FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
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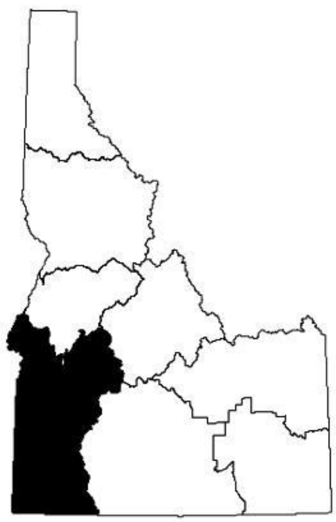

SOUTHWEST REGION
2020

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LAKES AND RESERVOIRS INVESTIGATIONS

ARRROWROCK AND LUCKY PEAK RESERVOIRS

ABSTRACT

Arrowrock and Lucky Peak reservoirs are water storage reservoirs near Boise, ID. Water operations are cooperatively managed by the US Army Corps of Engineers (USACE) and the Bureau of Reclamation (BOR), recreation is managed by BOR and Idaho State Parks (ISP), and fish and wildlife are managed primarily by Idaho Department of Fish & Game (IDFG). Arrowrock and Lucky Peak reservoirs provide diverse recreational opportunities, including recreational watercraft use and myriad angling opportunities. The kokanee *Oncorhynchus nerka* fisheries at Arrowrock and Lucky Peak reservoirs continue to be two of the most popular in the state and have experienced a sizeable increase in angler interest during the last decade. In 2020, IDFG conducted a series of evaluations on Arrowrock and Lucky Peak reservoir fisheries including gill net, and standardized lowland lake surveys. Based on these evaluations, kokanee fall gill net catch per unit efforts (CPUE) were higher than previous surveys. Lowland lake surveys indicated high CPUE of non-game fishes (Northern Pikeminnow *Ptychocheilus oregonensis* and sucker species *Catostomus spp.*). With regard to kokanee management, ongoing investigations evaluating relationships between stocking, environmental metrics, and angler CPUE or growth are an important component of fisheries management. Additionally, fall gill net surveys will continue to provide insight into the following year's kokanee fishery. Due to high angler interest and variability in these kokanee fisheries, continued angler effort and population monitoring are important and will continue into the future.

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INTRODUCTION

Arrowrock and Lucky Peak reservoirs are two popular kokanee *Oncorhynchus nerka* fisheries in Idaho and have experienced a sizeable increase in angler interest since annual kokanee stocking began in the late 1990s. Hatchery stocking is required to support both fisheries, as wild recruitment is limited. Annual variation in angler catch per unit effort (CPUE) at these reservoirs has led Idaho Department of Fish and Game (IDFG) to examine if this variability may be attributed to size at stocking, timing of stocking, stocking density, or hydrologic conditions. Prior to 2012, IDFG had anecdotal information on which years had produced good fishing, but no quantifiable angler catch or CPUE data. Due to the growing popularity of kokanee fishing, IDFG recognizes the need to monitor these fisheries more quantitatively. Therefore, our objectives for this work were to continue to contribute annual biotic and abiotic data to a suite of correlations to better assess current and future kokanee population trends. These correlations will allow IDFG to more clearly define kokanee management goals for angler CPUE and size-at-maturity, and obtain better understanding of how reservoir management, spawning conditions, and stocking affect survival and growth of individual kokanee year classes.

Kokanee life history differs considerably from other inland salmonids, resulting in different monitoring and management strategies for these populations. Kokanee are semelparous salmon that feed and grow in lakes or reservoirs for two to four years, then spawn in tributaries or along shorelines during fall, before subsequently dying. Eggs incubate in the streambed or shoreline gravels until hatching in late winter. Alevins remain in the gravel for several more weeks before emerging at night and migrating to the lake or reservoir. Fry commonly migrate directly to pelagic areas (Foerster 1968), but can spend time feeding in the littoral habitats, particularly in lakes or reservoirs with pronounced littoral regions (Burgner 1991; Gemperle 1998). Juvenile and adult kokanee are primarily found in pelagic zones of lakes and reservoirs, where they feed almost exclusively on zooplankton.

Managing kokanee fisheries is often challenging and complex because of the relatively short life cycle (approximately 3 - 5 years), as well as 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. 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 (Wydoski and Bennett 1981; McGurk 1999). 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. IDFG has observed a notable increase in angler interest in the management of kokanee fisheries across the state, particularly inquiries into stocking rates (Cassinelli 2019, personal communication). The Department has numerous kokanee monitoring objectives, including documenting entrainment, determining relative year class abundance and natal origin, and monitoring angler effort, harvest and catch rates.

STUDY AREA

Arrowrock Reservoir is a 1,255 ha dendritic impoundment located approximately 32 km northeast of Boise in the Boise River drainage (Figure 1). It is a 29 km-long, narrow canyon reservoir that impounds two major tributaries; the Middle Fork Boise River (MFBR) and South Fork Boise River (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 (defacto minimum of 6,167 x 10^4 m^3), after which the reservoir slowly refills during the fall and winter. 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 2012-2014.

Lucky Peak Reservoir is a 1,141-ha mesotrophic impoundment in the Boise River drainage, immediately downstream from Arrowrock Reservoir (Figure 2). It has a mean depth of 32.8 m, a total capacity of 3,615 x 10^5 m^3, and is managed by the U.S. Army Corps of Engineers to provide flood control, irrigation, power generation, recreation, and winter stream 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. The default kokanee stocking request for Lucky Peak Reservoir is 250,000 fingerlings or 217 fish/ha in early June (Table 1).

METHODS

Creel Survey

Check stations have been used by the Department and were historically conducted in late-April to early-June. However, due to the COVID-19 pandemic, we were unable to conduct creel surveys of kokanee anglers at Lucky Peak and Arrowrock reservoirs in 2020. We plan on conducting these surveys beginning again in 2021.

Kokanee Abundance Gillnetting

Gillnet surveys were conducted on both Lucky Peak and Arrowrock reservoirs in fall 2020. Fall gill net surveys were implemented as a means to evaluate the kokanee populations post-spawning. Sampling in the fall provides insight into the relative abundance of the age class that will spawn the following year. In other words, age-1+ fish sampled in nets in the fall of 2020 will be the age-2 fish that make up the majority of the fishery in the spring and summer of 2021.

Gillnetting was conducted at Lucky Peak Reservoir on the evening of October 19, 2020 and at Arrowrock Reservoir on October 26, 2020. In each water, two gill nets were used to sample the entire kokanee layer (2–14 m below water surface) at three locations, for a total of six net-nights. Nets were set at dusk and retrieval started at dawn of the following day. Each gill net measured 48.8 m in length and 6.0 m in depth. Gill nets contained 16, 3-m panels, and consisted of eight different mesh sizes (13-, 19-, 25-, 38-, 51-, 64-, 76-, 102-mm; stretch mesh) with two panels of each mesh size randomly positioned throughout the net. Each pair of gill nets were horizontally suspended with the two nets covering 2-14 m of water depth.

Kokanee stocked in 2018 (age-2) and 2019 (age-1) received a single thermal mark during egg incubation at Cabinet Gorge Fish Hatchery. Fish stocked in 2020 (age-0) received differential thermal marks depending on release location and stocking strategy as part of an ongoing size-at-release evaluation. Stock-year 2020 fish released in the three Boise River impoundments (Anderson Ranch Reservoir, Arrowrock Reservoir, and Lucky Peak Reservoir), received one of six unique thermal marks based on their release location and size-at-release. All kokanee collected were measured for total length (mm) and weighed (g) and otoliths were removed. Otoliths were processed and examined for presence of thermal marks (Volk et al. 1999). These unique thermal marks allow for both identifying and aging of hatchery-origin kokanee. Kokanee lacking a thermal mark were presumed to be from natural production.

Previous efforts to quantify the amount of kokanee entrainment that occurs between Arrowrock and Lucky Peak reservoirs relied on clipping adipose fins. Approximately 20% of the 100,000 kokanee (≈ 20,000) fingerlings stocked into Arrowrock Reservoir during 2017–2019 were adipose fin clipped. These fish were hand-clipped by Southwest Region staff at the Mackay Fish Hatchery in April of each year. All fish captured in gill nets at both Lucky Peak and Arrowrock reservoirs were examined for a fin clip.

At Lucky Peak Reservoir, the number of recovered adipose-clipped fish was expanded by the year-specific clipping rate. To get a capture percentage, 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. 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 kokanee entrained in Lucky Peak Reservoir, by age. Stock year 2020 kokanee are part of an ongoing size-at-release evaluation. All kokanee stocked in Lucky Peak, Arrowrock and Anderson Ranch reservoirs received a differential thermal mark that corresponds to a unique water body and release strategy. As such, quantifying entrainment becomes simpler; fish captured in fall kokanee index netting can be attributed to the reservoir in which they were originally stocked based on thermal marks. The proportionate contribution of each reservoir can then be expanded to the annual stocking numbers, thus roughly estimating entrainment.

Predator Gillnetting

Predatory fish populations in Lucky Peak Reservoir were sampled with gill nets in conjunction with the lowland lake surveys during June 2020 following the stocking of hatchery kokanee fingerlings. Two 46 m x 2 m monofilament gill nets were used and each had six panels composed of 19, 25, 32, 38, 51, and 64-mm bar mesh. One gill net, fished for one night, equaled one unit of gill net effort, resulting in three total net-nights of effort. Nets were set at sites near the 2020 kokanee release location; both nets were set in Mores Creek downstream of the Robie Creek boat ramp (Figure 1). Captured fish were identified to species, measured for total length (mm) and weighed (g) using a digital scale. Stomach contents were examined; if contents appeared to be fish, the contents were estimated for total length (mm) and attempted to identify to species. Catch data were summarized as the number of fish caught per unit effort (CPUE).

Lowland Lake Surveys

Standardized lowland lake survey methods employed by IDFG are outlined IDFG Report Number 12-10 (Standard Fish Sampling Protocol for Lowland Lakes and Reservoirs in Idaho). Fish populations in Lucky Peak Reservoir and Arrowrock Reservoir were sampled with standard IDFG lowland lake sampling gears during June 2020. Arrowrock Reservoir was divided into three sections, (main reservoir, South Fork Boise River arm, and Middle Fork Boise River arm; Figure 2). In total, eight trap nets, eight gill net pairs, and one electrofishing unit (composed of three 1,200 second sub-samples) were used in Arrowrock Reservoir. Lucky Peak Reservoir was divided into three sections (lower, middle, and upper sections; Figure 1). In total, nine trap nets, ten gill net pairs, and one electrofishing unit (composed of three 1,200 second sub-samples) were used in Lucky Peak Reservoir.

RESULTS

Kokanee Abundance Gillnetting

At Arrowrock Reservoir, gill nets captured a total of eight kokanee. Other fish encountered included Rainbow Trout *Oncorhynchus mykiss*, Yellow Perch *Perca flavescens*, Largescale Sucker *Catostomus macrocheilus*, and Northern Pikeminnow *Ptychocheilus oregonensis*. Of the eight kokanee sampled, otoliths from seven kokanee were successfully processed to determine fish age, and seven were successfully processed to determine thermal marks. Gill net CPUE for kokanee was 0.8 fish/net-night for age-0 fish, 0.3 fish/ net-night for age-1 fish. No kokanee older than age-1 were captured in fall kokanee index surveys at Arrowrock Reservoir in 2020 (Figure 3). Kokanee total length ranged from 140 to 322 mm (mean = 218.4 mm, SD = 73.9 mm; Figure 4).

At Lucky Peak Reservoir, gill nets captured a total of 63 kokanee. Other fish encountered included fall Chinook Salmon *O. tshawytscha*, Rainbow Trout, Yellow Perch, Bridgelip *C. columbianus* and Largescale suckers, Chiselmouth *Acrocheilus alutaceus*, Redside Shiner *Richardsonius balteatus*, Smallmouth Bass *Micropterus dolomieu*, Black Bullhead *Ameiurus melas*, sculpin spp., and Northern Pikeminnow. Of the 63 kokanee sampled, otoliths from 57 were successfully processed to estimate fish age, and 55 were successfully processed for thermal marks. Gill net CPUE for kokanee was 3.2 fish/net-night for age-0, and 5.7 fish/net-night for age-1. No kokanee older than age-1 were captured in fall kokanee index surveys at Lucky Peak Reservoir in 2020 (Figure 5). Kokanee total length ranged from 121 to 372 mm (mean = 266.4 mm, SD = 87.0 mm; Figure 6).

With the ongoing kokanee size-at-release evaluation and resulting differential thermal marks, we were able to document downstream entrainment of kokanee. We did not observed any entrained age-1 fish (noted by a clipped adipose fin) in Lucky Peak Reservoir. In Arrowrock Reservoir, we did not observe any entrained age-0 fish. However, we documented entrained age-0 fish in Lucky Peak from both Arrowrock Reservoir (n = 4) and even Anderson Ranch Reservoir (n = 1). Based on these estimates, approximately 10,765 age-0 kokanee were entrained from Arrowrock Reservoir and approximately 2,760 fish were entrained from Anderson Ranch Reservoir to Lucky Peak Reservoir.

Predator Gillnetting

At Lucky Peak Reservoir, a total of 57 fish were captured during the predator netting exercise, including Northern Pikeminnow (n = 14), Largescale Sucker (n = 37), Rainbow Trout (n = 2), Black Bullhead (n = 3), and Chiselmouth (n = 1). Gillnet CPUE was 7 fish/net-night for Northern Pikeminnow, and 1 fish/net-night for Rainbow Trout. From the stomach content analysis, no fish were found with identifiable fish remains in their stomachs (Table 2).

Lowland Lake Surveys

Arrowrock Reservoir

A total of 328 fish were captured during the standard lowland lake survey at Arrowrock Reservoir in 2020 (Table 3). Catch was predominately Northern Pikeminnow (n = 109) and Largescale Sucker (n = 95). Other species captured included Bridgelip Sucker, Bull Trout *Salvelinus confluentus*, Chiselmouth, kokanee, Mountain Whitefish *Prosopium williamsoni*, Rainbow Trout, Smallmouth Bass, and Yellow Perch. CPUE and weight per unit effort (WPUE) indices for all species combined were 19.3 and 11.1 (Table 3). Gill nets were the most effective gear type with a total CPUE of 12.7 fish/unit effort, followed by electrofishing (CPUE = 5.3) and trap nets (CPUE = 1.3). Based on CPUE, Northern Pikeminnow made up 33% of the total catch, followed by Largescale Sucker (29%), and Smallmouth Bass (20%). All the other species collected contributed <10% of total catch. Based on WPUE, the fish community consisted of Largescale Sucker (63%) and Northern Pikeminnow (22%). All the other species collected contributed <10% of total catch (Table 3).

Northern Pikeminnow were the most abundant fish sampled by CPUE (6.4; Table 3). Gillnets yielded the highest CPUE (5.1) of the individual capture methods followed by electrofishing (CPUE = 0.9) and trap nets (CPUE = 0.5). Total length of Northern Pikeminnow ranged from 92 to 484 mm (mean = 344.9, SD = 60.9; Figure 7).

Largescale Sucker (n = 95) was the most abundant fish sampled by WPUE (6.9). Total Largescale Sucker CPUE was 5.6 (Table 3). Gillnets yielded the highest WPUE (5.7) of the individual capture methods followed by electrofishing (WPUE = 1.2) and trap nets (WPUE = 0.07). Total length of Largescale Sucker ranged from 162 to 615 mm (mean = 487.8, SD = 65.0; Figure 8).

Lucky Peak Reservoir

A total of 509 fish were captured during the standard lowland lake survey at Lucky Peak Reservoir in 2020 (Table 4). Catch was predominately Largescale Sucker (n = 205), Northern Pikeminnow (n = 78) and Bridgelip Sucker (n = 57). Other species captured include Black Bullhead, Chiselmouth, kokanee, Rainbow Trout, Redside Shiner, sculpin spp., Smallmouth Bass and Yellow Perch (Table 4). CPUE and WPUE indices for combined species were 25.4 and 11.3, respectively (Table 4). Electrofishing was the most effective gear type with a total CPUE of 12.9, followed by gill nets (CPUE = 11.0) and trap nets (CPUE = 1.7). Based on CPUE, Largescale Sucker made up 40% of the total catch, followed by Northern Pikeminnow (15%), Smallmouth Bass (11%) and Bridgelip Sucker (11%). All the other species collected contributed <5% of total catch (Table 4). Based on WPUE, the fish community consisted of Largescale Sucker (58%), Northern Pikeminnow (19%), and Rainbow Trout (10%). Remaining species collected represented less than 5% of the total biomass (Table 4).

Largescale Sucker were the most abundant fish sampled by CPUE (10.3) and WPUE (6.6; Table 4). Electrofishing yielded the highest CPUE (12.8) of the individual capture methods followed by gill nets (CPUE = 10.9) and trap nets (CPUE = 1.7). Total length of Largescale Sucker ranged from 152 to 554 mm (mean = 386.9, SD = 81.1; Figure 9).

DISCUSSION

Kokanee Abundance Gillnetting

Fall kokanee abundance indices have been difficult to build based on the low catch rates we have experienced for the last several years. A 2016 graduate study (Klein 2019), found that using overnight experimental curtain gill net sets, suspended in the kokanee layer of the water column, was the most effective tool to capture and monitor kokanee adult populations in Arrowrock and Lucky Peak reservoirs. Based on this finding, since 2017, gill nets have been used as the primary tool for annually sampling these populations in both reservoirs. From 2017 to 2020, gill net samples from both reservoirs provided low numbers of kokanee. As gill net indices are established over the next several years, it will be important for us to gain a better understanding of an appropriate number of nets to adequately sample the population and provide an appropriate estimate of age-specific relative abundances each fall. Capture rates of age-0 kokanee in Lucky Peak Reservoir increased in 2020 compared to 2019. Additionally, more age-1 kokanee were sampled in 2020 compared to 2019. Regardless of whether this is attributed to our sampling efficiency or a true increase in kokanee recruiting to the fishery, we are hopeful these are positive signs for the Lucky Peak Reservoir kokanee fishing in the future. Additionally, we were able to successfully process approximately 87% of the otoliths to evaluate for thermal marks. This was significantly more than the 2019 survey results; 48 kokanee were captured in 2019 with no thermal marks detected, despite 5 adipose-clipped fish captured (which should have received thermal marks). Differential thermal marks will be used for at least the next four years as part of a size-at-release evaluation, which will significantly improve our ability to understand and quantify entrainment.

Thermally-marked otoliths will continue to be utilized in kokanee stocked in both Lucky Peak and Arrowrock reservoirs. The year 2020 was the fourth consecutive year of using thermally-marked otoliths to identify hatchery and natural-origin kokanee recovered from gill nets. In 2017, 23% of the age-1 kokanee from Lucky Peak and 49% of the age-1 kokanee from Arrowrock were of natural origin. In 2018, the Lucky Peak proportion of natural origin age-1 fish declined to 10% and no natural origin age-1 fish were sampled in Arrowrock Reservoir. In 2019, we did not observe any thermally marked otoliths from either Lucky Peak or Arrowrock Reservoir. However, five kokanee from Lucky Peak Reservoir had clipped adipose fins, indicating hatchery origin. We believe this discrepancy can be attributed to errors in processing otoliths for thermal marks. The 2020 survey collected 62 thermally-marked kokanee (Arrowrock Reservoir n = 7, Lucky Peak Reservoir n = 55); of which 36 were identified as stock year 2019 and 24 were identified as stock year 2020. Compared to the 2019 fall kokanee index survey results, we captured approximately 30% more kokanee during the 2020 fall kokanee index surveys in Lucky Peak Reservoir.

Utilizing differential thermal marks, we were able to document entrainment of kokanee in Lucky Peak Reservoir from both upstream reservoirs (Arrowrock and Anderson Ranch reservoirs). Stock year 2020 was the first year when the Department utilized thermal marks unique to each reservoir and release cohort. Prior to stock year 2020, a portion of kokanee stocked in Anderson Ranch Reservoir and Arrowrock Reservoir received adipose clips which were used to monitor entrainment. Due to the small number of kokanee that have been captured during annual fall kokanee index netting efforts in Lucky Peak Reservoir from 2017 to 2020, monitoring entrainment has been difficult with such a small sample size. While kokanee entrainment estimates from Arrowrock Reservoir into Lucky Peak Reservoir continue to be highly variable, utilizing differential thermal marks on all kokanee stocked in the future will aid in monitoring entrainment.

Kokanee fisheries in Lucky Peak and Arrowrock reservoir are popular, and their popularity is highly variable based on kokanee abundance. Consistently high kokanee abundance will likely result in consistently high participation in these fisheries. These two large Boise River Basin reservoirs (along with Anderson Ranch Reservoir in the Magic Valley Region) have the potential to produce high levels of angling effort when kokanee abundance is relatively high. Continued monitoring of angler catch and effort, environmental variability, population trends, entrainment, and hatchery/natural composition have emphasized the complexity of this system. Continued data collection will help managers further understand these relationships and improve the management of these complex sport fisheries.

Predator Gillnetting

Based on surprising findings in 2019, we repeated predator gillnetting efforts in 2020. Few fish were captured during the predator netting exercise (n = 57). The predominant predatory species captured in the preliminary predator gill nets was Northern Pikeminnow (n = 14). No kokanee fingerlings were recovered in the stomachs of any fish, predatory or otherwise. While this is not an unexpected result, it was surprising that no kokanee fingerlings were found in any stomachs of fish captured in the predator netting exercise based on spatial proximity to kokanee release location and temporal proximity to kokanee release date (four days post-stocking). While not a part of the explicit predator gill net surveys, we also assessed stomach contents of all predatory fish captured during the concurrent lowland lake survey and did not recover any kokanee fingerlings in any stomachs of any predatory fish. We acknowledge the predator gillnetting exercise resulted in a small sample size; however, when combined with findings from the lowland lake survey, our data suggest predation is not a major factor limiting kokanee recruitment or survival or stocked fingerlings in Lucky Peak Reservoir.

Lowland Lake Surveys

Arrowrock Reservoir

Since the last lowland lake survey at Arrowrock Reservoir (June 2012), the species composition has remained similar. During the 2012 survey, Northern Pikeminnow and sucker spp. comprised 91% of the total biomass. During the 2020 survey, Northern Pikeminnow and sucker spp. comprised 87% of the total biomass. Very few gamefishes were captured, with only Smallmouth Bass comprising more than 5% of the total catch by either CPUE or WPUE.

As a result of the 2012 Arrowrock Reservoir lowland lake survey, the Department coordinated with the United States Bureau of Reclamation (USBOR), removal netting efforts targeting nongame fishes. During the removal efforts, nearly 6,600 kg of nongame fishes were removed. As mentioned, costs were shared between agencies; as such IDFG costs were limited to personnel costs (≈$2,500). Overall project success was inconclusive, as a significant decrease in nongame fish biomass was not observed, nor was a significant increase in sportfish biomass.

However, monetary investment from the Department was minimal. Less than a decade later, fishery managers find themselves facing a similar question. In 2019, overall catch was dominated by nongame fishes, despite overall catch being lower when compared to the previous standardized lowland lake survey. However, we conducted the standardized lowland lake survey at Arrowrock Reservoir during late July, whereas the previous survey was conducted in early June. We believe that the difference in timing may have factored into our lower catch rates. During the 2012 lowland lake survey, Arrowrock Reservoir was held at 3,213' elevation, whereas during the 2019 lowland lake survey, Arrowrock Reservoir was held at 3,177' elevation. This 36' difference caused sample locations which are typically in shallow littoral habitats to shift towards deeper, pelagic habitats, which may have limited capture efficiency. Furthermore, the 41-day difference in survey dates likely affected catch. Earlier in the season, fishes such as Smallmouth Bass are in shallow, littoral habitats for spawning; however, later in the season, those fish move out of the shallows and into deeper habitat with decreased water level and warming surface water temperatures (Hubert and Lackey 1980; Beamesderfer and Rieman 1991).

Based on our findings from the 2019 lowland lake survey at Arrowrock Reservoir, we decided to repeat the survey in 2020. As mentioned, the 2012 lowland lake survey was completed in early June, 2012. We conducted the 2020 survey in early June as well, to hopefully draw more relevant comparisons between the two surveys. When Arrowrock Reservoir was surveyed post-removal, fisheries managers observed a 42% decrease in Northern Pikeminnow CPUE, but did not observe a decrease in Largescale Sucker CPUE. However, both Northern Pikeminnow and Largescale Sucker WPUE increased drastically post-removal (Butts et al. 2013a). Based on the 2020 lowland lake survey, CPUE and WPUE for both Northern Pikeminnow and Largescale Sucker are almost an order of magnitude less than what was observed in 2012, yet are only slightly higher than what was observed in the July 2019 lowland lake survey (Table 5). Based on these results, we surmise the 2020 survey is more relevant to compare with the 2009 survey.

Standardized lowland lake surveys are designed to reduce biases, by utilizing a number of different gear types with broad spatial distribution. However, these gear types may not be adequately characterizing sportfish composition. For certain sportfish species, a more targeted approach may be warranted. For example, kokanee are a prized gamefish across their range, and Arrowrock Reservoir is no exception. Kokanee are typically found in the pelagic zone at intermediate depths, and are most susceptible to gill nets. The gill net sets used in the standardized lowland lake surveys are typically littoral and either sinking or floating nets. As mentioned, previous work (Klein 2019) evaluated optimal gear type and selectivity indices for kokanee, which the Department has implemented in our kokanee abundance gillnetting efforts.

When evaluated at the gear-specific level, the majority of Smallmouth Bass (~52%) were captured via electrofishing, and Smallmouth Bass contributed the majority (~62%) of the total electrofishing catch. Biases in capture probability, especially with regard to electrofishing, are well documented across a number of taxa including salmonids (Peterson et al. 2004) and centrarchids (Dauwalter and Fisher 2007). In order to properly estimate biases in gear selectivity, typically mark-recapture or depletion estimates are used. In a lacustrine environment such as Arrowrock Reservoir, a depletion estimate would be logistically impossible to conduct at the reservoir-wide scale, and it would be difficult to partition the reservoir into smaller sample units without violating an assumption of physical closure (i.e. block nets) due to the physical geography and steep-sided nature of the reservoir. A mark-recapture estimate would be extremely logistically intensive in terms of gear and man-hours required, albeit not completely impossible. However, under the context of a lowland lake survey, we are merely estimating relative densities and species composition. Furthermore, based on information gained from annual creel surveys, Smallmouth Bass play a minor role in the desires of our constituents at Lucky Peak and Arrowrock reservoirs.

In the future, should the Department have an increased desire for a more fine-scale evaluation of Smallmouth Bass in these reservoirs, an intensive mark-recapture evaluation may be the best avenue to estimate demographics while also accounting for gear biases.

Lucky Peak Reservoir

Since the last lowland lake survey at Lucky Peak Reservoir (June 2009), the species composition has remained similar. During the 2009 survey, Northern Pikeminnow and sucker spp. comprised 68% of the total biomass. During the 2019 survey, Northern Pikeminnow and sucker spp. comprised 67% of the total biomass. Very few gamefishes were captured, with only Smallmouth Bass comprising more than 5% of the total catch by either CPUE or WPUE.

The last lowland lake survey conducted on Lucky Peak Reservoir was in early June, 2009 (Butts et al. 2013b). Unlike Arrowrock Reservoir, there were no removal efforts on nongame fishes after this survey. The 2009 survey found the majority of both CPUE and WPUE was attributed to Northern Pikeminnow, Largescale Sucker and Bridgelip Sucker. During the 2020 Lucky Peak Reservoir lowland lake survey, the majority of the CPUE and WPUE were also attributed to these same three species, but were up to 75% less than the 2009 survey. When compared to the 2019 lowland survey, CPUE and WPUE of nongame fishes were only slightly higher in the 2020 lowland survey (Table 5). Based on these results, we surmise the 2020 survey is more relevant to compare with the 2009 survey.

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

2. Continue to use curtain gill nets to evaluate kokanee relative abundance through annual index surveys

3. Evaluate thermal marks of hatchery-origin kokanee to be stocked in Anderson Ranch and Arrowrock reservoirs to monitor entrainment into Arrowrock and Lucky Peak reservoirs

Table 1. Waterbody, year, date, number of kokanee, size, fish/lb and stocking density (fish/ha and lb/ha) for Arrowrock and Lucky Peak reservoirs, between 2004 and 2020.

Waterbody	Year	Date	# of fish	Mean size (mm)	Fish/lb	Stocking density (fish/ha)	Stocking density (lb/ha)
Arrowrock	2004	14-Jun	77,025	100.0	41.1	61	1.5
Reservoir (ha)	2006	9-May	70,000	89	79.1	56	0.7
1,255	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
	2017	7-Jun	103,579	84	92.0	83	0.9
	2018	5-Jun	98,580	69	164.0	79	0.5
	2019	5-Jun	100,644	75	130.2	80	0.6
	2020	3-Jun	98,745	78	113.5	79	0.7
	2020	3-Jun	49,280	99	61.6	39	0.6
Lucky Peak	2004	14-Jun	155,950	90	108.4	135	1.2
Reservoir (ha)	2005	3-Jun	200,150	86	75.5	174	2.3
1,153	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
	2017	18-Apr	99,998	49	478.0	87	0.2
	2017	7-Jun	194,220	78	117.0	168	1.4
	2018	5-Jun	214,310	71	148.0	186	2.2
	2019	5-Jun	501,468	75.6	126.2	435	3.4
	2020	4-Jun	200,600	77	118.0	174	4.4
	2020	4-Jun	100,330	98	63.5	87	5.4

Table 2. Species, number captured, and catch per unit effort (CPUE; fish/net-night) of fish sampled during predator gill net efforts in Lucky Peak Reservoir during 2020 sampling.

Species	n	CPUE
Black Bullhead	3	1.5
Chiselmouth	1	0.5
Largescale Sucker	37	18.5
Northern Pikeminnow	14	7
Rainbow Trout	2	1

Table 3. Species, number captured, catch per unit effort (CPUE; fish/unit effort) and weight per unit effort (WPUE; kg/unit effort) of fish sampled during lowland lake surveys at Arrowrock Reservoir during 2020 sampling.

Species	n	CPUE	WPUE
Bridgelip Sucker	12	0.7	0.2
Bull Trout	1	0.1	0.1
Chiselmouth	1	0.1	0.0
Kokanee	4	0.2	0.1
Largescale Sucker	95	5.6	7.0
Mountain Whitefish	3	0.2	0.0
Northern Pikeminnow	109	6.4	2.4
Rainbow Trout	31	1.8	0.8
Smallmouth Bass	66	3.9	0.4
Yellow Perch	2	0.1	0.0

Table 4. Species, number captured, catch per unit effort (CPUE; fish/unit effort) and weight per unit effort (WPUE; kg/unit effort) of fish sampled during lowland lake surveys at Lucky Peak Reservoir during 2020 sampling.

Species	n	CPUE	WPUE
Black Bullhead	15	0.8	0.1
Bridgelip Sucker	57	2.9	0.7
Chiselmouth	26	1.3	0.1
Kokanee	6	0.3	0.0
Largescale Sucker	242	12.1	7.9
Northern Pikeminnow	92	4.6	2.4
Rainbow Trout	57	2.9	1.2
Redside Shiner	3	0.2	0.0
Sculpin spp.	1	0.1	0.0
Smallmouth Bass	59	3.0	0.5
Yellow Perch	6	0.3	0.1

Table 5. Year, waterbody, catch per unit effort (CPUE; fish/unit effort), percent of total CPUE, weight per unit effort (WPUE; kg/unit effort) and percent of total WPUE of nongame fishes (Northern Pikeminnow, Largescale Sucker, and Bridgelip Sucker) captured during standard lowland lake surveys.

Year	Waterbody	CPUE	% of total CPUE	WPUE	% of total WPUE
2009	Lucky Peak Reservoir	168.7	53%	43.8	77%
2012	Arrowrock Reservoir	109.2	67%	77.2	93%
2019	Lucky Peak Reservoir	12.2	67%	5.7	85%
2019	Arrowrock Reservoir	11.9	82%	8.2	92%
2020	Lucky Peak Reservoir	19.6	70%	11.0	85%
2020	Arrowrock Reservoir	12.7	66%	9.7	87%

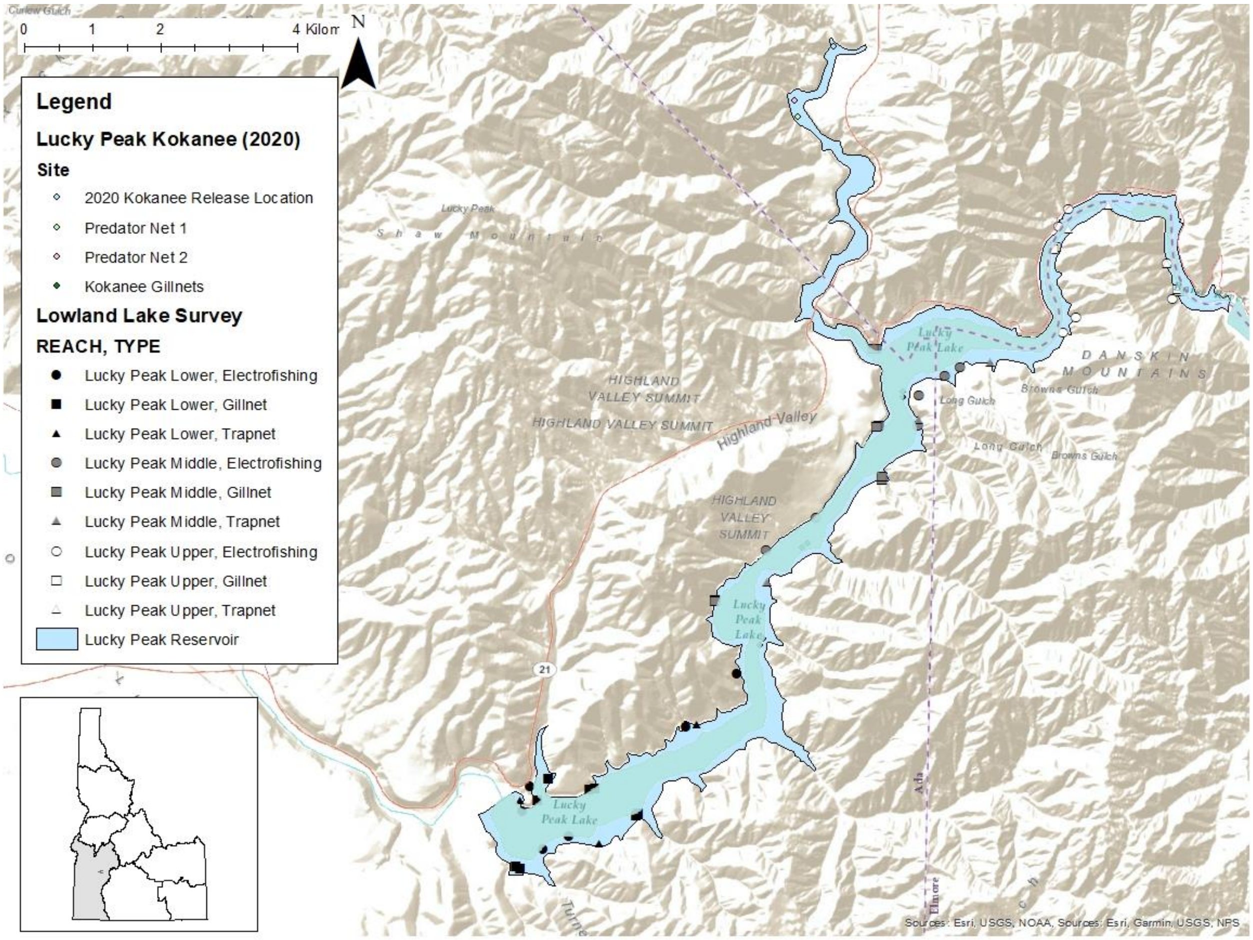

Figure 1. Map of Lucky Peak Reservoir with locations of lowland lake, predator gill net, and kokanee index survey sites sampled in 2020.

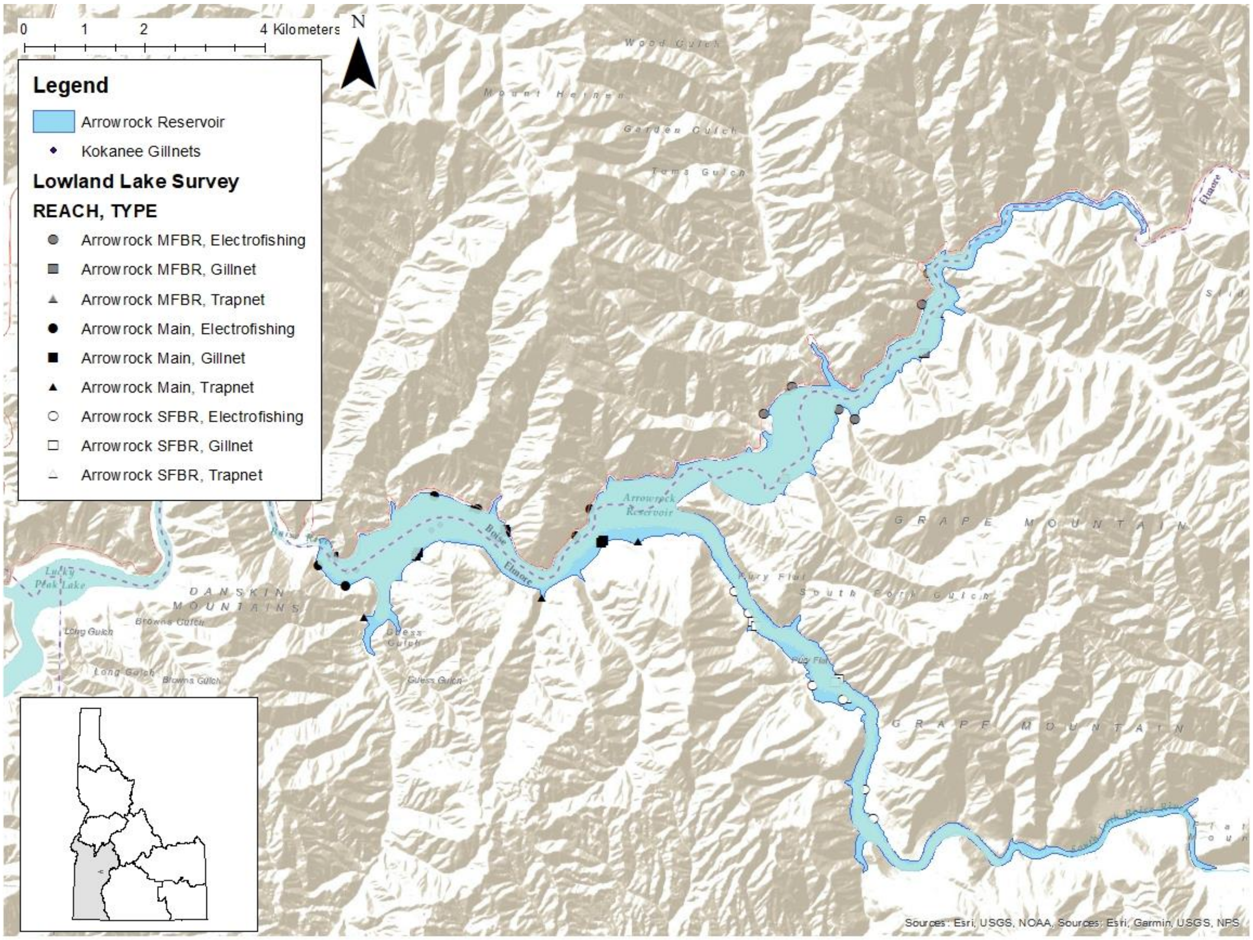

Figure 2. Map of Arrowrock Reservoir with locations of the lowland lake, predator gill net, and kokanee index survey sites sampled in 2020.

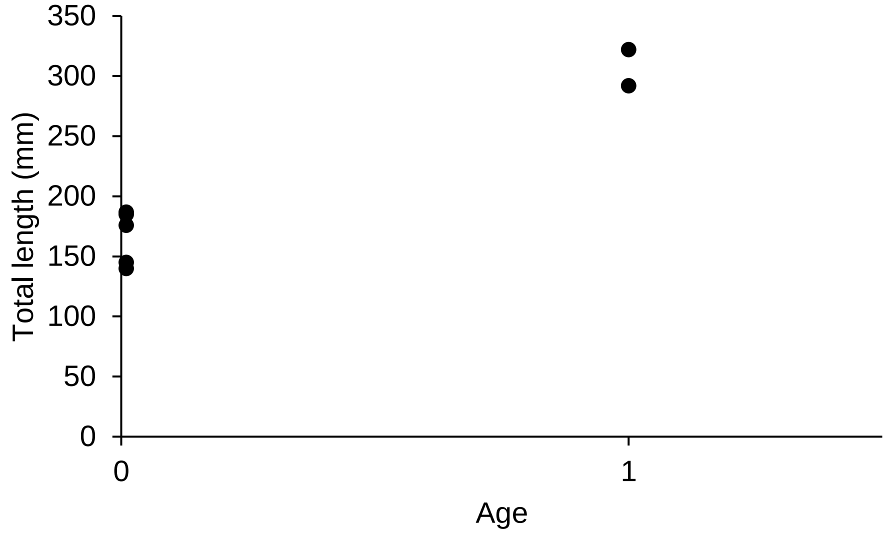

Figure 3. Kokanee age from otoliths recovered during fall kokanee index netting efforts at Arrowrock Reservoir during 2020.

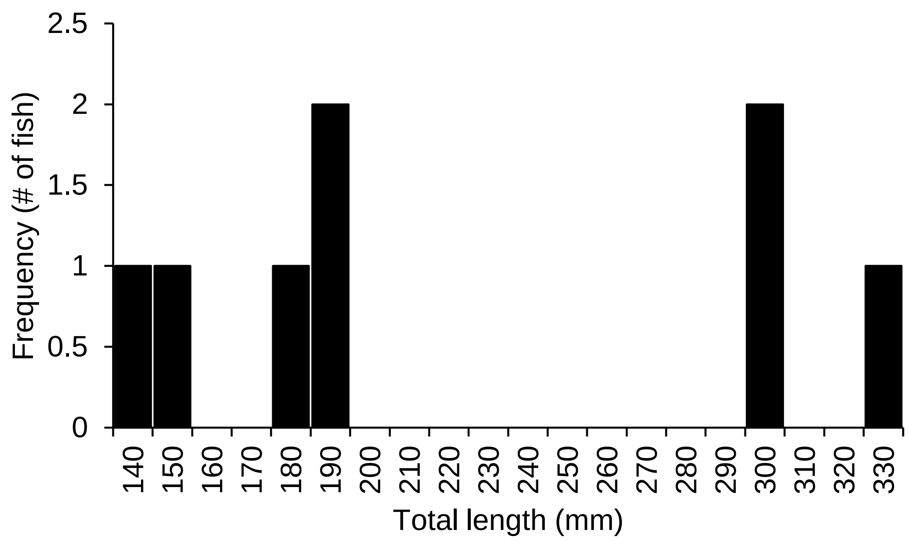

Figure 4. Length frequency of kokanee sampled during fall kokanee index netting efforts at Arrowrock Reservoir during 2020.

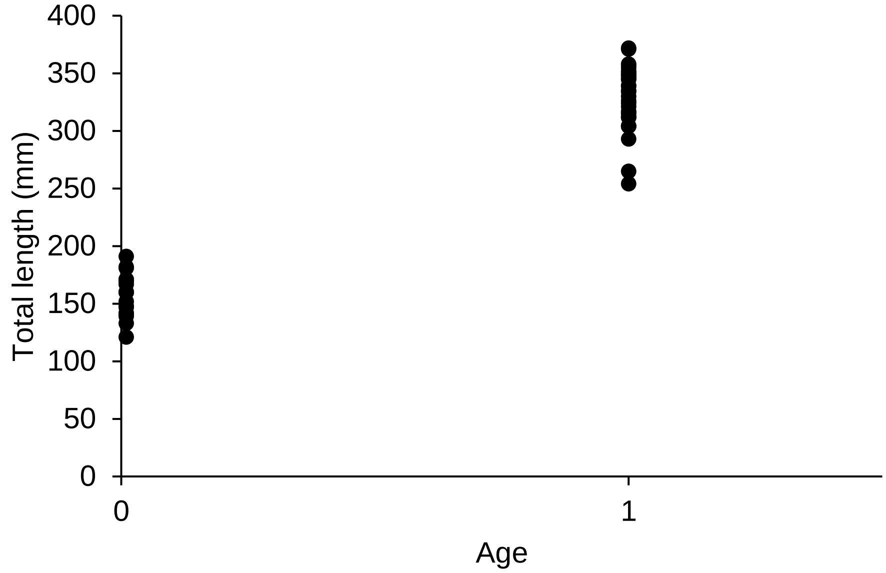

Figure 5. Kokanee age from otoliths recovered during fall kokanee index netting efforts at Lucky Peak Reservoir during 2020.

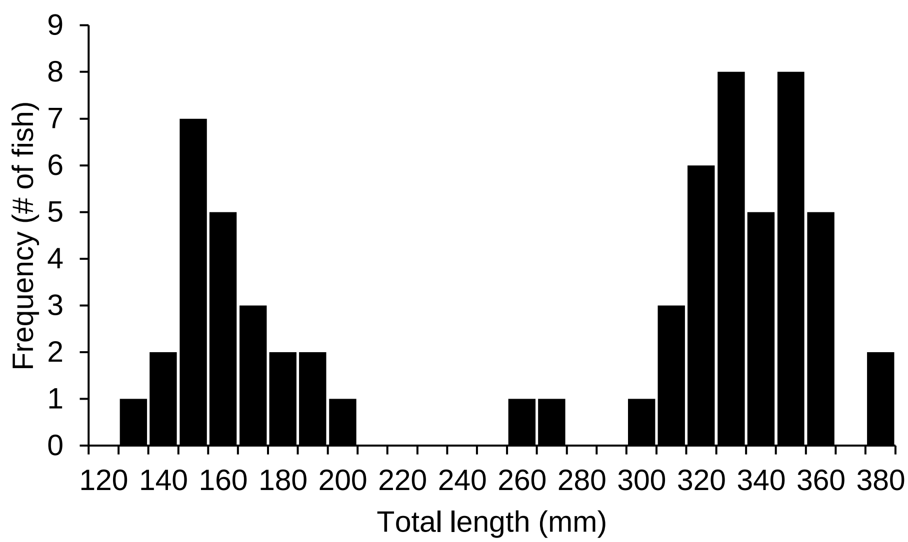

Figure 6. Length frequency of kokanee sampled during fall kokanee index netting efforts at Lucky Peak Reservoir during 2020.

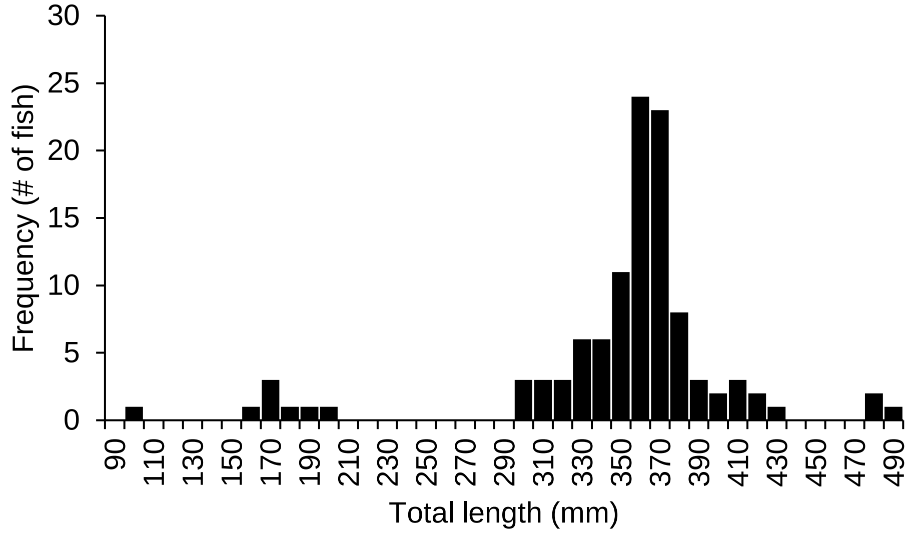

Figure 7. Length frequency of Northern Pikeminnow sampled during lowland lake surveys at Arrowrock Reservoir during 2020.

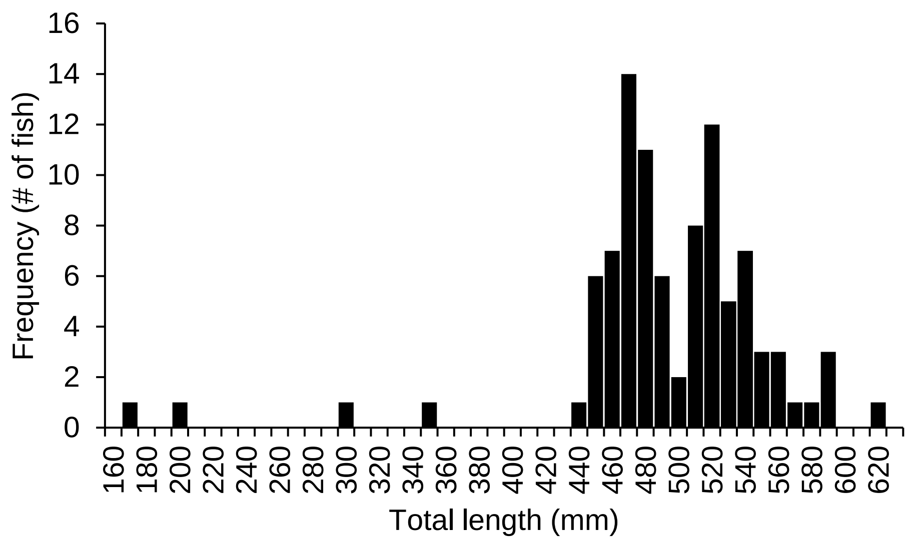

Figure 8. Length frequency of Largescale Sucker sampled during lowland lake surveys at Arrowrock Reservoir during 2020.

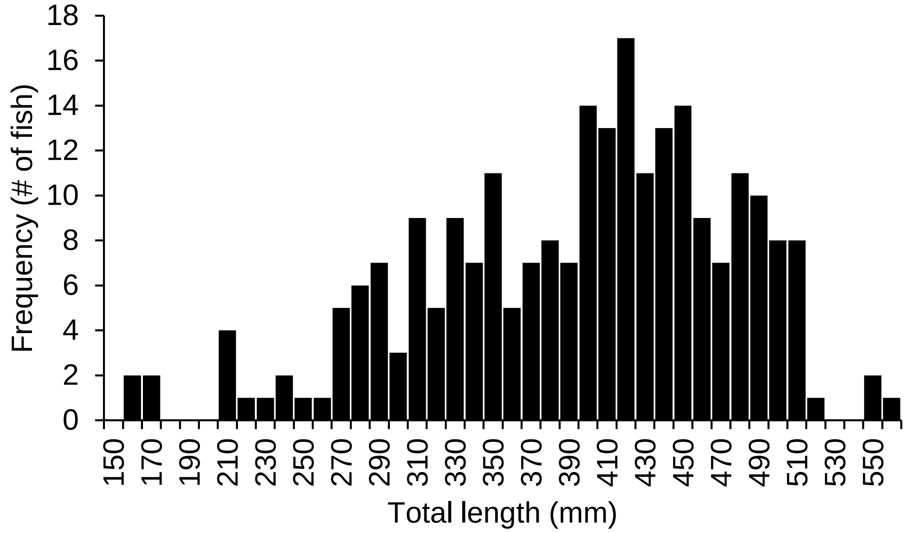

Figure 9. Length frequency of Largescale Sucker sampled during lowland lake surveys at Lucky Peak Reservoir during 2020.

DEADWOOD RESERVOIR

ABSTRACT

Kokanee (landlocked Sockeye Salmon; *Oncorhynchus nerka*) 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. Additionally, this kokanee population has historically been Idaho's primary egg source to produce hatchery kokanee of early-run strain. Kokanee escapement has been managed annually since 2010 to regulate fish densities (to meet target sizes), manage escapement, meet egg collection goals for hatchery stocking, and also provide desirable kokanee sizes for the sport fishery. Gill netting is important for setting escapement targets and monitoring the effectiveness of management strategies. In 2020, kokanee gill net CPUE was 46.8 fish/net-night.

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INTRODUCTION

Deadwood Reservoir's kokanee population and resulting spawning run into the Deadwood River serves as Idaho's primary egg source for producing hatchery-reared early spawning kokanee. Historically, this population has provided up to 7 million eggs to Idaho Department of Fish & Game (IDFG) hatcheries. On years when egg collection goals have been met, resultant fry and fingerlings have been distributed to 15-20 waters statewide. However kokanee populations are well known for having highly fluctuating densities and as a result, their growth rates are highly density dependent. Density-dependent growth results in decreased mean length at maturity at increased densities and is common in kokanee populations (Rieman and Myers 1992; Rieman and Maiolie 1995). Length and fecundity are highly correlated in kokanee (McGurk 1999) and larger females typically had higher fecundities (Kaeriyama et al. 1995). Wide fluctuations in kokanee density have been especially evident at Deadwood Reservoir, resulting in fluctuating levels of angling effort as well as variable success in egg collection. The reservoir also supports low densities of piscivores that have historically had little impact on kokanee abundance.

In addition to the Deadwood River upstream of the reservoir, kokanee have been known to utilize as many as five tributaries as spawning habitat. From 2006 to 2011, IDFG 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 were considered successful in most years. Subsequent periodic monitoring of these tributaries has indicated little to no kokanee spawning. In addition, continued restricted escapement above the Deadwood River weir also helped limit production. However, these restrictions were too effective in limiting kokanee production as kokanee numbers decreased below a level satisfactory to meet statewide early-run egg needs from 2015 to 2017. Fortunately, numbers have begun to rebound and minimum egg needs were again met in 2018.

Egg collection efforts at Deadwood Reservoir were discontinued in 2009 to evaluate a weir location on the South Fork Boise River. Due to limited success of the South Fork Boise River weir, egg collection and escapement management efforts resumed at Deadwood Reservoir in 2010 and continued through 2016. However, a continued downward trend in the Deadwood Reservoir kokanee population led to collection efforts on the Deadwood River being discontinued again in 2017 as the North Fork Clearwater River was evaluated as a potential alternative early run kokanee egg source. Again, limited success resulted in egg take at Deadwood Reservoir resuming in 2018.

Estimates of kokanee angling effort and corresponding potential harvest impacts have long been anecdotal at Deadwood. However, with recent declines in kokanee numbers and the corresponding increase in kokanee size, managers were concerned that the combination of large kokanee and liberal bag limits (25 fish per day) were resulting in a high level of overall angler harvest in the Deadwood fishery, further impacting subsequent egg take. A creel survey was conducted in 2018, and management recommendations resulted in reduced bag limits in 2019.

During 2020, we sampled the kokanee population as a continuation of our annual effort to index this population using gill net catch data. Data are used to populate a predictive model to help inform spawning operations, escapement and egg take goals at Deadwood Reservoir, thus providing early-run kokanee for anglers across the state of Idaho.

STUDY AREA

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. Deadwood reservoir offers a scenic setting at a relatively high elevation (1,615 m above sea level), and is a popular destination during summer. Deadwood Reservoir provides abundant sport fishing opportunities for kokanee, resident fall Chinook Salmon *Oncorhynchus tshawytscha*, Rainbow Trout *O. mykiss,* and Westslope Cutthroat Trout *O. clarkii lewisi*. Bull Trout *Salvelinus confluentus* are present, but at a very low abundance.

METHODS

The pelagic fish species composition in Deadwood Reservoir was assessed from June 22 to 24, 2020 using six curtain gill nets set over two nights at three separate trend locations (six total net-nights; Figure 10). At each site, two nets were suspended at offsetting depths in the water column with focus on the "kokanee layer"; one net from 3-6 m and one from 6-9 m. Nets were 55 m wide x 3 m deep and made up of 18 separate, 3-m wide panels comprised of 13-, 19-, 25-, 38-, 51-, 64-, 76-, 89-, and 102-mm stretch mesh. The nine various sized panels were each repeated twice, randomly, throughout the length of the net.

Captured fish were identified to species and measured for total length (± 1 mm). Kokanee greater than 150 mm were necropsied to determine sex, maturity, fecundity, 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; fish/net-night). All kokanee otoliths were removed for determining age using sectioned whole otoliths. Otoliths were aged by two agers and discrepancies between agers were settled via discussion and image review among agers and the aid of fish length. We also evaluated otoliths from kokanee sampled in gill nets during the June survey as well as a subsample (n = 50) of spawning-age kokanee who returned to the weir in early September 2020. All kokanee otoliths were also evaluated for thermal marks to determine natural or hatchery origin.

Based on results from the early summer gill net surveys, IDFG has developed a model to predict relationships in gill net survey data and subsequent annual weir returns. Model inputs include CPUE of adults and associated size of mature females. Model outputs include estimated growth and ultimately fecundity of females, as well as the predicted annual weir returns. IDFG uses this model to monitor egg take goals, and estimate escapement needs to the Deadwood River to supplement naturally-reproducing kokanee populations.

RESULTS

A total of 334 fish were captured in gill nets during the pelagic survey (Table 6). Approximately 84% of the catch was kokanee (n = 281, CPUE = 46.8 fish/net-night), followed by Mountain Whitefish *Prosopium williamsoni* (13%, n = 42, CPUE = 7.0 fish/net-night). Rainbow Trout (3%, n = 9, CPUE = 1.5 fish/net-night) and Bull Trout (>1%, n = 1, CPUE = 0.2 fish/net-night) were also captured, but in very low numbers. Age-specific CPUE of kokanee in 2020 was 17.0 fish/net-night for age-1, 23.7 fish/net-night for age-2, and 6.2 fish/net-night for age-3. CPUE of spawning-age adult fish (age-2 and age-3) was 29.8 fish/net-night.

Total length of kokanee captured in the gill nets ranged from 88 to 410 mm (mean = 190.5 mm, SD = 62.7). Total length of Mountain Whitefish ranged from 270 to 409 mm (mean = 348.0

mm, SD = 32.3). Total length of Rainbow Trout ranged from 325 to 457 mm (mean = 383.8 mm, SD = 40.8;

Figure 11,
Figure 12, and
Figure 13).

We took otoliths from 152 of the 281 kokanee captured in June 2020 to estimate mean age composition and mean length-at-age. Kokanee captured in gill nets were ages 1-3, with one age-7 fish observed (

Figure 14). No age-0 fish were captured in the gill net survey. Age-1 kokanee ranged from 88 to 152 mm, age-2 kokanee ranged from 175 to 283 mm and age-3 kokanee ranged from 269 to 308 mm. One fish (410 mm TL) was captured and estimated to be age-7. At the time of the gill net survey, it was difficult to determine mature males, and thus will not be included in this analysis. Mean TL of mature female kokanee was 257 mm.

Otoliths were also examined for thermal marks. Of the 152 kokanee otoliths taken in June 2020, 133 were successfully processed, of which 14 had thermal marks (age 1-3). Of the 50 otoliths we collected from spawning-age kokanee (September 2020), 47 were successfully processed, with 9 observed thermal marks (age-2 and 3).

Results from the modeling exercise predicted the adult kokanee return to the Deadwood weir based on gill net catch to be approximately 44,000 kokanee (

Figure 15).

DISCUSSION

Based on recent gill net surveys, the kokanee population in Deadwood Reservoir appears to be rebounding following the low numbers observed in 2017. Kokanee CPUE was 46.8 fish/net-night in 2020, which was almost double the 2019 CPUE, and one of the highest in recent years. We currently have six years (2013, 2015, 2016, 2018, 2019 and 2020; 2014 catch was under-representative due to alternative net locations and 2017 there was no weir) of catch and subsequent weir return data. The model predicts weir returns based on age-2 and 3 gill net catch. Each additional year of netting data helps inform the model and increases the accuracy of the model predictions. The model over predicted the 2020 weir returns (predicted return = 43,740, actual return = 21,017) yet did not change the model prediction strength (r^2 = 0.88). Based on the previous model inputs, our model has over predicted kokanee returns four of the past six years, typically during years where predicted returns have been under 50,000 fish. The 2020 egg take operation resulted in an estimated 1.3 million eggs taken from Deadwood, which did not meet total requests (2.06 million). We hypothesize this may be due to timing and water management of the reservoir. Anecdotal reports observed kokanee approximately 15 rkm above the weir prior to the weir installation in mid-August, suggesting a significant portion of the Deadwood River returning kokanee had escaped above the weir prior to its installation.

Thermally-marked otoliths provide managers the ability to not only have known-age fish, but also to determine proportional composition of spawning runs from both hatchery and wild fish. We assume otoliths that were successfully processed but did not observe thermal marks came from wild fish. Thermal marks from June 2020 suggested approximately 10% of kokanee were of hatchery origin, while the September 2020 subsample indicated approximately 19% were of hatchery origin. We captured three distinct age categories (age-1, age-2 and age-3) based on thermally-marked kokanee in the June 2020 gill net efforts, and two distinct age categories (age-2 and age-3) from the September 2020 sample.

As with the 2019 survey, the 2020 survey showed a large cohort of age-2 kokanee, which should bode well for the 2021 kokanee spawn year. Additionally, the reservoir has been stocked with hatchery fingerling kokanee since 2018 to help the population recover more quickly. Continuing early summer netting will provide insight into spawning kokanee abundance and aid in planning annual egg take and adult escapement strategies. We anticipate altering the timing and duration of the weir to better capture kokanee as they make their spawning migration. By installing the weir earlier and for a longer duration, we hope to capture more of the annual spawning run. However, earlier weir installation comes with its own suite of limitations, including deeper water, more tributaries to weir off, and potential for increased debris flows.

Managing the Deadwood Reservoir kokanee populations remains difficult given the numerous goals associated with the population. The current Fisheries Management Plan calls for a 12-inch (305 mm) kokanee yield fishery. Kokanee are notoriously density dependent; as population size grows, fish size decreases. Given our current knowledge of the density dependent growth relationship at Deadwood, a target female length of about 305 mm is likely ideal in achieving our management goals. With the 2019 length-at-age data, we were able to fit a Von Bertalanffy Growth Function (VBGF) to estimate hypothetical maximum age and hypothetical maximum length of Deadwood Reservoir kokanee. Based on the VBGF, the maximum modeled length for Deadwood Reservoir kokanee was approximately 372 mm and the modeled maximum age is age-5. During the 2020 survey, we captured a kokanee that exceeded both hypothetical maximum length and hypothetical maximum age; the fish was 410 mm and estimated at age-7. While this was a single observation, it was a curious finding. We will continue to monitor kokanee total lengths and ages to achieve management goals.

Deadwood Reservoir is the primary egg source for hatchery-reared early-run kokanee, which support highly popular kokanee fisheries across Idaho. As such, the ability to predict spawning returns in Deadwood Reservoir is paramount not only for Deadwood Reservoir, but all early-run kokanee fisheries in Idaho. However, managing kokanee abundance in a highly productive system with multiple spawning tributaries, such as Deadwood, remains difficult and we recognize the population will continue to fluctuate around specific goals. We will continue to monitor the kokanee population in Deadwood Reservoir and adjust management practices as necessary to achieve both hatchery production and sport fishing goals.

RECOMMENDATIONS

1. Continue gill net monitoring of the pre-spawning kokanee population in Deadwood Reservoir to generate age-specific CPUE and length-at-age to estimate potential spawners in 2021

2. Stock hatchery fingerling kokanee in Deadwood Reservoir in June 2021

3. Assist in weir operations on the Deadwood River to manage escapement and collect broodstock for egg collection

4. Monitor escapement in other Deadwood Reservoir tributaries (besides Deadwood River) by walking tributaries during the kokanee spawn

Table 6. Species, number collected and catch per unit effort (CPUE; fish/net-night) during gill net surveys in Deadwood Reservoir, Idaho during June 2020.

Species	n	CPUE
Kokanee	281	46.8
Mountain Whitefish	42	7.0
Rainbow Trout	9	1.5
Bull Trout	1	0.2

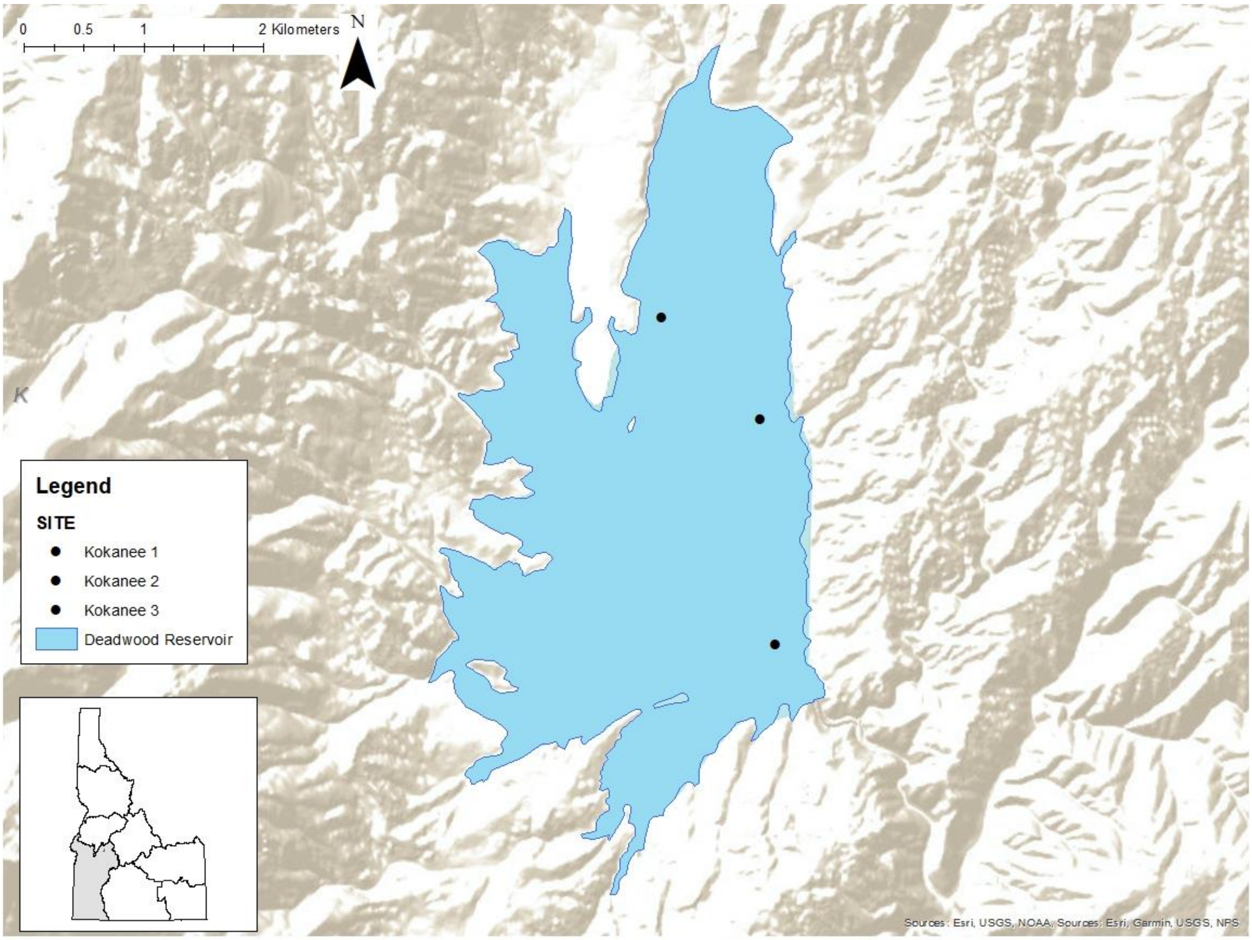

Figure 10. Gill net locations during surveys in Deadwood Reservoir, Idaho during June 2020.

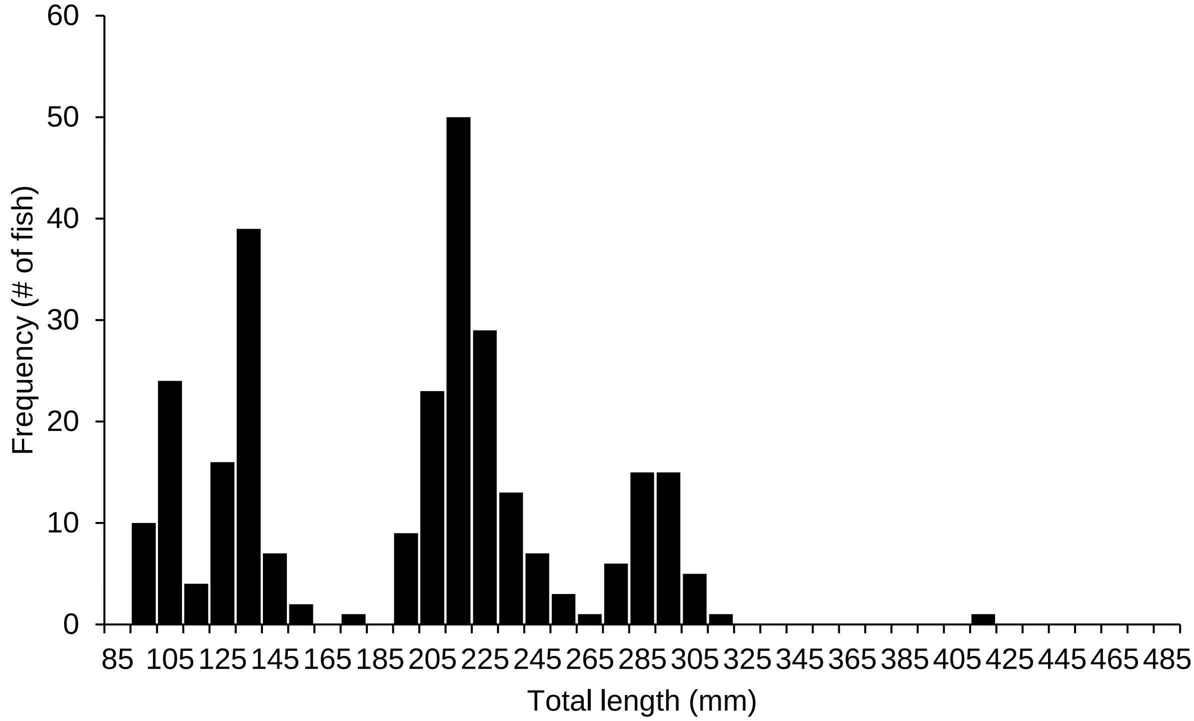

Figure 11. Length-frequency histogram of kokanee captured during gill net surveys in Deadwood Reservoir, Idaho during June 2020.

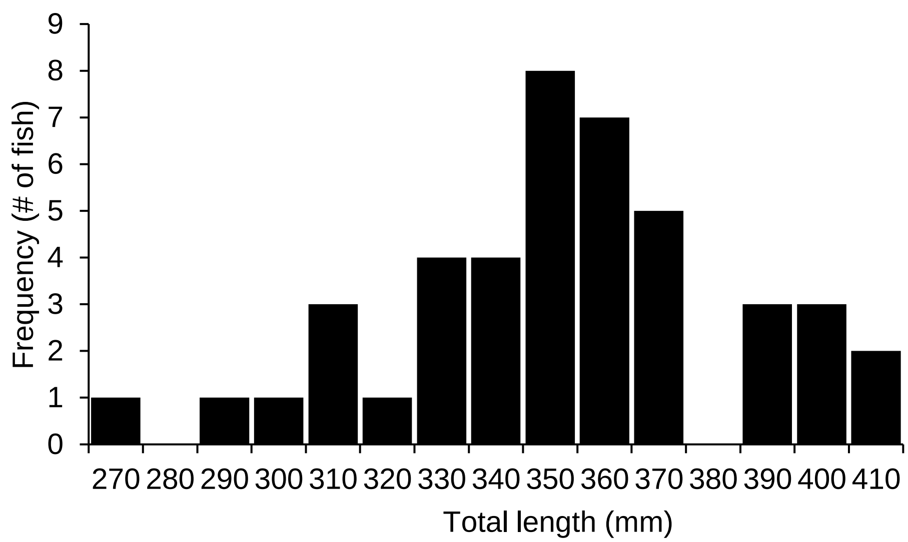

Figure 12. Length-frequency histogram of Mountain Whitefish captured during gill net surveys in Deadwood Reservoir, Idaho during June 2020.

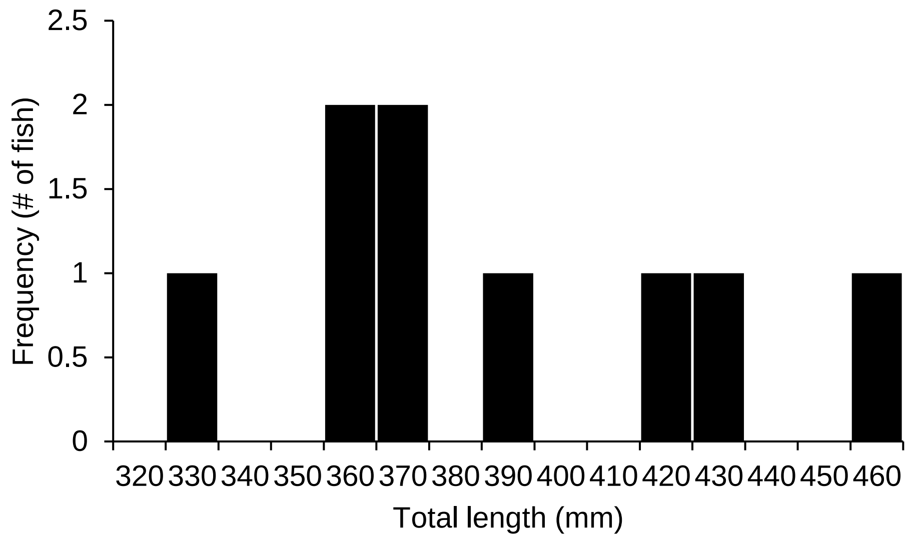

Figure 13. Length-frequency histogram of Rainbow Trout captured during gill net surveys in Deadwood Reservoir, Idaho during June 2020.

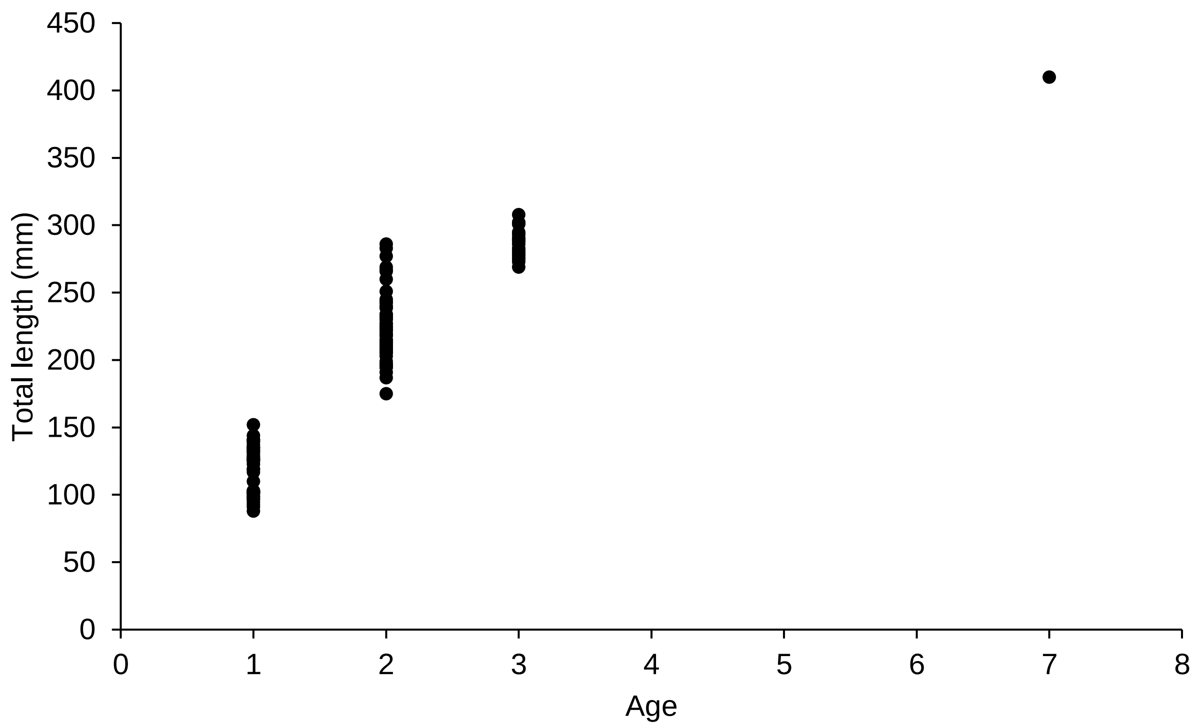

Figure 14. Length-at-age of kokanee captured during gill net surveys in Deadwood Reservoir, Idaho during June 2020.

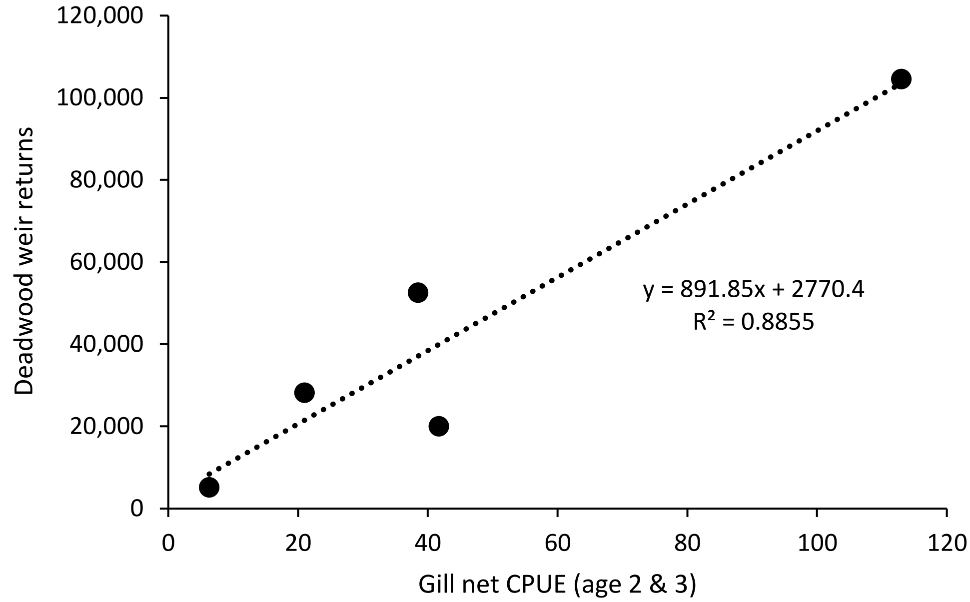

Figure 15. Weir returns as a function of gill net CPUE of kokanee captured during gill net surveys in Deadwood Reservoir, Idaho during June 2020.

ASSESSMENT OF PANFISH POPULATION DYNAMICS IN C.J. STRIKE RESERVOIR

ABSTRACT

Panfish species found in C.J. Strike Reservoir provide a popular recreational angling opportunity in Southwest Idaho. In 2016, regional staff began a multiyear investigation to better understand the population dynamics of crappie (Black Crappie *Pomoxis nigromaculatus*, White Crappie *Pomoxis annularis*, and their hybrids) and Yellow Perch *Perca flavescens*. We also endeavored to learn how anglers utilize these species in the fishery. In the spring and fall of 2020, staff completed surveys using standardized lowland lake sampling gears and index creel surveys to assess relative abundance of panfish species and angler use. Continued monitoring of larval fish production was completed to identify peak larval mean densities for crappie and Yellow Perch. Otter trawl gear was used in the fall of 2020 to determine relative abundance of panfish species prior to the onset of winter. The spring creel survey was not completed due to the COVID-19 pandemic. In the fall creel survey, 129 anglers were interviewed. Mean larval crappie density peaked at 57.2 fish/100 m^3 which occurred on June 3, 2020. In the spring index survey, crappie catch per unit effort was 93.7 fish/unit effort for all standardized gears, this value decreased to 12.9 fish/effort in the fall. Otter trawl survey catch was comprised of 51.1% crappie, 21.8% Yellow Perch and 25.6% Bluegill. Age and growth data were similar to data observed during the previous years of the assessment. Continued use of existing gear types and systematic sampling to develop indices of relative abundance should provide us with increased understanding of these sport fish populations.

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INTRODUCTION

Panfish (e.g. crappies Pomoxis spp., 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 southwestern Idaho is at C.J. Strike Reservoir. According to creel data collected by Idaho Power Company from 1994 to 2009, anglers expended an average of 260,000 hours annually at this fishery, and most of that time was directed at panfish species (Brown et al. 2010).

Crappie populations are often cyclical, exhibiting wide fluctuations in both larval production and adult abundance (Langlois 1937; Miranda and Allen 2000). This pattern is evident in C.J. Strike Reservoir where these same two demographics can fluctuate dramatically from one year to the next. In years when crappie are abundant, the proportion of anglers targeting this species may more than double (Brown et al. 2010). A large year-class of crappie was produced in 2006, documented by the high larval densities observed in the Bruneau River arm of the reservoir. These larval crappies survived at a high rate but were not sampled again in a meaningful way until 2009 when they were large enough to be susceptible to sampling gear targeting adults. Electrofishing catch per unit effort (CPUE) for Black Crappie *Pomoxis nigramaculatus* during the 2009 lowland lake survey was 23 times higher than the highest observed CPUE from the five year previous surveys (1995-2000; Butts et al. 2013). This year-class provided substantial fisheries in 2008, 2009 and later, although creel data was not collected after 2009 (Brown et al. 2010). This 2006 year-class declined in abundance after 2010 and no major year classes contributed to the fishery again until 2017, despite occasionally high larval production.

Yellow Perch populations seem to follow similar cyclic patters as crappie (Dembkowski et al. 2016). Past creel survey data at C.J. Strike indicated that the contribution of Yellow Perch to overall harvest ranges from a high of 40% to a low of 3% (Flatter et al. 2006). Similar fluctuations have been observed in electrofishing CPUE conducted by Idaho Department of Fish and Game (IDFG) which ranged from 1-159 fish/hour (Butts et al. 2013b). Angler preference for Yellow Perch appears to vary across years as well; in the 1992 creel survey, anglers indicated that they targeted Yellow Perch roughly 10% of the time. Conversely, in a survey conducted by Idaho Power Company from 2007 to 2009, anglers targeted Yellow Perch 6-23% of the time. Currently, population dynamic information for Yellow Perch in C.J. Strike Reservoir is incomplete and no Yellow Perch focused studies have been completed.

Year-class strength for crappie 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 location on C.J. Strike from 2005 to 2020. This tool is more effective at sampling larval crappies rather than Yellow Perch and provides and index of relative abundance. Peak larval densities from 2005 to 2016 averaged 17 fish/100 m^3 (10 year average; Butts et al. 2017). However, in 2006, densities averaged 58 fish/100 m^3 and produced a strong year class of crappie 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 crappie unless substantial over-winter mortality occurred. A previous project found no consistent relationship between the peak larval densities and year-class strength (Lamansky Jr. 2011), suggesting that other factors limiting early survival could be driving recruitment. Further investigation of larval production and subsequent survival is needed to determine the factors driving crappie recruitment.

Data for age-1 and older crappie and Yellow Perch have been collected for the C.J. Strike Reservoir in the past, however life-stage specific mortality rates are lacking. Several lowland lake surveys conducted on C.J. Strike provided CPUE and length frequency data for these species (Butts et al. 2013b). However, life-stage mortality for crappie or Yellow Perch were not investigated. The Idaho Department of Fish and Game (IDFG), used non-reward T-bar anchor tag return rates to generate annual mortality rates for crappie, which ranged from 50-86% for the entire population not specific to year-class (Meyer and Schill 2014). Age and growth data for crappie populations was also investigated throughout the state, including C.J. Strike Reservoir. Crappie sampled in C.J. Strike had relatively fast growth and very few crappie older than age-3 were observed (Lamansky Jr. 2011). This suggests that the crappie population exhibits high annual mortality, which was also observed in adjacent studies (Meyer and Schill 2014). Age data for crappie collected in other Southwest Region waters suggest that crappie can survive to age six or older (Butts et al. 2017). Describing life-stage specific mortality rates may help identify population bottlenecks, which, if manageable, may increase recruitment of crappie or Yellow Perch for future fisheries.

Multiple factors, both biotic and abiotic, likely increase the complexity of understanding crappie recruitment (Siepker and Michaletz 2013). Extensive research completed throughout the range of crappie have identified biotic factors such as size of spawning adults (Bunnell et al. 2006; Fayram et al. 2015), intraspecific and interspecific competition, as well as predation (Pope and Willis 1998; McKeown and Mooradian 2002; Parsons et al. 2004) as factors that affect recruitment. Abiotic factors such as water level (Sammons et al. 2002; Maceina 2003; Fayram et al. 2015), water temperature (Pine and Allen 2001; McCollum et al. 2003) and the physical and chemical characteristics of the waterbody (Bunnell et al. 2006) likely influence recruitment as well. Wisconsin’s Department of Natural Resources recently released two relevant literature reviews that address management approaches for crappie 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 2017).

Currently, no bag or length limits have been placed on panfishes in C.J. Strike Reservoir, and these populations are managed for maximizing harvest opportunity. However, the Southwest Region repeatedly received requests from anglers to implement restrictive regulations on crappie (most often a bag limit) with the hope of providing stable fishing opportunities on these cyclic fisheries. 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. Minimum length limits have been shown to increase both abundance and size structure in crappie and Yellow Perch populations (Allen and Miranda 1995; Isermann et al. 2002; Mosel et al. 2015). However, the benefits associated with bag limits of 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).Currently, a lack of available growth and mortality data prevents informed decisions regarding restrictive fishing rules. Prior to addressing the need for regulation changes (e.g. bag limit or minimum length requirement), data specific to C.J. Strike crappie and Yellow Perch need to be evaluated to predict whether these management tools can benefit sport fishing within the reservoir.

Lake and reservoir-specific studies are needed to better understand population fluctuation and the factors that affect panfish recruitment before appropriate management strategies can be applied (Lamansky Jr. 2011; Fayram et al. 2015). To advance management and determine whether regulations should be altered to maintain or improve crappie or Yellow Perch fisheries, an in-depth sampling of C.J. Strike Reservoir was implemented in 2016 to generate population-specific data, especially relating to abundance fluctuations. While the primary focus of this assessment is on crappie and Yellow Perch populations; when possible, data will also be collected for Smallmouth Bass *Micropterus dolomieu* and Bluegill to increase our understanding of these populations. The assessment includes an index creel survey in both spring and fall to learn how anglers utilize panfish species within the reservoir. The use of otter trawl gear was investigated to develop an index of relative abundance and monitor survival of larval production to the onset of winter. In 2017, spring and fall population indexing were initiated utilizing lowland lake survey gears (e.g. electrofishing, trap nets, and gill nets). Data generated from the spring relative abundance index will be used to assess whether overwinter mortality is a limiting factor that affects recruitment of young-of-year (YOY) crappie and Yellow Perch to future age classes. In addition, the data generated from the fall relative abundance index will allow us to identify whether larval fish survive to enter their first winter or if a survival bottleneck exists prior to fall. The spring and fall surveys also allow for the monitoring of older age classes of crappie and Yellow Perch at multiple life stages. Finally, zooplankton quality index (ZQI) sampling was established to determine whether zooplankton production affects panfish growth.

MANAGEMENT GOAL

Maintain or improve sport fishing opportunities for panfish species, specifically crappie species and Yellow Perch in C.J. 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, gill netting, electrofishing) for monitoring primary panfish populations in C.J. Strike Reservoir at several life stages

2. Develop and implement annual, consistent monitoring efforts

3. Estimate key parameters that describe population dynamics of crappie and Yellow Perch, specifically, index of stock, length frequency, age frequency, age and growth, total mortality, fishing mortality, age and length at sexual maturity

4. Estimate key parameters that describe angler harvest of crappie and Yellow Perch

STUDY AREA

C.J. Strike Reservoir's primary purpose is hydroelectric power production with minimal water fluctuation 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. C.J. Strike Reservoir is listed as an impaired waterbody by the Idaho Department of Environmental Quality due to nutrient and pesticide inputs (Idaho Department of Environmental Quality 2006). The reservoir is 3,035 ha and provides habitat for a wide variety of fish species ranging from cold-water species (e.g. White Sturgeon *Acipenser transmontanus* and Rainbow Trout *Oncorhynchus mykiss*) to warm-water species like crappie and Largemouth Bass *Micropterus salmoides*. C.J. Strike is influenced by two major water sources, the Snake and Bruneau Rivers, and can be divided into three distinctive segments: the Bruneau Arm (1,123 ha), the Snake Arm (759 ha) and the Main Pool (1,153 ha). The Bruneau Arm is relatively shallow, warm, turbid, and typically has a low turnover rate from the much lower discharge contributed by the Bruneau River. The Snake Arm is deeper, clearer and has a high turnover rate.

METHODS

Site Selection

A randomized sampling protocol was implemented to collect representative samples of the fish population throughout each section of the reservoir. Within each section, Google Earth Pro (version 7.1.7.2606) was used to estimate the length of the shoreline. This total shoreline distance was divided into 500-m sections and designated unique values. Sites were selected randomly and assigned a gear type using a random number generator applied to the unique values. These same sites have been sampled 2016-2020 and will continue to be sampled in successive years.

Angler Catch Rates

Six fixed dates were randomly selected, three weekdays and three weekend days, for spring and fall index creel surveys. Fixed dates are defined as the same day of each year (e.g. the first Tuesday of May). The spring creel survey was not completed due to the COVID-19 pandemic. The fall survey occurred between September 5 and October 13, 2020. Selected dates were subdivided into two five-hour time slots, 0900-1400 hours and 1500-2000 hours. One of these time slots was randomly selected for each date as the time of the creel survey. The two most popular boat ramps located at C.J. Strike Reservoir are Air Force and Cottonwood boat ramps and these were selected as suitable locations to collect creel data.

The survey design was based on a portion of access-access survey described by Pollock et al. (1994). Two signs are used to inform anglers leaving the boat ramp area of the check station location and several orange cones are used to direct anglers to a pullout area where our crew is stationed. Only completed fishing trip information was used for catch rate estimation to avoid bias associated with incomplete trips (MacKenzie 1991; Hoenig et al. 1997). Ordinarily, anglers are asked to present their catch and fish are measured and weighed. In 2020, a socially distanced format was adopted and fish were not presented or processed. Individual interview queries included party size, primary target species, how long they fished, harvest by species, release by species, angler residency and whether anglers were fishing from a boat or the bank. Interview data was summarized as the ratio of means by calculating the catch per unit effort (CPUE) for each angler and then averaging those values based on targeted species categories. Catch rates, variance and confidence intervals were derived using the multiday estimator found in McCormick and Meyer (2017).

Spring Relative Abundance

Fish populations in C.J. Strike Reservoir were sampled with standard IDFG lowland lake sampling gear (Butts et al. 2013b) from May 20-21 and May 27-29 and June 2-3, 2020. Gear included paired sinking/floating gill nets, trap nets and night boat electrofishing. Paired gill net sets consisted of one floating and one sinking monofilament nets (46 m x 2 m with six panels composed of 19-, 25-, 32-, 38-, 51- and 64-mm bar mesh sizes), nets were set approximately 100 m apart. Paired nets were fished for one night, equaling one unit of gill net effort. Trap nets were comprised of 19-mm bar mesh treated with black tar, 15-m leads with 1 m x 2 m frames and crowfoot throats on the first and third of five loops. One trap net fished for one night equaled one unit of trap net effort. Boat electrofishing utilized a Midwest Lake Electrofishing System (MLES) Infinity set-up set at 20% duty cycle and approximately 2,200-2,800 W of pulsed DC power generated by a 6,500 W Honda generator. One hour of active (on-time) electrofishing equaled one unit of effort. One hour of electrofishing, divided into six, ten-minute runs; seven trap nets and four paired gill net sets were deployed in each of the three section of C.J. Strike Reservoir, providing 12 units of effort in each section (Figure 16). Catch data were summarized as the CPUE for each gear type. Indices were calculated by standardizing the catch rate of each gear type to one unit of effort and then summing across the three gear types.

To estimate angler harvest and total catch for crappie and Yellow Perch, individuals captured in trap nets were tagged using 70 mm (51 mm tubing) fluorescent orange Floy FD-68BC T-bar anchor tags. Fish ≥ 200 mm had tags inserted just beneath the dorsal fin. Tag reporting data was collected using the IDFG Tag! You're It! phone system and website. Angler harvest and total catch rates of crappie and Yellow Perch were calculated from reported tags (Meyer et al. 2012; Koenig et al. 2015). Tag reports were adjusted using a non-reward tag reporting rate of 59.7% and 58.5% and a 1-year tag loss rate of 2.8% and 1.2% for crappie and Yellow Perch, respectively (IDFG unpublished data). Tag reporting data was analyzed for a 365-day duration after release for fish tagged in 2019.

Captured fish were identified to species, measured for total length (± 1 mm) and weighed (± 1 g) using a digital scale. If catch was too large to process fish quickly enough to ensure reasonable survival, fish were binned to 10-mm length intervals and released as quickly as possible. Relative weight (W_r) was calculated as an index of general fish body condition. A value of 100 was considered average condition, values greater than 100 were considered above average and values less than 100 were considered below average body condition. Proportional size distribution (PSD) was calculated for crappie and Yellow Perch to describe trends in length frequencies over time (Anderson and Neumann 1996). Stock size of 130 mm and quality size of 200 mm were used for both crappie and Yellow Perch (Gabelhouse Jr. 1984).

Larval Fish Production and Zooplankton

Horizontal surface trawls were used to sample larval fish at 10 sites throughout C.J. Strike Reservoir using a 1 m high x 2 m wide x 4 m long Neuston net with 1.3 mm mesh (Figure 17). Sampling took place on June 3, 9, 18, and 25 and July 1, 2020; these dates overlapped with peaks of crappie production in past years. Trawling commenced at dusk with each trawl being five minutes in duration. A flow meter was fitted to the bridle of the net to estimate the volume of water sampled. Specimens were preserved and stored in 70% ethanol (Parsons et al. 2004) and processed in the laboratory following sampling. A dissecting microscope was used to aid in identification to species. If the total catch of a trawl exceeded 30 individuals, a subsample of 30 was randomly selected to be identified and measured, these values were then used to extrapolate based on the remaining number of individuals in the sample. The week that had the highest crappie density averaged across all sample sites was assumed to be the peak of larval density for the year and reported as fish per 100 m^3. Data were compared across years to categorize trends in crappie production.

Zooplankton quality index (ZQI) was initiated in the spring of 2017 and continued in 2020 following the protocol set forth in Teuscher (1999). ZQI was defined as the samples of the 500 µm and 750 µm net samples added together for a total of usable zooplankton available. Sampling was conducted at three sites within the reservoir once a month beginning in May and ending in October, which is assumed to be when age-0 panfish would be utilizing zooplankton the most. Samples were processed to determine the Zooplankton Ratio (ZPR) defined as the ratio of preferred zooplankton captured in the 750-µm net to the usable zooplankton captured in the 500-µm net.

Fall Relative Abundance

Crappie and Yellow Perch populations in C.J. Strike Reservoir were sampled again in the fall with standard IDFG lowland lake sampling gears from October 13-17, 2020. Sampling gears included those referenced in the spring survey above and consisted of the same units of effort (e.g. one floating and one sinking gill net, fished for one night, equaled one unit of effort). Similar to the spring survey, we used equal amounts of effort in each of the sections but effort was halved from the spring sampling event with 0.5 hours of night boat electrofishing, divided into three, ten minute runs, four trap nets and two paired gill net sets were deployed in each of the reservoir sections for 6.5 units of effort (Figure 18). Sample location selection and fish/data processing methods were similar to the spring relative abundance survey described above. The same criteria was used to deploy tags in crappie and Yellow Perch captured in trap nets during the fall survey to estimate harvest and total catch.

Otter Trawl Relative Abundance

An otter trawl was used to develop an index of relative abundance for panfish species and to monitor survival from spring larval production to the onset of winter. In 2017, 12 sites were selected (four in each reservoir section) within areas with relatively uniform bottom based on depth profiles (Figure 19). Sampling of these 12 sites took place on November 6 and 9, 2020. The otter trawl net dimensions were 2.2 m x 4.6 m and 9 m long, made of 39-mm stretch mesh in the body and 13 mm mesh in the cod end. The trawl was outfitted with weighted otter doors to ensure the net remained open while in tow (Hayes et al. 1996). The net had a 15-m bridle 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 trawl was towed for three minutes at 11 sites, one site was reduced to two minutes due to repeated snags on the substrate.

Captured fish were identified to species, measured for total length (± 1 mm) and weighed (± 1 g) with a digital scale. Fish less than 100 mm were not weighed due to the inaccuracy of the scale at small values. In years of high abundance, like 2020, a subsample of fish was measured and weighed and the rest were identified to species and counted. Densities by species were calculated as the number of fish per 100 m^3 for each trawl. Due to a malfunction of the flow meter in three of the tows, the volume of water sampled was assigned the mean value from the remaining 10 tows. The mean fish density across all sample locations was calculated to index relative abundance of species.

Age and Growth

Dorsal fin rays were collected from up to 10 fish per species per 10-mm length bin during spring and fall relative abundance index, spring and fall creel and otter trawl surveys. Structures were processed and digitized using methods described in Butts et al. (2017). Two independent readers estimated fish age, discrepancies were revisited and the agreed upon age was used in further analysis. Age-length keys were generated separately for fish sampled in spring and fall surveys and used to allocate CPUE from each survey to the proper age-class by species. This data was also used to develop mean length-at-age by season (spring and fall) for crappie and Yellow Perch.

RESULTS

Angler Catch Rates and Harvest

The spring index creel survey could not be completed in 2020 due to COVID-19. The fall index creel survey was completed in a socially distanced format in 2020. We interviewed 129 anglers from 57 parties were with a mean party size of 2.3 anglers. Most anglers (92.2%) were Idaho residents. Targeted species included any (43.9%), crappie (17.5%), and bass species (12.3%; Table 7). Interviewed anglers fished a total of 285.3 hours with a mean of 5.0 hours per angler. Total catch was 1,308 fish of which 623 (47.6%) were harvested. The most harvested species was crappie at 60.2% of the total harvest, followed by Yellow Perch (28.6%) and Rainbow Trout (6.7%). Of the 433 Smallmouth Bass caught (33.1% of the total fall catch), only 2.3% were harvested (Table 8). Other species that made up minor proportions of the total catch included Bluegill, Largemouth Bass, Common Carp *Cyprinus carpio*, Northern Pikeminnow *Ptychocheilus oregonensis* and White Sturgeon.

The crappie average catch rate for anglers targeting crappie in the fall was 1.5 fish/h (
Figure 20). Anglers targeting Yellow Perch experienced an average catch rate of 2.2 fish/h for that species. Smallmouth Bass average catch rate for anglers targeting bass was 2.3 fish/h. The majority of anglers harvested 0-5 crappie (75.5%), while only 12.5% of interviewed groups had harvested over 15 crappie. More angler groups harvested 0-5 Yellow Perch making up 86.1% of angler groups. Anglers who harvested more than 15 Yellow Perch were only 5.4% of all angler groups interviewed (Table 9).

Tag report data for 2019 was retrieved from the Tag! You're it! database which allowed for tags to be in the environment and available to anglers for one year. A total of 137 T-bar anchor tags were deployed in Yellow Perch while 431 were placed in crappie (Table 10). The majority of fish were tagged in the spring index survey where 344 tags were deployed in crappie and 73 were deployed in Yellow Perch. However, no tags were returned from these tagging groups. Total use estimates for crappie in the two fall tagging events ranged from 17.6% ± 14.6% in November to 18.2% ± 19.3% in the October tagging event. For the Yellow Perch fall tagging events, total use was 0 in the October tagging event and 12.7% ± 16.9% in the November tagging event. All use estimates were less than 20%, indicating that while catch rates observed in the creel surveys may be high, use and exploitation remain relatively low. However, the very low number of tags returned did not allow for very precise estimates of use and exploitation, which is reflected in the large confidence intervals.

Spring Relative Abundance Index

Effort was reduced in the 2020 spring survey due to high catch rates and inclement weather. Trap net effort was completed in all three reservoir sections. Gill nets were reduced to half their usual effort with two paired sets per reservoir section. All electrofishing was completed in the Bruneau section but was reduced to one third the usual effort in the Main Pool and Snake sections. This resulted in 10 units of effort deployed in the Bruneau arm and 9.3 units of effort deployed in the Main Pool and Snake sections, as opposed to the usual 12 units of effort in each section.

Crappie were captured using all three gear types during the spring abundance survey and contributed 2,686 individuals to the total catch. Total CPUE, for crappie using all gear types was 93.7 fish per effort (f/e). CPUE was highest for crappie using electrofishing at 215.0 f/e, followed by trap nets at 102.3 f/e and gill nets at 29.7 f/e. Catch was highest for crappie in the Bruneau Arm where CPUE was 219.2 f/e, followed by the Main Pool at 46.1 f/e and the Snake Arm at 6.9 f/e. Mean total length of spring sampled crappie was 233.0 mm. Mean W_r was 97.7 for spring-captured crappie and ranged from 27.7-151.0. This indicated that most fish were in good body condition coming out of the winter months. PSD for spring-captured crappie was 92, indicating a skewed size structure dominated by large adults (
Figure 20). Length frequency for crappie was slightly right skewed in the spring survey with the most frequently captured length bin at 230-239 mm (
Figure 21).

Yellow Perch were captured using all three gear types and contributed 211 individuals to the total catch during the spring abundance survey. Total CPUE, using three gear types was 7.4 f/e. Yellow Perch per effort was highest for gill nets at 27.0 f/e, followed by trap nets at 2.3 f/e and electrofishing at 0 f/e. CPUE for Yellow Perch was highest in the Main Pool at 12.6 f/e, followed by the Snake Arm at 5.1 f/e and Bruneau Arm at 4.5 f/e. Mean total length of spring sampled Yellow Perch was 234.6 mm. Mean relative weight (W_r) was 92.5 for spring-captured Yellow Perch greater than 100 mm and ranged from 68.3-193.3. This indicated that most fish were in moderate body condition coming out of the winter months. PSD for spring-captured Yellow Perch was 98 indicating a heavily skewed size structure of mostly large individuals (
Figure 20). Length frequency for Yellow Perch was a bell curve across length bins with the most frequently captured bins at 230-239 and 240-249 mm (
Figure 22).

Average total length of Yellow Perch has remained relatively constant since the start of the panfish assessment, while that of crappie is has increased steadily since the spring of 2018 and is influenced by the recruitment of year classes (Figure 23). For example, the average length of crappie dropped dramatically in the fall of 2017 as the large year class recruited to our index survey gear types. This same correlation occurred in the fall of 2020 when average crappie total length decreased by 13 mm from the spring survey value, corresponding to an increase in catch of small juvenile crappie in the fall index survey.

Larval Fish Production and Zooplankton

Larval production on C.J. Strike was slightly above average based on 10 Neuston net tows completed in 2020. The average water volume sampled during larval fish tows in 2020 was 132.0 m^3/tow. Species composition for samples collected included crappies (84.9%) and Yellow Perch (4.4%). The peak in average density of larval crappie across all sampling sites was 57.0 fish/100 m^3, observed on the first sampling event on June 3, 2020 (Figure 24). Within C.J. Strike Reservoir, peak densities of larval crappie recorded since 2005 have averaged 30.1 fish/100 m^3. When averaged across all sampling sites and events, density of larval crappie in 2020 was 23.0 fish/100 m^3. The highest larval densities were consistently found in the Bruneau Arm for all sampling events (
Figure 25).

The highest value of zooplankton quality index sampled on C.J. Strike Reservoir in 2020 was collected in August at 25.7 g/tow (Figure 26). The Bruneau Arm consistently had the highest zooplankton values, followed by the Main Pool and Snake Arm.

Fall Relative Abundance Index

Effort was reduced in the 2020 fall survey due to time constraints and inclement weather. All usual effort was completed in the Bruneau Arm of the reservoir. All electrofishing was completed in all three sections. Trap net effort was reduced to half in the Main Pool and Snake Arm. Gill nets were reduced to half their usual effort with one paired set in the Main Pool and Snake Arm. This resulted in the usual 6.5 units of effort deployed in the Bruneau arm and 3.5 units of effort deployed in the Main Pool and Snake sections.

A total of 174 crappie were sampled during fall relative index surveys on C. J. Strike Reservoir in 2020. Total crappie CPUE using three gear types was 12.9 f/e. Electrofishing resulted in the highest crappie CPUE at 39.3 f/e, followed by gill nets at 19.0 f/e and trap nets at 4.9 f/e. Crappie CPUE was slightly higher in the Snake River Arm (17.1 f/e) than the Bruneau Arm (16.8 f/e) followed by the Main Pool (1.4 f/e). Relative weights (W_r) for crappie captured averaged 103.8 and ranged from 59.5-293.6, indicating that most crappie had above average body condition prior to entering the winter. Mean total length of fall sampled crappie was 220.6 mm. PSD for fall-captured crappie was 98, indicating a heavily skewed size structure with mostly large individuals (

Figure 20). The length frequency histogram for fall crappie indicated a left skewed distribution with numerous juvenile-sized length bins represented. The most frequently captured length bin was 230-239 mm, similar to the spring survey (

Figure 21).

A total of 388 Yellow Perch were sample during fall relative index surveys on C. J. Strike Reservoir in 2020. Total Yellow Perch CPUE using the three gear types was 28.7 f/e. Gill nets resulted in the highest Yellow Perch CPUE with 64.3 f/e, followed by electrofishing at 28.7 f/e and trap nets at 11.0 f/e. CPUE was highest for Yellow Perch in the Bruneau Arm at 43.4 f/e, followed by the Snake Arm at 15.7 f/e and Main Pool at 14.6 f/e. Relative weights for Yellow Perch averaged 95.5 and ranged from 49.7-171.8, indicating that most Yellow Perch had good body condition prior to entering the winter. Mean total length of Yellow Perch was 229.6 mm. Yellow Perch PSD value was 97, indicating a heavily skewed size structure with mostly large individuals (

Figure 20). The length-frequency histogram for fall Yellow Perch shows mostly adults were captured but numerous juvenile-sized length bins were also represented. The most frequently captured length bin for Yellow Perch increased from the spring survey to 250-259 mm (

Figure 22).

Otter Trawl Relative Abundance

The average water volume sampled during 2020 otter trawl sampling was 1,941.0 m^3 per tow. A total of 1,782 fish were captured across the 12 sites. Species composition consisted of crappie (51.1%), Bluegill (25.5%), and Yellow Perch (21.8%); Common Carp, Smallmouth Bass and Largemouth Bass all contributed less than 2% each. Bluegill and Yellow Perch were captured at more sites (n = 6) than any other species, followed by crappie and Common Carp (n = 5). Four sites had no catch in 2020: three sites in the Main Pool and one in the Snake Arm. Density of panfish species was highest in the Bruneau Arm (19.3 fish/100 m^3) followed by the Snake Arm

(0.2 fish/100 m^3) and the Main Pool (0.01 fish/100 m^3). Crappie density averaged 3.3 fish/100 m^3 and ranged from 0-12.8 fish/100 m^3. Yellow Perch density averaged 1.5 fish/100 m^3 and ranged from 0-7.4 fish/100 m^3. Bluegill density averaged 1.7 fish/100 m^3 and ranged from 0-11.4 fish/100 m^3. Densities were more consistent within the Bruneau Arm with more site-specific capture in the Main Pool and Snake Arm (

Figure 27). Length frequencies for crappie and Yellow Perch captured by otter trawl in 2020 depict two distinct cohorts of these species, suggesting that more larval fish had survived into the fall than in previous years (

Figure 21;

Figure 22).

Age and Growth

Age and growth data in 2020 were similar to that observed in the previous four years of the panfish assessment. To develop length-at-age metrics, 225 crappie (spring n = 135, fall n = 90) and 138 Yellow Perch (spring n = 53, fall n = 85) were aged using dorsal fin rays. Mean length-at-age differed more dramatically between spring and fall surveys for Yellow Perch than for crappie (

Figure 28). This difference is most notable in the age-2 Yellow Perch. The most numerous age class sampled for crappie was age-3 for both seasons while the most numerous age class for Yellow Perch was age-3 for both seasons.

DISCUSSION

The panfish assessment began in 2016 in an attempt to better understand population dynamics of crappie and Yellow Perch in C.J. Strike Reservoir. Following a strong year class of crappie produced in 2017, this project has continued to track that cohort through time to identify possible survival bottlenecks and assess their impact on subsequent year classes. This assessment continued in 2020, collecting valuable information on crappie since little is known about this species in western reservoirs.

In 2020, we continued the current systematic sampling design initiated in 2017 using multiple gear types in both the spring and fall to develop representative indices of crappie and Yellow Perch populations in C.J. Strike Reservoir (Cassinelli et al. 2018). These repeated surveys will allow for estimates of mortality and provide a better understanding of gear-specific biases. Monitoring age-specific relative abundances should also enable us to identify possible population bottlenecks such as overwinter mortality. In the spring and fall, electrofishing produced the highest CPUE for target species, aligning with previous studies where electrofishing produced the highest catch rates for crappie (Dillon 1989; Butts et al. 2013b). Based on previous literature (Dillon 1989), catch rates using the current gear types and methods should allow us to detect changes in the panfish populations through time. While the spring and fall index surveys target adult crappie and Yellow Perch, the primary objective of the otter trawl survey is to capture smaller and younger panfish than those caught by anglers or in the index survey gears.

C.J. Strike Reservoir experienced an unusually high amount of fishing effort in 2020 due to outdoor recreation increases during the COVID-19 pandemic. However, the spring creel survey had to be canceled in 2020 (due to pandemic concerns) and this increased fishing effort was not documented for that season. The fall creel survey was completed in a socially distanced manner with no harvested fish length measurements taken. The data collected in 2020 indicated that individual angler effort and demographics have remained similar since 2016. However, the number of fall anglers interviewed increased from 103 in 2019 to 129 in 2020, the highest number of fall anglers interviewed since of 2017. This increase in fall anglers was likely a result of the increased popularity and success of the crappie fishery. While the number of fall anglers increased 2020, the harvest of crappie in the fall creel as a percentage of total catch decreased from 92.6% in the fall of 2019 to 70.9% in the fall of 2020. Conversely, Yellow Perch harvest increased from 59.5% of total catch in the fall of 2019 to 88.1% in the fall of 2020. The decline in crappie harvest as a percentage of total catch is likely due to anglers becoming more selective in their harvest as the 2017 year class achieves more desirable sizes.

While the majority of interviewed anglers since 2016 have consistently harvested less than 5 crappie, the percentage of anglers harvesting over 15 crappie seems to have peaked in the fall of 2018 at 22%. It was assumed that the reporting of larger crappie harvest by anglers would become more prevalent as the 2017 year class grew and recruited to the fishery, but that increase has not been observed as only 12.5% of anglers harvested more than 15 crappie in the fall of 2020. For comparison, the PSD value for crappie captured in our seasonal index surveys has been increasing since the spring of 2019, achieving a value of 98 in the fall of 2020. This indicates that nearly all captured crappie were at least of stock length, 130 mm (Gabelhouse Jr. 1984), but interviewed anglers were still not harvesting large numbers of crappie. However, missing the 2020 spring creel caused a large data gap when catch rates and harvest were likely at their peak for the 2017 crappie year class. Regardless of this data gap, tag return data supports these creel survey findings with return rates for all tagging events in 2019 having values less than 20% use for both crappie and Yellow Perch. However, these estimates are not very precise with only 8 tags returned out of 431 deployed in crappie and only 2 returned out of 137 in Yellow Perch. It should also be noted that no tags were returned from the spring tagging event when the majority of tags were deployed. This could be a function of delayed mortality, tag loss, low reporting rates or a combination thereof. Future work will seek to evaluate natural mortality rates but they are almost certainly higher than that of angler use based on available tag return data.

The majority of Smallmouth Bass anglers reported great success, but only a small proportion of this catch was harvested. This could be a function of anglers practicing catch-and-release or possibly that the majority of Smallmouth Bass caught are less than the minimum legal harvest length of 12 inches. The Rainbow Trout fishery is also gaining popularity among anglers, comprising 6.7% of total catch in the fall of 2020. Trout anglers often expressed their excitement and satisfaction to our crew regarding the size of this species in C.J. Strike Reservoir.

Spines were not collected from angler-harvested fish in 2020 due to the socially distanced protocols adopted for the fall creel survey. Thus, all spines were collected from the spring and fall index surveys. The majority of crappie aged were assigned age-3 for both seasons, corresponding to the 2017 year class. The majority of Yellow Perch were also aged at age-3. Length-at-age comparisons for crappie and Yellow Perch across survey years were relatively similar to one another but crappie did appear to have a slightly steeper growth curve. A more in-depth analysis of growth by year-class will be completed with additional years of data. Both species continue to exhibit growth throughout the summer as mean length-at-age increased between the spring and fall surveys. Growth appears to vary slightly between survey years but separation (based on mean length-at-age) of year classes is still fairly well defined.

Relative weights for both crappie and Yellow Perch increased from the spring to the fall survey in 2020, indicating that these species are growing and gaining weight through the productive summer to have good body condition prior to entering winter. The proportional size distribution values for these two species are approaching the maximum value of 100, indicating that nearly all of the individuals captured by our gears in the spring and fall index surveys are all equal or greater to the stock lengths established in Gabelhouse Jr. (1984).

Relative production of larval crappie in C.J. Strike Reservoir has been indexed by regional staff for the past 15 years. Spatial and temporal variation was again observed in the 2020 assessment and suggests that sampling should continue across multiple weeks to identify peak larval production. The peak of observed larval density was recorded on the first week of larval sampling in 2020, which was earlier than recorded in recent years. This earlier peak may have been influenced by the hot weather during the spring survey when air temperatures were at or near 100° F for nearly a week. A corresponding increase in water temperatures may have influenced the timing of the crappie spawn and subsequent larval densities. Generally, more larvae are observed in the Bruneau Arm of the reservoir, likely a function of the warmer waters and greater availability of zooplankton relative to the other sections of the reservoir. These differences in each section's environmental factors may influence primary productivity, fish reproductive success or recruitment (Butts et al. 2013b). The 2020 survey represented the fifth time larval Yellow Perch have been reported. Alterations in larval fish processing may have influenced the 2020 larval results in several ways. In 2020, samples were brought back to the laboratory to be processed as opposed to the previous method of picking samples on the boat. In the majority of samples, it is likely that this laboratory processing increased precision as the preserved fish were easier to discern from the zooplankton in the samples. However, in some large samples, larval fish had degraded due to a lack of ethanol and some of the smallest larval fish could no longer be identified.

Distribution of juvenile panfish sampled in the otter trawl surveys has been sporadic since this sampling began in 2016. The sites with the most consistently high values of juvenile crappie density are those in the Bruneau Arm; however, several Snake Arm sites have also occasionally had high juvenile crappie densities. High densities of juvenile Yellow Perch have been observed in the Bruneau Arm and the Main Pool. In 2020, our juvenile density results suggest that more crappie had survived into the fall with the highest density estimates observed at the Bruneau Arm sites since 2017.

The panfish assessment at C.J. Strike Reservoir was initiated to gain additional knowledge of population dynamics for crappie and Yellow Perch populations. Our crew intends to continue this standardized sampling regimen for at least another year, possibly two, to follow to 2017 crappie year class through their entire life history. With this additional data, we intend to expand our analyses to include a more in-depth look at growth, mortality, and recruitment in the coming years' reports. A more detailed analysis will help aid managers in determining if harvest or length restrictions would benefit the fishery.

RECOMMENDATIONS

1. Continue the index creel survey in both the spring and fall to identify angler use patterns, specifically related to panfish populations found in C.J. Strike Reservoir

2. Continue sampling larval production and assess relationships between larval and older age classes using otter trawl density estimates

3. Continue the systematic sampling protocol for C.J. Strike Reservoir using gill nets, trap nets and electrofishing to develop a representative index of crappie and Yellow Perch populations

4. Continue collecting age structure data; using dorsal fin rays to develop length-age keys. Based on previous data, collect five fish per 10 mm length bin of both crappie and Yellow Perch

Table 7. Species targeted by angler groups in the 2020 and fall index creel surveys at C.J. Strike Reservoir.

Target species	# fall angler groups
Any	25
Crappie	10
Bass spp.	7
Yellow Perch	6
Rainbow Trout	4
Channel Catfish	2
Bluegill	2
White Sturgeon	1
Total	57

Table 8. Catch and catch per unit effort (CPUE; fish/h) estimates collected from anglers during the fall index creel survey at C.J. Strike Reservoir in 2019. CPUE values were calculated using only those anglers who were targeting those particular species. ** in the Bluegill column indicates that CPUE could not be calculated for this species as it was always bycatch, no anglers specified that they were primarily targeting Bluegill.

	Crappie	Yellow Perch	Smallmouth Bass	Bluegill	Rainbow Trout	Largemouth Bass
# Harvested	375	178	10	17	42	0
Harvested CPUE	1.1	4.2	0.0	**	0.3	0.0
# Released	154	24	423	14	64	1
Released CPUE	0.3	0.1	2.3	**	0.1	0.0
Total catch	529	202	433	31	106	1
Total catch CPUE	1.5	2.2	2.3	**	0.4	0.0

Table 9. The number and (percentage) of angler groups' crappie and Yellow Perch bags collected from angler interviews at C.J. Strike Reservoir during the 2020 fall creel survey.

Group harvest	Crappie	Yellow Perch
0	39 (68.4)	35 (61.4)
1	1 (1.8)	5 (8.8)
2	2 (3.5)	4 (7.0)
3	1 (1.8)	3 (5.3)
4	0 (0)	1 (1.8)
5	0 (0)	1 (1.8)
6	0 (0)	1 (1.8)
7	0 (0)	1 (1.8)
8	0 (0)	0 (0)
9	1 (1.8)	1 (1.8)
10	1 (1.8)	2 (3.5)
11	1 (1.8)	0 (0)
12	2 (3.5)	0 (0)
13	0 (0)	0 (0)
14	0 (0)	0 (0)
15	2 (3.5)	0 (0)
>15	7 (12.5)	3 (5.3)

Table 10. T-Bar Anchor tag return rates for Yellow Perch and Crappie tagged in C.J. Strike Reservoir in 2019, as of January 19, 2020.

Species	Month	Tags released	Tags returned	% Total Use	90% CI
Yellow Perch	May	73	0	0	0
	October	34	0	0	0
	November	30	2	12.7	±16.9
Crappie	May	344	0	0	0
	October	32	3	18.2	±19.3
	November	55	5	17.6	±14.6

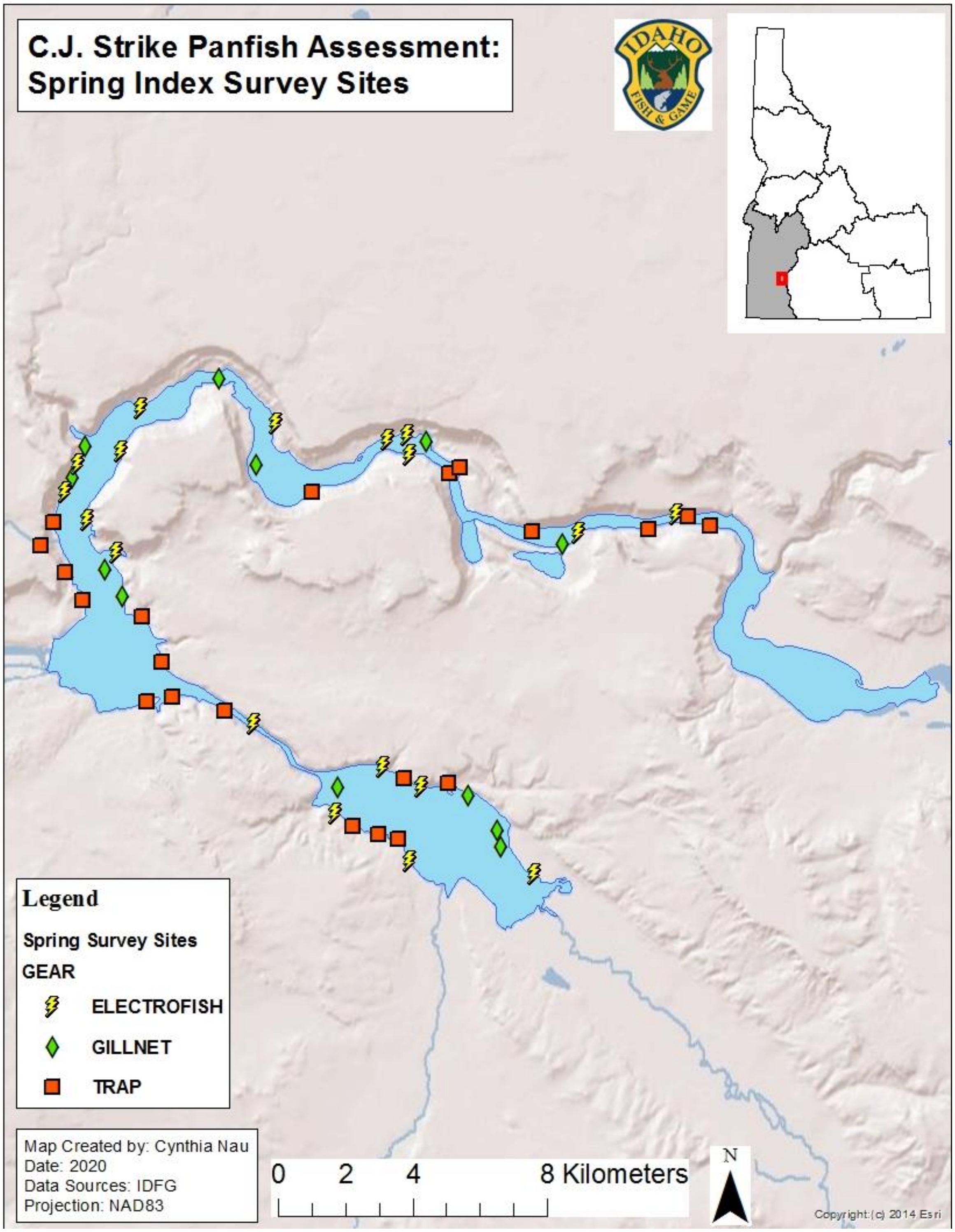

Figure 16. Location of 18 electrofishing (bolts), 21 trap net (squares), and 12 gill net (diamonds) sites used to index the relative abundance of crappies, Yellow Perch, and other game and non-game fish populations in C.J. Strike Reservoir in the spring index surveys 2017-2020.

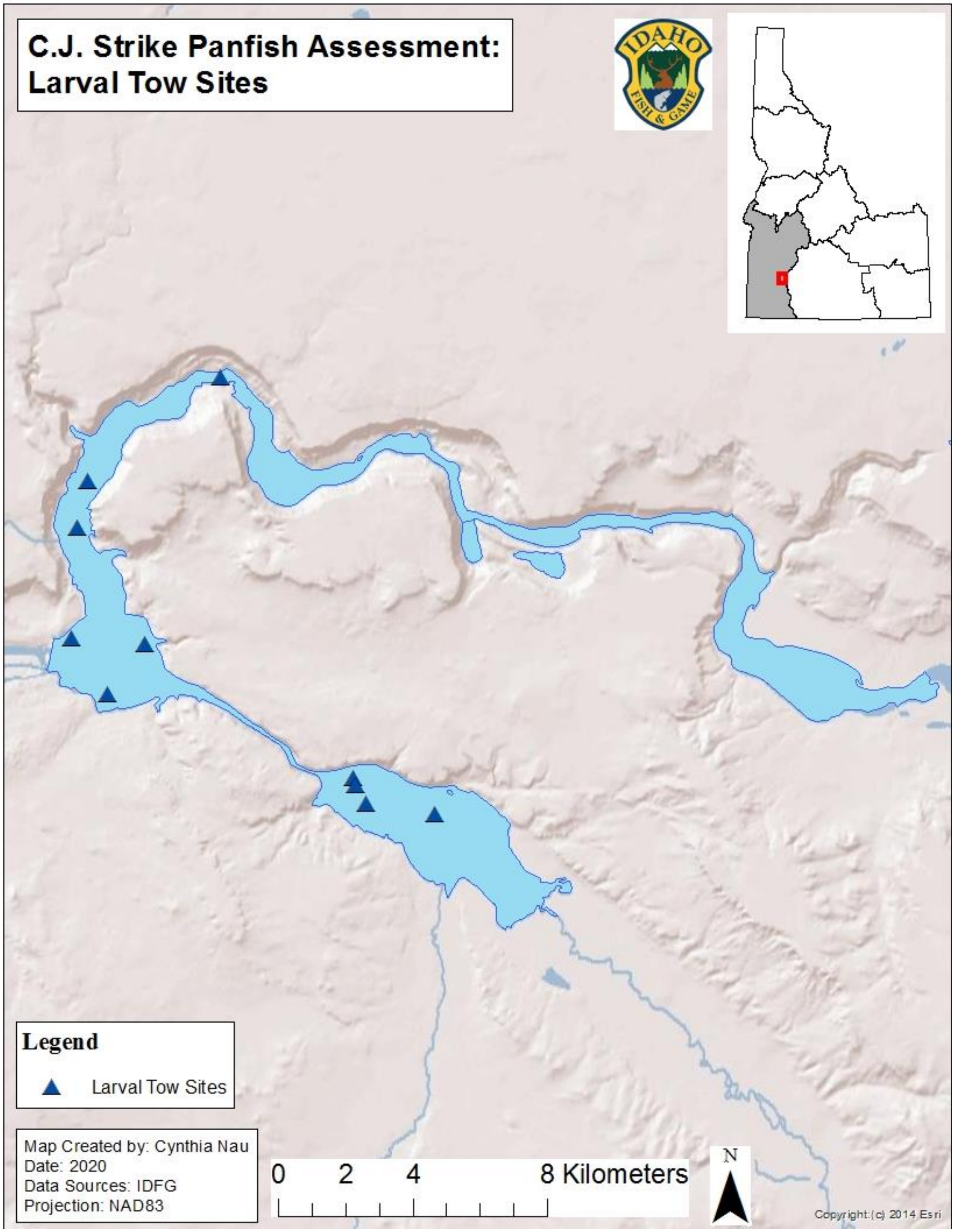

Figure 17. Location of 10 Neuston net trawl sites used to index the abundance of larval fish in C.J. Strike Reservoir from 2005-2020.

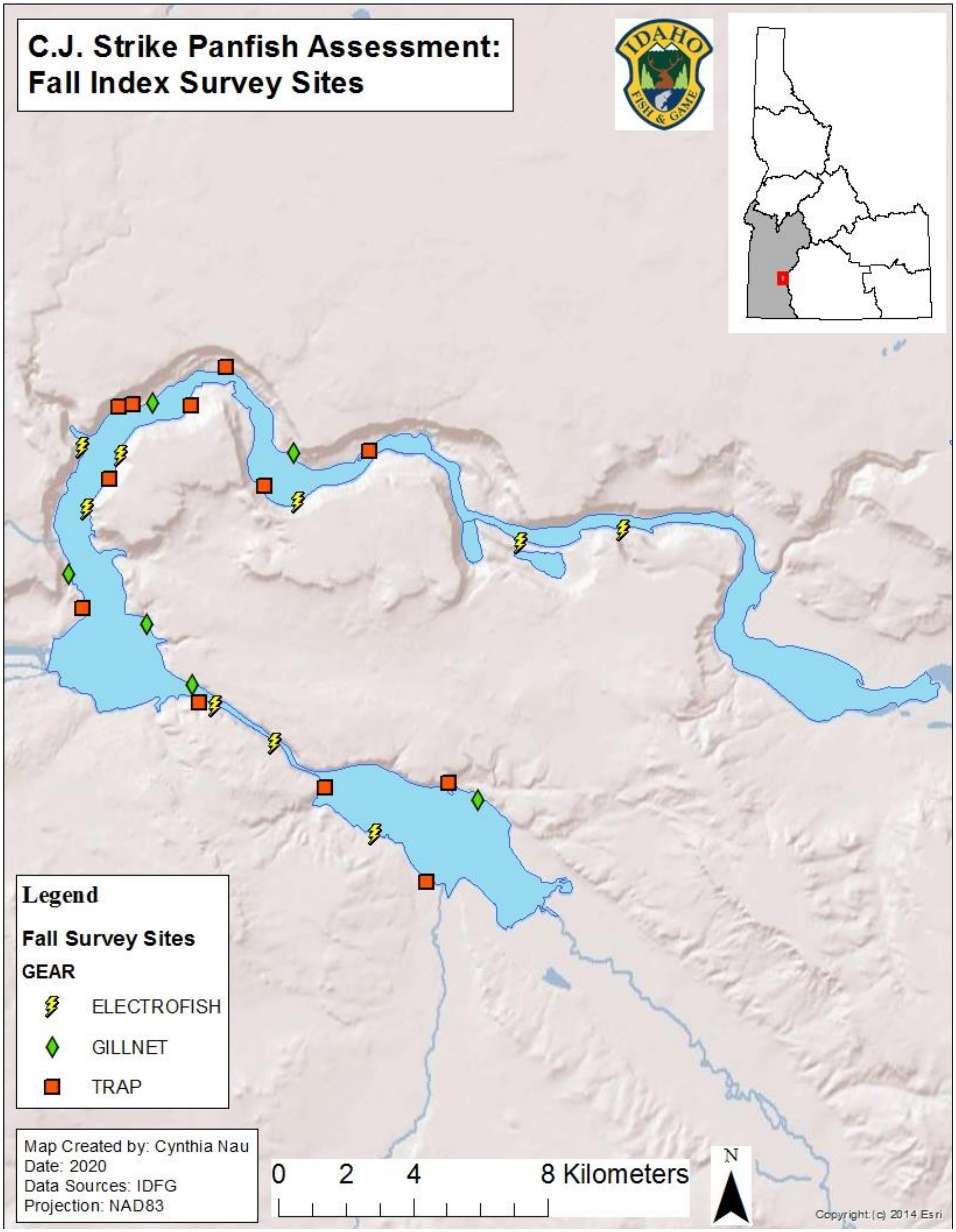

Figure 18. Location of 9 electrofishing (bolts), 12 trap net (squares), and 6 gill net (diamonds) sites used to index the relative abundance of crappies and Yellow Perch in C.J. Strike Reservoir in fall index surveys 2017-2020.

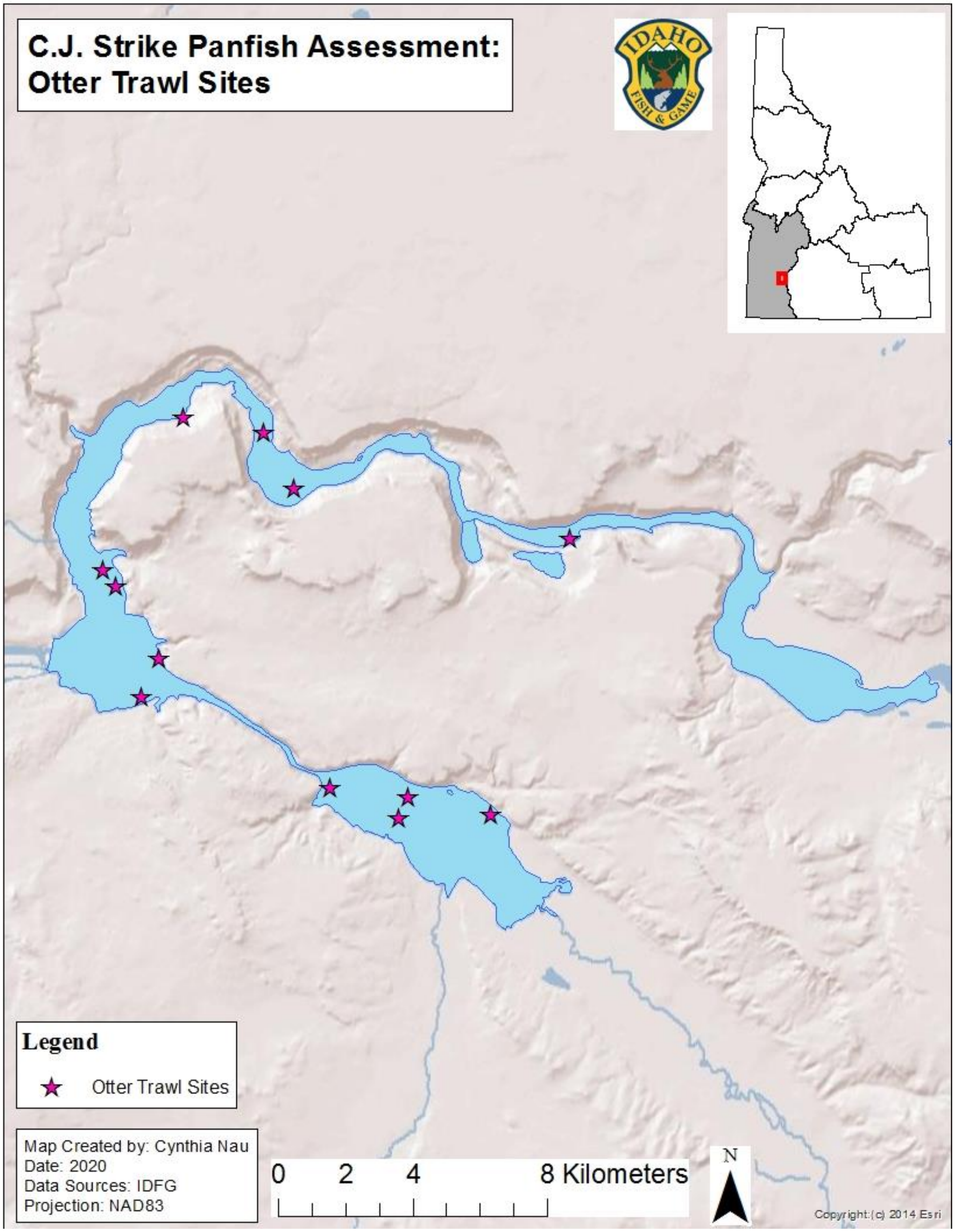

Figure 19. Location of 12 otter trawl sites used to index the abundance of crappie, Yellow Perch and Bluegill in C.J. Strike Reservoir in 2016-2020.

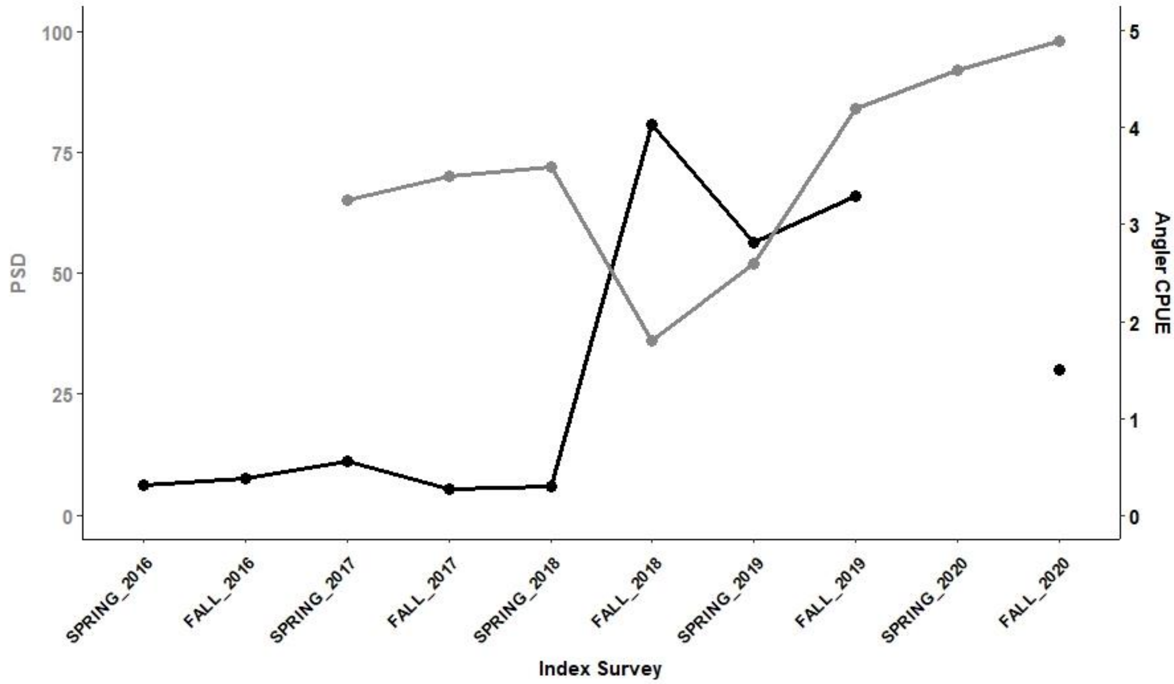

Figure 20. Proportional Size Density (PSD; gray) of crappie and angler catch per unit effort (CPUE; black) by seasonal index survey since the start of the panfish assessment in 2016.

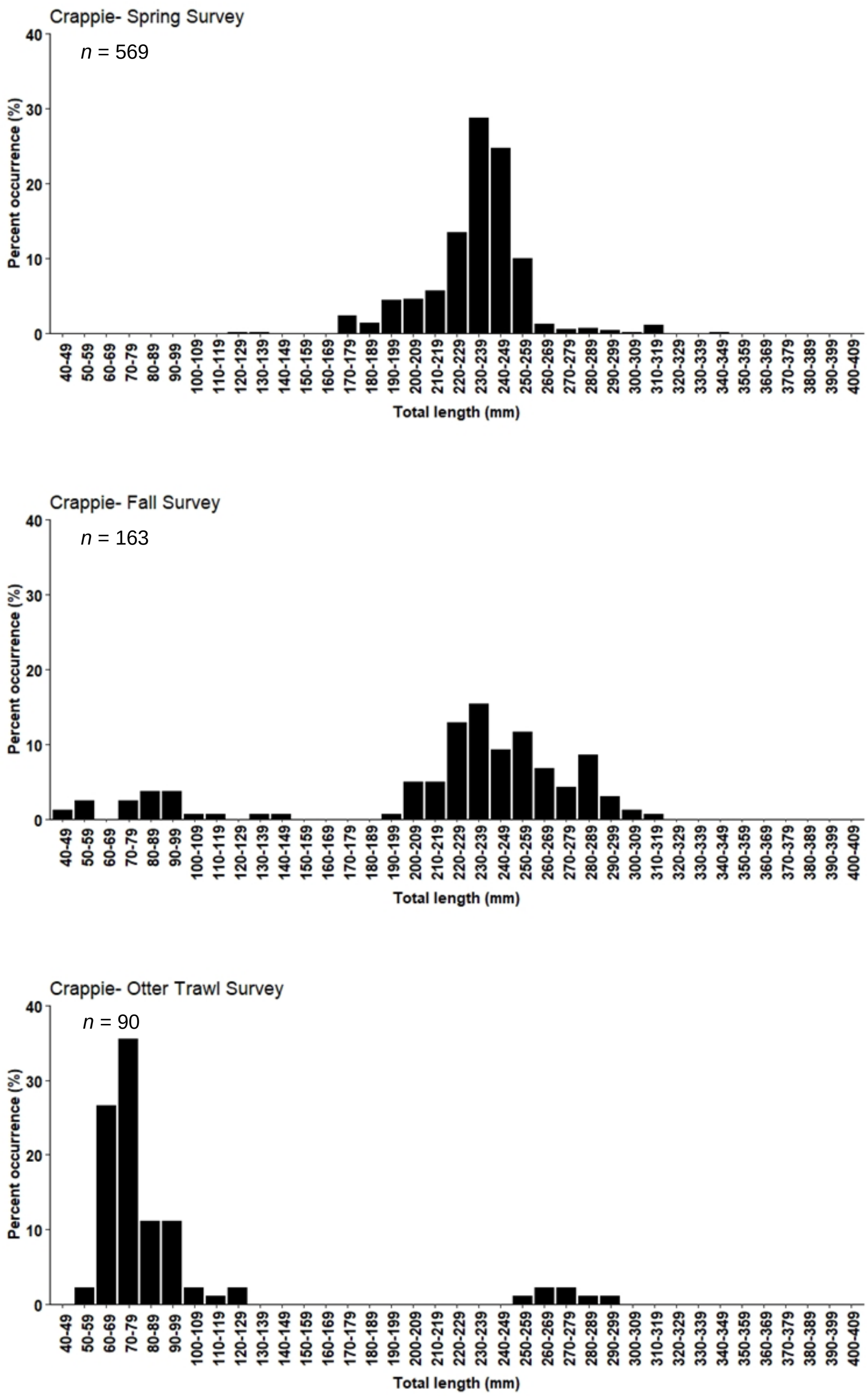

Figure 21. Relative length-frequency distribution observed for crappie during the spring, fall and otter trawl surveys of 2020.

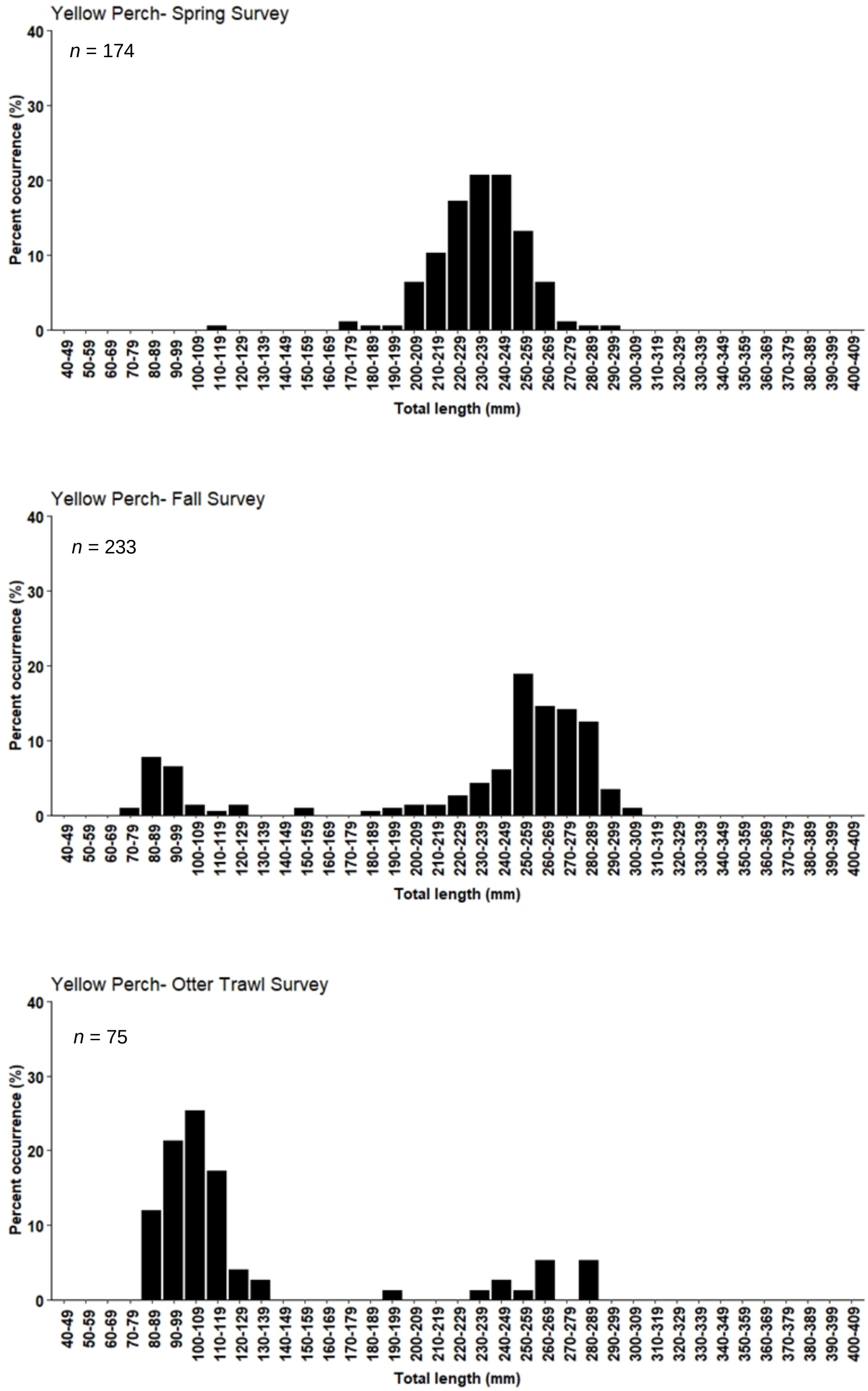

Figure 22. Relative length-frequency distribution observed for Yellow Perch during the spring, fall and otter trawl surveys of 2020.

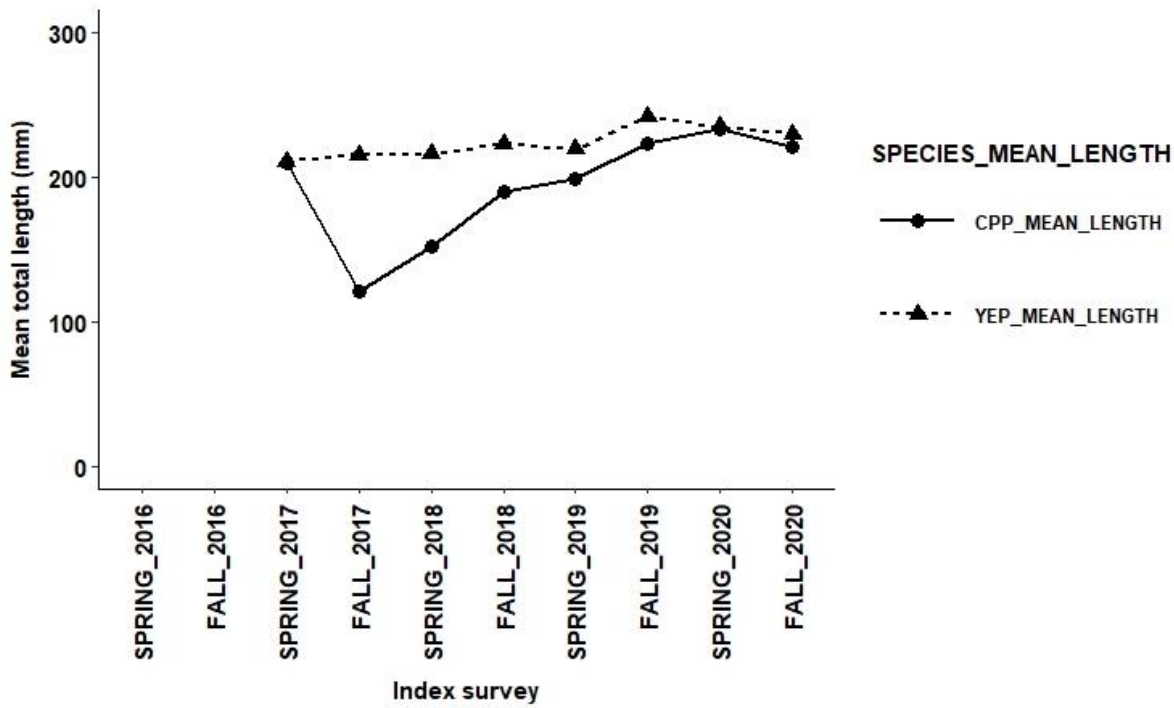

Figure 23. Mean total length of crappie (CPP) and Yellow Perch (YEP) in each seasonal index service since the start of the panfish assessment.

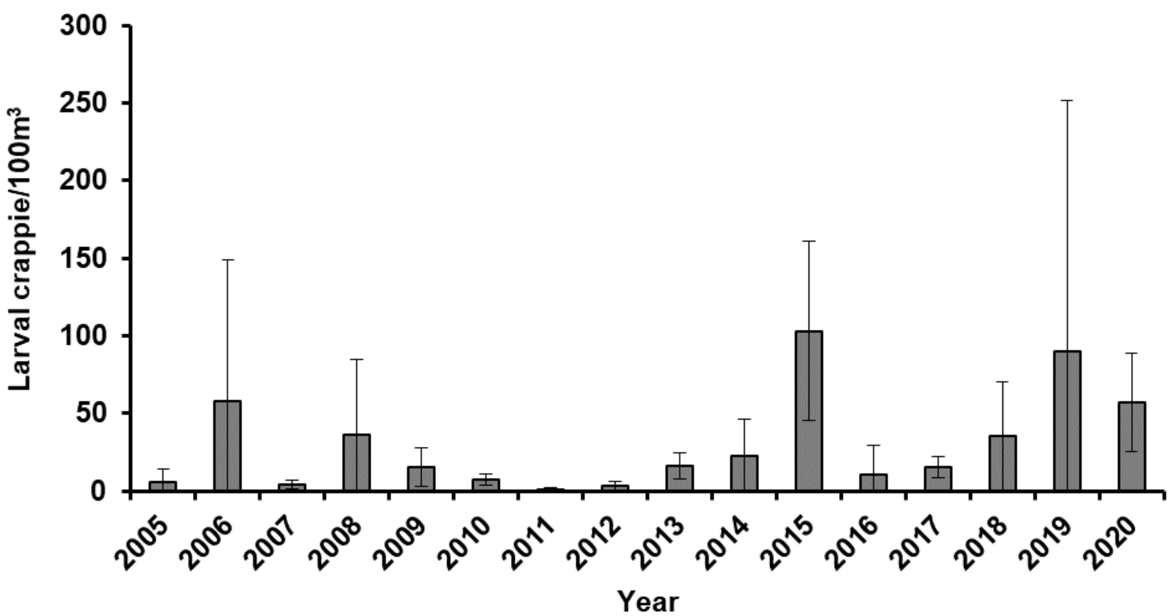

Figure 24. Peak densities of larval crappie averaged across the sample sites within C.J. Strike Reservoir from 2005-2020. Error bars represent 90% confidence intervals.

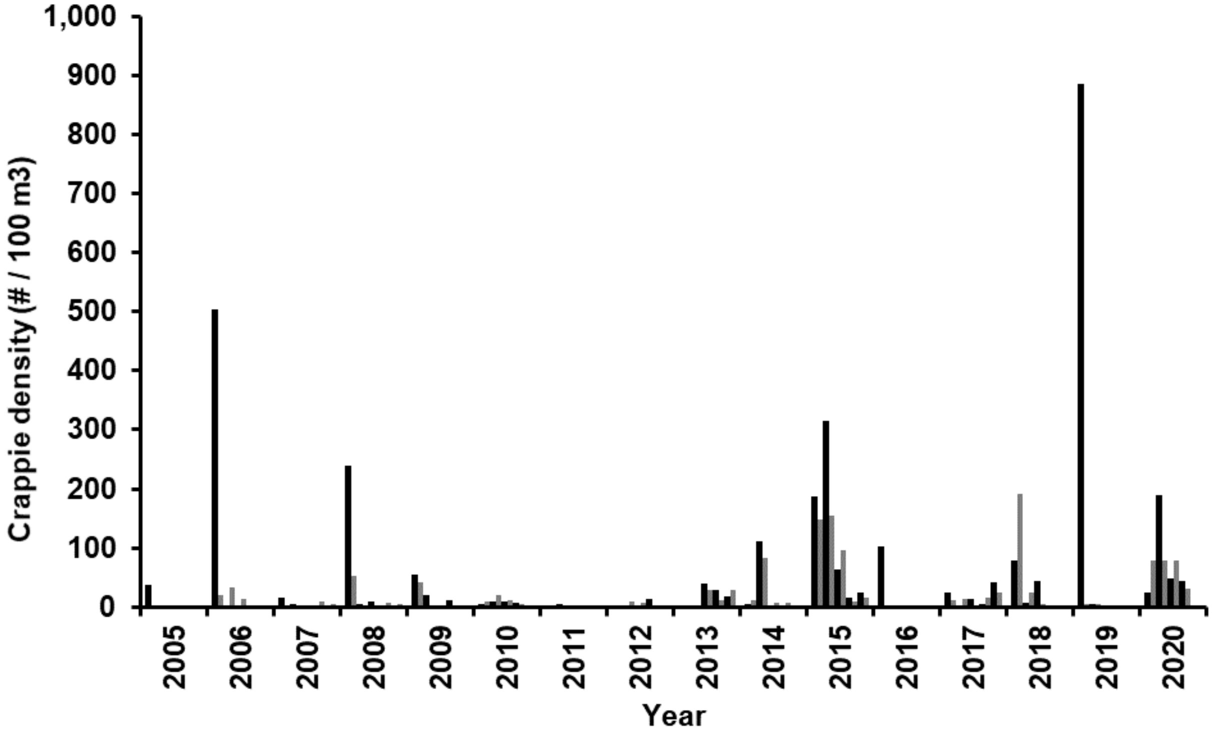

Figure 25. Density of larval crappie measured at 10 sites from 2005-2020. Sites 1 through 10 are displayed left to right in alternating colors within each year.

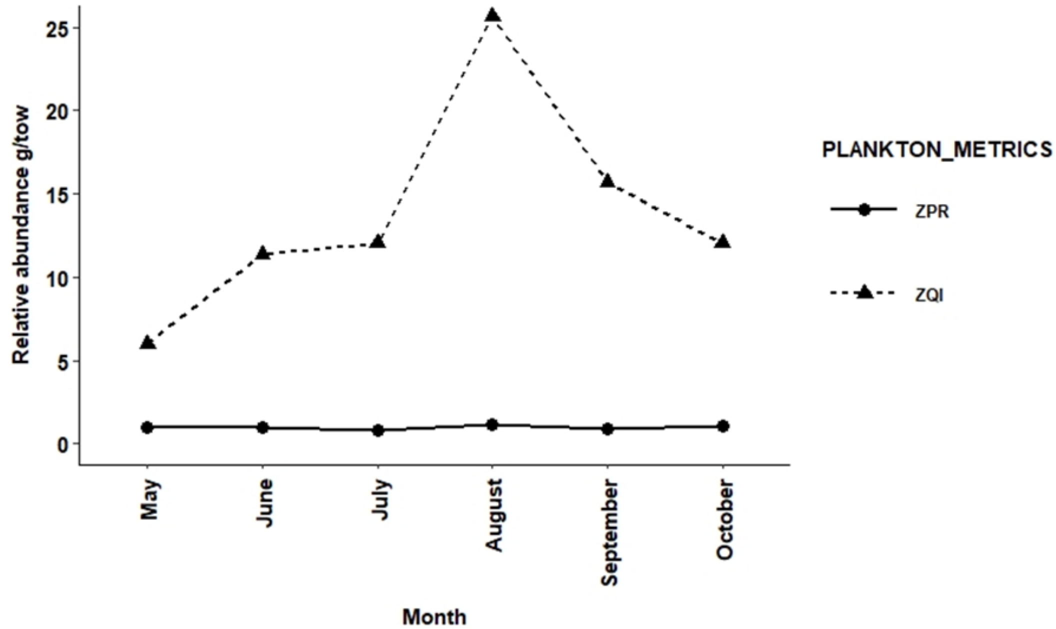

Figure 26. Zooplankton preferred ratio (ZPR) and zooplankton quality index (ZQI) average values taken at the three sampling locations, one in each section of C.J. Strike Reservoir, in 2020.

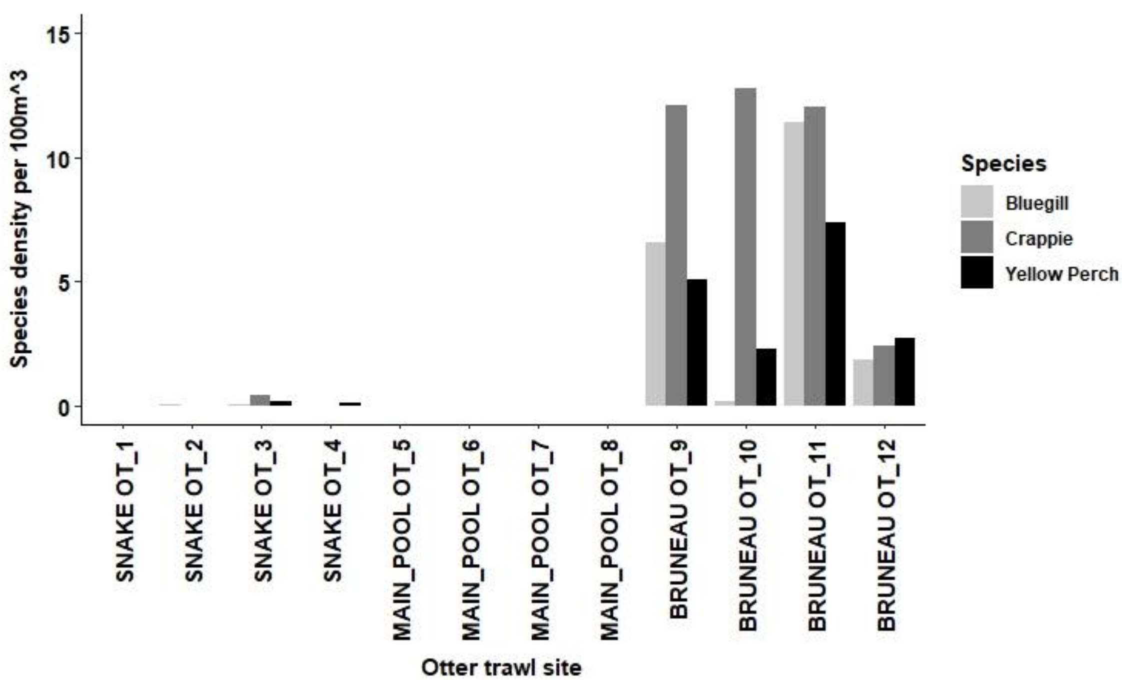

Figure 27. Species density observed for Bluegill, crappie and Yellow Perch during the C.J. Strike otter trawl surveys of 2020.

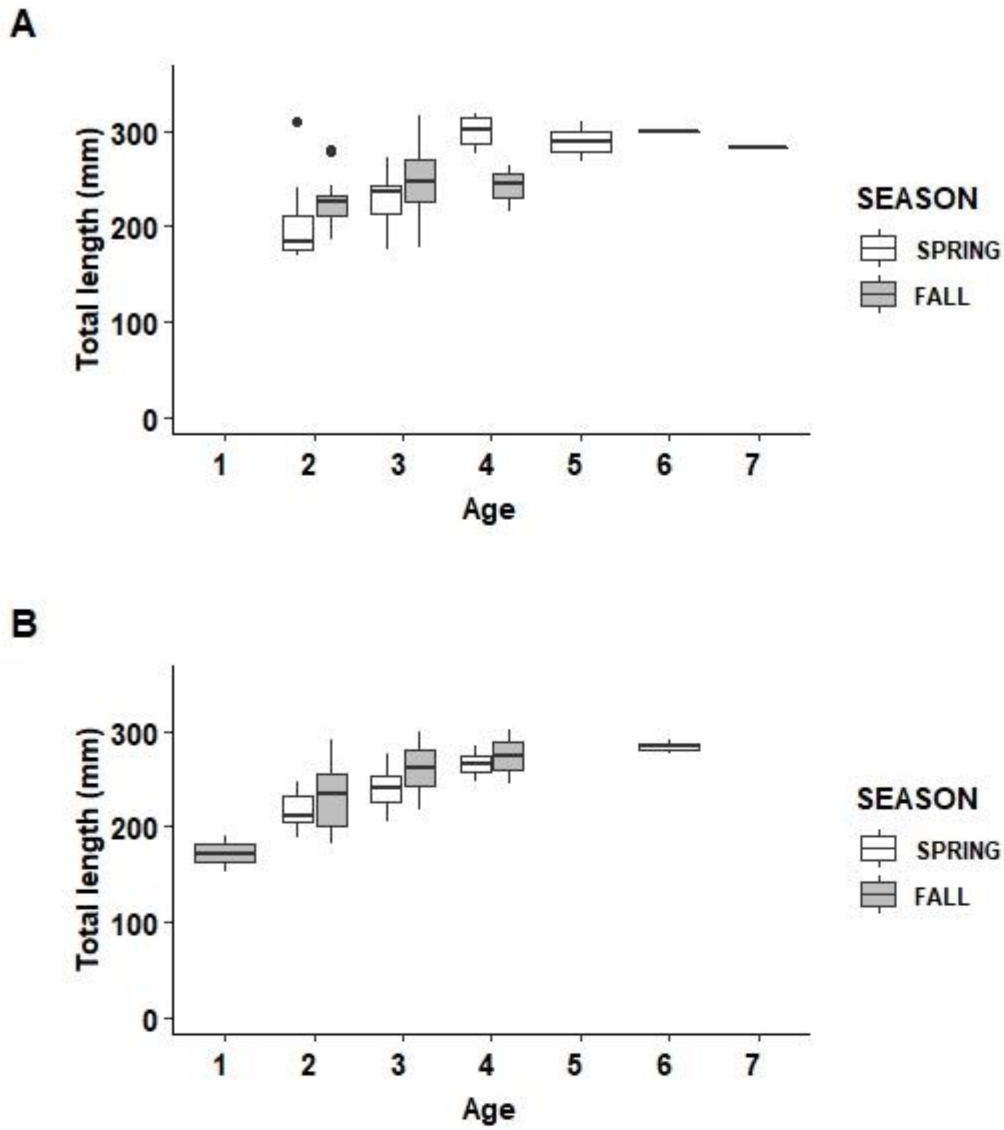

Figure 28. Length-at-age boxplots for all crappie (A) and Yellow Perch (B) aged in 2020, all spine sampled were collected in the 2020 spring and fall index surveys.

ALPINE LAKES

ABSTRACT

Idaho Department of Fish and Game staff from the Southwest Region surveyed ten alpine lakes during August 2020. All lakes sampled were in the Pinchot Creek drainage in the headwaters of the South Fork Payette River. One of the lakes was previously surveyed in 2014, while the remainder of the lakes had not been surveyed since the early to mid-1990s. Data were collected at each lake that described fish and amphibian populations, habitat, as well as human use patterns. Updated stocking requests were made to maximize fish densities, survival, and angler opportunity in the Pinchot Creek basin.

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INTRODUCTION

The Nampa subregion currently has 97 alpine lakes that are stocked with hatchery fingerling-sized trout. The majority of these stockings (83) are triploid Rainbow Trout *Oncorhynchus mykiss*, while others include Golden Trout *Oncorhynchus aguabonita* (6), Arctic Grayling *Thymallus arcticus* (6), and Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* (2). Most lakes are stocked as part of a three-year stocking rotation referred to as A, B, or C rotations. Stocking in 2020 was an A rotation year (so subsequently, 2021 would be a B year and 2022 a C year before the rotation repeats itself). In addition, more frequently fished lakes are part of a two-year rotation (defined as Even or Odd based on the stocking year), while the most popular and easily accessed lakes get stocked annually (All rotation). Because of this combination, the number of lakes stocked across calendar years is constantly varying. Within the current triennial cycle, A and C rotations align with the Even rotation and the B rotation aligns with those lakes stocked during the Odd rotation. Within the next triennial cycle beginning in 2023, A and C will align with Odd and B with Even. In 2020, 32 of the region's 97 stocked lakes were stocked with hatchery fish (20 as part of the A rotation, eight as part of the Even rotation, and four as part of the All rotation).

While the region currently stocks 97 lakes, there are a significant number of lakes within the region that are no longer stocked, but still contain self-sustaining populations from historic stocking events. The total number of lakes within the region containing fish is unknown. Region 3 fisheries staff samples a handful of alpine lakes each summer. This sampling is part of ongoing monitoring to both assess the alpine lake stocking program and better understand fish and amphibian distribution in alpine lakes across the landscape. Stocked lakes (and any adjacent unstocked lakes) are surveyed to better understand fish distribution, population structure, and relative abundance. Subsequently, survey data are used to adjust current stocking rates and frequencies if needed. Lakes with the longest lapse in survey data, or those lakes that have never been surveyed, are prioritized each year. Typically, only a single week of sampling is allocated to alpine lakes, focusing on a cluster of lakes in close proximity to each other.

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 where appropriate to use hatchery resources efficiently and minimize impacts to native fauna while preserving fishing opportunity where practical

METHODS

In August of 2020, regional staff surveyed 10 alpine lakes. We surveyed Pinchot Creek Lakes #2, #3, #4, #6, #10, #11, and two unnamed lakes on August 4. Pinchot Creek Lake (PCL) and PCL #1 were surveyed on August 5 (Figure 29). This basin of lakes was chosen because the majority of the lakes had either never been sampled, or had not been sampled within the last twenty years. The lone exception was PCL, which had been sampled in 2014, but was sampled again because of its vicinity to target lakes.

At each lake, we assessed fish and amphibian presence/absence, human use, and basic fish habitat characteristics. Fish were sampled with hook/line angling (2-4 anglers per lake; combo of fly and spinning gear) to determine species and total length (TL, mm). Catch per unit effort (CPUE; fish/h) was calculated for each lake by dividing both species-specific and total catch at the lake by the hours of total angler effort. Additionally, 70-mm fluorescent orange T-Bar anchor tags (Floy™) were inserted dorsally into fish prior to release back into the water as part of a larger scale ongoing state-wide research project studying angler use of fish in alpine lakes.

Habitat surveys assessed limnological and morphological characteristics of each lake, its tributaries, and its outlets. 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 campsites, number of fire rings, access trail conditions, trail distance, trail difficulty, and presence of litter. General levels of human use were categorized by IDFG staff as rare, low, moderate, and high based on an overall assessment of the factors described above.

All habitat, amphibian, and human use surveys were conducted by the same person for consistency in assessments.

RESULTS

The Pinchot Creek Basin lakes provide a wide variety of fishing opportunity. However, these lakes are remote and access requires a roughly 10-mile hike starting at the upper NF Boise River trailhead above Graham, going over the Bayhouse Creek Trail into Johnson Creek and following the Johnson Creek Trail up to near the headwaters, before going off trail up through the saddle at the head of Pinchot Creek and traversing to the lake basins. Adding to the difficulty is that as of 2020, none of the trail stretches had been cleared or maintained in multiple years resulting in large amounts of overgrowth and varying amounts of deadfall in some trail reaches. Due to difficulty of access, all lakes surveys showed limited signs of human use.

PCLs #2, #3, #4, #10, and #11 are all clustered together in a basin on the western side of upper Pinchot Creek (Figure 29). Lakes #10 and #11 are the upper most lakes of this cluster and both are small (each about 0.25 ha), shallow, and fishless. Neither are stocked. Lake #10 had Long-Toed Salamander *Ambystoma macrodactylum* present while Lake #11 had Columbia Spotted Frog *Rana luteiventris* adults and tadpoles present (Table 11).

Downhill of PCL#10 and #11 sits PCL #2 (Figure 29). PCL#2 is roughly 1.7 surface ha and has been stocked with 500 Golden Trout every three years on the A rotation. Hook and line sampling produced both Golden Trout (average 227 mm TL) and Arctic Grayling (average 376 mm TL). This lake was last stocked with grayling in 1999. Total CPUE for Golden Trout was 0.40 fish/h while CPUE for Arctic Grayling was 0.80 fish/h. No amphibians were observed in PCL#2 (Table 11).

A short outlet from PCL #2 drains into the larger (3.4 ha) PCL #4 (Figure 29). During the spring, these two lakes appear to be fairly connected and fish can likely move between them.

Despite being stocked with 500 Golden Trout every three years, fish populations in Lake #4 appeared very limited. Two hours of angling effort resulted in zero fish caught, and two separate visual surveys (with good visibility) around the lake's perimeter resulted in a single fish observed (this appeared to be a Golden Trout). Two adult Columbia Spotted Frog were observed (Table 11).

Just east of PCL #4, is PCL #3 (Figure 29). This smaller (0.75 ha) lake is stocked with 300 Arctic Grayling every three years. This lake contained a high density of Arctic Grayling with 24 fish being caught (average 272 mm TL) over 6 hours of effort resulting in a CPUE of 4.0 fish/h. Of these, 21 fish received T-bar anchor tags. Despite the higher concentration of fish present, an adult Long-Toed Salamander was also observed (Table 11).

Perched below PCL #3 are two small unnamed lakes (for the purposes of this report they are labeled Unnamed #1 and Unnamed #2; Figure 29). Neither of these small, shallow lakes are large enough to support fish. While no amphibians were observed in Unnamed Lake #1, a Long Toed Salamander and a Western Toad *Anaxyrus boreas* were observed in unnamed lake #2.

Farther down the drainage is PCL #6. This lake served as our base camp and while use still appeared limited, it had what appeared to be the most utilized camp area of any lake surveyed. Despite not having been stocked since 1993, this lake had various size classes of Golden Trout present that has likely escaped from PCL #2 and #4. Two hours of angling effort produces 6 Golden Trout (CPUE of 3.0 fish/h.). No amphibians were observed.

Due north of the above mentioned lakes in the adjacent downstream tributary to Pinchot Creek, sits PCL and PCL #1 (Figure 29). PCL is one of the larger (3.0 ha) lakes in the Pinchot Creek Basin and despite being stocked with 1,500 Arctic Grayling every three years, six hours of angling effort resulted in the catch of 36 Yellowstone Cutthroat *Oncorhynchus clarkii bouvieri* (CPUE of 6.0 fish/h.). PCL was last stocked with Yellowstone Cutthroat Trout in 1989, indicating natural reproduction is sustaining this population. No amphibians were observed in PCL and only limited signs of human use were present.

The final lake surveyed was PCL #1. This lake is stocked with 500 Golden Trout every three years but no fish were caught or seen during a visual survey. Numerous Columbia Spotted Frog adults and tadpoles were observed, further confirming an absence of fish. There was little sign of human use at PCL #1.

DISCUSSION

Our sampling revealed the need for some stocking modifications to lakes in the Pinchot Creek Basin. Because there were no fish present in PCL #1 and it appears shallow and prone to winter kill, stocking will be discontinued at that lake. The 500 Golden Trout from PCL #1 will be diverted to PCL #4 to increase its stocking rate from 500 to 1,000 fish every three years. PCL #4 had low densities of fish but appeared to offer adequate habitat. Hopefully increased stocking densities there will result in higher densities and catch rates. Additionally, stocking PCL with 1,500 Arctic Grayling will be terminated, as the Yellowstone Cutthroat Trout that were stocked there in 1989 have established a healthy, self-sustained population. A portion (1,000) of those Arctic Grayling will be diverted to PCL #2 where there are currently low numbers of grayling. Finally, the 500 Golden Trout that were being stocked into PCL #2 will be diverted to PCL #6 to supplement the low density population of Golden Trout in that lake. While both Golden Trout and Yellowstone Cutthroat Trout are not native to the Pinchot Creek Basin, stocked lakes are high in the basin with steep outlets. Concern of these fish escaping the lakes and becoming established I nthe SF Payette River remain low.

These stocking modifications highlight the need for continued monitoring of alpine lakes within the region. While the cost of stocking individual lakes remains low, recent sampling shows that some of these stockings are either ineffective or unnecessary. The region will continue to systematically sample alpine lakes throughout the region (both stocked and non-stocked) to work to maximize the efficiency of the stocking program.

The continued presence of amphibians, specifically, Columbia Spotted Frog, Western Toad, and Long-Toed Salamander in both fishless and to a lesser extent, fish-occupied lakes is encouraging. Monitoring the presence/absence of these species across the range of alpine lakes within the region will continue to be an important component of our sampling efforts.

RECOMMENDATIONS

1. Modify stocking in the Pinchot Creek Basin as outlined in the Discussion above to maximize fish survival and angling opportunity
2. Continue systematic sampling of alpine lakes throughout to region to further streamline fish stocking densities, frequencies, and locations

Table 11. Catalog number, lake name, sample date, amphibians present, human use, hook-and-line sampling information, fish size information, and number of fish receiving T-bar anchor tags from surveys completed during 2020 in alpine lakes in the headwaters of Pinchot Creek.

LLID	Lake name	Sample date	Amphibians present[a]	Human use	Fish stocked (most recently)	Fish data							
						Species[b]	Catch	Effort (h)	CPUE (Fish/h)	Mean length (mm)	Min length (mm)	Max length (mm)	No. fish T-bar anchor tagged
1151352440090	Pinchot Creek Lake	8/5/2020	none	low	0	YCT	36	6	6.00	241	150	305	32
					1500	GR	0	6	0	/	/	/	/
1151387440145	Pinchot Creek Lake #1	8/5/2020	CSF	low	500	GN	0	2	0	/	/	/	/
1151417439991	Pinchot Creek Lake #2	8/4/2020	none	low	500	GN	2	5	0.40	227	218	235	2
					0	GR	4	5	0.80	376	350	404	4
1151363440009	Pinchot Creek Lake #3	8/4/2020	LTS	low	300	GR	24	6	4.00	272	195	345	21
1151390440003	Pinchot Creek Lake #4	8/4/2020	CSF	low	1000	GN	0	2	0	/	/	/	/
1151338439947	Pinchot Creek Lake #6	8/4/2020	none	low	0	GN	6	2	3.00	no measurements			0
1151431439997	Pinchot Creek Lake #10	8/4/2020	LTS	none	0	none	/	/	/	/	/	/	/
1151413440004	Pinchot Creek Lake #11	8/4/2020	CSF	none	0	none	/	/	/	/	/	/	/
1151348439990	Unnamed Lake #1	8/4/2020	none	none	0	none	/	/	/	/	/	/	/
1151353439983	Unnamed Lake #2	8/4/2020	LTS, WT	none	0	none	/	/	/	/	/	/	/

[a] CSF (Columbia Spotted Frog); LTS (Long-Toed Salamander); WT (Western Toad)

[b] GN (Golden Trout); GR (Arctic Grayling); YCT (Yellowstone Cutthroat Trout)

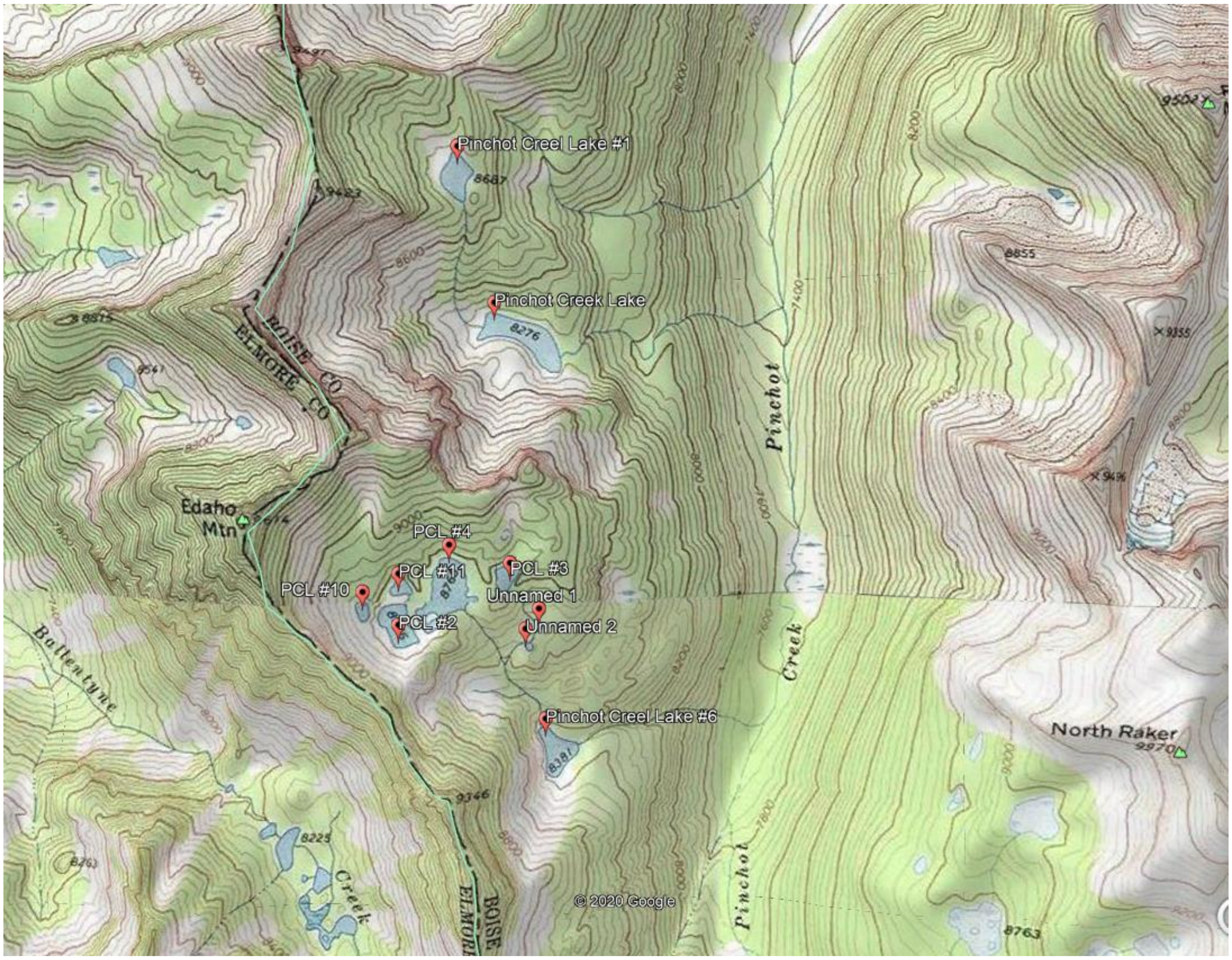

Figure 29. Location and names of ten alpine lakes sampled during 2020. Lakes were located in the headwaters of the Pinchot Creek drainage which is a tributary of the South Fork Payette River.

RETURN-TO-CREEL AND TAGGING SUMMARY OF HATCHERY RAINBOW TROUT STOCKED IN 2019

ABSTRACT

Idaho Department of Fish and Game hatcheries remain integral to managing coldwater sportfishing opportunities in Idaho. With the initiation of the Tag! You're It! program, catch and harvest rates have been evaluated in numerous regional waters since 2006 and regional staff continue to work to collect tag return data for waters and stocking periods that have previously not been evaluated. In 2019, catchables stocked into Banner Summit Lake, the Boise River and three community ponds (Duff Lane, Esther Simplot, and Merrill Park) were tagged from March through December to evaluate seasonal angler use. A total of 1,039 catchables were tagged and released in the five study waters in 2019. Total catch ranged from a high of 61.6% (October, Merrill Park Pond) to a low of 0.0% (in several stocking events). Similarly, days-at-large varied widely, ranging from a high of 102 d to a low of 7 d. The Tag! You're It! program enables managers to collect a large amount of data with minimal costs and labor. We will continue to use this tool to further evaluate angler use of hatchery catchables in regional waters on an annual basis and make stocking adjustments to further maximize the angler use of hatchery catchable trout.

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INTRODUCTION

Idaho Department of Fish and Game (IDFG) hatcheries are integral to managing coldwater sportfishing opportunities in Idaho. The Southwest Region stocked approximately 255,000 "catchable" sized Rainbow Trout (10-12"*;* herein "catchables") into 46 different waters in 2019. The majority of the catchables stocked in the Southwest Region are reared at the Nampa Fish Hatchery (>90%), with some coming from the Hagerman State Fish Hatchery (<10%). With the initiation of the Tag! You're It! program (see Meyer and Schill 2014), catch and harvest rates have been evaluated in numerous regional waters since 2006. These waters have been stocked with tagged fish as part of regional evaluations or as part of larger scale statewide hatchery evaluation studies. More recently, regional staff has worked to "fill in the gaps" and tag fish destined for waters that have not been previously evaluated or where previous evaluations have raised questions about stocking strategies. Tag return information from these stockings continue to provide managers with valuable information that aids in adjusting or maintaining hatchery catchable stocking numbers at various waters throughout the region.

METHODS

Locations and stocking months identified as lacking tag return data that received tagged catchables in 2019 included Banner Summit Lake (June and July), the Boise River (December), Duff Lane Pond (April, June, and October), Esther Simplot Pond (February, April, June, October, and December) and Merrill Park Pond (May, June, October).

Prior to stocking, roughly 10% of the fish to be stocked into study waters were tagged with 70-mm fluorescent orange T-bar anchor tags. Fish were collected for tagging by crowding them within raceways and capturing them with dip nets to ensure a representative sample. Fish were sedated, measured to the nearest mm, and tagged just under the dorsal fin. Within 24 h of tagging, tagged fish were loaded by dip net onto stocking trucks with the normal allotment of untagged fish and transported to stocking locations.

Angler catch and harvest data was based on the anchor tags that were reported by anglers. Anglers could report tags using the IDFG Tag! You're It! phone system or website (set up specifically for this program), as well as at regional IDFG offices or by mail. For a detailed description of the angler tag reporting system used, see Meyer and Schill (2014). To facilitate angler reporting of tagged catchables, anchor tags were labeled with "IDFG" and a tag reporting phone number on one side, with a unique tag number and reporting website on the reverse side. Year-specific tag reporting rates and tag loss rates were generated by IDFG's hatchery trout evaluation staff using a subset of $50 reward tags and double tagging a subset of fish.

Total angler returns (*c*) were calculated as the number of tagged catchables reported as caught within one year of stocking divided by the number of tagged catchables stocked. This included all catchables caught, including those released back into the fishery. Angler returns were evaluated within the first year post-stocking. Total angler returns were adjusted (*c'*), to estimate the total proportion of catchables caught by anglers for each stocking event, by incorporating the angler tag reporting rate (*λ)*, tag loss (Tag_l), and tagging mortality (Tag_m) taken from Meyer and Schill (2014) to be 0.8%. Adjusted tag returns were calculated for each individual stocking event using the formula:

$$c' = \frac{c}{\lambda(1 - Tag_l)(1 - Tag_m)}$$

Finally, days-at-large of the catchables that were eventually caught post-stocking was calculated by subtracting the stocking date from the date that each angler reporting catching their tagged fish.

RESULTS

A total of 1,039 catchables were tagged and released in the five study waters in 2019. Total catch (± 90% CI) ranged from a high of 61.6% (± 43.1%) for the October Merrill Park Pond stocking to a low of 0.0% for the June Duff Lane Pond, February Esther Simplot Pond and the May and June Merrill Park Pond stockings (Table 12). Similarly, days-at-large were also variable ranging from a high of 81 d for the December upper Boise River stocking to a low of 7 d for the April Duff Lane Pond stocking. All tag release numbers and estimates of harvest and total catch can be located in Table 12.

DISCUSSION

Catch and harvest of hatchery catchables across waters and stocking periods remain variable and continued tag return information is further helping managers refine when and where to stock. Similar to previous years, the waters and dates for which fish were tagged in 2019 were targeted to answer specific questions related to data gaps in our previous tag return information. In order to collect meaningful data, the ponds were stocked across multiple months.

Previous tagging studies of Banner Summit Lake had shown mixed results of total catch of hatchery trout stocked in June and July. In 2014 and 2015, average percent of the total stocking caught by anglers was 45.5% while July averaged 38.5%. In 2019, both months showed a catch of 16%. This reduced total catch led to the reevaluation in 2020, which showed moderate angler catch of fish stocked in early summer and high catch of mid-summer stocking in July. Given the remoteness of this lake, confirming that it experiences high catch rates was beneficial to confirm stocking was being utilized. Also of interest were the days-at-large for these stockings, as June-stocked fish were in the lake for an average of 57 days and July-stocked fish an average of 42 days, indicating many of this fish are caught in mid- to late-summer. Nampa Hatchery doesn't conduct many stocking events in July, but this high-elevation lake provides a good mid- to late-summer angling opportunity for hatchery catchables.

December stocking of the Boise River in Boise had not been previously evaluated. We evaluated both the lower (below Eagle Road) and upper (above Eagle Road) sections of the river. Surprisingly, we found that catch rates were much higher in the lower section, which was unexpected. In fact, previously, stocking has been skewed towards more fish going in the upper section (1,440) than the lower section (720) in November and December. Starting in 2021, both sections will receive 1,080 fish, similar to September and October stocking strategy.

Duff Lane Pond has moderate returns in the spring and fall, but no use in the early summer. Data collected during this assessment, coupled with poor returns in previous evaluations, resulted in the decision to no longer stock hatchery catchable trout into Duff Lane Pond in June. It's likely that water temperatures become too warm in June, and the majority of fish likely die prior to being encountered by anglers. Also of interest was the average days-at-large. Fish stocked in the spring were caught within a couple weeks of stocking, while the fish stocked in October were at large for a median of 44 days, indicating most were caught in the late fall. Longer days-at-large for fall-stocked catchable trout is not uncommon and is likely due to numerous factors including less fall fishing effort (many Idaho anglers switch their focus to hunting in the fall) and cooler water temperatures allowing for longer post stocking survival.

Esther Simplot Pond showed consistently low returns regardless of stocking month. While returns are generally low, this pond complex still appears to generate a decent amount of angler effort in a popular setting. Because of the low returns, stocking numbers have been decreased at Esther Simplot Pond from 1,300 fish per month to 600 fish in March and April, and 700 in May, June, October, November, and December.

Merrill Park Pond had no returns of tag fished stocked in May and June and will therefore no longer be stocked in the late spring/early summer. October stocking events did have decent returns and will be continued. Merrill Park Pond does not have easy access as it is steep sided and only had good shoreline access along one side.

Due to relatively stable statewide production of hatchery Rainbow Trout catchables, staff generally have little ability to increase stocking and have little desire to reduce stocking, so as to meet angler demand. So, anytime we cease or reduce stocking in one location, we initiate or increase stocking in another so that the balance of fish stocked in the region remains the same. For all stockings that were reduced or removed as part of the 2019 tagging results, those fish were added to the balance of new stocking to occur at the new Star City Pond (west) and the new Dick Knox Ponds in Emmett.

The use of T-bar anchor tags as a means to evaluate total catch and harvest across various regional waters will continue to be an important management tool. The Tag! You're It! program enables managers to collect a large amount of data with minimal costs and labor. We will continue to use this tool to further evaluate angler use of hatchery catchables in regional waters on an annual basis and make stocking adjustments to further maximize the angler use of hatchery catchable trout.

RECOMMENDATIONS

1. Discontinue June catchable stocking at Duff Lane Pond

2. Balance upper and lower Boise River stocking in November and December

3. Reduce stocking at Esther Simplot Pond

4. Discontinue May and June stocking at Merrill Park Pond

Table 12. Harvest and total catch (with 95% confidence intervals), and median days-at-large by waterbody and stocking month of hatchery catchable Rainbow Trout stocked in 2019.

Water	2019 stocking month	Tags stocked	Tags returned	Harvest	95% CI	Total Catch	95% CI	Median days-at-large
Banner Summit Lake	Jun	72	5	16.0%	11.3%	16.0%	11.3%	57
	Jul	59	4	15.7%	12.3%	15.7%	12.3%	42
Boise River - Lower	Dec	50	12	18.5%	14.4%	55.4%	24.0%	34
Boise Rover - Upper	Dec	100	4	0.0%	/	4.6%	5.2%	81
Duff Lane Pond	Apr	25	5	18.5%	20.2%	46.2%	30.3%	7
	Jun	25	0	0.0%	/	0.0%	/	/
	Oct	25	6	27.7%	24.3%	55.4%	32.7%	44
Esther Simplot Pond	Feb	125	0	0.0%	/	0.0%	/	/
	Apr	124	8	11.2%	7.3%	14.9%	8.5%	30
	Jun	120	3	3.8%	4.3%	5.8%	5.3%	25
	Oct	125	6	5.5%	5.1%	11.1%	7.3%	56
	Dec	125	0	0.0%	/	0.0%	/	/
Merrill Park Pond	May	25	0	0.0%	/	0.0%	/	/
	Jun	24	0	0.0%	/	0.0%	/	/
	Oct	15	4	61.6%	43.1%	61.6%	43.1%	68

WARMWATER FISH TRANSFERS TO REGIONAL WATERS

ABSTRACT

As a means of supplementing populations and bolstering catch rates in regional waters, Southwest regional personnel transferred four species of warmwater fish into 10 community fishing ponds in 2020. Raft and boat electrofishing were utilized to capture fish for transfer. A total of 373 fish were relocated including 148 catfish (either Channel Catfish *Ictalurus punctatus* or Flathead Catfish *Pylodictis olivaris*), 75 Smallmouth Bass *Micropterus dolomieu*, and 150 Bluegill *Lepomis macrochirus*.

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INTRODUCTION

The Southwest Region contains over 40 small public community fishing ponds as well as nearly 40 lowland reservoirs. These fisheries offer a variety of angling options for hatchery Rainbow Trout *Oncorhynchus mykiss* as well as several warmwater species. Nampa Fish Hatchery regularly supplies Rainbow Trout to many of these area fisheries. However, warmwater fish populations are perpetuated by either natural reproduction or transfers from other waters. The Idaho Department of Fish and Game (IDFG) seeks to maintain adequate populations of warmwater fish in many of these community ponds for recreational angling. The Channel Catfish *Ictalurus punctatus* transfer program began in 2008 to provide an additional sportfish opportunity at local community ponds during the summer months after suspending trout stocking because of warm water conditions. In 2020, annual transfers of warmwater species to community fishing ponds were continued to provide put-and-take fishing opportunities and encourage natural reproduction.

OBJECTIVES

1. Provide Channel Catfish fishing opportunity in community ponds

2. Provide bass and Bluegill fishing opportunity in community ponds

3. Enhance population structure within community ponds by introducing Smallmouth Bass *Micropterus dolomieu* to ponds dominated by small Bluegill *Lepomis macrochirus*. Bluegill are also utilized to establish a food source prior to bass transfers at some new community ponds

METHODS

Sources of warmwater fish species included C.J. Strike Reservoir and the Snake River near Centennial Park in Payette, Idaho. Redwood Park Pond in Boise was also utilized due to an overabundance of small Bluegill. C.J. Strike Reservoir was used for Smallmouth Bass collections as this population has increased 78% since 2009, and remains a viable source for additional translocations within the region (Cassinelli et al. 2018).

Crews collected fish between June 30 and July 10, 2020. Raft electrofishing was utilized in Redwood Park Pond due to its small size. On C.J. Strike Reservoir and the Snake River, electrofishing boats were used. Both the raft and boats were equipped with a Midwest Lake Electrofishing Systems (MLES) Infinity system. The MLES was set at 20% duty cycle and 6,500-watt Honda generator supplied approximately 2,200-2,800 watts of pulsed DC power. Dip nets were used to capture stunned fish which were then transferred to live cars and held until sufficient numbers were captured to fill a transport truck or trailer. Fish were then transported with supplemental oxygen at 1.5-2.0 liters/minute until they reached the release location.

RESULTS

During 2020, 373 fish were captured and transferred. This total included 148 catfish (either Channel Catfish or Flathead Catfish *Pylodictis olivaris*), 150 Bluegill *Lepomis macrochirus*, and 75 Smallmouth Bass. Releases occurred in 10 community fishing ponds and specific release numbers, waters, and dates are outlined in Table 13.

RECOMMENDATIONS

1. Continue transferring Channel Catfish to community fishing waters annually

2. Continue stocking bass (both Smallmouth and Largemouth when available) and Bluegill into area ponds to both supplement and promote population growth and suitable population size structure as well as providing for angling

3. Tag bass and utilize the Tag! You're It! program to evaluate harvest and angler use of those transferred to community fishing waters

Table 13. Warmwater fish transfers conducted in the Southwest region in 2020. Species codes are defined as CAT: catfish species (Channel Catfish or Flathead Catfish), SMB: Smallmouth Bass and BLG: Bluegill.

Date	Collecting water	Receiving water	Spp. code	#	Mean length (mm)	Release temp (°C)
6/30/2020	Redwood Park Pond	Star Lane Pond	BLG	150	-	-
7/2/2020	C.J. Strike Reservoir	Redwood Park Pond	SMB	30	214.1	22
7/2/2020	C.J. Strike Reservoir	Terry Day Pond	SMB	45	214.1	22
7/7/2020	Snake River at Payette	Horseshoe Bend Mill Pond	CAT	35	-	-
7/8/2020	Snake River at Payette	McDevitt Pond	CAT	11	-	-
7/8/2020	Snake River at Payette	Ed's Pond	CAT	12	-	-
7/8/2020	Snake River at Payette	Kleiner Pond	CAT	11	-	-
7/9/2020	Snake River at Payette	Sawyers Pond	CAT	30	-	-
7/9/2020	Snake River at Payette	Parkcenter Pond	CAT	21	-	-
7/10/2020	Snake River at Payette	Riverside Pond	CAT	20	-	-
7/10/2020	Snake River at Payette	Kleiner Pond	CAT	4	-	-
7/10/2020	Snake River at Payette	Parkcenter Pond	CAT	4	-	-

RIVERS AND STREAMS INVESTIGATIONS

LOWER BOISE RIVER

ABSTRACT

In order to estimate distribution, angler use and exploitation of adult trout, we surveyed approximately 30 km using raft electrofishing, collected adult Rainbow and Brown Trout using raft electrofishing and marked them with T-bar anchor tags. We sampled a total of 364 wild Rainbow Trout, 118 wild Brown Trout and 49 hatchery Rainbow Trout during the raft-electrofishing surveys. Preliminary tag return data indicates harvest of wild trout is low, with only ten total tags returned at the time of this publication. Additionally, standardized monitoring sites used to estimate relative density and size structure of juvenile wild Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta* in the lower Boise River between Harris Ranch and Middleton have been sampled annually since 2015. In 2020, 64 sites were surveyed across 45 km. We captured 358 wild Rainbow Trout and 290 wild Brown Trout. Relative density estimates of juvenile Rainbow Trout increased in 2020 compared to previous years, as did juvenile Brown Trout density estimates.

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INTRODUCTION

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 1972 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 wastewater, and stormwater management.

The lower Boise River fishery supports substantial angling effort throughout the year (Kozfkay et al. 2011), primarily for both wild and hatchery-origin Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta*. 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 seventeen-fold between 1994 and 2010 (Kozfkay et al. 2011). The increase in wild trout 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 2020, we repeated raft electrofishing surveys conducted in 2015-2016 (Butts et al. 2017; Peterson et al. 2018). The primary goal of the raft electrofishing survey was to deploy external T-bar anchor tags to evaluate angler use and exploitation of wild trout, as well as monitor trends in population sizes, species composition, relative density, and distribution throughout the lower Boise River. We also repeated our annual juvenile trout surveys, which have been conducted annually since 2015. The primary goal of the juvenile trout surveys was to monitor long term trends in species composition, relative density and distribution throughout the lower Boise River.

STUDY AREA

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) as well as channel alteration. Flows are managed for agricultural demands, flood control and streamflow maintenance. 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 14 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 historically resulted in significant reduced 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 above Glenwood Bridge, to a warmwater species assemblage near Middleton and downstream to the Snake River, with a transition zone in between. Species present in the lower Boise River include Rainbow Trout, Brown Trout, Mountain Whitefish *Prosopium williamsoni*, and sculpin *Cottus sp.* in the upstream coldwater portion of the river. Warmwater species including

Smallmouth Bass *Micropterus dolomieu*, Channel Catfish *Ictalurus punctatus*, and Common Carp *Cyprinus carpio* are found more frequently in the lower portion below Middleton, Idaho.

METHODS

Angler Use & Exploitation Surveys

In 2020, we investigated angler use and exploitation of wild trout in the Lower Boise River. This evaluation is a repeat of surveys conducted in 2015-2016. The study included approximately 30 km of river between Barber Park and Star, which is a large portion of the known extent of year-round trout habitat in the Lower Boise River (Figure 30). We delineated five river sections in this reach to describe spatial differences in wild trout abundance and exploitation (Table 14). River sections (1.88-11.83 km in length) were chosen based on locations of prominent access points, landmarks, or river barriers. While most sites were exact repeats of sites surveyed during the 2015-2016 survey, some were slightly altered based on recent barriers and channel development. We completed the upper portion in 2020 and will complete the lower portion in 2021.

Trout were collected with raft-mounted electrofishing gear during July 13-July 17, 2020. River flow at the Glenwood Bridge gauging station was 22.07 m^3/s during the survey. 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 two pole-mounted anodes on 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 (Champion 5000), 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, 1,200-1,800 watts, respectively. Crews consisted of two people, a rower and netter. Only trout were placed in the livewell. Oxygen was introduced to the live well (2 L/min) through an airstone. When the livewell was judged to be at capacity, the crews stopped at the nearest riffle to process fish. Rainbow Trout were identified as hatchery or wild origin based on visual characteristics such as fin condition and coloring. All trout were measured for total length (TL; mm) and weighed (g).

We evaluated exploitation (total harvest) and total use (caught and released) of wild trout using angler-reported t-bar anchor tags. Trout >200 mm were tagged dorsally using 70-mm (51 mm of tubing) fluorescent orange Floy® FD-68BC t-bar anchor tags. Each tag was uniquely numbered and had contact information for the IDFG Tag! You're It! program. Fish were released 20-50 m upstream from the processing site to prevent drift downstream into the next sampling area.

Tag return data were collected using the IDFG Tag! You're It! reporting system. 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), including an assumed 3% tag loss rate. Mean non-reward tag reporting rate for wild trout was 53%, based on angler tag returns of $50 reward tags in wild Rainbow Trout (Cassinelli 2016). Use is defined as tags reported from fish that were encountered and released, exploitation is defined as tags reported from fish that were encountered and harvested. Tag return data were analyzed for tags returned through February 1, 2021 and annual exploitation rates will be reported in a future report as data become available.

Annual Juvenile Wild Trout Surveys

Juvenile Rainbow and Brown Trout production was evaluated at 64 sites from the Highway 21 Bridge to Middleton from October 30 to November 13, 2020 (Figure 30). We have completed these juvenile trout surveys annually since 2015. These 64 sites were divided into 12 sample sections between lower Boise River mainstem and the associated tributaries. Most sections contained four sample sites, however the number of sample sites within a section ranged from one to five. Mainstem sites were stratified by river section with half of the mainstem locations selected randomly and the other half selected by crews. For the non-random sites, crews selected sites suspected to be high quality 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. In 2020, sites were 33 m long, as they have been historically. During mainstem sampling, the area from the one shoreline out to approximately 4 m was sampled. For tributary/side channel sample sites, the entire channel was sampled. A single, upstream electrofishing pass was completed at each site.

Juvenile Rainbow and Brown trout were sampled using a Smith-Root® LR-24 battery powered backpack shocker. Electrofishing voltage varied to produce approximately 100-120 watts, however duty cycle and hertz were held constant at 15% duty cycle and 60 Hz. All fish were identified, counted and measured for total length (TL; mm). Relative fish densities (fish/m^2) ± 95% confidence intervals were calculated.

Egg Supplementation Project

The Department conducted additional efforts to increase juvenile trout production in the lower Boise River during 2020. Approximately 10,000 fertilized triploid Rainbow Trout eggs were procured from surplus stock at Hayspur Hatchery and placed in four egg boxes at two locations. Locations were selected based areas of historic fry observations; one location with a history of higher observed historic fry densities (Barber Park) and one location with a history of lower observed historic fry densities (Esther Simplot). Eggs were placed in the egg boxes on May 26, 2020 and were left in-situ until June 26, 2020.

RESULTS

Angler Use & Exploitation Surveys

We captured 364 wild Rainbow Trout, 49 hatchery Rainbow Trout, and 118 Brown Trout during the 2020 angler use and exploitation survey (Table 14). Wild Rainbow Trout made up approximately 69% of the trout caught in the four sites and Brown Trout made up 22% of the trout captured. Rainbow Trout TL ranged from 74 to 575 mm, (mean = 311.4 mm, SD = 80.6, Figure 31). Brown Trout total length ranged from 76 to 703 mm (mean = 408.9 mm, SD = 105.4; Figure 32). As of June 2021, 33 tags were reported; nine from wild Rainbow Trout, five from a hatchery Rainbow Trout and 19 from Brown Trout. Adjusted use (± 90% adjusted confidence interval) and exploitation (± 90% adjusted confidence interval) for Rainbow Trout use was 19.9% (± 9.0) and 6.1% (± 4.9), respectively. Mean adjusted use and exploitation for Brown Trout was 16.7% (± 5.9) and 3.5% (± 2.5), respectively.

Annual Juvenile Wild Trout Surveys

Many different species were observed during juvenile trout surveys, including dace sp., sculpin sp., and sucker sp. (Table 15). A total of 290 Brown Trout and 358 Rainbow Trout were captured during the survey. Brown Trout catch ranged from 0-65 fish per site, while Rainbow Trout catch ranged from 0 to 127 fish per site (Table 15). Rainbow Trout TL ranged from 64 to 420 mm (mean = 99.8 mm, SD = 31.5; Figure 33) and Brown Trout TL ranged from 75 to 255 mm (mean = 117.0 mm, SD = 24.8; Figure 34).

Juvenile trout densities varied by location, habitat type, and species in 2020. Mean density of juvenile Rainbow Trout was 0.18 fish/m^2 ± 0.13 for the entire survey. Mean density of juvenile Brown Trout was 0.14 fish/m^2 ± 0.08 for the entire survey (Figure 35). Mainstem sites typically had lower densities than tributary/side channel sites (Figure 35). In mainstem sites, mean density of juvenile Rainbow Trout was 0.11 fish/m^2 ± 0.05 while tributary/side channel sites had a mean density of 0.58 fish/m^2 ± 0.81. Mean density of juvenile Brown Trout was 0.07 fish/m^2 ± 0.04 in mainstem sites and 0.54 fish/m^2 ± 0.42 in tributary/side channel sites (Figure 35). In the mainstem, the highest densities of Rainbow Trout were observed at Barber Park, whereas the highest densities of Brown Trout were sampled downstream at Star North. For tributary/side channel sites, juvenile Brown Trout density was highest in Loggers Creek, and juvenile Rainbow Trout density was highest at Heron Creek (Figure 36).

Egg Supplementation Project

This was a pilot study, with little quantitative results. When we removed the egg boxes, we observed a few (> 10) fully-developed fry still in the egg boxes, and limited egg mortality. However, anecdotal observations suggest the eggs were able to develop into fry and we assume fry were able to volitionally out-migrate from the egg boxes.

DISCUSSION

Angler Use & Exploitation Surveys

Human population growth in Idaho's Treasure Valley has steadily increased since the last angler exploitation and use surveys were conducted on the lower Boise River (Sharf 2018). As with population growth, number of fishing license sales have also increased (IDFG unpublished data). With additional population growth as well as increased license sales, IDFG was interested in repeating the angler use and exploitation surveys of 2015-2016. In 2015-2016, IDFG staff conducted a survey utilizing the Tag! You're It! program to estimate angler exploitation and use of trout in the lower Boise River. At the time of publication, only 33 tags have been reported. Preliminary results from that survey indicate angler exploitation and use of wild trout in the lower Boise River was low. Based on the raw count of tags returned, only 5.9% of tagged Rainbow Trout were caught and 2.6% were harvested, while 5.7% of Brown Trout were caught and 1.5% were harvested within one year of tagging. We are repeating this angler exploitation and use survey from 2020-2021. While it is still early to draw conclusions from the tag return data, preliminary findings are similar to past surveys. At time of publication, approximately 6.2% of tags were reported. Compared to previous surveys, adjusted angler use (RBT 19.9%, BNT 16.7%) increased and exploitation (RBT 6.1%, BNT 3.5%) estimates remain low.

The recent 2019 lower Boise River adult trout population estimates (D'Amico et al. 2020) indicate that the wild trout populations in the lower Boise River appear to have a growing population of larger trout. The increase in large individuals bodes well for Boise River anglers and may be influenced by the low exploitation of wild trout; lower fishing mortality may lead to increased longevity and therefore increased fish size. As with the 2019 survey, large trout were encountered during the 2020 raft surveys; mean TL of Rainbow Trout was 311.4 mm, and mean TL of Brown Trout was 408.9 mm. Approximately 18% of wild Rainbow Trout were greater than 400 mm, while 61% of Brown Trout were greater than 400 mm.

Hatchery Rainbow Trout were again captured in the lower Boise River adult trout surveys. Between 200-500 triploid hatchery Rainbow Trout are stocked monthly near the sample areas. During 2019, the stocking occurred in-between the mark and recapture runs, violating our population closure assumption. This is especially evident through the confidence intervals surrounding the population estimate overlapping zero. Hatchery Rainbow Trout population size has varied historically which can likely 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%.

Annual Juvenile Wild Trout Surveys

The continuation of the fall shoreline surveys for juvenile trout offered further insight into identifying important juvenile trout habitats in the lower Boise River. Fall densities of juvenile Rainbow Trout were lower in 2019 compared to 2018. Results from previous surveys speculated that the observed relative juvenile trout densities are affected by flow, specifically during the vulnerable stages of incubation and emergence. The lower Boise River sustained high flow events during early June 2019, which we speculate may have reduced recruitment of the 2019 year class (particularly Rainbow Trout), and thus impacted observed relative fish densities. In 2020, the lower Boise River did not sustain these same high flow events, and we observed a corresponding increase in observed relative juvenile trout densities. We evaluated observed juvenile trout density as a function of mean flow during both emergence (Figure 37) and incubation (Figure 38). As mean flow increases, observed juvenile trout density decreases. These correlations are not statistically significant at the 95% confidence level (due to wide confidence intervals), however a negative pattern is observed. While we are not advocating that more water leads to less fish, early flood control releases during these vulnerable life stages may reduce annual juvenile trout recruitment success.

The angler exploitation and use surveys provide fisheries managers with updated figures and understanding of trout harvest and population indices of in the lower Boise River, especially with the potential for higher angling effort associated with an increasing human population in the Treasure Valley. Further investigation of the relationship between abiotic conditions and juvenile trout production will increase our understanding in the underlying mechanisms. Hopefully this will provide opportunities to influence important variables through active management, with the ultimate goal to increase recruitment and higher catch rates. Coupling juvenile trout surveys with periodic population estimates and angling surveys may provide managers with a more holistic view of the lower Boise River trout populations to further meet our management objectives.

Egg Supplementation Project

As mentioned, this was a pilot study with little quantitative results. This is a low-cost project with limited drawbacks; egg boxes were readily available from Eagle Hatchery staff, the fertilized eggs are surplus and would otherwise be euthanized. While there are limited quantitative results, we anticipate continuing and potentially expanding this egg supplementation project should there continue to be surplus eggs. While the two locations appeared suitable, we may slightly alter egg box locations to areas with more suitable spawning habitat to hopefully improve survival and ultimately recruitment to the lower Boise River fishery.

RECOMMENDATIONS

1. Continue triennial adult trout population monitoring in the lower Boise River with a focus on Mountain Whitefish in 2021

2. Continue annual fall fry surveys to continually monitor annual variability in juvenile trout densities

3. Complete the lower portion surveys for the raft electrofishing survey in summer 2021 to evaluate population size and angler exploitation of wild Rainbow and Brown Trout in the lower Boise River

Table 14. Sites, reach length, species, and number of trout sampled during the 2020 angler exploitation and use surveys.

		n tagged		
Reach	Reach length (km)	Rainbow Trout (wild)	Rainbow Trout (hatchery)	Brown Trout
Eckert Bridge - Mallard	5.28	25	6	7
Mallard - Americana	4.45	37	19	22
Americana - Esther Simplot	1.88	7	3	3
Esther Simplot - Glenwood	5.26	56	2	36
Glenwood - Eagle Hatchery	11.83	239	19	50
Total	28.7	364	49	118

Table 15. Sites, species, and number captured of fishes sampled during the 2020 fall juvenile trout surveys.

Reach	Bluegill	Brown Trout	Dace spp.	Largemouth Bass	Largescale Sucker	Mountain Whitefish	Northern Pikeminnow	Oriental Weatherfish	Rainbow Trout	Redside Shiner	Sculpin spp.	Smallmouth Bass	Total
Americana	-	7	1	-	-	-	-	-	24	-	3	1	36
Barber	-	4	3	-	-	-	-	-	51	1	3	-	63
Can-Ada	-	7	-	-	4	-	2	2	3	1	-	-	19
Dry Creek	1	-	-	-	-	-	-	-	1	-	-	2	4
Eagle North	-	13	4	3	1	-	1	-	6	-	3	1	33
Eagle South	-	1	2	2	-	3	-	-	2	-	3	-	13
Glenwood	-	1	4	2	-	-	-	-	1	-	2	-	10
Harris Ranch	-	-	-	-	2	-	-	-	22	-	1	-	27
Heron Creek	-	14	-	-	-	7	2	-	127	-	-	-	150
Linder North	1	22	1	-	1	-	-	-	3	-	-	-	28
Logger Creek	-	147	1	2	1	3	-	-	42	1	1	-	198
Morrison	-	10	3	1	-	-	-	1	34	-	3	-	52
Plantation	-	4	4	3	-	-	-	-	19	-	4	-	34
Special Reg	-	-	4	-	-	-	-	-	14	-	4	-	22
Star	-	17	-	1	4	-	-	-	-	-	-	-	22
Star North	-	43	2	1	4	-	2	-	7	-	-	-	59
Star South	-	-	-	-	1	-	-	-	-	-	-	-	1
Warm Creek	-	-	1	-	-	-	-	-	2	1	1	-	5
Total	2	290	30	15	18	13	7	3	358	4	28	4	776

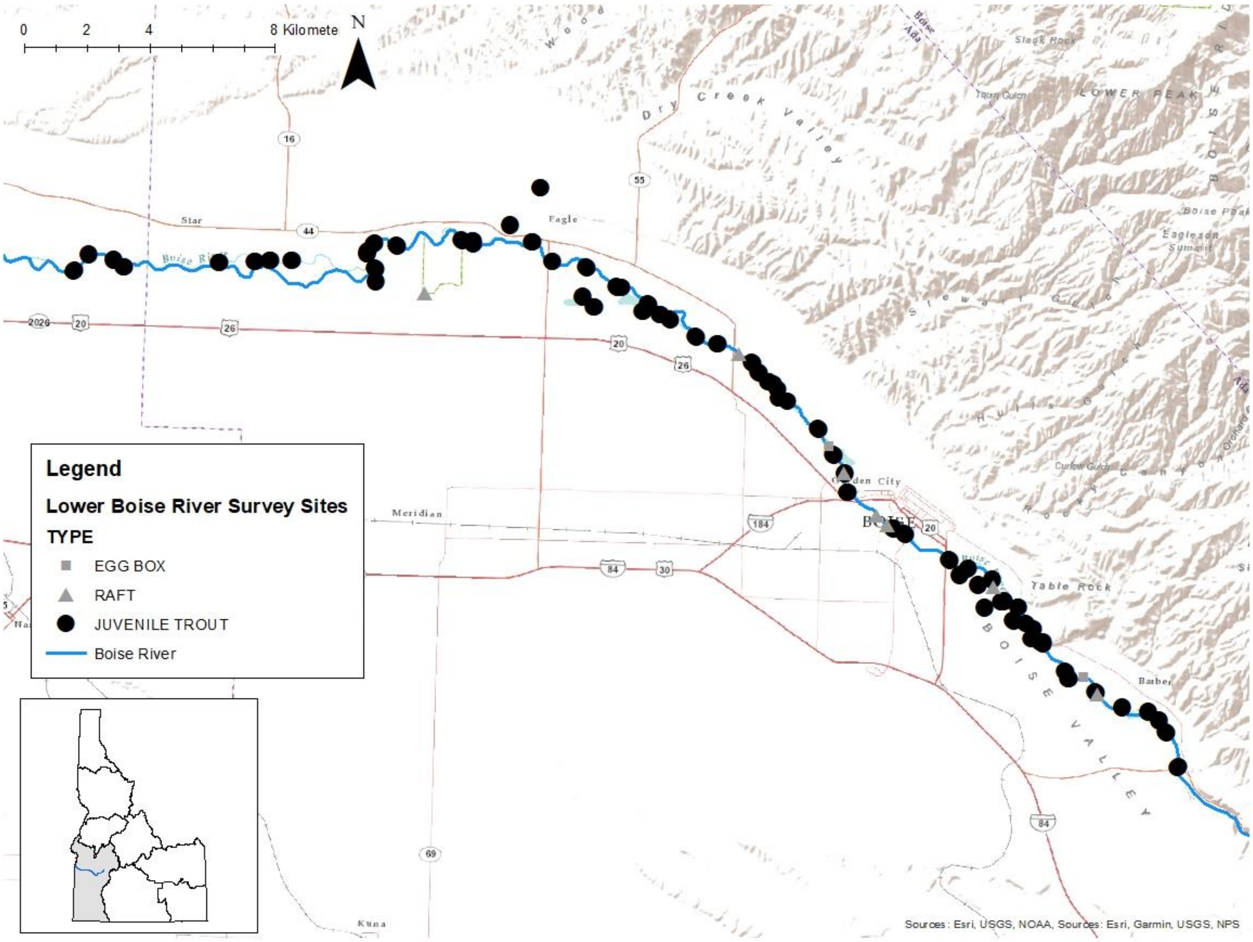

Figure 30. Map of sites surveyed during the 2020 field season. Angler exploitation and use survey locations are shown in gray triangles, egg boxes are shown in gray squares, juvenile trout surveys are shown in black circles.

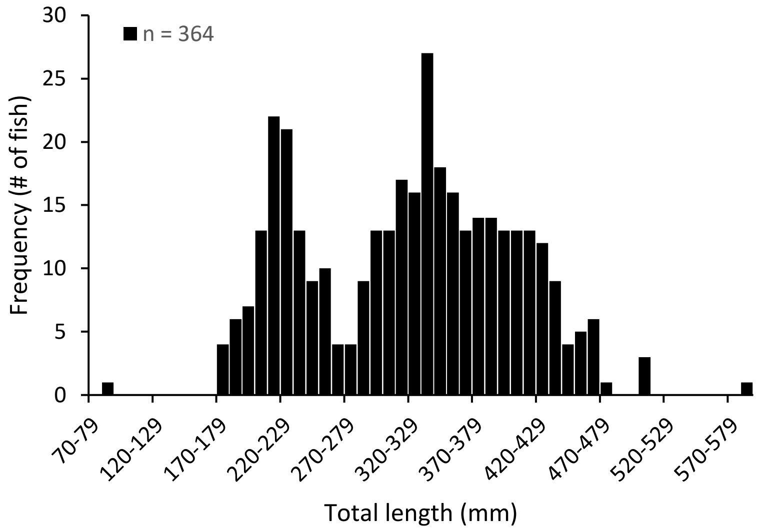

Figure 31. Length-frequency histogram of Rainbow Trout sampled during the 2020 angler exploitation and use survey on the lower Boise River.

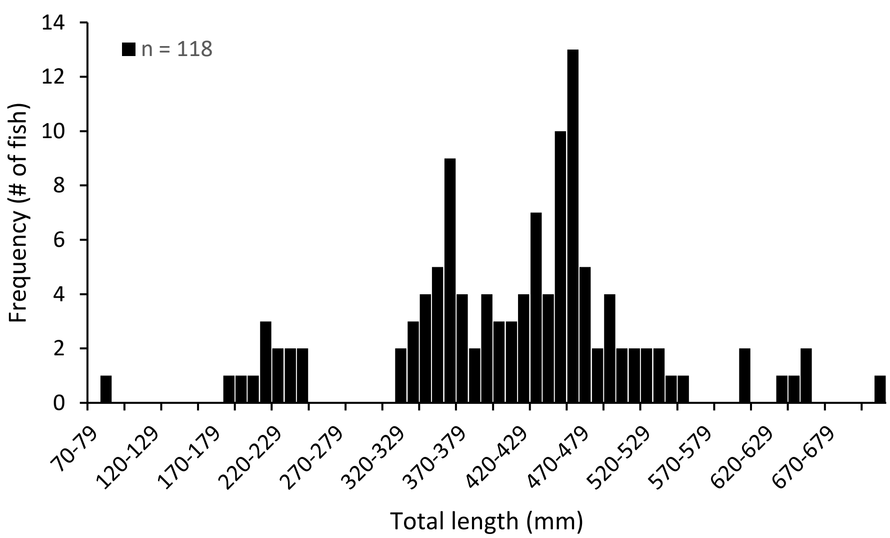

Figure 32. Length-frequency histogram of Brown Trout sampled during the 2020 angler exploitation and use survey on the lower Boise River.

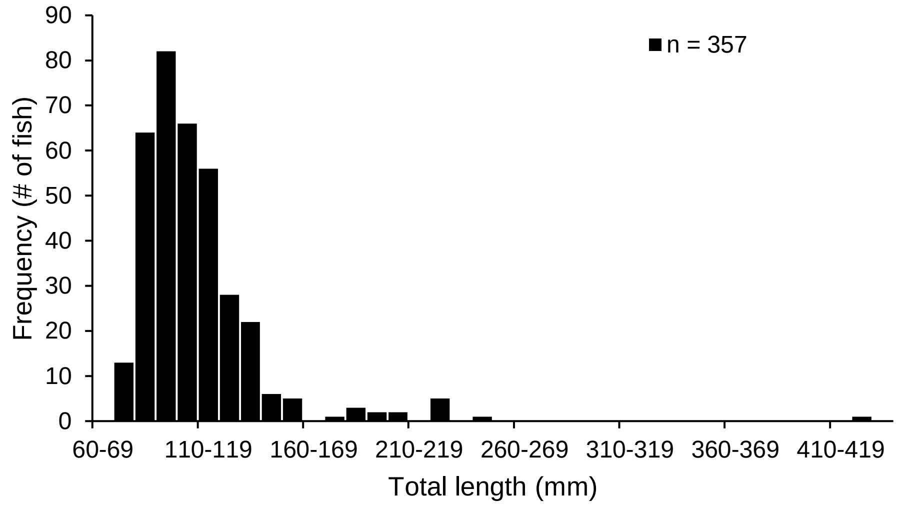

Figure 33. Length-frequency histogram of Rainbow Trout sampled during the 2020 juvenile trout surveys on the lower Boise River.

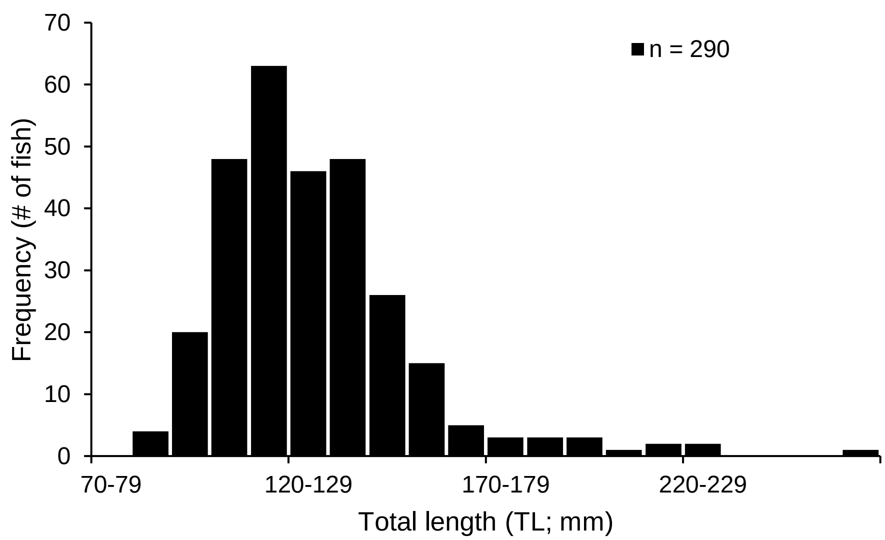

Figure 34. Length frequency histogram of Brown Trout sampled during the 2020 juvenile trout surveys on the lower Boise River.

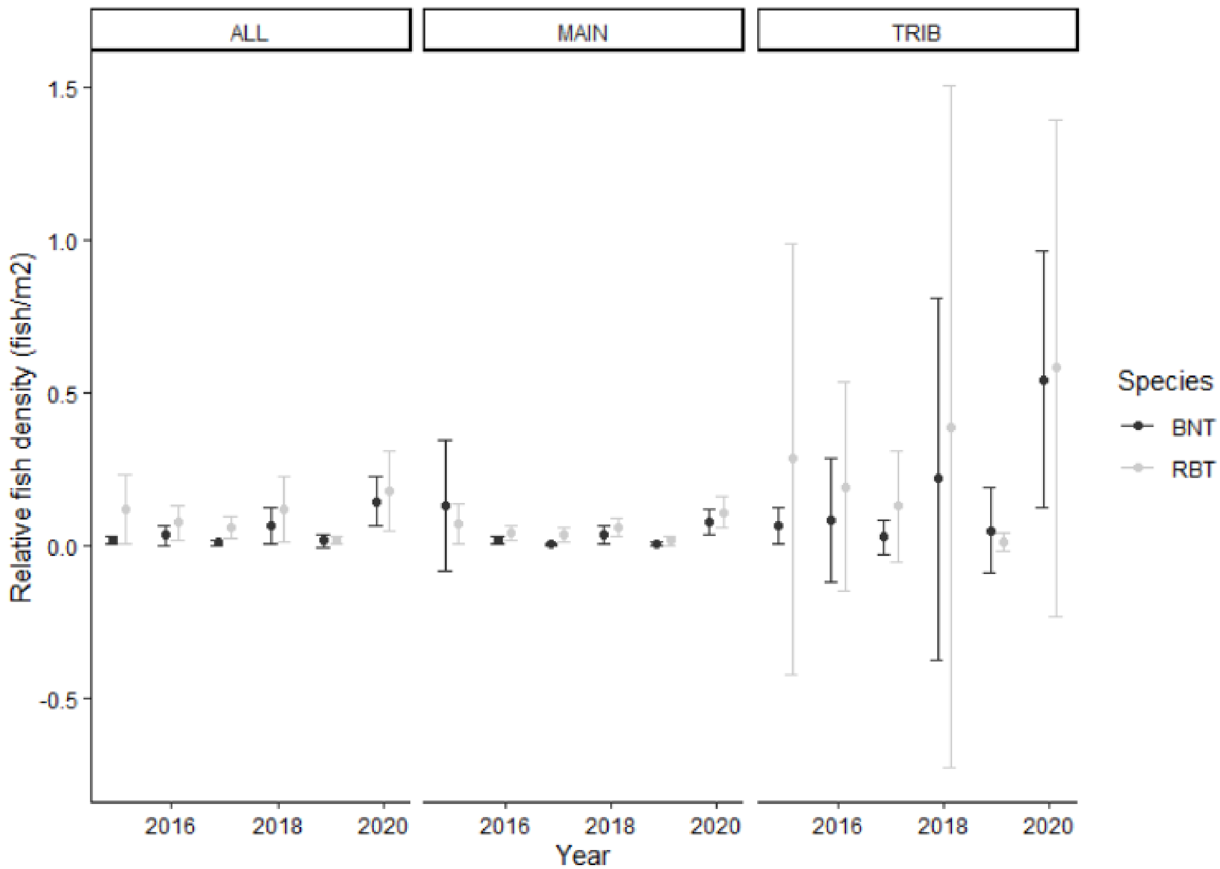

Figure 35. Observed relative fry densities from 2015-2020 on the lower Boise River. Left panel is all sites combined, middle panel is only mainstem sites, and right panel is only tributary/side channel sites. Rainbow Trout are shown in gray, Brown Trout are shown in black.

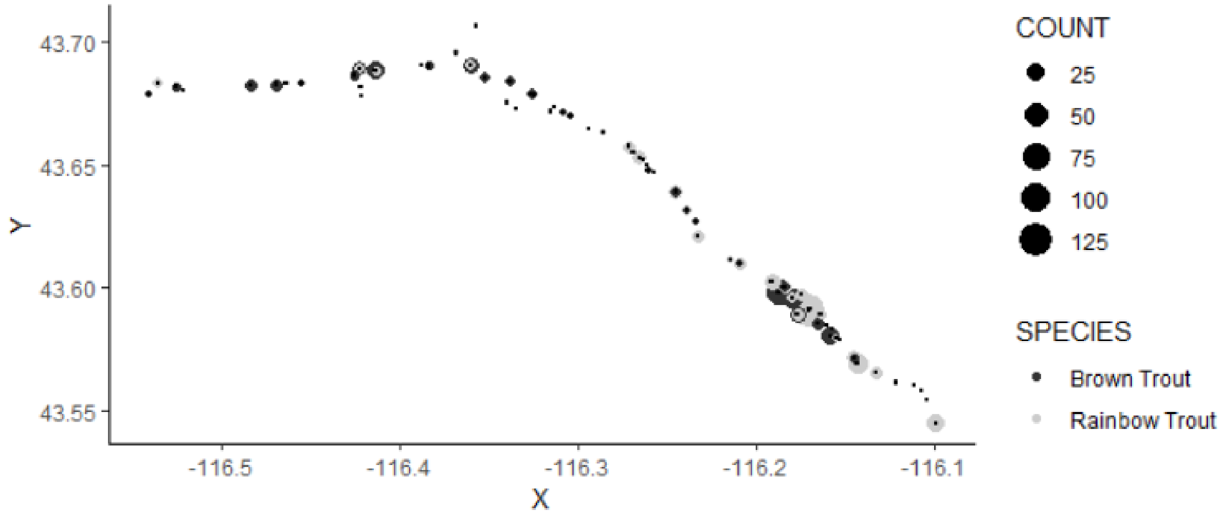

Figure 36. Spatial distribution of number of fry observed in 2020 during juvenile trout surveys on the lower Boise River. Black points are survey sites, Rainbow Trout are shown in gray, and Brown Trout are shown in black. Size of the dot corresponds to the number of fish observed.

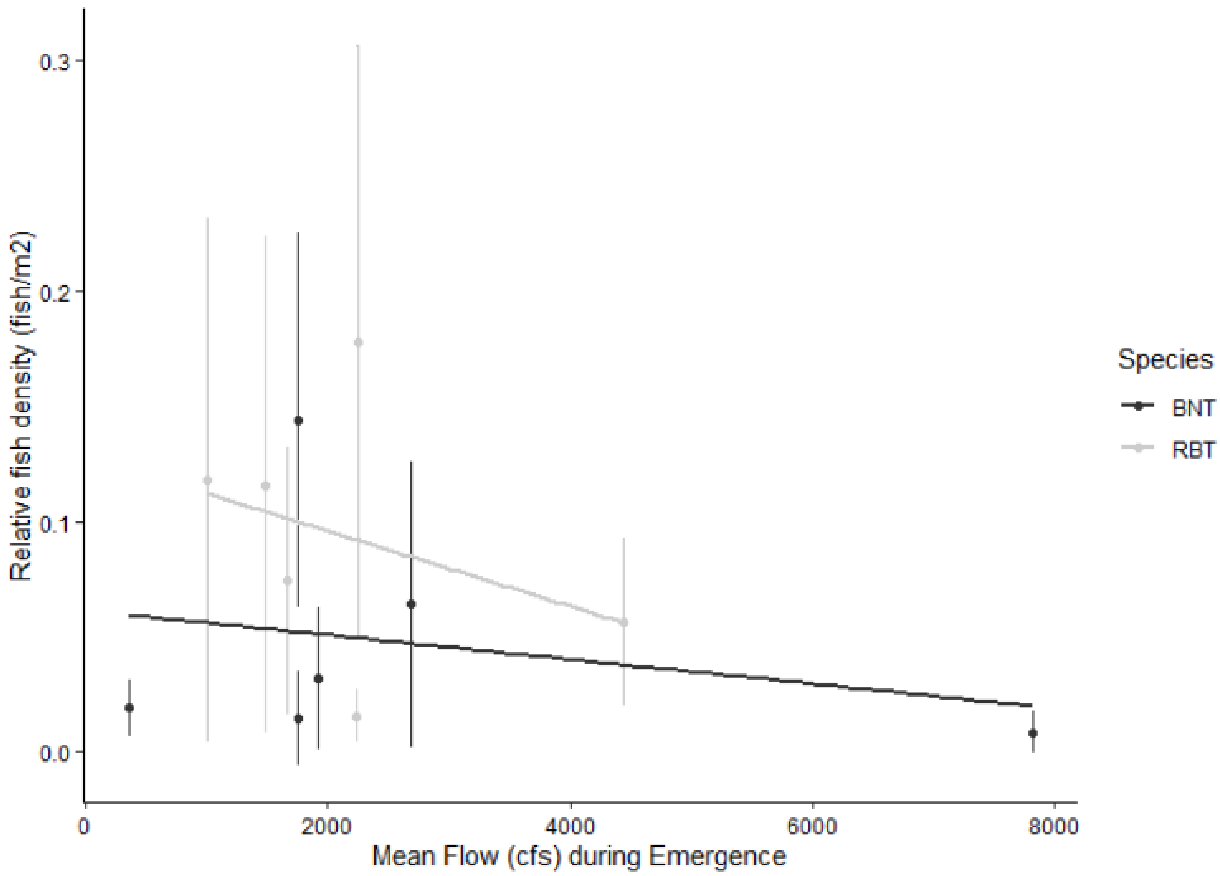

Figure 37. Observed relative fry density as a function of mean discharge during emergence for juvenile trout surveys 2015-2020 on the lower Boise River. Rainbow Trout are shown in gray, Brown Trout are shown in black.

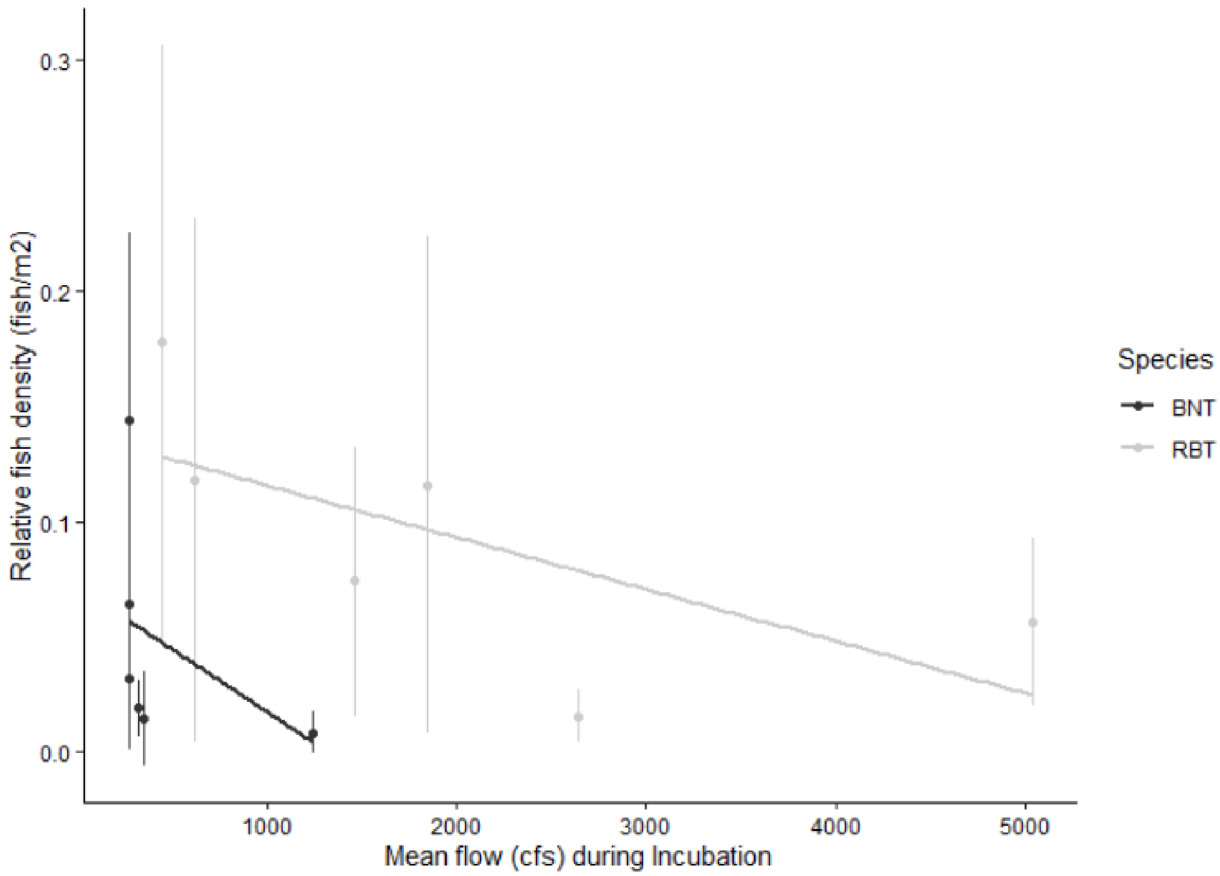

Figure 38. Observed relative fry density as a function of mean discharge during incubation for juvenile trout surveys 2015-2020 on the lower Boise River. Rainbow Trout are shown in gray, Brown Trout are shown in black.

MIDDLE FORK BOISE RIVER SNORKEL SURVEYS

ABSTRACT

During July 2020, 13 historic trend sites were surveyed in the Middle Fork Boise River (MFBR) using entire-width snorkeling. This is the first year of a three-consecutive-year monitoring effort to evaluate trends in relative abundance and streamflow using species-specific density estimates for each site and comparing amongst years. Idaho Department of Fish and Game has conducted snorkel surveys on nearby streams and documented correlations between fish densities and streamflow. These findings prompted a shift in large river snorkel monitoring techniques from single year to multi (three) year monitoring to minimize potential biases in fish densities due to one-time flow or other environmental conditions. By sampling these rivers three years consecutively, we will get a better representation of fish densities across a wider range of flow conditions and be better able to monitor population trends accounting for abiotic factors. As this is the first year of a three-year rotation, conclusions between streamflow and observed fish densities are premature. However, observed fish densities in 2020 were intermediate between previous surveys (1988 and 2000).

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INTRODUCTION

Similar to many of the streams and rivers in the Idaho Batholith, the Middle Fork Boise River (MFBR) is a relatively unproductive river with low levels of dissolved solids, nutrients, and low conductivity. Historically, the drainages within the Idaho Batholith received marine-derived nutrients from the carcasses of returning anadromous salmonids. However, anadromous returns to the Boise River basin were extirpated after the construction of numerous dams in the system starting as early as the completion of the Boise River Diversion Dam in 1909. The basin consists of granitic rocks and sand that result in shallow soil that is prone to high rates of erosion. Erosion is further amplified following wildfires, and large portions of the basin have been affected by wildfire. Due to the low productivity and resulting low fish densities, coupled with low dissolved solids, low conductivity and high visibility, snorkel surveys are the most effective sampling tool currently available for Idaho Department of Fish and Game (IDFG) regional fisheries staff to implement on streams such as the MFBR.

Thirteen sites on the MFBR have been intermittently surveyed using snorkeling techniques since the late 1980s, with the most recent prior surveys being conducted in 2000. After completing a three-year snorkel survey on the neighboring North Fork Boise River (NFBR), a strong correlation was observed between fish densities and the average flow across the three years prior to sampling. This finding corresponded with the findings of Copeland and Meyer (2011) who showed that stream flow three and four years previous to sampling was the most important bioclimatic condition influencing Brook Trout *Salvelinus fontinalis* and Bull Trout *S. confluentus* densities in Idaho rivers. Given this apparent strong correlation between fish densities and flow patterns on the NFBR, we decided to transition our large-river snorkeling methodology to three-consecutive-year sampling blocks to help avoid single-year biases in fish densities due to one-time flow conditions. By sampling these rivers in three year blocks, we will get a better representation of fish densities across a wider range of flow conditions and be better able to monitor population trends over time. Using this methodology, the goal is to sample the NFBR, MFBR, Middle Fork Payette River, and South Fork Payette River in three year blocks across a 12-year rotation.

STUDY AREA

The MFBR originates on the west side of the Sawtooth Mountain Range and flows in a southwesterly direction for approximately 84 km before the NFBR confluence. Ridgeline elevations at the head of the drainage are approximately 2,800 m, while the elevation at the confluence with the NFBR is approximately 1,060 m. The MFBR loses approximately 1,000 m in elevation over the 84 km from where it becomes a third-order stream to its mouth, dropping an average of 11.9 m per kilometer over that distance.

Native game fish in the MFBR consist of wild Rainbow/Redband Trout *Oncorhynchus mykiss spp.* (WRBT), Mountain Whitefish *Prosopium williamsoni* (MWF) and Bull Trout (BLT). Additionally, catchable-sized triploid hatchery Rainbow Trout are stocked annually during the summer. United States Forest Service road #268 runs parallel to the MFBR from Arrowrock Reservoir to Atlanta, Idaho. As such, recreation along the MFBR is much more consistent compared to the neighboring NFBR, where recreation varies due to topography and access. From the confluence with the NFBR, the MFBR is a special regulations water; trout limit is 2, none under 14 inches, no bait allowed and barbless hooks required. Nearby waters, such as the NFBR fall under general fishing regulations.

METHODS

During July 2020, thirteen historic trend sites of various lengths were surveyed using entire-width snorkeling (
Figure 39). We identified sites from previous sampling documentation that included written descriptions, drawings, photos, and GPS coordinates. This allowed for reasonably precise relocation of sites. Sites were sampled with three snorkelers completing an entire-width snorkel survey. Methods for conducting fish abundance surveys by snorkeling followed the methods outlined by Apperson et al. (2015). Snorkelers moved upstream or downstream (depending on the site), counted all fish within their respective lanes and estimated lengths to the nearest inch. Species, counts, and visually-estimated length were recorded on PVC wrist cuffs by each snorkeler during the survey, then transcribed to a datasheet immediately after the completion of each survey. Following the completion of each snorkel survey, staff measured and recorded individual site length, as well as quartile widths using a handheld laser rangefinder (Leupold RX-1000).

Trends in relative abundance were compared by calculating species-specific density estimates for each site and comparing amongst years and river sections. Density was calculated as the count of each sportfish species divided by site 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 site/year was calculated by dividing individual site fish observations by area first, then averaging densities among sites, rather than by total fish observations across all sites and area and dividing.

RESULTS

WRBT were distributed throughout the drainage and were observed at ten sites during the 2020 snorkel survey. In 2020, 132 WRBT were observed and site-specific densities ranged from 0-5.8 fish/100 m^2. Mean WRBT density across all sites was 1.2 fish/100 m^2. Of the 132 WRBT observed, 75% were 250 mm or smaller. The largest individual WRBT observed was 457 mm while the smallest was 76 mm (Figure 40). MWF are widely distributed in the MFBR and during the 2020 survey were observed at nine sites. A total of 168 MWF were observed in 2020 and site-specific densities ranged from 0-5.0 fish/100 m^2 (Table 16). Mean MWF density across all sites was 1.27 fish/100 m^2 (Table 16). MWF ranged from 101-533 mm TL, and 90% were 250 mm or greater (Figure 41). Additional fishes were observed infrequently during the 2020 survey. A total of eight BLT were observed across three sites (Table 16), ranging from 355-660 mm TL (Figure 42). Hatchery Rainbow Trout are stocked into the MFBR, however none were observed during the snorkel survey.

DISCUSSION

Overall mean WRBT densities were lower in 2020 compared to previous sampling period (2000), but higher than overall densities observed in the late 1980s (Figure 40). Overall mean MWF densities were lower in 2020 compared to previous sampling period (2000), but higher than overall densities observed in the late 1980s (Figure 41). Overall mean BLT densities were lower in 2020 compared to previous sampling period (2000), but higher than overall densities observed in the late 1980s (Figure 43). Hatchery Rainbow Trout are stocked downstream from the lowest snorkel site; as such we did not anticipate encountering them in our MFBR snorkel surveys.

Furthermore, because hatchery trout presence is correlated with stocking and snorkel survey timing, there is little value in looking at trends in hatchery trout densities over time.

Snorkel surveys have been conducted infrequently on the MFBR. In the last four decades, only four surveys have been conducted (1988, 1993, 2000 and 2020). Previous work on the neighboring NFBR (Cassinelli et al. 2018; Peterson et al. 2019; D'Amico et al. 2020) concluded that infrequent (once per decade) snorkel sampling of Idaho batholith rivers (i.e. NFBR, MFBR, and South Fork Payette River) may not be sufficient for trend monitoring. Instead, short term (< 5 years) intensive (annual) snorkel surveys can be related to stream discharge patterns to better capture trends in relative fish densities in Idaho batholith streams. Additionally, Copeland and Meyer (2011) documented correlations between annual streamflow (three years prior to the survey) and observed fish densities. The nearest streamflow gauge on the MFBR is below the confluence of the NFBR and the MFBR near Twin Springs, Idaho (USGS #13185000) with records dating back to 1911.

Outside of the aforementioned studies, there is little literature that evaluates seasonal variation in flow and densities of resident salmonid populations in a natural flowing river. However, these studies demonstrated positive relationships between streamflow and observed fish densities (Figure 44). When comparing historic MFBR snorkel surveys to patterns in streamflow, similar patterns are observed; observed relative fish densities are positively related to streamflow. As this is the first year of a three-year snorkel survey rotation, drawing conclusions regarding current trends in relative fish density and environmental covariates on the MFBR is premature. Additional years of intensive annual surveys should help to clarify these patterns.

As with other Idaho Batholith streams, snorkeling remains the most effective means of estimating fish densities in the MFBR. However, snorkel estimates can be biased by variation in observers, visibility, and flow. In previous years, snorkelers attended IDFG's snorkel training. Due to the COVID-19 pandemic, the official snorkel training course was cancelled. However, an unofficial training was conducted prior to surveying. As with previous surveys, sites were sampled at low flows during favorable weather conditions. Additional bias with historical sampling can occur due to variations in site locations. While historic descriptions, photos, and GPS coordinates helped limit this, exact site replication is difficult due to variation in landmarks and river features between sample years. Additionally, sites themselves can change within reaches. This is especially true when sites occur at the mouths of tributaries, as do many of the sites on the MFBR. Finally, turbidity can affect observation probability. Prior to conducting the 2020 MFBR snorkel surveys, a moderate rain event occurred. While water clarity and visibility remained high, some of the more downstream sites may have been affected by increased turbidity, decreased visibility and thus observation probability. Future surveys will help determine if observed fish densities were truly lower at those sites, or if observation probability negatively impacted observed fish densities.

Due to relatively easy access, the MFBR likely receives higher recreational use compared to the NFBR. However, the MFBR and NFBR are managed under different regulations. The MFBR has more restrictive regulations, including a smaller bag limit, as well as size and gear restrictions. Comparatively, the NFBR falls under IDFG Southwest general regulations, which are relatively liberal. Additionally, there is a rudimentary impoundment near the Atlanta township at the headwaters of the MFBR with a hydroelectric dam and fish passage structure. As such, the MFBR is relatively more impacted when compared to the NFBR. Differences in land, recreation and fisheries use between the NFBR and the MFBR may lead to interesting comparisons in the future between the two streams, whether in observed fish densities or size classes. However, as this is the first year of a three-year rotation, drawing conclusions from a single year of data is premature.

The MFBR has also experienced landscape-level disturbances and habitat alterations. As with most montane streams, wildfire has occurred in the basin (Little Queens, 2013; Trinity Ridge, 2012). However, no snorkel surveys were conducted in the MFBR during this period, and as such establishing correlations is difficult. Despite the increased recreational use, hydropower dam and natural disturbances, we believe annual streamflow remains the most highly variable factor affecting the river and subsequent fish populations. Additional sampling of trend snorkel sites in 2021 and 2022 will provide further clarity as to the impacts of year-specific stream flow variability on fish density and distribution.

RECOMMENDATIONS

IDFG Region 3 fisheries staff will continue the three year snorkel survey through 2022 on the MFBR and relate it to streamflow.

Table 16. Raw counts and relative fish densities of fish species observed during the 2020 MFBR snorkel survey.

Site	MWF	RBT	BLT	MWF density (fish/100 m^2)	RBT density (fish/100 m^2)	BLT density (fish/100 m^2)
Atlanta Power	2	0	0	0.14	0	0.00
Black Warrior Creek	18	24	0	1.98	2.65	0.00
Breadwinner	0	11	0	0.00	0.75	0.00
Cable Car	13	13	0	1.77	1.77	0.00
Dutch Creek	3	7	1	0.11	0.25	0.04
Eagle Creek	38	3	0	3.59	0.28	0.00
Hot Springs	0	0	0	0.00	0.00	0.00
Neinmeyer	13	5	0	0.98	0.38	0.00
NFBR Confluence	0	0	0	0.00	0.00	0.00
Queens River	53	26	7	4.97	2.44	0.66
Roaring River	6	28	0	1.24	5.81	0.00
Weatherby USFS	22	11	0	1.74	0.87	0.00
Yuba River	0	4	0	0.00	0.93	0.00

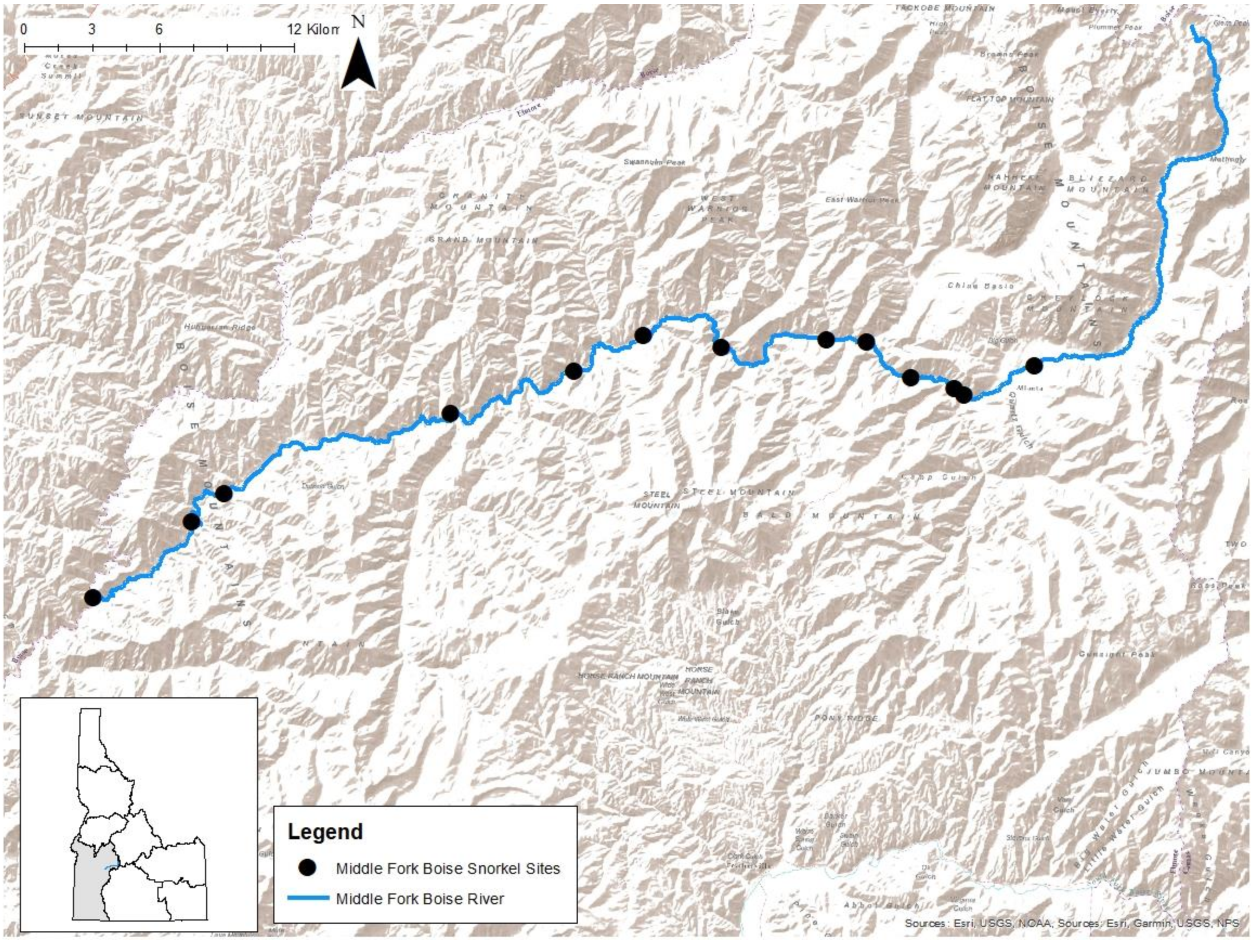

Figure 39. Map of Middle Fork Boise River and associated snorkel sites surveyed in 2020.

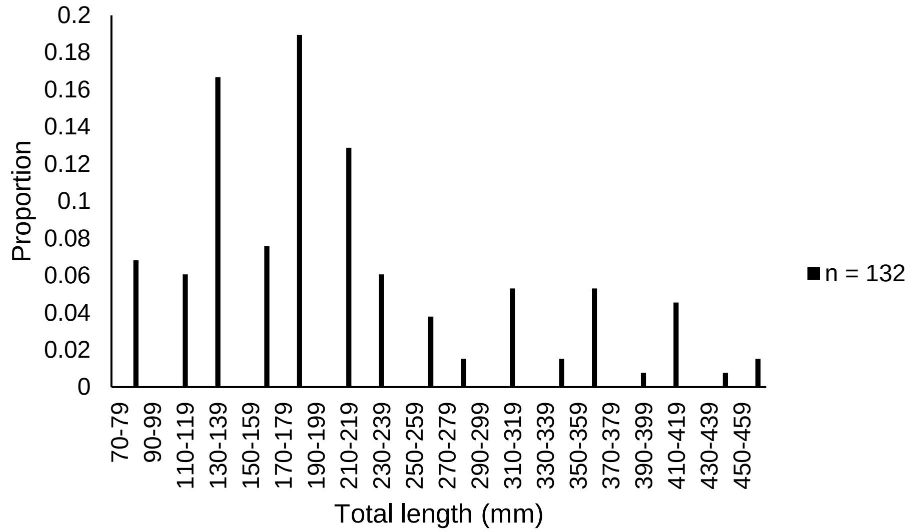

Figure 40. Proportional length frequency versus total length of observed Rainbow Trout during the 2020 MFBR snorkel survey.

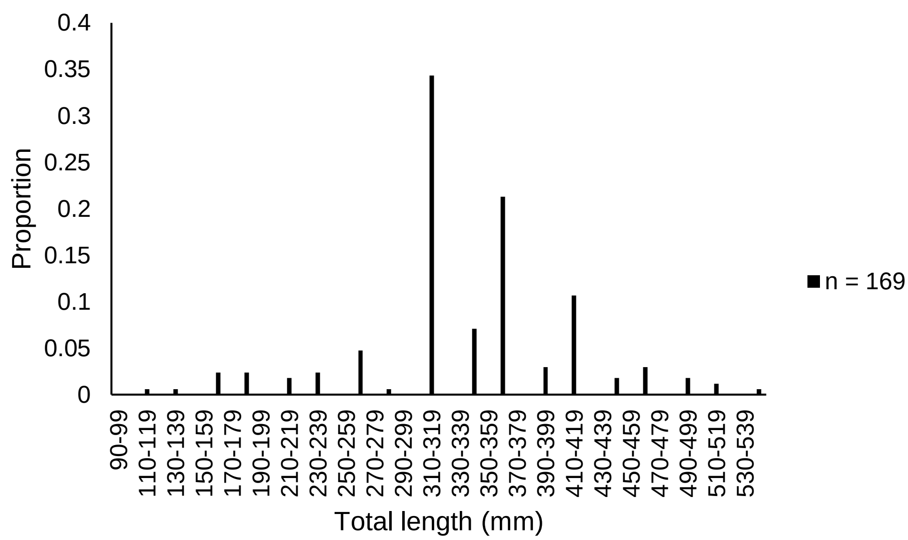

Figure 41. Proportional length frequency versus total length of observed Mountain Whitefish during the 2020 MFBR snorkel survey.

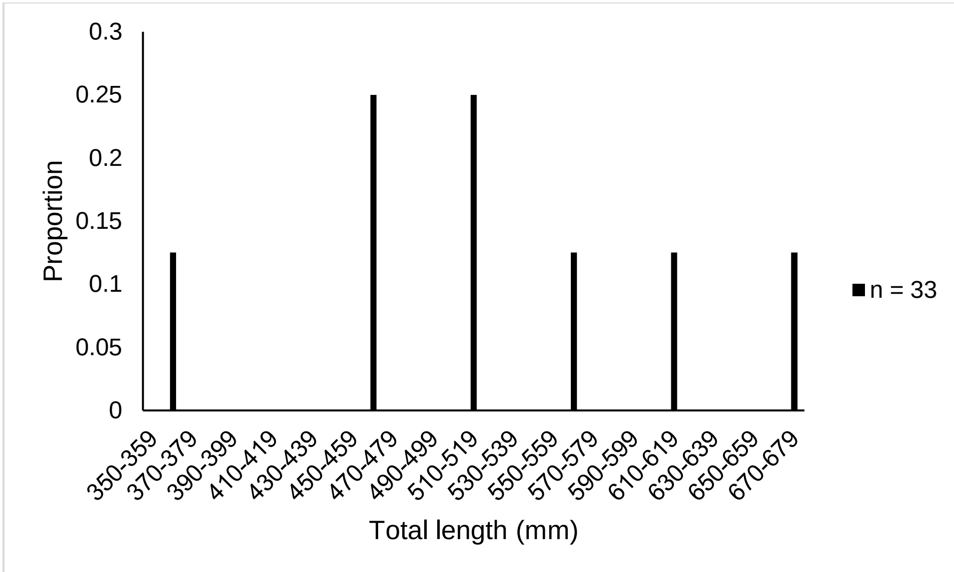

Figure 42. Proportional length frequency versus total length of observed Bull Trout during the 2020 MFBR snorkel survey.

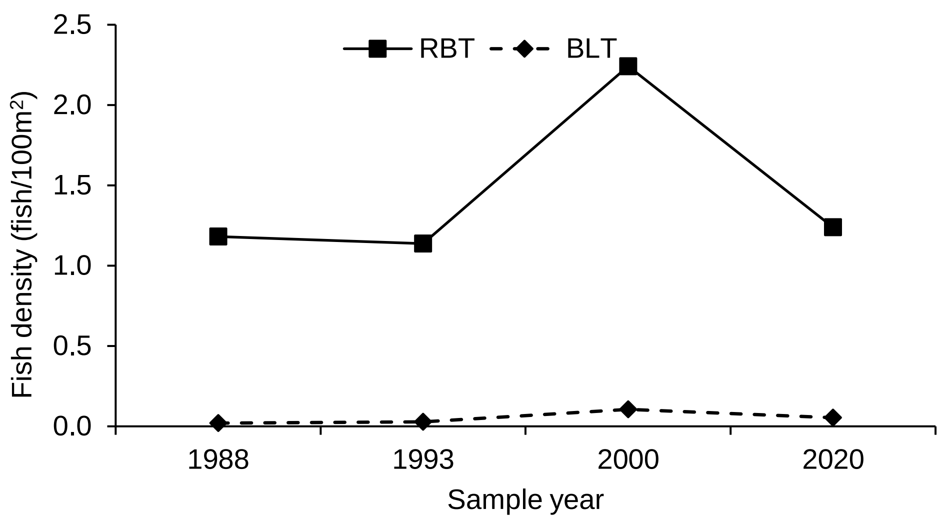

Figure 43. Observed relative fish density versus sample year for Rainbow Trout and Bull Trout observed during MFBR snorkel surveys.

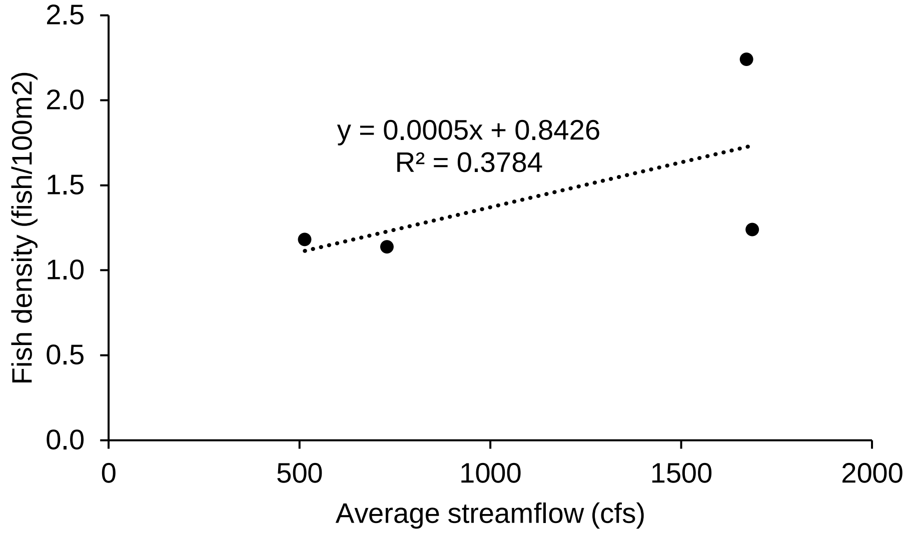

Figure 44. Observed relative fish density versus average streamflow for Rainbow Trout observed during MFBR snorkel surveys.

SOUTH FORK BOISE RIVER RAINBOW TROUT STATUS

ABSTRACT

The South Fork Boise River (SFBR) downstream of Anderson Ranch Dam is a nationally-renowned tailwater trout fishery. The Idaho Department of Fish and Game staff has monitored Rainbow Trout *Oncorhynchus mykiss* populations in the SFBR every three years since 1994, with standardized transects having been established since 2006. In October of 2020, the trout population was assessed using mark-recapture electrofishing techniques. Partial log-likelihood population estimates of Rainbow Trout (± 90% CI) for all three sites combined was 1,310 ± 73 fish. While mark-recapture estimates have generally increased since 2006, variation in marking run catch rate, recapture efficiency and size-specific capture efficiency have led to wide confidence intervals. Further investigation and long term trend monitoring is needed to maintain the quality fishery in the SFBR.

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INTRODUCTION

The South Fork Boise River (SFBR) downstream from Anderson Ranch Dam is a nationally-renowned tailwater trout fishery. This river section was the first and only in the Idaho Department Fish and Game's (IDFG) Southwest Region to be managed under "Trophy Trout" regulations, with a 2-trout daily bag limit and 20-inch minimum length. As such, the trout populations in the SFBR have been monitored by IDFG staff every three years since 1994. These efforts have been accompanied by critical evaluations of electrofishing methodologies which have resulted in changes in techniques and equipment configuration. In 2006, sampling methods were changed from raft electrofishing to canoe electrofishing in order to increase sampling efficiency across size classes and obtain better population estimates. In addition, three 1-km sites were established within the historic survey boundaries for sampling. Kozfkay et al. (2010b) demonstrated a pronounced increase in electrofishing efficiency for all size groups of Rainbow Trout resulting from the change in sampling methodologies. In 2012, an additional mobile anode was added to the canoe electrofishing configuration, which resulted in further improvement in sampling efficiency, particularly for fish exceeding 350 mm (Butts et al. 2017).

The SFBR drainage has undergone dramatic changes over the past decade. In August of 2013, the Elk-Pony fire complex burned roughly 280,000 acres in the basin. These fires resulted in two separate large debris and sediment flow events that occurred on several tributaries. Notably, sediment flows at Pierce, Granite, Buffalo, and Little Fiddler creeks created large slack-water runs followed by new and more technical rapids, impacting both fish habitat and floating conditions for anglers. In 2014, the primary objective for IDFG regarding SFBR was to describe the extent of the effects of the sediment flows on fish populations and habitat. To address this, the triennial main-stem population assessment was rescheduled to 2014 rather than 2015, when it normally would have occurred. In 2017, a record snowpack and subsequent runoff further changed the SFBR. Runoff in mid-May exceeded 9,000 cfs at the Anderson Ranch Dam USGS gauge, the highest flows on record for this gauge. These high flows further scoured the sediment inputs from the 2013 slides, further decreasing the depth and length of the slack-water areas and decreasing the difficulty of the resulting rapids. Our objectives for the 2020 survey were to continue monitoring the SFBR trout population in accordance with our triennial rotation to generate population estimates and quantify size structure.

STUDY AREA

The SFBR originates in the Sawtooth National Forest, approximately 30 km east of Pine, Idaho. The upper SFBR is in IDFG Region 4, and flows southeast into Anderson Ranch Reservoir. Below Anderson Ranch Dam, the SFBR enters IDFG Region 3, and flows northwest into Arrowrock Reservoir. The tailwater fishery between Anderson Ranch Dam and Arrowrock Reservoir is supported by populations of wild Rainbow Trout *Oncorhynchus mykiss* and Mountain Whitefish *Prosopium williamsoni*. Bull Trout *Salvelinus confluentus* are present at low densities, kokanee *Oncorhynchus nerka* migrate upstream from Arrowrock Reservoir, and native nongame fish include Largescale Sucker *Catostomus macrocheilus*, Northern Pikeminnow *Ptychocheilus oregonensis* and sculpin *Cottus sp*.

Between Anderson Ranch Dam to its terminus into Arrowrock Reservoir, the SFBR is approximately 43-km long and consists of two recreationally distinct sections. The roaded section is approximately 16-km long and runs from Anderson Ranch Dam downstream to Danskin Bridge. This section has a public road and access along the entire reach, resulting in the most angling pressure. It is popular for both drift-boat and wade fishing. The canyon section is approximately 27-km long and runs from Danskin Bridge downstream to Neal Bridge. The canyon section has extremely limited access by foot or road because of high canyon walls and is accessible mostly by raft due to challenging whitewater in the section.

METHODS

In October 2020, Rainbow Trout abundance was estimated at three sites (Figure 45) within the roaded section of the SFBR a using mark-recapture techniques. Since 2018, Mountain Whitefish abundance has not been estimated during these triennial surveys. Due to the large number of Mountain Whitefish encountered during the survey, there was concern that efforts to net all whitefish during shocking runs was reducing capture efficiency of trout. Therefore, only trout were targeted during the 2020 survey. Fish were collected with a canoe electrofishing unit consisting of a 5.2-m Grumman aluminum canoe fitted with three mobile anodes connected to 15.2-m cables. The canoe served as the cathode and carried the generator, Midwest Lake Electrofishing Systems (MLES) Infinity electrofisher, and a live well for holding fish. Oxygen was introduced to the live well (2 L/min) through an air-stone. Pulsed direct current was produced by a 5,000-watt generator (Champion 5000). Settings were 25% duty cycle, 60 pulses per second, 300-400 volts, producing 1,000-2,000 watts.

Rainbow Trout and Bull Trout were sampled at the three sites during October 2020 (Figure 45). Marking runs were conducted at the upper and middle sites on October 22 and the lower site on October 23. Recapture runs at the upper and middle sites occurred on October 28 and at the lower site on October 29. Riffles formed the upper and lower reach boundaries. Flow was approximately 9.1 m^3/s. Crews consisted of twelve or thirteen people. Three people operated the mobile anodes, one person guided the canoe and operated the safety switch and controlled the output, the remaining eight or nine people were equipped with dip nets and captured stunned fish. Only trout were placed in the live well. When the live well was judged to be at capacity, the crew stopped at the nearest riffle to process fish.

Fish were marked with a 7-mm diameter hole from a standard paper punch with an upper, caudal fin punch. Only fish longer than 100 mm were marked. Fish were measured for total length (mm) and a subset was weighed (g). Fish were released 50-100 m upstream from the processing site to reduce the potential of movement out of the site or into areas still to be electrofished. During the recapture effort, all trout greater than 100 mm were captured and placed in the live well. Fish were examined for marks on the caudal fin. All fish were measured for total length (mm).

Site length was determined from 1:24,000 topographic maps. Ten wetted widths from each site were measured with a hand-held laser range finder (Leupold RX series). Site area was estimated by multiplying the calculated mean widths over a section by the section length. For braided channels, mean width was measured across the river excluding any distances across islands.

Fisheries Analysis + (FA+), software developed by Montana Fish, Wildlife, & Parks, was used to generate mark-recapture and electrofishing capture efficiency estimates (MFWP 2004). To account for selectivity of electrofishing gear, population estimates (*N*) were calculated using a partial log-likelihood estimation to fit the recapture data. A capture probability function of the form:

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

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 (*N*) were calculated for each site separately and in addition, pooled for a comprehensive population estimate for comparison to surveys from previous years. Observed mortalities during the marking run were recorded and excluded from the population estimates.

The number of marked fish by site and recapture efficiency were also calculated to assess and compare the basic components of the 2020 survey to previous years. Recapture efficiency (R_{eff}) was simply calculated as:

$$R_{eff} = R/C$$

where *R* is the number of recaptures collected and *C* is the total number of fish collected during the recapture run. To characterize trends in Rainbow Trout size structure, proportional stock density (PSD) was calculated as described by Anderson and Neumann (1996), using 250 mm as stock size and 300 mm, 350 mm, and 400 mm as quality sizes.

RESULTS

A total of 787 Rainbow Trout were handled during marking and recapture runs at the three sites combined (Table 17). A total of 462 Rainbow Trout were marked during the marking runs and an additional 325 (118 of which were recaps) were collected during the recapture runs. Recapture efficiency for the upper site was 20%, while efficiency at the middle site was 19%, and the lower site was 37%. Mean recapture efficiency - the ratio of recaptured fish to captured fish during the recapture runs among sites - was 26% (Table 17). Partial log-likelihood population estimates (± 90% CI) for Rainbow Trout varied across trend sites, from 603 fish ± 87 at the upper site, 621 fish ± 96 at the middle site, and 319 fish ± 24 at the lower site. Estimated population size combined across all three sites (100-mm minimum length cutoff) was 1,310 fish ± 73 (Figure 46), or 1,226 fish ± 71 (225-mm minimum length cutoff; Figure 46). Rainbow Trout total length ranged from 116 to 591 mm (Figure 47). Rainbow Trout between 400 and 500 mm comprised 59% of the catch, while only 1% exceeded 500 mm. In 2020, the PSD-300, PSD-350, and PSD-400 all increased compared to the 2017 survey (Figure 48).

A total of 17 Bull Trout were captured, with eight fish marked and two recaptured. Bull Trout TL ranged from 360 to 572 mm (Figure 47). Due to low overall catch and recaptures, a population estimate was not generated for Bull Trout.

DISCUSSION

Partial log-likelihood population estimates generated from the mark-recapture exercise indicate that the overall Rainbow Trout population in the SFBR has been variable. From 2006 to 2012, the estimated population size (225-mm minimum length cutoff) held steady at approximately 950 fish. In 2014, following wildfires and debris flows, the population estimate decreased to 738, yet rebounded in 2017 to 1,420 fish. The 2020 population estimate decreased slightly to 1,310 fish (Figure 50). Size structure of the wild Rainbow Trout population has also changed through time (Figure 467). The 2017 survey (Cassinelli et al. 2018), observed a large cohort of fish between 250 and 350 mm, which is likely manifested in the large representation of fish 400 mm or greater (60% of the sampled fish) observed in the 2020 survey.

Compared to previous surveys, there was a notable decrease in fish less than 225 mm in 2020. As mentioned, the SFBR experienced wildfire and subsequent debris flows in 2013 and 2014. Wildfire and associated landscape-level disturbances are becoming increasingly prevalent in the intermountain West (Westerling et al. 2006), and their effects on salmonid populations has been relatively well studied (Rieman et al. 2003). Studies in Idaho (Rieman et al. 1995) and Montana (Sestrich et al. 2011) monitored populations pre and post-fire. Rieman et al. (1995) found that within one year, population levels had started to rebound, and within three years had recovered to pre-fire levels. Additionally, Rieman et al. (1995) observed temporary declines in abundance were especially pronounced in small (<75 mm) trout. Sestrich et al. (2011) hypothesized rapid recovery from post-fire declines to increased local recruitment or recolonization. When the 2014 population estimate is compared to the 2017 population estimate, the same pattern emerges. Debris flows in the SFBR contributed larger amounts of sediment and woody debris from adjacent tributaries. Subsequent pulse-flows from Bureau of Reclamation and high runoff in 2017 redistributed much of the newly introduced material. As a result, this may have led to an increase in available spawning substrate, which is at a premium in a relatively gravel-starved tailwater such as the SFBR. This may have produced a strong year class of trout, corresponding to the increase in small (> 225 mm) fish in 2017.The large cohort of fish ≈ 400 mm found in 2020 is likely that cohort aging through the population. However, attributing the current lack of small (> 225 mm) fish to one specific cause is difficult at best. Our current hypotheses (aside from sampling bias), include predation (due to the large cohort of ≈ 400 mm fish), competition or the population reaching carrying capacity. These are all purely speculative; however, and further evaluations are needed.

One principal tenet of mark-recapture estimates is that each individual is equally susceptible to capture. This can be affected by a myriad of factors, including fish size, gear biases, and survey methods. Larger fish have greater surface area thus are more susceptible to electrical impulses generated by electrofishing. Furthermore, large fish are more easily seen during electrofishing, are more easily differentiated to species (trout versus whitefish) and captured. As such, larger fish are more inherently susceptible to capture than smaller fish (Büttiker 1992; Bayley and Dowling 1993; Dolan and Miranda 2003; Peterson et al. 2004). Population estimates that do not account for length as a factor may introduce biases (Anderson 1995). The partial log-likelihood estimator we used takes fish length into account. The aforementioned population estimates are generated using a minimum length cutoff of 100 mm. While the partial log-likelihood estimator takes fish size into account, the model is still over-predicting capture efficiency of small fish compared to the observed data (Figure 49). If we generate population estimates based on a 225-mm minimum length cutoff, population estimates from 2006-2020 are slightly altered than those with a 100-mm minimum length cutoff. With a 225-mm minimum length cutoff, population estimates from 2006-2012 increased, in 2014 following wildfire and subsequent debris flows, the population estimate decreased. In 2017, the population estimate rebounded to higher than pre-disturbance levels (albeit with wide confidence intervals surrounding the estimate). In 2020, there was not a significant change in the population estimate (225-mm minimum length cutoff) at the 95% confidence level when compared to the 2017 estimate (Figure 50). Similarly to capture probability, recapture efficiencies of marked fish can also bias population estimates. In the SFBR, recapture efficiencies fluctuate across sample years and sites. The highest recapture efficiencies have historically occurred within the lower site, ranging from 11% to 52%. In 2020, the recapture efficiency in this site was 52% (Table 17). Overall average recapture efficiency since 2006 (all three sites combined) has been 21% and ranged from 12% to 36%. In 2020, our overall recapture efficiency was 36%.

Gear biases and survey methods and also affect population estimates. Surveys from 1997-2003 were conducted using raft electrofishing. Surveys since 2006 have been conducted using canoe electrofishing with two anodes, with a third anode added in 2012. Since switching to a canoe and two mobile anodes (2006-2012) mean recapture efficiency was 11.1% and increased with the addition of a third anode (2012-present; 19.6%). Since standardizing sampling methods and locations in 2006, we have also noticed a shift in size structure. This shift is primarily driven by a decrease in fish greater than 400 mm since 2012, but also (to a lesser degree) an increase in smaller fish.

Sampling crew variation (especially netters) and changes to trend sight habitat between sampling years can also impact recapture efficiencies. In an effort to limit variation in sampling efficiency due to netter bias, we've begun to be more selective in personnel conducting the surveys as well as utilizing more netters with the hope of missing fewer fish. Additionally, Mountain Whitefish are no longer sampled at the same time as trout, in an effort to minimize the number of trout that are missed due to efforts to capture whitefish. A realistic description of change in the SFBR Rainbow Trout population is likely best provided by a combination of mark-recapture and catch per unit effort (CPUE) comparisons with previous surveys.

Another index for evaluating trout populations in the SFBR is to compare trends in single-pass CPUE. As with population estimates, CPUE of the individual marking runs have also varied. The lowest single pass CPUE observed occurred in 2014, yet the mark-recapture estimate for that year was the third highest across all sample periods. Raw catch of individual recapture runs is typically lower than that of individual marking runs. The overall number of fish captured in the recapture run has been even more variable ranging from 42% to 71% (average 60%) of the total caught in the marking run during the nearly two decades of surveys. As such, CPUE of recapture runs has not been explicitly evaluated and compared against that of individual marking runs.

Finally, there are a number of environmental and abiotic factors that may affect changes in population estimates, including large scale landscape disturbances (wildfire and subsequent landslides), and variations in instream flow and temperature. We hypothesize the decrease of larger fish in the 2014 surveys is likely a result of mortality immediately following wildfire and poor water quality associated with heavy ash and sediment load during the debris flow events. The reduction of those larger fish in 2014 immediately following the wildfires could have been a direct result of the fire activity and subsequent sediment loads (Rieman et al. 2012), combined with increased water temperatures (Dunham et al. 2007). July-September water temperatures in 2013, recorded at the Neal Bridge USGS gauge, were the highest on record since the gauge began recording river temperature in 2011. This gauge is at the lower end of the drainage and increased water temperatures this low in the system were likely most influenced by warmer tributary inputs post-fire. Since the SFBR is a tailwater river, temperatures were likely less variable closer to the Anderson Ranch Dam outlet.

The lower raw catch observed in 2014 followed the large wildfires that occurred in the SFBR basin in 2013. Raw catch in 2014 was 49% lower than the pre-fire 2012 catch. These results were outlined in Butts et al. (2014) and concluded the SFBR Rainbow Trout population experienced a post-fire decline. However, despite the concern that there could be continued and prolonged post-fire effects on the fish population as previously observed in other systems (Meyer and Pierce 2003; Rieman et al. 2012), 2017 raw catch was only 1% lower than pre-fire (2012) raw catch and it appears that the wild Rainbow Trout population rebounded relatively quickly following the fires and subsequent landslides. Additional hydrologic conditions, including anthropogenic flushing flows (2015) and record runoff (2017) mobilized fine sediment, resorted spawning gravels and promoted riparian recruitment and revegetation likely contributed to the rapid recovery of the fishery.

The SFBR basin has experienced dynamic conditions over the last decade, including basin-wide wildfires, subsequent landslides and debris flows, and historically (post dam construction) high spring flows. These events have reshaped portions of the river, changing fish habitat in many areas. While the overall wild Rainbow Trout population appears healthy, there does appear to be some changes in size structure when compared to past years. The 2023 triennial sampling will provide further insight into trends in the size structure of the wild Rainbow Trout population in the SFBR.

RECOMMENDATIONS

1. Conduct single pass electrofishing surveys at three trend sites during fall 2021 to assess abundance and length distributions of Mountain Whitefish

2. Conduct mark-recapture estimates in the three adult trend sites during fall 2023 to assess abundance and length distributions of trout

Table 17. Number of fish, by species, collected during marking and recapture runs at each site in the South Fork Boise River, Idaho during October 2020 population assessments. Recapture efficiencies for Rainbow Trout were assessed in all three sites. Bull Trout population estimates were not calculated because of low sample size.

	Site		Marking run		Recapture run		
Year	Transect Length	Species	# Captured	# Marked	# Captured	# Marked	R/C
2020	Upper	Rainbow Trout	162	162	100	32	0.20
	1.03 km	Bull Trout	3	3	4	2	
	Middle	Rainbow Trout	131	128	105	24	0.19
	1.09 km	Bull Trout	3	3	1	0	
	Lower	Rainbow Trout	169	168	120	62	0.37
	0.99 km	Bull Trout	2	2	4	0	
	Total	Rainbow Trout	462	458	325	118	0.26
	3.11 km	Bull Trout	8	8	9	2	

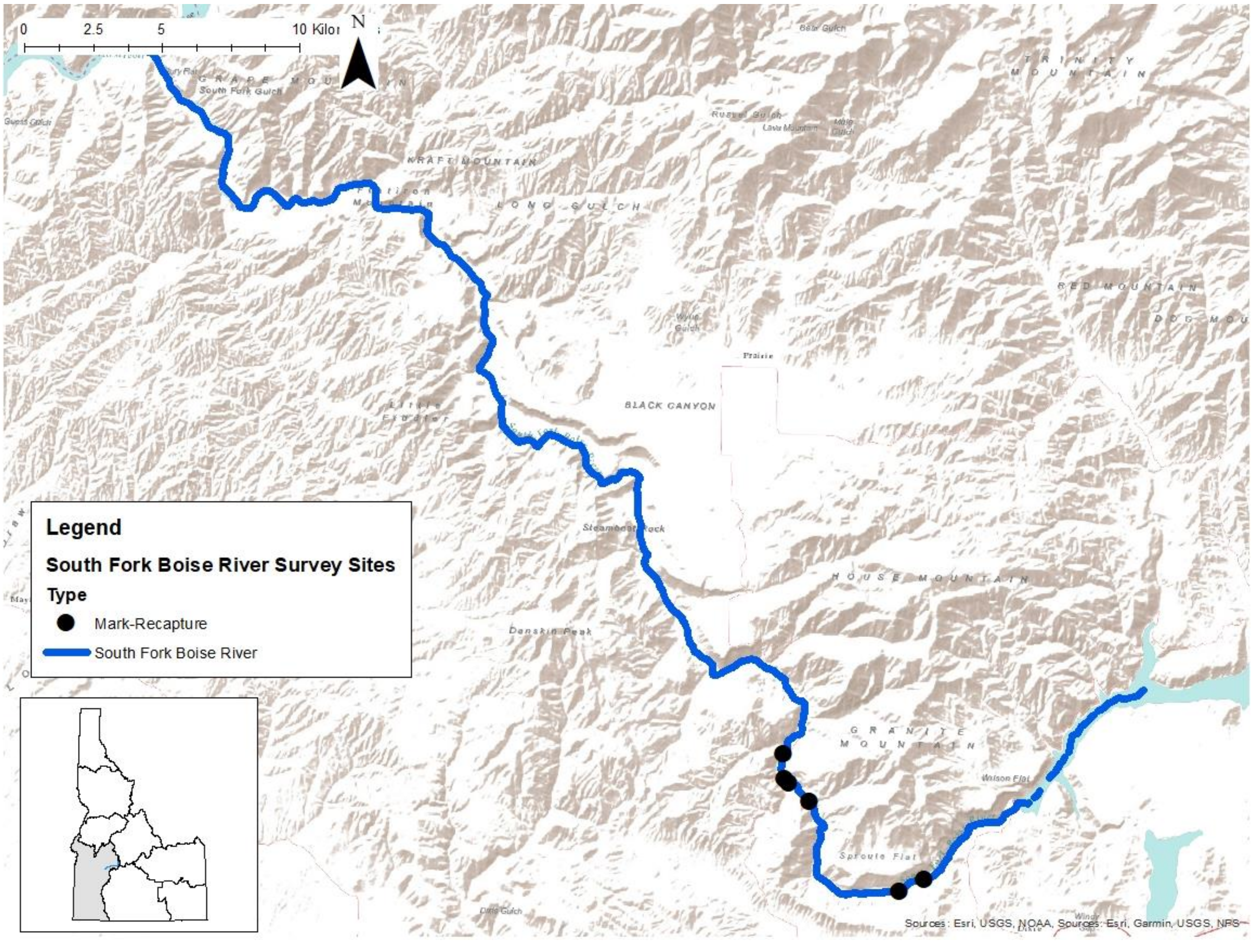

Figure 45. Map of South Fork Boise River and associated mark-recapture sites surveyed in 2020.

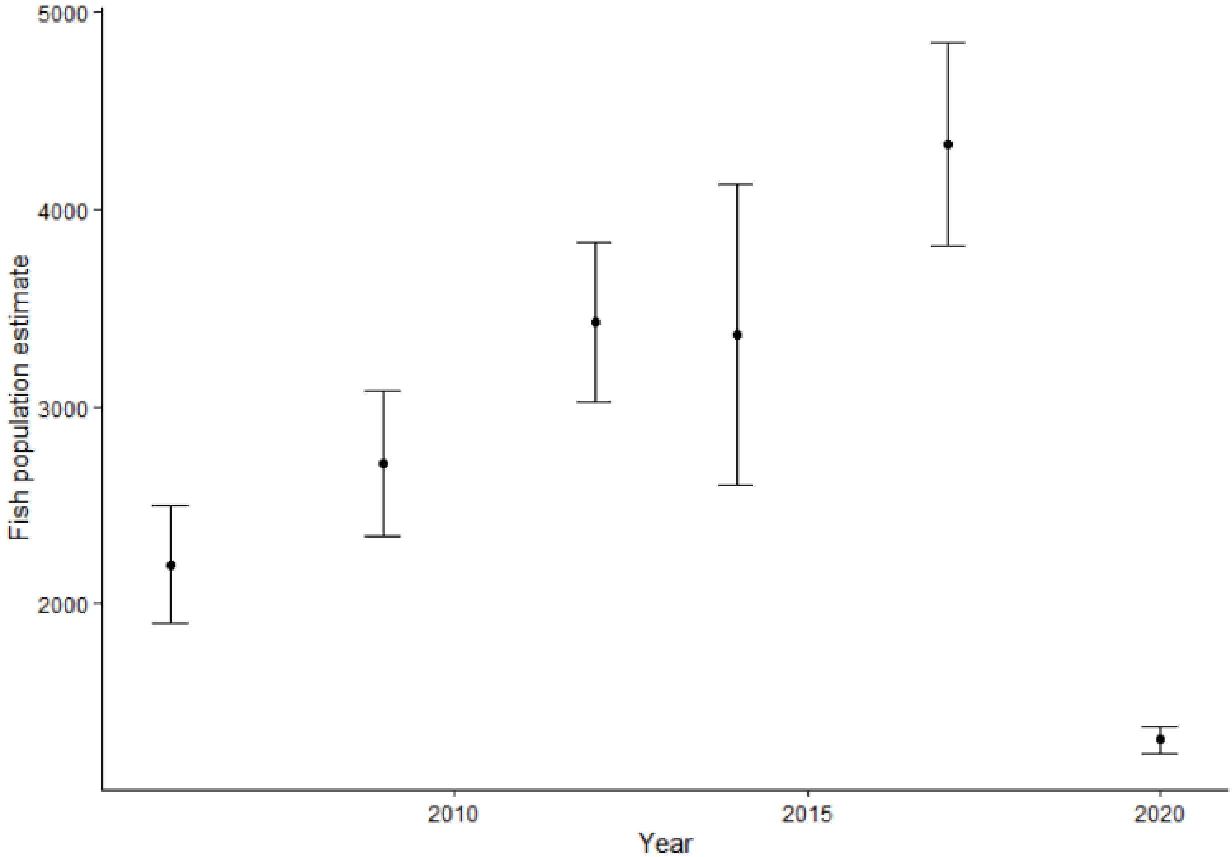

Figure 46. Partial log-likelihood population estimates and associated 95% confidence intervals for three mark/recapture sampling sites combined on the South Fork Boise River, Idaho below Anderson Ranch Dam (2006-2020). Estimates were generated with a 100-mm minimum length cutoff.

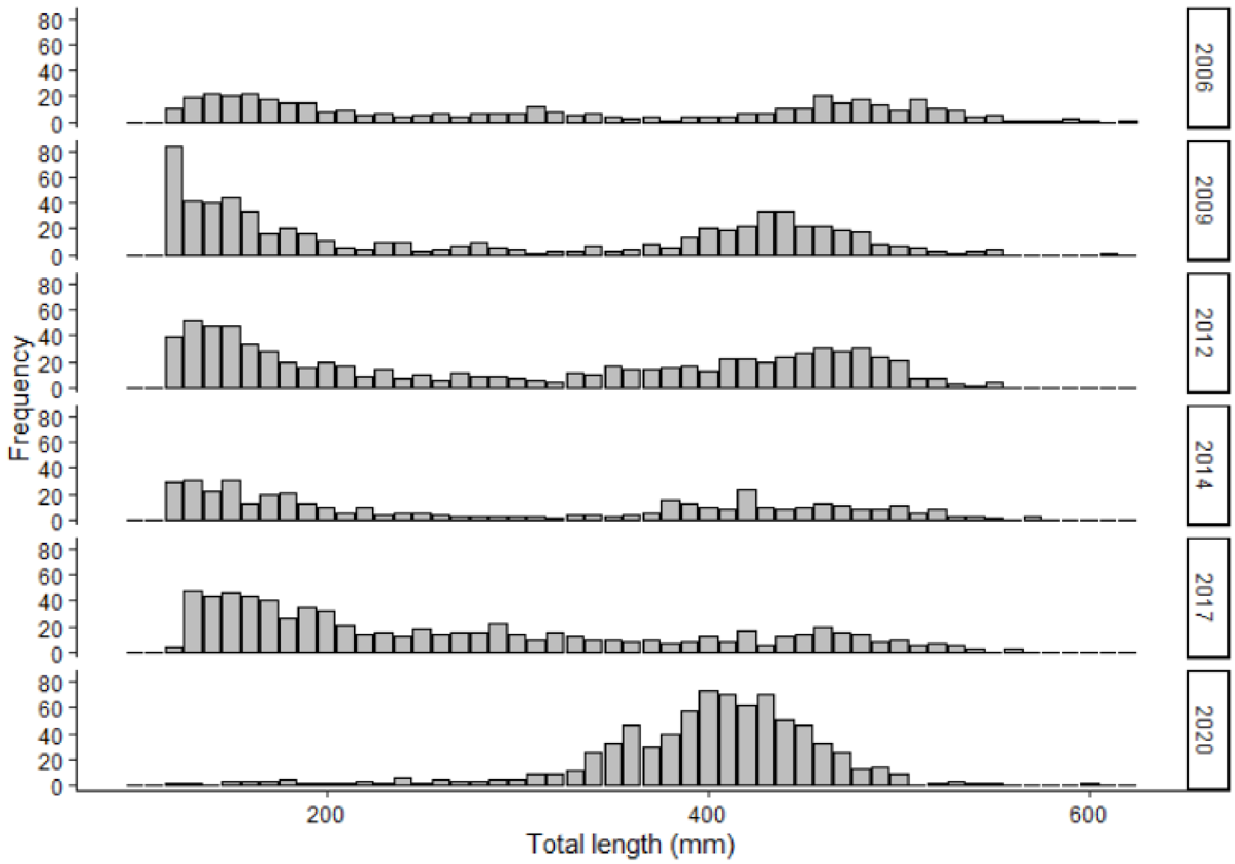

Figure 47. Length frequency histograms of Rainbow Trout ≥ 100 mm captured during population surveys at the South Fork Boise River below Anderson Ranch Dam from 2006-2020.

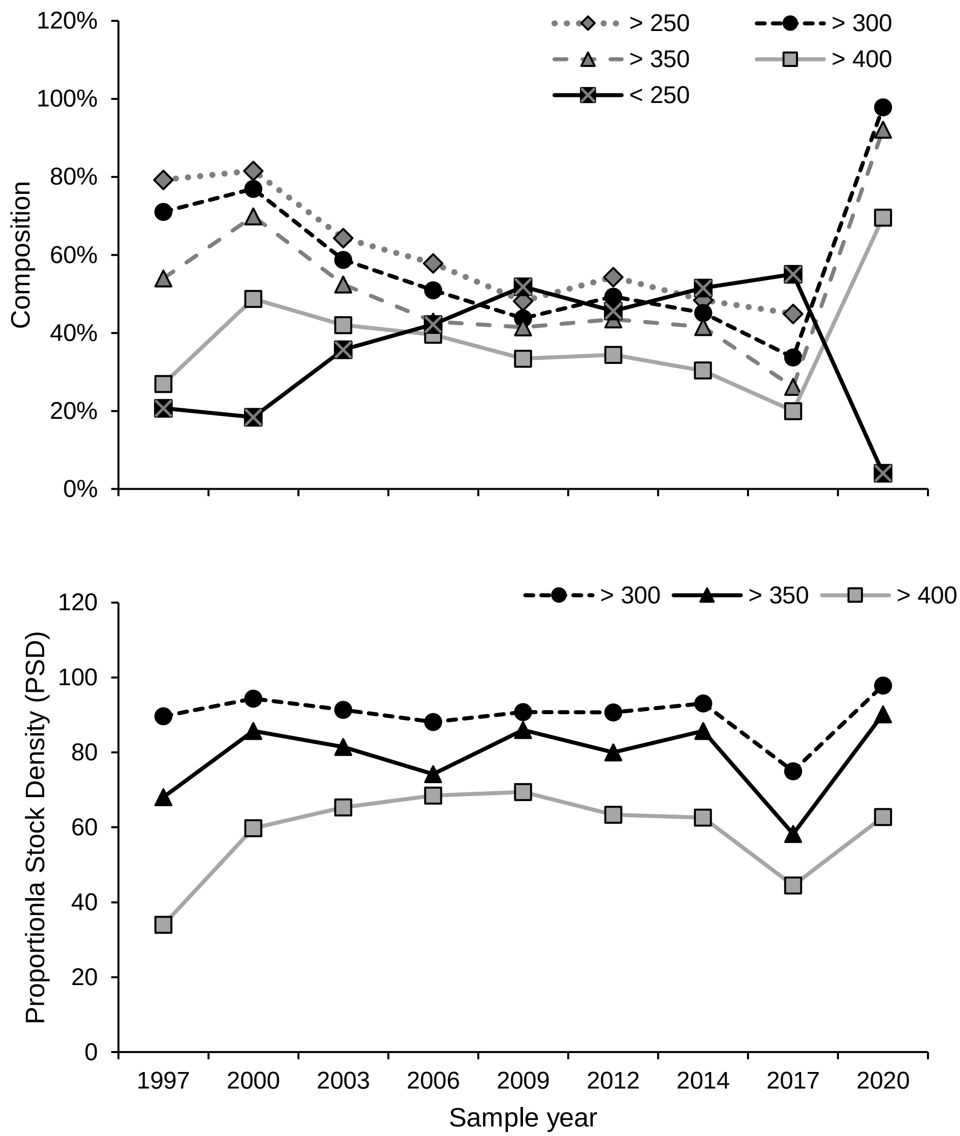

Figure 48. Percent composition and Proportional Stock Density (PSD) for Rainbow Trout of various size classes, collected during triennial mark-recapture surveys on the South Fork Boise River downstream from Andersen Ranch Dam from 1997 through 2020. For PSD calculations, 250 mm was used as stock size.

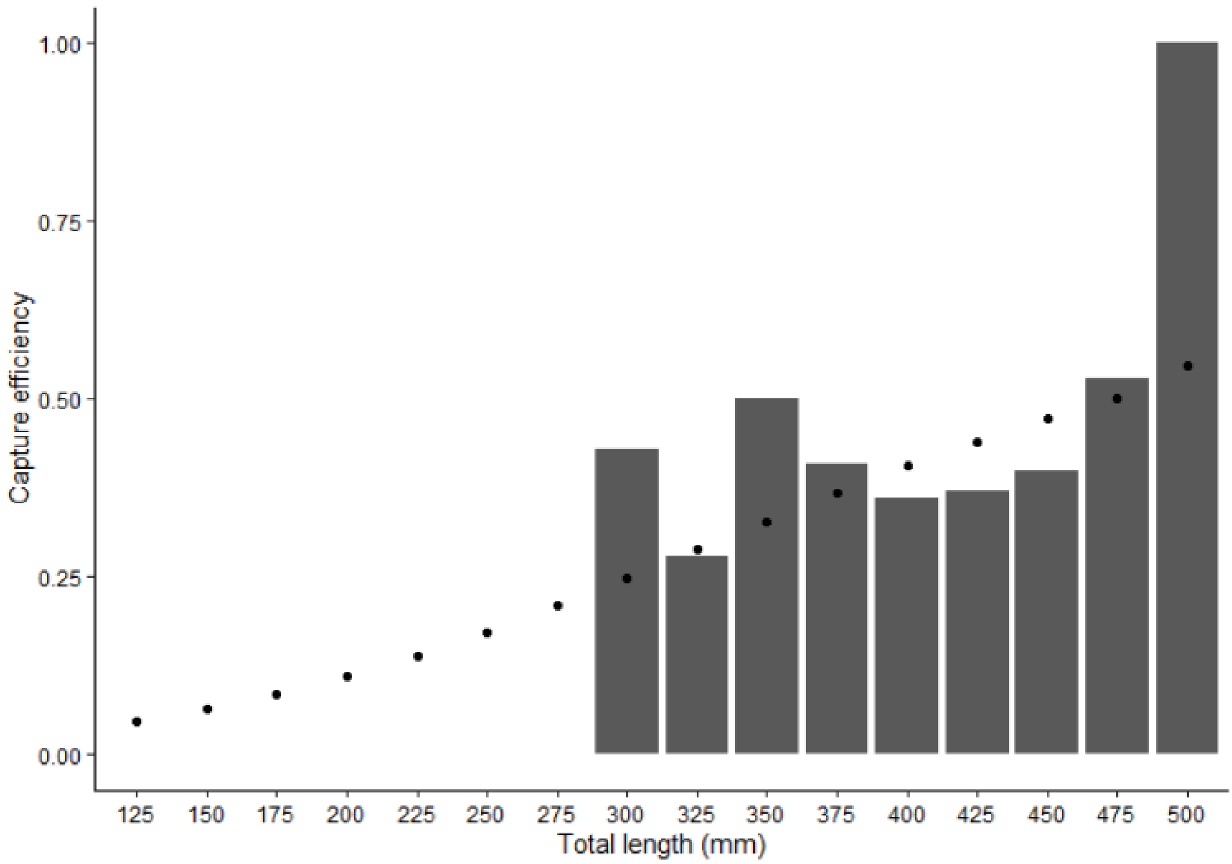

Figure 49. Observed (columns) and modeled (points) capture efficiency of Rainbow Trout by length category during population surveys at the South Fork Boise River below Anderson Ranch Dam in 2020.

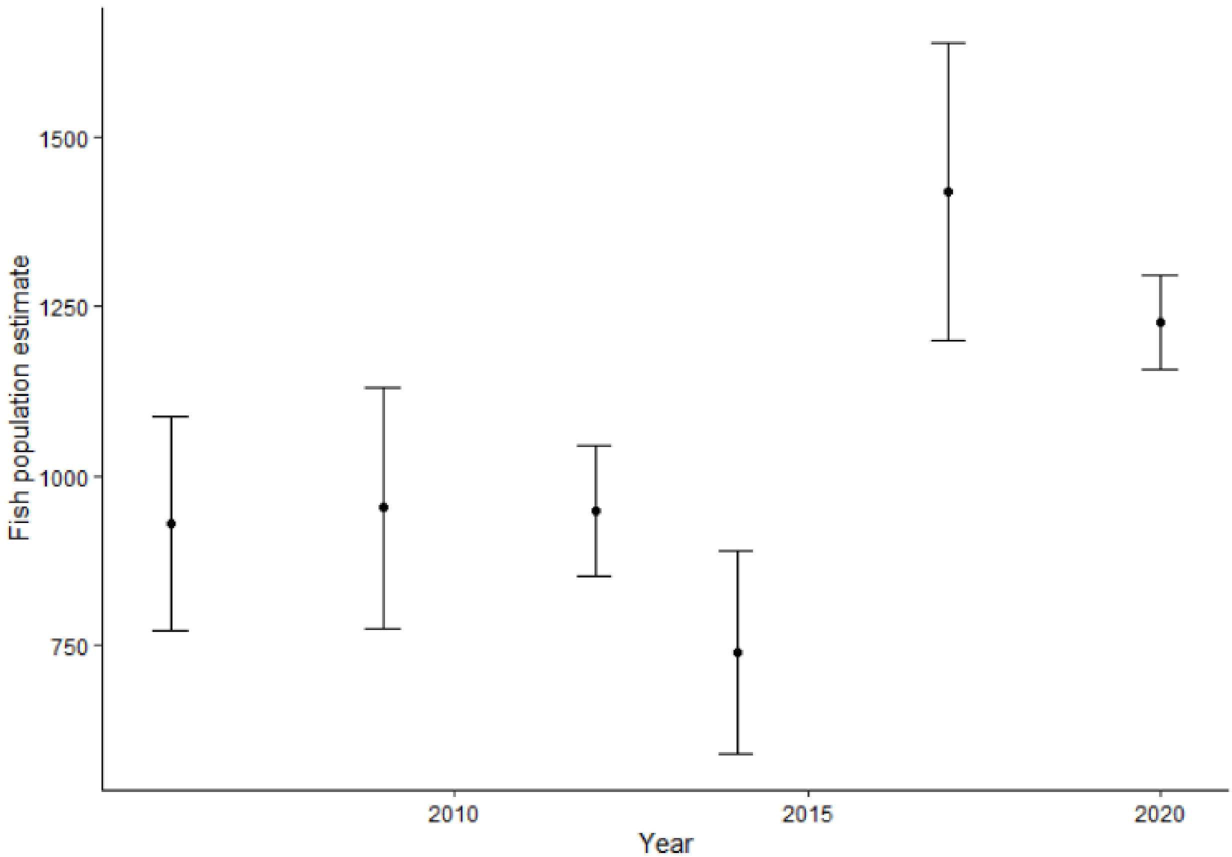

Figure 50. Partial log-likelihood population estimates and associated 95% confidence intervals for three mark/recapture sampling sites combined on the South Fork Boise River, Idaho below Anderson Ranch Dam (2006-2020). Estimates were generated with a 225-mm minimum length cutoff.

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

ABSTRACT

In 2020, the Idaho Department of Fish and Game continued population and trend monitoring for interior Redband Trout (*Oncorhynchus mykiss gairdneri*) within the Idaho portion of their range. Five tributaries, Jordan, Flint, Mammoth, North Boulder and Meadow creeks, were sampled. All of these creeks are within the Jordan Creek HUC4 watershed which ultimately drains into the Owyhee River in Oregon. Using a systematic sampling design, 35 sites were selected across these five drainages with 22 sites successfully sampled. We collected a total of 658 Redband Trout found in 13 occupied sites. Density estimates ranged from 0 to 180 trout/100 m^2. The data collected from Meadow Creek will serve as baseline data moving forward since this is the first time IDFG has sampled this drainage. The data from the Jordan Creek, Flint Creek and North Boulder Creek sites indicates increasing populations when compared to past surveys.

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INTRODUCTION

Redband Trout *Oncorhynchus mykiss gairdneri* are native to the Columbia and Fraser River basins east of the Cascade Mountains. Within this large and diverse geographic area, Redband Trout have adapted to a variety of stream habitats from montane to desert conditions. This species, like many native salmonids in the region, has experienced range reduction and population declines due to numerous factors including hybridization with hatchery stocks and habitat degradation (Meyer et al. 2014).

In southwest Idaho, Redband Trout are native to all major river drainages, including the Bruneau, Owyhee and Snake rivers (below Shoshone Falls). Due to remoteness and little angling interest, Redband Trout in the headwaters of these desert basins have historically received less attention from both the angling community and management agencies (Schill et al. 2007). Previous effort to quantify these populations included a comparative assessment of Redband Trout distribution, density, and size structure within these desert drainages from 1977-1982. In 1997, Redband Trout that reside in desert areas were petitioned for listing under the Endangered Species Act (ESA), postulating that they could be considered a separate subspecies. Although there is some evidence that these desert populations exhibit specialized adaptations such as increased thermal tolerance (Narum et al. 2010; Muhlfeld et al. 2015), not enough evidence to warrant listing was found at the time and this petition was denied (USFWS 2000).

Interest in Redband Trout was renewed in both management agencies and conservation groups in response to the possibility of ESA listing. In response, numerous studies were completed to document Redband Trout distribution and abundance. Data was collected from 1993-2003 at the same sites as the 1977-1983 study and documented an increased occurrence of Redband Trout (Zoellick et al. 2005). The Native Salmonid Assessment completed by the Idaho Department of Fish and Game (IDFG) from 1999-2005 sampled both montane and desert portions of the Redband Trout's range and found that habitat was more suitable for Redband Trout in desert streams based on their habitat preferences (Meyer et al. 2008), highlighting the importance of monitoring both the fish population and habitat features in future sampling efforts. In 2012, a range-wide assessment was compiled, this study relied heavily on past surveys and expert opinions to identify the current distribution of Redband Trout (Muhlfeld et al. 2015).

A range-wide conservation strategy was adopted in 2016 between states, tribes, federal agencies, and nonprofit groups within the native range of Redband Trout. This effort focuses largely on determining the current distribution of Redband Trout and developing conservation strategies, such as enhancing habitat, to ensure persistence (Interior Redband Conservation Team 2016). Within this strategy, IDFG agreed to conduct a systematic sampling effort to document distribution and population trends within the historic range of Redband Trout. As the desert populations of Redband Trout in Idaho are near the southern extent of the species' range and with water temperatures projected to increase, it is important to monitor the status of these fringe populations (Narum et al. 2010).

STUDY AREA

The Jordan Creek HUC4 located in the Owyhee Mountains of southwestern Idaho was selected as a target drainage for systematic sampling in 2016 (Figure 51). This watershed is largely public land with some scattering of private. Land use is primarily grazing with some irrigated agriculture along Jordan Creek near the Idaho-Oregon border. There is a long history of gold mining in the area dating back to 1863 (Lechler 1999). Currently, there is a large mining operation near the headwaters of Jordan Creek and smaller mining claims scattered throughout the basin. The sampling effort continued in 2020 with Redband Trout surveys conducted on four tributaries, Flint, Mammoth, North Boulder, and Meadow creeks. Due to time constraints in the 2019 season, two sites remaining on Jordan Creek were also completed in the 2020 sampling (D'Amico et al. 2020).

METHODS

Individual sample sites were determined following the systematic sampling design described in Peterson et al. (2016), which allocated approximately five percent of the total stream length to be sampled. Land ownership for each site was determined using Owyhee County's GIS layers and access was obtained for as many sites as possible. Seven sites were identified on Flint Creek with six completed. Six sites were identified on Mammoth Creek but due to access and landowner permission constraints, only one of these sites was completed. North Boulder Creek had 11 sites identified with only four sampled due to the remote nature of the remaining sites. All nine identified sites on Meadow Creek were accessed and sampled in 2020.

Using multiple-pass depletion electrofishing, Redband Trout abundance was estimated at the 22 sampled sites (Figure 51). Generally, fish were collected within a 100-m site with a Smith-Root LR-24 backpack electrofisher and a three person crew. In three instances, reaches were shortened due to large beaver dams within the site that were not able to be effectively sampled with a backpack electrofishing unit. At one location, the site had to be shortened as a result of dry streambed within the reach.

The number of electrofishing passes conducted was determined by the catch rates of Redband Trout. If more than five individuals were captured on the first pass, a second pass was completed. If the second pass capture was more than 25% of the first pass's capture, a third pass was also completed. In one instance, a forth pass was conducted to reach a suitable depletion. Redband Trout captured in each pass were held in separate buckets or live cars placed in the stream outside of the reach. Upon completion of the electrofishing, individual fish were measured for total length (mm) and weighed (g). Fin clips were collected to determine if genetic introgression had occurred with non-native strains of Rainbow Trout *Oncorhynchus mykiss*. Non-game fish captured were identified to species and the number observed for each species was categorized as few (1-10), many (10-50), numerous (50-100), or abundant (>100), these categories were based on those used for nongame fish on IDFG's Native Salmonid Assessment datasheets. All fish were returned to the site they originated from after processing.

Following fish surveys, the physical characteristics of the stream channel were also sampled within the surveyed reach. Habitat measurements of wetted width and water depth as well as a categorical visual estimate of substrate composition were collected every 10 meters. Wetted width in meters was measured from one water margin to the other perpendicular to the flow using a transect tape. Three water depth measurements in centimeters were taken with a stadia rod across the wetted width transect and averaged. The wetted width measurements were used to determine surface area sampled, this value was then used to determine Redband Trout densities at each site. Categorical descriptors were also used to describe large scale habitat features such as sinuosity, valley type, bank erosion, beaver activity, beaver suitability, and severity of riparian herbivory. Sinuosity was a categorical variable of low, medium or high. Valley type was based on the shape of the drainage at the site. Bank erosion was characterized by the percentage of the bank within the site that was exhibiting erosion. Beaver activity was a categorical variable based on the presence of dam structures and ponds in addition to whether the structures were actively being maintained. Beaver suitability was primarily based on the amount of willow present in the riparian area that would serve as both food source and building material. Severity of riparian herbivory was a categorical variable with values of low, medium or high based on the amount of this year's growth remaining on both riparian herbaceous grasses and forbs and woody shrubs. These habitat categories were based on the habitat assessments completed as part of the Native Salmonid Assessment.

Population estimates and 95% confidence intervals were calculated using the Carle-Strub method in the program R (version 3.6.1) for the total catch at each site (Ogle 2016). Due to the potential for size-related catchability differences, population estimates were also calculated for two size classes of Redband Trout, small (< 100 mm) and large (≥ 100 mm). If all sampled fish were collected in the first pass, maximum likelihood estimates could not be developed. Confidence intervals for population size (N) and mean density were calculated using $\alpha = 0.05$.

Temperature loggers were also deployed throughout the study area in October of 2020. Two were placed in Jordan Creek, one near Silver City and another off of the Duck Creek Road. Individual loggers were placed in Flint, North Boulder, and Meadow creeks (Table 18). All temperature loggers were placed on public land. These loggers will be retrieved in the fall of 2021 and the data will be incorporated into a summary of the Jordan Creek HUC4 sampling since 2016.

RESULTS

Six sites were sampled out of the seven identified on Flint Creek. Only one site was completed on Mammoth Creek due to access and landowner permission constraints. Four sites were sampled on North Boulder Creek due to the remote nature of the remaining sites. All nine identified sites on Meadow Creek were accessed and sampled in 2020. Redband Trout were found in 13 of the 22 sampled sites in 2020 (Table 19). Total catch of Redband Trout was 658 individuals with lengths ranging from 33-375 mm. This total catch was comprised of 264 (40.1%) large (≥ 100 mm total length) and 394 (59.9%) small (< 100 mm). Catch rates ranged from 0-159 trout per site. Density values were computed using the estimated population values divided by the surface area of sites where the depletion allowed for an estimated population to be calculated. Thus the mean density of Redband Trout across occupied sites with estimated population values was 22.5 trout/100 m^2 and ranged from a low of 1.4 trout/100 m^2 at Jordan Creek site 06 (JC_06) to a high of 180.1 trout/100 m^2 at Flint Creek site 05 (FC_05; Table 20).

Length-frequency histograms were generated for the total Redband Trout catch across all sampled sites of each stream sampled. Catch in the two Jordan Creek sites showed a distribution of mostly large individuals with no small or medium sized Redband Trout present (

Figure 52). This finding aligns with previous work completed in the watershed where Redband Trout were more numerous in higher elevations (Zoellick et al. 2005). Conversely, the size distribution of Redband Trout in Flint Creek was dominated by numerous small individuals with few large fish present, although most length bins were represented (

Figure 53). North Boulder Creek's catch exhibits at least two distinct cohorts of individuals but was dominated by small fish with nearly 30% of the total catch in the 70-79 mm length bin (Figure 54). Within the one site we were able to sample on Mammoth Creek, the majority of fish fall in the length bins from 120-170 mm, with few small or large fish in this sample (Figure 55). Only one fish was captured across Meadow Creek's nine sites at site 07 (ME_07) and it measured 313 mm.

Redband Trout genetic samples were collected from Jordan Creek, Flint Creek, North Boulder Creek, and Meadow Creek in 2020 but results were not available at the time of this report.

Nongame fish observed across the 22 sampled sites include Chiselmouth *Acrocheilus alutaceus*, Redside Shiner *Richardsonius balteatus*, Northern Pikeminnow *Ptychocheilus oregonensis*, Speckled Dace *Rhinichthys osculus*, Longnose Dace *R. cataractae*, Large Scale Sucker *Catostomus macrocheilus*, Bridgelip Sucker *C. columbianus,* and Sculpin Cottus spp.; likely Mottled or Shorthead Sculpin based on the species' ranges (Wallace and Zaroban 2013). Two nonnative game fish species were also observed, one Black Bullhead *Ameiurus melas* was found at Jordan Creek site 05 (JC_05) and one Largemouth Bass *Micropterus salmoides* was found in Meadow Creek site 02 (ME_02;

Table 21).

Habitat surveys were completed at all wetted sites sampled in 2020 and summarized (Table 22). The widest site on average was Jordan Creek site 05 at 8.9 m, this site is also the lowest in the basin sampled this year. The narrowest site was Flint Creek site 05 (FC_05) at 1.8 m, this site was also the shallowest at 6.6 cm on average. The deepest site was Meadow Creek site 02 (ME_02) at 66.2 cm, this site was heavily impounded by beavers, contributing to this large value. The majority of sites had moderate sinuosity within the reach. Higher bank erosion values tended to be correlated with severe levels of herbivory and lower levels of sinuosity.

DISCUSSION

Maintaining populations of Redband Trout throughout the Jordan Creek HUC4 remains important, as this watershed does not appear to have viable populations of nonnative fishes (i.e., Smallmouth Bass *Micropterus dolomieu;* Zoellick et al. 2005) and genetic integrity of the Redband Trout has been largely maintained (Meyer et al. 2014). The two sites sampled on the main-stem of Jordan Creek in 2020 both contained Redband Trout but are on the assumed thermal threshold of the stream where very few individuals have been found in previous sampling. In 2019, only one Redband Trout was found downstream of the two sites sampled in 2020 (D'Amico et al. 2020). Maintaining connectivity to cooler, high elevation habitats for these sparse low elevation individuals will be important for persistence (Zoellick et al. 2005).

Flint Creek has historically been sampled several times by IDFG at a site between FC_03 and FC_04. Two of these samplings utilized comparable three-pass depletion techniques. The first sampling in September 1993, estimated a site abundance of 17 Redband Trout, while the next depletion sampling was in 2008 when 36 Redband Trout were estimated. Based on the findings of the surrounding sites in our 2020 sampling, this population is likely increasing. This increase is also evident in the right-skewed length-frequency distribution of Flint Creek's histogram indicating a greater proportion of juvenile Redband Trout, and thus successful reproduction.

Mammoth Creek was sampled once before by IDFG in 1993. This site was upstream of our 2020 sampled site and did not contain Redband Trout. In 2020, the sampled site was near the terminus of the watershed and the stream bed went dry within 100 m of the top of our site. There was one relict beaver dam within the site that likely contributed to the persistence of Redband Trout in this location. The length frequency exhibited by this population indicated a majority of adult fish present at this site with minimal recruitment.

North Boulder Creek was sampled once before by IDFG in 1993. This site was sampled using a three-pass depletion and estimated that six fish were present in the reach. This historic site was nearly in the same location as the NB_03 site sampled in 2020, where a population of 66 fish was estimated. There were numerous new beaver dams within this site in 2020, contributing to scour pools, numerous side channels, and some braiding. This increase in habitat complexity has likely contributed to the increased Redband Trout population at this site.

The data collected from Meadow Creek is important baseline information since this is the first time that this stream has been sampled by IDFG. In obtaining access for these sites, landowners confirmed that Redband Trout used to be present in Meadow Creek but based on our surveys, this species has likely been functionally extirpated from this drainage. The most likely cause of extirpation is the lack of conductivity to downstream Redband Trout populations due to the Spencer Dam. Meadow Creek is also a drainage of interest to the IDFG habitat program that reintroduced several North American Beaver *Castor canadensis* to this drainage to create additional water storage and riparian habitat. Temperature loggers were also deployed in 2020 to determine if water temperatures may be conducive to Redband Trout survival. If temperatures and water availability are found to be favorable to Redband Trout, a reintroduction of this species to the Meadow Creek drainage may be worth exploring with landowners.

Habitat surveys will be a component of Redband Trout sampling moving forward as these data will be modeled alongside Redband Trout data when enough information is compiled. Documenting the changes in habitat that may be contributing to alterations in Redband Trout densities and distribution will be valuable information for future management.

Redband Trout genetic samples were collected from Jordan Creek, Flint Creek, North Boulder Creek, and Meadow Creek in 2020 but results were not available at the time of this report. Samples will be analyzed and results will be presented in future reports.

RECOMMENDATIONS

1. Continue to monitor Redband Trout distribution and abundance within the Jordan Creek HUC4 by selecting trend sites to be sampled at regular intervals. Particularly in response to recent beaver dam analog and juniper treatments within the watershed

2. Continue to document the distribution and densities of non-native species within the Jordan Creek HUC4 to determine if additional management is warranted

3. Identify a habitat improvement project that would benefit Redband Trout within the Jordan Creek basin

4. In response to temperature data, explore the possibility of working with landowners to reintroduce a viable Redband Trout population to Meadow Creek

5. Complete genetic analysis of fin clip samples to evaluate diversity and introgression within the Jordan Creek watershed

Table 18. Temperature logger deployment locations in the Jordan Creek HUC4 in October 2020.

Stream name	Date deployed	Latitude	Longitude
Jordan Creek	10/6/2020	43.03947	-116.75750
Jordan Creek	10/6/2020	42.95546	-116.90418
Flint Creek	10/7/2020	42.89349	-116.80637
N. Boulder Creek	10/7/2020	42.84043	-116.74099
Meadow Creek	10/7/2020	42.83034	-116.62382

Table 19. Summary of the sites sampled for Redband Trout within the Jordan Creek HUC4 in 2020.

Stream name	Sites selected	Sites sampled	Dry sites	Total sites completed	Sites with Redband Trout present
Jordan Creek	2	2	0	2	2
Flint Creek	7	5	1	6	5
Mammoth Creek	6	1	0	1	1
N. Boulder Creek	11	4	0	4	4
Meadow Creek	9	6	3	9	1

Table 20. Site specific catch, abundance and density estimates of Redband Trout for all captured fish, those less than 100 mm and those greater or equal to 100 mm in total length for each site sampled in 2020 (excluding dry sites). Lower confidence limits (LCL) and upper confidence limits (UCL) for population and density estimates were calculated with using α = 0.05.

Stream name	Site ID	Pass 1	Pass 2	Pass 3	Total	N	N LCL	N UCL	Density trout/100m^2	Density LCL	Density UCL
ALL REDBAND TROUT											
Jordan	JC_05	2	-	-	2	-	-	-	-	-	-
Jordan	JC_06	9	2	-	11	11	10	12	1.4	1.2	1.6
Flint	FC_01	34	8	-	42	43	39	47	18.7	17.0	20.3
Flint	FC_02	119	15	-	134	135	132	138	45.0	43.9	46.1
Flint	FC_03	96	48	15	159	171	159	183	58.2	54.2	62.1
Flint	FC_04	24	12	8	44	51	39	63	20.2	15.5	25.0
Flint	FC_05	101	21	-	122	127	120	134	180.1	170.4	189.9
Mammoth	MC_01	15	1	-	16	16	15	17	6.3	6.1	6.5
Meadow	ME_02	0	-	-	0	-	-	-	-	-	-
Meadow	ME_03	0	-	-	0	-	-	-	-	-	-
Meadow	ME_04	0	-	-	0	-	-	-	-	-	-
Meadow	ME_05	0	-	-	0	-	-	-	-	-	-
Meadow	ME_06	0	-	-	0	-	-	-	-	-	-
Meadow	ME_07	1	-	-	1	-	-	-	-	-	-
Meadow	ME_08	0	-	-	0	-	-	-	-	-	-
N. Boulder	NB_02	15	7	4	26	28	22	34	7.9	6.3	9.4
N. Boulder	NB_03	56	9	-	65	66	63	69	19.0	18.1	19.9
N. Boulder	NB_04	14	7	2	23	24	21	27	8.5	7.3	9.7
N. Boulder	NB_05	9	4	0	13	13	12	14	2.8	2.6	3.1
REDBAND TROUT ≥ 100 mm											
Jordan	JC_05	2	-	-	2	-	-	-	-	-	-
Jordan	JC_06	9	2	-	11	11	9.6	12.4	1.4	1.2	1.6
Flint	FC_01	11	3	-	14	14	12.1	15.9	6.1	5.3	6.9
Flint	FC_02	53	5	-	58	58	56.6	59.4	19.3	18.9	19.8
Flint	FC_03	36	21	6	63	68	60.0	76.0	23.1	20.4	25.9
Flint	FC_04	14	8	4	26	29	21.7	36.3	11.5	8.6	14.4
Flint	FC_05	17	3	-	20	20	18.5	21.5	28.4	26.2	30.5
Mammoth	MC_01	14	1	-	15	15	14.5	15.5	5.9	5.7	6.1
Meadow	ME_07	1	-	-	1	-	-	-	-	-	-
N. Boulder	NB_02	12	2	4	18	19	15.1	22.9	5.3	4.2	6.4
N. Boulder	NB_03	17	2	-	19	19	18.0	20.0	5.5	5.2	5.7
N. Boulder	NB_04	3	3	1	7	7	4.7	9.3	2.5	1.7	3.3
N. Boulder	NB_05	7	3	0	10	10	9.2	10.8	2.2	2.0	2.4
REDBAND TROUT < 100 mm											
Flint	FC_01	23	5	-	28	28	25.8	30.2	12.1	11.2	13.1
Flint	FC_02	66	10	-	76	77	73.9	80.1	25.7	24.6	26.7
Flint	FC_03	60	27	9	96	102	94.1	109.9	34.7	32.0	37.4
Flint	FC_04	10	4	4	18	20	13.6	26.4	7.9	5.4	10.5
Flint	FC_05	84	18	-	102	106	99.7	112.3	150.4	141.4	159.3
Mammoth	MC_01	1	0	-	1	-	-	-	-	-	-
N. Boulder	NB_02	3	5	0	8	8	5.9	10.1	0.02	0.02	0.03
N. Boulder	NB_03	39	7	-	46	47	43.9	50.1	13.5	12.6	14.4
N. Boulder	NB_04	11	4	1	16	16	14.6	17.4	5.7	5.2	6.2
N. Boulder	NB_05	2	1	0	3	3	2.5	3.5	0.7	0.5	.08

Table 21. Nongame fish catch described as categorical abundance across the Jordan Creek HUC4 sites sampled in 2020, dry sites and Flint Creek sites 04 and 05 were not included as these data were not collected at those sites. Species abbreviations include BBH: Black Bullhead, BLS: Bridgelip Sucker, CHM: Chiselmouth, LMB: Largemouth Bass, LND: Longnose Dace, LSS: Largescale Sucker, NPM: Northern Pikeminnow, RSS: Redside Shiner, SCL: Sculpin spp., and SPD: Speckled Dace.

Stream name	Site	BLS	CHM	LND	LSS	NPM	RSS	SCL	SPD
Jordan	JC_05	10-50	50-100	-	1-10	-	>100	-	>100
Jordan	JC_06	10-50	10-50	10-50	1-10	-	50-100	10-50	>100
Flint	FC_01	-	-	1-10	-	1-10	10-50	50-100	10-50
Flint	FC_02	10-50	-	-	-	-	10-50	50-100	10-50
Flint	FC-03	10-50	-	-	-	-	-	>100	-
Mammoth	MC_01	-	-	-	-	-	1-10	10-50	1-10
N. Boulder	NB_02	1-10	-	10-50	-	-	10-50	-	50-100
N. Boulder	NB_03	1-10	-	10-50	-	-	-	10-50	50-100
N. Boulder	NB_04	10-50	-	1-10	-	-	-	10-50	50-100
N. Boulder	NB_05	10-50	-	-	-	-	10-50	10-50	50-100
Meadow	ME_02	>100	1-10	-	-	>100	>100	-	-
Meadow	ME_03	-	-	-	-	-	-	-	10-50
Meadow	ME_05	--	-	-	-	-	-	-	-
Meadow	ME_06	50-100	-	-	-	-	>100	-	10-50
Meadow	ME_07	>100	-	-	-	-	10-50	-	10-50
Meadow	ME_08	10-50	-	-	-	-	-	-	>100

Table 22. Habitat variables summarized for each sampled site in the Jordan Creek HUC4 in 2020, excluding dry sites.

Stream name	Site	Average wetted width (m)	Average depth (cm)	Sinuosity	Valley type	Bank erosion (%)	Beaver activity	Herbivory-shrubs	Herbivory-grass and forbs
Jordan	JC_05	8.9	27.5	Moderate	Box Canyon	>75	None	Moderate	Moderate
Jordan	JC_06	7.7	28.5	Low	Box Canyon	<25	None	Moderate	Light
Flint	FC_01	2.3	16.8	Moderate	Flat Bottom	26-50	None	Moderate	Moderate
Flint	FC_02	3.0	17.4	Moderate	Flat Bottom	51-75	None	Moderate	Moderate
Flint	FC_03	2.9	12.6	Moderate	Flat Bottom	>75	None	Moderate	Severe
Flint	FC_04	4.2	41.9	Low	U Shape	26-50	Active Ponds	Light	Light
Flint	FC_05	1.8	6.6	Moderate	Flat Bottom	51-75	None	Severe	Severe
Mammoth	MC_01	2.5	14.2	Moderate	Trough	26-50	Relict	Light	Moderate
N. Boulder	NB_02	3.6	12.0	Moderate	V Shape	<25	None	Moderate	Moderate
N. Boulder	NB_03	3.5	9.8	Low	Flat Bottom	<25	None	Light	Light
N. Boulder	NB_04	5.6	15.4	Low	Flat Bottom	<25	Active Ponds	Moderate	Moderate
N. Boulder	NB_05	4.6	24.3	Low	Trough	51-75	Active Ponds	Severe	Severe
Meadow	ME_02	7.5	66.2	Moderate	Flat Bottom	<25	Active Ponds	Light	Light
Meadow	ME_03	6.1	58.5	Braided	Flat Bottom	<25	Active Ponds	Light	Moderate
Meadow	ME_05	2.5	8.7	Moderate	Trough	26-50	None	Moderate	Moderate
Meadow	ME_06	2.1	28.0	Moderate	Flat Bottom	>75	Relict	Moderate	Moderate
Meadow	ME_07	3.9	26.0	Low	Flat Bottom	51-75	Relict	Severe	Severe
Meadow	ME_08	2.3	10.9	Low	Flat Bottom	>75	None	Severe	Severe

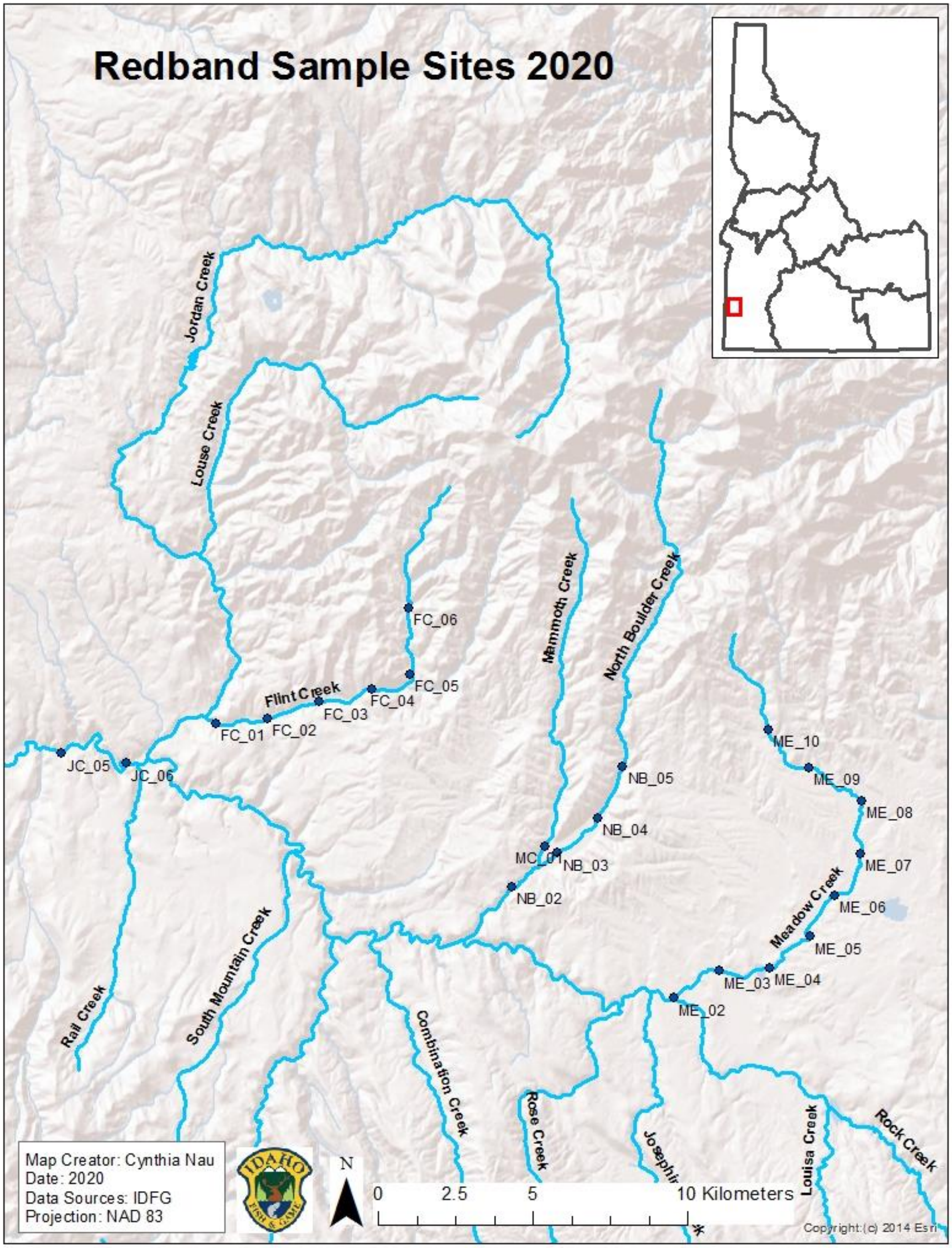

Figure 51. Locations of the 22 sites sampled for Redband Trout in the Jordan Creek HUC4 in 2020.

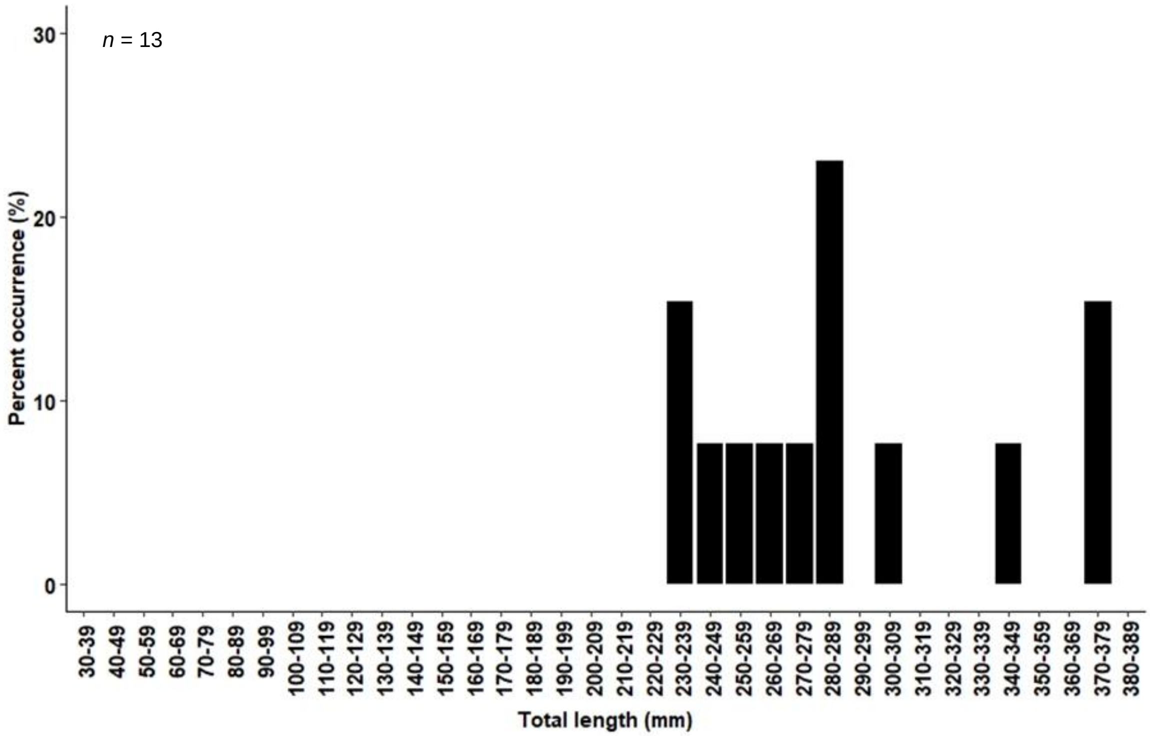

Figure 52. Relative length-frequency distribution of Redband Trout sampled at the two sampled sites on Jordan Creek in 2020.

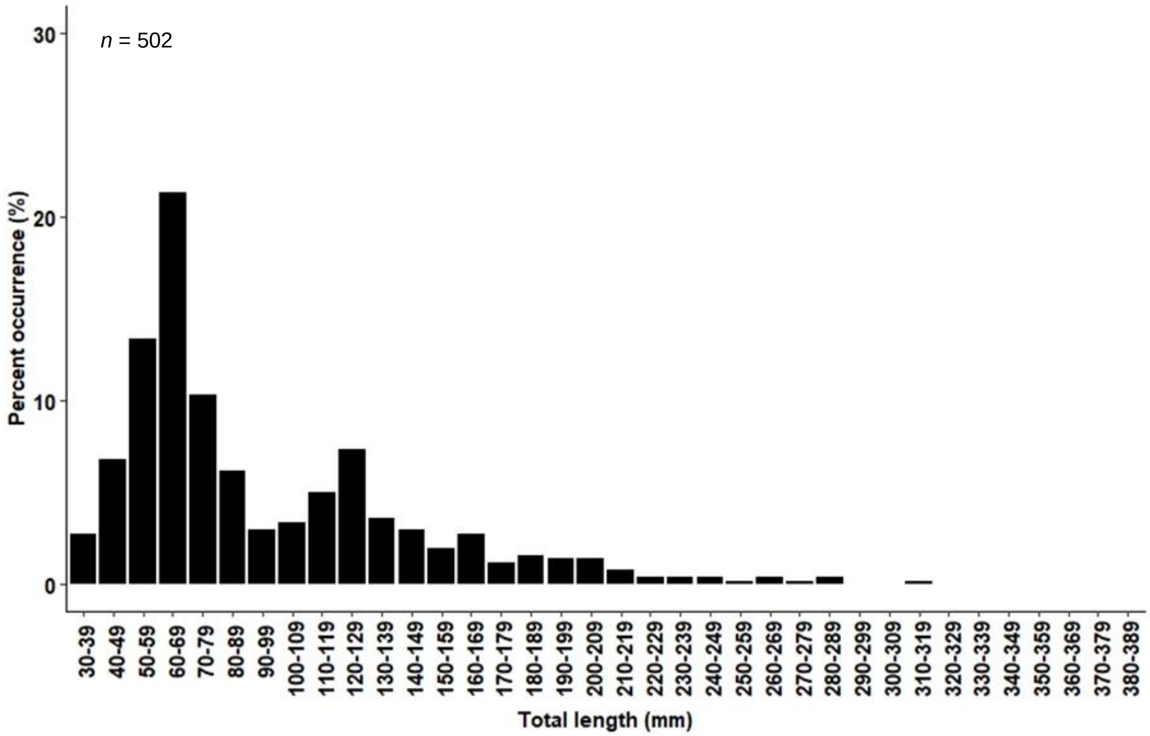

Figure 53. Relative length-frequency distribution of Redband Trout sampled across all six sampled sites on Flint Creek in 2020.

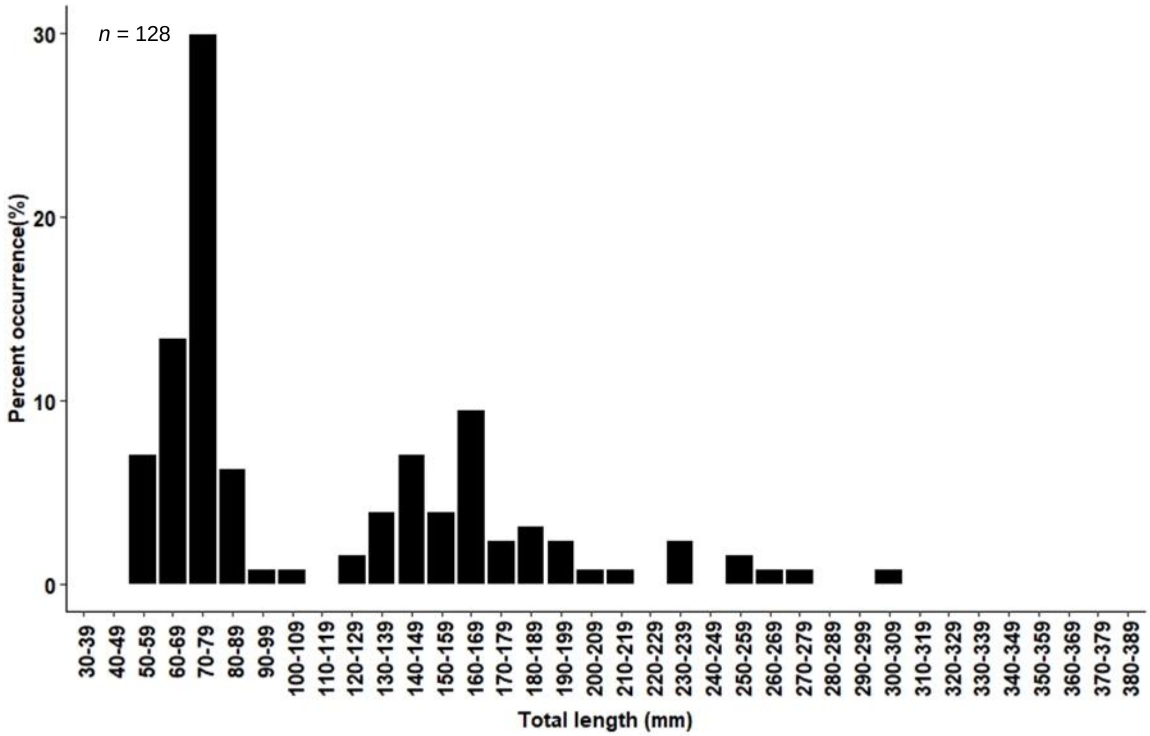

Figure 54. Relative length-frequency distribution of Redband Trout sampled across all four sampled sites on North Boulder Creek in 2020.

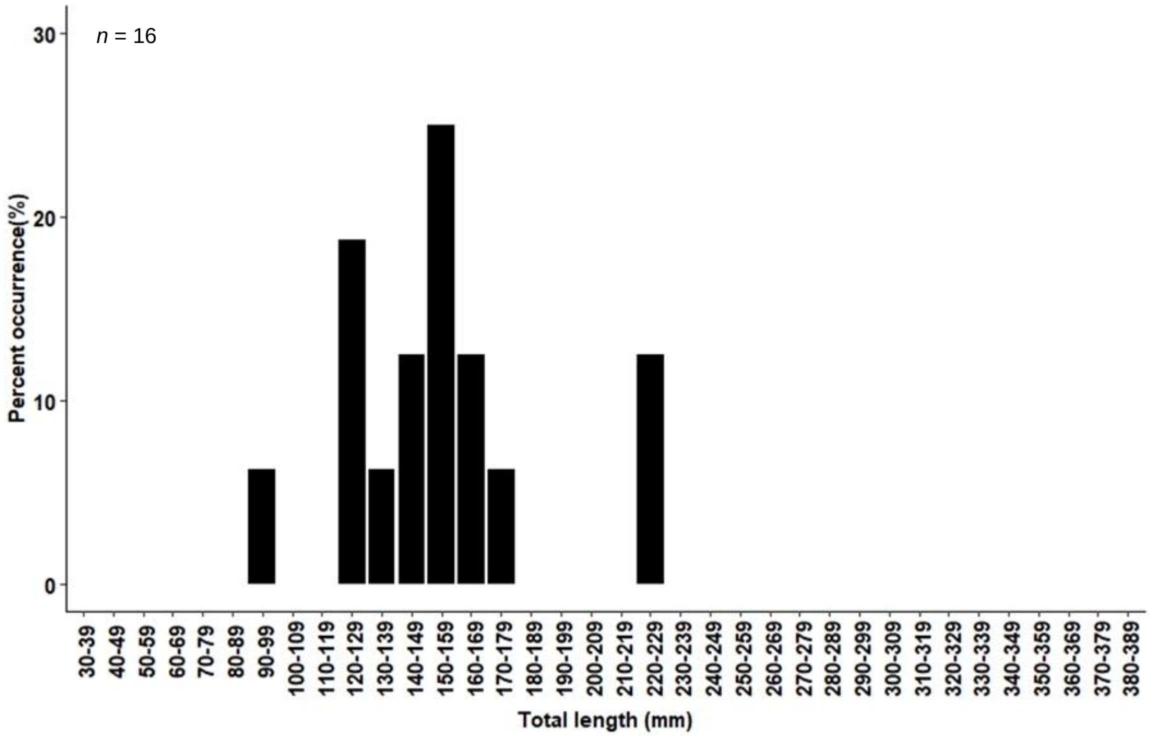

Figure 55. Relative length-frequency distribution of Redband Trout sampled at the one sampled site on Mammoth Creek in 2020.

REDBAND TROUT POPULATION TRENDS IN CANYON CREEK

ABSTRACT

In 2020, the Idaho Department of Fish and Game completed population trend monitoring for interior Redband Trout *Oncorhynchus mykiss gairdneri* in Canyon Creek, Elmore County, Idaho. Three trend sites were successfully sampled using three-pass depletion electrofishing protocols. No Redband Trout were found at the lowest site in the watershed, while 187 Redband Trout were found across the two upper sites. Density estimates for the three sites ranged from 0 to 41 trout/100 m^2. The data collected from Canyon Creek in 2020 was compared to sampling of the same three sites in 2002, population trends indicate an increasing population of Redband Trout in the uppermost site while the lower two sites have declined in abundance. Redband Trout were found at the lowermost trend site in 1995 and 2002. However, at the times of these historic sampling events, stream discharge was substantially higher than it was at the time of the 2020 sampling. Based on these results, Redband Trout may become displaced in the warm, lower reaches of Canyon Creek during periods of low flow and seek thermal refugia and more suitable habitat upstream.

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INTRODUCTION

Redband Trout *Oncorhynchus mykiss gairdneri* are native to all major river drainages in southwest Idaho, including the Boise, Bruneau, Owyhee, and Snake rivers (below Shoshone Falls). Within this diverse geographic area, Redband Trout have adapted to a variety of stream habitats from montane to desert conditions. This species, like many native salmonids in the region, has experienced range reduction and population declines due to numerous factors including hybridization with hatchery stocks and habitat degradation (Meyer et al. 2014).

Canyon Creek was sampled for the first time by the Idaho Department of Fish and Game (IDFG) in 1995 when one site was sampled. This survey yielded three Redband Trout as well as Bridgelip Sucker *Catostomus columbianus*, Redside Shiner *Richardsonius balteatus* and Speckled Dace *Rhinichthys osculus*. In 2002, the Native Salmonid Assessment project (completed by IDFG from 1999-2005) sampled three sites on Canyon Creek for fish and stream habitat (Meyer et al. 2008). Resampling of these same three sites was completed in 2020 in response to concern that populations of Redband Trout may be declining in Canyon Creek.

STUDY AREA

Canyon Creek in Elmore County, Idaho is formed by the confluence of Long Tom and Syrup creeks north of the city of Mountain Home (

Figure 56). For a portion of each year, water is diverted from Little Camas Reservoir through Long Tom Creek into Long Tom Reservoir to facilitate irrigation. Water is also diverted from Canyon Creek through the Feeder Canal both for irrigation and the filling of Mountain Home Reservoir when surplus water is available. The terminus of the Canyon Creek watershed is in the Snake River Arm of C.J. Strike Reservoir but surface water only reaches C.J. Strike during brief periods of high spring runoff.

METHODS

In 2020, the three Canyon Creek sites sampled in 2002 were resampled to explore potential changes in Redband Trout populations (

Figure 56). All of these sites are on public land while the watershed is a mix of public and private. The two uppermost sites were sampled on September 10, 2020 and the lowest site was sampled on September 11, 2020.

Redband Trout abundance was estimated using a multiple-pass depletion approach. Fish were collected over a 100 m reach of stream with a Smith-Root LR-24 backpack electrofisher and a three person crew. The number of electrofishing passes conducted was determined by the catch rates of Redband Trout. If more than five individuals were captured on the first pass, a second pass was completed. If the second pass capture was more than 25% of the first pass's capture, a third pass was also completed. In one instance, a forth pass was completed to reach a suitable depletion. Redband Trout captured in each pass were held in separate buckets. Upon completion of the electrofishing, individual fish were measured for total length (mm) and weighed (g). Non-game fish were identified to species and the number observed for each species was categorized as few (1-10), many (10-50), numerous (50-100), or abundant (>100). All fish were returned to the site they originated from after processing.

Following fish surveys, the physical characteristics of the stream channel were also sampled within the surveyed reach. Habitat measurements of wetted width and water depth as well as a categorical visual estimate of substrate composition were collected every 10 meters. Wetted width in meters was measured from one water margin to the other perpendicular to the flow using a transect tape. Three water depth measurements in centimeters were taken with a stadia rod across the wetted width transect and averaged. The wetted width measurements were used to determine surface area sampled. This value was then used to determine Redband Trout densities at each site. Categorical descriptors were also used to describe large scale habitat features such as sinuosity, valley type, bank erosion, beaver activity, beaver suitability, and severity of riparian herbivory. Sinuosity was a categorical variable of low, medium or high. Valley type was based on the shape of the drainage at the site. Bank erosion was characterized by the percentage of the bank within the site that was exhibiting erosion. Beaver activity was a categorical variable based on the presence of dam structures and ponds in addition to whether the structures were actively being maintained. Beaver suitability was primarily based on the amount of willow present in the riparian area that would serve as both food source and building material. Severity of riparian herbivory was a categorical variable with values of low, medium or high based on the amount of this year's growth remaining on both riparian herbaceous grasses and forbs and woody shrubs. These habitat categories were based on the habitat assessments completed as part of the Native Salmonid Assessment.

Population estimates and 95% confidence intervals were calculated using the Carle-Strub method in the program R (version 3.6.1) for the total catch at each site (Ogle 2016). Due to the potential for size-related catchability differences, population estimates were also calculated for two size classes of Redband Trout, small (< 100 mm) and large (≥ to 100 mm). Confidence intervals for population size (N) and mean density were calculated using $\alpha = 0.05$.

RESULTS

Redband Trout were found in two of the three sampled sites in 2020. Total catch of Redband Trout was 187 individuals with lengths ranging from 51 to 391 mm. This total catch was comprised of 151 (80.7%) large (≥ 100 mm total length) individuals and 35 (18.7%) small (< 100 mm). One individual captured on the first pass at site CC02 was not measured but was counted toward the total catch of that pass. Catch rates ranged from 0 to 158 trout per site. The mean density of Redband Trout across all occupied sites was 25.2 Redband Trout per 100 m^2 (Table 23).

A length-frequency histogram was generated for the total Redband Trout catch across the two occupied sites on Canyon Creek (

Figure 57). The majority of Redband Trout captured were adults in the 100-170 mm length bins. There were also some large individuals up to 391 mm and a small proportion of juveniles present, indicating that some level of reproduction is successfully occurring.

Non-game fish observed across the three sampled sites include Redside Shiner, Northern Pikeminnow *Ptychocheilus oregonensis*, Speckled Dace, and Bridgelip Sucker (

Table 24).

Habitat surveys were completed at sites sampled in 2020 (

Table 25). The widest site on average was CC03 at 4.0 m, this site was also the deepest on average at 18.3 cm, relict beaver activity likely contributed to these values. The narrowest site was CC02 at 3.2 m. All three sites were categorized as low sinuosity within the reach and had bank erosion values categorized at less than 25%.

Previous IDFG surveys on Canyon Creek include site CC01 sampled in 1995. This survey was not a depletion estimate and thus not directly comparable to our current results, but three Redband Trout were found in that single pass survey. Canyon Creek was sampled again in 2002 as part of the Native Salmonid Assessment. These depletion estimates yielded population estimates of 18 Redband Trout in site CC01, 39 in CC02 and 105 in CC03. These estimates plotted with the 2020 findings illustrates decreased abundance of Redband Trout in both sites CC01 and CC02 while site CC03 had increased Redband Trout abundance compared to 2002 (

Figure 58).

Redband Trout genetic samples were collected from Canyon Creek in 2020 but results were not available at the time of this report.

DISCUSSION

The isolated population of Redband Trout in Canyon Creek is important to maintain from both biodiversity and genetic standpoints. It appears that this population may be experiencing a reduction in longitudinal range within the Canyon Creek watershed. Timing of the sampling event, irrigation water diversion, and water year are likely contributing factors to observed Redband Trout distribution within Canyon Creek. The 1995 survey of site CC01 was on June 2 when the redistribution of irrigation water from Little Camas Reservoir was contributing to a monthly mean flow of 60.9 ft^3/s. This high discharge was likely keeping the water temperatures in Canyon Creek low enough to accommodate Redband Trout low in the watershed. The 2002 survey of the sites CC01 and CC02 were completed on October 23, while CC01 was sampled on November 20. Irrigation diversion of water ceased in September of that year and monthly mean discharge of 2.1 ft^3/s was recorded for both October and November. Cooler fall weather may have also been contributing to lower water temperatures in the stream this late in the season. In 2020, the diversion of irrigation water ceased in July with the monthly mean discharge for September recorded at 0.4 ft^3/s (US Geological Survey 2021). This extremely low discharge value coupled with warm August and September air temperatures was likely creating elevated water temperatures and contributing to the absence of Redband Trout in the CC01 site.

In addition to low flow, site CC01 has also experienced a reduction in over story riparian vegetation since the Native Salmonid Assessment sampling in 2002 based on photographs taken during sampling. This site also had some relict beaver structures that may have created thermal refugia in the past, but those dams have since been breached and the site currently has very little over-story shading, likely driving up temperatures, possibly to unsuitable levels for Redband Trout for at least a portion of years with low discharge values.

Habitat surveys will be a component of Redband Trout sampling moving forward. This data will be modeled against Redband Trout data when enough information is compiled from the Owyhee and Danskin mountains surveys. Documenting the changes in habitat that may be contributing to alterations in Redband Trout densities and distribution will be valuable information for future management.

RECOMMENDATIONS

1. Continue to monitor Redband Trout distribution and abundance in Canyon Creek by sampling the three established trend sites at regular intervals

2. Expand monitoring efforts to include tributaries Syrup and Long Tom creeks

3. Analyze genetic samples from Canyon Creek and collect additional samples from Syrup and Long Tom creeks

Table 23. Site specific catch, abundance and density estimates of Redband Trout for all captured individuals, those less than 100 mm and those greater or equal to 100 mm in total length for each site sampled in 2020. Lower confidence limits (LCL) and upper confidence limits (UCL) for population and density estimates were calculated with using α = 0.05.

Stream name	Site	Pass 1	Pass 2	Pass 3	Pass 4	Total	N	N LCL	N UCL	Density N/100m^2	Density LCL	Density UCL
ALL REDBAND TROUT												
Canyon	CC01	0	-	-	-	-	-	-	-	-	-	-
Canyon	CC02	18	5	4	2	29	29	27	31	9.2	8.5	9.9
Canyon	CC03	109	32	17	-	158	165	157	173	41.1	39.2	43.1
REDBAND TROUT ≥ 100mm												
Canyon	CC02	14	5	4	2	25	26	23	29	8.2	7.2	9.3
Canyon	CC03	93	23	10	-	126	129	124	134	32.2	31.0	33.3
REDBAND TROUT < 100mm												
Canyon	CC02	3	-	-	-	3	-	-	-	-	-	-
Canyon	CC03	16	9	7	-	32	39	25	53	9.7	6.2	13.3

Table 24. Nongame fish catch described as categorical abundance across the three Canyon Creek sites sampled in 2020. Species abbreviations include BLS: Bridgelip Sucker, NPM: Northern Pikeminnow, RSS: Redside Shiner and SPD: Speckled Dace. This data was not recorded for site CC02.

Stream name	Site	BLS	NPM	RSS	SPD
Canyon	CC01	-	-	10-50	50-100
Canyon	CC02	-	-	-	-
Canyon	CC03	10-50	1-10	10-50	50-100

Table 25. Summary of habitat variables collected at each Canyon Creek site in 2020.

Stream name	Site	Average wetted width (m)	Average water depth (cm)	Valley type	Beaver activity	Herbivory-shrubs	Herbivory-grass and forbs
Canyon	CC01	3.5	9.8	Box Canyon	Relict	Severe	Severe
Canyon	CC02	3.2	17.0	Box Canyon	None	Light	Moderate
Canyon	CC03	4.0	18.3	V-shape	None	Moderate	Moderate

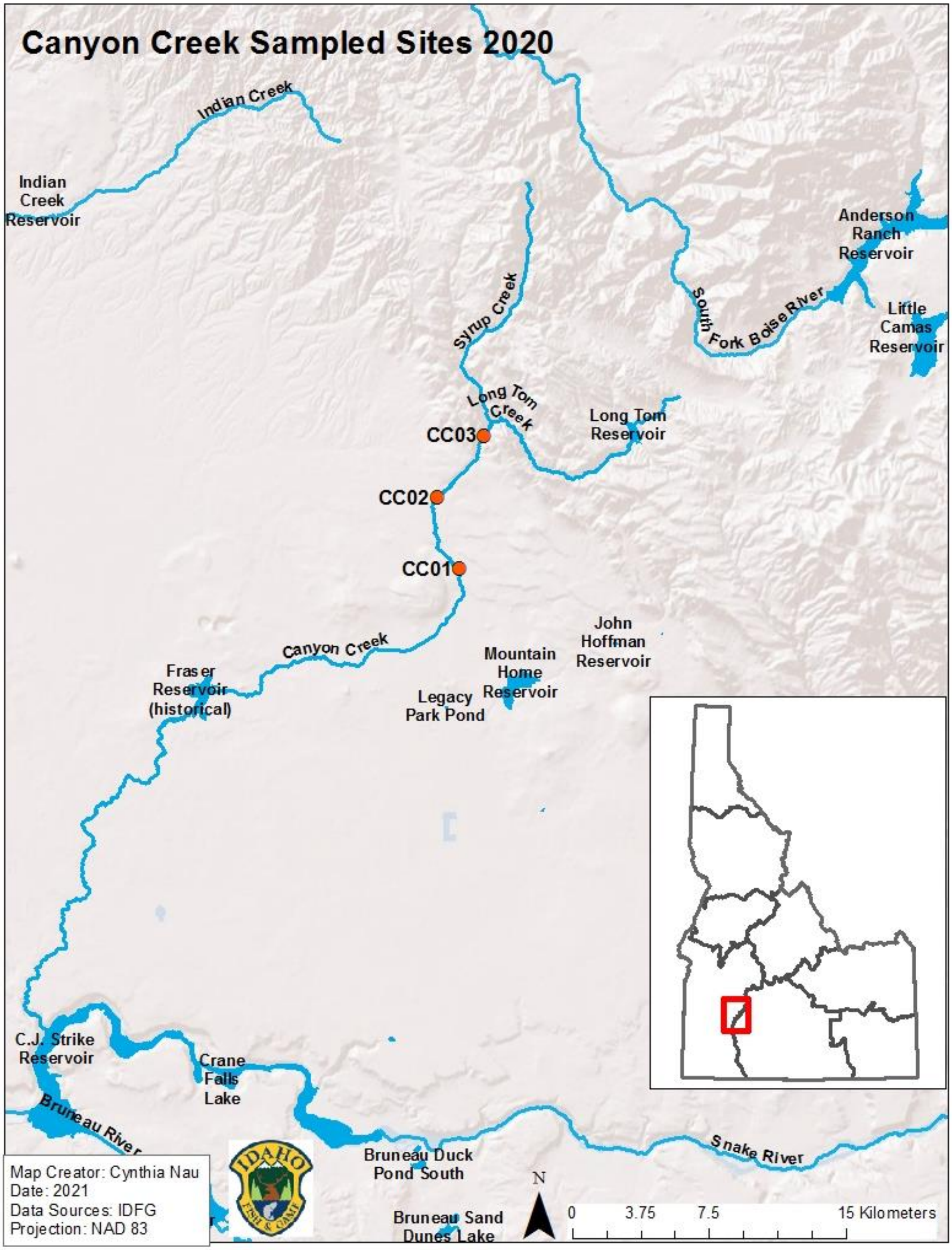

Figure 56. Locations of the three sites sampled for Redband Trout on Canyon Creek in 2002 and 2020.

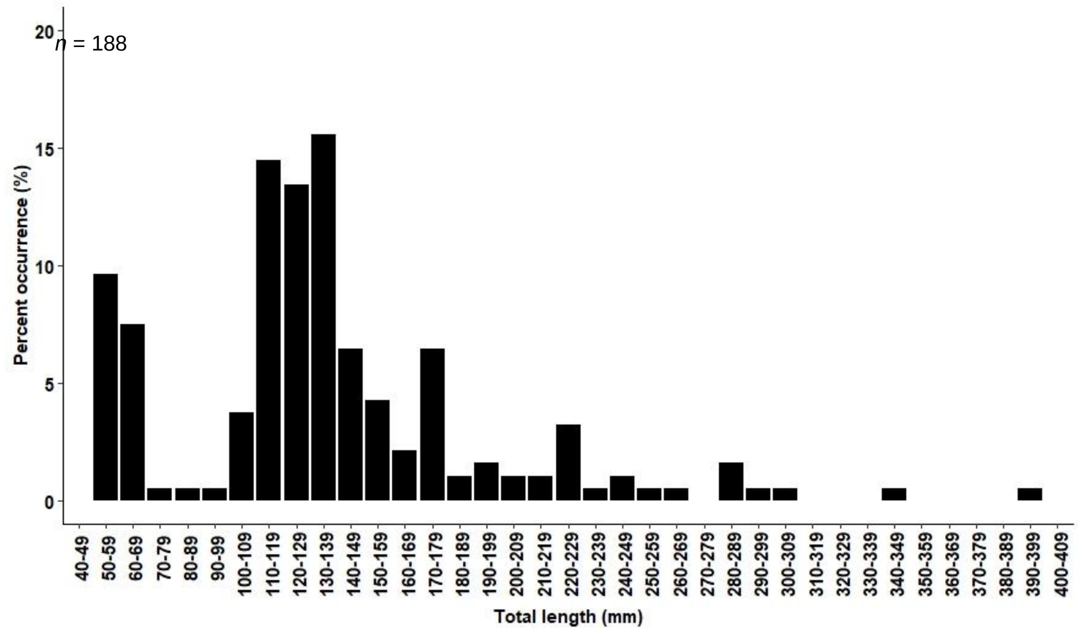

Figure 57. Relative length-frequency distribution of all Redband Trout sampled at the three Canyon Creek sites in 2020.

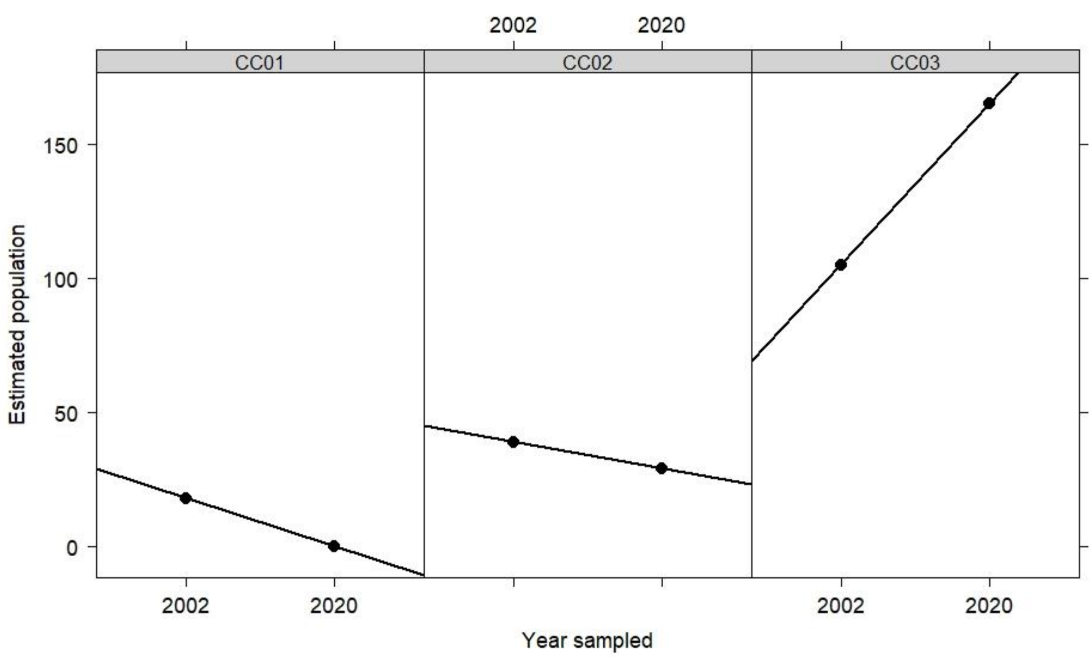

Figure 58. Population trends at the three Canyon Creek sites sampled in 2002 and 2020.

SOUTHWEST REGION FISHING & BOATING ACCESS PROGRAM

ABSTRACT

Staff maintains 67 fishing and boating access sites and campgrounds within IDFG's Southwest Region. Staff completed typical maintenance, repair, and cleaning in 2020. In addition, staff facilitated the initiation or completion of several improvement projects at IDFG-owned properties. Staff and volunteers also completed a variety of habitat plantings and seed collection at sites including planting 400 sagebrush seedlings, and spreading grass and pollinator mix seed. Staff also did numerous herbicide applications for both land and aquatics including two biological control releases agents to combat Purple Loostrife at Wilsons and Red Top ponds access sites. Furthermore, access staff initiated and met with landowners on the acquisition of two new access sites, one on the Weiser River and one off Boat Dock Road on the Snake River. In addition to the move and re-organization into the new facility, staff took on routine maintenance responsibilities for both the Powerline and North Gate offices. Staff made many improvements and addressed all facility inspection items. Staff also made numerous improvements to our access sites throughout the region including improvements to the Wilsons roller screens. Efforts were continued to increase and improve signage at regional sites. Staff spent considerable time developing or improving partnerships to cooperatively manage camping at Horsethief Reservoir with the YMCA and other partners at sites in the Nampa sub-region including Canyon and Gem County's collaborative help at access sites. Also staff continued to develop the volunteer program to include structural projects and habitat plantings in addition to the routine site monitoring and litter pickup of sites provided. This allows access staff to be able to focus on more pressing projects in the region and less on the smaller issues with sites.

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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 anglers, and in many instances, hunters and trappers, to safely utilize and enjoy a wide variety of water types throughout southwest Idaho. Staff maintains 67 fishing and boating access sites and campgrounds within IDFG's Southwest Region, including the McCall sub-region. Within this large geographical area, a total of 25 developed access sites are located on properties owned by IDFG, while the remaining 42 sites are located on 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 frequency are adjusted to account for use, weather, vandalism, and other factors. Typical maintenance activities include: campground maintenance, cleaning and pumping vault toilets, addressing vandalism and dumped garbage materials, maintaining and repairing pumps and other water control structures, inspecting and maintaining dams, repairing boat ramps, grading roads and parking areas, asphalt maintenance, managing cleaning contractors, installation and maintenance of docks, removing sediment from boat ramps and pond inlet and outlet structures, managing vegetation, maintaining border fences, hazard tree removal as well as installing and replacing worn or damaged signs.

In addition to access site work, access staff assists with maintenance of regional office facilities and takes on numerous other projects within the agency. With facilities maintenance, staff set up and oversee contracts and complete in-house repairs of buildings including plumbing, electrical, HVAC maintenance, monthly maintenance checks, irrigation repair and a variety of other building fixes. Staff also assist with facility inspections, address items of concern and develop new improvements at facilities. Also, maintenance staff are responsible for a variety of equipment and machinery repairs including preventative maintenance of buildings, structures and equipment.

The final component of the fishing and boating access program is participating in capital improvement projects. This often involves constructing amenities at new or existing sites and replacing worn infrastructure. 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 a variety of grant sources.

ACCOMPLISHMENTS

In 2020, staff completed typical operations and maintenance activities as expected. This large amount of work is comprehensively summarized in this section.

New Developments

Staff contributed directly to the completion of several larger-scale development projects including: the new Dick Knox Pond, Gem Island Boat Ramp as well as Osprey Bay and Easters Cove campground projects.

Near Emmett, a 26.3-ha (65 acres) fishing pond was opened to the public in November on 2020. The site (named Dick Knox Pond) includes a 16.4 x 3.7 m boat ramp, five docks, (four) two-sectional straight profile and one L-shaped three-sectional dock, two portable restroom shelters and two gates to prohibit vehicle us on portions of the site. All docks are attached to bulkheads with pilings for fluctuating water levels with gangways. The site also has sidewalks with a concrete stairway and handrails to the main dock. Access staff assisted with management and coordination of the development and took on projects like delivering materials, setting the kiosk/panel, and signage within the site. Access staff and volunteers later spent considerable time with habitat plantings and wrap up work prior to opening.

Gem Island is a cooperative project with Gem County Parks and Recreation and includes a new boat ramp site off the existing park near the town of Emmett. The site consist of a 27.4 x 6.1 m boat ramp to serves both fisherman and boaters on the Payette River. It also has a kiosk and steel pole/cable fence to prohibit parking and off-roading on non-designated areas. The access staff assisted with planning/coordination and aspects of the project including site design, and project wrap up including signage. Upon completion, a variety of habitat work was completed by the access staff and volunteers, including grass seeding the adjacent slopes and upper areas.

A large amount of work was completed in 2020 in further developing Horsethief Reservoir. A major undertaking was the development of the Osprey Bay and Easters Cove campgrounds. Osprey Bay has 25 paved RV sites with a paved loop road. All sites are equipment with a sand pad, BBQ, and picnic table. Drainage and culverts were added throughout the site in order to divert water in a desirable manner through or around the campground. There was some additional expansion to the lower day use area where an asphalt parking area was added adjacent to the lower restroom. Easter Cove was constructed with 13 primitive sites with gravel RV pads and loop road. All sites have a sand pad, BBQ, and picnic table. Both sites received native plantings of ponderosa pine going into the fall and winter seeding of Sage brush. Easters Cove has one ADA site. Additionally, a new well head with (two) camp host spigots were installed. For this application, the access staff was involved with the design and coordination of the in well system which excluded the need of housing a well system and requires less winterization. Managers were pleasantly surprised when the well was found to have in excess of 227 lpm (60 gpm) at a drilled depth of 27.4 m. This is enough to accommodate the future expansion of centralized spigots to the neighboring campgrounds as well as Kings Point. The access staff set up the well to be run off a generator until power is run to the well in 2021 for camp host use. Going into the fall of 2019 a large 15-cm crack was present through the width of the original Kings Point boat ramp. In spring of 2020, there were two large cracks 8 m apart in the ramp. After further inspection it was found that scouring and undercutting were occurring under the ramp and the original pour had no rebar or mesh. Through coordination, the access staff drew down the reservoir to a low enough level which allowed for the old ramp to be removed and a new ramp poured in place. The result was Kings Point having a new 15.8 x 4.6 m ramp with reinforced side walls.

Access Site Maintenance and Improvement

Staff completed renovation and/or repair projects on numerous department-managed properties during 2020. One project was the Seven Mile Slough road renovation. Prior to the work, the site had issues with potholes and ruts stemming from poor drainage of the roadway. The road was reconstructed, a culvert was added, and the slope was rebuilt before building up the roadway with 344 m^3 of pit run and 305 m^3 of 2 cm road mix that was water compacted.

The access staff also maintain asphalt parking lots at sites in the region. One that came due this year was at Walters Ferry that needed a seal coat/restripe. Access staff coordinated the closure and did most of the prep work prior to the work. This was a great improvement to the site and should extend the life of the parking area. We also coordinated and facilitated the chip seal restripe at the Power line facility this spring done by the same contractor.

Another project the access staff completed was the installation of a pre-fabricated engineered outhouse at Star Lane Ponds access site. With this project, we worked with a contractor to remove the old building, cast over the existing slab to thicken it, and cut out a new hole for the pump out access. The engineered building was set and a new 20-cm steel vent pipe was installed. Access staff did the final staining and painting of the interior and exterior of the structure.

Numerous repair projects were made at access sites including boat ramp repair at Map Rock, Sheep Camp and Bernard Landing. Also, the access staff and volunteers took on painting 6 outhouse structures in the region (one at Indian Creek, two at Paddock Reservoir, two at Horsethief Reservoir, and one at Tripod Reservoir). The access staff also did numerous repairs and fixes to our roller screens at Wilson Ponds, including adding automatic greasers to the screens to require less maintenance, building a new cobble landing for a turn around and parking area near the screens, and creating a gravel yard within the roller screen enclosure which should decrease future maintenance. We were also given a storage shed from fisheries that we moved to the site for future use. Additional fixes at the Wilsons Pond site included augmentation to the circuitry controls of the pump and conduit replacement and upgrades to the roller screen maintenance area including a new parking lot landing to park repair equipment.

In the McCall portion of the region, the access staff did numerous repair projects. These included replacing dock floats on the Little Payette Lake dock and made numerous improvements to the Tripod site including adding better drainage and expanding the restroom landing. Also the interior and exterior of the restroom were painted. Following the Kings Point development at Horsethief Reservoir in 2019, the access staff had some projects to follow up in the campgrounds. Two of our concrete outhouses (one at Osprey Bay and another At Kings Point) had badly deteriorated roofs. The one at Osprey Bay required hiring a contractor to remove the existing roof and build a new wooden roof on top of the walls. At Kings Point, the access staff fabricated a wooden roof shell and put tin metal over the existing roof. This should extent the useful life of the structure and prevent the roof from continuing to erode. Our northern staff member painted the exteriors and roof units of both structures. We also completed the installation of new stairs in some campsite and trail areas. This work was completed by mid-summer.

Another important 2020 accomplishment was routine maintenance of department-owned dams in the region. The access staff continually maintain all dams each season, including exercising water control structures, filling in holes on the face of dam structures, removal of vegetation at inlets and outlets and inspecting/monitoring structures. In early fall of 2020, we had difficulty getting our Horseshoe Bend Mill Pond outlet to close and hold our pond level through the winter. Access staff diagnosed a protruding sleeve issue in the outlet pipe. The staff was able to trim the lining and fix the issue.

Habitat Work

Various habitat projects were completed throughout the region by the access staff and volunteers. In 2019, major invasive weed removals were done at sites and chemicals were applied to control weed regrowth. In 2020, sites like Sheep Camp, Seven Mile Slough, and Walters Ferry were reseeded with a native grass blend and sagebrush seedlings. Rabbit brush, bitterbrush and sagebrush seed were collected and distributed at sites. Additionally, willows were planted on stream banks at Sheep Camp and Seven Mile Slough. Access staff also did a variety of aquatic and terrestrial herbicide applications at access sites. Staff did aquatic treatments for Eurasian milfoil at Wilsons and Lowman ponds and spent considerable amounts of time spaying weeds at sites. Our northern staff member worked with Valley County and applied herbicide to weeds at Horsethief Reservoir. The access staff also worked with the Nez Perce Tribe to apply two different biocontrol agents at Wilsons and Red Top pond access sites. The two agents were the Gallerucella and Hylobius insects used to control Purple Loostrife. Access staff members completed trainings for the two-year herbicide applicator maintenance credits through the ISDA.

Facilities Maintenance

In 2020, access and facility staff coordinated contract work and did a variety of in-house fixes from addressing facility inspection items to fixing maintenance items and facilitating improvements. Some notable fixes were installing a hand rail in the N. Gate building attic area, working through the warranty to replace the back-up generator computer board, numerous irrigation and plumbing fixes with the building, coordinating and working through warranty shop building issues including the CO2 alarm, adding in a window in the Hunter Education distribution area and adding in electrical outlets as needed. Also, access staff installed a spark proof surround to the welding area in the shop. Currently, facilities staff are working with a contractor to have the parking lot sealed where needed and restriped to create more functional use of the area. Our facility staffer has also been absorbed into access duties from project help to weekly checks and maintenance needed with sites.

Wildlife Management Area (WMA) Work

The access staff completed and enhanced sites in cooperative projects with WMA's. Staff organized, sought collaborative funding, and put in place a contractor to bale and remove tumbleweeds from the Crane Falls/ Cove Arm Access road. In some years, this road gets choked out by tumbleweeds. This is also a cooperative project with Idaho Power and the Bureau of Land Management which also utilize the same road. In the spring of 2020, the site was closed until the access staff was able to clear the road.

Additionally, access staff provided a variety of coordination and project input with the future Birding Island North development and dug test holes for the Payette River WMA shop septic system for inspection and backfill.

Partnerships

Staff has sought partnerships to increase efficiency, provide better service, and improve management of several access sites. In the Nampa sub-region our most active partnership is with Canyon County Parks and Recreation where we co-manage our Wilson's Ponds and Martins Landing sites. In 2020 numerous improvements were made to both sites including new park benches and dock railings were installed. New dock railings were fit with fishing rod holders. Both projects were funded by a donation from the Gem State Fly Fisherman group. Also at Martins Landing hazardous tree and branch removal was completed around the site and rodent control was completed. Currently access staff are seeking funding and working closely with Canyon County on a variety of other improvements for the site including adding BBQs, installing new kiosk panels, and purchasing batteries for the solar lights.

Two other strong partnerships are with Gem County and Idaho Power Company. Gem County provides restroom service for a bulk of our sites in that county. Often we provide a concrete pad and building and the county provides an indefinite service through a local contractor. With Idaho Power, we have numerous boat ramps we have installed and either co-manage and/or maintain. We also have this arrangement with some city entities. Our biggest partner for our northern sites is the Treasure Valley YMCA who manages most of the campground functions at Horsethief Reservoir. They have also been instrumental with input on the development of those campgrounds.

Staff also worked toward new partnership with existing sites. At Duff Lane Pond, we were able to provide trash service at the site through an MOU with one of the neighboring landowner/site caretakers. Staff is currently working on additional cooperative agreements with the Nampa Association of Realtors to seek funding through grants for improvement projects at Wilsons Ponds, and with Payette County to maintain new restrooms at Falk and Blacks bridge access sites.

Miscellaneous Access Site Work

Vandalism and illegal dumpings are still an issue at sites and access staff worked with volunteers to continually monitor and address issues. Site dumpings were down from 2019, but vandalism issues remained similar or slightly increased. Paddock Reservoir remains one of the program's most demanding sites, with trash and shooting of structures continuing to demand a great deal of attention. All three restrooms and all site kiosks get regularly shot up at this site. There has been discussion of installing a gate and doing a winter seasonal closure at this site. In the late fall the reservoir level drops and the site gets very little use. There has also been discussion of signage to raise awareness of issues. Access staff continue to do site improvements but have held off on replacing kiosk and doors on the CXT's that will likely get shot again unless some level of control can be achieved.

At the Boise River Midland access, we had an issue with off-roading and people driving through the river bed at the site. After a few attempts, access staff were able to install 1800 kg eco-blocks to prohibit off-roading into the river. One continued issue at the site is a local group likes to use the area for paintballing and air soft competitions. The paintballing seems to continue off site. However, plastic air soft pellets continue to litter the site. Future monitoring and enforcement are needed to address the issue.

Another considerable area of improvement was with signage at sites across the region. In 2020, Horsethief Reservoir signage was expanded and a removable sign installed off of Warm Lake Road. Signage was also added at Little Payette Lake, and we added a new kiosk and access sign at Rowlands Pond. In the Nampa Sub-region, we added and replaced worn out signage at Seven Mile Slough, Takatori, Midland, Indian Creek, Crane Falls/Cove Arm and Noble Island.

Lastly, staff continue to develop the access volunteer program where we elicit volunteer help with general site maintenance and monitoring activities, habitat improvement projects, and special projects like building and maintenance of structures. In 2020, despite the COVID Pandemic, we were still able to document 426 volunteer hours used in the program. Without these volunteers, the fishing and boating access needs would be unattainable by just access staff, making volunteers essential to the program. Access staff continue to work with volunteers and foster relationships.

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We have been fortunate to work with several loyal employees that return year after year including Tyler Kershner, Nate Campbell, Michael Murach, and Tim Spencer. In 2020, we were fortunate to employ Dennis Hardy and Caitlyn Ulhlenbrauck to help with northern projects and oversee development of Osprey Bay and Easters Cove. This has been a great help to access staff. We would also like to thank our partners, volunteers and the employees and volunteers of the TVYMCA and SWIDRCD, as well as staff from Canyon and Gem counties, as well as staff from Idaho Power Company.

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