defined using length-frequency histograms from each reservoir. In previous years, otoliths have been used to confirm age relationships corresponding with length frequencies. Relationships between both age-2 CPUE and length at age-2 and a suite of reservoir and stocking variables (Table 2) were examined by comparing correlation coefficient (*r*), which measures the linear relationship between two variables. We limited these correlations to CPUE of age-2 fish since that age-class makes up the majority of the total catch and using a specific age allows correlation back to year-specific variables. Variables correlated included the number of fish stocked, stocking date, length at stocking, reservoir inflow, outflow at time of stocking, and reservoir capacity at time of stocking. Additionally, we correlated minimum and maximum storage, average storage (during both the lowest three months and lowest month), minimum and maximum inflow and outflow, mean inflow and outflow, and total inflow and outflow; all within the year of stocking and for the year following stocking. 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). Five year classes of stocking (2010 – 2014) were analyzed. As additional years of creel data are collected, these correlations will be further analyzed.

Curtain Net – Trawl Comparisons

In 2016, both Arrowrock and Lucky Peak reservoirs were part of a doctoral research project through the University of Idaho comparing size selectivity of mid-water trawls to gillnetting in kokanee sampling. As part of this work, both reservoirs were sampled with both types of gear in early June 2016. Sampling was conducted at night within five days of the new moon (dark phase). Most of the methods outlined in this section were obtained from Zach Klein (unpublished data).

Lucky Peak Reservoir trawl tows were conducted on the evening of June 2, 2016 and Arrowrock Reservoir tows on the evening of June 3, 2016. The trawl measured 11.9 m in length and 2.4 m wide × 1.8 m high at the mouth. The trawl body was constructed of graduated mesh starting at 32 mm at the mouth decreasing to 25, 19, and 13 mm mesh in the body of the net. The cod end of the net has 6 mm mesh. The trawl was towed by a 7.3 m boat at approximately 1.6 m/s. Each trawl was towed in a stepwise-oblique pattern to sample the entire kokanee layer (Rieman 1992). Each step measured 2.4 m in height. Each step was towed for approximately three minutes, followed by raising the trawl a single step and trawling for another three minutes until the entire kokanee layer was sampled. All fish caught were measured for total length (mm) and weighed (g).

Gillnetting was conducted at Lucky Peak Reservoir on the evenings of June 3 and 4, 2016 and at Arrowrock Reservoir on June 2 and 6, 2016. In each water, three gill nets were used to sample the entire kokanee layer at three locations, for a total of nine net-nights. Nets were set at dusk and retrieval started at dawn on the following day. Each gill net measured 48.8 m in length and 6.0 m in depth. Gill nets contained 16 panels, each measuring 3.0 m in length. Nets consisted of eight different mesh sizes (12.7, 19.0, 25.4, 38.1, 50.8, 63.5, 76.2, 101.6 mm; stretch measure) with two panels of each mesh size randomly positioned throughout the net. Gill nets were horizontally suspended within the kokanee layer with the deepest net set at the bottom of the kokanee layer and subsequent nets placed in 6.0 m step, sampling the entire kokanee layer. Sampled fish were enumerated by mesh size, measured for total length (mm), and weighed (g).

In an effort to quantify the amount of entrainment that occurs between Arrowrock and Lucky Peak reservoirs, 10% of the 100,000 kokanee (≈ 10,000) fingerlings stocked into Arrowrock Reservoir were adipose fin clipped in both 2015 and 2016. These fish were hand clipped by Region 3 staff at the Mackay Fish Hatchery in late April of both years. All fish captured in gill nets and trawling at both Lucky Peak and Arrowrock reservoirs were examined for a fin clip. At Lucky Peak Reservoir, recovered adipose-clipped fish were expanded by the 10% clipping rate. Then, the unclipped (Lucky Peak Reservoir-origin) fish recovered by age were divided by the total number of Lucky Peak fingerlings stocked for that specific year class, to get a capture percentage. The expanded Arrowrock fish (from the same age-class) were then divided by this same percentage to generate an estimated total number of Arrowrock-stocked fish entrained in Lucky Peak Reservoir, by age.

RESULTS

Angler CPUE and fish size

In May of 2016, angler use was nearly three times higher at Lucky Peak Reservoir than at Arrowrock Reservoir. A total of 475 anglers were interviewed for catch information. Of the 475 anglers interviewed, 110 (23%) anglers had fished at Arrowrock Reservoir, and the remaining 365 (77%) anglers had fished at Lucky Peak Reservoir (Table 3). Average trip duration of anglers fishing at Arrowrock and Lucky Peak reservoirs were 3.7 and 4.2 h, respectively. About 60% of the interviewed anglers reported their primary target species as kokanee (31% at Arrowrock Reservoir; 70% at Lucky Peak Reservoir). Approximately 45% of the anglers at Arrowrock Reservoir and 18% at Lucky Peak Reservoir indicated they were targeting Rainbow Trout (Figure 2). Anglers indicating they had no preference on fish species represented 23% and 11% of anglers at Arrowrock and Lucky Peak reservoirs, respectively. Finally, less than 1% of all anglers at Lucky Peak Reservoir targeted Smallmouth Bass.

In 2016, angler CPUE was higher at Lucky Peak Reservoir than at Arrowrock Reservoir. On average, anglers targeting kokanee harvested 0.3 kokanee at Arrowrock Reservoir and 1.5 kokanee at Lucky Peak Reservoir, per trip. At Arrowrock Reservoir, approximately 82% of kokanee anglers were unable to harvest a kokanee during that specific trip, while 45% of anglers did not harvest a kokanee at Lucky Peak Reservoir (Figure 3). None of the interviewed kokanee anglers harvested their bag limit at Arrowrock Reservoir, while 7% of Lucky Peak Reservoir kokanee anglers harvested their limit. At Arrowrock Reservoir, overall CPUE of kokanee was 0.05 fish/h, while CPUE at Lucky Peak Reservoir was 0.32 fish/h (Table 4). For anglers targeting kokanee, CPUE was somewhat higher, with 0.12 fish/h estimated at Arrowrock Reservoir and 0.39 fish/h at Lucky Peak Reservoir. Length of kokanee in the creel from Arrowrock Reservoir ranged from 276 to 475 mm, with a mean of 385 mm (Figure 4). At Lucky Peak Reservoir, fish ranged from 253 to 588 mm, with a mean of 352 mm (Figure 4).

Both catch and harvest rates for Rainbow Trout were higher at Arrowrock Reservoir in 2016 than at Lucky Peak Reservoir. Overall, anglers targeting Rainbow Trout harvested an average of 0.7 Rainbow Trout at Arrowrock Reservoir and 0.4 Rainbow Trout at Lucky Peak Reservoir. Approximately 66% and 82% of Rainbow Trout anglers were unsuccessful in harvesting Rainbow Trout at Arrowrock and Lucky Peak reservoirs, respectively. No interviewed anglers harvested their bag limit of Rainbow Trout (six fish) at either reservoir (Figure 3). Rainbow Trout were caught at overall rates of 0.13 and 0.16 fish/h at Arrowrock and Lucky Peak reservoirs, respectively (Table 4). Angler CPUE for anglers specifically targeting Rainbow Trout was 0.21 fish/h at Arrowrock Reservoir and 0.15 fish/h at Lucky Peak Reservoir. Rainbow Trout at Arrowrock Reservoir ranged from 319 to 416 mm with a mean of 363 mm, while fish from Lucky Peak Reservoir ranged from 254 to 385 mm with a mean of 321 mm (Figure 5).

At Lucky Peak Reservoir, angler CPUE and length of age-2 kokanee appear to be positively correlated with later stocking and larger fingerling size. Additionally, angler CPUE was also positively correlated with increased flow metrics during the fish’s stocking year and second year in the reservoir. Finally, length at age-2 was also positively correlated with reservoir capacity at time of stocking (Table 2). Both age-2 CPUE and length at age-2 are negatively correlated with the number of fish stocked and low period storage in the fish’s first year in the reservoir (Table 2).

Based on knowledge of the overall fishing season at Arrowrock Reservoir in 2015, we believe that the high angler CPUE observed there for that year was an outlier. Our CPUE calculations were likely biased high by a short period of good fishing that corresponded with the creel period, and this value was not representative of the Arrowrock fishery as a whole. Therefore, we removed the 2015 CPUE from our correlation analysis. At Arrowrock Reservoir there was little correlation between fish length at age-2 and any of the metrics assessed. The one exception was a strong negative correlation of both age-2 length and CPUE with minimum inflow in the fish's second year in the reservoir (Table 2). CPUE was positively correlated with inflow at time of stocking, higher low-period storage levels, and most flow metrics within the fish's first and second year in the reservoir (Table 2).

Curtain Net – Trawl Comparisons

At Arrowrock Reservoir, gill nets captured a total of 170 fish, with kokanee composing approximately 62% (*n* = 105) of the catch. Rainbow Trout, Yellow Perch (*Perca flavescens)*, Largescale Sucker (*Catostomus macrocheilus*), Chiselmouth (*Acrocheilus alutaceus*), and Northern Pikeminnow (*Ptychocheilus* oregonensis) were also captured (Table 5). Gill net CPUE for kokanee was 5.8 fish/net-night, while WPUE was 1.2 kg/net-night. Length of kokanee ranged from 59 to 450 mm with a mean of 207 mm. Comparatively, the trawl only captured 25 fish, all kokanee. Length of these kokanee ranged from 46 to 106 mm with a mean of 73 mm (Figure 6).

At Lucky Peak Reservoir, a total of 732 fish were captured in gill nets with 88% of the catch comprised of kokanee (*n* = 645). Rainbow Trout, Mountain Whitefish (*Prosopium williamsoni*), Chinook Salmon (*Oncorhynchus tshawytscha*), Redside Shiner (*Richardsonius balteatus*), Yellow Perch, Largescale Sucker, Chiselmouth, and Northern Pikeminnow were also captured (Table 5). CPUE for kokanee was 35.8 fish/net-night, and WPUE was 6.6 kg/net-night. Length of kokanee ranged from 57 to 427 mm with a mean length of 229 mm (Figure 6). Trawling at Lucky Peak Reservoir produced 59 kokanee and 3 Chinook Salmon. Similar to Arrowrock, kokanee captured at Lucky Peak in the trawl were much smaller than those captured using gill nets. Length of trawl-captured kokanee ranged from 53 to 290 with a mean of 108 mm (Figure 6).

For both waters combined, gillnetting efforts captured 750 kokanee with an average length of 225 mm and a size range of 57-450 mm. Combined trawling efforts from both waters produced 84 kokanee with an average length of 98 mm and a range of 46-290 mm.

Four out of the 200 kokanee between 85-131 mm (assumed size range of hatchery-origin age-0 kokanee) sampled in Lucky Peak Reservoir were adipose fin clipped indicating they had been stocked in Arrowrock Reservoir. Expanding these four fish by the 10% clipping rate indicates that of these 200 fish, 40 were likely Arrowrock-stocked and 160 were Lucky Peak-stocked. Assuming equal mortality and catchability, each sampled kokanee represents 1,562.5 stocked fish from the Lucky Peak stocking (250,000/160 = 1,562.5). Extrapolating this to the Arrowrock portion, 1562.5 * 40 = 62,500 or an estimated 62.5% of the 100,000 kokanee stocked into Arrowrock Reservoir were entrained into Lucky Peak Reservoir. Further restricting the length criteria to 90-131 mm (perhaps even more appropriate for hatchery-origin fish) reduced the ratio to 40 to 138 and yields a 72.5% entrainment rate.

DISCUSSION

Angler CPUE and fish size

Since IDFG began using a check station to monitor the kokanee fisheries at Arrowrock and Lucky Peak reservoirs, indexed May effort has varied annually among the reservoirs (Figure

7). For the five years in which the May creel was conducted, angler CPUE appears to be a more prominent driver of effort than fish size, as in all five years of creel surveys, Arrowrock Reservoir has produced larger average sized kokanee than Lucky Peak Reservoir. However, it is important to note that this size discrepancy is not very large (less than 40 mm on average). Lucky Peak Reservoir likely also receives some additional effort due to its closer proximity to the Treasure Valley. Overall effort (for both waters combined) was lower in 2016 when compared to previous years. However, Lucky Peak Reservoir had the highest amount of effort that either water has had in the five years of the survey. The lower overall effort and increased Lucky Peak Reservoir effort are both likely due to the fact that Arrowrock Reservoir had very low angler CPUE (the lowest we have documented at either water in the five years of the survey), while angler CPUE at Lucky Peak Reservoir was the highest it had been since 2013 (Figure 7). Additionally, at Arrowrock Reservoir no interviewed anglers harvested more than two kokanee in a single trip. At Lucky Peak Reservoir, 6.6% of the anglers targeting kokanee caught a bag limit of 6 fish. Conversely, the percentage of anglers who were unable to harvest a kokanee at Arrowrock Reservoir was 82% (compared to 30% in 2015) and 45% at Lucky Peak (compared to 82% in 2015). These metrics confirm the variable nature of these fisheries. The continued downward trend in kokanee fishing at Arrowrock Reservoir is likely due to a combination of water supply and management (low water and poor access to spawning tributaries in the late summer/early fall), slight shifts in stocking practices (earlier stocking), fingerling size at stocking (smaller fingerlings), and variable entrainment levels from both Anderson Ranch Reservoir into Arrowrock Reservoir, and from Arrowrock Reservoir into Lucky Peak Reservoir.

Contrary to kokanee, angler CPUE of Rainbow Trout was higher at Arrowrock Reservoir than at Lucky Peak Reservoir in 2016. Angler CPUE at Arrowrock Reservoir was over 2.5 times higher than in 2015 and second only to 2013 for the five years of surveys (Figure 8). However, in 2016 Lucky Peak Reservoir had the lowest CPUE for Rainbow Trout since 2012. While the average length of Rainbow Trout in the creel was slightly lower at Lucky Peak Reservoir in 2016 than in 2015, there is a general increasing average length of Rainbow Trout caught in both reservoirs since 2014 (Figure 8). This increasing size trend corresponds with the change in catchable stocking size from a 10-inch average to a 12-inch average. Additionally, Rainbow Trout from Arrowrock Reservoir continued to be longer than Rainbow Trout from Lucky Peak Reservoir. This difference has averaged 1.1 inches across all five years of the creel surveys and was 1.7 inches in 2016. Similar to previous years, Rainbow Trout anglers continued to represent about 25% of all anglers interviewed. Trends in creel survey day indicate that Rainbow Trout fisheries, as would be expected, remain much more consistent from year to year than kokanee fisheries in both reservoirs.

The timing and size at stocking of kokanee showed a high level of correlation with both age-2 catch and length observed in creel surveys. Both metrics have been variable over the last few years and this may be a contributing factor to the inconsistent fisheries as we suspect earlier stocking of smaller kokanee has a negative impact on post-stocking survival. In 2012 and 2013, Lucky Peak and Arrowrock reservoir anglers experienced three out of the four highest CPUEs of kokanee for any year of the creel surveys (Figure 7). These kokanee were primarily from fish stocked in 2010 and 2011 and were stocked in early June rather than early May, which has been the typical stocking period for kokanee at both reservoirs since 2012. However, there has been a shift to earlier stocking in order to accommodate raceway space needs for other programs (Butts et al. 2017). This suggests that stocking in June rather than early May could lead to higher angler CPUE of these fish as age-2 adults. IDFG hatchery and management personnel were made aware of this potential issue in early 2016 and are currently re-examining our ability to stock kokanee in June.

In addition to stocking size and timing, various reservoir variables were also correlated with angler CPUE and size at catch of age-2 kokanee. In Lucky Peak Reservoir, both angler CPUE and length at age-2 were negatively correlated with low period storage levels in the year of stocking. In other words, the lower the reservoir was at its lowest level in the months following a fish's stocking event, the better the angler CPUE and larger the size of those fish at age-2. While this may seem counterintuitive in that lower reservoir levels would likely lead to increased water temperatures, lower dissolved oxygen, and increased vulnerability of age-0 fish to predators, Martinez and Wiltzius (1995) found that kokanee in a Colorado reservoir had higher growth and survival when drawdown was the greatest. The authors attributed the higher growth and better survival at lower reservoir levels to increased zooplankton production in the warmer, lower water. While these findings might correspond with drawdown at Lucky Peak Reservoir, we found the opposite to be true at Arrowrock Reservoir where angler CPUE at age-2 was strongly positively correlated with low water periods in the fish's first year, meaning eventual CPUE of these fish was better when minimum reservoir levels were higher in the months following their stocking. These contrary responses to low period reservoir levels might be indicative of differing fish densities and food supplies in the two waters. If overall densities are higher in Lucky Peak Reservoir and food supply is more critical, increased zooplankton production during warmer, lower water events might be more important than in Arrowrock Reservoir where densities are likely much lower and food supply is less critical.

Beyond reservoir drawdown, both reservoirs showed correlations between inflow/outflow metrics and age-2 CPUE within the ranges of flows observed. At Arrowrock Reservoir, the majority of the year-one (fish's first year in the reservoir following stocking) flow metrics as well as year-two max inflow and outflow, showed a strong positive correlation with angler CPUE of those fish at age-2 (Table 2). This would indicate that more water moving through the reservoir (higher inflow and outflow) is beneficial to eventual catch. While intuitively, one might think that higher flow through the reservoir would increase entrainment into Lucky Peak Reservoir, if entrainment is actually driven by lower water and higher late summer temperatures, it makes sense that more age-2 fish are caught when they experience greater inflow and outflow as age-0. At Lucky Peak reservoir, flow metrics in the fish's first year in the reservoir also showed positive correlations with age-2 CPUE, though the correlations were not as strong as at Arrowrock Reservoir. However, the majority of flow metrics evaluated in the fish's second year in the reservoir had a very strong positive correlation with age-2 CPUE (Table 2) indicating again that increased flow through the reservoir is beneficial to kokanee.

Curtain Net – Trawl Comparisons

In 2016, IDFG partnered with University of Idaho researchers to examine and compare curtain nets and mid-water trawling as kokanee monitoring tools. Arrowrock and Lucky Peak reservoirs were part of these statewide evaluations. At both Arrowrock and Lucky Peak reservoirs, the towed trawl was less effective at capturing all size classes of kokanee and was biased towards smaller fish. It is evident that gill nets are the most effective tool in capturing the widest range of kokanee size classes. While trawls might be the most effective at capturing the smallest kokanee size classes, the effort, cost, and time required to conduct these surveys are likely not worth the limited amount of additional data. Using overnight experimental curtain gill net sets, suspended in the kokanee layer of the water column, appears to be the most effective tool to capture and monitor kokanee populations in Arrowrock and Lucky Peak reservoirs and will be the primary tool for annually sampling these populations in the future.

Adipose clipped age-0 kokanee stocked in Arrowrock Reservoir and recovered in Lucky Peak Reservoir, indicate that entrainment of hatchery-origin kokanee was high during 2016.

Estimates of entrainment, depending on the size cut-off of hatchery origin fingerlings used, ranged from ≈ 62-73%. Based on the notion that gillnetting occurred in mid-reservoir portions of Lucky Peak Reservoir and that entrained fish undoubtedly suffer higher mortality, it is likely these are underestimates. Reliance on the recovery of adipose-clipped fish to evaluate entrainment is more difficult and less valid to perform on age-1 kokanee clipped in 2015 and recovered in 2016 because after age-0, there is not a discernable size discrepancy between hatchery-origin and wild kokanee. This makes excluding the wild component from the catch difficult and makes any hatchery-origin specific age-1 expansion estimates (based on capture rates), unreliable. As more year-specific entrainment estimates are generated, we will begin to be able to build more robust correlations between conditions at Arrowrock Reservoir and entrainment levels into Lucky Peak Reservoir, to help us understand what conditions influence entrainment. Entrainment might be influenced by factors such as fingerling size and time of stocking, the amount of flow through the reservoir, as well as reservoir temperatures during low water periods in late summer. In 2017, we will likely adipose clip a higher percentage of the hatchery kokanee destined for Arrowrock Reservoir and further monitor the recovery of these fish in Lucky Peak Reservoir sampling.

RECOMMENDATIONS

1. Continue to monitor the effect of kokanee stocking practices and environmental conditions at Arrowrock and Lucky Peak reservoirs by indexing CPUE 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. Use curtain gill nets to evaluate kokanee relative abundance and possibly, fisheries, through annual index surveys.

3. Discontinue trawling at both reservoirs.

4. Continue to clip a portion of the hatchery-origin kokanee to be stocked in Arrowrock Reservoir to monitor entrainment into Lucky Peak Reservoir.

5. Monitor water temperatures in Arrowrock Reservoir during low pool in August to assess availability of water temperatures <21°C.

Table 1. Kokanee stocking information including stocking dates with associated fish densities and size at stocking for kokanee stocked in Arrowrock and Lucky Peak reservoirs, Idaho between 2004 and 2016.

Waterbody	Year	Date	No. Fish	Mean size (mm)	Fish/lbs	Stocking density (fish/ha)	Stocking density (lb/ha)
Arrowrock	2004	14-Jun	77,025	3.9	41.1	61	1.5
Reservoir	2006	9-May	70,000	89	79.1	56	0.7
1,255 ha	2010	3-Jun	29,000	79	116.0	23	0.2
	2011	8-Jun	30,000	76	100.0	24	0.2
	2012	2-May	50,130	76	111.4	40	0.4
	2013	1-May	50,160	69	152.0	40	0.3
	2014	15-May	49,995	76	97.1	40	0.4
	2015	13-May	101,198	81	95.7	81	0.8
	2016	4-May	99,992	81	100.9	80	0.8
Lucky Peak	2004	14-Jun	155,950	90	108.4	135	1.2
Reservoir	2005	3-Jun	200,150	86	75.5	174	2.3
1,153 ha	2006	24-May	308,050	83	101.0	267	2.6
	2007	31-May	245,000	89	87.5	212	2.4
	2008	3-Jun	195,570	57	288.4	170	0.6
	2009	3-Jun	199,800	83	99.9	173	1.7
	2010	3-Jun	151,050	79	100.7	131	1.3
	2011	8-Jun	174,640	76	94.4	151	1.6
	2012	2-May	200,910	76	107.9	174	1.6
	2013	1-May	251,877	69	148.6	218	1.5
	2014	15-May	237,120	76	98.8	206	2.1
	2015	13-May	250,515	81	87.9	217	2.5
	2016	4-May	252,993	81	99.8	219	2.2

Table 2. Relationship of kokanee length and angler CPUE at age-2 expressed as correlation coefficient (r) values for a suite of reservoir and stocking metrics at both Lucky Peak and Arrowrock reservoirs. Data is from stocking years 2010 through 2014.

Metric	Lucky Peak		Arrowrock	
	CPUE	Length	CPUE	Length
Number of fish stocked	-0.952	-0.791	-0.532	-0.153
Stock-day post May 1	0.855	0.743	0.381	-0.044
Length (mm) at stocking	0.659	0.741	0.195	0.310
Total inflow (cfs) at time of stocking	0.189	-0.372	0.997	0.509
Total outflow (cfs) at time of stocking	0.307	-0.140	0.571	0.644
Percent capacity at time of stocking	0.496	0.959	-0.350	-0.144
Minimum storage (acre-feet) during stocking year	-0.679	-0.541	0.411	0.059
Minimum storage (acre-feet) during year following stocking	-0.455	-0.483	-0.121	-0.310
Maximum storage (acre-feet) during stocking year	0.664	0.667	-0.487	-0.307
Maximum storage (acre-feet) during year following stocking	0.155	0.362	-0.136	-0.284
Average storage (acre-feet) during lowest three months of stocking year	-0.758	-0.817	0.741	0.248
Average storage (acre-feet) during lowest three months of year following stocking	-0.117	-0.398	0.149	-0.112
Average storage (acre-feet) during lowest single month of stocking year	-0.901	-0.773	0.895	0.432
Average storage (acre-feet) during lowest single month of year following stocking	-0.289	-0.687	0.189	-0.11
Minimum inflow (cfs) during stocking year	0.656	0.145	-0.078	0.058
Minimum inflow (cfs) during year following stocking	0.782	0.642	-0.976	-0.755
Maximum inflow (cfs) during stocking year	0.677	0.210	0.787	0.565
Maximum inflow (cfs) during year following stocking	0.922	0.588	0.704	0.349
Mean inflow (cfs) during stocking year	0.605	0.413	0.833	0.523
Mean inflow (cfs) during year following stocking	0.804	0.568	0.482	0.168
Total inflow (cfs) during stocking year	0.603	0.142	0.833	0.526
Total inflow (cfs) during year following stocking	0.791	0.597	0.421	0.092
Minimum outflow (cfs) during stocking year	-0.150	-0.017	*a*	*a*
Minimum outflow (cfs) during year following stocking	-0.462	-0.110	*a*	*a*
Maximum outflow (cfs) during stocking year	0.787	0.344	0.864	0.579
Maximum outflow (cfs) during year following stocking	0.904	0.628	0.708	0.388
Mean outflow (cfs) during stocking year	0.608	0.149	0.806	0.501
Mean outflow (cfs) during year following stocking	0.802	0.574	0.503	0.196
Total outflow (cfs) during stocking year	0.606	0.147	0.804	0.502
Total outflow (cfs) during year following stocking	0.786	0.603	0.446	0.124

a - minimum outflow at Arrorock was 0 cfs for all years

Table 3. Creel survey sampling schedule 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 2016. Dates, day type, and time period were initially selected randomly in 2012.

Date	Day Type	Time Period	Arrowrock	LuckyPeak
5/1	Weekend/Hol	Early	43	122
5/2	Weekday	Late	10	46
5/11	Weekday	Early	8	49
5/20	Weekday	Early	0	12
5/27	Weekend/Hol	Late	12	21
5/29	Weekend/Hol	Early	37	115
Total			110	365

Table 4. Angler CPUE by time periods, day type, angling methods, and gear types for Kokanee Salmon and Rainbow Trout at Arrowrock and Lucky Peak reservoirs, Idaho in 2016.

	Kokanee (fish/h)		Rainbow trout (fish/h)	
	Arrowrock	Lucky Peak	Arrowrock	Lucky Peak
Weekday	0.08	0.25	0.15	0.04
Weekend/Hol	0.04	0.35	0.16	0.16
Early Period	0.03	0.32	0.17	0.12
Late Period	0.11	0.32	0.14	0.15
Kokanee targeted	0.12	0.39	-	-
Rainbow trout targeted	-	-	0.12	0.14
Overall	0.05	0.32	0.13	0.16

Table 5. Number, catch-per-unit-effort (CPUE), and weight-per-unit-effort (WPUE) for various species captured in gill nets at Arrowrock and Lucky Peak reservoirs in 2016.

Waterbody	Species	Number	CPUE	WPUE (kg)
Arrowrock Res	Fall Chinook	3	0.17	0.04
	Rainbow x Cutthroat	1	0.06	0.02
	Kokanee	105	5.83	1.20
	Largescale Sucker	7	0.39	0.32
	Northern Pikeminow	40	2.22	0.70
	Rainbow Trout	10	0.56	0.15
	Yellow Perch	4	0.22	0.01
Lucky Peak Res	Chiselmouth	2	0.11	0.02
	Fall Chinook	8	0.44	0.02
	Kokanee	645	35.83	6.63
	Largescale Sucker	13	0.72	0.40
	Mountain Whitefish	1	0.06	0.02
	Northern Pikeminow	7	0.39	0.26
	Rainbow Trout	24	1.33	0.30
	Redside Shiner	22	1.22	0.01
	Yellow Perch	10	0.56	0.00

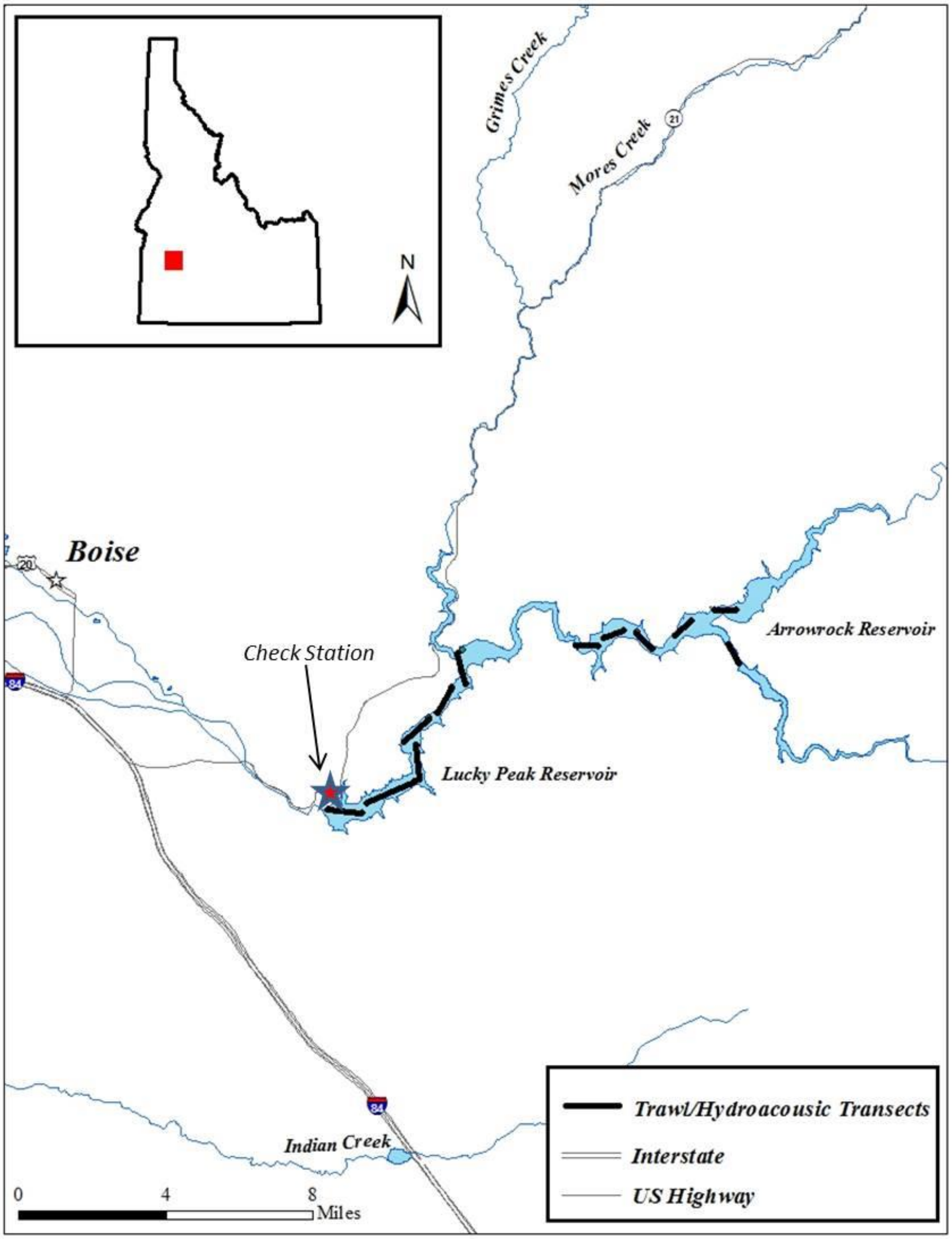

Figure 1. Map of Arrowrock and Lucky Peak reservoir, Idaho, with location of the creel station where clerks can intercept anglers from both waters. Trawl surveys were conducted in 2016 while hydroacoustic surveys were discontinued in 2015.

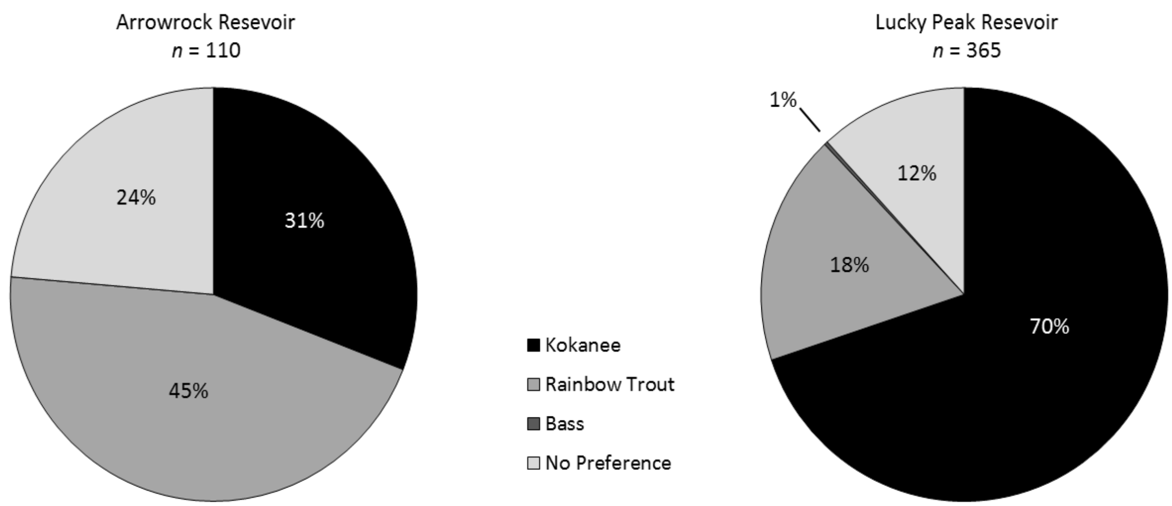

Figure 2. Proportion of anglers targeting game fish species at Arrowrock and Lucky Peak reservoirs in May 2016.

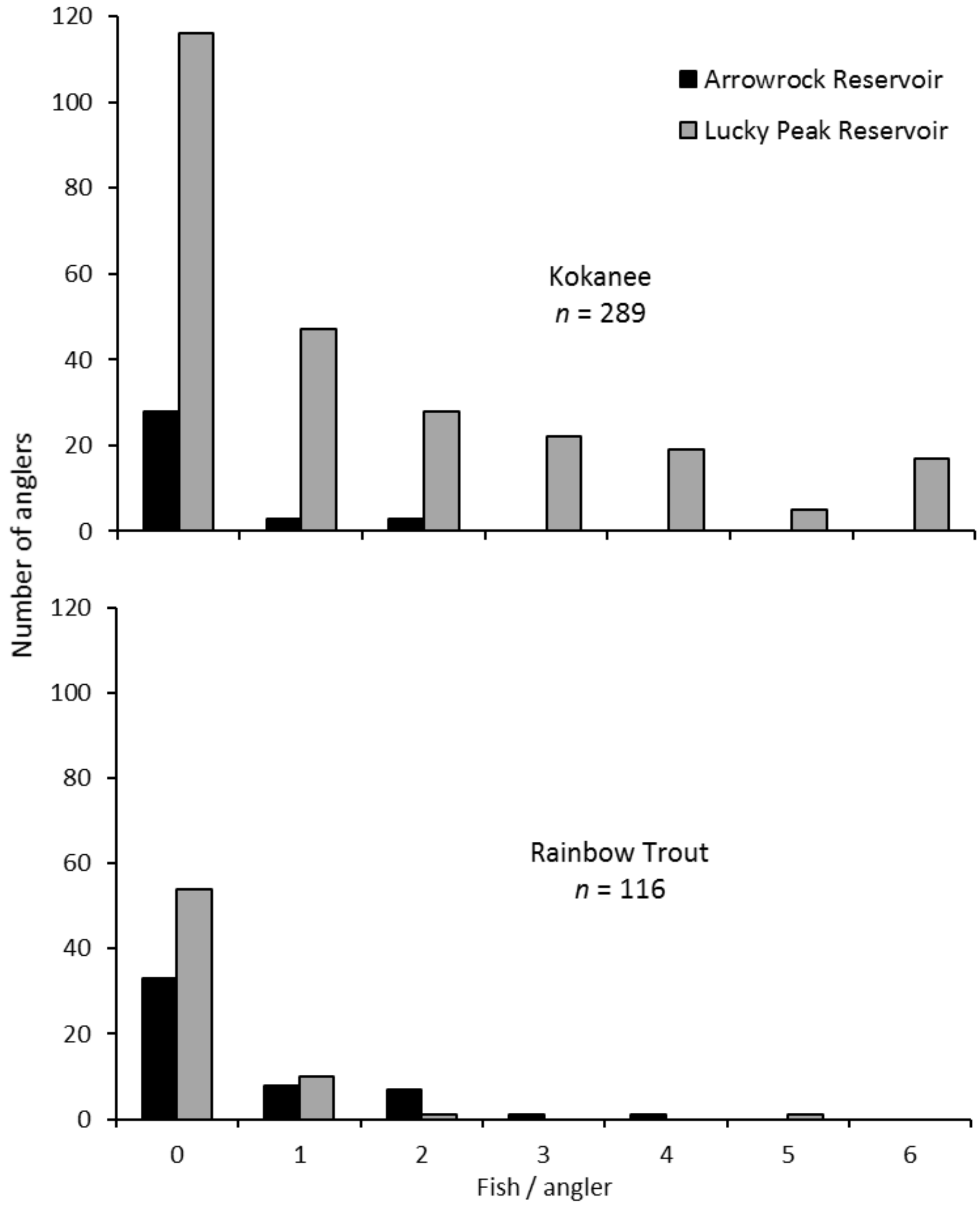

Figure 3. Frequency of harvest by angler for kokanee and Rainbow Trout at Arrowrock and Lucky Peak reservoirs in 2016.

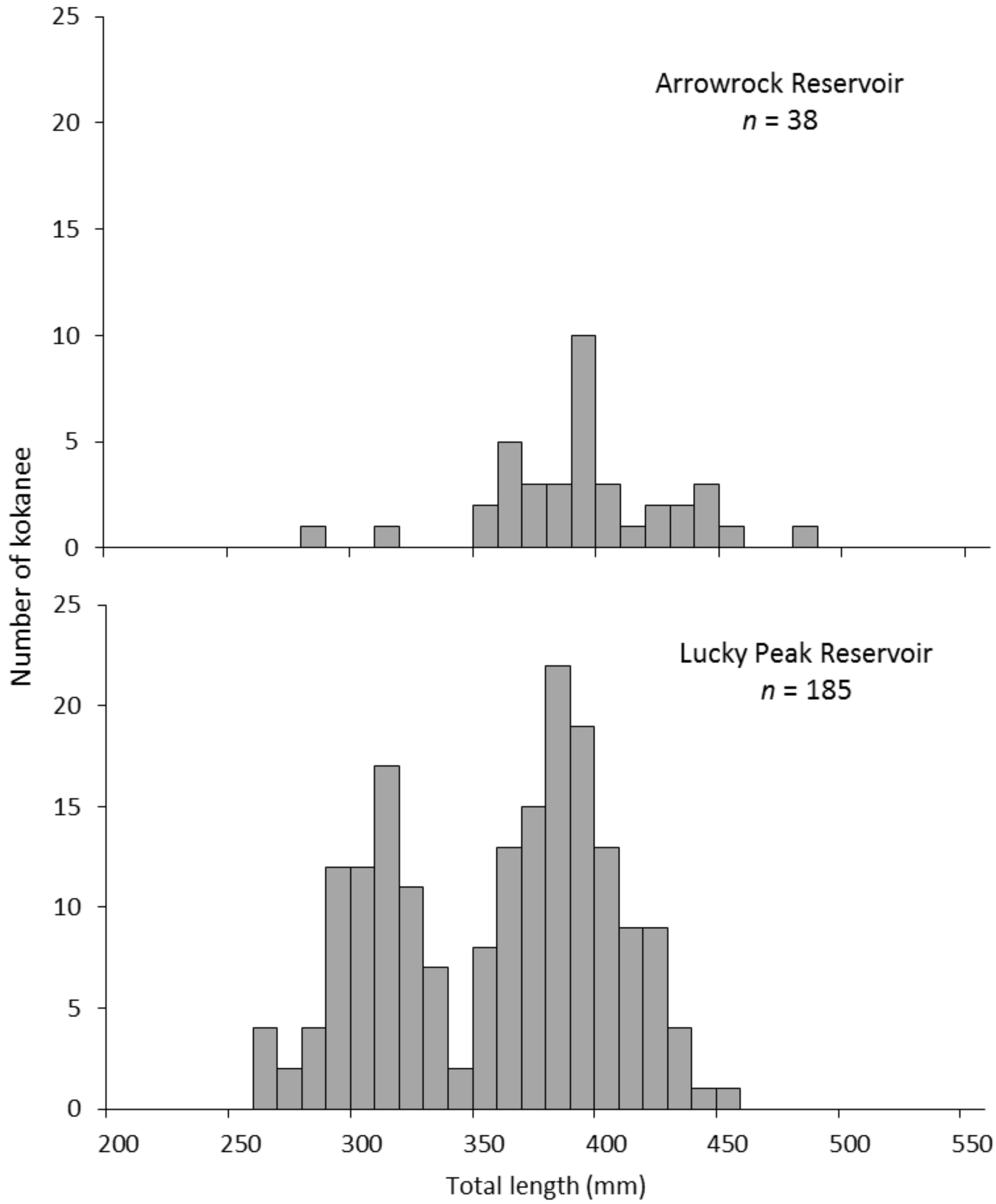

Figure 4. Length frequency distributions of kokanee observed in the creel in May 2016 at Arrowrock and Lucky Peak reservoirs.

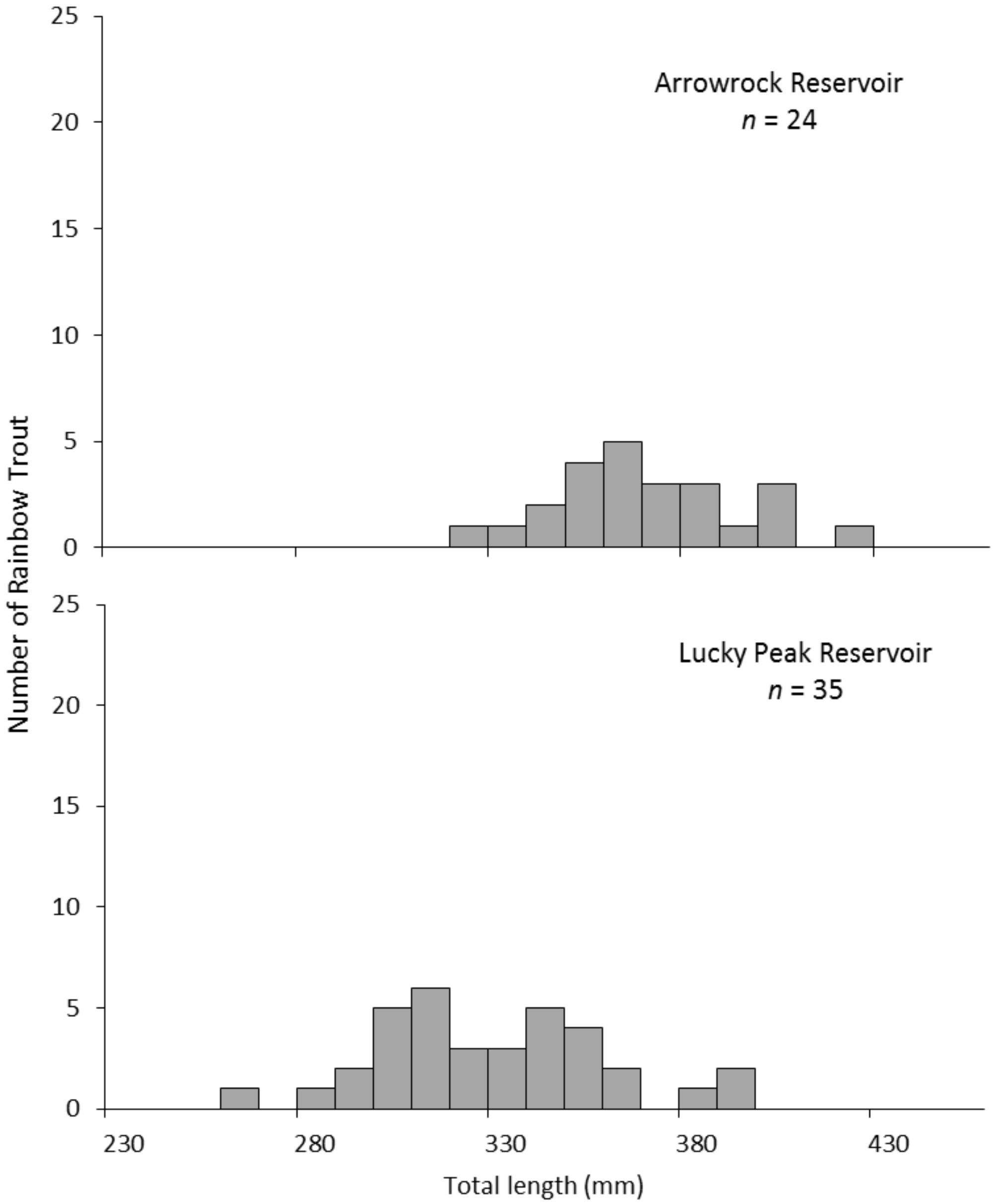

Figure 5. Length frequency distributions of Rainbow Trout observed in the creel in May 2016 at Arrowrock and Lucky Peak reservoirs.

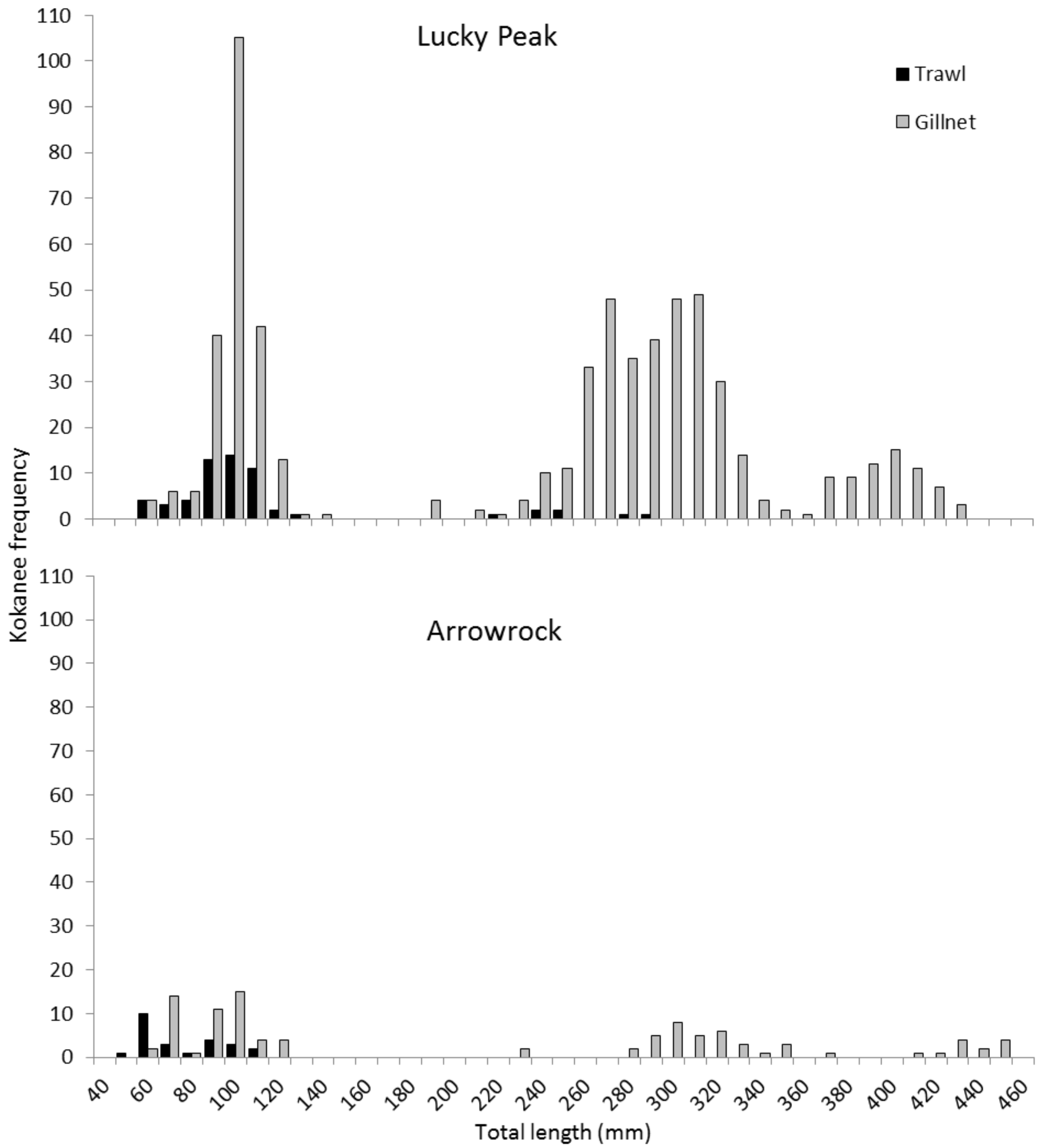

Figure 6. Length frequency distributions of kokanee captured in curtain nets compared to a towed trawl in June, 2016 at Arrowrock and Lucky Peak reservoirs.

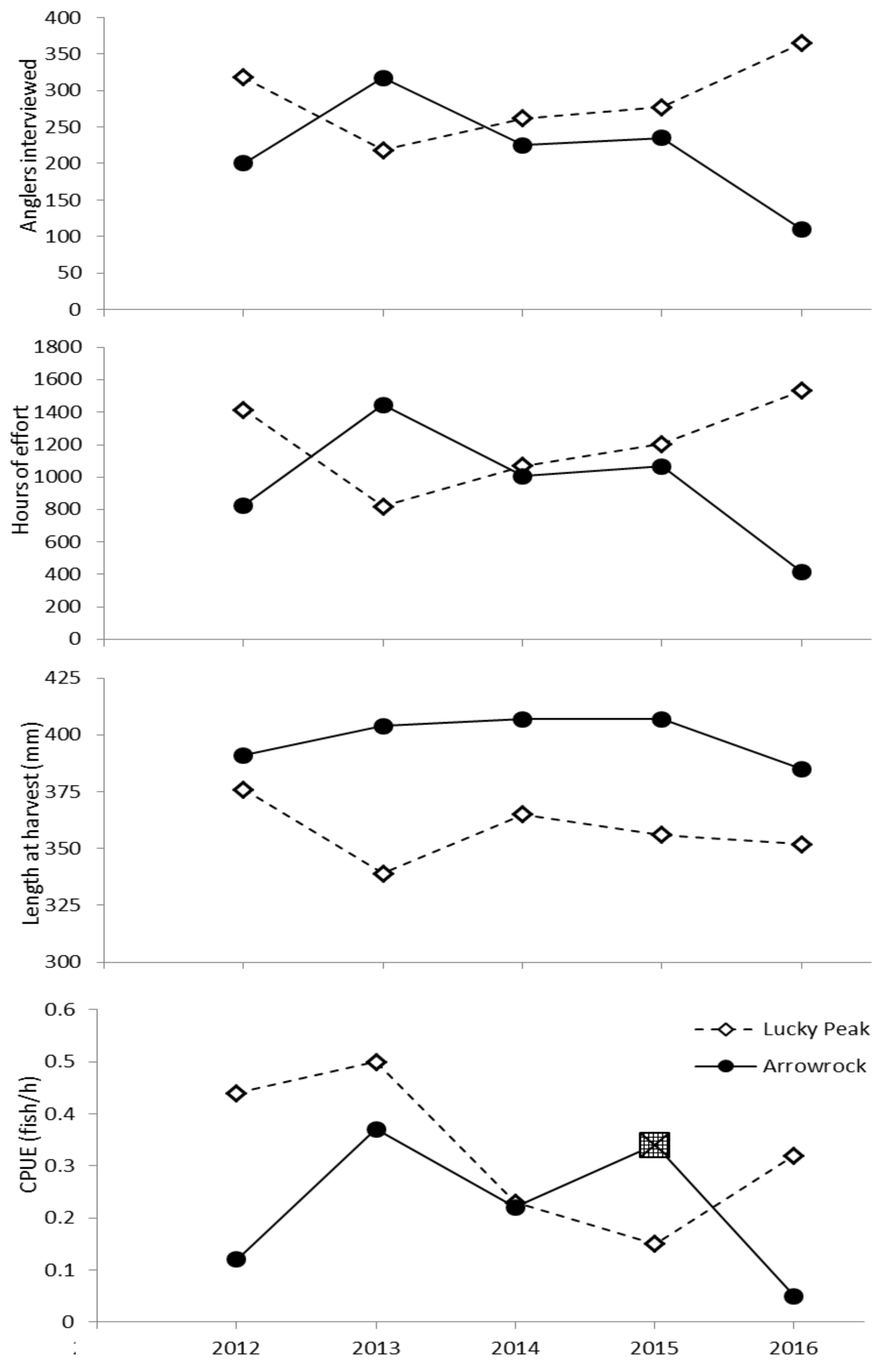

Figure 7. Trends in anglers interviewed, hours fished, kokanee mean length in creel (mm), and kokanee CPUE (fish/h) at Arrowrock and Lucky Peak reservoirs during May 2012 to 2016. CPUE data at Arrowrock in 2015 is likely biased high and considered an outlier based on other anecdotal evidence.

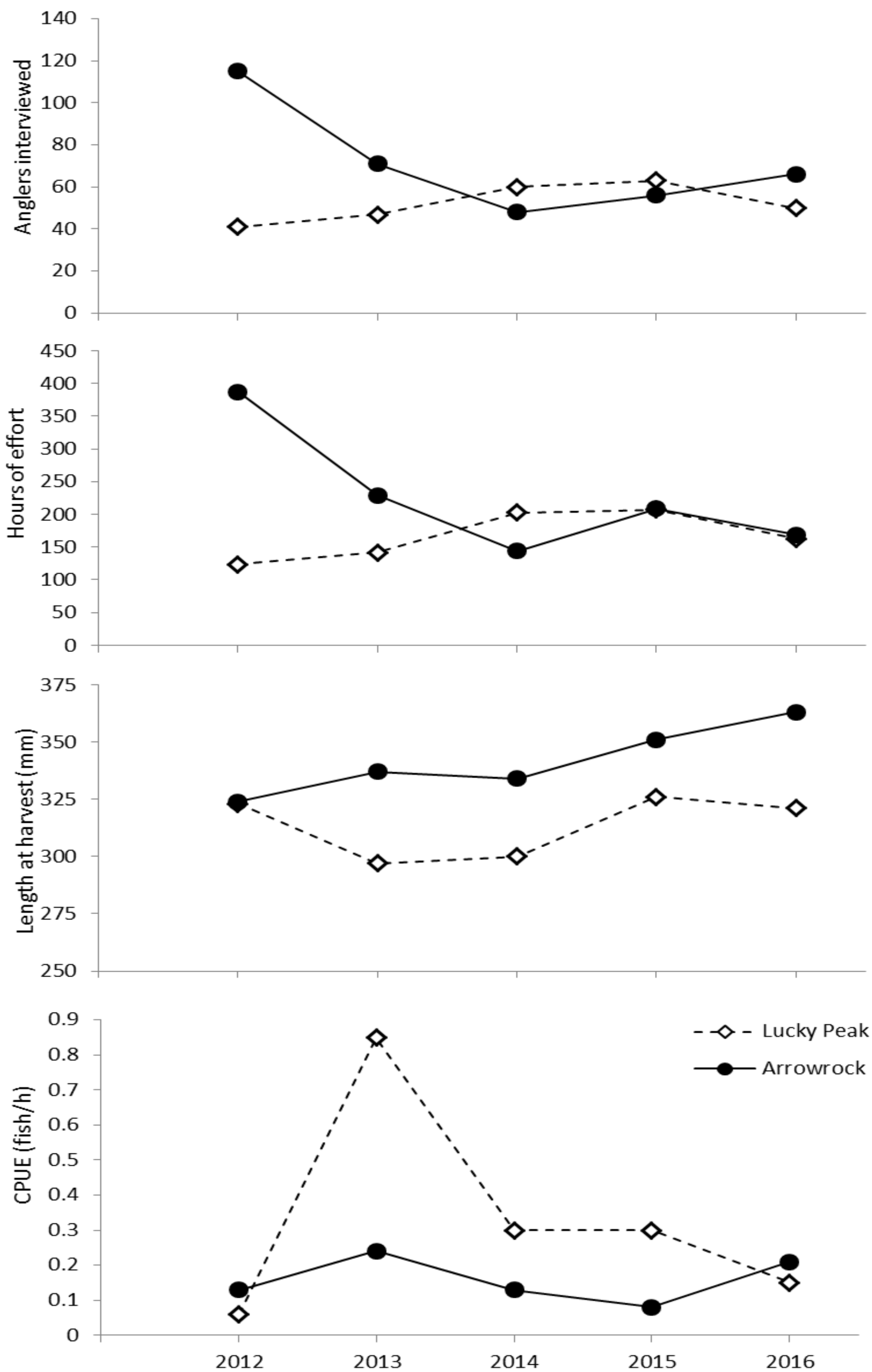

Figure 8. Trends in anglers interviewed, hours fished, Rainbow Trout mean length in creel (mm), and Rainbow Trout CPUE (fish/h) at Arrowrock and Lucky Peak reservoirs during May 2012 to 2016. Data is for anglers specifically targeting Rainbow Trout.

DEADWOOD RESERVOIR MONITORING IN 2016

ABSTRACT

Kokanee *Oncorhynchus nerka* are the landlocked form of Sockeye Salmon *O. nerka* and provide recreational fisheries and a prey base for piscivores in many waters of the western United States. The fishery at Deadwood Reservoir is supported primarily by kokanee and other salmonids that may prey on kokanee to reach large sizes. Also, the kokanee population at Deadwood Reservoir is Idaho's primary egg source of early run strain. Kokanee escapement has been managed annually since 2010 to regulate fish densities, provide desirable sizes for the sport fishery, and meet egg collections goals to support other kokanee fisheries. Monitoring, utilizing hydroacoustics and netting, is important for setting escapement targets and monitoring the effectiveness of management strategies. During 2016 hydroacoustics monitoring, kokanee densities among transects ranged from 67 to 246 fish/ha with the highest densities corresponding to age-0 fish. The lowest densities (8 fish/ha) corresponded to age-3 kokanee. Geometric mean kokanee density was 144 fish/ha. When expanded to a population estimate using the reservoir surface area (1,183 ha) on the survey date, total kokanee abundance was 177,717. Age-0 kokanee were 48% of this total or 86,421 fish. Age-0 kokanee abundance decreased by 75% while total kokanee abundance declined by 67% between 2015 and 2016. Utilizing curtain nets, kokanee CPUE was 6.5 fish/net night during 2016. We projected the mean length of a mature female at the weir three weeks later to be 356 mm. In 2015, kokanee CPUE was 23.9 fish/net night and mean length of mature female was 344 mm (Butts et al. 2016). Kokanee CPUE decreased by 73% between 2015 and 2016. Hydroacoustics and curtain gill net monitoring indicated that kokanee abundance has declined further than desired or intended. Abundance of young kokanee needs to be increased through stocking or increased escapement.

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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 9). The reservoir offers a scenic setting at a relatively high elevation, and is a popular destination for many during 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. clarkii lewisi*. Bull Trout *Salvelinus confluentus* are present, but at a 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 here as this kokanee population experiences low angling pressure and has five tributaries with excellent spawning habitat. In addition, the reservoir supports low densities of piscivores that have been incapable of suppressing kokanee abundance. Therefore, staff has sought to suppress kokanee abundance and increase mean size by managing escapement into spawning tributaries with weirs.

Deadwood Reservoir's kokanee population also serves as Idaho's primary egg source for producing early spawning kokanee. Annually, this population usually 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 objectives 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 measurements, estimates, and objectives will be beneficial for the management of this fishery. Current kokanee population management and monitoring activities include annual hydroacoustics and nettings surveys, as well as monitoring and managing escapement with weirs on the Deadwood River and Trail Creek. In 2010 and 2011, kokanee escapement was managed successfully in the Deadwood River and Trail Creek, using picket weirs and traps until the egg collection quota was met. After meeting the egg quota, the weirs were removed with an unknown number of prospective spawning kokanee remaining. This practice, if implemented for several years, could lead to altered spawn timing as additional kokanee would migrate upstream and spawn after weir operations ceased. To avoid shifting the spawn timing, weir operations in 2012 and annually through 2016 have incorporated weekly escapement targets for female kokanee and required that the weirs were operated through the entire run. In 2015, mean length at maturity of female kokanee surpassed objectives and kokanee escapement was increased above the Deadwood River weir (Butts et al. 2016).

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 echo sounder on July 5-6, 2016. 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 two small-mesh and two large-mesh curtain nets during July 5-6, 2016 (Figure 9). Plans for an additional night of netting were canceled due to boat mechanical problems. 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. Effort for the small-mesh and large-mesh nets were for three and four net nights, respectively.

Captured fish were identified to species and measured for total length (± 1 mm). Larger kokanee were necropsied to determine sex, maturity, and to assess mean length of females during the spawning run. Catch data were summarized as the number of fish caught per unit of effort (CPUE).

RESULTS

Hydroacoustics

Hydroacoustics data were analyzed to estimate kokanee abundance by size/age group. Converted target strengths of fish ranged between 30 to 700 mm, and kokanee were assumed to range between 30 and 400 mm (Figure 10). Kokanee densities among transects ranged from 67 to 246 fish/ha with the highest densities corresponding to age-0 fish (Table 6). The lowest densities (8 fish/ha) among all age classes corresponded to age-3 kokanee. Over all transects, geometric mean kokanee density was 144 (range 122 to 171) 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 177,717 (range 150,277 to 210,126). Age-0 kokanee were 48% of this total or 86,421 (range 66,961 to 111,435) fish (Figure 11). In 2015, total kokanee abundance was estimated to be 543,352 (range 452,968 to 651,724) of which 348,764 or 64% (range 282,103 to 431,110) were age-0 fish (Butts et al. 2016). Age-0 kokanee abundance decreased by 75% while total kokanee abundance declined by 67% between 2015 and 2016.

From 2002 through 2016, mean female length (mm) at maturity (measured at the Deadwood weir) and total kokanee density (fish/ha) have exhibited a negative relationship (Figure 12; $r^2 = 0.56$, $P < 0.05$). This model predicts the management objective for adult kokanee length is met when reservoir kokanee densities 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 hydroacoustics density estimate and mean length of adults for that year.

Curtain nets

A total of 56 fish were captured in curtain nets during the pelagic survey (Table 10). Approximately 46% of the catch was kokanee (*n* = 26), followed by Mountain Whitefish *Prosopium williamsoni* (46%; *n* = 26). Westslope Cutthroat Trout and Rainbow Trout were also captured, but in very low numbers. No fall Chinook Salmon were captured in 2016.

The kokanee captured in curtain nets ranged from 125 to 410 mm (Figure 10) and were presumed to be composed of three age classes (ages 1-3; Figure 10). Kokanee CPUE was 6.5 fish/net night (Table 7). From specimens collected in curtain nets, we projected the mean length of a mature female at the weir three weeks later to be 356 mm. In 2015, kokanee CPUE was 23.9 fish/net and mean length of mature female was 344 mm (Butts et al. 2016). Kokanee CPUE decreased by 73% between 2015 and 2016.

Mountain Whitefish, Rainbow Trout, and Westslope Cutthroat Trout were also captured in curtain nets (Figure 10). Total length of Mountain Whitefish ranged from 190 to 418 mm, and CPUE was 6.5 fish/net night (Table 7). Total lengths of the two Rainbow Trout sampled were 402 and 418 mm, and CPUE was 0.5 fish/net. Total lengths of the two Westslope Cutthroat Trout were 367 to 380 mm, and CPUE was 0.5 fish/net.

DISCUSSION

Annual kokanee population management efforts have resulted in larger kokanee. During 2016, adult kokanee lengths exceeded the management objective of 325 mm by more than 40 mm. Unfortunately and correspondingly, the numbers of adults that migrated to the weir were well below desired levels leading to poor egg collection totals. Concern over low abundance of older age classes began after 2015 curtain gill net sampling efforts and continued after 2016 sampling efforts. Catch in 2015 indicated that mean female size at maturity was 340 mm, a 74-mm increase from the previous year (Butts et al. 2016). This trend continued during 2016 as mean length increased again. Correspondingly, abundance trends have shown a decreasing trend. A hydroacoustics survey during that same period corroborated that mean kokanee density had declined from 764 kokanee/ha in 2014 to 455 kokanee/ha in 2015. Managers responded by increasing kokanee escapement upstream of the weir in 2015 to 9,850 females or about three million eggs. Despite this, density measured during 2016 declined further again.

There are several possible reasons why increased levels of managed escapement has not led to reversing populations trends towards 325 mm adults and higher densities. It is possible that age-0 or age-1 fish are not being measured properly with either of our sampling gears. There is some evidence supporting this notion as age-0 and age-1 fish do not appear to be fully susceptible to our sampling gears. Secondly, it is possible that the regulated escapement is not producing enough age-0 kokanee. This could be due to too few females being released above the weir or due to survival rates less than expected and modeled. Using a mean survival of 35% for age-0 to of age-1 kokanee from past hydroacoustics estimates (2005-2014), the abundance of age-1 kokanee was predicted to be 254,582 for the 2015 brood year. However, the age-1 year class was estimated at 31,853 (range 26,728 to 37,916) fish in 2016, or 87% lower than expected.

Concerns over low adult kokanee abundance were confirmed during the 2016 egg take. In previous years, hydroacoustics estimates of age-3 kokanee were a reasonable predictor of total kokanee handled at the weir during the egg take. For example, in 2015, the hydroacoustics estimate of age-3 kokanee was 47,591 and approximately 47,000 kokanee were handled at the weir during the subsequent egg take (A. Endicott, personal communication). In comparison, while managers were expecting approximately 9,000 fish in 2016, only 4,436 were handled. Reasons for the disparity include sampling error with hydroacoustics or high angler exploitation. Angler effort and harvest for kokanee were reportedly high during the 2016 summer based on officer and angler reports. Angler pressure may have been higher than normal as a response to reports of high bag limits of large kokanee (≥350 mm or 14 in). Numbers of spawning females at the Deadwood River weir were low enough that managers were unable to meet escapement or egg collection objectives in 2016, though staff were still able to collect about 1.3 million eggs. Escapement objectives for 2016 were not met due to the low number of adults returning and need to maximize egg collection; therefore, only 710 females were passed. The 2016 kokanee brood year class will be supplemented by stocking approximately 360,000 fingerling kokanee in June 2017. It is possible that this year class may mature earlier than their wild counterparts due to differential early life growth rates.

Managers also assessed spawning escapement management during the year that the 2016 mature kokanee would have originated to identify possible reasons for the low numbers. Most mature spawning kokanee in 2016 would have originated from fish spawning in 2013. In 2013, the weir was installed on August 15, after which a spawner survey was conducted which revealed nearly 7,000 kokanee had moved upstream prior to the weir installation (Koenig et al. 2015). Because of the high numbers of fish already upstream, only 50 females per week were released upstream for the remainder of the spawning season. It is possible that most of the early kokanee were males as has often been observed for sockeye salmon (Burgner et al. 1991).

Unfortunately, hydroacoustics monitoring of the Deadwood Reservoir kokanee population indicate abundance continues to decline despite increasing escapement in 2015. Total abundance of kokanee during 2016 has declined approximately 96% compared to 2010, 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 third consecutive year for which mean length at maturity of females has increased. Additionally, the abundance of age-0 kokanee decreased to approximately 86,421, the lowest estimate since 2003 (Figure 11).

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 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 12. 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 and leakage is always present. However, this assumption was likely invalid since there has not been a weir failure since 2012, and the weir has been operated for entire spawning seasons. Therefore, we likely did not pass sufficient numbers of female kokanees between 2013-2014 to meet population and egg collection 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 in the future.

Pelagic curtain nets continue to provide important information on kokanee 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 hydroacoustics data. As hydroacoustics surveys will become increasingly unlikely with changes in personnel, technology, and cost, the kokanee population at Deadwood Reservoir will likely be monitored by pelagic curtain nets after 2016.

Chinook Salmon abundance has remained relatively stable, low, and has not been supported by natural spawning or production. During the previous year, spawning ground surveys were discontinued in the Deadwood River. Unfortunately, Chinook Salmon were not captured in curtain nets in 2016. However, future monitoring of Chinook Salmon may be continued periodically using curtain nets. Additionally, Deadwood Reservoir is part of an IDFG multi-waterbody study to evaluate sterile triploid (3N) fall Chinook Salmon.

The kokanee population at Deadwood Reservoir is currently less than management objectives in terms of numbers, but the overall size of fish is exceeding objectives. Although anglers may experience lower catch rates, they will likely be highly satisfied with kokanee size. We expect the population will still support a quality sport fishery which will attract anglers to Deadwood Reservoir. However, it appears that kokanee numbers will be too low to support an egg take in 2017 as numbers of mature fish are predicted to be lower than in 2016. With supplementation and active management, we expect the kokanee population to support both a sport fishery and broodstock collection operation by 2018.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring the kokanee population in Deadwood Reservoir with curtain nets and sample prespawning fish to project mean length in 2017.

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 monitor kokanee escapement in 2017. 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.

5. Stock 360,000 fingerling kokanee in Deadwood Reservoir in June 2017.

Table 6. Kokanee densities (number/ha) per transect and total abundance estimates calculated by arithmetic and geometric mean densities at Deadwood Reservoir, Idaho on July 5-6, 2016.

		Fish densities (number / ha)				
Transect	**Transect length (m)**	**Age-0**	**Age-1**	**Age-2**	**Age-3**	**Total**
1	805	197	22	21	6	246
2	801	147	26	25	25	223
3	776	43	15	35	5	98
4	803	27	26	24	11	88
5	817	27	53	71	5	156
6	861	101	25	47	21	194
7	829	127	46	64	8	245
8	651	97	35	28	7	167
9	766	91	10	43	17	162
10	836	59	33	33	17	142
11	805	35	28	4	0	67
12	946	63	20	3	2	89
	Geometric Mean (GM)	**70**	**26**	**25**	**8**	**144**
	90% CI (GM)	**54 to 90**	**22 to 31**	**18 to 36**	**5 to 11**	**122 to 171**
	Abundance (GM)	**86,421**	**31,853**	**31,358**	**9,243**	**177,717**
		66,961 to 111,435	**26,728 to 37,916**	**22,057 to 44,374**	**6,148 to 13,636**	**150,277 to 210,126**

Table 7. Total catch and catch per unit effort (CPUE) by species in seven pelagic net curtains in Deadwood Reservoir, Idaho on July 5-6, 2016.

Species	Total Catch	Total CPUE
Kokanee	26	6.5
Mountain Whitefish	26	6.5
Rainbow Trout	2	0.5
Westslope Cutthroat Trout	2	0.5
Total	56	14.0

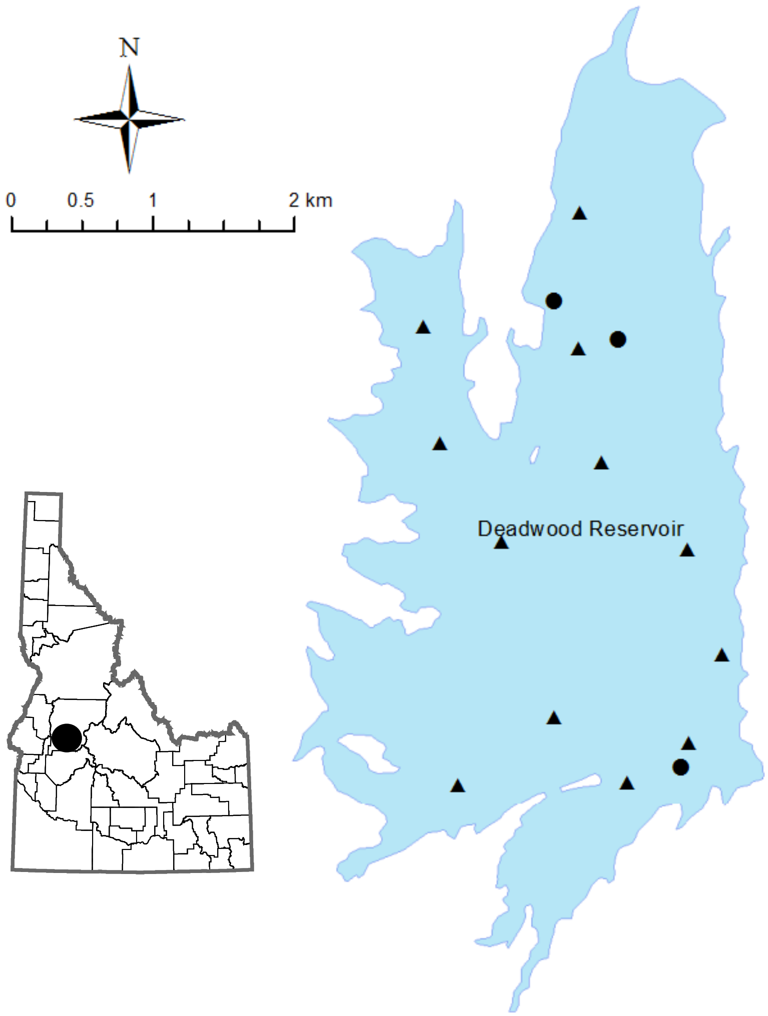

Figure 9. Map of Deadwood Reservoir, Idaho showing hydroacoustic transect starting points (triangles) and curtain net locations (circles).

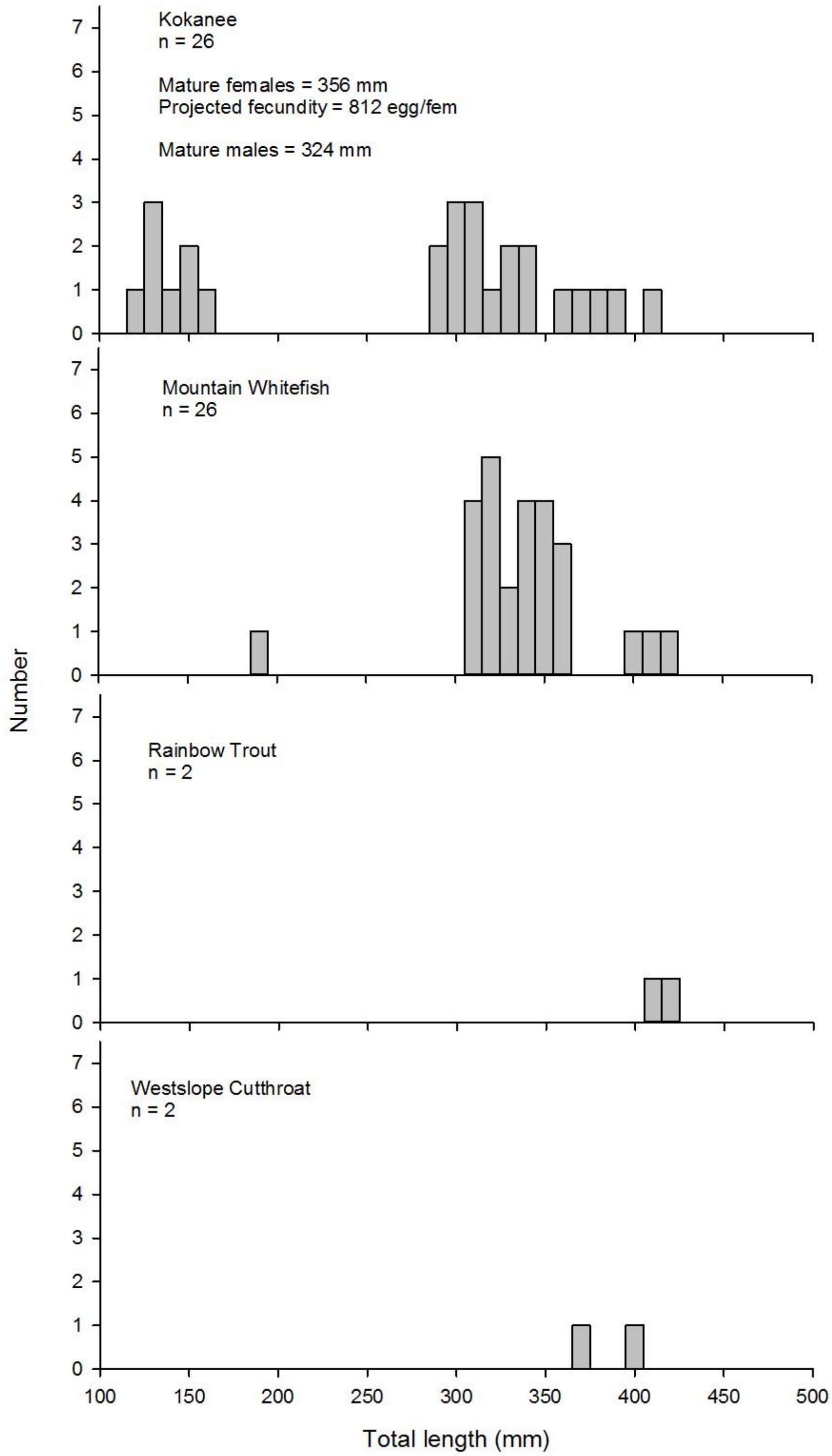

Figure 10. Length distributions for kokanee, Mountain Whitefish, Rainbow Trout, and Westslope Cutthroat Trout caught in curtain nets at Deadwood Reservoir, Idaho on July 5-6, 2016.

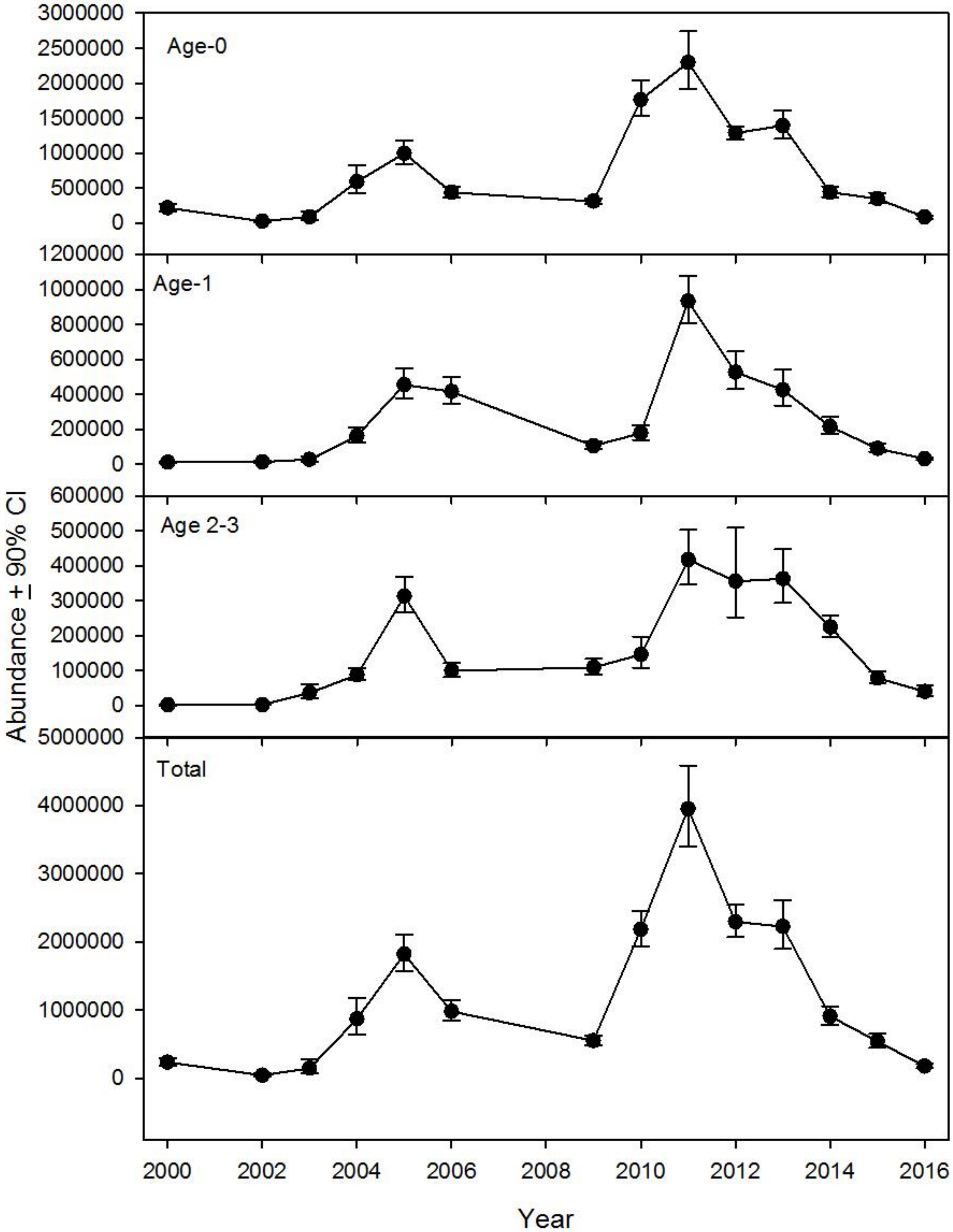

Figure 11. Comparison of kokanee abundance estimates ± 90% Confidence Intervals for fish <100 mm (age-0), 100-200 mm (age-1), >200 mm (age 2+), and total fish as estimated from annual hydroacoustics surveys from 2000-2016 at Deadwood Reservoir, Idaho.

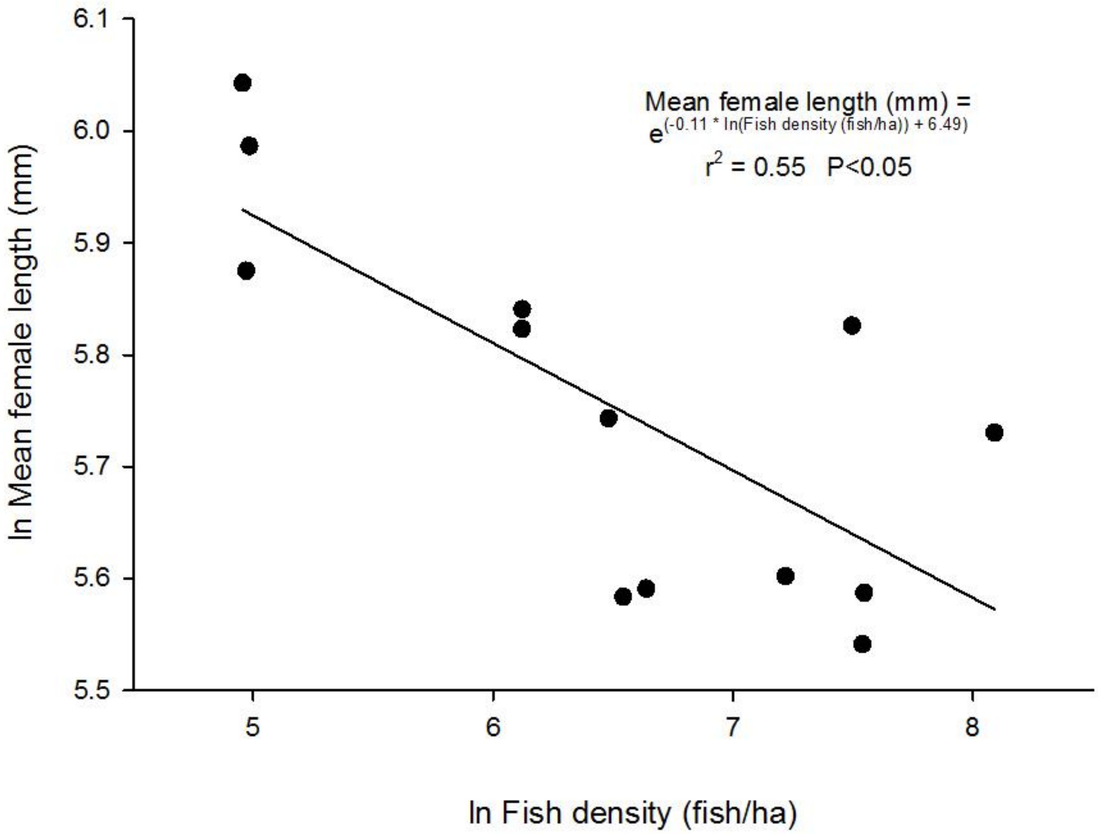

Figure 12. Density-dependent relationship plotted as a function of fish density and length-at-maturity of females, for kokanee at Deadwood Reservoir, Idaho. Fish density was estimated using summer hydroacoustics estimates while mean female length at maturity was obtained from weir data on Deadwood River.

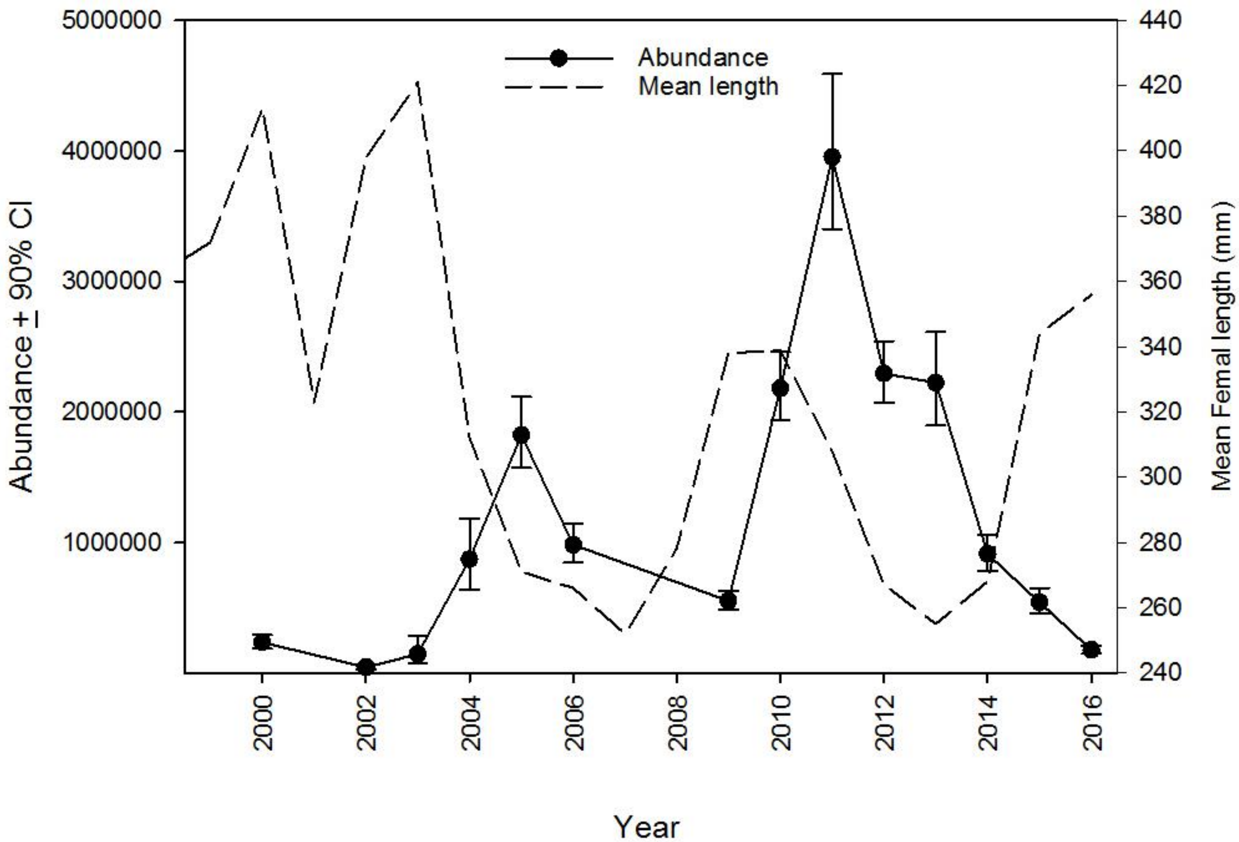

Figure 13. Hydroacoustics abundance estimates and mean female total length (mm) collected at the Deadwood River trap from 1998-2016. The management goal for mean adult length is represented by the horizontal dotted line.

ASSESSMENT OF PANFISH POPULATION DYNAMICS IN CJ STRIKE RESERVOIR

ABSTRACT

Panfish species found in CJ Strike Reservoir are very popular and provide recreational angling opportunities. This fishery can also be very important economically. Past survey data indicated that much of the fishing effort expended on CJ Strike Reservoir was for panfish species such as Black Crappie *Pomoxis nigromaculatus*, White Crappie *Pomoxis annularis*, and Yellow Perch *Perca flavescens*. An assessment was initiated in 2016, the first of a multiyear investigation, to gain a better understanding of crappie (both Black and White Crappie) and Yellow Perch population dynamics and to learn how anglers utilize these species in the fishery. Index creel surveys were designed and conducted in both the spring and fall months. Continued monitoring of larval fish production was also completed in 2016 using a Neuston net to identify peak larval mean densities for crappies and Yellow Perch. In addition, otter trawl gear was operated to index relative abundance of young panfish species prior to entering their first winter. A total of 317 anglers were interviewed during the index creel surveys in 2016. Harvest rates were higher during the fall survey for Yellow Perch, but were similar in both seasons for crappies. Harvested crappies and Yellow Perch were predominately age-4 in both seasons. Peak larval crappies abundance was 10.6 fish/100 m^3, which represented a decrease of 58% below the mean since 2005. The larval Yellow Perch abundance was measured at 12.0 fish/100 m^3, slightly higher than crappies. A total of 21 tows were conducted using the otter trawl net and species composition consisted of mainly Yellow Perch (49%), Bluegill (36%), and crappies (13%). During the first year of the assessment, angler harvest patterns were identified and new gears were used to sample panfish species. Additional years of data collection and analysis are needed to further increase our understanding of these populations.

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INTRODUCTION

Panfish (e.g. crappies *Pomoxis* sp., Yellow Perch *Perca flavescens*, and Bluegill *Lepomis macrochirus*) commonly provide angling opportunity in many Idaho waters. One of the most popular and robust fisheries for panfish in Idaho may be found at CJ Strike Reservoir. According to creel data collected by Idaho Power Company (IPC) between 1994 and 2009, anglers expended an average of 260,000 hours annually at CJ Strike Reservoir (Brown et al. 2010). This fishery is important to local economies. In 2011, anglers spent an estimated $13.8 million per year to fish here (IDFG, unpublished data). Both of these survey efforts indicated that much of the angling effort and expenditures were directed at panfish (Brown et al. 2010).

Populations of and fisheries for crappies in CJ Strike Reservoir are perceived to be cyclic and can fluctuate dramatically from one year to the next. In years when crappies are abundant, the proportion of anglers targeting crappie may more than double (Brown et al. 2010). The most recent large year class of crappies was produced in 2006 and provided substantial fisheries in 2008, 2009, and later, though creel information wasn't collected after 2009 (Brown et al. 2010). Very high larval densities were sampled in the Bruneau River arm during 2006. These larval crappies survived at a high rate, but were not sampled again in a meaningful way until 2009. Electrofishing catch per unit effort (CPUE) for Black Crappie during the 2009 lowland lake survey was 23 times higher than the highest observed CPUE from five previous surveys (1995-2000; Butts et al. 2011). This year class declined in abundance after 2010, and no major year classes have contributed to the fishery since, despite occasionally high larval production.

Yellow Perch populations appear to have cyclic tendencies as well. Past creel survey data indicated the contribution to overall harvest by Yellow Perch ranged from a high of 40% (Allen et al. 1995) to a low of 3% (Flatter et al. 2003). Similar fluctuations have been observed in electrofishing CPUE which ranged from a low of 1 to 159 fish/h (Butts et al. 2011). Angler preference for Yellow Perch appears to vary across years as well. In the 1992 creel survey, anglers indicated they targeted Yellow Perch roughly 10% of the time (Allen et al. 1995), whereas in a survey conducted by Idaho Power in 2007-2009, results varied from 6 to 23%. Currently, population dynamic information for Yellow Perch in CJ Strike Reservoir is incomplete. Past surveys have provided limited length-at-age data. Unlike with crappies, a Yellow Perch specific study has not been conducted for CJ Strike Reservoir.

Population fluctuation and the factors that affect panfish recruitment to these populations and fishery are currently not well understood within this reservoir. Fisheries personnel are interested in: 1) developing methods or techniques to sample panfish that allow quantification of abundance at several life stages or ages, 2) monitoring changes in abundance and other parameters for several years, 3) comparing biotic and abiotic factors that may influence abundance, 4) gaining an understanding of how or whether angling impacts panfish populations, and 5) modeling population parameters to evaluate whether restrictive rules are needed. The primary focus of this assessment will be on crappies and Yellow Perch populations within CJ Strike Reservoir: However, when possible, data will be collected for Smallmouth Bass and Bluegill to increase our understanding of these populations.

Year-class strength for crappies and Yellow Perch may be determined at early life stages; whether this occurs before or after the first winter is currently unknown. A Neuston net has been towed at ten locations on CJ Strike from 2005-2016 (Butts et al. 2016). This tool has been more effective at sampling crappies rather than Yellow Perch and provides an index of relative abundance for larval crappie. Peak larval densities have averaged 17 fish/100 m^3 (10-year average; Butts et al. 2016); however, in 2006, densities averaged 58 fish/100 m^3 and produced crappies in the fishery 2-4 years later. A statewide research project, initiated in 2005, hypothesized that peak larval density would be a useful index for predicting year-class strength of crappies unless substantial over-winter mortality occurred (Lamansky 2011). The project found no consistent relationship between peak larval densities and year-class strength (Lamansky 2011), which suggests that overwinter mortality may be a recruitment bottleneck in some years. Quantifying larval production and subsequent survival should be investigated further.

Data for age-1 and older crappies and Yellow Perch are limited for the CJ Strike Reservoir populations. Several lowland lake surveys have been conducted on the reservoir and provide limited data, including CPUE and length frequency histograms (Butts et al. 2011); however, none has investigated life-stage mortalities for crappies or Yellow Perch. Meyer and Schill (2014) used nonreward tags to generate annual mortality rates for crappies, which ranged from 50-86% for the entire population (i.e. not year-class specific). Lamansky (2011) investigated age and growth data for crappies populations throughout the state, which included CJ Strike Reservoir. Crappies sampled in CJ Strike Reservoir had relatively fast growth and very few crappies older than age-3 were observed (Lamansky 2011), which suggests a population that exhibits high annual mortality, as observed by Meyer and Schill (2014). Age data for crappies collected in other Southwest Regional waters suggest that crappies can survive to age-6 or older (Butts et al. 2013a). Describing life-stage specific mortality rates may help identify population bottlenecks, which, if manageable, may increase recruitment of crappies (or Yellow Perch) to future fisheries.

Extensive research has been completed throughout the range of crappies to identify biotic and abiotic factors that affect recruitment in populations. Biotic factors such as size of spawning stock (Fayram et al. 2015; Bunnell et al. 2006), intraspecific and interspecific competition, as well as predation (Pope and Willis 1998; McKeown and Mooradian 2002; Parsons et al. 2004) have been shown to affect recruitment. Abiotic factors such as water levels (Sammons et al. 2002; Maceina 2003; Fayram et al. 2015), water temperatures (Pine and Allen 2001; McCollum et al. 2003), and the physical and chemical make-up of the waterbody (Bunnell et al. 2006) have also been shown to affect recruitment in crappie populations. Wisconsin’s Department of Natural Resources recently released two relevant literature reviews that address management approaches for crappies and Yellow Perch based on biotic and abiotic factors (Fayram et al. 2015; Niebur et al. 2015) and implemented a 10-year strategic plan for managing panfish within the state (Hansen and Wolter 2016). A study in Missouri reservoirs found that multiple factors, both biotic and abiotic, likely add complexity to understanding crappies recruitment (Siepker and Michaletz 2013). Studies suggest lake or reservoir specific studies are needed before appropriate management strategies may be implemented (Lamansky 2011; Fayram et al. 2015). Implementing the work described later in this document would generate population specific data to improve understanding, especially relating to abundance fluctuations and determine whether management strategies should be altered to maintain or improve crappies or Yellow Perch fisheries in CJ Strike Reservoir.

Currently, no bag or length limits have been placed on CJ Strike Reservoir panfishes, and these populations are managed for harvest opportunity. In other systems and states, biologists have studied the effects of restrictive regulations such as bag limits (Allen and Miranda 1995; Mosel et al. 2015) and minimum length limits (Isermann et al. 2002; Mosel et al. 2015) and suggested that natural mortality, angling mortality, and growth rates of a population need to be fully understood prior to deciding whether regulation changes are warranted. The Southwest Region repeatedly receives requests from anglers to implement restrictive regulations on crappies (most often a bag limit) with the hope of providing stable fishing opportunities on these cyclic fishes. In some systems, minimum length limits have been shown to increase both abundance and size structure in crappies (Allen and Miranda 1995; Isermann et al. 2002; Mosel et al. 2015) and Yellow Perch (Mosel et al. 2015) populations. However, the benefits associated with minimum length limits could be negated if the population exhibits slow growth and high natural mortality rates (Mosel et al. 2015; Isermann et al. 2002); therefore, due to the lack of available growth and mortality data, informed decisions regarding restrictive fishing rules cannot be currently made. Prior to assessing the need for regulation changes (e.g. bag or minimum length limits), data specific to CJ Strike crappies and Yellow Perch needs to be collected, analyzed, and modeled to predict whether these management tools can benefit sportfishing within the reservoir.

Several tasks were initiated in 2016 to increase our knowledge of panfish population dynamics within CJ Strike Reservoir. I developed an index creel survey, in both spring and fall, to learn how anglers utilize panfish species within the reservoir. I investigated the use of otter trawl gear to develop an index of relative abundance and monitor survival from larval production to winter. I estimated length-at-age for crappies and Yellow Perch to compare the age composition between sampling gears.

STUDY AREA

CJ Strike Reservoir is primarily managed for hydroelectric power production and water storage. The reservoir experiences minimal water fluctuations throughout the year. Elevation of the reservoir is approximately 750 msl. The reservoir is geologically characterized as the Snake River plain, which consists of sedimentary and volcanic deposits (IDEQ 2006). CJ Strike Reservoir is listed as an impaired waterbody by the Idaho Department of Environmental Quality because of nutrients and pesticides (IDEQ 2006). The reservoir is 3,035 ha and provides habitat for a wide variety of fish species ranging from cold water (e.g. White Sturgeon *Acipenser transmontanus* and Rainbow Trout *Oncorhynchus mykiss*) to warm water species (e.g. Black Crappie and Largemouth Bass *Micropterus salmoides*). The reservoir is influenced by two major water sources (Snake and Bruneau rivers) and can be split into three distinctive segments: Bruneau River arm (1,123 ha), Snake River arm (759 ha), and the main pool (where the two rivers join; 1,153 ha). The Bruneau Arm can be characterized as relatively shallow, warm, turbid, and typically has a low turnover rate, whereas the Snake Arm is deeper, clearer, and has a higher turnover rate (Butts et al. 2011). These differences in environmental factors may have an influence on primary productivity, fish reproductive success, or recruitment (Butts et al. 2011).

MANAGEMENT GOAL

Maintain or improve sportfishing opportunities for panfish species (specifically Black Crappie, White Crappie *Pomoxis annularis*, and Yellow Perch) in CJ Strike Reservoir, Idaho through increased understanding of population dynamics and angler utilization.

OBJECTIVES

1. Identify optimal techniques (e.g. larval trawling, otter trawling, trap netting, gillnetting, and electrofishing) for monitoring primary panfish populations in CJ Strike Reservoir at several life stages.
2. Develop and implement annual, consistent monitoring efforts.

3. Estimate key parameters that describe population dynamics of crappies and Yellow Perch (e.g. index of stock, length frequency, age frequency, age and growth, total mortality, fishing mortality, age at first reproduction, and length at first reproduction).
4. Estimate key parameters that describe angler harvest of crappies and Yellow Perch.
5. Determine, through modeling exercises, whether more restrictive harvest rules are likely to reduce cyclic variations in panfish populations and sportfishing in CJ Strike Reservoir.

METHODS

Angler Catch Rate

I randomly selected six fixed dates (three weekdays and three weekend days) for a spring and fall index creel survey. Fixed dates are defined as the same day of each year (e.g. the first Tuesday of May). The spring survey was conducted between April 15 through June 15 and the fall survey between August 15 and October 15. Selected dates were subdivided into two five-hour time periods, of which one time period was randomly selected for each date. These time periods included morning (0900 to 1400 h) and afternoon (1500 to 2000 h). Two boat ramps located at CJ Strike Reservoir were selected for suitable locations to collect data: the Air Force or Cottonwood boat ramps. Anglers were surveyed at the completion of their trip. This survey design is similar to a portion of the access-access survey design described by Pollock et al. (1994).

Catch rates were determined from angler interviews. Only complete trip information was used for catch rate estimation to avoid bias associated with incomplete trips (MacKenzie 1991; Hoenig et al. 1997). I determined party size, primary target species, harvest by species, release by species, and angler residency. Interviews were conducted on an individual basis. Interview data were summarized as the ratio of means. Catch rates were derived using the multiday estimator found in McCormick and Meyer (2017). Variance and 90% confidence bounds were calculated using formulas 12, 13, and 14, also found in McCormick and Meyer (2017).

Larval Fish Production

Horizontal surface trawls were used to sample larval fish at 10 sites in CJ Strike Reservoir. Trawls were conducted throughout the reservoir (Figure 14) 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 five minutes in duration and we used a flow meter fitted to the net to estimate the volume of water sampled. Trawling was conducted on seven separate dates including June 7, June 14, June 21, June 27, July 6, July 12, and July 19, 2016, which overlapped peaks of crappies production in previous years. Specimens were fixed in 10% formalin for two 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 of 50 individuals, identified and measured those, then counted the remainder and extrapolated to the whole sample. The week that had the highest crappies densities averaged across all sample sites was indexed as the peak larval density for the year and reported as fish/100 m^3. Data were compared across years to categorize trends in crappies production.

Otter Trawl Relative Abundance

An otter trawl was selected to investigate whether an index of relative abundance could be developed for panfish species and to monitor survival from larval production to entry of winter months. The otter trawl net was 9-m in length, 2.2-m wide, 4.6-m high and was rigged with 39-mm stretch mesh in the body, with 13-mm mesh in the cod end. The trawl was outfitted with weighted otter doors to ensure the net remained open while in tow (as described in Hayes et al. 1996). The net had a 15-m long bridle, which was attached to a rope and towed at a speed of 4.0 km/h with a 6.4-m boat equipped with a 175-hp outboard motor. A flow meter was placed at the connection point with the bridle and tow rope to estimate the volume of water sampled. The net was towed at each location for three minutes and Global Positioning Satellite coordinates were recorded at the start and end of each transect. Sites were randomly selected using depth profiles and identifying areas with a relatively uniform bottom (e.g. not in areas with large boulders). Trawling was conducted on three separate dates, which included October 27, November 3, and November 17, 2016.

Captured fish were identified to species, measured for total length (TL; ± 1 mm), and weighed (±1 g) with a digital scale. Smaller individuals (less than 100 mm in length) were placed in sample collection bags and processed in the laboratory. Larger fish were processed and released back into the lake, when possible. Densities by species were calculated as the number of fish per 100 m^3 for each transect. The mean across all sample locations was calculated to index relative abundance.

Dorsal fin rays, scales, and sagittal otoliths were collected during the index creel and otter trawl surveys described above. Aging structures were collected from up to 10 fish (by species) per 10 mm length interval from harvested fish. Dorsal fin ray and sagittal otoliths were processed and digitized using the methods described in Butts et al. (2016). Scales were processed and digitized using methods described in Schrader et al. (2011). Fish age was estimated by two independent readers. Samples with disagreements in age were revisited and the consensus age was used in further analysis. Mean length-at-age was presented separately for angler caught and otter trawl captured fish to determine if differences existed between sampling methods. Length frequency distributions were examined using a Kolmogorov-Smirnov test to examine if anglers harvested fish larger than those collected in otter trawl gear.

RESULTS

Angler Catch Rates

Fisheries staff interviewed 157 anglers from 78 individual parties during the spring index creel survey of 2016. Interviews consisted of 66 boat and 12 bank angler parties. Mean party size was 2.3 anglers per boat and 1.4 anglers per bank party. The majority of surveyed anglers were residents (94%). Anglers mainly targeted crappies (39%) in the spring followed by Smallmouth Bass *Micropterus dolomieu* (26%; Table 8). Spring anglers expended a total of 690 h for a mean of 4.4 h/trip. Total catch for the spring survey was 787 fish of which 47% were harvested. Crappies and Yellow Perch contributed similarly to the harvested fish at 45% and 44%, respectively. Smallmouth Bass were released more frequently than harvested (Table 9). Total catch of Bluegill, Largemouth Bass, and hatchery Rainbow Trout was minor (*n* = 17). The mean total length of angler harvested crappies, Yellow Perch, and Smallmouth Bass collected during the spring index creel were 272, 248, and 362 mm, respectively.

During the fall index creel survey, 160 anglers from 67 individual parties were interviewed. The interviews consisted of 56 boat and 11 bank angler parties. Mean party size was 2.5 anglers per boat and 1.9 anglers per bank party, both of which were slightly higher than the spring survey. Similar to the spring survey, most anglers were residents (91%). Anglers targeted "any" species (39%) most frequently in the fall, followed by Yellow Perch (29%; Table 8). Anglers fished a total of 762 h for a mean of 4.8 h/trip. Total catch was 1,339 fish of which 63% were harvested. The most commonly harvested species were Yellow Perch (62%), crappies (25%), and hatchery Rainbow Trout (6%). Similar to the spring survey, most Smallmouth Bass were released after capture (Table 10). Total catch of Bluegill, Largemouth Bass and Pumpkinseed *Lepomis gibbosus* was minor (n = 68) in the fall survey. Mean length of fall harvested crappies and Smallmouth Bass decreased to 199 and 335 mm, respectively, but increased for Yellow Perch to 256 mm (Figure 15).

Overall, crappies catch rates were higher in the fall than spring, while the opposite was observed for Yellow Perch (Table 9 and Table 10). Anglers targeting crappies or Yellow Perch (specifically) had higher catch rates than the average angler of 0.70 and 1.67 fish/h, respectively. Smallmouth Bass anglers exhibited nearly a 1.5 fold increase in catch rates over the average angler. Most anglers (84%) harvested zero to five fish/trip; however, 8% of anglers harvested greater than 15 fish/trip (Table 11).

A total of 227 fish (n = 133 crappies and n = 94 Yellow Perch) were aged using hard structures collected during the index creel surveys. Mean length-at-age differed slightly between spring and fall surveys (Figure 16). Harvested crappies and Yellow Perch observed in the index creel surveys were predominately age-4. Differences were observed between surveys in terms of which age classes contributed to the harvest. Crappies age-3 to age-7 were represented in the spring survey, whereas only age-2, age-3, age-4, and age-8 were represented in fall harvested fish. Yellow Perch had fewer age classes represented for both the spring and fall survey than crappies (Figure 16).

Larval Fish Production

A total of 70 trawl tows (10 per date) were completed on CJ Strike Reservoir during 2016. The average water volume sampled was 276 m^3/tow at CJ Strike Reservoir. Species composition for samples collected from CJ Strike Reservoir included crappies (50.8%), Yellow Perch (46.8%), Bluegill (0.5%), Channel Catfish *Ictalurus punctatus* (0.2%), Smallmouth Bass (0.2%), and unknown species (1.4%). The peak densities of larval crappies were observed on the third sampling event conducted on June 21, 2016. Peak densities of larval crappies, among sites sampled in 2016, ranged from 0 (sites CJ03-CJ10) to 102 fish/100 m^3 (CJ01; Figure 17). Peak densities of larval crappies recorded since 2005 have averaged 25 fish/100 m^3 within CJ Strike Reservoir. Peak densities of larval crappies in 2016 were 10.6 fish/100 m^3 (Figure 18).

Peak densities of larval Yellow Perch were observed during the fourth sampling event conducted on June 27, 2016. Peak densities of larval Yellow Perch ranged from 1.3 (site CJ04) to 43.9 fish/100 m^3 (CJ08) among sites sampled in CJ Strike Reservoir. This was the first year peak densities of larval Yellow Perch were identified within the reservoir. Peak densities of larval Yellow Perch, averaged across all sample sites, were 12.0 fish/100 m^3 in the 2016 survey.

Otter Trawl Relative Abundance

A total of 21 otter trawl tows were completed on CJ Strike Reservoir during 2016 (Figure 19). The average water volume sampled was 2,230 m^3/tow at CJ Strike Reservoir. Species composition consisted mainly of Yellow Perch (49%), Bluegill (36%), and crappies (13%), while Common Carp *Cyprinus carpio*, Brown Bullhead *Ameiurus nebulosus*, Largescale Sucker *Catostomus macrocheilus*, and Northern Pikeminnow *Ptychocheilus oregonensis* composed the remaining 2%. Bluegill were captured at more sites (n = 16) than any other species, followed by Yellow Perch (n = 11). Densities of panfish species were the highest in the Bruneau River Arm and the lowest in the Snake River Arm and the main pool (Figure 20). Crappie densities (both species combined) ranged from 0.00 to 3.45 fish/100 m^3. Yellow Perch densities ranged from 0.00 to 3.28 fish/100 m^3. Bluegill densities ranged from 0.00 to 3.48 fish/100 m^3 (Figure 20). Mean densities of crappies, Yellow Perch, and Bluegill were 0.19, 0.72, and 0.59 fish/100 m^3, respectively (Figure 21). Length frequencies for crappies, Yellow Perch, and Bluegill captured by otter trawl are presented in Figure 22.

A total of 95 hard structures were aged using fish captured with the otter trawl net; including 27 crappies and 68 Yellow Perch. Age-0 crappies were the most abundant age class with a mean density of 0.19 fish/100 m^3 (Figure 23). Ages of crappies represented in otter trawl ranged from age-0 to age-3. Mean length-at-age for crappies captured in otter trawl gear are presented in Figure 24. Age-0 Yellow Perch were the most abundant Yellow Perch age class sampled by otter trawl with a mean density of 0.49 fish/100 m^3 (Figure 23). Ages of Yellow Perch sampled in otter trawls? ranged from age-0 to age-5. Mean length-at-age for Yellow Perch captured in otter trawl gear are presented in Figure 24. Length-frequency distributions of fall angler harvested crappies and Yellow Perch were statistically different from fish captured with otter trawl (crappies D = 0.98, P <0.001; Yellow Perch D = 0.80, P <0.001). Mean relative weights for crappies, Yellow Perch, and Smallmouth Bass ranged from 82 (Yellow Perch in spring) to 119 (crappies in fall; Figure 25). Fish had slightly below average body condition coming out of the winter months and appeared to increase body condition over the summer months.

DISCUSSION

The development of the index creel surveys was one of the primary tasks initiated in 2016 to begin learning how anglers utilize panfish populations in CJ Strike Reservoir. The combination of spring and fall index creel surveys allowed for the establishment of metrics such as angler catch and harvest rates, frequency of bag, and ages and sizes of harvested fish. I observed catch rate differences between seasons among species (e.g. Yellow Perch had higher fall catch rates than in the spring). Frequency of bag data indicated that less than 12% of interviewed anglers harvested more than 15 fish. Crappies and Yellow Perch harvested by anglers were predominantly age-4 fish. As more years of data are collected, angler patterns specific to panfish populations in CJ Strike Reservoir will likely become more pronounced; therefore, additional years of the index creel surveys should be conducted to better define patterns in angler catch and how catch and harvest is related to population metrics generated by various sampling gears.

Relative production of larval crappies has been indexed for the past 12 years in CJ Strike Reservoir. Spatial and temporal variation was again observed in the 2016 assessment and suggested sampling should continue across multiple weeks to identify peak larval production. Relative production of larval crappies in 2016 represented a 58% decrease from mean peak larval estimates since 2005. The 2016 survey represented the first time larval Yellow Perch were reported in substantial densities, although they have been intermittently observed in past surveys. Prior to 2016, very few larval Yellow Perch had been sampled. These surveys indicated mean densities for larval Yellow Perch ranged from 0 to 1.9 fish/100 m^3 (2012 to 2015 unpublished data, IDFG). Larval fish misidentification may be another possible explanation for the abnormally high larval Yellow Perch densities observed in 2016. Data quality control measures are in place to reduce misidentification error; therefore, misidentification bias is thought to be low. Monitoring larval crappie and Yellow Perch production will be important to estimating survival of these species at multiple life-stages and should be continued.

Otter trawl gear captured smaller and younger panfish than those harvested by anglers. Otter trawling has been shown to be effective at sampling smaller and younger crappies (Allen et al. 1999; Pine 2000; Bonvechio et al. 2008). Otter trawling has also been successfully used to monitor age-0 and age-1 Yellow Perch (Janssen et al. 2012). Sampling older age classes of crappies may require use of additional gear types, such as electrofishing (Bonvechio et al. 2008), hoop nets (Flammang et al. 2016) or trap nets (Allen et al. 1999). Janssen et al. (2012) also recommended the use of gill nets to sample older age classes of Yellow Perch. Identifying and understanding biases associated with different sampling gears will be very important for this panfish assessment. The observed fish size differences between angler-harvested fish and otter trawl samples should continue to be monitored in subsequent sampling events. In addition, gear types such as gill nets, electrofishing, or trap nets should be used to collect a more representative sample of these species within CJ Strike Reservoir.

Comparisons of length-at-age for crappies were not directly comparable with data presented in Lamansky (2011) due to methodology differences. In general, age-1 crappies were slightly larger, whereas crappies age-2 through age-4 were smaller than those presented in Lamansky (2011). This relationship should be investigated further and back-calculated length-at-age data should be developed, so direct comparisons of current and past growth can be assessed. Mean length-at-age estimates for Yellow Perch captured in CJ Strike Reservoir are higher than those observed using back calculated lengths in 1993 (Allen et al. 1996). Yellow Perch from CJ Strike Reservoir were smaller in mean total length, at ages one to five, than those found in Cascade Reservoir in 2011 (Janssen et al. 2012). Overall, otoliths provided the cleanest and easiest structures to age for both crappies and Yellow Perch. However, dorsal fin rays also produced images adequate to interpret and determine fish age. Dorsal fin rays were also the easiest to collect, were non-lethal, and should continue to be collected as aging structures for crappies and Yellow Perch. After completion of additional years of surveys, a more thorough analysis of panfish population dynamics will be completed.

RECOMMENDATIONS

1. Continue the index creel survey in both the spring and fall and identify angler use patterns, specifically related to panfish populations found in CJ Strike Reservoir.
2. Continue sampling larval production and assess relationships between larval and older age classes using otter trawl density estimates.
3. Develop a systematic sampling protocol for CJ Strike Reservoir using gill nets, trap nets, and electrofishing to develop a representative index of crappies and Yellow Perch populations.
4. Continue collecting age structure data, using primarily dorsal fin rays. These aging structures consistently produced the highest quality images for developing ages for crappies and Yellow Perch.
5. Develop back calculated length-at-age (length at annulus) estimates to compare current and past growth rates.

Table 8. Angler's primary targeted species and residency collected at CJ Strike Reservoir during the spring and fall index creel surveys in 2016.

Species/Type	Anglers Spring	Frequency (%)	Anglers Fall	Frequency (%)	Anglers Spring and Fall Combined	Frequency (%)
			Primary Targeted Species			
crappies	62	39%	12	8%	74	23%
Yellow Perch	26	17%	46	29%	72	23%
Smallmouth Bass	41	26%	29	18%	70	22%
Rainbow Trout	4	3%	8	5%	12	4%
Channel Catfish	2	1%	3	2%	5	2%
any species	22	14%	62	39%	84	26%
			Residency			
Idaho resident	148	94%	145	91%	293	92%
Non-resident	9	6%	15	9%	24	8%

Table 9. Catch and catch rate estimates collected from anglers during the spring index creel survey at CJ Strike Reservoir in 2016.

Disposition	Bluegill	crappies	Largemouth Bass	Rainbow Trout	Smallmouth Bass	Yellow Perch
			Number			
Harvest	0	166	2	6	35	164
Release	0	51	3	6	308	46
Total Catch	0	217	5	12	343	210
			CPUE fish/h (± 90% CI)			
Harvest	0.00 (0.00)	0.24 (0.35)	< 0.01 (0.01)	0.01 (0.02)	0.05 (0.07)	0.24 (0.32)
Release	0.00 (0.00)	0.07 (0.11)	< 0.01 (0.01)	0.01 (0.02)	0.45 (0.55)	0.07 (0.11)
Total Catch	0.00 (0.00)	0.31 (0.45)	< 0.01 (0.01)	0.02 (0.03)	0.50 (0.60)	0.30 (0.40)

Table 10. Catch and catch rate estimates collected from anglers during the fall index creel survey at CJ Strike Reservoir in 2016.

Disposition	Bluegill	crappies	Largemouth Bass	Rainbow Trout	Smallmouth Bass	Yellow Perch
			Number			
Harvest	13	214	0	47	29	523
Release	38	74	2	2	250	129
Total Catch	51	288	2	49	279	652
			CPUE fish/h (± 90% CI)			
Harvest	0.02 (0.03)	0.28 (0.40)	< 0.01 (0.00)	0.06 (0.08)	0.04 (0.05)	0.69 (0.85)
Release	0.05 (0.08)	0.10 (0.16)	< 0.01 (0.00)	< 0.01 (0.00)	0.33 (0.42)	0.17 (0.22)
Total Catch	0.07 (0.10)	0.38 (0.53)	< 0.01 (0.00)	0.06 (0.09)	0.37 (0.47)	0.86 (1.04)

Table 11. Frequency of harvested crappies and Yellow Perch observed in the creel of interviewed anglers at CJ Strike Reservoir during spring and fall of 2016.

Frequency of Bag	Anglers with crappies (Spring)	Frequency (%)	Anglers with Yellow Perch (Spring)	Frequency (%)	Anglers with crappies (Fall)	Frequency (%)	Anglers with Yellow Perch (Fall)	Frequency (%)
0 fish	139	89%	131	83%	132	83%	109	68%
1 fish	6	4%	5	3%	13	8%	5	3%
2 fish	1	1%	2	1%	4	3%	11	7%
3 fish	2	1%	4	3%	2	1%	1	1%
4 fish	2	1%	3	2%	1	1%	6	4%
5 fish	0	0%	2	1%	0	0%	3	2%
6 fish	1	1%	1	1%	0	0%	1	1%
7 fish	0	0%	2	1%	0	0%	0	0%
8 fish	0	0%	1	1%	0	0%	2	1%
9 fish	0	0%	1	1%	0	0%	1	1%
10 fish	0	0%	2	1%	0	0%	3	2%
11 fish	0	0%	1	1%	0	0%	1	1%
12 fish	0	0%	0	0%	1	1%	2	1%
13 fish	0	0%	0	0%	0	0%	0	0%
14 fish	0	0%	0	0%	1	1%	0	0%
15 fish	1	1%	0	0%	0	0%	3	2%
> 15 fish	5	3%	2	1%	6	4%	12	8%

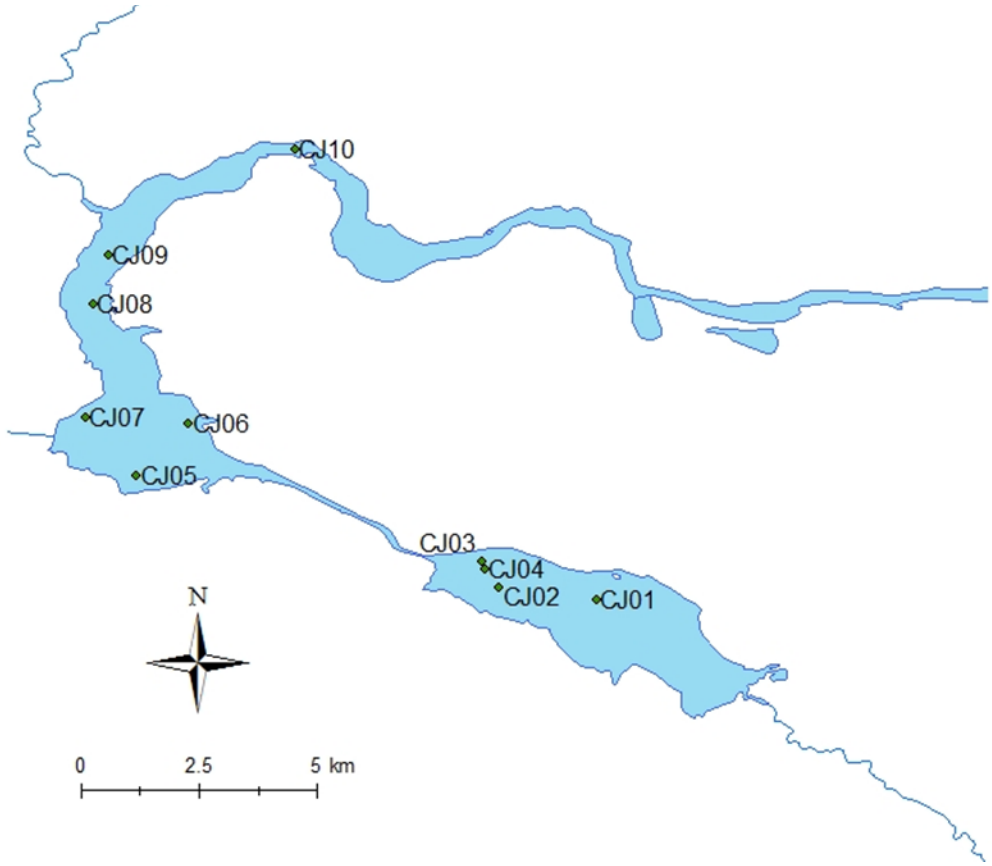


Figure 14. Location of 10 trawl sites used to index the abundance of larval fish in CJ Strike Reservoir from 2005-2016.

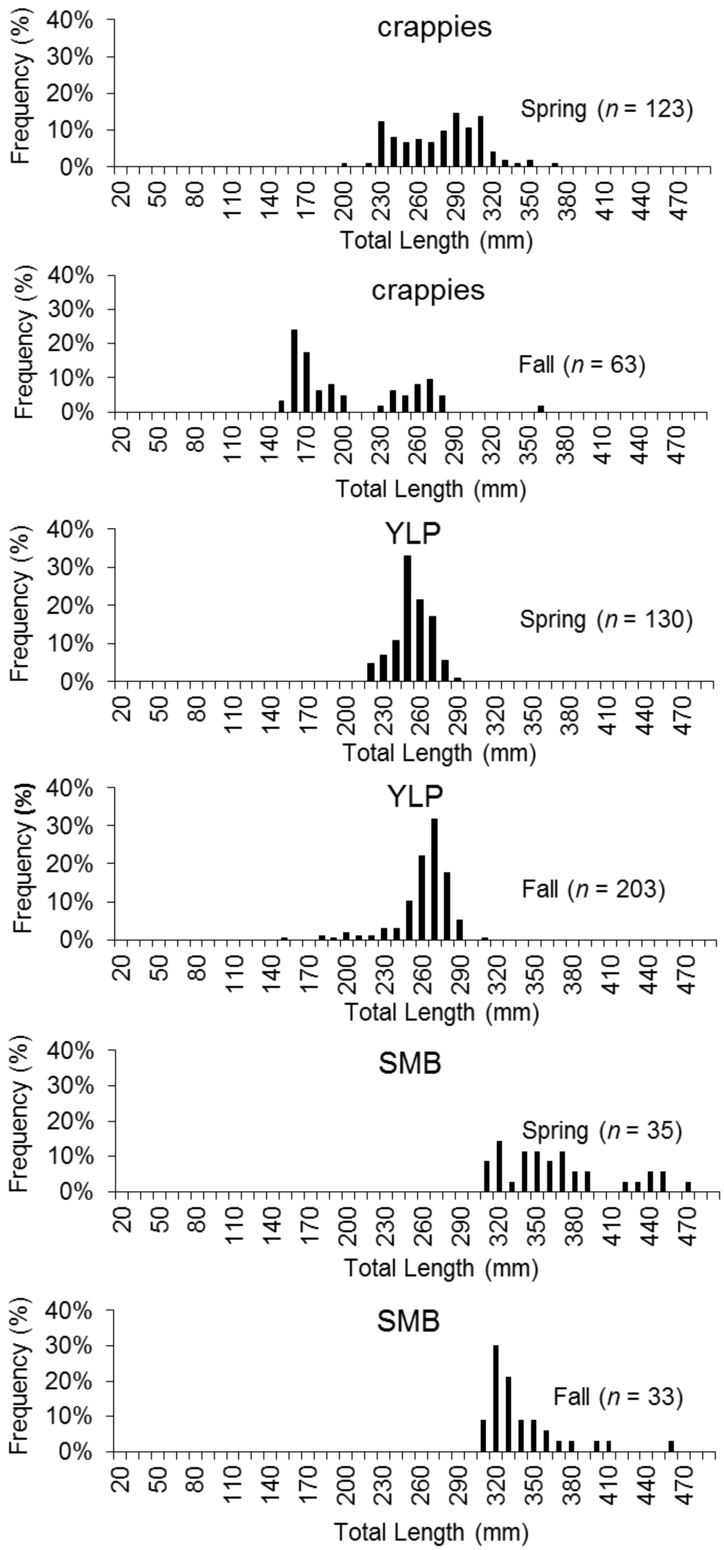
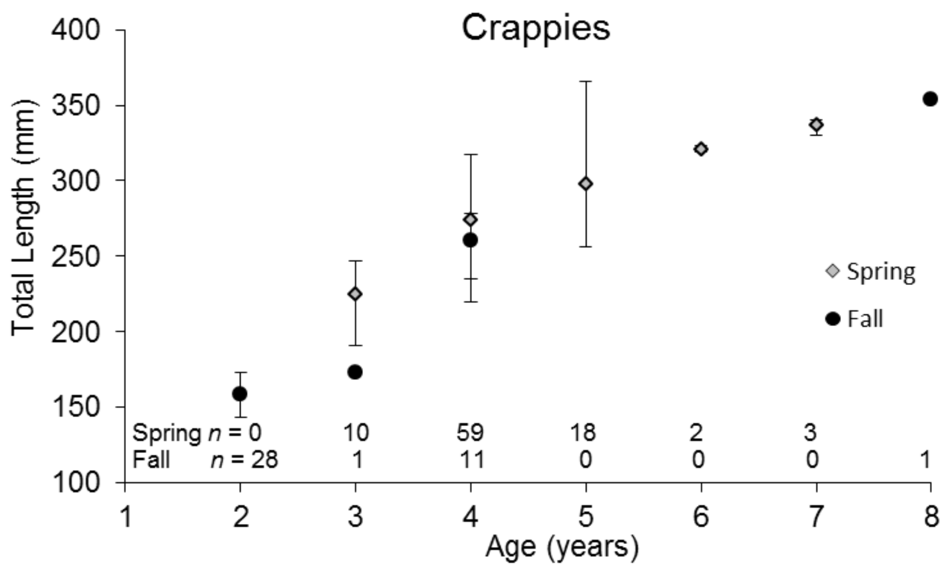


Figure 15. Length-frequency distribution of harvested crappies, Yellow Perch (YLP), and Smallmouth Bass (SMB) sampled during spring and fall index creel surveys in 2016.



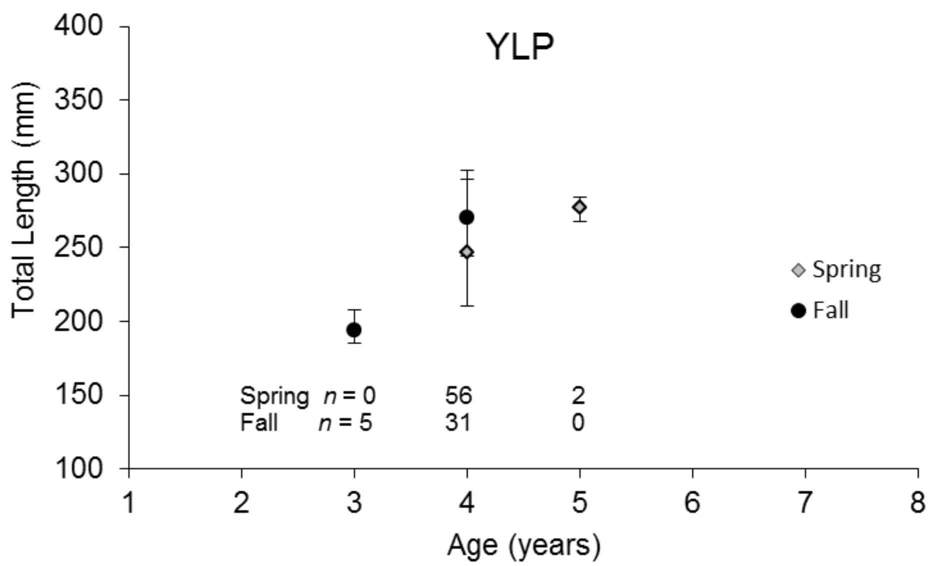


Figure 16. Mean length-at-age for crappies and Yellow Perch from CJ Strike Reservoir, Idaho sampled in the spring and fall index creel surveys in 2016. The number of samples aged for each age class is presented. Error bars represent the minimum and maximum values.

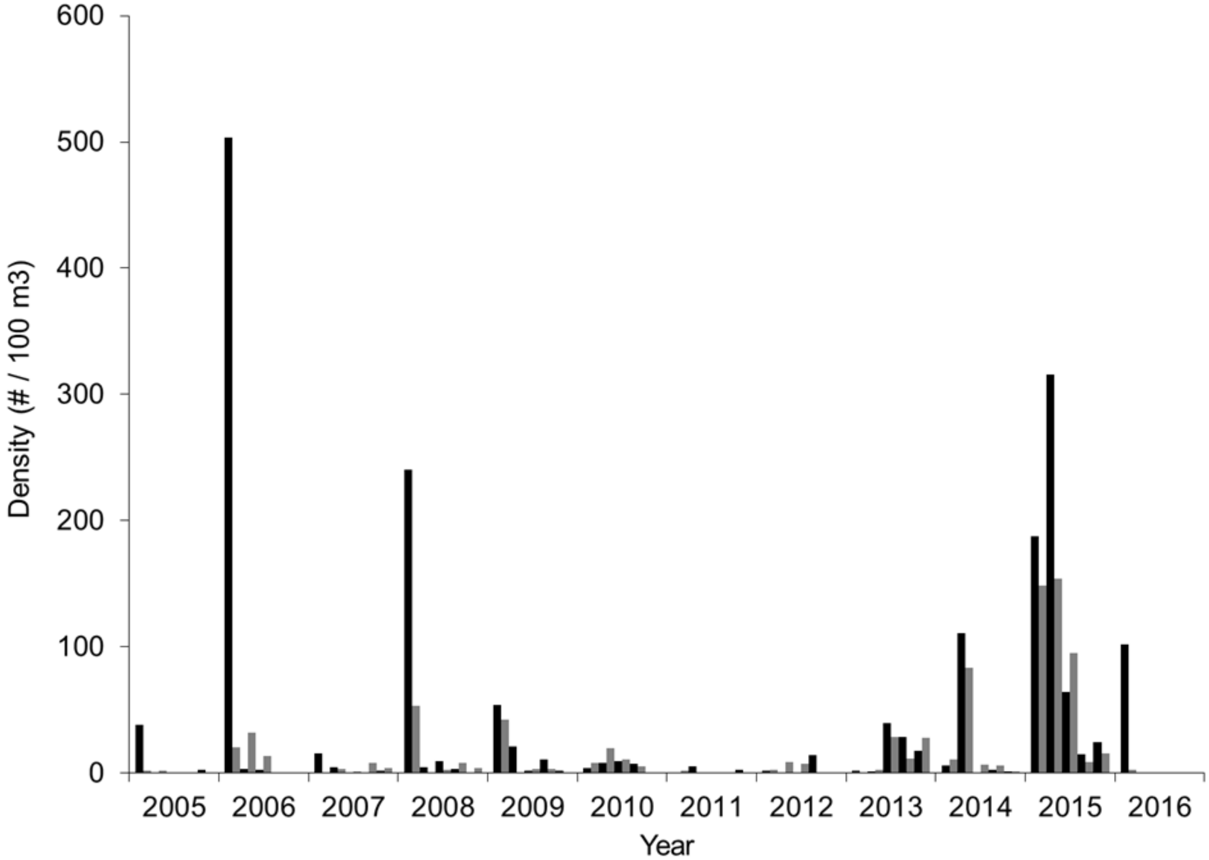


Figure 17. Densities of larval crappies (#/100 m^3) measured in CJ Strike Reservoir during 2005 through 2016. Bars within each year represent 10 individual sites. Site 1 through site 10 is displayed from left to right within each year.

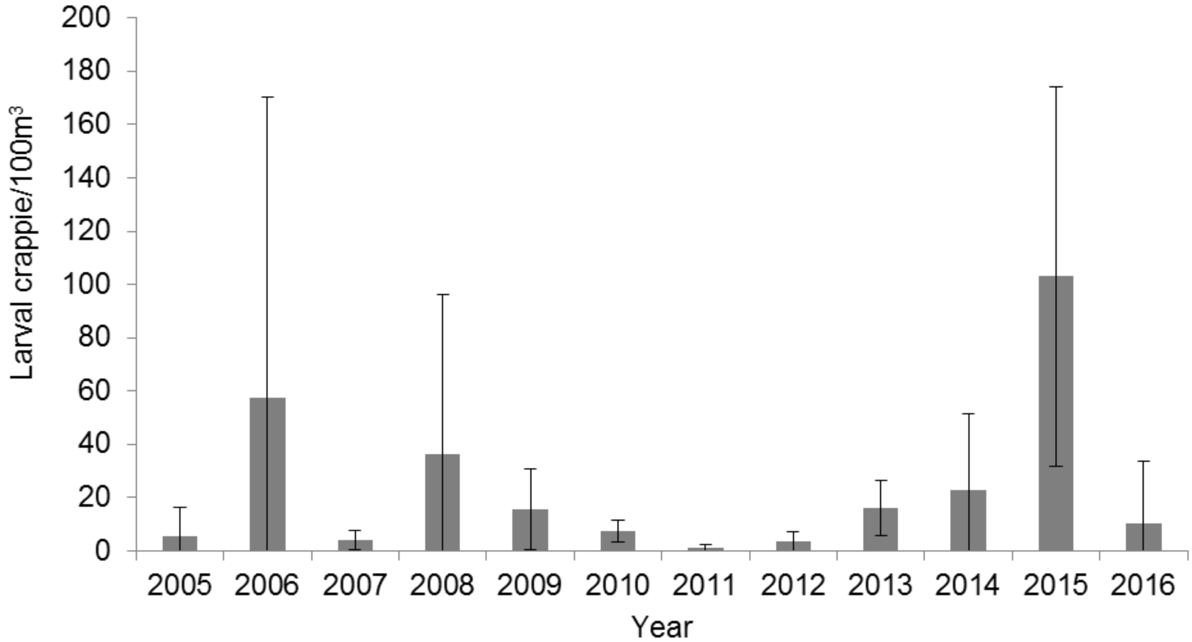


Figure 18. Mean peak densities of larval crappies (averaged across the sample sites) within CJ Strike Reservoir from 2005 to 2016. Error bars represent 90% confidence intervals.

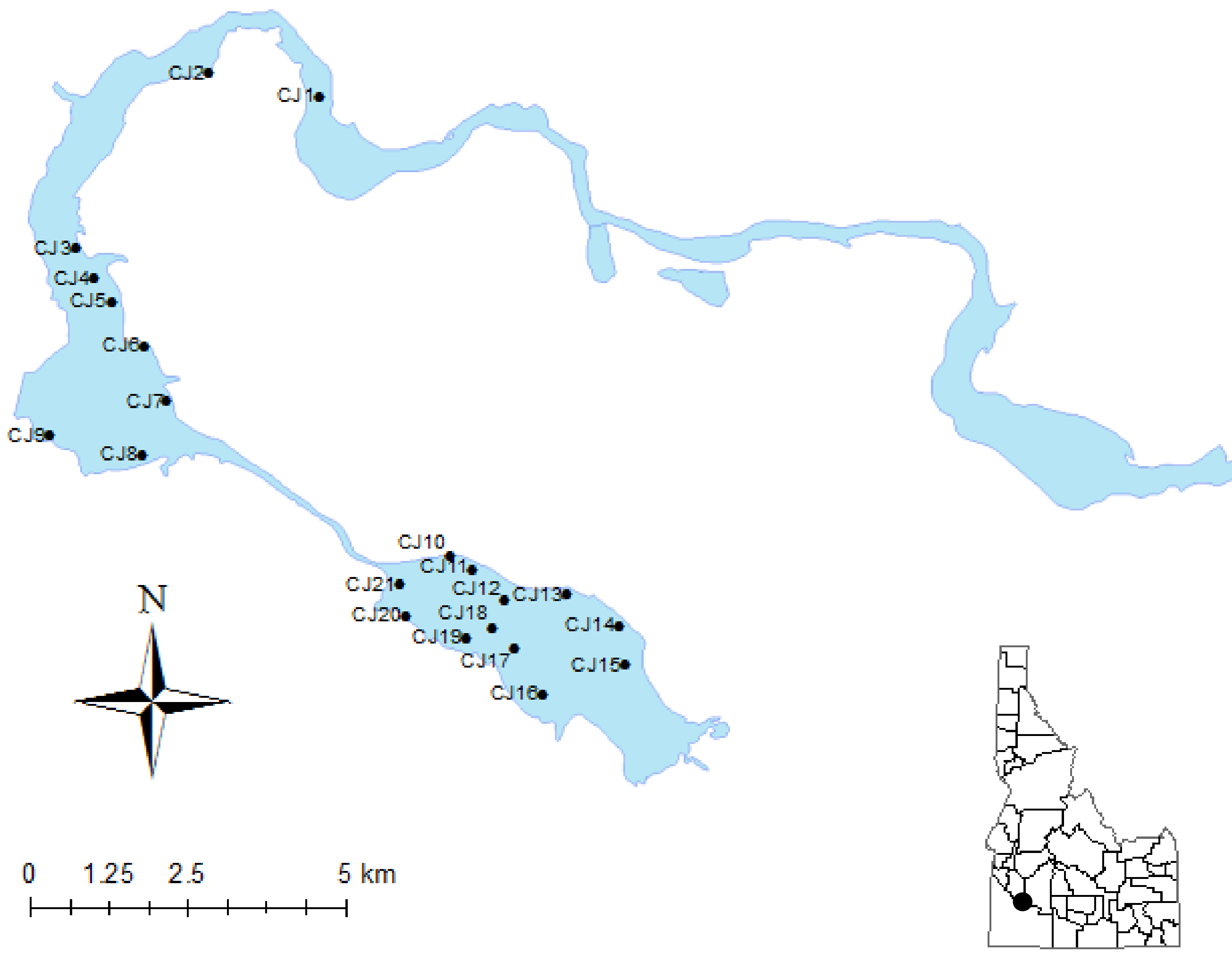


Figure 19. Location of 21 otter trawl sites used to index the abundance of crappies and Yellow Perch, and Bluegill in CJ Strike Reservoir in 2016.

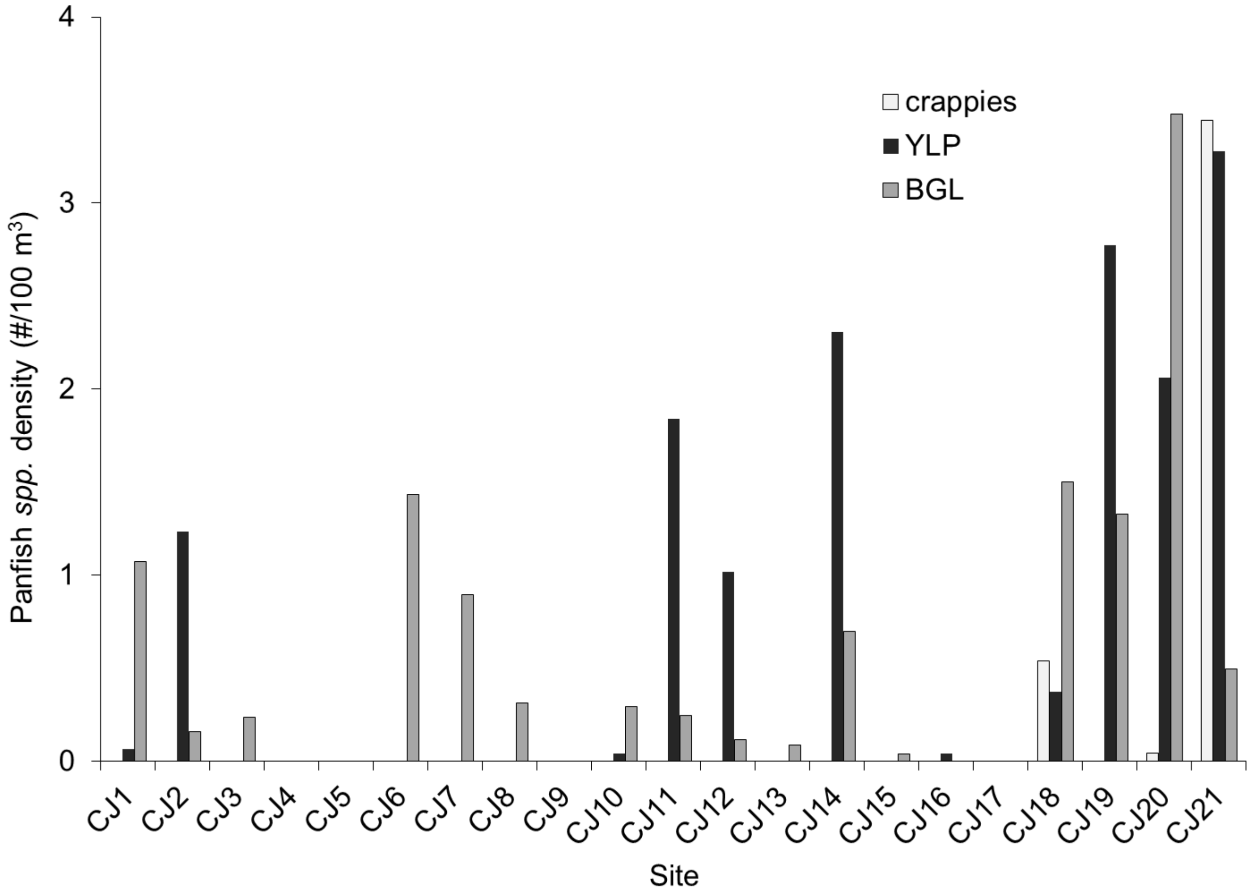


Figure 20. Densities of crappies, Yellow Perch, and Bluegill (#/100 m^3) in CJ Strike Reservoir from otter trawl sampling in 2016. Sites CJ1-CJ5 were located in the Snake River segment, CJ6-CJ9 the main pool (near the dam), and sites CJ10-CJ21 were located in the Bruneau River segment.

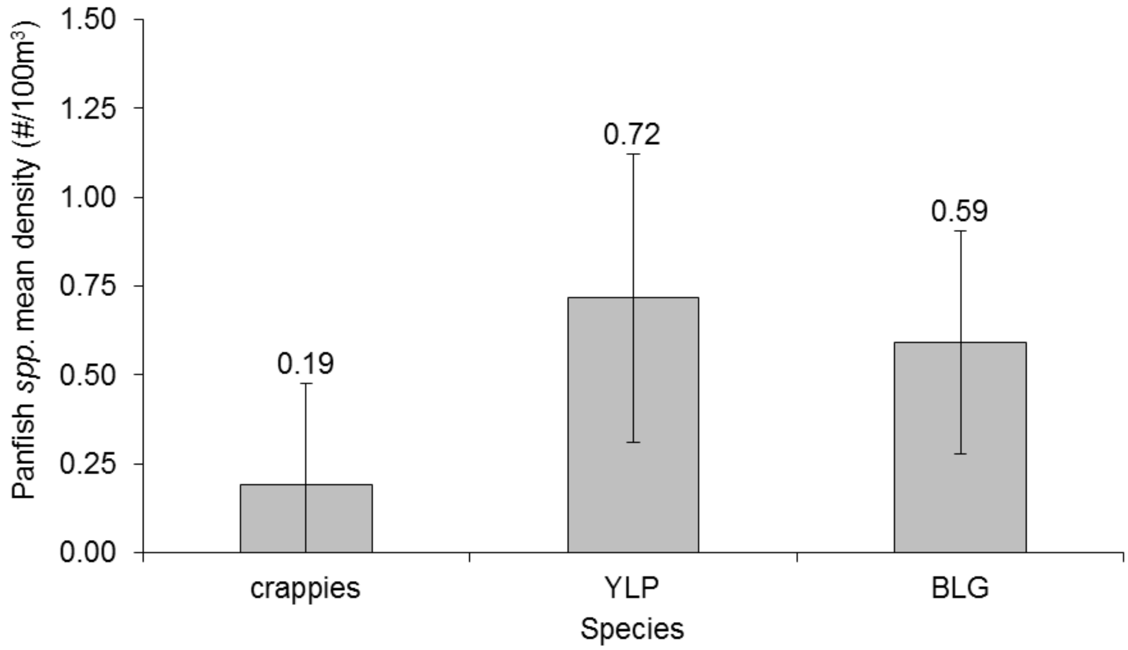


Figure 21. Mean densities of crappies, Yellow Perch, and Bluegill (#/100 m^3) measured using otter trawl in CJ Strike Reservoir during 2016. Error bars represent 90% confidence intervals.

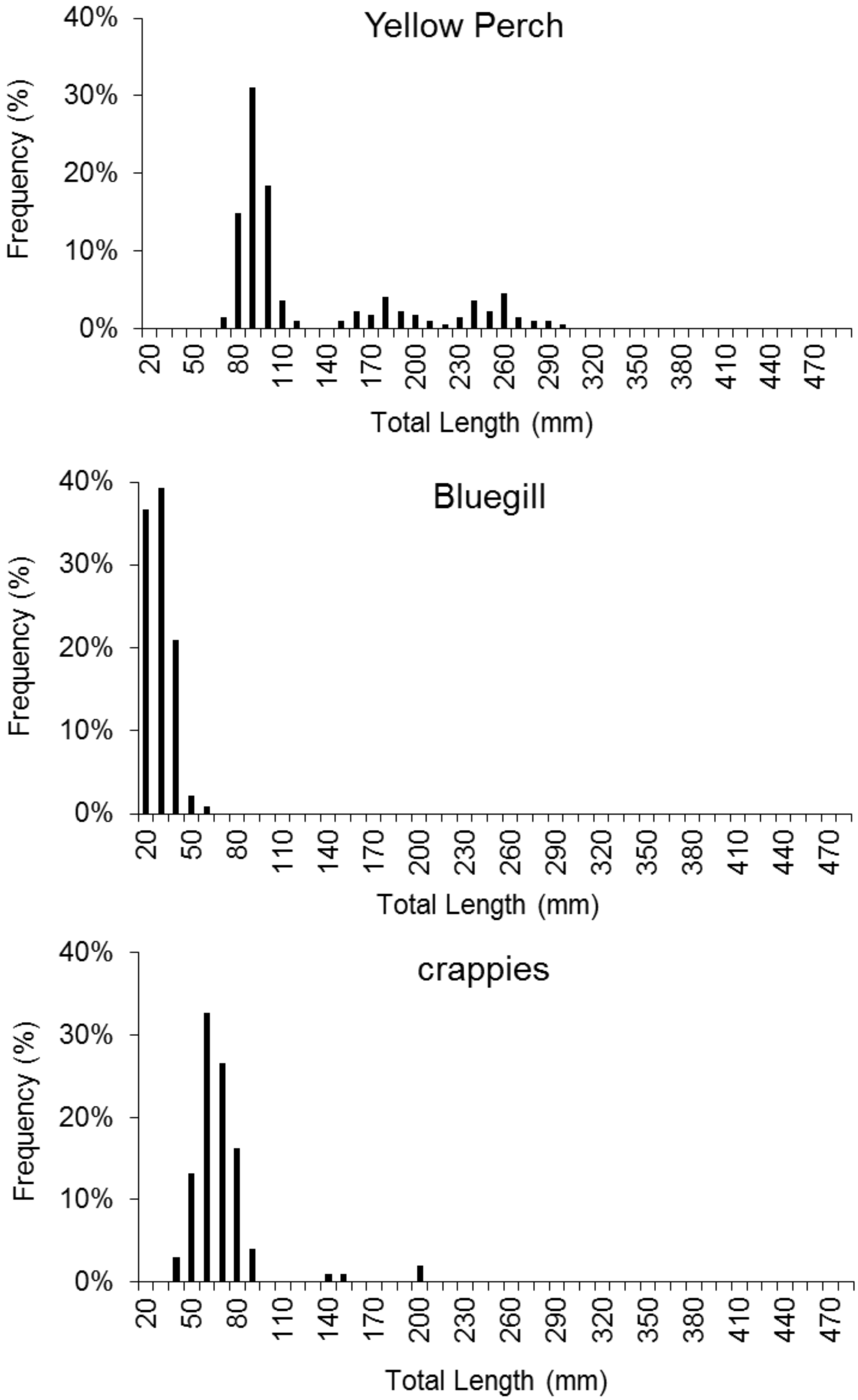


Figure 22. Length-frequency distribution of crappies (*n* = 98), Yellow Perch (*n* = 222), and Bluegill (*n* = 229) sampled using otter trawl during the fall of 2016 in CJ Strike Reservoir.

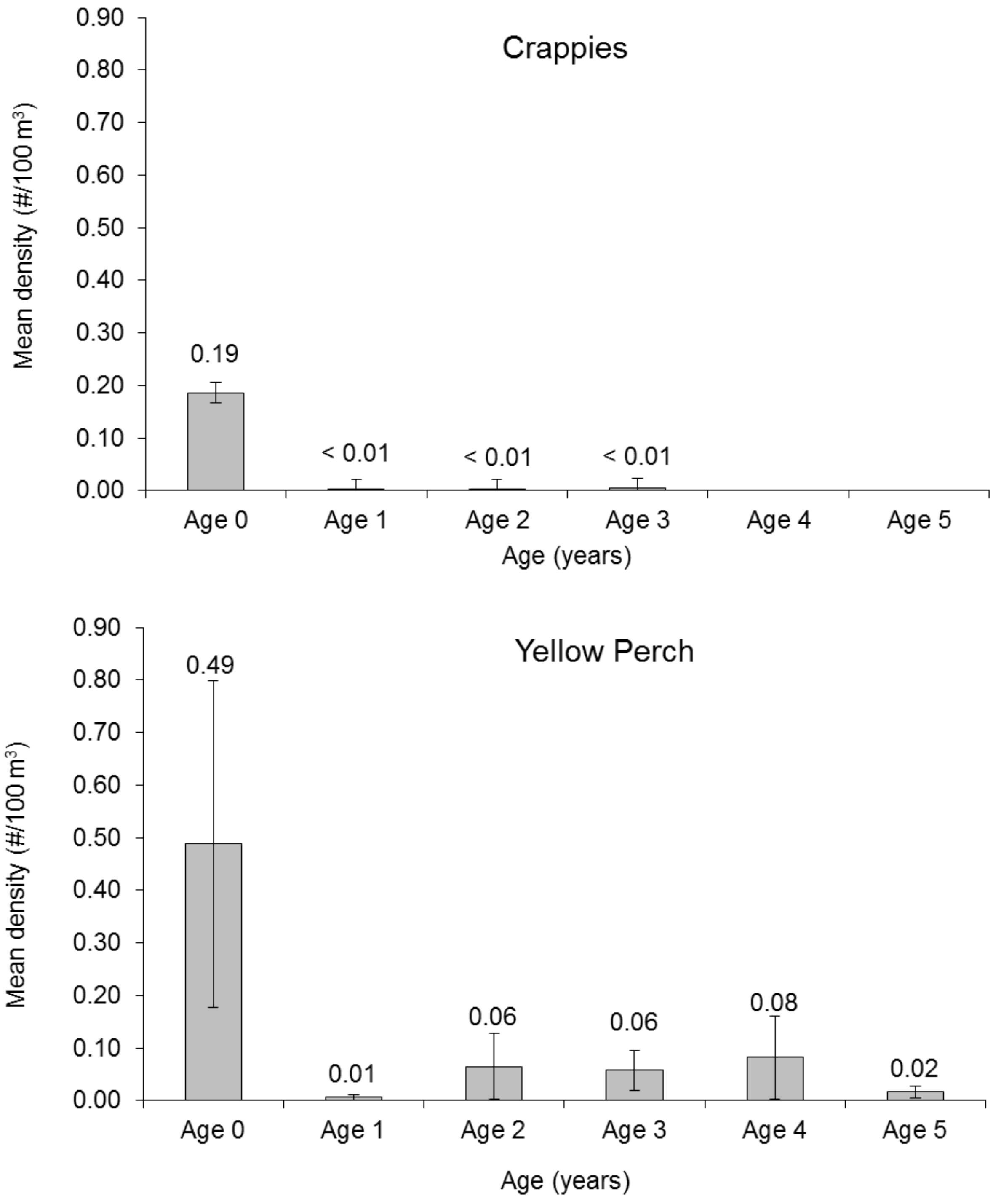


Figure 23. Mean densities of crappies (upper panel) and Yellow Perch (lower panel) densities (#/100 m3) by each age-class collected using otter trawl in CJ Strike Reservoir during 2016. Error bars represent 90% confidence intervals.

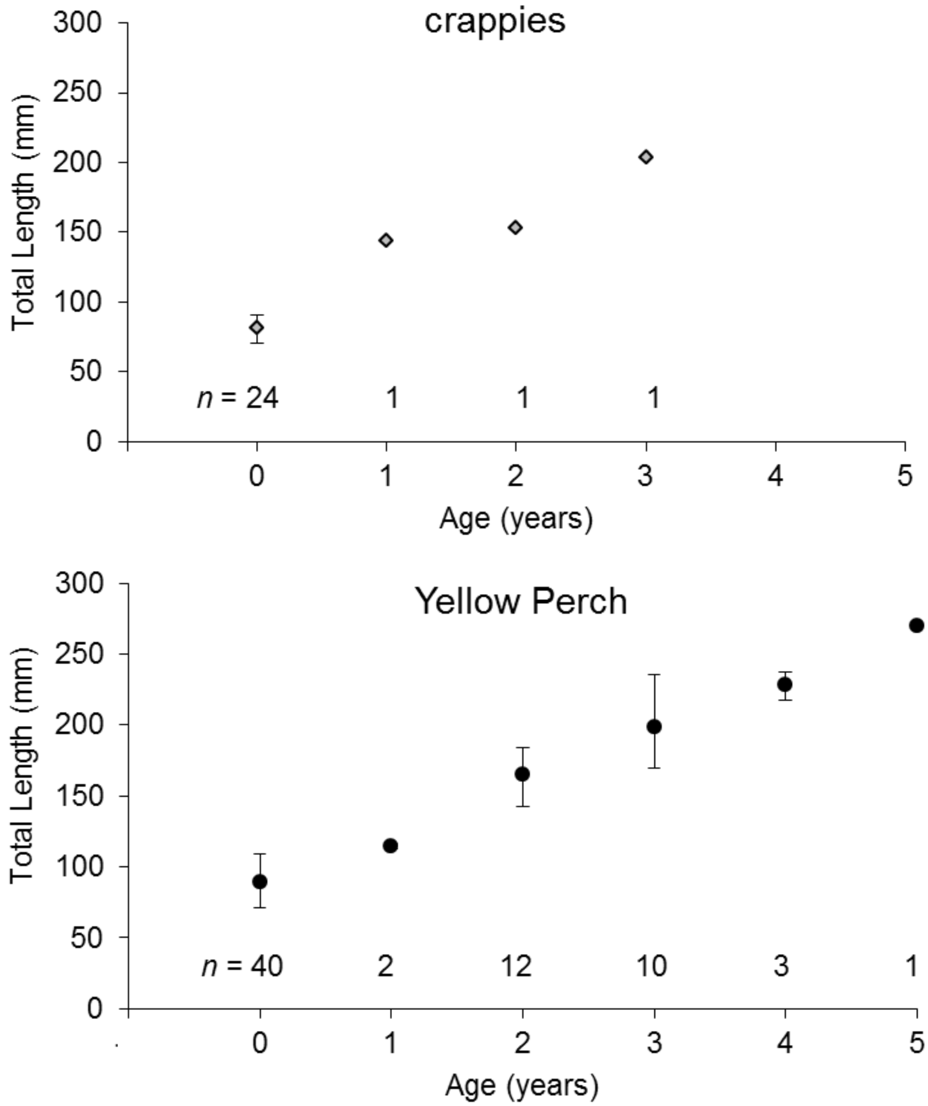


Figure 24. Mean length-at-age for crappies and Yellow Perch from CJ Strike Reservoir, Idaho sampled in the fall using otter trawl in 2016. The number of samples aged for each age class is presented. Error bars represent the minimum and maximum values.

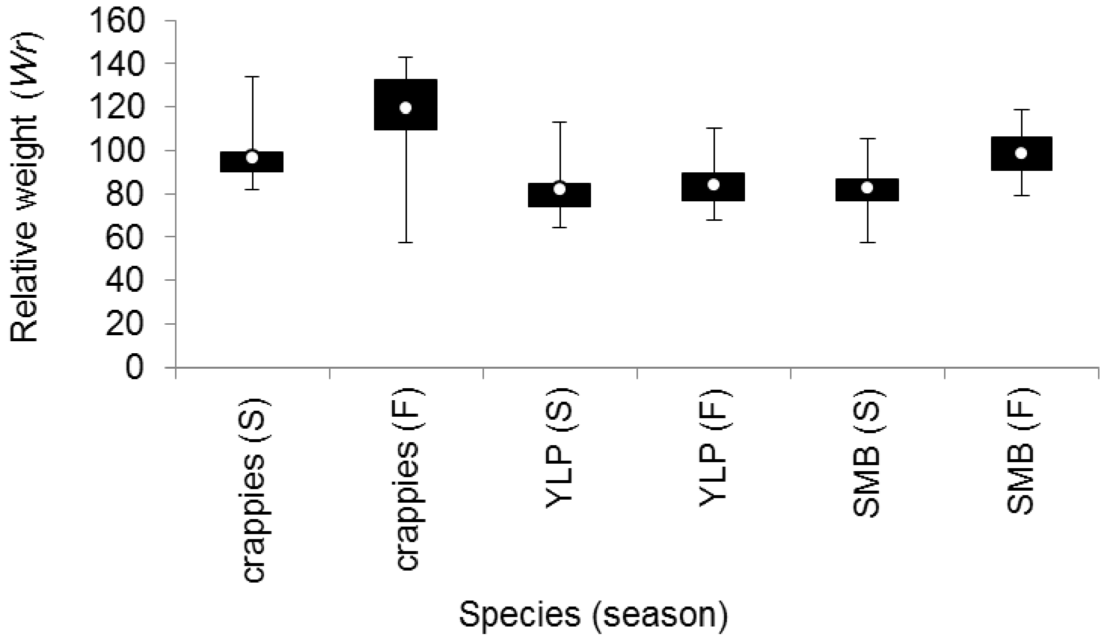


Figure 25. Relative weights shown for crappies, Yellow Perch (YLP), and Smallmouth Bass (SMB) collected in surveys conducted in the spring (S; creel survey) and fall (F; creel and otter trawl survey). The bottom and top of the black box represents the first and third quartile, respectively. The bars represent the minimum and maximum relative weights observed. The white circle represents the mean relative weight for the species and season. The value of 100 represents the average body condition of a standard fish.

FISH POPULATION MONITORING IN PADDOCK VALLEY AND SAGE HEN RESERVOIRS

ABSTRACT

Paddock Valley and Sage Hen reservoirs have supported popular sport fisheries in past years. However, both reservoirs had extremely low water levels during the summer of 2015. I used standardized gears and sampled both reservoirs in 2016 to determine the fisheries resources that remained in each reservoir. Paddock Valley Reservoir was surveyed on June 15, 2016. A total of 400 fish were collected, which included Brown Bullhead *Ameiurus nebulosus*, Black Crappie *Pomoxis nigromaculatus*, and Bluegill *Lepomis macrochirus*. Brown Bullhead was the most abundant species. Brown Bullhead had a mean total length of 175 mm and mean weight of 126 g. Black Crappie and Bluegill combined made up only 5% of the sample proportion. PSD and relative weight indicated a balanced size structure and normal body condition. Restocking of warm water species such as Largemouth Bass *Micropterus salmoides*, Black Crappie and Bluegill should be considered to rebuild the fishery. Sage Hen Reservoir was surveyed on July 14, 2016 and 39 wild and 13 hatchery Rainbow Trout *Oncorhynchus mykiss* were collected. Total catch per unit effort for Rainbow Trout was 24 fish and weight per unit effort was 7.5 kg of trout. Wild Rainbow Trout were slightly smaller (by length and weight) than hatchery Rainbow Trout. Ages of sampled wild Rainbow Trout ranged from age-1 to age-5. The proportion of wild Rainbow Trout has varied through time leading to confusion concerning their contribution to the fishery. Estimates of exploitation and angler use should be developed to determine how anglers utilize wild Rainbow Trout and how these fish contribute to the fishery.

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INTRODUCTION

Paddock Valley Reservoir is a 482-ha irrigation reservoir (at full pool) that impounds Little Willow Creek, a tributary to the lower Payette River. Paddock Valley Reservoir is located 30 km east of Weiser, Idaho and lies at 980 msl. Largemouth Bass *Micropterus salmoides*, Bluegill *Lepomis macrochirus*, Black Crappie *Pomoxis nigromaculatus*, and Brown Bullhead *Ameiurus nebulosus* have been sampled in past fish population surveys (Kozfkay et al. 2010). When adequate winter water levels are sustained for several years, Paddock Valley Reservoir has the ability to produce high yield fisheries for Black Crappie and Bluegill as well as high catch rates for Largemouth Bass. For instance, 68,918 crappies were harvested during 1987 (Mabbott and Holubetz 1989). Additionally, the reservoir is well known for producing large Brown Bullhead. Paddock Valley Reservoir has been managed under IDFG's general fishing regulations of six trout and six bass, since 1983, when the bass length limit was instituted (none under 12"; 305 mm; Reid and Mabbott 1987). There are no other restrictions or bag limits applied to other species residing in the reservoir.

Sage Hen Reservoir is a 73-ha impoundment of Sage Hen Creek, a tributary to the lower Payette River. Sage Hen Reservoir is located 80 km north of Boise, Idaho. The mountain reservoir is located at 1,506 msl within the Boise National Forest. Past fish surveys indicate that both hatchery Rainbow Trout (RBT) and wild RBT *Oncorhynchus mykiss* were present in the reservoir (Hebdon et al. 2008). Historically, the drainage supported native Redband Trout *Oncorhynchus mykiss gairdneri*, which may still be present in the system. However, based on stocking records, finding pure (non-introgressed) native Redband Trout is unlikely (Meyer et al. 2014). The wild component is assumed to be naturally reproducing RBT from past stocking events or hybridized Redband Trout. A creel survey conducted in 1994 identified that most of the RBT harvested were of hatchery origin; however, wild RBT did contribute to the harvest (Allen et al. 2000). Exploitation studies in 2011 indicated that stocked RBT were harvested at a rate of 24% to 35% annually in Sage Hen Reservoir (Koenig 2012). Information regarding the contribution of wild RBT to the fishery is limited. Currently, Sage Hen Reservoir is stocked with hatchery RBT three times per year between late May and early July. RBT are managed under IDFG's general fishing regulations of six trout with no size restriction.

Both reservoirs have experienced variable and often low water levels over the past few years. Paddock Valley Reservoir was nearly dewatered during the fall and winter of 2015 and Sage Hen Reservoir experienced similar conditions. Paddock Valley Reservoir was previously nearly dewatered during the winter of 2005-06 (Kozfkay et al. 2010). Precipitation during the winter of 2015-16 nearly filled both reservoirs to capacity. I used standardized lowland lakes and reservoir sampling gears in the summer of 2016 to describe the fish communities that remained within both reservoirs.

OBJECTIVES

1. To describe relative abundance, composition, and size structure of fish populations in Paddock Valley Reservoir.

2. To determine relative abundance of wild and hatchery RBT in Sage Hen Reservoir.

METHODS

Sampling gear included: (1) paired gill nets, (2) trap nets, and (3) night electrofishing. Paired gill net sets included floating and sinking monofilament nets, 46 m x 2 m, with six panels composed of 19, 25, 32, 38, 51, and 64 mm bar mesh. One floating and one sinking net, fished for one night, equaled one unit of gill net effort. Trap nets possessed 15 m leads, 1-m x 2-m frames, crowfoot throats on the first and third of five loops, 19-mm bar mesh, and had been treated with black tar. One trap net fished for one night equaled one unit of trap net effort. For boat electrofishing effort, a Midwest Lake Electrofishing System (MLES) Infinity system set at 20% duty cycle and approximately 2,000-2,500 watts of pulsed DC power generated by a 5000 watt Honda generator was used. One hour of active on-time electrofishing equaled one unit of effort. Fish populations in Paddock Valley Reservoir were sampled on June 15, 2016. In total, four trap net, three gill net, and one electrofishing units were utilized during 2016 (Figure 26). Sage Hen Reservoir was sampled on July 14, 2016 and a total of four trap net and two gill net units were utilized (Figure 27).

Captured fish were identified to species and origin (wild or hatchery, based on fin condition when necessary), measured for total length (± 1 mm), and weighed (±1 g for fish under 5,000 g or ±10 g for fish greater than 5,000 g) with a digital scale. In the event that weight was not collected, length-weight relationships were built from fish weighed and measured in 2016, which allowed us to estimate weights of unweighed fish. Proportional size distribution (PSD) were calculated for gamefish populations as outlined by Anderson and Neumann (1996) to describe length-frequency data. In addition, Wr was calculated as an index of general fish body condition where a value of 100 is considered average. Values greater than 100 describe robust body condition, whereas values less than 100 indicate less than ideal foraging conditions. Catch data were summarized as the number of fish caught per unit of effort (CPUE) and the weight (kg) caught per unit effort (WPUE). These indices were calculated by standardizing the catch of each gear type to one unit of effort and then summing across the gear types. CPUE data were compared to previous surveys, where sampling methodologies were similar, as reported in Kozfkay et al. (2010) for Paddock Valley Reservoir and in Hebdon et al. (2008) for Sage Hen Reservoir. The proportion of wild and hatchery RBT were calculated with 90% confidence bounds for fish captured in Sage Hen Reservoir.

Pectoral fin rays were collected from wild RBT collected from Sage Hen Reservoir to estimate mean length at age. Aging structures were collected from up to 10 fish per 10 mm length interval. Pectoral fin rays were processed and digitized using the methods described in Butts et al. (2016). Two independent readers estimated fish age. Samples with disagreements in age were revisited and the consensus age was used in further analysis.

RESULTS

A total of 400 fish were collected from Paddock Valley Reservoir, which included 379 Brown Bullhead, 15 Bluegill, and 6 Black Crappie. Trap nets yielded the highest catch for all species, followed by gill nets (Table 12). Electrofishing produced zero fish in the 2016 survey. Multiple year classes were represented in length-frequency histograms for all three species (Figure 28). Mean total length and weight of Brown Bullhead was 175 mm (± 10; 90% CI) and 126 g (± 25). Mean total length and weight of Black Crappie was 139 mm (± 58) and 66 g (± 71). Bluegill had the lowest mean length and weight at 94 mm (± 6) and 17 g (± 3). PSD was calculated at 32 for Brown Bullhead, which indicated a balanced size structure. PSD was not calculated for Black Crappie or Bluegill, due to small sample size. Mean relative weights for Brown Bullhead, Black Crappie, and Bluegill were 120, 84, and 115, respectively. This indicated that Brown Bullhead and Bluegill had average body condition and were in balance with the food resources available in the reservoir. Black Crappie had below average body condition suggesting food resources may be limited for the species.

CPUE (f/unit effort), of all gear types combined, consisted mostly of Brown Bullhead (96), followed by Bluegill (4) and Black Crappie (2; Table 12). Electrofishing CPUE for Black Crappie and Bluegill indicated abundance has decreased since the previous survey (Figure 29 and Figure 30, respectively). WPUE (kg/unit effort) was also dominated by Brown Bullhead (12.9) and was followed by Black Crappie (0.1) and Bluegill (0.1; Table 13).

Sampling on Sage Hen Reservoir yielded 52 RBT, of which 39 were identified as wild and 13 as hatchery (based on fin erosion). Wild RBT were represented in multiple age classes in the sample (Figure 31). Mean total length (90% CI) and weight (90% CI) of wild RBT was 277 mm (± 23) and 277 g (± 56). Mean total length and weight of hatchery RBT was 326 mm (± 18) and 340 g (± 58). PSD for wild RBT was 4, which indicates size structure is skewed towards smaller fish. Relative weights for wild RBT ranged from 63 to 115 and had a mean of 89, which indicated slightly below average body condition. A total of 34 pectoral fin rays were aged. Ages present in the sample ranged from age-1 to age-5 (Figure 32). The proportion of wild RBT in the sample was 75% (63% and 85%); hatchery RBT made up 25% (16% and 37%).

CPUE (f/unit effort), combining both gear types, was 18 wild RBT and 6 hatchery RBT (Table 14). Gill nets captured 44 of the 52 RBT sampled. Gill-net CPUE of wild RBT (17) has decreased through time (Figure 33); however, a slight increase was observed between 2005 and 2016. CPUE of hatchery RBT also decreased from levels in previous surveys. WPUE (kg/unit effort) for wild RBT was 5.3 and hatchery RBT contributed 2.2 during 2016 (Table 15).

DISCUSSION

Reservoir drawdown and low water conditions continue to restrict fish population re-establishment in Paddock Valley Reservoir. Black Crappie and Bluegill were the only species sampled in 2016 that were part of the reintroduction effort in 2006 (Kozfkay et al. 2010). The current assessment was the first time that Largemouth Bass were not observed since 1994 (Kozfkay et al. 2010). A total of 444 Largemouth Bass was stocked during the reintroduction effort in 2006 and was subsequently the most abundant game fish sampled in 2008 (Kozfkay et al. 2010). Brown Bullhead, which were not part of the reintroduction effort, continued to persist in the reservoir. No fish have been stocked in the reservoir since 2008. Multiple year classes of Brown Bullhead, Black Crappie, and Bluegill were present in the sample, suggesting reproduction is occurring at a low frequency within the reservoir.

Current densities of reintroduced species were extremely low. Successful gears used in past surveys produced low catch rates in the current assessment (e.g. electrofishing resulted in zero Largemouth Bass sampled). Electrofishing CPUE has been highly variable for Black Crappie and Bluegill (Kozfkay et al. 2010). We have observed zero CPUE for both Black Crappie and Bluegill in previous surveys (Figures 29 and 30). Snowpack during the winter 2016-2017 may provide adequate water to initiate another reintroduction effort to rebuild warm water fisheries. If stocking does not occur during the spring of 2017, reservoir drawdown and fall level should be monitored to determine if acceptable water remains. Largemouth Bass and Bluegill populations have the ability to rebound quickly in the reservoir (Kozfkay et al. 2010) and may provide a fishery opportunity in Paddock Valley Reservoir, two or three years post-stocking.

At Sage Hen Reservoir, gill net CPUE (f/unit effort) for wild and hatchery RBT have decreased since 1994. Gill-net CPUE for wild RBT (17) was lower than that observed in 1994 (49; Allen et al. 2000) and 2001 (42; Flatter et al. 2003) and similar to CPUE observed in 2005 (14; Hebdon et al. 2008). Wild RBT CPUE has increased by 21% since the 2005 survey; however, the trend through time indicated an overall decrease (Figure 33). Continued monitoring of wild RBT is necessary to determine if abundance continues to decrease over time. Gill-net CPUE for hatchery RBT decreased 88% between 2005 and the current survey. However, the 2005 gill-net CPUE may have been skewed by a large release of hatchery RBT less than one month from the survey date (12,013 fish released on May 26, 2005). This release was the largest release of hatchery RBT (greater than 6 inches) in the stocking record. Changes in stocking numbers, frequency, sampling period, survey design, and fish marking techniques have made comparisons of hatchery RBT CPUE difficult.

Our understanding of how wild RBT contributes to the overall fishery at Sage Hen Reservoir remains unclear; however, it is apparent that these fish continue to contribute to some degree. Multiple age classes of wild RBT were present in the sample, which suggests these fish continue to reproduce and occupy the reservoir. Growth rates for wild RBT in Sage Hen Reservoir were similar to those observed in Mann Creek Reservoir (Holecek and Scarnecchia 2013). Growth rates also determine how quickly wild RBT recruit to the fishery. It takes approximately two or three years for wild RBT to achieve a similar size to hatchery RBT at stocking. If reservoir water levels continue to decline each year, wild RBT may become more vulnerable to predation, harvest (Allen et al. 2000), and mortality associated with increased water temperature. In 2016, mid-summer water temperatures were suitable for both types of RBT found in the system (Figure 34). Developing estimates of exploitation and characterizing angler use of wild RBT would help us better understand how these fish contribute to the fishery. Additional sampling is needed to tag wild RBT to develop these estimates.

MANAGEMENT RECOMMENDATIONS

1. Paddock Valley Reservoir should be reintroduced with Largemouth Bass, Black Crappie, and Bluegill to rebuild warm water fisheries. If stocking does not occur in the spring of 2017, reservoir water level should be monitored in the fall to determine if adequate water remains to restock warm water species in the spring of 2018.

2. Sample wild RBT in Sage Hen Reservoir to estimate exploitation and to characterize the contribution to the fishery. Tag wild RBT using T-bar anchor tags and monitor exploitation and angler use for one year.

Table 12. Catch and catch per unit effort (CPUE) statistics by species and gear type for a lowland lake survey conducted on Paddock Valley Reservoir on June 15, 2016.

	Electrofish Catch	Electrofish CPUE	Gill Net Catch	Gill Net CPUE	Trap Net Catch	Trap Net CPUE	Catch Total	Total CPUE
Brown Bullhead	0	0	13	4	366	92	379	96
Black Crappie	0	0	0	0	6	2	6	2
Bluegill	0	0	0	0	15	4	15	4
Total	0	0	13	4	387	97	400	101

Table 13. Total biomass (kg) and weight per unit effort (WPUE) statistics by species and gear type for a lowland lake survey conducted on Paddock Valley Reservoir on June 15, 2016.

	Electrofish Catch	Electrofish WPUE	Gill Net Catch	Gill Net WPUE	Trap Net Catch	Trap Net WPUE	Catch Total	Total WPUE
Brown Bullhead	0.0	0.0	1.0	0.3	50.3	12.6	51.3	12.9
Black Crappie	0.0	0.0	0.0	0.0	0.4	0.1	0.4	0.1
Bluegill	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.1
Total	0.0	0.0	1.0	0.3	50.9	12.7	51.9	13.1

Table 14. Catch and catch per unit effort (CPUE) statistics for wild (w) and hatchery (h) Rainbow Trout by gear type for a lowland lake survey conducted on Sage Hen Reservoir on July 14, 2016.

	Gill Net Catch	Gill Net CPUE	Trap Net Catch	Trap Net CPUE	Catch Total	Total CPUE
Rainbow Trout (w)	33	17	6	2	39	18
Rainbow Trout (h)	11	6	2	1	13	6
Total	44	22	8	2	52	24

Table 15. Total biomass (kg) and weight per unit effort (WPUE) statistics for wild (w) and hatchery (h) Rainbow Trout by gear type for a lowland lake survey conducted on Sage Hen Reservoir on July 14, 2016.

	Gill Net Catch	Gill Net WPUE	Trap Net Catch	Trap Net WPUE	Catch Total	Total WPUE
Rainbow Trout (w)	10.5	5.3	0.3	0.1	10.8	5.3
Rainbow Trout (h)	4.2	2.1	0.3	0.1	4.5	2.2
Total	14.7	7.4	0.6	0.2	15.3	7.5

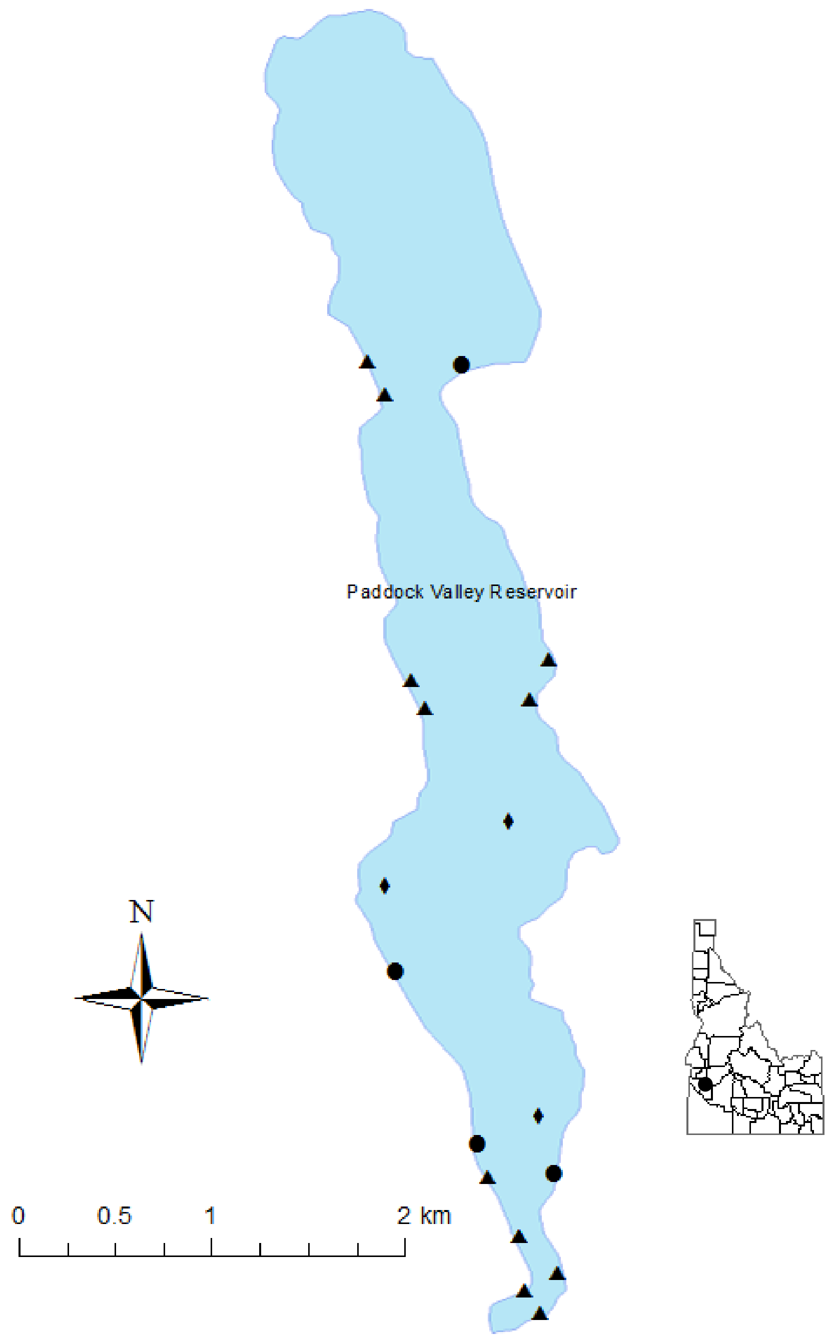

Figure 26. Location of effort in Paddock Valley Reservoir, Idaho during the 2016 survey. Trap net locations are denoted with circles and paired gill nets with diamonds. Start and endpoints for electrofishing surveys are denoted with triangles.

Figure 27. Location of effort in Sage Hen Reservoir, Idaho during the 2016 survey. Trap net locations are denoted with triangles and paired gill nets with circles.

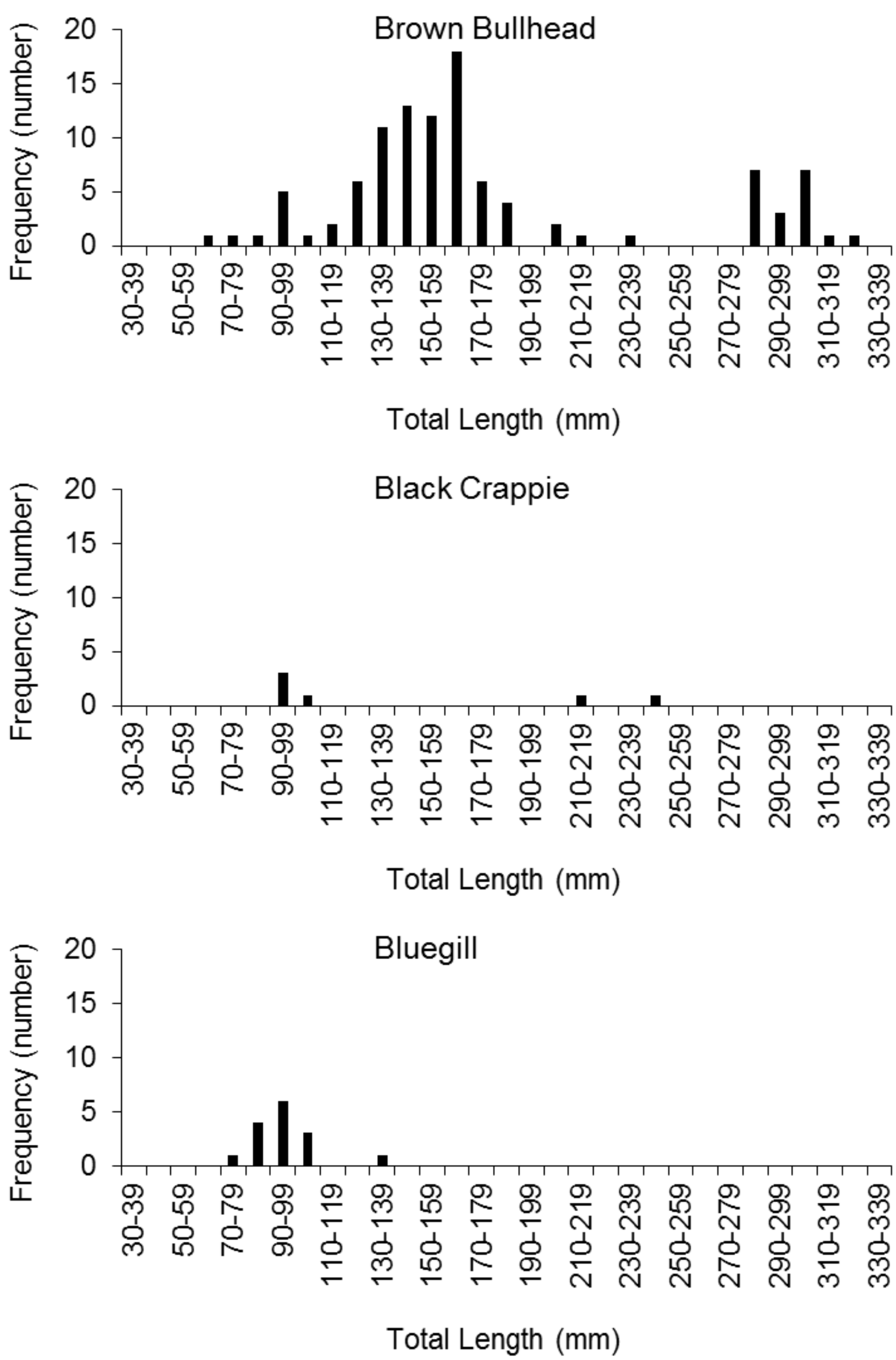

Figure 28. Length-frequency histogram of Brown Bullhead (n = 104), Black Crappie (n = 6), and Bluegill (n = 15) sampled from Paddock Valley Reservoir during 2016.

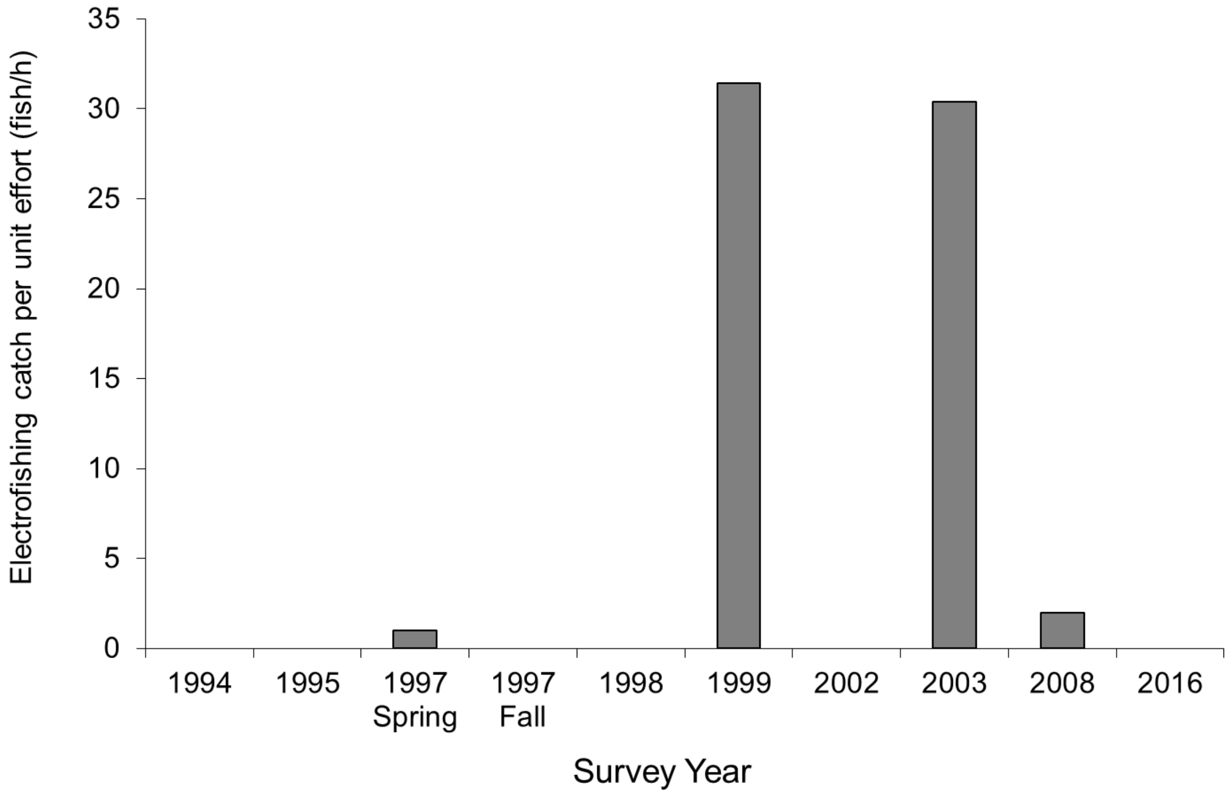

Figure 29. Black Crappie catch per unit effort (fish/h) for electrofishing surveys conducted during the last 23 years in Paddock Valley Reservoir.

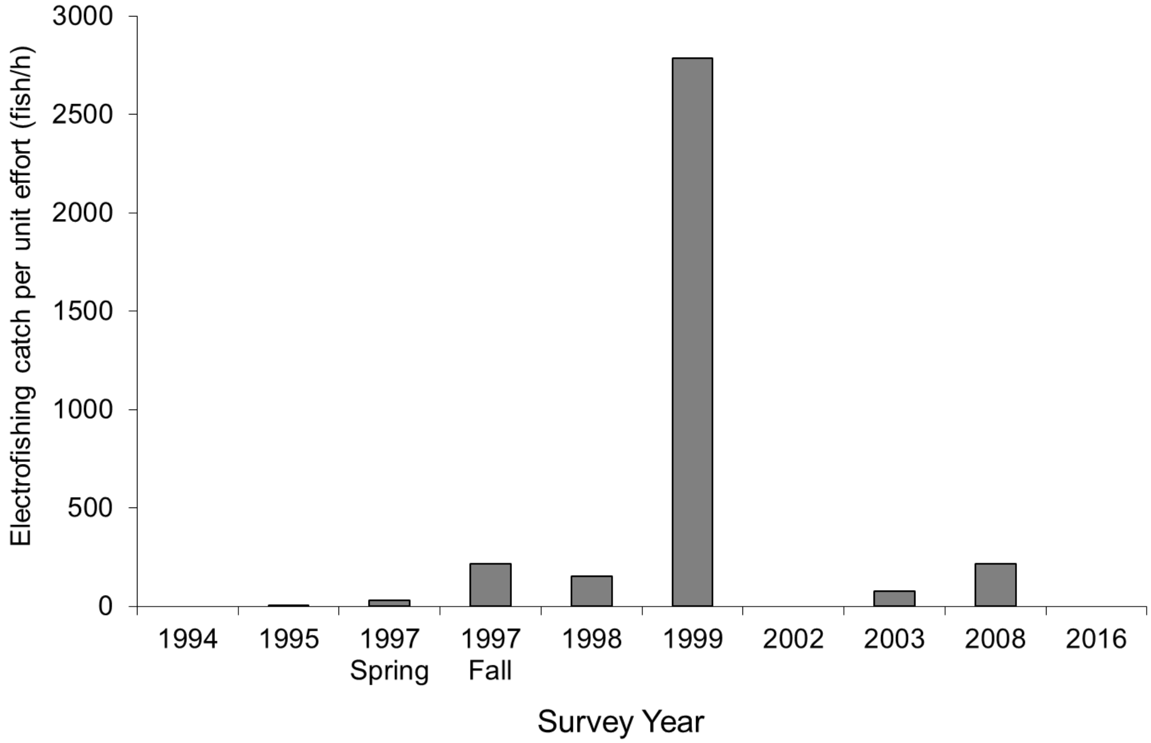

Figure 30. Bluegill catch per unit effort (fish/h) for electrofishing surveys conducted during the last 23 years in Paddock Valley Reservoir.

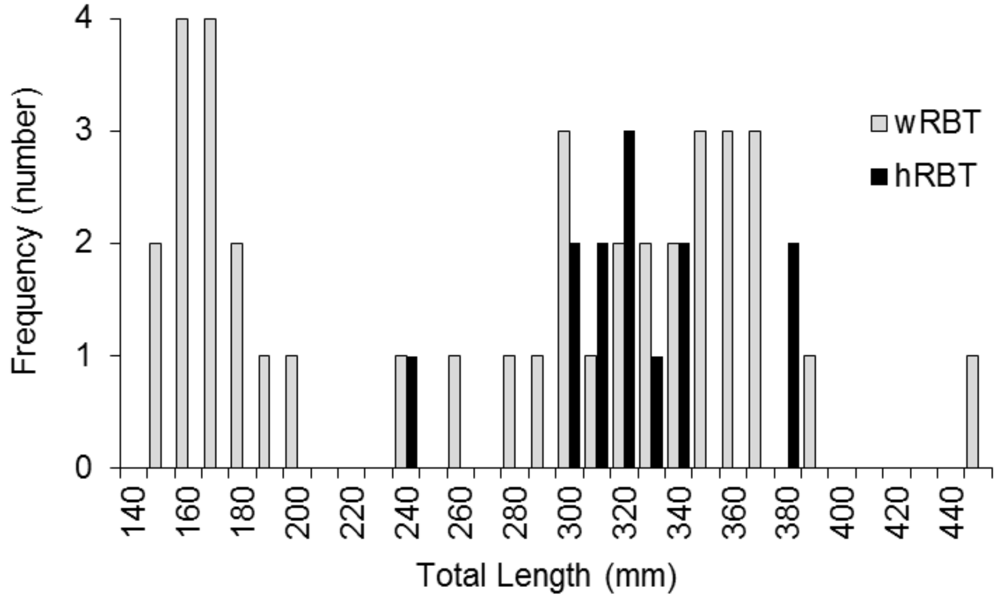

Figure 31. Length-frequency histogram of wild (wRBT; n = 39) and hatchery Rainbow Trout (hRBT; n = 13) sampled from Sage Hen Reservoir in 2016.

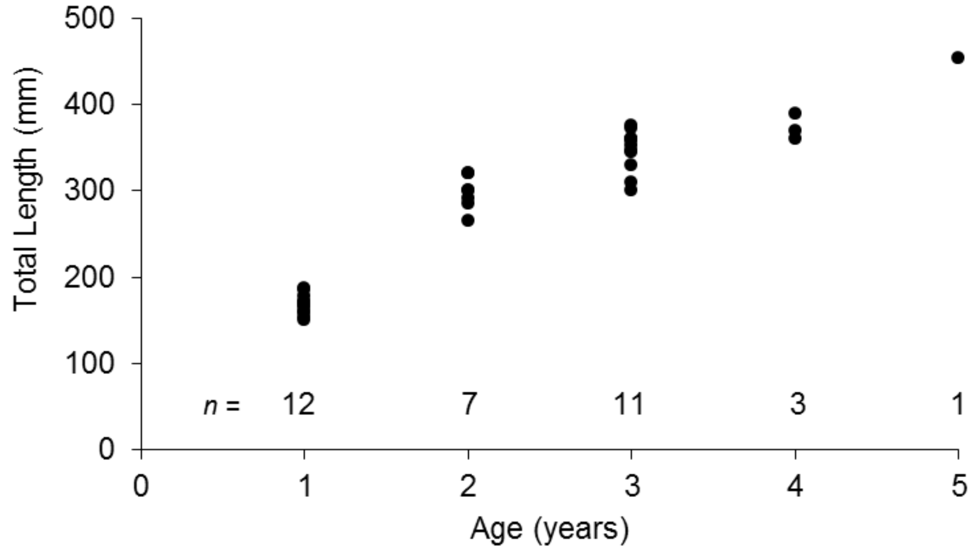

Figure 32. Length-at-age for wild Rainbow Trout from Sage Hen Reservoir, ID sampled on July 14, 2016. The number of samples aged for each age class are presented.

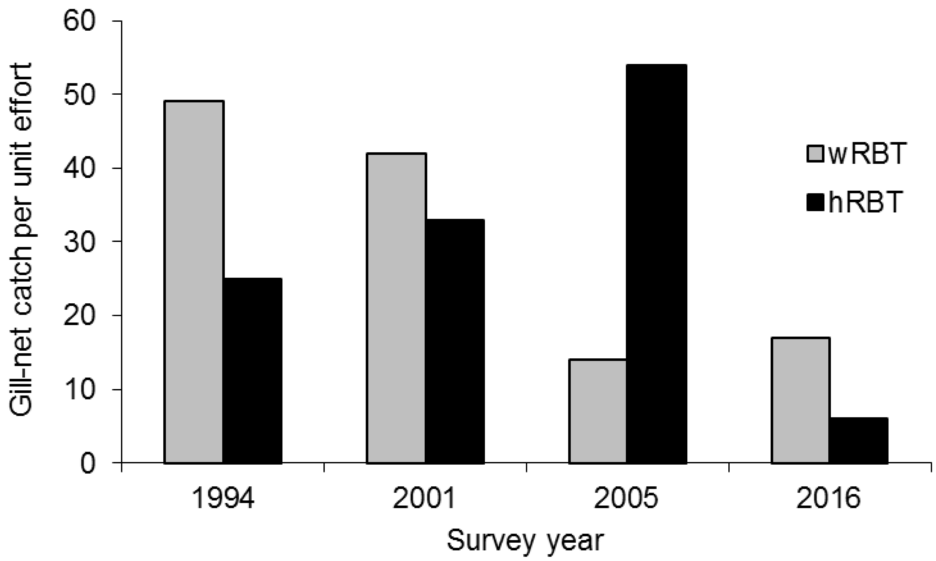

Figure 33. Wild Rainbow Trout (wRBT) and hatchery Rainbow Trout (hRBT) catch per unit effort (f/unit effort) for gill-net surveys conducted during the last 23 years in Sage Hen Reservoir, Idaho.

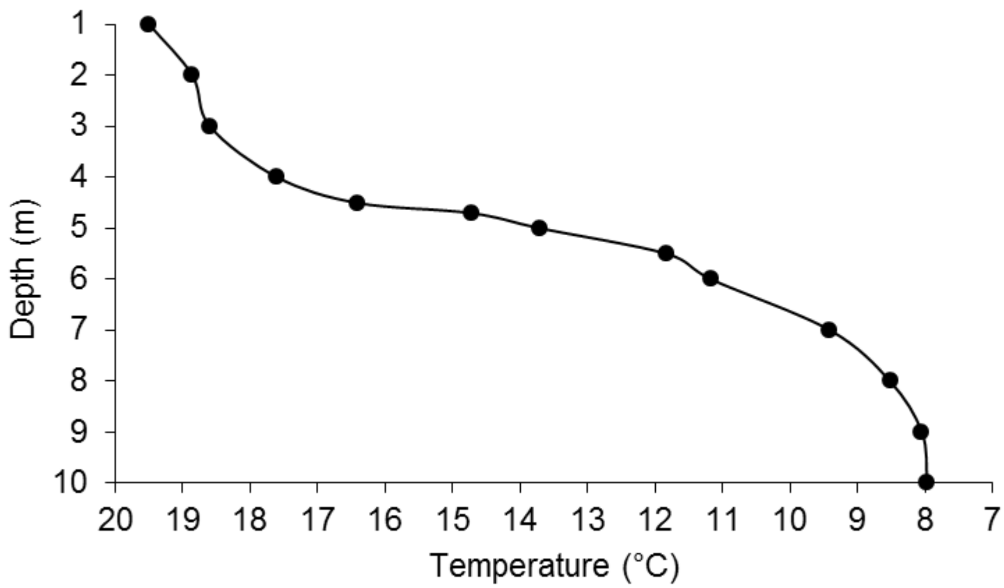

Figure 34. Vertical temperature (°C) profile for Sage Hen Reservoir, ID sampled on July 14, 2016.

USE OF PESTICIDED AND HERBICIEDES TO CONTROL NUISANCE AQUATIC FISH AND PLANTS IN SMALL WATERS

ABSTRACT

Excessive aquatic plant growth in Duff Lane, Lowman, and Payette Greenbelt ponds was hampering boating and fishing opportunities. In order to maintain fisheries quality, we treated these waters with aquatic herbicide (Navigate®, a granular 2, 4-D) at application rates of 150 lb/acre. Submerged aquatic plant abundance was reduced by late summer. Effective long-term weed management will require vigilance and finding a balance between aquatic plant eradication and maintaining adequate amounts and types of aquatic plants for invertebrates and as cover for fish. Also, staff became aware that Rosy Red Shiner, a bright orange or red color morph of the Fathead Minnow *Pimephales promelas*, had been illegally introduced and had established a population in Redwood Park Pond. Staff treated the pond with rotenone to hopefully eliminate this population and species from the state prior to further establishment in the wild.

Author

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INTRODUCTION

Idaho Department of Fish and Game's (IDFG) Southwest Region manages fisheries in about 50 publicly-accessible small ponds and reservoirs. These waters receive significant fishing effort and are an important resource for providing family-friendly fishing opportunities. In some ponds, excess plant coverage especially during the summer months may limit access or in extreme cases may totally preclude fishing. Furthermore, excess plant coverage may create other problems such as high oxygen demand during decomposition or by providing too much cover for juvenile fish, leading to high abundances and small sizes. Excess plant coverage was reducing fishing opportunities and potentially impacting fish populations in Duff Lane (5.5 acres), Lowman (1.8 acres), and Payette Greenbelt (5.5 acres) ponds. Eurasian Watermilfoil *Myriophyllum spicatum* and Curly-leaf Pondweed *Potamogeton crispus* were the predominant species present. Staff treated these waters with herbicide to reduce nuisance plant abundance and biomass.

Release of fish by the general public may lead to establishment of undesirable species or populations that may negatively impact existing fisheries. During summer of 2016, a partial fish kill was reported at Redwood Park Pond, a 0.74-acre water located within a City of Boise park. Assessment of the fish kill indicated that an illegally introduced fish species, Rosy Red Shiner (RRS), had become established. This species is a bright orange or red color morph of the Fathead Minnow *Pimephales promelas* that is bred and sold as bait or for aquaria. Heretofore, RRS had not been sampled in the wild in Idaho. It is not known if RRS would have deleterious impacts to any fish and wildlife populations in Idaho. IDFG staff was unwilling to assume this risk, and therefore decided to renovate the pond. The intent of this renovation project was to kill and remove all fish from Redwood Park Pond utilizing a rotenone application, thereby reducing or eliminating the probability of further establishment of this species in other waters.

METHODS

For aquatic plant management, we selected Navigate, a granular 2, 4-D, to treat these waters, based on past efficacy in nearby waters and low fish toxicity. Recommended application rates for Eurasian Watermilfoil and Curly-leaf Pondweed were 150 lb/surface acre. We used Geographic Information Systems (ArcView version 11) to estimate surface acreage. Herbicide was applied using a granular fertilizer spreader mounted to the front of a small boat that was powered with an electric motor. On April 14, 2016, we treated Payette Greenbelt Pond with 825 lb of Navigate. On April 19, 2016, we treated Lowman Ponds with 270 lb of Navigate. On May 17, 2016, we treated Duff Lane Pond with 825 lb of Navigate.

For renovation of Redwood Park Pond, staff followed guidelines as outlined in the "Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management" (Finlayson 2000). Furthermore, application rates and methods were in accordance with the piscicide label, state and federal laws, as well as the NPDES permit. In addition to the intended target species, this pond contained bullhead *Ameiurus* sp. and has a moderately rich organic layer. I intended to completely renovate the pond; therefore, I treated with Synpren™ - Fish Toxicant at a rate of 4.0 ppm. The pond contained approximately 4.3 acre feet of water (0.74 acres x 5.9' average depth). The total volume of Synpren™ - Fish Toxicant (2.5% rotenone) utilized to treat the pond was 5.7 gallons. The product was diluted 10 to 1 (water to product ratio) then applied to the entire pond in a systematic fashion from a boat equipped with a gas-powered sprayer, hoses, and garden nozzle. The sprayer was calibrated prior to treatment to ensure effective treatment and attainment of desired concentrations throughout the pond. The sprayer had a spray width of 9’ and a flow volume of 2.6 gallons per minute. The boat was propelled with an electric trolling motor at a rate of 1.7 miles per hour to ensure equal and adequate treatment concentrations. Due to the proximity of occupied houses, larger dead fish resulting from the treatment were removed and deposited at a landfill. Visual estimates and measured weights were utilized to estimate total fish mortality.

RESULTS AND DISCUSSION

Herbicide treatments were effective in ponds treated during 2016. Based on visual estimates, >95% of rooted submerged vegetation was killed at Duff Lane, Lowman, and Payette Greenbelt ponds. No significant plant regrowth occurred at these three ponds prior to fall. 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.

Although no formal post-treatment efficacy assessment was completed at Redwood Park Pond during 2016, treatments appeared to be effective, especially for the primary target species. RRS began to show acute signs of toxicity and appeared on the surface within an hour of application. I visually estimated total mortality of RRS as 10,000 individuals. Most RRS were 0.5-3” in length. Bullhead began to show acute signs of toxicity quickly, within 2-4 h. We used dip nets to remove about 380 lb of the larger dead fish, most of which were bullhead. Average weight of bullhead was 116 g or 0.26 lb, yielding a total mortality estimate for bullhead of 1,484 individuals. In addition, we removed about 50 dead Goldfish *Carassius auratus* and one Plecostomus *Hypostomus plecostomus*. Goldfish were resilient with some individuals taking more than 24 h to perish. In addition to reducing the possibility of establishment of these illegally-introduced nonnative fishes, this action will eventually lead to improved fishing opportunity as this fish community had become dominated by bullhead and RRS that were small and of little interest to anglers.

RECOMMENDATIONS

1. Monitor plant mortality and re-growth in ponds treated during 2015 and 2016. Apply herbicide or stock Grass Carp on a semi-annual basis or as needed.
2. Monitor aquatic plant coverage in other waters that have a tendency to possess nuisance levels and initiate treatments where necessary.
3. Determine efficacy of rotenone treatments at Redwood Park Pond.
4. Based on efficacy results, initiate re-stocking of Largemouth Bass and Bluegill or additional piscicide treatments as necessary.

AN ASSESSMENT OF THE LARGEMOUTH BASS AND BLUEGILL POPULATIONS IN RED TOP POND

ABSTRACT

Red Top Pond is a public fishing water managed by the Idaho Department of Fish and Game. Community fishing ponds, like Red Top Pond, are important for recruiting young anglers, retaining older or less mobile anglers, and raising the awareness for fisheries programs statewide. The pond was closed to the public while being mined for gravel. The closure allowed us to develop baseline population data for Bluegill and Largemouth Bass prior to the pond re-opening to the public in May of 2016. The goal of this assessment was to describe relative abundance and size structure of Bluegill and Largemouth Bass in Red Top Pond. Bluegill and Largemouth Bass were the most numerous species sampled. Catch per unit effort (CPUE) for Bluegill and Largemouth Bass declined between 2015 and 2016, and both were lower than the national median. Bluegill had a mean total length of 90 mm, with a Proportional size distribution (PSD) of 24. Bluegill mean relative weight (W_r) was 113 and higher than the national median of 104. Largemouth Bass had a mean total length of 325 mm and a high PSD of 84. Mean relative weight of Largemouth Bass was 93 for quality length fish (>300 mm), which was higher than the national average of 89. Largemouth Bass exploitation increased between 2015 and 2016 from 3% to 29%, respectively. Total use (either harvested or released) followed a similar pattern and increased from 22% (2015) to 92% (2016). The observed levels of exploitation and use could lead to a size structure shift towards smaller fish. Additional monitoring is necessary to determine how the fishery changes in the years after it re-opens, and if any additional restrictions are necessary to maintain desirable size structures.

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INTRODUCTION

Community ponds are some of the most important and utilized fishing waters in the state. When managed effectively, community ponds are essential for recruiting and retaining anglers (Eades et al. 2008). Often, they provide easy access to individuals interested in fishing. These ponds also raise awareness of fisheries and wildlife resources as well as conservation issues (Eades et al. 2008).

Formerly a publicly accessible water, Red Top Pond was closed to public access for approximately eight years while being mined for gravel by the Idaho Transportation Department (ITD). Once gravel mining ceased, the property was offered to Idaho Department of Fish and Game (IDFG) through a long-term lease agreement with the purpose of allowing fishing and boating access. The pond remained closed to the general public until construction of several amenities was completed. IDFG engineering staff constructed a parking area, perimeter fencing, restroom, and an ADA-compliant fishing dock. The pond was re-opened to public access in May 2016.

Red Top Pond currently supports a warmwater fish assemblage supported by natural reproduction; the pond was originally excavated in the early 1990s, but has no previous stocking history by IDFG. Bluegill *Lepomis macrochirus* and Largemouth Bass *Micropterus salmoides* are common in Red Top Pond; whereas Pumpkinseed *Lepomis gibbosus*, Crappie *Pomoxis spp*, Bullhead Catfish *Ameiurus spp,* and Common Carp *Cyprinus carpio* are present, but in low abundance. The pond is open year round and is managed under general fishing rules. Anglers may harvest six bass per day over 12”, with no size or bag limits for other species.

Prior to this study, our understanding of the abundance and size structure of Bluegill and Largemouth Bass was very limited in Red Top Pond. Understanding fish density, species diversity, length frequency, age, growth rates, exploitation, and total angler use data are an important part of proper management. The goal of this study was to develop baseline data for Bluegill and Largemouth Bass populations in Red Top Pond. The baseline data will be important to quantify potential population changes in the years following the re-opening to public access.

OBJECTIVES

1. Describe relative abundance, biomass, as well as age and size structure of Bluegill and Largemouth Bass in Red Top Pond.

STUDY SITE

Red Top Pond is an eight-ha pond located nine kilometers west of Caldwell, Idaho in Canyon County. Amenities include a parking area, a public restroom, and a handicap accessible fishing dock. Currently, the pond is managed as a walk-in access for shore-bound anglers or carry-in access for anglers using small boats small watercraft. Emergent aquatic vegetation provides primary cover for fish. In addition, other forms of cover include large woody debris (tree stumps) as well as artificial habitat structures.

METHODS

Bluegill and Largemouth Bass were the primary focus of this study. Other species were observed, which included Pumpkinseed *Lepomis gibbosus*, Crappie *Pomoxis spp*, Bullhead Catfish *Ameiurus spp,* and Common Carp *Cyprinus carpio*; however, no attempts were made to capture these species. Red Top Pond was surveyed on two dates in 2015 (May 28 and June 3) and 2016 (April 19 and May 3). The 2016 survey was conducted earlier to complete the evaluation prior to opening the pond to public access. The pond was sampled at night with electrofishing gear mounted to an aluminum drift boat fitted with an outboard motor and a lighting bar. We used a Midwest Lake Electrofishing System (MLES) Infinity system set at 20% duty cycle, 60 pulses per second, and approximately 2,000-2,500 watts of pulsed DC power created by a 5,000 watt Honda generator. Total electrofishing effort (time with power on) was recorded for calculation of CPUE and WPUE. The first date for each year was used to mark fish (marking run), followed by a recapture survey 5-14 days later. Stunned Bluegill and Largemouth Bass were netted. Captured fish were identified to species, measured for total length (TL) to the nearest millimeter (mm), and weighed to the nearest gram (g). During the marking runs, collected Bluegill and Largemouth Bass were marked with a caudal fin punch for identification during the recapture survey.

We calculated catch-per-unit-effort (CPUE) as the number of stock length and greater fish captured per hour of electrofishing (Bonar et al. 2009), and weight-per-unit-effort (WPUE) as the total weight in kilograms (kg) captured per hour of electrofishing. We calculated missing weights for individual fish with length information using the following species-specific formulas presented by Blackwell (2000):

$$\text{Bluegill: } \log_{10}(W) = -5.374 + 3.316 \log_{10}(L)$$

$$\text{Largemouth Bass: } \log_{10}(W) = -5.528 + 3.273 \log_{10}(L)$$

Electrofishing effort was not recorded for the first run conducted on May 3, 2016; therefore, we used the average electrofishing effort observed on the other three runs completed that evening. CPUE and WPUE were calculated as an average of mark and recapture runs. We compared our CPUE data to national average catch rates presented in Bonar et al. (2009) for small lentic waters. We also estimated the abundance of Largemouth Bass in Red Top Pond for each sample year using the modified Petersen method and the program Fisheries Analysis + (MFWP 2007). Proportional size distribution (PSD) was calculated using the Fishery Analysis and Modeling Simulator software (FAMS; Slipke and Maceina 2014), using the formula:

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

while relative stock density (RSD) was calculated using:

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

We defined stock and quality-length for Bluegill as 80 and 150 mm respectively, and 200 and 300 mm for Largemouth Bass, respectively, based on values presented in Anderson and Neumann (1996). Confidence intervals for PSD (95%) were calculated according to Gustafson (1988). We used a total length of ≥400 mm for RSD (RSD-400).

We described fish body condition using relative weight (W_r), calculated according to Wege and Anderson (1978) using the slope and intercept parameters for standard weights (W_s) presented in Blackwell et al. (2000). Relative weight was only calculated for fish greater than the minimum stock lengths for Bluegill and Largemouth Bass as recommended by Blackwell et al. (2000). Mean W_r was calculated for stock and quality fish so that condition data could be compared to other waters throughout the United States (Bonar et al. 2009).

Largemouth Bass and Bluegill ages were estimated using cross-sectioned dorsal spines from a subsample of up to 10 fish per 10 mm length interval. The first three dorsal spines were removed by cutting as close to the skin as possible (DeVries and Frie 1996, Koch et al. 2008). Spines were prepared according to methods described by Koch and Quist (2007). Two independent readers estimated fish age. Samples with age disagreements were reviewed and the consensus age was determined and used in further analysis. If a consensus age was not agreed upon, the sample was eliminated from further analysis. We estimated the age distribution of Bluegill and Largemouth Bass by assigning the proportion of ages in the subsample to the total sample using an age-length key as described by Quist et al. (2007). Age distribution was then used to estimate instantaneous and annual mortality rates using a linearized catch curve for the age classes fully recruited to the gear. Due to sample size limitations, we combined age data from both years to produce the mortality estimates (Miranda and Bettoli 2007). Mean length-at-age was calculated using only fish from the aged subsample.

We estimated angler exploitation (fish harvested) and use (harvested or caught but released) rates of Largemouth Bass using 70 mm (51 mm of tubing) fluorescent orange Floy® FD-68BC T-bar anchor tags injected just beneath the dorsal fin. Fish were tagged during both the marking and recapture runs, and only Largemouth Bass of approximate legal harvest size (≥305 mm) were tagged. Tag reporting data was collected using the IDFG Tag! You're It! phone system and IDFG website. We calculated exploitation and total use rates of Largemouth Bass from reported tags and the analysis methods presented in Meyer et al. (2010) and Koenig (2012). Tag reports were adjusted using the standard Idaho non-reward tag reporting rate of 51.0%, a 1-year tag loss rate of 13.1%, and a 7-day tagging mortality rate of 0.8% (Unpublished IDFG Data). Tag reporting data was analyzed for a 365-day duration after release for both 2015 and 2016 tagged fish.

RESULTS

Bluegill CPUE was 54.5 and 29.5 f/h for 2015 and 2016, respectively (Table 16). WPUE for Bluegill was 2.3 kg/h in 2015 and decreased to 2.0 kg/h in 2016. Bluegill PSD was 14 and 24 for 2015 and 2016, respectively (Table 17). Mean relative weight for Bluegill was 113 for quality length fish in both years (Table 18). Bluegill ages ranged from age-0 to age-5. Bluegill growth was relatively fast, taking approximately 2 years to reach quality-length. Bluegill had an estimated instantaneous mortality rate of -1.0 and a total annual mortality rate of 0.64. We did not recapture enough marked Bluegill to estimate the population within reasonable confidence bounds.

Largemouth Bass CPUE was 91.5 and 61.8 f/h in 2015 and 2016, respectively (Table 126). Largemouth Bass WPUE was 44.5 kg/h in 2015 and decreased to 34.5 kg/h in 2016. Largemouth Bass PSD was 82 and 84 in 2015 and 2016, respectively (Table 17). Mean relative weight for quality length Largemouth Bass was 90 in 2015 and was similar (93.3) in 2016 (Table 18). We marked 79 Largemouth Bass and recaptured 19 marked Largemouth Bass during the recapture run. The Largemouth Bass population was estimated at 462 individuals, or 57.8 fish/ha.

Largemouth Bass ages ranged from one to six. Largemouth Bass tagged in 2015 had an estimated harvest rate of 2.6% and an estimated total use of 28.6%. Largemouth Bass experienced an average days-at-large (DAL) of 286 days before being recaptured and reported by anglers. Largemouth Bass tagged in 2016 had a 22.2% harvest rate and a total use of 92.0%, with an average days-at-large of 26 days (Table 19). Largemouth Bass had an estimated instantaneous mortality rate of -2.3 and a total annual mortality of 0.90.

DISCUSSION

The Bluegill population in Red Top Pond can be classified as low in abundance compared to other local ponds and having skewed size structure towards small fish. CPUE was considerably lower than those observed in Duff Lane, Horseshoe Bend Mill, and Parkcenter ponds in 2014 (Butts et al. 2016) and the national average of 127 (Bonar et al. 2009). We also observed a decrease in CPUE between 2015 and 2016, which may be explained, partially, by differences in sample timing between surveys. The survey conducted in 2016 occurred approximately a month earlier than the 2015 survey, which resulted in water temperatures up to 5°C colder and may have negatively affected the estimates of CPUE and PSD. Bluegill PSD was slightly higher than those identified in the ponds listed above and lower than the national average (Bonar et al. 2009). Mean relative weights for BLG were higher than average and consistent across all sizes (Figure 38). Mean length at age was higher than similar community ponds within the region (Butts et al. 2016). Annual mortality for Bluegill was similar to estimates for 11 Michigan lakes, which ranged from 37% to 86% (Spotte 2007).

The Largemouth Bass population in Red Top Pond can be described as average in abundance compared to other local ponds, and primarily made up of medium-sized fish between 300 and 400 mm. CPUE was within the range observed for several local ponds that were surveyed in 2014 (Butts et al. 2016). Largemouth Bass from Red Top Pond had higher CPUE than observed in Settlers and Parkcenter ponds, but lower than observed in Duff Lane and Horseshoe Bend Mill ponds (Butts et al. 2016). CPUE decreased between 2015 and 2016 surveys, which may be explained partially by the difference in sampling time. PSD of Largemouth Bass was higher than both the local and national average, and higher than the PSD range of 40-60 proposed for healthy bass populations by Novinger and Legler (1978). Relative weights were close to the national average (Figure 38), but decreased with increasing length, which could be explained by either competition for food resources that occurs at larger body sizes, or as weight loss due to spawning. The 2015 survey may have occurred post-spawn, whereas the 2016 survey likely occurred prespawn, which may have biased relative weight and WPUE estimates. Largemouth Bass exhibited a higher than average growth rate compared to other local ponds, reaching a mean length of 348 mm by age 4 (Figure 35). Despite good growth rates, very few large Largemouth Bass were sampled, evidenced by a RSD-400 of only 2.2. Largemouth Bass reached an estimated maximum age of 6 in Red Top Pond. Annual mortality was high (87%) compared to the national average of 57% (Allen et al. 2008). Largemouth Bass have been aged much older than age-6 in other regional waters (Butts et al. 2016; Butts et al. 2013b).

The exploitation rate of Largemouth Bass in Red Top Pond increased more than seven fold from 2.6% in 2015 to 22% in 2016 after the pond was officially reopened to public angling. Furthermore, the use rate exceeded 90% indicating that fishing effort or catches for bass were relatively high. Assuming marginal rates of hooking mortality for released fish, fishing related mortality rates likely exceeded 30%. We assume that this level of mortality will lead to reduced abundance and size structure especially if recruitment is intermittent. Because of this relatively rare opportunity to study a “newly-opened-to-the-public” water, we think it beneficial to continue studying CPUE, exploitation, and use, for the next couple of years to determine if fishing-related mortality is reducing abundance or size structure of Largemouth Bass.

RECOMMENDATIONS

1. Survey Red Top Pond in 2018 to compare fish community composition and size structure with the baseline data presented in this chapter.
2. Tag additional Bluegill and Largemouth Bass in Red Top Pond to monitor exploitation and use rates for additional years.

Table 16. Electrofishing catch per unit effort (CPUE; fish/h), and weight per unit effort (WPUE; kg/h) by year and species.

Year	Species	CPUE (fish/h)	WPUE (kg/h)
2015	BLG	55	2
2016	BLG	34	2
2015	LMB	92	45
2016	LMB	62	35

Table 17. Proportional size distribution (PSD) by year for Largemouth Bass (LMB) with associated sample size (n), count at size group, and 95% confidence intervals. National average PSD values taken from Bonar et al. (2009) for small lentic waters are used for comparison.

Year	Species	*n*	Stock (n)	Quality (n)	PSD (95% CI)	National Average
2015	BLG	97	56	8	14.3 ± 9.2	41
2016	BLG	132	100	24	24.0 ± 8.4	41
2015	LMB	104	93	76	81.7 ± 7.8	56
2016	LMB	173	169	142	84.0 ± 5.5	56

Table 18. Relative weight (W_r) of stock length and quality length fish by year and species with associated sample size (n). National average W_r values taken from Bonar et al. (2009) for small lentic waters are used for comparison.

Year	Species	Stock Wr	Stock (n)	Stock National Average	Quality Wr	Quality (n)	Quality National Average
2015	BLG	120.5	48	106	112.5	8	104
2016	BLG	111.3	67	106	112.7	18	104
2015	LMB	98.1	17	92	90	74	93
2016	LMB	102.3	29	92	93.3	142	93

Table 19. Total amount of tagged (n) and reported Largemouth Bass between May 28, 2015 and May 3, 2017. Exploitation (harvest) and use (harvest + release) are shown with 90% confidence intervals. Median days at large (DAL) are listed by year.

Release Dates	n	Harvested	Released	Adjusted Harvest	Adjusted Use	Average DAL
			2015			
5/28/2015	46	1	6	4.4	30.9±20.3	252
6/3/2015	32	0	4	0	25.4±22.0	345
2015 Total	78	1	10	2.6	28.6±.15.4	286
			2016			
4/19/2016	55	5	18	18.5	84.9±29.2	27
5/3/2016	73	9	20	25	80.7±25.9	26
2016 Total	128	14	38	22.2	92±23.6	26

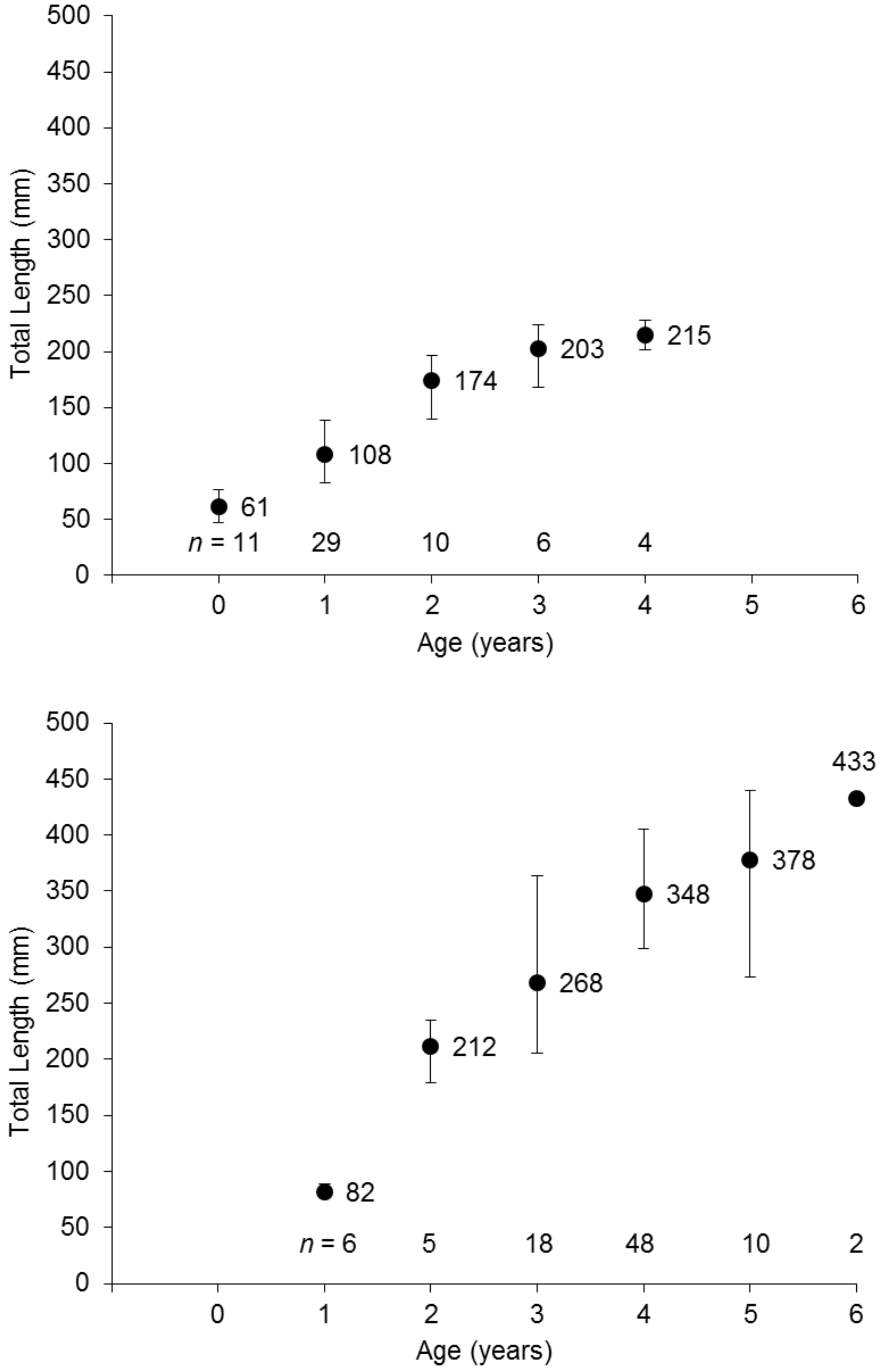
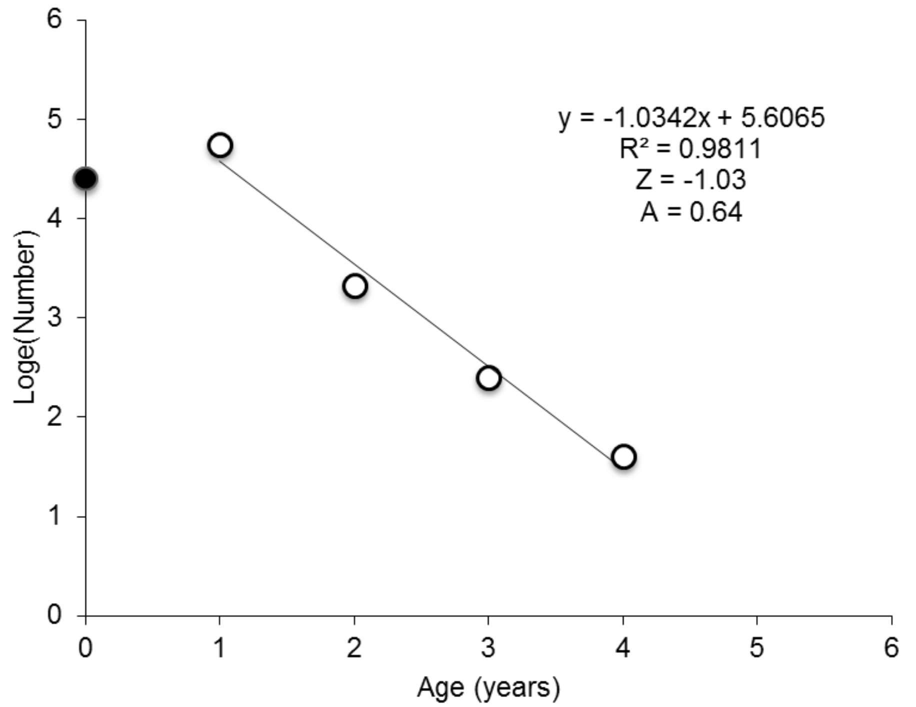


Figure 35. Mean length-at-age for Bluegill (top) and Largemouth Bass (bottom). Sample sizes for mean length-at-age are shown across the bottom. Error bars indicate minimum and maximum values.



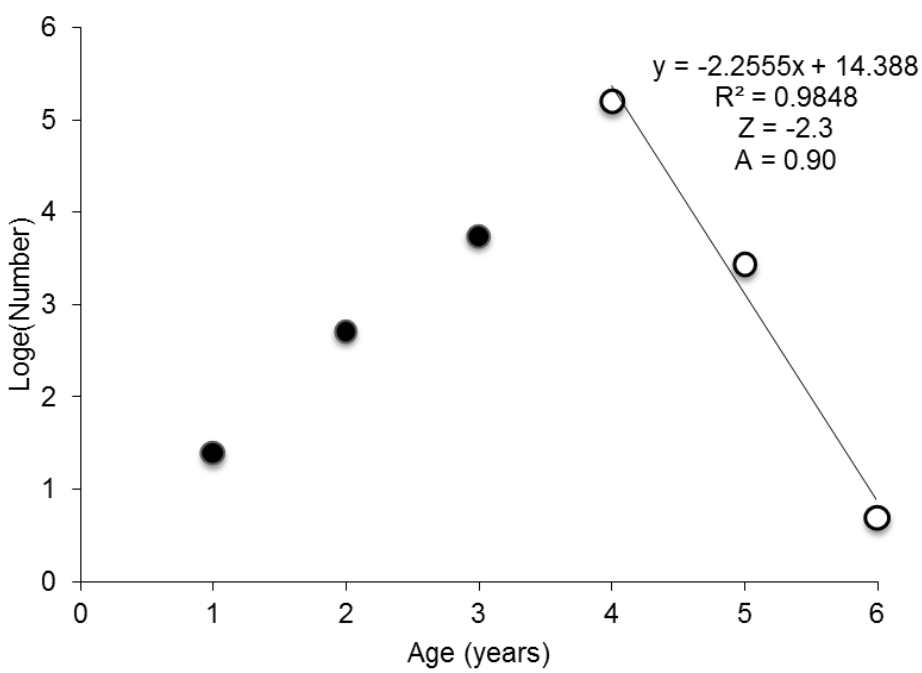
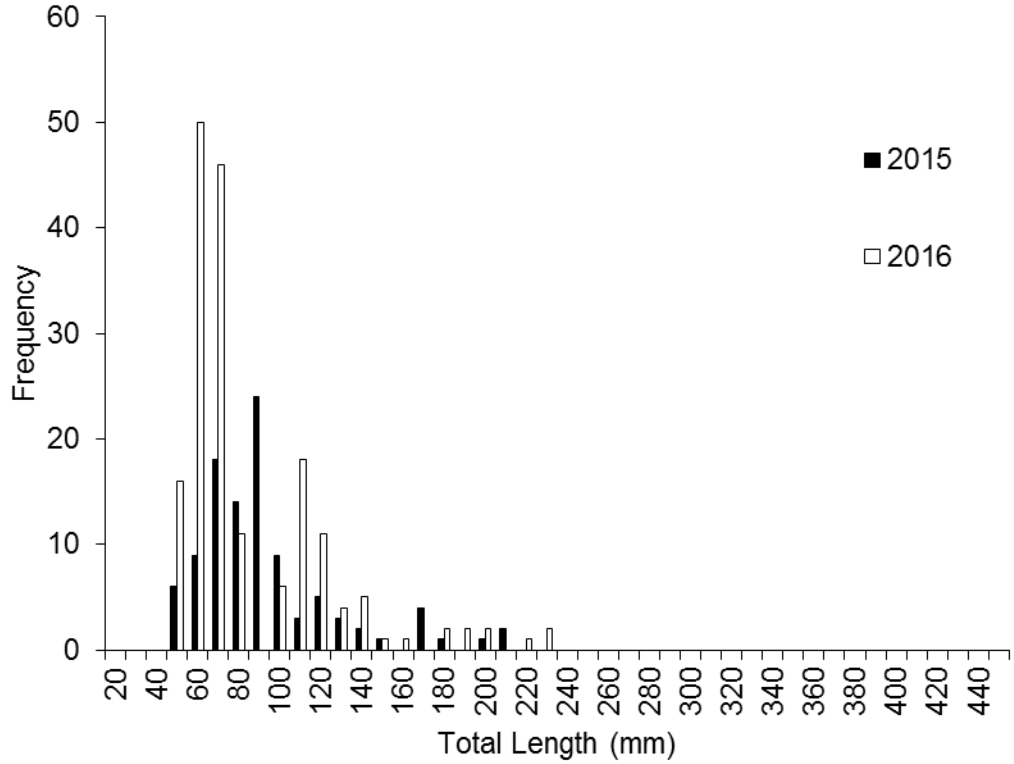


Figure 36. Catch curve plots for Bluegill (top) and Largemouth Bass (bottom) from Red Top Pond. Age distribution for catch curves were assigned from an age-length key developed from a subsample of aged fish using dorsal spine cross sections. The trend line was fit to only model fully recruited age classes (open circles) and not unrecruited age classes (solid circles).



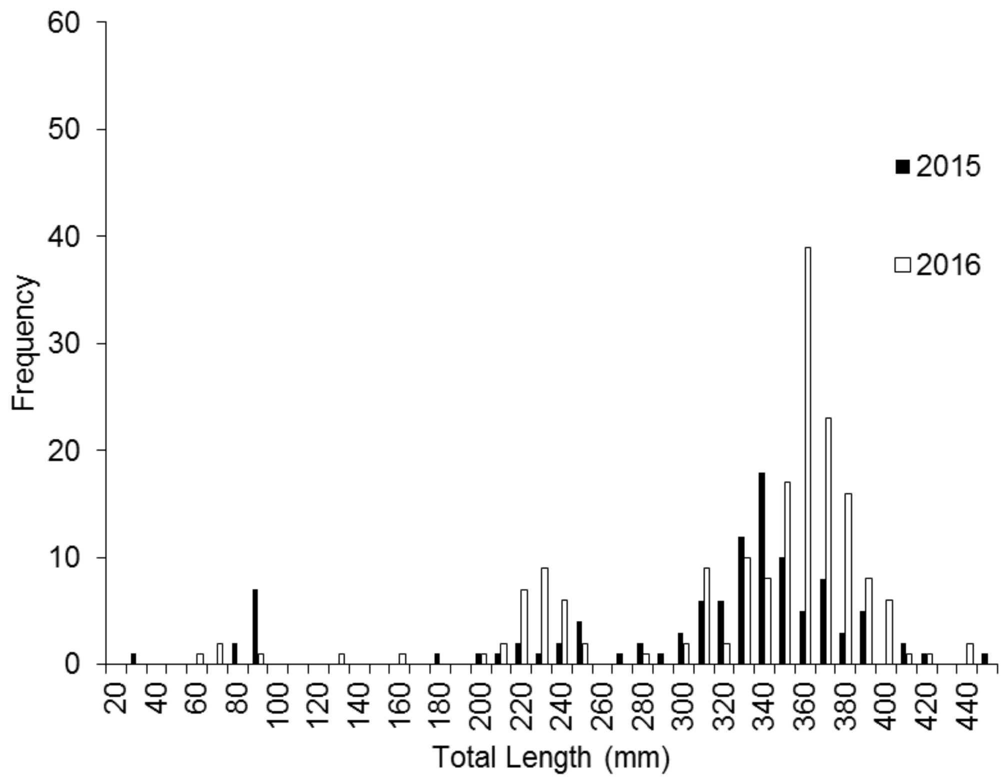


Figure 37. Length-frequency distribution of Bluegill (top) and Largemouth Bass (bottom) from Red Top Pond by year sampled.

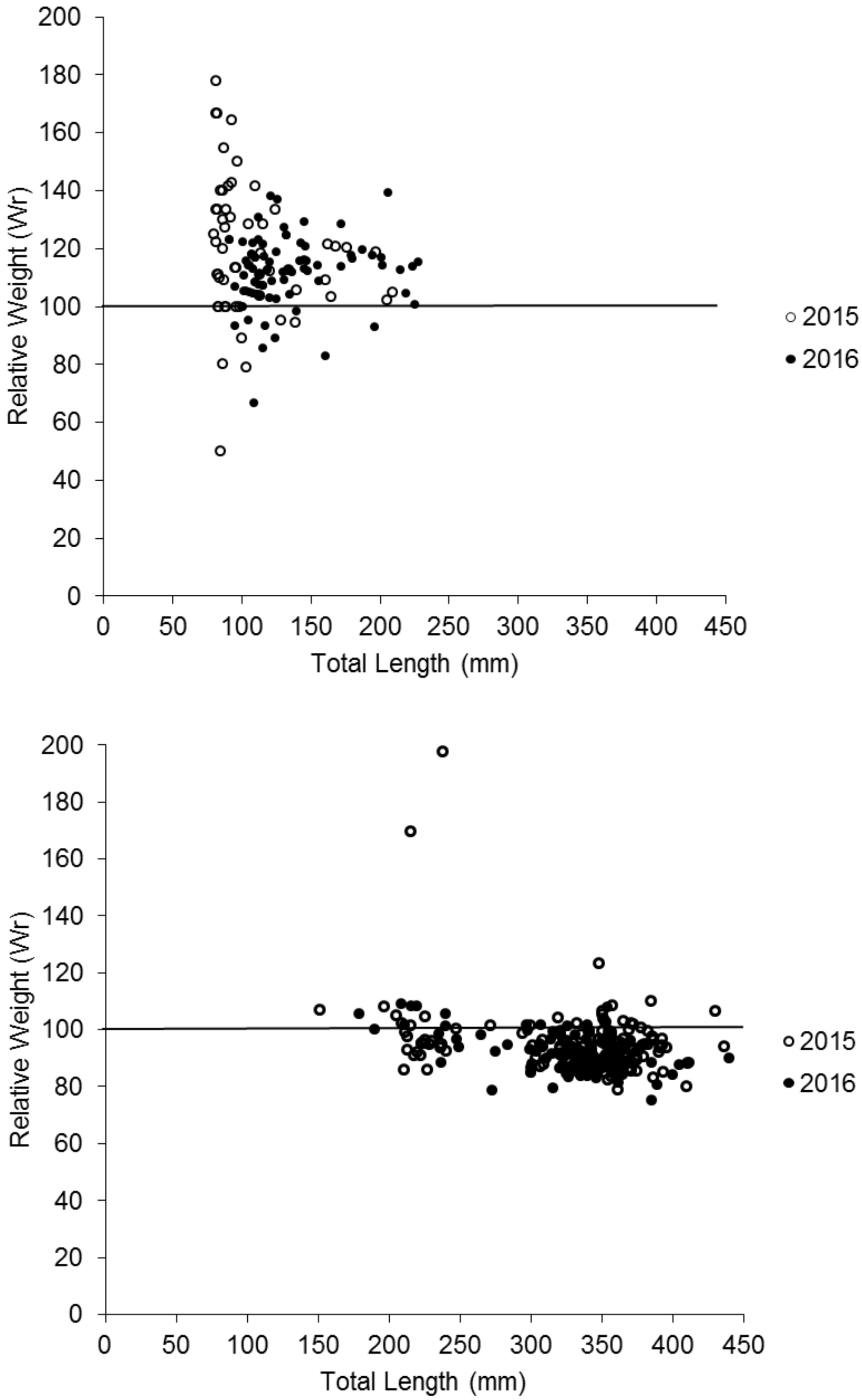


Figure 38. Relative weight (W_r) distribution of Bluegill (top) and Largemouth Bass (bottom) by year in Red Top Pond. Relative weight was only calculated for fish longer than stock lengths for Bluegill (80 mm) and Largemouth Bass (150 mm) as recommended by Blackwell et al. (2000).

WARMWATER FISH TRANSFERS TO COMMUNITY PONDS

ABSTRACT

Southwest Region personnel transferred several species of warmwater fish to 13 waters during 2016 to create new populations and to bolster catch rates in existing fisheries. We transferred a total of 1,464 fish, including: 1,052 Bluegill *Lepomis macrochirus*, 383 Channel Catfish *Lepomis macrochirus*, and 29 Largemouth Bass *Micropterus salmoides*. Bluegills were released in three new community ponds, which included Esther Simplot Park, Molenaar Park, and Magnolia Park ponds.

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INTRODUCTION

The Southwest Region contains 40 small public community fishing ponds. These ponds offer a variety of angling options for both hatchery rainbow trout and several warmwater species. While trout are supplied regularly by Nampa Hatchery, warmwater fish populations must depend on natural reproduction or transfers from other waters. Idaho Department of Fish and Game (IDFG) seeks to maintain adequate populations of warmwater fish in community ponds for recreational angling. In 2016, IDFG fisheries personnel transferred Bluegill *Lepomis macrochirus*, Channel Catfish *Ictalurus punctatus*, and Largemouth Bass *Micropterus salmoides* to community fishing ponds throughout the Southwest Region, Idaho to improve fishing opportunities. Also, three, new community park ponds in Boise, Idaho (Esther Simplot, Magnolia, and Molenaar Park ponds) were stocked with Bluegill to establish self-sustaining populations. I also continued annual transfers of adult Channel Catfish to community fishing ponds to provide put and take fishing opportunities.

OBJECTIVES

1. Establish warmwater fish populations in newly developed community ponds.

2. Provide Channel Catfish fishing opportunities in community ponds.

METHODS

I utilized boat electrofishing gear to capture warmwater fish for transfer to local waters. Source waters included public waters Horseshoe Bend Pond, Sawyers Pond, Crane Falls Reservoir, CJ Strike Reservoir, and the Snake River. We collected fish between May 20 and August 2, 2016 using an electrofishing boat equipped with a Midwest Lake Electrofishing Systems (MLES) Infinity system. The MLES unit was set at 20% duty cycle and approximately 2,000-2,500 watts of pulsed DC power was produced by a 5000 watt Honda generator. Stunned fish were caught using dip nets, transferred to live cars, and held until sufficient numbers were captured to fill a transport truck or trailer. Once loaded, fish were supplied with supplemental oxygen at 1.5-2 liters/minute.

RESULTS AND DISCUSSION

During 2016, I captured and transferred 1,464 fish, which included 1,052 Bluegill, 383 Channel Catfish, and 29 Largemouth Bass (Table 20). These fish were released in both established and new community ponds, located in Boise, Idaho. Bluegills were released to establish self-sustaining populations in three new community ponds. These Bluegill releases included 521 fish to Esther Simplot, 177 fish to Magnolia Park, and 105 fish to Molenaar Park ponds. Additional releases of Bluegills may be needed to establish viable populations within these ponds. Largemouth Bass should be released in the new community ponds to prevent Bluegill overpopulation and provide a predator for the species. Exploitation and angler use within these ponds should be evaluated by tagging Largemouth Bass prior to release. If angler exploitation and use is high in these ponds, it may not be possible to establish and maintain self-sustaining fish populations (Eades and Lang 2012). The balance of Bluegill (249 fish) were released into Caldwell Pond #2 to supplement the existing population. Largemouth Bass, totaling 29 fish, were also released to Caldwell Pond #2. Channel Catfish were released into nine waters located within the Southwest Region. Channel Catfish transfers provide an additional sportfish opportunity within the region and should be continued.

The highest capture efficiency for Bluegill occurred during nighttime events. Collection of Largemouth Bass and Channel Catfish were not restrictive using daytime capture events. All collection waters had sufficient Bluegill populations and could be used in future collections for additional fish transfers.

RECOMMENDATIONS

1. Stock Esther Simplot, Molenaar, and Magnolia Park ponds with Largemouth Bass during 2017. Evaluate harvest and angler use patterns, after three years to establish a routine fishery clientele, using T-bar anchor tags for at least one year post stocking.

2. Continue transferring Channel Catfish to community fishing waters.

Table 20. Summary of Bluegill (BGL), Channel Catfish (CAT), and Largemouth Bass (LMB) capture and transfer efforts to local waters during 2016.

Date Stocked	Collection method	Collecting Water	Receiving Water	Species	Number	Mean weight (g)	Mean length (mm)	Release Temp (°C)
5/20/2016	Electrofishing	Horseshoe Bend Pond	Caldwell Pond #2	BLG	20	185	193	16.9
5/20/2016	Electrofishing	Horseshoe Bend Pond	Caldwell Pond #2	LMB	29	765	358	16.9
5/26/2016	Electrofishing	Crane Falls Reservoir	Caldwell Pond #2	BLG	23	163	116	17.4
6/9/2016	Electrofishing	Snake River	Caldwell Pond #1	CAT	50	1814	-	-
6/9/2016	Electrofishing	Snake River	Ed's Pond	CAT	25	1814	-	-
6/9/2016	Electrofishing	Snake River	Sawyers Pond	CAT	70	1814	-	-
6/9/2016	Electrofishing	Snake River	Horseshoe Bend Pond	CAT	60	1814	-	-
6/20/2016	Electrofishing	Sawyers Pond	Caldwell Pond #2	BLG	156	26	101	21.2
6/21/2016	Electrofishing	Snake River	Settlers Pond	CAT	15	1814	-	20.6
6/21/2016	Electrofishing	Snake River	McDevitt Pond	CAT	20	1814	-	22.5
6/21/2016	Electrofishing	Snake River	Riverside Pond	CAT	40	1814	-	21.2
6/21/2016	Electrofishing	Snake River	Quinn's Pond	CAT	50	1814	-	23.7
6/21/2016	Electrofishing	Snake River	Parkcenter Pond	CAT	53	1814	-	24.7
6/23/2016	Electrofishing	Crane Falls Reservoir	Esther Simplot Park Pond	BLG	77	41	107	28
6/28/2016	Electrofishing	Crane Falls Reservoir	Caldwell Pond #2	BLG	50	NA	96	26.8
6/28/2016	Electrofishing	Sawyers Pond	Esther Simplot Park Pond	BLG	199	NA	81	29.4
6/28/2016	Electrofishing	Crane Falls Reservoir	Esther Simplot Park Pond	BLG	245	NA	96	29.4
7/13/2016	Electrofishing	CJ Strike Reservoir	Molenaar Pond	BLG	105	63	122	19.7
7/19/2016	Electrofishing	CJ Strike Reservoir	Magnolia Park Pond	BLG	44	40	110	24.9
8/2/2016	Electrofishing	Sawyers Pond	Magnolia Park Pond	BLG	133	31	110	24.9

2016 ALPINE LAKE SURVEYS

ABSTRACT

Idaho Department of Fish and Game (IDFG) staff from the Southwest Region surveyed 70 alpine lakes during July 2016. Sampling efforts focused on headwater portions of the Middle Fork Boise River drainage near Atlanta, Idaho. Sampling occurred in the Lynx, Timpa, Rock, and Misfire drainages, as well as several un-named drainages. The majority of the lakes had not been surveyed recently or had never been surveyed by IDFG. Data were collected at each lake or site and described fish and amphibian populations, habitat, as well as human use patterns. If historical data was present, we compared trends in fish populations relative to stocking history. Where necessary, we used these data to adjust stocking strategies.

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OBJECTIVES

1. Describe the distribution, relative abundance, and species composition of fish and amphibian populations at alpine lakes in the Southwest Region.

2. Adjust stocking strategies where appropriate to use hatchery resources efficiently and minimize impacts to native fauna while preserving or improving fishing opportunity where practical.

METHODS

Alpine lakes were surveyed during July 19-20 and July 25-27, 2016 within the Upper Middle Fork Boise River HUC4 near Atlanta, Idaho. This included two hydrologic unit code (HUC) 5s: the Queens River – MF Boise River and the Upper MF Boise River (Figure 39). More specifically, we sampled three HUC 6s: Queens River (Figure 40), Mattingly Creek-MF Boise River (Figure 41), and Rock Creek-MF Boise River (Figure 42 and 43). We visited 70 sampling sites (i.e. polygons on IDFG hydrography layer that we expected to be lentic habitats; hereafter lakes). Lakes were chosen because they had never been sampled, or had not been sampled within the last ten years. At each lake, we assessed fish and amphibian presence/absence, human use, and basic fish habitat characteristics. Unless fish were observed, no angling surveys occurred in shallow lakes and ponds without suitable fish habitat. In lakes with suitable depths or that had been previously stocked, fish were sampled with hook and line angling, gill nets, or both to collect fish and determine species and measure total length (mm) and weight (g). Gill nets were floating experimental nets, measuring 46 m long by 1.5 m deep, with 19, 25, 30, 33, 38, and 48 mm bar mesh panels. Preferably, nets were set in the evening, perpendicular to shore, and fished overnight. Nets were pulled the following morning or as soon as possible thereafter. In some instances, we soaked gill nets for shorter time periods during the day.

Habitat surveys assessed limnological and morphological characteristics of lake, tributaries, and outlets. Lake length and width were measured using a laser rangefinder (Bushnell yardage-Pro). Mean depth was calculated from nine depth measurements recorded at three equally-spaced cross-sectional transects, using a hand-held sonar device (Strikemaster Polar Vision). Maximum depth was estimated as the greatest depth observed during these measurements. Surface water temperatures were recorded along the lakeshore at one point. A visual assessment of salmonid spawning habitat availability was conducted at each lake and its inlets and outlets. Salmonid spawning habitat quality was qualitatively described based on substrate size, flow, and gradient.

Amphibian surveys were conducted by walking the perimeter of each lake and visually inspecting shoreline and near-shore habitats, including areas under logs and rocks. For amphibians detected, we recorded the species, number, and life stage. Life stages were classified as adult, juvenile, larvae, or egg.

Human use was evaluated based on general appearance of use, number and condition of campsite, number of fire rings, access trail conditions trail distance and difficulty, and presence of litter. General levels of human use were categorized by Idaho Department of Fish and Game (IDFG) staff as rare, low, moderate, and high based on an overall assessment of the factors described above.

RESULTS AND DISCUSSION

Mattingly Creek – MF Boise River HUC 6

I surveyed five lakes in the Mattingly Creek – MF Boise River HUC 6, of which all five lakes contained water. Of these, fish or amphibians were sampled in one and one lakes, respectively. None of these lakes contained both fish and amphibians. Analysis of IDFG's stocking database indicated that only one of these lakes, Lynx Creek Lake #1, had been stocked historically. This lake has not been stocked recently and was last stocked during 2003 when it received 1,500 fingerling Rainbow Trout *Oncorhynchus mykiss* as part of a statewide research project. Decades ago, this lake was stocked mostly with Westslope Cutthroat Trout *O clarkii lewisi*. No fish were sampled from Lynx Creek #1 during 2016, though a couple of rise forms were observed indicating either low fish abundance, poor sampling efficiency, or a combination of these factors. Previous fish sampling efforts had indicated that Lynx Creek Lake #1 had contained Rainbow Trout during 2000 and 2007 (Flatter et al. 2003; Hebdon et al. 2009). These observations indicate that stocking is necessary to maintain fishing opportunity in Lynx Creek Lake #1. We recommend reinstituting stocking at this lake, based on evidence of prior stocking, adequate depths, and probable low fish abundance. At Lynx Creek Lake #3, one 295 mm cutthroat trout *O. clarkii* was sampled, despite no stocking records existing for this lake. It is likely that this lake was stocked long ago, when stocking records were more difficult to catalog and maintain. A previous effort at Lynx Creek #3 during 2000 sampled cutthroat trout at 2.5 fish per hour with hook and line gear. These observations indicated that Lynx Creek Lake #3 possesses a self-sustaining population of cutthroat trout. Lynx Creek Lake #2 and the remaining lakes have marginal depths, provide amphibian habitat, or possess no pre-wilderness stocking evidence and, therefore, should not be stocked. A total of 107 larval Long-toed Salamander *Ambystoma macrodactylum* were sampled at one unnamed lake (LLID 1150840438432). No herpetofaunal were sampled at other lakes.

Queens River HUC 6

I surveyed 11 lakes in the Queens River HUC 6, of which 11 lakes contained water. Of these lakes, fish or amphibians were sampled in one and nine lakes, respectively (Table 21). No lakes contained both fish and amphibians. Analysis of IDFG's stocking database indicated fish stocking records exist for three of these lakes, Nanny Creek, Upper Greylock Lakes, and Lower Greylock Lakes. Nanny Creek is stocked on a three-year rotation with the last stocking occurring during 2014 (1,000 Rainbow Trout). At Nanny Creek Lake, angling CPUE of cutthroat was 11 fish per hour and mean length was 290 mm, with a maximum of 340 mm. The 2016 fish sampling data does not align with recent stocking history as only cutthroat trout and a wide range of lengths were sampled. This indicates that this fish population is being maintained adequately with natural reproduction. This observation is further supported by the presence of multiple redds near the lake's primary inlet and that the last cutthroat trout stocking occurred during 2008. The two Greylock lakes are not currently stocked. Each lake has only one stocking record each. In 1938, Upper and Lower Greylock lakes were stocked with 2,000 and 4,000 cutthroat trout, respectively, of unknown strain. Sampling efforts in Upper and Lower Greylock lakes during 2016 were not sufficient to fully determine the presence or absence of fish due to a lack of time. However, no fish were visually observed in either indicating that fish were not common. Previous survey efforts during 2000 indicated that trout were not abundant at these lakes. Based on these observations, we recommend re-instituting stocking in Upper and Lower Greylock lakes, though this management change should be monitored within three years.

At nine other lakes, I sampled three different species of herpetofaunal including Larval Long-toed Salamander, multiple age-classes of Columbia Spotted Frog *Rana luteiventris*, and an unidentified adult garter snake *Thamnophis spp*. Long-toed Salamander was widely distributed (observed in 7 of 11 lakes) in this subsample of lakes and occasionally highly abundant (Table 21).

Rock Creek-MF Boise River HUC 6

I surveyed 54 lakes in the Rock Creek – MF Boise River HUC 6, of which 41 lakes contained water. Of these 41 lakes, live fish or amphibians were sampled in seven and seven lakes, respectively (Table 22). Both fish and amphibians were sampled in two lakes including Confusion and Dandy lakes.

Analysis of IDFG's stocking database indicated that 10 of these lakes had been stocked historically. In addition, two other lakes, Atlanta East #5 and Greylock #7, possessed fish, but no stocking records. It is likely that these lakes were stocked long ago, when stocking records were more difficult to catalog and maintain. For the Misfire lakes with stocking histories, Lakes #1 and #2 were removed after 1987 and 1997. This was the appropriate choice as these lakes are too shallow to support trout. Misfire Lake #3 was stocked through 2013. During our survey, we saw about 10 dead trout on the bottom of this lake (#3) that had likely died over the winter based on high decomposition and presence of bright green algae on carcasses. This is a small shallow lake that apparently winterkills at somewhat frequent intervals and is extremely difficult to access; therefore, it should be removed from the stocking request sheet and not be stocked in the future. Furthermore, Chickadee and Confusion lakes were last stocked during 1980 and 2003. These lakes were subsequently removed from the stocking list as self-sustaining trout populations were thought to exist. Our data supports this conclusion.

Dandy, Low Pass, Pancho, Surprise, and Timpa lakes are currently on the active stocking rotation. Fish were sampled or were present in all lakes currently on the stocking rotation. I sampled a total of 47 fish including Rainbow and cutthroat trout (Table 23). The highest catch was sampled from Dandy Lake, whereas the largest trout of each species and highest mean lengths came from Pancho Lake. At this time, these five lakes should remain on the stocking request sheet at current intervals, numbers, and strains with the exception of Dandy Lake at which stocking densities were too high and led to fair fish condition. In the future, additional attention and sampling effort should be expended at Timpa and Surprise lakes as only cutthroat trout were sampled despite recent stocking of only Rainbow Trout. Sample sizes were insufficient to remove these lakes from the stocking rotation at the current time though, but we suspect that these lakes might possess self-sustaining cutthroat trout populations.

Larval Long-toed Salamander, multiple age-classes of Columbia Spotted Frog, Western Toad *Anaxyrus boreas*, Terrestrial Garter Snake *Thamnophis elegans*, and an unidentified adult garter snake were sampled in the Rock Creek HUC 6. Larval long-toed salamander was widely distributed in this subsample of lakes (14 of 41 lakes) and occasionally highly abundant (Table 22).

RECOMMENDATIONS

1. Mattingly Creek HUC 6 - Re-institute stocking of Lynx Creek Lake #1. Stock Troutlodge Triploid Rainbow Trout at densities and rotations similar to nearby lakes (i.e. 1,000). Monitor Lynx Creek Lake #3 to ensure that this cutthroat trout population persists.

2. Queens River HUC 6 - Eliminate stocking in Nanny Creek Lake as it is apparent that natural reproduction is maintaining this population. Re-institute stocking of Troutlodge Triploid Rainbow Trout at Upper Greylock (1.77 acres) and Lower Greylock (5 acres) at densities similar to nearby lakes. This would equate to stocking numbers of approximately 400 and 1,000 fry at three-year intervals. After three years post stocking, initiate an effort to sample the Upper and Lower Greylock lakes with standard gears to assess the performance of these changes.
3. Rock Creek HUC 6 – Eliminate stocking in Misfire Lake #3; this lake does not possess adequate depths or surface acreage to maintain a fish population. Reduce stocking at Dandy Lake (2.6 acres) from 1,000 to 600. Recently, stocking rate was 400 fry per acre, which seems too high based on fish condition.

Table 21. Number and species of herpetofaunal sampled during 2016 lake surveys in the Queens River hydrologic unit code 6. Herpetofaunal are abbreviated as follows: Long-toed Salamander (LTS), Columbia Spotted Frog (CSF), garter snake (GS), and Western Toad (WT).

LLID	Water ID	Lake Name	Perimeter surveyed (%)	Common name abbreviation	Adults	Juveniles	Larvae
1150817438858	14996	Nanny Creek	100				
1150820438907	14977	Unnamed	100	CSF	8	2	182
1150820438907	14977	Unnamed	100	LTS			15
1150820438907	14977	Unnamed	100	GS	1		
1150927438695	15021	Queens River #32	100	LTS			61
1150970438654	15029	Queens River #04	100	LTS			102
1150970438654	15029	Queens River #04	100	WT	1		
1150978438511	66626	Unnamed	100				
1150986438498	66625	Unnamed	100	LTS			8
1151007438554	66627	Unnamed	100				
1151011438565	15042	Queens River #03	80	LTS			8
1151036438454	15063	Upper Greylock	100	LTS			10
1151080438515	15054	Lower Greylock	100	LTS			5
Unavailable	Unavailable	Unnamed	100				

Table 22. LLID, Lake Name, and sampling information collected from lakes within the Rock Creek hydrologic unit code 6. An asterisk after the LLID number indicates that the putative lake was dry. Herpetofaunal are abbreviated as follows: Long-toed Salamander (LTS), Columbia Spotted Frog (CSF), unidentified garter snake (GS), Terrestrial Garter Snake (TGS), and Western Toad (WT).

LLID	WATERID	Lake Name	Perimeter surveyed (%)	Common name abbreviation	Adults	Juveniles	Larvae
1150466439306	14773	Unnamed	100				
1150478439319	14756	Unnamed	100				
1150489439336	14749	Unnamed	100	CSF			2
1150498439310*	14769	Unnamed					
1150502439463	14643	Low Pass	100				
1150508439314*	14764	Unnamed					
1150513439372	14725	Unnamed	100				
1150513439379	14718	Unnamed	100	WT			2
1150531439369	14728	Unnamed	100				
1150534439390	14702	Confusion	100	CSF	1		
1150534439390	14702	Confusion	100	WT			26
1150535439252	14820	Timpa	100				
1150561439354	14731	Surprise	100				
1150575439328*	14754	Unnamed					
1150591439434	14668	Unnamed	100				
1150596439411	14684	Unnamed	100				
1150598439352*	14738	Unnamed					
1150600439310	14767	Chickadee	100	WT	1		2
1150610439399	14697	Unnamed	100				
1150615439323	14750	Unnamed	100				
1150623439402*	14695	Unnamed					
1150628439407*	14687	Unnamed					
1150631439404*	14690	Unnamed					
1150634439263*	14815	Unnamed					
1150650439295	14782	Unnamed	100				
1150690439398*	14699	Unnamed					
1150693439374	14719	Unnamed	100	LTS			6
1150704439390	14706	Unnamed	100	LTS			7
1150706438819	66629	Unnamed	100				
1150728438646	15034	Unnamed	100	LTS			13

Table 22 continued. LLID, Lake Name, and sampling information collected from lakes within the Rock Creek hydrologic unit code 6. An asterisk after the LLID number indicates that the putative lake was dry. Herpetofaunal are abbreviated as follows: Long-toed Salamander (LTS), Columbia Spotted Frog (CSF), unidentified garter snake (GS), and Terrestrial Garter Snake (TGS).

LLID	WATERID	Lake Name	Perimeter surveyed (%)	Common name abbreviation	Adults	Juveniles	Larvae
1150729439334*	14747	Unnamed					
1150742439312	14766	Unnamed	100	LTS			7
1150745438662	15028	Atlanta East #03	100	LTS			86
1150745438662	15028	Atlanta East #03	100	GS	2		
1150745439304*	14772	Unnamed					
1150750438791	15011	Misfire #03	100				
1150753438819	15005	Unnamed	100	LTS			9
1150756438829	15001	Misfire #02	100	LTS			7
1150756438829	15001	Misfire #02	100	TGS	1		
1150760438978	14956	Unnamed	100	CSF	1		
1150761439317	14758	Unnamed					
1150767439380*	14714	Unnamed					
1150769439139	14889	Unnamed	100	CSF			20
1150769439139	14889	Unnamed	100	LTS			1
1150769439139	14889	Unnamed	100	GS	1		
1150774438792	15012	Unnamed	100				
1150774439347*	14740	Unnamed					
1150775438564	15045	Atlanta East #6	60				
1150779438983	14953	Unnamed	100	CSF	6		8
1150779438983	14953	Unnamed	100	LTS			74
1150782438542	15049	Unnamed	75				
1150782439023	14940	Unnamed	100	LTS			65
1150786438567	15044	Unnamed	100	LTS			3
1150794438562	15043	Atlanta East #05	20				
1150794438638	15035	Atlanta East #04	70	LTS			12
1150795438792	15010	Misfire #01	100	LTS			76
1150804439384	14708	Pancho	100				
1150820438541	15050	Greylock #07	100				
1150826438547	16561	Unnamed	100	LTS			2
1150870439172	14862	Dandy Lake	100	LTS	2		

Table 23. LLID, Lake Name, and fish sampling information collected from lakes within the Rock Creek hydrologic unit code 6. Fish are abbreviated as follows: Westslope cutthroat trout (WCT), unknown cutthroat trout (CT), and Rainbow Trout (RBT).

HUC 6 Name	LLID	Water ID	Lake Name	Species	Method	Catch	Effort (h)	CPUE (fish/h)	Mean	Min	Max
Rock Creek-MF Boise R	1150534439390	14702	Confusion	WCT	Gill Net	1	4.0	0.3	301	301	301
Rock Creek-MF Boise R	1150535439252	14820	Timpa	WCT	Hook / Line	6	3.0	2.0	43	29	50
Rock Creek-MF Boise R	1150561439354	14731	Surprise	WCT	Hook / Line	4	1.0	4.0	175	34	340
Rock Creek-MF Boise R	1150794438562	15043	Atlanta East #5	CT	Hook / Line	6	0.8	7.5	288	229	330
Rock Creek-MF Boise R	1150804439384	14708	Pancho	RBT	Hook / Line	1	1.0	1.0	425	425	425
Rock Creek-MF Boise R	1150804439384	14708	Pancho	WCT	Hook / Line	7	1.0	7.0	416	395	440
Rock Creek-MF Boise R	1150820438541	15050	Greylock #7	CT	Hook / Line	6	0.3	20.0	212	179	254
Rock Creek-MF Boise R	1150870439172	14862	Dandy	RBT	Hook / Line	14	1.0	14.0	284	220	320
Rock Creek-MF Boise R	1150870439172	14862	Dandy	WCT	Hook / Line	2	1.0	2.0	366	310	422

Figure 39. Locations and names of hydrologic unit code (HUC) 5s (bold and italicized) and HUC 6s at which alpine lake sampling occurred during 2016.

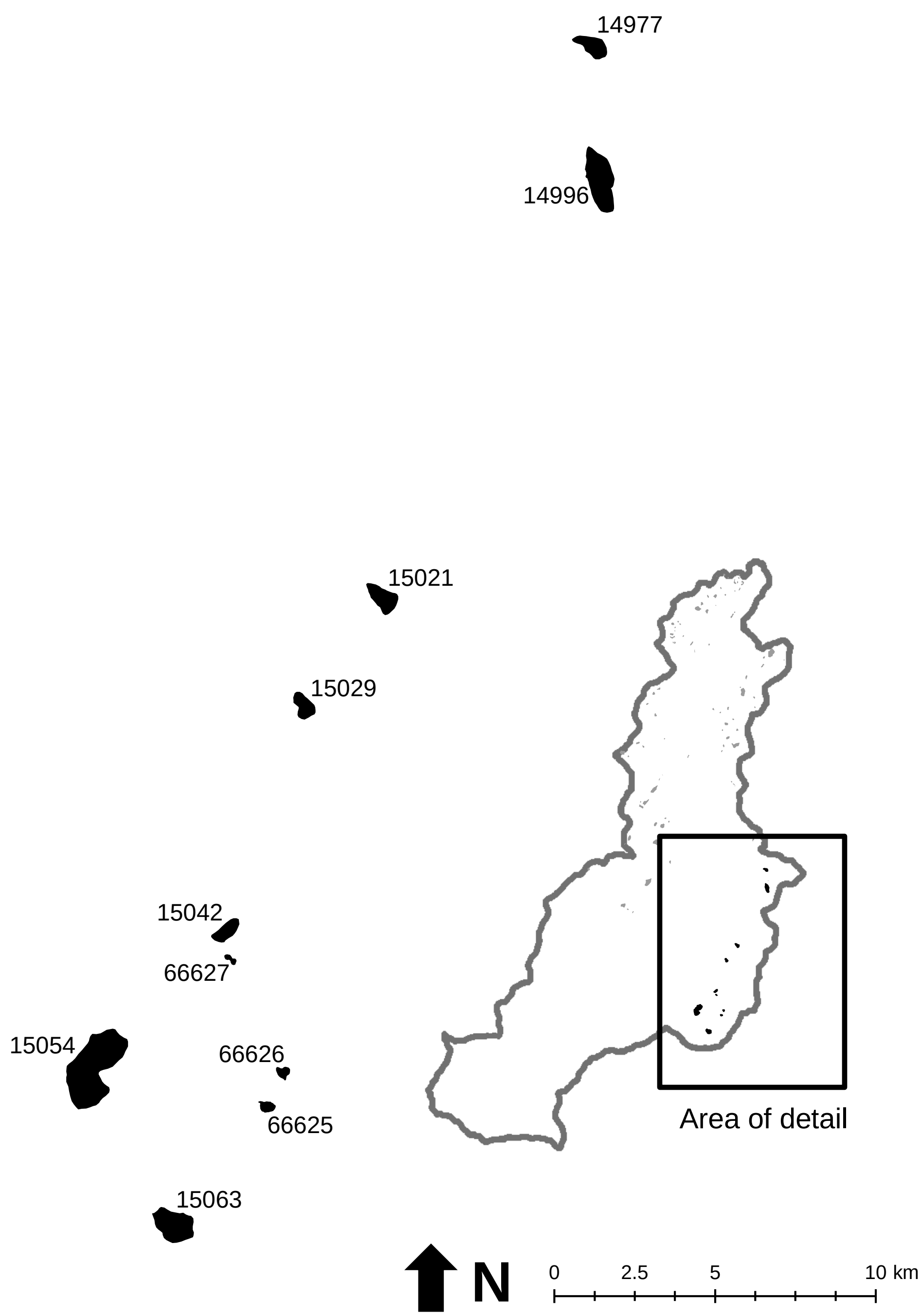

Figure 40. Location and water identification number of lakes sampled within the Queens River hydrologic unit code 6 during 2016.

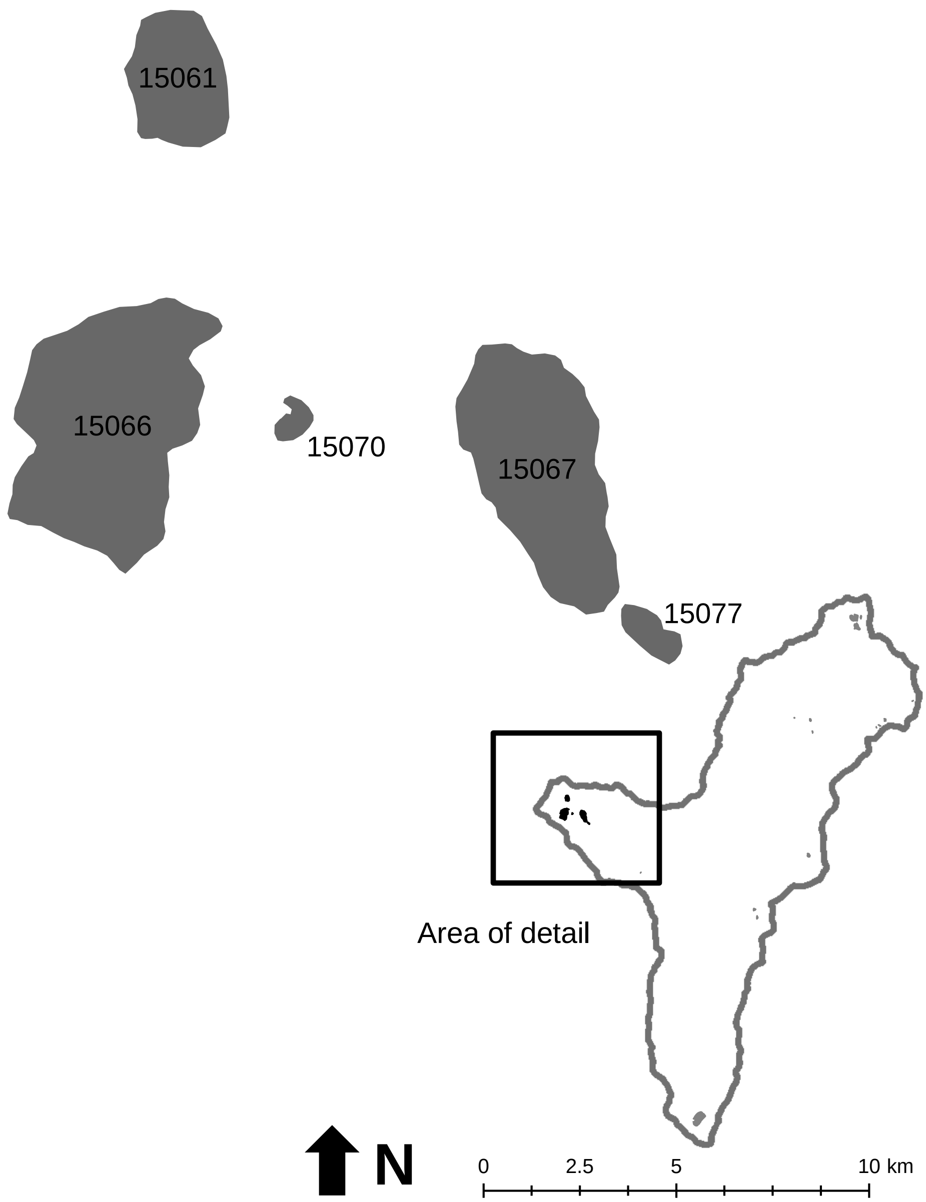

Figure 41. Location and water identification number of lakes sampled within the Mattingly Creek hydrologic unit code during 2016.

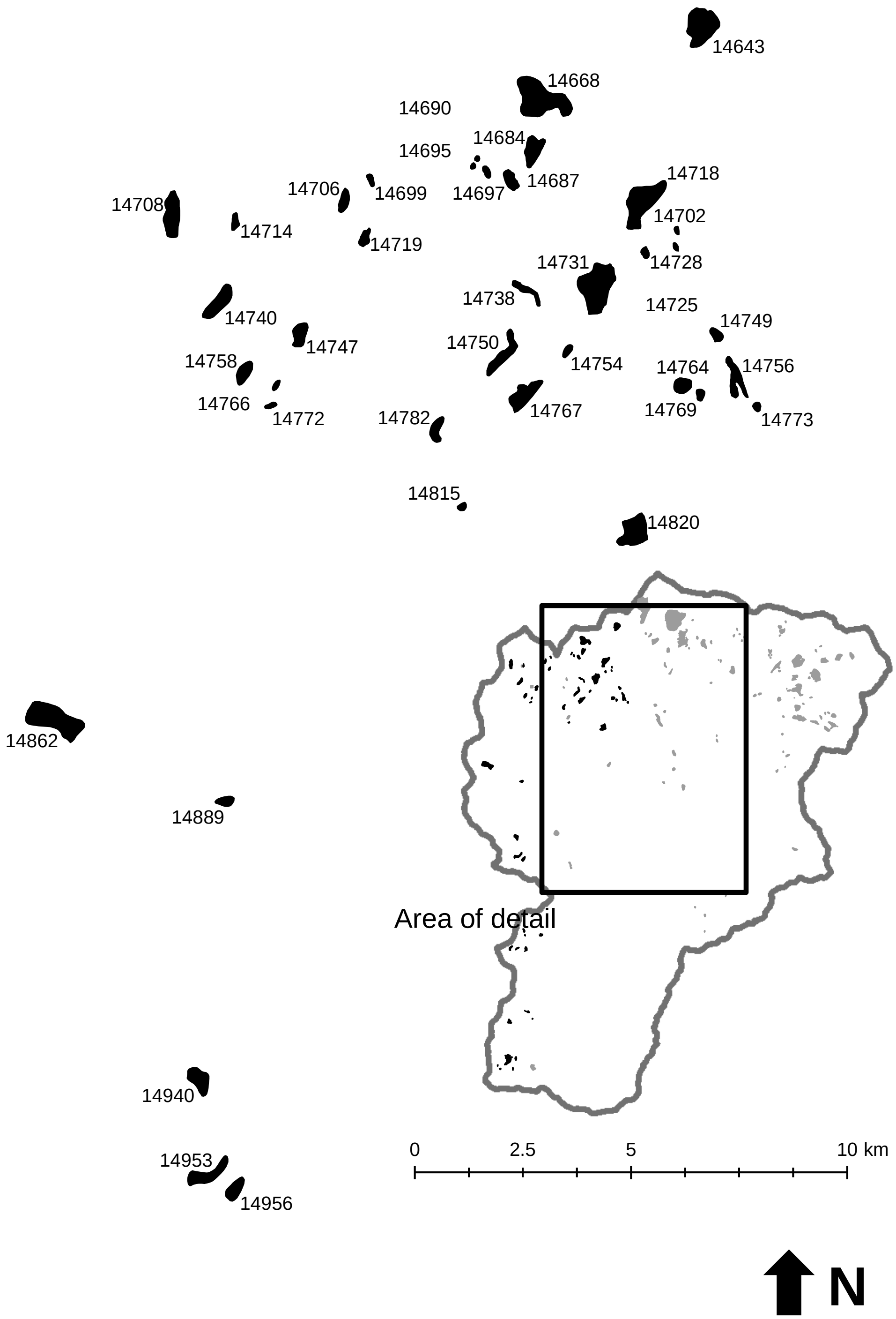

Figure 42. Location and water identification number of lakes sampled within the Rock Creek hydrologic unit code (northwest portion) during 2016.

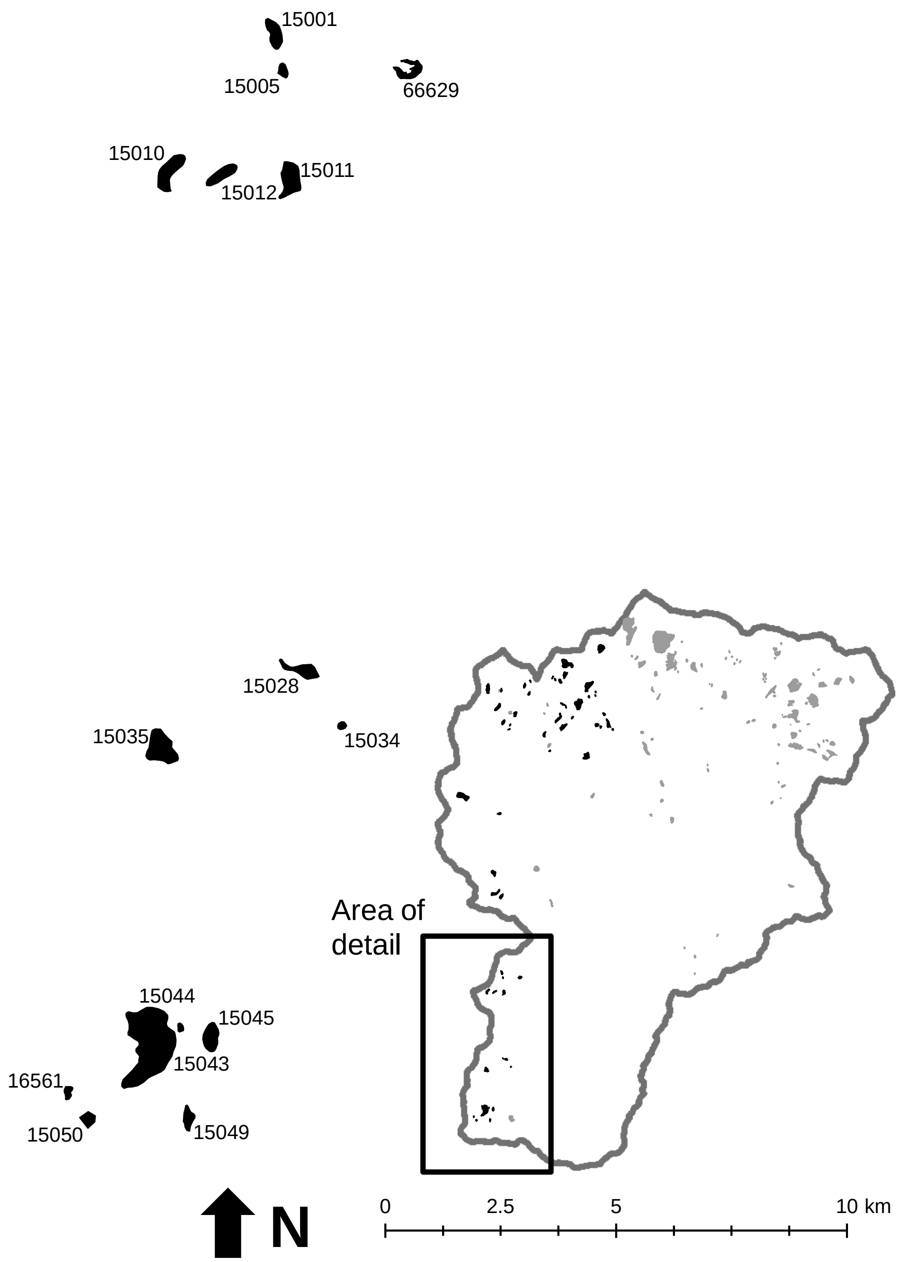

Figure 43. Location and water identification number of lakes sampled within the Rock Creek hydrologic unit code 6 (southwest portion) during 2016.

RIVERS AND STREAMS INVESTIGATIONS

LOWER BOISE RIVER

ABSTRACT

Since 2004, triennial sampling has been performed at standardized monitoring sites to estimate abundance and size structure of wild Rainbow Trout, Brown Trout, and Mountain Whitefish in the lower Boise River between Barber Park and the East Parkcenter Bridge. In 2016, a total of 2.2 km of the lower Boise River was electrofished at three sites. We captured 701 wild Rainbow Trout, 114 hatchery Rainbow Trout, 83 Brown Trout, and 4 hatchery Brown Trout at the three sites combined. Wild Rainbow Trout abundance estimates were 3,588 ± 460 (90% CI) for all trend sites combined, with an average length of 224 mm. Wild Rainbow Trout abundance estimates have stabilized after experiencing remarkable increases during the past two decades. Within the middle sample section, Rainbow Trout density were unchanged from 2013 to 2016 at 6.6 fish/100 m^2.

In both 2015 and 2016, we investigated relative abundance, distribution, and exploitation of wild trout in the lower Boise River using raft electrofishing gear. Additionally, juvenile Rainbow Trout and Brown Trout production was evaluated using shoreline backpack electrofishing. We sampled a total of 948 wild Rainbow Trout and 173 wild Brown Trout during two years of raft-electrofishing surveys. Average wild Rainbow Trout catch-per-unit effort (CPUE) was similar in 2015 (32.4 fish/h) and 2016 (34.0 fish/h). Wild Brown Trout CPUE averaged 6.9 fish/h in 2015 and 4.9 fish/h in 2016. Angler use of wild trout in the lower Boise River was low with 5.5% of tagged Rainbow Trout being caught and 2.4% being harvested and 16.1% of Brown Trout being caught and 0% being harvested, within one year of tagging. Densities of age-0 trout differed spatially between species with Rainbow Trout showing higher densities upstream of Eagle and Brown Trout having higher densities downstream of Eagle. These surveys have improved our understanding of wild Rainbow and Brown trout populations in the Lower Boise River.

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INTRODUCTION

The Lower Boise River segment 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 this reach. 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 Lower 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 composition shifts from primarily coldwater obligate species in the upper sections upstream of 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 downstream of 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- and stormwater management.

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. Prior to establishing standardized monitoring sites in 2004, non-standardized sampling efforts on the lower Boise River captured few wild trout. More recent survey data and anecdotal information suggests that the number of wild Rainbow and Brown trout in the river has improved over the last 20 years. Wild Rainbow Trout in particular have increased nearly 17-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 1984. Wild trout populations were also likely enhanced by water quality improvements and an increase in catch-and-release practices over the same period.

In both 2015 and 2016, the lower Boise River from Harris Ranch downstream to the Ada County/Canyon County boundary, was thoroughly sampled at numerous sites using both corridor raft electrofishing and shoreline backpack electrofishing. Additionally, in 2016 we completed the triennial long-term population monitoring at our standardized sample locations. The goal of this work was to monitor long-term trends in wild trout abundance and gain valuable knowledge of adult and juvenile species composition, abundance, and distribution throughout the lower river.

METHODS

Triennial Mark Recapture Surveys

Trout and Mountain Whitefish populations in the lower Boise River have been monitored every three years since 2004 at two sites between Barber Park and the West Parkcenter Boulevard Bridge (Hebdon et al. 2009; Flatter et al. 2011). The upper site begins at the first diversion below Barber Park and continues down to the Loggers Creek diversion, less than 50 m upstream from the East Parkcenter Boulevard Bridge. The middle site starts at the Canal diversion and stops downstream at the first riffle downstream of the confluence of Heron Creek (Figure 44). This site is within the reach managed with quality trout regulations (2-trout bag limit, none less than 360 mm). Additionally, in 2016 a third site was added starting from the Ridenbaugh Canal diversion dam and ending at the Barber Park boat ramp. This site was added in order to monitor fish population response to habitat improvement work (included in this chapter) that was completed on this section of river following the fish survey. This site, referred to as the habitat site, will be surveyed again during the next survey rotation (in 2019) to monitor populations pre- and post-habitat improvements. Approximately 2.2 km of the lower Boise River was sampled in three sites with electrofishing gear in 2016 (Figure 44). Site lengths ranged from 280 to 998 m (Table 24). Wetted widths were measured with a hand-held laser range finder (Leupold RX series). Site area was estimated by multiplying the mean width (n = 10) and site length.

We used mark-recapture techniques to estimate abundance of trout in all three sections. Fish were collected with a canoe electrofishing unit consisting of a 5.2-m Grumman aluminum canoe fitted with three mobile anodes connected to 15-m cables. The canoe served as the cathode and carried the generator, Midwest Lake Electrofishing Systems (MLES) Infinity electrofisher, and a livewell for holding fish. Oxygen was introduced to the livewell (2 L/min) through an air-stone. Pulsed direct current was produced by a 5,000-watt generator (Honda EG500X). Frequency was set at 25% pulse width at 60 pulses per second with a power output of 1,700-2,300 watts. Crews consisted of nine to twelve people. Starting with the 2013 surveys, three mobile anodes have been used for each survey. Surveys conducted prior to 2013 utilized two mobile anodes. Three operators managed the mobile anodes, one person guided the canoe and operated the safety switch controlling the output, and the remaining crew of five to eight people were equipped with dip nets to capture stunned fish. Only trout were placed in the livewell.

Marking and recapture runs were conducted with a single pass from upstream to downstream. The canoe was held upstream of the anode operators. Anodes were swept through the water or thrown across the stream and retrieved. Crews with dip nets walked backward facing upstream, while staying downstream of the anodes and capturing stunned fish. Fish were placed in the livewell and when the livewell was judged to be at capacity, the crew stopped at the nearest riffle to process fish.

Sites were sampled between October 26 and November 2, 2016. Fish were identified, enumerated, and measured for total length (mm) and weighed (g). Brown Trout were examined for clipped adipose fins, indicating hatchery origin. Both Rainbow Trout and Brown Trout ≥100 mm were marked in the upper sites on October 25 and the middle site on October 26. In an effort to better focus on trout sampling, estimates for Mountain Whitefish were not conducted in 2016. Fish were marked with a 7-mm diameter hole from a standard paper punch on either the upper or lower section of the caudal fin, corresponding to their capture reach. Fish were released 50 to 100 m upstream from the processing site to prevent downstream displacement or resampling. Recapture sampling was completed on November 1 and 2. During the recapture effort all trout greater than 100 mm were captured and placed in the livewell. Fish were examined for marks on the caudal fin. All recaptured fish were measured for total length (mm).

To account for size-selectivity of electrofishing gear, population estimates (N) were calculated using a maximum likelihood estimation to fit the recapture data. A capture probability function was calculated as

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

where Eff is the probability of capturing a fish of length L, and β_1 and β_2 are estimated parameters (MFWP 2004). Then N is estimated by length group where M is the number of fish marked by length group.

$$N = M / Eff$$

Population estimates were calculated for each reach and pooled for a comprehensive estimate expressed as # fish/100 m^2 for comparison to previous surveys. Trout population estimates ($\check{N}$) for surveys from which mark-recapture numbers were not adequate to use log-likelihood, were estimated using the modified Petersen equation for fish ≥100 mm

$$\check{N} = [((M+1)*(C+1)) / (R+1)] – 1$$

where M is the number of fish marked, C is the number of fish captured, and R is the number of fish recaptured. Population estimates, length frequencies, and species composition were compared to results reported from prior surveys (Koenig et al. 2015; Kozfkay et al. 2011; Hebdon et al. 2009; Flatter et al. 2011; Allen et al. 1999).

To characterize the size distribution of Rainbow and Brown trout captured during the survey and make trend comparisons between surveys, proportional size distribution (PSD) was calculated as:

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

where X was calculated for 305, 356, and 406-mm fish (Neumann et al. 2012). A minimum stock length of 250 mm is recommended for Rainbow Trout in lotic environments, but was used for both species to simplify results (Simpkins and Hubert 1996).

Wild Trout Production, Abundance, and Exploitation

Similar to 2015, we again investigated production, relative abundance, distribution, and exploitation of wild trout in the lower Boise River in 2016. The study included approximately 48 km of river between the Highway 21 Bridge and Middleton, which is the known lower extent of year-round trout habitat in the lower Boise River (Figure 45). We delineated 12 river sections in this reach to describe spatial differences in wild trout abundance, exploitation, and production (Table 25). 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.

Angler use and relative abundance of wild trout as well as survival of hatchery Brown Trout were evaluated by raft-mounted electrofishing gear during June 28-August 9, 2016. River flow at the Glenwood Bridge gauging station ranged from 37 m^3/s during the first week of sampling to 25

m^3/s during the final week of sampling. 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 livewell (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.

In both 2015 and 2016, 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 ≥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 (see above) 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 51%, based on angler tag returns of $50 reward tags in Rainbow Trout. One-year tag loss rate was 2.5% and 7-day tagging mortality rate was 0.8%. Tag return data were analyzed for tags returned through January 1, 2016. Exploitation rates for the first year at large for trout tagged in 2015 are included in this chapter, while only partial exploitation of trout tagged in 2016 were available at the time of this report. Full one-year exploitation of 2016 tagged trout will be reported in a future report as data become available.

To provide an index of abundance, we calculated catch-per-unit-effort (CPUE) as the number of fish captured per hour of electrofishing. The CPUE was calculated for both wild Rainbow and Brown trout by river section by combining 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 described above, for 350 mm fish, which corresponds to minimum length harvest restrictions in one section of the river (Neumann et al. 2012).

Similar to 2015, age-0 Rainbow and Brown trout production was evaluated at 61 sites from the Highway 21 Bridge to Middleton from November 8 to November 14, 2016 (Figure 45). These 61 sites were part of the 12 sample sections sampled during the raft surveys and while most sections contained four sample sites, the number of sample sites within a section ranged from two to four. Main stem sites were stratified by river section with half of the main stem 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. In 2015, sites were 33-m long while in 2016, sites were 100-m long. During main stem sampling, the area from the one shoreline out to approximately 4 m was sampled. For Tributary or side channel sample sites, the entire channel was sampled as these side channels were typically less than 4 m wide. A single, upstream electrofishing pass was completed at each site. All fish were identified, counted, and measured for total length. Fish densities (fish/m) ± 95% confidence intervals were calculated. Because side channels are typically narrower than main stem sample sites, future work in side channels and tributary sites should include wetted width measurements so that fish/m^2 can be calculated, further standardizing comparisons between the various habitat types.

In addition to these monitoring efforts and studies, staff participated in the planning and implementation of a habitat improvement project near Barber Park. On February 3-4, 2014, flows released from Barber Dam decreased from about 240 cfs to zero for about 8-10 hours. On September 17, flows decreased from about 600 cfs to 340 cfs for about two hours, and on December 31, flows decreased from 271 cfs to 147 cfs for about 3.5 hours. It is our understanding that a series of alarm failures and power grid glitches contributed to these flow reductions. The first, largest, and longest flow reduction resulted in substantial public discord between river recreationists and the dam owners (Ada County) and dam operators (Enel Green Power). In response, Ada County and Enel Green Power granted a $30,000 and $15,000 conservation donation, respectively, to improve habitat in the Boise River near the affected area. An Environmental Advisory Board was assembled to develop project ideas.

RESULTS

Triennial Mark Recapture Surveys

Across all three sites combined, we captured 701 wild Rainbow Trout, 114 hatchery Rainbow Trout, 83 wild Brown Trout, and 4 hatchery Brown Trout during the 2016 electrofishing survey (Table 24).

We estimated wild Rainbow Trout abundance as 2,415 ± 364 (90% CI) in the middle section, 869 ± 417 in the upper section, and 2,678 ± 1,484 in the habitat section. Hatchery Rainbow Trout and hatchery Brown Trout comprised just a small proportion of the catch during the survey; therefore, population estimates were not calculated. Wild Rainbow Trout composed approximately 77% of the trout catch in the three sites. Lengths of Rainbow Trout ranged from 73 to 535 mm, with a mean of 224 mm (Figure 46). Rainbow Trout PSD-305 mm was highest in the upper site while PSD-356 mm and PSD-406 were highest in the middle site, though both sites were similar. The habitat section has the lowest PSDs for all three size classes. Compared to previous years, wild Rainbow Trout PSDs were similar, with PSD-305 decreasing slightly from 2013 and PSD-356 and PSD-406 increasing slightly (Figure 47).

Brown Trout made up 10% of the trout captured in 2016. Lengths of Brown Trout ranged from 115 to 610 mm, with a mean of 295 mm (Figure 48). The middle site yielded the highest catch of Brown Trout (n = 83). We estimated abundance of wild Brown Trout to be 205 ± 48 (90% CI) in the middle site, and 283 ± 60 for the upper and middle sites combined. We were unable to estimate Brown Trout abundance in the habitat site due to limited sample size. Hatchery Brown Trout were a small component of our sample in 2016 (0.01%).

Rainbow Trout densities in the middle sampling section were identical (6.6 fish/100m^2) during 2013 and 2016 sampling (Table 26). Rainbow Trout densities in this section appear to have stabilized following years of increased densities (Figure 49). Brown Trout densities were slightly lower in 2016 (0.6 fish/100m^2) than in 2013 (0.9 fish/100m^2), but were still similar.

Wild Trout Production, Abundance, and Exploitation

For the raft sampling, wild Rainbow Trout composed 84% of the catch while hatchery Rainbow Trout composed 2% and Brown Trout composed 14%. A total of 533 wild Rainbow Trout and 88 wild Brown Trout were handled during the raft surveys. Rainbow and Brown trout catch differed spatially between the 12 river sections with the highest wild Rainbow Trout proportions being sampled in the south channels at Star and Eagle and the highest wild Brown Trout proportions being sampled in the north channels at Star and Eagle (Figure 50).

Similar to 2015, CPUE of wild Rainbow Trout again varied greatly between sites, from a low of 8.22 fish/h in the Harris Ranch reach to high of 91.7 fish/h in the Eagle South reach. Trends in catch rates across sites were similar between 2015 and 2016. However, Can-Ada, Star, Star South, Star North, Eagle North, Morrison, and Harris Ranch all had a greater than 50% difference in overall wild Rainbow Trout CPUE between 2015 and 2016 (Figure 51). Wild Brown Trout CPUE ranged from 0 fish/h caught in the Star South and Harris Ranch reaches to 15.4 fish/h in the Eagle North reach in 2016. Wild Brown Trout CPUE was also variable between 2015 and 2016, with Can-Ada, Star, Star South, Star North, Morrison, Special Reg., and Barber all having a greater than 50% difference in CPUE (Figure 51).

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 269 mm and ranged from 88 to 548 mm (Figure 52). Similar to 2015, smaller trout (≤250 mm) were again captured more frequently in sections upstream of Glenwood Bridge. Values for the Rainbow Trout PSD-350 mm ranged from 0% at North and South Star to 62.5% at Harris Ranch. The Eagle South, Special Regulation, Barber and Morrison reaches all had PSD-350 mm values of 50% or higher.

Lengths of Brown Trout ranged from 94 to 610 mm with a mean of 279 mm (Figure 53). The Can-Ada and Special Reg. reaches contained the widest size ranges and highest catch rates of Brown Trout. The PSD-350 mm index was not calculated for Brown Trout because of low sample sizes.

During the 2015 raft surveys, a total of 63 Brown Trout and 257 Rainbow Trout were released with tags. The fish tagged in 2015 were at large for a complete year. For wild Rainbow Trout, estimates of harvest and total catch were relatively low and tag reports were limited to sections downstream of Eagle while Brown Trout catch was slightly more spread out. After one year at large, only seven Rainbow Trout tags and five Brown Trout tags were reported (Table 27). Of these, three Rainbow Trout were harvested, while the others were released. First year-at-large exploitation of wild Rainbow Trout was 2.4% ± 2.5%, and total catch was 5.5% ± 3.9% in the lower Boise River. In comparison, the estimate for total catch of wild Brown Trout in the Boise River was 16.1% ± 12.9% with no estimated harvest. During the 2016 raft surveys, another 59 Brown Trout and 240 Rainbow Trout were released with tags. These tags were only at large for 5-6 months at the time of this report so only partial estimates of first year catch and harvest could be made. Partial first year-at-large exploitation of wild Rainbow Trout was 1.9% ± 1.9%, and total catch was 9.4% ± 4.4% in the lower Boise River. In comparison, the estimate for total catch of wild Brown Trout in the Boise River was 14.9% ± 12.1% with again, no estimated harvest (Table 28).

At least 14 different species were observed during shoreline surveys for juvenile trout, including dace sp., sculpin sp., and sucker sp. (Table 29). A total of 259 Brown Trout and 365 Rainbow Trout were captured during the survey. Brown Trout catch ranged from 0 to 139 fish per site, while Rainbow Trout catch ranged from 0 to 83 fish per site in the 18 sites sampled in 2016 (Table 29). Lengths of Brown Trout ranged from 70 to 310 mm, and lengths of Rainbow Trout ranged from 51 to 300 mm. Length-frequency distribution analysis suggested that Rainbow Trout <130 mm and Brown Trout <150 mm were likely age-0 trout (Figure 54).

As they were in 2015, age-0 trout densities again varied by location, habitat type, and species in 2016. The highest densities of main stem Rainbow Trout were sampled upstream of Eagle, whereas the highest densities of main stem Brown Trout were sampled downstream of Eagle (Figure 55). Mean density for age-0 Rainbow Trout was 0.07 ± 0.06 fish/m for the entire survey. Similar to 2015, in 2016 main channel sites typically had lower densities than side channel/tributary sites (Figure 56). In main stem habitats, mean density of age-0 Rainbow Trout (fish/m) was 0.041 ± 0.025 while tributary/side channel sites had a mean density of 0.19 ± 0.34. Similarly, mean density of age-0 Brown Trout was 0.019 ± 0.011 in main stem sites and 0.082 ± 0.20 in tributary/side channel sites. For tributary/side channel sites, age-0 Brown Trout density was highest in Loggers Creek. For the main stem sites, age-0 Brown Trout density was highest in sites around Star. Heron Creek had the highest density of age-0 Rainbow Trout. Within main stem sites, densities of age-0 Rainbow Trout were highest upstream of Glenwood (Figure 55).

After a series of meetings, the Ada County Environmental Advisory Board elected to improve the physical habitat of the Boise River adjacent to Barber Park. More specifically, the project was designed to treat an approximately 500' section of the River between the Ridenbaugh Diversion (i.e. just upstream of the Eckert Rd Bridge) and the Barber Park float-craft ramp. The project's intention was to improve habitat complexity thereby increasing cover for juvenile and adult fishes, especially trout, and to provide current velocity breaks that could act as resting areas during high flows. Technical plans were developed by IDFG engineering staff and reviewed by regional experts. Plans included three engineered logjams: two on the north bank and one on the south bank. In addition, approximately 50 large (cubic yard) boulders were added to the river channel in a semi-clustered patterns. Construction was completed by Copper River Energy. Activities began during mid-November and were completed by the end of December with no cost overruns or mishaps. Riparian replanting efforts are being planned for Spring 2017.

DISCUSSION

Triennial Mark Recapture Surveys

Following a sharp increase in wild Rainbow Trout abundance from 1994 to 2010, the population appears to have stabilized. Density estimates for the middle sample section remained the same from 2013 to 2016 at 6.6 fish/100 m^2 and wild Rainbow Trout densities remain more than double that which were measured prior to 2010. Lower Boise River Rainbow Trout length structure has varied over time. From 2004 to 2013, the PSD-305 mm, PSD-356 mm, and PSD-406 mm all steadily increased. In 2016, PSD-356 and PSD-406 continued to increase from previous years, while PSD-305 decreased after a spike in 2013 (Figure 47). The PSD of wild Rainbow Trout greater than 16 inches has doubled from 2007 to 2016. This increase in large wild rainbows in conjunction with a stable overall trout population is good news for Boise River anglers and likely influenced by the continued low exploitation of wild trout.

Similar to past sampling years, hatchery Rainbow Trout were again a small proportion of the catch, despite stocking 200-500 hatchery trout on a monthly basis near the areas surveyed. This consistently low abundance of hatchery Rainbow Trout encountered in these surveys can be attributed to both high angler exploitation, and poor survival of stocked fish in lotic systems beyond 14 days (High and Meyer 2009). In 2013, extensive tagging of hatchery Rainbow Trout in the lower Boise River showed a mean angler catch rate of 46.4% and a harvest rate of 31.7%.

Unlike wild Rainbow Trout populations that showed a drastic increase and then a stabilization, wild Brown Trout abundance has continued to fluctuate over time and remains much lower than wild Rainbow Trout abundance. Wild Brown Trout density decreased from 0.9 fish/m^2 in 2012 to 0.6 fish/m^2 in 2016. The regular fluctuations we observe in wild Brown Trout abundance are likely due to the fact that the overall Brown Trout population remains relatively low (only about 14% of lower Boise River trout are Brown Trout). With lower sample sizes, a few fish caught or missed can have a larger impact on the population estimate. However, regardless of this potential source of bias or error, the trend in the Brown Trout abundance remains stable (Figure 49).

The 2016 survey was the second mark/recapture survey of the lower Boise River using three anodes. Prior to 2013, the triennial survey was conducted using two anodes. There was a marked increase in capture efficiency between the 2010 and 2013 surveys when switching to the three anode system (Koenig et al. 2015) and the capture efficiencies remained higher in 2016. Adding a fourth anode might be an effective way to further increase capture efficiencies and further decrease confidence bounds around the lower Boise River abundance estimates. Additionally, capture efficiency continues to be directly influenced by the number or tenacity of netters per anode. Both issues suggest areas for continued improvement.

Wild Rainbow Trout population abundance plateaued in 2010 in the lower Boise River after over two decades of population increases. The remarkable increase in wild trout abundance followed the establishment of a minimum winter flow in the mid-1980s. Low winter flows have been shown to inhibit survival of juvenile trout in numerous systems (Hurst 2007; Mitro et al. 2003). In addition, water quality has improved and catch-and-release practices have become more prevalent during the same period. Wild Rainbow Trout abundance declined slightly from 2010 to 2013 and remained stable from 2013 to 2016, while the proportion of larger fish continued to increase. The 2016 survey indicates that the wild trout populations in the lower Boise River appear to be stable with an increased proportion of larger trout.

Wild Trout Production, Abundance, and Exploitation

In 2016, raft-mounted electrofishing equipment was used to assess relative abundance of wild Rainbow and Brown trout in the lower Boise River for the second consecutive year. 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 used 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 and 2016 raft electrofishing surveys offer 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. In general, site-specific CPUE of wild Rainbow Trout between sites were very similar between years (Figure 51). These results indicate a level of consistency in wild trout abundances in the lower Boise River. The results also point out areas such as Star South, Eagle South, Morrison, and the Special Regulation section, where abundances of wild Rainbow Trout are consistently higher as well as areas such as Plantation, Americana, and Harris Ranch, where abundance is consistently lower. The size distributions of wild Rainbow Trout within these sections contained a mix of both juvenile and adult fish (Figure 52); and in general, sites from Eagle upriver had a higher proportion of smaller fish when compared to sites downriver. Wild Brown Trout catch was more variable with the highest CPUE occurring in the Star North and Morrison sections in 2015 and in the Eagle North and Special Regulation sections in 2016. Ultimately, the much lower and less consistent catch rates of wild Brown Trout make their population more difficult to characterize. Future work might include identifying habitat characteristics within these reaches to better understand what characteristic within the lower Boise River are impacting wild trout abundance and size structure.

The Idaho Department of Fish and Game (IDFG) currently stocks approximately 12,000 catchable Rainbow Trout in the lower Boise River on an annual basis. However, due to an apparent lack of survival and angler exploitation, 2016 was the last year of annual hatchery Brown Trout stocking in the lower Boise River. Rainbow Trout are stocked at 10 locations from Barber Park downstream to the Star Bridge. A year-long creel survey indicated that 33,056 h were expended from Barber Dam to the 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. Based on angler tag returns from wild trout tagged during raft surveys, harvest and total catch estimates in the lower Boise River remain quite low for both wild Brown and Rainbow trout tagged in 2015 (Table 27). Interestingly, despite tagging fish from Barber Park to the Canyon/Ada county boundary, all of the angler returns for wild Rainbow Trout were for fish caught downriver of Eagle. Conversely, the majority of the Brown Trout catch occurred in the Morrison and Special Regulation sections. The partial return estimates for trout tagged in 2016 are again showing higher Brown Trout returns in the special regulation section though Rainbow Trout returns appear to be more uniform throughout the lower Boise River. However, it is important to note that overall returns are low and estimates for many individual river section are based on one or two tag returns. Final estimates and analysis for fish tagged in 2016 will not be complete until June 2017.

The continuation of the fall shoreline surveys for age-0 trout offered further insight into identifying important rearing areas (and to a lesser extent, spawning areas) in the lower Boise River. Fall age-0 densities of Rainbow Trout were similar in 2015 (0.08 fish/m) and 2016 (0.09 fish/m). These fry densities are relatively low when compared to the SF Boise River, where fall fry densities average nearly 2 fish/m (Butts et al. 2016). Side channels and tributaries appear to be the preferred spawning and rearing areas based on relative abundance of age-0 trout. In both years of the survey, tributary or side channel sites had greater than four times the densities of age-0 Rainbow and Brown trout than main stem 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 in both 2015 and 2016, is only about 60 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 six cubic 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. While current wild trout populations appear robust and stable, protecting these types of habitats and finding additional opportunities to improve larger sections of existing side channel or tributary habitat would ensure resiliency in this fishery in the future.

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 the Plantation section. In contrast, wild Brown Trout production is highest between Eagle and Star. 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. A better understanding of the specific habitat differences that influence wild Rainbow and Brown trout-specific recruitment would benefit fishery management and future habitat enhancement efforts in the lower Boise River. Future work might include correlating species-specific densities and CPUE info from the shoreline surveys to specific habitats within the lower Boise River.

The widespread and intensive surveys conducted on the lower Boise River in 2015 and 2016 have provided a large amount of useful information about wild Rainbow and Brown trout populations between the Highway 21 Bridge and Middleton. With increased knowledge of the spatial distribution of wild trout populations, a better understanding of habitat and flow characteristics correlated with areas of better fry and adult populations would be beneficial. Identifying specific habitats correlated with higher populations of both juvenile and adult wild trout will help with future habitat work.

The Barber Park Habitat Improvement Project was one of the first large-scale aquatic habitat improvement projects in the main stem Lower Boise River. In terms of planning, permitting, and implementation the project was completed as expected and on budget. It is our hope that this project will serve as a template for future projects. Pre-project fish population surveys were completed in October 2016 and when compared to future data should allow some indication as to whether this projects will serve its intended purpose.

MANAGEMENT RECOMMENDATIONS

1. Continue population and habitat monitoring in the upper and middle sections every three years.
2. Repeat the fall shoreline electrofishing surveys for age-0 Rainbow and Brown trout to assess annual variability in production. Establish spring shoreline surveys to estimate overwinter survival.

Table 24. Numbers of fish captured and marked during electrofishing population surveys in the Boise River, Idaho during October or November 2016. Mark-recaptures population estimates were conducted in all three sites.

Section (site length)	Species	No. captured	No. marked	No. captured	No. recaptured
Upper	Rainbow trout (wild)	71	71	64	4
(998 m)	Rainbow trout (hatchery)	7	7	4	0
	Brown trout (wild)	4	4	6	0
	Brown trout (hatchery)	0	0	2	0
Middle	Rainbow trout (wild)	235	228	129	27
(963 m)	Rainbow trout (hatchery)	7	7	9	0
	Brown trout (wild)	49	49	34	14
	Brown trout (hatchery)	0	0	0	0
Habitat	Rainbow trout (wild)	103	102	135	5
(280 m)	Rainbow trout (hatchery)	42	42	46	1
	Brown trout (wild)	1	1	3	0
	Brown trout (hatchery)	0	0	2	0
Totals	*Rainbow trout (wild)*	*409*	*401*	*328*	*36*
(2,241 m)	*Rainbow trout (hatchery)*	*56*	*56*	*59*	*1*
	Brown trout (wild)	*54*	*54*	*43*	*14*
	Brown trout (hatchery)	*0*	*0*	*4*	*0*

Table 25. Description of river sections used for raft sampling on the Lower Boise River during 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 26. Density estimates (fish/km) for wild Rainbow Trout and wild Brown Trout in the upper, middle, and both sections of the lower Boise River, 1994-2016.

		Fish/km					
Species	Site	1994	2004	2007	2010	2013	2016
RBT	Upper		1,381		563	2,175	871
	Middle	179	1,326	1,253	3,172	2,519	2,508
	All				1,813	3,037	1,830
BRN	Upper				32		17
	Middle		459	216	79	350	213
	All					195	144

Table 27. First year-at-large harvest and total catch estimates for wild Rainbow Trout and wild Brown Trout that were tagged with Floy tags in the Lower Boise River in 2015 and subsequently reported by anglers.

Tagging Year	Water Body	Species	Release Location	Tagging Date	Tags Released	Disposition			Total Harvest		Total Catch	
						Harvested	Harvested b/c Tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
2015	Boise River	Brown Trout	Harris Ranch	No Tags	0	-	-	-	-	-	-	-
			Barber	No Tags	0	-	-	-	-	-	-	-
			Special Reg	6/30/2015	6	0	0	3	0.0%	0.0%	101.6%	77.3%
			Morrison	6/30/2015	8	0	0	1	0.0%	0.0%	25.4%	43.2%
			Americana	6/23/2015	2	0	0	0	0.0%	0.0%	0.0%	0.0%
			Plantation	6/24/2015	2	0	0	0	0.0%	0.0%	0.0%	0.0%
			Eagle North	6/29/2015	8	0	0	0	0.0%	0.0%	0.0%	0.0%
			Eagle South	6/29/2015	2	0	0	0	0.0%	0.0%	0.0%	0.0%
			Star	6/25/2016	18	0	0	1	0.0%	0.0%	11.3%	19.9%
			Star North	6/25/2016	10	0	0	0	0.0%	0.0%	0.0%	0.0%
			Star South	6/25/2016	4	0	0	0	0.0%	0.0%	0.0%	0.0%
			Can-Ada	6/22/2015	3	0	0	0	0.0%	0.0%	0.0%	0.0%
			Total		*63*	*0*	*0*	*5*	*0.0%*	*0.0%*	*16.1%*	*12.9%*
		Rainbow Trout	Harris Ranch	No Tags	0	-	-	-	-	-	-	-
			Barber	6/30/2015	6	0	0	0	0.0%	0.0%	0.0%	0.0%
			Special Reg	6/30/2015	13	0	0	0	0.0%	0.0%	0.0%	0.0%
			Morrison	6/30/2015	25	0	0	0	0.0%	0.0%	0.0%	0.0%
			Americana	6/23/2015	13	0	0	0	0.0%	0.0%	0.0%	0.0%
			Plantation	6/24/2015	10	0	0	0	0.0%	0.0%	0.0%	0.0%
			Eagle North	6/29/2015	8	0	0	0	0.0%	0.0%	0.0%	0.0%
			Eagle South	6/29/2015	49	1	0	1	4.2%	7.6%	8.5%	10.7%
			Star	6/25/2016	63	1	0	2	3.2%	5.8%	9.7%	10.0%
			Star North	6/25/2016	17	1	0	1	11.9%	21.1%	23.9%	29.0%
			Star South	6/25/2016	26	0	0	0	0.0%	0.0%	0.0%	0.0%
			Can-Ada	6/22/2015	27	0	0	1	0.0%	0.0%	7.5%	13.4%
			Total		*257*	*3*	*0*	*4*	*2.4%*	*2.5%*	*5.5%*	*3.9%*

Table 28. Partial first year-at-large harvest and total catch estimates for wild Rainbow Trout and wild Brown Trout that were tagged with Floy tags in the Lower Boise River in 2016 and subsequently reported by anglers.

Tagging Year	Water Body	Species	Release Location	Tagging Date	Tags Released	Disposition			Total Harvest		Total Catch	
						Harvested	Harvested b/c Tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
2016	Boise River	Brown Trout	Harris Ranch	No Tags	0	-	-	-	-	-	-	-
			Barber	6/28/2016	1	0	0	0	0.0%	0.0%	0.0%	0.0%
			Special Reg	6/28/2016	10	0	0	2	0.0%	0.0%	51.7%	47.1%
			Morrison	6/28/2016	2	0	0	0	0.0%	0.0%	0.0%	0.0%
			Americana	6/27/2016	5	0	0	0	0.0%	0.0%	0.0%	0.0%
			Plantation	8/9/2016	4	0	0	0	0.0%	0.0%	0.0%	0.0%
			Eagle North	6/29/2016	7	0	0	0	0.0%	0.0%	0.0%	0.0%
			Eagle South	6/29/2016	3	0	0	1	0.0%	0.0%	86.2%	100.7%
			Star	6/30/2016	9	0	0	0	0.0%	0.0%	0.0%	0.0%
			Star North	6/29/2016	2	0	0	0	0.0%	0.0%	0.0%	0.0%
			Star South	No Tags	0	-	-	-	-	-	-	-
			Can-Ada	7/6/2016	9	0	0	0	0.0%	0.0%	0.0%	0.0%
			Total		*52*	*0*	*0*	*3*	*0.0%*	*0.0%*	*14.9%*	*12.1%*
		Rainbow Trout	Harris Ranch	7/1/2016	9	0	0	1	0.0%	0.0%	28.7%	38.7%
			Barber	6/28/2016	9	0	0	1	0.0%	0.0%	28.7%	37.8%
			Special Reg	6/28/2016	19	0	0	0	0.0%	0.0%	0.0%	0.0%
			Morrison	6/28/2016	9	0	0	0	0.0%	0.0%	0.0%	0.0%
			Americana	6/27/2016	24	1	1	1	10.8%	15.1%	32.3%	25.2%
			Plantation	8/9/2016	11	0	0	0	0.0%	0.0%	0.0%	0.0%
			Eagle North	6/29/2016	16	0	0	1	0.0%	0.0%	16.2%	22.3%
			Eagle South	6/29/2016	32	0	1	0	0.0%	0.0%	8.1%	11.4%
			Star	6/30/2016	40	0	1	0	0.0%	0.0%	6.5%	9.1%
			Star North	6/29/2016	6	0	0	0	0.0%	0.0%	0.0%	0.0%
			Star South	6/30/2016	12	1	0	1	21.5%	29.5%	43.1%	40.0%
			Can-Ada	7/6/2016	88	0	0	0	0.0%	0.0%	0.0%	0.0%
			Total		*275*	*2*	*3*	*5*	*1.9%*	*1.9%*	*9.4%*	*4.4%*

Table 29. Species composition of all sites sampled for fry on the lower Boise River and its tributaries in 2016.

Section	Brown Trout	Rainbow Trout	Hatchery Rainbow Trout	Bluegill	Dace (Var. Sp.)	Largemouth Bass	Mountain Whitefish	Northern Pikeminnow	Oriental Weatherfish	Pumpkin-seed	Redside Shiner	Sculpin (Var. Sp.)	Smallmouth Bass	Sucker (Var. Sp.)
Harris Ranch		31			120									
Barber	1	45			500		1					500		
Special Reg.	2	26			860							990		
Morrison	11	47			40	3						155		
Americana	6	25			230	5						210		
Plantation	10	36			400	70		1			20	240		
Glenwood	8	3			380	6	1					120		
Eagle North	8	4												
Eagle South	10	7			150	6	1							2
Linder North	26	4		3	310	13				4				4
Star North	33	1		3	162	20								3
Star South	1			1	175	15								
Star		41			450	14						2		1
Can-Ada*				P	P	P			P				P	
Loggers Creek	139	83			225	10	13					65		
Heron Creek	6	38	4		25	3	10							5
Warm Creek	1	12			10		1					20		
Dry Creek		1			8									
Grand Total	262	404	4	7	4,045	165	27	1	0	4	20	2,302	0	15

* Species quantities not recorded. P indicates species present

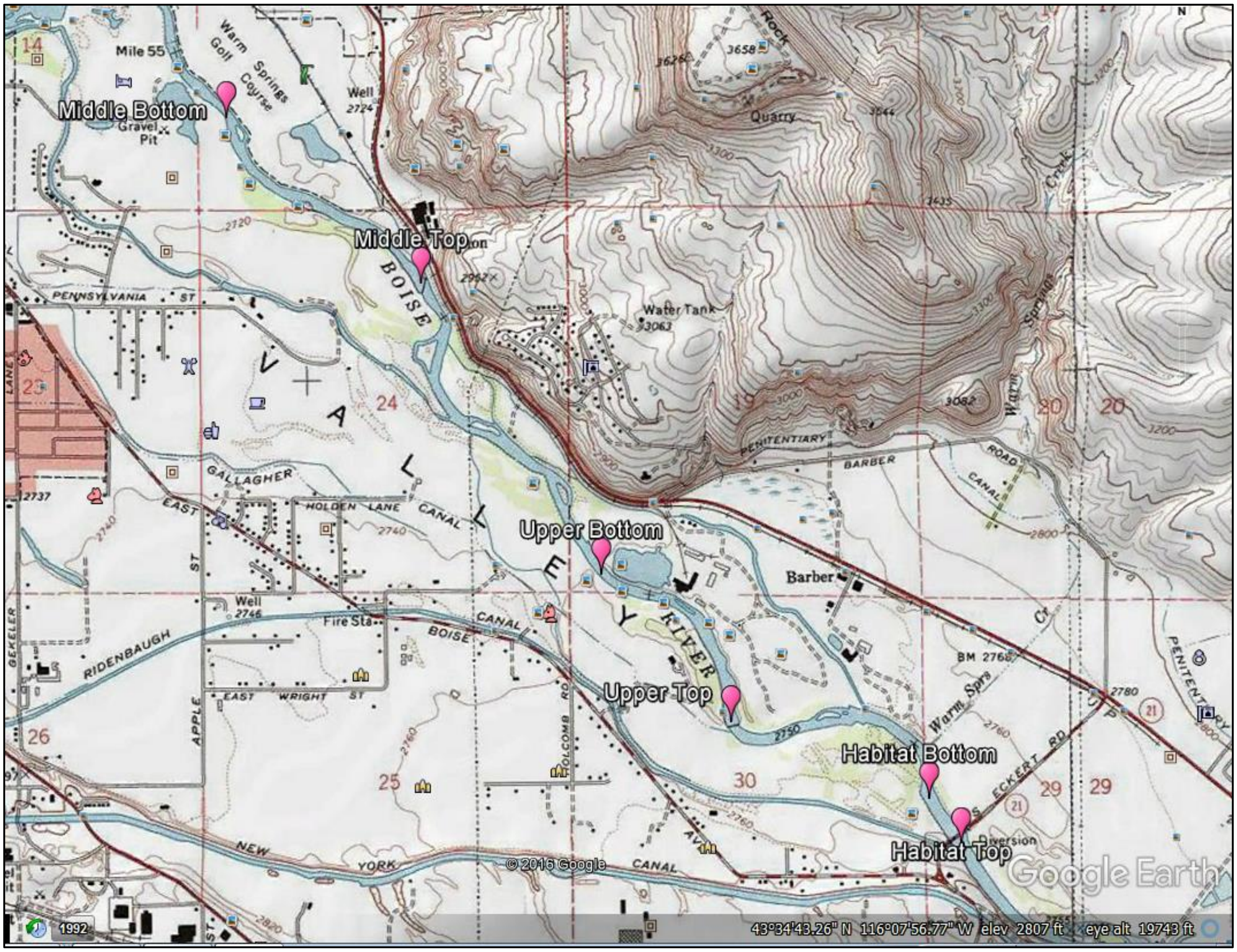

Figure 44. Location of sample sites in the lower Boise River, Idaho sampling sites showing boundary sections for the 2016 upper, middle, and habitat sites.

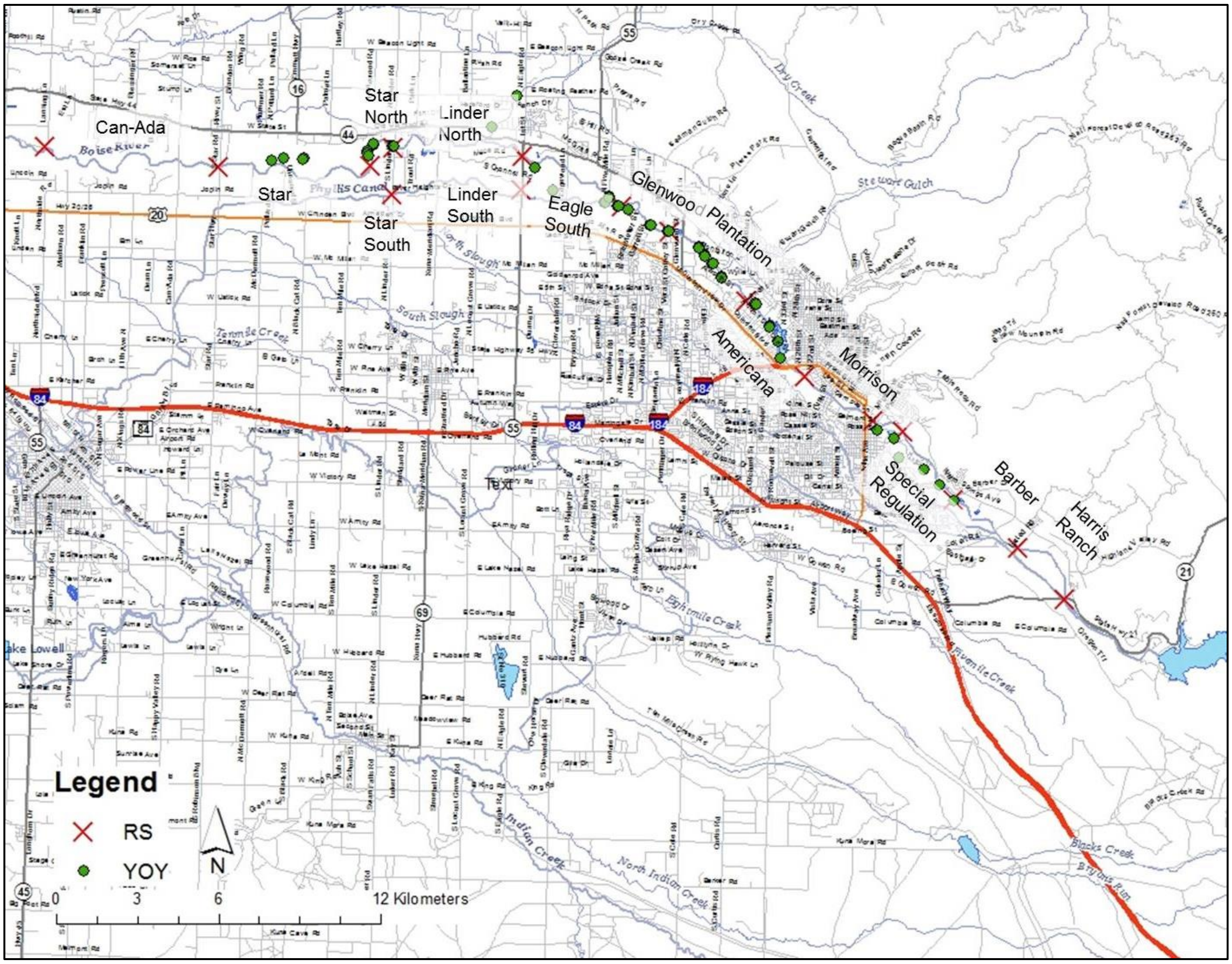

Figure 45. Location of sample sites in the Lower Boise River sections used during electrofishing surveys during summer 2015 and 2016. Sites marked by RS denote raft shocking boundaries and YOY denotes age-0 survey sites.

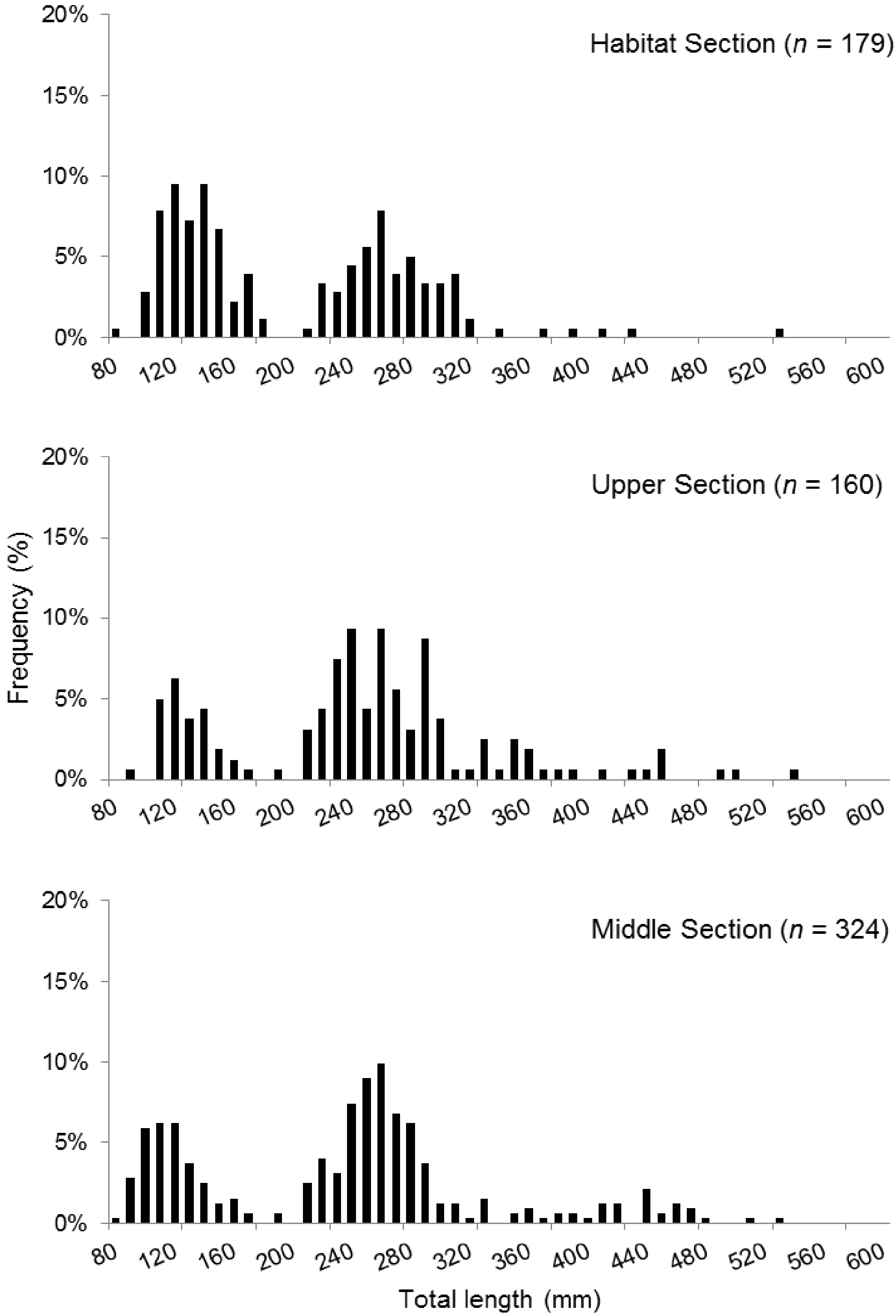

Figure 46. Length frequency distribution of wild Rainbow Trout collected during the 2016 lower Boise River mark/recapture electrofishing survey at three sites.

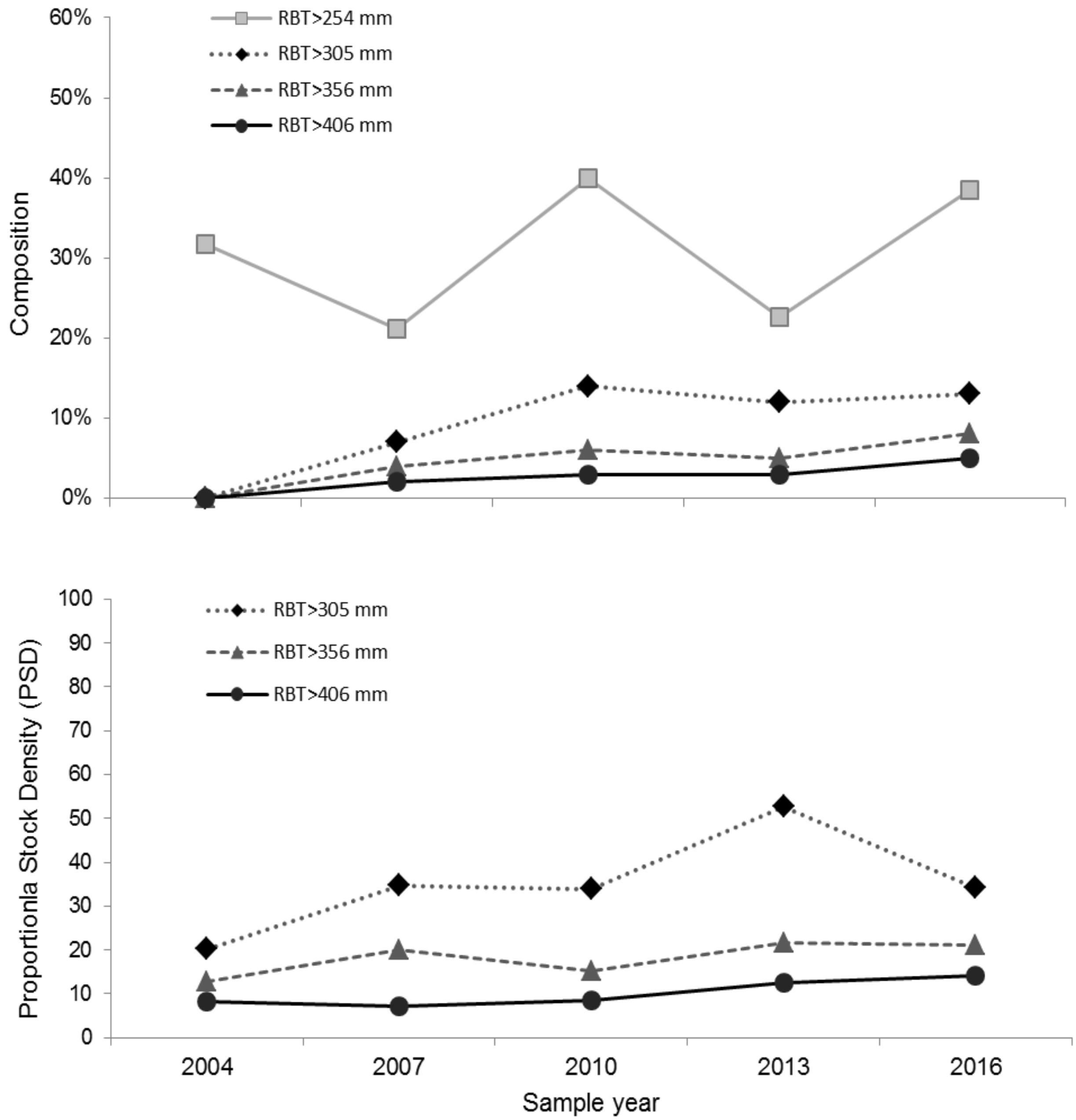

Figure 47. Proportional size distribution of the total catch (top panel) and proportional size distribution (lower panel) for wild Rainbow Trout in different length groups across all sample sites from 2004 to 2016. For the proportional size distribution, Rainbow Trout stock length was 254 mm.

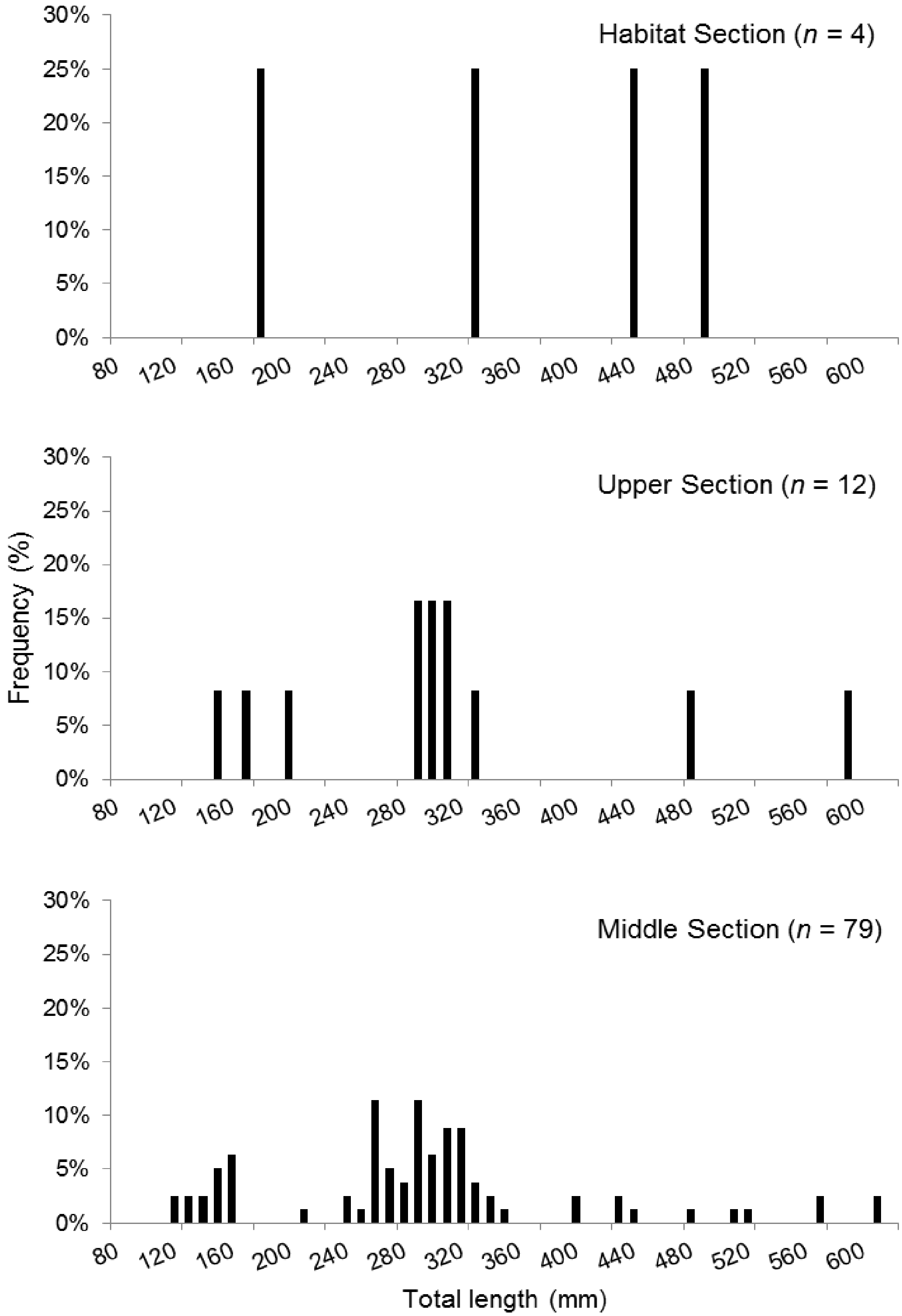

Figure 48. Length frequency distribution of wild Brown Trout collected during the 2015 lower Boise River mark/recapture electrofishing survey at three sites.

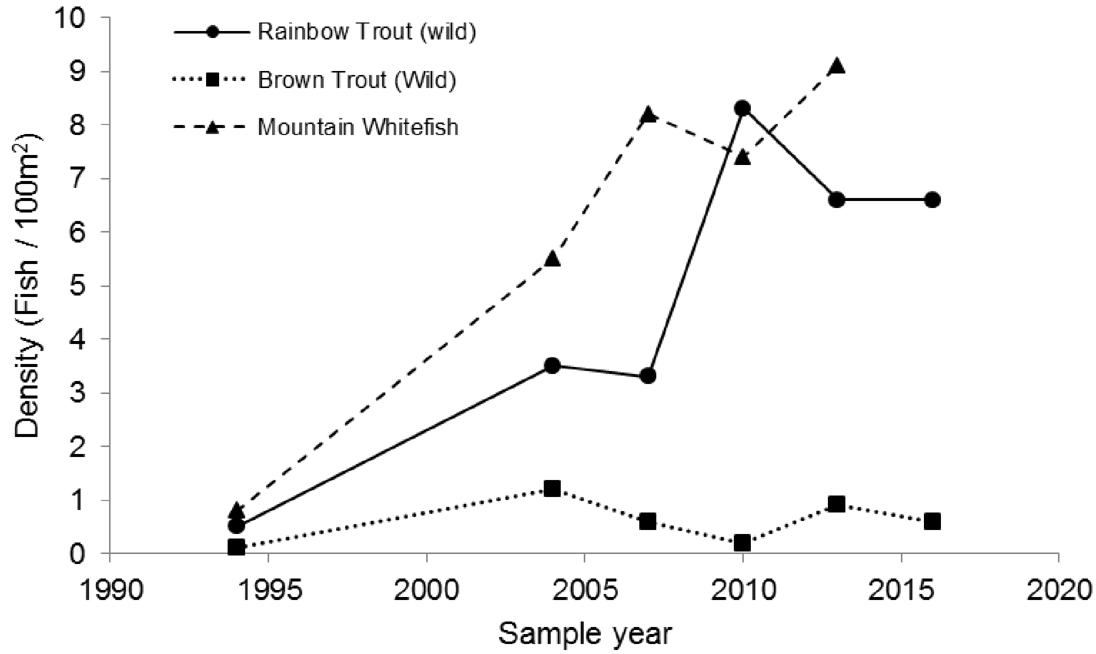

Figure 49. Fish densities (fish/100m^2) of Rainbow Trout, Brown Trout, and Mountain Whitefish for all sampling years in the middle sampling section of the lower Boise River. Mountain Whitefish were not sampled in 2016.

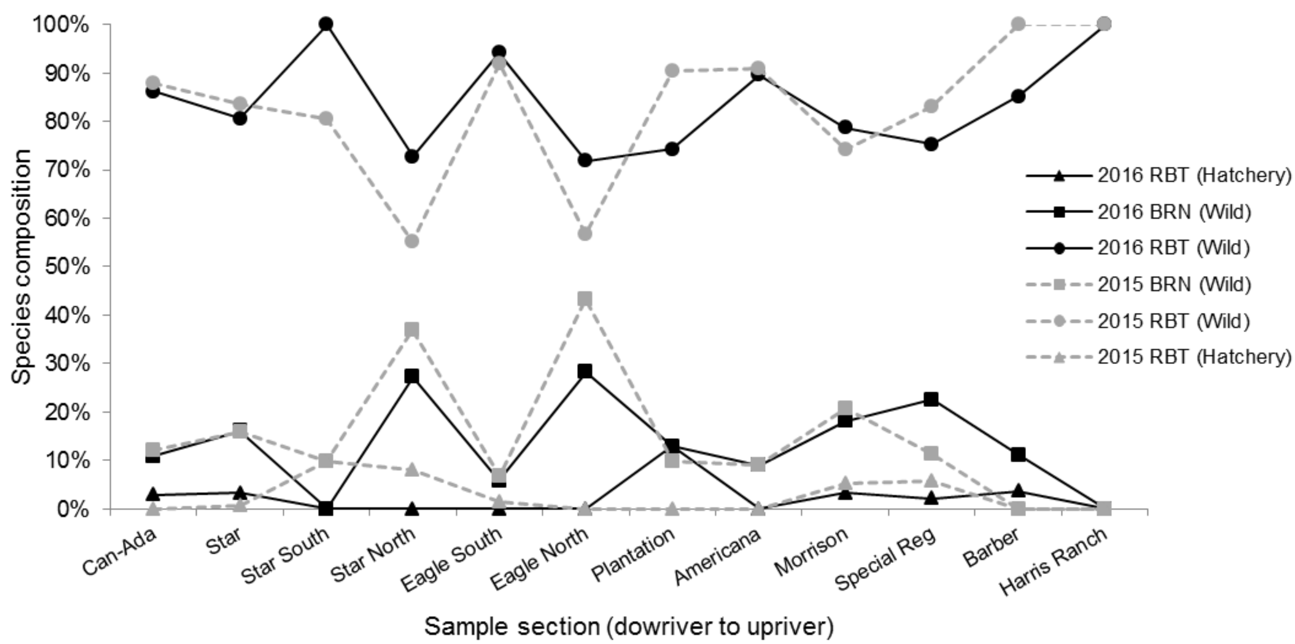

Figure 50. Trout species composition of the twelve raft electrofishing sites sampled in 2016 on the lower Boise River.

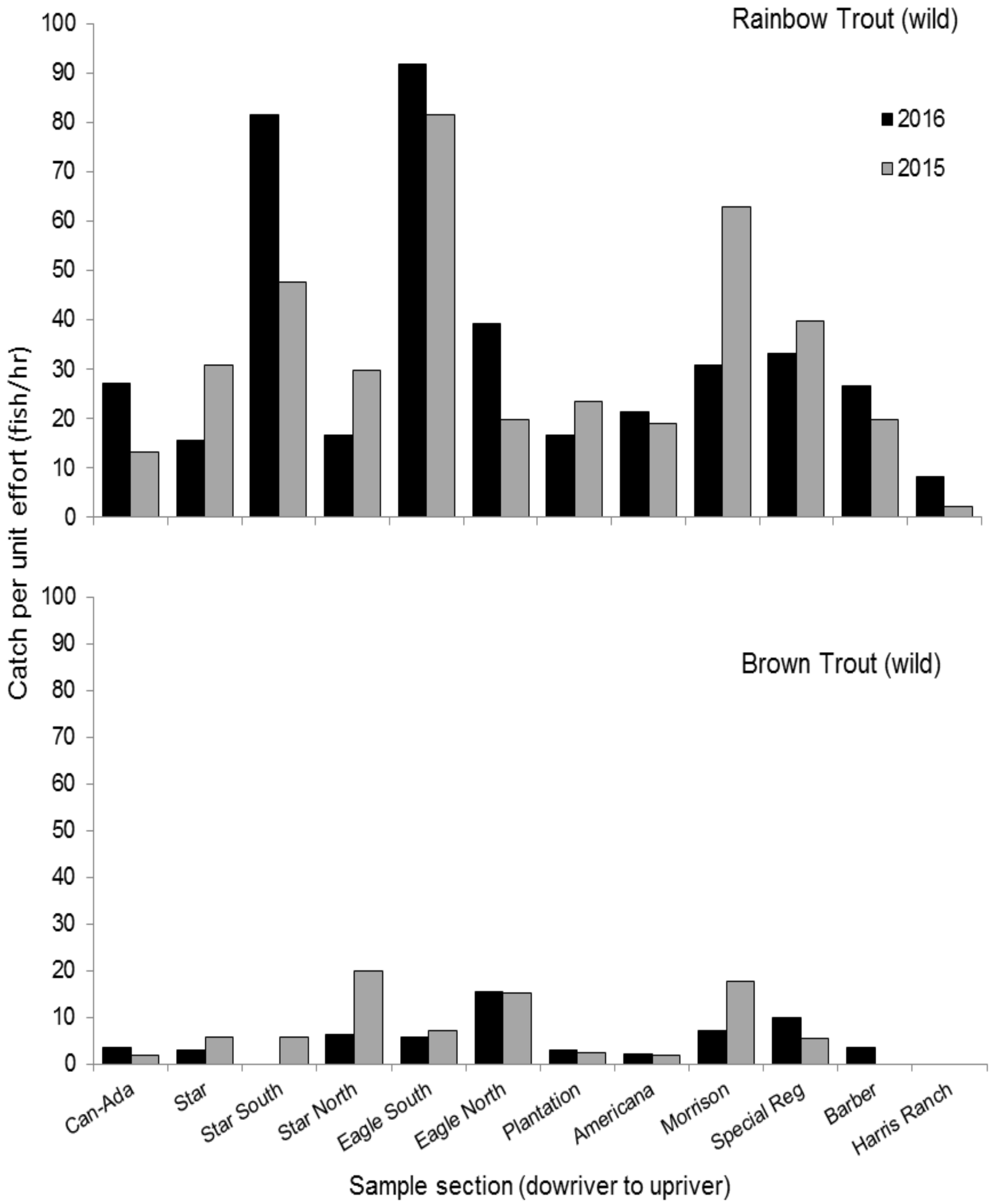

Figure 51. Catch Per Unit Effort (fish/h) of wild Rainbow and Brown trout sampled in 2015 and 2016 from twelve raft electrofishing sample sites.

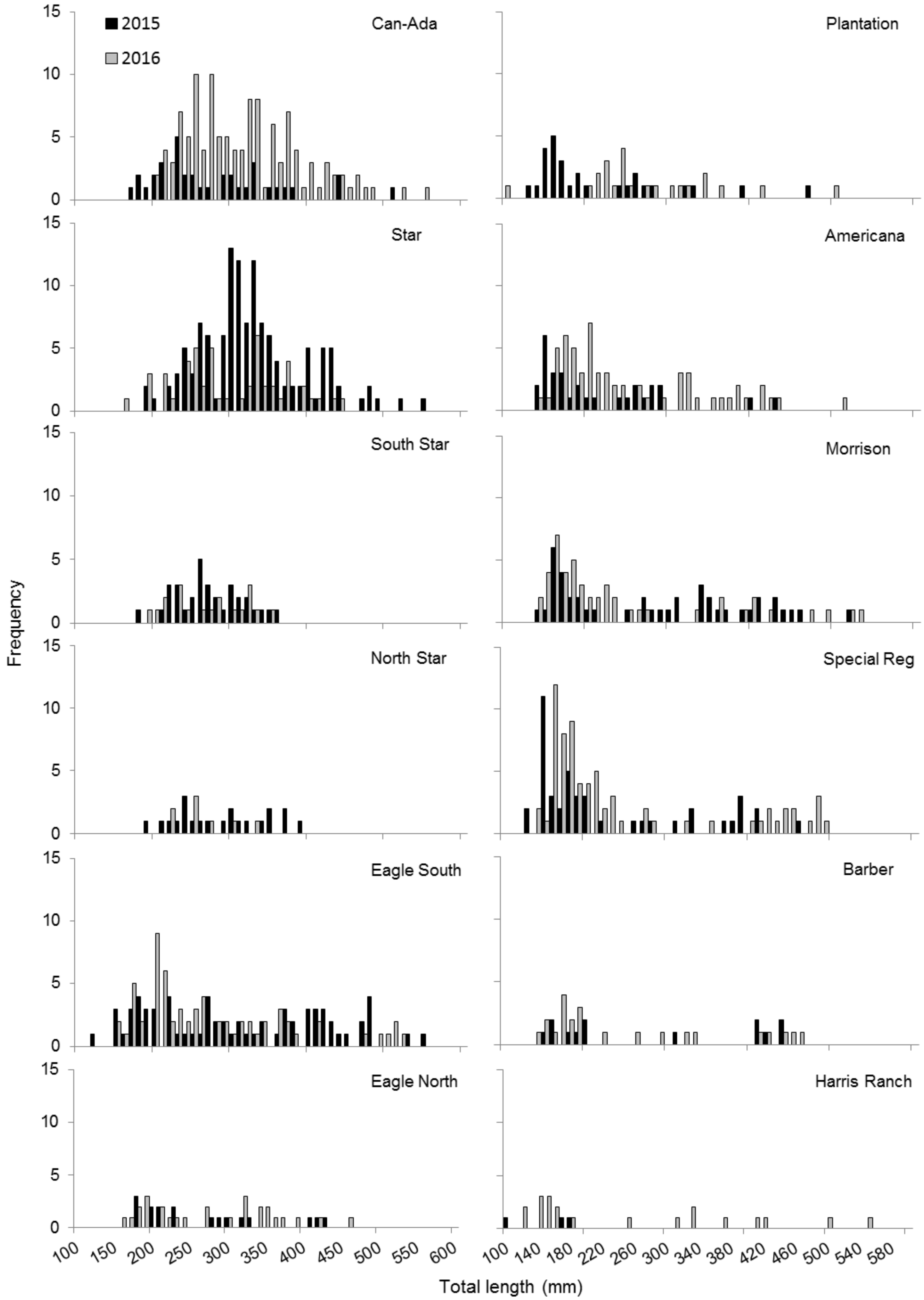

Figure 52. Length frequency distribution of wild Rainbow Trout (n = 995) by river section sampled during raft electrofishing surveys in the lower Boise River in the summers of 2015 and 2016.

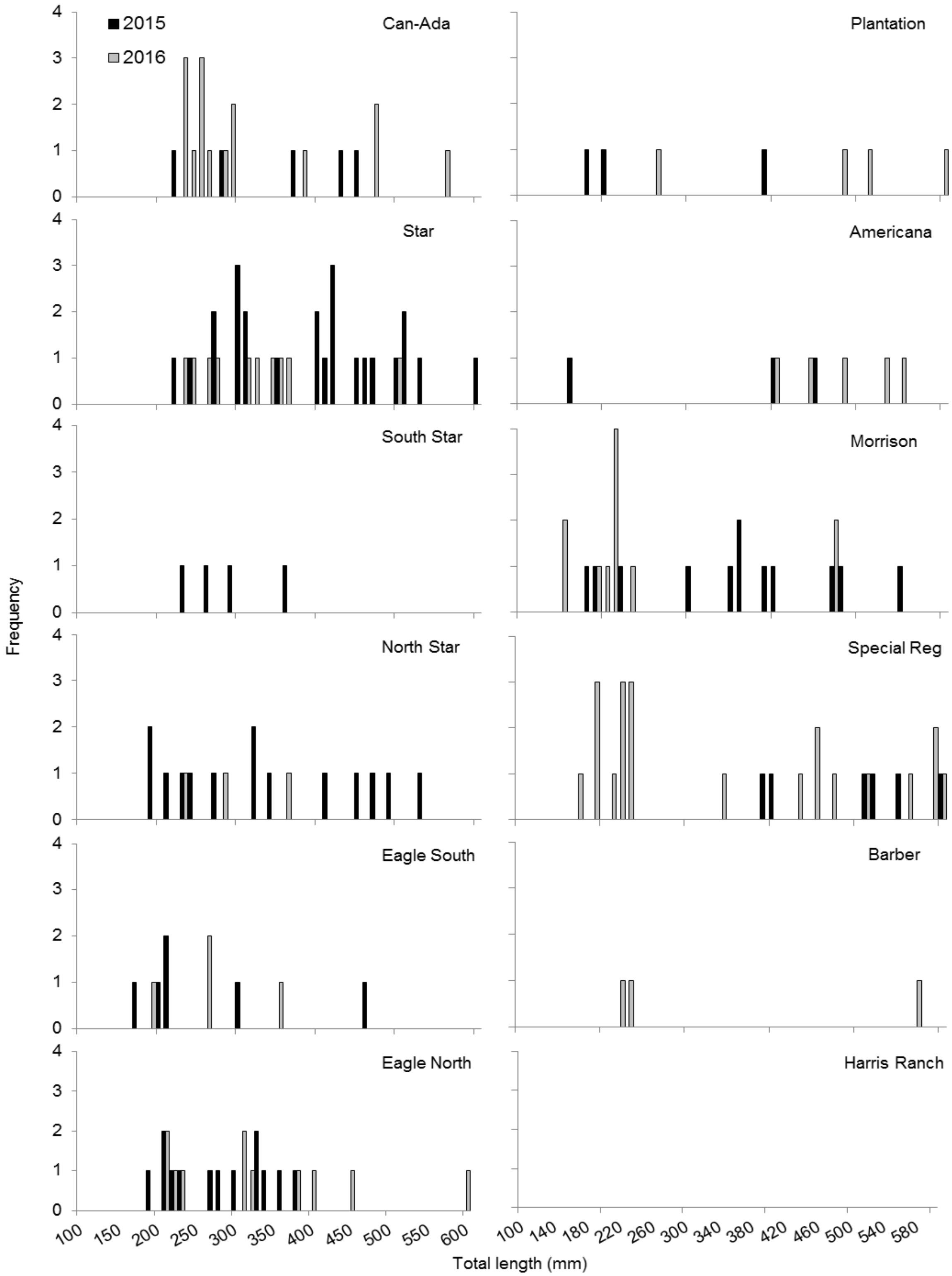

Figure 53. Length frequency distribution of wild Brown Trout (n = 177) by river section sampled during raft electrofishing surveys in the lower Boise River in the summers of 2015 and 2016.

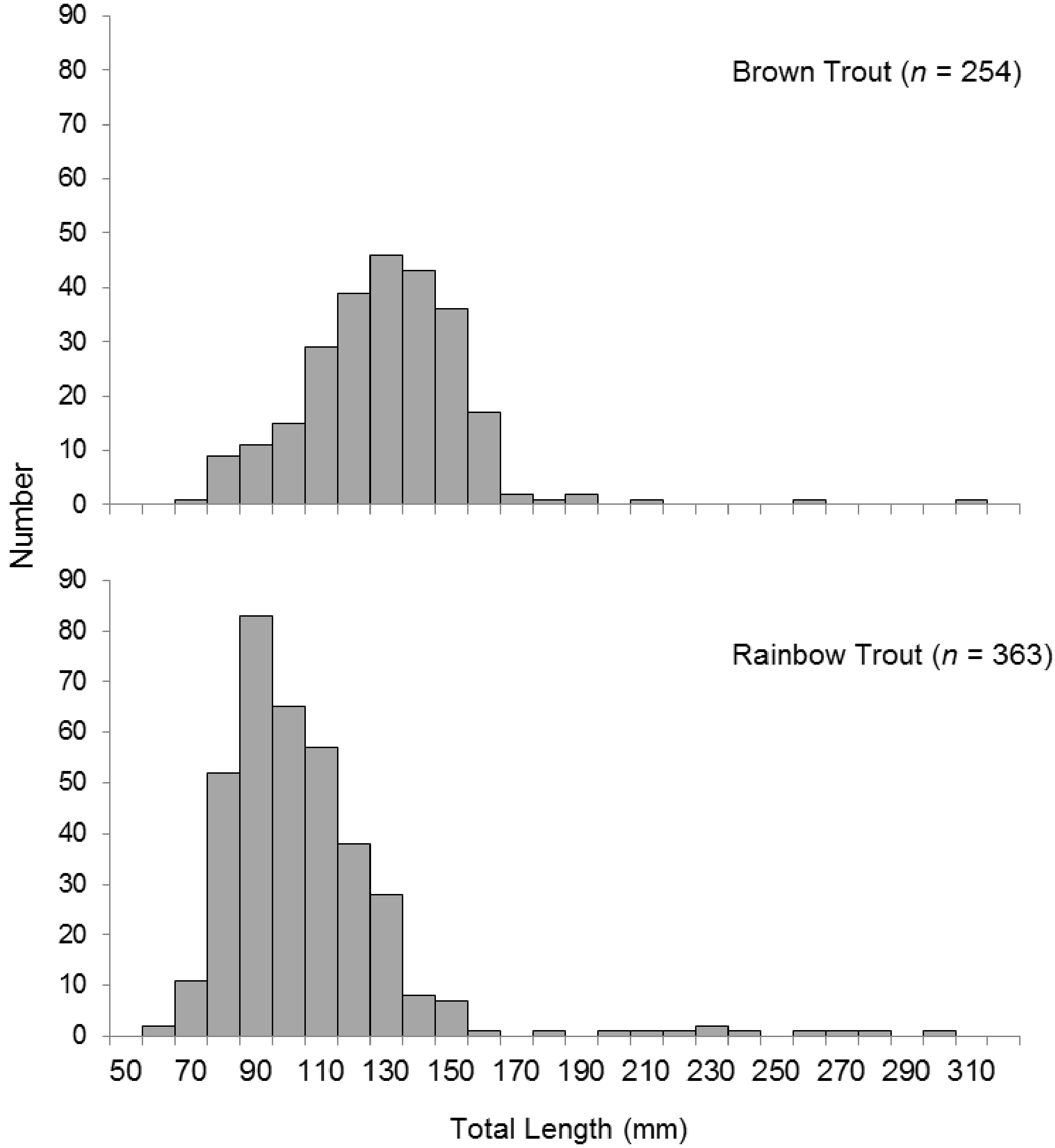

Figure 54. Length frequency distribution of wild Brown Trout and Rainbow Trout sampled during shoreline electrofishing surveys in the lower Boise River and its tributaries in 2016.

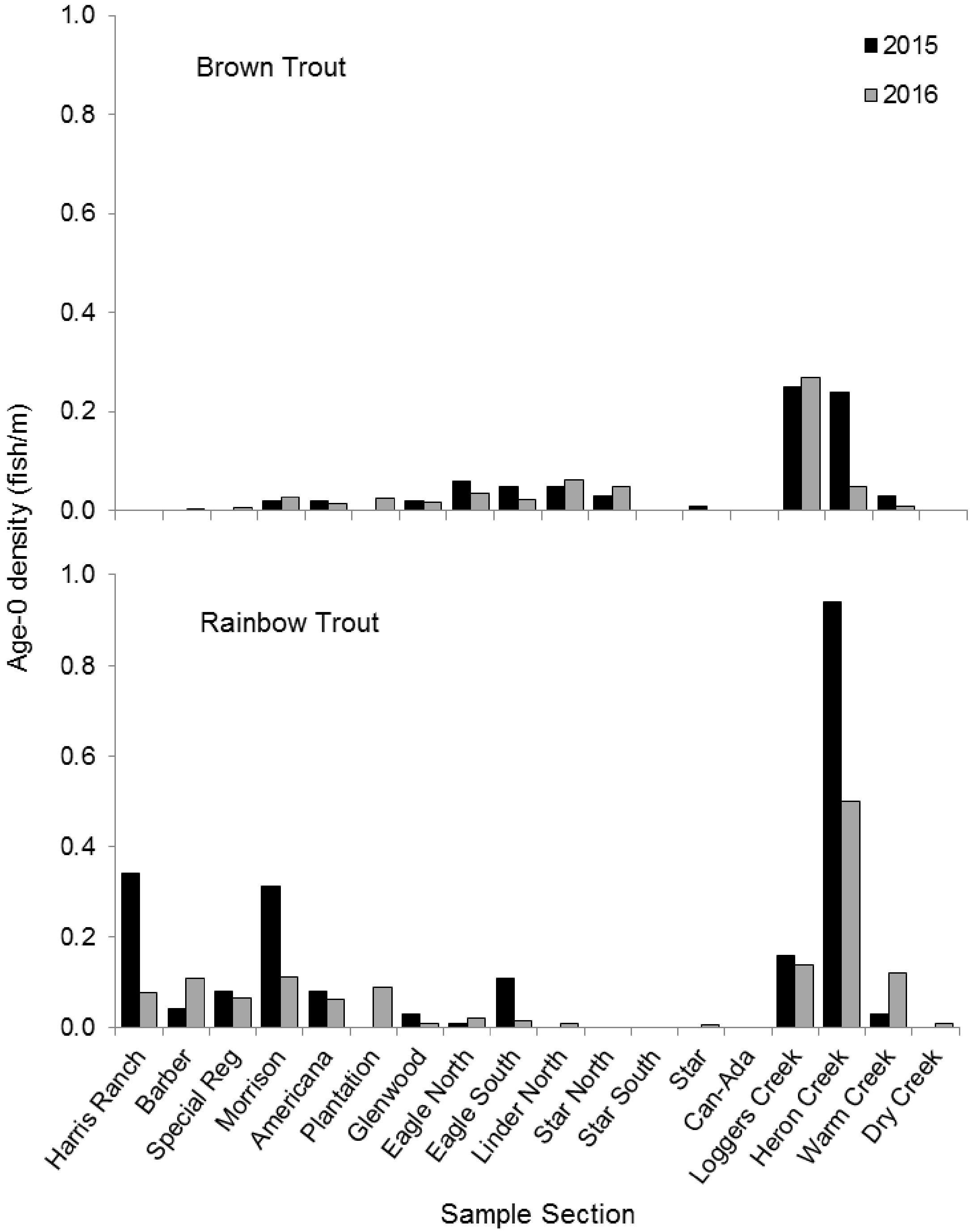

Figure 55. Densities (fish/m) of age-0 wild Brown Trout and Rainbow Trout, by sample section, sampled during shoreline electrofishing surveys in the lower Boise River and its tributaries in 2015 and 2016.

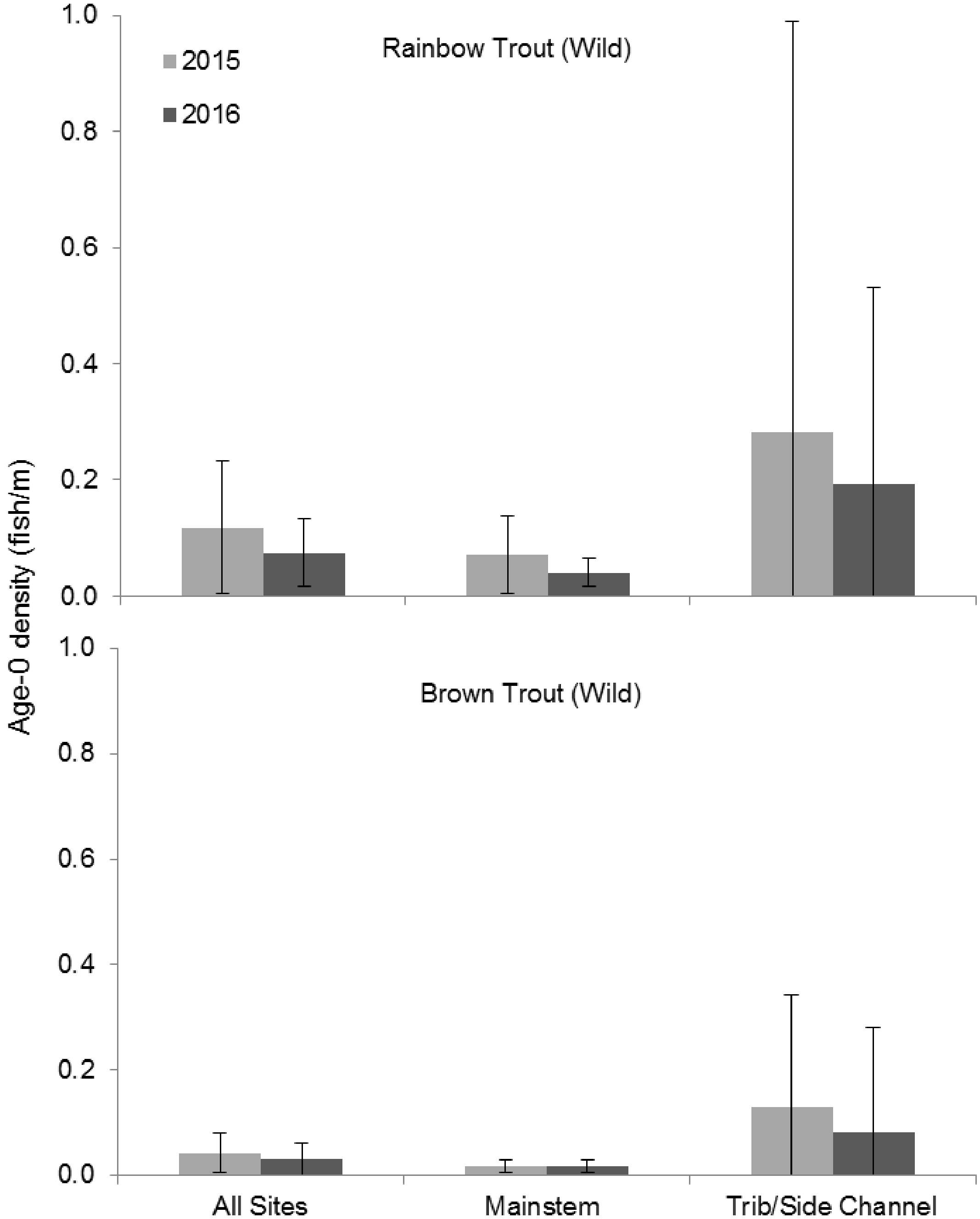

Figure 56. Densities (fish/m) of age-0 wild Brown Trout and Rainbow Trout sampled in the all sections, main stem Boise River sections, and side channel/tributaries during shoreline electrofishing surveys in 2015 and 2016.

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 with canoe-mounted electrofishing gear. These monitoring efforts only effectively sample trout longer than 100 mm. To gain a better understanding of the production of Rainbow Trout (i.e. age-0s prior to fall and less than 100 mm), apparent overwinter survival, and recruitment to age-1, staff conducted annual spring and fall surveys along standardized transects during 2009-2016. During this period, mean fall density and length were 1.55 fry/m and 55 mm, respectively. Mean densities tended to be higher at upstream locations, but mean lengths tended to be shorter at upstream locations. For the spring, mean density and length were 0.31 fry/m and 67 mm, respectively. There was no trend in density during spring indicating that shorter fry in upstream locations died at a higher rate than longer fry in downstream locations. Mean apparent overwinter survival was 37%. Fry production and apparent overwinter survival are highly variable in the SFBR. Fires negatively affected production for about two years, then rebounded to pre-fire levels. Overwinter survival of fall fry to the following spring was lower than reported for most other systems. We suspect this result was influenced by the small size of fry entering the winter and production of more fall fry than may be supported by available habitat conditions.

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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. Native nongame fishes including Largescale Sucker *Catostomus macrocheilus*, Northern Pikeminnow *Ptychocheilus oregonensis*, and sculpin *Cottus sp*. are present also.

During the past decade, the Rainbow Trout population greater than 100 mm in the SFBR has been relatively stable (~1,000 Rainbow Trout/km; Butts et al. 2016), but the relative paucity of trout in the 200 to 400 mm length range upstream of Danskin Bridge has puzzled anglers and biologists. Concerns about the irregular size structure, evidence of fry mortality during fall flow down ramping, prevalence and severity of whirling disease infections (Hiner and Moffitt 2001), and a belief by some anglers that the SFBR lacked adequate spawning habitat led staff to investigate whether reproduction or recruitment were limiting adult population abundance. Annual fry monitoring efforts were initiated during 2009 and utilized transects established earlier (Elle 1997 and 1998). The objectives of this study were to: (1) estimate the linear density of age-0 Rainbow Trout during the fall, (2) estimate the linear density of age-1 Rainbow Trout during the spring, and (3) estimate apparent survival rates.

It is important to note that during the middle of this study, the SFBR drainage underwent dramatic changes as a result of the Elk-Pony wildfire that burned 280,000 acres during August 2013. The loss of vegetation on steep adjacent hill slopes and tributary areas created unstable conditions. On September 12, 2013, an intense rainstorm fell on the burn scar and led to large debris and sediment flows from at least six tributary streams. About one year later (early August 2014), similar large rainstorms led to additional debris and sediment flows especially from several drainages to the north, including Pierce and Granite creeks. Furthermore, large debris flows occurred in a few drainages in the canyon section, including Devils Hole and Little Fiddler creeks, creating new large rapids.

METHODS

We indexed the abundance of putative age-0 and age-1 Rainbow Trout at fixed transects from 2009 to 2016 excluding 2011. Initially, six transects were utilized and were sampled during the fall only (mid- to late October). During 2013, we added 34 randomly-selected sites to improve precision and ensure that indices were not biased by non-random site selection. Occasionally, a few sites were not sampled due to excessive depths (from landslide-induced channel constrictions). In addition, during 2013, we began completing surveys in both fall and spring (mid- to late March) to allow comparisons of apparent overwinter survival. The apparent adjective qualifies that this methodology does not measure mortality of individuals, is unable to account for movement if any occurred, and does not allow determination of whether emigration or immigration affected estimates. Despite these potential limitations, this methodology has been used widely to describe survival of juvenile trout in wild populations. Even if one or more of these sources of bias existed, this method should still produce reasonable approximations of survival and allow comparisons of trends in survival across multiple years.

Sites were 33-m long by 4-m wide and located in the roaded section of the tailwater (i.e. from the dam downstream to the Danskin Bridge). A single, upstream electrofishing pass was completed at each site. Rainbow Trout were sampled using a Smith-Root Type LR-24 backpack shocker. All fish were identified and counted. We measured total length of at least 10 individuals at each site and counted the remainder. We plotted lengths and analyzed length frequencies to visually determine the separation between age-0 or age-1 fish and older age classes. Density was calculated as the count of age-0 or age-1 Rainbow Trout divided by site length (33 m). In both spring and fall, for the years when the full suite of sites was sampled, we calculated a mean density for each site (average of four years; dependent variable) and plotted against location (river mile; independent variable). We used simple linear regression to describe this relationship. Plots and analyses were completed for both spring and fall surveys. We completed similar analyses to describe the relationship between total length and location (river mile). Lastly, for these same years, we calculated apparent 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 this seven-year evaluation, 5,347 Rainbow Trout were sampled. This total included 4,036 fry sampled during the fall. A plot of the length frequency for fry sampled during the fall indicated that a trough existed at 100 mm (Figure 57). Because of this, we assumed all fish shorter than 100 mm to be age-0. Mean length of these age-0 Rainbow Trout was 55 mm (n = 1,807). Very few fish (n = 37 or 2%) sampled during fall were greater 100 mm (i.e. older than age-0). A plot of mean total length at a site against location (river mile; Figure 58) showed a significant negative relationship (r^2 = 0.25, P < 0.01, n = 35). More simply, fall fry tended to be somewhat shorter at upstream locations.

Spring sampling occurred during four years and a total of 1,311 Rainbow Trout fry were sampled. A plot of the length frequency for fish sampled about five months later than fall surveys indicated that a trough existed at around 100 mm (Figure 59). Because of this, we assumed all fish shorter than 100 mm in the spring to be age-1. Mean length of age-1 Rainbow Trout was 67 mm (n = 1,807) or 12 mm greater than the length of fall age-0s (Figure 57). Very few fish (n = 36 or 4%) sampled during fall were greater than 100 mm (i.e. older than age-1). A plot of mean total length at a site against location (river mile; Figure 60) showed a very weak, though significant, negative relationship (r^2 = 0.05, P = 0.09, n = 34). Spring age-1s tended to be very slightly shorter at upstream locations, though not as disparate as fall age-0s.

Densities of fall age-0 Rainbow trout were fairly stable from 2009-2012, declined substantially during 2013 and 2014, and increased to pre-fire levels by 2015 (Figure 61). Overall mean fall fry density for 2009-2015 was 1.55 fry/m. Annual mean densities ranged from a minimum of 0.4 fry/m during 2014 to a maximum of 3.1 fry/m during 2009. This represents nearly a 10-fold difference in annual fall fry production that appeared to be substantially affected by the fire and related sediment and debris flows. Densities at individual sites ranged from 0 to 7.2 fry/m. A plot of mean fall fry density at a site against location (river mile; Figure 62) indicated a positive significant relationship with much spread around the regression line (r^2 = 0.19, P < 0.01, n = 38). Fall densities tended to be higher at upstream locations.

Densities of spring age-1 Rainbow Trout showed much less variation than fall densities with only slight variations that occurred after the fire. Overall mean spring fry density for 2013-2016 was 0.31 fry/m. Annual mean densities ranged from a minimum of 0.14 fry/m during 2015 to a maximum of 0.58 fry/m during 2016 (Figure 63). Densities at individual sites ranged from 0 to 2.0 fry/m. A plot of mean spring age-1 density at a site against location (river mile; Figure 64) indicated no relationship with much spread around the data ($r^2 = 0.03$, $P = 0.29$, $n = 38$).

Apparent overwinter survival estimates were calculated for four cohorts. The overall mean apparent survival was 37%. Apparent survival for 2012-13 was 15%. This cohort's survival estimate was not affected by the fire. Surprisingly, the next two cohorts, 2013-14 and 2014-15, experienced fire-affected conditions, but survived at higher rates, 57 and 42%, respectively. Lastly, the 2015-16 cohort survived at 36%, near the overall mean (Figure 65). Apparent overwinter survival rate tended to be higher at downstream locations presumably because fry were larger and, therefore, better equipped to survive the winter. A plot of mean apparent overwinter survival rate at a site against location (river mile; Figure 66) showed a negative but statistically insignificant relationship, with much spread around the regression line ($r^2 = 0.03$, $P = 0.33$, $n = 37$). However, this analysis was heavily influenced by one data point. The overwinter survival rate at site 6 was 722%, whereas the next highest rate was 123% and the overall mean was 43%. We removed that data point and relationship remained negative with much spread around the regression line but became statistically significant ($r^2 = 0.09$, $P = 0.07$, $n = 36$).

DISCUSSION

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 relatively stable and comparatively high. However, following the fire and debris slides, fall densities 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, poor 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). Despite these precipitous declines, fall fry densities returned to near pre-fire levels within two years. Compared to another popular Idaho tailwater, the Henrys Fork of the Snake River, densities in the SFBR were similar and within the range (0.2 - 3.8 fry/m) of those reported by Mitro and Zale (2002).

Fall fry in the SFBR were smaller at upstream locations and much smaller than reported for other similar systems. Smith and Griffith (1994) reported a critical size of 100 mm for fry in the Henrys Fork of the Snake River and very high survival (90%) of the largest fish (130-160 mm) in a cohort. Several years later, a similar study reported similar lengths, though no size-dependent survival (Mitro and Zale 2002). Fry in the SFBR were about half the length of those reported in these two studies. SFBR fry entered the winter at a size at which overwinter depletion of lipids would be expected to cause substantial if not complete mortality in other systems. Anderson Ranch Reservoir is a very deep and steep-sided reservoir. Water releases from Anderson Ranch Dam originate from deep in the water column. These factors lead to cold-water releases, slow egg incubation, late emergence from the gravel, slow growth rates, and small fry size by their first fall. These observations are further supported by length trends by location. In the SFBR, water warms slightly as it moves downstream during summer and fall (i.e. fry growth period) according to USGS gauge measurements. This tendency led to higher average lengths in downstream locations which in turn led to higher overwinter survival rates at downstream locations.

There was a tendency for fall densities and overwinter survival to vary widely. The large-scale impacts of recent fires and debris slide partially explain these variations. Contrastingly, spring densities tended to be much more stable. These observations suggest that additional production of fall fry is unlikely to increase recruitment substantially or eventual adult population abundance further. Instead, management should focus on actions designed to increase the size of fall fry and to improve winter habitat conditions thereby increasing overwinter survival rates.

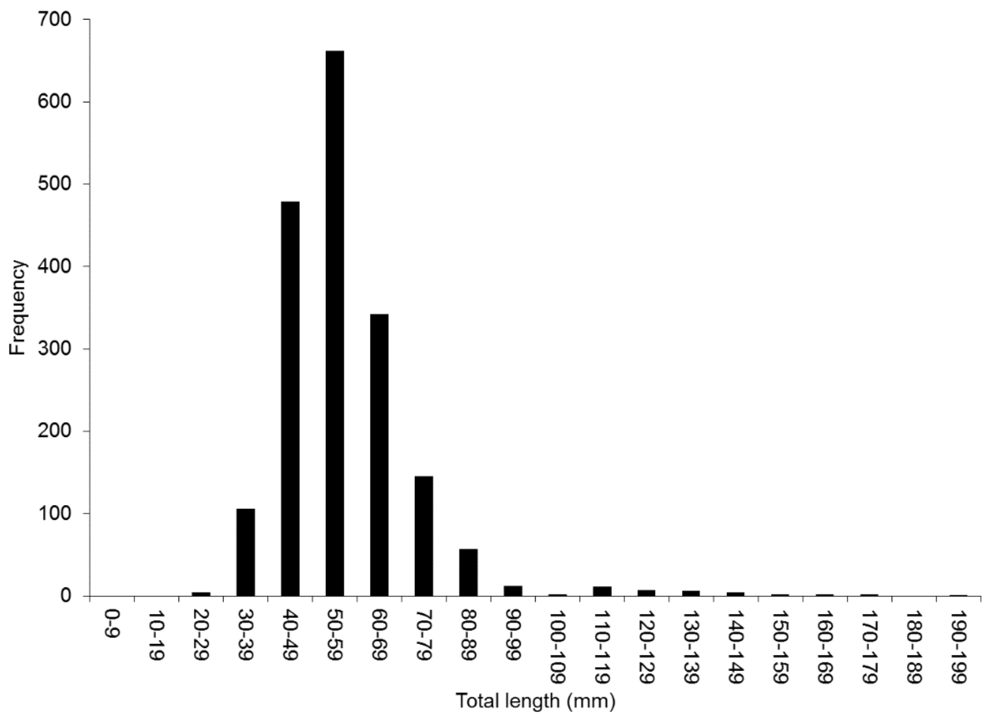

Figure 57. Length-frequency distribution of Rainbow Trout fry (n = 4,036) sampled from the South Fork Boise River during the fall.

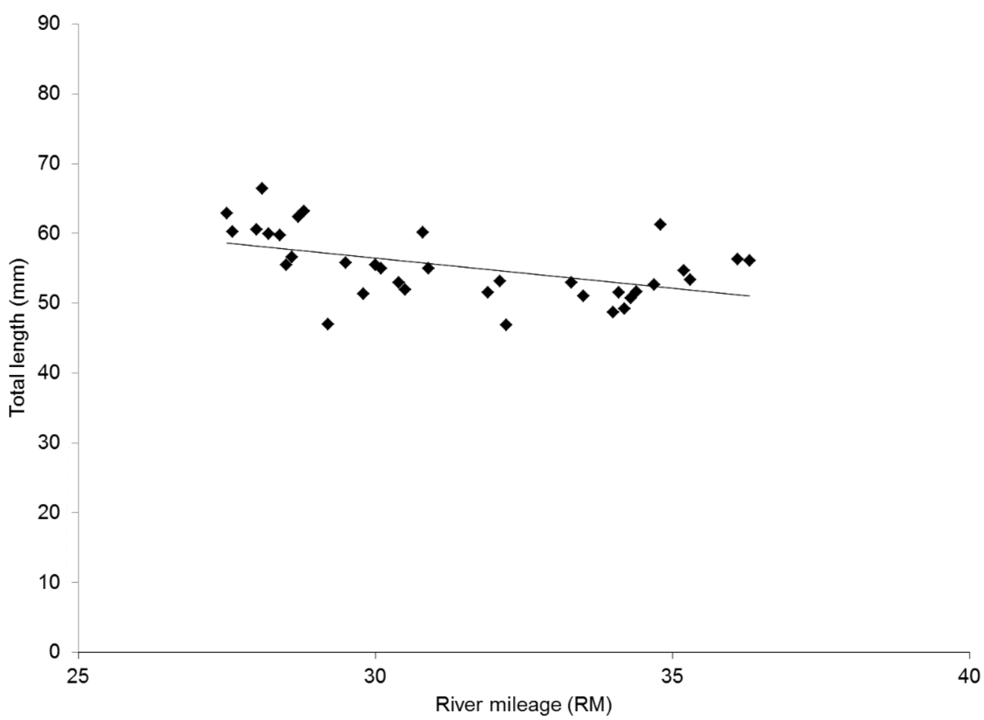

Figure 58. Relationship between mean length of Rainbow Trout fry and sampling location (river mile; n = 35) sampled from the South Fork Boise River during the fall.

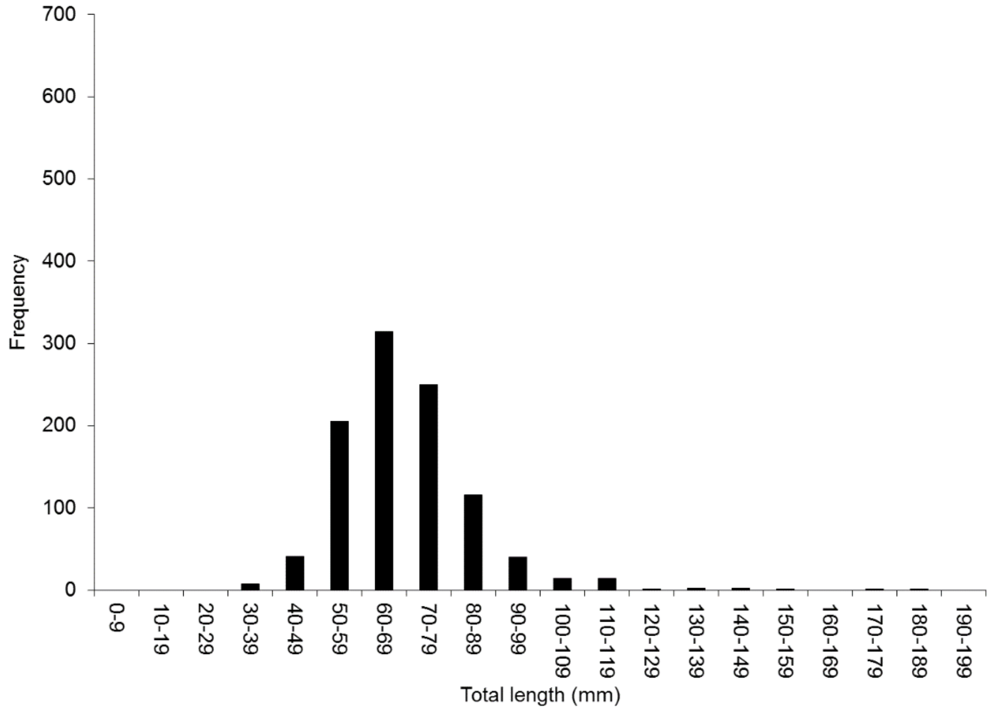

Figure 59. Length-frequency distribution of Rainbow Trout fry (n = 1,311) sampled from the South Fork Boise River during the spring.

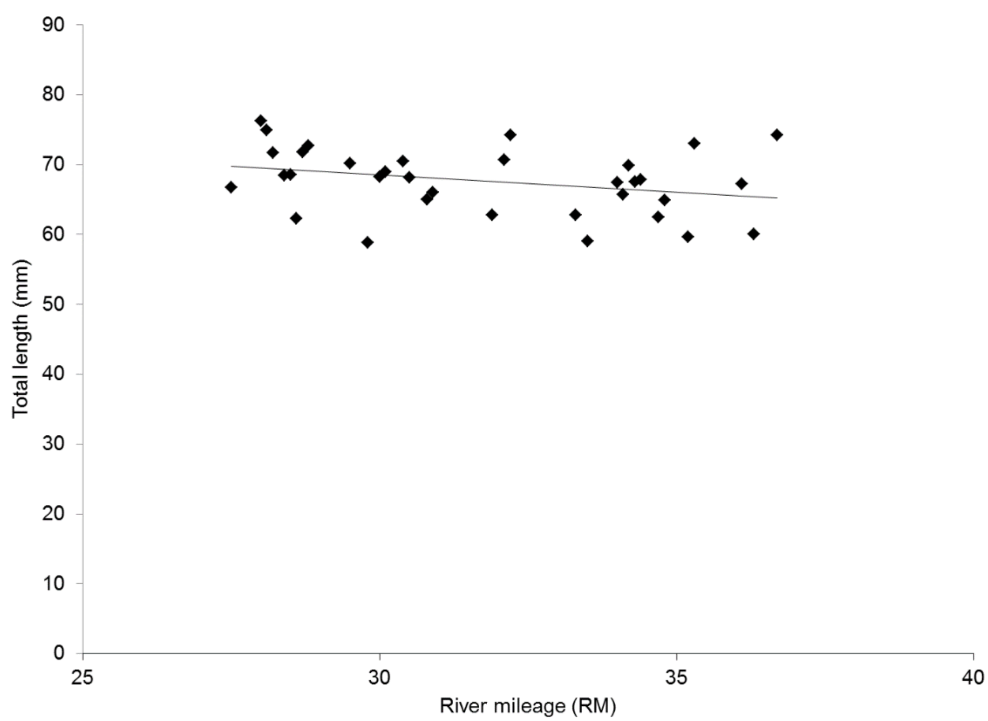

Figure 60. Relaitonship between mean length of Rainbow Trout fry and sampling location (river mile; n = 35) sampled from the South Fork Boise River during the spring.

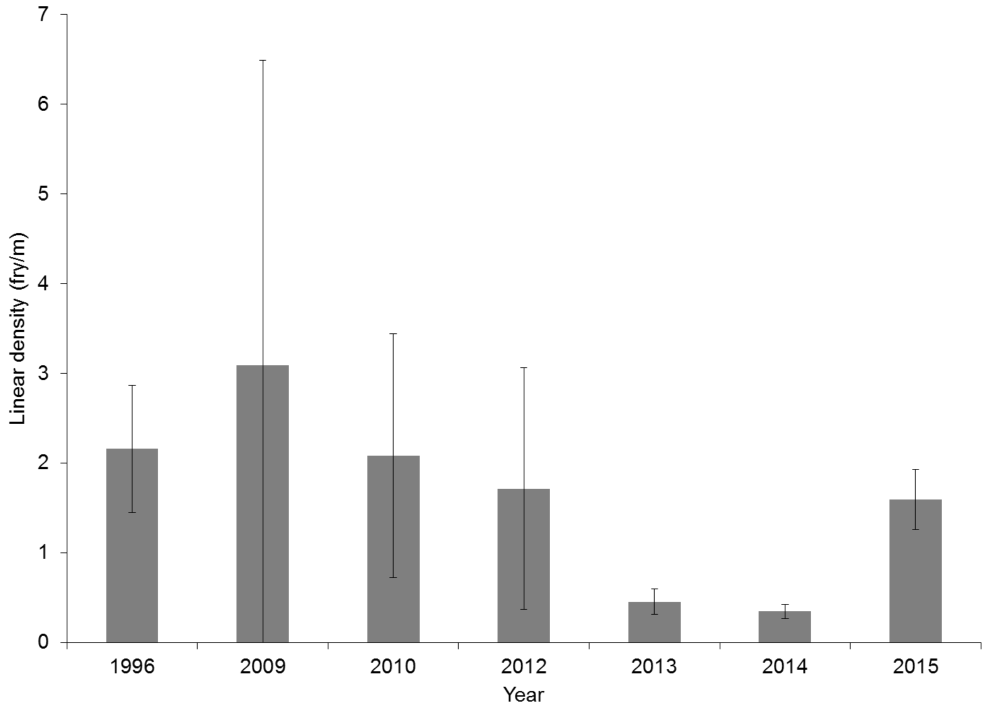

Figure 61. Mean density of Rainbow Trout fry (<100 mm) sampled from the South Fork Boise River during the fall.

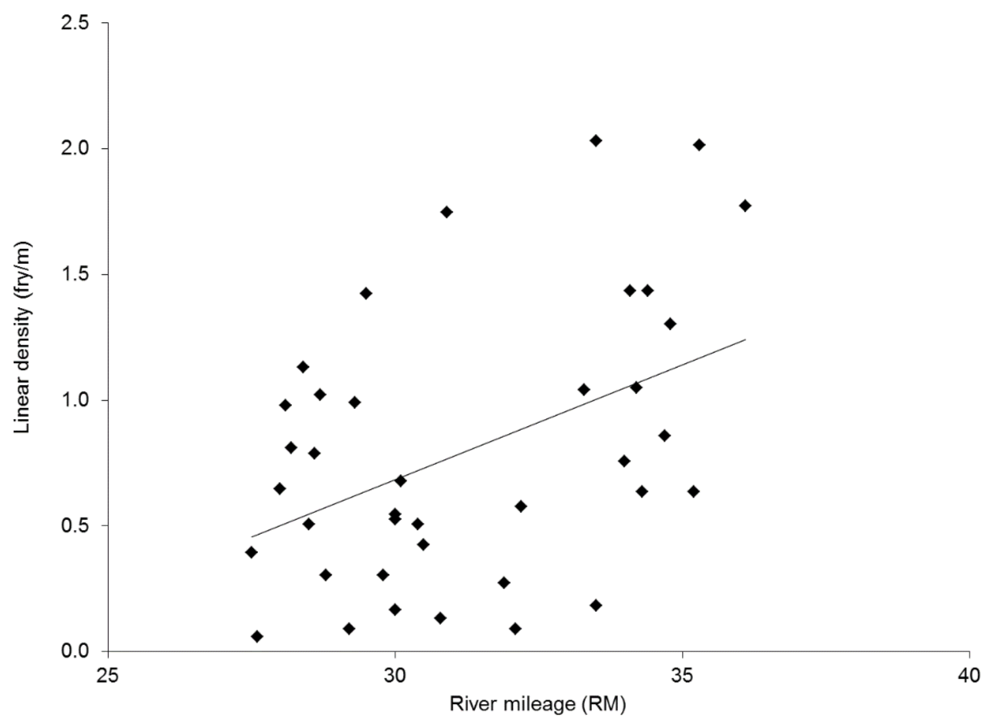

Figure 62. Relationship between mean density of Rainbow Trout fry and location (river mile; *n* = 35) sampled from the South Fork Boise River during the fall.

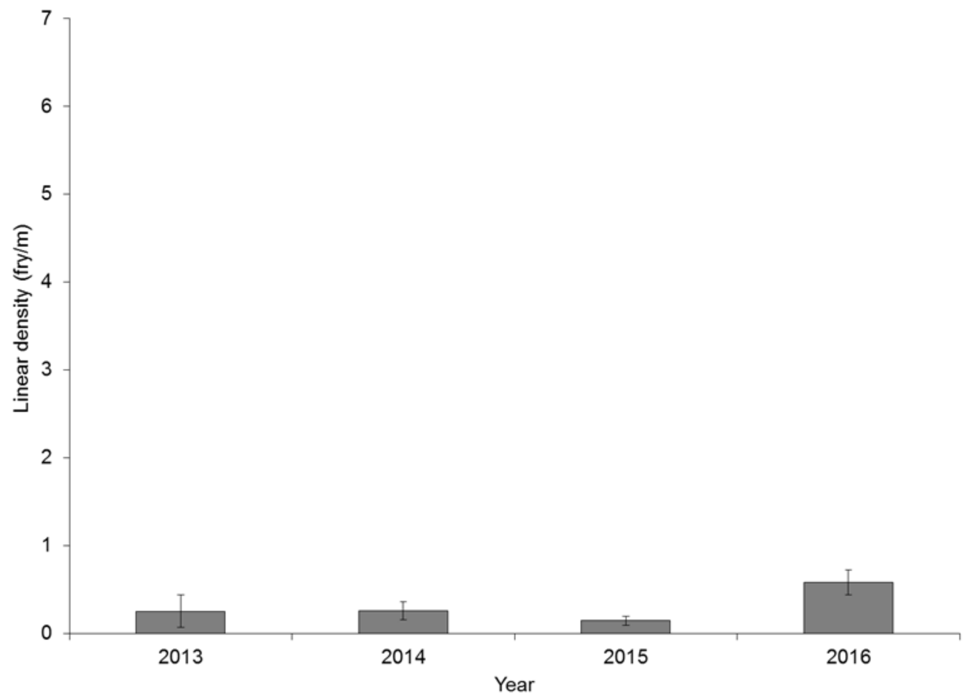

Figure 63. Mean density of Rainbow Trout fry (<100 mm) sampled from the South Fork Boise River during the spring.

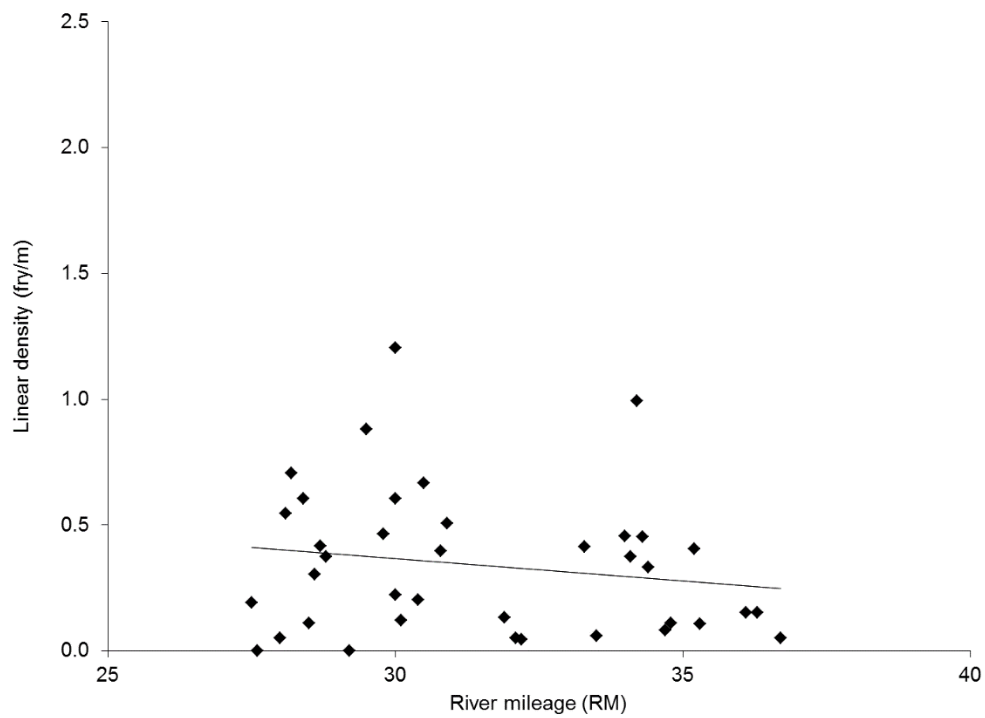

Figure 64. Relationship between mean density of Rainbow Trout fry and location (river mile; *n* = 34) sampled from the South Fork Boise River during the spring.

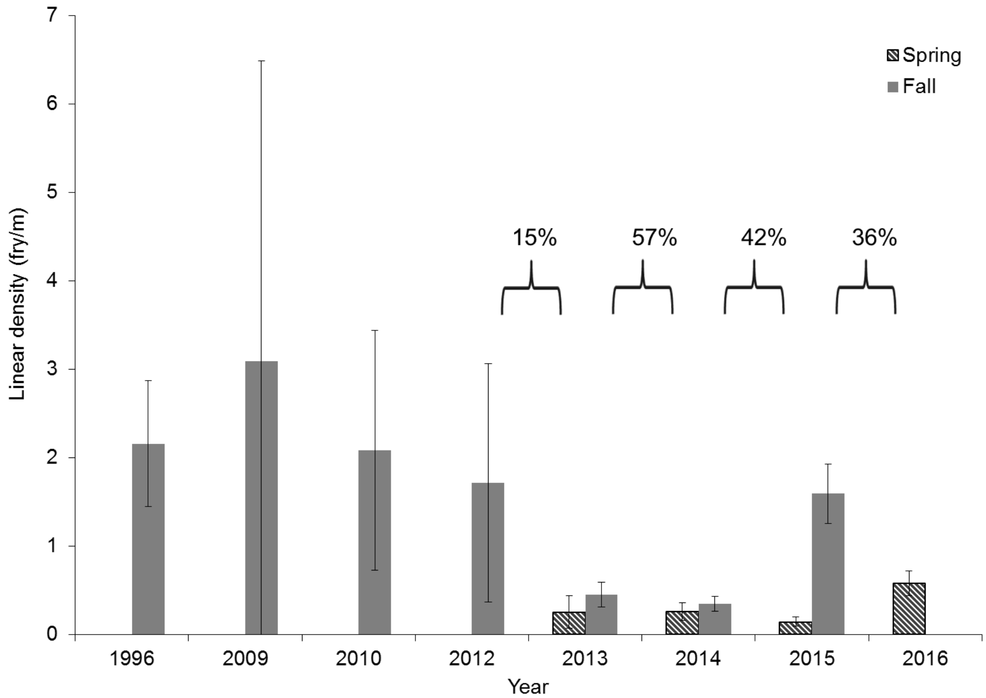

Figure 65. Mean density of Rainbow Trout fry (<100 mm) sampled from the South Fork Boise River during the fall and spring including apparent survival rates.

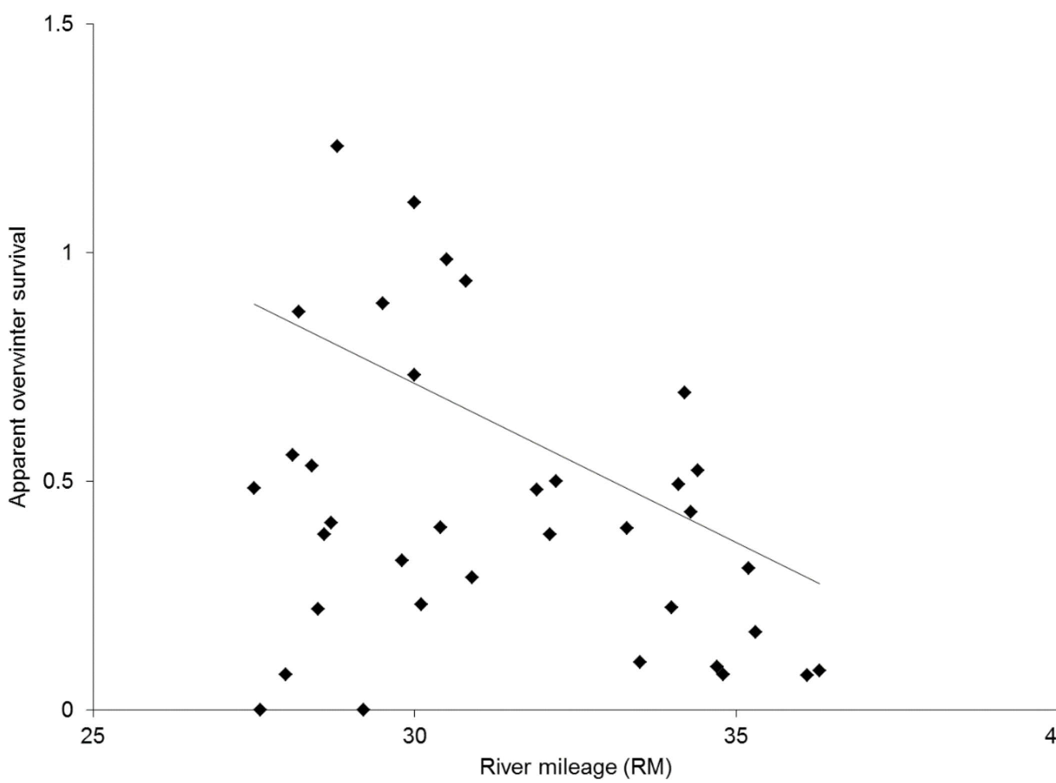

Figure 66. Relationship between apparent overwinter survival rate and location (RM). One outlier was removed.

EXPLOITATION AND TOTAL USE SUMMARY FOR CATCHABLE-SIZED HATCHERY RAINBOW TROUT IN THE SOUTHWEST REGION STREAMS AND RIVERS

ABSTRACT

Limited hatchery capacities and funding coupled with an increased demand for stocked catchable Rainbow Trout has increased the importance of monitoring catch and harvest of these fish post stocking. Since 2011, IDFG has been evaluating harvest and total catch rates of hatchery catchables on a statewide basis using angler-caught tagged fish. The majority of this work has focused on lakes, reservoirs, community ponds, and some larger rivers. Further evaluations of flowing waters, specifically smaller streams and medium-sized rivers, was needed. In 2015 and 2016, catchable-sized hatchery Rainbow Trout tagged with T-bar anchor tags were stocked from May through August into five lotic waters in IDFG's Southwest Region. Angler returns of these tags were tracked through the "Tag, You're It!" (see above) program for 365 days post-stocking (some tags released in 2016 had not been at-large for the entire 365 days at the time of this report). Stream temperatures were monitored at all study waters using temperature loggers and flows were monitored at waters with USGS gauges. Tags stocked in 2015 had a combined total harvest of 6.5% (± 1.9%) and a total catch of 9.3% (± 2.5%). For 2016 stockings, combined preliminary harvest was 9.3% (± 2.3%) and the total catch was 13.6% (± 3.0%). The average days-at-large of angler reported tags stocked in 2015 was 24 days with a range of 1-132 days. In 2016, the average was 22 days with a range of 0-161 days. In general, higher catch and harvest of stocked catchables were correlated with lower stream temperatures and earlier summer stocking events. Fish stocked after mid-July had lower angler return rates, and these stockings would be better allocated to earlier stockings or other lentic waters.

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INTRODUCTION

Each year, IDFG's Southwest Region is allocated approximately 300,000 "catchable" sized (200-280 mm; herein, catchables) hatchery Rainbow Trout *Oncorhynchus mykiss* that are stocked in rivers, lakes, reservoirs, and community ponds (Koenig 2015). Approximately 85% of these catchables are reared at the Department's Nampa Fish Hatchery and the production of catchables accounts for a large percentage (nearly 99%) of the annual Nampa Fish Hatchery budget.

Current hatchery production capacities and funding are not increasing, while the demand for stocked catchable Rainbow Trout remains steady or is increasing (Cassinelli 2015). Considering the high costs that are associated with stocking catchables and the objective to maximize benefits to anglers, further evaluation of catchable exploitation (i.e. harvest) and total catch rates is needed in the Southwest Region's put-and-take fisheries (Cassinelli 2015). Only evaluating total hatchery production is an insufficient method to determine whether hatcheries are successful; instead the success of a hatchery should be measured in terms of production and contribution to harvest (Blankenship and Daniels 2004). In 2011, IDFG began to evaluate harvest and total catch rates on a statewide basis using angler-caught tagged fish under the Hatchery Trout Evaluation Project, which was originally implemented by the Nampa Fisheries Research Office, but has extended into the regional offices (Koenig 2015). To date, the majority of this work has focused on angler returns of hatchery catchables stocked into lakes, reservoirs, community ponds, and some larger rivers. However, only a small amount of work had been done on smaller flowing waters. Therefore, further evaluations of angler use of catchables stocked into smaller streams and river headwaters, were needed. While stocking of hatchery catchables into flowing waters has been greatly reduced over the past several decades, the Southwest Region still utilizes put-and-take stocking practices in a small number of flowing waters that are highly used by anglers and do not support abundant wild populations. Factors such as stream flow and water temperature as well as month of stocking likely impact angler catch rates, and a further understanding of how these factors influence angler catch would benefit the management of these fisheries.

Monitoring exploitation and total use rates of catchables stocked in the Southwest Region could identify locations where angler catch objectives are being met, or where hatchery stocking is not providing the expected benefit (Koenig 2015). As the cost of producing catchables continues to increase, catch and harvest information is used as an important metric to advise decision-making on how to allocate hatchery production and determine stocking location. Effective allocation of hatchery stocked Rainbow Trout could subsequently improve the efficiency of the Nampa Fish Hatchery and directly benefit anglers in the Southwest Region by increasing the return-to-creel rate of catchable trout (Cassinelli 2015). Because IDFG hatchery funding does not appear to be increasing, resourceful efforts must be made to ensure that hatchery programs remain efficient and successful while producing a quality product for Idaho anglers (Koenig 2015). In this chapter, we summarize the angler return data for hatchery-reared catchables tagged and stocked into five lotic waters in the Southwest Region.

OBJECTIVES

1. Summarize exploitation and total use of catchable-sized Rainbow Trout stocked in five rivers and streams within the Southwest Region in 2015 and 2016.

2. Assess variables (temperature, stocking period) that may affect exploitation and total use of hatchery stocked catchable-sized Rainbow Trout.

STUDY SITES

Crooked River is located about 24 km south of Lowman on Highway 21. The main stem 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 (Figure 67). Mores Creek is located about 11 km east of Boise, Idaho. The main stem 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 (Figure 68). The MF Payette River is located about 65 km north of Boise, Idaho. The main stem of the MF 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 main stem is 20.1-km long with elevations that range from 1,137 to 1,829 m and drains into the MF Payette River (Figure 69). 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.

METHODS

Catchable Rainbow Trout were reared at the Nampa Fish Hatchery on a single-pass well water system at 15°C. Treatment groups were hatched into small, covered outdoor concrete raceways (7.6 m x 1.5 m x 0.6 m sections) and fed using a combination of belt feeders and hand-feeding every 12 hours (Cassinelli 2015). After reaching approximately 150 fish/kg, fish were inventoried and transferred to larger outdoor concrete raceways (30 m x 3.7 m 0.6 m sections) to be hand-fed for the remainder of the rearing period (Cassinelli 2015).

Prior to stocking, fish were crowded, collected with dip nets, anesthetized, and tagged. Fish were individually measured for total length (mm) and tagged just below the dorsal fin using 70 mm (51 mm of tubing) fluorescent orange Floy® FD-68BC T-bar anchor tags (Koenig 2015). Tags were labeled with the “IDFG Tag-You’re It” phone number and website, as well as the unique tag number. After tagging, trout were returned to the raceway in submerged box enclosures to recover overnight. Tagged fish were loaded onto hatchery stocking trucks the following morning along with the normal stocking load, and stocked into the five study waters from May through August.

Harvest and total catch (both fish harvested and those caught but released) were calculated following the methods reported by Meyer et al. (2010) and Cassinelli (2015). Catchables that were harvested only because they were tagged were not included in the harvest calculations and only included in total catch. For tags stocked in 2015, we used an average angler reporting rate of 50.9% and for tags stocked in the 2016 stocking season, we used an average reporting rate of 40.1%. These reporting rates were calculated from $50 reward tags included in stocking year-specific statewide hatchery catchable tagging conducted by research staff (Cassinelli 2015). For this report, harvest and total catch were calculated for tags reported within 365 days of stocking. At the time of this report, all fish stocked in 2015 have been at large for the full 365 days. However, tag returns for fish stocked in 2016 have not been at large for the full 365 days, so those return rates are still considered preliminary.

Water temperatures were measured with submerged Hobo (model U22) temperature sensors, recording the water temperature every hour at each sensor location (Figures 67-69). Hobo sensors were placed in small, protective PolyVinyl Chloride pipes and secured to the bank with cable and rebar. Three temperature sensors were placed in each of the five waterbodies (totaling 15 sensors), which include one located 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). Water temperatures were measured, recorded, and compared graphically to the upper lethal temperature for Rainbow Trout (Hillman et al. 1999). Upper lethal temperature (ULT) is the temperature at which fish survival is 50% in a 10-minute exposure, given a prior acclimation to temperatures within the tolerance zone; for this study the ULT for hatchery-reared Rainbow Trout is a range of 21-27°C due to variations between stocks and systems (Hillman et al. 1999). The mean, minimum, and maximum water temperatures were summarized for the following week after each stocking event in order to determine the relationship between the stocking period, water temperatures, exploitation, and total use rates. These independent values were plotted and fit using a simple linear regression.

Flow data from two nearby USGS gauging sites was analyzed to compare 2015 and 2016 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. 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.

RESULTS

In 2015 and 2016, approximately 37,800 hatchery catchables were stocked throughout Crooked River, Grimes Creek, Mores Creek, MF Payette River, and Silver Creek. The Nampa Fish Hatchery raised and stocked 19,300 trout in 2015 and 18,500 in 2016 for the five study waters (Table 30). Mean length for tagged catchables in 2015 and 2016 was 263 mm (90% CI ± 7.3) and 266 mm (90% CI ± 6.9), respectively. Table 1 displays the number of catchables stocked by the hatchery in each of the five waters in 2015 and 2016 by stocking month. We tagged about 10% of these stocked catchables (1,930 in 2015 and 1,372 in 2016). In total, 88 tags from 2015 and 73 tags from 2016 were reported to the "IDFG Tag-You're It' program; though as noted previously, tag reports form the 2016 release groups are still preliminary since tag returns have not been at large for 365 days.

For tags stocked in 2015, the adjusted total harvest rate was 6.5% (± 1.9%) and the adjusted total catch was 9.3% (± 2.5%) for all five waters combined. Grimes Creek had the lowest overall harvest (3.4%) and total catch (4.8%), while Silver Creek had the highest harvest (12.5%) and total catch (16.8%) (Table 31). For tags stocked in 2016, the preliminary adjusted total harvest was 9.3% (± 2.3%) and the adjusted total catch was 13.6% (± 3.0%) for all five waters combined. Mores Creek had the lowest overall harvest (2.6%) and total catch (5.2%) while the MF Payette River had the highest harvest (18.8%) and total catch (20.3%) (Table 32). We did not evaluate catch and harvest by upper and lower strata due to low overall returns but instead, analyzed returns by each water as a whole. In 2015, the average days-at-large of angler reported tags stocked was 24 days with a range of 1-132 days. In 2016, the average was 22 days with a range of 0-161 days. However, these tags are still in their first year at large more tags could be reported.

Of the fifteen temperature sensors that were placed in May throughout each of the five waters, two (one from Grimes Creek Upper and one from Mores Creek Lower) were lost and, therefore, temperature data was not recovered. In 2016, mean monthly temperatures across all sites were 8.3°C for May, 13.1°C for June, 15.8°C for July, and 15.3°C for August. Overall, both catch and harvest increased with increasing water temperatures (Figures 70 and 71). Total catch by stocking date showed a polynomial relationship with decreased catch in May followed by increased catch in June and early July, and then an abrupt decrease in catch in late July and August (Figure 72).

Stream flows during our study period in 2015 and 2016 (at the MF Payette River and Mores Creek) were generally well below the ten-year average (Figures 73 and 74). The only exception were 2016 May flows in the MF Payette. For the entire study period, 2015 MF Payette flows were about 27% and 2016 flows 53% of the previous ten-year average. At Mores Creek, 2015 flows were 32% and 2016 flows were 56% of the previous ten-year average.

DISCUSSION

Estimates of catch and harvest for catchables stocked in 2016 are still considered preliminary (as these fish have not been at large for an entire 365 day period at the time of this report). However, numerous studies have shown that few catchables live more than a couple of months when stocked in streams and rivers. Dillon et al. (2000) found that 90%, of tags were reported within 57 days of stocking in flowing waters. Similarly, High and Meyer (2009) reported that 85% of stream-stocked catchables were dead within 30 days and mean days at large was 14.3 days (Meyer et al. 2012). Dillon et al. (2000) also found that over-winter survival rates of stocked trout are very low. We believe the estimates presented above represent the majority all the catch and harvest from catchables stocked during 2016. In fact, of the 89 tags reported by anglers from fish stocked in 2015 none were reported after the first winter post-stocking. The latest reporting of any tags stocked in the summer of 2015 was mid-October from the MF Payette River. Similarly, no tags from the 2016 stockings have been reported after October of 2016. Therefore, we do not expect any additional angler returns of tags stocked in 2016 to occur after the publication of this report.

For both the 2015 and the 2016 stocking groups, catch and harvest rates were highly variable across stocking locations and stocking periods. For fish stocked in 2015, there was a moderately strong negative relationship between catch and harvest with both water temperature and time of year. Highest catch occurred with the earliest stockings in May and became progressively lower as stocking continued through August. This corresponded with steady increases in water temperature throughout the summer in 2015. For fish stocked in 2016, this relationship was more complex and in general, catch and harvest were lower on each end of the stocking period and the highest for mid-summer stockings. Additionally, there was a slightly positive relationship between angler catch and harvest and water temperature. However, this positive relationship was driven by a pair of data points from the MF Payette River and a single data point from Grimes Creek where angler catch rates were the highest of the entire study, and water temperatures were in excess of 16°C. It is also worth noting that 2016 was a higher water year and study streams experienced higher flows throughout the stocking period than were observed in 2015. Therefore, water temperatures did not get as high in 2016 as in 2015 so the effects temperature might have had on stocked catchable behavior and survival were likely less.

Regardless of flow, angler returns of fish stocked in late summer (late July and August) were low in both years. It was not that fish were not caught in the late summer at study waters as fish were reported throughout August and September in both study years. However, these fish were typically from earlier stockings in June and July, and even as early as May. This indicates that while fishing pressure likely remains high through the late summer, fish stocked during this low flow, warmer time period do not survive at a high rate likely due to the additional stress associated with the stocking process. It may be that those fish stocked earlier in the summer have had time to establish themselves in the receiving streams and rivers and are better able to survive these periods. Therefore, continuing to stock these waters in the latter parts of the summer is likely a poor use of hatchery catchables. These stockings should be reallocated to other waters or earlier stocking periods to maximize the use of the hatchery product.

RECOMMENDATIONS

1. Reduce late summer stocking of hatchery Rainbow Trout in Grimes Creek and Mores Creek due to poor tag returns and overall total use rates.
2. Discontinue stocking of Crooked River due to overall poor returns regardless of stocking period and location.

Table 30. Number of catchable-sized hatchery Rainbow Trout stocked in the five study sites by month for 2015 and 2016, respectively.

2015

Water	May	June	July	August	Total
Crooked River	500	1000	1000	1000	3500
Grimes Creek	500	500	1990	-	2990
Mores 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

2016

Water	May	June	July	August	Total
Crooked River	1000	1000	1000	500	3500
Grimes Creek	1000	1000	1000	-	3000
Mores Creek	1000	1000	1000	-	3000
Middle Fork Payette	-	1500	1500	1500	4500
Silver Creek	-	1500	1500	1500	4500
Monthly totals	300	6000	6000	3500	18500

Table 31. Adjusted harvest and total catch rates for catchable-sized hatchery Rainbow Trout stocked in the five study sites for 2015.

2015

Water	# tagged	Tags harvested	Harvest because tagged	Tags released	Harvest (± 90% CI)	Total Catch (± 90% CI)
Crooked River	350	7	3	0	4.1% (± 5.8%)	5.8% (± 3.4%)
Grimes Creek	299	5	1	1	3.4% (± 2.8%)	4.8% (± 3.3%)
Mores Creek	299	5	2	4	3.4% (± 2.8%)	7.5% (± 4.2%)
Middle Fork Payette	510	19	1	4	7.6% (± 3.4%)	9.6% (± 3.9%)
Silver Creek	472	29	2	8	12.5% (± 4.7%)	16.8% (± 5.6%)
Totals	1930	65	9	17	6.5% (± 1.9%)	9.3% (± 2.5%)

Table 32. Adjusted harvest and total catch rates for catchable-sized hatchery Rainbow Trout stocked in the five study sites for 2016.

2016

Water	# tagged	Tags harvested	Harvest because tagged	Tags released	Harvest (± 90% CI)	Total Catch (± 90% CI)
Crooked River	250	5	0	0	5.2% (± 3.3%)	5.2% (± 3.3%)
Grimes Creek	188	7	2	6	9.6% (± 5.3%)	20.6% (± 7.9%)
Mores Creek	200	2	0	2	2.6% (± 2.6%)	5.2% (± 3.7%)
Middle Fork Payette	330	24	0	2	18.8% (± 5.9%)	20.3% (± 6.2%)
Silver Creek	404	12	3	8	7.7% (± 3.3%)	14.7% (± 4.8%)
Totals	1372	50	5	18	9.3% (± 2.3%)	13.6% (± 3.0%)

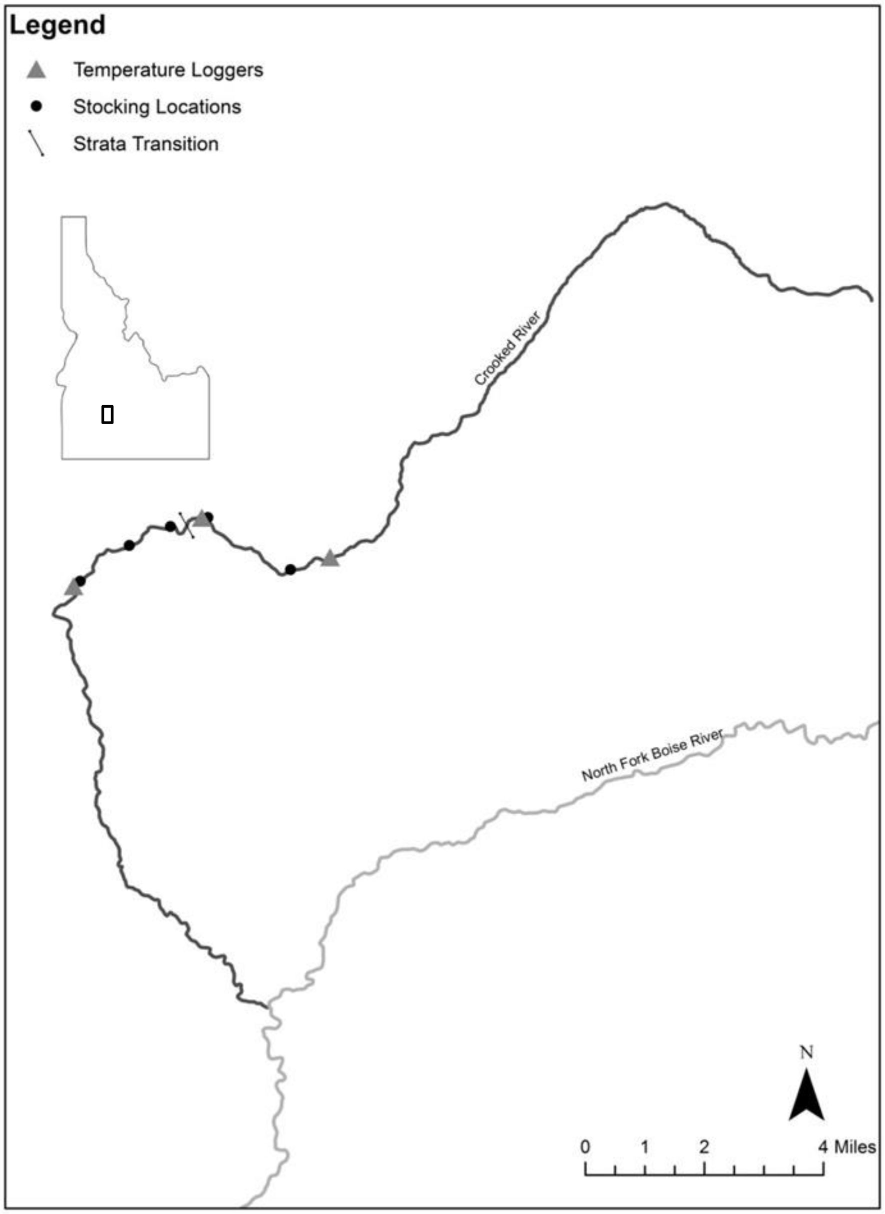

Figure 67. Locations of temperature sensors (gray triangles), strata (black bars), and stocking locations (black circles) in Crooked River, Idaho.

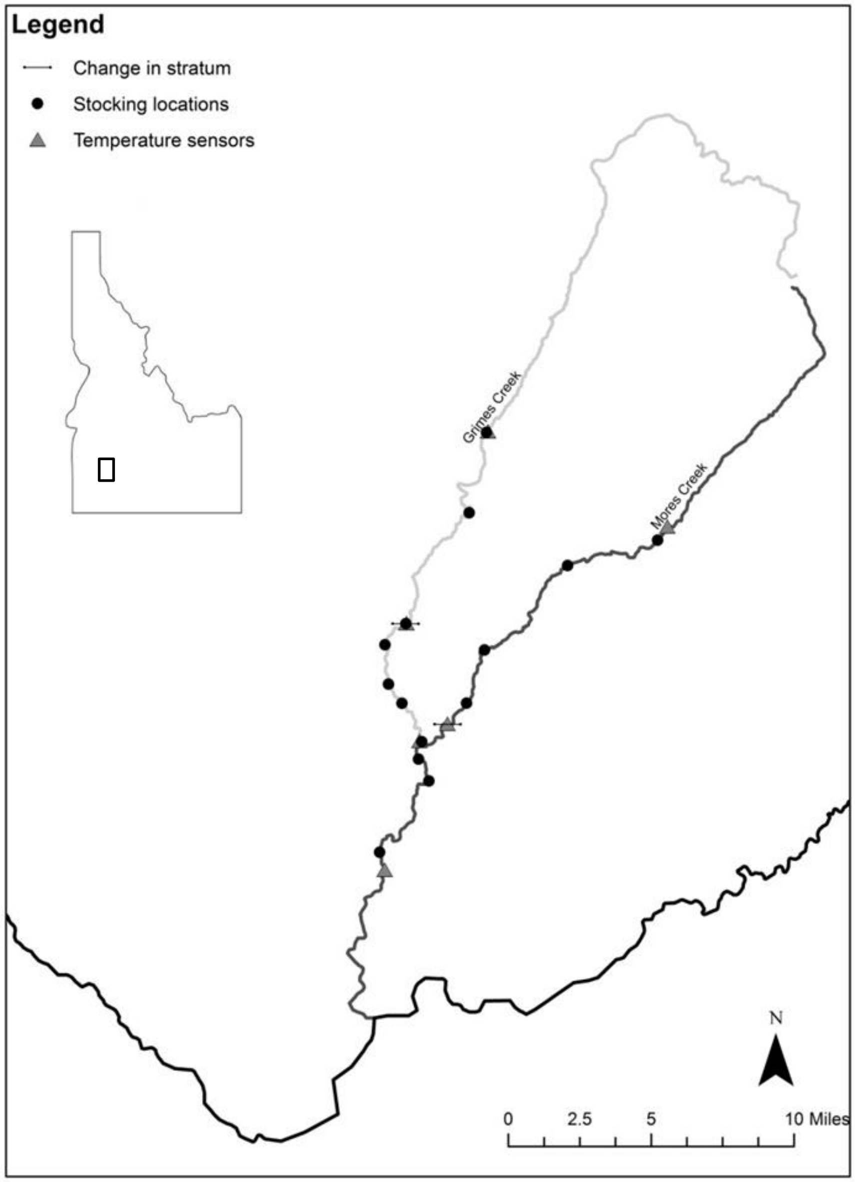

Figure 68. Locations of temperature sensors (gray triangles), strata (black bars), and stocking locations (black circles) in Grimes and Mores creeks, Idaho.

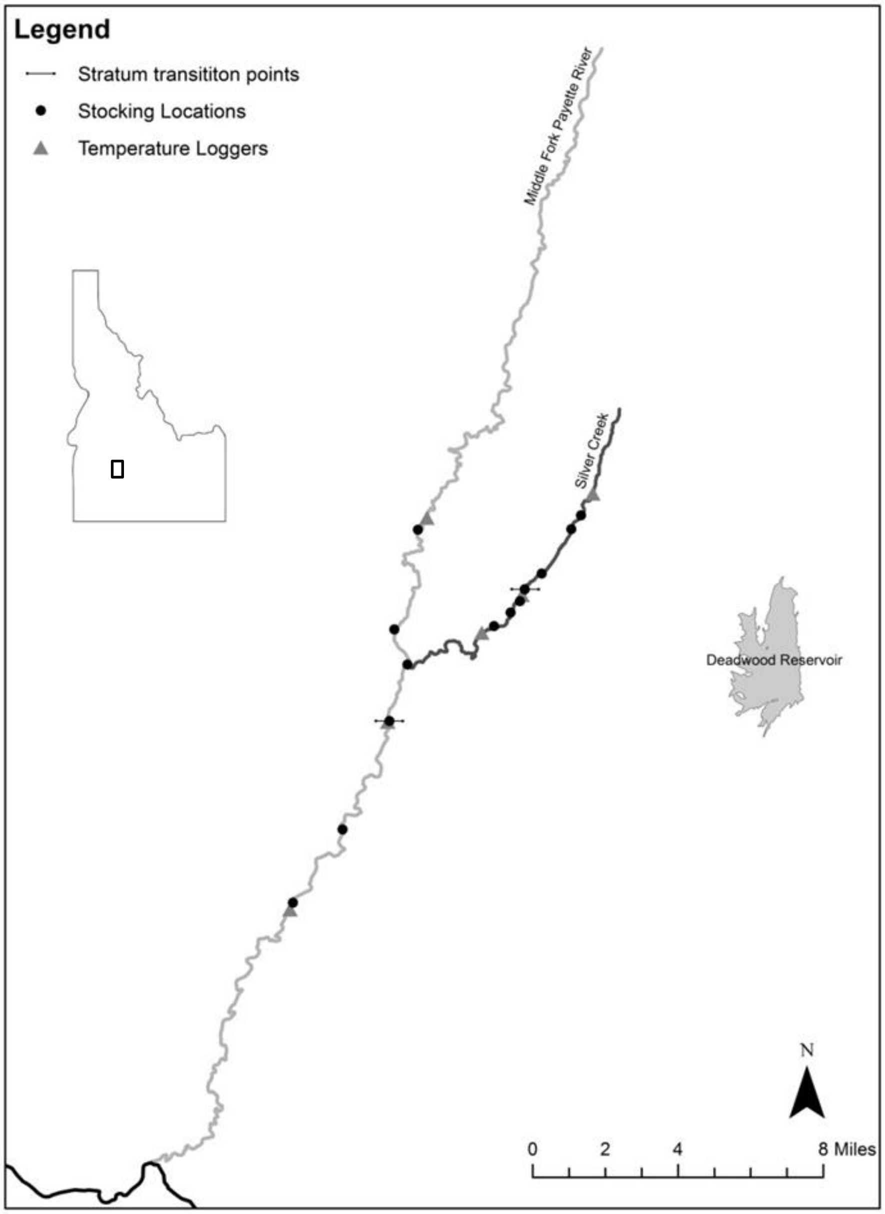

Figure 69. Locations of temperature sensors (gray triangles), strata (black bars), and stocking locations (black circles) in MF Payette River and Silver Creek, Idaho.

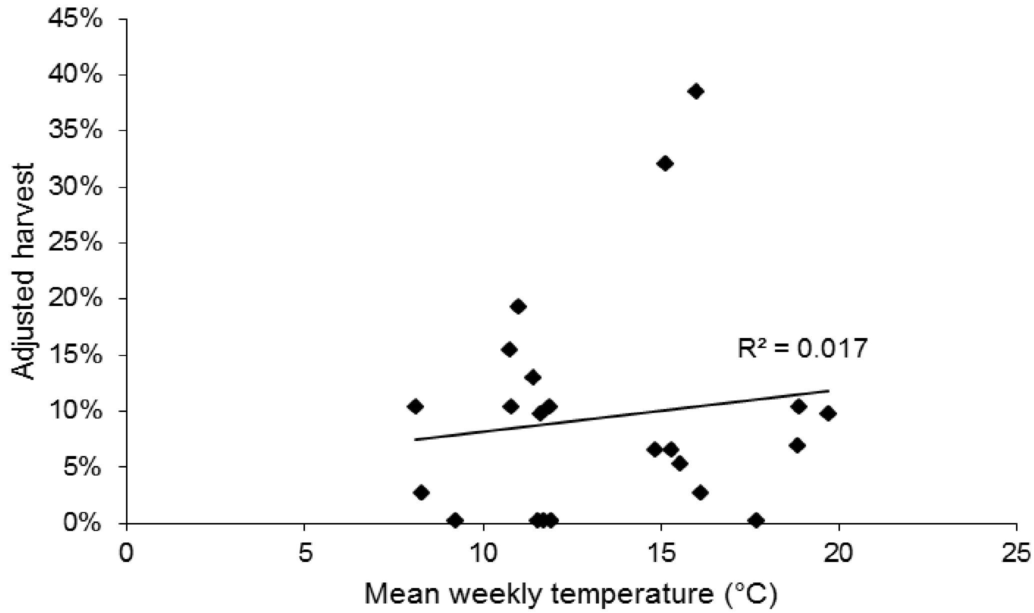

Figure 70. Comparison of the 2016 adjusted harvest rates and mean weekly temperature recorded the week after each stocking event.

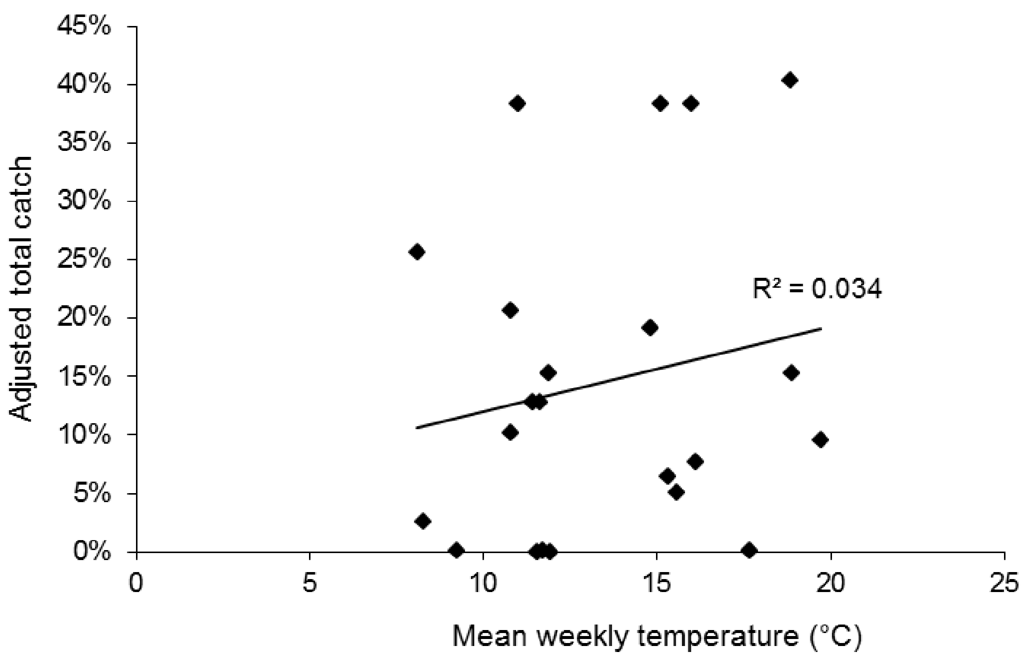

Figure 71. Comparison of the 2016 adjusted catch rates and mean weekly temperature recorded the week after each stocking event.

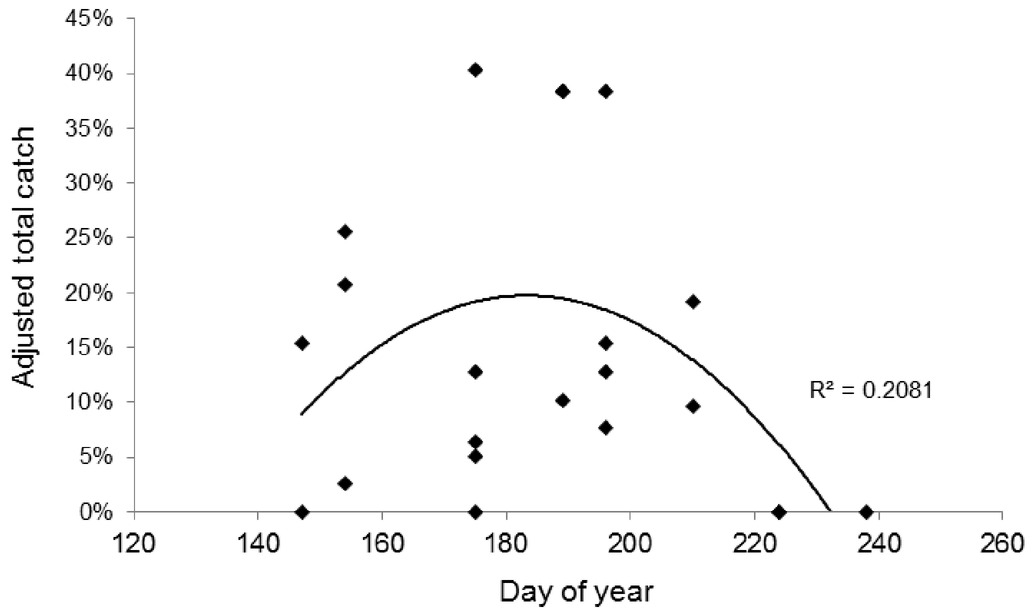

Figure 72. Comparison of the 2016 adjusted overall total use rates and day of year recorded the week after each stocking event.

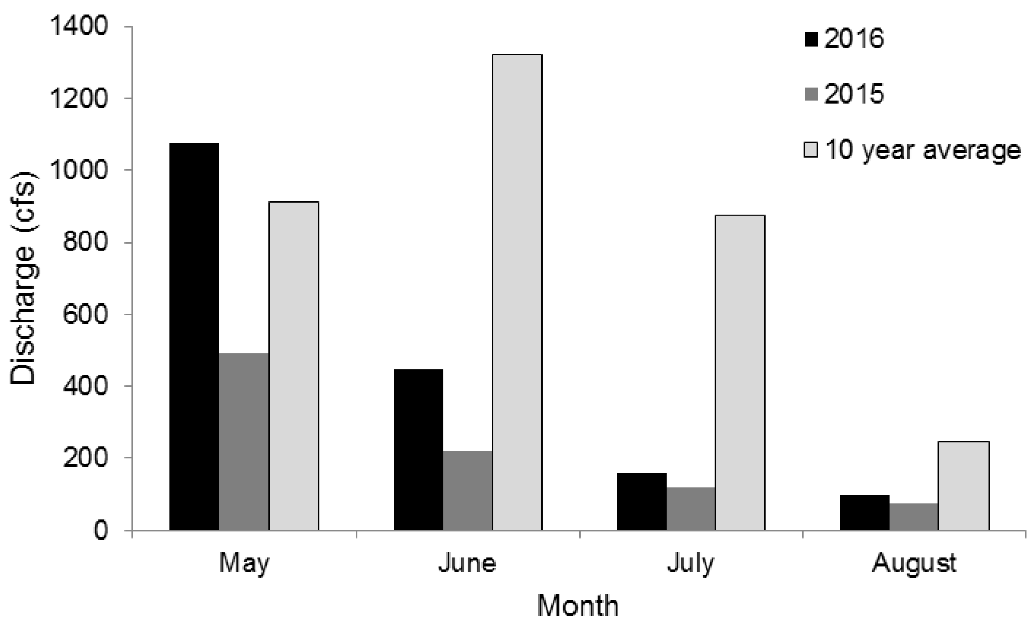

Figure 73. Comparison of mean monthly discharge rates for MF Payette River, measured at the Crouch USGS gage station.

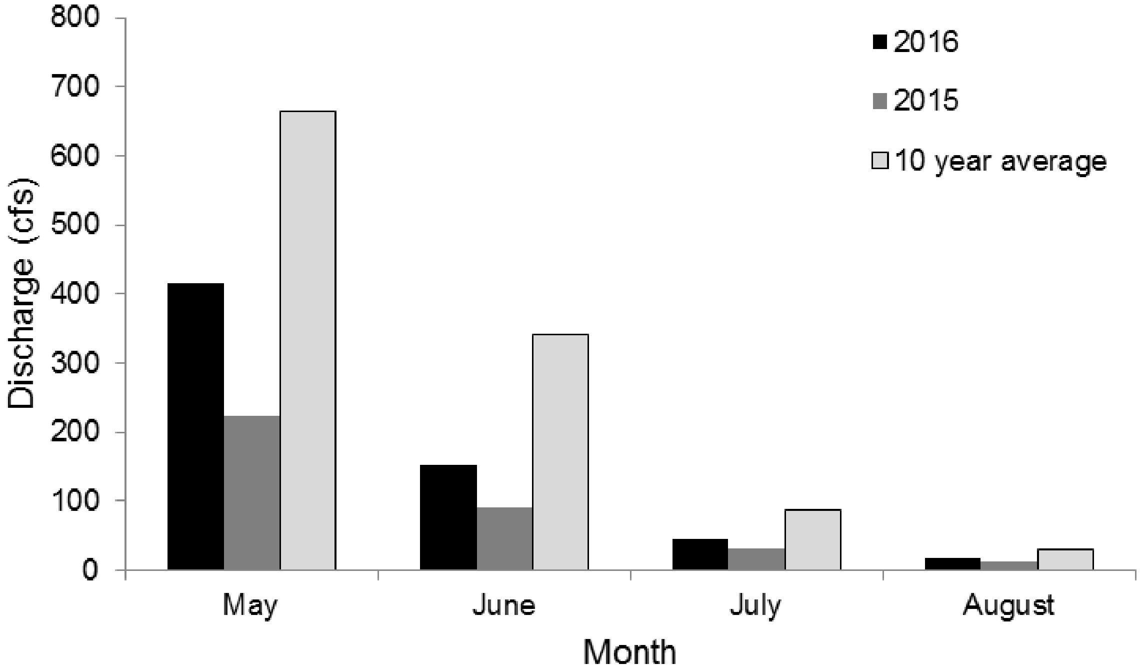

Figure 74. Comparison of mean monthly discharge rates for Mores Creek, measured at the Robie Creek USGS gage station.

LONG-TERM MONITORING OF REDBAND TROUT POPULATIONS IN THE OWYHEE RIVER DRAINAGE

ABSTRACT

During 2016, the Idaho Department of Fish and Game (IDFG) continued population and trend monitoring for interior Redband Trout (*Oncorhynchus mykiss gairdneri*) within the Idaho portion of their distribution. As part of that effort, I sampled two tributaries of Jordan Creek in 2016. Utilizing a systematic sampling design, I selected a total of 15 sites to be sampled among the two tributaries (Combination and Rose creeks). In total, 12 sites were sampled, of which nine sites were dry and three sites were wet. I observed Redband Trout in all of the wet sites and estimated the percent occupancy for Combination and Rose creeks at 33% and 17%, respectively. Density estimates for sites, which contained Redband Trout, ranged from 30 to 83 fish/100 m^2. Overall, capture efficiencies were high, ranging from 58 to 95%. This year's survey provided baseline information for Rose Creek and indicated that the Redband Trout population found in Combination Creek has remained stable since the 2008 survey.

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INTRODUCTION

Redband Trout *Oncorhynchus mykiss gairdneri* are native to all major river drainages in Southwestern Idaho. Within this large and diverse geographical area, Redband Trout have adapted to a variety of stream habitats, including those of montane and desert areas. Some controversy has existed regarding whether adaptation to these disparate habitats has led to speciation at some level. In 1997, Redband Trout that reside in desert locales were petitioned for listing under the Endangered Species Act (ESA; USFWS 2000), under the assumption that they could be considered a separate subspecies. The petition was denied. Since that time, additional research has indicated that only one species of resident stream dwelling Redband Trout may exist in Southwest Idaho (Cassinelli 2008). Regardless of species designations, it is important to monitor Redband Trout population status across their full distribution. Population status of the Redband Trout from montane habitats has been extensively studied in Southwestern Idaho. However, due to remoteness and little angling interest (Schill et al. 2007), Redband Trout from desert habitats have received less attention. These habitats include tributaries of the Bruneau, Owyhee, and Snake River drainages most often in headwater areas. As these populations are near the southern extent of their range and water temperatures are projected to increase, it has become more important to monitor these populations closely (Narum et al. 2010).

Since the 1997 petition for listing was denied, a considerable amount of effort has been placed on determining the current species distribution and developing conservation strategies to ensure persistence. Zoellick et al. (2005) completed a long-term assessment of Redband Trout distribution, density, and size structure. This assessment compared Redband Trout population characteristics at 43 sites within the Bruneau, Owyhee, and Snake river drainages from 1993-2003 to data collected at the same sites during 1977-1982. In 2012, a rangewide assessment was conducted, which relied heavily on available data and the expert opinion of biologists to identify the current distribution (Muhlfeld et al. 2015). The assessment identified a framework to develop rangewide conservation measures and to provide structure for long-term species persistence which was developed in 2016 (IRCT 2016). Specifically within the Conservation Strategy, the Idaho Department of Fish and Game (IDFG) has agreed to continue population and trend monitoring within Redband Trout distribution. In 2016, I conducted Redband Trout surveys in two tributaries within the Jordan Creek drainage (a tributary of the Owyhee River) located in the high desert environs of Southwest Idaho.

METHODS

During 2016, I determined sample sites following a systematic sampling design, which allowed for approximately five percent of total stream length to be sampled. Using ArcGIS (version 10.3.1), I built a survey map using GIS data and measured total stream length. I multiplied stream length by five percent, and then divided the resulting length into 100 m survey reaches, to determine the number of sample sites for the stream (e.g. Rose Creek sample sites = 16,772 m long x 0.05 = 839 m /100 meter sample sites = 8.4 or 8 sample sites). To determine the location of sample sites, I divided the first km of stream into ten equidistant waypoints and randomly selected the start location. Additional sites were equally spaced from the start point until the necessary sites were identified. During 2016, Combination and Rose creeks were surveyed within the Jordan Creek drainage (HUC 4). A total of 15 sites within the two tributaries were selected for the survey. GPS site coordinates were added to the survey map and used to identify land ownership. During 2016, 27% of the selected sites were located on private property. Access was denied for two sites located on private property and these sites were removed from further analyses.

Fish population characteristics were estimated at all sites using multiple-pass depletion methods. Block nets were installed at the upstream and downstream end of each transect. Fish were collected with a Smith Root backpack electrofisher (Model LR-24) and a two- or three-person crew. Captured Redband Trout were held in small buckets and transferred to a livewell placed downstream of the site, where they were identified to species and measured for total length (± 1 mm). Non-game species, if captured, were identified to species, and visually categorized as sparse (1-10), many (10-50), or abundant (>50). The number of passes completed depended on catch during the first pass. If redband trout catch in the first pass was less than five, sampling was terminated. If more than five redband trout were sampled, a second pass was completed. If catch remained relatively high in subsequent passes (>25% of the previous pass) additional passes were completed. In addition, herpetofauna were identified visually to species and recorded as eggs, larval form, juvenile, or adult.

We sampled 12 sites during 2016 within the two tributaries of Jordan Creek (Figure 75). Population estimates were calculated using MicroFish 3.0 (Van Deventer 2006). Due to the potential for size-related catchability differences, population estimates were calculated for two strata: (1) trout less than 100 mm, and (2) trout greater than or equal to 100 mm, then summed. To determine the percent occupancy for each stream, I divided the number of sites where Redband Trout were observed by the number of sites sampled. Confidence intervals for mean density and the percent occupancy were calculated using an $\propto = 0.1$.

RESULTS

In 2016, Redband Trout total catch ranged from 0 to 84 trout per site. The mean density of Redband Trout for all surveyed sites was 13 ± 14 trout/100 m^2 (mean ± 90% CI). The mean density at occupied sites was 52 (± 46) trout/100 m^2. Densities, for all fish sizes at occupied sites, ranged from 30.0 (± 1) to 82.9 (± 3) trout/100 m^2 (Table 33). A total of 189 Redband Trout were sampled in 2016, of which 137 (72%) were less than 100 mm and 52 (28%) were greater than 100 mm. Capture probabilities were relatively high and ranged from 0.58 to 0.95. The mean capture probability was 0.79 ± 0.31 and 0.87 ± 0.12 for fish <100 mm and ≥100 mm, respectively. Length frequency data are presented in Figure 76.

A total of nine sites were found to be dry in 2016 (Table 34). We observed Redband Trout in all three wet sites. The percent occupancy was calculated at 17% (1 – 58%; 90% CI) for Rose Creek and 33% (7 – 72%) for Combination Creek (Table 34). Sampling was completed on approximately four percent of each stream.

DISCUSSION

A new systematic sampling methodology was used to sample Redband Trout within two tributaries of the Jordan Creek drainage in 2016. The systematic sampling will allow for the development of specific tributary or basin wide abundance estimates. Muhlfeld et al. (2015) recommended this type of rigorous sampling design. The estimates of density and stream occupancy produced in Rose Creek provided data for an additional stream that was missing from the 2012 range wide assessment. It also provided a baseline for future population surveys within the tributary. The density observed in Combination Creek validated information presented in the 2012 assessment with population densities ranging from 0 to 35 fish/km. The population within Combination Creek appeared to have similar density estimates as those presented in 2008

(Kozfkay et al. 2010), which indicate a stable population. I also observed similar size structures when I compared these data to the 2008 sample.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor Redband Trout distribution and abundance within the Jordan Creek drainage, using the systematic sampling design developed for 2016 surveys.

Table 33. Site specific population (N), capture probability, and density estimates for Redband Trout of all sizes, less than 100 millimeters (mm) and greater than or equal to 100 mm in total length. Lower (LCL) and upper (UCL) confidence limits were calculated with an ∝ = 0.1 for the population and density estimates.

Site #	Stream Name	Run 1	Run 2	Total	*N*	LCL	UCL	Confidence Range (%)	Capture Probability	Density #/100m2	LCL	UCL
					ALL							
CC 55	Combination Creek	40	17	57	67	51	83	23.9	0.61	44.5	33.9	55.1
CC 57	Combination Creek	74	10	84	85	82	88	3.5	0.88	82.9	80.0	85.9
RO 82	Rose Creek	43	5	48	48	46	50	4.2	0.91	30.0	28.8	31.3
					< 100 mm							
CC 55	Combination Creek	30	14	44	53	36	70	32.1	0.58	35.2	23.9	46.5
CC 57	Combination Creek	55	9	64	65	62	68	4.6	0.85	63.4	60.5	66.3
RO 82	Rose Creek	27	2	29	29	28	30	3.4	0.94	18.1	17.5	18.8
					≥ 100 mm							
CC 55	Combination Creek	10	3	13	13	11	15	15.4	0.81	8.6	7.3	10.0
CC 57	Combination Creek	19	1	20	20	20	20	0	0.95	19.5	19.5	19.5
RO 82	Rose Creek	16	3	19	19	17	21	10.5	0.86	11.9	10.6	13.1

Table 34. Stream specific statistics for sites surveyed during 2016 which include number of sites selected and sampled, the percent of the stream sampled, the number of sites that were dry and wet, the number of sites Redband Trout were observed, and the percent occupancy for the stream.

Stream Name	Sites Selected	Sites Sampled	% of stream sampled	Dry Sites	Wet Sites	# of sites Redband Trout were observed	% Occupancy	LCL	UCL
Combination Creek	7	6	3.9%	4	2	2	33.3%	0.0%	73.0%
Rose Creek	8	6	3.6%	5	1	1	16.7%	1.0%	58.0%

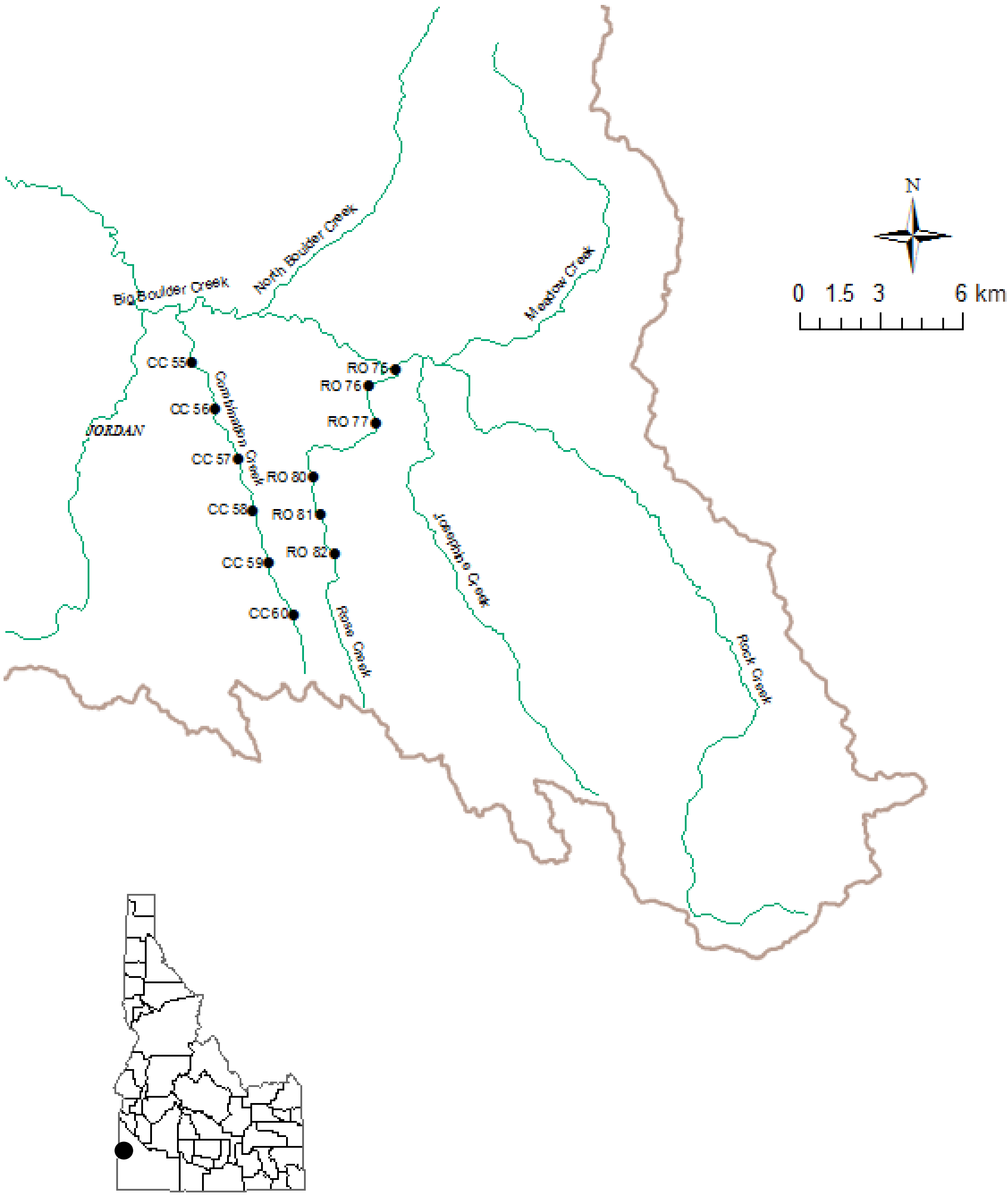

Figure 75. Location of sample sites within the Jordan Creek drainage that were surveyed to assess Redband Trout populations in 2016.

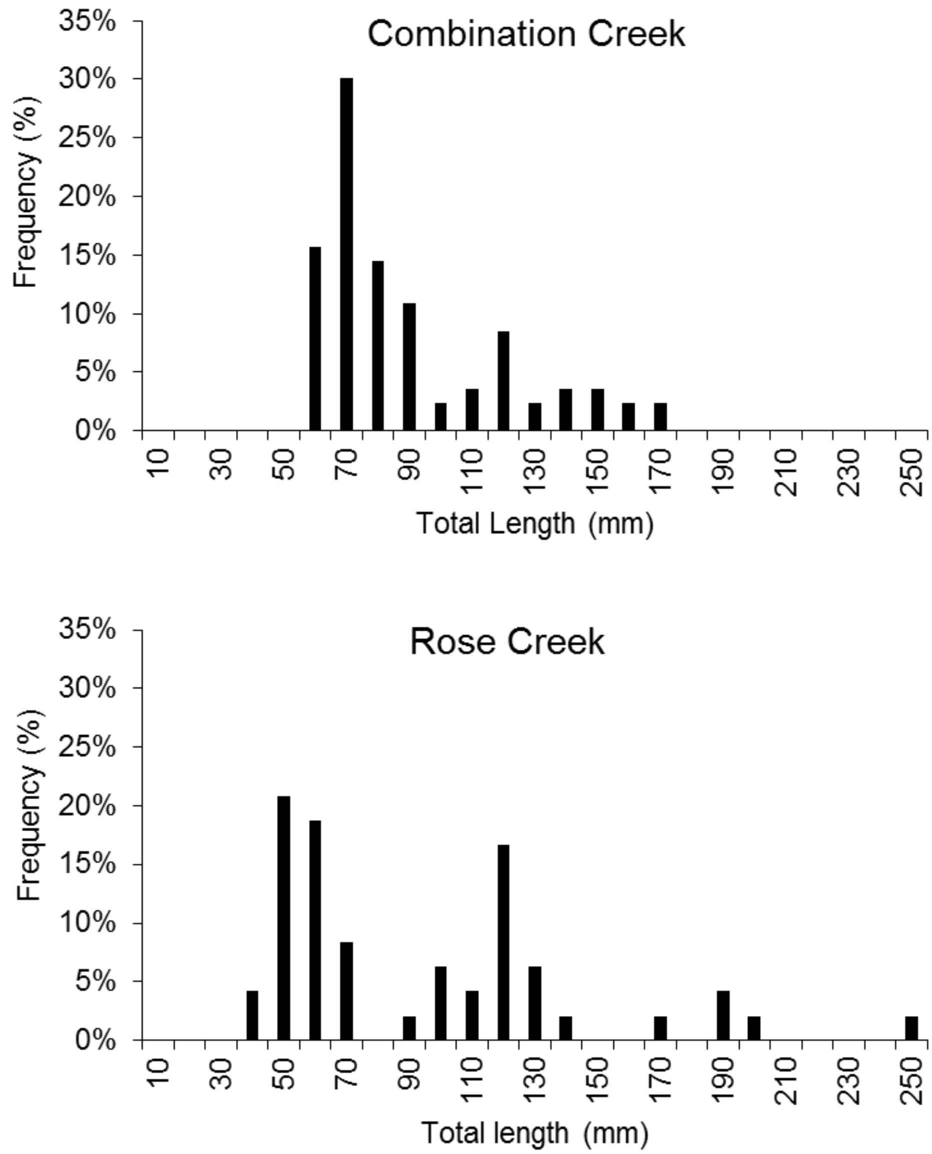

Figure 76. Length-frequency histogram for Redband Trout sampled in Combination (n = 83) and Rose (n = 48) creeks during 2016 electrofishing surveys.

2016 SOUTH FORK PAYETTE RIVER SURVEYS

ABSTRACT

The South Fork of the Payette River is a steep, relatively unproductive drainage that originates in the Sawtooth Mountains of southwestern Idaho. Fishing effort is thought to be low, but has not been directly measured recently. Furthermore, anglers have expressed discontent regarding catch rates of trout. Staff initiated studies to assess the status of wild game fishes to determine if management direction changes are needed. Entire-width snorkeling survey methods were utilized to estimate fish population characteristics during August and September 2016. A frame of previously-monitored sites was utilized thereby allowing us to compare trends in densities and sizes of game fishes for the last two-plus decades. Redband Trout *Oncorhynchus mykiss* was present at 72% of sites. Mean total density was 0.20 fish/100 m^2 and ranged from 0 to 1.04 fish/100 m^2. Densities were about one-third to one-fourth of estimates for 1996-1997. Redband Trout tended to be small and length rarely exceeded 12”. Mountain Whitefish *Prosopium williamsoni* was present at 84% of sites. Mean total density was 0.84 fish/100 m^2 and ranged from 0 to 4.79 fish/100 m^2. Current Mountain Whitefish total densities estimates were more than 70% higher than 1996-1997. Mountain Whitefish were sampled from a wide variety of length groups including some individuals that exceeded 16”. Present densities and sizes of wild game fishes are insufficient to generate angling interest. We recommend reallocation and stocking of sterile triploid hatchery Rainbow Trout catchables to increase angling interest and satisfaction.

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INTRODUCTION

The main stem of the South Fork Payette River (SFPR) originates on the west side of the Sawtooth Mountain Range and flows in a westerly direction for approximately 80 miles (130 km) before joining the North Fork Payette River (NFPR) at Banks, Idaho. Here, these tributaries form the Payette River. The SFPR watershed is steep, laterally confined, incised, and prone to fire. Elevations at headwater ridgelines and peaks exceed 3,000 m (10,000'), whereas elevation at the mouth is approximately 900 m. A narrow valley and rock-dominated landscape among other factors create a river that with little exception lacks sinuosity and is often incised including within canyon sections (Pierce et al. 2011). Recent climatic conditions and other factors have caused a series of large stand-replacing fires that have burned a high percentage of the drainage especially since the mid-1980s. This includes the 2016 Pioneer Fire that burned approximately 200,000 acres, much of which is in the middle portion of the drainage.

The SFPR is known to be a relatively unproductive drainage pertaining to fish production. The topography is steep especially on the south side of the drainage, where most tributaries are first order and flow for only a few kilometers before entering the main stem. Many of these tributaries lack year-round connection to the main stem due to sediment and debris fans as well as velocity, vertical, or flow barriers. Alder and Tenmile creeks would be higher order exceptions (2^{nd} & 3^{rd} order). The north side of the main stem is more expansive and includes several larger tributaries (2^{nd} & 3^{rd} order) including Canyon, Warm Springs, and Clear creeks, as well as the Deadwood and Middle Fork Payette rivers. The underlying geology of the SFPR is dominated by the Idaho Batholith. This landform is composed primarily of granite rock at higher elevations and decomposing granitic sands at lower elevations. Combining geology and topography, soils are shallow and unproductive leading to high erosion rates and a high frequency of mass failures that have been exacerbated by recent fire history. Furthermore, floods caused by rain-on-snow events occur occasionally including an especially large event during 1996-1997, described as depositing several thousand years' worth of sediment in one day (Meyer et al. 2001).

During the last 100 years, the SFPR has been altered by a variety of habitat modifications. Historically, the SFPR received marine-derived nutrients from the returns and carcasses of anadromous fishes. These runs were extirpated after Black Canyon Dam was completed in 1921, and has likely led or contributed to a general decline in productivity. Deadwood Dam was completed in 1931. This dam isolated a portion of the drainage for migratory forms of resident fishes and altered temperature and flow regimes. Water releases from Deadwood Dam are hypolimnetic, variable, and colder than optimal for growth of native fishes, including sport fishes, during summer. Prior to the early 1970s, the SFPR upstream of Lowman was remote and inaccessible, but the expansion of Hwy 21 increased access to this portion of the drainage.

The SFPR is native range and occupied habitat for three native game fishes including Redband Trout *Oncorhynchus mykiss*, Bull Trout *Salvelinus confluentus*, and Mountain Whitefish *Prosopium williamsoni*, among other native non-game fishes. Redband Trout are widespread throughout the SFPR and certain tributaries. Bull Trout are present, but in low abundance. A recent sampling effort indicated that approximately 21,303 ± 9,734 (mean ± 90% CI) Bull Trout reside in the drainage within nine local populations (High et al. 2005). Past stocking practices have created some challenges for native fishes including genetic introgression in some tributaries and the establishment of competitors, especially Brook Trout *Salvelinus fontinalis*. Mountain Whitefish are widespread, but exist in low abundance compared to other Idaho basins (mean basin-wide density = 1.4 fish /100 m^2; Meyer et al. 2009).

Fisheries management direction in the main stem SFPR shifted in the mid to late 1990s. Prior to the 1980s, few sampling efforts and written summaries were completed that describe resident fish populations and fisheries. However, analysis of IDFG stocking records indicates that the main stem SFPR was stocked often and at high rates beginning in 1950. Since then, nearly 1.6 million catchables have been stocked. Stocking declined over time and eventually ceased after 1999 with only two later exceptions caused by transport truck mechanical failures. Of the nearly 1.6 million total, 21%, 39%, 18%, 15%, and 7% occurred in the 1950s, 1960s, 1970s, 1980s, and 1990s. The maximum annual stocking total (85,770 catchables) occurred during 1964. This is an exceptionally high stocking rate considering the partial-year stocking season and no road access upstream of Lowman at that time.

Results from several fisheries studies, increasing hatchery feed costs, inconsistent performance of hatchery trout, and increasing public requests for more wild trout management caused management direction of the SFPR to shift. Prior to the late 1990s, the SFPR was managed as a combination hatchery-supported and wild trout fishery. Studies indicated that small wild Redband Trout (<300 mm) were commonly sampled in the creel, along with hatchery Rainbow Trout and Mountain Whitefish (Reid and Anderson 1980; Elle 1993). Wild trout in the SFPR are known to grow very slowly. When compared to a variety of other Idaho Rainbow and Redband trout populations, Redband trout from the upper SFPR would rank as having the slowest growth rates in Idaho (203 mm at age 4), whereas trout from the lower SFPR would rank as having the 4th slowest growth rates (233 mm at age 4; Schill 1991; Elle 1993). A two-trout bag limit was instituted during 1992 based on these growth rates and high harvest rates of wild fish in the 6-trout bag limit reaches. Around 1995, increasing fish food costs led to 33% reduction in statewide catchable stocking. At around the same time, a series of hatchery performance studies indicated that returns of hatchery trout were inconsistent for certain reaches in the SFPR, though other studies indicated adequate returns in other reaches. The combination of these factors along with changing agency and public perceptions about wild trout management led to cessation of stocking in the main stem SFPR, though stocking still occurred in two tributaries, Silver Creek and MFPR.

Since this management direction shift, little fisheries, fish population, or public satisfaction data has been collected for or about the SFPR. A recent economic survey indicated that a relatively small amount of fishing effort and related fishing-related expenditures are directed towards the SFPR (not ranked in top five of Boise County's waters during 2011; IDFG 2011, unpublished data). During 2011, anglers made 1,000 trips to the SFPR, whereas a nearby river, the Middle Fork Payette River, supported 2.3 times more trips. Furthermore, angler discontent has been expressed on multiple occasions including two formal petitions during 1992 and 2015 requesting altered management strategies. Because of the low fishing effort, discontent, and need for contemporary populations data, staff initiated studies to assess the status of wild game fish populations to determine if management direction changes are needed. A first step in this process is to gauge or index the abundance and size structure of wild game fishes.

OBJECTIVES

1. Describe the distribution, relative abundance, and species composition of salmonids in the main stem South Fork Payette River.
2. Compare contemporary data to historical data to determine and describe trends in the distribution, relative abundance, and species composition of salmonids in the main stem South Fork Payette River.
3. Estimate growth and angler exploitation of Redband Trout.

METHODS

Entire-width snorkeling survey methods were utilized to estimate fish population characteristics in the SFPR during August and September 2016. We considered the study area to be from the mouth (River Mile [RM] 72.4) near Banks, Idaho to the confluence of Lake Creek and the main stem SFPR (RM 148.2), a total distance of 72.8 RM. A frame of historical sites (n = 34) sampled during 1996, 1997, 2003, and 2004 (Allen et al. 1999; Allen et al. 2000; Meyer et al. 2014) were utilized to select sampling locations and as a reference for trend comparisons, though not all sites were utilized in all years. Historical accounts included site descriptions, drawings, and coordinates allowing for reasonably precise relocation of sites. For simplicity, we used site coordinates and plotted those on maps to determine RM (Figure 77). Notably, we did not sample historical sites located on the Main Payette River downstream of Banks and previous attempts noted poor visibility (i.e. sampling efficiency) and lack of utility.

After determining a site's location, a crew of four completed an entire-width snorkel survey. Methods for conducting fish abundance surveys by snorkeling were recently detailed by Apperson et al. (2015), which include specific protocols used to evaluate densities, and are the primary methods reference for this evaluation. In short, staff entered just upstream of the upstream boundary and snorkeled in a downstream direction. Snorkelers counted sport fishes within their respective lanes and estimated lengths to the nearest inch. Species, counts, and visually-estimated length were reported to and documented by another staff member positioned on the bank. Non-game species were identified and noted, but not counted. At the completion of the snorkel survey, staff measured site and habitat characteristics such as length, width, depth profile, and substrate composition.

Spatial and temporal trends in relative abundance were compared by calculating species specific areal density estimates for each site and comparing amongst years. Density was calculated as the count of each sport fish species divided by area (site length multiplied by average width). Density was then corrected to fish per 100 m^2 to account for differences in area. Mean density for a particular year was calculated by dividing individual site catch by area first, then averaging densities, rather than by totaling catch and area and dividing. To facilitate analysis, we pooled fish lengths into four-inch bins (0 ≥ 4", 4 ≥ 8", 8 ≥ 12", etc.). To assess spatial differences within sampling year, we plotted density against river miles and used linear regression to determine if trends existed. Also, we compared mean values and confidence intervals between approximately equidistant strata (Lower RM 72.8 - RM 98.1; Middle, RM 98.1 - 123.4; Upper RM 123.4-148.2) For 1996-1997 and 2003-2004 data, we made similar comparisons and then assessed trends amongst these two time periods.

RESULTS

During 2016, Redband Trout was widely distributed, but densities were low and individuals tended to be small. Redband Trout was present at 72% (18 of the 25) of sites. Total count was 160. Mean count per site was 6.4 and ranged from 0 to 34 fish/site. Mean total density was 0.20 fish/100 m^2 and ranged from 0 to 1.04 fish/100 m^2. Graphical plots of density versus river mile indicated that density decreased moving upstream (i.e. a negative slope, -0.004), but the relationship was not significant (p = 0.16; Figure 78). Redband Trout tended to be small and estimated length rarely exceeded 12" (Figure 79). Densities for the < 4", 4 ≥ 8", 8 ≥ 12", and ≥ 12" length categories were 0.001, 0.09, 0.08, and 0.03 fish/100 m^2, respectively. The maximum estimated length was 16”; however, only six individuals (4% of total count) were estimated to be 14” or greater.

Redband Trout densities have declined over the last two decades. Comparison of mean total densities from the previous four survey years shows a substantial decline. Mean total density for 1996, 1997, 2003, 2004, and 2016 was 0.80, 0.63, 0.31, 0.13, and 0.20 fish/100 m^2, respectively. Accordingly, current Redband Trout densities are approximately one-third or one-fourth that of 1996 or 1997. Furthermore, the pattern of densities has shifted over time. Pooled 1996 and 1997 data indicated that total density tended to be positively correlated to river mile (Figure 80). The three highest total densities all occurred upstream of RM 120 and at least one trout was observed at nearly all surveys upstream of RM 90. By 2003-2004, these tendencies persisted, but the slope of the relationship had declined and become nearly flat (Figure 81). Furthermore, maximum total density was less than 1 fish/100 m^2 or one-fourth the maximum total density observed during 1996-1997. For 2016, the slope of this relationship had become negative and very few or no trout were observed at many sites, especially upstream of RM 115 (Figure 78).

During 2016, Mountain Whitefish, similar to Redband Trout, was widely distributed, but densities were low to moderate. Contrastingly, quality-sized Mountain Whitefish were present. Mountain Whitefish was present at 84% of sites (21 of the 25). Total count was 1,375. Mean count was 55 fish/site and ranged from 0 to 688 fish/site. Mean total density was 0.84 fish/100 m^2 and ranged from 0 to 4.79 fish/100 m^2. Graphical plots of total density versus river mile indicated that density decreased moving upstream (i.e. a negative slope, -0.036; Figure 82), and the relationship was significant ($p < 0.01$). Mountain Whitefish were sampled from a wide variety of length groups including some long individuals (Figure 83). Densities for the < 4”, 4 ≥ 8”, 8 ≥ 12”, 12 ≥ 16”, and ≥ 16” length categories were 0.006, 0.13, 0.34, 0.29, and 0.02 fish/100 m^2, respectively. It is important to note that these partial estimates do not equal the mean total density; because at two sites, lengths were not estimated for all fish. The maximum estimated length was 20”; however, 359 individuals (26% of total count) were estimated to be 14” or greater.

In contrast, Mountain Whitefish densities, size structure, and patterns of relative abundance have remained mostly stable since 1996. Mean total density for 1996, 1997, 2003, 2004, and 2016 was 0.49, 0.48, 0.32, 0.22, and 0.84 fish/100 m^2, respectively. Accordingly, current Mountain Whitefish total densities estimates were more than 70% higher than 1996 or 1997. Patterns in densities have remained relatively stable also. Pooled 1996 and 1997 data indicated that total density tended to be weakly, though negatively, correlated to river mile (Figure 84). Five of the six highest total densities all occurred downstream of RM 100. During 2003-2004, the relationship remained weak, but slope had become positive, though not significant (Figure 85). The occasionally high densities documented during 1996 and 1997 downstream of RM 100 were not evident and maximum total density did not exceed 0.5 fish/100 m^2 at any site. For 2016, the slope of this relationship had become stronger, more negative, and significant (Figure 82). This change was influenced by a couple of relatively high densities observed downstream of RM 90, including the highest density for this data set (3.6 fish/100 m^2 at RM 89.4). Densities at sites upstream of RM 100 changed very little compared to earlier sampling years and were mostly less than 0.7 fish/100 m^2.

Other sport fish were rarely observed during this effort. We sampled one Bull Trout at RM 140.7, though sample timing was likely not conducive to sampling fluvial Bull Trout which would likely be spawning in headwater tributaries at the time of surveys. Also, Smallmouth Bass *Micropterus dolomieu* was observed near the mouth at two sites (RM 74.8 & 77.7), which we believe to be the first observations of Smallmouth Bass in the South Fork Payette. Also, as expected, several other native fishes were observed including Bridgelip Sucker *Catostomus columbianus*, Northern Pikeminnow *Ptychocheilus oregonensis*, Sculpin *Cottus sp.*, and Largescale Sucker *Catostomus macrocheilus*.

DISCUSSION

Snorkeling is most likely the best or only option to estimate salmonid densities in flowing waters with low conductivity like the South Fork Payette. Despite this notion, snorkeling estimates may be biased by timing, visibility, flow, observer variability, or other factors. We attempted to reduce these potential biases by requiring snorkeling training for all surveyors, by practicing, by conducting surveys using sites descriptions, and aligning survey timing as much as possible to previous efforts. Though we attempted to reduce bias, we made no assessment of accuracy or precision. In addition, we slightly altered the sampling techniques from previous surveys. Past sampling efforts mostly utilized corridor methods with two snorkelers, one positioned near each bank, looking towards the river's center. During 2016, we switched to entire-width methods to increase sampling efficiency of a relatively wide river. If anything, this methodology change would have positively biased counts compared to historic surveys.

We observed very low densities of wild Redband Trout and very few medium- to large-sized individuals in the South Fork Payette River compared to previous surveys and to other systems. Prior surveys had indicated that Redband Trout densities tended to be on the low end of the spectrum. Over the last 20 years, densities have declined even further. Determining the reason(s) for this decline was well beyond the scope of 2016 efforts. A variety of causes have been implicated in trout population declines elsewhere, including altered hydrology, sediment delivery and deposition, productivity, disease, predation, excessive harvest, barriers, chemicals or toxins, competition, water temperature, and others. Some of these factors seem likely or unlikely for the SFPR. For instance, sediment delivery (Meyer et al. 2001) and flow timing and magnitude (Clark 2010) have changed substantially during our frame of reference. It is possible that these factors contributed to observed declines. In contrast, we do not believe that chemicals or toxins are likely culprits as many long, and therefore old (Meyer et al. 2009) Mountain Whitefish were observed. Further narrowing this list of potential causes through focused effort will be necessary to describe primary limiting factors, which may or may not be manageable. We assume that growth rates in the SFPR are still very poor, but we were unable to dedicate enough time to collect sufficient numbers of hard structures for aging. Regardless, assumed low growth rates, small sizes, and low densities of wild trout in the South Fork Payette for at least the last two decades have not provided an adequate fishery.

We observed low to moderate densities of Mountain Whitefish though a wide range of lengths and some large-sized fish were sampled. There appeared to be no negative change in Mountain Whitefish densities or sizes during our frame of reference. Mountain Whitefish are a fall spawning, broadcast spawning species, very much in contrast to Redband Trout. Their apparent stability may be influenced by relatively stable fall conditions compared to spring conditions which have changed. Furthermore, Mountain Whitefish have slightly higher thermal tolerances than Redband Trout (Brinkman et al. 2013). Though, the SFPR is considered to be a relatively cold system declining summer minimum flows (Clark 2010) are likely causing warmer peak summer temperatures. This notion is supported by observations of Smallmouth Bass in the lower river for the first time.

The current management strategy and existing fish populations are not providing adequate fisheries. Densities and sizes of wild Redband Trout are insufficient to attract anglers and interest in fishing for Mountain Whitefish is fairly low throughout southwest Idaho. Therefore, the SFPR is rarely fished, especially considering its proximity to the Treasure Valley. In accordance, we believe it would be beneficial to re-distribute some catchable-sized hatchery Rainbow Trout from other regional waters to increase angling opportunity and utilization of this river. Assessment of availability indicates that about 9,000 catchables could be re-allocated from fully or partially under-performing waters. We propose to stock the reach from the mouth of the Deadwood River upstream to approximately 10-mile Creek. This reach produced adequate return to anglers during the early 1990s. We expect that it make take several years for anglers to re-discover this fishery, but that this period could be shortened through focused publicity efforts.

RECOMMENDATION

1. Re-institute stocking of catchable-sized hatchery Rainbow Trout with the intention of providing an adequate put-and-take fishery. Stock 3,000 catchables during each of June, July, and August for a total of 9,000. Monitor and alter stocking timing if high or low flows are likely to impact angler access, success, or safety.

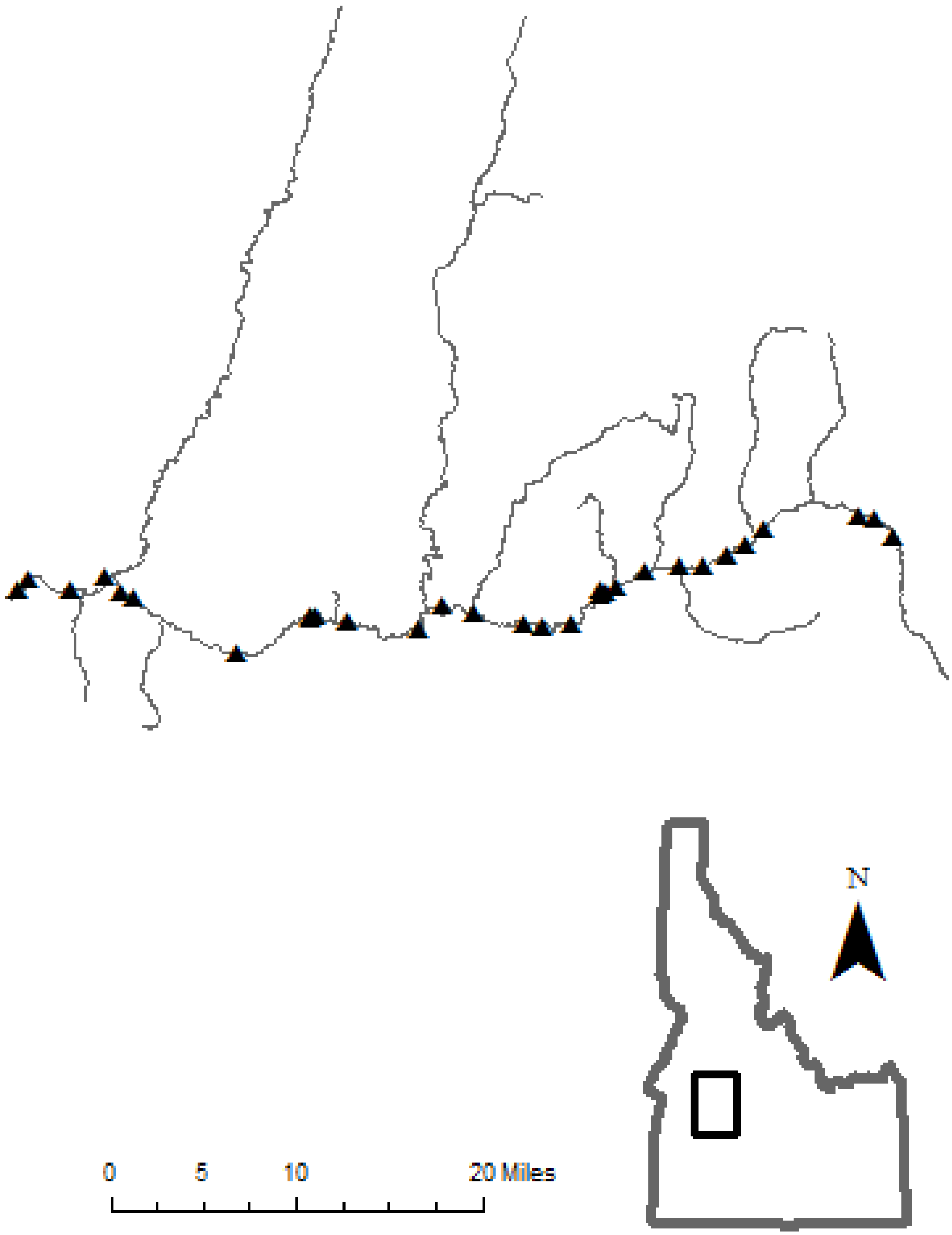

Figure 77. Locations of snorkeling sites sampled in the South Fork Payette River during 2016.

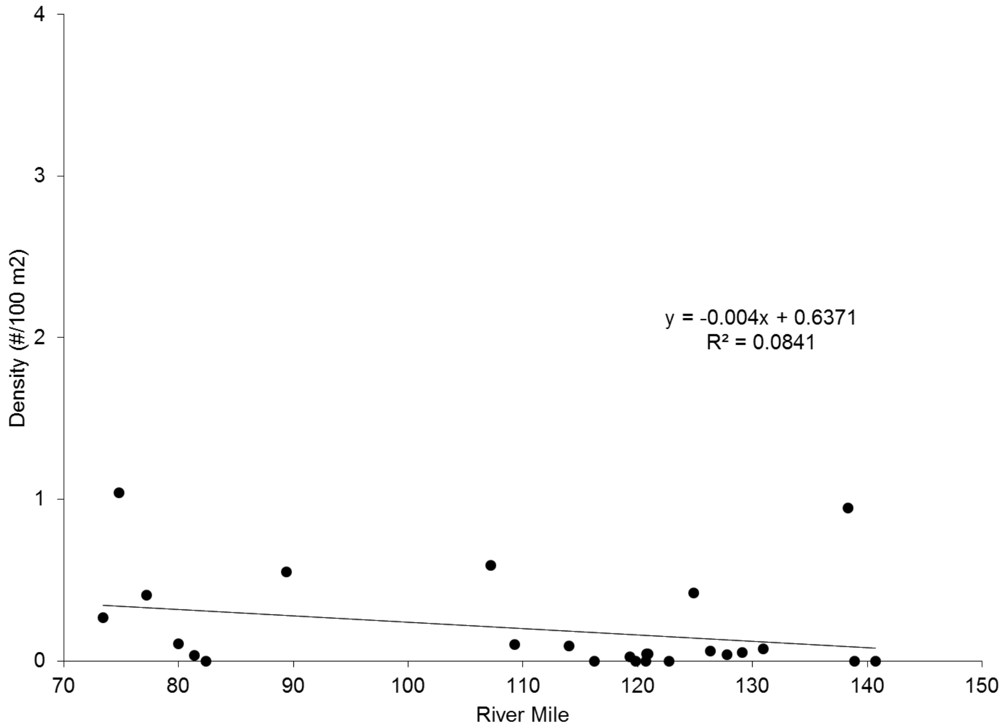

Figure 78. Densities of Redband Trout in the South Fork Payette River during 2016.

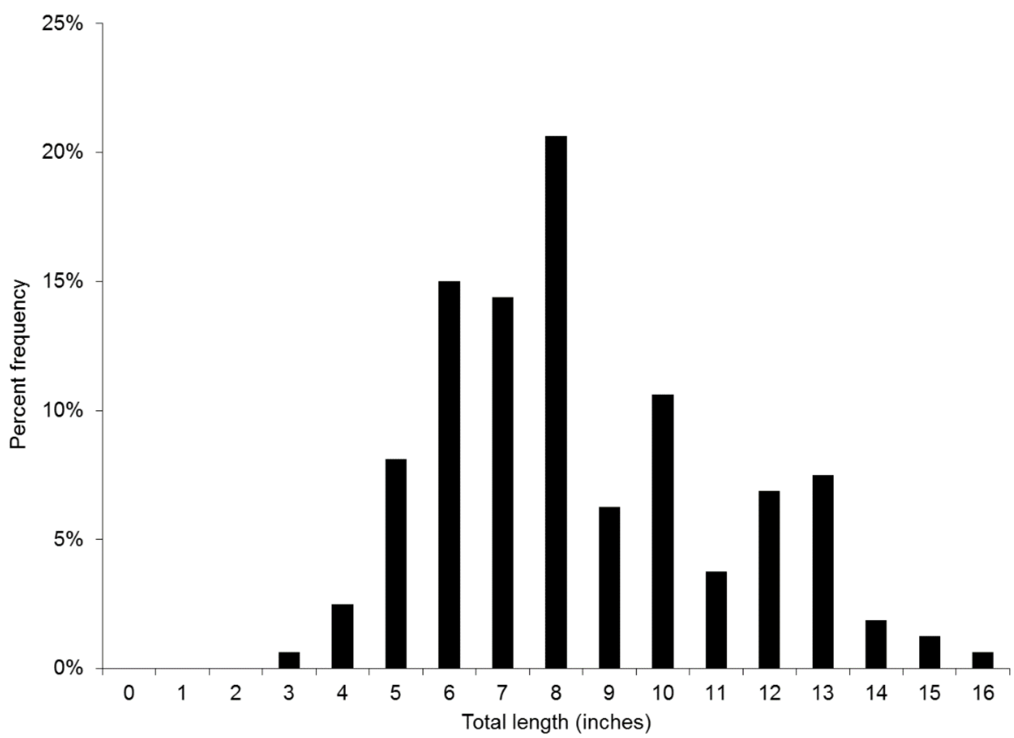

Figure 79. Length-frequency distribution of Redband Trout (n = 160) in the South Fork Payette River during 2016.

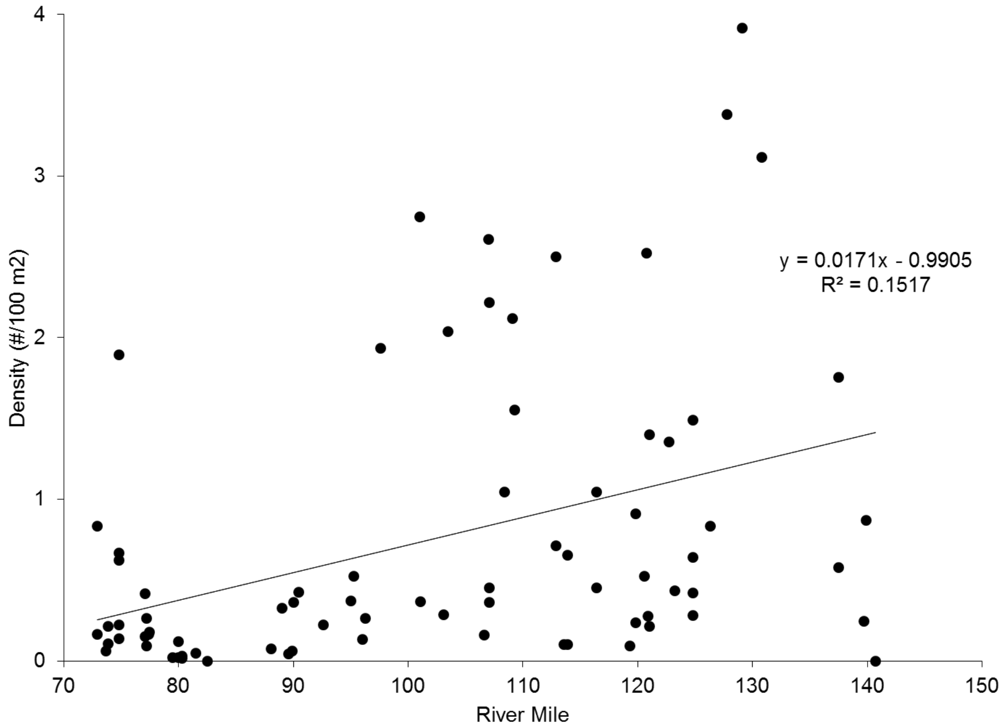

Figure 80. Densities of Redband Trout in the South Fork Payette River during 1996 and 1997.

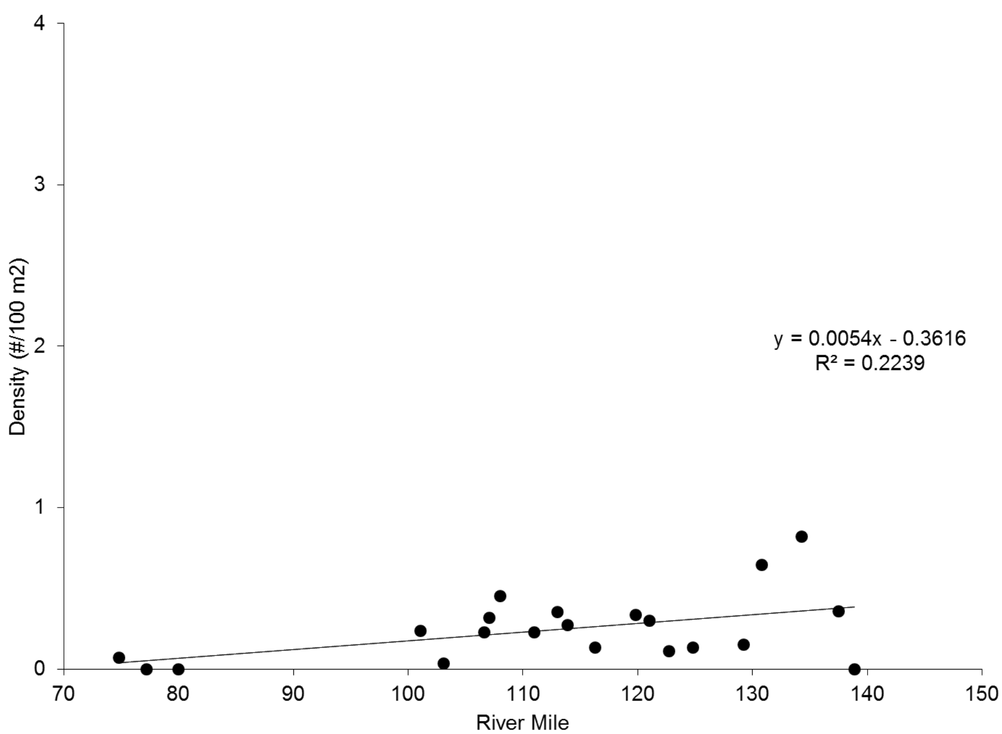

Figure 81. Densities of Redband Trout in the South Fork Payette River during 2003 and 2004.

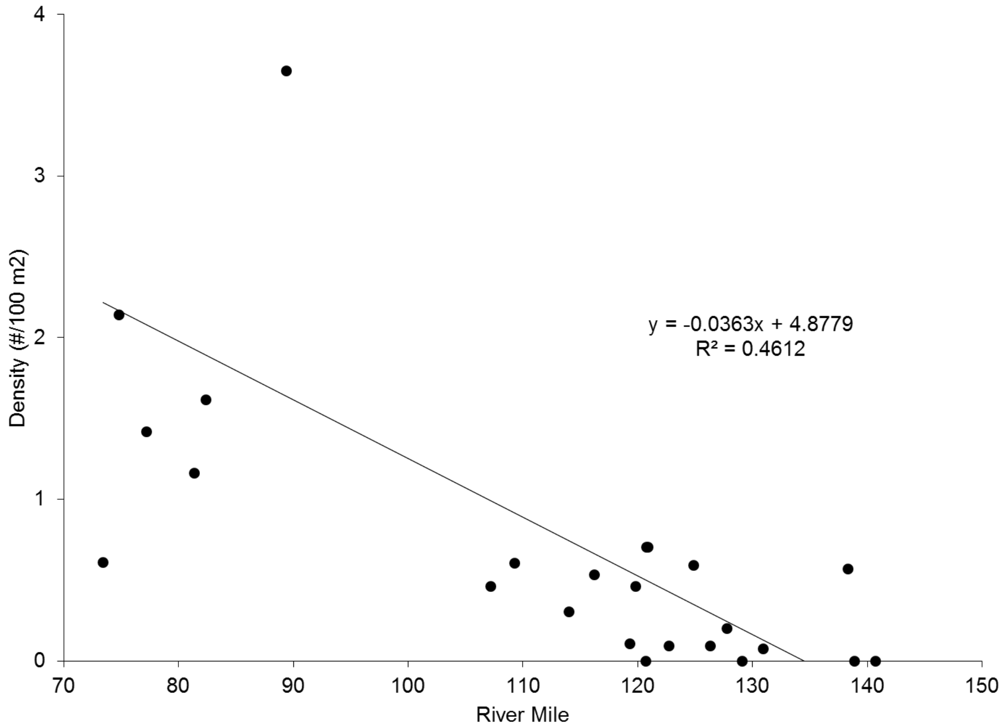

Figure 82. Densities of Mountain Whitefish in the South Fork Payette River during 2016.

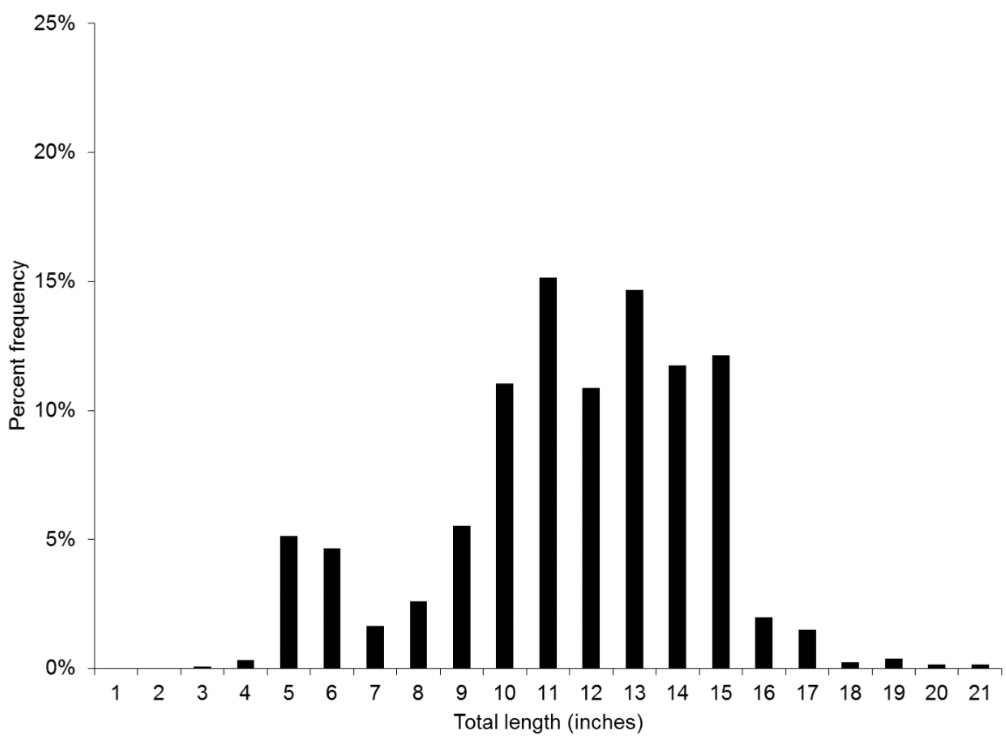

Figure 83. Length-frequency distribution of Mountain Whitefish (n = 1,268) in the South Fork Payette River during 2016.

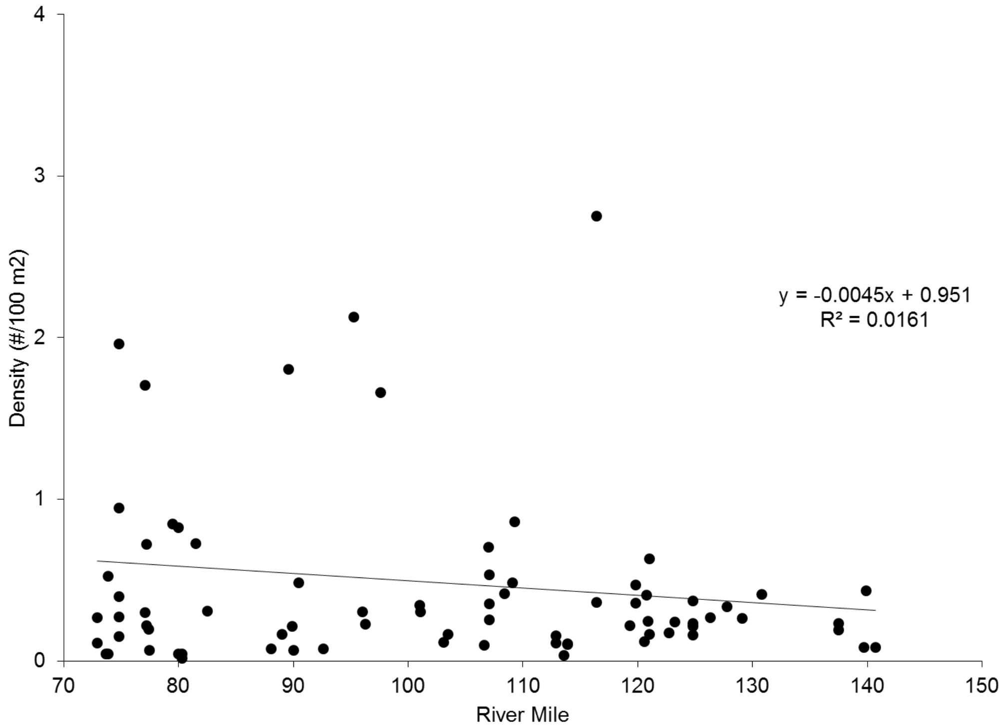

Figure 84. Densities of Mountain Whitefish in the South Fork Payette River during 1996 and 1997.

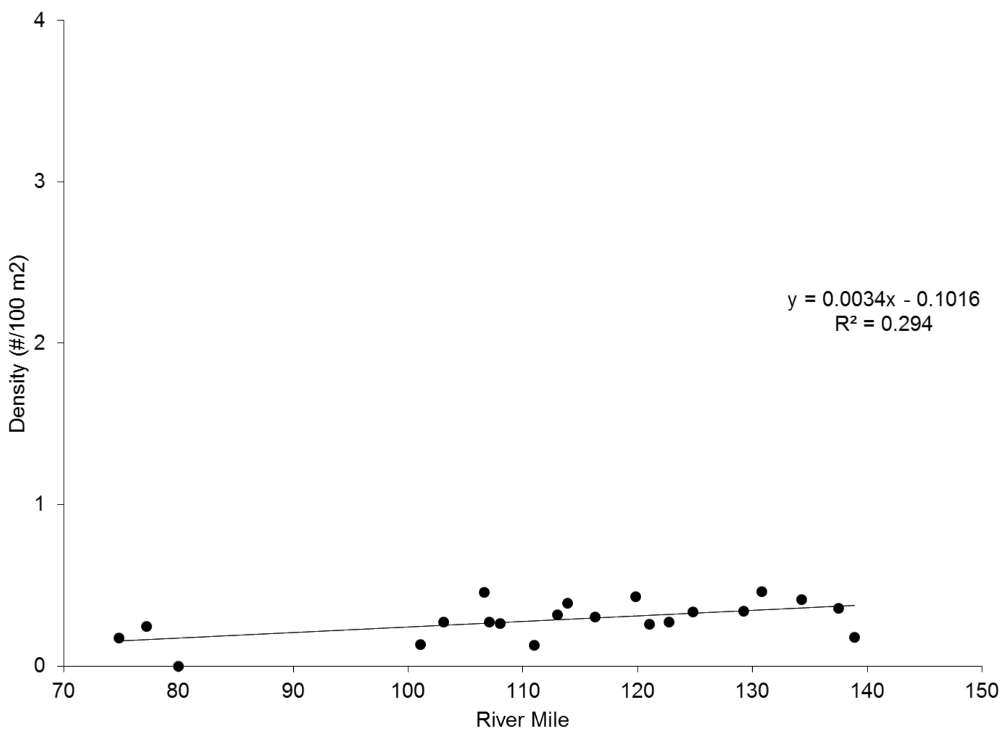

Figure 85. Densities of Mountain Whitefish in the South Fork Payette River during 2003 and 2004.

THE SOUTHWEST REGION'S FISHING AND BOATING ACCESS PROGRAM

ABSTRACT

Idaho Department of Fish and Game staff maintains 48 fishing and boating access sites within Region 3. Sites need continual maintenance, repair, and cleaning. These responsibilities were completed as usual. In addition, staff facilitated the completion of several improvement projects at IDFG-owned properties including Cove Arm, Red Top Pond, as well as C Ben Ross, Horsethief, and Tripod reservoirs. Furthermore, staff facilitated the development of fishing and boating infrastructure at non-department properties including Black Sands at CJ Strike Reservoir and Caldwell Rotary Pond. Lastly, staff spent considerable time working on prospective partnerships to cooperatively manage camping at Horsethief Reservoir.

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Joe Kozfkay
Regional Fishery Manager

INTRODUCTION

The goal of Idaho Department of Fish and Game's Fishing and Boating Access program is to provide high-quality developed access sites and amenities that allow hunters, anglers, and trappers to safely utilize and enjoy a wide variety of water types throughout southwest Idaho. Staff maintains 48 fishing and boating access sites within IDFG's Region 3 boundaries including the McCall subregion. Within this large geographical area, a total of 27 developed access sites are located on properties owned by IDFG, while the remaining 21 developed access sites provide opportunities on and from non-department owned properties. Also, access to properties owned by others (state, federal, or non-governmental organizations) is provided with cooperative agreements, memorandums-of-understanding, or right-of-ways. Access facilities and properties require a high amount of maintenance. Maintenance activities and frequencies are adjusted to account for use, weather patterns, and other reasons. Typical maintenance activities include: pumping and cleaning vault toilets, inspecting and maintaining dams and water control infrastructure, grading roads and parking lots, managing cleaning contractors, installing and removing docks (to avoid ice damage), removing sediment from boat ramps, managing vegetation, maintaining border fences, as well as posting and replacing worn or damaged signs. In addition to normal maintenance responsibilities and activities, regional staff participates in capital improvement projects that often involve constructing new access amenities at new or existing sites or replacing dilapidated infrastructure at existing sites. Furthermore, staff encourages and facilitates the development of fishing and boating access sites and opportunities on properties owned by others such as city or county governments. Funding for this program originates from a variety of sources including the Dingell-Johnson and Pittman-Robertson excise taxes administered by the U.S. Fish and Wildlife Service; license money generated from the sales of IDFG licenses, tags, and permits; mitigation settlements; as well as through a variety of grant sources.

ACCOMPLISHMENTS

Staff completed normal operations and maintenance activities as usual and expected. In addition, staff contributed directly to the completion of two larger-scale renovation projects during 2016. IDFG's Cove Arm access site was identified as a priority for renovation due to poor concrete condition at the sole boat ramp and due to the degraded condition (long-term ice damage) of the adjacent boarding dock bulkhead. These structures were decommissioned and removed, then disposed of at a sanitary landfill. A new solid-concrete pour-and-push type ramp was installed during February 2016. In addition, a new fixed boarding dock was installed. This structure was constructed by driving steel pilings into the reservoir's bottom. A rectangular dock frame oriented in a horizontal direction was welded to the pilings and topped with planks. Furthermore, staff regraded roads, delineated and regraded the existing parking lot, as well as installed a new kiosk, and new directional and regulatory signs. Projects costs totaled approximately $39,200, excluding staff wages.

The second large-scale project completed during 2016 focused on reopening Red Top Pond to the public and constructing necessary amenities. This previously-accessible and popular fishing pond is located five miles northwest of Caldwell. The pond is located on property owned by the Idaho Transportation Department (ITD). ITD allowed walk-in public access for fishing from 1999 through 2006 via a short-term agreement with IDFG. After 2006, ITD chose to resume gravel mining and closed the pond to the public for several years. By 2015, most of the usable gravel had been harvested and ITD offered a 99-year lease (for $1) to IDFG with several stipulations including that the property be managed for public fishing opportunities. The length of the agreement made it feasible to proceed with design and installation of amenities to improve public fishing access. Staff constructed or installed a gravel parking area, large boulders and fencing to control and limit vehicle usage, IDFG pit-vault outhouse, concrete block-type boat ramp (designed for small craft), a T-shaped fishing dock, a sign kiosk, as well as regulatory and informational signs. The dock was secured with three pilings. In addition, three additional pilings were driven to allow installation of another T-dock in the future as funds become available. This project was funded by IDFG license funds, a $5,000 grant from the Idaho Fish and Wildlife Foundation and contributions from the Boise Valley Fly Fishers for a total cost of $32,000, excluding staff time.

Other noteworthy accomplishments included replacement of the last four wooden pit-vault outhouses at Horsethief Reservoir. The 20-year-old wooden outhouses were replaced with IDFG-constructed concrete outhouses. It is hoped that these improvements will benefit the public and facilitate negotiations to transfer campground management at Horsethief Reservoir to another agency or entity. Along these lines, staff initiated talks and necessary actions to develop a cooperative agreement for transfer of campground management responsibilities to the Treasure Valley YMCA. Several meetings were held and substantial progress was made in developing an MOU. This MOU is currently in the legal review process with the hope that transfer would occur by July 1, 2017. The fishing and boating access site amenities located at C. Ben Ross Reservoir, 13 miles southwest of Cambridge, were improved during 2016. The reservoir is owned and operated by the Little Weiser Irrigation District. Previously, only a boat ramp was present. Staff improved infrastructure while other scheduled dam maintenance was being completed. IDFG committed engineering assistance and helped fund construction of a new boarding dock, parking area, and restroom kiosk. This work was completed during summer 2016. During an inspection, staff became aware that the control gate at Tripod Reservoir had been vandalized. In order to ensure proper water levels and comply with Idaho Water Resources regulations regarding dam safety standards, staff lowered the reservoir with large pumps and completed repairs. The waterman-style control gate was replaced, and a protective metal cover to deter future vandalism was installed. Staff also inspected and maintained three other dams and their associated water control infrastructure including Indian Creek, Horsethief, and Hancock (Fish Lake) reservoirs. Regular inspections and maintenance at these sites included exercising control gates; searching for sinkholes and leaks; removing brush, debris, and woody growth from the dam faces and spillways; filling mammal-created holes, and recording maintenance activities for each dam.

Staff has also made efforts to facilitate the efforts of others to improve fishing and boating access. During 2016, staff assisted Owyhee County with the Black Sands access site renovation (on CJ Strike Reservoir) and the City of Caldwell (COC) with their efforts to improve fishing docks and pathways at Rotary Pond. Staff assisted Owyhee County by applying for and obtaining permits, applying for and securing grants (IDPR Waterways Improvement Grant for $133,881), providing technical assistance and project design, as well as some project oversight and guidance. The Black Sands project is underway and is expected to be completed by March 31, 2017. Secondly, staff held meetings with the COC engineers and parks department employees to develop a project concept focused on replacing a series of old and potentially dangerous fishing docks. Next, COC staff solicited necessary approvals and funding from their mayor's office. Regional staff secured a $10,000 Idaho Fish and Wildlife Foundation Grant to partially fund this project and is presently purchasing materials for its construction, whereas the COC has committed $25,000. This project is expected to be completed in the summer of 2017.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the many people whose assistance, cooperation, and hard work allowed us to complete these projects. We thank Wyatt Tropea, Jared Kunz, Kayla Kinkead, Nathan Woods, and Joel Van Patten who comprised the 2015 field crew. Their work and dedication to their jobs was invaluable. We also thank IDFG's enforcement, fisheries bureau, hatchery, and regional staff as well as our management partners at the US Fish and Wildlife Service, Bureau of Reclamation, Bureau of Land Management, and Forest Service for assistance provided in 2016.

We have been fortunate to work with several Maintenance Craftsmen that return year after year. Two of particular note are Jim Johnson and Dana Moyer. Jim Johnson was hired in 2004 and just recently retired in 2016. Jim's primary duty was to clean and maintain the region's 48 access sites while working only 30 hours per week. Jim excelled at this by creating a method of cleaning outhouses that was both fast and efficient. Jim would often adjust his schedule to clean a busy area before or after holidays to ensure cleanliness and safety for the public. Dana Moyer has been seasonally employed since 2006. Dana has a wide range of skills and experiences including a willingness to complete everything asked of him and more. He works well independently and in groups to keep sites clean and safe. He is a positive influence and mentor to younger employees.

Two IDFG officers have been very helpful to the success of the Access Program during the past year also: Chris Rowley and Craig Mickelson. Chris has always made himself available to help out at Horsethief Reservoir, especially when our volunteer hosts encounter problems with campers. Chris does everything possible to respond, often late in the evening and on busy weekends. His patience with the hosts and with the Access Maintenance Foreman has been very much appreciated. Craig's patrol area and the access sites within are very heavily used. There has been an increase in homesteading and large-scale vandalism and littering. Craig has been quick to respond to calls for help, has removed transients, and has made litter and vandalism cases within the last year. We appreciated Chris's and Craig's efforts.

Angie and Dave Barkell have been the driving force for Owyhee County's Black Sands renovation project. Angie, the Owyhee County Clerk, has remained committed to the project in spite of setbacks. Angie enlisted her husband, Dave, to act as the project manager. Dave has taken time from his own business and work schedule to ensure that the project was progressing properly. Their efforts and work to rebuild this heavily-used boat ramp and access area at CJ Strike Reservoir will be valued by thousands of boat anglers for many years to come.

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